

Arrowhead – Lakes Management

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Objectives

- Describe 2023 Lakes and Watershed Scope of Work
- Background Information on Lake Ecology
- Present Water Quality and Plant Information
- Discuss Watershed
- Preliminary Recommendations
- Stakeholder Feedback



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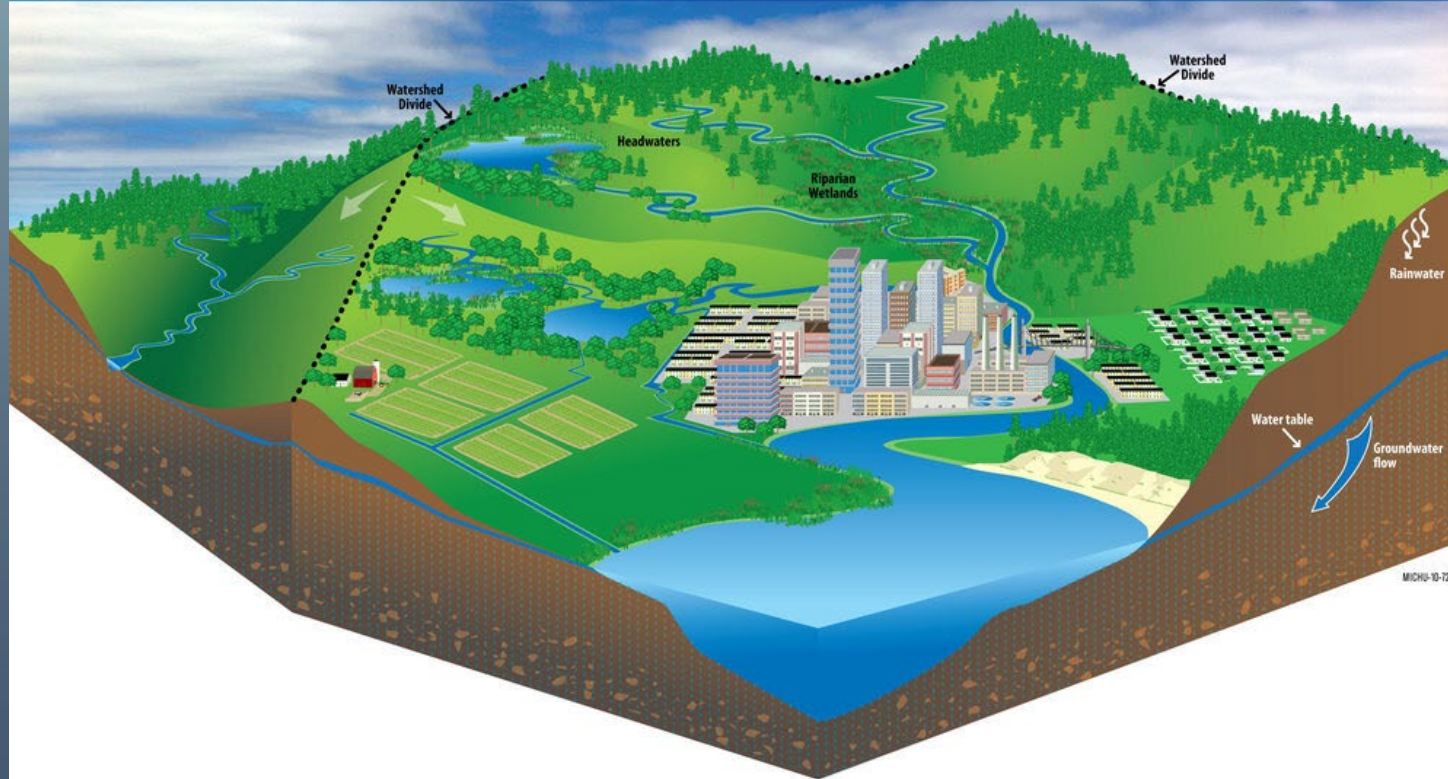
2023 Scope of Work

- ✓ Review of Historical Data / Gap Analysis
- ✓ Water Quality Monitoring
- ✓ Aquatic Plant Surveys
- ✓ Watershed Assessment
- ✓ Develop Lake and Watershed Management Plan

Lake Management Basics

Lakes & Watersheds

HOW WATERSHEDS WORK



Lake and Watershed Management

Each Lake is unique

Lakes are reflective of their watersheds!

Understand each lake by collecting lake specific data

Identify Causes and Symptoms of pollution

Make informed management choices and evaluate objectively

Balance management decisions with lake uses and stakeholder input



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Data Collection

- ✓ Check the 'health' of each lake
- ✓ Monitor during the growing season
- ✓ Differences annually and within seasons
- ✓ Understand sources and causes of **eutrophication**



Data Types

- ✓ Chemical
 - Nutrients
 - Cyanotoxins
- ✓ Physical
 - Dissolved oxygen
 - Temperature
 - pH
- ✓ Biological
 - Aquatic plants
 - Phytoplankton (Algae) and Zooplankton
 - Fishery



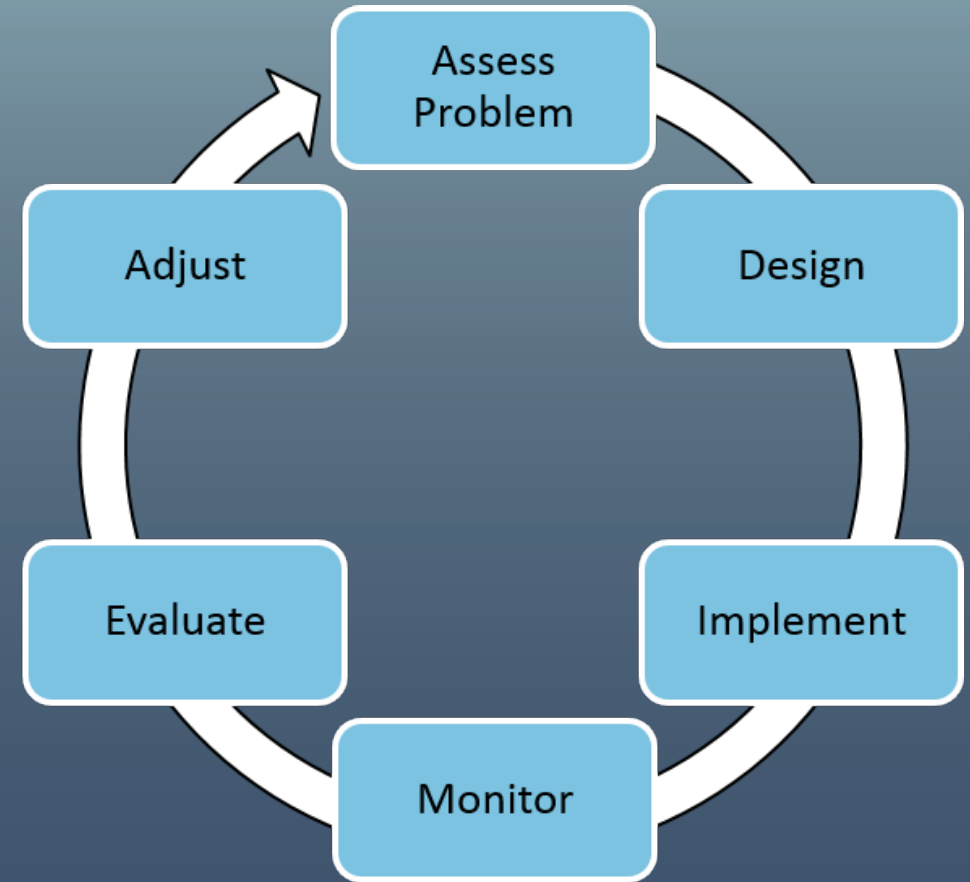
YSI



Abraxis / Eurofins

Data Driven Management

- ✓ Use data collected to recommend management measures and to objectively evaluate implemented measures
- ✓ Adapt plan as conditions change
- ✓ Include stakeholder engagement, education, timelines, funding strategies, technical assistance



2023 Water Quality - Key Data & Recommendations

Arrowhead Lake & North Lake

Water Quality Protocol

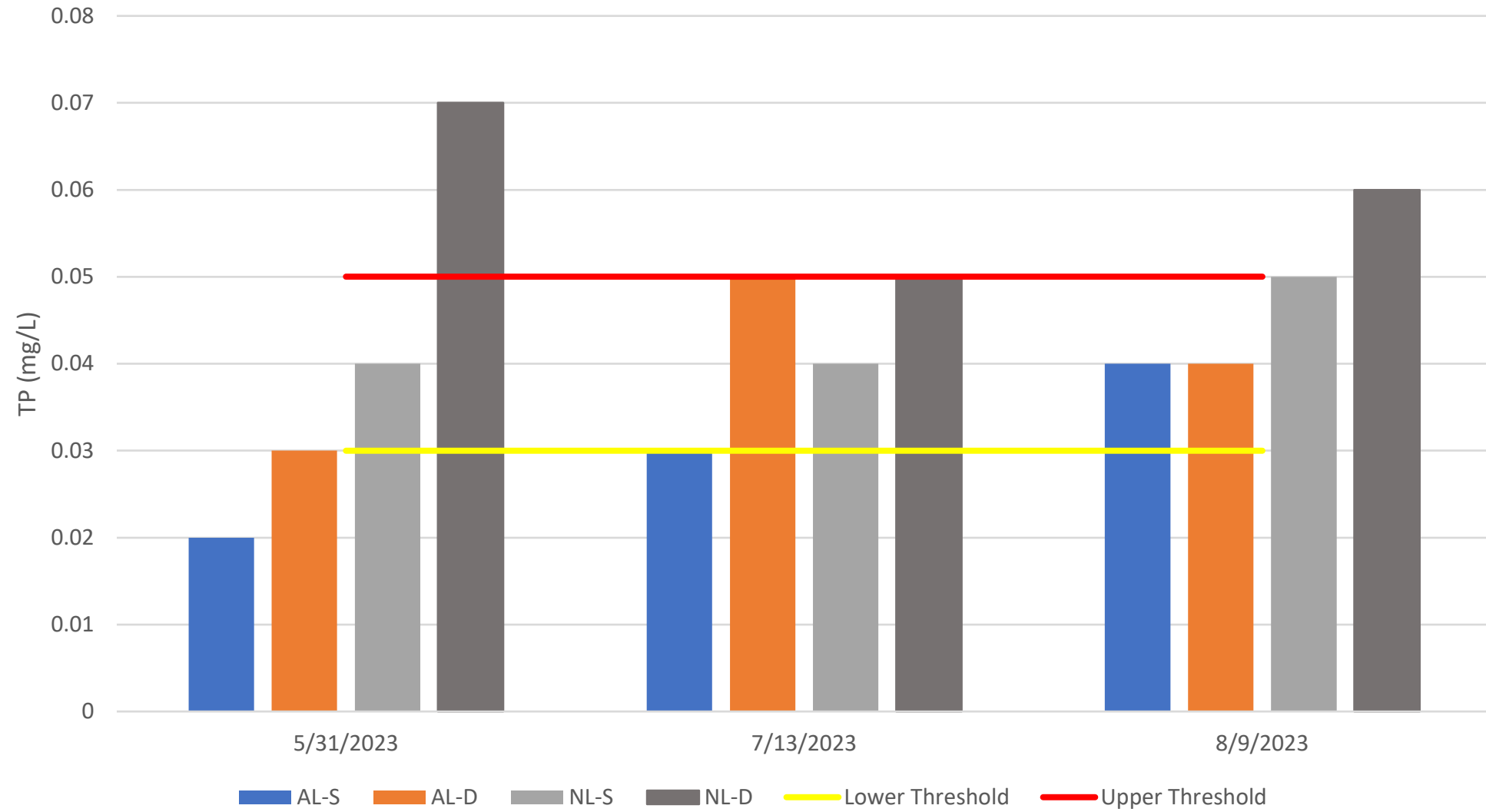
- ✓ 3 Events – May, July, August
- ✓ *In-situ*: Temperature, dissolved oxygen, pH, conductivity, Secchi, phycocyanin
- ✓ Lab: Total and soluble reactive phosphorus, nitrate, ammonia, suspended solids, chlorophyll *a*
- ✓ Phytoplankton & zooplankton



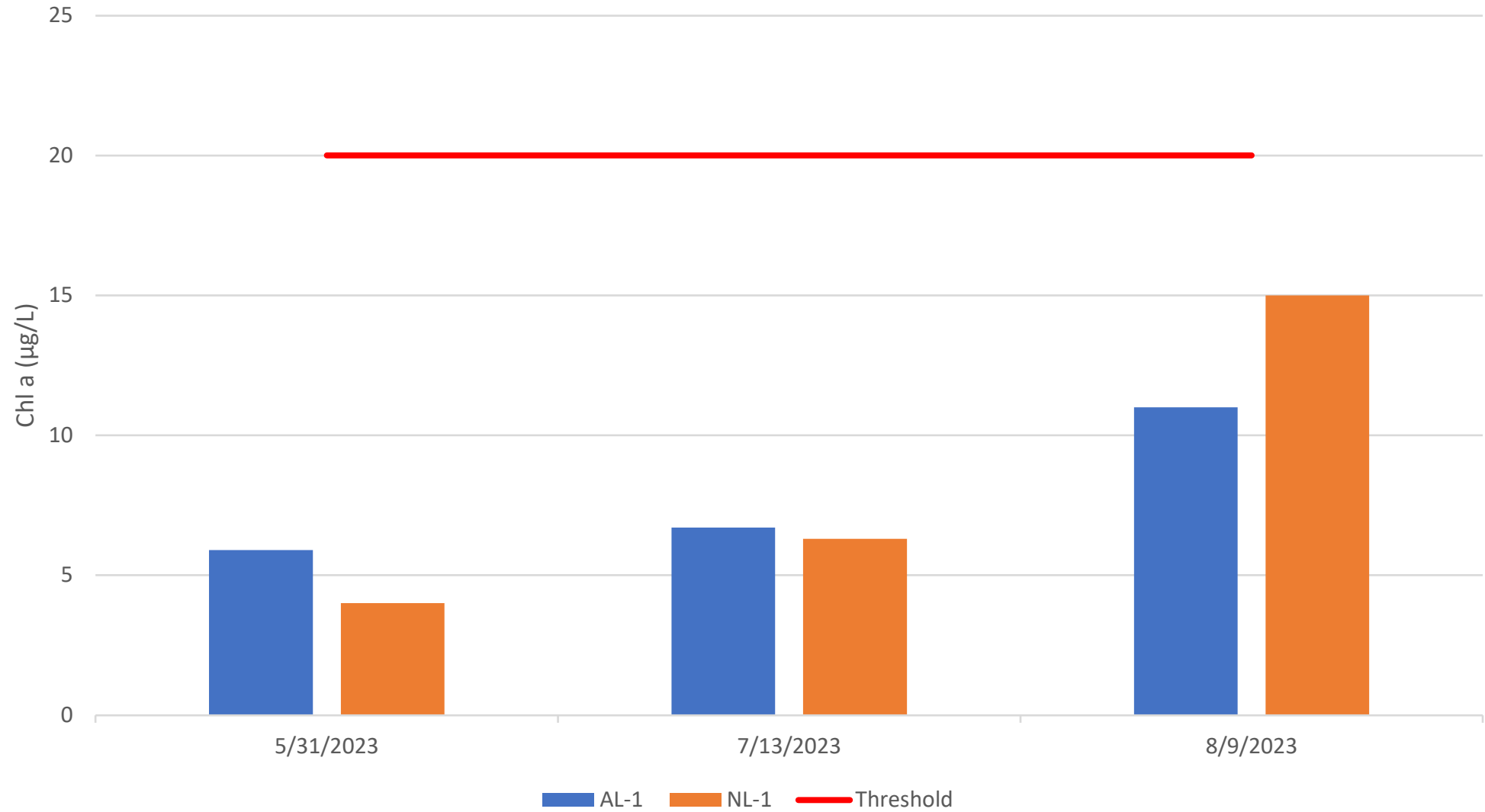


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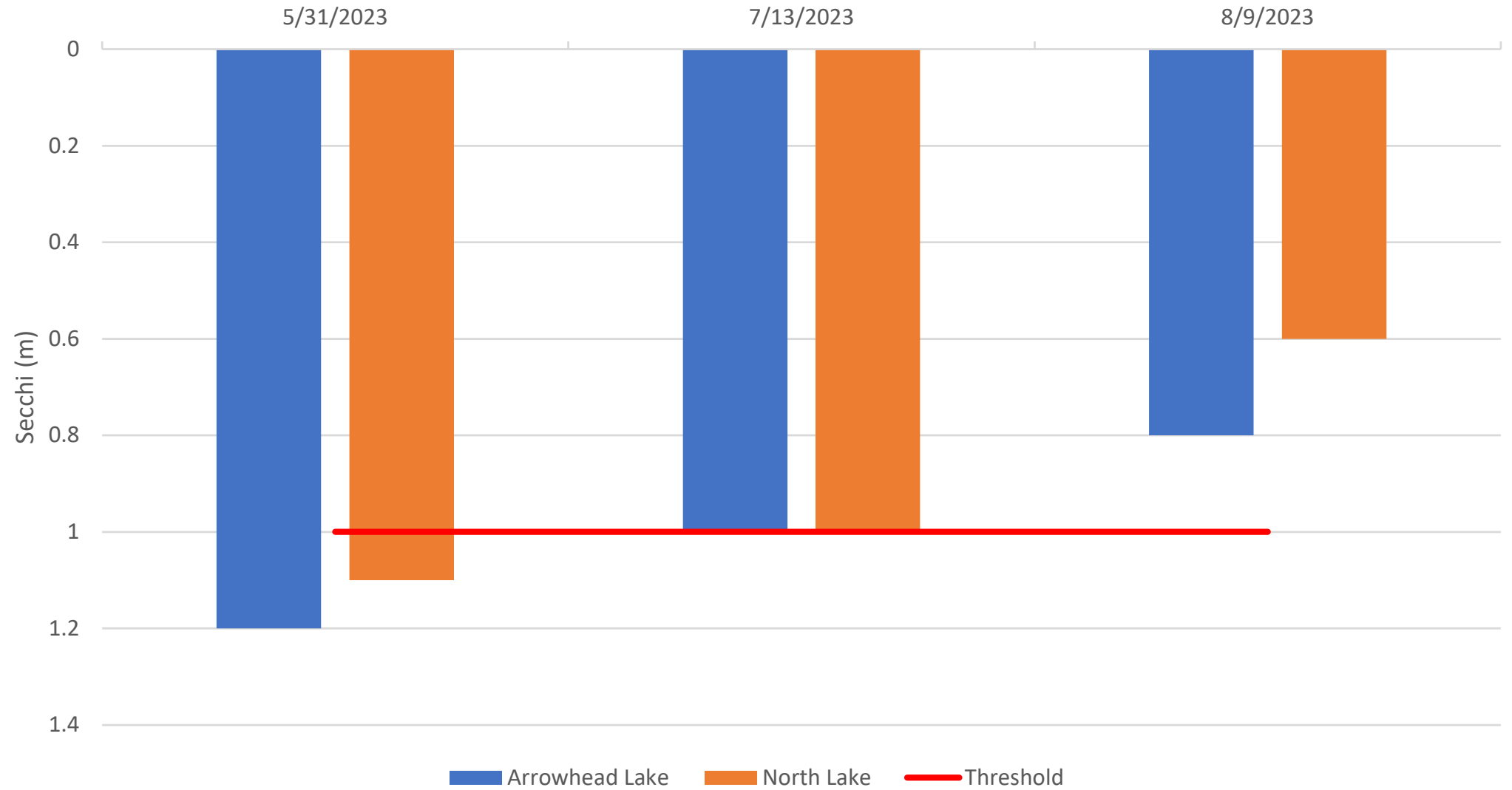
Arrowhead Lakes - Total Phosphorus



Arrowhead Lakes - Chlorophyll a

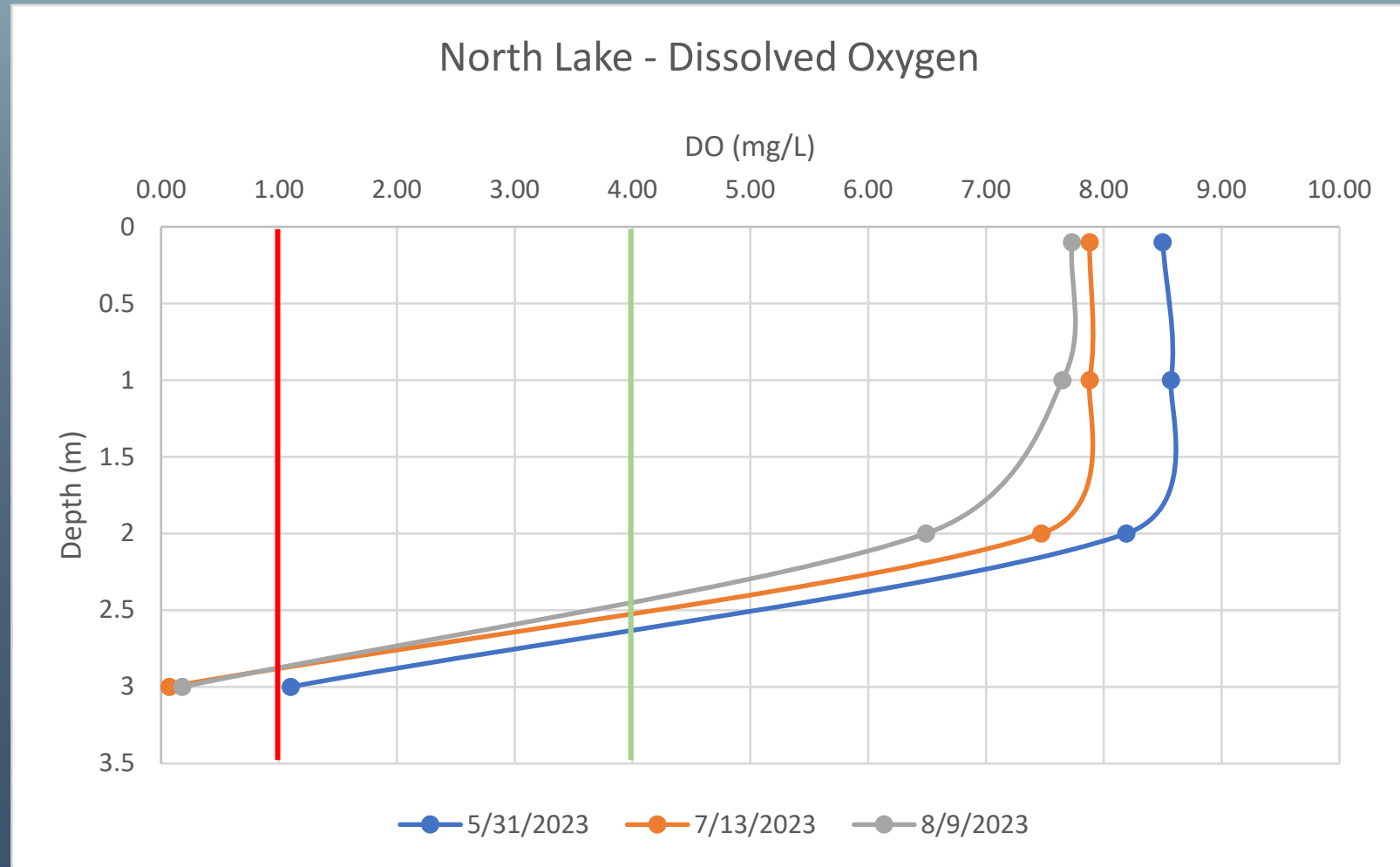


Arrowhead Lakes - Secchi Transparency



Dissolved Oxygen

- Critical for fish health
- Absence of oxygen can result in phosphorus release from sediments leading to higher algae growth
- **DO > 4 mg/L for fish health**
- **DO > 1 mg/L to preclude internal loading**





Arrowhead Lake – Beach 1

- Early season cyanobacteria accumulation at Beach 1.
- ***Dolichospermum* 59,946 cells/mL**
- Typically, cyanobacteria manifest later in the season but early season blooms *can occur*.
- The build up of cyanobacteria dissipated by the remaining events.



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Arrowhead Beach 1 Algae Composition

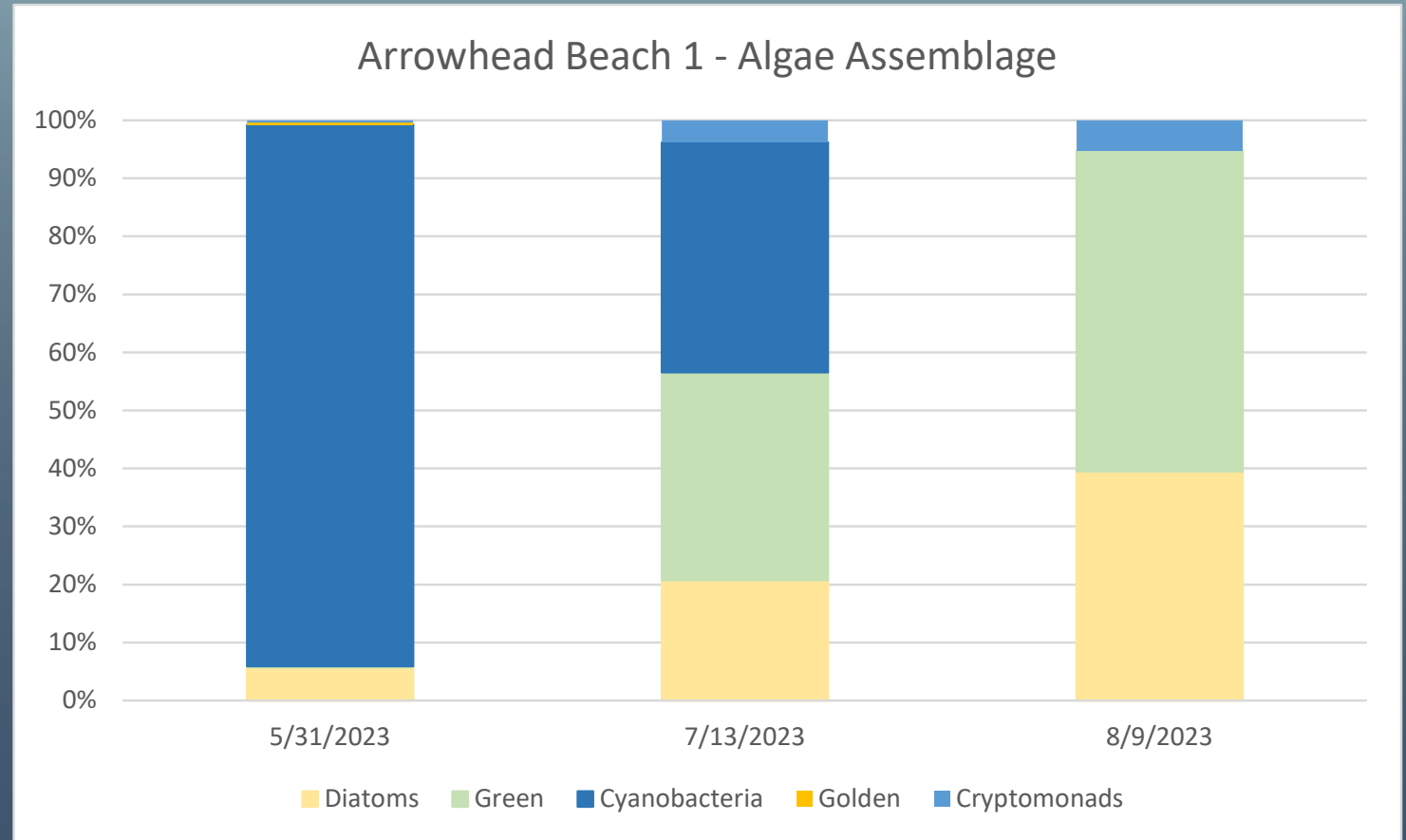
Higher levels of cyanobacteria earlier in the season > 'Good' algae (Green and Diatoms) in the middle and later-season samples.

May

- TP **0.13 mg/L**
- Chl **a 66 µg/L**
- Phycocyanin **48 µg/l**



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Aeration – Destratification System

- Strategically placed diffusers (bubblers) throughout the lake
- Mixes water column / atmosphere replenishes oxygen
- Diffusers sit on lake bottom and are connected to shoreline compressor via weighted rubber tubing
- 15' from compressor ~ 49 decibels (Normal conversation 60 decibels)



Aeration – Destratification System



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Bubble Curtains for Beaches

- ✓ Strategically placed diffusers to create 'wall' of bubbles
- ✓ Prevents wind blown algae and debris from entering beach
- ✓ Assists in mixing stagnant water

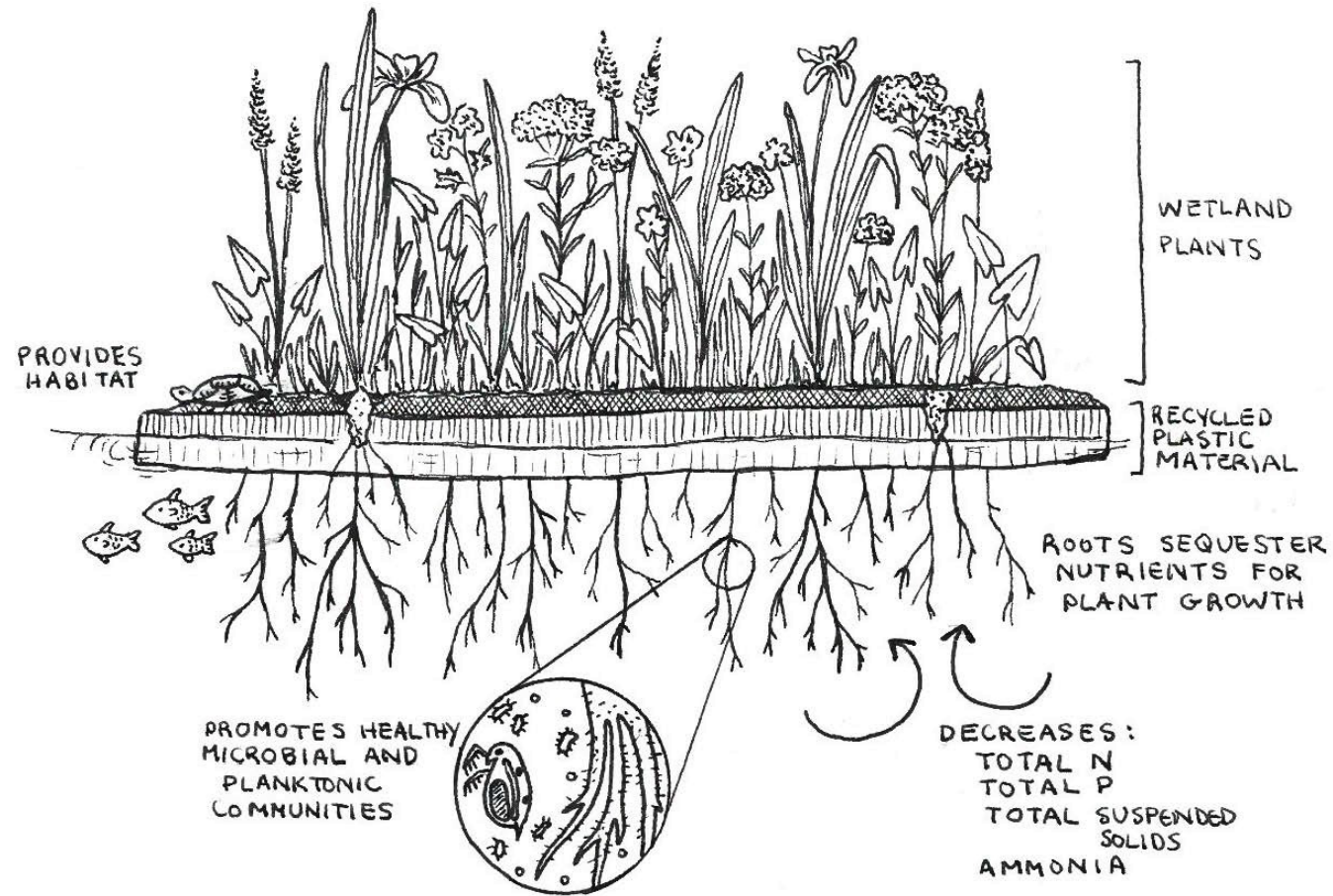


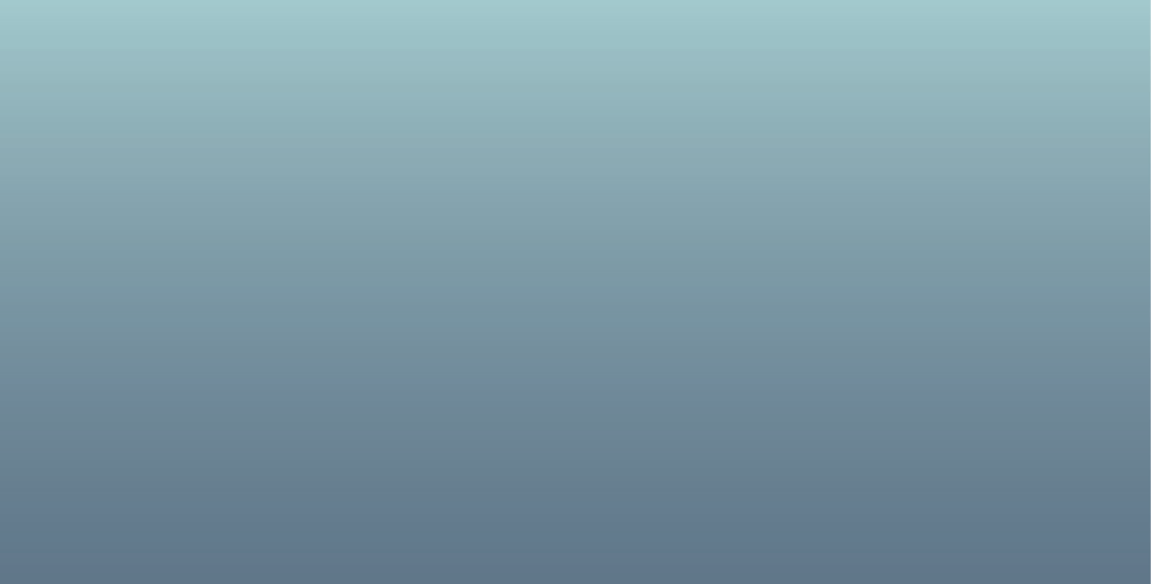
Phosphorus Control - Biochar

- ✓ Carbon based material that is pyrolyzed (sometimes treated) to absorb phosphorus
- ✓ Non-chemical / low-cost
- ✓ Can be deployed in mesh bags anchored or attached to docks
- ✓ Deploy near stream inputs – both lakes



FLOATING WETLAND ISLAND





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2023 Aquatic Plant Data & Recommendations

Arrowhead Lake & North Lake

Aquatic Plant Surveys

- Line-Intercept aquatic plant surveys at North Lake & Arrowhead Lake
- Document species composition, distribution, and densities (biomass) in both lakes
- Identify any potential invasive plants
- Transects – 12 in Arrowhead Lake, 6 in North Lake
- Surveys conducted on August 16, 2023



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North Lake

- ✓ 4 submerged plant species identified – all native and beneficial
- ✓ 2 emergent plant species identified – *Phragmites* is non-native/invasive
- ✓ Overall, very low densities of aquatic plants



Arrowhead Lake

- ✓ 16 species identified
 - 11 submerged
 - 2 floating
 - 2 emergent
 - 1 macroalgae
- ✓ Curlyleaf pondweed (*Potamogeton crispus*) only invasive identified.



Plant Management – Truxor

- ✓ Amphibious machine that can access very shallow water
- ✓ Various attachments:
 - Cutter bar
 - Rake
 - Clamshell dredge
- ✓ Mechanically remove vegetation – lilies, cattails, Phragmites, submerged native plants



Plant Management - Herbicides

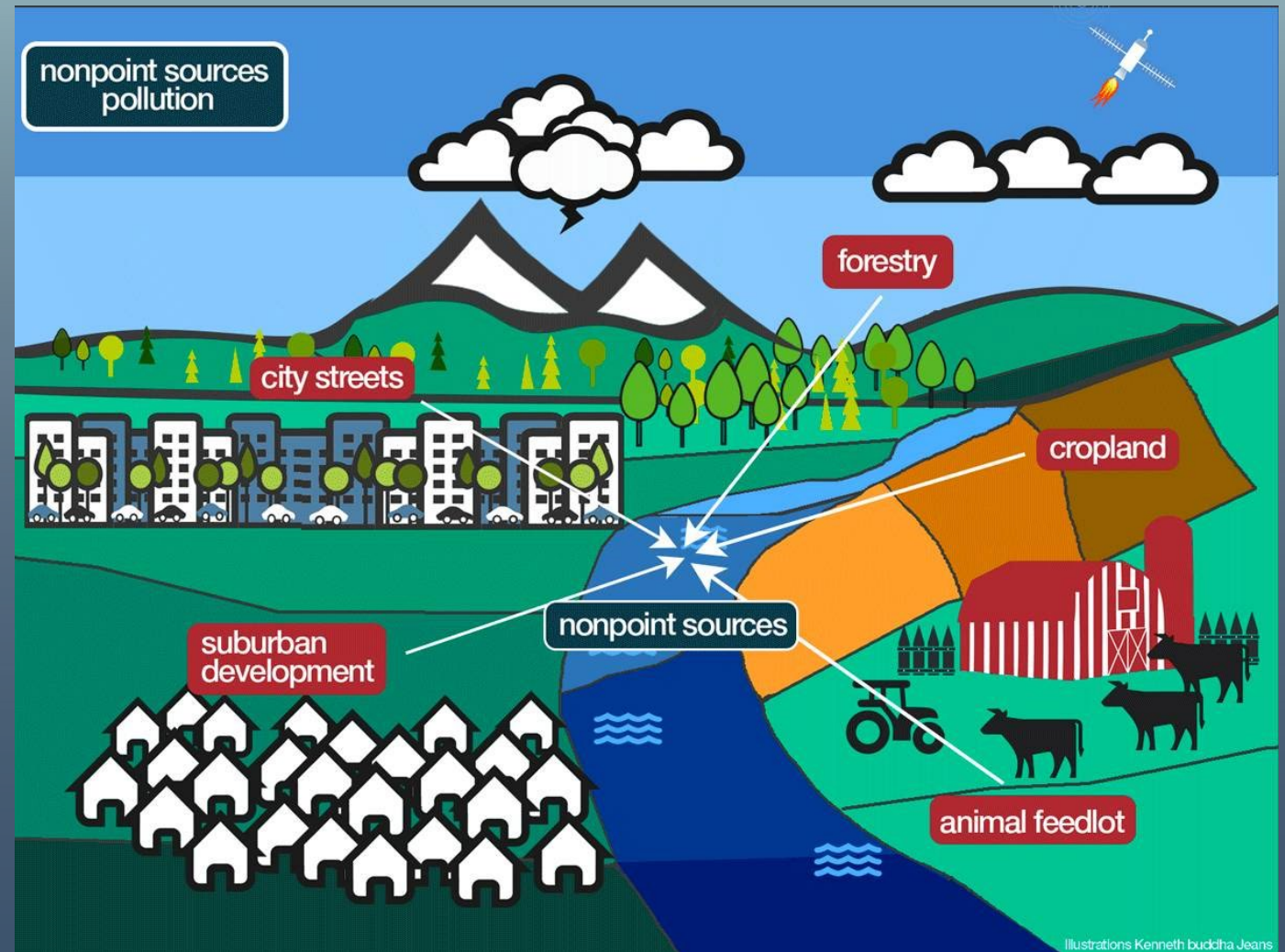
- ✓ Curly-leaf pondweed
 - Mechanical management leads to fragmentation and spread
 - Low dose of systemic herbicide (e.g. Sonar) can control this plant with minimal impact on native species
- ✓ Phragmites
 - Foliar treatment with contact herbicide (e.g. glyphosate)
 - Treatments typically conducted in autumn

Watershed Survey & Recommendations

Arrowhead Lake & North Lake

Non-Point Source Pollution

- Diffuse areas of pollution of nutrients and sediments
- Potential areas of NPS
 - Stormwater
 - Septic systems
 - Streambank erosion / impaired buffers
 - Lakeshore erosion
 - Waterfowl
 - Pet wastes
- Alteration of hydrologic cycle



Watershed Evaluation

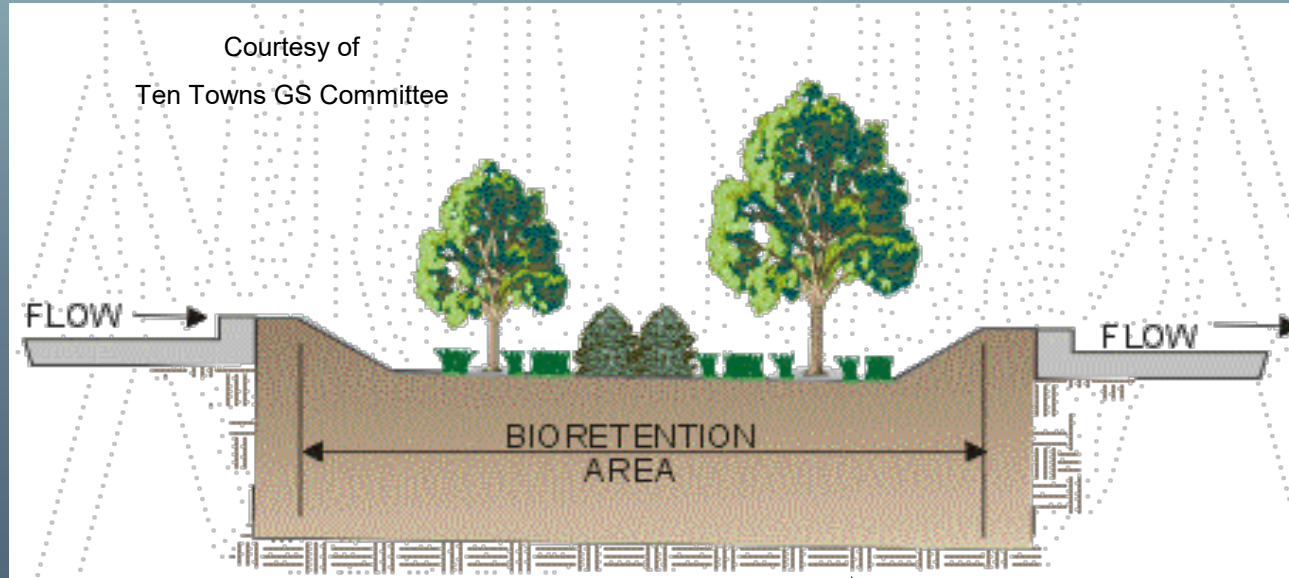
- Evaluation of watershed by 1 aquatic ecologist and 1 stormwater engineer
- Scout for areas of
 - Erosion
 - Flooding
 - Impaired buffer areas
 - Stormwater infrastructure that can be improved
- Analyze data and recommend best management practices (BMPs)

WHAT IS GREEN INFRASTRUCTURE?



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Bioretention Swale - Parking Lots



Runoff routed to
swale via curb-cuts or
standard inlets



Watami Road – Bioretention Swale



Arrowhead Lake Island – Bioretention Swale



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Stormwater Gullies



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Step-Pool Conveyance

- Create step pools to slow water velocity
- Integrate native plantings for nutrient filtering and volume control
- As with any BMP, maintenance is necessary to maintain functionality



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Canada Goose Management

- Deter resident Canada geese (*Branta canadensis*) through egg adding, harassment, and habitat modifications
- Shoreline buffers help deter geese from accessing lake in non-beach areas
- Geese can contribute to elevated fecal coliform levels and high nutrients
- 1 goose = 0.13 lbs P daily
- 1 lb of P = 500 lbs of algae



Beach 2



Other General Measures

- ✓ Fertilizers
 - Non-phosphorus fertilizers
- ✓ Septic Systems
 - Routine pump-outs
 - Inspection and replacement of failing systems
- ✓ Pet Waste Clean Up

Next Steps

Next Steps

- ✓ Receive stakeholder feedback
- ✓ Integrate feedback into draft plan to be completed in January 2024
- ✓ 2024 – Water Quality Monitoring / Plant Management

Stakeholder Feedback & Questions

QUESTIONS?



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*THANK
YOU!*

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