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David Goshorn, Deputy Secretary

Maryland Department of Natural Resources Quality Assurance Project Plan for the Chesapeake Bay Tidal and Non-tidal Monitoring Programs Long-term Trends Analysis Methods Version 1

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Quality Assurance Project Plan for the Chesapeake Bay Tidal and Non-tidal Monitoring Programs Long-term Trends Analysis Methods

Maryland Department of Natural Resources
Version 1

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A. *Program Management*

A1. Approval Sheet

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Approval

EPA Region 3

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Note: This approval action represents EPA's determination that the document(s) under review comply with applicable requirements of the EPA Region 3 Quality Management Plan [https://www.epa.gov/sites/production/files/2020-06/documents/r3qmp-final-r3-signatures-2020.pdf] and other applicable requirements in EPA quality regulations and policies [https://www.epa.gov/quality]. This approval action does **not** represent EPA's verification of the accuracy or completeness of document(s) under review, and is **not** intended to constitute EPA direction of work by contractors, grantees or subgrantees, or other non-EPA parties.

Preface

This document describes and references other documents describing data analysis for the Maryland Department of Natural Resources ('the department') Chesapeake Bay Longterm Tidal and Nontidal Monitoring Program. Included are data analysis methods for long-term tidal and non-tidal water quality data. This program is funded through the department and the U.S. Environmental Protection Agency.

This Quality Assurance Project Plan is available on-line on the department's *Eyes on the Bay* website section Monitoring News and Reports (https://eyesonthebay.dnr.maryland.gov/eyesonthebay/stories.cfm). This section includes a searchable database (search term under 'Publication Type' is 'Quality Assurance Project Plans').

A2. Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the Quality Manager.

Document Control Number	**History/ Changes**	**Effective Date**
230226	First submitted Version 1	July 2023

A3. Table of Contents

A4. Abbreviations and Acronyms

AP	above pycnocline
APC	Analytical Problem Codes
BBP	bottom mixed layer (bottom and below pycnocline)
BDL	below detection limit
BP	below pycnocline
CBL	University of Maryland's Chesapeake Biological Laboratory
CBP	EPA's Chesapeake Bay Program
CHLA	active chlorophyll *a*
COND	conductivity
CRAN	Comprehensive R Archive Network
DIN	dissolved inorganic nitrogen
DL	detection limit
DNR	Maryland Department of Natural Resources
DO	dissolved oxygen
EPA	U.S. Environmental Protection Agency
GAM	General Additive Model
ITAT	Integrated Trends Analysis Team
MDH	Maryland Department of Health
MDLs	method detection limits
MSA	Maryland State Archives
NH4	ammonium
NO23	nitrate + nitrite
PN	particulate nitrogen
PO4	phosphate
PP	particulate phosphorus
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
R	R analysis platform
S	surface
SALINITY	salinity
SAP	surface mixed layer (surface and above pycnocline)
SAS	SAS® software
SAV	submerged aquatic vegetation
SECCHI	Secchi depth
TDN	total dissolved nitrogen
TDP	total dissolved phosphorus
TKNW	total keldjahl nitrogen (whole)
TN	total nitrogen
TP	total phosphorus
TSS	total suspended solids
USGS	U.S. Geological Survey
WTEMP	water temperature

Abbreviations used for filenames

BA	Mainstem
BDL	below detection limit data
chng	**baytrends** output file for trends analysis and seasonal changes
csv	comma seperated text file extension
CY	calendar year (4-digit)
docx	Microsoft Word document file extension
GAM	GAM model(s)
LE	LE2.3 (Potomac station with different historical sampling from other Potomac stations)
MAIN	Mainstem dataset
NT	non-tidal tributary
PV	previous years (4-digit)
PX	Patuxent stations
QA	quality assurance checked dataset
stat	**baytrends** output file for trends analysis
TB	tidal tributary and Potomac stations
TRIB	Tributary dataset (tidal tributaries, Potomac and Patuxent)
Year	Year for the analysis (4-digit)
yr	year (2-digit) for the end of the analysis period

Abbreviations specific to GAM equations (Table 3)

c()	list of parameters in R code
cyear	centered decimal date
doy	day of year
flw_sal	indicates either a pre-processed average river flow, or salinity measured at the same place and time
k	knots in the GAM equation
mgcv	Mixed GAM Computation Vehicle
num_years	number of years
s()	a spline function with the smooth class defined by bs='cc' or 'tp'
ti()	tensor product interaction between two variables

A5. Distribution List

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A6. Project Organization

The following individuals are responsible for the major aspects of the department's long-term trends analysis program. Figure 1 shows the organizational relationships and lines of communication.

Principal Investigator: Thomas Parham, Director and Principal Investigator, Tidewater Ecosystem Assessment Division, DNR. Responsibilities: The director and principal investigator oversees the administrative aspects of the program including fiscal management, coordination among other department managers and coordination with cooperating agencies and institutions.

Quality Assurance Officer: David Goshorn, Deputy Secretary/Quality Assurance Officer, DNR. Responsibilities: The quality assurance officer is responsible for documenting and assuring the implementation of field, laboratory and data management procedures that comprise this study.

Data Management: Mark Trice, Tidewater Ecosystem Assessment Division, DNR. Responsibilities: This individual oversees the management of data collected under the monitoring program, maintaining existing data management software, and oversees the data processing technician and data management staff.

Statistical Analysis: Renee Karrh, Tidewater Ecosystem Assessment Division, DNR. Responsibilities: This individual prepares the analysis datasets, performs statistical analysis, oversees subordinate statisticians, and maintains the Quality Assurance Project Plan (QAPP).

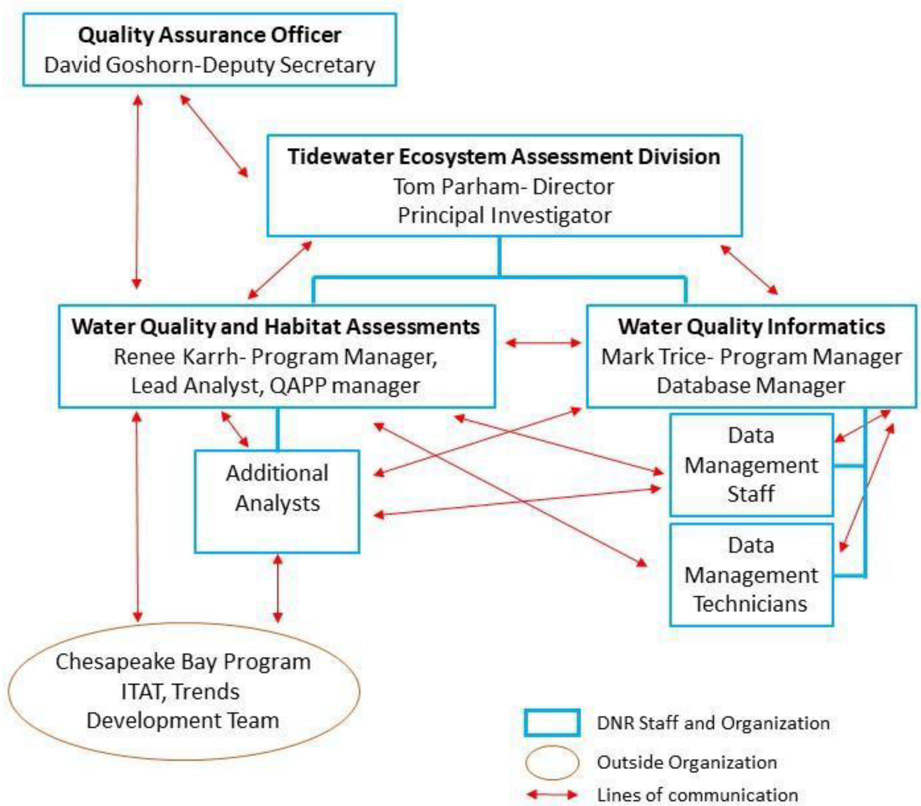

Figure 1. Project organization, key staff and lines of communication.

A7. Problem Definition/Background

At the completion of the U. S. Environmental Protection Agency's (EPAs) $27 million study of Chesapeake Bay, the Agency published a document entitled *Chesapeake Bay: A Framework for Action* (EPA 1983). This report strongly recommended a long-term monitoring program to serve the Bay's management community by accurately describing the current state of the Bay mainstem and tidal tributaries (baseline or 'status', now referred to as 'current condition') and detecting long-term changes (trends) resulting from human activities. Management strategies at that time were hindered by the lack of precise information about the Bay and its response to increasing or decreasing pollution.

Managers, scientists, and statisticians recognized that to establish baseline conditions and then begin to identify trends would require a multi-year effort on the order of a decade or more. Long-term data was needed to overcome the natural year-to-year variability that can obscure changes due to human activities. As the EPA study drew to a close, scientists and managers convened in workshops to formulate plans on several topics, including water quality monitoring. The monitoring workshop recommendations for chemical and physical measurements were published in the appendices of *Chesapeake Bay: A Framework for Action* (EPA 1983).

Maryland's tidal monitoring programs, supported by both EPA 117e grant funding and State funding, were initiated in May 1984, building on existing monitoring programs that began in the 1970s. The monitoring programs have developed over a number of years, and as of 2022 there are 38 years of monitoring data that can be used in the annual trends analysis. Sampling is completed year round at 22 Mainstem stations and an additional five stations are assessed in the months March-October; Mainstem sampling is completed in five Chesapeake Bay Program (CBP) segments. Sampling is also completed year round at 69 stations in 42 CBP segments. Details of the sample programs are found in the project QAPPs noted in Section B.

Maryland has also had a long-term non-tidal monitoring program (the department's Ambient Water Quality Monitoring Program Core/Trend Monitoring). This program is part of a nationwide ambient monitoring effort designed to measure progress towards achieving EPA's national water quality goals. This program was initiated in 1974 to meet an EPA-mandated monitoring requirement for the State of Maryland to collect data that can be used to detect status and trends in the quality of the State's waters. This program is supported by both EPA 106 grant funding and State funding. Sampling is completed year round at 46 stations in seven CBP segments. Details of the sample programs are found in the project QAPP noted in Section B.

The key objectives of both the tidal and non-tidal water quality monitoring programs are to accurately describe the current water and habitat conditions in Maryland Mainstem, tidal and non-tidal tributaries and to detect long-term trends. Trends are analyzed using techniques recommended by the CBP's Integrated Trends Analysis Team (ITAT) and are described in this document in Section B2.

Water quality current conditions and trends analytical results are available on the department's Eyes on the Bay website (https://eyesonthebay.dnr.maryland.gov/eyesonthebay/statustrends.cfm). Methods documentation is also available on the Eyes on the Bay website (https://eyesonthebay.dnr.maryland.gov/eyesonthebay/status_trends_methods.cfm).

A8. Project description and rationale

The department analyzes long-term monitoring program data to address water quality monitoring objectives of the Chesapeake Bay Water Quality Monitoring Program. Long-term water quality datasets are analyzed to determine if trends are present; trends, either increasing or decreasing, are used to evaluate effectiveness and track progress of management actions to reduce nutrient and sediment pollution.

Tidal and non-tidal water quality trends are calculated for the field and laboratory parameters listed in Section B1.1.1. Additional analyses may be completed as per the needs of the CBP and/or the department. This QAPP describes the department's data analysis and quality assurance/ quality control methods used when determining long-term trends in water quality parameters. Datasets used in these analyses are from the Maryland Long-term Water Quality Monitoring Program databases, 1985 to present (the department databases).

A9. Data analysis objectives and acceptance criteria objectives

The quality assurance objective for data analysis is to estimate the trends of tidal and non-tidal water quality parameters at individual stations, with a minimum 95% confidence as per the CBP guidelines.

Acceptance Criteria for data usability are:

1. Annual (calendar year) and seasonal water quality trends will be determined for stations with continuous sampling throughout the time period. Using the recommendations from Helsel and Hirsch (2002, pg. 351) with regard to trend analysis, data completeness is evaluated by:
    a. dividing the study period into thirds (three periods of equal length);
    b. determining the coverage in each period (e.g. if the record is generally monthly, count the months for which there are data); and
    c. if any of the thirds has less than 20 percent of the total coverage then the trend will not be reported.

2. Due to sampling protocols, Eastern and Western Mainstem stations are not sampled in January, February, November or December. Annual trends will not be calculated for these stations.

3. Water quality data used in this project must meet the specifications described in the project specific approved EPA-approved Quality Assurance Project Plan (QAPP). Data that fail to meet quality assurance/quality control criteria for sampling and laboratory analysis are excluded from databases and not available to data analysts.

4. “Preliminary” data may not be used for preparing final data analysis products and interpretations.

A10. Special Training and Certification

Data analysts are in classified State positions that require a Master’s Degree in a relevant scientific field or professional experience comparable to a Master’s Degree. No specialized certifications are required to successfully complete the analysis tasks needed for this project; however, all staff have extensive statistical analysis experience and proficiency with the statistical software used. All analysts actively participate with the CBP Integrated Trends Assessment Team (ITAT) and trends development team working groups.

A11. Documents and Records

All QAPPs fall under the umbrella of Maryland Department of Natural Resources Quality Management Plan (QMP), approved by the EPA Region III Quality Assurance Manager on March 2, 2022 and effective through March 2, 2027 (DNR 2022).

EPA approved QAPPs are valid for up to five (5) years. The QAPP is reviewed at least annually by the lead analyst/Program Chief to ensure that methodologies are accurately described and that the documents reflect the project activities. Material changes to the QAPP will be resubmitted to EPA for approval. The synopsis of change and versioning history is documented in a table in Section A1.1 of the QAPP. Each version is numbered consecutively with the date of approval and a summation of changes made.

Records retention for this project follows the department's procedures described in the QMP. The department is required to manage its records, including the establishment or revision of records retention schedules to ensure effective and efficient disposal of records not required by the department. The Maryland Department of General Services oversees the State Records Management Program. This project is part of the Resource Assessment Service Unit of the department, and follows:

Maryland State Archives -- Agency Retention Schedules -- Series 1468
Schedule 2813 - Resource Assessment Service (MSA Citation pending final review)

Current and many historic QAPPs are available through the department's *Eyes on the Bay* website section Monitoring News and Reports. This section includes a searchable database (search term under 'Publication Type' is 'Quality Assurance Project Plans'). Both department staff and outside users have access to the quality assurance plans through this website.

Information and records for field monitoring, cruise reports, field sheets, instrument maintenance and performance, split sample program, laboratory methods and results, data management, etc. are described in the monitoring programs project specific QAPPs noted in Section B.

Electronic datasets are maintained on the analyst's hard drive and periodically backed up (Section B1.1). Project statistical programs maintain the full list of all edits needed; these are also saved and backed up in the same manner as the electronic datasets. None of these electronic datasets or statistical programs are deliverables under the 117e grant. These include:

1. Raw data electronic files
2. Quality assurance checks of data identify outliers and other data points that require verification
3. Quality assurance corrected data electronic analysis datasets

Progress reports for the 117e grant include the activities for this project. Any problems encountered with the project are thoroughly described and reported through the progress reports to the EPA Project Officer and also through email.

Final reporting from this project includes electronic files of tabular results and graphics that are output directly from the R package **baytrends** (Section B2.5). No other reporting products are created as a deliverable for this project.

B. *Data Management, Verification (Acceptance Criteria) And Documentation*

All of the data used for the long-term trends analysis project is generated under the procedures described in the most current version of the following project-specific QAPPs:

> Maryland Department of Natural Resources (DNR). 2023. Quality Assurance Project Plan for the Maryland Department of Natural Resources Chesapeake Bay Mainstem and Tributary Water Quality Monitoring Program- Chemical and Physical Properties Component.
>
> Maryland Department of Natural Resources (DNR). 2020. Section 106 Ambient Water Quality Monitoring (CORE/Trend Monitoring) Quality Assurance Project Plan.

These documents are reviewed annually and updated as needed.

These QAPPs document the following aspects of the Quality Assurance Requirements that are outside of the long-term trends analysis project:

1. Sampling Process Design
2. Sampling Methods
3. Sample Handling and Custody
4. Analytical Methods (Laboratory)
5. Quality Control
6. Instrument/Equipment Testing, Inspection and Maintenance
7. Instrument/Equipment Calibration and Frequency
8. Inspection/Acceptance of Supplies and Consumables
9. Non-direct Measurements

B1. Data Management

B1.1. Software used

The department currently uses the database management software Microsoft Access.

The department currently uses statistical software programs written by the department's analysts in SAS® software version 9.4 (SAS Institute Inc. 2013) for dataset preparation. Final analysis datasets are imported into the R statistical software (R Core Team 2021, or most recent version at the start of the analysis) using the R package **baytrends** (https://cran.r-project.org/web/packages/baytrends/index.html) using RStudio software (RStudio Team 2020, or most recent version at the start of the analysis).

B1.2. Input data

Primary database electronic files are managed and maintained on the department's network under the protocols described in the monitoring program specific QAPPs noted in Section B.

Data management and verification (acceptance criteria) procedures for input (raw) databases used in this project are described in the monitoring program project specific QAPP documents as noted above. All data has been verified according to the QAPPs for submission to the CBP databases.

The department maintains an internal Microsoft Access database of the data (from 2000-present). Each calendar year of data is in a separate Microsoft Access database file. These Microsoft Access database files are used for preparation of analysis datasets for this project because the below detection limited data (analysis laboratories began providing in 1996) is available to the data analysts from these databases. Input data for the current analysis year is pulled from these Microsoft Access databases each year once all data (January-December) is complete.

B1.3. Analysis datasets

A summary of the process used to create analysis datasets for the long-term trends project is shown in Figures 2-4. More detailed descriptions are provided in the following sections.

The department has developed data extraction SAS programs to extract the needed data from the Microsoft Access databases (input datasets). SAS programs and electronic datasets are stored on the analyst's personal computer hard drive under a directory set up for the analysis project, named 'Baytrends **Year**', where **Year** is the 4-digit year for the analysis (i.e. analysis in **Year** 2023 is for data through calendar year 2022). All data extraction SAS programs are saved under a subdirectory named 'SAS Programs'. The intermediate electronic datasets created by these SAS programs are stored under a subdirectory named 'SAS Datasets'. The intermediate electronic dataset is imported into R software using the **loaddata** and **makeSurvDF** functions to use in **baytrends** (see Section B1.1). The final analysis dataset (in R) is stored in the subdirectory 'myData'.

The entire project directory is backed up to the department's network periodically and can be available to other analysts as needed. The department's network is backed up to a separate location each evening and can be used in the event of a loss of the files from the network. The analyst's personal computer hard drive is backed up periodically to external data storage (thumb drive) that can be used in the event of a loss of files from the personal computer.

Final trends output tabular results and graphical summaries are saved to the subdirectory 'Trends Deliverable **Year**' and also in a Google Drive repository. CBP analysis staff and the Project Officer are given access permission to download the final deliverable files from the Google Drive location.

Datasets for Field parameters and Laboratory parameters (pre-1996)

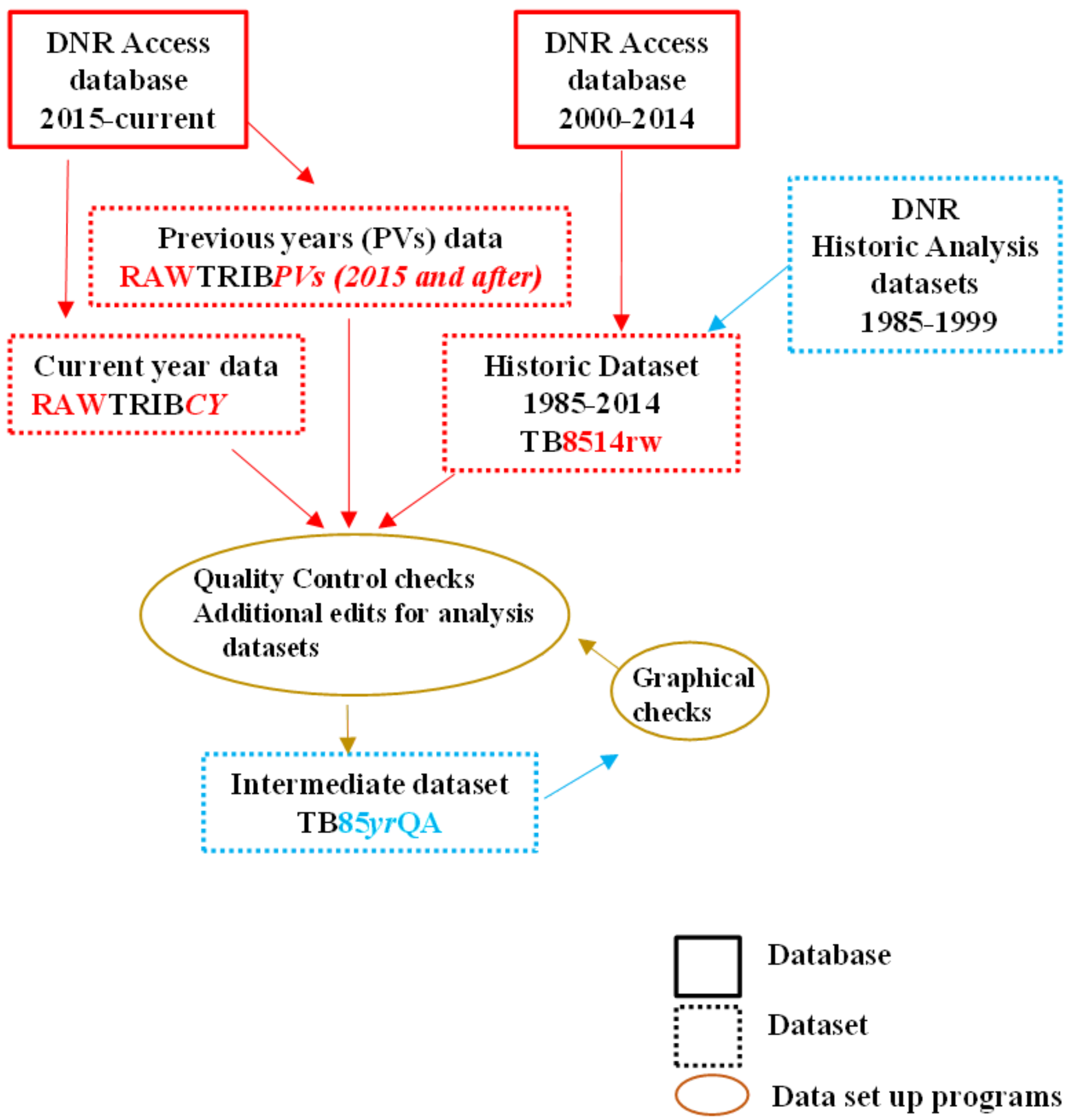

Figure 2. Preparation of the intermediate dataset for field parameters (all years) and for laboratory parameters pre-1996.

The preparation includes extraction of data from databases, quality control checks and applying previously identified edits needed, and graphical checks to finalize the intermediate dataset. *CY* is the four-digit current year, *PVs* are the four digit years of all previous years (2015 and later), *yr* is the two-digit year for the current year. The example shown is for the tidal tributary program data (TRIB and TB in dataset names); other programs follow a similar process and dataset naming convention.

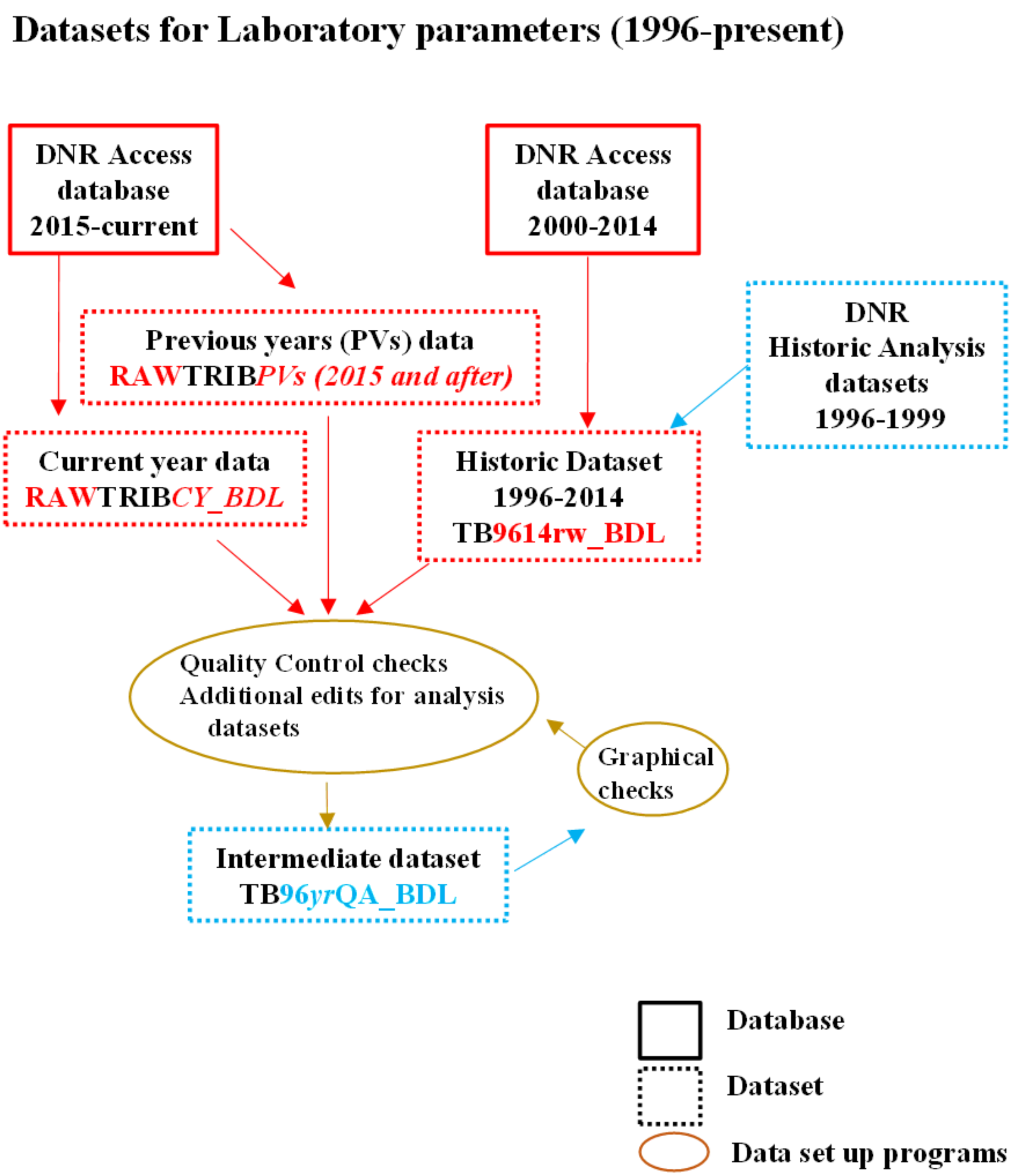

Figure 3. Preparation of the intermediate dataset for laboratory parameters 1996 to present using below detection limit (BDL) data.

The preparation includes extraction of data from databases, quality control checks and applying previously identified edits needed, and graphical checks to finalize the intermediate dataset. *CY* is the four-digit current year, *PVs* are the four digit years of all previous years (2015 and later), *yr* is the two-digit year for the current year. The example shown is for the tidal tributary program data (TRIB and TB in dataset names); other programs follow a similar process and dataset naming convention.

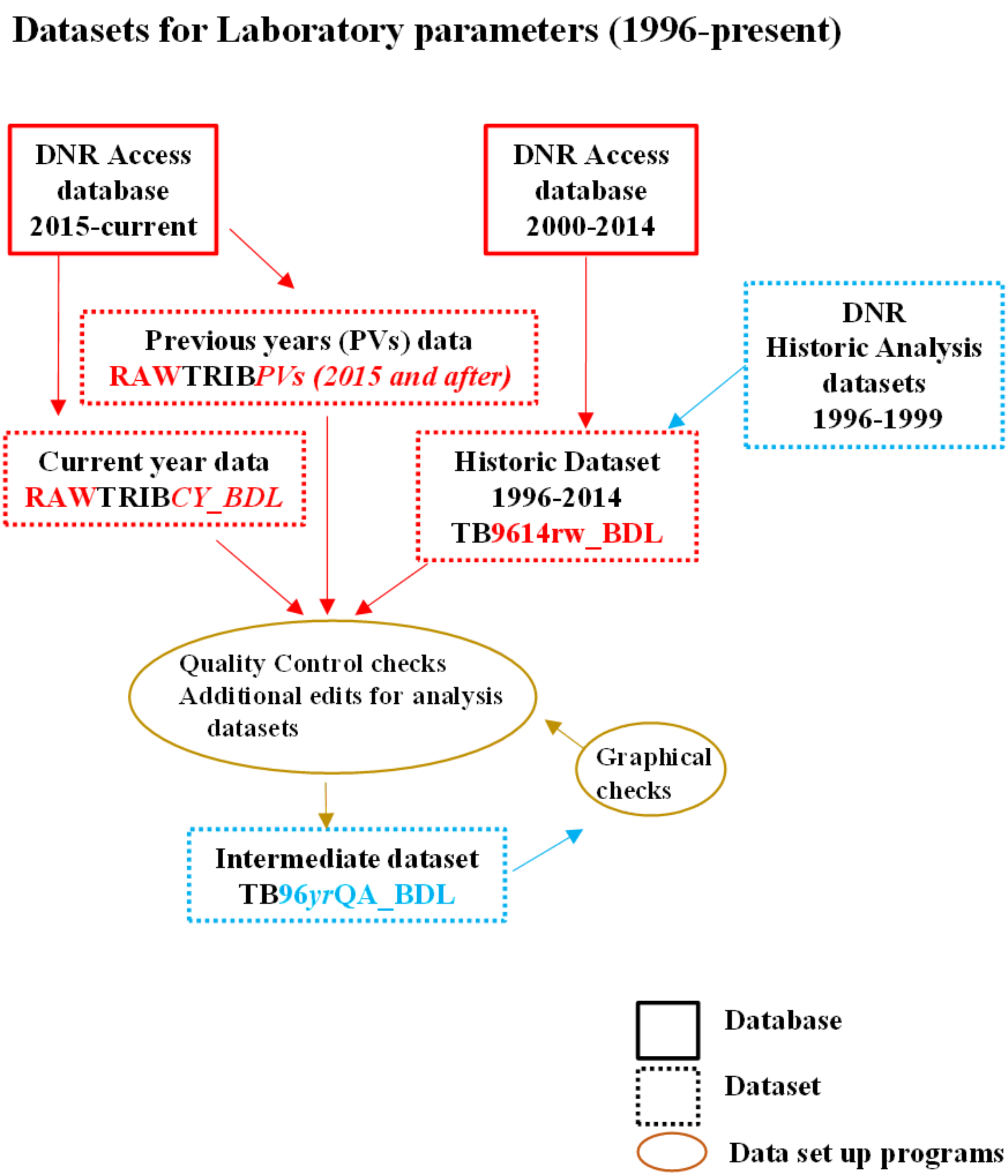

Figure 4. Preparation of the final long-term trend analysis dataset.
The preparation includes combining the intermediate datasets (see Figures 2 and 3), calculating parameters as needed (DIN, TN, and TP, see Table 1), and formatting as required for the trends analysis method. *yr* is the two-digit year for the current year. The example shown is for the tidal data (includes Mainstem and tidal tributary data); non-tidal data follows a similar process and dataset naming convention.

B1.3.1. Analysis Parameters

Analysis datasets are created with the descriptive parameters and primary trends analysis field and laboratory parameters (or those needed to calculate the primary trends analysis parameters, see Table 1). The full list of what parameters are available is different between years and between monitoring programs.

Descriptive parameters: Program Code, Project Code, Station Name, Sample Date, Sample Depth, Layer Code, Replicate Number, Parameter, Parameter Value, Parameter APC code, Parameter Flag

Databases use a distributed database structure. Parameter is renamed to the name of the parameter (i.e. NO23). Parameter APC code is renamed parameter name_A (i.e. NO23_A). Parameter Flag is renamed parameter name_G (i.e. NO23_G). A separate temporary dataset for each parameter is created and then all individual parameters temporary datasets are merged into a single dataset using Station Name, Sample Date, Sample Depth, Layer Code, Replicate Number record. This creates a dataset that has a single line of data for a given Station Name, Sample Date, Sample Depth, Layer Code, Replicate Number record.

Analyzed for trends

Field parameters: Secchi depth (SECCHI) in tidal waters only, dissolved oxygen (DO), salinity (SALINITY) in tidal waters or conductivity (COND) in non-tidal waters, water temperature (WTEMP), pH (PH)

Laboratory parameters: dissolved inorganic phosphorus (PO4), total suspended solids (TSS), active chlorophyll a (CHLA)

Calculated parameters: dissolved inorganic nitrogen (DIN), total nitrogen (TN), total phosphorus (TP)

Not analyzed for trends

Laboratory parameters needed to calculate other parameters: nitrate-nitrate (NO23), ammonium (NH4), total Kjeldahl nitrogen (TKNW), particulate nitrogen (PN), total dissolved nitrogen (TDN), total dissolved phosphorus (TDP), particulate phosphorus (PP)

Table 1. Calculated Parameters from measured parameters.

Dissolved inorganic nitrogen (DIN) is always calculated for all programs. Total Nitrogen (TN) is always calculated for all programs, but the measured parameters differ between programs and time periods. Total Phosphorus (TP) was directly measured in historic data for some programs; other programs and time periods it is calculated as noted. If both measured constituents APC code (G) = ‘<’ then the calculated parameter APC code is assigned _G = ‘<’.

Calculated parameter	Program	Time period	Calculation from measured parameters	Method code
DIN	All	All	DIN = NH4 + NO23	DIN_M = 'D01'
TN	Non-tidal	Prior to 6/30/2005	TN = TKNW + NO23	TN_M = 'D01'
		After 7/1/2005	TN = PN + TDN	TN_M = 'D01'
	Tributary/Potomac	Prior to 4/30/1998	TN = TKNW + NO23	TN_M = 'D01'
		After 5/1/1998	TN = PN + TDN	TN_M = 'D01'
	Patuxent/CB5.1W	Prior to 6/30/1990	TN = TKNW + NO23	TN_M = 'D01'
		After 7/1/1990	TN = PN + TDN	TN_M = 'D01'
	Mainstem/LE2.3	1/1/1985 -5/15/1985 10/1/1986- 9/30/1987	TN = TKNW + NO23	TN_M = 'D01'
		5/16/1985-9/30/1986 After 10/1/1987	TN = PN + TDN	TN_M = 'D01'
TP	Non-tidal	Prior to 6/30/2005	Directly measured	TP_M = 'L01'
		After 7/1/2005	TP = PP + TDP	TP_M = 'D01'
	Tributary/Potomac	Prior to 4/30/1998	Directly measured	TP_M = 'L01'
		After 5/1/1998	TP = PP + TDP	TP_M = 'D01'
	Patuxent/CB5.1W	Prior to 6/30/1990	Directly measured	TP_M = 'L01'
		After 7/1/1990	TP = PP + TDP	TP_M = 'D01'
	Main/LE2.3	1/1/1985 -5/15/1985 10/1/1986- 9/30/1987	Directly measured	TP_M = 'L01'
		5/16/1985-9/30/1986 After 10/1/1987	TP = PP + TDP	TP_M = 'D01'

B1.3.2. Historic data

Historic data (before 2000) was stored in an older database structure than the current Microsoft Access databases (2000-present). Historic data was stored in Mainstem and Tributary (both tidal and non-tidal) datasets.

The historic Mainstem datasets are fairly straightforward. The exceptions are Mainstem station CB5.1W, which is collected under the Patuxent River Tributary program and data is stored in Tributary datasets, and the Potomac River station LE2.3, which is collected and processed as a Mainstem station and data was stored in Mainstem datasets. As the result of these differences, separate subgroups of Mainstem (without CB5.1W) and LE2.3 data were maintained.

The historic tidal tributary datasets are not straightforward due to differences in the sampling of Potomac and Patuxent rivers in previous sampling programs and differences between those and the rest of the tidal tributary monitoring stations. Data was stored in Tributary datasets. As a result of these differences, separate subgroups of tidal tributary/Potomac and Patuxent data (with CB5.1W, see above) were maintained.

The historic non-tidal tributary datasets are straightforward and data was stored in Tributary datasets.

Analysis datasets containing historic data (1985-2000) were created and saved by individual analysts in the past and are retained as permanent analysis datasets. These historic analysis datasets were named a variety of things depending on what years of data were included. Historic analysis datasets are used to create current analysis datasets (instead of extracting data from the CBP datasets or from the department's historic databases). This is done for the primary reason that any and all knowledge needed to handle the historic data is already incorporated into the creation of these historic analysis datasets and may not be available to the current analyst to recreate the same dataset. Also, any data corrections identified in previous years of analysis are already made in these datasets but may or may not have been made in the historic input (raw) databases.

The department's analysts combined these historic analysis datasets (from 1985 to 1999) and more recent data (2000-2014) and made all parameter names and codes consistent with the recent data structures and naming conventions. These datasets are maintained in historic program groupings and are named **program**8514rw where **program** is one of the following subsets of data based on the historic dataset:

BA Mainstem
LE LE2.3 (Potomac station with different historical sampling from other Potomac stations)
TB tidal tributary and Potomac stations
PX Patuxent stations
NT non-tidal tributary

The department's analysts completed an extensive quality assurance check of all of the historic data (from 1985 to 1999) and more recent data (2000-2014) and developed a list of additional edits that are made to the analysis datasets once the **program**8514rw file is combined with datasets from 2015-present (Section B1.1.3).

Data from 2015-previous year were reviewed in the same manner and any needed edits were added to this quality assurance step. Each current year of data is reviewed in the same manner and any new edits needed are added to the quality assurance step on an annual basis.

Note that the datasets for laboratory parameters that include data below detection limits (1996 and later) are handled in a slightly different manner described in Section B1.1.5.

B1.3.3. Current year and full time period dataset

The data for the current year are not extracted for the analysis datasets until all data for the calendar year are available in the input datasets, generally by April or May of the following year. The resulting dataset file is named 'RAW**type***CY*', where **type** is determined by the program and *CY* is the four-digit year for the current year data. **Type** codes include **MAIN** (combined Mainstem and LE2.3 data), **TRIB** (combined tidal tributary, Potomac and Patuxent data) and **NT** (non-tidal tributary data). The current year's RAW**type***CY* dataset is appended to the historic dataset (**program**8514rw) and the datasets from 2015 to the previous year (*PV*, filenames RAW**type***PVs,* see Figure 2).

The combined dataset then passes through a series of checks to remove data that have specific Analytical Problem Codes (APC) which disqualify the data for analysis. Definitions of these APCs are included in Table 2. It was previously determined that these were the only problematic APC codes present in the analysis datasets; any new APC codes that should preclude data from being included in analysis are also identified each year and added to this list. The combined dataset is then merged with a list of the stations assigned to each CBP segment. Next, any parameter that is coded as 'greater than the upper detection limit' (*parameter*_G = 'G') is deleted.

Table 2. Analytical Problem Codes (APC) that prevent data use for analysis.

DNR Code	CBP Code	Description
A	A	Laboratory accident
B	B	Chemical matrix interference
BB	TP	Torn filter pad
C	C	Instrument failure
D	D	Insufficient sample
F	F	Unknown
J	J	Incorrect sample fraction for analysis
M	X	Sample received warm
NN	NN	Particulates found in filtered sample
P	A	Lost results
R	R	Sample contaminated
RR	RR	No sample received
S	A	Sample container broken during analysis
TS	SS	Sample rejected due to high suspended sediment concentration
TT		If NH4 is greater than dissolved Kjeldahl N by 0.1 mg N/L
U	U	Inconsistent relationship between variables
V	V	Sample results rejected due to quality control criteria
VV		Station name not sampled due to bad field conditions
X	X	Sample not preserved properly

Graphs of the data are reviewed to ensure that all data for all years and all analyzed parameters is in the saved dataset. If data are missing, the analyst returns to the previous steps to determine what errors in the input database or the SAS programs have prevented the data from being extracted or included, or to verify that the data does not exist. Once complete, the intermediate dataset **program**85*yr*QA, where *yr* is the two-digit year for the end of the analysis period, is saved to the analyst's harddrive.

Note that the datasets for laboratory parameters that include data below detection limits (1996 and later) are handled in a slightly different manner described in Section B1.3.5 below.

B1.3.4. Laboratory parameter data prior to 1996

In the historic data, method detection limits (MDLs) were changed at uneven time intervals when analysis methods or equipment changed. Since 2006, these MDLs have been determined each year. The process is described in the *Quality Assurance Project Plan For the Maryland Department of Natural Resources Chesapeake Bay Mainstem and Tributary Water Quality Monitoring Program- Chemical and Physical Properties Component* (DNR 2023). The current year's MDLs are applied to the raw data as part of the data processing procedures as detailed in the same document. This same process is used by the Maryland Department of Health laboratory for the non-tidal station nutrient analysis.

For laboratory parameter data prior to 1996, a secondary check of all detection limits, historic through current year, are verified in the **program**85*yr*QA datasets. This ensures that any measured value at or below the MDL at the time of sample collection for a given parameter is coded as below detection limit (*parameter*_G = '<'). If the value is below MDL, the parameter value is corrected to the value of the MDL at the time of sample collection and the *paramete*r_G code is coded as below detection limit. This also ensures that no data values that are greater than the MDL at the time of sample collection are incorrectly coded as less than the detection limit; if so, the *parameter*_G code is removed. Once all of the data are checked for correct MDLs, calculated parameters are determined as appropriate (different parameters are calculated at different time periods, see Table 1). Parameter method codes are added as needed (*parameter*_M).

B1.3.5. Laboratory parameters data for 1996 to current year

Since 1996, the laboratories provide actual readings data values for parameters even when those values are below the current MDL; this is the 'below detection limits' data. Trends analysis uses this below detection limits data to remove the impact of censored data on trends analysis.

The below detection limits data are stored separately in the department's Microsoft Access databases. Separate analysis datasets are created for 1996-current containing the readings data values (below detection limit data) (Figure 3).

Datasets are named using the same conventions as above (Section B1.1.2), with the addition of '**_BDL**' at the end of the name to distinguish them as below detection limits datasets (e.g. TB96*yr*rw**_BDL**).

B1.3.6. Interval censoring and final analysis dataset

Interval censoring is used for the input datasets to the R package **baytrends** (https://cran.r-project.org/web/packages/baytrends/baytrends.pdf, see Section B2). Interval censoring is required for the pre-1996 laboratory parameters and is completed from the intermediate analysis datasets using SAS programs. This requires the creation of a temporary dataset 'detlimsub8595' from the **program**85*yr*QA datasets: 'detlimsub8595' has any data that is below the detection limit replaced with the method detection limit at the time of sampling. A second temporary dataset 'nosub96*yr*' is created from the **program** 96*yr*QA_BDL nt85*yr*QA_BDL datasets: 'nosub96*yr*' has the data as reported by the laboratory even if it is below the method detection limit (including in some cases negative values).

These two temporary datasets are combined and parameters that potentially have censored data (i.e. TN, TP, TSS, CHLA, DIN, PO4) are converted to a two parameter format. For data before 1996, if a specific datapoint is below detection limit and coded with a '<' in the *parameter*_G field, then that datapoint is translated to two columns, *parameter*_lo value = zero (as the lowest part of the censoring interval) and the *parameter*_hi value being set the value in the original dataset (the highest part of the censoring interval, which was set to the detection limit at the time of sampling in previous steps of dataset preparation). If a specific datapoint is not below detection limit (all years) or the below detection limit data is available (after 1996) both *parameter*_lo and *parameter*_hi are set to the value of the datapoint. This reformatted dataset is then saved as a comma-delimited (csv) file MD85*yr***.**csv for tidal data (Mainstem, tidal tributaries including Potomac and Patuxent) or **NT**MD85*yr***.**csv for non-tidal data. This final analysis dataset is imported into R using the **baytrends** function **loaddata** and formatted using the **baytrends** function **makeSurvDF**, and named MDR85*yr*_Surv.rda for tidal data and NTMDR86*yr*_Surv.rda for the non-tidal data. These final analysis datasets (in R) are saved to the subdirectory 'myData'.

B1.4. Daily Flow datasets and Salinity datasets

Daily flow data and station/sample date salinity data are required for portions of the trends analysis.

Daily flow measurement datasets are created using the R package **dataRetrieval** (https://cran.r-project.org/web/packages/dataRetrieval/index.html) to retrieve the daily flow measurements for years and specific flow gages requested by an R script written by the department's analysts. Flow data for the period 1984-current year is downloaded for all relevant UGSG gages and then the daily flow is detrended for season using **baytrends**. The detrended flow dataset is saved to the subdirectory 'USGS_Flowdata' as Seasdetrended_flow1984*CY*.

Station/sample date salinity datasets are subset from the **program**85*yr*QA datasets for tidal data as a comma-delimited (csv) file salinity85*yr*.csv and saved to the subdirectory 'myData'. An R script imports the data and then the data is detrended for season using **baytrends**. The detrended salinity dataset is saved to the subdirectory 'myData' as SeasdetrendedSal85*yr*.

B2. Data Analysis

B2.1. Software used

Trends analysis is completed using the R statistical software (R Core Team 2021, or most recent version at the start of the analysis). The R package **baytrends** (https://cran.r-project.org/web/packages/baytrends/index.html) is loaded into the R statistical program using RStudio software (RStudio Team 2020) and calls on many other pre-written and specialty written packages and scripts. The department's analysts write additional R scripts for providing the user supplied information needed to use **baytrends**.

B2.2. Reference tables for baytrends

Several reference tables are required for **baytrends** and are all included in an Microsoft Excel file called 'MDDNRLookupTables(*layer parameter*Final).xlsx'. The *layer* is dependent on the station (either S for surface or SAP for surface-above pycnocline and B for bottom and BBP for bottom-below pycnocline); the *parameter* is the analysis parameter. A separate Microsoft Excel file is needed for each layer-parameter pairing because the best flow model for a given station and parameter is independently determined for each layer-parameter pair for a station and is not required to be the same across all parameters or between layers. The trends programming reads in these lookup tables from '\mySettings\'. These tables are provided in Appendix II.

B2.3. Layer groupings

For tidal waters, water samples for laboratory analysis of nutrients, chlorophyll *a* and total suspended solids are collected at surface and bottom layers. For some stations, additional samples are taken at 1.5 m above and 1.5 m below the pycnocline, if a pycnocline exists, or at defined depths in the water column. For trend analyses, where both surface (S) and above-pycnocline (AP) samples are collected, measurements are averaged, resulting in one value for the surface-mixed layer (SAP). Likewise, where both bottom (B) and below-pycnocline (BP) samples are collected, measurements are averaged, resulting in one value for the bottom-mixed layer (BP). Trend analyses are done for SAP and BBP layers for TN, TP, DIN, PO4, CHLA and TSS.

Secchi depth is measured at most stations and recorded as a surface layer measurement and analyzed for trends.

Dissolved oxygen, salinity or conductivity and water temperature are measured *in-situ* at 1- to 2-m intervals through the water column and at the same depths where nutrient samples are collected (see above). For dissolved oxygen, only the data corresponding to the bottom nutrient sample collection depth (B) are analyzed for trends. For salinity and water temperature, readings from the depths that correspond to the depths where the nutrient parameters were collected (S and AP or BP and B) are averaged, resulting in one value for the surface-mixed (SAP) layer and bottom-mixed (BBP) layers and are analyzed for trends.

For non-tidal waters, water samples for laboratory analysis of nutrients, chlorophyll *a* and total suspended solids are collected only at the surface (S). Trend analyses are done for the S layer for all parameters.

B2.4. General Additive Models (GAMs)

Trend tests are conducted using methods developed by the CBP analysts, contractors and partners. Trend tests are completed using a Generalized Additive Models (GAMs) approach. The methods used are described in Murphy and Perry (2018) and Murphy et al (2019). A listing of the applicable GAMs models available for use is given in Table 3.

Table 3. Temporal GAM structures in baytrends (Murphy and Perry, 2018).

Model name	Description	Structure of right hand side of equation
GAM2	Nonlinear trend with seasonality (plus interaction)	cyear + s(cyear, k=gamK1) + s(doy,bs='cc') + ti(cyear,doy,bs=c('tp','cc')), knots = list(doy = c(1,366)), select=TRUE *where: gamK1=c(10,2/3) means that the maximum of 10 or 2/3*number of years is selected*
GAM3	Nonlinear trend with seasonality (plus interaction) and intervention	intervention + cyear + s(cyear, k=gamK1) + s(doy,bs='cc') + ti(cyear,doy,bs=c('tp','cc')), knots = list(doy = c(1,366)), select=TRUE *where: gamK1=c(10,2/3) means that the maximum of 10 or (2/3*number of years) is selected*
GAM4	Nonlinear trend with seasonality (plus interaction) and hydrology effect	cyear + s(cyear, k=gamK1) + s(doy,bs='cc') + ti(cyear,doy,bs=c('tp','cc')) + s(flw_sal,k=gamK2) + ti(flw_sal,doy,bs=c('tp','cc')) + ti(flw_sal, cyear,bs=c('tp' ,'tp')) + ti(flw_sal,doy,cyear, bs=c('tp','cc','tp')), knots = list(doy = c(1,366)), select=TRUE *where: gamK1=c(10,1/3) means that the maximum of 10 or (1/3*number of years) is selected, and gamK2=c(10,2/3) means that the maximum of 10 or (2/3*number of years) is selected*
GAM5	Nonlinear trend with seasonality (plus interaction), hydrology effect, and intervention	intervention + cyear + s(cyear, k=gamK1) + s(doy,bs='cc') + ti(cyear,doy,bs=c('tp','cc')) + s(flw_sal,k=gamK2) + ti(flw_sal,doy,bs=c('tp','cc')) + ti(flw_sal, cyear,bs=c('tp' ,'tp')) + ti(flw_sal,doy,cyear, bs=c('tp','cc','tp')), knots = list(doy = c(1,366)), select=TRUE *where: gamK1=c(10,1/3) means that the maximum of 10 or (1/3*num years) is selected, and gamK2=c(10,2/3) means that the maximum of 10 or (2/3*num years) is selected*

From Murphy and Perry (2018): In the equations, cyear is a centered decimal date, meaning that a date is turned into a decimal (i.e., 2002.41), and then a time series is centered so that the middle date in a record becomes zero. The variable doy is day of year (e.g, 1, 2,… 366), with each year adjusted to 366 days to account for leap years. The s() indicates a spline function with the smooth class defined by bs='cc' or 'tp'. The ti() indicates a tensor product interaction between two variables. The parameter "intervention" refers to an indicator variable that changes during the time series if a method or lab changed occurred that the analyst wants to test as a potentially significant indicator of a change in the values of the observations. And the parameter flw_sal indicates either a pre-processed average river flow, or salinity measured at the same place and time. Other items in the equations include specification of knots for the doy parameter to include days 1 and 366 so that the seasonal models do not have an artificial jump from one year to the next. The select=TRUE specification allows for individual splines to be completely removed from the GAM during model fitting if they provide no benefit (Wood 2018). An upper limit on the number of knots for each spline can be specified (the basis dimension), and in model development we found that this k-value needed to be set to allow for enough flexibility in the cyear function over time. It is set to the maximum of 10 or 2/3 times the number of years for gam2 and gam3. For gam4 and gam5, it was found that the concurvity (Buja et al., 1989) between the spline bases for cyear and flw_sal was an issue. So an approach based on Peng et al., (2006) was used to limit the flexibility of the smooth on cyear so that more of the variability can be modeled with the smooth on flw_sal.

Buja, A., Hastie, T., Tibshirani, R., 1989. Linear Smoothers and Additive Models. Ann. Stat. 17, 453–510. https://doi.org/10.1214/aos/1176347115

Peng, R.D., Dominici, F., Louis, T.A., 2006. Model choice in time series studies of air pollution and mortality. J. R. Stat. Soc. Ser. A Stat. Soc. 169, 179–203.

Wood, S., 2018. mgcv. https://cran.r-project.org/web/packages/mgcv/index.html

The R package **baytrends** was developed through coordinated efforts of the CBP analysts and consultants; it is available on the Comprehensive R Archive Network (CRAN). Documentation for **baytrends** is maintained by the developers and is included in the R repository on CRAN (https://cran.r-project.org/web/packages/baytrends/baytrends.pdf). The R package **baytrends** uses a separate R package **mgcv** (https://cran.r-project.org/web/packages/mgcv/mgcv.pdf) as described in Murphy and Perry (2018).

Testing in previous years determined that the GAM2 model is the chosen model, based on Akaike information criterion (AIC) score, in almost all cases for all parameters when interventions are not required and flow correction is not used. Intervention testing (GAM3 model), flow or salinity correction testing (GAM4 models) and combined flow/intervention testing (GAM5 models) to determine what as the best model (based on AIC score and test p-value) was completed in 2018 and 2019 for parameters TN, TP, DIN, PO4, TSS, and CHLA, Secchi, dissolved oxygen, water temperature and pH. Best flow models and if intervention models were required was determined for each individual Maryland tidal and non-tidal station.

Once the individual stations were tested, in 2019 and 2020 those results were used to determine an overall best model (by layer and parameter) for flow or salinity correction and for intervention by looking at results for stations within a geographic region or that were in the same subgroup of data historically (i.e. Patuxent data or Tributary data). In most instances, this best overall model was still within the top three chosen models for the individual stations, but when necessary the best model for the overall group was used for consistency among stations even if it was not the best model for a given station.

In 2022, these flow models were again tested and a few stations had minor updates to reflect changes that occurred when the 2019-2021 flow data was included. This best flow period information (or salinity for some stations) is stored in the StationMasterList table (Appendix II) and accessed by **baytrends** for each individual station.

Trends are determined for three time periods: start of sampling to present (for most stations this is either 1985-present or 1986-present), 1999 to present and the most recent 10-year period. Stations with less than 10 years of data are not analyzed for trends. Trends are evaluated for several seasons:

seasonName = "All", all months (annual trends)
seasonName = "Spring1", March-May
seasonName = "Summer1", June-September (for dissolved oxygen trends in particular)
seasonName = "Summer2", July-September (for chlorophyll trends in particular)
seasonName = "SAV1", submerged aquatic vegetation (SAV) growing season April-October for salinity regimes tidal fresh, oligohaline and mesohaline

Trends analysis is completed using both observed data (GAM2 or GAM3) and flow-adjusted data (GAM4 or GAM5).

Graphics are produced for the annual season for all parameters except DO and chlorophyll *a*. Graphics for DO are produced for Summer1 (June-September) season for bottom waters. Graphics for chlorophyll *a* are produced for Spring1 (March-May) and Summer2 (July-September).

B2.5. Data analysis output datasets

Output from the **baytrends** includes comma-delimited (*.csv) results summary tables and Microsoft Word documents (*.docx) containing individual summary tables and graphics by *parameter***.** Naming of the files includes the ***version*** of **baytrends** and *GAM* indicates which GAM model(s) are included. Output file names include:

MD *yr* ***version*** stat *parameter layer*.csv
MD *yr* ***version*** chng *parameter layer*.csv
MD *yr* ***version**_parameter layer GAM*_all**.**docx

Output files are saved to the subdirectory 'Trends Deliverable **Year**', where **Year** is the analysis year (i.e. **Year** = 2023 is for trends through calendar year 2022). These files are also uploaded to a Google Drive for access by the CBP analysts and the Project Officer.

C. *Assessment and Oversight*

C1. Assessments and Response Actions

All of the data used for the long-term trends analysis is generated under the procedures described in monitoring program project specific QAPPs as listed in Section B. These QAPPs document the assessments and response actions relevant to the generation of the data used for analysis and are outside of the Trends analysis project.

C2. Reports to Management

The lead analyst/Program Chief is responsible for submitting all electronic output files to the Project Officer. Data tables output as comma-delimited (*.csv) tables and summary results and graphics output as Microsoft Word (*.docx) files are provided to the CBP to fulfill the data deliverable requirement under the 117e grant. This data deliverable is due June 30 of each year. Generally, trends analyses are completed by the end of May each year, results are proofed and verified for completeness and correctness, and final results are available and submitted to the Project Officer by mid-June. The electronic summary tables are sent by email to the Project Officer and are uploaded to a Google Drive and shared with the Project Officer and other CBP analysts. The department also submits an informal summary of the trends analysis project entitled 'Trends through *year* data methods and notes.docx' where *year* is the 4-digit end year of the trends analysis period as a documentation of the project activities.

The Project Officer and/or CBP analysts notify the department that the output files are received by email to the lead analyst/Program Chief. Any irregularities or questions regarding the output files are communicated to the lead analyst/Program Chief and resolved as soon as the issue can be identified and the remedy made.

Various other summary tables are compiled for the department's needs. One of these is a table of Annual trends results that is used on the department's Eyes on the Bay website for creating on demand maps. These maps are available to the user by the end of July each year.

Semi-annual progress reports are prepared by the lead analyst/Program Chief and as part of the overall semi-annual reporting for all of the departments 117e grant related projects and submitted to the Project Officer in July and January each project year. The department also submits an informal summary of the trends analysis project entitled 'Trends through *year* data methods and notes.docx' where *year* is the
4-digit end year of the trends analysis period as a documentation of the project activities.

D. *Data Validation and Usability*

All of the data used for the long-term trends analysis is generated under the procedures described in monitoring program project specific QAPPs as listed in Section B. These QAPPs document the following aspects of the Quality Assurance Requirements that are outside of the Trends analysis project:

1. Data Review, Verification and Validation
2. Verification and Validation Methods
3. Reconciliation with User Requirements

D1. Validation of Analysis Datasets and Results

As described in Section B, numerous quality assurance checks of dataset compilation and the statistical analyses are performed:

1. Data is evaluated to ensure that the required number of months and years for each station are present in the analyzed dataset to meet the Acceptance Criteria.

2. Data passes through a series of checks to remove data that has specific Analytical Problem Codes (APC) which disqualify the data for analysis. Definitions of these APCs are included in Table 2.

3. Data are graphically reviewed to ensure that all data for all years and all analyzed parameters is in the analysis dataset. If any data is not present, the analyst returns to the previous steps to determine what errors in the input database or the SAS program have prevented the data from being extracted or included, or to verify that the data does not exist.

4. All detection limits are verified in the intermediate datasets. This ensures that any measured value at or below the MDL at the time of sample collection for a given parameter is coded as below detection limit. This also ensures that no data values that are greater than the MDL at the time of sample collection are incorrectly coded as less than the detection limit.

Further quality and completeness checks are performed once the trends results have been calculated:

1. Output files are reviewed to ensure the correct data has been analyzed and that the results are complete.

2. Results from the previous year's trends analysis are compared to the results of the current analysis to determine if any major changes occurred. If major changes occurred, the analyst returns to the analysis datasets, program and output files to ensure that the results are correct.

3. Final verification of results is completed once the output files are submitted to the CBP analysts. Any irregularities or questions regarding the output files are communicated to the lead analyst/Program Chief and resolved as soon as the issue can be identified and the remedy made.

The department's analysts prepare the output files but not any of the additional reporting the CBP makes to decision makers, such as Baywide maps of the results (combined with similar results from Virginia), or summary reporting. The department also submits an informal summary of the trends analysis project entitled ‘Trends through *year* data methods and notes.docx’ where *year* is the 4-digit end year of the trends analysis period as a documentation of the project activities.

The department’s analysts participate in the Integrated Trends Analysis Team monthly meetings and offer expert advice on the limitations or considerations of the trends analysis itself and Maryland long-term data in general. The department’s analysts are also available for any additional questions from the CBP analysts.

E. *References*

Helsel, D.R. and R. M. Hirsch, 2002. Statistical Methods in Water Resources Techniques of Water Resources Investigations, Book 4, chapter A3. U.S. Geological Survey. 522 pages. http://pubs.usgs.gov/twri/twri4a3/html/toc.html

Maryland Department of Natural Resources (DNR). 2020. Section 106 Ambient Water Quality Monitoring (CORE/Trend Monitoring) Quality Assurance Project Plan.

Maryland Department of Natural Resources (DNR). 2022. Quality Assurance Management Plan for Environmental Data Collection Maryland Department of Natural Resources, Version 2.0. Publication tracking number DNR 12-020422-303. https://eyesonthebay.dnr.maryland.gov/eyesonthebay/documents/MD_DNR_QMP2022.pdf

Maryland Department of Natural Resources (DNR). 2023. Quality Assurance Project Plan for the Maryland Department of Natural Resources Chesapeake Bay Mainstem and Tributary Water Quality Monitoring Program- Chemical and Physical Properties Component.

Murphy, R. and E. Perry. 2018. Draft: Methods for Application of Generalized Additive Models (GAMs) for Water Quality Trends in Tidal Waters of Chesapeake Bay. https://d18lev1ok5leia.cloudfront.net/chesapeakebay/draft-gam_method_for_chesapeake_5-10-18.pdf

Murphy, R.R., E. Perry, J. Harcum, J. Keisman. 2019. A Generalized Additive Model approach to evaluating water quality: Chesapeake Bay case study. Environmental Modeling and Software 118:1-13. https://doi.org/10.1016/j.envsoft.2019.03.027

R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

RStudio Team (2020). RStudio: Integrated Development for R. RStudio, PBC, Boston, MA http://www.rstudio.com/.

SAS Institute Inc. (2013) SAS software Version 9.4. Copyright © 2013 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

U.S. Environmental Protection Agency (EPA). 1983. Chesapeake Bay: A Framework for Action. 186 pp. http://www.chesapeakebay.net/publications/title/chesapeake_bay_a_framework_for_action

Appendix I: Chronological List of Tidal and Non-Tidal Water Quality Trend Analysis Methods

Date	**Methods used**
1985	First full year of monitoring at most tidal monitoring locations Additional tidal tributary stations started in 1986 and 2003
1990-2016	Seasonal Kendall Test Sen's slope estimator Van Belle and Hughes procedure for segment trends
1999-2014	Non-linear trend analysis Replaced with new method in 2015
1996-1999	Flow adjusted trend analysis
1995-present	Calendar year trend analysis
2007-2014	Water year trend analysis
2012-present	Initiated trends with data as reported below detection limits by the labs (censoring not performed) for 1999-current trend period.
2012-2013, annual review current year data	Extensive quality assurance checks of all historic data; developed additional edits to the datasets from the results
2015	Initiated use of new statistical programming in R software (version 1) as developed by the CBP for tidal trends (non-tidal continued to use previous methods). Using only the below detection limited datasets for the 1999-current trend period and the most recent ten year trend period. 1985-present trends were not completed due to continuing development of new statistical models by the CBP. No longer doing segment trends.
2017	No longer doing Seasonal Kendall trends for tidal trends (non-tidal continued to use previous methods). Version 2.6 of the R package for GAMs used. 1985-present trends were completed for parameters not impacted by laboratory changes (DO, SALINITY, SECCHI, WTEMP). 1999-2016 trends were completed for parameters potentially impacted by lab changes and or change to below method detection limit data (TN, TP, DIN, PO4, TSS, CHLA). Percent change for the most recent 10 years was also determined from the full time period model.
2018	Version 4 of the R package **baytrends** for GAMs used. Start using the **baytrends** method for the non-tidal trends analysis. Flow or salinity corrections and significant interventions (lab changes, methods changes, changes to below detection limited data) were determined through extensive testing and applied on a station-by-station basis for each parameter as determined using the GAM3 (intervention), GAM4 (flow or salinity correction) or GAM5 (flow correction and interventions) models for surface-mixed layer trends for TN, TP, TSS, CHLA, Secchi depth and dissolved oxygen. Flow/salinity adjusted (GAM4) trends were completed for water temperature. Un-adjusted trends (GAM2) were completed for all parameters.

Date	Methods used
2019	Version 1.1.0 of **baytrends** for GAMs used. Flow/salinity corrections and significant interventions (lab changes or methods changes) were determined through extensive testing and applied on a station-by-station basis for each parameter as determined using the GAM3 (intervention), GAM4 (flow or salinity correction) or GAM5 (flow correction and interventions, where applicable) models for TN, TP, DIN, PO4, TSS, CHLA, Secchi depth, dissolved oxygen, water temperature and pH. Un-adjusted trends (GAM2) were also completed for these parameters.
2020	Version 1.2.1 of **baytrends** for GAMs used. Extensive review was completed to determine the best flow models to use for groups of stations to make trends analysis models more consistent within geographic regions, monitoring programs, parameters, etc.
2021	Version 2.0.5 of **baytrends** for GAMs was used; switch to the Surv data format (previous version of **baytrends** had used a QW data format)
2022	Version 2.0.8 of **baytrends** for GAMs was used; flow models retested for all station/layer/parameter combinations to include 2019-2021 flow in the model chosen.
2023	Version 2.0.9 of the **baytrends** for GAMs was used.

Appendix II: Reference Tables required for the R package baytrends

1) **parameterLis**t: list of parameters and related information

parm	parmSourc	parmCat	parmName	parmCalc	parmNamelc	parmUnits	parmRecensor	parmRO1	parmRO2	parmTrend	logTrans	trendIncrease
secchi	SECCHI	Primary	Secchi Depth	No	Secchi depth	m		1	1	TRUE	FALSE	Improving
chla	CHLA	Primary	Chlorophyll a (Corrected)	No	chlorophyll a (corrected)	ug/L	0.1	1	2	TRUE	TRUE	Degrading
do	DO	Primary	Dissolved Oxygen	No	dissolved oxygen	mg/L	0.1	1	3	TRUE	FALSE	Improving
tn	TN	Primary	Total Nitrogen	Yes	total nitrogen	mg/L	0.1	1	4	TRUE	TRUE	Degrading
tp	TP	Primary	Total Phosphorus	Both		mg/L	0.01	1	5	TRUE	TRUE	Degrading
tss	TSS	Primary	Total Suspended Solids	No	total suspended solids	mg/L	0.1	1	6	TRUE	TRUE	Degrading
din	DIN	Primary	Dissolved Inorganic Nitrogen	Yes	dissolved inorganic nitrogen	mg/L		1	7	TRUE	TRUE	Degrading
po4	po4	Primary	Orthophosphorus	No	orthophosphorus	mg/L	0.001	1	8	TRUE	TRUE	Degrading
salinity	SALINITY	Primary	Salinity	No	salinity	ppt		1	9	TRUE	FALSE	Increasing
wtemp	WTEMP	Primary	Water Temperature	No	water temperature	deg C		1	10	FALSE	FALSE	Increasing
ph	PH	Primary	pH	No	pH	SU		1	11	TRUE	FALSE	Increasing
cond	COND	other	Conductivity	No	conductivity	umhos/cm at 25 deg C		8	8	TRUE	TRUE	Increasing

2) \ **layerLukup**: list of layer codes

layers	name
S	Surface
B	Bottom
SAP	Surface & Above Pycnocline
BBP	Below and Below Pycnocline

3) \ **usgsGages**: list USGS gage locations for matching flow data to trend datasets for analysis

usgsGageID	usgsGageName	for
"01491000"	CHOPTANK RIVER NEAR GREENSBORO, MD	**tidal and nontidal**
"01578310"	SUSQUEHANNA RIVER AT CONOWINGO, MD	**tidal and nontidal**
"01591000"	PATUXENT RIVER NEAR UNITY, MD	**tidal and nontidal**
"01646500"	POTOMAC RIVER AT CHAIN BRIDGE, WASHIN	**tidal and nontidal**
"01580000"	DEER CREEK AT ROCKS, MD	nontidal only
"01582000"	LITTLE FALLS AT BLUE MOUNT, MD	nontidal only
"01582500"	GUNPOWDER FALLS AT GLENCOE, MD	nontidal only
"01586000"	NORTH BRANCH PATAPSCO RIVER AT CEDA	nontidal only
"01592500"	PATUXENT RIV NEAR LAUREL, MD	nontidal only
"01597500"	SAVAGE RIV BL SAVAGE RIV DAM NEAR B	nontidal only
"01598500"	NORTH BRANCH POTOMAC RIVER AT LUKE,	nontidal only
"01599000"	GEORGES CREEK AT FRANKLIN, MD	nontidal only
"01601500"	WILLS CREEK NEAR CUMBERLAND, MD	nontidal only
"01603000"	NORTH BRANCH POTOMAC RIVER NEAR CUN	nontidal only
"01610000"	POTOMAC RIVER AT PAW PAW, WV	nontidal only
"01613000"	POTOMAC RIVER AT HANCOCK, MD	nontidal only
"01614500"	CONOCOCHEAGUE CREEK AT FAIRVIEW, MD	nontidal only
"01619500"	ANTIETAM CREEK NEAR SHARPSBURG, MD	nontidal only
"01637500"	CATOCTIN CREEK NEAR MIDDLETOWN, MD	nontidal only
"01638500"	POTOMAC RIVER AT POINT OF ROCKS, MD	nontidal only
"01638500"	POTOMAC RIVER AT POINT OF ROCKS, MD	nontidal only
"01639000"	MONOCACY RIVER AT BRIDGEPORT, MD	nontidal only
"01639500"	BIG PIPE CREEK AT BRUCEVILLE, MD	nontidal only
"01643000"	MONOCACY RIVER AT JUG BRIDGE NEAR F	nontidal only
"01645000"	SENECA CREEK AT DAWSONVILLE, MD	nontidal only
"01646502"	POTOMAC RIVER (ADJUSTED) NEAR WASH,	nontidal only
"01648000"	ROCK CREEK AT SHERRILL DRIVE WASHIN	nontidal only
"01649500"	NORTH EAST BRANCH ANACOSTIA RIVER A	nontidal only

6) **methodsList (tidal)**: detailed list of time periods for changes in methods or a lab change needed for running GAM3 and GAM5 models. Details are for each 'stationMethodGroup' defined for Maryland's tidal datasets and is linked to the trend dataset through this variable. This table was developed in 2018-2020 will be updated as additional parameters are added.

stationMethodGroup	intervention	parameter	beginDate	label	endDate	period	laboratory	Calc	Component1	Component2	MDL1	MDL2	EQ	CalcMDL
MD-CB51W	TRUE	tn	7/1/1990	lab_change	12/31/1995	2	CBL	TRUE	pn	tdn	0.0105	0.02	ADD	0.0305
MD-CB51W	TRUE	tss	7/1/1990	lab_change	12/31/1995	2	CBL	FALSE			1.5			
MD-Patuxent	TRUE	tn	7/1/1990	lab_change	12/31/1995	3	CBL	TRUE	pn	tdn	0.0105	0.02	ADD	0.0305
MD-Patuxent	TRUE	tss	7/1/1990	lab_change	12/31/1995	2	CBL	FALSE			1.5			
MD-Potomac	TRUE	din	5/1/1998	lab_change	6/30/1998	7	CBL	TRUE	nh4	no23	0.003	0.0002	ADD	0.0032
MD-Potomac	TRUE	po4	5/1/1998	lab_change	12/31/2018	6	CBL	FALSE			0.0006			
MD-Potomac	TRUE	tn	5/1/1998	lab_change	12/31/2007	8	CBL	TRUE	pn	tdn	0.0105	0.02	ADD	0.0305
MD-Potomac	TRUE	tss	5/1/1998	lab_change	12/31/1999	3	CBL	FALSE			1.5			
MD-Tributary	TRUE	din	5/1/1998	lab_change	12/31/1999	7	CBL	TRUE	nh4	no23	0.003	0.0002	ADD	0.0032
MD-Tributary	TRUE	po4	5/1/1998	lab_change	12/31/2018	5	CBL	FALSE			0.0006			
MD-Tributary	TRUE	tn	5/1/1998	lab_change	12/31/2007	8	CBL	TRUE	pn	tdn	0.0105	0.02	ADD	0.0305
MD-Tributary	TRUE	tss	5/1/1998	lab_change	12/31/1999	3	CBL	FALSE			1.5			
MD-XGG8251	TRUE	po4	7/1/2005	lab change	12/31/2018	4	CBL	FALSE			0.0006			

7) **methodsList (non-tidal)**: detailed list of time periods for changes in methods or a lab change needed for running GAM3 and GAM5 models. Details are for each 'stationMethodGroup' defined for Maryland's non-tidal datasets and is linked to the trend dataset through this variable. This table was developed in 2019-2020 will be updated as additional parameters are added.

stationMethodGroup	intervention	parameter	beginDate	label	endDate	laboratory	Calc	Component1	Component2	MDL1
MD-CORE	TRUE	po4	2/1/1993	method_change	12/31/1995	MDH	FALSE			0.004
MD-CORE	TRUE	po4	7/1/2005	Whole-Filter	12/31/2006	MDH	FALSE			0.004
MD-COREWMD	TRUE	po4	2/1/1993	method_change	12/31/1995	MDH	FALSE			0.004
MD-COREWMD	TRUE	po4	7/1/2005	Whole-Filter	12/31/2006	MDH	FALSE			0.004
MD-COREWMD	TRUE	tss	11/1/2013	lab_change	12/31/2017	MDH	FALSE			0.8

8) **StationMethodList (partial, tidal)**: information specific to each individual tidal station including station information (name, location type, coordinates, relevant USGS gage, station group, stationMethodGroup (links to MethodList), flow correction averaging windows (if applicable), parameters that are flow corrected in GAM3/GAM5 (flwParms) and parameters that are salinity corrected in GAM3/GAM5 (salParms). Separate tables are maintained for each parameter and by layer (either Surface and Surface/Above Pycnocline or Bottom and Below Pycnocline/Bottom). Below is an example using the TN Surface trends. flowAvgWin is the selected flow or salinity (flow is set to 1 by default but not used) for each station for each parameter and layer. Table 9 shows the flowAvgWin of the tables for other parameters and layers.

station	state	location Type	waterbody	latitude	longitude	cbSeg92	usgsGageName	usgsGageID	usgsGage Match	station RO1	station RO2	stationGrpName	stationMethodGroup	hydro Term	flwAvg Win	flwParms	salParms	RMs_ QorSal	start	layer	GAM
CB1.1	MD	main	Chesapeake Bay	39.5479	-76.0848	CB1TF	Susquehanna River a	"01578310"	Direct	1	1	Chesapeake Bay M	MD-Mainstem	flow	150	tn	nh4	Q	1985	S	4
CB2.1	MD	main	Chesapeake Bay	39.4415	-76.0260	CB1TF	Susquehanna River a	"01578310"	Direct	1	2	Chesapeake Bay M	MD-Mainstem	flow	15	tn	nh4	Q	1985	S	4
CB2.2	MD	main	Chesapeake Bay	39.3487	-76.1758	CB2OH	Susquehanna River a	"01578310"	Direct	2	1	Chesapeake Bay M	MD-Mainstem	flow	30	tn	nh4	Q	1985	SAP	4
CB3.1	MD	main	Chesapeake Bay	39.2495	-76.2405	CB2OH	Susquehanna River a	"01578310"	Direct	2	2	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	Q	1985	SAP	4
CB3.2	MD	main	Chesapeake Bay	39.1637	-76.3063	CB3MH	Susquehanna River a	"01578310"	Direct	3	1	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	Q	1985	SAP	4
CB3.3C	MD	main	Chesapeake Bay	38.9960	-76.3597	CB3MH	Susquehanna River a	"01578310"	Direct	3	2	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	Q	1985	SAP	4
CB3.3E	MD	main	Chesapeake Bay	39.0041	-76.3452	CB3MH	Susquehanna River a	"01578310"	Direct	3	3	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	S	1985	S	4
CB3.3W	MD	main	Chesapeake Bay	39.0046	-76.3881	CB3MH	Susquehanna River a	"01578310"	Direct	3	4	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	S	1985	S	4
CB4.1C	MD	main	Chesapeake Bay	38.8259	-76.3995	CB4MH	Susquehanna River a	"01578310"	Direct	4	1	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	Q	1985	SAP	4
CB4.1E	MD	main	Eastern Bay	38.8181	-76.3714	CB4MH	Susquehanna River a	"01578310"	Direct	4	2	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	Q	1985	SAP	4
CB4.1W	MD	main	Chesapeake Bay	38.8150	-76.4627	CB4MH	Susquehanna River a	"01578310"	Direct	4	3	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	S	1985	S	4
CB4.2C	MD	main	Chesapeake Bay	38.6462	-76.4213	CB4MH	Susquehanna River a	"01578310"	Direct	4	4	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	Q	1985	SAP	4
CB4.2E	MD	main	Chesapeake Bay	38.6450	-76.4013	CB4MH	Susquehanna River a	"01578310"	Direct	4	5	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	S	1985	S	4
CB4.2W	MD	main	Chesapeake Bay	38.6435	-76.5022	CB4MH	Susquehanna River a	"01578310"	Direct	4	6	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	S	1985	S	4
CB4.3C	MD	main	Chesapeake Bay	38.5551	-76.4279	CB4MH	Susquehanna River a	"01578310"	Direct	4	7	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	Q	1985	SAP	4
CB4.3E	MD	main	Chesapeake Bay	38.5562	-76.3912	CB4MH	Susquehanna River a	"01578310"	Direct	4	8	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	Q	1985	SAP	4
CB4.3W	MD	main	Chesapeake Bay	38.5573	-76.4940	CB4MH	Susquehanna River a	"01578310"	Direct	4	9	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	S	1985	S	4
CB4.4	MD	main	Chesapeake Bay	38.4146	-76.3457	CB4MH	Susquehanna River a	"01578310"	Direct	4	10	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	Q	1985	SAP	4
CB5.1	MD	main	Chesapeake Bay	38.3187	-76.2921	CB5MH_MD	Susquehanna River a	"01578310"	Direct	5	1	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	Q	1985	SAP	4
CB5.1W	MD	main	Chesapeake Bay	38.3252	-76.3757	CB5MH_MD	Patuxent River near	"01594440"	Indirect	5	2	Chesapeake Bay M	MD-CB51W	salinity	1	nh4	tn	S	1985	SAP	5
CB5.2	MD	main	Chesapeake Bay	38.1371	-76.2279	CB5MH_MD	Susquehanna River a	"01578310"	Direct	5	3	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	Q	1985	SAP	4
CB5.3	MD	main	Chesapeake Bay	37.9101	-76.1714	CB5MH_MD	Susquehanna River a	"01578310"	Direct	5	4	Chesapeake Bay M	MD-Mainstem	salinity	1	nh4	tn	Q	1985	SAP	4
WT1.1	MD	trib	Bush River	39.4351	-76.2421	BSHOH	Susquehanna River a	"01578310"	SusDefault	14	1	Upper Western Sho	MD-Tributary	flow	120	tn	nh4	Q	1985	S	5
WT2.1	MD	trib	Gunpowder River	39.3775	-76.3347	GUNOH	Susquehanna River a	"01578310"	SusDefault	14	2	Upper Western Sho	MD-Tributary	salinity	1	nh4	tn	S	1986	S	5
WT3.1	MD	trib	Middle River	39.3054	-76.4095	MIDOH	Susquehanna River a	"01578310"	SusDefault	14	3	Upper Western Sho	MD-Tributary	salinity	1	nh4	tn	S	1986	S	5
WT4.1	MD	trib	Back River (Md)	39.2776	-76.4437	BACOH	Susquehanna River a	"01578310"	SusDefault	14	4	Back_Patapsco	MD-Tributary	salinity	1	nh4	tn	S	1985	S	5
WT5.1	MD	trib	Patapsco River	39.2131	-76.5225	PATMH	Susquehanna River a	"01578310"	SusDefault	14	5	Back_Patapsco	MD-Tributary	salinity	1	nh4	tn	S	1985	SAP	5
WT6.1	MD	trib	Magothy River	39.0785	-76.5101	MAGMH	Susquehanna River a	"01578310"	SusDefault	14	6	Lower Western Sho	MD-Tributary	salinity	1	nh4	tn	S	1985	S	5
WT7.1	MD	trib	Severn River	39.0076	-76.5035	SEVMH	Susquehanna River a	"01578310"	SusDefault	14	7	Lower Western Sho	MD-Tributary	salinity	1	nh4	tn	S	1986	S	5
WT8.1	MD	trib	South River	38.9496	-76.5461	SOUMH	Susquehanna River a	"01578310"	SusDefault	14	8	Lower Western Sho	MD-Tributary	salinity	1	nh4	tn	S	1985	S	5
WT8.2	MD	trib	Rhode River	38.8870	-76.5349	RHDMH	Susquehanna River a	"01578310"	SusDefault	14	9	Lower Western Sho	MD-Tributary	salinity	1	nh4	tn	S	1985	S	5
WT8.3	MD	trib	West River	38.8425	-76.5341	WSTMH	Susquehanna River a	"01578310"	SusDefault	14	10	Lower Western Sho	MD-Tributary	salinity	1	nh4	tn	S	1985	S	5

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station	state	location Type	waterbody	latitude	longitude	cbSeg92	usgsGageName	usgsGageID	usgsGage Match	station RO1	station RO2	stationGrpName	stationMethodGroup	hydro Term	flwAvg Win	flwParms	salParms	RMs_ QorSal	start	layer	GAM
TF1.0	MD	pax	Patuxent River	38.9556	-76.6941	PAXTF	Patuxent River near	"01594440"	Direct	15	0	Patuxent River	MD-Patuxent	flow	1	tn	nh4	Q	1985	S	4
TF1.3	MD	pax	Patuxent River	38.8109	-76.7123	PAXTF	Patuxent River near	"01594440"	Direct	15	2	Patuxent River	MD-Patuxent	flow	5	tn	nh4	Q	1985	S	4
TF1.2	MD	pax	Western Branch	38.8143	-76.7508	WBRTF	Patuxent River near	"01594440"	Indirect	15	3	Patuxent River	MD-Patuxent	flow	1	tn	nh4	Q	1985	S	4
WXT0001	MD	pax	Western Branch	38.7854	-76.7134	WBRTF	Patuxent River near	"01594440"	Indirect	15	4	Patuxent River	MD-Patuxent	flow	180	tn	nh4	Q	1991	S	4
TF1.4	MD	pax	Patuxent River	38.7730	-76.7093	PAXTF	Patuxent River near	"01594440"	Direct	15	5	Patuxent River	MD-Patuxent	flow	5	tn	nh4	Q	1985	S	4
TF1.5	MD	pax	Patuxent River	38.7101	-76.7015	PAXTF	Patuxent River near	"01594440"	Direct	15	6	Patuxent River	MD-Patuxent	flow	5	tn	nh4	Q	1985	SAP	4
TF1.6	MD	pax	Patuxent River	38.6585	-76.6838	PAXOH	Patuxent River near	"01594440"	Direct	15	7	Patuxent River	MD-Patuxent	flow	5	tn	nh4	Q	1985	SAP	4
TF1.7	MD	pax	Patuxent River	38.5821	-76.6810	PAXOH	Patuxent River near	"01594440"	Direct	15	8	Patuxent River	MD-Patuxent	flow	5	tn	nh4	Q	1985	S	4
RET1.1	MD	pax	Patuxent River	38.4909	-76.6643	PAXMH	Patuxent River near	"01594440"	Direct	15	9	Patuxent River	MD-Patuxent	flow	30	tn	nh4	Q	1985	SAP	4
LE1.1	MD	pax	Patuxent River	38.4254	-76.6018	PAXMH	Patuxent River near	"01594440"	Direct	15	10	Patuxent River	MD-Patuxent	flow	90	tn	nh4	Q	1985	SAP	4
LE1.2	MD	pax	Patuxent River	38.3789	-76.5113	PAXMH	Patuxent River near	"01594440"	Direct	15	11	Patuxent River	MD-Patuxent	salinity	1	nh4	tn	S	1985	SAP	5
LE1.3	MD	pax	Patuxent River	38.3398	-76.4849	PAXMH	Patuxent River near	"01594440"	Direct	15	12	Patuxent River	MD-Patuxent	salinity	1	nh4	tn	S	1985	SAP	5
LE1.4	MD	pax	Patuxent River	38.3120	-76.4215	PAXMH	Patuxent River near	"01594440"	Direct	15	13	Patuxent River	MD-Patuxent	salinity	1	nh4	tn	S	1985	SAP	5
PIS0033	MD	pot	Piscataway Creek	38.6984	-76.9867	PISTF	Potomac River at Ch	"01646500"	Indirect	16	1	Potomac River	MD-Potomac	flow	1	tn	nh4	Q	1986	S	5
XFB1986	MD	pot	Piscataway Creek	38.6979	-77.0232	PISTF	Potomac River at Ch	"01646500"	Indirect	16	2	Potomac River	MD-Potomac	flow	5	tn	nh4	Q	1986	S	5
TF2.1	MD	pot	Potomac River	38.7066	-77.0488	POTTF_MD	Potomac River at Ch	"01646500"	Direct	16	3	Potomac River	MD-Potomac	flow	1	tn	nh4	Q	1985	S	5
TF2.2	MD	pot	Potomac River	38.6907	-77.1111	POTTF_MD	Potomac River at Ch	"01646500"	Direct	16	4	Potomac River	MD-Potomac	flow	1	tn	nh4	Q	1985	S	5
TF2.3	MD	pot	Potomac River	38.6082	-77.1739	POTTF_MD	Potomac River at Ch	"01646500"	Direct	16	5	Potomac River	MD-Potomac	flow	10	tn	nh4	Q	1985	S	5
MAT0078	MD	pot	Mattawoman Cre	38.5885	-77.1186	MATTF	Potomac River at Ch	"01646500"	Indirect	16	6	Potomac River	MD-Potomac	flow	60	tn	nh4	Q	1986	S	5
MAT0016	MD	pot	Mattawoman Cre	38.5651	-77.1935	MATTF	Potomac River at Ch	"01646500"	Indirect	16	7	Potomac River	MD-Potomac	flow	15	tn	nh4	Q	1986	S	5
TF2.4	MD	pot	Potomac River	38.5301	-77.2654	POTTF_MD	Potomac River at Ch	"01646500"	Direct	16	8	Potomac River	MD-Potomac	flow	10	tn	nh4	Q	1985	S	5
RET2.1	MD	pot	Potomac River	38.4035	-77.2691	POTOH1_MD	Potomac River at Ch	"01646500"	Direct	16	9	Potomac River	MD-Potomac	flow	30	tn	nh4	Q	1985	S	5
RET2.2	MD	pot	Potomac River	38.3525	-77.2051	POTOH1_MD	Potomac River at Ch	"01646500"	Direct	16	10	Potomac River	MD-Potomac	salinity	1	nh4	tn	S	1985	S	5
RET2.4	MD	pot	Potomac River	38.3626	-76.9906	POTMH_MD	Potomac River at Ch	"01646500"	Direct	16	11	Potomac River	MD-Potomac	salinity	1	nh4	tn	S	1985	SAP	5
LE2.2	MD	pot	Potomac River	38.1576	-76.5980	POTMH_MD	Potomac River at Ch	"01646500"	Direct	16	12	Potomac River	MD-Potomac	salinity	1	nh4	tn	S	1985	SAP	5
LE2.3	MD	main	Potomac River	38.0215	-76.3477	POTMH_MD	Potomac River at Ch	"01646500"	Direct	16	13	Potomac River	MD-LE23	salinity	1	nh4	tn	Q	1985	SAP	4
ET1.1	MD	trib	Northeast River	39.5698	-75.9678	NORTF	Susquehanna River a	"01578310"	SusDefault	18	1	Upper Eastern Shor	MD-Tributary	flow	60	tn	nh4	Q	1986	S	5
ET2.1	MD	trib	Back Creek	39.5293	-75.8114	C&DOH_MD	Susquehanna River a	"01578310"	SusDefault	18	2	Upper Eastern Shor	MD-Tributary	flow	50	tn	nh4	Q	1986	S	5
ET2.3	MD	trib	Elk River	39.5087	-75.8978	ELKOH	Susquehanna River a	"01578310"	SusDefault	18	3	Upper Eastern Shor	MD-Tributary	flow	50	tn	nh4	Q	1986	S	5
ET2.2	MD	trib	Bohemia River	39.4670	-75.8737	BOHOH	Susquehanna River a	"01578310"	SusDefault	18	4	Upper Eastern Shor	MD-Tributary	flow	210	tn	nh4	Q	1986	S	5
ET3.1	MD	trib	Sassafras River	39.3642	-75.8820	SASOH	Susquehanna River a	"01578310"	SusDefault	18	5	Upper Eastern Shor	MD-Tributary	flow	180	tn	nh4	Q	1986	S	5
ET4.1	MD	trib	Chester River	39.2437	-75.9249	CHSTF	Choptank River near	"01491000"	ChopDefault	18	6	Upper Eastern Shor	MD-Tributary	flow	5	tn	nh4	Q	1985	S	5
ET4.2	MD	trib	Chester River	38.9923	-76.2151	CHSMH	Choptank River near	"01491000"	ChopDefault	18	8	Upper Eastern Shor	MD-Tributary	salinity	1	nh4	tn	S	1985	SAP	5
XGG8251	MD	tidal	Chester	38.9714	-76.2483	CHSMH	Susquehanna River a	"01578310"	SusDefault	18	8.5	Upper Eastern Shor	MD-XGG8251	salinity	1	nh4	tn	S	1986	S	4
EE1.1	MD	trib	Eastern Bay	38.8800	-76.2515	EASMH	Susquehanna River a	"01578310"	SusDefault	18	9	Upper Eastern Shor	MD-Tributary	salinity	1	nh4	tn	S	1985	SAP	5

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station	state	location Type	waterbody	latitude	longitude	cbSeg92	usgsGageName	usgsGageID	usgsGage Match	station RO1	station RO2	stationGrpName	**stationMethodGroup**	hydro Term	flwAvg Win	flwParms	salParms	RMs_ QorSal	start	layer	GAM
ET5.1	MD	trib	Choptank River	38.8065	-75.9097	CHOOH	Choptank River near	"01491000"	Direct	18	10	Choptank	MD-Tributary	salinity	1	nh4	tn	S	1985	S	5
ET5.2	MD	trib	Choptank River	38.5807	-76.0587	CHOMH2	Choptank River near	"01491000"	Direct	18	11	Choptank	MD-Tributary	flow	60	tn	nh4	Q	1985	SAP	5
EE2.1	MD	trib	Choptank River	38.6549	-76.2643	CHOMH1	Choptank River near	"01491000"	Direct	18	12	Choptank	MD-Tributary	salinity	1	nh4	tn	S	1985	SAP	5
EE2.2	MD	trib	Little Choptank Riv	38.5261	-76.3041	LCHMH	Susquehanna River a	"01578310"	SusDefault	18	13	Choptank	MD-Tributary	salinity	1	nh4	tn	S	1986	S	5
ET6.1	MD	trib	Nanticoke River	38.5483	-75.7031	NANTF_MD	Choptank River near	"01491000"	ChopDefault	18	14	Lower Eastern Shor	MD-Tributary	flow	30	tn	nh4	Q	1986	S	5
ET6.2	MD	trib	Nanticoke River	38.3413	-75.8883	NANMH	Choptank River near	"01491000"	ChopDefault	18	15	Lower Eastern Shor	MD-Tributary	salinity	1	nh4	tn	S	1986	S	5
ET7.1	MD	trib	Wicomico River	38.2678	-75.7879	WICMH	Choptank River near	"01491000"	ChopDefault	18	17	Lower Eastern Shor	MD-Tributary	salinity	1	nh4	tn	S	1986	S	5
ET8.1	MD	trib	Manokin River	38.1379	-75.8141	MANMH	Choptank River near	"01491000"	ChopDefault	18	18	Lower Eastern Shor	MD-Tributary	salinity	1	nh4	tn	S	1986	S	5
ET9.1	MD	trib	Big Annemessex R	38.0550	-75.8017	BIGMH	Choptank River near	"01491000"	ChopDefault	18	19	Lower Eastern Shor	MD-Tributary	flow	150	tn	nh4	Q	1986	S	5
ET10.1	MD	trib	Pocomoke River	38.0762	-75.5713	POCTF	Choptank River near	"01491000"	ChopDefault	18	20	Lower Eastern Shor	MD-Tributary	flow	15	tn	nh4	Q	1986	S	5
EE3.0	MD	trib	Fishing Bay	38.2809	-76.0103	FSBMH	Choptank River near	"01491000"	ChopDefault	18	21	Lower Eastern Shor	MD-Tributary	salinity	1	nh4	tn	S	1986	S	5
EE3.1	MD	trib	Tangier Sound	38.1969	-75.9732	TANMH_MD	Susquehanna River a	"01578310"	SusDefault	18	22	Lower Eastern Shor	MD-Tributary	flow	150	tn	nh4	Q	1985	SAP	5
EE3.2	MD	trib	Tangier Sound	37.9814	-75.9242	TANMH_MD	Susquehanna River a	"01578310"	SusDefault	18	23	Lower Eastern Shor	MD-Tributary	flow	150	tn	nh4	Q	1986	SAP	5
EE3.3	MD	trib	Pocomoke Sound	37.9146	-75.8015	POCMH_MD	Susquehanna River a	"01578310"	SusDefault	18	24	Lower Eastern Shor	MD-Tributary	flow	150	tn	nh4	Q	1986	S	5
WIW0141	MD	trib	Wicomico River	38.3415	-75.6957	WICTF	Choptank River near	"01491000"	ChopDefault	18	30	Lower Eastern Shor	MD-Tributary	salinity	1	nh4	tn	S	2003	S	4

9) **StationMethodList (tidal, partial)**: Summary for each tidal station of the hydroTerm and flowAvgWin for different parameters (see top row for which parameter is shown) by layer (see third column)- Surface (S), Surface/Above Pycnocline (SAP), Bottom (B), Below Pycnocline/Bottom (BBP). flowAvgWin is the selected flow or salinity (flow is set to 1 by default but not used) for each station for each parameter and layer. Grey fill indicates the parameter is not measured for that station/layer.

							TN		TP		TSS		DIN		PO4		CHLA		DO		WTEMP		PH		SECCHI	
station	start	layer	usgsGageID	station RO1	station RO2	stationMethod Group	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win
CB1.1	1985	S	"01578310"	1	1	MD-Mainstem	flow	150	flow	1	flow	1	flow	150	flow	5	flow	10	flow	10	flow	5	flow	5	flow	5
CB2.1	1985	S	"01578310"	1	2	MD-Mainstem	flow	15	flow	5	flow	5	flow	15	flow	10	flow	30	flow	10	flow	5	flow	5	flow	5
CB2.2	1985	SAP	"01578310"	2	1	MD-Mainstem	flow	30	flow	5	flow	10	flow	30	salinity	1	salinity	1	flow	10	flow	10	flow	210	salinity	1
CB3.1	1985	SAP	"01578310"	2	2	MD-Mainstem	salinity	1	flow	5	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	flow	90	salinity	1
CB3.2	1985	SAP	"01578310"	3	1	MD-Mainstem	salinity	1	flow	5	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	flow	30	salinity	1
CB3.3C	1985	SAP	"01578310"	3	2	MD-Mainstem	salinity	1	flow	10	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	flow	210	salinity	1	salinity	1
CB3.3E	1985	S	"01578310"	3	3	MD-Mainstem	salinity	1	flow	10	salinity	1	salinity	1	flow	40	flow	210	salinity	1	salinity	1	salinity	1	salinity	1
CB3.3W	1985	S	"01578310"	3	4	MD-Mainstem	salinity	1	flow	10	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	flow	150	salinity	1	salinity	1
CB4.1C	1985	SAP	"01578310"	4	1	MD-Mainstem	salinity	1	flow	10	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	flow	210	salinity	1	salinity	1
CB4.1E	1985	SAP	"01578310"	4	2	MD-Mainstem	salinity	1	flow	10	flow	90	salinity	1	salinity	1	flow	210	salinity	1	salinity	1	salinity	1	salinity	1
CB4.1W	1985	S	"01578310"	4	3	MD-Mainstem	salinity	1	flow	10	flow	90	salinity	1	salinity	1	flow	210	salinity	1	flow	150	salinity	1	salinity	1
CB4.2C	1985	SAP	"01578310"	4	4	MD-Mainstem	salinity	1	flow	30	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	flow	210	salinity	1	salinity	1
CB4.2E	1985	S	"01578310"	4	5	MD-Mainstem	salinity	1	flow	30	flow	90	salinity	1	flow	40	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1
CB4.2W	1985	S	"01578310"	4	6	MD-Mainstem	salinity	1	flow	30	flow	90	salinity	1	flow	40	salinity	1	salinity	1	flow	150	salinity	1	salinity	1
CB4.3C	1985	SAP	"01578310"	4	7	MD-Mainstem	salinity	1	salinity	1	flow	90	salinity	1	salinity	1	flow	60	salinity	1	flow	210	salinity	1	salinity	1
CB4.3E	1985	SAP	"01578310"	4	8	MD-Mainstem	salinity	1	flow	40	flow	90	salinity	1	flow	40	flow	60	salinity	1	flow	150	salinity	1	salinity	1
CB4.3W	1985	S	"01578310"	4	9	MD-Mainstem	salinity	1	flow	40	flow	90	salinity	1	flow	40	flow	60	salinity	1	flow	150	salinity	1	salinity	1
CB4.4	1985	SAP	"01578310"	4	10	MD-Mainstem	salinity	1	salinity	1	flow	120	salinity	1	salinity	1	flow	60	salinity	1	flow	150	salinity	1	flow	50
CB5.1	1985	SAP	"01578310"	5	1	MD-Mainstem	salinity	1	salinity	1	flow	120	salinity	1	salinity	1	flow	60	salinity	1	flow	150	salinity	1	flow	50
CB5.1W	1985	SAP	"01594440"	5	2	MD-CB51W	salinity	1	flow	90	flow	180	salinity	1	salinity	1	flow	180	salinity	1	flow	40	salinity	1	salinity	1
CB5.2	1985	SAP	"01578310"	5	3	MD-Mainstem	salinity	1	flow	150	flow	120	salinity	1	salinity	1	salinity	1	salinity	1	flow	150	salinity	1	flow	60
CB5.3	1985	SAP	"01578310"	5	4	MD-Mainstem	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	flow	150	salinity	1	flow	60
WT1.1	1985	S	"01578310"	14	1	MD-Tributary	flow	120	flow	180	flow	150	flow	10	flow	60	flow	90	flow	1	flow	1	flow	30	flow	50
WT2.1	1986	S	"01578310"	14	2	MD-Tributary	salinity	1	flow	180	flow	180	flow	10	flow	40	flow	150	flow	20	flow	1	flow	210	flow	180
WT3.1	1986	S	"01578310"	14	3	MD-Tributary	salinity	1	flow	180	flow	5	flow	40	flow	30	flow	150	flow	20	flow	1	flow	150	flow	90
WT4.1	1985	S	"01578310"	14	4	MD-Tributary	salinity	1	flow	40	flow	120	flow	150	salinity	1	flow	10	flow	20	flow	1	flow	210	flow	210
WT5.1	1985	SAP	"01578310"	14	5	MD-Tributary	salinity	1	flow	15	salinity	1	flow	120	flow	90	flow	40	salinity	1	salinity	1	salinity	1	flow	20
WT6.1	1985	S	"01578310"	14	6	MD-Tributary	salinity	1	salinity	1	flow	210	salinity	1	flow	15	flow	40	flow	10	flow	210	salinity	1	salinity	1
WT7.1	1986	S	"01578310"	14	7	MD-Tributary	salinity	1	salinity	1	flow	60	salinity	1	salinity	1	flow	60	salinity	1	flow	210	flow	60	salinity	1
WT8.1	1985	S	"01578310"	14	8	MD-Tributary	salinity	1	salinity	1	flow	60	salinity	1	flow	5	flow	210	salinity	1	flow	210	salinity	1	salinity	1
WT8.2	1985	S	"01578310"	14	9	MD-Tributary	salinity	1	salinity	1	flow	150	salinity	1	flow	90	salinity	1	salinity	1	flow	210	salinity	1	salinity	1
WT8.3	1985	S	"01578310"	14	10	MD-Tributary	salinity	1	salinity	1	flow	150	salinity	1	flow	90	salinity	1	salinity	1	flow	210	salinity	1	salinity	1
TF1.0	1985	S	"01594440"	15	0	MD-Patuxent	flow	1	flow	1	flow	1	flow	1	flow	90	flow	1	flow	1	flow	1	flow	1		
TF1.3	1985	S	"01594440"	15	2	MD-Patuxent	flow	5	flow	1	flow	1	flow	5	flow	5	flow	5	flow	1	flow	5	flow	5		
TF1.2	1985	S	"01594440"	15	3	MD-Patuxent	flow	1	flow	1	flow	1	flow	1	flow	1	flow	1	flow	1	flow	1	flow	1		
WXT0001	1991	S	"01594440"	15	4	MD-Patuxent	flow	180	flow	1	flow	1	flow	1	flow	1	flow	5	flow	1	flow	5	flow	1	flow	1
TF1.4	1985	S	"01594440"	15	5	MD-Patuxent	flow	5	flow	1	flow	1	flow	5	flow	5	flow	5	flow	1	flow	5	flow	5	flow	1
TF1.5	1985	SAP	"01594440"	15	6	MD-Patuxent	flow	5	flow	60	flow	50	flow	5	flow	5	flow	5	flow	5	flow	5	flow	5	flow	60
TF1.6	1985	SAP	"01594440"	15	7	MD-Patuxent	flow	5	salinity	1	flow	180	flow	15	flow	120	flow	5	flow	60	flow	5	flow	150	salinity	1
TF1.7	1985	S	"01594440"	15	8	MD-Patuxent	flow	5	salinity	1	salinity	1	flow	15	flow	90	salinity	1	flow	120	flow	5	flow	5	salinity	1

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station	start	layer	usgsGageID	station RO1	station RO2	stationMethod Group	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win
RET1.1	1985	SAP	"01594440"	15	9	MD-Patuxent	flow	30	salinity	1	salinity	1	salinity	1	flow	120	salinity	1	flow	120	flow	5	flow	5	salinity	1
LE1.1	1985	SAP	"01594440"	15	10	MD-Patuxent	flow	90	flow	60	flow	120	salinity	1	flow	120	salinity	1	flow	180	flow	5	flow	210	salinity	1
LE1.2	1985	SAP	"01594440"	15	11	MD-Patuxent	salinity	1	flow	60	flow	120	salinity	1	flow	150	salinity	1	flow	180	flow	40	flow	210	salinity	1
LE1.3	1985	SAP	"01594440"	15	12	MD-Patuxent	salinity	1	flow	90	flow	210	salinity	1	flow	150	flow	150	salinity	1	flow	40	flow	210	salinity	1
LE1.4	1985	SAP	"01594440"	15	13	MD-Patuxent	salinity	1	flow	120	flow	210	salinity	1	flow	150	flow	150	salinity	1	flow	40	flow	210	salinity	1
PIS0033	1986	S	"01646500"	16	1	MD-Potomac	flow	1	flow	15	flow	1	flow	1	flow	5	flow	5	flow	1	flow	1	flow	150		
XFB1986	1986	S	"01646500"	16	2	MD-Potomac	flow	5	flow	5	flow	1	flow	15	flow	5	flow	20	flow	60	flow	1	flow	5	flow	1
TF2.1	1985	S	"01646500"	16	3	MD-Potomac	flow	1	flow	1	flow	1	flow	5	flow	5	flow	1	flow	10	flow	5	flow	5	flow	1
TF2.2	1985	S	"01646500"	16	4	MD-Potomac	flow	1	flow	1	flow	1	flow	5	flow	5	flow	10	flow	10	flow	5	flow	5	flow	5
TF2.3	1985	S	"01646500"	16	5	MD-Potomac	flow	10	flow	5	flow	5	flow	5	flow	10	flow	10	flow	180	flow	5	flow	5	flow	5
MAT0078	1986	S	"01646500"	16	6	MD-Potomac	flow	60	flow	210	flow	1	flow	10	flow	10	flow	5	flow	1	flow	1	flow	210		
MAT0016	1986	S	"01646500"	16	7	MD-Potomac	flow	15	flow	10	flow	5	flow	40	flow	10	flow	20	flow	90	flow	1	flow	1	flow	10
TF2.4	1985	S	"01646500"	16	8	MD-Potomac	flow	10	flow	5	flow	5	flow	30	flow	20	flow	40	flow	180	flow	5	flow	180	flow	10
RET2.1	1985	S	"01646500"	16	9	MD-Potomac	flow	30	flow	5	salinity	1	salinity	1	flow	50	flow	30	salinity	1	flow	15	flow	30	flow	10
RET2.2	1985	S	"01646500"	16	10	MD-Potomac	salinity	1	flow	5	salinity	1	salinity	1	salinity	1	flow	30	salinity	1	flow	15	flow	180	flow	10
RET2.4	1985	SAP	"01646500"	16	11	MD-Potomac	salinity	1	flow	50	salinity	1	salinity	1	salinity	1	flow	30	salinity	1	flow	15	flow	30	salinity	1
LE2.2	1985	SAP	"01646500"	16	12	MD-Potomac	salinity	1	flow	60	flow	5	flow	50	salinity	1	flow	150	salinity	1	flow	210	salinity	1	salinity	1
LE2.3	1985	SAP	"01646500"	16	13	MD-LE23	salinity	1	flow	150	flow	210	salinity	1	flow	40	flow	180	salinity	1	flow	210	salinity	1	flow	90
ET1.1	1986	S	"01578310"	18	1	MD-Tributary	flow	60	flow	20	flow	5	flow	5	flow	20	flow	150	flow	210	flow	150	flow	210	flow	5
ET2.1	1986	S	"01578310"	18	2	MD-Tributary	flow	50	flow	50	flow	40	flow	90	flow	50	flow	30	flow	210	flow	40	flow	210	flow	40
ET2.3	1986	S	"01578310"	18	3	MD-Tributary	flow	50	flow	50	flow	40	flow	120	flow	50	flow	30	flow	210	flow	40	flow	210	flow	30
ET2.2	1986	S	"01578310"	18	4	MD-Tributary	flow	210	flow	50	flow	40	flow	210	flow	30	flow	30	flow	210	flow	40	flow	210	salinity	1
ET3.1	1986	S	"01578310"	18	5	MD-Tributary	flow	180	flow	1	flow	1	flow	210	flow	150	flow	150	flow	90	flow	1	flow	210	flow	5
ET4.1	1985	S	"01491000"	18	6	MD-Tributary	flow	5	flow	1	flow	120	flow	5	flow	5	flow	15	flow	5	flow	1	flow	5	flow	150
ET4.2	1985	SAP	"01491000"	18	8	MD-Tributary	salinity	1	flow	180	flow	150	flow	30	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1
XGG8251	1986	S	"01578310"	18	8.5	MD-XGG8251	salinity	1	flow	90	flow	210	salinity	1	salinity	1	salinity	1	salinity	1	flow	1	salinity	1		
EE1.1	1985	SAP	"01578310"	18	9	MD-Tributary	salinity	1	salinity	1	flow	150	flow	120	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1
ET5.1	1985	S	"01491000"	18	10	MD-Tributary	salinity	1	flow	20	flow	150	flow	20	flow	20	flow	20	flow	10	flow	1	flow	15	flow	60
ET5.2	1985	SAP	"01491000"	18	11	MD-Tributary	flow	60	flow	40	flow	150	flow	90	salinity	1	flow	210	flow	210	flow	5	salinity	1	flow	120
EE2.1	1985	SAP	"01491000"	18	12	MD-Tributary	salinity	1	salinity	1	flow	150	flow	60	flow	210	flow	210	salinity	1	salinity	1	salinity	1	salinity	1
EE2.2	1986	S	"01578310"	18	13	MD-Tributary	salinity	1	salinity	1	flow	150	flow	120	salinity	1	salinity	1	salinity	1	flow	1	salinity	1	salinity	1
ET6.1	1986	S	"01491000"	18	14	MD-Tributary	flow	30	flow	5	flow	150	flow	30	flow	5	flow	40	flow	1	flow	1	flow	10	flow	180
ET6.2	1986	S	"01491000"	18	15	MD-Tributary	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	flow	5	salinity	1	salinity	1
ET7.1	1986	S	"01491000"	18	17	MD-Tributary	salinity	1	salinity	1	flow	210	salinity	1	salinity	1	flow	150	salinity	1	flow	5	salinity	1	salinity	1
ET8.1	1986	S	"01491000"	18	18	MD-Tributary	salinity	1	salinity	1	flow	90	flow	150	flow	30	salinity	1	salinity	1	flow	1	flow	120	salinity	1
ET9.1	1986	S	"01491000"	18	19	MD-Tributary	flow	150	salinity	1	flow	180	flow	150	flow	60	salinity	1	salinity	1	flow	1	flow	15	flow	40
ET10.1	1986	S	"01491000"	18	20	MD-Tributary	flow	15	flow	180	flow	10	flow	15	flow	5	flow	5	flow	10	flow	5	flow	10	flow	120
EE3.0	1986	S	"01491000"	18	21	MD-Tributary	salinity	1	salinity	1	salinity	1	flow	120	flow	15	salinity	1	salinity	1	flow	5	salinity	1	salinity	1
EE3.1	1985	SAP	"01578310"	18	22	MD-Tributary	flow	150	salinity	1	flow	60	flow	150	flow	1	salinity	1	salinity	1	flow	5	flow	210	salinity	1
EE3.2	1986	SAP	"01578310"	18	23	MD-Tributary	flow	150	salinity	1	flow	60	flow	210	flow	150	salinity	1	salinity	1	flow	5	salinity	1	salinity	1
EE3.3	1986	S	"01578310"	18	24	MD-Tributary	flow	150	flow	210	flow	180	flow	210	salinity	1	salinity	1	salinity	1	flow	5	salinity	1	salinity	1
WIW0141	2003	S	"01491000"	18	30	MD-Tributary	salinity	1	flow	15	flow	90	salinity	1	flow	30	flow	210	flow	210	flow	1	flow	210	salinity	1

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							TN		TP		TSS		DIN		PO4		CHLA		DO		WTEMP		PH		SECCHI	
station	start	layer	usgsGageID	station RO1	station RO2	stationMethod Group	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvgWin
CB1.1	1985	B	"01578310"	1	1	MD-Mainstem	flow	150	flow	1	flow	1	flow	150	flow	5	flow	10	flow	10	flow	5	flow	5		
CB2.1	1985	B	"01578310"	1	2	MD-Mainstem	flow	15	flow	5	flow	5	flow	15	flow	10	flow	30	flow	10	flow	5	flow	120		
CB2.2	1985	BBP	"01578310"	2	1	MD-Mainstem	flow	30	flow	5	flow	10	salinity	1	flow	30	flow	40	flow	10	flow	10	flow	120		
CB3.1	1985	BBP	"01578310"	2	2	MD-Mainstem	flow	60	flow	60	salinity	1	flow	40	salinity	1	flow	40	salinity	1	salinity	1	flow	30		
CB3.2	1985	BBP	"01578310"	3	1	MD-Mainstem	flow	90	flow	90	salinity	1	flow	40	salinity	1	flow	210	salinity	1	salinity	1	flow	30		
CB3.3C	1985	BBP	"01578310"	3	2	MD-Mainstem	salinity	1	flow	90	flow	180	flow	40	flow	30	flow	210	flow	210	flow	210	flow	120		
CB3.3E	1985	B	"01578310"	3	3	MD-Mainstem	flow	90	flow	90	salinity	1	flow	40	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1		
CB3.3W	1985	B	"01578310"	3	4	MD-Mainstem	flow	90	flow	90	flow	120	flow	40	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1		
CB4.1C	1985	BBP	"01578310"	4	1	MD-Mainstem	salinity	1	flow	90	flow	180	flow	120	flow	60	flow	210	flow	210	flow	210	flow	180		
CB4.1E	1985	BBP	"01578310"	4	2	MD-Mainstem	flow	150	salinity	1	flow	150	flow	120	salinity	1	flow	210	salinity	1	salinity	1	flow	180		
CB4.1W	1985	B	"01578310"	4	3	MD-Mainstem	flow	150	flow	90	flow	150	flow	40	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1		
CB4.2C	1985	BBP	"01578310"	4	4	MD-Mainstem	salinity	1	salinity	1	flow	180	flow	150	salinity	1	salinity	1	flow	210	flow	210	flow	180		
CB4.2E	1985	B	"01578310"	4	5	MD-Mainstem	flow	150	flow	40	flow	90	flow	150	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1		
CB4.2W	1985	B	"01578310"	4	6	MD-Mainstem	flow	150	salinity	1	flow	90	flow	40	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1		
CB4.3C	1985	BBP	"01578310"	4	7	MD-Mainstem	salinity	1	salinity	1	flow	180	flow	150	salinity	1	salinity	1	flow	210	flow	210	flow	180		
CB4.3E	1985	BBP	"01578310"	4	8	MD-Mainstem	salinity	1	flow	120	flow	180	flow	150	salinity	1	salinity	1	flow	180	flow	210	flow	180		
CB4.3W	1985	B	"01578310"	4	9	MD-Mainstem	salinity	1	salinity	1	flow	90	flow	60	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1		
CB4.4	1985	BBP	"01578310"	4	10	MD-Mainstem	salinity	1	flow	150	flow	210	flow	150	salinity	1	flow	210	flow	210	flow	150	flow	150		
CB5.1	1985	BBP	"01578310"	5	1	MD-Mainstem	salinity	1	flow	150	flow	180	flow	150	salinity	1	flow	210	flow	210	flow	150	flow	150		
CB5.1W	1985	BBP	"01594440"	5	2	MD-CB51W	salinity	1	flow	90	flow	180	salinity	1	salinity	1	flow	180	salinity	1	flow	40	salinity	1		
CB5.2	1985	BBP	"01578310"	5	3	MD-Mainstem	salinity	1	flow	150	flow	120	flow	150	salinity	1	flow	210	flow	150	flow	210	flow	150		
CB5.3	1985	BBP	"01578310"	5	4	MD-Mainstem	flow	180	flow	210	flow	210	flow	180	salinity	1	flow	210	flow	210	flow	210	flow	150		
WT1.1	1985	B	"01578310"	14	1	MD-Tributary	flow	120	flow	180	flow	150	flow	10	flow	60	flow	90	flow	1	flow	1	flow	30		
WT2.1	1986	B	"01578310"	14	2	MD-Tributary	salinity	1	flow	180	flow	180	flow	10	flow	40	flow	150	flow	20	flow	1	flow	210		
WT3.1	1986	B	"01578310"	14	3	MD-Tributary	salinity	1	flow	180	flow	5	flow	40	flow	30	flow	90	flow	20	flow	1	flow	150		
WT4.1	1985	B	"01578310"	14	4	MD-Tributary	salinity	1	flow	180	flow	120	flow	150	salinity	1	flow	10	flow	20	flow	1	flow	210		
WT5.1	1985	BBP	"01578310"	14	5	MD-Tributary	salinity	1	flow	15	salinity	1	flow	120	flow	90	flow	40	flow	10	salinity	1	salinity	1		
WT6.1	1985	B	"01578310"	14	6	MD-Tributary	salinity	1	salinity	1	flow	210	flow	210	flow	15	flow	60	salinity	1	flow	10	salinity	1		
WT7.1	1986	B	"01578310"	14	7	MD-Tributary	flow	180	salinity	1	salinity	60	flow	180	flow	15	flow	60	salinity	1	flow	10	flow	210		
WT8.1	1985	B	"01578310"	14	8	MD-Tributary	flow	180	flow	210	salinity	60	flow	180	flow	5	flow	210	flow	60	flow	10	flow	210		
WT8.2	1985	B	"01578310"	14	9	MD-Tributary	salinity	1	flow	20	salinity	60	salinity	1	flow	90	salinity	1	flow	60	flow	10	flow	210		
WT8.3	1985	B	"01578310"	14	10	MD-Tributary	salinity	1	flow	10	salinity	60	salinity	1	flow	90	salinity	1	flow	60	flow	10	flow	210		
TF1.5	1985	BBP	"01594440"	15	6	MD-Patuxent	flow	5	flow	150	flow	50	flow	5	flow	5	flow	5	flow	5	flow	5	flow	150		
TF1.6	1985	B	"01594440"	15	7	MD-Patuxent	flow	5	flow	150	flow	180	flow	15	flow	120	flow	5	flow	60	flow	5	flow	50		
TF1.7	1985	B	"01594440"	15	8	MD-Patuxent	flow	5	salinity	1	salinity	1	flow	15	flow	90	salinity	1	flow	120	flow	5	flow	20		

9) **StationMethodList (tidal, partial)**: Summary for each tidal station of the hydroTerm and flowAvgWin for different parameters (see top row for which parameter is shown) by layer (see third column)- Surface (S), Surface/Above Pycnocline (SAP), Bottom (B), Below Pycnocline/Bottom (BBP). flowAvgWin is the selected flow or salinity (flow is set to 1 by default but not used) for each station for each parameter and layer. Grey fill indicates the parameter is not measured for that station/layer.

							TN		TP		TSS		DIN		PO4		CHLA		DO		WTEMP		PH		SECCHI	
station	start	layer	usgsGageID	station RO1	station RO2	stationMethod Group	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvg Win	hydroTerm	flwAvgWin
RET1.1	1985	BBP	"01594440"	15	9	MD-Patuxent	flow	90	salinity	1	salinity	1	salinity	1	flow	120	salinity	1	flow	120	flow	5	flow	210		
LE1.1	1985	BBP	"01594440"	15	10	MD-Patuxent	flow	90	flow	60	flow	120	flow	150	flow	120	salinity	1	flow	210	flow	5	flow	210		
LE1.2	1985	BBP	"01594440"	15	11	MD-Patuxent	flow	90	flow	60	flow	120	flow	90	flow	150	salinity	1	salinity	1	flow	40	flow	210		
LE1.3	1985	BBP	"01594440"	15	12	MD-Patuxent	flow	90	flow	90	salinity	1	flow	90	flow	150	flow	150	flow	90	flow	40	flow	210		
LE1.4	1985	BBP	"01594440"	15	13	MD-Patuxent	flow	90	flow	120	salinity	1	salinity	1	flow	150	flow	150	salinity	1	flow	40	flow	210		
TF2.1	1985	B	"01646500"	16	3	MD-Potomac	flow	1	flow	1	flow	1	flow	5	flow	5	flow	1	flow	10	flow	5	flow	90		
TF2.2	1985	B	"01646500"	16	4	MD-Potomac	flow	1	flow	1	flow	1	flow	5	flow	5	flow	10	flow	10	flow	5	flow	90		
TF2.3	1985	B	"01646500"	16	5	MD-Potomac	flow	10	flow	5	flow	5	flow	5	flow	10	flow	10	flow	10	flow	5	flow	180		
TF2.4	1985	B	"01646500"	16	8	MD-Potomac	flow	10	flow	5	flow	5	flow	30	flow	20	flow	40	flow	10	flow	5	flow	180		
RET2.1	1985	B	"01646500"	16	9	MD-Potomac	salinity	1	flow	5	salinity	1	salinity	1	flow	180	flow	30	salinity	1	flow	15	flow	180		
RET2.2	1985	B	"01646500"	16	10	MD-Potomac	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	flow	30	salinity	1	flow	50	flow	180		
RET2.4	1985	BBP	"01646500"	16	11	MD-Potomac	salinity	1	salinity	1	salinity	1	flow	50	salinity	1	flow	30	salinity	1	flow	50	flow	30		
LE2.2	1985	BBP	"01646500"	16	12	MD-Potomac	flow	120	flow	150	salinity	1	flow	120	salinity	1	salinity	1	salinity	1	flow	210	salinity	1		
LE2.3	1985	BBP	"01646500"	16	13	MD-LE23	flow	150	flow	150	salinity	1	flow	120	salinity	1	salinity	1	salinity	1	flow	210	salinity	1		
ET1.1	1986	B	"01578310"	18	1	MD-Tributary	flow	60	flow	20	flow	5	flow	5	flow	20	flow	150	flow	210	flow	150	flow	210		
ET2.1	1986	B	"01578310"	18	2	MD-Tributary	flow	50	flow	50	flow	40	flow	90	flow	50	flow	30	flow	210	flow	40	flow	210		
ET2.3	1986	B	"01578310"	18	3	MD-Tributary	flow	50	flow	50	flow	40	flow	120	flow	50	flow	30	flow	210	flow	40	flow	210		
ET2.2	1986	B	"01578310"	18	4	MD-Tributary	flow	210	flow	50	flow	40	flow	210	flow	30	flow	30	flow	210	flow	40	flow	210		
ET3.1	1986	B	"01578310"	18	5	MD-Tributary	flow	180	flow	1	flow	1	flow	210	flow	150	flow	150	flow	90	flow	1	flow	60		
ET4.1	1985	B	"01491000"	18	6	MD-Tributary	flow	5	flow	1	flow	120	flow	5	flow	5	flow	15	flow	5	flow	1	flow	5		
ET4.2	1985	BBP	"01491000"	18	8	MD-Tributary	flow	120	flow	180	salinity	1	flow	30	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1		
EE1.1	1985	BBP	"01578310"	18	9	MD-Tributary	flow	150	salinity	1	salinity	1	flow	120	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1		
ET5.1	1985	B	"01491000"	18	10	MD-Tributary	salinity	1	flow	20	flow	15	flow	20	flow	20	flow	20	flow	10	flow	1	flow	15		
ET5.2	1985	BBP	"01491000"	18	11	MD-Tributary	flow	60	flow	210	flow	150	flow	90	flow	150	flow	210	flow	210	flow	5	flow	180		
EE2.1	1985	BBP	"01491000"	18	12	MD-Tributary	salinity	1	salinity	1	flow	150	flow	60	salinity	1	flow	210	salinity	1	salinity	1	salinity	1		
EE2.2	1986	B	"01578310"	18	13	MD-Tributary	flow	150	salinity	1	flow	150	flow	120	salinity	1	salinity	1	salinity	1	flow	1	salinity	1		
ET6.1	1986	B	"01491000"	18	14	MD-Tributary	flow	30	flow	5	flow	150	flow	30	flow	5	flow	40	flow	1	flow	1	flow	10		
ET6.2	1986	B	"01491000"	18	15	MD-Tributary	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	salinity	1	flow	5	salinity	1		
ET7.1	1986	B	"01491000"	18	17	MD-Tributary	salinity	1	salinity	1	flow	210	salinity	1	salinity	1	flow	150	salinity	1	flow	5	salinity	1		
ET8.1	1986	B	"01491000"	18	18	MD-Tributary	salinity	1	salinity	1	flow	90	flow	150	flow	30	salinity	1	salinity	1	flow	1	flow	120		
ET9.1	1986	B	"01491000"	18	19	MD-Tributary	flow	150	flow	150	flow	180	flow	150	flow	60	salinity	1	salinity	1	flow	1	flow	15		
ET10.1	1986	B	"01491000"	18	20	MD-Tributary	flow	15	flow	180	flow	10	flow	15	flow	5	flow	5	flow	10	flow	5	flow	1		
EE3.0	1986	B	"01491000"	18	21	MD-Tributary	salinity	1	salinity	1	salinity	1	flow	120	flow	60	salinity	1	salinity	1	flow	5	salinity	1		
EE3.1	1985	BBP	"01578310"	18	22	MD-Tributary	flow	150	salinity	1	flow	60	flow	150	flow	1	salinity	1	salinity	1	flow	5	flow	210		
EE3.2	1986	BBP	"01578310"	18	23	MD-Tributary	flow	150	salinity	1	flow	60	flow	210	flow	150	salinity	1	salinity	1	flow	5	salinity	1		
EE3.3	1986	B	"01578310"	18	24	MD-Tributary	flow	150	flow	210	flow	180	flow	210	salinity	1	salinity	1	salinity	1	flow	5	flow	210		

10) **Flow adjusted GAM models used (tidal, partial)**: GAM model used for each tidal station for each parameter and layer; observed trend models are paired, so a GAM4 flow adjusted model is paired with a GAM2 observed model (not intervention) and a GAM5 flow adjusted model is paired with a GAM3 observed model (intervention used). Grey fill indicates the parameter is not measured for that station/layer. For some stations the trend period is shortened for PO4 trends due to high percentage of below detection limited data in the early portion of the full trend period; PO4 trend start year is highlighted in blue if it is different from the other parameters.

station	start	usgsGageID	station RO1	station RO2	stationMethod Group	TN	TP	TSS	DIN	‡PO4 start year due to censored data	PO4	CHLA	DO	WTEMP	PH	SECCHI
CB1.1	1985	"01578310"	1	1	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB2.1	1985	"01578310"	1	2	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB2.2	1985	"01578310"	2	1	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB3.1	1985	"01578310"	2	2	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB3.2	1985	"01578310"	3	1	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB3.3C	1985	"01578310"	3	2	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB3.3E	1985	"01578310"	3	3	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB3.3W	1985	"01578310"	3	4	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB4.1C	1985	"01578310"	4	1	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB4.1E	1985	"01578310"	4	2	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB4.1W	1985	"01578310"	4	3	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB4.2C	1985	"01578310"	4	4	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB4.2E	1985	"01578310"	4	5	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB4.2W	1985	"01578310"	4	6	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB4.3C	1985	"01578310"	4	7	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB4.3E	1985	"01578310"	4	8	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB4.3W	1985	"01578310"	4	9	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB4.4	1985	"01578310"	4	10	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB5.1	1985	"01578310"	5	1	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB5.1W	1985	"01594440"	5	2	MD-CB51W	5	4	5	4	1991	4	4	4	4	4	4
CB5.2	1985	"01578310"	5	3	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
CB5.3	1985	"01578310"	5	4	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	4
WT1.1	1985	"01578310"	14	1	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	4
WT2.1	1986	"01578310"	14	2	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	4
WT3.1	1986	"01578310"	14	3	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	4
WT4.1	1985	"01578310"	14	4	MD-Tributary	5	4	4	4	1985	5	4	4	4	4	4
WT5.1	1985	"01578310"	14	5	MD-Tributary	5	4	4	4	1985	5	4	4	4	4	4
WT6.1	1985	"01578310"	14	6	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	4
WT7.1	1986	"01578310"	14	7	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	4
WT8.1	1985	"01578310"	14	8	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	4
WT8.2	1985	"01578310"	14	9	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	4
WT8.3	1985	"01578310"	14	10	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	4
TF1.0	1985	"01594440"	15	0	MD-Patuxent	4	4	4	4	1985	4	4	4	4	4	
TF1.3	1985	"01594440"	15	2	MD-Patuxent	4	4	4	4	1985	4	4	4	4	4	
TF1.2	1985	"01594440"	15	3	MD-Patuxent	4	4	4	4	1985	4	4	4	4	4	
WXT0001	1991	"01594440"	15	4	MD-Patuxent	4	4	4	4	1991	4	4	4	4	4	4
TF1.4	1985	"01594440"	15	5	MD-Patuxent	4	4	4	4	1985	4	4	4	4	4	4
TF1.5	1985	"01594440"	15	6	MD-Patuxent	4	4	4	4	1985	4	4	4	4	4	4
TF1.6	1985	"01594440"	15	7	MD-Patuxent	4	4	4	4	1985	4	4	4	4	4	4
TF1.7	1985	"01594440"	15	8	MD-Patuxent	4	4	4	4	1985	4	4	4	4	4	4

10) **Flow adjusted GAM models used (tidal, partial)**: GAM model used for each tidal station for each parameter and layer; observed trend models are paired, so a GAM4 flow adjusted model is paired with a GAM2 observed model (not intervention) and a GAM5 flow adjusted model is paired with a GAM3 observed model (intervention used). Grey fill indicates the parameter is not measured for that station/layer. For some stations the trend period is shortened for PO4 trends due to high percentage of below detection limited data in the early portion of the full trend period; PO4 trend start year is highlighted in blue if it is different from the other parameters.

station	start	usgsGageID	station RO1	station RO2	stationMethod Group	TN	TP	TSS	DIN	*PO4 start year due to censored data	PO4	CHLA	DO	WTEMP	PH	SECCHI
RET1.1	1985	"01594440"	15	9	MD-Patuxent	4	4	4	4	1985	4	4	4	4	4	4
LE1.1	1985	"01594440"	15	10	MD-Patuxent	4	4	5	4	1991	4	4	4	4	4	4
LE1.2	1985	"01594440"	15	11	MD-Patuxent	5	4	5	4	1991	4	4	4	4	4	4
LE1.3	1985	"01594440"	15	12	MD-Patuxent	5	4	5	4	1991	4	4	4	4	4	4
LE1.4	1985	"01594440"	15	13	MD-Patuxent	5	4	5	4	1991	4	4	4	4	4	4
PIS0033	1986	"01646500"	16	1	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	
XFB1986	1986	"01646500"	16	2	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	4
TF2.1	1985	"01646500"	16	3	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	4
TF2.2	1985	"01646500"	16	4	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	4
TF2.3	1985	"01646500"	16	5	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	4
MAT0078	1986	"01646500"	16	6	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	
MAT0016	1986	"01646500"	16	7	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	4
TF2.4	1985	"01646500"	16	8	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	4
RET2.1	1985	"01646500"	16	9	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	4
RET2.2	1985	"01646500"	16	10	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	4
RET2.4	1985	"01646500"	16	11	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	4
LE2.2	1985	"01646500"	16	12	MD-Potomac	5	4	5	4	1993	5	4	4	4	4	4
LE2.3	1985	"01646500"	16	13	MD-LE23	4	4	4	4	1985	4	4	4	4	4	4
ET1.1	1986	"01578310"	18	1	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	4
ET2.1	1986	"01578310"	18	2	MD-Tributary	5	4	4	4	1986	5	4	4	4	4	4
ET2.3	1986	"01578310"	18	3	MD-Tributary	5	4	4	4	1986	5	4	4	4	4	4
ET2.2	1986	"01578310"	18	4	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	4
ET3.1	1986	"01578310"	18	5	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	4
ET4.1	1985	"01491000"	18	6	MD-Tributary	5	4	4	4	1985	5	4	4	4	4	4
ET4.2	1985	"01491000"	18	8	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	4
XGG8251	1986	"01578310"	18	8.5	MD-XGG8251	4	4	4	4	1986	5	4	4	4	4	
EE1.1	1985	"01578310"	18	9	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	4
ET5.1	1985	"01491000"	18	10	MD-Tributary	5	4	4	4	1985	5	4	4	4	4	4
ET5.2	1985	"01491000"	18	11	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	4
EE2.1	1985	"01491000"	18	12	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	4
EE2.2	1986	"01578310"	18	13	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	4
ET6.1	1986	"01491000"	18	14	MD-Tributary	5	4	4	4	1986	5	4	4	4	4	4
ET6.2	1986	"01491000"	18	15	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	4
ET7.1	1986	"01491000"	18	17	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	4
ET8.1	1986	"01491000"	18	18	MD-Tributary	5	4	5	5	1993	5	4	4	4	4	4
ET9.1	1986	"01491000"	18	19	MD-Tributary	5	4	5	5	1993	5	4	4	4	4	4
ET10.1	1986	"01491000"	18	20	MD-Tributary	5	4	4	4	1986	5	4	4	4	4	4
EE3.0	1986	"01491000"	18	21	MD-Tributary	5	4	4	5	1995	5	4	4	4	4	4
EE3.1	1985	"01578310"	18	22	MD-Tributary	5	4	5	5	1995	5	4	4	4	4	4
EE3.2	1986	"01578310"	18	23	MD-Tributary	5	4	5	5	1995	5	4	4	4	4	4
EE3.3	1986	"01578310"	18	24	MD-Tributary	5	4	5	5	1995	5	4	4	4	4	4
WIW0141	2003	"01491000"	18	30	MD-Tributary	4	4	4	4	2003	4	4	4	4	4	4

10) **Flow adjusted GAM models used (tidal, partial)**: GAM model used for each tidal station for each parameter and layer; observed trend models are paired, so a GAM4 flow adjusted model is paired with a GAM2 observed model (not intervention) and a GAM5 flow adjusted model is paired with a GAM3 observed model (intervention used). Grey fill indicates the parameter is not measured for that station/layer. For some stations the trend period is shortened for PO4 trends due to high percentage of below detection limited data in the early portion of the full trend period; PO4 trend start year is highlighted in blue if it is different from the other parameters.

station	start	layer	usgsGageID	station RO1	station RO2	stationMethod Group	TN	TP	TSS	DIN	*PO4 start year due to censored data	PO4	CHLA	DO	WTEMP	PH	SECCHI
CB1.1	1985	B	"01578310"	1	1	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB2.1	1985	B	"01578310"	1	2	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB2.2	1985	BBP	"01578310"	2	1	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB3.1	1985	BBP	"01578310"	2	2	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB3.2	1985	BBP	"01578310"	3	1	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB3.3C	1985	BBP	"01578310"	3	2	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB3.3E	1985	B	"01578310"	3	3	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB3.3W	1985	B	"01578310"	3	4	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB4.1C	1985	BBP	"01578310"	4	1	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB4.1E	1985	BBP	"01578310"	4	2	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB4.1W	1985	B	"01578310"	4	3	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB4.2C	1985	BBP	"01578310"	4	4	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB4.2E	1985	B	"01578310"	4	5	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB4.2W	1985	B	"01578310"	4	6	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB4.3C	1985	BBP	"01578310"	4	7	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB4.3E	1985	BBP	"01578310"	4	8	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB4.3W	1985	B	"01578310"	4	9	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB4.4	1985	BBP	"01578310"	4	10	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB5.1	1985	BBP	"01578310"	5	1	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB5.1W	1985	BBP	"01594440"	5	2	MD-CB51W	5	4	5	4	1991	4	4	4	4	4	
CB5.2	1985	BBP	"01578310"	5	3	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
CB5.3	1985	BBP	"01578310"	5	4	MD-Mainstem	4	4	4	4	1985	4	4	4	4	4	
WT1.1	1985	B	"01578310"	14	1	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	
WT2.1	1986	B	"01578310"	14	2	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	
WT3.1	1986	B	"01578310"	14	3	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	
WT4.1	1985	B	"01578310"	14	4	MD-Tributary	5	4	4	4	1985	5	4	4	4	4	
WT5.1	1985	BBP	"01578310"	14	5	MD-Tributary	5	4	4	4	1985	5	4	4	4	4	
WT6.1	1985	B	"01578310"	14	6	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	
WT7.1	1986	B	"01578310"	14	7	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	
WT8.1	1985	B	"01578310"	14	8	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	
WT8.2	1985	B	"01578310"	14	9	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	
WT8.3	1985	B	"01578310"	14	10	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	
TF1.5	1985	BBP	"01594440"	15	6	MD-Patuxent	4	4	4	4	1985	4	4	4	4	4	
TF1.6	1985	B	"01594440"	15	7	MD-Patuxent	4	4	4	4	1985	4	4	4	4	4	
TF1.7	1985	B	"01594440"	15	8	MD-Patuxent	4	4	4	4	1985	4	4	4	4	4	

10) **Flow adjusted GAM models used (tidal, partial)**: GAM model used for each tidal station for each parameter and layer; observed trend models are paired, so a GAM4 flow adjusted model is paired with a GAM2 observed model (not intervention) and a GAM5 flow adjusted model is paired with a GAM3 observed model (intervention used). Grey fill indicates the parameter is not measured for that station/layer. For some stations the trend period is shortened for PO4 trends due to high percentage of below detection limited data in the early portion of the full trend period; PO4 trend start year is highlighted in blue if it is different from the other parameters.

station	start	layer	usgsGageID	station RO1	station RO2	stationMethod Group	TN	TP	TSS	DIN	*PO4 start year due to censored data	PO4	CHLA	DO	WTEMP	PH	SECCHI
RET1.1	1985	BBP	"01594440"	15	9	MD-Patuxent	4	4	4	4	1985	4	4	4	4	4	
LE1.1	1985	BBP	"01594440"	15	10	MD-Patuxent	4	4	5	4	1991	4	4	4	4	4	
LE1.2	1985	BBP	"01594440"	15	11	MD-Patuxent	5	4	5	4	1991	4	4	4	4	4	
LE1.3	1985	BBP	"01594440"	15	12	MD-Patuxent	5	4	5	4	1991	4	4	4	4	4	
LE1.4	1985	BBP	"01594440"	15	13	MD-Patuxent	5	4	5	4	1991	4	4	4	4	4	
TF2.1	1985	B	"01646500"	16	3	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	
TF2.2	1985	B	"01646500"	16	4	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	
TF2.3	1985	B	"01646500"	16	5	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	
TF2.4	1985	B	"01646500"	16	8	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	
RET2.1	1985	B	"01646500"	16	9	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	
RET2.2	1985	B	"01646500"	16	10	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	
RET2.4	1985	BBP	"01646500"	16	11	MD-Potomac	5	4	4	4	1986	5	4	4	4	4	
LE2.2	1985	BBP	"01646500"	16	12	MD-Potomac	5	4	5	4	1993	5	4	4	4	4	
LE2.3	1985	BBP	"01646500"	16	13	MD-LE23	4	4	4	4	1985	4	4	4	4	4	
ET1.1	1986	B	"01578310"	18	1	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	
ET2.1	1986	B	"01578310"	18	2	MD-Tributary	5	4	4	4	1986	5	4	4	4	4	
ET2.3	1986	B	"01578310"	18	3	MD-Tributary	5	4	4	4	1986	5	4	4	4	4	
ET2.2	1986	B	"01578310"	18	4	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	
ET3.1	1986	B	"01578310"	18	5	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	
ET4.1	1985	B	"01491000"	18	6	MD-Tributary	5	4	4	4	1985	5	4	4	4	4	
ET4.2	1985	BBP	"01491000"	18	8	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	
EE1.1	1985	BBP	"01578310"	18	9	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	
ET5.1	1985	B	"01491000"	18	10	MD-Tributary	5	4	4	4	1985	5	4	4	4	4	
ET5.2	1985	BBP	"01491000"	18	11	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	
EE2.1	1985	BBP	"01491000"	18	12	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	
EE2.2	1986	B	"01578310"	18	13	MD-Tributary	5	4	5	4	1993	5	4	4	4	4	
ET6.1	1986	B	"01491000"	18	14	MD-Tributary	5	4	4	4	1986	5	4	4	4	4	
ET6.2	1986	B	"01491000"	18	15	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	
ET7.1	1986	B	"01491000"	18	17	MD-Tributary	5	4	4	4	1993	5	4	4	4	4	
ET8.1	1986	B	"01491000"	18	18	MD-Tributary	5	4	5	5	1993	5	4	4	4	4	
ET9.1	1986	B	"01491000"	18	19	MD-Tributary	5	4	5	5	1993	5	4	4	4	4	
ET10.1	1986	B	"01491000"	18	20	MD-Tributary	5	4	4	4	1986	5	4	4	4	4	
EE3.0	1986	B	"01491000"	18	21	MD-Tributary	5	4	4	5	1995	5	4	4	4	4	
EE3.1	1985	BBP	"01578310"	18	22	MD-Tributary	5	4	5	5	1995	5	4	4	4	4	
EE3.2	1986	BBP	"01578310"	18	23	MD-Tributary	5	4	5	5	1995	5	4	4	4	4	
EE3.3	1986	B	"01578310"	18	24	MD-Tributary	5	4	5	5	1995	5	4	4	4	4	

11) **StationMethodList (partial, non-tidal)**: information specific to each individual non-tidal station including station information (name, location type, coordinates, relevant USGS gage, station group, stationMethodGroup (links to MethodList), flow correction averaging windows (if applicable), parameters that are flow corrected in GAM3/GAM5 (flwParms) and parameters that are salinity corrected in GAM3/GAM5 (salParms). All trends are surface trends so different tables are not required for separate layers. Only 3 flow regimes are tested for non-tidal stations (1, 3, and 7) so all parameters can use the same table. flowAvgWin is the selected flow for each station for each parameter. Table 12 shows the flowAvgWin of the tables for other parameters. Unlike for tidal station parameters (Table 10), non-tidal stations use the same GAM models (with or without intervention) and are summarized in Table 13.

station	state	location Type	waterbody	latitude	longitude	cbSeg92	usgsGageName	usgsGageID	station RO1	station RO2	stationGrpName	stationMethod Group	hydroTerm	flwAvg Win	flwParms	salParms	RMs_ QorS	start
NBP0689	MD	Non-tidal	POTOMAC	39.3893	-79.17936	POTNT	NORTH BRANCH PO	"01598500"	2	1	UPPER POTOMAC R	MD-COREWMD	flow	1 3 7	tn tp tss	nh4	Q	1986
SAV0000	MD	Non-tidal	POTOMAC	39.4806	-79.06806	POTNT	SAVAGE RIV BL SAVA	"01597500"	2	2	UPPER POTOMAC R	MD-COREWMD	flow	1 3 7	tn tp tss	nh4	Q	1986
NBP0534	MD	Non-tidal	POTOMAC	39.4792	-79.06802	POTNT	NORTH BRANCH PO	"01598500"	2	3	UPPER POTOMAC R	MD-COREWMD	flow	1 3 7	tn tp tss	nh4	Q	1986
GEO0009	MD	Non-tidal	POTOMAC	39.4936	-79.0447	POTNT	GEORGES CREEK AT	"01599000"	2	4	UPPER POTOMAC R	MD-COREWMD	flow	1 3 7	tn tp tss	nh4	Q	1986
NBP0461	MD	Non-tidal	POTOMAC	39.4449	-78.97175	POTNT	SAVAGE RIV BL SAVA	"01597500"	2	5	UPPER POTOMAC R	MD-COREWMD	flow	1 3 7	tn tp tss	nh4	Q	1986
NBP0326	MD	Non-tidal	POTOMAC	39.5668	-78.83891	POTNT	NORTH BRANCH PO	"01603000"	2	6	UPPER POTOMAC R	MD-COREWMD	flow	1 3 7	tn tp tss	nh4	Q	1986
BDK0000	MD	Non-tidal	POTOMAC	39.6705	-78.79081	POTNT	WILLS CREEK NEAR	"01601500"	2	7	UPPER POTOMAC R	MD-COREWMD	flow	1 3 7	tn tp tss	nh4	Q	1986
WIL0013	MD	Non-tidal	POTOMAC	39.6619	-78.78029	POTNT	WILLS CREEK NEAR	"01601500"	2	8	UPPER POTOMAC R	MD-COREWMD	flow	1 3 7	tn tp tss	nh4	Q	1986
NBP0103	MD	Non-tidal	POTOMAC	39.5827	-78.73145	POTNT	NORTH BRANCH PO	"01603000"	2	9	UPPER POTOMAC R	MD-COREWMD	flow	1 3 7	tn tp tss	nh4	Q	1986
NBP0023	MD	Non-tidal	POTOMAC	39.5745	-78.61537	POTNT	NORTH BRANCH PO	"01603000"	2	10	UPPER POTOMAC R	MD-COREWMD	flow	1 3 7	tn tp tss	nh4	Q	1986
TOW0030	MD	Non-tidal	POTOMAC	39.553	-78.55339	POTNT	NORTH BRANCH PO	"01603000"	2	11	UPPER POTOMAC R	MD-COREWMD	flow	1 3 7	tn tp tss	nh4	Q	1986
POT2766	MD	Non-tidal	POTOMAC	39.5387	-78.45449	POTNT	POTOMAC RIVER AT	"01610000"	2	12	UPPER POTOMAC R	MD-COREWMD	flow	1 3 7	tn tp tss	nh4	Q	1986
POT2386	MD	Non-tidal	POTOMAC	39.6974	-78.1763	POTNT	POTOMAC RIVER AT	"01613000"	3	1	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
CON0180	MD	Non-tidal	POTOMAC	39.716	-77.82505	POTNT	CONOCOCHEAGUE	"01614500"	3	2	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
CON0005	MD	Non-tidal	POTOMAC	39.6032	-77.8216	POTNT	CONOCOCHEAGUE	"01614500"	3	3	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
ANT0366	MD	Non-tidal	POTOMAC	39.716	-77.60822	POTNT	ANTIETAM CREEK N	"01619500"	3	4	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
ANT0203	MD	Non-tidal	POTOMAC	39.5946	-77.71079	POTNT	ANTIETAM CREEK N	"01619500"	3	5	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
ANT0044	MD	Non-tidal	POTOMAC	39.4504	-77.73165	POTNT	ANTIETAM CREEK N	"01619500"	3	6	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
POT1830	MD	Non-tidal	POTOMAC	39.4351	-77.80266	POTNT	POTOMAC RIVER AT	"01638500"	3	7	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
MON0528	MD	Non-tidal	POTOMAC	39.6792	-77.23489	POTNT	MONOCACY RIVER	"01639000"	4	1	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
BPC0035	MD	Non-tidal	POTOMAC	39.6122	-77.23821	POTNT	BIG PIPE CREEK AT B	"01639500"	4	2	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
MON0269	MD	Non-tidal	POTOMAC	39.4803	-77.38939	POTNT	MONOCACY RIVER	"01643000"	4	3	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
MON0155	MD	Non-tidal	POTOMAC	39.3878	-77.3811	POTNT	MONOCACY RIVER	"01643000"	4	4	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
MON0020	MD	Non-tidal	POTOMAC	39.2717	-77.44157	POTNT	MONOCACY RIVER	"01643000"	4	5	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
CAC0148	MD	Non-tidal	POTOMAC	39.4258	-77.559	POTNT	CATOCTIN CREEK NE	"01637500"	5	1	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
CAC0031	MD	Non-tidal	POTOMAC	39.3318	-77.58018	POTNT	CATOCTIN CREEK NE	"01637500"	5	2	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
POT1596	MD	Non-tidal	POTOMAC	39.2721	-77.5479	POTNT	POTOMAC RIVER AT	"01638500"	5	3	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
POT1595	MD	Non-tidal	POTOMAC	39.2735	-77.54367	POTNT	POTOMAC RIVER AT	"01638500"	5	4	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
POT1471	MD	Non-tidal	POTOMAC	39.1544	-77.52125	POTNT	POTOMAC RIVER AT	"01638500"	6	2	UPPER POTOMAC R	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
SEN0008	MD	Non-tidal	POTOMAC	39.0796	-77.33964	POTNT	SENECA CREEK AT D	"01645000"	6	3	MIDDLE POTOMAC	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986

11) **StationMethodList (partial, non-tidal)**: information specific to each individual non-tidal station including station information (name, location type, coordinates, relevant USGS gage, station group, stationMethodGroup (links to MethodList), flow correction averaging windows (if applicable), parameters that are flow corrected in GAM3/GAM5 (flwParms) and parameters that are salinity corrected in GAM3/GAM5 (salParms). All trends are surface trends so different tables are not required for separate layers. Only 3 flow regimes are tested for non-tidal stations (1, 3, and 7) so all parameters can use the same table. flowAvgWin is the selected flow for each station for each parameter. Table 12 shows the flowAvgWin of the tables for other parameters. Unlike for tidal station parameters (Table 10), non-tidal stations use the same GAM models (with or without intervention) and are summarized in Table 13.

station	state	location Type	waterbody	latitude	longitude	cbSeg92	usgsGageName	usgsGageID	station RO1	station RO2	stationGrpName	stationMethod Group	hydroTerm	flwAvg Win	flwParms	salParms	RMs_ QorS	start
CJB0005	MD	Non-tidal	POTOMAC	38.9735	-77.14883	POTNT	ROCK CREEK AT SHE	"01648000"	6	4	MIDDLE POTOMAC	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
POT1184	MD	Non-tidal	POTOMAC	38.9482	-77.12734	POTNT	POTOMAC RIVER (AI	"01646502"	6	5	MIDDLE POTOMAC	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
RCM0111	MD	Non-tidal	POTOMAC	38.993	-77.06303	POTNT	POTOMAC RIVER (AI	"01646502"	6	6	MIDDLE POTOMAC	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
ANA0082	MD	Non-tidal	POTOMAC	38.9389	-76.94344	ANATF	NORTH EAST BRANC	"01649500"	6	7	MIDDLE POTOMAC	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
PXT0972	MD	Non-tidal	PATUXENT	39.2393	-77.05619	PAXTF	PATUXENT RIVER NI	"01591000"	7	1	PATUXENT RIVER	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
PXT0809	MD	Non-tidal	PATUXENT	39.1168	-76.87493	PAXTF	PATUXENT RIV NEAI	"01592500"	7	2	PATUXENT RIVER	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
NPA0165	MD	Non-tidal	MD WESTERI	39.4828	-76.88209	PATNT	NORTH BRANCH PA	"01586000"	8	1	PATAPSCO/BACK RI	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
JON0184	MD	Non-tidal	MD WESTERI	39.4087	-76.74277	PATNT	NORTH BRANCH PA	"01586000"	8	2	PATAPSCO/BACK RI	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
GWN0115	MD	Non-tidal	MD WESTERI	39.3428	-76.72639	PATNT	NORTH BRANCH PA	"01586000"	8	3	PATAPSCO/BACK RI	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
PAT0285	MD	Non-tidal	MD WESTERI	39.3124	-76.79224	PATNT	NORTH BRANCH PA	"01586000"	8	4	PATAPSCO/BACK RI	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
PAT0176	MD	Non-tidal	MD WESTERI	39.2178	-76.70534	PATNT	NORTH BRANCH PA	"01586000"	8	5	PATAPSCO/BACK RI	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
GUN0476	MD	Non-tidal	MD WESTERI	39.6894	-76.78047	GUNNT	LITTLE FALLS AT BLU	"01582000"	9	1	UPPER WESTERN SH	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
GUN0258	MD	Non-tidal	MD WESTERI	39.5506	-76.63586	GUNNT	GUNPOWDER FALLS	"01582500"	9	2	UPPER WESTERN SH	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
GUN0125	MD	Non-tidal	MD WESTERI	39.4256	-76.52889	GUNNT	GUNPOWDER FALLS	"01582500"	9	3	UPPER WESTERN SH	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
CB1.0	MD	Non-tidal	MD WESTERI	39.6562	-76.17504	SUSNT	SUSQUEHANNA RIV	"01578310"	10	1	UPPER WESTERN SH	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
DER0015	MD	Non-tidal	MD WESTERI	39.6235	-76.16477	SUSNT	DEER CREEK AT ROC	"01580000"	10	2	UPPER EASTERN SH	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986
ET5.0	MD	Non-tidal	CHOPTANK	38.9972	-75.78644	CHOTF	CHOPTANK RIVER N	"01491000"	11	1	CHOPTANK RIVER	MD-CORE	flow	1 3 7	tn tp tss	nh4	Q	1986

12) **StationMethodList (partial, non-tidal)**: Summary for each non-tidal station of the flowAvgWin for different parameters (see top row for which parameter is shown). flowAvgWin is the selected flow for each station for each parameter. Grey fill indicates the parameter is not measured for that station.

station	usgsGageID	station RO1	station RO2	stationMethod Group	TN	TP	TSS	DIN	PO4	CHLA	DO	WTEMP	PH	COND
NBP0689	"01598500"	2	1	MD-COREWMD	3	1	1	1	1		1	1	7	1
SAV0000	"01597500"	2	2	MD-COREWMD	1	1	1	3	7		3	7	3	7
NBP0534	"01598500"	2	3	MD-COREWMD	7	1	1	1	1		1	1	7	3
GEO0009	"01599000"	2	4	MD-COREWMD	1	1	1	7	1		1	3	1	3
NBP0461	"01598500"	2	5	MD-COREWMD	1	1	1	1	3		3	1	1	3
NBP0326	"01603000"	2	6	MD-COREWMD	1	1	1	1	1		3	1	3	3
BDK0000	"01601500"	2	7	MD-COREWMD	1	1	1	1	1		1	1	1	1
WIL0013	"01601500"	2	8	MD-COREWMD	1	1	1	1	1		1	1	1	1
NBP0103	"01603000"	2	9	MD-COREWMD	1	1	1	1	1		7	3	3	3
NBP0023	"01603000"	2	10	MD-COREWMD	1	1	1	1	1		7	3	7	3
TOW0030	"01603000"	2	11	MD-COREWMD	1	1	1	7	1		1	1	1	1
POT2766	"01610000"	2	12	MD-COREWMD	1	1	1	7	1		1	3	1	3
POT2386	"01613000"	3	1	MD-CORE	1	1	1	7	1	1	1	1	1	3
CON0180	"01614500"	3	2	MD-CORE	7	1	1	7	7	1	1	3	1	1
CON0005	"01614500"	3	3	MD-CORE	3	1	1	7	1	1	1	3	1	3
ANT0366	"01619500"	3	4	MD-CORE	1	1	1	1	3	7	1	7	1	1
ANT0203	"01619500"	3	5	MD-CORE	1	1	1	1	7	1	7	3	7	1
ANT0044	"01619500"	3	6	MD-CORE	7	1	1	7	7	1	1	1	1	1
POT1830	"01638500"	3	7	MD-CORE	1	1	1	7	1	1	1	3	3	3
MON0528	"01639000"	4	1	MD-CORE	3	1	1	7	1	1	3	1	3	7
BPC0035	"01639500"	4	2	MD-CORE	1	1	1	1	1	1	3	1	3	3
MON0269	"01643000"	4	3	MD-CORE	3	1	1	7	1	1	1	1	1	3
MON0155	"01643000"	4	4	MD-CORE	1	1	1	1	3	1	3	1	3	1
MON0020	"01643000"	4	5	MD-CORE	3	1	1	1	3	1	1	1	1	3
CAC0148	"01637500"	5	1	MD-CORE	3	1	1	3	1	7	3	1	3	3
CAC0031	"01637500"	5	2	MD-CORE	3	1	1	3	1	1	3	1	1	3
POT1596	"01638500"	5	3	MD-CORE	1	1	1	7	1	1	1	1	1	3
POT1595	"01638500"	5	4	MD-CORE	7	1	1	1	1	1	7	1	1	3
POT1471	"01638500"	6	2	MD-CORE	1	1	1	1	1	1	1	3	3	1
SEN0008	"01645000"	6	3	MD-CORE	3	1	1	1	1	1	1	3	3	1
CJB0005	"01648000"	6	4	MD-CORE	1	1	1	1	1	1	1	1	1	1
POT1184	"01646502"	6	5	MD-CORE	3	1	1	1	1	1	1	1	1	7
RCM0111	"01646502"	6	6	MD-CORE	1	1	1	3	3	3	7	1	3	1
ANA0082	"01649500"	6	7	MD-CORE	1	1	1	1	1	7	1	3	3	1
PXT0972	"01591000"	7	1	MD-CORE	3	1	1	1	1	7	1	1	1	3
PXT0809	"01592500"	7	2	MD-CORE	7	1	1	7	1	7	1	3	1	7
NPA0165	"01586000"	8	1	MD-CORE	1	1	1	1	1	1	1	1	1	1
JON0184	"01586000"	8	2	MD-CORE	1	1	1	1	1	1	1	1	1	1
GWN0115	"01586000"	8	3	MD-CORE	1	1	1	1	1	1	3	1	1	1
PAT0285	"01586000"	8	4	MD-CORE	3	1	1	1	1	1	1	1	7	3
PAT0176	"01586000"	8	5	MD-CORE	3	1	1	1	3	1	1	1	7	3
GUN0476	"01582000"	9	1	MD-CORE	1	1	1	1	1	1	1	1	1	1
GUN0258	"01582500"	9	2	MD-CORE	3	1	1	1	1	1	1	3	1	1
GUN0125	"01582500"	9	3	MD-CORE	1	1	1	7	3	1	7	1	1	7
CB1.0	"01578310"	10	1	MD-CORE	3	1	1	3	3	7	7	7	7	7
DER0015	"01580000"	10	2	MD-CORE	1	1	1	1	1	1	1	1	1	1
ET5.0	"01491000"	11	1	MD-CORE	1	1	1	1	1	1	3	3	3	3

13) **Flow adjusted GAM models used (non-tidal, partial)**: GAM model used for each non-tidal station for each parameter; observed trend models are paired, so a GAM4 flow adjusted model is paired with a GAM2 observed model (not intervention) and a GAM5 flow adjusted model is paired with a GAM3 observed model (intervention used). Grey fill indicates the parameter is not measured for that station. For some stations the trend period is shortened for PO4 trends due to a high percentage of below detection limited data in the early portion of the full trend period; PO4 trend start year is highlighted in blue because all stations have a different start year for PO4 than for other parameters, either 1987 or 1993.

station	start	station RO1	station RO2	stationMethod Group	TN	TP	TSS	DIN	PO4	PO4 start	CHLA	DO	WTEMP	PH	COND
CAS0479	1986	1	1	MD-COREWMD	4	4	5	4	5	1993		4	4	4	4
YOU0925	1986	1	2	MD-COREWMD	4	4	5	4	5	1993		4	4	4	4
CCR0001	1986	1	3	MD-COREWMD	4	4	5	4	5	1993		4	4	4	4
YOU1139	1986	1	4	MD-COREWMD	4	4	5	4	5	1987		4	4	4	4
LYO0004	1986	1	5	MD-COREWMD	4	4	5	4	5	1987		4	4	4	4
NBP0689	1986	2	1	MD-COREWMD	4	4	5	4	5	1993		4	4	4	4
SAV0000	1986	2	2	MD-COREWMD	4	4	5	4	5	1993		4	4	4	4
NBP0534	1986	2	3	MD-COREWMD	4	4	5	4	5	1993		4	4	4	4
GEO0009	1986	2	4	MD-COREWMD	4	4	5	4	5	1987		4	4	4	4
NBP0461	1986	2	5	MD-COREWMD	4	4	5	4	5	1987		4	4	4	4
NBP0326	1986	2	6	MD-COREWMD	4	4	5	4	5	1987		4	4	4	4
BDK0000	1986	2	7	MD-COREWMD	4	4	5	4	5	1993		4	4	4	4
WIL0013	1986	2	8	MD-COREWMD	4	4	5	4	5	1993		4	4	4	4
NBP0103	1986	2	9	MD-COREWMD	4	4	5	4	5	1987		4	4	4	4
NBP0023	1986	2	10	MD-COREWMD	4	4	5	4	5	1987		4	4	4	4
TOW0030	1986	2	11	MD-COREWMD	4	4	5	4	5	1993		4	4	4	4
POT2766	1986	2	12	MD-COREWMD	4	4	5	4	5	1993		4	4	4	4
POT2386	1986	3	1	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
CON0180	1986	3	2	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
CON0005	1986	3	3	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
ANT0366	1986	3	4	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
ANT0203	1986	3	5	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
ANT0044	1986	3	6	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
POT1830	1986	3	7	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
MON0528	1986	4	1	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
BPC0035	1986	4	2	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
MON0269	1986	4	3	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
MON0155	1986	4	4	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
MON0020	1986	4	5	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
CAC0148	1986	5	1	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
CAC0031	1986	5	2	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
POT1596	1986	5	3	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
POT1595	1986	5	4	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
POT1471	1986	6	2	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
SEN0008	1986	6	3	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
CJB0005	1986	6	4	MD-CORE	4	4	4	4	4	1987	4	4	4	4	4
POT1184	1986	6	5	MD-CORE	4	4	4	4	5	1987	4	4	4	4	4
RCM0111	1986	6	6	MD-CORE	4	4	4	4	5	1987	4	4	4	4	4
ANA0082	1986	6	7	MD-CORE	4	4	4	4	5	1987	4	4	4	4	4
PXT0972	1986	7	1	MD-CORE	4	4	4	4	5	1987	4	4	4	4	4
PXT0809	1986	7	2	MD-CORE	4	4	4	4	5	1993	4	4	4	4	4
NPA0165	1986	8	1	MD-CORE	4	4	4	4	5	1993	4	4	4	4	4
JON0184	1986	8	2	MD-CORE	4	4	4	4	5	1987	4	4	4	4	4
GWN0115	1986	8	3	MD-CORE	4	4	4	4	5	1987	4	4	4	4	4
PAT0285	1986	8	4	MD-CORE	4	4	4	4	5	1987	4	4	4	4	4
PAT0176	1986	8	5	MD-CORE	4	4	4	4	5	1987	4	4	4	4	4
GUN0476	1986	9	1	MD-CORE	4	4	4	4	5	1987	4	4	4	4	4
GUN0258	1986	9	2	MD-CORE	4	4	4	4	5	1993	4	4	4	4	4
GUN0125	1986	9	3	MD-CORE	4	4	4	4	5	1993	4	4	4	4	4
CB1.0	1986	10	1	MD-CORE	4	4	4	4	5	1987	4	4	4	4	4
DER0015	1986	10	2	MD-CORE	4	4	4	4	5	1987	4	4	4	4	4
ET5.0	1986	11	1	MD-CORE	4	4	4	4	5	1987	4	4	4	4	4