RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

A Systems Approach to Watershed & Lake Management

Mitchell Lake & Red Rock Lake Watersheds

May 28, 2026

Presenters

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

BARR

Liz Forbes
Deputy Administrator

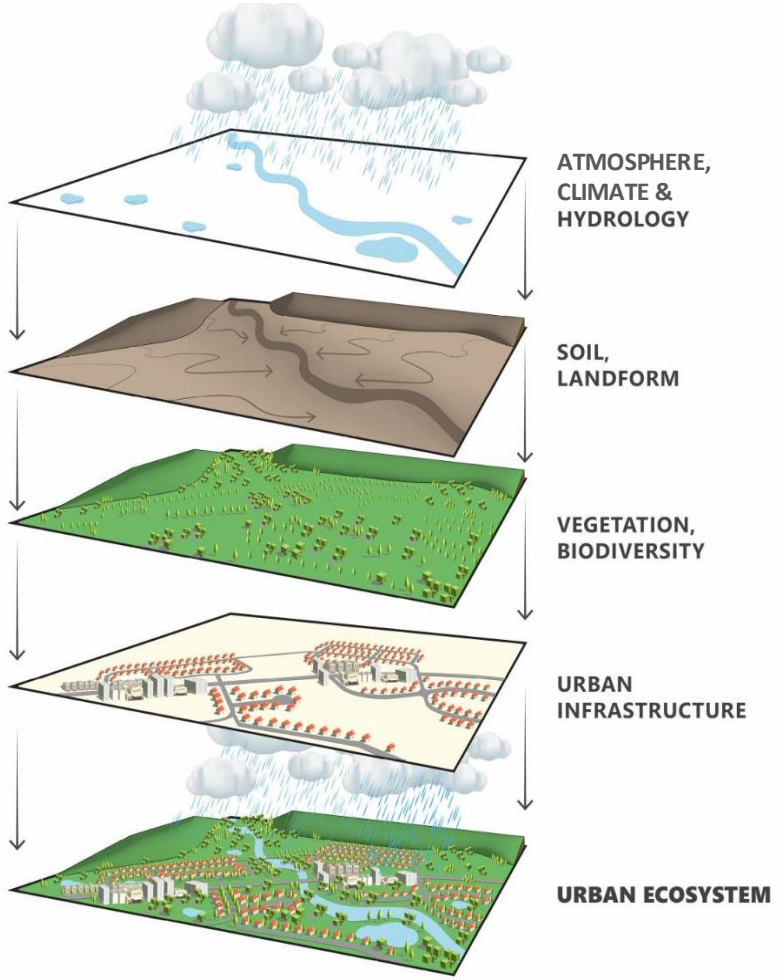
Joe Bischoff
Senior Aquatic Ecologist

Dylan Monahan
Watershed Planner

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

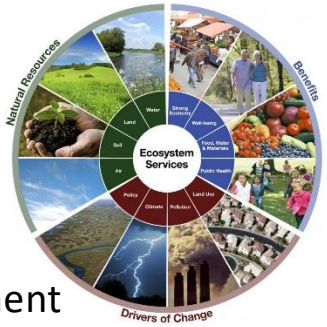
Identifies watershed issues

Sets goals & strategies for the next 10 years

Identifies process for project prioritization

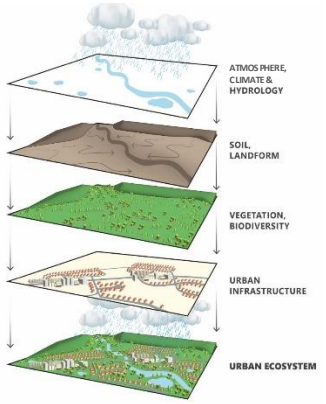
Ecosystem Health Action Plan (EHAP)

- 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

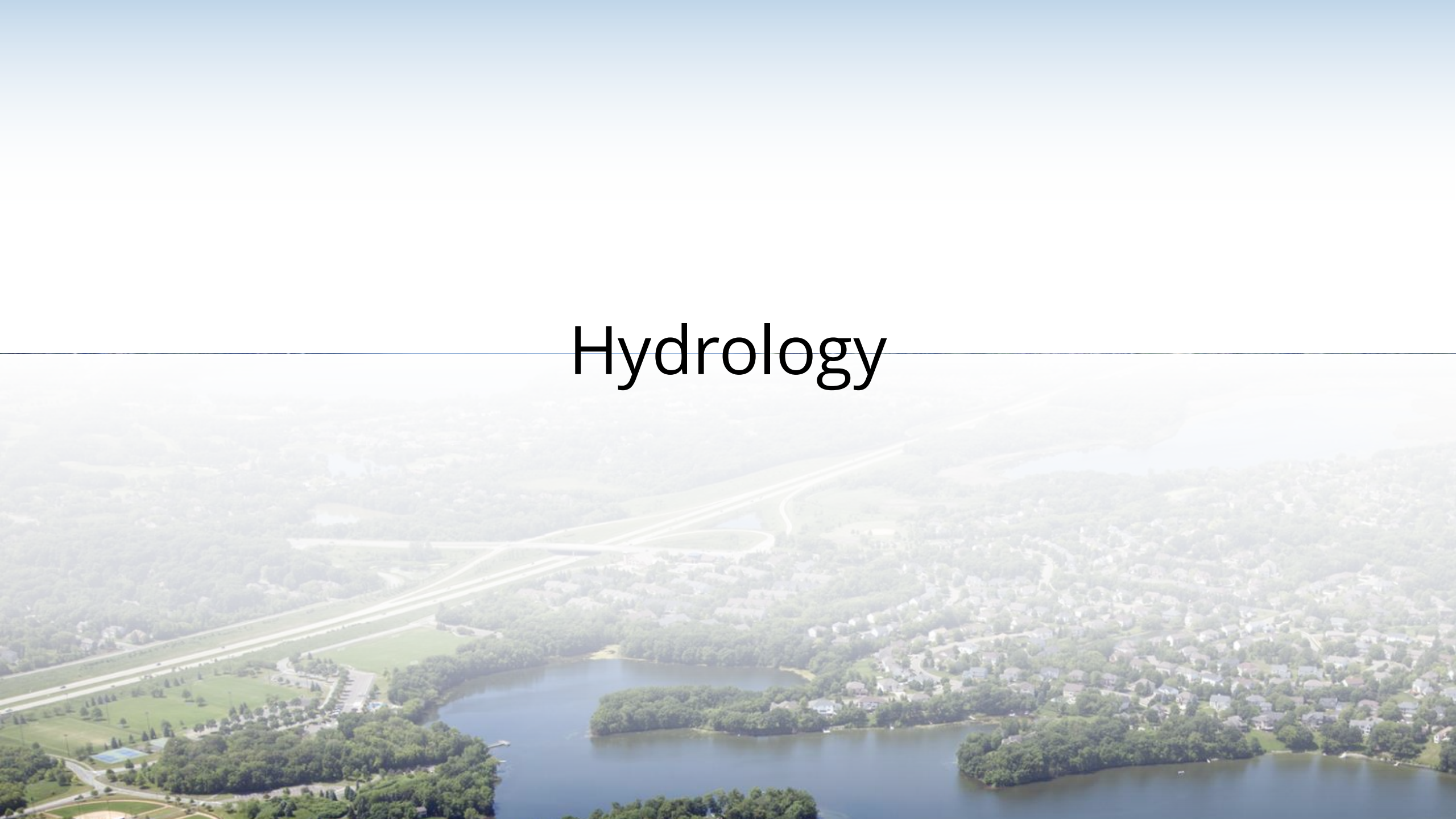
- Nutrient Cycling
  - Nitrogen and Phosphorus
- Flood Storage
- Biodiversity
- Recreation

Lake and Watershed Stressors

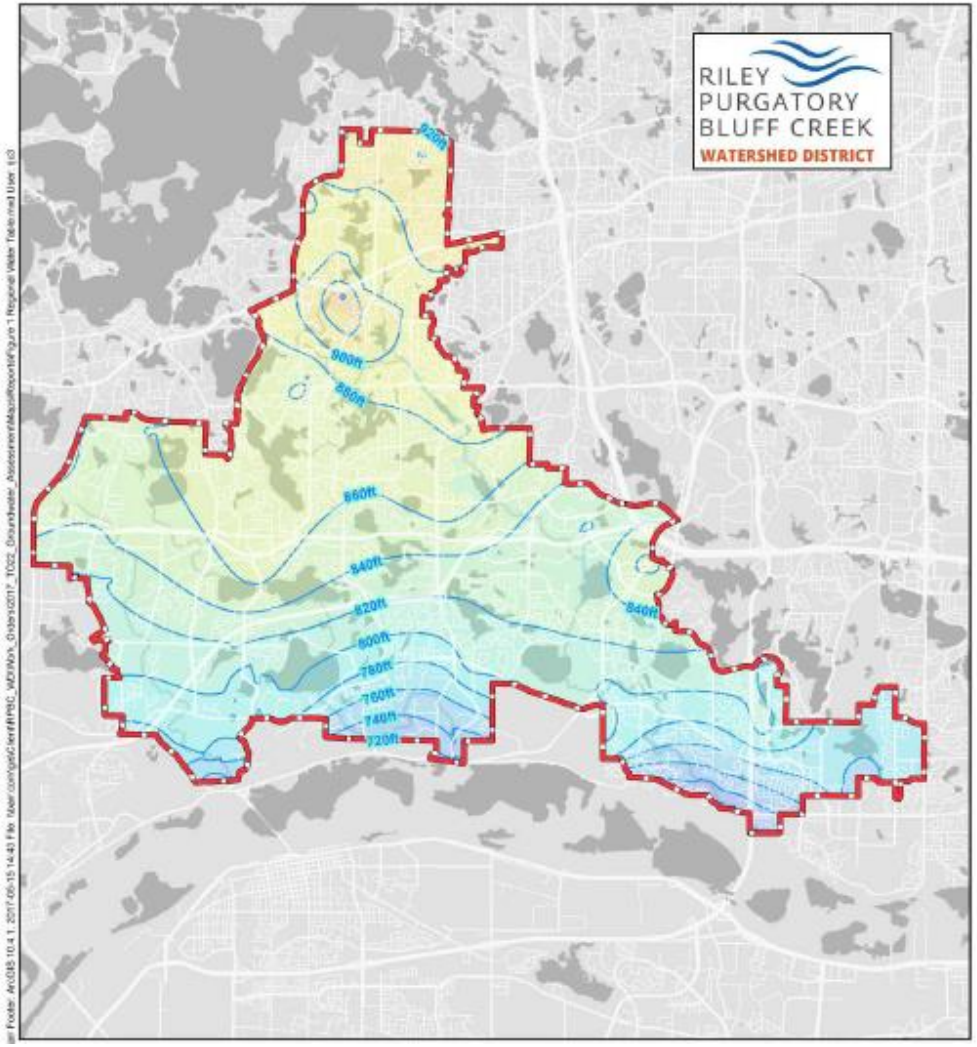
Impervious surfaces/loss of green space/soil health and compaction

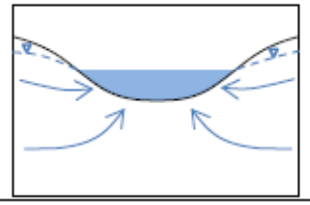
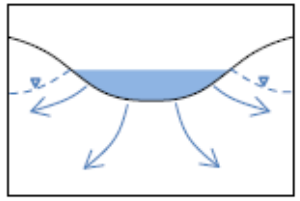
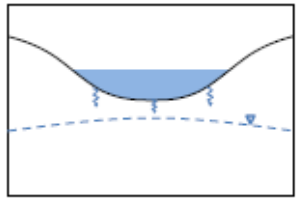
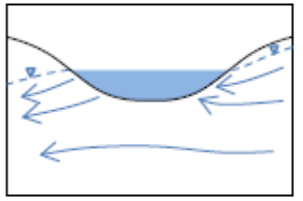
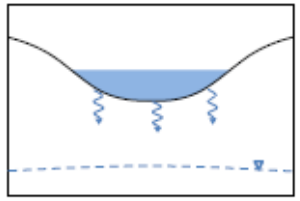
- Excess nutrients (nitrogen and phosphorus)
- Toxic contaminants (chloride)
- Unnatural hydrology and flooding
- Pipe and ditch conveyance

Hydrology

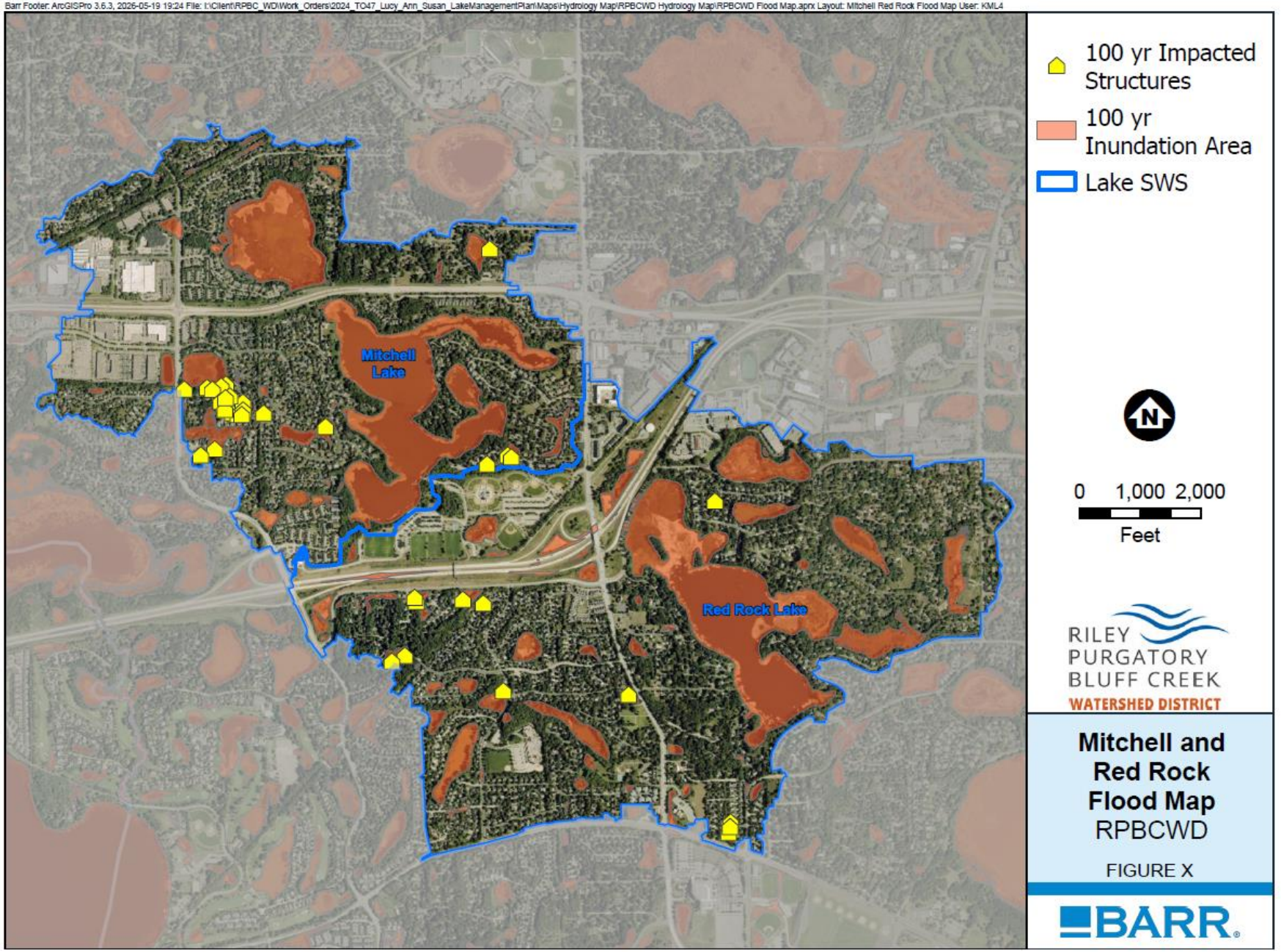


RPBCWD Regional Groundwater Study

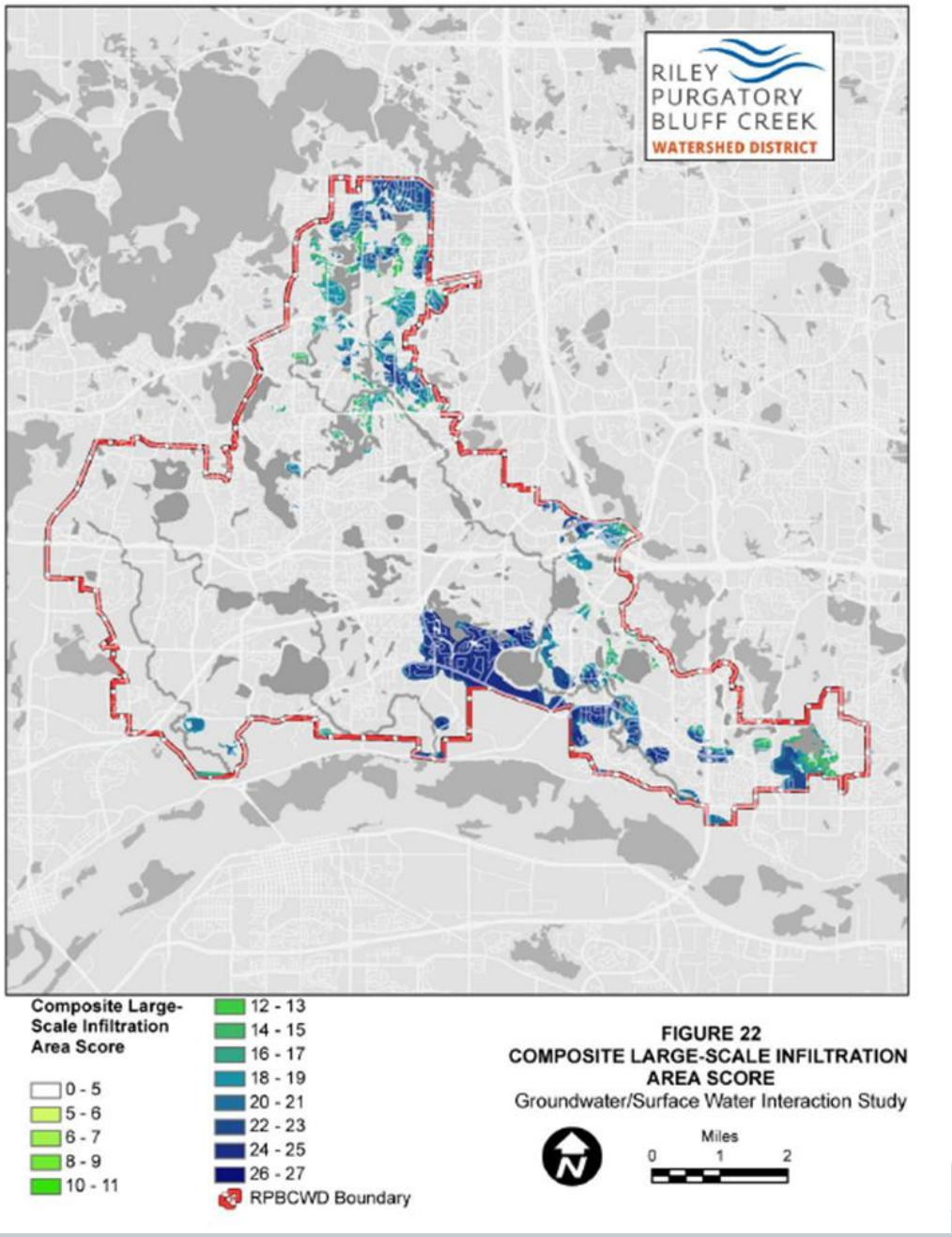


Type	Description		Qualifiers
Discharge lake/wetland	Mostly receives groundwater inflow		Connected to groundwater, surface water elevation below regional groundwater table
Recharge lake/wetland or Indeterminate	Connected to groundwater. Mostly loses water as seepage to groundwater		Groundwater connection 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



Mitchell Lake

- Recharge lake that are not overly vulnerable to groundwater changes

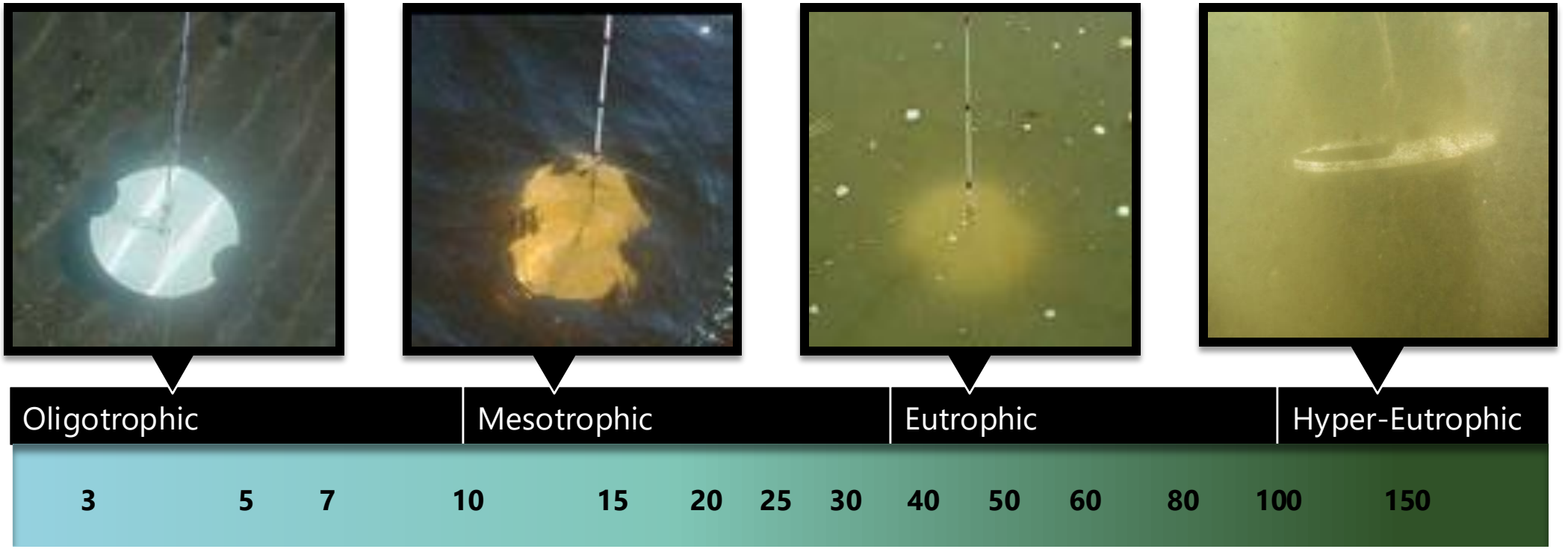
Red Rock Lake

- Recharge lake vulnerable to changes in groundwater table
- Chloride likely driven by surface water runoff but vulnerable to groundwater
- High infiltration potential in southwest watershed

Eutrophication

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

Algal growth (water clarity)



Total Phosphorus (µg/L)

Photos: Minnesota Pollution Control Agency

Nitrogen

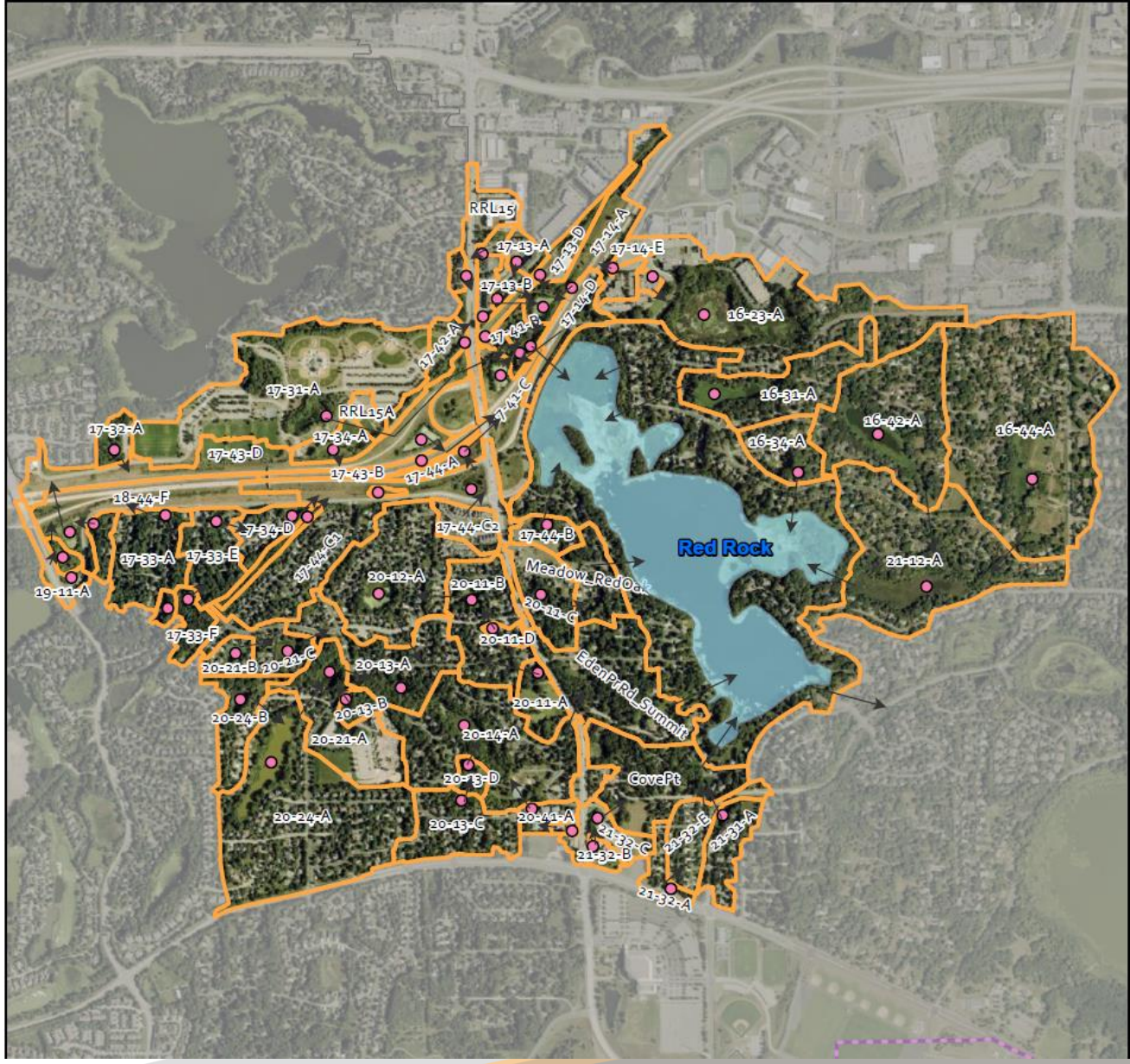
Nitrogen Species	Chemical Formula	Bioavailability	Role in Lake Algae Blooms
Ammonium	NH_4^+	Highest	Fuel source. Algae absorb it instantly without expending energy, triggering rapid bloom growth.
Dissolved Organic Nitrogen	DON	High	Selectively fuels non-fixing, toxic species like *Microcystis*. Enters 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.

Mitchell Lake

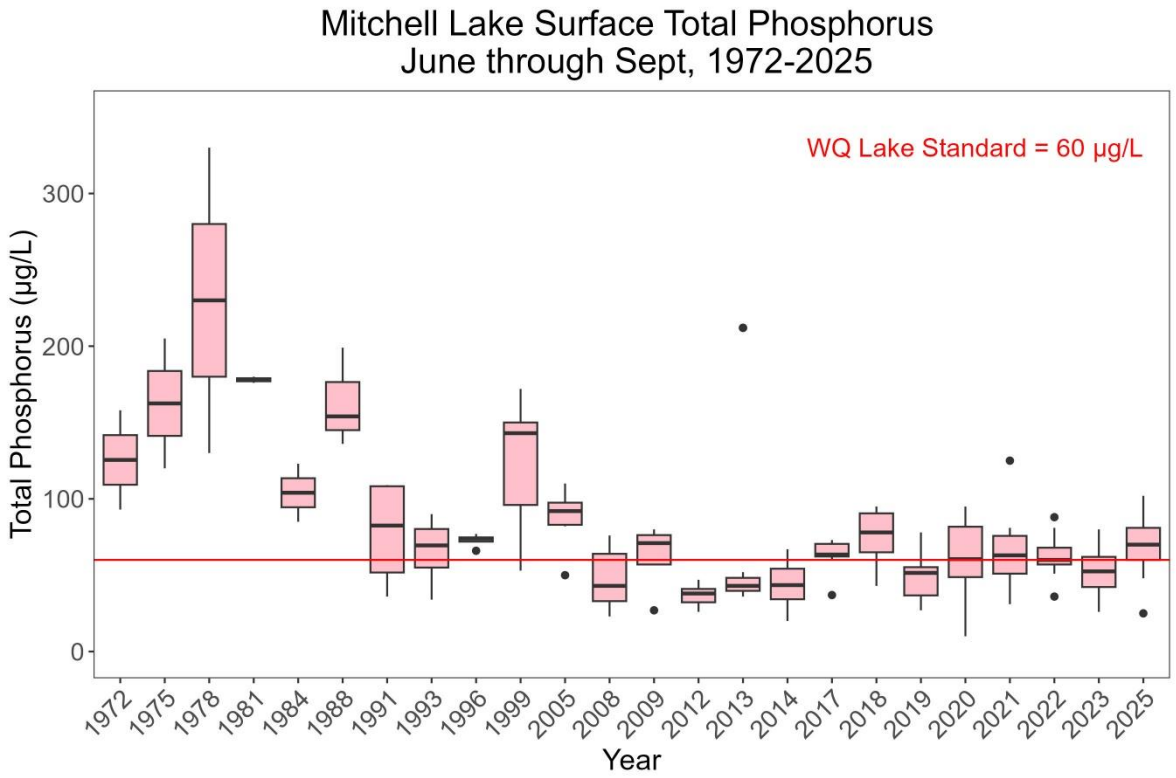
Lake Characteristic	Mitchell Lake
Surface Area (acres)	124
Average Depth (ft)	5.3
Maximum Depth (ft)	19
Littoral Area (ac)	109
Watershed Area (ac)	1,412
Direct Watershed Area (ac)	937
DNR Classification	Natural Environment

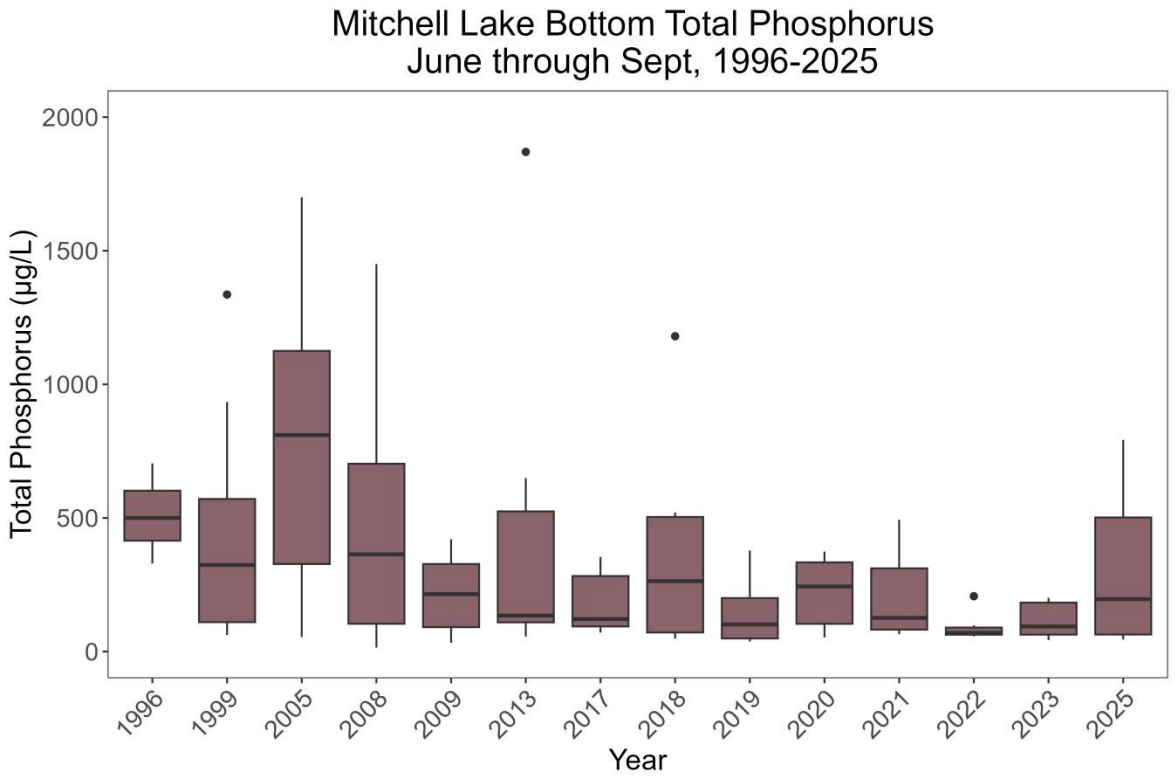
Red Rock Lake

Lake Characteristic	Red Rock Lake
Surface Area (acres)	121
Average Depth (ft)	4.7
Maximum Depth (ft)	19
Littoral Area (ac)	119
Watershed Area (ac)	2,698
Direct Watershed Area (ac)	1,286



Mitchell Lake Total Phosphorus





Physical Characteristics of Lakes

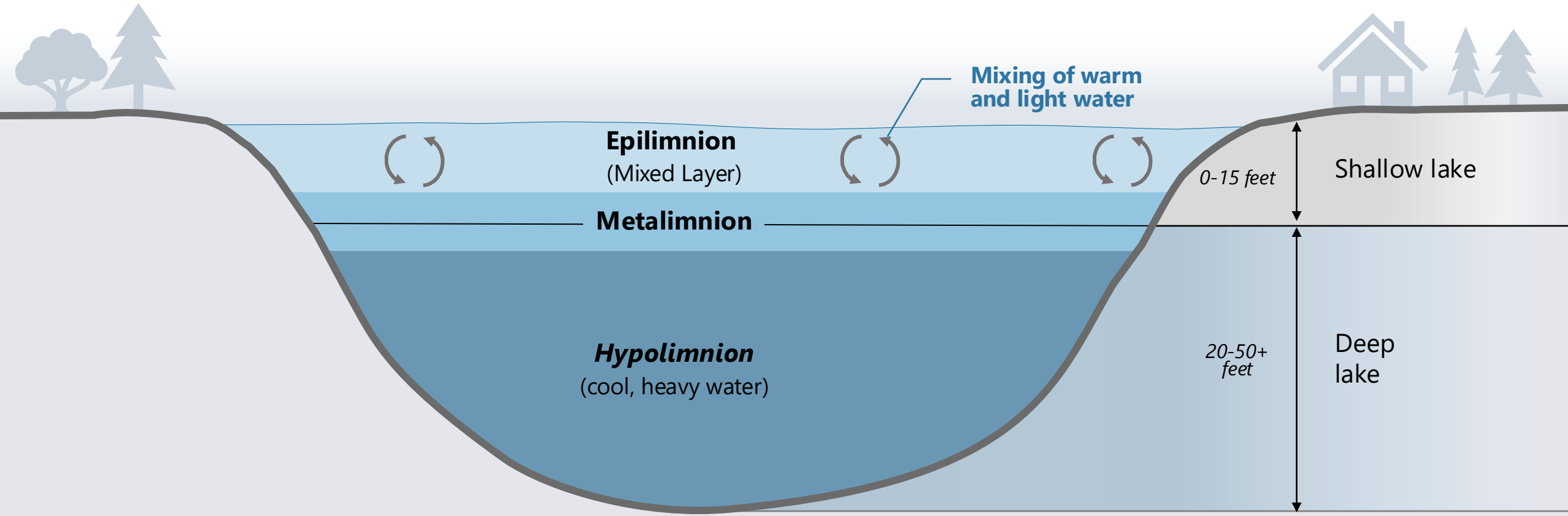
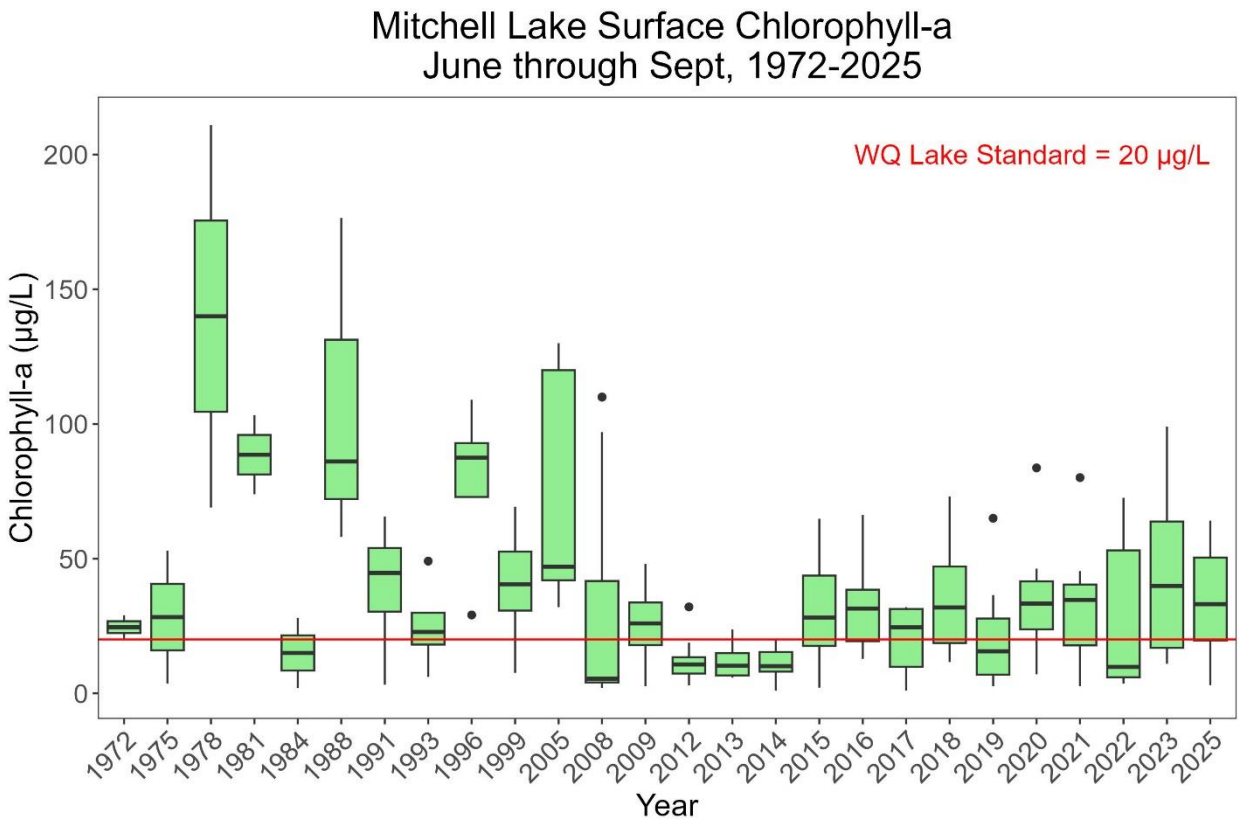
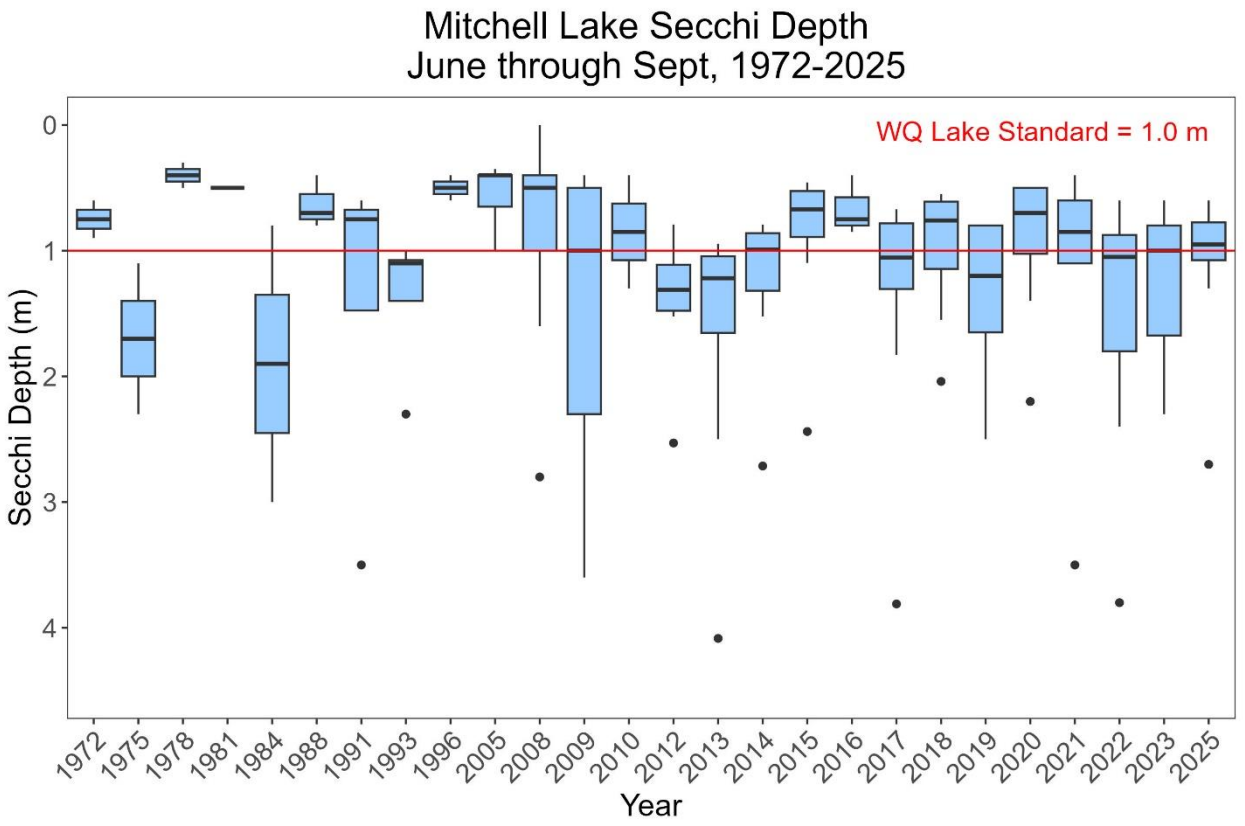


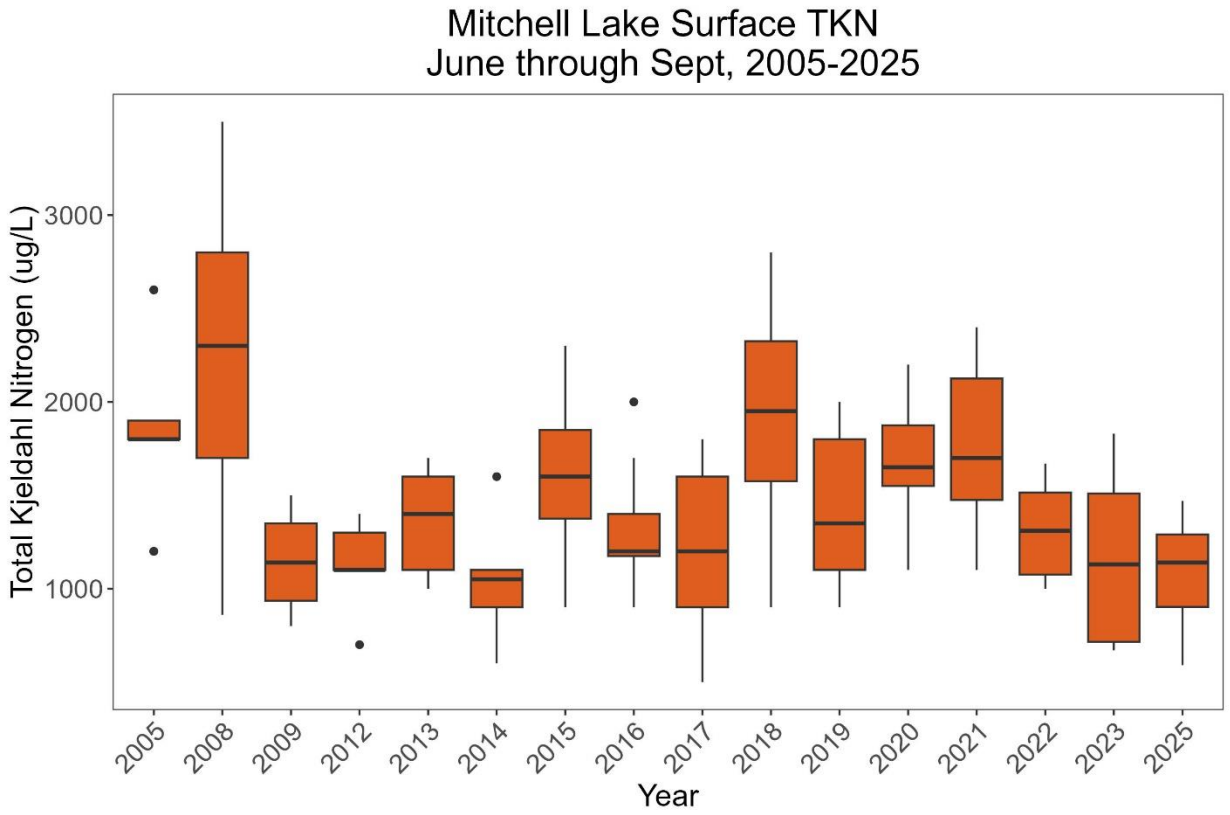
Diagram not to scale

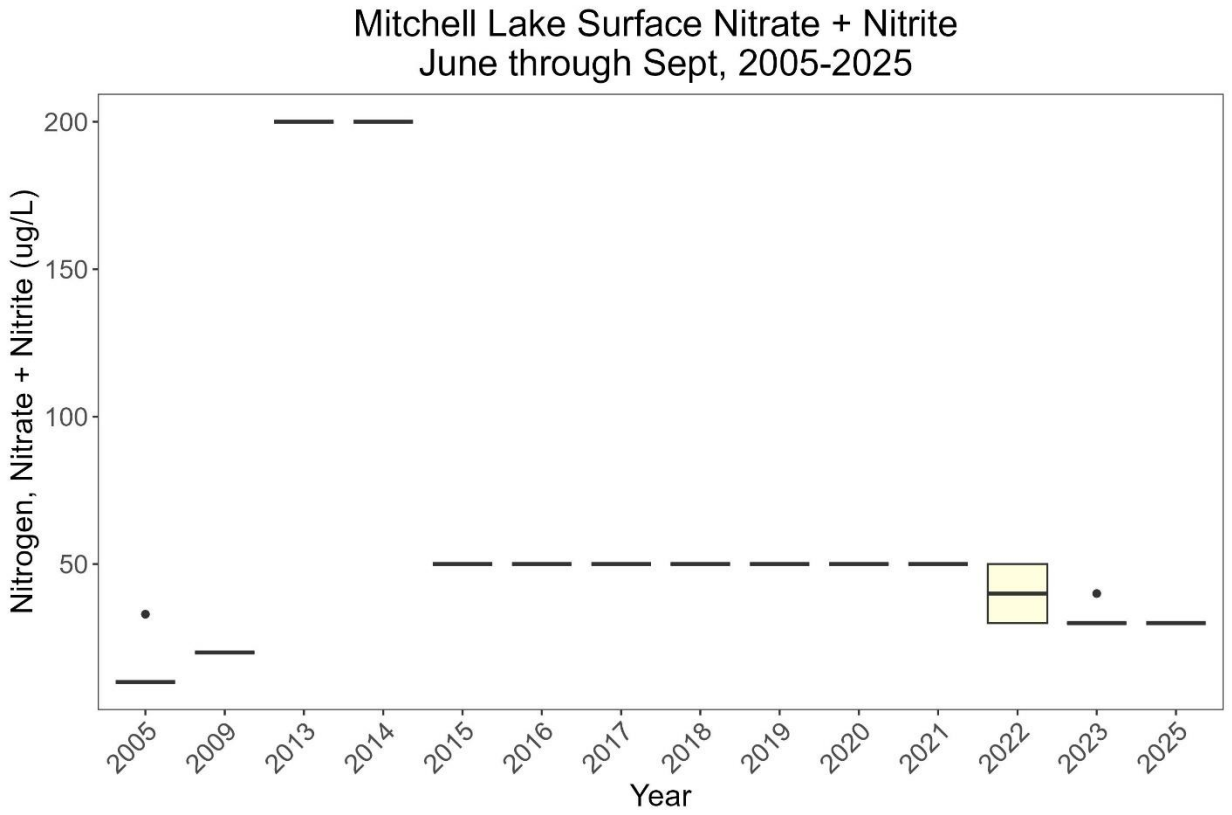
Mitchell Lake Chlorophyll-a and Secchi





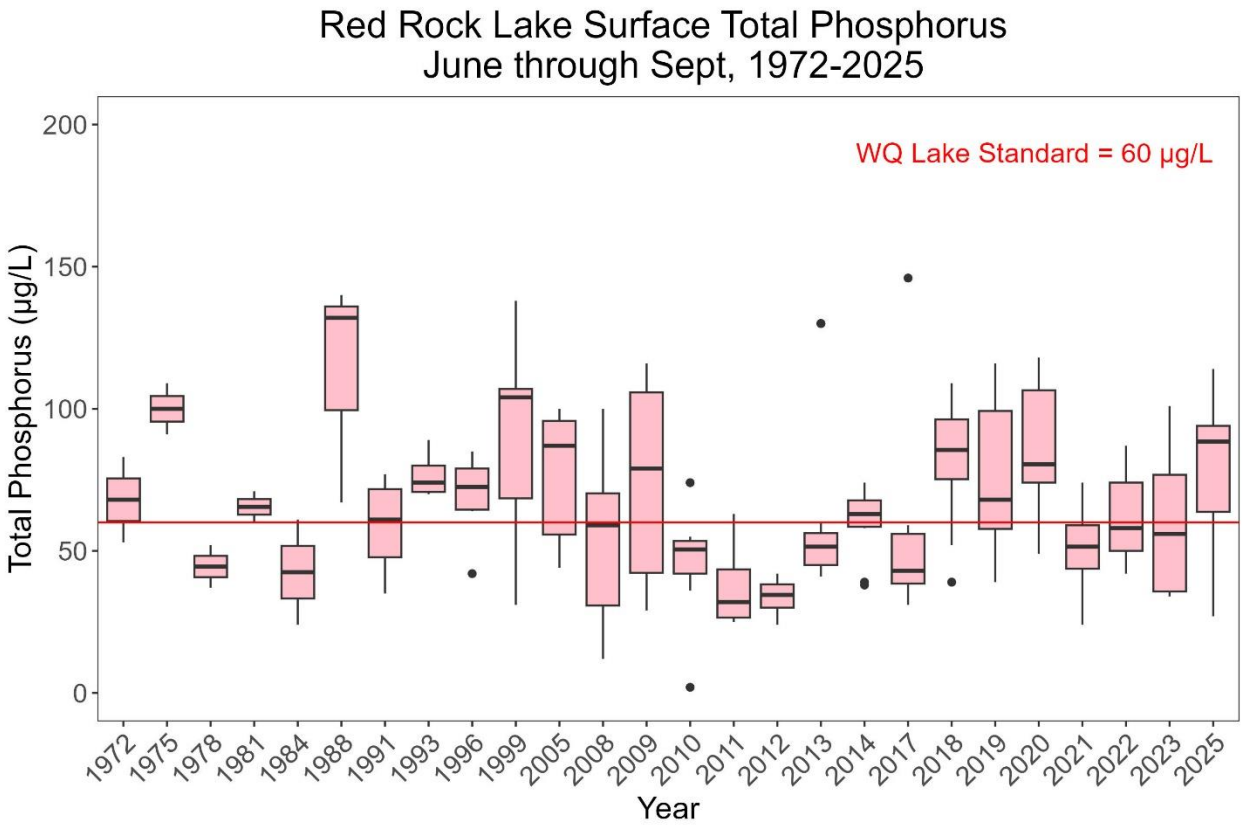
Mitchell Lake Nitrogen

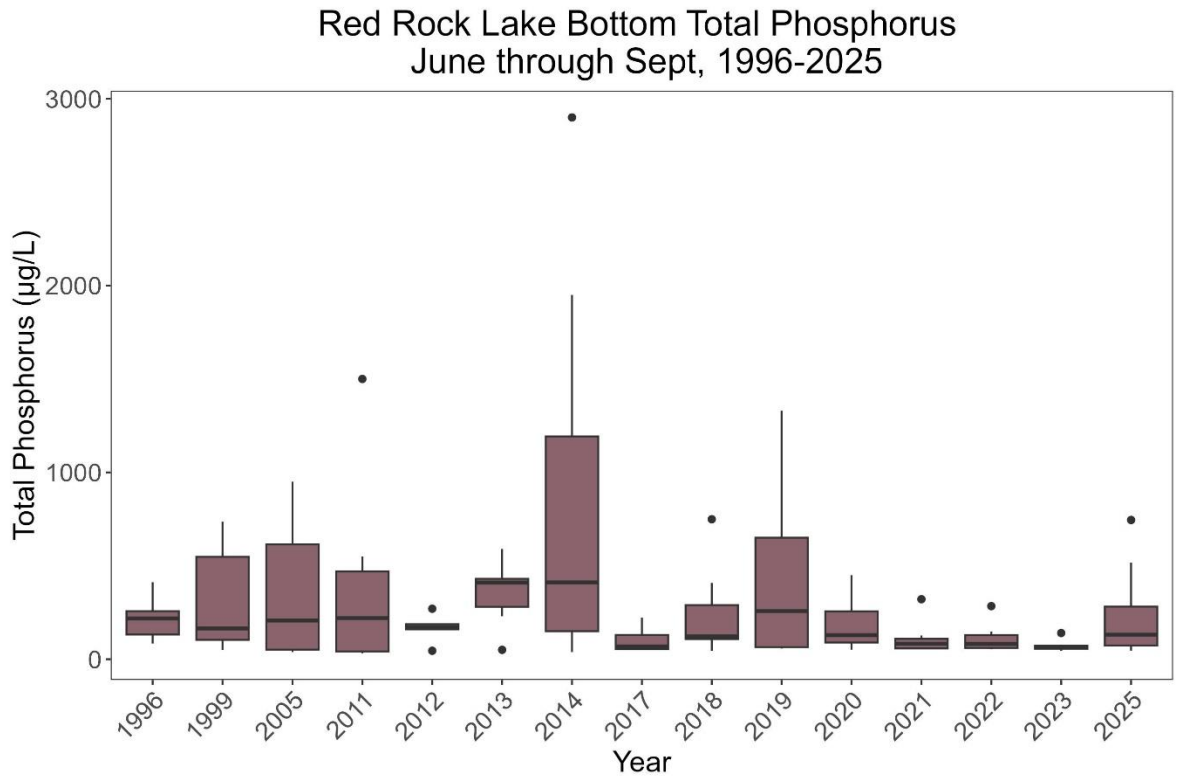




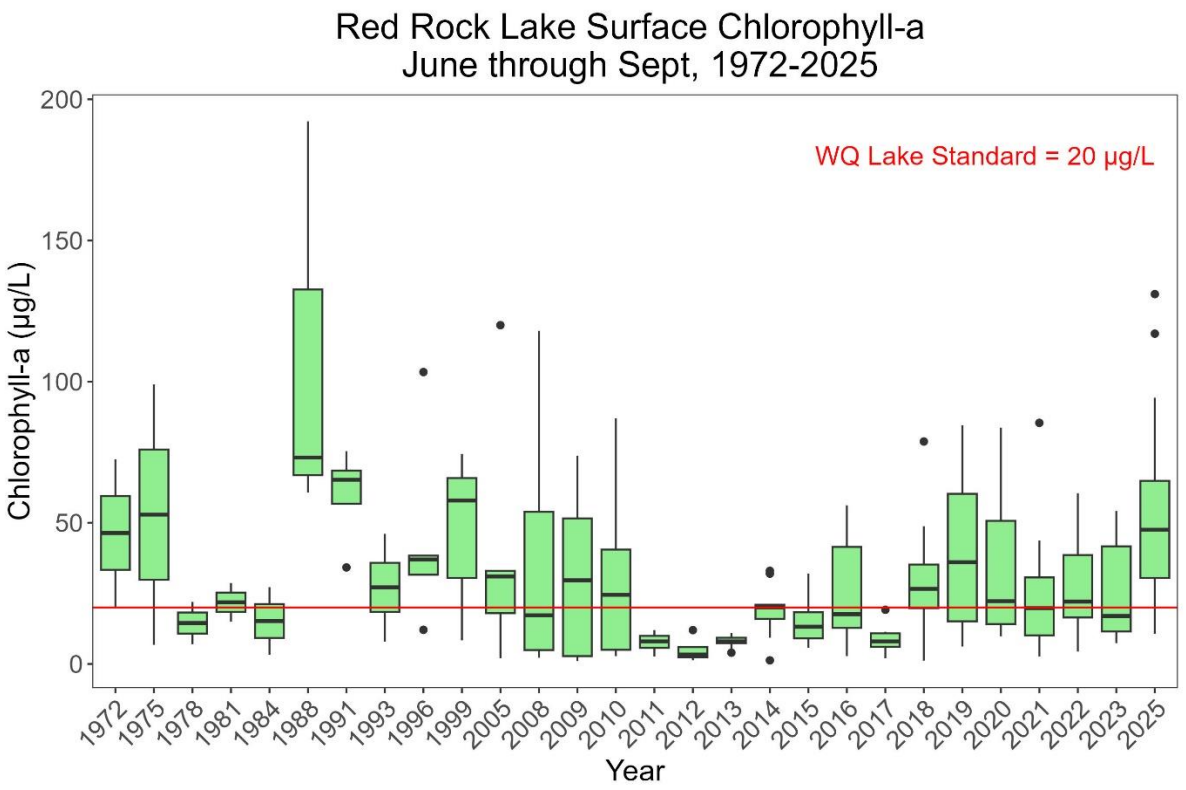
NCHF Reference Lakes: 600 to 1,200 ug/L TKN; <10 NO3/NO2

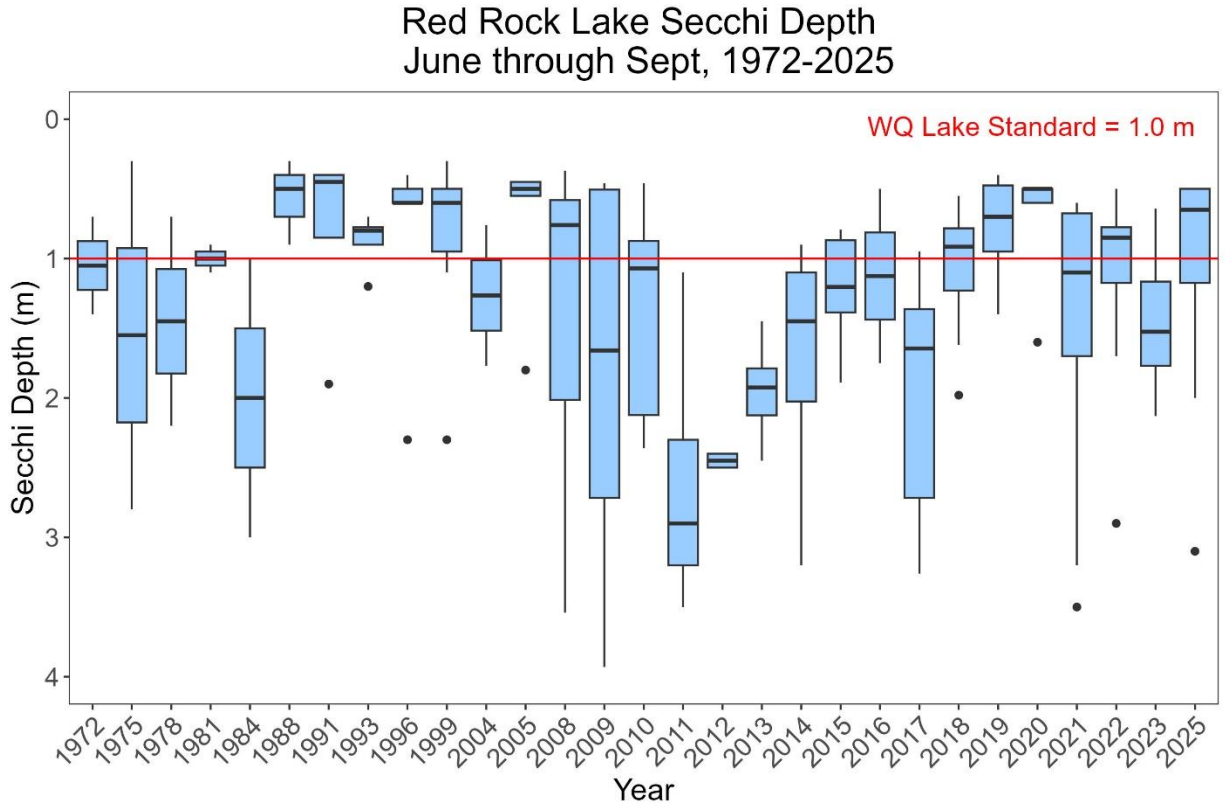
Red Rock Lake Total Phosphorus



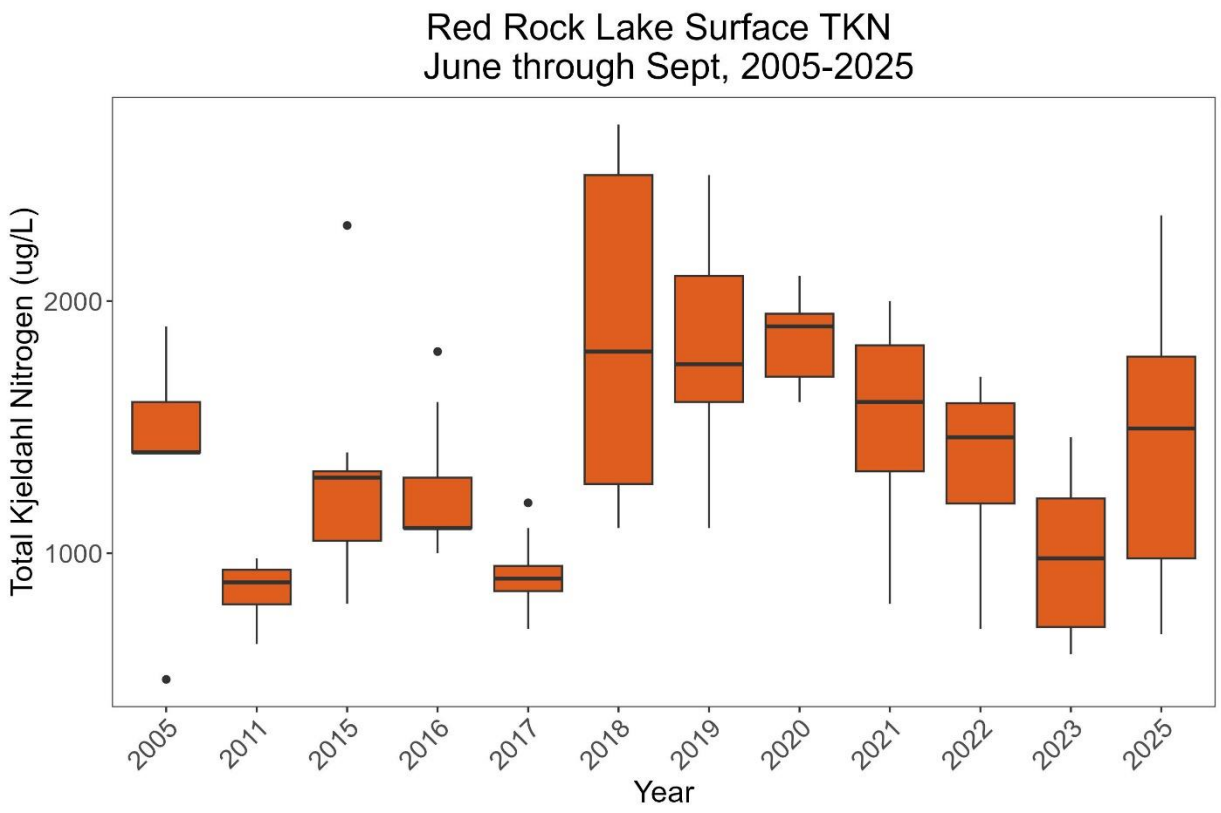


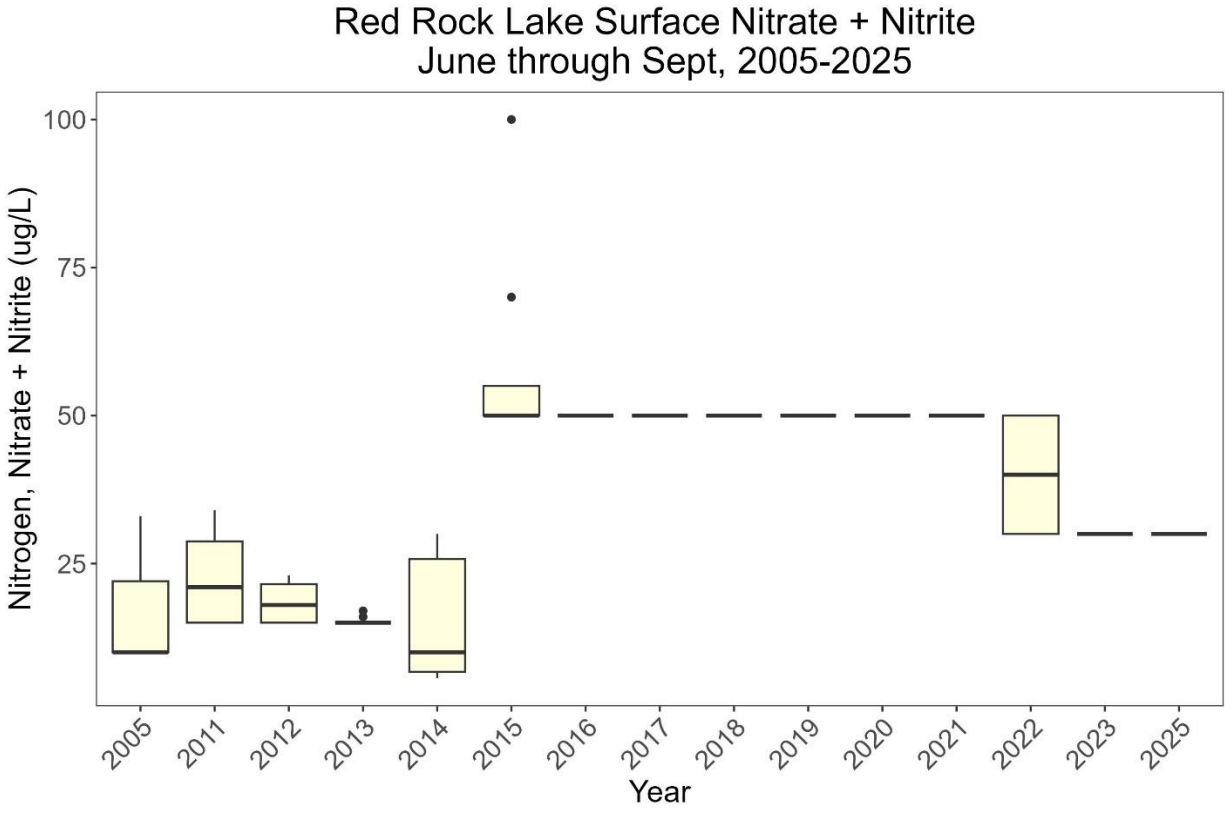
Red Rock Lake Chlorophyll-a and Secchi





Red Rock Lake Nitrogen





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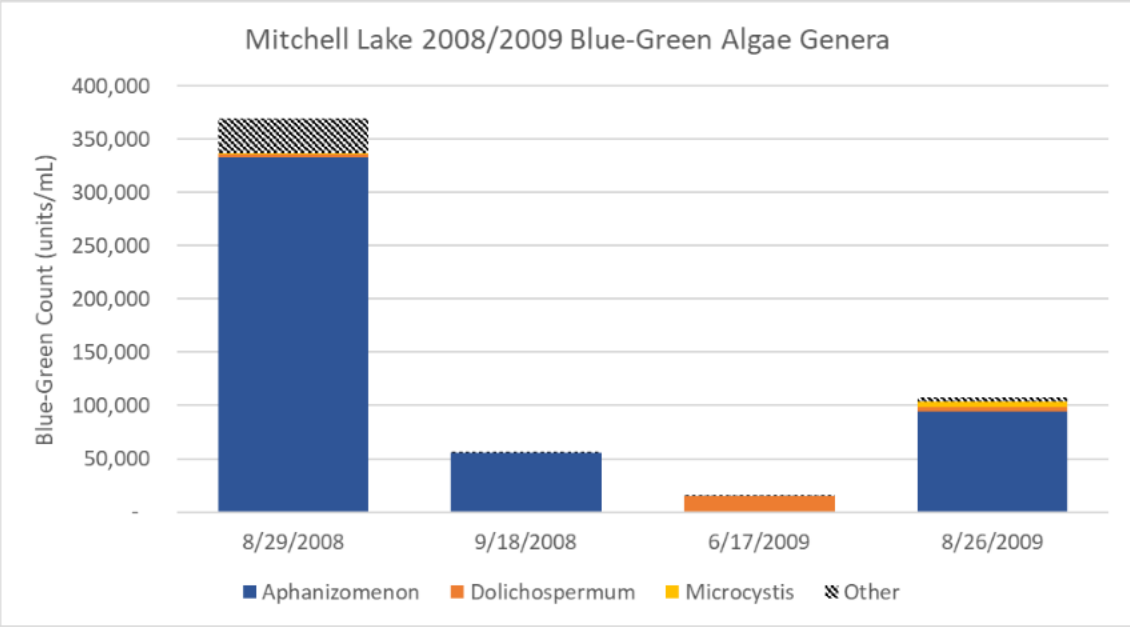
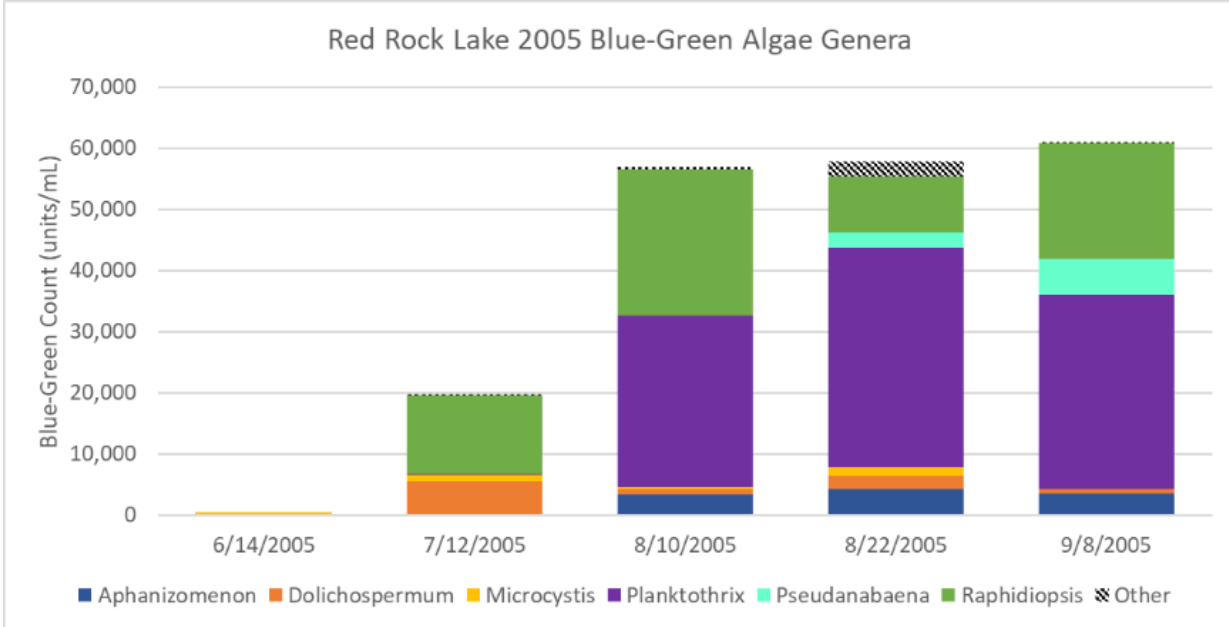
Mitchell and Red Rock Cyanobacteria





Cyanobacteria Species	Hepatotoxins		Neurotoxins	
	Cylindrospermopsin	Microcystins	Anatoxin-a	Saxitoxins
Aphanizomenon flos-aquae*	**X**			**X**
Dolichospermum flos-aquae*		**X**	**X**	
Dolichospermum spiroides*			**X**	
Planktothrix agardhii*		**X**	**X**	**X**
Pseudanabaena limnetica	X	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

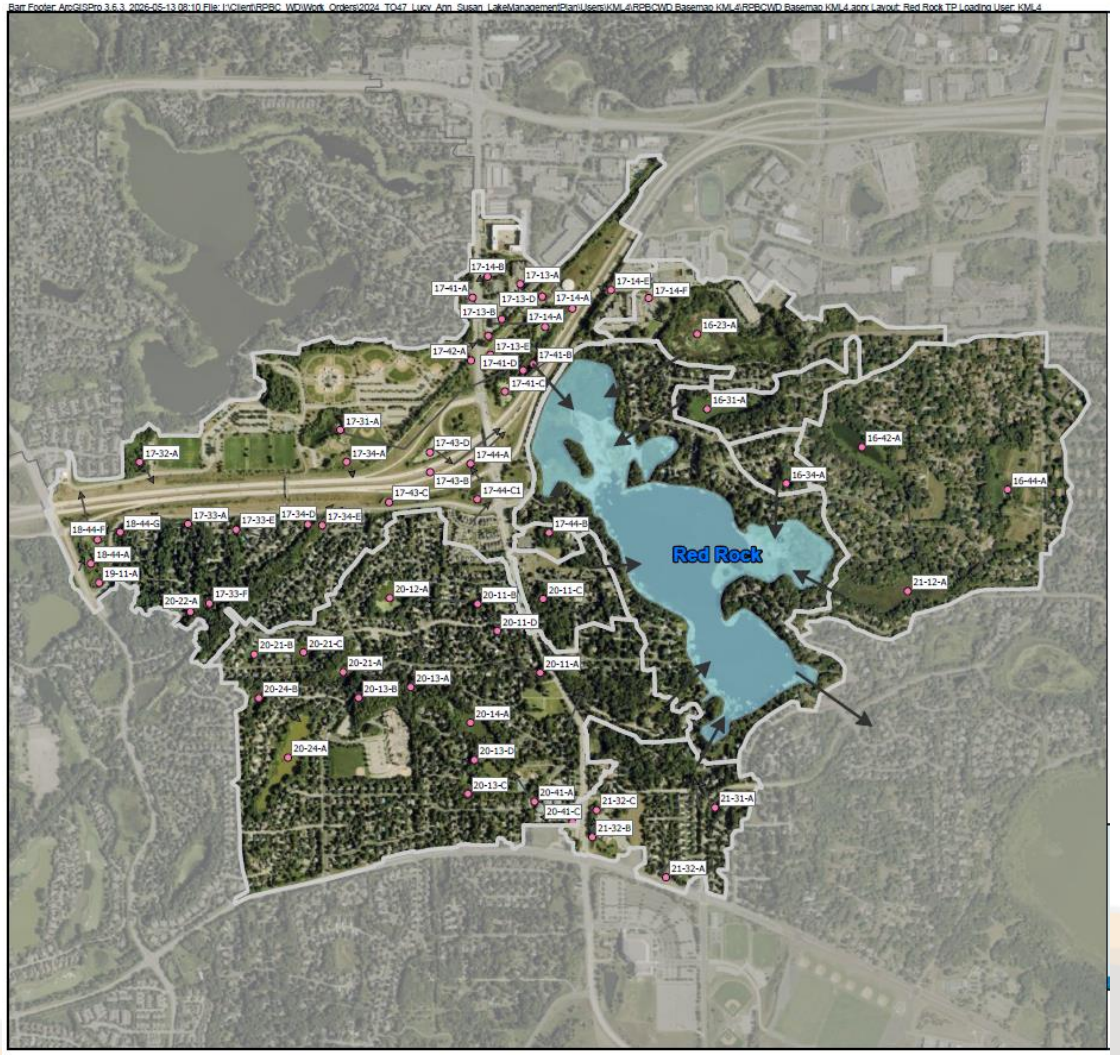
Eutrophication Parameter	Shallow Lakes[1]	Deep Lakes
Total Phosphorus (summer average, µg/L)	≤ 60	≤ 40
Chlorophyll-a (summer average, µg/L)	≤ 20	≤ 14
Secchi Disk transparency (summer average, meters)	≥ 1.0	≥ 1.4

Barr Lake Response Model

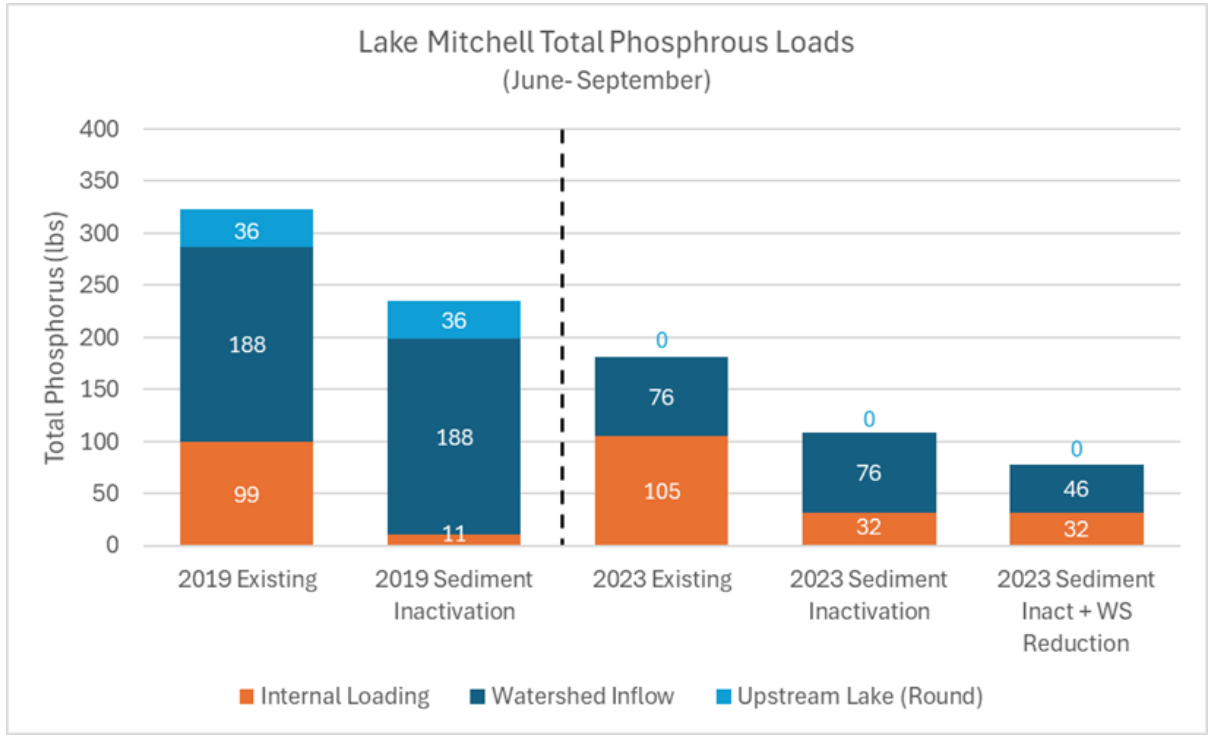
- Water Balance (wet and dry year)
- Temperature and Dissolved Oxygen
- Nitrogen and Phosphorus
- Sediment phosphorus release
  - Inorganic and organic sources
- Phytoplankton
  - Chlorophytes and cyanobacteria

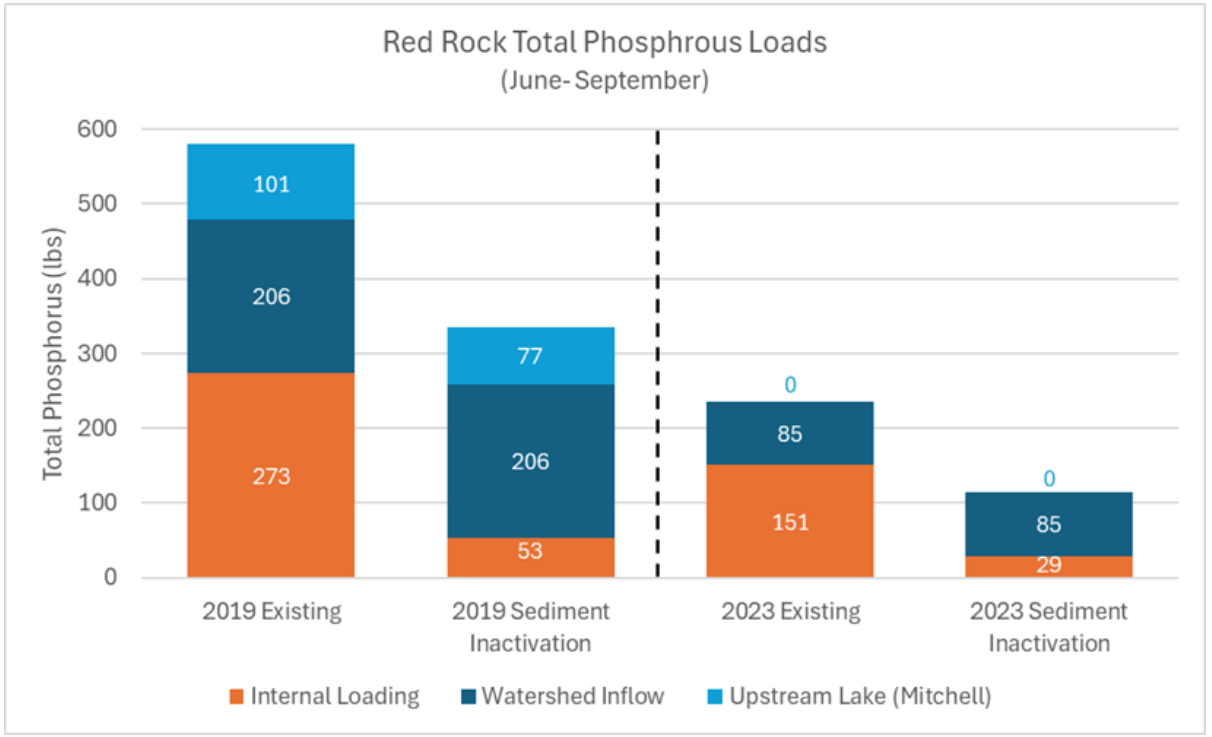
Questions

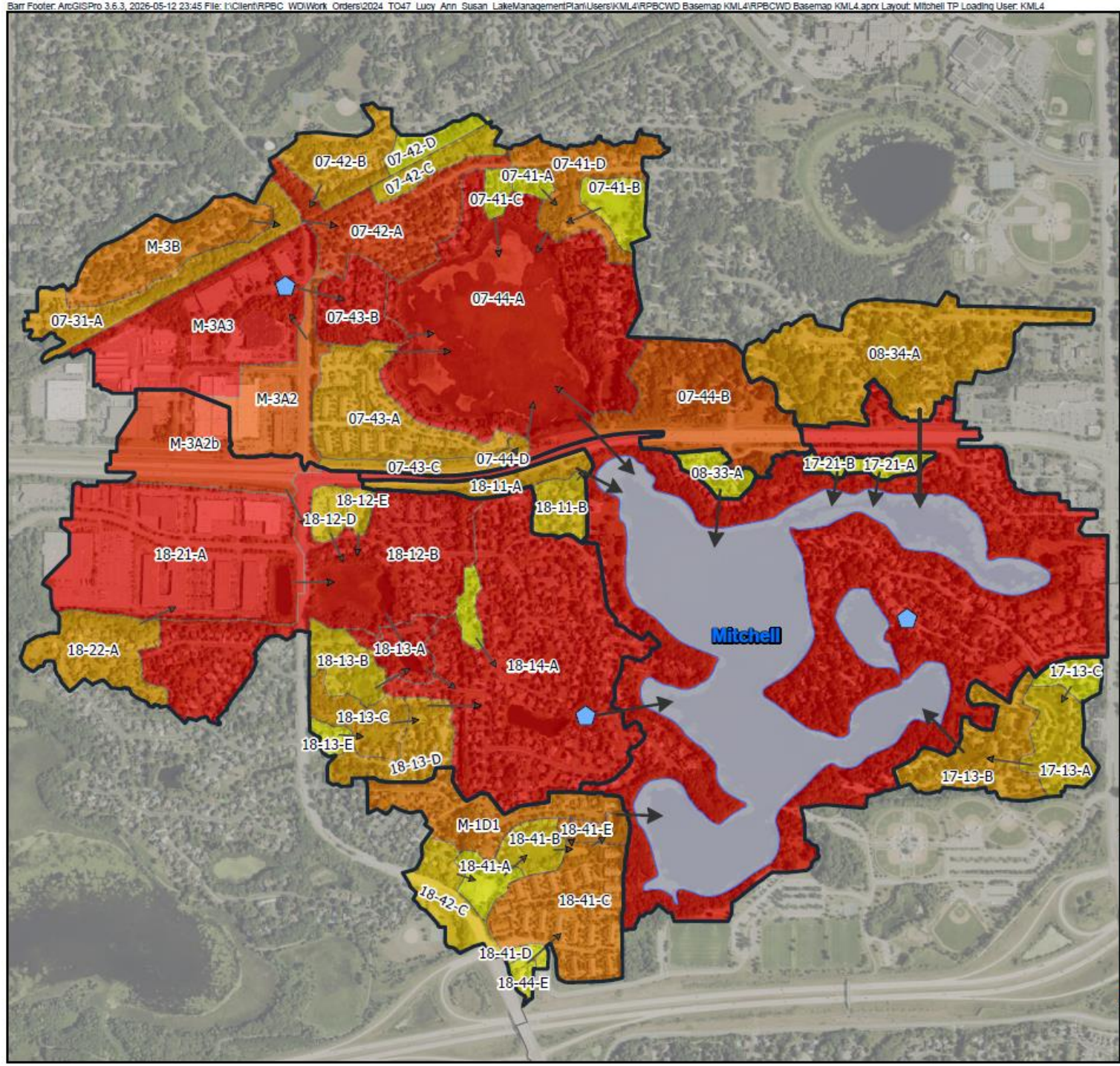
- What role does N play in driving cyanobacteria blooms?
- What reductions are required to meet state water quality standards?
- Are both N and P reductions beneficial?
- Where should nutrient reductions be pursued?



Mitchell and Red Rock Lake Reductions







TP Load (lb/yr)

- 0 - 2.0
- 2.0 - 5.0
- 5.0 - 10.0
- 10.0 - 20.0
- 20.0 - 30.0
- 30.0 - 50.0
- 50.0 - 500.0
- Identified Projects
- Flow lines
- Pour Point Boundary

<10, 10=50
50-100, 10(
200, 200-5(

get rid of decimal, lessen the
red category, label projects
with our naming convention

Make arrows bolder

N

0 550 1,100

Feet

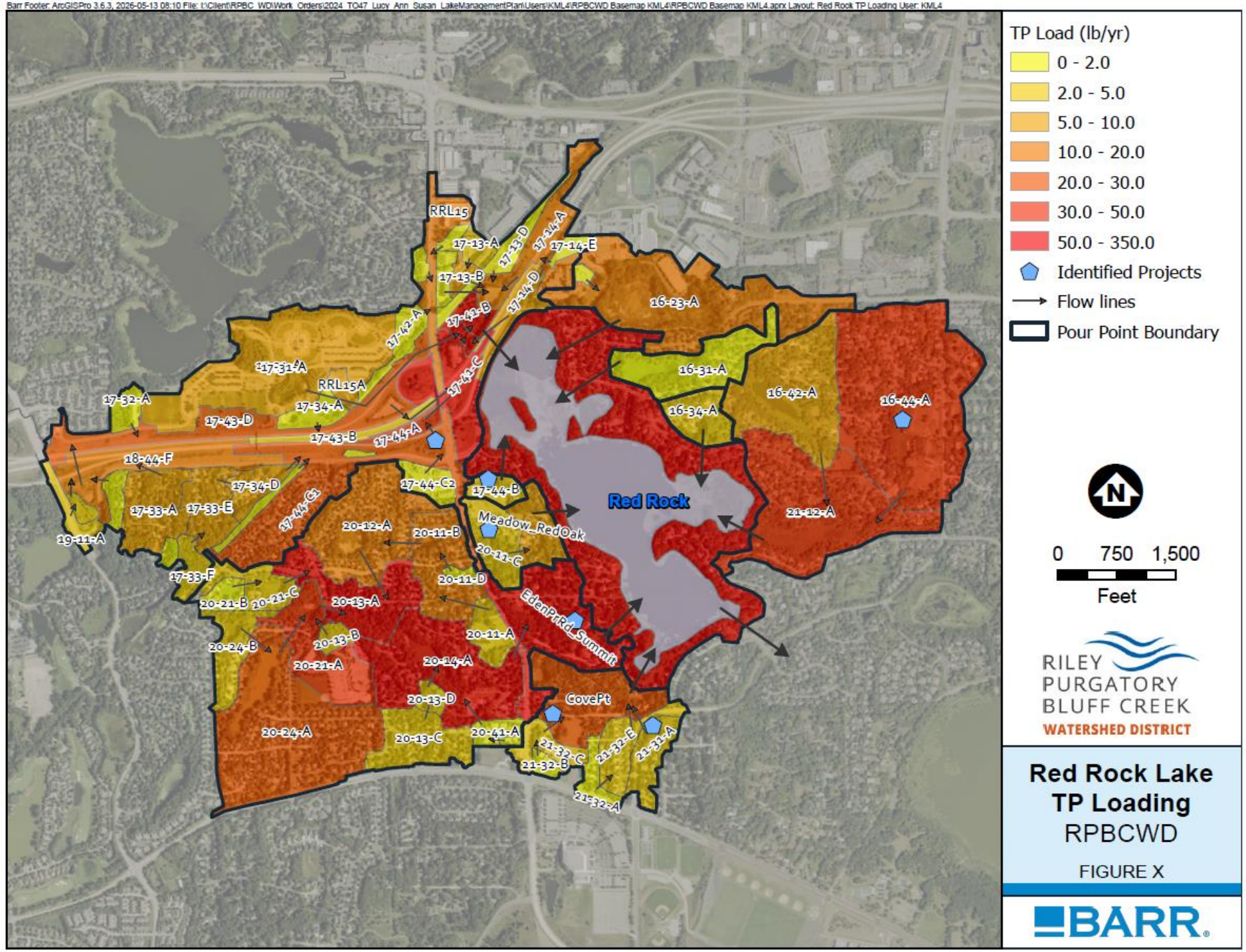
RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

Mitchell Lake TP Loading

RPBCWD

FIGURE X

BARR



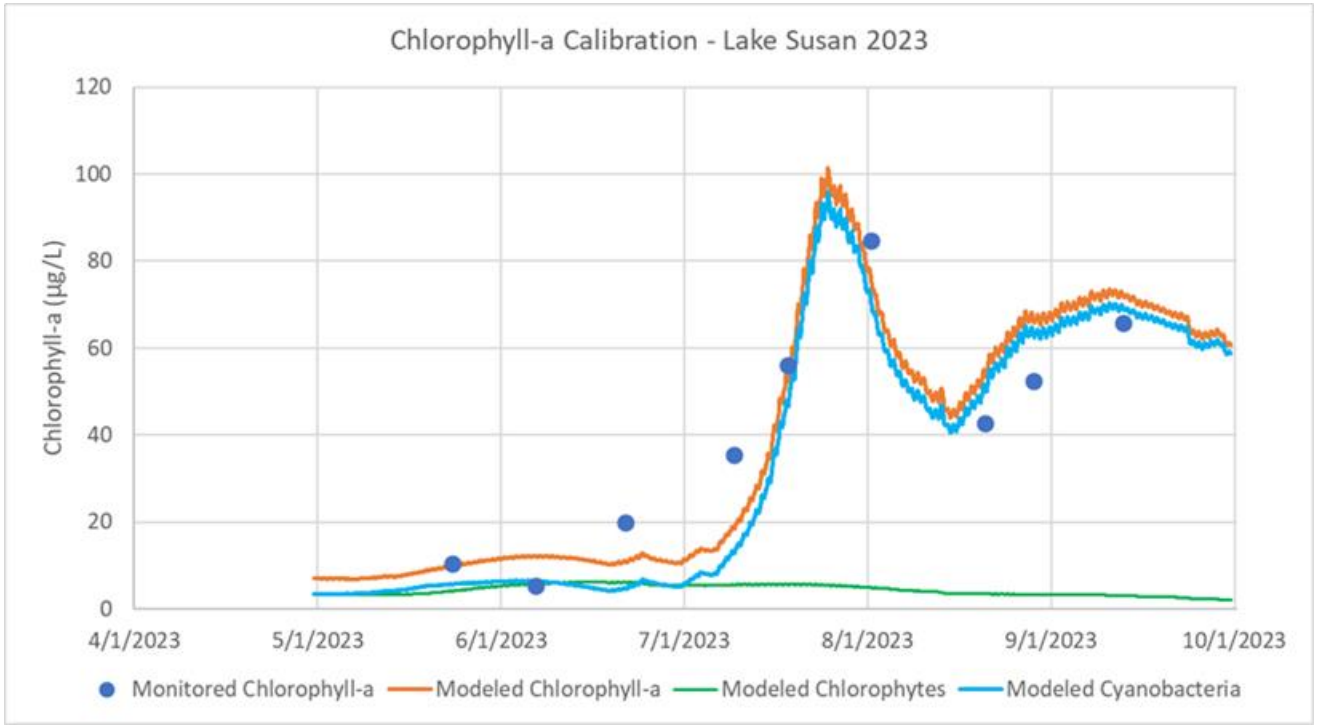
Red Rock Lake TP Loading

RPBCWD

FIGURE X

BARR

The Role of Nitrogen (N)



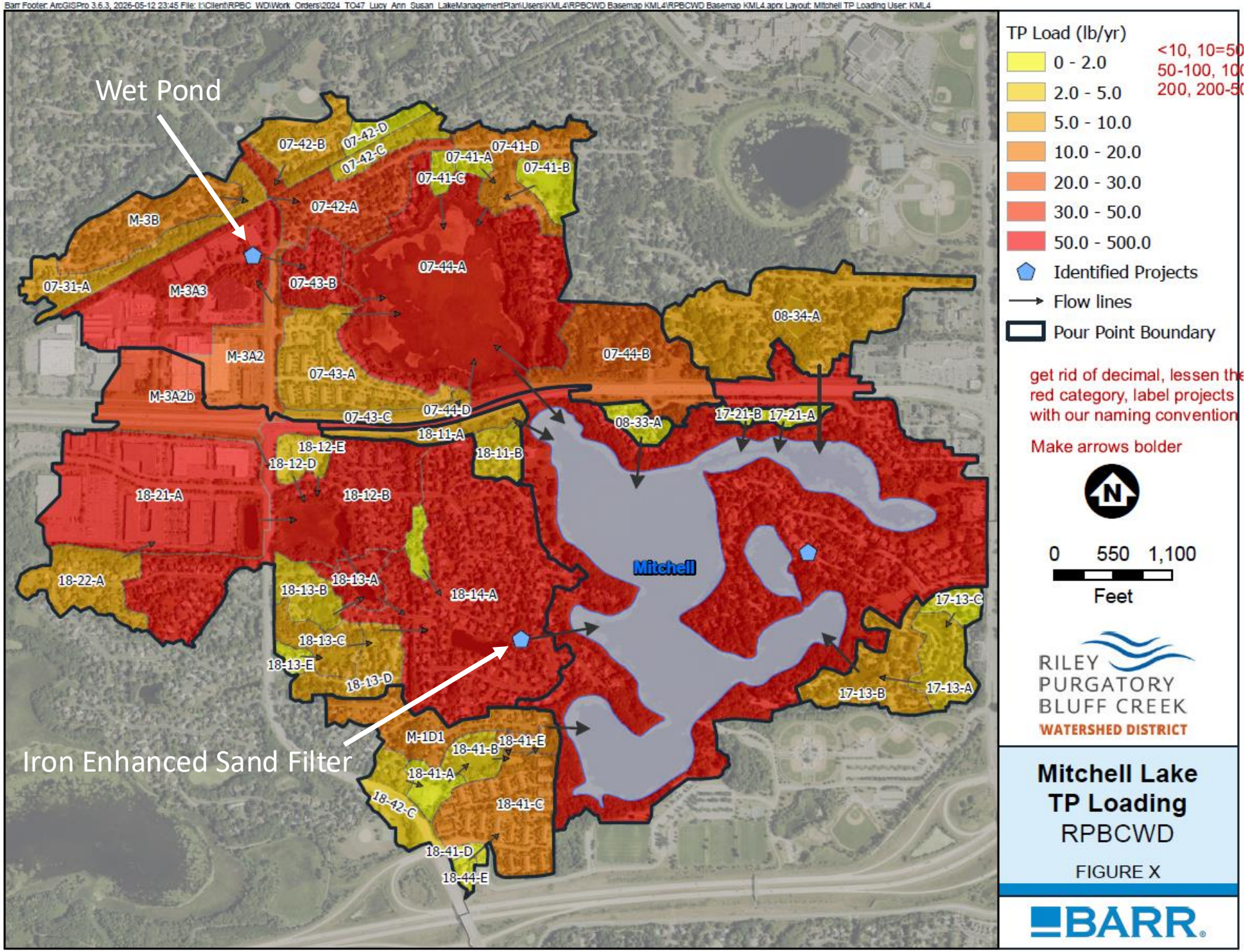
- Limited nitrate data suggest high nitrogen periods in the lakes
- Phytoplankton are co-limited by N+P
  - N-fixation by cyanobacteria starts in mid- to late-June
- N management will have limited benefits to phytoplankton production due to N-fixing cyanobacteria
- However, lower N environments are less 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 potential driver in both 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



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Mitchell Lake TP Loading

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FIGURE X

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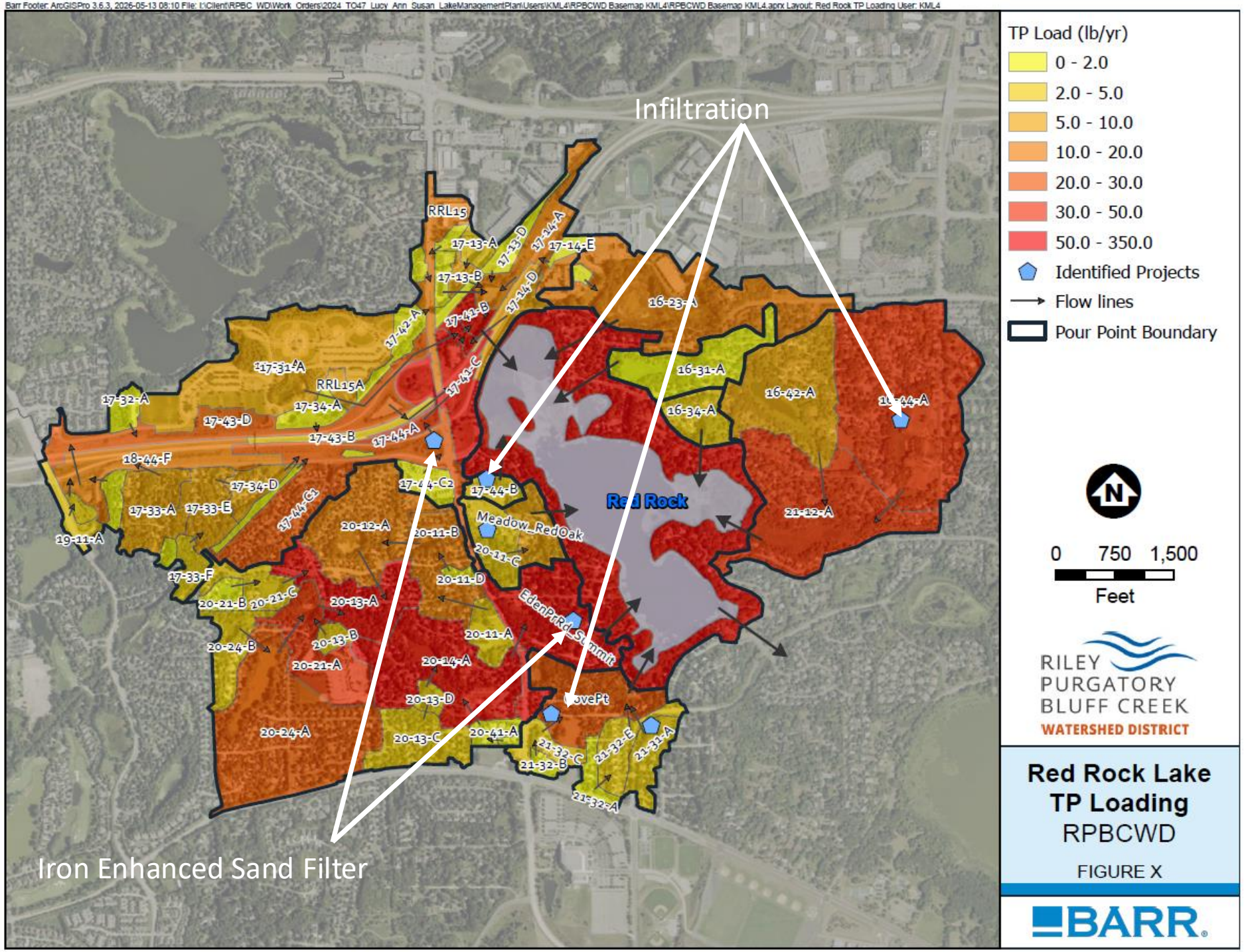


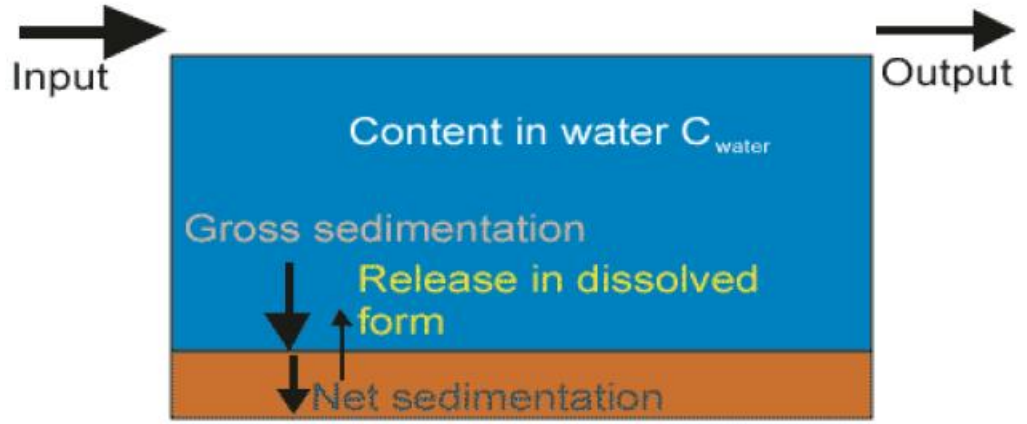
Internal P Loading in Ponds

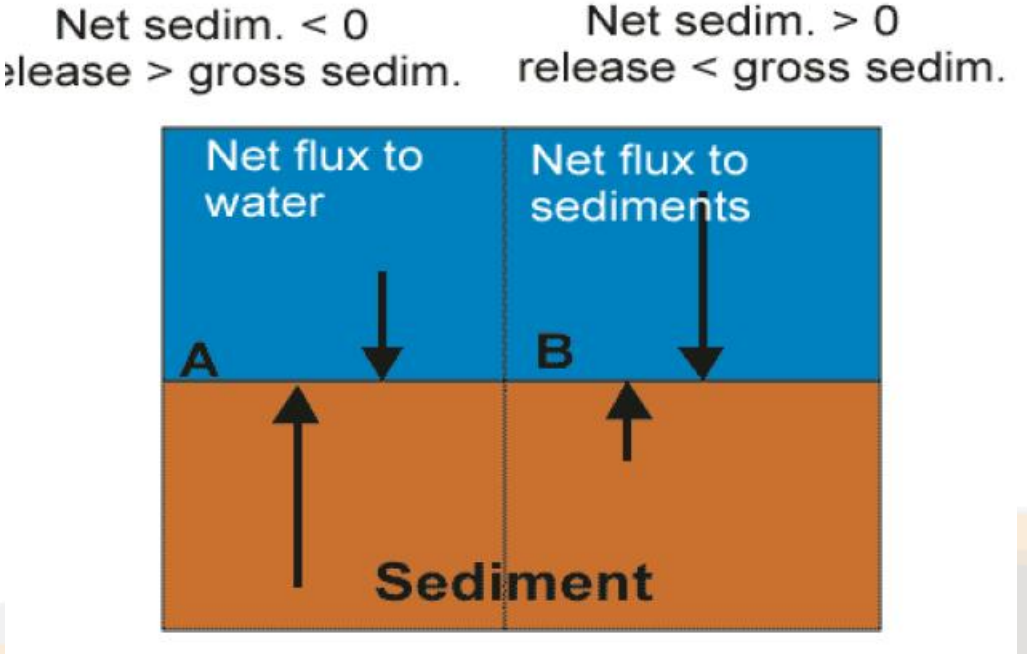
Mitchell and Riley Subwatershed Study (2021)

- 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



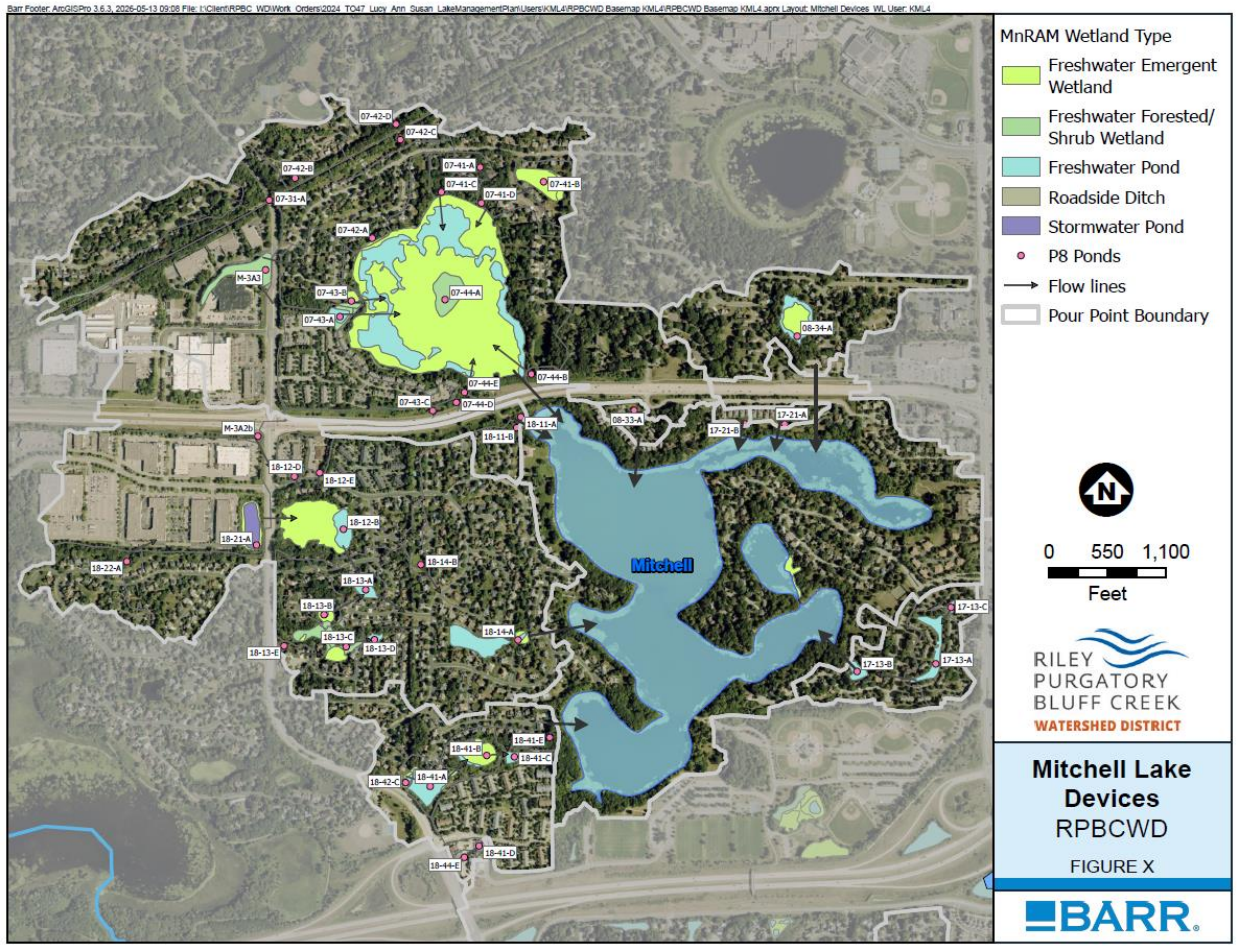


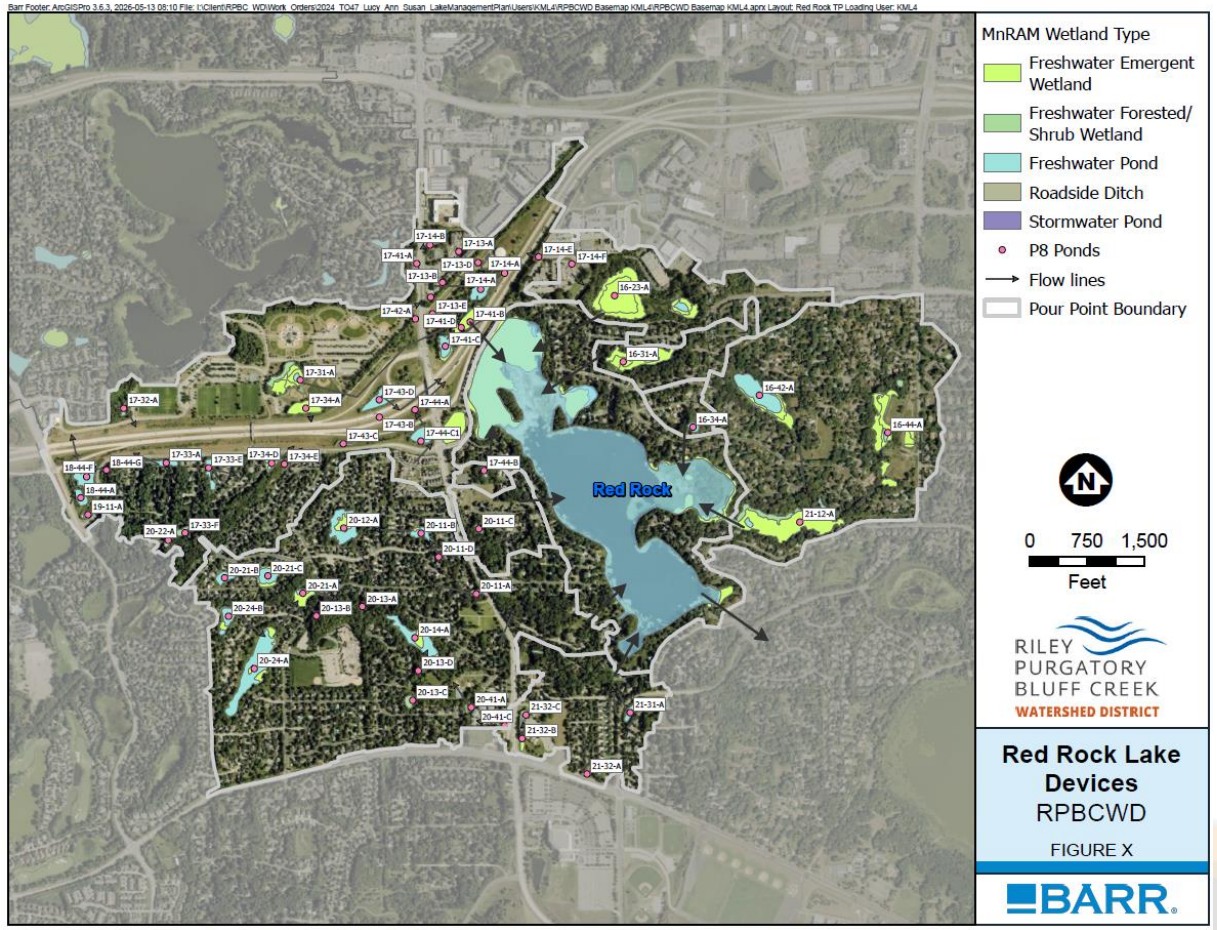
Lake	Pond ID	Wetland Classification	Pond Area (ac)	Average Depth (ft)	Potential P Load (lbs/yr)
Mitchell	18-14-A	Pond	2.0	5.16	6.0
Red Rock	16-42-A	Pond	10.3	10.99	31.6
Red Rock	16-23-A	Emergent Wetland	15.0	10.25	46.0
Red Rock	16-31-A	Emergent Wetland	4.9	5.08	15.0
Red Rock	20-14-A	Emergent Wetland	2.8	4.41	8.4
Red Rock	20-12-A	Emergent Wetland	2.6	3.83	8.1
Red Rock	18-44-F	Pond	1.4	3.67	4.3

Pond Types

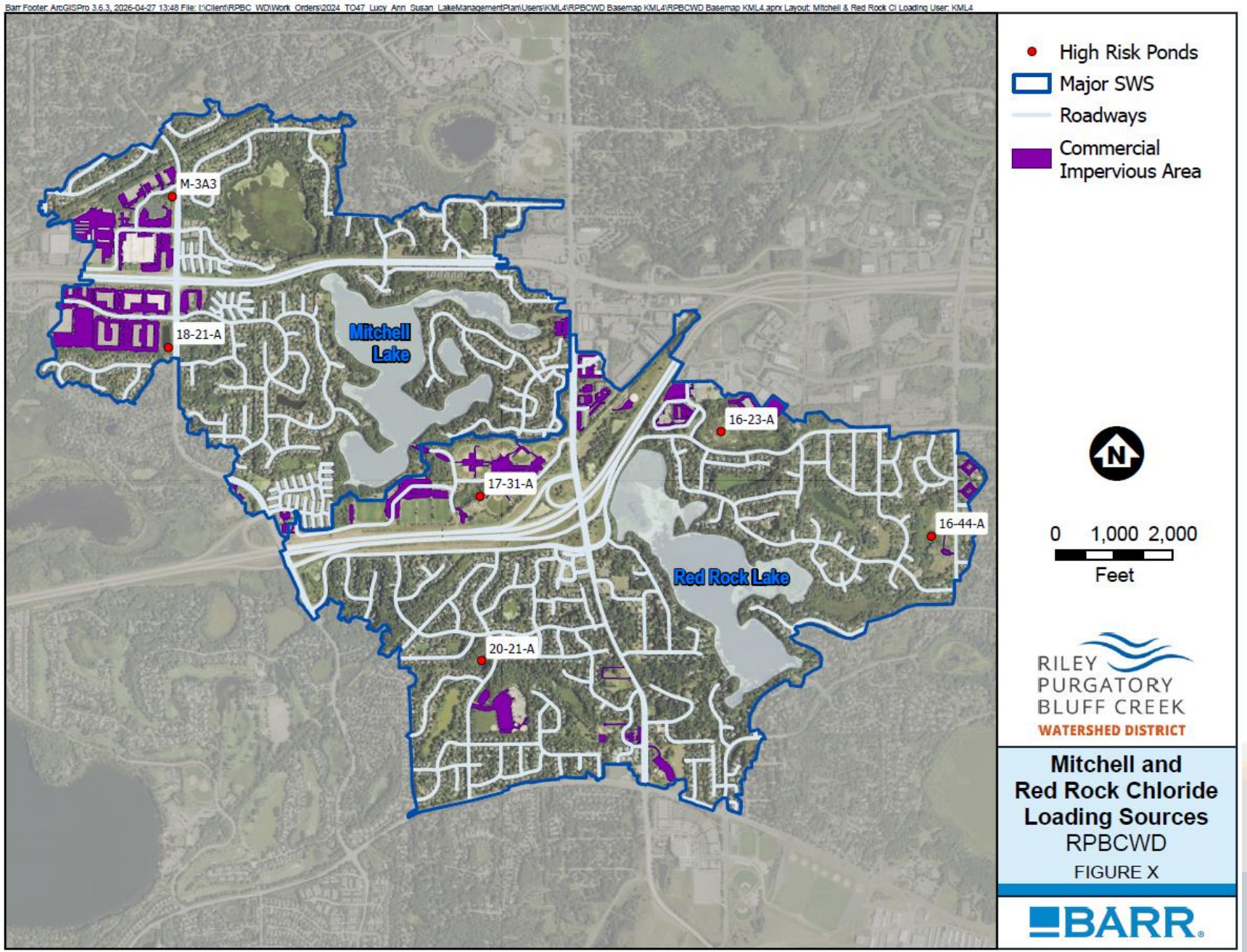
- Emergent Wetlands
  - Varying degrees of open water
  - Wetland versus pond restoration
- Large wetted areas can release or transform phosphorus (P)

Wetland Restoration





Non-Structural – Street Sweeping



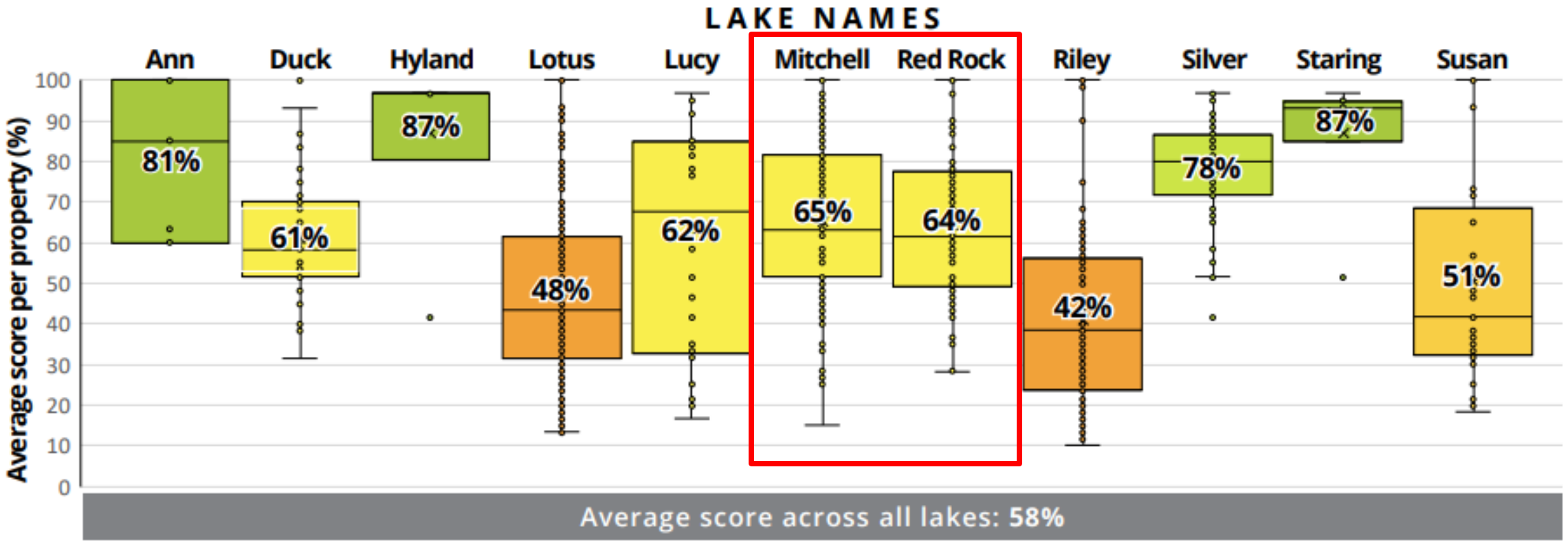
Sediment Phosphorus Inactivation - Alum

- 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

BARR

Shoreland Conditions

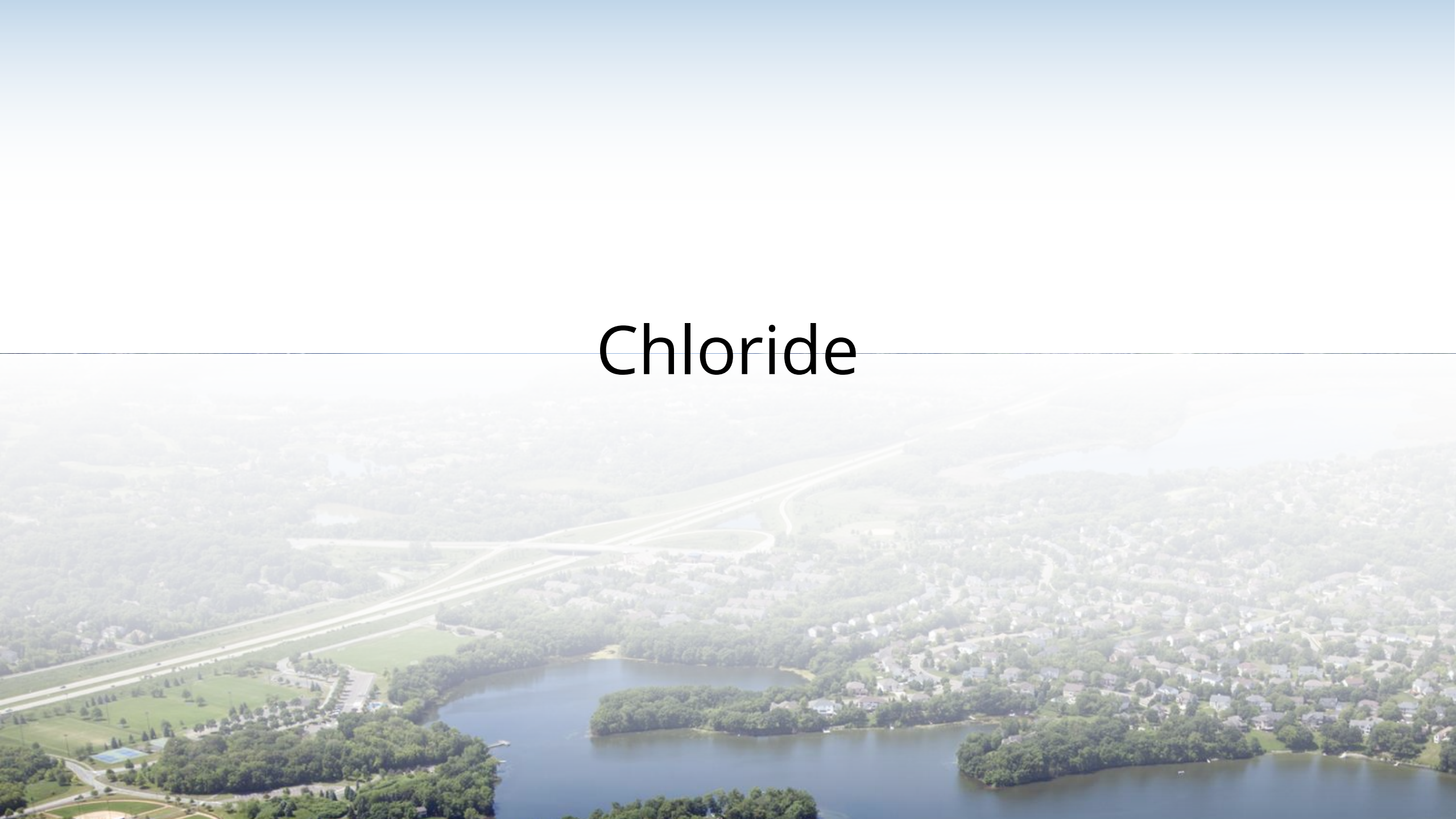
Figure 23. Distribution of RPBCWD individual property shoreland scores and overall average property score (unweighted).



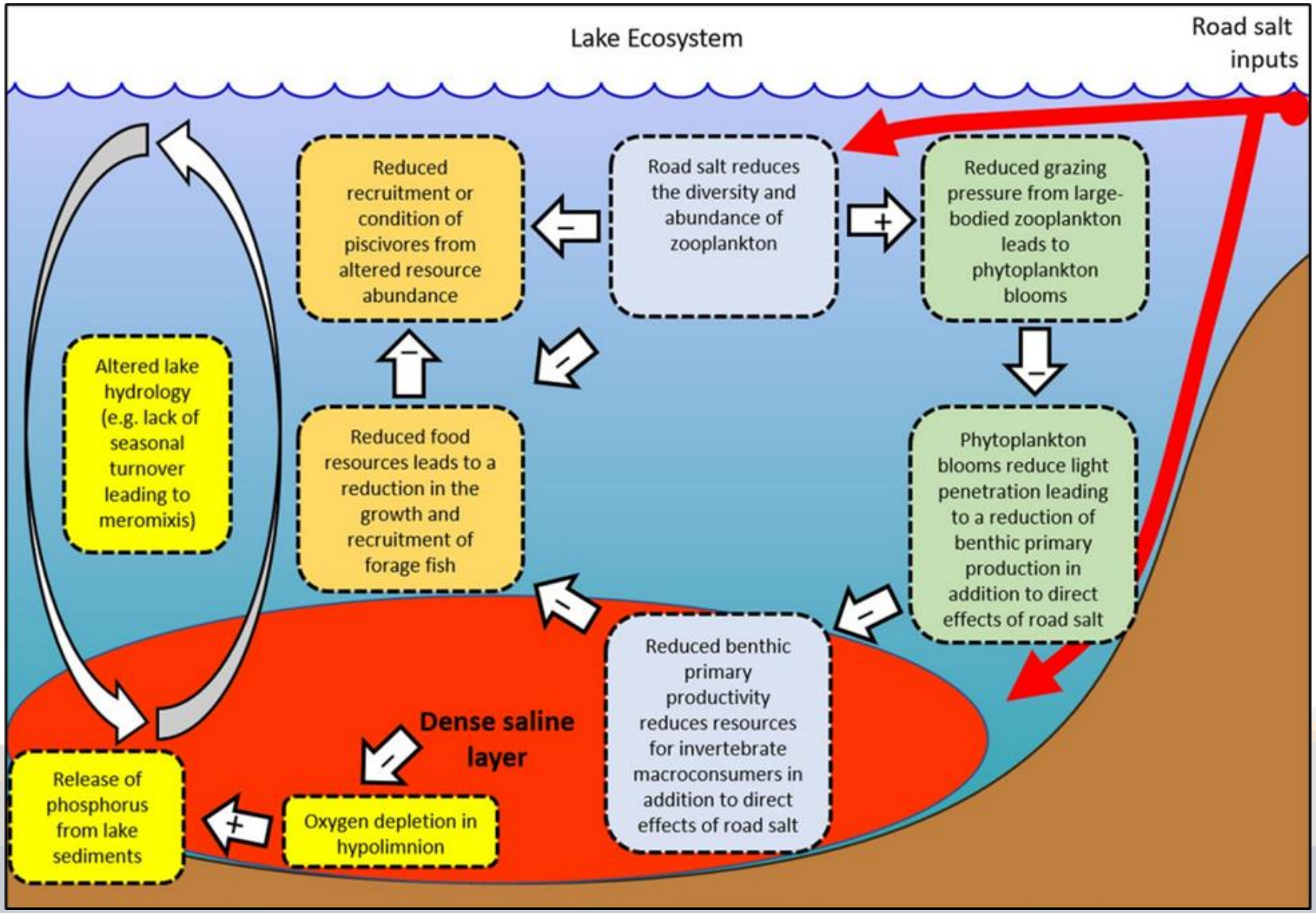
Lake Restoration Summary

- **Lake are co-limited by phosphorus (P) and nitrogen (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
- **Both lakes demonstrated high internal P loading that is likely driving algal blooms**
  - Red Rock Lake is more complicated by boom-bust fishery

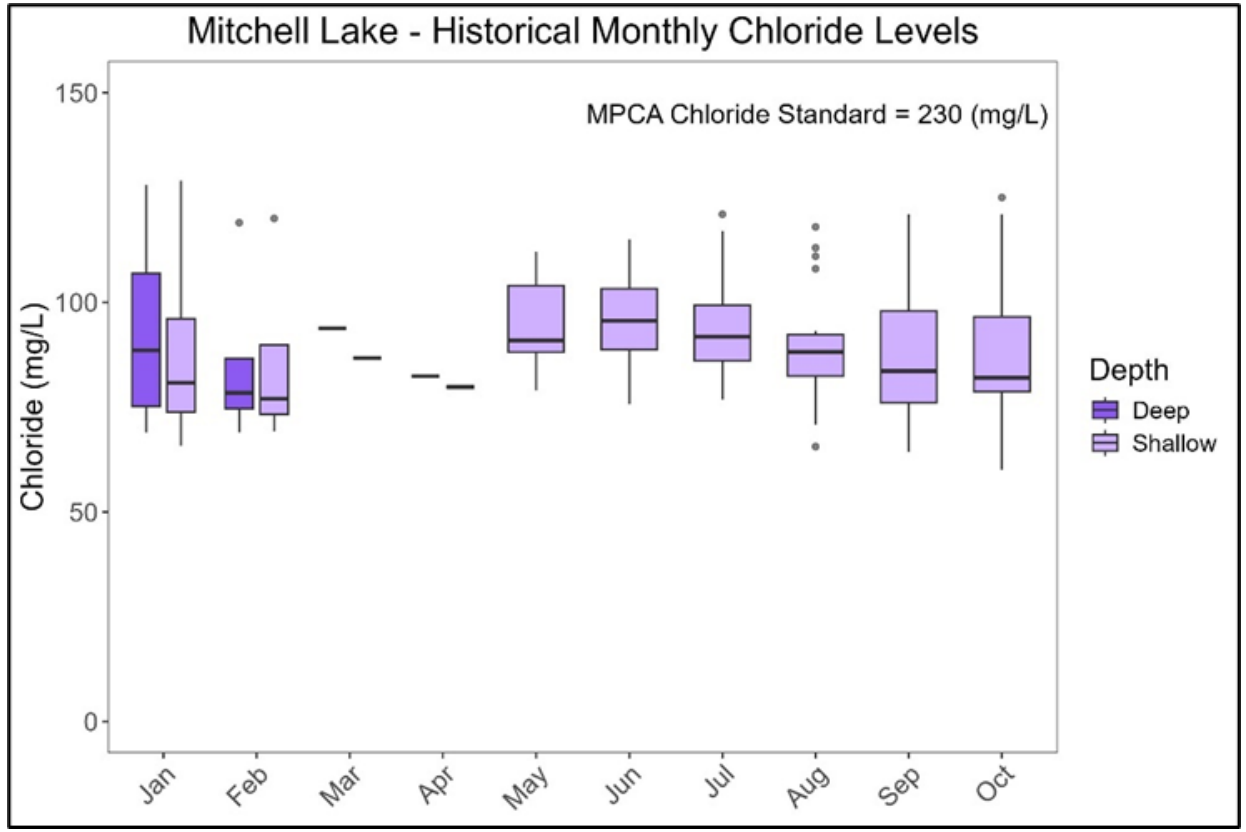
Chloride

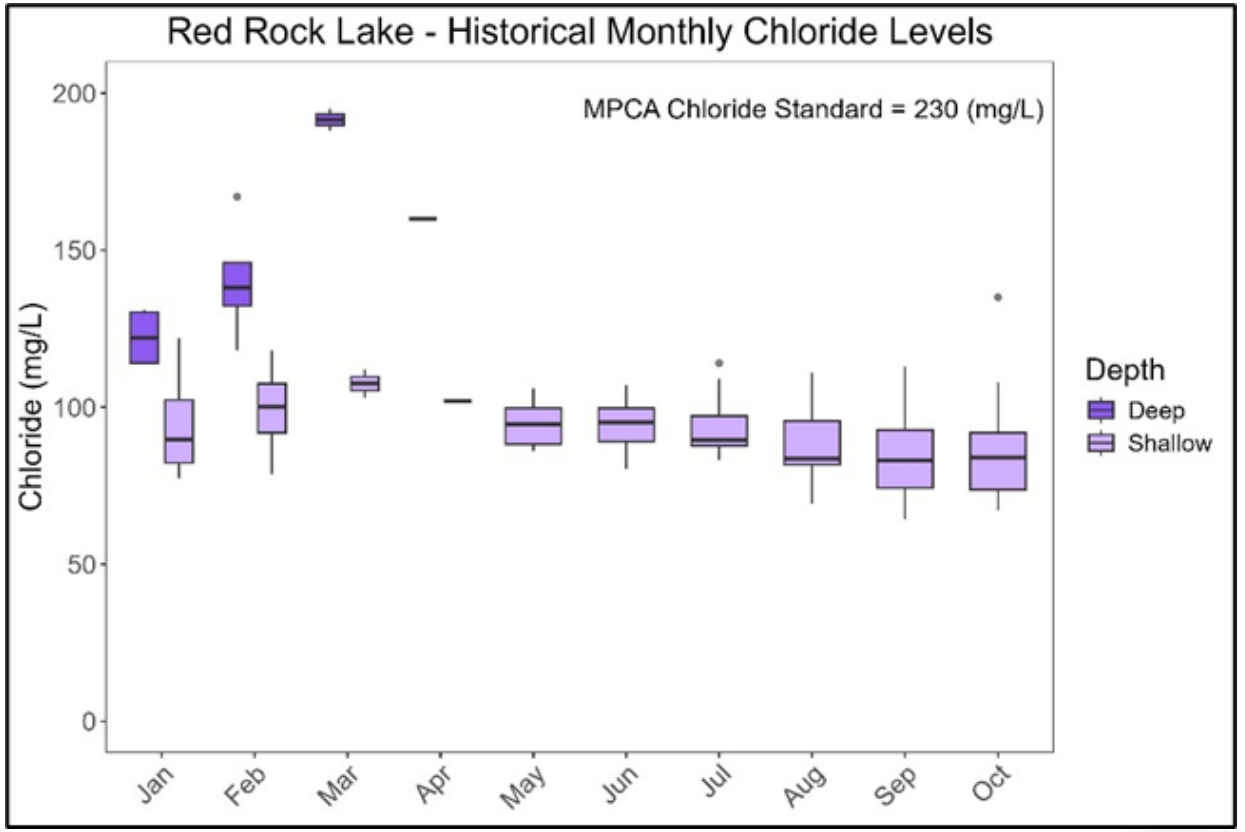


Chloride Impacts to Lakes (and ponds)

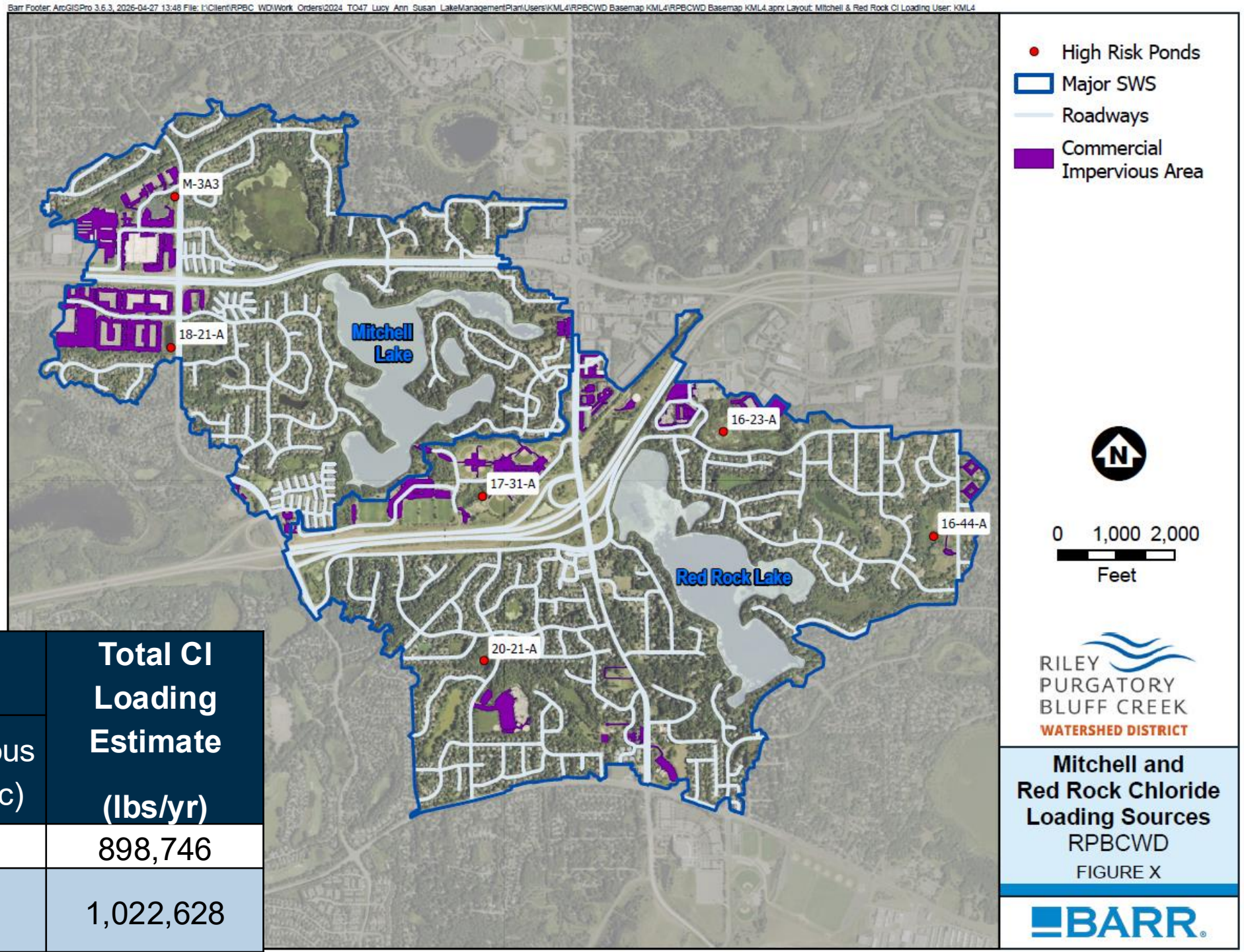


Mitchell and Red Rock Chloride





Chloride



Lake	Chloride Loading Sources		Total Cl Loading Estimate
	Roadway (ac)	Impervious Area (ac)	(lbs/yr)
Mitchell	29.6	45.7	898,746
Red Rock	45.7	42.1	1,022,628

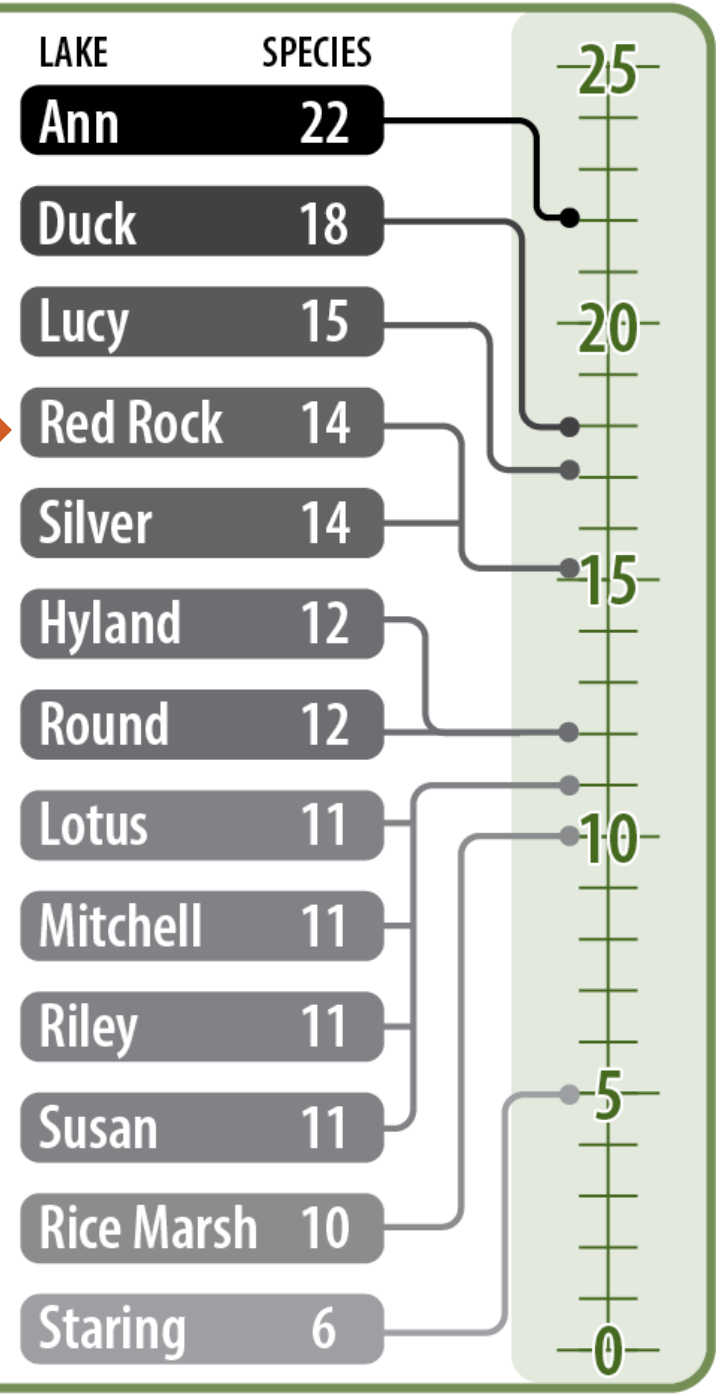
Chloride Summary

- **Mitchell and Red Rock show signs of chloride impacts**
  - Remained below the standard but elevated compared to regional lakes
  - Roads were largest impervious areas receiving salt
- **Ponds in the watershed are likely impacted by road/parking lot salt**
  - High risk ponds were identified using loading

Aquatic Plants

Native Aquatic Plant Diversity

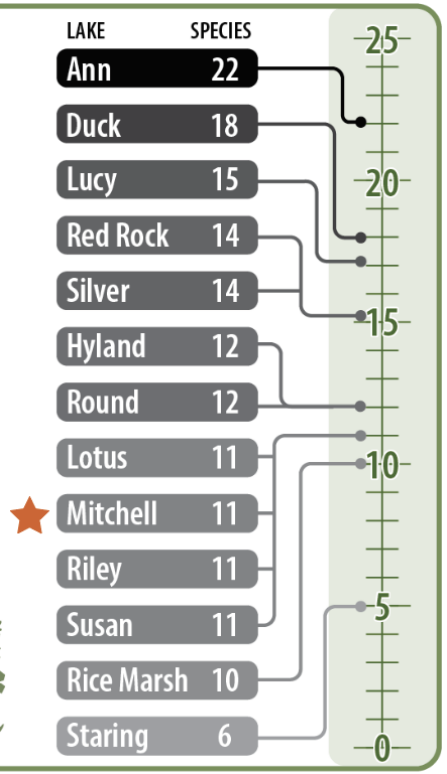
How do district lakes compare to each others in the number of native aquatic plant species?

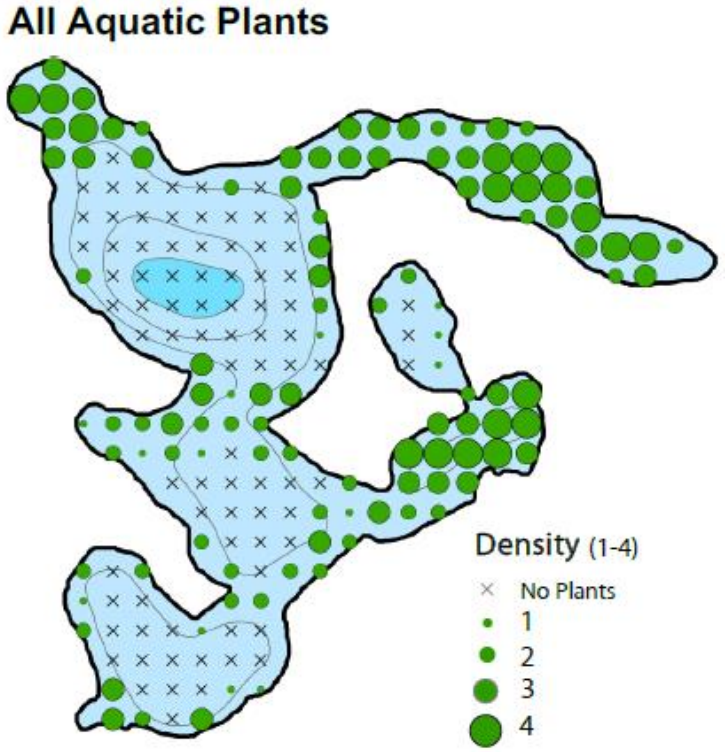


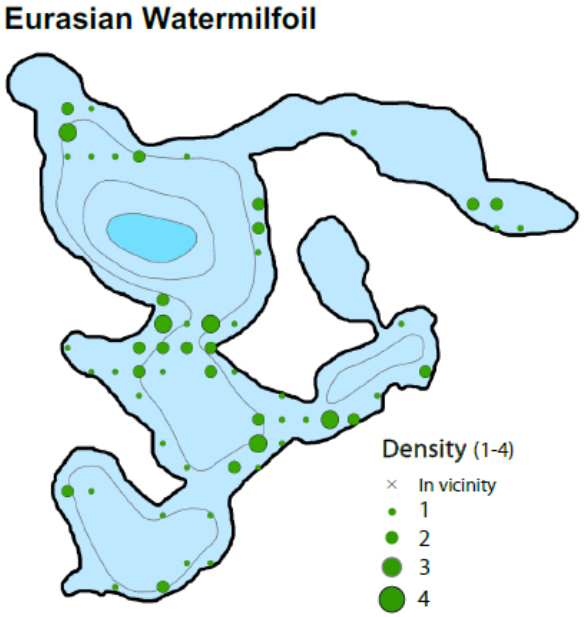
Aquatic Plants – Mitchell Lake

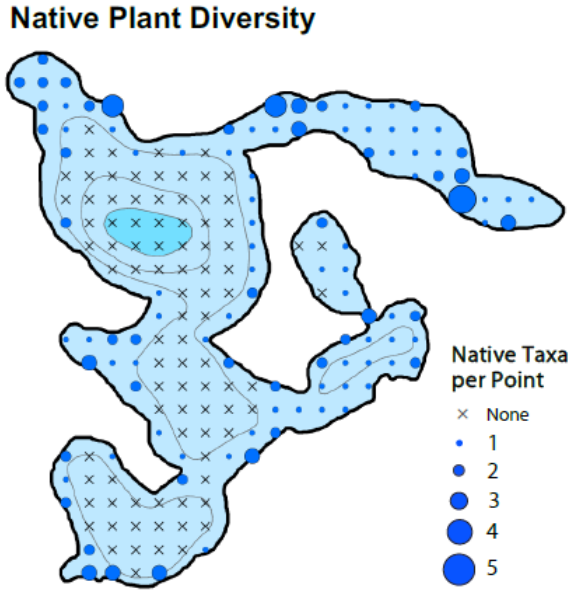
Native Aquatic Plant Diversity

How does **Mitchell Lake** compare to **other lakes** in the District in **number of native plant species**?





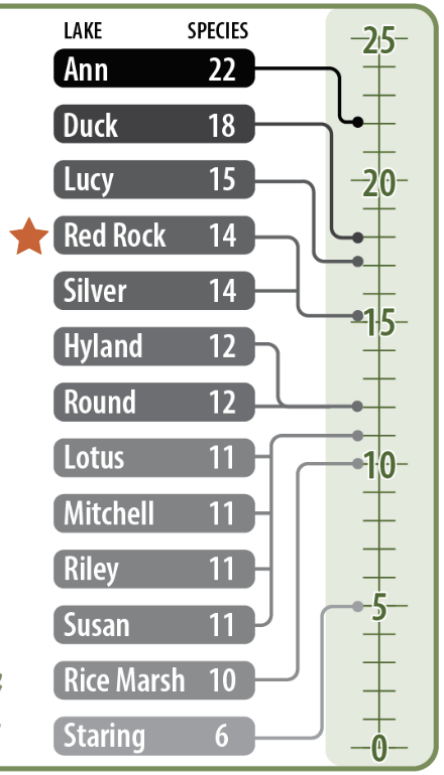


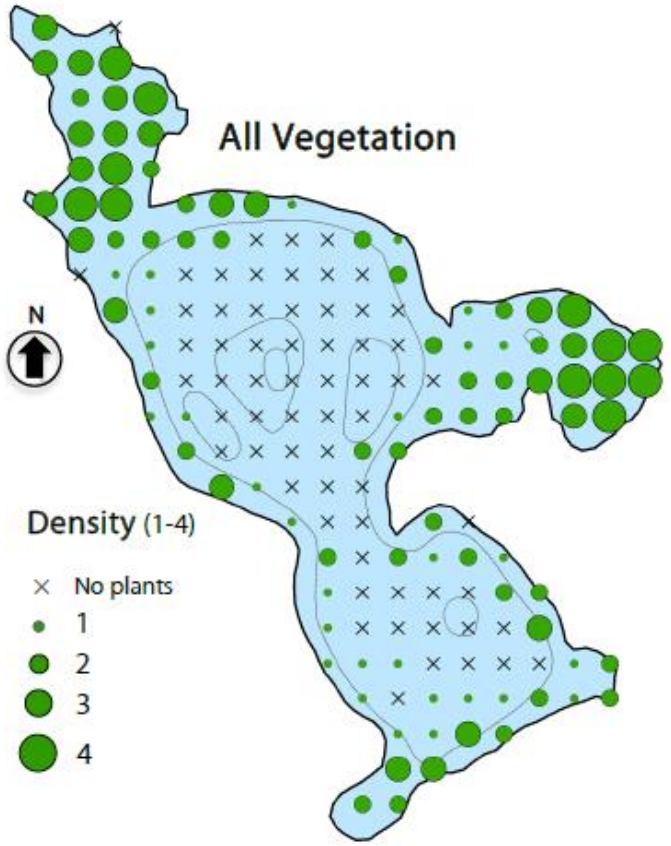


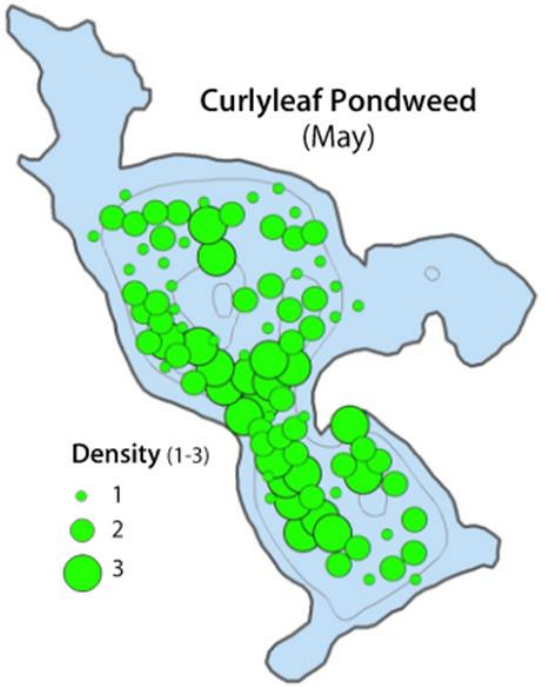
Aquatic Plants – Red Rock Lake

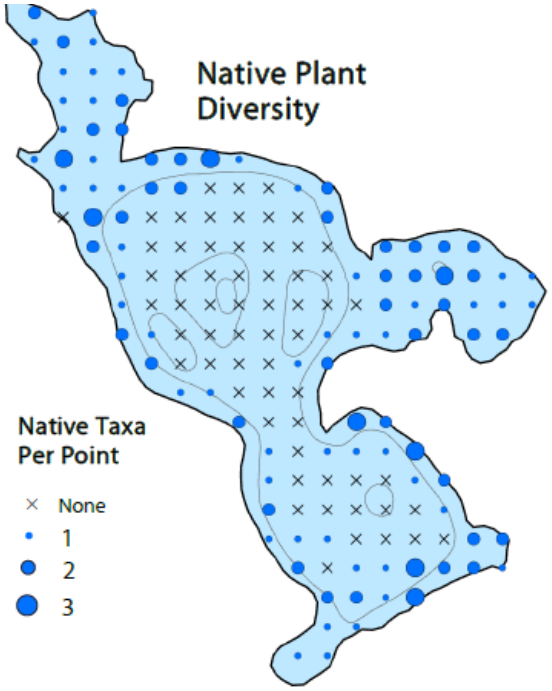
Native Aquatic Plant Diversity

How does **Red Rock Lake** compare to **other lakes** in the District in **number of native plant species**?









Next Steps

- Public meetings round #2
  - 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

Contact

Terry Jeffery
District Administrator
tjeffery@rpbcwd.org

Liz Forbes
Deputy District Administrator
lforbes@rpbcwd.org

Dylan Monahan
Watershed Planner
dmonahan@rpbcwd.org

RILEY PURGATORY BLUFF CREEK
WATERSHED DISTRICT

rpbcwd.org/systems-approach

- Submit a comment
- Learn more about the project