

**2022 Cyanobacteria Monitoring Report for
Town of Brewster and the Brewster Ponds Coalition,
Massachusetts**

December 21, 2022

**Prepared for the Town of Brewster and the Brewster Ponds Coalition
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Table of Contents

Section Name	Page
1. SUMMARY	4
2. BACKGROUND	5
3. METHODS	6
Overview	6
Sampling Locations	7
Water Sampling	8
Field Observations	9
Lab Analysis	9
Interpretation of Results	10
Recommendations for Posting Use Restrictions and Advisories Reporting	13
4. RESULTS	14
Bakers Pond	14
Blueberry Pond	16
Cliff Pond	17
Cobbs Pond	20
Elbow Pond	22
Greenland Pond	24
Griffiths Pond	25
Lower Mill Pond	27
Long Pond	30
Myricks Pond	31
Owl Pond	33
Pine Pond	34
Schoolhouse Pond	35
Seymour Pond	38
Sheep Pond	40
Slough Pond	42
Upper Mill Pond	43
Walkers Pond	46
5. CONCLUSIONS	48
6. RECOMMENDATIONS	49
7. ACKNOWLEDGEMENTS	50
8. REFERENCES	50

Table of Contents Continued

APPENDICES

Appendix 1. Resources on Cyanobacteria	53
Appendix 2. APCC's Cyanobacteria Risk Categories	54
Appendix 3. Cyanobacteria Risk Comparison in Brewster Ponds in Brewster (2018-2022)	55
Appendix 4. Sample Site Locations	62

List of Tables and Figures

Table 1. Summary of Cyanobacteria Monitoring Results for Bakers Pond, Brewster	15
Table 2. Summary of Cyanobacteria Monitoring Results for Blueberry Pond, Brewster	16
Table 3. Summary of Cyanobacteria Monitoring Results for Cliff Pond, Brewster	18
Table 4. Summary of Cyanobacteria Monitoring Results for Cobbs Pond, Brewster	21
Table 5. Summary of Cyanobacteria Monitoring Results for Elbow Pond, Brewster	23
Table 6. Summary of Cyanobacteria Monitoring Results for Greenland Pond, Brewster	24
Table 7. Summary of Cyanobacteria Monitoring Results for Griffiths Pond, Brewster	26
Table 8. Summary of Cyanobacteria Monitoring Results for Lower Mill Pond, Brewster	28
Table 9. Summary of Cyanobacteria Monitoring Results for Long Pond, Brewster	30
Table 10. Summary of Cyanobacteria Monitoring Results for Myricks Pond, Brewster	32
Table 11. Summary of Cyanobacteria Monitoring Results for Owl Pond, Brewster	33
Table 12. Summary of Cyanobacteria Monitoring Results for Pine Pond, Brewster	34
Table 13. Summary of Cyanobacteria Monitoring Results for Schoolhouse Pond, Brewster	36
Table 14. Summary of Cyanobacteria Monitoring Results for Seymour Pond, Brewster	39
Table 15. Summary of Cyanobacteria Monitoring Results for Sheep Pond, Brewster	41
Table 16. Summary of Cyanobacteria Monitoring Results for Slough Pond, Brewster	42
Table 17. Summary of Cyanobacteria Monitoring Results for Upper Mill Pond, Brewster	44
Table 18. Summary of Cyanobacteria Monitoring Results for Walkers Pond, Brewster	47
Figure 1. Sampling Locations for Town of Brewster in 2022	7



2022 Cyanobacteria Monitoring Report for Brewster ponds, Brewster, Massachusetts

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1. SUMMARY

In 2022, the Association to Preserve Cape Cod (APCC) continued cyanobacteria monitoring in Brewster for the Brewster Ponds Coalition (BPC) and Town of Brewster, following similar monitoring from 2018 through 2021. From June through November, APCC conducted bi-weekly sampling in collaboration with BPC at 18 sampling locations (see Appendix 4 for a list of all sampling locations). BPC and APCC conducted 288 sampling events and collected a total of 288 samples and analyzed samples for cyanobacteria composition and phycocyanin, a cyanobacteria pigment that provides a measure of cyanobacteria biomass.

APCC utilizes a three-level risk characterization system known as “Risk Categories” to describe the results of cyanobacteria monitoring in terms of low, moderate, and high potential risks to human health and pets exposed to harmful cyanobacteria blooms (HCBs). The three Risk Categories are: “Acceptable” (low risk), “Potential for Concern” (moderate risk for humans and pets), and “Use Restriction Warranted” (high risk for humans and pets). In 2022, APCC incorporated complementary microcystin testing from the Barnstable County Department of Health and the Environment Water Quality Lab. Samples characterized by APCC as at risk for an exceedance of the Massachusetts Department of Public Health (MDPH) guidelines for microcystin in recreational waters of 8 parts per billion (ppb) were sent to the County Water Quality Lab for confirmatory testing. The lab then communicated confirmation of microcystin risks in terms of the state limit to APCC and the town health department.

During the 2022 monitoring season, cyanobacteria levels in Bakers Pond, Blueberry Pond, Cliff Pond, Cobbs Pond, Elbow Pond, Griffiths Pond, Lower Mill Pond, Myricks Pond, Schoolhouse Pond, Seymour Pond, Sheep Pond, Upper Mill Pond, and Walkers Pond reached APCC’s “Potential for Concern” Risk Category. Cliff Pond, Lower Mill Pond, Schoolhouse Pond, Sheep Pond, and Walkers Pond reached the higher “Use Restriction Warranted” Risk Category. The Town of Brewster Health Department followed up on APCC’s recommendations for responding to the “Use Restriction Warranted” Risk Category by issuing recreational advisories in these five ponds during periods of cyanobacteria bloom conditions. APCC sent 20 water samples from Cliff Pond, Cobbs Pond, Elbow Pond, Lower Mill Pond, Seymour Pond, Upper Mill Pond, and Walkers Pond to the County Water Quality Lab for testing for microcystin. Only one sample

exceeded state guidelines; Cliff Pond on September 3, 2022, was found to contain a microcystin concentration of <10,000 ppb. In at least one case, the monitoring data helped to predict an oncoming HCB. APCC shared all monitoring results with Town of Brewster and BPC and the public throughout the season via emailed updates, e-newsletters, frequent updates to our online map at <https://apcc.org/our-work/science/community-science/cyanobacteria/>, and written reports, including this report. This document should be printed in color, as some sections are color-coded.

2. BACKGROUND

APCC's Cyanobacteria Monitoring Program partners with officials at the town, county, state, and federal levels as well as local pond associations and residents to conduct cyanobacteria monitoring in Cape Cod ponds. Each season, water samples are collected and processed weekly and shared with local officials and the general public through reports, emails, and an interactive map of monitoring results provided on our website (<https://apcc.org/cyano>). Our goals are to raise public awareness of the health and ecological risks posed by HCBs, to help inform proper responses to cyanobacteria blooms to protect public health, to monitor priority ponds across the Cape, and to motivate public action to address the causes of HCBs by improving water quality.

Cyanobacteria are an ancient group of photosynthetic microorganisms common in freshwater systems on Cape Cod, in the U.S., and worldwide. Under the right conditions, they can multiply rapidly and form harmful cyanobacteria blooms. According to the Centers for Disease Control and Prevention, certain common cyanobacteria genera can produce toxins known as cyanotoxins that can be harmful to humans ([CDC](https://www.cdc.gov)). HCBs have increased worldwide, including in the U.S., due in part to nutrient enrichment and rising water temperatures due to climate change. As the occurrence of HCBs increases, the need for increased cyanobacteria monitoring and awareness has also increased. Additional resources on cyanobacteria are provided in Appendix 1.

Cape Cod ponds are commonly used for swimming, boating, paddle boarding, and fishing. Due to the increasing prevalence of HCBs and the resulting increased threat of public exposure to cyanobacteria and their toxins, MDPH provides guidelines for municipal officials to post and remove advisories at ponds based on established thresholds for cyanobacteria risks ([MDPH](https://www.mass.gov)). Frequent cyanobacteria monitoring of ponds provides the data for resource managers to track cyanobacteria trends in their ponds throughout the season, apply relevant public health criteria, and proactively post and remove recreational advisories. Cyanobacteria monitoring data also provide information on pond health and water quality and help to address data gaps caused by lack of conventional pond water quality monitoring data.

3. METHODS

Overview

APCC's Cyanobacteria Monitoring Program provides scientifically sound data on cyanobacteria community composition, biomass, and estimated toxin concentrations. Our program uses and follows the EPA's Quality Assurance Project Plan (QAPP) for cyanobacteria monitoring, developed by EPA for the Cyanobacteria Monitoring Collaborative or CMC ([CMC QAPP](#)). The CMC QAPP was developed by EPA Region 1 scientists, including Hillary Snook and others, with the goal of encouraging and facilitating widespread monitoring of cyanobacteria. The QAPP is based on methods created by EPA scientists and other cyanobacteria specialists, including Dr. James Haney at the University of New Hampshire Center for Freshwater Biology and Nancy Leland of Lim-Tex, Inc. The method involves taking concentrated samples of "Bloom Forming Colonies" (BFCs) of cyanobacteria through a 3-meter student plankton net tow and unconcentrated samples of "Whole Lake Water" (WLW) through a 1-meter integrated tube. Samples are then examined for cyanobacteria composition using microscopy. Cyanobacteria composition is important to document because toxicity varies according to cyanobacteria genus. Samples are also analyzed for phycocyanin concentrations using fluorometry. Phycocyanin is an algal pigment produced by cyanobacteria, different and distinct from chlorophyll, which is produced by algae and plants. Phycocyanin concentrations provide a measure of cyanobacteria biovolume and abundance. The combination of information on composition (obtained through microscopy) and information on cyanobacteria pigment concentrations enables an estimation of risk posed by cyanobacteria at the time of monitoring.

APCC also utilizes the CyanoCasting method developed by Nancy Leland ([Leland, 2018](#)), which builds on the methods described in the QAPP by including metrics that allow for the forecasting of potential imminent cyanobacteria blooms and estimates of cyanotoxin (i.e., microcystin) concentrations. The forecasting ability of this method provides valuable advance warnings of potential HCBs to inform proactive responses, such as increased sampling frequency or precautionary advisories of ponds to warn the public of the potential for cyanobacteria blooms. The ability to anticipate potential HCBs and estimate their microcystin concentrations based on frequent monitoring is a unique and valuable feature of APCC's program and stands in contrast to reactive responses involving measurement of cyanobacteria concentrations after a bloom has occurred ([Leland et al. 2018](#), [Leland et al 2019](#)).

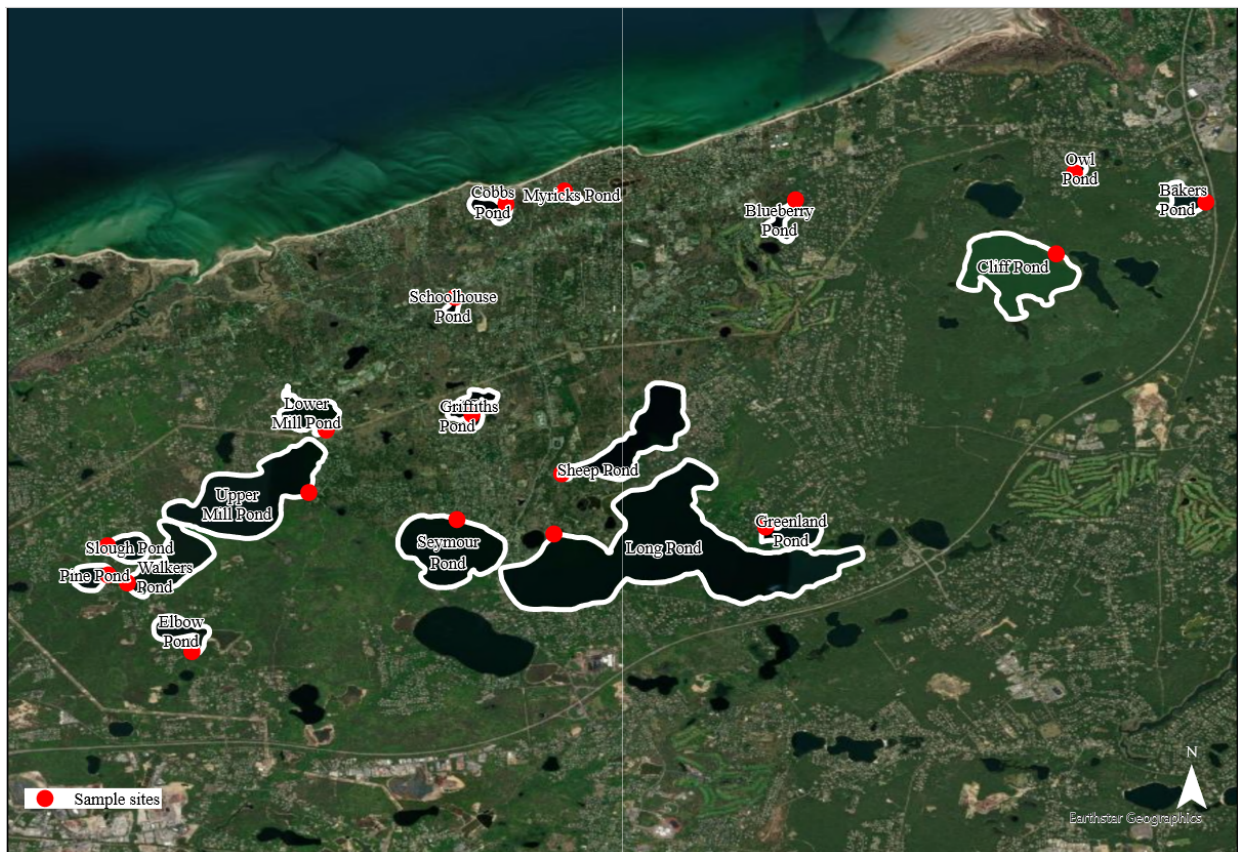
This year, as a complement to APCC's established monitoring program, the Barnstable County Department of Health and the Environment (BCDHE) Water Quality Lab expanded its cyanobacteria toxin testing capabilities to provide local officials with toxin measurements from ponds pre-screened by APCC as potentially containing cyanobacteria toxin levels of concern. The screening process was as follows: At each cyanobacteria sampling event, APCC collected separate water samples for toxin analysis if needed. APCC then analyzed cyanobacteria as described above and used the results to screen each pond. If samples had cyanobacteria results (i.e., risk categories) that indicated a possibility of an exceedance of state microcystin guidelines, APCC sent the separate water samples to the BCDHE Water Quality Lab to conduct confirmatory toxin testing of microcystin, one type of cyanobacteria toxin. Toxin test results

were then used to determine whether an advisory was warranted. If so, APCC provided a recommendation to the local health official to post an advisory. Local health officials are responsible for deciding whether to post advisories or not. To assist with decision-making, APCC conducted follow-up monitoring that included information on when cyanobacteria levels decreased to the point where an advisory, if posted, could be lifted.

Sampling Locations

This season, at least 12 samples were collected at each location on a bi-weekly basis between June and November. Samples were collected with BPC for the Town of Brewster at the locations shown in Figure 1.

Figure 1. Sampling Locations for BPC and the Town of Brewster in 2022.



Water Sampling

Water samples were collected by BPC citizen scientists with assistance from APCC staff and interns on a biweekly schedule, between June and November. At each sampling event, three samples were collected from shore, one using a 1-meter tube called the Whole Lake Water sample, a second using a 50-micron (um) mesh student plankton net called the Bloom Forming Colonies sample, and a third grab sample taken in a glass bottle with a PTFE-lined lid called the toxin sample. When cyanobacteria bloom material was found, a sample of the bloom material was taken for additional analysis. Between May 30, 2022, and November 11, 2022, APCC conducted 12 bi-weekly sampling events at each location for a total of 216 sampling events. Throughout the season extra off-week samples were taken if there was a concern that a cyanobacteria acceleration in growth could occur between the scheduled biweekly sampling events. There was a total of 72 extra samples taken from 15 ponds. The types of samples collected are described below.

Whole Lake Water (WLW) Sample

The sample taken from the 1-meter tube is called the Whole Lake Water (WLW) sample. This is an unconcentrated water sample containing cyanobacteria from the full extent of the 1-meter sampling depth from the surface to just above the bottom near shore. This sample is processed by APCC staff to obtain data on cyanobacteria size fractions in the water column. This process is further explained in the “Lab Analysis” section. This sample is not used to forecast future bloom accumulations, as it contains cyanobacteria currently in the water column near shore.

Bloom Forming Colonies (BFC) Sample

The second sample, which is taken through the student plankton net, is called the Bloom Forming Colonies (BFC) sample. This is a concentrated sample taken by towing the student plankton net across a 3-meter cast near the surface. This sample contains larger cyanobacteria colonies, which tend to form visible blooms and scums. Fundamentally, this sample is analogous to a natural cyanobacteria accumulation that may occur on a pond if the wind condensed cyanobacteria over a distance of 3 meters into a potentially harmful accumulation near shore. Nearshore accumulations of cyanobacteria are considered to pose a higher risk because this is where children and pets typically interact with the pond.

The concentrations of cyanobacteria in BFC samples can fluctuate dramatically and sudden or continuous increases of cyanobacteria concentrations in BFC samples can foreshadow cyanobacteria bloom formations in the near future. Understanding the toxin concentrations of this sample can also provide information on the likelihood of a future microcystin exceedance. This concept is discussed in more detail below.

Toxin Sample

The third sample is a simple grab sample using a 125 milliliter (mL) amber glass bottle with a PTFE-lined cap. This sample is called the toxin sample. When APCC's metrics using cyanobacteria composition and concentration indicate a likelihood that microcystin concentrations may exceed 8 parts per billion (ppb), APCC delivered this sample to the Barnstable County Water Quality Lab for analysis of microcystin.

Cyanobacteria Scum Sample

The fourth sample, taken only when needed, is called the scum sample and may contain cyanobacteria bloom material. Although visual evidence alone of potential cyanobacteria bloom material can be compelling, microscope and fluorometry analysis of the material can confirm whether the material is indeed a cyanobacteria bloom rather than an accumulation of other algae, diatoms, etc. Microscope analysis of the bloom material also provides information on the genus of cyanobacteria making up the bloom, giving an understanding of the types of toxins that may be present.

Field Observations

Field observations were documented at each sampling event by completion of a field data sheet with information on weather, visual appearance of pond surface, water temperature, etc. Photographs were taken of the pond's shoreline at each sampling event, providing documentation of pond appearance and visible conditions and evidence of bloom accumulations.

Lab Analysis

Sample processing

On the same day as sample collection, APCC processed and analyzed samples following our protocol. Triplicate 5 milliliter (mL) samples were taken of each of the 3 to 4 sample types: the WLW sample, the < 50 micron (μm) sample, the BFC sample, and the scum sample when possible cyanobacteria bloom material was discovered. The < 50 μm sample was isolated by filtering the WLW sample through a 50 micron (μm) filter, which resulted in a sample containing only the relatively small colonies of cyanobacteria. Smaller cyanobacteria, known as pico-cyanobacteria, are also believed to produce cyanotoxins at concerning levels. APCC has been contributing to Nancy Leland's research on these communities and we hope to apply these findings to inform our program in future seasons. The WLW and scum samples were processed without further action. The BFC sample was further separated through the use of Zappres (see EPA QAPP, [CMC QAPP](#)).

Microscopy

Using a microscope, APCC staff and interns counted colonies of cyanobacteria from a 1 mL sample from the BFC sample up to 100 colonies per mL. The information was used to estimate dominance of different cyanobacteria genera. If one genus was found to be the "dominant genus" (defined as 70% of the cyanobacteria community on the slide), then APCC targeted the toxins

produced by that genus of cyanobacteria as the toxins of concern for that pond at that time. If a scum sample was taken, APCC also analyzed it under the microscope to inspect genus composition and to confirm whether the scum was indeed composed of cyanobacteria.

Fluorometry to measure phycocyanin pigments

Each triplicate 5 mL sample was frozen and thawed for the purpose of lysing cells to liberate cyanobacteria pigments. Samples were then analyzed for cyanobacteria pigments (phycocyanin) and non-cyanobacteria algal pigments (chlorophyll-a) using a calibrated fluorometer in parts per billion (ppb). APCC uses phycocyanin concentrations in micrograms per liter (ug/L) as an indicator of cyanobacteria biomass rather than cell counts. Understanding cyanobacteria concentrations using fluorometry allows APCC to track cyanobacteria community trends over time. All data was stored on APCC's online server.

Microcystin Testing by County Water Quality Lab

At each sampling event, APCC collected extra samples for analysis of microcystin if cyanobacteria risk levels were in the "Use Restriction Warranted" category. To ensure that samples for toxin testing were collected on the same date, time, and place as samples for cyanobacteria monitoring, APCC collected GRAB samples for toxin analysis at the same time and location as our samples for cyanobacteria analyses. Samples for toxin analyses were collected and preserved according to MDPH and EPA protocols ([Local Public Health Institute of Massachusetts, Method 546](#)). In the event that APCC's cyanobacteria data indicated the likelihood of a microcystin exceedance, the corresponding GRAB sample(s) were sent to the County Water Quality Lab for toxin analysis. The BCDHE Water Quality Lab then forwarded the toxin testing results and recommendations of a recreational advisory, when warranted, to local officials and APCC. Toxin testing results supplemented APCC's cyanobacteria monitoring data. The simultaneous collection of samples for cyanobacteria and cyanotoxins helped to ensure that cyanotoxin analyses (if warranted) correspond to cyanobacteria monitoring data in terms of time and place. This proactive sampling approach avoids a common pitfall of reactive sampling that can occur when cyanobacteria monitoring data are collected on one date and confirmatory samples are collected several days to a week later when conditions may have changed.

Interpretation of Results

APCC staff interpreted the results within a guidance framework that incorporates the most recent scientific information as well as existing state and federal guidance ([EPA recreational waters, MDPH](#)).

Massachusetts Department of Public Health (MDPH) Guidelines for Cyanobacteria

The MDPH cyanobacteria webpage describes guidelines for cyanobacteria in recreational freshwater bodies that are described in italics as follows ("Guidelines for Cyanobacteria at Recreational Freshwater Locations") ([MDPH](#)). Italics indicates text taken directly from state and federal guidance documents and websites.

[Issuing a Public Health Advisory]

“DPH recommends issuing a public health advisory for HABs at recreational freshwater locations when at least one of the following criteria is met:

- 1. A visible cyanobacteria scum or mat is evident.*
- 2. Total cell count of cyanobacteria exceeds 70,000 cells/mL.*
- 3. Concentration of the toxin microcystins exceeds 8 µg/L; or*
- 4. Concentration of the toxin cylindrospermopsin exceeds 15 µg/L*

Guideline values are based on US Environmental Protection Agency ([US EPA](#)) and World Health Organization ([WHO 1999](#)) ([WHO 2003](#)) recommendations. When issuing an advisory, signage should be posted at each access point at the waterbody warning against any contact with the water.

Rescinding a Public Health Advisory

Cyanobacteria cells can release cyanotoxins into the water when they die. Therefore, algal toxins may be present when a visible scum or mat is no longer evident. DPH recommends the rescinding of a public health advisory after two successive samples, collected a week apart, demonstrate cell counts or toxin levels below the quantitative guideline values.” ([MDPH](#))

Cyanobacteria Risk Categories

APCC interpreted cyanobacteria data using a system called “Cyanobacteria Risk Categories.” This data interpretation system was created using guidance and feedback from cyanobacteria researchers, Cape Cod health agents, and state guidance. The criteria for the Risk Categories do not include cell counts or cylindrospermopsin (another cyanobacteria toxin), as neither APCC nor the BCDHE Water Quality Lab test for these metrics.

APCC tracked changes in cyanobacteria concentrations between each sampling event. The reason for tracking changes in cyanobacteria concentrations over time is that rapid growth rates, defined here as net daily cyanobacteria growth rates greater than or equal to 0.05, may indicate that a cyanobacteria bloom formation or microcystin exceedance is about to occur. Alternatively, the cyanobacteria concentrations may peak and then decrease before a cyanobacteria bloom or microcystin exceedance occurs. APCC recommended weekly testing of ponds where any APCC sample had a confirmed net daily cyanobacteria growth rate greater than or equal to 0.05. Before August 1, 2022, APCC would also place ponds in the “Potential for Concern” category for one week following a growth rate above 0.05. However, following new guidance from program partners, APCC began to not recommend a change in risk category based on cyanobacteria growth rate data alone starting August 1, 2022. Additionally, starting on August 1st, APCC would not calculate net daily cyanobacteria growth rates for phycocyanin values less than 5 ppb.

To assign a Cyanobacteria Risk Category to a pond for a given monitoring period, the most hazardous result among multiple criteria determined the risk category in which the pond was

placed. A pond that met even a single criterion in the “Use Restriction Warranted” category was placed in that category. Likewise, a pond that met even a single criterion in the “Potential for Concern” category, but did not meet any criteria in the “Use Restriction Warranted” category, was placed in the “Potential for Concern” category. If a pond met no criteria in the “Use Restriction Warranted” or the “Potential for Concern” categories, that pond was placed in the “Acceptable” category. All descriptions and criteria for these categories are summarized in Appendix 2 and discussed below.

APCC Cyanobacteria Risk Categories

Acceptable

Definition: No concerning cyanobacteria results at the time and place of sampling. To the best of APCC’s knowledge and based on our monitoring results, regular recreational usage of the pond is safe with respect to cyanobacteria and toxins. Map color is blue. Formerly the Low Warning Tier.

Recommended Sampling Frequency: Biweekly. In samples containing low levels of cyanobacteria with high growth rates APCC will recommend weekly sampling.

Recommended Action: None.

Potential for Concern

Definition: Monitoring results or the presence of cyanobacteria scum at the time and place of sampling indicate a potential for increased risk for exposure to cyanobacteria toxins approaching but below state standards. Conditions do not yet warrant the posting of a recreational human health advisory according to guidelines from the Massachusetts Department of Public Health (MDPH). While these conditions pose low health risks to adults, risks are higher for children or pets based on lower body mass, particularly if contaminated water is incidentally ingested. Children may inadvertently consume pond water while swimming and pet exposure can result from drinking or ingesting pond water or from grooming after swimming. Map color is yellow. Map color yellow with crosshatching indicates a municipal pet advisory has been issued. Formerly the Moderate Warning Tier^{1,2,4}.

Recommended Sampling Frequency: Weekly.

Recommended Action:

1. APCC or the town will provide a GRAB sample for toxin analysis to the Barnstable County Water Quality Lab for samples suspected of possibly exceeding the MDPH guidelines for microcystin in recreational waters.
2. The posting of a “Pet Advisory” or similar advisory according to municipal policies and procedures until the pond returns to “Acceptable” status.
3. Sampling should be increased to weekly until all results are once again in the “Acceptable” category.

Use Restriction Warranted

Definition: Monitoring results at the time and place of sampling indicate the pond is unsafe for recreation by humans and pets based on one or more of the following criteria: 1) presence of microcystin at or above state standards (8 ppb microcystin) as described in MDPH guidance, 2) presence of significant cyanobacteria scum layers according to MDPH guidance, 3) a municipal health agent issues a closure for any other reason related to cyanobacteria. Recreational risk to

adults is moderate following exposure. Recreational risks are especially high for children and pets following exposure through accidental ingestion of contaminated water. Children may inadvertently consume pond water while swimming and pet exposure can result from ingestion or directly drinking pond water or from grooming after swimming. Due to lower body masses, children and pets are more susceptible to cyanobacteria risks than adults. Map color is red. Map color red with crosshatching indicates a municipal advisory has been issued. Formerly the High Warning Tier³.

Recommended Sampling Frequency: Weekly.

Recommended Action:

1. APCC or the town will provide a GRAB sample for toxin analysis to the Barnstable County Water Quality Lab for samples suspected of possibly exceeding the MDPH guidelines for microcystin in recreational waters.
2. The town should post a recreational advisory or similar advisory according to municipal policies and procedures and otherwise notify the public to avoid contact and exposure until the pond meets criteria to be reopened or the advisory is lifted by the local health agent.
3. Sampling should be conducted weekly until there are two consecutive weeks when results include no significant cyanobacteria scum and toxin testing of samples contain a microcystin concentration below 8 ppb.

Recommendations for posting Use Restrictions and Advisories

Use restrictions and advisories are issued at the discretion of the municipal health agents. As of this date, there is no common set of guidelines in use by health agents across the Cape that provides consistency in posting criteria. As a result, members of the public are advised to contact the health agent in their town (see the contact list provided on APCC's website) to determine the official status of the pond in which they are interested. While ponds exceeding MDPH standards as discussed above were marked in red on APCC's map, this coloration does not always mean that a use restriction was issued by the town. APCC updates our list of restricted ponds as we are informed by the respective towns, but APCC does not speak for the towns unless otherwise and explicitly noted on our posting map.

APCC's recommendations for removing a recreational use advisory mirrors the reopening guidance from MDPH. For a microcystin toxin exceedance or cyanobacteria scum, APCC will recommend lifting a recreational use advisory or closure after two consecutive tests a week apart show microcystin concentrations less than 8 parts per billion (ppb) and little to no presence of cyanobacteria bloom material, depending on the basis for the original restriction. Health agents are solely responsible for the issuance and removal of recreational use advisories or closures related to water clarity, such as clarity less than 4 feet.

Reporting

Biweekly reports

APCC provided biweekly reports to report results to local municipal officials and pond associations. Depending on results, reports included recommendations concerning appropriate advisory posting or removal for the public to minimize or avoid risks due to cyanobacteria exposure. During periods of possible harmful cyanobacteria bloom formation requiring weekly sampling, additional reports and updates were sent to officials and pond associations as well. Pond associations play a key role in raising public awareness of cyanobacteria risks and alerting pond residents of cyanobacteria monitoring results throughout the season.

Interactive map

An interactive map is hosted on APCC's website where recent monitoring results were posted throughout the season. Updates were submitted on an automated basis at 7 p.m. on the same day as reports of results were emailed to town officials. In some cases, automated map updates were postponed a day if a town official requested additional time to review results before they would be posted. The interactive map is located at: <https://apcc.org/cyano>.

Email alerts

APCC provided an email registry signup on our website for an e-blast system designed to update interested residents about recent harmful cyanobacteria bloom discoveries. Residents could sign up for these Cyanobacteria Alerts throughout the season. The link for the Cyanobacteria Alert e-blast signup is located here <https://apcc.org/our-work/science/community-science/cyanobacteria/cyanobacteria-alert/>.

4. RESULTS

Cyanobacteria monitoring results, Risk Categories, and risk communication are described in this section. For each pond, a table is provided to describe results and risk category designations for each sampling event. A complete table of results is provided in Attachment 1 containing all data collected for BPC and the Town of Brewster in 2022. This table is formatted to be printed on an 11"x17" sheet. The full Risk Category criteria are included in Appendix 2. Data interpretation and risk communication to town officials and the public for each sampling event are described in this section as well.

Results for the sampling locations are described below. APCC sampled in collaboration with BPC from 18 locations (see Appendix 4 for sampling locations).

Bakers Pond

During the 2022 monitoring season, Bakers Pond experienced changes in cyanobacteria levels that at different times placed it in APCC's "Acceptable," and "Potential for Concern" Risk Categories (Table 1 below).

Following early “Acceptable” sampling events at Bakers Pond, the site reached the “Potential for Concern” category on 7/13/22, 7/20/22, and 7/27/22 due to elevated net daily cyanobacteria growth rates that exceeded 0.05. At these points, APCC increased sampling to weekly until the growth rates returned below 0.05. The pond also reached this category on 10/12/22 due to the presence of a small cyanobacteria scum that dissipated by the following week. Bakers Pond was “Acceptable” for the remainder of the sampling season.

Table 1. Summary of cyanobacteria monitoring results for Bakers Pond, Orleans, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
6/1/2022	Acceptable	<i>Dolichospermum</i> spp.	128	-
6/15/2022	Acceptable	N/A	2	-
6/29/2022	Acceptable	N/A	10	-
7/13/2022	Potential for Concern	<i>Dolichospermum</i> spp.	37	The BFC net daily cyanobacteria growth rate exceeded 0.05. Growth Rate: 0.10 (BFC)
7/20/2022	Potential for Concern	<i>Microcystis</i> spp.	59	The BFC net daily cyanobacteria growth rate exceeded 0.05. Growth Rate: 0.07 (BFC)
7/27/2022	Potential for Concern	<i>Dolichospermum</i> spp.	100	The BFC net daily cyanobacteria growth rates exceeded 0.05. Growth Rate: 0.08 (BFC)
8/2/2022	Acceptable	<i>Dolichospermum</i> spp.	6	-
8/10/2022	Acceptable	<i>Dolichospermum</i> spp.	39	-
8/18/2022	Acceptable	<i>Microcystis</i> spp.	15	-
8/22/2022	Acceptable	<i>Dolichospermum</i> spp.	71	-
8/31/2022	Acceptable	<i>Dolichospermum</i> spp.	24	-
9/7/2022	Acceptable	<i>Dolichospermum</i> spp.	17	-
9/21/2022	Acceptable	<i>Dolichospermum</i> spp.	33	-
9/28/2022	Acceptable	<i>Dolichospermum</i> spp.	24	-
10/5/2022	Acceptable	Mixed	57	-
10/12/2022	Potential for Concern	<i>Dolichospermum</i> spp.	153	A slight cyanobacteria scum present.
10/19/2022	Acceptable	N/A	90	-

11/2/2022	Acceptable	<i>Microcystis spp.</i>	2	-
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Blueberry Pond

During the 2022 monitoring season, Blueberry Pond experienced changes in cyanobacteria levels that at different times placed it in APCC’s “Acceptable” and “Potential for Concern” Risk Categories (Table 2 below).

After a few early season “Acceptable” results, Blueberry Pond reached APCC’s “Potential for Concern” category on 6/28/22 due to a net daily cyanobacteria growth rate that exceeded 0.05. At this point, APCC increased sampling to weekly until the growth rate returned below 0.05. Fortunately, this elevated growth rate did not result in cyanobacteria bloom formations nor toxin exceedances. Blueberry Pond was “Acceptable” for the remainder of the sampling season.

Blueberry Pond also experienced elevated net daily cyanobacteria growth rates on 8/23/22 prompting weekly sampling, however, due to a change in communication protocol beginning on August 1st, 2022 Blueberry Pond remained “Acceptable” on this date.

Table 2. Summary of cyanobacteria monitoring results for Blueberry Pond, Brewster, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
5/31/2022	Acceptable	N/A	39	-
6/14/2022	Acceptable	<i>Woronichinia spp.</i>	5	-
6/28/2022	Potential for Concern	N/A	10	The BFC net daily cyanobacteria daily cyanobacteria growth rates equaled 0.05. Net growth rates: 0.05 (BFC)
7/6/2022	Acceptable	N/A	3	-
7/12/2022	Acceptable	N/A	6	-
7/26/2022	Acceptable	<i>Anabeana spp.</i>	5	-
8/9/2022	Acceptable	N/A	6	-
8/23/2022	Acceptable	<i>Lyngbya spp.</i>	31	-
8/31/2022	Acceptable	N/A	0	-

9/6/2022	Acceptable	N/A	2	-
9/20/2022	Acceptable	N/A	3	-
10/4/2022	Acceptable	<i>Lyngbya</i> spp.	2	-
10/18/2022	Acceptable	N/A	2	-
11/1/2022	Acceptable	N/A	3	-

Cliff Pond

During the 2022 monitoring season, Cliff Pond experienced changes in cyanobacteria levels that at different times placed it in APCC’s “Acceptable,” “Potential for Concern,” and “Use Restriction Warranted” Risk Categories (Table 3 below).

After an initial “Acceptable” sampling event, Cliff Pond reached APCC’s “Potential for Concern” category on 6/14/22, 6/28/22, 7/12/22, 7/20/22, and 7/26/22 due to net daily cyanobacteria growth rates that exceeded 0.05. At these points, APCC increased sampling to weekly. The pond also reached this category on 8/2/22, and from 10/18/22 through 11/7/22 due to increased future microcystin concerns. The estimated microcystin from the BFC sample on these dates included values above 8 ppb, indicating the possibility of a microcystin exceedance in the near future. On 7/20/22, 8/23/22, 8/30/22, and 10/25/22, Cliff Pond reached APCC’s “Potential for Concern” category due to the presence of a small cyanobacteria scums. These accumulations did not warrant a recreational advisory.

From 9/3/22 until 10/4/22, Cliff Pond reached the “Use Restriction Warranted” due to the presence of large cyanobacteria bloom and a microcystin exceedance reported by the County Water Quality Lab. Recreational advisories were posted immediately by Nickerson State Park staff on 9/3/22 and the advisory was lifted by 10/4/22 once MDPH was able to collect and analyze two weekly samples which reported low results.

Cliff Pond also experienced elevated net daily cyanobacteria growth rate on 8/9/22 prompting weekly sampling, however, due to a change in communication protocol beginning on August 1st, 2022, Cliff Pond remained “Acceptable” on this date.

During the season, fourteen toxin samples from Cliff Pond were sent to the County Water Quality Lab for microcystin analysis including samples on 6/14/22, 7/12/22 through 8/2/22, 8/30/22 through 9/20/22, and 10/18/22 through 11/7/22. The County Lab reported microcystin results above 8 ppb for only one of these samples, although four of the samples contained above 4 ppb microcystin.

Table 3. Summary of cyanobacteria monitoring results for Cliff Pond, Brewster, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
5/31/2022	Acceptable	Mixed	26	-
6/14/2022	Potential for Concern	Mixed	362	The BFC net daily cyanobacteria growth rate exceeded 0.05. Net growth rate: 0.19 (BFC) Microcystin Result: ND
6/22/2022	Acceptable	<i>Microcystis</i> spp.	44	-
6/28/2022	Potential for Concern	<i>Dolichospermum</i> spp.	2,462	The BFC net daily cyanobacteria growth rate exceeded 0.05. Net growth rate: 0.67 (BFC)
7/5/2022	Acceptable	Mixed	723	-
7/12/2022	Potential for Concern	<i>Microcystis</i> spp.	284	BFC estimated microcystin concentration included values above 8 ppb. Microcystin Result: ND
7/20/2022	Potential for Concern	Mixed	781	Cyanobacteria scum present. The BFC net daily cyanobacteria growth rate exceeded 0.05. Net growth rate: 0.13 (BFC) Microcystin Result: 0.28 ppb.
7/26/2022	Potential for Concern	<i>Microcystis</i> spp.	415	BFC estimated microcystin concentration included values above 8 ppb. Microcystin Result: 0.43 ppb
8/2/2022	Potential for Concern	<i>Microcystis</i> spp.	736	BFC estimated microcystin concentration included values above 8 ppb. Microcystin Result: ND
8/9/2022	Acceptable	Mixed	386	-
8/18/2022	Acceptable	<i>Microcystis</i> spp.	113	-
8/23/2022	Potential for Concern	Mixed	572	Cyanobacteria scum present.

8/30/2022	Potential for Concern	Mixed	1,649	Cyanobacteria scum present. Microcystin Result: >5 ppb.
9/3/2022	Use Restriction Warranted	<i>Microcystis spp.</i>	5,096	Large cyanobacteria bloom present. Microcystin Result: >10,000 ppb.
9/6/2022	Use Restriction Warranted	<i>Dolichospermum spp.</i>	1,410	Recreational advisory posted due to cyanobacteria bloom and toxin exceedance on 9/3/22. Microcystin Result: 4.4 ppb.
9/13/2022	Use Restriction Warranted	<i>Dolichospermum spp.</i>	1,396	Awaiting additional testing from DPH to lift advisory. Microcystin Result: 1.3 ppb.
9/20/2022	Use Restriction Warranted	<i>Dolichospermum spp.</i>	974	Awaiting additional testing from DPH to lift advisory. Microcystin Result: 0.81 ppb.
9/27/2022	Use Restriction Warranted	<i>Dolichospermum spp.</i>	870	Awaiting additional testing from DPH to lift advisory.
10/4/2022	Acceptable	<i>Dolichospermum spp.</i>	350	-
10/18/2022	Potential for Concern	<i>Microcystis spp.</i>	1,309	BFC estimated microcystin concentration included values above 8 ppb. Microcystin Result: 1 ppb.
10/25/2022	Potential for Concern	<i>Microcystis spp.</i>	810	Cyanobacteria scum present. BFC estimated microcystin concentration included values above 8 ppb. Microcystin Result: 0.89 ppb
11/1/2022	Potential for Concern	<i>Microcystis spp.</i>	2,048	BFC estimated microcystin concentration included values above 8 ppb. Microcystin Result: 4.8 ppb.
11/7/2022	Potential for Concern	<i>Microcystis spp.</i>	704	BFC estimated microcystin concentration included values above 8 ppb. Microcystin Result: 4.2 ppb.

Cobbs Pond

During the 2022 monitoring season, Cobbs Pond experienced changes in cyanobacteria levels that at different times placed it in APCC's "Acceptable" and "Potential for Concern" Risk Categories (Table 4 below).

After an initial "Acceptable" sampling event at Cobbs Pond, the site reached APCC's "Potential for Concern" category on 6/14/22 and 6/28/22 due to net daily cyanobacteria growth rates that exceeded 0.05. At these points, APCC increased sampling to weekly until the growth rate returned below 0.05. Fortunately, these elevated growth rates did not result in cyanobacteria bloom formations nor toxin exceedances. Cobbs Pond was "Acceptable" for the remainder of the sampling season.

Cobbs Pond also experienced elevated net daily cyanobacteria growth rates on 8/9/22 and 9/6/22 prompting weekly sampling, however, due to a change in communication protocol beginning on August 1st, 2022 Cobbs Pond remained "Acceptable" on these dates.

During the season, one toxin sample from Cobbs Pond was sent to the County Water Quality Lab for microcystin analysis including a sample on 6/14/22. The County Lab reported microcystin results to be non-detectable for this sample.

Table 4. Summary of cyanobacteria monitoring results for Cobbs Pond, Brewster, MA.

Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
5/31/2022	Acceptable	<i>Woronichinia</i> spp.	10	-
6/14/2022	Potential for Concern	<i>Woronichinia</i> spp.	22	The BFC net daily cyanobacteria growth rates exceeded 0.05. Net growth rate: 0.06 (BFC). Microcystin Result: ND
6/22/2022	Acceptable	<i>Woronichinia</i> spp.	23	-
6/28/2022	Potential for Concern	<i>Woronichinia</i> spp.	15	The WLW net daily cyanobacteria growth rates exceeded 0.05. Net Growth Rates: 0.14 (WLW)
7/6/2022	Acceptable	<i>Woronichinia</i> spp.	21	-
7/12/2022	Acceptable	<i>Woronichinia</i> spp.	9	-
7/26/2022	Acceptable	Mixed	10	-
8/9/2022	Acceptable	Mixed	22	-
8/18/2022	Acceptable	<i>Anabaena</i> spp.	10	-
8/23/2022	Acceptable	<i>Dolichospermum</i> spp.	3	-
9/6/2022	Acceptable	<i>Anabaena</i> spp.	28	-
9/20/2022	Acceptable	<i>Anabaena</i> spp.	5	-
10/4/2022	Acceptable	<i>Anabaena</i> spp.	7	-
10/18/2022	Acceptable	<i>Oscillatoria</i> spp.	2	-
11/1/2022	Acceptable	<i>Anabaena</i> spp.	16	-

Elbow Pond

During the 2022 monitoring season, Elbow Pond experienced changes in cyanobacteria levels that at different times placed it in APCC's "Acceptable" and "Potential for Concern" Risk Categories (Table 5 below).

After an initial "Acceptable" sampling event at Elbow Pond, the site reached APCC's "Potential for Concern" category on 6/13/22 due to a net daily cyanobacteria growth rate that exceeded 0.05. At this point, APCC increased sampling to weekly until the growth rate returned below 0.05. Fortunately, this elevated growth rate did not result in cyanobacteria bloom formations nor toxin exceedances. Elbow Pond was "Acceptable" for the remainder of the sampling season.

Elbow Pond also experienced elevated net daily cyanobacteria growth rates on 9/8/22, 9/16/22 and 10/3/22 prompting weekly sampling, however, due to a change in communication protocol beginning on August 1st, 2022, Elbow Pond remained "Acceptable" on these dates.

During the season, one toxin sample from Elbow Pond was sent to the County Water Quality Lab for microcystin analysis including a sample on 6/13/22. The County Lab reported microcystin results to be non-detectable for this sample.

Table 5. Summary of cyanobacteria monitoring results for Elbow Pond, Brewster, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
5/31/2022	Acceptable	<i>Dolichospermum</i> spp.	289	-
6/13/2022	Potential for Concern	<i>Dolichospermum</i> spp.	454	The <50 net daily cyanobacteria growth rates exceeded 0.05. Net Growth Rates: 0.05 (<50) Microcystin Result: ND
6/22/2022	Acceptable	<i>Dolichospermum</i> spp.	22	-
6/27/2022	Acceptable	N/A	18	-
7/11/2022	Acceptable	<i>Lyngbya</i> spp.	4	-
7/25/2022	Acceptable	<i>Anabaena</i> spp.	2	-
8/8/2022	Acceptable	<i>Microcystis</i> spp.	0	-
8/22/2022	Acceptable	N/A	5	-
9/8/2022	Acceptable	<i>Dolichospermum</i> spp.	326	-
9/16/2022	Acceptable	N/A	1	-
9/19/2022	Acceptable	<i>Dolichospermum</i> spp.	53	-
10/3/2022	Acceptable	<i>Dolichospermum</i> spp.	182	-
10/12/2022	Acceptable	<i>Dolichospermum</i> spp.	5	-
10/17/2022	Acceptable	<i>Dolichospermum</i> spp.	22	-
10/31/2022	Acceptable	N/A	17	-

Greenland Pond

During the 2022 monitoring season, Greenland Pond contained no concerning cyanobacteria results at the time and place of each sampling event, keeping the pond in APCC’s “Acceptable” category for the entire season. (Table 6 below).

Table 6. Summary of cyanobacteria monitoring results for Greenland Pond, Brewster, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
5/31/2022	Acceptable	<i>Woronichinia</i> spp.	5	-
6/13/2022	Acceptable	N/A	2	-
6/27/2022	Acceptable	N/A	5	-
7/11/2022	Acceptable	Mixed	6	-
7/25/2022	Acceptable	N/A	0	-
8/8/2022	Acceptable	N/A	0	-
8/22/2022	Acceptable	N/A	11	-
9/8/2022	Acceptable	<i>Aphanizomenon</i> spp.	0	-
9/19/2022	Acceptable	N/A	5	-
10/3/2022	Acceptable	<i>Dolichospermum</i> spp.	0	-
10/17/2022	Acceptable	N/A	1	-
10/31/2022	Acceptable	N/A	3	-

Griffiths Pond

During the 2022 monitoring season, Griffiths Pond experienced changes in cyanobacteria levels that at different times placed it in APCC's "Acceptable" and "Potential for Concern" Risk Categories (Table 7 below).

After initial "Acceptable" sampling events, Griffiths Pond reached APCC's "Potential for Concern" category on 6/28/22, 7/12/22, and 7/20/22 due to net daily cyanobacteria growth rates that exceeded 0.05. At these points, APCC increased sampling to weekly until the growth rates returned below 0.05. Fortunately, these elevated growth rates did not result in cyanobacteria bloom formations nor toxin exceedances. Griffiths Pond was "Acceptable" for the remainder of the sampling season.

Griffiths Pond also experienced elevated net daily cyanobacteria growth rates on 8/23/22 and 9/20/22 prompting weekly sampling, however, due to a change in communication protocol beginning on August 1st, 2022, Griffiths Pond remained "Acceptable" on these dates.

Table 7. Summary of cyanobacteria monitoring results for Griffiths Pond, Brewster, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
5/31/2022	Acceptable	Mixed	5	-
6/14/2022	Acceptable	<i>Microcystis</i> spp.	4	-
6/28/2022	Potential for Concern	N/A	27	The BFC net daily cyanobacteria growth rates exceeded 0.05. Net Growth Rates: 0.14 (BFC)
7/5/2022	Acceptable	N/A	11	-
7/12/2022	Potential for Concern	N/A	20	The WLW and BFC net daily cyanobacteria growth rates exceeded 0.05. Net Growth Rates: 0.13 (WLW) and 0.09 (BFC)
7/20/2022	Potential for Concern	<i>Aphanizomenon</i> spp.	39	The BFC net daily cyanobacteria growth rate exceeded 0.05. Net Growth Rates: 0.09 (BFC)
7/26/2022	Acceptable	<i>Dolichospermum</i> spp.	20	-
8/9/2022	Acceptable	<i>Dolichospermum</i> spp.	9	-
8/23/2022	Acceptable	N/A	38	-
8/30/2022	Acceptable	N/A	10	-
9/6/2022	Acceptable	N/A	9	-
9/20/2022	Acceptable	<i>Dolichospermum</i> spp.	22	-
9/27/2022	Acceptable	N/A	9	-
10/4/2022	Acceptable	N/A	4	-
10/18/2022	Acceptable	<i>Microcystis</i> spp.	3	-
11/1/2022	Acceptable	N/A	2	-

Lower Mill Pond

During the 2022 monitoring season, Lower Mill Pond experienced changes in cyanobacteria levels that at different times placed it in APCC's "Acceptable," "Potential for Concern," and "Use Restriction Warranted" Risk Categories (Table 8 below).

After early season "Acceptable" sampling events, Lower Mill Pond reached APCC's "Potential for Concern" category on 6/28/22, 7/12/22, 7/20/22, and 7/26/22 due to a net daily cyanobacteria growth rate that exceeded 0.05. In addition, the sampling event on 7/20/22 included the presence of a small cyanobacteria scum. This accumulation did not warrant a recreational advisory. At these points, APCC increased sampling to weekly until the growth rate returned below 0.05. Fortunately, these elevated growth rates did not result in significant cyanobacteria bloom formations nor toxin exceedances.

Lower Mill Pond then reached the "Use Restriction Warranted" category from 8/9/22 through 8/23/22, 9/13/22 through 9/20/22, and 9/28/22 through 10/24/22, and on 9/16/22 due to the presence of large cyanobacteria blooms. Recreational advisories were posted immediately by the Town Health Department during these times and they remained in place until the pond met the criteria for lifting each advisory. Lower Mill Pond was then "Acceptable" for the remainder of the sampling season.

Lower Mill Pond also experienced elevated net daily cyanobacteria growth rates on 8/2/22, 8/23/22, 9/6/22, 9/20/22, and 10/24/22 prompting weekly sampling, however, due to a change in communication protocol beginning on August 1st, 2022, Lower Mill Pond remained "Acceptable" on these dates.

During the season, one toxin sample from Lower Mill Pond was sent to the County Water Quality Lab for microcystin analysis including a sample on 8/5/22. The County Lab reported microcystin results to be non-detectable for this result.

Table 8. Summary of cyanobacteria monitoring results for Lower Mill Pond, Brewster, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
5/17/2022	Acceptable	<i>Woronichinia</i> spp.	7	-
5/31/2022	Acceptable	NA	8	-
6/14/2022	Acceptable	NA	4	-
6/28/2022	Potential for Concern	<i>Dolichospermum</i> spp.	13	The WLW and BFC net daily cyanobacteria growth rates exceeded 0.05. Net Growth Rates: 0.09 (WLW) and 0.08 (BFC)
7/6/2022	Acceptable	<i>Dolichospermum</i> spp.	15	-
7/12/2022	Potential for Concern	<i>Dolichospermum</i> spp.	45	The WLW and BFC net daily cyanobacteria growth rates exceeded 0.05. Net Growth Rates: 0.10 (WLW) and 0.19 (BFC)
7/20/2022	Potential for Concern	Mixed	604	Cyanobacteria scum present. The <50, WLW and BFC net daily cyanobacteria growth rates exceeded 0.05. Net Growth Rates: 0.10 (<50), 0.09 (WLW) and 0.33 (BFC).
7/26/2022	Potential for Concern	<i>Dolichospermum</i> spp.	288	The <50 and WLW net daily cyanobacteria growth rates exceeded 0.05. Net Growth Rates: 0.14 (<50) and 0.14 (WLW).
8/2/2022	Acceptable	<i>Dolichospermum</i> spp.	365	-
8/9/2022	Use Restriction Warranted	<i>Dolichospermum</i> spp.	274	Large cyanobacteria bloom present. Microcystin Result: ND
8/17/2022	Use Restriction Warranted	<i>Dolichospermum</i> spp.	1750	Recreational advisory posted due to large

				cyanobacteria bloom on 8/5/22.
8/23/2022	Acceptable	<i>Dolichospermum</i> spp.	444	-
8/30/2022	Acceptable	<i>Dolichospermum</i> spp.	92	-
9/6/2022	Acceptable	<i>Dolichospermum</i> spp.	241	-
9/16/2022	Use Restriction Warranted	<i>Dolichospermum</i> spp.	56	Large cyanobacteria bloom present on 9/13/22.
9/20/2022	Acceptable	<i>Dolichospermum</i> spp.	203	-
9/28/2022	Use Restriction Warranted	<i>Dolichospermum</i> spp.	300	Large cyanobacteria bloom present on 9/29/22.
10/4/2022	Use Restriction Warranted	<i>Dolichospermum</i> spp.	325	Recreational advisory posted due to large cyanobacteria bloom on 9/29/22.
10/12/2022	Use Restriction Warranted	<i>Dolichospermum</i> spp.	110	Large cyanobacteria bloom present.
10/19/2022	Use Restriction Warranted	<i>Dolichospermum</i> spp.	26	Recreational advisory posted due to large cyanobacteria bloom on 9/29/22.
10/24/2022	Acceptable	<i>Dolichospermum</i> spp.	50	-
11/1/2022	Acceptable	<i>Lyngbya</i> spp.	4	-

Long Pond

During the 2022 monitoring season, Long Pond contained no concerning cyanobacteria results at the time and place of each sampling event, keeping the pond in APCC’s “Acceptable” category for the entire season. (Table 9 below).

Long Pond also experienced elevated net daily cyanobacteria growth rates on 8/10/22, 8/24/22, and 8/31/22 prompting weekly sampling, however, due to a change in communication protocol beginning on August 1st, 2022, Long Pond remained “Acceptable” on these dates.

Table 9. Summary of cyanobacteria monitoring results for Long Pond, Brewster MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
6/1/2022	Acceptable	N/A	1	-
6/15/2022	Acceptable	N/A	1	-
6/29/2022	Acceptable	N/A	3	-
7/13/2022	Acceptable	N/A	14	-
7/27/2022	Acceptable	Mixed	6	-
8/10/2022	Acceptable	<i>Dolichospermum</i> spp.	50	-
8/18/2022	Acceptable	<i>Dolichospermum</i> spp.	10	-
8/24/2022	Acceptable	<i>Dolichospermum</i> spp.	13	-
8/31/2022	Acceptable	<i>Dolichospermum</i> spp.	28	-
9/7/2022	Acceptable	<i>Dolichospermum</i> spp.	28	-
9/21/2022	Acceptable	<i>Dolichospermum</i> spp.	19	-
10/5/2022	Acceptable	<i>Lyngbya</i> spp.	5	-
10/19/2022	Acceptable	<i>Lyngbya</i> spp.	16	-
11/2/2022	Acceptable	N/A	8	-

Myricks Pond:

During the 2022 monitoring season, Myricks Pond experienced changes in cyanobacteria levels that at different times placed it in APCC's "Acceptable" and "Potential for Concern" Risk Categories (Table 10 below).

After a few early season "Acceptable" sampling events, Myricks Pond reached APCC's "Potential for Concern" category on 7/11/22 and 7/25/22 due to net daily cyanobacteria growth rates that exceeded 0.05. At these points, APCC increased sampling to weekly until the growth rates returned below 0.05. Myricks Pond also reached this category on 8/22/22 and 8/29/22 due to the presence of small cyanobacteria scums. These accumulations did not warrant recreational advisories. Fortunately, these elevated growth rates and small cyanobacteria scums did not result in larger cyanobacteria bloom formations nor toxin exceedances. Myricks Pond was "Acceptable" for the remainder of the sampling season.

Myricks Pond also experienced elevated net daily cyanobacteria growth rates on 8/2/22, 9/8/22 and 9/16/22 prompting weekly sampling, however, due to a change in communication protocol beginning on August 1st, 2022, Myricks Pond remained "Acceptable" on these dates.

Table 10. Summary of cyanobacteria monitoring results for Myricks Pond, Brewster, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
6/13/2022	Acceptable	<i>Anabaena</i> spp.	31	-
6/27/2022	Acceptable	N/A	17	-
7/11/2022	Potential for Concern	<i>Oscillatoria</i> spp.	38	The BFC net daily cyanobacteria growth rates exceeded 0.05. Net Growth Rates: 0.06 (BFC)
7/18/2022	Acceptable	<i>Anabaena</i> spp.	11	-
7/25/2022	Potential for Concern	<i>Anabaena</i> spp.	11	The <50 and WLW net daily cyanobacteria growth rates exceeded 0.05. Net Growth Rates: 0.07 (<50) and 0.13 (WLW)
8/2/2022	Acceptable	<i>Anabaena</i> spp.	30	
8/8/2022	Acceptable	<i>Anabaena</i> spp.	34	-
8/22/2022	Potential for Concern	<i>Anabaena</i> spp.	101	Small cyanobacteria scum present.
8/29/2022	Potential for Concern	<i>Anabaena</i> spp.	48	Small cyanobacteria scum present
9/8/2022	Acceptable	<i>Anabaena</i> spp.	112	-
9/16/2022	Acceptable	<i>Anabaena</i> spp.	57	-
9/19/2022	Acceptable	<i>Dolichospermum</i> spp.	26	-
10/3/2022	Acceptable	<i>Anabaena</i> spp.	48	-
10/24/2022	Acceptable	N/A	24	-
10/31/2022	Acceptable	<i>Anabaena</i> spp.	1	-

Owl Pond

During the 2022 monitoring season, Owl Pond contained no concerning cyanobacteria results at the time and place of each sampling event, keeping the pond in APCC’s “Acceptable” category for the entire season. (Table 11 below).

Table 11. Summary of cyanobacteria monitoring results for Owl Pond, Brewster MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
6/1/2022	Acceptable	N/A	2	-
6/15/2022	Acceptable	N/A	44	-
6/29/2022	Acceptable	<i>Nostoc</i> spp.	5	-
7/13/2022	Acceptable	N/A	6	-
7/27/2022	Acceptable	N/A	3	-
8/10/2022	Acceptable	N/A	2	-
8/24/2022	Acceptable	N/A	5	-
9/7/2022	Acceptable	N/A	7	-
9/21/2022	Acceptable	N/A	9	-
10/5/2022	Acceptable	N/A	6	-
10/19/2022	Acceptable	<i>Dolichospermum</i> spp.	2	-
11/2/2022	Acceptable	N/A	3	-

Pine Pond

During the 2022 monitoring season, Pine Pond contained no concerning cyanobacteria results at the time and place of each sampling event, keeping the pond in APCC’s “Acceptable” category for the entire season. (Table 12 below).

Table 12. Summary of cyanobacteria monitoring results for Pine Pond, Brewster, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
5/31/2022	Acceptable	N/A	111	-
6/14/2022	Acceptable	N/A	2	-
6/28/2022	Acceptable	N/A	3	-
7/12/2022	Acceptable	N/A	1	-
7/26/2022	Acceptable	N/A	6	-
8/9/2022	Acceptable	N/A	3	-
8/23/2022	Acceptable	N/A	2	-
9/6/2022	Acceptable	N/A	8	-
9/16/2022	Acceptable	N/A	3	-
9/20/2022	Acceptable	N/A	9	-
10/4/2022	Acceptable	N/A	3	-
10/18/2022	Acceptable	N/A	2	-
11/1/2022	Acceptable	N/A	9	-

Schoolhouse Pond

During the 2022 monitoring season, Schoolhouse Pond experienced changes in cyanobacteria levels that at different times placed it in APCC's "Acceptable," "Potential for Concern," and "Use Restriction Warranted" Risk Categories (Table 13 below).

Schoolhouse Pond reached APCC's "Potential for Concern" category on 6/29/22, 7/13/22, and 7/27/22 due to net daily cyanobacteria growth rates that exceeded 0.05. At these points, APCC increased sampling to weekly until the growth rates returned below 0.05. Schoolhouse Pond also reached this category on 8/2/22 and 8/31/22 due to the presence of small cyanobacteria scums. These accumulations did not warrant a recreational advisory. From 8/10/22 through 8/24/22, Schoolhouse Pond reached the "Use Restriction Warranted" due to the presence of a large cyanobacteria bloom. A recreational advisory was posted immediately by the Town Health Department and it remained in place until the pond met the criteria for the advisory to be lifted. Schoolhouse Pond was "Acceptable" for the remainder of the sampling season.

Schoolhouse Pond also experienced elevated net daily cyanobacteria growth rates on 8/24/22, 9/21/22, 9/28/22, 10/17/22 and 10/31/22 prompting weekly sampling, however, due to a change in communication protocol beginning on August 1st, 2022 Schoolhouse Pond remained "Acceptable" on these dates.

Table 13. Summary of cyanobacteria monitoring results for Schoolhouse Pond, Brewster MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
6/1/2022	Acceptable	<i>Woronichinia</i> spp.	6	-
6/15/2022	Acceptable	<i>Woronichinia</i> spp.	10	-
6/29/2022	Potential for Concern	<i>Dolichospermum</i> spp.	51	The BFC net daily cyanobacteria growth rates exceeded 0.05. Net growth rates: 0.12 (BFC)
7/6/2022	Acceptable	<i>Dolichospermum</i> spp.	6	-
7/13/2022	Potential for Concern	<i>Dolichospermum</i> spp.	327	The <50, WLW, and BFC net daily cyanobacteria growth rates exceeded 0.05. Net growth rates: 0.21 (<50), 0.18 (WLW) and 0.58 (BFC)
7/20/2022	Acceptable	N/A	12	-
7/27/2022	Potential for Concern	<i>Dolichospermum</i> spp.	27	The BFC net daily cyanobacteria growth rates exceeded 0.05. Net growth rates: 0.12 (BFC)
8/2/2022	Potential for Concern	<i>Dolichospermum</i> spp.	101	Small cyanobacteria scum present.
8/10/2022	Use Restriction Warranted	<i>Dolichospermum</i> spp.	4,271	Large cyanobacteria bloom present.
8/17/2022	Use Restriction Warranted	<i>Dolichospermum</i> spp.	49	Recreational advisory posted due to large cyanobacteria bloom on 8/10.
8/24/2022	Acceptable	<i>Dolichospermum</i> spp.	704	-
8/31/2022	Potential for Concern	<i>Dolichospermum</i> spp.	190	Small cyanobacteria scum present.
9/7/2022	Acceptable	<i>Dolichospermum</i> spp.	31	-
9/21/2022	Acceptable	<i>Dolichospermum</i> spp.	175	-
9/28/2022	Acceptable	<i>Dolichospermum</i> spp.	196	-
10/4/2022	Acceptable	<i>Dolichospermum</i> spp.	120	-

10/17/2022	Acceptable	<i>Dolichospermum</i> spp.	56	-
10/24/2022	Acceptable	<i>Dolichospermum</i> spp.	14	-
10/31/2022	Acceptable	Mixed	330	-

Seymour Pond

During the 2022 monitoring season, Seymour Pond experienced changes in cyanobacteria levels that at different times placed it in APCC's "Acceptable" and "Potential for Concern" Risk Categories (Table 14 below).

After an initial "Acceptable" sampling event, Seymour Pond reached APCC's "Potential for Concern" category on 6/13/22 and 6/22/22 due to net daily cyanobacteria growth rates that exceeded 0.05. The sampling event on 6/13/22 also included the presence of a small cyanobacteria scum which fortunately dissipated by the following week. At these points, APCC increased sampling to weekly until the growth rates returned below 0.05. Seymour Pond was "Acceptable" for the remainder of the sampling season.

Seymour Pond also experienced elevated net daily cyanobacteria growth rates on 10/3/22 and 10/17/22 prompting weekly sampling, however, due to a change in communication protocol beginning on August 1st, 2022 Seymour Pond remained "Acceptable" on these dates.

During the season, one toxin sample from Seymour Pond was sent to the County Water Quality Lab for microcystin analysis including a sample on 6/13/2022. The County Lab reported microcystin results to be non-detectable for this sample.

Table 14. Summary of cyanobacteria monitoring results for Seymour Pond, Brewster, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
5/31/2022	Acceptable	<i>Dolichospermum</i> spp.	12	-
6/13/2022	Potential for Concern	<i>Dolichospermum</i> spp.	270	In this category due to a slight cyanobacteria scum. The BFC net daily cyanobacteria growth rates exceeded 0.05. Net growth rates: 0.24 (BFC) Microcystin Result: ND
6/22/2022	Potential for Concern	<i>Dolichospermum</i> spp.	8	The <50 net daily cyanobacteria growth rates exceeded 0.05. Net Growth Rates:0.10 (<50).
6/27/2022	Acceptable	Mixed	4	-
7/11/2022	Acceptable	Mixed	4	-
7/25/2022	Acceptable	N/A	4	-
8/8/2022	Acceptable	N/A	1	-
8/22/2022	Acceptable	N/A	9	-
9/8/2022	Acceptable	<i>Dolichospermum</i> spp.	4	-
9/19/2022	Acceptable	<i>Dolichospermum</i> spp.	8	-
10/3/2022	Acceptable	<i>Lyngbya</i> spp.	30	-
10/12/2022	Acceptable	N/A	10	-
10/17/2022	Acceptable	<i>Dolichospermum</i> spp.	20	-
10/24/2022	Acceptable	N/A	4	-
10/31/2022	Acceptable	N/A	5	-

Sheep Pond

During the 2022 monitoring season, Sheep Pond experienced changes in cyanobacteria levels that at different times placed it in APCC's "Acceptable," "Potential for Concern," and "Use Restriction Warranted" Risk Categories (Table 15 below).

Sheep Pond reached APCC's "Potential for Concern" category on 6/1/22 due to a net daily cyanobacteria growth rate that exceeded 0.05. At this point, APCC increased sampling to weekly until the growth rate returned below 0.05. From 10/24/22 through 11/8/22, Sheep Pond reached the "Use Restriction Warranted" category due to the presence of a large cyanobacteria bloom. A recreational advisory was posted immediately by the town health department and it remained in place until the pond met the criteria for the advisory to be lifted. Sheep Pond was "Acceptable" for the remainder of the sampling season.

Sheep Pond also experienced elevated net daily cyanobacteria growth rates on 8/10/22, 8/18/22, 8/24/22, 10/19/22 and 10/24/22 prompting weekly sampling, however, due to a change in communication protocol beginning on August 1st, 2022, Sheep Pond remained "Acceptable" on these dates.

Table 15. Summary of cyanobacteria monitoring results for Sheep Pond, Brewster, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
5/26/2022	Acceptable	<i>Dolichospermum</i> spp.	240	-
6/1/2022	Potential for Concern	<i>Dolichospermum</i> spp.	1557	The BFC net daily cyanobacteria growth rate exceeded 0.05. Net growth rate: 0.31 (BFC)
6/15/2022	Acceptable	<i>Dolichospermum</i> spp.	112	-
6/29/2022	Acceptable	<i>Dolichospermum</i> spp.	167	-
7/13/2022	Acceptable	<i>Dolichospermum</i> spp.	16	-
7/27/2022	Acceptable	<i>Dolichospermum</i> spp.	11	-
8/10/2022	Acceptable	<i>Dolichospermum</i> spp.	29	-
8/18/2022	Acceptable	<i>Microcystis</i> spp.	58	-
8/24/2022	Acceptable	<i>Dolichospermum</i> spp.	123	-
8/31/2022	Acceptable	<i>Dolichospermum</i> spp.	87	-
9/7/2022	Acceptable	N/A	33	-
9/21/2022	Acceptable	N/A	16	-
10/5/2022	Acceptable	Mixed	23	-
10/19/2022	Acceptable	<i>Dolichospermum</i> spp.	405	-
10/24/2022	Use Restriction Warranted	<i>Dolichospermum</i> spp.	893	Large cyanobacteria bloom present.
11/2/2022	Use Restriction Warranted	<i>Dolichospermum</i> spp.	129	Recreational advisory in place due to large cyanobacteria bloom on 10/24/22.
11/8/2022	Acceptable	N/A	64	-

Slough Pond

During the 2022 monitoring season, Slough Pond contained no concerning cyanobacteria results at the time and place of each sampling event, keeping the pond in APCC’s “Acceptable” category for the entire season. (Table 16 below).

Table 16. Summary of cyanobacteria monitoring results for Slough Pond, Brewster, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
5/31/2022	Acceptable	N/A	4	-
6/13/2022	Acceptable	N/A	5	-
6/27/2022	Acceptable	<i>Aphanizomenon</i> spp.	6	-
7/11/2022	Acceptable	<i>Aphanizomenon</i> spp.	3	-
7/25/2022	Acceptable	<i>Aphanizomenon</i> spp.	6	-
8/8/2022	Acceptable	N/A	3	-
8/22/2022	Acceptable	Mixed	3	-
9/8/2022	Acceptable	N/A	4	-
9/19/2022	Acceptable	N/A	7	-
10/3/2022	Acceptable	N/A	0	-
10/17/2022	Acceptable	N/A	3	-
10/31/2022	Acceptable	N/A	0	-

Upper Mill Pond

During the 2022 monitoring season, Upper Mill Pond experienced changes in cyanobacteria levels that at different times placed it in APCC's "Acceptable" and "Potential for Concern" Risk Categories (Table 17 below).

After an initial "Acceptable" sampling event, Upper Mill Pond reached APCC's "Potential for Concern" category on 5/31/22, 6/14/22, 6/22/22, 7/12/22 and 7/20/22 due to net daily cyanobacteria growth rates that exceeded 0.05. Upper Mill Pond also reached this category on 6/28/22 and 7/20/22 due to the presence of cyanobacteria scums which quickly dissipated by the following week. At these points, APCC increased sampling to weekly until the growth rates returned below 0.05. Fortunately, these elevated growth rates and cyanobacteria scums did not result in larger cyanobacteria bloom formations nor toxin exceedances. Upper Mill Pond was "Acceptable" for the remainder of the sampling season.

Upper Mill Pond also experienced elevated net daily cyanobacteria growth rates on 10/5/22 prompting weekly sampling, however, due to a change in communication protocol beginning on August 1st, 2022 Upper Mill Pond remained "Acceptable" on this date.

During the season, one toxin sample from Upper Mill Pond was sent to the County Water Quality Lab for microcystin analysis including a sample on 6/14/22. The County Lab reported microcystin results to be non-detectable for this sample.

Table 17. Summary of cyanobacteria monitoring results for Upper Mill Pond, Brewster, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
5/17/2022	Acceptable	<i>Dolichospermum</i> spp.	6	-
5/31/2022	Potential for Concern	N/A	8	The <50 net daily cyanobacteria growth rate exceeded 0.05. Net Growth Rate: 0.10 (<50)
6/9/2022	Acceptable	<i>Dolichospermum</i> spp.	5	-
6/14/2022	Potential for Concern	<i>Dolichospermum</i> spp.	16	The <50, WLW, and BFC net daily cyanobacteria growth rate exceeded 0.05. Net Growth Rates: 0.16 (<50), 0.24 (WLW) and 0.23 (BFC). Microcystin Result: ND
6/22/2022	Potential for Concern	<i>Dolichospermum</i> spp.	42	The BFC net daily cyanobacteria growth rate exceeded 0.05. Net Growth Rate: 0.12 (BFC)
6/28/2022	Potential for Concern	<i>Dolichospermum</i> spp.	39	Small cyanobacteria scum present.
7/6/2022	Acceptable	<i>Dolichospermum</i> spp.	34	-
7/12/2022	Potential for Concern	<i>Dolichospermum</i> spp.	69	The WLW and BFC net daily cyanobacteria growth rate exceeded 0.05. Net Growth Rate: 0.10 (WLW) and 0.12 (BFC)
7/20/2022	Potential for Concern	<i>Dolichospermum</i> spp.	160	Small cyanobacteria scum present. The <50, WLW and BFC net daily cyanobacteria growth rate exceeded or equaled 0.05. Net Growth Rate: 0.30 (<50), 0.05 (WLW), and 0.11 (BFC)
7/27/2022	Acceptable	<i>Dolichospermum</i> spp.	34	-
8/9/2022	Acceptable	<i>Dolichospermum</i> spp.	16	-

8/24/2022	Acceptable	<i>Dolichospermum</i> spp.	12	-
9/6/2022	Acceptable	N/A	9	-
9/20/2022	Acceptable	<i>Anabaena</i> spp.	17	-
9/28/2022	Acceptable	<i>Lyngbya</i> spp.	20	-
10/5/2022	Acceptable	<i>Dolichospermum</i> spp.	36	-
10/12/2022	Acceptable	<i>Lyngbya</i> spp.	2	-
10/18/2022	Acceptable	<i>Microcystis</i> spp.	33	-
11/1/2022	Acceptable	N/A	5	-

Walkers Pond

During the 2022 monitoring season, Walkers Pond experienced changes in cyanobacteria levels that at different times placed it in APCC's "Acceptable," "Potential for Concern," and "Use Restriction Warranted" Risk Categories (Table 18 below).

After a few early season "Acceptable" sampling events, Walkers Pond reached APCC's "Potential for Concern" category on 6/14/22 and 6/22/22 due to net daily cyanobacteria growth rates that exceeded 0.05. At these points, APCC increased sampling to weekly until the growth rate returned below 0.05. From 8/30/22 until 9/15/22, Walkers Pond reached the "Use Restriction Warranted" category due to the presence of a large cyanobacteria bloom. A recreational advisory was posted immediately by the Town Health Department and it remained in place until the pond met the criteria for the advisory to be lifted. Walkers Pond was "Acceptable" for the remainder of the sampling season.

Walkers Pond also experienced elevated net daily cyanobacteria growth rates on 8/9/22, 8/18/22, 8/24/22, and 9/15/22 prompting weekly sampling, however, due to a change in communication protocol beginning on August 1st, 2022, Walkers Pond remained "Acceptable" on these dates.

During the season, one toxin sample from Walkers Pond was sent to the County Water Quality Lab for microcystin analysis including a sample on 6/14/22. The County Lab reported microcystin results below 8 ppb for this sample.

Table 18. Summary of cyanobacteria monitoring results for Walkers Pond, Brewster, MA.

Sampling Date	APCC Current Risk Category	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Current Risk Category Notes
5/17/2022	Acceptable	<i>Anabaena</i> spp.	5	-
5/31/2022	Acceptable	<i>Dolichospermum</i> spp.	3	-
6/14/2022	Potential for Concern	<i>Dolichospermum</i> spp.	11	The <50, WLW and BFC net daily cyanobacteria growth rate exceeded 0.05. Net growth rates: 0.25 (<50), 0.22 (WLW), and 0.09 (BFC). Microcystin Result: 0.45 ppb
6/22/2022	Potential for Concern	<i>Anabaena</i> spp.	22	The WLW and BFC net daily cyanobacteria growth rates exceeded 0.05. Net growth rates: 0.05 (WLW) and 0.09 (BFC)
6/28/2022	Acceptable	N/A	13	-
7/12/2022	Acceptable	<i>Microcystis</i> spp.	8	-
7/27/2022	Acceptable	N/A	10	-
8/9/2022	Acceptable	<i>Lyngbya</i> spp.	115	-
8/18/2022	Acceptable	<i>Dolichospermum</i> spp.	123	-
8/24/2022	Acceptable	Mixed	9	-
8/30/2022	Use Restriction Warranted	Mixed	532	Large cyanobacteria bloom present.
9/6/2022	Use Restriction Warranted	<i>Dolichospermum</i> spp.	336	Large cyanobacteria bloom present on 8/30/22.
9/15/2022	Acceptable	<i>Lyngbya</i> spp.	342	-
9/20/2022	Acceptable	Mixed	85	-
10/5/2022	Acceptable	<i>Lyngbya</i> spp.	42	-
10/18/2022	Acceptable	<i>Lyngbya</i> spp.	9	-
11/1/2022	Acceptable	<i>Lyngbya</i> spp.	19	-

5. CONCLUSIONS

In 2022, 18 ponds were monitored in Brewster (see Appendix 4 for sampling locations). Bakers Pond, Blueberry Pond, Cliff Pond, Cobbs Pond, Elbow Pond, Griffiths Pond, Lower Mill Pond, Myricks Pond, Schoolhouse Pond, Seymour Pond, Sheep Pond, Upper Mill Pond, and Walkers Pond reached APCC’s “Potential for Concern” due to moderate levels of cyanobacteria. Cliff Pond, Lower Mill Pond, Schoolhouse Pond, and Walkers Pond reached APCC’s “Use Restriction Warranted” category due to the presence of cyanobacteria blooms. The Town of Brewster Health Department followed up by posting recreational advisories at these ponds.

In 2022, Cliff Pond received a recreational advisory from September 3, 2022, through September 27, 2022. Lower Mill Pond received three recreational advisories: from August 9, 2022, through August 17, 2022; on September 16, 2022; and from September 28, 2022, through October 19, 2022. Schoolhouse Pond received a recreational advisory August 10, 2022, through August 17, 2022. Sheep Pond received a recreational advisory from October 24, 2022, through November 2, 2022. Walkers Pond received a recreational advisory from August 30, 2022, through September 6, 2022. As in years past, Cliff Pond received recreational advisories for the majority of the sampling season, Lower Mill Pond received recreational advisories in the beginning and the end of the sampling season, Schoolhouse Pond received recreational advisories in the months of August and September, and Walkers Pond received recreational advisories throughout the sampling season. For a comparison of interpreted cyanobacteria risks in 2022 compared to previous seasons, see Appendix 3. These results from four years of monitoring suggest that Cliff Pond, Lower Mill Pond, Schoolhouse Pond, Sheep Pond, and Walkers Pond may continue to experience cyanobacteria risks warranting recreational advisories in the future.

In 2022, Cliff Pond received recreational advisory postings due to both significant cyanobacteria scums and microcystin exceedances measured by the County Water Quality Lab. Cliff Pond on September 3, 2022, was found to contain a microcystin concentration of <10,000 ppb. In the previous four years of monitoring, APCC’s monitoring data and the presence of cyanobacteria scums was used to estimate cyanobacteria risk. In 2022, the County Water Quality Lab’s capability to conduct microcystin analyses provided the town health department and APCC with direct measurements of toxin, increasing understanding of current toxin risks. For this season, 20 toxin samples were sent to the County Water Quality Lab due to concerns of a possible exceedance, but only one was reported above the MDPH microcystin threshold of 8 ppb.

APCC’s 2022 cyanobacteria monitoring program collected and analyzed 216 samples and documented field conditions on each of the scheduled 216 sampling dates throughout the season as well as an additional 72 based on higher growth rates or higher warning categories. In at least one case, the monitoring helped to predict an oncoming bloom. All results were promptly shared with the BPC and the Town of Brewster via biweekly reports and then entered into the APCC Interactive Map following the completion of sample analysis (<https://apcc.org/cyano>).

6. RECOMMENDATIONS

Based on the results from the 2022 monitoring season and previous monitoring work, APCC provides the following recommendations:

Recommendation 1: Continue the sampling season to include early and late season monitoring. Many ponds in APCC's cyanobacteria monitoring program experience their highest cyanobacteria concentrations in the spring and the fall. Additional early and late season monitoring could shed light on potential bloom conditions outside of the typical June to Labor Day monitoring season performed in BPC and Town of Brewster this season. Although residents may interact with these ponds less during these times, there are still dangers posed to pets who may consume or swim in these waters while on walks during colder months.

Recommendation 2: Continue yearly cyanobacteria monitoring. Monitoring over multiple years for full seasons would provide greater understanding of the cyanobacteria community in the Brewster ponds. More seasons of data will allow us to draw better predictions year after year. Continued monitoring will also allow for the ability to track degradation in the ponds as increased occurrence of harmful cyanobacteria blooms point to larger issues of pond impairment. Monitoring efforts will shed light on the ponds most in need of protection and restoration.

Recommendation 3: Reduce nutrient loading to freshwater ponds. Residents surrounding vulnerable pond ecosystems should reduce potential nutrient pollution flowing from their properties towards the pond. Excess fertilizer use, septic systems around ponds, inadequate stormwater management, and inadequate vegetated buffers are examples of behaviors that exacerbate nutrient loading of ponds.

In addition to managing nutrients, changing climate conditions, including the currently warming atmosphere and altered rainfall patterns, are believed to play a significant role in the increasing frequency and intensity of harmful cyanobacteria blooms ([Paerl et al., 2019](#)). Residents and officials should understand that there may be many factors leading to cyanobacteria issues on Cape Cod. Continued work around cyanobacteria and water quality will lead to increased awareness, a safer public, and hopefully improved health of our freshwater ponds.

For a comprehensive list of actions that residents, municipalities, and state agencies can take to promote pond health, visit APCC's State of the Waters: Cape Cod website ([State of the Waters](#)), specifically, the Action Plan for ponds. For additional information on restoration of impaired ponds, the new Freshwater Initiative program for Cape Cod ponds will provide towns, communities, and organizations with information and resources for pond protection, management, and restoration. This program is led by the Cape Cod Commission with support from APCC. For more information, visit the Cape Cod Commission's Freshwater Initiative website at: <https://capecodcommission.org/our-work/cape-cod-freshwater-initiative/>.

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Appendix 1. Resources on Cyanobacteria

Harmful cyanobacteria blooms in freshwater bodies are the subject of numerous reports published by scientists, state and federal agencies, and organizations, some of which are listed here:

- The World Health Organization recognized the public health consequences of cyanobacteria in water in 1999 ([WHO](#)¹).
- The Centers for Disease Control (CDC) call cyanotoxins “among the most powerful natural poisons known” ([CDC Fact Sheet on Harmful Algal Blooms](#)). The [CDC's Physician Card on Harmful Algal Blooms \(HABs\)](#) states that swallowing water containing cyanobacteria can damage the central nervous system, liver or kidneys; skin contact can cause allergic dermatitis and conjunctivitis; and inhalation of aerosols containing cyanobacteria or their toxins can cause wheezing, coughing, chest tightness, and shortness of breath.
- New England Interstate Water Pollution Control Commission ([NEIWPC](#)) is an interstate commission that helps the states of the Northeast preserve and advance water quality. NEIWPC's webpage states that “the frequency of HAB occurrence is on the rise and cyanobacteria toxicity has been associated with human health impacts including skin rashes, gastrointestinal and respiratory disease, and liver damage. Effects can be even more pronounced (potentially even fatal) in animals ranging from cattle to dogs. HABs have direct implications to the use of recreational waterbodies for contact recreation, the susceptibility of public water supplies to toxins, and the overall degradation of our aquatic resources.”
- U.S. Environmental Protection Agency (EPA):
 - “Monitoring and Responding to Cyanobacteria and Cyanotoxins in Recreational Waters.” ([EPA recreational waters](#))
 - EPA Office of Ground Water and Drinking Water webpage. Managing Cyanotoxins in Public Drinking Water Systems. ([EPA drinking water](#))
 - EPA webpage on nutrient pollution and HABs. ([EPA and nutrient pollution](#))
- State agencies, including New York ([NY](#)), Rhode Island ([RI](#)), and New Hampshire ([NH](#)) have cyanobacteria monitoring programs and provide guidance concerning public health and environmental risks posed by cyanobacteria.
- Commonwealth of Massachusetts:
 - Cyanobacteria webpage: ([Massachusetts](#))
 - Massachusetts Department of Public Health (MDPH) website on “Guidelines for cyanobacteria in freshwater recreational water bodies.” ([MDPH](#))

Appendix 2. APCC’s Cyanobacteria Risk Categories.

APCC 2022 Cyanobacteria Risk Categories Revised 7/26/2022				
Criteria		APCC Acceptable	APCC Potential for Concern	APCC Use Restriction Warranted
Microcystin	Potential microcystin calculated by APCC based on measurement of phycocyanin in Bloom Forming Colony samples.	Potential microcystin calculated at low levels that do not warrant additional toxin testing ^{2,4} .	Potential microcystin is elevated to a point where an exceedance is deemed possible and confirmatory toxin testing warranted ^{2,4} .	
	Measured microcystin by Barnstable County Water Quality Lab.	Less than 4 ppb microcystin <u>measured</u> in GRAB sample.	Between 4 and 8 ppb microcystin <u>measured</u> in GRAB sample.	Greater than 8 ppb microcystin <u>measured</u> in GRAB sample ³ .
Cyanobacteria Blooms and Scums	Cyanobacteria bloom material reported and confirmed by APCC.	None present at the time and place of sample collection.	A cyanobacteria scum or bloom is present but is deemed to be <u>insignificant</u> by the Massachusetts Department of Public Health and the town’s health agent.	A cyanobacteria scum or bloom is present and is deemed to be <u>significant</u> by the Massachusetts Department of Public Health or the town’s health agent ³ .
Notes	<p>To interpret cyanobacteria data using this table, the most hazardous result determines the category the pond is placed in from right to left. A pond that meets even a single criterion in the “Use Restriction Warranted” column will be placed in that category. Likewise, a pond that meets even a single criterion in the “APCC Potential for Concern” category but does not meet any criteria in the “APCC Use Restriction Warranted” category, will be placed in the “APCC Potential for Concern” category. If a pond meets no criteria in the “APCC Use Restriction Warranted” or the “APCC Potential for Concern” category, that pond is placed in the “APCC Acceptable” category.</p> <p>² Developed with recommendations from Nancy Leland of Lim-Tex Inc. and affiliated with the University of New Hampshire Center for Freshwater Biology.</p> <p>³ Criteria attributed to MDPH.</p> <p>⁴ Predictive cyanobacteria metrics that project and estimate risks, rather than reactive cyanobacteria metrics that measure risk after a bloom has occurred.</p>			

Appendix 3. Brewster ponds 2018-2022 Cyanobacteria Risk Comparison.

As of 2022 APCC has completed five seasons of cyanobacteria monitoring for the Town of Brewster and BPC. In 2018 however, APCC had yet to formalize a cyanobacteria risk interpretation framework similar to what is used today. For this reason, data from 2018 has been omitted from this comparison. The tables below detail APCC’s communication of cyanobacteria risk for the Brewster ponds in each season. Red indicates a “Use Restriction Warranted” or “High Warning Tier” designation, yellow indicates a “Potential for Concern” or “Moderate Warning Tier” designation, and blue indicates an “Acceptable” or “Low Warning Tier” designation. See the 2020 and 2021 APCC reports for the Town of Brewster and BPC for more information on findings and risk communication in these sampling seasons.

Bakers Pond 2019 -2022 Cyanobacteria Risk Comparison												
	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2019						Yellow	Blue	Blue				
2020	Yellow	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue			
2021	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Red	Red		
2022	Blue	Blue	Yellow	Yellow	Blue	Blue	Blue	Blue	Yellow	Blue		

Blueberry Pond 2019-2022 Cyanobacteria Risk Comparison												
	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2019	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue			
2020												
2021	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue			
2022	Blue	Yellow	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue		

Cliff Pond 2019-2022 Cyanobacteria Risk Comparison

	June		July		August		September		October		November		
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th	
2019													
2020													
2021													
2022													

Cobbs Pond 2020-2022 Cyanobacteria Risk Comparison

	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2020												
2021												
2022												

Elbow Pond 2019-2022 Cyanobacteria Risk Comparison

	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2019												
2020												
2021												
2022												

Griffiths Pond 2020-2022 Cyanobacteria Risk Comparison

	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2020												
2021												
2022												

Greenland Pond 2019-2022 Cyanobacteria Risk Comparison

	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2019												
2020												
2021												
2022												

Long Pond 2019-2022 Cyanobacteria Risk Comparison

	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2019												
2020												
2021												
2022												

Lower Mill Pond 2019-2022 Cyanobacteria Risk Comparison

Year	June		July		August		September		October		November	
	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2019	Red		Yellow	Red	Yellow				Red			
2020	Blue						Red				Yellow	Blue
2021	Red	Blue										
2022	Blue	Yellow			Red		Blue	Red			Blue	

Myricks Pond 2019-2022 Cyanobacteria Risk Comparison

Year	June		July		August		September		October		November	
	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2019				Yellow	Blue							
2020				Blue								
2021				Blue								
2022	Blue		Yellow		Blue	Yellow	Blue					

Owl Pond 2021 -2022 Cyanobacteria Risk Comparison

Year	June		July		August		September		October		November	
	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2021	Blue											
2022	Blue											

Pine Pond 2019-2022 Cyanobacteria Risk Comparison												
	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2019	Blue											
2020												
2021	Blue											
2022	Blue											

Schoolhouse Pond 2019-2022 Cyanobacteria Risk Comparison													
	June		July		August		September		October		November		
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th	
2019	Blue												
2020					Yellow		Red		Blue				
2021	Blue				Red		Blue						
2022	Blue		Yellow			Red		Blue					

Seymour Pond 2020-2022 Cyanobacteria Risk Comparison												
	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2020	Blue		Red		Blue							
2021	Blue		Red		Blue		Red		Blue		Yellow	
2022	Yellow		Blue									

Sheep Pond 2019-2022 Cyanobacteria Risk Comparison												
	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2019	Yellow		Blue		Yellow		Blue					
2020	Blue		Blue		Blue		Yellow		Blue			
2021	Blue		Blue		Blue		Blue		Blue			
2022	Yellow		Blue		Blue		Blue		Blue		Red	

Slough Pond 2019-2022 Cyanobacteria Risk Comparison												
	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2019	Blue		Blue		Blue		Blue		Blue			
2020	Blue		Blue		Blue		Blue		Blue			
2021	Blue		Blue		Blue		Blue		Blue			
2022	Blue		Blue		Blue		Blue		Blue			

Upper Mill Pond 2019-2022 Cyanobacteria Risk Comparison												
	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2019	Red		Yellow		Yellow		Red		Yellow		Red	
2020	Blue		Blue		Blue		Blue		Blue			
2021	Blue		Blue		Blue		Blue		Blue			
2022	Yellow		Yellow		Blue		Blue		Blue			

Walkers Pond 2019-2022 Cyanobacteria Risk Comparison												
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	June		July		August		September		October		November	
Year	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-31st	1st-15th	16th-30th	1st-15th	16th-31st	1st-15th	16th-30th
2019	Yellow		Red	Yellow	Red		Yellow					
2020	Yellow	Red				Blue				Red	Blue	
2021	Red		Blue				Yellow		Blue			
2022	Yellow		Blue			Red		Blue				

Appendix 4: Sample Site Locations

- Bakers Pond - Dirt boat ramp and parking area off Bakers Pond Road.
- Blueberry Pond - Neighborhood beach. (Private)
- Cliff Pond - Beach in Nickerson State Park.
- Cobbs Pond - Channel Way. (Private)
- Elbow Pond - Neighborhood landing off Elbow Pond Drive. (Private)
- Greenland pond - Neighborhood beach off Janelle's Way. (Private)
- Griffiths Pond - Neighborhood landing off Griffith's Pond Road.
- Long Pond - Town beach off Crowells Bog Road.
- Lower Mill Pond - Town landing off Mill Pond Drive. (Private)
- Owl Pond - Cypress Lane. (Private)
- Pine Pond - Residence off Pine Pond Road. (Private)
- Schoolhouse Pond - Town Boat Launch off 6A.
- Seymour Pond - Neighborhood beach off Beachwood Drive. (Private)
- Sheep Pond - Town beach and boat ramp off Fishermans Landing Road.
- Slough Pond - Boat Launch off Slough Road.
- Upper Mill Pond - Boat ramp off Run Hill Road.
- Walkers Pond - Boat launch off Slough Road.