Great Sand Lakes Water Quality Update

By: Ann Frechette, PhD

June 24, 2023

Agenda

- What is Happening to the Water on the Cape?
- What is the Condition of the Great Sand Lakes Water?
- When is the Sewer Project Scheduled to Begin?
- What is the GSLA Board Doing to Monitor and Maintain Water Quality?
- What Can Residents Do?
- Q&A

The Regional Context

- Water in the saltwater estuaries and freshwater ponds across Cape Cod is degrading due to excess nutrients primarily from septic systems (75-85%), road run-off and lawn fertilizers
- In 2010, Conservation Law Foundation started filing Clean Water Act lawsuits against towns to force them to clean up the water
- In 2015, the Cape Cod Commission updated its Areawide Section 208 Plan for wastewater management across all 15 Cape towns
- The plan focused on coastal saltwater environments, as the introduction to the plan states clearly:

> Cape Cod has a water problem. The saltwater border that has defined our peninsula is being poisoned by nitrogen. The rapid decrease in the water quality of Cape Cod's marine ecosystems is plain to see. The problem is nitrogen, and the largest controllable source is the septic systems used every day.

The Freshwater Initiative

- Realization that freshwater ponds were also degrading led the Cape Cod Commission to launch its Freshwater Initiative in 2021 to:

    - Update its Pond and Lake Atlas
    - Organize quarterly meetings of the Ponds Network to share best practices on pond maintenance
    - Connect pond groups to funding sources (such as DEP Watershed Planning Program)
    - Collect data on freshwater ponds to understand how to address the problem of excess nutrients (Nitrogen and Phosphorus) leading to eutrophication and cyanobacteria proliferation

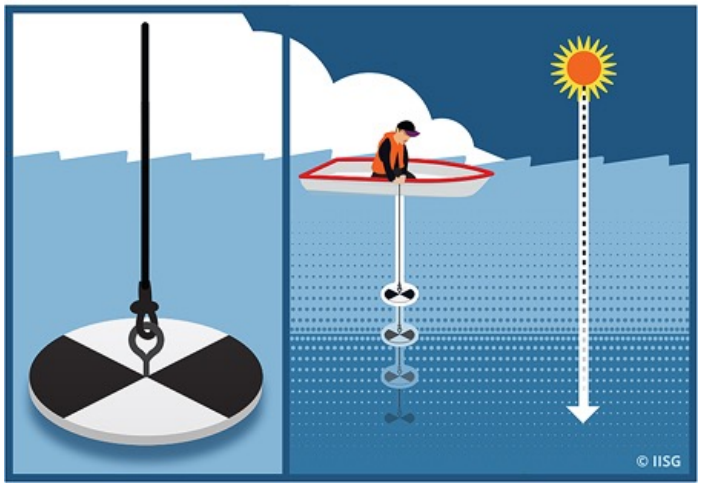
- In 2023, out of 900+ ponds on the Cape, 50 were chosen for a systematic study, none of which are in the GSL neighborhood

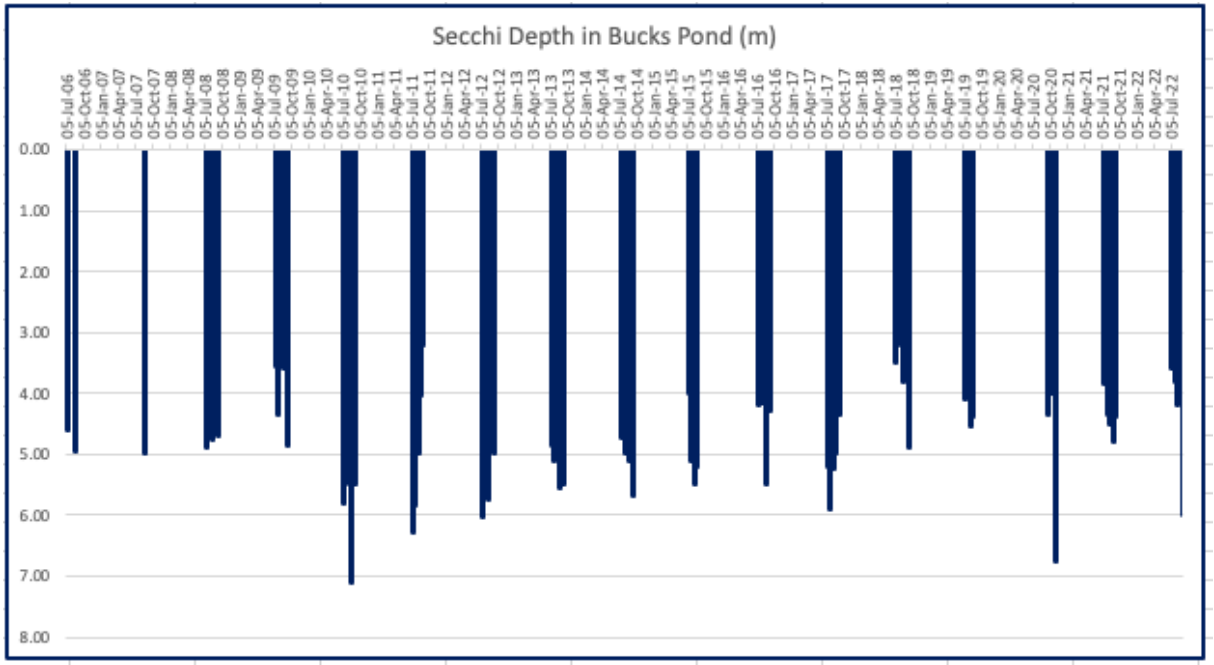
Data on Great Sand Lakes Water

- In 2007, the Town of Harwich published a study of the water in the Great Sand Lakes neighborhood for drinking water supply issues
- Barnstable County tests water on Bucks and John Joseph Ponds every summer for E.coli, a bacteria indicating fecal matter
- APCC tests water on Bucks and John Joseph Ponds every summer since 2019 for cyanobacteria
- GSLA volunteers collect water from Bucks and John Joseph Ponds every summer and it is analyzed at UMass Dartmouth (SMAST)
- In this presentation, I will focus on:
  - Clarity: Secchi tests show relatively clear water
  - Softness: Tests for calcium carbonate show very soft water
  - Acidity: pH levels are typically in the neutral range
  - Nutrient Levels: Tests for Total Phosphorus and Total Nitrogen show high baseline levels and intermittent spikes both at the surface and 8-9 m in depth
  - Temperature: Usually around 25 degrees Celsius in summer

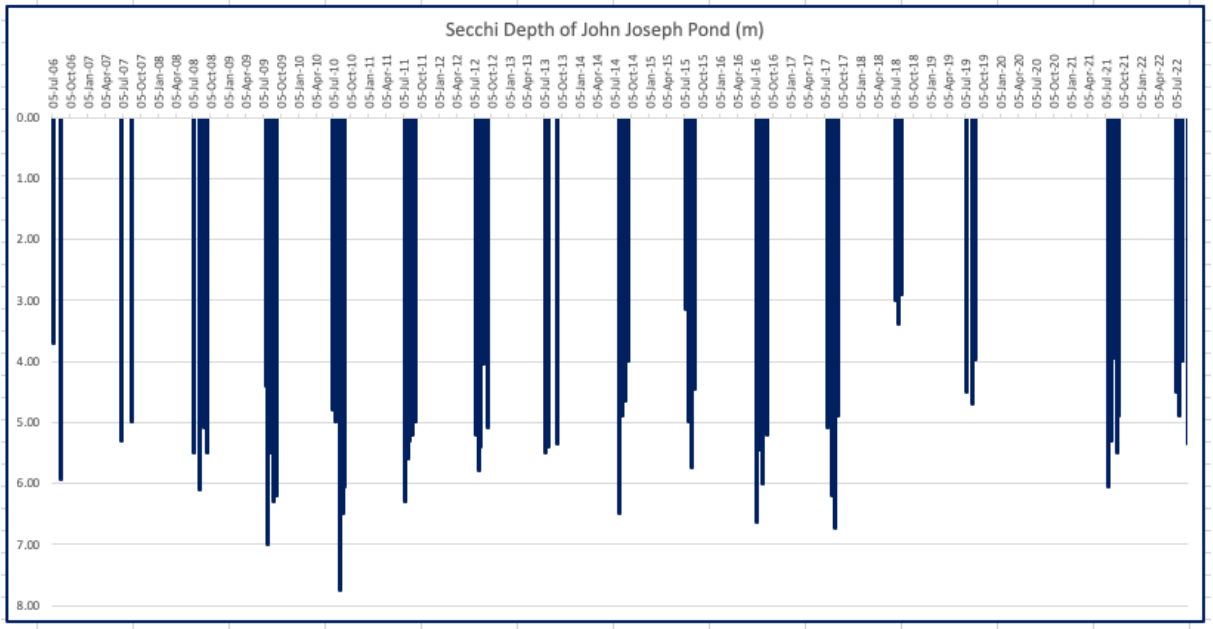
Secchi Tests Show Water in Bucks and John Josephs Ponds is Relatively Clear

Secchi Disk





- The higher number, the deeper the Secchi disk is visible, which means the clearer the water.
- Typical range for Secchi depth in a freshwater pond is 2 to 10 m
- Bucks Pond typically measures between 4 and 6 m
- John Joseph typically measures between 3 and 6 m



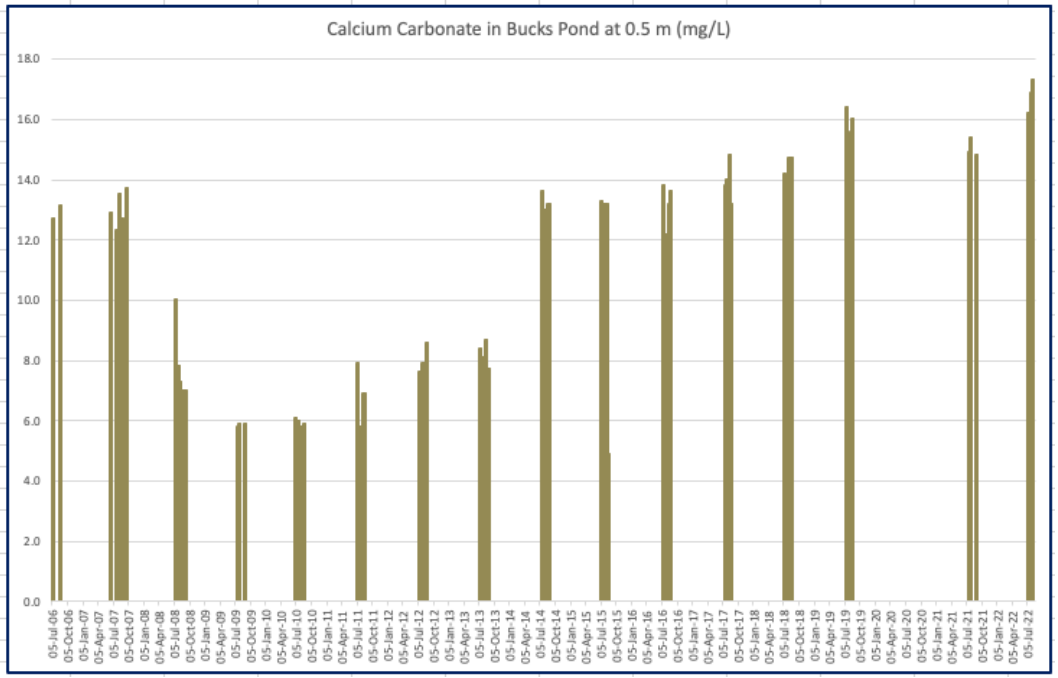
Source: SMAST Spreadsheets, 2006-2022

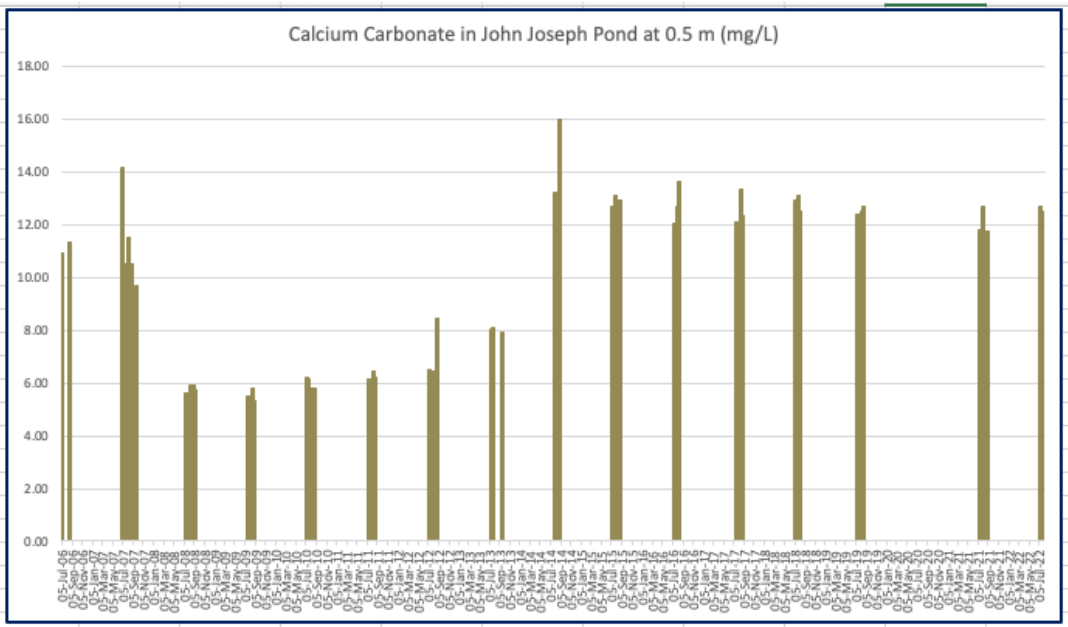
Tests for Calcium Carbonate Show the Water is Very Soft

Soft Water (0-60 mg/L)
Moderately Hard Water (61-120 mg/L)
Hard Water (121-180 mg/L)
Very Hard Water (>180 mg/L)

Source: USGS

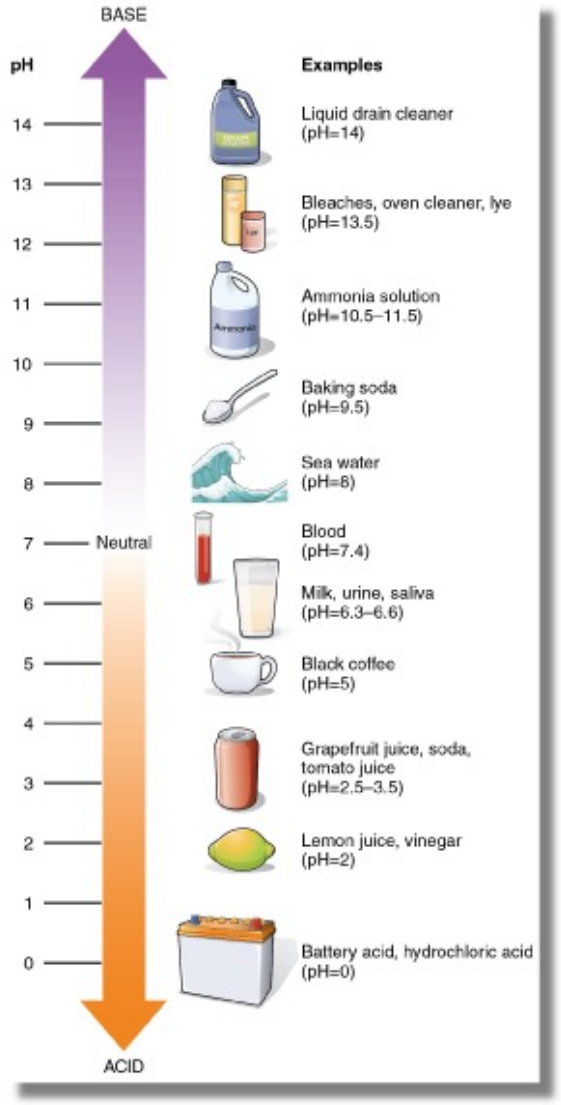
- Levels of Calcium Carbonate in Bucks Pond Range between 6 and 17 mg/L
- Levels of Calcium Carbonate in John Joseph Pond Range between 6 and 16 mg/L





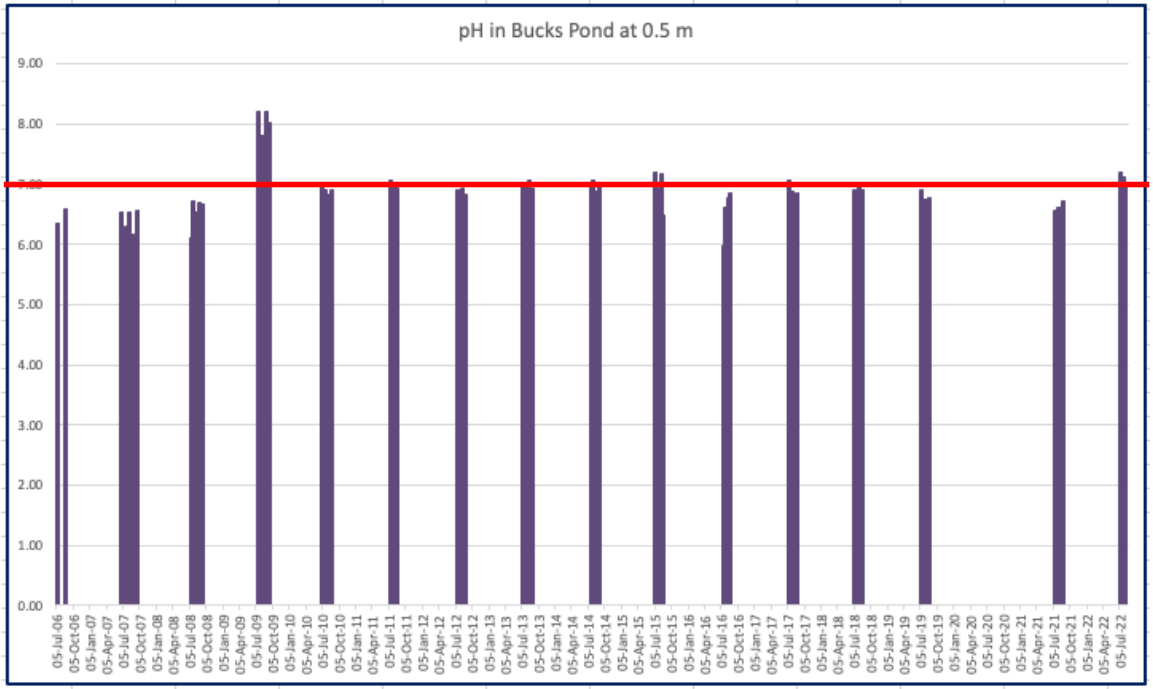
Source: SMAST Spreadsheets, 2006-2022

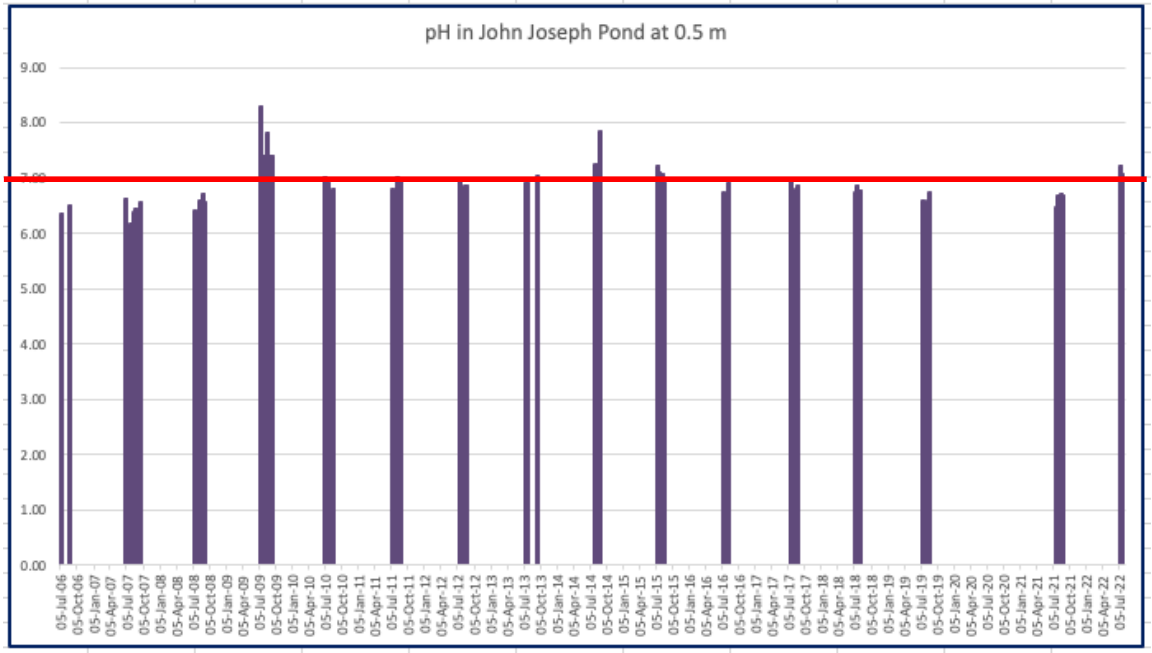
pH Levels in Both Bucks and John Joseph Ponds are Within Neutral Range



Source: USGS Water Science School

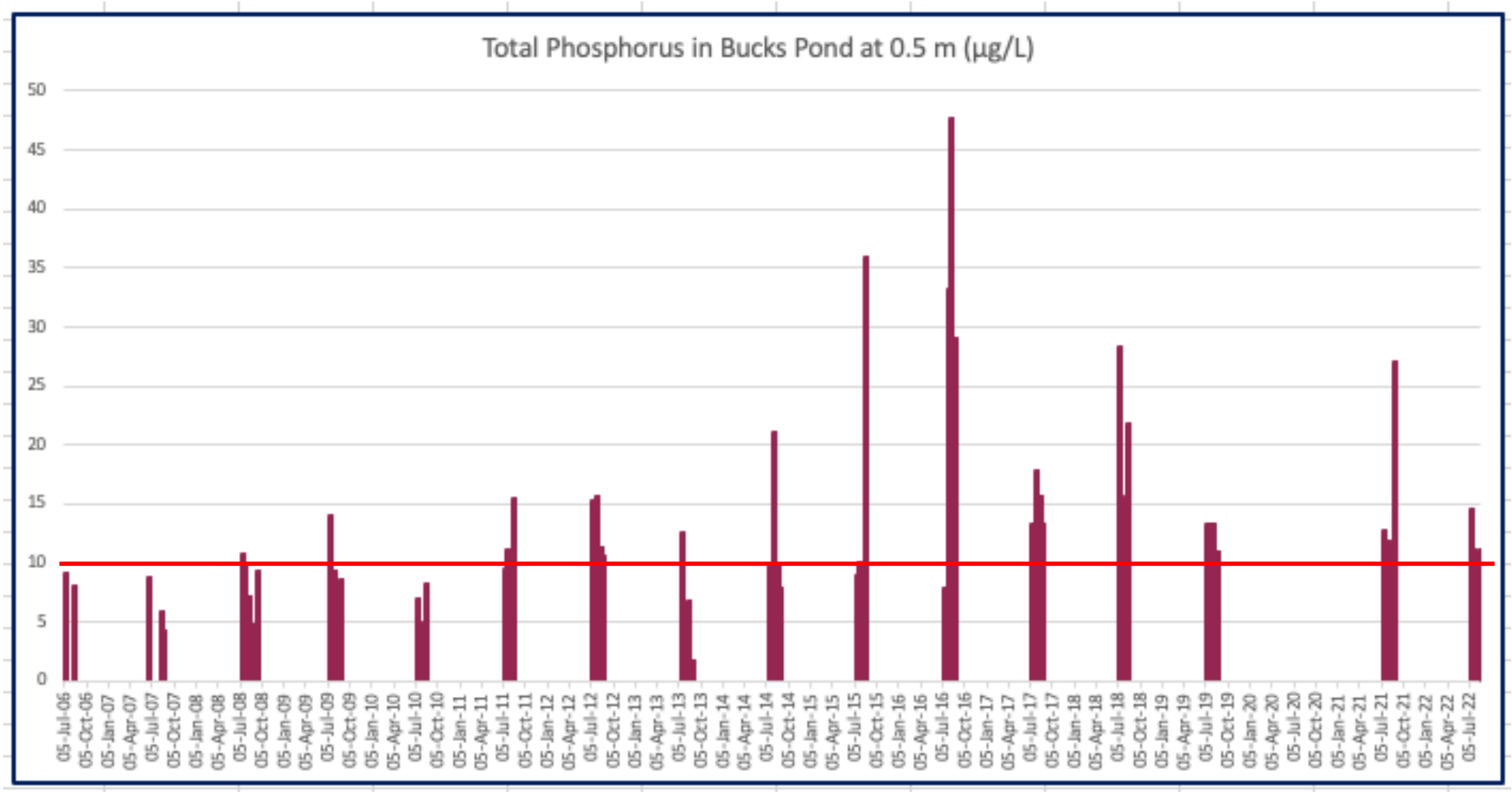
- 7 is Neutral pH
- <7 Indicates Acidity
- >7 Indicates Alkalinity





Source: SMAST Spreadsheets, 2006-2022

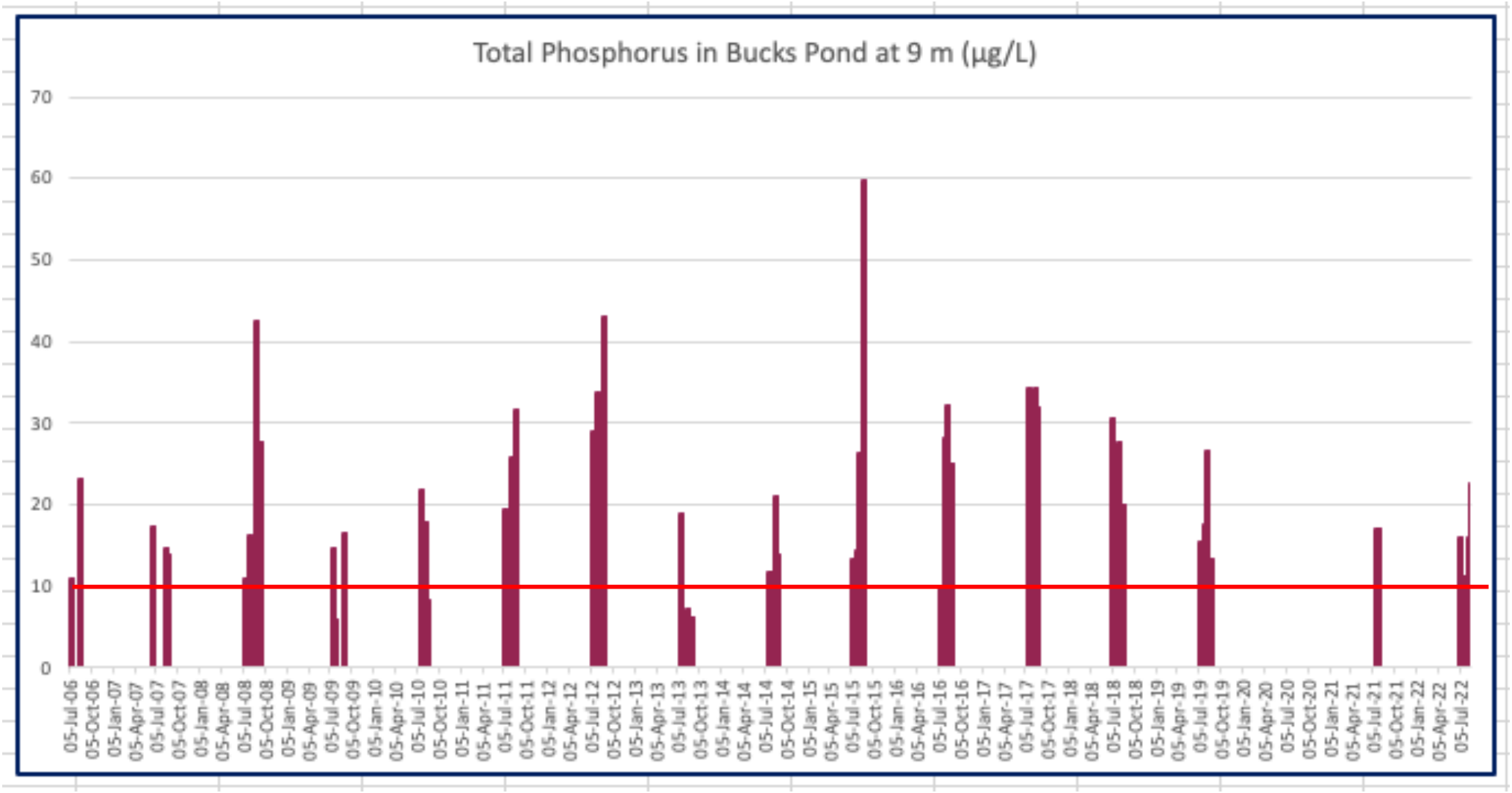
Bucks Pond Has High Levels of Phosphorus
Phosphorus Levels Above 10 µg/L Promote Cyanobacteria Growth



Source: SMAST Spreadsheets, 2006-2022, data analysis was not done during the pandemic

- EPA-predicted range for Cyanobacteria Growth starts at 10 µg/L of Total Phosphorus (https://www.epa.gov/sites/default/files/2018-10/documents/nutrient-criteria-manual-lakes-resevoirs.pdf)

There is an Even Greater Concentration of Phosphorus at Lower Depths



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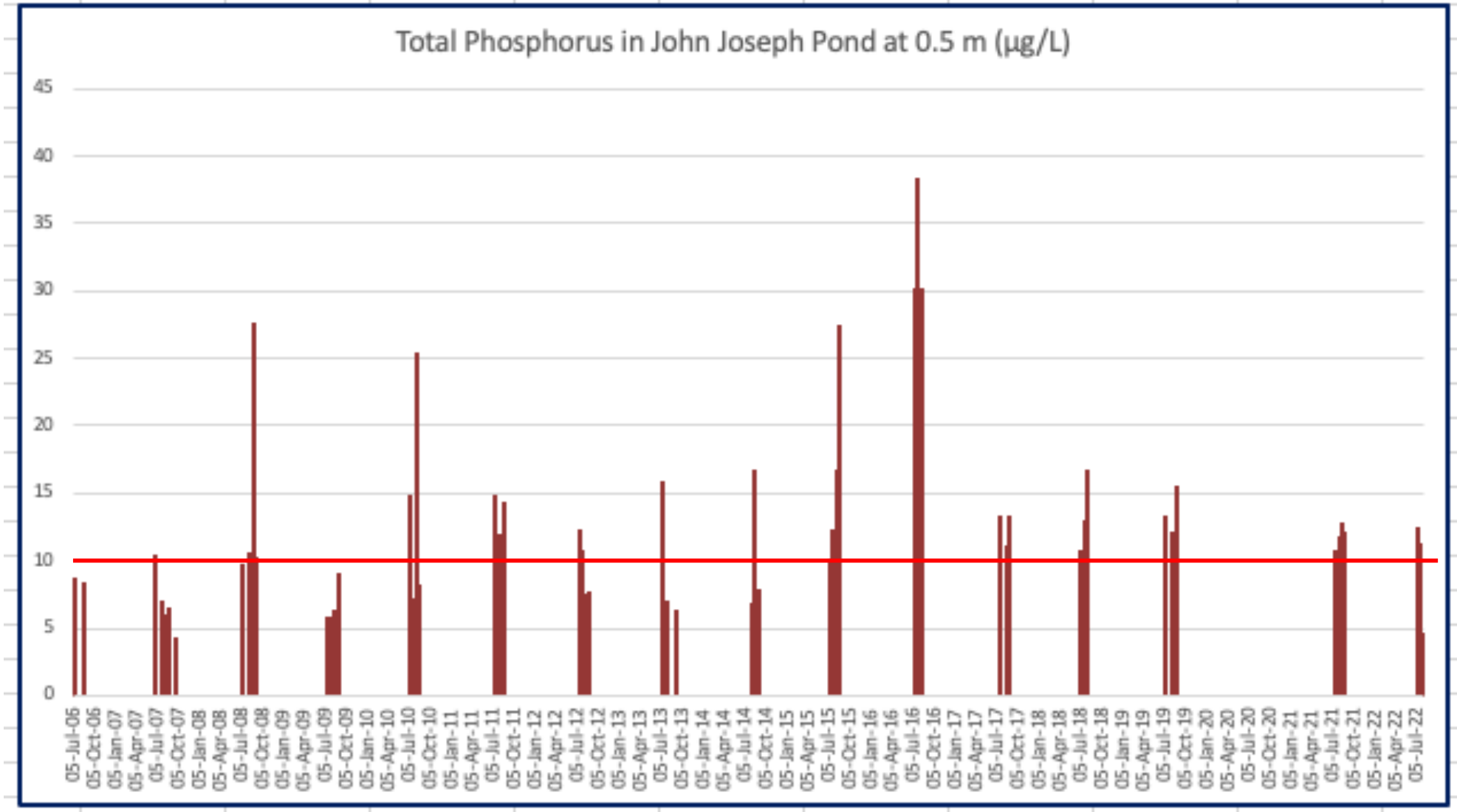
High Levels of Phosphorus Are Also Found in John Joseph Pond
Phosphorus Levels Above 10 µg/L Promote Cyanobacteria Growth



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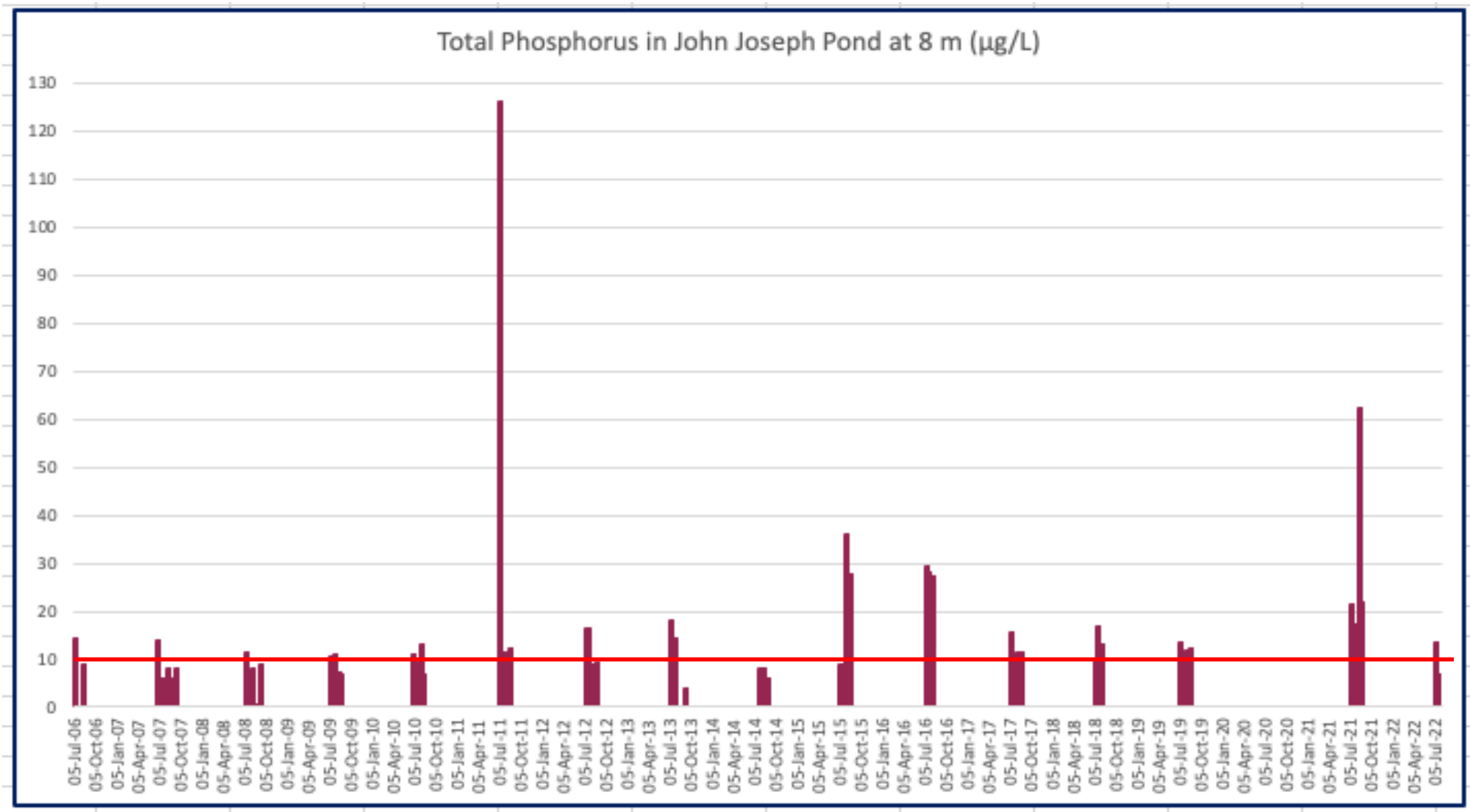
Phosphorus at Lower Depths in John Joseph Pond Spiked in 2011 and 2021



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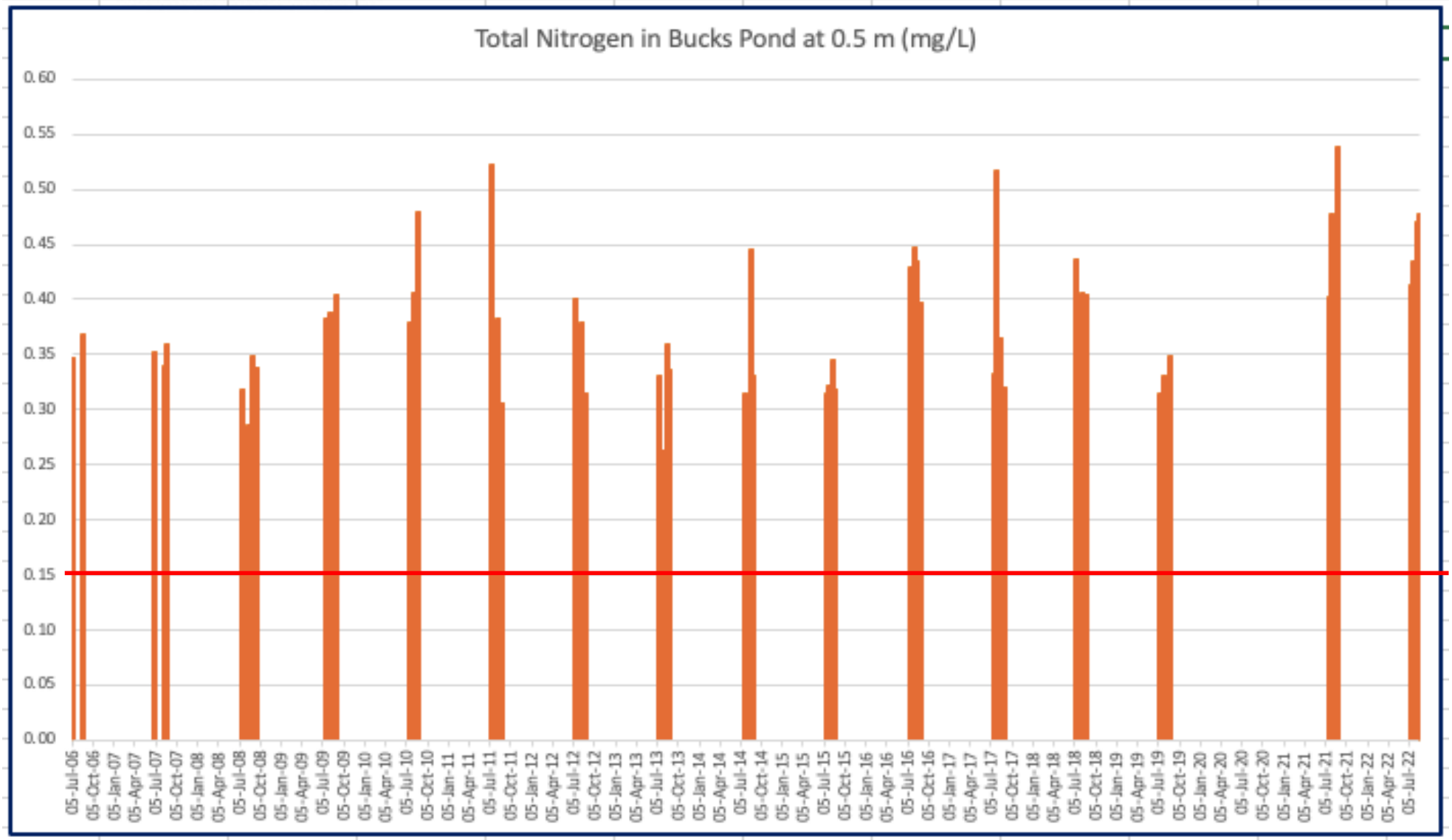
Bucks Pond Has High Levels of Nitrogen
Nitrogen Levels Above .15 mg/L Promote Cyanobacteria Growth



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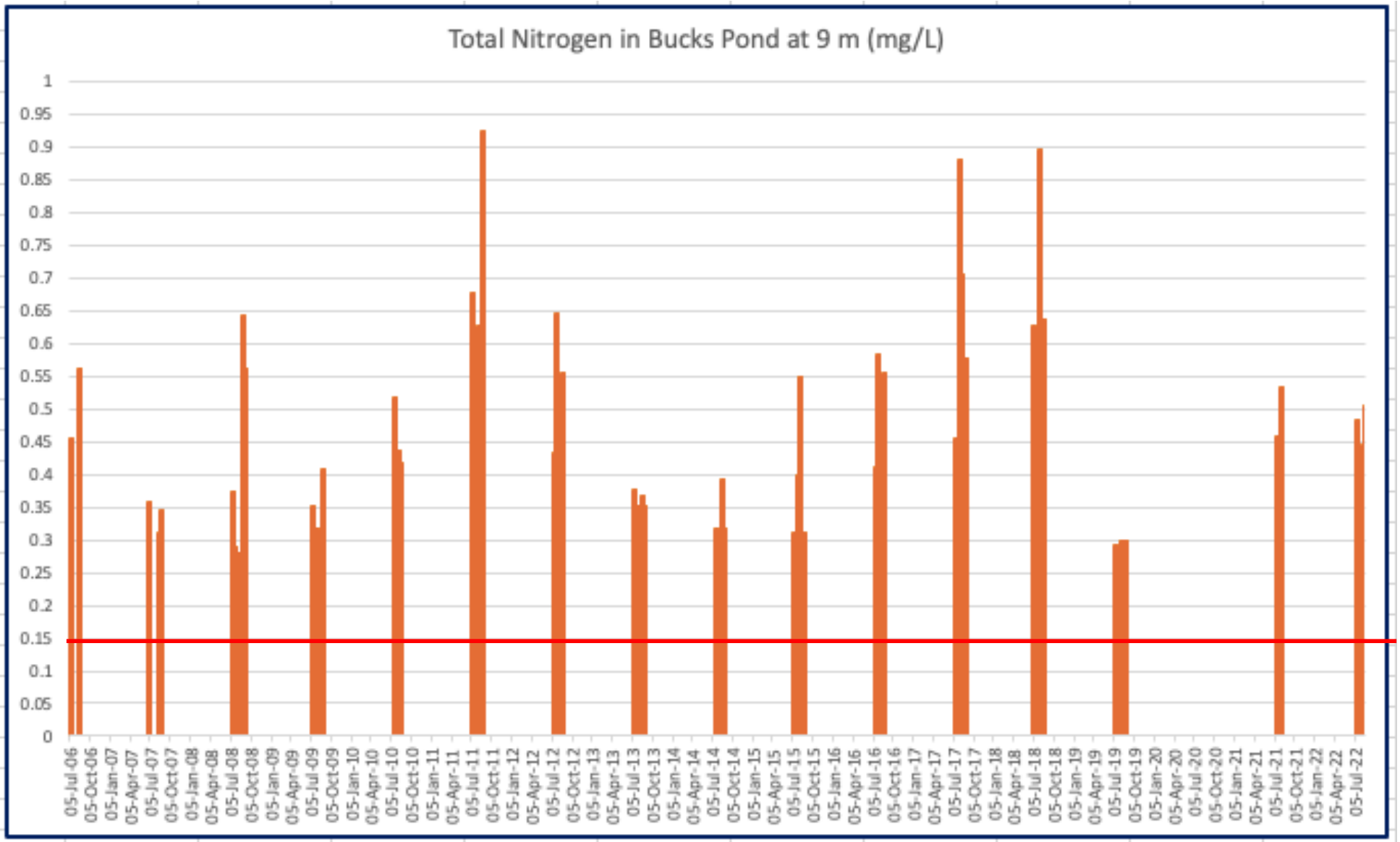
There is an Even Higher Concentration of Nitrogen at Lower Depths



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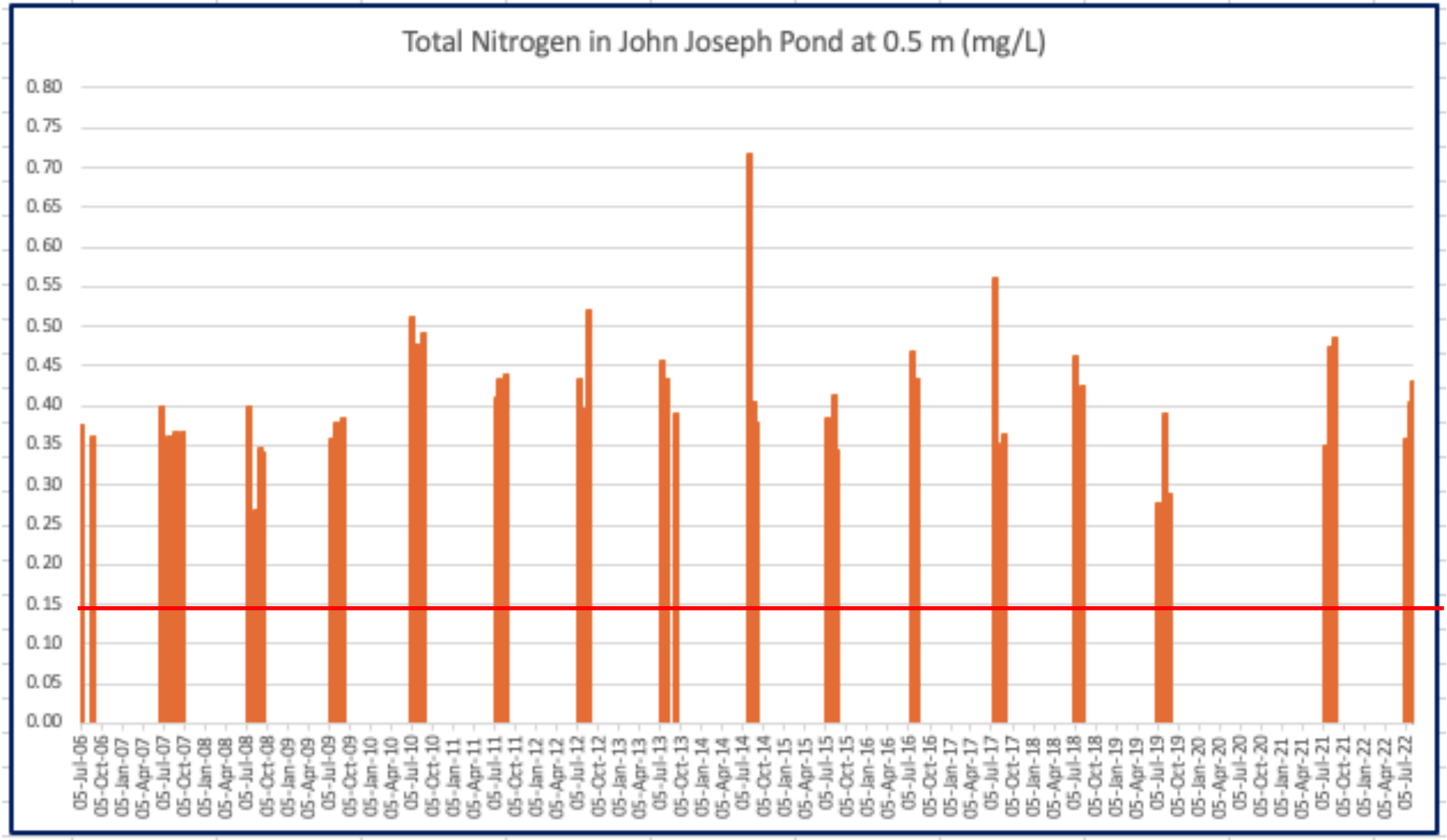
John Joseph Pond Has Excess Nitrogen
Nitrogen Levels Above .15 mg/L Promote Cyanobacteria Growth



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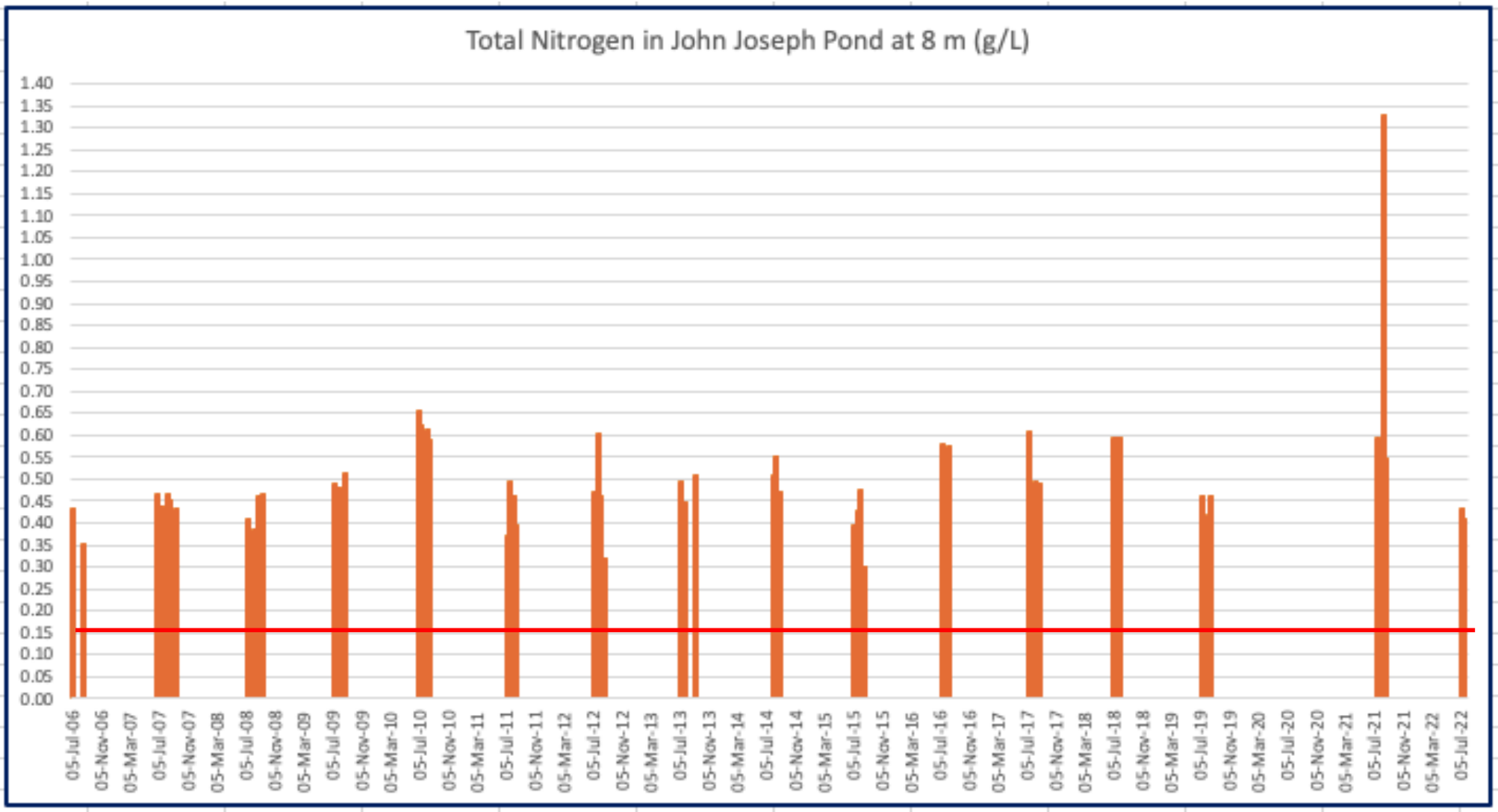
Nitrogen at Lower Depths in John Joseph Pond Spiked in 2021



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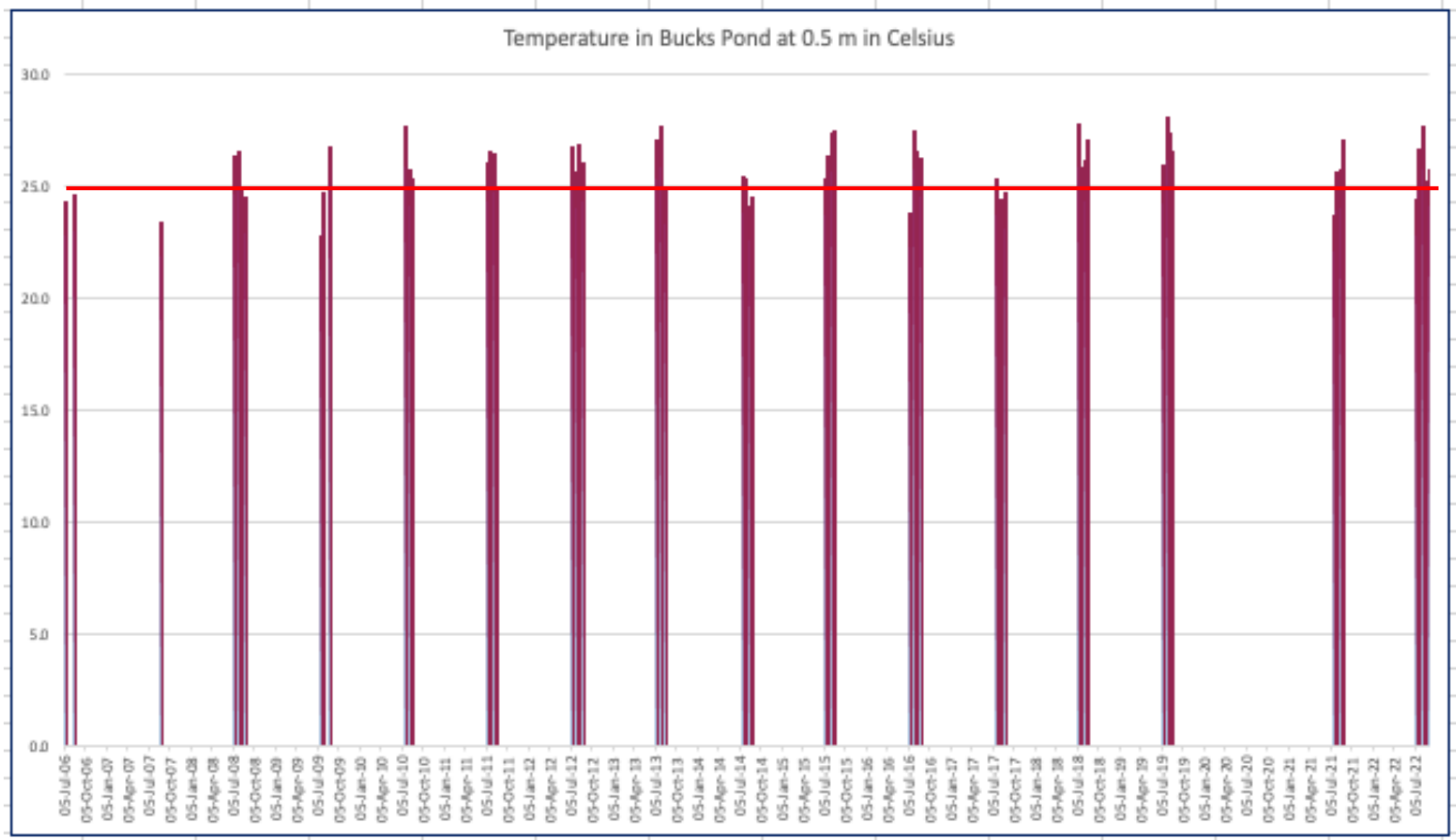
Warmer Water in the Summer Contributes to the Problem
Temperatures above 25 Degrees Celsius Promote Cyanobacteria Growth



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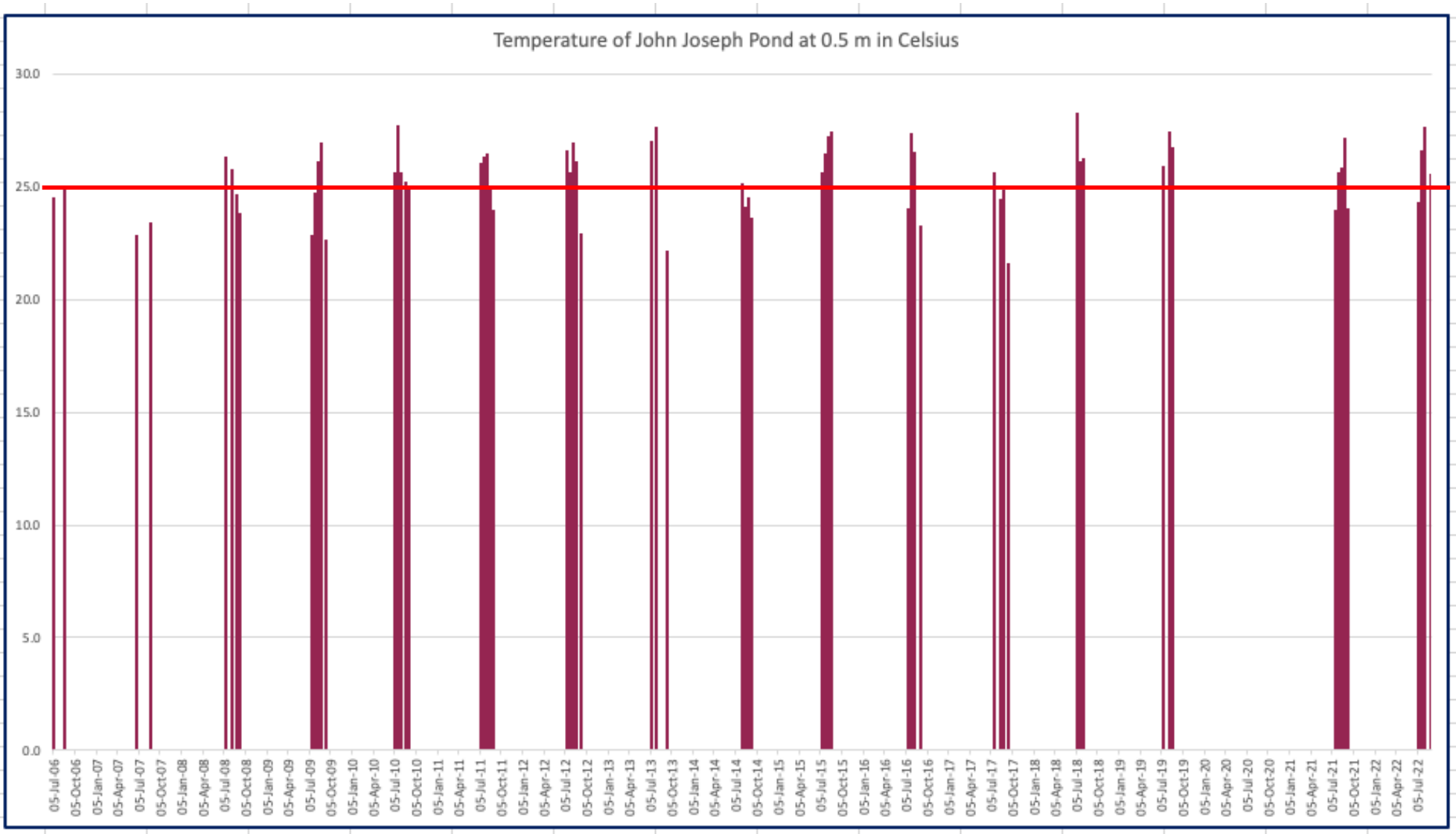
Summer Temperatures in John Joseph Pond Also Exceed 25 Degrees Celsius



Source: SMAST Spreadsheets, 2006-2022, data analysis was not done during the pandemic

Conditions are Favorable for Cyanobacteria Growth

Conditions favorable to cyanobacteria include:

- Temperatures above 25 Degrees Celsius
- Excess Phosphorus and Nitrogen
- Stable non-Circulating Water

At low concentrations, cyanobacteria is not problematic for human health. When cyanobacteria proliferate, however, toxins are released at levels that can cause illnesses including upper respiratory infections, gastrointestinal distress, neurological damage, liver damage and even death.

When cyanobacteria proliferate, they can form "harmful cyanobacteria blooms" (HCBs), sometimes called "mats" that give a visual indication of unsafe conditions. Cyanotoxins can rise to dangerous levels even before a mat takes form and are often the most toxic just after the mat dissipates.

Table 1. Cyanotoxins on the Contaminant Candidate List (CCL)

Cyanotoxin	Number of Known Variants or Analogues	Primary Organ Affected	Health Effects[1]	Most Common Cyanobacteria Producing Toxin[2]
Microcystin-LR	80~90	Liver	Abdominal pain Vomiting and diarrhea Liver inflammation and hemorrhage	*Microcystis* *Anabaena* *Planktothrix* *Anabaenopsis* *Aphanizomenon*
Cylindrospermopsin	3	Liver	Acute pneumonia Acute dermatitis Kidney damage Potential tumor growth promotion	*Cylindrospermopsis* *Aphanizomenon* *Anabaena* *Lyngbya* *Rhaphidiopsis* *Umezakia*
Anatoxin-a group[3]	2-6	Nervous System	Tingling, burning, numbness, drowsiness, incoherent speech, salivation, respiratory paralysis leading to death	*Anabaena* *Planktothrix* *Aphanizomenon* *Cylindrospermopsis* *Oscillatoria*

[1]Source: *Harmful Algal Research and Response National Environmental Science Strategy (HARRNESS)*
[2]Not all species of the listed genera produce toxin; in addition, listed genera are not equally as important in producing cyanotoxins.
[3]The anatoxin-a group does not include the organophosphate toxin anatoxin-a(S) as it is a separate group. In the US, the most common member is thought to be anatoxin-a, and thus this toxin is listed specifically.

Source: APCC

Mid-Cape Beach Closures due to Cyanobacteria

- There is no state-wide mandate to close beaches due to cyanobacteria; town health departments vary in responsiveness

- Ponds with documented beach closures due to cyanobacteria proliferations include West Reservoir, Hinckley's Pond, Skinequit Pond, Long Pond, Walker's Pond, Sheep Pond, Cliff Pond, Cobb's Pond, Lower Mill Pond, Seymour Pond, Schoolhouse Pond, Lovers Pond, Stillwater Pond, Scargo Lake, Minister's Pond, Uncle Harvey's Pond

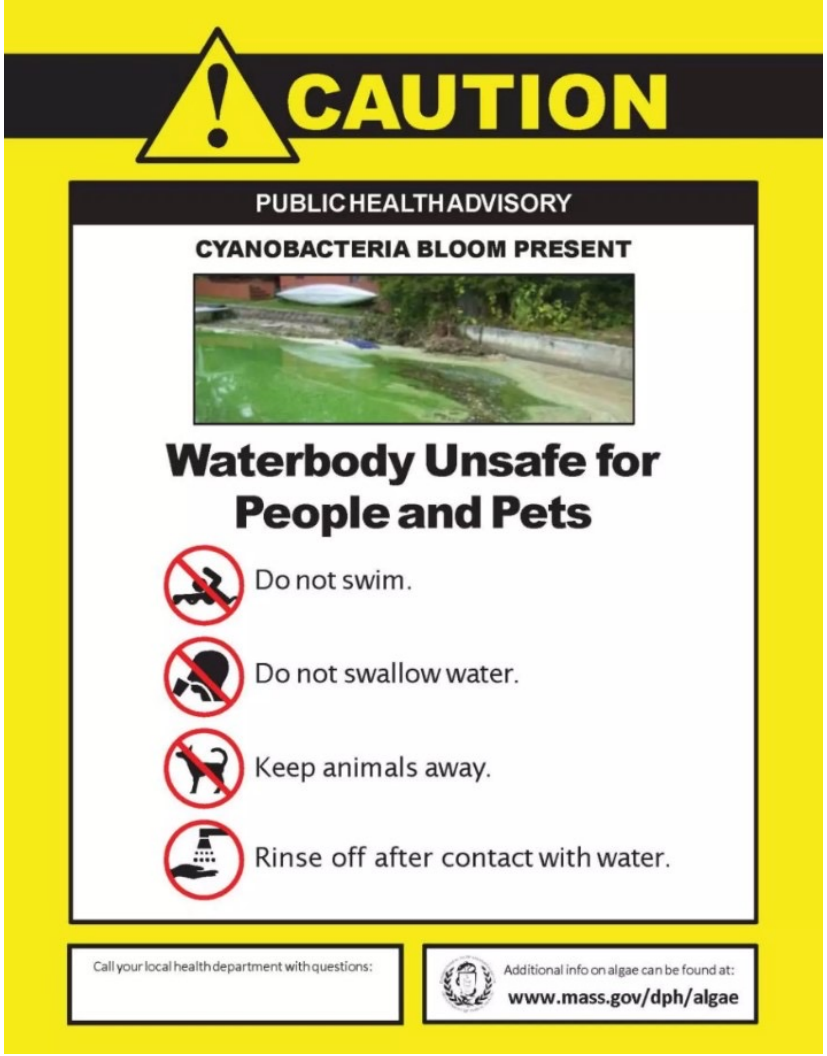
- Info on ponds with documented cyanobacteria outbreaks: https://barnstablewaterresources.com/category/beach-water-quality-updates/

Efforts Toward Consistent Signage

- MA Department of Public Health Released a Document to Town Health Departments in 2022 to Provide Guidance on Cyanobacteria Blooms

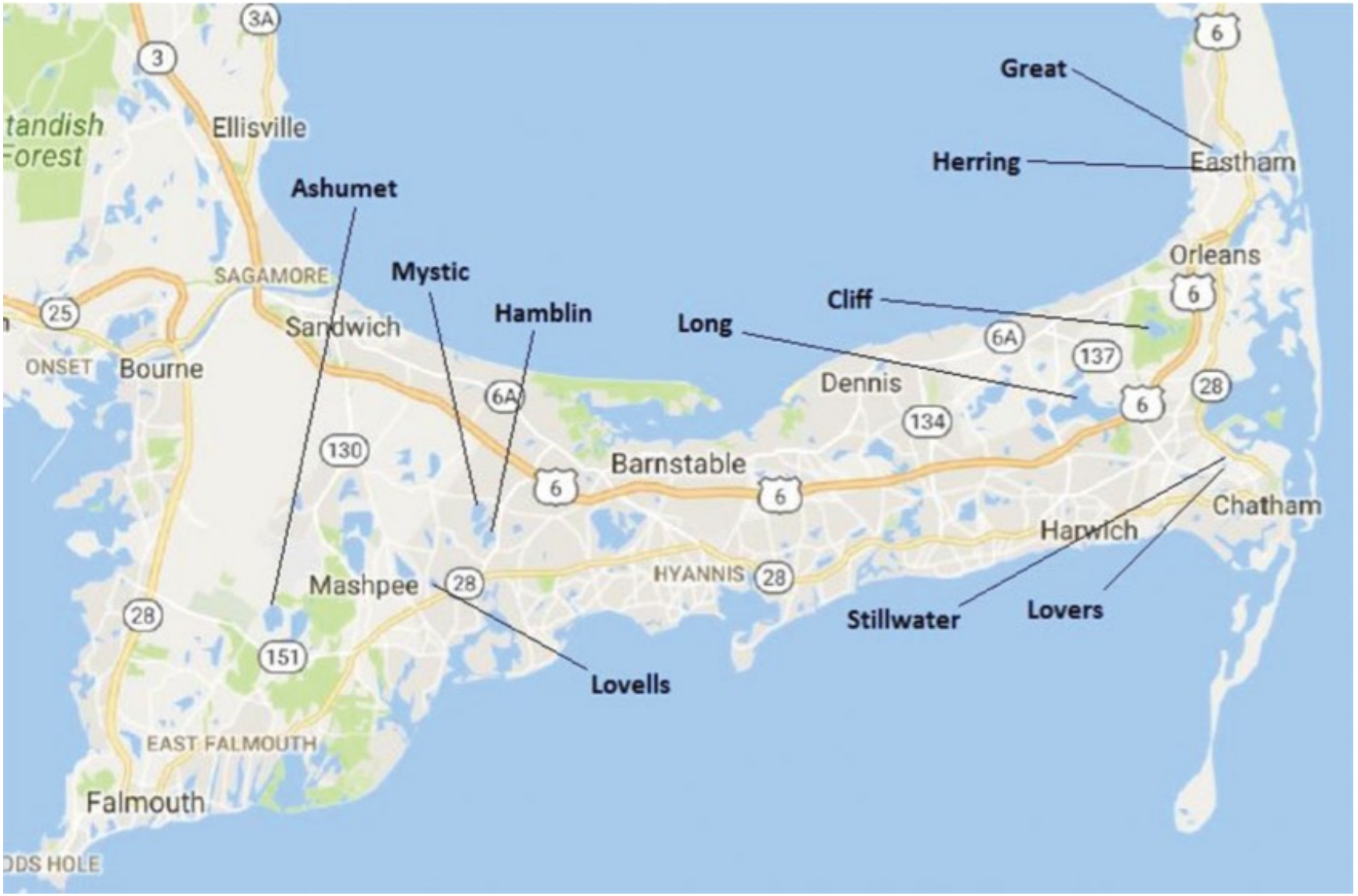
- With No Regulatory Mandate, Health Department Officials Can Choose to Post or Not to Post the Signage

- Email alert sign-up: https://apcc.org/our-work/science/community-science/cyanobacteria/cyanobacteria-alert/



Source: MA Department of Public Health

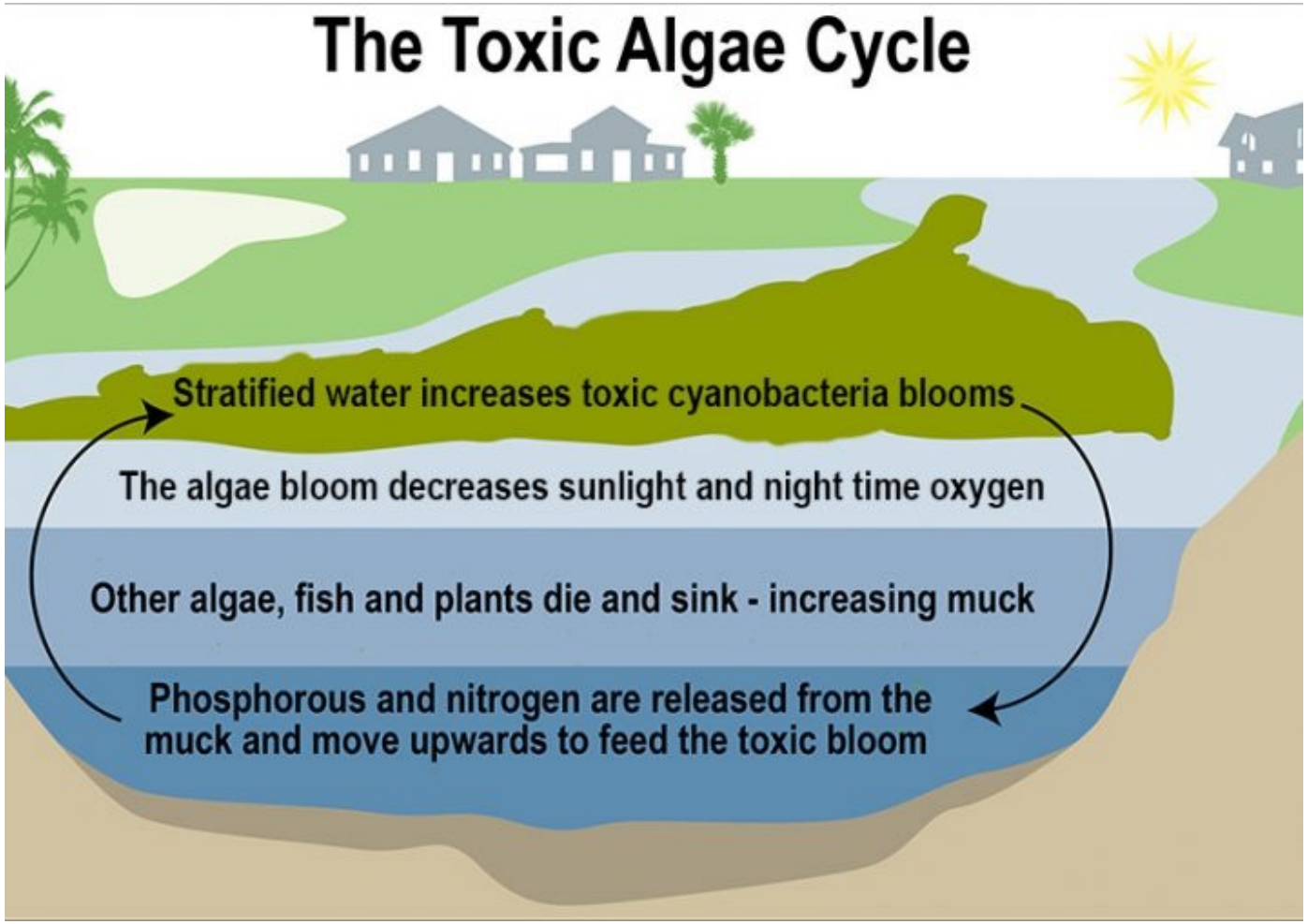
Ponds Treated with Alum for Cyanobacteria



Source: Wagner et al (2017), Lake and Reservoir Management

Cyanobacteria Proliferations Recur Once Established

- Mid-Cape Ponds that have had alum remediation treatments include Cliff Pond (2016), Hinckley's Pond (2019), Long Pond (2009)
- Cyanobacteria Blooms Returned After the Treatments



Source: Vertex Aquatic Solutions

Association to Preserve Cape Cod (APCC) Tests Showed High Levels of Cyanobacteria in Bucks Pond in October 2019

2019 Cyanobacteria Monitoring Data			WLW			BFC				Dominance%		BFC PC to MC Regressions			WLW PC to MC Regressions					Notes:	Map Cyano Status	Other notes
Sample Date	Fluor Date	Pond Temp (F)	PC (ug/L)	CHLA (ug/L)	Ratio	PC (ug/L)	CHLA (ug/L)	Ratio	Microcystis	Dolichospermum	Other	100% MC	Mixed	100% DS	100% MC	Mixed	100% DS				
7/18/19	7/19/19	79.5	0.17	0.01	13	53.66	0.3	180.88	96	1	3	1.96	0.1438	0.0243	0.01	0.0003	0.0008			Low	
7/30/19	7/30/19	79.4	16.08	0	0	386.86	0.86	449.84	62	35	3	14.11	1.1737	0.077	0.59	0.0399	0.012			Low	
8/6/19	8/6/19	80.3	2.02	0	0	120.63	0.24	495.73	69	23	8	4.41	0.3401	0.039	0.07	0.0044	0.0036			Low	
8/14/19	8/15/19	75.3	33.98	0.01	0	326.81	0.63	521.51	48	48	4	11.92	0.9811	0.0698	1.24	0.0884	0.0186			Low	
8/20/19	8/20/19	80.8	15.56	0	0	329.49	0.93	355.56	76	21	3	12.02	0.9896	0.0701	0.57	0.0386	0.0118			Low	
9/25/19	9/26/19	65.4	3.26	0.09	34.96	771.17	2.84	271.54	100	0	0	28.08	2.4437	0.1153	0.12	0.0073	0.0047	High due to est Microcystin in BFC sample above 14ppb	High	Contacted town to give warning of concerning findings	
9/30/19	10/1/19	65.4	2.46	0.11	23.03	490.84	2.36	207.98	100	0	0	17.89	1.5117	0.0886	0.09	0.0054	0.004	High due to est Microcystin in BFC sample above 14ppb	High	Updated town that levels were still high.	
10/7/19	10/8/19	73.2	2.53	0.16	16.32	57.15	0.45	127.95	100	0	0	2.09	0.1537	0.0252	0.09	0.0056	0.0041	High due to less than two weeks with elevated Microcystin	High		
10/17/19	10/18/19	59.8	3.78	0.12	31.47	96.43	0.38	251.56	100	0	0	3.53	0.2681	0.0342	0.14	0.0086	0.0051		Low	Updated town of Low concern	

Source: APCC 2019 Cyanobacteria Monitoring Report

In July 2021, APCC Tests Showed Two Weeks of High Concentrations of Cyanobacteria in John Joseph Pond

Sampling Date	APCC Map Warning Tier	Dominant Genus	Bloom Forming Colonies Phycocyanin (ug/L)	Estimated Microcystin Concentrations in Bloom Forming Colonies (ug/L)	Cyanobacteria Bloom Material Presence
6/10/2021	Low	Mixed	28.3	0.07	No
6/25/2021	Low	*Microcystis* spp.	1.7	0.06	No
7/2/2021	Low	*Microcystis* spp.	12.0	0.44	No
7/16/2021	High	*Microcystis* spp.	311.6	11.37	No
7/21/2021	High	*Microcystis* spp.	261.5	9.54	No
7/30/2021	High	*Microcystis* spp.	107.7	3.94	No
8/6/2021	Low	*Dolichospermum* spp.	95.9	0.03	No
8/13/2021	Low	*Microcystis* spp.	38.7	1.42	No
8/27/2021	Low	Mixed	31.2	0.08	No

Table 2. Summary Cyanobacteria monitoring results for John Josephs Pond in Harwich, MA

Source: APCC 2021 Cyanobacteria Monitoring Report for Bucks, John Josephs, Skinequit Ponds and West Reservoir

In 2022, Bucks and John Joseph Ponds Showed High Levels of Cyanobacteria

2022 Cyanobacteria Monitoring Data		WLW			BFC				Map Cyano Status
Sample Date	**Pond Name**	PC (ug/L)	CHLA (ug/L)	Ratio	PC (ug/L)	CHLA (ug/L)	Ratio	**Dominant Genus**	
date	pond	pc_WLW	chla_WLW	ratio_WLW	pc_BFC	chla_BFC	ratio_BFC	dom_gen	cyano_status
6/1/22	Bucks Pond	1.18	0.13	9.35	68.23	0.92	74.50	Dolichospermum	Acceptable
6/15/22	Bucks Pond	1.05	0.40	2.59	2.46	0.92	2.76	Microcystis	Acceptable
6/29/22	Bucks Pond	0.55	0.39	1.37	11.38	0.75	14.93	Microcystis	Acceptable
7/13/22	Bucks Pond	13.68	0.80	17.32	5.21	0.30	17.49	Microcystis	Acceptable
7/27/22	Bucks Pond	6.42	0.33	19.61	23.38	1.04	21.57	Microcystis	Potential for Concern
8/4/22	Bucks Pond	4.08	0.42	10.02	33.93	2.00	5.79	Microcystis	Acceptable
8/10/22	Bucks Pond	2.73	0.47	5.86	13.69	1.09	13.32	Microcystis	Acceptable
8/24/22	Bucks Pond	1.25	0.39	3.25	17.22	1.02	17.25	Microcystis	Acceptable
Total Ponds	8								
Total Extra	1								
6/1/22	John Joseph's Pond	0.40	0.32	1.14	154.32	2.78	53.53	Dolichospermum	Acceptable
6/15/22	John Joseph's Pond	1.63	0.46	3.60	25.03	2.38	10.51	NA	Acceptable
7/7/22	John Joseph's Pond	2.27	0.40	5.50	3.10	1.22	2.55	NA	Acceptable
7/13/22	John Joseph's Pond	4.53	0.49	9.35	5.20	1.20	4.31	NA	Potential for Concern
7/21/22	John Joseph's Pond	4.82	0.30	16.24	23.95	1.22	18.32	Mixed	Potential for Concern
7/27/22	John Joseph's Pond	2.87	0.30	9.49	9.32	1.75	6.86	Dolichospermum	Acceptable
8/10/22	John Joseph's Pond	6.87	0.28	24.54	20.14	0.86	24.83	Mixed	Acceptable
8/18/22	John Joseph's Pond	1.04	0.25	4.21	24.52	3.02	8.14	Dolichospermum	Acceptable
8/24/22	John Joseph's Pond	5.18	0.30	17.60	46.60	2.14	21.45	Mixed	Acceptable
8/29/22	John Joseph's Pond	5.43	0.70	7.91	2.25	1.29	3.57	Dolichospermum	Acceptable
Total Ponds	10								
Total Extra	3								

Source: APCC 2022 Cyanobacteria Monitoring Report

- There is not yet consensus on when and how to report this information to residents.
- MA Department of Public Health recommends: “When in doubt, stay out”

Sewer Project Update

- Most of the excess nutrients in the ponds are from septic systems
  - Septic systems remove solids but allow nutrients into the soil
  - Cape Cod soil is largely porous sand
  - Nutrients are leaching into ponds through the sand
- GSLA lobbying efforts in January 2022 during the public comments period for the revision of the Harwich Comprehensive Wastewater Management Plan (CWMP), “the sewer plan,” were successful in prioritizing the neighborhood (thank you everyone!)
- Queen Anne Road is now scheduled for sewer construction in 2026 (up from 2048), after a stretch along Route 137 is completed
- The plan makes sense due to unused flow capacity in the current sewer treatment agreement between Harwich and Chatham
- Barnstable County provided Harwich with a $619,000 ARPA grant to redesign the wastewater plan to address water quality in GSL
- https://www.harwich-ma.gov/health/pages/sewer-information

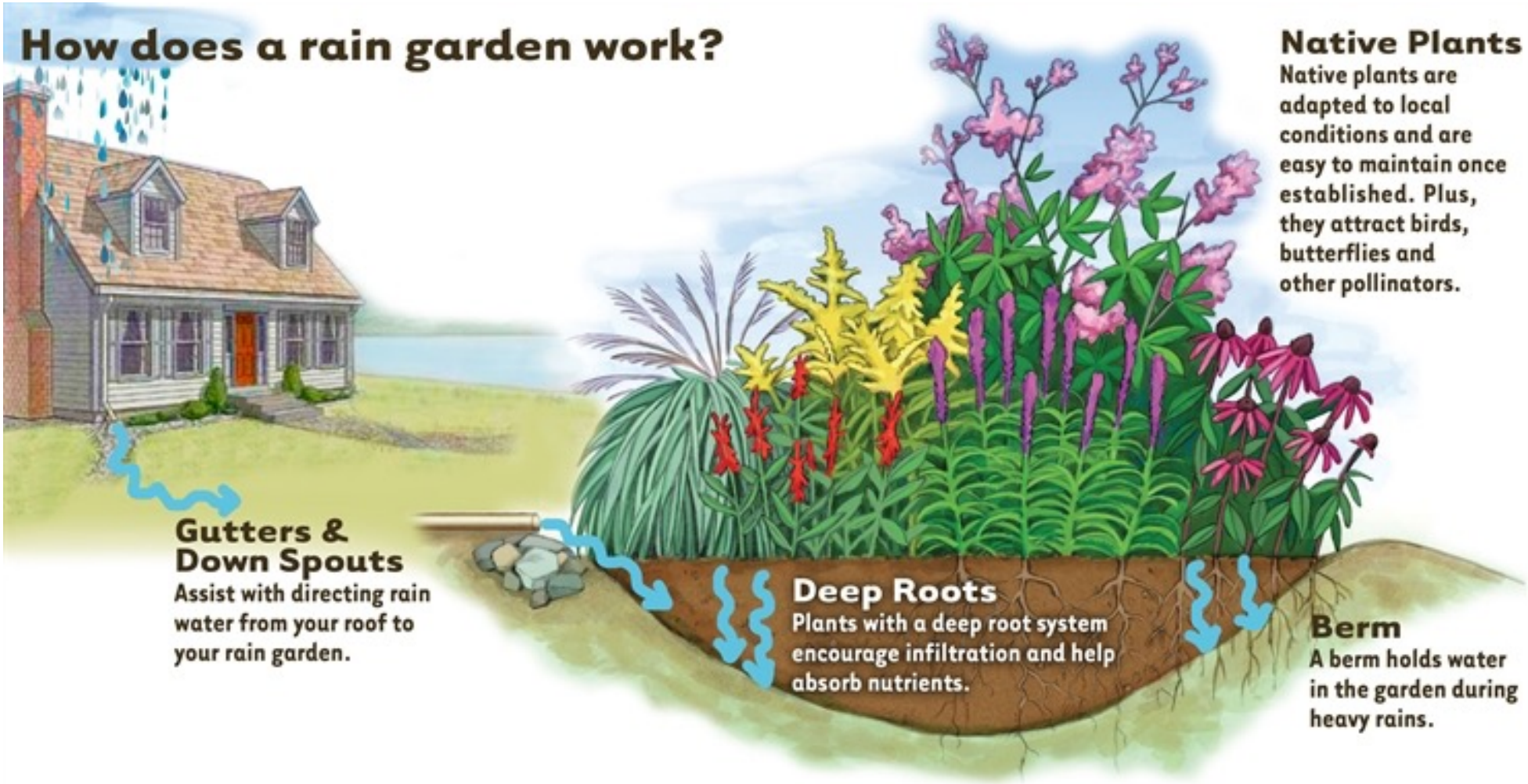
GSLA Board Efforts to Maintain the Ponds

- Water Quality Testing Every Other Week
- Agreement with APCC for Extended Cyanobacteria Tests (Sept-Oct)
- Training with APCC for Cyanobacteria Screening Field Tests (stick test and jar test)
- Weed Watcher Workshop to learn to identify invasive plants will take place on July 10, 2023, 11:30-1:30, Harwich Community Center
- Invasives Removal with Homeowner Permission
- Storm Drain Monitoring and Maintenance
- Erosion Monitoring
- Plant Barrier Gardens and Rain Gardens – “Jim’s Garden”

What GSLA Residents Can Do

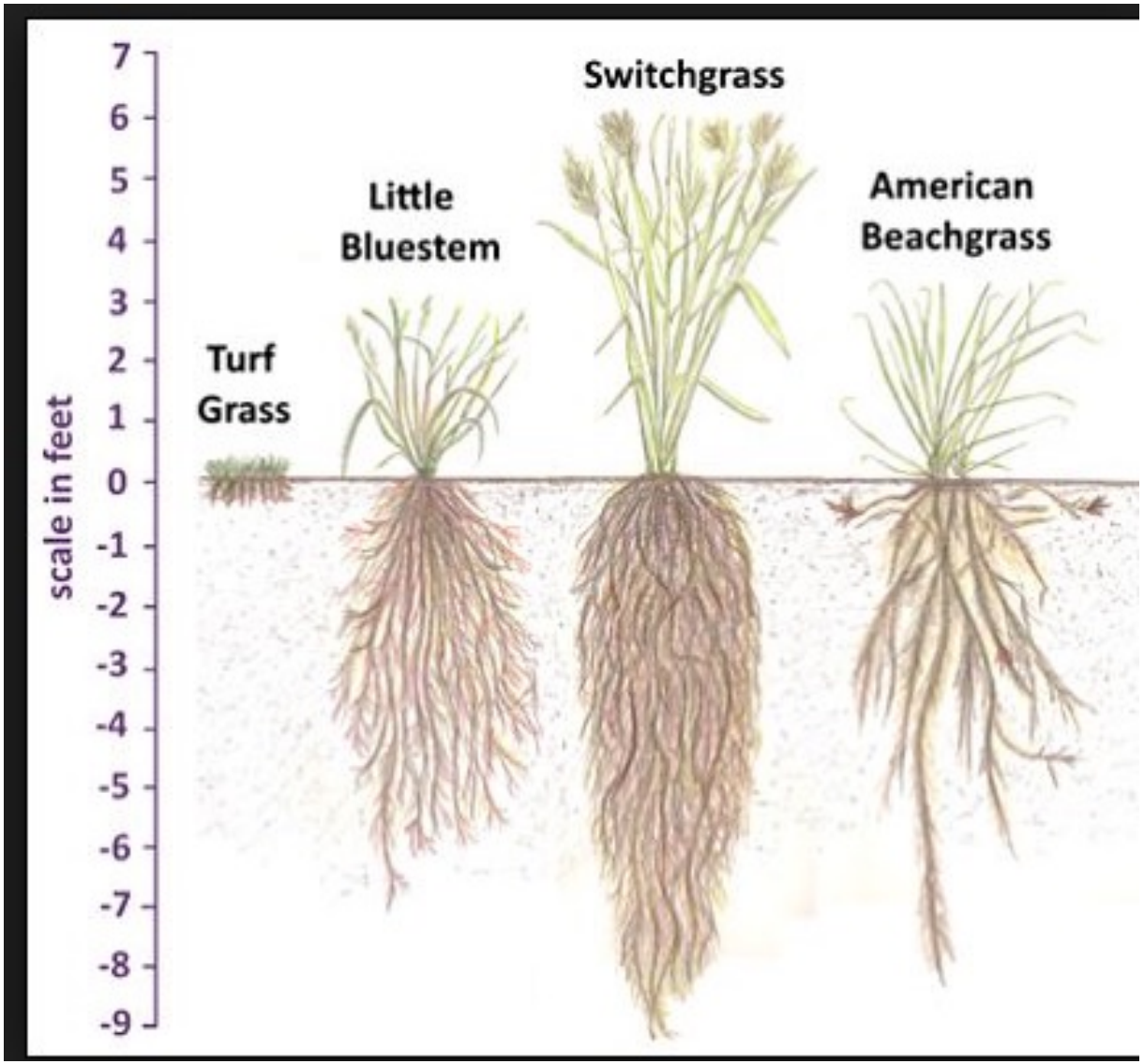
- Maintain septic systems to prevent overflow (empty every 3 years)
- Plant native plants, barrier gardens, and rain gardens to enable run-off to filtrate before it reaches the ponds
- Participate in the Weed Watchers Workshop to identify invasives
- Remove invasive plants from your own properties
- Use landscaping techniques that do not pollute the ponds
- Donate native plants to GSL common-area barrier gardens
- Volunteer to do water sampling at GSL for testing at SMAST
- Volunteer to do water sampling for the Association to Preserve Cape Cod (www.apcc.org)

Rain Gardens Help Filter Run-Off



Source: Greater Lansing Regional Committee for Stormwater Management

Native Plants are More Effective at Filtration



https://www.nativeplanttrust.org

https://www.mass.gov/service-details/coastal-landscaping-in-massachusetts-plant-list