RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 ANNUAL REPORT


Merganser family at Kerber Pond by Steven Harder.

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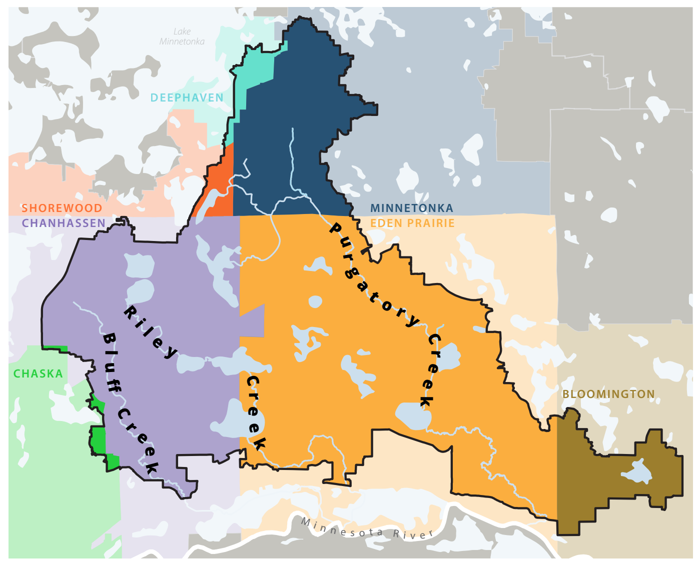
INTRODUCTION

The purpose of the annual report is to fulfill the requirements set forth in Minnesota Statute Chapter 103D.351, which requires watershed districts to file an annual report with the Board of Soil and Water Resources and the Department of Natural Resources. Minnesota Regulation MR 8410.0150 requires the report to contain certain information.



DISTRICT OVERVIEW

The Riley Purgatory Bluff Creek Watershed District (RPBCWD or the District) is a local government unit established on July 31, 1969, to protect, manage, and restore water resources. It encompasses some 50 square miles of land that drains into any of the three creeks in its name. The District includes parts of seven cities (Bloomington, Chanhassen, Chaska, Deephaven, Eden Prairie, Minnetonka, and Shorewood) and two counties (Carver and Hennepin).

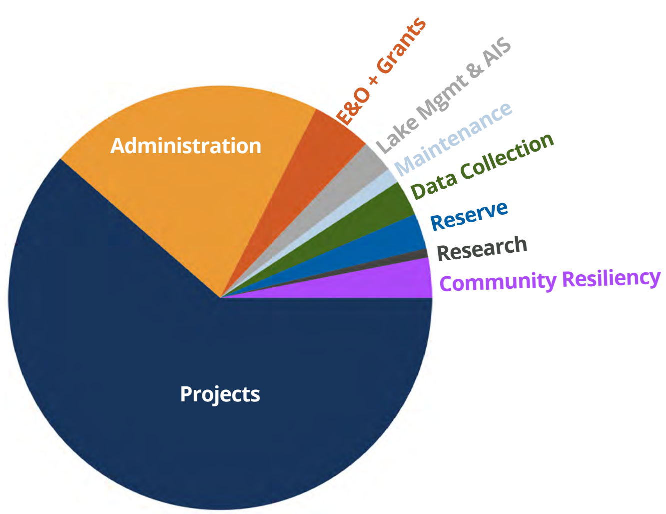
The District is led by five managers (four appointed by the Hennepin County Commissioners and one by Carver) each serving three-year terms directing District activities. The District partners with these local communities and residents to identify issues affecting the water resources and to prioritize projects and regulations to address these issues. In addition, the District works to educate and engage community members regarding the protection of the District's water resources.

TAX DOLLARS AT WORK

Projects and programs of the Riley Purgatory Bluff Creek Watershed District are funded through property tax levies. We thank our community for their part in financing our mission of protecting, managing, and restoring our water resources!

The 2023 levy was $3.8 million, and the board-approved 2023 budget, including funds from previous levies, was $7.3 million. The funds were used for projects, as well as administration, maintenance, lake and creek monitoring, aquatic invasive species management (AIS), education and outreach (E&O) and grant funding, community resiliency, and a reserve fund for emergencies.

Figure 1. Distribution of 2023 budget.



GOVERNANCE

The District is governed by a five-person board of managers. Two independent committees, the Citizens Advisory Committee (CAC) and Technical Advisory Committee (TAC), provide advice and comment to the Board as required by Minnesota Statute 103D.331. Daily operations are carried out by a team of employees and consultants led by the District's administrator.

BOARD OF MANAGERS

Four managers are appointed by the Hennepin County Commissioners and one by the Carver County Commissioners. Managers serve three-year terms. No new managers were appointed in 2023. Two manager positions will be up for appointment in 2024. The table on this page shows the list of 2023 managers, their county of appointment, positions, term end date, and city of residence.

The 2023 RPBCWD Board of Managers

Name	Appointed by	Position	Term ends	City of Residence
David Ziegler	Hennepin County	President	7/31/2025	Eden Prairie
Tom Duevel	Hennepin County	Vice President	7/31/2025	Minnetonka
Dorothy Pedersen	Hennepin County	Secretary	7/31/2026	Shorewood
Jill Crafton	Hennepin County	Treasurer	7/31/2024	Bloomington
Larry Koch	Carver County	Member	7/31/2024	Chanhassen

Photos of managers (left to right): Tom Duevel, Jill Crafton, Dorothy Pedersen, David Ziegler, and Larry Koch.

ADVISORY COMMITTEES

The District has two advisory committees. The Citizen Advisory Committee (CAC) is a group of community volunteers that advise the Board of citizen interests. The CAC usually meets monthly. At the end of 2023, there were 12 CAC members. More information can be found at rpbcwd.org/CAC.

The Technical Advisory Committee (TAC) includes representatives of cities, counties, and government agencies. The TAC provides technical advice to the District about projects and programs. The board of managers annually appoints members to the TAC. Staff from agencies or local government units are welcome to join us at these meetings. For a current list of TAC members, visit rpbcwd.org/advisors.

STAFF

In 2023, Riley Purgatory Bluff Creek Watershed District had ten permanent staff plus two interns and one GreenCorps member. A list of permanent staff is below.

Terry Jeffery
District Administrator
tjeffery@rpbcwd.org

Eleanor Mahon
Community Engagement Coordinator
emahon@rpbcwd.org

Amy Bakkum
Office Manager
abakkum@rpbcwd.org

Dylan Monahan
Administrative Assistant
dmonahan@rpbcwd.org

Zach Dickhausen
Natural Resources Coordinator
zdickhausen@rpbcwd.org

Josh Maxwell
Water Resources & Fisheries Manager
jmaxwell@rpbcwd.org

Liz Forbes
Communications Manager
lforbes@rpbcwd.org

Mat Nicklay
Natural Resources Technician
mnicklay@rpbcwd.org

Andrew Hartmann
Water Resources Technician
ahartmann@rpbcwd.org

Alaina Portoghese
Communications Assistant
aportoghese@rpbcwd.org

RPBCWD Contact Info

Administrator Terry Jeffery
18681 Lake Drive East
Chanhassen, MN 55317
info@rpbcwd.org
952-607-6512

CONSULTANTS

DISTRICT ENGINEER
Barr Engineering Co.
Attn: Scott Sobiech, CFM, PE
4300 Market Pointe Drive, Suite 200, Edina, MN 55435

LEGAL
Smith Partners PLLP
Attn: Louis Smith
250 S Marquette Ave, Ste 250, Minneapolis, MN 55401

ACCOUNTING
Redpath and Company, Ltd.
Attn: Bonnie Burns
4810 White Bear Parkway, White Bear Lake, MN 55110

AUDITING
Abdo
Attn: Justin Nilson
5201 Eden Avenue Ste 250, Edina, MN 55436

ADMINISTRATION & PLANNING

10-YEAR MANAGEMENT PLAN

The District's current Watershed Management Plan was adopted in 2018. The plan guides all the District's actions, from monitoring to water quality projects, over a 10-year period. The plan can be found at rpbcwd.org/10yearplan. If you cannot access it online, contact District staff to obtain a copy.

Each year, a district workplan is developed to guide implementation of the 10-Year Watershed Management Plan. The workplan can be viewed in the next section of this report.

COMPONENTS OF THE 10-YEAR PLAN

Click item/chapter name to open URL.

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Chapter 7 | Purgatory Creek Watershed

Chapter 8 | Riley Creek Watershed

Chapter 9 | Implementation - The Next 10 Years

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Appendices

Appendix A: Public and Stakeholder Participation

Appendix B: Education and Outreach Plan

Appendix C: Goals and Strategies Tied to Stakeholder Input

Appendix D: Envision Credits and Criteria

Appendix E: Capital Improvements Implementation Process

Appendix F: Example Water Resources Report

Appendix G: Draft Report Card

Appendix H: BWSR Approval and RPBCWD Adoption

Amendments

Cost-share amendment (3-6-19)

St Hubert Catholic School Opportunity Project (10-2-19)

Spring Road Conservation Project (11-16-23); Resolution 23-064

LOCAL PLAN ADOPTION & IMPLEMENTATION

The District has received and approved Local Surface Water Management Plans for all cities within the District as required under the District's regulatory program. The District will continue to administer its regulatory program in all municipalities until such time as a city adopts local controls deemed to be equally protective.

FINANCIAL STATUS

The District's fund balance and financial status are included in the District's Annual Audit. The Annual Audit is included as Appendix D to this report. The District's audited financial report was prepared by Abdo, a certified public accounting firm. As required by Minnesota Rules §8410.0150, subp. 2, the Audited Financial Report includes classification and reporting of revenues and expenditures, a balance sheet, an analysis of changes in final balances, and all additional statements necessary for full financial disclosures.

2023 AUDIT

Upon its completion in late spring of 2024, the 2023 Audited Financial Report may be found at rpbcwd.org/annualreport. and will be distrubuted as required by statute.

BIENNIAL SOLICITATION OF INTEREST PROPOSALS

Under Minnesota Statute §103B.227, subd. 5, the District must issue a biennial solicitation for professional services. In early 2023, the District solicited for engineering, legal, accounting, and auditing services through local newspapers, the District website, and professional organization websites. The District selected Barr Engineering for engineering services, Smith Partner for legal services, Redpath and Company for accounting services, and Abdo for auditing services.

Lotus flower at Red Rock Lake by Kelley Regan.

LAND ACKNOWLEDGMENT

We acknowledge that we are on ancestral and contemporary Očhéthi Šakówiŋ land that was stolen from the Wahpékhute Dakota tribe in the 1851 Treaty of Mendota. We recognize these tribal nations as the original stewards of the land, water, and natural resources within the District, and we honor the importance of protecting the culturally significant resources of this land.

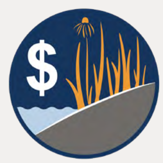
OVERVIEW OF DISTRICT PROGRAMS

WATER QUALITY MONITORING

Our water monitoring program supports our management plan's goal to remove waterbodies from the MPCA Impaired Waters list. We regularly monitor thirteen lakes, three creeks, and two wetlands in the district. Collected data allows tracking of water quality trends over time and to determine if a waterbody is meeting standards.
rpbcwd.org/waterquality

PERMITTING

State law requires us to have water protection standards. We run a permitting program to help meet those standards. Anyone planning a project that triggers District rules must obtain a permit from the District before beginning work.
rpbcwd.org/permits



STEWARDSHIP GRANT

The Stewardship Grant program offers financial support for clean water projects to property owners in the watershed district. Project examples include habitat restorations, shoreline restorations, rain gardens, and tree trenches. Residents can earn up to $5,000 for a project! Non-profits can earn up to $20,000!
rpbcwd.org/grants

COMMUNITY ENGAGEMENT

There are many ways volunteers can help protect water. RPBCWD fosters an engaged community through an aquatic invasive species monitoring program, support of the Minnesota Water Steward program, working with our Citizen Advisory Committee, and offering events and workshops.
rpbcwd.org/volunteer

CAPITAL IMPROVEMENT PROJECTS

Our capital improvement program identifies large-scale solutions and control measures to attain the District's water resource goals. Over the past 50 years, the District has implemented many projects, none of which would have been possible without our many community partners.
rpbcwd.org/projects

CAPITAL IMPROVEMENT PROGRAM UPDATE

To update the District's 10-year Watershed Management Plan, the District worked in 2018 to evaluate and prioritize its capital improvement projects. Of the 175 projects identified, the District, with input from partners, identified 34 projects to be implemented during the next 10 years beginning in 2018. One new project, Lake Riley Alum Treatment, was identified and added later. The table below provides a summary of the status of the District's Capital Improvement Program as of the end of 2023.

Status of Capital Improvement Projects Identified in Chapter 9 of the 10-year Plan.

Capital Improvement Project Name	Anticipated Substantial Completion	Status at end of 2022
BLUFF CREEK		
Bluff Creek Tributary	2020	Substantially complete; ongoing vegetation establishment
Bluff Creek Reach 5	2024	Feasibility study complete. Headwater wetland restoration added and completed. 30% design of Galpin Blvd crossing.
Chanhassen High School	Completed 2019	Closed out in 2020 and operations turned over to ISD 112.
Wetland Restoration at Pioneer Trail	2022	Substantial completion in July of 2022. On-going vegetation establishment and maintenance.
RILEY CREEK		
Like Riley Alum Treatment (second)	Completed 2020	Post-treatment monitoring including vegetation response.
Lake Susan Water Quality Improvement Phase 1	Completed 2019	Completed
Rice Marsh Lake In-lake Phosphorus Load Control	First dose completed 2018	Second dose scheduled for 2025.
Rice Marsh Lake Water Quality Improvement Phase 2	2022	Substantial completion in August of 2022. On-going vegetation establishment and maintenance. Monitoring of BMPs. Intake modifications and SCADA installation scheduled for 2024.
Riley Creek Restoration (Reach E and D3)	2020	Project closed out in fall of 2023. Management turned over to City of Eden Prairie.
Lake Riley and Rice Marsh Lake Subwatershed Assessment	Completed 2021	Assessment completed
Upper Riley Creek Stabilization	Construction 2024/2025	90% design complete; permitting finished; bid solicitation in spring of 2024 with construction in fall of 2024.
Middle Riley Creek Restoration	2022	Substantial completion in August of 2022; ongoing vegetation establishment and maintenance as well as E&O.
St. Hubert Water Quality Project	2021	Substantially completion Sept of 2021; ongoing vegetation establishment; development of education curriculum.
PURGATORY CREEK		
Lotus Lake Kerber Pond Ravine	2020	Feasibility complete
Purgatory Creek Recreation Area - Berm/Retention Area feasibility and design	2022	Design 90% complete; collaborating with City of Eden Prairie; construction postponed indefinitely.
Lotus Lake In-lake phosphorus Load Control	First dose completed 2018	Monitoring; second dose scheduled in 2024.
Silver Lake Water Quality Improvement Project	2022	Substantially complete in November 2021; ongoing vegetation establishment. Anticipated close out in fall of 2024.
Scenic Heights	2020	Completed. Maintenance turned over to Minnetonka Public Schools and City of Minnetonka.
Hyland Lake In-lake phosphorus Load Control	First dose completed 2019	Completed; turned over lead to Three Rivers Parks; still partnering as requested.
Mitchell Lake Subwatershed Assessment	Completed 2021	Assessment completed
Duck Lake Watershed Load	2021	Substantially complete; ongoing vegetation establishment
Lotus Lake Watershed Load - LL_1, LL_3, LL_7, & LL_8	2026	Draft feasibility report to be completed in February 2024. Project ordering in late spring of 2024 with construction to follow.

2023 FINAL BUDGET & WORKPLAN

The District adopted its 2023 Annual Budget in September 2022 and shared it with county assessors in December 2022. A table of 2023 revenue and expenditures, including tasks, goals, and expenses is below. These numbers are current as end of November 2023. To see complete revenue and expenditures, please review the RPBCWD Annual Financial Audit.

REVENUE

Item	2023 Budget	Actual received (Nov 2023)
Levy for Plan Implementation	$3,821,711	$3,773,853
Permit Fees	$114,000	$103,114
Grant Income	—	$54,500
Investment Income	$57,000	$355,568
Miscellaneous Income	—	$170

REVENUE (continued)

Item	2023 Budget	Actual received (Nov 2023)
Reimbursements	—	$62,992
Partner Funds	$100,000	$3,000
TOTAL REVENUE	**$4,092,711**	**$4,353,197**
Past Levies (carry-over)	**$3,136,338**	

EXPENDITURES

ADMINISTRATION

Budget item	Tasks	Done?	Goals	2023 Budget	Actual spent
Audit Services	• Coordinate with auditor for development of annual audit report	✓	Admin 1	$17,500	$16,078
Accounting Services	• Coordinate with accountants for development of financial reports	✓	Admin 1	$50,400	$28,608
Advisory Committees	• Engage with the Technical Advisory Committee on water conservation, chloride management, regulatory program, and emerging topics. • Engage with the Citizen Advisory Committee on water resources, regulatory program, grant program, E&O program, annual budget, and emerging topics	✓	Admin 1, Plan 1	$5,000	$0
Insurance and Bonds	• Purchase insurance for general liability, public official liability, property, and workers compensation.	✓	Admin 1	$30,000	0
Engineering Services	• Work with engineering consultant for oversight of all District Engineering activities. Includes engineer attendance at District meetings. mini case studies, assistance with District water management planning activities and other matters requiring District Engineer, and assistance for the District Administrator as needed.	✓	Admin 1, Reg 1	$145,000	$118,408
Legal Services	• Work with legal consultant to prepare and review legal documentation	✓	Admin 1	$108,000	$58,569
Manager Per Diem/Expense	• Compensate managers for time and expense for official duties	✓	Admin 1	$42,500	$37,265
Dues and Publications	• Purchase professional dues and publication subscriptions	✓	Admin 1	$16,000	$703
Office Costs	• Pay for office space, utilities, and supplies	✓	Admin 1	$256,700	$253,492
Permit Review and Inspection	• Collect fees for permit application reviews and project inspections	✓	Admin 1, Reg 1	$231,000	$152,946
Permit and Grant Database	• Maintain databases for permitting and cost share programs	✓	Admin 1, EO 1, Reg 1	$31,500	$7,537
Professional Services	• Engage professional services for information technology, professional coach, human resources, banking, etc.	✓	Admin 1	$36,300	$7,230
Recording Services	• Hire professional recorder to take minutes for board meetings	✓	Admin 1	$34,800	$16,368
Staff Cost	• Fund staff benefits such as salary and health insurance	✓	Admin 1	$776,271	$772,672
Fleet Management	• Maintain and repair vehicles for staff use	✓	Admin 1	$11,040	$3,435
			SUBTOTAL	**$1,792,011**	$1,475,668

PROGRAMS AND PROJECTS

Item	Tasks	Done?	Goals	2023 Budget	Actual spent (Nov 2023)
District Wide					
10-Year Management Plan Update	• Review and evaluate regulatory program for improved efficiency • Review and evaluate project prioritization metrics • Facilitate meetings for TAC, CAC, and othe stakeholders • Develop Ecological Health Action Plan (EHAP)	✓	Plan1, Plan 2	$135,000	$132,809
AIS Inspection and early response	• Partner with municipalities and counties to provide watercraft inspections at launches • Provide capacity and mechanics for rapid response to newly discovered aquatic invasive plant populations	✓	Wqual 1, Wqual 3	$68,000	$6,441
Cost-Share/Stewardship Grant	• Provide financial incentive to private landowners to implement best management practices on their properties • Provide financial assistance to municipalities to implement and incorporate best management practices into facilities management and capital projects • Provide technical assistance to landowners concerning erosion prevention, sediment control, and surface water management	✓	EO 1, Wqual 1, Wqual 3	$280,000	$93,845
Data Collection and Monitoring	• Collect hydraulic, hydrologic, and water quality data on District lakes and streams • Monitor and assess near-bank scour and escarpment erosion • Maintenance of Watershed Outlet Monitoring Program (WOMP) stations • Monitor flow rates and volumes as well as water quality parameters in areas identified as potential locations for BMPs • Monitor installed best management practices to assess efficacy and to guide future projects • Assist lake associations and municipalities in the development of lake management plans	✓	DC 1, Wqual 1	$233,300	$194,104
Community Resiliency	• Develop high resolution hydraulic and hydrologic model throughout the District • Develop flood risk mapping for various climate change impact scenarios • Partner with municipalities and local road authorities to identify and address community resilience practices and projects	✓	Plan1, Plan 2	$260,000	$14,834
Education and Outreach	• Work with local schools and other youth organizations to provide educational programs and curriculum pertaining to surface water management • Develop and disseminate information through written formats, website development, social media platforms, etc • Recruit, engage, and supervise volunteer groups • Engage in partnerships such as the Minnesota Water Steward program and the Hennepin County Chloride Initiative • Partner with municipalities to fulfill their MS4 requirements	✓	EO1, Plan 1	$110,000	$32,509
Plant Restoration – U of M	• Partner with faculty and students at the University of Minnesota to gather data on aquatic vegetation management and restoration.	✓	Wqual 1, Wqual 3, DC 1	$54,000	$32,577
Repair and Maintenance Fund	• Maintenance of best management practices initiated by the District	✓	Admin 1, Plan 1	$100,000	$25,041
Wetland Management*	• Assess all wetlands within the District utilizing the MN Rapid Assessment Methodology • Perform Floristic Quality Assessments on all District wetlands • Develop metrics for the assessment of functions and values that can be improved or restored throughout the District for water quality, erosion prevention, sediment control, habitat provision, biodiversity, community resilience. • Develop and maintain GIS database of wetland function and values	✓	Wqual 1, Wqual 2, Wquan 1, Plan 2	$140,000	$11,376
Groundwater Conservation*	• Work with cities to develop programs aimed at reduction of potable water supply use. • Collect data and employ modeling to understand groundwater / surface water interaction		Ground 1, Plan 1	$100,000	$0

Item	Tasks	Done?	Goals	2023 Budget	Actual spent (Nov 2023)
District Wide (continued)					
Lake Vegetation Implementation	• Perform point intercept surveys • Perform aquatic invasive species surveys • Perform turion counts	✓	Wqual 1, Wqual 3, Data 1	$148,000	$53,487
Opportunity Project*	• Funds dedicated to capital projects brought forward by stakeholders not currently identified in the 10-year plan. **Will require plan amendment when implemented.	✓	Admin 1, Plan 1	$250,000	$202.,063
Stormwater Ponds - U of M	• Finalization of the research done by the UofM SAFL on performance of stormwater pond and potential treatment.	✓	Plan 1, DC 1, Wqual 1	$4,830	$4,830
			SUBTOTAL	**$1,883,130**	$803,971

Bluff Creek					
Bluff Creek Tributary*	• Last year of maintenance for vegetation establishment and punchlist items in restored Bluff Creek tributary.	✓	Wqual 1	$5,000	$8,411
Wetland Restoration at Pioneer Trail*	• Removal of three homes from floodplain of large wetland complex • Restoration of seven acres of hydrologically altered wetland. • Flood storage, rate control, and stream protection for Bluff Creek • Work with volunteer organizations and local government to develop and provide for educational opportunities	✓	Plan 2, Wquan 1	$100,000	$13,248
Bluff Creek B5 by Galpin Blvd*	• Feasibility and design of creek restoration in upper Bluff Creek near headwaters • Evaluation of headwater wetland for restoration, flood storage, and habitat restoration.	✓	Wqual 21, Wqual 2, Wqual 3, Wquan 1, Plan 2, EO 1	$110,000	$7,517
			SUBTOTAL	**$215,000**	$29,175

Riley Creek					
Lake Riley Alum Treatment*	• Continue monitoring of Lake Riley to determine future actions.	✓	Wqual 1, DC 1	$0	$0
Rice Marsh Lake in-lake phosphorus load	• Sediment coring.	✓	Wqual 1, DC 1	$15,000	$0
Rice Marsh Lake Water Quality Improvement Phase 1	• Installation of two inline manufactured treatment devices • Construction of bioinfiltration practice • Restoration of prairie area as well as soils correction for infiltration and for data collection of efficacy as treatment practice	✓	Wqual 1, DC 1	$27,000	$10,653
Riley Creek Restoration (Reach E and D3)	• Final plant establishment and punchlist item completion for stabilization of lower Riley Creek	✓	Wqual 1,Wqual 3	$58,000	$16,618
Upper Riley Creek Stabilization	• Feasibility, design, and construction of upper Riley Creek from TH 5 to Lake Susan.	✓	Wqual 1,Wqual 3	$1,924,000	$174,576
Middle Riley Creek	• Final plant establishment and punchlist item completion for stabilization of middle Riley Creek	✓	Wqual 1,Wqual 3	$27,000	$30,181.15
St. Hubert Water Quality Project	• Work with school staff to develop educational curriculum and opportunities for students at St Hubert's and elsewhere • Final plant establishment and punchlist item completion for stabilization of St. Hubert Water Quality Project	✓	EO 1, Wqual 1	$50,000	$22,437
			SUBTOTAL	**$2,101,000**	**$263,732**

Item	Tasks	Done?	Goals	2023 Budget	Actual spent (Nov 2023)
Purgatory Creek					
Purgatory Creek Rec Area - Berm	• Partnership with Eden Prairie to repair of berm for flood control, water treatment, and recreational access.	✓	Wqual 1, Wqual 3, Plan 2	$214,000	$0
Lotus Lake in-lake phosphorus load control	• Dosing calculations for future alum treatment; will carry over to next year	✓	Wqual 1, Wqual 3	$115,000	$0
Silver Lake Water Quality BMP	• Final vegetation establishment and punch list items for project that installed iron enhanced sand filter ditch checks and channel stabilization	✓	Wqual 1	$9,400	$7,242
Hyland Lake in-lake phosphorus load control	• Assist Three Rivers Park District as needed.	✓	Wqual 1, Wqual 3 DC 1	—	$0
Duck Lake watershed load	• Vegetation maintenance of biofiltration features constructed in 2021 throughout the Duck Lake Watershed.	✓	Wqual 1, EO 1	$15,000	$78
Duck Lake Road Partnership	• Partnership with Eden Prairie to reconnect fragmented Duck Lake, protect lacustrian wetland areas and provide flood storage.	✓	Wqual 1, Plan 1, Plan 2	$235,000	$235,000
Lotus Lake Watershed Improvement Project	• Design and feasibility of multiple regional stormwater treatment practices throughout the Lotus Lake watershed in concert with Chanhassen	✓	Wqual 1, DC 1, Plan 1	$350,000	$49,332
Kerber Pond Ravine - Lotus Lake	• Partner with City of Chanhassen to stabilize tributary to Lotus Lake	✓	Wqual 1, Plan 1	$80,000	$0
			SUBTOTAL	**$1,018,400**	$320,365
			RESERVE	**$325,000**	TBD
			TOTAL EXPENDITURES	**$7,334,541**	**$2,870,752**

*Denotes multi-year-project.

2023 Final Budget notes

- Permit Review and Inspection – Still permit fee deposits to be released.
- AIS Inspection and early response – Have not been invoiced by Carver County.
- Cost-Share/Stewardship Grant – No municipalities requested grants. Still reimbursements pending spring inspection.
- Community Resiliency – Have not begun Phase II the identification of mitigation practices.
- Wetland Management* - Have not begun Phase II. Delayed for BWSR/DNR assessment work.
- Groundwater Conservation* - Monitoring well installation pushed to 2024.
- Lake Vegetation Implementation – Partnership with University of MN transferred some of the anticipated workload to U of M.
- Bluff Creek B5 by Galpin Blvd – delayed to align with Chanhassen road reconstruction project.
- Upper Riley Creek Stabilization – delayed one year to coordinate with the City of Chanhassen and acquire land use rights.
- Purgatory Creek Rec Area – Berm – delayed indefinitely to coordinate roles and responsibilities with the City of Eden Prairie.
- Lotus Lake in-lake phosphorus load control – delayed one year to wait for phase II of U of M wake study.
- Lotus Lake Watershed Improvement Project – delayed to align with proposed road CIP of Chanhassen.
- Kerber Pond Ravine - Lotus Lake – Rolled into the Lotus Lake Watershed Improvement Project.

2024 ADOPTED BUDGET & WORKPLAN

The District adopted its 2024 Annual Budget in September 2023 and was shared with county assessors in December 2023. A table of 2024 revenue and expenditures, including tasks and goals, is below. Values are rounded to the nearest dollar.

REVENUE

Item	2024 Budget
Levy for Plan Implementation	$4,047,281
Permit Fees	$114,000
Grant Income	$209,000
Investment Income	$200,000

REVENUE (continued)

Item	2024 Budget
Partner Funds	$666,000
TOTAL REVENUE	**$9,636,281**
Past Levies (Carry-over)	**$4,400,000**
Expendable Funds	**$9,636,281**

EXPENDITURES

ADMINISTRATION

Budget item	Tasks	Goals	2024 Budget
Audit Services	• Coordinate with auditor for development of annual audit report	Admin 1	$18,025
Accounting Services	• Coordinate with accountants for development of financial reports	Admin 1	$56,694
Advisory Committees	• Engage with the Technical Advisory Committee on water conservation, chloride management, regulatory program, and emerging topics. • Engage with the Citizen Advisory Committee on water resources, regulatory program, grant program, E&O program, annual budget, and emerging topics	Admin 1, Plan 1	$5,150
Insurance and Bonds	• Purchase insurance for general liability, public official liability, property, and workers compensation.	Admin 1	$30,900
Engineering Services	• Work with engineering consultant for oversight of all District Engineering activities. Includes engineer attendance at District meetings. mini case studies, assistance with District water management planning activities and other matters requiring District Engineer, and assistance for the District Administrator as needed.	Admin 1, Reg 1	$149,350
Legal Services	• Work with legal consultant to prepare and review legal documentation	Admin 1	$111,240
Manager Per Diem/Expense	• Compensate managers for time and expense for official duties	Admin 1	$34,763
Dues and Publications	• Purchase professional dues and publication subscriptions	Admin 1	$16,480
Office Costs	• Pay for office space, utilities, and supplies	Admin 1	$187,003
Permit Review and Inspection	• Collect fees for permit application reviews and project inspections	Admin 1, Reg 1	$237,930
Permit and Grant Database	• Maintain databases for permitting and cost share programs	Admin 1, EO 1, Reg 1	$26,000
Professional Services	• Hire other professional services as needed	Admin 1	$35,844
Recording Services	• Hire professional recorder to take minutes for board meetings	Admin 1	$35,844
Staff Cost	• Fund staff benefits such as salary and health insurance	Admin 1	$966,980
Fleet Management	• Maintain and repair vehicles for staff use	Admin 1	$11,371
		SUBTOTAL	**$1,923,574**

PROGRAMS AND PROJECTS

Item	Tasks	Goals	2024 Budget
District Wide			
10-Year Management Plan Update	• Review and evaluate regulatory program for improved efficiency • Review and evaluate project prioritization metrics • Facilitate meetings for TAC, CAC, and othe stakeholders • Develop Ecological Health Action Plan (EHAP)	Plan1, Plan 2	$95,000
AIS Inspection and early response	• Partner with municipalities and counties to provide watercraft inspections at launches • Provide capacity and mechanics for rapid response to newly discovered aquatic invasive plant populations	Wqual 1, Wqual 3	$68,000
Cost-Share/Stewardship Grant	• Provide financial incentive to private landowners to implement best management practices on their properties • Provide financial assistance to municipalities to implement and incorporate best management practices into facilities management and capital projects • Provide technical assistance to landowners concerning erosion prevention, sediment control, and surface water management	EO 1, Wqual 1, Wqual 3	$205,000
Data Collection and Monitoring	• Collect hydraulic, hydrologic, and water quality data on District lakes and streams • Monitor and assess near-bank scour and escarpment erosion • Maintenance of Watershed Outlet Monitoring Program (WOMP) stations • Monitor flow rates and volumes as well as water quality parameters in areas identified as potential locations for BMPs • Monitor installed best management practices to assess efficacy and to guide future projects • Assist lake associations and municipalities in the development of lake management plans	DC 1, Wqual 1	$170,250
Community Resiliency	• Develop high resolution hydraulic and hydrologic model throughout the District • Develop flood risk mapping for various climate change impact scenarios • Partner with municipalities and local road authorities to identify and address community resilience practices and projects	Plan1, Plan 2	$200,000
Education and Outreach	• Work with local schools and other youth organizations to provide educational programs and curriculum pertaining to surface water management • Develop and disseminate information through written formats, website development, social media platforms, etc • Recruit, engage, and supervise volunteer groups • Engage in partnerships such as the Minnesota Water Steward program and the Hennepin County Chloride Initiative • Partner with municipalities to fulfill their MS4 requirements	EO1, Plan 1	$115,500
Repair and Maintenance Fund	• Maintenance of best management practices initiated by the District	Admin 1, Plan 1	$100,000
Wetland Management*	• Assess all wetlands within the District utilizing the MN Rapid Assessment Methodology • Perform Floristic Quality Assessments on all District wetlands • Develop metrics for the assessment of functions and values that can be improved or restored throughout the District for water quality, erosion prevention, sediment control, habitat provision, biodiversity, community resilience. • Develop and maintain GIS database of wetland function and values	Wqual 1, Wqual 2, Wquan 1, Plan 2	$25,000
Groundwater Conservation*	• Work with cities to develop programs aimed at reduction of potable water supply use. • Collect data and employ modeling to understand groundwater / surface water interaction	Ground 1, Plan 1	$5,000

Item	Tasks	Goals	2024 Budget
District Wide (continued)			
Lake Vegetation Implementation	• Perform point intercept surveys • Perform aquatic invasive species surveys • Perform turion counts	Wqual 1, Wqual 3, Data 1	$142,200
Opportunity Project*	• Funds dedicated to capital projects brought forward by stakeholders not currently identified in the 10-year plan. **Will require plan amendment when implemented.	Admin 1, Plan 1	$0
Spring Road Conservation Project	• Protect rare and threatened species and habitat • Protect highly erodible land from development • Protect Riley Creek and riparian wetland from degradation • Provide for unique and collaborative education and outreach programs • Provide opportunity to study the impact of vegetation management, soil development, and other characteristics on ground water/surface water interaction • Evaluation and relocation of RPBCWD offices and facilities	Wqual 1, Wqual 2, Wqual 3, Ground 1, Wquan 1, Wquan 2	$420,000
UAA Updates	• Update Use Attainability Analyses	Multiple	$60,000
		SUBTOTAL	**$1,605,950**

Bluff Creek			
Wetland Restoration at Pioneer Trail	• Removal of three homes from floodplain of large wetland complex • Restoration of seven acres of hydrologically altered wetland. • Flood storage, rate control, and stream protection for Bluff Creek • Work with volunteer organizations and local government to develop and provide for educational opportunities	Plan 2, Wquan 1	$381,428
Bluff Creek B5 by Galpin Blvd	• Feasibility and design of creek restoration in upper Bluff Creek near headwaters • Evaluation of headwater wetland for restoration, flood storage, and habitat restoration.	Wqual 21, Wqual 2, Wqual 3, Wquan 1, Plan 2, EO 1	$260,000
		SUBTOTAL	**$641,428**

Riley Creek			
Rice Marsh Lake in-lake phosphorus load	• Sediment coring.	Wqual 1, DC 1	$15,000
Rice Marsh Lake Water Quality Improvement	• Installation of two inline manufactured treatment devices • Construction of bioinfiltration practice • Restoration of prairie area as well as soils correction for infiltration and for data collection of efficacy as treatment practice	Wqual 1, DC 1	$23,000
Riley Creek Restoration (Reach E and D3)	• Final plant establishment and punchlist item completion for stabilization of lower Riley Creek	Wqual 1,Wqual 3	$28,000
Upper Riley Creek Stabilization	• Feasibility, design, and construction of upper Riley Creek from TH 5 to Lake Susan.	Wqual 1,Wqual 3	$1,255,000
Middle Riley Creek	• Final plant establishment and punchlist item completion for stabilization of middle Riley Creek	Wqual 1,Wqual 3	$18,000
St. Hubert Water Quality Project	• Work with school staff to develop educational curriculum and opportunities for students at St Hubert's and elsewhere • Final plant establishment and punchlist item completion for stabilization of St. Hubert Water Quality Project	EO 1, Wqual 1	$40,000
		SUBTOTAL	**$1,379,000**

Item	Tasks	Goals	2024 Budget
Purgatory Creek			
Purgatory Creek Rec Area - Berm	• Partnership with Eden Prairie to repair of berm for flood control, water treatment, and recreational access.	Wqual 1, Wqual 3, Plan 2	$135,000
Lotus Lake in-lake phosphorus load control	• Dosing calculations for future alum treatment; will carry over to next year	Wqual 1, Wqual 3	$240,000
Silver Lake Water Quality BMP	• Final vegetation establishment and punch list items for project that installed iron enhanced sand filter ditch checks and channel stabilization	Wqual 1	$4,700
Duck Lake Road Partnership	• Partnership with Eden Prairie to reconnect fragmented Duck Lake, protect lacustrian wetland areas and provide flood storage.	Wqual 1, Plan 1, Plan 2	$235,000
Lotus Lake Watershed Improvement Project	• Design and feasibility of multiple regional stormwater treatment practices throughout the Lotus Lake watershed in concert with Chanhassen	Wqual 1, DC 1, Plan 1	$315,000
Kerber Ravine	• Partner with City of Chanhassen to stabilize tributary to Lotus Lake	Wqual 1, Plan 1	$75,000
		SUBTOTAL	**$1,004,700**
		RESERVE	**$453,645**
		TOTAL EXPENDITURES	**$6,554,652**

*Denotes multi-year-project.

APPENDICES

A. Acronyms

B. Annual Communication

C. Waterbody Factsheets

D. Water Resources Report

E. Regulatory Program Report

F. Wetland Program Report

G. Projects Report

H. Grant Program Report

I. Education and Outreach Report

J. Soil Health Program Report

APPENDIX A

Acronyms

Acronyms used in District Materials

ACEC	American Council of Engineering Companies
AIS	Aquatic Invasive Species
APWA	American Public Works Association
ASCE	American Society of Consulting Engineers
BFE	Base Flood Elevation
BMP	Best Management Practices
BWSR	Board of Water and Soil Resources
CAC	Citizens Advisory Committee
CIP	Capital Improvement Program
CRAS	Creek Restoration Action Strategy
CWA	Clean Water Act
CWF	Clean Water Fund
DWSMA	Drinking Water Supply Management Area
E&O	Education and Outreach
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
GIS	Geographic Information Systems
IAP2	International Association of Public Participation
IDDE	Illicit Discharge Detection and Elimination
LID	Low Impact Development
LGU	Local Government Unit
LOMA	Letter of Map Amendment
LVMP	Lake Vegetation Management Plan
MAWD	Minnesota Association of Watershed Districts
MBS	Minnesota Biological Survey
MCES	Metropolitan Council Environmental Services
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MDNR	Minnesota Department of Natural Resources
MnDOT	Minnesota Department of Transportation
MnRAM	Minnesota Routine Assessment Methodology
MLCCS	Minnesota Land Cover Classification System
MOU	Memorandum of Understanding
MPCA	Minnesota Pollution Control Agency
MRCC	Midwestern Regional Climate Center
MS4	Municipal Separate Storm Sewer System
MSHA	Minnesota Stream Habitat Assessment
MSL	Mean Sea Level
MSP	Minneapolis-St. Paul International Airport
MUSA	Metropolitan Urban Service Area
NAPP	National Aerial Photography Program
NFIP	National Flood Insurance Program
NHIS	Natural Heritage Information System
NPDES	National Pollutant Discharge Elimination System
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NRI	Natural Resources Inventory
NURP	Nationwide Urban Runoff Program
NWI	National Wetland Inventory
OHWL	Ordinary High Water Level
PAHs	Polycyclic Aromatic Hydrocarbons
PI Survey	Point-intercept survey (grid pattern aquatic plant survey)
PRAP	Performance Review and Assistance Review

PWI	Public Waters Inventory
RCL	Riley Chain of Lakes
RPBCWD	Riley Purgatory Bluff Creek Watershed District
RWI	Restorable Wetlands Inventory
SHPO	State Historic Preservation Office
SSTS	Subsurface Sewage Treatment Systems
SSURGO	Soil Survey Geographic dataset
SWCD	Soil and Water Conservation District
SWPPP	Stormwater Pollution Prevention Plan
TAC	Technical Advisory Committee
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TP-40	Technical Paper 40
TP-49	Technical Paper 49
TSS	Total Suspended Solids
TRPD	Three Rivers Park District
UAA	Use Attainability Analysis
UMN	University of Minnesota
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USDA	United States Department of Agriculture
USGS	United States Geologic Survey
VIC	Voluntary Investigation and Cleanup
WCA	Wetland Conservation Act
WHPP	Wellhead protection plan
WMO	Watershed Management Organization
WOMP	Watershed Outlet Monitoring Program
WRAPS	Watershed Restoration and Protection Strategy
WSTMP	Wetland Status and Trends Monitoring Program
YOY	Young of the Year

APPENDIX B

Annual Communication

RILEY PURGATORY BLUFF CREEK
WATERSHED DISTRICT







District Update

December 2023

As we wrap up another active year at the Riley Purgatory Bluff Creek Watershed District (RPBCWD), we reflect on what we've accomplished. Our monitoring program continues to collect a wealth of data used to track the health of our lakes, streams, and wetlands. This data informs prioritization of projects selected to improve the health of the watershed. Projects such as the Upper Riley Ecological Enhancement Project, planned to begin construction in 2024, will improve watershed health by stabilizing erosion, reestablishing native vegetation, and restoring floodplains.

District staff continue to regulate activities that impact the watershed through our permitting program. In addition to reviewing permit applications, staff inspect construction sites to ensure appropriate measures are taken to protect our waterbodies. Staff also mailed postcards to nearly 600 lakeshore owners to provide information about shoreline permit requirements and who to contact with questions.

October brought the District's first ever Creek Week with activities for all. A Build Your Own Rain Barrel workshop hosted at the RPBCWD office had participants convert retired wine barrels into rain barrels to capture roof runoff. Residents could also pick up a tree sapling reserved earlier in the year; the trees spent the summer growing strong roots in gravel beds at our office, giving them a strong start when planted in fall. Creek Week wrapped up with the annual Cycle the Creek – a staff-guided bicycle tour along Riley Creek. Beginning with Creek Week, and lasting all month long, the Passport Adventure encouraged people to get out to explore the watershed district by offering a prize pack to determined explorers.

In 2023, our Stewardship Grant program awarded almost $170,000 to residents, homeowner associations, cities and others committed to implementing natural shoreline restorations, habitat restorations, waterbody native vegetation buffers, and stormwater management projects. Some projects were also awarded funds to help pay for professional maintenance during the first three years, which is a critical time to establish native vegetation.

RPBCWD welcomed three new staff to our team this year: Dylan Monahan as Administrative Assistant, Alaina Portoghese as Communications Specialist and Andrew Hartmann as Water Resources Technician. We were also excited to welcome a new GreenCorps member, Rachel Whittington, this fall.

We at the district look forward to 2024, where we will continue our work to develop our Ecosystem Health Action Plan (EHAP for short). This collaborative effort includes contributions from many partners to inform, through an ecosystem lens, development of the 10-year management plan update. Learn more about this effort at rpbcwd.org/EHAP.

Sincerely,

Terry Jeffery
District Administrator

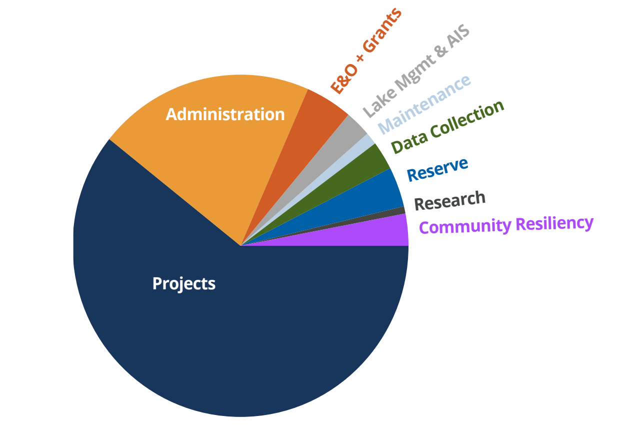
55 Years of Watershed Protection

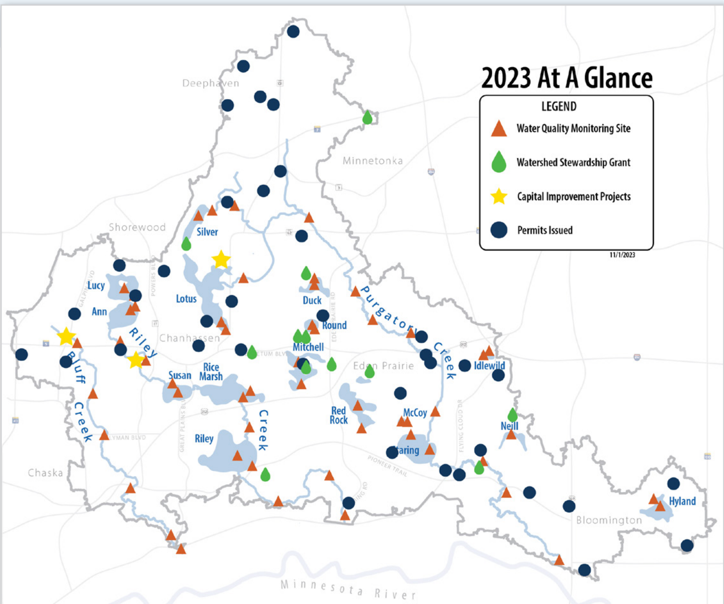
The Riley Purgatory Bluff Creek Watershed District (RPBCWD) is a special unit of local government with a boundary based on the watersheds of Riley, Purgatory, and Bluff creeks. It was established on July 31, 1969, following a petition by local property owners to the Minnesota Board of Water and Soil Resources. The purpose of RPBCWD is to protect and improve the water resources of our communities. RPBCWD partners with local communities to identify top priorities and plan, implement, and manage efforts which protect and improve local water resources. In addition, the District works to educate and engage community members regarding the protection of the District's water resources.

District tax dollars at work

Activities of the Riley Purgatory Bluff Creek Watershed District are funded through property tax levies. We thank our community for their part in financing our mission of protecting, managing, and restoring our water resources!

The 2023 levy was $3.8 million, and the board-approved 2023 budget, including funds from previous levies, was $7.3 million. The funds were used for projects, as well as administration, maintenance, lake and creek monitoring, aquatic invasive species management (AIS), education and outreach (E&O) and grant funding, community resiliency, and a reserve fund for emergencies.





Photos in the 2024 calendar were submitted by community members through our 2023 Photo Contest.

Board of Managers

The District is governed by a five-person board of managers. Four managers are appointed by the Hennepin County Commissioners and one by the Carver County Commissioners. They serve three-year terms.

Tom Duevel	Jill Crafton	Dorothy Pedersen	David Ziegler	Larry Koch
Vice President	*Treasurer*	*Secretary*	*President*	*Member*
Minnetonka	Bloomington	Shorewood	Eden Prairie	Chanhassen

Ecosystem Health Action Plan

RPBCWD has worked for decades to protect its natural waterbodies through directing management of stormwater runoff from hard surfaces. We are now developing an Ecosystem Health Action Plan to expand this mission to directly address green space runoff to take the next step to protect and restore water resources and reach towards a healthy urban ecosystem. The purpose of this plan has been to identify strategies, programs, and projects that can be undertaken to initiate ecosystem recovery to protect and restore water resources. Learn more at **rpbcwd.org/EHAP**.

Check out our Annual Reports

The watershed district's annual report is a summary of what happened the past year. It includes more information on watershed finances, projects, and plans for the upcoming year. Read the full report online at **rpbcwd.org/annualreport**.

Subject: Wrapping up 2023 at RPBCWD
Date: Monday, December 11, 2023 at 9:23:41 AM Central Standard Time
From: RPBCWD <info@rpbcwd.org>
To: Liz Forbes <LForbes@rpbcwd.org>

2023 Wrap-up from the Riley Purgatory Bluff Creek Watershed District

View this email in your browser

Letter from the District

As we wrap up another active year at the Riley Purgatory Bluff Creek Watershed District (RPBCWD), we reflect on what we've accomplished. Our monitoring program continues to collect a wealth of data used to track the health of our lakes, streams, and wetlands. This data informs prioritization of projects selected to improve the health of the watershed. Projects such as the Upper Riley Ecological Enhancement Project, planned to begin construction in 2024, will improve watershed health by stabilizing erosion, reestablishing native vegetation, and restoring floodplains.

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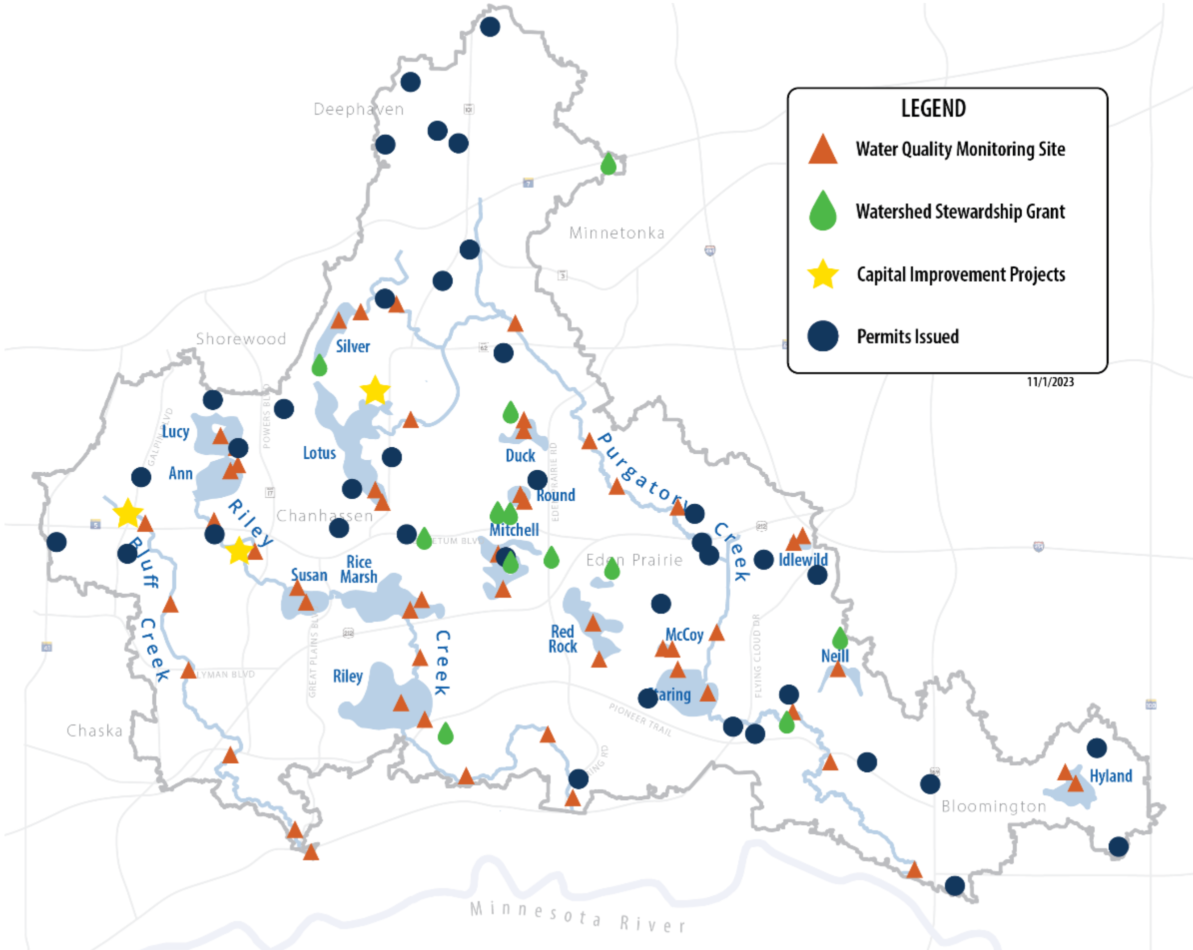
2023 At a Glance



District Tax Dollars at Work

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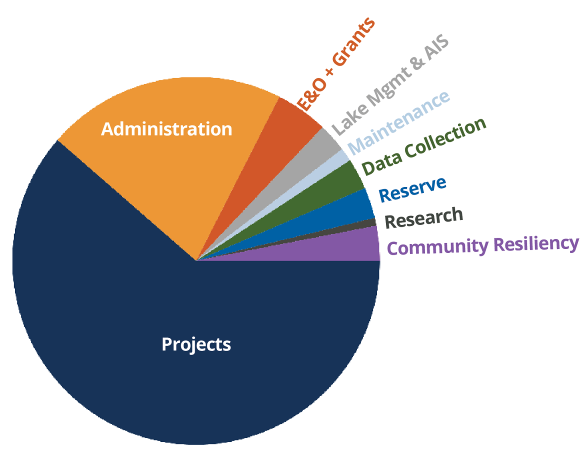

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and a reserve fund for emergencies.

Make Waves in 2024

The Riley Purgatory Bluff Creek Watershed District has 2 opportunities to get your feet wet in the new year. If you're looking for opportunities to get more involved in clean water protection, now's your chance!

Join the Citizen Advisory Committee

The Citizen Advisory Committee (CAC) is a volunteer advisory board comprised of community members whose role is to advise the RPBCWD Board of Managers as a representative of community interest. During monthly meetings, you will learn about water resource issues and management strategies within the district as well as review and comment on new programs and projects. As a community representative, you will be a voice for community interests and concerns. You will play an active role in making decisions that impact clean water in the district.

Youth Representative: Are you or someone you know a high school student looking to get more involved in our community? We are seeking to add young voices to our committee through a designated Youth Seat on the CAC.

If you want to be a part of this welcoming, active committee of engaged volunteers, consider submitting an application today! Apply by December 17th.

Become a Minnesota Water Steward

The Minnesota Water Stewards certification program offers a great opportunity for you to join a local network of energized leaders and tackle environmental problems in your community. You don't have to be an expert. We'll show you the way!

Minnesota Water Stewards work within their communities as knowledgeable resources around local water health:

- **Educating Communities:** Help neighbors understand the most pressing environmental problems in their area.
- **Reducing Pollutants & Conserving Water:** Raise awareness of pollution sources such as pet waste, fertilizer, or pesticides and work to reduce their impact.
- **Coordinating Action:** Organize and help coordinate projects within communities to protect and conserve water.

The Minnesota Water Stewards (MWS) certification was developed by Freshwater to provide those interested in protecting and improving water health in their communities with the knowledge, skills, and relationship with local governments they need. Stewards work through in-depth coursework that includes water science, land/water/climate interaction, behavior change, and best practices in water efficiency and protection. A culminating capstone project unites the curriculum with action that benefits the health of local waters. Stewards gain experience and confidence to serve as a source of knowledge and influence in their communities.

Learn more and apply

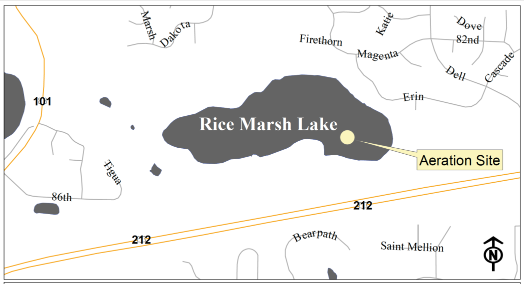
2024 Calendars Now Available

Our 2024 Calendars are ready to go home with you! The photos in this calendar were submitted by community members to our 2023 Photo Contest. Click here to view all winning photographs.

Want to see your photographs featured in our 2025 calendar? Submit them to our 2024 photo contest!

Pick up a free copy at a location near you

Notice of Open Water on Rice Marsh Lake



Rice Marsh Lake Aeration

The Riley Purgatory Bluff Creek Watershed District will be operating an aeration system on Rice Marsh Lake from December 1, 2023, until May 1st, 2024, that will result in open water. Anyone on the lake should be aware of the danger of open water and thin ice around the aeration system. This aeration system is necessary to prevent winter fish kill in the lake. The aeration system will be marked and located in the southeast quadrant of the lake; a map of the aeration system location is shown. This notice is being provided with residents' safety in mind and in accordance with MN Statute 103G.611 Subd. 4.

Board of Managers

Tom Duevel	Jill Crafton	Dorothy Pedersen	David Ziegler	Larry Koch
Vice President	*Treasurer*	*Secretary*	*President*	*Member*
Minnetonka	Bloomington	Shorewood	Eden Prairie	Chanhassen

The District is governed by a five-person board of managers. Four managers are appointed by the Hennepin County Commissioners and one by the Carver

County Commissioners. They serve three-year terms.

Learn more about RPBCWD

Facebook Instagram Twitter Website Email

Our mailing address is:
18681 Lake Drive East | Chanhassen, MN 55317

Our phone number is: 952-607-6512

APPENDIX C

Waterbody Factsheets

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Update

Riley Creek

Riley Creek begins at lakes Lucy and Ann in Chanhassen and flows through three lakes - Susan, Rice Marsh, and Riley - before descending to the Minnesota River Valley. The creek has mild topography in its upper and middle watershed, but below Lake Riley the banks become steep.

Keeping Riley Creek healthy requires several tools and strategies. Conducting projects to stabilize streambanks and restore stretches of stream is one strategy. Cleaning and slowing rainwater runoff before it reaches the creek is another. Before either of these can be done, we need to understand how the creek is doing and where it needs the most help.

District staff and the Metropolitan Council have monitored the creek's water quality for almost 20 years. The District developed a tool to assess the creek: the Creek Restoration Action Strategy (CRAS). The CRAS uses water quality data, as well as information on erosion and habitat, to rank which creek stretches (sections) are doing the best and which are doing the poorest. CRAS scores for each stretch of stream are located on the next page.

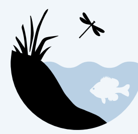
The three major types of data used in creek monitoring

Water quality

District staff take samples at five sites during the summer. They gather information about nutrient levels (phosphorus), sediment, pH, and dissolved oxygen. This data lets us know how clean the water is and if it's healthy for plants, animals, and people.

Erosion

Every three years, staff walk sections of the creek. They note sites with erosion, its severity, and whether any structures like houses or bridges are at risk. Erosion is also a problem because any soil that erodes into the creek is a pollutant.

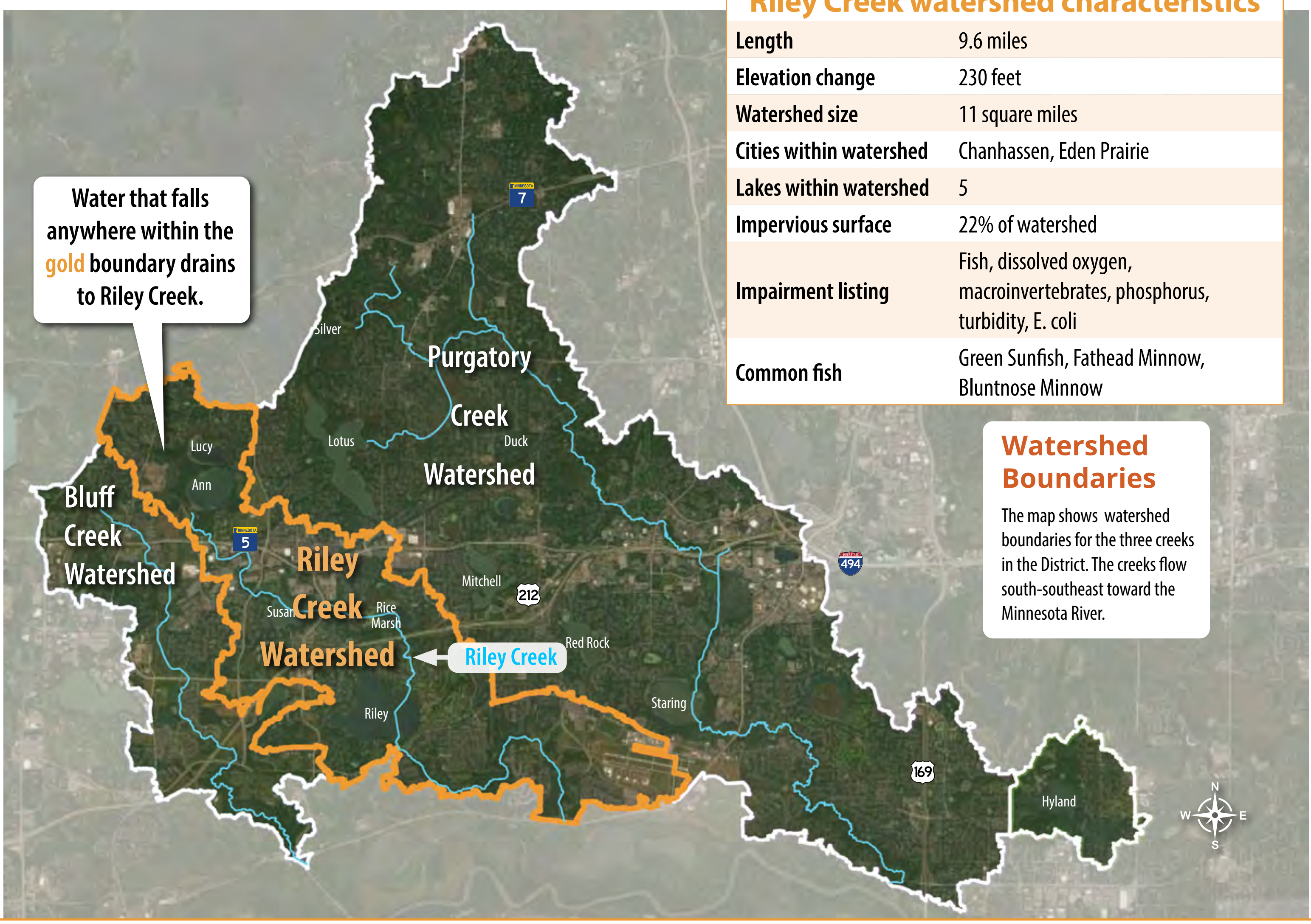


Habitat

Creeks are important habitat for insects, plants, fish, birds, and other animals. When staff check for erosion, they also assess the habitat. Reaches receive a score based on the quality of habitat they provide and whether it needs to be restored.

Riley Creek watershed characteristics

Length	9.6 miles
Elevation change	230 feet
Watershed size	11 square miles
Cities within watershed	Chanhassen, Eden Prairie
Lakes within watershed	5
Impervious surface	22% of watershed
Impairment listing	Fish, dissolved oxygen, macroinvertebrates, phosphorus, turbidity, E. coli
Common fish	Green Sunfish, Fathead Minnow, Bluntnose Minnow



Watershed Boundaries

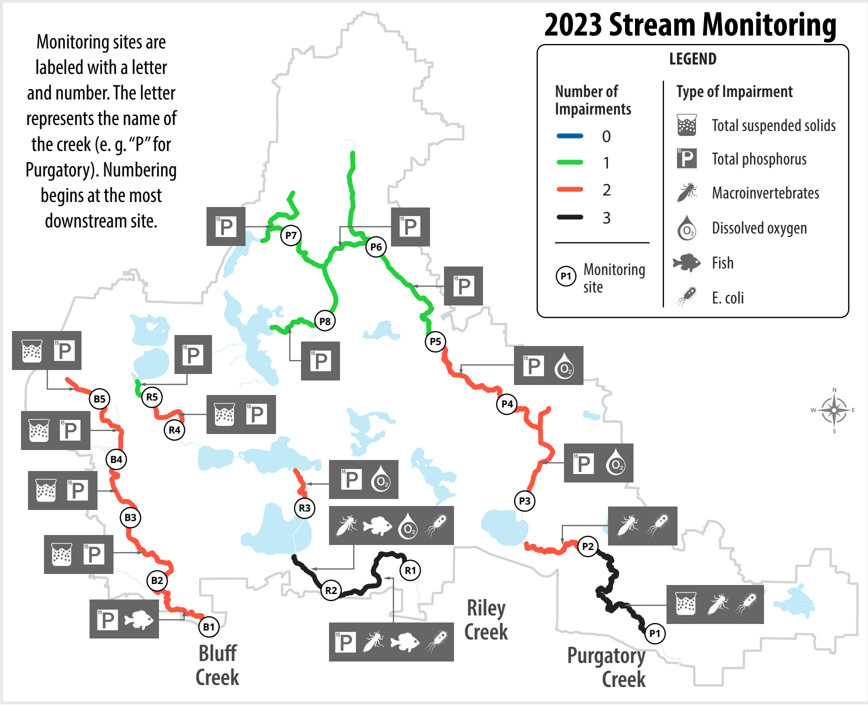
The map shows watershed boundaries for the three creeks in the District. The creeks flow south-southeast toward the Minnesota River.

2023 Stream Monitoring Results

Stream Water Quality Monitoring

In 2023, District staff collected and analyzed water samples every two weeks, April through September, to determine the average water quality of Bluff, Riley, and Purgatory creeks. The District monitors six impairment categories based upon standards set by the Minnesota Pollution Control Agency (MPCA)

In 2023, the continued drought significantly impacted the streams. Of the 18 regular sampling sites, 14 went dry or became stagnant at some point. From 2022 to 2023, stream water quality was reduced slightly across the district. Excluding the dissolved oxygen impairment, the number of water quality standards exceeded overall increased slightly from 2021 to 2022. Similar to previous years, Total Phosphorus (TP) was the water quality standard causing the most impairments in 2023 with 15 of the 18 sites not meeting the standard.

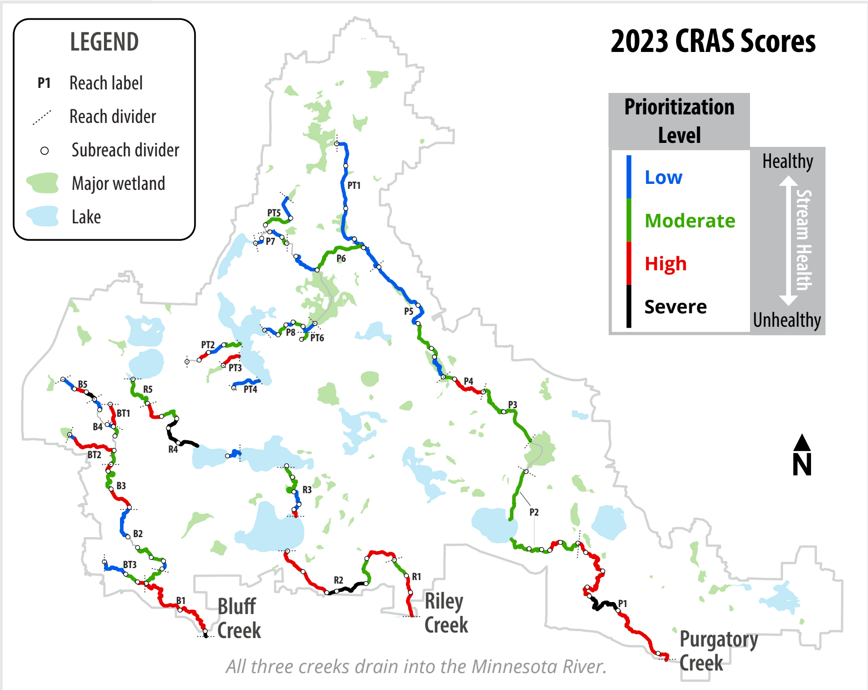


CRAS Scores for Stream Restoration Planning

The District developed the Creek Restoration Action Strategy (CRAS) to prioritize creek reaches, sub-reaches, or sites, in need of stabilization and/or restoration. The District identified eight categories of importance for project prioritization:

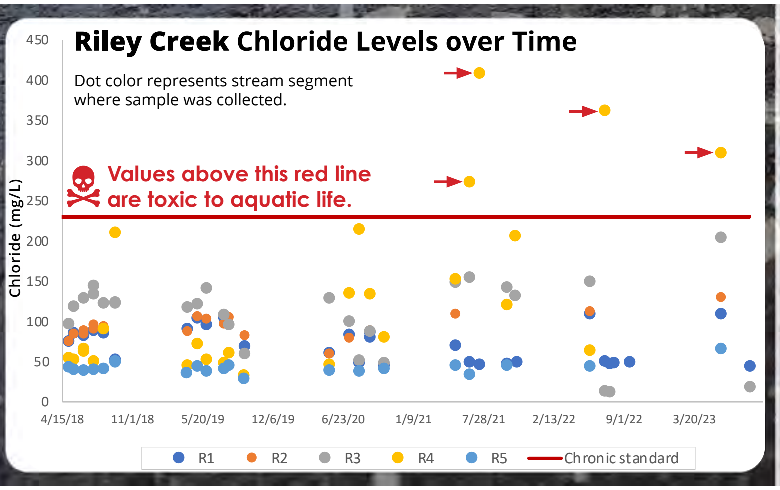
- Infrastructure risk
- Erosion and channel stability
- Public education
- Ecological benefits
- Water quality
- Project cost
- Partnerships
- Watershed benefits

These categories were scored using methods developed for each category based on a combination of published studies and reports, erosion inventories, field visits, and scoring sheets from specific methodologies. Final tallies of scores for each category, using a two-tiered ranking system, were used to prioritize sites for restoration/ remediation.



Chloride: A Growing Concern

Chloride permanently pollutes our lakes, ponds, and streams. Winter de-icers, water softeners, and fertilizers all contribute to chloride pollution.



What can I use instead of winter de-icers?

All affordable & effective residential de-icing products contain chloride, even those labeled as "eco-friendly" or "pet safe."

Focus instead on reducing build up of ice on your property:

- **Shovel early & often**
- **Prevent ice formation, avoid driving or walking on snow**
- **Pile snow where it won't melt & refreeze on walkways**

Learn more rpbcwd.org/salt

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Update

Purgatory Creek

Purgatory Creek has three headwaters: Lotus Lake in Chanhassen, Silver Lake in Shorewood, and wetlands in Minnetonka. After these forks join, the creek flows through the Purgatory Recreation Area and Staring Lake before eventually reaching the Minnesota River.

Keeping Purgatory Creek healthy requires several tools and strategies. Conducting projects to stabilize streambanks and restore stretches of stream is one strategy. Cleaning and slowing rainwater runoff before it reaches the creek is another. Before either of these can be done, we need to understand how the creek is doing and where it needs the most help.

District staff have monitored Purgatory Creek since the 1970s. The District developed a tool to assess the creek: the Creek Restoration Action Strategy (CRAS). The CRAS uses water quality data, as well as information on erosion and habitat, to rank which creek stretches (sections) are doing the best and which are doing the poorest. CRAS scores for each stretch of stream are located on the next page.

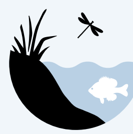
The three major types of data used in creek monitoring

Water quality

District staff take samples at five sites during the summer. They gather information about nutrient levels (phosphorus), sediment, pH, and dissolved oxygen. This data lets us know how clean the water is and if it's healthy for plants, animals, and people.

Erosion

Every three years, staff walk sections of the creek. They note sites with erosion, its severity, and whether any structures like houses or bridges are at risk. Erosion is also a problem because any soil that erodes into the creek is a pollutant.

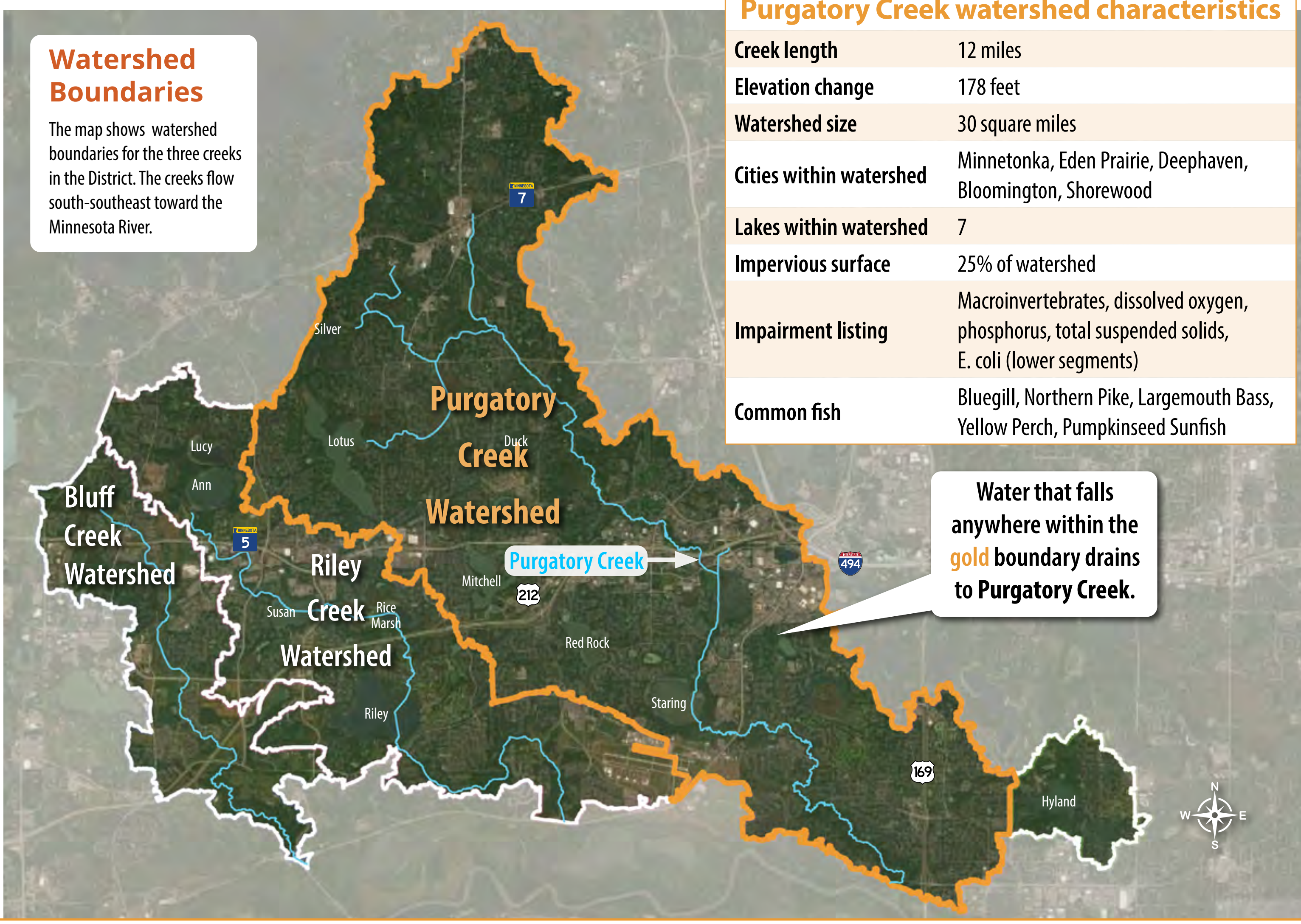


Habitat

Creeks are important habitat for insects, plants, fish, birds, and other animals. When staff check for erosion, they also assess the habitat. Reaches receive a score based on the quality of habitat they provide and whether it needs to be restored.

Watershed Boundaries

The map shows watershed boundaries for the three creeks in the District. The creeks flow south-southeast toward the Minnesota River.



Purgatory Creek watershed characteristics

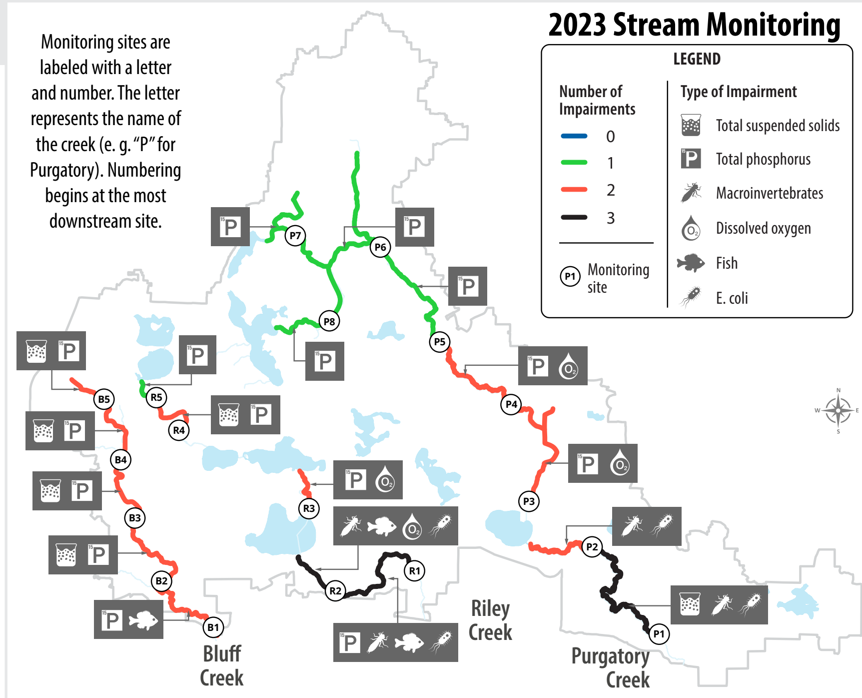
Creek length	12 miles
Elevation change	178 feet
Watershed size	30 square miles
Cities within watershed	Minnetonka, Eden Prairie, Deephaven, Bloomington, Shorewood
Lakes within watershed	7
Impervious surface	25% of watershed
Impairment listing	Macroinvertebrates, dissolved oxygen, phosphorus, total suspended solids, E. coli (lower segments)
Common fish	Bluegill, Northern Pike, Largemouth Bass, Yellow Perch, Pumpkinseed Sunfish

2023 Stream Monitoring Results

Stream Water Quality Monitoring

In 2023, District staff collected and analyzed water samples every two weeks, April through September, to determine the average water quality of Bluff, Riley, and Purgatory creeks. The District monitors six impairment categories based upon standards set by the Minnesota Pollution Control Agency (MPCA)

In 2023, the continued drought significantly impacted the streams. Of the 18 regular sampling sites, 14 went dry or became stagnant at some point. From 2022 to 2023, stream water quality was reduced slightly across the district. Excluding the dissolved oxygen impairment, the number of water quality standards exceeded overall increased slightly from 2021 to 2022. Similar to previous years, Total Phosphorus (TP) was the water quality standard causing the most impairments in 2023 with 15 of the 18 sites not meeting the standard.

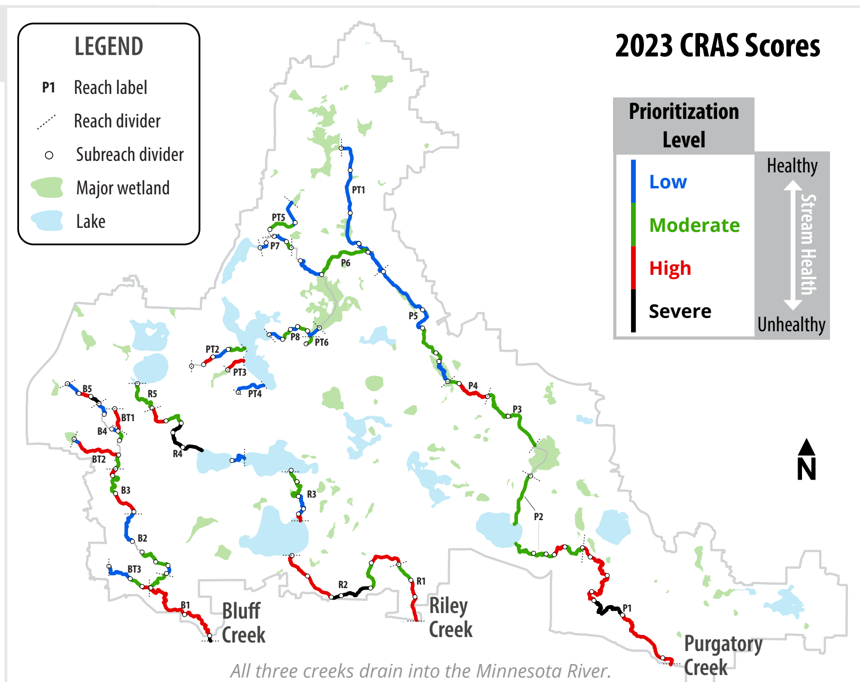


CRAS Scores for Stream Restoration Planning

The District developed the Creek Restoration Action Strategy (CRAS) to prioritize creek reaches, sub-reaches, or sites, in need of stabilization and/or restoration. The District identified eight categories of importance for project prioritization:

- Infrastructure risk
- Erosion and channel stability
- Public education
- Ecological benefits
- Water quality
- Project cost
- Partnerships
- Watershed benefits

These categories were scored using methods developed for each category based on a combination of published studies and reports, erosion inventories, field visits, and scoring sheets from specific methodologies. Final tallies of scores for each category, using a two-tiered ranking system, were used to prioritize sites for restoration/ remediation.



Chloride: A Growing Concern

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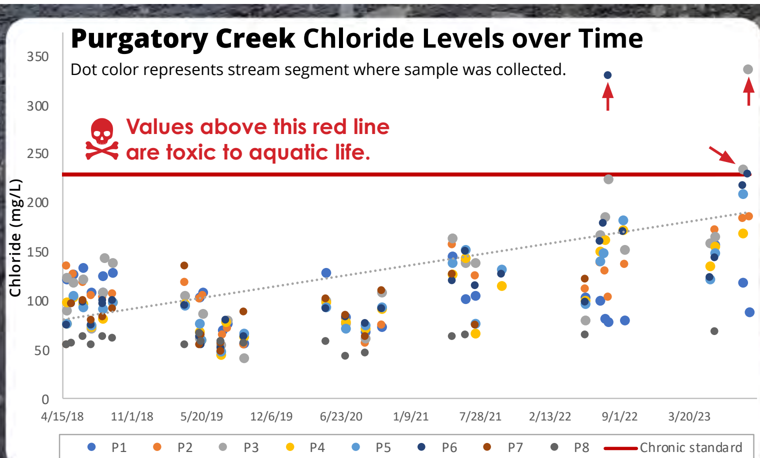

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Learn more rpbcwd.org/salt

2023 Update

Bluff Creek

Bluff Creek is about seven miles long. Unlike Purgatory and Riley creeks, it does not connect any lakes on its way to the Minnesota River. However, it does connect many wetlands, and you can explore almost its entire length on trails.

Keeping Bluff Creek healthy requires several tools and strategies. Conducting projects to stabilize streambanks and restore stretches of stream is one strategy. Cleaning and slowing rainwater runoff before it reaches the creek is another. Before either of these can be done, we need to understand how the creek is doing and where it needs the most help.

District staff have monitored Bluff Creek since the 1980s. To assess creek health, staff developed a tool called the Creek Restoration Action Strategy (CRAS). CRAS uses water quality data, as well as information on erosion and habitat, to rank which creek stretches (sections) are doing the best and which are doing the poorest. CRAS scores for each stretch of stream are located on the next page.

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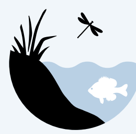

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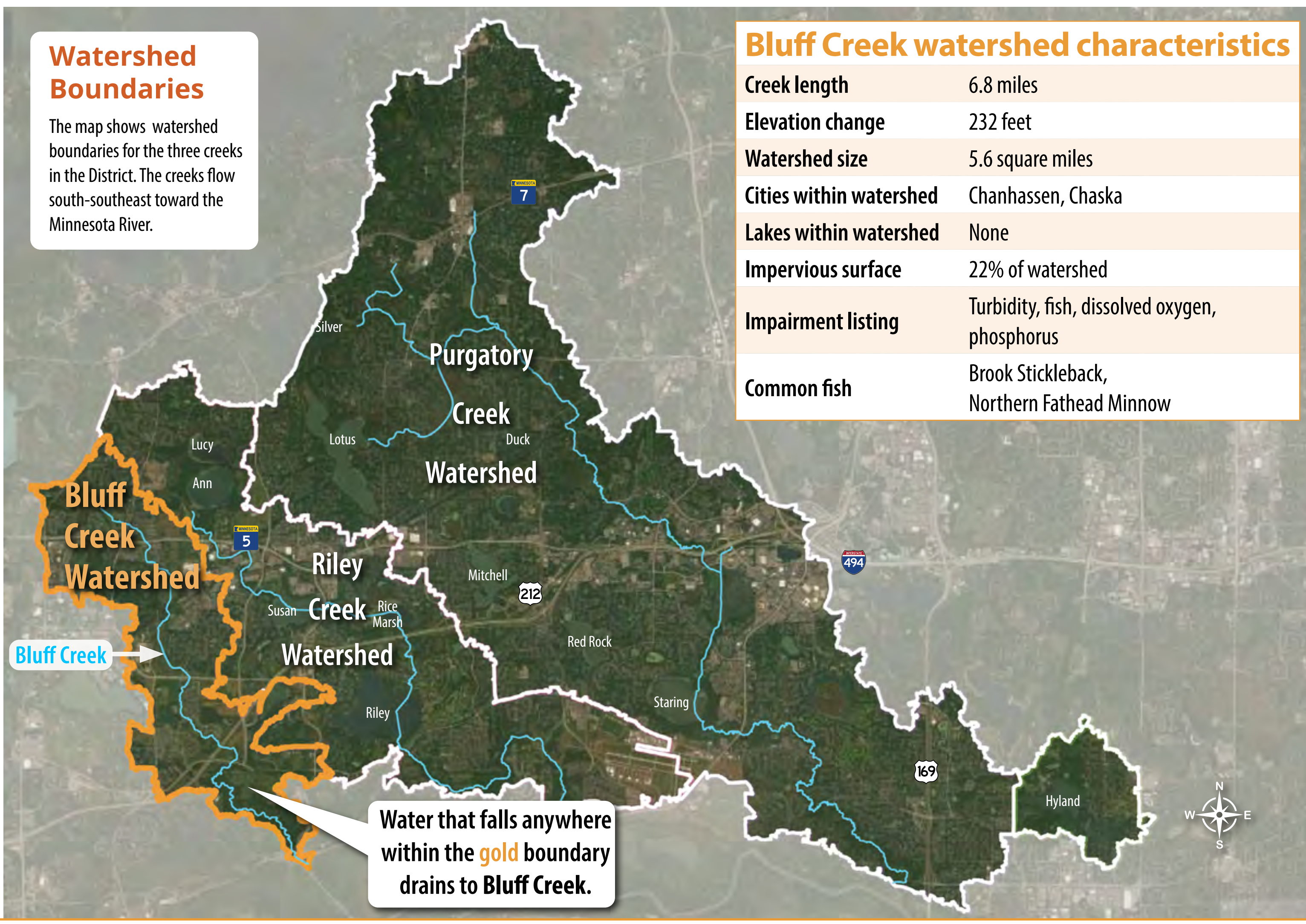

Watershed Boundaries

The map shows watershed boundaries for the three creeks in the District. The creeks flow south-southeast toward the Minnesota River.

Bluff Creek watershed characteristics

Creek length	6.8 miles
Elevation change	232 feet
Watershed size	5.6 square miles
Cities within watershed	Chanhassen, Chaska
Lakes within watershed	None
Impervious surface	22% of watershed
Impairment listing	Turbidity, fish, dissolved oxygen, phosphorus
Common fish	Brook Stickleback, Northern Fathead Minnow

2023 Stream Monitoring Results

Stream Water Quality Monitoring

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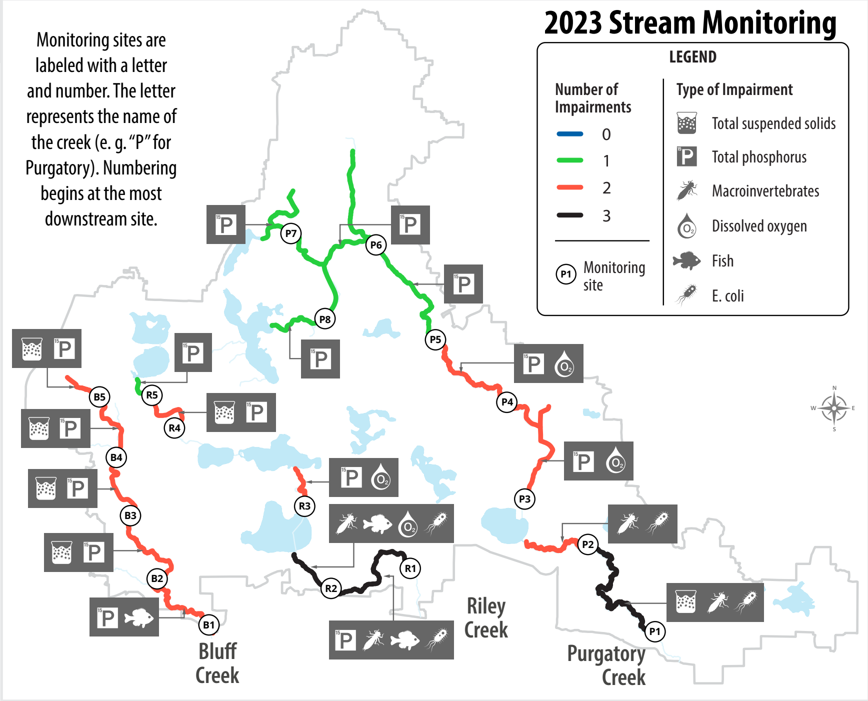

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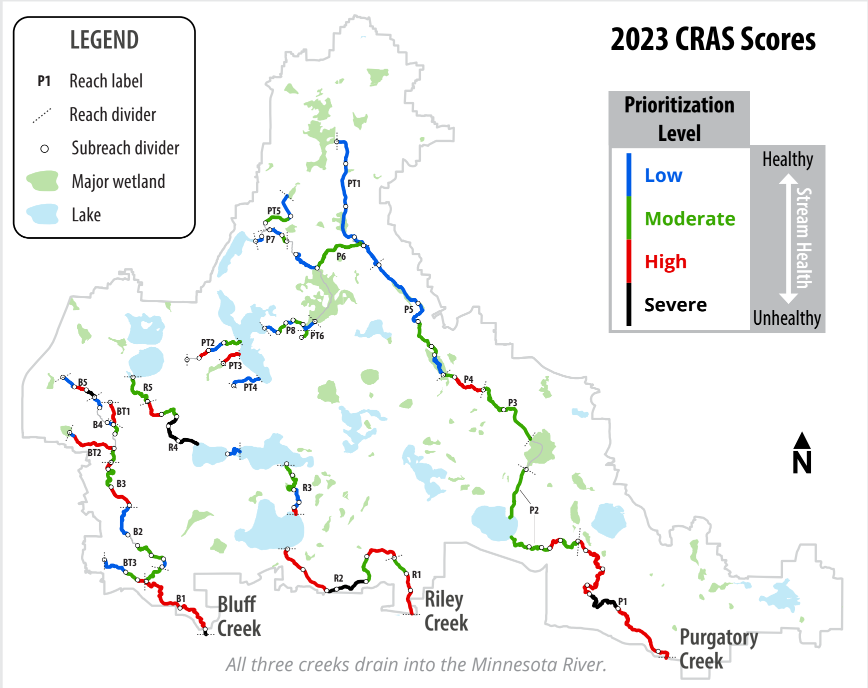

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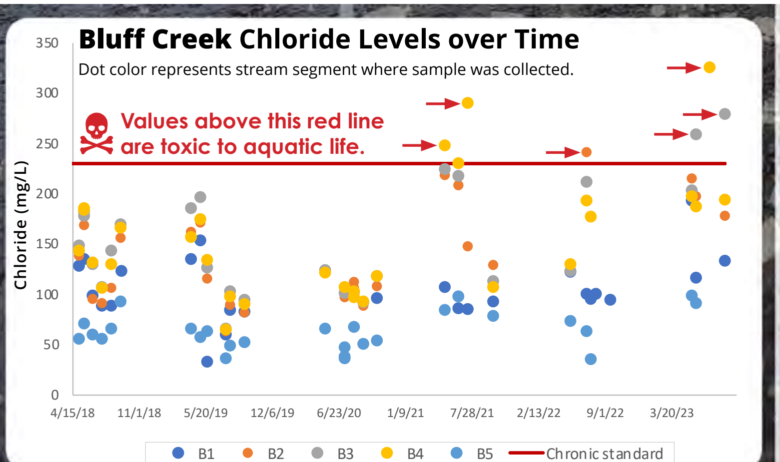

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Learn more rpbcwd.org/salt

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Update

Lake Ann

Located in Chanhassen, Lake Ann is at the headwaters of Riley Creek. Over the past 40 years, Lake Ann has consistently met the Minnesota Pollution Control Agency clean water standards.

From June to September every year, District staff visit the lake every two weeks to collect water samples and take readings. Samples are sent to a laboratory to be tested for nutrients and other compounds. Staff also measure water clarity by lowering a Secchi disk into the water and measuring how deep it goes before it is no longer visible. The data indicates the lake's health based on standards set by the Minnesota Pollution Control Agency (MPCA).

Lake Ann is classified as a "Deep Lake" by the MPCA. To be considered healthy, the lake must have very low average phosphorus and chlorophyll-a levels and an average water clarity of 1.4 meters (4.6 feet) or greater. See summary below. Additional details are located on the next page.

Total Phosphorus: The lake consistently meets the MPCA deep lake standard (<0.04 mg/L). In 2023, the average was **0.022 mg/L**, which is slightly up from 2022. Ann continues to have some of the best water quality in the District.

Chlorophyll-a: The lake consistently meets the MPCA deep lake standard (<14 µg/L). In 2023, the average chlorophyll-a reading was **10.98 µg/L**, This is slightly worse than the historical average of 8.2 µg/L.

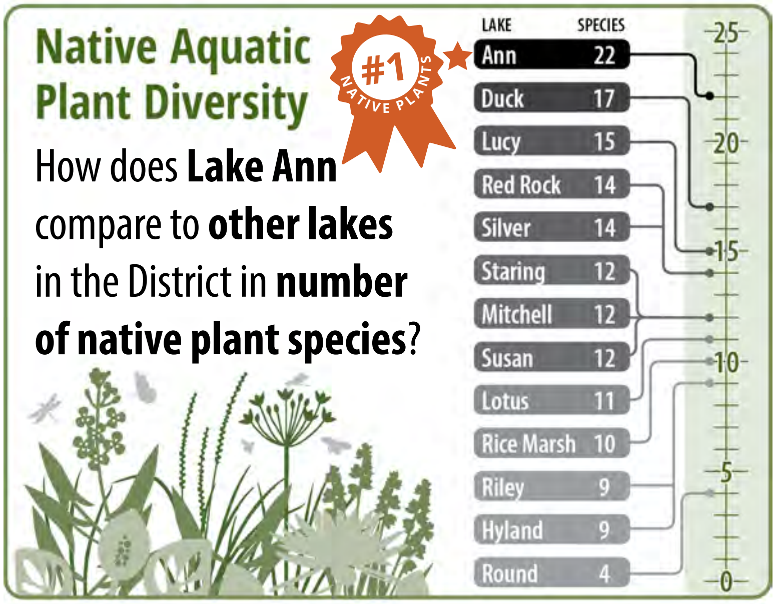
Water clarity: The lake consistently meets the MPCA deep lake standard (>1.4 meters). The average reading in 2023 was **3.0 meters**, which is better than the historical average of 2.6 meters.

Plants: Lake Ann has the highest plant diversity of all lakes in the district at 22 species. Coontail was the most common plant found at 67% of sites followed by Flatstem Pondweed at 55% of sites. White Water Lily was the most dominant floating plant at 28% frequency of occurrence. In the 2023 survey, no Eurasian Watermilfoil was sampled. However, for the first time, Brittle Naiad was at a detectable level (4% frequency of occurrence) since its discovery in the lake in 2017.

Lake & watershed characteristics

Lake size	119 acres
Average lake depth	16.8 feet
Maximum lake depth	40 feet
MPCA lake classification	Deep lake
Watershed size	257 acres
Impervious surface	2% of watershed
Impaired Waters listing	Mercury
Common fish	Bluegill, Northern Pike, Largemouth Bass, Yellow Perch, Pumpkinseed Sunfish
Invasive species	Curly-leaf Pondweed, Eurasian Watermilfoil, Common Carp, Brittle Naiad, Zebra Mussel

Watershed Boundary

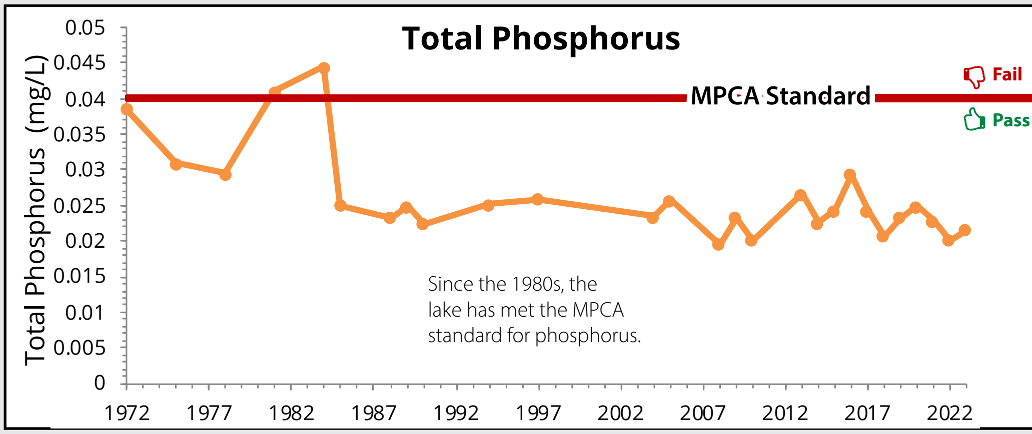


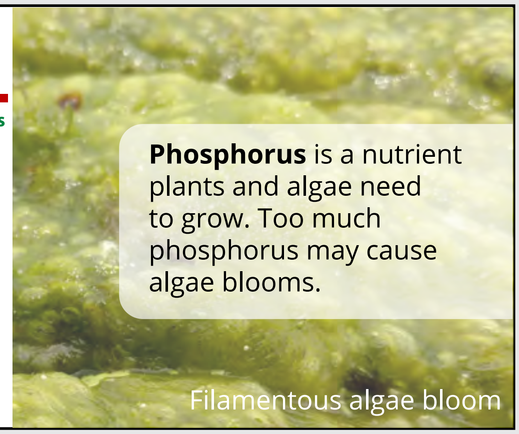
Lake Ann Water Quality by the Numbers

Water Quality Report Card
rpbcwd.org/grades
A

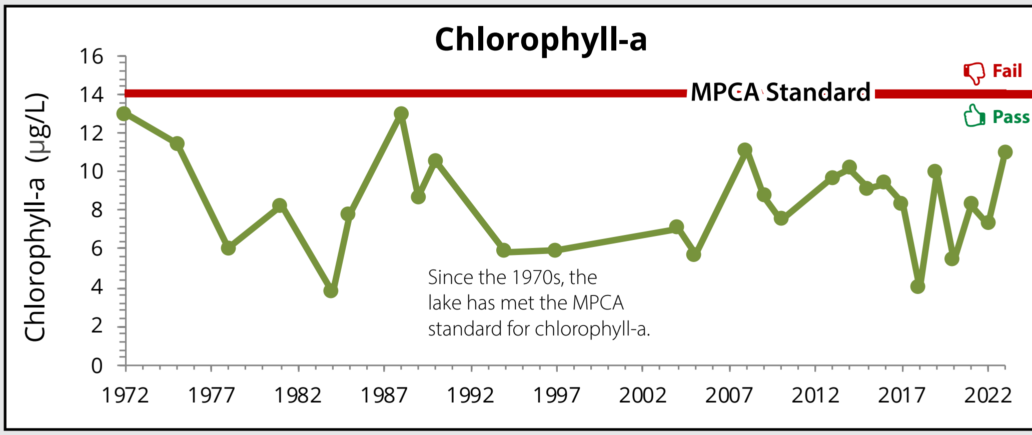
For the past 40 years, **Lake Ann** has consistently met the clean water standards set by the MPCA. The graphs below show water quality trends over time with the red line representing the MPCA standard for **deep lakes**.

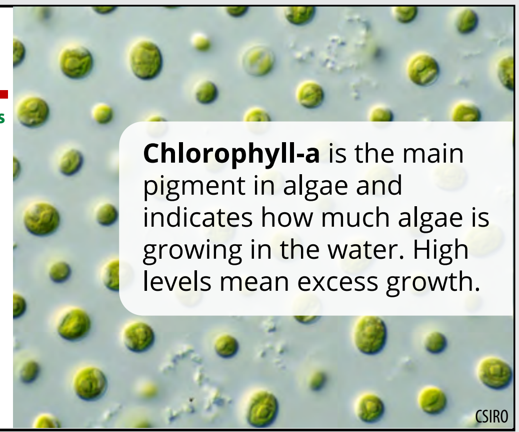
Trends Over Time: 1972-present



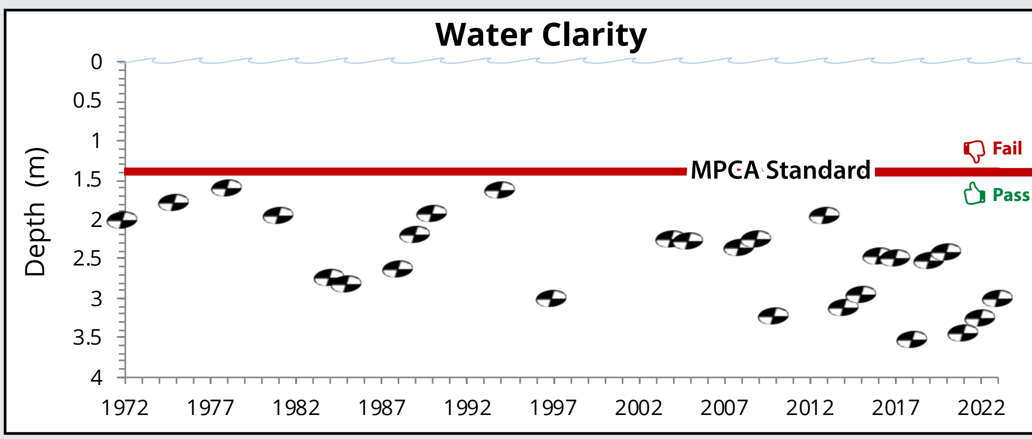


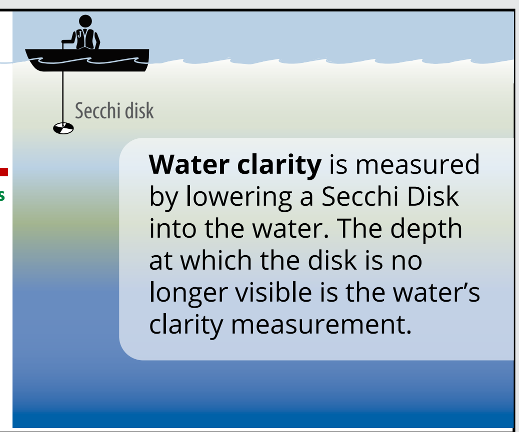
Phosphorus is a nutrient plants and algae need to grow. Too much phosphorus may cause algae blooms.





Chlorophyll-a is the main pigment in algae and indicates how much algae is growing in the water. High levels mean excess growth.

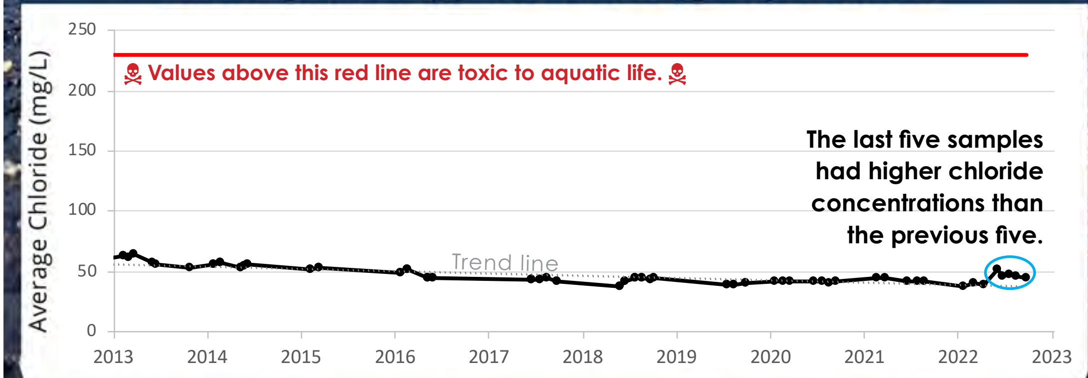




Water clarity is measured by lowering a Secchi Disk into the water. The depth at which the disk is no longer visible is the water's clarity measurement.

Chloride: A Growing Concern

Chloride permanently pollutes our lakes, ponds, and streams!



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RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Update

Duck Lake

Located in Eden Prairie, Duck Lake is one of the District's shallow lakes. Since 2011, it has seen improvement in water quality and met the Minnesota Pollution Control Agency's clean water standards for several years.

From June to September every year, District staff visit the lake every two weeks to collect water samples and take readings. Samples are sent to a laboratory to be tested for nutrients and other compounds. Staff also measure water clarity by lowering a Secchi disk into the water and measuring how deep it goes before it is no longer visible. The data indicates the lake's health based on standards set by the Minnesota Pollution Control Agency (MPCA).

Duck Lake is classified as a "Shallow Lake" by the MPCA. To be considered healthy, the lake must have very low average phosphorus and chlorophyll-a levels and average water clarity of 1.0 meter (3.3 feet) or greater. See summary below. Additional details are located on the next page.

Total Phosphorus: No significant trend. In 2023, the lake met the MPCA shallow lake standard (<0.06 mg/L) with an average total phosphorus level of **0.057 mg/L**.

Chlorophyll-a: No significant trend. In 2023, the lake met the MPCA shallow lake standard (<20 µg/L) with the average for the year at **15.2 µg/L**.

Water clarity: No significant trend. The lake consistently meets the MPCA shallow lake standard for water clarity (>1.0 meters). The average reading in 2023 was **1.6 meters**. Typically, staff are able to lower the Secchi disk to the lake bottom and still see it, so water clarity is likley better than what the data indicates.

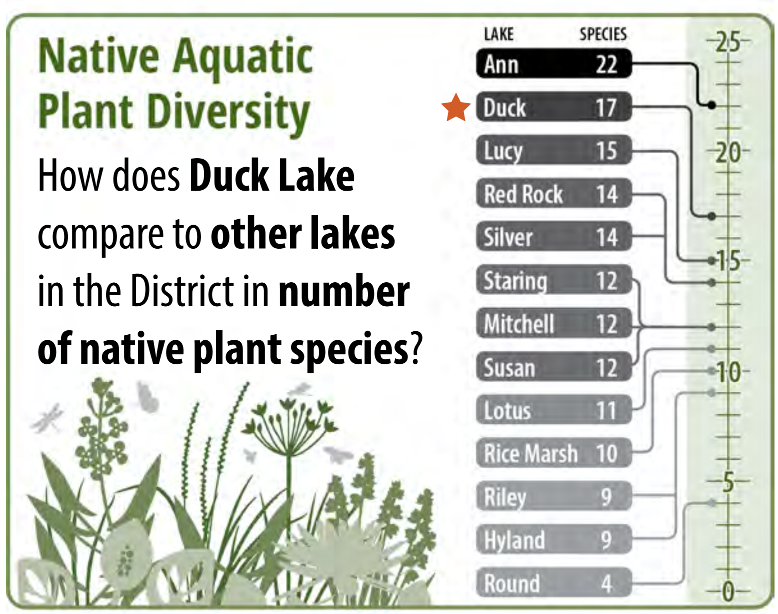
Fish: Over the past few years, Duck Lake has had consecutive winter fish kills due to depleted oxygen levels. This has reduced native fish survival and is considered a natural process for a shallow lake.

Plants: Coontail was the most dominant plant species (96% of sites) followed by Flatstem Pondweed at 52% of sites. Overall, plant growth in Duck Lake covered 100% of the lake surface. The number of plants increased from 6 in 2020 to 16 in 2023. This is partially due to the inclusion of the west bay and very low densities of additional floating and emergent native species that previously were not found (Longleaf Pondweed, Arrowhead, American Lotus, and Hardstem Bullrush).

Watershed Boundary

Lake & watershed characteristics

Lake size	41 acres
Average lake depth	3.4 feet
Maximum lake depth	8 feet
MPCA lake classification	Shallow lake
Watershed size	233 acres
Impervious surface	20% of watershed
Impaired Waters listing	Not listed
Common fish	Bluegill, Black Crappie, Largemouth Bass, Green Sunfish
Invasive species	Curly-leaf Pondweed, Purple Loosestrife, Eurasian Watermilfoil, Goldfish



Duck Lake Water Quality by the Numbers

The graphs below show water quality trends over time with the red line representing the MPCA standard for **shallow lakes.** Over the last decade, **Duck Lake** has typically met the clean water standards set by the MPCA.

Water Quality Report Card

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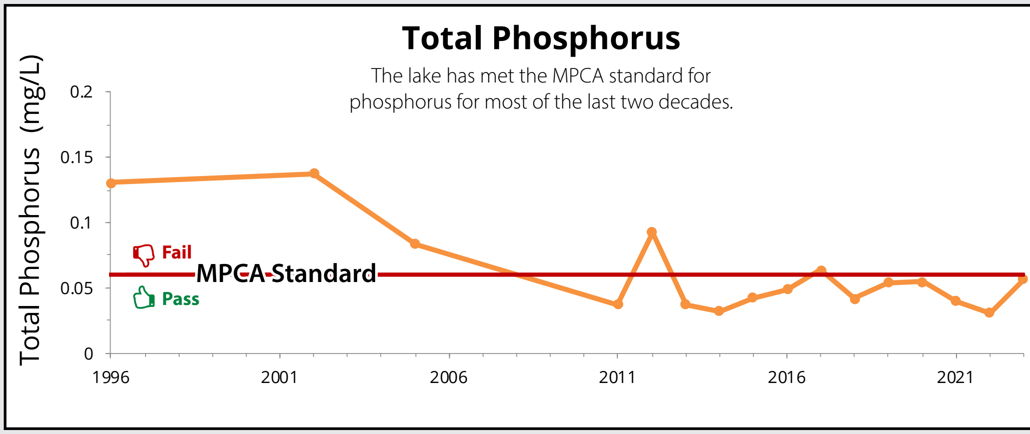
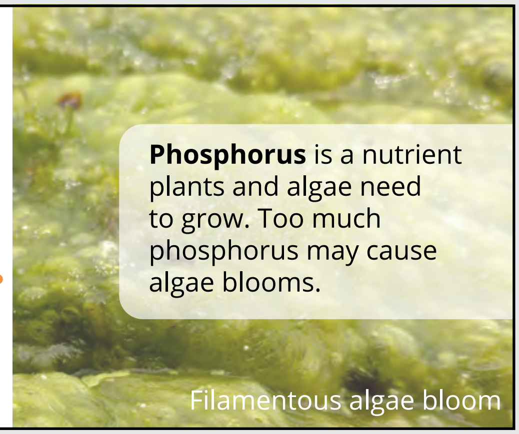
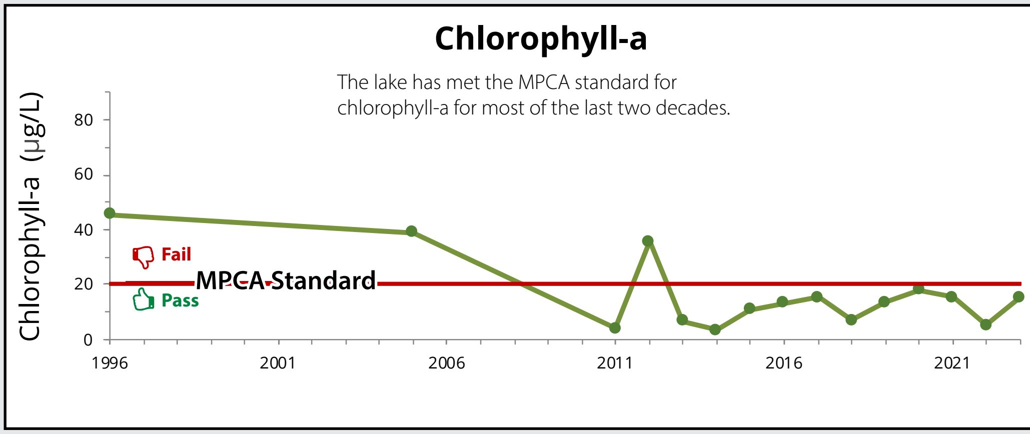
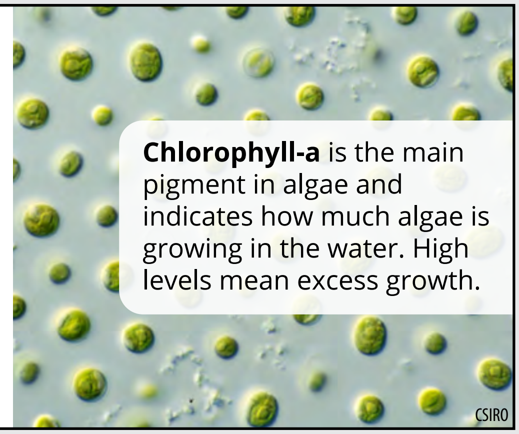
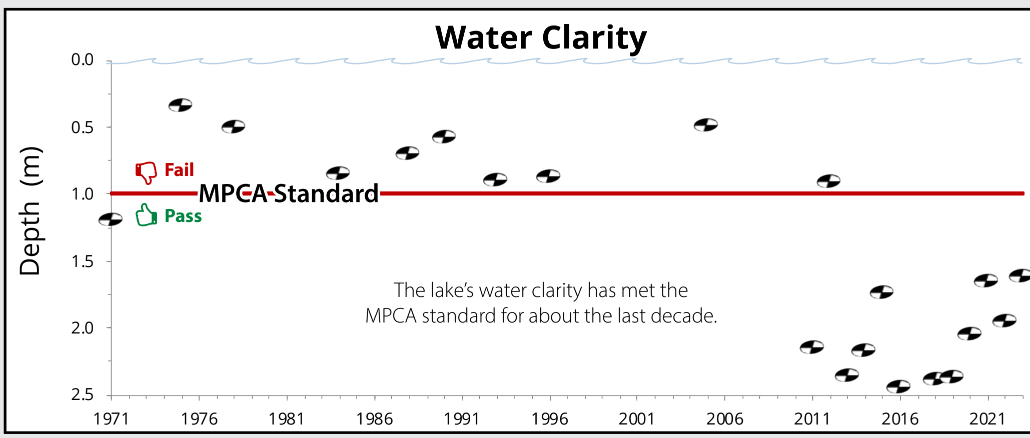
Trends Over Time: 1972-present

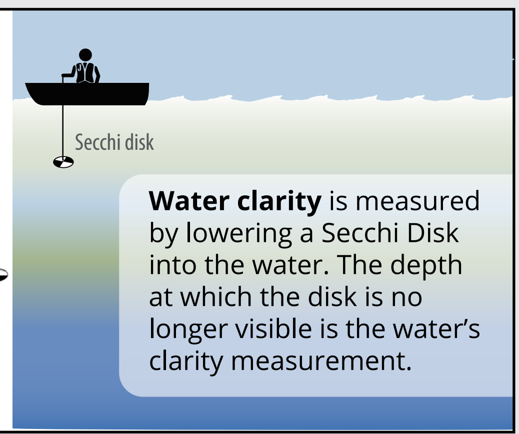












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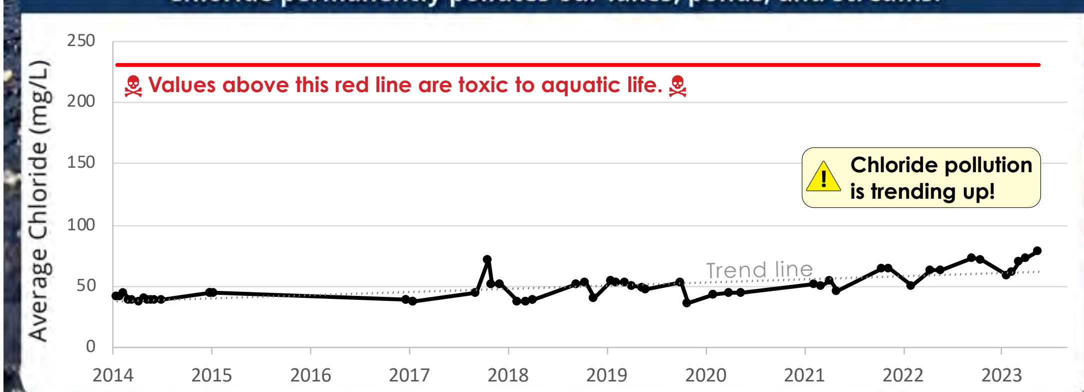

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RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Update

Hyland Lake

Located in Bloomington, Hyland Lake is surrounded by Hyland Lake Park Reserve, a Three Rivers Park District facility. Visitors can paddle the lake in the summer, hike nearby trails, and ski in the winter.

During June through September of each year, Three Rivers Park District staff visit the lake every two weeks to collect water samples and take readings. Samples are sent to a laboratory to be tested for nutrients and other compounds. Staff also measure water clarity by lowering a Secchi disk into the water and measuring how deep it goes before it is no longer visible. The data indicates the lake's health based on standards set by the Minnesota Pollution Control Agency (MPCA).

Hyland Lake is classified as a "Shallow Lake" by the MPCA. To be considered healthy, the lake must have very low average phosphorus and chlorophyll-a levels and average water clarity of 1.0 meter (3.3 feet) or greater. See summary below. Additional details are located on the next page.

Total Phosphorus: A second dose of aluminum sulfate (alum) was applied in 2022 by Three Rivers Park District. Alum reduces algae growth by trapping phosphorus, an algae food source, in lake sediments. In 2023, the lake met the MPCA standard (<0.06 mg/L) with an average total phosphorus level of **0.040 mg/L**. The lake has consistently met the standard since the first alum dose in 2019.

Chlorophyll-a: In 2023, the average reading for chlorophyll-a was **11.6 µg/L**, which met the MPCA shallow lake standard (<20 µg/L). Levels have dropped since the alum treatment.

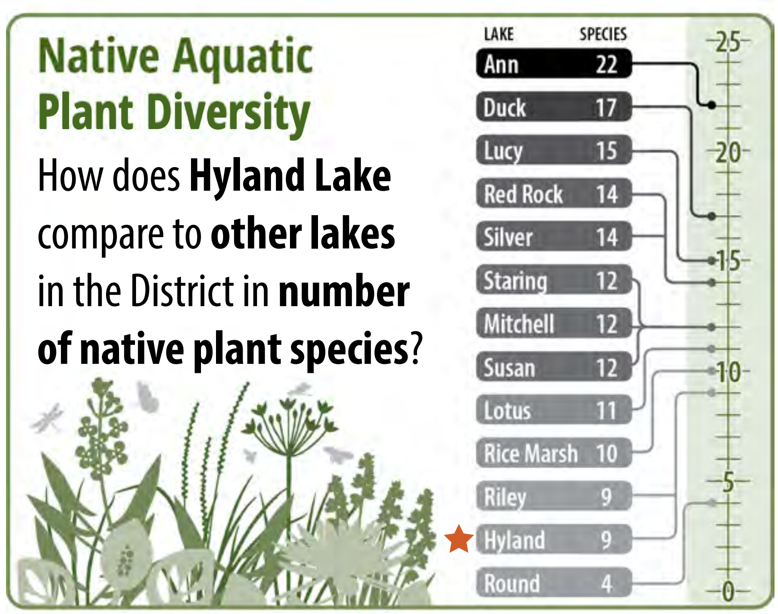
Water clarity: Since the first alum treatment, the lake has met the MPCA shallow lake standard (>1.0 meters) for the last four years. The average reading in 2023 was **1.3 meters**.

Plants: For the third consecutive year, the herbicide Fluridone was used to treat Curly-leaf Pondweed immediately after ice-off. In 2023, the number of native species increased to 9 species from a previous high of 6 species in 2019 and 2020. The combined herbicide treatments and aluminum sulfate application by Three Rivers Park District has allowed plants to expand to 50% of the littoral area.

Watershed Boundary

Lake & watershed characteristics

Lake size	84 acres
Average lake depth	7.5 feet
Maximum lake depth	12 feet
MPCA lake classification	Shallow lake
Watershed size	922 acres
Impervious surface	17% of watershed
Impaired Waters listing	Nutrients
Common fish	Bluegill, Black Crappie, Walleye, Black Bullhead, Largemouth Bass
Invasive species	Curly-leaf Pondweed



RPBCWD Office, 18681 Lake Drive East, Chanhassen, MN 55317 rpbcwd.org info@rpbcwd.org 952-607-6512 @rpbcwd

Hyland Lake Water Quality by the Numbers

The graphs below show water quality trends over time with the red line representing the MPCA standard for **shallow lakes.** Three Rivers Park District provides most of the water quality and plant survey data for Hyland Lake.

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Water Quality Report Card — **C**

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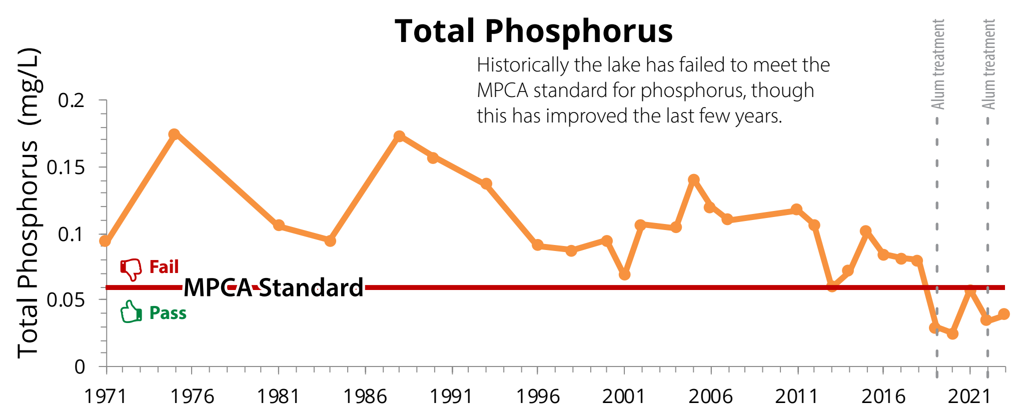
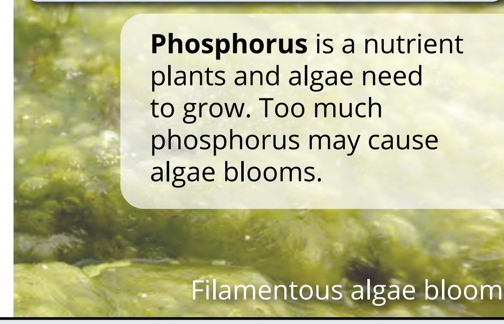
Trends Over Time: 1972-present

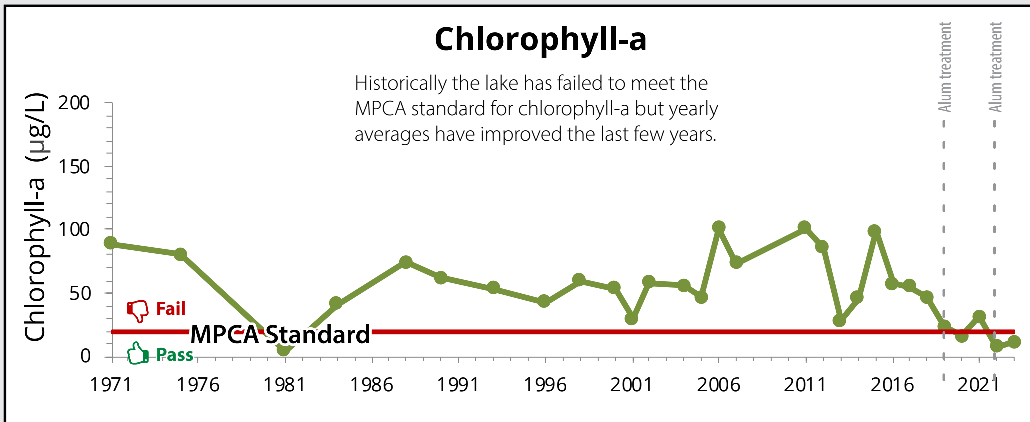


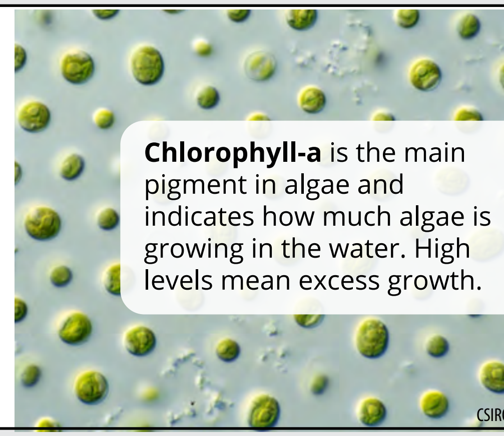
Hyland Lake received alum treatments in 2019 & 2022. Alum limits the availability of phosphorus in lakes to control algae growth & improve water clarity.



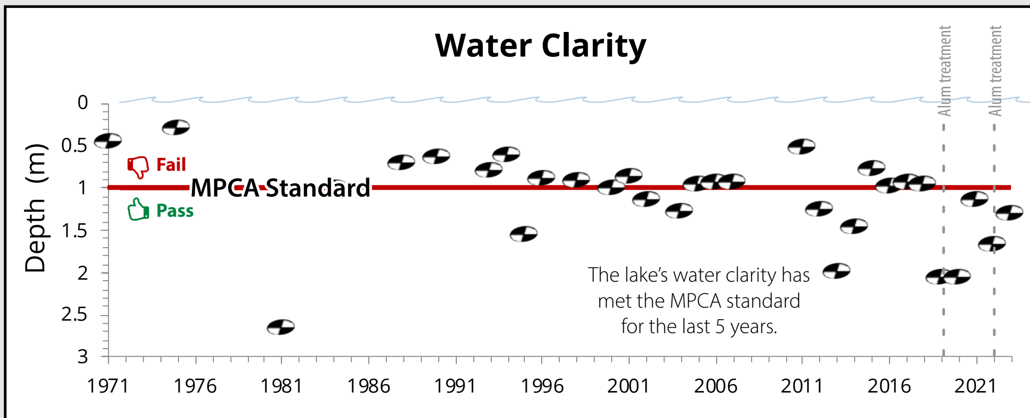
Phosphorus is a nutrient plants and algae need to grow. Too much phosphorus may cause algae blooms.

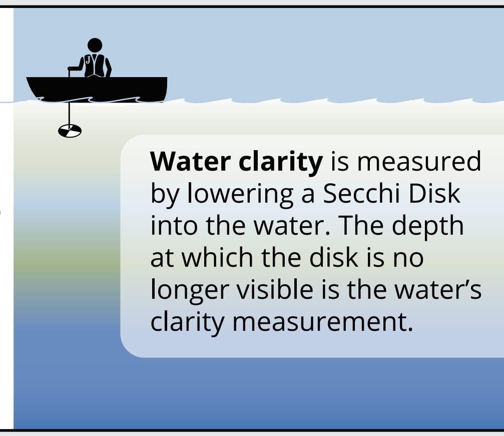
Filamentous algae bloom





Chlorophyll-a is the main pigment in algae and indicates how much algae is growing in the water. High levels mean excess growth.





Water clarity is measured by lowering a Secchi Disk into the water. The depth at which the disk is no longer visible is the water's clarity measurement.

Chloride: A Growing Concern

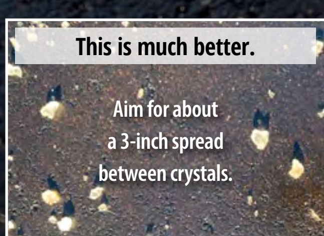
Chloride permanently pollutes lakes, ponds, & streams!

Using excess winter salt does not equal greater safety.

It does mean higher cost for you and more water pollution.

Way too much winter de-icer!

This is much better.



What can I use instead of winter de-icers?

All affordable & effective residential de-icing products contain chloride, even those labeled as "eco-friendly" or "pet safe."

Focus instead on reducing build up of ice on your property:

- **Shovel early and often**
- **Prevent ice formation, avoid driving or walking on snow**
- **Pile snow where it won't melt and refreeze on walkways**

Learn more rpbcwd.org/salt

RIVER PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Update

Lotus Lake

Located in eastern Chanhassen, Lotus Lake is one of three headwaters of Purgatory Creek. Water flows out of Lotus into the south fork of Purgatory Creek, which eventually meets up with the two other forks of the creek.

From June to September every year, District staff visit the lake every two weeks to collect water samples and take readings. Samples are sent to a laboratory to be tested for nutrients and other compounds. Staff also measure water clarity by lowering a Secchi disk into the water and measuring how deep it goes before it is no longer visible. The data indicates the lake's health based on standards set by the Minnesota Pollution Control Agency (MPCA).

Lotus Lake is classified as a "Deep Lake" by the MPCA. To be considered healthy, the lake must have very low average phosphorus and chlorophyll-a levels and average water clarity of 1.4 meters (4.6 feet) or greater. See summary below. Additional details are located on the next page.

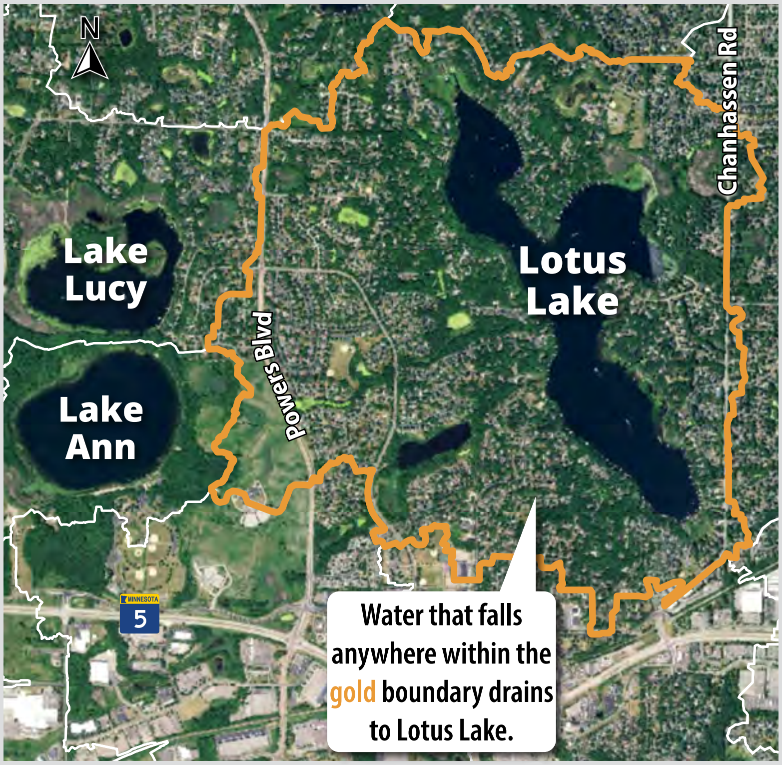
Total Phosphorus: Since the alum treatment in 2018, the lake has consistently met the MPCA standard (<0.04 mg/L) In 2023, the average level was **0.031 mg/L**.

Chlorophyll-a: The lake has never met the MPCA standard (<14 µg/L). In 2023, the average chlorophyll-a reading was **24.6 µg/L**.

Water clarity: Since 2013, the lake has consistently met the MPCA standard (>1.4 meters) for water clarity except for one year. The average reading in 2023 was **2.0 meters**.

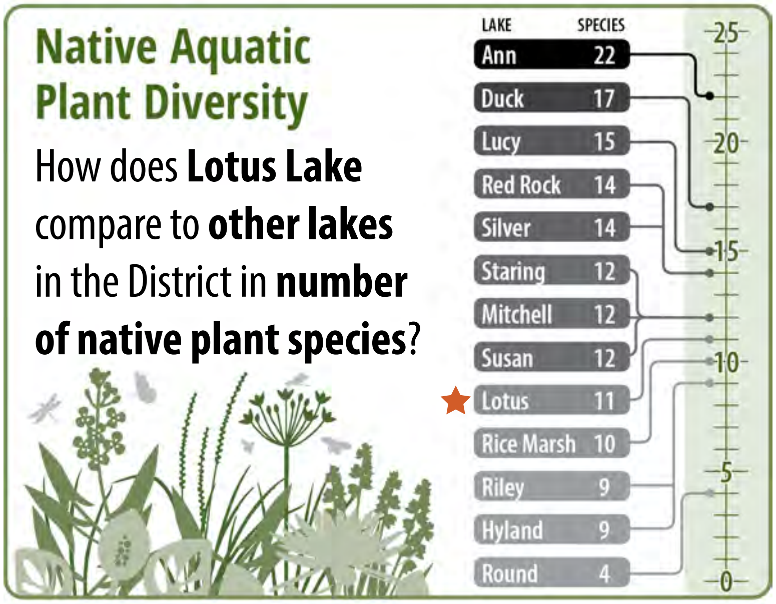
Plants: Eurasian Watermilfoil and Curly-leaf Pondweed were targeted with a single Diquat herbicide treatment (22.92 acres) in the spring of 2023.

Watershed Boundary



Lake & watershed characteristics

Lake size	248 acres
Average lake depth	16 feet
Maximum lake depth	31 feet
MPCA lake classification	Deep lake
Watershed size	1,408 acres
Impervious surface	16% of watershed
Impaired Waters listing	Mercury, nutrients, fish
Common fish	Bluegill, Yellow Bullhead, Walleye, Black Crappie
Invasive species	Eurasian Watermilfoil, Common Carp, Curly-leaf Pondweed, Brittle Naiad



Lotus Lake Water Quality by the Numbers

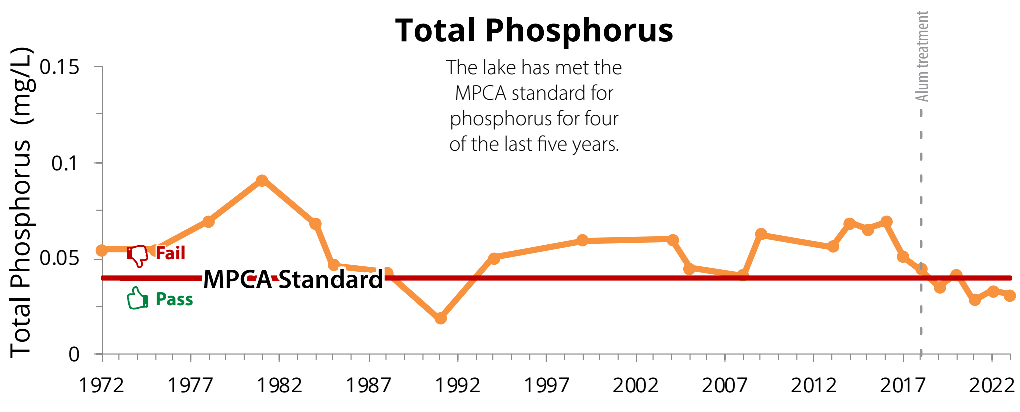
For the last few years, **Lotus Lake** has consistently met the clean water standards set by the MPCA, except for Chlorophyll-a. The graphs below show water quality trends over time with the red line representing the MPCA standard for **deep lakes**.

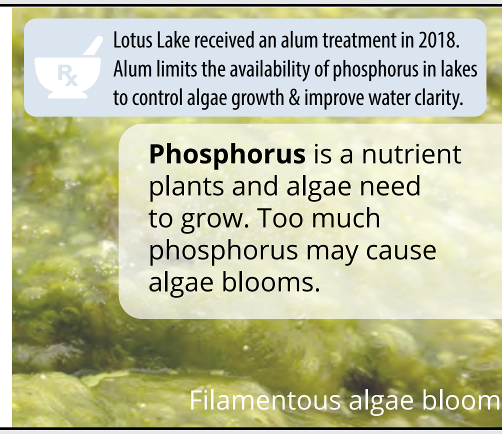
Water Quality Report Card — C
rpbcwd.org/grades

Trends Over Time: 1972-present

Total Phosphorus

The lake has met the MPCA standard for phosphorus for four of the last five years.





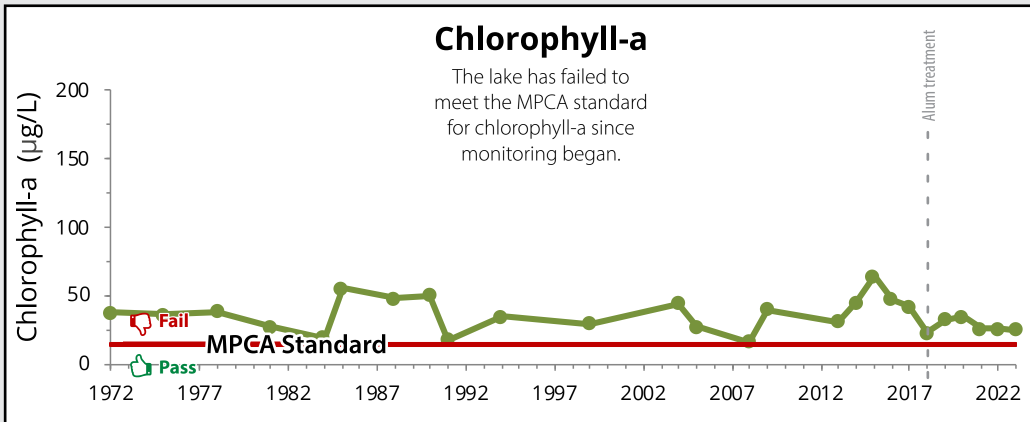
Lotus Lake received an alum treatment in 2018. Alum limits the availability of phosphorus in lakes to control algae growth & improve water clarity.

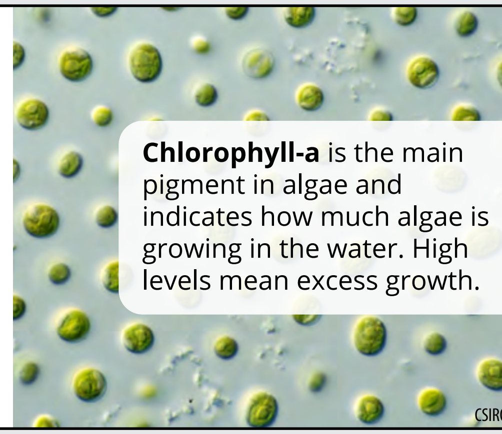
Phosphorus is a nutrient plants and algae need to grow. Too much phosphorus may cause algae blooms.

Filamentous algae bloom

Chlorophyll-a

The lake has failed to meet the MPCA standard for chlorophyll-a since monitoring began.



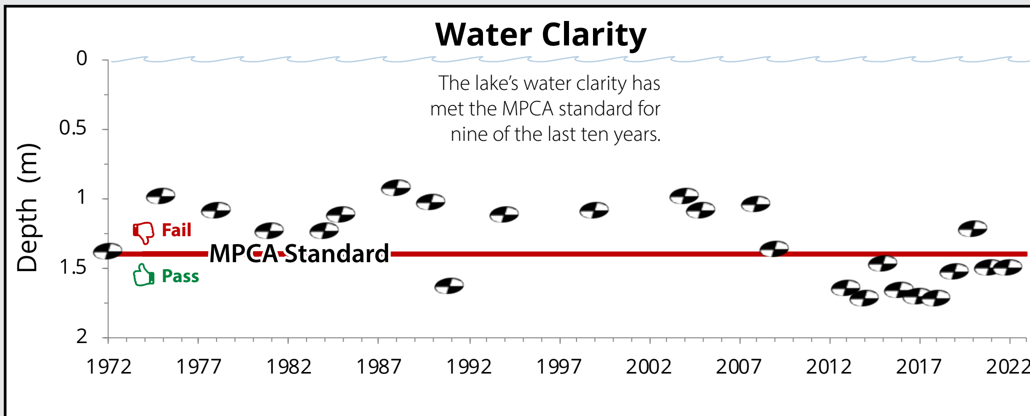


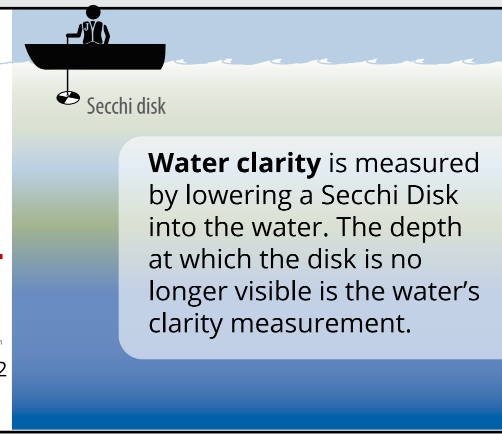
Chlorophyll-a is the main pigment in algae and indicates how much algae is growing in the water. High levels mean excess growth.

CSIRO

Water Clarity

The lake's water clarity has met the MPCA standard for nine of the last ten years.

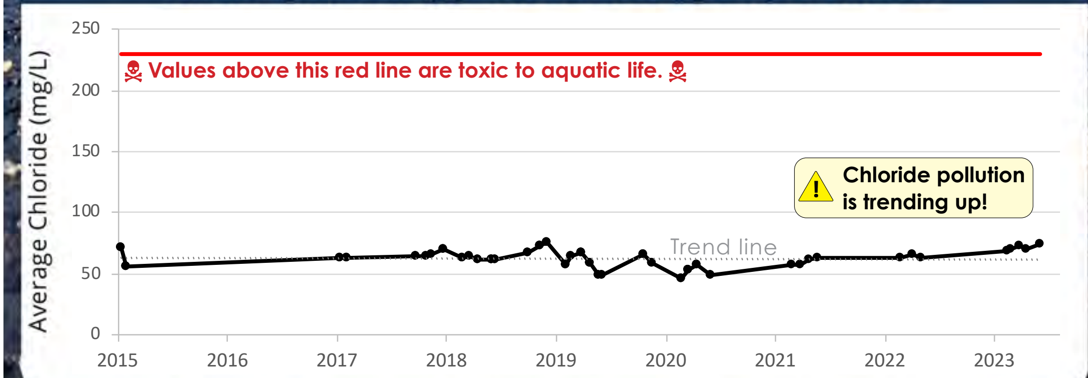




Water clarity is measured by lowering a Secchi Disk into the water. The depth at which the disk is no longer visible is the water's clarity measurement.

Chloride: A Growing Concern

Chloride permanently pollutes our lakes, ponds, and streams!



What can I use instead of winter de-icers?

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Learn more rpbcwd.org/salt

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Update

Lake Lucy

Lake Lucy is the headwaters to Riley Creek. Water flows out of Lucy to Lake Ann and then to Riley Creek. On its way south to the Minnesota River, Riley Creek passes through Susan, Rice Marsh, and Riley lakes.

From June to September every year, District staff visit the lake every two weeks to collect water samples and take readings. Samples are sent to a laboratory to be tested for nutrients and other compounds. Staff also measure water clarity by lowering a Secchi disk into the water and measuring how deep it goes before it is no longer visible. The data indicates the lake's health based on standards set by the Minnesota Pollution Control Agency (MPCA).

Lake Lucy is classified as a "Shallow Lake" by the MPCA. To be considered healthy, the lake must have very low average phosphorus and chlorophyll-a levels and average water clarity of 1.0 meter (3.3 feet) or greater. See summary below. Additional details are located on the next page.

Total Phosphorus: No significant trend since monitoring began. In 2023, the lake met the MPCA shallow lake standard (<0.06 mg/L) with average level of **0.028 mg/L**.

Chlorophyll-a: Levels have declined the last few years, which is likely linked to a winterkill events in 2018/2019 and 2022/2023. In 2023, the average reading for chlorophyll-a was **11.3 µg/L**, well within the MPCA standard (<20 µg/L).

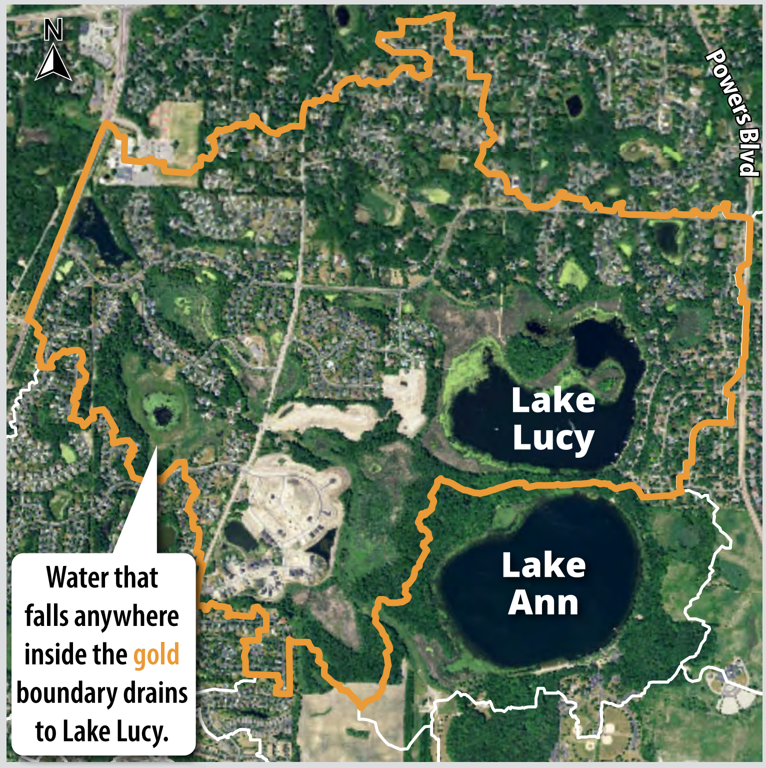
Water clarity: Lake clarity has improved since 2019, and the lake consistently meets the MPCA standard (>1.0 meters). The average reading in 2023 was **2.0 meters**.

Fish: Small mesh trap netting was conducted in 2023 to see if successful reproduction of Common Carp occurred following the partial winterkill. No young of year carp were captured during the survey indicating carp are not a problem in Lucy. About 300 bluegills were stocked in the spring to ensure a breeding population was established to prevent carp recruitment from occurring.

Lake & watershed characteristics

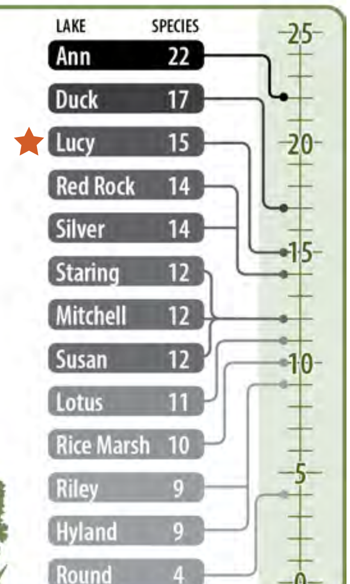
Lake size	88 acres
Average lake depth	6.5 feet
Maximum lake depth	20 feet
MPCA lake classification	Shallow lake
Watershed size	988 acres
Impervious surface	14% of watershed
Impaired Waters listing	Mercury
Common fish	Bluegill, Northern Pike, Yellow Bullhead, Black Crappie, Pumpkinseed Sunfish
Invasive species	Curly-leaf Pondweed, Eurasian Watermilfoil, Common Carp

Watershed Boundary



Native Aquatic Plant Diversity

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



Lake Lucy Water Quality by the Numbers

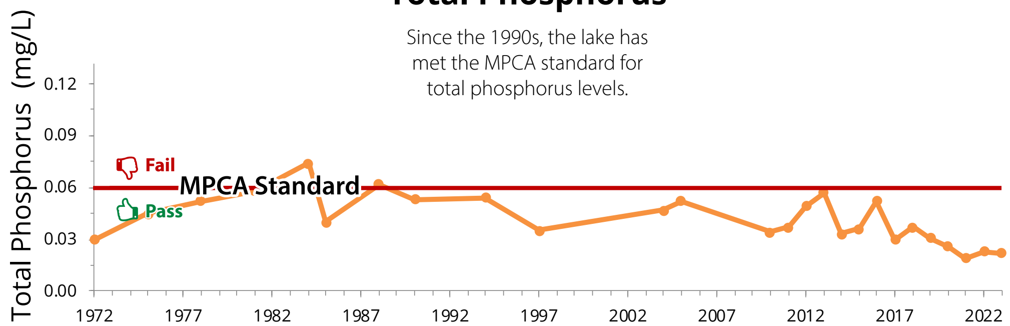
Over the last few years, **Lake Lucy** has met the clean water standards set by the MPCA. The graphs below show water quality trends over time with the red line representing the MPCA standard for **shallow lakes**.

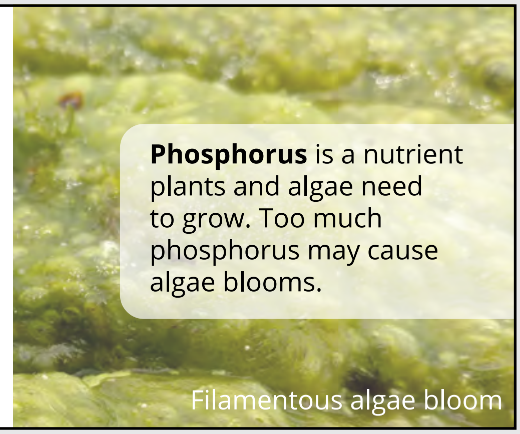
Water Quality Report Card B
rpbcwd.org/grades

Trends Over Time: 1972-present

Total Phosphorus

Since the 1990s, the lake has met the MPCA standard for total phosphorus levels.

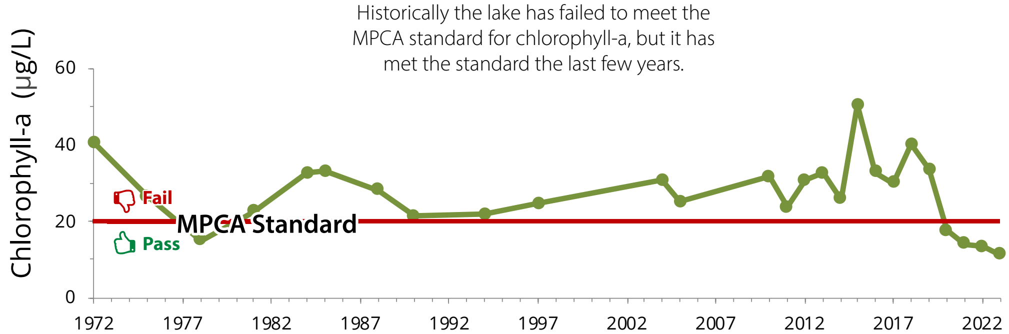


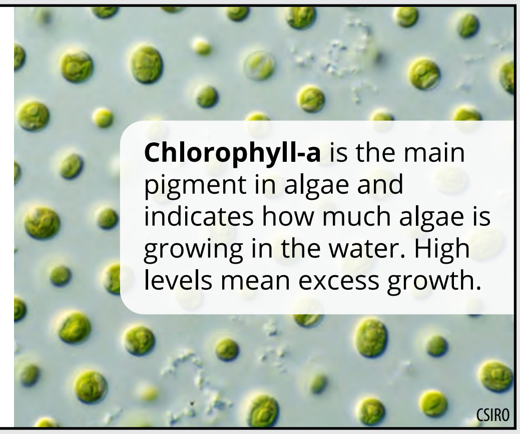


Phosphorus is a nutrient plants and algae need to grow. Too much phosphorus may cause algae blooms.

Chlorophyll-a

Historically the lake has failed to meet the MPCA standard for chlorophyll-a, but it has met the standard the last few years.

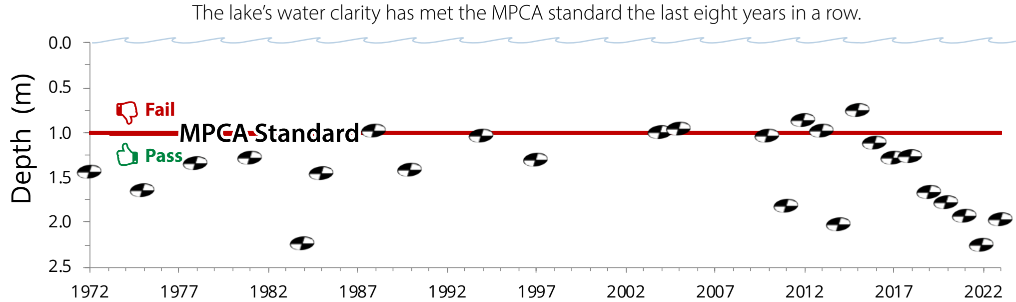


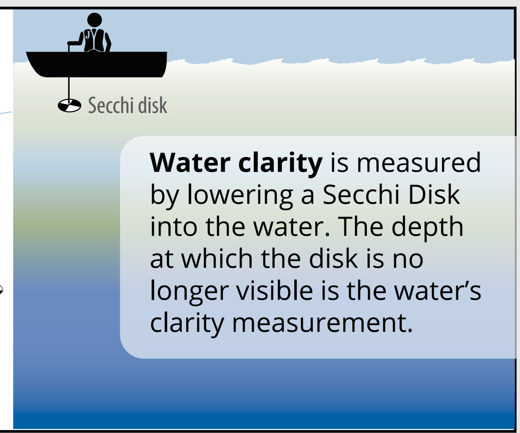


Chlorophyll-a is the main pigment in algae and indicates how much algae is growing in the water. High levels mean excess growth.

Water Clarity

The lake's water clarity has met the MPCA standard the last eight years in a row.





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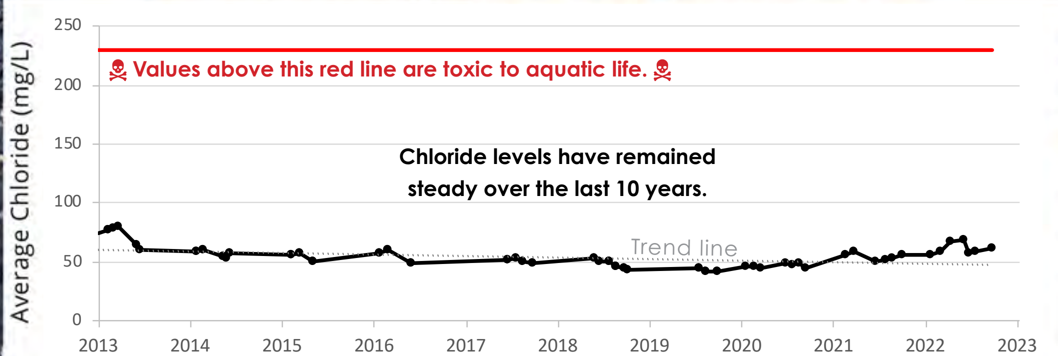
Chloride: A Growing Concern

Chloride permanently pollutes our lakes, ponds, and streams!



What can I use instead of winter de-icers?

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Learn more rpbcwd.org/salt

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Update

Mitchell Lake

Located in Eden Prairie, Mitchell Lake is a part of the Purgatory Creek chain of lakes. During high water events it outflows through an overflow pipe to Red Rock Lake.

From June to September every year, District staff visit the lake every two weeks to collect water samples and take readings. Samples are sent to a laboratory to be tested for nutrients and other compounds. Staff also measure water clarity by lowering a Secchi disk into the water and measuring how deep it goes before it is no longer visible. The data indicates the lake's health based on standards set by the Minnesota Pollution Control Agency (MPCA).

Mitchell Lake is classified as a "Shallow Lake" by the MPCA. To be considered healthy, the lake must have very low average phosphorus and chlorophyll-a levels and average water clarity of 1.0 meter (3.3 feet) or greater. See summary below. Additional details are located on the next page.

Total Phosphorus: Concentrations have decreased since monitoring began in 1972. In 2023, the lake's average total phosphorus level of **0.052 mg/L** met the MPCA shallow lake standard (<0.06 mg/L).

Chlorophyll-a: No significant trend. In 2023, the average reading was twice the MPCA shallow lake standard (<20 µg/L) at **44.1 µg/L**. 2023 was also higher than 2022 (27.3 µg/L).

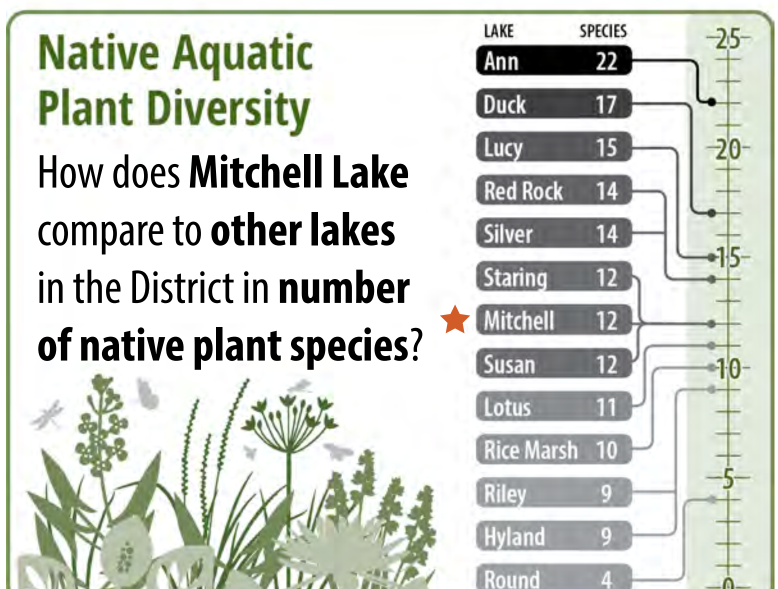
Water clarity: No significant trend. The lake consistently meets the MPCA shallow lake standard (>1.0 meters). The average reading in 2023 was **1.3 meters**.

Plants: In 2023, a plant survey was conducted to track aquatic plant populations. Coontail was dominant (52% of sites). At 15 sites, light growth of Eurasian Watermilfoil was found. An established population of Brittle Naiad (invasive) was discovered in the northeast end of the lake. In late summer, submerged aquatic plants covered about 68 acres (61% of the lake). A total of 13 acres of the lake was treated with herbicide, which reduced Curlyleaf Pondweed abundance to a frequency of occurrence of 1%. A fall turion survey (main reproductive structure of Curlyleaf Pondweed) yielded a relatively low abundance of turions.

Watershed Boundary

Lake & watershed characteristics

Lake size	124 acres
Average lake depth	5.3 feet
Maximum lake depth	19 feet
MPCA lake classification	Shallow lake
Watershed size	937 acres
Impervious surface	30% of watershed
Impaired Waters listing	Mercury
Common fish	Bluegill, Black Bullhead, Black Crappie, Northern Pike, Pumpkinseed
Invasive species	Curly-leaf Pondweed, Eurasian Watermilfoil, Purple Loosestrife, Brittle Naiad



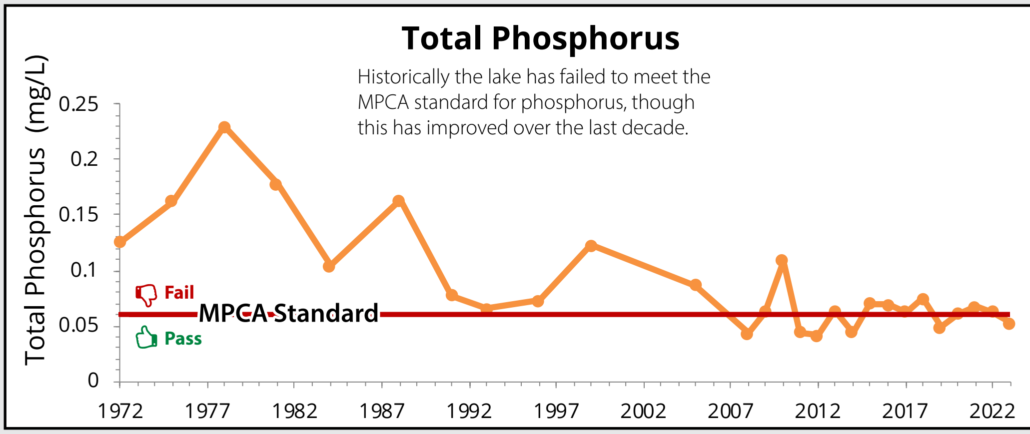
Mitchell Lake Water Quality by the Numbers

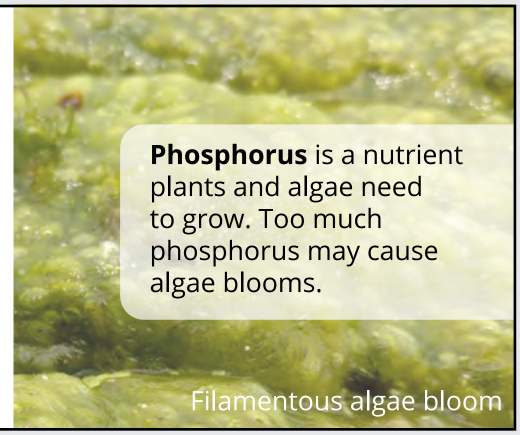
The graphs below show water quality trends over time with the red line representing the MPCA standard for **shallow lakes**. For the last few years, the City of Eden Prairie has collected water quality data for Mitchell Lake.

Water Quality Report Card — **C**

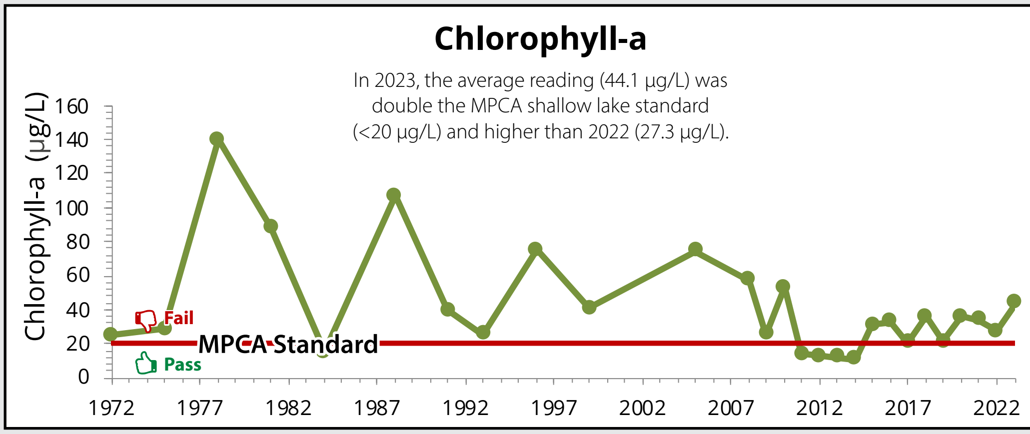
rpbcwd.org/grades

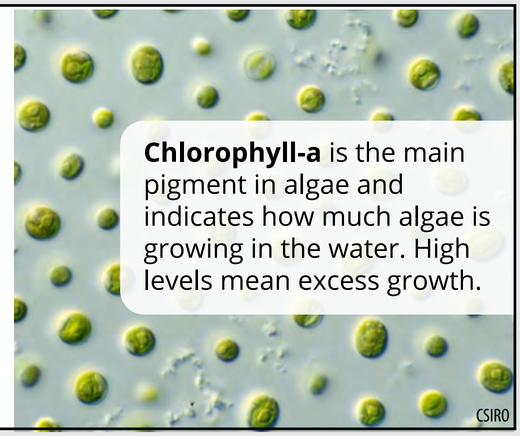
Trends Over Time: 1972-present



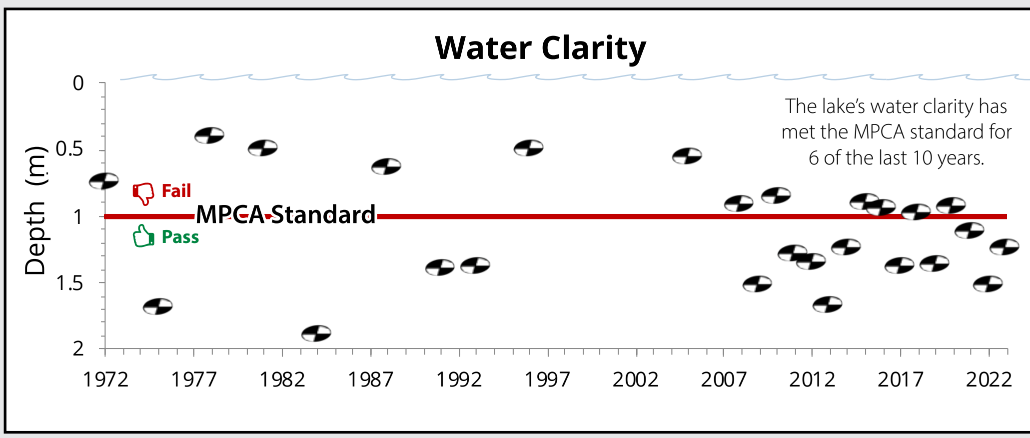


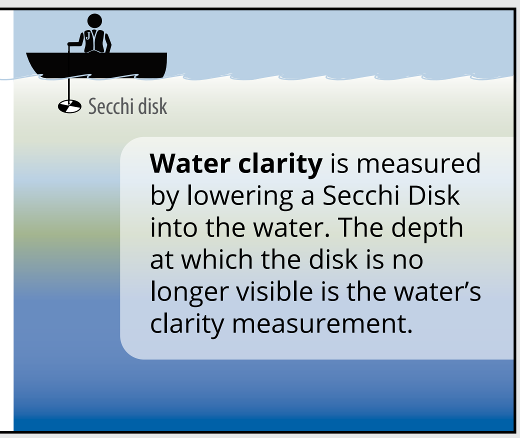
Phosphorus is a nutrient plants and algae need to grow. Too much phosphorus may cause algae blooms.





Chlorophyll-a is the main pigment in algae and indicates how much algae is growing in the water. High levels mean excess growth.





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Chloride: A Growing Concern

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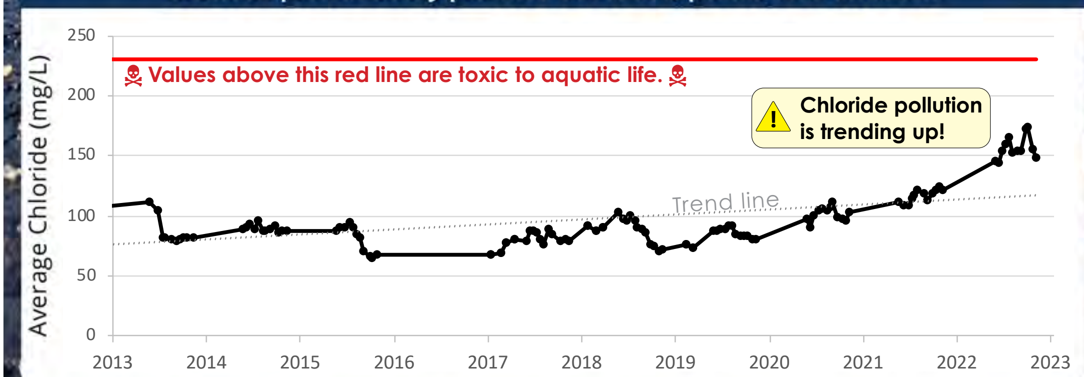

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Learn more rpbcwd.org/salt

2023 Update

Red Rock Lake

Located in Eden Prairie, Red Rock Lake is a part of the Purgatory Creek chain of lakes. During high water events it outflows through an overflow pipe to Staring Lake.

From June to September every year, District staff visit the lake every two weeks to collect water samples and take readings. Samples are sent to a laboratory to be tested for nutrients and other compounds. Staff also measure water clarity by lowering a Secchi disk into the water and measuring how deep it goes before it is no longer visible. The data indicates the lake's health based on standards set by the Minnesota Pollution Control Agency (MPCA).

Red Rock Lake is classified as a "Shallow Lake" by the MPCA. To be considered healthy, the lake must have very low average phosphorus and chlorophyll-a levels and average water clarity of 1.0 meter (3.3 feet) or greater. See summary below. Additional details are located on the next page.

Total Phosphorus: No significant trend. In 2023, the lake met the MPCA shallow lake standard (<0.06 mg/L) with an average total phosphorus level of **0.059 mg/L**.

Chlorophyll-a: Over the last decade, the yearly average chlorophyll-a measurements have improved. In 2023, the lake had an average reading of **30.6 µg/L**, which failed to meet the MPCA shallow lake standard (<20 µg/L).

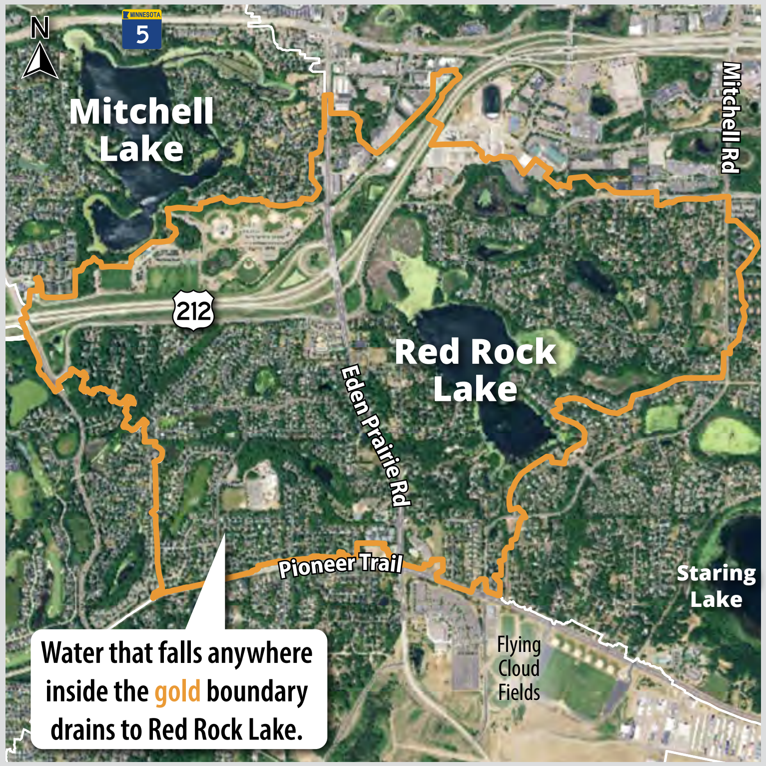
Water clarity: No significant trend. The lake consistently meets the MPCA shallow lake standard (>1.0 meters). The average reading in 2023 was **1.4 meters**.

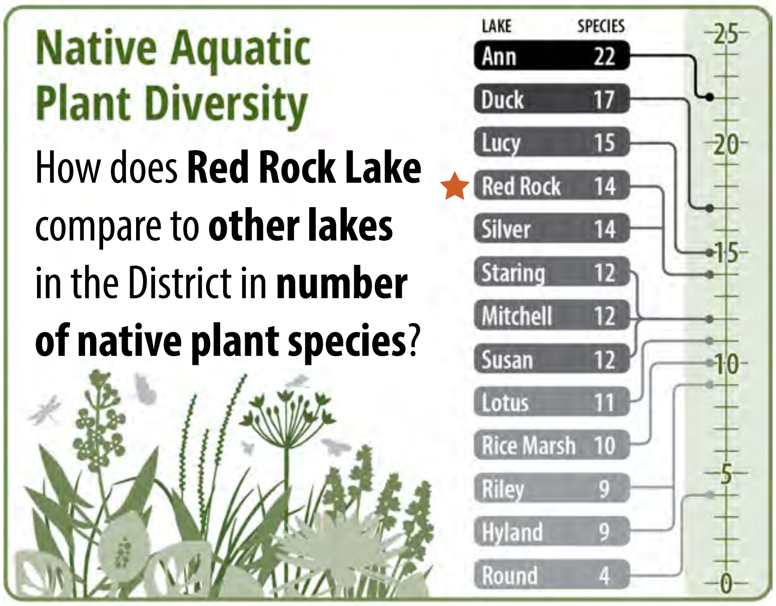
Plants: A point-intercept plant survey was conducted in 2023 by the City of Eden Prairie to track aquatic vegetation populations. In 2023, 13 acres were treated with the herbicide Endothall to reduce Curlyleaf Pondweed abundance.

Lake & watershed characteristics

Size	121 acres
Average depth	4.7 feet
Max depth	19 feet
MPCA lake classification	Shallow lake
Watershed size	1,286 acres
Impervious surface	25% of watershed
Impaired Waters listing	Mercury
Common fish	Bluegill, Northern Pike, Pumpkinseed, Yellow Perch
Invasive species	Curly-leaf Pondweed

Watershed Boundary



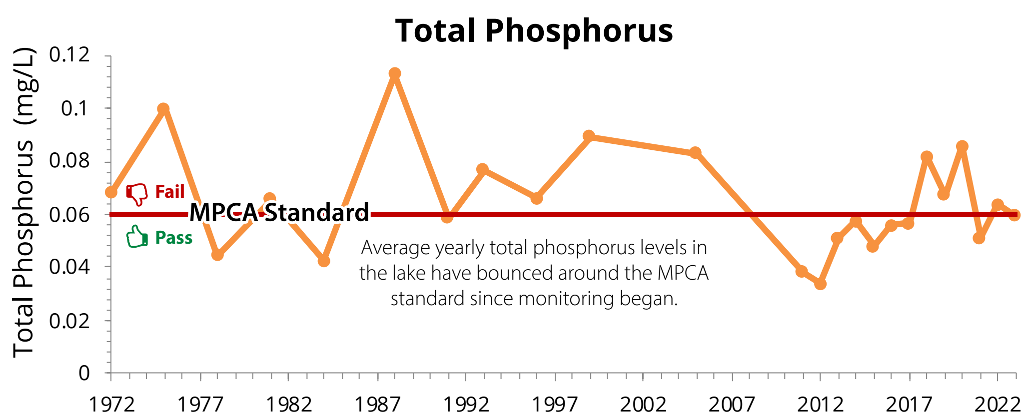


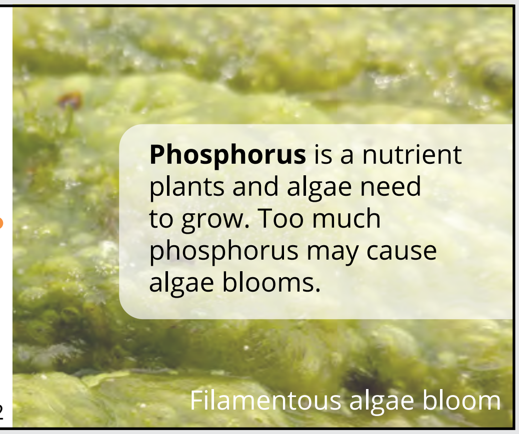
Red Rock Lake Water Quality by the Numbers

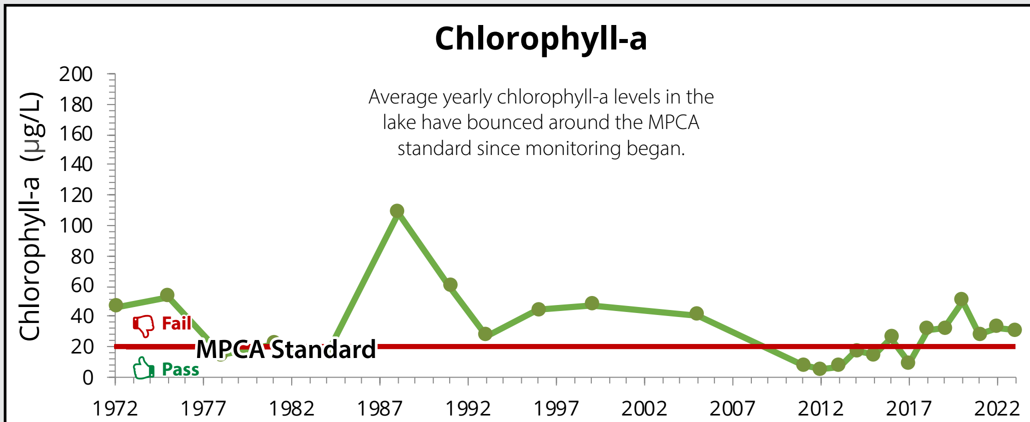
The graphs below show water quality trends over time with the red line representing the MPCA standard for **shallow lakes**. For the last few years, the City of Eden Prairie has collected water quality data for Red Rock Lake.

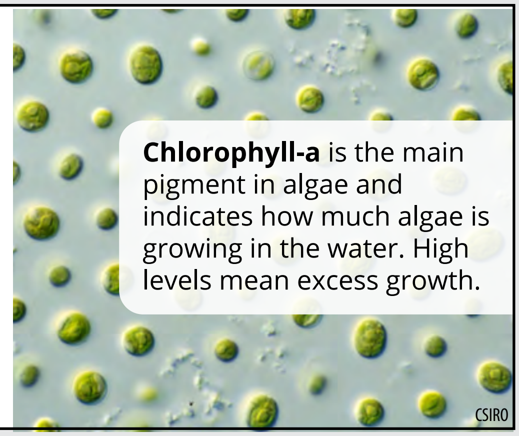
Water Quality Report Card: C
rpbcwd.org/grades

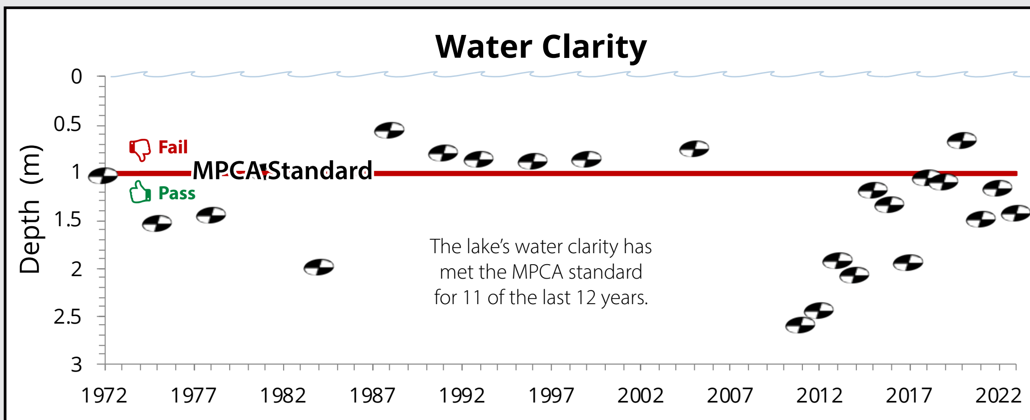
Trends Over Time: 1972-present

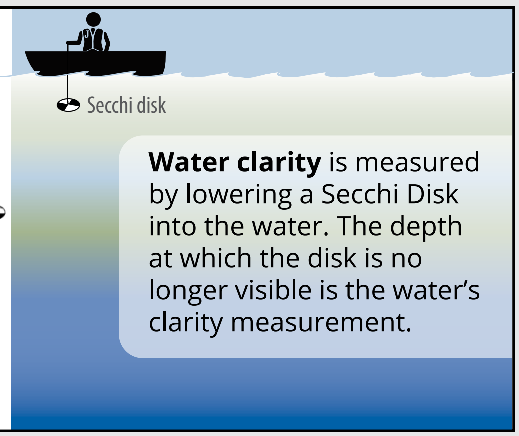












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RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Update

Rice Marsh Lake

Located in both Eden Prairie and Chanhassen, Rice Marsh Lake is aerated in the winter. This management practice helps keep bluegill sunfish alive so that they can feed on invasive carp eggs in the spring.

From June to September every year, District staff visit the lake every two weeks to collect water samples and take readings. Samples are sent to a laboratory to be tested for nutrients and other compounds. Staff also measure water clarity by lowering a Secchi disk into the water and measuring how deep it goes before it is no longer visible. The data indicates the lake's health based on standards set by the Minnesota Pollution Control Agency (MPCA).

Rice Marsh Lake is classified as a "Shallow Lake" by the MPCA. To be considered healthy, the lake must have very low average phosphorus and chlorophyll-a levels and average water clarity of 1.0 meter (3.3 feet) or greater. See summary below. Additional details are located on the next page.

Total Phosphorus: Levels have decreased since monitoring began in 1972. In 2023, the lake met the MPCA shallow lake standard (<0.06 mg/L) with an average total phosphorus level of **0.044 mg/L**.

Chlorophyll-a: Levels have decreased since monitoring began in 1972. In 2023, the average reading met the MPCA shallow lake standard (<20 µg/L) with an average chlorophyll-a reading of **15.1 µg/L**.

Water clarity: Since 1972, average Secchi disk depths have increased, and the lake consistently meets the MPCA shallow lake standard (>1.0 meters). The average reading in 2023 was **2.1 meters**.

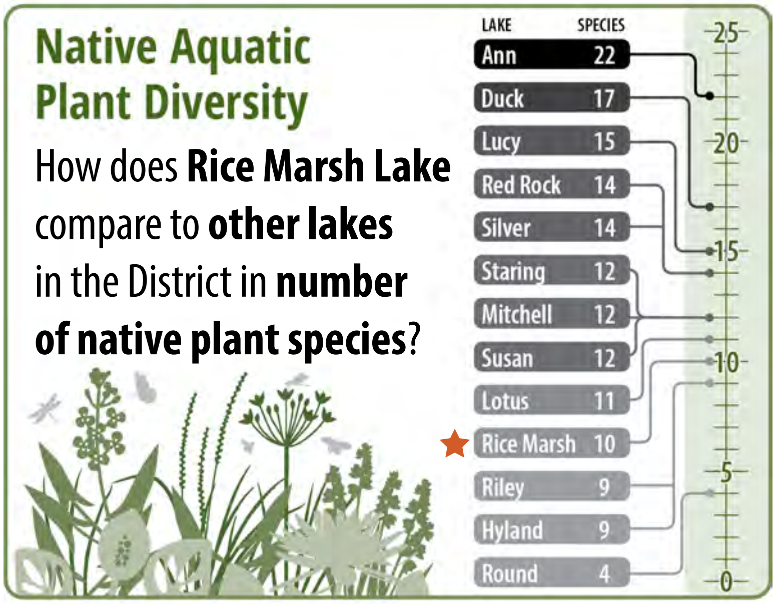
Fish: Small mesh trap netting was conducted in 2023 to see if successful reproduction of Common Carp occurred following the partial winterkill. No young of year carp were captured during the survey indicating carp are not a problem in the lake. About 300 bluegills were stocked in the spring to ensure a breeding population was established to prevent carp recruitment from occurring.

Lake & watershed characteristics

Lake size	83 acres
Average lake depth	5 feet
Maximum lake depth	11 feet
MPCA lake classification	Shallow lake
Watershed size	966 acres
Impervious surface	32% of watershed
Impaired Waters listing	Nutrients
Common fish	Bluegill, Northern Pike, Black Crappie, Yellow Bullhead, Pumpkinseed Sunfish
Invasive species	Curly-leaf Pondweed, Purple Loosestrife, Common Carp

Great news! Because Rice Marsh Lake's 10-year water quality averages meet shallow lake standards, the District is requesting that the MPCA removes it from the Impaired Waters List.

Watershed Boundary

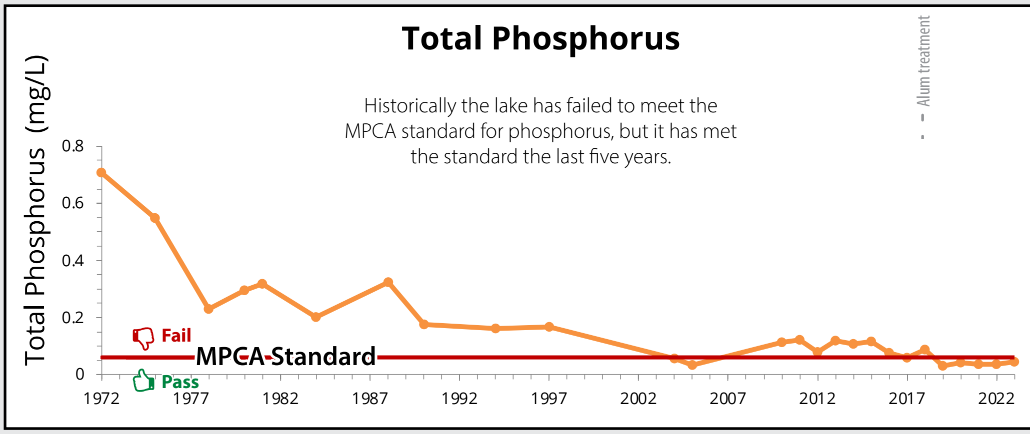


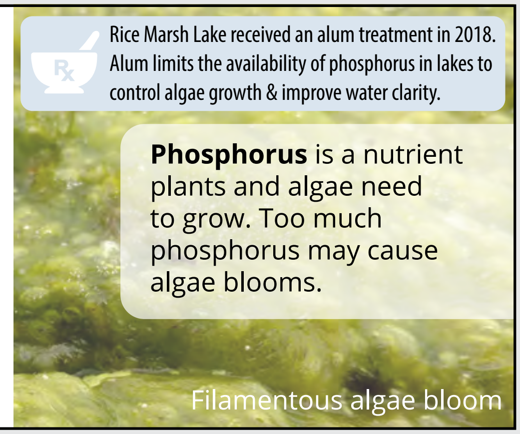
Rice Marsh Lake Water Quality by the Numbers

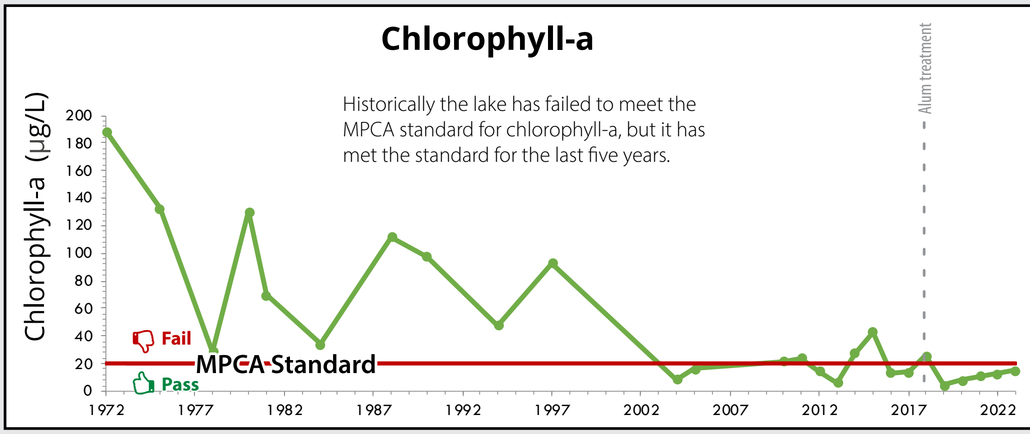
Over the last few years, **Rice Marsh Lake** has met the clean water standards set by the MPCA. The graphs below show water quality trends over time with the red line representing the MPCA standard for **shallow lakes**.

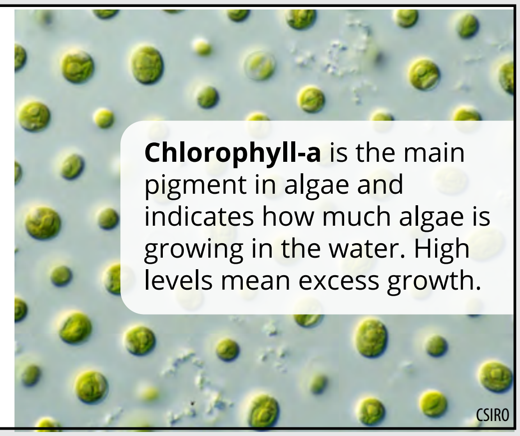
Water Quality Report Card C
rpbcwd.org/grades

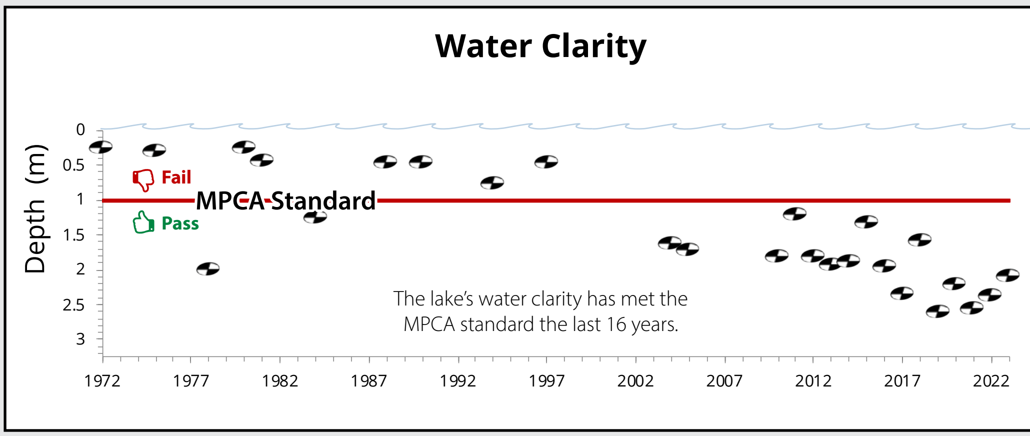
Trends Over Time: 1972-present

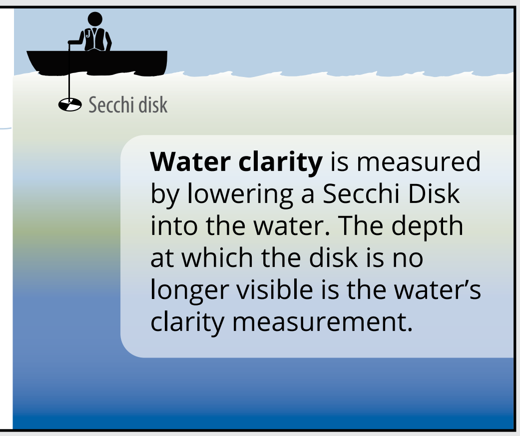






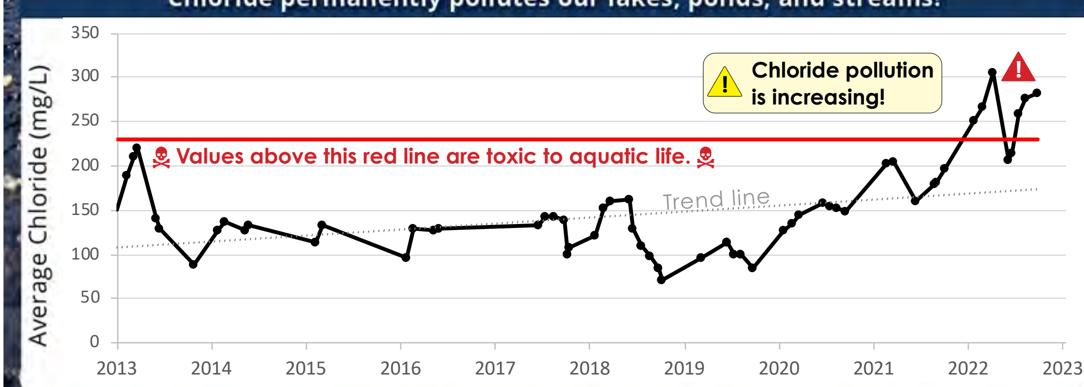






Chloride: A Growing Concern

Chloride permanently pollutes our lakes, ponds, and streams!



What can I use instead of winter de-icers?

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Focus instead on reducing build up of ice on your property:

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Learn more rpbcwd.org/salt

2023 Update

Lake Riley

At 297 acres and average depth of 23 ft, Lake Riley is the largest lake in the Watershed District. It is located on the boundary of Chanhassen and Eden Prairie and is a popular summer recreation spot.

From June to September every year, District staff visit the lake every two weeks to collect water samples and take readings. Samples are sent to a laboratory to be tested for nutrients and other compounds. Staff also measure water clarity by lowering a Secchi disk into the water and measuring how deep it goes before it is no longer visible. The data indicates the lake's health based on standards set by the Minnesota Pollution Control Agency (MPCA).

Lake Riley is classified as a "Deep Lake" by the MPCA. To be considered healthy, the lake must have very low average phosphorus and chlorophyll-a levels and average water clarity of 1.4 meters (4.6 feet) or greater. See summary below. Additional details are located on the next page.

Total Phosphorus: The lake consistently meets the MPCA deep lake standard (<0.04 mg/L). In 2023, the average TP level was **0.020 mg/L**.

Chlorophyll-a: The lake consistently meets the MPCA deep lake standard (<14 µg/L). In 2023, the average chlorophyll-a reading was **6.1 µg/L**.

Water clarity: The lake consistently meets the MPCA deep lake standard (>1.4 meters). The average reading in 2023 was **3.7 meters**.

Plants: Lake Riley was treated for Curly-leaf Pondweed (9 acres). UMN conducted three plant surveys in 2023 to track aquatic plant populations. In August, 11 species were observed, 9 of which were native species. In all survey years, most plants were in water < 2 meters deep. However, with improved water clarity in 2016-23, plants were observed in sites up to 5 meters deep. Eurasian Watermilfoil greatly decreased in 2023 with <3% frequency of occurrence. Frequency of Curlyleaf Pondweed increased slightly from 2020 (25%) to 2023 (29%) but has not expanded further.

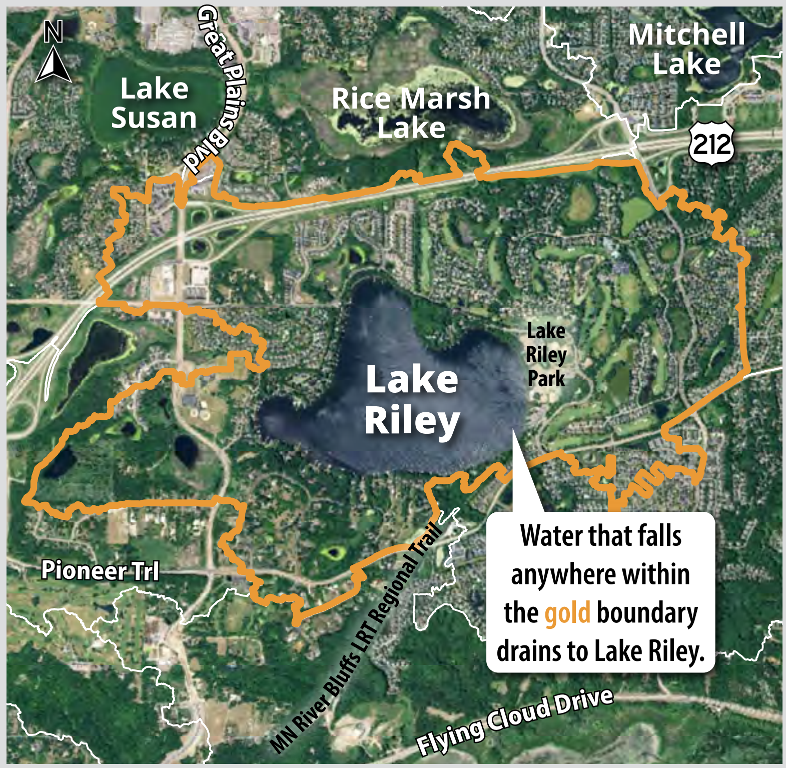
Fish: Electrofishing was used to monitor Common Carp, an invasive species that harms water quality by destroying aquatic vegetation and stirring up lake bottom sediments. Carp numbers have been very low in Lake Riley, indicating carp are not an issue in the lake.

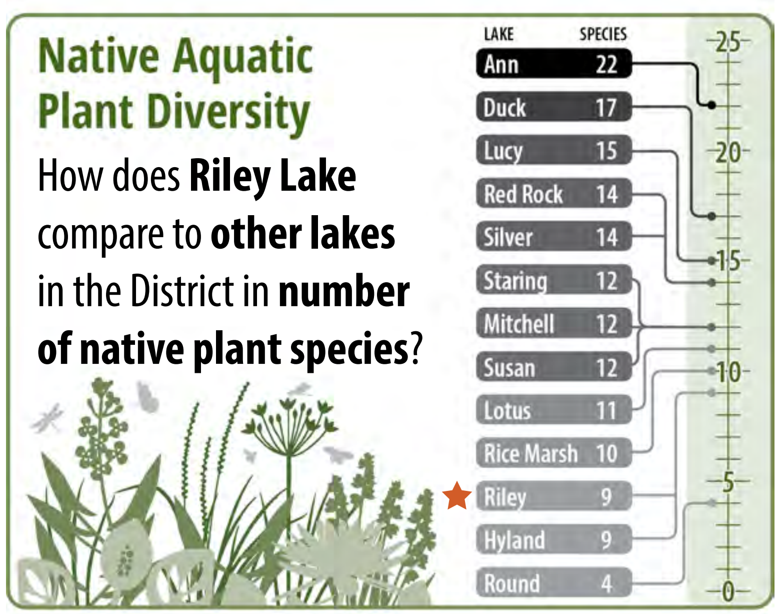
Lake & watershed characteristics

Lake size	297 acres
Average lake depth	23 feet
Maximum lake depth	49 feet
MPCA lake classification	Deep lake
Watershed size	1,776 acres
Impervious surface	18% of watershed
Impaired Waters listing	Mercury, fish, nutrients
Common fish	Bluegill, Northern Pike, Yellow Perch, Yellow Bullhead, Black Crappie
Invasive species	Curly-leaf Pondweed, Eurasian Watermilfoil, Zebra Mussels

Great news! Because Lake Riley's 10-year water quality averages meet deep lake standards, the District is requesting that the MPCA removes it from the Impaired Waters List for nutrients.

Watershed Boundary



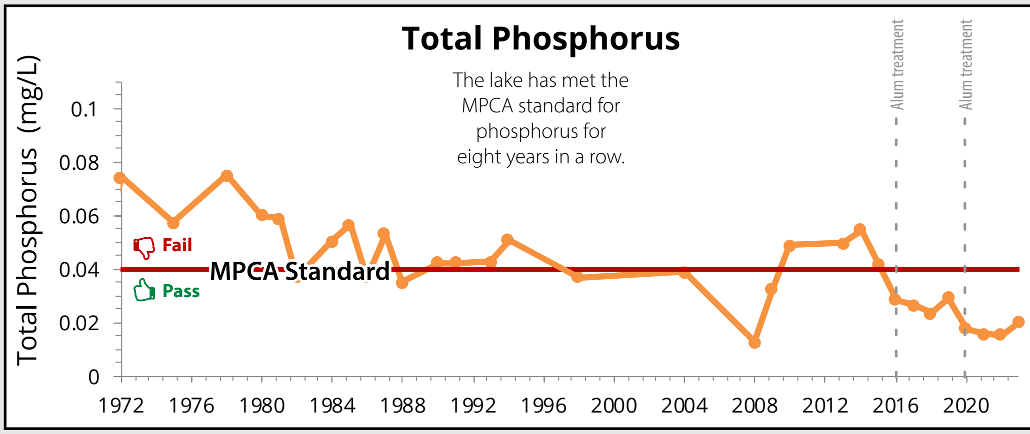


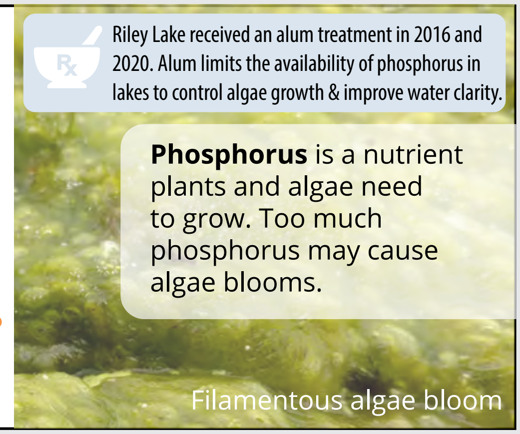
Lake Riley Water Quality by the Numbers

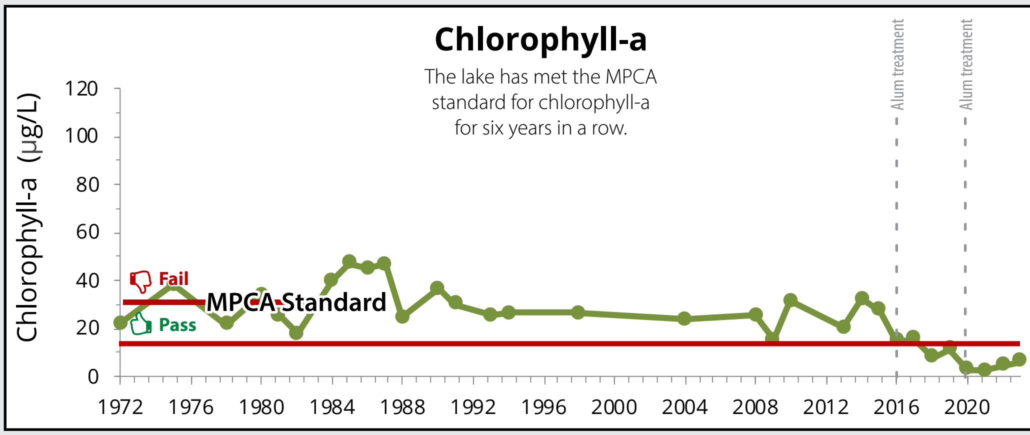
For the last few years, **Lake Riley** has consistently met the clean water standards set by the MPCA. The graphs below show water quality trends over time with the red line representing the MPCA standard for **deep lakes**.

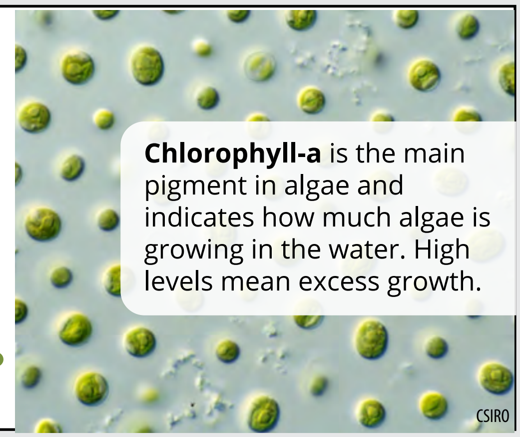
Water Quality Report Card — **A**
rpbcwd.org/grades

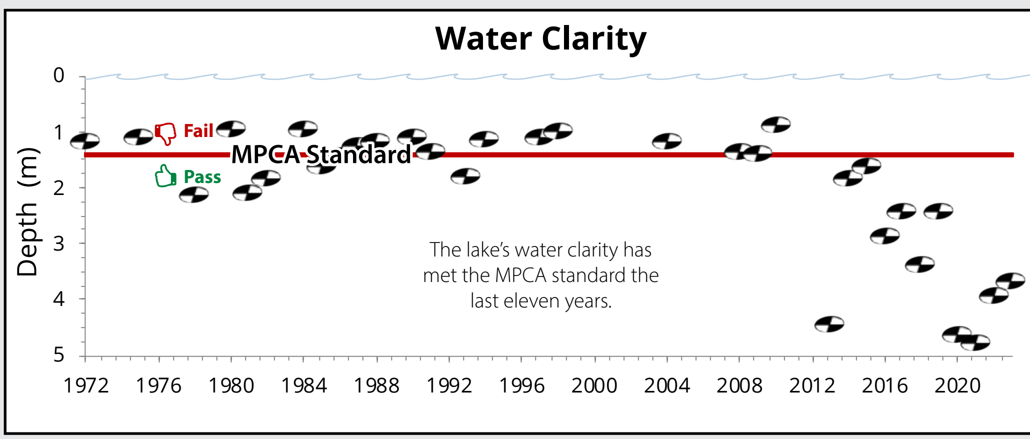
Trends Over Time: 1972-present

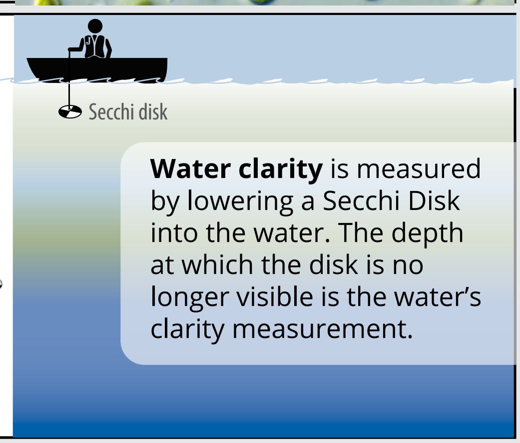












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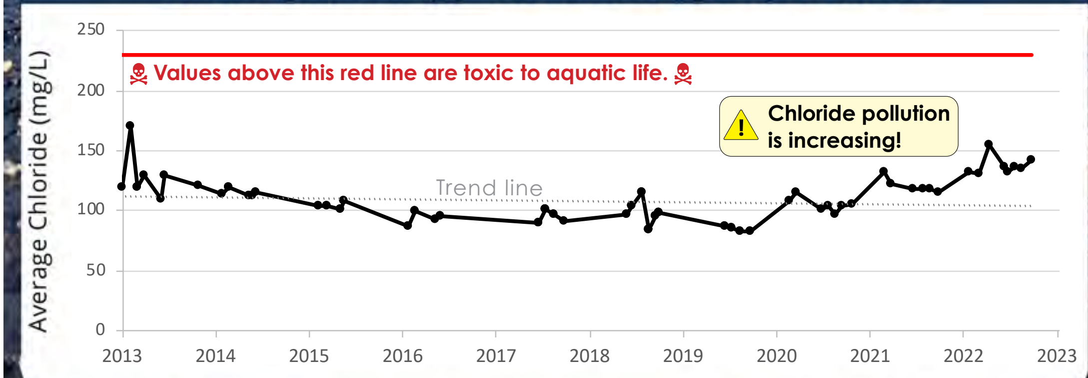

What can I use instead of winter de-icers?

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RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Update

Round Lake

Located in Eden Prairie, Round Lake is a part of the Purgatory Creek Chain of Lakes. With a park and trail system around the lake, it is a popular recreation spot.

From June to September every year, District staff visit the lake every two weeks to collect water samples and take readings. Samples are sent to a laboratory to be tested for nutrients and other compounds. Staff also measure water clarity by lowering a Secchi disk into the water and measuring how deep it goes before it is no longer visible. The data indicates the lake's health based on standards set by the Minnesota Pollution Control Agency (MPCA).

Round Lake is classified as a "Deep Lake" by the MPCA. To be considered healthy, the lake must have very low average phosphorus and chlorophyll-a levels and average water clarity of 1.4 meters (4.6 feet) or greater. See summary below. Additional details are located on the next page.

Total Phosphorus: Since the alum treatment in 2012, average TP concentrations have been consistently below the MPCA deep lake standard (<0.04 mg/L). In 2023, Round Lake had an average TP concentration of **0.025 mg/L**.

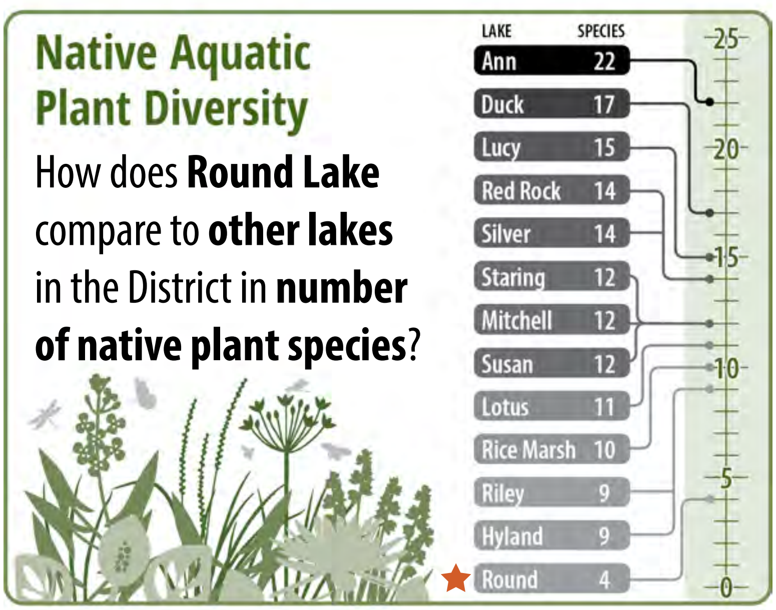
Chlorophyll-a: Lake averages have consistently met the MPCA deep lake standard (<14 µg/L). In 2023, the average chlorophyll-a concentration was **7.7 µg/L**.

Water clarity: Since the alum treatment in 2012, the average water clarity has stabilized below the MPCA deep lake standard (>1.4 meters). In 2023, the average Secchi disk depth was **2.7 meters**.

Watershed Boundary

Lake & watershed characteristics

Lake size	30 acres
Average lake depth	11 feet
Maximum lake depth	37 feet
MPCA lake classification	Deep lake
Watershed size	440 acres
Impervious surface	32% of watershed
Impaired Waters listing	Mercury
Common fish	Bluegill, Yellow Bullhead, Black Bullhead, Black Crappie
Invasive species	Curly-leaf Pondweed , Eurasian Watermilfoil, Brittle Naiad

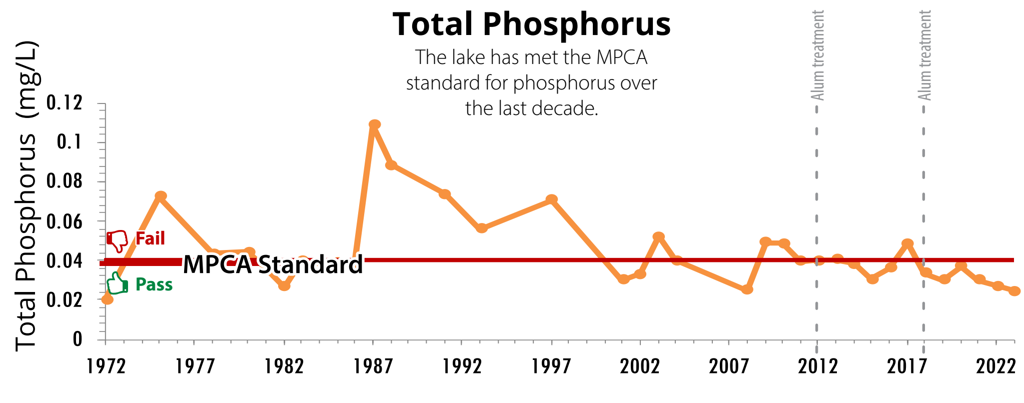


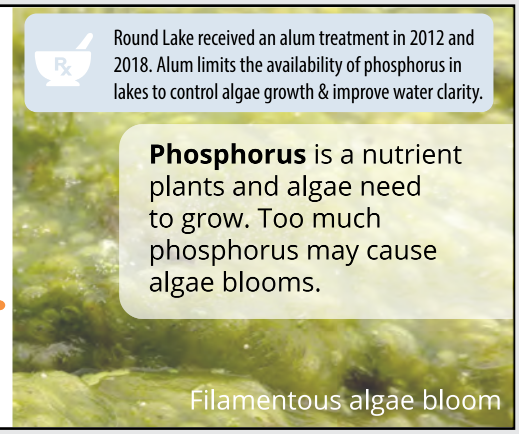
Round Lake Water Quality by the Numbers

The graphs below show water quality trends over time with the red line representing the MPCA standard for **deep lakes.** For the last few years, the City of Eden Prairie has collected water quality data for Round Lake.

Water Quality Report Card B
rpbcwd.org/grades

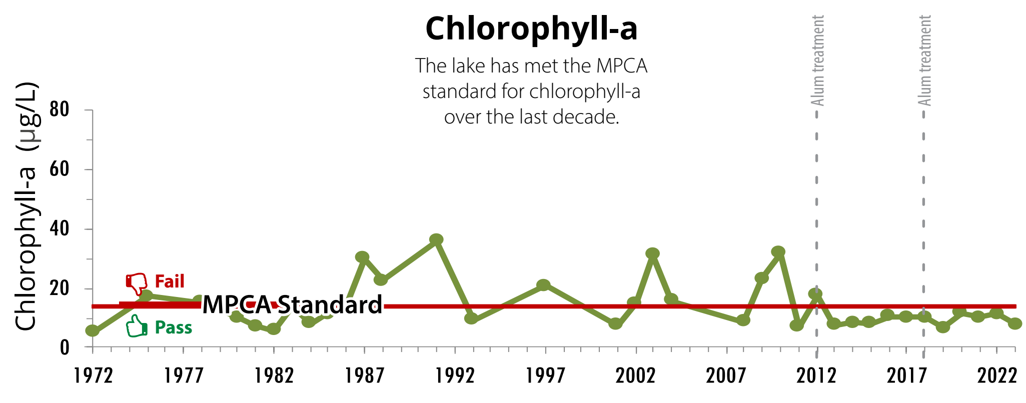
Water Quality Graphs, 1972-present

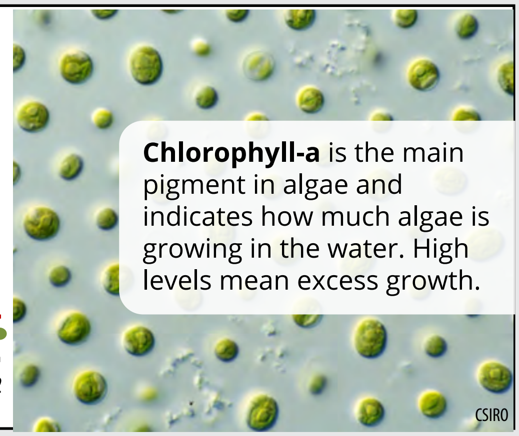




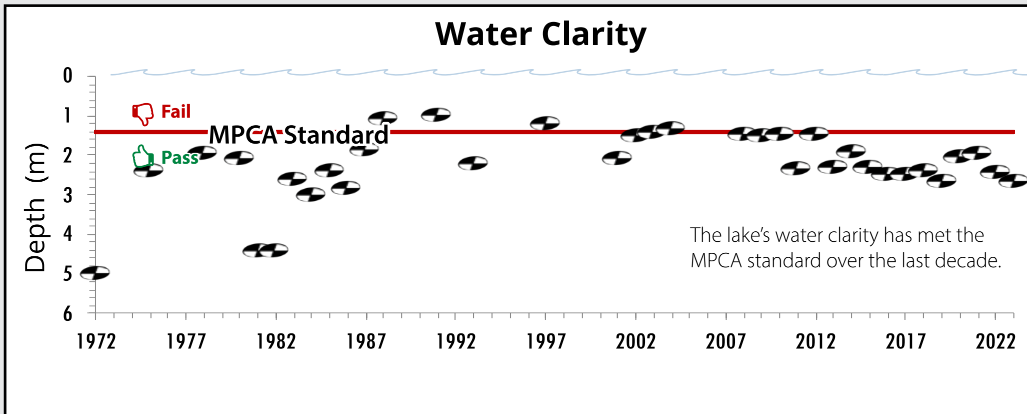
Round Lake received an alum treatment in 2012 and 2018. Alum limits the availability of phosphorus in lakes to control algae growth & improve water clarity.

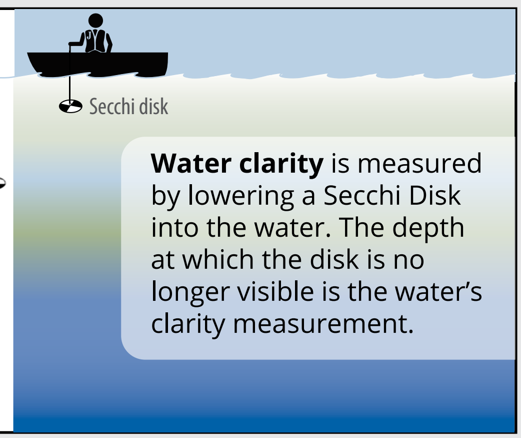
Phosphorus is a nutrient plants and algae need to grow. Too much phosphorus may cause algae blooms.





Chlorophyll-a is the main pigment in algae and indicates how much algae is growing in the water. High levels mean excess growth.

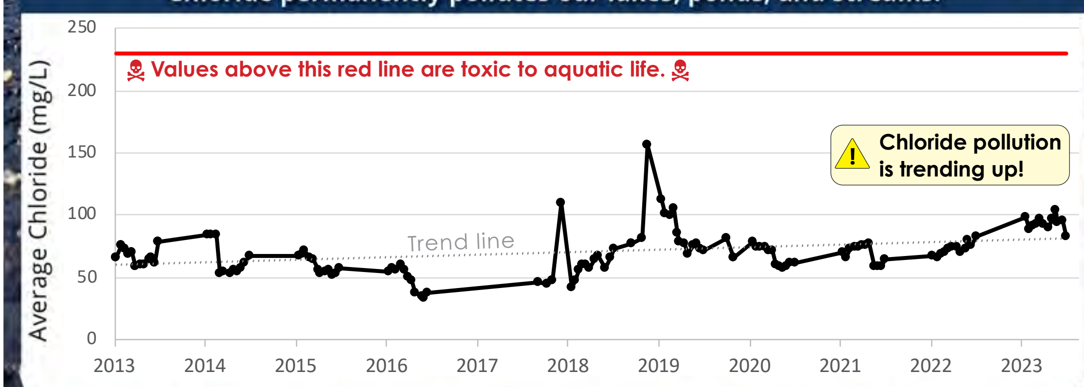




Water clarity is measured by lowering a Secchi Disk into the water. The depth at which the disk is no longer visible is the water's clarity measurement.

Chloride: A Growing Concern

Chloride permanently pollutes our lakes, ponds, and streams!



What can I use instead of winter de-icers?

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RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Update

Silver Lake

Located in Shorewood, Silver Lake sits at the edge of the watershed district. It is the only lake in the District with a native wild rice population, a rarity in metro area lakes!

From June to September every year, District staff visit the lake every two weeks to collect water samples and take readings. Samples are sent to a laboratory to be tested for nutrients and other compounds. Staff also measure water clarity by lowering a Secchi disk into the water and measuring how deep it goes before it is no longer visible. The data indicates the lake's health based on standards set by the Minnesota Pollution Control Agency (MPCA).

Silver Lake is classified as a "Shallow Lake" by the MPCA. To be considered healthy, the lake must have very low average phosphorus and chlorophyll-a levels and average water clarity of 1.0 meter (3.3 feet) or greater. See summary below. Additional details are located on the next page.

Total Phosphorus: No significant trend. In 2023, the lake met the MPCA shallow lake standard (<0.06 mg/L) with an average total phosphorus level of **0.063 mg/L**.

Chlorophyll-a: No significant trend. In 2023, the average reading for chlorophyll-a was **19.1 µg/L**, which met the MPCA standard for shallow lakes (<20 µg/L).

Water clarity: Since 2017, the lake has consistently met the MPCA shallow lake standard for water clarity (>1.0 meters). This is likely linked to reduced water levels that occurred after the outlet was cleared and the increased fish winterkill frequency. The average reading in 2023 was **1.7 meters**.

Plants: An aquatic plant survey was conducted in 2023. Submersed Coontail (94% frequency of occurrence) and floating White Waterlily (50% frequency of occurrence) are the dominant vegetation in the lake. Since the 2013 survey, the number of species has increased from 10 species to 16 in 2020 and 14 in 2023. Most plant species have increased in abundance and density due to increased water clarity. This includes Northern Wild Rice which has increased from 5% in 2013 and 1% in 2020 to 13% in 2023.

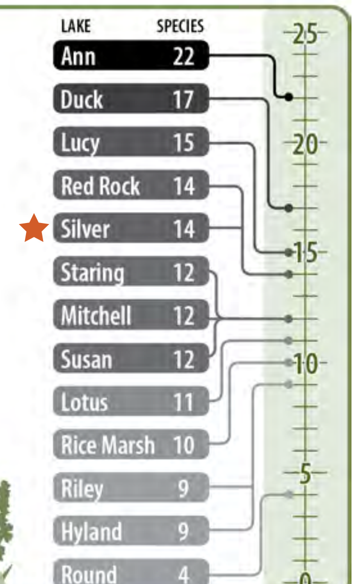
Lake & watershed characteristics

Lake size	71 acres
Average lake depth	5 feet
Maximum lake depth	14 feet
MPCA lake classification	Shallow lake
Watershed size	391 acres
Impervious surface	14% of watershed
Impairment listing	Nutrients
Common fish	Black Bullhead, Fathead Minnow, Central Mudminnow
Invasive species	Curly-leaf Pondweed, Purple Loosestrife

Watershed Boundary

Native Aquatic Plant Diversity

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

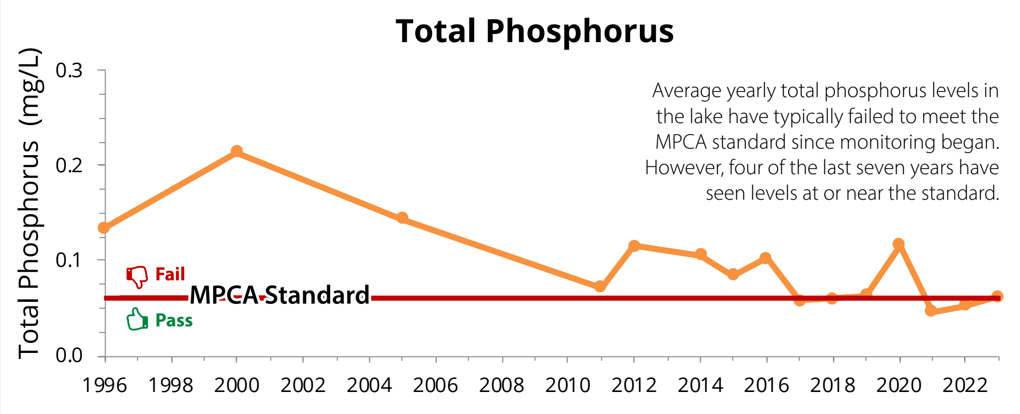


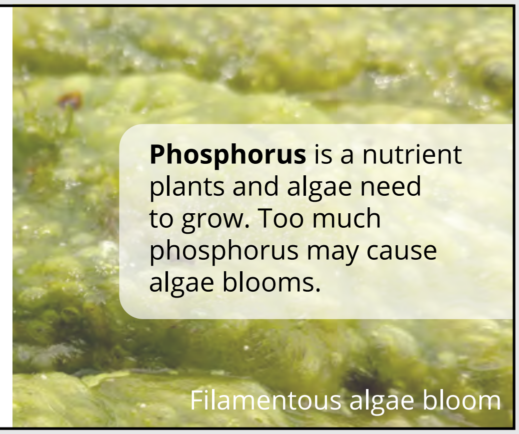
Silver Lake Water Quality by the Numbers

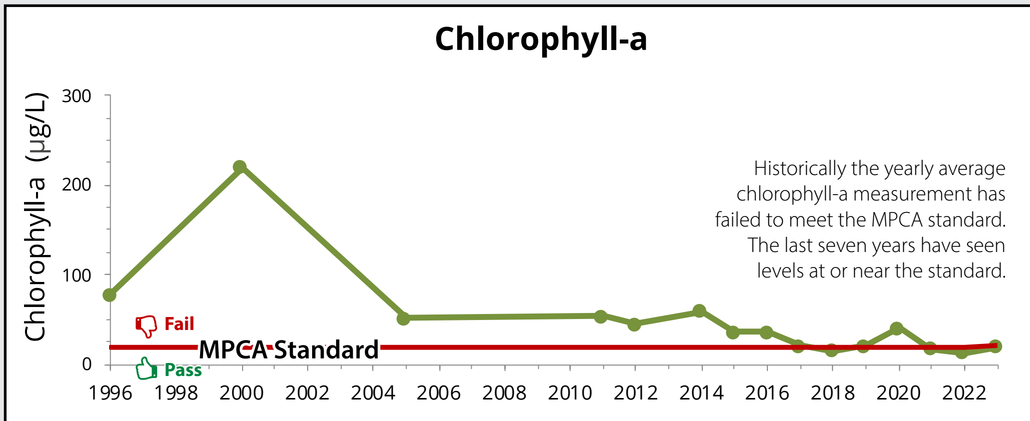
The graphs below show water quality trends over time with the red line representing the MPCA standard for **shallow lakes**.

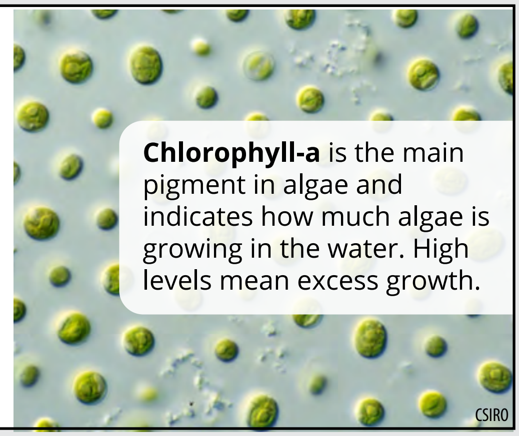
Water Quality Report Card: C
rpbcwd.org/grades

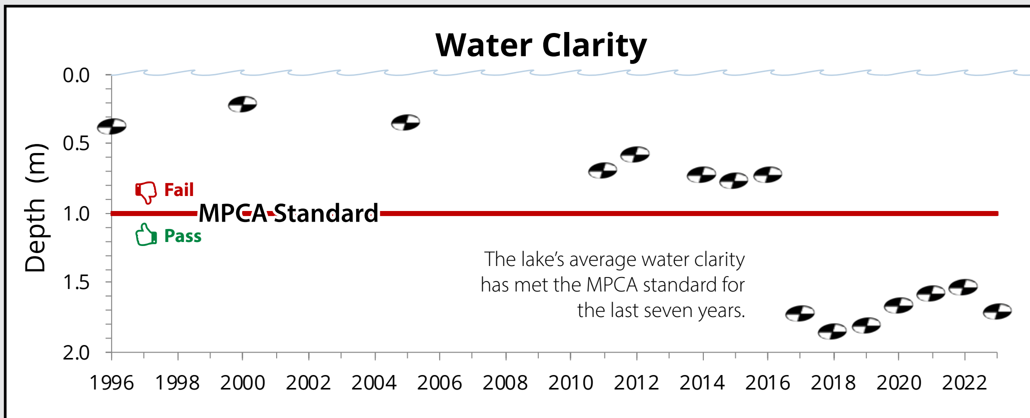
Trends Over Time: 1972-present

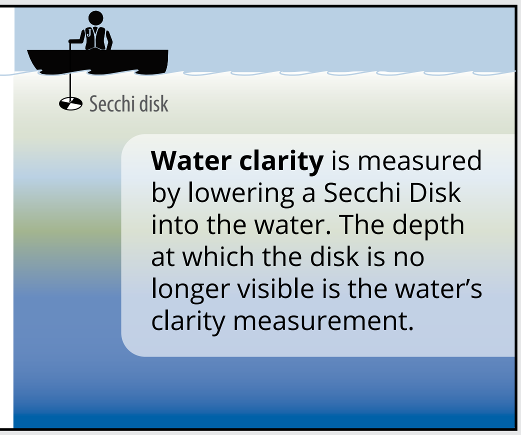












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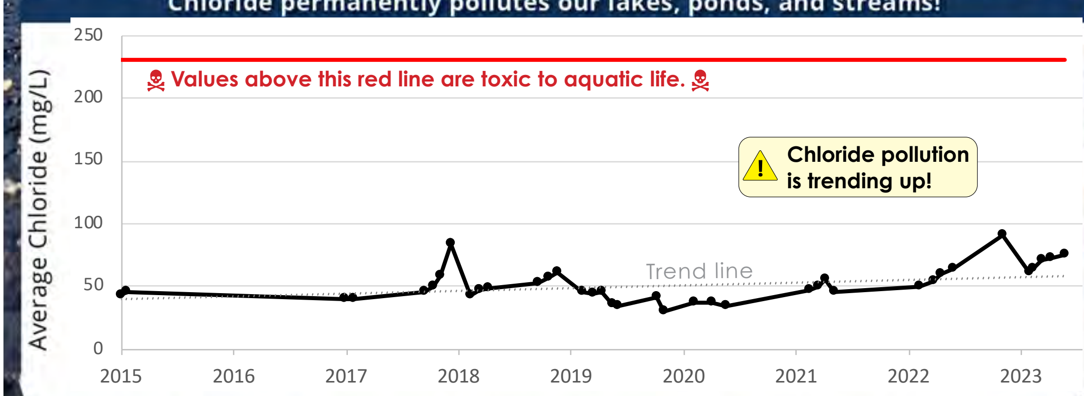

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Learn more rpbcwd.org/salt

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Update

Staring Lake

Staring Lake is located in Eden Prairie, west of Flying Cloud Drive and north of Pioneer Trail. Staring has a public boat ramp and a fishing pier. The Eden Prairie Outdoor Center is also located on its shores, off of Staring Lake Parkway.

From June to September every year, District staff visit the lake every two weeks to collect water samples and take readings. Samples are sent to a laboratory to be tested for nutrients and other compounds. Staff also measure water clarity by lowering a Secchi disk into the water and measuring how deep it goes before it is no longer visible. The data indicates the lake's health based on standards set by the Minnesota Pollution Control Agency (MPCA).

Staring Lake is classified as a "Shallow Lake" by the MPCA. To be considered healthy, the lake must have very low average phosphorus and chlorophyll-a levels and average water clarity of 1.0 meter (3.3 feet) or greater. See summary below. Additional details are located on the next page.

Total Phosphorus: Since carp management began in 2011, levels have decreased. In 2023, the lake did not meet the MPCA shallow lake standard for total phosphorus (<0.06 mg/L). The 2023 average was **0.101 mg/L**, which in part was likely due to low water levels and a whole-lake herbicide treatment in 2022.

Chlorophyll-a: No significant trend. In 2023, the average reading for chlorophyll-a was **87.6 µg/L**, which failed to meet the MPCA standard for shallow lakes (<20 µg/L), and was significantly higher than recent years. In an August sample, blue-green algae numbers were high, indicating a probable presence of toxins at that time.

Water clarity: Since carp management began in 2011, clarity has improved. The average reading in 2023 was **0.9 meters**, which failed to meet the MPCA standard (>1.0 m).

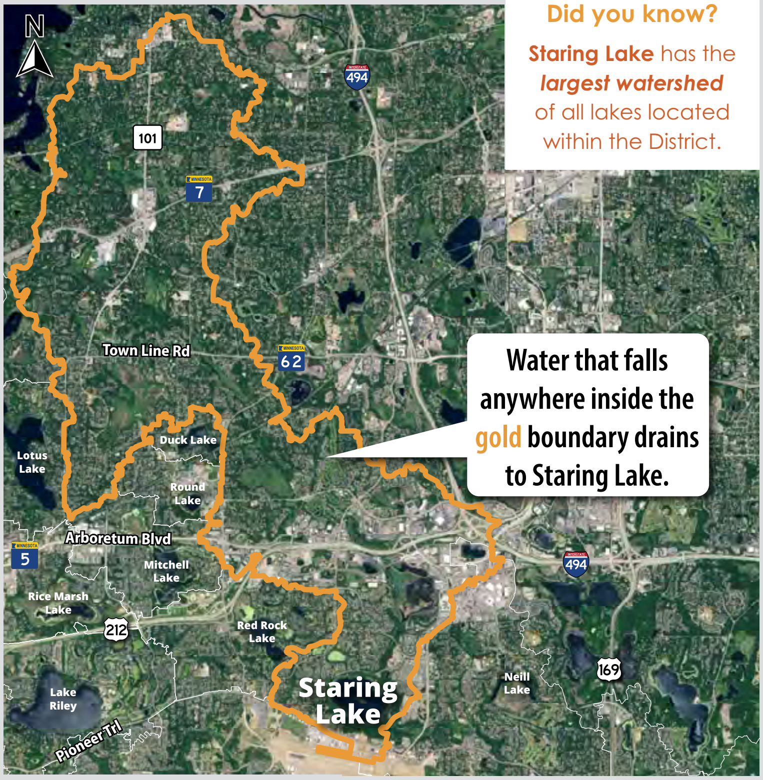
Fish: Electrofishing was used to monitor Common Carp, an invasive species that harms water quality by stirring up lake bottom sediments. Carp biomass is decreasing in the lake with little to no reproduction detected the last six seasons. However, near record low water levels led to a winterkill of native fish, which eat carp eggs. Bluegill were stocked in late spring to offset this loss, but not before carp reproduction occurred. This was the first time since 2015 that a significant carp reproduction event has occurred.

Plants: In 2022, a herbicide treatment successfully treated Eurasian Watermilfoil with none of this invasive species observed in 2023. Unfortunately, the reduced vegetation combined with low water levels led to reduced water quality. Nutrient levels should improve as native vegetation expands across the lake. The District will continue to monitor the plant community to assess native vegetation and keep invasives in check.

Lake & watershed characteristics

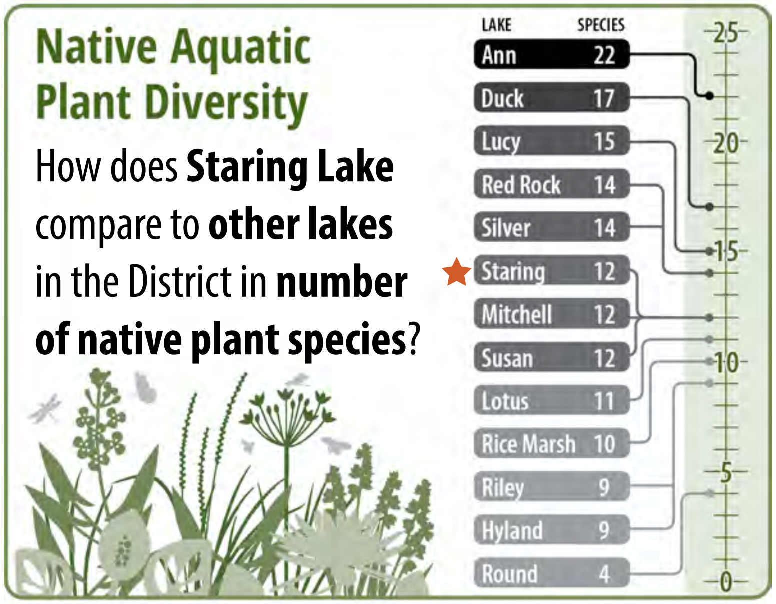
Lake size	166 acres
Average lake depth	7 feet
Maximum lake depth	16 feet
MPCA lake classification	Shallow lake
Watershed size	10,158 acres
Impervious surface	21% of watershed
Impairment listing	Mercury & nutrients
Common fish	Bluegill, Black Crappie, Black Bullhead
Invasive species	Curly-leaf Pondweed, Eurasian Watermilfoil, Brittle Naiad, Common Carp

Watershed Boundary



Did you know?

Staring Lake has the ***largest watershed*** of all lakes located within the District.



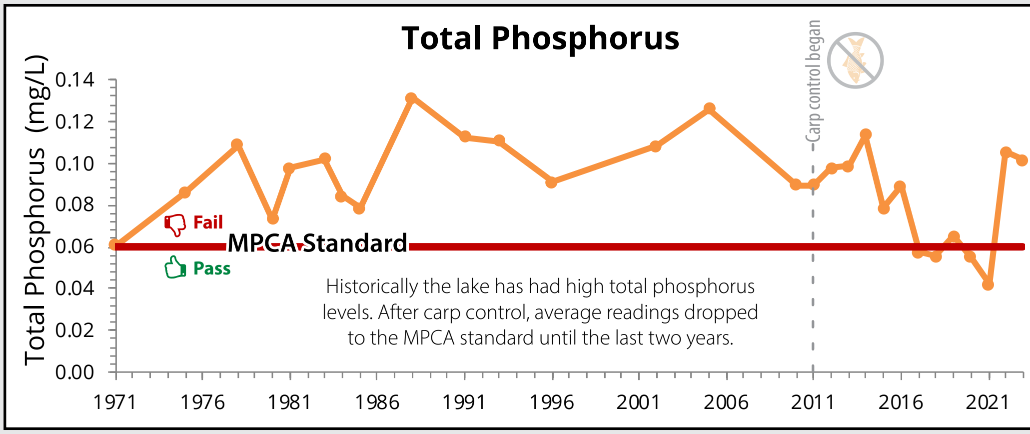
RPBCWD Office, 18681 Lake Drive East, Chanhassen, MN 55317 rpbcwd.org info@rpbcwd.org 952-607-6512 @rpbcwd

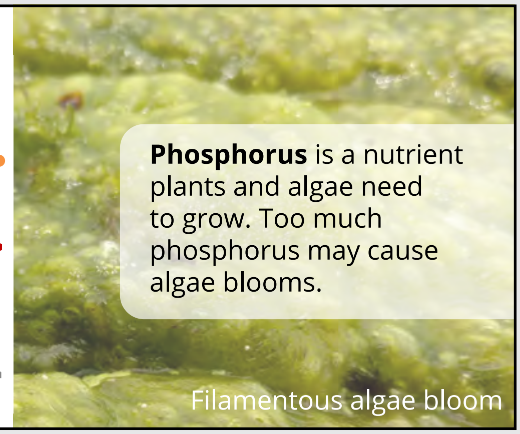
Staring Lake Water Quality by the Numbers

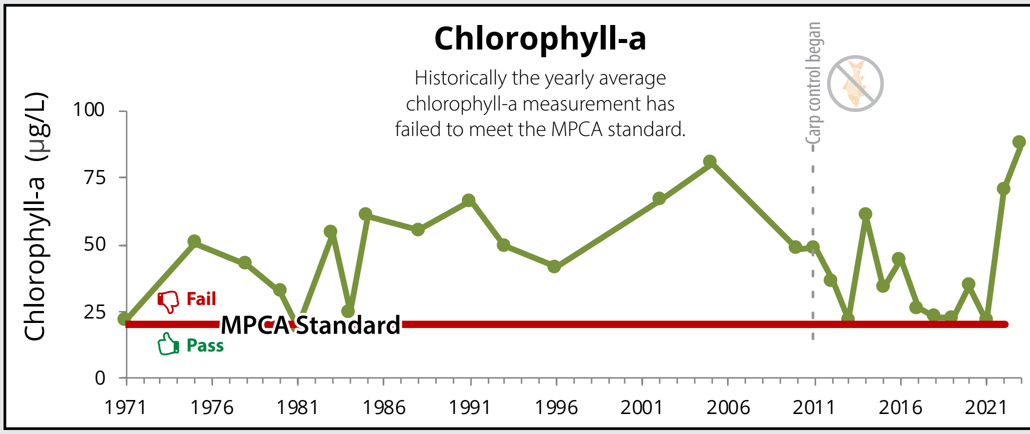
The graphs below show water quality trends over time with the red line representing the MPCA standard for **shallow lakes**. Over the last decade, **Staring Lake** has failed to consistently meet clean water standards set by the MPCA.

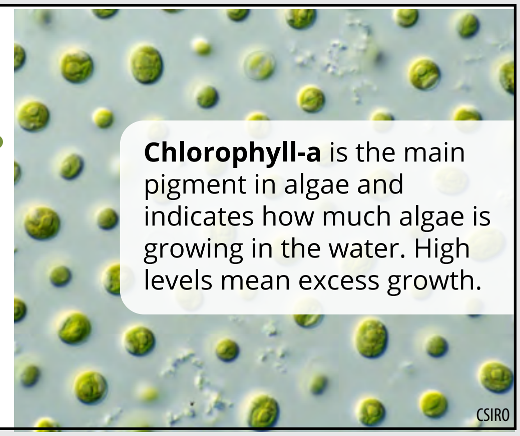
Water Quality Report Card — **D**
rpbcwd.org/grades

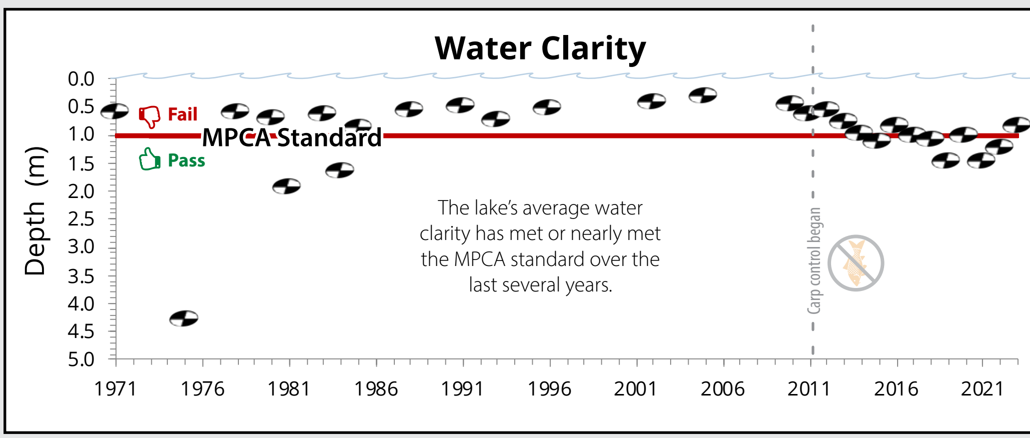
Trends Over Time: 1972-present

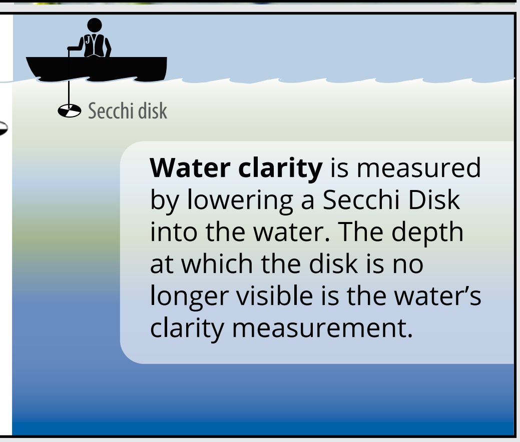












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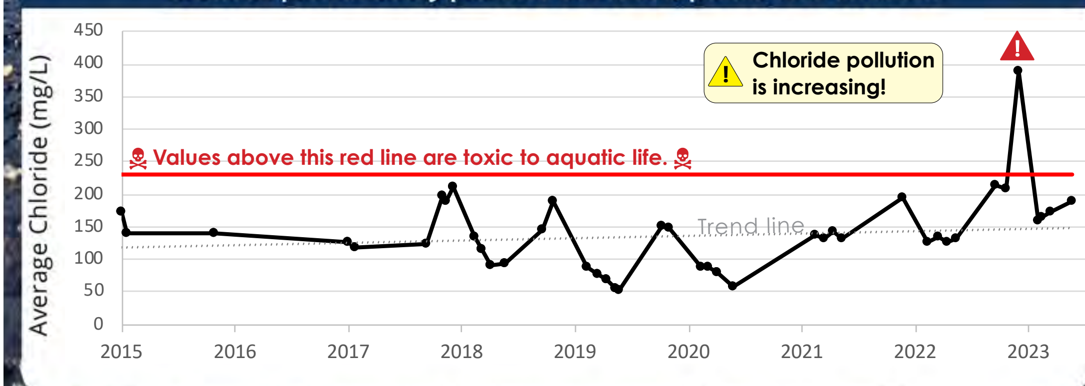

What can I use instead of winter de-icers?

All affordable & effective residential de-icing products contain chloride, even those labeled as "eco-friendly" or "pet safe."

Focus instead on reducing build up of ice on your property:

- **Shovel early & often**
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RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Update

Lake Susan

Located in Chanhassen, Lake Susan is a part of the Riley Creek Chain of Lakes. It is the third lake that Riley Creek flows through as it makes its way to the Minnesota River.

From June to September every year, District staff visit the lake every two weeks to collect water samples and take readings. Samples are sent to a laboratory to be tested for nutrients and other compounds. Staff also measure water clarity by lowering a Secchi disk into the water and measuring how deep it goes before it is no longer visible. The data indicates the lake's health based on standards set by the Minnesota Pollution Control Agency (MPCA).

Lake Susan is classified as a "Shallow Lake" by the MPCA. To be considered healthy, the lake must have very low average phosphorus and chlorophyll-a levels and average water clarity of 1.0 meter (3.3 feet) or greater. For more detail, see the back page.

Total Phosphorus: No significant trend. In 2023, the lake just met the MPCA shallow lake standard (<0.06 mg/L) with an average total phosphorus level of **0.055 mg/L**.

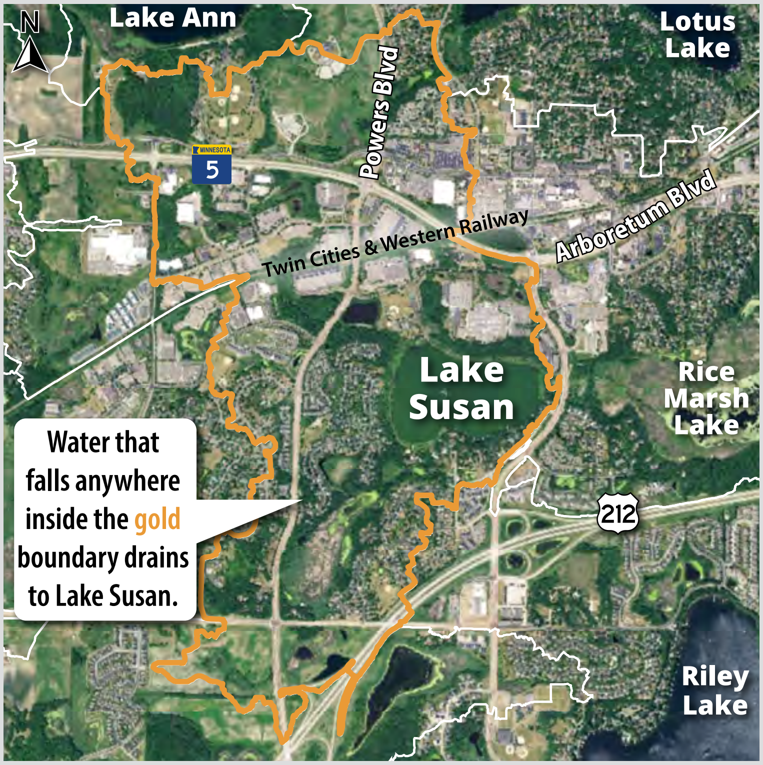
Chlorophyll-a: No significant trend. In 2023, the average reading for chlorophyll-a was **45.3 µg/L**, which failed to meet MPCA shallow lake standard (<20 µg/L). Blue-green algae numbers were high in June-August, indicating a probable presence of toxins during that time.

Water clarity: No significant trend. Over the previous few years, the lake was consistently meeting the MPCA shallow lake standard (>1.0 meters). In 2023, the average reading of **0.7 meters** did not meet standard.

Fish: Electrofishing was used to monitor Common Carp, an invasive species that harms water quality by destroying aquatic vegetation and stirring up lake bottom sediments. The 2023 carp biomass estimate was 11 kg/ha, which was well below the damaging threshold of 100 kg/ha. This combined with limited recruitment mean carp are not an issue for Lake Susan.

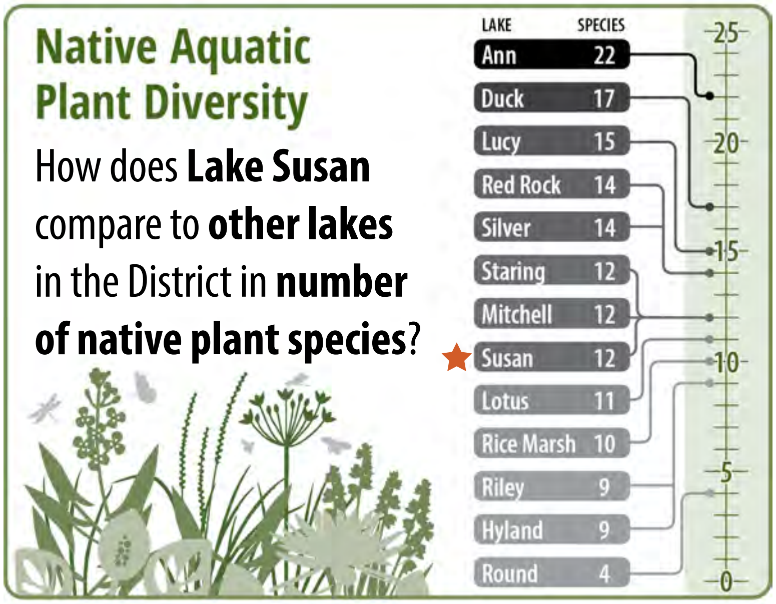
Plants: In 2023, herbicide treatments were carried out on 5.3 acres to reduce Curly-leaf Pondweed. UMN conducted three plant surveys in 2023 to track aquatic vegetation populations. In May maximum depth of growth was 3.1 meters, decreasing to 1.5 in August. Invasive Eurasian watermilfoil has declined in frequency since 2011 and was not observed on any rake tosses in 2018-2023. Invasive Brittle Naiad remains at low levels.

Watershed Boundary



Lake & watershed characteristics

Lake size	88 acres
Average lake depth	10 feet
Maximum lake depth	17 feet
MPCA lake classification	Shallow lake
Watershed size	1,231 acres
Impervious surface	27% of watershed
Impairment listing	Mercury & nutrients
Common fish	Bluegill, Black Crappie, Northern Pike, Black Bullhead, Yellow Bullhead
Invasive species	Curly-leaf Pondweed, Eurasian Watermilfoil, Common Carp, Brittle Naiad



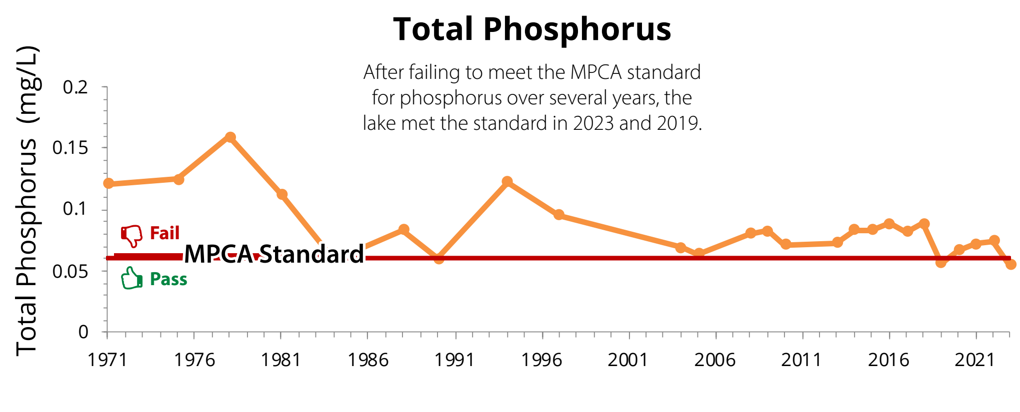
RPBCWD Office, 18681 Lake Drive East, Chanhassen, MN 55317 rpbcwd.org info@rpbcwd.org 952-607-6512 @rpbcwd

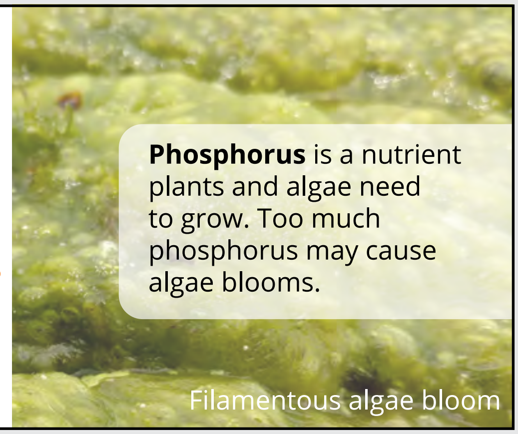
Lake Susan Water Quality by the Numbers

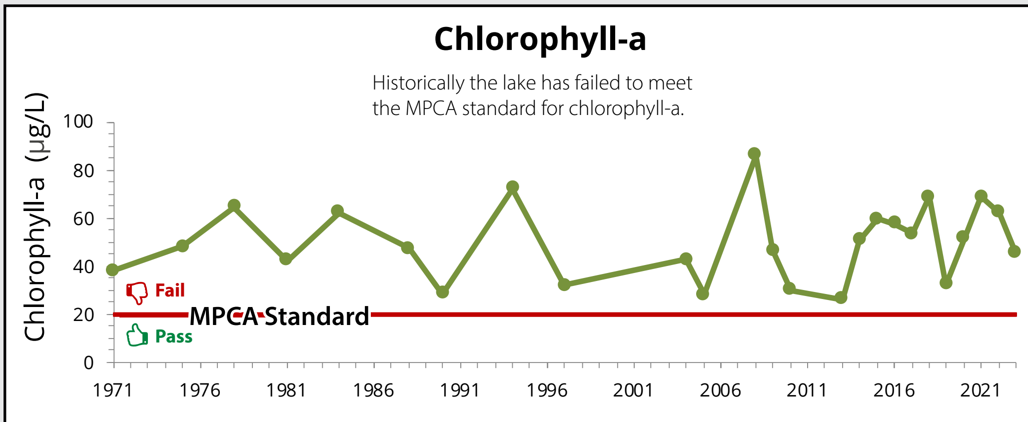
The graphs below show water quality trends over time with the red line representing the MPCA standard for shallow lakes. **In 2023, Lake Susan failed to meet two clean water standards set by the MPCA.**

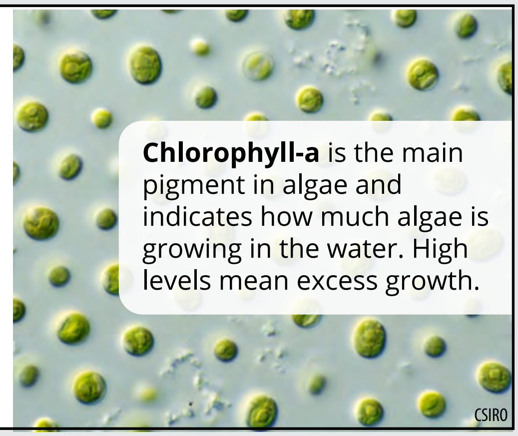
Water Quality Report Card D
rpbcwd.org/grades

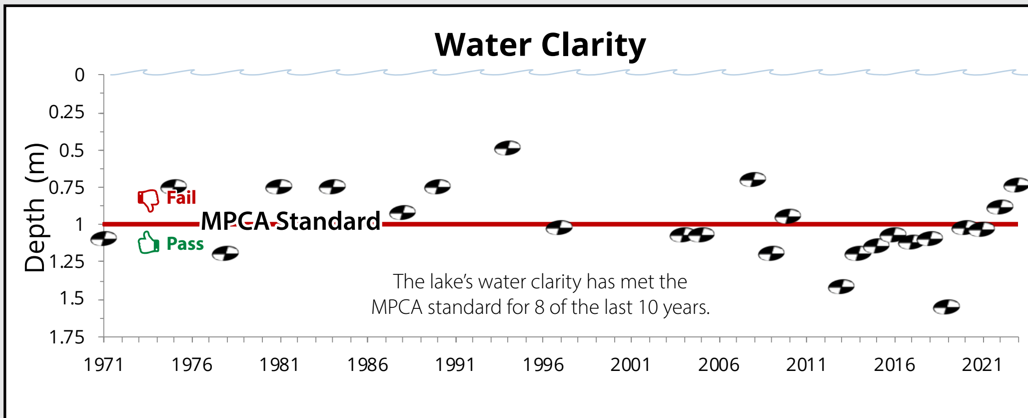
Trends Over Time: 1972-present

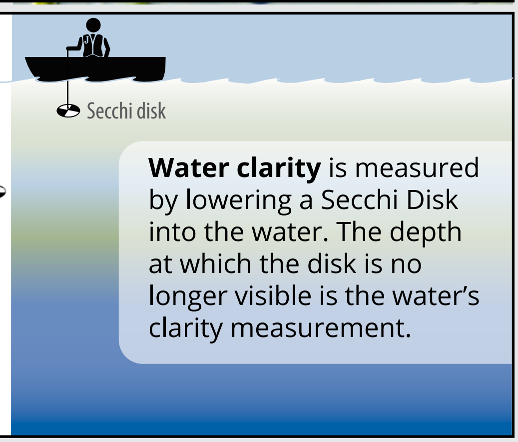












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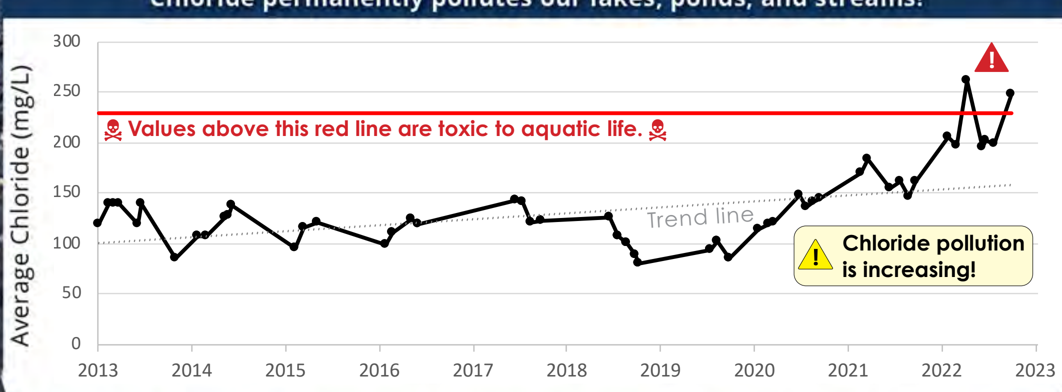

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APPENDIX D

Water Resources Report

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Water Resources Report

Josh Maxwell, *Water Resources & Fisheries Manager*
Andrew Hartmann, *Water Resources Technician*

Photo of Rice Marsh Lake by Tom Duevel

2023 Water Resources Report

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2023 Water Resources Report

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

EXECUTIVE SUMMARY

The Riley Purgatory Bluff Creek Watershed District (RPBCWD) had a successful sampling season in 2023, completing a full year of sample collection and data analysis. This effort was made possible through multiple partnerships with municipalities and organizations based within the watershed. The results from the 2023 sampling effort are presented in this report. Table 1 provides an overview of water quality parameters. For a list of commonly used acronyms and abbreviations used in this report, see Exhibit K.

2023 LAKE SUMMARY

During the 2023 monitoring season, 13 lakes and two open-water wetlands were intensively monitored. Regular water quality lake sampling was conducted on each lake approximately every two weeks throughout the growing season (June-September). Surface water samples were collected, analyzed, and compared to standards set by the Minnesota Pollution Control Agency (MPCA) to assess overall lake health. Figure 1 displays lakes sampled in 2023 that met or exceeded the MPCA lake water quality standards.

In 2023, lake water quality remained relatively the same across the district with Lake Ann, Duck Lake, Hyland Lake, Lake Idlewild, Lake Lucy, Rice Marsh Lake, Lake Riley, and Round Lake meeting all three MPCA standards. Following the past aluminum sulfate treatments, both Lake Riley and Rice Marsh Lake continued to meet all MPCA standards and are in the process of being delisted from the MPCA Impaired Waters List for nutrients. Lake Susan had the most degraded water quality of all Riley chain lakes but did improve to meet the total phosphorous standard in 2023. Of the Purgatory Chain of Lakes, Red Rock Lake and Mitchell both improved from 2022 by meeting the TP standard, but neither meet the Chl-a standard. Silver had an increase in TP and is now just above the threshold from 2023. Hyland Lake continued to meet the standards in 2023 following the completed alum treatment in 2022. Staring Lake saw a decrease in water clarity and is now below all three MPCA standards. All lakes met the proposed nitrate water quality standard. Rice Marsh Lake and Idlewild were above the chloride standard in 2023. Susan and Staring have shown increasing chloride levels in 2023 and are approaching the standard.

Staff removed 394 Common carp (735 pounds) from the district in 2023, 365 of which were removed from the Purgatory Creek system during the spring migration. Following the winterkill in Staring Lake, a significant carp recruitment event occurred which is the first time since 2015. The district also monitored public access points and analyzed water samples for the presence of Zebra Mussels in 13 waterbodies. Zebra Mussel veligers and adults were found on Lake Riley in 2023, which was expected. During an intensive Zebra Mussel survey, adult Zebra Mussels were found on Lake Ann and a rapid response copper sulfate treatment was conducted to try and eliminate them from the lake. During an end of the year Zebra Mussel scan a boat lift

Table 1. Water quality parameter indications.

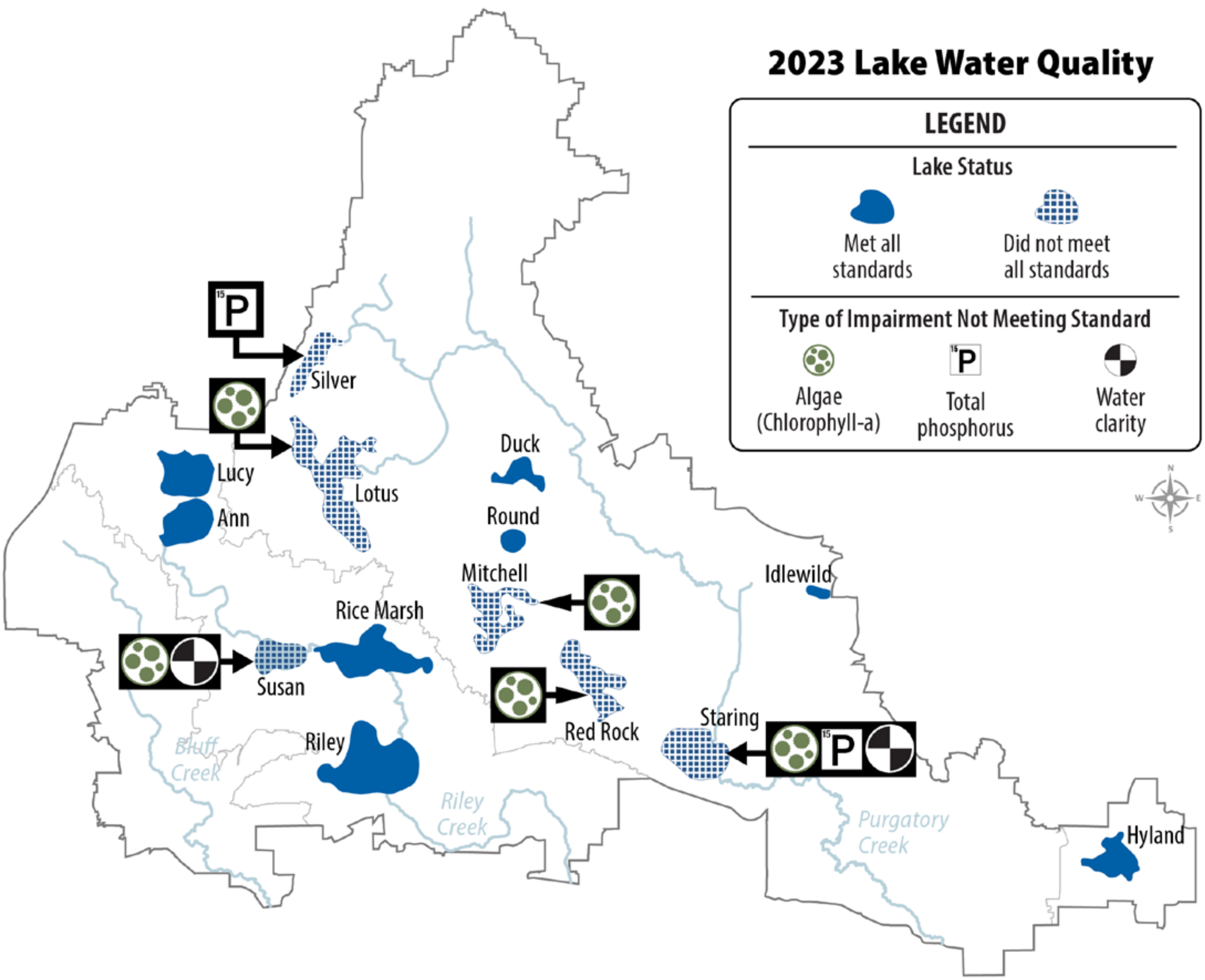
Abbreviation	What is stands for	What it indicates
Chl-a	Chlorophyll-a	Level of algae growth
CL	Chloride	Level of salt pollution
DO	Dissolved oxygen	Oxygen level of water
TP	Total phosphorus	Level of all phosphorus
TDP	Total dissolved phosphorus	Level of all available phosphorus
OP	Ortho phosphorus	Level of biologically available phosphorus
TSS	Total suspended solids	Level of silt/sediment suspended in water

with desiccated mussels was found onshore on Lotus Lake. Water samples processed for eDNA on Carver County lakes tested positive for the presence of Zebra Mussels in Lotus Lake and Lake Ann and veligers were also found on Lotus Lake. In 2023, point-intercept surveys were conducted on Hyland Lake (Three Rivers Park District), Mitchell Lake, Red Rock Lake (Eden Prairie), Lake Susan, Lake Riley, Staring Lake, Duck Lake, Silver Lake, and Lake Ann (RPBCWD). In the spring, Curly-leaf Pondweed was treated on Mitchell Lake (12.9 acres), Lake Riley (9 acres), Lake Susan (5.35 acres), and Red Rock (13 acres). Both Eurasian Watermilfoil and Curly-leaf Pondweed were targeted with a single treatment on Lotus Lake (22.92 acres).

Staff Maxwell collects water samples from Lake Susan.

Figure 1. Summary of lake water quality in 2023 within RPBCWD.

Summary of the lake water quality data collected within the Riley Purgatory Bluff Creek Watershed District in 2023 as compared to the Minnesota Pollution Control Agency Water Quality Standards. Chlorophyll-a, Total Phosphorus, and Secchi Disk depth during the growing season (June-September) for both "deep lakes" or lakes >15 ft deep and < 80% littoral area and "shallow lakes" or lakes <15 ft deep and >80% littoral area. The corresponding symbols next to each lake indicate which water quality standard was not met and lakes remaining blue met all water quality standards.



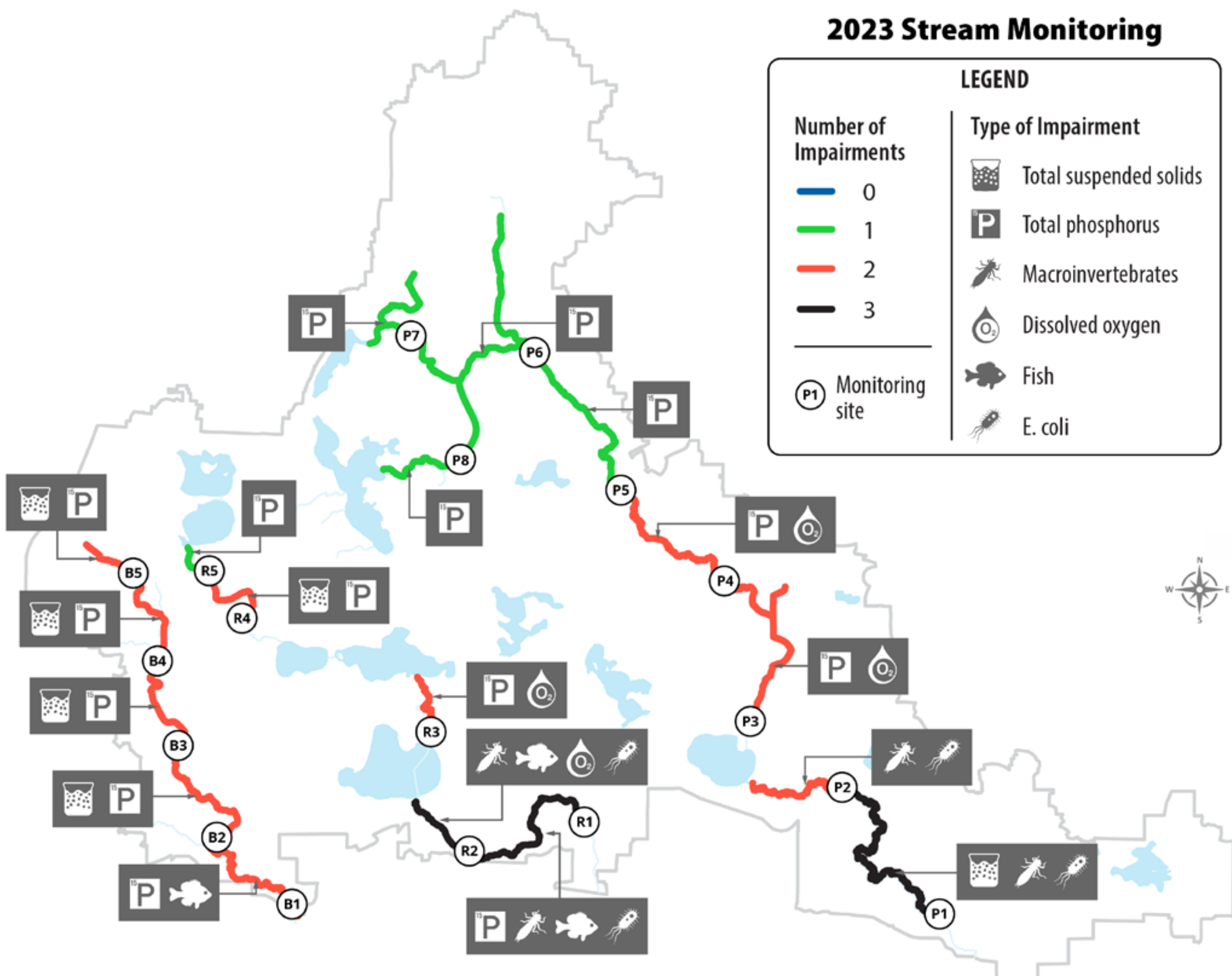
2023 STREAM SUMMARY

In 2023, RPBCWD and its partners collected water quality samples and performed data analysis on 28 different sampling sites along Riley Creek (six sites), Bluff Creek (eight sites), and Purgatory Creek (14 sites). During the 2023 creek monitoring season, (April-September) water chemistry, nutrients, and turbidity were regularly measured at the 18 regular water quality creek monitoring sites every two weeks. Creek flow was calculated by taking velocity measurements from consistent creek cross sections at each water quality monitoring location. Staff deployed automated sampling units on Purgatory Creek


Staff collect data for Bluff Creek.

Figure 2. Summary of stream water quality in 2023 within RPBCWD.

2023 stream water quality data from Bluff Creek, Riley Creek, and Purgatory Creek in the Riley Purgatory Bluff Creek Watershed District as compared to MPCA Water Quality Standards. Eighteen water monitoring locations (white circles) were sampled every other week and data from the individual sites were applied upstream to the next monitoring location. The summer season (April-September) eutrophication and total suspended solids water quality standards used in this assessment included: Dissolved Oxygen (DO) daily minimum > 4 mg/L, average Total Phosphorus (TP) < 0.1 mg/L, Total Suspended Solids (TSS) < 10% exceedance of 30 mg/L limit, average Chlorophyll-a (CHLA) <18 µg/L, average pH < 9 su and > 6 su. The corresponding labels next to each stream section indicate which water quality standards were not met.



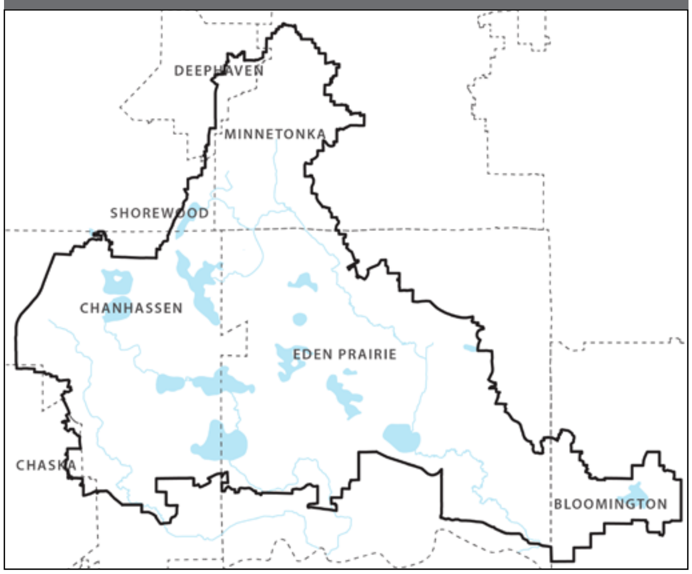
on the upper Lotus Lake ravines and Bluff Creek on the upper reach to assess pollutant loads and assess the potential for restoration projects. Data was also collected on all three creeks near the confluence with the Minnesota River at the Metropolitan Council's Watershed Outlet Monitoring Stations (WOMP). District staff attempted to collect macroinvertebrates at all Purgatory Creek regular water quality monitoring sites in 2023, however due to the low water levels only five sites were able to be sampled. Staff walked and assessed lower Bluff Creek and upper Riley Creek. Overall, most stream sections had Creek Restoration Action Strategy (CRAS) scores slightly improved from years past.

The summary for all three creeks is based on water quality parameters developed by the MPCA in 2014 for Eutrophication and TSS as well as impairment status for fish, macroinvertebrates, and E. coli can be seen in Figure 2. In 2023, the continued drought significantly impacted the streams. Of the 18 regular sampling sites, 14 went dry or became stagnant at some point. From 2022 to 2023, stream water quality was reduced slightly across the district. Excluding the dissolved oxygen impairment, the number of water quality standard exceedances remained relatively the same from 2022. Bluff had 10, Riley has had 13, and Purgatory had 13 water quality standard exceedances. No regular creek sampling sites met all MPCA water quality standards assessed in 2023 . Like previous years, TP was the water quality standard causing the most impairments in 2023 with 15 of the 18 sites not meeting the standard. TSS impairments were slightly reduced from 2022, which is likely related to the low flows. In 2023, Riley Creek had the most water quality exceedances with 13. MPCA macroinvertebrate and E. coli impairments included the lower reaches of Riley and Purgatory Creeks. The lower reaches of Riley and Bluff creeks had fish impairments.

1: INTRODUCTION

The Riley Purgatory Bluff Creek Watershed District (RPBCWD) was established on July 31, 1969, by the Minnesota Water Resources Board acting under the authority of the watershed law. The district is located in the southwestern Twin Cities Metropolitan Area. It consists of a largely developed urban landscape and encompasses portions of Bloomington, Chanhassen, Chaska, Deephaven, Eden Prairie, Minnetonka, and Shorewood (Figure 3). The watershed district includes portions of both Hennepin and Carver counties. The total district area is about 50 square miles and includes three creek subwatersheds: Riley Creek, Purgatory Creek, and Bluff Creek.

Figure 3. Cities with land within the RPBCWD boundary.



Data collection and reporting are the foundation of the District's work. Regular, detailed water quality monitoring provides staff with scientifically reliable information needed to decide if water improvement projects are needed and how effective they are in watershed improvement. Data collection remains a key component of the district's work as we strive to de-list, protect, and improve the waterbodies within the watershed. The purpose of this report is to summarize the water quality and quantity results collected over the past year, which can be used to direct the district in managing our water resources.

Through partnerships with various cities, Three Rivers Park District (TRPD), the University of Minnesota (UMN), Metropolitan Council (METC), and Carver County, data was collected on 13 lakes and two wetlands (Lake Idlewild and Neill Lake). In 2023, the district and its partners collected water quality samples and performed data analysis on 28 different sampling sites along Riley Creek (six sites), Bluff Creek (eight sites), and Purgatory Creek (fourteen sites). Each partner was responsible for monitoring particular parameters of their respective lakes and/or streams and reporting their findings, allowing for more time and attention to be given to each individual water resource (see Table 2). Monitoring frequency and intensity depended on monitoring purpose(s).

Water quality and quantity were monitored at each regular stream monitoring site during the field season (April-September) typically twice a month. The district assisted METC with collecting data at continuous monitoring stations near the outlet of each creek as part of its Watershed Outlet Monitoring Program

Table 2. Water resources sampling partnerships.

Name	RPBCWD	Three Rivers Park District	City of Eden Prairie	Carver County	Met Council
LAKES					
Ann	💧			💧	
Duck	💧				
Hyland	💧	💧			
Idlewild	💧				
Lotus	💧			💧	
Lucy	💧				
McCoy	💧				
Mitchell	💧		💧		
Neill	💧				
Red Rock	💧		💧		
Rice Marsh	💧				
Riley	💧				
Round	💧		💧		
Silver	💧				
Staring	💧				
Susan	💧			💧	
CREEKS					
Bluff	💧				💧
Purgatory	💧				💧
Riley	💧		💧		💧

(WOMP) or long-term monitoring program which identifies pollutant loads entering the Minnesota River.

In addition to water quality monitoring, staff conducted creek walks to gather more information about current stream conditions. The information was included in the Creek Restoration Action Strategy (CRAS), which was developed by the district to identify and prioritize future stream restoration sites. More information about CRAS is available in Chapter 4.9. Bank pin data was collected near each of the creek water quality monitoring sites to measure generalized sedimentation and erosion rates. In 2023, macroinvertebrates were collected from Purgatory Creek but only five of eight sites could be sampled due to low water levels.

Lakes were also monitored bi-weekly during the summer growing season (June-September), and lake levels were continuously recorded from ice-out to ice-in. Lake water samples were collected in early summer and analyzed for the presence of Zebra Mussel veligers. Additionally, during every sampling event, boat launch areas and Zebra Mussel monitoring plates were scanned for adult Zebra Mussels and other aquatic invasive species (AIS).

Zooplankton and phytoplankton samples were collected on five lakes to assess the overall health of the population as it applies to fishery health and water quality. Plant surveys and herbicide treatments were also conducted to assess overall health of the aquatic plant community and to reduce the number of invasive aquatic plants.

Common carp have been identified as being detrimental to lake health and are continually monitored by the district. In 2023, winter monitoring occurred on the Riley Chain of Lakes as well as three separate stormwater ponds. Extending monitoring activities into winter months can provide key insights into ways to improve water quality during the summer months. Winter monitoring also allows us to evaluate the influence of chloride levels in our lakes. The data collection and reporting events were tracked throughout the year (see summary in Table 3).

In addition to lakes and streams, multiple specialty projects were monitored to evaluate their effectiveness at preventing or contributing pollutant loads to the watershed.

Table 3. Monthly field data collection locations.

Waterbody name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
LAKES												
Ann	💧	💧	💧		💧	💧	💧	💧	💧	💧		
Duck	💧	💧	💧		💧	💧	💧	💧	💧	💧		
Hyland					💧	💧	💧	💧	💧	💧		
Idlewild					💧	💧	💧	💧	💧	💧		
Lotus					💧	💧	💧	💧	💧	💧		
Lucy	💧	💧	💧		💧	💧	💧	💧	💧	💧		
McCoy					💧							
Mitchell					💧	💧	💧	💧	💧	💧		
Neill					💧	💧	💧	💧	💧	💧		
Red Rock					💧	💧	💧	💧	💧	💧		
Rice Marsh	💧	💧	💧		💧	💧	💧	💧	💧	💧		
Riley	💧	💧	💧		💧	💧	💧	💧	💧	💧		
Round					💧	💧	💧	💧	💧	💧		
Silver					💧	💧	💧	💧	💧	💧		
Staring	💧	💧	💧		💧	💧	💧	💧	💧	💧		
Susan	💧	💧	💧		💧	💧	💧	💧	💧	💧		
CREEKS												
Bluff	💧	💧	💧	💧	💧	💧	💧	💧	💧	💧	💧	💧
Purgatory	💧	💧	💧	💧	💧	💧	💧	💧	💧	💧	💧	💧
Riley	💧	💧	💧	💧	💧	💧	💧	💧	💧	💧	💧	💧

2: METHODS

Water quality and quantity monitoring entails the collection of multi-probe sonde data readings, water samples, zooplankton samples, phytoplankton samples, macroinvertebrate samples, Zebra Mussel veliger samples, and physical readings, as well as recording the general site and climactic conditions at the time of sampling. Listed in the following sections are the methods and materials, for both lake and stream monitoring, used to gather water data during the field monitoring season Table 4 identifies many of the different chemical, physical, and biological variables analyzed to assess overall water quality.

2.1. Water Quality Sampling

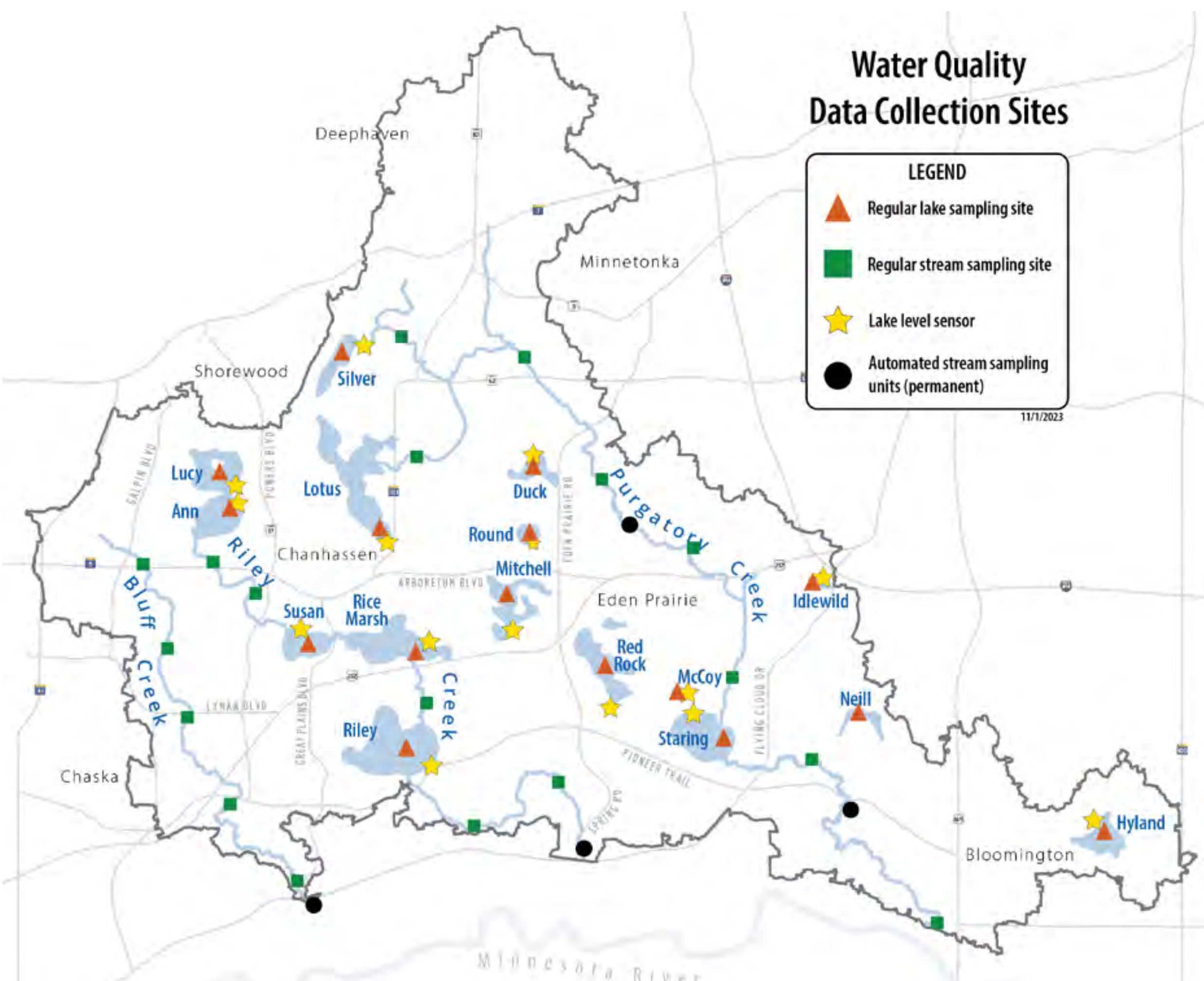
The data collection and monitoring program supports the District's 10-year management plan to delist waters from the MPCA 303d Impaired Waters list. The parameters monitored during the field season help determine the sources of water quality impairments and provide supporting data that is necessary to best design and implement water quality improvement projects. Table 5 provides an overview of

Table 4. Water quality sampling parameters.

Parameter	How data is collected	Where and when data is collected			Reason for monitoring the parameter
		Lakes - Summer	Lakes - Winter	Streams	
Total Phosphorus (TP)	Water sample	💧	💧	💧	Nutrient that controls algae growth
Orthophosphate	Water sample	💧	💧	💧	Nutrient; form of phosphorus (P) available to algae
Total Dissolved Phosphorus	Water sample	--	--	💧	Fraction of total phosphorus (P) in solution
Chlorophyll-a, pheophytin	Water sample	💧	💧	💧	Measure of algae concentration
Ammonia as N	Water sample	💧	💧	--	Nutrient; form of nitrogen (N) available to algae
Nitrate + Nitrite as N	Water sample	💧	💧	--	Nutrient and oxygen substitute for bacteria
Total Kjeldahl Nitrogen	Water sample	💧	--	--	Nutrient; sum of nitrogen bound in organics
Calcium (Ca)	Water sample	💧	--	--	Measure of water hardness
Total Alkalinity, adjusted	Water sample	💧	💧	--	Measure of ability to resist drop in pH
Total Suspended Solids (TSS)	Water sample	--	--	💧	Measure of solids in water (solids block light)
Chloride (Cl)	Water sample	💧	💧	💧	Measure of chloride ions (salts) in water
Temperature	Sonde	💧	💧	💧	Impacts biological and chemical activity in water
pH	Sonde	💧	💧	💧	Acidity/alkalinity level impacts chemical reactions
Conductivity	Sonde	💧	💧	💧	Indicates ability to carry an electrical current (TSS and Cl)
Dissolved Oxygen (DO)	Sonde	💧	💧	💧	Oxygen available to aquatic organisms
Macroinvertebrates	Water sample	--	--	💧	Organisms that fluctuate due to environmental conditions
Oxidation Reduction Potential	Sonde	💧	💧	💧	Tracks chemistry in low- or no-oxygen conditions
Phycocyanin	Sonde	💧	💧	--	Indicates measure of cyanobacteria concentration based on pigment
Phytoplankton	Water sample	💧	--	--	Organisms that fluctuate due to environmental conditions
Turbidity	Sonde	--	--	💧	Measure of light penetration in shallow water
Secchi disk depth	Observation	💧	💧	--	Measure of light penetration in deep water
Transparency tube	Observation	--	--	💧	Measure of light penetration in shallow water
Zooplankton	Water sample	💧	--	--	Organisms that fluctuate due to environmental conditions
Zebra Mussel veligers (larvae)	Water sample	💧	--	--	Use of monitoring plates tracks presence/abundance of Zebra Mussels (AIS)

Table 5. An overview of water quality data collection sites.

Type	Purpose	Data collected	Number of sites/units
Regular lake sampling site ▲	Staff collect bi-weekly samples at the same locations to allow comparison from year-to-year and trends over time.	TP, OP, Cl, Chl-a, TSS	*One site each at these lakes*: Ann, Duck, Hyland, Lotus, Lucy, Mitchell, Rice Marsh, Red Rock, Riley, Round, Silver, Staring, Susan *One site each at these waterbodies*: Idlewild, McCoy, Neill
Regular stream sampling site ■	Staff collect bi-weekly samples at the same locations to allow comparison from year-to-year and trends over time.	TP, OP, Cl, Chl-a, TSS, water flow rate	Bluff Creek: 5 sites Riley Creek: 5 sites Purgatory Creek: 8 sites
Lake level sensor ☆	In-lake sensors collect lake level data.	Lake level	*One each at these lakes*: Ann, Duck, Hyland, Lotus, Lucy, Mitchell, Rice Marsh, Red Rock, Riley, Round, Silver, Staring, Susan *One each at these waterbodies*: Idlewild, McCoy
Automated stream sampling unit - *Permanent* ●	Units collect data continuously and collect water samples during storm events. Permanent locations allow comparison.	*Continuous*: Water level, temperature, flow rate, conductivity *Storm events*: TP, OP, Chl-a, TDP, TSS	Bluff Creek: 1 site near RPBCWD southern boundary Riley Creek: 1 site near RPBCWD southern boundary Purgatory Creek: 1 site east of Round Lake; 1 site near Pioneer Trail
Automated stream sampling unit - *Temporary*	Units collect data continuously and collect water samples during storm events. Temporary units installed as needed at project sites to collect data before/ during/after project installation.	*Continuous*: Water level, temperature, flow rate, conductivity *Storm events*: TP, OP, Chl-a, TDP, TSS	Varies and is based upon project site monitoring needs.



sampling locations and purpose.

Multi-probe sondes (Hach Lake DS-5 and Stream MS-5; YSI EXO3) were used for collecting water quality measurements across both streams and lakes. Sonde readings measured include temperature, pH, dissolved oxygen, conductivity, oxidation reduction potential (ORP), and phycocyanin. Secchi disk depth readings were recorded at the same time as sonde readings at all lake sampling locations. When monitoring stream locations, transparency, turbidity (Hach 2100Q), and flow measurements (Flow Tracker) were collected. General site conditions related to weather and other observations were recorded as well.

At each lake monitoring location, multiple water samples are collected using a Van Dorn, and a depth integration sampler, for analytical laboratory analysis. For Duck, Idlewild, Rice Marsh, Silver, and Staring Lakes, water samples were collected at the surface and bottom due to their shallow depths of two to three meters. For all other lakes within the District, water samples were collected at the surface, middle (when stratified), and bottom of the lake. Lakes are monitored at the same location on each sampling trip, typically at the deepest location of the lake. All samples are collected from whole or half-meter depths to the lake bottom. The surface sample is a composite sample of the top two meters of the water column. The middle sample is collected from the approximate midpoint of the temperature/dissolved oxygen change (greater than one degree Celsius change) or thermocline. Pictures and climatic data are collected at each monitoring site. Winter water quality information is collected utilizing the same procedures as in the summer. Zooplankton samples were collected using a 63 micrometer Wisconsin style zooplankton net and Phytoplankton samples were collected using a two-meter integrated water sampler on Lake Susan, Lotus Lake, Staring Lake, Lake Riley, and Rice Marsh Lake. Zooplankton are collected by lowering the net to a depth of one-half meter from the bottom at the deepest point in the lake and raising it slowly. Zebra Mussel veliger samples were collected on all lakes using the same zooplankton sampling procedures but collected at three sites and consolidated before being sent to a lab for analysis. A Zeiss Primo Star microscope

Table 6. Water Quality Monitoring Activities.

Pre-Field Work Activities	• Calibrate Water Quality Sensors (sonde) • Obtain Water Sample Bottles and Labels from Analytical Lab • Prepare Other Equipment and Perform Safety Checks • Coordinate Events with Other Projects and Other Entities
Summer Lake – Physical and Chemical	• Navigate to Monitoring Location • Read Secchi Disk Depth and Record Climatic Data • Record Water Quality Sonde Readings at Meter/Half Meter Intervals • Collect Water Samples from Top, Thermocline, and Bottom
Summer Lake – Biological	• Collect Zooplankton Tow (steady pull of net) from Lake Bottom to Top • Collect Phytoplankton (2 m surface composite sample) • Collect Zebra Mussel Veliger Tow (steady pull of net) from Lake Bottom to Top at Multiple Sites
Winter Lakes	• Navigate to Monitoring Location • Record Ice Thickness • Read Secchi Disk Depth and Record Climatic Data • Record Water Quality Sonde Readings at Meter Intervals • Collect Water Samples from Top and Bottom
Streams – Physical, Chemical, and Biological	• Navigate to Monitoring Location • Measure Total Flow by Measuring Velocity at 0.3 to 1 Foot Increments across Stream • Record Water Quality Sonde Measurements from Middle of Stream • Read Transparency Tube and Perform Turbidity Test • Collect Water Samples from Middle of Stream • Collect macroinvertebrate samples (D-net collection across representative habitat types) • Collect Climatic Data and Take Photos
Post-Field Work Activities	• Ship Water Samples to Analytical Lab • Enter Data, Perform Quality Control Checks, and Format Data for Database • Clean and Repair Equipment • Reporting and Summarizing Data for Managers, Citizens, Cities, and Others

with a Zeiss Axiocam 100 digital camera was used to monitor zooplankton populations, scan for invasive zooplankton, and to calculate Cladoceran-grazing rates on algae.

Water quality samples collected during stream monitoring events were collected from the approximate middle (width and depth) of the stream in ideal flow conditions or from along the bank when necessary. Both water quality samples and flow monitoring activities were performed in the same section of the creek during each sampling event. Stream velocity was calculated at 0.3 to 1.5-foot increments across the width of the stream using the FlowTracker Velocity Meter at each sampling location. If no water or flow was observed, only pictures and climatic data were collected. Macroinvertebrate samples were collected on one stream per year on a rotating basis. A D-net was used to sample macroinvertebrates and each habitat type was sampled proportional to the amount of habitat in each reach. The activities associated with the monitoring program are described in Table 6.

2.2. Analytical Lab Methods

RMB Environmental Labs, located in Burnsville, Minnesota, is the third-party company that is responsible for conducting analytical tests on the water samples that were collected by district staff. The methods used by the laboratory to analyze the water samples for the specified parameters are noted in Table 7.

Additional samples were sent to the Metropolitan Council (METC), Saint Paul, Minnesota. These samples included quality samples for the Watershed Outlet Monitoring Program (WOMP) and other permanent auto sampling stream units. Macroinvertebrate samples were sent to RMB, and all phytoplankton samples were sent to Barr Engineering. Zebra Mussel veliger samples were processed by Kylie Cattoor, an independent consultant.

Table 7. RMB Environmental Laboratories Parameters and Methods used for Analyses.

PARAMETER	STANDARD METHOD
Alkalinity	EPA 310.2, SM 2320 B-2011
Ammonia	EPA 350.1 Rev 2.0 or Timberline Ammonia-001
Nitrogen, Nitrate & Nitrite	EPA 353.2 Rev 2.0
Chlorophyll-a	SM 10200H
Total Phosphorus	EPA 365.3
Orthophosphate	EPA 365.3
Chloride	SM 4500-Cl E-2011
Total Kjeldahl Nitrogen	EPA 351.2 or Timberline Kjeldahl Nitrogen-001
Calcium	EPA 200.7
Total Dissolved Phosphorus	365.3_LF_(DL)
Total Suspended Solids	USGS_(BL)

3: WATER QUALITY

In 1974, the Federal Clean Water Act set forth the requirement for states to develop water quality standards for surface waters. In 2014, specific standards were developed for eutrophication and Total Suspended Solids (TSS) for rivers and streams. In Minnesota, the agency in charge of regulating water quality is the Minnesota Pollution Control Agency (MPCA). Water quality monitoring and reporting is a priority for the District to determine the overall health of the waterbodies within the watershed boundaries. The District's main objectives are to prevent a decline in the overall water quality within lakes and streams and to prevent waterbodies from being added to the MPCA 303(d) Impaired Waters list. The District is also charged with the responsibility to take appropriate actions to improve the water quality in waterbodies that are currently listed for impairments.

There are seven ecoregions in Minnesota. RPBCWD is within the Northern Central Hardwood Forest (NCHF) Ecoregion. Rural areas in the NCHF are dominated by agricultural land and fertile soils. For most water resources in the region, phosphorus is the limiting (least available) nutrient within lakes and streams, meaning that the available concentration of phosphorus often controls the extent of algal growth. The accumulation of excess nutrients (i.e., TP and Chl-a) in a waterbody is called eutrophication. This relationship has a direct impact on the clarity and recreational potential of our lakes and streams. Waterbodies with high phosphorus concentrations and increased levels of algal production have reduced water clarity and limited recreational potential.

All lakes sampled in the District are considered Class 2B surface waters. The MPCA states that this class of surface waters should support the propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life, and their habitats. They should also be suitable for aquatic recreation of all kinds, including bathing. This class of surface water is not protected as a source of drinking water. For more detailed information regarding water quality standards in Minnesota, please see the MPCA Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment, 305(b) Report, and 303(d) List of Impaired Waters. These resources provide information to better understand the water quality assessment process and the reasoning behind their implementation (MPCA 2021).

3.1. Lakes

The MPCA has standards for lakes based upon their maximum depth and percent of littoral zone (surface area able to support aquatic plants. "Deep lakes" are defined as more than 15 feet

Figure 4. MPCA water quality standards used for waterbodies in RPBCWD.

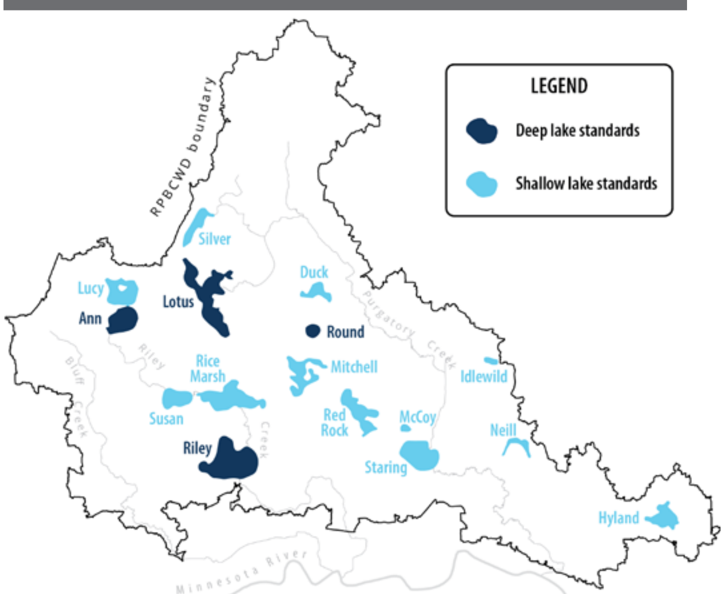


Table 8. MPCA Water Quality Standards for Lakes.

PARAMETER	SHALLOW LAKES CRITERIA (<15 ft deep)	DEEP LAKES CRITERIA (>15 ft deep)
Total Phosphorus (mg/L)	≤ 0.060	≤ 0.040
Chlorophyll-a (µg/L)	≤ 20	≤ 14
Secchi Disk (m)	≥ 1	≥ 1.4
Chloride Chronic Standard (mg/L)	230	230
Chloride Maximum Standard (mg/L)	860	860

deep and less than 80 percent of littoral zone. "Shallow lakes" are defined as less than 15 feet deep and greater than 80 percent littoral zone. See Figure 4 for lake classifications within RPBCWD. Except for chlorides, summer growing season (June-September) averages of the parameters listed in Table 8 for each lake are compared to the MPCA standards to determine the overall state of the lake. The standards are set in place to address issues of eutrophication (excess nutrients) in local waterbodies. Staff collect water samples and send them to a laboratory to assess concentrations of TP, Chl-a, and chlorides. If result values are greater than the standards listed in Table 8, the lake is considered impaired. Secchi disk readings are collected to measure the transparency (visibility) in each lake. A higher individual reading corresponds to increased clarity within the lake (this indicates the Secchi Disk was visible at a deeper depth in the water column).

Chlorides (Cl) are of increasing concern in Minnesota, especially during the winter when de-icing salt is heavily used. Targeted sampling occurs during the winter and early spring melting periods when salts are being flushed through our waterbodies. Monthly samples are collected during the summer to establish a baseline for chloride in our lakes and streams. The chloride standard is the same for both deep and shallow lakes. Table 8 includes both the Chloride chronic standard (CS) and a maximum standard (MS). The CS is the highest water concentration of Chloride to which aquatic life, humans, or wildlife can be exposed to indefinitely without causing chronic toxicity. The MS is the highest concentration of Chloride in water to which aquatic organisms can be exposed for a brief time with zero to slight mortality.

3.2. Streams

Table 9 displays water quality parameters developed by the MPCA in 2014 for eutrophication and TSS in streams. The standards include some parameters the District has not yet incorporated into their monitoring procedures that may eventually be added in the future. All streams sampled in the District are considered Class 2B surface waters. The MPCA states that this class of surface waters should support the propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life and their habitats. They should also be suitable for aquatic recreation of all kinds including bathing. This class of surface water is not protected as a source of drinking water. For more detailed information regarding water quality standards in Minnesota, please see the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment, 305(b) Report and the 303(d) List of Impaired Waters. These resources provide information to better understand the water quality assessment process and the reasoning behind their implementation.

Eutrophication pollution is measured based upon the exceedance of the summer growing season average (May-September) of Total Phosphorus (TP) levels and Chl-a (seston), five-day biochemical oxygen demand (cBOD, amount of DO needed by organisms to breakdown organic material present in a given water sample at a certain temperature over a five-day period), diel DO flux (difference between the maximum DO concentration and the minimum daily DO concentration), or summer average pH levels. Streams that exceed the phosphorus standard but do not exceed the Chl-a (seston), cBOD, diel DO flux, or pH standard meet the eutrophication

Table 9. MPCA Water Quality Standards for Streams.

MPCA STANDARD	PARAMETER	CRITERIA
Eutrophication	Phosphorus	≤ 100 µg/L
	Chlorophyll-a (seston)	≤ 18 µg/L
	Diel Dissolved Oxygen	≤ 3.5 mg/L
	Biochemical Oxygen Demand	≥ 2 mg/L
	pH Maximum	≤ 9 su
	pH Minimum	≥ 6.5 su
Total Suspended Solids	TSS	≤ 30 mg/L

standard. The District added Chl-a to its monthly sampling regime in 2015 to account for the polluted condition that occurs when Chl-a (periphyton) concentration exceeds 18 µg/L. The daily minimum DO concentration for all Class 2B waters cannot dip below 4 mg/L to achieve the MPCA standard, which was used in the analysis for this report.

TSS is a measure of the amount of particulate (soil particles, algae, etc.) in the water. Increased levels of TSS can be associated with many negative effects including nutrient transport, reduced aesthetic value, reduced aquatic biota, and decreased water clarity. For the MPCA standard, TSS concentrations are assessed from April through September and cannot exceed 30 mg/L more than 10 percent of the time during that period.

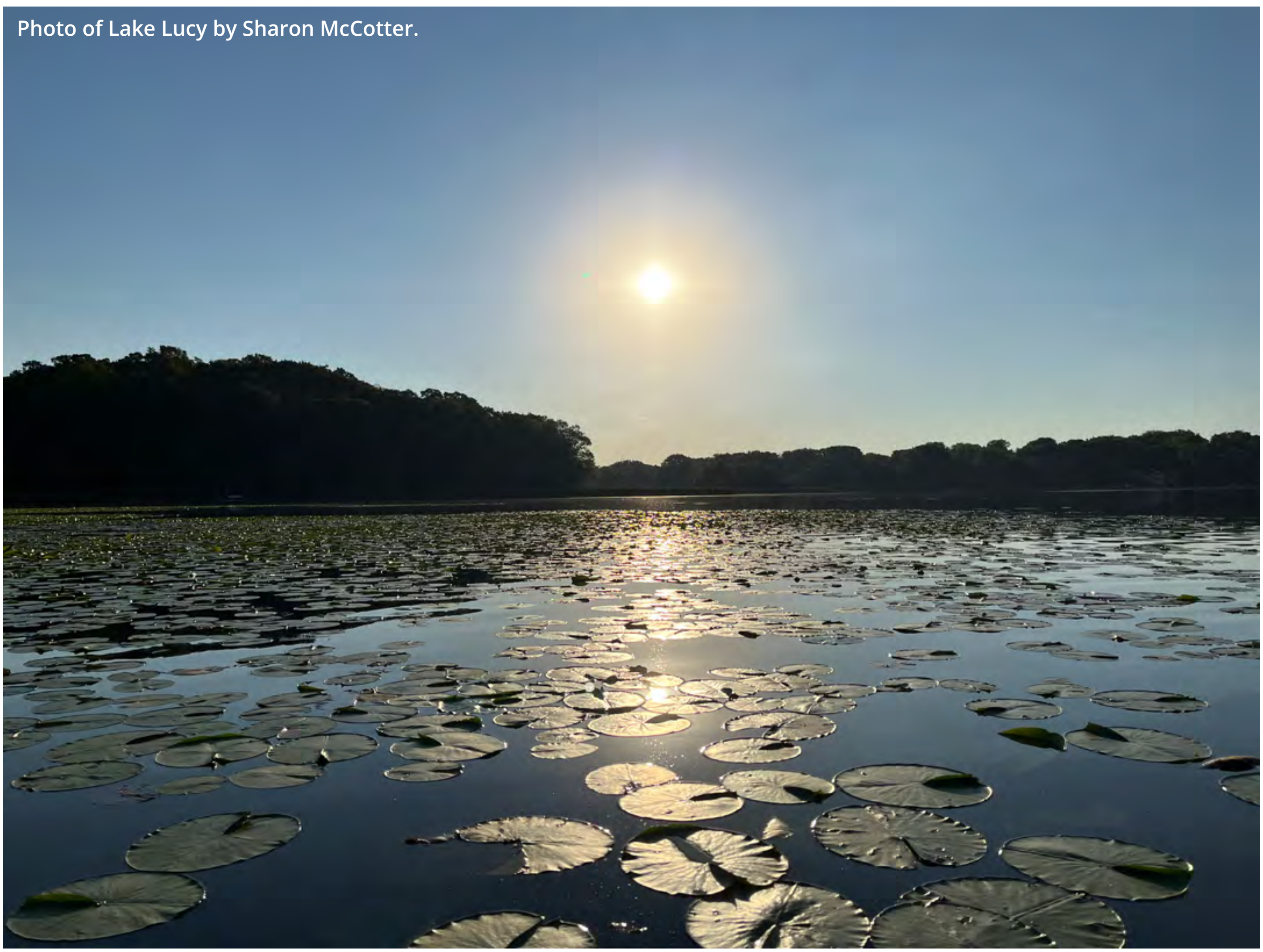


Photo of Lake Lucy by Sharon McCotter.

4: DATA COLLECTION

To assess and improve water quality within the watershed, the District continues to collect long-term data from specific locations on waterbodies to monitor temporal changes or gage the success or need of a water quality project. The District also conducts studies to root out key sources of pollution or other negative variables that impact our lakes and streams. Once identified, the District will often monitor these locations and eventually act to improve the water resource if the data confirms the suspicion. Below is a summary of each special project/monitoring and an overall summary of the long-term water quality data the District has collected.

4.1. 2023 Lakes Eutrophication Summary

More information about lake nutrient and water clarity data can be seen in the water quality factsheets located on the District website (rpbcwd.org/factsheets). Nutrient summary tables and Sonde lake profile data is located in the Exhibit G and Exhibit H.

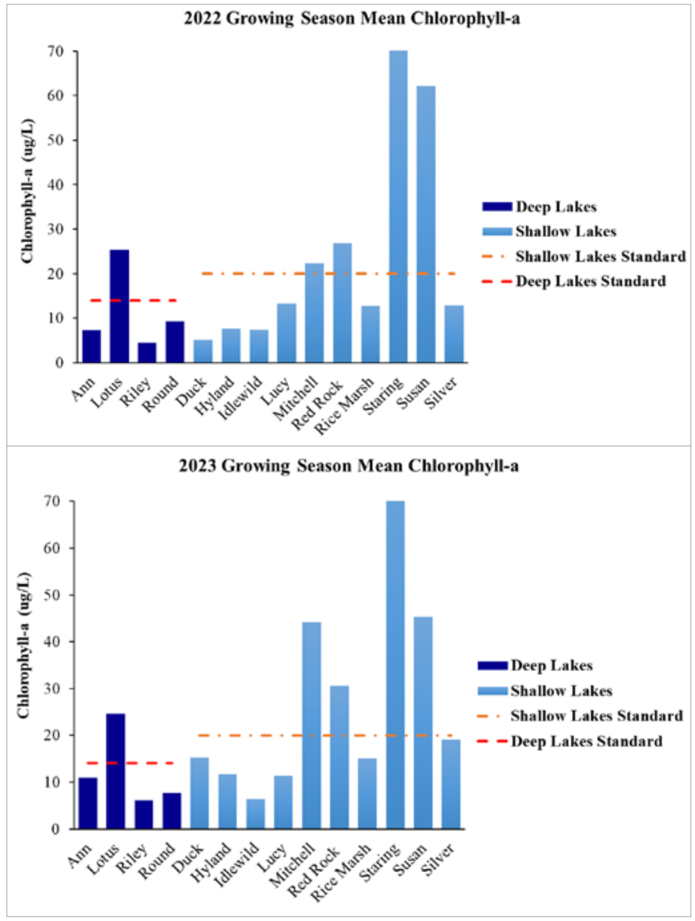
Chlorophyll-a

The 2023 growing season Chl-a mean concentrations for all lakes sampled within the District are shown in Figure 5. As seen in previous years, of the three main eutrophication lake water quality standards (Chl-a, TP, Secchi), Chl-a was the nutrient with the most impairments in 2023. Overall, nine of the 14 lakes sampled in 2023 met the MPCA Chl-a standards for their lake classification (eight lakes in 2022 and 2021, nine in 2020, and six lakes in 2018 and 2019): Lake Ann, Lake Riley, Round Lake, Duck Lake, Hyland Lake, Lake Idlewild, Lake Lucy, Rice Marsh Lake, and Silver Lake.

Four lakes sampled within the district are categorized as "deep" by the MPCA (>15 ft deep, < 80% littoral area): Lake Ann, Lotus Lake, Lake Riley, and Round Lake. The MPCA standard for Chl-a in deep lakes (<14 ug/L) was met by Lake Ann, Lake Riley, and Round Lake. Lake Ann has met the Chl-a standard since data collection began in the 1970s and continues to have some of the best water quality in the district. Due to the past alum treatment, Lake Riley had the lowest summer Chl-a average of all lakes sampled in 2023 at 6.1 ug/L. (4.5 ug/L in 2022, 2.3 ug/L in 2021, and 2.8 ug/l in 2020). Similarly, Round Lake has also met the standard since the first alum treatment in 2012. Lotus Lake did not meet the standard in 2023 and had Chl-a average concentrations at 24.6 ug/L (consistent with 25.4 in 2022 and 25.3 in 2021).

Figure 5. 2022-2023 Lakes Growing Season Mean Secchi Depth.

Lakes growing season (June-September) mean chlorophyll-a concentrations (μg/L) for shallow (lakes <15 ft. deep, >80% littoral area- light blue bars) and deep lakes (lakes >15 ft. deep, <80% littoral area- dark blue bars) in the Riley Purgatory Bluff Creek Watershed District during 2021 and 2022. The dashed lines represent the Minnesota Pollution Control Agency water quality standards for Chlorophyll-a for shallow (<20 μg/L-orange dashed line) and deep lakes (<14 μg/L-red dashed line).



The remainder of the lakes sampled in 2023 are categorized as "shallow" by the MPCA (<15 ft deep, >80% littoral area): Duck Lake, Hyland Lake, Lake Idlewild, Lake Lucy, Lake Mitchell, Neill Lake, Red Rock Lake, Rice Marsh Lake, Staring Lake, Lake Susan, and Silver Lake. Water quality metrics on Lake Idlewild and Neill Lake, which are classified as open water wetlands, were compared to MPCA shallow lake standards. The water quality standard for shallow lakes (< 20 ug/L) was met by Duck Lake, Hyland Lake, Lake Idlewild, Lake Lucy, Rice Marsh Lake, and Silver Lake. Chl-a concentrations improved in Lake Lucy and were well below the MPCA standard in 2023 (11.3 ug/L), and Hyland remained below the standard for the second year in a row. Silver Lake increased slightly and is now above the standard for chl-a. Duck, Idlewild, Red Rock, and Rice Marsh remained similar to what was seen in previous years with only Red Rock Lake not meeting the standard of that list (30.6 ug/L). Lake Susan had a decrease in chlorophyll-a from 2022, (62.2 ug/L) but is still well above the standard (45.3 ug/L). Mitchell Lake Chl-a concentrations increased to 44.1 ug/L which is double the standard. Staring Lake had the highest concentration of chl-a in the district (87.6 ug/L). This is a significant increase from 2021 (21.52 ug/L) and in 2022 when it began to have the highest concentrations across all lakes (70.38 ug/L). This is likely from a combination of very low water levels, increasing sediment resuspension via wind mixing, and the reduced vegetation following the whole lake fluridone treatment meant to reduce Eurasian Watermilfoil. These values will likely decline as native vegetation increases in abundance.

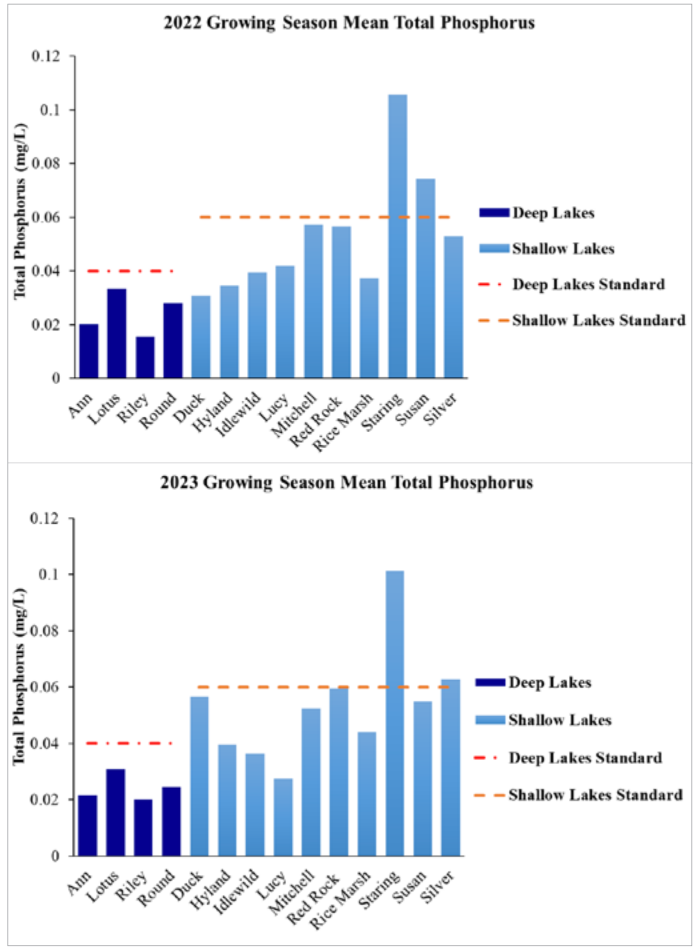
Total Phosphorus

The TP growing season averages for all lakes sampled within the district in 2023 are shown in Figure 6. Overall, twelve of the 14 lakes sampled met the MPCA total phosphorus standard for their lake classification in 2023: Lake Ann, Lotus Lake, Lake Riley, Round Lake, Duck Lake, Lake Hyland, Lake Idlewild, Lake Lucy, Mitchell Lake, Red Rock, Rice Marsh Lake, and Lake Susan from 2021-2023, 12 lakes have achieved the standard, an increase from eight lakes not achieving the TP standard in 2020 and 11 lakes in 2019.

The MPCA standard for TP in deep lakes (<0.040 mg/L) was met by all deep lakes in 2023. All deep lake TP concentrations in 2023 remained relatively the same from what was seen in 2022. Following the second dose of the alum treatment in May of 2020, Lake Riley continues to have the lowest summertime average TP concentration (0.020 mg/L) across all lakes sampled

Figure 6. 2022-2023 Lakes Growing Season Mean Total Phosphorus

Lakes growing season (June-September) mean total phosphorus concentrations (mg/L) for shallow (lakes <15 ft. deep, >80% littoral area-light blue bars) and deep lakes (lakes >15 ft. deep, <80% littoral area-dark blue bars) in the Riley Purgatory Bluff Creek Watershed District during 2022 and 2023. The dashed lines represent the Minnesota Pollution Control Agency water quality standards for Total Phosphorus for shallow (<0.060 mg/L-orange dashed line) and deep lakes (<0.040 mg/L-red dashed line).



(2022-0.015 mg/L, 2021-0.016 mg/L, 2020-0.0178 mg/L) followed by lake Ann (0.022 mg/L). For shallow lakes, the MPCA TP standard (<0.060 mg/L) was met by Duck Lake, Hyland Lake, Lake Idlewild, Lake Lucy, Red Rock Lake, Mitchell Lake, Rice Marsh Lake, and Lake Susan in 2023. Silver Lake and Staring Lake both did not meet the MPCA TP standard in 2023. Silver Lake had barely met the standard the previous two years and slightly increased back above it in 2023. Staring Lake significantly increased from 2021 (0.042 mg/L) to 2022 (0.106 mg/L) and then decreased slightly in 2023 (0.104 mg/L). This is likely from a combination of very low water levels, increasing sediment resuspension via wind mixing, and the reduced vegetation following the whole lake fluridone treatment meant to reduce Eurasian Watermilfoil. These values will likely decline as native vegetation increases in abundance. Mitchell Lake did not achieve the standard in 2021 (0.067 mg/L) but improved and met the standard in 2022 (0.057 mg/L) and 2023 (0.052 mg/L.) Following the second spring alum application in Hyland Lake in 2022, average concentrations were reduced for 0.054 mg/L in 2021 to 0.034 mg/L in 2022 and 0.044 mg/L in 2023. Duck Lake had an increase in TP concentration from 0.0301 mg/L in 2022 to 0.0565, just below the standard.

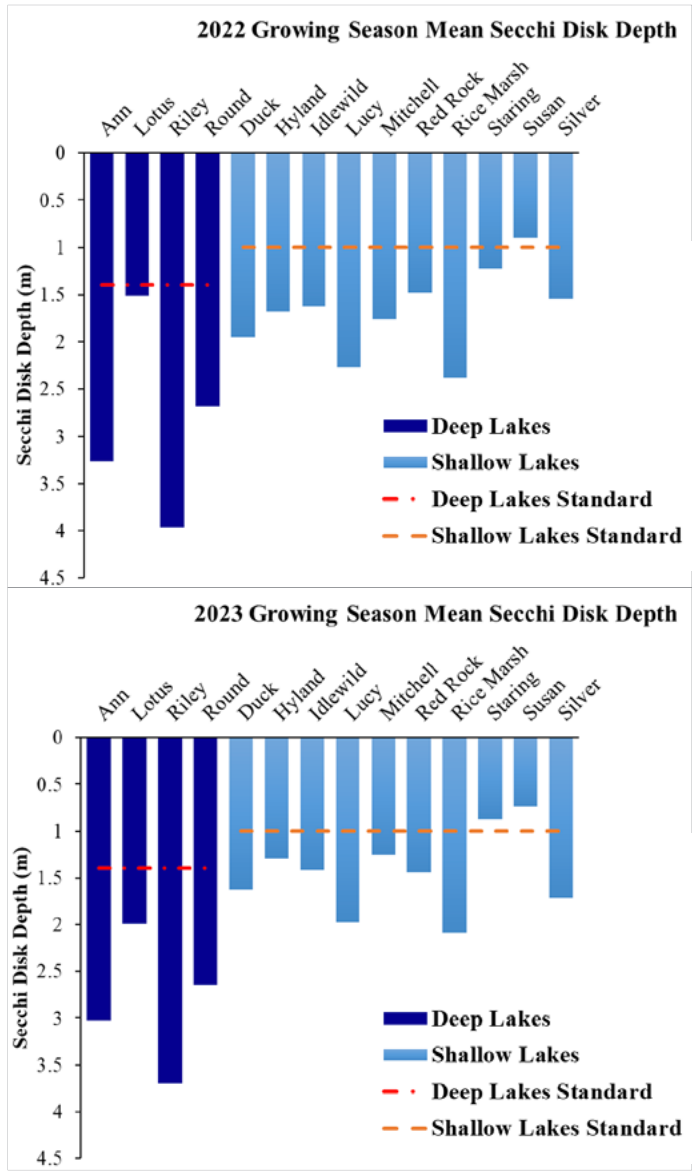
Secchi Disk

The 2023 Secchi disk growing season means for all district lakes sampled are shown in Figure 7. Overall, water clarity in most lakes stayed the same from 2022 except for Staring Lake which declined below the standard.

The MPCA standard for Secchi disk depth/water clarity for deep lakes (> 1.4 m) was met by all deep lakes in 2023. Lotus did not meet the standard in 2020 (1.24 m) but met the standard in 2021 and 2022 (1.51 m). In 2023 Lotus continued to improve with an average of 1.99 m. Lake Riley had the highest summer average for all lakes sampled in 2023 (3.7 meter) and the average was only slightly down (3.96 meter) from 2022. For shallow lakes, the MPCA standard was not met by only Staring Lake and Lake Susan. Staring Lake met the standard in 2022 with a reading of 1.23 m, but fell below the standard in 2023 with a mean Secchi depth of only 0.87 m. Susan had a mean Secchi depth of 0.74 in 2023, a decrease from 0.89 in 2022, marking its second year in a row below the water quality standard. Red Rock had the shallowest average secchi reading at 0.66 meter in 2020 but improved to 1.5 meter in 2021. This was sustained in 2022 and 2023 at 1.48 m and 1.4 m respectively. Lucy and Rice Marsh both had Secchi readings near 2 m (1.98 and 2.09), and Duck and Silver averaged around 1.65 m (1.63 and 1.70). Hyland was reduced from 2.05 m in 2020 to 1.14 meters in 2021 but increased to 1.67 meter in 2022 following the spring alum treatment. It recorded its 4th consecutive year meeting the standard in 2023 (1.29 m). Mitchell Lake did not meet the standard in 2020 (0.93 m) but improved in 2021 and met the standard (1.13 m). This continued to further improve in 2022 (1.53 m) and continued to meet the standard in 2023 with a mean depth of 1.25 meters.

Figure 7. 2022-2023 Lakes Growing Season Mean Secchi Disk Depth.

Lakes growing season (June-September) mean Secchi disk depths (m) for shallow (lakes <15 ft. deep, >80% littoral area-light blue bars) and deep lakes (lakes >15 ft. deep, <80% littoral area-dark blue bars) in the Riley Purgatory Bluff Creek Watershed District during 2022 and 2023. The dashed lines represent the Minnesota Pollution Control Agency water quality standards for Secchi disk depths for shallow (>1 m-orange dashed line) and deep lakes (>1.4 m-red dashed line).



4.2. Alum Treatments

Alum (aluminum sulfate) is a compound derived from aluminum, the earth's most abundant metal. Alum has been used in water purification and wastewater treatment for centuries and in lake restoration for decades. Many watershed management plans recommend that some lakes be treated with alum to improve their water quality. Alum treatments provide a safe, effective, and long-term control of the quantity of algae in our lakes by trapping phosphorus in sediments. Algal growth is directly dependent on the amount of phosphorus available in the water. Phosphorus enters the water in two ways:

- **Externally** from surface runoff entering the water or from groundwater.
- **Internally** from the sediments on the bottom of the lake.

Phosphorus already in the lake settles to the bottom and is periodically re-released from the sediments back into the water under anoxic conditions. Even when external sources of phosphorus have been significantly reduced through best management practices, the internal recycling of phosphorus within a lake can still support explosive algal growth. Alum is used primarily to control this internal loading of phosphorus from lake bottom sediments. The treatment is most effective when it occurs after external sources of phosphorus have been or are in the process of being controlled. Internal phosphorus loading is a large problem in Twin Cities Metropolitan Area lakes because of historic inputs of phosphorus from the urban storm water runoff and past agriculture practices. Phosphorus in runoff has concentrated in the sediments of urban lakes and successive years of algal blooms have died and settled to the lake bottoms. This phosphorus is recycled from the lake sediments into the overlying waters, primarily during summer periods, when it contributes to the growth of nuisance algal blooms.

Alum is applied by injecting it directly into the water several feet below the surface. On contact with water, alum becomes floc, or aluminum hydroxide (the principal ingredient in common antacids such as Maalox). This fluffy substance settles to the bottom of the lake. On the way down, it interacts with phosphorus to form an aluminum phosphate compound that is insoluble in water. Phosphorus in the water is trapped as aluminum phosphate and can no longer be used as food by algae. As the floc settles downward through the water, it also collects other suspended particles in the water, carrying them down to the bottom and leaving the lake noticeably clearer.

On the bottom of the lake, the floc forms a layer that acts as a phosphorus barrier by combining with (and trapping) the phosphorus as it is released from the sediments. This reduces the amount of internal recycling of phosphorus in the lake. An alum treatment can last 10–20 years or even longer, depending on the level of external phosphorus loading to the lake. The less phosphorus that enters the lake from external sources after it is applied, the more effective the treatment will be over a longer period.

A list of the alum treatments completed/partially completed in the district can be found in Table 10. Treatments are split into two doses to ensure the entirety of the lake is being treated effectively. District staff and its partners have continued to monitor phosphorus levels within treatment lakes and sediment cores to evaluate the effectiveness of each alum treatment and to assess when a second dose might be needed. More information about Lake Riley, Lotus Lake, Rice Marsh Lake, Round Lake, and Hyland Lake nutrient and water clarity data can be seen in the factsheets located at rpbcwd.org/factsheets and Nutrient Summary Table in the (Exhibit G).

Figures 9 through 13 illustrate epilimnetic (surface) and hypolimnetic (bottom) total phosphorus (TP) levels prior to treatment, through the end of this current year for all lakes that received alum treatments. As seen across all lakes, after alum was applied, TP levels declined considerably throughout the water column in the year immediately succeeding the treatment. In the years following the alum treatment, all these lakes met the MPCA water quality standard for TP (exception – 2013 & 2017 Round Lake and 2020 Lotus Lake). In addition, often both Secchi readings and Chlorophyll-a levels were improved which led to most lakes meeting all three water

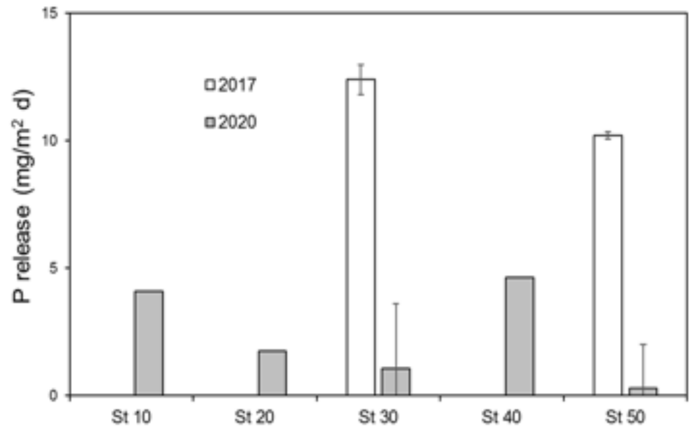
Table 10. Aluminum sulfate (alum) treatments.

LAKE	FIRST DOSE	SECOND DOSE
Riley	5/5/2016	6/11/2020
Lotus	9/18/2018	Fall 2024
Rice Marsh	9/21/2018	2025
Round	11/15/2012	10/24/2018
Hyland	6/3/2019	5/18/2022

quality standards after treatment. Exceptions include Lotus Lake, which did not meet chlorophyll-a and Secchi standards in 2020, and Hyland Lake, which did not meet the chlorophyll-a standard in 2021.

In Table 11 the percent reduction of surface and bottom growing season values of total phosphorus pre and post-alum treatment can be seen across all lakes. Utilizing five years of post-treatment data, it appears Rice Marsh and Hyland Lake had very effective alum treatments with phosphorus reductions of surface phosphorus with a reduction of over 55% on both lakes. Hyland Lake was treated with the second dose in the spring of 2022 and the surface TP concentration decreased to 57%. Rice Marsh will be treated with a second dose likely in 2025. Despite having a smaller reduction in total phosphorus at the surface (9%), Round Lake had reductions in lake bottom total phosphorus comparable with the other treated lakes (85% for dose 1 and 83% for dose 2). In 2020, Lake Riley received the second dose of alum which led to a historically good water quality year with record secchi disk depths of 4.6 m which was followed by another record year in 2021 at 4.8 meters with a slight decline in secchi depth since then. Overall, comparing pre and post treatment years, Lake Riley had a reduction in total phosphorus of 63% at the surface and 91% near the lake bottom.

Figure 8. Lotus Lake Sediment release rates in 2017 and 2020.



After the first dose of alum in Lotus Lake, water quality did not respond as well as seen across other lakes, however the surface and bottom phosphorus concentrations did match with what we have seen across other lakes (only 40% surface and 61% bottom). The lakewide limited water quality response may be due to the high phosphorus release rates observed from the sediment cores taken outside of the treatment areas (Figure 8). These shallower areas (15 feet) of the lake may be contributing more phosphorus release than first thought. Although a second dose would further reduce the release rates, expanding some of the treatment areas may produce a more robust water quality response. The district monitored TP and OP in both deep-water basins that received alum (south and east) in Lotus

Table 11. Aluminum sulfate (alum) treatment effectiveness at lake surface and lake bottom.

LAKE	SAMPLE YEARS	SAMPLE LOCATION	FIRST DOSE			SECOND DOSE	
			Average TP Pre-treatment	Average TP Post-treatment	Percent Reduction	Average TP Post-treatment	Percent Reduction
Riley	2009-2023	Surface	0.0457	0.0267	41%	0.0170	63%
	2009-2023	Bottom	0.5334	0.1684	68%	0.0465	91%
Lotus	2014-2023	Surface	0.0540	0.0349	40%	*Not treated yet*	*n/a*
	2014-2023	Bottom	0.5423	0.2088	61%	*Not treated yet*	*n/a*
Rice Marsh	2014-2023	Surface	0.0745	0.0380	56%	*Not treated yet*	*n/a*
	2014-2023	Bottom	0.1210	0.0413	66%	*Not treated yet*	*n/a*
Round	2008-2023	Surface	0.0415	0.0388	9%	0.0274	34%
	2008-2023	Bottom	0.8945	0.1376	85%	0.1491	83%
Hyland	2016-2023	Surface	0.0819	0.0375	58%	0.0377	57%
		Bottom	*No data*				

Lake to gauge phosphorus release rates. The south basin had a concentration of 0.032 mg/L in 2021, 0.033 mg/L in 2022, 0.031 mg/L in 2023. The east basin had a concentration of 0.03 mg/L in 2021, 0.035 mg/L in 2022, and 0.031 mg/L in 2023. Bottom summer averages were slightly different with the south bay (normal monitoring location) having higher concentrations at 0.185 mg/L in 2021, 0.238 mg/L in 2022, and 0.273 mg/L in 2023 vs 0.146 mg/L in 2021, 0.171 mg/L in 2022, and 0.106 mg/L measured in the east bay. Overall, both locations have averages well below the pretreatment conditions indicating the first dose was successful.

Overall, the water quality results pre and post alum treatment indicate that alum applications are effective and can drastically reduce phosphorus levels caused by internal loading within a lake. Staff will continue to monitor each lake to determine the second dose application and gauge the temporal success of each treatment. Total Phosphorus levels before and after alum treatment are included for the following lakes:

- Hyland, Figure 9
- Riley, Figure 10
- Rice Marsh, Figure 11
- Lotus, Figure 12
- Round, Figure 13

Figure 9. Hyland Lake Total Phosphorus Levels pre and post-alum treatment.

Total phosphorus levels (TP) in Hyland Lake between May 5, 2014, and October 10, 2023. The aluminum sulfate (alum) treatments occurred on June 3, 2019, and May 18, 2022 (indicated by vertical bar). The graph displays TP levels (mg/L) measured from 0-2 m composite samples and the MPCA water quality standard for TP is represented by the horizontal red line (0.06 mg/L).

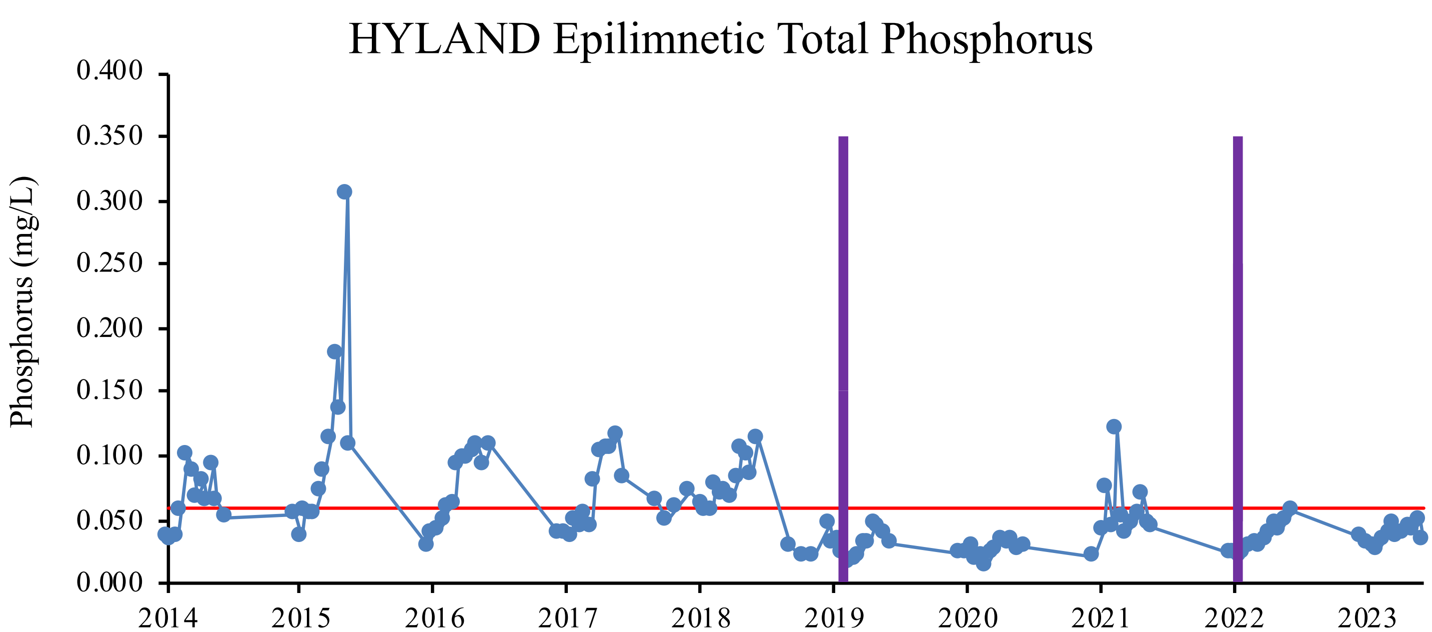
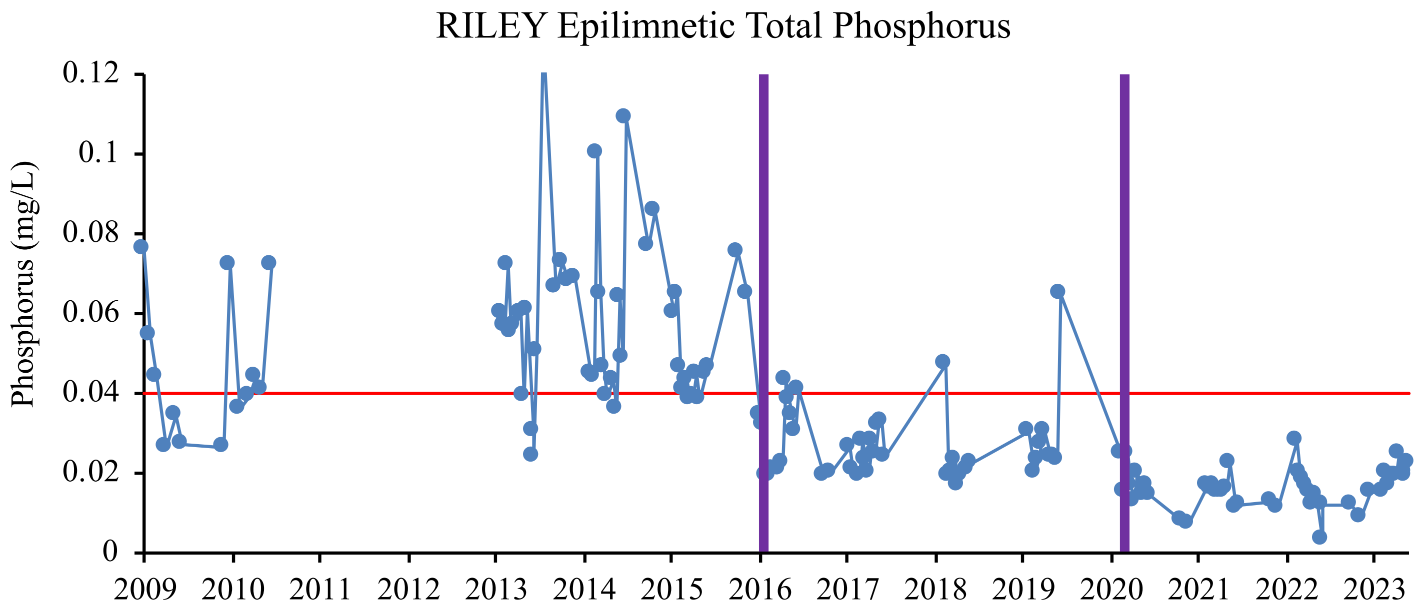


Figure 10. Lake Riley Total Phosphorus Levels pre and post-alum treatment.

Total phosphorus levels (TP) in Lake Riley between April 22, 2009, and September 12, 2023. The aluminum sulfate (alum) treatments occurred on May 5, 2016, and June 11, 2020 (indicated by vertical bar). The upper graph displays TP levels (mg/L) measured from 0-2 m composite samples and the lower graph displays the TP levels (mg/L) measured from samples taken 0.5-1 m above the sediment near the deepest point in the lake. The MPCA water quality standard for TP is represented in the upper graph by the horizontal red line (0.04 mg/L).



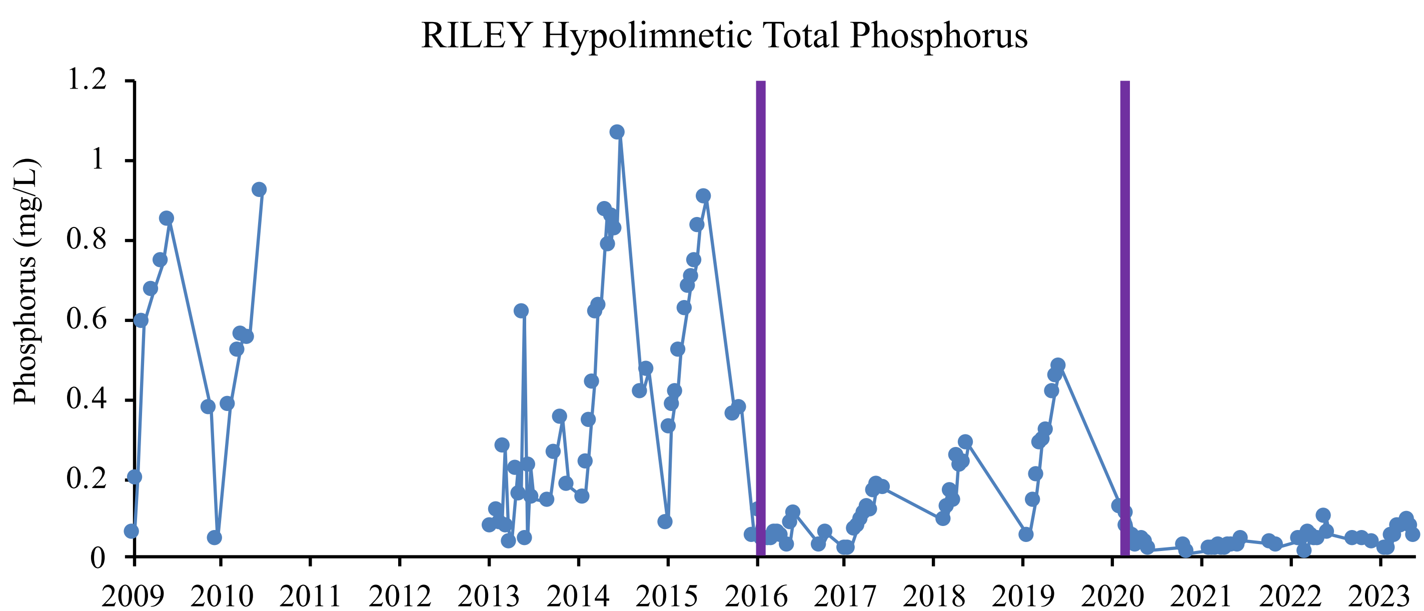
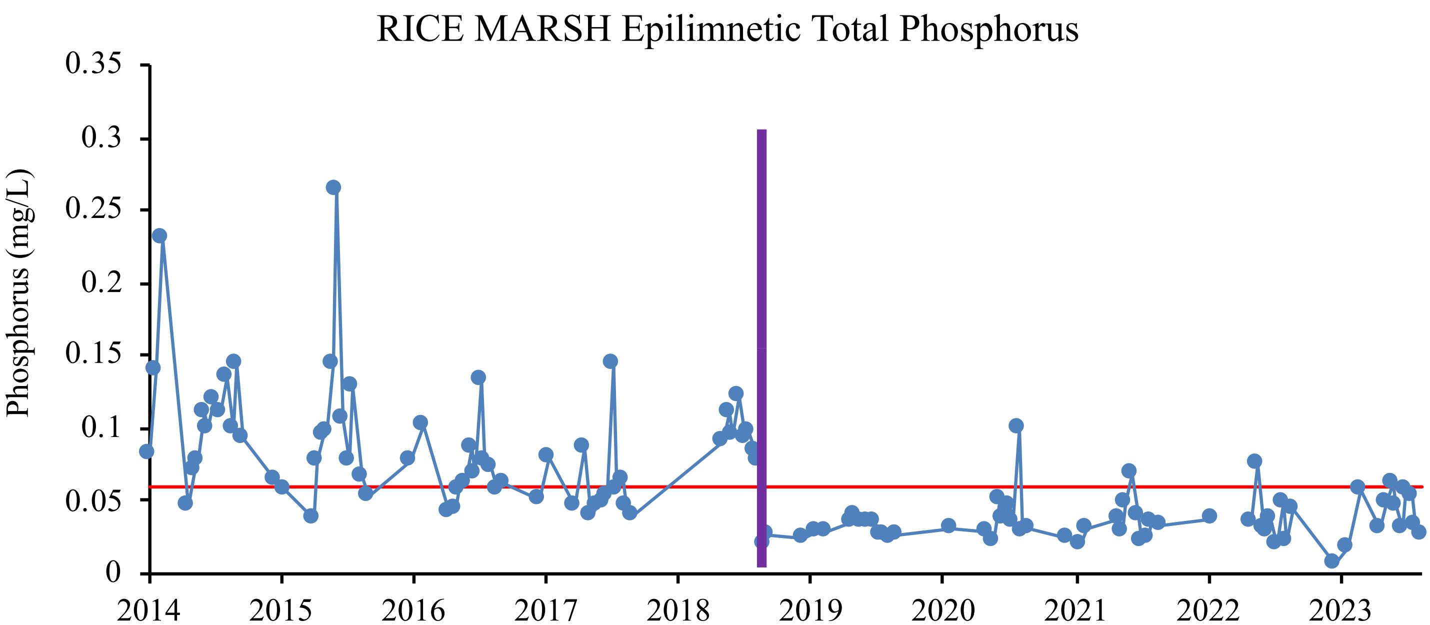


Figure 11. Rice Marsh Lake Total Phosphorus Levels pre and post-alum treatment.

Total phosphorus levels (TP) in Rice Marsh Lake between January 31, 2014, and September 14, 2023. The aluminum sulfate (alum) treatment occurred on September 21, 2018 (indicated by vertical bar). The upper graph displays TP levels (mg/L) measured from 0-2 m composite samples and the lower graph displays the TP levels (mg/L) measured from samples taken 0.5-1 m above the sediment near the deepest point in the lake. The MPCA water quality standard for TP is represented in the upper graph by the horizontal red line (0.06 mg/L).



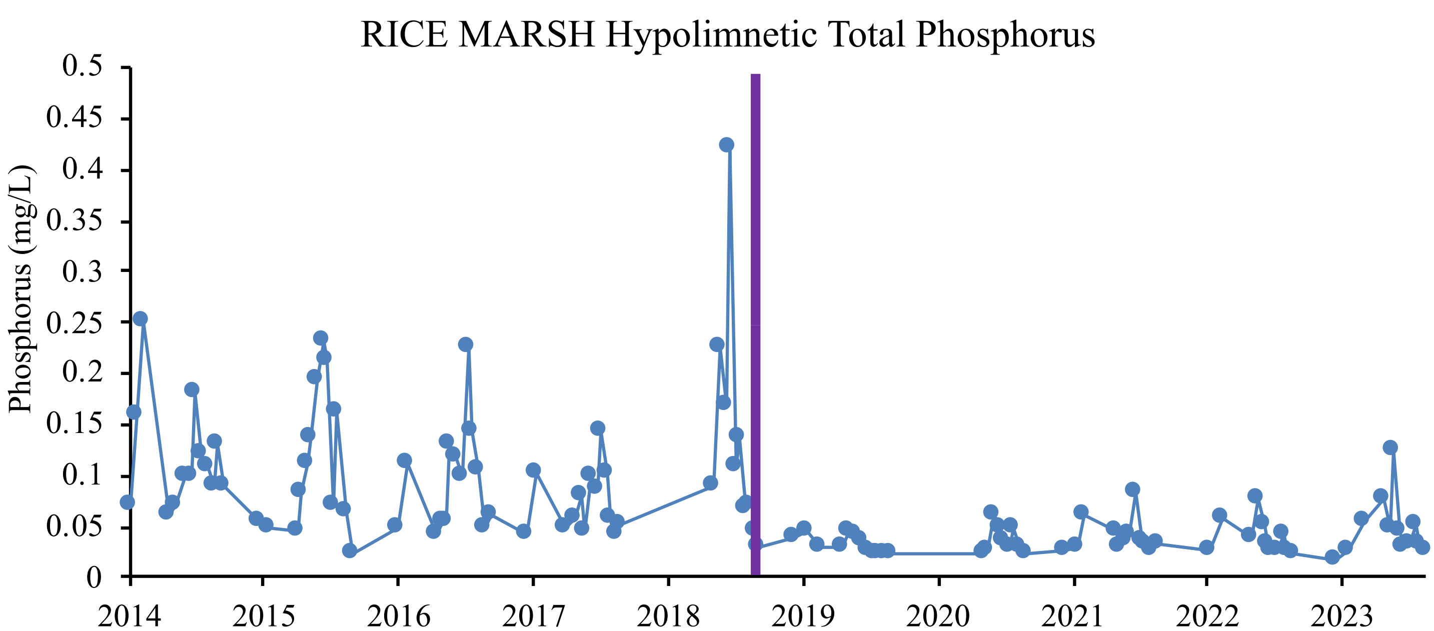
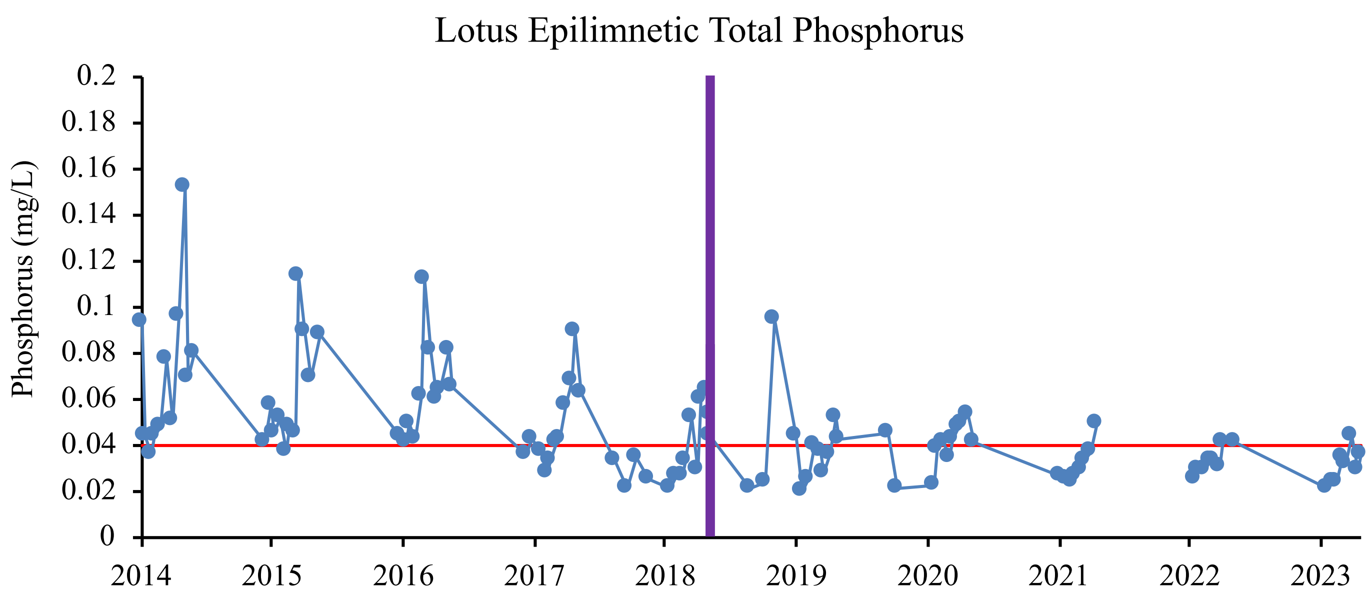


Figure 12. Lotus Lake Total Phosphorus Levels pre and post-alum treatment.

Total phosphorus levels (TP) in Lotus Lake between May 20, 2014, and September 11, 2023. The aluminum sulfate (alum) treatment occurred on September 18, 2018 (indicated by vertical bar). The upper graph displays TP levels (mg/L) measured from 0-2 m composite samples and the lower graph displays the TP levels (mg/L) measured from samples taken 0.5-1 m above the sediment near the deepest point in the lake. The MPCA water quality standard for TP is represented in the upper graph by the horizontal red line (0.04 mg/L).



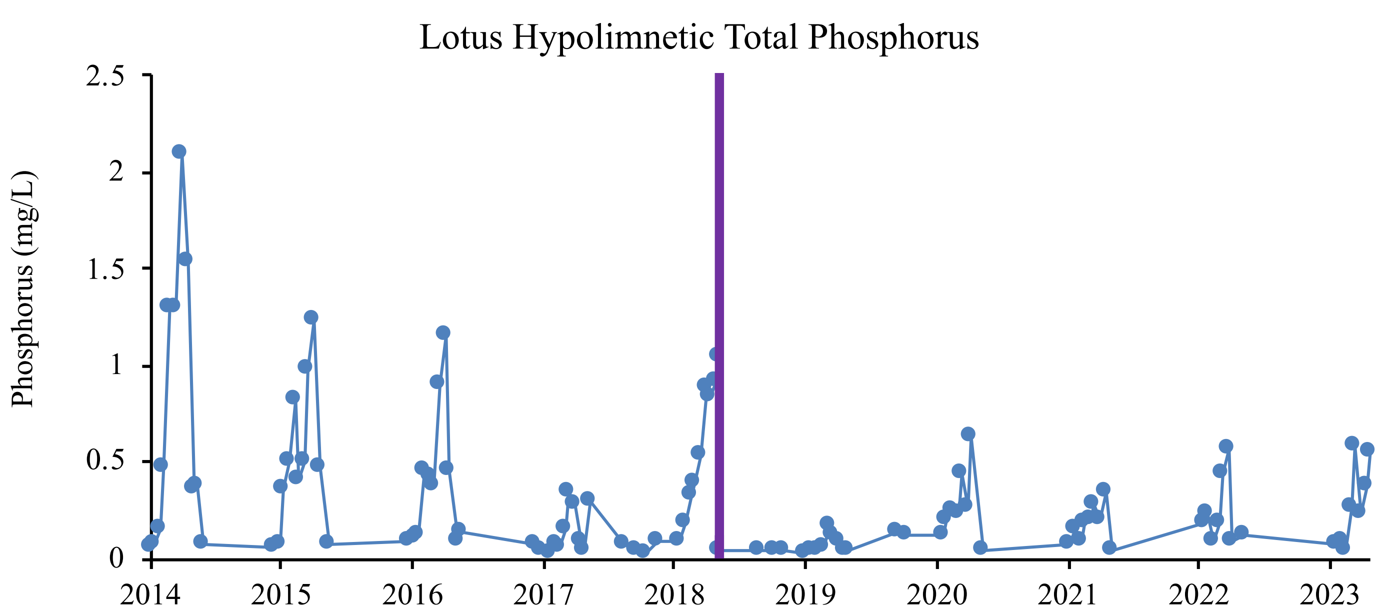
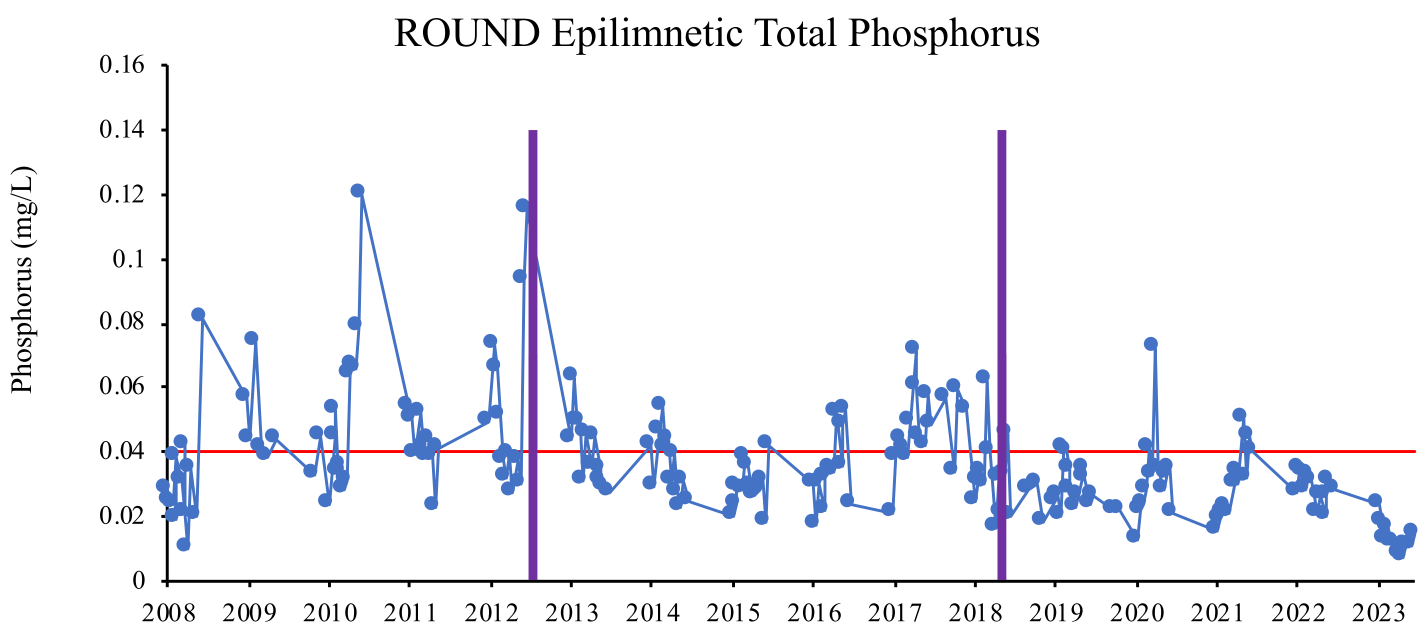
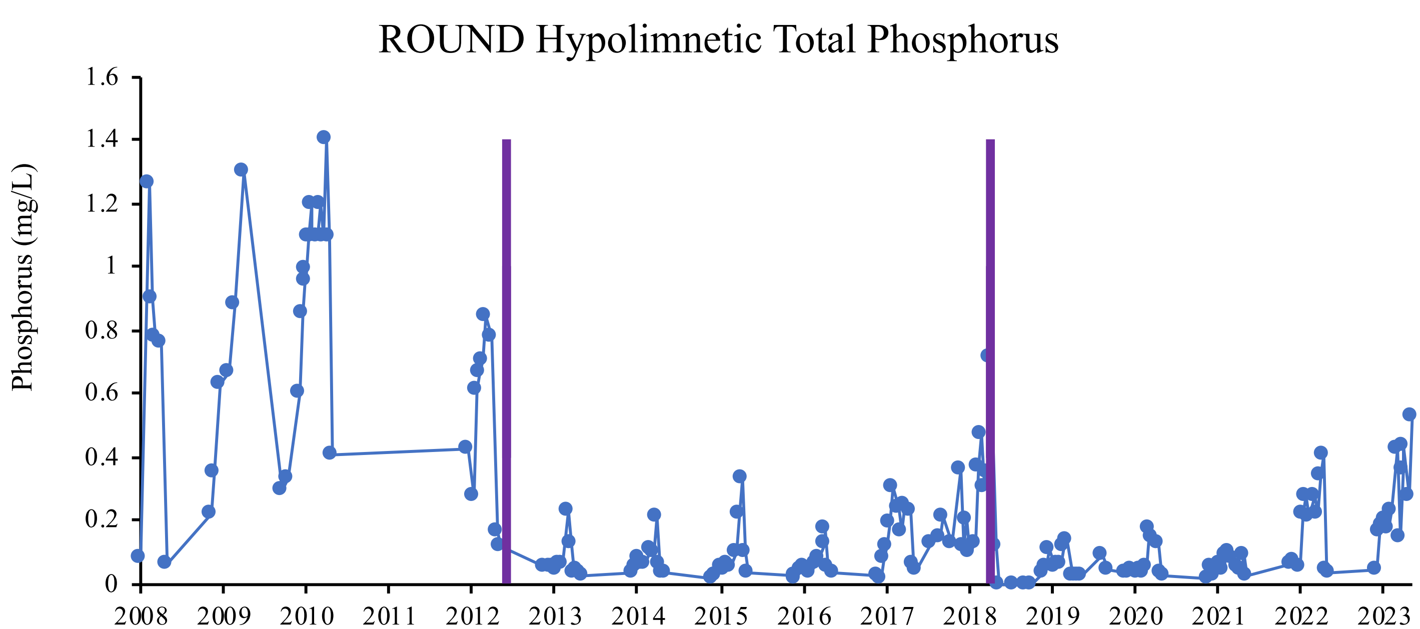


Figure 13. Round Lake Total Phosphorus Levels pre and post-alum treatment.

Total phosphorus levels (TP) in Round Lake between May 15, 2008 and October 26, 2023. The aluminum sulfate (alum) treatments occurred on November 15, 2012 and October 25, 2021 (indicated by vertical bars). The upper graph displays TP levels (mg/L) measured from 0-2 m composite samples and the lower graph displays the TP levels (mg/L) measured from samples taken 0.5-1 m above the sediment near the deepest point in the lake. The MPCA water quality standard for TP is represented in the upper graph by the horizontal red line (0.04 mg/L).





4.3. Chloride Monitoring

Increasing chloride (Cl) levels in water bodies are becoming of greater concern within the state of Minnesota. It takes only one teaspoon of road salt to permanently pollute five gallons of water, as chlorides do not break down over time. At high concentrations, chloride can also be harmful to fish, aquatic plants, and other aquatic organisms. The MPCA Cl Chronic Standard (CS, highest water concentration of Cl to which aquatic life, humans, or wildlife can be indefinitely exposed without causing chronic toxicity) is 230 mg/L for class 2B surface waters (all waters sampled within the District, excluding storm water holding ponds). The MPCA Cl Maximum Standard (MS, highest concentration of Cl in water to which aquatic organisms can be exposed for a brief time with zero to slight mortality) is 860 mg/L for class 2B surface waters.

The District has been monitoring salt concentrations in our lakes and ponds since 2013 and will continue monitoring efforts to identify high salt concentration areas and to assess temporal changes in salt concentrations. In 2016, staff carried out Cl sampling in lakes and streams every other week during the spring, switching to monthly sampling in summer/winter. In 2022-2023, winter monitoring included the Riley Chain of Lakes (Lucy, Ann, Susan, Rice Marsh, and Riley) and a chain of ponds that drain the City of Eden Prairie Center to Purgatory Creek. During sampling, staff collected a surface two-meter composite sample (when possible) and a bottom water sample to be analyzed for Cl.

Since 2012, except for multiple samples taken from Lake Idlewild (high value wetland), the average chloride levels from the PCL are below the MPCA CS of 230 mg/L (Figure 14, Figure 15). Similar to previous years, Lake Idlewild did not meet the chloride CS standard in 2023. Previously, the maximum concentration measured in Idlewild was from a bottom sample taken in March of 2019 which measured 390 mg/L. In 2023, summertime chloride levels were nearly double what has been seen in the past, with the max concentration occurring on 6/25/2023 from a bottom sample (639 mg/L). The location of Lake Idlewild is likely the cause of elevated chloride levels as much of the receiving water is drainage from the heavily developed and

Figure 14. Riley Creek Chain of Lakes chloride levels 2013-2023.

All average chloride sampling results (mg/L) on the Riley Chain of Lakes from 2013-2023. The MPCA chloride chronic standard for class 2B waters (230 mg/L) is indicated by the red line.

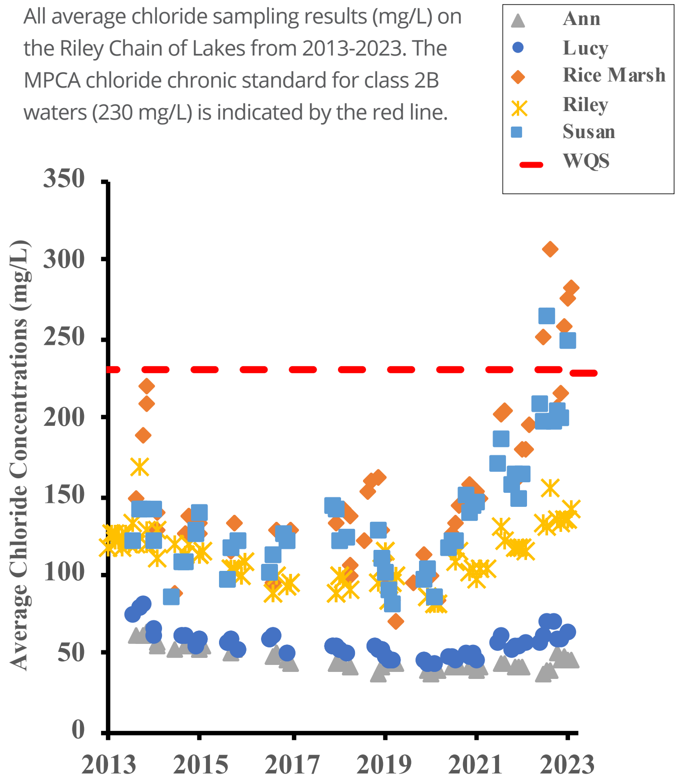
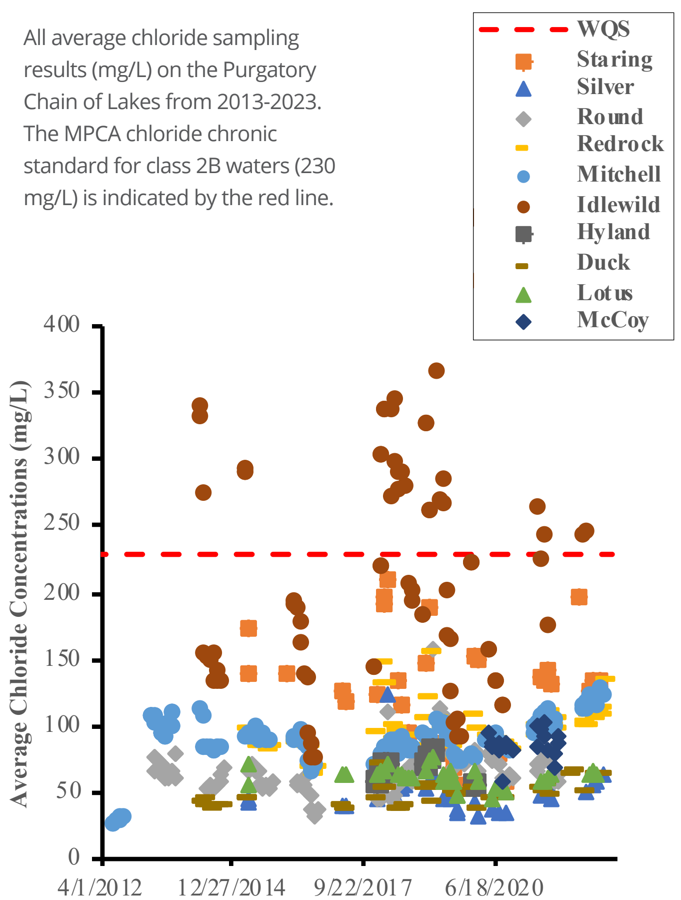


Figure 15. Purgatory Creek Chain of Lakes average chloride levels 2013-2023.

All average chloride sampling results (mg/L) on the Purgatory Chain of Lakes from 2013-2023. The MPCA chloride chronic standard for class 2B waters (230 mg/L) is indicated by the red line.



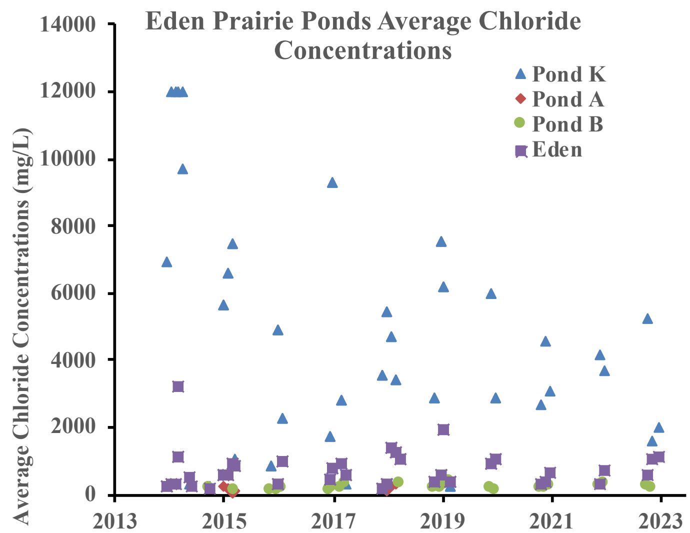
impervious area near the City of Eden Prairie City Center. The only other lake in the Purgatory Chain that had chloride concentrations above the standard was Staring Lake in 2018, 2022 and 2023. Previously, multiple lake bottom concentrations exceeded the standard, however the average (top/bottom) did not. In 2023, one sample average on 3/28/23 did not meet the MPCA standard (390 mg/L). The remainder of the PCL lakes had Cl levels below the MPCA water quality standard and have stayed relatively consistent within lakes year-to-year. There are however signs of slight increases in the past two to three years.

In the RCL system, no lake exceeded the water quality standard from 2013-2022. In 2023, both Rice Marsh Lake and Lake Susan exceeded the standard on multiple dates. Both lakes are downstream of Highway 5 and are smaller in size which may explain partially why they do not meet the standard. Unfortunately, Susan, Rice Marsh, and Riley have been on an increasingly alarming trend for the past three years which, if continued, could lead to all lakes exceeding the standard soon. Rice Marsh Lake had the highest average chloride concentration in RCL, measuring 306 mg/L (3/28/2023). At the top of RCL. Lucy and Ann have remained relatively flat with low concentrations near 50 mg/L but have seen subtle increases as well.

Figure 16 shows chloride levels within the four stormwater ponds, which includes all sampling events since 2013. All samples taken from Pond K (top of the chain) exceed class 2B CS. This includes 2013 samples which exceeded the maximum chloride concentrations the lab equipment could measure. All but three samples from Pond K were below the class 2B MS of 860 mg/L. Additionally, most samples taken from Eden Pond exceeded the class 2B CS, some exceeding the class 2B MS of 860 mg/L. In the spring of 2015, staff were no longer able to take accurate water samples on Pond B due to low water levels, so, sampling began on Pond A located directly upstream. In 2018, due to inconsistencies with getting samples without disturbing sediment, staff reverted again to sampling Pond A in place of Pond B for multiple monitoring events. It is important to note that these stormwater ponds are not classified as class 2B surface waters by the MPCA and so the standards do not apply but are simply a gauge to what is being seen in the watershed.

Figure 16. Chloride levels 2013-2023 in Eden Prairie stormwater ponds.

All average chloride results (mg/L) on stormwater ponds draining the City of Eden Prairie City Center to Purgatory Creek from 2013-2023.



The highest chloride concentration in 2023 occurred in January on Pond K at 5,265 mg/L which is over six times the maximum standard. Moving from upstream to downstream (Pond K - Eden Lake - Pond A - Pond B) it appears that the ponds are retaining much of the chloride they are receiving from the surrounding watershed during the winter and even during melting events. This is preventing high chloride levels from reaching Purgatory Creek. During significant rain events, specifically in the spring, chloride is most likely being flushed downstream at a larger scale than in the winter or during normal water level periods.

Regular stream monitoring sites have had chloride samples collected monthly from 2018-2023. Samples collected during the open water season act as a baseline of standard chloride levels within the watershed. They can also alert staff of any chloride level spikes during this period. From 2018-2021, no sites had chloride levels above the CS. In 2021, only sites R4 and B4 exceeded the MPCA CS water quality standard in May, June, and July. R4, B2, and P6 exceeded the CS in 2022 and R4, B3, B4, and P3 exceeded the CS in 2023. In the drought period between 2021-2023, water levels were very low and there was limited spring rainfall which generally flushes streams of chloride. This may explain why concentrations exceeded the standard well into the summer months. Sites B3, B4, and R4 which consistently do not meet the MPCA CS are the stream locations nearest to Highway 5. Even with the data limitations both Bluff Creek and Purgatory Creek appear to have rising trends.

Winter and early spring monitoring, specifically after melting events, is often the time to capture maximum chloride levels from each stream. The district's regular monitoring often does not completely capture these events, so we rely on and assist with the Metropolitan Council's (METC) Watershed Outlet Monitoring Program. These continuous monitoring stations are sampled biweekly for a variety of parameters including chloride, and capture storm and melting events. The METC released findings (METC 2020a; METC 2020b) on both Riley (Figure 17) and Bluff Creek (Figure 18) indicating Chloride concentrations have increased since 1999. Bluff Creek is at high risk of chloride impairment. Flow in both creeks has generally increased since 1999 although it has been extremely variable. Chloride varied seasonally across both creeks with higher values occurring in the spring and early summer, indicating salt use for winter de-icing is likely the major source for chloride in the stream. Other sources, such as synthetic fertilizer, are not well understood and should be investigated.

Staff will continue winter monitoring of Cl in the PCL in 2024 which will include: Silver, Lotus, Mitchell, Red Rock, Duck, Staring, Round, and Hyland, along with the stormwater ponds draining Eden Prairie Center. The PCL will be monitored over a three-year cycle before staff shift to the RCL. Once-a-month chloride sampling will continue as part of the monthly sampling SOP's during the regular growing season on both lakes and streams. Continuing data collection and analysis will allow us to guide more comprehensive and effective chloride pollution reduction projects and initiatives. More information on chloride concentrations can be seen in the Nutrient Summary Tables in the Exhibit F and Exhibit G in the Appendix.

Figure 17. Ambient and Annual Median Chloride Concentration in Riley Creek (Metropolitan Council).

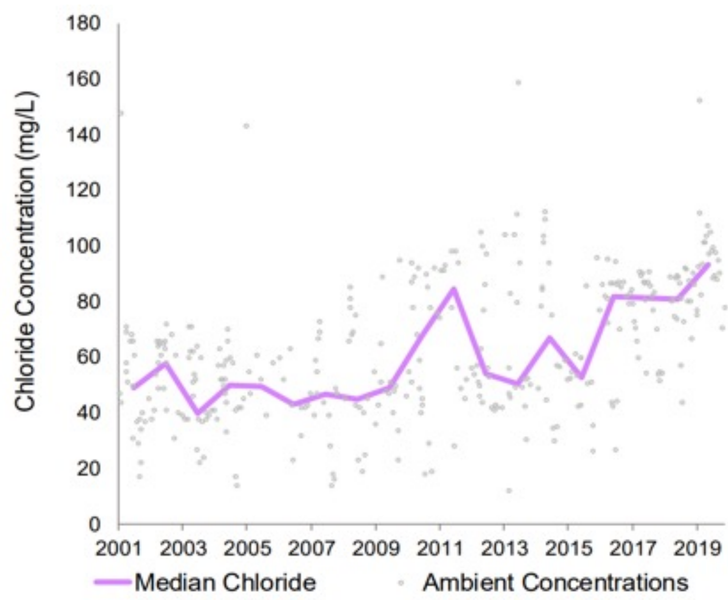
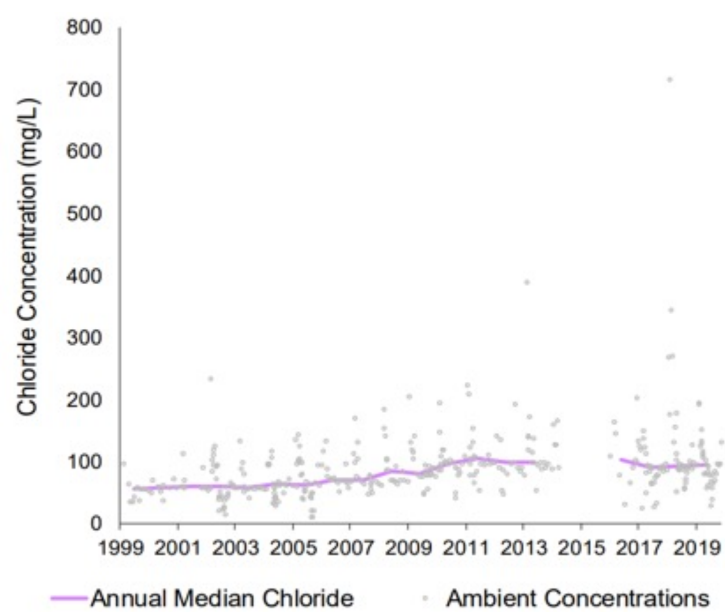


Figure 18. Ambient and Annual Median Chloride Concentration in Bluff Creek (Metropolitan Council).



4.4. Nitrogen Monitoring

Toxicity of nitrates to aquatic organisms is a growing concern in Minnesota over the last decade. Nitrate (NO3), the most available form of nitrogen for use by plants, can accumulate in lakes and streams since aquatic plant growth is not limited by its abundance. While nitrates have not been found to directly contribute to eutrophication of surface waters (phosphorus is the main cause of eutrophication) and is not an MPCA water quality standard, studies have found that nitrate can cause toxicity in aquatic organisms. In 2010, the MPCA released the Aquatic Life Water Quality Standards Technical Support Document for Nitrates: Technical Water Quality Standard Amendments to Minn. R. chs. 7050 and 7052 to address concerns of the toxicity of nitrate in freshwater systems and develop nitrate standards for class 2B and 2A systems. This document was updated in 2020 (still in the draft stage for external review). The draft acute value (maximum standard) calculated is 60 mg/L N:NO_3 for a one-day duration concentration for all Class 2 waters, and the draft chronic values are 8 mg/L N:NO_3 mg/L for Class 2B and 2Bd waters and 5 mg/L for class 2A waters Draft Aquatic Life Water Quality Standards Draft.

Once a month during regular sampling, staff collects a surface two-meter composite and a bottom water sample to be analyzed for nitrate+nitrite and ammonia+ammonium. In 2019, staff added Total Kjeldahl Nitrogen (TKN) to its monthly sampling regime. Organic-N levels are determined in a laboratory method called Total Kjeldahl Nitrogen (TKN). This measures the combination of organic N and ammonia+ammonium. Organic-N can be biologically transformed to ammonium and then to nitrate and nitrite forms. Because of this, monitoring for TKN could provide important supplemental data if staff observe increases in harmful forms of N in the future. Three Rivers Park District conducts water sampling on Hyland Lake and shares data with the District. Their lab tests do not specifically test for nitrogen as nitrate+nitrite or ammonia, therefore, nitrogen data on Hyland only includes Total Nitrogen. The average total Nitrogen for Hyland in 2023 was 0.98 mg/L). The District monitors nitrates in lakes as a part of its regular sampling regime. The District tests for nitrates in the form of nitrate+nitrite (the combined total of nitrate and nitrite) and tests for ammonia in the form of ammonia+ammonium. As seen in Table 12, all the lakes in the District met the draft nitrate CS. It is also important to note that the lab equipment used to test for nitrate has a lower limit of 0.03 mg/L. Therefore, it is possible that some of the samples contained less than 0.03 mg/L nitrate; because of this, actual average nitrate levels in District lakes may be lower than what was measured.

Ammonia (NH_3), a more toxic nitrogen-based compound, is also of concern when discussing toxicity to aquatic organisms. It is commonly found in human and animal waste discharges, as well

Table 12. 2023 Lakes Summer Average of Nitrogen

2023 growing season (June-September) averages of nitrate+nitrite, ammonia+ammonium, and total kjeldahl nitrogen levels for District lakes. The MPCA proposed chronic standards (CS) are in gold near the top of the table. The lower limit of lab analysis of nitrate+nitrite is 0.03 mg/L and ammonia+ammonium is 0.04 mg/L.

LAKE	AVERAGE NITRATE [NO_3] + NITRITE [N] (mg/L)	AVERAGE AMMONIA [NH_3] + AMMONIUM [NH_4^+] (mg/L TAN)	TOTAL KJELDAHL NITROGEN (mg/L)
MPCA Proposed Chronic Standard (CS)	**5.0 mg/L**	**1.9 mg/L TAN***	**none**
Ann	0.03	0.99	1.84
Duck	0.03	0.03	0.90
Hyland	--	--	0.97
Idlewild	0.03	0.02	0.65
Lotus	0.03	1.55	2.56
Lucy	0.03	0.99	2.05
Mitchell	0.03	0.05	1.11
Neill	0.03	0.06	1.15
Red Rock	0.03	0.03	0.09
Rice Marsh	0.03	0.03	1.06
Riley	0.06	0.40	1.02
Round	0.03	0.10	0.66
Silver	0.03	0.03	1.12
Staring	0.03	0.18	1.80
Susan	0.03	0.34	1.50

*The NH_4 (CS) standard should not be directly compared to lake values (as mg/L TAN (pH=7, T=20°C).

as agricultural fertilizers in the form of ammonium nitrate. When ammonia builds up in an aquatic system, it can accumulate in the tissues of aquatic organisms and eventually lead to death. The new proposed acute water quality standard for Classes 2B, 2Bd, and 2D is defined by the set of numeric values at an example pH of 7 and temperature of 20°C, the proposed chronic standards for Class 2 waters are 1.9 mg/L TAN (30-day rolling average) and 4.8 mg/L TAN (highest 4-day average within a 30-day averaging period), applied uniformly across all subclasses. The MPCA current standard for assessing toxicity of ammonia; the CS of ammonia in class 2B is 0.04 mg/L. RMB Environmental Lab water sample testing methods measures for ammonia in the form of ammonia+ammonium. The lab lower limit for these samples is 0.02 mg/L. The lower limit for sample data provided by the City of Eden Prairie for Red Rock, Round, and Mitchell Lakes is 0.16 mg/L. Due to these limits, some of the average levels of ammonia+ammonium provided in Table 12 may be lower than what is given. In lakes and streams, ammonium (NH_4^+) is usually much more predominant than ammonia (NH_3) under normalized pH ranges. Ammonium is less toxic than ammonia, and not until pH exceeds 9 will ammonia and ammonium be present in about equal quantities in a natural water system (as pH continues to rise beyond 9, ammonia becomes more predominant than ammonium). Table 12 shows ammonia+ammonium average levels in each lake during the growing season. These numbers are not of concern at this point seeing that pH levels were normal throughout the 2023 growing season and because lab testing measures the combination of ammonia and ammonium. This suggests that most of nitrogen found in these tests was from the less toxic compound ammonium.

4.5. Lake Water Levels and Precipitation

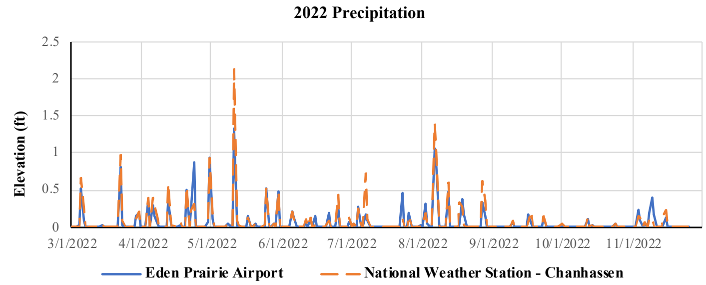
In-Situ Level Troll 500, 15-psig water level sensors, METER Environment Hydros 21 water level sensors, and MaxBotix MB7389 HRXL-MaxSonar water level sensors were placed on all lakes throughout the watershed District to monitor water quantity and assess yearly and historical water level fluctuations. The pressure sensors are mounted inside a protective PVC pipe that are attached to a vertical post and placed in the water. The sonars are placed on a vertical post above the water surface. The Hydros 21 pressure sensors and MaxBotix Sonars were outfitted with solar panels and radios which allows for remote communication with the station for real-time viewing of elevation/data. A staff gauge, or measuring device, is also mounted to the vertical post, and surveyed by District staff to determine the elevation for each level sensor. Once the water elevation is established, the sensors record continuous water level monitoring data every 15 minutes from ice out until late fall.

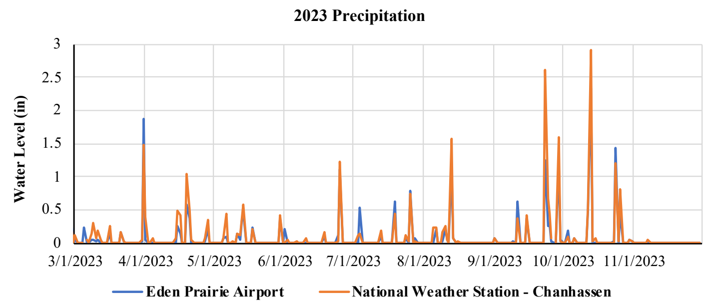
Precipitation data from the Flying Cloud Airport (Pioneer Trail, Eden Prairie) and the National Weather Service Station (Lake Drive West, Chanhassen) was used for precipitation data throughout the following report. Figure 19 displays daily precipitation totals across the two stations from March 1 through December 1 in 2022 and 2023. Overall, precipitation levels were very low in 2023, and the District continued to be in drought condition. During this period, rainfall at the Flying Cloud Airport and National Weather Service Station totaled 20.73 inches (16.78 inches in 2022 and 19.12 inches in 2021) and 26.82 inches (23.49 inches in 2022 and 19.95 inches in 2021) respectively. In 2023, the max rainfall event at Flying Cloud Airport occurred on 10/13/2023 at 2.33 inches of rain (5/11/22, 1.32 inches in 2022) of rain. At the National Weather Service Station, the max rainfall total occurred on 10/13/2023, totaling 2.92 inches of rain (5/11/2022, 2.13 inches). The 2023 autumn rains helped increase water levels going into winter.

Lake level data is used for developing and updating the District's models, which are used for stormwater and floodplain analysis. Monitoring the lake water levels can also help to determine

Figure 19. Daily precipitation levels in 2022 and 2023.

2022 and 2023 precipitation daily totals in inches for Flying Cloud Airport in Eden Prairie, MN and the National Weather Service Station in Chanhassen, Minnesota.





the impact that climate change may have on lakes and land interactions in the watershed. Lake level data is also used to determine epilimnetic zooplankton grazing rates (Chapter 4.10). Lake level data is submitted to the Minnesota Department of Natural Resources (MNDNR) at the end of each monitoring season and historical data specific to each lake can be found on MNDNR website using the LakeFinder database. Exhibit A in the Appendix shows historical lake level data and current year lake level data compared with precipitation data. In both the DNR LakeFinder database and in Exhibit A, the Ordinary High-Water Level (OHWL) is displayed so water levels can be compared to what is considered the "normal" water level for each lake. The OHWL is used by governing bodies like the RPBCWD for regulating activities that occur above and below this zone.

In 2023, lake level measurements were collected on 13 lakes in the District and three wetlands (Lake Idlewild, Lake McCoy, Eden Lake) (Table 13). Idlewild experienced the greatest seasonal water level change over the 2023 season, decreasing 1.07 feet from spring sensor placement to the last day of recording. In 2022, Round Lake experienced the greatest seasonal water level change, decreasing 3.04 feet.

Like 2022, Round Lake had the largest range of fluctuation through 2023. During the 2023 season, Round Lake had a low elevation of 874.752 feet above sea level (FASL) and a high of 877.119 FASL (2.34-foot difference). Round Lake also had the lowest recorded water level according to past district data and DNR LakeFinder data. The previous low was recorded on 7/25/1977 and measured 875.290 FASL compared to a low of 874.752 on 9/5/2023. Round Lake water levels are highly influenced by precipitation events within the watershed which is why it commonly has the highest flux (Table 13). Staring Lake had the least seasonal flux (0.065 feet) across all district lakes. On average, lake levels seasonal flux or change in water levels was 0.351 ft in PCL and 0.286 in RCL in 2023. The average fluctuation range across PCL was 1.755 and 1.645 ft for RCL.

Table 13. Summary of 2023 Lake Water Levels.

The 2023 (March-November) and historical recorded lake water levels (feet above sea level or FASL) for all monitored lakes within the Riley Purgatory Bluff Creek Watershed District. The overall change in water level, the range of elevation fluctuation, and the highest and lowest recorded elevations are included. Historical data includes the highest and lowest historical recorded levels and the date they were taken. Lake levels are represented by flux in feet and high/low level in FASL.

	2023 LAKE WATER LEVEL DATA				HISTORIC LAKE WATER LEVELS			
Lake	Seasonal Flux (feet)	Flux Range (feet)	High level (FASL)	Low level (FASL)	Highest Level (FASL)	Date	Lowest Level (FASL)	Date
Riley Creek Chain of Lakes (RCL)								
Ann	0.356	1.465	956.373	954.908	957.930	2/18/1998	952.800	9/28/1970
Lucy	-0.153	1.613	956.731	955.118	957.683	6/20/2014	953.290	11/10/1988
Rice Marsh	-0.204	1.879	876.492	874.613	877.250	5/28/2012	872.040	8/27/1976
Riley	-0.289	1.890	865.434	863.544	866.855	6/20/2014	862.000	2/1/1990
Susan	0.430	1.378	882.317	880.939	884.226	6/19/2014	879.420	12/29/1976
AVERAGE	**0.286**	**1.645**	--	--	--	--	--	--
Purgatory Creek Chain of Lakes (PCL)								
Duck	0.429	1.493	913.242	911.749	915.317	6/20/2014	911.260	11/10/1988
Eden	-0.184	1.778	810.647	808.869	811.046	8/27/2021	809.008	10/12/2022
Hyland	0.407	1.949	813.839	811.890	819.800	8/11/1987	811.660	12/2/1977
Idlewild	-1.071	2.178	854.764	852.586	860.780	3/29/1976	852.586	9/23/2023
Lotus	0.136	1.358	895.943	894.585	897.080	7/2/1992	893.180	12/29/1976
McCoy	-0.240	1.168	823.223	822.055	823.902	8/16/2020	821.956	11/4/2022
Mitchell	0.222	2.045	871.283	869.238	874.210	6/25/2014	865.870	7/25/1977
Red Rock	0.684	1.640	840.288	838.648	842.702	7/13/2014	835.690	9/28/1970
Round	-0.356	2.367	877.119	874.752	884.260	8/17/1987	874.752	9/5/2023
Silver	-0.071	1.417	899.291	897.874	901.030	6/20/2012	894.780	6/6/1972
Staring	0.065	1.911	815.445	813.534	820.000	7/24/1987	812.840	2/12/1977
AVERAGE	**0.351**	**1.755**	--	--	--	--	--	--

4.6. Lake Shoreline Assessment

In 2021, Riley Purgatory Bluff Creek Watershed District staff began a district-wide assessment of lake shoreland health. Staff followed the Score the Shore (STS) methodology outlined in the DNR Minnesota Lake Plant Survey Manual (Perleberg et al. 2016) with adaptations to allow for generation of individual property scores as well as an overall lake score.

As with the original STS methodology, RPBCWD staff evaluated shoreland in three zones: upland, shoreline, and aquatic (Figure 20). The score from each zone was equally weighted and combined to provide an overall score for each survey point (in the RPBCWD approach, each individual property served as a survey point). Within each zone, the evaluator scored for three metrics, resulting in a total of nine metrics assessed for each property. The metrics used in the assessment primarily relate to habitat value and include density of trees, shrubs, and natural ground cover; overhanging wood; woody debris within the water, amount of human-built structure (e.g. docks), and openings in aquatic plant beds. See comparison between a low and moderate scoring property in Figure 21.

Figure 20. Score The Shore (STS) property zones (MN DNR) shown with a bird's-eye view (top) and side view (bottom).

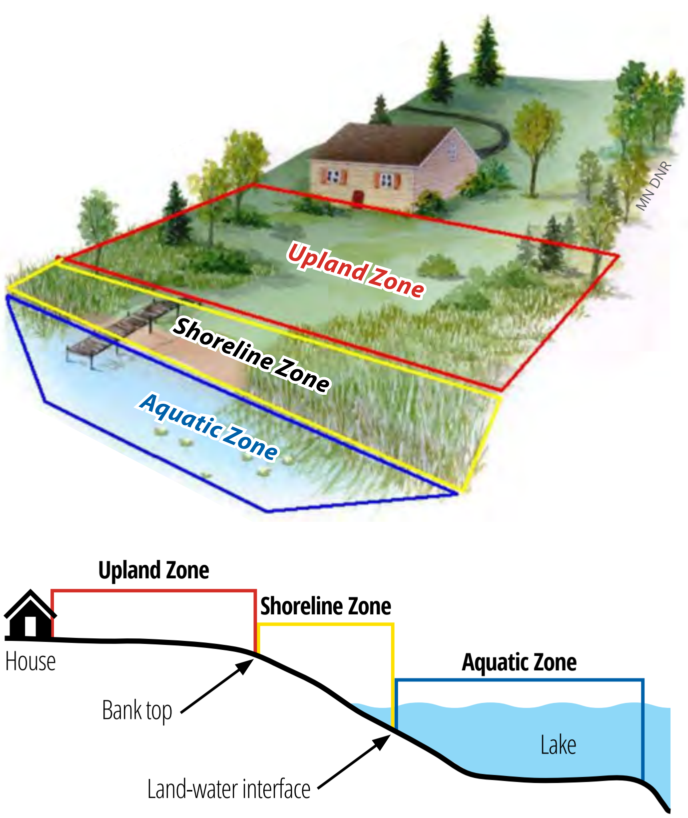


Figure 21. Example of a STS low scoring property (top) and STS high scoring property (bottom).

STS is an intuitive rapid assessment survey designed to be completed by boat. See Table 14 for the DNR STS scoring form. The upland zone should be judged as the area from the house/cabin to the top of the lake bank (area where land begins slope to water). If there is no clearly defined bank on the property (which is frequently the case), the best judgment of the assessor must be used. The shoreline zone extends from the bank to the land-water interface. This zone fluctuates depending on the water level. When necessary, the shoreline can be defined by the assessor as the first one-third of the lot toward the house and the upland zone the remaining two-thirds. The aquatic zone is the area extending from the land-water interface into the water body for 50 feet. For scoring purposes, trees are defined as larger woody plants that have a canopy. Shrubs are tree saplings or other small woody plants. Groundcover includes natural vegetative cover, wetland shrubs, shoreline grasses, and leafy debris.

Eleven of thirteen lakes in the District were scored in 2021 through 2023 (Figure 23). These lakes included Ann, Duck, Hyland, Lotus, Lucy, Mitchell, Red Rock, Riley, Silver, Staring, and

Table 14. Original Score The Shore (STS) scoring form developed by the MnDNR to assess lake shoreland health.

FEATURE	FEATURE DESCRIPTION	COVERAGE	POINTS	SCORE (%)
UPLAND ZONE - *House to lake bank*				
1	Percent of frontage with trees	75-100%	20	13.3$\overline{3}$ %
		50-74%	15	10 %
		25-49%	10	6.6$\overline{7}$ %
		1-24%	5	3.3$\overline{3}$ %
		0%	0	0%
2	Percent of frontage with shrubs	75-100%	20	13.3$\overline{3}$ %
		50-74%	15	10 %
		25-49%	10	6.6$\overline{7}$ %
		1-24%	5	3.3$\overline{3}$ %
		0%	0	0 %
3	Percent of frontage with natural ground cover	75-100%	10	6.6$\overline{7}$ %
		50-74%	7.5	5 %
		25-49%	5	3.3$\overline{3}$ %
		1-24%	2.5	1.6$\overline{7}$ %
		0%	0	0 %
SHORELINE ZONE - *Lake bank to waterline*				
4	Percent of frontage with trees, shrubs, and/or wetland	75-100%	20	13.3$\overline{3}$ %
		50-74%	15	10 %
		25-49%	10	6.6$\overline{7}$ %
		1-24%	5	3.3$\overline{3}$ %
		0%	0	0%
5	Percent of frontage with natural ground cover or wetland	75-100%	20	13.3$\overline{3}$ %
		50-74%	15	10 %
		25-49%	10	6.6$\overline{7}$ %
		1-24%	5	3.3$\overline{3}$ %
		0%	0	0 %
6	Overhead woody habitat	Yes	10	6.6$\overline{7}$ %
		No	0	0 %
AQUATIC ZONE - *Waterline to 50 feet into water*				
7	Human-made openings in plant beds	No	20	13.3$\overline{3}$ %
		Yes	0	0 %
8	Downed woody habitat	Yes	10	6.6$\overline{7}$ %
		No	0	0 %

9	STRUCTURE					
	Number of docks	**Number of Rafts**	**Number of Lifts**	**Number of Marinas**	**Points**	**Score**
	None	None or many	None	None	20	13.3$\overline{3}$ %
	One simple	None or many	None	None	15	10 %
	At least 1 simple or 1 complex	None or many	None to 2	None	10	6.6$\overline{7}$ %
		None or many	More than 2	None	5	3.3$\overline{3}$ %
	None to many	None or many	None or many	One or more	0	0%

Susan. Round and Rice Marsh lakes did not receive shoreland evaluations from RPBCWD staff. More developed shorelines generally received lower scores compared to more natural shorelines, which have less disturbed vegetation and habitat throughout each zone. A healthy shoreline has a wide variety of vegetation, which provides stabilization, reduces runoff, and decreases water pollution. A healthy shoreline also has downed woody debris with undisturbed plant beds providing habitat for aquatic macroinvertebrates and fish and trees that shade the water and provide habitat. An unhealthy shoreline is typically dominated by turf grass maintained by mowing. Shoreline armoring (e.g. riprap) in place of naturally vegetated banks also lowers a shoreline's score.

Not to be Confused with Score Your Shore

Score the Shore (STS) is easy to confuse with the name of another DNR tool, Score Your Shore (SYS) (MNDNR 2023). SYS is used by an individual with limited experience and equipment (e.g. homeowner) to assess one or more lake properties. While similar to STS, SYS is primarily a hands-on educational tool for lake residents, the DNR does not generally collect SYS scores for statewide comparison of lakes.

Overview of RPBCWD Adaptations of STS

Most lakes within the district have shoreland largely developed as residential properties. To allow for more detailed assessment and more effective outreach with shoreland property owners, RPBCWD adapted DNR methodology in three primary ways:

1. **Selection of survey points:** RPBCWD used individual properties as a survey point so that each property received its own score. The DNR utilizes a standard-length method based on lake size with survey points distributed evenly around the lake. Because of the difference in how survey points were selected, RPBCWD calculated a weighted lakewide average that considers shoreline length for comparison with the DNR lakewide average.

2. **Addition of partial credit for aquatic plant beds:** The RPBCWD approach allowed partial credit when assessing aquatic plant bed openings (Feature 7/Aquatic Plant Zone). With a three-point scale (20/10/0 points), a lakeshore owner receives points if the aquatic plant bed along their property has only minimal disturbance such as a narrow boat path cleared to open water. The DNR all or nothing (20/0 points) scoring option does not allow partial credit to lakeshore owners with mostly intact aquatic plant beds.

3. **Finer-scaled rating system:** The DNR rating scale uses four categories: Excellent (91-100 percent), Good (81-90 percent), Average (71-80 percent), and Poor (less than 70 percent). Based on the DNR rating scale, most residential lakeshore properties in the District score as Poor. The DNR scoring scale is designed to be used for all Minnesota waterbodies, ranging from completely natural to heavily developed. Considering the mostly developed nature of lakes within RPBCWD, staff developed a finer scale with ten categories instead of the DNR's four. This allowed for a finer scale of assessment for shorelines scoring 70 percent or lower. See Figure 22 for a comparison between the DNR and RPBCWD scales.

Table 15 provides an overview of RPBCWD modifications to the original STS approach.

DNR and District Lakewide Score Comparison

Figure 22. Comparisons between the original STS rating scale and modified version used by RPBCWD.

MNDNR Rating Scale

MEAN LAKEWIDE SCORE	MEAN SHORELAND SCORE	MEAN SHORELINE SCORE	MEAN AQUATIC SCORE	RATING
90-100%	30 - 33.3 %	30 - 33.3 %	30 - 33.3 %	**Excellent**
80-89%	25 - 29 %	25 - 29 %	25 - 29 %	**Good**
70-79%	20 - 24 %	20 - 24 %	20 - 24 %	**Fair**
<70%	<20 %	<20 %	<20 %	**Poor**

The DNR's standard Score The Shore method uses a shoreline rating of four categories. The rating scale does not allow for a finer level of assessment below a score of 70 percent, which is the category where most fully developed suburban lakes fall within.

RPBCWD Rating Scale

SCORE RANGE	COLOR CODE	RATING
90-100%		**Healthy**
80-89%		↑
70-79%		
60-69%		
50-59%		
40-49%		
30-39%		
20-29%		
10-19%		↓
0-9%		**Degraded**

RPBCWD staff use a modified version of the Score The Shore rating scale. Instead of the DNR's four categories, the RPBCWD rating method has 10 rating categories (of 10 points each) along a continuum from healthy to degraded. The addition of a corresponding color scale (green to red) allows for visual representation of scores on GIS-generated maps.

Table 15. Overview RPBCWD modifications to the original DNR Score The Shore (STS) methods.

METHOD	Original STS developed by DNR	Modified STS used by RPBCWD
Features assessed	9 feature categories	*Same as DNR*
Survey points	Number of survey points based upon lake shoreline length; points spaced evenly	Number of survey points based upon property lines (one survey point per parcel)
Zone scoring	Points based upon percent coverage or presence/absence of feature	*Same as DNR except* addition of partial credit for minimal human-made openings in plant beds (Feature 7 in Aquatic Zone): scoring option changed to 0/10/20 from 0/20
Overall rating scale	4 rating categories with variable percent ranges (10%, 10%, 10%, and 70%)	10 rating categories divided evenly between percent ranges (10% each)

The DNR calculates a lakewide score by averaging the STS scores collected at points evenly distributed around the lake; the number of survey points per lake is based upon lake size. As RPBCWD survey locations were based upon property lines and not lake size, the RPCWD lakewide scores were weighted to make a reasonable comparison to the DNR lakewide scores.

To calculate the RPBCWD lakewide score, each individual property score was multiplied by the property's shoreline length. The sum of this value was then divided by the length of the lake shoreline. The formula for this calculation is shown below:

$$lake\ weighted\ average = \frac{\Sigma\,(property\ score \times property\ length)}{\Sigma\,property\ length}$$

As of this report, five lakes located within the district boundary had STS scores from the DNR. Scores by property were used to map in ArcGIS and then converted to lakewide weighted average scores for comparison to DNR STS scores. This allowed a more direct comparison to the standard width scoring method that the DNR utilizes.

Differences can arise upon comparing scoring processes due to variation in property sizes. For instance, park and city land can skew property averages as they are typically larger than residential lots and generally have limited disturbance. The scoring by property and weighted average scoring provides a much finer level of detail than what is captured with the DNR method. The DNR scoring is geared towards a fast and general assessment of the lake as a whole and does not assess individual properties as accurately. Regardless, the scoring of RPBCWD lakes can show lakeshore residents the difference in shoreline health between a natural/undeveloped shore and their own.

RPBCWD average lakewide scores (straight and weighted averages) and the corresponding DNR lakewide score is shown in the Table 17. Lake weighted scores displayed along the RPBCWD rating scale is shown on Figure 24. Lakes with less developed properties scored higher and had smaller range of property scores.

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

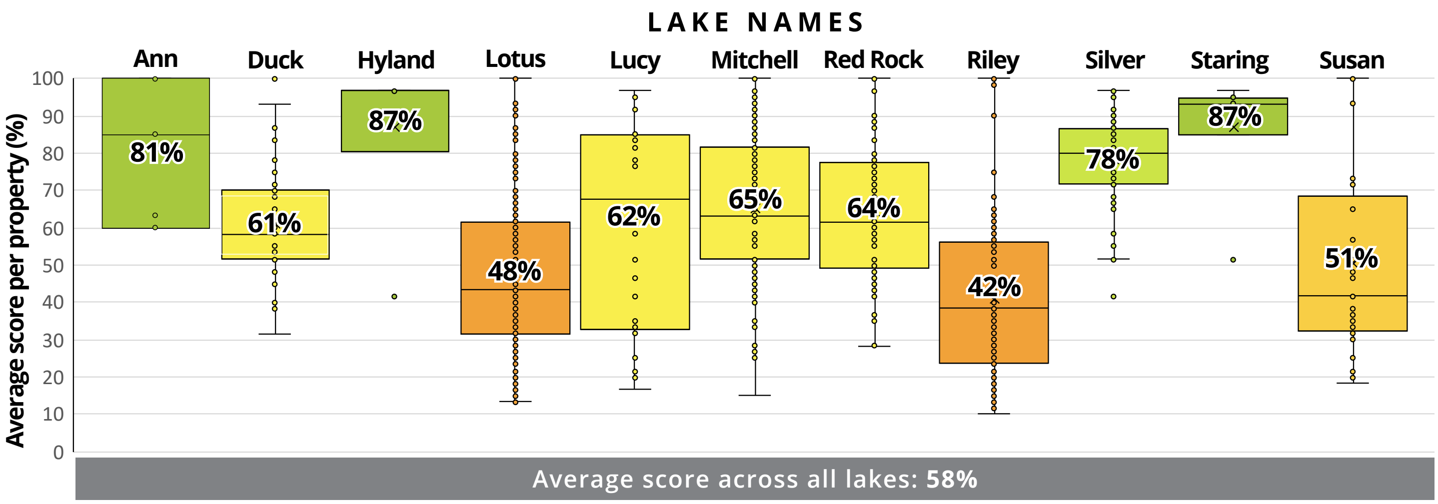


Table 16. Overview of RPBCWD Score The Shore (STS) averages for each lake, each zone within a lake, and all lakes combined (unweighted averages).

LAKE NAME	SCORE PER ZONE			OVERALL LAKE SCORE
	UPLAND ZONE	SHORELINE ZONE	AQUATIC ZONE	
Ann	27%	29%	26%	**81%**
Duck	14%	20%	27%	**61%**
Hyland	30%	29%	28%	**87%**
Lotus	18%	16%	14%	**48%**
Lucy	21%	20%	21%	**62%**
Mitchell	21%	22%	23%	**65%**
Red Rock	18%	21%	26%	**65%**
Riley	18%	13%	10%	**41%**
Silver	22%	24%	31%	**78%**
Staring	27%	31%	29%	**87%**
Susan	18%	17%	16%	**50%**
Combined lakes average	19%	19%	20%	**58%**

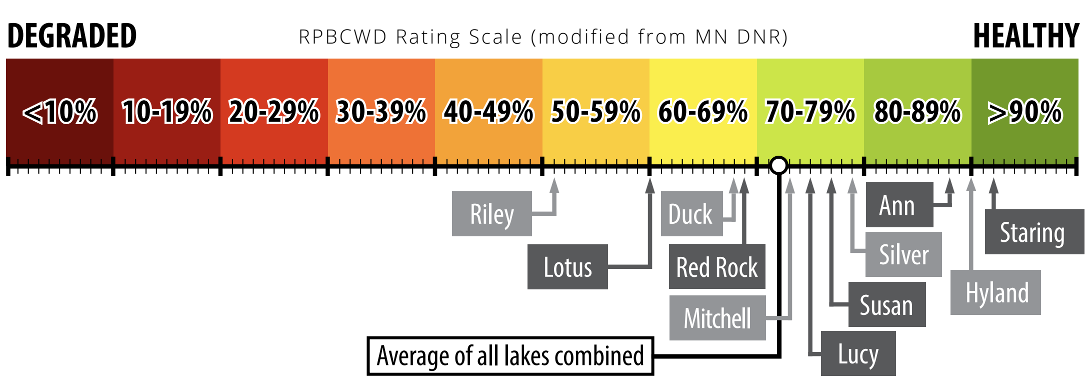
Table 17. Comparison of lakewide Score the Shore (STS) scores between RPBCWD and the DNR.

	RPBCWD Lakewide Score		DNR Lakewide Score
Lake	STRAIGHT AVERAGE (average of property scores)	WEIGHTED AVERAGE (accounts for shoreline length)	Average score considers lake size
Ann	81	88	92
Duck	61	68	*unavailable*
Hyland	87	90	*unavailable*
Lotus	48	60	75
Lucy	62	75	*unavailable*
Mitchell	65	73	89
Red Rock	65	69	*unavailable*
Riley	41	51	55
Silver	78	79	*unavailable*
Staring	87	91	97
Susan	50	77	*unavailable*
All-lake average	58	72	--

RPBCWD Shoreland Scoring Results

The average individual property shoreland score for all lakes in the District was 58 percent (Table 16 and Table 17). The weighted average of all shoreline in the district is higher, at 72 percent. This can be explained in part by larger average shoreland scores from higher scoring public land properties. Although the DNR method for shoreline scoring is standardized, the subjectivity in scoring still allows for judgment differences by the scorer and can explain some of the differences between scores. The weighted average scores by property are more accurate and precise on fully developed lakes than the DNR standard method because there is more definition (each property is scored compared to its property length). On less developed lakes, the inverse is true where the DNR standard scoring method has more definition (more scored transects per parcel). This is because less developed lakes have much larger parcels such as parks or other public land, which are only scored once using in the RPBCWD approach. However, there is typically not much change in score within larger, undeveloped properties which generally have better scores. The higher definition garnered by the DNR scoring in larger properties is generally not needed to achieve the same lakewide score. Evidence of this

Figure 24. Comparison of RPBCWD Score The Shore weighted lake scores along the modified rating scale.



can be seen in the closeness in scoring between the weighted lakewide average score and DNR lakewide average score for less developed lakes such as Ann and Staring. These lake scoring differences had some of the least variability between methods at 3 percent and 5 percent respectively. If additional DNR surveys are performed on other lakes in the future, it could provide enough data for more in-depth comparisons between the DNR and RPBCWD scoring approaches.

Several lakes (Duck, Lotus, Red Rock, and Riley) have a lower weighted average than the weighted average for all lakes. This is likely due to these lakes containing a higher proportion of developed property and subsequently a higher percentage of deteriorated shoreline. All lakes had a weighted average that was higher than their property average. Susan had the highest difference, with a weighted average 26 percent higher than the individual property score. Lake Susan has one side of the lake dominated by natural parkland and the other side as heavily developed private property. Lake Lucy has a similar case, with a property average of 62 and a weighted average of 75. For these lakes, the individual property score is skewed and the average is a gross underestimation of the overall shoreline health. All other lakes had a difference of 11 percent or less. Lake Riley is the most developed lake within the district and had similar scores comparing the DNR and weighted method (four percent difference). Both Lotus and Mitchell scores were significantly different between the district and DNR scoring with differences greater than 15 percent.

Scoring by property leads to scores that are lower than the comparable lake wide average created from scoring set intervals in DNR methodology. However, with the standard STS scoring performed by the District, the ability for the homeowner to see their individual property score is realized. A homeowner seeing a lower score for their property may be called to action and aim to improve their individual score. The weighted average allowed for a better comparison with the standard methodology and fully took into consideration the different lengths and associated scores of individual properties.

After completing all surveys, commonalities on solutions to improve shoreline scores were found. Residents can improve their scores by increasing the percentage of their upland and shoreland areas covered by trees, shrubs, and groundcover. One of the simplest ways to increase a score is by leaving woody habitat in the water, as having no downed woody habitat eliminates 10 points from the total score (6.67 percent of the total score). Another simplistic way to increase score is to avoid treating/removing aquatic plant beds. By not clearing a swimming area or boat path, a maximum score of 20 points (13.3 percent) can be obtained for this category. If they do modify their aquatic vegetation (<25 percent disturbance as with a boat path and no other clearing) the district modified scoring allows them to still gain 10 points (6.67 percent). If a resident leaves their aquatic zone natural (with the exception of their dock) and does not remove plants or woody debris in any capacity their score can increase by 30 points (20 percent).

Overall, the STS assessment suggests there is room for ecological improvement in the form of shoreline restoration, upland restorations, and aquatic improvements across all lakes within the district. It is understood that we are in an urban setting and people want to utilize their lakeshore. With this study, District staff hope to start constructive conversations about how lakeshore owners can take small steps to improve their shorelines. Developing a district wide or individual goal residential property average may engage residents to improve their shorelines.

District staff are discussing the potential of adapting the grant program to allow for targeted grants to residents to specifically increase their STS score. This could include tree/shrub planting, buffer plantings, etc. Follow up surveys will be conducted on a rotational basis moving forward to assess changes in shoreline health over time.

More information about Score Your Shore including individual property scores will be available at rpbcwd.org in late spring 2024.

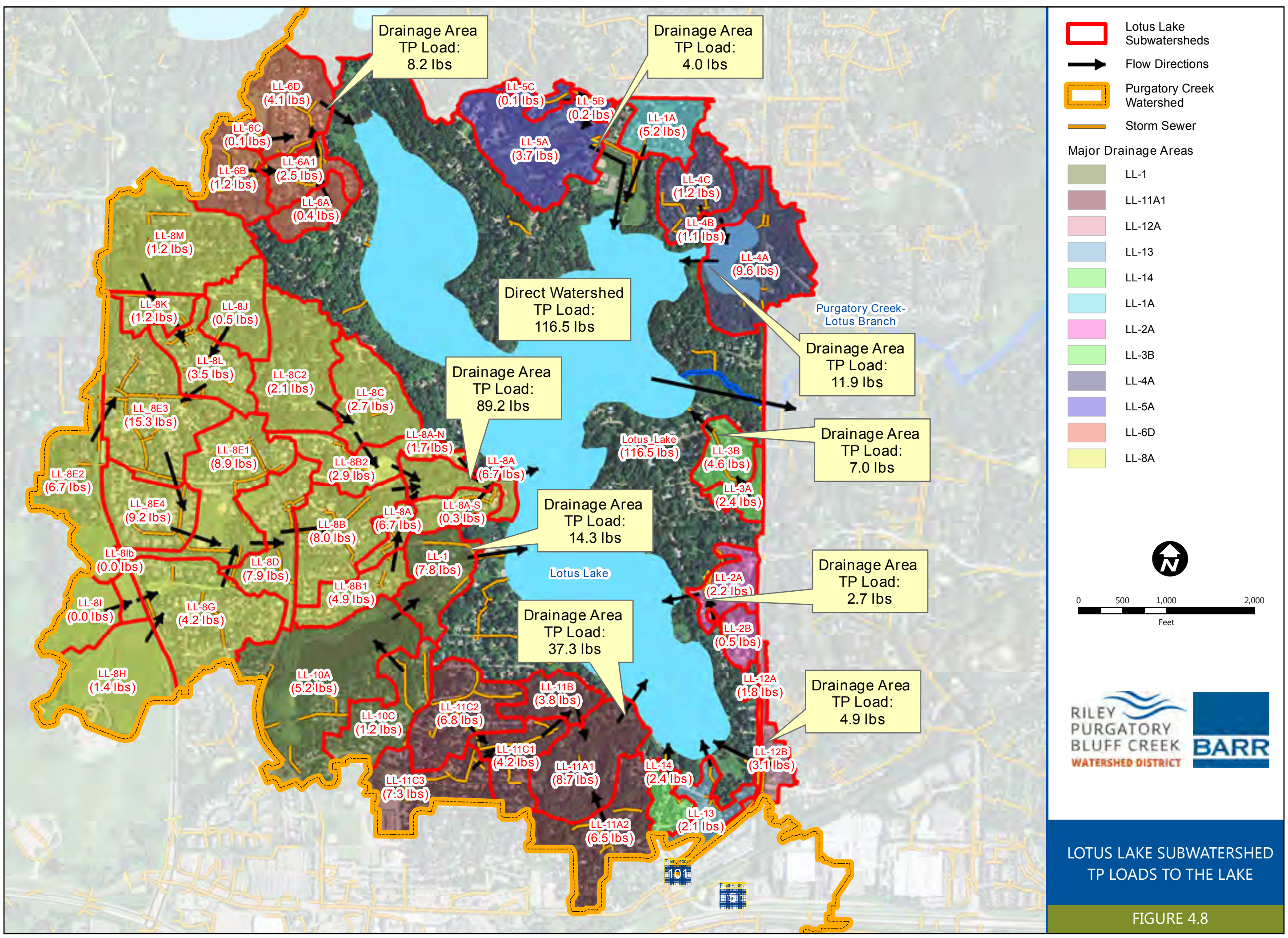
4.7. Purgatory Creek Auto-Sampling Units

Within the Purgatory Creek Chain of Lakes, Lotus Lake consistently fails to achieve the water quality standards set forth by the MPCA including total phosphorus (TP) chlorophyll-a, and water clarity (Secchi disk depth). Additionally, Lotus Lake was listed on the MPCA 2002 Minnesota Section 303(d) List of Impaired Waters due to nutrients. In 2017, an updated Use Attainability Analysis (UAA) for most of the Purgatory Creek watershed was completed which further identified sources and potential solutions for correcting the nutrient loading to the lake.

- (LL_3 & LL_7) For Lotus Lake, the three ravines on the west side of the lake were estimated to be contributing 140.8 lbs. of TP. The uppermost ravine contributed 89.2 pounds alone (Figure 25). This is the largest estimated loading drainage area besides the direct runoff from the area around the lake which could potentially be addressed by the installation of a BMP.
- (LL_1/Kerber 1 and Kerber 2) For Lotus Lake, the three ravines on the west side of the lake were estimated to be contributing 140.8 lbs. of TP. The middle ravine is estimated to contribute 14.3 lbs. but there is likely more as the City of Chanhassen must clean out sediment from the modified culvert near the lake multiple times a year. (Figure 25). Since the upper site is being studied, the middle and lower ravines will also have samples collected to potentially gain cost savings for project implementation.

Figure 25. Estimated subwatershed Total Phosphorus loading to Lotus Lake .

Image below is "Figure 4.8" from the *Lotus, Silver, Duck, Round, Mitchell, Red Rock Use Attainability Analysis Update; Lake Idlewild and Staring Lake Use Attainability Analysis; and Lower Purgatory Creek Stabilization Study* (Revised March 2017).



When a project is identified, RPBCWD staff will often monitor the site before and after the project is implemented. This helps confirm if a project is warranted and assess the effectiveness of a project once it is in place. In the Lotus subwatershed, staff placed an automated sampling units at the grated access site downstream of Kerber Boulevard (upper tributary), the culvert under the recreational trail connected to the end of Carver Beach Road (upper tributary), the culvert draining Kerber Pond (middle tributary), and the culvert under frontier trail (middle tributary). This was done to better quantify rain event nutrient loading from upstream sources. Analyzing the "first flush" of a storm event is important because these events are when water pollution entering storm drains in areas with high proportions of impervious surfaces is typically more concentrated compared to the remainder of the storm. Water samples were collected and analyzed for total dissolved phosphorus (TDP), total phosphorus (TP), total suspended solids (TSS), and Chlorophyll-a (Chl-a). The automated water-sampling units also estimated flow of the creek or drainage channel at that point.

From 2021-2023, total phosphorus levels on the upper Lotus Lake ravine during storm events were high compared to the MPCA standards, as seen in Figure 26 and Table 18. In 2023, the average TP coming from upstream of Kerber Blvd. (LL_3) averaged 0.506 mg/L and the average TP leaving the stormwater pond upstream of the recreational trail (LL_7) measured 0.442 mg/L in (Table 18). Water at LL_3 is piped from upstream to a stormwater pond just upstream of the sampling location LL_7. The average percent reduction of 13% (16% in 2022). This slight reduction in TP suggests the stormwater pond is undersized for the hydrology at this location and is likely not effectively treating much of the water. When comparing the individual storm events this becomes more apparent. The overall reduction in TP in 2022 and 2023 from 2021 (0.534 mg/L) for LL_7 was likely due to the reduced amount of precipitation seen in 2022 and 2023. Regardless, the 2023 TP levels were over four times the MPCA eutrophication water quality standard for class 2B streams (≤ 0.1 mg/L TP) and double the MPCA estimated typical total phosphorus range (0.1 mg/L to 0.25 mg/L) for effluent (outgoing) stormwater. Of the 13 storm event TP samples collected 11 out of 13 samples from LL_3 and 8 out of 11 samples from LL_7 measured above the MPCA stormwater effluent standard, but all measured above the MPCA stream standard. The highest TP concentration for LL_7 occurred on 9/11/23 which corresponded with a relatively small rain event 0.37 inches (Figure 26). This followed a month-long dry period and could be linked with an internal loading release event from the pond. The highest concentration for LL_3 occurred on 9/24/23 which corresponded with the largest storm event. In 2023, the average TDP concentration was reduced from the previous years to 0.085 mg/L, previously 0.106 mg/L in 2021 and 0.108 mg/L in 2022.

The average amount of TSS across 2023 storm events was 142.7 mg/L for station LL_3 and 89.7 mg/L for LL_7. This is down from 180.7 mg/L for station LL_3 and 107.5 mg/L for station LL_7 in 2022. Across all the sampling events, 12 out of 13 for LL_3 and 8

Table 18. Lotus Lake Northern Tributary First Flush Auto Sampling Units Average Nutrient Summary (2021-2023).

		SITE LL_3		SITE LL_7			AVERAGE PERCENT REDUCTION	
PARAMETER	**MPCA WQS**	**2022**	**2023**	**2021**	**2022**	**2023**	**2022**	**2023**
TP (mg/L)	≤ 0.1	0.505	0.506	0.534	0.424	0.442	16.04%	12.65%
TDP (mg/L)	--	0.117	0.105	0.106	0.108	0.085	7.69%	19.05%
Chl-a (µg/L)	≤ 18	20.9	24.9	18.5	14.9	15.8	28.71%	36.55%
TSS (mg/L)	≤ 30	180.7	142.7	76.6	107.5	89.7	40.51%	37.14%

of the 10 samples taken in 2023 were above 30 mg/L TSS water quality standard for streams (Figure 26). The average percent reduction from LL-3 to LL_7 was around 40 percent indicating the upstream pond from LL_7 is settling out suspended solids. From the limited Chl-a samples collected, concentrations at LL_3 both averaged just above the MPCA standard while LL_7 averaged just below.

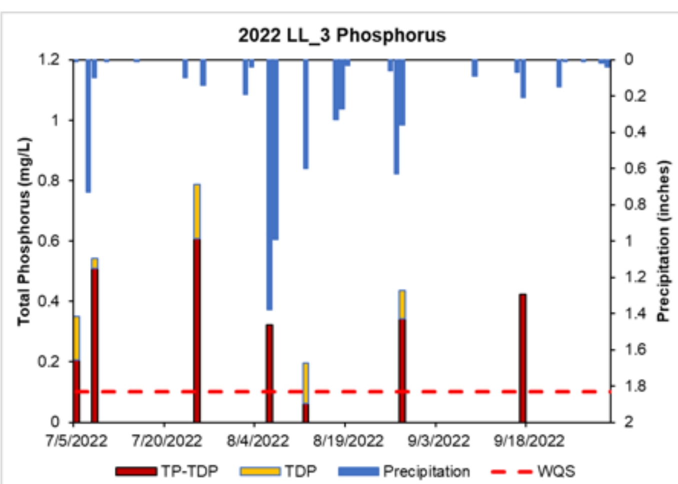
It is important to note that these samples were targeted samples, representative of the initial flush of water and pollutants that occur during rain events, and do not represent season-long pollutant levels in the Lotus Lake Ravine. Precipitation graphs are shown in Figure 27, Figure 28, and Figure 29. With the low water levels, this site may have met the TSS and Chl-a MPCA standard for streams if more continuous or consistent nutrient monitoring occurred. Regardless, the results suggest that a bmp placement or upstream clean out of the ravine at this location would likely reduce loading to Lotus Lake. Additionally, the LL_7 site is specifically measuring effluent directly after a stormwater pond and LL_3 is an intermittent non navigable stream. Therefore, a direct comparison to the MPCA stream water quality standards is cautioned. The high nutrient levels at the downstream site indicates the stormwater pond is likely undersized for the volume of water it receives.

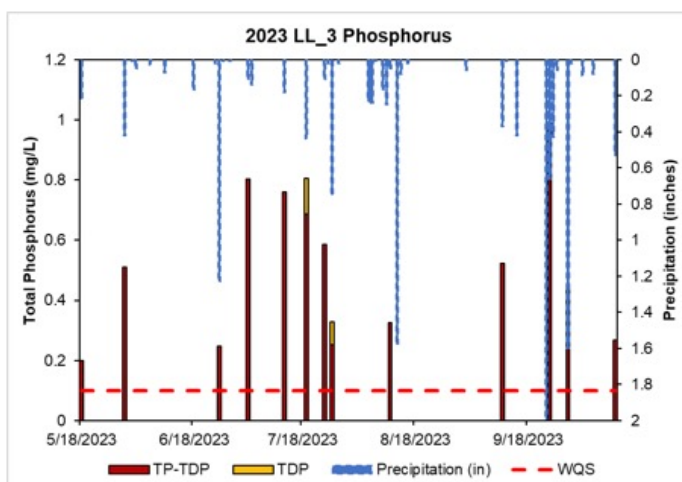
Site LL_3 levels may have been elevated due to the upstream sediment that was cleared upstream of Kerber Blvd in 2022. This clearing caused the down cutting upstream of the culvert which contributed TP and TSS downstream. This excess material is likely from the upstream pond cleanout, outlet reconstruction, and stabilization that occurred recently.

Kerber site 1 and 2 were installed later in the year during the drought conditions so limited nutrient and flow data was collected. Only two samples were collected for site Kerber 2 and none were collected for Kerber 1. Both samples indicated high TP and TSS loading. All sites will again be monitored in 2024 to assess nutrient loading to Lotus Lake.

Figure 26. 2022-2023 Lotus Upper Ravine Total Suspended Solids and Phosphorus

Total Suspended Solids (TSS), Total Dissolved Phosphorus (TDP), and Total Phosphorus (TP) first flush concentrations (mg/L) from 2022-2023 Lotus Lake Upper Ravine downstream of Kerber Blvd (LL_3) and from 2022-2023 Lotus Lake Upper Ravine off end of Carver Beach Road (LL_7) from an automated sampling unit. Precipitation data is from the Chanhassen MN National Weather Service Station. Dashed line represents the Minnesota Pollution Control Agency standard for TSS (≤30 mg/L) TP in class 2B creeks (≤ 0.1 mg/L).





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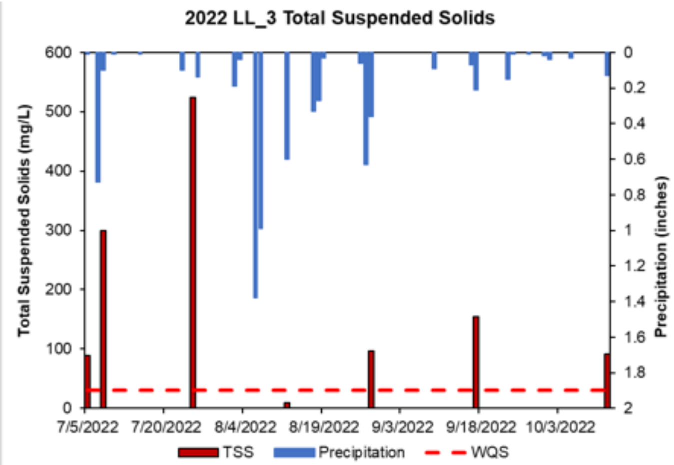
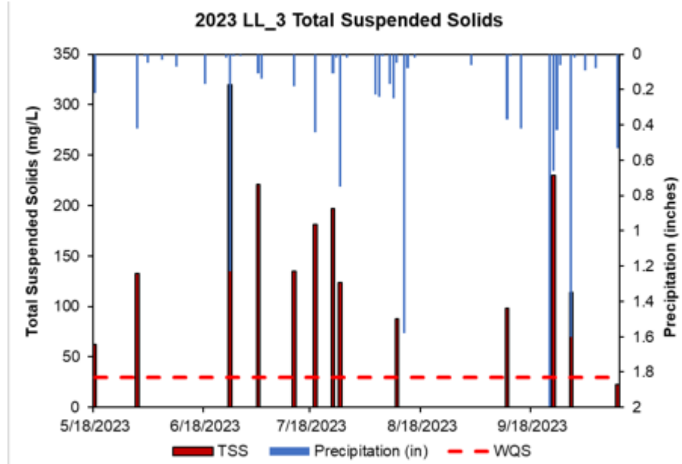
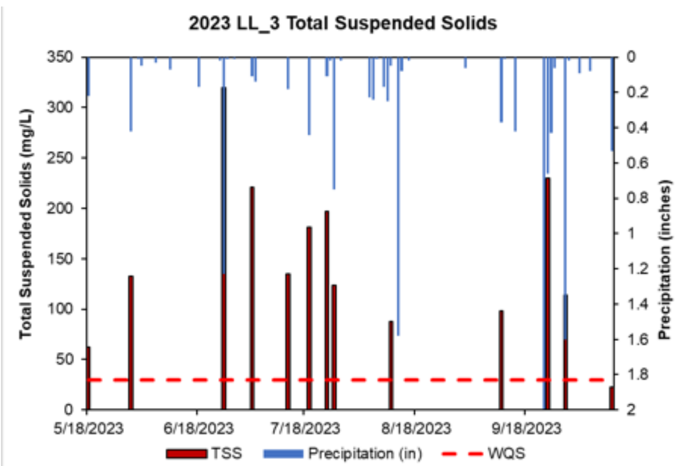
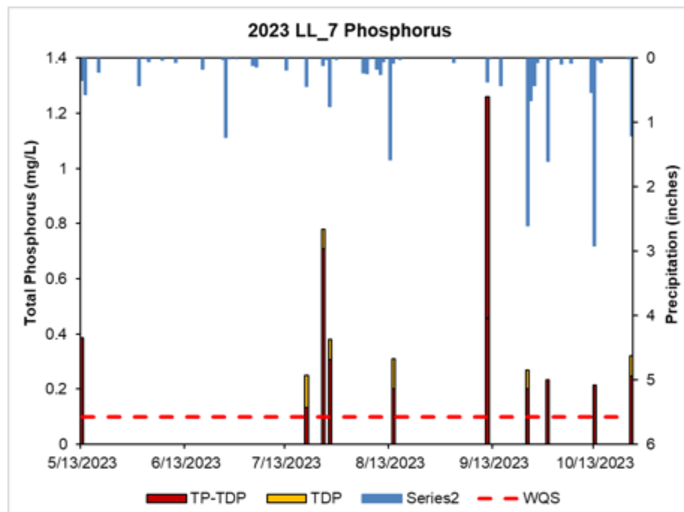
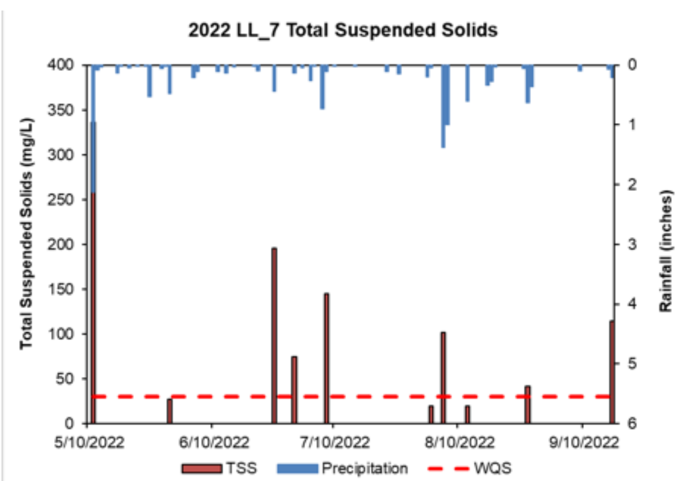










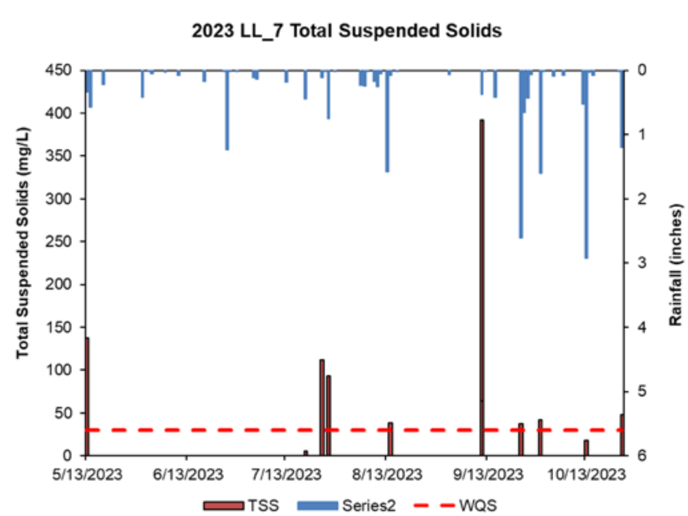


Figure 27. 2023 Kerber 2 Lotus Lake Middle Ravine water level.

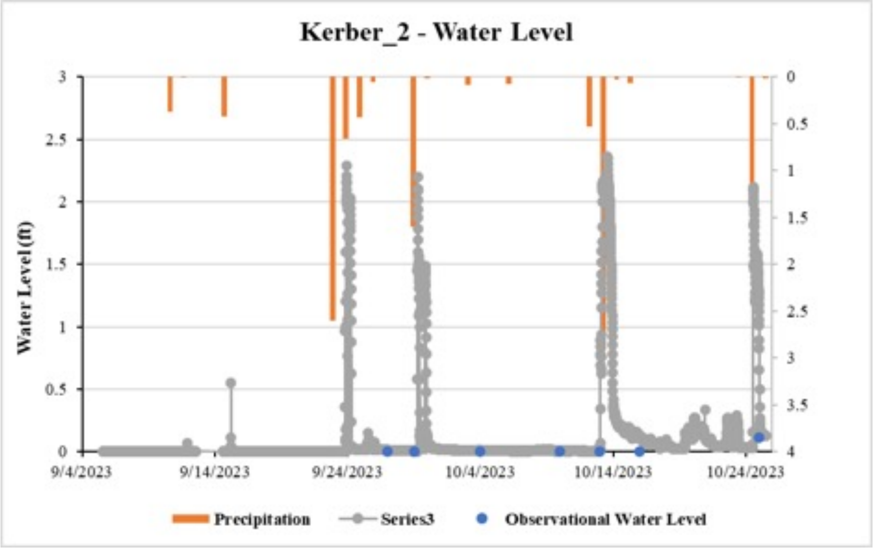


Figure 28. 2023 Kerber Blvd/Upper Lotus Lake Ravine Water Level

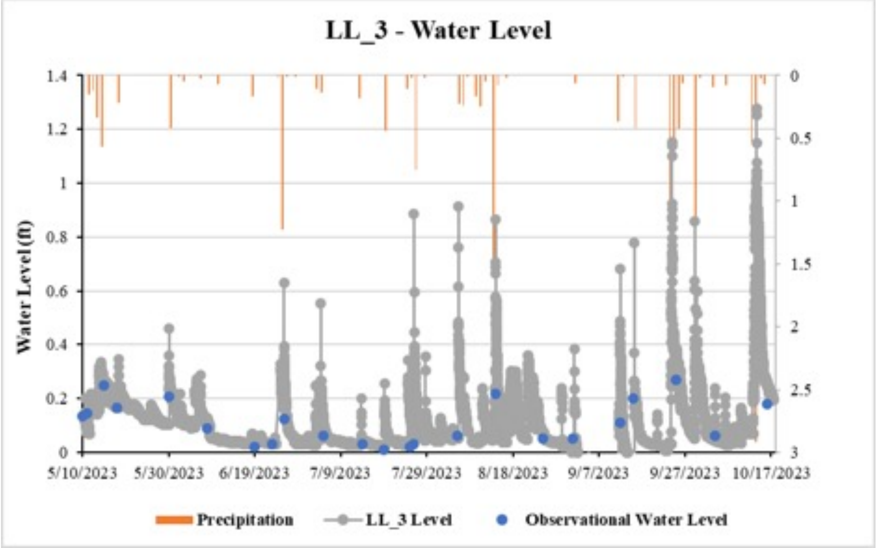
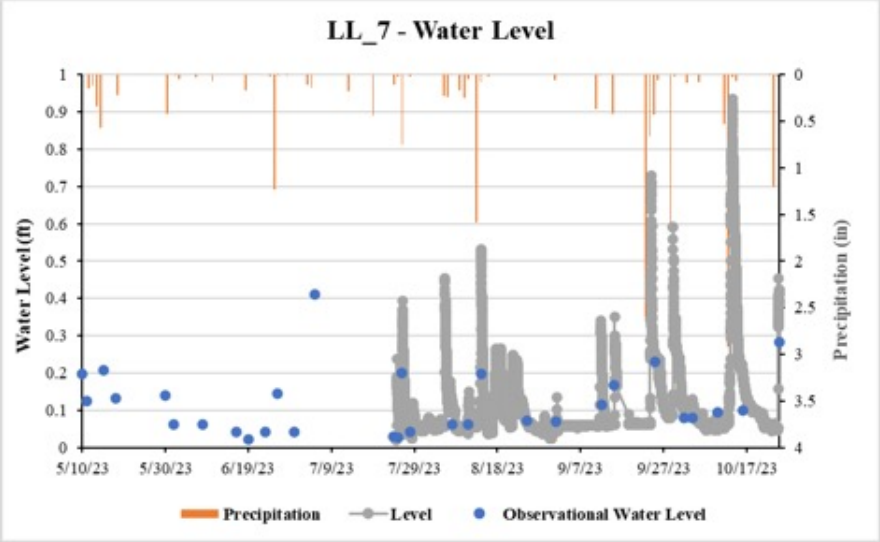


Figure 29. 2023 Carver Beach Road/Upper Lotus Lake Ravine Water Level



4.8. Upper Bluff Creek Auto-Sampling Units

Bluff Creek is listed on the 2002 and 2004 Minnesota Section 303(d) List of Impaired Waters due to impairment of turbidity and low fish Index of Biological Integrity (IBI) scores. Turbidity in water is caused by suspended sediment, organic material, dissolved salts, and stains that scatter light in the water column making the water appear cloudy. Excess turbidity can degrade aesthetic qualities of water bodies, can harm aquatic life, and have greater thermal impacts from increased sediment deposition in the stream. Primary sources contributing to TSS within the Bluff Creek Watershed are streambank and bluff erosion, as well as poorly vegetated ravines and gullies (Barr 2013). These sources of sediment are contributing to excess TSS loading mobilized by stormwater runoff from the watershed under high flow conditions. In addition, total phosphorus levels across all five Bluff Creek water quality sites are consistently above the MPCA water quality standard from year to year (≤ 0.1 mg/L). The Creek Restoration Action Strategy identified sub-reaches B5B and B5C near Galpin Road as sites that could benefit from restoration/stabilization and therefore reduce downstream nutrient and sediment loading.

When a project is identified RPBCWD staff will often monitor a site before and after the project is implemented. This helps confirm if a project is warranted and monitor the effectiveness of a project once it is in place. In 2019, 2020, 2021, and 2023, staff placed an automated sampling unit at the culvert under Galpin Road and the culvert under Highway 5 on Bluff Creek. This was done to better quantify rain event nutrient loading from upstream sources of Bluff Creek. Analyzing the "first flush" of a storm event is important because these events are when water pollution entering storm drains in areas with high proportions of impervious surfaces is typically more concentrated compared to the remainder of the storm. Water samples were collected and analyzed for total dissolved phosphorus (TDP), total phosphorus (TP), total suspended solids (TSS), and Chlorophyll-a (Chl-a). The automated water-sampling unit also estimated the flow of the creek at that point.

In 2019, 2020, and 2023 total phosphorus levels at the Galpin Bluff Creek site during storm events were high compared to the MPCA standards, as seen in Figure 30. As seen in Table 19, the average TP has been consistent at 0.525 mg/L in 2019, 0.425 mg/L in 2020, and 0.434 mg/L in 2023. This level is over three times the MPCA eutrophication water quality standard for class 2B streams (≤ 0.1 mg/L TP). All TP samples across three years measured above the MPCA standard.

The highest TP concentration in 2019 occurred in early August (1.77 mg/L). The highest concentration in 2020 occurred in mid-October (1.12 mg/L) and the highest in 2023 occurred in mid-September (1.05 mg/L). The TDP average in 2019 was 0.135 mg/L with a high measurement of 0.237 mg/L and the and the only measurement in 2023 was 0.127 mg/L (Table 19). The average amount of TSS across the 17 samples taken in 2019 was 84.6 mg/L. It was reduced in 2020 was 26.4 mg/L (15 samples) and then the average increased across the 5 samples in 2023 to 33.5 mg/L. To achieve the MPCA TSS stream water quality standard, a stream may not exceed 30 mg/L TSS more than 10% of the time. Across all the sampling events, nine of the 17

Table 19. Upper Bluff Creek Crossing Nutrient Loading Summary.

		Galpin Boulevard			Highway 5	
PARAMETER	**MPCA WQS**	**2019 Average**	**2020 Average**	**2023 Average**	**2021 Average**	**2023 Average**
TP (mg/L)	≤ 0.1	0.525	0.425	0.434	0.365	0.811
TDP (mg/L)	--	0.135	--	0.127*	0.074	0.081
Chl-a (µg/L)	≤ 18	11.56	32	1*	9.7	11.53
TSS (mg/L)	≤ 30	84.6	26.4	33.5	99.4	109.2

*Only one sample collected.

samples taken in 2019 were above 30 mg/L TSS, only five of the fifteen samples taken in 2020, two of the five samples in 2023 were above the standard (Figure 31). Four of the six in 2019, five of six in 2020, and the only Chl-a samples collected were less than the MPCA eutrophication water quality standard of ≤18 ug/L Chl-a indicating Chl-a is not loading downstream from the upper wetland.

In 2021 and 2023 total phosphorus levels on Bluff Creek downstream of Highway 5 during storm events were high compared to the MPCA standards (Table 19). The average TP across 19 samples was 0.365 mg/L 2021. Of the 15 samples in 2023, the average total phosphorus doubled to 0.811 mg/L. Concentrations at the Highway 5 site were over seven times the MPCA eutrophication water quality standard for class 2B streams (≤ 0.1 mg/L TP). All storm event TP samples collected measured above the MPCA standard across both years. The highest TP concentration occurred at the end of August at 1.07 mg/L in 2021 and the first sample taken in 2023 (June) at 2.43 mg/L. In 2021, the average TDP concentration was 0.074 mg/L which remained similar in 2023 at 0.081 mg/L (Figure 33).

Figure 30. 2020 and 2023 Galpin/Bluff Creek Phosphorus

The Total Dissolved Phosphorus (TDP) and Total Phosphorus (TP) concentrations (mg/L) from Bluff Creek under Galpin Blvd from 2020 and 2023 automated, level triggered, flow-paced samples. Dashed line represents the Minnesota Pollution Control Agency standard for TP in class 2B creeks (≤ 0.1 mg/L).

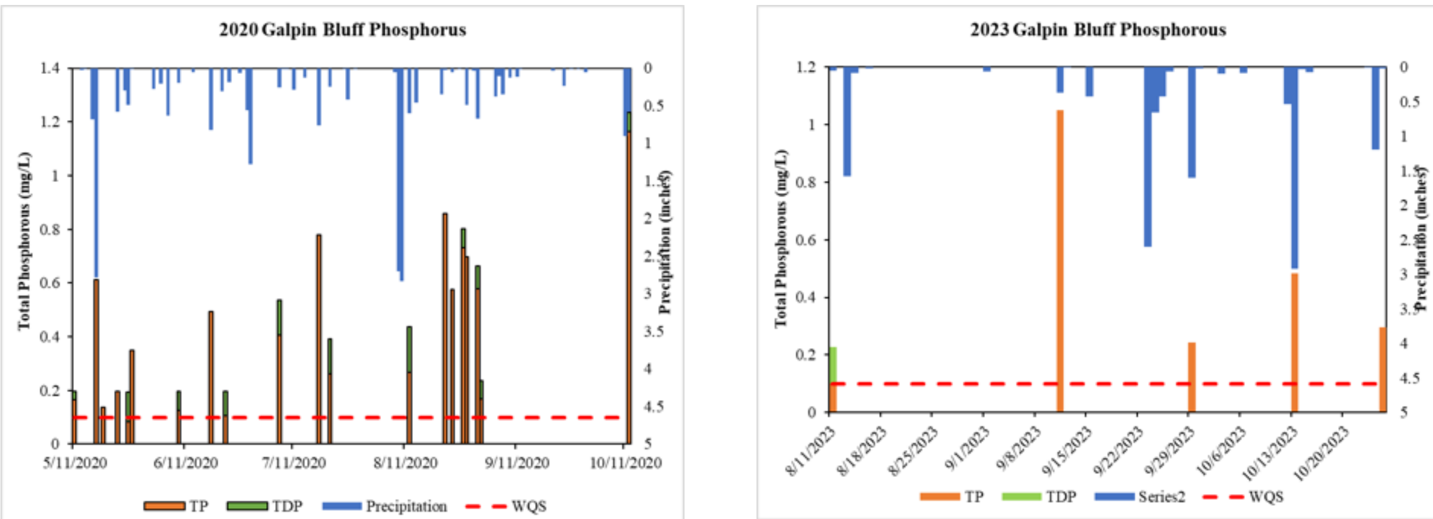
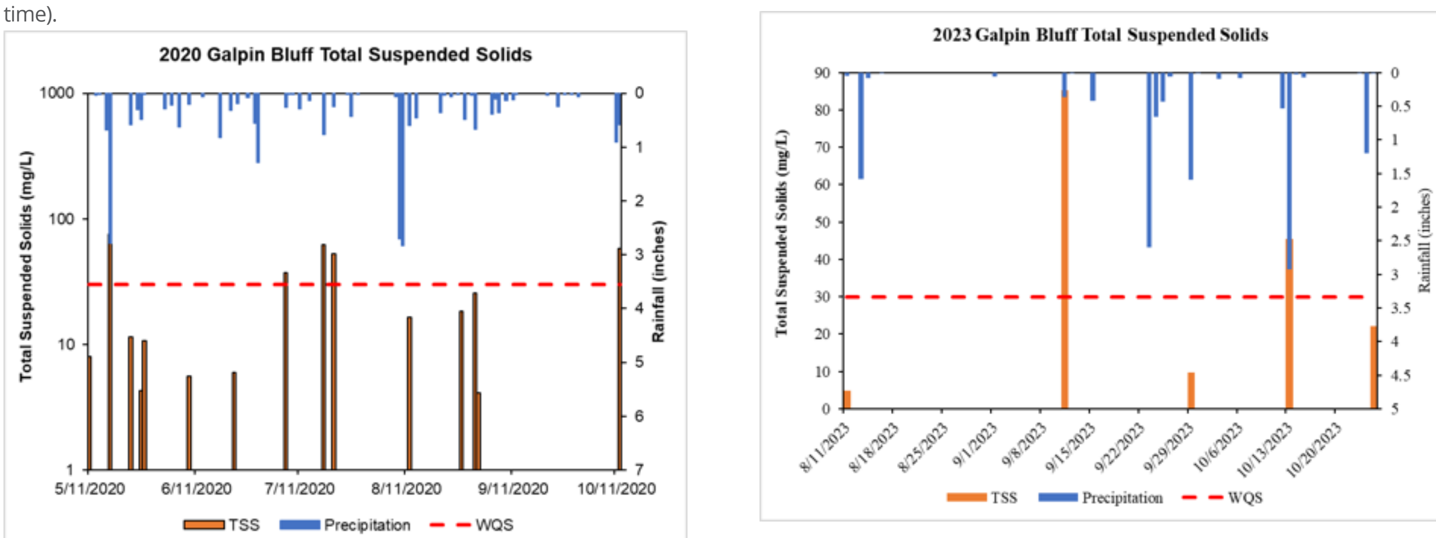


Figure 31. 2020 and 2023 Galpin/Bluff Creek Total Suspended Solids

Total Suspended Solids (TSS) concentrations (mg/L) from Bluff Creek under Galpin Blvd from 2020 and 2023 automated, level triggered, flow-paced sampler. Dashed line represents the Minnesota Pollution Control Agency standard for TSS in class 2B creeks (≤ 30 mg/L TSS no more than 10% of the time).



The average amount of TSS was 99.4 mg/L in 2021 which increased slightly to 109.2 mg/L in 2023. Across all the sampling events, 10 of the 17 samples taken in 2021 were above 30 mg/L TSS (Figure 32) while all 15 samples were above the standard in 2023. Water level graphs are shown in Figure 34 and Figure 35.

It is important to note that these samples are targeted samples, representative of the initial flush of water and pollutants that occurs during a rain event, and do not represent season-long pollutant levels in Bluff Creek. Therefore, a direct comparison to the MPCA water quality standards is cautioned.

Figure 32. 2021 and 2023 Highway 5/Bluff Creek Total Suspended Solids

Total Suspended Solids (TSS) concentrations (mg/L) from Bluff Creek downstream of highway 5 from 2021 and 2023 automated, level triggered, flow-paced sampler. Dashed line represents the Minnesota Pollution Control Agency standard for TSS (≤ 30 mg/L TSS no more than 10% of the time).

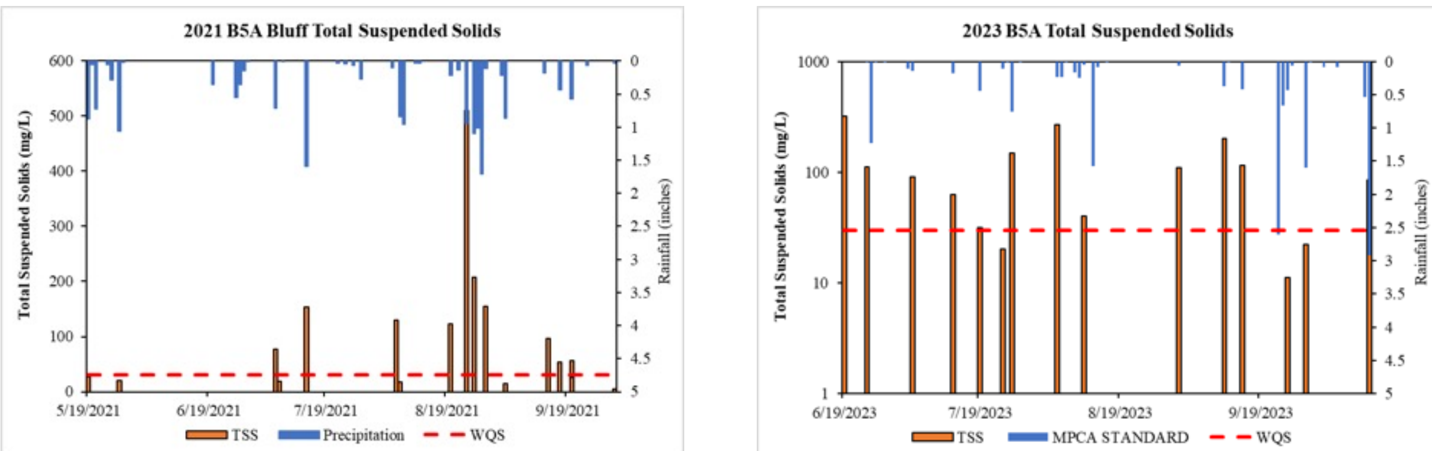


Figure 33. 2021 and 2023 Highway 5/Bluff Creek Phosphorous

Total Dissolved Phosphorus (TDP) and Total Phosphorus (TP) concentrations (mg/L) from Bluff Creek downstream of highway 5 from 2021 and 2023 automated, level triggered, flow-paced sampler. Dashed line represents the Minnesota Pollution Control Agency standard for TP (≤ 0.1 mg/L) in class 2B creeks.

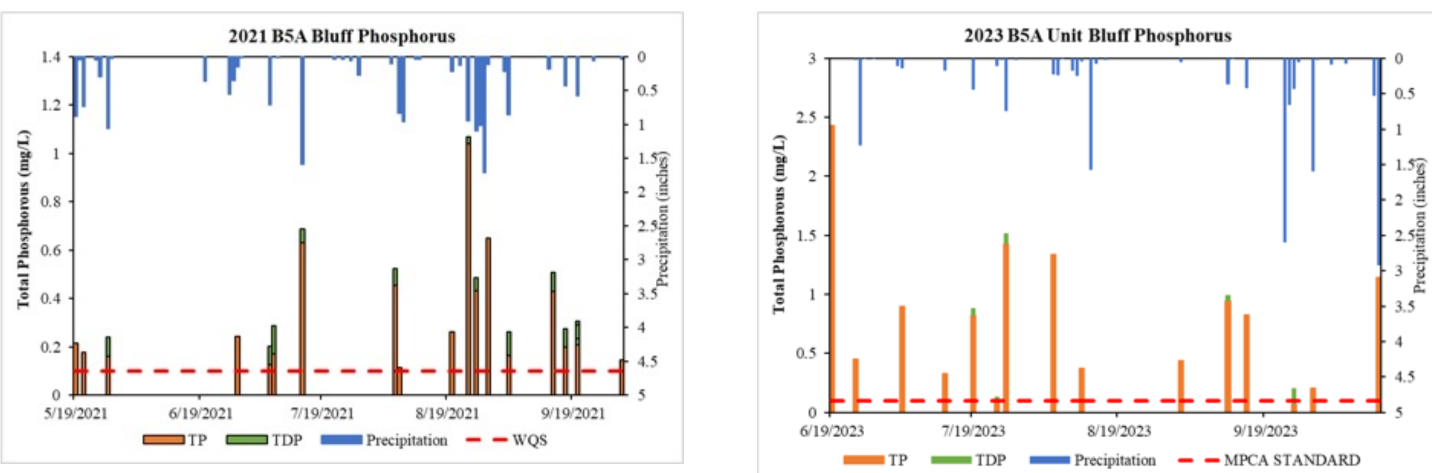


Figure 34. 2023 Highway 5/Bluff Creek Water Levels at Galpin Blvd.

Water levels recorded from the autosampler and visual staff gauge readings from Bluff Creek under Galpin Boulevard in 2023.

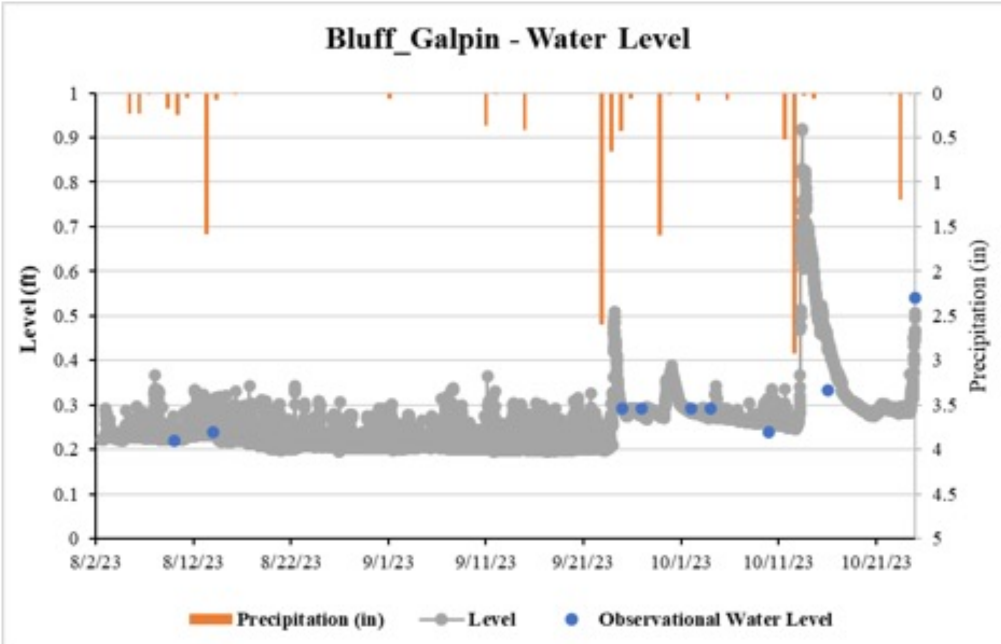
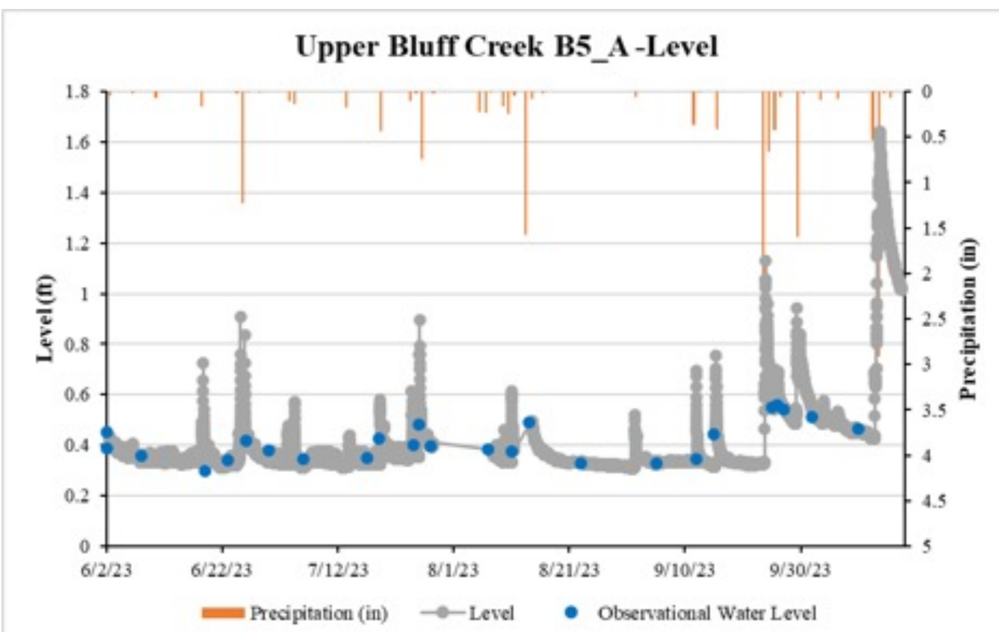


Figure 35. 2023 Highway 5/Bluff Creek Water Levels at Highway 5.

Water levels recorded from the autosampler and visual staff gauge readings from Bluff Creek under Highway 5 in 2023.



4.9. Creek Restoration Action Strategy

RPBCWD developed the Creek Restoration Action Strategy (CRAS) to prioritize creek reaches, subreaches, or sites in need of stabilization and/or restoration. The District identified eight categories of importance for project prioritization including: infrastructure risk, erosion and channel stability, public education, ecological benefits, water quality, project cost, partnerships, and watershed benefits. These categories were scored using methods developed for each category based on a combination of published studies and reports, erosion inventories, field visits, and scoring sheets from specific methodologies. Final tallies of scores for each category, using a two-tiered ranking system, were used to prioritize sites for restoration/remediation. The CRAS was finalized/adopted in 2015, updated in April of 2017, and published in the Center for Watershed Protection Science Bulletin in 2018. A severe site list (Table 21) and a CRAS Map (Figure 36) were updated to include results from 2023.

Streams are monitored biweekly between May and September for nutrients and flow. The data is used to assess water quality across each stream which is then incorporated into the CRAS. Results from the 2023 data can be seen in Exhibit E and Exhibit F in the Appendix. As part of the CRAS, stream reaches are walked on a rotational basis after initial assessment was completed. This allows staff to evaluate changes in the streams and update the CRAS accordingly. In 2023 staff walked: Reach 5 of Riley Creek (Lake Ann to Hwy 5), subreach R4F of Riley Creek (Lake Susan to Rice Marsh Lake), and Reach B1 excluding B1A (downstream of Pioneer Trail). Staff conducted Modified Pfankuch Stream Stability Assessments, MPCA Stream Habitat Assessments (MSHA), took photos, and recorded notes of each sub-reach to assess overall stream conditions. Staff also checked bank pins (Table 22) originally installed in 2015 near all the regular water quality sites. The bank pins were installed at representative erosion sites to evaluate general erosion rates for each reach. Changes to the CRAS based upon 2023 creek walks and updated water quality scores can be seen in Table 20. Overall, scores remained relatively the same across most sites from 2016 to 2023.

Staff attempted to collect macroinvertebrates at all eight Purgatory Creek sites in 2023. However, due to drought conditions only five sites had adequate to water to sample. Biological monitoring can often detect water quality problems that water chemistry analysis misses or underestimates. Chemical pollutants, agricultural runoff, hydrologic alterations, and other human activities have cumulative effects on biological communities over time. The condition of these communities represents the condition of their aquatic environment. Bluff Creek macroinvertebrate collection will occur in 2024.

In 2024, staff will finish the CRAS assessment on Riley Creek and begin Purgatory Creek assessment. CRAS updates and potential additional monitoring for 2024 include:

- Placement of additional bank pins at sites that align with upcoming projects.
- Walk additional first order tributaries not yet assessed.
- Assessing additional ravine erosion areas.
- Using the stream power index (SPI) to identify and assess potential areas of erosions upstream of wetland, creeks, and lakes.
- Installing EnviroDIY stations near areas of concern or where information is lacking.
- Utilize CRAS2 to advance creek stability assessments.
- Potentially add macroinvertebrates Index of Biotic Integrity to CRAS scoring methodology.
- Identify spring locations along channel.

Bank Pins

In addition to creek walks, staff have checked bank pins yearly since installation in 2015 near all the regular water quality sites. Bank pins were installed at representative erosion sites to evaluate erosion rates for each reach. Staff measurement of the amount of exposed bank pin or sediment accumulation (if pin was buried) has been ongoing since 2016 (see Table 22). Staff can use the measurements to quantify estimates of lateral bank recession rates and total annual bank loss. Engineering firm Wenck Associates, Inc. also installed bank pins at 11 sites on lower Riley Creek (south of Lake Riley) and Purgatory Creek (south of Riverview Road) in 2008 and 2010 to monitor bank

Table 20. 2023 Creek Restoration Action Strategy Updates.

Staff reassess a portion of subreaches each year. The table below shows subreaches revaluated in 2023 along with their original Tier I scores from 2015.

Reach	Subreach	Location	Original Tier I Scores (2015)	Updated Tier I Scores (2023)	Updated Tier II Scores (2023)
B1	**B1B**	2,150 feet downstream of Pioneer Trail to 300 ft US of Bluff Creek Park	22	20	36
B1	**B1C**	300 feet upstream of Bluff Creek Park to 475 ft US of Great Plains Blvd	18	20	36
B1	**B1D**	475 feet upstream of Great Plains Blvd to Great Plains Blvd	26	24	42
R4	**R4F**	Lake Susan to Rice Marsh Lake	14	12	28
R5	**R5**	Lake Ann to Highway 5	16	14	28

KEY: Severe Poor Fair Good

Table 21. Updated 2023 Creek Restoration Action Strategy severe site list.

Every year the list of most degraded creek subreaches is updated to reflect any CRAS score reassessments done that year.

Reach	Subreach	Location	Tier I Score	Tier II Score	Tier II Rank	Restoration Status
R4	**R4E**	Powers Blvd to Lake Susan	22	48	1	Planning
P1	**P1E**	1,350 feet downstream of Wild Heron Point to Burr Ridge Lane	22	44	2	--
R4	**R4D**	Railroad Bridge to Powers Blvd	22	44	3	Planning
R4	**R4C**	Park Rd to Railroad Bridge	22	42	4	Planning
B1	**B1D**	475 feet upstream of Great Plains Blvd to Great Plains Blvd	24	40	5	--
B5	**B5C**	Galpin Blvd to West 78th Street	22	40	6	Planning
R2	**R2D**	Upper Third between Dell Rd and Eden Prairie Rd	24	36	7	--
R2	**R2C**	720 feet upstream of Dell Trail to Dell Rd	22	36	8	--

loss and quantify lateral recession rates (Wenck, 2017). Wenck was able to track the potential effectiveness of upstream bank repairs on bank-loss-reduction at the Purgatory Creek sites. Results from monitoring the Riley Creek bank pins informed Wenck's recommendation to the City of Eden Prairie to prioritize several reaches for stabilization. District staff will continue to monitor the bank pins/bank loss at our 18 regular monitoring sites and major erosion sites as needed.

- In 2018, reach R5 had the highest estimated lateral loss (7.75 in/year) while reach P7 had the highest bank volume loss per one yard stretch of creek (4.96 ft3).
- In 2019, B4 had the highest estimated lateral loss (12.06 in/year) and the highest bank volume loss per one yard stretch of creek (12.81 ft3).
- In 2020, reach B4 had the highest estimated lateral loss (12.02 in/year) and the highest bank volume loss per one yard stretch of creek (11.49 ft3).
- In 2021, reach P1 had the highest estimated lateral loss (7.33 in/year) and the highest bank volume loss per one yard stretch of creek (18.82 ft^3). Due to the low water levels in 2021, erosion appeared to be reduced across most sites.
- In 2022, reach R5 had the highest estimated lateral loss (5.61 inch/year) and the highest bank volume loss per one yard stretch of creek (4.62 ft^3). Due to the low water levels in 2021 and 2022, erosion appeared to be reduced across most sites.
- In 2023, reach R3 had the highest estimated lateral loss (1.38 in/year) while reaches R3 and B4 had the highest bank volume loss per one yard stretch of creek (1.28 ft^3). Due to the low water levels in 2021, 2022, and 2023, erosion appeared to be reduced across most sites.

Figure 36. 2023 Creek Restoration Action Strategy (CRAS) Prioritization Map of 2023.

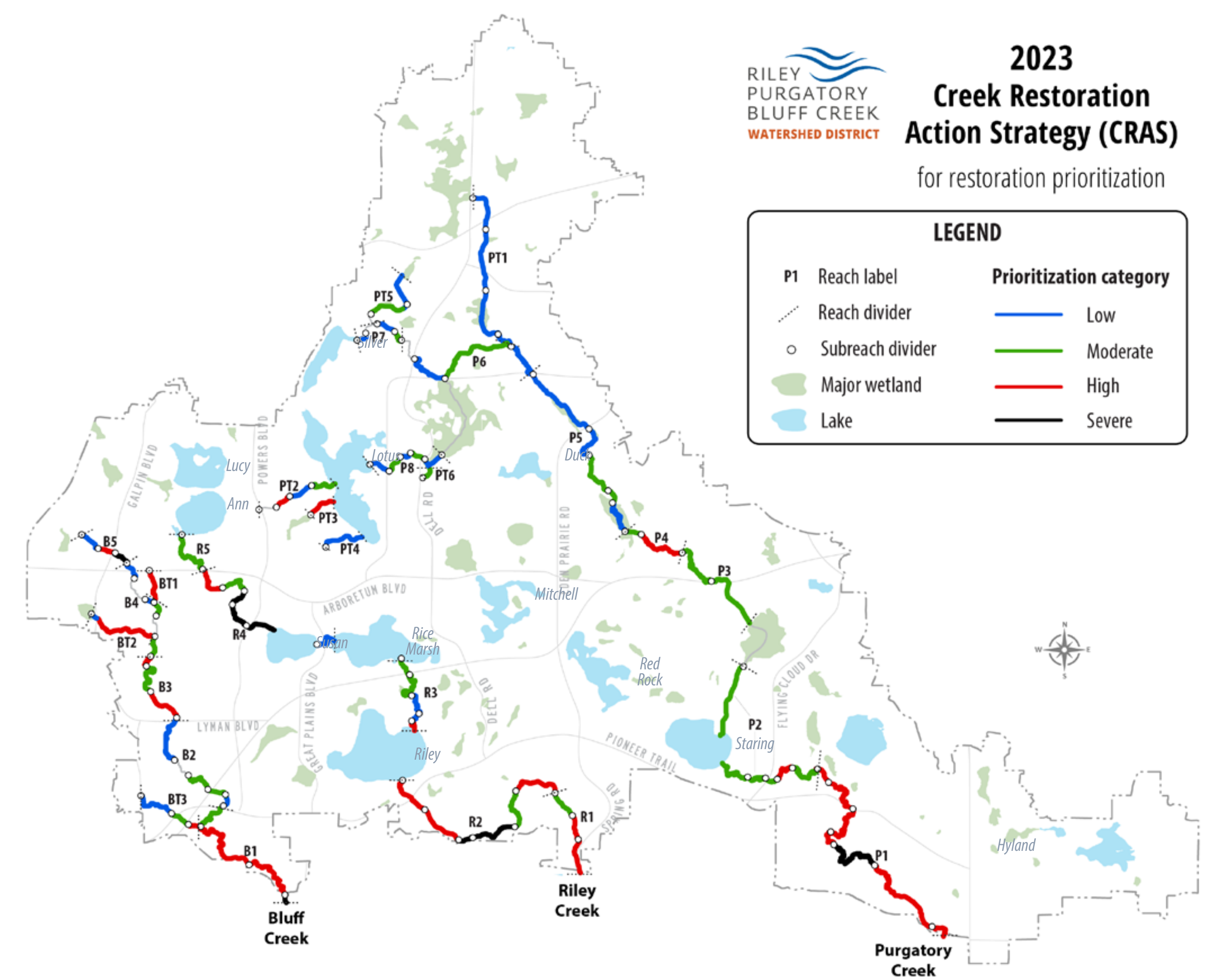


Table 22. 2018-2023 Bank Pin Data

Average lateral stream bank loss per year and the estimated bank volume loss for a one-yard section of streambank at each of the 18 regular creek monitoring sites from 2018-2023. Negative values denote areas of bank where there was sediment deposition. Empty cells denote sites where pins were not found. Red text in cells indicate only pins from one bank were found. P1 calculations in 2019 and 2020 were estimated across both years as the banks were in the process of collapsing.

Reach	Average Lateral Loss (in/year)						Estimated bank loss per one yard stretch of creek (cubic feet)					
	2018	2019	2020	2021	2022	2023	2018	2019	2020	2021	2022	2023
R5	7.75	8.03	1.58	1.38	5.61	0.7	4.81	3.93	1.69	1	4.62	0.36
R4	0.42	3.63	1.77	0.5	0.43	0.7	0.25	2.93	1.31	0.13	0.27	0.57
R3	5.31	14.9	5.69	1.63	1.82	1.38	6.36	11.42	4.84	1.64	1.66	1.28
R2	--	6.45	2.15	0.69	1.03	0.47	--	13.3	4.24	1.41	2.2	0.98
R1	2.96	4.88	1.79	1	1.13	0	1.23	4.29	1.57	1.04	1.03	0
P8	0.55	3.16	0.63	0.25	0.01	0.25	0.25	0.50	0.75	1.25	2.01	0.05
P7	2.02	2.02	--	1.56	0.05	0.30	4.96	5.17	0	2.34	-0.21	0.35
P6	0.83	3.7	2	1.45	0.38	0.54	0.7	2.41	1.57	1.54	0.51	0.52
P5	0.77	3.07	1.58	0.83	0.25	0.71	0.81	3.82	1.77	0.94	0.31	0.89
P4	0.78	1.8	1.2	0.25	0.25	1.12	0.53	0.33	0.3	0.09	0.64	0.70
P3	0.94	1.96	0.66	0.42	0.42	-0.06	1.02	2.77	0.89	0.61	0.61	-0.03
P2	0.5	3.15	3.6	2.8	0.91	0.18	0.47	3.99	3.74	2.05	0.72	0.11
P1	0.38	3.52	3.35	7.33	1.2	-0.45	0.92	6.38	10.98	18.82	3.12	-1.24
B5	-0.79	0.89	1.16	-0.03	1.35	-0.03	-0.46	0.87	1.13	0	2.2	0.03
B4	5.58	12.06	12.02	2.96	2.44	1.28	3.66	12.81	11.49	2.77	2.51	1.28
B3	--	3.29	1.77	0.23	0.87	1.34	--	3.67	1.66	0.21	0.83	0.87
B2	3	7	5.56	1.6	1.95	1.18	1.25	4.08	3.19	1.51	2.11	1.04
B1	-0.67	5.54	--	3.81	1.08	-0.19	-0.44	6.62	--	4.48	-1.39	0.10

4.10. Phyto and Zooplankton

In 2023, five lakes were sampled for both zooplankton and phytoplankton: Lake Riley, Rice Marsh Lake, Lake Susan, Lotus Lake, and Staring Lake. Zooplankton plays an important role in a lake's ecosystem, specifically in fisheries and bio control of algae.

Healthy zooplankton populations are characterized by having balanced densities (number per m2) of three main groups of zooplankton: Rotifers, Cladocerans, and Copepods. A Sedgwick-Rafter Chamber (SRC) was used for zooplankton counting and species identification. A two mL sub-sample was prepared. All zooplankton in the sample were counted and identified to the genus and/or species level. The sample was scanned at 10x magnification to identify and count zooplankton using a Zeiss Primo Star microscope. Cladocera images were taken using a Zeiss Axiocam 100 digital camera and lengths were calculated in Zen lite 2012. The District analyzed zooplankton populations for the following reasons:

1. **Epilimnetic Grazing Rates** (Burns 1969): The epilimnion is the uppermost portion of the lake during stratification where zooplankton feed. Zooplankton can be a form of bio control for algae that may otherwise grow to an out-of-control state and therefore influence water clarity.
2. **Population Monitoring** (APHA, 1992): Zooplankton are a valuable food source for planktivorous fish and other organisms. The presence or absence of healthy zooplankton populations can determine the quality of fish in a lake. Major changes in a lake (significant reduction in common carp, winter kills, large scale water quality improvement projects, etc.) can change zooplankton populations drastically. By ensuring that the lower parts of the food chain are healthy, we can protect the higher ordered organisms.
3. **Aquatic Invasive Species Monitoring:** Early detection of water fleas is important to ensure these organisms are not spread throughout the District. These invasive species outcompete native zooplankton for food and grow large spines which make them difficult for fish to eat.

The SRC was used for phytoplankton counting and species identification. A one mL aliquot of the sample was prepared using a Sedgewick Rafter cell. Phytoplankton were identified to genus level. The sample was scanned at 20x magnification to count and identify phytoplankton species using a Carl Zeiss Axio Observer Z1 inverted microscope equipped with phase contrast optics and digital camera. Higher magnification was used as necessary for identification and micrographs. The District analyzed phytoplankton populations for the following reasons:

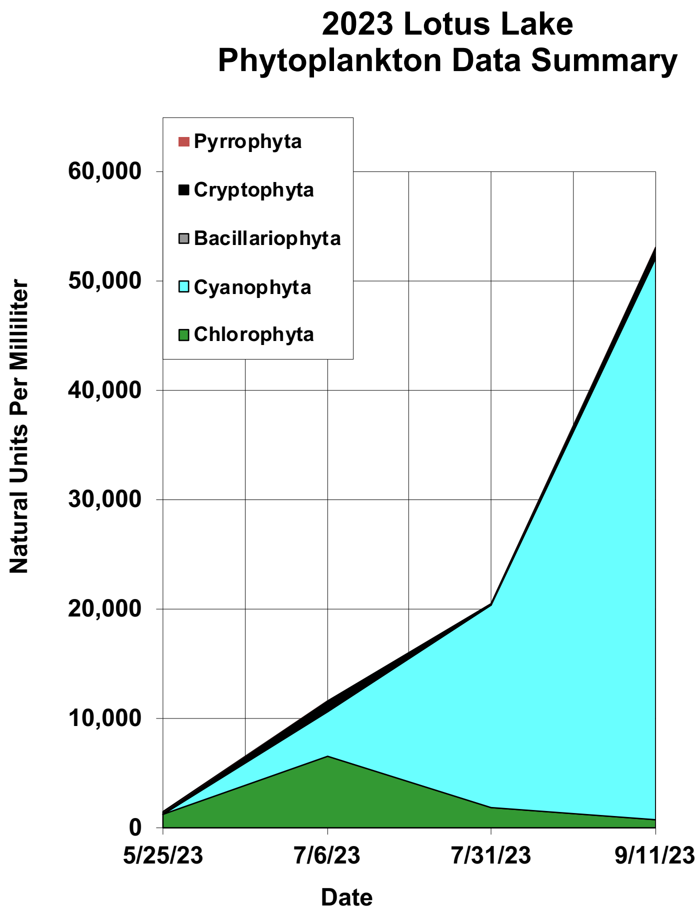
1. **Population Monitoring:** Phytoplankton are the base of the food chain in freshwater systems and populations fluctuate throughout the year. By ensuring that the lower parts of the food chain are healthy, we can protect the higher ordered organisms such as macroinvertebrates and fish.
2. **Toxin Producers and Algae Blooms:** Some phytoplankton produce toxins that can harm animals and humans, or cause water to have a foul taste or odor (Microcystis, Aphanizomenon, Dolichospermum, Planktothrix, and Cylindrospermopsis). Monitoring these organisms can help us take the proper precautions and identify possible sources of pollution. The presence of toxin producing algae in a lake does present a health risk. Specific conditions must be met for the algae to become toxic. The World Health Organization provides threshold guidance for the probability of adverse health risks related to blue-green algal counts for, slight to no risk (0-20,000 mg/L) low risk (>20,000 cells/mL), moderate risk (>100,000 cells/mL) probabilities of adverse health risks for people or pets (WHO 2003).

Lotus Lake

During the summer of 2023, staff collected four phytoplankton samples on Lotus Lake (Exhibit D). The abundance of phytoplankton across all sampling dates is presented Figure 37. In 2023, the most abundant division was Cyanophyta, characterized by a high number of *Aphanizomenon flos-aquae* in July, followed by an increase in *Aphanizomenon flos-aquae* and the addition of *Aphanocapsa* sp. in August. *Raphidopsis raciborskii* was the most abundant taxon in the division, with the highest count of all species. Aphanizomenon species are a potential producer of cylindrospermopsin, anatoxins, and saxitoxins. This trend matched what was seen in 2020 and 2021 with *Aphanizomenon flos-aquae* being the most consistently dominant species with a spike of *Cylindrospermopsis raciborskii* and *Anabaenopsis raciborskii* in August and September (Figure 39). These species can produce similar toxins to Aphanizomenon. Historically, blue-green algae have comprised a large proportion of phytoplankton sampled in Lotus Lake but have been the dominant phytoplankton group since 2004 (Figure 39).

In 2023, all three groups of zooplankton were present in Lotus Lake (Exhibit D). Similar to past years (Figure 40), Rotifers were the most abundant clade of zooplankton. Rotifers made up 56% of the total zooplankton captured, with Copepods at 39% and

Figure 37. 2023 Lotus Lake Phytoplankton Summary by Order (units/mL)



Cladcerans at 5%. All three groups had their highest population in May and their lowest in June. Cladocerans and Copepods had their second highest concentration in July contrasting with the second highest abundance of Rotifers in September (Figure 38). Copepods numbers reached a high of 2.1 million and a low of 72 thousand, averaging 619 thousand. Rotifers had a maximum of 2.9 million and a minimum of 34 thousand, averaging 902 thousand. Cladocerans had a maximum of 156 thousand and a minimum of 27 thousand, averaging 75 thousand.

Large Cladocera consume algae and, if enough are present in a lake, they have the potential to improve water quality. Estimated grazing rates for 2023 ranged from 59.7% in May to 1.1% in September, averaging 16.3%. Cladocerans of considerable size (greater than 1mm) in high abundance can highly impact the grazing rate. The 2023 grazing rates are higher than previous years (2022-0 to 7% 2021-0 to 4%, 2020-0%, 2019-0 to 5%, 2018-6 to 19%) (Figure 38). The high grazing rate in May is associated with an increased abundance of large bodies cladoceran *Daphnia galeata mendotae* which are most commonly found in mesotrophic to eutrophic lakes such as Lotus.

Figure 38. 2023 Lotus Lake Zooplankton Summary by Division (number/m²).

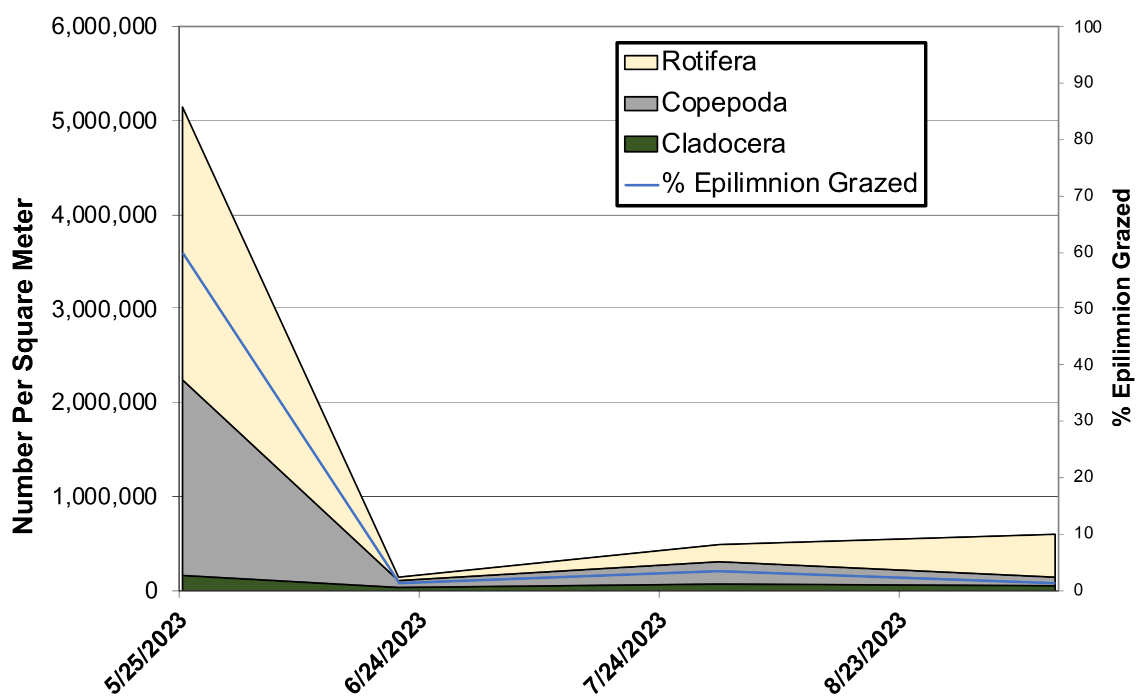


Figure 39. 1999-2023 Lotus Lake Phytoplankton Historical Abundance (units/mL).

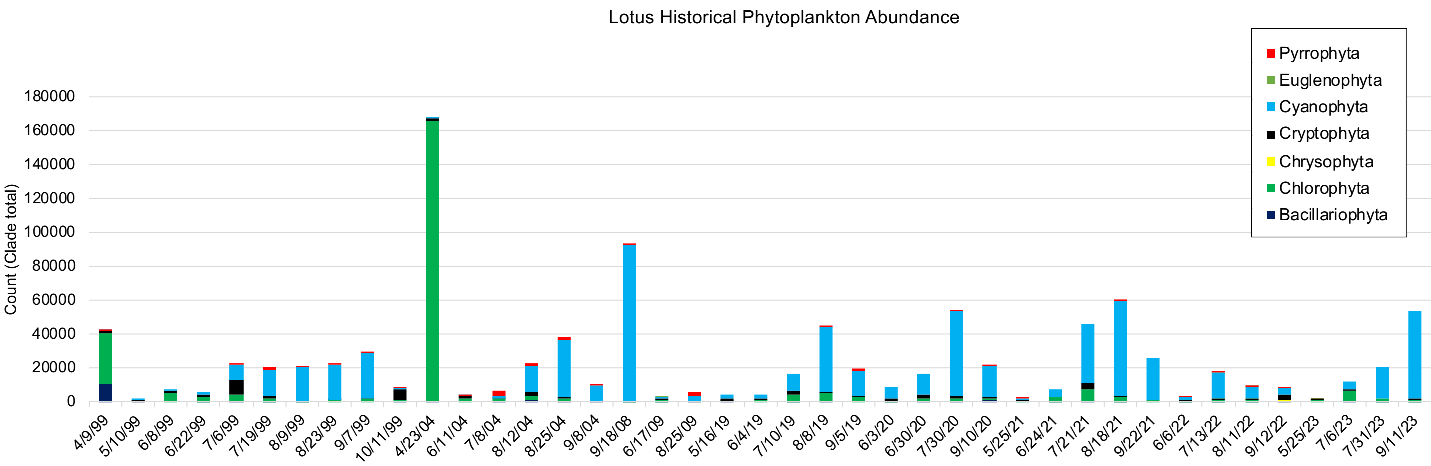
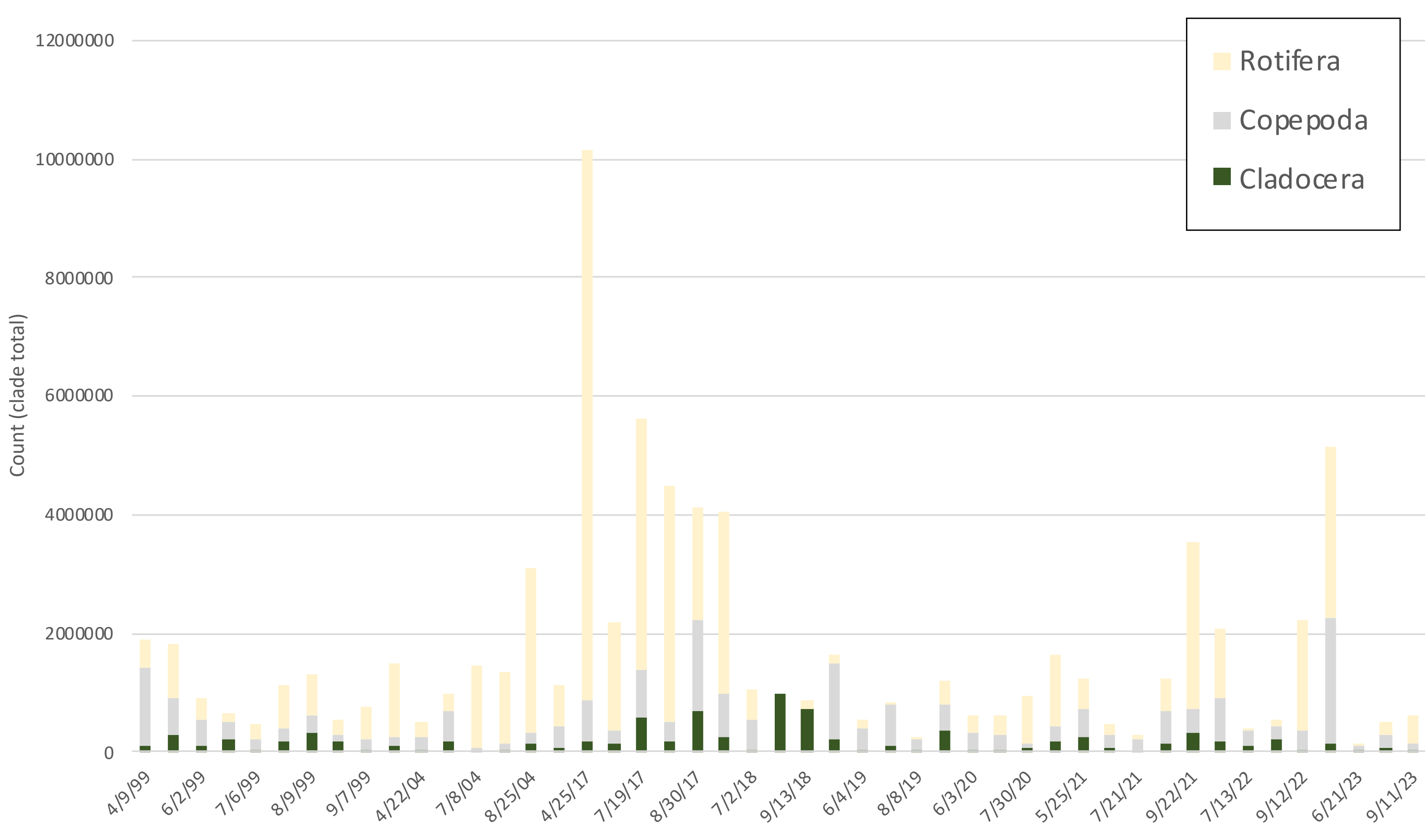


Figure 40. 1999-2023 Lotus Lake Zooplankton Historical Abundance (number/m^2).



Rice Marsh Lake

During the summer of 2023, staff collected four phytoplankton samples on Rice Marsh Lake (Exhibit C). Chlorophyta and Cryptophyta were the most dominant division, mostly due to *Chlamydomonos globosa* and *Cryptomonas erosa* respectively. This trend is similar to what has been observed since 2019. Abundance of phytoplankton by Class for Rice Marsh Lake is presented in Figure 41. Historically, the phytoplankton community has been balanced with limited numbers of Cyanobacteria except for 2018 and 1997 (Figure 42).

In 2023, all three groups of zooplankton were captured in Rice Marsh Lake, of which Cladocerans comprised 13.5% of the total population collected, Copepods 54.2% of the population, and Rotiferans 32.3% (Figure 43). The Cladoceran population peaked in September at 185 thousand, with a minimum of 23 thousand in June, and an average of 103 thousand. This overall percentage of 13.5% is down from 2021-2022 (22% in 2022, 24% in 2021) but consistent with previous years (17% in 2020, 8% in 2019, and 13% in 2018 Figure 44. Copepod populations collected peaked at 559 thousand in May, with a minimum of 45 thousand in June, and an average of 415 thousand. Rotifers had

Figure 41. 2023 Rice Marsh Lake Phytoplankton Summary by Division.

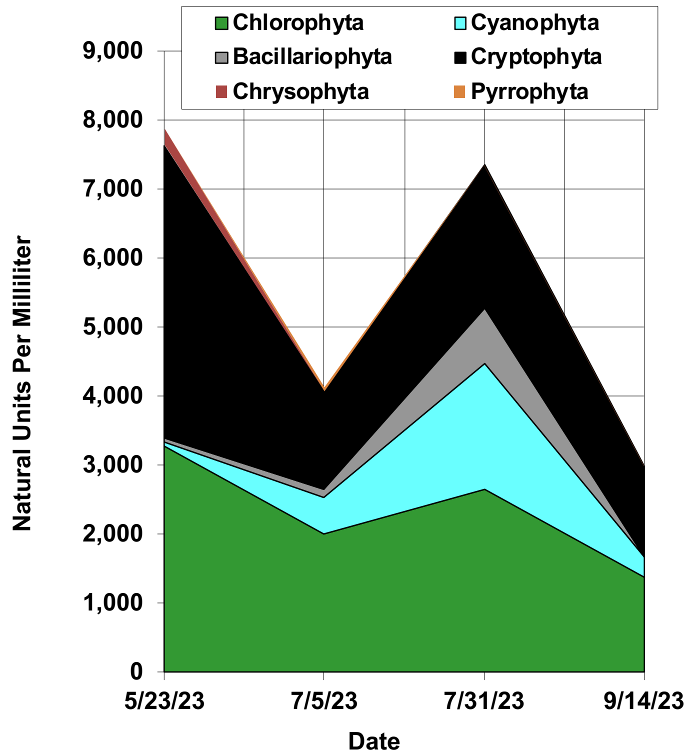
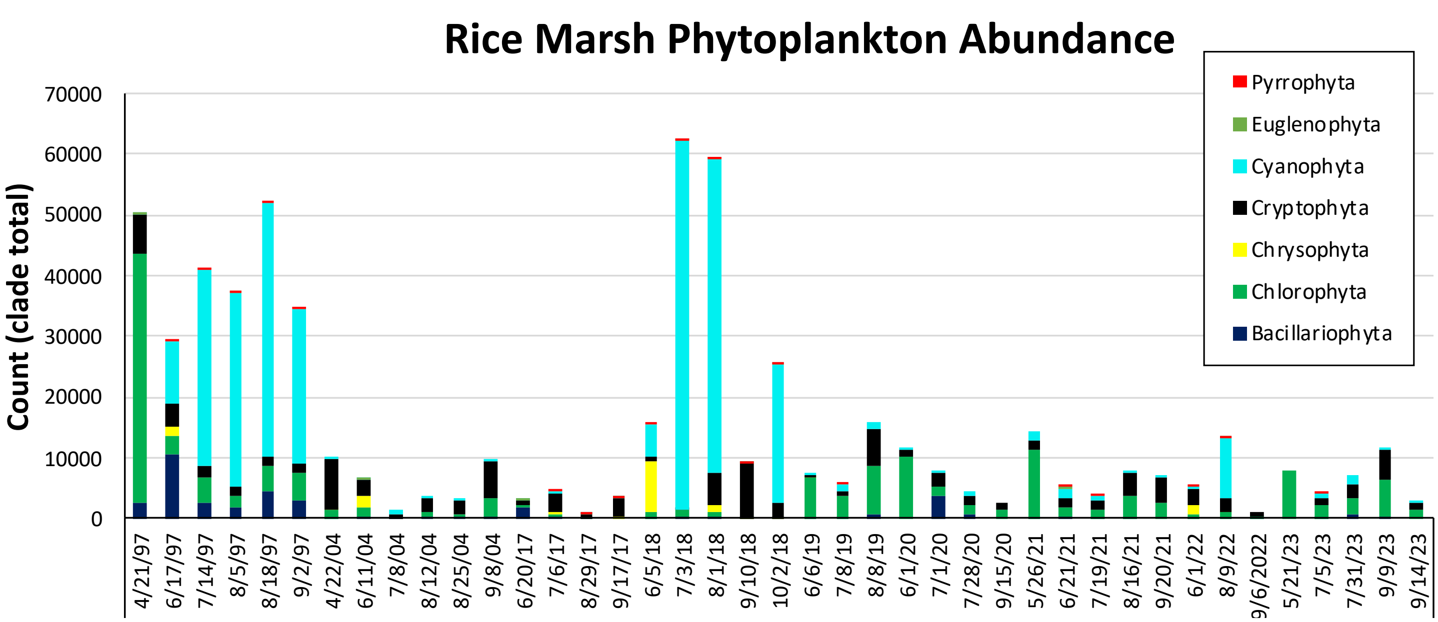


Figure 42. 1997 to 2023 Rice Marsh Lake Phytoplankton Historical Abundance (number/m^2)



a maximum of 466 thousand, a minimum of 14 thousand, and an average of 247 thousand. The estimated grazing epilimnetic grazing rate was 5.2% in May, 0.3% in June, 2.5% in August, and 2.3% in September. The highest overall zooplankton density corresponded with the highest Cladoceran populations in August (Figure 43). The most abundant Cladoceran were the smaller *Ceriodaphnia* sp. and *Chydorus sphaericus*.

Figure 43. 2023 Rice Marsh Lake Zooplankton Summary by Division (number/m²).

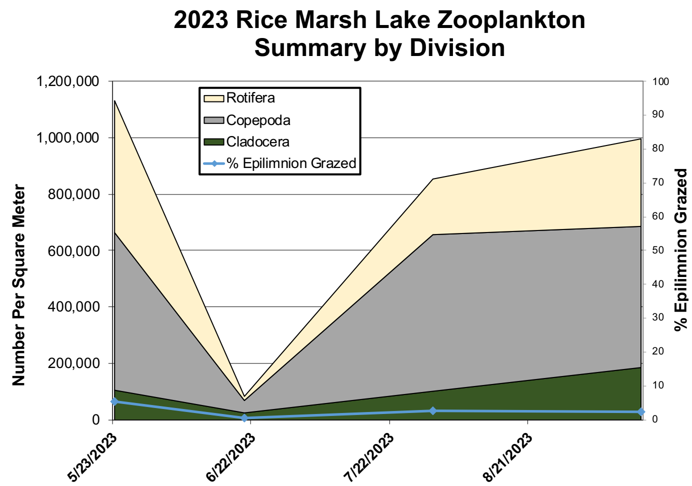
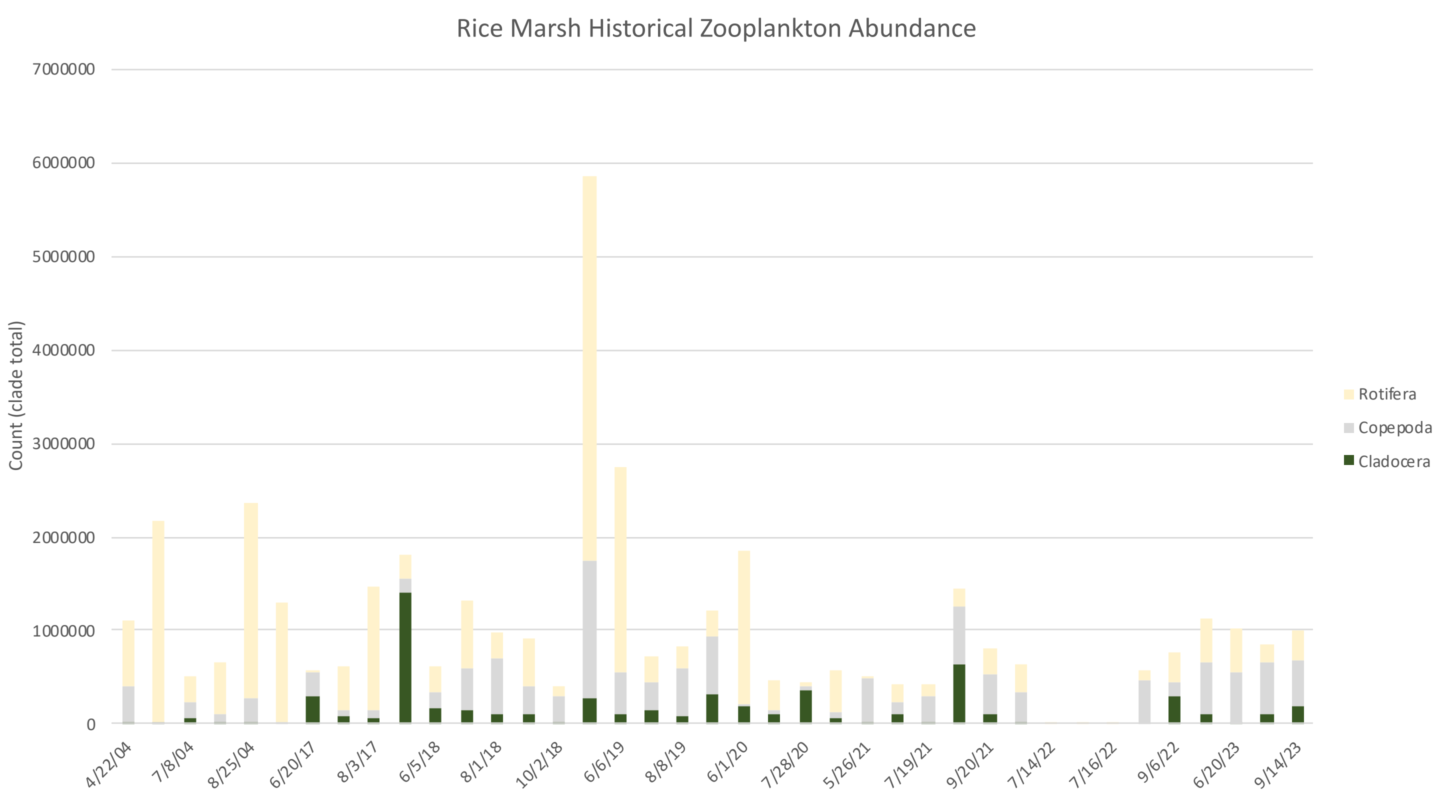


Figure 44. 2004-2023 Rice Marsh Lake Zooplankton Historical Abundance (number/m²).



Lake Riley

During the summer of 2023, staff collected four phytoplankton samples on Lake Riley (Exhibit C). The dominant phytoplankton in 2023 was Chlorophyta, specifically *Chlamydomonas globosa* or green algae (Figure 45). Cyanophyta was the second most abundant class of phytoplankton. Cyanophytes, also known as cyanobacteria or blue-green algae, are a group of free-living bacteria that obtain energy through photosynthesis. Under favorable conditions large, toxic blooms of cyanobacteria can occur.

The 1997 to 2023 total historical abundance is presented in Figure 47. Phytoplankton numbers in Lake Riley have been declining since 2019 and are now lower than previously seen. The reduction can be explained by the significant reduction in cyanobacteria which had previously dominated the phytoplankton population. The total of all other classes of phytoplankton has remained relatively unchanged. The reduction in cyanobacteria is likely related to the success of the alum treatment which improved water quality and reduced the severity of harmful algal blooms seen in the past. A secondary consideration is the introduction of Zebra Mussels which are filter feeders and can reduce phytoplankton numbers. Before 2019, potentially harmful blue-green algae were the dominant phytoplankton in Lake Riley. This has now changed, transitioning to a more balanced community.

In 2023, all three groups of zooplankton were captured in Lake Riley (Exhibit D). Around 7.7% of the zooplankton captured were Cladocera which is similar to 2022 (11%) and 2021 (6%), but still low in comparison to the 18% from 2020 and 2019 (Figure 48). Copepods were the most abundant zooplankton sampled, at around 46.7% slightly above the 45.6% abundance of rotifers (Figure 46). In 2023, September had the lowest abundance for all three groups of zooplankton in Lake Riley. Cladocerans experienced a downward trend of abundance throughout the four samples taken. Rotiferans had the highest populations in May followed by the second highest abundance in August. Cladocerans were slightly less abundant than in 2022, with an average of 78 thousand in comparison to 87 thousand. Copepods and Rotiferans had high averages in 2023 compared to previous years averaging roughly 470 thousand for both groups. The most numerous Cladoceran found in Riley was *Daphnia galeata mendotae*, which are common in the northern part of the United States, especially in glaciated regions such as MN. The most common Copepods found were Nauplius larvae.

Figure 45. 2023 Lake Riley Phytoplankton Summary by Division (units/mL).

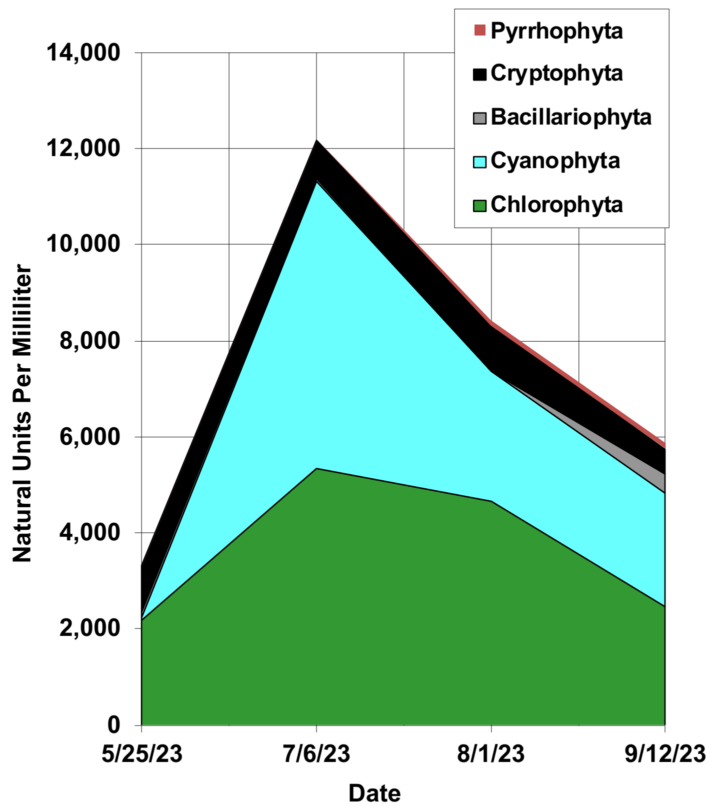


Figure 46. Lake Riley Zooplankton Summary by Division (number/m²)

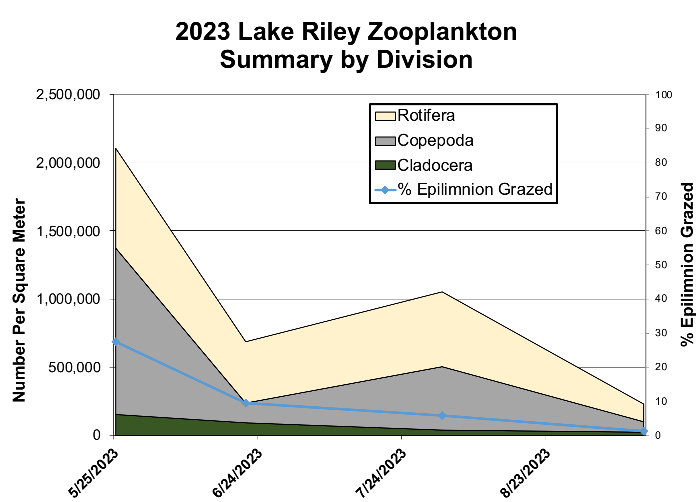


Figure 47. 1997-2023 Lake Riley Phytoplankton Historical Abundance (units/mL).

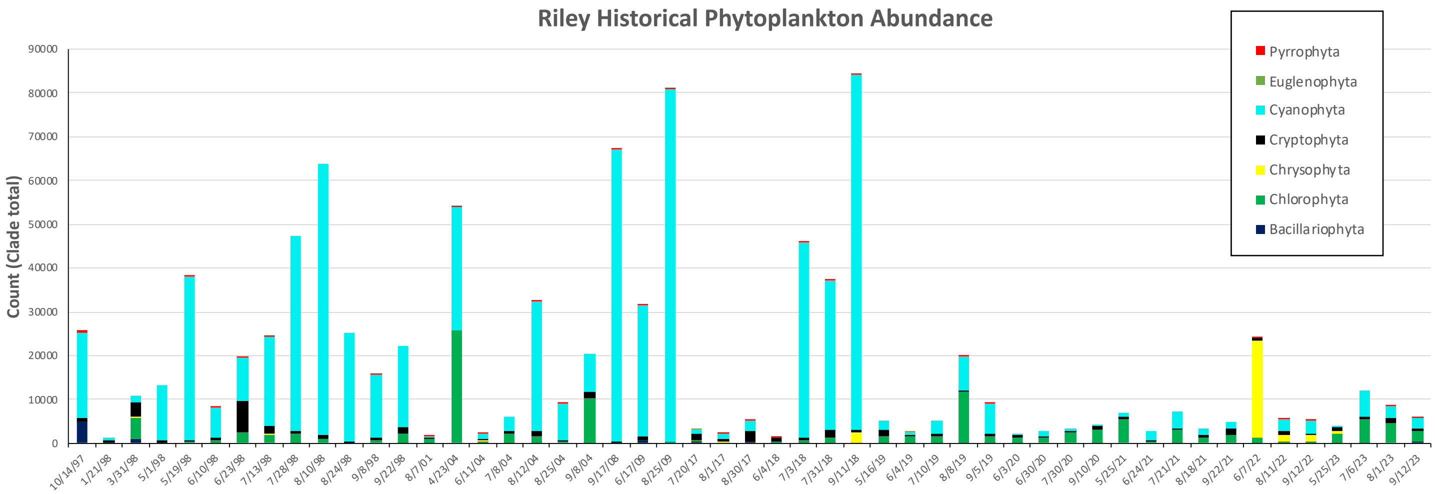
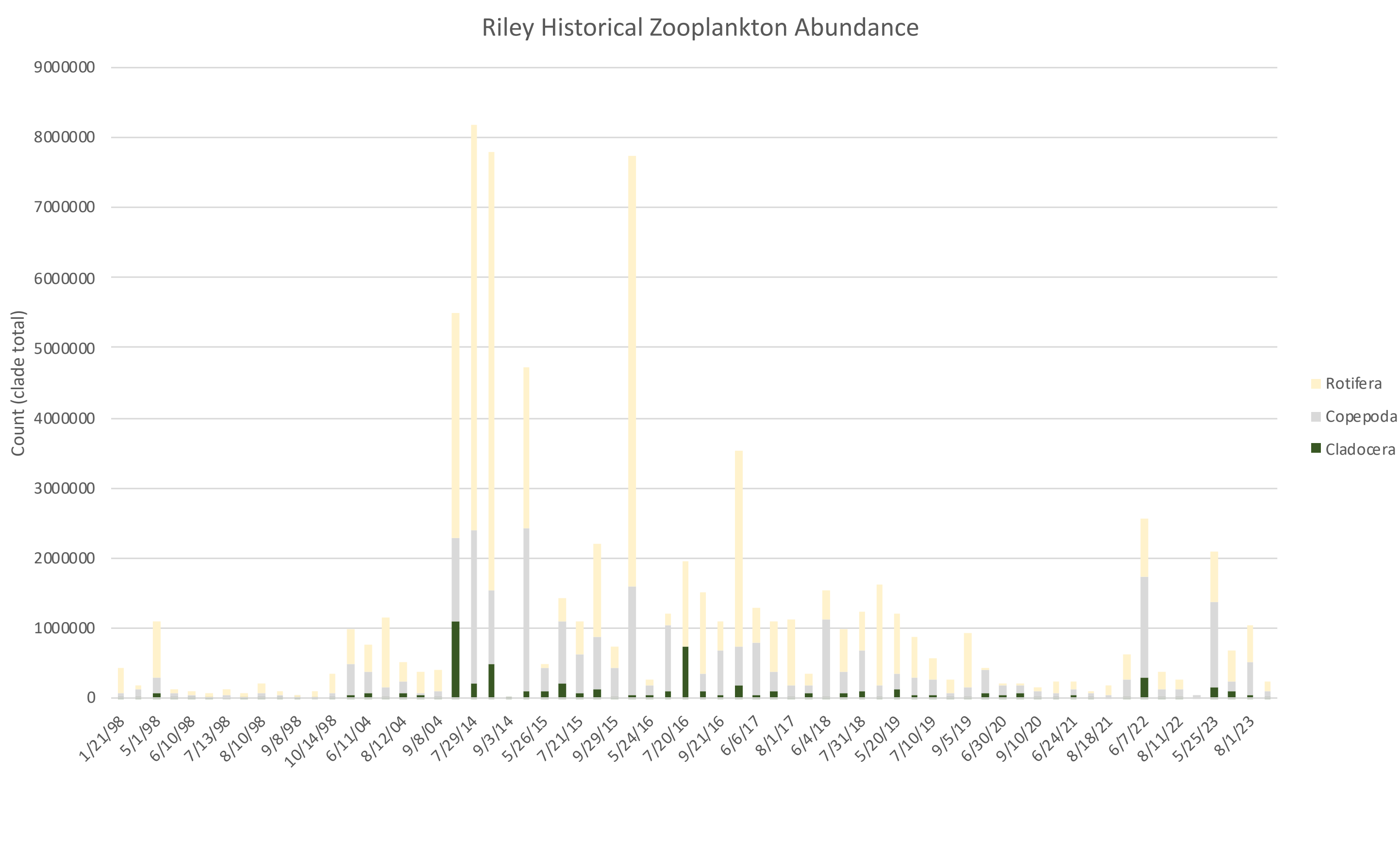


Figure 48. 1998-2023 Lake Riley Historical Abundance (number/m²)

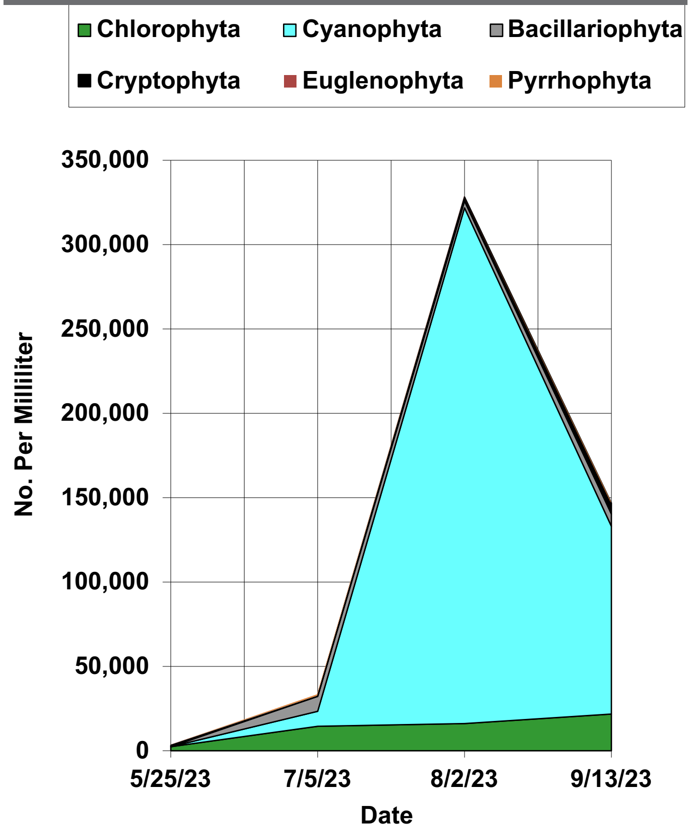


Cladocerans consume algae and have the potential to improve water quality if they are abundant in large numbers. The average grazing rate on Riley for 2023 was 11.1%, ranging from a maximum of 27.6% in May to a minimum of 1.3% in September. This trend matched the Cladoceran population fluctuations with the highest grazing rate being equal to the highest abundance (Figure 46).

Staring Lake

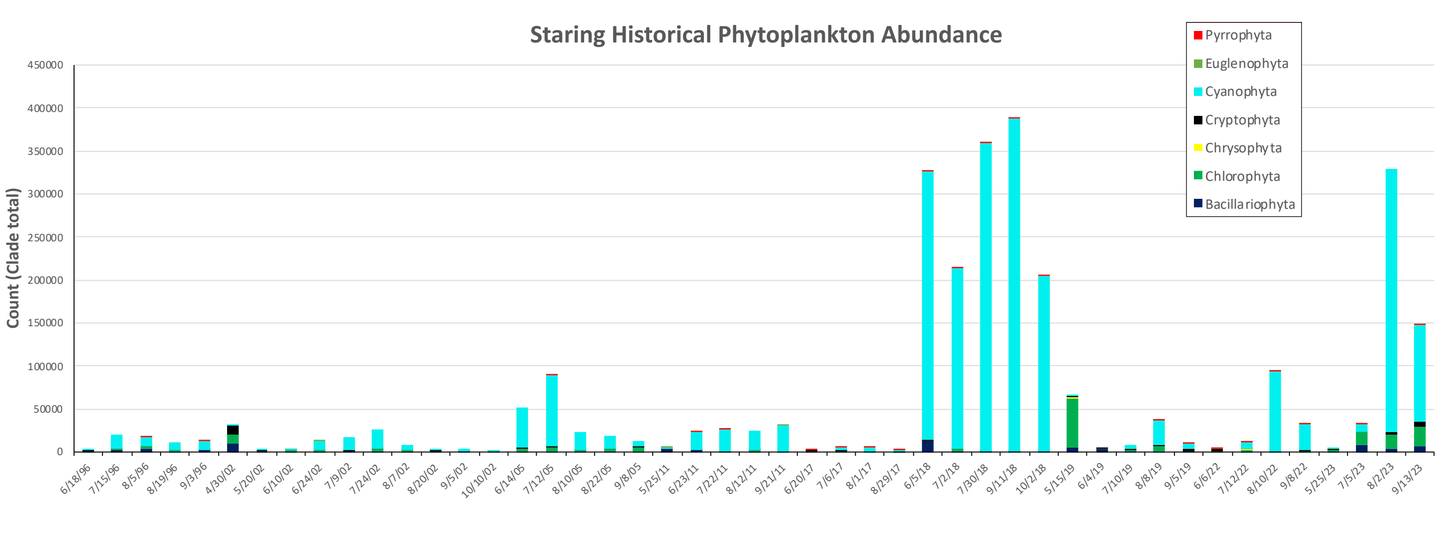
During the summer of 2023, staff collected four phytoplankton samples on Staring Lake (Exhibit C). Abundance of phytoplankton by Class are presented in Figure 49. Cyanophyta was the most dominant phytoplankton across all sampling events in 2023. Cyanobacteria populations reached such high levels in August that *Raphidiopsis raciborski* represented 88% of the total phytoplankton population. This matches historical data, with August samples containing populations of blue-green algae taking up a majority proportion of total phytoplankton (Figure 50). The blue-green algae numbers in Staring Lake in August and September were 305 thousand and 111 thousand respectively, which is above the WHO threshold (>100,000 units/mL) for moderate probability of adverse health impacts. This is also one of the highest blue-green numbers to date. Continued yearly monitoring of these plankton populations is necessary in order to monitor potentially toxic blooms.

Figure 49. 2023 Staring Phytoplankton Summary by Order (units/mL)



In 2023, all three groups of zooplankton were found in Staring Lake. Out of the total population collected, 54.3% were Rotiferans, 33.1% were Copepods, and 12.6% were Cladocerans (Figure 51). The Rotifer population peaked at 1.2 million in September, were lowest at 177 thousand in May, and averaged 705 thousand across the four samples. Copepod populations were 573 thousand at a maximum in August, 258 thousand at minimum, and averaged 430 thousand. Cladoceran populations were 351 thousand at a maximum in

Figure 50. 1996-2023 Staring Lake Phytoplankton Historical Abundance (units/mL).



August, 72 thousand at a minimum in June, and averaged 163 thousand. Historical changes in zooplankton population are shown in (Figure 52).

The estimated percentage of the epilimnion grazed is 9.7% for May, 21.9% for June, 1.3% for August, and 0.3% in September. A high presence of *Daphnia galeata mendotae* collected in June accounts for the highest grazing rate. May and July had a higher presence of Cladocerans, but smaller organisms that lack the filtering capacity of *Galeata mendotae* (Figure 51).

Figure 51. 2023 Staring Lake Zooplankton Summary by Division (number/m²)

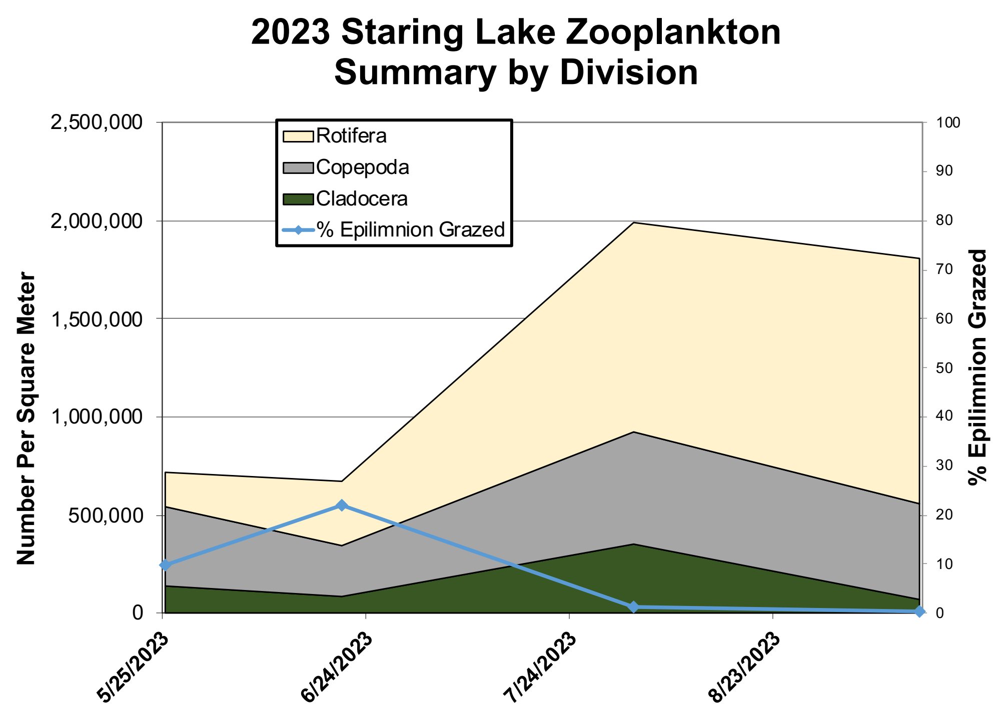
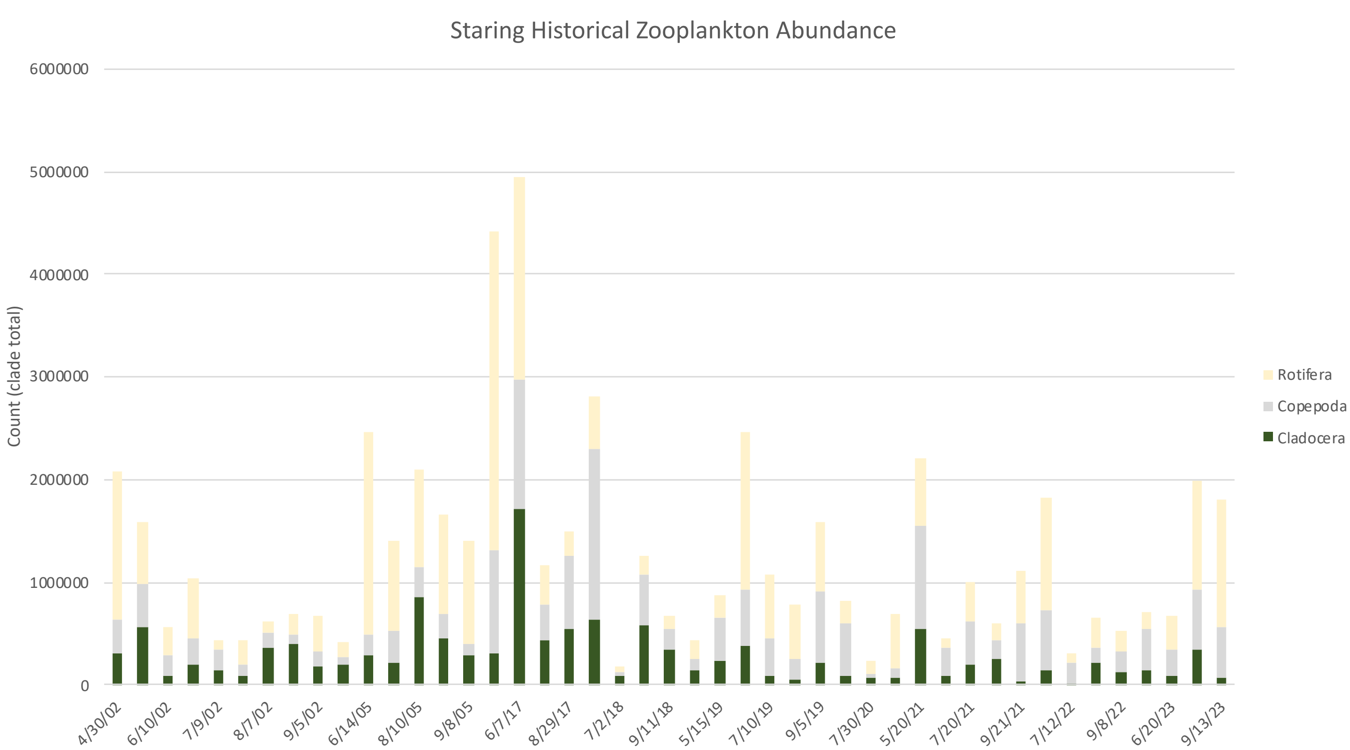


Figure 52. 2002-2023 Staring Lake Historical Zooplankton Abundance (number/m²)



Lake Susan

During the summer of 2023, staff collected four phytoplankton samples on Lake Susan (Exhibit C). The abundance of phytoplankton by Class is presented in Figure 53. Similar to previous years, Cyanophytes were the dominant phytoplankton groups in 2023. Cyanophytes such as *Raphidiopsis raciborskii*, *Amphanizmenon flos-aqauae*, and *Pseudanabaena limnetica* began to grow in numbers, and the populations eventually culminated with a bloom in August and September. The 2023 blue-green numbers in Lake Susan were one of the highest to date as shown in Figure 55. Lake Susan blue-green algae numbers during July (215 thousand) and August (160 thousand) exceeded the World Health Organization (WHO) threshold for moderate probability of adverse health effects (>100,000 units/mL). This threshold indicates when blue-green algal toxins may be high enough to cause adverse health effects. Although the presence of algae able to produce toxins within Lake Susan is known, the concentration of algal toxins cannot be known unless samples are collected. The climatic conditions in 2023 seemed to support higher blue-green algal numbers in many shallow lakes across the metro area (personal communication - Margaret Rattei). Since Lake Susan exceeded this threshold in 2023, in the future staff may send samples from Lake Susan to be analyzed shortly after collection to assess blue-green numbers and potentially post warnings for recreational use.

Historically, the trend of Chlorophyta and Cyanobacteria being the two dominant types of phytoplankton has persisted (Figure 53). Cryptomonads were also commonly found across most years. Since 2008, Blue Green Algae populations have increased significantly, which is of concern. Numerous water quality projects have been implemented around Lake Susan and others are projected to be completed soon. These water quality improvements will hopefully reduce potentially harmful algal blooms moving forward.

In 2023, Rotifers were the most abundant zooplankton in Susan with *Keretella* sp. being dominant. Rotifers made up 48.7% of the total zooplankton, Copepods with 46.0%, and Cladocerans with 5.3% (Figure 54). The Cladoceran population peaked at 66 thousand in May, had a minimum of 4 thousand in June, and had an average of 27 thousand. The copepod population peaked at 461 thousand in August, had a minimum of 8 thousand in June, and an average of 233 thousand. The Rotifer population peaks at 497 thousand in August, a minimum of 8 thousand in June, and an average of 246 thousand.

Estimated grazing rates of 2023 ranged from 1.8% to 0.1%. This is slightly greater than 2022 and 2021, neither of which had a maximum grazing rate higher than 1%. Averages of around 1% were seen in 2019 and 2020. More Cladocerans found in lake Susan would result in a higher estimated grazing rate (Figure 54). While historically Cladoceran numbers have been low, this years numbers have been even lower (Figure 56).

Figure 53. 2023 Lake Susan Phytoplankton Summary by Division (unit/mL)

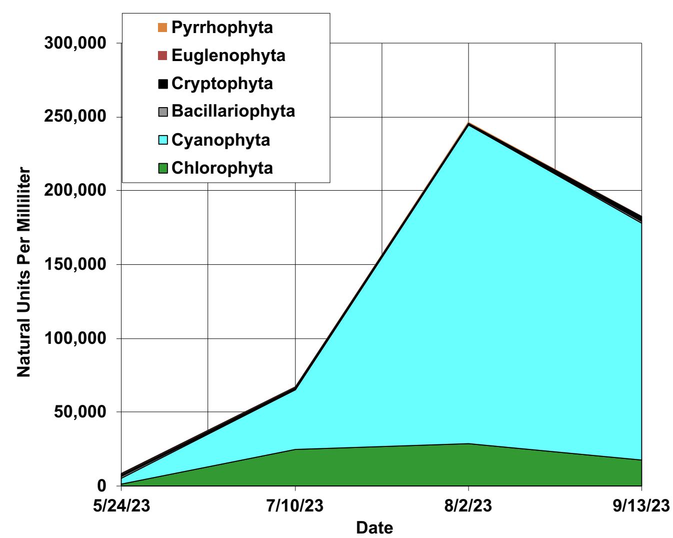


Figure 54. 2023 Lake Susan Zooplankton Counts by Division (number/m²).

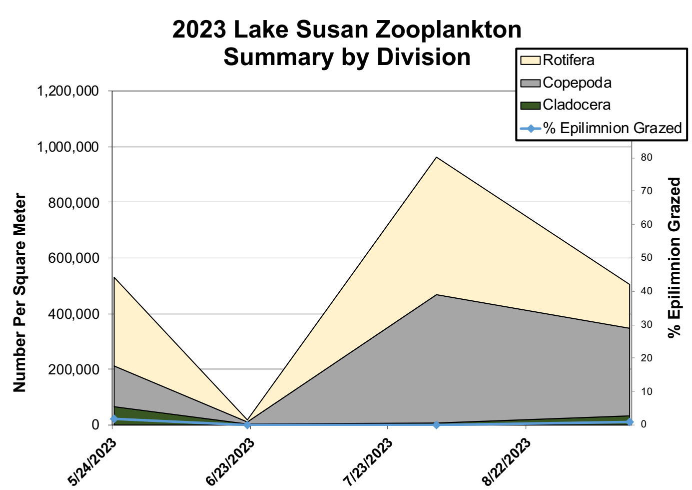


Figure 55. 1997-2023 Lake Susan Phytoplankton Historical Abundance (number/mL).

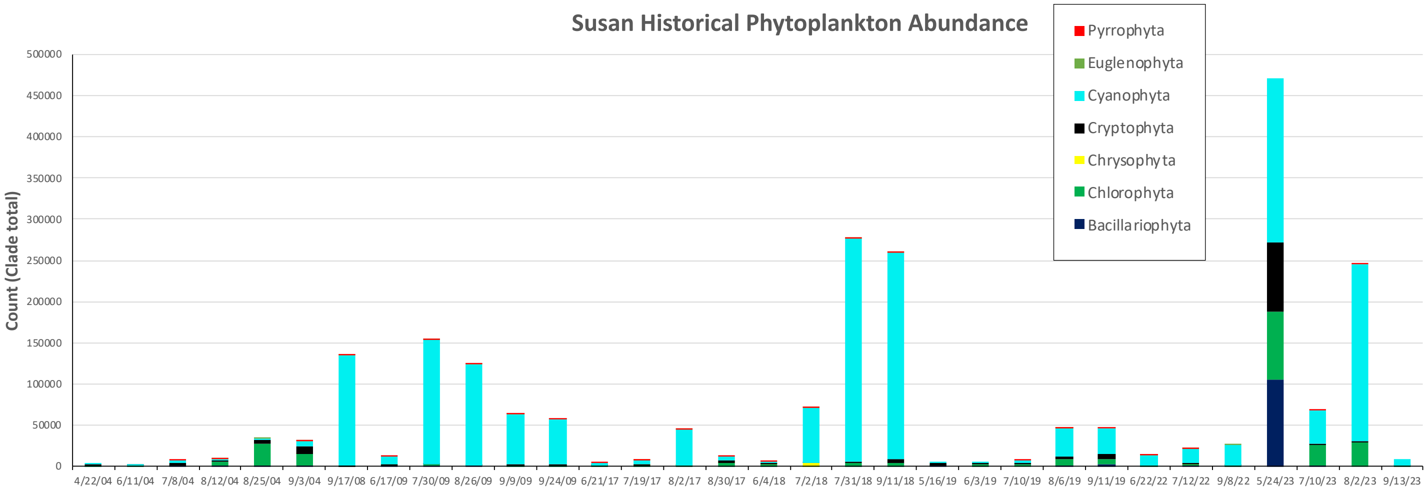
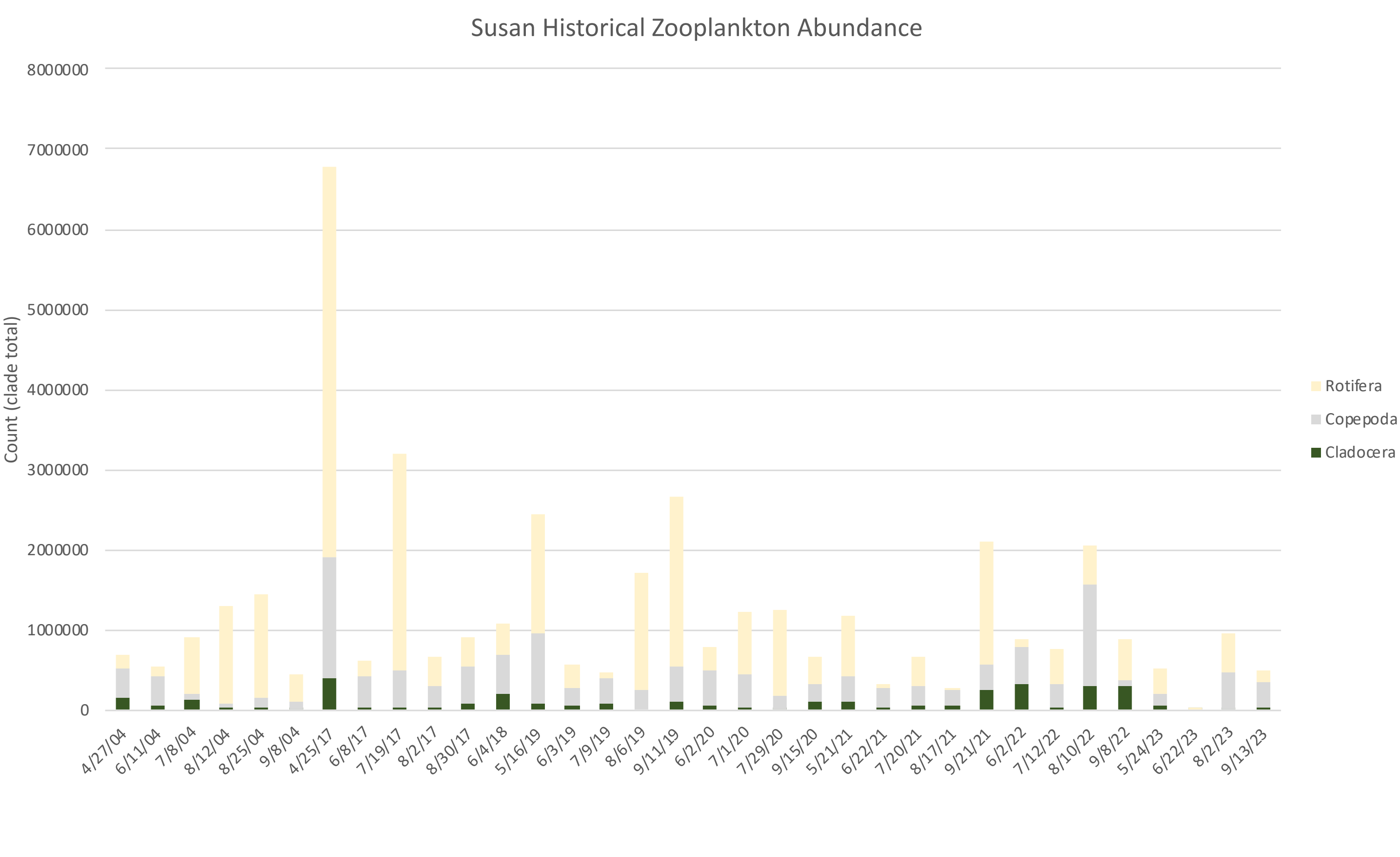


Figure 56. 2004-2023 Lake Susan Historical Zooplankton Abundance (number/m^2)



4.11. **Lake Susan Spent-Lime Treatment System**

Lake Susan is an 88-acre lake next to Lake Susan Park. It is an important resource in the City of Chanhassen and the Riley Purgatory Bluff Creek Watershed District. The lake is a popular recreational water body used for boating and fishing. Lake Susan is connected to four other lakes by Riley Creek. It receives stormwater runoff from 66 acres of surrounding land, as well as stormwater that enters two upstream lakes (Lake Ann and Lake Lucy). The stormwater entering the lake carries debris and pollutants, including the nutrient phosphorus. Phosphorus is a nutrient that comes from sources such as erosion, fertilizers, and decaying leaves and grass clippings. Excess phosphorus can cause cloudy water and algal blooms in lakes. Removing phosphorus from stormwater is a proven way to improve the water quality of lakes and streams.

In 2016, an innovative spent lime filtration system was constructed along a tributary stream draining a wetland on the southwest corner of Lake Susan (Figure 57). Based on system performance of the one other experimental spent lime filter site in the eastern Twin Cities area, modeling simulations based on available water quality measurements suggested the Lake Susan system had the potential to remove up to 45 pounds of phosphorus annually from water entering the lake. This would result in improved water quality and recreational opportunities. Spent lime is calcium carbonate that comes from drinking-water treatment plants as a byproduct of treating water. Instead of disposing of it, spent lime can be used to treat stormwater runoff. When nutrient-rich water flows through the spent lime system, the phosphorus binds to the calcium. The water flows out of the spent lime system, leaving the phosphorus behind.

Figure 57. Spent Lime Treatment System

Figure 58. Column testing for lime/sand mixture.

Observation and monitoring data collected by District staff in 2016 - 2018 indicated inconsistent system performance and periods of extended inundation, which deviated from the original design parameters. District staff worked with Barr to review monitoring data and identify potential shortcomings of the system (e.g., monitoring, materials, influent, changed conditions, etc.) It was discovered that the spent lime media appeared to be significantly restricting flow of water through the filter. District and Barr staff conducted field testing of the filtration capacity of the spent lime and discovered that the spent lime structure had degraded into a clay-like consistency, thus essentially preventing water from filtering through the media. During the summer of 2019, District staff completed laboratory column testing for mixtures of spent lime and sand. Column testing indicated that mixing spent lime with sand improves the filtration capacity of the media, while still removing phosphorus. Figure 58 is a photograph of the column testing completed by District staff during 2019. The testing revealed the following key points:

- Filtering water through sand washed to MnDOT standard specifications (washed sand) results in phosphorus export from the test columns.
- Water filtered through the various spent lime/pool sand mixtures elevated the pH in the effluent water, thus supporting the chemical reaction to precipitate phosphorus (i.e., remove phosphorus).
- Filtration rates through the various spent lime/pool sand mixtures appear relatively unchanged after 114 days of inundation and continuous flow for 10 days did not reduce

drain times.

- Initial testing of plaster sand obtained from a local pit also results in phosphorus export from the material.
- Total phosphorus removals were generally higher the larger the content of spent lime in the mixture (Figure 59).

The laboratory testing completed by District staff was used to guide modifications to the spent lime system to improve filtration capacity and performance of the system. Modifications included the replacement of the deteriorated spent lime with a mixture of 70% plaster sand and 30% spent lime, replacement of the underdrain slotted piping, and the installation of an automated water control structure and solar panel.

Water samples were collected and analyzed from the inlet and outlet of the treatment system for total dissolved phosphorus (TDP), total phosphorus (TP), total suspended solids (TSS), ortho phosphorus (OP), and Chlorophyll-a (Chl-a). In 2020, the automated water control structure unit was brought online on 5/28/2020 and allowed to flow on Mondays and Fridays for 4 hours. On 6/23/2020, after a month of testing and the addition of a stop log, the unit was changed to remain open on Mondays, Wednesdays, and Fridays for five-hour periods. In 2021 (5/14/2021) and 2022 (5/26/2022), the unit was brought online and allowed flow on Mondays, Wednesdays, and Fridays for seven-hour periods. This schedule was increased to a nine-hour period (8am-5pm) in 2023 after the unit was started on 5/15/2023. This was to increase the amount of water being treated through the system.

Overall, a total of 18 samples were collected in 2020 and 22 samples were collected in 2021. The average TP reduction across all samples collected in 2020 was 62% (Figure 60). The average TP reduction in 2021 was 40% (Figure 61). In 2020, the maximum reduction was measured during a July sampling event and was 91%. In 2021, the maximum reduction occurred in early August and removed 81% of the phosphorus. For TDP, TSS, OP, Chl-a, reductions were around 50% in 2020. Similar to 2020, OP and Chl-a, reductions in 2021 were around 50%, but TDP and TSS removals were reduced to 30-40% removals (Table 23). Due to the extremely low water levels in 2022, the units last significant flow through event was on 6/17/22. Because of the low water only a single sample was collected in 2022. Drought

Figure 59. Pool Sand/Spent Lime Mixture Column Testing Phosphorus Removals

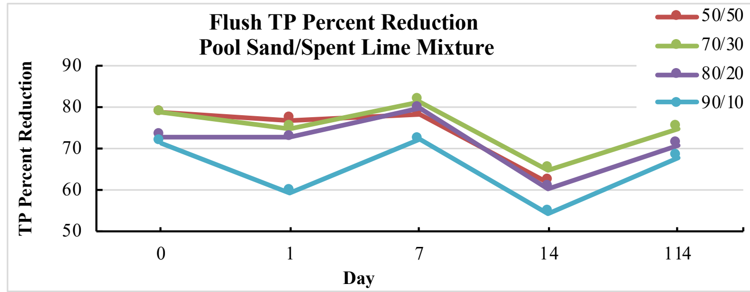


Figure 60. 2020 Lake Susan Spent Lime Treatment System Total Phosphorous Percent Reduction

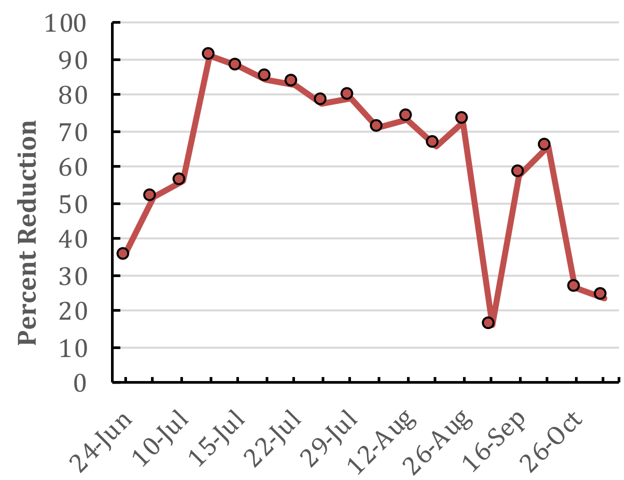
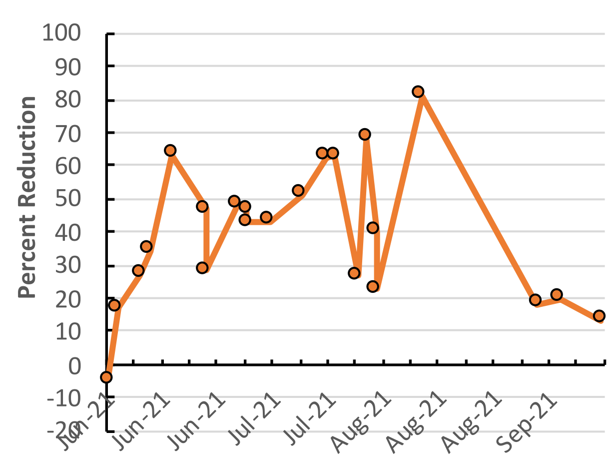


Figure 61. 2021 Lake Susan Spent Lime Treatment System Total Phosphorous Percent Reduction



conditions continued in 2023, which only allowed 6 samples to be collected in the spring and fall. Nutrient reductions were limited, but the small number off samples collected did not allow for an accurate performance evaluation of the unit.

The reduced TP removal efficiencies in 2021 could be linked to the need for additional mixing or “fluffing” of the sand/spent lime mixture. The District has been manually mixing the material once a year, but additional mixing may be needed to prevent media from compacting over time and to break up preferential flow paths within the BMP. Another explanation of reduced performance of the system could be that it may be overloading due to high upstream TP concentrations. The average inlet TP concentrations ranged from 0.099 to 1.41 mg/l across both years with averages well above the MPCA estimated typical total phosphorus range (0.1 mg/L to 0.25 mg/L) for effluent (outgoing) stormwater. These extremely high TP levels might be limiting system performance and additional treatments of the upstream wetland may be needed to address the nutrient impairment. Overall, the spent lime treatment system effectively removes phosphorus and other nutrients.

Table 23. 2020-2023 Average TSS and Nutrient Percent Removals from the Spent Lime Treatment System

Analyte	2020	2021	2022*	2023*
TDP (mg/l)	50	37	6	5
TP (mg/l)	62	40	16	14
TSS (mg/l)	46	28	48	No change
OP (mg/l)	59	51	1	7
CHLA (mg/l)	53	55	25	61

*Actual values - Limited samples collected due to drought.

4.12. **Rice Marsh Lake Water Quality Improvement Project: Kraken Filter**

The Use Attainability Assessment (UAA) undertaken by the District and the City of Chanhassen in 2016 found that the majority of pollutant loading to Rice Marsh Lake is due to runoff within the watershed (44%), with internal loading accounting for an additional 35% of the pollutant load. The remaining load is from upstream water bodies or atmospheric deposition. Further, the UAA concluded that Rice Marsh Lake Subwatershed RM-12A (232 acres) was the largest contributor to external pollutant loading to Rice Marsh Lake (Figure 62). In the fall of 2018, Rice Marsh Lake was treated with aluminum sulfate (alum) to treat the internal loading , but the external load still needed to be addressed. This led to the Kraken Filtration Project..

This project consisted of two manufactured treatment devices (MTDs) used in parallel along with a rain garden, soil amendments, and prairie restoration. These practices will result in the removal of approximately one-third of the load from the watershed or around 90 pounds of total phosphorus per year. The Kraken Filter by BioClean was the MTD selected; it is an engineered stormwater membrane filter that provides treatment for high flow rates (up to 2.9 cfs) using a number of filter cartridges. Runoff first passes through a pre-treatment chamber, moving to the membrane filter where it fills up the outer chamber. Once water reaches the top of the chamber, it flows down through the filter membrane, collecting in the underdrain, and flowing to the discharge chamber. High flow conditions cause water to pass over the high-flow weir, directly into the discharge chamber. The manufacturer evaluation indicates that the device can remove 63% of TP and 85% of TSS from influent runoff.

Construction began in fall 2021 with the installation of the two Kraken filters and ancillary storm sewer improvements. Vegetative restoration occurred in the spring 2022. Monitoring of the system began in 2023. Parameters monitored included total phosphorus, total dissolved phosphorus, chlorophyll-a, and total suspended solids. Continuous water level on the inlet and outlet along with inlet flow was collected (Figure 63). Nutrient data was not processed in time for the report and will be included in the next water resources report. Initial data review

Figure 62. Rice Marsh Lake RM-12A Watershed & Flow Patterns

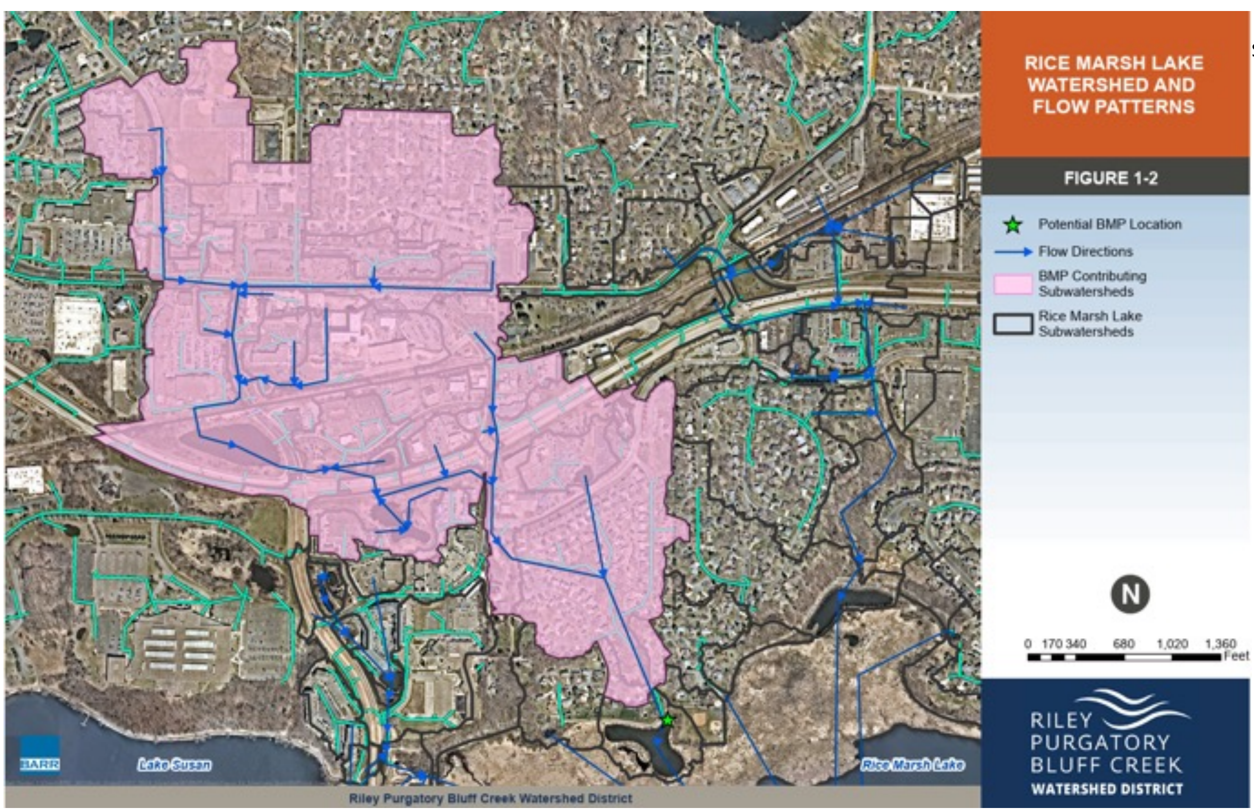


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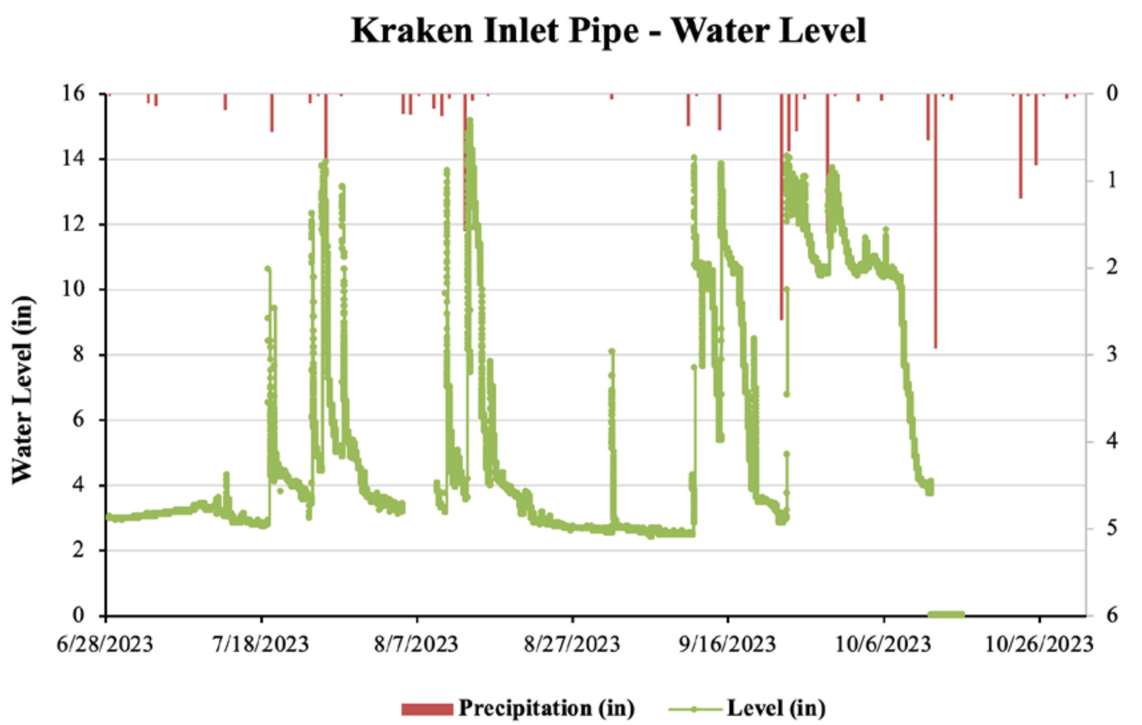
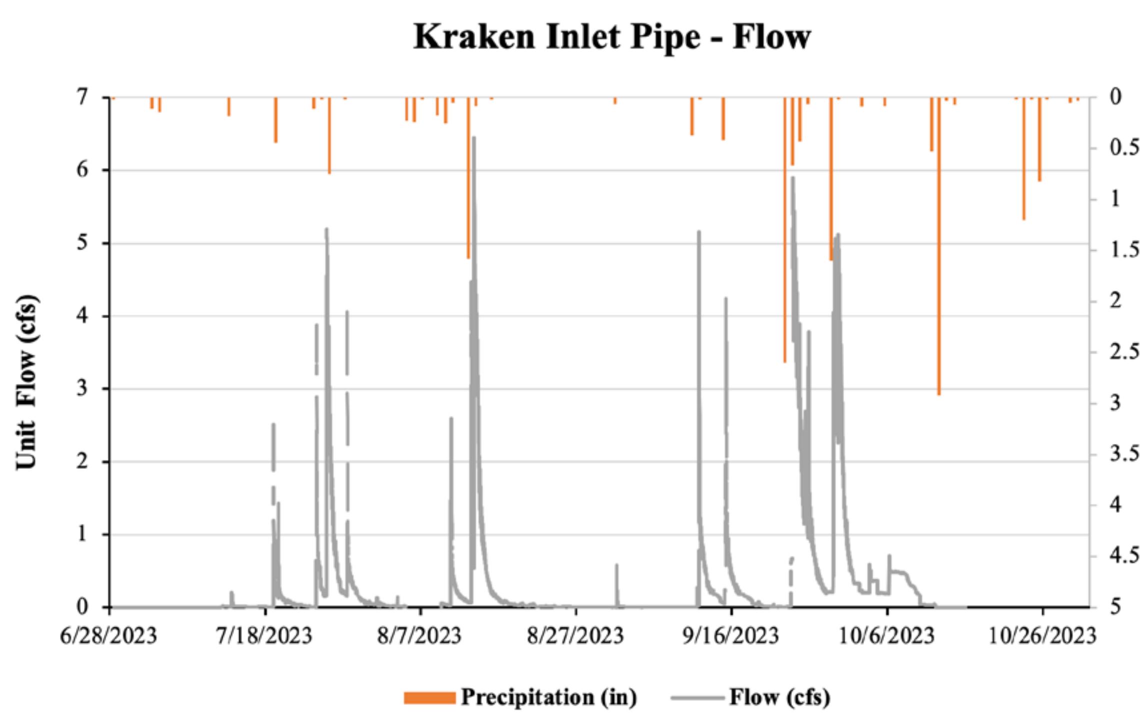
Figure 63. Rice Marsh Lake Kraken Inlet Water Level and Flow





4.13. Fish Kills and Stocking

Fish kills have commonly been recorded within the Riley Purgatory Bluff Creek Watershed District and generally have two causes:

- Winterkills (oxygen depletion)
- Columnaris Bacteria

In 2023 a summertime fish kill was observed and reported by residents around Lake Riley. Eden Prairie Parks staff counted just under 80 dead fish of all species ranging in size from 1-18inches. The cause of the fish kill was unknown and was reported to the DNR Fisheries Office. The number of fish was relatively small and the kill was considered minor.

Winterkills are common across the state of Minnesota, especially in shallow, eutrophic (nutrient-rich) lakes with muck bottoms and an abundance of aquatic plants. Many shallow lakes within the District have had a history of winterkills. A winterkill occurs when dissolved oxygen (DO) levels within a lake drop below 2 mg/L for an extended period, causing fish to suffocate and perish. During the summer season, oxygen is added to lakes through wind action and photosynthesis by phytoplankton and macrophytes. In the winter, if there are limited amounts of persisting snow-blocking sunlight, phytoplankton and some macrophytes may continue to photosynthesize and help prevent a winterkill from occurring. Microorganisms near the lake bottom and in the sediment of a lake are continuously decomposing material, consuming DO in the process. If a large snow event occurs or snow coverage has been present for an extended period, it becomes too dark below the ice for photosynthesis to occur. The high organic content in shallow lakes provides an abundance of food for the decomposers which can deplete DO levels. This can cause a fish kill.

In the winter of 2022/2023, winterkills occurred on Rice Marsh Lake, Lake Lucy, Silver Lake, and String Lake. The significant drought conditions that persisted in the summer of 2022, along with the record winter snowfalls can likely explain the number and severity of some of the winterkills. Table 24 shows DO levels for all lakes sampled across all sampling dates. At some point during the winter season, each lake measured below 2 mg/L from top to bottom, indicating a winterkill occurred. In most cases, staff also verified a fish kill by discovering dead fish on the perimeter of the lake as the ice receded, on the lake bottom, and/or near the openings. This includes the aeration opening on Rice Marsh Lake and the multiple holes which formed on Silver Lake. The District operates only a single aeration unit on Rice Marsh Lake which was operating all winter in 2023 but this still did not prevent a partial winterkill. Additionally, bird species (osprey, crows, eagles) were also observed in numbers eating deceased fish on Rice Marsh Lake and Silver Lake. Residents were often the first to detect a winterkill and observed these winterkill signs before contacting the District.

Preventing a winterkill in Rice Marsh Lake is a critical part of the Common Carp Management Plan for the RCL. Common carp have been known to move from various lakes in the RCL into Rice Marsh Lake to spawn. Before the aeration unit was operational, Rice Marsh Lake would winterkill every few years. This eliminated all predators of common carp in the system, allowing carp to successfully spawn. These successful spawning events caused large carp populations to form in all lakes within the RCL. Since operation of the unit in 2010, partial winterkills have occurred in 2017/2018, 2020/2021, and 2022/2023. Lake Lucy is also the top of the RCL and has similar reasons for maintaining a healthy bluegill population. The most important predator of common carp is the bluegill sunfish which can suppress a carp population by consuming eggs and larval stages of carp. A well-established bluegill population in a lake can control a carp population and prevent it from becoming a problem. Staring lake and the Purgatory Creek Recreation Area also act as a chain of lakes. Similarly, to Rice Marsh Lake in the RCL, carp migrate into the Rec Area to spawn and have free range when a winterkill occurs if the barrier is not in place or has to be removed. This is why maintaining healthy bluegill populations in this system is critical. For shallow lakes such as Duck Lake and Silver Lake, winterkills are common and often reset the lake. The Duck Lake and Silver Lake fisheries are not regularly sampled as part of the Districts carp management plan and are lower priority lakes for the DNR sampling, so fisheries data is limited.

Table 24. 2023 Dissolved Oxygen (DO) profiles on winterkill lakes.

Winter dissolved oxygen profiles (mg/L) for all 2023 winterkill lakes for each date sampled. Blue indicates good (>3mg/L), yellow indicates critical (2 mg/L), and red indicates winterkill DO levels (<2mg/L).

Dissolved Oxygen Level Status	Good	Critical	Winterkill

Depth (m)	LUCY			STARING			RICE MARSH			DUCK		SILVER
	Sample dates			Sample dates			Sample dates			Sample dates		Sample dates
	1/11/2023	2/16/2023	3/28/2023	1/11/2023	2/25/2023	3/28/2023	1/12/2023	2/16/2023	3/28/2023	1/12/2023	2/15/2023	2/28/2023
0.5							2.82	2.57	1.54	1.86	3.25	1.61
1.0	7.73	3.45	1.02	1.59	3.3	10.41	2.51	1.87	1.27	1.42	2.29	1.4
1.5					2.53	7.52	2.34	1.73	0.94	1.26	1.6	1.2
2.0	5.07	2.91	0.85	1.37	2.0	4.29	1.59	1.66	0.5	1.11	1.47	1.14
2.5	5.07	2.91	0.85		1.69	1.68	1.38	1.78	0.14			
3.0	4.74	2.32	0.13	1.32	1.54	0.55						
4.0	4.87	1.82	0		1.44	0.21						
5.0	4.32	1.58	0	1.35		0.14						
6.0	1.05	1.41	0									

Fish stocking following a winterkill is a common practice to reestablish a population. Due to the importance of Rice Marsh Lake in combating carp within the RCL, bluegill sunfish were stocked in the lake. After both the 2019/2020 and 2022/2023 winterkill in Lake Lucy, stocking occurred to quickly re-establish a base bluegill population. Bluegills have also been stocked in the Upper and Lower Purgatory Creek Recreational Area and Staring Lake. These water bodies have variable carp populations that are not under full control. Stocking bluegills in these waterbodies has been used in the past to aid in common carp control, the hope being to eliminate carp recruitment. Duck lake was stocked by the DNR in 2021 and 2023. Bluegill stocking rates can be seen in Table 25. Figure 64 displays the total number of bluegill/net captured in each trap net survey for the lakes that have been stocked with bluegills. Corresponding winterkill years are indicated in the figure by the red arrows. From this figure it clearly shows a reduction in bluegill numbers in most lakes with winterkills. Staff will monitor lakes of concern through the winter and will likely stock bluegills in 2024 as needed.

Figure 64. 2016-2023 Total Bluegill Trap Net Numbers

The number of bluegill caught per net for each of the five winterkill lakes from 2016-2023. Each arrow indicates a winterkill. Rice Marsh Lake and Lake Lucy are not sampled yearly.

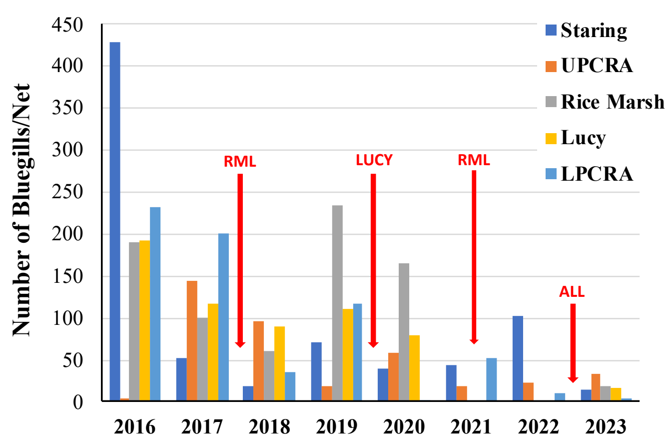


Table 25. 2018-2023 Bluegill Stocking Numbers

Lake	Number of Bluegill Stocked					
	2018	2019	2020	2021	2022	2023
Rice Marsh Lake	1,000	300	0	800	0	300
Staring	300	200	0	0	0	300
Upper Purgatory Creek Recreation Area (UPCRA)	200	100	0	100	0	50
Upper Purgatory Creek Recreation Area (LPCRA)	500	100	0	100	0	50
Lucy	0	300	0	0	0	300
Duck (stocked by DNR)	20	0	0	18	0	20
TOTAL	**2,020**	**1,000**	**0**	**1,018**	**0**	**1,020**

5: AQUATIC INVASIVE SPECIES

Due to the increase in spread of Aquatic Invasive Species (AIS) throughout the state of Minnesota, staff completed an AIS early detection and management plan in 2015. As part of the plan, an AIS inventory for all waterbodies within the District was completed. A foundation was also set up to monitor invasive species that are currently established within District waters (Table 26). Early detection is critical to reduce the negative impacts of AIS and to potentially eliminate an invasive species before it becomes fully established within a waterbody. Effective AIS management of established AIS populations will also reduce negative impacts and control their further spread. The RPBCWD AIS plan is adapted from the Wisconsin Department of Natural Resources (WIDNR, 2015), Minnehaha Creek Watershed District (MCWD, 2013), and the Minnesota Department of Natural Resources (MNDNR, 2015a) Aquatic Invasive Species Early Detection Monitoring Strategy. The goal is to not only assess AIS that currently reside in RPBCWD waterbodies, but to be an early detection tool for new infestations of AIS. Figure 65 identifies AIS monitoring/management that occurred in 2023, excluding common carp management.

Figure 65. 2023 AIS monitoring and treatment summary

Aquatic Invasive Species (AIS) work conducted in 2023 within the Riley-Purgatory-Bluff Creek Watershed District. Symbols indicate Zebra Mussel monitoring plates and/or monthly public boat launch scans (grey), zooplankton and phytoplankton sampling conducted (orange), herbicide treatments occurred (green), point-intercept vegetation surveys (purple). All lakes received juvenile mussel sampling.

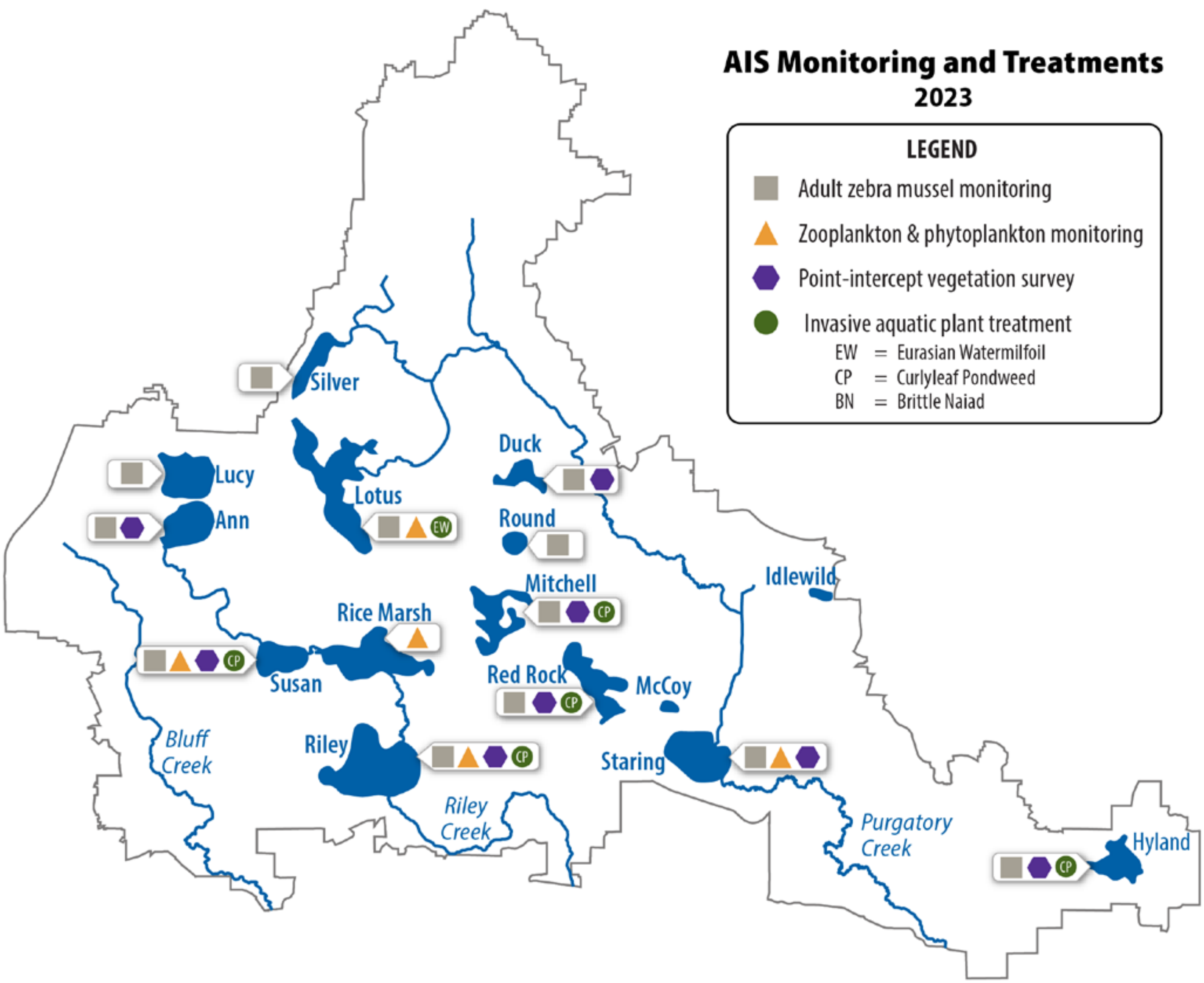


Table 26. Aquatic Invasive Species Infested Lakes

Lake Names	Brittle Naiad	Eurasian Watermilfoil	Curly-leaf Pondweed	Purple Loosestrife	Common Carp	Zebra Mussels
Ann	✓	✓	✓	✓	✓	✓ (new)
Lotus	✓	✓	✓	✓	✓	✓
Lucy	--	✓	✓	✓	✓	--
Red Rock	--	✓	✓	✓	--	--
Rice Marsh	--	--	✓	✓	✓	--
Riley	--	✓	✓	✓	✓	✓
Silver	--	--	✓	✓	--	--
Staring	✓	✓	✓	✓	✓	--
Susan	✓	✓	✓	✓	✓	--
Duck	--	✓	✓	✓	--	--
Mitchell	✓ (new)	✓	✓	✓	--	--
Round	✓	✓	✓	--	--	--
Hyland	--	--	✓	--	--	--

✓ (new) Indicates new infestation

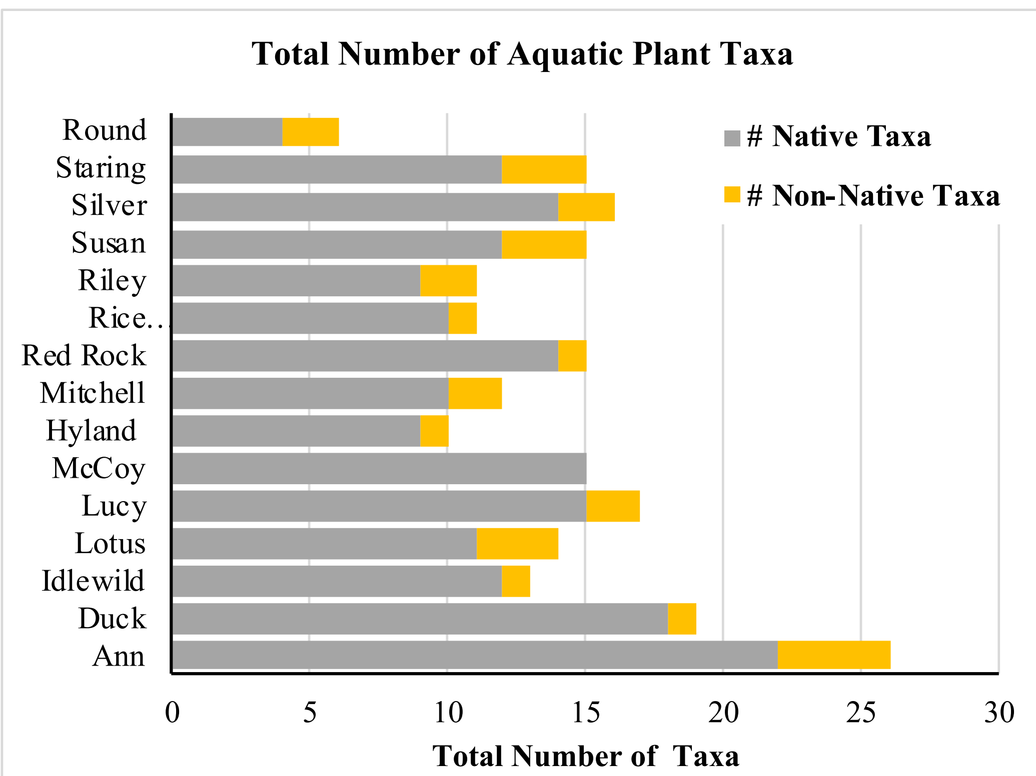
5.1. Aquatic Vegetation Monitoring & Management

Aquatic plant surveys are important because they allow the District to map out invasive plant species for treatment, locate rare plants for protection, create plant community/density maps which evaluate temporal changes in vegetation community, identify the presence of new AIS within water bodies, and can assess the effectiveness of herbicide treatments. Aquatic plant surveys have been conducted on a rotational basis within RPBCWD to ensure all lakes have received adequate assessments. As projects arise, or issues occur, additional plant surveys are conducted to aid in the decision-making process. The most comprehensive aquatic plant survey is called a point-intercept method. This survey utilizes sample points arranged in a uniform grid across the entire lake which can vary in number depending on the lake size. At each designated sample location, plants are collected using a double-headed, 14-tine rake on a rope. For each rake sample, the rake is dragged over the lake bottom for approximately 5 ft before it is retrieved. Roving surveys are also used when species of concern are in question. This survey method involves driving around the lake, visually scanning the shallows, tossing rakes, and marking every plant found using a handheld GPS device. The other type of aquatic plant survey is a delineation survey which guides and directs herbicide treatments. Herbicide treatments have been shown to reduce and control aquatic invasive plants to a manageable level, which may in turn allow for native plants to increase in abundance.

In 2023, point-intercept surveys were conducted Hyland Lake (TRPD), Mitchell Lake, Red Rock Lake (EP), Lake Susan, Lake Riley, Staring Lake (UMN), Duck Lake, Silver Lake, and Lake Ann (District). Aquatic plant reports can be provided upon request. Figure 66 shows the number of native and non-native taxa from each lake within the District based on the latest completed point-intercept survey. Lake Ann continues to have the greatest number of native taxa with 22 species (reduction from 25 species in 2020) which is followed by Duck with 19 species. Most lakes have between 10-15 species of native plants with Round Lake having the least native plant diversity (four species). The District will continue to monitor the aquatic plant communities

Figure 66. Total Number of Aquatic Plant Taxa

Total number of native and non-native taxa across all lakes within the RPBCWD based on their most recent point-intercept survey.



within our lakes and use herbicide treatments to manage aquatic invasive plants to sustain healthy aquatic communities into the future. A list of highlights from each point-intercept survey is below.

- **HYLAND:** For the third consecutive year, the herbicide Fluridone was used to treat Curly-leaf Pondweed immediately after ice-off on Hyland Lake. In 2023, the number of native species increased to nine species from a previous high of six species in 2019 and 2020. The combined herbicide treatments and aluminum sulfate (alum) treatment by Three Rivers Park District has allowed plants to expand to 50% of the littoral area.
- **SILVER:** Submersed Coontail (94% frequency of occurrence) and floating White Waterlily (50% frequency of occurrence) are the dominant vegetation in the lake. Since the 2013 survey, the number of species has increased from 10 species to 16 in 2020 and 14 in 2023. Most plant species have increased in abundance and density due to the increased water clarity. This includes Northern Wild Rice which has increased from 5% in 2013 and 1% in 2020 to 13% in 2023.
- **MITCHELL:** Coontail was the dominant plant in Mitchell Lake and was found growing at 52% of the sites. Eurasian Watermilfoil was found at 15 sites at mostly light growth and Curly-leaf Pondweed was present. Brittle naiad, an AIS, was discovered and determined to be established in the northeast end of Mitchell Lake. The acreage of aquatic submerged plants in Mitchell Lake in late summer was about 68 acres (61% of the lake). The number of species observed at each site ranged from 1 to 5 species.
- **DUCK:** Coontail was the most common plant found at 96% of sites followed by Flatstem Pondweed at 52% of sites. Overall, plant growth in Duck Lake covered 100% of the lake surface. The number of plants increased from six in 2020 to 16 in 2023. This is partially due to the inclusion of the west bay and very low densities of additional floating and emergent native species that previously were not found (Longleaf Pondweed, Arrowhead, American Lotus, and Hardstem Bullrush)
- **RILEY:** Lake Riley was treated for Curly-leaf Pondweed (9 acres). The University of Minnesota conducted three point-intercept plant surveys in 2023 to track aquatic vegetation populations. In August, 11 species were observed, 9 were native, and native richness declined slightly from previous years with a high of 1.3 natives per point. Throughout all survey years, most plants were in water < 2m deep. However, with the improved water clarity, from 2016 through 2023, plants were observed in sites up to 5.0 meters deep. Eurasian Watermilfoil greatly decreased in 2023, with all three sampling months having less than 3% observed frequency. Frequency of Curly-leaf Pondweed increased slightly from June 2020 to June 2023, from 25% to 29% but has not expanded further. Turion density was sampled in 2022 and 2023 and remained low at 8 turions/m^2 in 2022 which increased slightly to 25 turions/m^2 in 2023, well below the abundance prior to the start of invasive control.

Table 27. Lake Vegetation Monitoring and Management in 2023.

Species delineated for treatment included Curly-leaf Pondweed (CLP) and Eurasian Watermilfoil (EWM). All aquatic herbicide treatments were directed and financed by the RPBCWD and executed by PLM Lake and Land Management Corporation except for Red Rock which was carried out by Midwest AquaCare.

Lake	Point-Intercept Surveyor	Delineation Species	Delineation Surveyor	Herbicide	Acreage Treated
Red Rock	EP	CLP	RPBCWD	Aquathol	13
Mitchell	EP	CLP	RPBCWD	Flumioxazin	12.9
Lotus	RPBCWD	CLP/EWM	RPBCWD	Diquat	22.92
Riley	UMN	CLP	UMN	Diquat	9
Susan	UMN	CLP	UMN	Flumioxazin	5.35
Hyland	TRPD	CLP	TRPD	Fluridone	Whole-lake
Staring	UMN	--	--	--	--
Ann	RPBCWD	--	--	--	--
Duck	RPBCWD	--	--	--	--
Silver	RPBCWD	--	--	--	--

EP = City of Eden Prairie; UMN = Univesity of Minnesota; TRPD = Three Rivers Park District

- **ANN:** At 22 species, Lake Ann has the highest plant diversity of all lakes in the District. Coontail was the most common plant found at 67% of sites followed by Flatstem Pondweed at 55% of sites. White Water Lily was the most dominant floating plant at 28% frequency of occurrence. In the 2023 survey, no Eurasian Watermilfoil was sampled. However, for the first time, Brittle Naiad was at a detectable level (4% frequency of occurrence) since its initial discovery in 2017.
- **STARING:** In 2022, the herbicide Fluridone was used to treat Eurasian Watermilfoil and was successful; no Eurasian Watermilfoil was observed in 2023. Unfortunately, the reduced vegetation from the treatment combined with the low water levels for 2022 and 2023 has led to reduced water quality. Nutrient levels should decline as native vegetation expands across the lake. The University of Minnesota conducted three point-intercept plant surveys in 2023 to track aquatic vegetation populations. Native plant coverage decreased to 25% in August 2023 down from > 50% in 2016-2022. In 2023, 13 total species were found throughout the year, with 12 total natives. In 2023, Curly-leaf Pondweed was found at 20% of points in peak season. White Water Lily, Sago Pondweed, and Star Duckweed were all found at the highest frequency in 2023 since sampling started.
- **SUSAN:** Lake Susan was treated via herbicide for Curly-leaf Pondweed in 2023 (5.3 acres). The University of Minnesota conducted three point-intercept plant surveys in 2023 to track aquatic vegetation populations. In 2023, May maximum depth of growth was 3.1 and decreased to 1.5 in August. The invasive Eurasian Watermilfoil declined in frequency since 2011 and was not observed on any rake tosses during the aquatic vegetation surveys of 2018 through 2023. Brittle Naiad although present in the lake, has not been detected in point-intercept surveys. Turion density decreased in 2023 to 20 turions/m^2 and viability was 87%.

2023 Herbicide Treatments

In the spring 2023, herbicide treatments were carried out by PLM Lake and Land Management Corporation and Midwest AquaCare (Red Rock Lake) on District lakes. Curly-leaf Pondweed was treated on Mitchell Lake (12.9 acres), Lake Riley (9 acres), Lake Susan (5.35 acres), and Red Rock (13 acres). The survey maps can be seen in Exhibit J. Both Eurasian Watermilfoil and Curly-leaf Pondweed were targeted with a single treatment on Lotus Lake (22.92 acres). A DNR Traditional AIS Control Grant in the amount of $3,000 was awarded and utilized for a Lake Riley Diquat treatment for Curly-leaf Pondweed and to cover the early season point-intercept survey. A summary of the 2023 lake vegetation monitoring and management can be seen in Table 27 and Exhibit I.

Curly-leaf Pondweed Flumioxazin Treatment

The herbicide Flumioxazin was used for the first time in the District and was part of a study to evaluate its effectiveness. This collaborative study between the UMN, DNR, and the District involved the submission of water samples to test the time the herbicide was in the water and extensive pre and post point-intercept surveys of the area to gauge control of the Curly-leaf Pondweed and damage to native plants. The Mitchell Lake Flumioxazin treatment monitoring included a pre-treatment point-intercept survey on May 15 before the application was administered on May 17. The follow-up point-intercept survey was conducted on June 20. A control area was surveyed in addition to the treatment area to identify any variability to what was seen in the treatment area. Pre-treatment frequency of occurrence was 67% in the control area and 69% in the treatment area. In the post treatment PI survey, Curly-leaf Pondweed frequency of occurrence declined 22% in the control area and 99% in the treatment area (Figure 67). Native plants declined 19% in the treatment area while increasing 13% in the control area. Overall, the Flumioxazin treatment seems to be a highly effective treatment for Curly-leaf Pondweed in Mitchell Lake with a drastic reduction in occurrence following the treatment.

Lake Susan also had a Flumioxazin treatment applied on 5/17/2023. The UMN conducted a pre-treatment survey was conducted on 5/15/2023, and a post-treatment survey on 6/13/2023. Pretreatment Curly-leaf Pondweed frequency of occurrence declined from 53% to 7% in the treatment area or an 87% decline overall (Figure 68). Native plant density declined 21%. Overall, Flumioxazin performed well and will likely be utilized moving forward.

Figure 67. 2023 Curly-leaf Pondweed Pre and Post Treatment Densities on Mitchell Lake (source: DNR).

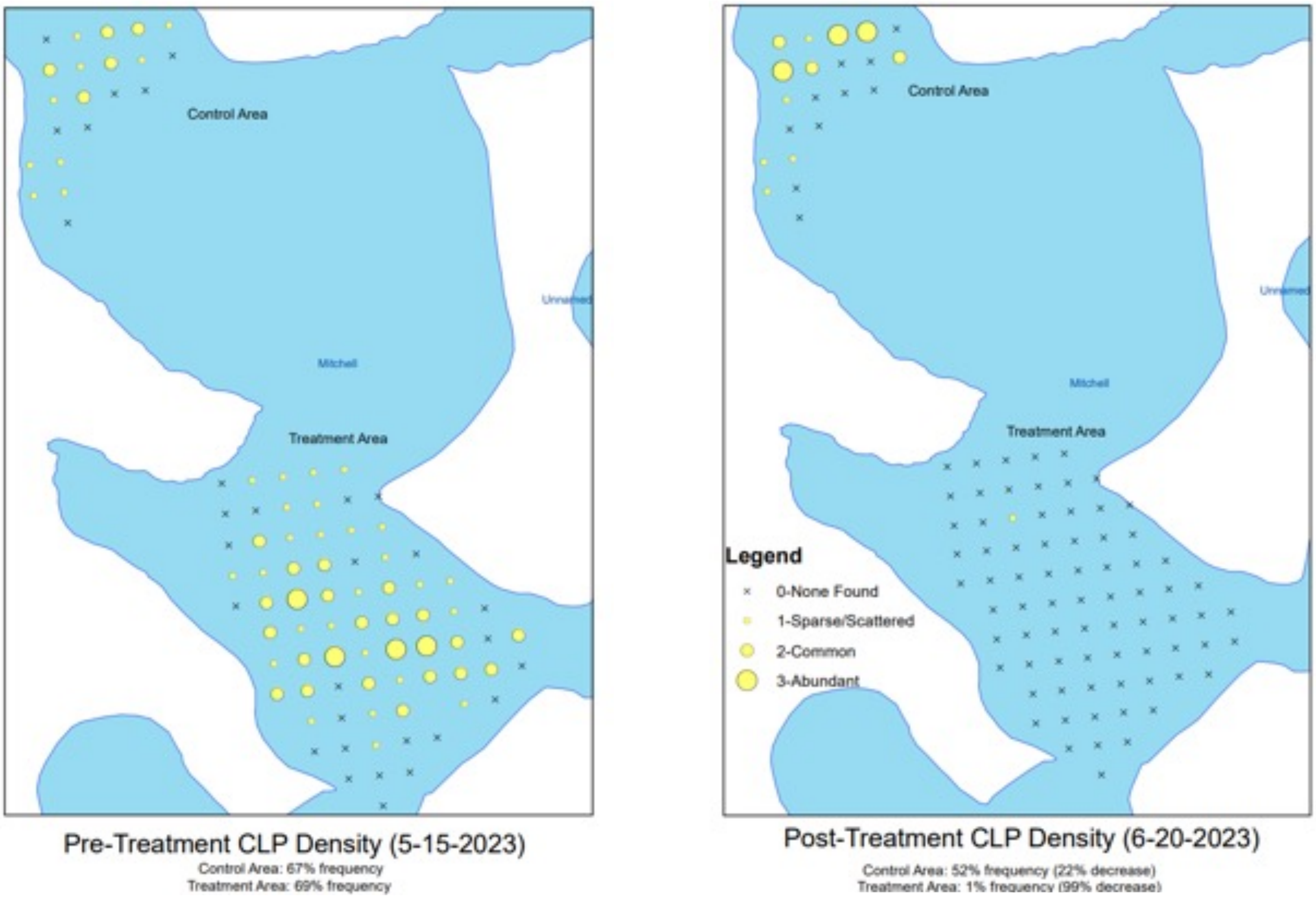
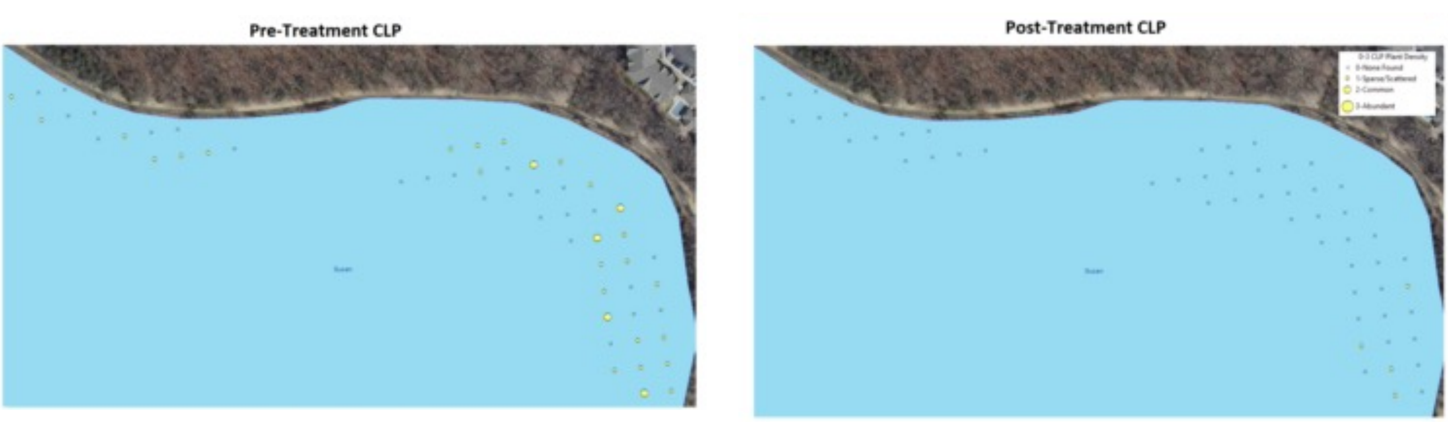


Figure 68. 2023 Curly-leaf Pondweed Pre and Post Treatment Densities on Lake Susan (source: DNR)



Mitchell Lake Turion Survey

In 2023, District staff completed a Curly-leaf Pondweed turion survey on Mitchell Lake. Turions are the primary reproductive structure of Curly-leaf Pondweed. Research suggests approximately 50% of turions germinate in a growing season while the rest remain dormant until the following growing season when another 50% will germinate (Johnson 2012). Depending on the level of turions at a given location (knowing that latent turions may be able to survive for over five years in the sediment), it may take several years of control to exhaust the "turion bank" (R. Newman – U of M unpublished data). Evaluating the turions in a lake can help researchers evaluate the effectiveness of treatments.

Staff followed procedures outlined by the UMN (Johnson, 2012). In October, the abundance of Curly-leaf turions in littoral sediment was measured. A petite Ponar dredge (225 cm^2 basal area; sample depth ~10 cm) was used to collect one sediment sample at each of the same 40 locations where biomass (point-intercept surveys) was collected (40 points surveyed in 2023). Upon retrieving each sediment sample, the sampler contents were emptied into a sifting bucket with a 1-millimeter screen and searched for turions or spread thinly across the boat deck and hand-sifted. Turions were placed into a labeled plastic bag and stored in a cooler while in the field. Small turion fragments (those that did not include a portion of a central turion stem) and severely decayed turions (those that did not retain their shape when lightly squeezed) were discarded and not included in final turion counts. Turion abundance at each sampled site (N of turions ÷ 0.0225 m^2; N/m^2) and yearly mean littoral turion abundance for each lake was calculated.

Turion viability was also assessed. Turions found sprouting at the time of sample processing were tallied as viable and then discarded. Remaining unsprouted turions from each lake were placed into clear sealable plastic bags with a small amount of water and stored in the dark at 5°C for 30 days to simulate typical fall conditions in surface sediments of Minnesota lakes to break turion dormancy (Sastroutomo 1981). During this period of cold storage, bagged turions were inspected weekly and any sprouted turions were tallied and discarded. After this period of cold storage, remaining unsprouted turions were incubated for an additional 90 days at 20 °C with 14 hours of light per day from a bank of four fluorescent 20-watt grow lamps. After 90 days of warm incubation, staff calculated final turion viability (proportion sprouted) by dividing the total number of sprouted turions (in-lake + cold-storage + warm incubation) by the total number of turions collected (sprouted + unsprouted) from each lake and calculated the abundance of viable turions (turion abundance × proportion sprouted; N/m^2) in each lake for each year. The results from the survey are shown in Table 28.

Table 28. 2023 Mitchell Lake CLP Turion Statistics

Total Number of Sample Points	40
Total Number of Live Turions/Total Turions	7/17
Total Number of Points with Viable Turions/Total Points with Turions	6/10
Frequency of Occurrence	25%
Number of points above potential impairment (+50/m^2)	4
Number of points above predicted nuisance level (+200/m^2)	0
Maximum Turions/m^2	129.31
Mean Turions/m^2	17.24
Standard deviation/m^2	11.04

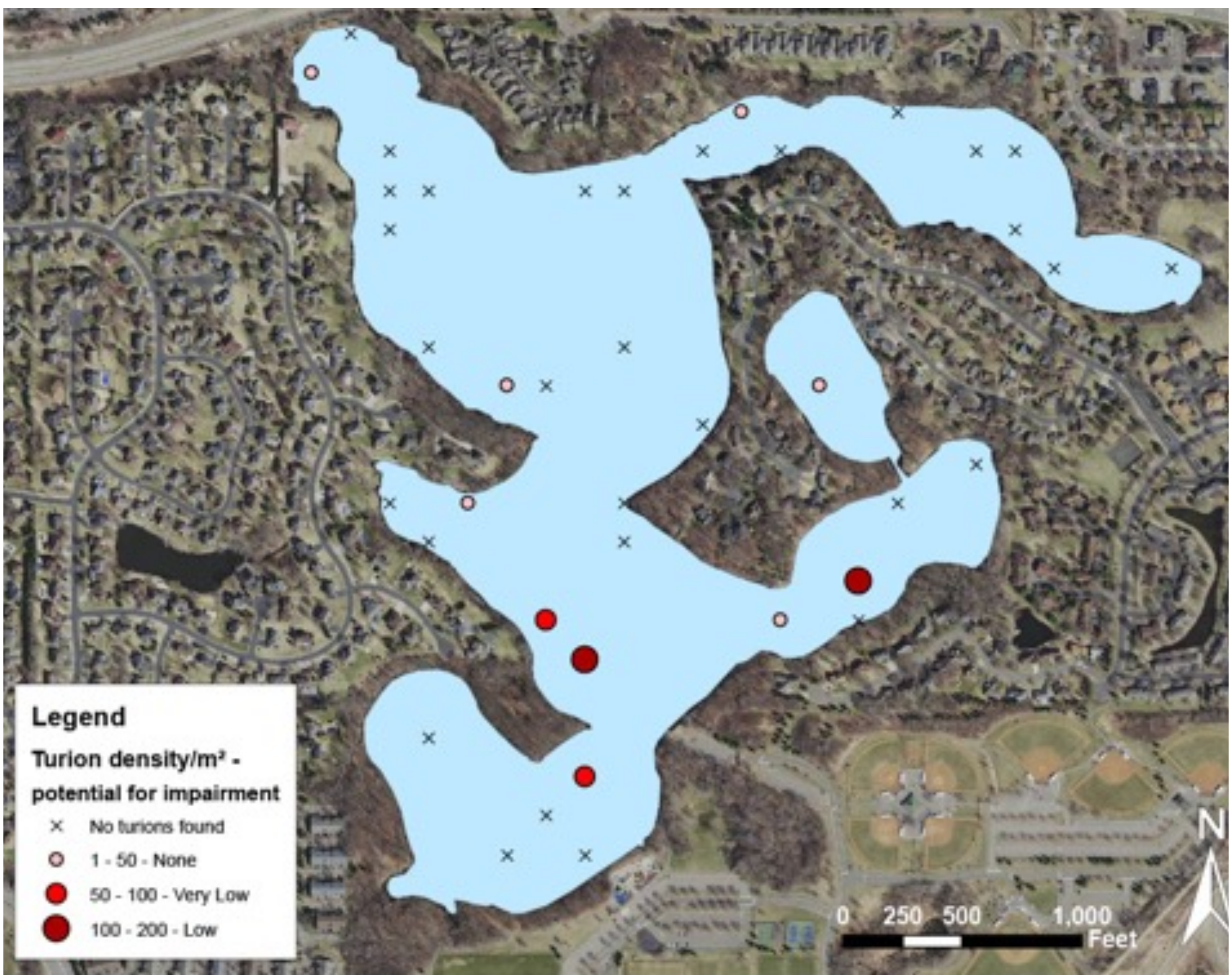
Table 29 summarizes the results from the 2023 Mitchell Lake turion survey. During the October 5, 2023, survey, District staff found 17 total CLP turions; 6 of 40 points had live turions (25% occurrence). In the 2021 survey, District staff found 17 total CLP turions; 10 of 53 points had live turions (19% occurrence), an overall decrease from 2017 (12 out of 40 points with live turions, a 30% occurrence). This is also well below the occurrence of live turions first sampled in 2013 (29 out of 40 points with live turions, a 73% occurrence). Turions appeared to be scattered throughout the lake at very low densities (Figure 69).

The overall mean density within the study areas was 17.24 turions/m^2 with a standard deviation of 11.04 turions/m^2 slightly higher than the 2021mean density of 13.57 turions/m2 with a standard deviation of 8.77 turions/m2. This is a significant decline from 2013 (190.73 turions/m2 with a standard deviation of 85.81 turions/m2). It has remained relatively unchanged since the last survey in 2017 (12.93 turions/m2 with a standard deviation of 15.8 turions/m^2). Overall, the total number of turions has been reduced with the application of consecutive herbicide treatments. No herbicide treatments occurred in 2013 and 2014, but the herbicide endothall was applied to the lake in 2015, 2016, and 2017. Diquat was applied in 2018, 2020, 2021, and 2023. In 2023, the herbicide flumioxazin was used. Turion surveys show a clear reduction in viable turions following herbicide applications. Four of the survey points topped an estimated 50 turions/m2. This indicates a low potential for navigation impairment (Johnson 2012) (50% of points with turions). However, none of these points exceeded the expected "nuisance level" of 200/m^2 (Figure 67). District staff will continue to monitor the CLP pondweed on Mitchell Lake to assess if treatment is needed moving forward.

Table 29. Mitchell Lake turion survey results (2013-2023)

Date	Turions/m^2	Viability	Viable Turion Density (turions/m^2)
Oct 2013	177	77%	137
Oct 2014	152	44%	72
Oct 2015	13	80%	11
Oct 2016	25	38%	10
Oct 2017	12	49%	5
Oct 2021	17	50%	7
Oct 2023	17	44%	6

Figure 69. 2023 Fall Mitchell Lake CLP Turion Survey Density and Distribution



5.2. Common Carp Management

RPBCWD, in cooperation with the University of Minnesota (UMN), has been a key leader in the development of successful carp management strategy for lakes within the state of Minnesota. Following the completion of the Riley Chain of Lakes (RCL) Carp Management Plan drafted by the UMN in 2014 (Bajer et al., 2014), and the Purgatory Creek Carp Management Plan drafted in 2015 (Sorensen et al., 2015), the District took over monitoring duties from UMN. Carp can be detrimental to lake water quality. They feed on the bottom of the lake, uprooting aquatic plants and resuspending nutrients found in the sediment.

Adult carp are monitored within RPBCWD by conducting three electrofishing events per lake each year, between late July and early October. Each event consists of three 20-minute transects (totaling three hours per lake). The population is considered harmful to lake water quality if the total biomass estimate of carp is above 100 kg/h; at this point the District would need to consider management. Young of the year (YOY) carp are monitored by conducting 24-hour small mesh trap net sets between August and September. Each sampling event consists of five nets set per lake. Capture of YOY carp during this sampling suggests successful recruitment has occurred, and monitoring efforts should be increased on that water body. At that point, the District would also consider further management action. In 2023, 394 carp or 735 lbs. of fish were removed from RPBCWD (Table 30).

Table 30. Total Common Carp removed in 2023.

System	Number of Fish	Weight (pounds)
Riley Chain of Lakes (RCL)	29	121.13
Purgatory Chain of Lakes (PCL)	365	613.80
Total	**394**	**734.93**

Trap Netting

District staff completed trap net surveys on Staring Lake, Lake Lucy, Rice Marsh Lake, and the Upper (UPCRA) and Lower Purgatory Creek Recreational Area (LPCRA) in 2023. Of the lakes sampled, Staring Lake had the most fish captured (n=2,782). Similar to 2022, Staring Lake had the most diverse fish population in 2023 (n=13). Previously, Staring Lake had 10 different species in 2022 and the UPCRA had the highest in 2021 (n=10) and 2020 (n=11). As is true with many lakes during late summer located within the Twin Cities' metro area, the RCL and PCL inshore fish community was dominated by bluegill sunfish. The Upper Purgatory Recreation Area had the highest number of bluegills captured, averaging 33.5 fish per net. This is up from 2022 (n=23.75) and historically on the higher end of bluegill numbers. The LPCRA had the lowest bluegill abundance at around 4.75 bluegills/net. This is down from 10.7 bluegills/net in 2022. Other species that were abundant included pumpkinseed sunfish, black crappies, and bullhead species. LPCRA had the highest number of black crappies by far (200 fish/net captured), which was primarily made up of YOY crappies. Large predatory fish including northern pike and largemouth bass were captured via trap netting in low numbers across the lakes. A full summary table of the fish captured for each lake can be found in Exhibit B.

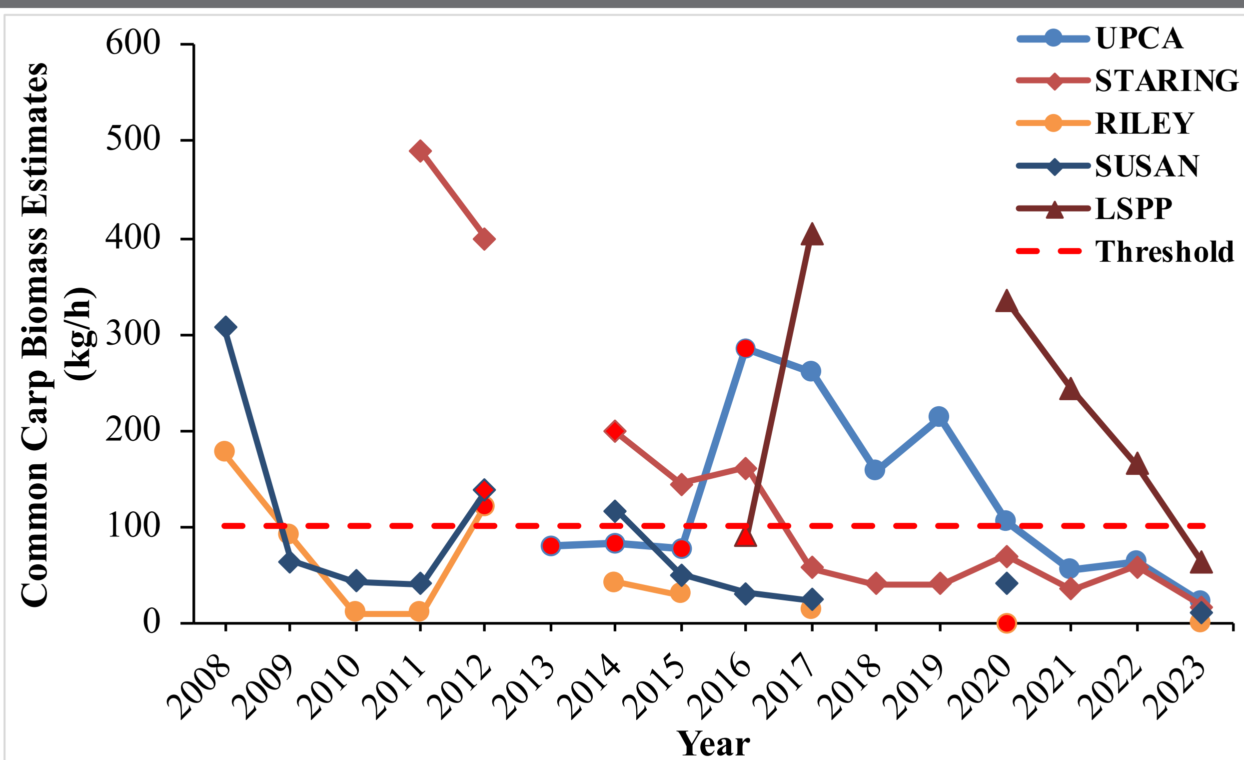
In 2023, a total of 107 YOY carp were captured via trap net surveys. Of the 107 YOY found in fyke nets, 92 were captured in the LPCRA, and 15 were found in Staring Lake. The abundance of YOY carp found in trap net surveys combined with 55 YOY carp found electrofishing on Staring indicates a full recruitment year. This recruitment is directly related to the decreased predation pressure resulting from winterkill in both Staring and the LPRCA. Although bluegills were stocked, they were only available later in the spring and the sheer numbers of YOY carp were not able to be exploited. This recruitment event marks the first time since 2015 that largescale reproduction has occurred. The amount of YOY carp in LPRCA (n=92) is a large increase from 2022 (n=4) and 2020 (n=17).

Electrofishing

Lake Susan, LSPP, and Lake Riley were the RCL waterbodies electrofished in 2023. For 2023, Lake Susan had a biomass estimate of 11.28 kg/h, well below the threshold and consistent with past estimates. LSPP continues to be a congregation area for common carp albeit reduced within the RCL system. Despite this, the 2023 biomass estimate was below the biomass threshold of 100 kg/ha at 63.54 kg/ha (Table 31). Fish move into LSPP during spring high water and are trapped as water levels recede. This was thought to be a management opportunity within the RCL lakes as carp in LSPP are more easily captured due to the pond's limited depth and area. This is also a likely explanation as to why the biomass estimates are so high, suggesting an overestimation of the population within the pond. Although the pond was suspected to be deep enough to prevent winterkill, in 2021 25 YOY carp were captured. Although the pond does offer some removal potential, staff put up a barrier at the beginning of spring in 2022 to prevent carp movement into the pond to reduce the chance of recruitment occurring. The overall reduction in adult carp in the system is likely due to the District's removal efforts. The District will continue monitoring and removing carp from LSPP in addition to the recommended management actions established in the RCL management plan. Lake Riley had no carp captured, yielding an estimate of 0 kg/ha. The carp population in Riley is comprised of a few large adults that are able to visually detect and flee surveyors because of the clear water conditions.

The PCL waterbodies surveyed via electrofishing in 2023 were Staring Lake and the UPCRA. As seen in (Figure 70), the adult common carp biomass estimates have been decreasing in Staring Lake since management began. The adult carp biomass estimate fell below the threshold for the first time in 2017, at 62 kg/ha. Since then, the population has been maintained around 40-60 kg/ha. The fish captured each year have primarily consisted of individuals from the 2014/2015-year class, which was the last major recruitment year for common carp in this system. In 2023 the adult carp biomass was the lowest ever at 18 kg/ha. Electrofishing does not regularly occur in the LPCRA due to access issues and the amount of brittle naiad present in the system. In 2023, the UPCRA carp biomass estimate was below the threshold at 23 kg/ha (Table 31). The UPCRA biomass estimate has exceeded the threshold every year from 2016 until 2020, before falling below the threshold in 2021. Since the UPCRA area is essentially the top of the system (fish cannot travel to Silver Lake and Lotus Lake), and has a deeper-water refuge, fish move to this location. The fluctuations in Staring and UPCRA can be explained by removals happening in the

Figure 70. Common Carp Biomass Estimates (2008-2023)



system and fish migrating between the watetbodies. Due to the shallowness of the system, winter seining would have limited effectiveness at capturing carp in UPCRA and LPCRA. Success of winter seining may also be limited in Staring Lake due to the low number of carp estimated in the system. Capture rates in the recreational area can be highly variable as the UMN biomass estimates were based on lakes and not wetlands/ponds (UPCRA and LPCRA are shallow water wetlands).

Unfortunately, in 2023, both Staring Lake and the Recreational Area experienced a significant winterkill with signs of low dissolved oxygen levels present even in December of 2022. This is extremely early for winterkill to occur. The winterkill was likely linked to the near record low water year which led to near zero flows in Purgatory Creek. With these conditions most native predators of carp were eliminated and a recruitment event occurred. Staff are discussing the possible placement of an aeration unit on Staring Lake to prevent such an event from happening again. Staff will attempt to remove carp in the spring of 2024 and may need to conduct other removal events to try and eliminate much of the 2023-year class.

Table 31. Common Carp Biomass Estimates for 2023.

Body of water name	Fish per Hour	Density per Hectare	Average Weight (kg)	Carp Biomass (kg/ha)
Lake Susan Park Pond	8.95	45.18	1.41	63.54
Susan	0.30	4.45	2.54	11.28
Staring	0.92	7.37	2.43	17.91
Riley	0.00	3.04	0.00	0.00
Upper PCRA	3.36	18.85	1.24	23.44

PCRA Spring Removals

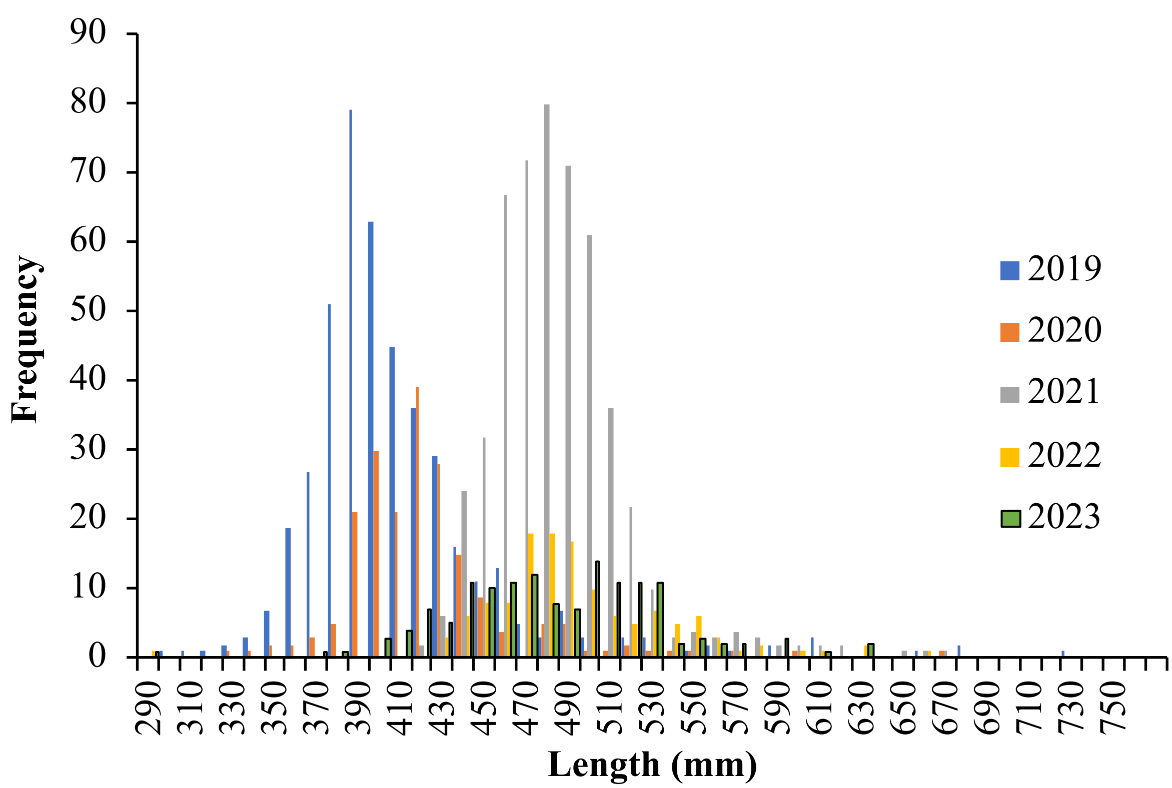
In 2014, a metal fish barrier was installed in Purgatory Creek at the outlet of the LPCRA. This was installed to prevent carp from moving into the recreational area to spawn in the spring. It was also used to trap carp in the LPCRA over winter in hopes of a complete winterkill. In 2022 and 2023, the physical carp barrier was closed all year. Due to the low water levels, the City of Eden Prairie rarely opened, cleaned, and closed the fish barrier during high water levels in the Purgatory Creek Recreational Area. The barrier was opened twice for an extended period (two weeks) in April 11-April 25 and once in late fall. During this time, fish could move freely throughout the system. Staff utilized a backpack electrofishing unit combined with block nets to remove common carp during the spring spawning run.

Backpack electrofishing and block nets were utilized in the channel upstream and downstream of the barrier and at the breach in the berm that separates the Upper and Lower Purgatory Creek Recreational Area (Figure 72). In the past, most of the fish had been captured/removed via backpack electrofishing at the breached berm site. This breach allows water to short circuit the overflow structure. Water is always flowing at this location which leads to carp concentrating in the shallow water near the breach before trying to move upstream. The sheet piling, combined with the consistent flow, has eroded the downstream side of the berm, causing a drop that impedes carp movement. A block net is anchored on the downstream side of the flow at the breach, stretched around the congregating carp, trapping them between the berm and net. During the heavy spawning run, staff repeated the process, sometimes up to three times a day, taking about an hour each time from installation of the net to completion of removal. In 2023 only one successful removal event occurred at the berm. Water levels were either too high or too low for this method to be successful. Additionally, a majority of the carp in this system are now larger in size and able to navigate the berm more easily. Upon visual inspection, it appears that the berm has further eroded and/or subsided, making it easier for fish to move freely at the site.

In 2023, the backpack electrofishing below the barrier combined with a block net across two sampling events yielded a total 144 carp removed or 416 lbs. By sex, 26% were males and 74% were females Utilizing all spring gear types in the past, a total of 315 carp were removed in 2022, 511 in 2021, 201 in 2020, 441 in 2019, and 1,901 carp in 2018. Most of the fish removed were from the 2015-year class, in which approximately 3000 YOY carp had entered Staring Lake from LPCRA and started to grow rapidly (Sorensen et al., 2015). This year class was a result of the last major recruitment event that occurred in the system until 2023 (Figure 71). In 2023, most of the carp were removed on May 23rd and 26th when water was over the top of the staff gauge and the water temperature was 20.2 degrees Celsius (May 26th). This is compared to April 19, 2022, when upstream barrier water levels were 57.4 inches (based on the installed staff gauge) and water temperatures at 7.8 degrees Celsius; April 19th, 2021, at 57.4 inches and 7.8 degrees; May 7, 2019, at 37.5 inches and 17.2 degrees; and June 29th, 2020, at 39 inches and 22 degrees Celsius. District staff have been working with the City of Eden Prairie to stabilize the berm and correct/improve the regular overflow location to allow staff to utilize the berm location for future carp removal events. Staff will utilize all the same techniques and potentially conduct electrofishing after dark in 2024 to improve capture efficiency.

Figure 72. PCRA Spring Removal Site Map

Figure 71. Length Frequency of PCRA Spring Removals (2019-2023).



5.3. Zebra Mussels

Zebra Mussels (*Dreissena polymorpha*) are native to Eastern Europe and Western Russia and introduced in the United States. Zebra Mussels can cover submerged equipment, clog water intakes, cut bare feet, smother native mussels by covering them, and they can fundamentally change the food web of a lake by extensively filtering out the phytoplankton on which many aquatic animal diets depend (MNDNRb 2015). Treatment methods available to date are considered experimental and have not been effective in eradicating Zebra Mussels from a lake once they are introduced.

Figure 73. A range of Zebra Mussel sizes have been found on monitoring plates.

The District continued to monitor for adult and veliger Zebra Mussels in 2023. The District conducted veliger sampling from June to July on 13 lakes to detect the presence of Zebra Mussels. Each lake was sampled once, apart from Lotus Lake and Lake Ann which were sampled twice. Consultant Kylie Cattoor processed the samples and only found Zebra Mussel veligers on Lake Riley in 2023. Carver County veliger testing also yielded veligers on Lotus Lake. Adult Zebra Mussel presence was assessed using monitoring plates (Figure 73) that were hung from all public access docks, as well as some private docks of residents participating in the District's Adopt-a-Dock program. Monitoring plates were checked monthly, and no mussels were found across all lakes except for Lake Riley in 2023.

Public accesses were scanned monthly for approximately five to ten minutes during the regular bi-weekly water quality sampling events. Staff visually searched anchoring sites such as rocks, docks, sticks, and vegetation for adult Zebra Mussels. Expanded visual surveys were conducted on Lotus Lake and Lake Ann, where multiple locations on each lake were intensively searched. During these intensive scans adult Zebra Mussels were only found on Lake Ann and a copper sulfate treatment occurred. Carver County also submitted water samples to process Zebra Mussel eDNA on Lotus and Ann.

Lake Ann

After a single adult Zebra Mussels was found on a swimming buoy 9/21/20, monitoring efforts were increased in attempt to make sure this was only an isolated event. On 7/12/2023, district staff conducted an intensive Zebra Mussel scan on Lake Ann. This scan occurred over a 150m area in the NE part of the lake and over a 300m area in the southern end. In the southern transects four adult Zebra Mussels were found attached to woody debris in shallow water. A rapid response survey with partners including the district, Carver County, and the DNR occurred on 7/14/2023. During this survey, divers and snorkelers intensively searched for mussels from 0-18 feet of water for a total of 14.25 hours. Five more mussels were found at the original discovery location.

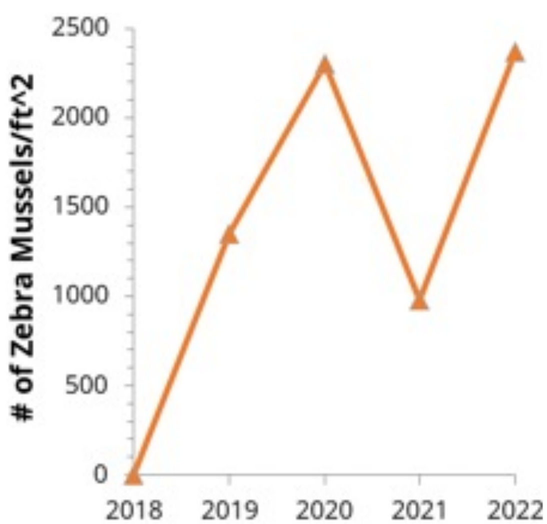
On 8/4/2023 a barricade was set up to concentrate the treatment, and on 8/7/2023 the copper sulfate treatment (EarthTechQZ) was applied to about an acre by PLM Lake and Land Management. Ideally, the treatment will eliminate mussels from the lake although there have been no known eradication events from a lake to date. At minimum the treatment will slow the spread of mussels through the lake.. No Zebra Mussels were found on attached boat launch deployed adult mussel monitoring plate. Lake Ann will be monitored in the same fashion as the other infested lakes in the district, with continued eDNA, veliger, adult mussel monitoring plates and visual surveys for population monitoring. An additional SCUBA/snorkel survey will likely be added in 2024 as well.

Lake Riley

On October 22, 2018, RPBCWD staff confirmed Zebra Mussels on Lake Riley after a lake service provider discovered some Zebra Mussels while pulling docks and lifts. Previously, no Zebra Mussels had been found in the lake during the regular monitoring season, which included all the different monitoring efforts. The Zebra Mussels appeared to be widespread across the lake at low densities. Mussels were found of varying sizes suggesting that reproduction in Lake Riley had occurred.

In 2018 Zebra Mussels were estimated at four mussels per plate and the population appeared to have peaked at 2,623 mussels per plate in 2020. In 2022, the mussels were found on all plates ranging in number from 4,015 mussels to 29,959 mussels/plate (Figure 74). This indicates a robust population that is well established across the lake. The increase in 2022 and 2023 indicates a rebound in the population that should cycle up and down in the future similar to what has been seen on Lake Minnetonka (McComas 2018).

Figure 74. Zebra Mussel density on Lake Riley, 2018-2023.



Lotus Lake

On August 30, 2019, five Zebra Mussel veligers were found in veliger tows collected by Carver County from the public access of Lotus Lake (Figure 75). No Zebra Mussel veligers were found in samples collected on June 20, 2019, or on September 10, 2019, by the RPBCWD. Additional in-lake searching occurred on October 9, 2020, by RPBCWD staff. No adult Zebra Mussels were found during the search. An additional veliger tow was collected on October 10, 2019, and eDNA samples were taken at four locations. On October 24, 2019, staff from DNR, Carver County and the RPBCWD surveyed pulled docks on shore around the lake and found five Zebra Mussels ranging in size from 6-16 millimeters on a single boat lift footing in the east bay (Figure 73). After the October survey, the eDNA results were complete and indicated Zebra Mussel eDNA was present near the boat launch sample and the east bay sample near where the adults were captured. Based on the collected information, Lotus Lake was added to the Infested Waters List for Zebra Mussels in 2019 by the MNDNR.

Similar to 2020 and 2021, veliger tows were collected twice in spring 2022 but yielded no Zebra Mussel veligers. Both boat launch and mussel plate checks (five plates, previously 10 plates) yielded no adult mussels. Staff visually searched multiple areas of the lake for mussels twice in 2022, once in August and once in October after docks were pulled. Many desiccated mussels were found on boat lifts at different locations in the east bay in 2019 and in 2022 during the fall surveys, but none were found in the lake or elsewhere. The eDNA results for 2022 were the first negative result since 2019 when mussels were found in Lotus

Figure 75. Lotus Lake Zebra Mussel summary map.

Lake. Several hundered Zebra Mussels were found dessicated on a lift in 2023 during the fall survey on the north end of the lake. Staff will continue to monitor for Zebra Mussels in 2024.

Lake Suitability for Zebra Mussels

The chemical and physical makeup of a lake determines the suitability of that lake to support Zebra Mussels. Like many organisms, there is a wide range of suitable conditions in which Zebra Mussels can survive. Optimal conditions are conditions in which there are no limiting variables that are controlling an organism's ability to grow and reproduce. Table 32 lists the different variables associated with Zebra Mussels measured by the District in 2023 for Lake Riley, Lotus Lake, and Lake Ann. The criteria in Table 32 used to determine the level of infestation by Zebra Mussels in North America (Mackie and Claudi 2010) with the variables being arranged from greatest to least importance for determining suitability for Zebra Mussels. For consistency, all variables included in the analysis were measured during the summer growing season (June-September) and include only the top two meters for the lakes. The different variables can be grouped into three categories:

- Chalk variables which are needed for shell formation.
- Trophic (nutrient) variables which are associated with growth and reproductive success.
- Physical variables or basic lake variables that limit where Zebra Mussels can live in a lake.

Calcium concentrations were estimated based on average monthly alkalinity samples. Comparing all lakes in the District with the calcium threshold established by Mackie and Claudi 2010, only Round and Hyland have less than optimal calcium concentrations (>30 mg/L) for Zebra Mussels. Alkalinity and pH are associated with calcium concentrations and were both highly suitable for sustaining Zebra Mussels in the three lakes. The nutrient variables for Lake Riley and Lake Ann were at moderate to high levels for Zebra Mussel suitability. Lotus Lake nutrient data indicates minimal growth parameters for Zebra Mussels because of lower Secchi disk depths and higher Chlorophyll-a concentrations. This indicates the Zebra Mussel population may not be as significant if they invade Lotus Lake. Steve McComas of Blue Water Science found Chlorophyll-a concentrations directly impacted Zebra Mussel populations in Lake Minnetonka bays. Areas of the lake with optimal chlorophyll conditions experienced significant reductions in chlorophyll concentrations after infestation. This was followed by a Zebra Mussel dieback, occurring three to four years after the first mussels were found (McComas 2018). Physical variables all scored moderate to high for Zebra Mussel suitability in Riley and Lotus. These variables all change with depth, however optimal conditions for each were present in both lakes. Hard structure suitability was estimated as moderately suitable in both lakes but had low suitability in Lake Ann due to the lack of hard structure. In 2016, it was found that 98 percent of the Zebra Mussel population in Lake Minnetonka were mostly juveniles and were found on submerged aquatic plants (McComas 2018). That said, it was hypothesized that many of those individuals died off and the main source of Zebra Mussel year to year recruitment may be from small but dense groups of adults spread on isolated hard structure in slightly deeper portions of the lake. Hard structure in Riley and Lotus lakes included predominantly rock and woody debris and is hypothesized to not be limiting for Zebra Mussels.

Based on the results in Table 32 the suitability of Lake Riley to support a robust and expansive Zebra Mussel population is high. These results were confirmed by mussel counts on plates placed by Adopt-a-Dock volunteers. Once large Zebra Mussel populations become established, it is hypothesized that Chl-a and TP will decrease, and water clarity will increase due to Zebra Mussel filtering rates. Table 32 indicates that in Lotus Lake a slow growing or restricted population limited by minimal growth nutrient levels. Lake Ann would likely have moderate growth.

Table 32. Suitability of lake conditions to support a robust and expansive Zebra Mussel population.

	Variable	Suitability Ranges			Lake Suitability by Variable		
		Low	Moderate	Maximum	ANN	LOTUS	RILEY
Shell formation	Calcium (mg/L)	8-15	15-30	30-80	41	56	44
	Alkalinity (mg/L)	30-55	55-100	100-280	145.5	173	140.5
	pH	7-7.8; 9-9.5	7.8-8.2; 8.8-9	8.2-8.8	8.53	8.65	8.51
Trophic variables	TP (µg/L)	5-10; 35-50	10-25	25-35	22	33	15
	Chl-a (µg/L)	2-2.5; 20-25	8-20	2.5-8	11.0	25.4	4.5
	Secchi (m)	1-2; 6-8	4-6	2-4	2.8	1.5	4
Physical variables	Temp (° C)	26-32	10-20	20-26	24.8	24.2	23.8
	DO (mg/L)	3-7	7-8	>8	8.98	8.82	8.79
	Cond (uS/cm)	0-60	60-110	>110	317	483	589
	Hard Structure	Low	Moderate	Max	Low	Moderate	Moderate

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7: APPENDIX

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Exhibit A. Historical and 2023 Lake Level Graphs (NAVD 1929)

Figure A-1: Water surface elevation on Lake Ann from 2013 to 2023 & Ordinary High-Water Level (955.5 ft).

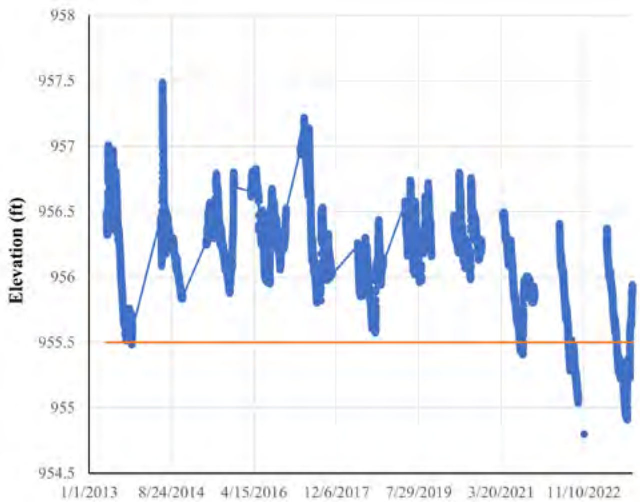


Figure A-2: Water surface elevation, precipitation & Ordinary High-Water Level on Lake Ann 2023 (955.5 ft).

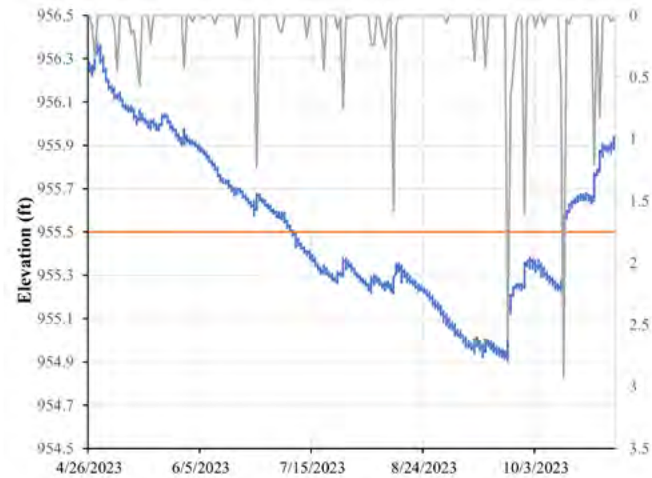


Figure A-3: Water surface elevation on Duck Lake from 2013 to 2023 & Ordinary High-Water Level (915.3 ft).

Figure A-4: Water surface elevation, precipitation & Ordinary High-Water Level on Duck Lake 2023 (915.3 ft).

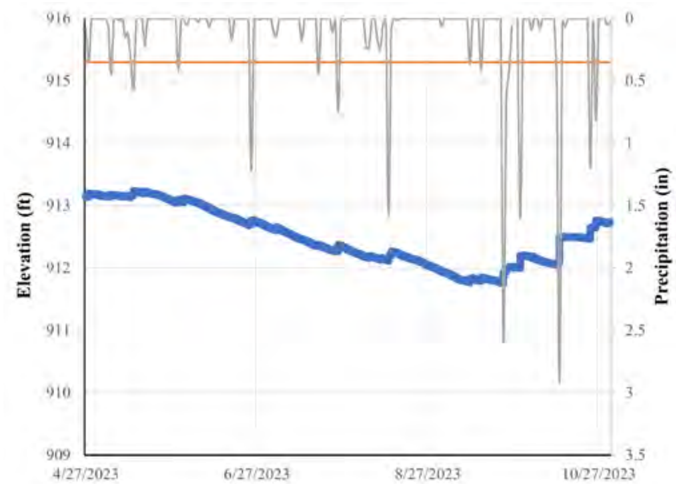


Figure A-5: Water surface elevation on Hyland Lake from 1970 to 2023 & Ordinary High-Water Level (817.9 ft).

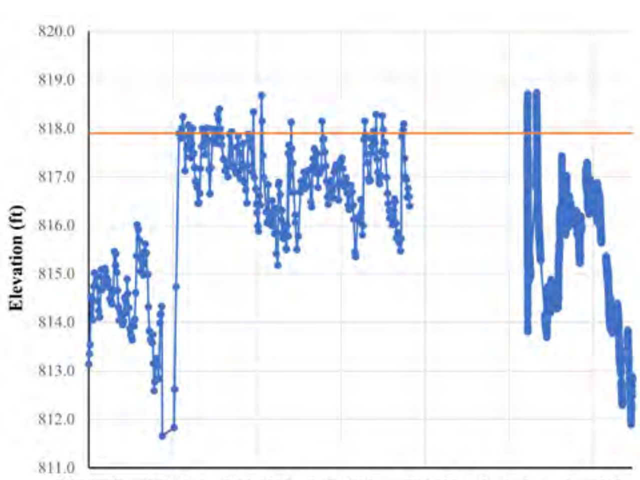


Figure A-6: Water surface elevation, precipitation & Ordinary High-Water Level on Hyland Lake 2023 (817.9 ft).

Figure A-7: Water surface elevation on Lake Idlewild from 2015 to 2023 & Ordinary High-Water Level (856 ft).

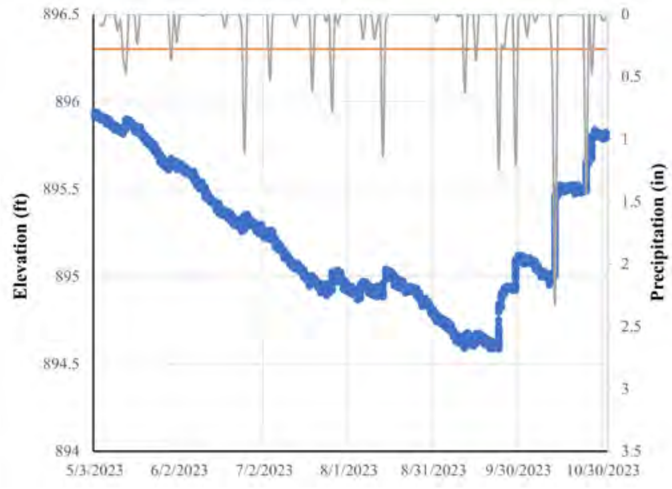


Figure A-8: Water surface elevation, precipitation & Ordinary High-Water Level on Lake Idlewild 2023 (856 ft).

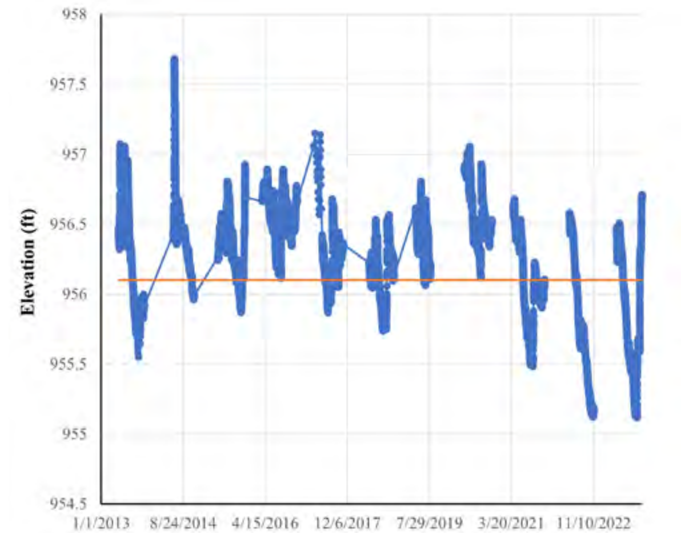


Figure A-9: Water surface elevation on Lotus Lake from 2013 to 2023 & Ordinary High-Water Level (896.3 ft).

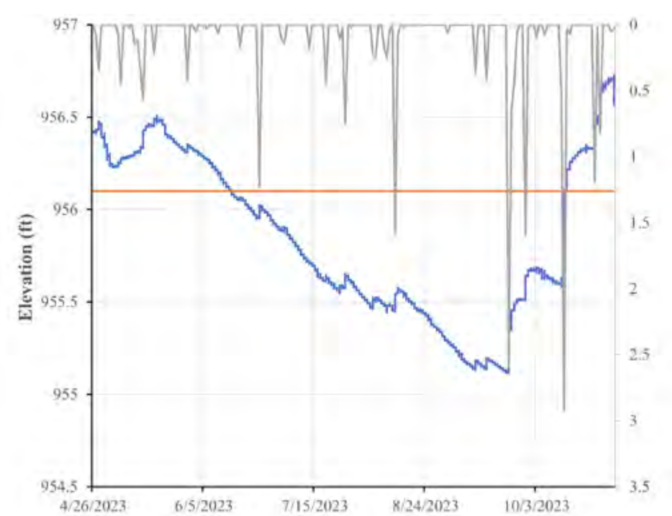


Figure A-10: Water surface elevation, precipitation & Ordinary High-Water Level on Lotus Lake 2023 (896.3 ft).

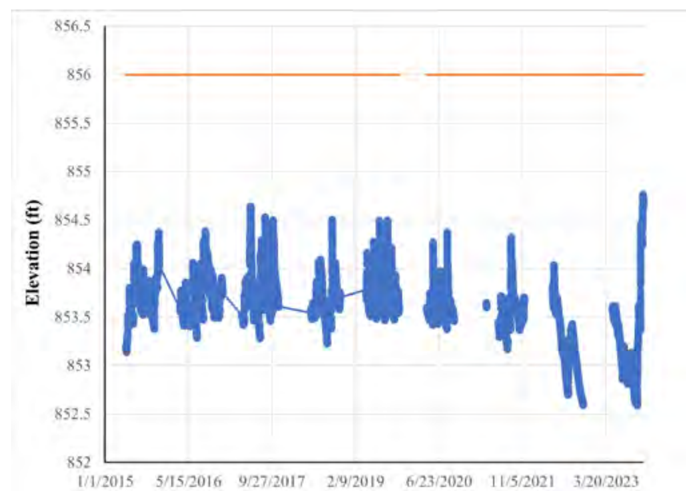


Figure A-11: Water surface elevation on Lake Lucy from 2013 to 2023 & Ordinary High-Water Level (956.1 ft).

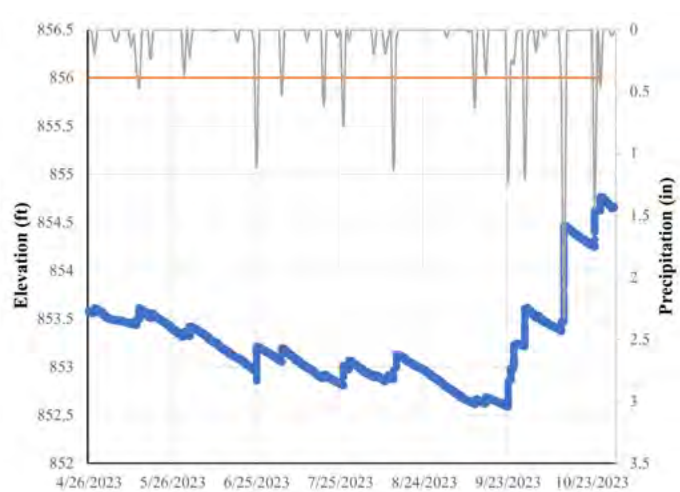


Figure A-12: Water surface elevation, precipitation & Ordinary High-Water Level on Lake Lucy 2023 (956.1 ft).

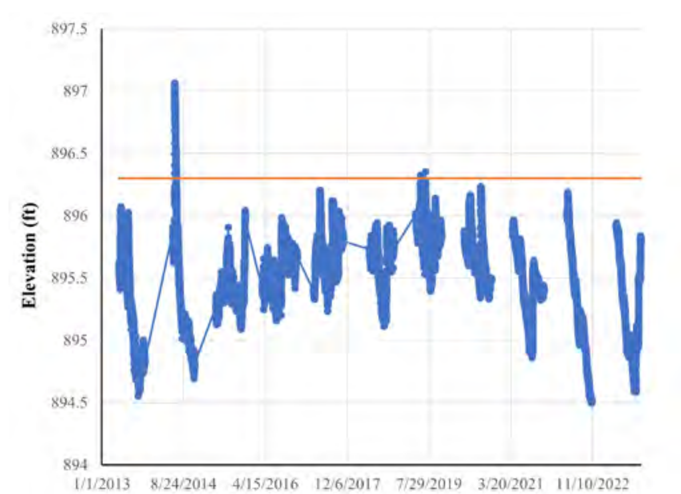


Figure A-13: Water surface elevation on Mitchell Lake from 2013 to 2023 & Ordinary High-Water Level (815.3 ft).

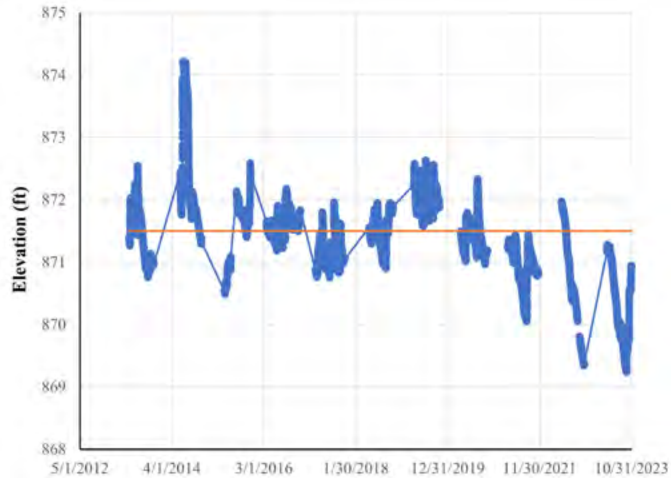


Figure A-14: Water surface elevation, precipitation & Ordinary High-Water Level Mitchell Lake 2023 (815.3 ft).

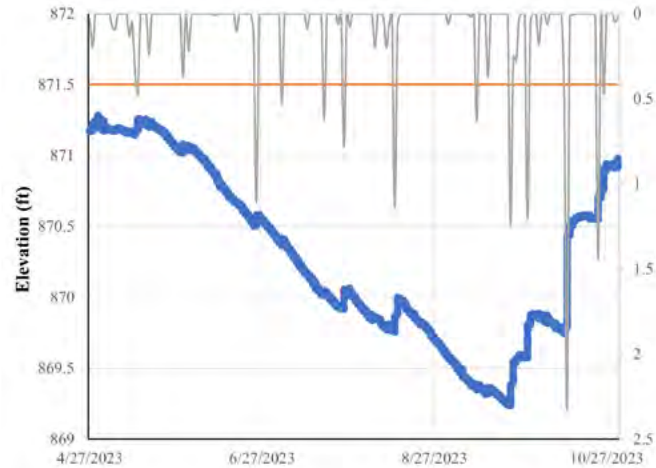


Figure A-15: Water surface elevation on Red Rock Lake from 2013 to 2023 & Ordinary High-Water Level (840.5 ft).

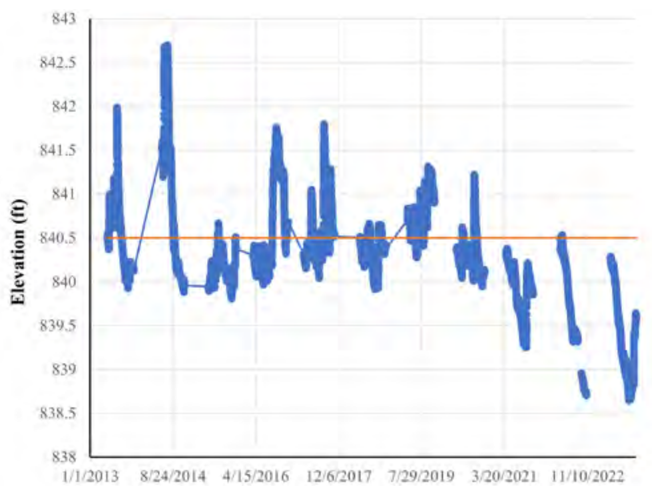


Figure A-16: Water surface elevation, precipitation & Ordinary High-Water Level Red Rock Lake 2023 (840.5 ft).

Figure A-17: Water surface elevation on Rice Marsh Lake from 2013 to 2023 & Ordinary High-Water Level (877 ft).

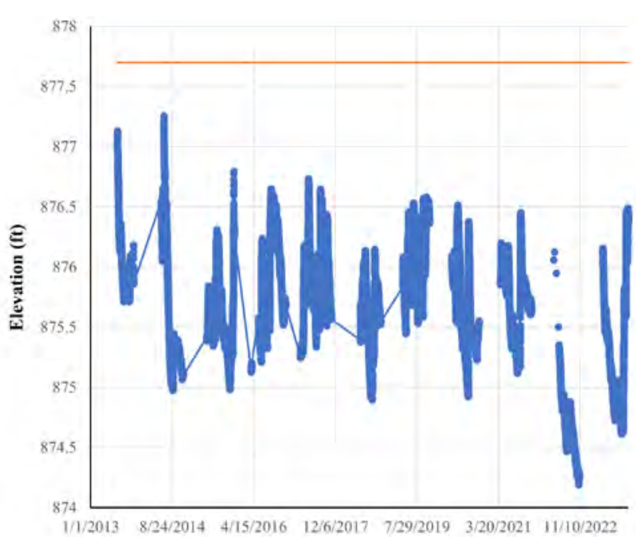


Figure A-18: Water surface elevation, precipitation & Ordinary High-Water Level Rice Marsh Lake 2023 (877 ft).

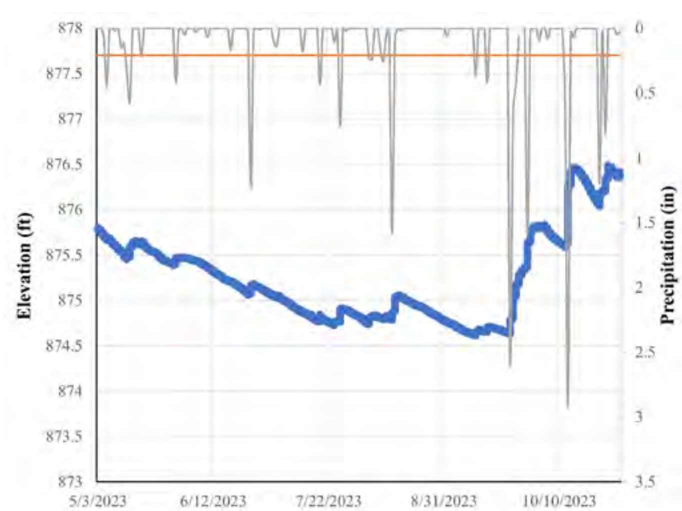


Figure A-19: Water surface elevation on Lake Riley from 2013 to 2023 & Ordinary High-Water Level (865.3 ft).

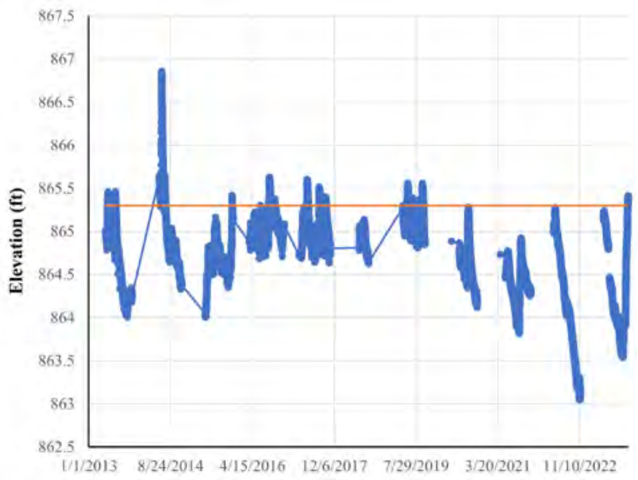


Figure A-20: Water surface elevation, precipitation & Ordinary High-Water Level Lake Riley 2023 (865.3 ft).

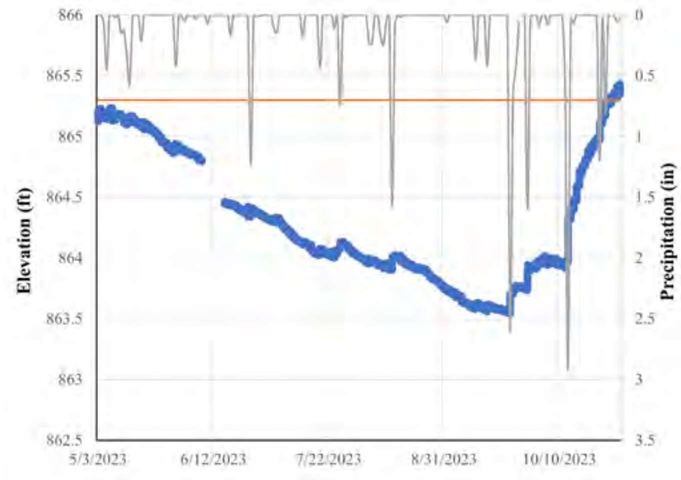


Figure A-21: Water surface elevation on Round Lake from 2013 to 2023 & Ordinary High-Water Level (880.8 ft).

Figure A-22: Water surface elevation, precipitation & Ordinary High-Water Level Round Lake 2023 (880.8 ft).

Figure A-23: Water surface elevation on Silver Lake from 2013 to 2023 & Ordinary High-Water Level (898.1 ft).

Figure A-24: Water surface elevation, precipitation & Ordinary High-Water Level Silver Lake 2023 (898.1 ft).

Figure A-25: Water surface elevation on Staring Lake from 2013 to 2023 & Ordinary High-Water Level (815.3 ft).

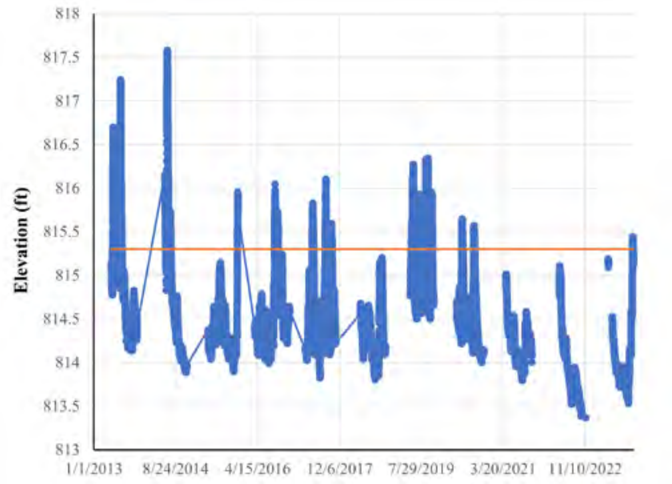


Figure A-26: Water surface elevation, precipitation & Ordinary High-Water Level Staring Lake 2023 (815.3 ft).

Figure A-27: Water surface elevation on Lake Susan from 2013 to 2023 & Ordinary High-Water Level (881.8 ft).

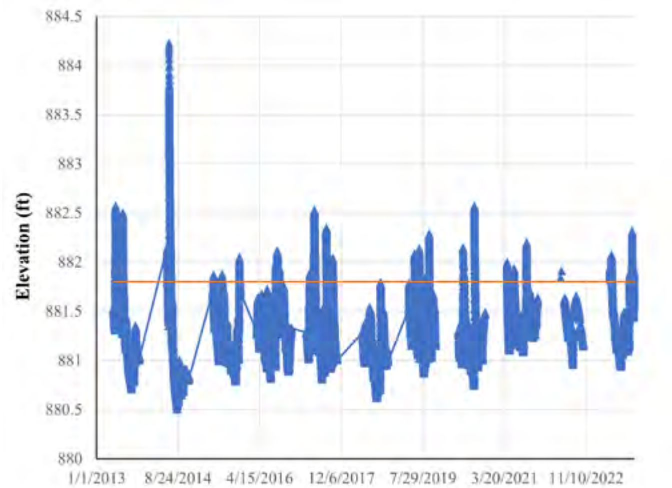


Figure A-28: Water surface elevation, precipitation & Ordinary High-Water Level Lake Susan 2023 (881.8 ft).

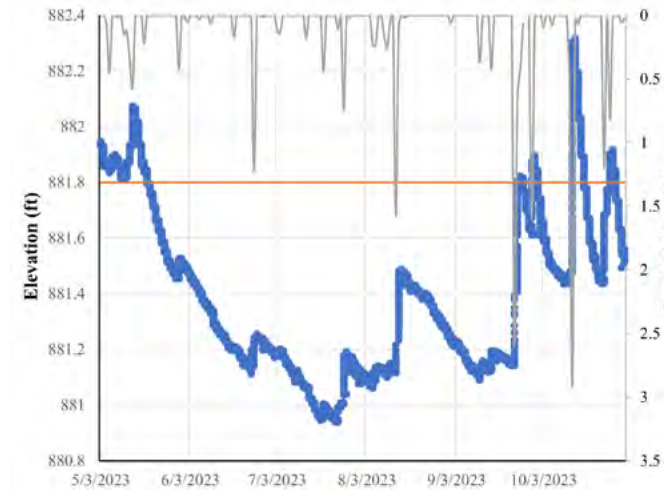


Figure A-29: Water surface elevations on Lake Eden from 2021 to 2023.

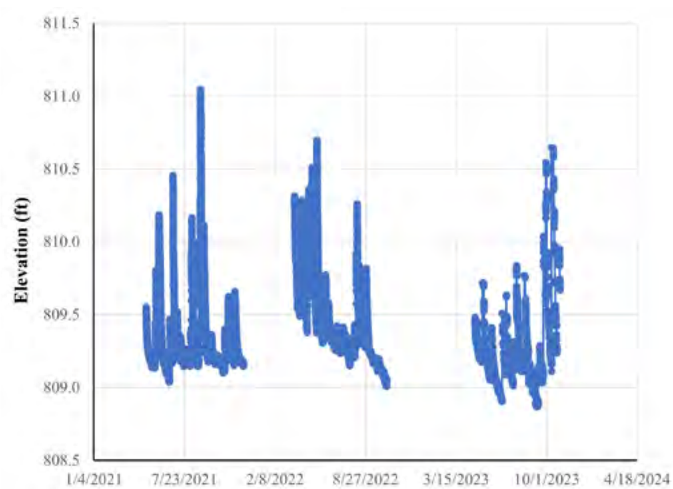


Figure A-30: Water surface elevation & precipitation Lake Eden 2023.

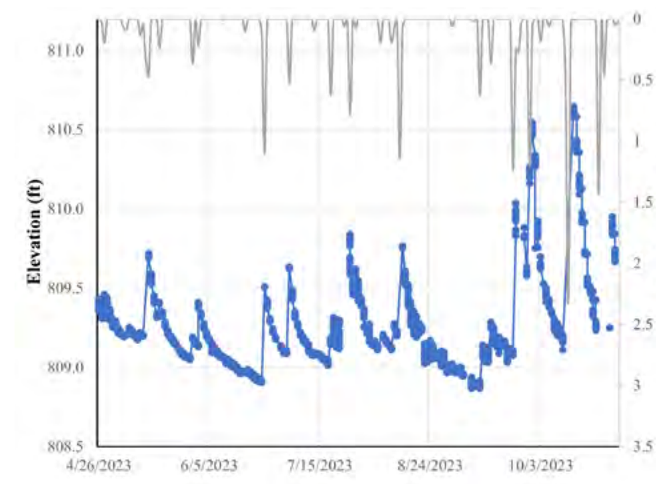


Figure A-31: Water surface elevation on Lake McCoy from 2020 to 2023 & Ordinary High-Water Level (824.5 ft).

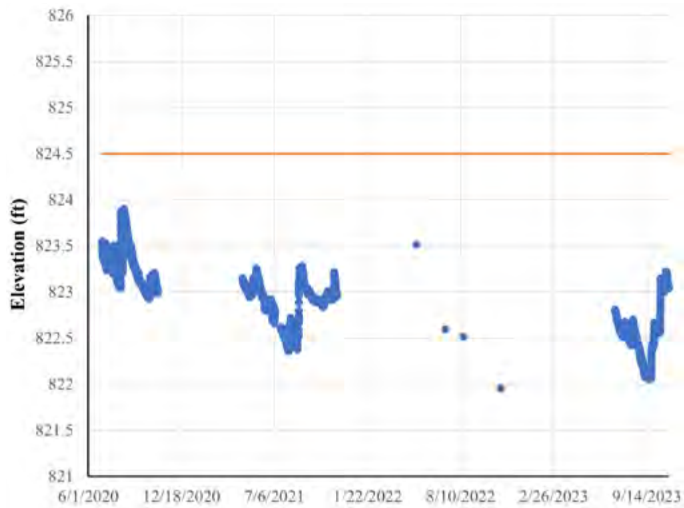


Figure A-32: Water surface elevation, precipitation & Ordinary High-Water Level Lake McCoy 2023 (824.5 ft).

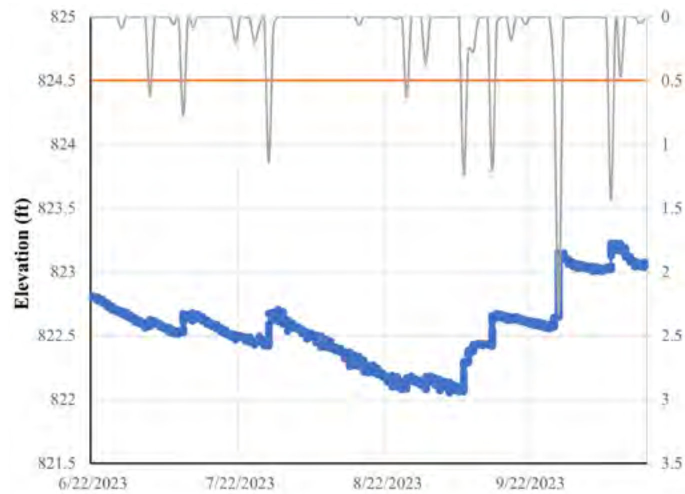


Exhibit B. 2023 Trap Net Summary Data

Table B-1: 2023 **Lower Purgatory Recreation Area** trap net data.

Species	Number of fish caught in each category (inches)												
	0-5	6-7	8-9	10-11	12-14	15-19	20-24	25-29	30-34	35-39	40-44	Total	2023 Fish/Net
Black bullhead	842	44	3									889	222.25
Black crappie	791	6	3	2								800	200
Bluegill sunfish	19											19	4.75
Bigmouth buffalo	12	1										13	3.25
Common carp	89	3	1			23	6		1			123	30.75
Green sunfish	24											24	6
Golden shiner	7											7	1.75
Hybrid sunfish	22	1										23	5.75
Largemouth bass	6	2				1						9	2.25
Pumpkinseed sunfish	33											33	8.25
Yellow bullhead	14	5	11	2								32	8
Yellow perch	1											1	0.25
Total												**1973**	**493.25**

Table B-2: 2023 **Lake Lucy** trap net data.

Species	Number of fish caught in each category (inches)												
	0-5	6-7	8-9	10-11	12-14	15-19	20-24	25-29	30-34	35-39	40-44	Total	2023 Fish/Net
Black crappie	13	1	14	3								31	6.2
Bluegill sunfish	64	18	1									83	16.6
Common carp							6	3				9	1.8
Green sunfish	5											5	1
Hybrid sunfish	15	16										31	6.2
Largemouth bass	2											2	0.4
Northern pike			1	1								2	0.4
Pumpkinseed	85	4										89	17.8
Yellow bullhead	14	10	13	7								44	8.8
Yellow perch	1	1										2	0.4
Total												**298**	**59.6**

Table B-3: 2023 **Rice Marsh Lake** trap net data.

Species	Number of fish caught in each category (inches)												
	0-5	6-7	8-9	10-11	12-14	15-19	20-24	25-29	30-34	35-39	40-44	Total	2023 Fish/Net
Black crappie	16	1	1									18	3.6
Bluegill sunfish	21	68	1									90	18
Brown bullhead					1							1	0.2
Largemouth bass	1											1	0.2
Northern pike						1						1	0.2
Pumpkinseed sunfish	4	1										5	1
Yellow bullhead			1	3								4	0.8
Total												**120**	**24**

Table B-4: 2023 **Staring Lake** trap net data.

Species	Number of fish caught in each category (inches)											
	0-5	6-7	8-9	10-11	12-14	15-19	20-24	25-29	30-34	35-39	40-44	Total	2023 Fish/Net
Black bullhead	2582	7	5	9								2603	520.6
Black crappie	21	17	13	1								52	10.4
Bluegill sunfish	41	14	11				2					68	13.6
Bigmouth buffalo		4										4	0.8
Common carp	7	8					5					20	4
Green sunfish		4										4	0.8
Hybrid sunfish	2	3										5	1
Largemouth bass	8	3										11	2.2
Northern pike					4							4	0.8
Pumpkinseed sunfish	2											2	0.4
Walleye						1						1	0.2
Yellow bullhead		1										1	0.2
Yellow perch	4	3										7	1.4
Total												**2782**	**556.4**

Table B5: 2023 **Upper Purgatory Creek Recreation Area** trap net data.

Species	Number of fish caught in each category (inches)											
	0-5	6-7	8-9	10-11	12-14	15-19	20-24	25-29	30-34	35-39	40-44	Total	2023 Fish/Net
Black crappie	439	1					5	6	43			494	123.5
Bluegill sunfish	130						4					134	33.5
Common carp				4								4	1
Green Sunfish	1											1	0.25
Golden shiner	1											1	0.25
Northern pike			1		4	5						10	2.5
Yellow perch	6						1					7	1.75
Total												**651**	**162.75**

Exhibit C. 2023 Phytoplankton Summary Data

Table C-1: 2023 **Lotus Lake** Phytoplankton #/mL

	5/25/2023	7/6/2023	7/31/2023	9/11/2023
Class	#/mL	#/mL	#/mL	#/mL
Chlorophyta	1,206	6,548	1,838	796
Chrysophyta	0	0	0	0
Cyanophyta	57	4,021	18,494	51,371
Bacillariophyta	0	172	0	100
Cryptophyta	172	919	115	896
Euglenophyta	0	0	0	0
Pyrrophyta	0	0	0	0
Total	1,435	11,660	20,447	53,063

Table C-2: 2023 **Rice Marsh Lake** Phytoplankton #/mL

	5/23/2023	7/5/2023	7/31/2023	9/14/2023
Class	#/mL	#/mL	#/mL	#/mL
Chlorophyta	3,274	2,010	2,642	1,378
Chrysophyta	230	0	0	0
Cyanophyta	57	517	1,838	287
Bacillariophyta	57	115	804	0
Cryptophyta	4,250	1,436	2,068	1,321
Euglenophyta	0	0	0	0
Pyrrophyta	0	57	0	0
Total	7,869	4,135	7,352	2,987

Table C-3: 2023 **Lake Riley** Phytoplankton #/mL

	5/25/2023	7/6/2023	8/1/2023	9/12/2023
Class	#/mL	#/mL	#/mL	#/mL
Chlorophyta	2,183	5,342	4,652	2,470
Chrysophyta	459	0	0	0
Cyanophyta	57	5,973	2,699	2,355
Bacillariophyta	115	57	0	402
Cryptophyta	976	804	976	517
Euglenophyta	0	0	0	0
Pyrrhophyta	0	0	115	115
Total	3,791	12,176	8,443	5,858

Table C-4: 2023 **Staring Lake** Phytoplankton #/mL

	5/25/2023	7/5/2023	8/2/2023	9/13/2023
Class	#/mL	#/mL	#/mL	#/mL
Chlorophyta	2,355	14,761	16,082	21,826
Chrysophyta	115	230	0	0
Cyanophyta	57	8,788	305,558	111,425
Bacillariophyta	230	8,328	4,595	6,892
Cryptophyta	632	689	2,297	6,892
Euglenophyta	0	115	0	0
Pyrrhophyta	0	345	0	1,149
Total	3,389	33,255	328,533	148,184

Table C-5: 2023 **Lake Susan** Phytoplankton #/mL

	5/24/2023	7/10/2023	8/2/2023	9/13/2023
Class	#/mL	#/mL	#/mL	#/mL
Chlorophyta	1,436	24,783	28,718	17,231
Chrysophyta	0	0	0	0
Cyanophyta	3,475	40,161	215,959	160,820
Bacillariophyta	1,838	254	0	1,149
Cryptophyta	1,465	1,779	1,149	3,446
Euglenophyta	0	0	0	0
Pyrrhophyta	0	127	1,149	0
Total	8,213	67,105	246,974	182,646

Exhibit D. 2023 Zooplankton Summary Data

Table D-1: 2023 Lotus Lake Zooplankton (number/m²)

DIVISION	TAXON	5/25/2023 #/m²	6/21/2023 #/m²	7/31/2023 #/m²	9/11/2023 #/m²
CLADOCERA	*Bosmina longirostris*	0	0	18,986	6,253
	Ceriodaphnia sp.	0	3,428	0	0
	Chydorus sphaericus	0	0	0	0
	Daphnia galeata mendotae	134,670	13,712	4,746	0
	Daphnia retrocurva	21,547	10,284	18,986	28,139
	Diaphanosoma leuchtenbergianum	0	0	23,732	15,633
	CLADOCERA TOTAL	**156,217**	**27,424**	**66,450**	**50,026**
COPEPODA	*Cyclops sp. / Mesocyclops sp.*	1,352,084	6,856	85,435	28,139
	Nauplii	624,868	41,135	109,167	37,519
	Diaptomus sp.	113,123	23,996	33,225	18,760
	COPEPODA TOTAL	**2,090,075**	**71,987**	**227,827**	**84,418**
ROTIFERA	*Asplanchna sp.*	5,387	0	0	0
	Brachionus sp.	0	0	0	0
	Filinia longiseta	37,708	0	0	0
	Keratella sp.	2,704,169	17,140	113,914	221,989
	Keratella quadrata	0	3,428	0	0
	Keratella bostoniensis	134,670	6,856	61,703	9,380
	Kellicottia sp.	0	0	0	0
	Polyarthra sp.	21,547	6,856	18,986	21,886
	Conochilus sp.	0	0	4,746	215,735
	ROTIFERA TOTAL	**2,903,480**	**34,280**	**199,349**	**468,990**
	TOTALS	**5,149,772**	**133,690**	**493,626**	**603,434**

Table D-2: 2023 Rice Marsh Lake Zooplankton (number/m²)

DIVISION	TAXON	5/23/2023 #/m²	6/20/2023 #/m²	7/31/2023 #/m²	9/14/2023 #/m²
CLADOCERA	*Bosmina longirostris*	5,274	22,602	0	22,602
	Ceriodaphnia sp.	0	0	11,301	139,378
	Chydorus sphaericus	52,738	0	90,408	22,602
	Acroperus sp.	0	0	0	0
	Daphnia galatea mendotae	47,464	0	0	0
	Diaphanosoma leuchtenbergianum	0	0	0	0
	CLADOCERA TOTAL	**105,476**	**22,602**	**101,709**	**184,582**
COPEPODA	*Cyclops sp. / Mesocyclops sp*	5,274	0	118,660	67,806
	Diaptomus sp.	0	0	0	290,058
	Nauplii	553,747	45,204	435,087	143,145
	Copepodid	0	0	0	0
	COPEPODA TOTAL	**559,021**	**45,204**	**553,747**	**501,009**
ROTIFERA	*Asplanchna priodonta*	0	0	0	7,534
	Brachionus sp.	0	0	5,650	0
	Conochilus sp.	0	0	0	7,534
	Filinia longiseta	0	0	25,314	0
	Monostyla sp.	0	0	2,110	0
	Keratella cochlearis	0	0	0	0
	Keratella sp.	455,956	13,561	16,876	66,713
	Kellicottia sp.	0	0	0	0
	Platyias sp.	0	0	0	0
	Polyarthra vulgaris	10,058	0	145,556	229,146
	Trichocerca multicrinis	0	0	0	0
	UID Rot	0	0	0	0
	ROTIFERA TOTAL	**466,014**	**13,561**	**195,507**	**303,393**
	TOTALS	**1,130,510**	**81,367**	**850,962**	**988,985**

Table D-3: 2023 Lake Riley Zooplankton (number/m²)

DIVISION	TAXON	5/25/2023 #/m²	6/21/2023 #/m²	8/1/2023 #/m²	9/12/2023 #/m²
CLADOCERA	*Bosmina longirostris*	0	6,329	19,438	2,486
	Ceriodaphnia sp.	0	0	0	0
	Chydorus sphaericus	0	0	0	0
	Daphnia ambigua/parvula	0	0	0	0
	Daphnia galeata mendotae	155,388	56,957	4,859	17,403
	Daphnia pulex	0	28,478	14,578	0
	Daphnia retrocurva	0	0	0	2,486
	Diaphanosoma leuchtenbergianum	0	0	4,859	0
	Immature Cladocera	0	0	0	0
	CLADOCERA TOTAL	**155,388**	**91,764**	**43,735**	**22,376**
COPEPODA	*Cyclops sp. / Mesocyclops sp.*	122,427	41,135	58,313	22,376
	Diaptomus sp.	32,961	25,314	29,156	19,890
	Nauplii	1,059,465	82,271	374,175	34,807
	Calanoida	0	0	0	0
ROTIFERA	**COPEPODA TOTAL**	**1,214,853**	**148,721**	**461,644**	**77,073**
	Asplanchna sp.	9,417	6,329	0	4,972
	Keratella sp.	197,767	259,470	92,329	0
	Keratella quadrata	9,417	0	0	0
	Kellicottia sp.	230,728	79,107	4,859	87,017
	Polyarthra sp.	287,233	101,257	21,8674	39,779
	Conochilus sp.	0	0	228,392	0
	ROTIFERA TOTAL	**734,562**	**446,162**	**544,254**	**131,769**
	TOTALS	**2,104,804**	**686,646**	**1,049,633**	**231,218**

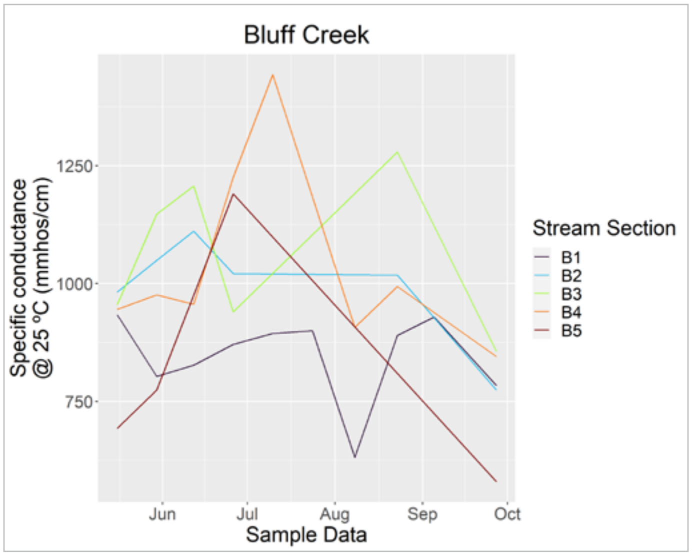
Table D-4: 2023 Staring Lake Zooplankton (number/m²)

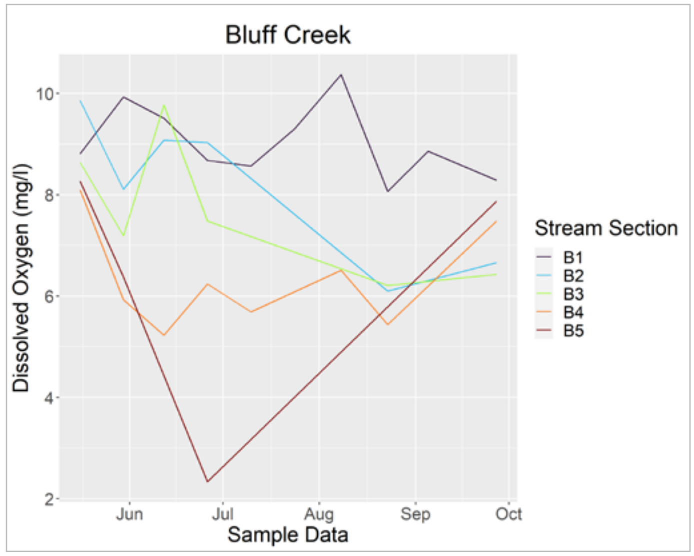
DIVISION	TAXON	5/25/202 #/m²	6/20/2023 #/m²	8/2/2023 #/m²	9/13/2023 #/m²
CLADOCERA	*Bosmina longirostris*	18,082	0	338,577	72,326
	Ceriodaphnia sp.	0	0	3,164	0
	Chydorus sphaericus	0	0	0	0
	Daphnia parvula	28,930	0	0	0
	Daphnia galeata mendotae	50,628	88,901	0	0
	Daphnia retrocurva	43,396	0	0	0
	Diaphanosoma leuchtenbergianum	0	0	9,493	0
	CLADOCERA TOTAL	**141,036**	**88,901**	**351,234**	**72,326**
COPEPODA	*Cyclops sp. / Mesocyclops sp.*	108,489	88,901	148,721	62,683
	Nauplii	289,305	160,022	420,848	419,492
	Diaptomus sp.	3,616	8,890	3,164	7,233
	COPEPODA TOTAL	**401,410**	**257,813**	**572,733**	**489,407**
ROTIFERA	Asplanchna sp.	25,314	93,346	6,329	0
	Brachionus angularis	0	17,780	15,821	4,822
	Brachionus havanaensis	0	0	0	57,861
	Filinia longiseta	0	0	0	0
	Lecane sp.	0	0	37,971	0
	Monostyla sp.	0	0	3,164	0
	Keratella cochlearis	144,652	195,582	348,070	547,268
	Keratella quadrata	0	0	0	0
	Kellicottia sp.	0	0	0	0
	Polyarthra sp.	7,233	22,225	655,004	636,470
	ROTIFERA TOTAL	**177,199**	**328,933**	**1,066,358**	**1,246,420**
	TOTALS	**719,645**	**675,647**	**1,990,325**	**1,808,153**

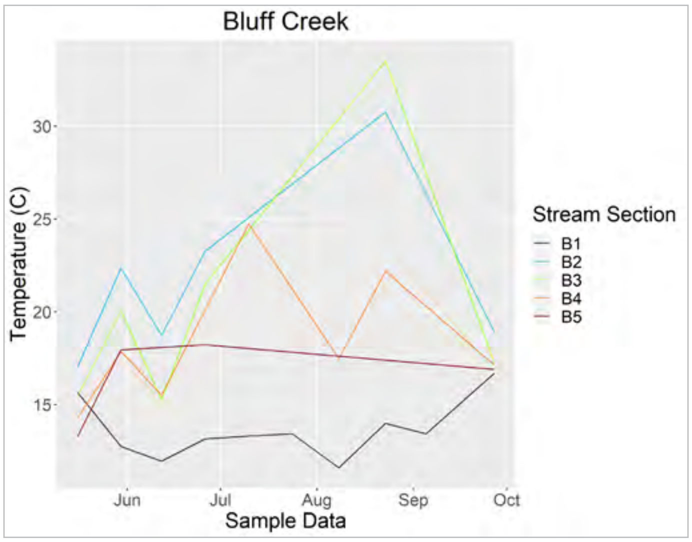
Table D-5: 2023 Lake Susan Zooplankton (number/m^2)

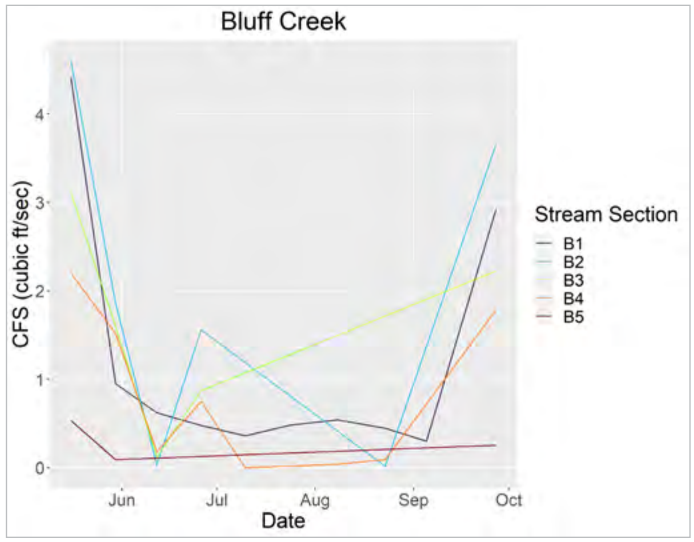
DIVISION	TAXON	5/24/22 #/m^2	6/22/22 #/m^2	8/2/22 #/m^2	9/13/22 #/m^2
CLADOCERA	*Bosmina longirostris*	0	0	0	0
	Ceriodaphnia sp.	0	0	0	0
	Chydorus sphaericus	0	0	0	0
	Daphnia galeata mendotae	42,379	3,955	0	0
	Daphnia pulex	23,544	0	0	0
	Diaphanosoma leuchtenbergianum	0	0	5,876	28,328
	Leptodora kindtii	0	0	0	3,541
	CLADOCERA TOTAL	**65,922**	**3,955**	**5,876**	**28,328**
COPEPODA	*Cyclops sp. / Mesocyclops sp.*	47,087	3,955	52,888	24,787
	Nauplii	75,340	3,955	393,725	262,032
	Diaptomus Sp.	23,544	0	14,691	28,328
	COPEPODA TOTAL	**145,971**	**7,911**	**461,305**	**315,146**
ROTIFERA	*Asplanchna priodonta*	0	0	0	0
	Brachionus havanaensis	0	0	23,506	0
	Filinia longiseta	0	0	20,568	0
	Lecane sp.	0	0	0	0
	Monostyla sp.	0	0	0	0
	Keratella sp.	301,359	7,911	449,552	159,344
	Keratella quadrata	18,835	0	0	0
	Keratella bostoniensis	0	0	2,938	0
	Kellicottia sp.	0	0	0	0
	Trichocerca multicrinis	0	0	0	0
	ROTIFERA TOTAL	**320,194**	**7,911**	**496,564**	**159,344**
	TOTALS	**532,087**	**19,777**	**963,746**	**502,817**

Exhibit E. 2023 Creek Seasonal Sonde & Flow Data : **BLUFF CREEK**









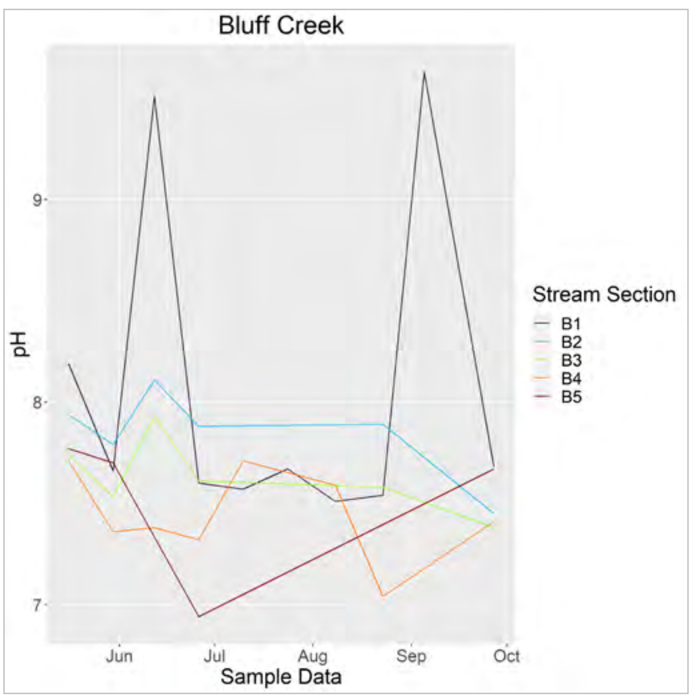
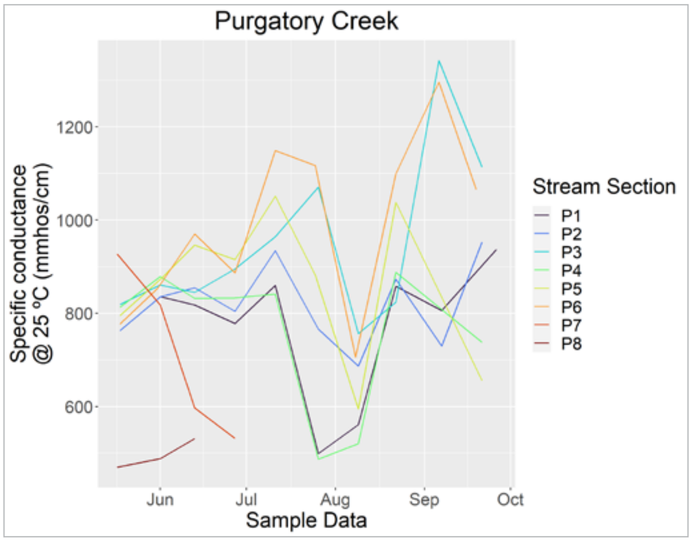
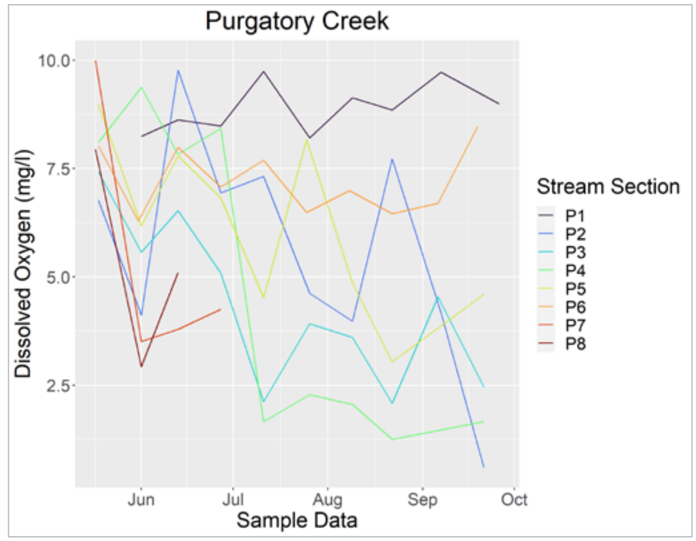
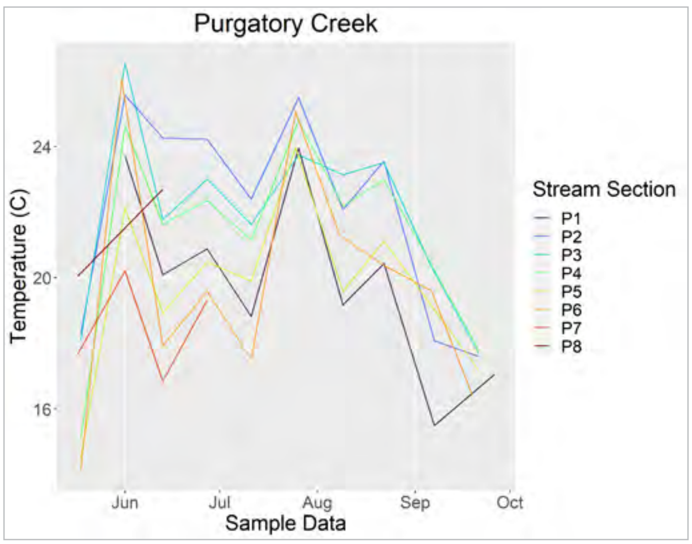
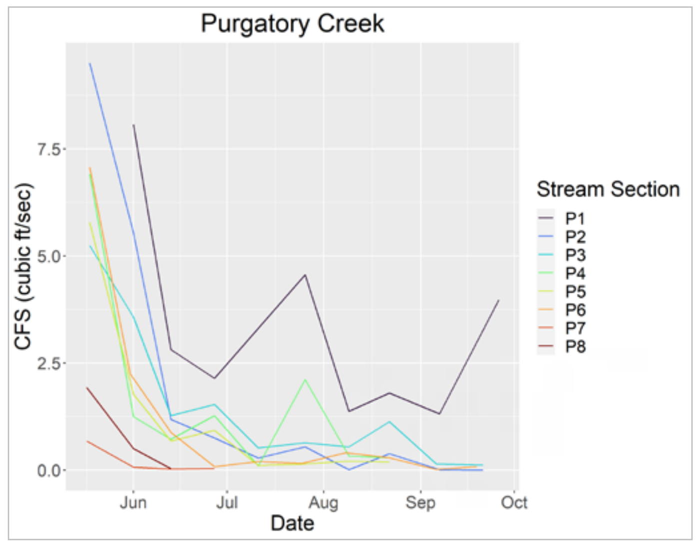


Exhibit E. 2023 Creek Seasonal Sonde & Flow Data: **PURGATORY CREEK**









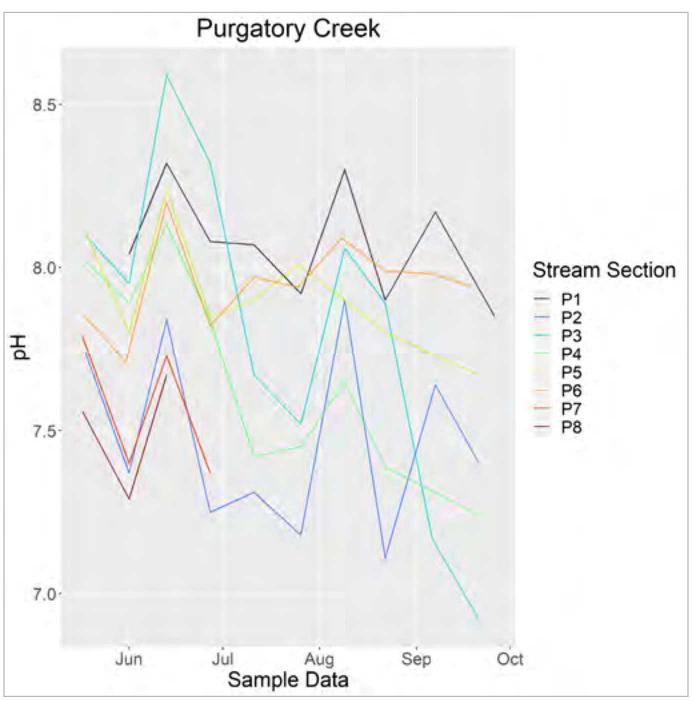
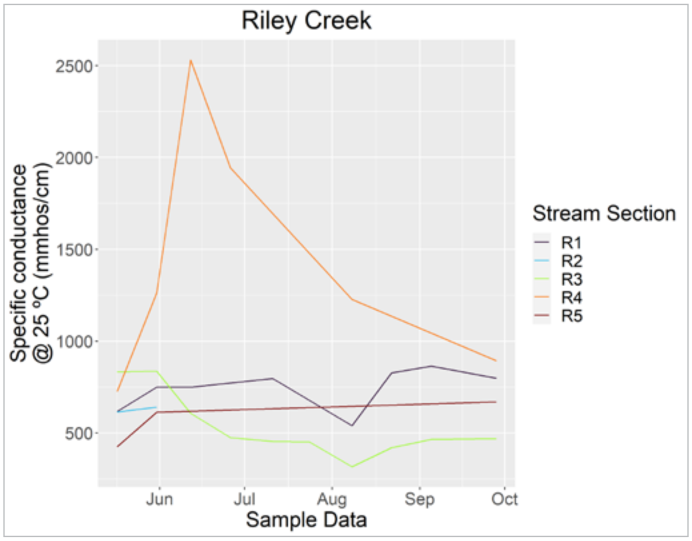
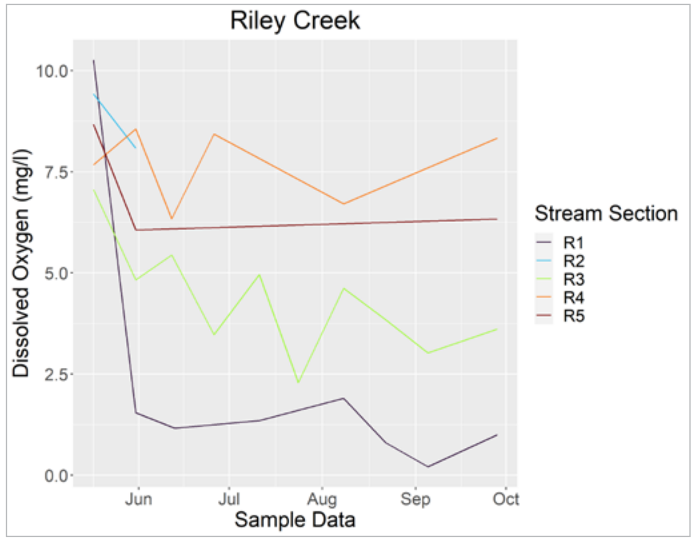
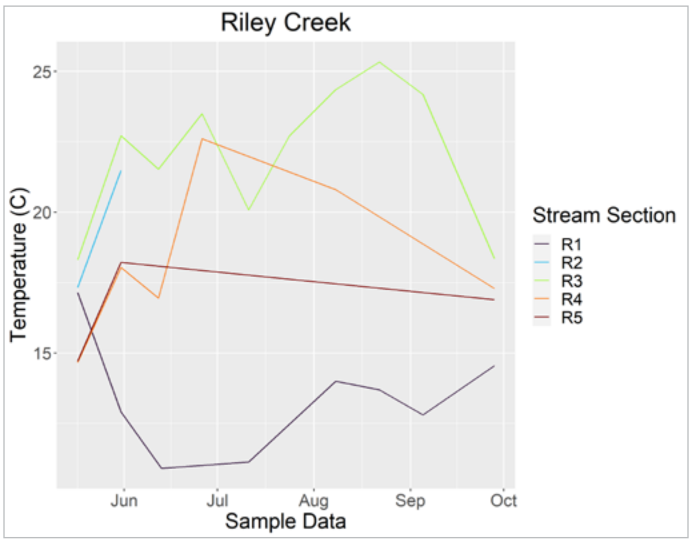
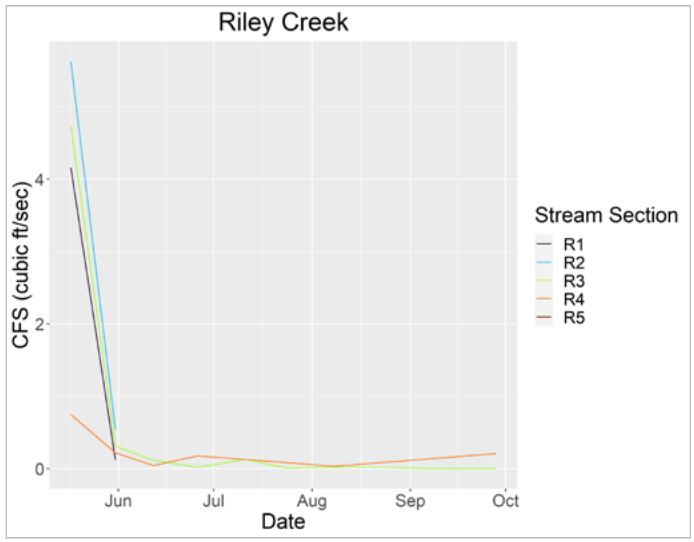


Exhibit E. 2023 Creek Seasonal Sonde & Flow Data: **RILEY CREEK**









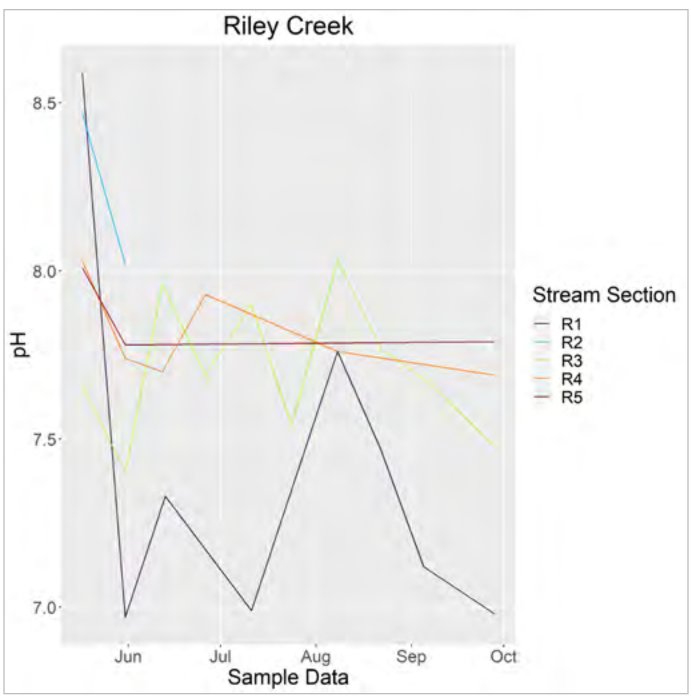


Exhibit F. 2023 Creek Nutrient Data Summary Table

Stream	Stream Section	Cl- (mg/l)	Chl a (ug/l)	OP (mg/l)	TP (mg/l)	TSS (mg/l)
Bluff	B5	94.6500	1.875000	--	0.19600000	19.500000
Bluff	B4	225.7500	4.730000	--	0.20750000	6.850000
Bluff	B3	247.0000	4.967500	--	0.10287500	4.975000
Bluff	B2	196.6667	5.990000	--	0.13700000	5.175000
Bluff	B1	147.3333	2.170000	0.0360	0.03778571	2.028571
Purgatory	P8	67.9000	6.800000	--	0.21233333	37.766667
Purgatory	P7	119.0000	3.957500	--	0.11412500	11.125000
Purgatory	P6	177.7500	6.398571	0.1315	0.13264286	7.342857
Purgatory	P5	159.0000	6.273333	0.2130	0.17466667	9.300000
Purgatory	P4	152.0000	7.971667	0.1460	0.14233333	2.800000
Purgatory	P3	222.7500	62.950000	0.0270	0.11358333	17.416667
Purgatory	P2	179.3333	2.695000	0.0470	0.07191667	3.783333
Purgatory	P1	120.4000	5.364000	0.0400	0.07020000	4.540000
Riley	R5	65.5000	3.500000	--	0.06600000	17.800000
Riley	R4	309.0000	2.448000	--	0.08080000	14.820000
Riley	R3	111.1000	11.940000	0.0730	0.13400000	5.171429
Riley	R2	130.0000	3.320000	--	0.02525000	4.300000
Riley	R1	76.5000	3.446667	--	0.06783333	9.066667

Exhibit G. 2023 Lake Nutrient Data

All values given in mg/L

Lake	Location	Alk	Ca	Cl	Chl-a	Fe	NH_3	NO_2/NO_3	TN	TKN	OP	TP	TSS
Ann	Top	151.5		48.50	0.003138333		0.03750000	0.05250000		0.830000	0.005333333	0.02050000	
Ann	Middle										0.005833333	0.02700000	
Ann	Bottom			46.83			1.45500000	0.03750000		2.540000	0.203500000	0.48050000	
Duck	Top	81.0	25.7	66.85	0.014426667		0.02250000	0.03000000		0.787500	0.003500000	0.04000000	
Duck	Bottom		25.5	66.48			0.02000000	0.03000000		0.632500	1.016600000	0.02420000	
Hyland	Middle				9.393333333				1.065		0.007085000	0.03517000	
Idlewild	Top	66.0	32.3	528.25	0.004415000		0.02000000	0.03000000		0.652500	0.004000000	0.03333333	
Idlewild	Bottom		32.6	565.75			0.02000000	0.03000000		0.597500	0.003600000	0.03220000	
Lotus	Top	160.5	41.8	70.93	0.009636667		0.04750000	0.03000000		0.830000	0.005500000	0.02783333	
Lotus	Middle			72.90			2.37000000	0.03000000		4.520000	0.011428571	0.09285714	
Lotus	Bottom		48.5	68.60			1.93666667	0.03000000		2.753333	0.045400000	0.21300000	
Lucy	Top	176.0		62.60	0.007974000		0.02666667	0.03000000		0.935000	0.004800000	0.02720000	
Lucy	Middle										0.005600000	0.04500000	
Lucy	Bottom			60.63			0.45000000	0.03000000		1.840000	0.038800000	0.33620000	
McCoy	Top	186.0	69.0	118.00	0.003340000		0.07000000	0.03000000		0.990000	0.025000000	0.09700000	
Mitchell	Top	141.6		155.20	0.014080000	0.1480	0.02000000	0.03200000		0.740000	0.003200000	0.03680000	3.88
Mitchell	Middle				0.019740000						0.004600000	0.05100000	
Mitchell	Bottom				0.014780000						0.009200000	0.07900000	

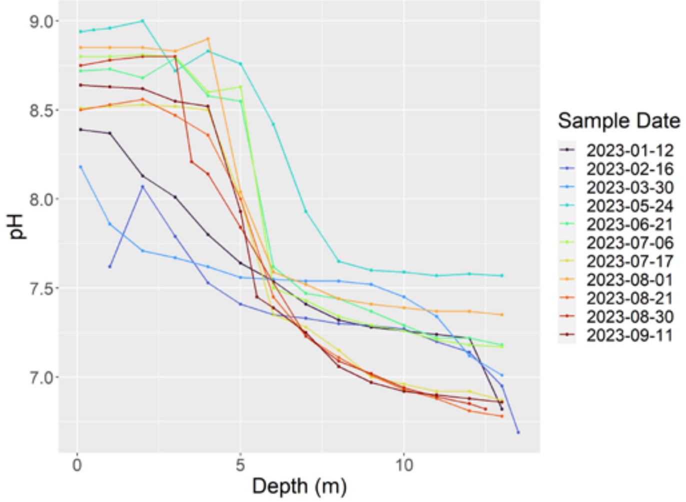
Exhibit H. 2023 Lake Nutrient Data (continued)

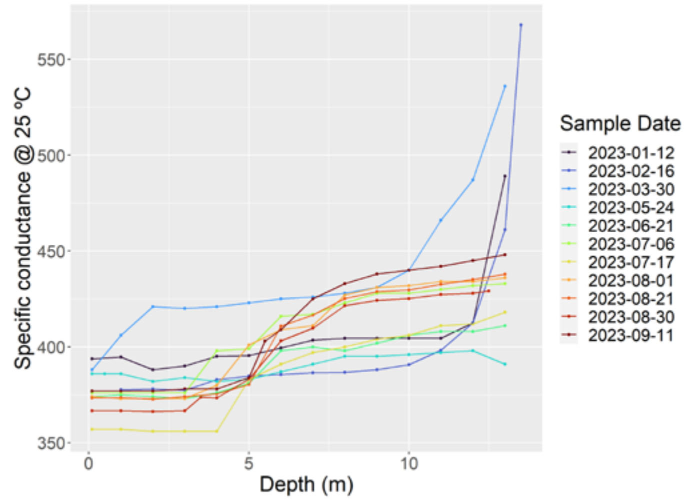
All values given in mg/L

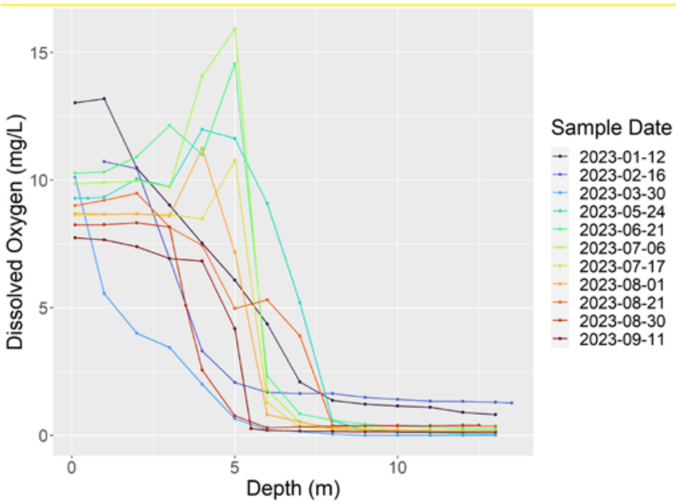
Lake	Location	Alk	Ca	Cl	Chl-a	Fe	NH_3	NO_2/NO_3	TN	TKN	OP	TP	TSS
Neill	Top	102.0		237.67	0.033074000		0.06333333	0.03000000		1.193333	0.004200000	0.06840000	
Neill	Bottom	108.0	35.2	232.00	0.003050000		0.05333333	0.03000000		1.043333	0.004200000	0.05240000	
Red Rock	Top	152.4		125.00	0.010560000	0.1134	0.02600000	0.03000000		0.694000	0.004200000	0.03280000	3.08
Red Rock	Middle				0.010480000						0.005800000	0.04440000	
Red Rock	Bottom				0.013980000						0.011000000	0.05040000	
Rice Marsh	Top	114.0		239.75	0.015291667		0.03000000	0.03000000		0.940000	0.004000000	0.04533333	
Rice Marsh	Bottom			238.50			0.03000000	0.03000000		0.940000	0.004000000	0.05966667	
Riley	Top	138.0	44.2	133.75	0.004203333		0.02750000	0.06500000		0.697500	0.004666667	0.01916667	
Riley	Middle							0.15000000			0.005000000	0.02066667	
Riley	Bottom		43.7	136.50			0.47750000	0.10250000		1.050000	0.030666667	0.04866667	
Round	Top	62.4		92.48	0.004880000	0.1052	0.02800000	0.03000000		0.672000	0.003400000	0.02500000	1.72
Round	Middle				0.012160000						0.005200000	0.04560000	
Round	Bottom				0.024800000						0.052800000	0.19280000	
Silver	Top	120.0		66.13	0.018978333		0.02500000	0.03000000		1.192500	0.004333333	0.07516667	
Silver	Bottom			66.88			0.02000000	0.03000000		1.042500	0.004400000	0.04260000	
Staring	Top	180.0	64.0	166.00	0.038436000		0.05333333	0.03000000		1.116667	0.010000000	0.07760000	
Staring	Bottom		68.4	166.67			0.51333333	0.03000000		1.873333	0.225200000	0.34160000	
Susan	Top	150.0		199.33	0.025448000		0.03333333	0.03000000		0.980000	0.004000000	0.04460000	
Susan	Bottom			198.67			0.69666667	0.03333333		1.995000	0.039375000	0.18337500	

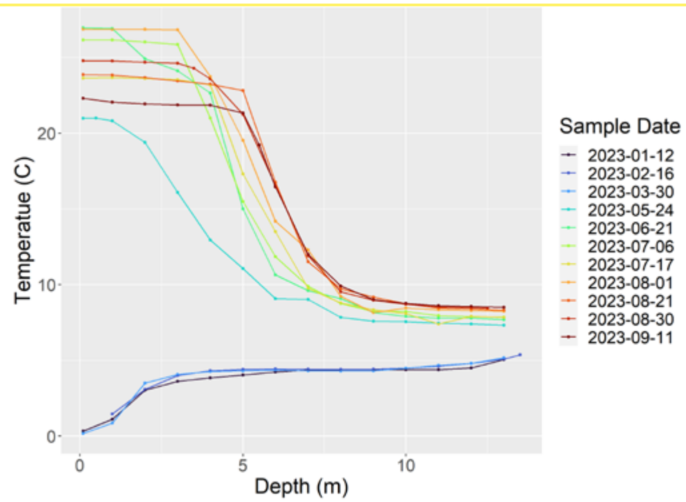
Exhibit I. 2023 Lake Profile Data

Lake Profile: ANN









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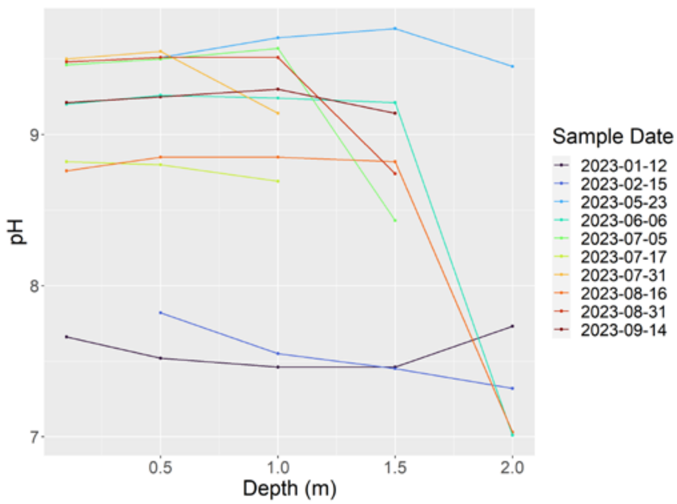

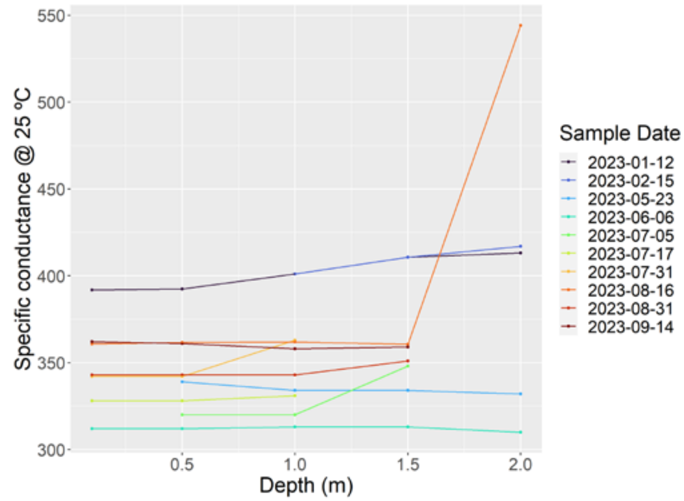

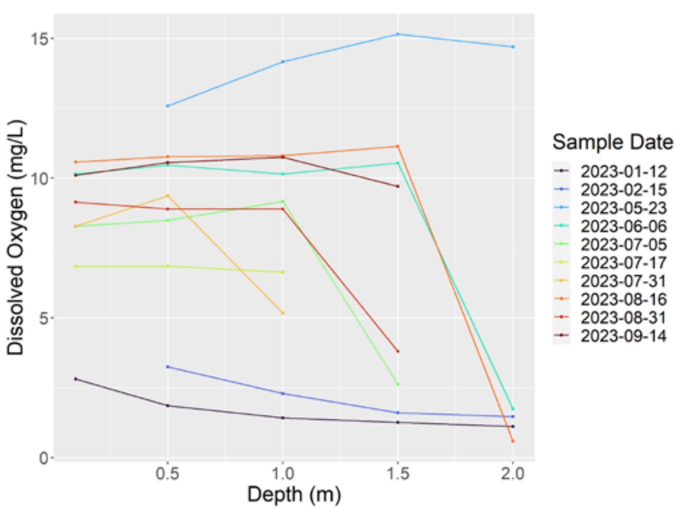

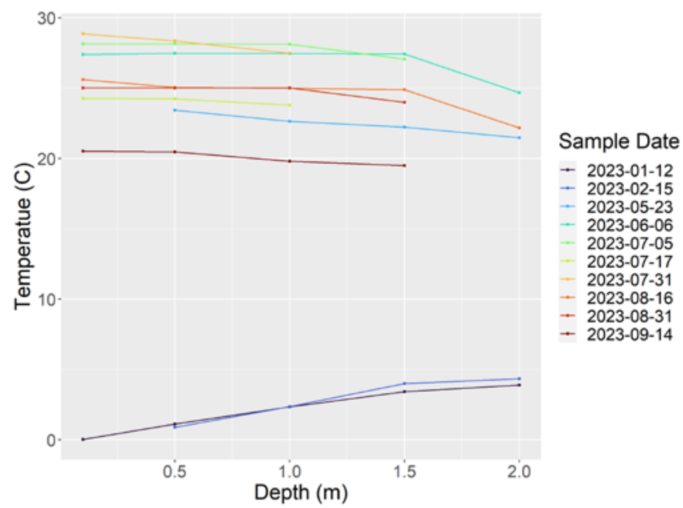

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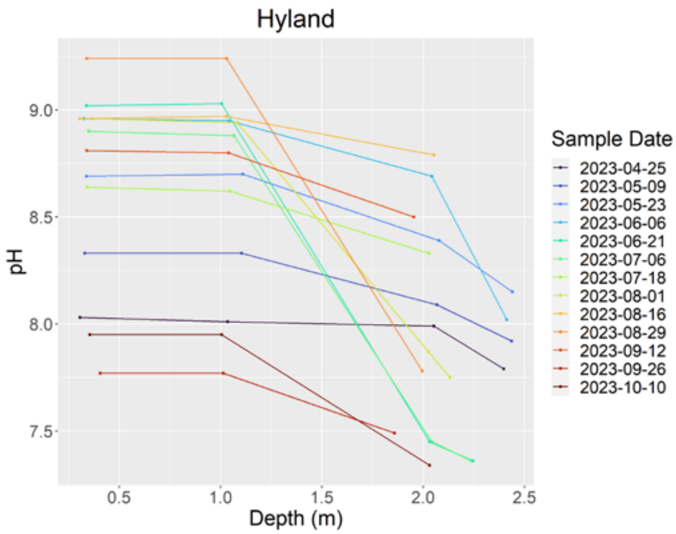

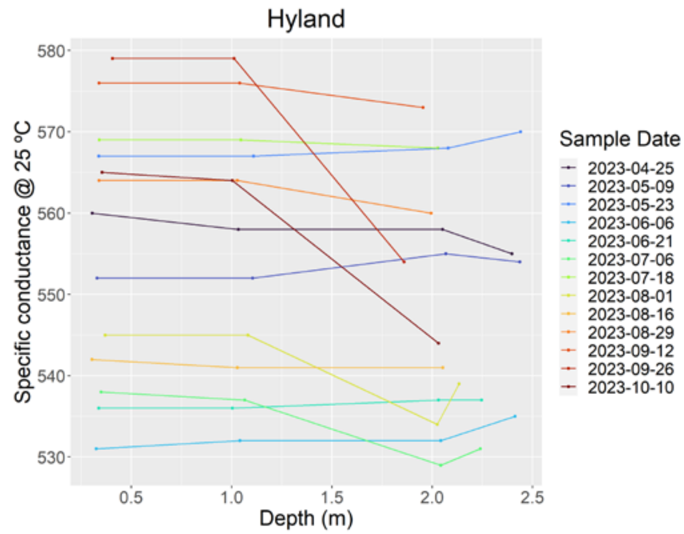

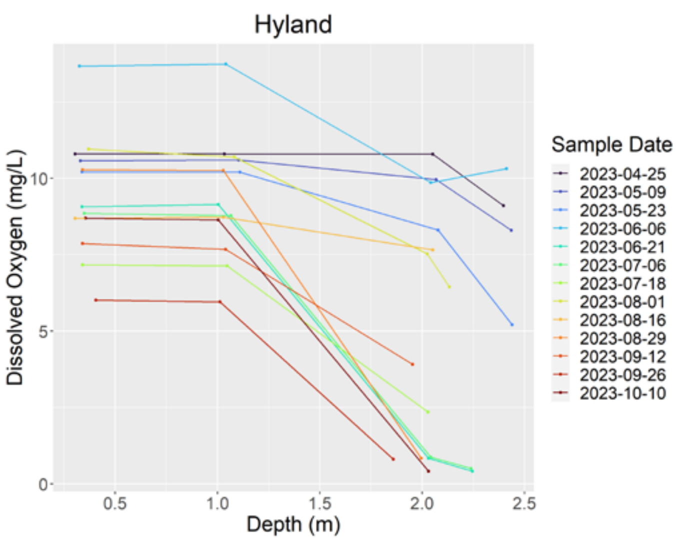

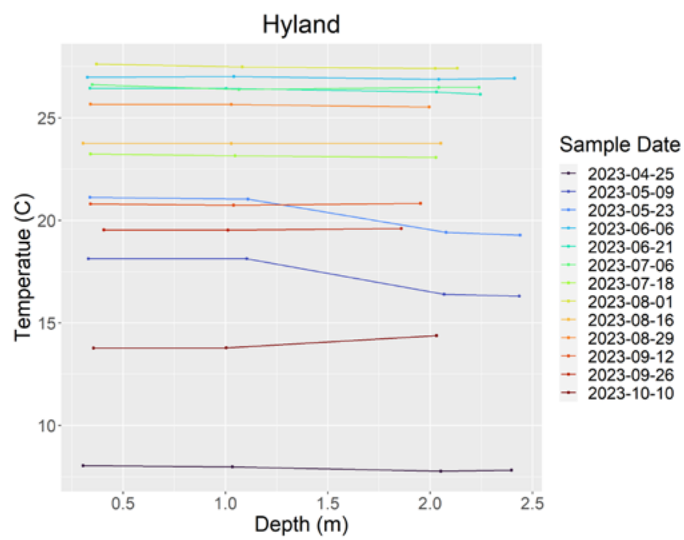

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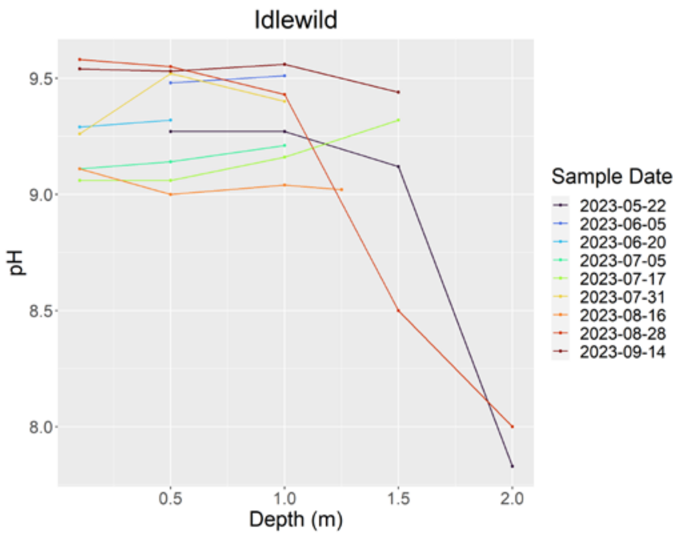

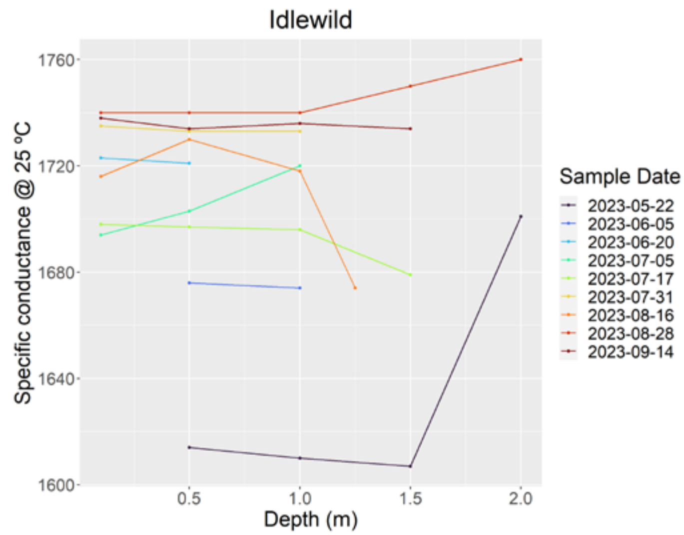

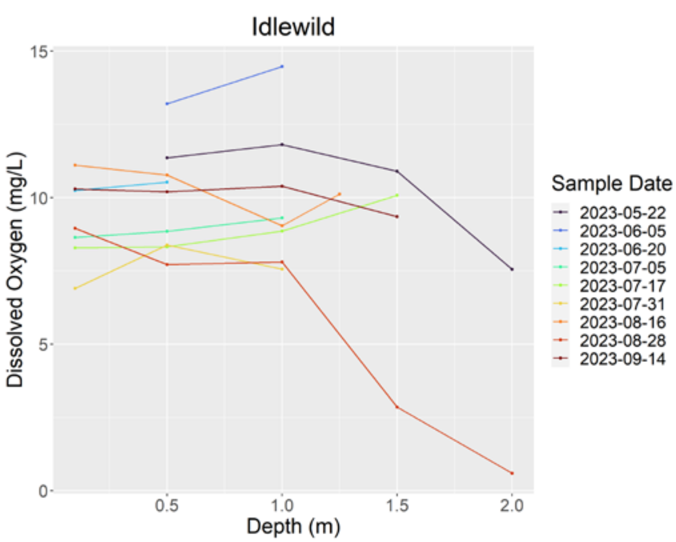

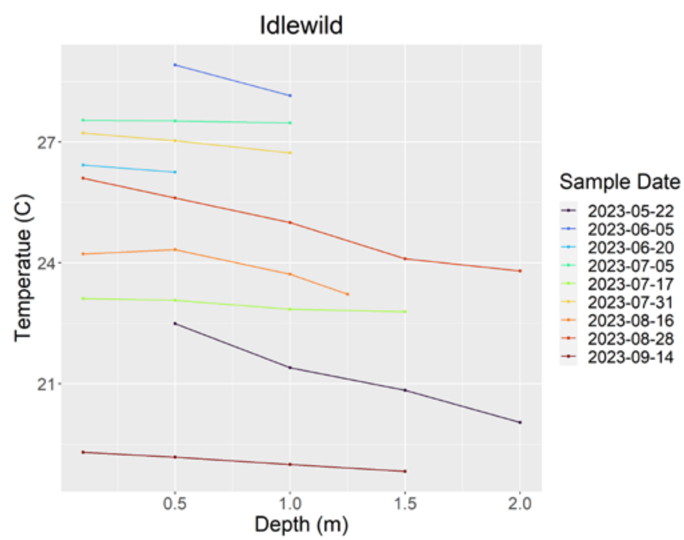

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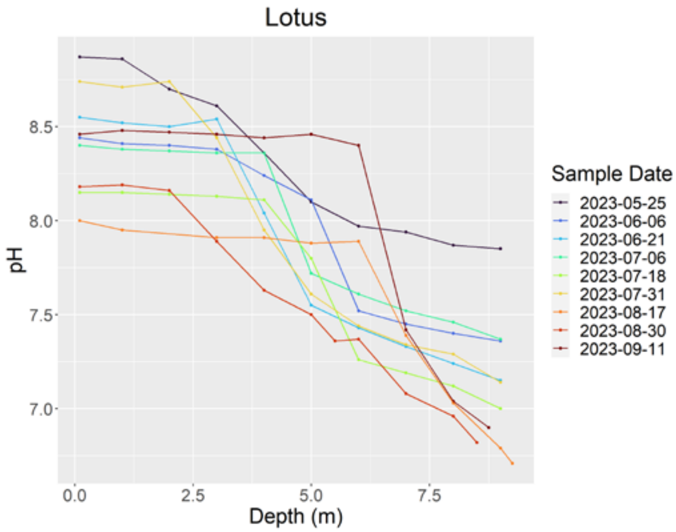

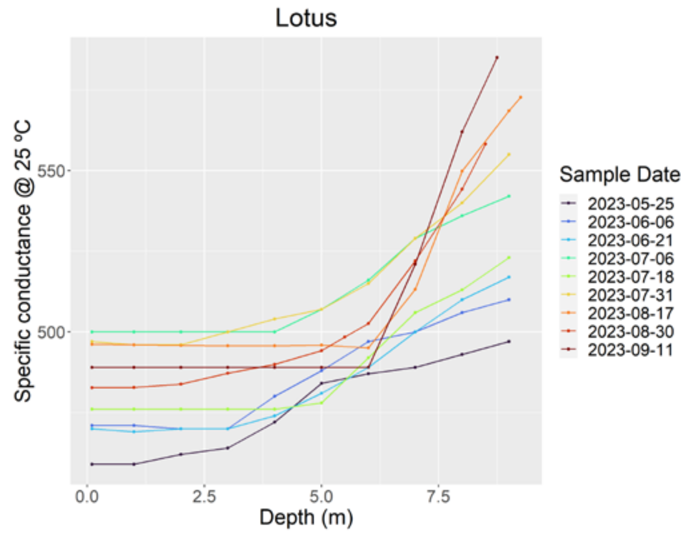

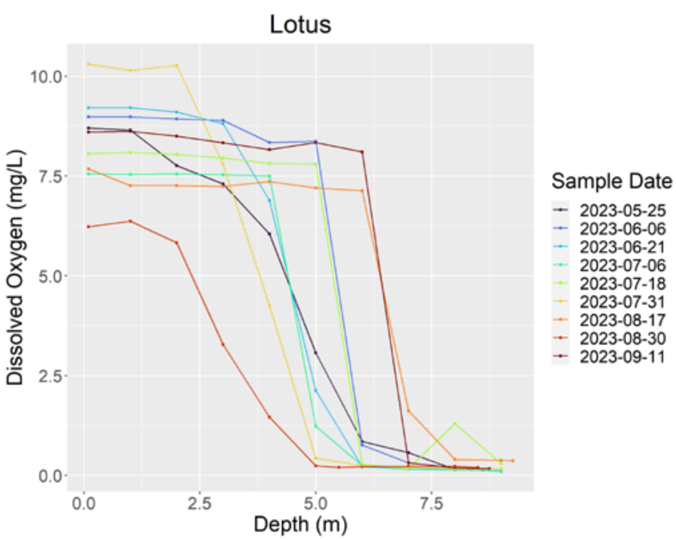

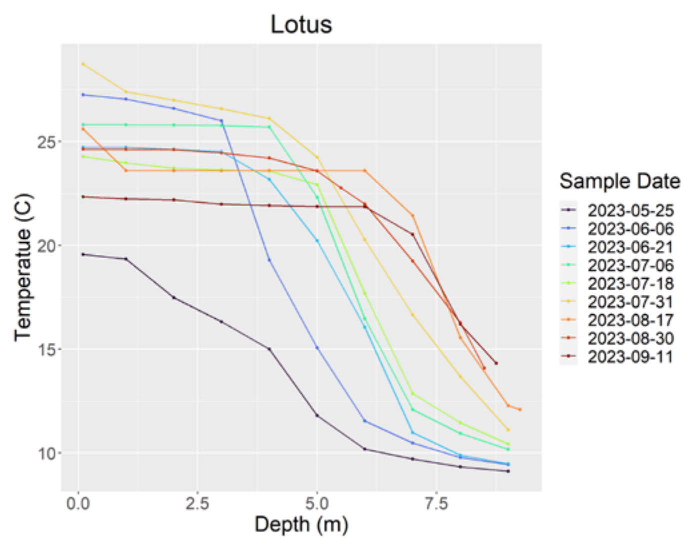

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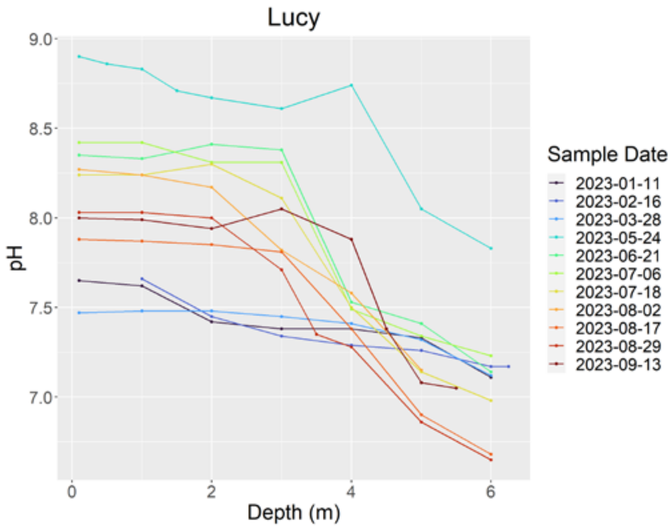

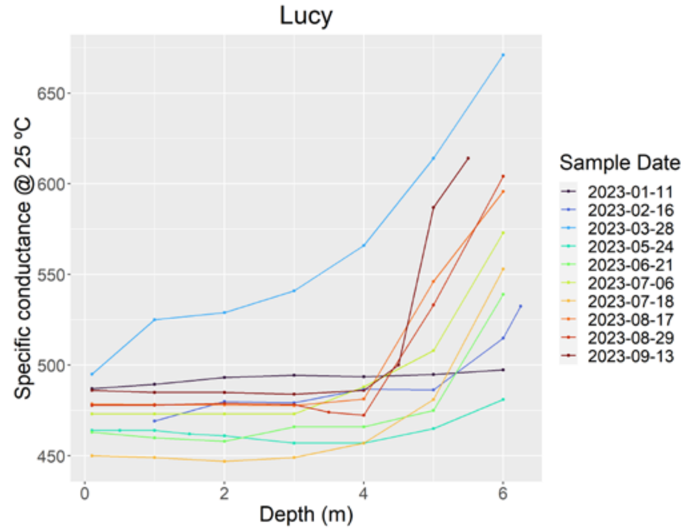

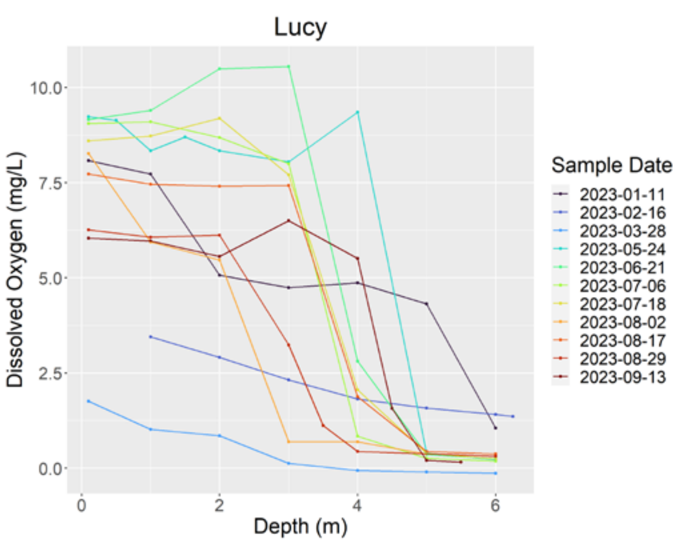

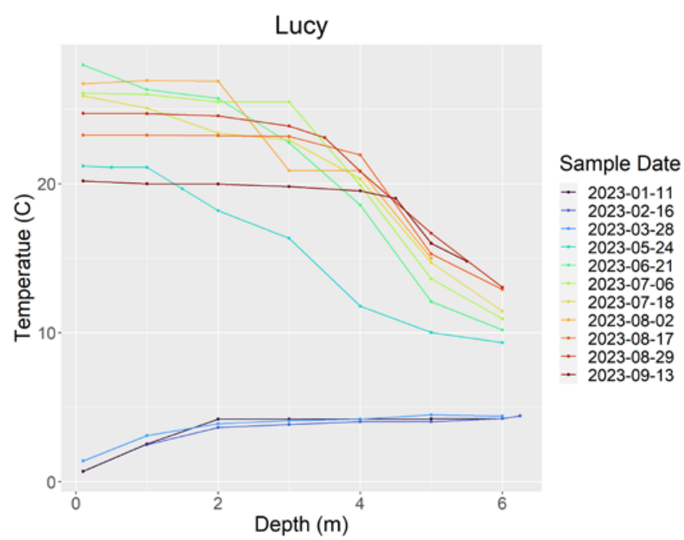

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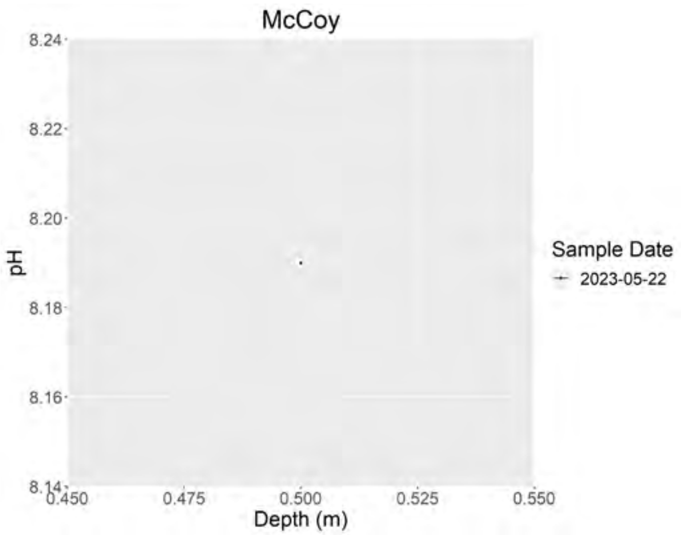
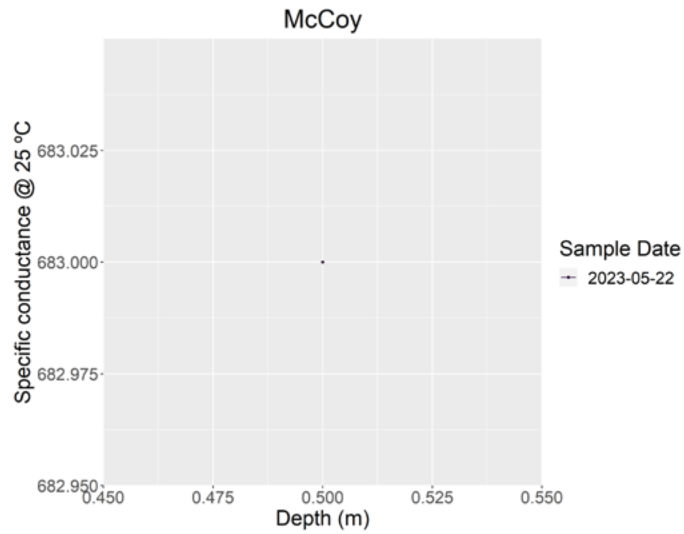
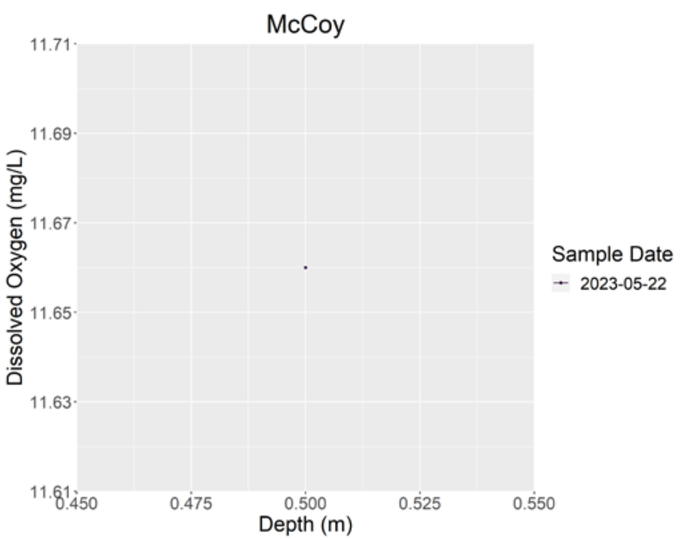
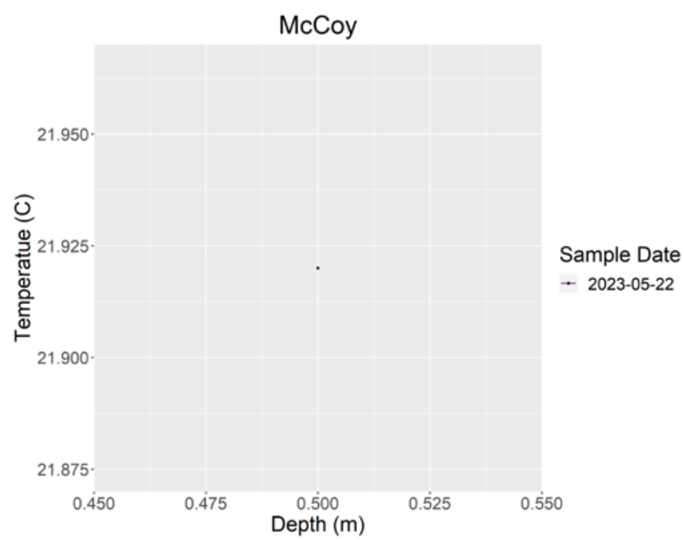
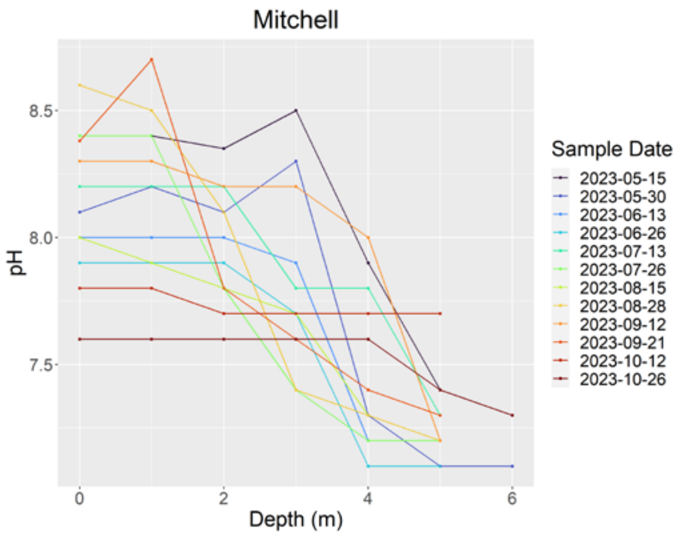


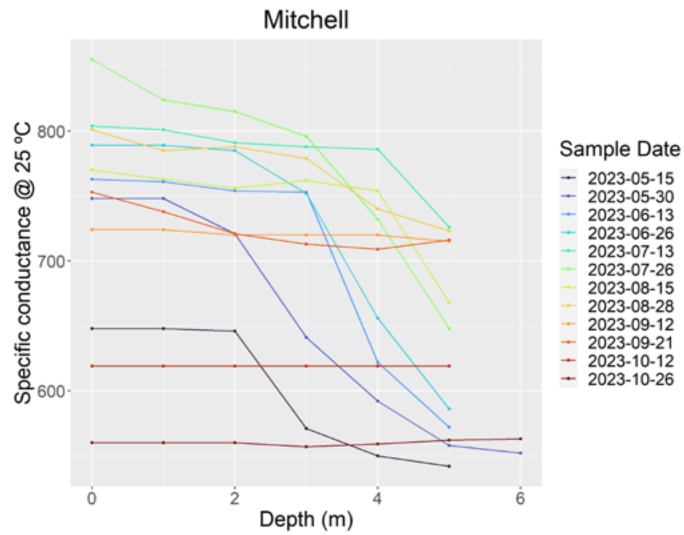


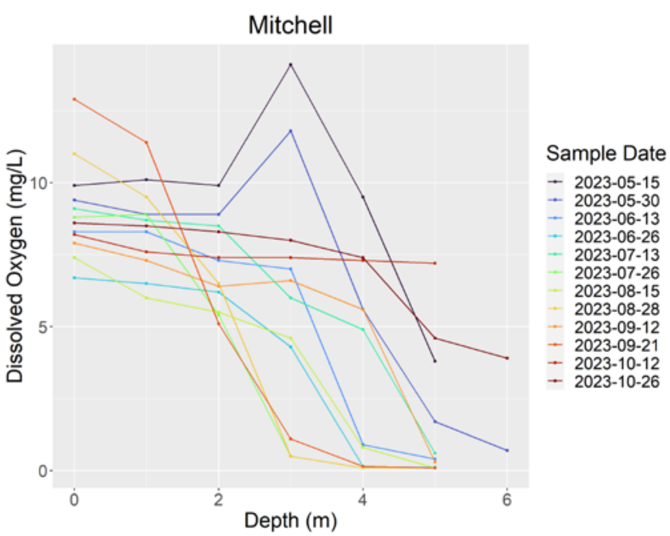


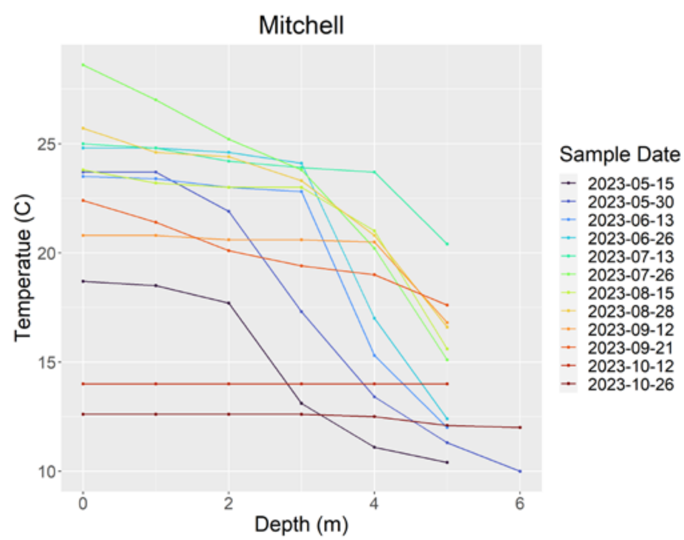


Lake Profile: MITCHELL

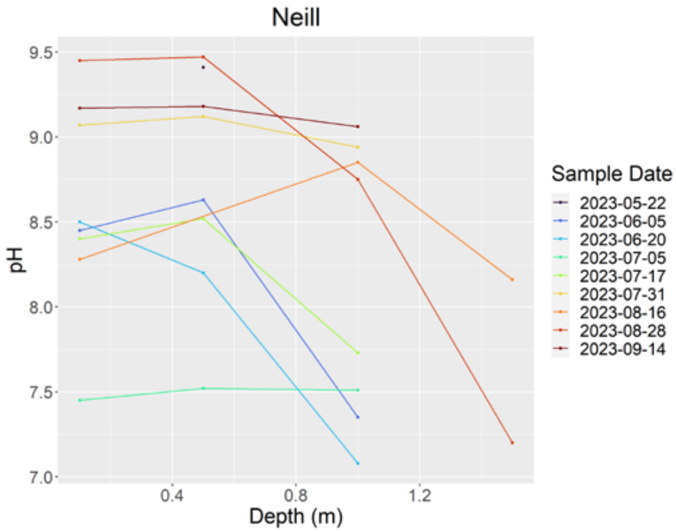


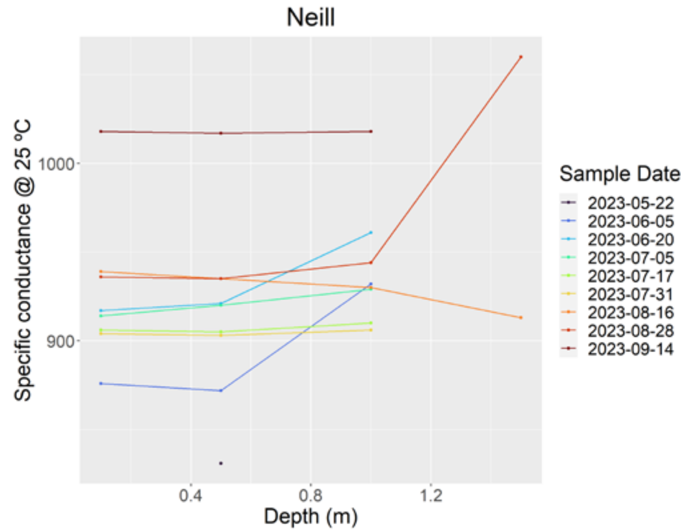


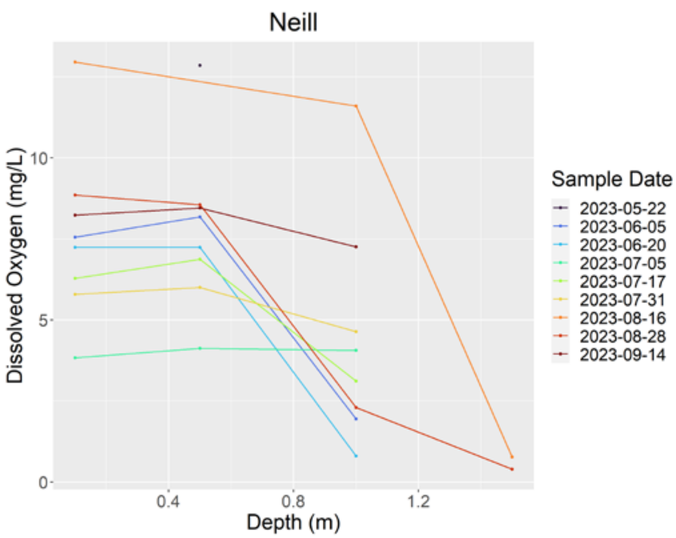


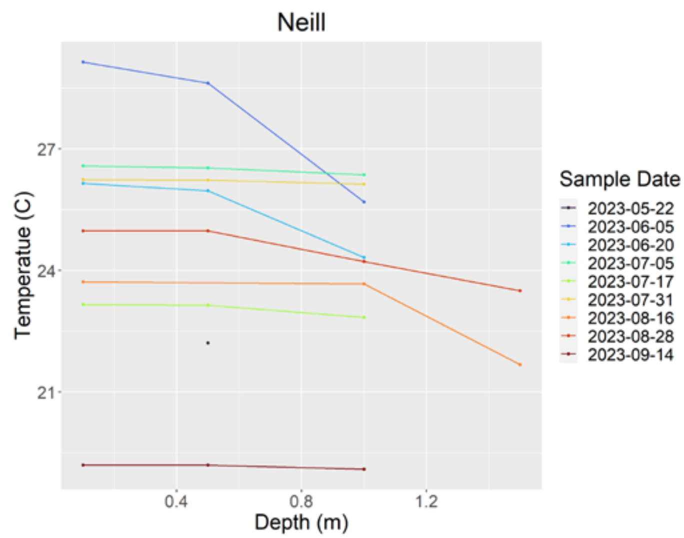


Lake Profile: NEILL

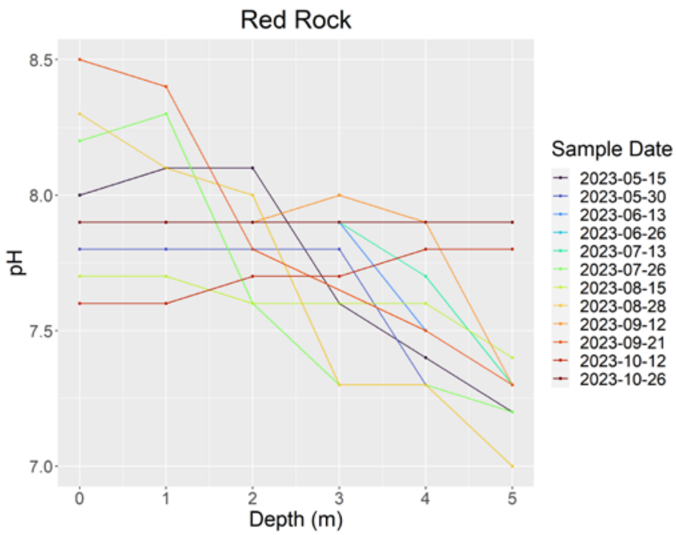


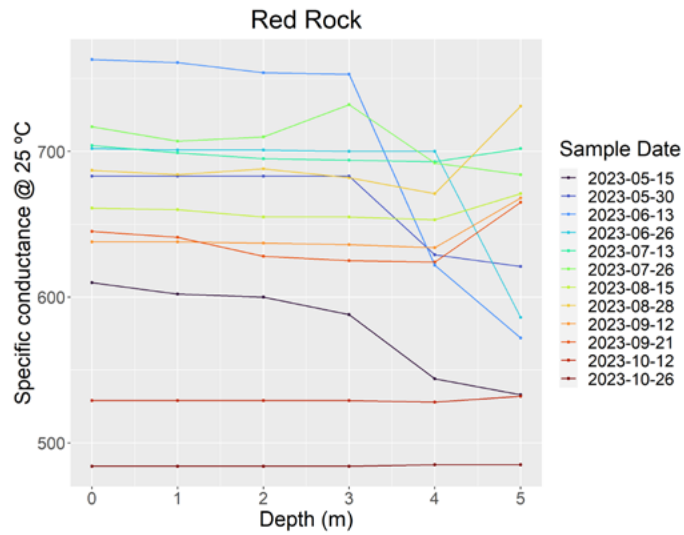


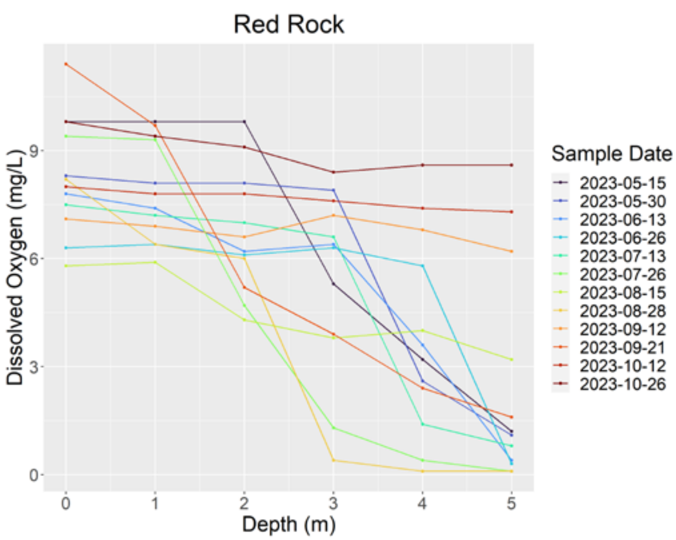


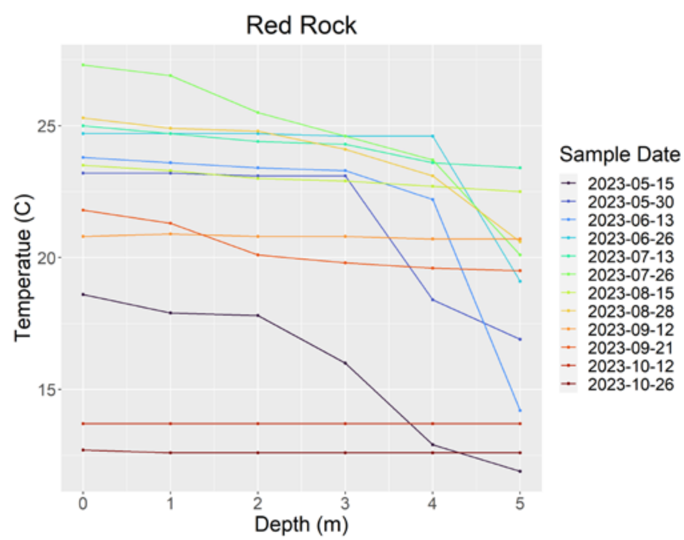


Lake Profile: RED ROCK

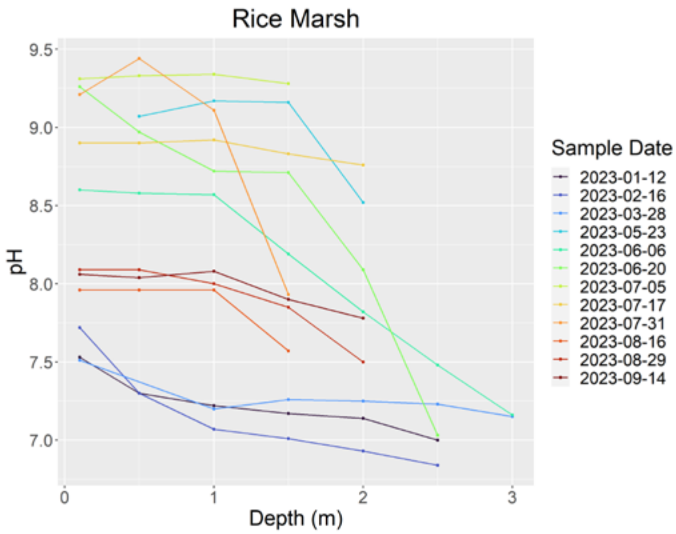


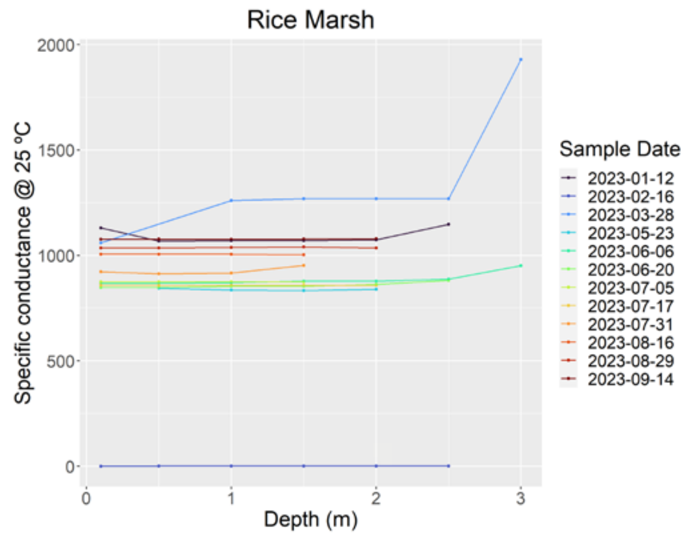


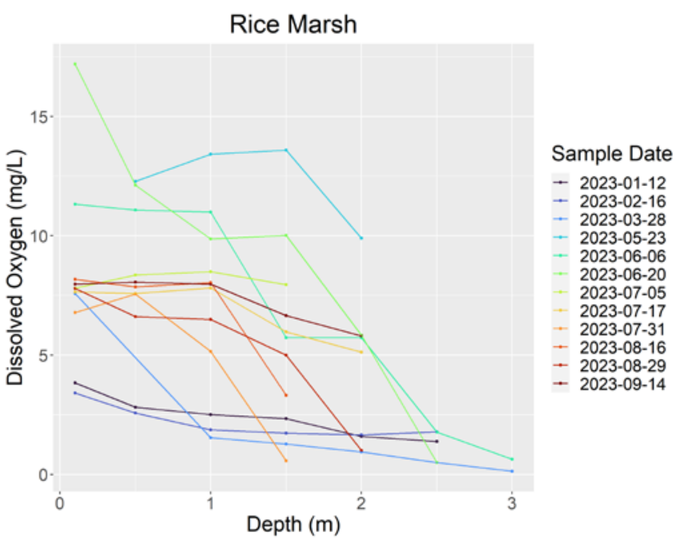


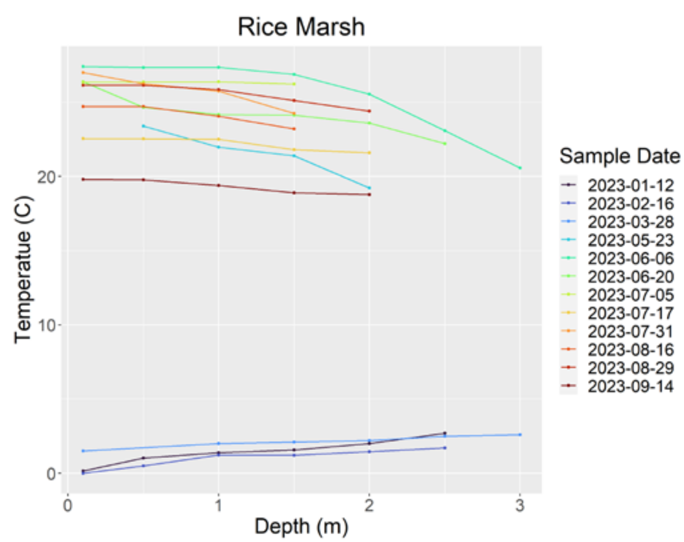


Lake Profile: RICE MARSH

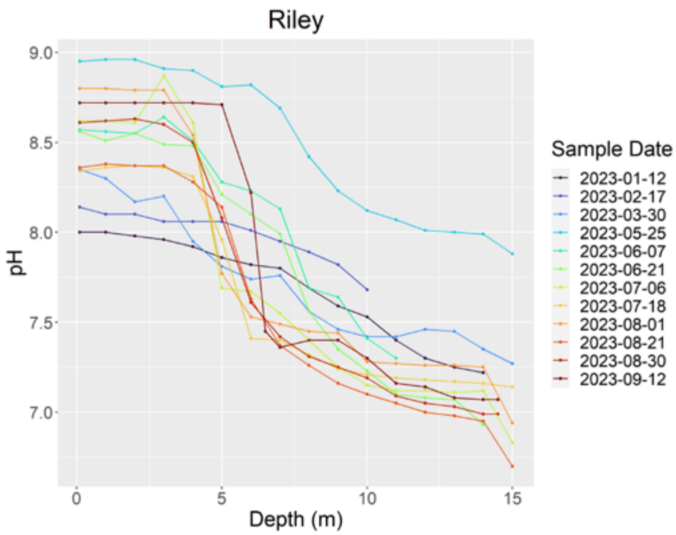


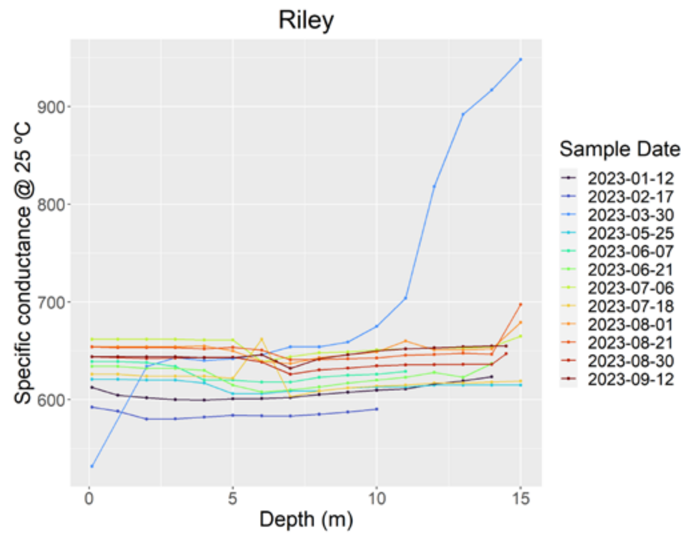


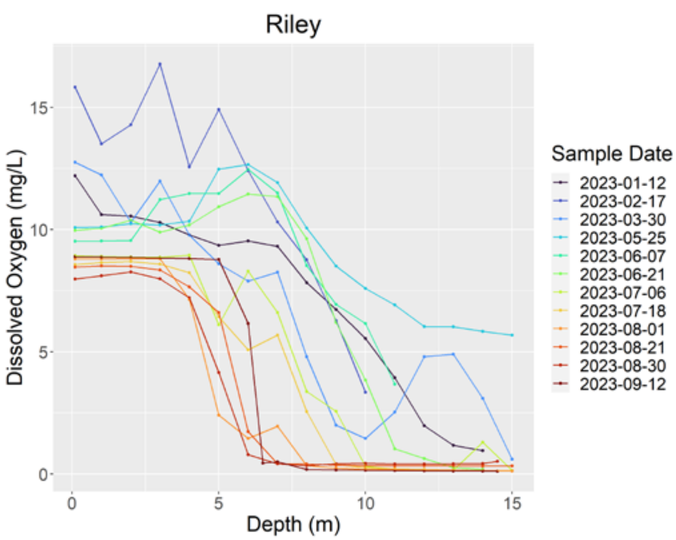


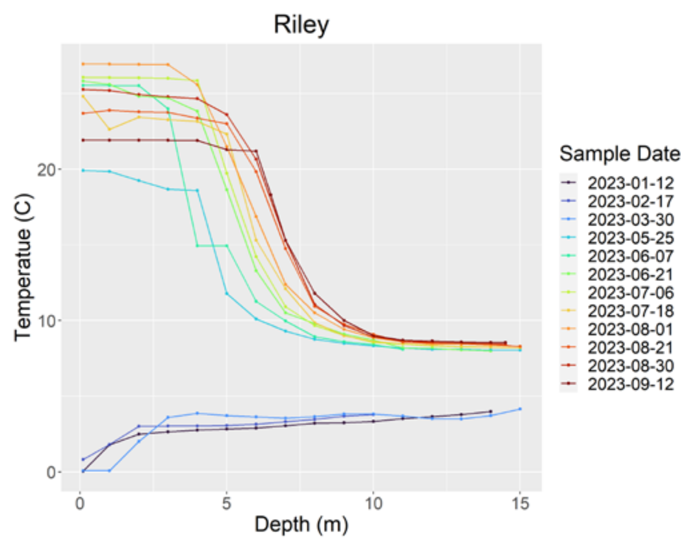


Lake Profile: RILEY

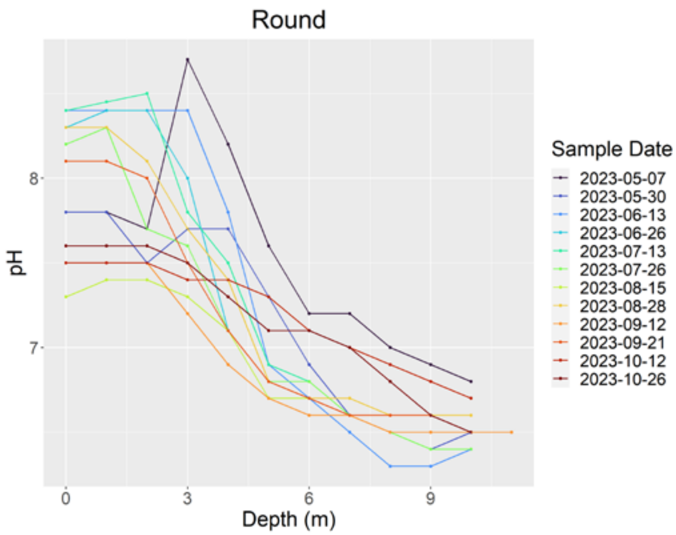


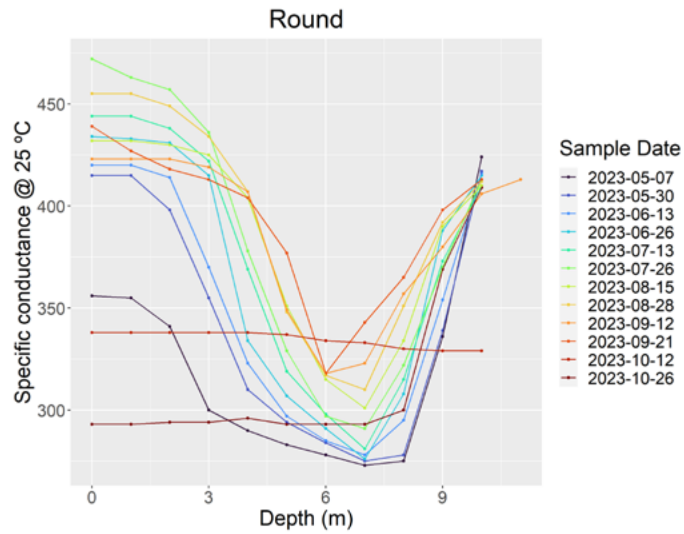


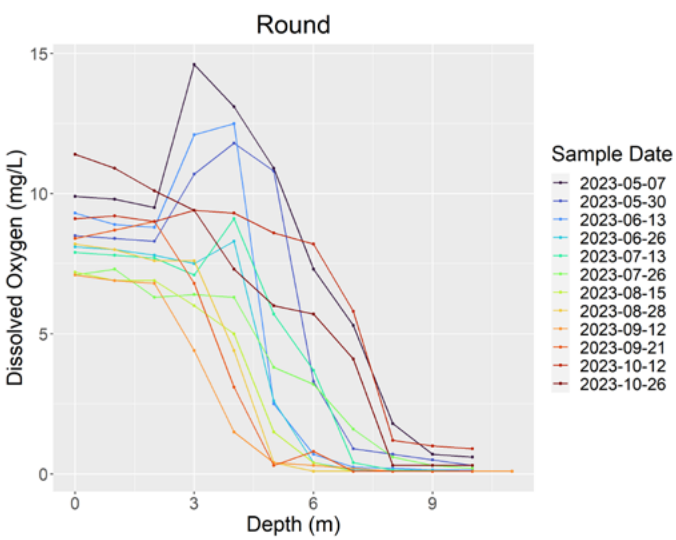


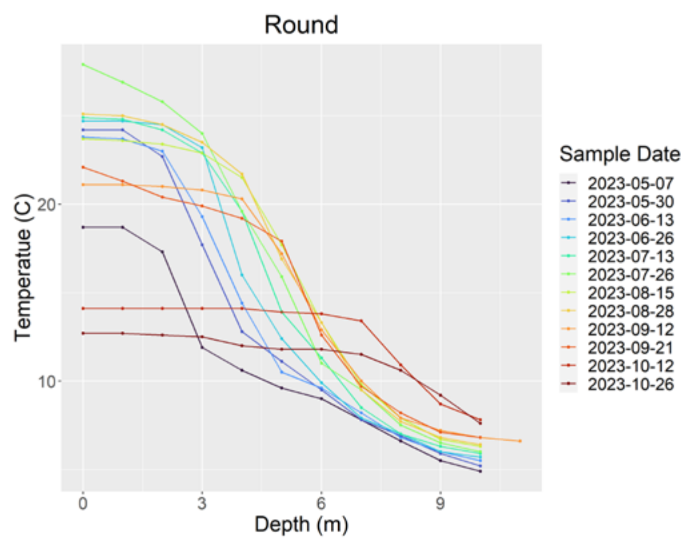


Lake Profile: ROUND

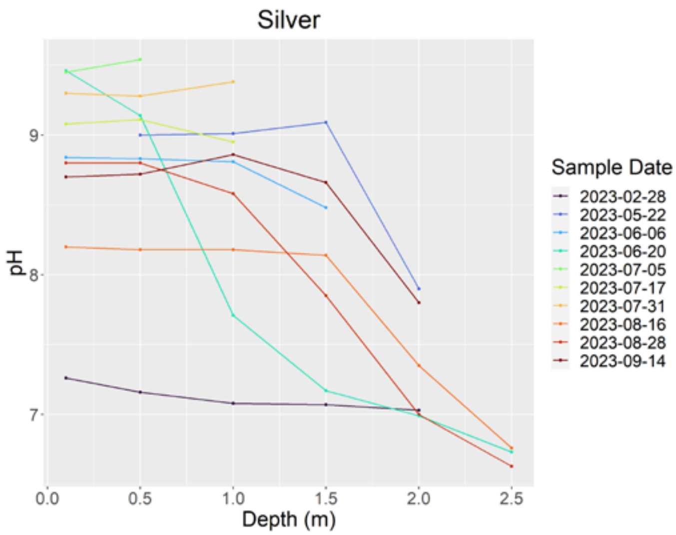


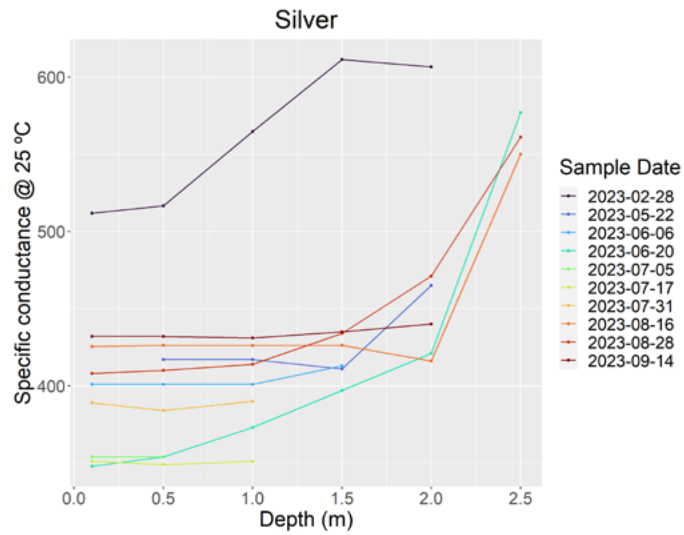


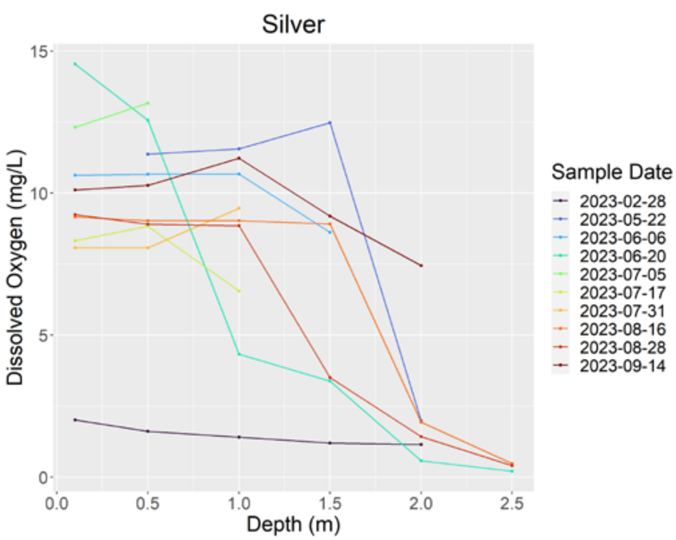


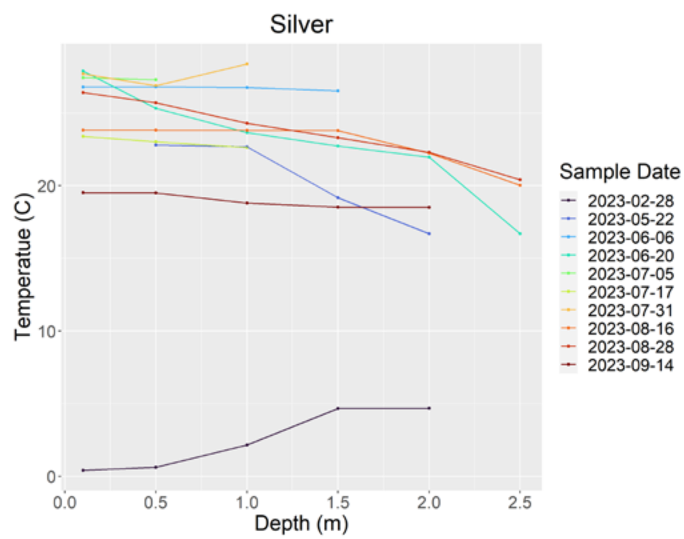


Lake Profile: SILVER

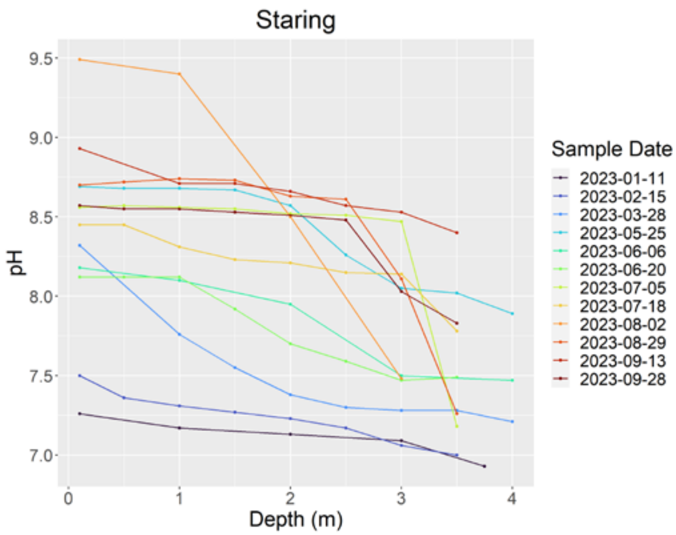


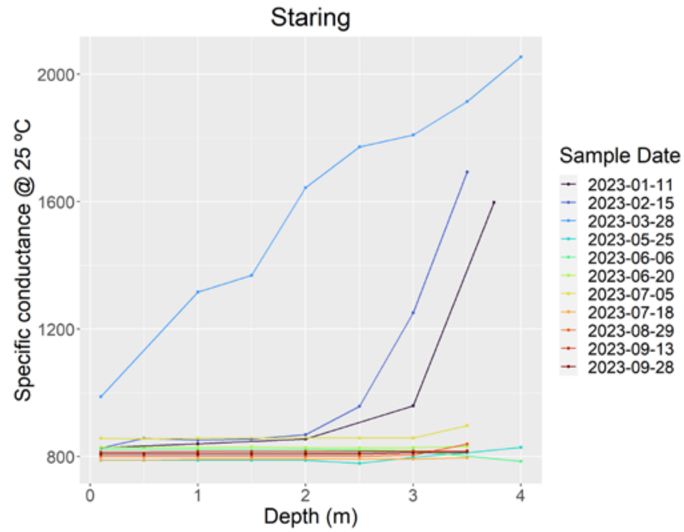


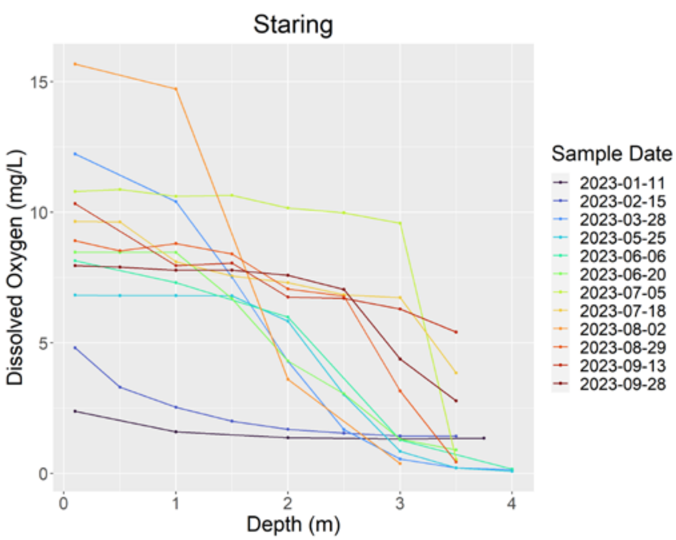


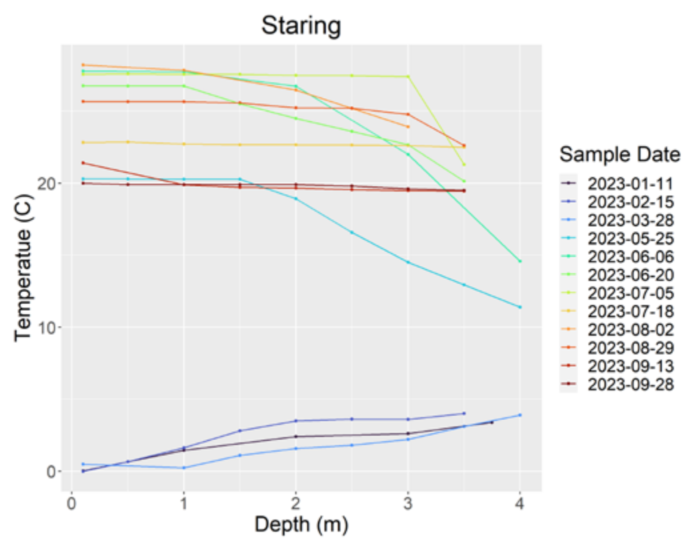


Lake Profile: STARING

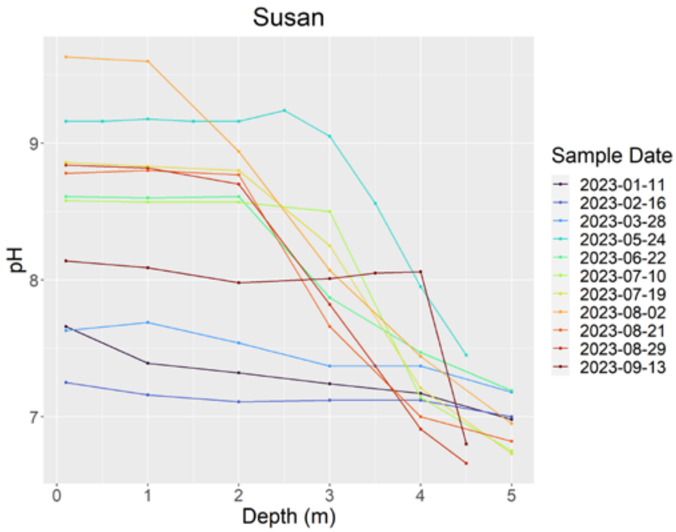


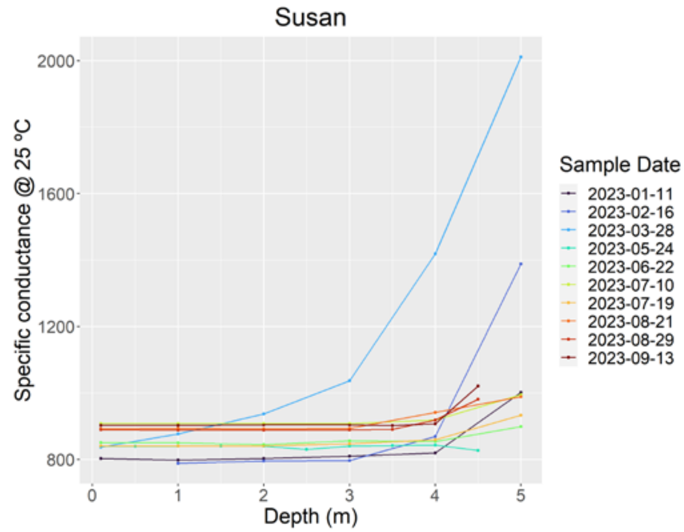


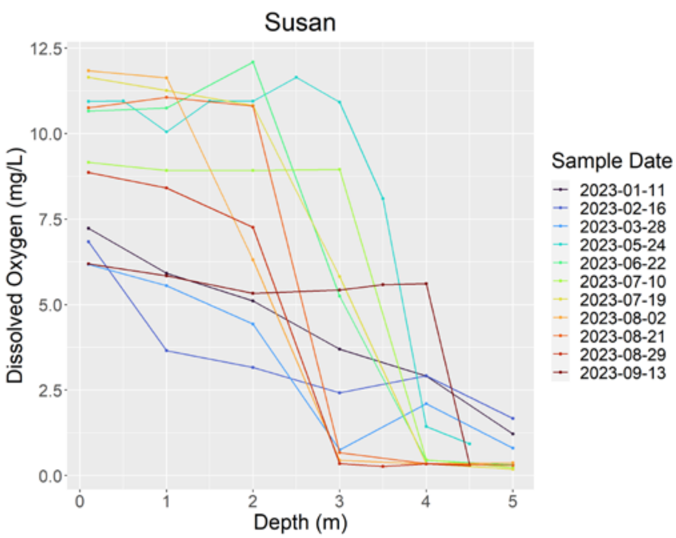




Lake Profile: SUSAN







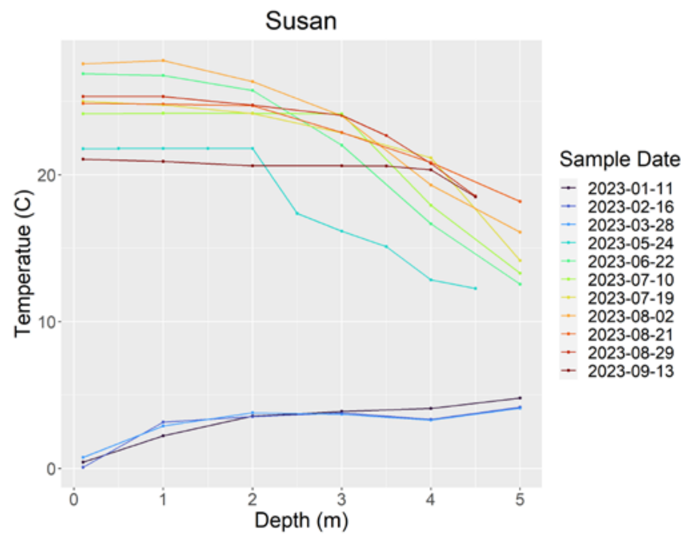


Exhibit J. 2023 Invasive Aquatic Plant Treatment Areas.

Figure I-1. **Mitchell Lake** Curly-leaf Pondweed delineation and treatment area (12.9 acres).

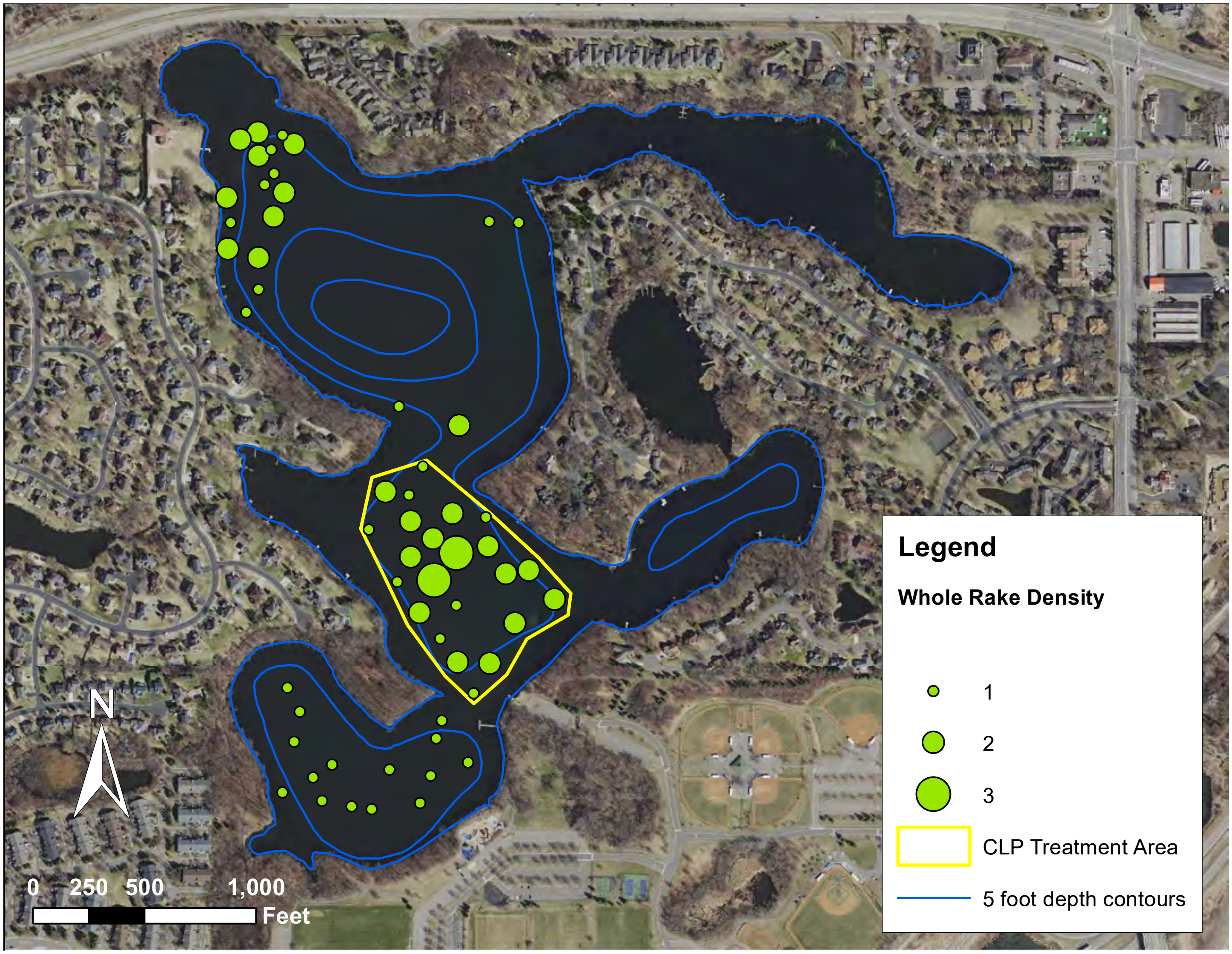


Figure I-2. **Lake Susan** Curly-leaf Pondweed delineation and treatment area (5.3 acres).

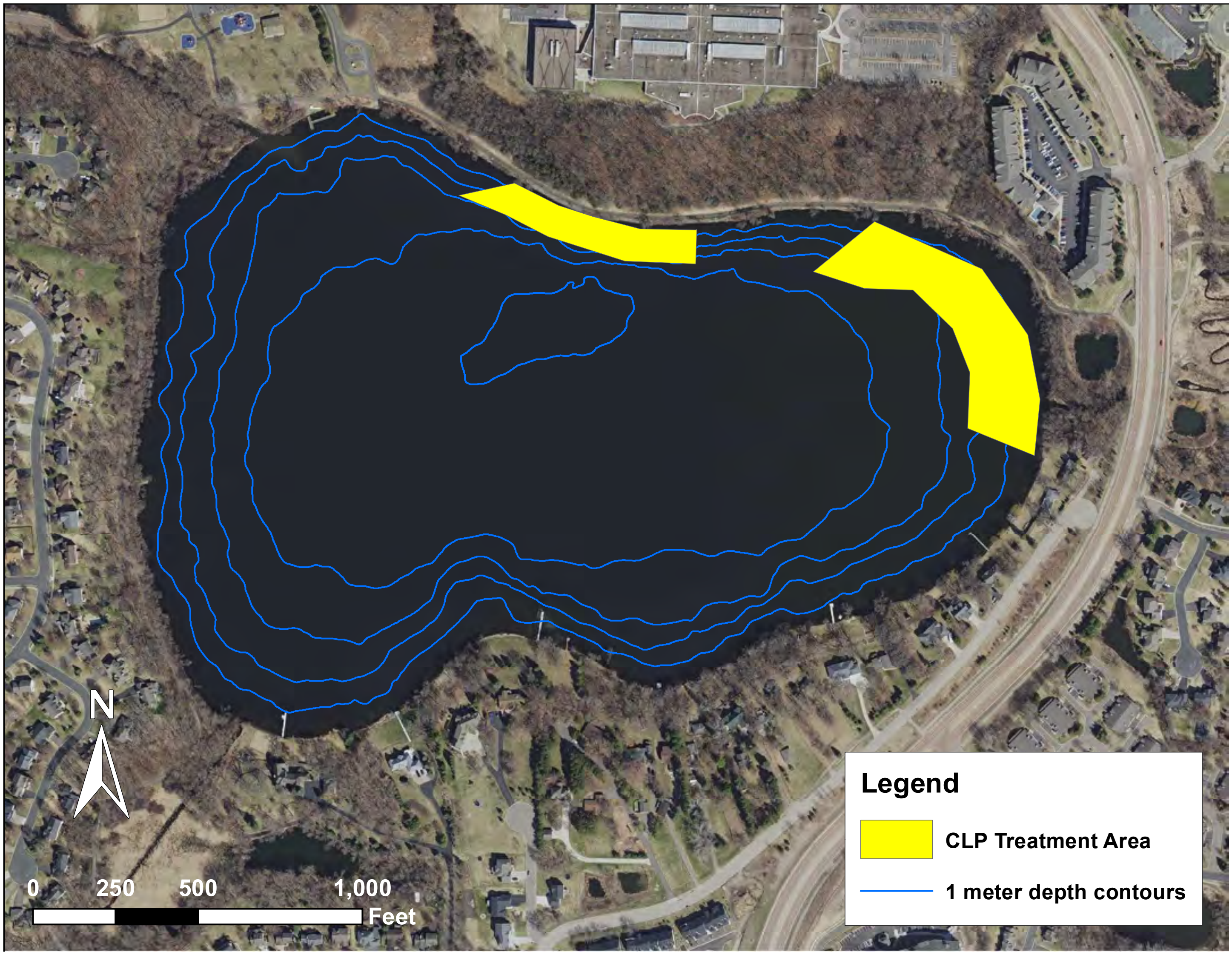


Figure I-3. **Red Rock Lake** Curly-leaf Pondweed delineation and treatment area (13 acres).

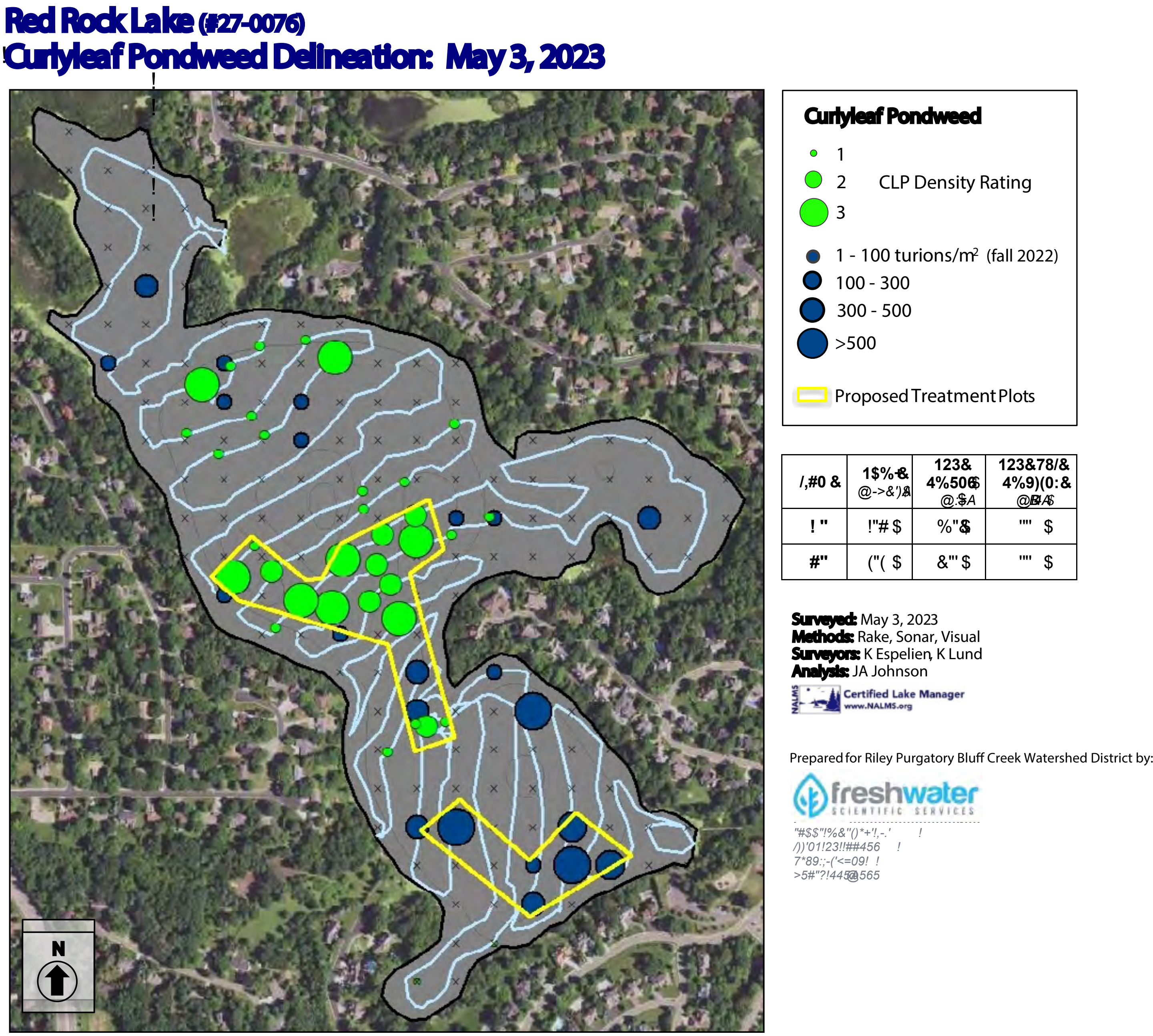


Figure I-4. **Lake Riley** Lake Curly-leaf Pondweed delineation and treatment area (9 acres).

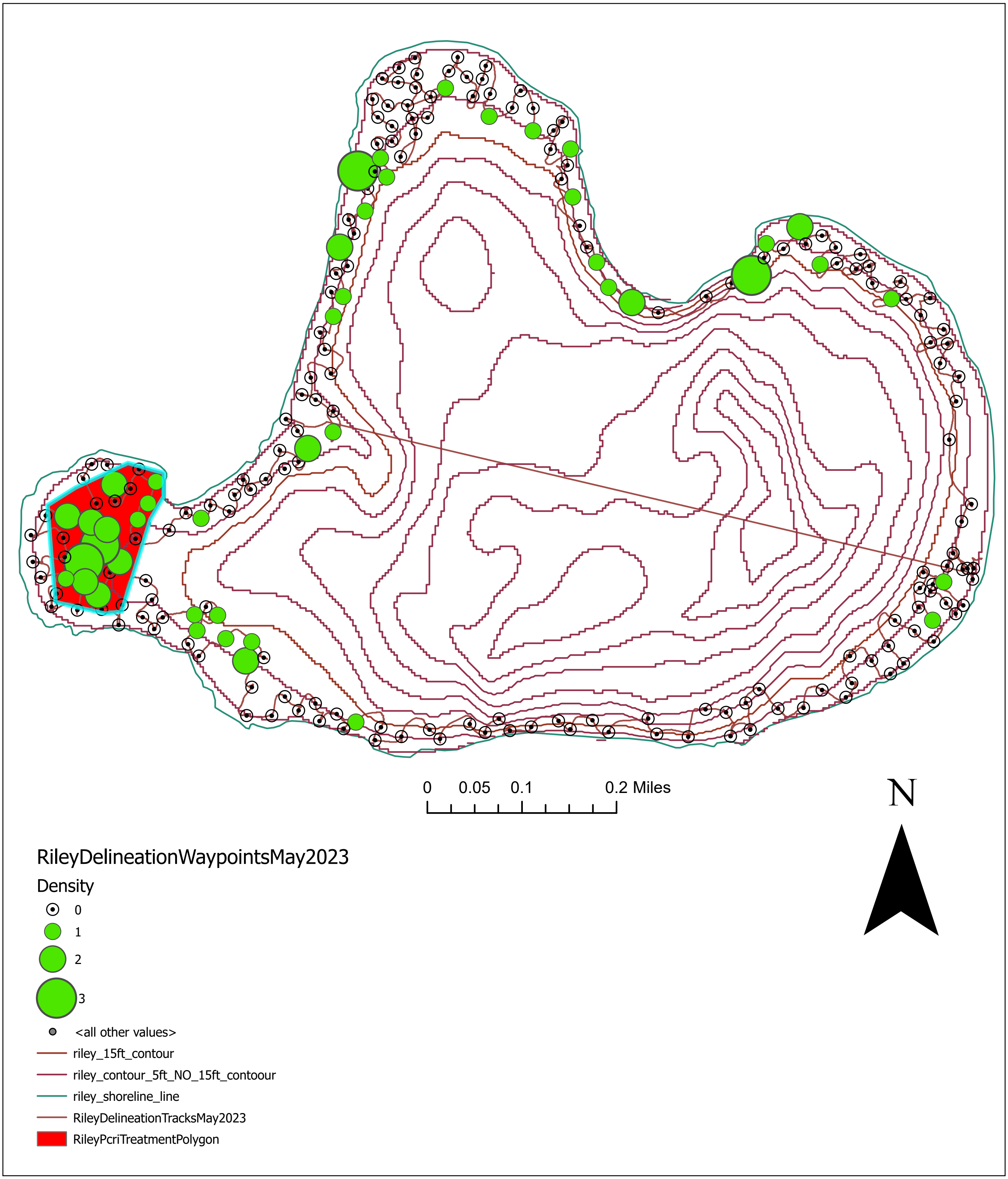


Figure I-5. **Lotus Lake** Eurasian Watermilfoil delineation and treatment area (22.92 acres).

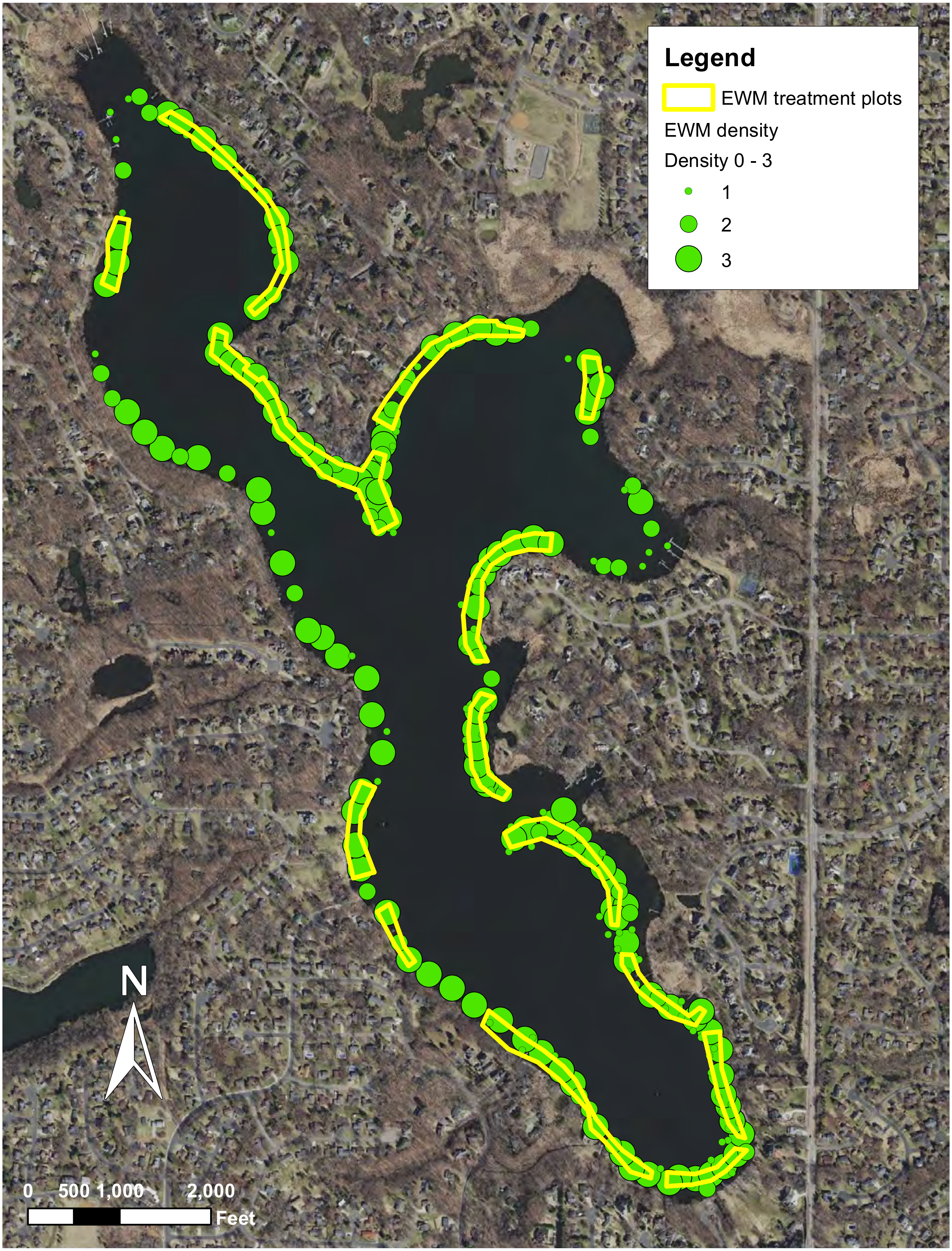


Exhibit K. Acronyms and Abbreviations

ac	acre
BMP	Best Management Practice
cBOD	5-day Carbonaceous Biochemical Oxygen Demand
cf	cubic feet
cfs	cubic feet per second
Chl-a	Chlorophyll-a
Cl	Chloride
CPUE	Catch Per Unit Effort
CRAS	Creek Restoration Action Strategy
CS	Chronic Standard
DO	Dissolved Oxygen
E. coli	*Escherichia coli* (bacteria)
EP	Eden Prairie
EPA	Environmental Protection Agency
EWM	Eurasian Watermilfoil
Ft	feet
FWSS	Freshwater Scientific Services
GPS	Global Positioning System
Ha	hectare
HAB	Harmful Algal Bloom
IBI	Index of Biological Integrity
in	inch
kg	kilogram
L	liter
lb	pound
m	meter
MCWD	Minnehaha Creek Watershed District
METC	Metropolitan Council
Mg	milligram
mL	milliliter
MNDNR	Minnesota Department of Natural Resources
MnDOT	Minnesota Department of Transportation
MPCA	Minnesota Pollution Control Agency
MS	Maximum Standard
MS4	Municipal Separate Storm Sewer System
NA	Not available
NCHF	North Central Hardwood Forest
NH3	ammonia
NO2	Nitrite
NO3	Nitrate

NOAA	National Oceanic and Atmospheric Administration
NURP	National Urban Runoff Program
NWS	National Weather Service
OHWL	Ordinary High-Water Level
ORP	Oxidation Reduction Potential
Ortho-P	Orthophosphate
PAR	Photosynthetic Active Radiation
PCL	Purgatory Chain of Lakes
RCL	Riley Chain of Lakes
PI Survey	Point-intercept survey (approach to aquatic plant surveying using a grid sampling pattern)
RPBCWD/ District	Riley Purgatory Bluff Creek Watershed District
sec	second (unit of time)
sp	species

APPENDIX E

Regulatory Program Report

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Regulatory Program Report

Mat Nicklay, *Natural Resources Technician*

rpbcwd.org/permits

OVERVIEW

Regulation plays an important role in preventing and mitigating water resource issues. The regulatory program sets standards that must be met by entities that develop or otherwise disturb land within the District. The regulatory program is intended to provide for consistent application of resource protection from impacts related to land use change throughout the watershed.

The District's Board of Managers adopted the regulatory program on November 5, 2014, and implementation of the regulatory program went into effect in January 2015. In response to stakeholder comments, the District modified the regulatory program in 2018 and 2019. The regulatory program includes thirteen rules, A - N, (rule I was eliminated in 2018 revisions). The rules and summary of modifications are available on the District's website at rpbcwd.org/permits.

In 2023, the District was responsible for administration of regulations **throughout the District** as no municipalities *adopted ordinances equally protective of the resources.*

PERMITTING

The District Regulatory Program requires individuals and entities desiring to take certain actions to obtain a permit from the District before commencing any work covered by District Rules. Since the District reinstituted its regulatory program in 2015, 651 permit applications have been submitted to the District, including 80 for the 2023 calendar year. In 2021 District staff began using MS4Front permit management software and database which allows staff to easily view and track permits, escrows, fees, inspections, and violations.

In 2023, there were 24 permit applications that were approved by the Board of Managers. In addition, another 32 were approved administratively as set forth in District policy. These included 13 permits for work on existing single-family lots of record, 14 issued to municipalities or local road authorities, and five to commercial properties.

VARIANCES

In 2023, four requests for variances from District rules were submitted and approved by the Board of Managers:

- One variance request was for the floodplain management and drainage alterations rule (Rule B) for the Xcel Service Center project (Permit Number 2022-074). The request pertained to the provision of compensatory storage criteria.
- One variance request was for the wetland and creek buffers rule (Rule D) for theChanhassen Trail Improvements project (Permit Number 2023-044). The request pertained to the buffer widths criteria.
- One variance request was for the wetland and creek buffers (Rule D) for the Cortrust Parking Improvements project (Permit Number 2023-022). The request pertained to the buffer widths criteria.

- One variance request was for the wetland and creek buffers rule (Rule D) and the stormwater management rule (Rule J). The request pertained to the buffer widths criteria of Rule D and the rate control criteria of Rule J.

PERMIT VIOLATIONS

During 2023 there were three locations where work was conducted without a permit from RPBCWD. The district continues to work with the property owners to rectify these conditions and as such the Board of Managers has not pursued formal violation notices or enforcement action as indicated in Rule N.

BENEFITS TO WATER RESOURCES

The District Regulatory Program sets standards to regulate the management of stormwater runoff to limit the runoff quality and rate on receiving waterbodies. The intent of these standards is to improve water quality to support environmental health and recreational usability of waterbodies within the District. In pursuit of these goals, the District requires that permittees limit the rate and volume of stormwater leaving their site, as well as managing stormwater runoff for total phosphorus (TP) and total suspended solids (TSS).

For every year for which data is available (2018-2023) permitted sites within the district have met or exceeded the 60% TP and 90% TSS removal goals. Additionally, for every year except 2019, the 1.1" volume abstraction goal has been met or exceeded. In 2023, implementation of the District's regulatory program resulted in the removal of 378 pounds of phosphorus and 116,120 pounds of sediment from the stormwater that will be discharged annually from permitted sites. From 2018 through 2023, 747 pounds of total phosphorus and 226,121 pounds of sediment were removed from stormwater discharge. Without the standards set by the District's Regulatory Program these pollutants would have reached our lakes and streams.

Each year, erosion control measures required by the ***Regulatory Program*** prevents an estimated

FOUR DUMP TRUCKS of SEDIMENT

from ending up in ***our lakes and streams.***

This number grows each year.

APPENDIX F

Wetland Program Report

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Wetland Program Report

Zach Dickhausen, *Natural Resources Coordinator*

rpbcwd.org

Introduction

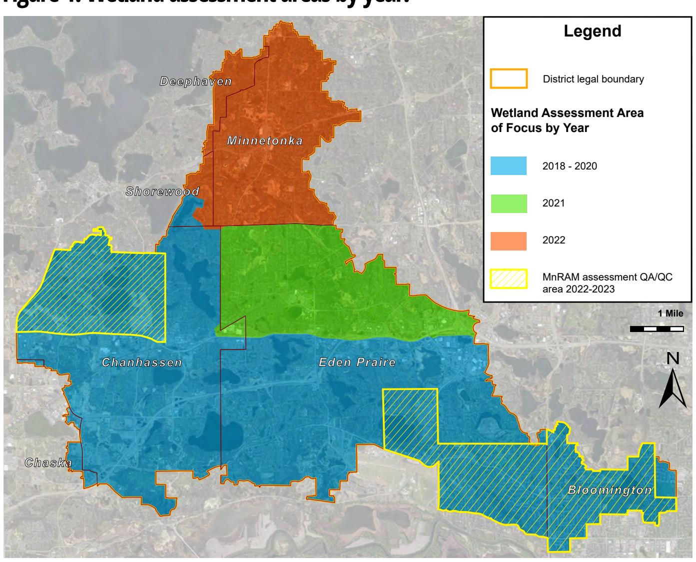
In 2023 , the District staff re-assessed a total of 72 wetlands using the District's modified Minnesota Routine Assessment Method (MnRAM) and the Rapid Floristic Quality Assessment (Rapid FQA). Staff also conducted wetland re-assessments in the southeast part of the District. This included areas around the Staring Lake Subwatershed, the southeastern part of the Purgatory Creek Watershed between Staring Lake and Minnesota Highway 169, and the majority of area within and immediately surrounding the Hyland Lake subwatershed (Figure 1).

Methods

Minnesota Routine Assessment Method

The Minnesota Routine Assessment Method (MnRAM) for Evaluating Wetland Functions was developed by an interagency working group to assess wetlands following passage of the Minnesota Wetland Conservation Act in 1991. It is a systematic way of documenting wetland functions and characteristics such as vegetative communities, habitat, anthropomorphic values and impacts, stormwater interactions, general site hydrology, water quality, soils, topography, and buffer widths.

Figure 1. Wetland assessment areas by year.



Barr updated the Microsoft Access Database version of the MnRAM worksheet for the District to use in its wetland assessment. This modified version of the MnRAM worksheet allows staff to input more details about wetlands and their functions, providing a more accurate assessment of the site. It also generates a report that provides wetland function classifications/values based upon input.

During wetland site visits, staff assess the site, fill out a MnRAM worksheet, and document the site with photographs. If staff observe indications of a potential wetland, they perform an initial assessment of the approximate wetland boundary or flag the site for future investigation.

Through MnRAM wetland assessment, staff are building a detailed catalogue of wetlands in the District. The catalogue supplements standard state and federal wetland inventories by including details such as fine-scale wetland extent, more accurate vegetative community designations, record of wetland impacts and degradation, and infrastructure risks. Figure 2 shows the extent of wetlands within the District based on National Wetland Inventory (NWI) data.

Floristic Quality Assessment for MN Wetlands

Developed by the Minnesota Pollution Control Agency (MPCA), the Rapid Floristic Quality Assessment (FQA) for wetlands provides an ecological assessment approach based on plant habitat requirements and/or tolerance for disturbance. The

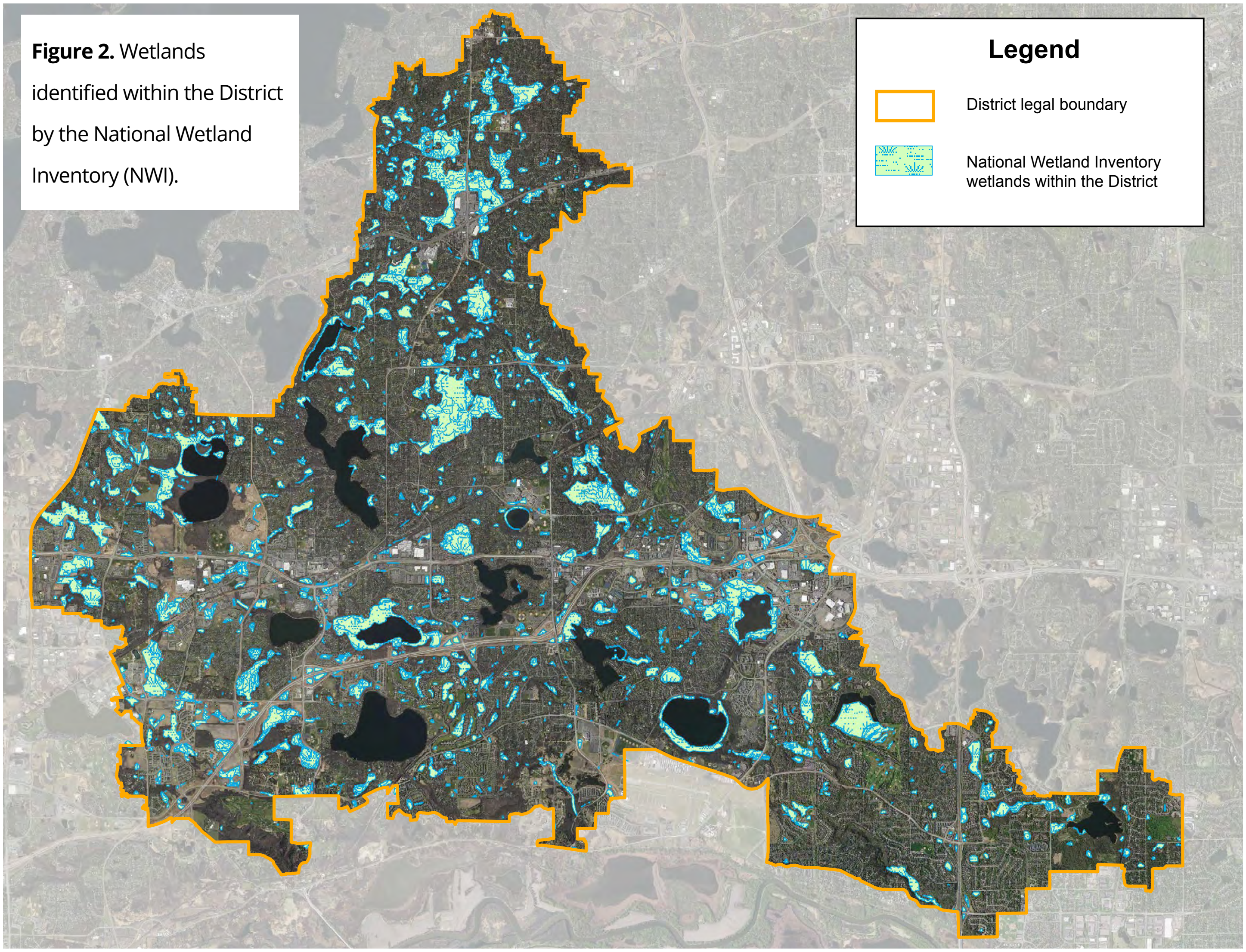


Figure 2. Wetlands identified within the District by the National Wetland Inventory (NWI).

approach is based on a C-value assigned to each plant species by Minnesota botanical experts. The higher the C-value, the more sensitive a plant is to site conditions and disturbance. C-values of plants within a given community are used to calculate a floristic quality index (FQI). The greater the FQI, the closer a plant community is to a natural state.

FQA compliments MnRAM by providing a quantitative assessment of the makeup and quality of plant communities within a wetland. When used together, FQA and MnRAM data sets provide a much more comprehensive metric to assess wetlands. RPBCWD first began FQA at the end of the 2020 field season. FQA has been a standard part of all District wetland assessments since 2021.

Wetland Management Classification

To advance the wetland assessment program, District staff are developing an assessment and management methodology based on ecosystem services to prioritize wetland rehabilitation, protection, and creation. These functions are listed on the

Wetland Assessment Methods

MnRAM

Rapid, qualitative assessment used to identify wetland functions. Combines data and observations gathered from a site visit and remote sensing data. This data produces ratings for assessed wetland functions.

This method asks: What are the characteristics of the wetland as a whole?

FQA

Vegetation-based ecological condition assessment. Sites are assessed for diversity and abundance of plant species. The higher a site scores, the closer it is to a natural condition and the more sensitive it is to disturbance.

This method asks: What plant species grow in the wetland? How abundant are they?

"Wetland Classification Continuum" section of this report.

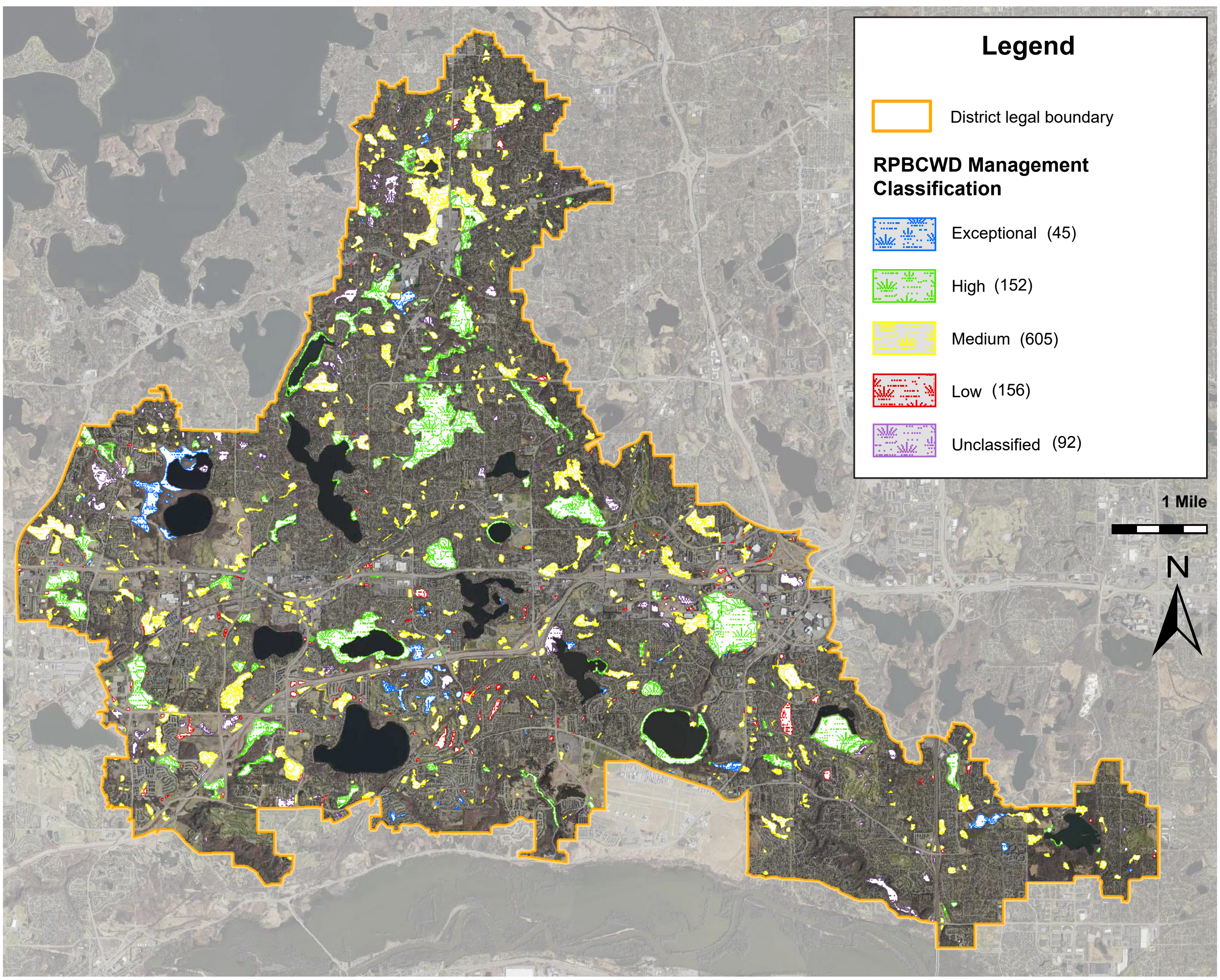
Metrics have been developed for each of these services, which, along with data gathered from the updated MnRAM and FQA assessments, determine the assignment of District management classifications to wetlands. These classifications include low, medium, high, or exceptional value wetlands. Management efforts to promote functions and services and to restore, protect, and create wetlands are prioritized on wetlands with higher classification values. Vegetated buffer rules are also set based on these classifications.

To date, staff have conducted assessments and assigned management classifications to 957 wetlands within the District. Table 1 and Figure 3 detail and show the distribution of these management classifications for wetlands identified within the District. The Wetland Classification Continuum on the next page provides details on how wetland functions (or lack of functions) help determine and assign a management approach.

Table 1. Distribution of wetland classifications in the District.

Classification	Quantity
Exceptional	45
High	152
Medium	605
Low	156
Unclassified	92
TOTAL WETLANDS	1,050

Figure 3. Classification of wetlands assessed with the Riley Purgatory Bluff Creek Watershed District as of 2023.



Wetland Classification Continuum

Assigning management classification to wetlands provides input for prioritization of restoration efforts. These classifications are based on FQA data and MnRAM functional categories which include:

- **Vegetation diversity/integrity**
- **Habitat structure**
- **Amphibian habitat**
- **Fish habitat**
- **Shoreline protection**
- **Cultural/recreational/ educational value**
- **Stormwater/urban sensitivity**
- **Wetland water quality**
- **Characteristic hydrology**
- **Flood/stormwater attenuation**
- **Commercial use**
- **Downstream water quality**

Exceptional Value

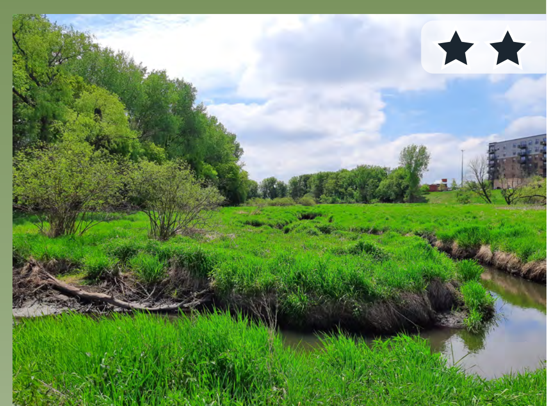
Wetland has large buffer area or buffers shoreline. High plant diversity. Little or no alteration of soils and plants. Water quality is good. Provides fish and/or amphibian habitat. Significant recreational, educational and/or cultural value.

High Value

Wetland with buffer or provides buffer for shoreline. Provides floodwater attenuation. Better to good water quality. Water deep enough to provide overwintering amphibian habitat. May provide fish habitat. Moderate plant diversity.

Medium Value

Wetland may have been excavated or serve as stormwater pond. Low plant diversity. Minimal educational, aesthetic, or recreational opportunity. Deeper water may provide overwintering wildlife habitat.



Low Value

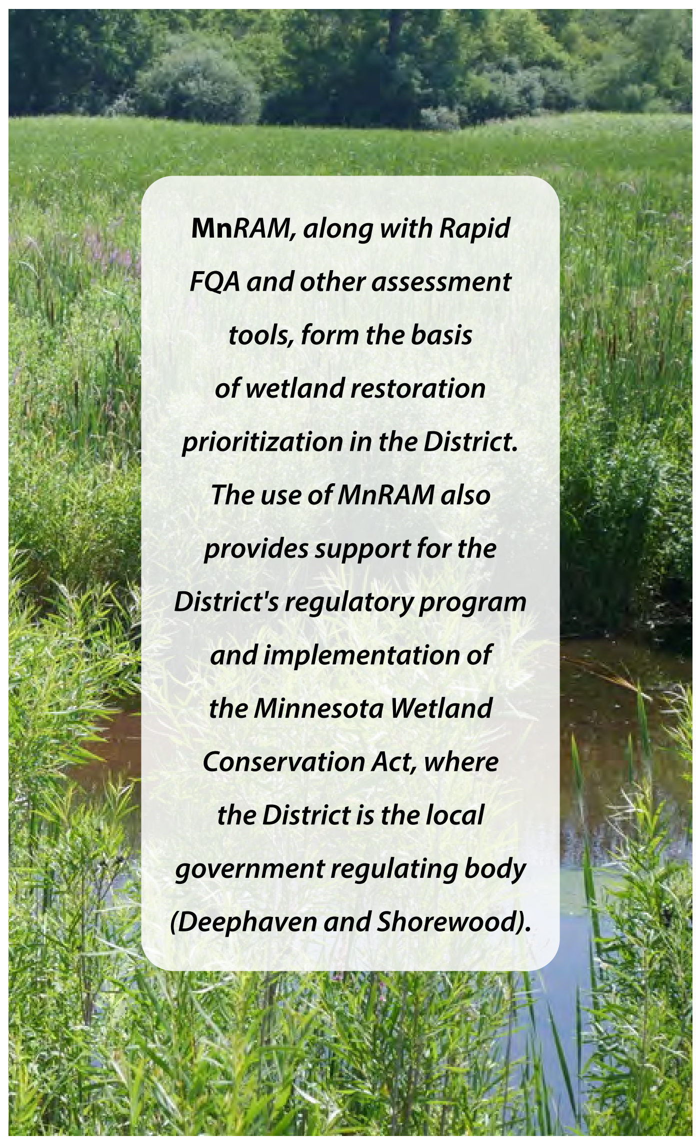
Associated with agricultural or high-intensity land use. Very low species diversity and dominated by invasive species. Poor water quality, usually due to high inputs of untreated stormwater runoff. Has alteration or excavation. Little or no recreational or cultural value.

2024 Wetland Assessment and Next Steps

As of the end of 2023, the majority of wetlands within the District have been assessed using MnRAM and assigned a management classification. Staff Dickhausen will continue to conduct QA/QC assessments in different parts of the District. Assessment efforts in 2024 will focus on re-assessing vegetation at wetlands within the area of Chanhassen south of MN HWY 5. This area was assessed prior to the introduction of FQA into the District's wetland assessment protocol. Re-assessment using FQA/Rapid FQA methods will provide staff with a more accurate biodiversity and vegetation community value, as well as better provide guidance for prioritization of wetlands to be considered for restoration, rehabilitation and/or protection in the next steps of the program.

The overall goal of this program is to identify areas within the District where wetlands can be restored, rehabilitated and/or protected. The main focus of these restoration/protection actions are the functions that the wetlands provide or could potentially provide within the watershed. Often when impacts to wetlands occur, mitigation efforts do not always take place within that watershed. Many replacement plans for wetland loss have mitigation action taking place outside of the District. This means that even though off-site mitigation is required and taking place, wetland impacts are leading to the loss of vital wetland functions such as water storage, biodiversity, habitat, water quality improvement, etc. within that specific watershed. By identifying these areas, the District and its staff can work to bring back and improve these functions and values within the watershed.

Over the last six years, staff have assessed the majority of wetlands within the District, determining the health and quality of the functions they provide. They cataloged this data and assigned management classifications to each wetland. From here, staff, along with staff from Barr Engineering, can start identifying groups of wetlands which could be classified as higher priority for restoration, rehabilitation and/or protection. If any special wetland types such as calcareous fens or tamarack swamps are identified within the District, they will be set aside as automatic candidates for rehabilitation and/or protection. The majority of wetlands to be chosen for restoration/rehabilitation/protection will be those deemed higher priority from the first round of wetland assessments. In this next step of determination for these wetlands, staff will focus on three main functions: biodiversity, water quality and water storage/flood mitigation. A wetland will gain higher priority if it provides or could potentially provide more value for one or more of these three functions within the watershed/subwatershed it is in. A wetland that has good potential for providing flood retention functions and makes up 3% of a watershed after restoration is bound to have higher priority than a wetland that only makes up 0.5% of the watershed; a wetland that has higher levels of nutrients flowing through it and its watershed may have higher priority due to water quality functions it could provide; a wetland that has rich vegetation community interspersion



and plant biodiversity will beat out those with one or two plant communities and a lack of plant diversity. Those wetlands that provide higher functional value for two or all three of these functions will gain the highest priority along side the special wetland types. Over the course of 2024, staff will work with Barr staff to determine which of the wetlands already assessed will be analyzed at this next level. From, here they can start to assess these wetlands for their priority for restoration, rehabilitation and/or protection.

Restoration versus Rehabilitation

Wetlands have primary impacts, where the hydrology is altered to a point where they no longer function as a wetland. This can be through the installation of drain tile, excavation of ditches, installation of outlet structures below the bed elevation of the wetland, or placement of fill. When one of the three parameters for determining the existence of a wetland are missing, in this case hydrology, the area does not meet the definition of wetland. If repairs take place so that wetland hydrology is restored to functions like a wetland again, this is considered wetland restoration.

Conversely, wetlands may have secondary impacts that result in diminished functions, but the area still meets the definition of a wetland. This could be any of several factors. Some examples might be hydrologic alterations such as ineffective tiling or ditching where the wetland is only partially drained. It may be that the contributing watershed was diverted resulting in less water inputs to the basin resulting in a drier hydrologic regime. The hydrology may remain the same but, due to land use changes, excessive nutrient or sediment loading may occur which impacts the community type, avian or amphibian habitat, or result in a proliferation of invasive or pioneer species colonizing the wetland. In these cases, the wetland could be rehabilitated to enhance the diminished functions and possibly provide additional functions and public values.

Identification of Restorable Wetlands

In concert with the wetland inventory and assessment program, staff will work to identify historic wetlands that have been drained or filled and have the potential to be restored. In order to be considered for a wetland restoration, an area must have the following characteristics:

1. An adequate source of hydrology.
2. Hydric soils.
3. Unimpeded by structures except when removal of the structures is desired by all stakeholders.
4. Property must be owned by an entity that is agreeable to protecting the area in perpetuity.

MN DNR/WI DNR Wetland Rapid Assessment Update

In the fall of 2020 a memorandum of understanding was completed between the Minnesota Board of Water and Soil Resources (BWSR) and the Wisconsin Department of Natural Resources (WI DNR) regarding the Wetland Functional Assessment Initiative, a joint effort between several agencies (WI DNR, MN DNR, BWSR, MPCA, EPA, and St. Paul USACE) to develop wetland functional assessment tools that can be used in Minnesota and Wisconsin to assist in wetland regulatory implementation and other wetland conservation uses. Current standards for wetland functional assessments in the state, such as MnRAM, are outdated and may not serve the needs of regulatory programs. Because of this initiative, development of new tools for functional assessment is underway. In February 2021, a steering committee was formed to define goals and objectives of the initiative. A technical advisory team made up of professionals within the agencies was established in summer 2021 to develop the tool and its functional categories. A draft tool draft and spreadsheet was completed in 2023.

Staff Dickhausen attended the Minnesota Water Resources Conference, special wetland session on October 17, 2023 where updates about the Wetland Functional Assessment Initiative were discussed. One of the main pushes for this initiative, besides the lack of updates to MnRAM over the years, is that

MnRAM is considered too qualitative of an assessment. The technical advisory team referenced aspects of the Minnesota Stream Qualification Tool (MNSQT), a tool which uses function-based parameters and metrics to assess functional categories of streams. It was used as a template when drafting aspects of the new wetland tool. The tool will still be a rapid assessment, but it is going to rely more on observation-based metrics. Hydrogeomorphic (HGM) classification will also play a larger role in the assessment and establishment of areas of interest. Speakers also presented a basic breakdown of how the tool will work in providing functional assessment of wetlands. The assessment helps identify drivers/factors that change how well the wetland will perform functions. Indicators (the observable characteristics related to the drivers) are assessed and from this primary and secondary indicators are established. From here, the assessment helps identify primary and secondary opportunity values.

The tentative timeline for continued development and release of the tool is as follows:

- Continue developing and testing of the tool/spreadsheet in 2024
- Beta testing with help from wetland professionals and environmental organizations in Minnesota and Wisconsin in late summer of 2024
- Release of version 1.0 of tool and spreadsheet in summer of 2025

Although the District has worked with Barr to update and improve upon aspects of MnRAM and the Microsoft Access MnRAM worksheet for use within our watersheds, staff are interested in reviewing the new tool. Once it is available, staff will assess it to see if it should be considered for use in some capacity within the District's wetland program. District staff remain in contact with MN DNR staff about being a beta testing site of the new tool when it reaches that stage.

Wetland Conservation Act Activities

The overall goal of the Wetland Conservation Act (WCA), passed as Minnesota law in 1991, is to achieve no net loss of wetlands in the state. It does this by regulating the:

- Draining and filling of wetlands
- Excavation within type 3, 4, and 5 wetlands
- Excavation of all wetland types if said excavation fills or drains the wetland, converting it to a non-wetland.

Local government units (LGU) are responsible for administering WCA and for making determinations on applications/projects/activities impacting wetlands. The District acts as the LGU in charge of administering WCA for parts of Shorewood and Deephaven located within the District and makes the decision to accept or deny WCA joint applications proposing activities within wetlands. Applications range from seeking a concurrence of wetland boundaries, based on a formal delineation, to seeking approval of an application for the purchase of wetland banking credits to replace wetlands lost during the course of a project. Staff also sit on WCA Technical Evaluation Panel (TEP) for cities who act as the WCA authority throughout the rest of the District. Staff, along with other TEP members, advise LGUs on making decisions on to accept or deny WCA joint applications.

The District received one WCA joint application in 2023 for a wetland boundary and type confirmation in Deephaven. Staff Dickhausen, along with a TEP consisting of members from Hennepin County and BWSR, met on-site and reviewed the wetland delineation. After having the applicant's wetland delineator edit a few small parts of the delineated edge to better represent the overall boundary of the wetland, the TEP was in agreement that the delineation was accurate and the application was approved.

Over the course of 2023, Staff Dickhausen represented the District on the various TEPs of the other LGUs within the District boundaries. This included the review of applications received by Chanhassen, Eden Prairie, and Minnetonka. Staff also worked with Chanhassen and their TEP to review a pair of related WCA violations.

APPENDIX G

Projects Report

2023 Projects Report

Terry Jeffery, *District Administrator*

rpbcwd.org/projects

INTRODUCTION

Several programed projects got underway in 2023. Plans were finalized for the last portion of Riley Creek to be stabilized, from Highway 5 to Lake Susan. The Bluff Creek headwaters channel stabilization and ecological enhancement was ordered as well. The Lotus Lake watershed water quality improvement project feasibility study was completed.

The District also amended their 10-year plan to include the acquisition of 27 acres of prairie land in the lower bluffs area of the Minnesota River. This project met numerous plan goals and could potentially serve as the future location for the district office. After more than a dozen meetings to discuss the merits and detractions of this project, the Board of Managers voted 4-1 to acquire the project. The lone dissenting manager filed suit against the Board of Managers. The case was still pending as of February 2024.

The District also began their next planning initiative, Ecosystems Health Action Plan (EHAP), which aims to take a more holistic approach to watershed management, considering all biological, chemical, and physical characteristics of the watershed and the role they play in water quality.

The first workshop of four of the EHAP Technical Advisory Panel was held in May 2023.

In 2023, the District amended its 10-year plan to include acquisition of 27 acres of Minnesota River bluff land in the Riley Creek watershed.

CAPITAL IMPROVEMENT PROJECTS

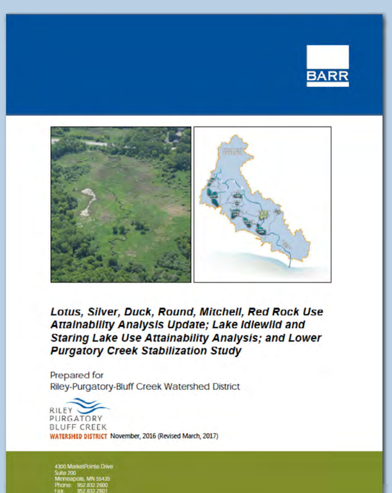
LOTUS LAKE WATER QUALITY IMPROVEMENT PROJECT

Lotus Lake is classified as a deep water lake with a beneficial use category of Class 2: Aquatic life and recreation. The MPCA standard for total phosphorus (TP) less than or equal to 0.04 µg/L. Lotus Lake has only met this standard once between 1972 and 2018. Since Lotus Lake received an alum treatment in 2018, it has consistently met the standard with an average TP concentration in 2021 of 0.029 µg/L. The MPCA standard for chlorophyll-a (Chl-a) is at or below 14µg/L, and Lotus Lake has not met this standard in any year tested although it has been trending downward since the alum treatment. Based upon the 2017 Use Attainability Analysis (UAA), internal loading accounts for 68% of the TP loads to Lotus Lake. A second alum treatment is planned for 2023, addressing the internal loading component. This internal load control is modeled to reduce annual loading approximately 586 pounds per year. In total, Lotus Lake needs a load reduction of 37% or 682 pounds.

The UAA identified eight potential locations for best management practices to treat the contributing watershed. In chapter 9 of the 2018 10-year plan, these projects were listed individually. It was decided while setting the 2022 budget that an economy of scale could result in a reduction of cost by combining several of the practices into one larger project. To this end, LL_1, LL_3, LL_5, and LL_7 have been combined into one project and the feasibility study was initiated in 2022. Based upon planning level estimates, these practices could potentially reduce external loading to Lotus Lake by 122.9 pounds of TP per year.

What is a UAA?

A Use Attainability Analysis (UAA) is a structured scientific assessment of the factors affecting the attainment of uses specified in Section 101(a)(2) of the Clean Water Act (sometimes called the "fishable/ swimmable uses"). Factors considered include the physical, chemical, biological, and economic use removal criteria.



At the planning level for the UAA, these projects, in total, ranged in cost from $2,896,000 to $4,059,000. It is important to emphasize that this is at the planning stage and that range will narrow as the design is developed. Funding for the project is anticipated to come from the RPBCWD levy, the City of Chanhassen, and, if awarded, grant funds. The City of Chanhassen has three road reconstruction projects planned for the area in the capital improvement plan. RPBCWD and Chanhassen are working as partners to provide regional treatment for these planned activities.

The project feasibility study was completed in December of 2024. The feasibility report found that certain constraints to the various areas would limit the TP removal indicated by the planning level estimate. If all four practices are implemented, as well as the stabilization of Kerber Ravine, the annual TP loading to Lotus Lake would reduce by 57.3 lbs/year. This reduction, combined with the alum treatment, will bring the total load reduction to within less than 39 lbs/year of the target loading identified in the UAA. In addition to the reduction in total phosphorus loading to Lotus Lake, these projects will also reduce sediment load to Lotus Lake by more than ten tons per year.

A public hearing will be held in late spring of 2024 with an anticipated project order date in the early summer of 2024. When a project is "ordered" by the Board of Managers, it is not authorized for construction. What is ordered is for the design, permitting, and bid or quote solicitation to occur. Depending upon qualified bids, coordination of road projects, and property access, construction is anticipated to begin in the 4th quarter of 2024 with substantial completion occurring in late 2025.

BLUFF CREEK HEADWATERS ECOLOGICAL RESTORATION PROJECT

Design of the Bluff Creek Headwaters Ecological Restoration Project is underway. The project will restore a section of Bluff Creek north of Highway 5.

The District has partnered with the City of Chanhassen to stabilize Riley Creek from Highway 5 (MN TH5) to Lake Susan. The goal of the project, described in the Bluff Creek Reach 5 Ecological Enhancement Plan was to create an ecologically diverse stream corridor and significantly reduce streambank erosion and sediment deposition into Bluff Creek and the Minnesota River, both of which have Total Suspended Solids (TSS) identified as the stressor. The project will also provide extended detention and ecological restoration within the headwater wetland. Where constraints allow, the stream will be reconnected to the floodplain.

Bluff Creek is impaired for both aquatic life (2002) and aquatic recreation (2002 and 2018). A Total Maximum Daily Load (TMDL) Study was conducted in 2010 and identified in-stream and near-stream erosion as the primary sources of sediment. It further concluded that extended detention, such as will be provided by the wetland restoration, will aid in the reduction of erosive forces in the channel. In 2022, the Bluff Creek Reach 5 Ecological Enhancement Plan was completed. Conversations with the city of Chanhassen made the district aware that Chanhassen was planning on a full reconstruction of Galpin Boulevard. The district is working with Chanhassen to align these projects to the extent practical. One outcome of this communication was that the district advanced study of the creek crossing at Galpin Boulevard and designed a crossing that would not increase rates, velocities, or flood elevations while providing for animal migration. This design was provided to Chanhassen for inclusion in their reconstruction plans for Galpin Boulevard. The RPBCWD will pay for that portion of the culvert replacement that exceeds the delta of what the cost would otherwise have been for Chanhassen had they only sought regulatory compliance.

Modeling completed in 2022 indicates that flow rates and velocities can be reduced to pre-settlement conditions for the 1-year, 2-year, and 10-year return interval storms. This could translate into a reduction of 8,225 pounds of TSS and 31 pounds of total phosphorus (TP) in addition to the reductions resulting from the channel stabilization. The recommended channel stabilization concept (Concept C) is estimated to reduce loading of TSS by 60,200 pounds per year and TP by 38 pounds per year.

Planning level cost estimates range from $545,500 to $848,600. As is always the case, planning level opinions of cost have a wide range because the specific design parameters are unknown. As the design becomes more resolved, the range will narrow. The project was ordered by the Board of Managers in December of 2023.

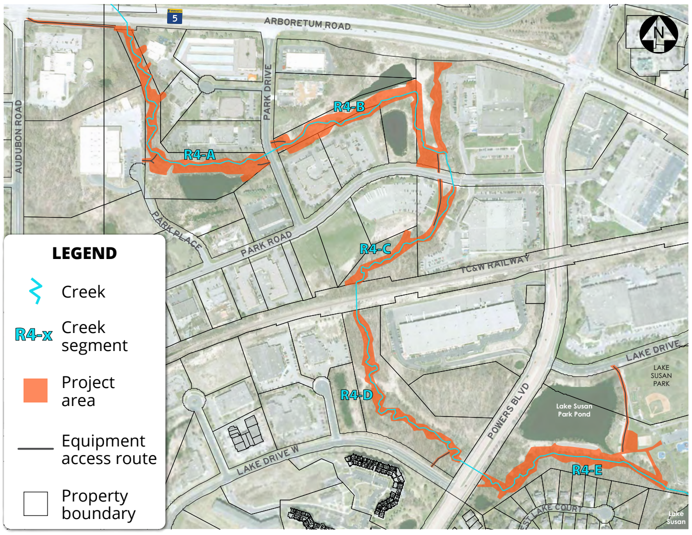
Design will continue through 2024. Bid solicitation is anticipated in late 2024 with construction to occur in 2025.

UPPER RILEY CREEK ECOLOGICAL ENHANCEMENT PROJECT

The District has partnered with the City of Chanhassen to stabilize Riley Creek from Highway 5 (MN TH 5) to Lake Susan. The goal of the project, described in the Upper Riley Creek Corridor Ecological Enhancement Plan, is to create an ecologically diverse stream corridor and significantly reduce streambank erosion in Riley Creek and sediment deposition into Lake Susan. Where constraints allow, the stream will be reconnected to the floodplain.

Riley Creek is impaired for both aquatic life (2002) and aquatic recreation (2002 and 2018). The receiving water, Lake Susan, is impaired for aquatic consumption, aquatic life, and aquatic recreation due to mercury, Fish Index of Biotic Integrity (IBI), and nutrients. The sampling performed where Riley Creek passes under Powers Boulevard found that all but two samples in 2018

The Upper Riley Creek Ecological Enhancement Project will stabilize Riley Creek from Highway 5 to Lake Susan.



and all of the 2019 samples exceeded the MPCA standard for total suspended solids (TSS) of ≤30mg/L. Results of the P8 model indicate that 83,000 pounds (about 37,648 kg) of sediment are carried from the watershed to Lake Susan annually. This does not include loading from streambank erosion. To achieve and maintain the long-term water quality goals of Lake Susan, a 67% reduction in erosion source loading is necessary.

This reach, known as R4, was analyzed using the Bank Erosion Hazard Index and the Near Bank Stress Ratings. These tools were used to estimate bank erosion rates and were estimated at about 250 tons of total suspended solids (TSS) each year. By stabilizing Reach 4, engineers estimate the project will reduce TSS by 470,000 pounds per year and total phosphorus (TP) by 250 pounds per year. This represents the bank recession rate of 0.10 to 0.25 feet per year.

In 2022, the district performed a Phase I Environmental Site Assessment (ESA), and Environmental Assessment Worksheet (EAW), preliminary plan design, and hydrologic and hydraulic modeling of the reach. The EAW produced a finding of no recognized environmental conditions. The ESA found nothing of consequence as well. The design has been modified to achieve no rise in flood elevation as required by FEMA. Design was completed in October of 2023. The RPBCWD has partnered with the City of Chanhassen to address an outdoor storage area currently used by the city that lies immediately adjacent to Riley Creek and surrounding wetlands. Chanhassen desires a decant facility to be constructed that would allow for deposit of materials such as street sweepings, slurry obtained through vacuuming out manufactured treatment devices and sump manholes, as well as other debris currently stored in the outdoor facility. Coordination with the city has resulted in a delay of the project timeline to work through design and logistics.

Late winter and early spring of 2024 will be spent finalizing design of the decant facility, developing and executed a cooperative agreement with Chanhassen, and procuring necessary rights from property owners with the work area. Solicitation of bids will take place in late summer of 2024 with construction tentatively scheduled for winter 2024/2025.

RICE MARSH LAKE WATER QUALITY IMPROVEMENT PROJECT

Rice Marsh Lake is classified as a shallow lake. The MPCA standard for TP is ≤ 60 µg/L. The average growing season total phosphorus in 2010 was 115 µg/L with a peak of 130 µg/L. In 2014 the average TP load concentration was 107 µg/L with a peak of 134 µg/L. The 2016 Rice Marsh Lake and Lake Riley Use Attainability Analysis (UAA) found that 44% (712 pounds) of the load was from watershed runoff, 35% was from internal loading, and 19% originated from upstream lakes. To meet water quality goals, TP loading must be reduced by 41% or 681 pounds.

Rice Marsh Lake has a contributing local watershed of 883 acres. The selected subwatershed (RM_12) accounts for approximately 232 of those acres including the highly urbanized town center of Chanhassen, which has minimal treatment. The area accounts for loading of one pound per acre or 232 pounds of TP. The next largest contributing subwatershed (RM_33) accounts for 169 pounds. Most other subwatersheds are in the single digits.

The Feasibility Report for the Rice Marsh Lake Subwatershed RM_12a Water Quality Improvement Project evaluated seven different potential best management practices with one of these, manufactured treatment devices (MTD) looking at 14 different products. After meeting with Chanhassen staff of the Parks and Recreation Department and evaluating other site constraints such as the Metropolitan Council Interceptor Sewer Line, it was decided to go with a manufactured treatment device (MTD). The Kraken® Filter by Bio Clean was the preferred option as it was modeled to have the best removal efficiencies at between 52 and 59 pounds/year as well as having the needed capacity to handle the storm event flows through the system. A sampling unit was placed into the outlet for the

At the feasibility stage, the engineer's opinion of cost for the project ranged from $456,000 to $854,000. The awarded bid was for $594,830. Funding for the project came from the RPBCWD levy. Chanhassen paid for installation of the curb cut rain garden during their road project and to have an existing storm sewer utility access hole adjusted and refurbished. The city also donated land for the project and partnership with Chanhassen is in the form of their donation of land and their committed to long-term maintenance of the area and the MTDs.

Two filters were installed in series in November 2021. In spring 2022, another raingarden was installed, and 15,000 square feet of park area maintained as lawn had the soils amended and was planted with either pollinator plants or native prairie. There will be three years of ongoing vegetation management.

MIDDLE RILEY CREEK STABILIZATION PROJECT

The District partnered with the Bearpath Golf and Country Club and the Bearpath Homeowners Association on this project. The goal of the project, described in the feasibility report, was to create an ecologically diverse stream corridor and significantly reduce streambank erosion and sediment deposition into Riley Creek. In conjunction, the project needed to maintain the aesthetics and playability of the original Jack Nicklaus-designed golf course.

Riley Creek is impaired for both aquatic life (2002) and aquatic recreation (2002 and 2018). The receiving water, Lake Riley, is impaired for aquatic consumption, aquatic life, and aquatic recreation due to mercury, Fish IBI, and nutrients. Downstream, the Minnesota River is impaired for aquatic life and aquatic consumption.

Portions of this reach, known as R3 (extends from Rice Marsh Lake to Lake Riley), were analyzed using the Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) model, which is comprised of two erosion estimation tools. Based upon the Bank Erosion Hazard Index portion of the BANCS, these reaches rated as "high." By stabilizing Sub-Reaches E and D3, engineers estimate the project will reduce total suspended solids (TSS) by 16,640 pounds per year and total phosphorus (TP) by 8.3 pounds per year.

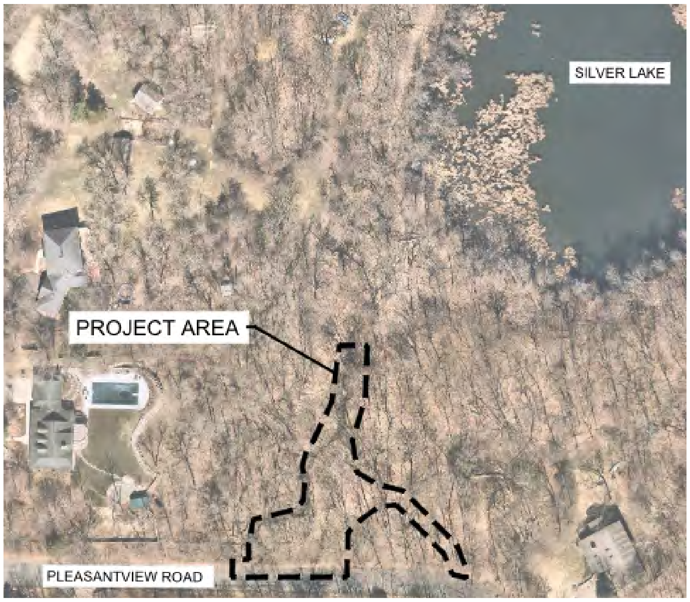
At the feasibility stage, the engineer's opinion of cost for the project ranged from $504,000 to $819,000. The awarded bid was for $439,582. Funding for this project came from the RPBCWD levy and the Bearpath Golf and Country Club. In 2021, the channel was realigned, all stabilization practices such as riffles, root wads, and vegetated reinforced soil slope (VRSS) were installed, and the flood plain area has been temporarily stabilized. The spring of 2022 saw the remainder of the buffer areas planted into native vegetation. This will be the last year of vegetation maintenance by the district before turning that responsibility over to Bear Path Golf and Country Club.

SILVER LAKE WATER QUALITY IMPROVEMENT PROJECT

Silver Lake is classified as a shallow lake, which has an MPCA standard for total phosphorus (TP) less than or equal to 60 µg/L. Silver Lake has only met this standard in 2017. The District set a goal for chlorophyll-a (Chl-a) at or below 20 µg/L, and Silver Lake has not met this standard in any year tested. Based upon the 2017 Use Attainability Analysis, TP loads to Silver Lake need a reduction of 16% or 179 pounds.

The Feasibility Report for the Silver Lake Subwatershed SiL_2 Water Quality Improvement Project identified five potential best management practices to treat the contributing watershed. Installation of a drop manhole structure with sump, channel reshaping, and installation of an iron-enhanced sand ditch check was selected to minimize cost, disturbance to the natural area, and potential utility conflicts. Based on estimates, the project will remove 2.6 to 4.7 pounds of TP per year.

During the feasibility study, the engineer's opinion of project



cost ranged from $98,000 to $183,000. The awarded bid was for $127,977. Additional erosion was noted just beyond the construction limits and a change order was authorized to extend the curb and gutter and repair the eroded area for $4,111, bringing total project cost to $132,088. Funding for the project came from the RPBCWD levy with change order paid for by the City of Chanhassen. The City also partnered by donating land for the project and committing to long-term maintenance of the sump manhole and iron-enhanced sand filters.

The project was substantially complete in November 2021. Fall of 2024 will mark the completion of the three years of contracted vegetation maintenance.

WETLAND RESTORATION AT PIONEER TRAIL

Initiated as a flood hazard mitigation project, the project evolved into a wetland restoration project. The City of Chanhassen and RPBCWD purchased three houses that were constructed in an historic wetland and experienced regular flooding. The structures were removed from the property, either by home movers or demolition, and their appurtenances also removed. Upon removal of the homes, RPBCWD commissioned a Feasibility Report – Pioneer Trail Wetland Restoration Project, to determine what ecological, flood protection, and stream protection benefits could be garnered from restoring the wetland on these three properties. The feasibility report looked at two outlet configurations for hydrologic and hydraulic control as well as two conceptual plans for habitat restoration.

At the feasibility stage, the engineer's opinion of cost for the selected options ranged from $400,000 to $650,000. The awarded bid was for $295,098. Funding for the project came from the RPBCWD levy, the City of Chanhassen, a Minnesota Department of Natural Resources Flood Hazard Mitigation Grant, and Watershed Based Funding Grant from the State of Minnesota. In 2021, the outlet structure was installed and earthwork was completed. Invasive species were treated as well. In the spring of 2022, the final treatment of invasive species was completed and in the summer of 2022 the wetlands were sown with native seed mixes and live container shrubs and trees were installed. There will be professional maintenance for a minimum of five years. Volunteers will be asked to perform additional maintenance into the future.

DUCK LAKE ROAD PARTNERSHIP

For many years, Duck Lake Road divided Duck Lake into two separate bodies of water. The separation negatively impacted water quality and wildlife habitat and caused frequent flooding of the roadway. In 2019, the City of Eden Prairie applied for a permit to reconstruct Duck Lake Road. This project evolved into construction of a bridge to replace the section of road dividing the lake.

The project replaced approximately 235 feet of two-lane roadway with a bridge and pedestrian improvements. Environmental benefits include restoration of the shoreline and about 7,000 square feet of the lake bed, removal of habitat

A double row of yellow silt curtains in the water protect the lake from the Duck Lake Road construction zone (fall 2021).

fragmentation, and improved floodplain impacts by increasing the water storage volume of the lake.

Total project cost is approximately $4.7 million over five years with the District providing up to $1.175 million in support. The project was constructed entirely on city property, and the city will own and maintain Duck Lake Road and its right-of-way when the project is complete.

Project construction began in 2021 with substantial completion in late 2022. The official opening ceremony was held in June 2023. For more information, check out the City of Eden Prairie Duck Lake Road Improvement Project webpage.

The City of Eden Prairie hosted a Ribbon cutting ceremony for the Duck Lake bridge on June1, 2023.

OPPORTUNITY PROJECTS

ST. HUBERT WATER QUALITY AND NATIVE VEGETATION RESTORATION PROJECT

This project was a public/private partnership between the District, St. Hubert Catholic School, and Carver Soil and Water Conservation District (SWCD). The project germinated from a school staff member's desire to install a raingarden for her classroom as a project to address runoff from the school's parking lot that had created a deeply incised gully had formed within a tributary to Rice Marsh Lake. The project evolved to address the gully, install a rain garden, install a tree trench, restore 0.6 acres of fallow land to prairie, as well as make some drainage improvements on the site. In addition to the water quality benefits, RPBCWD staff are working with staff at St. Hubert to develop curriculum to turn the prairie into a living classroom. The school and RPBCWD are also working with a class at the University of Minnesota to study soil health and vegetation establishment at the site.

A memorandum of conceptual design was prepared to communicate conceptual design options, approximate costs, as well as benefits and limitations of specific practices. The preliminary opinion of cost ranged from $204,000 to $277,000. The awarded bid was for $290,964. Funding is from the RPBCWD levy, St. Hubert Parish Council, the State of Minnesota Watershed Based Implementation Fund, and Carver SWCD. The

A view of a St. Hubert project tree trench in October 2022.

project was substantially completed in August of 2021. Three years of maintenance remains on the prairie, rain garden, and tree trench.

SPRING ROAD CONSERVATION PROJECT

This project originated out of a significant grassroots upwelling. The area was deemed to be a priority area for protection by the RPBCWD. The RPBCWD ten-year plan was updated to include the Spring Road Conservation Project on November 16, 2023. A public hearing was held on October 16, 2023. This project will protect and restore approximately 27 acres of highly erosive bluff land in the Riley Creek and Minnesota River valleys. In addition, the acquisition will allow for targeted education and outreach opportunities, will add one of two remaining properties needed to complete a contiguous natural corridor from Lake Riley to the Minnesota River, will aid in meeting the TMDL for both waterways, and will provide opportunity for research. The area may also be used to house the RPBCWD offices in the future.

Acquisition is tentatively scheduled to occur in 2024. The RPBCWD will work with Hennepin County Land and Water to develop a restoration plan and restore the native dry prairie and savanna ecotypes in late 2024 into 2025.

APPENDIX H

Grant Program Report

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Grant Program Report

Liz Forbes, *Communications Manager*
Eleanor Mahon, *Community Engagement Coordinator*

rpbcwd.org/grants

OVERVIEW

Riley Purgatory Bluff Creek Watershed District (RPBCWD) has three grant offerings. The Action Grant is open to all RPBCWD community members, and the Educator Mini-Grant is open to teachers and informal educators located within the district boundary. The Stewardship Grant is open to property owners within RPBCWD including homeowners, non-profits such as homeowners' associations and communities of faith, local units of government such as cities, schools, and businesses.

EDUCATOR MINI-GRANTS

The Educator Mini-Grant supports educators in their efforts to connect their students with water resources. An applicant can be awarded up to $400 for a project that has a water resources component. Previous grantees received reimbursements for bus fees to a nature center, binoculars for wildlife watching, and snowshoe rentals. No applications were received for a Mini-Grant in 2023 despite multiple emails to teacher contacts.

In 2022, a teacher from Scenic Heights Elementary utilized an Educator Mini-Grant to purchase materials to repair a dock at a pond on school property. Students can now access the pond more safely to learn about water resources.

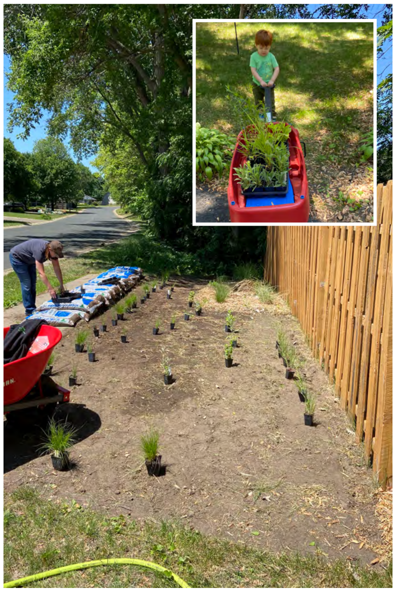
ACTION GRANT

Action grants are small, simple grants of up to $250 for projects to protect clean water. They are designed to help members of the community install fun, easy projects as a way to grow awareness throughout within communities in our watershed. Applications may be submitted year-round, and grant money is reimbursed upon project completion.

Six Action Grants were awarded $250 each in 2023. Two projects were completed and the four others will wrap up in 2024. Four of the projects occurred in Eden Prairie with the two others taking place in Chanhassen. The grants were awarded for these project types:

- Bee lawn with pocket prairie (one project)
- Native planting (two projects)
- Rain barrel purchase (two projects)
- Buckthorn blasters (one project)

Two Action Grant projects installed in 2023 included a native planting and purchase of a rain barrel.



STEWARDSHIP GRANT

The Stewardship Grant Program provides cost-share and technical advice for projects that protect and conserve natural resources. Ideal projects increase public awareness of the vulnerability of local water resources and solutions to improve them.

Potential grantees begin the application process by requesting a site visit. In 2023, 30 site visits were completed. These initial or "kick off" site visits are typically performed by Seth Ristow, Landscape Restoration Specialist, with the Carver Soil and Water Conservation District (SWCD). This ongoing partnership provides opportunity for district residents to discuss their project ideas with someone experienced in implementing a variety of best management practices including habitat restoration, erosion control, and rain gardens.

After the initial site visit, an application packet may be submitted. The application is reviewed initially by the RPBCWD grant coordinator to see if all required information was submitted. If so, the application is forwarded to the grant review committee, which in 2023 consisted of RPBCWD staff, Seth Ristow (SWCD), and Marilynn Torkelson (RPBCWD Citizen Advisory Committee).

Grant awards are based on the type of project and its value toward accomplishing District goals. The table below shows the maximum awards per applicant category. Not all projects are awarded the maximum.

APPLICANT CATEGORY	MAXIMUM AWARD	
	Percent of project cost	Dollar amount
Homeowner	75%	$5,000
Non-profit	75%	$20,000
Local government/ school/business	50%	$50,000

Eleven grant projects were completed in 2022 with total cost-share reimbursement of $134,719. Before reimbursement, grantees must schedule and pass a project inspection (Carver County SWCD). The grantee must also submit a project report consisting of a summary description, photographs, and receipts before reimbursement is considered by grant coordinator. Grantees are required to maintain projects and submit reports after installation. Individual homeowners must maintain their project for at least five years. Other grant applicant types (non-profits such as homeowners associations, municipalities, etc.) must maintain their projects for at least ten years.

2023 STEWARDSHIP GRANT ACTIVITIES	QUANTITY
Site visits completed	31
New agreements signed	11
Active projects	19
Follow up inspections completed (projects completed in previous years)	58

Steps for a Stewardship Grant applicant/grantee.

1

Request a site visit

The first step in the grant process is to request a site visit for a consultation. Any requests that come in when the ground is frozen, will be held until spring thaw.

Request a site visit →

2

Submit a grant application

There are three different applications: One for a native planting, one for a rain barrel, and one for all other project types. The application period for new applicants is March 1st through October 31st.

Submit an application →

3

Submit a project report

Is your project complete? You'll need to submit a report to begin the project close-out review process.

Submit your report →

4

Annual reporting - long-term

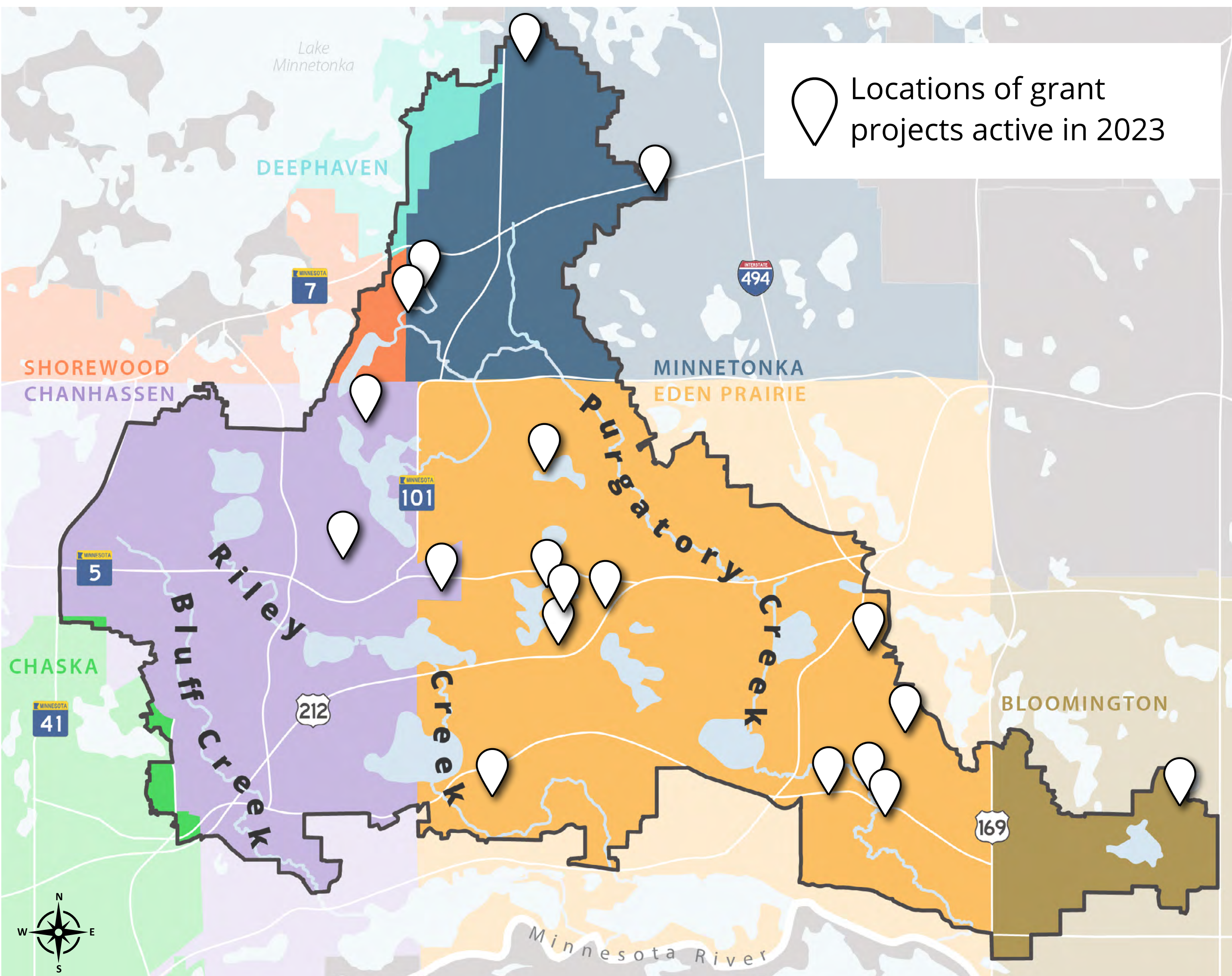
Depending on the type of project/location, you are required to to maintain your project for 5 years or 10 years.

Complete annual report →

Active 2023 Stewardship Grants

In 2023, there were 19 projects undergoing active installation. The figures below summarizes who, where, and what types of projects were active. The majority of grantees were single family homeowners. More than half of the projects occurred in Eden Prairie, and most projects incorporated use of native plants through upland habitat or shoreline restorations. The map shows the approximate location of the active projects, which were distributed across four cities.

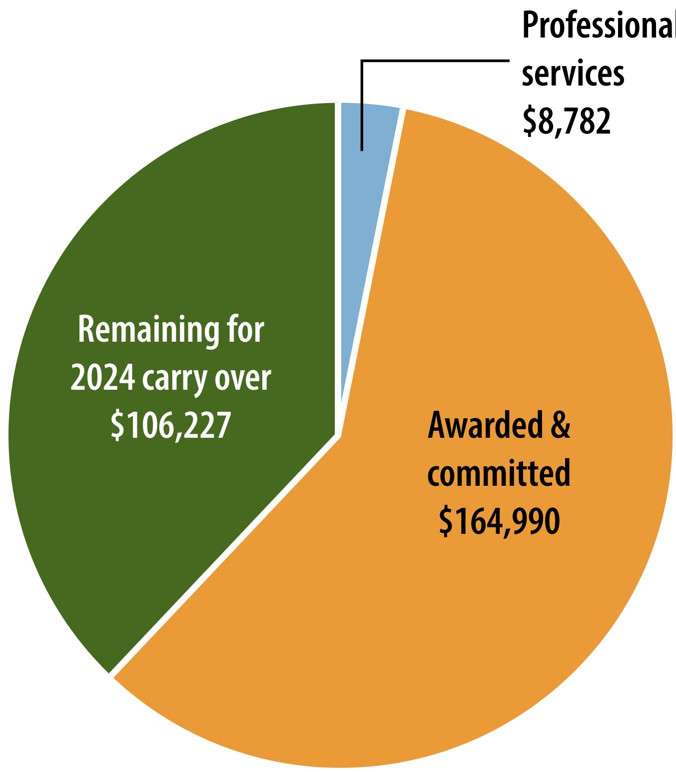
Who were the grantees?		Where were they from?		What kind of project did they do?	
Homeowners	12	Eden Prairie	11	Habitat restoration	10
Non-profits	4	Chanhassen	3	Shoreline resto/buffer	3
Municipality	2	Minnetonka	4	Native planting	4
Business	1	Bloomington	1	Other BMP	2



BUDGET STATUS

In 2023, the Stewardship Grant program had a budget of $280,000. Of this, almost $165,000 was awarded or committed to grant projects, and another $9,000 was paid out to professional service support such as attorney review of cost share agreements and funds for Carver SWCD to perform site visits and inspections. About $106,227 will be carried over to next year. The leftover amount of funds was higher than last year due to no high-dollar municipal project grant applications or awards as there has been in previous year.

2023 BUDGET END-OF-YEAR STATUS



EXAMPLE PROJECT:

NATURAL SHORELINE RESTORATION ALONG DUCK LAKE

Near Duck Lake Trail, the project restored an average of nine feet long a 120-foot stretch of eroded shoreline.

The project was installed in summer of 2023. Work included installation of native plant plugs, installation of native shrubs, application of erosion control fabric to protect soils while plants become established, and temporary fencing to protect young plants from geese. The total grant award for the project was $5,000 with an additional $1,500 to help pay for three years of professional maintenance.

BEFORE: Eroded shoreline with few plants to protect soil.

AFTER: A professional landscaper specializing in native plants stabilized the shoreline using coconut coir erosion control blanket. This was followed by installation of native plant plugs and native shrubs appropriate for the site. Temporary fencing was also installed to protect the young plants from geese and other wildlife.

APPENDIX I

Education and Outreach Report

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Education & Outreach Report

Liz Forbes, *Communications Manager*
Eleanor Mahon, *Community Engagement Coordinator*

rpbcwd.org/events
rpbcwd.org/calendar

There are many ways to have a positive impact on watershed health, and we can't do it alone. The District's Education & Outreach program aims to support the goals outlined in the 10-Year Management Plan by fostering an engaged community and offering opportunities for involvement. This report provides an overview of the ways the program continues to provide opportunities for stewardship and build a network of engaged community members.

2023 Fall Tour

EVENTS

Water Resources Summit

Water Resources Manager Josh Maxwell hosted the annual Water Resources Summit for partner organizations in March 2023. The summit provided an opportunity to share monitoring results, planning efforts, and identify potential partnering opportunities.

Lake Association Summit

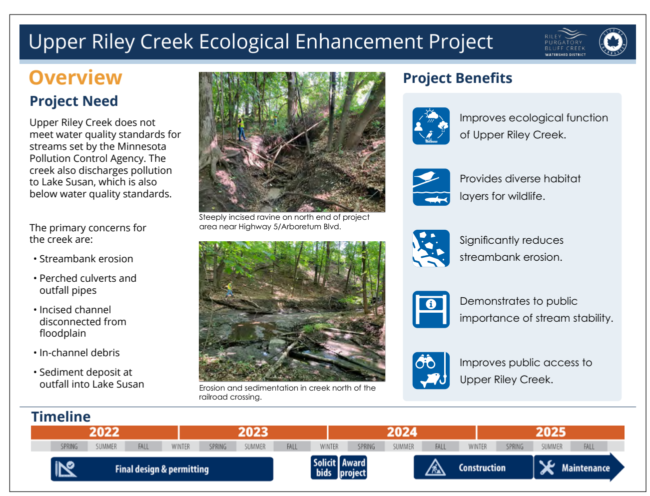
Fifteen representatives from seven lake associations attended the 2023 Lake Association Summit at the RPBCWD office in April. The event provided an opportunity for staff and consultants to provide an overview of the District's role in watershed protection, how to achieve a healthy lake, and capital improvement projects. Fifteen lake association representatives attended.

Fall Tour

Staff and consultants hosted a tour on September 26th for the Board of Managers and Citizen Advisory Committee. The public were also invited to join at tour stops. The purpose of the tour was to see and learn about ecotypes within the District. The group was provided a tour guidebook to provide supporting information about the five ecotypes visited.

Open House for Upper Riley Project

An open house was held on October 24th at the District office for the Upper Riley Creek Ecological Enhancement Project scheduled to begin construction in fall 2024. Attendees had the opportunity to view exhibits about the project and talk to project designers and District staff. About a dozen people attended the event.



One of several exhibits for the Upper Riley Creek Project open house.

Creek Week

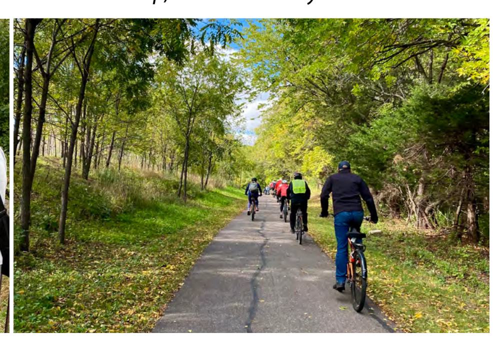
October brought the District's first ever Creek Week with activities for all. A Build Your Own Rain Barrel workshop hosted at the RPBCWD office had participants convert retired wine barrels into rain barrels to capture roof runoff. Residents could also pick up a tree sapling reserved earlier in the year; the trees spent the summer growing strong roots in gravel beds at our office, giving them a strong start when planted in fall. Creek Week wrapped up with the annual Cycle the Creek – a staff-guided bicycle tour along Riley Creek. Beginning with Creek Week, and lasting all month long, the Passport Adventure encouraged people to get out to explore the watershed district by offering a prize pack to determined explorers.

Creek Week Statistics

- Passport Adventure: 35 completed
- Build Your Own Rain Barrel Workshop: 19 attendees
- Gravel Bed Tree Giveaway: Distributed 100 trees of five species (Bur Oak, Red Splendor Crabapple, American Plum, Red Osier Dogwood, White Pine) to 35 households
- Cycle the Creek: 22 riders joined staff on a crisp fall morning to tour a portion of Riley Creek

2023 Creek Week events (left to right): Build a Rain Barrel Workshop, tree seedlings ready to harvest for Gravel Bed Tree Giveaway, participants at the Urban Soils Walkshop, and riders at Cycle the Creek.





VOLUNTEERS

Adopt a Dock

Adopt-a-Dock is a citizen science initiative where lakeshore residents monitor for aquatic invasive species. In 2023, 25 participants used passive plate samplers to monitor for zebra mussels on Duck, Lucy, Lotus, Mitchell, Red Rock, Riley, and Silver lakes.

Adopt a Drain

In 2023, 96 participants adopted 128 storm drains within the Riley Purgatory Bluff Creek Watershed District, preventing 1,755 pounds of leaves, sediment, salt and other debris from entering our waterways. Led by Hamline University, Adopt-a-Drain allows individuals, businesses and organizations to adopt a storm drain in their neighborhood and pledge to keep it clear of leaves and debris throughout the year. Participants track their impact by logging the amount of debris cleared into an online portal. Homeowners who have adopted drains can opt to receive small yard signs to place near their drains, educating their neighbors about their positive impact on clean water. Across all of Minnesota, the Adopt-a-Drain program kept 118,233 pounds of debris out of waterways in 2023.

Minnesota Water Stewards

A partnership with the Freshwater Society, Minnesota Water Stewards trains and supports community leaders to reduce water pollution and educate their community to conserve and protect our waterways. In 2023, RPBCWD sponsored one steward through the program, while 19 past stewards continued their service hours within the District.

Citizen Advisory Committee

Staff Forbes and Staff Mahon serve as liaisons for the Citizen Advisory Committee (CAC). In 2023, there were up to 14 members of the CAC with a couple of resignations due to schedule conflicts. The CAC met monthly for a total of 12 meetings with six of those meetings having guest speakers. Meetings began virtually in 2023 and returned to in-person in October. In addition to regular meetings, the two technical advisory members of the CAC participated in workshops to inform development of the Ecological Health Action Plan (EHAP), and one other member served on the Stewardship Grant review committee.

COMMUNITY EVENTS

In 2023, District staff participated in 15 community events. Staff tabled at these events:

- Minnetonka Contractor's Expo
- Eden Prairie Home, Landscape & Garden Expo
- Eden Prairie Eco Expo
- Eden Prairie Arbor Day Walk & Green Fair
- Minnetonka Winter Farmer's Market
- Mitchell Lake Association Annual Meeting

Staff engaged with youth audiences at these events:

- Cedar Ridge Elementary School Science Night
- Eden Prairie Outdoor Center Animal Open House
- Prairie View Elementary School Watershed Presentation and Art Contest
- Prairie Planting with St. Hubert 7th graders
- Metro Children's Water Festival
- Bluff Creek Elementary STEM Fest
- Staff presented on clean water topics at:
- Minnesota Educational Facilities Management Professionals Association (MASMS) Conference
- Minnetonka High School Envirothon

Staff Portoghese at Bluff Creek Elementary STEM Fest.

WORKSHOPS & WEBINARS

Name	Description	Participation	Partner(s)
Turfgrass Maintenance for Reduced Environmental Impacts Training	Turfgrass maintenance professionals learn how turf management affects local lakes and rivers, gain techniques to optimize fertilizer and pesticide applications, and access resources to help implement new techniques into their lawn care maintenance.	59	Minnesota Pollution Control Agency, NMCWD
Resilient Shorelines Workshop	Covers fundamentals that shoreline property owners need for protecting water quality near their home, including shoreline site assessments, lakescaping and shoreline projects, plant selection tips, regulatory reminders, and access to resources.	40	Metro Blooms, City of Eden Prairie, NMCWD
Project WET Workshop for Educators	K-12 educators learned how to incorporate Project WET education into their curriculum.	20	NMCWD
Building Healthy Soils Workshop	Participants learn about soil ecology in the urban environment and find out what actions they can take to build healthier soils at home.	20	City of Minnetonka, NMCWD
Smart Salting for Parking Lots & Sidewalks	Training to provide winter maintenance professionals the opportunity to learn best practices to reduce their salt use while maintaining safety and minimizing impacts on the environment and infrastructure.	30	Minnesota Pollution Control Agency, NMCWD
Buckthorn Workshop	Hands-on event to learn about how to identify and control the invasive plant.	29	City of Eden Prairie
Urban Soils: Challenges and Opportunities Walkshop	Participants joined Dr. Ann Marie Journey for a walk around Minnetonka's Civic Center Park to see how soil varies between woodlands, wetlands and lawns.	13	City of Minnetonka, NMCWD
Build Your Own Rain Barrel Workshop	Residents learned about the benefits of rainwater reuse and the importance of minimizing stormwater runoff while building oak rain barrels to take home.	19	n/a

COMMUNICATIONS

Annual Communication

In compliance with Minnesota Statute §103B.227, subdivision 4, the District created and distributed an Annual Communication. The 2023 Annual Communication includes general district information, project updates, and ways community members can help improve our water resources. Approximately 2,000 copies of the Annual Communication were sent to local leaders, distributed to city halls, libraries, and community centers across the District, and handed out at community events. Download the document at rpbcwd.org/annualreport.

Social Media

The District posts content on three social media platforms including Facebook, Instagram, and Twitter (now know as X) under the username @rpbcwd. Through interactions and on handouts, the District encourages residents to follow District social media accounts.

Follow us: @rpbcwd | Subscribe

Newsletters

Electronic newsletters are sent quarterly to mailing list subscribers who opt-in for district updates. Subscribers can also opt to receive emails for volunteer opportunities and board meeting notices. A summary of newsletter distribution is provided below.

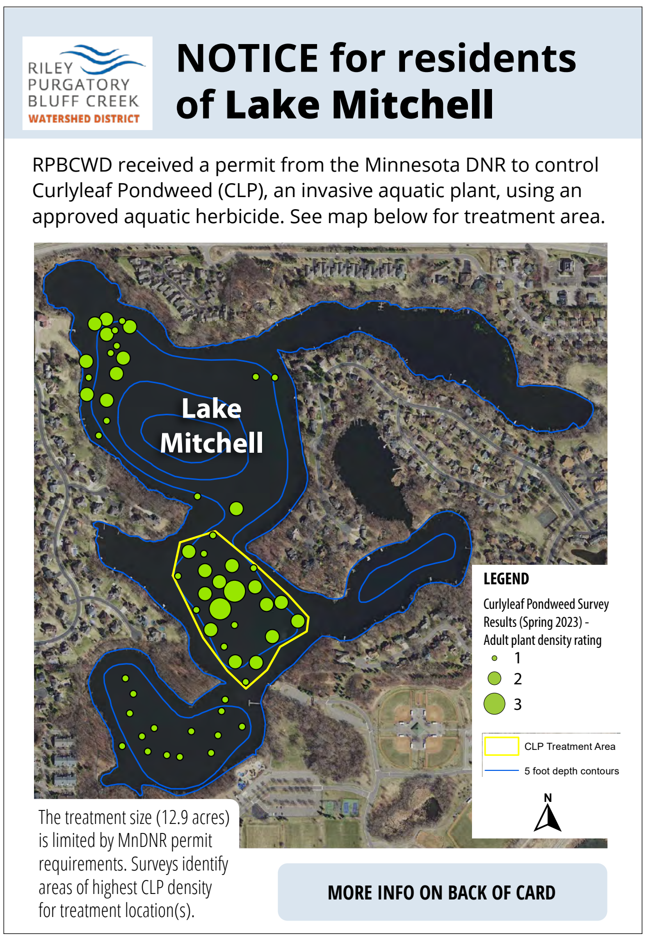
2023 Newsletter Summary

Issue	Recipients	Opens	Link Clicks
Winter	740	289	14
Spring	743	300	23
Summer	751	302	28
Fall	808	370	28

Direct Mail

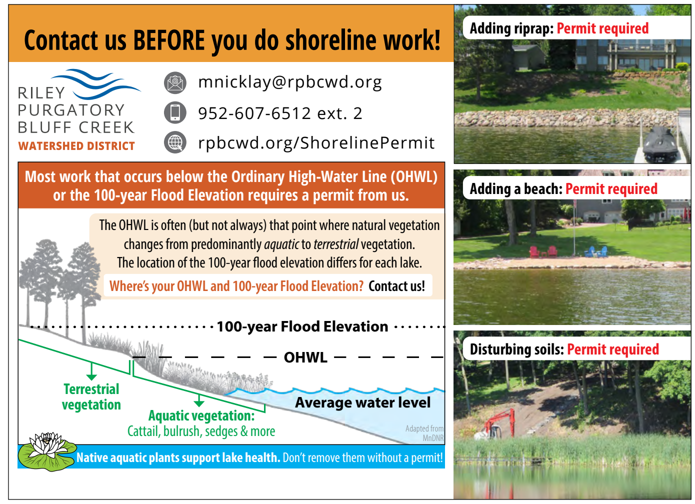
Herbicide treatments to control aquatic invasive plants were conducted on five lakes in 2023. Before the treatments,, property owners adjacent to the treatment sites were notified with a postcard mailing. A website link was provided on the postcard so that residents could find out the latest information about treatment timing. Lake residents were also encouraged to sign up for a new lake email notification service set up in 2023. Lake association contacts were also emailed regarding treatment timing.

Example of postcard notification for AIS lake treatment.



In July, 618 postcards were mailed out to residential lake properties to alert them to the need for a permit before doing shoreline work. The postcard provided contact information as well as a website link with more detail.

Postcard mailed to lakeshore properties regarding permitting needs.

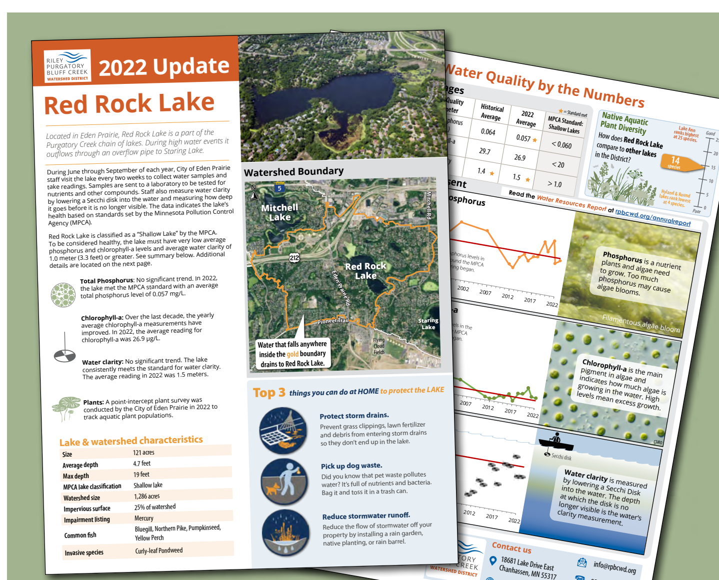


Water Quality Factsheets

Every year, staff update water quality factsheets for the three creeks and thirteen lakes:

- Ann
- Duck
- Hyland
- Lotus
- Lucy
- Mitchell
- Red Rock
- Rice Marsh
- Riley
- Round
- Silver
- Staring
- Susan

The 2022 factsheets were distributed electronically through email and on the website. A list of the factsheets may be accessed online at rpbcwd.org/factsheets and on individual waterbody webpages at rpbcwd.org/waterbodies. Printed copies were placed in the District office's front vestibule and provided upon request to lake associations and others.

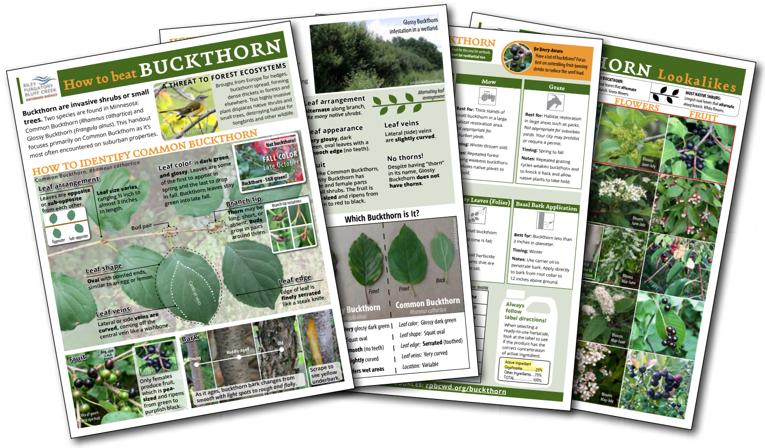


Example of a 2022 lake factsheet.

Other Communication Materials

In addition to growing content on the RPBCWD website, Education and outreach staff continue to expand the library of community engagement materials. We've also sponsored booklet printing with the Prairie Edge Chapter of Wild Ones and purchased a full-page advertisement in the Eden Prairie Community Guide.

In 2023, staff participated in development of a brief video about stormponds by the City of Chanhassen. As of this report, the video is in final production and will likely be part of a broader series.

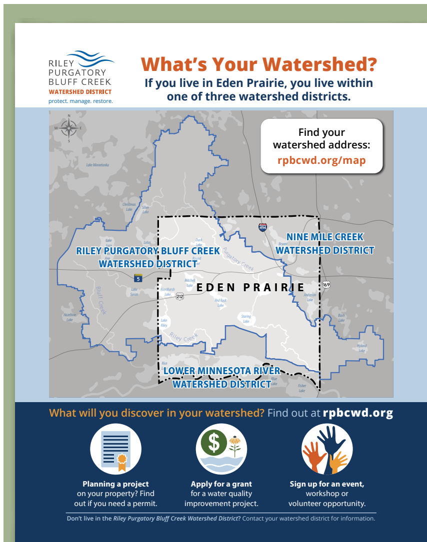


Staff developed a guide on How to Beat Buckthorn for the 2023 Buckthorn Workshop, which was co-hosted with the City of Eden Prairie.

Staff developed a Grow Wild! handout and a Favorite Native Plants for Suburban Yards guide in 2023. The plant list was developed by Stewardship Grant committee members.

E&O staff continued assisting other District staff with needs for temporary or permanent signage, webpages, e-notifications, and graphics for reports. The temporary sign (below) was created to post at Lake Ann when at Zebra Mussel infestation was discovered and treated.

A new wetland buffer sign was produced in 2023 for the District's regulatory program. These signs are required to be posted at permitted sites with delineated wetlands.



For the past few years, RPBCWD has purchased a full page ad in the Eden Prairie Community Guide.

In 2023, staff developed a new set of stickers celebrating our creeks. Stickers are popular giveaways and a great draw at tabling events.

APPENDIX J:

Soil Health Program Report

2023 Soil Health Program Report

Zach Dickhausen, *Natural Resources Coordinator*

rpbcwd.org

INTRODUCTION

Riley Purgatory Bluff Creek Watershed District and Barr Engineering staff are working to establish and develop the Soil Health Program as a branch of the Ecosystem Health Action Plan (EHAP). Through this plan, staff are identifying a set of soil health indicators to sample within the District. The goal of the sampling is to establish baseline soil conditions across a variety of landscape-use types and to characterize what constitutes healthy/unhealthy soil in the District. This data will be used to inform future District actions and management practices. Soil assessment and sampling results are a major tool for developing the Soil Health Program.

WHAT IS SOIL HEALTH?

Soil health can be seen as "the continued capacity of the soil to function as a vital living ecosystem that sustains plants, animals and humans" (NRCS 2023). Soil health and soil quality are considered synonymous, although many professionals will make one distinction between the two, that soil quality includes both inherent and dynamic quality (Moebieus-Clune 2017). Inherent quality is the makeup and properties of soil, shaped by long-term geological processes; Dynamic qualities, more of the "soil health" qualities, are the properties of the soil which are influenced by use and changes on a human time scale (Cornell University 2017). It is important to manage and strive for good soil health and function, as it is its own ecosystem, working as a vital part of broader ecosystems. Properly functioning soil will allow for nutrient cycling and retention, support healthy vegetation communities, sequester carbon, allow for greater water infiltration and storage, etc. For more information on soil health and healthy soil characteristics, refer to Cornell University's "What is Soil Health?" Soil Health Manual Series, Fact sheet number 16-02 found in Appendix A, or the Cornell University Comprehensive Assessment of Soil Health Training Manual, Edition 3.2, 2017. Extensive research exists on soil health and its effectiveness on improving water quality and water conservation. Staff have started the process of reviewing literature on the subject to compile research findings and to identify best practices for soil improvement and soil guidance/ policies that can result in water conservation improvements in the District.

The following is a summary of the soil assessment efforts staff undertook during late 2022 through the 2023 field season. This includes methods of assessment, as well as data collected pertaining to infiltration/hydraulic conductivity, and soil physical, biological, and chemical characteristics data collected. Apparent trends in said data across different landscape-use types and soil types is also discussed.

Soil sample collection

SAMPLE METRICS

The following table (Table 1) contains the current list of sampling metrics being collected during a typical site assessment. These metrics may change/be-added-to upon further literature review and reassessment of data/needs. Metrics to be analyzed by Cornell University's Soils lab as a part of their standard soil health analysis package are noted in the following table.

Table 1. List of current RPBCWD Soil Health Program sampling metrics.

Metric	Assessment
Infiltration rates (MPD infiltrometer)	On-site
Compaction (field penetrometer)	On-site
Soil respiration	Cornell University Soils Lab
pH	Cornell University Soils Lab
Modified Morgan Extractable P	Cornell University Soils Lab
K, Mg, Fe, Mn, Zn, Al, Ca, Cu, S, B	Cornell University Soils Lab
Soil texture	On-site *and* Cornell University Soils Lab
Active carbon	Cornell University Soils Lab
Wet aggregate stability	Cornell University Soils Lab
Soil organic carbon	Cornell University Soils Lab
Predicted Autoclave-citrate Extractable (ACE) protein*	Cornell University Soils Lab
Available water capacity	Cornell University Soils Lab
Surface/sub-surface hardness interpretation (based off field penetrometer readings)	Cornell University Soils Lab
Soil profile/horizon assessment (texture, color, thickness, matrix makeup, redoximorphic features, presence of wetland soils and/or hydrology, etc.)	On-site
Soil moisture	On-site
Vegetation	On-site
Presence of earthworms	On-site

*Autoclave-citrate extractable (ACE) protein and available water capacity are predicted based on other indicators measured.

SAMPLE SITES/POINTS

Sample points were based on identification of representative sites and landscape/ecosystem types (disturbed woodland, old field, wet prairie wetland, field/mowed lawn, etc.), and soil textures/types (sand *vs.* clay/USDA mapped soils). Figure 1 shows sites sampled in the fall of 2022 and during the 2023 field season. At least one composite sample, consisting of at least two sub-samples taken across the site, was taken within each identified landscape type. Samples taken at smaller areas (small scale rain gardens/bee lawns, sites adjacent to BMPs such as the Rice Marsh Lake Kraken unit, etc.) usually consisted of only two subsamples. If multiple mapped soils occurred within these identified landscape types, a separate composite sample was taken within each mapped soil unit. Subsamples were usually taken adjacent to (within 10 feet) of the corresponding infiltration measurement (two subsamples taken 15 feet apart; if more than two subsamples were needed, they were taken at other points within the landscape type).

Sampling was conducted when there was no precipitation and had not been any for the previous 24 hours. Clear, sunny days were needed to properly evaluate the soil profile. In instances where it was too overcast to properly assess soil horizon colors, soil profiles were conducted at a later date during sunny conditions.

Figure 1. Map of soil assessment areas in RPBCWD.
The red dots indicate area where soil assessments were conducted. Thirty-nine sites were identified and assessed within these areas.

INFILTRATION

Infiltration testing was conducted to measure the hydraulic conductivity of the soil (Ksat) at each site using a Modified Philip Dunne infiltrometer (MPD). For each site tested three, four-inch diameter graduated cylinders were pounded into the soil at a three-foot radius around a center point. They were each filled with 30 centimeters of water. Once filled, the MPD sensor heads were placed onto the cylinders and the test was started immediately (each individual cylinder constituted one test). Each test ran until all the water had drained from the tube. If no water drainage was detected after four hours, the test was concluded. Once the sensor head is in place and turned on, the MPD automatically records data for each test.

SAMPLES

Each composite sample consisted of at least two subsamples. Each pair of subsamples were taken 15 feet apart (if taken at an MPD sample point, the same center point was used for both the sampling and infiltration testing). For each subsample, surface debris was removed before digging. With a tile spade, an 8-inch deep hole was dug. From the side of the hole (two inches below surface), a six-by-two-inch sample, the width of the shovel blade, was removed. Any extra soil was removed from the sample so as to make it as uniform as possible. Subsamples were placed together in a clean, five-gallon bucket, mixed thoroughly, and five cups were measured out and double bagged in gallon freezer bags. Samples were labeled with site information, refrigerated and sent to the Cornell University Soils Lab for analysis (all samples sent by end of day, the day after sampling to ensure freshness of the soil). A penetrometer was used to measure surface and subsurface compaction at each subsample site. Penetrometer readings were included with the soil samples to be analyzed by the soils lab.

RESULTS

INFILTRATION DATA

Thirty-nine sites were assessed for infiltration/hydraulic conductivity from fall 2022 through the 2023 field season. Across these sites, 129 individual infiltration tests (one MPD graduated cylinder constitutes one test) were conducted using the MPD infiltrometer (at least one set of three tests at each site; some sites had repeat or extra tests). Of these sites, 18 tests had some sort of error occur and produced a "NULL" result (this is in-part why some sites had multiple tests). Sites were chosen to look at soil conditions at BMP/project sites, as well as collect data on different types of landscape/land-use types. Of the 111 successful tests, 17 were done in rain gardens, 41 across maintained lawns/parkland/bare soil, 19 on restored prairie, six on bee lawns, 11 in restored wet meadow, two in restored shallow marsh, three in stormwater basins, five in restored woodland, and seven in woodland (Table 2). Of the sites planned for assessment across the 2024 field season, the majority will be sites containing landscape use types which are currently lacking in data (woodlands, wet meadows, prairie, old field that has reverted to prairie, restoration sites, etc.) as well as project-specific sites.

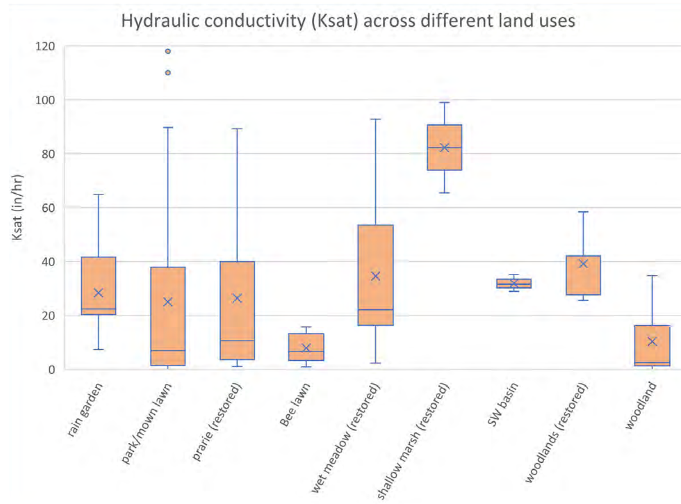
Table 2. Number of successful infiltration tests conducted in 2022-2023 and their associated landscape type.

Landscape use	Number of tests
Field/park/mowed lawn	41
Prairie (restored)	19
Rain garden	17
Wet meadow (restored)	11
Woodland (not restored)	7
Bee lawn	6
Woodland (restored)	5
Stormwater basin	3
Shallow marsh (restored)	2
Total	**111**

Infiltration varied across the different landscape uses (Figure 2). One thing to note across several of the BMP and restored sites, some of these projects were recently finished and vegetation had been recently planted. Many of these sites will be re-assessed in the future to see how conditions and soil structure/health have changed. Restored landscape types tended to have the greater mean Ksat (prairie: 26.38 inch/hour over 19 tests; wet meadow: 34.60 inch/hour over 11 tests; shallow marsh: 82.25 inch/hour over two tests; restored woodlands: 39.16 over five tests). The bee lawn tests and woodland tests produced the lowest mean Ksat (7.92 inch/hour at the bee lawns over six tests, and 10.34 inch/hour over seven woodland tests). The bee lawn contained mostly native vegetation (planted in spring of 2022) which was seemingly not fully grown in at the time of sampling. The woodland tests took place adjacent to wooded ravines and upland draining to Lotus Lake.

Park/mowed lawn areas consisted mainly of mowed Kentucky Bluegrass (*Poa pratensis*) used for recreation and sports fields. There were some areas within this landscape type sampled that had bare ground as well. Test results from these areas had the greatest range. The mean Ksat was 25.03 in/hr across 41 tests. The lowest value was 0.006 in/hr, and the highest was 118 in/hr (which was plotted with a measurement of 110 in/hr as outliers). At most of the lawn/park land sites, soil profiles showed mixed soil layers and clear evidence of soil disturbance. Most of these sites are moderately-to-heavily traveled/used. All these park/lawn sites specifically scored either low functioning/quality or very low functioning/quality (constraining) scores for surface hardness and sub surface hardness (these scores are provided by Cornell University Soils lab based on site compaction readings taken during sampling, Appendix A and Appendix B). Of all the MPD sites where penetrometer readings were taken and compaction was assessed, only one of the wooded sites (Kerber Ravine, penetrometer readings were not taken at the other two wooded sites: LL_7 and LL_8) and two of the rain garden sites (Rice Marsh Lake and St Hubert's) had a sub-surface hardness score above low (all three scored very high). Only the Kerber ravine site and the Rice Marsh Lake raingarden had a surface hardness score above low (high and very high function scores, respectively, Appendix A).

Figure 2. Hydraulic conductivity measured over 111 successful infiltration tests.
"X" indicates the mean hydraulic conductivity (Ksat) value across all the tests within that particular landscape type. The lines intersecting each box plot indicate the median Ksat value of the tests conducted for that particular landscape type.



SAMPLE DATA

From fall 2022 through the 2023 field season, 29 site samples were mailed to the Cornell lab for testing/analysis. Each site sample was a composite, consisting of at least two sub-samples from within the site. Samples were collected from the upper eight inches of soil. Lab results and assessment of the samples included a comprehensive analysis of soil health, including physical, biological, and chemical metrics (Table 3). The Cornell soils lab also provided a comprehensive assessment of soil health, along with functional ratings for each soil sample submitted. (Figure 3 is the results of a sample assessment report for one of three samples taken at North Lotus Lake Park. This site is labeled as "NLLP2" on all the figures displaying functional ratings in this report. The full comprehensive assessment of this site is included in Appendix C). This assessment is based off the Cornell Comprehensive Assessment of Soil Health (CASH) Training Manual/framework (Moebius-Clune 2017). The assessment for each sample also includes soil texture composition (sand/silt/clay), as well as management suggestions to correct indicators which scored poorly. It is important to note that the CASH framework assessment and soil health focus around agricultural settings.

Most samples had an overall quality score of medium or higher. Samples taken from maintained lawn/park landscapes tended to have more mid-to-lower scores overall than other landscape types (six of the 15 field/lawn sites had an overall score of medium, and one had a low score). The undisturbed wooded areas (all located just west of Lotus Lake) had the highest scores (two of three had very high overall scores). Outside of surface hardness ratings, and aggregate stability at one of the sites, these two undisturbed wooded sites scored high – very high across all indicators sampled for. The one undisturbed wooded site that scored lower was observed to have similar understory and herbaceous vegetation growing to those the other two wooded sites. The one stormwater basin sampled so far had the lowest overall score of 29/low. It also tended to have lower, if not the lowest scores across most of the indicators sampled for. This basin was dry at the time of sampling. As far as the restored sites and BMPs were concerned, their scores varied across the indicators sampled for. The Scenic Heights Forest Restoration sites samples (including samples: Sc Ht Woods, Sc Ht Prairie, Sc Ht wet meadow) tended to score higher, more consistently across the indicators sampled for. This is the oldest restored area sampled thus far, and vegetation was well established across the site. Outside of hardness ratings, the Scenic Heights wet meadow and woods scored a medium rating or better across all the indicators, and outside of hardness and soil respiration, these two sites scored a high – very high rating across the board.

Most of the sites sampled to date were on landscapes that had a higher amount of recent disturbance and/or compaction: field/park/mowed lawn (11 sites), landscapes that had been recently restored (prairie, wet meadows, woodland, seven sites), recent BMPs (one stormwater basin, two rain gardens, one bee lawn).

The majority of sites scored low-very low for surface hardness and sub-surface hardness (23 of 25 and 22 of 25, respectively). As stated before, most of these sites have regular foot traffic or have recently in the last few years been restored and had some level of soil disturbance and/or compaction.

Most sites scored high–very high for nutrient content (presence of extractable P and K, and presence of additional nutrients: Mg, Fe, Mn, Zn, Al, Ca, Cu, S, B). Three of the field/park/mowed lawn sites with somewhat lower scores for extractable P (compared to the other sites, three with high and two with medium scores) also had the lowest scores for presence of additional nutrients (all three still having high scores). However, soil pH tended to be lower across most of the field/mowed lawn sites, the SW basin, and a couple of the restored sites (including three of four sites/BMPs located at the NW side of Rice Marsh Lake near the Kraken unit). Six of the 15 sampled field/mowed lawn sites had medium-low pH scores, indicating that the nutrients in the soil may be less available for plant use.

Table 3. Soil Health Indicators - Cornell Framework

PHYSICAL	**Predicted Available Water Capacity:** reflects the quantity of water that a disturbed sample of soil can store for plant use. It is the difference between water stored at field capacity and at the wilting point, and is measured using pressure chambers.
	Surface Hardness: is a measure of the maximum soil surface (0 to 6 inch depth) penetration resistance (psi), or compaction, determined using a field penetrometer.
	Subsurface Hardness: is a measure of the maximum resistance (psi) encountered in the soil between 6 to 18 inch depths using a field penetrometer.
	Aggregate Stability: is a measure of how well soil aggregates resist disintegration when hit by rain drops. It is measured using a standardized simulated rainfall event on a sieve containing soil aggregates between 0.25 and 2.0 mm. The fraction of soil that remains on the sieve determines the percent aggregate stability.
BIOLOGICAL	**Organic Matter:** is a measure of all carbonaceous material that is derived from living organisms. The percent organic matter is determined by the mass of oven dried soil lost on combustion in a 500º C furnace.
	Predicted Soil Protein: is a measure of the fraction of the soil organic matter which contains much of the organically bound N. Microbial activity can mineralize this N and make it available for plant uptake. This is measured by extraction with a citrate buffer under high temperature and pressure.
	Soil Respiration: is a measure of the metabolic activity of the soil microbial community. It is measured by re-wetting air dried soil, and capturing and quantifying carbon dioxide (CO_2) produced.
	Active Carbon: is a measure of the small portion of the organic matter that can serve as an easily available food source for soil microbes, thus helping fuel and maintain a healthy soil food web. It is measured by quantifying potassium permanganate oxidation with a spectrophotometer.
CHEMICAL	**Soil Chemical Composition:** is a standard soil test analysis package measures levels of pH and plant nutrients. Measured levels are interpreted in this assessment's framework of sufficiency and excess but no crop specific recommendations are provided. Nutrients measured include extractable phosphorus, extractable potassium, calcium, magnesium, iron, zinc, aluminum, boron, copper, manganese, and sulfur.

Figure 3. Sample comprehensive assessment of soil health from Cornell University Soils Lab.

The assessment gives functional ratings for each sampled indicator, as well as an overall soil health quality score (the overall score is the mean value of indicator functional ratings). In the rating column, dark green indicates a "very high quality" functional rate, light green indicates "high quality," yellow indicates "medium quality," orange indicates "low quality," and red indicates "very low quality."

Comprehensive Assessment of Soil Health

From the Cornell Soil Health Laboratory, Department of Soil and Crop Sciences
School of Integrative Plant Science, Cornell University, Ithaca, NY 14853
https://soilhealthlab.cals.cornell.edu

Grower:
Zach Dickhausen
18681 Lake Drive East
Chanhussen, MN 55317
zdickhausen@rpbcwd.org

Sample ID:	WW2424
Field ID:	N. Lotus Lake Park 2
Date Sampled:	05/09/2023
Given Soil Type:	Lester-Kilkenny
Crops Grown:	PRK/PRK/PRK
Tillage:	no till
Coordinates:	Latitude: 44.884027000000 Longitude: -93.526559000000

Measured Soil Textural Class: **sandy loam**

Sand: **59%** - Silt: **23%** - Clay: **16%**

Group	Indicator	Value	Rating	Constraints
physical	Predicted Available Water Capacity	**0.18**	**76**	
physical	Surface Hardness	**325**	**2**	Rooting, Water Transmission
physical	Subsurface Hardness	**600**	**0**	Subsurface Pan/Deep Compaction, Deep Rooting, Water and Nutrient Access
physical	Aggregate Stability	**39.0**	**48**	
biological	Organic Matter Soil Organic Carbon: 1.73 / Total Carbon: 1.80 / Total Nitrogen: 0.16	**2.8**	**82**	
biological	Predicted Soil Protein	**4.70**	**22**	
biological	Soil Respiration	**0.5**	**34**	
biological	Active Carbon	**359**	**32**	
chemical	Soil pH	**7.4**	**96**	
chemical	Extractable Phosphorus	**2.5**	**72**	
chemical	Extractable Potassium	**62.5**	**87**	
chemical	Additional Nutrients Ca: 2770.2 / Mg: 398.8 / **S: 2.0** Al: 3.2 / B: 0.26 / Cu: 0.03 Fe: 0.6 / Mn: 2.3 / **Zn: 0.1**		**77**	

Overall Quality Score: **52** / Medium

Table 4 has a list of all the sample site IDs, their corresponding landscape type, and their soil texture composition. These site IDs correspond to the IDs used in all 13 of the figures which display the functional ratings for each soil health indicator (Appendix A). Figure 4 shows the overall soil quality score for each site. Each of these scores is an average of the 12 soil health indicator functional ratings. Figures for the results of each of those 12 indicators can be found in Appendix A. Figures showing average scores for the 12 soil indicators within the eight different landscape types can be found in Appendix B. The CASH manual does note that the overall score should be taken as a general summary rather than the main focus of the soil health assessment.

Most samples had an overall quality score of medium or higher. Samples taken from maintained lawn/park landscapes tended to have more mid-to-lower scores overall than other landscape types (six of the 15 field/lawn sites had an overall score of medium, and one had a low score). The undisturbed wooded areas (all located just west of Lotus Lake) had the highest scores (two of three had very high overall scores). Outside of surface

Figure 4. Sample site IDs with corresponding location description, Landscape type and soil texture composition.

Site ID	Location description	Landscape	Texture ratio (sand/silt/clay)
NLLP1	N. Lotus Lake Park, northern field area	Field/park/mowed lawn	44/36/18
NLLP2	N. Lotus Lake Park, middle of field area	Field/park/mowed lawn	59/23/16
NLLP3	N. Lotus Lake Park, southern field area	Field/park/mowed lawn	47/28/23
LSP outfield	Lake Susan Park, ball fields	Field/park/mowed lawn	45/30/24
St hub field	St Hubert's ball field	Field/park/mowed lawn	38/35/26
RML outfield	Ball field near Kraken unit, NW side of Rice Marsh Lake	Field/park/mowed lawn	41/37/20
ChanDTSW1	Chanhassen city center park, ball fields north of school	Field/park/mowed lawn	41/35/22
ChanDTSW2	Chanhassen city center park, ball fields north of school	Field/park/mowed lawn	38/38/22
ChanDTSW3	Chanhassen city center park, ball fields north of school	Field/park/mowed lawn	38/37/24
ChanDTSW4	Chanhassen city center park, ball field south of school	Field/park/mowed lawn	37/36/25
ChanDTSW5	Chanhassen Elementary School ball fields west of school	Field/park/mowed lawn	38/36/24
ChanDTSW6	Chanhassen Elementary School ball fields west of school	Field/park/mowed lawn	39/36/23
ChanDTSW7	Chanhassen Elementary School ball fields west of school	Field/park/mowed lawn	40/35/23
ChanDTSW8	Chanhassen Elementary School ball fields west of school	Field/park/mowed lawn	33/40/26
LL_3	Meadow Green Park, south end near wooded area	Field/park/mowed lawn	8/56/35
LL_7	Wooded area between Meadow Green Park and Lotus Lake	Woodland	38/36/24
LL_8	Wooded area, just west of Lotus Lake, south end	Woodland	41/34/23
Kerber rav	Ravine downstream of Kerber Pond	Woodland	44/33/21
LSP FE sand	Lake Susan Park, prairie area buffering Iron (FE) sand filter	Prairie (restored)	48/28/22
Sc HT Prairie	Scenic Heights School Forest Restoration, prairie area	Prairie (restored)	81/8/9
St Hub m prairie	St Hubert's restored prairie	Prairie (restored)	41/30/28
RML prairie	Rice Marsh Lake restored prairie near Kraken unit	Prairie (restored)	43/34/21
Sc Ht wet meadow	Scenic Heights School Forest Restoration, wet meadow area	Wet meadow (restored)	70/14/14
St Hub basin	St Hubert's restored basin	Wet meadow (restored)	46/32/21
Sc Ht woods	Scenic Heights School Forest Restoration, wooded area	Woodland (restored)	65/20/14
FH s basin	Stormwater pond, SW of Fawn Hill Rd, across from Bentz Ct	SW basin	90/1/9
St Hub rain garden	St Hubert's rain garden	Rain garden	91/3/4
RML rain garden	Rice Marsh Lake Rain Garden near Kraken unit	Rain garden	91/3/5
RML bee lawn	Rice Marsh Lake Bee Lawn near Kraken unit	Bee lawn	38/24/36

hardness ratings, and aggregate stability at one of the sites, these two undisturbed wooded sites scored high–very high across all indicators sampled for. The one undisturbed wooded site that scored lower was observed to have similar understory and herbaceous vegetation growing to those the other two wooded sites. The one stormwater basin sampled so far had the lowest overall score of 29/low. It also tended to have low, if not the lowest, scores across most of the indicators sampled for. This basin was dry at the time of sampling. As far as the restored sites and BMPs were concerned, their scores varied across the indicators sampled for. The Scenic Heights Forest Restoration sites samples (including samples: Sc Ht Woods, Sc Ht Prairie, Sc Ht wet meadow) tended to score higher, more consistently across the indicators sampled for. This is the oldest restored area sampled thus far, and vegetation was well established across the site. Outside of hardness ratings, the Scenic Heights wet meadow and woods scored a medium rating or better across all the indicators, and outside of hardness and soil respiration, these two sites scored a high–very high rating across the board.

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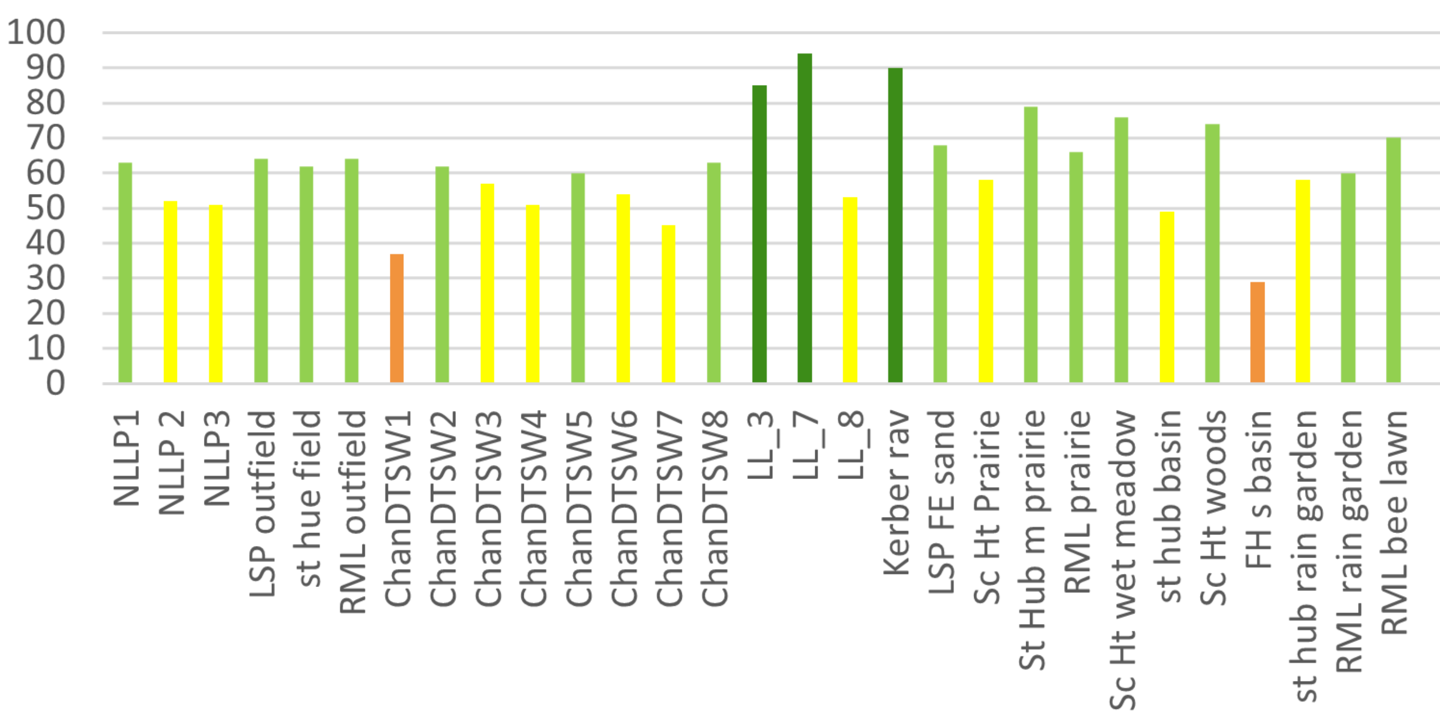
The majority of sites scored low-very low for surface hardness and sub-surface hardness (27 of 29 and 26 of 29, respectively). As stated before, most of these sites have regular foot traffic or have recently in the last few years been restored and had some level of soil disturbance and/or compaction.

Most sites scored high–very high for nutrient content (presence of extractable P and K, and presence of additional nutrients: Mg, Fe, Mn, Zn, Al, Ca, Cu, S, B). Three of the field/park/mowed lawn sites with somewhat lower scores for extractable P (two high and one medium scores) also had the lowest scores for presence of additional nutrients (all three still having high additional nutrient scores). However, soil pH scores tended to be lower across almost half of the field/mowed lawn sites, the

Figure 5. Overall quality score of soil samples taken.

Dark green bars indicate a "very high quality" functional rating (score ≥ 80), light green indicates "high quality" (60 – 80), yellow indicates "medium quality" (40 – 60), orange indicates "low quality" (20 – 40), and red indicates "very low quality" (< 20). This score was determined by the Cornell University Soils Lab based on guidelines developed for the Cornell Comprehensive Assessment of Soil Health manual.



SW basin, and a couple of the restored sites (including three of four sites/BMPs located at the NW side of Rice Marsh Lake near the Kraken unit). Six of the 15 sampled field/mowed lawn sites had medium-low pH scores, indicating that the nutrients in the soil may be less available for plant use.

REFERENCES

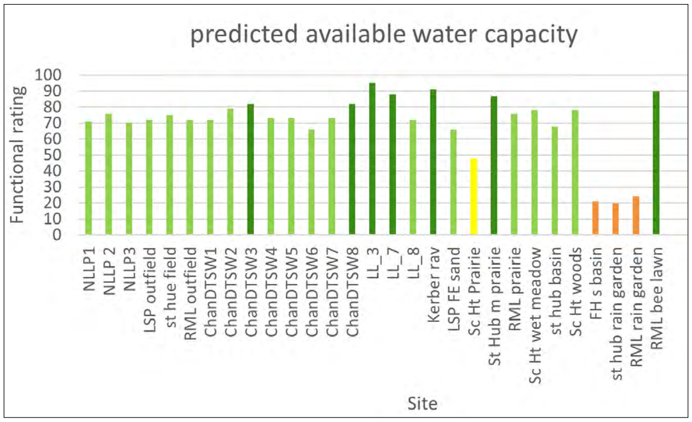
Moebius-Clune, B.N., D.J Moebius-Clune, B.K. Gugino, O.J. Idowu, Et al. 2017. Comprehensive Assessment of Soil Health, The Cornell Framework. Cornell University. Ithaca, New York. Available at: soilhealth.ca ls.cornell.edu/manual

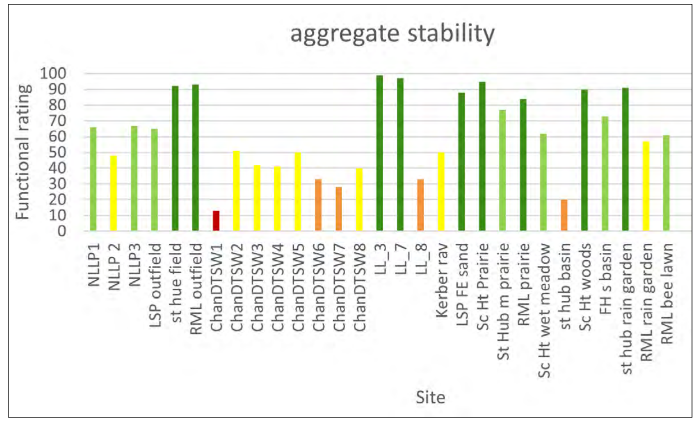
Natural Resources Conservation Services (NRCS). 2023. Soil Health. Natural Resources Conservation Services, U.S. Department of Agriculture Retrieved from: www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health

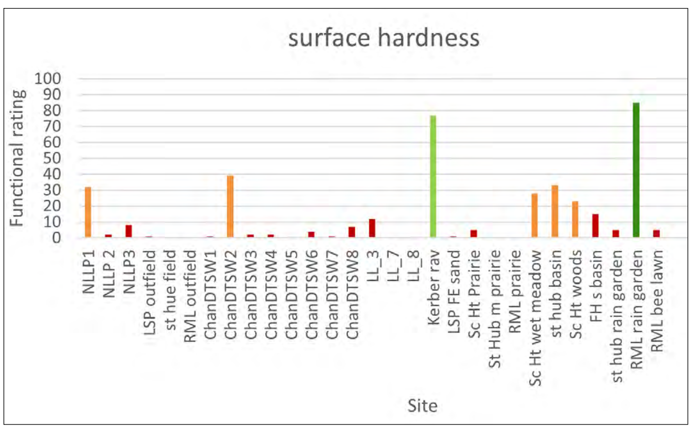
APPENDICES

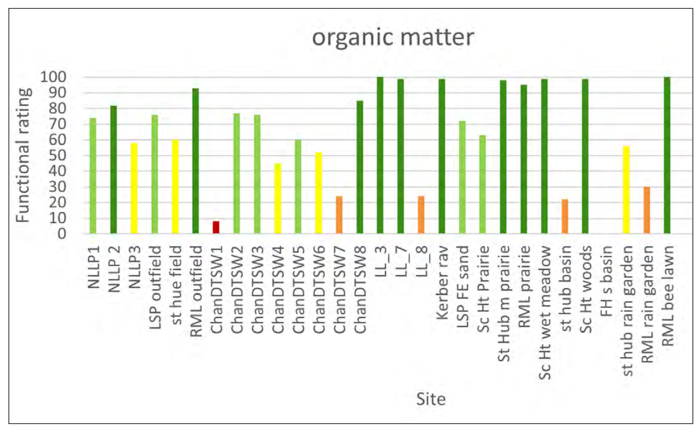
APPENDIX A

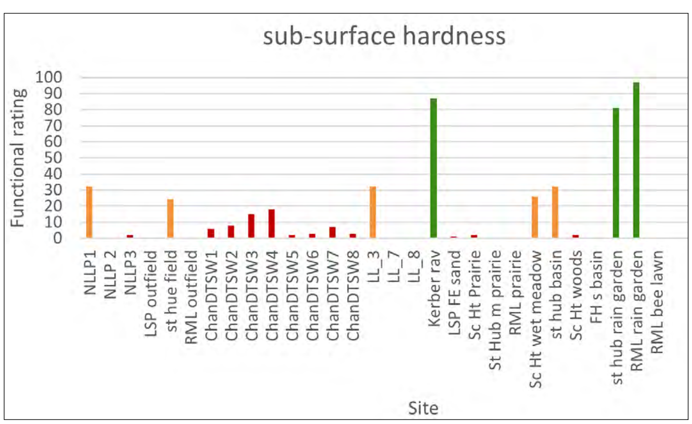
Comprehensive assessment of soil health indicator function/health ratings across all sites sampled.

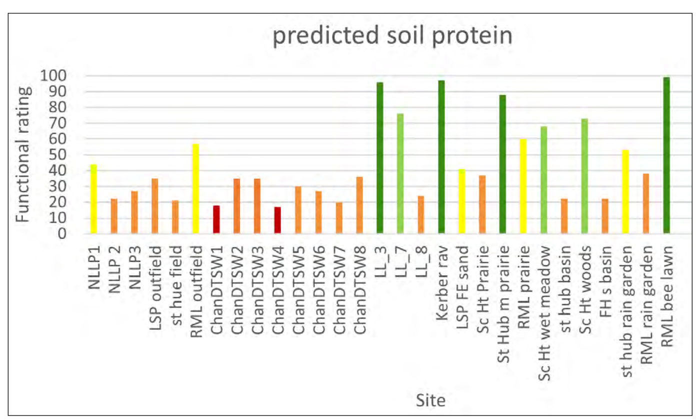


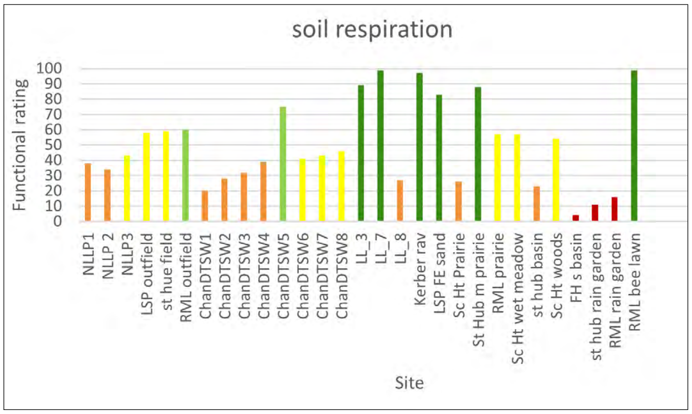











soil respiration
Functional rating
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30
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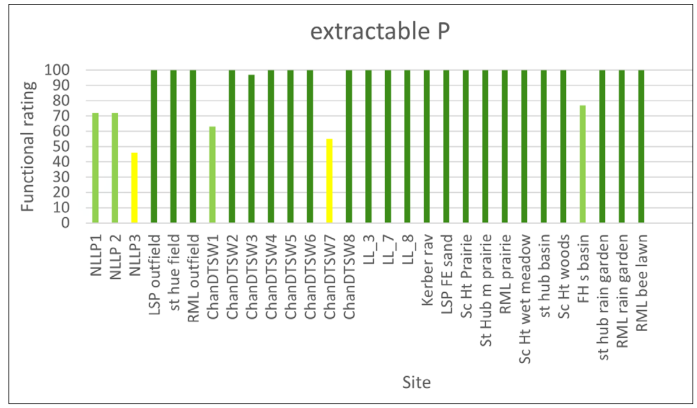
NLLP1
NLLP 2
NLLP3
LSP outfield
st hue field
RML outfield
ChanDTSW1
ChanDTSW2
ChanDTSW3
ChanDTSW4
ChanDTSW5
ChanDTSW6
ChanDTSW7
ChanDTSW8
LL_3
LL_7
LL_8
Kerber rav
LSP FE sand
Sc Ht Prairie
St Hub m prairie
RML prairie
Sc Ht wet meadow
st hub basin
Sc Ht woods
FH s basin
st hub rain garden
RML rain garden
RML bee lawn
Site


extractable P
Functional rating
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LSP outfield
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ChanDTSW2
ChanDTSW3
ChanDTSW4
ChanDTSW5
ChanDTSW6
ChanDTSW7
ChanDTSW8
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LL_8
Kerber rav
LSP FE sand
Sc Ht Prairie
St Hub m prairie
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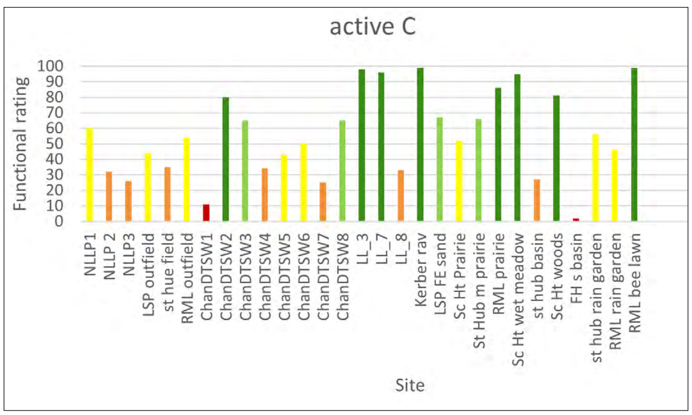
Sc Ht wet meadow
st hub basin
Sc Ht woods
FH s basin
st hub rain garden
RML rain garden
RML bee lawn
Site


active C
Functional rating
100
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80
70
60
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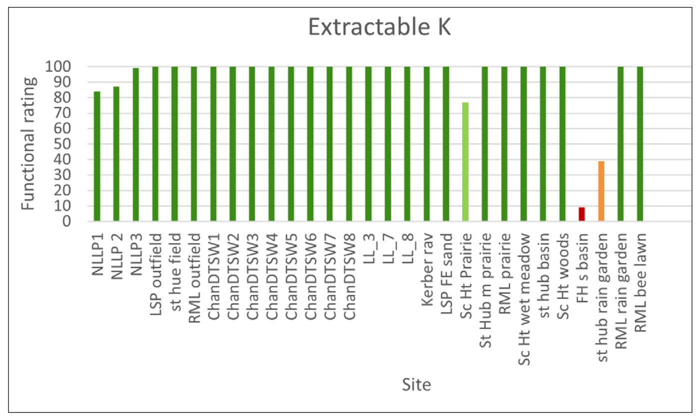
NLLP1
NLLP 2
NLLP3
LSP outfield
st hue field
RML outfield
ChanDTSW1
ChanDTSW2
ChanDTSW3
ChanDTSW4
ChanDTSW5
ChanDTSW6
ChanDTSW7
ChanDTSW8
LL_3
LL_7
LL_8
Kerber rav
LSP FE sand
Sc Ht Prairie
St Hub m prairie
RML prairie
Sc Ht wet meadow
st hub basin
Sc Ht woods
FH s basin
st hub rain garden
RML rain garden
RML bee lawn
Site


Extractable K
Functional rating
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80
70
60
50
40
30
20
10
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NLLP1
NLLP 2
NLLP3
LSP outfield
st hue field
RML outfield
ChanDTSW1
ChanDTSW2
ChanDTSW3
ChanDTSW4
ChanDTSW5
ChanDTSW6
ChanDTSW7
ChanDTSW8
LL_3
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Kerber rav
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Sc Ht Prairie
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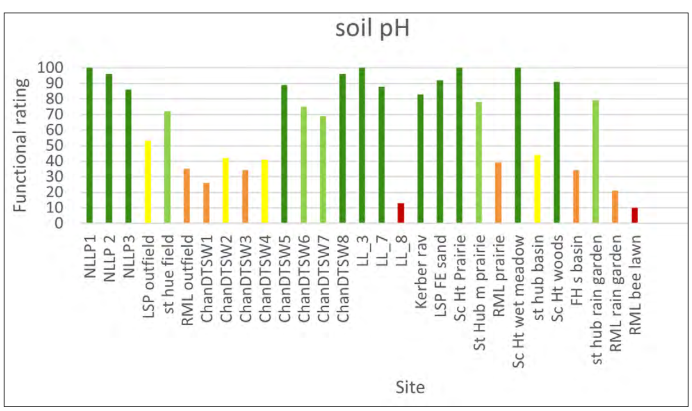
Sc Ht wet meadow
st hub basin
Sc Ht woods
FH s basin
st hub rain garden
RML rain garden
RML bee lawn
Site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90
80
70
60
50
40
30
20
10
0
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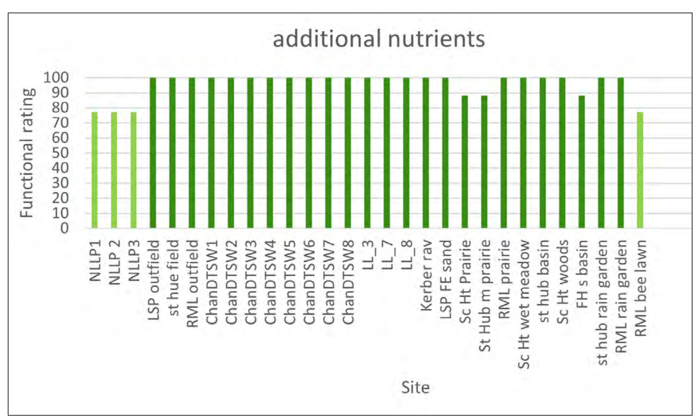
NLLP 2
NLLP3
LSP outfield
st hue field
RML outfield
ChanDTSW1
ChanDTSW2
ChanDTSW3
ChanDTSW4
ChanDTSW5
ChanDTSW6
ChanDTSW7
ChanDTSW8
LL_3
LL_7
LL_8
Kerber rav
LSP FE sand
Sc Ht Prairie
St Hub m prairie
RML prairie
Sc Ht wet meadow
st hub basin
Sc Ht woods
FH s basin
st hub rain garden
RML rain garden
RML bee lawn
Site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Functional rating
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90
80
70
60
50
40
30
20
10
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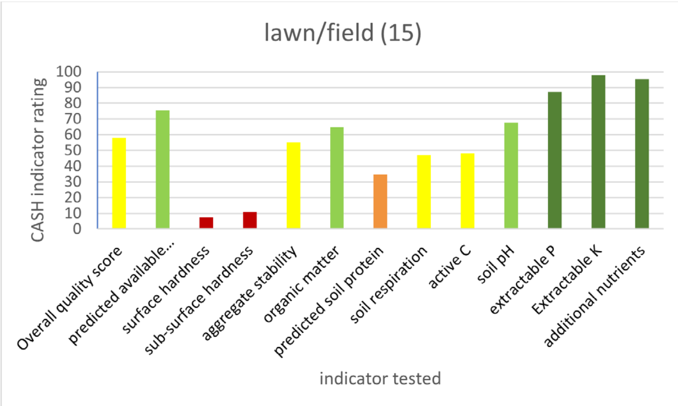
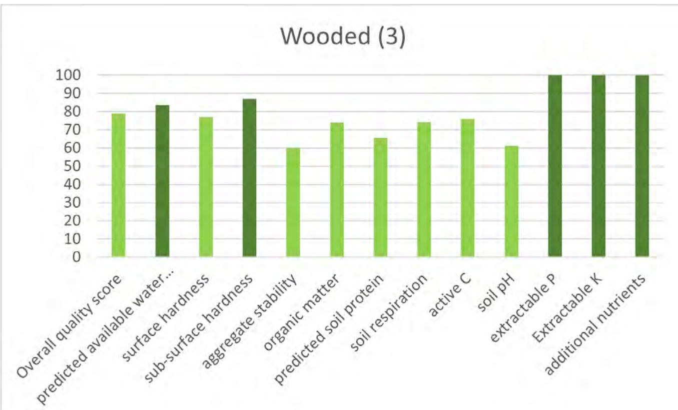
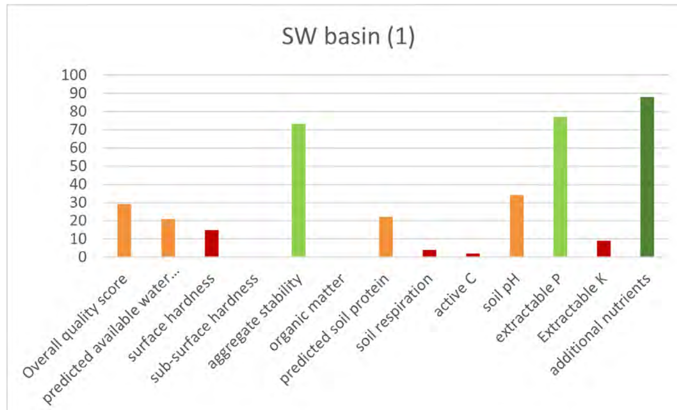
NLLP 2
NLLP3
LSP outfield
st hue field
RML outfield
ChanDTSW1
ChanDTSW2
ChanDTSW3
ChanDTSW4
ChanDTSW5
ChanDTSW6
ChanDTSW7
ChanDTSW8
LL_3
LL_7
LL_8
Kerber rav
LSP FE sand
Sc Ht Prairie
St Hub m prairie
RML prairie
Sc Ht wet meadow
st hub basin
Sc Ht woods
FH s basin
st hub rain garden
RML rain garden
RML bee lawn
Site

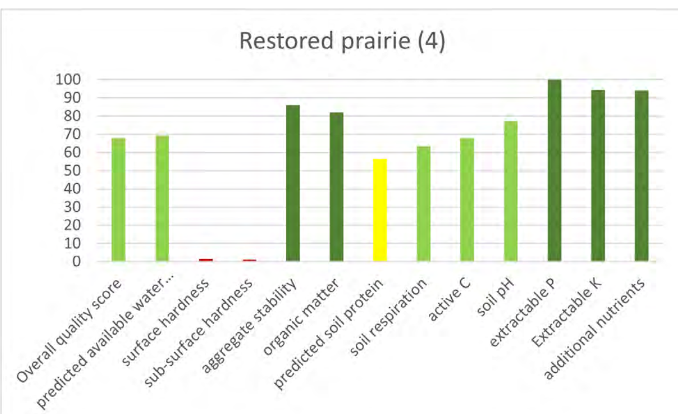
APPENDIX B

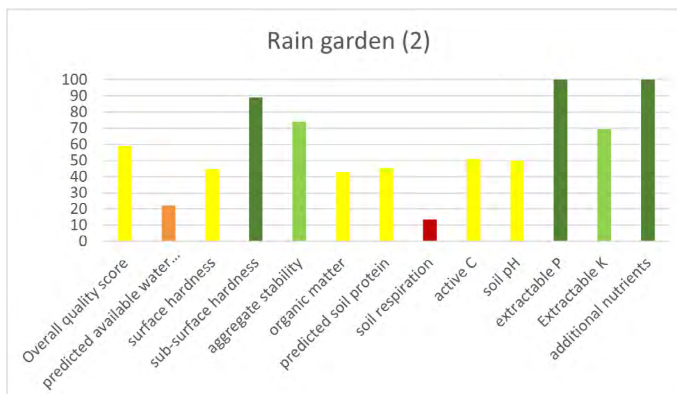
Comprehensive assessment of soil health indicator function/health: average ratings across landscape types. Number of total sites sampled per landscape type denoted in parentheses.

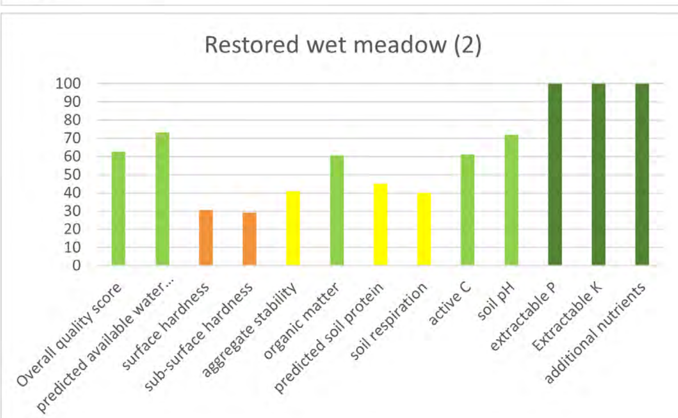


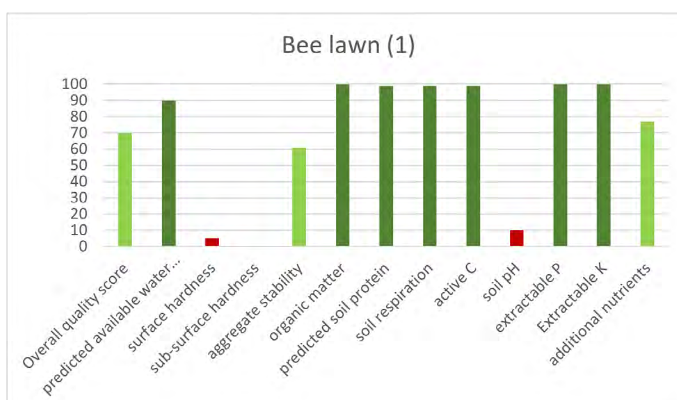












APPENDIX C

Sample Cornell University Comprehensive Assessment of Soil Health Report: one of three samples taken from North Lotus Lake Park (NLLP2)

Comprehensive Assessment of Soil Health

From the Cornell Soil Health Laboratory, Department of Soil and Crop Sciences
School of Integrative Plant Science, Cornell University, Ithaca, NY 14853
https://soilhealthlab.cals.cornell.edu

Grower:
Zach Dickhausen
18681 Lake Drive East
Chanhussen, MN 55317
zdickhausen@rpbcwd.org

Sample ID:	WW2424
Field ID:	N. Lotus Lake Park 2
Date Sampled:	05/09/2023
Given Soil Type:	Lester-Kilkenny
Crops Grown:	PRK/PRK/PRK
Tillage:	no till
Coordinates:	Latitude: 44.884027000000 Longitude: -93.526559000000

Measured Soil Textural Class: **sandy loam**

Sand: **59%** - Silt: **23%** - Clay: **16%**

Group	Indicator	Value	Rating	Constraints
physical	Predicted Available Water Capacity	**0.18**	**76**	
physical	Surface Hardness	**325**	**2**	Rooting, Water Transmission
physical	Subsurface Hardness	**600**	**0**	Subsurface Pan/Deep Compaction, Deep Rooting, Water and Nutrient Access
physical	Aggregate Stability	**39.0**	**48**	
biological	Organic Matter Soil Organic Carbon: 1.73 / Total Carbon: 1.80 / Total Nitrogen: 0.16	**2.8**	**82**	
biological	Predicted Soil Protein	**4.70**	**22**	
biological	Soil Respiration	**0.5**	**34**	
biological	Active Carbon	**359**	**32**	
chemical	Soil pH	**7.4**	**96**	
chemical	Extractable Phosphorus	**2.5**	**72**	
chemical	Extractable Potassium	**62.5**	**87**	
chemical	Additional Nutrients Ca: 2770.2 / Mg: 398.8 / **S: 2.0** Al: 3.2 / B: 0.26 / Cu: 0.03 Fe: 0.6 / Mn: 2.3 / **Zn: 0.1**		**77**	

Overall Quality Score: **52** / Medium

Measured Soil Health Indicators

The Cornell Soil Health Test measures several indicators of soil physical, biological and chemical health. These are listed on the left side of the report summary, on the first page. The "value" column shows each result as a value, measured in the laboratory or in the field, in units of measure as described in the indicator summaries below. The "rating" column interprets that measured value on a scale of 0 to 100, where higher scores are better. Ratings in red are particularly important to take note of, but any in yellow, particularly those that are close to a rating of 30 are also important in addressing soil health problems.

- **A rating below 20 indicates *Very Low (constraining)* functioning and is color-coded red.** This indicates a problem that is likely limiting yields, crop quality, and long-term sustainability of the agroecosystem. In several cases this indicates risks of environmental loss as well. The "constraint" column provides a short list of soil processes that are not functioning optimally when an indicator rating is red. It is particularly important to take advantage of any opportunities to improve management that will address these constraints.
- **A rating between 20 and 40 indicates *Low* functioning and is color-coded orange.** This indicates that a soil process is functioning somewhat poorly and addressing this should be considered in the field management plan. The Management Suggestions Table at the end of the Soil Health Assessment Report provides linkages to field management practices that are useful in addressing each soil indicator process.
- **A rating between 40 and 60 indicates *Medium* functioning and is color-coded yellow.** This indicates that soil health could be better, and yield and sustainability could decrease over time if this is not addressed. This is especially so if the condition is being caused, or not being alleviated, by current management. Pay attention particularly to those indicators rated in yellow and close to 40.
- **A rating between 60 and 80 indicates *High* functioning and is color-coded light green.** This indicates that this soil process is functioning at a non-limiting level. Field soil management approaches should be maintained at the current intensity or improved.
- **A rating of 80 or greater indicates *Very High* functioning and is color-coded dark green.** Past management has been effective at maintaining soil health. It can be useful to note which particular aspects of management have likely maintained soil health, so that such management can be continued. Note that soil health is often high, when first converting from a permanent sod or forest. In these situations, intensive management quickly damages soil health when it includes intensive tillage, low organic matter inputs, bare soils for significant parts of the year, or excessive traffic, especially during wet times.
- **The Overall Quality Score** at the bottom of the report is an average of all ratings, and provides an indication of the soil's overall health status. However, the important part is to know which particular soil processes are constrained or suboptimal so that these issues can be addressed through appropriate management. Therefore the ratings for each indicator are more important information.

The Indicators measured in the Cornell Soil Health Assessment are important soil properties and characteristics in themselves, but also are representative of key soil processes, necessary for the proper functioning of the soil. The following is a summary of the indicators measured, what each of these indicates about your soil's health status, and what may influence the relevant properties and processes described.

A Management Suggestions Table follows, at the end of the report, with short and long term suggestions for addressing constraints or maintaining a well-functioning system. This table will indicate constraints identified in this assessment for your soil sample by the same yellow and red color coding described above. Please also find further useful information by following the links to relevant publications and web resources that follow this section.

Texture is an inherent property of soil, meaning that it is rarely changed by management. It is thus not a soil health indicator per se, but is helpful both in interpreting the measured values of indicators (see the Cornell Soil Health Assessment Training Manual), and for deciding on appropriate management strategies that will work for that soil.

Your soil's measured textural class and composition: sandy loam

Sand: 59% Silt: 23% Clay: 16%

Predicted Available Water Capacity (AWC) is not a directly measured soil property but is modeled from a suite of measured soil health indicators including the percent sand, silt, clay and organic matter. By using a decision tree approach, the developed Random Forest model can predict the laboratory measured AWC value with no more error than that encountered in the raw laboratory analysis. Details of this modeling effort can be found in our Soil Health Management Series Fact Sheet Number 19-05b.

https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/f/5772/files/2016/12/05b_Soil_Health_Fact_Sheet_Available_Water_Capacity-Predicted-2019-002-132f3th.pdf

The Soil Health Lab continues to offer the laboratory measured AWC test as an add-on to the soil health package analyses.

The Predicted AWC value is presented as grams of water per gram of soil. This value is scored against an observed distribution in regional soils with similar texture. A physical soil characteristic, AWC is an indicator of the amount of plant-available water the soil can store, and therefore how crops will fare in droughty conditions. Soils with lower storage capacity will cause greater risk of drought stress. AWC is generally lower when total organic matter and/or aggregation is low. It can be improved by reducing tillage, long-term cover cropping, and adding large amounts of well-decomposed organic matter such as compost. Coarse textured (sandy) soils inherently store less water than finer textured soils, so that managing for relatively high water storage capacity is particularly important in coarse textured soils. While the textural effect cannot be influenced by management, management decisions can be in part based on an understanding of inherent soil characteristics.

Your Predicted Available Water Capacity value is **0.18 g/g**, corresponding with a score of **76**. This score is in the **High** range, relative to soils with similar texture. **This suggests that this soil process is enhancing overall soil resilience. Soil management should aim at maintaining this functionality while addressing any other measured soil constraints as identified in the Soil Health Assessment Report.** Please refer to the management suggestions table at the end of this document.

Surface Hardness is a measure of compaction that develops when large pores are lost in the surface soil (0-6 inches). Compaction is measured in the field using a penetrometer, and the resultant value is expressed in pounds per square inch (p.s.i.), representing the localized pressure necessary to break forward through soil. It is scored by comparison with a distribution observed in regional soils, with lower hardness values rating higher scores. A strongly physical characteristic of soils, surface hardness is an indicator of both physical and biological health of the soil, as growing roots and fungal hyphae must be able to grow through soil, and may be severely restricted by excessively hard soil. Compaction also influences water movement through soil. When surface soils are compacted, runoff, erosion, and slow infiltration can result. Soil compaction is influenced by management, particularly in timing and degree of traffic and plowing disturbance, being worst when the soil is worked wet.

> **Your measured Surface Hardness value** is **325 p.s.i.**, corresponding with a score of **2**. This score is in the **Very Low (constraining)** range, relative to soils with similar texture. **Surface Hardness level should be given a high priority in management decisions based on this assessment, as it is likely to be an important constraint to proper soil functioning and sustainability of management at this time.** Please refer to the management suggestions table at the end of this document.

Subsurface Hardness is a measure of compaction that develops when large pores are lost in the subsurface soil (6-18 inches). Subsurface hardness is measured and scored similarly to surface hardness, but deeper in the profile, and scored against an observed distribution in regional soils with similar texture. Large pores are necessary for water and air movement and to allow roots to explorethe soil. Subsurface hardness prevents deep rooting and thus deep water and nutrient uptake by plants, and can increase disease pressure by stressing plants. It also causes poor drainage and poor deep water storage. After heavy rain events, water can build up over a hard pan causing poor aeration both at depth and at the surface, as well as ponding, poor infiltration, runoff and erosion. Impaired water movement and storage create greater risk during heavy rainfall events, as well as greater risk of drought stress. Compaction occurs very rapidly when the soil is worked or trafficked while it is too wet, and compaction can be transferred deep into the soil even from surface pressure. Subsoil compaction in the form of a plow pan is usually found beneath the plow layer, and is caused by smearing and pressure exerted on the undisturbed soil just beneath the deepest tillage operation, especially when wet.

> **Your measured Subsurface Hardness value** is **600 p.s.i.**, corresponding with a score of . This score is in the **Very Low (constraining)** range, relative to soils with similar texture. **Subsurface Hardness level should be given a high priority in management decisions based on this assessment, as it is likely to be an important constraint to proper soil functioning and sustainability of management at this time.** Please refer to the management suggestions table at the end of this document.

Aggregate Stability is a measure of how well soil aggregates or crumbs hold together under rainfall or other rapid wetting stresses. Measured by the fraction of dried aggregates that disintegrate under a controlled, simulated rainfall event similar in energy delivery to a hard spring rain, the value is presented as a percent, and scored against a distribution observed in regional soils with similar textural characteristics. A physical characteristic of soil, Aggregate Stability is a good indicator of soil biological and physical health. Good aggregate stability helps prevent crusting, runoff, and erosion, and facilitates aeration, infiltration, and water storage, along with improving seed germination and root and microbial health. Aggregate stability is influenced by microbial activity, as aggregates are largely held together by microbial colonies and exudates, and is impacted by management practices, particularly tillage, cover cropping, and fresh organic matter additions.

Your measured Aggregate Stability value is 39.0 %, corresponding with a score of 48. This score is in the Medium range, relative to soils with similar texture. This suggests that, while Aggregate Stability is functioning at an average level, management practices should be geared toward improving this condition, as it currently indicates suboptimal functioning. Soil management should aim at improving this functionality while addressing any other measured soil constraints as identified in the Soil Health Assessment Report. Please refer to the management suggestions table at the end of this document.

Organic Matter (OM) is a measure of the carbonaceous material in the soil that is biomass or biomass-derived. Measured by the mass lost on combustion of oven-dried soil, the value is presented as a percent of the total soil mass. This is scored against an observed distribution of OM in regional soils with similar texture. A soil characteristic that measures a physical substance of biological origin, OM is a key or central indicator of the physical, biological, and chemical health of the soil. OM content is an important influence on soil aggregate stabilization, water retention, nutrient cycling, and ion exchange capacity. Soils with low organic matter tend to require higher inputs, and be less resilient to drought and extreme rainfall. The retention and accumulation of OM is influenced by management practices such as tillage and cover cropping, as well as by microbial community growth. Intensive tillage and lack of organic matter biomass additions from various sources (amendments, residues, active crop or cover crop growth) will decrease organic matter content and overall soil health with time.

Total Carbon (Tot C) is an indicator for the OM in soil, with carbon comprising 48-58% of the total weight of OM. The Tot C analysis measures all of the carbon in a sample using complete oxidation of carbon to CO2 using high temperature combustion (1100C). The measured Tot C includes ***organic*** forms of carbon (Soil Organic Carbon SOC), comprised of available carbon as well as relatively inert carbon in stable organic materials. Carbon can also be found in ***inorganic*** form (Soil Inorganic Carbon SIC) as carbonate minerals such as calcium carbonate (lime).

Soil Organic Carbon (SOC) is equivalent to Tot C when there are no carbonate minerals. However, soils above pH 6.5 may contain high levels of carbonates. These carbonates are measured as SIC and subtracted from the Tot C: **SOC = Tot C - SIC**.

Total Nitrogen (Tot N) includes the organic (living and non-living) and inorganic (or mineral) forms of nitrogen. About half of the Tot N found in soil is in relatively stable organic compounds. Inorganic nitrogen is liberated from organic nitrogen sources in the soil, particularly proteins and amino acids through the action of soil microorganisms. Ammonium (NH4+) and nitrate (NO3-) are the inorganic forms of nitrogen found in soil that are plant available. The Tot N is determined following the combustion methodology known as DUMAS.

Your measured Organic Matter value is **2.8 %**, corresponding with a score of **82**. This score is in the **Very High** range, relative to soils with similar texture. **This suggests that management practices should be geared toward maintaining this condition, as it currently indicates ideal soil functioning.** Please refer to the management suggestions table at the end of this document. The **SOC** level is **1.73%**, the **Tot C** level is **1.80%**, the **Tot N** level is **0.16%**.

<u>**Predicted**</u> **Soil Protein** is not a directly measured soil property but is modeled from a suite of measured soil health indicators including the percent sand, silt, clay and organic matter. By using a decision tree approach, the developed Random Forest model can predict the laboratory measured soil protein value with a tolerable small error. Details of this modeling effort can be found in our Soil Health Management Series Fact Sheet 20-09b.

https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/f/5772/files/2020/05/09b-Predicted-Protein.pdf

The Soil Health Lab continues to offer the laboratory measured Soil Protein test as an add-on to the Standard soil health package analyses.

The Predicted Soil Protein is presented as mg per gram of soil. This indicator represents the fraction of the soil organic matter that is present as protein or protein-like substances. Protein content, as organically bound N, influences the ability of the soil to make N available by mineralization, and has been associated with soil aggregation and water movement. Protein content can be influenced by biomass additions, the presence of roots and soil microbes, and tends to decrease with increasing soil disturbance such as tillage.

> **Your measured Predicted Soil Protein value** is **4.70** , corresponding with a score of **22**. This score is in the **Low** range, relative to soils with similar texture. **This suggests that, while Predicted Soil Protein does not currently register as a strong constraint, management practices should be geared toward improving this condition, as it currently indicates suboptimal functioning.** Please refer to the management suggestions table at the end of this document.

Soil Respiration is a measure of the metabolic activity of the soil microbial community. Measured by capturing and quantifying carbon dioxide (CO_2) produced by this activity, the value is expressed as total CO_2 released (in mg) per gram of soil over a 4 day incubation period. Respiration is scored against an observed distribution in regional soils, taking texture into account. A direct biological activity measurement, respiration is an indicator of the biological status of the soil community, integrating abundance and activity of microbial life. Soil biological activity accomplishes numerous important functions, such as cycling of nutrients into and out of soil OM pools, transformations of N between its several forms, and decomposition of incorporated residues. Soil biological activity influences key physical characteristics like OM accumulation, and aggregate formation and stabilization. Microbial activity is influenced by management practices such as tillage, cover cropping, manure or green manure incorporation, and biocide (pesticide, fungicide, herbicide) use.

> **Your measured Soil Respiration value** is **0.5 mg**, corresponding with a score of **34**. This score is in the **Low** range, relative to soils with similar texture. **This suggests that, while Soil Respiration does not currently register as a strong constraint, management practices should be geared toward improving this condition, as it currently indicates suboptimal functioning.** Please refer to the management suggestions table at the end of this document.

Active Carbon is a measure of the small portion of the organic matter that can serve as an easily available food source for soil microbes, thus helping maintain a healthy soil food web. Measured by potassium permanganate oxidation, the value is presented in parts per million (ppm), and scored against an observed distribution in regional soils with similar texture. While a measure of a class of physical substances, active carbon is a good leading indicator of biological soil health and tends to respond to changes in management earlier than total organic matter content, because when a large population of soil microbes is fed plentifully with enough organic matter over an extended period of time, well-decomposed organic matter builds up. A healthy and diverse microbial community is essential to maintain disease resistance, nutrient cycling, aggregation, and many other important functions. Intensive tillage and lack of organic matter additions from various sources (amendments, residues, active crop or cover crop growth) will decrease active carbon, and thus will over the longer term decrease total organic matter.

> **Your measured Active Carbon value** is **359 ppm**, corresponding with a score of **32**. This score is in the **Low** range, relative to soils with similar texture. **This suggests that, while Active Carbon does not currently register as a strong constraint, management practices should be geared toward improving this condition, as it currently indicates suboptimal functioning.** Please refer to the management suggestions table at the end of this document.

Soil pH is a measure of how acidic the soil is, which controls how available nutrients are to crops. A physico-chemical characteristic of soils, pH is an indicator of the chemical or nutrient status of the soil. Measured with an electrode in a 1:1 soil:water suspension, the value is presented in standard pH units, and scored using an optimality curve. Optimum pH is around 6.2-6.8 for most crops (exceptions include potatoes and blueberries, which grow best in more acidic soil – this is not accounted for in the report interpretation). If pH is too high, nutrients such as phosphorus, iron, manganese, copper and boron become unavailable to the crop. If pH is too low, calcium, magnesium, phosphorus, potassium and molybdenum become unavailable. Lack of nutrient availability will limit crop yields and quality. Aluminum toxicity can also be a concern in low pH soils, which can severely decrease root growth and yield, and in some cases lead to accumulation of aluminum and other metals in crop tissue. In general, as soil OM increases, crops can tolerate lower soil pH. Soil pH also influences the ability of certain pathogens to thrive, and of beneficial organisms to effectively colonize roots. Raising the pH through lime or wood ash applications, and organic matter additions, will help immobilize aluminum andheavy metals, and maintain proper nutrient availability.

> **Your measured Soil pH value** is **7.4** , corresponding with a score of **96**. This score is in the **Very High** range, relative to soils with similar texture. **This suggests that management practices should be geared toward maintaining this condition, as it currently indicates ideal soil functioning.** Please refer to the management suggestions table at the end of this document.

Extractable Phosphorus is a measure of phosphorus (P) availability to a crop. Measured on a modified Morgan's extract using an ICP Spectrometer, the value is presented in parts per million (ppm), and scored against an optimality curve for sufficiency or excess. P is an essential plant macronutrient, and its availability varies with soil pH and mineral composition. Low P values indicate poor P availability to plants, and excessively high P values indicates a risk of adverse environmental impact through runoff and contamination of surface waters. Most soils in the Northeast store unavailable P from the soil’s mineral make up or from previously applied fertilizer or manure. This becomes more available to plants as soils warm up. Therefore, incorporating or banding 10-25 lbs/acre of soluble ‘starter’ P fertilizer at planting can be useful even when soil levels are optimum. Some cover crops, such as buckwheat, are good at mining otherwise unavailable P so that it becomes more available to the following crop. When plants associate with mycorrhizal fungi, these can also help make P (and other nutrients and water) more available to the crop. P is an environmental contaminant and runoff of P into fresh surface water will cause damage through eutrophication, so over-application is strongly discouraged, especially close to surface water, on slopes, and on large scales.

> **Your measured Extractable Phosphorus value** is **2.5 ppm**, corresponding with a

score of **72**. This score is in the **High** range, relative to soils with similar texture. **This suggests that this soil process is enhancing overall soil resilience. Soil management should aim at maintaining this functionality while addressing any other measured soil constraints as identified in the Soil Health Assessment Report.** Please refer to the management suggestions table at the end of this document.

Extractable Potassium is a measure of potassium (K) availability to the crop. Measured on a modified Morgan's extract using an ICP Spectrometer, the value is presented in parts per million (ppm), and scored against an optimality curve for sufficiency. K is an indicator of soil nutrient status, as it is an essential plant macronutrient. Plants with higher potassium tend to be more tolerant of frost and cold. Thus good potassium levels may help with season extension. While soil pH only marginally affects K availability, K is easily leached from sandy soils and is only weakly held by increased organic matter, so that applications of the amount removed by the specific crop being grown are generally necessary in such soils.

Your measured Extractable Potassium value is **62.5 ppm**, corresponding with a score of **87**. This score is in the **Very High** range, relative to soils with similar texture. **This suggests that management practices should be geared toward maintaining this condition, as it currently indicates ideal soil functioning.** Please refer to the management suggestions table at the end of this document.

Additional Nutrients including (calcium (Ca), magnesium (Mg) and sulfur (S)) with micronutrients (aluminum (Al), boron (B), copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn), etc.) are essential plant nutrients taken up by plants in smaller quantities than the macronutrients N, P and K. Note that some leafy vegetables can require significant amounts of these nutrients. If any of these nutrients are deficient, this will decrease yield and crop quality, but toxicities can also occur when concentrations are too high. While Al is not technically a plant nutrient, it can become toxic to crop plants at pH below 5.5. The solubility and availability of all of the elements are strongly influenced by pH and organic matter. High pH favors the availability of magnesium and calcium whereas low pH increases the availability of most micronutrients. High OM and microbial activity tend to increase micronutrient availability. The ratings indicate whether these measured nutrients are deficient or excessive.

Your measured Additional Nutrients Rating is **77**. This score is in the **High** range. Magnesium (398.8 ppm) is sufficient, Iron (0.6 ppm) is sufficient, Manganese (2.3 ppm) is sufficient, Zinc (0.1 ppm) is deficient, Aluminum (3.2 ppm) is sufficient, Calcium (2770.2 ppm) is sufficient, Copper (0.03 ppm) is sufficient, Sulfur (2.0 ppm) is deficient, Boron (0.26 ppm) is sufficient. **This suggests that this soil process is enhancing overall soil resilience. Soil management should aim at maintaining this functionality while addressing any other measured soil constraints as identified in the Soil Health Assessment Report.** Please refer to the management suggestions table at the end of this document.

Overall Quality Score: an overall quality score is computed from the individual indicator scores. This score is further rated as follows: less than 20% is regarded as very low, 20-40% is low, 40-60% is medium, 60-80% is high, and greater than 80% is very high. The highest possible quality score is 100 and the least score is 0, thus it is a relative overall soil health status indicator. However, of greater importance than a single overall metric is identification of constrained or suboptimally functioning soil processes, so that these issues can be addressed through appropriate management. The overall soil quality score should be taken as a general summary rather than the main focus.

Your Overall Quality Score is **52**, which is in the **Medium** range.

Management Suggestions for Physical and Biological Constraints

Constraint	Short Term Management Suggestions	Long Term Management Suggestions
Predicted Available Water Capacity Low	• Add stable organic materials, mulch • Add compost or biochar • Incorporate high biomass cover crop	• Reduce tillage • Rotate with sod crops • Incorporate high biomass cover crop
Surface Hardness High	• Perform some mechanical soil loosening (strip till, aerators, broadfork, spader) • Use shallow-rooted cover crops • Use a living mulch or interseed cover crop	• Shallow-rooted cover/rotation crops • Avoid traffic on wet soils, monitor • Avoid excessive traffic/tillage/loads • Use controlled traffic patterns/lanes
Subsurface Hardness High	• Use targeted deep tillage (subsoiler, yeomans plow, chisel plow, spader.) • Plant deep rooted cover crops/radish	• Avoid plows/disks that create pans • Avoid heavy loads • Reduce traffic when subsoil is wet
Aggregate Stability Low	• Incorporate fresh organic materials • Use shallow-rooted cover/rotation crops • Add manure, green manure, mulch	• Reduce tillage • Use a surface mulch • Rotate with sod crops and mycorrhizal hosts
Organic Matter Low	• Add stable organic materials, mulch • Add compost and biochar • Incorporate high biomass cover crop	• Reduce tillage/mechanical cultivation • Rotate with sod crop • Incorporate high biomass cover crop
Predicted Soil Protein Low	• Add N-rich organic matter (low C:N source like manure, high N well-finished compost) • Incorporate young, green, cover crop biomass • Plant legumes and grass-legume mixtures • Inoculate legume seed with Rhizobia & check for nodulation	• Reduce tillage • Rotate with forage legume sod crop • Cover crop and add fresh manure • Keep pH at 6.2-6.5 (helps N fixation) • Monitor C:N ratio of inputs
Soil Respiration Low	• Maintain plant cover throughout season • Add fresh organic materials • Add manure, green manure • Consider reducing biocide usage	• Reduce tillage/mechanical cultivation • Increase rotational diversity • Maintain plant cover throughout season • Cover crop with symbiotic host plants
Active Carbon Low	• Add fresh organic materials • Use shallow-rooted cover/rotation crops • Add manure, green manure, mulch	• Reduce tillage/mechanical cultivation • Rotate with sod crop • Cover crop whenever possible

Management Suggestions for Chemical Constraints

Constraint	Short Term Management Suggestions	Long Term Management Suggestions
Soil pH Low	• Add lime or wood ash per soil test recommendations • Add calcium sulfate (gypsum) in addition to lime if aluminum is high • Use less ammonium or urea	• Test soil annually & add "maintenance" lime per soil test recommendations to keep pH in range • Raise organic matter to improve buffering capacity
Soil pH High	• Stop adding lime or wood ash • Add elemental sulfur per soil test recommendations	• Test soil annually • Use higher % ammonium or urea
Extractable Phosphorus Low	• Add P amendments per soil test recommendations • Use cover crops to recycle fixed P • Adjust pH to 6.2-6.5 to free up fixed P	• Promote mycorrhizal populations • Maintain a pH of 6.2-6.5 • Use cover crops to recycle fixed P
Extractable Phosphorus High	• Stop adding manure and compost • Choose low or no-P fertilizer blend • Apply only 20 lbs/ac starter P if needed • Apply P at or below crop removal rates	• Use cover crops that accumulate P and export to low P fields or offsite • Consider low P rations for livestock • Consider phytase for non-ruminants
Extractable Potassium Low	• Add wood ash, fertilizer, manure, or compost per soil test recommendations • Use cover crops to recycle K • Choose a high K fertilizer blend	• Use cover crops to recycle K • Add "maintenance" K per soil recommendations each year to keep K consistently available
Additional Nutrients Low	• Add chelated micronutrients per soil test recommendations • Use cover crops to recycle micronutrients • Do not exceed pH 6.5 for most crops	• Promote mycorrhizal populations • Improve organic matter • Decrease soil P (binds micronutrients) • Add lime (Ca and Mg), gypsum (S), rock powder
Additional Nutrients High	• Raise pH to 6.2-6.5 (for all high micro-nutrients and Aluminum) • Do not use fertilizers with micronutrients	• Maintain a pH of 6.2-6.5 • Monitor irrigation/improve drainage • Avoid compost additions with high micronutrient levels

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