Chesapeake Monitoring Cooperative

Prepared by : The Alliance for the Chesapeake Bay and University of Maryland Center for Environmental Science with assistance from Izaak Walton League of America, Dickinson College's Alliance for Aquatic Resource Monitoring and the Chesapeake Bay National Estuarine Research Reserve in Virginia

Quality Assurance Project Plan:
CAPACITY EXPANSION AND INTEGRATING CITIZEN-BASED AND NONTRADITIONAL MONITORING INTO THE CHESAPEAKE BAY PROGRAM PARTNERSHIP : WATER QUALITY MONITORING IN TIDAL WATERS

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A3. Distribution List

Table A3-1. Distribution list for this Quality Assurance Project Plan.

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Participating Monitoring Groups		Varies	See Appendix F

A4. Project Organization

A4.1 Project Organization

The Capacity Expansion and Integration of Citizen-based and Nontraditional Monitoring into the Chesapeake Bay Program Partnership project provides support, training and guidance to monitoring groups sampling non-tidal and tidal portions of the Chesapeake Bay Watershed, now known as the Chesapeake Monitoring Cooperative (CMC). The CMC is managed by the Alliance for the Chesapeake Bay (Alliance) in partnership with the project coordinator at Izaak Walton League of America (IWLA), and includes project partners at the University of Maryland Center for Environmental Science Integration and Application Network (UMCES), Dickinson College's Alliance for Aquatic Resource Monitoring (ALLARM), and the Chesapeake Bay National Estuarine Research Reserve in Virginia (CBNERR-VA). These five organizations together are hereafter referred to as the "Project Team", and each plays a specific role to carry out the three monitoring components: Tidal Water Quality Monitoring, Non-Tidal Water Quality Monitoring, and Benthic Macroinvertebrate Monitoring, and managing the Chesapeake Data Explorer.

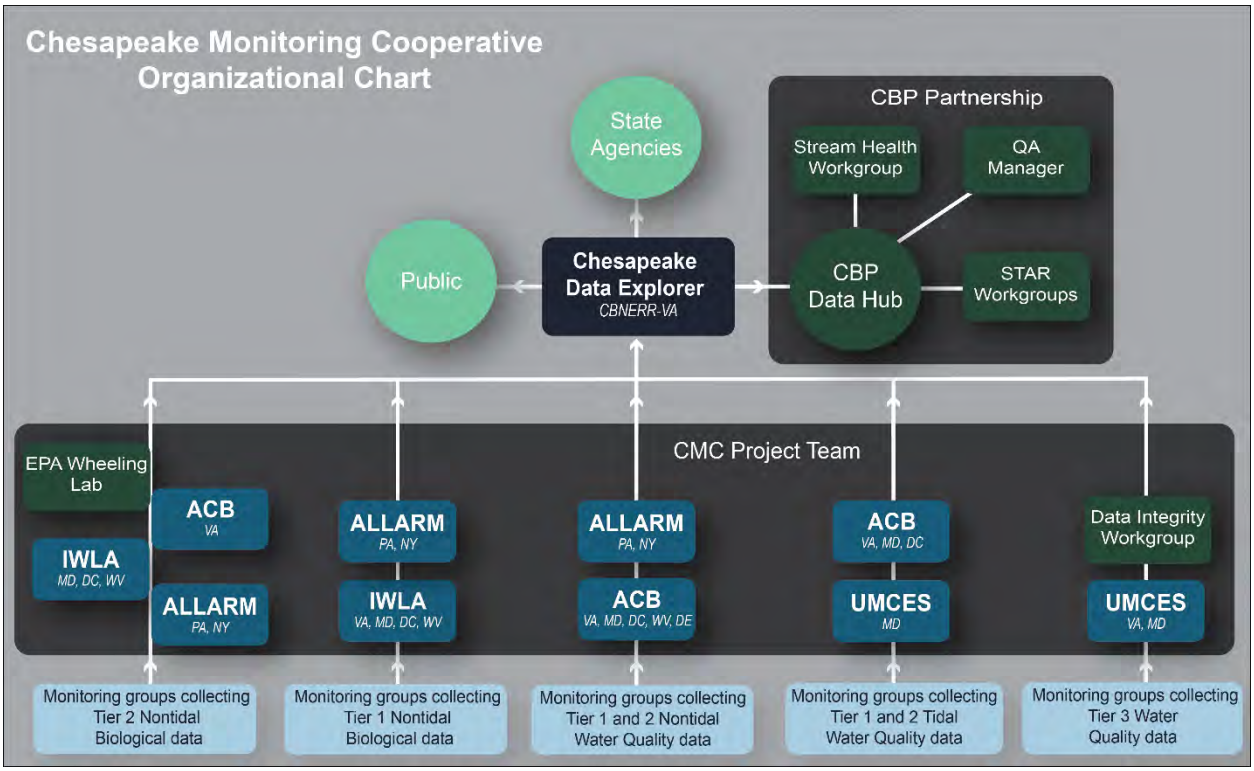

Figure A4-1. Organizational chart for the entire CMC project.

The Alliance and IWLA provide project management and project coordination respectively for all components of the CMC. The Alliance and UMCES train and support volunteer monitoring groups to collect water quality data following this Water Quality Monitoring in Tidal Stream (Tier I and II) Quality Assurance Project Plan (QAPP), referred to as CMC service providers. The Alliance coordinates the project's Tidal Water Quality Monitoring Program for Tier I and Tier II data collectors in Virginia. UMCES

coordinates the Tidal Water Quality Monitoring Program for Tier I and Tier II data collectors in Maryland, the Tidal Tier III Water Quality Monitoring Program and data interpretation workshops. CBNERR-VA manages the Chesapeake Data Explorer that houses all of the data collected through the CMC. Table A4-1 lists the personnel involved in tidal water quality monitoring covered in this QAPP and Figure A4-1 reflects the organization chart for the entire Chesapeake Monitoring Cooperative project.

Table A4-1. Organizations, Roles, and Personnel involved in Tidal Water Quality Monitoring

Organization	Role in Project	Individuals Involved in Project, Title
Alliance for the Chesapeake Bay (Alliance)	Project Manager	Liz Chudoba, Water Quality Monitoring Initiative Director
Izaak Walton League of America (IWLA)	Project Coordinator	Matthew Kierce, Chesapeake Monitoring Outreach Coordinator
Alliance for the Chesapeake Bay (Alliance)	Project Team	Liz Chudoba, Water Quality Monitoring Initiative Director Sophie Stern, Water Quality Monitoring Project Coordinator
University of Maryland Center for Environmental Science Integration and Application Network (UMCES IAN)	Project Team	Alex Fries, Program Manager
Chesapeake Bay National Estuarine Research Reserve in Virginia (CBNERR-VA)	Project Team	Dave Parrish, Environmental Data Center Manager
Monitoring Groups	Data Collectors	Monitors and Certified Trainers. See Appendix E for current list of participating groups
Chesapeake Bay Program	Data Users/QA Management	Durga Ghosh, QA Coordinator Peter Tango, Chesapeake Bay Watershed Monitoring Coordinator Mike Mallonee

A4.2 Roles and Responsibilities

The roles and responsibilities that pertain to Tier I and II water quality data collection in tidal streams are listed below. A full list of roles and responsibilities that pertain to the entire CMC project can be found in the project Quality Management Plan.

Project Manager, Alliance for the Chesapeake Bay

- Manages and provides support for the Project Team to ensure implementation of the Quality Management Plan (QMP), Quality Assurance Project Plans (QAPPs), Standard Operating Procedures (SOPs), and QA policies;
- Annually reviews and updates the approved QMP, QAPP and SOP documents as needed. Small changes will be reported to the Environmental Protection Agency (EPA) in bi-annual reports. When substantial changes that impact the quality system are made to the QMP or QAPPs, the Project Manager will resubmit the QMP or QAPP to EPA for review and approval;
- Schedules, coordinates and facilitates Project Team meetings to build and strengthen partnerships;
- Acts as the liaison between the Project Team and Chesapeake Bay Program Workgroups, including attending workgroup meetings and calls with the STAR Team and the STAR Team's Integrated Monitoring Networks Workgroup and Data Integrity Workgroup (as needed);
- Submit water quality data published in the Chesapeake Data Explorer to the Chesapeake Bay Program's DUET system; and
- Provide CBP with all reporting documentation under the Cooperative Agreement.

Project Coordinator, Izaak Walton League of America

- Assists Project Manager in the coordination and supporting the Project Team to ensure implementation of the Quality Management Plan (QMP), Quality Assurance Project Plans (QAPPs), Standard Operating Procedures (SOPs), and QA policies;
- Assists the Project Manager in annual reviews and updates of the approved QMP, QAPP and SOP documents as needed;
- Schedules, coordinates and facilitates Project Team meetings to build and strengthen partnerships; and
- Acts as the liaison between the Project Team and Chesapeake Bay Program Workgroups, including attending workgroup meetings and calls with the STAR Team and the STAR Team's Integrated Monitoring Networks Workgroup, and the Stream Health Workgroup.

Project Team, Alliance for the Chesapeake Bay

- Develop, review and update EPA approved Water Quality Tidal Quality Assurance Project Plans and the Standard Operating Procedures (SOPs) for monitoring activities;
- Resolve disputes regarding quality system requirements, QA/QC procedures, certifications, or corrective actions.
- Assess data management procedures of the monitoring programs and the Chesapeake Data Explorer to ensure they meet data quality objectives.
- Review and oversee QA policies and SOP's of monitoring groups and document findings for CBP and project records (all Tiers);
- CMC service provider for Tier I and Tier II data collectors in tidal waters in Virginia and as needed in Maryland;
    - Provide regular training (Tier I and II) and certification for individual monitors and data collectors;
    - Ensure all water quality monitoring data operations are covered by the appropriate documentation (i.e., SOPs, QAPPs, project plans) for assigned Tier level;

- Ensure that all data collectors are submitting data to the Chesapeake Data Explorer and adhere to the approved QAPPs and SOPs;
- Assess and re-certify participants to identify QA compliance or deficiencies. QA deficiencies will be resolved when identified and properly documented;
- Comply with annual QA reviews or audits with individual Data Collectors.

Project Team, University of Maryland Center for Environmental Science

- Support the development, review, and update of the EPA approved Water Quality Tidal Quality Assurance Project Plans (QAPPs) and the Standard Operating Procedures (SOPs) for monitoring activities.
- Assess data management procedures of the monitoring programs and the Chesapeake Data Explorer to ensure they meet data quality objectives.
- Review and oversee QA policies and SOP's of monitoring groups and document findings for CBP and project records (all Tiers);
- Acts as the liaison between the Project Team and Chesapeake Bay Program Workgroups, including attending workgroup meetings and calls with the STAR Team's Data Integrity Workgroup and the CBP Communications Workgroup;
- CMC service provider for Tier I and Tier II data collectors in tidal waters in Maryland:
    1. Provide regular training (Tier I and II) and certification for individual monitors and data collectors;
    2. Ensure all water quality monitoring data operations are covered by the appropriate documentation (i.e., SOPs, QAPPs, project plans);
    3. Ensure that all data collectors are submitting data to the Chesapeake Data Explorer and adhere to the approved QAPPs and SOPs;
- CMC service provider for Tier III data collectors in Maryland and Virginia:
    1. Screen Tier III candidate QAPPs and/or SOPs, summarize findings and make recommendations to the CBP for group integration;
    2. Schedule and coordinate on-site audits of Tier III candidates;
    3. Review Tidal Tier III audit reports and recommendations; provide technical assistance as needed to achieve Tier III status;
    4. Support the coordination of the Tier III lab audit process;

Project Team, Chesapeake Bay National Estuarine Research Reserve in VA

- Continually manage the Chesapeake Data Explorer to ensure functional and data storage of tidal water quality data.
- Assess data management procedures of the monitoring programs and the Chesapeake Data Explorer to ensure they meet data quality objectives.
- Coordinate with QA Management, monitoring groups, project partners, and CBP to ensure incorporation of all required QA measures and documentation into the Chesapeake Data Explorer structure;
- Respond to and implement needed changes in the Chesapeake Data Explorer structure to improve the QA/QC checks and ease of user interface; and
- Coordinate with CBP Data Center to submit data from the Chesapeake Data Explorer to the CBP.

QA Oversight, Chesapeake Bay Program Partnership

- Provides approval of Tier III QAPPs submitted by volunteer and nontraditional monitoring groups participating in this project so that their data may be admitted into the Chesapeake Bay Program monitoring network at the level of attainment;
- Identifies individual(s) to approve the three project Tier I and II QAPPs (macroinvertebrate, non-tidal water quality, and tidal water quality monitoring);
- Annual check ins with CMC Project Team to review QAPP and SOP implementation (3 meetings, one for each QAPP that consists of the relevant project team for each QAPP).
- Reviews CMC project QAPPs and provides guidance to Project Team for effective implementation of QAPPs;
- Follows the communication protocols outlined in Figure A4-1.

Data Collectors (MD, DC, and VA monitoring groups)

- Provide all appropriate monitoring documentation (QAPP, Program Manual, SOP, etc) to the CMC service provider in order to be assigned a tier level;
- Follow all monitoring protocols and QA processes as written in the appropriate monitoring documentation to meet their designated tier level;
- Annual review, quality assurance and oversight of all data uploaded to the Chesapeake Data Explorer;
- Evaluate and report QA issues to designated CMC service provider or QA Management as they occur;
- Maintain annual and biennial certification and re-certification with the designated CMC service provider for Tier II data collection;
- Complies with QA reviews or audits by Project Team and/or QA Officer; and
- At least annually uploads data collected to the Chesapeake Data Explorer.

Participating Labs

- Provide all appropriate lab documentation (SOP, QAPP, certification) for each lab method analyzed by a Data Collector included in this project;
- Follow EPA approved or Standard Methods;
- Report QA issues to the Data Collector and/or CMC service provider;
- Provides data to the Data Collector after analysis.

A5. Project Background

The Project Team members are partnering to provide technical, logistical, and outreach support for the capacity expansion and integration of citizen-based and nontraditional (e.g., non-agency) monitoring data into the Chesapeake Bay Program (CBP) partnership. The project is known as the Chesapeake Monitoring Cooperative, or CMC. While the CBP has immediate access to agency (federal and state) data collected in the watershed, nontraditional data producers are scattered among the watershed and collect information that can augment data gathered by the CBP. Both the promotion of data collection as well as the integration of these data into the CBP monitoring network will provide additional cost-

effective data and information that supports shared decision-making and adaptive management by the CBP partners focused on restoration of the Chesapeake Bay and its watershed.

This project started in 2015 through a 6-year cooperative agreement between the Alliance for the Chesapeake Bay and the Chesapeake Bay Program. The first cooperative agreement (2015 – 2021) established the foundation for a consistent and cohesive, watershed-wide, community-based monitoring network. In 2021, the team received a second cooperative agreement (2021 – 2027) in order to maintain this network and increase capacity of community-based monitoring groups to collect data.

A5.1 Goals and Objectives

The CMC project team facilitates data integration from non-traditional and community-based partners throughout the Chesapeake Bay watershed into the Chesapeake Bay Program partnership. To do this, the CMC team works with individual monitoring partners who are currently collecting non-tidal water quality data or wish to develop a new non-tidal monitoring program. Each individual data collector develops their monitoring program around specific goals and data use objectives. These program goals are documented in individual program manuals or standard operating procedures and determine the monitoring frequencies, indicators and equipment used. Program goals typically include the following:

1) Determine long-term trends or changes in water quality indicators;
2) Characterize the present state of a watershed by establishing baseline data, including spatial and seasonal variation, using key water quality indicators;
3) Characterize dissolved oxygen concentrations throughout the water column to track algal blooms and dead zones in the warm weather months;
4) Use data to screen for pollution hot spots or issues that the county or state need to address (e.g. values exceeding state standards;
5) Educate community members about local water quality issues and land use impacts.

The CMC is able to use its QAPPs, tiered framework, and data integration rubric to leverage this data beyond the monitoring partners original scope and to help meet the data needs of the Chesapeake Bay Program and State agency partners and answer questions about the Chesapeake Bay.In June 2000, the Chesapeake Bay Program adopted a new Bay agreement, Chesapeake 2000: A Watershed Partnership to guide the management and restoration of the Bay. In this “C2K”document, Bay Program Partners agreed upon multiple objectives, one of which was “to achieve and maintain the water quality necessary to support the aquatic living resources of the Bay and its tributaries”. Additionally, in June 2018, the CBP Principal Staff Committee unanimously signed an historic Memorandum of Understanding (MOU). This MOU acknowledges that water quality monitoring data are necessary to assess these objectives, however, the monitoring needs exceed the capability of individual CBP partners, therefore it is essential that all data sources of known quality be integrated into the CBP monitoring networks.

The CBP has identified a series of goals for which additional data are essential. For tidal water quality monitoring programs these include (but are not limited to):

a. Assess the habitat conditions for aquatic living resources and determine if these conditions meet tidal water quality criteria and standards designed to protect them from nutrient and sediment impacts;

b. Deduce the likely causes of nutrient and sediment impairments, and determine the best course of action necessary to meet the water quality criteria and standards;
c. Support continued refinement, calibration and validation of Chesapeake Bay Program models such as the Estuarine Water Quality and Sediment Transport Model; and
d. Provide a long-term consistent set of data that is available for public and private research.

The CMC project team will work with individual monitoring partners to achieve the following objectives during the 6-year cooperative agreement:

a. To continue to provide technical, logistical, and outreach support to nontraditional data collectors working in tributaries of the Chesapeake Bay Watershed, in order to integrate data into the Chesapeake Data Explorer;
b. To provide support for data collectors to produce and use data to help address concerns they may have about the health of their local waterways and the impacts of their land use practices on tributaries of the Chesapeake Bay;
c. Facilitate the use of the data by local, state, and federal entities, including addressing science and information needs identified in the CBP's SSRF; and
d. Improve the capacity of federally recognized tribes and other underrepresented and environmental justice communities to conduct nontraditional monitoring.

A5.2 Data Classification

All data collected will be categorized into tiers based on equipment sensitivity and quality assurance approaches with suggestions on possible avenues for the intended data use following the 2016 *Tiered Framework for Data Collection and Integration of Nontraditional Monitoring* (*Tiered Framework*, Appendix C). The tiered framework provides suggested data use options, it is ultimately the decision of a data user to choose the data appropriate for their specific use given the metadata supplied in the Chesapeake Data Explorer. The Project Team categorized these procedures into tiers based on comparability testing, manufacturer's specifications, experience, and how other water quality monitoring programs have classified procedures. The data categorization process largely depend on the methodology used (analysis method and the established accuracy, precision, and sensitivity of the equipment) and the quality assurance requirements (documented internal and external QC procedures - calibration logs, replicates, field blanks, certification, field audits, duplicate analysis of external lab, etc.) implemented by the monitor/group per parameter. The protocols established in this QAPP are designed to produce Tier I and Tier II data.

Field data are categorized into the tiers using a standardized classification rubric. Data are categorized based on individual parameters, so each monitoring program can consist of multiple tiers based on parameters monitored and methods used. If data do not meet the requirements for one of the three tiers, they can be classified as provisional, which includes provisional, provisional Tier I or provisional Tier II. Table A5-1 lists tiers, their intended data uses, and a summary of the data requirements, this QAPP only covers Tier I and II data.

Table A5-1. All tiers of equipment sensitivity, data quality, intended data use, and data requirements for field data, this QAPP only covers Tier I and Tier II data.

Tier	Intended Data Use	Summary of Data Requirements
Provisional	As a mechanism to move groups into the tiered framework and as users see fit given methodologies.	No quality assurance procedures, methods manuals, program documentation.
Provisional Tier I	Education, environmental health screening	Historic dataset that is categorized as tier 1 or current dataset that is categorized as tier 1 but the group did not attend a CMC certification training workshop.
Tier I	Education, environmental health screening, watershed/county report cards, spot checking problematic sites for further investigation	● Documented monitoring methodology - study design, methods manual or SOP. ● Equipment sensitivity meets Tier 1 requirements according to Table B2-1. ● Consistent sampling frequency, equipment and methods. ● Annual or biennial water quality training.
Provisional Tier II	Environmental health screening, environmental health report cards, targeting of management actions	Historic dataset that is categorized as tier 2 or current dataset that is categorized as tier 2 but lacking documented QA practices or necessary metadata.
Tier II	Tier I uses plus environmental health report cards and targeting of management actions	● All Tier I Requirements. ● State or federal government approved QAPP *or* CMC approved Program Manual/SOP. ● Equipment sensitivity meets Tier 2 requirements according to Table B2-1. ● Acquires Tier II certification and maintains certification with CMC Project Team or Program Coordinator.
Tier III	Chesapeake Bay Watershed trends and assessments to help inform policy and management decisions	● Maintain QAPP and field/lab standard operating procedures approved by CBP ● Participation in CBP DIWG field and lab audits

Lab data are classified as provisional Tier II, Tier II or Tier III, as listed in Table A5-2. The Project Team is working with the CBP in order to further define Tier II lab data requirements.

Table A5-2. All Tiers of equipment sensitivity, data quality, intended data use, and data requirements for laboratory data, the QAPP only covers Tier II data.

Tier	Intended Data Use	Summary of Data Requirements
Provisional Tier II	Environmental health screening, environmental health report cards, targeting of management actions	Historic dataset, or current data not analyzed at a lab that meets Tier II requirements (<10% blanks and duplicates).
Tier II	Environmental health screening, environmental health report cards, targeting of management actions	Certified/CBP approved lab and ≥10% blanks and duplicates analyzed.
Tier III	Chesapeake Bay Watershed trends and assessments to help inform policy and management decisions	Completed CBP audit process for field grab samples and CBP approved QAPP.

Data collected at the Tier III level will meet the standards and requirements of the Chesapeake Bay Program monitoring program and thus will be used by the CBP. Depending on the requirements of the data users, Tier III data could potentially be used for regulatory assessments of water and quality standards attainment in addition to the variety of data uses of Tier I and Tier II data. Tier III data requirements and approval process are found in Appendix H.

A5.3 Data Use

All data collected through this project will be archived in the Chesapeake Data Explorer accompanied by the appropriate metadata to allow data users (both traditional and nontraditional) to determine appropriate end uses for the data and to use them as they see fit. The primary intended data user is the monitoring group collecting the data. Each Data Collector will outline their intended data uses and applicable local, state or federal standards to define the health of a waterbody in their program documentation. Typical data uses include, but are not limited to:

- Produce a report card for various chemical, physical, and biological parameters to educate the community residents on the local water quality;
- Assess changing conditions in a waterway due to land use changes;
- Track dissolved oxygen levels throughout the summer months;
- Target or assess restoration progress.

Secondary data users include the Chesapeake Bay Program partnership. Data collected as Tier I, Tier II and Tier III from the CMC Tidal Water Quality Monitoring Program are uploaded to the Chesapeake Bay Program annually. All Tier III data is included in the CBP annual assessment.

Additionally, Data Collectors can opt in to data sharing with state agencies in response to Data Solicitation Notices, in doing so, State agencies access data through the query function of the

Homepage. Data can also be shared and used at a local level, including local government, community stakeholders, and residents to increase awareness and address environmental concerns at multiple levels. Using the data to inform local practices helps to meet the overall goal of the CBP to improve citizen engagement and the health of the Chesapeake Bay Watershed.

A6. Project Description

This Quality Assurance Project Plan is designed to ensure that new data collected (data collected after 2017) in tidal areas and tidal tributaries of Chesapeake Bay (Figure A6-1) will be done in an approved, quality-controlled, and standardized fashion. Data collected prior to 2017 will be considered for inclusion, but may be labeled as provisional depending on the methodology used.

Figure A6-1. Tidal areas and tidal tributaries of Chesapeake Bay Watershed.

In order to be included in the CMC as a Tier I or Tier II group, Data Collectors must follow the on-boarding process outlined in Table A6-1 and demonstrate their ability to meet the data quality objectives, quality assurance standards, and Standard Operating Procedures (SOP) established by this QAPP. At a minimum Tier I groups must have documented site locations with latitude and longitude coordinates, a monitoring methods manual and a consistent monitoring frequency. At a minimum Tier II groups must have all the Tier I requirements, plus either a state or federally approved QAPP that has equivalent QA guidelines to this QAPP. A CMC approved Program Manual can substitute for a state or federally approved QAPP in states that do not have a QAPP approval process (Appendix D).

The CMC Project Team will review the monitoring group's documentation, determine the tier designation following a classification rubric, and provide any necessary training (see Section A8 for more information on the trainings provided) in order for the group to be considered integrated into the CMC. After a group has been integrated, they may then begin to collect new water quality data, or continue collecting water quality data under an existing program, and submit it to the Chesapeake Data Explorer. If a groups data does not meet the Tier I or Tier II data requirements, those data can still be submitted to the Chesapeake Data Explorer, but will be marked as provisional until such a time the methodology is found to be comparable to the SOP established by this QAPP or the quality assurance standards are met.

Table A6-1. On-boarding process for Tier I and Tier II data.

Step 1	Connect a monitoring group to the regional CMC service provider.
Step 2	New Groups complete a study design process or decide to connect to an established program (e.g RiverTrends). Existing groups complete a methods/QA review and evaluation using the Rubric.
Step 3	All monitoring groups complete necessary training. Trainings required are determined by the CMC Service Provider based on monitoring groups individual needs and desired tier level.
Step 4	Upload data to the Chesapeake Data Explorer.
Step 5	Participate in Data Interpretation workshops (as desired).

Tier III groups are not included in this QAPP and must demonstrate that they meet the sampling and analytical requirements of the CBP Methods and QA for water quality monitoring, which must be documented in a separate individual QAPP. The group's documentation must undergo an audit process and be accepted as a Tier III group by the DIWG in order to submit data to the Chesapeake Data Explorer for use by the CBP (see Appendix H for full Tier III process).

A6.1 Project Timeline

Data collection started in 2017 with the approval of three QAPPs covering the tidal, non-tidal and benthic programs under the first cooperative agreement. Monitoring for this project is planned to continue over the next 6-year project period (May 2021 through April 2027) and beyond. Some CMC Data Collectors have been collecting data for decades, historic data (data collected prior to 2017), will also be included in the project but potentially marked as provisional, provisional Tier I, or provisional Tier II depending on the methodology used. The full project timeline is found in **Table A6-2** including all deliverables and tasks for the 6-year grant period under Cooperative Agreement CB96387101.

Each Data Collector participating in the CMC will have their own project timeline tailored to their specific monitoring program which should include at a minimum the information found in Section B, **Table B1-1**.

Table A6-2. CMC project timeline for individual tasks during the 6-year grant period (May 2021-April 2027).

Objective	Deliverable	Deadline
1. Improve capacity of Citizen Science and nontraditional monitoring partner to conduct monitoring.	Provide consistent communication to CMC partners and at least one meeting between the CMC partners and key CBP program staff annually.	Annually, 2021-2027
	Improve capacity of federally recognized tribes and other underrepresented and environmental justice communities to conduct nontraditional monitoring.	2024-2027
2. Develop and improve data analysis, data management, and reporting procedures.	Support and maintenance for the Chesapeake Data Explorer.	Annually, 2021-2027
	Enhance the Chesapeake Data Explorer data visualization components to enable citizen-oriented monitoring and nontraditional monitoring programs to support the analysis and visualization of their data.	2024-2025
	Submit data to the CBP from the Chesapeake Data Explorer	Annually, 2021-2027
3. Strategize data collection efforts by citizen science and nontraditional partners to fill data gaps using regionally standardized approaches.	Update the 2017 Prioritization Report to identify spatial and temporal gaps in the CBP's SSRF and develop strategies to fill those gaps.	2023
	Increase jurisdictional use of nontraditional water quality monitoring data.	Annually, 2021-2027
	Attend relevant CBP workgroup meetings.	Annually, 2021-2027
	Collect 100 benthic macroinvertebrate samples to fill in gaps in the Stream Health Indicator.	Annually, 2021-2027
4. Coordinate and conduct training and support for monitoring program integration.	Provide 30 training sessions annually, including: study design, water quality, biological, train-the-trainer, field audits/QC checks, Data Explorer upload, data interpretation, and recertification.	Annually, 2021-2027
	Revise and update project Quality Management Plan (QMP).	2021 and 2026
	Revise and update three project QAPPs	2022

	Revise and update a scientifically-valid and user-friendly protocol for monitoring and reporting data	2021-2023
	400 individuals participating in citizen-based and nontraditional partner monitoring programs annually.	Annually, 2021-2027
	1,000 individuals reached beyond the CMC network and partners over the six years (170 annually).	Annually, 2021-2027
	Maintain the CMC website that houses all of the recruitment materials, training materials, monitoring protocols, methods manuals, and toolkits.	Annually, 2021-2027

A6.2 Site Selection

Samples will be collected from tidal freshwater areas of tidal tributaries through the river mouths and open waters of Chesapeake Bay (Figure A6-1). Tidal areas are defined as the waters that are influenced by the tidal cycle (ebb and flow). Tidal waters include freshwater areas, called tidal fresh regions, which are subjected to the tides pushing water upstream and receding downstream, even if there is no mixing of saline waters with the freshwater.

Monitoring sites are chosen by individual Data Collectors (following the process in Section B) or with the help of the CMC Project Team if needed. All sampling sites will include detailed metadata including a unique site ID, name of sampled waterbody, description of sample site, and latitude/longitude coordinates (in decimal degrees to 4 decimal places) in order to provide the information needed to compare data across all monitoring groups.

When new sampling sites are needed, they will be selected based on the following criteria:

- Individual monitoring groups data needs,
- Local water quality risks and impairments,
- Data gaps identified in the 2016 Prioritization Report,
- Chesapeake Bay Program data requests,
- State agency data requests.

Site selection can follow a probability based or fixed station design, with most monitoring groups using fixed station design. For fixed station design, stations should be chosen that give the best representation of the waterway monitored. The number of stations recommended is based on the size and location of the watershed balanced with resources to support data collection (people and equipment). In an ideal situation, a HUC 10 watershed has a site located near the mouth but also central watershed and headwaters. Where possible, sites should be located in the free-flowing section of the waterway, representing main channel conditions, which can be collected from a boat, a bridge, or wading. Monitors sampling from a boat must ensure that they are located within 10 meters of the original site location during the sample collection.

Monitoring sites that cannot be located in the middle of a channel due to safety or resource limitations can be located at the end of docks or on the shoreline. Samples should be collected from areas that represent the characteristics of the waterway, as far out into the main channel as possible, and ideally utilize a sampling pole or bucket to collect the sample. It is important to avoid sample collection near stagnant water, eddies, or areas where debris has accumulated.

Once a sampling site or sites are selected, the monitor/coordinator will:

1. Visit their site to confirm that it is safe and easy to access.
2. Use the Property Owner Permission and Liability Release Agreement form (Appendix E) to obtain written permission allowing them to access the stream, if the sampling site is on private property.
3. Record a description of the site and the latitude and longitude coordinates in decimal degrees using GPS with the North American Datum of 1983 (NAD83).
4. Send the sampling site description and coordinates to the CMC Service Provider for verification using Google Maps and/or the USGS National Hydrography Dataset (NHD) in ESRI ArcMap and for upload on the Data Explorer.

A6.3 Water Quality Parameters

There are many different water quality indicators for the concerns associated with the health of tidal tributaries and their impacts on Chesapeake Bay health. The parameters chosen for this project provide a basic assessment of water quality associated with the key issues of Bay eutrophication as well as secondary parameters that are important to local watershed groups in the watershed. The parameters chosen for this project include *in-situ* measurements and lab grab samples. However, this QAPP only covers the field collection methods for lab grab samples, lab analytic methods must also follow the process identified in Section C1.1 in order for data to be included. The full list of parameters that can be analyzed and the equipment that can be used are found in Table B2-1.

This project consists of a diversity of monitoring groups, each with their own goals for what they wish to achieve with their sampling. All projects are not required to monitor all parameters listed, the process for individual monitoring groups to determine their suit of indicators is found in Section B. However, all groups that monitor dissolved oxygen (DO) depth profiles are required to measure total depth, and are recommended to monitor temperature and salinity.

A6.4 Data Management

All data collected through this project (All data Tiers and provisional Tiers) are archived in a centralized database, the Chesapeake Data Explorer (Data Explorer), and accompanied by the appropriate metadata to allow data users to determine appropriate uses for the data and to use them as they see fit. Data is uploaded to the Data Explorer by certified monitors, certified program coordinators or the CMC Service Provider. To upload data, an individual will create a personal account that is linked to their specific monitoring group using an active email address. Once an account is created it is activated by a certified program coordinator or a CMC Service Provider and given a specific role listed in Table A6-3. Only Members can designate accounts as coordinators for particular monitoring groups if they meet the QA standards.

Table A6-3. Chesapeake Data Explorer Roles and Responsibilities

Role	Personnel	Responsibility
Monitor	Certified Monitors	Have access to upload data to sites registered under their group and to edit and review data points they personally upload into the Data Explorer until it is published by the program coordinator.
Coordinator	Certified Program Coordinator/QA Manager	Have access to upload, edit, review and publish data for all sites and monitors assigned to their monitoring group. Have access to add or remove stations, monitors or parameters from their monitoring program.
Member	CMC Service Provider	Have access to upload, edit, review and publish data for all sites and monitoring groups participating in the CMC. Have access to add or remove stations, monitors or parameters from any monitoring program. Uploads all published data to the Chesapeake Bay Program annually.

All published data in the Chesapeake Data Explorer are publicly accessible for download on the homepage and will be uploaded to the Chesapeake Bay Program's Data Upload and Evaluation Tool (DUET) system annually. Data uploaded to DUET are automatically uploaded to EPA's Water Quality Exchange (WQX).

A7. Measurement Quality Objectives

This project is designed to provide water quality measurements that will be utilized to assess the health of the Chesapeake Bay Watershed. Therefore, the most effective means of assuring the data quality objectives are met is to establish quality goals for the individual measurements that will be utilized to meet those objectives. Measurement of the quality for the various measurements obtained for the project can be expressed in terms of precision, accuracy, measurement range, representativeness, comparability, and completeness.

A7.1 Data Precision

Data precision is defined as the ability of a measurement to consistently be reproduced. Repeated measurements are usually used to determine precision. In the case of repeated measurements, one would typically see how close those measurements agree.

This project meets data precision goals by completing the appropriate field duplicate, replicate, and blank at frequencies found in Section B4.3. The methods for collecting the duplicate, replicate and blank samples can be found in the SOP in Appendix A. Any duplicate, replicate or blank samples that fall outside of the acceptable precision range for a specific parameter will be flagged in the Chesapeake Data Explorer. Additionally, precision ranges for each parameter and equipment type are listed in the Chesapeake Data Explorer (where applicable) and included in the metadata files provided with the data.

A7.2 Data Accuracy

Data accuracy is defined as a degree of confidence in a measurement. The smaller the difference between a measurement of a parameter and it's "True" expected value, the more reliable the more accurate the measurement. Also, the more precise or reproducible the result, the more reliable or accurate the result. Accuracy can be determined by comparing an analysis of chemical standard to its actual value.

This project meets data accuracy goals by calibrating, standardizing, and verifying equipment following the frequency and specification criteria outlined in Section B4.2. The methods for performing calibrations, standardizations, and verifications can be found in the SOP in Appendix A. Any calibration samples that fall outside of the acceptable range for a specific equipment will be flagged in the Chesapeake Data Explorer. Additionally, accuracy ranges for each parameter and equipment type are listed in the Chesapeake Data Explorer (where applicable) and included in the metadata files provided with the data.

A7.3 Measurement Range

Measurement range is defined as the range of reliable readings of an instrument or measuring device, or a laboratory method, as specified by the manufacturer or lab.

This project meets measurement range goals by listing the appropriate measurement range for each type of equipment based on manufacturer specifics in the Chesapeake Data Explorer, and included in the metadata files provided with the data. Additionally, upon data upload the data are checked against typical measurement ranges for that particular parameter and flagged if outside of the range. Data can still be accepted if outside the range.

A7.4 Data Representativeness

Data representativeness is defined as how well the collected data depict the true system. This project meets data representativeness goals through the site selection process, sample collection methodology and sampling timelines.

Site locations and the number of sites are chosen with the expectation that they will provide an adequate representation of what is occurring in the water body being sampled. The Project Team will work with individual monitoring groups to select sites based on accessibility, volunteer availability, and budget. More information on the site selection process can be found in Section B4.

Sample collection methodologies should be chosen so that individual samples collected represent the actual conditions or concentrations present in the sampled water body. During sampling, the monitors will utilize reliable QA procedures, follow sample collection and handling methodologies in their methods manual, and follow sample container requirements, preservation, and holding times described in the project SOP (Appendix A).

Water quality samples will be collected following a consistent schedule in order to ensure representativeness. The specific sampling frequency chosen by each monitoring group will depend on the monitoring goals, potential data uses, and resources available, and must be documented in their

project QAPP, SOP and/or methods manual. An outline of typical monitoring timelines can be found in Section B1.2.

A7.5 Data Comparability

Data comparability is defined as the extent to which data from one data set can be compared directly to another data set. The data sets should have enough common ground, equivalence or similarity to permit a meaningful analysis.

The Tiered Framework for data collected ensures comparability within and between monitoring groups, by providing the baseline requirements for each Tier Level (see Table A5-1 and A5-2 for requirements for each tier).

Comparability of data within and between monitoring groups is achieved through:

a. Attending training workshops,
b. Following detailed methodology on sample collection, storage, maintenance, and analysis,
c. Using the monitoring equipment supplied or recommended by the CMC Project Team,
d. Following the standard operating procedures, and
e. Following QA and QC requirements. Details on these items are outlined in their Water Quality Monitoring Methods Manual.
f. Monitors collecting Tier II data will be required to pass a certification test and maintain re-certification annually for the first two years of monitoring and then biennially after that.

When time and resources allow, monitoring groups are encouraged to coordinate samples at the same location and time with other monitoring groups or state monitoring agencies. It is recommended that this occurs at least once a year for each monitoring group. The results from these side by side sampling events will allow the Project Team to assess the comparability of sampling methods and monitoring groups and to identify QA issues that are illuminated at that time.

A7.6 Data Completeness

Data completeness is defined by the amount of data that must be collected to achieve the goals and objectives state for the project. It is typically assessed by comparing the amount of data obtained versus expected given the sampling timeline/frequency set.

For this project, the CMC Project Team works with each individual monitoring group to set their own data completeness goal based on their monitoring frequency and data use goals, which must be documented in the project specific QAPP, SOP or methods manual. Ideally monitoring groups would achieve at least a 90% data completeness percentage within a monitoring year. However, given the nature of volunteer-based monitoring, groups are required to meet a 75% completeness goal from each of the sites during the monitoring timeframe. The minimum (75%) data completeness goal for typical monitoring frequencies (weekly and biweekly, year-round, and weekly summer sampling) can be found in Table A7-1.

The actual number of samples collected and analyzed is not known until after the sampling is completed, and should be calculated as part of the data analysis and review.

Table A7-1. Minimum data completeness requirements for a monitoring group sampling monthly or biweekly, year-round or weekly in the summer following a 75% data completeness goal.

Monitoring Frequency	Number of Samples Anticipated	Minimum Samples Achieved
Monthly, Year-round	12	9
Biweekly, Year-round	24	18
Weekly, Summer (May – October)	24	18

A8. Training Requirements and Certification

The CMC Service Providers hold workshops and offer customized assistance to monitoring groups participating in the CMC depending on their specific needs. Specific details of how and when trainings occur for individual data collectors should be documented in their approved program QAPP, methods manuals or CMC Program Manual. Some options for typical training processes include, but are not limited to:

- A monitoring program has a program coordinator that trains volunteers to collect data independently at selected sites: CMC service provider trains the program coordinator annually to be a certified trainer for their specific monitoring group. The certified trainer then trains individual monitors to go out on their own to collect the data associated with their monitoring program. The certified trainer must retain certification documents for all certified monitors. The CMC service provider additionally trains the program coordinator or an additional staff/volunteer to become the QA manager for their specific monitoring group.
- A monitoring program has a program coordinator and/or staff that collect data at selected sites with the help of volunteers that act as the "crew members": CMC service provider trains a program coordinator and/or staff annually to be a certified monitor for their specific monitoring group. The QA manager can either be the CMC service provider or the program coordinator if they are additionally trained as a QA Manager.
- CMC service provider trains individual volunteers to be certified monitors and collect data independently at their specified monitoring sites: The CMC service provider is the certified trainer and QA manager for the monitoring program. This typically only occurs for the CMC service provider programs (Stream Team, RiverTrends and VASOS).

The CMC service providers conduct five types of training on an annual basis: Study Design Workshops, Water Quality Monitoring Training, Train-the-Trainer Training, Program Coordination/QA Management Training and Data Explorer Training. Finally, the CBP QA officer conducts an annual review of the CMC Project Team/Service Providers.

A8.1 Study Design Workshop

Prior to developing a monitoring program, it is essential to think through the scientific process and the steps necessary to create a program that answers a monitoring question, thinks through intended data uses, identifies the appropriate indicators and equipment for the assessment goals. The study design

process facilitates these important decisions. The Project Team provides Study Design Workshops to monitoring groups who request it (typically monitoring groups who are starting new programs), this process is recommended but not required to collect data under this project. During the study design workshop, the monitoring group will review and determine the following:

- Monitoring goal(s) and question(s)
- Appropriate parameters to monitor and methods to follow
- Number and location of monitoring sites
- When data will be collected
- How they will use and disseminate their data and results locally
- Who will monitor
- Data management, visualization, and storage
- Quality control/quality assurance procedures
- Monitoring schedule

The Study Design process is also a tool to ensure that monitoring programs are set up in accordance with the CMC QAPPs.

A8.2 Water Quality Monitoring Training

All monitors are required to attend a Water Quality Monitoring Training before they begin collecting water quality data. These workshops can be held by anyone and monitors can participate in trainings in many ways, including: attending in-person workshops, attending a virtual workshop, watching online tutorial videos or recordings of workshops, or side-by-side monitoring tutorials (in the field or in a home/lab setting). The specific training type and topics covered is based on the individual monitoring groups sample collect methods, but should include:

- Goals and objectives of the CMC and individual monitoring project;
- Information on the science of water quality issues in the Chesapeake Bay Watershed;
- Potential uses and applications for their data;
- Information on water quality impacts and the significance of the indicators to be measured, including state criteria, values of concern, etc.;
- Data management process including completing a field datasheet and uploading data to the Chesapeake Data Explorer;
- Equipment maintenance and storage;
- Review of standard operating procedures, QA/QC, etc.; and
- A demonstration using the monitoring equipment and methodologies of their specific program.

It is expected that each certified monitor will be able collect samples, measure concentrations of analytes according to their methods manual, and enter data into the Chesapeake Data Explorer (if applicable). Monitors collecting only Tier I data can start data collection after attending their water quality monitoring training. Monitors who wish to collect any Tier II data must take additional steps to become a Certified Monitor. Certified monitors independently collect field data and/or lab grab samples at designated sites and can be volunteers or paid staff. A certified monitor can start collecting data after attending the training held by a Certified Trainer and completing one of the following certification requirements:

1. Pass a certification test with an 80% or greater within 90 days of training, or
2. Submitting a quality assurance duplicate sample to the Project Team/Certified Trainer and have the results fall within a threshold of acceptance based on the precision of the methodology.

Monitors that are unable to meet the certification requirements will be retrained on their deficiencies and allowed to retake the certification test or resubmit their duplicate sample. Monitors are allowed to retake the certification test, and demonstrate proper sampling and analysis technique up to three times in order to become a certified monitor. Monitors that are still unable to meet the certification standard will remain un-certified and can either assist a certified monitor in the field until they have become comfortable with the procedures and QA/QC protocols or collect Tier I data.

All monitors that have passed the initial certification training, are collecting Tier II data, and wish to maintain their certification must attend a re-certification workshop annually for the first two years, and biennially after that to maintain their certification. During re-certification workshops monitors are checked to assure that: they remain proficient in methodology and understanding of basic water quality parameters; their equipment is operational and properly calibrated/verified; and, they have an adequate supply of viable chemicals, procedures, equipment verification/check, and updated information about monitoring. Replacement equipment, datasheets, information, and chemicals are given if needed.

All document of both certification and re-certification trainings are retained at the monitoring groups office or regional Project Team office for 7 years.

A8.3 Train-the-Trainer

A Certified Trainer is any person who is certified to lead a Water Quality Monitoring Workshop and certification process for monitors collecting Tier II data. Certified trainers can be volunteers or paid staff at an organization and must attend a Train-the-Trainer workshop held by a CMC Service Provider. These workshops are held on an as-need basis and can be regionally based, where a few trainers are trained together, or one-on-one with the individual trainers. Typically, Certified Trainers are program coordinators and only certify volunteers monitoring under their specific program, however, a Certified Trainer could also be a regional trainer that works with multiple groups. Train-the-Trainer Workshops are tailored to each monitoring group, but typically cover the goals of the project, information on how to conduct Water Quality Monitoring and Certification Workshops, and how to manage the project documentation. If a group does not have a Certified Trainer, a CMC Service Provider can host water quality monitoring workshops for the monitors or their data is considered Tier 1 or Provisional.

In order to become certified, trainers are required to attend a Train-the-Trainer Workshop led by a CMC Service Provider and demonstrate:

1. A thorough understanding of water quality monitoring methods and QA/QC procedures implemented by this project and their individual monitoring project. This can be achieved through prior knowledge and experience (as deemed appropriate by the CMC service provider) or by being a Certified Monitor for at least one year;
2. An ability to conduct a Water Quality Monitoring Workshop or Certification Workshop, by showing their ability to:

a. Logistically plan and lead a Water Quality Monitoring Workshop, including preparing the equipment and completing all of the necessary documentation,
b. Explain water quality parameters, water quality science, and the importance of assessing stream health in the Chesapeake Bay Watershed, and
c. Effectively train workshop participants to collect data following the project's Tidal Water Quality Monitoring Program.

Trainers may be asked to perform a "mock" training or to undergo an observation by a Project Team member in person or by video in order to qualify. Once a trainee qualifies by these means, they become a Certified Trainer and may train and re-certify volunteer monitors under their program.

In order to stay certified as trainers, the Certified Trainers must meet every year with the regional Project Team member in person or by video in order to be re-certified as a Certified Trainer. During this meeting, trainers will:

1. Review the CMC Tidal Water Quality Monitoring Program Manual and update if needed.
2. Demonstrate their ability to perform monitor certification trainings.
3. Provide equipment to check and verification of the Trainer's master thermometer against the Project Team's NIST verified thermometer.
4. Provide all program documentation, including the list of current monitoring sites, certified monitors, and calibration/verification logs.

Certified Trainers must document all of their certification trainings, including a detailed list of active certified monitors. All documentation resulting from the Certified Trainer workshop will be sent to the CMC service provider annually and filed in their office for at least seven years. The CMC service provider may attend and possibly assist with trainings held by the Certified Trainers as time and funding allow.

A8.4 Coordinator/QA Training

A QA Manager is any person who is certified to perform all QA and data management protocols (including data upload and publishing on the Chesapeake Data Explorer) for a monitoring program collecting Tier II data. QA Managers can be the program coordinator/certified trainer, paid staff or a highly engaged volunteer.

The CMC service provider will provide one-on-one workshops on an as-needed basis during the project timeframe (2021-2027), for those interested and qualified to become QA Managers for their monitoring program.

In order to become a QA Manager, the designated person must demonstrate:

1. A thorough understanding of water quality monitoring methods and QA/QC procedures written in the project QAPP or CMC Program Manual;
2. A proficiency in troubleshooting issues with equipment or any other field supplies;
3. A proficiency in data management using Microsoft Excel or some other electronic data mechanism;
4. Annual recertification or passing of prescribed QC practices;
5. A proficiency in data upload to the Chesapeake Data Explorer.

This can be achieved through prior knowledge and experience (as deemed appropriate by the CMC service provider) or by being a Certified Monitor/Trainer for at least one year. Once a QA Manager is designated for a monitoring group, they are responsible for all QA protocols established for their program with support from the CMC service provider as needed, including but not limited to: entering data into an electronic form, spot checking data, performing data QC checks in order to flag questionable data, reviewing calibration records, troubleshooting issues, uploading and publishing data in the Chesapeake Data Explorer. The QA Manager is designated as a Coordinator in the Data Explorer and has full access to upload, edit, publish and delete data associated with their monitoring group.

If a monitoring group does not have a QA Manager either the CMC service provider acts as the QA Manager for that group, or the data is considered Tier I or provisional.

A8.5 Data Explorer Training

These workshops are held as needed and one-on-one between the CMC service provider and individual monitoring groups (typically the Certified Coordinator, but can include other staff as well) to learn how to upload data to the Data Explorer (typically the bulk upload process). Typically held after a group has collected a few months of data and are ready to start uploading to the Data Explorer.

There are no certification requirements because these trainings are held either with monitoring groups who have gone through the monitor and/or coordinator certification workshops, or are not participating in the CMC training workshops and therefore data is marked as provisional. Workshops typically cover:

1. Transfer of data from an excel file (post-QA) to the Data Explorer bulk upload template. This is done using an excel macro tailored to the specific monitoring group.
2. Logging on to the Data Explorer - overview of the stations, monitors and group info that the Coordinator has control to change.
3. Walk through the bulk upload process

A9. Documentation and Records

The CMC Project Team recommends the following documentation and records. Monitoring groups can use their own existing forms if applicable. If a monitoring group does not have a form, the CMC Project Team has developed templates that can be tailored to the monitoring groups needs. Templates for Property Owner Permission Forms, Liability Release Forms, Field Datasheets and Calibration Logs can be found in Appendix E.

A9.1 Property Owner Permission Form

The CMC recommends any monitoring sites located on private property have a property owner release form to give permission to monitor on that site (recommended that these be signed even if the monitor is the property owner). Property owner permission forms are held by individual monitors and/or Project Coordinators for seven years, and archived digitally.

A9.2 Liability Release Form

The CMC is not responsible for any volunteers monitoring under programs working with the CMC. The CMC recommends that all volunteers sign a liability release form prior to starting monitoring activities. Liability release forms are held by the Project Coordinator for seven years, and archived digitally.

A9.3 Field Datasheets

During every sampling occasion, the monitor must fill out and complete a field data sheet. Participating monitoring groups may already have a data sheet in place that fits the individual group's project design and that the group's monitors are already comfortable with. The CMC service provider will review and approve the field data sheet for use in the project. Monitoring groups that do not have field data sheets or data sheets that are deemed appropriate by the Project Team may use the CMC Datasheet as a template.

On the data sheet, monitors record essential metadata including their name, date, time, sample site location/station ID and field data including values for replicates as applicable. They may also record weather conditions, whether or not they calibrated their equipment, and time spent monitoring. These data sheets are either entered into the Data Explorer directly upon returning from the field or passed on to the monitoring groups Certified Trainer for data entry.

The Project Team/Certified Trainer maintains original hardcopy or scanned records (data sheets) of water quality data submitted by all participating groups for seven years after submission to the project. In addition, the project maintains electronic (digital) records of the data within the Chesapeake Data Explorer.

A9.4 Calibration Logs

All calibration/standardization information must be recorded before and after monitoring as applicable for Tier II methodologies. Calibration and standardization values are recorded on either field datasheets or separate calibration logs. It is recommended to upload calibration values to the Chesapeake Data Explorer for metadata reporting. However, it is not necessary, as long as data are properly flagged with calibration/standardization QA issues. Calibration and standardization logs must be kept by the CMC Service Provider or the Certified QA Manager for 7 years.

All temperature verifications (including the Alliance's Master Thermometer) must be recorded in Temperature Verification logs annually. All verification logs must be kept by the Certified Trainer or the CMC Service Provider for 7 years.

A9.5 Lab Data Sheets

Each lab will be expected to supply their own lab data sheets to record the results. Labs should submit their lab data sheets to the Project Team or Coordinator for review (No template is included in Appendix E). The lab data sheets are to be held by the lab and the regional Project Team/Certified Trainer for a period of seven years.

A9.6 Training Documentation

All documentation from trainings, certifications, and re-certifications, including Train-the-Trainer documents, are held at the regional CMC Service Provider office for seven years.

All certified trainers/QA managers must keep a record of and present the following items during annual training/reviews:

- list of certified monitors, certification test results,
- training sign in sheets/registration sheet,
- a copy of their SOP/Methods Manual/QAPP,
- list/map of sites,
- equipment documentation, etc.

All CMC Service Providers must keep a record of all certified monitoring groups working in their jurisdiction and uploading data to the Data Explorer, records should include:

- a list of certified trainers/QA Managers,
- a completed Tiered Rubric (which includes the equipment used, parameters monitored, QA processes in place, site locations and lab info),
- each groups SOP/QAPP,
- partnership agreement and data sharing agreement,
- QC check lists, etc.

SECTION B – DATA COLLECTION METHODS

This section includes detailed information on how individual monitoring groups/data collectors make decisions about sampling design, sampling frequencies, sampling sites, analytical methods used, and quality control requirements. All information must be documented in a monitoring groups state approved QAPP (where applicable), CMC Program Manual or Methods Manual/SOP in order to be considered for inclusion in the tiered framework. Monitoring groups that do not have the proper documentation will be considered *provisional, provisional* Tier 1 or *provisional* Tier 2 until they complete their documentation.

B1. Sampling Design

This project includes discrete sampling using either *in-situ* sensors, water quality probes, monitoring kits, or lab grab samples that utilize reliable QA procedures. *In-situ* sensors and water quality probes take measurements directly from a waterway, or in some cases a bucket, and include both single parameter sensors and multiprobe sondes. Monitoring kits are used for a variety of parameters, typically using a sample container to collect the sample from a waterway, then samples are analyzed by a monitor either stream-side or at a home, office or lab setting. Lab grab samples are collected directly from a waterway, or in some cases a bucket, and transported to a lab for analysis. Most programs use a combination of techniques to analyze a suite of parameters based on resources available. This project specifically does not include continuous monitoring techniques, air monitoring, drinking water monitoring, groundwater/aquifer monitoring, monitoring for toxic contaminants.

All sampling protocols and equipment will utilize reliable QA procedures in order to meet the data quality objectives of this QAPP. For Tier II field data (*in situ* sensors and monitoring kits), these procedures include calibration/standardization of equipment and field replicates (monitoring kits only) described in the project SOP. For lab analyzed data, these procedures include field blanks and

duplicates, sample container requirements, sample preservation, and sample holding times described in the project SOP.

The CMC Project Team will help monitoring groups determine their individual sampling design decisions. Once a project is set up the CMC Project Team will tailor the CMC Tidal Methods Manual (Appendix A) to suit the needs of the monitoring group, based on the decisions made during the Study Design Workshop (A8.1). Monitors will follow the methods and QA procedures in their tailored monitoring manual to collect water quality data (possible parameters listed in Table B2-1) at their sampling site monthly or more frequently for a minimum of one year. They will test all field parameters in-stream or stream-side and will collect water samples to test non-field parameters within the maximum holding time.

B1.1 Sample Collection

Sample data shall be representative of the actual conditions or concentrations present in the sampled water body. Samples should be collected from the thalweg (mid-channel) of the channel when accessible via wading, boat, or bridge. Samples that cannot be collected from the thalweg can be collected from a dock or shoreline, following guidelines in Section A6.2. If data are collected using probes it is recommended to use a pole to help extend the probe off the bank and into the free-flowing section of the water body. Nitrile or latex gloves are typically required for bacteria monitoring, but may be used for other monitoring as well.

All equipment, technologies and sampling methods selected for this project are used to monitor baseline surface water conditions following the EPA volunteer monitoring methods for streams and estuaries. Individual groups may have more specific methods to meet specific objectives, like targeting restorations projects, tracking bacteria levels for human health, etc.

B1.2 Sampling Frequency

Each Data Collector participating in the CMC will have their own sampling schedule and project timeline based on their project design, monitoring goals, and resources available. Program documentation should include at a minimum the information found in **Table B1-1**. In order to be considered Tier 2, groups must monitor the same parameters following a specified sampling frequency (ie. weekly, biweekly, monthly), with sampling events ideally occurring on a consistent scheduled (ie. The first Thursday of each month) and at a consistent time of day (ie. 10am or only at high tide).

Sampling may be canceled due to unsafe conditions such as high water, strong storms, or other conditions deemed by the monitors to put them at risk of bodily injury or harm if sampling were to proceed. If the set sampling day is canceled, the sample should be collected within 2 days (before or after) of the regular sampling day. If sampling within 2 days is not possible, the Program Coordinator will determine if the sample should be taken at some other frequency or skipped.

If sampling multiple sites that cannot be sampled within one sampling day, the monitoring should be broken up into different sampling runs that are completed on a consistent schedule (ie. Run 1 consists of Sites 1-5 and are sampled every Tuesday, Run 2 consists of Sites 6-10 and are sampled every Wednesday, etc.).

Typical sampling frequencies for tidal monitoring programs include, but are not limited to:

- Once monthly water quality sampling should be conducted year-round when possible, but can be done at a minimum from March to November.
- Biweekly water quality sampling should be conducted year-round when possible, but can be done at a minimum from March to November.
- Weekly water quality sampling typically occurs during the summer months, May through September/October.
- Combination of timeframes – some monitoring programs perform weekly sample collection in the summer and monthly sample collection the rest of the year.

Monitoring programs that do not follow a standard sampling frequency will be considered for inclusion on a case-by-case basis by a CMC Service Provider and will be marked as *provisional*, *provisional* Tier 1 or Tier 1 based on the methodology used.

Sampling timelines should also include schedules for data upload to the Chesapeake Data Explorer and training frequencies. Data should be uploaded at least annually, specific data upload deadlines are determined based on local, state and federal calls for data. Training frequencies should follow guidelines in Section A8 for the monitoring groups designated Tier level.

Table B1-1. Sample project timeline that should be included in program documentation for individual Data Collectors.

Task	Timeline
Program Start Date and End Date (if applicable)	Date the group is considered integrated into the CMC network and an end date for monitoring if there is one.
Sampling frequency (eg. monthly, bimonthly, weekly and year-round or specific months)	Weekly, Biweekly or Monthly
Data upload to the Chesapeake Data Explorer	At least once annually
CMC Field Audit	At least once annually
Volunteer monitor recruitment/training	At least once annually
Recertification for Certified Monitors	Annually for Tier II groups
Recertification for Certified Coordinators	Biennially for Tier II groups

B1.3 Site Selection

Sampling sites are chosen by individual Data Collectors (following the process in Section B) or with the help of the CMC Project Team if needed following either probability based or fixed station design outlined in Section A6.2. Where possible, sites will be chosen with respect to complementing or augmenting data obtained by state and federal agencies and the CBP as well as to provide data that allows monitoring of changes resulting from best management practices, TMDL implementation plans, and other restoration activities. All sampling sites will include detailed metadata including a unique site ID, name of sampled waterbody, description of sample site, and latitude/longitude coordinates in order to provide the information needed to compare data across all monitoring groups. Latitude and longitude coordinates must be documented in decimal degrees to 4 decimal places and can be obtained using a

handheld GPS unit with the North American 1983 Datum (NAD83) or with online mapping tools, like google maps.

Data Collectors determine sites by accessing available information about the local watershed including historical water quality data, land use types, and water quality health concerns in order to see if there are specific data gaps that could be filled or areas that need further monitoring. Data Collectors also review site characteristics such as accessibility and placement in the watershed in order to choose an appropriate monitoring location that represents the waterway and meets the monitoring goals.

To the degree practical, the following criteria are used when selecting sites or groups of sites for the program:

a. There should be an equal number of monitoring sites in the estuarine, transition, and tidal fresh portions of a tidal river.
b. Monitoring sites should be located in the main channel of a tidal stream or river, when feasible. Monitoring sites that cannot be located in the middle of the channel due to safety or resource limitations can be located on docks, piers or the shoreline with sample collection occurring as close to mid-channel as possible.
c. Monitoring sites may be co-located at CBP, state monitoring, or nearby group sites to allow for comparison of datasets.
d. Monitoring sites should be located in accessible and safe areas.

B2. Sampling/Analytical Methods for Field Data

All Data Collectors must follow standard methods manual in order to collect data within the Tiered Framework. The full list of approved parameters, sampling procedures, and equipment along with the highest achievable tier and the requirements to meet that tier designation for field data are listed in **Table B2-1**. Each Data Collector selects parameters, equipment and analytical methods used for their program based on their individual monitoring needs and Tier designation. If a monitor or a program does not meet all of the Tier requirements for a given parameter and equipment (ie. Proper calibration is not performed), or proper data documentation/metadata is not maintained the data are downgraded a Tier or considered *provisional, provisional* Tier I or *provisional* Tier 2 based on the requirement missing. See Section B4.2 for calibration, standardization and verification frequencies and standards needed to meet the Tier Requirements in Table B2-1.

A full description of sampling methods available for use by monitors participating is given in the non-tidal standard operating procedures (SOP) in Appendix A. The SOP is all inclusive of methods that can be used to collect Tier I and Tier II data under this QAPP. Monitoring groups will be provided abridged SOPs that contain only instructions pertinent to their project design if they do not have an SOP of their own.

Table B2-1. Highest achievable Tier and sample method requirements for tidal field data.

Parameter	Approved Procedure	Equipment	Highest Achievable Tier	Tier Requirements
Conductivity	USEPA Method 120.1	Electronic Probe (LaMotte 1749,	Tier II	Calibration

		Extech, HACH Pocket Tester, Multiprobe Sonde)		
Dissolved oxygen	USEPA Method 360.2	Winkler Titration (LaMotte 5860)	Tier II	Standardization, 100% field replicates
Dissolved oxygen	USEPA Method 360.1; As described in probe manual	Electronic Probe (Oakton, Extech, Hanna, Multiprobe Sonde)	Tier II	Calibration
Nitrate-nitrogen	Appendix A	Colorimetric Kit (Hach NI-14 1416100, LaMotte 3110, LaMotte 3354)	Tier I	Acid-wash glassware, 100% field replicates
Nitrite-Nitrate	Appendix A	Field Colorimeter or Spectrophotometer (Hanna HI 707 Digital Checker)	Tier I	Acid-wash glassware, 100% field replicates
Nitrate-nitrogen	Appendix A	Field Colorimeter or Spectrophotometer (Hach)	Tier II	Standardization, Acid-wash glassware, >10% field replicates
Orthophosphate	Appendix A	Colorimetric Kit (Hach PO-19 224800, Hanna HI 38061)	Tier I	Acid-wash glassware, 100% field replicates
Orthophosphate	USEPA Method 356.2	Field Colorimeter (Hanna HI 713 Digital Checker)	Tier I	Acid-washed glassware, 100% field replicates
Orthophosphate	USEPA Method 356.2	Field Colorimeter or Spectrophotometer (Hach)	Tier II	Standardization, Acid-washed glassware, >10% field replicates
pH	Appendix A	ColorpHast pH Strips (2 - 9)	Tier I	N/A
pH	Appendix A	Colorimetric Kit (LaMotte, Hach)	Tier II	Narrow Range, 100% field replicates
pH	USEPA Method 150.1; As described in probe manual	Electronic Probe (Hanna, LaMotte, Oakton, Extech, Multiprobe Sonde)	Tier II	Calibration

Salinity	Appendix A	Refractometer (Extech, General)	Tier I	Standardized
Salinity	USEPA Method 120.1; As described in probe manual	Electronic Probe (LaMotte 1749, Extech, Multiprobe Sonde)	Tier II	Calibration
Total dissolved solids	Appendix A; As described in probe manual	Electronic Probe (LaMotte 1749, Extech)	Tier I	N/A
Water clarity	Appendix A	Turbidity Test Kit (LaMotte 7519)	Tier I	N/A
Water clarity	Appendix A	Secchi Disk (Ben Meadows 224217)	Tier I	N/A
Water clarity	Appendix A	Transparency Tube (Forestry Suppliers 77107, Ben Meadows 111360)	Tier I	N/A
Water clarity	USEPA Method 180.1	Field colorimeter (ex. Hach DR 900)	Tier II	Standardization, >10% field replicates
Water clarity	USEPA Method 180.1	Turbidimeter (ex. Hach 2100P)	Tier II	Standardization, >10% field replicates
Water temperature	USEPA Method 170.1	Armored Glass Thermometer (LaMotte 1066)	Tier II	Verified
Water temperature	USEPA Method 170.1	Digital Thermometer (ex. Hanna 98509)	Tier II	Verified
Water temperature	USEPA Method 170.1; As described in probe manual	Multiprobe Sonde Thermistor (Ex. LaMotte 1761)	Tier II	Verified

B3. Sampling/Analytical Methods for Lab Data

Some Data Collectors may choose to collect field grab samples that are transported and analyzed in a laboratory setting. The full list of approved parameters and sampling procedures for lab data are listed in **Table B3-1**. Each Data Collector selects parameters and lab used for their program based on their individual monitoring needs.

This QAPP and associated SOP in Appendix A, include field sampling operations for collecting the field grab sample, filling out a standard Chain of Custody form and sample label tags, and preparing the sample for transport to the lab. Sample transport processes must be documented in individual

monitoring groups SOPs or Program Manuals. It is recommended that all samples with transport temperature requirements are packed in a cooler with cubed ice and water, samples should be placed in the ice but not fully submerged. A temperature blank can be used if required by the lab or monitoring methods used. Specific requirements for transport temperatures can be found in Appendix B. All laboratory procedures must be documented in a separate lab specific SOP or QAPP.

To be considered Tier 2, groups must:

a. Collect at least 10% field blank and duplicate samples;
b. Prepare samples according to the procedures in Appendix A;
c. Transport all samples to the lab within the appropriate holding times and at the appropriate temperature referenced in Appendix B; and,
d. The Lab must meet the criteria for Tier 2 data in Section C1.1.

If any of the Tier 2 requirements are not met, the data will be marked *provisional* Tier 2 until the criteria are met. If an individual sample is prepared or preserved incorrectly, received at the lab outside of the appropriate holding time or outside of the appropriate temperature the data point will be flagged with the appropriate problem code as described in Section B4.5.3.

Table B3-1. Tier designations and sample method requirements for lab data.

Parameter	Approved Procedure	Equipment	Tier Designation	Hold Time	Transport Temperature
Ammonia-nitrogen	USEPA Method 349.0 (tidal); 4500-NH3D	Specific to individual lab	Tier II	48 hours*	≤ 6° C
Chlorophyll a	USEPA Method 445.0	Fluorometry	Tier II	30 days	Freeze to -20°C
Chlorophyll a,b,c	CBP Chlorophyll	Spectrophotometry	Tier II	30 days	Freeze to -20°C
E.coli	Colilert SM 9223B	IDEXX Colilert	Tier II	6 hours	<10°C
Enterococcus	Enterolert 40 CFR 136; ASTM Method (#D6503-99)	IDEXX Enterolert	Tier II	6 hours	<10°C
Enterococcus	USEPA Method 1600; 1106.1	Membrane Filtration, m-EI prepared Agar Plates	Tier II	6 hours	<10°C
Nitrate-nitrogen	USEPA Method 352.1	Specific to individual lab (colorimeter/spectophotometer)	Tier II	48 hours*	≤ 6° C
Nitrite-Nitrate	USEPA Method 353.4 (tidal)	Specific to individual lab	Tier II	48 hours*	≤ 6° C
Orthophosphate	USEPA Method 365.5 (tidal)	Specific to individual lab	Tier II	48 hours*	≤ 6° C

Phaeophytin	USEPA Method 445.0	Fluorometry	Tier II	30 days	Freeze to -20°C
Silicate	USEPA Method 366.0	Specific to individual lab	Tier II	28 days	<4°C
Total Nitrogen	USEPA Method 351.2; 4500 N-C	Specific to individual lab	Tier II	48 hours*	≤ 6° C
Total Phosphorus	USEPA Method 365.4	Specific to individual lab	Tier II	48 hours*	≤ 6° C
Total Suspended Solids	USEPA Method 160.2	Specific to individual lab	Tier II	7 days	<4°C

*Hold times are for unpreserved samples. Hold times may be extended to up to 28 days depending on the preservation method prescribed by the individual lab used. Each monitoring program must specify their individual preservation and hold time requirements (typically adding H_2SO_4 to pH <2 and freeze to -20°C.

B4. Quality Control Requirements

Because the data generated in this program are going to be used to assist decisions that affect the Chesapeake Bay Watershed, it is essential to maintain a high level of QA/QC. Field, laboratory, and data management personnel will utilize established procedures to ensure data accuracy, precision, representativeness, comparability, and completeness necessary for a successful program.

B4.1 Instrument Acquisition, Testing, Inspection and Maintenance

The Project Team will obtain monitoring equipment and supplies from reputable laboratory supply companies such as LaMotte, Micrology, HACH, Forestry Suppliers, Hanna, AquaPhoenix Scientific, VA Laboratory Supply, and Fisher Scientific. Monitoring equipment for this project will be chosen based on accuracy, precision, ease of use, cost, experience using, and/or recommendations from other monitoring program coordinators.

Upon receipt of equipment, Project Team members and Certified Trainers inspect all supplies as soon as they are received. Items that are broken or appear defective are immediately sent back to the supplier. The Project Team members and Certified Trainers clearly mark the expiration dates in permanent marker on all chemicals and reagents (based on the lot number or manufacture expiration date) before sending to monitors. Expired chemicals should not be used and are collected during re-certification events so they may be disposed of properly in accordance with federal, state, and local environmental control regulations.

Monitors are to inspect their equipment before each monitoring event or as outlined in Appendix A. Monitoring supplies are kept in a secure area, unless otherwise specified. Equipment is stored at room temperature and is kept out of reach of animals and children. Unless discolored, failed verification, or other obvious signs of degradation or damage, chemicals are considered valid until the printed date of expiration. All equipment will be maintained according to the manufacturer's instructions.

B4.2 Instrument Calibrations, Standardizations and Verifications

All field probes and some field kits require field quality control samples in order to be considered Tier II data. Field equipment calibrations and standardizations are performed within 24 hours prior to going out on a sample run according to Appendix A or the manufacturer's instructions to ensure it is properly operating and not damaged. If calibrations are performed on a different frequency it is documented in the groups individual QAPP or SOP. Equipment calibration or standardization is done using known references or standards and must fall within limits set in **Table B4-1**. Equipment that fails calibration or verification should not be used until the issue is remedied and the calibration is successful. Data collected using equipment that failed calibration/verification is flagged in the Chesapeake Data Explorer and can be used at a lower or provisional tier based on the nature of the issue encountered.

Post-sample checks are performed for probe measurements and must be performed within 24 hours after a sampling event to identify any instrument drift during sampling. Post-sample checks use the same standard used to calibrate the equipment, but without performing the calibration. The equipment is placed in the standard solution, allowed to stabilize and the reading is recorded on the calibration log or field datasheet. The same calibration ranges apply. If the calibration is successful, but the post-sample check fails, this is an indication that the probe is starting to go bad and it is recommended to replace the sensor and recalibrate the probe. In this case, data can typically still be used as the designated Tier but should be marked with Problem Code F in the Data Explorer.

All calibrations/standardizations events must be documented on a field data sheet or calibration log. See Appendix E for sample data sheets and calibration logs.

Thermometer verifications are performed using a NIST traceable thermometer annually and must fall within the limits set in **Table B4-1**. Thermometer verifications can be performed using the Alliance's master precision thermometer that is verified annually against the Virginia Department of Environmental Quality's NIST-traceable thermometer or another verified thermometer. Thermometer verifications are tracked in Verification Logs and kept by the CMC Service Provider or Certified Trainer for seven years. See Appendix E for sample verification logs.

Table B4-1. Equipment calibration standards and acceptable ranges.

Parameter	Equipment	Calibration standard	Acceptable Calibration Range
Conductivity (TDS/salinity)	Meter or Probe	It is preferred to do a two-point calibration bracketing the average conductivity field value range. A one-point calibration within the typical conductivity field value range is acceptable.	+/- 5% of the standard
Dissolved Oxygen	Meter or Probe	100% saturation	+/- 0.3 mg/L 97% - 103%
Dissolved Oxygen	Winkler Titration	Sodium thiosulfate check – if first check is not within acceptable range, conduct a second check. If the second check is not within range, do not run samples during	9.4 – 10.0 mg/L

		that sampling event. If the second check is within range, conduct a third check and report the closest two.	
Nutrients	Colorimeter	Verified using the verification vial provided by the manufacturer.	+/- 5 mg/L
pH	Meter or Probe	It is preferred to do a two-point calibration bracketing the pH field value, always using pH 7 buffer (either 7 and 10 OR 7 and 4). If the pH field value is outside of the calibration bracket, the post-sample check should be completed with the third buffer solution.	+/-0.20 of standard
Temperature	Armored glass thermometer, digital thermometer	Verification against a standard NIST thermometer in cold (0-4°C), room temp (18-22°C) and warm (30-35°C) water.	Armored thermometer - +/-0.50°C; Digital thermometer - +/-0.20°C
Water Clarity	Colorimeter or Turbidimeter	It is preferred to do a three-point calibration bracketing the typical turbidity field value, using 0 NTU, 10 NTU and 20 or 100 NTU standards.	+/- 0.2 NTU of the 0 NTU standard, +/- 10% of the 10, 20 or 100 NTU standards

B4.3 Field QC Checks

B4.3.1 Field Replicates

Replicates of *in situ* field parameters are recommended 10% of the time, but generally do not occur as monitors have one set of equipment and field parameters change too quickly for a true replicate to occur. However, a field replicate can be performed for many field parameters where the monitor takes the instrument to the site and obtains a reading. The instrument is removed and then reinserted into the sample to obtain a second reading. Valid replicates are if readings are within the accuracy range stated for the equipment used.

B4.3.2 Field Duplicates

Monitors collecting data using a field kit (Winkler Titration, nutrient colorimetric kits, etc) must perform duplicates (within a range informed by equipment specifications) 100% of the time for every site collected regardless of the Tier. Monitors collecting data using a field colorimeter (nutrients or turbidity) must perform duplicates (within a range informed by equipment specifications) at least 10% of the time for every site collected to be considered Tier II. Duplicates are generated either by testing a single sample twice or by collecting two or more samples from the same site, at the same time, using the same collection method, and then testing them with the equipment to generate two duplicates. Duplicate values must fall within the specified accuracy range for the equipment used. If the duplicate values

differ by more than the specified accuracy range, a third analysis may be recommended. Both duplicate values are recorded on the datasheet and monitors will enter both values into the Chesapeake Data Explorer.

If a monitor or group has more than three duplicates outside of the accepted range for a particular parameter in a quarter, the Project Team member or trainer is notified and the problem is investigated further by a site audit. If the audit uncovers an underlying problem, refresher training is provided. If the problem continues, data from the monitor/group is flagged depending on the type of problem found.

B4.3.3 Field Audits

Project Team members, the QC management, or Certified Trainers may accompany monitors in the field and observe field collection procedures as part of the re-certification process for monitors. As stated above, if a problem is found with field QA samples or another QA issue is discovered, a field audit will likely be required. During the audit, monitors must demonstrate proper sample collection, analysis, labeling, and preservation in accordance with the SOPs. If deficiencies are found, onsite re-training is provided and the problem noted in a corrective action report for reference by the Project Team. A follow up audit may be required if the problem found was significant and resulted in downgrades to a lower tier.

B4.4 Laboratory QC checks

B4.4.1 Field Duplicates

Monitors collecting samples for Tier II laboratory analysis will perform duplicate samples at least 10% of the time (ie. 1 out of every 10 samples collected). Monitors will perform all field procedures including preserving the samples as required and taking them to the lab for analysis using a second sample bottle marked as a duplicate. Results from field duplicates will be recorded and appropriately marked during data entry in the Chesapeake Data Explorer. Field duplicates exceeding >20% deviation for soluble parameters (TN, TP, nitrate, etc) and >30% deviation for solid parameters (TSS and chlorophyll) will be flagged as questionable data for the associated samples collected.

If a monitor or group has more than three field duplicates in a three-month period outside of the accepted range for a particular parameter, the Project Team member or trainer is notified and the problem is investigated further by a site audit. If the audit uncovers an underlying problem, refresher training is provided. If the problem continues, data from the monitor/group is flagged until a resolution is found.

B4.4.2 Field Blanks

Monitors collecting samples for Tier II laboratory analysis will perform field blank samples at least 10% of the time (ie. 1 out of every 10 samples collected). Monitors will perform all field procedures including preserving the samples as required and taking them to the lab for analysis using deionized water supplied by the lab. Results from field blanks will be recorded and appropriately marked during data entry in the Chesapeake Data Explorer. Field blanks exceeding 20% of the expected concentration range for each sample will be flagged as questionable data for the associated samples collected.

If a monitor or group has more than three field blanks in a three-month period outside of the accepted range for a particular parameter, the Project Team member or trainer is notified and the problem is

investigated further by a site audit. If the audit uncovers an underlying problem, refresher training is provided. If the problem continues, data from the monitor/group is flagged until a resolution is found.

B4.5 Data Entry QC Checks

All data are checked for data transfer error (spot-checks), out of range results, incomplete data sheets, and written notes by monitors that signal to the Project Team of the possibility of questionable data. These data checks are completed after data upload and before data are published for data uploaded via the data upload form, and prior to data upload for data uploaded via the bulk upload process. Typically this process includes:

1. Transfer hard copy field datasheets to an electronic version (either directly on the Data Explorer or an excel spreadsheet);
2. Spot-check the data transfer;
3. Check the calibrations and flag questionable data;
4. Check lab data and flag questionable data;
5. Upload/publish data in the Data Explorer.

B4.5.1: Data Transfer Spot Checks

All data are recorded on a paper field datasheet and must be transferred to an electronic version. In order to ensure data are transferred accurately, spot checks must be performed for at least 10% of the datasheets. This transfer process can occur in two ways: via the data upload form on the Chesapeake Data Explorer, or onto a Microsoft Excel spreadsheet that is then bulk uploaded to the Data Explorer.

Data that are uploaded directly on the Data Explorer via the data upload form will be spot checked on the Data Explorer prior to publishing. Monitors upload their data directly on the Data Explorer, then submit the original copies of their field data sheets to their Certified Trainer/QA Manager or CMC Service Provider ideally every three to six months. The Project Team/Certified Trainer will spot check ≥10% of the data sheets and compare the results entered in the Chesapeake Data Explorer for data entry errors or missing data points. For year-round, monthly monitoring, this means checking at least 2 data sheets per monitor or monitoring team per site annually. If a monitor is found to be at fault of a data entry error, all their recent data sheets from the previous six months are to be checked. Errors will be corrected by the Project Team/Certified Trainer and a note is put on the data sheet and in the "Comments" field of the Chesapeake Data Explorer indicating that an error was made before data are published. If substantial QC issues are identified the Project Team/Certified Trainer will alert the monitor and work to remedy the issue.

Data that are uploaded to the Data Explorer via the bulk upload process will be spot checked prior to data upload. Data are transferred from the field datasheets to an electronic form (typically a Microsoft Excel spreadsheet) by either a monitor, program coordinator or CMC Project Team member. After data has been entered into the electronic form a spot check will be performed on ≥10% of the data sheets entered and compare the results entered in the Excel spreadsheet for data entry errors or missing data. The spot check ideally is performed by a different person than the person who transferred the data, however, if that is not possible the same person can perform the spot check ≥ 24 hours after the data has been transferred. If a data entry error is found, all of the data sheets transferred at that time are to

be checked. Errors will be corrected by the spot-checker before the data are uploaded to the Data Explorer. If substantial QC issues are identified the Project Team/Certified Trainer will work to remedy the issue.

If no errors are found through the spot-check process all data checks outlined in sections B4.5.2 and B5.4.3 should be completed before publishing data.

B4.5.2: Check field data

Once data are transferred to an electronic form (either the Data Explorer or Excel spreadsheet) and the spot-check is complete, additional data checks should be performed to ensure data meet the intended data quality goals. Data checks should include the following, but may include additional checks based on specific equipment or data use goals.

- Check calibrations/standardizations are within acceptable ranges according to **Table B4-1**.
- Check the post-sample check values (when applicable) are within acceptable ranges according to **Table B4-1**.
- Check that the values from calibrated probes are within the calibration standard ranges (ie. pH reading of 7.40 was calibrated with 7 and 10 buffer solution).
- Check that the readings are within "normal" ranges.
- Check that duplicates and replicates are within the acceptable accuracy range for the equipment used.

If data quality issues are found the questionable data points can be removed from the dataset or flagged with the appropriate problem code. Typical problem codes can be found in **Table B4-2**, see Appendix G for a full list of problem codes.

Table B4-2. Problem codes used to flag field data in the Chesapeake Data Explorer.

CBP Problem Code	QA Issue
(C) Instrument Failure (during sampling that may have effected results)	pH/DO/conductivity post-sample check failure, if values appear inaccurate
(F) post-calibration failure (likely due to equipment damage after sampling; data appear normal)	pH/DO/conductivity post-sample check failure, if values appear accurate
(V) Sample results rejected due to QC Criteria	pH/DO/conductivity calibration failed – data is questionable
(HI)	Duplicates are not within accepted range

B4.5.3: Check Lab Data

Typically, data sent to a lab will be checked to ensure all laboratory blanks, duplicates, matrix spikes, etc. are within range and the data are good. Additionally, the lab should check the samples to ensure they were sampled and preserved correctly, arrived within the appropriate hold time and at the appropriate temperature. The lab should flag any data that does not meet the lab standards, see Section C.1.1 for more details on lab criteria.

Monitors or Coordinators should check this data to look for any flags that would indicate a laboratory issue, if found the data should be flagged with the appropriate problem code from **Table B4-4**. If none appear, the field duplicate and blank readings should be checked to ensure they are within proper range, found in **Table B4-3**. Additionally, data should be checked to ensure reported values fall above the PQL (or lab reporting limit) and MDL. Any values that fall below the MDL must be flagged with a "<" detection flag, and any values that fall between the MDL and RL must be flagged with Problem Code "G" found in **Table B4-4**.

Table B4-3. Acceptable field duplicate and blank ranges for lab analyzed parameters.

Parameter	Approved Procedure	Duplicate Range	Blank Range
Chlorophyll a	USEPA Method 445.0	30%	20%
Chlorophyll a, b, c	CBP IV-12.0	30%	20%
Enterococcus	ASTM Method (#D6503-99)	TBD	20%
E.coli	SM 9223B	10x	>1 MPN/100mL
Total Phosphorus	USEPA Method 365.4	20%	20%
Nitrate-Nitrogen	USEPA Method 352.1	20%	20%
Nitrite-Nitrogen	USEPA Method 353.4	20%	20%
Ammonia	USEPA Method 349.0	20%	20%
Total Kjeldahl Nitrogen	USEPA Method 351.1	20%	20%
Total Nitrogen	USEPA Method 351.2	20%	20%

Table B4-4. Problem codes used to flag data in the Chesapeake Data Explorer.

CBP Problem/Qualifier Code	QA Issue
(E) Sample received after holding time	Sample was sent to the lab after the proper holding time window
(G) Value between MDL and RL	Reported value for a parameter is between the MDL and the lab Reporting Limit
(GG) Sample analyzed after holding time	Sample was analyzed at the lab after the appropriate holding time
(<) Sample results are lower than the MDL	Reported value for a parameter is lower than the MDL
(V) Sample results rejected due to QC criteria	Data are questionable

B4.5.4: Upload/Publish data on the Data Explorer

Once data has passed the spot-check and all additional data checks it can be uploaded and/or published on the Data Explorer and made publicly accessible. For data uploaded via the data upload form, the Coordinator or QA Manager can publish all data that completed the data checks for each site from the edit and review page of the Data Explorer. For data uploaded via the bulk upload process, the data can now be translated into the bulk upload template, see the Data Explorer Manual for more details on that process. This data can be uploaded via the Bulk Upload form and published immediately.

The Data Explorer features a series of automated checks on any data uploaded to the application. First, the application requires basic data formats to be valid. For example, a decimal type number must be

uploaded for a sample value. The application also checks data validity, such as confirming that the parameter code associated with a sample exists in the database. Further, the application also ensures that samples are not duplicated in the database based on a unique combination of sample time, sample location, sample depth, parameter, and sample id. The Data Explorer requires that a problem code is associated with any null sample value. The application also provides a warning when the sample values fall outside of an established range for its associated water quality parameter.

B5. Data Acquisition Requirements

The CMC will acquire data from monitoring groups that have demonstrated that data were collected using QA/QC procedures that generate data of known quality. Historic data are defined as data collected prior to 2017 and will be incorporated into the Chesapeake Data Explorer along with all available QA/QC supplemental information including any QAPPs, SOPs and other QA documentation. Historic data will be assigned a tier level based on available QA/QC and SOP documentation. If historic data do not have the appropriate documentation or are missing critical QA measures, they will be designated a provisional tier level. Data users will be able to determine the level of QA rigor of historical datasets based on associated metadata and tier designation.

Monitoring site coordinates will be obtained using USGS 7.5 minute topographic maps or online mapping applications of known accuracy such as Google Maps.

Weather conditions are collected along with the benthic data to contextualize the local conditions of the site. Weather conditions are obtained from field observations, or vetted and reliable local sources, some common ones include:

- Weather Underground: www.wunderground.com
- Community Collaborative Rain, Hail and Snow Network (CoCoRaHS): https://www.cocorahs.org/Maps/ViewMap.aspx?state=usa
- National Weather Service: https://www.wrh.noaa.gov/mesowest/getobext.php?wfo=sew&sid=KSEA&num=72&raw=0

Local tide tables will be referred to by the monitoring group to determine the correct tide phase to collect samples or notate it in their field sheet. There are a number of online resources as well as publications a monitor or group can refer to based on their location. As a general reference, groups can refer to the US Harbors Chesapeake Tide Charts at http://usharbors.com/chesapeake-tide-charts to find general tide information. However, groups are encouraged to use other tide charts that apply to their specific area or are familiar with. In such cases, the Project Team member or trainer can evaluate the reference the group will use to see if it is well suited to the needs of the project.

B6. Data Management

All Tier I and Tier II field data collected (observational and water quality data) will be recorded on field datasheets, or computers as appropriate for the monitoring equipment used (some multiprobe sondes have data storage abilities). Each Data Collector must have a standard field datasheet or recording mechanisms used. If a group does not have a field datasheet, they can adopt the CMC template (found in Appendix E). Following data collection, data will be entered into the Chesapeake Data Explorer by the

monitor, program coordinator, or CMC Project Team either from the field datasheet or via bulk upload (see Table A6-3 for the Data Explorer Roles). The data upload process is a two-step process: 1.) data are uploaded (data does not appear on the publicly accessible Data Explorer homepage) and 2.) data are published (QA checks are performed and data appears on the homepage and is available to query and download).

Data can be uploaded via the data upload form by monitors, coordinators and members (see Section A6.4 for Data Explorer roles). Typically, a monitor uploads the data from the field datasheet through their active Data Explorer account via the data upload form for their designated site. The monitor then sends their field datasheet to their program coordinator or CMC Service Provider. The data are then checked by the program coordinator or CMC Service Provider and published on the Data Explorer according to the quality assurance procedures in Section B4. This process typically occurs on a monthly or quarterly basis. Hard copies of the field data sheets are kept in a secure location for 7 years.

Data can be uploaded via the bulk upload process by coordinators and members, monitors are not able to bulk upload data. Typically, data are transferred from the field datasheet to some type of electronic data recording mechanism (typically a Microsoft Excel spreadsheet) by either the monitor or coordinator. The data is then checked by the program coordinator or CMC Service Provider according to the quality assurance procedures in Section B4. The data file is then converted via a Microsoft Excel Macro developed for this project to the Data Explorer template and uploaded via the bulk upload page. If the data file fails any of the data checks, errors will appear on the bulk upload page detailing the nature of the issue and none of the data is uploaded. If the data file passes all of the data checks, the user will be prompted to publish the data uploaded. This process typically occurs annually.

Lab data sheets or excel files are typically uploaded to the Chesapeake Data Explorer separately than the field data and as it is received. All lab data are uploaded via the bulk upload process as described above.

All data uploaded and/or published in the Chesapeake Data Explorer are stored indefinitely, however members and coordinators have permission to delete data associated with their monitoring group at any point in time. All published data are publicly accessible for download on the homepage and uploaded to the Chesapeake Bay Program's Data Upload and Evaluation Tool (DUET) system annually. Data uploaded to DUET are automatically uploaded to EPA's Water Quality Exchange (WQX).

See **Figure B6-1** for the CMC data management flow chart from data collection, to storage, to use.

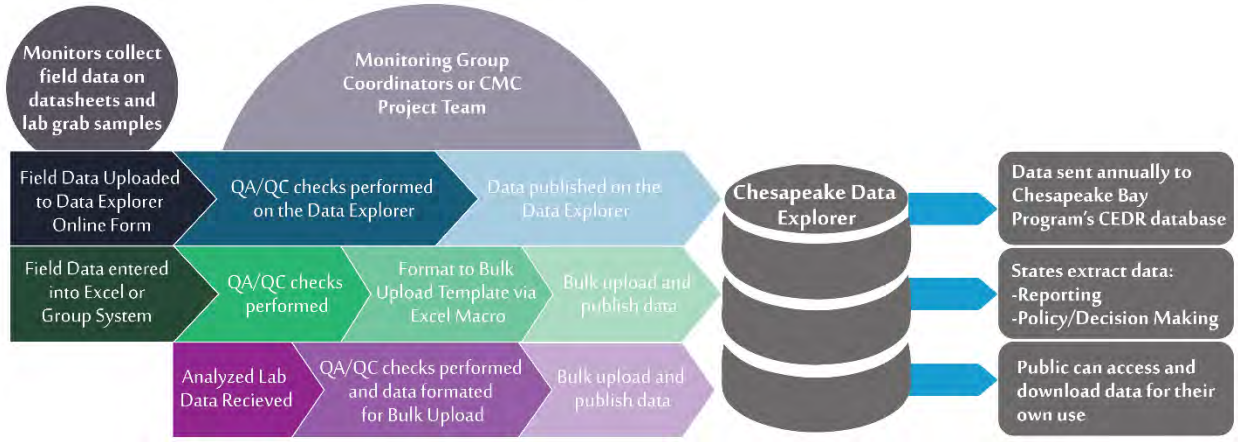

Figure B6-1. Data management flow chart from data collection, to storage, to use.

SECTION C - ASSESSMENT AND OVERSIGHT

Assessments or evaluations are designed to determine whether the QA Project Plan is being implemented as approved (conformance/nonconformance), to increase confidence in the information obtained, and ultimately to determine whether the information may be used for their intended purpose. The elements in this group detail what assessments or evaluations will occur both during and after the project. Data assessments, such as data verification and validation, are discussed in the Group D elements.

C1. Assessment and Response Actions

The Citizen-based and Nontraditional Monitoring Integration project utilizes several levels of assessment to ensure the integrity of the reported data. The assessments are divided into 4 areas:

a. Laboratory
b. Programmatic
c. Field Sampling
d. Validation and Reporting

C1.1 Laboratory Assessments

Each Data Collector will select a laboratory to perform lab analysis that meet their program objectives. In addition to the field sample collection process outlined in Section B4.4, a laboratory will be considered Tier 2 if they meet one of these criteria:

1. Obtain a state, federal or NELAP certification for the parameters and analytical methods requested by the monitoring group.
2. Obtain approval by the Chesapeake Bay Program's Data Integrity Workgroup by participating in the split sample, blind audit, and USGS reference sample processes.

If a lab does not meet either of those criteria they will be considered for inclusion as Tier 2 on a case by case basis by the CMC team. The CMC team will use the following criteria for consideration:

1. Laboratory SOPs for each analytical method must follow an EPA approved or standard method.

2. Labs must perform appropriate lab blanks, duplicates and matrix spikes and must submit that data to the CMC at least annually.

The CMC team will review all relevant SOPS for each analytical method to ensure they meet the EPA or Standard method requirements and review lab blank, duplicate, and matrix spike data annually. All labs must adhere to the established standards for precision and accuracy control limits for each parameter, listed in Table C1.1. If any data fail these criteria they are to be flagged as failing QC criteria.

Labs that do not maintain a certification, are not approved by the CBP, or do not meet the criteria for a case-by-case basis will be marked as *provisional* Tier 2 until one of the criteria for Tier 2 are achieved.

Labs used to produce Tier 3 data must obtain approval by the Chesapeake Bay Program's Data Integrity Workgroup by participating in the split sample, blind audit, and USGS reference sample processes.

Labs must define and provide the both the MDL and PQL for each parameter being analyzed:

- Method Detection Limit (MDL) is the ability to detect a certain concentration of the analyte with 99% confidence. Thus, values below MDL are not meaningful.
- Practical Quantitation Limit (PQL) is typically defined by the lab, and it may either correspond to the lowest concentration standard analyzed in a sample set, or a value such as 3 times the MDL.

C1.2 Program Assessments

Each of the 5 organizations listed as Project Partners in this QAPP act as CMC Service Providers, the roles and responsibilities for each organization are provided in Section A4.2. Each organization designates paid staff, listed in Table A4-1, to perform CMC Service Provider responsibilities.

Annually, the CBP QA Officer meets with all individuals working as CMC Service Providers under this QAPP to ensure the CMC Service Providers are following QA measures. This meeting typically covers:

a. A review of this Tidal QAPP and SOP to ensure everything is up to date and no changes are needed;
b. A review of all of the monitoring groups the CMC Service Providers are training;
c. An overview of typical training sessions that have occurred with each CMC Service Provider organizations; and,
d. Discuss and resolve any QA issues.

C1.3 Field Sampling Assessments

The Project Team and Certified Trainers are responsible for ensuring that all monitors collecting Tier II data attend a re-certification session every year for the first two years of data collection and once every two years after that as written in Section A8.2. These sessions serve as an audits or proficiency test for the monitors and their equipment. The Project Team retrains any monitor who demonstrates a faulty sampling technique and will not renew a monitor's certification until they can adequately demonstrate that they have mastered the sampling technique.

The Project Team is responsible for ensuring all Coordinators collecting Tier II data attend a recertification session annually as written in Section A8.4. As time and resources allow, the Project Team

will conduct field audits with Certified Coordinators to ensure they meet the data quality objectives for their program. If the objectives are not met by the Coordinator, the Project Team will decide on the appropriate corrective action (e.g. downgrade data to Tier I; require more frequent check ins and audits).

C2. Reports to Management

All Project Team members are required to submit a quarterly report to the Project Manager of all project activities. QA matters will be included in these reports including trainings, certifications, re-certifications, and QA problem resolution. In addition, the Project Manager is required to submit bi-annual reports to EPA Region III of all project activities and will include any significant QA issues that have been addressed by EPA or CBP staff. EPA Region III then conducts biennial monitoring review with the Project Manager to review the bi-annual report.

SECTION D - DATA VALIDATION AND USABILITY

D1. Data Review, Validation, and Verification Requirements

All data collected through this project are reviewed, validated and verified by the Project Team and/or Certified Coordinator to determine whether the data meet the project objectives listed in Section A7. Specific review, validation and verification frequencies are determined by each individual monitoring group to meet their monitoring objectives (e.g some groups perform all requirements weekly in order to post data for public access immediately and other groups perform all requirements once annually). At a minimum - data review, validation and verification needs to occur once annually prior to data being published on the Data Explorer.

D2. Validation and Verification Methods

Data verification can be performed by monitors, coordinators or the Project Team depending on the structure of the individual monitoring project. If monitors perform any of the verification steps, those steps should be checked by the project coordinator. Specific verification requirements are determined by each monitoring project, but should include at a minimum recording results on a field datasheet, reviewing datasheets to ensure they were fully completed and that all data were collected uniformly, and spot-checking data entry process according to Section C4.5.1. For equipment that require standardization, verification, or calibration, all calibration logs are examined to ensure all standardizations, verifications, and calibrations occurred in accordance with Section B4.2 and to determine how well the measurement instruments performed. If there appears to be significant drift in instrument performance, the data are flagged accordingly before publishing on the Data Explorer. All field replicate and duplicate data should be checked to ensure the frequency requirements for the project was met and all field replicates and duplicates are within the specified range in Section B4.3. If field replicates and duplicates suggest a substantial data quality issue, all data for that monitor should be flagged in the Data Explorer. All datasheets and verification or calibration logs are kept by the Certified Coordinator or Regional Project Team office for seven year.

All lab data should be verified by the Certified Coordinator or Project Team as it is received from the lab by reviewing the field blank and duplicate data to ensure all checks are within the appropriate ranges

specified in Section B4.5.3. Additionally, data should be checked to see if the report value is below the Method Detection Limit (MDL) or between the MDL and the Reporting Limit (RL). If the data fall below either of these values they must be flagged appropriately.

Validation methods occur after verification to determine whether the monitoring activities for an individual monitoring project conform to the user needs for the project. This process must occur at least annually and typically occurs at the end of a sampling season, Validation methods should include at a minimum:

- Review sampling locations to ensure coordinates and site descriptions are accurate and up to date;
- All monitors are up to date on their training requirements;
- Calculate completeness metrics for samples collected;
- Review project documentation (methods manuals, SOPs, QAPPs) to ensure the appropriate methods are being used; and,
- Review chain-of-custody, field datasheets and any other documentation to ensure it collects the appropriate information.

All of this information should be used to evaluate the impacts of the monitoring program and if the data collected meets the Data Quality Objectives for the project.

D3. Reconciliation with Data Quality Objectives

All field and laboratory data that do not meet data quality objectives identified in this Tier I and II QAPP will be flagged, downgraded a Tier, be labeled as provisional, or discarded before publishing on the Data Explorer. Data corrections will be reported to the monitoring group as well as the EPA, CBP, or other report-requiring body by a Project Team member or the QA Management.

If Data Quality Objectives for the project are not being met, the Certified Coordinator should discuss with the Project Team and/or CBP QA Officer to remedy the issue. Updated Program Documentation (such as methods manuals, SOPs, or QAPPs) may be needed in order to meet the Data Quality Objectives for the next sampling season.