Quality Assurance Project Plan

for the

Cooperative Lakes Monitoring Program

Supported By:

Michigan Department of Environmental Quality
Water Resources Division

and

The Michigan Clean Water Corps Partnership

Great Lakes Commission
Huron River Watershed Council
Michigan Lake and Stream Associations, Inc.
Michigan State University

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This Quality Assurance Project Plan (QAPP) for the Cooperative Lakes Monitoring Program (CLMP) was originally written by Howard Wandell, Michigan State University, Department of Fisheries and Wildlife and Ralph Bednarz of the Water Bureau, Michigan Department of Environmental Quality. It is intended to be a comprehensive documentation of the program's planning, implementation and assessment including the elements of program management, data generation and acquisition, assessment and oversight as well as data validation and usability. The original QAPP was developed over a six month time period in 2001, during which numerous meetings were held by the involved organizations and input was secured from volunteers, environmental managers, researchers and other interested parties. The QAPP was organized following *The Volunteer Monitor's Guide to Quality Assurance Project Plans* (U.S. EPA 1996). The QAPP was updated in August 2004, January 2007, July 2009, October 2013, March 2015, July 2018. Since the CLMP is a long-term, ongoing program the QAPP is intended to be a living document, reviewed and updated periodically.

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A. Program/Task Organization

As a Michigan Clean Water Corps (MiCorps) program, the Cooperative Lakes Monitoring Program (CLMP) is a partnership between the Michigan Department of Environmental Quality (MDEQ), the Great Lakes Commission (GLC), the Huron River Watershed Council (HRWC), Michigan Lake & Stream Associations, Inc. (MLSA), Michigan State University (MSU) and Michigan citizen volunteer samplers.

- MDEQ Water Resources Division - Coordinate and oversee MiCorps, including the CLMP. Coordinate laboratory support, data evaluation and quality assurance and quality control (QA/QC).
- Great Lakes Commission – Primary contractor for MiCorps. Oversee MiCorps contract for development and implementation of all MiCorps programs, including the CLMP and the MiCorps Data Exchange (MDE).
- Huron River Watershed Council – MiCorps partner under contract with GLC. Oversee development and implementation of MiCorps programs, including all CLMP operations.
- Michigan Lake and Stream Associations, Inc. – Administer CLMP operations including administrative logistics, enrollment targets, volunteer training, sampling logistics, sample handling and delivery, data management, and annual report printing and distribution. Assist with program coordination, pilot study development and implementation, and quality control activities.
- Michigan State University– Support MLSA in administering CLMP operations. Assist with volunteer training, sampling logistics, sample handling and delivery, data management and reporting, pilot study development and implementation, and quality control activities. Provide technical and scientific expertise and program outreach.
- MDEQ Environmental Laboratory and its overflow laboratories - Perform all specified analyses on lake water quality samples collected for the CLMP.

Table 1 provides specific names and contact information for each participating agency.

Table 1. Contact Information for CLMP Partners			
Name	**Agency**	**Contact Information**	**Role**
Marcy Knoll Wilmes	MDEQ	517- 284-5544 KnollM@michigan.gov	DEQ Contract Administrator
Laura Kaminski	GLC	734-971-9135 laurak@glc.org	Contract Manager
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Jo Latimore	MSU	517-432-1491 latimor1@msu.edu	Project Specialist Sample Handling, QA/QC
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Melissa Smith	MDEQ Lab	517- 335-9800 smithm36@michigan.gov	Laboratory Sample Coordinator

B. Problem Definition/Program Goal

Effective environmental monitoring is an essential component of the MDEQ mission. The MDEQ and the MiCorps partners recognize that comprehensive water quality monitoring is necessary to improve natural resource management, maintain sustainable ecosystems, and protect public health. The MDEQ and the MiCorps partners have certain responsibilities and interests in the management and protection of Michigan's inland lake resources.

Michigan has nearly 3500 lakes over 25 acres in size and many thousand smaller lakes and ponds. The state has made a substantial effort to monitor the major inland lakes and has supported a citizen volunteer lakes monitoring program since 1974. However, non-stable funding in the past has limited the scope of these water quality monitoring and lake water quality assessment programs.

In 1998 the citizens of Michigan passed a general obligation bond, the Clean Michigan Initiative (CMI), to protect and enhance Michigan's environmental quality, natural resources, and infrastructure. The Governor and Legislature supported this initiative. The bond legislation called for a portion of the CMI funds, known as the Clean Water Fund (CWF) to implement the "Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (Strategy), which was developed by the MDEQ in January 1997 (MDEQ 1997). This Strategy identifies a number of monitoring activities necessary for a comprehensive assessment of water quality in Michigan surface waters. One

component of the Strategy is to expand the citizen volunteer lakes monitoring program.

With CMI-CWF support a cooperative project was undertaken in September 2000 by the MDEQ and MLSA in partnership with MSU to expand and enhance the CLMP volunteer monitoring network in terms of lakes enrolled and water-quality indicators monitored. A five-year program expansion plan was developed and the first year of the plan was implemented during the spring of 2001.

In September 2003 the Michigan Clean Water Corps (MiCorps) was created as a statewide network of volunteer monitoring programs to assist the MDEQ in collecting and sharing water quality data for use in water resources management and protection programs (www.micorps.net). The GLC in partnership with the HRWC was retained under contract to assist the MDEQ in developing and implementing MiCorps. The CLMP is a core MiCorps program. MLSA and MSU continue to provide administrative and technical support to the CLMP as MiCorps partners.

The CLMP goals are both data and education oriented including:

- Provide baseline information and document trends in water quality for individual lakes.
- Provide a cost-effective process for the MDEQ to increase baseline data for lakes statewide.
- Make volunteer lake monitoring data electronically available on the MiCorps web-site.
- Educate lake residents, users, and interested citizens in the collection of water quality data, lake ecology, and lake management practices.
- Build a constituency of citizens to practice sound lake management at the local level and to build public support for lake quality protection.

Data collected as part of the CLMP are incorporated into Michigan's lake water quality assessment process for classifying lakes by their water quality trophic state, identifying possible conflicts with water quality standards (screening tool assessment), documenting trends in lake eutrophication indicators, and supporting lake management activities. The CLMP is a significant source of consistent long-term eutrophication data for Michigan's inland lakes.

Besides the MDEQ, CLMP data may be used by other state and local agencies and groups including: the Department of Natural Resources (MDNR), lake boards, watershed councils, local government public works boards, lake and stream associations, conservation groups and others interested in water resource management.

CLMP records are often the only current lake water quality data available to state and local agencies and organizations. These groups may use CLMP data to

make initial assessments of water resource conditions and management needs. From these initial assessments, planning activities may be set in motion leading to comprehensive resource/watershed management projects.

C. General Program/Task Description

Originally known as the Self-Help Program, the CLMP continues a long tradition of citizen volunteer monitoring of Michigan's inland lakes. Michigan has maintained a volunteer lakes monitoring program since 1974, making it the second oldest volunteer monitoring program for lakes in the nation.

The original program was designed for lake property owners to monitor water quality by measuring water clarity with a Secchi disk. In 1992, the MDEQ (then part of the MDNR) and MLSA entered into a cooperative agreement to expand the basic program. An advanced Self-Help program was initiated in 1993 that included a monitoring component for total phosphorus during spring lake turnover. In 1998, the program was further enhanced to include chlorophyll *a* and late-summer total phosphorus sampling. At that time the program was re-named the CLMP. In 2001, dissolved oxygen and temperature profile monitoring was added to the CLMP and an aquatic plant identification and mapping component was pilot tested and then added to the CLMP in 2002. An exotic plant watch component was pilot tested and then added as a full project parameter to the CLMP in 2011. A shoreline health parameter, called "Score the Shore" was pilot tested in 2015 and then added as a full project parameter to the CLMP in 2016.

C1. CLMP Parameters Measured

The CLMP is a volunteer-based program for monitoring trophic state indicators in lakes. The focus of the CLMP is on the primary indicators Secchi disk transparency, total phosphorus and chlorophyll *a*. However, with CMI-CWF support additional parameters have been added to the CLMP including water-column dissolved oxygen and temperature, aquatic plant identification and mapping, a specialized exotic plant program, and shoreline habitat (Score the Shore). Volunteer participation determines which lakes will be monitored for these parameters.

Table 2 provides a summary of the parameters currently being monitored in the CLMP. A general description of each CLMP sampling component follows.

Table 2. Parameters Measured as Part of the CLMP

Parameter	Sample matrix	Measures
Secchi disk transparency	physical	clarity, trophic state
Spring phosphorus	water chemistry	water chemistry, nutrient enrichment

Summer phosphorus	water chemistry	water chemistry, trophic state
Chlorophyll *a*	biological	algal productivity, trophic state
Dissolved oxygen and temperature	water chemistry and physical	hypolimnetic oxygen depletion and thermal stratification
Aquatic plants ID and mapping	biological	species present, relative abundance, exotic species, trophic state
Exotic plant watch	biological	species present, relative abundance
Score the Shore	Physical, biological	Shoreline and riparian ecological health

C2. Secchi disk transparency component:

Clear lakes are universally valued as resources with exceptional quality. For almost 150 years a lake's clarity or transparency has been used to appraise its quality. The Secchi disk has become a standard tool used by scientists around the world to generally assess lakes. It has been standardized as an eight-inch (20-centimeter) disk, with four alternating black and white quadrants painted on the surface.

To make a transparency measurement the disk is attached to a measured line and lowered into the lake until it disappears. The water depth at which the disk disappears is the Secchi disk depth or value for the lake. Obviously the deeper the disk is seen the clearer the water or the greater the transparency of the lake. A lake's clarity or transparency is influenced by several factors, but for most lakes the amount of algae in the water is a major cause for changes in transparency. As more nutrients like phosphorus enter the lake from the watershed more algae is produced. As more algae is produced the clarity of the water decreases. In very clear lakes, Secchi disk values greater than 30 feet can be measured. On the other hand, in lakes with high nutrient supplies and algae production the disk can disappear in two to three feet.

CLMP volunteers measure Secchi disk transparency weekly or every other week through out the summer growing season from mid-May through mid-September.

The Secchi disk transparency along with total phosphorus and chlorophyll *a* results provide an estimate of the level of biological productivity, or trophic state, of lakes. These results are used to calculate a set of trophic state indices (i.e. Carlson TSI_{SD}, TSI_{TP}, and TSI_{CHL}) for the lake (Carlson 1977). These indices provide a quantitative means of describing the stage of lake aging, or eutrophication. Using the Carlson's TSI approach, lakes are classified according to their trophic status (i.e. oligotrophic, mesotrophic, eutrophic, hypereutrophic, etc.).

The summer season average of the weekly summer Secchi disk transparency measurements is used to calculate the Carlson TSI_{SD} for the lake which is compared with the TSI_{TP} and TSI_{CHL} for the trophic status determination.

C3. Total phosphorus component:

In the CLMP, total phosphorus is sampled once just below the water surface (1-2 feet depth) in the spring and in late summer. Phosphorus is one of several essential nutrients that algae and rooted aquatic plants need to grow and reproduce. For most lakes in Michigan, phosphorus is the limiting factor for algae growth. The total amount of phosphorus in the water is used to predict the level of biological productivity and eutrophication in a lake. An increase in phosphorus over time is an indication of nutrient enrichment.

Phosphorus is found in lakes in several forms that are in a constant state of flux as environmental conditions change and plants and animals live, die, and decompose in the lake. Because the forms of phosphorus are continuously changing and recycling, it is convenient to measure all of the forms of phosphorus together as total phosphorus.

During spring overturn most Michigan lakes are well mixed from top to bottom. This is an opportune time to sample just the surface of the lake to obtain a representative sample for estimating the total amount of phosphorus in the lake and for determining whole lake nutrient changes or trends over time. At other times of the year, more extensive water column sampling is needed to determine phosphorus levels in the lake. A surface sample taken during late summer stratification is a representative sample of the upper water layer of the lake, the epilimnion.

The late summer phosphorus results are used to calculate the Carlson TSI_{TP} for the lake which is compared with the TSI_{SD} and TSI_{CHL} for the trophic status determination.

C4. Chlorophyll *a* component:

The relative amount of algae in a lake can be estimated by measuring the chlorophyll *a* concentration in the water. The amount of chlorophyll in an algal cell varies among algae species as well as with changing light conditions at different depths within the lake. Changing seasons also create different light conditions that, in turn, affects chlorophyll production. To account for some of this variability, algal chlorophyll is monitored during five mid-month sampling events over the summer season (May through September) using a water column composite sampling technique. Samples are field filtered by the volunteer and frozen until delivered to the MDEQ laboratory for analysis.

The median value of the summer chlorophyll monitoring results is used to calculate the Carlson TSI_{CHL} for the lake which is compared with the TSI_{SD} and TSI_{TP} for the trophic status determination.

C5. Dissolved oxygen and temperature component:

In the CLMP, dissolved oxygen and temperature are measured from the water surface to within three feet of the bottom in the deepest basin of the lake. Measurements are taken twice per month from early spring to late summer. Dissolved oxygen and temperature profiles are plotted for each sampling event.

Dissolved oxygen and temperature are two of the fundamental variables in lake ecology. Measuring these parameters together provides valuable information for assessing the condition of a lake. The amount of dissolved oxygen in the water is an important indicator of overall lake health. Water temperature serves as a driving force for many important lake processes. The temperature controls the length of the growing season in lakes, which influences the type and amount of biological activity.

During the summer growing season, most lakes with sufficient depth (greater than 30 feet) are thermally stratified forming distinct layers of differing temperature and density. These layers are referred to as the epilimnion (warm surface layer) and hypolimnion (cold bottom layer) separated by a metalimnion or thermocline (middle layer with decreasing temperature). The greatest changes in temperature occur at the thermocline.

Physical and chemical changes within these layers influence the cycling of nutrients and other elements within the lake system. Temperature also affects the level of dissolved oxygen in the water. As temperature increases, the amount of atmospheric oxygen that can be dissolved in water decreases. Dissolved oxygen levels also are influenced by the time of day and by oxygen requirements of bacteria and other aquatic organisms. Photosynthesis during the daylight hours increases dissolved oxygen levels in the lake while dissolved oxygen is consumed by respiration at night.

The bottom waters of many stratified lakes are susceptible to oxygen depletion, since atmospheric replenishment and photosynthetic production of oxygen are decreased at greater water depth and decomposition of organic matter in the bottom waters and sediment utilizes available oxygen. Low dissolved oxygen levels can result in the loss of susceptible organisms, such as trout and other cold water fish, and the plant nutrient phosphorus can be released from the sediments when dissolved oxygen is depleted in the bottom waters. Hypolimnetic dissolved oxygen decline during summer stratification is used as an early warning indicator of eutrophication in oligotrophic lakes.

C6. Aquatic plant identification and mapping component:

Rooted aquatic plants are a natural and essential part of the lake, just as grasses, shrubs and trees are a natural part of the land. Their roots are a fabric for holding sediments in place, reducing erosion and maintaining bottom stability. They provide habitat for fish, including structure for food organisms, nursery areas, foraging and predator avoidance. Waterfowl, shore birds and aquatic mammals use plants to forage on and within, and as nesting materials and cover. Though plants are important to the lake, nutrient enrichment and the spread of exotic species can cause overabundance of plants. Excessive plant populations can negatively affect fish populations, fishing and the recreational activities of property owners. In this situation, it is advantageous to manage the lake and its aquatic plants for the maximum benefit of all users. To be able to do this effectively it is necessary to know the plant species present in the lake and their relative abundance and location. A map of the lake showing the plant population locations and densities will greatly aid management projects.

Quantifying the aquatic plant populations of a lake is not an easy task. Additionally, sampling procedures used to collect aquatic plant data that can be statistically analyzed are complicated and time and cost intensive. Consequently, the CLMP is using qualitative techniques that allow volunteer monitors to generally assess the aquatic plants in their lake. This assessment may be viewed as a “snapshot” of the species of plants in the lake, their general location and relative abundance. Although not quantitative, this CLMP component provides valuable information about a lake’s aquatic plants that is often missing in many lake and aquatic plant management programs.

C7. Exotic plant watch component:

Exotic plants are a significant threat to the health of Michigan lakes. Species such as Eurasian milfoil, curly-leaf pondweed, European frog-bit, and hydrilla can quickly spread across a lake and impair human, fish, and wildlife use of the resource. However, exotic species can be managed effectively through early detection and rapid response.

This component trains volunteers how to recognize and effectively sample selected exotic plants. It is intended for lake communities that currently do not have exotic species or are managing existing populations and have them under good control. The program will have less value for lake communities that currently have exotic species covering large areas. However, it can help these lake communities identify new exotics that may invade the lake. Upon discovering exotic plants in a lake, the lake community has the option of pursuing outside assistance in proper control and eradication.

C8. Score the Shore component: Healthy shorelines are an important and valuable component of the lake ecosystem. The shoreline area is a transition zone between water and land, and is a very diverse environment that provides habitat for a great variety of fish, plants, birds, and other animals. A healthy shoreline area is also essential for maintaining water quality, slowing runoff, and limiting erosion. However, Michigan's inland lake shorelines are threatened. Extensive development, often combined with poor shoreline management practices, can reduce or eliminate natural shoreline habitat and replace it with lawn and artificial erosion control such as sea walls and rock. As a result, shoreline vegetation is dramatically altered, habitat is lost, and water quality declines.

The goal of this component of the program is to train volunteers on the procedures and then have them conduct an assessment of the quality of a lake's shoreline on three primary categories: Littoral Zone Characteristics, Riparian Zone Characteristics, and Shoreline Erosion Control Practices. Volunteers motor around the lake, scoring aspects of each of the characteristics on a data sheet per every 1000 foot shoreline section.

C9. How Results are Evaluated

Data collected in the CLMP are used to assess water quality/trophic status conditions, nutrient enrichment, and water quality changes and trends in lakes enrolled in the program. Volunteer collected CLMP data are evaluated with professionally collected side-by-side data, other quality control data and data from other state agency monitoring programs. These data are collectively utilized to assess the water quality status and update the trophic status classification of Michigan's inland lakes.

The Carlson TSI approach is used for updating trophic status classification of Michigan's inland lakes (Carlson 1977). The TSI equations for calculating the individual trophic state indicators are listed in Table 3.

Table 3. Carlson TSI Equations

$TSI_{SD} = 60 - 33.2 \log_{10} SD$ where, SD = Secchi depth transparency (m)
$TSI_{TP} = 4.2 + 33.2 \log_{10} TP$ TP = total phosphorus concentration (ug/l)
$TSI_{CHL} = 30.6 + 22.6 \log_{10} CHL$ CHL = chlorophyll *a* concentration (ug/l)

Individual TSI values are calculated for each trophic state indicator. An overall TSI is determined from the mean of the individual TSI values and the trophic status classification is determined based on the criteria listed in Table 4.

Table 4. Michigan Inland Lakes Trophic Status Classification Criteria

Trophic State	Carlson TSI	TP (ug/l)	SD-Trans. (ft)	SD-Trans. (m)	Chl-a (ug/l)
Oligotrophic	<38	<10	>15	>4.6	<2.2

Meotrophic	38-48	10-20	7.5-15	2.3-4.6	2.2-6
Eutrophic	48-61	20-50	3-7.5	0.9-2.3	6-22
Hypereutrophic	>61	>50	<3	<0.9	>22

A trend analysis is done for lakes that have eight or more years of Secchi disk transparency or total phosphorus data. A regression analysis is done and an apparent trend line fitted to the data. Figure 1 illustrates the annual mean transparency results over time with the apparent trend line for Corey Lake, St. Joseph Co. It should be noted that Corey Lake has been in the volunteer monitoring program continuously from the beginning in 1974 to the present and most of the measurements have been taken by the same volunteer over the this time span. This is a tremendous set of long-term data for this lake.

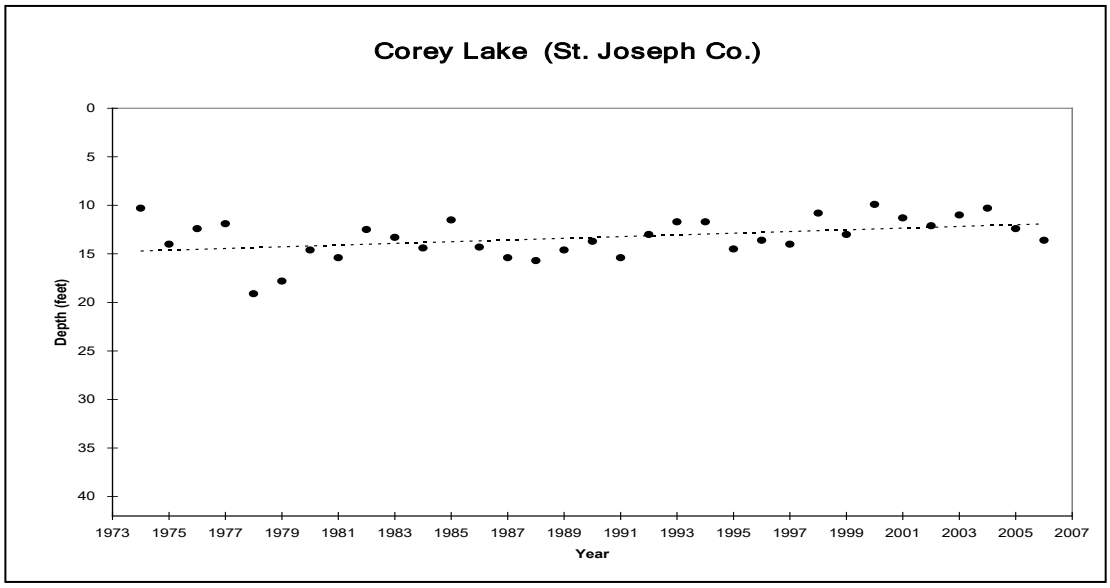

Figure 1. CLMP Annual Mean Transparency – Corey Lake, St. Joseph Co.

Figure 2 illustrates the spring total phosphorus concentration over time with the apparent trend line for Long Lake, Iosco Co. This is another lake with a long-term history of volunteer monitoring.

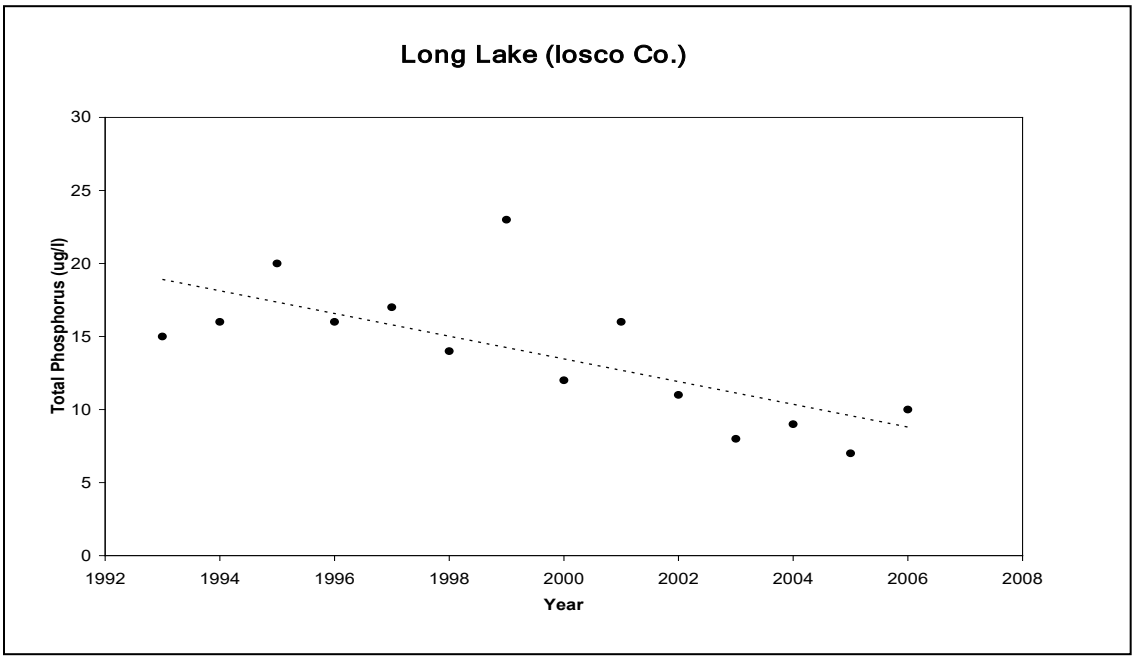

Figure 2. CLMP Annual Spring Total Phosphorus – Long Lake, Iosco Co.

These data are provided to the volunteer monitors to show apparent increasing, declining, or stable trends for these trophic state indicators in their lakes. The long-term data are tracked by the MDEQ to identify lakes that may need increased management activities. These data have also been evaluated to identify regional and state-wide trends (Bruhn and Soranno, 2005).

C10. Program Timetable

Table 5 is a general timetable for the CLMP. A complete and detailed monthly timetable is provided in Appendix 1.

Table 5. Monthly Work Task Within the CLMP Sampling Schedule

Date	Task
August	Review registration materials and revise as necessary
September	Distribute registration materials
Nov. – Dec.	Review sampling literature and revise as necessary; prepare equipment
Jan. – Mar.	Receive registration materials
March	Review training materials and revise as necessary
April	Give training, distribute sampling literature and equipment

April - Sept	Volunteer sampling, side-by-side sampling, laboratory analysis
October	Data recording
November-December	Data entry into the central database
January-February	Produce and distribute reports for each lake in the program
March	Produce a programmatic annual summary report.

D. Data Quality Objectives for Measured Parameters

D1. Precision, Accuracy, and Measurement Range

The precision, accuracy and measurement range for the CLMP parameters are listed in Table 6.

Table 6. CLMP Parameter Precision, Accuracy and Measurement Range

Matrix	Parameter	Precision	Accuracy	Measurement Range
Water	Secchi Disk Transparency	± 5%[a]	± 0.5 feet[a]	0.4 – 62 feet[b]
Water	Total Phosphorus (Spring)	± 14%[c]	± 11.5%[d]	<5 – 120 ug/l[b]
Water	Total Phosphorus (Late-Summer)	± 13%[c]	± 21%[d]	<5 – 470 ug/l[b]
Water	Chlorophyll *a*	± 25%[c]	± 33%[d]	<1 – 98 ug/l[b]
Water	Temperature	± 10%[a]	± 0.3 °C[e]	-5 – 45 °C[e]
Water (550A)	Dissolved Oxygen	± 10%[a]	± 0.3 mg/l[e]	0 – 20 mg/l[e]
Water (Pro20)	Dissolved Oxygen	± 10%[a]	± 0.3 mg/l[e]	0 – 50 mg/l[e]

a CLMP general observations
b CLMP data range
c CLMP volunteer replicate (QA/QC) data
d CLMP side-by-side (QA/QC) data
e YSI model 550A, Pro20 meters specifications

Secchi disk transparency, dissolved oxygen and temperature measurement precision are determined through field observations during side-by-side sampling events. Total phosphorus and chlorophyll *a* measurement precision are determined from annual volunteer replicate sample data based on a cumulative relative percent difference analysis.

Accuracy of the Secchi disk transparency measurements is determined through field observations during side-by-side sampling events. Accuracy of total phosphorus and chlorophyll *a* measurements are determined from annual side-by-side sampling data for these parameters based on a relative percent difference analysis. Accuracy of dissolved oxygen and temperature measurements are from manufacturer specifications for the YSI model 550A and Pro20 meters.

Measurement ranges for Secchi disk transparency, total phosphorus, and chlorophyll *a* are minimum and maximum values that have been measured in the CLMP. Measurement ranges for dissolved oxygen and temperature are from manufacturer specifications for the YSI model 550A and Pro20 meters.

D2. Completeness, Comparability, and Representativeness

The lakes that are sampled in the CLMP are based on volunteer enrollment. A program goal is 90% participation for those lakes enrolled. A follow-up telephone survey is conducted annually with the volunteers on the lakes that are enrolled in the various CLMP parameters but do not complete the sampling or sample turn-in requirements.

For all CLMP parameters, comparability is addressed by the use of standardized VOPs and analytical methods by the volunteers and the MDEQ Lab. Comparability of data within and among parameters is also facilitated by the implementation of QA\QC techniques and performance and acceptance criteria. For all measurements, reporting units and format are specified, incorporated into the field data recording forms, and documented in the MiCorps Data Exchange (MDE). Comparability is also addressed by providing results of QA/QC sample data, such as estimates of precision and bias; conducting methods comparison studies and side-by-side sampling, and conducting interlaboratory performance evaluation studies (see Quality Control Requirements, p. 23, for details.

For the CLMP, the primary sampling station is established at the deep basin of the lake and is intended to represent the open water of the lake as the location to evaluate the trophic status of the lake during the summer growing season and long-term trends in nutrient enrichment in the lake. The individual sampling components designed for each parameter attempt to address representativeness within the constraints of a volunteer monitoring program. Holding time requirements for analyses ensure analytical results are representative of conditions at the time of sampling. Use of replicate and side-by-side sampling provides estimates of precision and bias.

E. Training Requirements

Training for all CLMP projects is held in conjunction with the MLSA annual spring conference in April or early May. MDEQ and MiCorps staff conduct the training sessions. Participants in the Secchi disk transparency and spring and summer phosphorus components are not required to attend a training session. The detailed monitoring instructions and procedures serve as self training materials for these parameters. However, participants in these three components, particularly first time participants, are encouraged to attend the training sessions.

Volunteer training for all other parameters is required to receive monitoring supplies and participate in the advanced components. If volunteers are unable to attend the official annual training, the DEQ Contract Administrator, the Program Manager, or the Project Specialist may train the volunteer personally if circumstances allow this. Otherwise, the volunteers may receive training from a veteran CLMP volunteer with permission from the DEQ Contract Administrator, the Program Manager, and the Project Specialist. This permission is given based on the veteran volunteer's amount of experience and proven track record of accuracy and is done on a case by case basis.

Starting in 2015, online webinars held by MiCorps staff can substitute for in-person training. The webinars may or may not be held each year, depending on demand.

Resource personnel are available throughout the summer sampling season to answer questions, and provide assistance with sample collection, handling, and species identification. In addition to training, volunteer samplers are provided detailed written monitoring procedures for each project in which they participate.

The effectiveness of volunteer training is assessed through the use of two types of evaluation surveys. The first, administered immediately after each training session at the MLSA annual spring conference, asks volunteer trainees to provide feedback on the clarity of training and suggestions for training improvement. A second evaluation survey is administered by program staff during side-by-side sampling visits, during which volunteer sampling performance is observed and deviations noted, and, following sampling, volunteers are given the opportunity to provide feedback on the sampling procedures, written instructions, training, and other program components. Program staff make use of the results of all evaluation surveys to improve program training, sampling procedures and instructions; and to address concerns specific to individual volunteers.

The exact training requirements for each component are detailed in the VOPs.

F. Documents and Records

The CLMP relies extensively on printed forms and documents to facilitate a number of important tasks. Print materials are provided to volunteers for registration, training, sample collection and sample handling and delivery. Other documents are used for data storage, report writing and to facilitate communication between MDEQ and MiCorps personnel. Each parameter includes detailed instructions, data recording forms and the contact information of MDEQ and MiCorps personnel.

Starting in 2015, the VOP procedures in the CLMP are not included in the QAPP. These procedures have been turned into their own standalone document called the CLMP Manual. All of the CLMPs documentation meant for the public- the application, the CLMP Manual, datasheets, fact sheets, quick references procedures- can be found in their most recent version at https://micorps.net/lake-monitoring/clmp-documents/.

The primary document used internally by CLMP staff is Appendix 1.

The retention longevity of forms and documents depends upon the purpose of the document. Administrative forms and letters, such as registration materials and waivers are retained three to five years. Data documents such as volunteer sampler field sheets and laboratory reporting forms are, as of this time, retained at the MDEQ central office indefinitely. These documents are still available from the early years of the former Self Help program.

Electronic data files are retained by the MDEQ Program Manager. The CLMP sample results are retained on the Laboratory Information Management System. The MDE files are retained on the MDE database. The database is housed on a MySQL database platform on a server at the Great Lakes Commission. The GLC backs up all of their server data daily, and retains back-ups for two weeks before overwriting. Records will be retained on the system as long as it remains in operation, and, by contract, would be turned over to the DEQ, should the GLC discontinue database maintenance.

G. Volunteer Operating Procedures (VOP)

(Sampling Design, Sampling Procedures, Sample Handling and Shipping)

The VOPs for each of the CLMP parameters are included in the CLMP Manual, https://micorps.net/lake-monitoring/clmp-documents/.

Each project's VOP includes a description of the utility of the parameter being sampled, sampling design, equipment and supplies used, sampling procedures, sample labeling instructions, sample handling and preservation, shipping requirements, training requirements, safety precautions and technical support contacts. The sampling methods requirements are summarized in Table 7.

Timing and Frequency of Collection:

Secchi Disk:

- Once a week through the summer.
- The first week is the full week that includes May 15th.
- The last week is the week that includes September 15th.
- These dates are listed in the Secchi data sheet every year.

Spring Phosphorus:

- Starting in 2015: Volunteers take water sample within 2 weeks of ice out as judged by themselves.
- Previously: DEQ would predict ice out dates for all counties and assign sampling date ranges.

Late Summer Phosphorus:

- There are five sample ranges and turn in dates based on County tier.
- The five tiers are determined by a north-south gradient and are listed on the late summer phosphorus schedule.
- The southern-most tier of counties turn in their sample the Tuesday of the last full week in September. The sample must be taken in a five day range with the final day of the range falling on the day before the turn in date. i.e. if the turn-in is September 29, the sample must be taken September 24-28.
- The next County tier, heading in a northern direction, turns their samples in on the Tuesday a week before the southern-most tier, and so on heading north through the tiers so the whole process takes 5 weeks.

Chlorophyll:

- One sample in each date range: May 10-20, June 10-20, July 10-20, August 10-20.
- The September sample falls in the same date range as the late summer phosphorus sample.

Dissolved Oxygen/Temperature

- Take every other week from mid-May through mid-September. No exact dates are prescribed.

Plants and Score the Shore

- Volunteers are asked to do the assessments mid to late summer, after full plant growth has been achieved.

Table 7. CLMP Sampling Methods Requirements					
Matrix	Parameter	Sampling Equipment	Sample Holding Container	Method Sample Preservation	Maximum Holding Time
water	transparency	Secchi disk	none	none	immediately
water	total phosphorus	sample holding container	screw top, polypropylene bottle (250 ml)	freeze sample post-delivery acidification	6 months frozen
water	chlorophyll *a*	composite sampler	wide-mouth amber polypropylene bottle (250 ml)	MgCO3, filter and freeze sample	4 months frozen
water	dissolved oxygen and temperature	YSI 550A, Pro20 meter	none, in-lake measurement	None	immediately
water and substrate	aquatic plants ID and mapping, exotic plant watch	plant rake	self-sealing plastic bags	dry in plant press & mount	indefinite
Water and land	Shoreline health (visual inspection only)	None	None	NA	NA

The volunteer sampling, sample handling, sample turn-in, and sample shipping schedules are designed to get the samples to the lab so they can be analyzed within the prescribed holding times for each parameter. If delays occur and holding times are exceeded, the data for these samples are coded and reported.

H. Laboratory and Analytical Methods

CLMP samples requiring laboratory chemical analysis (total phosphorus and chlorophyll *a*) are analyzed at the MDEQ state laboratory in Lansing.

In 2002 the CLMP late-summer total phosphorus samples were analyzed at an approved commercial laboratory due to sample capacity constraints at the MDEQ state laboratory. Results for these samples have been coded accordingly in the CLMP records.

The information collected in the CLMP's Aquatic Plant Identification and Mapping Project is tabulated and analyzed according to the procedures outlined in Chapter Five (Mapping Aquatic Plants in the Lake) of the book *A Citizen's Guide for the Identification, Mapping and Management of the Common Rooted Aquatic Plants of Michigan Lakes* (Wandell and Wolfson 2000). The data collected in the Aquatic Plant Mapping Project are qualitative. These data provide a general description of the lake's plant population, common species present and their relative abundance and location. The data products include a generalized map of the lake's plant populations and a data sheet of the species found and their relative lake-wide abundance.

The lab uses several error codes commonly for phosphorus and chlorophyll. Below is the code and how it is handled in the CLMP reports, the MDE online database, and trend graphs.

Phosphorus: **W**. Value is less than the method detection limit (3 ug/l). The CLMP treats this results as a 3 for reporting and trends. It is listed as <=3 in reports.

Phosphorus: **T**. Value is less than the reporting limit (5 ug/l). The CLMP treats this results as a 4 for reporting and trends. It is listed as <5 in reports.

Chlorophyll: **ND or <.** Sample values is less than limit of quantification (1 ug/l). The CLMP treats this result as a 0.5 for median calculation in CLMP reports and trend graphs, but it is listed as <1 in reports.

I. Quality Control Requirements

Several types of quality control samples are collected in the field and performed in the laboratory in the CLMP. These quality control samples include:

Field bottle/preservative blank – Preservative appropriate for the phosphorus/chlorophyll parameter are added to clean sample bottles. The samples are delivered to the laboratory and they are analyzed to check for bottle and preservative purity.

Replicate field sample - Two samples collected at the same site, at the same time, using the same method, and independently analyzed in the same manner. These samples are used to determine the precision of the field sampling methods.

Side-by-side field sample - DEQ staff sample or make observations side-by-side with volunteers at least 10 times per year, dividing the visits between Secchi Disk/Chlorophyll, Spring Phosphorus, Summer Phosphorus, and Dissolved Oxygen/Temperature. DEQ staff and volunteer collect samples or make observations at the same site and the same time. Volunteers use the VOP and the DEQ staff use agency Standard Operating Procedures (SOPs) (Appendix 2). Chemical samples are independently analyzed. Side-by-side sampling provide a check on the VOP and the reliability of the volunteer sampling.

Mail-in field sample: Volunteers mail in voucher samples of plants that they have identified. CLMP biologists double-check the identification.

Second independent reading - Biological samples requiring interpretation are analyzed by two professionals as a check on professional interpretation quality and analytical procedures.

Proficiency audit sample – Annually, samples are obtained from an independent quality control lab. The samples are prepared and analyzed according to the provided instructions. The results are then submitted to the source for evaluation. Participation in these studies is used as a means to independently monitor this method's performance and to compare its performance against that of the other participants.

These quality control samples are incorporated in the CLMP sampling components as outlined in Table 8.

Table 8. CLMP Quality Control Samples

QC Sample Type	Secchi Disk	Spring Total Phosphorus	Summer Total Phosphorus	Chlorophyll	Dissolved Oxygen & Temperature	Aquatic Plant Mapping	Exotic Plant Watch	Score the Shore
Field bottle/preservative blank	NA	1%	1%	NA	NA	NA	NA	NA
Replicate field sample	NA	10%	10%	10%	NA	NA	NA	NA
Side-by-side field sample	10 total visits divided between these parameters					NA	*	*
Mail-in field sample	NA	NA	NA	NA	NA	NA	10%	NA

* Not a required part of the program, but staff try to conduct several side-by-side visits a year on these parameters to make sure volunteers understanding the training and can produce similar results to staff.

The following actions are taken when a quality control sample reveals a sampling or analytical problem.

Field bottle/preservative blank - Bottles are checked for contamination and the preservative is exchanged at the laboratory for a new allotment.

Replicate field sample - The problem is discussed with the volunteer sampler to identify any possible abnormal environmental conditions or nonconformity with sampling procedures.

Side-by-side field sample - Volunteer sampling procedures and equipment are reviewed for comparability with state agency standard operating procedures.

Mail-in field sample – In case of plant misidentification by the volunteers, CLMP biologists will revise the volunteers final reports to reflect the

corrected plant identification. This is done after communicating with the volunteers to ensure that this is the appropriate course of action (e.g. the voucher sample represents that plants they saw at all sites).

J. Equipment Testing, Inspection and Maintenance Requirements

At the beginning of each sampling season, the CLMP volunteers are directed to check their monitoring equipment for damaged or missing parts. An equipment checklist is included in the monitoring procedures for each parameter. Damaged or missing parts are replaced and the equipment is repaired prior to sampling.

For the total phosphorus components, new sample bottles are shipped to the volunteers prior to each sampling event. The sample bottles are capped at the laboratory supply facility prior to shipment. The volunteers are directed to request a replacement bottle should they receive an un-capped bottle.

A full sampling and filtering kit is provided at the annual training session to volunteers who are enrolled in the chlorophyll component for the first time. The full kit includes new equipment and supplies which are assembled and inspected by CLMP staff. A re-supply kit is provided to the volunteers who are continuing in the chlorophyll component. The re-supply kit includes replacement reagents and supplies for filtering and sample storage for each sampling event. Replacement parts for the sampling and filtering equipment are also available if needed.

For the dissolved oxygen and temperature component, the YSI Model 550A and Pro20 DO/temperature meters are checked and serviced each year prior to the monitoring season. Batteries and oxygen probe membrane caps and electrolyte solution are replaced for each meter. The meters are calibrated according to the manufacturer's specifications in the lab prior to distribution to the volunteers at the annual training session. The volunteers are instructed on meter calibration at the annual training session and the meters are re-calibrated by the volunteers prior to each use in the field. Should a meter fail to calibrate in the field, the volunteer is instructed to contract the CLMP program manager for the appropriate course of action. A replacement meter may be provided if necessary. At the end of the sampling season, the meters are returned and checked by the CLMP program manager prior to post-season storage. If a meter has been damaged or failed to function according to manufacturer's specifications it is returned to the manufacturer for repair. All pre- and post-season calibration and service records are kept by the CLMP program manager. Lake associations or volunteers who have purchased a YSI Model 550A or the Pro20 DO/temperature meters for individual lake use are instructed to follow the same pre- and post-season maintenance schedule as outlined for the CLMP program equipment.

K. Equipment Calibration

As described above, the YSI Model 550A, and Pro20 DO/temperature meters are calibrated, prior to each monitoring event, according to the manufacturer's specifications. Calibration results are recorded on the dissolved oxygen and temperature data forms which are returned to the CLMP program manager at the end of each monitoring season. Calibration procedures are contained in the VOP for the dissolved oxygen and temperature component.

L. Acceptance Requirements for Supplies

A number of supplies are required for the CLMP. A brief overview of the required supplies is listed here. For more detailed information, consult the individual parameter monitoring procedures in the CLMP Manual, http://www.micorps.net/documents/CLMP_Manual.pdf

The MDEQ laboratory provides all of the sample collection bottles and appropriate labels. MLSA staff assembles Secchi disks that may be purchased by the volunteer sampler. If the volunteer sampler chooses to build their own Secchi disk, instructions are provided. MDEQ and MiCorps staff assembles the chlorophyll *a* composite sampling equipment. The chlorophyll filter apparatus are purchased from a scientific supply company and given to volunteers during their training session. Volunteers assemble plant rakes according to detailed instructions in the monitoring procedures.

All supplies and equipment are inspected for problems and defects by MDEQ or MiCorps personnel before being given to the volunteer samplers. If any defects develop during sampling supplies and equipment are to be returned to MDEQ or MiCorps personnel for replacements. MDEQ and MiCorps personnel also inspect supplies and equipment being used by the volunteer samplers during side-by-side sampling.

Preservatives required for sample preparation, such as sulfuric acid (H_2SO_4), are provided by the MDEQ laboratory but are not handled by volunteers.

M. Outside Program Information Requirements

There are two special information requirements for the CLMP, hydrographic and topographic maps. Hydrographic maps are required to determine the deepest basin of the lake, which is the primary sampling location for several CLMP components. The maps are also useful in the aquatic plant mapping project. Individual lake hydrographic maps are available from Michigan Department of Natural Resources web-site (http://www.michigan.gov/dnr/0,1607,7-153-30301_31431_32340---,00.html). Additionally, Sportsman's Connections (http://www.sportsmansconnection.com/#top) offers books of hydrographic maps

for Michigan counties. These maps are based upon work done by the MDNR's Institute for Fisheries Research over several decades. Maps are available for about 2000 Michigan lakes. If a map of the lake is not available the volunteer sampler must use a fathometer to locate the deepest spot in the lake.

Topographic maps are helpful to volunteers to obtain the altitude and, optionally, the latitude/longitude location of the lake to be sampled. These data are needed to calibrate the dissolved oxygen meter and identify the lake location. Topographic maps are available to the volunteers on the internet web-site http://www.topozone.com to look up and determine the altitude and location of their lake.

N. Data Management

For CLMP monitoring components that require sample handling and shipping to the MDEQ laboratory (spring and summer total phosphorus and chlorophyll *a*), a tracking log is maintained to maintain the chain of sample custody. The log records when sampling materials are delivered to the volunteer sampler, receipt of the samples into the MSUE processing office and delivery to the MDEQ laboratory and finally receipt of analytical results from the laboratory. The log allows for identification of missing samples as well as the tracking of samples to insure their analysis within required holding times.

Volunteer field sheets are used for all parameters. The field sheets are reviewed by the MDEQ program manager and MiCorps project specialists for completeness and discrepancies. If problems are identified on the field sheets the data may be 1) excluded from the program results if the problem is significant, 2) included in the results but the problem noted or 3) accepted. Table 9 provides a summary of data management actions when incomplete field sheets and improperly collected or handled samples.

Table 9. Data Management Actions for Completeness and Discrepancies

Parameter -condition	**Accept Data**	**Accept Data and Note Problem**	**Reject Data**
SD Transparency			
- sampling time	9 AM – 6 PM	+/- 1 hour outside sampling time	all other times
Total Phosphorus			
- sampling dates	5 day sampling window	+/- 1 week outside sampling window	all other dates
- sample bottle condition	normal condition	bottle over full – unable to stand up	bottle and/or cap cracked
- sample frozen	frozen	delivered un-frozen but collected within 4 hours of delivery	shipped un-frozen

		and frozen prior to shipping	
Chlorophyll - sampling dates	target sampling date +/- 5 days	+/- 6 to 10 days from sampling dates	greater than +/- 10 days from sampling dates
- foil wrapped vials	wrapped in foil		no foil or poorly wrapped
- sample frozen	frozen	delivered un-frozen but collected within 4 hours of delivery and frozen prior to shipping	shipped un-frozen
- replicate sample			not collected at same location as primary sample
All parameters - sampling location	deep primary station	deep secondary station	non-representative location – shoreline, inlet, outlet, or other
- other sampling event data (i.e. instrument calibration)	complete and within tolerances	incomplete, but data within tolerances	incomplete, and data beyond tolerances

If samples or measurements are properly collected by the volunteer sampler but incomplete in terms of adequate numbers for the data summary calculations (i.e seasonal averages, medians, TSI values, etc.) the data are reported but the data summary calculations are not included in the annual report.

Laboratory reporting forms are reviewed by the MDEQ program manager and the MiCorps project specialists. Any unusual or highly variable data are questioned. Unusual high or low data values may be compared with other values reported in the sampling run for consistency. They may also be compared to historical or other data sources for the lake in question. If necessary the laboratory may be asked to rerun the samples if holding times have not been exceeded.

Data from the laboratory reporting forms (spring and summer total phosphorus, chlorophyll) and field sheets (all parameters) are entered in the MDE by the volunteers via the internet or MiCorps data management personnel. Each volunteer data collector can gain password-protected access to the data entry system via an internet interface at https://micorps.net. Data can be entered via electronic forms that mirror the field forms. Critical fields are fixed with minimum and maximum value limitations that will not allow unreasonable data to be entered and help eliminate data entry errors. MiCorps and MLSA staff enter the remaining data into the system using the same web interface. Data sheets with missing or problem data are flagged for verification by the database manager. Once data are entered into the system, MiCorps staff briefly review all records

(as they come in) to verify that data entries are reasonable before considering the data “accepted.” Problematic data sheets are further reviewed and either rejected or flagged as “accepted, with comment”, and a comment describing the problem is entered. All data that are accepted (with or without comment) are then available for public review through the data view web interface.

Lab results for total phosphorus and chlorophyll *a* are submitted electronically from the DEQ Environmental Lab once or twice per year, as results are generated. The lab data are imported into the MDE after the metadata is completely entered. Lab records are manually matched with field records by comparing STORET codes (also known as Field ID number) and lake and county names.

From the MDE, results are tabulated for reporting in the annual report. Means, medians, ranges, and trophic state index values calculations and dissolved oxygen/temperature profile graphs are compiled using Excel spreadsheet data management format. Formulas are checked for accuracy and computations are spot checked to assure the formulas have been correctly applied and to minimize calculation or data handling errors. Once all data have been entered and reviewed for inclusion in the annual report, MiCorps staff randomly check the data entry for approximately 5-10% of the tabulated data for each parameter by comparing original field forms and lab analytical reports to the tabulated data.

O. Reports

2013 and earlier: An annual report is prepared each year for the CLMP that gives program summary information. The report is included on the MiCorps web-site. The report includes a general description of lake classification, eutrophication, measures of eutrophication and each water quality parameter monitored in the CLMP. Complete sampling results for Secchi disk, spring and summer total phosphorus and chlorophyll *a* are presented in tables. Representative sample results for dissolved oxygen/temperature and aquatic plant identification and mapping are included in the report. Summary results for each parameter are included in the report. In addition to the annual report, each lake that has been enrolled in the CLMP Secchi disk transparency, summer total phosphorus, and chlorophyll components for eight years or greater receives an apparent trend-line graph for that parameter. Reporting errors in the prior annual report are identified in the current report.

2014 and later: A data report is generated for each individual lake, giving trend graphs, results, and trophic status. A more general summary report is also produced, which gives program averages and a list of volunteers. All individual lake reports and the smaller annual report are available on the Micorps website.

P. Data Review, Validation and Verification Requirements

All CLMP field and laboratory data are reviewed by the MiCorps project specialists and the MDEQ program manager to determine if the data meet QAPP objectives. Decisions to reject or qualify data are made by the program manager and program specialists collaboratively after review and evaluation of the data.

Q. Data Validation and Verification Methods

The data are reviewed for outliers, unusual values, discrepancies between samples and replicates and discrepancies between volunteer collected data and MDEQ collected side-by-side data.

As noted previously, field collected data sheets are verified for acceptability during at least two points in the data review process. First, when the field sheets are entered into the data entry interface, the database is programmed to reject sheets with critical missing data or values exceeding criteria. Illegible or other problematic data sheets may be identified at this point. The data are further verified by the database manager after the sheets are entered into the system, but before they are made publicly available. Minor problems are noted in a comment field. All field forms remaining in the system are validated once the data entry error check is completed, and the error rate is below 5%. If any problems are identified the appropriate section of the table or the entire table is assessed and redone if necessary.

When problems are identified these data are compared with previously collected data to determine if they are within the target range of variability. If outside the target range of variability field sheets are reviewed to identify possible explanations. The volunteer sampler may be contacted to go over collection procedures, equipment performance, supplies used and unusual environmental conditions on the day of sampling. If necessary the sample may be rerun if still within holding times or the site may be re-sampled.

Replicate Sampling:

Each year a comparison is made of the volunteer collected samples and the replicates collected. Data from previous years to the current sampling event are plotted, graphed and assessed for agreement. Historically there has been a very high degree of agreement between the volunteer collected samples and replicates. Figure 3 illustrates the cumulative results for the replicate spring overturn total phosphorus samples since the quality assurance program was implemented in 1993. Figure 4 illustrates the cumulative results for the replicate late summer total phosphorus samples since this parameter was added to the CLMP in 1998. Figure 5 illustrates the cumulative results for the replicate summer chlorophyll *a* samples since this parameter was added to the CLMP in 1998.

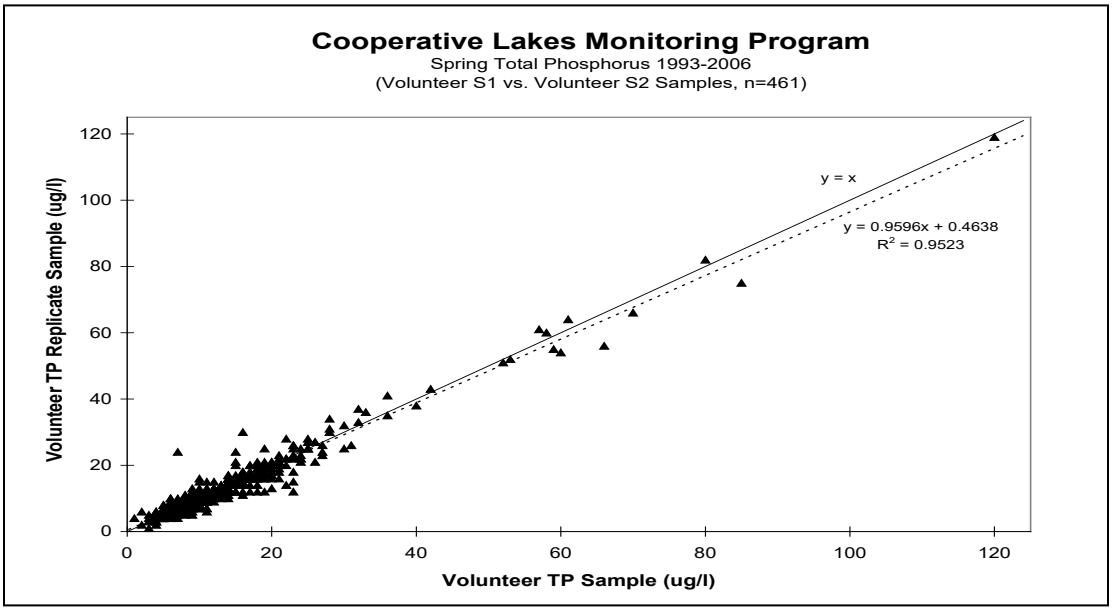

Figure 3. CLMP Spring Total Phosphorus Replicate Quality Assurance Samples.

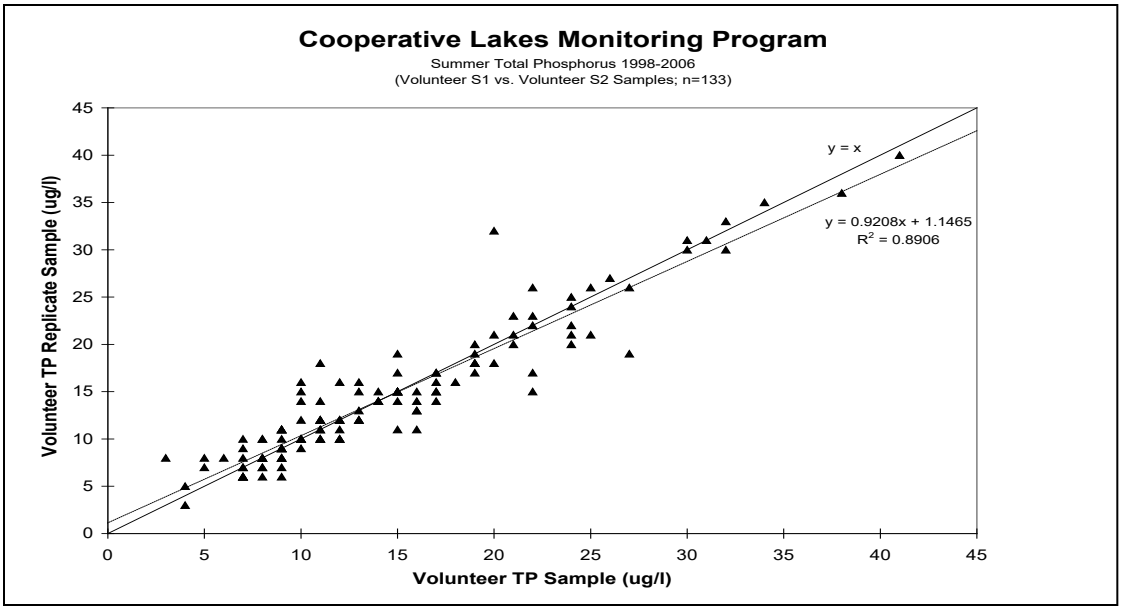

Figure 4. CLMP Late Summer Total Phosphorus Replicate Quality Assurance Samples.

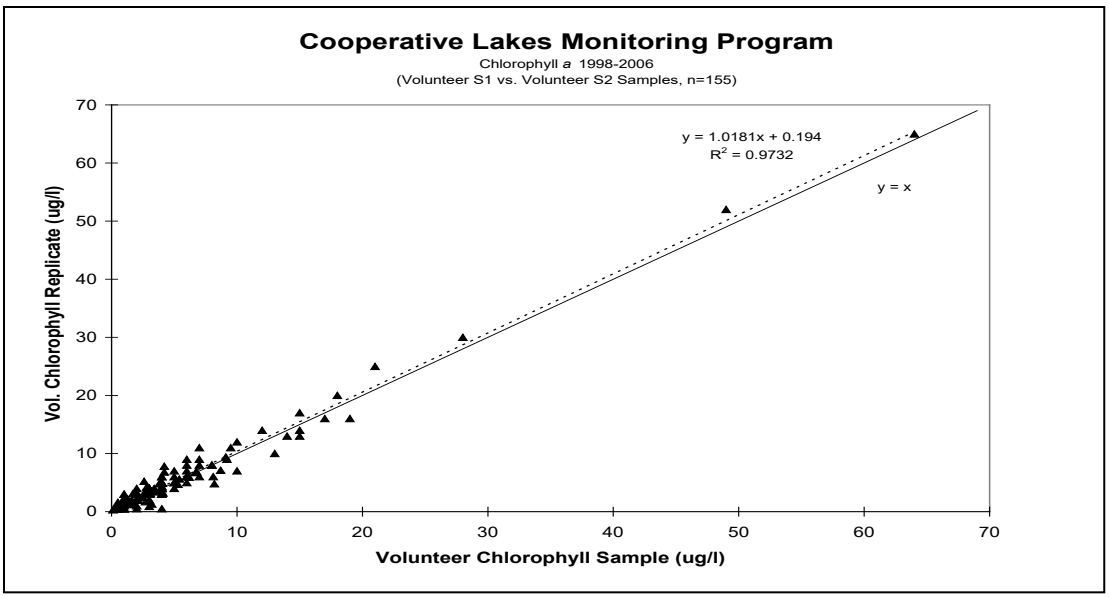

Figure 5. CLMP Summer Chlorophyll *a* Replicate Quality Assurance Samples.

The high correlation of agreement indicates that volunteer chlorophyll and phosphorus sampling are consistent.

Side-by-Side Sampling

In addition to the volunteer replicate agreement assessment, results of volunteer and professional sampling conducted side-by-side are compared annually. Data are plotted, graphed and assessed for agreement. Historically, there has been a high degree of agreement between results of the volunteer and professional side-by-side sampling efforts.

Phosphorus: DEQ samples yield slightly more phosphorus than volunteer samples, but there is no significant change in difference as phosphorus increases.

For Spring phosphorus (Figure 6), both the intercept and slope are close to an ideal distribution (intercept of 0, slope of 1.0). The intercept (1.3184 ug/L) is significantly different from 0, indicating that DEQ sampling methods result in slightly more phosphorus per sample. The slope (1.0293) is above 1.0, but not significantly different from the ideal 1.0, indicating little change in the DEQ-Volunteer relationship as phosphorus increases.

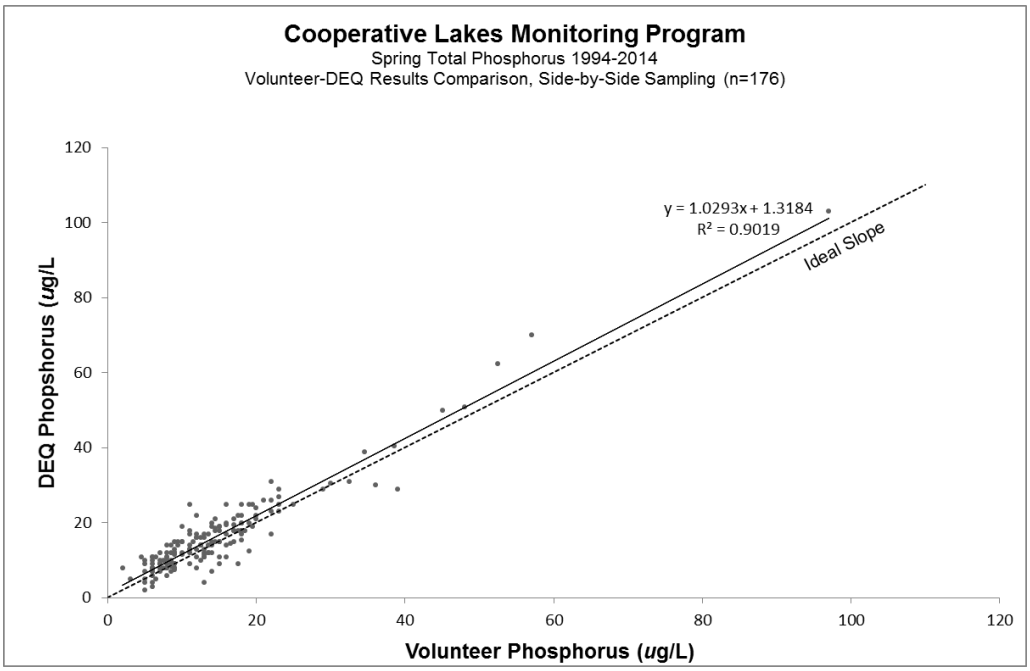

Figure 6. CLMP Spring Total Phosphorus Side-by-Side Quality Assurance Samples.

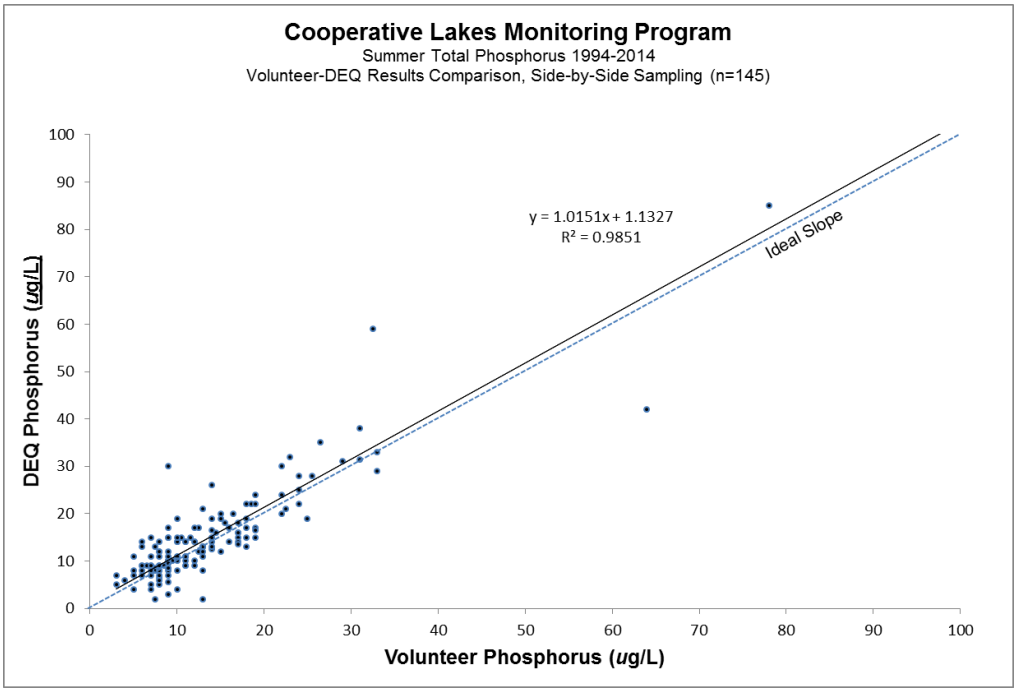

Figure 7. CLMP Late Summer Total Phosphorus Side-by-Side Quality Assurance Samples. Please note that a single very high summer phosphorus value (460-470 ug/l) was not depicted on the chart for illustration purposes, but was included in the analysis.

For Summer phosphorus (Figure 7), like Spring phosphorus, both the intercept and slope are close to, but slightly exceed, an ideal distribution (intercept of 0, slope of 1.0). The slope (1.0151) is slightly greater than the ideal 1.0, although the difference is not statistically significant. The intercept (1.1327 ug/L) is significantly different from 0,

The Spring and Summer phosphorus DEQ-Volunteer relationships are consistent. Slight but statistically significant higher DEQ intercepts, and slight but not significant slopes.

In lay terms, this means DEQ phosphorus values are consistently ~ 1 *u*g higher than volunteer values, and the relationship changes little as phosphorus increases.

The fractional but consistent exceedance of volunteer values by DEQ values likely results from the different preservation methods used by volunteers and DEQ. DEQ staff immediately preserve samples with sulfuric acid. However, sulfuric acid is not available to volunteers because of safety concerns.

Instead, volunteers preserve phosphorus samples by freezing, accomplished in home freezers upon return to shore after sampling. There may be a fractional loss of phosphorus from volunteer samples to sample container walls during the interval between sample collection and freezing.

Because of the lack of acidification, a small fraction of volunteer phosphorus may be lost to the sides of sample containers at each sample collection. This loss would not increase much with increasing phosphorus concentration if the available phosphorus binding sites were complexed by the initial fraction of phosphorus.

The side-by-side phosphorus comparisons indicate an acceptable degree of agreement between CLMP volunteer data and DEQ data.

Chlorophyll: Volunteer and DEQ results agree

For Chlorophyll (Figure 8), both the intercept and slope are close to an ideal distribution (intercept of 0, slope of 1.0). The intercept (0.4762 ug/L) is slightly above 0, but not significantly different from 0. The slope (1.0261) is slightly above 1.0, but not significantly different from the ideal 1.0.

The side-by-side chlorophyl comparisons indicate an acceptable degree of agreement between CLMP volunteer data and DEQ data.

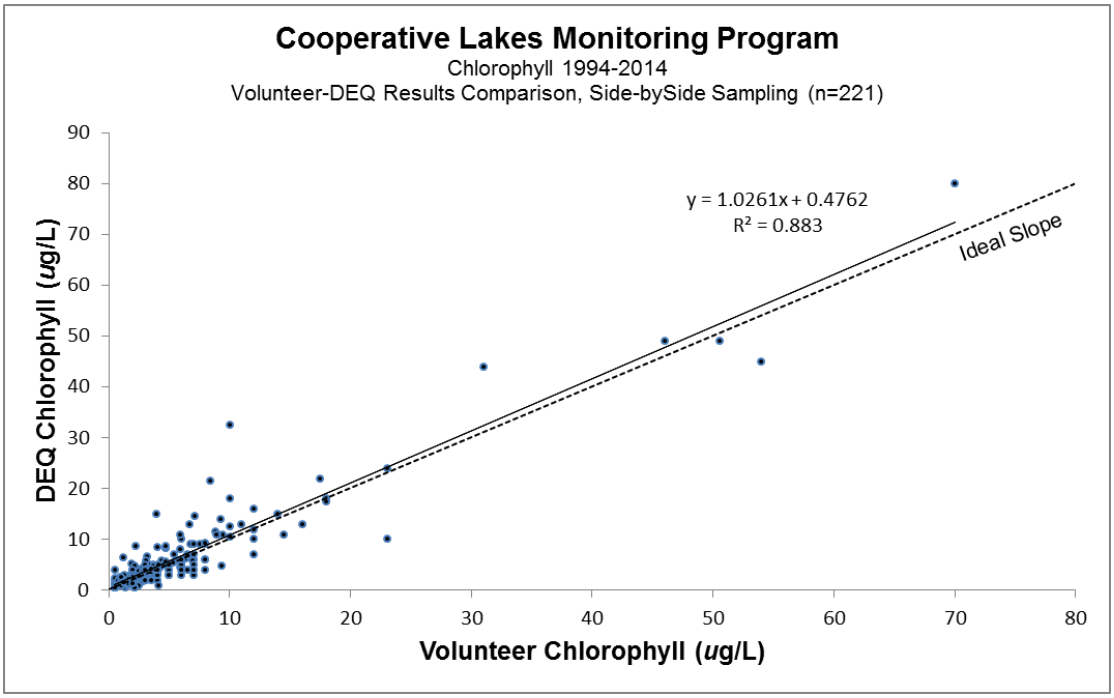

Figure 8. CLMP Chlorophyll *a* Side-by-Side Quality Assurance Samples.

R. Reconciliation with Data Quality Objectives

As soon as the data are reported from the laboratory for each CLMP parameter each year, the results are reviewed and evaluated both individually and collectively. The relative percent difference (RPD) is determined for the replicate and side-by-side data for the total phosphorus and chlorophyll parameters. An annual average RPD is calculated for each set of data and compared to the cumulative average RPD for each parameter. These data quality indicators are used to determine the precision and accuracy of the date as compared with the program specifications. If the data quality indicators do not meet the program specifications the data set will be evaluated and may be coded or discarded from the database. Individual data may also be coded if a problem was found in the sample collection, handling and shipping, processing, and laboratory analysis steps. The cause of failure will be evaluated and corrected. Any limitations on data use will be noted in the annual report and other documentation as needed. If failure to meet project specifications is found to be unrelated to equipment, methods, or sample error, specifications may be revised for the next sampling season and the QAPP will be updated.

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Appendix 1. CLMP Internal Planning Documents