RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

A Systems Approach to Watershed & Lake Management

Ann, Lucy, and Susan Lake Watersheds

May 21, 2026
Chanhassen City Hall

Presenters

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

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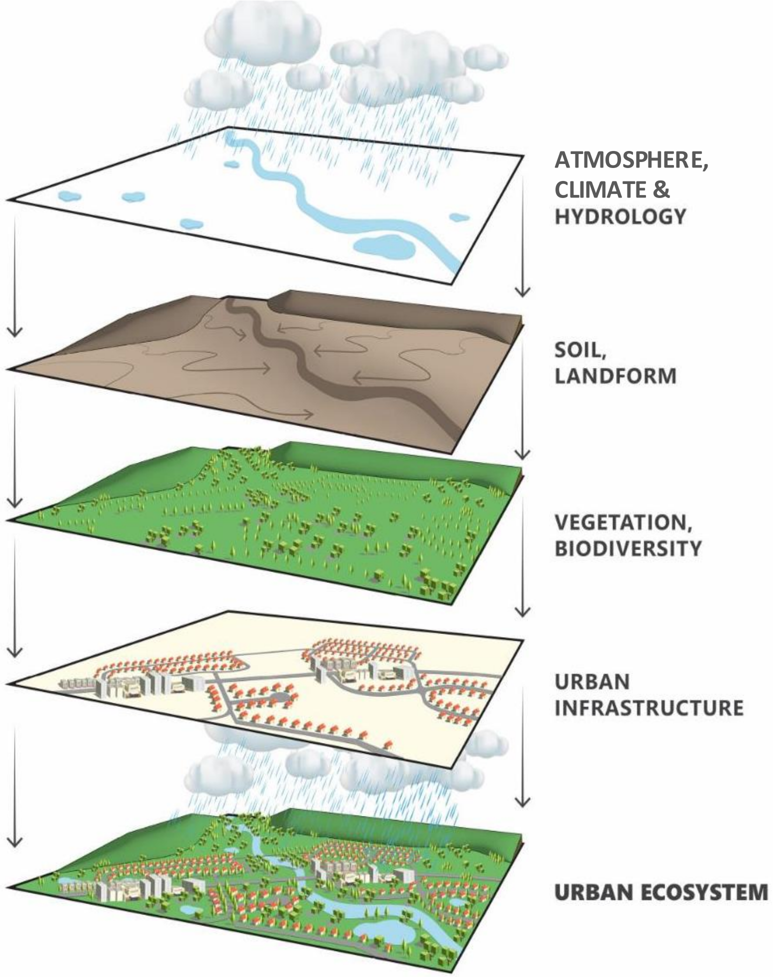
A Systems Approach for Lake & Watershed Management

Lake & watershed characteristics

Balancing goals



Layered systems

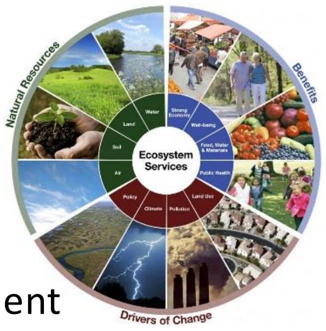
The Big Picture: 10-year Plan Update

10-year Management Plan (2028-2038)

Assesses land & water resources	Identifies watershed issues	Sets goals & strategies for the next 10 years	Identifies process for project prioritization

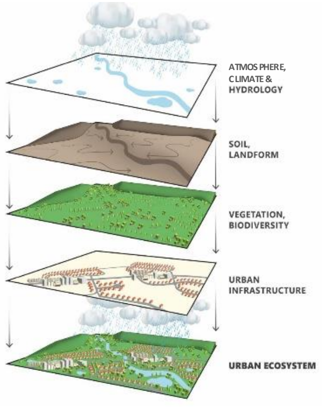
Ecosystem Health Action Plan (EHAP)

- Inform, through an ecosystem lens, development of the 10-year plan update
- Identified 70+ strategies
  - Regulation
  - Climate resiliency
  - Land protection & regeneration
  - Surface water management
  - Education & outreach
  - Partnerships
  - Data collection



Systems Approach to Watershed & Lake Management

- Perform lake & watershed diagnostic studies to inform development of the 10-year plan update
- Five lakes as case studies:
  - **Ann**
  - **Lucy**
  - **Susan**
  - **Mitchell**
  - **Red Rock**



Suburban Watersheds

Watershed Features

- Lakes
- Ponds
- Wetlands
- Uplands
- Streams and floodplains

Watershed Functions

- Nutrient Cycling
  - Nitrogen and Phosphorus
- Flood Storage
- Biodiversity
- Recreation

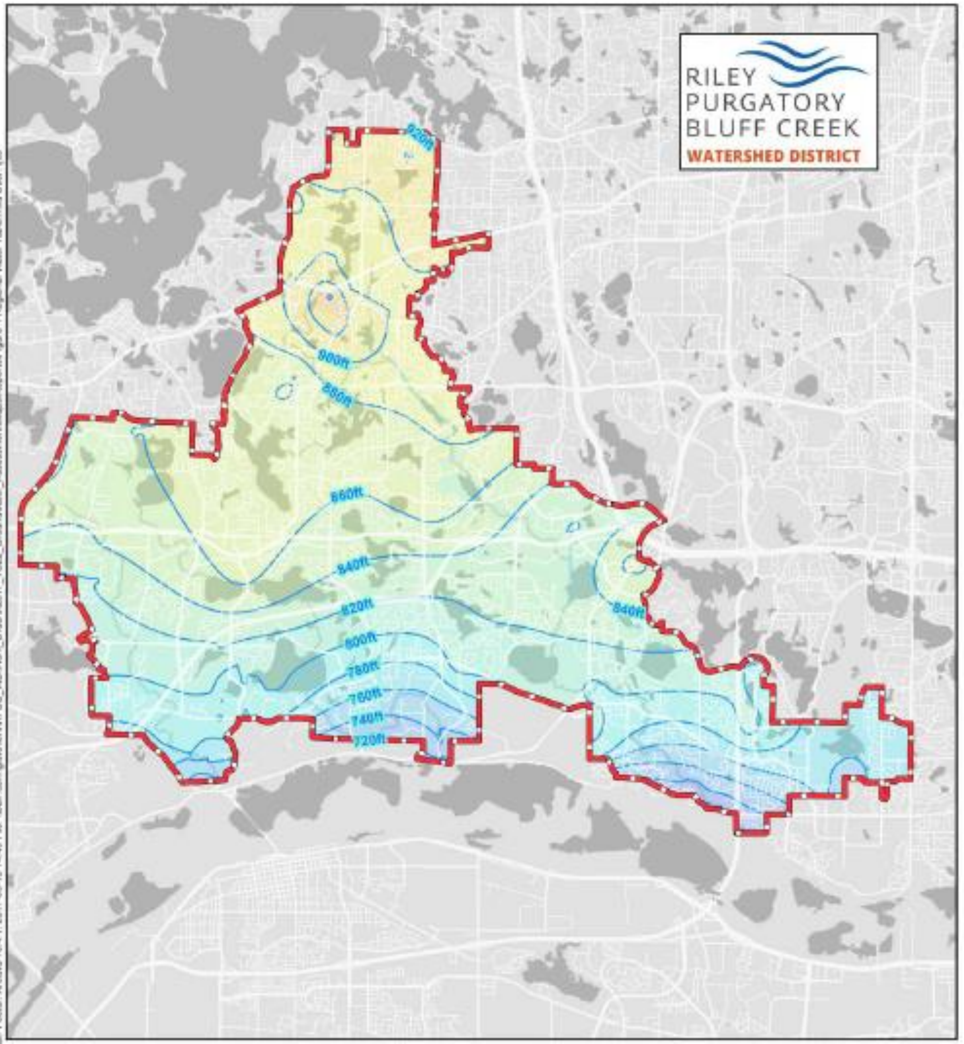
Lake and Watershed Stressors

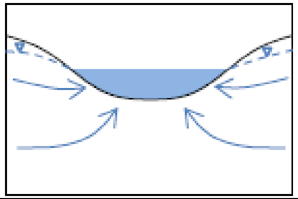
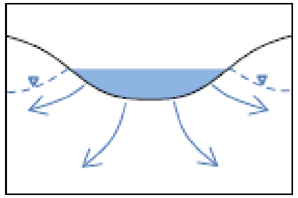
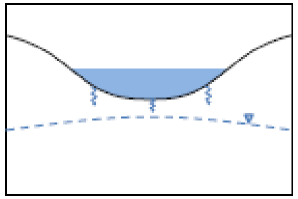
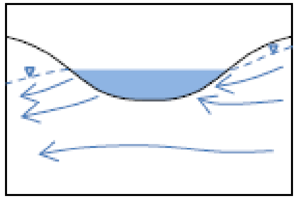
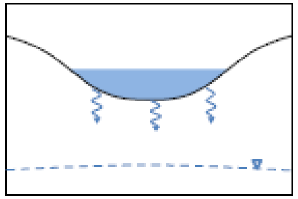
Impervious surfaces/loss of green space/soil health and compaction

- Excess nutrients (nitrogen and phosphorus)
- Toxic contaminants (chloride)
- Unnatural hydrology and flooding
- Pipe and ditch conveyance

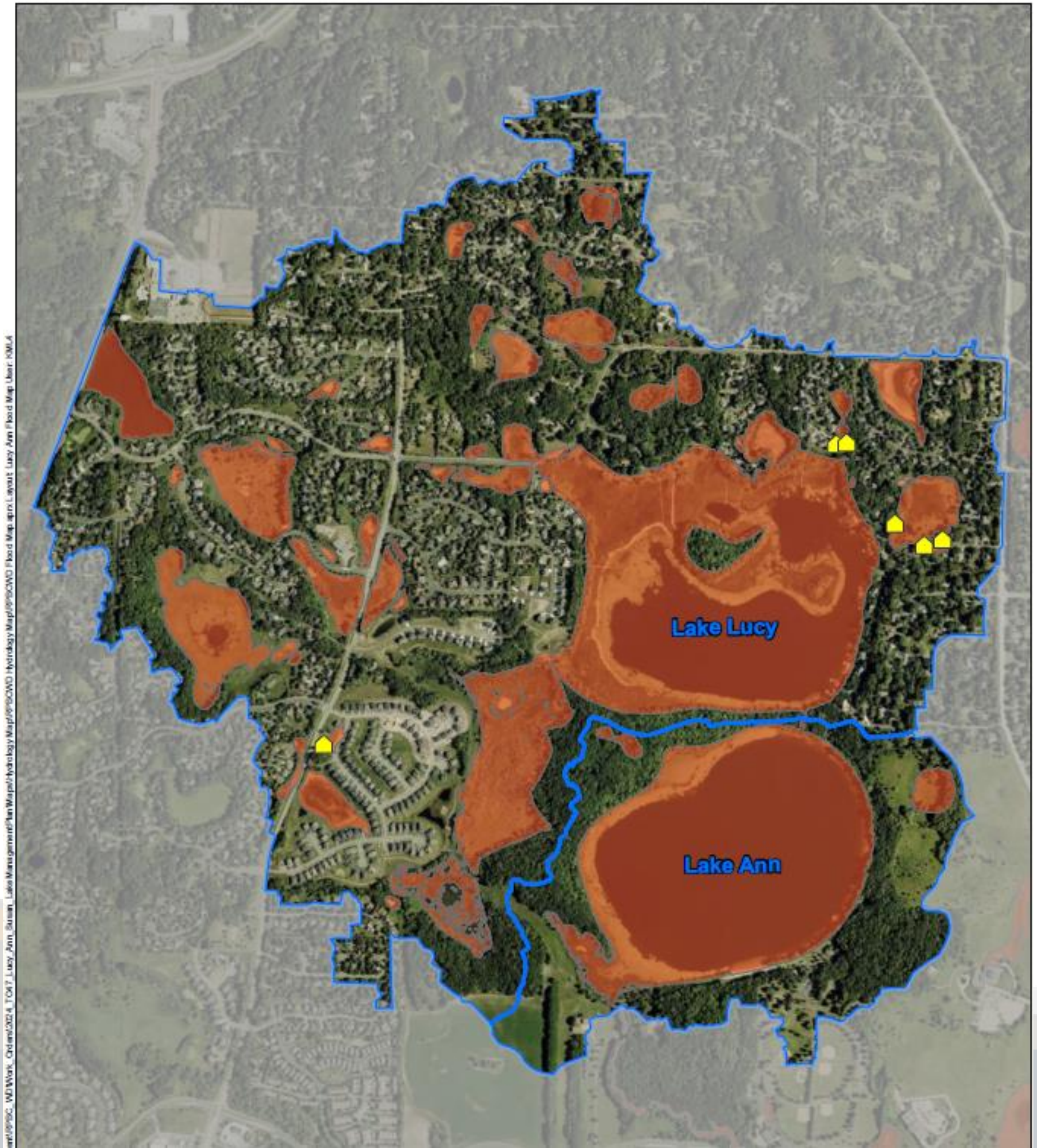
Hydrology

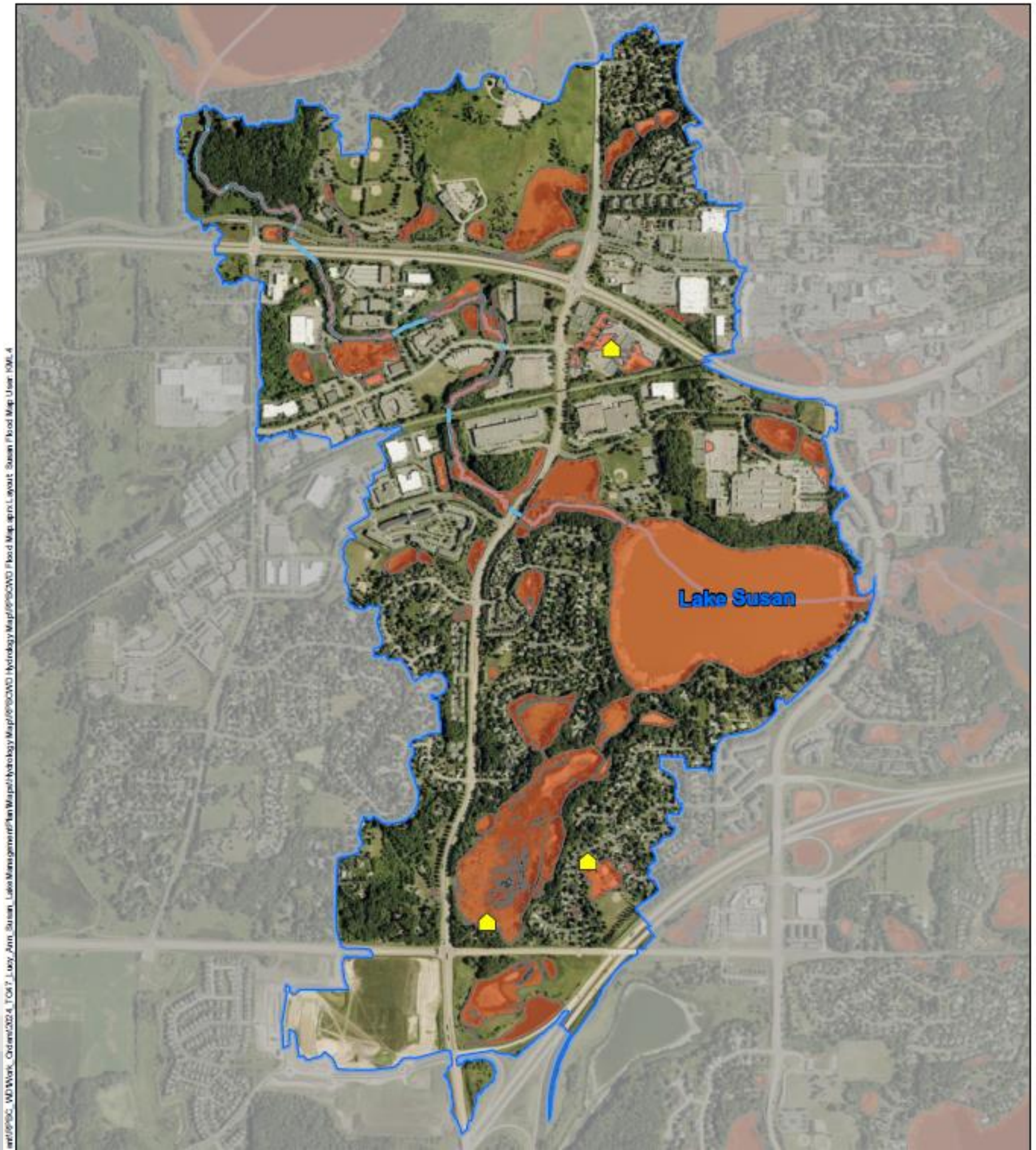
RPBCWD Regional Groundwater Study

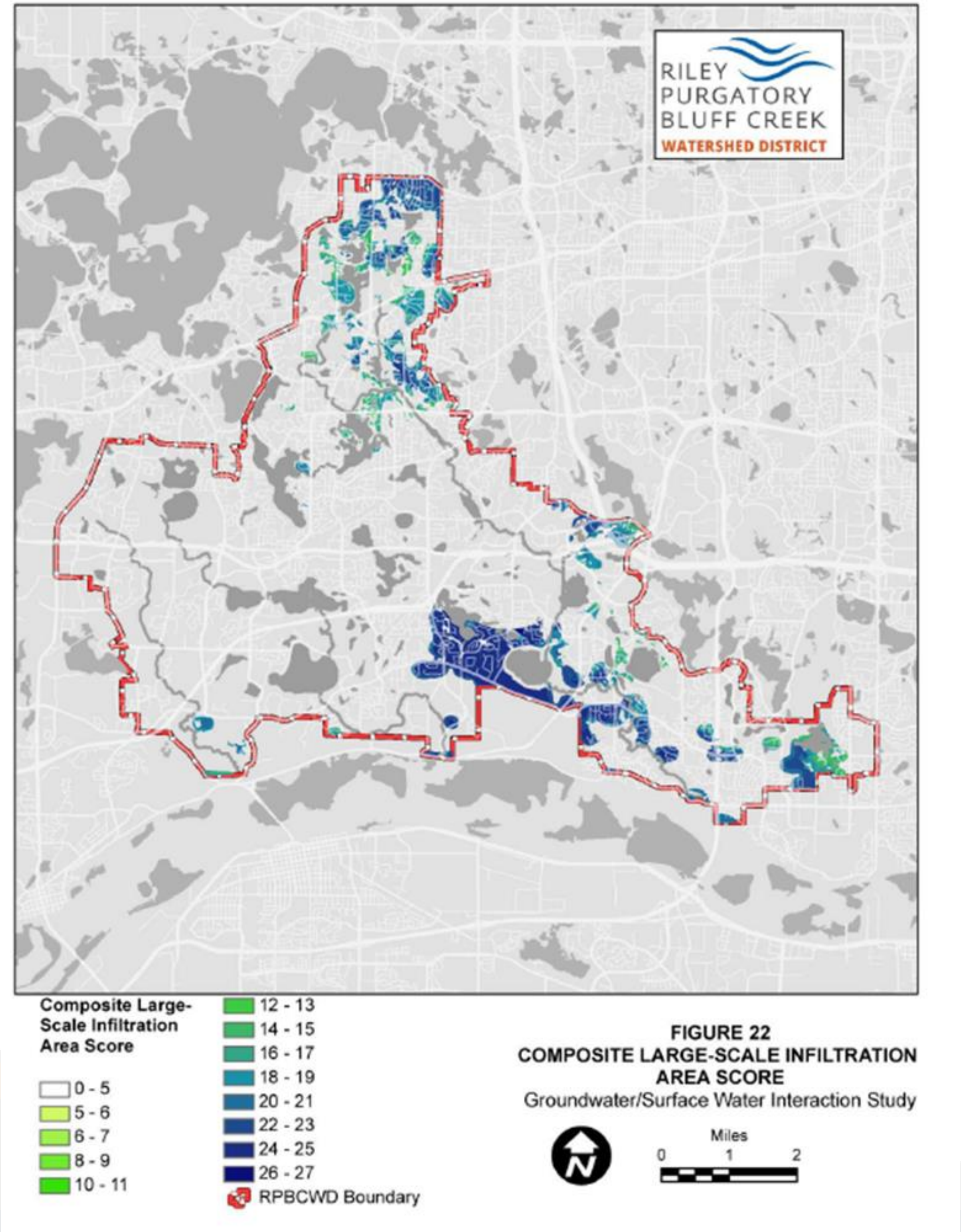


Type	Description		Qualifiers
Discharge lake/wetland	Mostly receives groundwater inflow		Connected to groundwater, surface water elevation below regional groundwater table
Recharge lake/wetland or Indeterminate	Connected to groundwater. Mostly loses water as seepage to groundwater		Groundwater connection is indeterminate, regional groundwater table lower than surface water elevation. Uncertainty in regional groundwater table makes it difficult to distinguish between features that are connected and those that are disconnected to groundwater.
	Disconnected to groundwater. Water table slightly below lake bottom. Fluctuations in the water table can affect the flow dynamics out of lake.		
Flow-through lake/wetland	Groundwater flow both into and out of lake/ wetland		Connected to groundwater, surface water elevation above or equal to regional groundwater table
Perched lake/ wetland with deep water table	Water table deep below feature. Loss of water into the unsaturated zone. Change in water table has no effect on feature		Disconnected from groundwater

100-year Flood Inundation and At-risk Structures







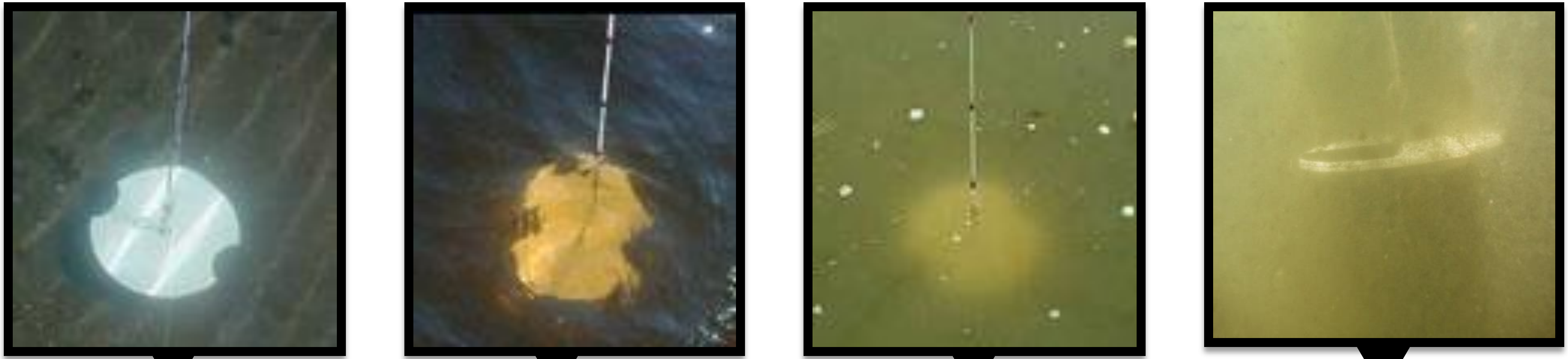
Hydrology Summary

- **Lake Lucy and Lake Ann**
  - Perched lakes that are not overly vulnerable to groundwater changes
  - Primarily driven by surface water
  - Groundwater chloride and nutrients are low risk to the lakes
  - Infiltration not likely to reach the lakes; low infiltration potential in watershed
- **Lake Susan**
  - Recharge lake but not vulnerable to changes in groundwater table
  - Chloride likely driven by surface water runoff

Eutrophication

Relationship between **Total Phosphorus** and **Transparency**

Algal growth (water clarity)



Oligotrophic	Mesotrophic	Eutrophic	Hyper-Eutrophic

3 5 7 10 15 20 25 30 40 50 60 80 100 150

Total Phosphorus (µg/L)

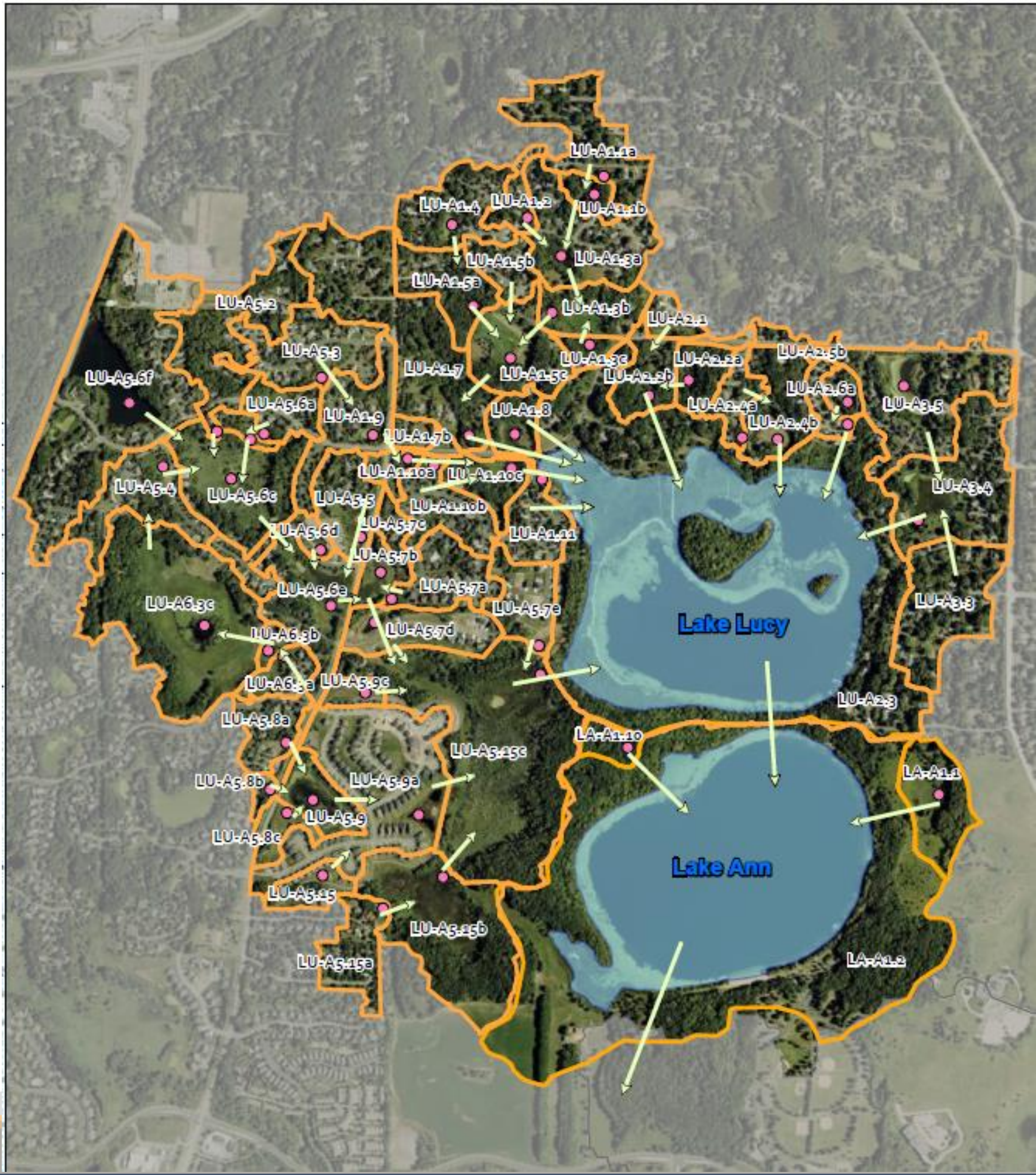
Photos: Minnesota Pollution Control Agency

Nitrogen

Nitrogen Species	Chemical Formula	Bioavailability	Role in Lake Algae Blooms
Ammonium	NH_4^+	Highest	Fuel source. Algae absorb it instantly without expending energy, triggering rapid bloom growth.
Dissolved Organic Nitrogen	DON	High	Selectively fuels non-fixing, toxic species like *Microcystis*. Enters lakes via modern fertilizers.
Nitrate/Nitrite	NO_3^-/NO_2^-	Moderate	Promotes large-scale biomass. Mobile in soil, causing massive agricultural runoff that feeds blooms.
Total Kjeldahl Nitrogen	**TKN** (Ammonium + Organic N)	High	Measures the total pool of nitrogen immediately available plus nitrogen locked in organic matter that will eventually decay and feed future blooms.
Particulate Organic Nitrogen	PON	Low (requires decomposition)	Represents the bloom itself. This is the nitrogen locked inside living or dead algae tissue.
Total Nitrogen	TN (nitrate/nitrite+TKN)	Variable	Represents all bound organic nitrogen; slowly breaks down into usable fuel.

Lake Lucy and Lake Ann

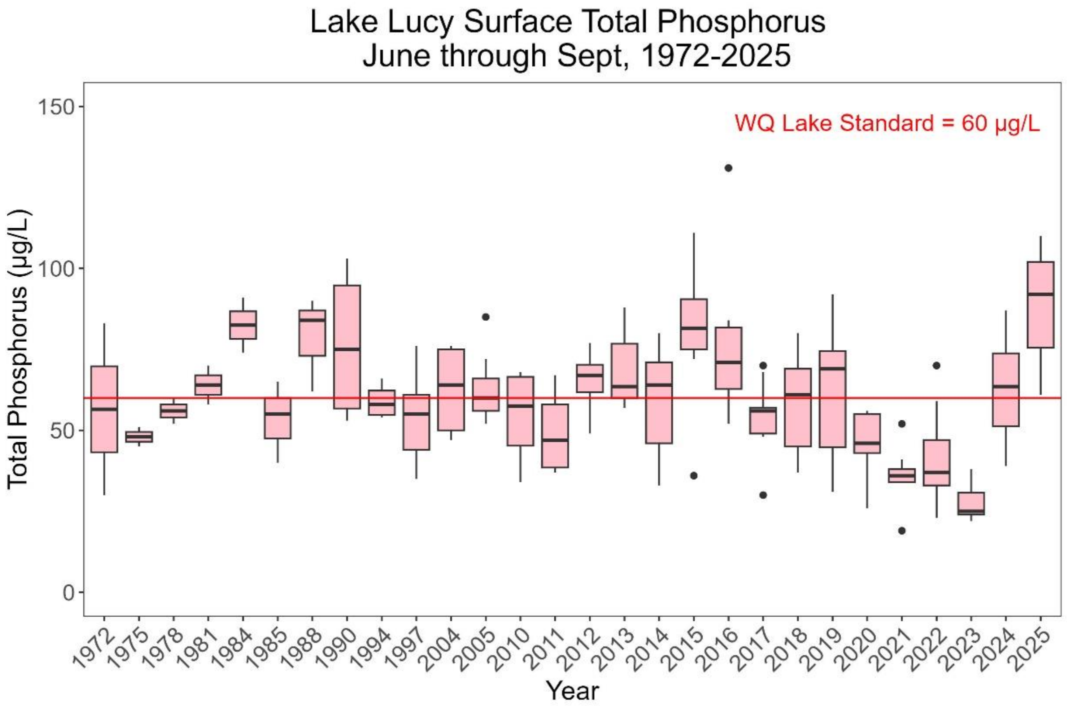
Lake Characteristic	Lake Lucy	Lake Ann
Surface Area (acres)	88	119
Average Depth (ft)	6.5	17
Maximum Depth (ft)	20	40
Littoral Area (ac)	86	45
Watershed Area (ac)	--	1,245
Direct Watershed Area (ac)	988	257
Invasive Species	Curly-leaf Pondweed Eurasian Watermilfoil Common Carp Zebra Mussels	Curly-leaf Pondweed Eurasian Watermilfoil Common Carp Brittle Naiad Zebra Mussels

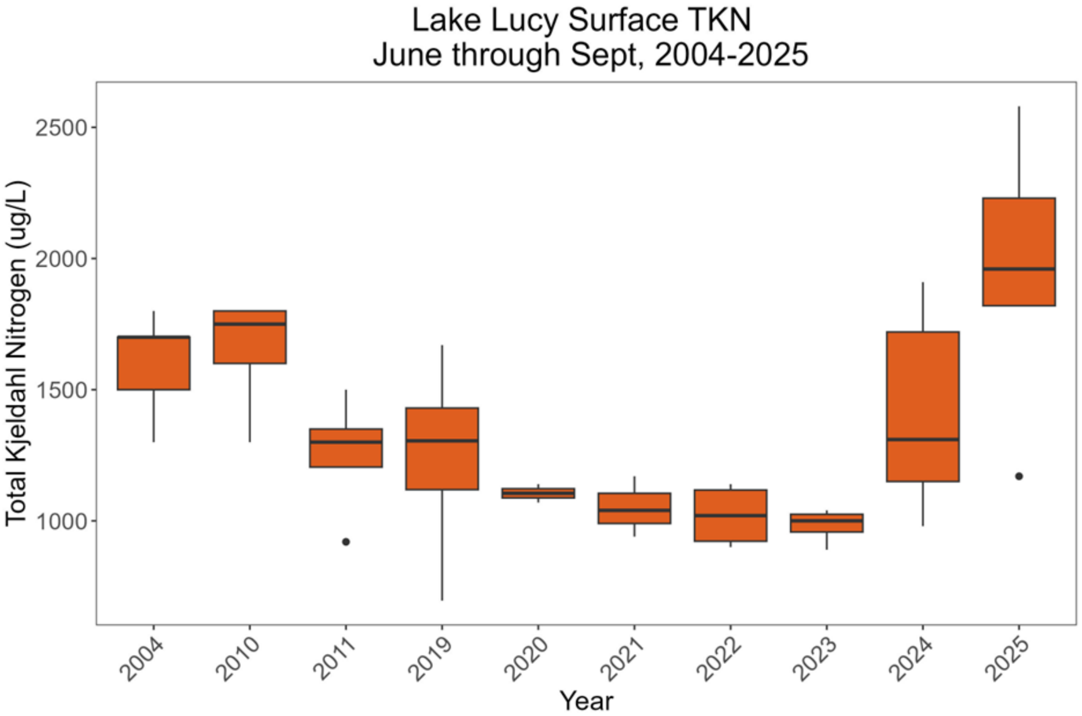


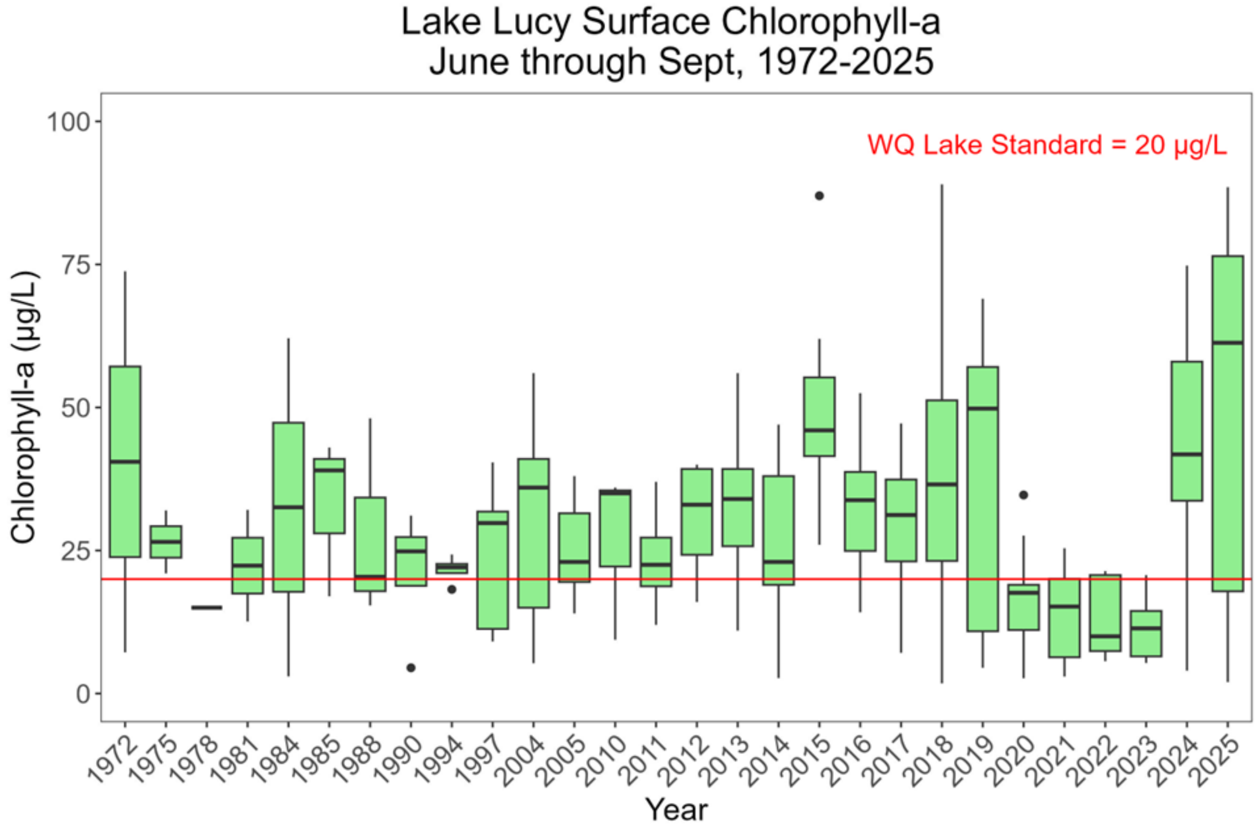
Lake Susan

Lake Characteristic	Lake Susan
Surface Area (acres)	88
Average Depth (ft)	10
Maximum Depth (ft)	17
Littoral Area (ac)	83
Watershed Area (ac)	2,553
Direct Watershed Area (ac)	1,231
Invasive Species	Curly-leaf Pondweed Eurasian Watermilfoil Common Carp Brittle Naiad

Lake Lucy Nutrients and Algae

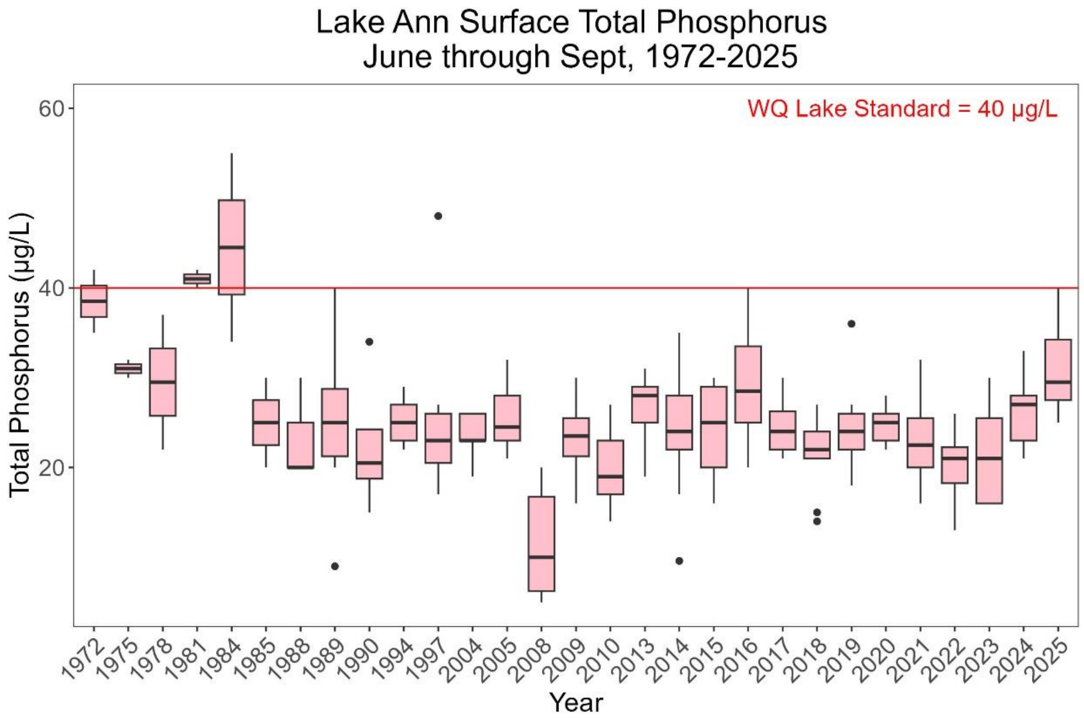


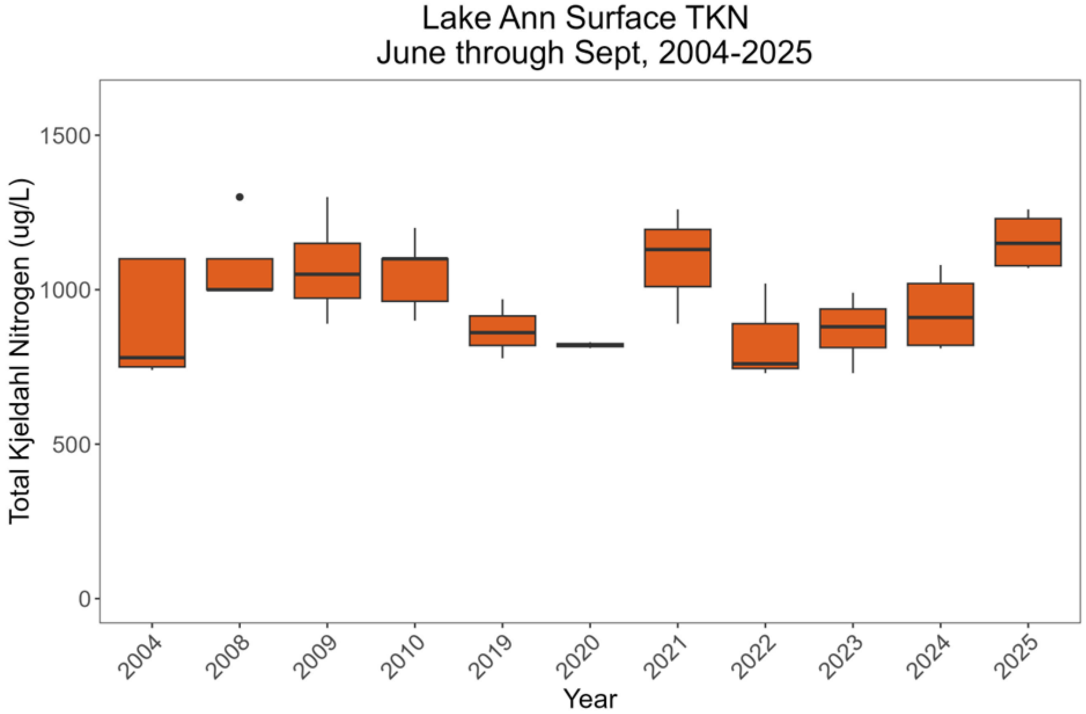


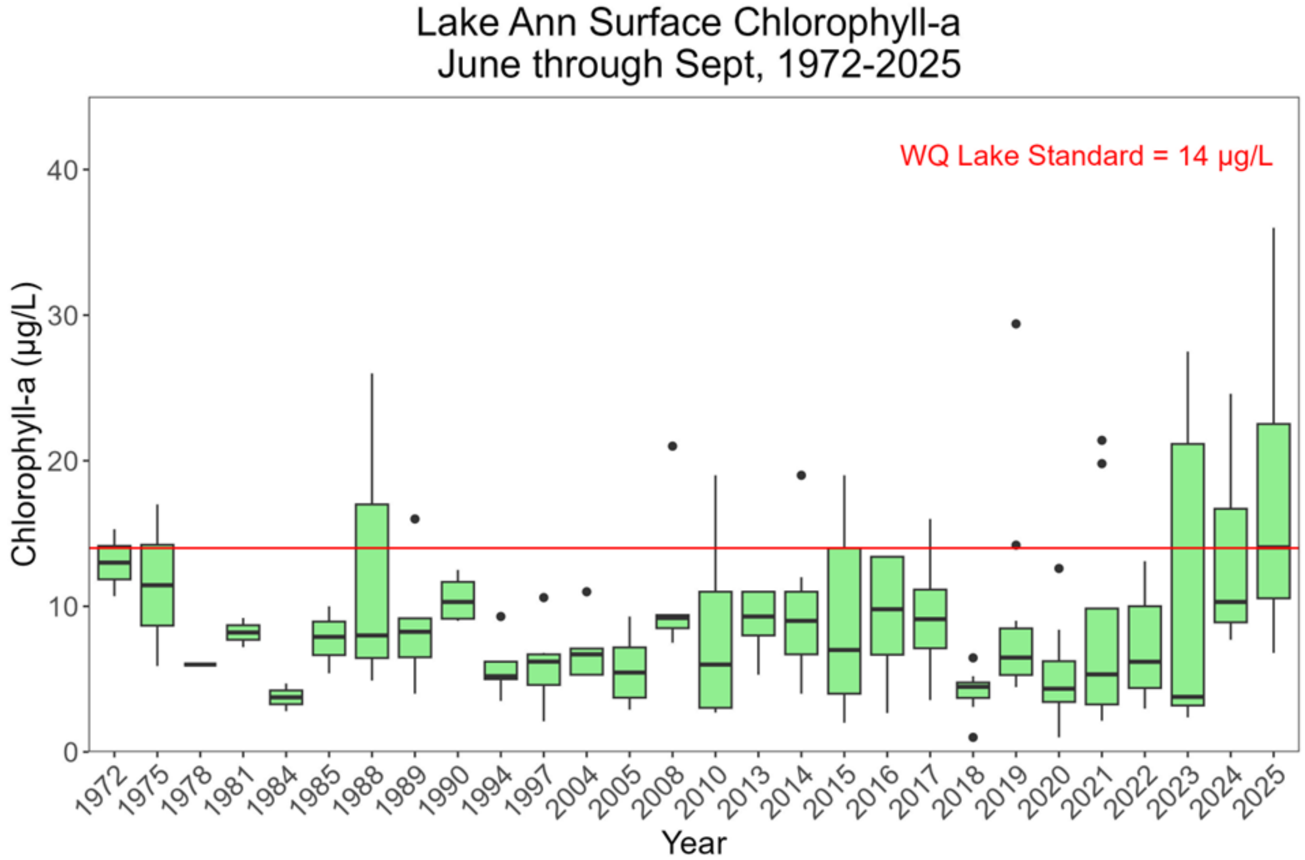


NCHF Reference Lakes: 600 to 1,200 ug/L TKN; <10 NO3/NO2

Lake Ann Nutrients and Algae

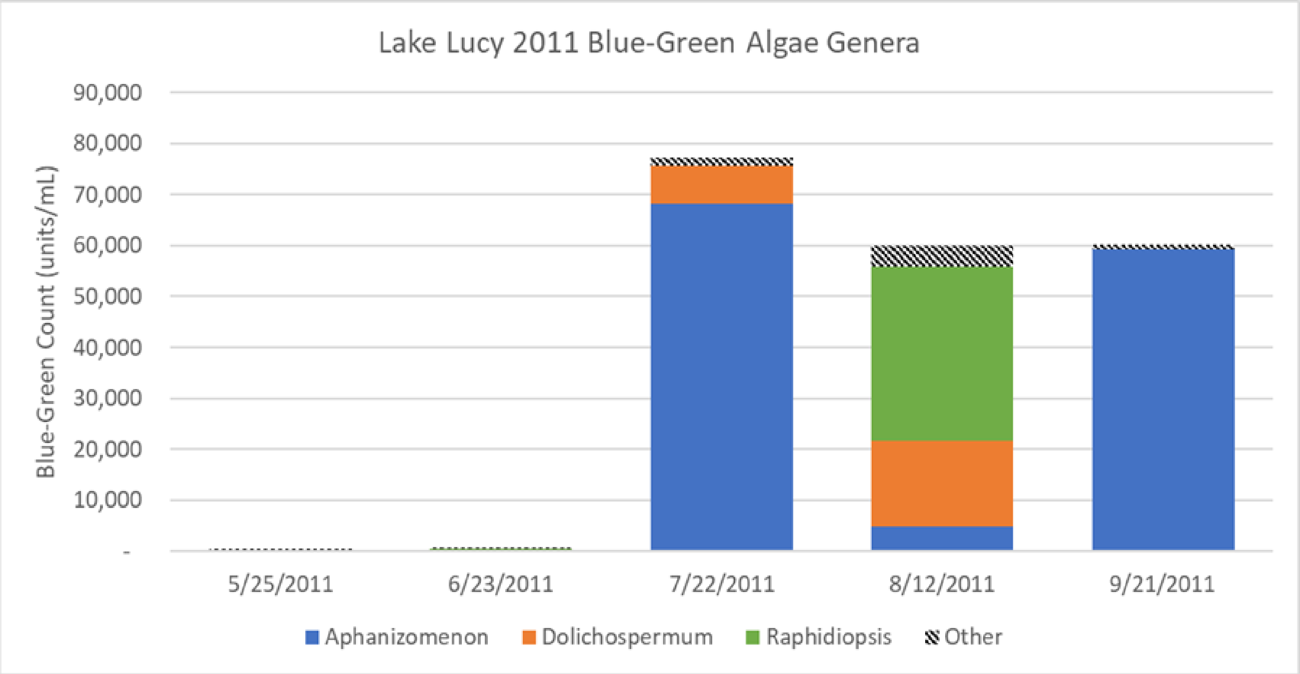


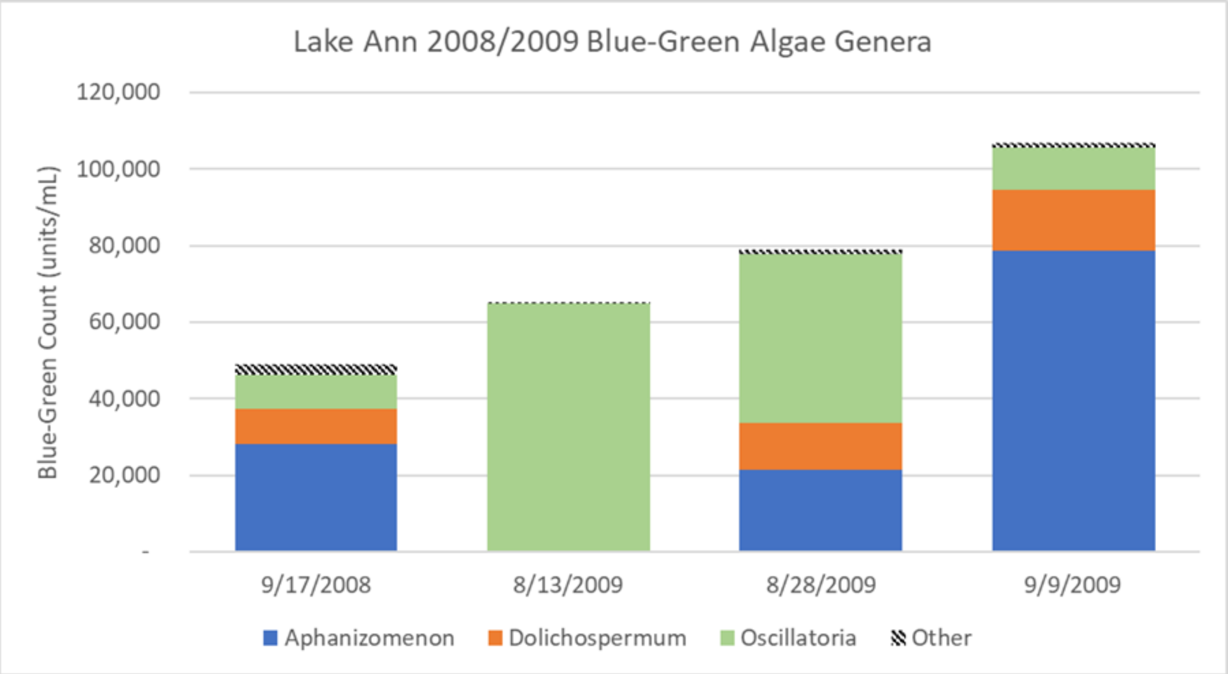




NCHF Reference Lakes: 600 to 1,200 ug/L TKN; <10 NO3/NO2

Lake Ann and Lake Lucy Cyanobacteria





Cyanobacteria Species	Hepatotoxins		Neurotoxins	
	Cylindrospermopsin	Microcystins	Anatoxin-a	Saxitoxins
Aphanizomenon flos-aquae*	X			X
Dolichospermum flos-aquae*		X	X	
Dolichospermum circinale*		X	X	X
Dolichospermum planctonicum*			X	
Raphidiopsis raciborskii*	X	X	X	X

Physical Characteristics of Lakes

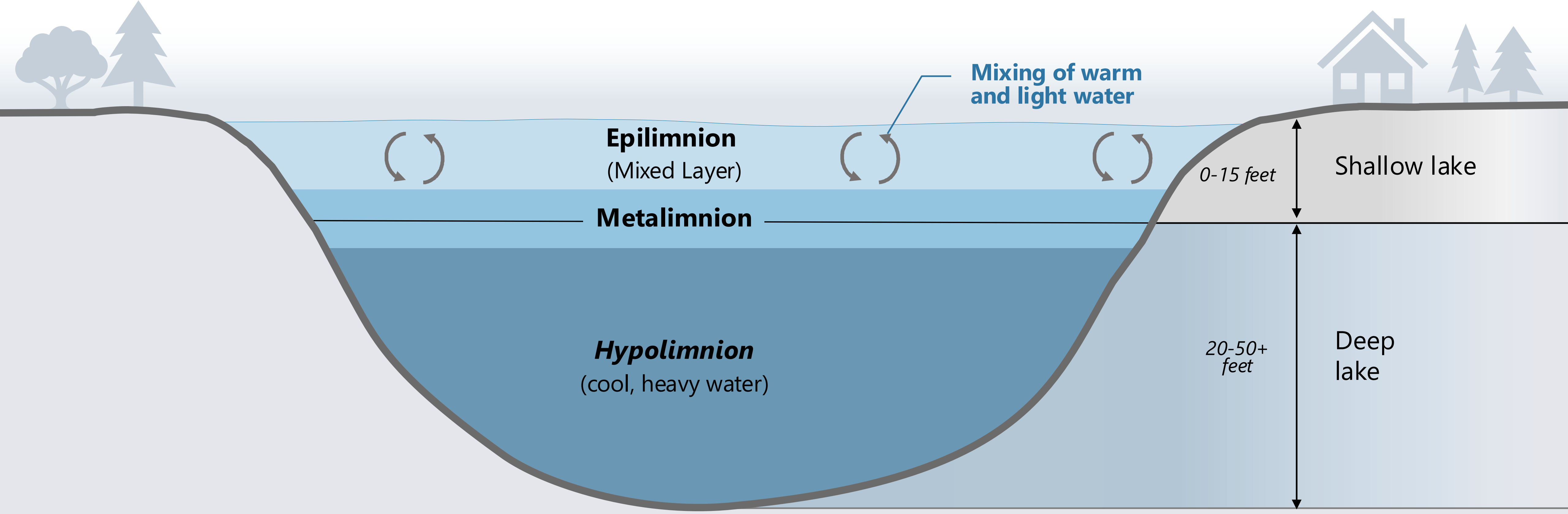
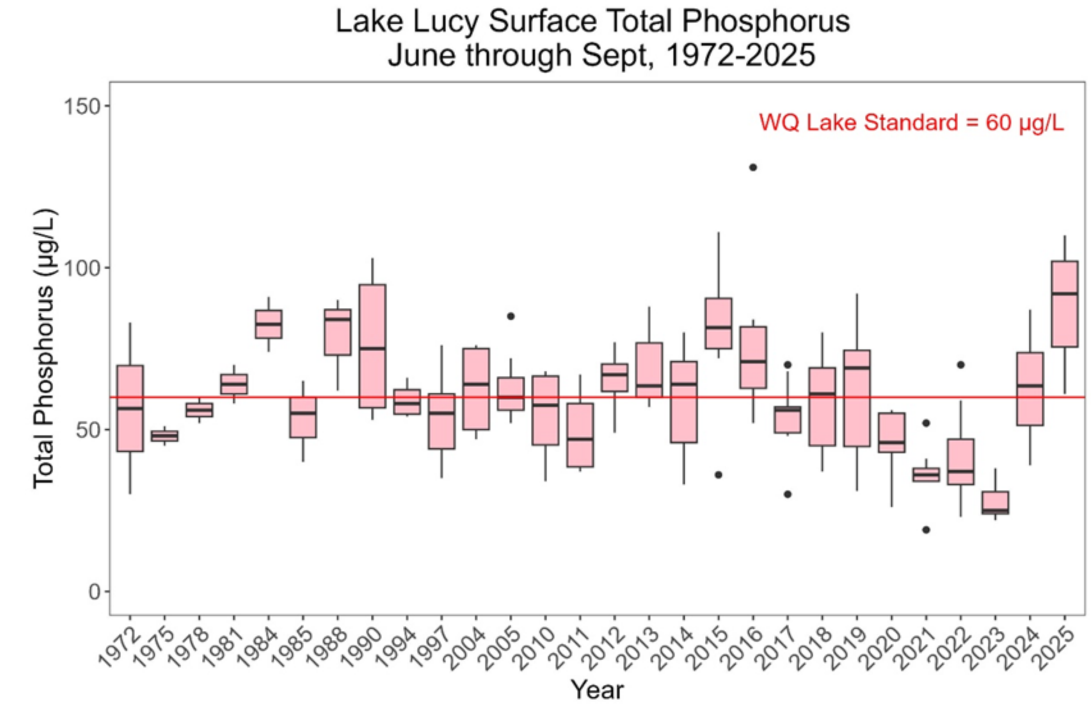
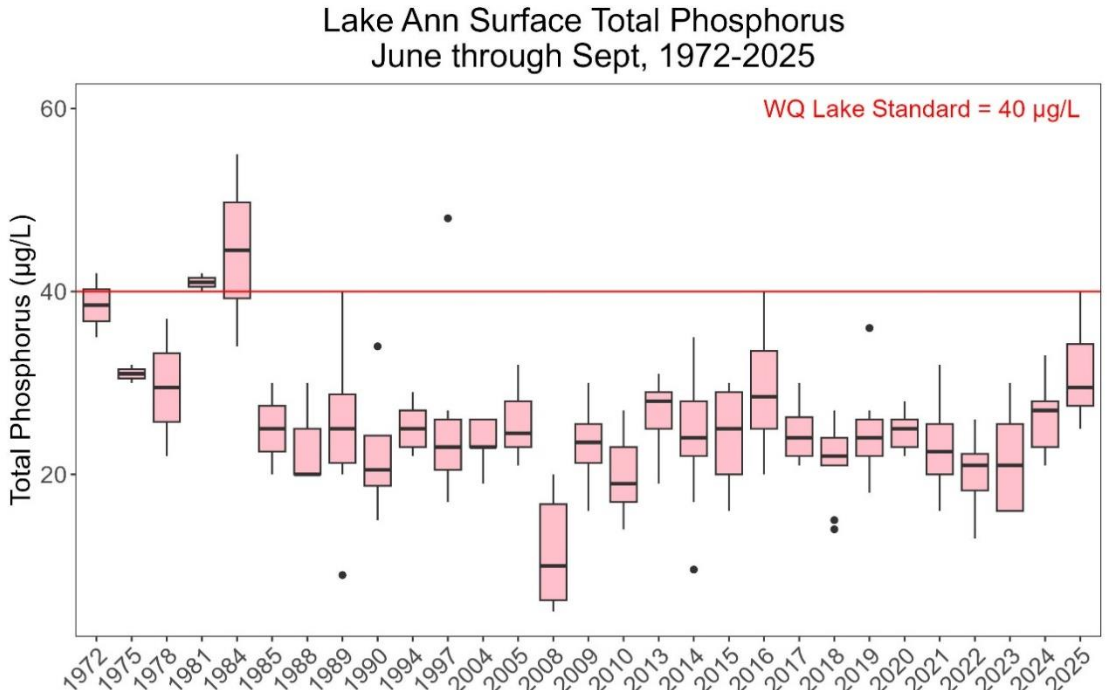
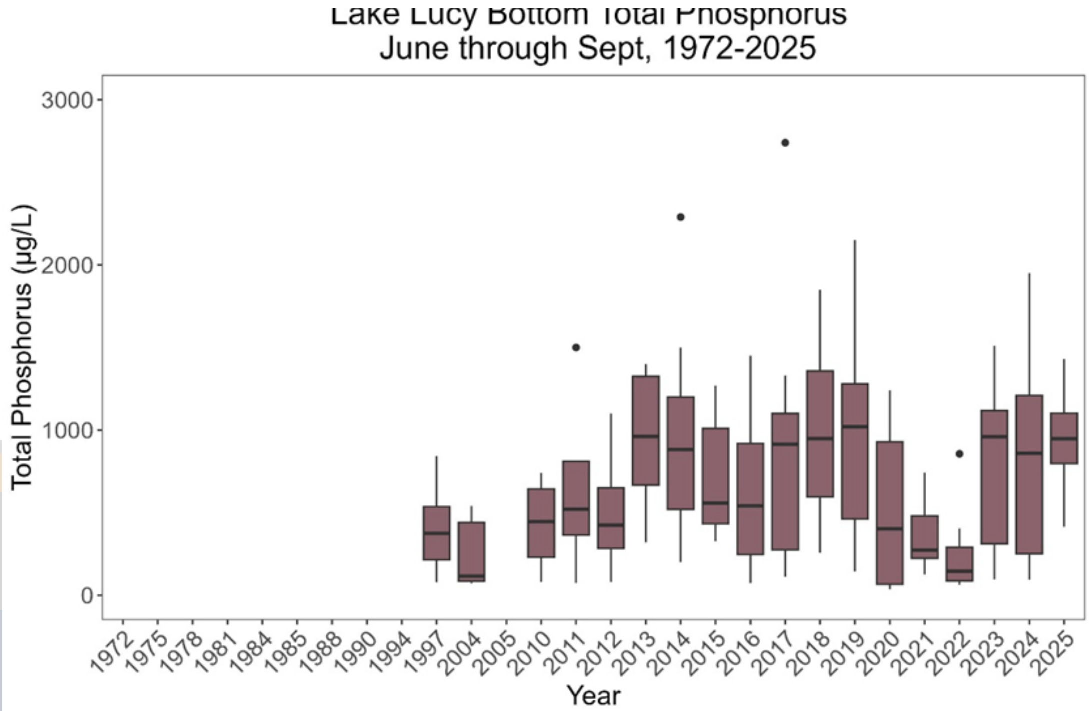
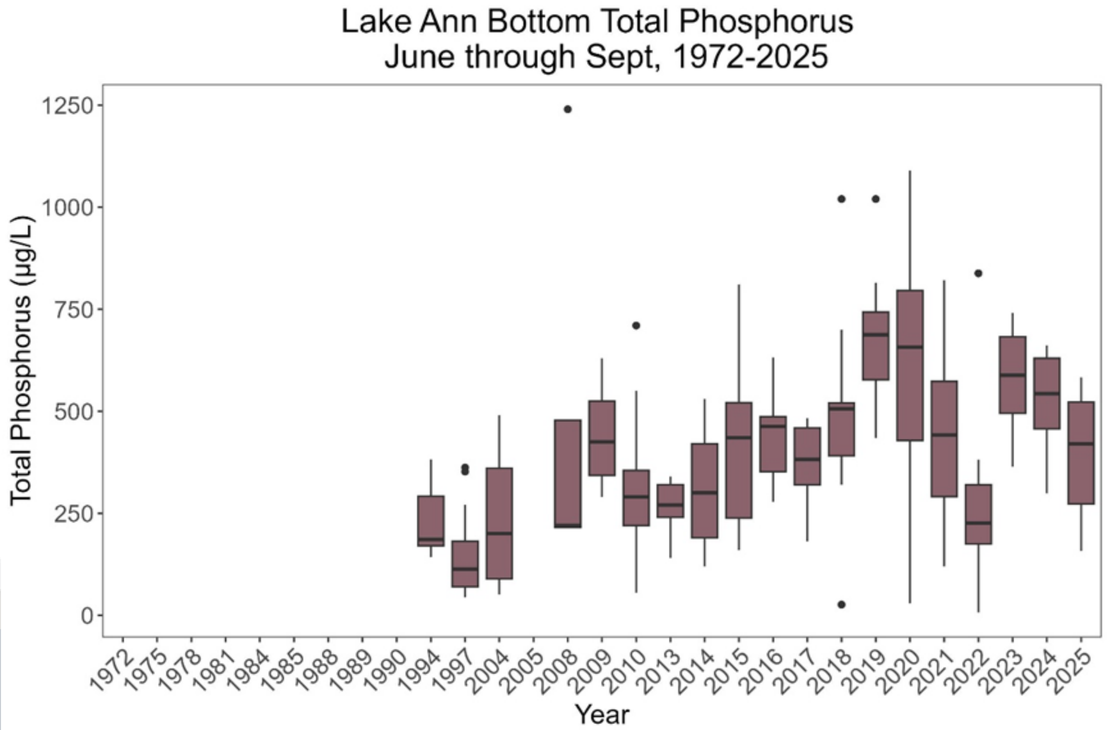


Diagram not to scale

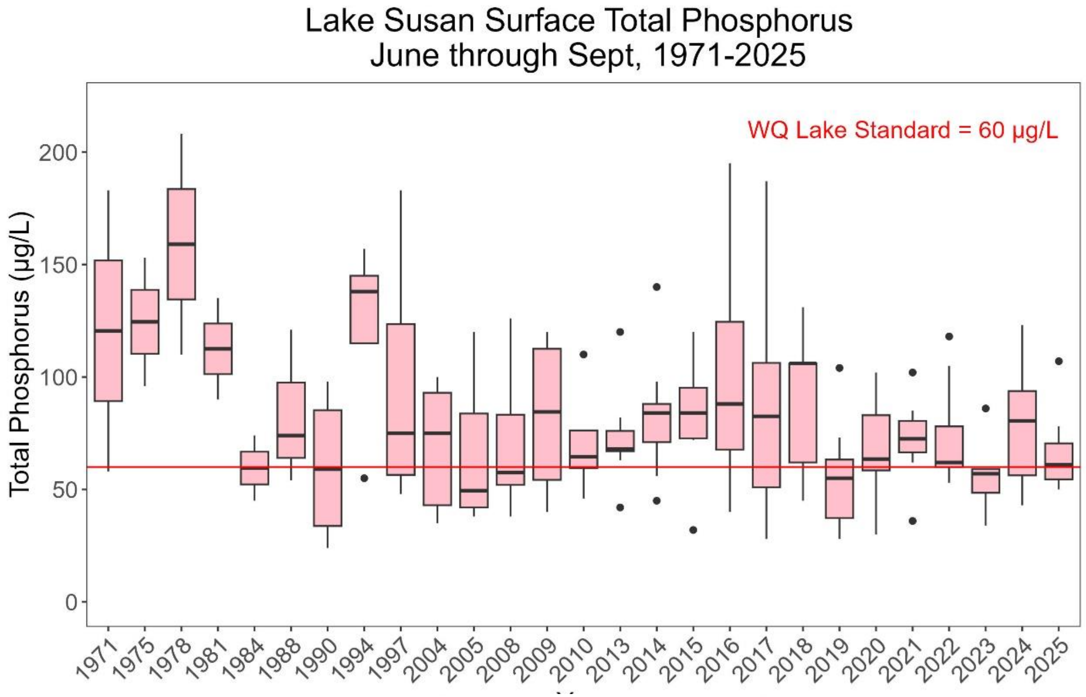

Lake Lucy Surface Total Phosphorus
June through Sept, 1972-2025
WQ Lake Standard = 60 µg/L
Total Phosphorus (µg/L)
Year

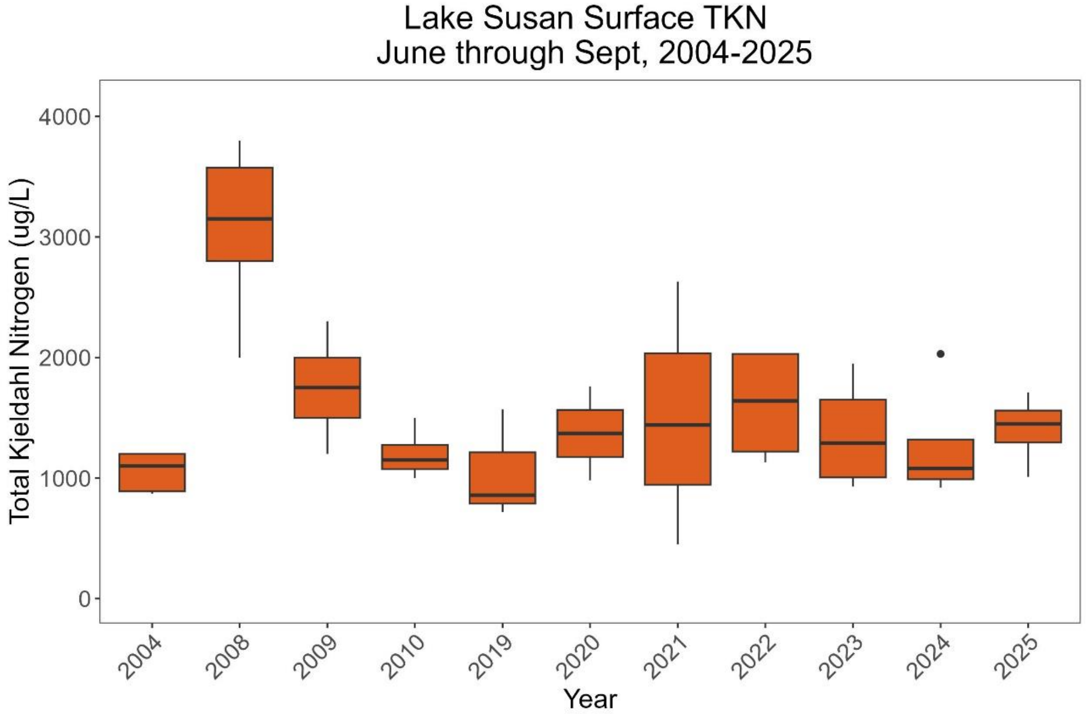

Lake Ann Surface Total Phosphorus
June through Sept, 1972-2025
WQ Lake Standard = 40 µg/L
Total Phosphorus (µg/L)
Year

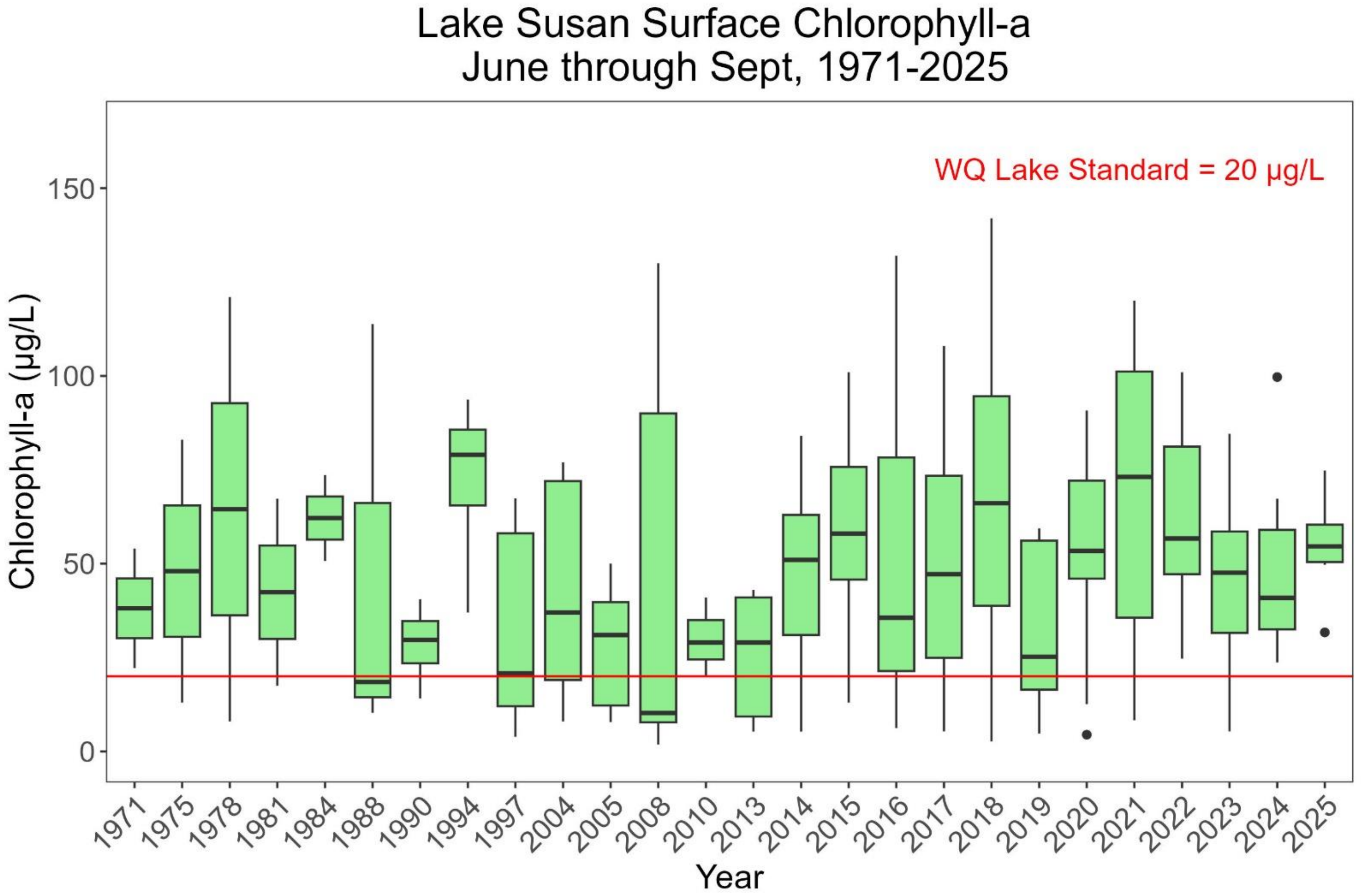

Lake Lucy Bottom Total Phosphorus
June through Sept, 1972-2025
Total Phosphorus (µg/L)
Year


Lake Ann Bottom Total Phosphorus
June through Sept, 1972-2025
Total Phosphorus (µg/L)
Year

Lake Susan Nutrients and Algae

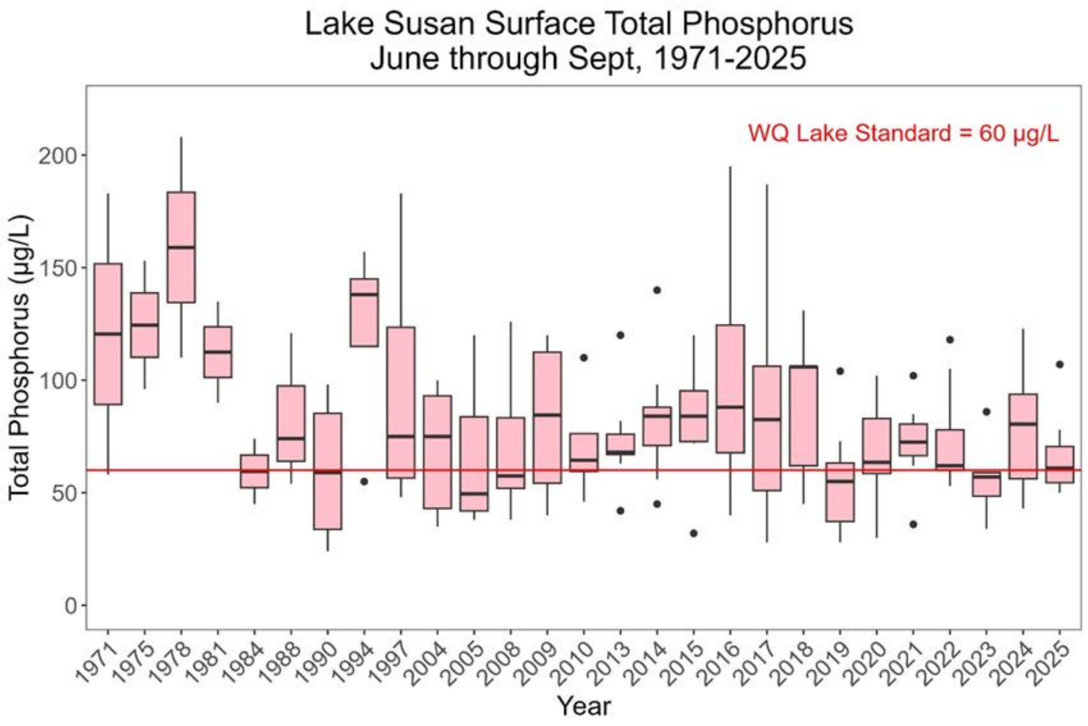


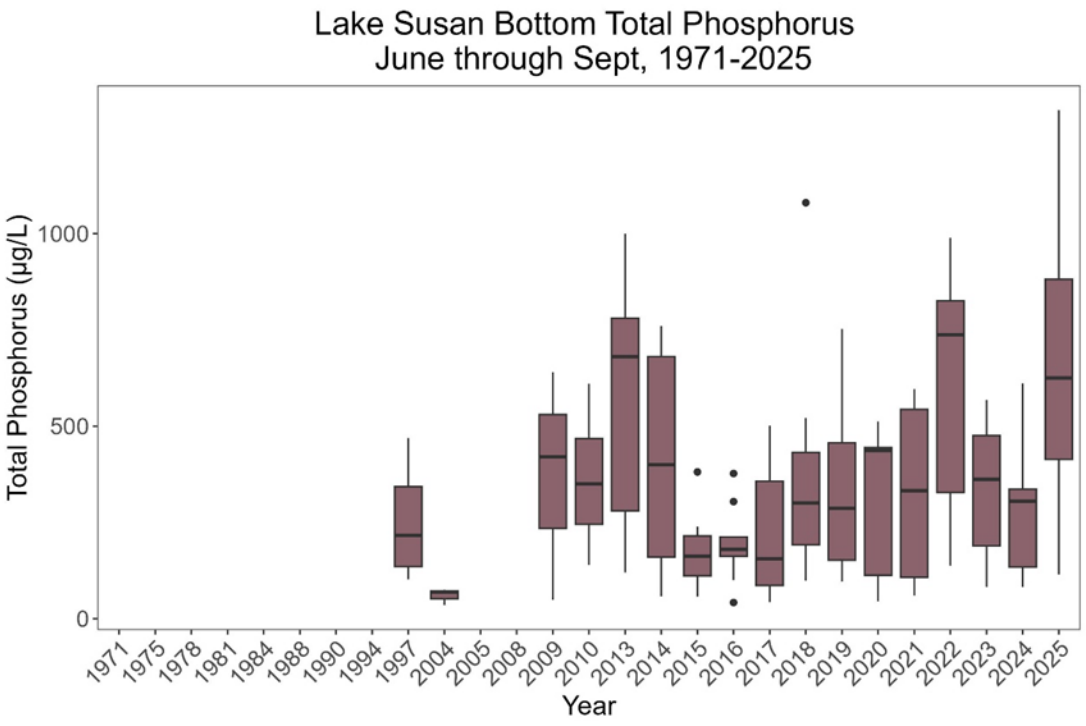




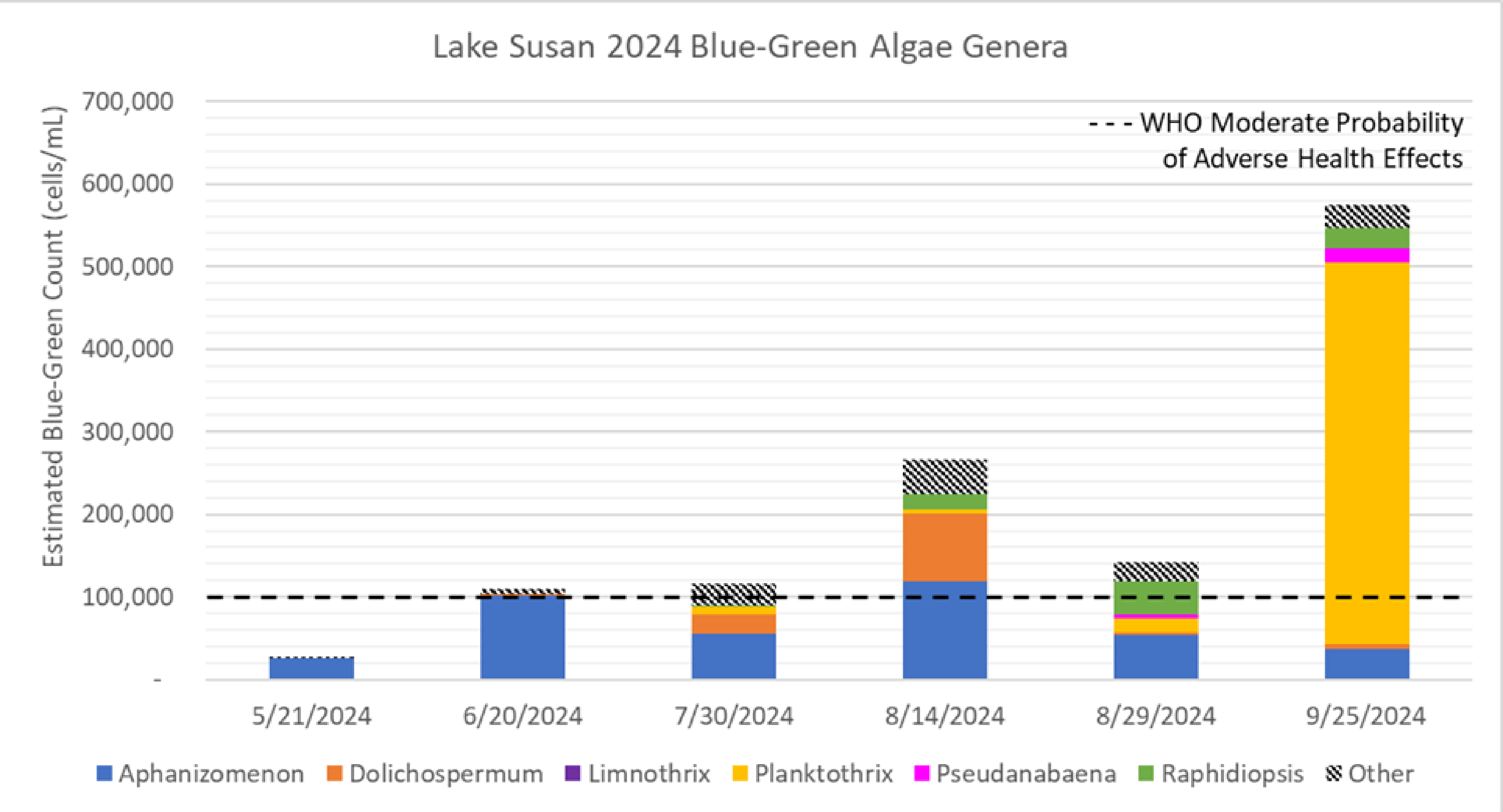
NCHF Reference Lakes: 600 to 1,200 ug/L TKN; <10 NO3/NO2

Surface and Bottom Total Phosphorus





Lake Susan Cyanobacteria



Cyanobacteria Species	Hepatotoxins		Neurotoxins	
	Cylindrospermopsin	Microcystins	Anatoxin-a	Saxitoxins
Aphanizomenon flos-aquae*	**X**			**X**
Aphanocapsa sp.		X		
Dolichospermum flos-aquae*		**X**	**X**	
Limnothrix redekei		X		
Merismopedia tenuissima		X		
Microcystis sp.*		**X**	**X**	
Planktothrix agardhii*		**X**	**X**	**X**
Pseudanabaena limnetica	X	X		
Pseudanabaena mucicola		X		
Raphidiopsis raciborskii*	**X**	**X**	**X**	**X**

Eutrophication Goals

Goal 1. Meet summer average state water quality standards for the lakes

Goal 2. Minimize cyanobacteria blooms below WHO thresholds throughout the growing season

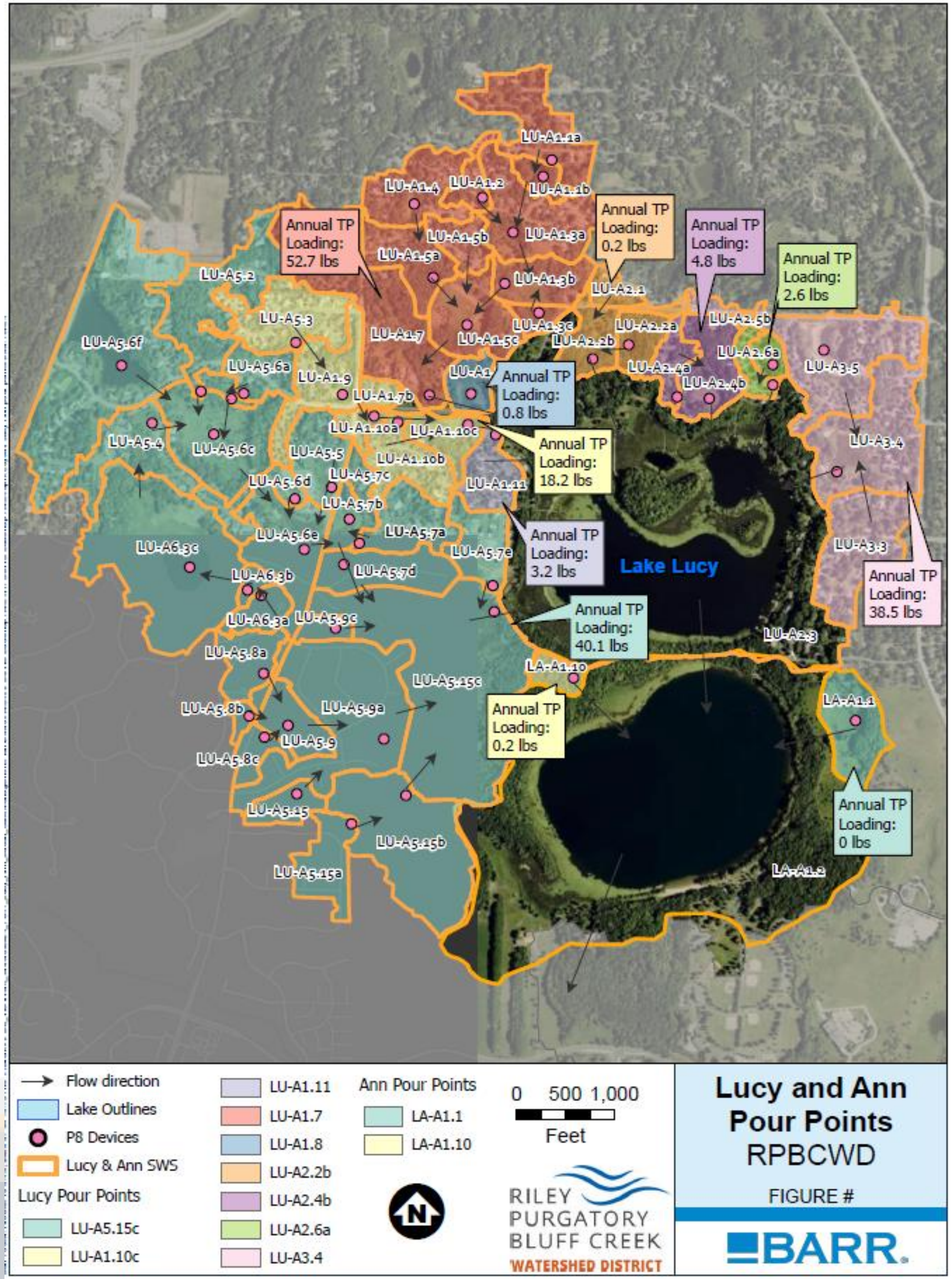
Eutrophication Parameter	Shallow Lakes[1]	Deep Lakes
Total Phosphorus (summer average, µg/L)	≤ 60	≤ 40
Chlorophyll-a (summer average, µg/L)	≤ 20	≤ 14
Secchi Disk transparency (summer average, meters)	≥ 1.0	≥ 1.4

Barr Lake Response Model

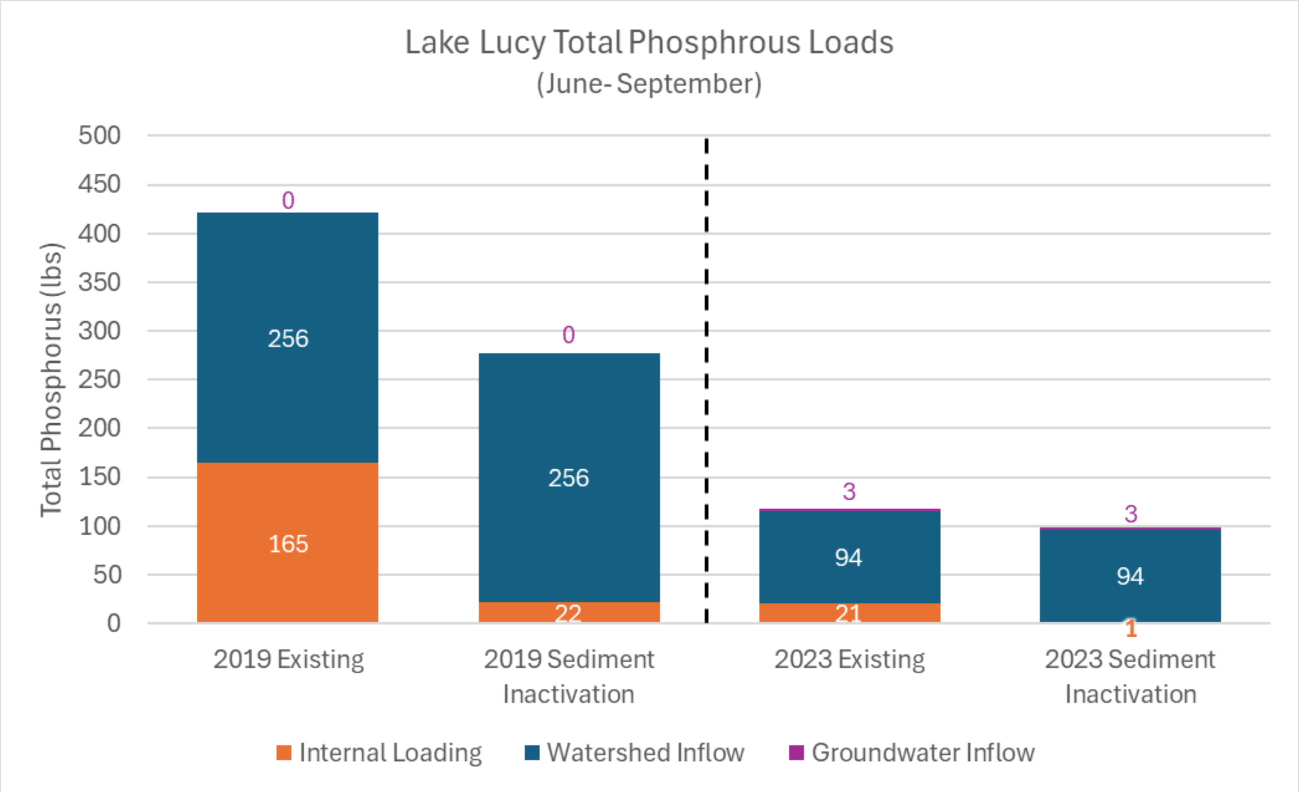
- Water Balance (wet and dry year)
- Temperature and Dissolved Oxygen
- Nitrogen and Phosphorus
- Sediment phosphorus release
  - Inorganic and organic sources
- Phytoplankton
  - Chlorophytes and cyanobacteria

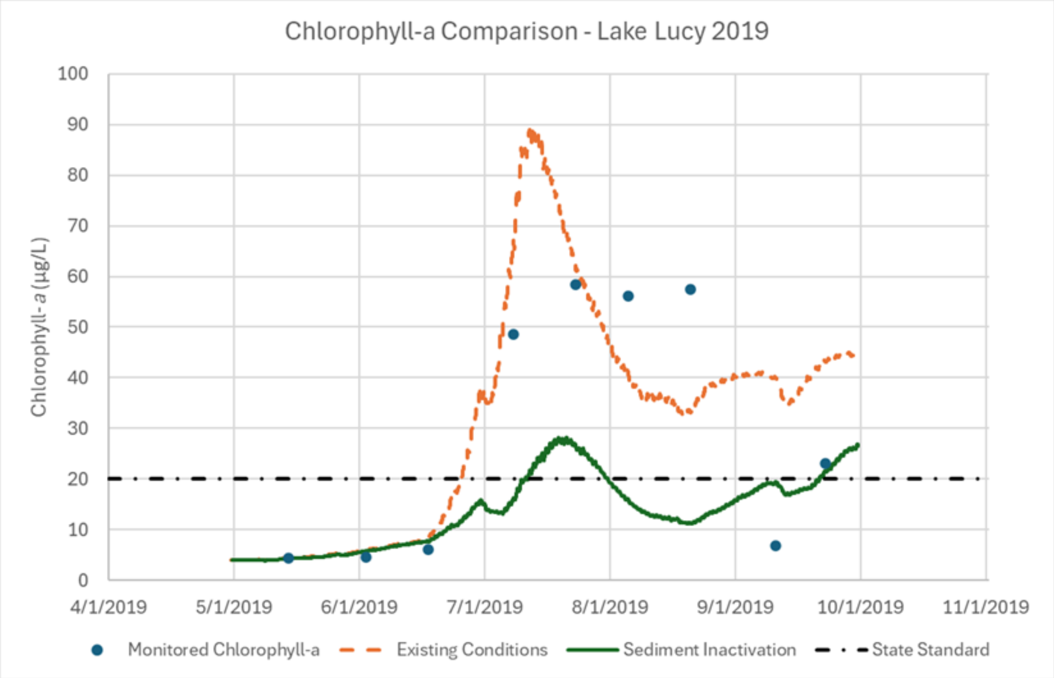
Questions

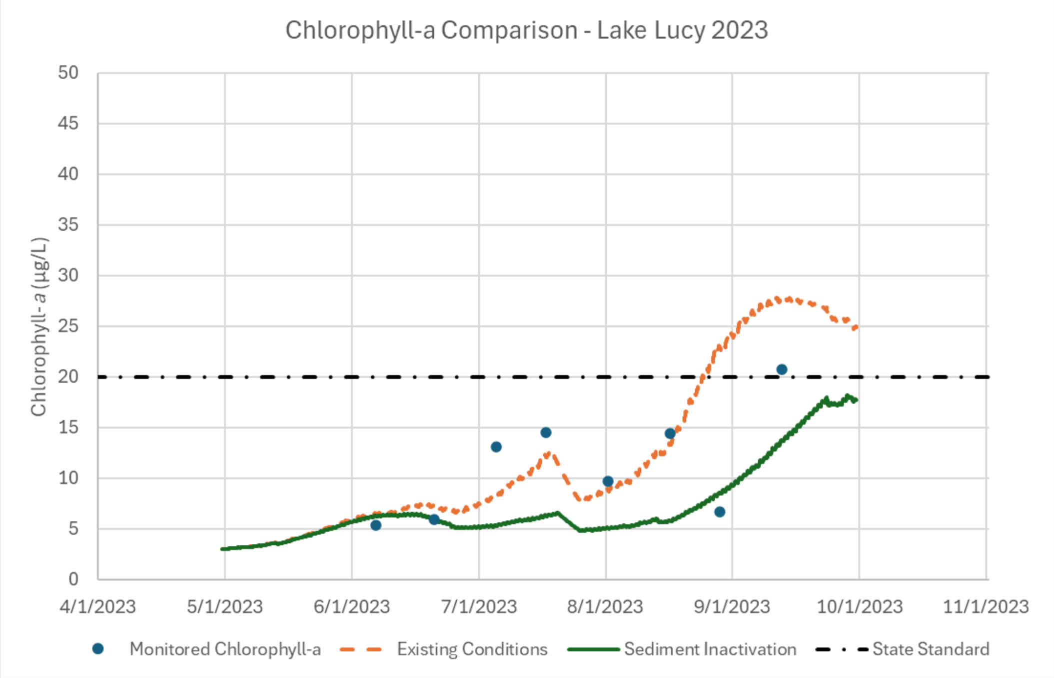
- What role does N play in driving cyanobacteria blooms?
- What reductions are required to meet state water quality standards?
- Are both N and P reductions beneficial?
- Where should nutrient reductions be pursued?



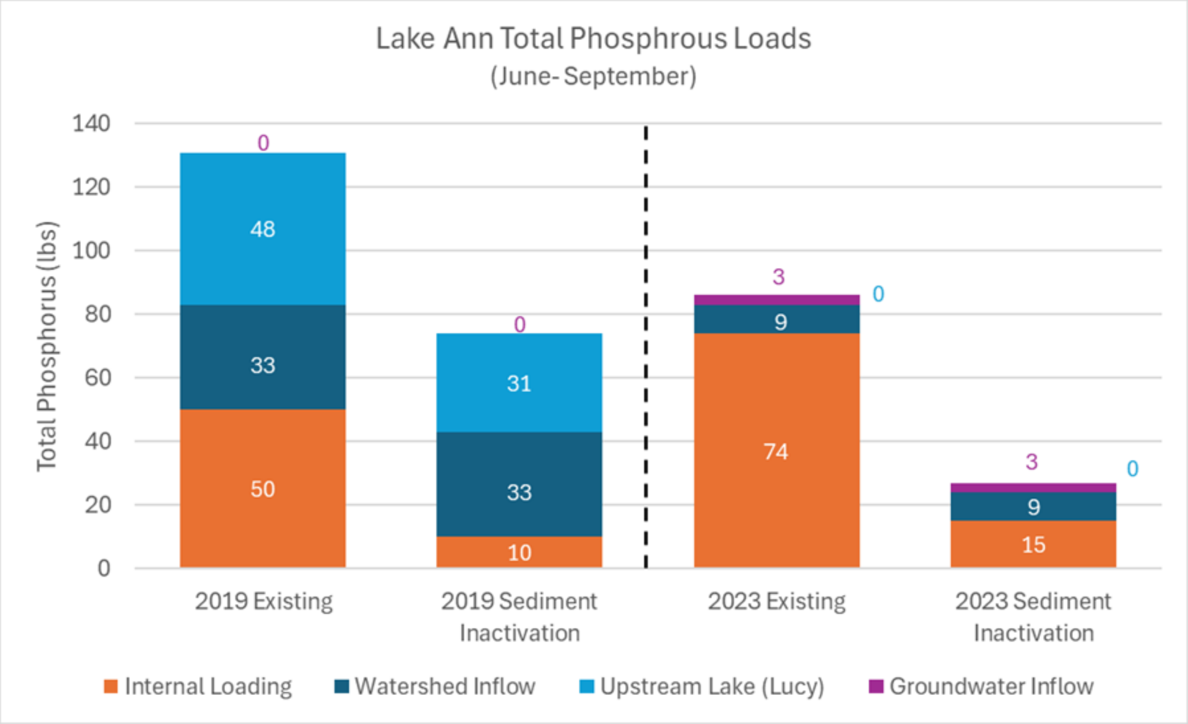
Model Scenarios – Lake Lucy

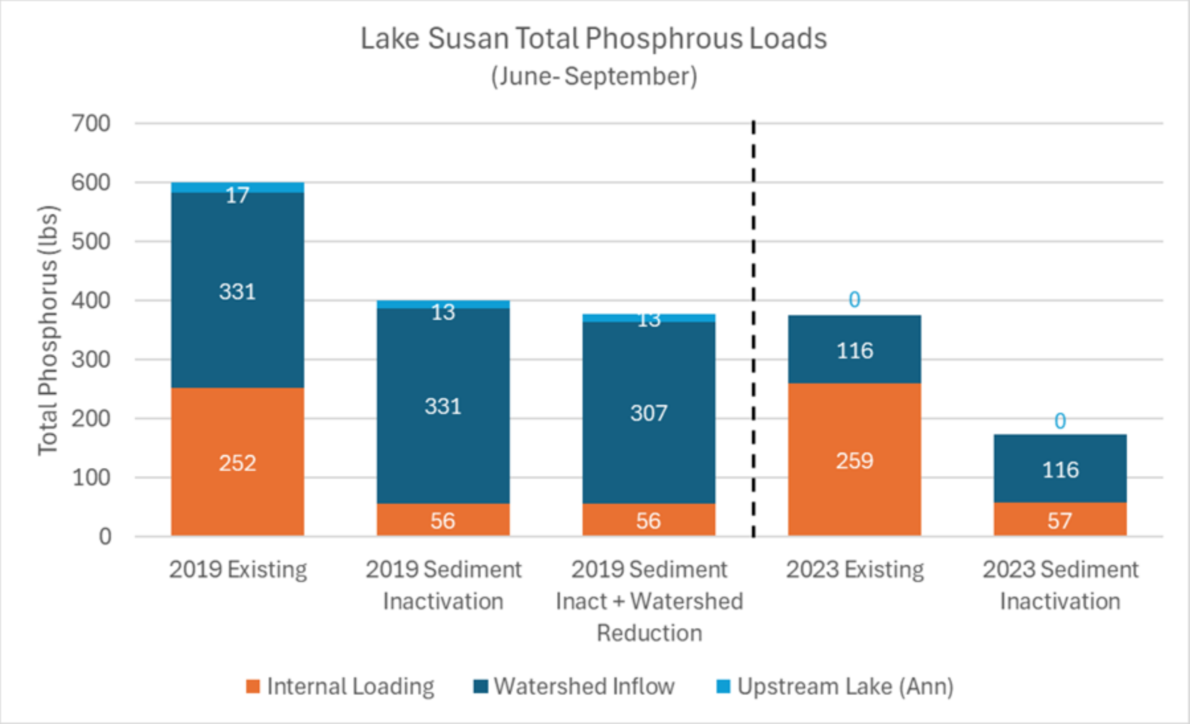




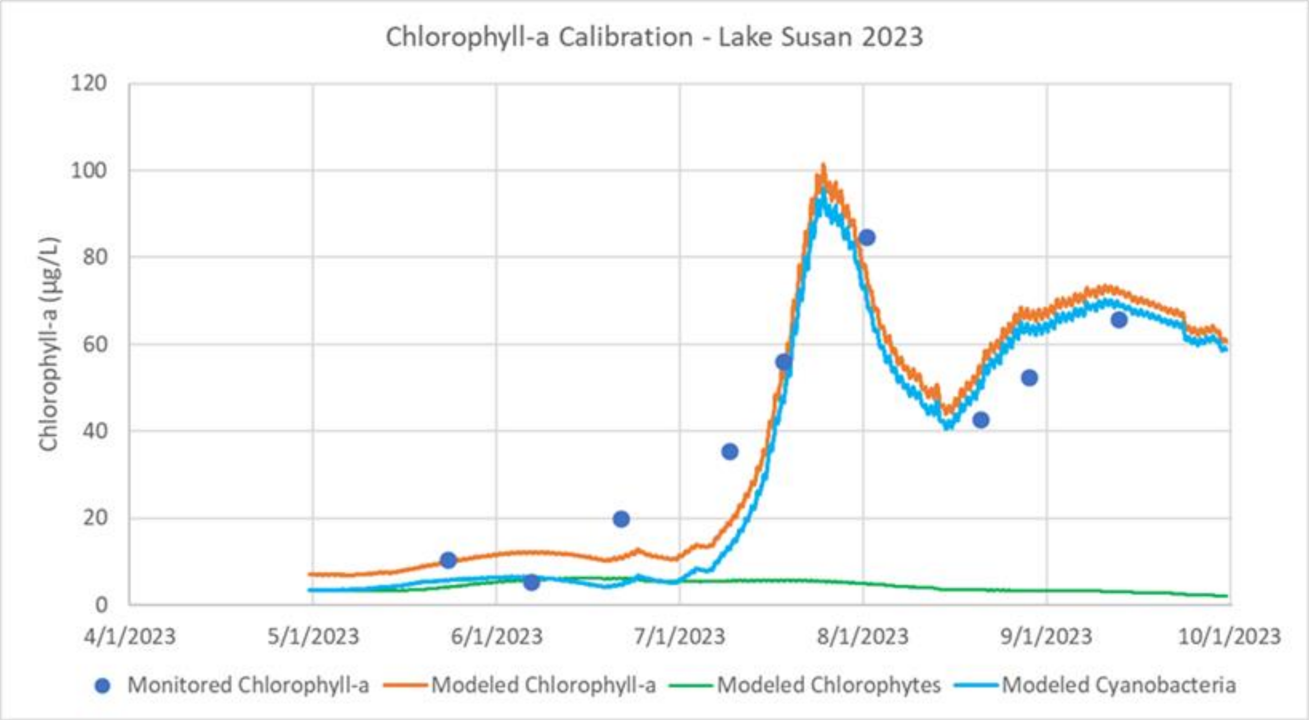


Lake Ann and Lake Susan Model Scenarios





The Role of Nitrogen



- Limited nitrate data suggest high nitrogen periods in the lakes
- Phytoplankton are co-limited by N+P
  - N-fixation by cyanobacteria starts in mid- to late-June
- N management will have limited benefits to phytoplankton production due to N-fixing cyanobacteria
- However, lower N environments are less likely to produce toxic cyanobacteria blooms
- Opportunistic with N management
- Need better N monitoring in lakes and tributaries

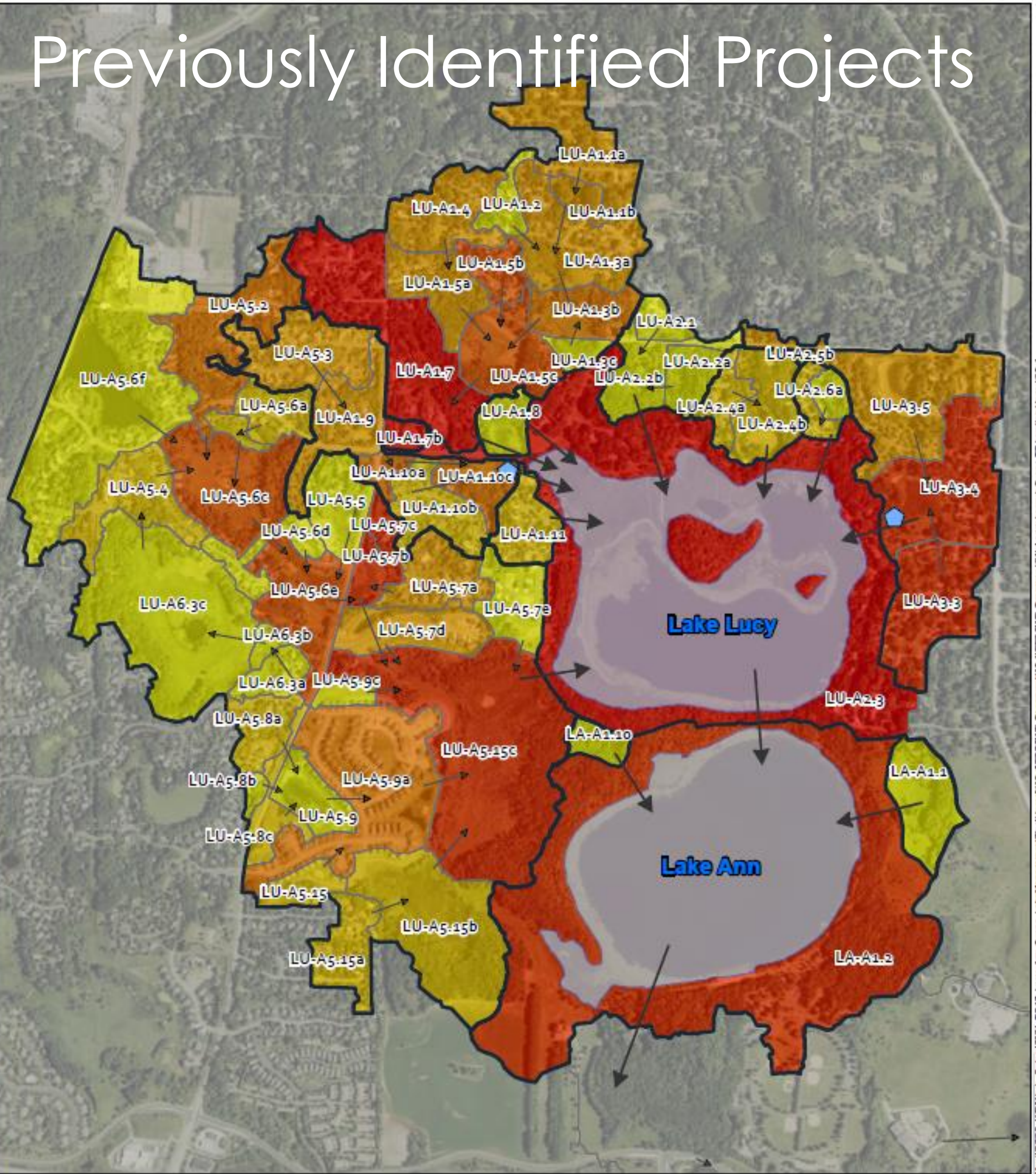
Summary of Lake Water Quality Drivers

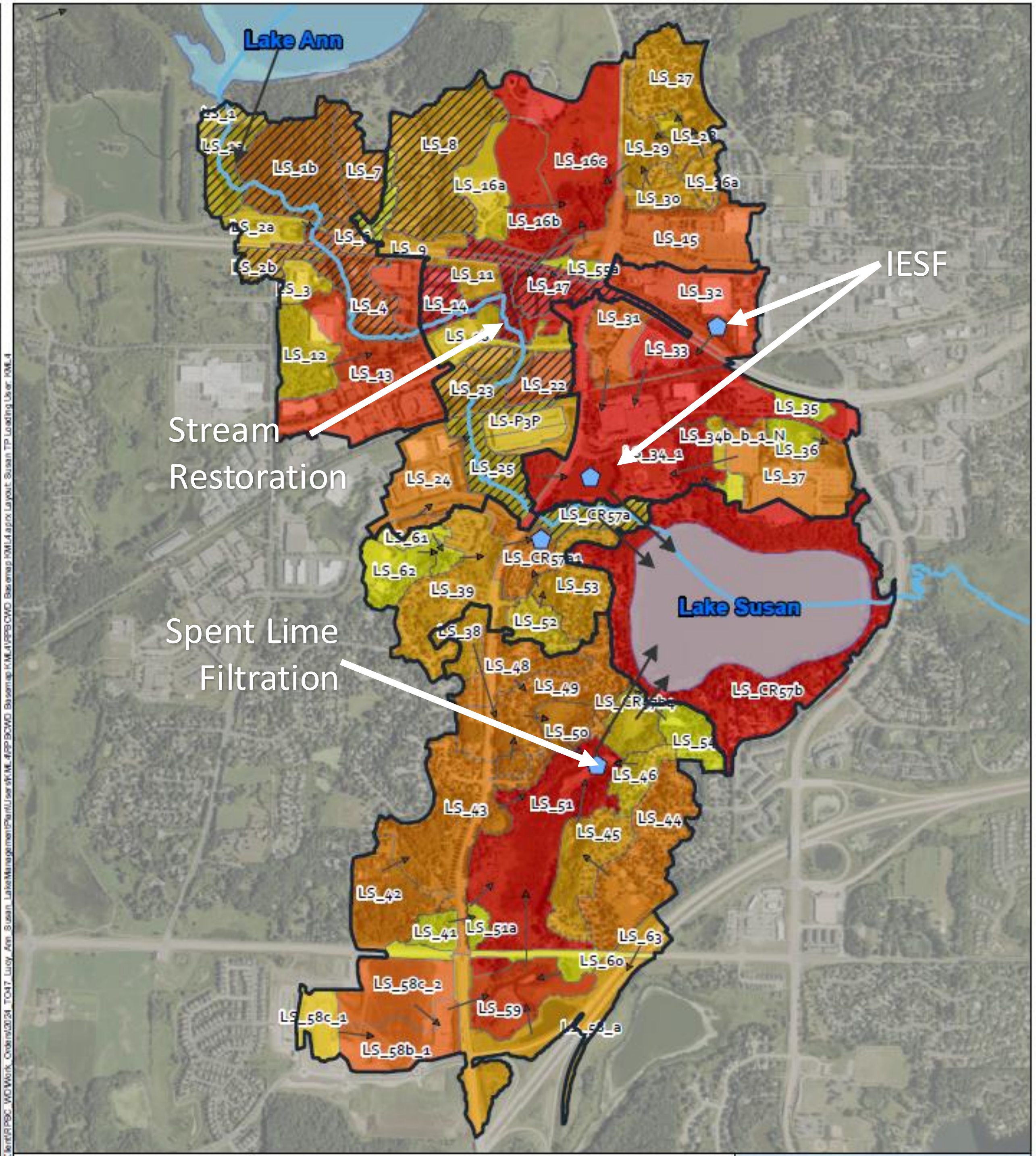
- Phosphorus management is still the best approach for reducing nuisance algae blooms and cyanobacteria
  - Internal P loading is a major driver in all three lakes
  - Watershed reductions can be protective long term
- Improved nitrogen monitoring is required to better understand nitrogen conditions
- Nitrogen reductions as opportunities arise
  - Wetland restoration to increase denitrification, N retention

Watershed Project Types

- **Structural engineered projects**
  - Spent lime filter, iron enhanced sand filters, new ponds
- **Pond Maintenance**
  - Internal phosphorus loading in ponds
- **Wetland restoration**
  - Address both nitrogen and phosphorus if possible
- **Non-structural**
  - Street sweeping, education and outreach, individual practices

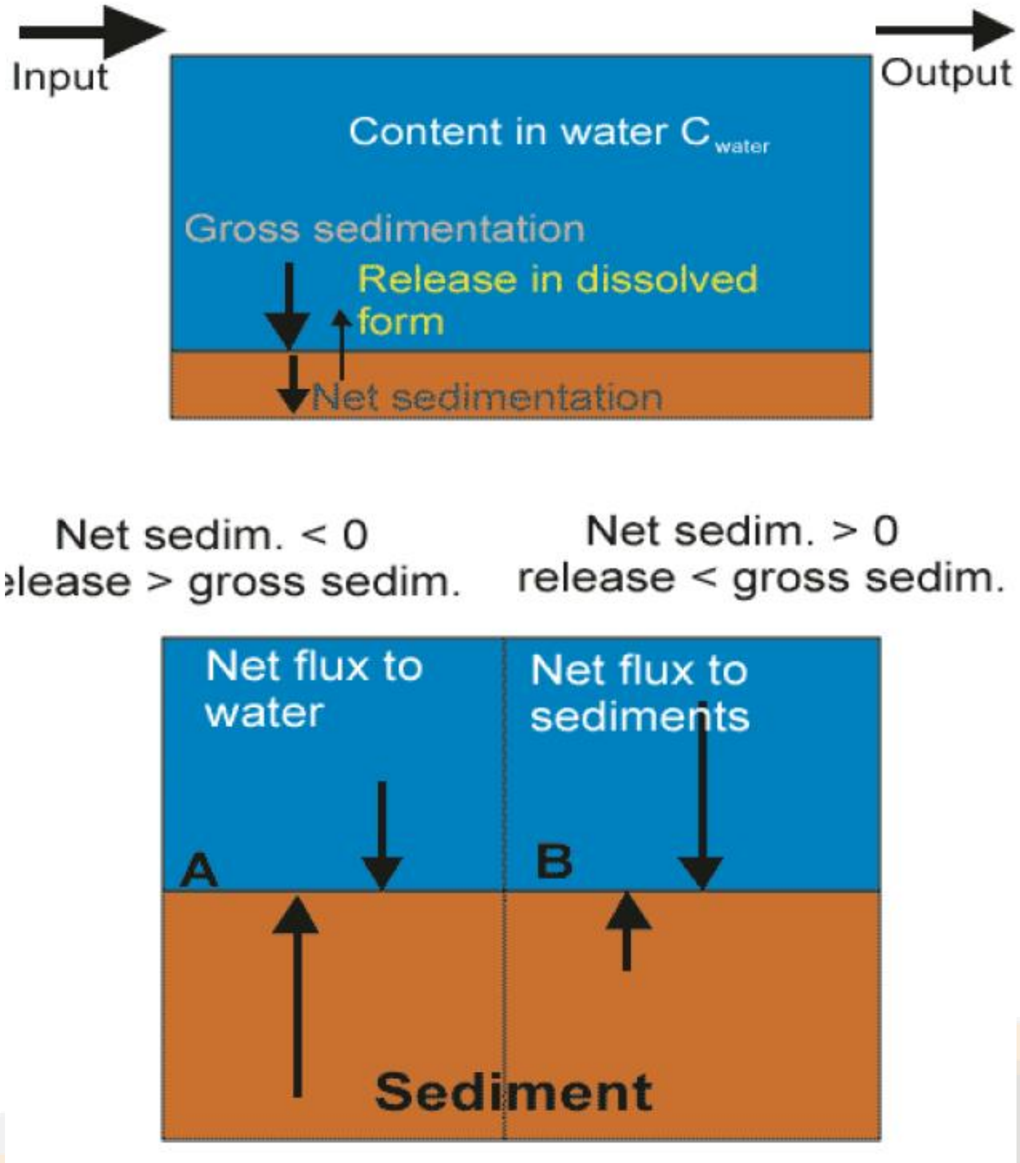
Previously Identified Projects





Internal P Loading in Ponds

- **Mitchell and Riley Subwatershed Study** (2021)
  - Field assessment of 9 ponds
  - High anoxia and high P loading
  - Possible source of P to surface waters
- **Pond Screening**
  - Applied average release rates and anoxic factors to estimate P mass load
  - Pond >1 acre and >3 feet in depth



Pond Maintenance Projects – Pond Screening

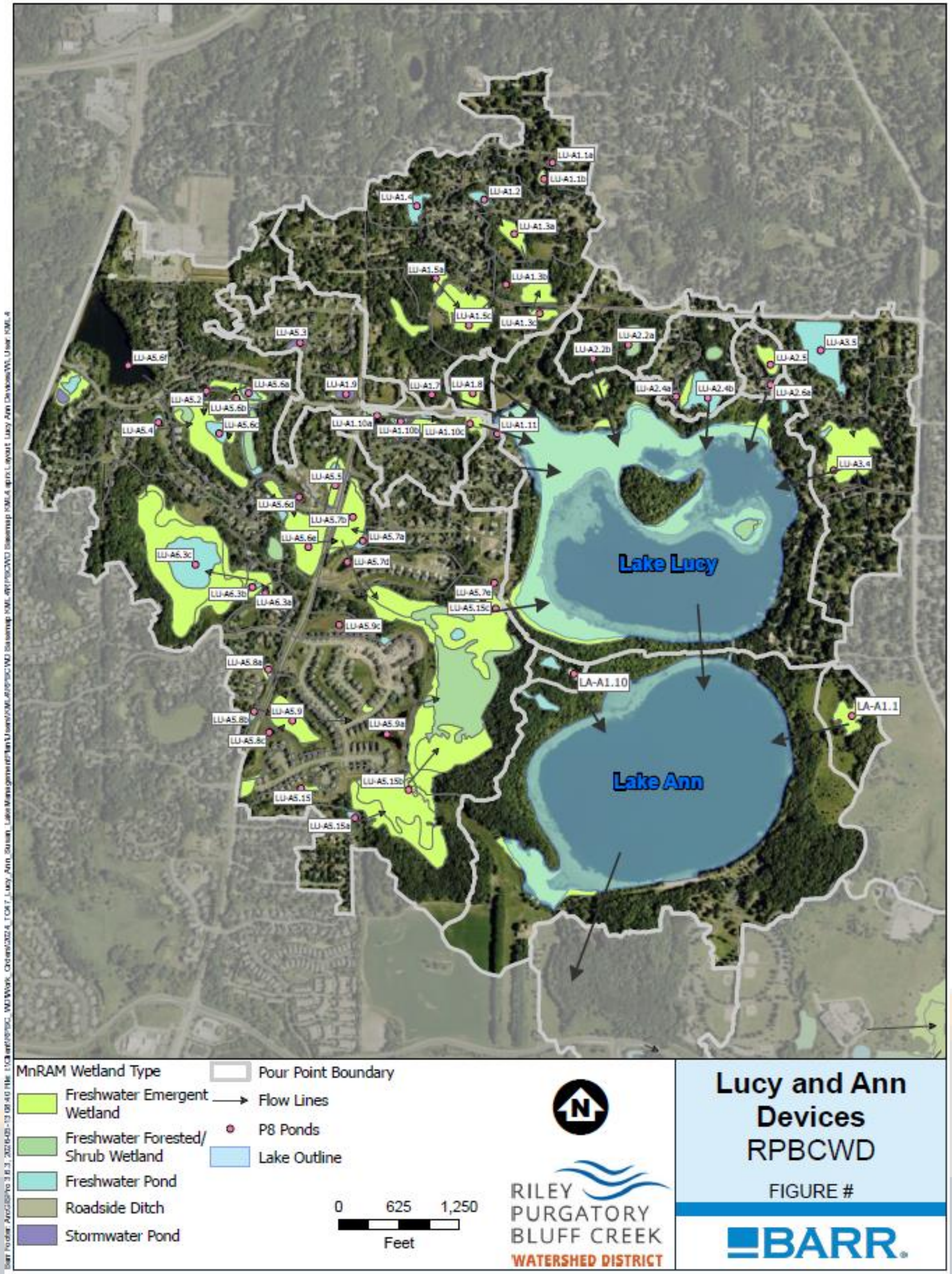
Lake	Pond ID	Pond Area (ac)	Average Depth (ft)	Potential P Load (lbs/yr)	Surveyed?
Lucy	LU-A3.5	4.5	5.7	13.8	No
Lucy	LU-A5.9a	1.4	5.6	4.2	No
Lucy	LU-A6.3c	22.2	5.5	68.0	No
Lucy	LU-A5.6f	9.4	3.3	28.8	No
Susan	3.63	1.5	3.4	4.6	No
Susan	58b_1_a	1.6	6.5	4.9	No
Susan	2.6	2.0	5.3	6.2	No
Susan	3.37	4.3	4.7	13.1	No
Susan	2.13	2.8	3.8	8.5	No

Sediment Phosphorus Inactivation - Alum

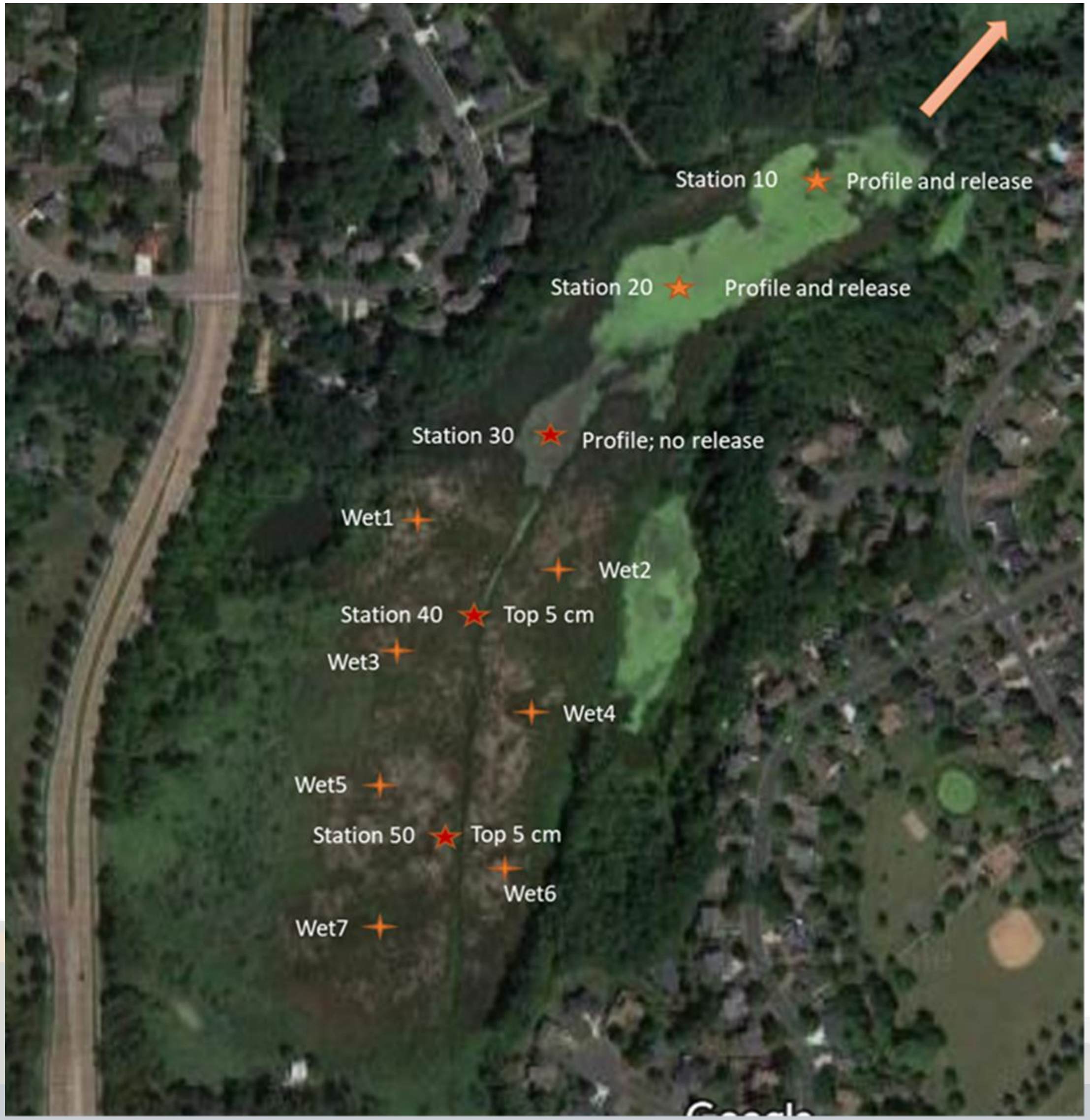
- Aluminum Sulfate (liquid)
  - Hydrolyzes in water to form aluminum hydroxide and sulfate
  - Aluminum hydroxide is a precipitate that settles to the lake bottom
- Permanently binds phosphorus in the sediments
  - Very stable in the environment
  - Not sensitive to environmental changes

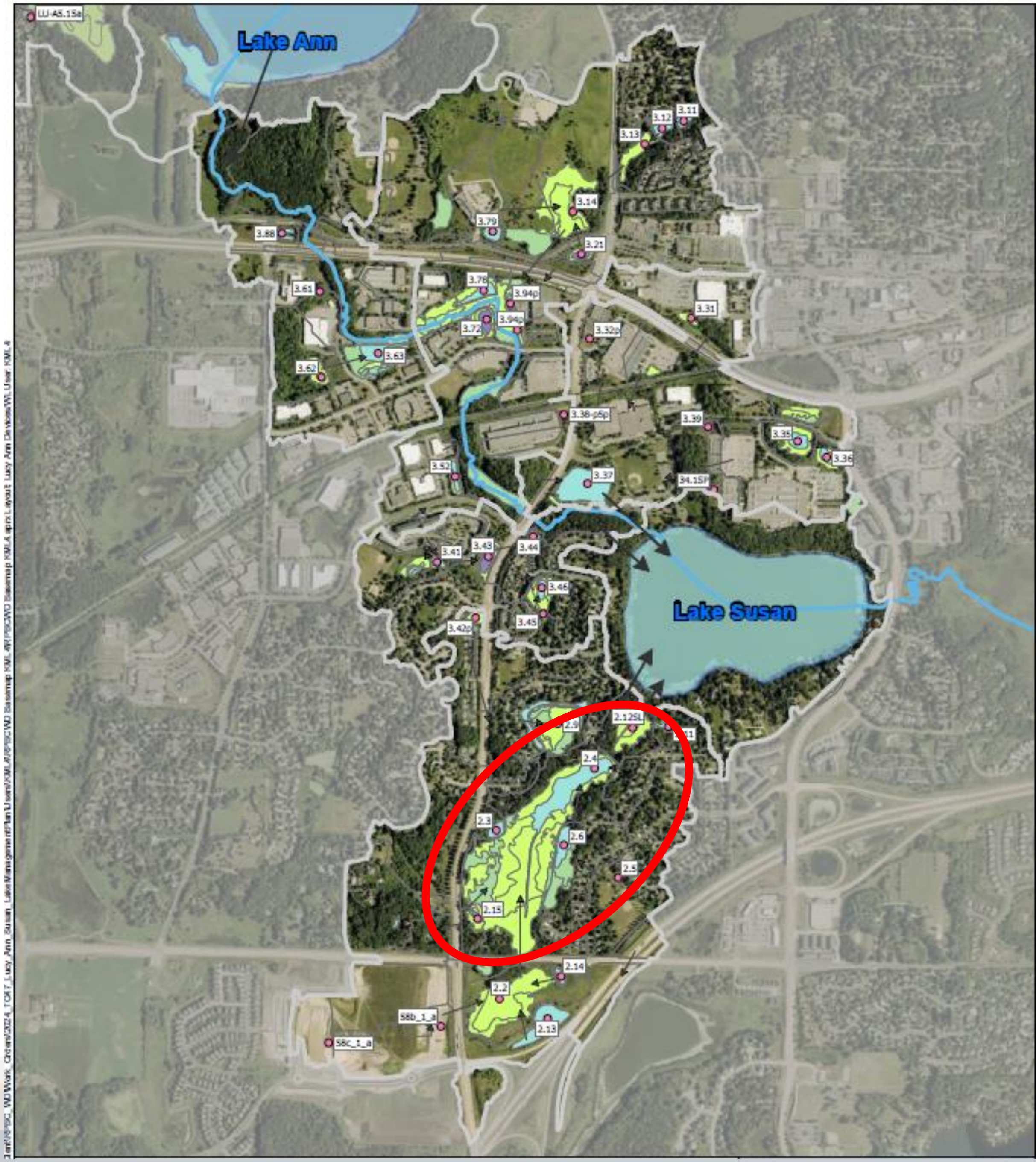
Wetland Restoration

- Identify wetlands with high restoration potential
- Develop Diagnostic and Feasibility Study
- Explore wetland restoration techniques
  - **N and P sequestration**
  - **Flood control**
  - **Biodiversity**



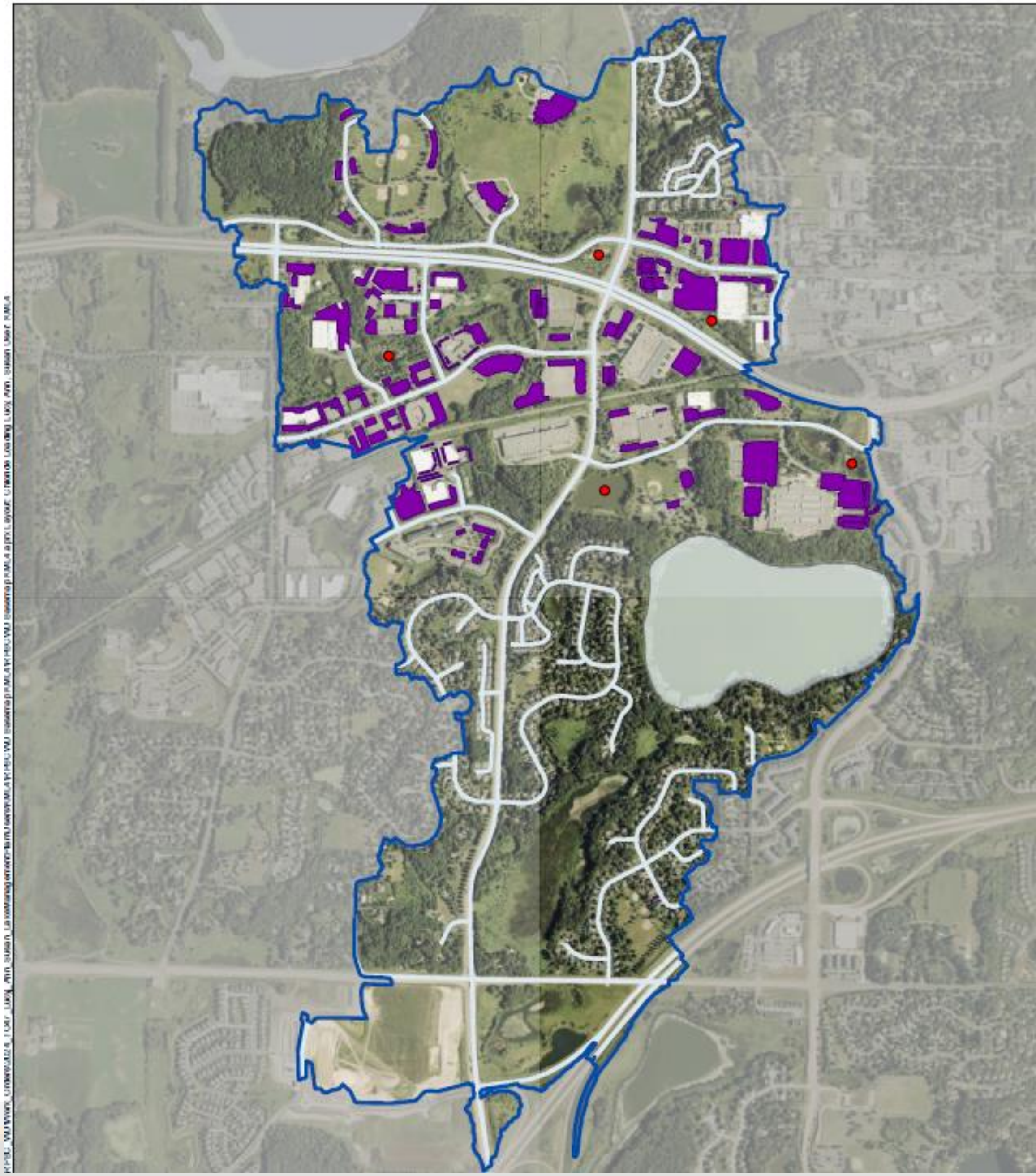
Wetland Restoration





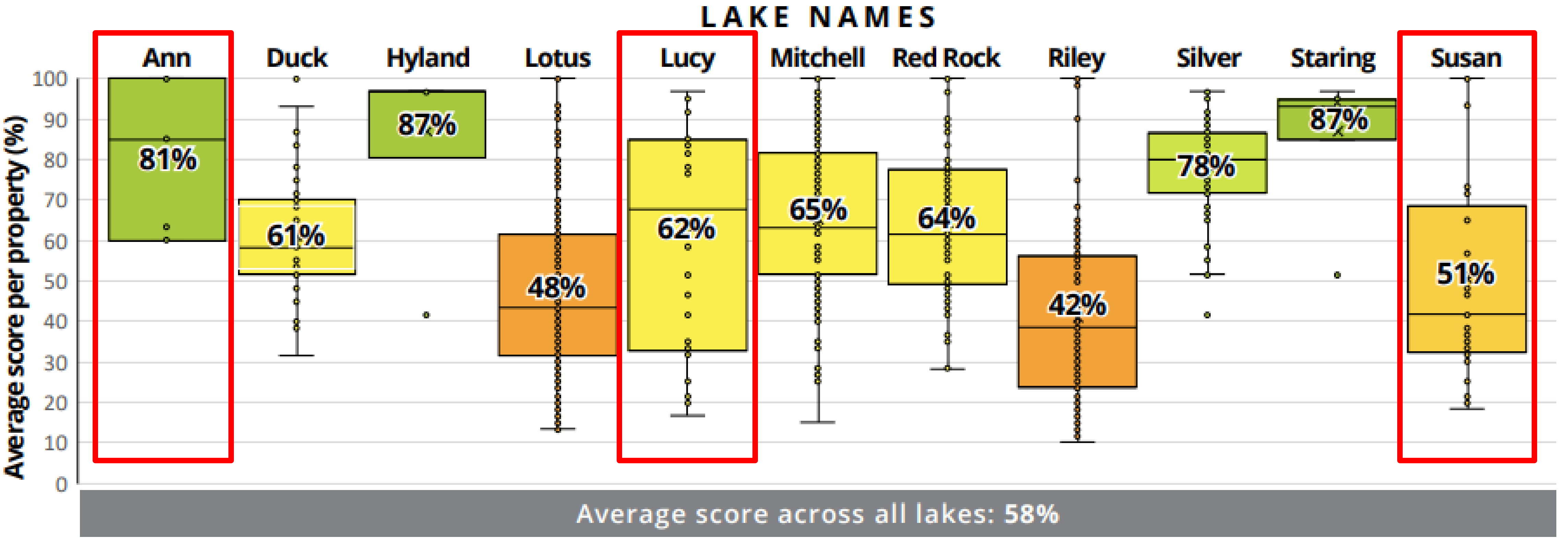
Non-structural Projects

- **Street sweeping model to identify critical areas**
  - Commercial versus roadway
  - Streets with high canopy cover
- **Street sweeping beneficial to long-term pond function for P retention**
- **Policy: considerations in development maintenance agreements**
  - Need to assess loading from commercial parking lots



Shoreland Conditions

Figure 23. Distribution of RPBCWD individual property shoreland scores and overall average property score (unweighted).

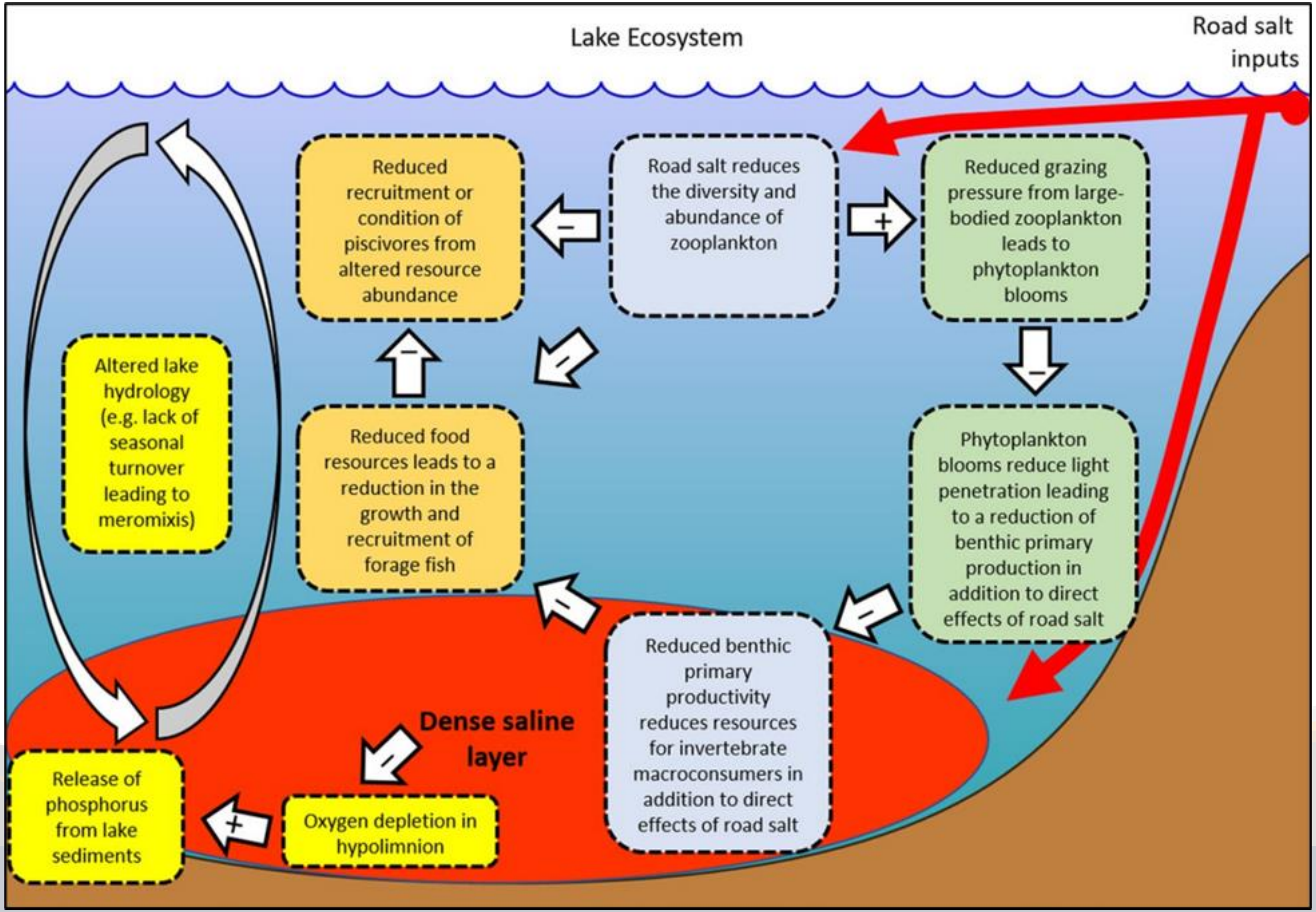


Lake Restoration Summary

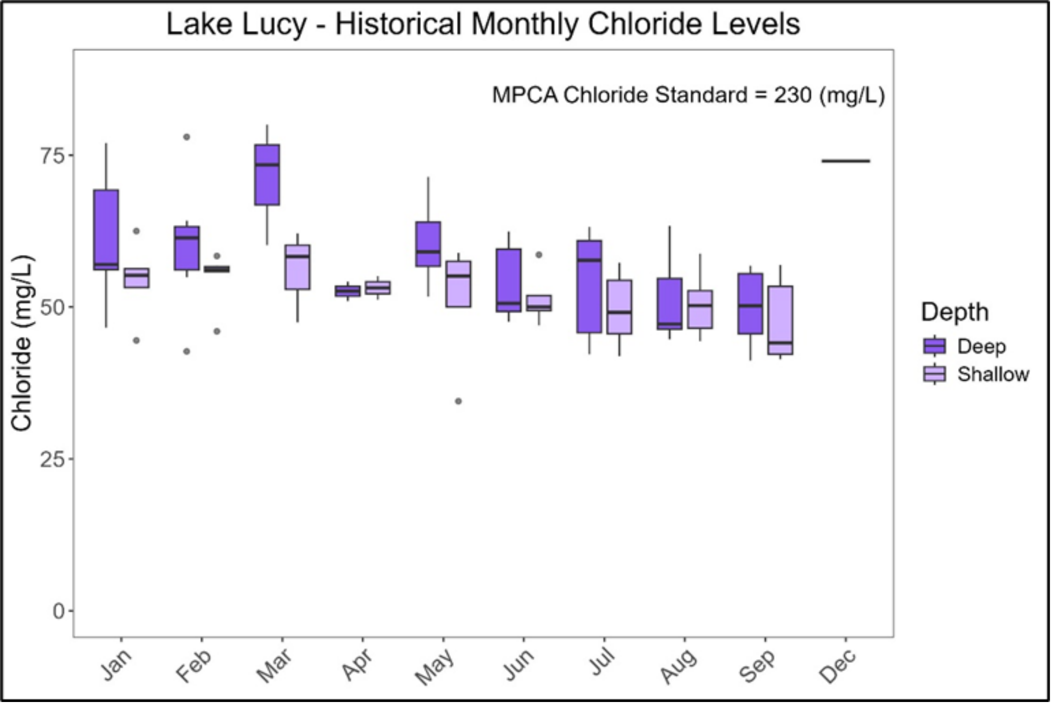
- **Lake are co-limited by P and N**
  - Phosphorus is still the best path for improving water quality and limiting cyanobacteria
  - Requires improved N monitoring to better understand N loading
- **Watershed phosphorus reduction needs are moderate**
    - A few structural projects
    - Pond maintenance to minimize sediment P release
    - Wetland restoration (addresses both N and P)
    - Street sweeping
  - **All 3 lakes demonstrated high internal P loading that is likely driving algal blooms**

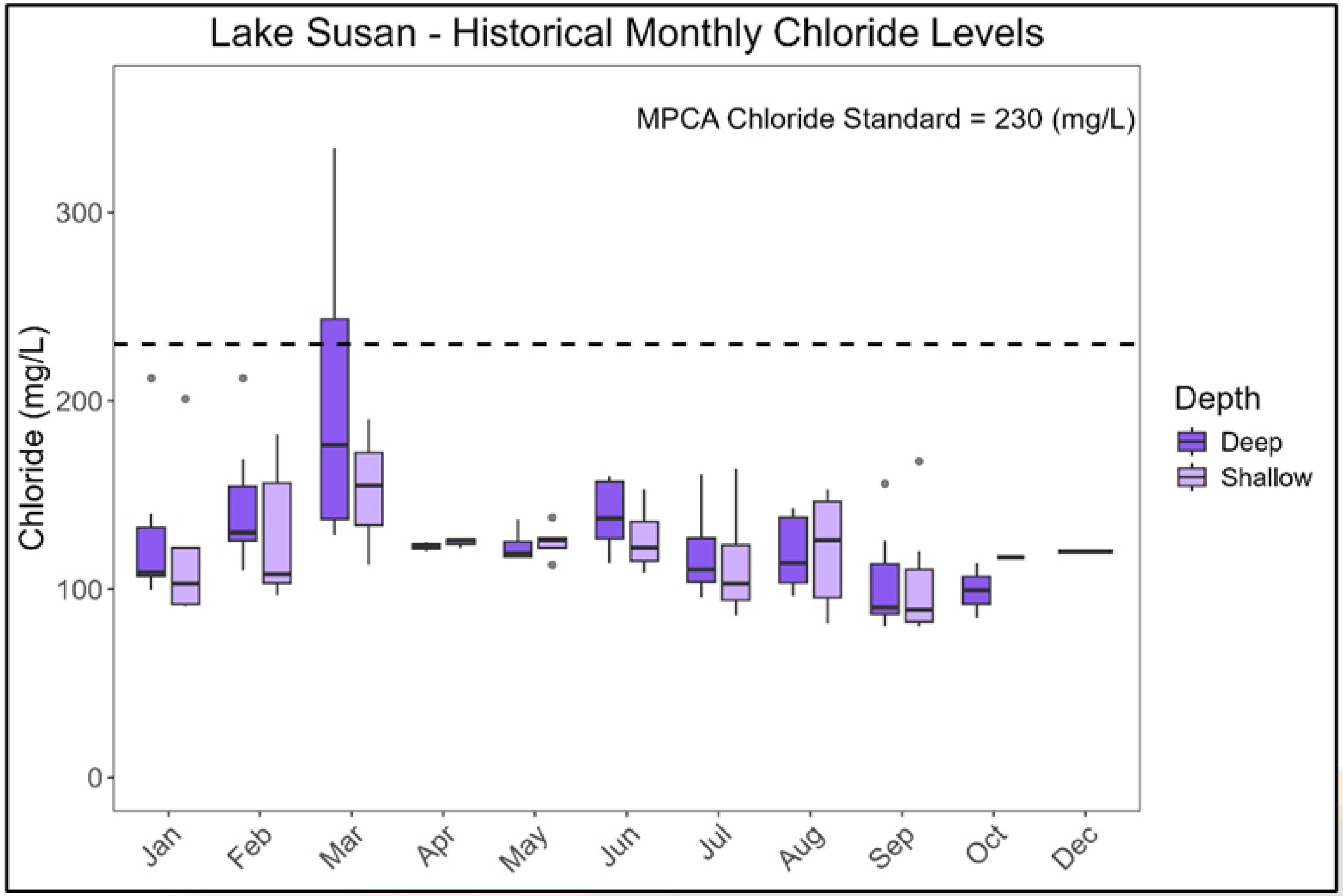
Chloride

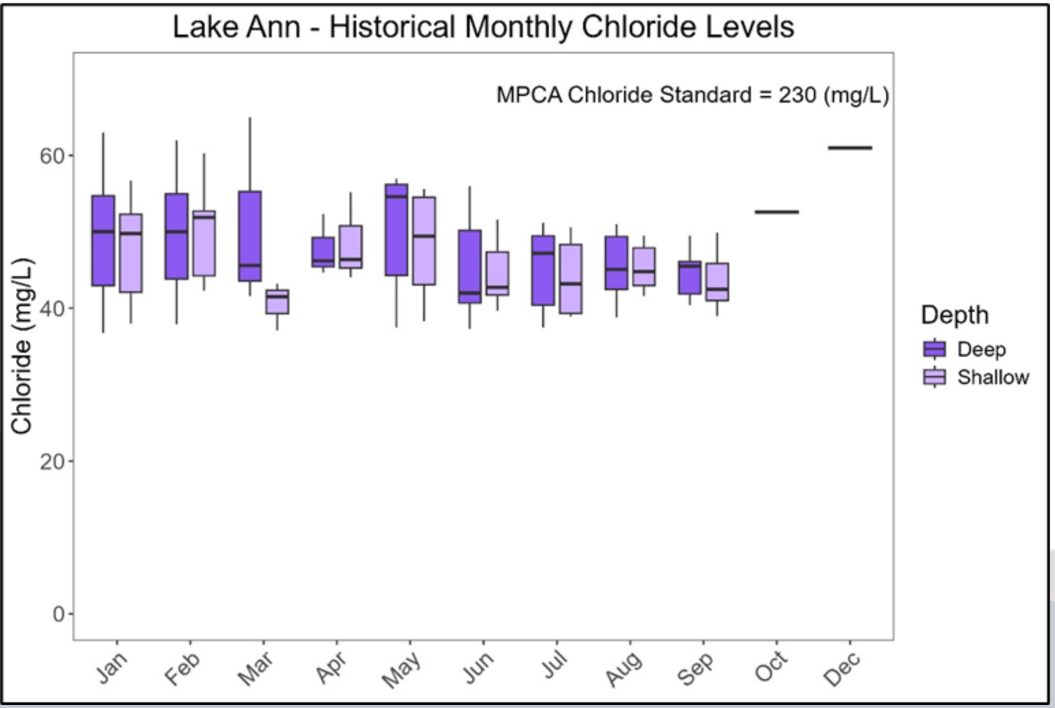
Chloride Impacts to Lakes (and ponds)



Chloride

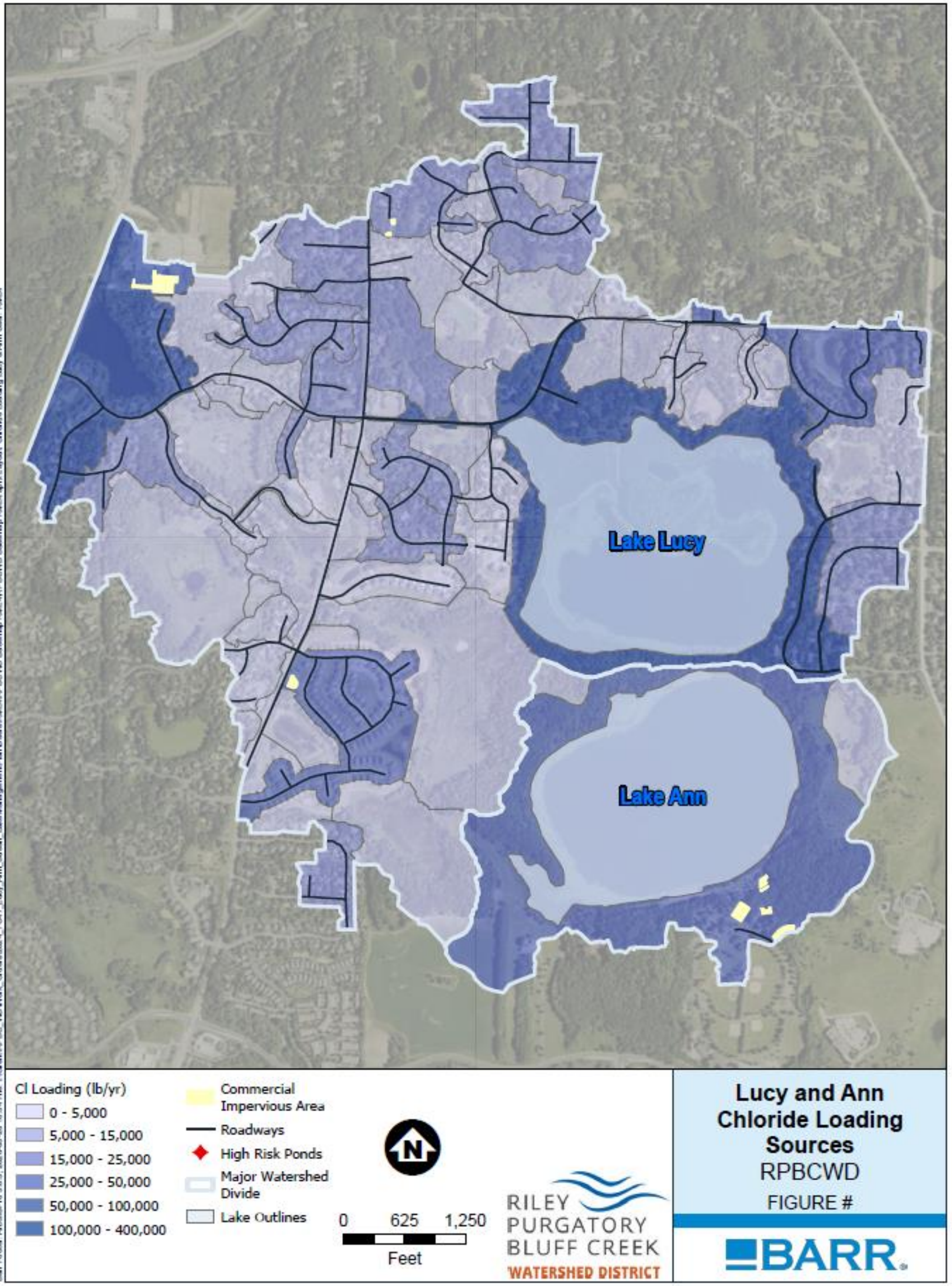

Lake Lucy - Historical Monthly Chloride Levels
MPCA Chloride Standard = 230 (mg/L)
Chloride (mg/L)
75
50
25
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Dec
Depth
Deep
Shallow

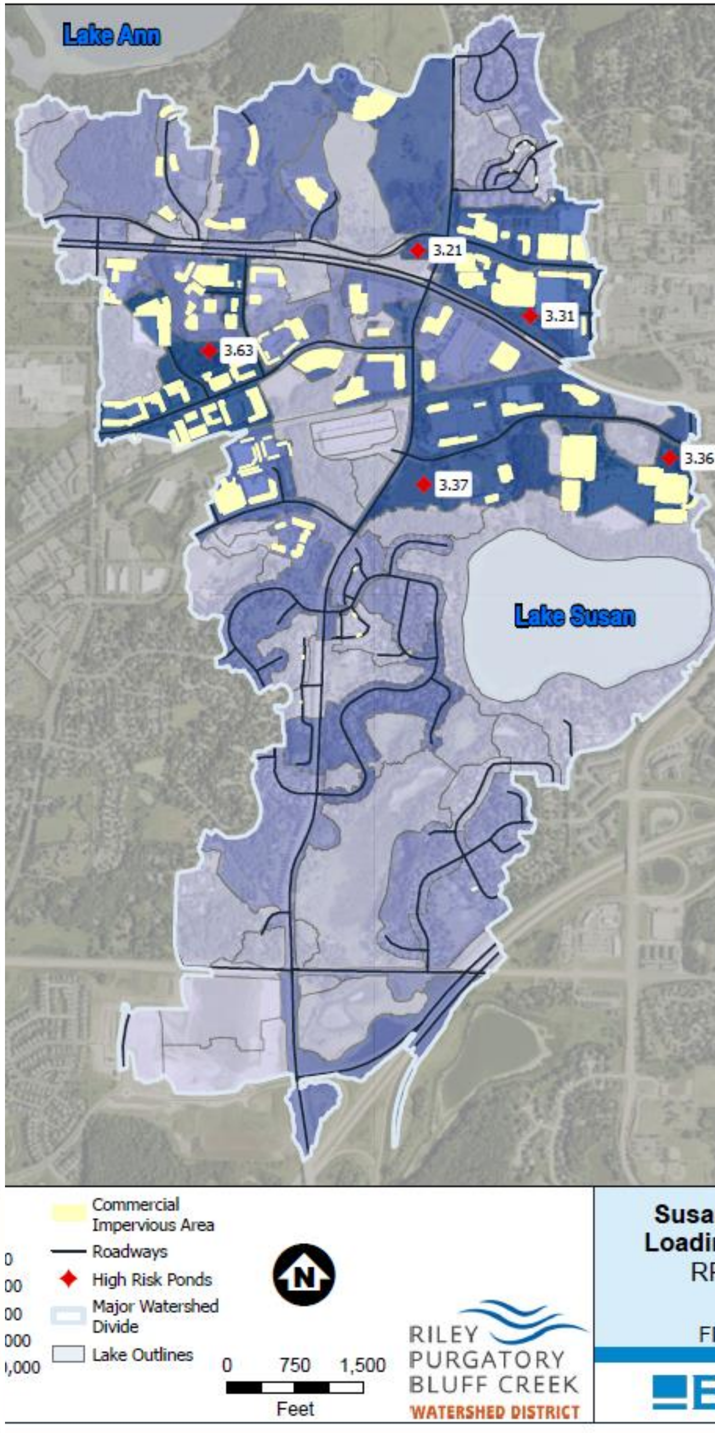

Lake Susan - Historical Monthly Chloride Levels
MPCA Chloride Standard = 230 (mg/L)
Chloride (mg/L)
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Dec
Depth
Deep
Shallow


Lake Ann - Historical Monthly Chloride Levels
MPCA Chloride Standard = 230 (mg/L)
Chloride (mg/L)
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Dec
Depth
Deep
Shallow

Chloride Loading Source	Loading Assumption (lb/ac/yr)
Street Surfaces	10,600
Impervious Surfaces (parking lots)	12,800

Lake	Chloride Loading Sources		Total Cl Loading Estimate (lbs/yr)
	Roadway (ac)	Impervious Area (ac)	
Lucy	22.7	1.4	258,508
Ann	0.1	1.1	15,479
Susan	24.1	61.2	1,038,616





Chloride Summary

- **Lake Lucy and Lake Ann do not demonstrate strong chloride impacts**
  - Elevated when compared to reference conditions but below standard
  - Low road and parking lot impervious density
- **Lake Susan exceeded the standard in spring**
  - High parking lot density in watershed
- **Ponds in the watershed are likely impacted by road/parking lot salt**
  - High risk ponds were identified using loading

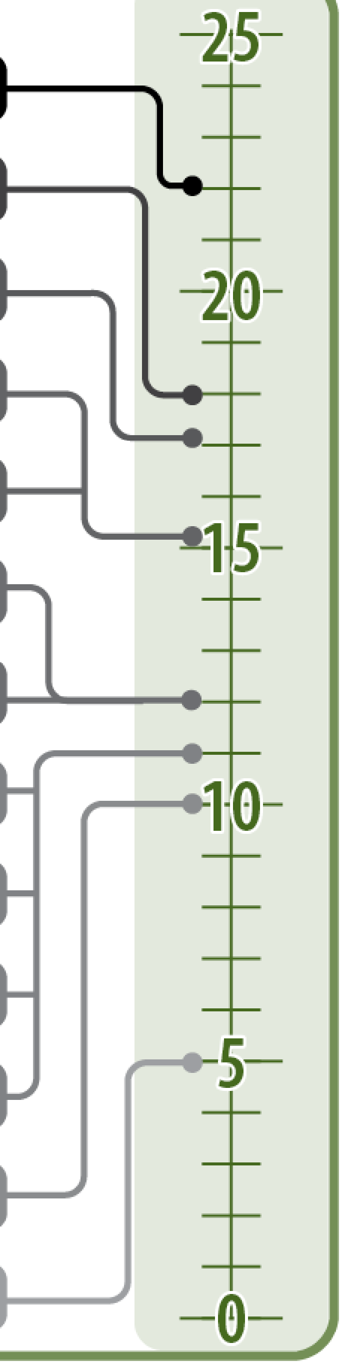
Aquatic Plants

Aquatic Plants

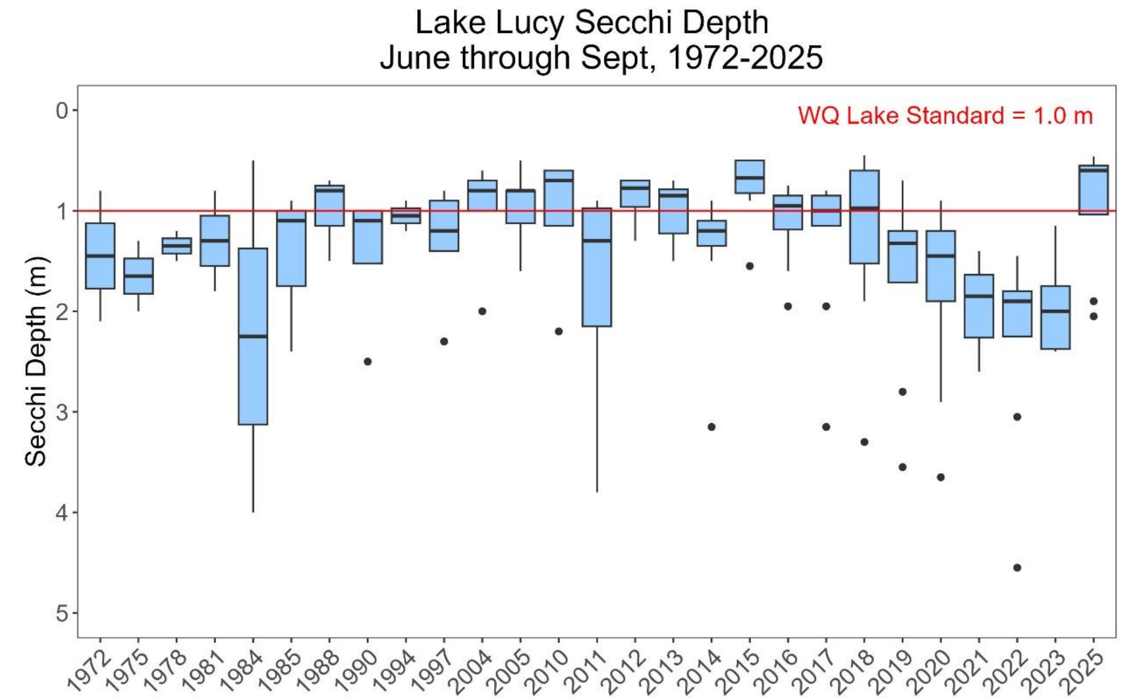
Native Aquatic Plant Diversity

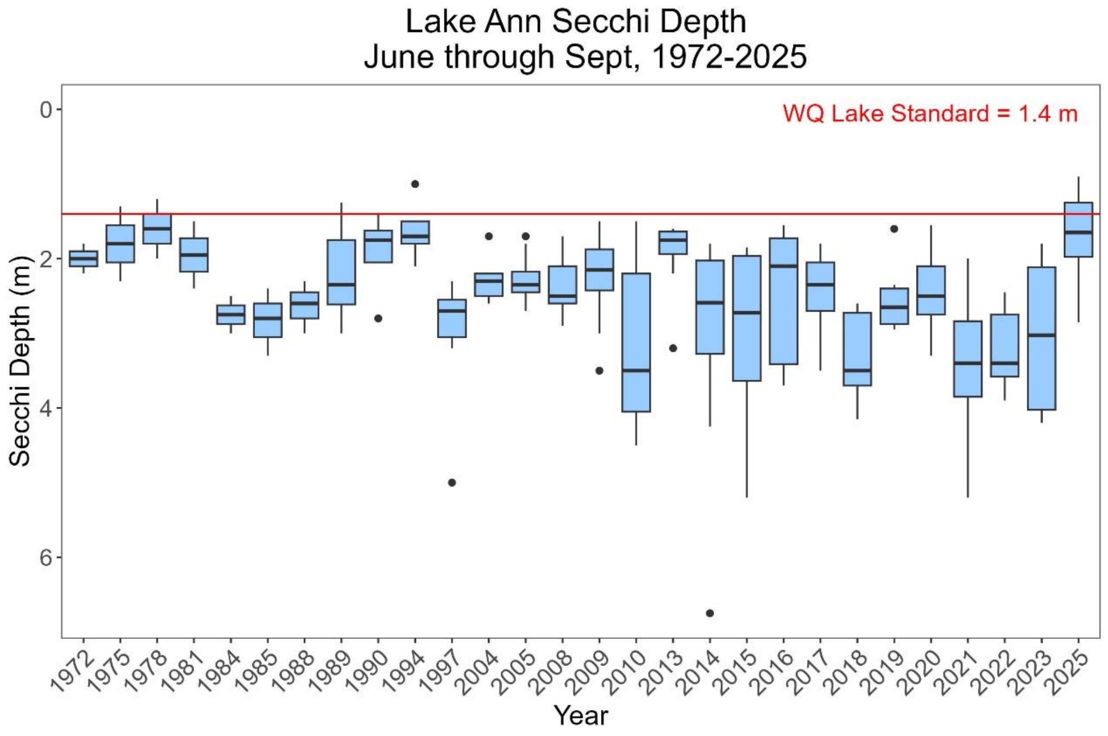
How do district lakes compare to each others in the number of native aquatic plant species?

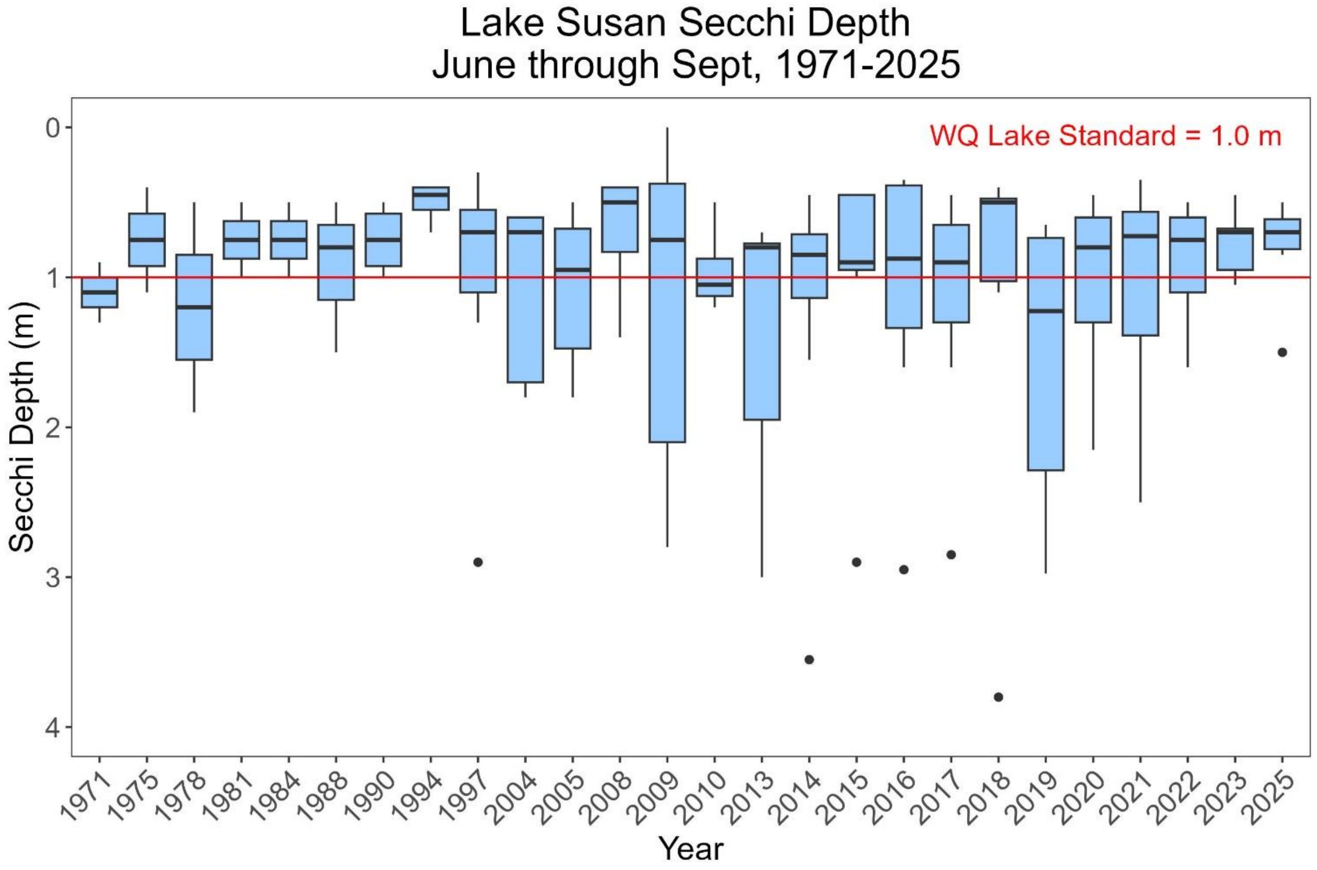
LAKE	SPECIES
Ann	22
Duck	18
Lucy	15
Red Rock	14
Silver	14
Hyland	12
Round	12
Lotus	11
Mitchell	11
Riley	11
Susan	11
Rice Marsh	10
Staring	6



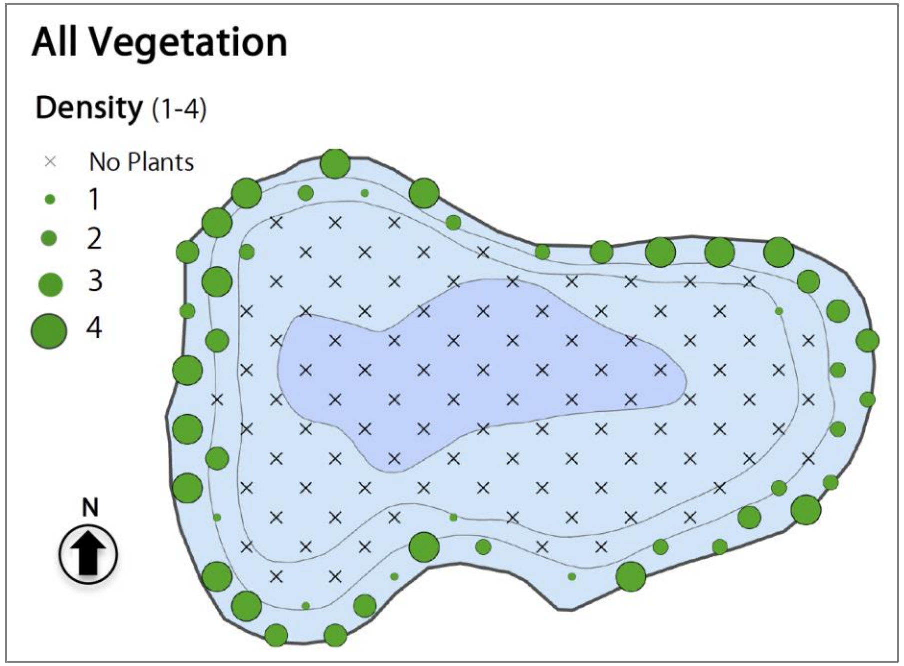
Secchi Depth

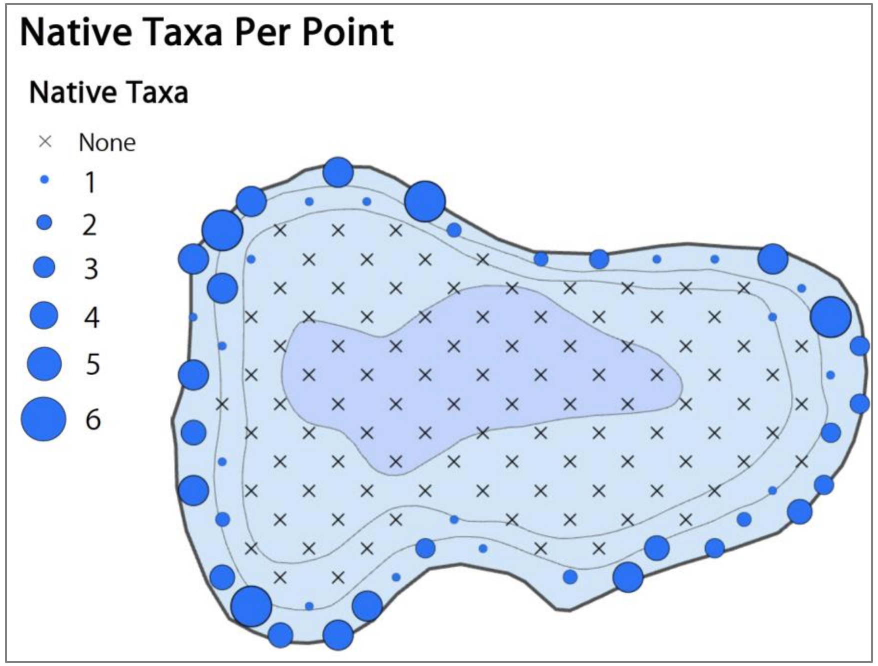


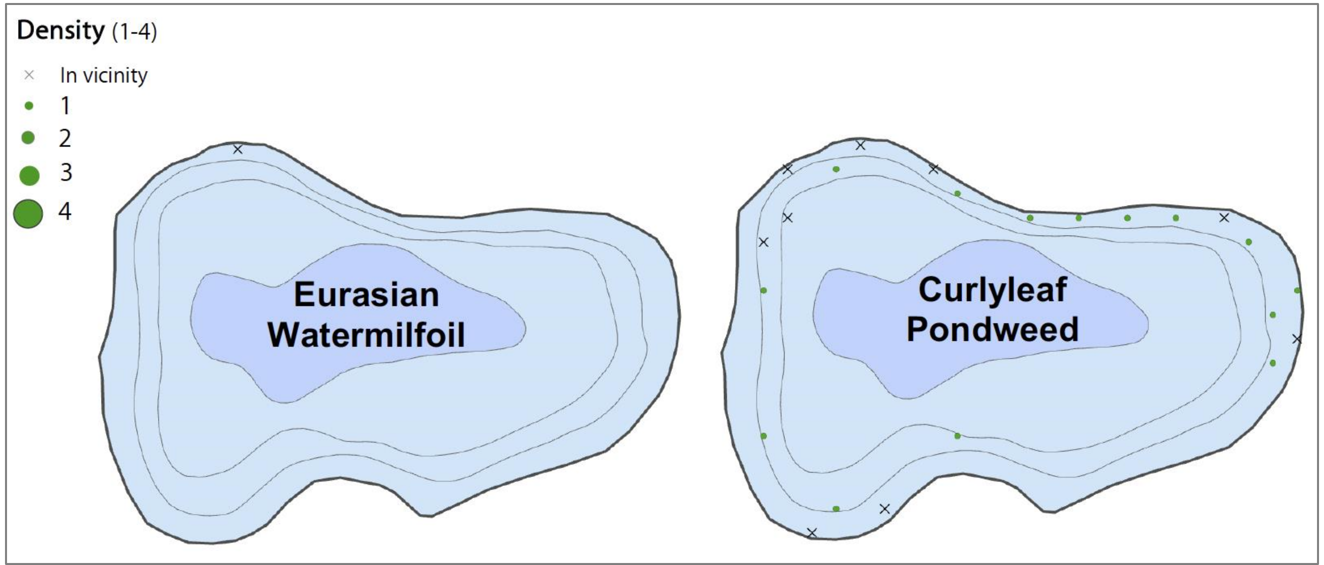




Aquatic Plants – Lake Susan







Source: 2024 point-intercept survey

Next Steps

- Public meetings
  - May 21 – Chan City Hall
  - May 28 - EP Community Center
- Draft plans (late June) with focus group meetings to follow
- Final plans (end of year)

rpbcwd.org/EHAP

Ecosystem Health Action Plan

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RILEY PURGATORY BLUFF CREEK
WATERSHED DISTRICT

rpbcwd.org/systems-approach

- Submit a comment
- Learn more about the project