2023 ANNUAL REPORT

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

Merganser family at Kerber Pond by Steven Harder.

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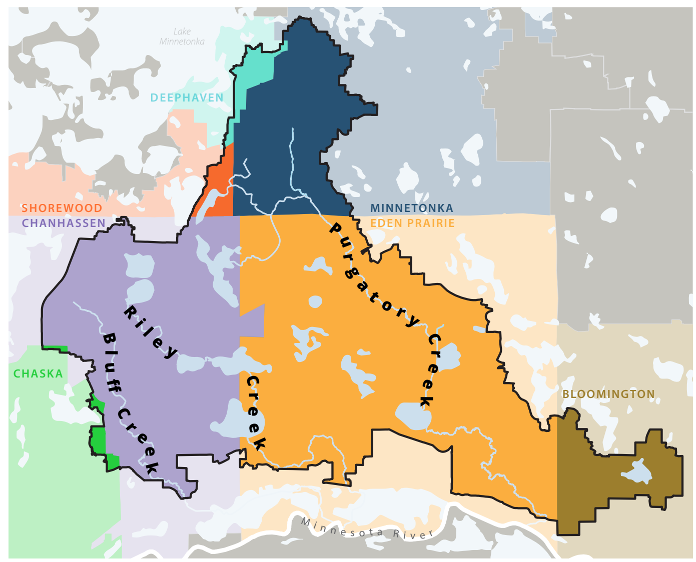
INTRODUCTION

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).

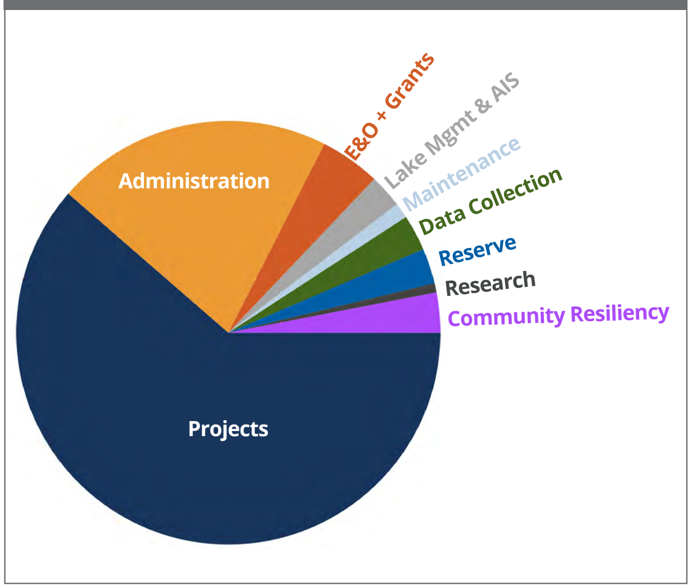
The District is led by five managers (four appointed by the Hennepin County Commissioners and one by Carver) each serving three-year terms directing District activities. The District partners with these local communities and residents to identify issues affecting the water resources and to prioritize 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.

Appendices

Amendments

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.

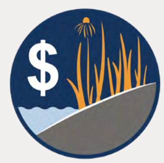
OVERVIEW OF DISTRICT PROGRAMS

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 2022.

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	$3,357,659.67
Permit Fees	$114,000	$102,342.89
Grant Income	—	$57,500
Investment Income	$57,000	$315,780.94
Past Levies (Carry-over)	$3,136,388	$3,442,326
Miscellaneous Income	—	$259.49
Reimbursements	—	$62,728
Partner Funds	$100,000	$0
TOTAL REVENUE	**$7,229,099**	**$7,338,597**

EXPENDITURES

ADMINISTRATION

Budget item	Tasks	Done?	Goals	2023 Budget	Actual spent (Nov 2023)
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	$28,607.49
Advisory Committees	• Engage with the Technical Advisory Committee on water conservation, chloride management and emerging topics. • Engage with the Citizen Advisory Committee on water conservation, 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	TBD
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	$118,408.13
Legal Services	• Work with legal consultant to prepare and review legal documentation	✓	Admin 1	$108,000	$58,569.25
Manager Per Diem/Expense	• Compensate managers for time and expense for official duties	✓	Admin 1	$42,500	$37,265.07
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	$253,492.13
Permit Review and Inspection	• Collect fees for permit application reviews and project inspections	✓	Admin 1, Reg 1	$231,000	$152,945.74
Permit and Grant Database	• Maintain databases for permitting and cost share programs	✓	Admin 1, EO 1, Reg 1	$31,500	$7,536.50
Professional Services	• Engage professional services for information technology, professional coach, human resources, banking, etc.	✓	Admin 1	$36,300	$7,229.50
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	$772,602.19
Fleet Management	• Maintain and repair vehicles for staff use	✓	Admin 1	$11,040	$3,434.70
			SUBTOTAL	**$1,792,011**	$1,476,244

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	$132,808.97
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	$6,440.54
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	$93,844.95
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	$194,103.56
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	$14,833.84
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	$31,496.03
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	$32,577.04
Repair and Maintenance Fund	• Maintenance of best management practices initiated by the District	✓	Admin 1, Plan 1	$100,000	$25,040.59
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	$7,654.02
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		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	$53,487.34
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	$202,063.38
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**	$799,236

Bluff Creek					
Bluff Creek Tributary*	• Last year of maintenance for vegetation establishment and punchlist items in restored Bluff Creek tributary.	✓	Wqual 1	$5,000	$8,410.95
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	$13,247.72
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	$7,516.50
			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	$6,549.50
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	$0	$8,808.69
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	$16,617.50
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	$174,576.27
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	$22,437.30
			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	$34,079
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	$7,241.70
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	$77.70
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	$15,252.50
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**	$291,650
			RESERVE	**$325,000**	TBD
			TOTAL EXPENDITURES	**$7,334,541**	**$2,870,752**

*Denotes multi-year-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
Past Levies (Carry-over)	$4,400,000
Partner Funds	$666,000
TOTAL REVENUE	**$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 and emerging topics. • Engage with the Citizen Advisory Committee on water conservation, 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	$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 USED BY RPBCWD

B. COPY OF ANNUAL COMMUNICATION

C. 2023 WATER RESOURCES REPORT

D. 2023 REGULATORY PROGRAM UPDATE

E. 2023 WETLAND UPDATE

F. 2023 PROJECTS UPDATE

G. 2023 GRANT PROGRAM UPDATE

H. 2023 E&O UPDATE

I. 2023 SOIL STUDY UPDATE

APPENDIX REPORTS
IN DEVELOPMENT.

Draft versions
included as available.

APPENDIX A

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

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

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

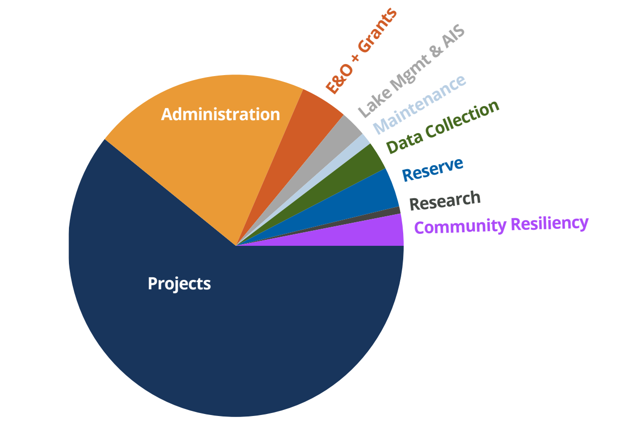
55 Years of Watershed Protection

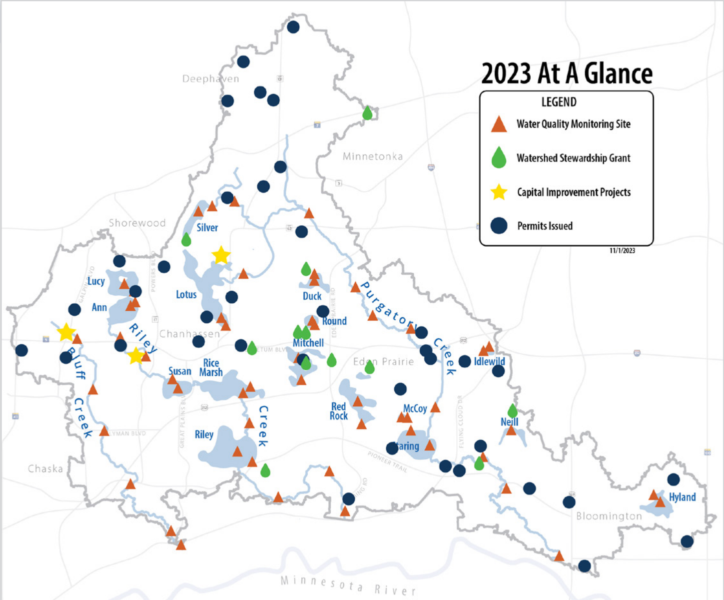
The Riley Purgatory Bluff Creek Watershed District (RPBCWD) is a special unit of local government with a boundary based on the watersheds of Riley, Purgatory, and Bluff creeks. It was established on July 31, 1969, following a petition by local property owners to the Minnesota Board of Water and Soil 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.

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**.

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

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**.

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

APPENDIX C

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

DRAFT

Version **1/19/2024**. Update pending receipt of datasets.

Text in RED has not been updated. YELLOW boxes denote sections that need update/review.

2023 Water Resources Report

Josh Maxwell, *Water Resources & Fisheries Manager*

Andrew Hartmann, *Water Resources Technician*

Photo of Rice Marsh Lake by Tom Duevel

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Water Resources Report

Josh Maxwell, *Water Resources & Fisheries Manager*

TABLE OF CONTENTS

WILL NEED TO BE UPDATED

LIST OF FIGURES

TABLE OF CONTENTS for Figures TO BE CREATED LATER

LIST OF TABLES

TABLE OF CONTENTS for Tables TO BE CREATED LATER

ACRONYMS & 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	Survey Point-intercept survey (approach to aquatic plant surveying using a grid pattern)
RPBCWD/ District	Riley Purgatory Bluff Creek Watershed District
sec	second (unit of time)
sp	species

2023 Water Resources Report

Josh Maxwell, *Water Resources & Fisheries Manager*

EXECUTIVE SUMMARY

The Riley Purgatory Bluff Creek Watershed District (RPBCWD) had a successful water quality 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. This executive summary provides a brief overview of lake and stream monitoring results.

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). In addition to regular lake sampling, the district monitored water levels on each lake, assessed carp populations on seven waterbodies, and collected zooplankton and phytoplankton populations in five lakes.

Staff were able to remove 394 common carp (735 pounds) from District lakes in 2023, 365 of which were removed from the Purgatory Creek system during the spring migration. District staff 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 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, Lotus Lake, Duck Lake, Silver Lake, and Lake Ann (RPBCWD). In spring, Curlyleaf 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 Curlyleaf Pondweed were targeted with a single treatment Lotus Lake (22.92 acres).

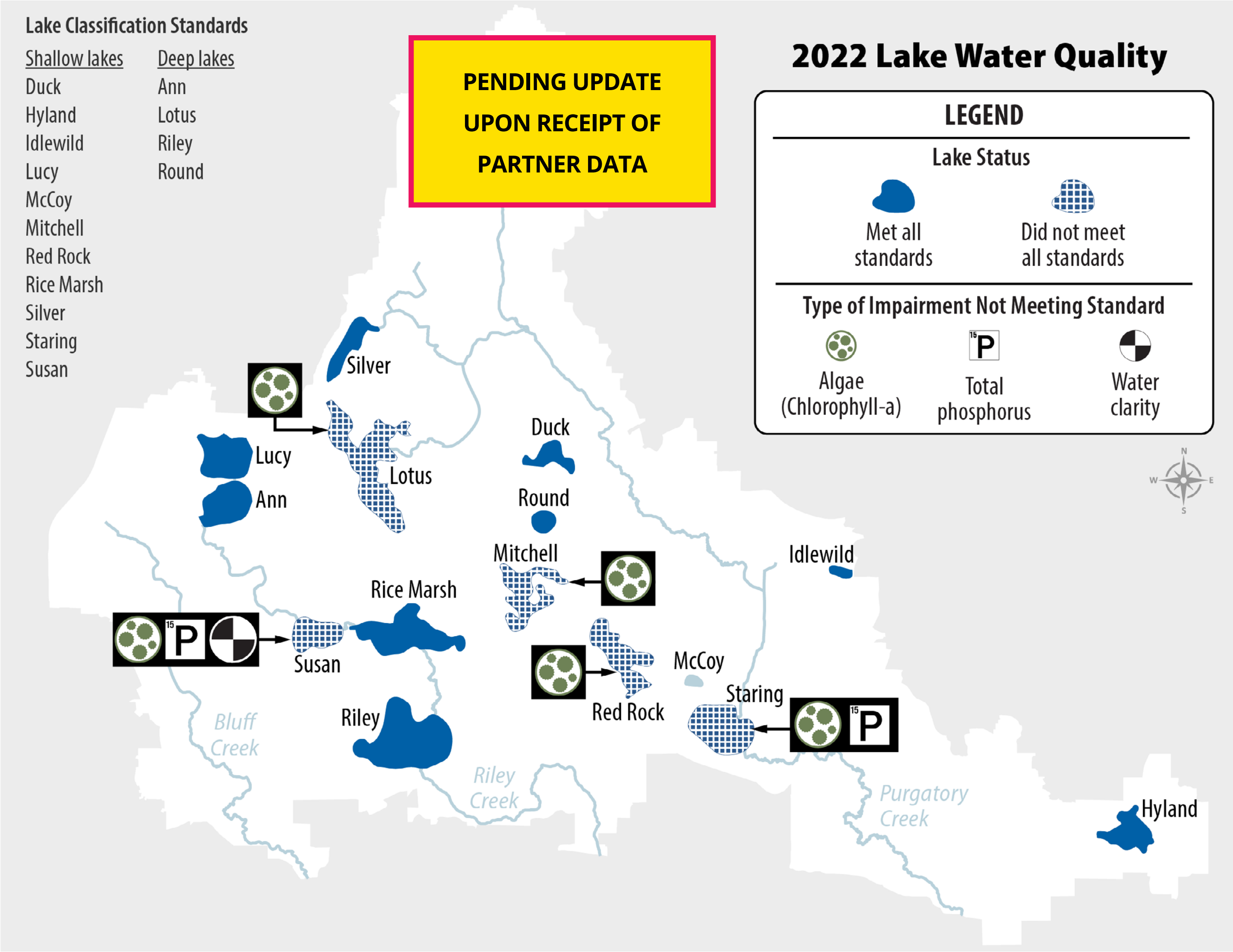
Surface water samples were collected, analyzed, and compared to standards set by the Minnesota Pollution Control Agency (MPCA) to assess overall lake health. Table 1 defines water quality parameters monitored in the District. Figure 1 displays lakes sampled in 2023 that met or exceeded the MPCA lake water quality standards for Chlorophyll-a (Chl-a), Total Phosphorus (TP), and Secchi Disk depth during the growing season (June-September). The MPCA has specific standards for both "deep lakes" (Lake Ann, Lotus Lake, Lake Riley, and Round Lake) and "shallow lakes" (Duck Lake, Hyland Lake, Lake Idlewild*, Lake McCoy*, Neill Lake*, Lake Lucy, Mitchell Lake, Red Rock Lake, Rice Marsh Lake, Staring Lake, Lake Susan, and

Table 1. Water quality parameter abbreviations.

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

Figure 1. Summary of lake water quality in 2023 within the Riley Purgatory Bluff Creek Watershed District.

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.



Silver Lake) (MPCA 2016).

In 2022, lake water quality improved across the district with Lake Ann, Lake Lucy, Lake Riley, Rice Marsh Lake, Silver Lake, Round Lake, Duck Lake, Hyland Lake, and Lake Idlewild meeting all three MPCA standards. The Riley Chain of Lakes 2022 water quality remained unchanged from 2021. Following the past aluminum sulfate treatments, both Lake Riley and Rice Marsh Lake continued to meet all MPCA standards. Lake Susan had the most degraded water quality in 2022 and did not meet any of the standards. Of the Purgatory Chain of Lakes, Mitchell Lake improved from 2021 by meeting the TP while still not meeting the Chl-a standard. Following the 2022 alum treatment, Hyland Lake improved from 2021 by meeting all the standards. Staring Lake saw a decrease in water clarity and had significant increases in TP and Chl-a. This is due to a combination of the low water levels and the reduction in nonnative vegetation following the whole lake fluridone herbicide treatment. This led to increased suspension of sediment which should only improve as native plants expand in the lake. All lakes met the proposed nitrogen water quality standard. and only Idlewild (wetland) did not meet the chloride standard.

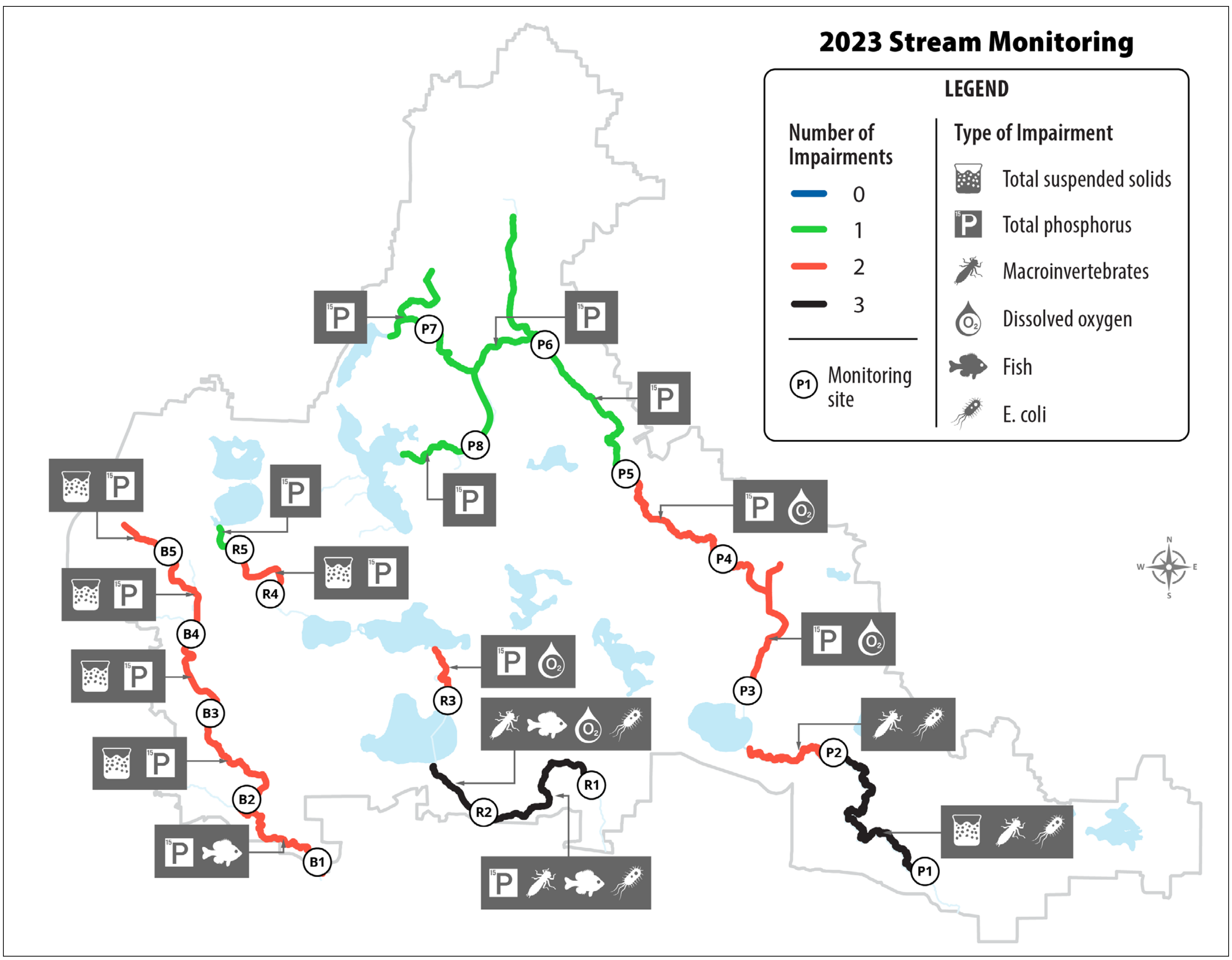
2023 STREAM SUMMARY

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 and turbidity were regularly measured at the 18 regular water quality creek monitoring sites every two weeks. Water samples were collected to assess nutrients [TP, Ortho-Phosphorus (OP), Chloride (CL), and Chl-a] and total suspended sediment (TSS) concentrations. Creek flow was calculated by taking velocity measurements

Figure 3. Water quality monitoring at Bluff Creek.

Figure 2. Map of stream impairments.

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.



from consistent creek cross sections at each water quality monitoring location. Staff deployed automated sampling units on Purgatory Creek 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 Councils Watershed Outlet Monitoring Stations (WOMP). The District 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, overall, most stream sections had CRAS scores slightly improved from years past. The exceptions were Bluff Tributary 2, Riley Creek Reach 1 and 4, and Bluff Creek Subreach B1A, which all declined in health.

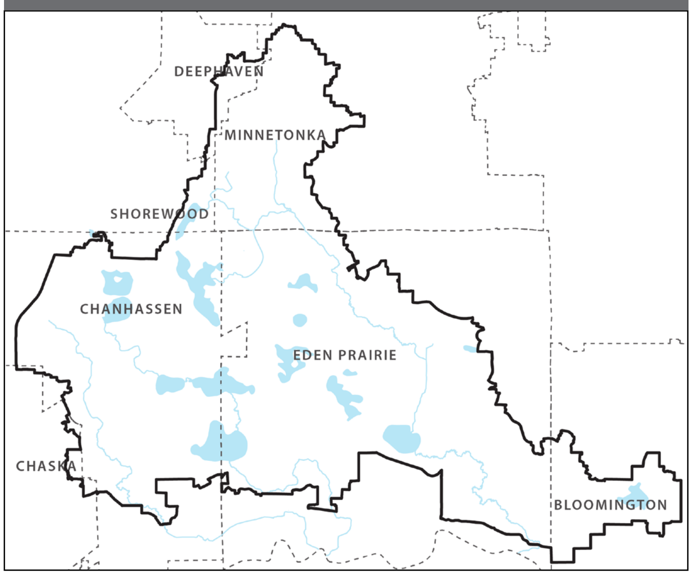
The summary for all three creeks is based on water quality parameters developed by the MPCA in 2014 for Eutrophication and TSS as well as impairment status for fish and macroinvertebrates. The parameters measured from April to September and the associated MPCA water quality limits for streams located in the Central River Region include Dissolved Oxygen (DO) daily minimum greater than 4 mg/L, summer season average Total Phosphus (TP) less than 0.1 mg/L, Total Suspended Solids (TSS) less than 10% exceedance of 30 mg/L limit during the summer season, summer season average Chlorophyll-a (Chl-a)less than 18 µg/L, and summer season average pH between 6 and 9 standard units (MPCA 2016).

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 overall increased slightly from 2021 to 2022; Bluff had 10 (previously 11), Riley has had 12 (previously 11), and Purgatory had 13 (previously 9). No regular creek sampling sites met all MPCA water quality standards assessed in 2023 (Figure 2). 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. Six (previously seven) sites exceeded the water quality standard. In 2023 Riley Creek had the most water quality exceedances with 13. Prior to 2021, Bluff Creek consistently had the most impairments. MPCA macroinvertebrate and *E. coli* impairments included the lower reaches of Riley and Purgatory Creeks. Lower reaches of Riley and Bluff Creek 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 4). The watershed district includes portions of both Hennepin and Carver counties. The total district area is about 50 square miles and includes three creek watersheds: Riley Creek, Purgatory Creek, and Bluff Creek.

Figure 4. Cities with land within the RPBCWD boundary.



Data collection and reporting are the foundation of the Distict'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 (seven 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) at 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

Table 2. Water resources sampling partnerships.

Waterbody 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	💧		💧		💧

Program (WOMP) or long-term monitoring program which identifies pollutant loads entering the Minnesota River. District EnviroDIY stations were also installed at some stream locations to gather more information.

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: Water Quality Data Collection. 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 search and/or treat for 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, specifically in regards to chloride. 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).

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	💧	💧	💧	💧	💧	💧	💧	💧	💧	💧	💧	💧

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

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

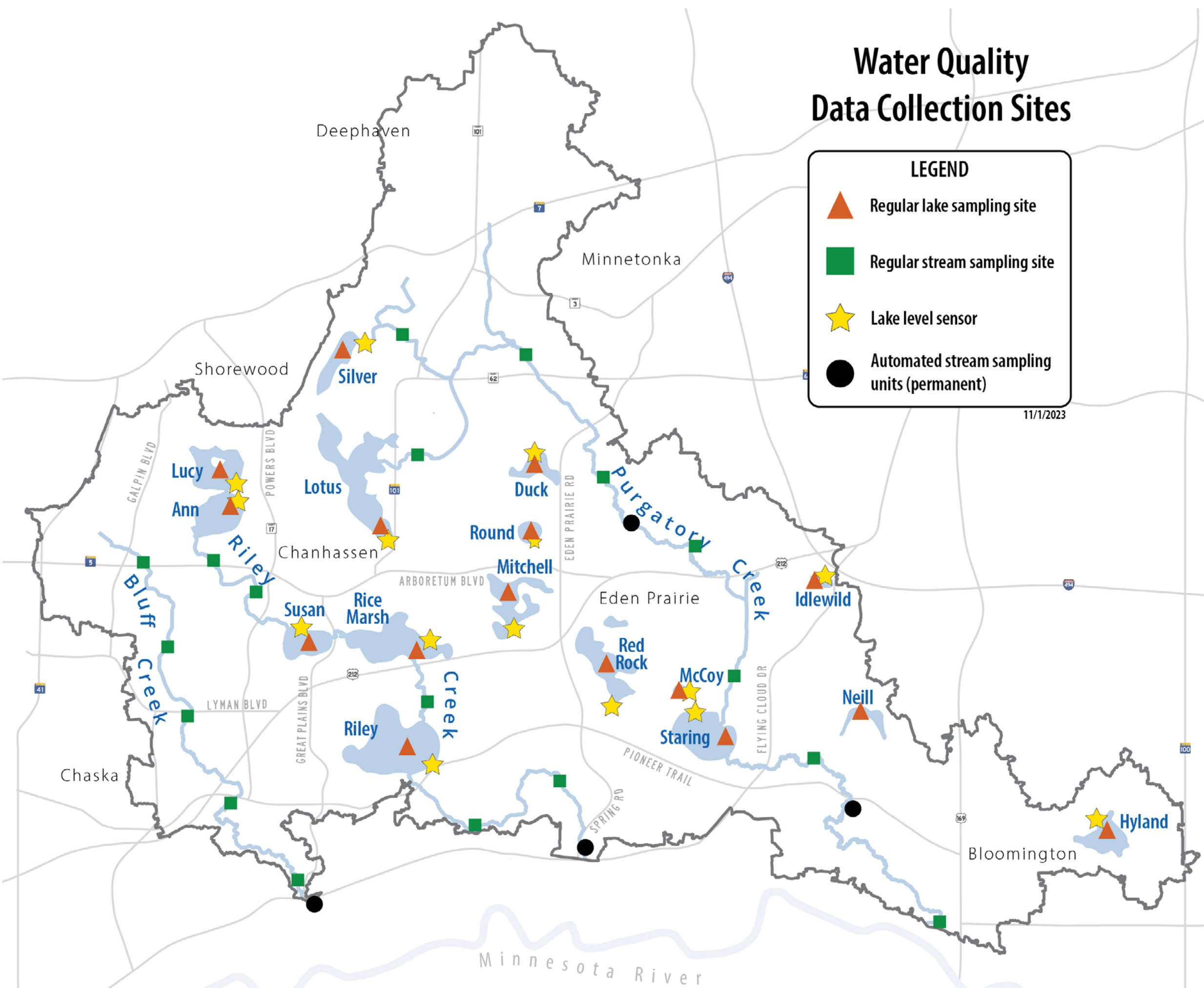
The data collection and monitoring program supports the District's 10-year water management plan to delist waters from the MPCA 303d Impaired Waters list. The parameters monitored during the field season help determine the sources of water quality impairments and provide supporting data

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
Photosynthetic Active Radiation	Sonde	💧	💧	--	Measure of light available for photosynthesis
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. 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.



that is necessary to best design and implement water quality improvement projects.

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, photosynthetic active radiation (PAR), 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, or 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 the 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

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

being sent to a lab for analysis. A Zeiss Primo Star microscope 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 the 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 general samples that were not able to be sent to RMB Labs. 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

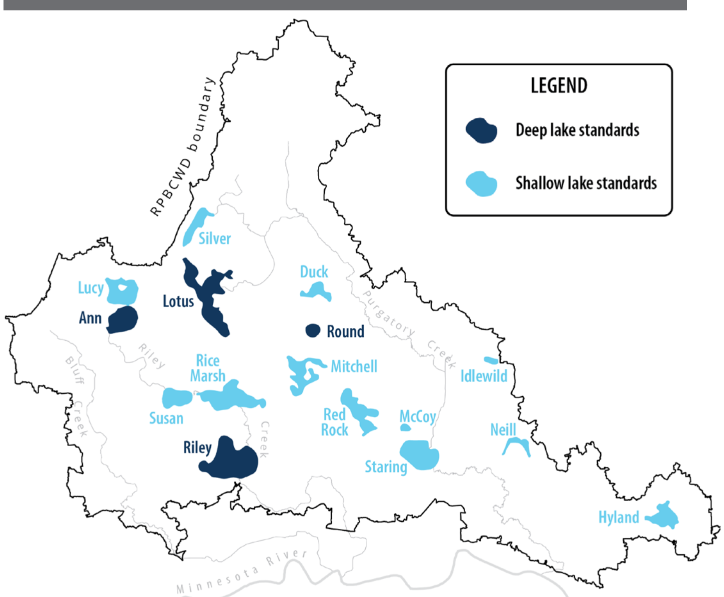


Figure 5. MPCA water quality standards used for waterbodies in RPBCWD.

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

feet 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. 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, early spring melting periods when salts are being flushed through our waterbodies, and monthly during the summer to set a base line. 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 standard. The District added Chl-a to its monthly sampling regime in 2015 to account for the polluted condition that occurs

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

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.

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 Fact Sheets which are located on the District website (rpbcwd.org) and Nutrient Summary Table in Exhibit E. Sonde lake profile data can be viewed in Exhibit G.

Chlorophyll-a

The 2022 growing season Chl-a mean concentrations for all lakes sampled within the District are shown in Figure 4-1 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 2022. Lake McCoy values were not applied in 2022 due to extreme low water conditions. Overall, eight of 14 lakes sampled in 2022 met the MPCA Chl-a standards for their lake classification (eight lakes in 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 µg/L) was met by Lake Ann, Lake Riley, and Round Lake. Due to the past alum treatment, Lake Riley had the lowest summer Chl-a average of all lakes sampled in 2022 at 4.5 µg/L. (2.3 µg/L in 2021 and 2.8 µg/L in 2020). Similar to 2019-2021, Lotus Lake did not meet the standard and had Chl-a average concentrations at 25.35 µg/L (an improvement of 8 and 9 µg/L from 2019 and 2020). The remainder of the lakes sampled in 2022 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 µg/L) was met by Duck Lake, Hyland Lake, Lake Idlewild, Lake Lucy, Rice Marsh Lake, and Silver Lake. Chl-a concentrations improved in Hyland Lake and were well below the MPCA standard in 2022 (7.6 µg/L). These concentrations were also significantly below 2021 concentrations (31.1 µg/L). Idlewild, Lucy, Red Rock, Rice Marsh, and Silver remained similar to what was seen in 2021 with only Red Rock Lake not meeting the standard of that list (26.93 µg/L). Similar to 2021, Mitchell Lake and Lake Susan did not meet the MPCA standard in 2022 although they both showed a slight improvement. Lake Susan continued to have high Chl-a concentrations (62.2 µg/L) similar to what has been seen in the past (51.5 µg/L in 2020, 69 µg/L in 2021. Duck Lake had reduced Chl-a levels decreasing from 15.18 µg/L in 2021 to 5.19 µg/L in 2022. Staring Lake Chl-a levels increased significantly from 2021 (21.52 µg/L) and had the highest concentrations across all lakes (70.38 µg/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 2022 are shown in Figure 4-2. Overall, twelve of the 14 lakes sampled met the MPCA total phosphorus standard for their lake classification in 2022: Lake Ann, Lotus Lake, Lake Riley, Round Lake, Duck Lake, Lake Hyland, Lake Idlewild, Lake Lucy, Mitchell Lake, Red Rock, Rice Marsh Lake, and Silver Lake. This is the same number of lakes as 2021 but represents 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 Lake Ann, Lotus Lake, Lake Riley, and Round Lake in 2022. All deep lake TP concentrations in 2022 remained relatively the same from what was seen in 2021. Following the second dose of the alum treatment in May of 2020, Lake Riley continues to have the lowest summertime average TP concentration (0.015 mg/L) across all lakes sampled (2020-0.0178 mg/, 2021-0.016 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, Rice Marsh Lake, and Silver Lake in 2022. Lake Susan and Staring Lake both did not meet the MPCA TP standard in 2022. Susan had concentrations similar to 2020 (0.073 mg/L), while Staring Lake significantly increased from 2021 (0.042 mg/L) to 2022 (0.106 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). 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.

Secchi Disk

The 2022 secchi disk growing season means for all District lakes sampled are shown in Figure 4-3. Overall, water clarity in most lakes stayed the same or improved 2022 except for Lake Susan which declined.

The MPCA standard for secchi disk depth/water clarity for deep lakes (> 1.4 m) was met by all deep lakes in 2022. Lotus did not meet the standard in 2020 (1.24 m) but met the standard in 2021 and 2022 (1.51 m). Lake Riley had the highest summer average for all lakes sampled in 2022 and the average was only slightly down (3.96 m) from 2021. The 2021 secchi of 4.82 m was the highest recorded since data collection began in 1971 on the

Table 10. 2023 Lakes water level summary.

The 2022 (March-November) and historical recorded lake water levels (ft) 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	2022 Lake Water Level Data				Historical Lake Water Levels			
	Seasonal Flux	Flux Range	High Level	Low Level	Highest Level	Date	Lowest Level	Date
PURGATORY CREEK CHAIN OF LAKES								
Duck	1.641	1.654	913.854	912.200	915.317	6/20/2014	911.260	11/10/1988
Eden	1.220	1.690	810.698	809.008	854.324	8/27/2021	809.008	10/12/2022
Hyland	1.608	2.101	814.391	812.290	818.733	6/23/2014	811.660	12/2/1977
Idlewild	1.228	1.445	854.036	852.591	860.780	3/29/1976	853.100	1/7/1985
Lotus	1.509	1.693	896.189	894.497	897.080	7/2/1992	893.180	12/29/1976
McCoy	1.560	1.560	823.516	821.956	823.902	8/16/2020	821.956	11/4/2022
Mitchell	2.599	2.635	871.974	869.339	874.210	6/25/2014	865.870	7/25/1977
Red Rock	1.625	1.829	840.534	838.705	842.702	7/13/2014	835.690	9/28/1970
Round	3.040	3.351	878.518	875.167	884.260	8/17/1987	875.167	11/4/2022
Silver	1.764	1.772	898.969	897.197	901.030	6/20/2012	894.780	6/6/1972
Staring	1.421	1.738	815.111	813.373	820.000	7/24/1987	812.840	2/12/1977
AVERAGE	1.747	1.952						
RILEY CREEK CHAIN OF LAKES								
Ann	1.604	1.608	956.408	954.800	957.930	2/18/1998	952.800	9/28/1970
Lucy	1.393	1.459	956.581	955.122	957.683	6/20/2014	953.290	11/10/1988
Rice Marsh	1.778	1.932	876.123	874.191	877.250	5/28/2012	872.040	8/27/1976
Riley	1.872	2.227	865.274	863.047	866.855	6/20/2014	862.000	2/1/1990
Susan	0.694	0.954	881.912	880.958	884.226	6/19/2014	879.420	12/29/1976
AVERAGE	1.468	1.636						

lake. For shallow lakes, the MPCA standard was not met by only Lake Susan. Red Rock had the lowest (worst) secchi reading at 0.66 m in 2020 but improved 1.5 m in 2021 and was sustained in 2022 (1.48 m). Duck, Rice Marsh, and Lucy had secchi readings near 2 m and Hyland was reduced from 2.05 m in 2020 to 1.14 m in 2021 but increased to 1.67 m in 2022 following the spring alum treatment. Mitchell Lake did not meet the standard in 2020 (0.93 m) but improved in 2021 and met the standard (1.13 m) which further improved in 2022 (1.76 m).

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 actively 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 as 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 in the District can be found in Table 11. 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 to evaluate their success 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 Fact Sheets located on the District website (rpbcwd.org) and Nutrient Summary Table in Exhibit E.

Figure 4-4 through Figure 4-8 illustrate epilimnetic and hypolimnetic total phosphorus (TP) levels prior to treatment,

Table 11. Aluminum Sulfate (Alum) Treatments.

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

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 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 and Chlorophyll-a levels were improved which led to most lakes meeting all three water quality standards after treatment (exception Lotus Lake). In Table 4-2 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 four years of post-treatment data, it appears Rice Marsh and Hyland Lake were very effective alum treatments with phosphorus reductions of surface phosphorous 51% and 54% respectively. Hyland Lake was treated with the second dose in the spring of 2022 and had a reduction and the percent decrease increased slightly to 56%. Rice Marsh will be treated with the second dose in 2024. Despite having a smaller reduction in total phosphorus at the surface, Round Lake had reductions in lake bottom total phosphorus comparable with the other treated lakes (85% (dose 1) and 87% (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 m. Overall, comparing pre and post treatment years, Lake Riley had a reduction of total phosphorus of 68% at surface and 92% near the lake bottom phosphorus. After the first dose of alum in Lotus Lake, water quality did not respond as well as seen across other lakes (only 35% surface and 64% bottom). This may be due to the high phosphorus release rates observed from the sediment cores taken and because the untreated, shallower areas 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 more robust results. The District monitored TP and OP in both deep-water basins that received alum (south and east) in Lotus Lake to gauge phosphorus release rates 2021 and 2022. Both basins had similar summer average surface concentrations (0.032-0.033 and 0.03-0.035 mg/L respectively). Bottom summer averages were slightly different with the south bay (normal monitoring location) having higher concentrations at 0.185 mg/L in 2021 and 0.238 mg/L in 2022 vs 0.146 mg/L in 2021 and 0.171 mg/L in 2022 measured in the east bay.

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 second dose application and gauge temporal success of each treatment.

Table 12. Aluminum Sulfate (Alum) Treatment Effectiveness at Lake Surface and Lake Bottom.

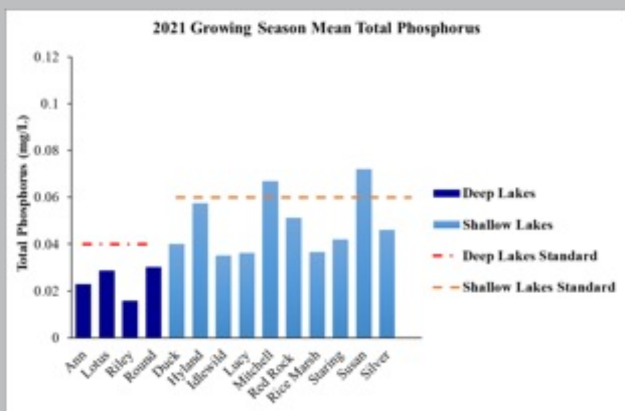
LAKE	YEARS	SAMPLE LOCATION	FIRST DOSE			SECOND DOSE	
			Average TP Pre-treatment	Average TP Post-treatment	Percent Reduction	Average TP Post-treatment	Percent Reduction
Riley	2009-2022	Surface	0.0457	0.0267	41%	0.0160	65%
		Bottom	0.5334	0.1684	68%	0.0418	92%
Lotus	2014-2022	Surface	0.0540	0.0349	35%	*Not treated yet*	*n/a*
		Bottom	0.5423	0.1925	64%	*Not treated yet*	*n/a*
Rice Marsh	2015-2022	Surface	0.0745	0.0366	51%	*Not treated yet*	*n/a*
		Bottom	0.1217	0.0362	70%	*Not treated yet*	*n/a*
Round	2008-2022	Surface	0.0415	0.0388	6%	0.0313	24%
		Bottom	0.8945	0.1376	85%	0.1184	87%
Hyland	2016-2022	Surface	0.0819	0.0375	54%	0.0360	56%
		Bottom	*No data*				

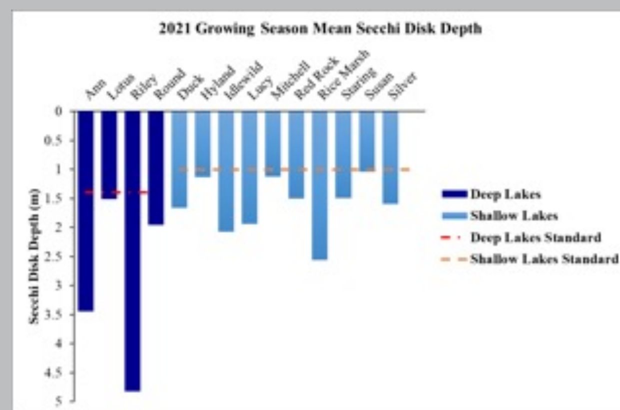
Figure 6. Mean Total Phosphorus during Lakes Growing Seasons (2022-2023)

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 2021 and 2022. 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).

Figure 7. Mean Secchi Depth during Lakes Growing Seasons (2022-2023)

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).





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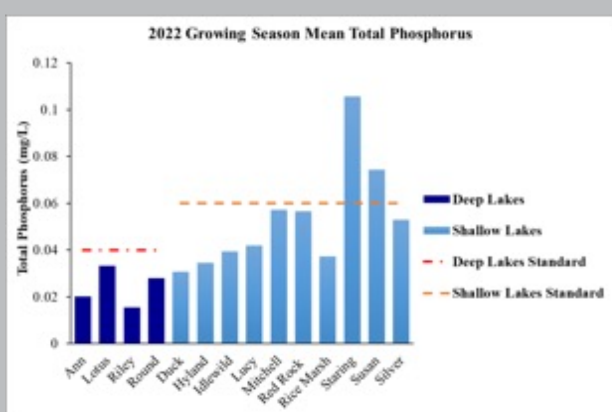


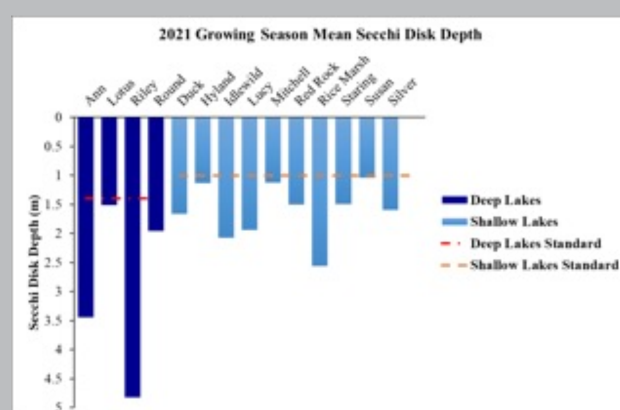


Figure 8. Hyland Lake Total Phosphorus Levels pre- and post-alum treatment.

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).

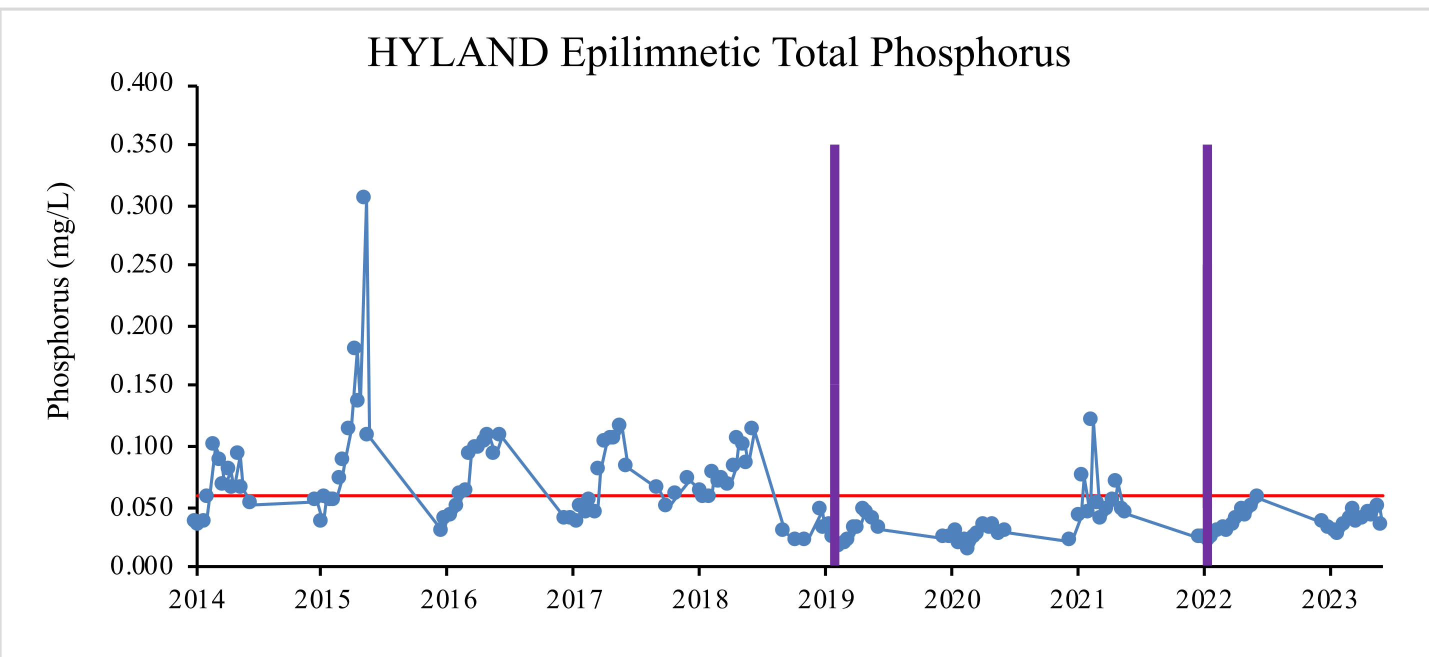
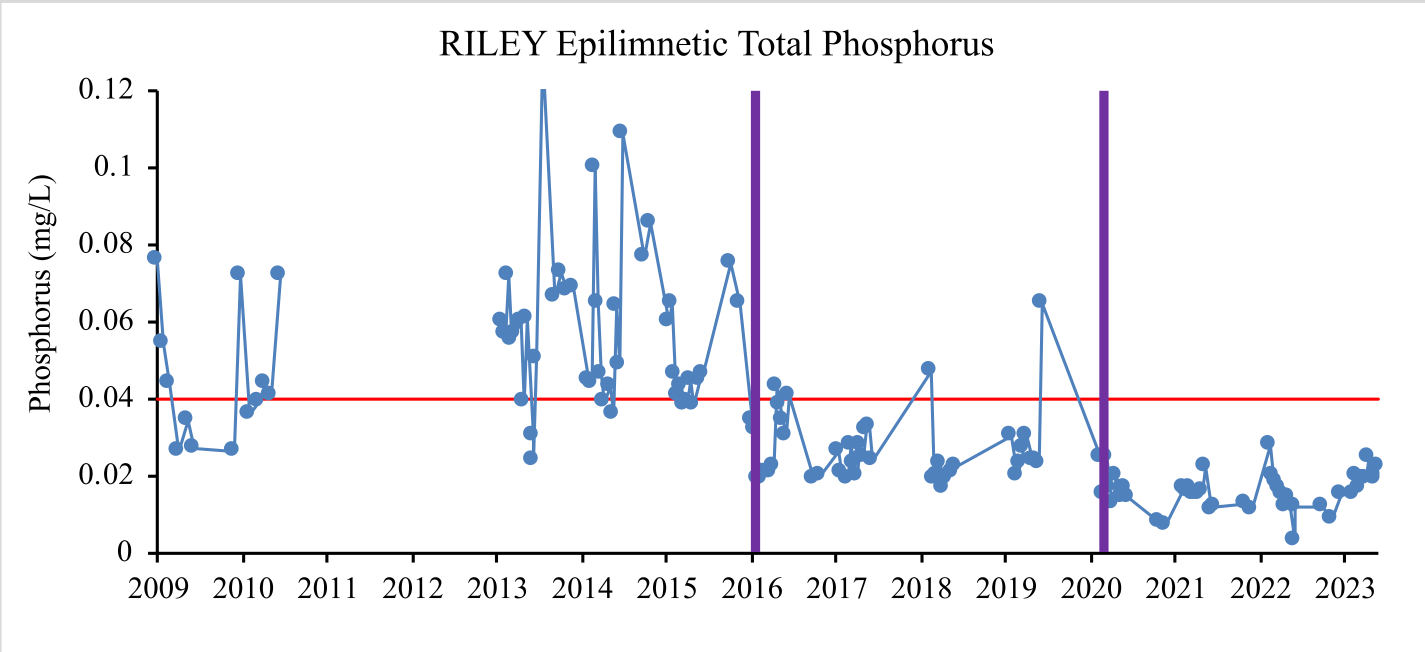


Figure 9. Lake Riley Total Phosphorus Levels pre- and post-alum treatment.

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).



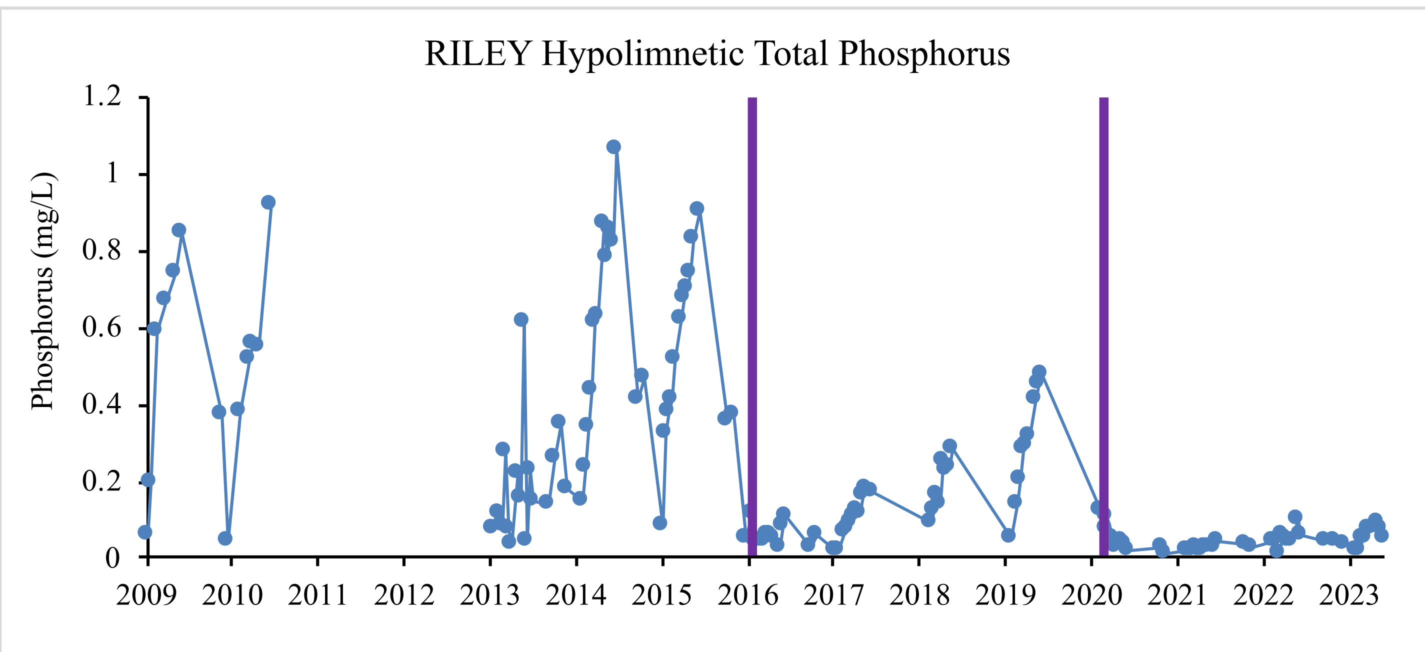
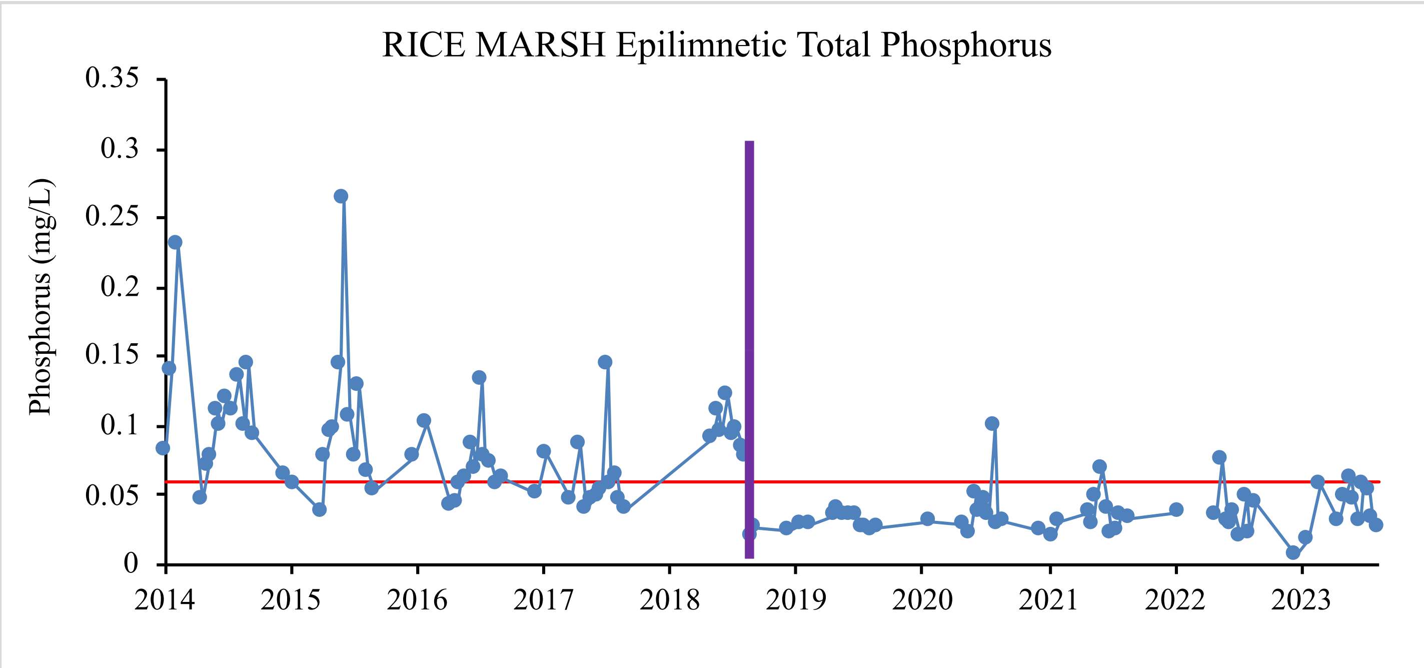


Figure 10. Rice Marsh Lake Total Phosphorus Levels pre- and post-alum treatment.

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).



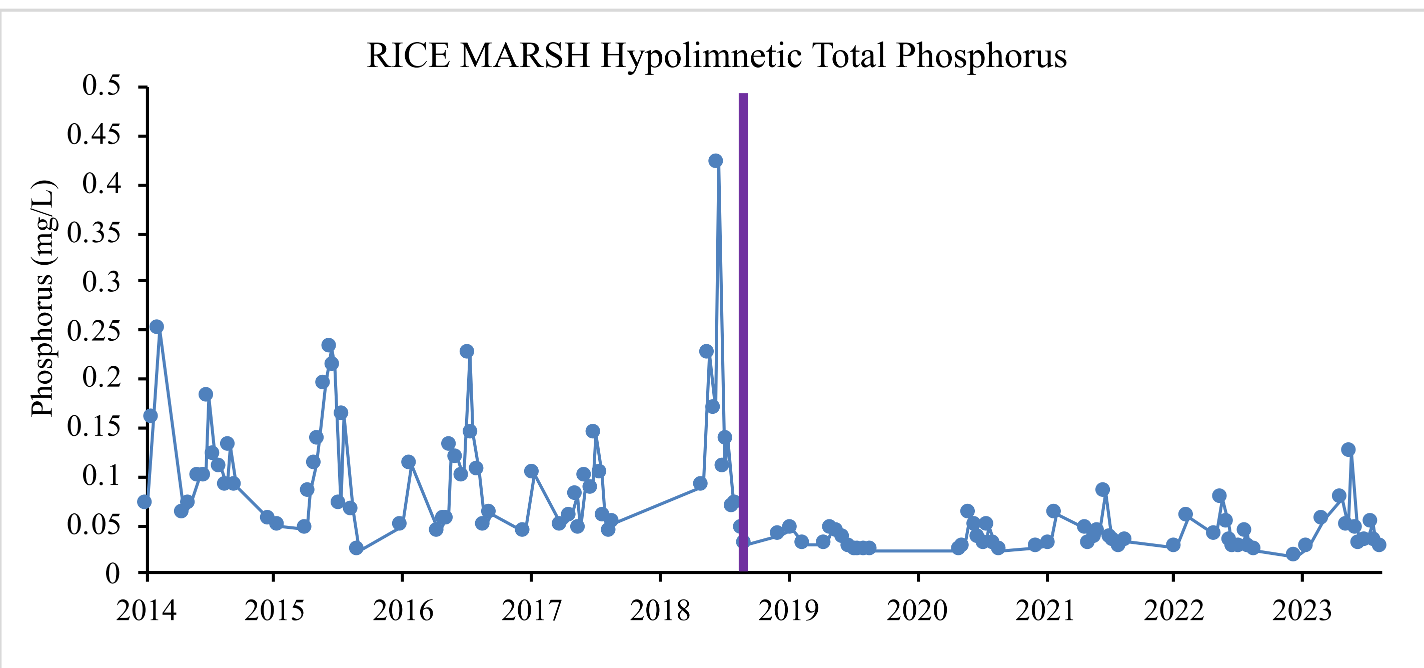
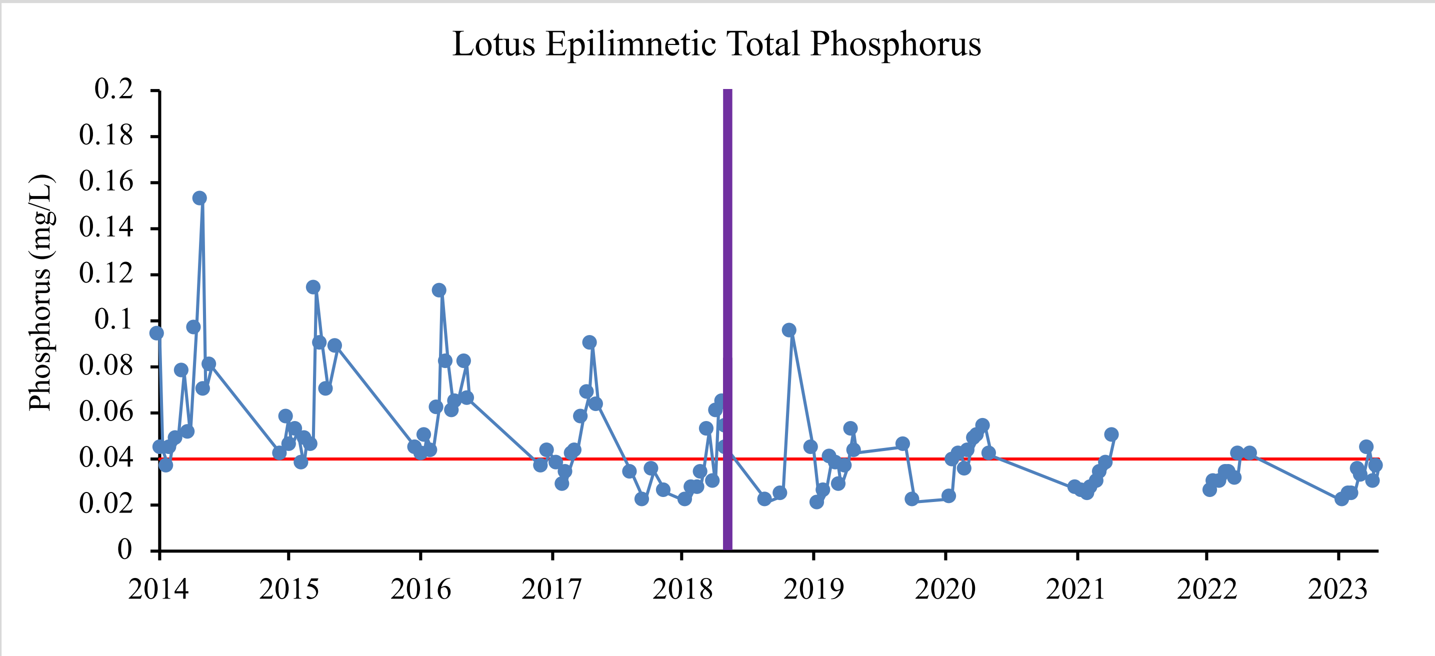


Figure 11. Lotus Lake Total Phosphorus Levels pre- and post-alum treatment.

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).



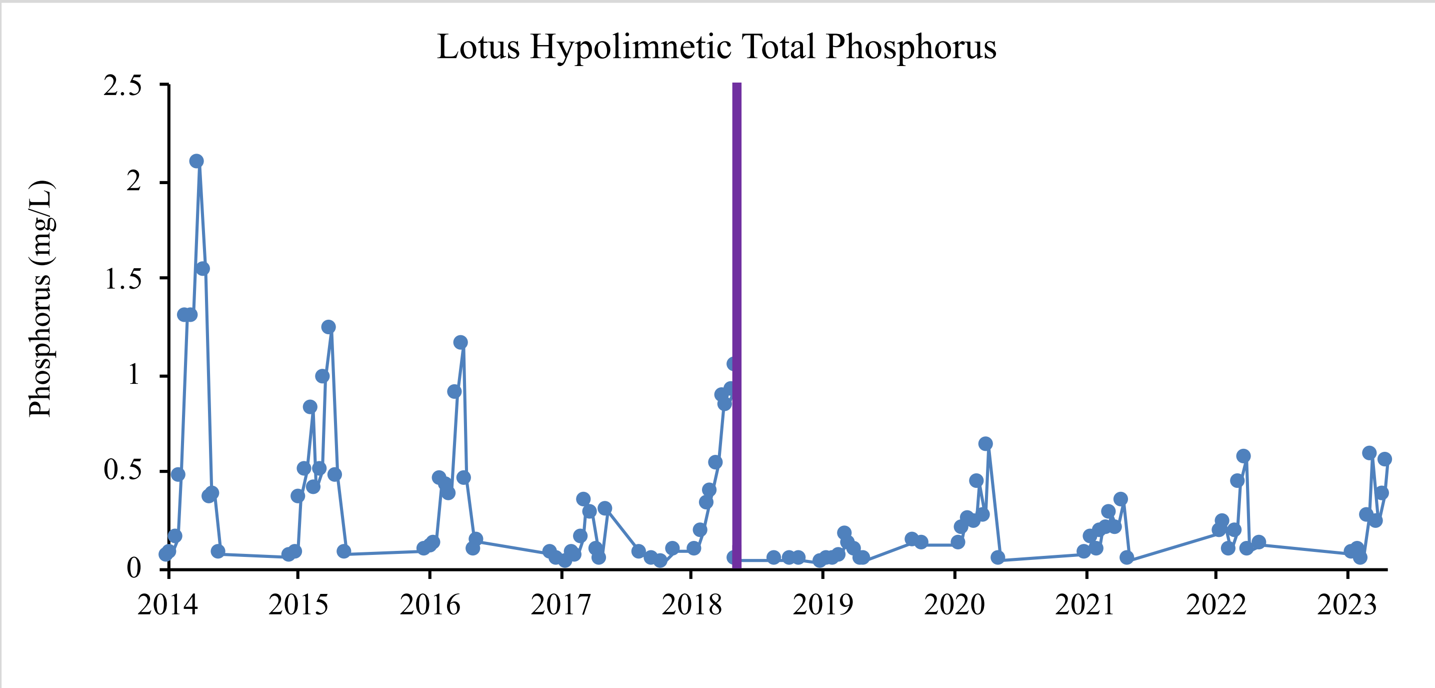
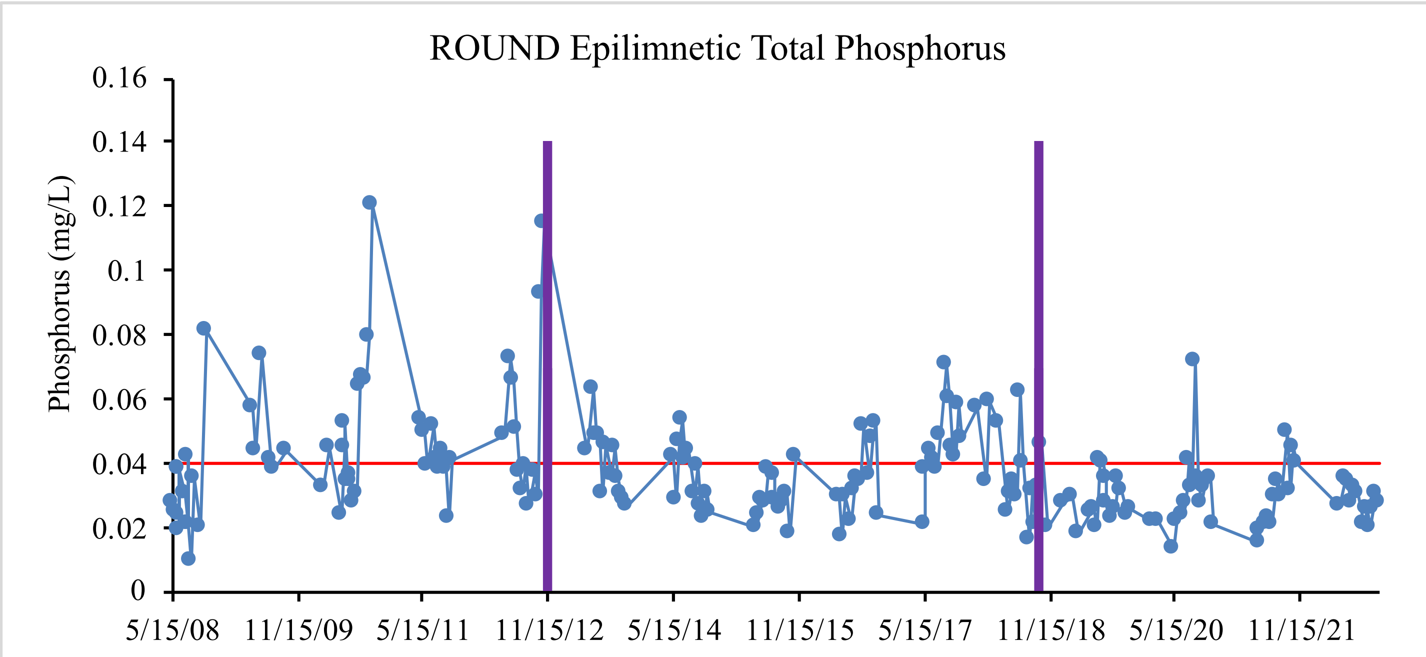
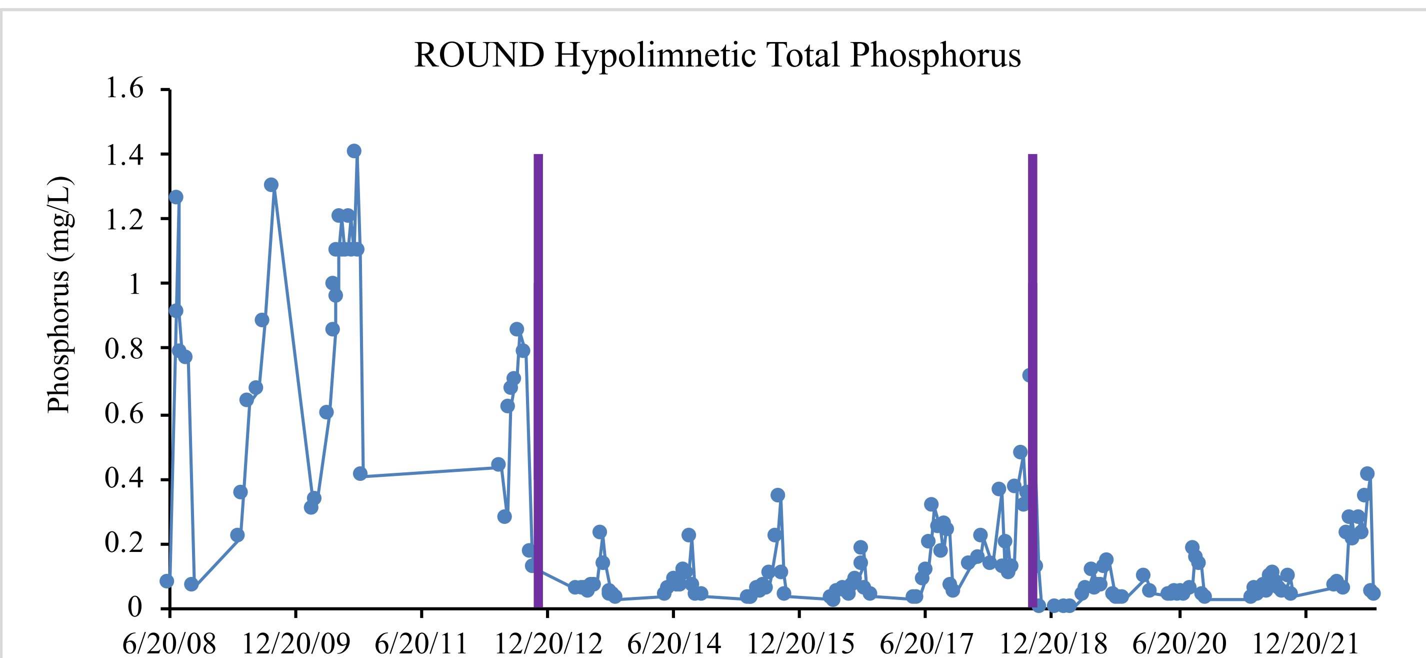


Figure 12. Round Lake Total Phosphorus Levels pre- and post-alum treatment.

Total phosphorus levels (TP) in Round Lake between May 15, 2008 and October 27, 2022. 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 2019, 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 have fallen below the MPCA CS of 230 mg/L (Figure 4-10, Figure 4-11). 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 6/25/23 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

Figure 13. 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.

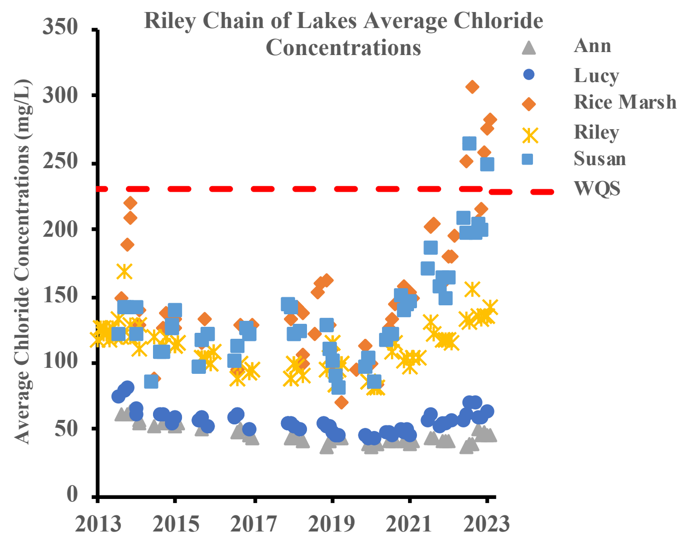
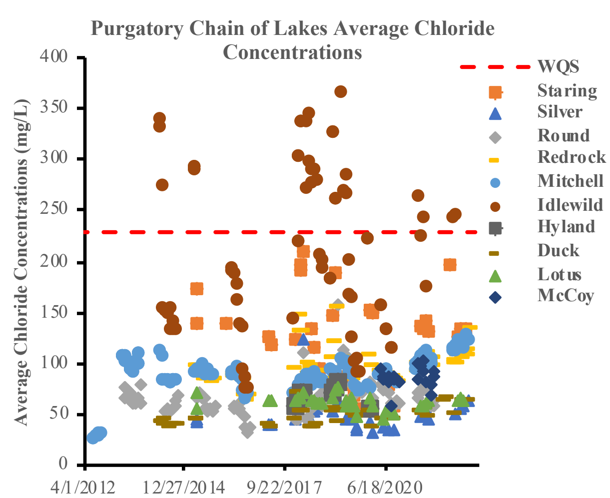


Figure 14. Purgatory Creek Chain of Lakes chloride levels 2013-2023.

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.



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and 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.

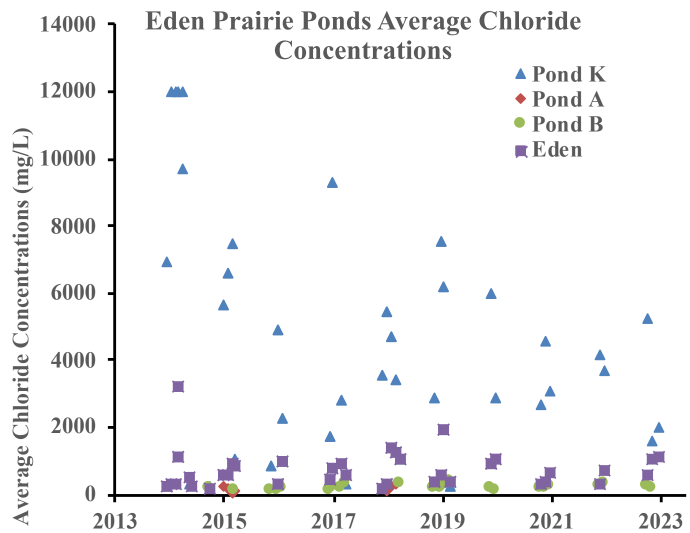
In the RCL system, no lake exceeded the water quality standard from 2013-2022. In 2023, both Rice Marsh Lake and Lake Susan exceeded the standard on multiple dates. Unfortunately, Susan, Rice Marsh, and Riley have been on an increasingly alarming trend for the past three years which, if continued, could lead to all lakes exceeding the standard in the near future. 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 15 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.

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

Figure 15. 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.



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. They can also alert staff of any chloride level spikes during this period. From 2108-2021, 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 4-13) and Bluff Creek (Figure 4-14) 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 Table in Exhibit F and stream conductivity readings can be seen in Exhibit D.

Figure 16. Ambient and Annual Median Chloride Concentration in Riley Creek (Metropolitan Council).

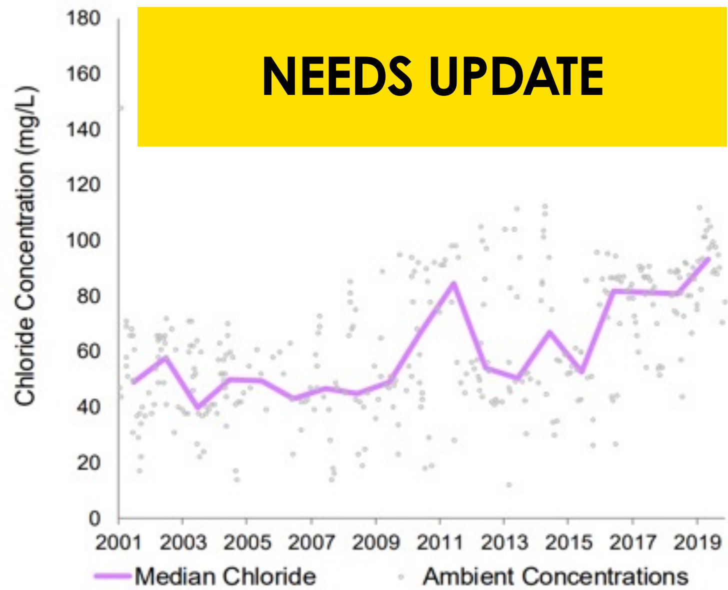
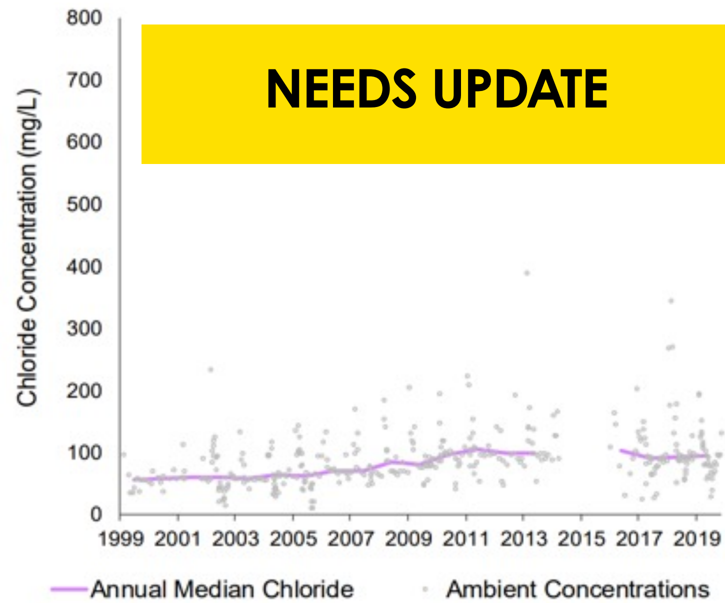


Figure 17. Ambient and Annual Median Chloride Concentration in Bluff Creek (Metropolitan Council).



4.4. Nitrogen Monitoring

Section needs update

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 (still in the draft stage for external review) 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. 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 2022 was 0.74 mg/L (1.099 mg/L in 2021). The District monitors nitrates in lakes as a part of its regular sampling regime. The District tests for nitrates in the form of [illegible] and nitrite). This lab also tests for ammonia in the form of ammonia+ammonium. As seen in Table 4-3, 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 (Table 4-3).

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 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 4-3 may be lower than what is given. In lakes and streams, ammonium (NH_4^+) is usually much more predominant than ammonia (NH3) 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 4-3 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.

Table 13. 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.

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

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	0.030	0.682	1.482
Duck	0.052	0.025	0.718
Hyland	--	--	0.74
Idlewild	0.030	0.023	0.568
Lotus	0.032	1.293	2.066
Lucy	0.030	0.411	1.506
Mitchell	0.040	0.129	1.306
Neill	0.030	0.023	0.867
Red Rock	0.040	0.140	1.364
Rice Marsh	0.057	0.047	0.865
Riley	0.033	0.43	0.959
Round	0.040	0.099	0.863
Silver	0.030	0.049	1.245
Staring	0.030	0.124	1.860
Susan	0.030	1.377	2.806

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

4.5. Lake Water Levels and Precipitation

Section needs update

as 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 4-15 and Figure 4-16 displays daily precipitation totals across at the two stations from March 1, through December 1 for 2021 and 2022. Overall, precipitation levels were very low in 2021. In 2022, we continued to be in a drought condition with even less precipitation than seen in 2021. During this period, rainfall at the Flying Cloud Airport and National Weather Service Station totaled 16.78 inches (19.12 inches in 2021) and 23.49 inches (19.95 inches in 2021) respectively. In 2022, The max rainfall event at Flying Cloud Airport occurred on 5/11/22, totaling 1.32 inches of rain (8/27/21, 1.49 inches). At the National Weather Service Station, the max rainfall total occurred on 5/11/22, totaling 2.13 inches of rain (8/28/21, 1.71 inches).

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 the impact that climate change may have on lakes and land

Figure 18. Precipitation in 2022.

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

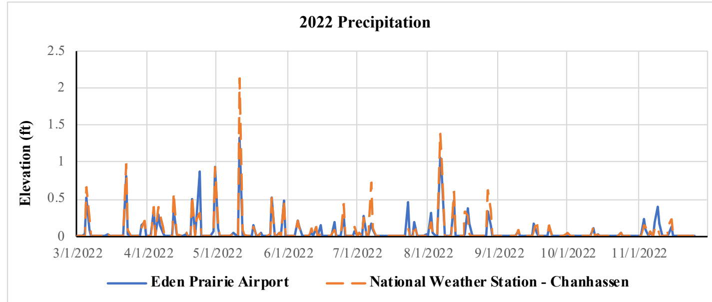


Figure 19. Precipitation in 2023.

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

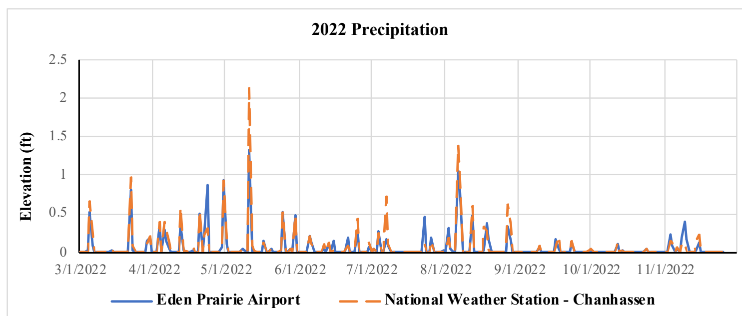


Figure 20. Round Lake level sensor high and dry in ??.

interactions in the watershed. Lake level data is also used to determine epilimnetic zooplankton grazing rates (located in section 4.8). 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. See Exhibit A for figures showing historical lake level data and 2022 lake level data compared with precipitation data. In both the 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 2022, lake level measurements were collected on 13 lakes in the District and three wetlands (Lake Idlewild, Lake McCoy, Eden Lake) (Table 4-4). This was the third year Lake McCoy had water levels monitored and second for Eden. Round Lake experienced the greatest seasonal water level change over the 2022 season, decreasing 3.04 ft from spring sensor placement to the last day of recording. Like 2021, Round Lake had the largest range of fluctuation through 2022. During the 2022 season, Round Lake had a low elevation of 875.167 ft, and a high of 878.518 ft (3.351 ft difference). Round Lake also had the lowest recorded water level according to past District data and MN DNR Lakefinder data. The previous low was recorded on 7/25/1977 and measured 875.290. Round Lake water levels are highly influenced by precipitation events within the watershed which is why it commonly has the highest flux (Figure 4-17). Lake Susan had the least seasonal flux (0.694 ft) and flux range (0.954 ft) across all District lakes. This is likely from a beaver dam which was located between Lake Susan and Rice Marsh Lake which artificially raised the water levels through the 2022 season. On average, lake levels seasonal flux was 1.747 ft in the PCL and 1.468 in RCL in 2022. The average fluctuation range across PCL was 1.952 and 1.636 ft for RCL.

4.6. Lake Shoreline Assessment

In 2021, RPBCWD began using the MN DNR Score The Shore (STS) system to evaluate health of lake shorelines. Using the approach outlined in the *MNDNR 2016 Minnesota Lake Plant Survey Manual*, staff assessed three zones: Upland, Shoreline, and Aquatic (Figure 21). Scores in each zone are weighted equally and combined to generate an overall score for each property. Within each zone, a user scores for features such as tree, shrub, and natural ground cover; wetlands; overhanging branches; woody habitat in the water; presence of docks; and opening in aquatic plant beds (Table 14). For the full Score The Shore scoring method, see Table 15.

The Upland Zone is considered as the area from the house/cabin to the top of the bank of the lake. 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 (waterline). This zone fluctuates depending on the water level. When necessary, the Shoreline Zone can be defined by the assessor as the first one-third of the lot towards the house and

Figure 21. Score The Shore (STS) property zones (MN DNR) shown with a bird's-eye view (top) and side view (bottom).

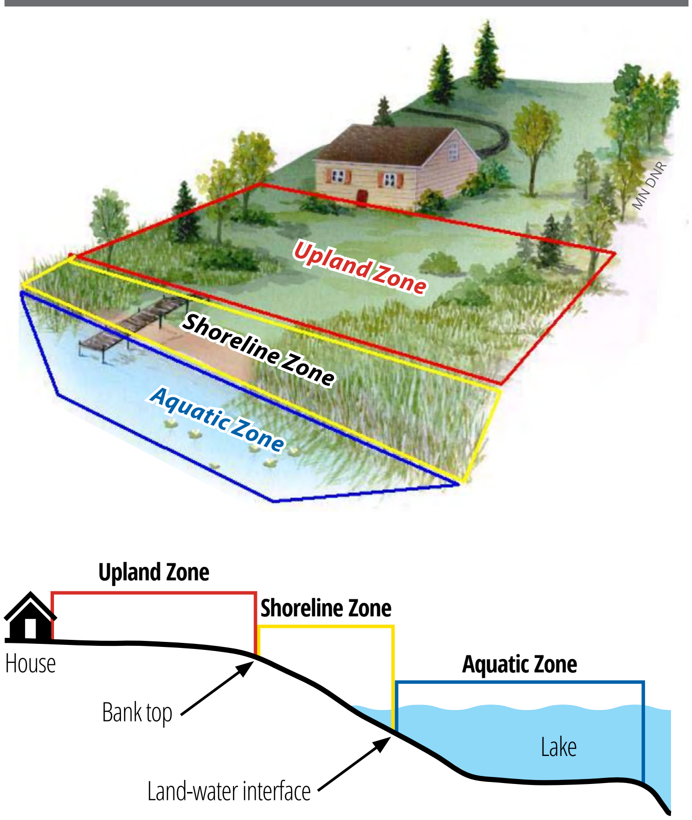


Table 14. Score The Shore (STS) is used by the MnDNR staff when they assess a lake. RPBCWD uses a modified version of STS.

FEATURE	FEATURE DESCRIPTION	MAX POINTS	MAX SCORE (%)
Upland Zone - *House to lake bank*			
1	Percent of frontage with trees	20	$13.3\overline{3}\%$
2	Percent of frontage with shrubs	20	$13.3\overline{3}\%$
3	Percent of frontage with natural ground cover	10	$6.6\overline{7}\%$
	Maximum points/score for Upland Zone	**50**	**$33.\overline{3}\%$**
Shoreline Zone - *Lake bank to waterline*			
4	Percent of frontage with trees, shrubs, and/or wetland	20	$13.3\overline{3}\%$
5	Percent of frontage with natural ground cover or wetland	20	$13.3\overline{3}\%$
6	Overhead woody habitat	10	$6.6\overline{7}\%$
	Maximum points for Shoreline Zone	**50**	**$33.\overline{3}\%$**
Aquatic Zone - *Waterline to 50 feet into water*			
7	Human-made openings in plant beds	20	$13.3\overline{3}\%$
8	Downed woody habitat	10	$6.6\overline{7}\%$
9	Structure (number/type of docks, rafts, lifts, marinas)	20	$13.3\overline{3}\%$
	Maximum points for Aquatic Zone	**50**	**$33.\overline{3}\%$**
	MAXIMUM POINTS/SCORE POSSIBLE	**150**	**100%**

the Upland Zone the remaining two-thirds. The Aquatic Zone is the area form the land-water interface and extending 50 feet into the waterbody.

Score The Shore - RPBCWD Modification

RPBCWD staff assessed the same features in the same way as the original STS approach developed by the DNR. However, the method of selecting the number and location survey points was modified by RPBCWD. The DNR use a lake's shoreline length to determine the number and spacing of shoreline survey points. However, because of distinct differences between residential properties of the district's developed lakes, RPBCWD staff surveyed each property lot separately, regardless of shoreline length.

Scoring by individual properties results in a lower lakewide average than the lakewide average calculated from the DNR's equalized spacing survey method. A long shoreline that would receive multiple scores with the standard DNR method only receives one score with the RPBCWD modified method. For

Table 15. Score The Shore (STS) was developed the MnDNR to assess lake shoreland health.

<table>
<tr><th>FEATURE</th><th colspan="3">FEATURE DESCRIPTION</th><th>COVERAGE</th><th>POINTS</th><th>SCORE (%)</th></tr>
<tr><td colspan="7">UPLAND ZONE - House to lake bank</td></tr>
<tr><td rowspan="5">1</td><td colspan="3" rowspan="5">Percent of frontage with trees</td><td>75-100%</td><td>20</td><td>$13.3\overline{3}$ %</td></tr>
<tr><td>50-74%</td><td>15</td><td>10 %</td></tr>
<tr><td>25-49%</td><td>10</td><td>$6.6\overline{7}$ %</td></tr>
<tr><td>1-24%</td><td>5</td><td>$3.3\overline{3}$ %</td></tr>
<tr><td>0%</td><td>0</td><td>0%</td></tr>
<tr><td rowspan="5">2</td><td colspan="3" rowspan="5">Percent of frontage with shrubs</td><td>75-100%</td><td>20</td><td>$13.3\overline{3}$ %</td></tr>
<tr><td>50-74%</td><td>15</td><td>10 %</td></tr>
<tr><td>25-49%</td><td>10</td><td>$6.6\overline{7}$ %</td></tr>
<tr><td>1-24%</td><td>5</td><td>$3.3\overline{3}$ %</td></tr>
<tr><td>0%</td><td>0</td><td>0 %</td></tr>
<tr><td rowspan="5">3</td><td colspan="3" rowspan="5">Percent of frontage with natural ground cover</td><td>75-100%</td><td>10</td><td>$6.6\overline{7}$ %</td></tr>
<tr><td>50-74%</td><td>7.5</td><td>5 %</td></tr>
<tr><td>25-49%</td><td>5</td><td>$3.3\overline{3}$ %</td></tr>
<tr><td>1-24%</td><td>2.5</td><td>$1.6\overline{7}$ %</td></tr>
<tr><td>0%</td><td>0</td><td>0 %</td></tr>
<tr><td colspan="7">SHORELINE ZONE - Lake bank to waterline</td></tr>
<tr><td rowspan="5">4</td><td colspan="3" rowspan="5">Percent of frontage with trees, shrubs, and/or wetland</td><td>75-100%</td><td>20</td><td>$13.3\overline{3}$ %</td></tr>
<tr><td>50-74%</td><td>15</td><td>10 %</td></tr>
<tr><td>25-49%</td><td>10</td><td>$6.6\overline{7}$ %</td></tr>
<tr><td>1-24%</td><td>5</td><td>$3.3\overline{3}$ %</td></tr>
<tr><td>0%</td><td>0</td><td>0%</td></tr>
<tr><td rowspan="5">5</td><td colspan="3" rowspan="5">Percent of frontage with natural ground cover or wetland</td><td>75-100%</td><td>20</td><td>$13.3\overline{3}$ %</td></tr>
<tr><td>50-74%</td><td>15</td><td>10 %</td></tr>
<tr><td>25-49%</td><td>10</td><td>$6.6\overline{7}$ %</td></tr>
<tr><td>1-24%</td><td>5</td><td>$3.3\overline{3}$ %</td></tr>
<tr><td>0%</td><td>0</td><td>0 %</td></tr>
<tr><td rowspan="2">6</td><td colspan="3" rowspan="2">Overhead woody habitat</td><td>Yes</td><td>10</td><td>$6.6\overline{7}$ %</td></tr>
<tr><td>No</td><td>0</td><td>0 %</td></tr>
<tr><td colspan="7">AQUATIC ZONE - Waterline to 50 feet into water</td></tr>
<tr><td rowspan="2">7</td><td colspan="3" rowspan="2">Human-made openings in plant beds</td><td>Yes</td><td>20</td><td>$13.3\overline{3}$ %</td></tr>
<tr><td>No</td><td>0</td><td>0 %</td></tr>
<tr><td rowspan="2">8</td><td colspan="3" rowspan="2">Downed woody habitat</td><td>Yes</td><td>10</td><td>$6.6\overline{7}$ %</td></tr>
<tr><td>No</td><td>0</td><td>0 %</td></tr>
<tr><td rowspan="7">9</td><td colspan="6">STRUCTURE</td></tr>
<tr><td>Number of docks</td><td>Number of Rafts</td><td>Number of Lifts</td><td>Number of Marinas</td><td>Points</td><td>Score</td></tr>
<tr><td>None</td><td>None or many</td><td>None</td><td>None</td><td>20</td><td>$13.3\overline{3}$ %</td></tr>
<tr><td>One simple or none</td><td>None or many</td><td>None</td><td>None</td><td>15</td><td>10 %</td></tr>
<tr><td rowspan="2">At least 1 simple or 1 complex</td><td>None or many</td><td>None to 2</td><td>None</td><td>10</td><td>$6.6\overline{7}$ %</td></tr>
<tr><td>None or many</td><td>More than 2</td><td>None</td><td>5</td><td>$3.3\overline{3}$ %</td></tr>
<tr><td>None to many</td><td>None or many</td><td>None or many</td><td>One or more</td><td>0</td><td>0%</td></tr>
</table>

Table 16. Overview of differences between the original Score The Shore (STS) system and RPBCWD modification.

METHOD	Original STS developed by DNR	Modified STS used by RPBCWD
Features assessed	9 categories	*Same as DNR*
Survey points	Based upon lake shoreline length; points spaced evenly	Based upon property lines; one survey point per parcel
Rating scale	4 rating categories with variable percent ranges (10%, 10%, 10%, and 70%)	10 rating categories divided evenly between percent ranges (10% each)

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.

example, city park properties are typically large parcels with lengthy, natural shorelines, but, with the RPBCWD modified method, each park property receives only one score. This approach tends to bring down the overall lake score as a park shoreline property tends to score high but only counts once toward the overall lake shoreline average.

However, the benefit of the RPBCWD modified method is that it allows homeowners to see their individual shoreline score. The DNR scoring method does not provide individual shoreline scores for homeowners, which misses out on the opportunity for them to see their individual score and possibly feel a call to action to improve it.

Staff also used a different rating method for shorelines than the DNR. The DNR rating method 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 highly developed nature of lakes within RPBCWD, staff expanded the DNR rating categories from four to ten, which allows for a finer scale of assessment for shorelines scoring 70 percent or lower. For an overview of modifications made by RPBCWD, see Table 16 and Figure 22.

District Lake Shoreline Scores

From 2021 to 2023, District staff performed shoreline assessments for eleven lakes (Ann, Duck, Hyland, Lotus, Lucy, Mitchell, Red Rock, Riley, Silver, Staring, and Susan). More developed shorelines generally had lower scores compared to more natural shorelines. Individual property scores can be compared to the overall lake score as well as to other lakes' scores. The RPBCWD approach to shoreline assessment of each individual property does not take into account shoreline length so scores inherently contain bias due to variations in parcel size, especially between residential and public lots (e.g. city parks). Regardless, scoring District lakes can demonstrate to residents the difference in health between a natural/undeveloped shore and their own. The average score across all lakes in the District

Figure 23. Score The Shore lake average scores and distribution plots from data collected 2021-2023.

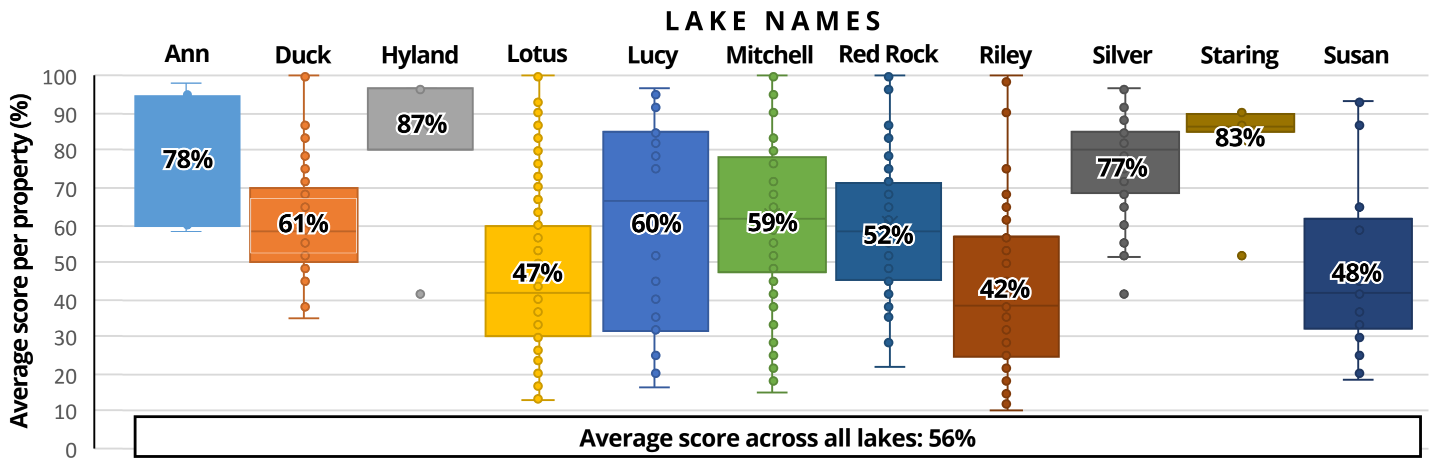


Table 17. Overview of RPBCWD Score The Shore (STS) averages for each lake, each zone within a lake, and all lakes combined.

LAKE NAME	SCORE PER ZONE			OVERALL LAKE SCORE
	UPLAND ZONE	SHORELINE ZONE	AQUATIC ZONE	
Ann	22.6%	30.0%	25.2%	**78%**
Duck	14.3%	20.1%	26.3%	**61%**
Hyland	29.7%	28.9%	28.3%	**87%**
Lotus	18.5%	15.9%	12.5%	**47%**
Lucy	20.5%	19.8%	19.8%	**60%**
Mitchell	18.9%	21.0%	18.7%	**59%**
Red Rock	14.8%	16.7%	21.0%	**52%**
Riley	18.5%	13.3%	10.0%	**42%**
Silver	21.5%	23.7%	31.4%	**77%**
Staring	24.8%	29.0%	29.0%	**83%**
Susan	17.5%	16.7%	13.3%	**48%**
Combined lakes average	18.6%	18.2%	18.1%	**56%**

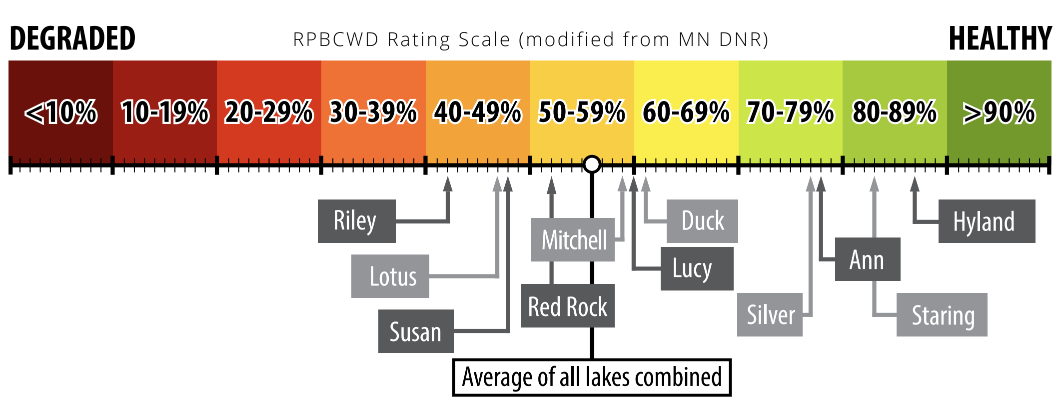
was 56 percent. Average scores by lake are shown in Figure 23. and Table 17.

A healthy shoreline has diverse vegetation, which provides soil stabilization, reduces runoff, and decreases water pollution. A healthy shoreline also has downed woody material and undisturbed aquatic plant beds that provide habitat for fish and macroinvertebrates, and they have shoreline trees that provide shade to reduce water temperatures.

Unhealthy shorelines are typically dominated by turfgrass with an armored shoreline of riprap in place of natural vegetation. Unhealthy shorelines also offer minimal aquatic habitat as aquatic plants and woody debris has been reduced or removed.

Completion of lake shoreline surveys revealed commonalities across lakes with similar remedies to improve scores. In general, residents can improve their scores by increasing the amount of trees, shrubs, and natural groundcover in upland and shoreland

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



zones. One simple way for homeowner to increase their score by 10 points (6.67 percent of their total score) is to leave fallen tree branches in the water to provide habitat. Another easy way to increase a score is to avoid herbicide treatments or physical removal of aquatic plants. By not clearing a swimming area or boat path, a maximum score of 20 points (13.3 percent) can be gained in this category. If a resident leaves their aquatic zone natural and does not remove aquatic plants or woody debris, a score can increase by 20 percent. Overall, our assessment of lake shorelines suggests room for ecological improvement through shoreline restoration, upland restoration, and aquatic improvements across all lakes. The District plans to implement further study into the Score Your Shore program. Moving forward, follow up surveys will likely be conducted on a rotational basis to assess changes in shoreline health over time.

Score Your Shore

Score Your Shore (SYS) is a simplified version of STS developed for an individual with limited equipment and/or experience, such as a property owner. As with STS, SYS is designed to be an intuitive rapid assessment survey completed from the lake by boat. However, SYS differs in that it simplifies the feature assessment and scoring method with only a total points score for each of the three zones. Table 18 provide an overview of the SYS features assessment developed for use by an individual property owner.

Table 18. Score Your Shore (SYS) is a simplified method for a property owner to assess their shoreline.

FEATURE	FEATURE DESCRIPTION	MAX POINTS
Upland Zone - *House to top of the lake bank*		
Tree cover	Percent coverage of trees	25
Shrub cover	Percent coverage of shrubs	20
Natural ground cover	Percent coverage of unmowed ground cover	20
	Maximum points for Upland Zone	**65**
Shoreline Zone - *Lake bank to waterline*		
Tree and shrub cover	Percent coverage of trees and shrubs along shoreline	20
Natural ground cover	Percent coverage of unmowed ground cover along shoreline	15
	Maximum points for Shoreline Zone	**35**
Aquatic Zone - *Waterline to 50 feet into water*		
Emergent and floating-leaf plants	Percent coverage of emergent and floating-leaf plants along shore	40
Submerged plants	Abundance of submerged plants along shore	35
Openings in aquatic plant beds	Presence/absence of human-made channels in aquatic plant beds	5
Overhead woody habitat	Presence/absence of trees and/or shrubs hanging over water	10
Downed woody habitat	Presence/absence of tree branches in water	10
	Maximum points for Aquatic Zone	**100**

4.7. Purgatory Creek Auto-Sampling Units

Section needs update

standards set forth by the MPCA including total phosphorus (TP) chlorophyll-a, and water clarity (secchi disk depth). Additionally, both lakes were 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 these lakes.

- (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 lbs. alone (Figure 4-18). 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.
- (STL_17) For Staring Lake, a creek restoration and stabilization project of a 1,000-foot reach between the Recreation Area and Staring Lake (behind Oak Point Elementary School) would reduce the phosphorus load in Purgatory Creek and to Staring Lake by 4% and provide increased education and outreach to residents.

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 2022, staff placed an automated sampling unit at the grated access site downstream of Kerber Boulevard, the culvert under the recreational trail connected to the end of Carver Beach Road (Lotus Lake), and the culvert under Staring Lake Parkway. 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), ortho-phosphorus (OP), 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.

In 2021 and 2022, total phosphorus levels on the upper Lotus Lake ravine during storm events were high compared to the MPCA standards, as seen in Figure 4-19 and Table 4-5. The average TP coming from upstream of Kerber Blvd. (LL_3) averaged 0.505 mg/L and the average TP leaving the stormwater pond upstream of the recreational trail (LL_7) measured 0.424 mg/L in 2022 (Table 4-5). The reduction in 2022 from 2021 (0.534 mg/L) for LL_7 was likely due to the reduced amount of precipitation seen in 2022. Regardless, the 2022 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 storm event TP samples collected 7 out of 8 samples from LL_3 and 6 out of 10 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 in early May which corresponded with the largest rain event (Figure 4-19). This would have likely also occurred for station LL_3 but it was installed later in the year. In 2022, the average TDP concentration was just over the 2021 value of 0.106 mg/L across both stations. The OP average varied across the stations with LL_3 double the concentration (0.1 mg/L) of station LL_7 (0.053 mg/L) in 2022.

The average amount of TSS across 2022 was 180 mg/L for station LL_3 and 107 mg/L for LL_7. This is up from 76 mg/L for station LL_7 in 2021. Across all the sampling events, 6 out of 7 for LL_3 and 7 of the 10 samples taken in 2022 were above 30 mg/L TSS water quality standard for streams (Figure 4-19). From the limited Chl-a samples collected, concentrations at LL_7 averaged just above the MPCA standard with two out of three sampling events greater than the MPCA standard (<18 µg/L).

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. 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 cleanout 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 at the beginning of the year. 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. Staff will walk the upstream site to assess if any of the ravine is eroding significantly.

At the Staring Lake Road Purgatory Creek Crossing, total phosphorus levels were high compared to the MPCA standards, as seen in Figure 4-20 and Table 4-5. In Table 4-5, the average TP at that site on Purgatory Creek across four samples was 0.337 mg/L in 2022. This is nearly twice the average TP across 19 samples in 2021 (0.197 mg/L). This level is nearly four times the MPCA eutrophication water quality standard for class 2B streams (≤ 0.1 mg/L TP), but these measurements only include rain events. All four storm event TP samples collected measured above the MPCA stream standard. The highest TP concentration occurred on 7/23/22 (0.544 mg/L), which was up from 0.466 mg/L in 2021. In 2022, the average TDP concentration was 0.045 mg/L and the OP was 0.036 mg/L (0.043 mg/L and 0.029 mg/L in 2021).

The average amount of TSS across the four sampling events was nine samples taken was 99.3 mg/L which is double what was found in 2021 (52.9 mg/L). Across all the sampling events, samples taken in 2022 were above the MPCA water quality standard for streams which is 30 mg/L for TSS (Figure 4-21). It

Table 19. 2022 Purgatory Creek first flush auto sampling units average nutrient summary.

PARAMETER	Stormpond Name			MPCA WQS
	STL_17	LL_3	LL_7	
TP (mg/L)	0.337	0.505	0.424	≤ 0.1
TDP (mg/L)	0.045	0.117	0.108	--
OP (mg/L)	0.036	0.100	0.053	--
Chl-a (µg/L)	12.2	20.9	14.9	≤ 18
TSS (mg/L)	99.3	180.7	107.5	≤ 30

is important to note that these samples are targeted samples, representative of the initial flush of water and pollutants that occur during a rain event, and do not represent season-long pollutant levels in Purgatory Creek. With the low water levels, this site may have met the TSS, TP, and Chl-a stream standards if continuous monitoring and baseline sampling occurred. Therefore, a direct comparison to the MPCA stream standards is cautioned.

Overall, the limited precipitation in 2022 may have concentrated nutrients in Purgatory Creek and the Lower Purgatory Creek Recreational Area. These concentrations were likely transported downstream during the few rain events that occurred, which could explain the elevated levels seen in 2022.

Figure 25. 2022 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 Lotus Lake Upper Ravine downstream of Kerber Blvd (LL_3) and from 2021-2022 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).

PLACEHOLDER FOR 6 GRAPHS TO BE UPDATED

Figure 26. 2021-2022 Purgatory Creek/Staring Lake Road Phosphorus

The Total and Dissolved Phosphorus first flush concentrations (mg/L) from the Staring Lake Road/Purgatory Creek automated, level triggered, flow-paced auto sampling unit in 2021 and 2022. Precipitation data is from the Flying Cloud Airport. Dashed line represents the Minnesota Pollution Control Agency standard for TP (≤ 0.1 mg/L).

PLACEHOLDER FOR 2 GRAPHS TO BE UPDATED

Figure 27. 2021-2022 Purgatory Creek/Staring Lake Road Total Suspended Solids

The Total Suspended Solids first flush concentrations (mg/L) from the Staring Lake Road/Purgatory Creek culvert from a 2021-2022 automated, level triggered, flow-paced auto sampling unit. Precipitation data is from the Flying Cloud Airport. Dashed line represents the Minnesota Pollution Control Agency standard for TSS (≤30 mg/L).

PLACEHOLDER FOR 2 GRAPHS TO BE UPDATED

Figure 28. 2022 Purgatory Creek/Staring Lake Road Water Level

Figure 29. 2022 Kerber Blvd/Upper Lotus Lake Ravine Water Level

Figure 30. 2022 Carver Beach Road/Upper Lotus Lake Ravine Water Level

PLACEHOLDER FOR 3 GRAPHS TO BE UPDATED

4.8. Creek Restoration Action Strategy

Section needs update

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 4-6) and a CRAS Map (Exhibit H) 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 D 2022 Creek Seasonal Sonde & Flow Data and Exhibit F 2022 Stream Summary Table. 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 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 4-7, in our Fact Sheets on the District website (rpbcwd.org), and in (Exhibit H). 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 2022 (Riley Creek in 2021 and Bluff Creek in 2020). However, due to drought conditions samples were not collected. Biological monitoring can often detect water quality problems that water chemistry analysis misses or underestimates. Chemical pollutants, agricultural runoff,

Table 20. 2022 Creek Restoration Action Strategy Updates.

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

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. Purgatory macro collection will occur in 2023.

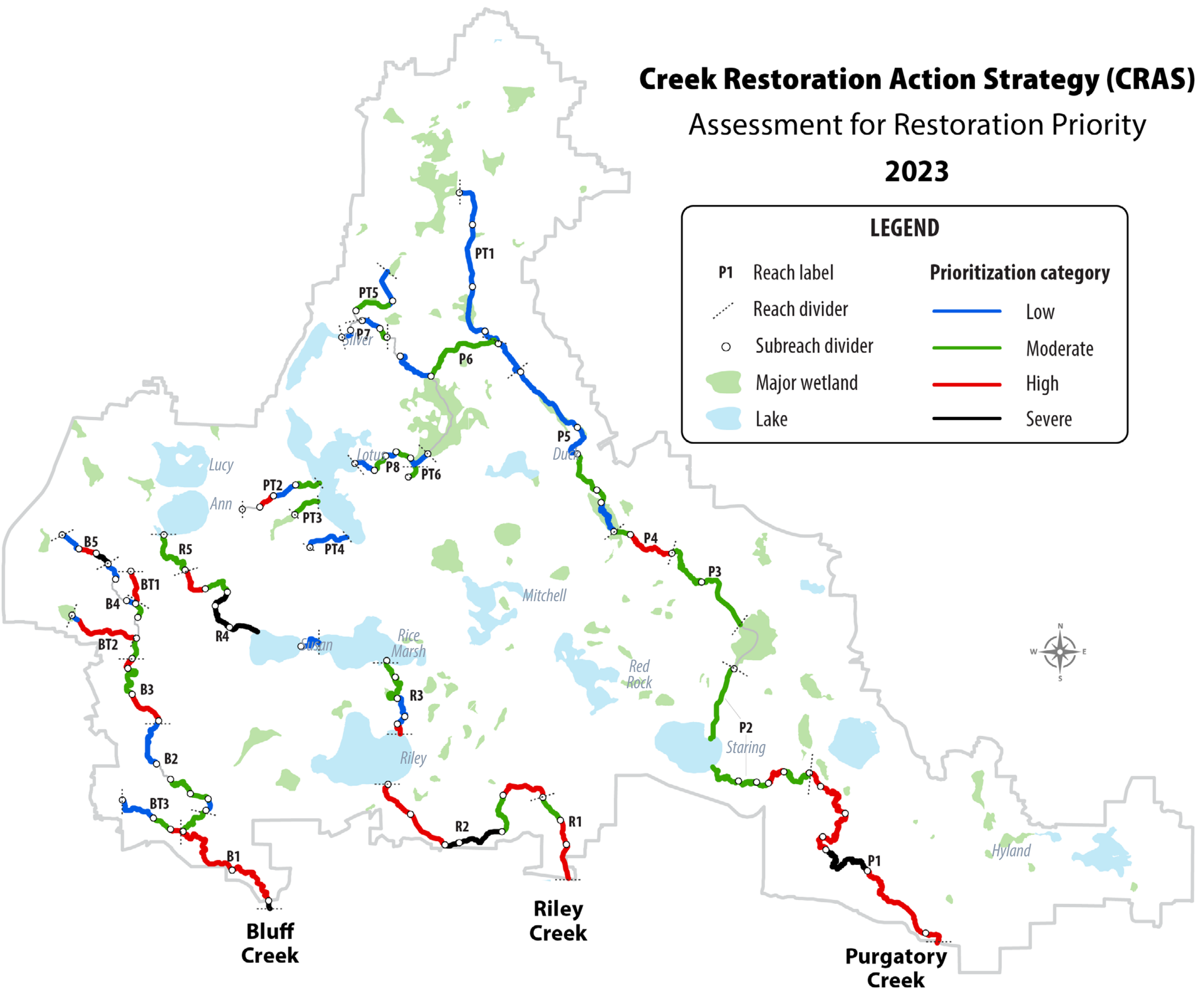
Staff will finish the assessment on Riley Creek next year and update accordingly. CRAS updates and potential additional monitoring for 2024 include:

- 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

Figure 31. Map of 2023 creek reach prioritization scores.



of the amount of exposed bank pin or sediment accumulation (if pin was buried) has been ongoing since 2016 (see Table 21). 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 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, reach 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 ft3). Due to the low water levels in 2021, 2022, and 2023, erosion appeared to be reduced across most sites.

Table 21. 2018-2022 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. Yellow highlighted 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

4.9. Zooplankton

Section needs update

Lake, and Staring Lake. Zooplankton plays an important role in a lake's ecosystem, specifically in fisheries and bio control of algae. The 2022 phytoplankton results were not available in time for this report.

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 fowl 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).

Lake Riley

In 2022, all three groups of zooplankton were captured in Lake Riley (Exhibit C). About 11% of the zooplankton captured were Cladocera, up from 6% in 2021 but down from 18% from 2020. Rotifers were the most abundant zooplankton sampled across all sampling events but the June sample. (Figure 4-25). In 2022, all zooplankton groups were at their highest levels in June and decreased throughout the year. The largest number of Copepods captured were Nauplii which are the larval stage of Copepods. Cladocera numbers were relatively high averaging 87 thousand across the year, while only averaging 17 thousand across the five sampling events in 2021. This temporal reduction through the year may be due to the continued excellent water clarity caused by alum treatment, which can lead to increased predation on zooplankton populations. Zebra mussels were discovered in 2018 which could also be contributing to the increase in water clarity and the removal of phytoplankton (a Cladoceran food source). The most numerous Cladocera found in Riley was Daphnia galeata mendotae, which are common in the northern part of the United States, especially in common in glaciated regions such as MN.

Cladocera consume algae and have the potential to improve water quality if they are abundant in large numbers. Due to the lower numbers of Cladocera in 2022, grazing rates were low across all sampling events. The maximum grazing rate of around 11% occurred in June and corresponded with the highest Cladocera numbers seen across the year.

Lotus Lake

In 2022, all three groups of zooplankton were present in Lotus Lake (Exhibit C). Rotifers were the most abundant zooplankton sampled making up 61% of the total zooplankton captured in 2022, which was the same as 2021 (Figure 4-26). Copepod numbers were relatively stable across sampling events averaging 281 thousand after the June sample which was 734 thousand. Cladoceran populations were stable from June through August (average 155 thousand) before bottoming out in September at 24 thousand. The most common Cladocera were Daphnia galeata mendotae in the spring and Daphnia

Figure 32. 2021 & 2022 Lake Riley Zooplankton Counts (#/m²).

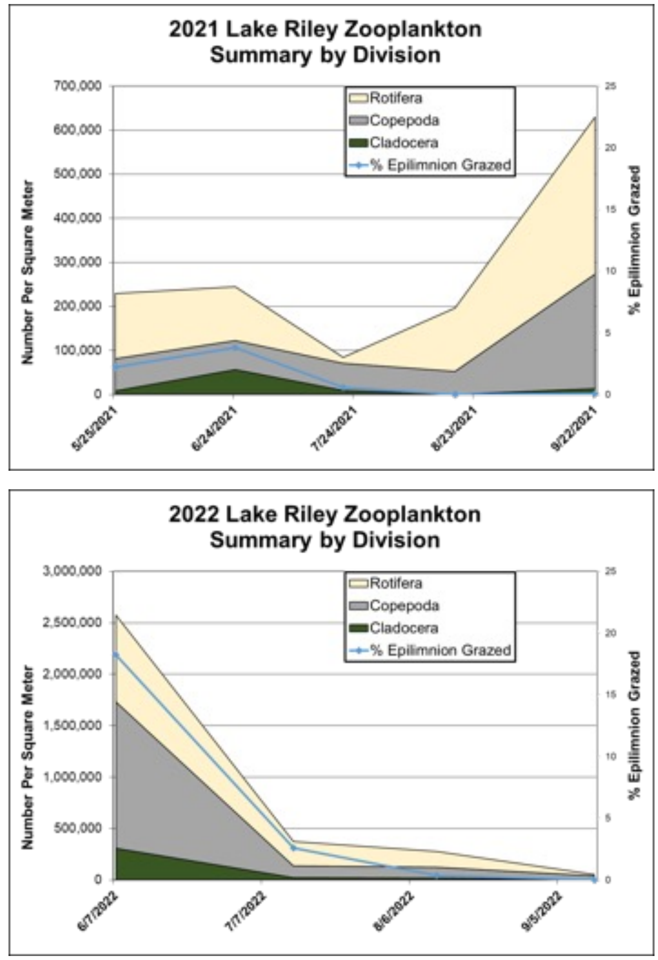
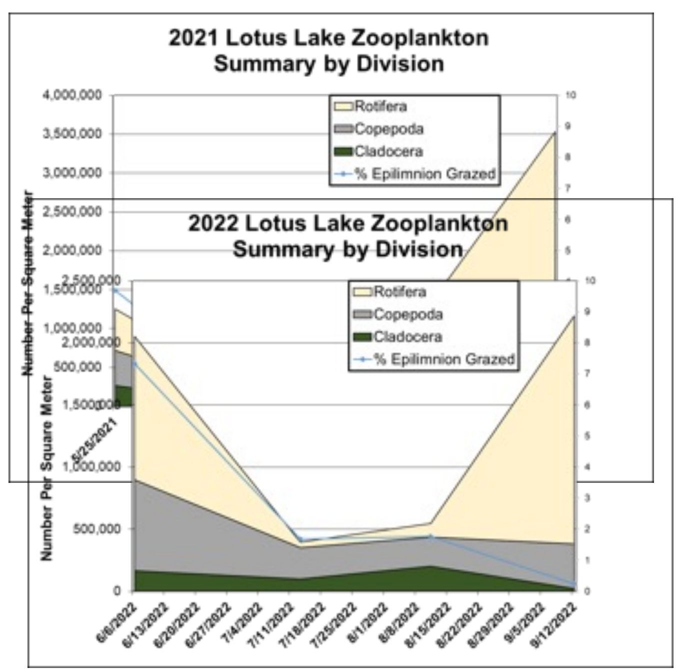


Figure 33. 2021 & 2022 Lotus Lake Zooplankton Counts (#/m²).



retrocurva in August. Daphnia retrocurva is known for its large, curved helmet it develops in late spring-to-summer to reduce predation by planktivorous fish and invertebrates.

Large Cladocera consume algae and, if enough are present in a lake, they have the potential to improve water quality. The estimated epilimnetic grazing rates in ranged from 6% to 19% in 2018, near 0% to under 5% in 2019, and were near 0% in 2020. In 2021, grazing rates increased, ranging from 0% to 4% (Figure 4-26.) and further increased to 0% to 7% in 2022

Lake Susan

In 2022, Copepoda were the most abundant zooplankton captured in Lake Susan (Exhibit C). The Copepoda population was variable with the highest level occurring in August at 1.26 million and the lowest the following month at 85 thousand. Except for a smaller population in June (117 thousand), the rotifer population was relatively stable across the remaining sampling events averaging 491 thousand (Figure 4-27). Overall, Cladocera numbers comprised 21% of the total zooplankton captured. This is up from 2021 which was 11.6%. The highest Cladocera population recorded in 2022 was in June when Daphnia galeata mendotae were captured in high numbers. Daphnia galeata mendotae are common in the northern part of the United States, especially in common in glaciated regions such as MN.

The estimated epilimnetic grazing rates upon algae in 2018 ranged from 0% to 11%. They were around 1% in 2019 and 2020. In 2021 and 2022, grazing rates were less than 1% across all sampling dates. This is due to the limited number of Cladocera present in all the samples collected.

Rice Marsh Lake

In 2022, all three groups of zooplankton were captured in Rice Marsh Lake (Exhibit C), of which 42% of the population was comprised of Cladocerans. This number is up from 24% in 2021, 17% in 2020, 8% in 2019, and 13% in 2018. Rotifers were not the most abundant zooplankton sampled in 2021 and 2022 (Figure 4-28). Rotifer numbers were over 300,000 in the spring and fall, while numbers dwindled during the peak of summer.

Figure 34. 2021 & 2022 Lake Susan Zooplankton Counts (#/m²).

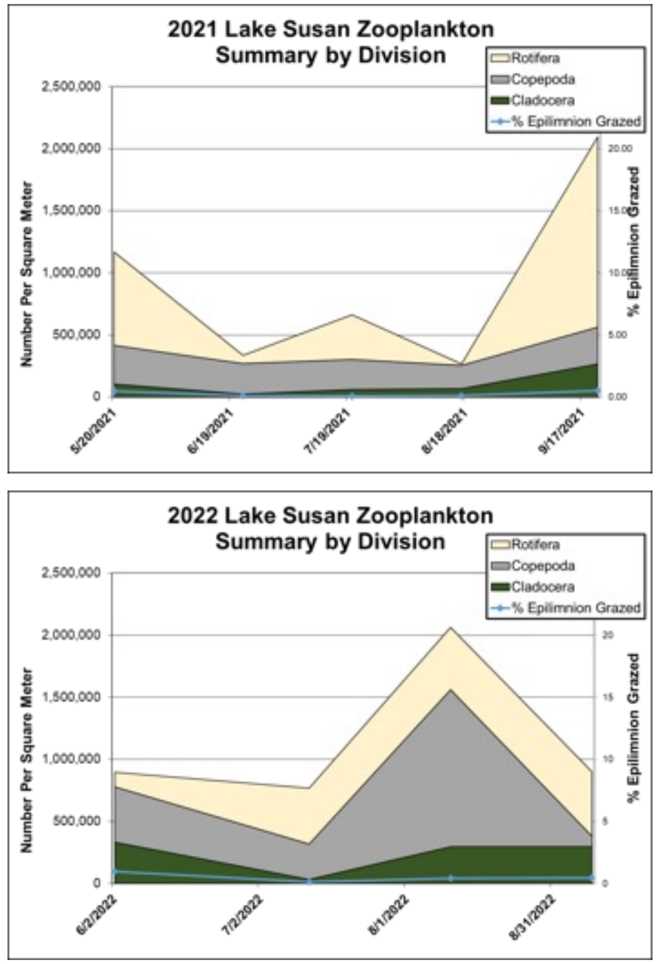
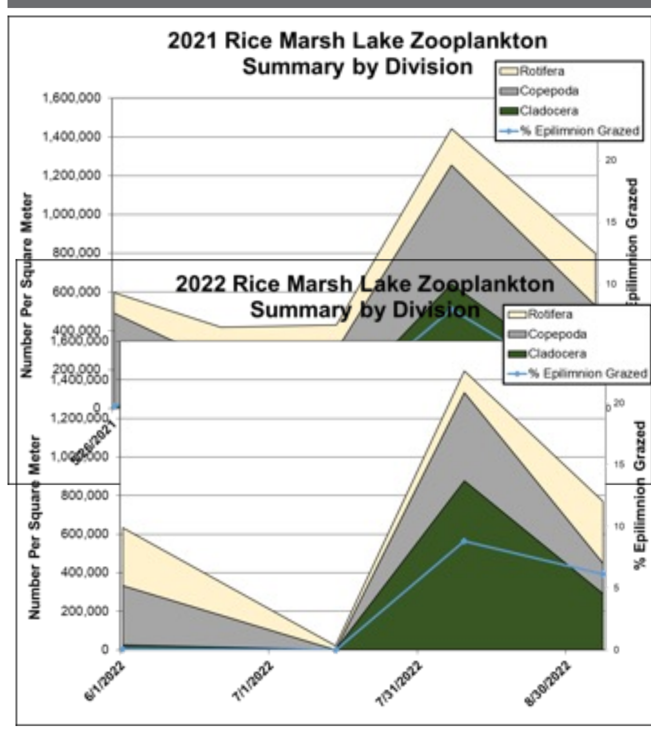


Figure 35. 2021 & 2022 Rice Marsh Lake Zooplankton Counts (#/m²).



Copepod densities were highly variable across the year with the highest density in August at 458 thousand. Across all sampling dates the Cladoceran community was dominated by small-bodied zooplankton consisting mainly of *Bosmina longirostris*, *Ceriodaphnia* sp., and *Chydorus sphaericus*.

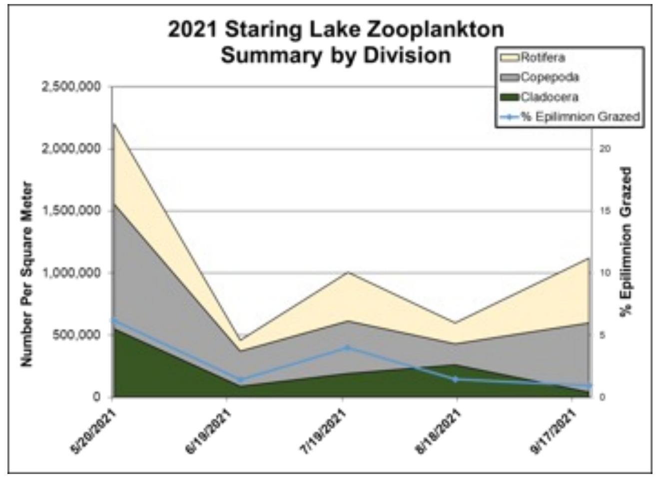
The estimated epilimnetic grazing rates of Cladocera ranged from near 0% to 23% in 2018, 2% to 39% in 2019, 0 to 11 % in 2020 and 0 to 8% in 2021 (Figure 4-28). In 2022, the highest August grazing rate of 6% was linked with the highest density of smaller Cladocerans and the presence of the larger bodied *Diaphanosoma leuchtenbergianum*.

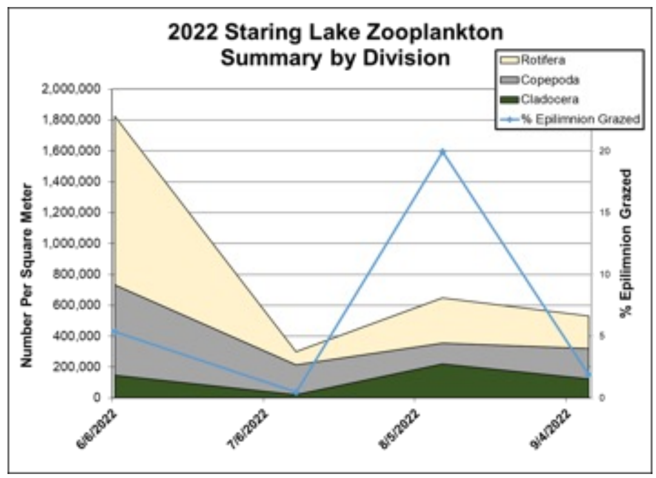
Staring Lake

In 2022, all three groups of zooplankton were present in Staring Lake (Exhibit C). Similar to 2019 through 2021, the 2022 June sampling event had the highest number of organisms present (Figure 4-29). In 2022, rotifers were highly variable across the year with the highest abundance occurring in June at 1.09 million. The dominant Rotifer species was *Keratella cochlearis*, which occurs worldwide in virtually all bodies of water whether fresh, marine, or brackish. Copepod numbers were also highly variable and comprised 48% of the total zooplankton abundance across the year. Cladocera species made up 16% of the total zooplankton population and averaged 129,000 across the year. In 2021 they made up 23% of the zooplankton and averaged 253,000. In 2020, the Cladocera population was lower, averaging only 75,000. In 2022, the Cladocera population was highest in August (221,000) and lowest in July (21,000). The most abundant Cladocera were *Bosmina longirostris* which are common in ponds and lakes throughout the continent.

Large Cladocera consume algae and may have the potential to improve water quality when present in high densities. The estimated epilimnetic grazing rates ranged from 2% to 24% in 2018, 1% to 4% in 2019, 0% to 1.4% in 2020, and 1 to 6% in 2021. Grazing rates increased in 2022, ranging from 0% to 20%.

Figure 36. 2021 and 2022 Staring Lake Zooplankton Counts (#/m²).





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

Section needs update

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 4-30). 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

Figure 37. Spent Lime Treatment System

out of the spent lime system, leaving the phosphorus behind.

Figure 38. Spent Lime Treatment System

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 4-31 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 appears 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 where generally higher the larger the content of spent lime in the mixture (Figure

4-32).

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 5-hour periods. In 2021, the unit was brought online 5/14/2021 and allowed flow on Mondays, Wednesdays, and Fridays for 7-hour periods. This schedule was also followed in 2022 after the unit was started on 5/26/2022. 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 4-33). The average TP reduction in 2021 was 40% (Figure 4-34). 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 4-9). 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.

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

Figure 39. Pool Sand/Spent Lime Mixture Column Testing Phosphorus Removals

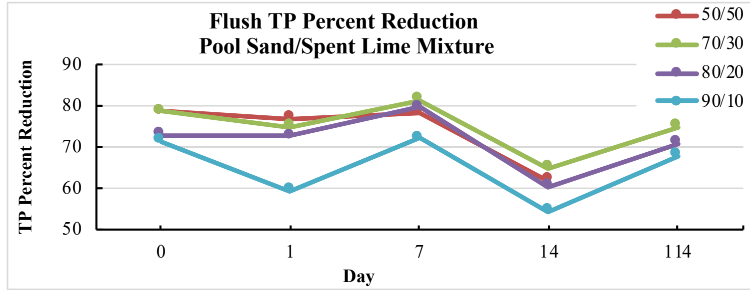


Figure 40. 2020 Lake Susan Spent Lime Treatment System Total Phosphorous Percent Reduction

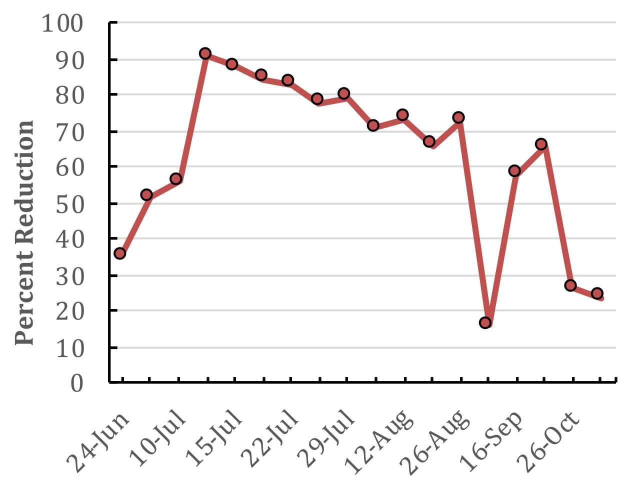
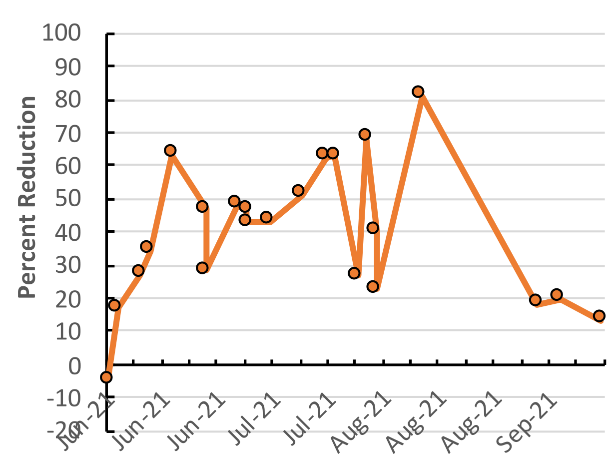


Figure 41. 2021 Lake Susan Spent Lime Treatment System Total Phosphorous Percent Reduction



media from compacting over time and to break up preferential flow paths within the BMP. The long dry period in 2022, may also increase system performance in 2023. 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 22. 2020-2022 Average TSS and Nutrient Percent Removals from the Spent Lime Treatment System

Analyte	2020	2021	2022
TDP (mg/l)	50	37	6
TP (mg/l)	62	40	16
TSS (mg/l)	46	28	48
OP (mg/l)	59	51	1
CHLA (mg/l)	53	55	25

*Actual values - only one sample collected in 2022 due to drought.

4.11. 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 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 is limited persisting snow to block 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 4 1 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 wholes which formed on Silver Lake. The District operates only a single aeration unit on Rice Marsh Lake which was operating all year in 2023 but 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

Table 23. 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

	LUCY			STARING			RICE MARSH			DUCK		SILVER
	Sample dates			Sample dates			Sample dates			Sample dates		Sample dates
Depth (m)	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									
6.5		1.36										

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, 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 similar 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.

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 there in order 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 MN DNR in 2021 and was likely stocked again by the DNR. Bluegill stocking rates can be seen in Table 4 11. Figure 4 43 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 2023.

Figure 42. 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.

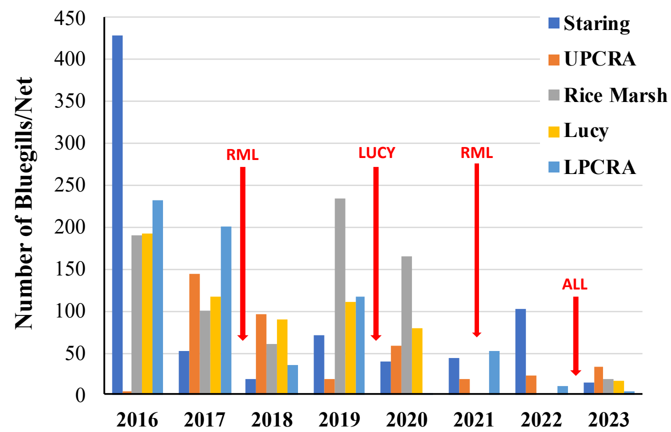


Table 24. 2018-2023 Bluegill Stocking Numbers

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	20	0	0	0	0	0
TOTAL	2,020	1,000	0	1,000	0	1,000

5: AQUATIC INVASIVE SPECIES

Section needs update

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 5-1). 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 exist in RPBCWD waterbodies, but to be an early detection tool for new infestations of AIS. Figure 5-1 identifies AIS monitoring/management that occurred in 2022, excluding common carp management.

Figure 43. 2022 Aquatic Invasive Species Summary

Aquatic Invasive Species (AIS) work conducted in 2022 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.

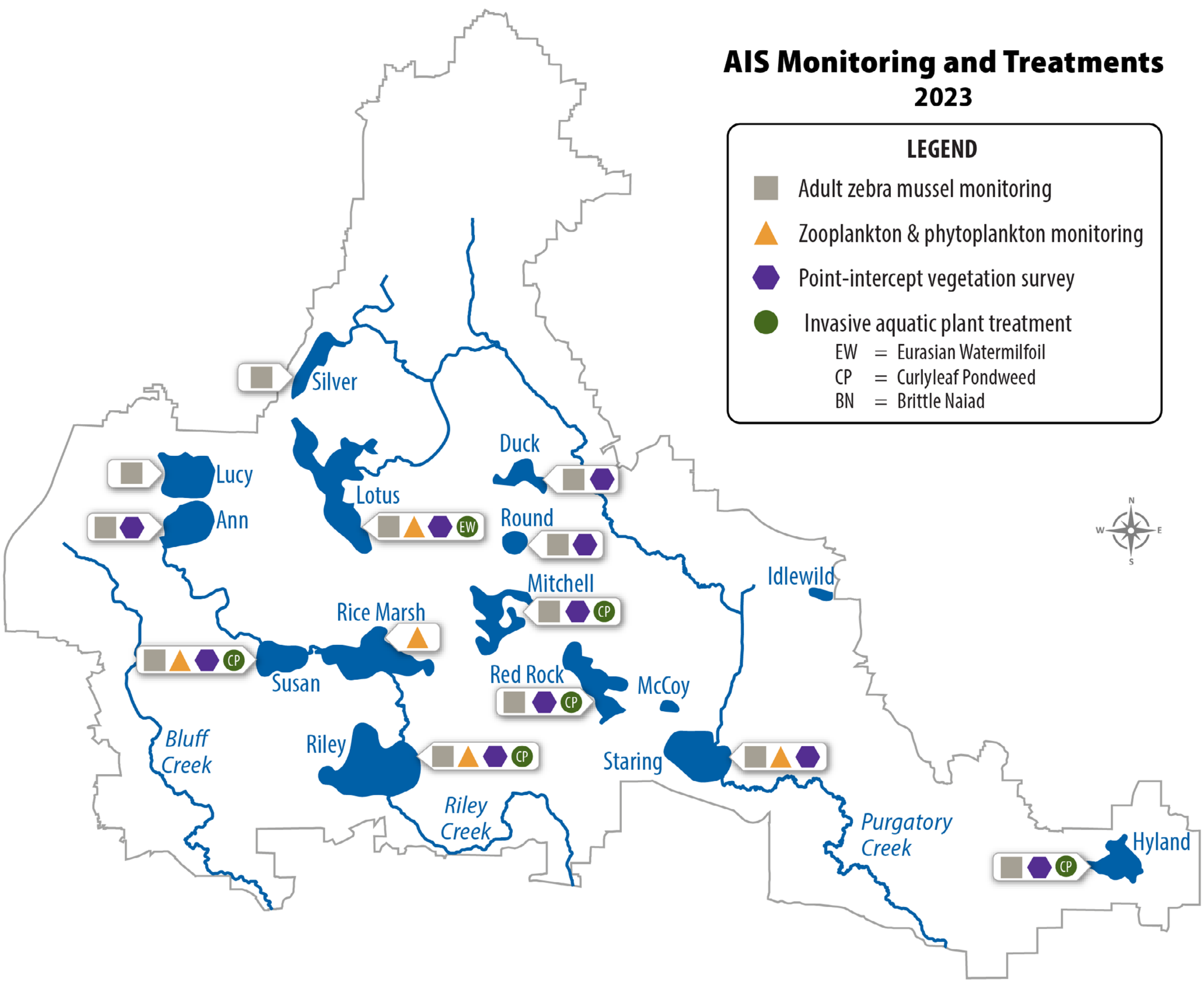


Table 25. Aquatic Invasive Species Infested Lakes

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

✓ Indicates new infestation

5.1. Aquatic Vegetation Monitoring & Management

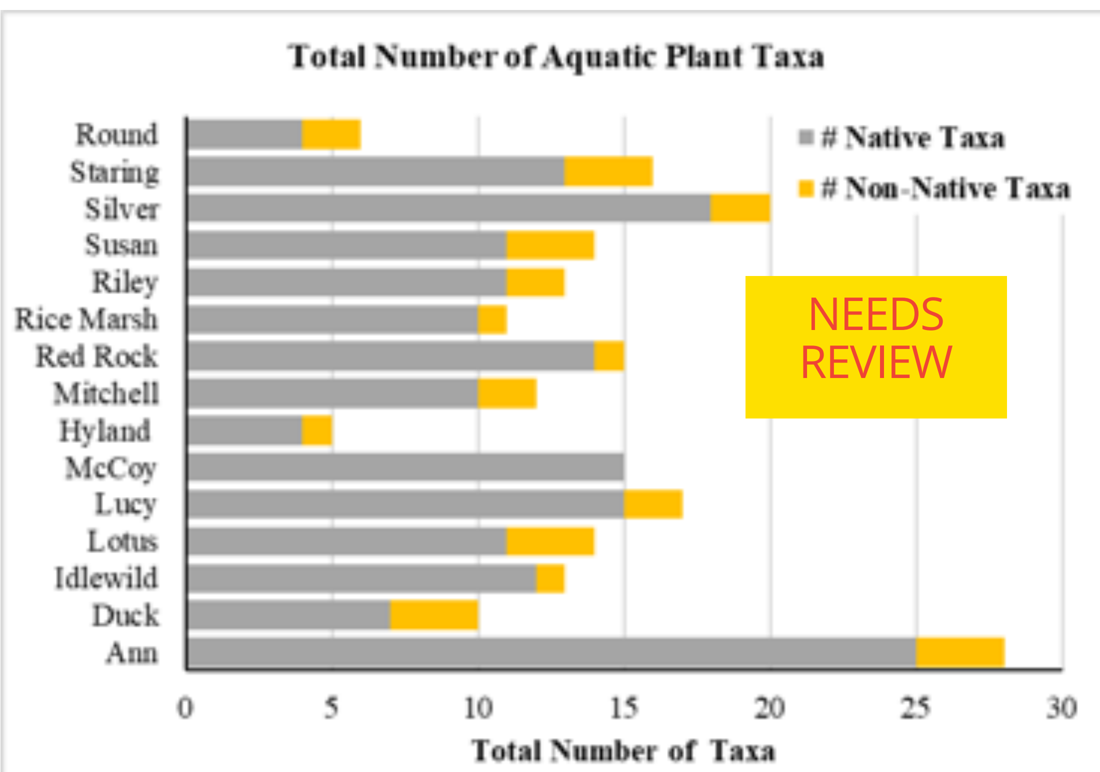
Section needs update

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), Lotus Lake, Duck Lake, Silver Lake, and Lake Ann (District). Aquatic plant reports can be provided upon request. Figure 5-2 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 for 25 species) which is followed by Duck with 19 species. Most lakes have between 10-15 species of native plants with Hyland and Round with the least native plant diversity (4 species). The District will continue to monitor the aquatic plant communities

Figure 44. 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 Curlyleaf 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.
- **LOTUS:** A late summer point-intercept survey indicated that the percent littoral area vegetated has declined since the 2017 and 2019 surveys. Coontail was the most common native plant species while Eurasian Watermilfoil has been steadily increasing since 2017.
- **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 9% in 2023 and 1% in 2020 to 13% in 2023.
- **MITCHELL:** Coontail was the dominant plant in Mitchell Lake and was found growing at 54% of the sites. The number of species observed at each site ranged from one to six species with the most occurring in the northeast arm.
- **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:** In June, 13 species were observed, 11 that were native. In August, 12 species were observed, 10 that were native. Due to the lake management in and around the lake, native plants have steadily increased in frequency of occurrence and have been able to expand into deeper depths because of the increased water quality. A Curlyleaf Pondweed turion survey in 2022 showed a slight increase in the number of turions in the lake. Turion densities remained low indicating the success of the herbicide treatments.
- **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.

Table 26. Lake Vegetation Monitoring and Management in 2023.

Species delineated for treatment included Curlyleaf 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

- **STARING:** In 2022, the herbicide Fluridone was used to treat Eurasian Watermilfoil and was successful. Unfortunately, the reduced vegetation from the treatment combined with the low water levels led to reduced water quality. Nutrient levels should decline as native vegetation expands across the lake. A Curlyleaf Pondweed turion survey in 2022 yielded no turions, indicating the herbicide treatment was effective.
- **SUSAN:** Native plant frequency of occurrence and number of species remained low due to poor water quality. The number of projects planned for the lake along with projects already in the ground should improve the lake. A Curlyleaf Pondweed turion survey in 2022 showed a similar number of turions as seen in 2020 (35).

In the spring of 2023, herbicide treatments were carried out by PLM Lake and Land Management Corporation and Midwest AquaCare (Red Rock Lake) on District lakes. Curlyleaf 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 I. Both Eurasian Watermilfoil and Curlyleaf Pondweed were targeted with a single treatment on Lotus Lake (22.92 acres). The herbicide fluridone was used for the first time in the District and was part of a study to evaluate its effectiveness. This collaborative study between the University of Minnesota, Minnesota Department of Natural Resources, and the District involved the submission of water samples to test the time the herbicide was in the water and intensive pre- and post-point intercept surveys of the area to gauge control of the Curlyeaf Pondweed and any damage to native plants. The herbicide appeared to be very effective at controlling Curlyleaf Pondweed while minimizing native plant damage. A MNDNR Traditional AIS Control Grant in the amount of $3,000 was awarded and utilized for the Lake Riley Diquat treatment for Curlyleaf 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 26 and Exhibit I.

Mitchell Lake Turion Survey

In 2023, District staff completed a Curlyleaf Pondweed turion survey on Mitchell Lake. Turions are the primary reproductive structure of Curlyleaf 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 Curlyleaf 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 27.

Table 27. 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

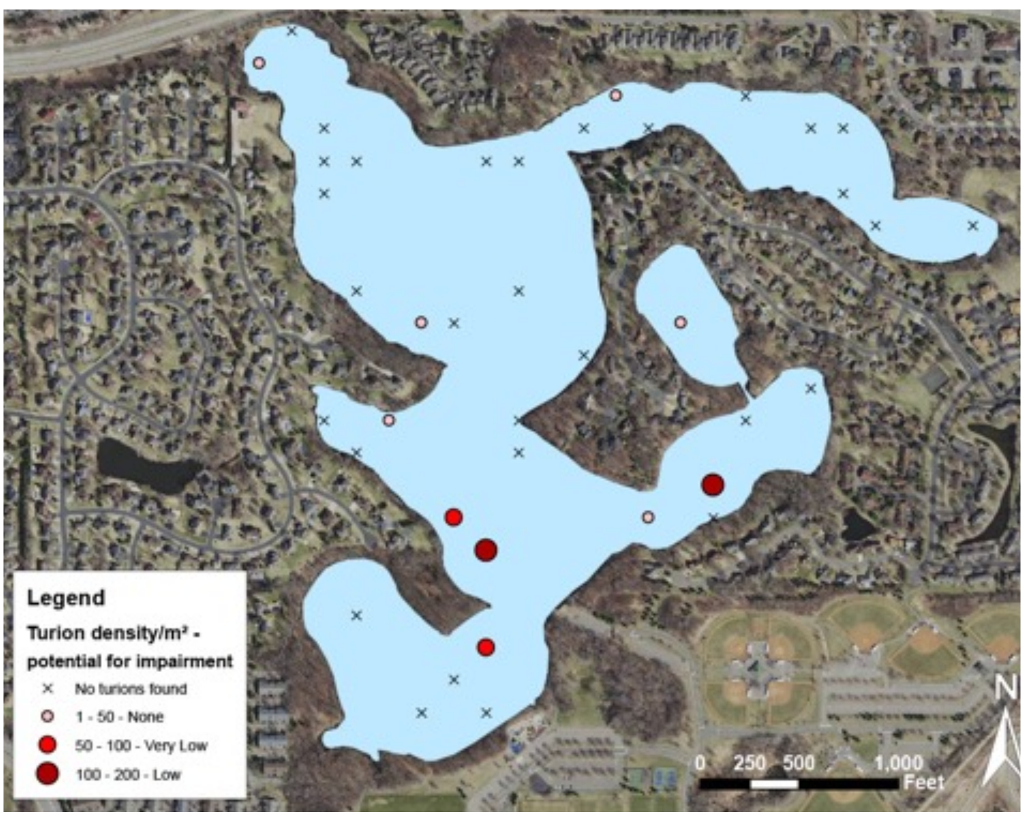
Table 28 summarizes the results from the 2023 Mitchell Lake turion survey. During the October 5, 2023, survey, District staff found 17 total CLP turions; 6 of 40 points had live turions (25% occurrence). In the 2021 survey, District staff found 17 total CLP turions; 10 of 53 points had live turions (19% 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 45).

The overall mean density within the study areas was 17.24 turions/m² with a standard deviation of 11.04 turions/m² 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/m²). 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, and 2021. 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/m² (Figure 5). District staff will continue to monitor the CLP pondweed on Mitchell Lake to assess if treatment is needed moving forward.

Table 28. Mitchell Lake turion survey results (2013-2021)

Date	Turions/m²	Viability	Viable Turion Density (turions/m²)
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 45. 2023 Fall Mitchell Lake CLP Turion Survey Density and Distribution



5.2. **Common Carp Management**

Section needs update

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 5-4).

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

Table 29. Electrofished Common Carp 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**

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.

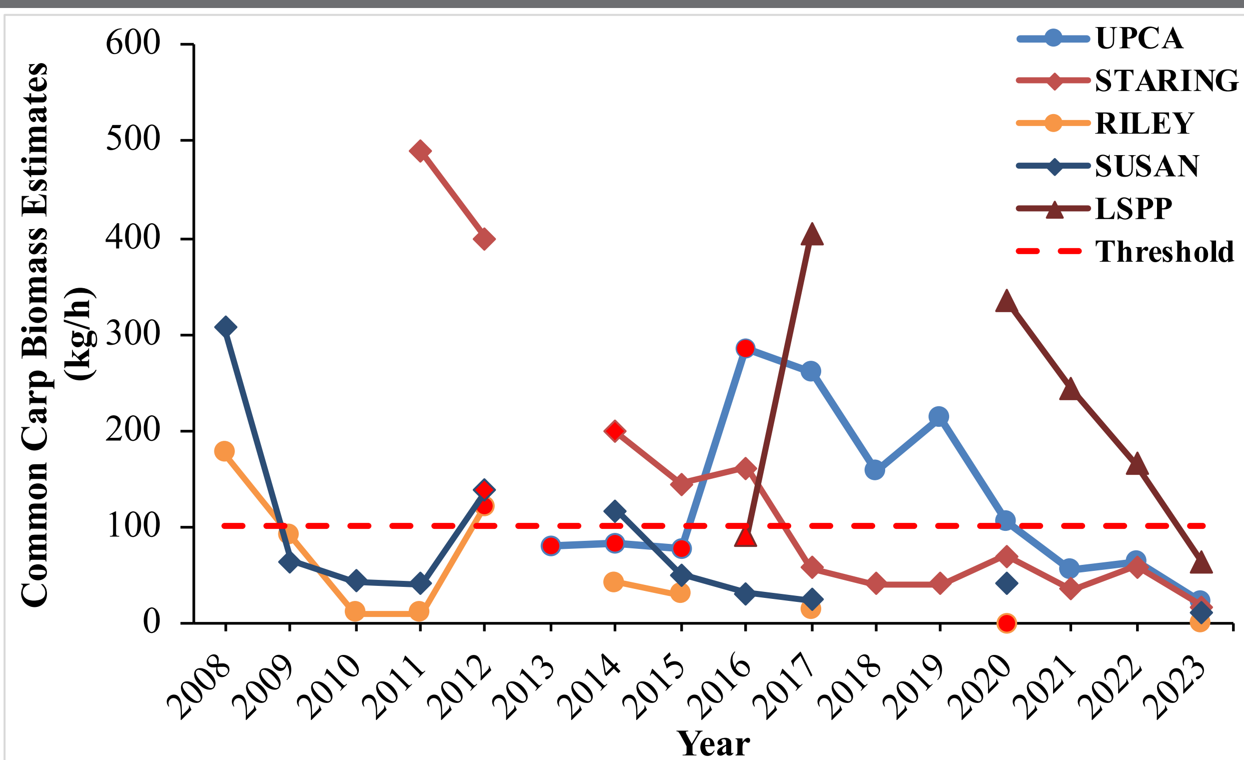
In 2023, a total of 107 YOY carp were captured via trap net surveys. Of the 107 YOY found in fyke nets, 92 were captured in the LPCRA, and 15 were found in Staring Lake. The abundance of YOY carp found in trap net surveys combined with 55 YOY carp found electrofishing on Staring indicates a full recruitment 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 5-5). 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 5-6), 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 (Figure 5-6). 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 5-5). 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 system

Figure 46. Common Carp Biomass Estimates (2008-2023)



and fish migrating between the systems. 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 30. 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

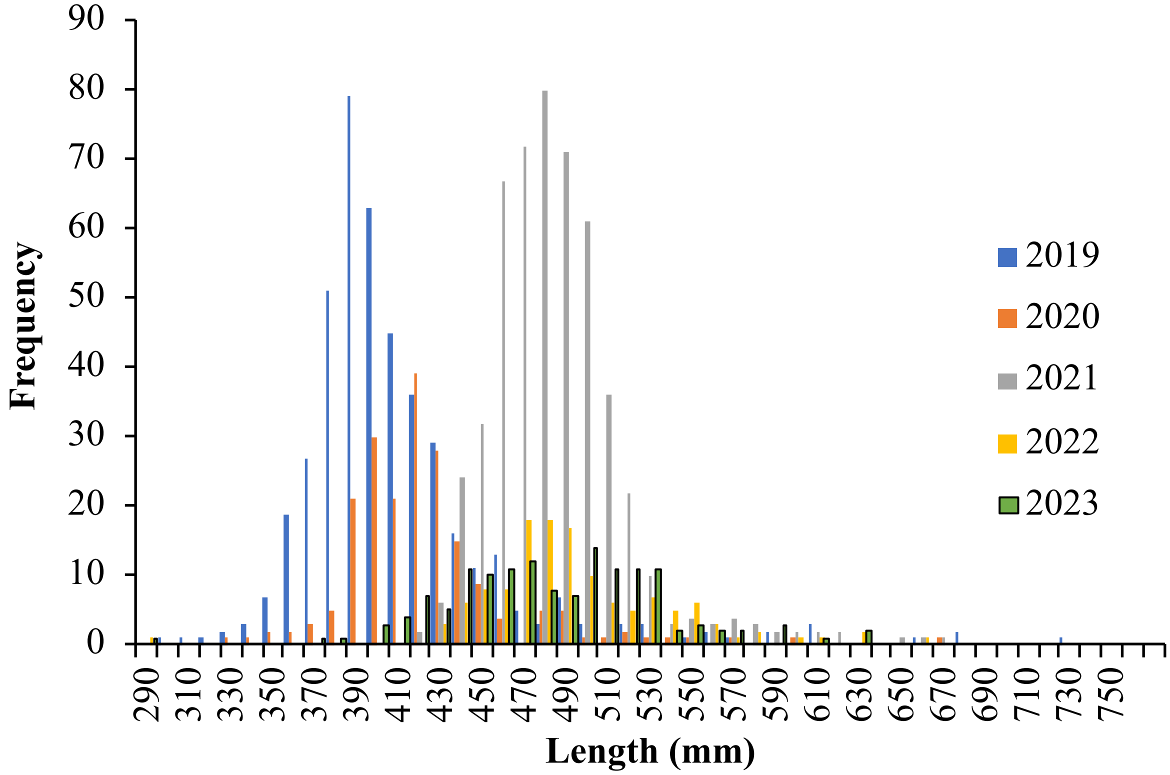
PCRA Spring Removals

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. Twice the barrier opened for an extended period (2 weeks) in late on April 11th-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 5-7). 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. It is also assumed 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,

Figure 47. Length Frequency of PCRA Spring Removals (2019-2023).



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 5-8). 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 19th, 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 7th, 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.

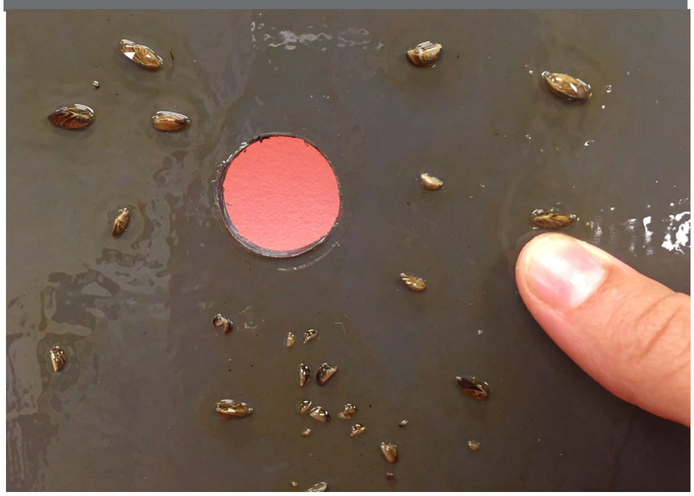
5.3. **Zebra Mussels**

Zebra Mussels (*Dreissena polymorpha*) are native to Eastern

Section needs update

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 mMussels from a lake once they are introduced.

Figure 48. A range of Zebra Mussel sizes have been found on monitoring plates.

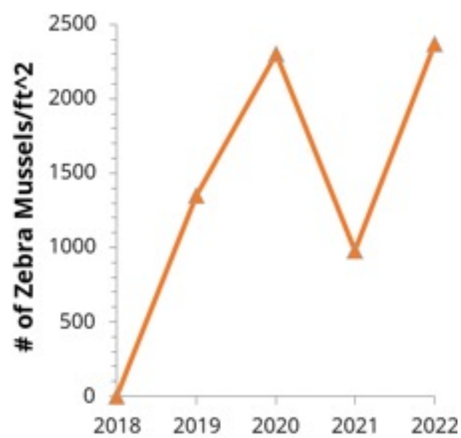


The District continued to monitor for adult and veliger Zebra Mussels in 2023. The District conducted veliger sampling from June to July on 13 lakes and a wetland to detect the presence of Zebra Mussels. Each lake was sampled once, apart from Lotus Lake and Lake Ann which were sampled twice. Kylie Cattoor processed the samples and only found Zebra Mussel veligers on Lake Riley in 2023. Adult Zebra Mussel presence was assessed using monitoring plates 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 water quality sampling period. 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 searched. During the 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, Ann, and Susan. Both Lotus and Ann tested positive for eDNA. Carver County veliger testing also yielded veligers on Lotus Lake

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. This

Figure 49. Zebra Mussel density on Lake Riley in 2018-2022.



indicates a robust population that is well established across the lake. The increase in 2022 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).

Lotus Lake

Figure 50. Zebra Mussel map on Lotus Lake in 2019.

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 5-1). 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 5-1). 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 the 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. Thousands of desiccated mussels were found on a lift on shore near where the mussels were found in 2019 during the fall survey, but none were found in the lake or elsewhere. The eDNA results for 2022 was the first negative result since 2019 when mussels were found for Lotus Lake. Staff will continue to monitor for Zebra Mussels in 2022.

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 31 lists the different variables associated with Zebra Mussels measured by the District in 2022 for Lake Riley and for Lotus Lake. The criteria in Table 31 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. The estimated calcium concentrations in Lotus Lake and Lake Riley were similar to actual calcium concentrations collected from all other lakes in the Riley Chain. 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 both lakes. The nutrient variables for Lake Riley were at moderate to high levels for zebra mussel suitability. Lotus Lake nutrient data indicates minimal growth parameters for Zebra Mussels. 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 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. 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 both lakes included predominantly rock and woody debris and is hypothesized to not be limiting for Zebra Mussels.

Based on the results in Table 31 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 31 indicates that in Lotus Lake a slow growing or restricted population limited by minimal growth nutrient levels.

Table 31. Suitability of lake conditions to support a robust and expansive Zebra Mussel poputlation.

	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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APPENDIX

TABLE OF CONTENTS for Appendix TO BE CREATED LATER

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Appendix H: 2023 Creek Restoration Action Strategy (CRAS)

Appendix I: 2023 Curlyleaf Pondweed & Eurasian Watermilfoil Treatment Areas

Appendix J: Lake & Creek Fact Sheets

APPENDIX D

RIILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

DRAFT

Version **1/19/2024**

2023 Regulatory Program Update

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 E

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

DRAFT
Version 1/19/2024

2023 Wetland Update

Zach Dickhausen, *Natural Resources Coordinator*

rpbcwd.org

Introduction

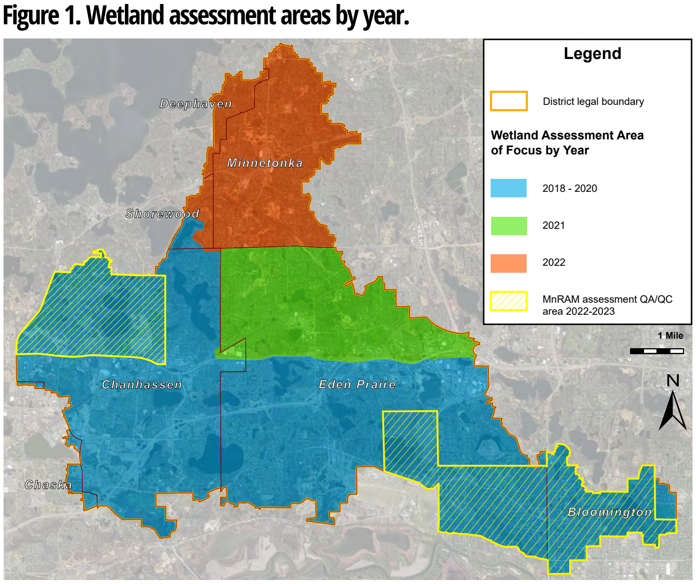
In 2023 , the District staff re-assessed a total of 72 wetlands using the District's modified Minnesota Routine Assessment Method (MnRAM) and the Rapid Floristic Quality Assessment (Rapid FQA). Staff also conducted wetland re-assessments in the southeast part of the District. This included areas around 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 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

Figure 1. Wetland assessment areas by year.



such as size, water depth, soils, topography, vegetation type, buffer widths, wildlife habitat, and human impacts including structures, wetland alterations, and wildlife migration barriers.

Barr updated the Microsoft Access Database version of the MnRAM worksheet for the District to use in its wetland assessment. This modified version MnRAM worksheet allows staff to input more details about wetlands and their functions. 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 approach is based on a C-value assigned to each plant species by Minnesota botanical experts. The higher the C-value, the

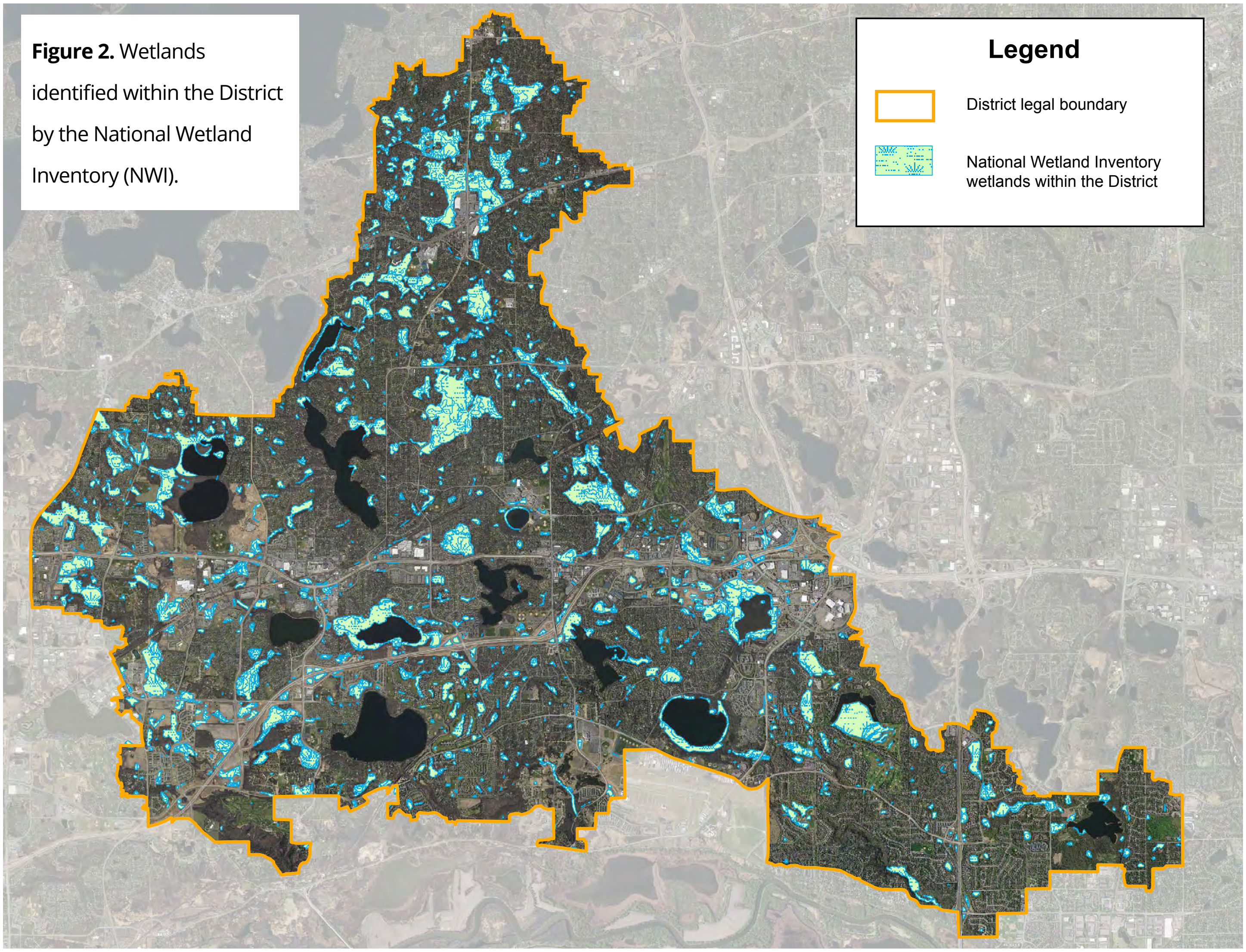


Figure 2. Wetlands identified within the District by the National Wetland Inventory (NWI).

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 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. Staff are currently focusing on five ecosystem services: nutrient cycling, community resilience, biodiversity, habitat, and recreation/cultural resources.

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?

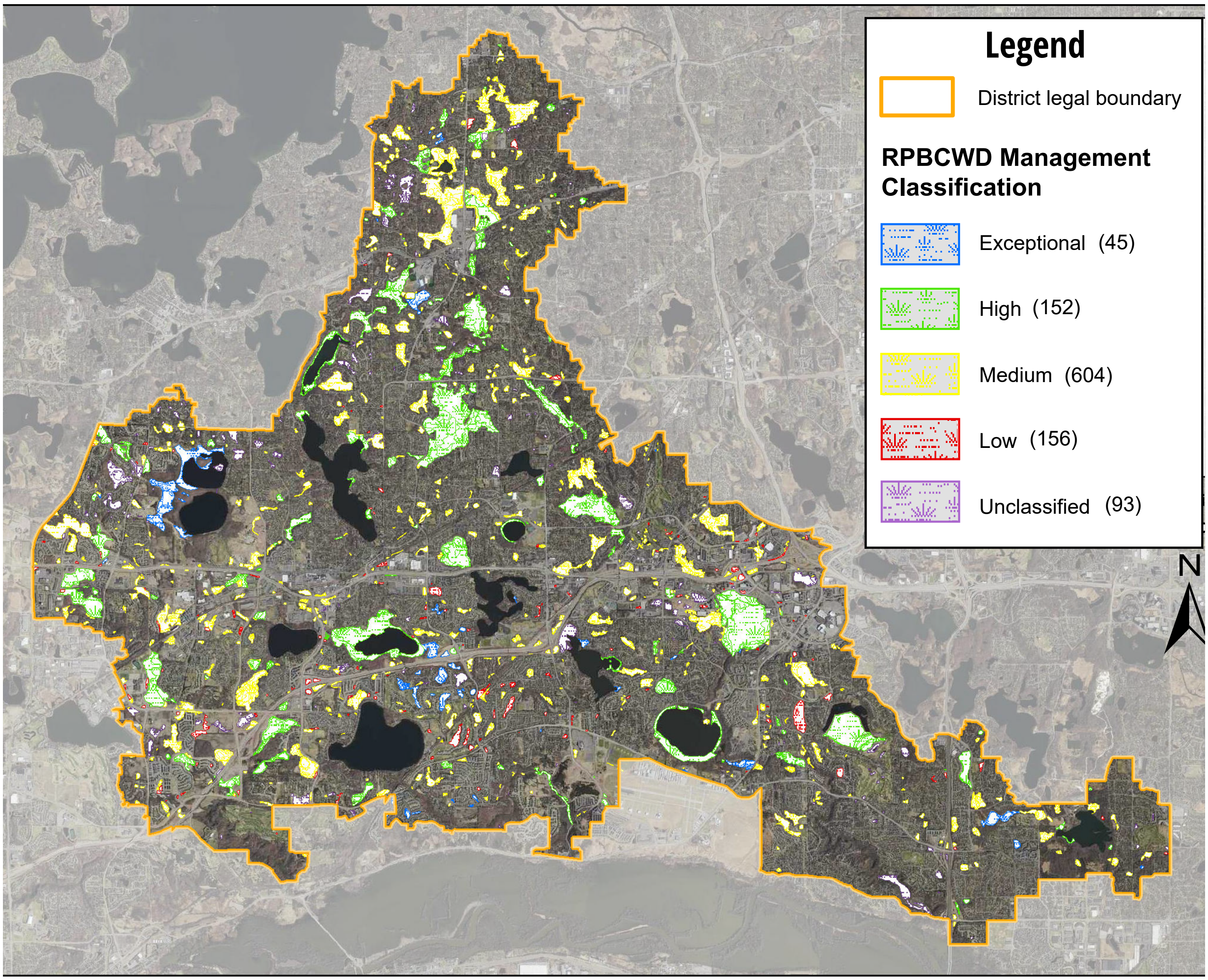
Metrics have been developed for each of these services, which, along with data gathered from the updated MnRAM and FQA assessments, determine the assignment of District management classifications to wetlands. These classifications include low, medium, high, or exceptional value wetlands. Management efforts 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. Distribution of wetland classifications in the District.

Classification	Quantity
Exceptional	45
High	152
Medium	604
Low	156
Unclassified	93
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

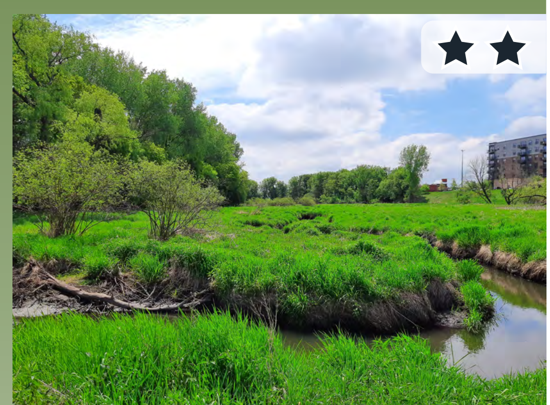
Wetland has large buffer area or buffers shoreline. High plant diversity. Little or no alteration of soils and plants. Water quality is good. Provides fish and/or amphibian habitat. Significant recreational, educational and/or cultural value.

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

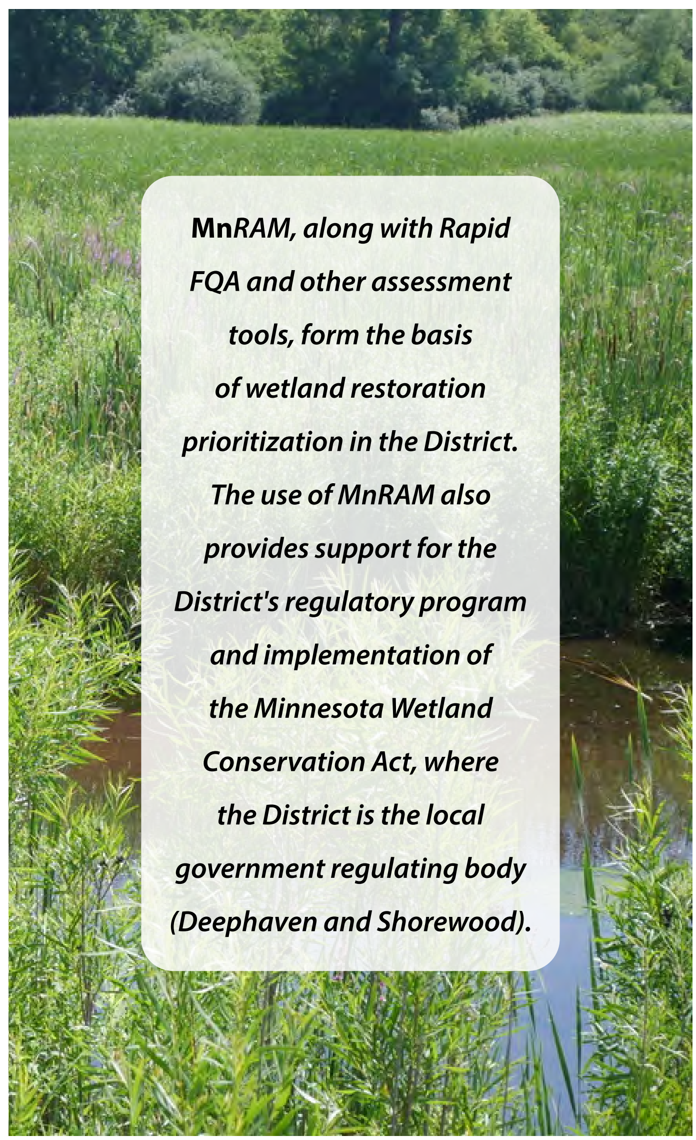
Associated with agricultural or high-intensity land use. Very low species diversity and dominated by invasive species. Poor water quality, usually due to high inputs of untreated stormwater runoff. Has alteration or excavation. Little or no recreational or cultural value.

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 these wetlands with a more accurate biodiversity and vegetation community value, as well as better provide guidance for prioritization of wetlands to consider 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 occur within that watershed. Many replacement plans for wetland loss occur in other areas of the state. 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 improves these functions and values within the watershed.

The first step in identifying high priority wetlands to be restored, rehabilitated and/or protects has been completed. 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 Barr staff, can start identifying groups of wetlands which could be classified as higher priority for restoration, rehabilitation and/or protection. Special wetlands types such as calcareous fens or tamarack swamps will be set aside as automatic candidates for rehabilitation and/or protection. The majority of wetlands to be chosen for restoration/rehabilitation/protection will 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 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 possible 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 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

District staff remain in contact with MN DNR staff about beta testing of the tool when it becomes available.

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 participated 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 F

APPENDIX G

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

2023 Grant Program Update

DRAFT
Version **1/18/2024**

Liz Forbes, *Communications Manager*

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.

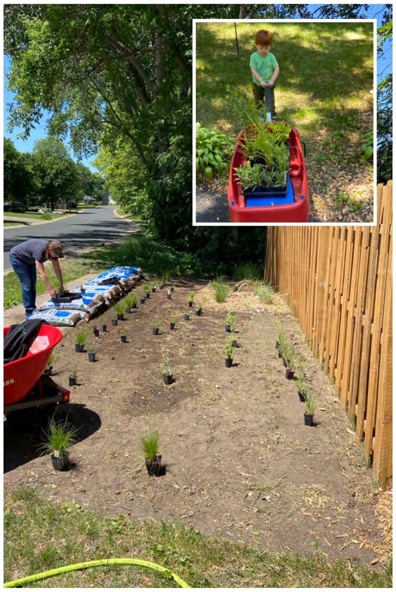
ACTION GRANT

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

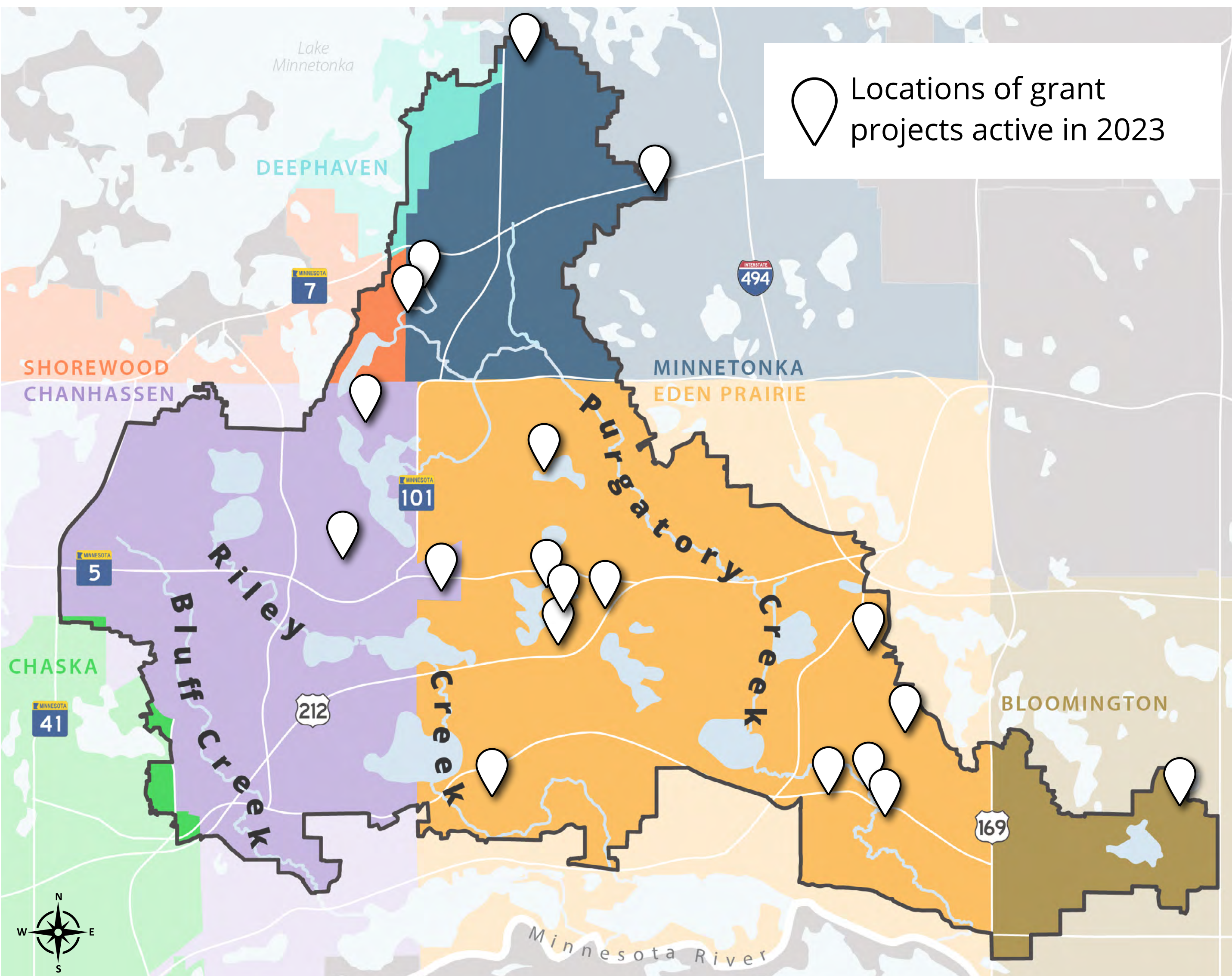
Depending on the type of project/location, you are required to to maintain your project for 5 years or 10 years.

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.

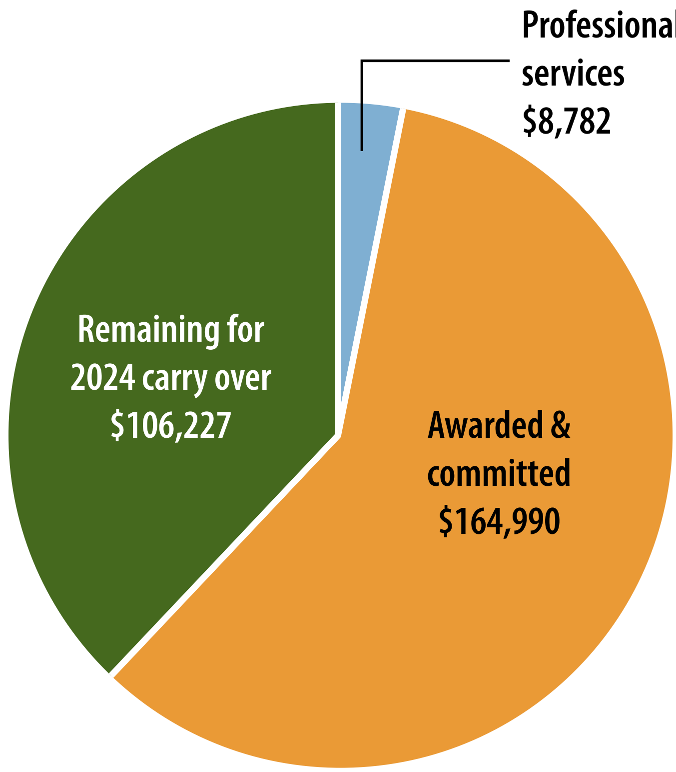
Who were the grantees?		Where were they from?		What kind of project did they do?	
Homeowners	12	Eden Prairie	11	Habitat restoration	10
Non-profits	4	Chanhassen	3	Shoreline resto/buffer	3
Municipality	2	Minnetonka	4	Native planting	4
Business	1	Bloomington	1	Other BMP	2



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 H

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

DRAFT

Version 1/19/2024

2023 Education & Outreach Update

Eleanor Mahon, *Community Engagement Coordinator*

rpbcwd.org/events

OVERVIEW

There are many ways to have an impact on clean water, and we can't do it alone. The District's Education & Outreach program aims to support the goals outlined in the 10-Year Plan by fostering an engaged community and offering opportunities for involvement. This document provides an overview of the ways the Education & Outreach program continued to provide opportunities for stewardship and build a network of engaged residents.

EVENTS

Annual Summit

Water Resources Manager Josh Maxwell hosted the RPBCWD Annual Summit for partner organizations in March 2023. The summit provides an opportunity to share monitoring results, planning efforts, and identify partnering opportunities.

Lake Association Summit

Fifteen representatives from seven lake associations attended the 2023 Lake Association Summit at the RPBCWD office in April 2023. 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.

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 Stats:

- 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

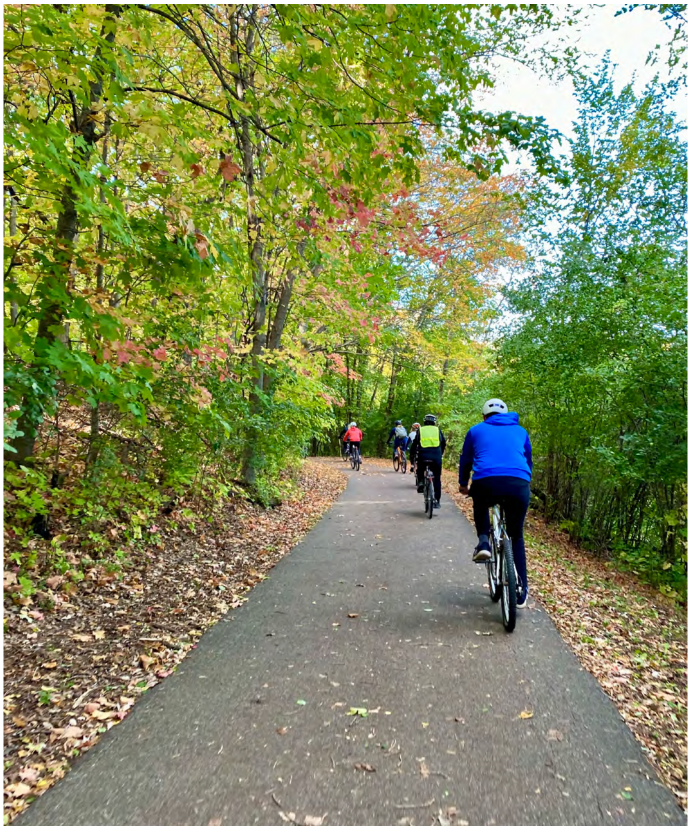


Image from Cycle the Creek event held on October 7, 2023.

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.

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	None

COMMUNITY ENGAGEMENT

In 2023, District staff participated in 13 community engagement events with various audiences.

Staff tabled at:

- 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

Staff engaged with youth audiences at:

- Cedar Ridge Elementary School Science Night
- Eden Prairie Outdoor Center Animal Open House
- Prairie View Elementary School Watershed Presentation & Art Contest
- St. Hubert Prairie Planting
- 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

COMMUNICATIONS

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, updates on projects, 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 currently posts content on three social media platforms including Facebook, Instagram, and Twitter under the username @rpbcwd. Through interactions and on handouts, the District encourages residents to follow District social media accounts.

APPENDIX I

RIPLEY PURGATORY BLUFF CREEK
WATERSHED DISTRICT

2023 Soil Health Plan Update

DRAFT
Version 1/19/2024

Zach Dickhausen, *Natural Resources Coordinator*

rpbcwd.org

INTRODUCTION

The purpose of the Soil Health Investigation Plan is to direct and guide District staff and their partners as they work to establish and develop the Soil Health Program as a branch of the Ecosystem Health Action Plan (EHAP). Through this plan, staff are establishing a set of soil health indicators to sample within the District. The goal of said sampling is to establish baseline soil conditions across a variety of landscape-use types, 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 during the fall of 2022 and the 2023 field season. Apparent trends in said data across different landscape-use types and soil types is also discussed.

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 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.

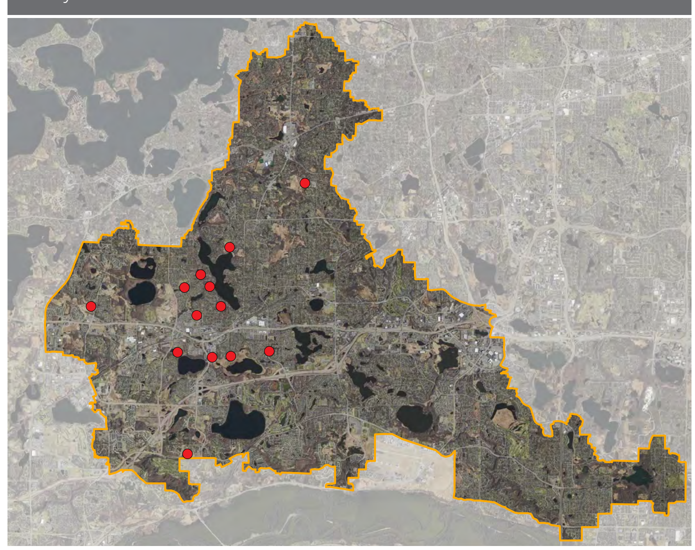
SAMPLE SITES/POINTS

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. Sub samples 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 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.

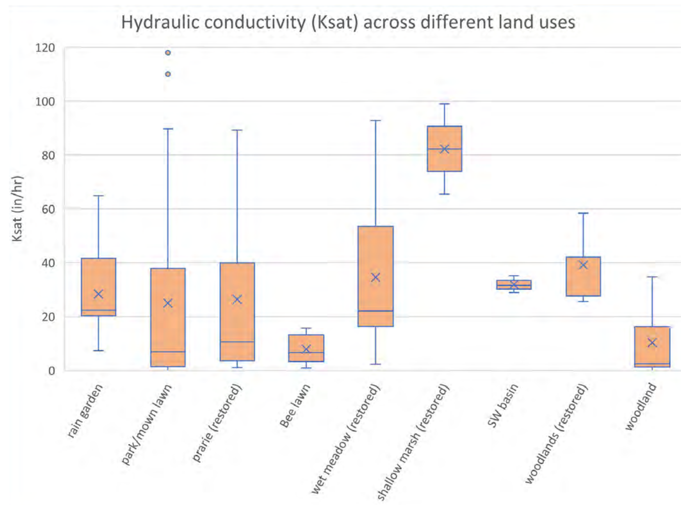
Table 2. Number of successful infiltration tests conducted in 2022-2023 and their associated landscape type.

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 (vegetated 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. To date, the District has received lab reports from 24 samples. 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 (four of the 11 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 (two high and one medium score) 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 11 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 (four of the 11 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 low, if not the lowest, scores across most of the indicators sampled

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
LL_3	Meadow Green Park, s. 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

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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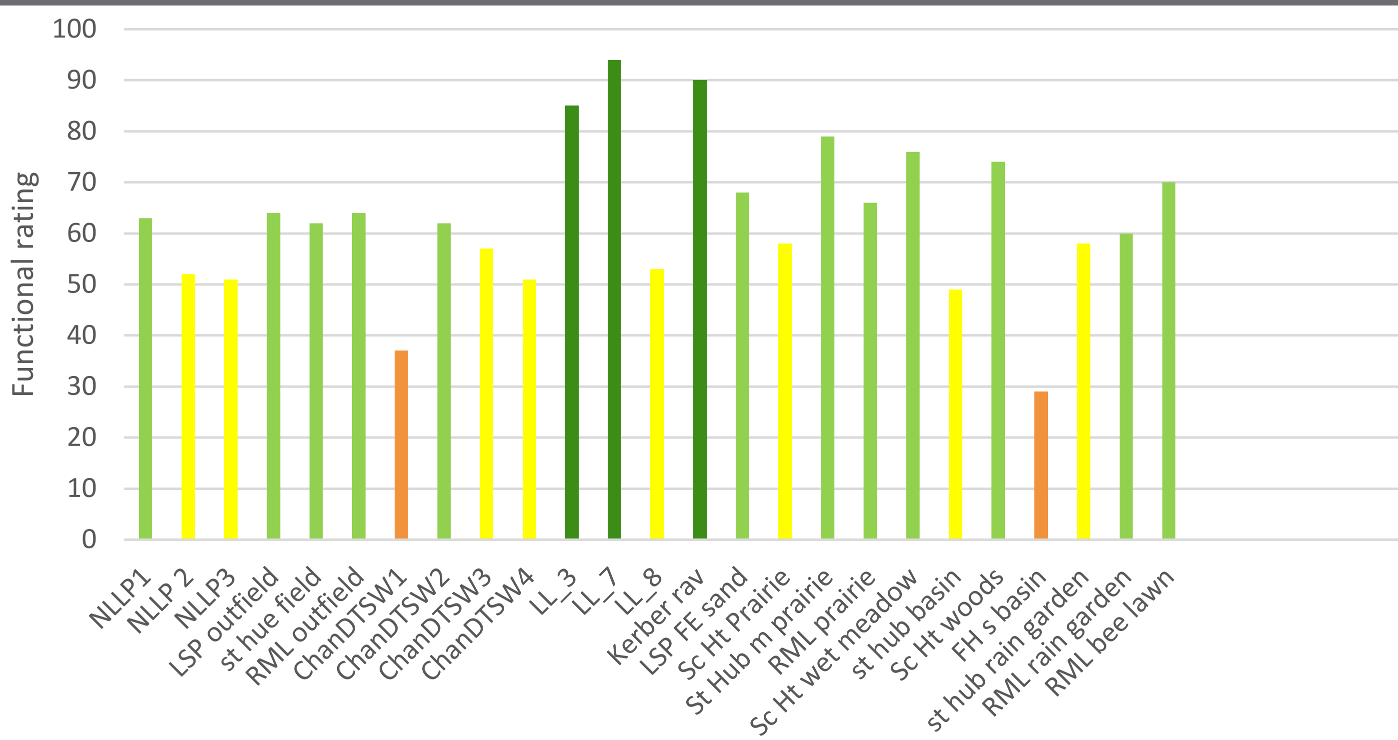
Figure 5. Overall quality score of soil samples taken.

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.



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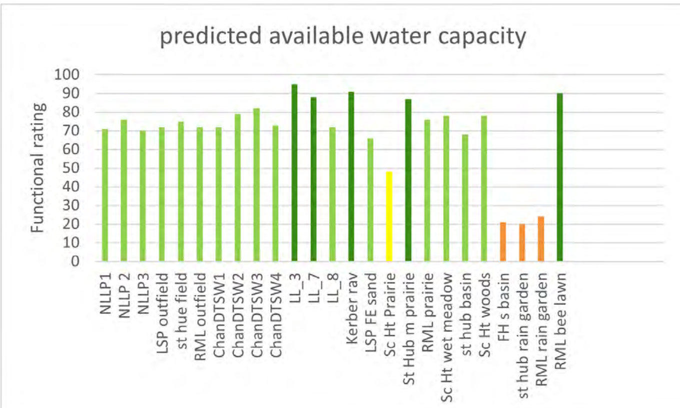
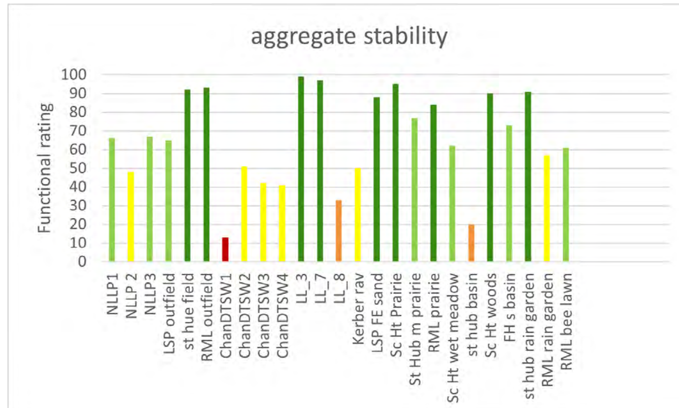
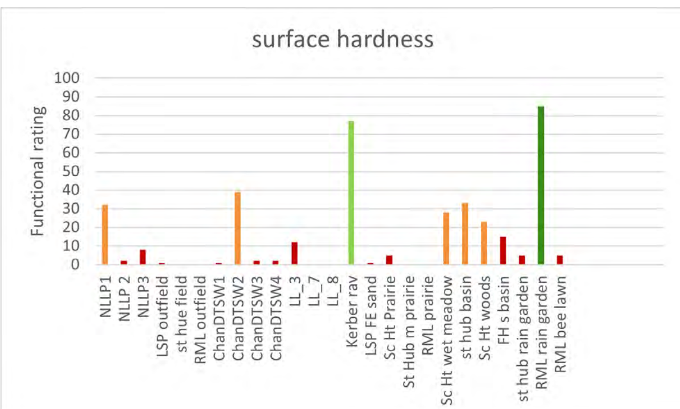
APPENDICES

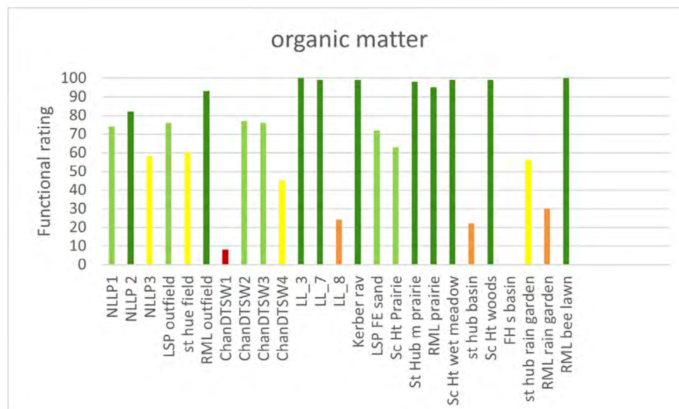
APPENDIX A

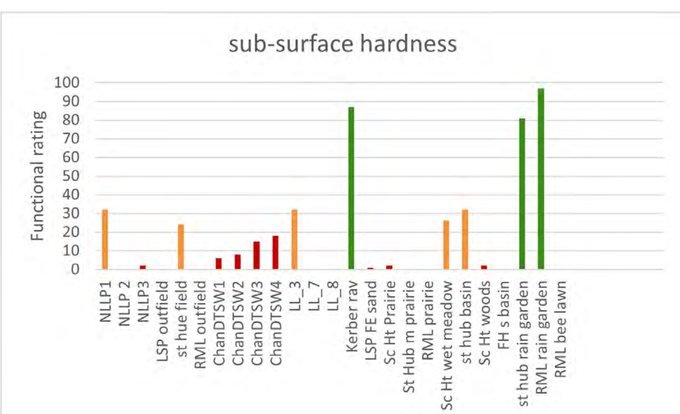
Comprehensive assessment of soil health indicator function/health ratings across all sites sampled.

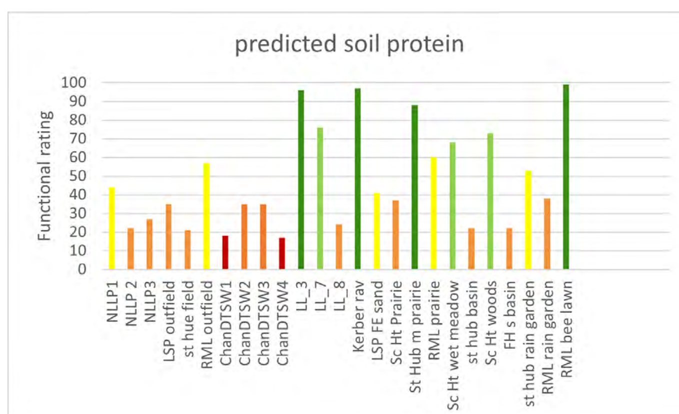


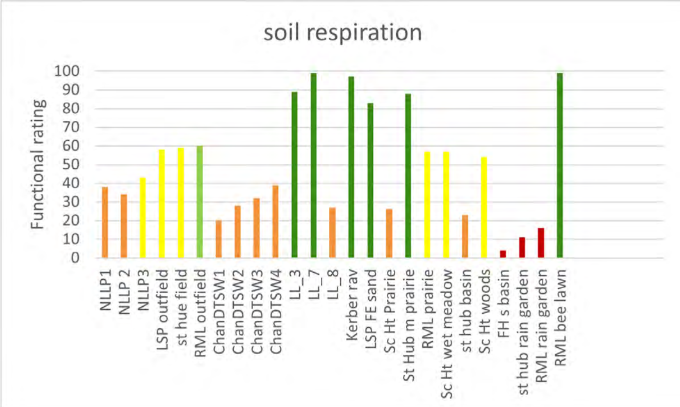


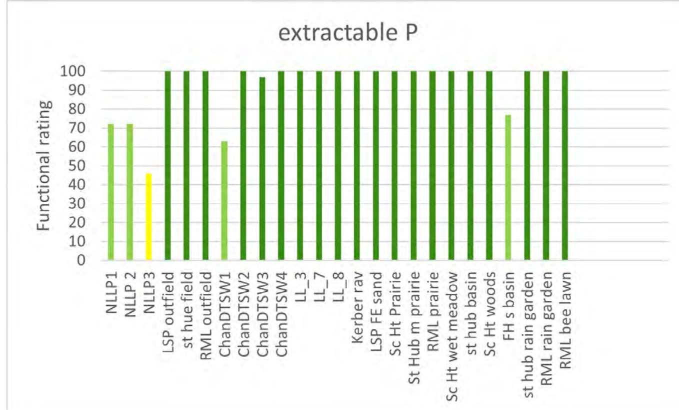









soil respiration
Functional rating
NLLP1
NLLP 2
NLLP3
LSP outfield
st hue field
RML outfield
ChanDTSW1
ChanDTSW2
ChanDTSW3
ChanDTSW4
LL_3
LL_7
LL_8
Kerber rav
LSP FE sand
Sc Ht Prairie
St Hub m prairie
RML prairie
Sc Ht wet meadow
st hub basin
Sc Ht woods
FH s basin
st hub rain garden
RML rain garden
RML bee lawn


extractable P
Functional rating
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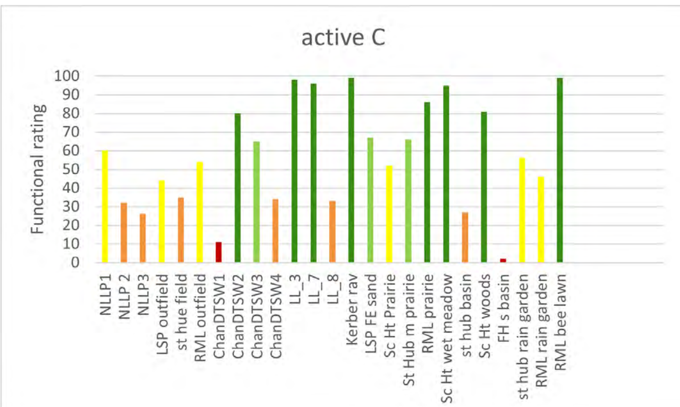
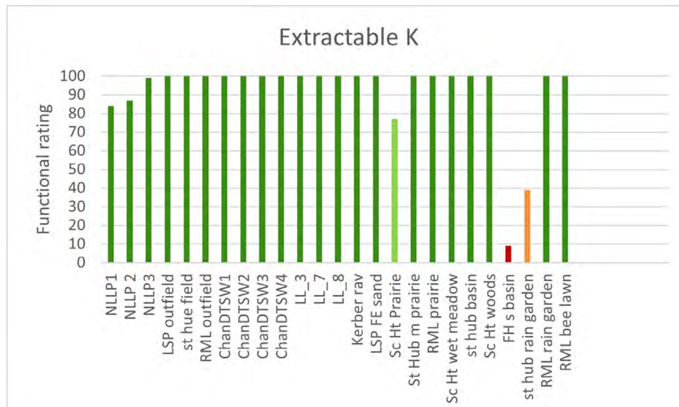
NLLP 2
NLLP3
LSP outfield
st hue field
RML outfield
ChanDTSW1
ChanDTSW2
ChanDTSW3
ChanDTSW4
LL_3
LL_7
LL_8
Kerber rav
LSP FE sand
Sc Ht Prairie
St Hub m prairie
RML prairie
Sc Ht wet meadow
st hub basin
Sc Ht woods
FH s basin
st hub rain garden
RML rain garden
RML bee lawn


active C
Functional rating
NLLP1
NLLP 2
NLLP3
LSP outfield
st hue field
RML outfield
ChanDTSW1
ChanDTSW2
ChanDTSW3
ChanDTSW4
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


Extractable K
Functional rating
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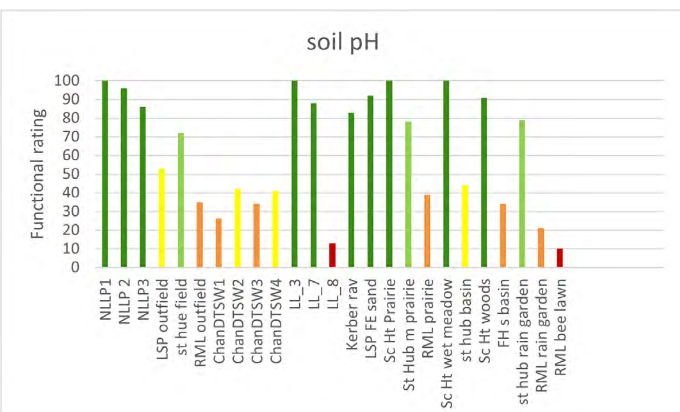
NLLP 2
NLLP3
LSP outfield
st hue field
RML outfield
ChanDTSW1
ChanDTSW2
ChanDTSW3
ChanDTSW4
LL_3
LL_7
LL_8
Kerber rav
LSP FE sand
Sc Ht Prairie
St Hub m prairie
RML prairie
Sc Ht wet meadow
st hub basin
Sc Ht woods
FH s basin
st hub rain garden
RML rain garden
RML bee lawn


soil pH
Functional rating
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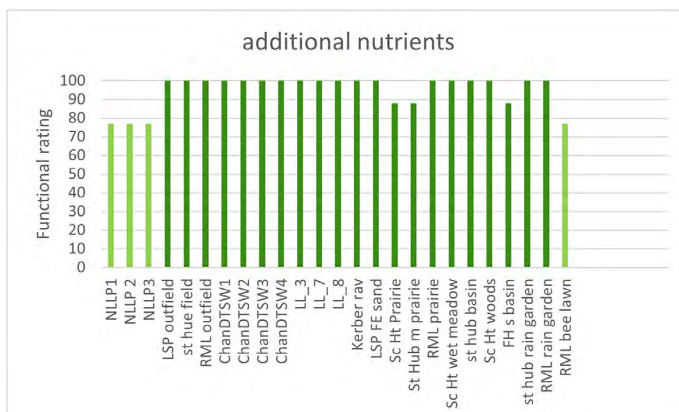
NLLP 2
NLLP3
LSP outfield
st hue field
RML outfield
ChanDTSW1
ChanDTSW2
ChanDTSW3
ChanDTSW4
LL_3
LL_7
LL_8
Kerber rav
LSP FE sand
Sc Ht Prairie
St Hub m prairie
RML prairie
Sc Ht wet meadow
st hub basin
Sc Ht woods
FH s basin
st hub rain garden
RML rain garden
RML bee lawn


additional nutrients
Functional rating
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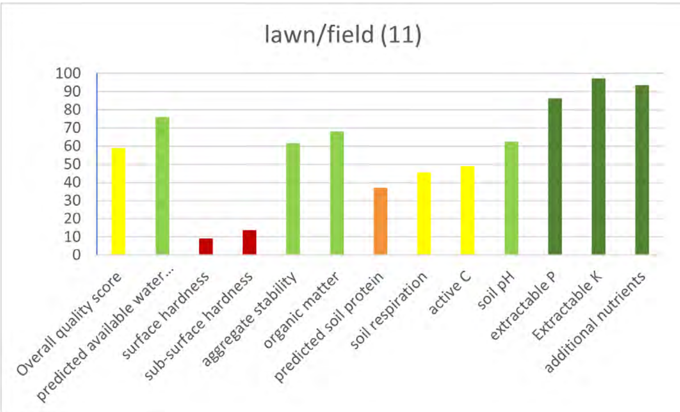
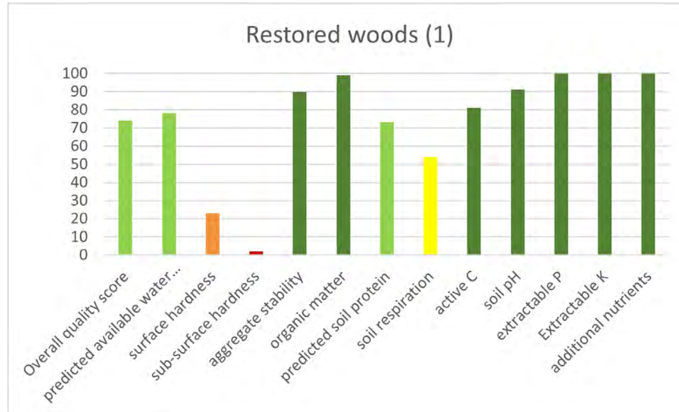
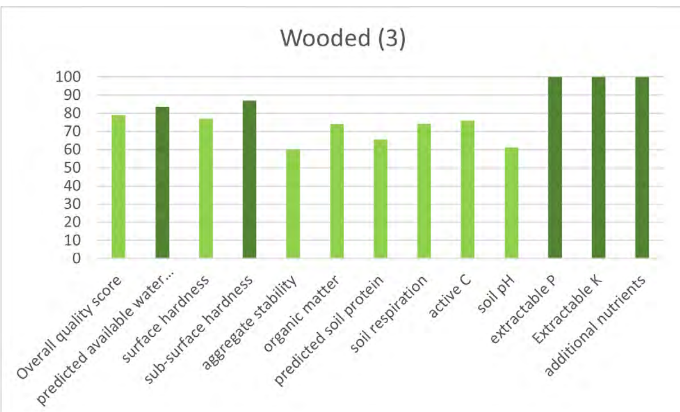
NLLP 2
NLLP3
LSP outfield
st hue field
RML outfield
ChanDTSW1
ChanDTSW2
ChanDTSW3
ChanDTSW4
LL_3
LL_7
LL_8
Kerber rav
LSP FE sand
Sc Ht Prairie
St Hub m prairie
RML prairie
Sc Ht wet meadow
st hub basin
Sc Ht woods
FH s basin
st hub rain garden
RML rain garden
RML bee lawn

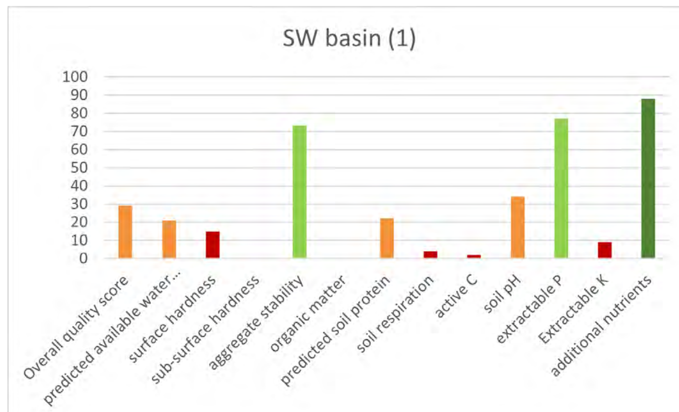
APPENDIX B

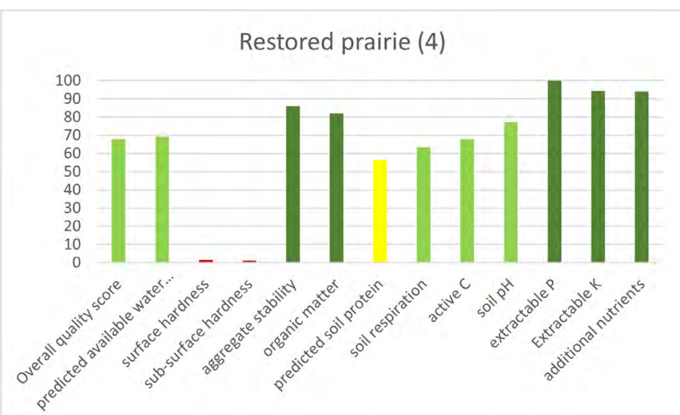
Comprehensive assessment of soil health indicator function/health: average ratings across landscape types. Number of total sites sampled per landscape type denoted in parentheses.

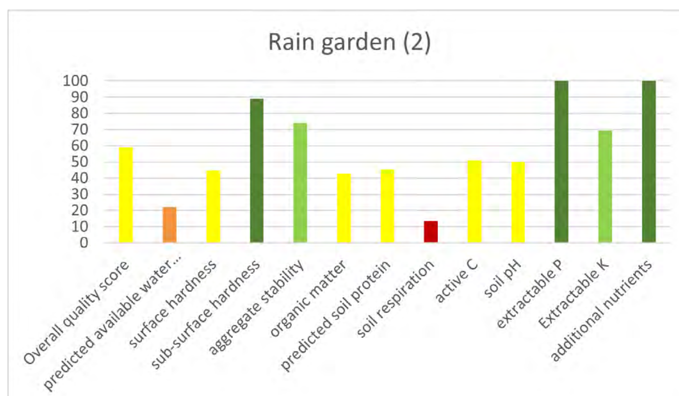


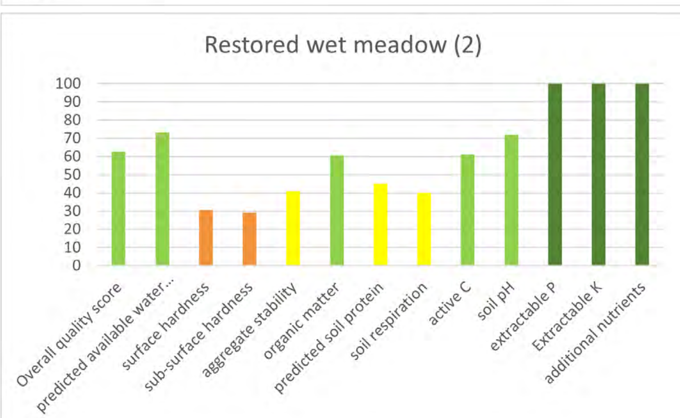


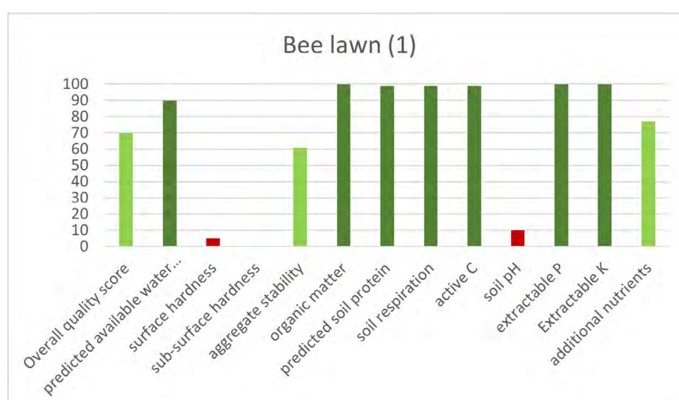












APPENDIX C

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