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

BENTHIC MACROINVERTEBRATE MONITORING IN WADEABLE STREAMS (TIERS I & II)

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SECTION A - PROGRAM MANAGEMENT ELEMENTS

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A3. Distribution List

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

Name	Phone Number	E-mail	Organization
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Dave Parrish	540-529-3463	parrishd@vims.edu	CBNERR
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 benthic macroinvertebrates, non-tidal, and tidal portions of the Chesapeake Bay Watershed, 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.

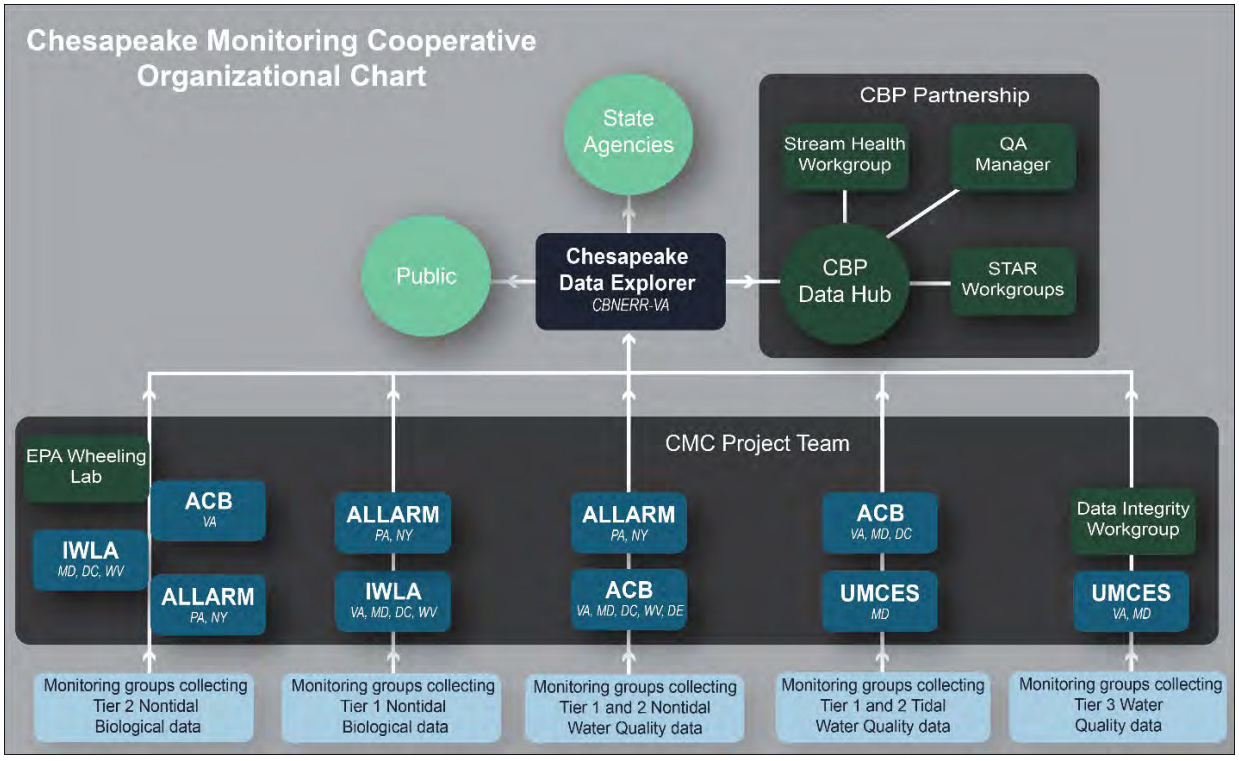

Figure A4-1. Organizational chart for the entire CMC project.

The Alliance and IWLA provide project management and project coordination respectively for all components of the CMC. IWLA and ALLARM train and support volunteer monitoring groups to collect benthic macroinvertebrates in Wadeable Streams (Tier I and II) Quality Assurance Project Plan (QAPP), referred to as CMC service providers. IWLA coordinates the project's Benthic Macroinvertebrate Monitoring Program for Tier I data collectors in Virginia, Maryland, DC, West Virginia, and Delaware through their Virginia Save our Streams program. ALLARM coordinates the Benthic Macroinvertebrate Monitoring Program for Tier I data collectors in Pennsylvania and New York using the Environmental Protection Agency's

volunteer monitoring macroinvertebrate protocol. Additionally, IWLA, ALLARM, and the Alliance coordinate Tier II data collection using the CBP Benthic Macroinvertebrate Sample Collection Protocol across the entire watershed, which is covered under a separate QAPP, Volunteer Monitoring Support for Macroinvertebrate Sampling to FIll Chesapeake Bay Program Data Gaps, effective March 1, 2021 (Project ID: CBT 18880) . 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 benthic 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 Non-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	Emily Bialowas, 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
Izaak Walton League (IWLA)	Project Team	Sam Briggs, Clean Water Program Director Emily Bialowas, Chesapeake Monitoring and Outreach Coordinator Kira Carney, Mid Atlantic Save Our Streams Coordinator
Alliance for Aquatic Resource Monitoring (ALLARM)	Project Team	Julie Vastine, Director Stephanie Letourneau, Community Science Specialist
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 F 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 benthic monitoring data collection in non-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 and benthic 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, Izaak Walton League of America

- Develop, review and update EPA approved Benthic Macroinvertebrate 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 IWLA database 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 wadeable non-tidal streams in Maryland, DC, Virginia, West Virginia, and Delaware;
    - Provide regular training (Tier I and II) and certification for individual monitors and data collectors;

- Ensure all benthic 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 IWLA database or 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, Alliance for Aquatic Resource Monitoring

a. Develop, review and update EPA approved Water Quality Non-tidal and Benthic Quality Assurance Project Plans and the Standard Operating Procedures (SOPs) for monitoring activities;
b. Review and oversee QA policies and SOP's of monitoring groups and document findings for CBP and project records;
c. Complies with findings and recommendations from QA reviews and audits;
d. Resolves disputes regarding quality system requirements, QA/QC procedures, certifications, or corrective actions;
e. Acts as the liaison between the Project Team and Chesapeake Bay Program Workgroups, including attending workgroup meetings and calls with the CBP Diversity Workgroup;
f. CMC service provider for Tier I and Tier II data collectors in non-tidal waters in Pennsylvania and New York:
    - Provide regular training (Tier I and II) and certification for individual monitors and data collectors;
    - Ensure all benthic 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, Alliance for the Chesapeake Bay

- Support the development, review, and update of the EPA approved Benthic Macroinvertebrate Quality Assurance Project Plans (QAPPs) and the Standard Operating Procedures (SOPs) for monitoring activities.
- CMC service provider for CBP Benthic Macroinvertebrate Sample Collection tier II data collectors in non-tidal waters in Virginia:
    1. Provide training and certification for individual monitors and sample collectors;
    2. Ensure all benthic monitoring data operations are covered by the appropriate documentation (i.e., SOPs, QAPPs, project plans) for CBP Benthic Macroinvertebrate Sample Collection.

Project Team, University of Maryland Center for Environmental Science

- Support the development, review, and update of the EPA approved Benthic Macroinvertebrate Quality Assurance Project Plans (QAPPs) and the Standard Operating Procedures (SOPs) for monitoring activities.

Project Team, Chesapeake Bay National Estuarine Research Reserve in VA

- Continually manage the Chesapeake Data Explorer to ensure functional and data storage of benthic monitoring 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

- 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

- Participate in benthic macroinvertebrate training with CMC Service Provider or Certified Trainer, and pass necessary certification tests;
- Follow all monitoring protocols and QA processes as written in the standard operating procedures;
- Maintain certification with the designated CMC service provider for data collection;
- Complies with QA reviews by Project Team and/or QA Officer; and
- Annually uploads data or shares data with a CMC service provider to be uploaded to the Chesapeake Data Explorer.

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 now 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. Additionally, in 2020 the CMC Team received a grant from the Chesapeake Bay Trust to create a new benthic monitoring program collecting family level data, aimed at filling in gaps in the Chessie BIBI. This collection program has two components, the CBP Benthic Macroinvertebrate Sample Collection Protocol and the CBP Benthic Macroinvertebrate Picking Protocol. All samples are analyzed at the EPA Wheeling Laboratory.

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 benthic macroinvertebrate quality data or wish to develop a new benthic 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 stream health indicators;
2) Characterize the present state of a watershed by establishing baseline data, including spatial and seasonal variation, using benthic stream health indicators;
3) Use data to screen for stream health and benthic macroinvertebrate issues that the county or state need to address (e.g. too low/high populations of certain species, lack of diversity, invasives)
4) Increase understanding of stream health in areas with large amounts of anthropogenic impacts
5) Educate community members about benthic macroinvertebrates, 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 benthic macroinvertebrate data are helpful. These include, but are not limited to:

a. Understanding the water quality status and trends of Chesapeake Bay waters based;
b. Identify potential areas for targeted action (restoration, protection, screening for state agencies); ;
c. Complement chemical and physical data collection to flesh out a holistic interpretation of watershed health; and
d. Assess the health of the waters at prominent input sites (e.g., headwaters, major tributary inputs, small watersheds).

During the first 6-year cooperative agreement, the Project Team, using their background, expertise, and knowledge with the nontraditional monitoring community, worked with CBP Scientific, Technical Assessment, and Reporting Team (STAR) to:

a. Establish standardized institutional structures and procedures to support data integration, such as the development of a Tiered Framework and data classification rubric;
b. Facilitate development of consistent monitoring and training protocols, technical guidance, data gathering tools, quality assurance mechanisms, and data analysis and communication tools through three approved QAPPs and SOPs;
c. Inventory, prioritize, and recruit monitoring groups through a Prioritization Report published in 2017; and,
d. Provide training and technical support to integrate data into the Chesapeake Data Explorer and the CBP.

The objectives for the next 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,
d. Improve the capacity of federally recognized tribes and other underrepresented and environmental justice communities to conduct nontraditional monitoring; and,
e. Collect benthic macroinvertebrate samples to fill in gaps in the Stream Health Indicator.

A5.2 Data Classification

All benthic macroinvertebrate data collected will be categorized into tiers based on level of taxonomic resolution and quality assurance approaches with suggestions on possible avenues for data use following the 2016 *Tiered Framework for Data Collection and Integration of Nontraditional Monitoring* (Appendix B). While 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 data categorization process largely depends on the methodology used (order or family level macroinvertebrate identification) and the quality assurance requirements (documented internal and external QC procedures) implemented by the monitor/group. The protocols established in this QAPP are designed to produce Tier I (order level identification) and Tier II (family level identification) data.

Table A5-1 lists tiers, their intended data uses, and a summary of the data requirements. This QAPP only covers IWLA's Virginia Save our Streams and ALLARM's benthic programs (Tier I) and the CBP Benthic Macroinvertebrate Sampling Protocol (Tier II) data.

Table A5-1. All tiers of data quality, intended data use, and data requirements for benthic data.

Tier	Intended Data Use	Summary of Data Requirements
Tier I	Education, environmental health screening	• Documented site location(s) (with coordinates) • Identifying benthic macroinvertebrates to order level following IWLA's VA SOS protocol or EPA Volunteer Monitoring, or equivalent order level benthic protocol • Monitors acquire and maintain certification
Tier II	Environmental health screening, environmental health report cards, targeting of management actions	• Documented site location(s) (with coordinates) • Identifying benthic macroinvertebrates to family level following the CBP Benthic Macroinvertebrate Sampling Protocol or an equivalent family level protocol • Monitors acquires and maintain certification

A5.3 Data Use

Data 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.

Data collected as Tier I and Tier II from the CMC Benthic Macroinvertebrate Monitoring Program are uploaded to the Chesapeake Data Explorer and then shared annually with the Chesapeake Bay Program. Tier 1 benthic data are used for educational purposes and Tier 2 benthic data can help provide water quality assessments for use by state and federal agencies as well as environmental health screening, environmental health reports, targeting management actions, and education.

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 benthic macroinvertebrate data collected (data collected after 2017) in non-tidal areas of the Chesapeake Bay (Figure A6-1) will be done in an approved, quality-controlled, and standardized fashion.

Figure A6-1. Areas of coordination by project partners (IWLA and ALLARM).

To be included in the CMC as a Tier I or Tier II group, Data Collectors must follow the on-boarding process in Table A6-1, and use one of three set protocols established by this QAPP. Tier I monitoring groups identify benthic macroinvertebrates to the order level and follow the IWLA Virginia Save our Streams method or the EPA Volunteer Monitoring protocol. The approved methods for these protocols are found in Appendix A. Tier II monitoring groups follow the CBP Benthic Macroinvertebrate Sample Collection Protocol, where samples are collected and preserved streamside and sent to the Wheeling Lab in West Virginia for Family level identification. The approved methods for this protocol are found in the

Volunteer Monitoring Support for Macroinvertebrate Sampling to Fill Chesapeake Bay Program Data Gaps QAPP, effective March 1, 2021 (Project ID: CBT 18880)

If a monitoring group is collecting benthic data following a comparable sample collection protocol, they will be considered for inclusion on a case by case basis, based on the guidelines in Appendix C. The CMC Project Team will review the monitoring group's documentation in order to submit data to the Chesapeake Data Explorer.

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	Individual monitors or monitoring groups join one of the three established monitoring programs; or Existing groups complete a methods/QA review and evaluation to be included as a separate Tier II group based on the guidelines in Appendix C.
Step 3	All monitoring groups complete necessary training.
Step 4	Share data with the project team or upload data to the Chesapeake Data Explorer.
Step 5	Participate in Data Interpretation workshops (as desired).

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. 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 sampling frequencies tailored to their specific monitoring program, examples can be found in Section B1.2.

Table A6-2. CMC project timeline for 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

This project aims to collect benthic data through the assessment of non-tidal, freshwater streams throughout the Chesapeake Bay Watershed in order to gain a broader understanding of the health of the Chesapeake Bay and its tributaries. Non-tidal areas are defined as the waters that are not influenced by the tidal cycle (ebb and flow).

Monitoring sites are chosen by individual Data Collectors (following the process in Section B) or with the help of the CMC Project Team. 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 2017 Prioritization Report,
- Chesapeake Bay Program data requests,
- State Agency data requests.

Site selection follows fixed station design and 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 other strategic sites throughout the watershed as resources allow, as long as all sites are wadeable and safe for benthic sample collection. Benthic sample collection also requires access to at least 100 feet of wadeable stream, with water not regularly flowing above the knees.

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 Collection Protocols

There are many different water quality indicators for the concerns associated with the health of non-tidal tributaries and their impacts on Chesapeake Bay health, but benthic macroinvertebrates can provide a holistic overview of the water quality at a stream reach. Macroinvertebrates are animals that are large enough to see without magnification and do not have a backbone. Examples include crustaceans, insect larvae, and worms. They play critical roles in stream ecosystems, occupying numerous feeding levels and being the primary group of organisms that can process leaves and detritus, which are the major source of energy in streams. They are also an important food source for other stream organisms, such as vertebrates and other large macroinvertebrates.

This QAPP includes Tier I protocols following IWLA's Virginia Save our Streams protocol and the EPA Volunteer Monitoring Benthic Macroinvertebrate protocol (the protocol ALLARM uses), where macroinvertebrates are collected and identified streamside to the Order level, then counted and placed into one of three pollution categories (sensitive, somewhat sensitive, or tolerant) using a classification rubric. The number and diversity of organisms found in the pollution tolerance categories are inserted into the metric to classify a stream reach as having good, fair, or poor water quality. See Section B for details outlining the quality assurance procedures for these protocols.

The Volunteer Monitoring Support for Macroinvertebrate Sampling to Fill Chesapeake Bay Program Data Gaps QAPP, effective March 1, 2021 (Project ID: CBT 18880) details the CMC's Tier II Monitoring Protocol, where macroinvertebrates are collected and preserved for lab identification to the family level.

If additional monitoring groups are collecting equivalent data, they may be included on a case by case basis based on the guidelines in Appendix C.

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 are uploaded to the Data Explorer by

certified monitors or a CMC Service Provider. Quality assured data may be provided to a CMC Service Provider as an excel file to be uploaded to the Data Explorer. For a monitor 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 CMC Service Provider and given a specific role listed in Table A6-3. Data collected under IWLA's benthic monitoring protocol is uploaded to the IWLA database by volunteers and reviewed by IWLA staff before being uploaded to the Data Explorer.

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.
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 benthic data in the Chesapeake Data Explorer are publicly accessible for download on the homepage and are shared with the CBP Stream Health Workgroup and ICPRB for inclusion in the Chessie BIBI.

A7. Measurement Quality Objectives

This project is designed to provide water quality measurements and benthic macroinvertebrate collections that will be utilized to assess the health of the Chesapeake Bay Watershed rather than to accept or reject a hypothesis. 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, bias, representativeness, comparability, and completeness.

A7.1 Data Precision

Data precision is defined as the ability of a measurement to consistently be reproduced. In the case of the two Tier I benthic monitoring protocols that measurement that should be reproduced is the final metric "scoring" the stream site.

This project meets data precision goals by having monitors meet a standard certification requirement on implementing protocol and macroinvertebrate identification skill level and collecting composite samples at stream sites that are representative of the stream. The methods for meeting those requirements can be found in Section A8. Any questionable data will be flagged in the Chesapeake Data Explorer.

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 following training procedures, certification in macroinvertebrate identification, field audits, sample audits, and in some cases like the CBP Benthic Macroinvertebrate Sample Collection Protocol, lab identification by certified taxonomists. The methods for performing training procedures, certification in macroinvertebrate identification, field audits, sample audits can be found in the SOPs in Appendix A.

A7.3 Bias

Bias is defined as the tendency to systematically favor one outcome over another. This project meets goals around removing bias by sampling in the expected habitats of benthic macroinvertebrates, and by completing identification of all collected organisms. The tier I sampling protocols covered in this QAPP target productive habitats in the stream reach expected to yield a diverse collection of benthic macroinvertebrates. Rocky bottom methods target productive riffles, while muddy bottom methods target snags and logs, stream banks, aquatic vegetation, and gravelly substrate. Bias is removed from the metric scores by counting every organism collected in a net, regardless of size.

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 sampled at 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 existing monitoring sites, accessibility, volunteer availability, and budget. More information on the site selection process can be found in Section B4.

Sample data shall be representative of the actual conditions present at the stream site. Sample collection, handling and sampling design, as well as preservation (when applicable), are interactive factors that directly affect field sample representativeness. Monitors will follow standard operating and QA procedures found in their macroinvertebrate monitoring manual to ensure that representative data are collected. Collection methods include sampling at more than one point in a stream reach and compositing into a single sample to be more representative. These techniques combined with external validation will ensure that the minimum standards of field representativeness are met (Appendix A).

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 benthic sample collection, identification, and storage (when applicable),
c. Using the monitoring equipment supplied or recommended by the CMC Project Team,
d. Consistently following the same monitoring SOP chosen by the monitoring group
e. Following QA and QC requirements. Details on these items are outlined in their Benthic Macroinvertebrate Monitoring Methods Manual.

f. Certified benthic monitors will be required to pass two certification tests on macroinvertebrate identification and protocol and maintain certification annually for the first two years of monitoring and then biennially after that.
g. Monitors without certification being supervised by certified monitors to ensure proper implementation of protocol and correct identification.

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.

Monitoring groups are expected to achieve 100% data completeness for their monitoring frequency. For this project, the CMC Project Team works with each individual monitoring group to set their own monitoring frequency. Typically, groups monitor either annually (1 sample per year), biennially (2 samples per year), or once every six years, in the spring or fall.

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.

A8. Training Requirements and Certification

The CMC Service Providers or Certified Trainers hold workshops and offer customized assistance to monitoring groups participating in the CMC depending on the protocols they are following. CMC Service Provider or Certified Trainer trains individual volunteers to be certified monitors and collect data independently at their specified monitoring sites.

The CMC Service Providers conduct three types of trainings regularly to support benthic data collection: Study Design Workshops, Benthic Macroinvertebrate Monitoring Training, and Train-the-Trainer Training. Certified Trainers provide Benthic Macroinvertebrate Monitoring trainings for their region and program. Additionally, 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, and 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, 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 Benthic Macroinvertebrate Monitoring Training

All monitors are required to attend a Benthic Macroinvertebrate Monitoring Training before they begin collecting samples. These workshops can be hosted by anyone and monitors can participate in trainings in many ways, including: attending in-person workshops, attending a live virtual workshop, watching online tutorial videos or recordings of workshops, or side-by-side monitoring tutorials in the field.

It is expected that each certified monitor will be able to properly collect samples, accurately identify benthic macroinvertebrates, properly fill out a data sheet, and enter data into the Chesapeake Data Explorer or IWLA database (if applicable). A certified monitor can start collecting data after participating in a training held by a Certified Trainer and completing one of the following certification requirements, templates of the certification requirements can be found in Appendix E:

1. Pass a macroinvertebrate identification test in person with preserved specimens or online with an 87% or greater and pass a protocol certification test with an 80% or greater.
2. Pass a macroinvertebrate identification test in person with preserved specimens or online with an 87% or greater and be observed collecting and processing a sample in the field.
3. Participate in a data collection event with a certified trainer where identification is confirmed prior to a score being determined.

Monitors that are unable to meet the certification requirements will be retrained 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 assist a certified monitor in the field until they have become comfortable with the procedures and QA/QC protocols.

All monitors that have passed the initial certification training and wish to maintain their certification must collect and submit data every year. If a monitor misses for more than two years, they need to become recertified. Recertification involves attending a virtual or in person training workshop and passing the certification requirements outlined above. Replacement equipment and datasheets 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 Benthic Macroinvertebrate Monitoring Workshop and certification process for monitors. 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-needed 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 Benthic Macroinvertebrate Monitoring and Certification Workshops, and how to manage the project documentation (Appendix D). If a group does not have a Certified Trainer, a CMC Service Provider can host a workshop for the monitors.

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 benthic macroinvertebrate collection and identification 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 six months and completing two macroinvertebrate sampling events;
2. Complete the macroinvertebrate identification test that all monitors take, and answering all questions correctly;
3. An ability to conduct a Benthic Macroinvertebrate Monitoring Certification Workshop, by showing their ability to:
    a. Logistically plan and lead a Benthic Macroinvertebrate Monitoring Workshop, including preparing the equipment and completing all of the necessary documentation,
    b. Explain water quality science, the importance and function of benthic macroinvertebrates, 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 Benthic Macroinvertebrate Monitoring Program.

Alternatively, if professional monitors who are SFS certified or otherwise professionally recognized opt to train volunteers, they can bypass the full Train-the-Trainer Workshop, but still need to work with the CMC Project to learn the appropriate protocol and tips for teaching volunteers.

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 lead at least one certification workshop per year and certify at least two monitors per year. Certified trainers must meet every year with the regional Project Team member in person or by video in order to maintain certification as a Certified Trainer. During this meeting, trainers will:

1. Review the CMC Benthic Macroinvertebrate Monitoring Program protocols.
2. Demonstrate their ability to perform monitor certification trainings.
3. Provide all program documentation, including the list of current monitoring sites and certified monitors.

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.

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 group's needs. All templates 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 provided by the CMC service provider.

On the data sheet, monitors record essential metadata including their name, date, time, sample site location/station ID and counts of each benthic macroinvertebrate collected. They may also record weather conditions and time spent monitoring. These data sheets are either entered into the Data Explorer directly upon returning from the field, entered into the IWLA database, or passed on to the monitoring groups Certified Trainer for data entry.

The Project Team/Certified Trainer maintains original hardcopy 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 Quality Assurance Forms/ Field Audit

Field audits are carried out by CMC service providers or certified trainers following a field audit checklist. The audit includes a review of equipment to make sure it is maintained and functional. The checklist requires a review of sample collection and sample processing and identification by the volunteer. Completed audit forms are sent to the CMC service providers.

A9.5 Unknown Specimen Form

All unknown specimens needing identification should be photographed by the volunteer and emailed to Service Provider staff. After identification (following the protocol in Section B2.2.3), the unknown specimen form is completed by the

Service Provider and sent to the volunteer. A copy of the form will be filed with the field data sheet and kept by the volunteer for a minimum of seven years, photographs are not stored.

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 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, etc.

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

- a list of certified trainers/QA Managers,
- a list of certified monitors and their certification date and last data upload date,
- monitoring site locations.

SECTION B – DATA COLLECTION METHODS

This project includes three approved protocols to collect and identify benthic macroinvertebrates. 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 following the IWLA's Virginia Save our Streams protocol and ALLARM's use of the EPA Volunteer Monitoring Benthic Macroinvertebrate Protocol for collecting Tier I data.

The Tier II CBP Benthic Macroinvertebrate Sample Collection Protocol may be assigned to volunteers by volunteers or monitoring groups selected by the CMC team in order to fill in specific data gaps anywhere in the Chesapeake Bay watershed. The quality assurance procedures for this protocol are outlined in the Volunteer Monitoring Support for Macroinvertebrate Sampling to FIll Chesapeake Bay Program Data Gaps QAPP, effective March 1, 2021 (Project ID: CBT 18880).

If a monitoring group is collecting family level data but does not follow the CBP Benthic Macroinvertebrate Sample Collection Protocol, they will be considered for inclusion on a case by case basis, based on the guidelines in Appendix C.

B1. Sampling Design

Volunteers working with the CMC service providers will be trained using the Virginia Save our Stream or EPA Volunteer Monitoring protocols. The following sections of this QAPP outline the programmatic and quality assurance procedures for these two protocols.

B1.1 Sample Collection

Samples will be collected from wadeable streams and are intended to give a broad assessment of stream health. Each

group will follow the protocols outlined in their Macroinvertebrate Monitoring Manual. The manual will contain standard operating procedures (SOPs) for sample collection, field data sheets, and QA/QC procedures. Method Manuals will also be available online.

B1.2 Sampling Frequency

Each Data Collector will have their own sampling schedule. Groups are expected to conduct macroinvertebrate monitoring in the spring and/or fall, annually, biennially, or once every five years. Some groups rotate their sites every few years. A site is expected to be monitored at least once in a six year period.

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 the same season when it is safe to do so.

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

- Once per season;
- Annually spring and fall; or
- Annually, biennially, or once every six years in either spring or fall.

Sampling timelines should also include schedules for data management and upload to the Chesapeake Data Explorer. Data should be uploaded after the data have been collected ideally within six months of sampling and analysis. Training frequencies should follow guidelines in Section A8 for the monitoring groups designated Tier level.

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 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. The number of sites should provide an adequate representation of the water quality of the stream segment being sampled.

b. Monitoring sites should be wadeable and have access for sampling along at least a 100-foot reach of stream.
c. Monitoring sites may be co-located at CBP, state monitoring, or nearby group site to allow for comparison of datasets.
d. Monitoring sites should be located in accessible and safe areas.

B2. Sampling/Analytical Methods

ALLARM will coordinate, train, and certify monitors in the Upper Chesapeake Bay Watershed (New York and Pennsylvania) using the ALLARM Macroinvertebrate Monitoring Methods Manual (Appendix A), which is adapted from the EPA Volunteer Stream Monitoring Methods Manual. IWLA will coordinate, train, and certify monitors in the Lower Chesapeake Bay Watershed (south of Pennsylvania border) using the IWLA Macroinvertebrate Monitoring Methods Manual, which is based on the Virginia Save Our Streams Protocol.

B2.1 Choosing the correct sample collection method

Monitors will choose the correct sampling method given the substrate of the stream and the available macroinvertebrate habitat, substrate requirements and appropriate sample methods can be found in Table B2-1. A rocky bottom stream has a substrate of rock with boulders, cobbles, and pebbles and has riffles present in the stream where sampling can take place. A muddy bottom stream has a muddy or sandy substrate with overhanging bank vegetation and submerged organic debris available for sample collection. Once the appropriate method is chosen for a particular site, that method is consistently used for every sampling event.

Table B2-1. Highlights of sampling methods for each substrate and service provider.

Substrate	ALLARM Methods	IWLA Methods
Rocky Bottom	• 500 micron mesh kick net • Rubbing rocks and disturbing substrate in front of net • 3 riffle sites sampled within 100 foot stream reach • No minimum sample size	• 320 micron mesh kick seine • Rubbing rocks and disturbing substrate in front of net • Up to 4 riffles sampled to reach or overshoot sample minimum • Minimum of 200 organisms
Muddy Bottom	• 500 micron D-net • 100 foot stream reach • Collecting 20 jabs, combination dependent on number of habitats present out of vegetated bank margins, snags and logs, aquatic vegetation beds and decaying organic matter, and silt/sand/gravel substrate	• 500 micron D-net • 100 meter stream reach • Collecting 20 jabs in productive habitats (woody snags, stream banks, submerged aquatic vegetation, and riffles if present)

For more details on the step-by-step process of each protocol, see the Methods Manuals in Appendix A.

B2.2 Processing Tier I Samples in the Field

Most macroinvertebrate samples will be processed in the field and returned to the stream within a few hours after collection. Some samples will be preserved in the field (see section B3, *Sample Handling and Custody Procedures*, for field preservation procedures) for quality assurance purposes, or for the CBP Benthic Macroinvertebrate Sample Collection Protocol.

B2.2.1 Processing to Order Level

Monitors will place their macroinvertebrate samples on a flat, light-colored surface, such as a white sheet, table, or piece of plastic so the organisms are easy to see. Next, they will sort the macroinvertebrates into groups of organisms that have similar characteristics and appearance. It is important that monitors sort all of the organisms and they will look on both sides of any debris in the sample, since insects often cling to any available litter.

Once the organisms are divided into look-alike groups, using primarily body shape and number of legs and rear protrusions, monitors will use a hand lens or microscope (if needed) and reference materials to identify the organisms to Order level. If an organism cannot be identified or needs to be preserved for quality assurance purposes, monitors will follow the preservation technique listed in section B3. After the samples have been processed and identified and the information has been recorded onto the data sheet, the samples will be returned to the stream and the equipment will be thoroughly rinsed. In order to prevent the spread of invasive species, volunteers decontaminate their equipment using bleach or alconox if traveling to another site in the same day, or thoroughly wash equipment and leave it in the sun to dry if only visiting one site.

B2.2.2 Unknown Specimen

Organisms that monitors collect but cannot identify will either be photographed (Order level only) or preserved and sent to ALLARM/IWLA or a certified taxonomist for identification.

For Tier I level identification, organisms may be photographed. Monitors will take multiple photographs of the organism to document the number of legs/appendages (if any), the head and mouth features, the thorax and abdomen (top and bottom if possible), any tail features, and other distinguishing characteristics. In addition, another object, such as a ruler, should be included in the photograph for scale purposes. Monitors will record a physical description of the organism and the suspected taxonomic Order and Family (if applicable) on their field data sheet, and send a copy of the datasheet and the photographs to ALLARM/IWLA for identification.

If unable to collect photographs, monitors can preserve an unknown organism by placing it in a vial with 70% ethyl alcohol along with a paper label written in pencil with the site ID and sample date. They will also record a physical description of the organism and the suspected taxonomic Order and Family (if applicable) on their field data sheet. Monitors will send or deliver the preserved specimen and a copy of their data sheet to ALLARM/IWLA or a certified taxonomist for identification.

B2.2.3 Processing the Unknown Specimen

Preserved specimens and matched data sheets sent to ALLARM/IWLA or a certified taxonomist for identification, will be processed and identified, and the results will be recorded internally and on the monitor's field data sheet. The identification results will be sent to the monitor (certified taxonomists will also send the identification results to ALLARM/IWLA) and the monitor will enter the information into the project database. Submitted data that is quality assured should not have more than 5 unknowns in the sample.

B3. Sample Handling and Custody Procedures

Monitors are responsible for processing the macroinvertebrate samples in the field and returning them to the stream within a few hours after collection, unless preserving them for quality assurance purposes. To preserve a macroinvertebrate sample, monitors will place the sample and a label written with pencil in a glass or plastic container and fill it with 70% ethyl alcohol until the entire sample is covered. They will deliver the specimen and field data sheet to ALLARM/IWLA or certified taxonomist within three weeks of collection for identification. Once processed and identified, the results will be recorded internally and on the monitor's field data sheet. The identification results will be sent to the monitor (certified taxonomists will also send the identification results to ALLARM/IWLA) and the monitor will enter the information into the project database. Preserved specimens will be used for educational/training purposes or discarded.

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 Field QC Checks

B4.1.1 Internal Verification

To help ensure macroinvertebrate samples are identified correctly, monitors will work in teams (≥ 2 monitors) to sort and identify the macroinvertebrate samples. The team must agree on the identification before recording the organism on their field data sheet. If the team cannot reach an agreement, even after asking others for help, the team will consider the organism to be an unknown specimen and follow the procedures in B2.5.1.1 to identify it.

B4.1.2 External Verification

Monitors will have an entire macroinvertebrate sample verified externally ≥ 10% of sampling events. Monitors collecting Tier I data will have their sample and final calculated score verified by ALLARM/IWLA/Certified Trainer, which will often occur during the Certification Workshop or a data collection/analysis workshop. If the monitors identify > 10% of the sample incorrectly, ALLARM/IWLA/Certified Trainer will retrain the monitors on macroinvertebrate identification and the monitors will be asked to retake and pass the Macroinvertebrate Identification Test (see A8.3; Appendix E) in order to remain certified.

B4.1.3 Field Audits

Project Team members 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, identification, and documentation 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.

B4.2 Data Entry QC Checks

All data are checked for data transfer error (spot-checks), 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 counts and flag questionable data;
4. Upload/publish data in the Data Explorer.

B4.2.1: 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 a few ways: via the data upload form on the Chesapeake Data Explorer or IWLA database, or onto a Microsoft Excel spreadsheet that is then bulk uploaded to the Data Explorer.

Data that are uploaded directly on the Data Explorer or the IWLA database via the data upload form will be spot checked on the Data Explorer prior to publishing. Monitors upload their data directly, then maintain a copy of their field data sheets for 7 years after the monitoring date. The Project Team/Certified Trainer will spot check all submissions for data that is questionable (macroinvertebrate populations that do not make sense, macroinvertebrate counts that are not whole numbers, macroinvertebrate counts that do not equate to the total population reported, etc.). If an error is suspected, the original certified monitor will be asked to send a copy of the datesheet to the Project Team. 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 in the same manner as above prior to data upload.

B4.2.2: 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. The application also checks data validity, such as confirming that the parameter code (benthic macroinvertebrate name) 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, parameter, and sample id. The Data Explorer requires that a problem code is associated with any null sample value.

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

B6. Data Management

All Tier I and Tier II field data collected will be recorded on field datasheets. Following data collection, data will be entered into the Chesapeake Data Explorer by the monitor or CMC Project Team either from the field datasheet or via bulk upload. 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 Certified Trainers, and CMC Service Providers. 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 Certified Trainer or CMC Service Provider. The data are then checked by the Certified Trainer 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, this typically occurs only by the CMC Project Team, 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 certified trainer. The data is then checked by

the Certified Trainer 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 the data checks, the user will be prompted to publish the data uploaded. This process typically occurs annually.

A local partner, or program may choose to organize their macroinvertebrate data for multiple sites in excel files, which can be bulk uploaded into the Chesapeake Data Explorer episodically following provided Excel templates. All data analyzed at the Wheeling Lab are sent to the CMC Project Team after analysis as excel files and are uploaded by the CMC Project Team via the bulk upload process as described above.

Data collected under the IWLA's program are uploaded by certified monitors into the VASOS database or the Clean Water Hub. A monitor must have an account in one of these databases and upload data from the field datasheets provided by IWLA for each monitoring event. Data are downloaded to Excel, annually reviewed, and quality assured by IWLA staff. Following this QA review, accepted data are then added to the Chesapeake Data Explorer by IWLA staff via the bulk upload process 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.

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

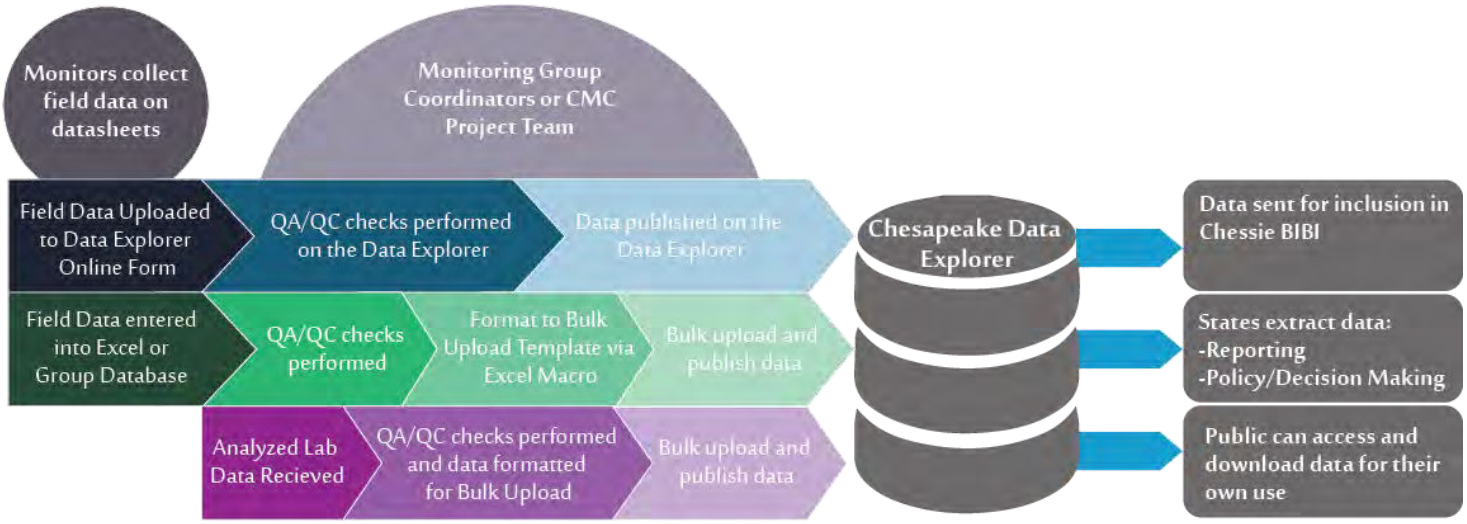

Figure B6-1. Data management flow chart from data collection, to storage, to use.

B7. Equipment Testing, Inspection, and Maintenance Requirements

Monitors will maintain their equipment and inspect (Table B7-1) it prior to each sampling event to ensure that all materials are clean and working properly. Any problems found during inspection will need to be addressed prior to sampling.

Table B7-1. Equipment inspection requirements for macroinvertebrate sampling.

Equipment Type	Inspection Frequency	Type of Inspection
Net (kick, D-frame)	Before each sampling event	Visual: • Cleanliness – debris, sediment, or dead organisms • Small rips or holes
Light-colored surface used to process samples (sheet, plastic)	Before each sampling event	Visual: • Cleanliness – debris, sediment, or dead organisms • Small rips or holes
Other sampling equipment (buckets, waders, sorting trays and utensils)	Before each sampling event	Visual: • Cleanliness – debris, sediment, or dead organisms • Small rips or holes
Microscope	As per manufacturer recommendation	Cleaned

After sampling, monitors will clean their equipment following the procedures in the ALLARM/IWLA Macroinvertebrate Methods Manual, and will store it in a secure, dry area when not in use.

ALLARM/IWLA/Certified Trainer will provide monitoring groups with the equipment they need to collect, sort, and identify macroinvertebrates or provide them with information on where to purchase the materials.

B7.1 Inspections/Acceptance Requirements for Supplies

ALLARM/IWLA will obtain and recommend monitoring equipment and supplies from reputable field/laboratory supply companies. ALLARM/IWLA/Certified Trainer will inspect purchased equipment and broken or defective items will be sent back to the supplier. Equipment will be distributed to monitors at the Macroinvertebrate Monitoring Workshop or afterwards as needed. The equipment must meet the specifications outlined in the ALLARM/IWLA Macroinvertebrate Methods Manual and will be inspected and verified by ALLARM/IWLA/Certified Trainer during the Certification Workshop or field audit.

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

All data collected under the CBP Benthic Macroinvertebrate Sample Collection Protocol will be sent to the EPA Wheeling Lab and analyzed by a Freshwater Science-certified taxonomist for Tier II data, or family level identification. See the Volunteer Monitoring Support for Macroinvertebrate Sampling to Fill Chesapeake Bay Program Data Gaps QAPP, effective March 1, 2021 (Project ID: CBT 18880) for more details.

Any other samples identified to family level, but not analyzed at EPA's Wheeling Lab, will have identification and analysis done on preserved samples conducted by a state or Society for Freshwater Science-certified taxonomist for Tier II data, or family level identification. It is the responsibility of the taxonomic laboratory to maintain the certification, and the Project Manager may ask the laboratory to supply a copy of the certification if needed.

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 Benthic Macroinvertebrate 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 maintain their certification by collecting and uploading data within the first two years of certification and continuing data collection annually after that. If not they attend a new certification session. These sessions serve as an audit 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 and Certified Trainers use re-certification sessions to identify macroinvertebrate mis-identification so that it can be immediately rectified.

Monitors can be re-certified at one of three meetings: a scheduled certification training; during a site visit by a Project Team member, Certified Trainer, or QA Management; or during a visit to any Project Team office for individual re-certification. The Project Team analyzes the data sheets from re-certification sessions to determine if the data quality objectives (e.g., correct values for parameters compared to controls) are met and if the monitor had any questions about the procedures. These objectives include:

a. Sampling collection method
b. Macroinvertebrate identification
c. QA procedures
d. Equipment inspection

If the objectives are not met by the monitor, the Project Team will decide on appropriate corrective action (e.g., training monitors to use an alternate method of sampling; requiring that equipment be more frequently verified; or the monitor ceases measuring the parameter in question.)

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 field data sheets and information are thoroughly reviewed by the Project Team and Certified Trainers prior to data analysis to assure that all data were collected uniformly. Field data are entered into the Chesapeake Data Explorer and compared against the original field data sheet for errors using the recommended 10% spot check procedure in section B4.2.1 These errors will be corrected by Project Team members. Field data sheets are retained by the regional Project Team member.

D2. Validation and Verification Methods

The Project Team works with monitoring groups to ensure that all data are validated and verified before acceptance in the Chesapeake Data Explorer. The Project Team recommends that Certified Trainers and monitoring groups perform a spot check of data sheets as described in Section B4.2 to ensure proper data entry procedures are upheld. The Project Team provides advice and technical assistance to ensure that procedures are properly followed and that submitted data have been checked thoroughly.

The monitoring group forwards the original datasheet to the regional Project Team or Certified Trainer. If during spot-checking process data are found to be questionable, it will be flagged by Certified Trainers or the Project Team during data review. When errors are identified by the Project Team during the spot check process, previous data sheets from that monitor are checked for the previous six months. If more errors are found, the Project Team contacts the monitoring group for more information and to thoroughly investigate the error. If errors are easily identifiable, the monitor is informed of errors and is retrained to ensure proper data collection. If the error is unable to be resolved the data from that monitor for that period and onward is flagged until a resolution is found.

QC verification samples will be processed externally ≥ 10% of sampling events. These quality control samples will be used to validate and verify identification accuracy.

D3. Reconciliation with Data Quality Objectives

This QAPP is applicable to two data quality objectives defined by Tier I and Tier II criteria. If Tier II data is found to not meet family level identification, the data can still be used and submitted underneath Tier I designation.

The results of all re-certifications are immediately analyzed to determine if monitors have met quality assurance requirements for protocol followed and identification accuracy. If a monitor's technique is incorrect, they are re-trained and re-assessed until they can demonstrate the correct technique and asked to join a different certified monitor until their identification and adherence to protocol is rectified. If the monitor continues to use incorrect technique, their data are flagged by the Project Team or certified monitor and not entered into the Chesapeake Data Explorer nor used in reporting.

Field and laboratory data that does not meet data quality objectives will be flagged. 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