

# The Use of Oxygenation to Contribute Toward the Control and Management of HABs in Lake Hopatcong

County of Morris  
Lake Hopatcong Commission  
Lake Hopatcong Foundation

Funding provided by the New Jersey Highlands Council  
2<sup>nd</sup> November 2023

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Lake Hopatcong, NJ, summer of 2019. Photo credit: Rick Loomis, New York Times

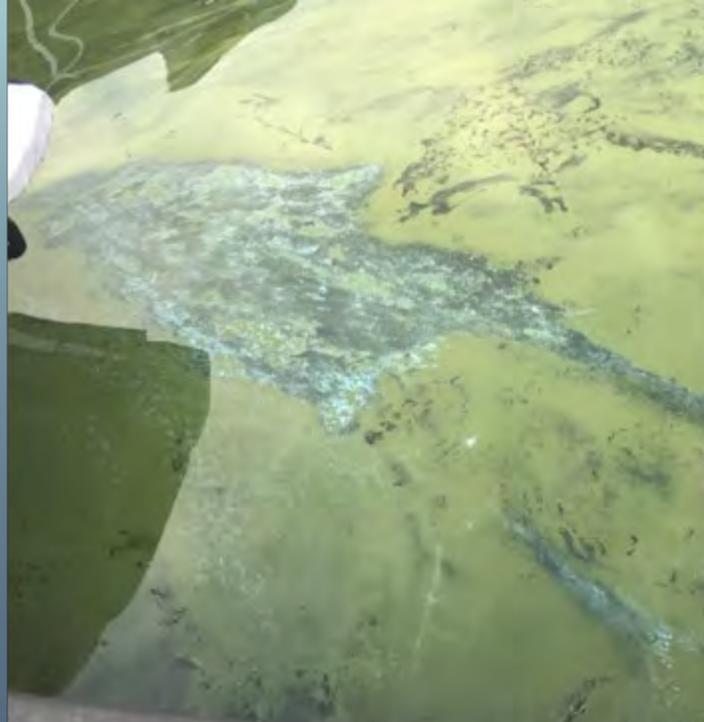


# Conditions that Result in a Cyanobacteria Algal Bloom

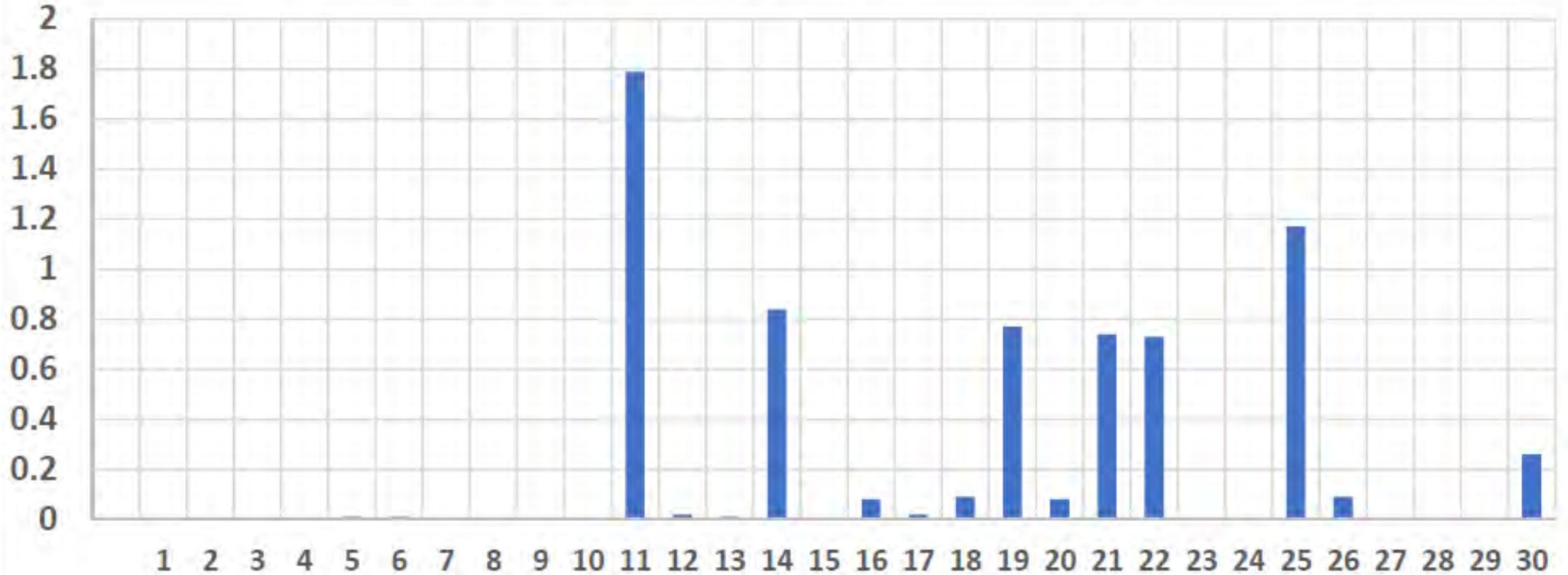


- High seasonal temperatures
- Still water conditions / thermal stratification
- Total Phosphorus concentrations 0.03 mg/L or greater can generate nuisance blooms / scums

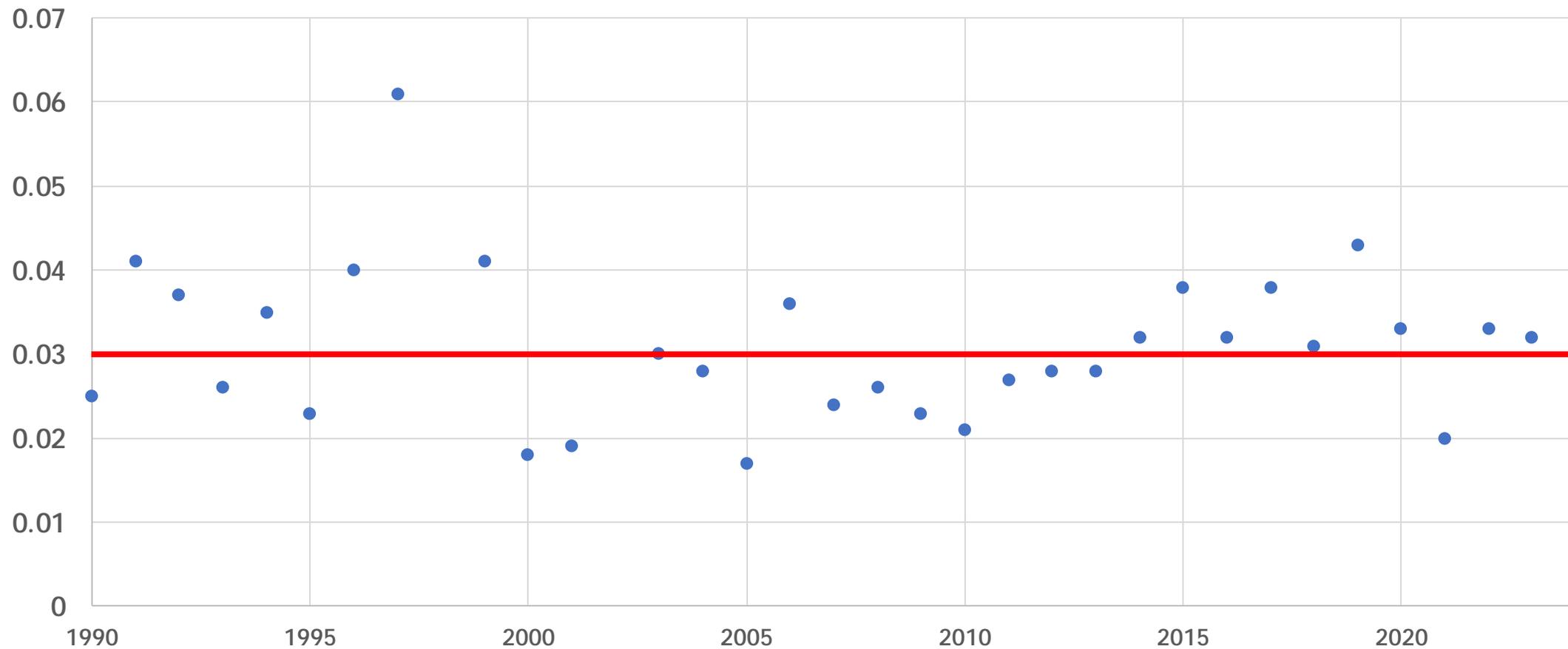
# Blooms at Lake Hopatcong, New Jersey (June 2019)



## Rainfall in June 2019 - Morris County - Boonton 1 SE Station



Mean June Total Phosphorus Concentrations (mg/L) in  
Lake Hopatcong, Sussex and Morris Counties, NJ

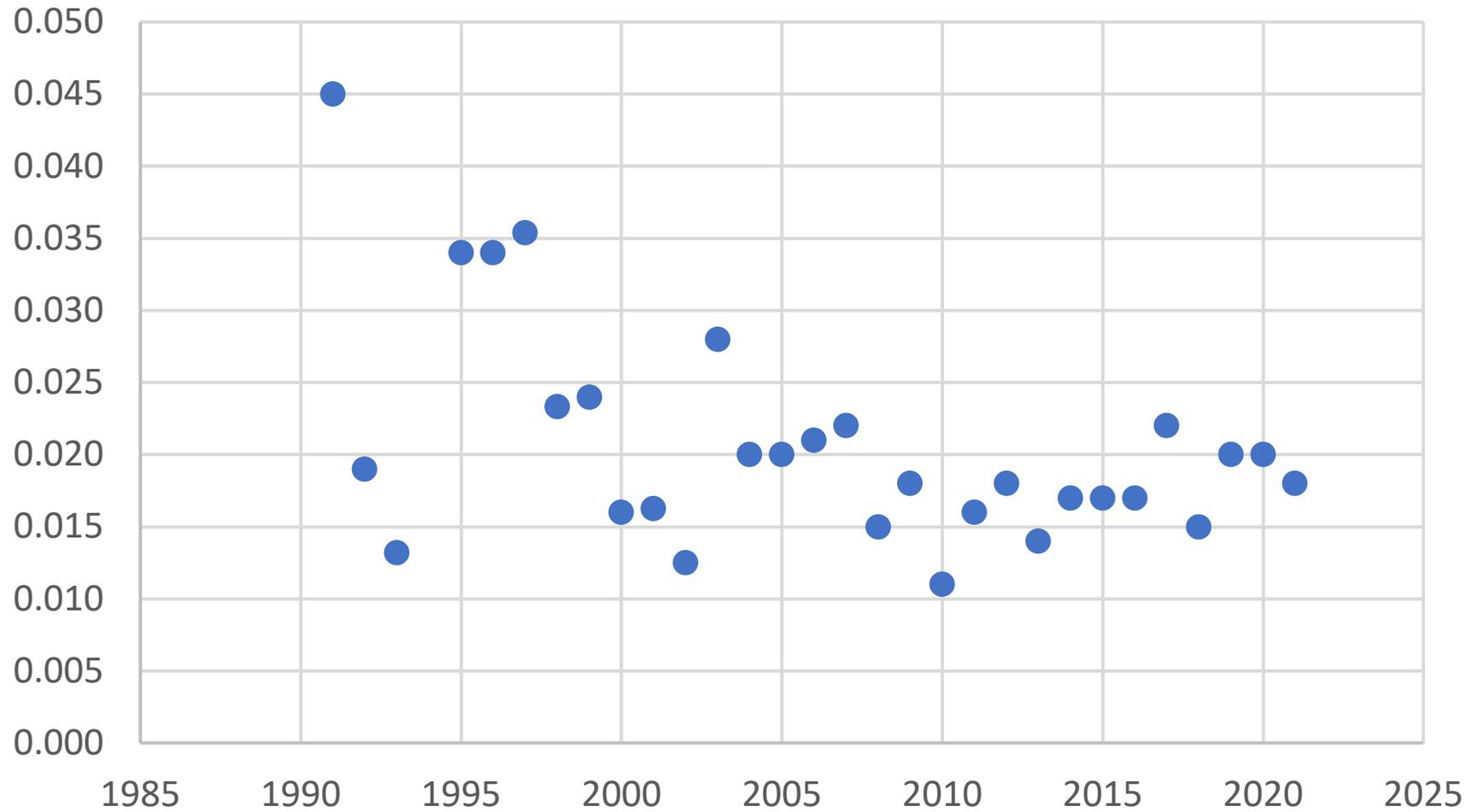


# Blooms at Lake Hopatcong, New Jersey persisted over the 2019 growing season.

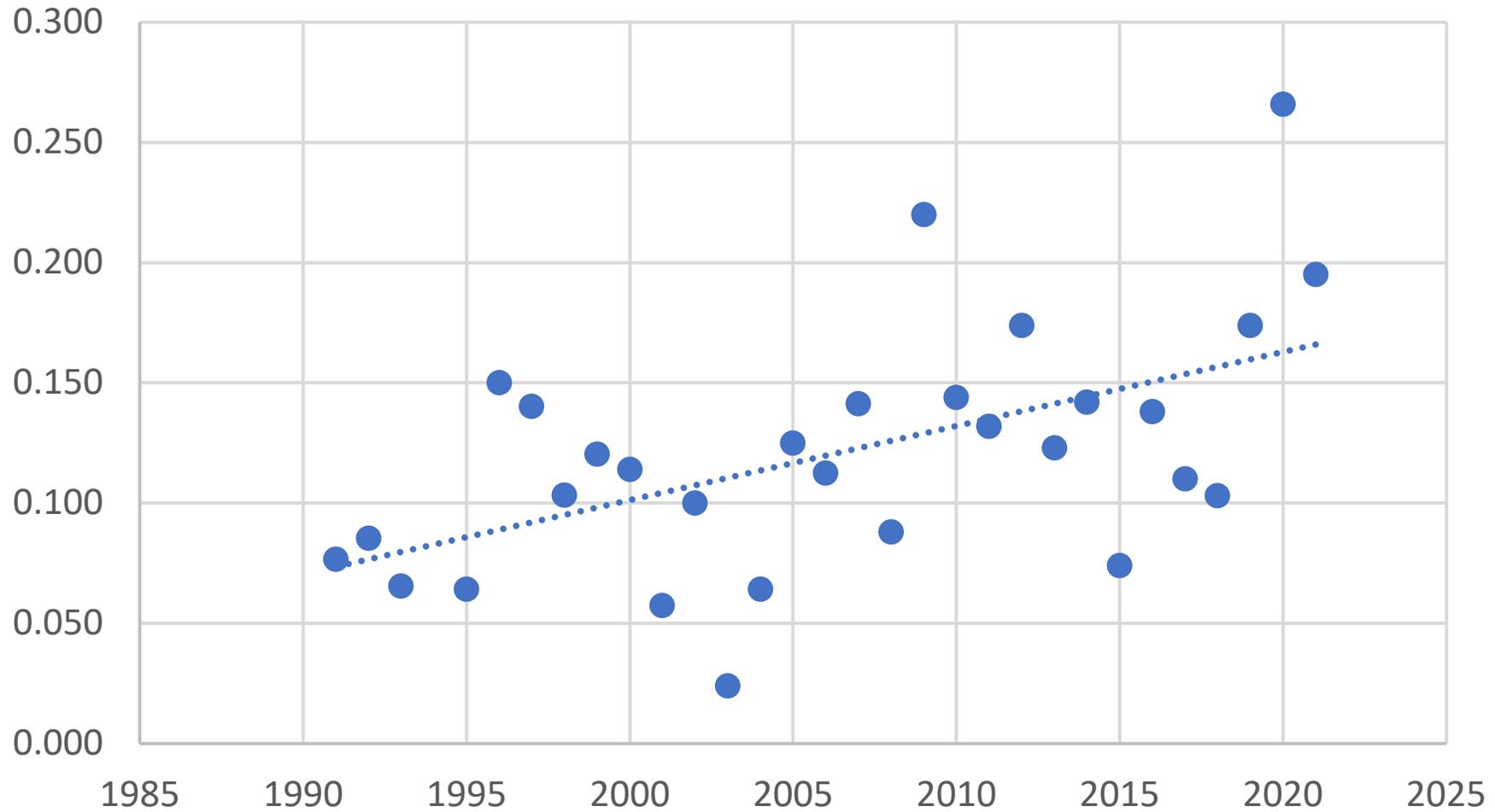


SCIENCE  
ENGINEERING  
DESIGN

# Annual Event Mean Surface TP (mg/L)



# Annual Event Mean Deep TP (mg/L)

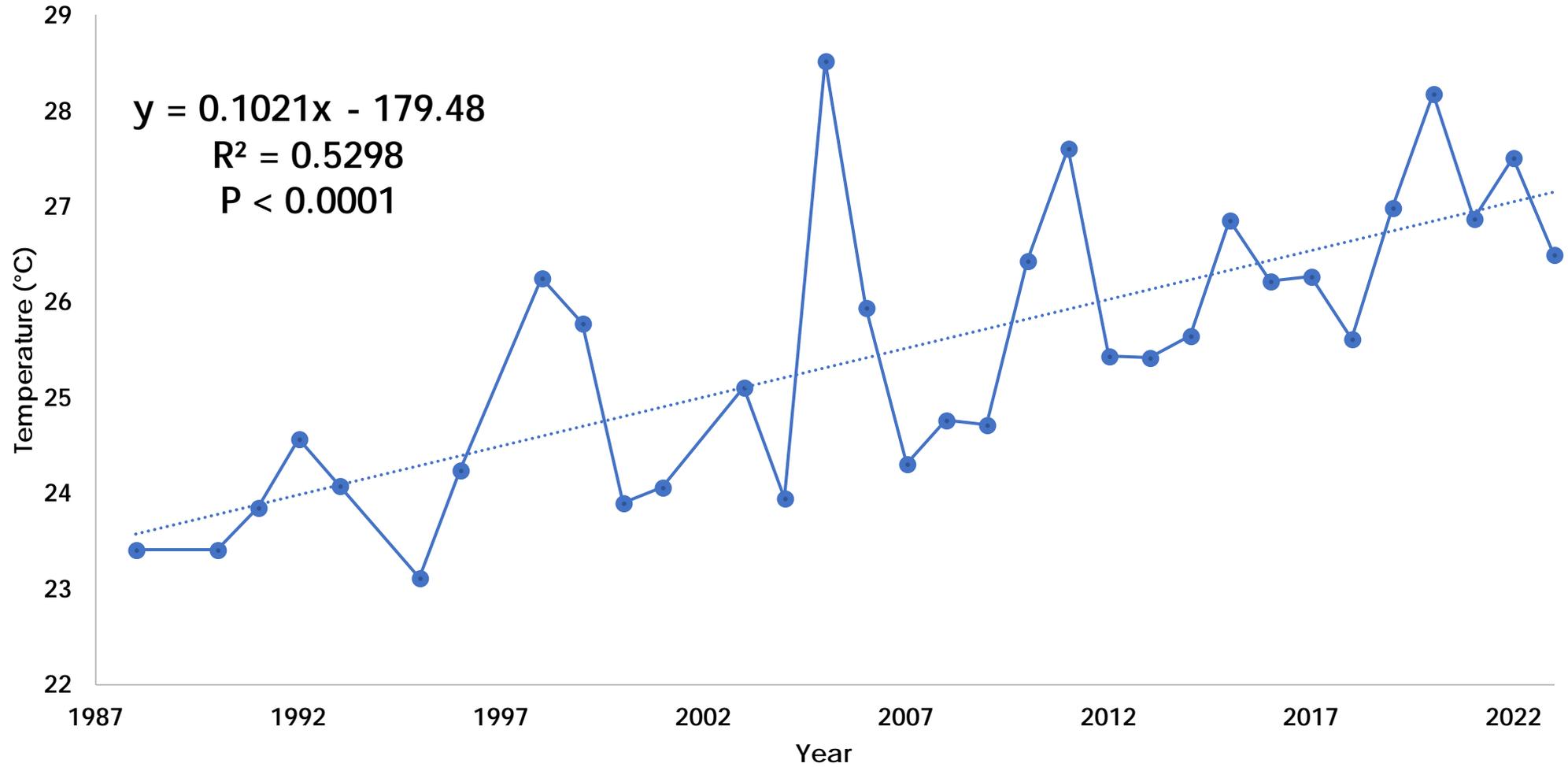


# 2019 and beyond – “one, two punch”

- **Watershed sources** (stormwater and septic leachate) in June triggered the HABs.
- However, **internal sources of phosphorus** (from the deep-water sediments when they go anoxic) allowed the HABs to remain through the entire growing season.



# Lake Hopatcong July Surface Temperature, Station 2



# Updated Strategy for Lake Hopatcong

- ✓ On an annual basis, the watershed-based loads of phosphorus (stormwater / septic systems) are the dominant sources of phosphorus. On an annual basis, the internal phosphorus load was less than 10% of the total load.
- ✓ However, during the summer months, depending on weather conditions, the internal phosphorus (from the sediments) can account for up to 70% of the daily / seasonal availability of phosphorus.
- ✓ Cyanobacteria have an advantage in harvesting internal phosphorus over other types of algae.

# Addressing the Internal Phosphorus Load in Lake Hopatcong

- ✓ **Nutrient inactivation** – use of alum to inactivate the phosphorus, making it unavailable for algal growth.
- ✓ **Aeration** – mixing / circulating the entire water column or a section of the water column. Using compressed air to circulate water to the surface for the transfer of oxygen from the atmosphere. In the presence of dissolved oxygen, phosphorus remains bound to iron.
- ✓ **Oxygenation** – directly generating oxygen and injecting it in the bottom to oxidize the organic matter along the bottom. Also, keeps phosphorus bound to iron, making it unavailable for algal growth.

# Advantages of Oxygenation

- ✓ Can “dial” in a designed amount of dissolved oxygen to breakdown the organic matter over / in the sediments.
- ✓ Can provide oxygenated conditions to prevent the leaching of phosphorus into the overlying waters, contributing toward the control of HABs (in oxygenated conditions the phosphorus is bound to iron, making it unavailable for algal growth).
- ✓ Can oxygenate the bottom waters and keep thermal stratification intact (preserve / possibly enhance carry-over trout habitat).
- ✓ The cost for such technology has declined over the last 10 years.

# Limitations with Oxygenation

- ✓ Annual electrical costs.
- ✓ A limited amount of required maintenance.
- ✓ Existing lines or infrastructure in the lake; concerns over possibly impacting infrastructure with anchors.
- ✓ Shoreline structures that may require permits / approvals.
- ✓ These limitations would apply to any form of aeration.

# Sediment Oxygen Demand (SOD) Study

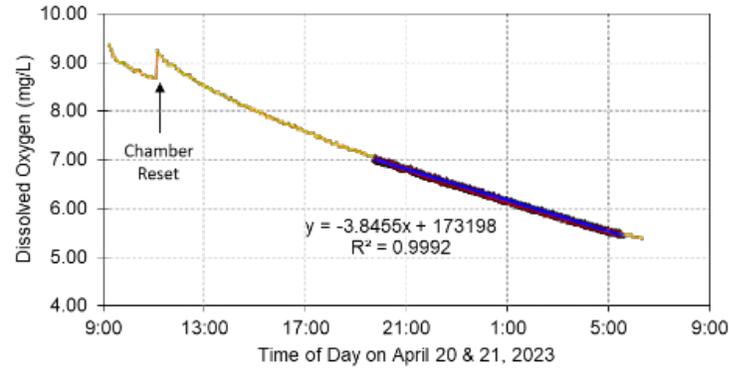
- ✓ SOD – Comprised of biological and chemical oxygen demand.
- ✓ Predominant contributor to oxygen depletion in stratified lakes.
- ✓ SOD analysis conducted 17 – 21 April by PH and Paul Gantzer.
- ✓ First step in the design of an oxygenation system.
- ✓ Phosphorus speciation of sediments also conducted.



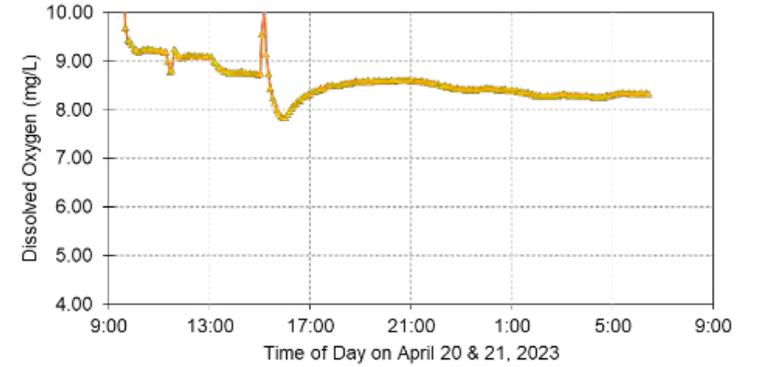


# Sediment Oxygen Demand Results

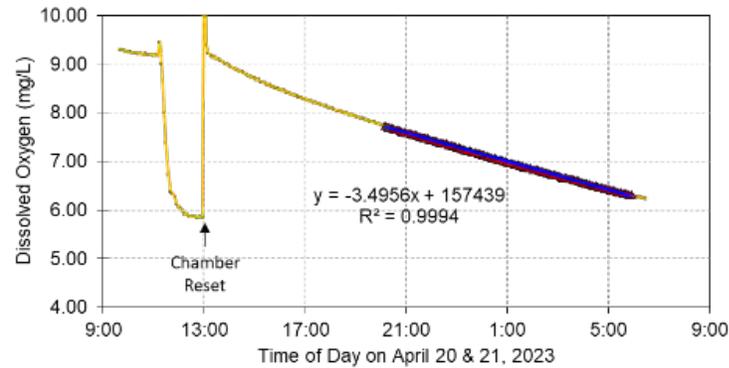
Site 1 SOD 1  
Lake Hopatcong, Hopatcong, NJ



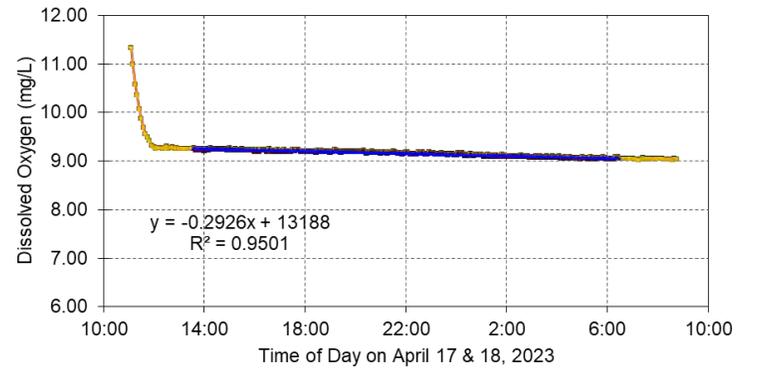
Site 1 SOD 2  
Lake Hopatcong, Hopatcong, NJ



Site 1 SOD 3  
Lake Hopatcong, Hopatcong, NJ



Site 1 WOD  
Lake Hopatcong, Hopatcong, NJ

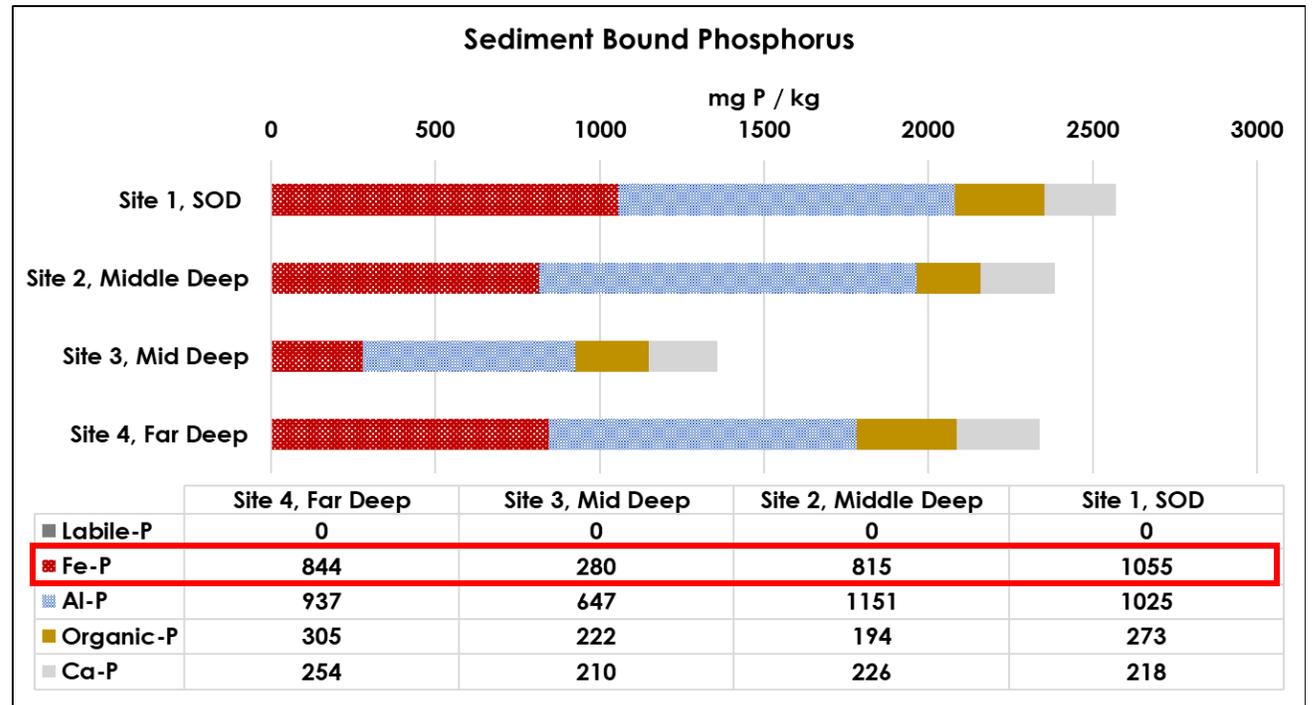


# Sediment Oxygen Demand Results

Location	Sample	Observed Rate of Change (mg/l day)	R <sup>2</sup>	Water Temp (°C)	SOD (g/m <sup>2</sup> day)	Average (g/m <sup>2</sup> day)	Std Dev	Coefficient of Variation (%)	SOD @ 15° C (g/m <sup>2</sup> day)	SOD @ 20° C (g/m <sup>2</sup> day)
Site 1	SOD <sub>1</sub>	3.85	0.999	8.1	0.92	0.811	0.059	6.7	1.11	1.40
	SOD <sub>2</sub>	"No Data"	"No Data"							
	SOD <sub>3</sub>	3.50	0.999	8.1	0.84					
	WOD	0.29	0.950	7.5	0.070					

Average Measured SOD – WOD = True SOD

# Sediment Phosphorus Speciation



Location	Iron (Fe) (mg/kg)	Total P (mg/kg)	Fe:P
Site 1, SOD (>50 ft)	57,100	2,572	22
Site 2, Middle Deep (>50 ft)	53,700	2,385	23
Site 3, Mid Deep (~40 ft)	33,200	1,358	24
Site 4, Far Deep (>50 ft)	51,600	2,340	22

# Sediment Oxygen Demand Conclusions

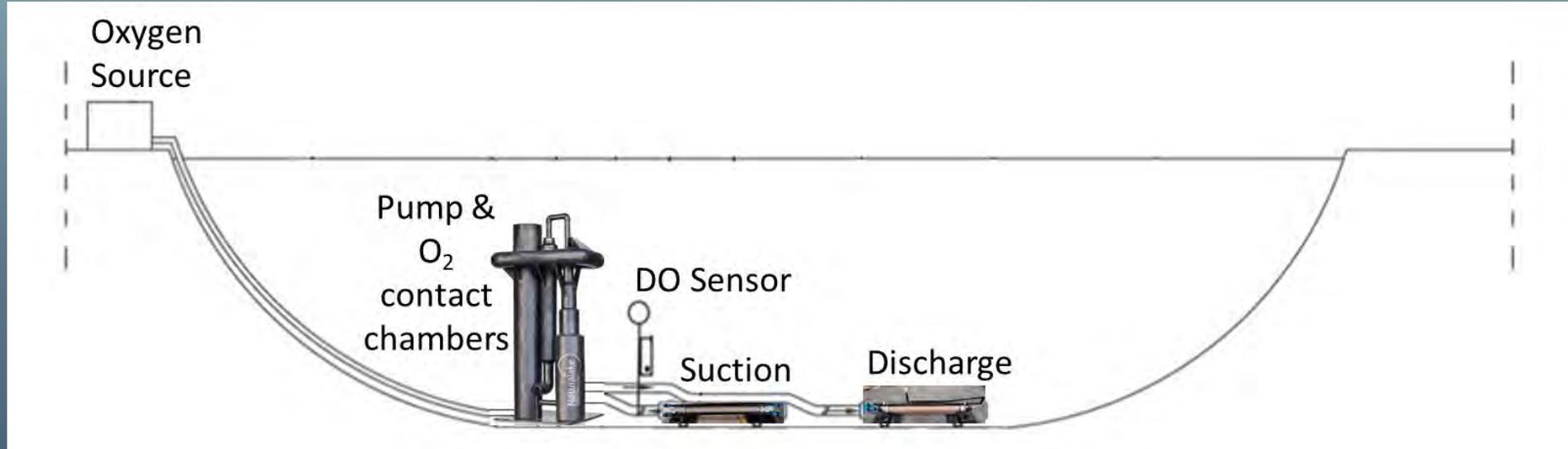
- ✓ Sediment oxygen demand in Lake Hopatcong is very high.
- ✓ Results support empirical data collected by PH over the past 30+ years.
- ✓ Iron : phosphorus ratios vary between 22 and 24, exceeding the threshold of success of 15 based on past studies.
- ✓ Lake Hopatcong is a strong candidate for the installation of an oxygenation system to control the internal phosphorus load.

# Preliminary Design

# Oxygen Saturation Technology <sup>®</sup>

US Patent US3643403A

2023-07-18



## Key Design Characteristics

- Uses oxygen gas (90% nominal purity)
- No bubbles
- No mixing (induced turbulence)
- Preserves thermal structure (ice cover and/or summer stratification)
- Automated (DO feedback)
- Modular and Scalable

# Preliminary Cost Estimates

- ✓ **Capital Cost:** \$1,500,000 - \$2,500,000
- ✓ **Annual Operation and Maintenance:** \$100,000+
- ✓ These estimates are based on Princeton Hydro's experience with similar systems on a smaller scale.
- ✓ Costs will be refined by Paul Gantzer during the design process.

# Moving Forward with Oxygenation

- ✓ Paul Ganzter is working on the final design of the system.
- ✓ Between 2 to 4 shoreline locations will be required for the source of oxygen; footprint of the shoreline structures will each have an area of somewhere between 12' x 12' to 8' x 12'.
- ✓ An oxygenation system has been installed in a lake in northwestern New Jersey and has had some promising results.
- ✓ Well oxygenation over most of the growing season; however, a dip in DO under the thermocline. More importantly, very low phosphorus concentration and no major HAB event in 2023.

# Moving Forward with Oxygenation

- ✓ As mentioned, conducted the *in-situ* study to quantify the oxygen demand (April 2023).
- ✓ Technical meeting with NJDEP reviewing the application of oxygenation (September 2023).
- ✓ Waiting for follow up questions from NJDEP.
- ✓ Once those questions are addressed, request a pre-application meeting to determine what permits / approvals may be needed for the installation of an oxygenation system.

# QUESTIONS?



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THANK  
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