

Arrowhead Lake & Indianhead Lake Water Quality Improvement Project

Feasibility Study & Preliminary Engineering

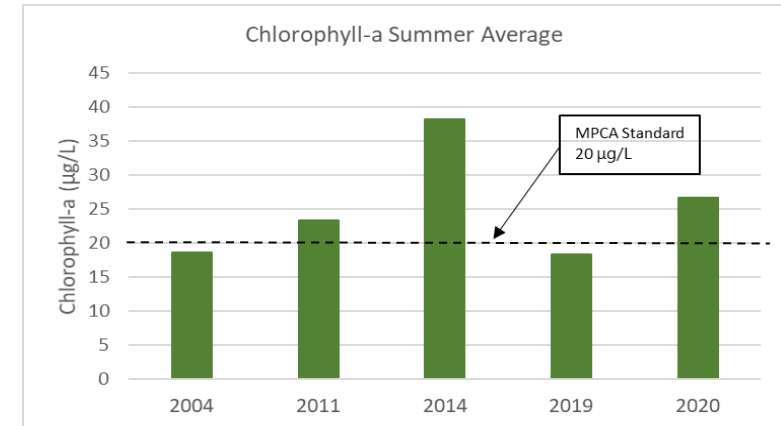
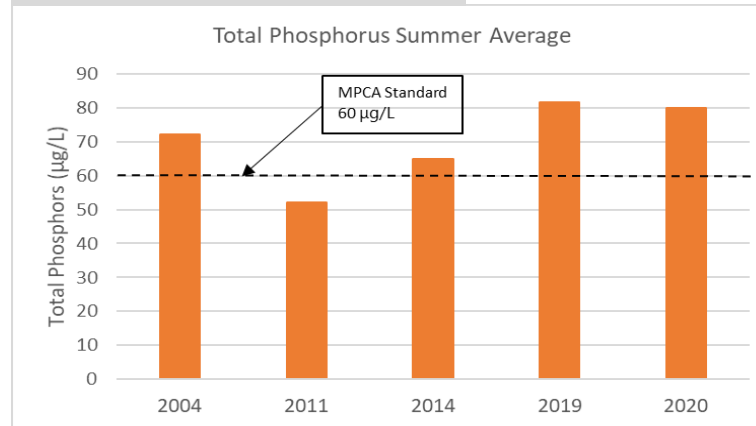
October 9, 2023

Stephanie Johnson, PhD, PE

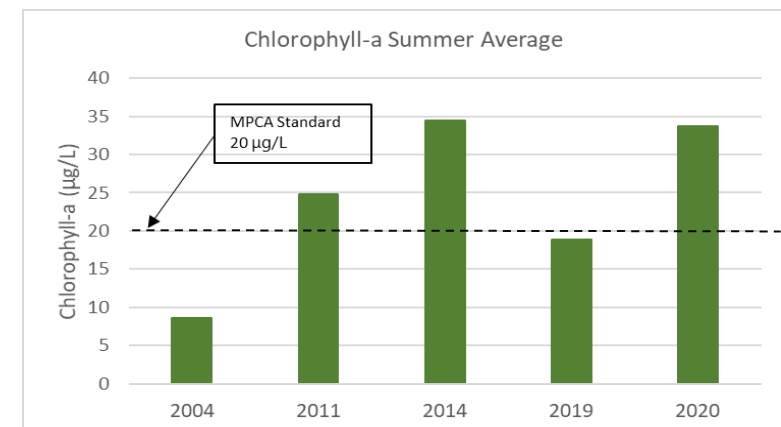
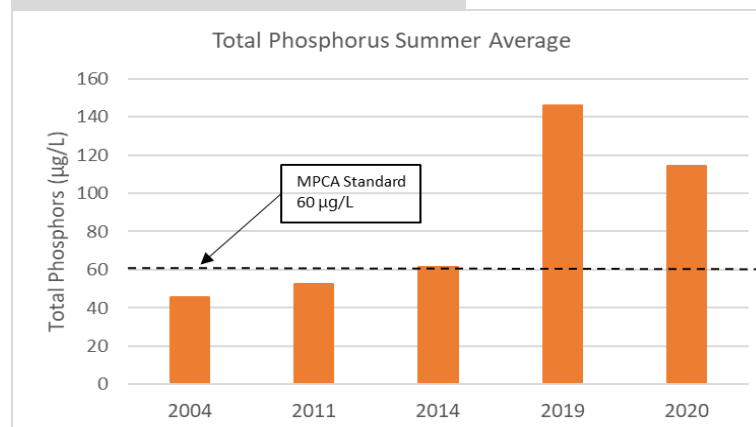
Project Background

- Arrowhead and Indianhead Lakes not consistently meeting water quality standards

Arrowhead Lake

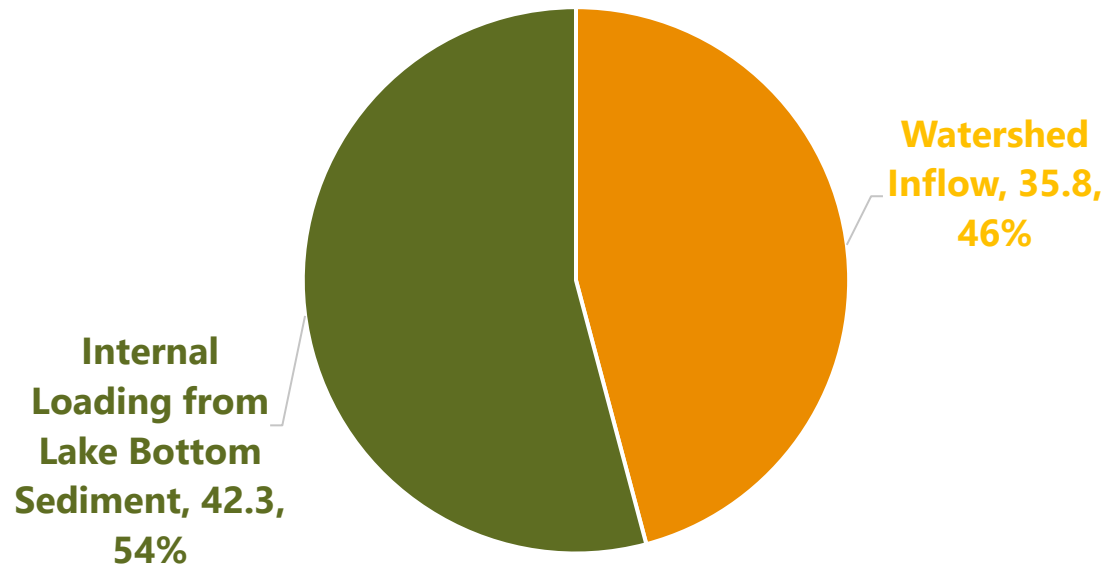


Indianhead Lake

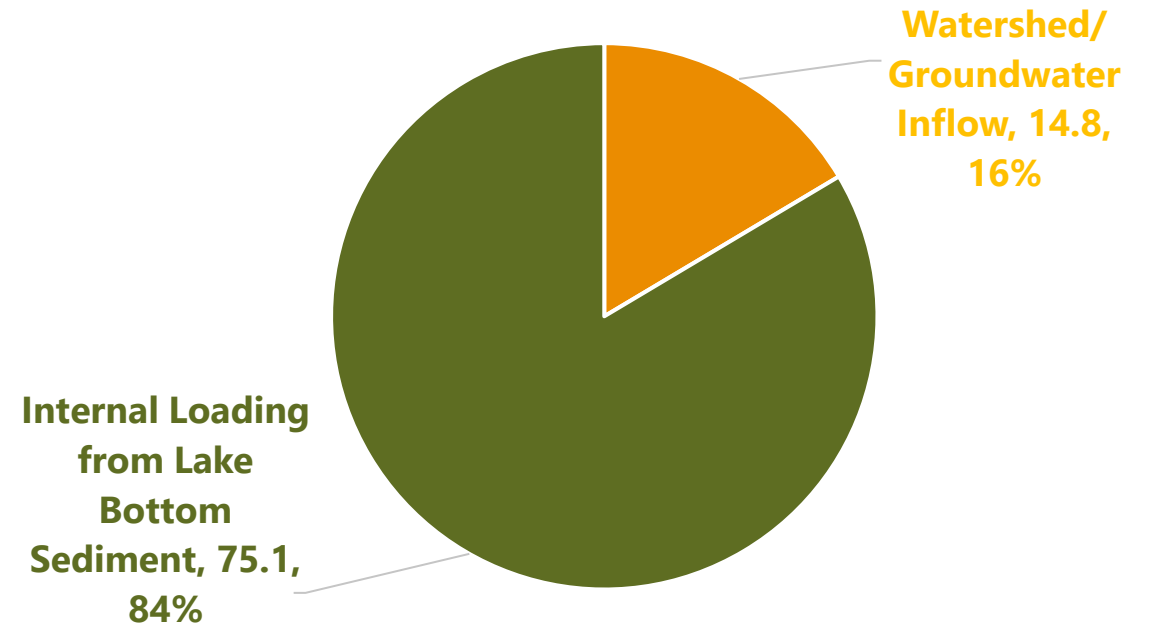


Nutrient sources (2020 growing season)

Arrowhead Lake Total Phosphorus Sources
(pounds)



Indianhead Lake Total Phosphorus Sources
(pounds)



Summary of Management & Protection Actions

(Water Quality Study, 2022)

Management/Protection Action	Basis	Estimated Timeline	
Address Internal Bottom Sediment Loading	Continuous dissolved oxygen monitoring	Determine aeration capacity of existing system	2022 - 2024
	Alum and iron treatment	Reduce bottom sediment phosphorus load	2023/2024
	Modify aeration system, as needed		2024
	Sediment release monitoring	Assess management effectiveness	2024 - 2025+
	Enhanced street sweeping program	Reduce pollutant loading from stormwater	2022 - 2023 (Planning begins)
Address External Nutrient Loading	Fertilizer management program	Reduce nitrogen sources from excess fertilizer use	2022 - 2023 (Planning begins)
	Chloride monitoring	Continue to identify/track chloride levels from winter salt use	As part of continued lake monitoring program
	Promote NMCWD cost-share grants to watershed residents	In a fully developed watershed, opportunities for largescale BMPs are limited	2022+
Aquatic Invasive Species	Curly-leaf pondweed management	Continue to monitor and treat curly-leaf pondweed growth	2022+
Promote Sustainable Management	Discontinue copper sulfate treatments	Evaluate timeline to discontinue copper sulfate treatments after internal loading management	2025
	Promote native aquatic plant growth	Encourage native plants to promote clear water conditions and competition with algae	2022
	Discontinue blue dye applications	Unnecessary addition of chemicals	2022

Focus of this study



Feasibility Study Goal & Tasks

- **Project Goal:**
Preliminary engineering analyses to further evaluate feasibility of recommendations from the Arrowhead and Indianhead Lakes Water Quality Study.
- **Task 1:** Develop sediment treatment plans to reduce internal loading
- **Task 2:** Evaluate lake aeration systems
- **Task 3:** Evaluate source control benefits of enhanced street sweeping within lake drainage areas
- **Task 4:** Project reporting

Internal Management - Sediment Treatment



Photo: Wing Lake, Minnetonka, June 2021

Phosphorus in Lake Bottom Sediments Stuck to:

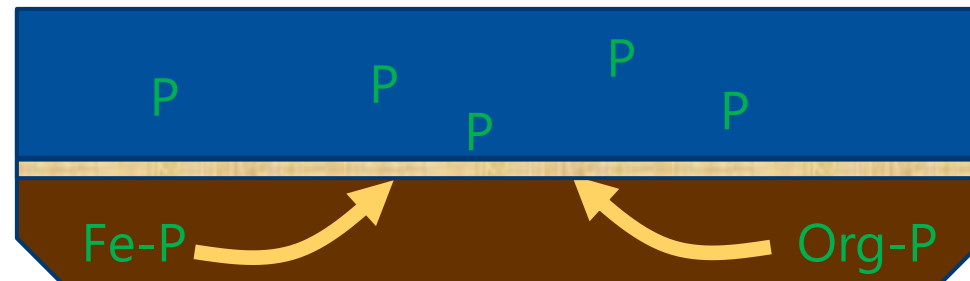
*Aluminum / Al-P

*Iron / Fe-P

*Calcium / Ca-P

*Organic matter (e.g. DNA) / Organic-P

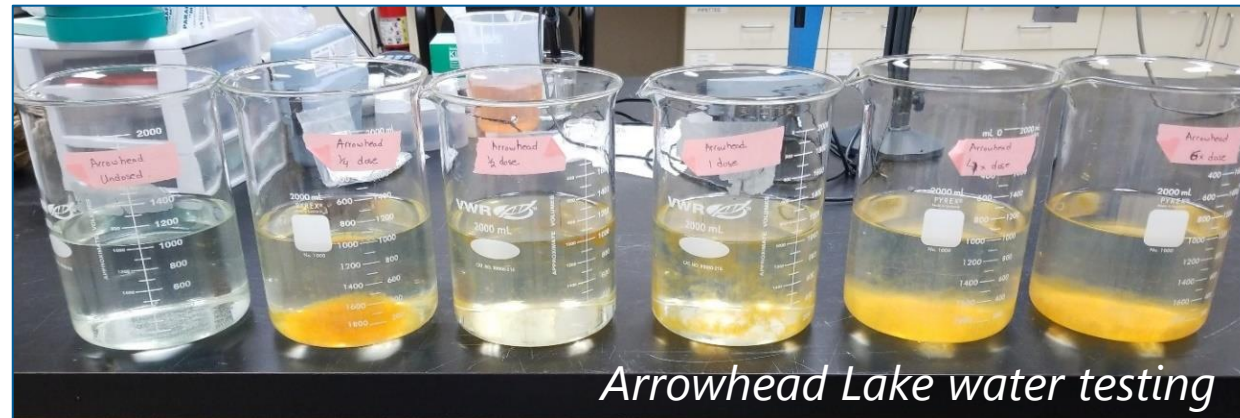
Sediment treatment
to bind P:
Aluminum + Iron



Internal
loading

Designing Aluminum + Iron Sediment Treatments

- Used water samples & sediment cores from Arrowhead and Indianhead Lakes to inform treatment design
- Combined aluminum + iron treatment
- Treatment floc will settle to bottom of lake and mix with sediments
- Contractor will perform the treatment via boat



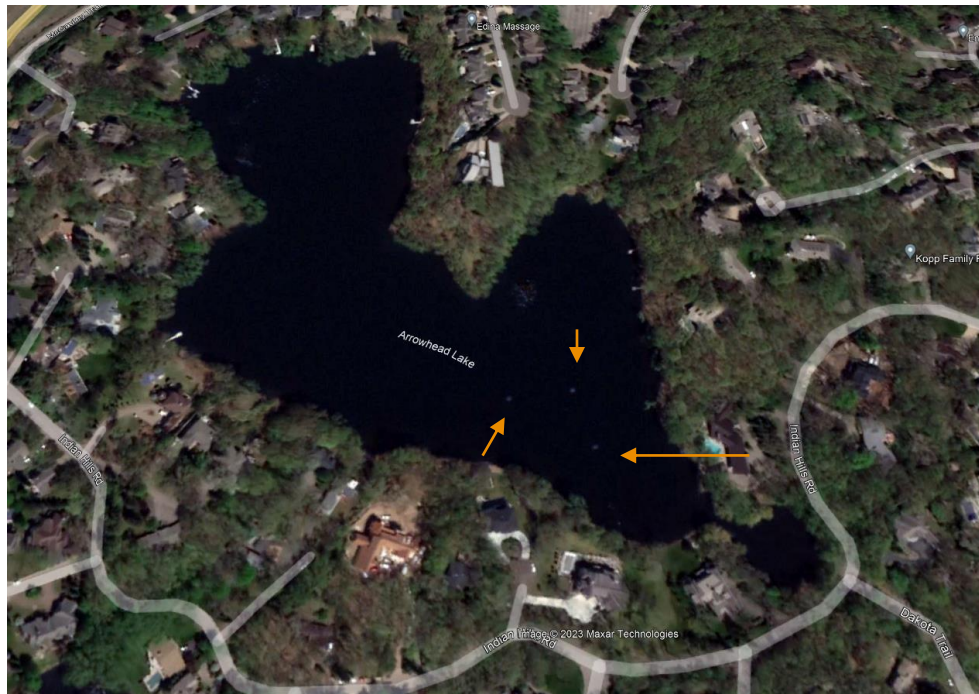
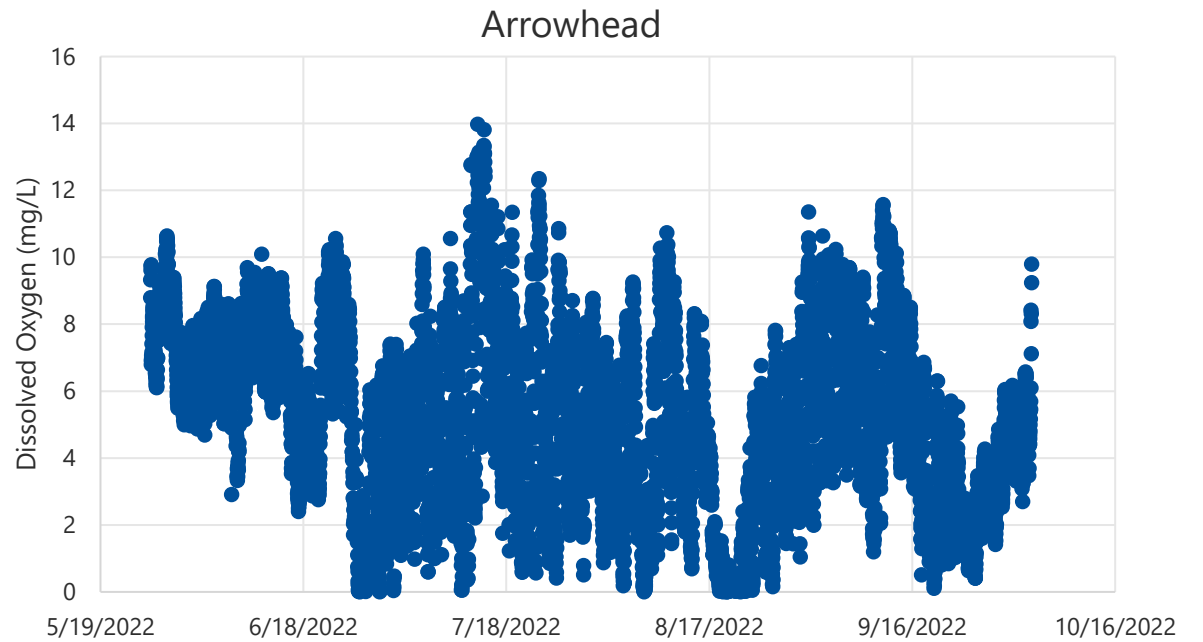
Arrowhead Lake water testing

Aeration System Analysis

- Dissolved oxygen levels at sediment / water interface impact binding of phosphorus
- Aeration will be needed to make sure the sediment treatment is effective
- Assessed the performance of existing aeration systems for this purpose

Arrowhead Lake Dissolved Oxygen Monitoring (2022)

Dissolved oxygen concentrations not adequate to support sediment treatment



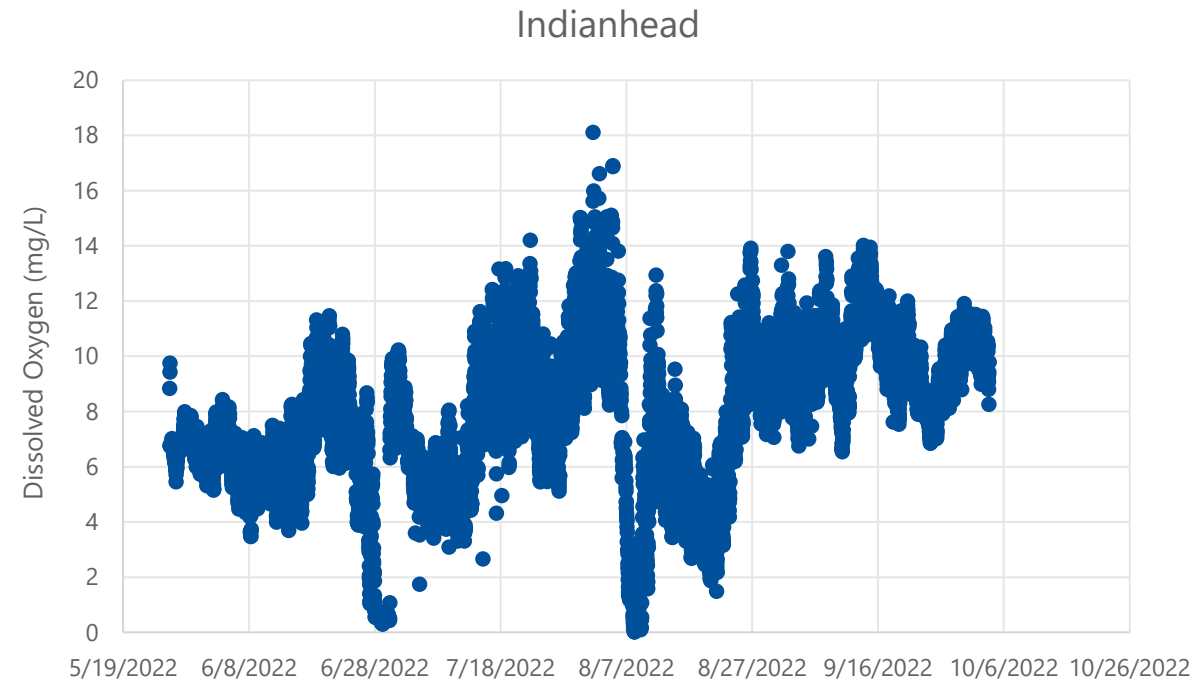
Existing system is limited:

- One compressor (3/4 hp)
- 3 aerator heads
- All aerator heads on southeast side of lake



Indianhead Lake Dissolved Oxygen Monitoring (2022)

Dissolved oxygen concentrations are variable



Existing system more robust, but would benefit from an upgrade:

- Two compressors (3/4 hp)
- 4 aerator heads
- Aerator heads more dispersed

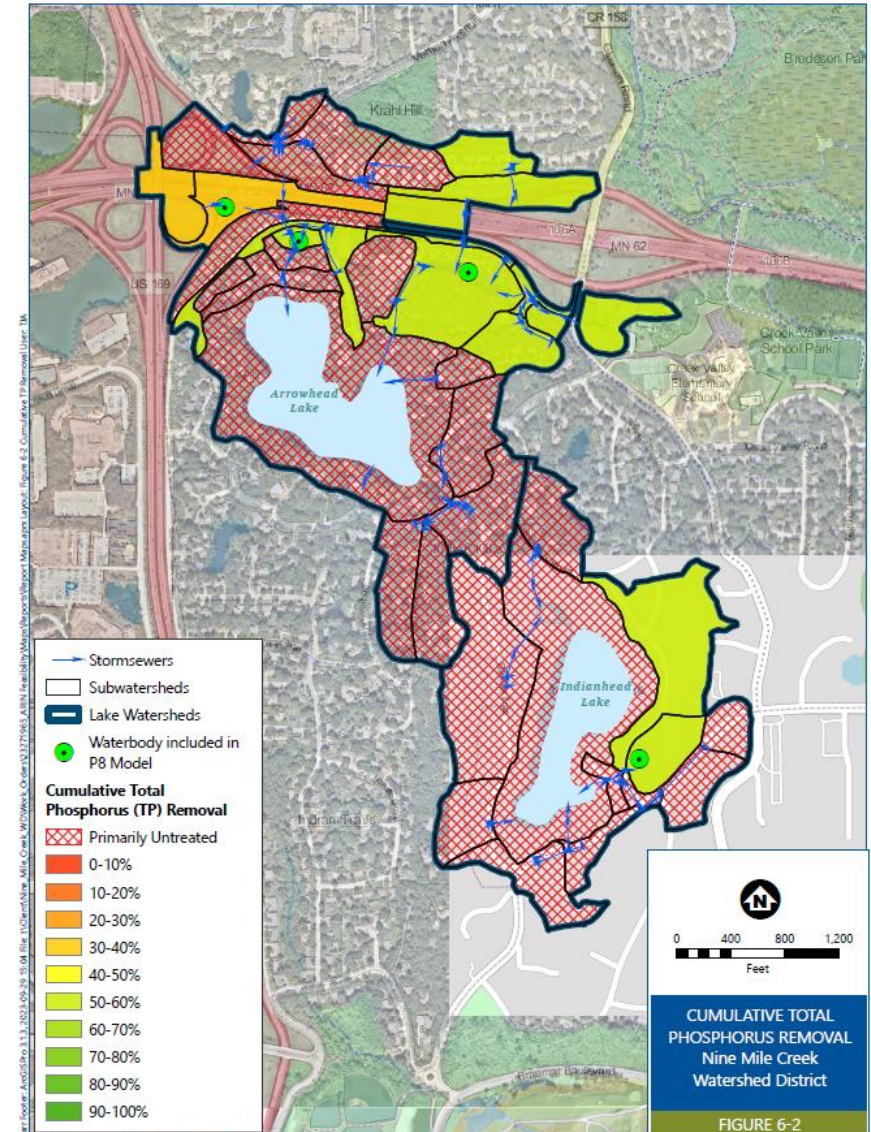
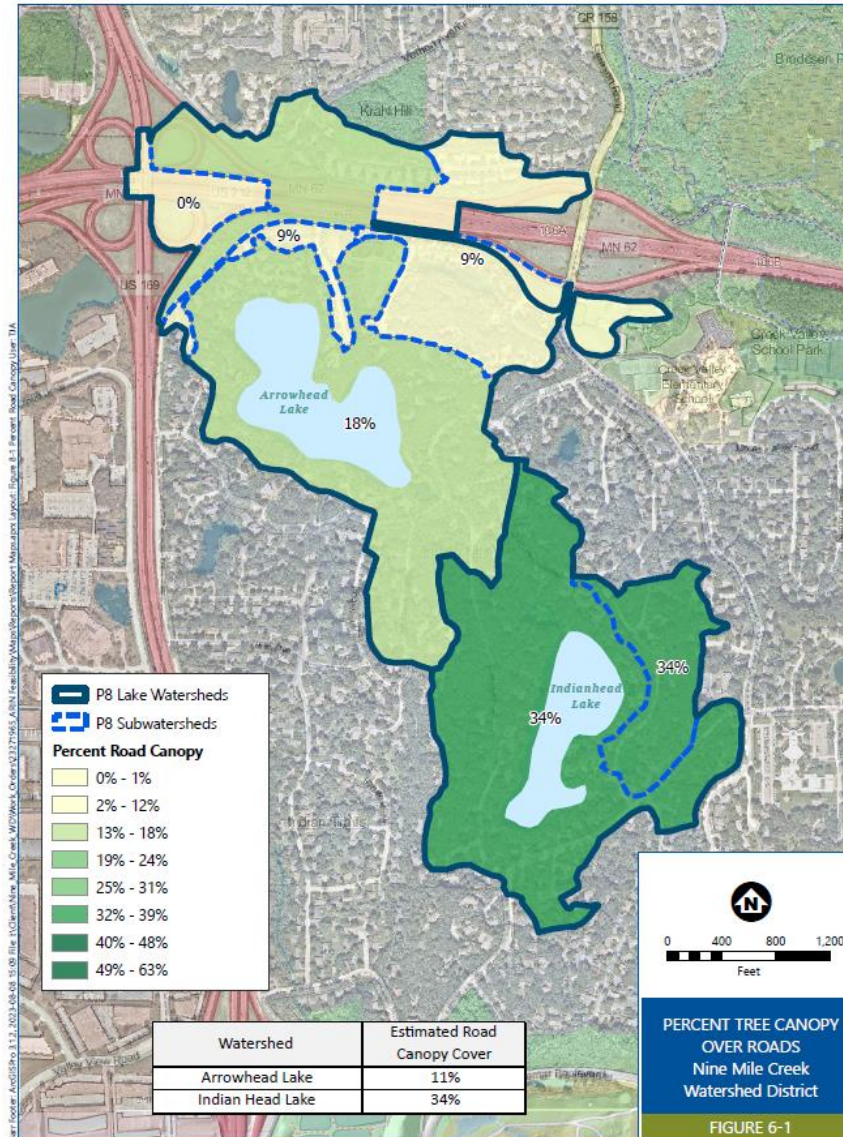
Enhanced Street Sweeping

- Street sweeping can be a cost-effective approach to reduce phosphorus loading to lakes
- Benefits of street sweeping (for water quality) tend to vary by season
- Edina sweeps streets (city-wide) twice / year: once in spring, once in fall
- Recently increased sweeping frequency in areas draining to Arrowhead and Indianhead Lakes



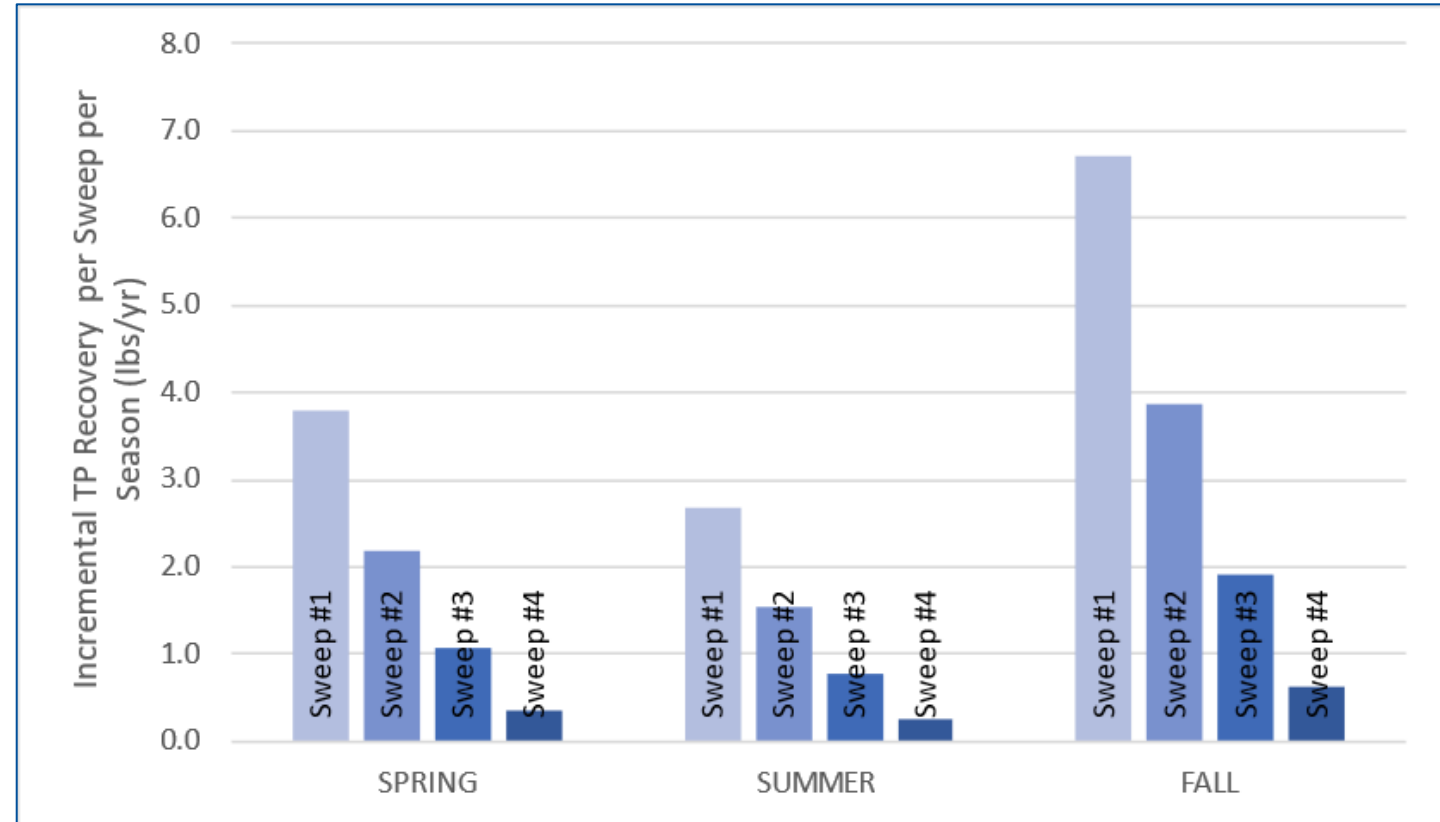
- Areas with higher tree canopy coverage and no existing stormwater treatment tend to be higher priority for street sweeping for water quality benefit

Arrowhead & Indianhead Watersheds



Enhanced Street Sweeping

- Estimated benefits are greatest in fall (during leaf drop), followed by spring and then summer
- Increased removals, but diminishing returns with each subsequent sweep



Recommendations

Arrowhead & Indianhead Lake Treatment Plans



- Co-application of iron + aluminum
- Arrowhead Lake treatment to be performed in two applications (tentative schedule)
 - 1st dose in spring 2024
 - 2nd dose expected spring 2026
- Indianhead treatment in one application
 - Spring 2024 (tentative)
- Follow up sediment & water quality monitoring over 10 years to assess outcomes
- Need for (future) retreatment will be based on sediment monitoring results and lake water quality

- Upgrade aeration systems at both lakes

Hydro Logic Aeration System



2-1/2 HP
Compressors

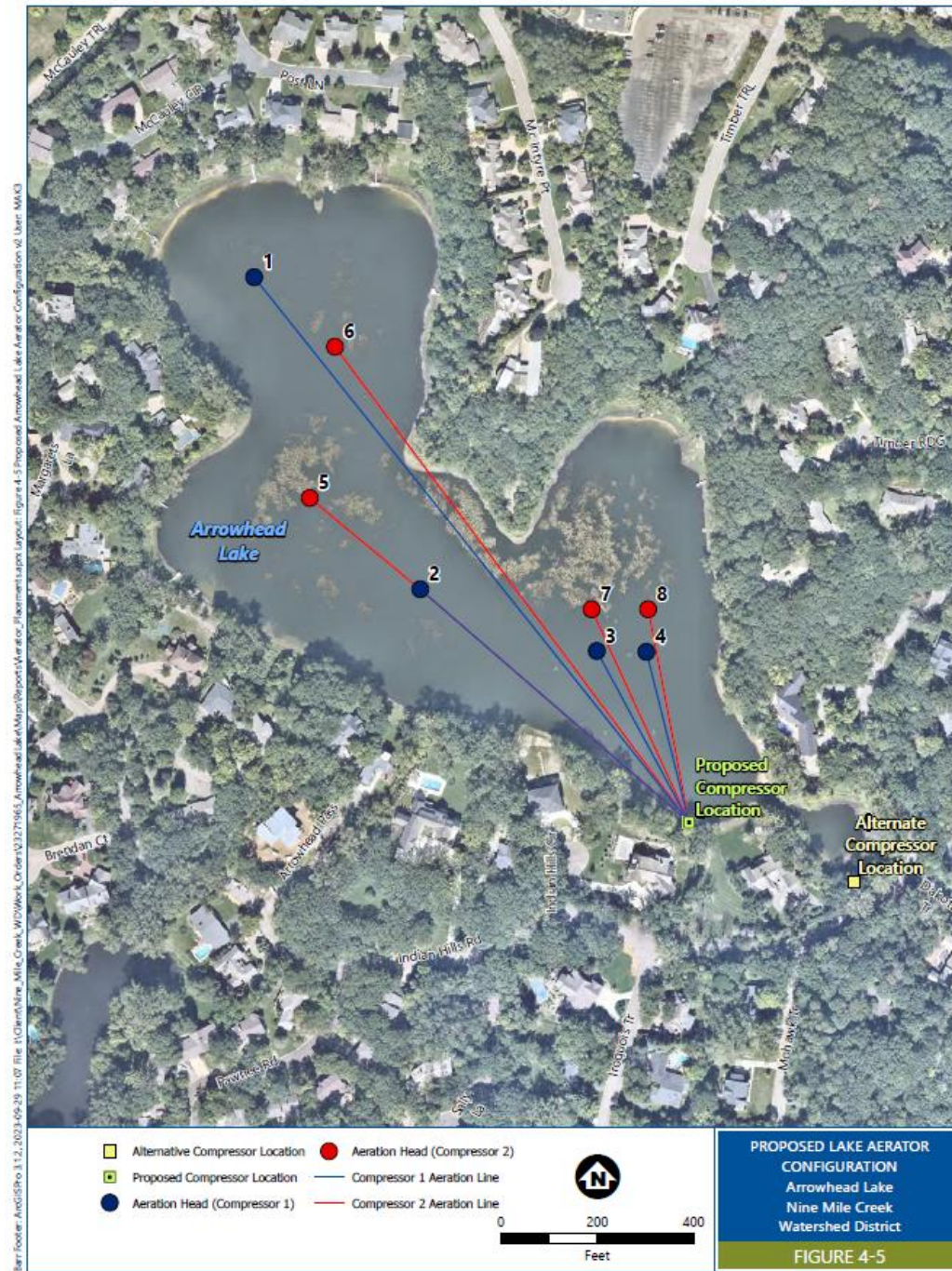
AirLift 6 Aeration System by **Hydro Logic Products**



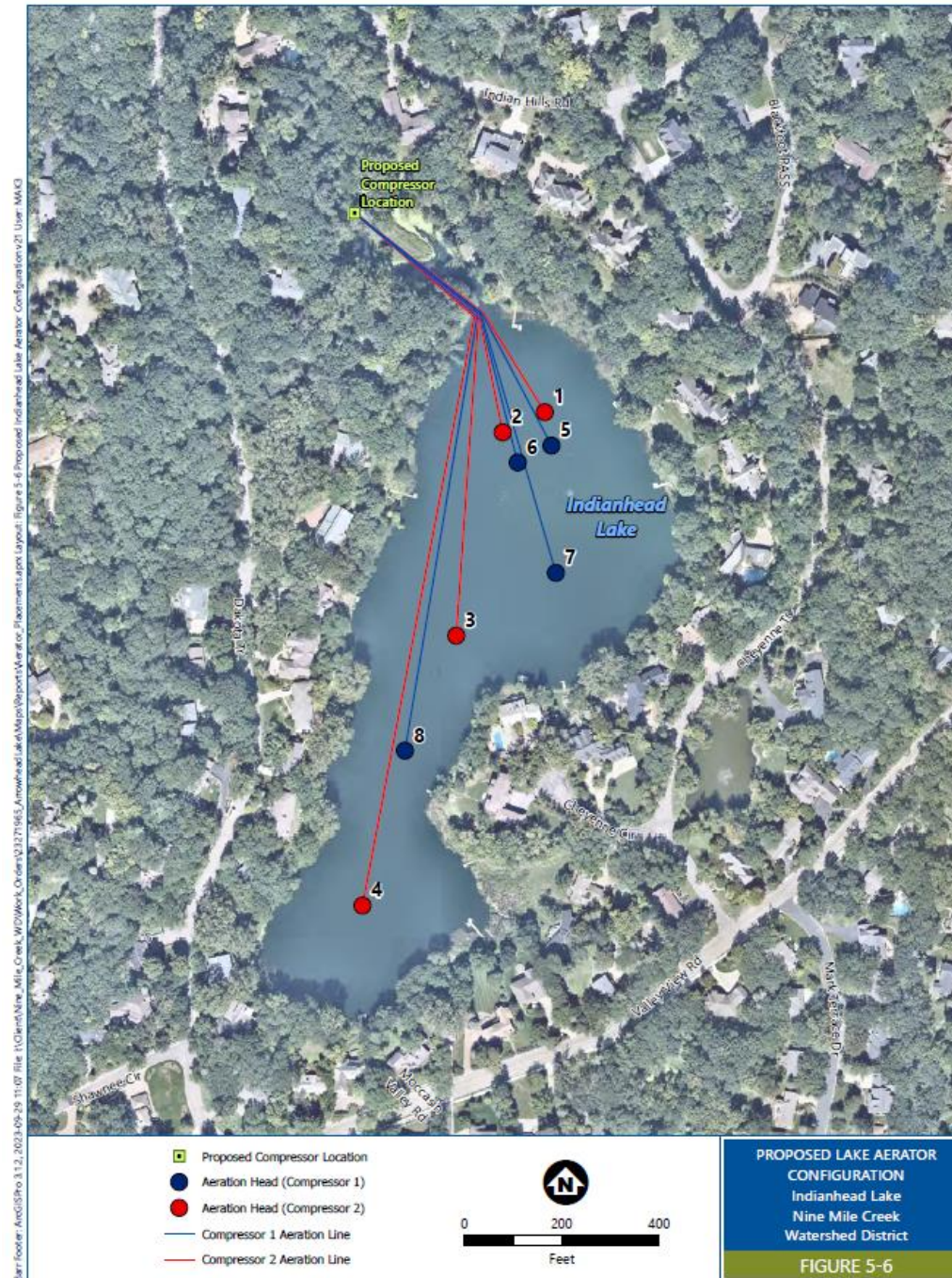
X 6 = 6 AirPod Diffusers



Arrowhead Lake Proposed Aerator Configuration



Indianhead Lake Proposed Aerator Configuration



Estimated Costs

Management Activity	Planning-level Cost Estimate ¹	Estimated Cost-Benefit
Arrowhead Lake Aluminum + Iron Treatment	\$182,000 (\$146,000-\$237,000)	\$1,500 / pound of TP reduction
Arrowhead Lake Aeration	\$89,000 (\$72,000-\$116,000)	
Indianhead Lake Aluminum + Iron Treatment	\$122,000 (\$98,000-\$159,000)	\$1,000 / pound of TP reduction
Indianhead Lake Aeration	\$95,000 (\$76,000-\$124,000)	

¹ Cost reflects an accuracy range between -20% and +30% of the estimated project cost.

Next steps

- Presentation posted to NMCWD website
 - Arrowhead & Indianhead Lakes Project Webpage
- Results presented to NMCWD Board of Managers
 - Tuesday, October 24th
- Public Hearing
 - Thursday, November 2nd

Questions