Title and Approval Page (A1)

Quality Assurance Project Plan for Cape Cod Regional Pond Monitoring Program

Revision: 1

EPA Grant #: 00A00370 (RAE Sub-award: SNEPWG18-9-CCC), and SE 00A01147
QA 24074
Lead Organization: Cape Cod Commission
Partner Organization(s): Association to Preserve Cape Cod and Center for Coastal Studies, **April 29, 2024**

DocuSigned by: Erin Perry 4E762A5F9E7C41E...	4/29/2024
Erin Perry – Cape Cod Commission	Date
DocuSigned by: Tim Pasakarnis 55092F92E1D8402...	4/30/2024
Tim Pasakarnis, Ph.D. – Cape Cod Commission	Date
DocuSigned by: Jo Ann Muramoto B480060E13BE427...	4/30/2024
Jo Ann Muramoto, Ph.D. – Association to Preserve Cape Cod	Date
DocuSigned by: Amy Costa 977C3CB5BDF240A...	4/30/2024
Amy Costa, Ph.D. – Center for Coastal Studies	Date
DocuSigned by: 3720F1E89260471...	5/1/2024
Jasper Sha – MassDEP Watershed Planning Program	Date
ELISE MCNALLY Digitally signed by ELISE MCNALLY Date: 2024.05.02 08:13:59 -04'00'	
Elise McNally – EPA Quality Assurance Officer	Date
HALEY MILLER Digitally signed by HALEY MILLER Date: 2024.05.02 09:00:59 -04'00'	
Haley Miller – EPA Project Officer	Date

Table of Contents (A2)

Distribution List (A3)

Organization	Contact / Address	Email Address
Cape Cod Commission	**Erin Perry,** Deputy Director **Tim Pasakarnis, Ph.D.** Water Resources Analyst **Tara Lewis** Water Resources Analyst 3225 Main Street PO Box 226 Barnstable, MA 02630 (508) 362-3828	eperry@capecodcommission.org tim.pasakarnis@capecodcommission.org tara.lewis@capecodcommission.org
Association to Preserve Cape Cod	**Jo Ann Muramoto, Ph.D.** Director of Science Programs 482 Main Street Dennis, MA 02638 (508) 619-3185	jmuramoto@apcc.org
Center for Coastal Studies	**Amy Costa, Ph.D.** Director, Cape Cod Bay Monitoring Program 5 Holway Avenue Provincetown, MA 02657 (508) 487-3623 x122	acosta@coastalstudies.org
Massachusetts Department of Environmental Protection	**Jasper Sha** Bureau of Water Resources, Watershed Planning Program 8 New Bond Street, Worcester, MA 01606	Jasper.sha@mass.gov
Environmental Protection Agency	**Elise McNally** 11 Technology Drive North Chelmsford, MA 01863 (617) 918-8335	mcnally.elise@epa.gov
Environmental Protection Agency	**Haley Miller** Project Officer 5 Post Office, Suite 100 Boston, MA 02109 (617) 918-1597	Miller.haley@epa.gov

Section A: Project Management

The following section provides information regarding the background of the Cape Cod Regional Pond Monitoring Program, the tasks involved in completing the project, and the names and responsibilities of key project team members.

A4: Project/Task Organization

The Cape Cod Commission (Commission) is the regional planning agency for Cape Cod (Barnstable County), established through the passage of the Cape Cod Commission Act in 1990 (https://www.capecodcommission.org/about-us/ccc-act/). The Act identifies the region as possessing unique natural, coastal, scientific, historical, cultural, architectural, archeological, recreational and other values that are threatened and may be irreparably damaged by uncoordinated or inappropriate uses of the region's land and other resources. The Act charges the Commission with protecting, preserving, and enhancing these unique values. The Commission's mission is to protect the unique values and quality of life on Cape Cod by coordinating a balanced relationship between environmental protection and economic progress (https://www.capecodcommission.org/about-us/ccc-overview/).

By developing a comprehensive Quality Assurance Project Plan (QAPP) for the Cape Cod Regional Pond Monitoring Program, the Commission and its partners the Association to Preserve Cape Cod (APCC) and Center for Coastal Studies (CCS) will be able to initiate and maintain a Cape-wide pond water quality monitoring program to collect data that will inform pond management, restoration and protection actions. The data will be incorporated into a regional database developed by the Commission and used to evaluate pond water quality and model nutrients and climate change parameters. The QAPP will strengthen the Commission's pond water quality data collection process and enhance its ability to share and integrate pond data across private and academic institutions and provide data to state and federal agencies for regulatory listings and other purposes. This increased capacity for standardized data sharing is significant for this project but also for future collaborations. Benefits to Cape Cod as a whole include collection of water quality data of assured quality, comparability of data across the region, acceptance of monitoring data and results by state and federal agencies that require QAPPs in order to fund and support local water quality monitoring programs, and enhanced ability to use water quality data to inform the public and decisionmakers regarding the need for pond protection and restoration.

Cape Cod Commission

The Commission manages the overall project; coordinates with APCC and CCS; disseminates program information to help recruit towns, pond monitoring organizations and volunteers; oversees the data quality assurance / quality control (QA/QC) program; maintains the QAPP; assimilates the Cape Cod Regional Pond water quality monitoring data into the regional database; maintains and analyzes the data, and manages an online interface so the data are available to the public and end-users including, but not limited to, the Cape Cod Water Protection Collaborative ("Collaborative"), a group with representatives from all fifteen Cape Cod towns and two Barnstable County representatives; APCC; individual towns; pond associations; other organizations; and other end-users such as scientists, restoration consultants, and regulatory agencies.

Association to Preserve Cape Cod

The Association to Preserve Cape Cod assists the Commission in developing the QAPP and distributing it to staff, outreach and recruiting of pond monitoring organizations and volunteers to monitor ponds: provides orientation and coordination of volunteers who assist APCC staff with collecting water samples; coordinates equipment distribution and calibration; provides preliminary QA/QC of data; and is an end-user of the data generated from the project through APCC's State of the Waters: Cape Cod

project.

Center for Coastal Studies
The Center for Coastal Studies provides sampling logistics support and laboratory analyses of water samples collected by APCC staff and volunteers, in accordance with standard operating procedures and this QAPP.

Restore America's Estuaries
Restore America's Estuaries (RAE) was selected by the Environmental Protection Agency (EPA) to manage the Southeast New England Watershed Grant Program (SNEP) for 2018 and 2019, under which the original QAPP for this project was prepared.

EPA
The Environmental Protection Agency provided the original grant funds used to prepare the QAPP for this project. The EPA will continue to review and approve subsequent revisions of this QAPP.

MassDEP
The Massachusetts Department of Protection (MassDEP) monitors and reports on the condition of water resources throughout the Commonwealth and whether they are healthy or impaired relative to their designated uses. MassDEP will review the QAPP and subsequent revisions to approve or qualify the program's data for use in future water quality assessments and regulatory listings.

See **Figure 1** for organizational chart.

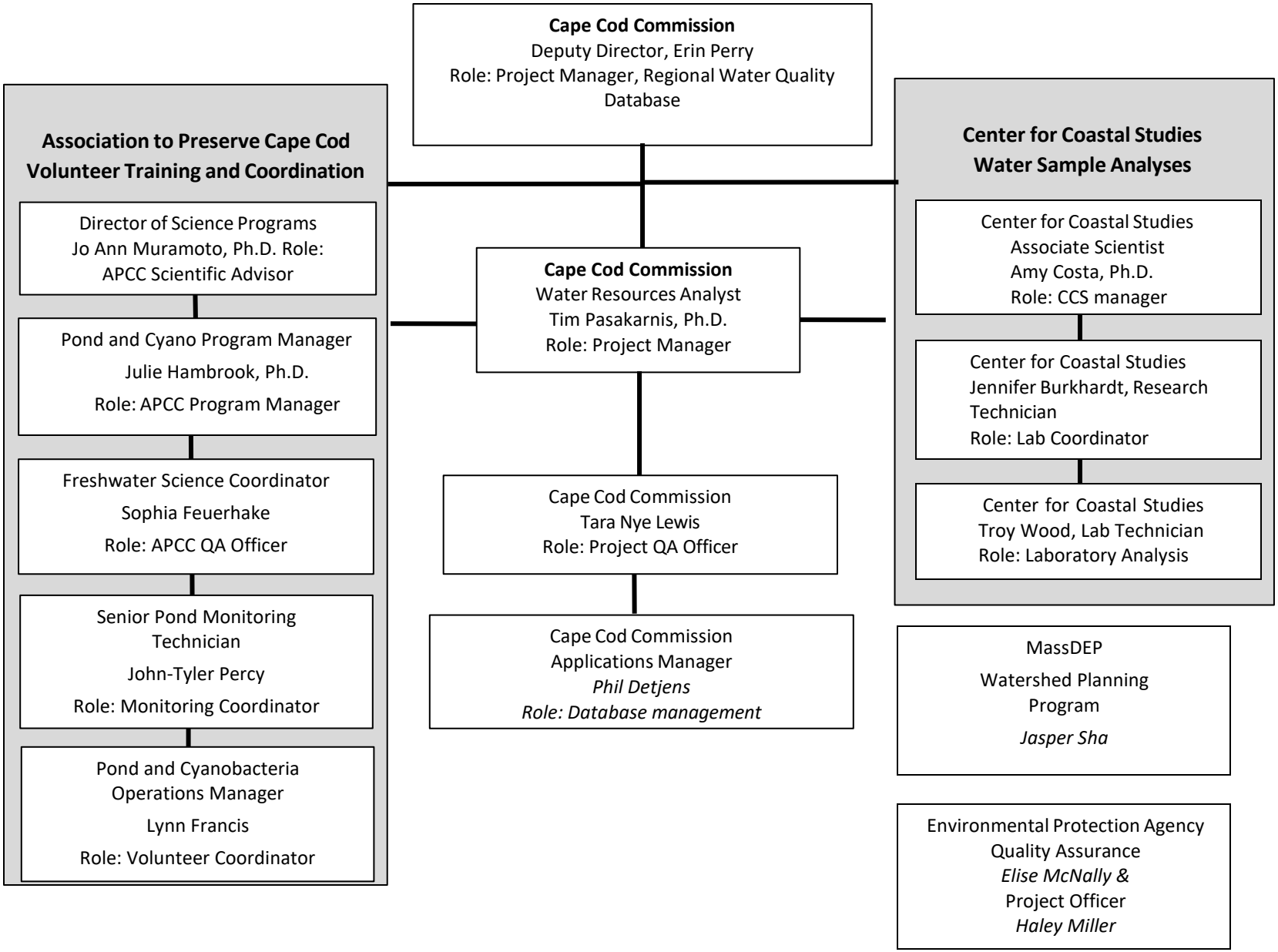

Figure 1: Organizational chart for Cape Cod Pond Monitoring Program Quality Assurance Project Plan.

Table 1: Project Team, Cape Cod Regional Pond Monitoring Program.

Name	Title	Organization	Project Role and Primary Responsibility
Erin Perry	Deputy Director	Cape Cod Commission	Project Manager for Regional Water Quality Database: Project lead for the Southeast New England Program Watershed Grant and Regional Water Quality Database. Oversees Ponds Monitoring project and coordination with partners: takes any corrective actions necessary to meet QAPP objectives.
Tim Pasakarnis, Ph.D.	Water Resources Analyst	Cape Cod Commission	Project Manager: General program oversight and development, including sampling design, data collection procedures, data management, and coordination with analytical lab (CCS). Coordinates data distribution with partner organizations and maintains QAPP document.
Tara Nye Lewis	Water Resources Analyst	Cape Cod Commission	Project QA Officer: Oversees all aspects of data QA/QC, including coordination of QA/QC with APCC and CCS; oversees all database QA/QC procedures; identifies issues; and recommends corrective actions.
Jo Ann Muramoto, Ph.D.	Director of Science Programs	Association to Preserve Cape Cod	APCC Scientific Advisor: Developed the QAPP and oversees updates and revisions as needed. Provides advice to ensure scientifically sound sampling procedures.
Julie Hambrook, Ph.D.	Pond and Cyano Program Manager	Association to Preserve Cape Cod	APCC Program Manager: Manages the Program and oversees QA Officer and Pond Monitoring Technicians, ensures the QAPP is followed, conducts QA/QC review of field data, and relays results to Project QA Officer.
Sophia Feuerhake	Freshwater Science Coordinator	Association to Preserve Cape Cod	APCC QA Officer: Provides QAPP updates or revisions as needed; reviews staff and volunteer operations to ensure QAPP is followed; provides QA/QC training to staff; conducts initial QA/QC review of field data and relays results to APCC Project manager; verifies chain-of-custody protocols are followed.

Lynn Francis	Pond and Cyano program Operations Manager	Association to Preserve Cape Cod	APCC Volunteer Coordinator: Assists the APCC Monitoring Coordinator and QA Officer with coordination and organization of volunteers, organizes annual orientation event; prepares orientation and outreach materials for volunteers.
John-Tyler Percy	Senior Pond Monitoring Technician	Association to Preserve Cape Cod	APCC Monitoring Coordinator: Oversees all field operations and ensures QAPP is followed; coordinates volunteers; calibrates and maintains equipment; coordinates bottles and sample transfer from/to lab (CCS); and conducts monitoring.
Amy Costa, Ph.D.	Associate Scientist	Center for Coastal Studies	CCS Manager: Oversees Water Quality Monitoring lab; reviews staff operations to ensure QAPP is followed; leads/supervises lab analyses; maintains chain of custody documentation; provides QA/QC check of lab data in accordance with standard operating procedures.
Jennifer Burkhardt	Lab Coordinator	Center for Coastal Studies	CCS Lab Coordinator: Coordinates bottles and data transfer; maintains chain of custody documentation; conducts initial QA/QC check; performs lab analyses.
Troy Wood	Lab Technician	Center for Coastal Studies	Performs lab analyses, conducts QA/QC checks
Volunteers	Cape Cod Regional Pond Monitoring Volunteers	Association to Preserve Cape Cod	Collect field data and water samples.
Phil Detjens	Applications Manager	Cape Cod Commission	Applications Manager: Assimilates data into regional database; manages online access.
Jasper Sha	Watershed Planning Program	MassDEP	Reviews and approves QAPP
Elise McNally	Quality Assurance	EPA	Reviews and approves QAPP
Haley Miller	Project Officer	EPA	Reviews and approves QAPP

A5: Problem Definition/Background

Background

Cape Cod (Barnstable County) is a peninsula located in Southeastern Massachusetts which is connected to mainland Massachusetts via three bridges. There are 15 towns (Barnstable, Bourne, Brewster, Chatham, Dennis, Eastham, Falmouth, Harwich, Mashpee, Orleans, Provincetown, Sandwich, Truro, Wellfleet and Yarmouth). The year-round population is approximately 222,230 residents of various ages and income levels, but the seasonal population increases greatly during the summer to more than twice this number. Shore areas, both coastal and fresh, attract residents and visitors alike due to their scenic value and recreational opportunities for swimming, boating and fishing.

The Cape has 890 freshwater ponds and lakes that cover nearly 11,000 acres and range in size from less than one acre to 735 acres, including 166 freshwater ponds of greater than 10 acres ("Great Ponds" under MGL, Chapter 91). Locally, freshwater ponds and lakes are often called ponds regardless of size, and that terminology is used here. Freshwater ponds are found in all 15 towns. Most ponds are hydrologically connected to groundwater and are groundwater-fed, though many ponds also connect directly to estuaries via streams or rivers.

Cape Cod's freshwater ponds are ecologically rich and extremely fragile. Ponds provide important spawning and nursery habitat for migratory fish such as river herring and American eels, and there are at least 41 active herring runs extending from such ponds to the sea. A number of ponds provide critical habitat for state-listed species and sensitive natural community types such as coastal plain pond shores and Atlantic white cedar swamps. These community types are relatively unique, and the majority of their global distribution is within Barnstable County and Southeastern Massachusetts. Ponds are also important resources for recreational and homeowner uses. While only one pond is used as a public drinking water source, most ponds on the Cape are hydrologically connected to the Cape Cod aquifer which serves as the region's sole source for drinking water.

In 2001, the Commission and a number of regional and local partners began monitoring pond water quality as part of the Cape Cod Ponds and Lakes Stewardship (PALS) program. Data generated by early PALS program sampling was used to publish the 2003 Cape Cod Ponds and Lakes Atlas (Pond Atlas), and the PALS program has continued to collect annual snapshots from a changing roster of individual ponds. Monitoring results were provided to towns, organizations and the public via reports and workshops. Pond and watershed associations and individual towns have assisted by collecting PALS data with their available resources. The Commission and partners frequently receive inquiries from residents regarding the water quality and existence of monitoring data for individual ponds, and often refer to the rather outdated Ponds Atlas and subsequent PALS data to answer many of these questions.

Many concerns relate to eutrophication of ponds. In 2018 the Commission received EPA SNEP funding to initiate an effort called the "Regional Collection and Analysis of Cape Cod Water Resources Data to Inform Local Decision-Making" (aka "Cape Cod Regional Water Quality Monitoring Program") to collect water quality data from Cape Cod, organize and evaluate old and new data, and provide feedback to citizens and town decision-makers about water resource status and management concerns. This has been a successful program to date and the addition of the freshwater pond monitoring program will add valuable data on pond water quality to this database making it accessible to towns, pond and watershed associations, resource managers, decisionmakers, the State and EPA.

Problem Definition

Based on historical data and ongoing monitoring, freshwater pond water quality throughout the Cape

has become significantly degraded by human activities and land use. The 2018-2020 Massachusetts 303d list of impaired waters lists twenty-five ponds in ten towns as Category 5 water bodies requiring Total Maximum Daily Loads (TMDL) due to excess nutrients, harmful algal blooms, dissolved oxygen deficiencies, or chlorophyll. From 2019 through 2022 APCC reviewed historical snapshot pond water quality data collected by the Commission, consisting mainly of PALS Program monitoring, for the purpose of grading water quality through APCC's State of the Waters: Cape Cod project (www.capecodwaters.org). PALS monitoring typically utilizes a "snapshot" approach involving monitoring once or at most several times during the summer. The most recent results for 2022 PALS data showed that only 64 ponds or 7% of the Cape's 890 ponds had sufficient water quality data to evaluate current conditions (defined as at least three years of data collected within the last five years). Thus, the vast majority of the Cape's freshwater ponds either have not been monitored or have not been monitored recently. Of the 64 ponds that have been monitored since 2018, half show signs of eutrophication including excess nutrients, harmful algal blooms, low dissolved oxygen, poor water clarity, and/or high chlorophyll concentrations. The main causes of nutrient pollution in ponds are discharge from nearby septic systems, stormwater runoff, and fertilizers. Other causes of impairment include mercury and PFAS contamination which are outside the scope of this QAPP.

The lack of comprehensive pond water quality data from ponds across the Cape hampers restoration and management of ponds even as pond associations and residents call for improvement of water quality in their ponds. Establishing a consistent monitoring program based on past monitoring that includes a regular review and reassessment will provide the Commission and local, regional, and state resource managers with a consistent and reliable basis for management of pond and lake water quality.

Towns are ultimately responsible for implementing nutrient reduction strategies to preserve and restore the health of these degraded water bodies. In many areas across the region however, development density is not adequate to support cost-effective traditional collection and treatment of wastewater via sewering. In response, the Area Wide Water Quality Management Plan for Cape Cod (208 Plan) was updated in 2015 to provide a framework of traditional and non-traditional strategies for estuarine and freshwater quality improvement available to assist towns with water quality improvement. Although the 208 Plan focuses on nitrogen as the major target for improving water quality in estuaries, nutrient loading (both nitrogen and phosphorus) is similarly impacting streams and freshwater ponds and should also be addressed in a strategic manner. Having high-quality pond data guided by a QAPP is important for helping communities to develop effective, environmentally safe and defensible pond protection and restoration methods.

The 208 Plan's efficacy as a framework for local water quality management depends on the ability to ground truth and record if strategies are effective in improving water quality. Towns must revisit implementation plans periodically for consistency with the 208 Plan and municipal separate storm sewer system (MS4) permits and to maintain compliance with Watershed Permits issued by the Massachusetts Department of Environmental Protection (DEP). In most cases, towns must revisit plans at least every five years, and adjust their approaches through adaptive management actions as necessary. Reliable high-quality data are needed to evaluate and determine the success – or failure – of selected approaches. Moreover, a body of regional pond water quality data would enable local, regional, state and federal managers to determine the efficacy of water quality improvement and restoration efforts at a variety of scales.

Although there are several local research institutions and non-governmental organizations that provide pond water quality monitoring services, frequently the data are not readily available, easily accessible or understandable for town officials and the public. Other continuing pond monitoring efforts are being conducted by individual towns and organizations working on their own. APCC's State of the Waters: Cape Cod project provides translation of water quality data into easily understood grades; however, it is

limited to using available data (i.e., PALS snapshot data). With the exception of this regional pond monitoring program, and the pond monitoring program in Orleans, pond monitoring throughout Cape Cod has generally occurred without an approved QAPP to govern QA/QC for sample collection, analysis and reporting. Having an approved QAPP for monitoring will help to provide quality data which can be used to compare water quality throughout the region and provide a basis for determining additional water bodies to include on the State Integrated List of Waters. State and federal agencies are also increasingly requiring a QAPP as a condition for awarding grants for water quality monitoring, and the lack of an approved pond monitoring QAPP creates additional burden for towns and organizations seeking to obtain funding for monitoring.

Addressing Needs

To address these needs, the Commission proposed a new Cape Cod Regional Pond Monitoring Program (CCRPMP) as a component of the Cape Cod Water Quality Monitoring Program. The CCRPMP was initially conceived as a snapshot monitoring program designed to provide initial and continuing long-term data about the status of selected ponds. When Barnstable County authorized funding for the new Freshwater Initiative in 2022, funding was included for a Cape-wide Pond monitoring program. The Commission subsequently issued an RFP for contractors to conduct a Cape-wide Pond Monitoring Program, and APCC was selected as the contractor. The Cape Cod Pond Monitoring Program now includes monthly monitoring of 50 ponds seven times a year (April – October), initially funded for three years (2023 – 2025), thus providing a longer season of sampling than the PALS program with more frequent sample collection during the growing season. This period of time includes late spring-early fall, including late summer when water quality is typically at its worst in terms of eutrophication and oxygenation. In addition, pending availability of funding, APCC plans to conduct shoulder-season sampling during March-November of each calendar year to obtain data on pond stratification in early spring and pond mixing in the fall. This QAPP will be amended as needed to accommodate additional planned sampling events.

Data collected by the CCRPMP is incorporated continuously into the Regional Water Quality Database and will form the basis for periodic regional pond water quality analysis and reporting. A web portal allowing for public, on-demand access to the data is currently being developed.

Goals

Goals for the CCRPMP are to:

- Establish a standard and consistent strategy to collect water quality data from the Cape's ponds;
- Collect new data;
- Enter data into the Commission's Regional Water Quality Database;
- Organize and evaluate old and new data;
- Engage municipal and citizen monitoring groups; and
- Provide data and analysis in an easily understood format and transparent manner to citizens and local, regional, state and federal decision-makers about pond status and management concerns.

The Cape Cod Pond Monitoring Program will gather water quality data on selected ponds, incorporate new data and existing historical data into the Regional Water Quality Database, share updated data and analysis through a public web portal and periodic analysis reports, and build a sustainable sampling model to continue pond monitoring beyond the timeframe funded by EPA SNEP funding. The Commission will work with project partners such as towns and pond associations, to share project findings in multiple settings and through various media outlets.

Having an approved Ponds Monitoring QAPP in place provides the following benefits to all Cape Cod towns and organizations that participate:

- Readily accessible and easily understood data;
- Systematically collected monitoring data of high quality to inform development of pond protection and restoration efforts, to track restoration progress, and enable comparison of water quality between ponds and throughout Cape Cod;
- Documented baseline level of data quality that supports its use for regulatory listing purposes;
- Reconnaissance-level or preliminary assessment of pond water quality to inform whether more in-depth or detailed pond monitoring studies are needed;
- Increased adoption of town sponsored pond monitoring programs, secure in the knowledge that their data will be accepted by state and federal agencies for use in pond protection and restoration programs;
- Facilitation in obtaining grants for pond monitoring from state and federal agencies which require QAPPs for monitoring programs; and
- Increased level of citizen stewardship to foster pond protection and restoration efforts, and a sustainable long-term network of volunteers.

A6: Project Task Descriptions

There are six main tasks associated with the CCRPMP. See Table 2 for a list of tasks and general timeframe associated with each task.

Table 2: Project Tasks and Schedule. ***Note that Tasks 2 – 6 will repeat each year of pond monitoring into the foreseeable future.***

Task	Deliverable	Timeline
1. QAPP Review and Revision	Updated Pond Monitoring Program QAPP	Annually, December – February
2. Field Season Preparation and Volunteer orientation event	Annual in-person or virtual volunteer orientation workshop	March-April, Annually in 2024 and 2025
3. Pond Sampling, Data Collection & Analysis	Preliminary data set of field and lab measurements	March-November (contingent upon funding), otherwise April - October, Annually, 2024-2025
4. Routine QA / QC Checks		March-November, Annually 2024-2025
5. Final Data Review	Reviewed and finalized data set	November – December, Annually 2024-2025
6. Final Reporting	Annual monitoring summary report	January – February, Annually 2024-2025

Task 1: QAPP Development

The first step for the CCRPMP involves reviewing and updating the QAPP to guide field season preparation and training of staff, as needed (Task 2), data collection including sample collection and sample analyses (Task 3), quarterly QA checks (Task 4), final data review (Task 5), and reporting (Task 6).

This QAPP describes the management system and procedures, as well as the roles and responsibilities of the Project Team. The QAPP provides an overview of the project and quality assurance procedures

related to data used for the project. Commission staff will be responsible for maintenance and distribution of the approved QAPP, which will be provided electronically as needed.

Task 2: Field Season Preparation and Training

Following QAPP review and revisions, at the beginning (January – February) of 2024 and 2025, APCC will conduct an inventory of field sampling equipment and verify equipment calibrations and maintenance are conducted as needed and any necessary equipment replacement or upgrades will be arranged in advance of the start of the sampling season in March. The Center for Coastal Studies will also prepare for lab analysis of samples.

An annual orientation event for APCC's volunteers will be conducted in March or April, APCC staff will conduct training for new and seasonal sampling personnel. Training will review sampling protocols, equipment use, sample handling procedures, sampling safety, and pre-sampling checklists; with an emphasis on consistency of sampling techniques. Training a new seasonal technician by the Senior Pond Monitoring Technician will occur during March sampling events, before volunteers join sampling in April. See Section A8 for more details regarding training events.

Task 3: Data Collection: Pond Sampling and Analyses

Data collection (water sample collection and analyses) will be conducted in accordance with sampling and analysis procedures detailed in Section B from March 1 to November 30 of 2024 and 2025, with March and November sampling contingent upon funding. Equipment calibrations will occur as needed throughout the sampling season – see Section B for more information regarding calibrations and other equipment protocols. This task will occur annually.

A list of ponds to be monitored was developed using criteria such as pond access and history of monitoring. Additional details regarding the criteria for pond selection are contained in Section B1. The selected sampling locations are shown in Figure 1: Map of Cape Cod Regional Pond Monitoring Program sampling locations, and a list of the selected ponds is provided in Appendix A. Prior to each year's sampling season additional ponds will be considered for inclusion in the monitoring program, and pending availability of funds and resources may be added to the list. Any updates to the sampling locations or additions of ponds will be recorded in a QAPP addendum or subsequent QAPP revision. To keep track of pond monitoring tasks as they are completed, a task tracking sheet will be maintained by the APCC Monitoring Coordinator to enable the Project Manager to track monitoring activities as they are completed (Appendix B, Tracksheet for Cape Cod Regional Pond Monitoring Activities).

Pond sampling and analyses

Pond water quality will be monitored for the following parameters:

1) Temperature (field measurement)
2) pH (field measurement)
3) Conductivity / salinity (field measurement)
4) Dissolved oxygen (field measurement)
5) Oxidation-reduction potential (field measurement)
6) Turbidity (field measurement)
7) Secchi disk depth (transparency) (field measurement)
8) Alkalinity (lab analysis)
9) Total Phosphorus (lab analysis)
10) Total Nitrogen (lab analysis)
11) Nitrate / nitrite (lab analysis)

12) Orthophosphate (lab analysis)
13) Ammonium (lab analysis)
14) Chlorophyll-a (lab analysis)
15) Phaeophytin (lab analysis).

The APCC Monitoring Technicians together with volunteers will collect field measurements and water samples for lab analyses.

The Center for Coastal Studies will conduct laboratory analyses of water samples. Laboratory procedures are described in the *CCS Laboratory Quality Assurance Plan* (Appendix G). Laboratory procedures for analysis of freshwater pond samples will be identical to those described in the CCS QAPP.

Data quality objectives for field and laboratory data are described in Section A7 and Tables 3 and 4.

Figure 1: Map of Cape Cod Regional Pond Monitoring Program sampling locations

Task 4: Routine QA/QC Checks

Throughout the data collection period, several layers of QA/QC checks will be performed by project partners as follows. APCC will review field data sheets and perform initial QA/QC to verify that errors have not occurred in the field or during electronic data entry before transmitting field measurement data to the Commission. Following receipt of field or lab data records and upon data import, basic and

extended validation is performed by Commission staff as described in Section B5 and further detailed in the *Quality Assurance Project Plan for Regional Collection and Analysis of Cape Cod Water Resources* (Appendix I). CCS will perform QA/QC checks on laboratory analyses and sample results as described in Section B5. If problems are identified at any of these steps, the required response actions will be initiated to resolve the issue. This task will be ongoing throughout the year.

Task 5: Final Data Review

The final review of each year's data will be completed following the conclusion of sampling and within 60 days of all field and lab sampling data having been received and imported into the database. Each season's data will be examined graphically and/or through standard statistical methods, including automated outlier flagging. This task will be ongoing on an annual cycle.

Task 6: Sharing and Distribution of Monitoring Data

This task will be ongoing on an annual cycle. Reporting for the CCRPMP will occur through the Commission's Regional Water Quality Data Portal and Database (https://www.capecodcommission.org/our-work/cape-cod-water-quality-data-portal/), which will provide users with access to the data once data are received and entered into the database, with accompanying release status information and applicable metadata. Data that passes basic and extended validation during import will be immediately available via the Water Quality Portal as provisional data. A public web interface for freshwater data is currently being developed, but monitoring data is incorporated into the water quality database on a rolling basis and is currently available by request. As described in Task 5, provisional data will undergo final review at the end of each sampling season and will be designated as final data once that review is complete. To take advantage of all available long-term monitoring data, while also establishing quality control standards, any historic data generated before or without an approved QAPP will be flagged accordingly in the database as part of the QA/QC process. The database includes sample metadata as well as an explanation of the appropriate uses and use limitations of non-QAPP approved data.

The Cape Cod Commission is working separately with the EPA Southeast New England Program's Monitoring Subcommittee to facilitate bulk imports of data from the Regional Water Quality Database into the federal Water Quality Portal (WQP/WQX). Once these procedures are set up, it is expected that freshwater pond monitoring data will be provided to the WQP on an annual basis.

A7: Quality Objectives and Criteria

Quality Objectives

In order for the data to be useable (i.e., for inclusion in a regional water quality monitoring database, which is intended for local decision makers to track changes in aquatic ecosystem health), data must meet certain data quality objectives. These data quality objectives are listed below:

1) Samples collected are representative of the study area;
2) Data collected in the field and in the lab are accurate and unbiased;
3) Data sensitivity and precision fall within acceptable resolutions specified by regulatory agencies and equipment manufacturers;
4) Data collection is complete – missing or erroneous data does not exceed 20% of intended collection; and
5) Data are comparable across sites and across water quality programs.

To achieve these data quality objectives, the CCRPMP will employ and satisfy the data quality objectives outlined in this section. Quality control measures to achieve these objectives are described in Section B5. The data collected will be used in making decisions regarding pond protection and management activities as described in the Program Description and Goals section. This section outlines measures to ensure samples are collected and analyzed properly, thereby meeting quality standards.

Field Measurements

Data quality objectives for water quality parameters to be measured in the field are described below and summarized in Table 3.

Representativeness

Data representativeness will be met by the following requirements:

- Pond monitoring and water quality sampling are conducted at the point in the pond where the deepest depth occurs, i.e., "deepest point" in order to obtain the most data throughout the water column. This is necessary because water quality can differ at different depths due to seasonal conditions, mixing, changes in water budget, etc. The depth at which water quality is monitored with the In-Situ depends on the depth of the pond. The In Situ instrument readings will be captured at 0.5 m below the surface and then at every full meter moving down the water column (e.g., 0.5 m, 1.0 m, 2.0 m, etc.). The last In-Situ reading is captured at 0.5 m above bottom. Additionally, multiple logging events occur throughout the water column. Meaning that there are repeat measurements with the same instrument that will assess field precision for the In-Situ measurements. For water samples collected for laboratory analyses, see Table 5 for the depths at which water samples are collected with the Van Dorn sampler.
- Any abnormal or episodic conditions that may affect the representativeness of sample data are noted and maintained as metadata.
- Field blanks will be collected every sampling day and subject to all analysis procedures that use blank correction, including reporting, to ensure sampling and lab procedures are not adding bias to results.

Precision and Accuracy

Accuracy refers to how close a measurement is to the true or accepted value of an item. Precision refers to how close measurements of the same item are to each other. Precision can be broken down into two components: repeatability and reproducibility. Repeatability is the variation observed when the same operator measures the same part repeatedly with the same device. Reproducibility is the variation observed when different operators measure the same part repeatedly using the same device (Accuracy vs. Precision: What's the Difference? (minitab.com)https://blog.minitab.com/en/real-world-quality-improvement/accuracy-vs-precision-whats-the-difference).

Accuracy is ensured by utilizing standardized sampling procedures and analytical equipment that has been calibrated using standards. By following standardized procedures during maintenance and calibration, inaccurate measurements or biases are avoided. Table 3 details the calibration frequency and acceptable ranges for the field measurement data quality criteria. These criteria are based on MassDEP WPP's Programmatic QAPP Table 2 (https://www.mass.gov/doc/quality-assurance-program-plan-for-surface-water-monitoring-assessment-2020-2024/download) and equipment specific recommendations provided by the manufacturer. See Section B for more information regarding standard operating procedures for equipment calibrations. Field instruments/sensors are checked against a reference standard in accordance with manufacturer specifications, and calibrated when the check falls outside the prescribed range. In the event that a sensor fails the accuracy check,

measurements collected since the previous calibration will be flagged accordingly. If a sensor fails two consecutive accuracy checks, the check frequency will be increased until the instrument undergoes maintenance or repair.

Sampling precision is ensured by obtaining replicate water samples for analyses:

- Replicate field samples (i.e., two samples) are required for approximately 10% of samples. A unique identifier will be assigned to the replicate and noted in the Field Monitoring and Chain-of-Custody Form (Appendix F).
- Replicate samples are collected from the same sample collection depth. Replicate samples are obtained by consecutively collecting two separate samples with the Van Dorn sampler at the same depth and filling two sets of three sample bottles, with one set of three bottles being filled from the first Van Dorn sample collection and the second set of three bottles being filled from the second Van Dorn sample collection.
- Equipment blanks will be collected by rinsing the equipment with blank water and then collecting the blank water that is poured through the Van Dorn as a blank sample to ensure no transfer of contaminants. One equipment blank will be collected per day.
- Upon receipt of field replicate results, the CCS Lab Manager will review to ensure samples are within an acceptable range, normally ±20%.

Comparability

The comparability of project data to previously collected pond data will be ensured by using the same protocols and by following these established protocols. This will ensure that all new samples are collected following the same procedure and approach and are assayed by the same methods as in the prior surveys:

- Documenting sampling sites, times and dates and sample transport using the Field Monitoring and Chain-of-Custody Forms (Appendix F). No samples will be accepted at the CCS Laboratory without completed chain-of-custody documentation. Detailed and complete sample records including the Field Monitoring and Chain-of-Custody Forms (Appendix F) will be maintained.
- Results can be compared to historical data from that station collected during the same season as previous years.
- Final reports detailing data and conclusions may be published and posted by the Commission.

Completeness

The Cape Cod Regional Pond Monitoring Program data are considered complete when at least 80% of the planned sampling events occur successfully. Missing data occurs primarily when poor weather conditions (e.g., high winds, storms, lightning, extreme heat or cold) prevent safe sampling activities. Every effort is made to find a substitute when staff or volunteers are unavailable. The Pond Monitoring Tracksheet (Appendix B) will enable the Monitoring Coordinator, Project Manager and Project Team to keep track of monitoring activities as they are completed.

Table 3: Data quality objectives for field parameters measured using In-Situ Aqua Troll 500 vented and a Secchi disk. Information provided by MassDEP WPP's Programmatic QAPP Table 2 and In-Situ Inc. (at 500-manual.pdf (in-situ.com)https://in-situ.com/pub/media/support/documents/at500-manual.pdf)

Parameter	Method	Units	Range	Accuracy	Resolution (Sensitivity)	Calibration
Temperature	EPA 170.1	°C	0-30° C	+/- 0.15 °C	0.01 °C	Checked against NIST-certified thermometer

						every sampling day. Required to be within 0.4°C, accounting for In-Situ Instrument and NIST-certified thermometer accuracy. In-Situ Sonde is maintained and calibrated by Manufacturer annually.
pH	Std. Methods 4500- H+/EPA 150.2	pH units	0-14	± 0.1 or better	0.01	3-point calibration is done weekly and In-Situ recommended slope and offset are checked and recorded. If slope and offset are out of range the sensor is re-calibrated.
Oxidation Reduction Potential (ORP)	Std. Methods 2580	mV	±1,400 mV	±5 mV	0.1 mV	Calibrated weekly, re-calibrated if offset is outside of In-Situ recommended range.
Specific Conductance	Std. Methods 2510/ EPA 120.1 ±1,400 mV	µS/cm	75-700 µS/cm (fresh)	+/- 1% of reading	4 digits	Checked with In-Situ 1413µS/cm calibration solution weekly. Only calibrated if outside of 5% range.
Salinity	Std. Methods 2520B	PSU	0-35	0.2	0.01 PSU	Calculated by instrument using the specific conductance and the dissolved oxygen sensor. See above for calibration method of specific

						conductance and dissolved oxygen sensors.
Dissolved Oxygen (optic)	HACH 10360 ASTM D888-05	mg/L	0-14 mg/L	+/- 0.2 mg/L	0.01mg/L	Calibrate daily prior to monitoring and checked in 100% DO environment before and after each sampling event. Re-calibrated if outside of +/-2% range of 100% DO saturation.
Turbidity	ISO 7027	NTU	0.1-100	2 NTU	0.1 NTU	Same as above
Depth (measured using pressure)	Piezores -istive; Ceramic	Pressure: psi, kPa, bar, mbar, inHg, mmHg Level: in, ft, mm, cm, m, cmH20, inH2O	9.0 m (30ft) (Burst: 27 m; 90 ft) 30 m (100 ft) (Burst: 40 m; 130 ft) 76 m (250 ft) (Burst: 107 m; 350 ft) 100 m (325 ft.) - Burst: 200 m (650 ft.	±0.1% FS from -5 to 50°C	0.01% full scale	NA
Water clarity	Secchi disk disappearance	m	1-15 m	NA	1 cm	NA – line is measuring tape

NA = not applicable

Laboratory Measurements

Precision and Accuracy

Precision and accuracy of laboratory procedures are ensured by the analysis of quality control (QC) samples including procedural/filter blanks, prepared standards, standard reference samples, where

available, laboratory control samples, laboratory replicates and field replicates, as applicable. Table 4 lists the data quality objectives for each parameter. QC samples and procedures to assess precision and accuracy are described in Section B and Tables 5, 6 and 7 (CCS QAPP Tables 2-3, 2-4 and 2-5). Method procedural blanks for parameters that use blank correction are the batch-average uncorrected method procedural blanks.

Comparability

The Center for Coastal Studies follows strict precision, accuracy, and storage procedures and generates results using comparable methods. Data will be directly comparable to results obtained previously at the same or similar sites in other Cape Cod ponds monitored by CCS because field program design and analytical procedures are similar or identical. In addition, use of written standardized procedures ensures that sample preparation and analyses will be comparable throughout the project and with other projects. The CCS lab routinely performs water quality analyses and provides data to towns and regulatory agencies under EPA- and MassDEP approved QAPPs for other monitoring programs.

Representativeness

Representativeness is addressed in sampling design. The sampling practices and laboratory measurements that will be performed during the water quality monitoring have already been used in many systems to characterize eutrophication and/or microbiological effects on the water column and are, therefore, expected to yield data representative of the study area. Representativeness will also be ensured by proper handling, storage (including appropriate preservation, holding times and temperatures), and analysis of samples so that the material analyzed reflects the material collected as accurately as possible. Deviations from the analytical scheme described in this QAPP will be noted in the laboratory records associated with analytical batches in the QA statements.

Sensitivity

Sensitivity is the capability of methodology or instrumentation to discriminate among measurement responses for quantitative differences of a parameter of interest. The method detection limits (MDLs) provide the sensitivity goals for the procedures as outlined in Table 4. Data users should be aware that precision and accuracy generally degrade as analyte concentrations decrease. While numerical results are being reported down to the MDL, results below the lowest calibration standard will often have precision and accuracy that do not meet the data quality objectives for the project.

Completeness

The lab is expected to successfully analyze 100% of the samples provided. However, a loss of <10% of the samples will not compromise the objectives of the monitoring programs. Contamination or loss of particulate filters is the most common form of lost data. The Tracksheet for Cape Cod Regional Pond Monitoring Activities (Appendix B) will enable the Project Manager, Monitoring Coordinator, and Project Team to track lab tasks as they are completed.

Table 4. Data quality objectives for laboratory analyses. From CCS QAPP.

Parameter	Units	MDL	Expected Range	Accuracy (+/-)	Precision
Alkalinity	mg/L	0.5	0 – 200	80-120 % recovery for QC std. and lab fortified matrix	20% RPD

Ammonia	μM	0.5	0 – 5	80-120 % recovery for QC std. and lab fortified matrix	± 0.1 μM if less than 0.5 μM or 20% RPD if more than 0.5 μM
Nitrite/Nitrate	μM	0.05	0 – 10	80-120 % recovery for QC std. and lab fortified matrix	± 0.1 μM if less than 0.5 μM or 20% RPD if more than 0.5 μM
Ortho-Phosphate	μM	0.02	0 – 3	80-120 % recovery for QC std. and lab fortified matrix	± 0.05 μM if less than 0.1 μM or 20% RPD if more than 0.1μM
Total Nitrogen	μM	0.5	0 – 50	80-120 % recovery for QC std. and lab fortified matrix	20% RPD
Total Phosphorus	μM	0.1	0 – 10	80-120 % recovery for QC std. and lab fortified matrix	20% RPD
Chlorophyll *a*	μg/L	0.02	0 – 50	75-125% recovery for QC std.	± 2.0 μM if less than 15 μg/L or 25% RPD if more than 15 μg/L

A8: Special Trainings/Certification

Preparing volunteers for pond monitoring and sampling.

APCC volunteers will not be trained to do pond monitoring. Volunteers join trained APCC staff members to assist with pond monitoring, for which an orientation session will be conducted in March or April of each year. Field personnel from the Commission and APCC are experienced in using the equipment identified within this QAPP and will be leading each sampling event, meaning volunteers will not need training in advance of sampling, as they will only be providing safety and logistical assistance.

Trained APCC Pond Monitoring Technicians will collect water samples and conduct water quality monitoring with the assistance of volunteers. Volunteer recruitment will be conducted through APCC, Commission and CCS contacts including pond associations, neighborhood associations, and town water quality committees.

All pond monitoring is led by a trained APCC Pond Monitoring Technician, who is joined by a volunteer for each sampling event. The seasonal APCC Pond Monitoring Technician will be trained by APCC QA Officer and Monitoring Coordinator on all sampling procedures during March sampling, before volunteers join the sampling effort. A log is kept of which staff are trained on pond monitoring efforts. Each spring, prior to volunteers joining pond sampling in April, staff from the Commission and APCC will meet to review standard procedures for monitoring lessons learned from the previous year's sampling program, and QA procedures. The results of this meeting are then incorporated into standard operating procedures and communicated with both pond monitoring technicians. Following the initial review of the past season, APCC staff (APCC Program Manager, QA Officer, Monitoring Coordinator, Monitoring Technician, Volunteer Coordinator) will organize an annual orientation meeting for volunteers before monitoring season starts (e.g., March, April), to introduce the program to new volunteers, share findings from previous monitoring data as available, and announce any updates to the general procedures. Additionally, any updates or improvements to the protocols will be finalized. The names of volunteers who attend the orientation meeting are documented and provided with a link to sign up for monitoring sessions.

All attendees of the annual meeting and volunteers that sign up throughout the year are provided with informational resources, e.g., recorded presentations, Secchi disk training materials (lakestewardsofmaine.org), and signup procedures. A list of volunteers who attend the orientation session (live or recorded) is maintained each year.

Laboratory Analyses

The lab analyses specified in Section A6, task 3 conducted by CCS are standard procedures for their lab and thus do not require any specialized training to complete the lab analytical tasks. Lab personnel are experienced in these standard protocols specified in CCS's QAPP for handling, storing, and preparing samples for analysis. If any changes to personnel occur during the project period, CCS will ensure that new employees are trained to meet the standard performance requirements.

A9: Documentation and Records

The Project QA Officer will ensure that all appropriate project personnel have the most current approved version of the QAPP. The APCC QA Officer will develop updates as needed and will provide the updated QAPP to the APCC Scientific Advisor, APCC Project Manager, CCS Manager and Project QA Officer for revision. The Project QA Officer will distribute the updated QAPP via email to the project team members.

The APCC Monitoring Coordinator and QA Officer will ensure that all staff use standard field data forms. Completed hard copy data forms will be scanned into electronic copies. Hard copy data forms and electronic data records will be maintained in both the APCC office and at the Commission.

APCC staff will enter field data into electronic form using a Survey123 database. The field data is exported from Survey123 as a Microsoft Excel file and stored locally on APCC's Share server which is automatically backed up each day. During the sampling season, electronic field data will be emailed to the Commission regularly or uploaded directly as .csv or Microsoft Excel (.xlsx) spreadsheet to the data portal (weekly / monthly). All field datasheets will be filed and archived by year in filing cabinets located in the APCC Office. These files will be maintained in either hardcopy or electronic form for the foreseeable future (at least ten years). The Commission will also maintain electronic forms for the foreseeable future (at least ten years).

The Center for Coastal Studies will provide all lab analyses results to APCC via email or direct upload as .csv or Microsoft Excel (.xlsx) spreadsheet. APCC staff will review the CCS data and will provide the reviewed data to the Commission via email or direct upload as .csv or Microsoft Excel (.xlsx) spreadsheet. Raw data submissions and compiled files are maintained on Commission Microsoft Azure servers which are continuously backed up. Sample metadata are developed upon import and are stored with data in the water quality database.

The primary output of this project is the collection, storage, organization, and dissemination of collected pond water quality data. All sampling records and accompanying metadata will be made available in near real-time via the Cape Cod Regional Water Quality Database to project partners and other end-users. The Regional Water Quality Database and other associated websites will be maintained into the foreseeable future (at least ten years).

Information on data QA/QC processes is provided in Section B10.

Requested citation format:
Cape Cod Regional Pond Monitoring Program (CCRPMP). Data accessed from the Cape Cod Commission's Cape Cod Regional Water Quality website: waterquality.capecodcommission.org; *accessed* 12 October 2012.

Section B: Data Generation and Acquisition

B1: Sampling Process Design (Experimental Design)

The Cape Cod Regional Pond Monitoring Program consists of monthly pond water quality monitoring at a representative set of ponds throughout Cape Cod to generate a regional baseline for pond conditions and identify potential issues that may require remediation or further in- depth monitoring or studies. Monitoring activities will include field monitoring of water quality conditions and collection of water samples for lab analyses. The field monitoring and water quality sampling tasks will be led and managed by APCC and Commission staff who will work with volunteers to obtain water samples. Each pond will be visited once per month during the April 1 to October 30 sampling period and visited in March and November to capture seasonal pond stratification and mixing. March and November sampling are weather and funding dependent, so ponds that have historically already stratified in April will be prioritized for March monitoring and ponds that have not yet mixed in October will be prioritized for November monitoring. Samples will be collected between 7 a.m. and 3 p.m. to maximize phytoplankton activity. Individual sampling dates within the sampling period will be arranged by the monitoring coordinator based on sampler availability, lab schedule, and weather forecasts to maintain representative sampling conditions. See Table 2 for the sampling duration and frequency of the monitoring program.

Ponds were selected for monitoring based on the following criteria, with the goal of sampling a subset of ponds that reflects the range of physical and ecological characteristics displayed throughout Cape Cod's 890 ponds:

- Ponds must have a public access point.
- Ponds were selected to include varying levels of development in their buffer areas, as determined from aerial photography and GIS analysis.
- Pond depth was considered to include deep ponds that stratify seasonally, and shallow ponds that do not stratify (remain completely mixed).
- Ponds with common special characteristics including herring runs, surface inlets or outlets, and ponds with previous remediation efforts were selected where possible.
- Input from towns, pond organizations, the Cape Cod National Seashore, and other entities was gathered to avoid duplication of monitoring effort while accounting for local interest and priorities.
- In the future, other data sets may be used to aid in the selection of additional ponds for monitoring. As specific data sets and criteria are identified, the QAPP will be updated appropriately to include those details.

The goal of the program is to monitor a representative sample of ponds across the Cape that provide insight into regional freshwater pond water quality and how it is impacted by factors including pond size, surrounding land use, land cover, and watershed characteristics.

As the monitoring program is periodically reviewed, information from further GIS analysis and other new data sets will be used to select additional ponds that fill gaps and allow for more representative sampling of different watershed characteristics. Details for that prioritization will be included in subsequent revisions to this QAPP.

B2: Sampling Methods

The field monitoring protocol requires that the deepest area of the pond be located first using a depth sounder. Sampling typically requires a small boat or canoe for access, unless a bridge or boardwalk facilitates safe collection of samples from the designated location. If a sampling location is newly established, GPS coordinates will be established and recorded prior to sampling. For existing sampling locations past coordinates will be used. At each location a pre-calibrated In-Situ Aqua Troll 500 vented instrument is used to measure temperature, pH, dissolved oxygen, turbidity, and conductivity/salinity profiles at regular depth intervals (see Table 5), and a Secchi disk to measure water transparency. Water quality samples will be collected at standardized depths through the water column using Van Dorn samplers or similar sample collection devices according to the following protocol shown in Table 5. All field monitoring is conducted according to the Standard Operating Procedures (SOP) for Field Sampling in Appendix E.

Table 5. Sampling depths based on total pond depth

Sampling Depth (measured from surface)	Overall Pond Depth			
	<3 m	3-9 m	9-11 m	>11 m
0.5 m	2 samples	1 sample	1 sample	1 sample
3 m			1 sample	1 sample
9 m				1 sample
1 m above bottom		1 sample	1 sample	1 sample

Samples will be collected for lab analyses of alkalinity, total phosphorus, total nitrogen, dissolved inorganic nutrients (nitrate+nitrite, ortho-phosphate, ammonium), chlorophyll *a* and phaeophytin at each pond at the water depths specified in Table 5. As detailed in Table 6, a Van Dorn sample is collected, and divided into three subsamples: one for total nitrogen and total phosphorus; one for nitrate/nitrite, ammonia, and ortho-phosphate, chlorophyll *a* and phaeophytin; and one for alkalinity. A minimum of two sets of samples for lab analyses will be collected at each pond. If a replicate is collected two Van Dorn samples will be collected consecutively at the same location and depth and will each be divided into the three subsamples as described before. The first subset of three samples from the first Van Dorn collection will be the "normal" water sample at that depth, the second subset of three from the second Van Dorn collection will be labelled as the field replicate. Electronic data will be stored in the In-Situ instrument memory and is emailed to the APCC Pond Technician in CSV format as soon as WiFi is available. This sampling protocol has been used for citizen-based, volunteer pond water quality monitoring snapshots for 22 years on Cape Cod and the consistency of this approach provides a valuable comparison between the ponds in the present study and other southeastern Massachusetts ponds that are in the same ecoregion.

Table 6. Sample collection and storage for lab analysis samples.

Parameter	Sample Container	Analytical Sample Volume per analyte	Sample Processing	Maximum Holding Time to Analysis

Total Nitrogen Total Phosphorus	125 ml HDPE bottle	125 ml	Decant into 125 ml polypropylene bottle and freeze until analysis.	28 days
Nitrate/Nitrite Ammonia Ortho-phosphate	1-L wide-mouth HDPE bottle	80 ml	Decant into 1-L polypropylene bottle. Refrigerate until analysis - unless laboratory staff instructs otherwise.	28 days
Chlorophyll *a* Phaeophytin		100 – 500 ml		28 days
Alkalinity	250 ml wide-mouth HDPE bottle	250 ml	Decant into 250 ml wide-mouth bottle until bottle is filled to the brim. Refrigerate until analysis - unless laboratory staff instructs otherwise	24 hours

Total Nutrients (Nitrogen and Phosphorus)

Water from the Van Dorn sampler will be decanted into a cleaned, pre-labeled 125 ml polypropylene container. This container will receive a triple rinse with pond water from the Van Dorn sample before being filled with sample water. The container will be stored in a cooler until it can be transferred to the lab where it will be analyzed or frozen within 8 hours. Samples will be processed according to CCS SOP for total nitrogen and phosphorus.

Dissolved Inorganic Nutrients (Ammonia, Nitrate/Nitrite, Orthophosphate)

Water from the Van Dorn sampler will be decanted into a cleaned, pre-labeled 1-L polypropylene container. This container will receive a triple rinse with pond water from the Van Dorn sample before being filled with sample water. The sample will be stored in a cooler until it is transferred to the lab within 8 hours of sample collection. Samples will be processed according to the CCS SOP for dissolved inorganic nutrients. Using a 60-ml syringe, sample water will be drawn up from the transfer bottle (1-L polypropylene container) and filtered through a 0.4 um-membrane filter into a 100-ml pre-labeled Whirl Pak. Syringes and filter holders are acid washed and rinsed three times with Milli-Q water before filtering begins and rinsed 3 times with Milli-Q water and 3 times with sample water between each sample. Filtered samples are stored in the freezer until analysis.

Chlorophyll *a* and Phaeophytin

Samples for chlorophyll *a*/phaeophytin determination will be collected in the same dark HDPE pre-cleaned 1-liter bottles as the dissolved inorganic nutrients and transferred to the lab in a cooler with ice packs (4°C) within 8 hours. Samples will be processed according to CCS SOP for chlorophyll *a*/phaeophytin. Sample water will be filtered in the lab as soon as possible.

Alkalinity

Water from the Van Dorn sampler will be decanted into a cleaned, pre-labeled 250 ml polypropylene container which is filled to the very top, leaving no room for air. This container will receive a triple rinse with pond water from the Van Dorn sample before being filled with sample water. The sample will be stored in a cooler until it is transferred to the lab and stored in the refrigerator within 8 hours of sample collection. Samples will be stored in the refrigerator until they are processed according to the CCS SOP for alkalinity.

Field and lab notes

All field notes and in-situ data are recorded on field datasheets (Appendix F). Data recorded in the field are scanned within one week of the sampling event and entered into a Survey123 database by APCC's monitoring staff on a monthly basis. Lab filtration notes including staff names, sampling and filtration dates, volumes filtered, and any other pertinent information are recorded on lab datasheets and filed for future reference. Electronic field data are stored and backed up on APCC's share server.

B3: Sampling Handling and Custody

Samples will be divided and frozen; or transferred to dark HDPE acid-washed 1- liter bottles and transported by the volunteers and or APCC's Monitoring Coordinator in coolers with ice packs (4°C) from the sampling site to the CCS lab. Replicate quality assurance (QA) samples will be collected and analyzed for 10% of samples collected during the sampling period. All samples will be frozen or delivered to the lab within six (6) hours of collection or within eight (8) hours of collection if the cooler temperature has been maintained at 4° Celsius or less. See Appendix F for Field Monitoring and Chain-of-Custody Forms.

Sample Bottles: The Center for Coastal Studies provides pre-cleaned polyethylene bottles to APCC's Monitoring Coordinator prior to sampling. The top and side of all bottles are labeled by APCC, including the organization's name, date sample was collected, and site ID.

Chain of Custody: The Field Monitoring and Chain-of-Custody Forms are included in Appendix F. The Chain of Custody form is included with the samples upon delivery to CCS and a copy is filed with APCC's records. It includes relevant information including the date and time of delivery, the pond name and location, who retrieved the samples at the delivery site, the number of samples, cooler ID, cooler temperature and a list of the sample ID's included in the delivery. See Table 6 for holding times. If samples surpass recommended holding times, the respective data are flagged as suspect (for this and additional sample handling information, see the CCS QAPP (Appendix G).

Field and lab notes: All field notes and in-situ data are recorded in the Field Monitoring and Chain-of-Custody Form (Appendix F). The completed form is photographed in the field before enclosing a copy with the samples to be sent to the lab. Data recorded in the field are entered into an electronic spreadsheet (Microsoft Excel 2007) within one week of the sampling event. CCS lab notes including staff names, sampling and analysis dates, sample IDs and any other pertinent information are recorded on lab datasheets and filed for future reference. Both APCC and CCS network servers are automatically backed up weekly.

B4: Analytical Methods

Laboratory analyses for dissolved inorganic nutrients, total nitrogen, total phosphorus, alkalinity, chlorophyll *a* and phaeophytin in collected pond water samples are conducted at the CCS laboratory. All lab analyses are conducted according to the CCS Laboratory QAPP (Appendix G).

A brief description of the analytical methods is provided below. Table 7 summarizes the methods used for sample analysis. The analyses will be conducted as described in the SOPs listed, which are based on literature references or EPA methods. For more information regarding waste disposal, corrective actions, etc., refer to the Appendix G. When an analytical system failure occurs, the CCS Program Manager or Laboratory Manager contacts the data recipient (Commission) immediately. Corrections are made to the data and equipment as necessary. Personnel involved in multiple errors or equipment failures are re-trained and must re-qualify for that assay.

Table 7. Methods for analysis of total nitrogen, total phosphorus, chlorophyll *a*, phaeophytin, and alkalinity.

Parameter	Units	Instrument	SOP/Analysis Method
Total nitrogen	µmol/L	Lachat QuikChem 8500 Series 2 FIA System	SOP 007 & 008/USGS 03-4174
Total phosphorus			SOP 007 & 009/USGS 03-4174
Nitrate/Nitrite	µmol/L	Astoria 2 Autoanalyzer	SOP 004/EPA 353.2
Ammonium			SOP 006/EPA 350.1
Ortho-phosphate			SOP 005/EPA 365.5
Chlorophyll *a* Phaeophytin	µg/L	Turner Trilogy	SOP 003/Modified EPA 445.0
Alkalinity	mg/L	Metrohm 855 Titrando	SOP 015/EPA 310.1

Dissolved and Total Inorganic Nutrients

The analyses of dissolved inorganic nutrients are based on the cited EPA methods. Dissolved inorganic nutrient concentrations are determined for samples that have been passed through a 0.4-µm pore size membrane filter. The concentrations of nitrate/nitrite, ortho-phosphate, ammonia, silicate, total nitrogen and total phosphorus are measured colorimetrically on an Astoria 2 Autoanalyzer. This instrument automates standard manual techniques for analysis of nutrients.

- For analysis of total nitrogen and total phosphorus, an alkaline persulfate digestion oxidizes all forms of inorganic and organic nitrogen to nitrate and hydrolyzes all forms of inorganic and organic phosphorus to ortho-phosphate. After digestion, sample analysis for total nitrogen and total phosphorus proceeds as described below for nitrate/nitrite and ortho-phosphate respectively.
- For nitrate/nitrite analysis, nitrate in the sample is reduced quantitatively to nitrite by cadmium metal in the form of an open tubular cadmium reactor. The nitrite thus formed plus any originally present in the sample is determined as an azo dye at 540 nm following its diazotization with sulfanilamide and subsequent coupling with N-1-naphthylethylenediamine. These reactions take place in an acidic solution.
- For analysis of ortho-phosphate, the ortho-phosphate in the sample reacts with molybdenum (VI) and antimony (III) in an acidic medium to form a phosphoantimonylmolybdenum complex. This complex is subsequently reduced by ascorbic acid to a heteropolyblue with an absorbance maximum at 880 nm.

Chlorophyll *a* and Phaeophytin

Samples for chlorophyll *a*/phaeophytin are processed according to EPA Method 445.0 using a Turner Trilogy Fluorometer. Samples are put on ice immediately after collection and then filtered in the CCS lab as soon as possible through Whatman 4.7-cm-diameter GF/F using a vacuum pump at a vacuum no greater than 6 inches Hg. The final volume, typically between 100 to 500 ml for most ponds, will result in a light green/brown residue on the filter. Using forceps, the filter will be removed from the filter holder, folded in half, and blotted on acid-free blotting paper to remove excess moisture. Filters are then stored at -10ºC until analysis. All handling steps are performed in subdued light. The chlorophyll *a*/phaeophytin is extracted from the cells retained on the GF/F filter by a 16-24-hour step in 90% acetone at 4ºC. The extract is analyzed using a fluorometer. 150 µL of 0.1 N HCl is added to the extract and the extract is remeasured after 90 seconds to determine phaeophytin concentrations.

Alkalinity

Samples for alkalinity are processed according to EPA Method 310.1 using a Metrohm Titrando 855 auto-titrator. Samples must be stored at 4º C in the dark and analyzed with 24 hours of collection or preserved with a saturated mercuric chloride solution and stored in a narrow mouth borosilicate glass necked bottle sealed with a ground borosilicate glass stopper coated with Apiezon high vacuum grease. Samples are then titrated to an electrometrically determined end point of pH 4.5 using H_2SO_4.

Finalized data are received from CCS on an annual basis according to the Schedule. Please refer to the CCS QAPP for their analysis procedures and quality control steps (Appendix G).

B5: Quality Control

Data quality objectives for the CCRPMP are described above in Section A7. Analytical methods for lab analyses are described above in Section B4. The Commission, APCC, and CCS will follow the procedures and data quality objectives outlined above in Sections A7, B4 and here in B5 in order to ensure quality data are collected.

Field measurements

Representativeness

To ensure representativeness, field blanks will be collected every sampling day and subject to all analysis

procedures that use blank correction, including reporting, to ensure sampling and lab procedures are not adding bias to results. Any abnormal or episodic conditions that may affect the representativeness of sample data are noted on the field datasheet and maintained as metadata in the Excel spreadsheet containing data.

Precision and Accuracy

To ensure accuracy of the In-Situ Aqua Troll 500 sonde, each year the In-Situ instruments are sent to the manufacturer for calibration. Each week during the monitoring season the In-Situ sensors are calibrated using standard solutions according to manufacturer instructions and MassDEP WPP's Programmatic QAPP Table 2. See Table 3 in Section A7 for data quality objectives for In-Situ parameters (pH, temperature, specific conductivity/salinity, turbidity, and dissolved oxygen). See Section B for more information regarding standard operating procedures for equipment calibrations.

Sampling precision is ensured by obtaining replicate water samples for analyses:

- Replicate field samples are required for approximately 10% of samples for each sampling run at a pond. A unique identifier will be assigned to the replicate and noted in the Field Monitoring and Chain-of-Custody Form (Appendix F). To determine when replicate field samples are collected Monitoring Technicians forecast the upcoming 10 samples and use a random number generator to select 1/10.
- Replicate samples are collected from the same sample collection depth. Replicate samples are obtained by consecutively collecting two separate samples with the Van Dorn sampler at the same depth and filling two sets of three sample bottles, with one set of three bottles being filled from the first Van Dorn sample collection and the second set of three bottles being filled from the second Van Dorn sample collection. Upon receipt of field replicate results, the QA Officer will review to ensure samples are within an acceptable range, normally ±20%.

Comparability

The comparability of project data to previously collected pond data will be ensured by using the same protocols and by following these established protocols. This will ensure that all new samples are collected following the same procedure and approach and are assayed by the same methods as in the prior surveys:

- Documenting sampling sites, times and dates and sample transfer to the lab on the Field Monitoring and Chain-of-Custody Forms (Appendix F). No samples will be accepted at the CCS lab without a chain-of-custody form.
- Results can be compared to historical data from that station collected during the same season.
- Detailed and complete sample records including the Field Monitoring and Chain-of-Custody Forms (Appendix F) will be maintained.
- Final reports detailing data and conclusions may be published and posted by the Commission.

Completeness

The Cape Cod Regional Pond Monitoring Program data are considered complete when at least 80% of the planned sampling events occur successfully. Missing data occurs primarily when poor weather conditions (e.g., high winds, storms, lightning, extreme heat) prevent sampling activities. Every effort is made to find a substitute when staff or volunteers are unavailable. Tracking of planned and executed sampling events will be carried out by the APCC Monitoring Coordinator, assisted by Commission staff, using a CCRPMP Pond Monitoring Excel spreadsheet for that year. Calculation of percentage of executed sampling events will be done by dividing the actual number of executed sampling events by the planned number of sampling events for that year and multiplying by 100. The Tracksheet for Cape Cod Regional

Pond Monitoring Activities (Appendix B) will be maintained and utilized to evaluate completeness of sampling.

Laboratory analyses quality control

As further detailed in the CCS QAPP (Appendix G), both the Laboratory Manager and the QA Officer will review data to determine if it meets the quality assurance objectives. Decisions to qualify or reject the data will be made by the Laboratory Manager and the QA Officer and if required, corrective actions will be implemented as outlined in the QAPP. Tables 8, 9, and 10 provide the lab quality control measures and response actions to ensure that lab analyses meet data quality objectives specified earlier in Section A7 and Table 4.

Table 8. Laboratory Analytical QC for Total Nitrogen, Total Phosphorus, Nitrate+Nitrite, Ortho-Phosphate, and Ammonia.

QC	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person Responsible for Corrective Action	Measurement Performance Criteria
Method Blank	1 per set of 20	< MDL	Re-run	Lab Manager	< MDL
Reagent Blank	1 per set of 20	< MDL	Re-run	Lab Manager	< MDL
Laboratory Duplicate	10% of samples	90-110% recovery	Re-run	Lab Manager	90-110% recovery
Internal Standards*	1 per set of 20	90-110% recovery	Re-run	Lab Manager	90-110% recovery
External Standards**	1 per set of 20	90-110% recovery	Re-run	Lab Manager	90-110% recovery

***Internal standard:** a known amount of a standard added to a test portion of a sample and carried through the entire determination procedure as a reference for calibrating and controlling the precision and bias of the applied analytical method.

****External standard:** USGS Standard Reference Nutrient Samples

Table 9. Laboratory Analytical QC for Chlorophyll *a* and Phaeophytin.

QC	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person Responsible for Corrective Action	Measurement Performance Criteria
Method Blank	1 per set of 20	< MDL	Re-clean, re-run	Lab Manager	< MDL

Instrument Blank	1 per set of 20	< MDL	Re-clean, re-run	Lab Manager	< MDL
Laboratory Duplicate	10% of samples	<20%RPD	Qualify	Lab Manager	<20%RPD
External Standards*	1 per set of 20	90-110% recovery	Qualify	Lab Manager	90-110% recovery

***External standard:** either a liquid primary chlorophyll *a* standard provided by Turner Designs or a solid secondary standard.

Table 10. Laboratory Analytical QC for Alkalinity.

QC	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person Responsible for Corrective Action	Measurement Performance Criteria
External Standards*	1 per set of 10	90-110% recovery	Re-run	Lab Manager	90-110% recovery

***External standard:** Fresh water: USGS Standard Reference Alkalinity Samples: The U.S. Geological Survey (USGS) conducts an inter-laboratory comparison study semiannually. This project provides a variety of Standard Reference Samples (SRSs) for laboratory quality assurance testing and are available to purchase for internal quality control. The majority of samples are prepared with water from Colorado streams and spiked with reagent grade chemicals to measurable concentrations. Samples from the most recent round are run blind. Samples from previous rounds of known concentration are used as a QC check.

Data validation, reporting and verification

As detailed in the following excerpt from the *Quality Assurance Project Plan for Regional Collection and Analysis of Cape Cod Water Resources*, basic and extended data validation is performed when data is imported into the regional water quality database.

Basic data validation is performed upon import to verify that incoming data matches the WISKI database hierarchy. The WISKI software will produce error messages and restrict import for any entries that are not formatted correctly (i.e. text in a numeric field, invalid characters, impossible parameter values, etc.), for sample locations that are not established in the system or associated with the monitoring program being imported, and for parameters that are not measured by the current program. Extended data validation additionally flags any values that are accepted for import where a value already exists in the database and require the database administrator to specify for each value whether to accept or reject the proposed change.

Basic and extended data validation prevents unintended changes to database values due to incorrect sample labeling, typographic errors, value transposition, and other common data issues. Values that fail import are logged, and the database administrator will be responsible for checking the source data and conferring with the appropriate project partner(s) to determine the source of the errors.

Analytical Methods

Data Evaluation: Both the Laboratory Manager and the Project QA Officer will review data to determine if it meets the quality assurance objectives (Tables 4, 7, 8) Decisions to qualify or reject the data will be made by the Laboratory Manager and the QA Officer and if required, corrective actions will be implemented as outlined in Tables 7 and 8.

B6: Instrument/Equipment Testing, Inspection and Maintenance

The In-Situ Aqua Troll 500 sonde is used for in-situ readings during pond sampling events. It is maintained by the APCC Monitoring Coordinator following In-Situ manual instructions. The unit, including temperature, specific conductivity/salinity, pH, ORP, turbidity and dissolved oxygen sensors, is calibrated at least weekly (certain sensors e.g. DO, temperature are calibrated more frequently) and the calibration logs are saved on the lab computer hard drive. Batteries and probes are replaced as necessary. Ordering parts is the responsibility of the Monitoring Coordinator.

If there are errors or unacceptable readings during the calibration process, the sensor is removed from its port, checked for damage, cleaned, and reinserted. In the case of pH, probes are “reconditioned” (soaked in 1:1 bleach and tap water for half an hour and then soaked in tap water for one hour) quarterly (i.e., every three months). The electrode is also replaced as needed to maintain readings within data quality objectives (DQOs). If the cleaning or other maintenance does not resolve the problem, the probe and calibration solution are replaced and the calibration for that parameter starts over. The failed probe is sent to In-Situ technical support for inspection and repair.

Pond sampling kits are comprised of one smart phone with the downloaded VuSitu app, In-Situ Aqua Troll 500 sonde, clipboard with datasheet, Van Dorn sampler, Secchi disk, AquaView, depth finder, and cooler containing sample bottles. The APCC Monitoring Coordinator maintains these kits, repairing and replacing broken or missing parts as necessary. There is one additional backup In-Situ instrument, which is also calibrated at most a week before use and maintained annually, in case problems arise. The APCC Monitoring Coordinator is responsible for ordering calibration solutions and replacement parts as needed.

If there is an error or unacceptable reading during calibration, the probes are removed, cleaned, and reinserted. Calibration resumes in new uncontaminated solution. If dissolved oxygen shows errors or has drifted substantially since the previous month (more than 25%) and cleaning and maintenance do not solve the problem, the probe is replaced and the faulty one is sent to In-Situ technical support for inspection and repair.

Pond monitoring volunteers will be trained by the APCC pond monitoring technician in the field on how to assist with monitoring procedures. Volunteers may attend an annual orientation meeting held in early spring before the sampling season (e.g., March, April, see Schedule) for reminders and protocol updates, as well as general information for new volunteers. For safety reasons sampling will always take place in teams of two, with at least one person in the field team being an APCC staff member. This creates a great educational opportunity for volunteers, as any adult can sign up to volunteer without prior training and without needing to make a long-term commitment.

B7: Instrument/Equipment Calibration and Frequency

Field monitoring

The In-Situ Aqua Troll sonde is maintained regularly and the probes on the instrument are calibrated following manufacturer’s specifications and MassDEP WPP’s Programmatic QAPP Table 2 prior to taking

the equipment into the field for measurements (at least 1 time per week). If personnel calibrating the equipment notice sensors are not calibrating properly or are otherwise functioning outside specified manufacturer guidelines, the sensors will be sent to the manufacturer for recalibration.

All water sampling equipment should be visually inspected prior to use to ensure it has been properly cleaned and decontaminated with deionized water and/or kept clean prior to use. Sample bottles from the lab should remain closed and clean of debris.

Laboratory analyses -- see CCS QAPP for instrument calibration procedures (Appendix G). These are copied here.

Instrument calibration for lab analyses of Nutrients (nitrate+nitrite, ammonium, ortho-phosphate, total nitrogen (TN), and total phosphorus (TP)

At least 6 working calibrants for each chemistry will be prepared from certified standards to cover the concentration range of the samples to be analyzed. The calibrants are run at the beginning of the analyses, and a calibration curve is fitted. If the correlation <0.995, new calibrants will be prepared, and calibration will be re-done. See SOPs for more detail. Standards are supplied from Astoria Pacific. Each standard is labeled with concentration and expiration date. Standards are stored at room temperature. Working calibrants of concentrations >100 µM are prepared weekly and stored at 4°C. Working calibrants of concentrations <100 µM are prepared daily.

Instrument calibration for lab analyses of Chlorophyll *a* and Phaeophytin

The laboratory fluorometer is calibrated at the beginning of each monitoring season with 2 liquid pure chlorophyll *a* standards and reagent. At the time of calibration, a solid secondary standard is also analyzed and the formula for calculating chlorophyll *a* in samples is determined. The solid secondary standard is analyzed with each batch of samples. Blanks of 90% acetone, and an unused filter extracted with 90% acetone are set up with each rack of samples.

Instrument calibration for lab analysis of Alkalinity

The laboratory Metrohm 855 Titrando is calibrated immediately prior to measuring samples. The pH electrode is calibrated using a 3-point calibration. The calibration slope should be 97.5 - 102.5 % to be acceptable. If it falls outside of this range change buffer solutions and redo. If it still falls out of this range with new buffer solution, service electrode.

B8: Inspection/Acceptance of Supplies and Consumables

Field monitoring supplies

The APCC Monitoring Coordinator will ensure that necessary supplies and calibration standards are maintained at the APCC monitoring center. Supplies must be ordered and received ahead of when the items will need to be consumed. The quantity and timing of procurement is managed to ensure that expiration dates are not exceeded, and all supplies meet high quality standards. Upon receipt of materials, the APCC Monitoring Coordinator or designated APCC staff signs the packing slip with the date of receipt. The signed packing slip is scanned for an electronic copy. One hard copy of the signed packing slip is filed in the APCC Monitoring Coordinator's file cabinet and a scanned copy is saved to the project files on the APCC server. A second hard copy is filed in the APCC grant manager's office, and a

scanned copy is stored in the grant manager's files on the APCC server, which is backed up weekly.

Supplies are inspected upon receipt and the date of receipt is labeled on the bottle or box. Any obviously damaged or contaminated supplies are rejected and returned. The date the bottle or individual package is opened for use is also marked on the bottle or box. All calibration certificates are filed in labeled folders in the lab office. All standards, chemicals, and materials are handled and stored properly according to the respective Material Safety Data Sheets (MSDS).

APCC will provide life preserver vests and sampling gloves for volunteers as needed. Sample bottles and labels will be provided by CCS and conform with their QAPP and standards.

B9: Non-Direct Measurements (i.e., secondary data)

Data collected before the approved QAPP may not meet the same stringent standards as the current design. However, all data included in the regional database will undergo another phase of QA as part of the data transfer process. Measurements are compared against historical means for each sampling location, and any values outside three standard deviations from the mean are flagged as suspect and reviewed against raw data and field sheets to identify potential data transcription errors or anomalous field conditions that would disqualify the data. Any suspect data will flagged and while maintained in regional database will not be viewable in the data portal. In regard to outputs, any analyses which include data collected before the EPA QAPP approval will be labeled accordingly and any online or paper reports will include a disclaimer describing the use of historical data and any potential biases therein. Additionally, all data collected before the QAPP approval will be highlighted in such a way that the user understands where there may be variability in data quality.

As detailed in section B1, the presence or absence of historical monitoring data (which is considered secondary data) may be used as a criterion for selecting which ponds will initially be monitored. At this time however, the secondary measurements themselves are not anticipated to play a role in the selection of ponds for monitoring.

Future expansion of the pond monitoring program beyond the April through October timeframe to include monitoring in March and November will be based upon CCRPMP data from the previous year (2023). Ponds that were stratified prior to the April 2023 monitoring and maintained stratification in October 2023 will be monitored in subsequent years (2024 and 2025) from March through November. Ponds are considered stratified if the temperature in the water column changes more than one degree per one meter.

In the future this expansion to additional ponds may also rely on other secondary data sources, e.g., analysis of remote sensing imagery. When applicable, the QAPP will be updated to appropriately detail those data sources and analysis methods, and how they will be used to determine additional ponds for monitoring.

B10: Data Management

Water quality field data collected by APCC and volunteers will be documented on the field datasheet and the Chain of Custody form. Chain of Custody form will be photographed in the field prior to being sent to the lab with the water samples. APCC staff will upload the photographs of the Chain of Custody forms to the APCC server after returning from the field. APCC staff will scan field datasheets on a weekly basis and file the hardcopy. These will serve as the electronic versions of the field datasheets. APCC's Monitoring Coordinator will enter field data into a Survey123 database while providing an initial QA/QC

review. A secondary review will be performed by the APCC QA Officer by exporting the data from Survey123 as an excel sheet and graphing the data, looking for outliers. After a third review by the APCC Program Manager, following corrections or comments, QA/QC checked field data will be sent to the Commission in electronic form (xlsx, csv) or uploaded directly into the water quality portal.

At the CCS lab, nutrient data are reviewed for primary QA/QC. Once the reviewed data is considered acceptable by the lab, it is transmitted to the Commission and imported into the Regional Water Quality Database.

All field and lab data will be retained in electronic copy on the Commission's Regional Water Quality Database. Pond field monitoring data will be imported into the Microsoft SQL database using automated procedures. The staff provides another QA/QC by identifying data which are missing, incomplete, or outside normal ranges. Errors are removed from the final dataset and metadata notes are entered into the excel spreadsheet containing data. Additionally, automated QA/QC will flag any data point that is outside a ten-year standard deviation as suspect.

Section C: Assessment and Oversight

This section addresses the activities for assessing the effectiveness of the implementation of the quality assurance and quality control activities. The purpose of the assessment is to ensure that QAPP is implemented as described.

C1: Assessments and Response Actions

Field monitoring

The APCC Monitoring Coordinator is responsible for ensuring that In-Situ instrument calibrations and rotations meet the expectations described in the QAPP. The data quality downloaded from the VuSitu app is also evaluated by the APCC QA Officer on an annual basis. The APCC QA Officer is responsible for noting degraded data quality and relaying those observations to the Project Manager, the APCC Program Manager and APCC Monitoring Coordinator. In a case of reduced data quality or completeness, the Project Manager and APCC Monitoring Coordinator must take action to resolve the issue (e.g., retraining staff, allocating funds to replace failing equipment, maintaining or repairing equipment, etc.). All questionable data will be flagged as necessary in the database by adding a quality code/comment in a separate column, and any equipment issues will be reported in the metadata.

The APCC Monitoring Coordinator and APCC QA Officer, with assistance from the Commission, supervise and train all APCC Pond Monitoring Technicians. The Monitoring Coordinator will work with the Seasonal Pond Monitoring Technician to review field monitoring data and to recognize issues as they arise after each monitoring event. The APCC QA Officer reviews the progress and data quality of the technicians to ensure completeness and accuracy after each sampling event. The Monitoring Coordinator will communicate issues to and work with the APCC QA Officer to determine whether the issues or problems are due to equipment, human error, or natural processes (e.g., storms) and decide on response actions. The APCC QA Officer will address corrective actions involving equipment and the monitoring team. If errors, missing data or other issues are due to human error, the APCC QA Officer and/or APCC Program Manager will meet with the technician whose work is in question to address the problem and resolve the issue with the help of the APCC Scientific Advisor if needed. When field data does not pass QA/QC checks, efforts will be made to collect a replacement sample at the location in question.

Lab analyses

Water samples collected for lab analyses will be reviewed by the CCS lab. If a problem is identified, the CCS Associate Scientist, who oversees the water quality analytical lab, will take the necessary steps towards resolving the issue. All questionable data will be flagged or removed in the database as necessary and all actions taken will be reported in the metadata.

The CCS Associate Scientist oversees the CCS task of analyzing pond samples. The CCS Lab Coordinator is responsible for processing the samples as dictated by the SOPs and QAPP. Data generated by the CCS is under constant review through regular QA/QC checks.

Corrective actions identified in the CCS QAPP Section 2.7. are as follows: If results from any analyses of QC checks are unacceptable, corrective actions will be taken as described for lab SOPs. Whenever possible, analyses will be re-run with new QC checks. If results are still unacceptable, the instrument will be re-calibrated according to manufacturer's instructions. The Lab manager is responsible for all corrective actions. The Project QA Officer must also be consulted. All corrective actions will be documented in the lab notebook. See Tables 7 and 8 for lab corrective actions.

If corrective actions do not resolve the issue, the CCS Lab Director documents this and notifies the CCS Associate Scientist who will relay the finding along with the data. The data are reviewed by the CCC QA Officer at least once a month. If the data do not meet data quality objectives in this QAPP through no fault of the lab, the CCC QA Officer will notify the Project Manager who will notify Project Team members (i.e., Commission, APCC and CCS) as needed to remedy the issue or be made aware of the issue. All questionable data will be flagged as necessary in the database and all actions taken will be reported in the metadata.

C2: Reports to Management

Data collection and assimilation will be ongoing while the CCRPMP is active. Updates regarding the project's progress, performance evaluation, and data quality assessments will be prepared annually and posted to the Commission's website and linked from the Regional Water Quality Database. Any applicable changes to the scope and frequency of pond monitoring in the future, as well as corresponding changes to the frequency of reporting actions will be reported detailed in subsequent revisions to the QAPP.

APCC provides a year end summary to the Cape Cod Commission as part of its monitoring contract with Barnstable County, and an annual report to the Massachusetts Department of Conservation and Recreation according to the research permit for Cliff Pond monitoring. The Cape Cod Commission will include updates on the monitoring program as a component of its semi-annual reports to SNEP under EPA grant 00A01147-0, and its final report at the close of the grant in 2026.

Section D: Data Validation and Usability

This section addresses the QA activities that occur after the data collection of the project has been completed. Implementation of these elements ensures that the data conform to the specified criteria and achieve the project objectives.

D1: Data Review, Verification, and Validation

QA/QC of the Cape Cod Regional Pond Monitoring data occurs in four phases: 1) field data review by the Seasonal Monitoring Technician who enters the data followed by review by the APCC Monitoring Coordinator; 2) field data review by the APCC QA Officer; 3) field data review by the APCC Program Manager; 4) lab data review by the CCS Lab Coordinator and Associate Scientist, 5) all data review by the Commission Project QA Officer and Project Manager.

During the first phase, the Seasonal Monitoring Technician will highlight missing or suspect data for the APCC Monitoring Coordinator to investigate further. Suspect data includes nonsensical readings (e.g., decimal place error or data entered in the wrong column on the datasheet) and readings outside the normal range. If the mistake is obvious and the error can be corrected, the Monitoring Coordinator will correct the data point in the electronic database and make a note on the datasheet. If the error cannot be corrected, the Monitoring Coordinator will make a note on the datasheet and communicate it to the APCC QA Officer.

During the second phase, the APCC QA Officer will review all field data to check for data quality objectives relating to representativeness, accuracy, precision, and completeness. Missing or suspect data will be flagged, and corrective actions will be implemented as needed to address issues that can be addressed (with the exception of natural events or events outside the control of APCC and volunteers). Field sampling and chain-of-custody forms (Appendix F) will be reviewed, any errors or omissions noted, and corrective actions identified. After review by the APCC Program Manager, a summary of field data QA activities and findings will be provided in electronic form (Word and/or Excel format), to be sent to the Project QA Officer.

During the third phase, the CCS Associate Scientist and Lab Coordinator will conduct a review of all lab QA/QC checks including lab blanks, duplicates, spikes, and recoveries. If the data does not meet the QA standards as described in the QAPP, the data affected are rejected. The CCS Lab Coordinator and Associate Scientist will identify and flag data that do not meet QA/QC checks when sending the final electronic files to APCC.

During the fourth and final phase, the Project QA Officer will review all electronically entered data provided by APCC and CCS by visually scanning the datasets, graphing, and/or automated statistical outlier procedures used as part of the Regional Water Quality Database. Each parameter is analyzed against previous years' data to locate outliers or unusual trends. Data that do not pass the quality criteria and assurance standards as described in the QAPP, are flagged as suspect or removed from the final database. These omitted data may be a result of a data recording error, inaccurate equipment calibration, contaminated sample, failed laboratory instrument, or events outside the control of the project (e.g., storm, pandemic-related shutdown, etc.). In these rare cases, the removed data is acknowledged and explained in the accompanying metadata.

D2: Verification and Validation of Methods

As part of the verification and validation process, the field sampling and lab analytical methods are also under review to ensure that the results meet QAPP standard requirements. Chain-of-custody records

must be on file to document the exchange of samples between sampling staff, APCC project staff, and the CCS lab before payment is approved by the Project Manager. These chain-of-custody records are managed by the APCC Monitoring Coordinator and APCC QA Officer and are reviewed by the Project Manager. If samples are missing, the chain-of-custody records also document who is responsible for the missing samples, and the supervising authorities of the responsible party will seek the necessary corrective measures.

Additionally, during periodic QA/QC checks, all calibration logs for the field In-Situ sonde are reviewed by the APCC Monitoring Coordinator and APCC QA Officer, and all calibration logs for CCS lab analytical instruments are reviewed by the CCS Lab Coordinator. Calibration logs are also reviewed by the Project QA Officer. By regularly checking the calibration logs, any drift or problematic symptoms associated with the equipment can be detected and resolved early. It is the responsibility of APCC and CCS to detect and resolve any equipment issues. If equipment needs to be replaced or repaired, the Project Manager is notified to approve funds.

The end users of the data will have access to metadata through the Regional Water Quality Database, which outlines any problems associated with data points and the measures taken to remedy those issues. Data which may have been impacted by poor sample handling or equipment calibrations are handled in accordance with the QAPP. Thus, the end user receives data which meet all performance standards and can be applied as intended for research and local decision-making.

D3: Reconciliation with User Requirements

The Ponds data will be reviewed for precision, accuracy, completeness, representativeness, sensitivity, and comparability by the Commission, APCC and CCS through the QA/QC methods described above. If the data meet the quality criteria as described in Section A, then the Commission will incorporate the data into the Cape Cod Regional Water Quality Database, which is the main objective of this project. Additional detail regarding the data, analysis, and users of the database can be found in Appendix I, *Quality Assurance Project Plan for Regional Collection and Analysis of Cape Cod Water Resources.*

If some of the data do not meet these standards, those measurements will be flagged as questionable data, which is not viewable in the online portal but can be downloaded from the database with corresponding metadata. If the pond water quality results are found to be insufficient to meet data use needs, the sampling design and/or methods will be revised for the following season. Any proposed QAPP revisions will be submitted to EPA for approval.

Additionally, for historical data collected before the approval of the QAPP, the use of those data will be more limited and in cases where they are used for analysis or interpretative tools, the reduced confidence of those findings will be acknowledged online and in written reports.

References

Association to Preserve Cape Cod. 2020. State of the Waters: Cape Cod. See: www.capecodwaters.org

Center for Coastal Studies. 2023. Laboratory Quality Assurance Plan, April 2023.

Cape Cod Commission. 2015. Section 208 Areawide Water Quality Management Plan for Cape Cod. See: https://www.capecodcommission.org/our-work/208

Cape Cod Commission. Cape Cod Ponds and Lakes. See: https://www.capecodcommission.org/our-work/ponds-and-lakes/

Cape Cod Commission. Freshwater Initiative. See: https://www.capecodcommission.org/our-work/cape-cod-freshwater-initiative/

Cape Cod Commission. Cape Cod Ponds and Lakes Restoration Projects. See: https://www.capecodcommission.org/our-work/cape-cod-freshwater-ponds-restoration-projects/

Cape Cod Groundwater Guardians project. Ponds and Lakes Stewardship program. See: https://www.capecodgroundwater.org/ponds-estuaries/stewardship-program/

Eichner, E. State of Cape Cod Ponds and Lakes. Presentation at Cape Coastal Conference. See: http://www.waquoitbayreserve.org/wp-content/uploads/02_Eichner_State-of-Cape-Cod-Ponds.pdf

Environmental Protection Agency. 2001. EPA Requirements for Quality Assurance Project Plans. EPA QA/R-5.

Environmental Protection Agency. EPA R-5 Checklist for Review of Quality Assurance Project Plans.

Environmental Protection Agency. 2010. New England Quality Assurance Project Plan Program Guidance. EQAQAPP2005PG2.

Massachusetts Department of Environmental Protection. Massachusetts Year 2022 Integrated List of Waters. See: https://www.mass.gov/lists/integrated-lists-of-waters-related-reports#final-2022-integrated-list-of-waters-

Massachusetts Department of Environmental Protection. Massachusetts Year 2018-2020 Integrated List of Waters. See https://www.mass.gov/info-details/massgis-data-massdep-20182020-integrated-list-of-waters-305b303d

Massachusetts Department of Environmental Protection. Quality Assurance Program Plan (QAPP) for Surface Water Monitoring and Assessment (2020-2024). See: https://www.mass.gov/doc/quality-assurance-program-plan-for-surface-water-monitoring-assessment-2020-2024/download

Massachusetts Division of Marine Fisheries. 2010. Quality Assurance Project Plan (QAPP) for Water Quality Measurements for Diadromous Fish Habitat Monitoring. See: https://www.mass.gov/files/documents/2016/08/tm/tr-42.pdf

Town of Plymouth. Quality Assurance Project Plan for Town of Plymouth Ponds and Lakes Stewardship (PALS) Project Monitoring Program. See: https://www.plymouth-ma.gov/DocumentCenter/View/4528/Plymouth-Ponds-and-Lake-Stewardship-Program-QAPP-Update-

2023-2026

Appendix A. List of Ponds to be Monitored

Appendix A. List of Ponds To Be Monitored.

Pond name	Town	ID	Latitude (decimal degrees)	Longitude (decimal degrees)	Year started	Most recent year
Garretts Pond	Barnstable	BA-510	41.69105431	-70.34961306		
Hathaway Pond (North)	Barnstable	BA-565	41.6840397	-70.31222273		
Long Pond	Barnstable	BA-737	41.65508587	-70.33815701		
Lovells Pond	Barnstable	BA-759	41.64762265	-70.44207416		
Lake Elizabeth	Barnstable	BA-795	41.63940988	-70.33292335		
Micah Pond	Barnstable	BA-797	41.63883834	-70.37879314		
Parker Pond	Barnstable	BA-875	41.61832308	-70.38759682		
Queen Sewell Pond	Bourne	BO-212	41.75605118	-70.60392369		
Flax Pond	Bourne	BO-556	41.6877782	-70.59496511		
Red Brook Pond	Bourne	BO-644	41.67761657	-70.60987182		
Cliff Pond	Brewster	BR-1028	41.7581971	-70.0221207		
Long Pond	Brewster	BR-279	41.72301169	-70.05922168		
Slough Pond	Brewster	BR-321	41.72491173	-70.13052989		
Goose Pond	Chatham	CH-458	41.69425439	-70.00605695		
Barclay Pond	Chatham	CH-479	41.6936966	-69.98773679		
Coles Pond	Dennis	DE-201	41.7563068	-70.13636336		
Scargo Lake	Dennis	DE-236	41.74112503	-70.18342674		
Flax Pond	Dennis	DE-355	41.71586768	-70.18669434		
Herring Pond	Eastham	EA-103	41.82575991	-69.98737		
Ministers Pond	Eastham	EA-92	41.83998446	-69.97555554		
Bridge Pond	Eastham	EA-98	41.83051744	-69.99724153		

Wing Pond	Falmouth	FA-845	41.62667913	-70.62575955		
Coonamessett Pond	Falmouth	FA-888	41.62034553	-70.56427192		
Jenkins Pond	Falmouth	FA-918	41.59720331	-70.58312684		
Mares Pond	Falmouth	FA-938	41.58903653	-70.59829071		
Shivericks Pond	Falmouth	FA-996	41.55414318	-70.61562516		
Hawksnest Pond	Harwich	HA-354	41.713413	-70.04463885		
Walkers Pond	Harwich	HA-358	41.71311542	-70.05156063		
Cornelius Pond	Harwich	HA-381	41.70557833	-70.05997505		
Sand Lake	Harwich	HA-418	41.70060677	-70.03626667		
Santuit Pond	Mashpee	MA-718	41.65405678	-70.45942504		
Moody Pond	Mashpee	MA-793	41.64147676	-70.51111825		
Johns Pond	Mashpee	MA-818	41.63164989	-70.51551841		
Reubens Pond	Orleans	OR-123	41.795544	-69.96263		
Crystal Lake	Orleans	OR-153	41.77286624	-69.98154559		
Pilgrim Lake	Orleans	OR-176	41.76290337	-69.97726678		
Blackwater Pond	Provincetown	PR-2	42.06723181	-70.19477013		
Clapps Pond	Provincetown	PR-28	42.05291324	-70.21035343		
Shawme Lake	Sandwich	SA-210	41.75592763	-70.50021473		
Spectacle Pond	Sandwich	SA-409	41.70505994	-70.45586675		
Lawrence Pond	Sandwich	SA-431	41.70057823	-70.43958843		
Peters Pond	Sandwich	SA-526	41.69075963	-70.48851997		
Village Pond	Truro	TR-38	42.03220833	-70.09032167		
Great Pond	Truro	TR-48	41.97479335	-70.03034502		
Herring Pond	Wellfleet	WE-56	41.96225671	-70.01253817		

Great Pond	Wellfleet	WE-67	41.94005161	-69.99916345		
Duck Pond	Wellfleet	WE-76	41.9328365	-70.00058491		
Dennis Pond	Yarmouth	YA-472	41.69591496	-70.25235984		
James Pond	Yarmouth	YA-693	41.66593857	-70.19616053		
West Sandy Pond	Yarmouth	YA-700	41.66339658	-70.25011819		

Bold = ponds still stratified in October 2023

Appendix B. Tracksheet for Cape Cod Regional Pond Monitoring Activities.

(Note: this is a PDF of the original Excel spreadsheet).

Cape Cod Ponds Monitoring Program
Pond Monitoring Trackshect for Tasks
Year

Identification					ACTIVITY Preparation						Field monitoring					Lab		QA/QC				Reporting	
Town	Pond Name	Pond ID	Latitude	Longitude	Confirmed Access Point	Pond Association	Volunteer Leader	No. of Volunteers	Field equipment checked & ready (date)	Training provided on (Date)	Sampling conducted on (Date)	Field measurements obtained time, date)	Water samples obtained (time, date)	Field data entry (date)	Samples delivered to CCS (time, date)	Lab samples analyzed (date)	Lab data received by CCC (date)	Quarterly QA done (date)	Field data QA'ed by APCC	Lab data QA'ed by CCS lab	Project QA Officer reviews	Draft and Final Report	Data uploaded to Database

Appendix C. Field Checklist, Cape Cod Regional Pond Monitoring Program

Pond Monitoring Program Checklist

Needed prior to sampling date:
o Ensure adequate bottle supply for all anticipated samples, including field duplicates and field blanks
o Ensure all sampling equipment is working properly.
o Gather all ancillary field materials, including GPS, sampling sheets, coolers, ice packs, labeling pen, etc.

For sampling day:

o Field monitoring/sampling chain-of-custody sheets for each pond
o Map(s) or queued digital map images of access points
o Phone numbers of access contacts for private access points
o Sufficient sample bottles for each pond plus field duplicates and a field blank
o Cooler and ice packs (each cooler is assigned a unique number)
o Sampling equipment, including In-Situ instrument sampling device, and Secchi disk

Return of samples to lab:

o Ensure samples remain cold until returned.
o Samples should be sent to CCS lab within 8 hours of collection with a cooler temperature of 4°C or less to maintain holding times.
o Field monitoring/sampling chain-of-custody sheets should be signed by samplers, transfer personnel, and all Lab staff that control/transport the samples/data sheets, including time and location.
o Photograph field monitoring/sampling chain-of-custody sheet
o Ensure field monitoring/sampling chain-of-custody sheets (see Appendix F) are collected and stored for later review and input of field data into spreadsheets.

Appendix D. Field Instructions, Cape Cod Regional Pond Monitoring Program

Cape Cod Ponds Sampling Procedures

1. Record all applicable information on the Cape Cod Ponds field datasheet/ chain-of-custody sheets, including name of sampler, date, weather conditions, and sampling depths.

2. Collect Secchi reading and total station depth; record readings on field datasheet.

3. Collect dissolved oxygen and temperature profile readings as detailed in Table 5; record readings on field datasheet.

4. If not already labeled, enter pond name, date and sample depth on sample bottles.

5. Collect water samples at depths specific to the total station depth. A minimum of two samples per pond with samples at 0.5 m and 1 m off the bottom. If the pond is 3 m or less in depth, collect two 0.5 m samples. In ponds of ~9 m deep, collect one additional sample at 3 m depth. In ponds with a total station depth greater than 11 m, collect one additional sample at 9 m depth. Record sampled depths on field datasheet.

6. Samples should be transferred to three dark, acid-washed Nalgene bottles. Care should be taken to avoid contact with the interior portion of the bottle or with the water stream between the sampling device and the sample bottles.

7. Sample bottles should be stored in the cooler as they are collected.

8. Duplicate sample for each sampling run should be randomly collected and recorded on appropriate sampling sheet.

9. Photograph field monitoring/chain-of-custody form

10. Samples should be returned to the CCS Lab within 6 hours of sampling or 8 hours of sampling if cooler temperature is 4°C or less to ensure holding times are met.

Appendix E. Standard Operating Procedures for Field Sampling

SOP 1 – Secchi depth / total depth measurements
Equipment needed: secchi disk, measuring tape
Procedure:

1. Using bathymetric maps or GPS coordinates, samplers should first confirm their field sampling location.
2. Begin Secchi reading collection without a view scope by lowering the Secchi disk into the water on the shaded side of the boat.
3. Continue to lower the Secchi disk until the black and white quadrants can no longer be distinguished, and the disk disappears. Be sure to remove sunglasses when taking the Secchi reading. Record the depth at which the disk disappears.
4. After the disk has disappeared, slowly raise the disk until it becomes visible again. Record the depth at which the disk reappears.
5. The Secchi depth is determined by averaging the disappearance and reappearance depths.
6. A reference video for this procedure can also be viewed at (https://youtu.be/xiRT2j54Y2U)
7. Next to collect Secchi disk depth with a view scope, lower the Secchi disk into the water on the sunny side of the boat. And then follow steps 3-5 looking at the Secchi disk through the view scope.
8. The Secchi disk can also be used to measure total depth, by lowering the disk vertically into the water until it hits the bottom surface. Record the depth at which the line begins to go slack.

SOP 2 – In-Situ Aqua Troll 500 vented (Dissolved oxygen, Temperature, pH, conductivity)
Equipment needed: In-Situ Aqua Troll sonde or equivalent
Procedure:

1. Open the VuSitu app on the field phone. Press the Power key  on the Bluetooth device to turn it on. The sonde S/N should appear on the VuSitu app. Click the S/N to connect the app with the instrument. Now navigate to “live readings” in the VuSitu app, where temperature, barometric pressure, dissolved oxygen (% and concentration), conductivity, turbidity and pH should be displayed. Change the location to reflect the pond ID in the app. Allow at least 5 minutes for the instrument to warm up and stabilize before taking measurements. If any of the parameters are not displayed on the run screen, contact the Monitoring Coordinator or consult the user manual (https://in-situ.com/pub/media/support/documents/at500-manual.pdf)
2. Lower the probe into the water on the opposite side of the boat from where maximum depth was measured with the Secchi disk. This minimizes the potential for interference from any sediment disturbed by the Secchi disk.
3. At the first sample depth, keep the probe in place until the temperature and dissolved oxygen readings have stabilized. Log the sample by capturing a snapshot reading, and record the temperature, pH, conductivity, and dissolved oxygen readings on the field sheet.
4. Repeat step 3 at each subsequent sampling depth, following the sampling guidance in Table 5 based on total pond depth.

Appendix F. Field Monitoring and Chain-of-Custody Form, Cape Cod Regional Pond Monitoring Program

Cape Cod Regional Pond Monitoring Program Field Form

Pond and ID_____ **Date**_____ **Time**_____

Cloud Cover (circle one) *<20% 20-50% >50% 100% light rain*	**Depth** (m)	Pre ODO%:	mmHG:
Wind (circle one) *calm slight breeze windy*	**Secchi average** (m)	Post ODO%:	mmHG:

Wave Intensity	Still	Calm	Average	Rough	Stormy
Water Odor	None	Faint	Medium	Strong	Smells like:
TURBIDITY	Clear	Slightly cloudy	Turbid	Opaque	Clumps
Water Color	Clear	Blue	Green	Brown	Other
GPS Location	Lat:		Lon:		
Check when GPS location is changed on In Situ app					☐
Time 1st sample taken		**CCS latest drop off time**			☐

Lab Calibration (daily)			
T(°C) NIST:	Sonde(SN:		):
	Pre Cal	**Post Cal**	**Post Field**
ODO%			
ODO Gain	NA		NA
BARO (mmHg)		NA	
Check Depth Reading (m)			

Recorder		*Deep Sample @ (m)*
In Situ Operator		

Secchi depth (m) WITH AquaView TIME:	Obs 1( ):		Obs 2( ):	
	Obs 1( ):		Obs 2( ):	
Did you **HIT BOTTOM** during In Situ profile?**Y***/N			Secchi? Y/N	

* If **Yes**, EXPLAIN what you did (& if reading possibly affected by hitting, etc.)

Plant, wildlife, human activity:

Comments:

Cape Cod Regional Pond Monitoring Program Field Form

Depth (m)	Temp (C)	SpCond (uS/cm)	%ODO (%Sat)	ODO (mg/L)	pH (pH)	Salinity (PSU)	Turbidity (NTU)	Depth logged (x)
Air		Strike through boxes for missing measurement. Check off meters as they are logged with In Situ instrument.						
0.5								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
1m a.b.*								
0.5m a.b.*								

*a.b. = above bottom

CHAIN-OF-CUSTODY FORM

APCC Pond Monitoring Program
Center for Coastal Studies
Hiebert Marine Laboratory
5 Holway Avenue
Provincetown, MA 02657
Amy Costa (phone: 508-247-7743); Jenny Burkhardt (585-314-8850); Troy Wood (719-838-0079)

CHAIN OF CUSTODY AND ANALYSIS REQUEST

Samplers Name:

REMARKS/SPECIAL INSTRUCTIONS:

INSTRUCTIONS: USE SEPARATE LINE FOR EACH CONTAINER (INCLUDING REPLICATES)

SAMPLING			REQUESTED ANALYSES					
			Chlorophyll and DIN 1000 ml brown bottle		Alkalinity 250 ml bottle (fill completely leaving no air space)		TN and TP 125 ml bottle (leave air space for freezing)	
DATE	TIME	SAMPLE IDENTIFICATION (POND NAME AND DEPTH IN METERS)	check if requested	Comments	check if requested	Comments	check if requested	Comments
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	
			☐		☐		☐	

CHAIN OF CUSTODY RECORD

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	DATE:	TIME	NUMBER OF SAMPLES RECEIVED
Name of Sampler:			Name of Lab Personnel:			

COC Form 050803

Example Sample Label

Sample ID:	_____	Sample #:	_____
Pond Name:	_____	Sample Depth	_____
Pond ID:	_____	Town:	_____
Sampler Initials:	_____	Organization:	_____
Date:	_____	Time:	_____

Appendix G. Center for Coastal Studies Laboratory Quality Assurance Plan

Appendix H. EPA Methods for Calculating Minimum Detection Limits

Appendix I. Quality Assurance Project Plan for Regional Collection and Analysis of Cape Cod Water Resources