Attachment J

Quality Assurance Project Plan for Lake Nutrient Monitoring for Integrated Report Assessment and Total Maximum Daily Load Development

FINAL Quality Assurance Project Plan

Lake Nutrient Monitoring for Integrated Report Assessment and Total Maximum Daily Load Development

Water and Science Administration

Watershed Protection, Restoration, and Planning Program

Field Services Program

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A2. Approval Page

Concurrence

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Approval

EPA Region 3 Delegated Approving Official

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A3. Table of Contents, Document Format, and Document Control

Document Format

This Quality Assurance Project Plan (QAPP) was developed by the Watershed Protection, Restoration, and Planning Program (WPRPP) and Field Services Program (FSP) in accordance with the U.S. EPA Quality Assurance Project Plan Standard (U.S. EPA, 2023). This QAPP documents the water quality monitoring activities, and quality control and quality assurance procedures developed for impoundment (hereafter called "lakes") eutrophication related monitoring for Integrated Report (IR) and Total Maximum Daily Load (TMDL) programs. The order of the elements in this QAPP follows the U.S. EPA Standard, as seen in the Table of Contents. The QAPP is also consistent with the applicable recommendations and requirements of the U.S. EPA Region 3 Quality Management Plan (2020; DCN R3QMP001-20200601) and MDE's Quality Management Plan (2020).

Document Control

This table shows changes to this controlled document over time. The Lake Nutrient Monitoring for Integrated Report Assessment and Total Maximum Daily Load Development QAPP is represented by the document control number (DCN) of LNMQAPP(i.e. "Lake Nutrient Monitoring QAPP").

Questions regarding this QAPP should be addressed to:

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Table 1 QAPP Versions

DCN Version	Changes	Effective Date
Lake Nutrient Monitoring QAPP- DCN LNMQAPP Version 0.0	Original Document Prepared By: Melinda Cutler and Becky Monahan-MDE	April 2025

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List of Acronyms

Ambient Water Quality Monitoring System	AWQMS
Chesapeake Biological Laboratory	CBL
Data Quality Indicator	DQI
Delegated Approving Official	DAO
Document Control Number	DCN
Field Data Manager	FDM
Field Services Program	FSP
Integrated Report	IR
Laboratory Data Manager	LDM
Lake Nutrient Monitoring	LNM
Maryland Department of the Environment	MDE
Project Manager	PM
Quality Assurance	QA
Quality Assurance Manager	QAM
Quality Assurance Project Plan	QAPP
Quality Control	QC
Quality Management Plan	QMP
Standard Operating Procedure	SOP
Total Maximum Daily Load	TMDL
United States Environmental Protection Agency	EPA
University of Maryland Center for Environmental Science	UMCES
Water Quality Exchange	WQX
Water Quality Portal	WQP
Watershed Protection, Restoration and Planning Program	WPRPP

A4. Project Purpose, Problem Definition, and Background

This section provides an overview of the Maryland Department of the Environment's (MDE) role in the execution of the Integrated Report (IR) and Total Maximum Daily Load (TMDL) water-quality monitoring program for assessing nutrients within Maryland's impoundments. It briefly states the project goals, describes the participants and discusses the general approach used to provide water quality monitoring support for the IR and TMDL programs.

Purpose and Problem Definition

This QAPP documents the water quality monitoring activities and quality control procedures developed for the Lake Nutrient Monitoring Project. This project establishes a water-quality monitoring program to identify and address eutrophication in Maryland's impoundments. The project provides direct measurements of water quality to compare against state regulatory standards and criteria to determine if Maryland's impoundments are impaired for nutrients (eutrophic). These data will be evaluated for assessments in Maryland's Integrated Report of Surface Water Quality (IR) and, if determined to be impaired, will be utilized in the subsequent development of a Total Maximum Daily Load (TMDL). This process allows Maryland to identify waters with impaired conditions and establish a plan to improve these waters. These operations fulfill sections 303(d), 305(b), and 314 requirements of the Clean Water Act.

MDE coordinates this effort, conducting data collection and analysis. Within MDE, the Watershed Protection, Restoration and Planning Program (WPRPP) and the Field Services Program (FSP) are the chief divisions responsible for the data collection, analysis, and implementation of this QAPP.

The purpose of the Lake Nutrient Monitoring QAPP is to document the environmental decision(s) that need to be made and the level of information quality needed to ensure that those decisions are based on sound environmental information. The QAPP describes the data collection process and the data acceptance and performance criteria determine if the data is of high quality. High quality data can be used to meet programmatic needs.

Background

Maryland's impoundments (hereafter referred to as "lakes") are valuable natural resources that provide numerous recreational and ecological benefits such as bathing beaches, fishing and boating opportunities, freshwater aquatic life habitat, and drinking water to Maryland citizens. Maryland Department of the Environment (MDE) and the Maryland Department of Natural Resources (MDDNR) have recognized the need for continued lake monitoring and partnered to address known sampling gaps and to coordinate sampling protocols. One of the primary goals is to monitor and assess all significant (> 5 acres surface area), publicly-owned lakes in Maryland for impacts due to nutrients. To inform current and future lake monitoring efforts, MDE and MDDNR jointly developed a prioritization strategy[1] to identify an order in which lakes will be sampled. MDE plans to sample 3-5 lakes per year according to the list and MDDNR will assist with other targeted sampling of State-owned Lakes. The data from these efforts will inform the Integrated Report (IR) assessment process to determine impairment status, as well as address any impairments through development of TMDLs.

The IR is a combined biennial report under sections 305(b) and 303(d) of the federal Clean Water Act, requiring states, territories and authorized tribes to perform annual water quality assessments to determine the status of

[1]https://mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/2021%20Final%20Prioritization%20Strategy%20for%20Monitoring%20Maryland%20Lakes.pdf

jurisdictional waters and to identify waters assessed as not meeting water quality standards (as specified in Code of Maryland Regulations 26.08.02). Waters that do not meet standards may require a TMDL to determine the maximum amount of an impairing substance or pollutant that a particular water body can assimilate and still meet water quality criteria. Please see MDE's assessment methodologies webpage[2] and The Assessment Methodology for Dissolved Oxygen and Chlorophyll a Criteria in Maryland's Seasonally Stratified Water-Supply Reservoirs[3] for information on how impairment status is determined. For information on water quality standards, see MDE's water quality standards webpage[4] or COMAR 26.08.02.03-3[5]. Nutrient data from this project will be used to inform future TMDL development, if necessary.

If a waterbody impairment is identified for a monitored lake, data from the Lake Nutrient Monitoring project will also assist with informing the WPRPP's TMDL development process. Under the direction of the U.S. Environmental Protection Agency (EPA), States are required to develop TMDLs for their impaired waters that do not meet or are not expected to meet designated State water quality standards. This process serves as a mechanism to determine limits and waste load allocations on allowable point and non-point source loadings to a waterbody in order to bring a waterbody back into compliance with the applicable water quality standards. MDE develops and implements TMDLs for the impaired-listed waters of the state of Maryland. This is accomplished through targeting and scheduling high priority impaired waters from the IR's impaired waters list (as identified on the 303(d) list), developing TMDLs to achieve State water quality standards, and ultimately implementing and assessing prescribed control actions to bring water bodies back into attainment of water quality standards.

Other QA Documents

Other quality assurance documents, including standard operating procedures (SOPs), that may be related to this project are listed in Table A4-1.

Table A4-1 Other QA Planning Documents that have Relevant Requirements

Document Title	Directive #, DCN, or Revision	Effective Date	Pertinence to this QAPP
MDE Standard Operating Procedure: Lake Nutrient Monitoring (LNM) Project-Data Management and QA/QC[6]	LNM01-	September 2024	SOP to be followed during data management
MDE Standard Operating Procedure: Sampling Station Selection and Naming in Free Flowing and Free Flowing Impoundment Waterbodies[7]	WQ01	September 2024	Field SOP to be followed

[2] https://mde.maryland.gov/programs/water/tmdl/integrated303dreports/pages/ir_listing_methodologies.aspx
[3]https://mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/DOandCHLa_Lakes_AM_2012_final.pdf
[4] https://mde.maryland.gov/programs/water/tmdl/waterqualitystandards/pages/index.aspx
[5] https://dsd.maryland.gov/regulations/Pages/26.08.02.03-3.aspx
[6] https://mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/Lakes/LNM01_DataManagement_SOP.pdf
[7]https://mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/Lakes/WQ01_SamplingStationSelectionName_SOP.pdf

Document Title	Directive #, DCN, or Revision	Effective Date	Pertinence to this QAPP
MDE Standard Operating Procedure: Water Quality Equipment Maintenance and Calibration SOP[8]	WQ02	September 2024	Field SOP to be followed
MDE Standard Operating Procedure: Collection and Handling of Water Samples[9]	WQ03	September 2024	Field SOP to be followed
Maryland Department of the Environment (MDE) Quality Management Plan. [10]		September 2020	QAPP developed in accordance with MDE Quality Management Plan
Chesapeake Biological Laboratory. Nutrient Analytical Services Laboratory: Quality Assurance/Quality Control[11]			Lab data QA/QC procedures to be followed
Chesapeake Biological Laboratory. Nutrient Analytical Services Laboratory: Methods[12]	TDN and TN - Revision 2023-1	May 15, 2023	Lab methods to be followed
	NO3+NO2 - Revision 2023-1	May 1, 2023	
	NO3 + NO2 Cd reduction - Revision 2023-1	May 1, 2023	
	NH4 - Revision 2023-1	May 1, 2023	
	PO4 - Revision 2023-1	May 1, 2023	
	Chla - Revision 2023-1	May 1, 2023	
U.S. EPA Quality Assurance Project Plan Standard[13]	CIO 2105-S-02.0	July 18, 2023	QAPP developed in accordance with EPA QAPP standard.
U.S. EPA Records Management Policy[14]	CIO 2155.5	June 9, 2020	Records managed in accordance with EPA's Record Management Policy.

[8]https://mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/Lakes/WQ02_EquipmentMaintenanceandCalibration_SOP.pdf

[9]https://mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/Lakes/WQ03_CollectionofWaterSamples_SOP.pdf

[10] https://mde.maryland.gov/Documents/MDE%20QMP%20Mgmt%20Plan%20Signed.pdf

[11] https://www.umces.edu/quality-assurancequality-control

[12] https://www.umces.edu/nasl/methods

[13] https://www.epa.gov/system/files/documents/2024-04/quality_assurance_project_plan_standard.pdf

[14] https://www.epa.gov/system/files/documents/2021-08/records_management_policy.pdf

Document Title	Directive #, DCN, or Revision	Effective Date	Pertinence to this QAPP
U.S. EPA Region 3 Quality Management Plan[15]	R3QMP001-20200601	June 1, 2020	QAPP developed in accordance with EPA Region 3 Quality Management Plan.
U.S. EPA Region 3 QAPP Template			Example QAPP Template developed in accordance with EPA Region 3 QAPP Template.

[15] https://www.epa.gov/quality/quality-management-plan-region-3

A5. Project Task Description

The Lake Nutrient Monitoring project will focus on the collection and quality assurance/ quality control (QA/QC) of water quality data within designated Maryland lakes. Quality data collected as part of the project will inform impairment status decisions on the IR for designated lakes. Additionally, for TMDL development, data collected as part of the project will help to identify spatial and temporal distribution of eutrophication related constituents, as well as the contribution of flow inputs under varying hydrological conditions for the waters listed as impaired.

The FSP is responsible for designing the Lake Nutrient Monitoring study, including selecting sampling locations and laboratories; conducting fieldwork; and sending documentation of final results to the WPRPP office in Baltimore. FSP and WPRPP work in coordination to establish appropriate QA/QC procedures for the project. All of these efforts, provided by the FSP with support from WPRPP, are structured to meet the data quality objectives that were set forth to support the data requirements for IR assessments and TMDLs.

Water quality at designated stations will be sampled twice a month from April to October. From November through March, sampling will be conducted once a month. The increased frequency of sampling during the summer season (April through October) was established with the intent to capture summer conditions of Maryland's lakes under varying hydrodynamic and meteorological scenarios.

Best efforts will be made to keep to the sampling schedule and frequency outlined; however, this schedule is subject to change due to unsafe sampling conditions or other competing Program objectives. In the event of canceled surveys, efforts to reschedule will be made by the Field Data Manager. However, the viability of rescheduling will be dependent on competing tasks at the FSP and laboratories, as well as the projected usefulness of the replacement data to the data users. All canceled surveys will be noted as appropriate in a centrally accessible data tracking spreadsheet.

All field data and sample collection will be completed by FSP personnel. All collected water samples will be analyzed by the appropriate laboratory, checked for completeness by FSP personnel and submitted to Baltimore headquarters. All data collected and analyzed through this project will be entered and stored in MDE's Ambient Water Quality Monitoring System (AWQMS) database and shared with the EPA's Water Quality Exchange (WQX) and Water Quality Portal (WQP). Following verification and validation, the data will be made available to the assessment staff for IR decisions and the modeling staff to support the development of TMDLs as applicable.

Following the procedures outlined in this QAPP, data will be of quality for regulatory decision-making.

To achieve this goal of high quality nutrient monitoring data, a variety of smaller work products will be produced as a result of the project. These work products include:

- A list of selected impoundments for monitoring (Excel format)
- A map of stations to be sampled (Excel and .mxd ArcGIS file)

- A Quality Assurance Project Plan (Word / PDF format)
- Field measurements (Hard copy field sheets, Scanned PDFs, AWQMs / database uploads)
- Laboratory analysis (Excel format, AWQMS / database uploads)
- Data tracking spreadsheet (Excel format)
- Quarterly QA/QC and duplicate reports (Word format / email communications)

The following table describes the progression and schedule of the Lake Nutrient Monitoring project with associated products and duties.

Table A5-1 Task Schedule and Products

Project Year	Task	Lead	Final Task Deliverable(s)	J	F	M	A	M	J	J	A	S	O	N	D
Year One	Selection of impoundments	PM	List of selected impoundments (Excel sheet)									X	X	X	X
	QAPP review	PM	QAPP (Word / PDF)									X	X	X	X
	Station selection	PM / FDM	Map of stations (Excel and .mxd ArcGIS file)									X	X	X	X
Year Two	QAPP Review	PM	QAPP (Word / PDF)	X	X	X									
	Station selection	PM	Map of stations (.mxd ArcGIS file)	X	X	X									
	Monitoring surveys and field data upload	FDM	Field data (Hard copy field sheets, Scanned PDFs, Excel data tracking sheet AWQMS uploads)				X	X	X	X	X	X	X	X*	X*
	Laboratory analysis	LDM	Laboratory data (Excel sheets, AWQMS uploads)							X			X		
	Quarterly QA/QC checks of data submissions & data upload	QAM	Quarterly data quality report (Word / Email)							X			X		
Year Three	Monitoring surveys and field data upload	FDM	Field data (Hard copy field sheets, Scanned PDFs, Excel data tracking sheet AWQMS uploads)	X*	X*	X*	X	X	X	X	X	X	X		
	Laboratory analysis	LDM	Laboratory data (Excel sheets, AWQMS uploads)	X			X			X			X		X
	Quarterly QA/QC checks of data submissions	QAM	Quarterly data quality report (Word / Email)	X			X			X			X		X

*Sampling will occur once per month from November - March

PM = Project Manager, FDM = Field Data Manager, LDM = Laboratory Data Manager

A6. Information/Data Quality Objectives and Performance/Acceptance Criteria

Data quality objectives are established to evaluate the quality of the data collected and ensure that it is suitable for its intended users. This section describes the quality objectives developed for the project and the measurement performance criteria used to achieve these objectives.

This element describes quality specifications at two levels:

1) at the level of the decision or study question (Quality Objectives)

2) at the level of the information/data used to support the decision or study question (Performance/Acceptance Criteria).

Data Quality Objectives

In-situ field water quality data and nutrient laboratory data collected under the Lake Nutrient Monitoring QAPP is intended for use by MDE staff in IR assessments and any future TMDL development needs. Data collected will be compared to regulatory standards to determine if an impoundment is impaired for nutrients. Data will be assessed following the Assessment Methodology for Dissolved Oxygen and Chlorophyll a Criteria in Maryland's Seasonally Stratified Water-Supply Reservoirs[16]. This methodology typically requires two summers and one winter season of data in order to inform a regulatory IR assessment decision. If there is evidence of impairment with less data, a decision may be made according to the best professional judgment of IR staff.

Data may also be utilized by MDE's TMDL modeling staff for any needed TMDL development; this process requires at least two years of available data to inform model development. If additional data are necessary for TMDL development, TMDL staff will organize an additional field sampling project to collect the additional information. The information collected for TMDL development will be used in mathematical models that simulate environmental conditions in non-tidal waters/impoundments and predict water quality concentrations in the watershed being studied.

The IR assessments and TMDL models typically require other input data such as meteorological and field monitoring parameters to characterize environmental conditions in the watershed. The majority of this data will be collected by the FSP as in-situ field measurements, field observations reported by the field scientists, and water samples to be analyzed by the laboratories.

MDE is committed to collecting primary lake nutrient data and obtaining existing data of the highest quality possible within the constraints of project resources. A system of performance criteria has been established to ensure that this data is of good quality and that it will be suitable for use by the IR assessment and TMDL modeling staff. The project will comply with the data quality policies outlined in Maryland Department of the Environment's Quality Management Plan (MDE, 2020). All

[16]https://mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/DOandCHLa_Lakes_AM_2012_final.pdf

data used for analysis within the IR and/or TMDL development will also be reviewed first using the quality procedures outlined in this QAPP and within the LNM Project-Data Management and QA/QC SOP. The involved laboratories (i.e. Chesapeake Biological Laboratory, CBL) will follow their internal quality procedures and perform all necessary quality assurance as required for each parameter's method (see section B2 - Methods for Environmental Information Acquisition) . QA/QC'ed data will be reviewed and stored in MDE's internal Ambient Water Quality Monitoring System (AWQMS) database and final data will be submitted to the Water Quality Exchange (WQX) where it will be considered in data analysis for the IR and TMDL development as appropriate.

Performance and Acceptance Criteria

Performance Criteria

Performance criteria address the adequacy of information that is to be collected for the project. These criteria often apply to new information collected for a specific use. The performance criteria that the data will need to achieve to minimize the possibility of either making erroneous conclusions or failing to keep uncertainty in estimates to within acceptable levels based on the quality objectives include:

- Field and lab quality requirements- as discussed throughout this QAPP and as described in the SOPs such as:
    - Sample collections will be made under all weather conditions, if necessary (i.e., rain, snow).
    - Collections will be made at the approximate same time of day (mornings) using the techniques and equipment described in Section B.
    - Field filtering and preparation of samples will be conducted using the techniques and equipment described in the MDE Standard Operating Procedure: Collection and Handling of Water Samples SOP
    - Consistent reporting and data verification techniques will be employed.
    - Consistent laboratory analyses will be conducted for specified suites of parameters at predetermined sampling sites.
    - Field scientists will note comments regarding unusual weather conditions or any other factors that may influence the integrity of the data collected.
    - The Program Manager and QA/QC team will be responsible for ensuring the adherence of project quality objectives.
- Table B2-1: In-situ Field Parameters provide the accuracy and acceptable measurement ranges for all in-situ field parameters.
- Table B2-2: Water Quality Parameters Analyzed for the Lake Monitoring Program provide the acceptable detection limits for laboratory analyzed parameters for the project.
- Data Quality Indicators, as outlined below.

Acceptance Criteria

Acceptance criteria address the adequacy of existing information proposed for inclusion in the project. These criteria often apply to information drawn from existing sources. Existing data to be collected for this project, their intended uses, and their limitations/acceptance criteria are described in Table A6-1. When appropriate, data will be uploaded or manually entered into the project database using the same quality protocols described for primary data. Primary data collected for this project will meet acceptance criteria through specific quality control activities described in Table B4-1.

Table A6-1 Existing Data

Existing Data Type	Source	Intended Use	Limitations/ Acceptance Criteria
Hydrological data	USGS Website-Water Data for the Nation https://waterdata.usgs.gov/nwi	To provide hydrological data for a site if needed for TMDL development purposes.	USGS's website notes on the stream gage's page when data are provisional and subject to revision until they have been thoroughly reviewed and received final approval. USGS's website also may indicate data quality for periods of time or certain parameters in the site's "Remarks". Data users should note in metadata upon data submission if the data is marked as provisional or has other QA notes on the USGS website. Additional follow-up to the website should occur to determine if there are any status changes to the data.

Data Quality Indicators

Data quality indicators (DQIs) are important in determining total measurement and sampling uncertainty, and thus assist in determining if performance (and acceptance) criteria were met for quality objectives. To ensure that data collected are of sufficient quality for the intended use, a system of qualitative and quantitative DQIs will be used to assess the level of acceptability: precision, accuracy, representativeness, comparability, completeness, and sensitivity (US EPA, 2023a). The following text describes these DQIs and practices used to assess data quality for each. Please see section B4 and Table B4-1 QC Activities for a more comprehensive description of quantitative quality control (QC) checks.

Precision

Precision is the measure of agreement among repeated measurements of the same property under identical or substantially similar conditions. This project meets data precision goals by completing the appropriate field duplicate frequencies found in section B4. The methods for collecting the duplicate samples can be found in the LNM Project-Data Management and QA/QC SOP. These duplicate samples will be processed by the CBL following the same procedures as non-duplicate samples and assessed using the checks outlined within the LNM Project-Data Management and QA/QC SOP to further ensure proper field precision. See section B4 and Table B4-1, or the LNM Project-Data Management and QA/QC SOP for more information on this process and quantified acceptance criteria. Any samples that fall outside of the acceptable precision range for a specific parameter will be flagged and the appropriate qualifier code, as listed in the LNM Project-Data Management and QA/QC SOP, will be added to the AWQMS database.

CBL will follow quality control processes (e.g., laboratory duplicates) as required for the individual laboratory analyses by their quality system. Refer to CBL's Quality Assurance/Quality Control Webpage and Laboratory Methods Webpage for specific discussions on performance measurements. The specific methods utilized for each parameter are listed in Section B2 - Methods for Environmental Information Acquisition, Table B2-1. See also section B4, QC Statistics, for more information on quality control methods and applicable formulas (ex; relative percent difference (RPD)).

The precision for in-situ measurements is also captured through the equipment sondes' manufacturer accuracy and measurement ranges. These ranges are reported in Section B2 - Methods for Environmental Information Acquisition, Table B2-2. Equipment will be maintained and calibrated regularly following the Water Quality Equipment Maintenance and Calibration SOP.

Accuracy (Bias)

Accuracy (Bias) is a measure of the overall agreement of a measurement to a known value. This project meets data accuracy goals by calibrating, standardizing, and verifying equipment following the frequency and specification criteria outlined in section B4.2. Accuracy in the field will be assured through the consistent execution of the approved proper sampling techniques. Field collection staff will follow the Collection and Handling of Water Samples SOP for the collection of in-situ field parameters and water samples collected for further laboratory analysis. Additionally, equipment sondes will be maintained and calibrated regularly following the Water Quality Equipment Maintenance and Calibration SOP. Manufacturer accuracy ranges for in-situ equipment are provided in Section B2 - Methods for Environmental Information Acquisition, Table B2-2. Any calibration samples that fall outside of the acceptable range for a specific equipment will be flagged and an appropriate qualifier code will be added to AWQMS for those data.

For laboratory assessments of the water quality samples, checks on accuracy will be calculated and reported by CBL. Refer to CBL's Quality Assurance/Quality Control Webpage[17] and Laboratory Methods Webpage[18] for specific discussions on these performance measurements. For additional information on the specific analytical methods and procedures utilized for each parameter, the

[17] https://www.umces.edu/quality-assurancequality-control
[18] https://www.umces.edu/nasl/methods

methods for each parameter are listed in Section B2 - Methods for Environmental Information Acquisition, Table B2-1 and SOP documentation is maintained on the CBL website (https://www.umces.edu/nasl/methods). Any calibration samples that fall outside of the acceptable range for a specific equipment will be flagged and an appropriate qualifier code will be added to AWQMS for those data.

Representativeness

Representativeness is defined as the measure of the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Sample design and procedures identified in the QAPP were chosen to optimize the potential for obtaining samples that reflect the true state of the environment, within practical limits. This project achieves the representativeness goal through its Sampling Station Selection and Naming in Free Flowing and Free Flowing Impoundment Waterbodies SOP that includes detailed procedures designed by experienced field scientists to select sample locations that will adequately characterize the actual conditions of the impoundment. Field Staff also complete thorough reconnaissance of the site, including in-person site visits prior to station selection and, as applicable, interviews with available impoundment managers to ensure that stations are representative of each individual impoundment.

Sample collections will be made under all weather conditions, if necessary (i.e., rain, snow) and follow a consistent schedule. Additionally, to ensure collected samples are representative of the sample waters, sample containers, as described in the Collection and Handling of Water Samples SOP, will be sterilized and pre-labeled prior to field collection. Sample containers and any associated collection equipment will be rinsed three times with site water prior to collecting the samples, unless noted otherwise in field collection protocols.

Comparability

Comparability is a qualitative measure that describes how data collected throughout the system can be compared to other data collected within the system. The dataset should have enough equivalence, comparability, or similarity to other data to make a meaningful analysis. This project achieves comparability through utilizing a set of standardized sample collection and handling techniques (See collection and handling of water samples SOPs), analytical methods (see CBL Laboratory SOPs and analytical methods), and reporting techniques. To minimize differences, the same laboratory (CBL) will be used for each survey. The laboratory methods used for each analysis will be recorded to allow for comparison between samples; the project intends to use the same laboratory methods for each parameter for the duration of the project. See Table B2-1 for the analytical methods to be used for each parameter.

The standardization of the lake nutrient study project, guided by this QAPP also ensures the comparability of datasets collected at different lakes under this project to water quality standards. Additionally, temporal variables will be controlled as sample collections will be made primarily in the mornings, between the timeframe of 9AM - 12 PM. Whether collection occurs during standard time

or daylight savings time will be noted on sample collection events. Any deviations in sampling times or modified methods will be noted with the datasets and considered during data analysis.

Additional checks for data comparability are included within theLNM Project-Data Management and QA/QC SOP; for example, the data will be checked to ensure data are in correct units and comparable methods, e.g., nutrients as nitrate or total nitrogen, dissolved vs. total. Following the QA/QC procedures outlined within the LNM Project-Data Management and QA/QC SOP and within the Lakes QAPP will ensure the data is of documented quality.

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system, expressed as a percentage of the number of valid measurements that should have been collected (i.e., measurements that were planned to be collected). At this time, no sampling locations have been deemed more critical to the overall project goal than any other. The completeness goal is 90% for each analytical parameter and field measurement type (see section B4, QC Statistics, for the formula) in this project. If the completeness goal is not met, the Project Manager and QAM will decide next steps, and sampling or analysis will be conducted again if necessary and possible.

In support of completeness goals, all sample containers will be filled properly and collected appropriately as described in The Collection and Handling of Water Samples SOP. Samples will also be checked for completeness by assuring they are preserved appropriately and met holding times and are labeled properly as specified in section B2.

Due to a variety of situations, all samples scheduled to be collected might not be (e.g., a storm may prohibit sampling, etc.) or the data from the samples cannot be used (e.g., sample bottles were broken in transit, sample holding times were grossly exceeded, etc.). Any notes will be made if a sample cannot be taken due to weather or other unforeseen circumstances. Data collection efforts and subsequent records of data entry into AWQMS, for both field collection and laboratory analysis data, will be tracked by a centrally accessible spreadsheet (GoogleDrive) and maintained by the Project Manager and Field Data Manager. The spreadsheet will maintain records of field visits, data entry tasks, checks for proper database uploads, as well as other qualifying information on the data collection (i.e., notes on equipment calibration checks, relevant field notes, etc.) Although this is tracked, the actual number of samples collected and achievement of the completeness goal for each lake is not known until after the sampling is completed and calculated as part of the data review.

Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest. The term "detection limit" is closely related to sensitivity and is often used synonymously. This project meets sensitivity goals by ensuring method detection limits/reporting limits are sufficient to capture the environmental conditions and regulatory requirements for this project, see Table B2-1 for the method detection limits for each assessed parameter. The Lab Data Manager will provide a qualifier code for any data

under the applicable detection limit; additional review checks are also completed by the QAM and Project Manager to ensure that the value reported is above the method detection limit or an appropriate qualifier code is added.

The in-situ field equipment used in the project also meets the required limits for the project's environmental conditions and regulatory requirements, the range and accuracy of the equipment sondes are reported inTable B2-2.

A7. Distribution List

The QAPP and all attachments (including SOPs, figures, references, and any subsequent revisions) shall be distributed to the following individuals and organizations as listed in Table A7-1.

A complete copy of the original version, all revisions of the QAPP and all SOPs and other attachments will be maintained in digital PDF format within the Maryland Department of the Environment by the Project Manager and made available to approval authorities upon request. Details on the retention of records and document revision are in section A-12. The project roles listed in Table A7-1 are detailed in Section A8.

Table A7-1 QAPP Distribution List and Project Roles

Name	Project Role	Organizational Affiliation	Email
Matthew Stover	Senior Manager	MDE, Water & Science, WPRPP	matthew.stover@maryland.gov
Delegated Approving Official	Delegated Approving Official	US EPA Region 3 Applied Science and Quality Assurance Branch	
Samantha Stanchak	Designated Project Manager	US EPA Region 3	stanchak.samantha@epa.gov
Melinda Cutler	Project/Operations Manager	MDE, Water & Science, WPRPP	melinda.cutler@maryland.gov
Jeff White	Acting WPRPP Program Manager	MDE, Water & Science, WPRPP	jeff.white@maryland.gov
Bel Martinez da Matta	Quality Assurance Manager (QAM)	MDE, Water & Science, WPRPP	bel.martinezdamatta@maryland.gov
Allison O'Hanlon	Senior Field Manager	MDE, Water & Science, FSP	allison.ohanlon@maryland.gov
Shawn Lowman	Field Data Manager	MDE, Water & Science, FSP	shawn.lowman@maryland.gov
Jerry Frank	Laboratory Data Manager	UMCES CBL	frank@umces.edu
Becky Monahan	Principal Data User	MDE, Water & Science, WPRPP	becky.monahan@maryland.gov

Name	Project Role	Organizational Affiliation	Email
Guido Yactayo	Principal Data User	MDE, Water & Science, WPRPP	guido.yactayo@maryland.gov

A8. Project Organization

Each staff member is individually and ultimately responsible for understanding and adhering to the quality and operation procedures they perform, and for the quality of the data they collect or produce. The specific responsibilities of personnel involved in project implementation are enumerated below.

EPA Region 3 Delegated Approving Official (DAO):

- This role has the EPA approval authority for the QAPP.
- The role will be knowledgeable of EPA requirements for QAPPs and other equivalent QA documents, follow the quality document review process outlined in the US EPA Region 3 Quality Management Plan (QMP), and acquire DAO certification as outlined in the QMP.
- The role may not approve QA documents they authored or prepared, or for projects/programs they manage.

Senior Manager:

- This person will provide overall direction for and leadership oversight of the project.
- The Senior Manager will meet with project members as needed over planning and QA topics.
- The senior manager will review and internally approve the QAPP and any other relevant documentation.
- Additionally, this role will oversee resource allocation for the project.

Project Operations Manager:

- The person responsible for the overall project. The Project Operations Manager ("Project Manager") will coordinate the tasks and goals of the QAPP with the Field and Laboratory Data Managers, and data users, ensuring all protocols and this QAPP are followed during sampling and other operations.
- The Project Manager will review impoundments selected, station maps, field data QA/QC correspondence, and quarterly data validation results. If issues are found, they will recommend corrective actions and ensure these actions are completed.
- The Project Manager will facilitate effective communication and execution of planning, budget, monitoring, and QA/QC tasks overall.
- In coordination with the Quality Assurance Manager, the Project Manager will maintain and review this QAPP on a yearly basis.
- The role will maintain the QAPP and associated records according to MDE's retention policies (see A-12) and distribute the final QAPP and any subsequent revisions to individuals identified in Table A7-1.

Project Quality Assurance Manager (QAM):

- The person chiefly responsible for overseeing the QA/QC of the project.
- The QAM will run the QA/QC data verification reports and will present results to the Project Manager and other relevant project roles.
- Throughout data collection, the QAM will review field staff data quality assessment and quality issues. If QA/QC issues are identified, the QAM will coordinate with the Project Manager to suggest corrective actions and ensure adequate corrective action is taken.
- If needed, the QAM will discuss quality-related issues with their organization's senior manager, even if outside of their direct supervisory chain.
- The QAM will assist the Project Manager in maintaining, reviewing, and assessing this QAPP for effectiveness.
- The QAM will review the QAPP annually and submit it to EPA if there are material changes made. After the annual review, the updated QAPP will be sent to staff on the distribution list of the QAPP.

Field Data Manager:

- The person responsible for organizing field data collection.
- The Field Data Manager will review and provide feedback on the impoundments selected for sampling and map monitoring stations at each lake.
- This role will document and communicate field collection QA/QC issues, on topics such as calibration, hold times, performance reviews, with the QAM through a monitoring tracking spreadsheet and, when needed, through meetings and email correspondences.
- This role will ensure all project personnel are properly trained and/or have the skills to fulfill assigned project tasks.
- They will assist with acquiring collection permits or other permissions as applicable, and ensure all equipment and supplies are sufficient.
- This person will coordinate with the Project Manager as needed to review and update the QAPP.
- A senior FSP staff member will serve this role.

Field Staff:

- Field Staff are responsible for reading and being very familiar with this QAPP and the related standard operating procedure(s) (SOPs) or methods for any operation they perform.
- These persons will ensure they are properly trained and/or have the skills to fulfill assigned tasks.
- This role will identify and report to either the Field Data Manager or the Project Manager of any emerging/unanticipated problems, data anomalies, or other project/data issues.
- This role will annotate the related SOPs for any activity they perform if necessary and permanent changes arise or will coordinate with the Field Data Manager to develop new SOPs if a gap exists.
- This role will assist with recording, entering to AWQMs, verifying, and validating data as outlined in this QAPP.
    - Note, a field staff member separate from the one who first entered field data will check the uploaded data for accuracy and consistency in the AWQMS database.

- This role will maintain data and retain field project records in conjunction with the Project Manager and in accordance with MDE's Records Retention policy.
- FSP field staff as assigned will serve this role.

Laboratory Data Manager:

- This role will be responsible for the laboratory sample analysis and submission of the laboratory data to MDE in MDE's outlined format.
- The Laboratory Data Manager will correspond with the Project Operations Manager, QAM, and Field Data Manager on QA/QC issues and operational processes.
- The Chesapeake Biological Laboratory at University of Maryland Center for Environmental Science will serve as a contractor support for the laboratory analysis of collected samples. Jerry Frank from CBL will serve as the Laboratory Data Manager.

Principal Data Users (IR and TMDL Staff):

- IR and TMDL staff will be the principal data users of the impoundment monitoring efforts; as such, staff will communicate early in the project with Senior or Project management about any specific needs and objectives.
- This role will assist the QAM and Project Manager where needed and be responsible for coordinating with the Project Manager and Field Data Manager in the selection of impoundments to sample.
- IR and TMDL Staff will be responsible for reading reports or other documentation to understand any quality concerns, e.g, any limitations to data use, flags on lab data, etc., before using information/data.
- WPRPP staff as assigned will serve this role.

A9. Project Quality Assurance Manager Independence

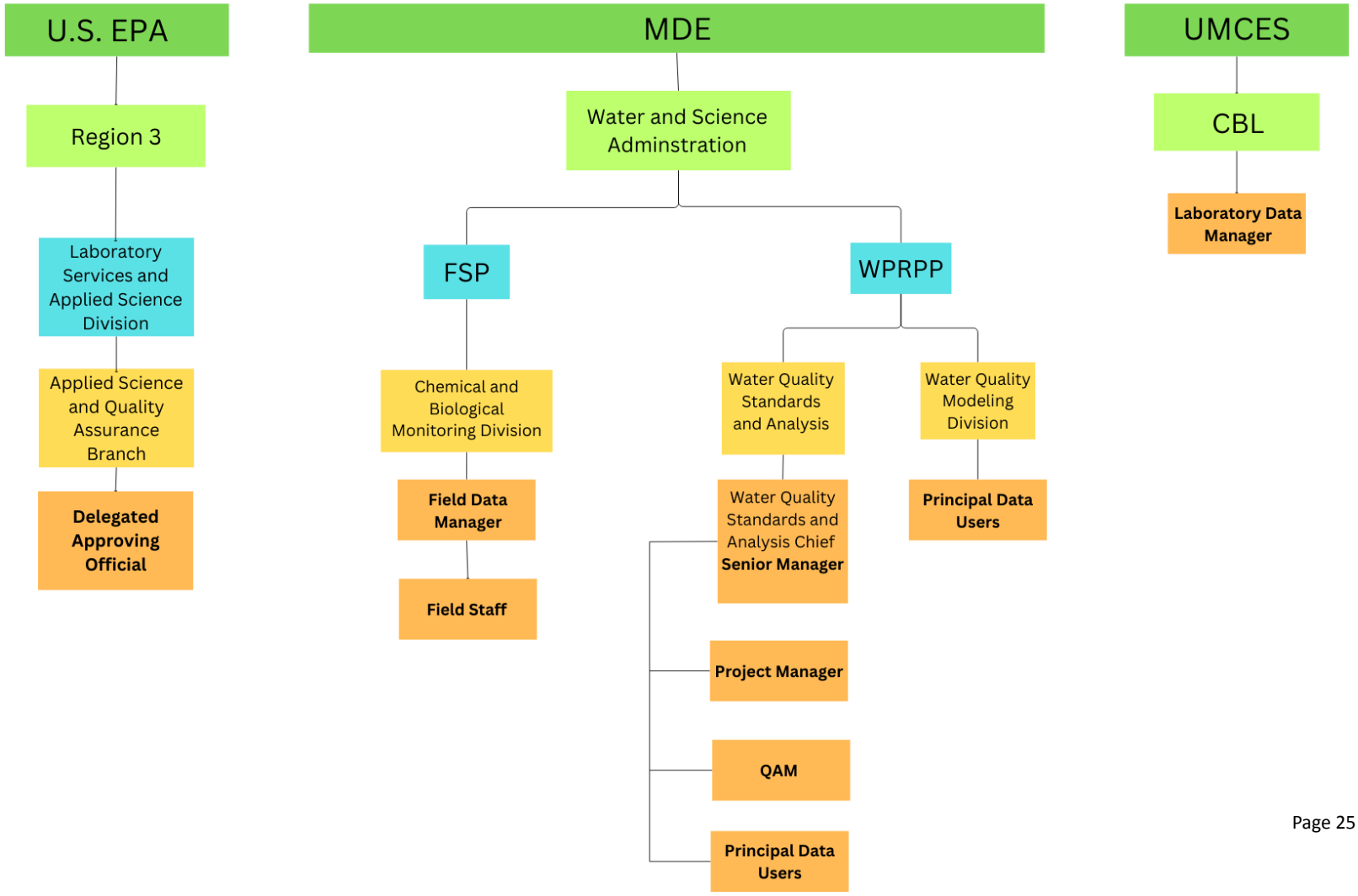
The QAM for the work described in this QAPP is not involved in the collection or laboratory analysis of the data for submission. They are contacted for assistance by the Project Manager or Technical Staff and are responsible for providing feedback on the Quality Assurance objectives and needs of EPA and MDE. They provide assistance with the management of the final data product and maintaining internal copies of the QAPP. The QAM does not otherwise use or engage with the data product in any way that would present a conflict with the project.

The Project Manager or designee will not have authority to sign QAPPs for the QAM or designee, nor will the QAM or designee have authority to sign QAPPs for the Project Manager or designee.

A10. Project Organization Chart and Communications Project Organization Chart

Figure A10-1 Project Organization Chart

This organization chart outlines all organizations responsible and involved in the project. Modifications to this chart will be completed as necessary on annual review of the Lakes QAPP. Lines of authority are provided in the organizational chart and project roles are bolded in black.



Communication

Project communication is detailed in Table A10-1. MDE project personnel will have access to the project's shared Google Drive folder. As soon as they are aware and within one business day, all project personnel will raise discrepancies, QAPP non-conformances, and process improvements to the Project Manager. After consulting with the QAM and Senior Manager if needed, the Project Manager gives final approval on any changes, notifies the affected members of the project team, and saves relevant documentation in the project folder. As needed, the Project Manager will elevate discrepancies and QAPP non-conformances to the appropriate EPA contacts.

The Field Data Manager will coordinate field surveys, including securing permissions and/or collection permits for sample locations. Landowners will be contacted by phone, then mail, if necessary, to seek approval to access their property. Please see the Sampling Station Selection and Naming SOP for more information on sample locations and the LNM Project-Data Management and QA/QC SOP for more details regarding communication pathways related to data communication.

Table A10-1 Communication Pathways

Communication Driver	Responsible Entity	Procedure (timing, pathway, etc.)
Manage field project phase	Project Manager and Field Data Manager	The Project Manager and Field Data Manager will inform the scientists about all field activities and any other pertinent project information.
Report field activities to Project Manager	Field Data Manager	Progress in field data collection will be recorded via the centrally shared Google Drive spreadsheet. The spreadsheet will be continuously updated as collection activities occur.
Report laboratory activities to Project Manager	Laboratory Data Manager	All materials and information about the project will be forwarded to the Project Manager. At a minimum, regular updates will be given once a quarter.
Reporting Lab Data Quality Issues	Laboratory Data Manager	The lab will communicate any issues in the quarterly data report and / or through the inclusion of applicable qualifier codes for the datasets.

Communication Driver	Responsible Entity	Procedure (timing, pathway, etc.)
Issues encountered in field data collection	Field Staff	Scientists will communicate any issues or deviations from the QAPP to the Field Data Manager within one business day of that activity. The Field Data Manager will report issues as needed to the Project Manager.
Corrective actions for field activities and data analysis	Project Manager and QAM	The Project Manager, in coordination with the QAM, will determine the need for corrective action for field and analytical issues and communicate those to affected staff as soon as possible.
Issues encountered in data collection or analyses.	Project Manager and EPA Region 3 Contacts	As needed, the Project Manager will elevate discrepancies and QAPP non-conformances to the appropriate EPA contacts.

A11. Personnel Training/Certification

The Field Data Manager will oversee and ensure proper training of field staff involved in sampling. All employees conducting field sampling have reviewed the SOPs for YSI DS Pro and In-Situ Aqua Troll 600 sondes and undergone training by the Field Data Manager or other qualified senior field staff in the general operation and calibration of the sondes as well as other field instruments, including a standard thermometer, OTT MF Pro Flow Meter, and filter kits. Field staff responsible for water quality sonde maintenance & calibration procedures will familiarize themselves with all manufacturers protocols for all equipment used including manuals, training videos, and tutorials. During an employee's first months of collection, the Field Data Manager or appointed senior field staff will supervise employee techniques to ensure that the employee possesses necessary skills to perform the sampling tasks. All field personnel will follow the procedures outlined in the SOPs.

If new equipment or sampling techniques are introduced for the project, appointed senior field staff with experience in the new equipment will provide demonstration and training for other respective field staff. If no senior field staff have experience with the new equipment, training may be received from the manufacturer. Training will be overseen by the Field Data Manager to ensure all relevant staff are properly trained in the new equipment / sampling techniques. Any unknown procedures will be reviewed in the office and/or field prior to sampling.

Internal individual performance audits will be conducted periodically by qualified senior staff. Technical on-site evaluations of field sample collection and processing techniques, and proper equipment use will be made. Retraining of staff will be conducted, if necessary.

A12. Documents and Records

Project-Specific Documents and Records

Project records will be managed in accordance with the current MDE policies, as described in the Documents and Records section of MDE's QMP (MDE, 2020). The Project Manager will be responsible for saving electronic files on the shared drive to ensure they are automatically backed up. Hard copy records will be filed in the field office location. Documents and records will include, but are not limited to:

- *Field Data Sheets.* These sheets will be used on-site to record field measurements and environmental conditions at the sampling locations. The original sheets will be maintained and archived by the Field Data Manager at the FSP office. Field sheets will also be scanned and saved as electronic PDFs within the project's shared GoogleDrive.

- *Laboratory Transfer Sheets.* Laboratory Transfer Sheets for nutrient and chlorophyll-a analyses will be prepared by the Field Data Manager prior to the surveys and sent with the samples to the laboratory and returned with the final laboratory results. Original copies will be maintained and archived by the Field Data Manager at the FSP office. Laboratory transfer sheets will also be scanned and saved as electronic PDFs within the project's shared Google Drive.

- Field Equipment Maintenance / Calibration Records. Field equipment will be calibrated according to the Water Quality Equipment Maintenance and Calibration SOP. Equipment will be maintained following manufacturer guidelines. Calibration and maintenance records generated by these processes will be reviewed and maintained by the Field Data Manager at the FSP office. Any issues with calibration or equipment failure will be noted in the shared data tracking sheet and communicated with the QAM and Project Manager as needed. The proper data qualifier codes will be assigned to data in the AWQMS database as needed by the Project Manager.

- *Standard Operating Procedures.* SOPs for fieldwork procedures will be maintained with the project QAPP files on MDE's internal network servers and within a cloud storage folder (i.e. Google Drive). The persons conducting fieldwork for this project will periodically review these SOPs.

- *Data Tracking Sheet.* A centrally accessible data tracking sheet will be maintained on Google Drive for all project members. The data tracking sheet will record the receival and entry of field and laboratory data into AWQMS and ensure accurate and complete data entry . Field related quality assurance comments on the data will also be noted within this tracking sheet. These notes will be periodically reviewed by the QAM and Project Manager and may result in the assignment of additional qualifier codes to finalized data within AWQMS.

- *Laboratory Data Sheets.* The Chesapeake Biological Laboratory (CBL) at the University of Maryland Center for Environmental Science (UMCES) will conduct the project's nutrient analyses and chlorophyll-a (CHLA) analyses. CBL sends final laboratory results via a shared Google Drive folder, accessible to all project team members. These data sheets will be reviewed for quality assurance and quality control by the QAM and Project Manager following the LNM Project-Data Management and QA/QC SOP.

- *Final Data Results.* Field and laboratory data will be entered into MDE's database, Ambient Water Quality Management System (AWQMS). Data entry will be tracked using the Data Tracking Sheet. The QAM and Project Manager will review the final data results at least quarterly to ensure the completeness and accuracy of the dataset, following the procedures outlined in the LNM Project-Data Management and QA/QC SOP. At the end of the project, finalized data results will be uploaded from AWQMS into the Water Quality Portal (WQX) by the Project Manager with support from the QAM.

- *Landowner permission documentation.* The Field Data Manager is responsible for securing landowner permissions, as needed, for sampling activities. Documentation for landowner permissions will be saved to MDE's internal network location and within a cloud storage folder via Google Drive.

- *QA/QC assessment results, corrective actions, and quality issues.* Any relevant reports, notes, or emails following data QA/QC activities, corrective actions, deviations from QAPP methods, etc. will be saved to MDE's internal network location and within a cloud storage folder via Google Drive. For ease of reference, notes will be stored under a folder labeled for the year of the data collection activity.

- *Data analyses and reports.* Any data analyses and reports created for this project will be saved to MDE's internal network location.

- *Receipts for purchasing equipment and supplies.* The Field Data Manager and delegated field staff are responsible for purchasing equipment and supplies. Purchase receipts will be saved according to MDE's Documents and Records policies (MDE, 2020).

- *Photos*. Any photo documentation for the project will be saved to MDE's internal network location and within a cloud storage folder via Google Drive. JPG file names will contain the lake name, station, and date the photo was taken.

- *Project QAPP.* The QAPP document, including any amendments or revisions, and all related materials (SOPs, attachments and referenced files) will be maintained in two locations on an MDE internal server: one in an internal MDE network location and another in a cloud storage folder via Google Drive where the QAM maintains all QAPP documentation. Additionally, print copies of the QAPP and its attachments are kept at the Project Manager and QAM's discretion at MDE's Baltimore Office.

QAPP Preparation and Distribution

This QAPP conforms to the format described in the U.S. Environmental Protection Agency publication Quality Assurance Project Plan Standard [Directive No: CIO 2105-S-02.0] (U.S. EPA, 2023). The QAPP shall always govern the operation of the project and must be accessible during operations. Each responsible party listed in Table A7-1 shall adhere to the procedural requirements of the QAPP and ensure that subordinate personnel do likewise.

This QAPP shall be reviewed at least annually to ensure that the project will achieve all intended purposes. In addition, it is expected that ongoing and perhaps unexpected changes may need to be made to the project. Project Managers, QA Staff and other applicable personnel in Table A7-1 shall participate in the review of the QAPP. The Project Manager shall authorize all changes or deviations in the operation of the project. The review and any revisions will be documented. If significant changes need to be made, the QAPP will be sent to the DAO again for approval. Examples of significant revisions include changes in:

1) the scope of the project resulting in new or revised objectives
2) implementation such as how information will be collected, produced, evaluated, or used
3) the design, construction, operation, or application of environmental technology
4) the statement of work or workplan for extramural agreements
5) expiration of the QAPP
6) the organization's mission or structure, such as in the delegation status of QAPPs
7) performance criteria as to how results will be assessed for acceptance.

The Project Manager will document the effective date of all changes made in the QAPP and distribute revised versions to all individuals listed in Table A7-1.

Field Documentation

To thoroughly document field activities, dedicated bound logbooks (or electronic equivalents), checklists, forms, electronic devices and/or other field documentation methods must be used for field data collection including, but not limited to, sampling, measurements, and observations. For field operations, all document control and records management requirements identified in the QMP, The Collection and Handling of Water Samples SOP, and the Lake Nutrient Data Management and QA/QC SOP must be followed.

Storage

While the project is underway, project information will be stored in a central filing cabinet at MDE headquarters or the Field Office, and on MDE's internal computer network, according to the standard retention time policies as outlined in the Quality Management Plan for MDE (MDE, 2020). Upon completion of the project, paper records (paper field sheets, station lists, field pack information, etc.) and any electronic media (e.g., CDs, flashdrives) will be retained in perpetuity at the MDE Field Office. Electronic records will be stored in perpetuity on MDE's main computer network and cloud-based storage (I.e. Google Drive) .

B Implementing Environmental Operations

This section details how the study design has been developed for the IR and TMDL programs to ensure that the data quality objectives are met. It discusses the preparation necessary prior to conducting fieldwork, the procedures and methods to be followed during and after field sampling, and the maintenance of the equipment used to ensure reliable measurements. A comprehensive monitoring plan that includes the selection of sampling locations, analytical parameters, and quality control samples, as well as the development of survey documentation should be operational prior to commencing fieldwork.

B1. Identification of Project Environmental Information Operations

To provide high quality data for IR assessment and TMDL development, this project includes extensive field, laboratory, and data verification SOPs that provide a standardized and stringent collection process. These SOPs ensure that data collected is accurate, representative, comparable, and complete. See the SOPs for the Lake Nutrient Monitoring project. The SOPs will also be placed in the project files and made available for routine referencing when needed.

Lakes are selected for sampling based on criteria in the Lake Prioritization List and will be monitored for 2 summers and 1 winter. Water quality sampling will be conducted twice a month from April to October and once a month from November to March. Sampling frequency is increased during April to October to capture variable hydrodynamic and meteorological conditions during the warmer season months. This schedule is subject to change due to inclement weather or other competing Program objectives.

Stations are selected for each lake following the Sampling Station Selection and Namin in Free Flowing and Free Flowing Impoundment Waterbodies. To appropriately characterize the water quality and conditions of an entire impoundment, sampling stations will be located both within the impoundment and on any designated input or output tributaries. Therefore, some of the field sampling parameters and protocols vary between land collection (inputs/outputs) and boat collection (in lake). For example, secchi depth information is taken only at boat collection stations and flow is taken only on land stations. Please see the Sampling Station Selection and Naming in Free Flowing and Free Flowing Impoundment Waterbodies SOP and the Collection and Handling of Water Samples SOP for comprehensive details on field data collection protocols. Table B1-1 shows the sampling components for this project.

Table B1-1 Sampling Components

Component/Matrix	Parameter(s)	# of Samples or Measurements	Frequency	Equipment
Surface Water Grab Samples	Nitrogen, Phosphorous, Chlorophyll a, and phaeophytin	1 sample	At each station in each lake 2X a month April-October 1X a month November-March	Bottleware, coolers, ice or ice packs
In situ Water Quality	Temperature, pH, Dissolved Oxygen, Salinity, Turbidity, Specific Conductance	1 measurement per parameter. These parameters are also used for depth profiles. 1 set of depth profile readings taken every 1-3 meters. Bottom readings will be taken at 1.0 meter above the bottom and the top readings at approximately 0.5 meters from the top.	At each station 2X a month April-October 1X a month November-March	YSI DS Pro & In-situ Aqua Troll 600, water quality sondes.
In situ Water Quality	Air Temperature - Celsius	1 measurement per lake	At each lake 2X a month April-October and 1X a month November-March	Standard Thermometer
Flow	Flow - cubic feet per second	1 set of flow reading for land stations only	At each station 2X a month April-October 1X a month November-March	OTT MF Pro Flow Meter
Water Light Penetration	Light Penetration Water Depth	1 secchi measurement for boat or in-lake stations only	At each station 2X a month April-October 1X a month November-March	Secchi Disk [The same individual will read the secchi disc to reduce error.]
Depth	Max Depth - meters	-1 set of depth readings for in-lake stations -Depth readings to interpret flow velocity at land stations	At each station 2X a month April-October 1X a month November-March	In-lake station - YSI DS Pro & In-situ Aqua Troll 600,

Component/Matrix	Parameter(s)	# of Samples or Measurements	Frequency	Equipment
				water quality sondes. Land station- Measuring stick or OTT MF Pro Flow Meter
Geospatial	outfall locations, shoreline types, and the surrounding land use	NA	Once before start of field activities	GIS layers
Geospatial	Distance from shore	20	Once at start of project's field activities	Rangefinder and/or GIS

B2. Methods for Environmental Information Acquisition

The project will follow the SOPs outlined below for the acquisition of environmental information. More information is included in MDE's SOPs. The Project Manager will oversee the maintenance of all SOPs associated with the project QAPP. The Project Manager will work in conjunction with the Field Data Manager, QAM, and Laboratory Data Manager in order to ensure up-to-date and accurate project policies and procedures are documented in the SOPs.

Field Data Collection

Once the lakes have been selected, water quality stations for each lake survey will be determined following the Sampling Station Selection and Naming in Free Flowing and Free Flowing Impoundment Waterbodies SOP. Samples will be collected twice a month from April until October, and once a month from November through March for each station. This schedule is subject to change due to inclement weather conditions, equipment malfunctions, and competing Program objectives. For in-lake samples, surface samples will be collected at all stations. A limited number of bottom samples will be selected for stations based on depth and channel dynamics. Typically, a bottom sample will be collected at stations deeper than 5 meters in areas prone to stratification or anoxia. For land stations, or inputs/outputs of the lakes, flow measurements will also be collected in addition to the other surface samples.

As a quality control check, one duplicate sample will be collected for each lake at each sampling event, which averages to be about 10% of samples. The selection of a duplicate site in each lake is at the discretion of the field staff. However, once selected, the duplicate sample will come from the same station at each sampling event.

Field data will be collected following the standardized operating procedures listed below.

- Sampling Station Selection and Naming in Free Flowing and Free Flowing Impoundment Waterbodies SOP
- Water Quality Equipment Maintenance and Calibration SOP

In-situ measurements of pH, temperature, dissolved oxygen, conductivity and salinity will be made using a YSI Pro DS or In-Situ Aqua Troll 600. At the stations collected from boats, the meter will be zeroed for depth and a vertical profile of pH, temperature, dissolved oxygen, conductivity and salinity will be measured throughout the water column at a maximum of 3 meter intervals. The bottom readings will be taken at 1.0 meter above the bottom and the top readings at approximately 0.5 meters below the surface.

At the stations collected from land, water samples will be collected directly in sample bottles in stainless steel buckets and one set of in-situ water quality measurements will be taken. In-situ water quality measurements will be taken using a multiprobe water quality sonde. Upon completion of the surveys, the multiprobe sonde will be thoroughly rinsed with de-ionized water. Secchi readings will be taken at impoundments stations when feasible. All measurements will be recorded on the field survey sheets, in addition to any comments about conditions that could influence the equipment performance or explain unusual data.

The sondes are multi-probe instruments with accuracy and measurement ranges reported by the manufacturer as follows:

Table B2-1 In-situ Field Parameters for YSI Pro DS[19] or In-Situ Aqua Troll 600[20]

Matrix	Parameter	Accuracy	Measurement Range	EPA Method Code
Water	pH	± 0.2 unit	0-14 units	Std. Methods 4500-H+, EPA 150.2
Water	Dissolved oxygen	±0.1 mg/L from 0 to 8 mg/L ±0.2 mg/L from 8 to 20 mg/L ±10% of reading from 20 to 50 mg/L	0 to 50 mg/L	EPA-approved In-Situ Methods (under the Alternate Test Procedure process): 1002-8-2009, 1003-8-2009, 1004-8-2009
Water	Temperature	± 0.2C	-5 to 50° C (23 to 122° F)	EPA 170.1
Water	specific conductance	±0.5% of reading plus 1 µS/cm	0 to 200,000 µS/cm	Std. Methods 2510, EPA 120.1

[19]https://www.ysi.com/File%20Library/Documents/Brochures%20and%20Catalogs/YSI-ProDSS-Catalog.pdf
[20] https://in-situ.com/pub/media/support/documents/aquatroll-500-600-700-800-spec-sheet-ltr-en.pdf

Matrix	Parameter	Accuracy	Measurement Range	EPA Method Code
		from 0 to 100,000 µS/cm; ±1.0% of reading from 100,000 to 200,000 µS/cm		
Water	Salinity	±1.0% of reading or ±0.1 ppt, whichever is greater	0-70 ppt	
Water	Turbidity	0 to 999 (0.3 or ±2% of reading, whichever is greater) 1000 to 4000 (±5% of reading)	0-4000 NTU	ISO 7027

All in-situ parameters will be measured at each station, as described in the Collection and Handling of Water Samples SOP. Water clarity will be measured in impoundments when possible using the techniques described in the Standard Operating Procedures. Air temperature will be measured at each station with a standard thermometer and recorded in Celsius. Flow will be measured at all “land” stations (Input/outputs) with a OTT MF Pro Flow Meter and follow the procedures outlined in the Collection and Handling of Water Samples SOP.

Laboratory Data Collection

Laboratory analyses for each parameter will follow SOPs outlined on the CBL website (CBL, 2023) for each respective analytical method, see Table B2-2 Water Quality Parameters Analyzed for the Lake Monitoring Program for more information.

Data packages from the CBL will be submitted to a centrally accessible Google Drive for all project members. Data will be uploaded by CBL at least quarterly and reviewed by the Project Manager and QAM for quality assurance and quality control purposes, following the LNM Project-Data Management and QA/QC SOP.

Table B2-2 Water Quality Parameters Analyzed for the Lake Monitoring Program

Parameters analyzed by the Chesapeake Biological Laboratory (CBL) at the University of Maryland Center for Environmental Science (UMCES)				
PARAMETER	**ABBR**	**DETECTION LIMIT**	**METHOD/REFERENCE**	**MAXIMUM HOLDING TIME**
Nitrate- + Nitrite-N	NO3 + NO2	0.0057 mg N/L (detection limit for ASTM method), 0.0009 mg N/L (detection limit for EPA method).	EPA Method 353.2, Rev. 2.0 (1993) & ASTM D-7781-14	28 days at 4°C (Freezing is used as the preservation technique)
Phosphate	PO_4	0.0034 mg P/L	EPA Method 365.1, Rev. 2.0 (1993)	28 days at 4°C (Freezing is used as the preservation technique)
Ammonium-N	NH4	0.009 mg N/L	SM4500-NH3, G-2011	28 days at 4°C (Freezing is used as the preservation technique)
Total Nitrogen	TN	0.05 mg N/L	EPA Method 353.2, w/alkaline persulfate digestion	28 days at -20°C
Total Phosphorus	TP	0.0015 mg P/L	EPA Method 365.1, w/alkaline persulfate digestion	28 days at -20°C
Phaeophytin (Spectrophotometer)	CHL-PHAEO	0.74 µg/L	EPA 446.0, SM 10200H.2b	28 days at -20°C
Chlorophyll-a (Spectrophotometer)	CHLA	0.62 µg/L	EPA 446.0, SM 10200H.2b	28 days at -20°C
* Information taken from CBL, 2024				

The nitrate, phosphate, and ammonium parameter samples will be collected in the field as whole-water samples using the procedures described in the Collection and Handling of Water Samples SOP and processed and analyzed by UMCES CBL. The dissolved parameters TN, TP, and CHLA pads will be processed in the field or at the laboratory using the filtering techniques described in the Collection and Handling of Water Samples SOP and forwarded to the appropriate laboratory for analysis.

All samples collected will be preserved on ice to 4º C until transferred to the Annapolis Field Office where they will be stored in a freezer until transferred to the laboratories for analysis within the holding time specified in the Table B2-2 above.

B3. Integrity of Environmental Information

Information/Data/Sample Handling

Unbound checklists and forms must remain in control of the field office lead, transferred to the Project Manager, and kept in the project file upon return from the field. Hard copy records will be kept in the field office and scanned to be saved electronically in the project folder. See section A12. Documents and Records for additional information on field documentation handling.

Information/Data/Sample Handling

The field sheets and laboratory transfer forms generated are shown in Figures B.1 – B.4 and described below.

- **Field survey sheets.** One sheet will be generated for each station location. This sheet will be pre-printed with the survey name, station identification number, sample type (duplicate, surface, bottom, boat, instream) and notations of activities to be performed on-site (i.e., flow measurements, chlorophyll-a collections). See Figure B.1.
- **Station location sheets**. One sheet will be generated for each individual survey to be conducted. This sheet will contain the station identification number, detailed written description of the station location, latitude and longitude and the type of sample to be collected.
- **Station location maps**. One map will be created for each survey. The map will be a detailed road map or NOAA navigational chart with the station location and identification clearly marked.
- **UMCES laboratory transfer sheets.** One sheet will be generated for each survey. This sheet will be pre-printed with the survey name and date, station identification numbers, sample type and sample depth. See Figure B.2.

Following the completion of items 1 through 4, a “field pack” will be compiled for each survey. It will consist of the field survey sheets, station location sheet and station location map. The laboratory transfer sheets will be completed immediately following surveys.

Figure B3-1 Field Sheet

						AWQMS:		QA/QC:	
Date:	Field Scientist(s):				Equip # ID:				
Station ID	VIF0000	VIF0001							
Bottle #	LAR-1	LAR-2 S							
Start Time 24hr									
End Time 24hr									
Sample/Reading Depth	0.1	0.5	1						
BR/IS									
Air Temp oC									
Weather Yesterday									
Weather Today									
Cloud Cover %									
Wind Direction									
Wind Velocity Min. knots									
Wind Velocity Max. knots									
Secchi Depth m									
Wave Height m									
Total Depth m									
Water Temp oC									
pH									
D.O. mg/l									
Specific Conductivity uS/cm									
Salinity ppt									
Turbidity NTU									
Discharge CFS									
Chlorophyll Filter Vol. m									
Comments: LAR-2 DUP	DUP Vol.								

When Total Depth >5M, collect Bottom sample = "LAR -2 B"

Write "LAR-2 B" in appropriate Column

Readings/Sample **1 M** off bottom

Weather Codes:		**Wave Height: m**	
0 = Cloudless	5 = Drizzle/Light Rain	Flat Calm - 0.03m	Slight Ripple - 0.09m
1 = Cloudy/Partly Cloudy	6 = Rain	Ripple 1ft - 0.2m	1-2ft = 0.4m
2 = Overcast	7 = Snow, Sleet, or Hail	2-4ft = 1.00m	4-6ft = 1.5m
3 = Drifting Snow/Dust/Sandstorm	8 = Rain Showers	6-8ft = 2.10m	8-13ft = 3.00m
4 = Fog	9 = Thunderstorms, Squalls		
Wind Velocity: Knots			
0-1, 1-3, 4-6, 7-10, 11-16, 17-21, 22-27			

Figure B3-2 UMCES Laboratory Transfer Sheet

MDE
LNM PROJECT 2024-2025
UMCES VOLUME SHEET
Eastern Shore Lakes

Date:_____ Scientist signoff:_____

Station Code	Sample #	Layer Code	Depth (m)	Time (MLTY)	Salinity	CHL-A Filtered Volume (ml)
GIV0012	ES-1	S	0.0			
ADK0019	ES-2	S	0.0			
TUI0006	ES-3	S	0.0			
SAA0005	ES-4	S	0.0			
CMP0016	ES-5	S	0.0			
LML0021	ES-6	S	0.0			
PAD0008	ES-7	S	0.0			
LML0000	ES-8	S	0.0			

A monthly calendar schedule will be developed for lake sampling fieldwork, as well as spreadsheets that will track sampling dates. On a monthly basis, these documents will be updated to reflect changes in scheduling and sample collections.

Details on how the samples and associated laboratory transfer sheets will be handled at the FSP are described in the SOP for Sample Collection and Handling of Samples at the FSP.

Laboratory Certification/Accreditation

All laboratory water samples will be analyzed by the Chesapeake Biological Laboratory (CBL) with the University of Maryland Center for Environmental Science (UMCES). The laboratory is nationally accredited with a National Environmental Laboratory Certification (NELAC) from the State of New York DOH, and Florida State DOH. Retention of these credentials requires bi-annual on-site audits, annual internal audits, and successful semiannual completion of proficiency test (PT) samples. Other credentials include the New York Dept. of Health Environmental Laboratory Approval Program (ELAP) PT Program (bi-annual) and ERA Proficiency Testing and Certified Reference Material Program. Analytical services provided by the CBL are documented on their Nutrient Analytical Services Webpage. Each method will be followed when submitting samples, which will help ensure field and laboratory aspects of the sampling are linked to produce reliable data of known quality.

B4. Quality Control

This section describes the activities used to assess the effectiveness of this QAPP and its associated Quality Control and Quality Assurance Programs, and ensure that it is properly implemented. This will largely be accomplished by internal and external audits that evaluate field, laboratory and data management activities; equipment; contract labs; and individual performance. In addition, the response actions and measures to be taken as a result of these audits or other unanticipated problems are discussed.

QC Activities

To provide high quality lakes data that meets the environmental information objectives described in section A.6, the following QA QC protocols are performed. Additional information is included in the LNM Project-Data Management and QA/QC SOP. Data transference is routinely checked and validated by field staff while in the field. Field datasheets are reviewed on site by the senior field staff member before departure to ensure no missing and/or questionable data. Data entered into AWQMS will be routinely checked against the original data sheets with 100% verification. To ensure a thorough review, a separate field staff member than the staff member that originally input the field data sheets will check the AWQMS data entry. Errors caught during cross-checking will be flagged and corrected, to the extent possible, in consultation with field staff that participated in the data collection.

FSP field staff will maintain a tracking spreadsheet containing detailed notes on environmental operation which contains information on calibration results, sampling complications if they occur, and any other information relevant to the project. If issues occur during sampling, field staff and the Field Data Manager will additionally coordinate with the Project Manager and QAM and determine the most appropriate corrective action.

For laboratory assessments of the water quality samples, checks on precision and accuracy will be calculated and reported by the laboratory performing the sample analyses – Chesapeake Biological Laboratory (CBL). To ensure precise, accurate, and comparable analyses, the laboratory uses lab duplicates for 10% of samples, lab spikes for 10% of samples, analysis deviation from standard curves, method detection limits, blind audits, and split samples. Corrective actions depend on the specific precision or accuracy violation but may involve rerunning a given analysis or giving a given sample a qualifier code. For specific information on laboratory QA practices, see the CBL's Quality

Assurance/Quality Control Webpage[21] or analytical method specific QA/QC practices, see CBL's Laboratory Methods Webpage[22] and visit the corresponding link for the given analytical method. Please see each SOP for the method specific QAQC procedures, as well as calibration acceptance and continued verification. Laboratory quality data will be reviewed as part of the data package, considered in data analysis, and reported in the final report as appropriate.

Other specific QC activities are described in Table B4-1. For more details, please see the LNM Project-Data Management and QA/QC SOP.

Table B4-1 QC Activities

QC Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Individual(s)	Communication Route
Field Data					
Field duplicates	One station per lake per sampling event (~8%-20% of field samples)	RPD<=20% (or 30% for TP) for concentrations > 5 x MDL	Qualify associated field data and coordinate with field and lab to decrease error.	Field Staff collect the duplicates QAM checks RPD	The duplicate, checks of RPD, and any qualifiers are listed in the communication tracking sheet.
Sonde Calibration	Pre and post calibration is performed once a week to document any drift.	Accuracy is within 10% of the standard calibration number	Equipment calibration and maintenance logs will be checked to ensure that no problems exist with equipment that may affect field observations reported on the field sheets. If calibration results highlight errors, the specific parameters are removed from the field sheets and sensors will be repaired or replaced before using the sonde again.	Field Staff	Recorded in the field sheet comments and the communication tracking sheet.
Field Sheet review	Every field collection survey	Reviewed for completeness and accuracy.	Any parameters that appear unusual or out of range will be investigated.	Field Staff	Recorded in the field sheet comments and the

[21] https://www.umces.edu/quality-assurancequality-control
[22] https://www.umces.edu/nasl/methods

QC Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Individual(s)	Communication Route
					communication tracking sheet.
Flow measurements	All “land” (input/output) stations	Reviewed for accuracy and anomalies	If necessary, flow values will be re-calculated. Any suspect numbers will be verified or omitted, and corrections made, if necessary.	Field Staff	Recorded on field sheets and related project tracking sheets.
Field Data Entry	Quarterly	100% accuracy for field data entry into AWQMS database	Any inaccuracies are corrected in AWQMS.	Field Staff	Recorded in the field sheet comments and the communication tracking sheet.
Hold Times	Quarterly	Sample date - lab analysis date is to be less than 28 (or 30 for chl-a and phaeophytin)	Add proper qualifier code to associated field data and coordinate with field and lab to decrease future error.	Project Manager; QAM	Recorded in the lab data sheet, assessed in data verification step, and issues noted in the communication tracking sheet.
Lab Data- note that checks differ slightly for chlorophyll-a and phaeophytin. Please see CBL SOPs for more information.					
Correlation Coefficient	1 per batch if acceptable.	≥ 0.995	If <0.995, evaluate data points of the calibration curve. If any data point is outside established limits, reject as outlier.	Lab Data Manager	Qualifier code added to data on lab data sheet
Quality Control Sample (QCS)/ Certified Reference Material (CRM)	Beginning of run and every 20 samples.	± 10%	If QCS value is outside ± 10% of the target value reject the run, correct the problem and rerun samples	Lab Data Manager	Qualifier code added to data on lab data sheet

QC Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Individual(s)	Communication Route
Initial Calibration Verification (ICV)	Beginning of run following standard curve.	± 10%	Recalibrate if outside acceptance limits.	Lab Data Manager	Qualifier code added to data on lab data sheet
Continuing Calibration Verification (CCV)	After every 10 samples.	± 10%	If outside 10%, correct the problem. Rerun all samples following the last in-control CCV.	Lab Data Manager	Qualifier code added to data on lab data sheet
Method Blank/Laboratory Reagent Blank (LRB)	Following the ICV and after every 10 samples prior to the CCV.	≤ Method Quantitation Limit	If the LRB exceeds the quantitation limit, results are suspect. Rerun the LRB. If the concentration still exceeds the quantitation limit, reject or qualify the data, or raise the quantitation limit.	Lab Data Manager	Qualifier code added to data on lab data sheet.
Laboratory Fortified Sample Matrix Spike	After every 10 samples.	± 10%	If the recovery of any analyte falls outside the designated acceptance limits and the QCS is in control, the recovery problem is judged matrix induced. Repeat the LFM and if the sample results are again outside the acceptable recovery range, the sample should be reported with a “matrix induced bias” qualifier.	Lab Data Manager	Qualifier code added to data on lab data sheet.
Laboratory Duplicate	After every 20 samples.	±10%	If the RPD fails to meet the acceptance limits, the samples should be reanalyzed. If the RPD again fails to meet the acceptance limits, the sample must be reported with a qualifier identifying the sample analysis result as not having acceptable RPD for duplicate analysis.	Lab Data Manager	Qualifier code added to data on lab data sheet.

*Note that the table above does not include representativeness or completeness checks, for instance data entry checks. Please see section A.6 and B.4 for more information on these data quality indicators.

QC Statistics

Following the DQIs outlined in Section A6, the following QC statistics will be calculated. For more information on when and how these statistics are calculated, see the Lake Nutrient Monitoring (LNM) Project-Data Management and QA/QC. If issues are highlighted as part of the QC assessment, the QAM and Project Manager will contact the Lab Data Manager to investigate and correct the issue or otherwise use a qualifier code for the data for informational purposes.

Table B4-2 QC Statistics

Calculation	Formula	Abbreviations
Duplicate Precision	RPD = $\frac{(D_L-D_S)}{(D_L+D_S)/2}$ x 100	RPD = relative percent difference between duplicate determinations D_L and D_S = results for the duplicate values with D_L = larger of two observed values D_S = smaller of two observed values
Completeness	%C = $\frac{V}{}$ x 100 V >= N	%C=percent completeness V =number of measurements judged valid N=target number of measurements necessary to achieve a specific statistical level of confidence in decision making
Method Detection Limit and Result Comparison	MDL> RV	MDL= Method Detection Limit RV= Result Value
Total and constituent comparison for nitrogen and phosphorous	NH3+NO2+NO3=<TN and PO4=<TP	NH3= Ammonia Value NO2= Nitrite Value NO3=Nitrate Value TN=Total Nitrogen PO4=Phosphate Value TP= Total Phosphorus

B5. Instrument/Equipment Calibration, Testing, Inspection, and Maintenance

The Field Data Manager is responsible for ensuring instruments and equipment used for taking and handling field samples are to be inspected, maintained, and cleaned according to manufacturer's recommendations. Extra batteries, chargers, and other critical spare parts will be packed for field activities. The manufacturer's guidelines, an inventory of spare parts, and the maintenance log are located in the FSP laboratory area. CBL will maintain their laboratory equipment according to their SOPs for a given analytical method found on the CBL Laboratory Methods Webpage

The water quality sondes will be pre-calibrated on the Friday prior to the sampling work for pH, conductivity, turbidity, and dissolved oxygen, no more than 72 hours prior to field use. In addition, the meters will be post-calibrated following use in the field, no more than 48 hours after use, to document any drift from expected values that may have occurred during its use. Any deviations noted will be reported to the QA/QC section that makes any necessary corrections to the field data. All pre-and post calibrations will be conducted as recommended by the manufacturer.

Weekly inspections and preventative maintenance are conducted on-site at the FSP office by trained field staff. These procedures will follow the manufacturer's guidelines, as well as the in-house Water Quality Equipment Maintenance and Calibration SOP. The weekly maintenance activities performed are listed in the following table:

Table B5-2 Weekly Water Quality Sonde Maintenance Schedule

D.O. probe	Clean sensor
pH probe	Replace porous junction Replace electrolyte Clean glass in-situ pH reference electrode Replace pH standard
Conductivity probe	Clean sensor Examine and clean cell block
Turbidity probe	Clean sensor Examine and clean cell block
General	Clean wiring/gold pins

After sampling, equipment will be cleaned of aquatic plants, animals, and debris before leaving the site. On return to the office, all equipment will again be rinsed and cleaned with a 10% bleach solution (1 part bleach per 9 parts water) for a minimum exposure time of 10 minutes then rinsed off and then dried.

B6. Inspection/Acceptance of Supplies and Services

The Field Data Manager will conduct regular inspection of all equipment to ensure proper functioning. All sample bottles will be inspected by the Field Data Manager or designee to ensure they are free of any contaminants. The Field Data Manager will use a checklist to ensure all items are available during sampling. Additionally, CBL and the Lab Data Manager are responsible for properly maintaining their facilities and all equipment used in the laboratory analyses described in this project. Laboratory supplies and acceptance standards are described in CBL's SOPs for a given analytical method.

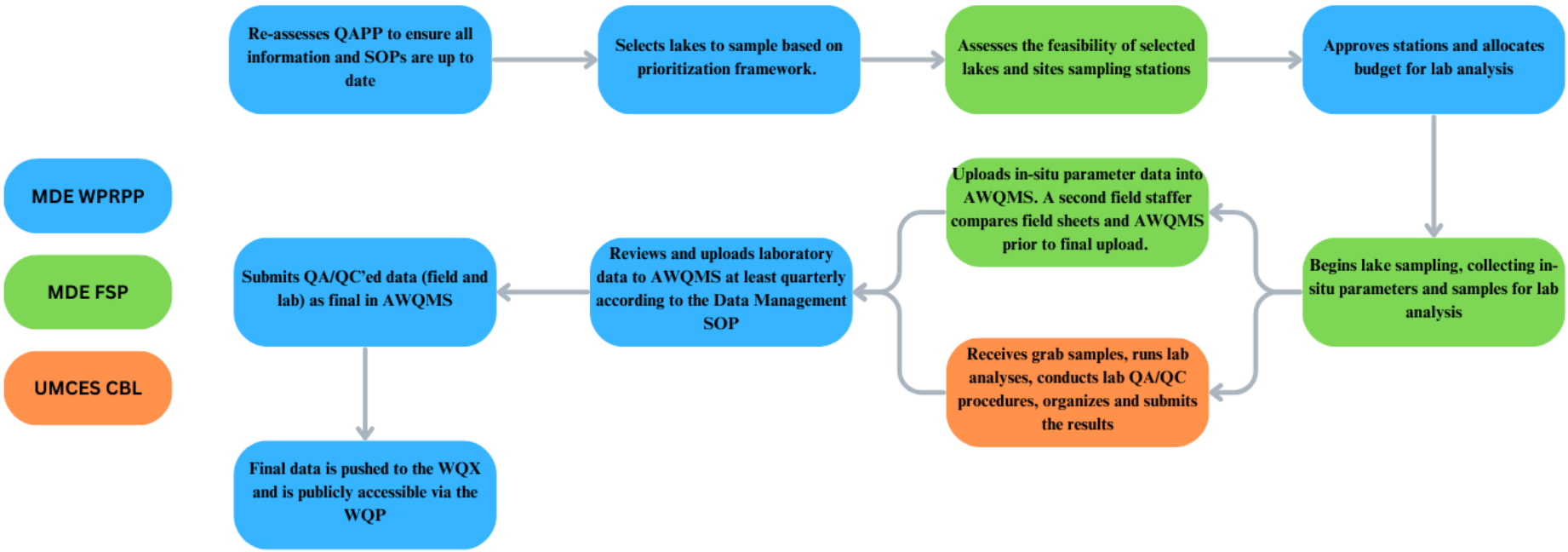
New and used sondes will be tested to meet calibration standards described in section B5. Containers will be inspected for breakage and proper sealing of caps. Filtering equipment is examined prior to field use for leaks, cracks, etc. Equipment such as thermometers and hoses will be checked routinely to ensure proper operating conditions and cleanliness. Sondes, thermometers, flow meters, safety equipment, containers, coolers, filtering kits, and other relevant sampling equipment will all be acquired by MDE from reputable suppliers. Damaged equipment will be returned or replaced.

Laboratory services received for this project will also be reviewed upon receipt. The QAM or IR and TMDL staff from WPRPP will review the received lab data for completeness and accuracy as described in section B4 and the LNM Project-Data Management and QA/QC SOP .

B7. Environmental Information Management

The environmental information process for this project is summarized in the following diagram:

Figure B7-1 Environmental Information Process Diagram



Field data sheets are checked for accuracy prior to leaving the field site. Data is then checked again upon return to the field office and data is entered into the AWQMS database by FSP staff. Hard copies of the original data sheets are kept on file in the Field Office. Scanned PDFs of the original field data sheets and laboratory transfer sheets are scanned and added to the shared Google Drive. Data generated by the laboratory is sent via a shared Google Drive to the Project Manager. The Project Manager enters the laboratory data into AWQMS.

AWQMS is used to record and organize all data. Once all data is entered, the Program Manager, with assistance from IR Staff, TMDL Staff, or the QAM as needed, inspects the data for accuracy and corrects any errors, cross checking with calibration and QC logs to confirm successful sampling and data management.

MDE incorporates checks at multiple points throughout this process to minimize loss of information during data entry by having separate reviews of lab and field data.

- Reviewers will compare field sheets to AWQMS entries and CBL's lab excel data to AWQMS entries respectively.
- All data entry and error correction activities are recorded in a set of documents prior to and immediately after any data management activity.
- Queries have been set up within Microsoft Access to facilitate the analysis of data without risking any alteration to the master dataset. Both completeness and accuracy will be checked in this process.
- The spreadsheet tracking sheet will serve as a place to document sample specific notes and issues that inform project management.
- Notes specific to samples and data use will be reflected in the AWQMS notes column field as well.

C Assessment, Response Actions, and Oversight

This section describes the activities used to assess the effectiveness of this QAPP and its associated QA/QC Program, and ensure that it is properly implemented. This will largely be accomplished by internal and external audits that evaluate field, laboratory and data management activities; equipment; contract labs; and individual performance. In addition, the response actions and measures to be taken as a result of these audits or other unanticipated problems are discussed.

C1. Assessments and Response Actions

During the project, the Project Manager and QAM will assess the project's activities to ensure that the QAPP is being implemented as planned. The purpose is to help to ensure that everything is on track and serves to minimize learning about critical deviations toward the end of the project when it may be too late to remedy the situation.

The Field Data Manager will conduct a general review prior to each major primary data collection step and take corrective action (if any is necessary). As part of the review, the Field Data Manager will ensure equipment is ready to go and all calibrations are checked; all sampling methods and equipment will be reviewed by staff prior to initiating sampling. The Project Manager will meet regularly with project implementation staff and the Field Data Manager to identify emerging/unanticipated problems and be responsible for stop work orders, corrective actions, and follow-up.

At least once annually, the QAM will assess the sample collection methodologies, field measurement procedures, and record keeping to ensure activities are being conducted as planned (and as documented in this QAPP). Any deviations that are noted will be corrected immediately to ensure all subsequent samples and field measurements collected are valid. If the deviations are associated with technical changes and/or improvements made to the procedures, the QAM will verify that the changes have been documented by the Project Manager and addressed in an amendment to this QAPP.

Audits of the QA procedures and QC activities

Internal individual performance audits will be conducted periodically by qualified senior field staff and reported to the Field Data Manager. Technical on-site evaluations of field sample collection and processing techniques, and proper equipment use will be made. Retraining of staff will be conducted, if necessary. Any issues relevant to data quality will be reported to the Project Manager and data will be assigned an appropriate qualifier code by the Field Data Manager, see the Lake Nutrient Monitoring (LNM) Project-Data Management and QA/QC for a list of qualifier codes.

Data management activities will be evaluated monthly by the Field Data Manager. Monthly schedules will be updated to reflect scheduling changes due to inclement weather or other factors to capture the status of data completeness for the project. All field sheets, flow measurements, and laboratory results are periodically reviewed by the Project Manager and QAM to determine if the data meets the quality standards set forth in this QAPP. In the event that discrepancies or unusual conditions are noted, the lab or field scientists will be contacted, as necessary.

Laboratory analysis activities will be evaluated by the Laboratory Data Manager following the policies and procedures of the CBL. The Laboratory Data Manager will assign any data qualifier codes to laboratory data prior to submission to MDE, see theLNM Project-Data Management and QA/QC SOP for qualifier codes. The QAM will also review laboratory data following the LNM Project-Data Management and QA/QC SOP.

An internal technical systems audit will be conducted annually by the QAM after all surveys have been completed and all laboratory results have been received. The QAM will follow protocols outlined in the LNM Project-Data Management and QA/QC SOP. The Project Manager may assist the QAM as needed with the audit process. Field sheets, laboratory results, equipment logs, and tracking sheets will be examined for completeness and discrepancies. Any anomalies will be addressed and corrected, if necessary. In addition, the adequacy of equipment, supplies, laboratory analytical procedures, data collection and reporting procedures, and sample collection and processing procedures will be reviewed and assessed as needed by the Project Manager. Any recommendations or changes will be reflected in future versions of this QAPP document. A description of quality control checks and acceptable corrective actions are provided in Table B4-1: QC Activities.

External audits, if found necessary, will be conducted by qualified individuals from the Environmental Protection Agency or other federal agency.

The Project Manager holds primary responsibility for ensuring that the problems identified through the audits are responded to and corrected in a timely fashion. The Project Manager will coordinate and maintain communication with the QAM and Data Managers.

If any problems are identified from the audits discussed above, various measures will be taken. In the event of equipment failure, laboratory logs will be reviewed and calibration/maintenance techniques will be reassessed and improved, as necessary. If problems are found with sampling team error, team members will be retrained, as necessary. If failure is not due to equipment methods or sampling error, specifications may be revised for the next sampling season. In all cases, the appropriate qualifier codes will be assigned to the data as needed. For a list of qualifier codes applicable to the project, The LNM Project-Data Management and QA/QC SOP.

C2. Oversight and Reports to Management

There are various reports that will be made available to management to address the status of the project. A centrally accessible (Google Drive) data tracking sheet will be maintained and available for reference for all project team members. The data tracking sheet will reflect the current status of field and laboratory data collection / analysis and entry into the AWQMS. An example of the data tracking sheet can be found in The LNM Project-Data Management and QA/QC.

The Laboratory Data Manager will send laboratory data at least quarterly, to the MDE team via Google Drive submissions. Laboratory data will be reviewed by the QAM, with assistance as needed by the Project Manager, following the quality checks and data verification procedures outlined in the Data Verification SOP. Through these data review efforts, a quarterly report will be generated to highlight any data quality issues. Data qualifier codes will be assigned and/or corrective actions will

be taken as needed following the data review, see Table B4-1 for a list of quality control checks with planned corrective actions.

The Field Data Manager and Laboratory Data Manager (Data Managers) also have oversight authority for their respective field and laboratory data collection teams. Upon identification of any data issues, the Data Managers will assign the appropriate qualifier code to the data, see The LNM Project-Data Management and QA/QC SOP for applicable qualifier codes for the project.

If data issues affect large portions of the dataset, or other data quality issues arise under the discretion of the Data Managers, the Data Managers will prepare and send a report detailing the data quality issue. This report will be sent to the Project Manager and QAM through email communications and entail:

- A description of the issue
- What data the quality issue affects
- Planned recourse or management actions that the Data Managers will undertake to remediate the issue for future data collection / analysis

Documentation for assessment activities, corrective actions, etc. will be kept in the shared Google Drive project folder. Two kinds of reports will be prepared: progress reports, and final reports. Progress reports will note the status of project activities, identify any QA problems encountered, and explain how they were handled. The final report will analyze and interpret data, present observations, draw conclusions, identify data gaps, and describe any limitations in the way the results should be interpreted. Reports that will be produced are outlined in Table C2-1.

Table C2-1 Reports

Type	Frequency	Timeframe	Transmission Route	Preparer(s)	Recipient(s)
Readiness Review Memo	Periodic	Before each major data collection step	Email	Project Manager	Field Data Manager, Field Staff, Data Users, QAM
Quarterly Progress Reports	Every 4 months	4 months after start date and ongoing	Email	Project Manager	All Project Personnel
Final Report	Once	At conclusion of project	PDF sent through email	Project Manager	Distribution List as seen in Table A7-1

D Environmental Information Review and Useability Determination

D1. Environmental Information Review

During information/data review, verification, and validation, staff will be guided by the data quality criteria listed in A6 as well as any additional criteria discussed in B2-B7. All onsite analytical data will be reviewed against QAPP requirements. The Project Manager, scientists, and relevant staff will:

1) Ensure that all sampling and analytical methods or SOPs were followed.

2) Establish that all method required QC samples were run and met required limits.

3) Establish that all QAPP required QC samples were run and met required limits.

The Project Manager and QAM will review each laboratory data package's narrative report and summary tables to see whether the laboratory "flagged" any sample results based on poor or questionable data quality or exceedances of the laboratory's QC criteria.

Through the data verification step, as described in the LNM Project-Data Management and QA/QC SOP, the QAM will check for data anomalies including but not limited to:

- Missing data,
- Data that fall outside the range of the expected or plausible based on industry averages,
- non-standard environmental aspects/indicators,
- incorrect/non-standard units,
- incorrect reporting years,
- incorrect normalizing factors or bases of normalization,
- incorrect calculations, conversions, etc.).

When possible, checking for data anomalies will be automated as part of the electronic data entry process into AWQMS or other automation softwares (i.e. RStudio and Microsoft Access), refer to the LNM Project-Data Management and QA/QC SOP for more information. Data anomalies will be flagged and corrected, to the extent possible, in consultation with field data collection staff and the Project Manager. When data used for analysis are incomplete, the potential impact of their incompleteness on the analysis will be described in relevant reports.

If at any point during review, the Project Manager identifies a problem (e.g., the use of substandard data when higher-quality data are available, a faulty algorithm, a mismatch between a data set and the question it is meant to answer), the Project Manager, field staff and any relevant staff will discuss corrective action. If necessary, the Project Manager will issue a stop-work order until a solution is agreed upon. The Project Manager will implement corrective action. If the solution involves changes in project design, the Project Manager will amend the QAPP as necessary, pass it through quality review if necessary, and then re-distribute it to the Distribution List.

Field Sampling and Measurement Data

Any information collected during sample collection and field measurements is considered field data. Once the field staff return to the office following a sampling event, they are responsible for conducting a technical review of the field data to ensure that all information is complete and any deviations from the planned methodologies are documented. (Note: This function is typically performed by a third party not directly involved in the activities. However, due to the small size of the staff, the field staff may self-evaluate their activities.) For the purpose of this project, the review will be documented using the monitoring tracking spreadsheet to ensure that data meet the data quality indicators and practices described in section A.6.

Laboratory Data

For the data generated by the off-site laboratory (The Chesapeake Biological Laboratory), the laboratory is responsible for its own internal data review and verification prior to submitting the associated lab results package to the Project Manager. The details of the review (including checking calculations, reviewing for transcription errors, ensuring the data package is complete, etc.) are discussed in the laboratory's QA /QC Webpage[23].

D2. Useability Determination

The purpose of the Lake Nutrient Monitoring sampling project is to assess impoundment water quality data against state regulatory standards for use in the Integrated Report and for TMDL development for impaired impoundments. This process allows Maryland to identify waters with impaired conditions and establish a plan to improve these waters. These operations fulfill sections 303(d), 305(b), and 314 requirements of the Clean Water Act.

Data must fulfill the requirements of this QA Project Plan to be useful for the overall project and support decision making under the Watershed Protection, Restoration, and Planning Program. To ensure data usability (after all the data have been assembled, reviewed, verified, and validated) a final usability determination should be made prior to summarizing the information in the Quarterly and Annual Reports. Once the field data and laboratory data are received through AWQMS, the QAM is responsible for further review and validation of the whole data package. For the purpose of this project, final data review and validation will be conducted using the accuracy and usability assessment steps provided below in conjunction with the QC criteria and activities (i.e., frequency, acceptance limits, and corrective actions) defined in section B.4- Quality Control. Once all the data from the field and laboratory have been reviewed, the Project Manager and QAM will make an overall assessment concerning the final usability of the data (and any limitations on its use) in meeting the project's needs.

Some steps of this assessment will include, but not necessarily be limited to:

1) Discussions with Field Staff, IR and TMDL staff, or other scientists.
2) Review of deviations from the QAPP or associated SOPs to determine whether these deviations may have impacted data quality (and determining whether any impacts are widespread or single

[23] https://www.umces.edu/quality-assurancequality-control

incidents, related to a few random samples or a batch of samples, and/or affecting a single or multiple analyses).

3) Evaluation of the field and laboratory results and QC information such as ensuring data are reported in compliance with the project action limits and quantitation limits, the sample preparation/analytical procedures were performed as written, the sample container, preservation, and holding times met the requirements listed in Table B2-2 Water Quality Parameters Analyzed for the Lake Monitoring program, and; the integrity of the sample (ensuring proper chain of custody and correct sample storage temperatures) is documented from sample collection through shipment and ultimate analysis, and the data packages.
4) Review of any other external information which might influence the results, such as off-site activities in the vicinity, meteorological conditions (such as storm events preceding sampling), etc.
5) Evaluation of whether the completeness goals defined have been met.
6) Examination of any assumptions made when the study was planned, if those assumptions were met, and, if not, how the project's conclusions are affected.
7) This review will include evaluation of the field and laboratory duplicate results, field and laboratory blank data, matrix spike recovery data, and laboratory control sample data pertinent to each analysis.

The final project report will contain an evaluation of the certainty of project results prepared by the Project Manager. For each conclusion reached by the project (i.e., each determination that an anticipated outcome has or has not been achieved, and the basis for each decision made or recommended by project authorities), this evaluation will describe, in narrative form: the quality of data and the methodologies used to inform the conclusion, the subsequent confidence in the conclusion, and the validity of generalizing results beyond the project.

References

See Table A4-1 for SOPs.

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