Minneapolis
City of Lakes

NPDES MS4 Phase I Permit No. MN0061018

Annual Report for 2023 Activities

City of Minneapolis and the Minneapolis Park & Recreation Board – Co-Permittees

June 30, 2024

NPDES MS4 Phase I Permit
Annual Report for 2023 Activities

June 30, 2024

I hereby certify that this plan, specification, or report, was prepared by me or under my direct Supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

Elizabeth Stout

Elizabeth Stout

Date 6/30/2024 Registration No. 46328

NPDES PERMIT NO. MN0061018
Issued February 16, 2018

Resolution No. 2024R-133 **City of Minneapolis** **File No. 2024-00334**

Author: Cashman Committee: CI Public Hearing: May 2, 2024

Passage: May 9, 2024 Publication: MAY 18 2024

RECORD OF COUNCIL VOTE				
COUNCIL MEMBER	AYE	NAY	ABSTAIN	ABSENT
Payne	X			
Chughtai	X			
Wonsley	X			
Rainville	X			
Vetaw	X			
Ellison				X
Osman	X			
Cashman	X			
Jenkins	X			
Chavez	X			
Koski	X			
Chowdhury	X			
Palmisano	X			

MAYOR ACTION

☑ APPROVED ☐ VETOED

MAYOR

MAY 15 2024

DATE

Certified an official action of the City Council

ATTEST:

CITY CLERK

Presented to Mayor: MAY 10 2024

Received from Mayor: MAY 15 2024

Adopting the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Phase I Permit Annual Report for 2023 Activities.

Whereas, the City of Minneapolis is committed to improving water quality in the lakes, wetlands, streams, and Mississippi River; and

Whereas, on December 12, 2023, the City of Minneapolis was issued National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit No. MN0061018 (Permit); and

Whereas, the STORMWATER MANAGEMENT PROGRAM, which was prepared in accordance with the Permit, was submitted to the Minnesota Pollution Control Agency (MPCA) in July 2019; and

Whereas, as required under the Permit, a public hearing was held on May 2, 2024; and

Whereas, the ANNUAL REPORT FOR 2023 ACTIVITIES will now be submitted to the Minnesota Pollution Control Agency;

Now, Therefore, Be It Resolved by The City Council of The City of Minneapolis:

That the Minneapolis City Council hereby adopts the NPDES MS4 ANNUAL REPORT ON 2023 ACTIVITIES.

NPDES MS4 Phase I Permit No. MN0061018

Annual Report for 2023 Activities

City of Minneapolis and the Minneapolis Park & Recreation Board
Co-Permittees

June 30, 2024

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Contents

Acronyms

BCWMC	Bassett Creek Watershed Management Commission
BMP	Best Management Practice
BOD_5	Biochemical Oxygen Demand of wastewater during decomposition over a 5-day period
CIP	Capital Improvement Program
CSO	Combined Sewer Overflow
DNR	Department of Natural Resources
EPA	Environmental Protection Agency
ESC	Erosion and Sediment Control
GIS	Geographic Information Services
I & I	Inflow and Infiltration
IPM	Integrated Pest Management
MCES	Metropolitan Council Environmental Services
MCM	Minimal Control Measure
MCWD	Minnehaha Creek Watershed District
MDA	Minnesota Department of Agriculture
MDR	Minneapolis Development Review
MIDS	Minimal Impact Design Standards
MNDOT	Minnesota Department of Transportation
MPCA	Minnesota Pollution Control Agency
MPRB	Minneapolis Park & Recreation Board
MS4	Municipal Separate Storm Sewer System
MWMO	Mississippi Watershed Management Organization
NPDES	National Pollutant Discharge Elimination System
PW-SWS	Public Works – Surface Water and Sewers
PW-TMR	Public Works – Transportation Maintenance and Repair
SCWMC	Shingle Creek Watershed Management Commission
SMP	Stormwater Management Practice
SOP	Standard Operating Procedure
SSO	Sanitary Sewer Overflow
SWMP	Stormwater Management Program
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
TSI	Trophic State Index
TSS	Total Suspended Solids
VRS	Vehicle-Related Spills
WMO	Watershed Management Organization

ACKNOWLEDGEMENTS

Minneapolis Public Works - Surface Water & Sewers

Nico Cantarero
Paul Chellsen
Angie Craft
Kevin Danen
Justin Flannery
Paul Hudalla
Kelly MacIntyre
Shahram Missaghi
Kelly Moriarity
Sean Oberg
Isaac Prehall
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Carolyn Eckstein
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MaryLynn Pulscher
Kait Ryan
James Shaffer

BACKGROUND

This report provides documentation and analysis of the Stormwater Management Program (SWMP) activities conducted during 2023. The City of Minneapolis and Minneapolis Park & Recreation Board (MPRB) both lead the implementation of the SWMP activities and are jointly responsible for the completion of the required Permit submittals.

This Annual Report is prepared in compliance with the requirements of National Pollutant Discharge Elimination System (NPDES) Permit No. MN0061018, a Municipal Separate Storm Sewer System (MS4) Phase I permit issued to City of Minneapolis and the Minneapolis Park & Recreation Board as co-permittees. Permit No. MN0061018 was initially issued in December 2000, reissued in January 2011, and again in February 2018. The current permit was issued in December 2023. Activities completed under the 2018 permit and approved Stormwater Management Program (SWMP) have been reported in the 2023 Annual Report and will be submitted to the MPCA (Minnesota Pollution Control Agency) by June 30, 2024. Next year's annual report will begin documenting compliance with the 2023 permit.

The NPDES program was created in 1990 by the United States Environmental Protection Agency (EPA) to safeguard public waters through the regulation of the discharge of pollutants to surface waters including lakes, streams, wetlands, and rivers. The MPCA is the local authority responsible for administering this program. Under the NPDES program, specific permits are issued to regulate different types of municipal, industrial, and construction activities. This report is related specifically to municipal stormwater activities.

The SWMP is based on an adaptive management system, as outlined in Part III of the Permit, by which the Permittees continuously monitor, analyze, and adjust the SWMP to achieve pollutant reductions. Using the adaptive management approach, revisions to the SWMP are made and submitted to the MPCA as necessary. A 2013 EPA/MPCA audit helped to identify opportunities for improvement regarding comprehensive training, written procedures and documentation, and availability of staff resources that have influenced subsequent revisions to the SWMP. The Permit requires the implementation of approved Stormwater Management Activities, referred to as SMPs, also known as Best Management Practices (BMPs).

Minneapolis Public Works, Surface Water & Sewer Division provides program management and completes each Annual Report. An annual opportunity for public input into the SWMP and city priorities is required under the permit, as is the adoption of a formal resolution by the Minneapolis City Council each year, adopting the Annual Report.

In February 2018, the NPDES permit this annual report is reporting on was reissued by the MPCA. In response to that permit update, the City's Stormwater Management Program (SWMP) was updated to reflect any new permit requirements or changes. The updated SWMP was approved by the Minneapolis City Council in 2019 for submittal to the MPCA.

CATEGORY ONE: PUBLIC EDUCATION AND OUTREACH

PROGRAM OBJECTIVES

The objective of this stormwater management practice is to educate the public regarding point and non-point source stormwater pollution.

PROGRAM OVERVIEW

A successful stormwater management program involves participation and good management from everyone in the City, including municipal staff, residents, business owners, park visitors, facility managers, contractors, developers, and all others who live and work in Minneapolis. Public education serves to provide information on the importance of water quality, the impacts of stormwater runoff, sources of pollutants in stormwater runoff, and activities that the public should adopt to fulfill their responsibilities towards improved water quality.

Many of the components of the program can be found at the City of Minneapolis Stormwater website or on the MPRB Water Resources website.

Program activities include hosting of educational events, distribution of educational materials, regular updates of web-based information and staff training. Some of the program activities are carried out directly by the co-permittees, the City, and the Minneapolis Park & Recreation Board (MPRB). Other activities are coordinated with and carried out by watershed management organizations, Hennepin County, and other entities.

PREVIOUS YEAR ACTIVITIES

MINNEAPOLIS PARK AND RECREATION BOARD EDUCATION ACTIVITIES

In 2023, the Minneapolis Park & Recreation Board's (MPRB) Environmental Management Naturalist staff offered 130 hours of in-person programming and interacted with just over 2,000 people in neighborhood and regional parks throughout the city. Education staff utilized engaging materials such as a portable mini-golf, bean bag toss, an aerial photo floor graphic of the city and its watersheds, and other hands-on learning activities about stormwater and human impacts on the water quality in Minneapolis. The summer season included 28 sessions of free drop-in canoeing at Loring, Wirth, and Powderhorn Parks. **Figure 29-1** shows two canoe participants from the weekly free programing at Loring Park. To kick off the winter season, 8 local hardware stores were furbished with displays to educate customers about the use of salt for winter snow and ice management. All program locations are shown in **Figure 29-2**.

 1

Figure 29-1. Two participants returning to shore after canoeing on Loring Pond.

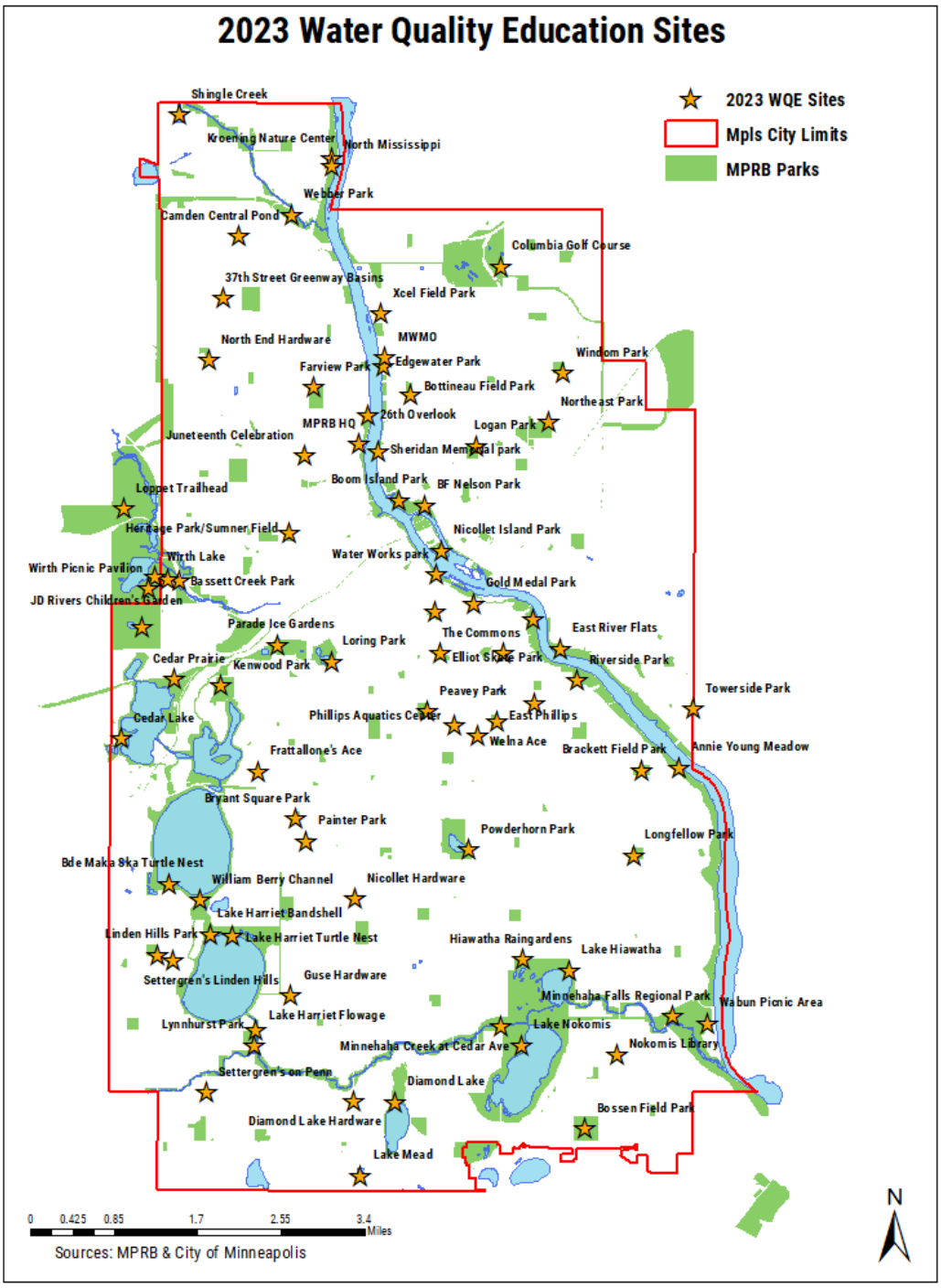


Figure 29-2. Map of water quality education sites in 2023.

Minnehaha Park

A moveable water quality education exhibit was deployed at Minnehaha Park near the pavilion that houses the popular restaurant, Sea Salt Eatery. **Figure 29-3** shows the spinning cubes on the

installation which can be rotated to provide information about watersheds, stormwater runoff, and actions people can take to positively impact water quality. This location was chosen because of the consistent captive audience of people standing in line waiting to order food. Intermittent staff observations throughout the season confirmed that many of the people waiting in line were reading from the exhibit.

Figure 29-3 An installed Spinning cube with information watersheds, stormwater runoff, and actions people can take to positively impact water quality.

Water Quality Water Trail

In June, the Water Trail, which is a series of buoys designed to be followed like a trail on the water, was deployed in the lagoon west of the bridge in Lake Nokomis. A set of 10 stand up paddleboard (SUP) yoga poses were designed to float above the waterline on buoys holding water quality education messages. Shoreline signs were also posted for the summer season, letting park visitors know about the new resource, see **Figure 29-4**. **Figure 29-5** shows two adults engaging with one of the educational buoys.

Figure 29-4. Shoreline sign posted around the Nokomis Lagoon to draw attention to this new resource.

Figure 29-5. A small group testing out a stop on The Water Trail in the Lake Nokomis Lagoon.

Aquatic Invasive Species Education

Figure 29-6. Aquatic invasive species boat inspection (A) and water quality education at boat launches (B).

The MPRB continued its extensive Aquatic Invasive Species (AIS) Inspection & Education Program at the public boat launches located at Bde Maka Ska, Lake Harriet, and Lake Nokomis. The boat launches are staffed seven days a week from May 1 to December 1, and all trailered boats entering and leaving the lakes are inspected for AIS. In addition to providing watercraft inspections, staff are an information source for the park visitors. Staff directly interacted with 13,112 park visitors in 2023. Access to the Bde Maka Ska launch was impacted in the 2023 season by the construction project to rebuild the Bde Maka Ska Refectory building. The launch was closed for approximately 25% of the season due to the construction, which decreased the number of park visitor interactions with AIS Inspectors. Adjacent to the AIS booths are sandwich boards, see **Figure 29-6**, with action steps people can take to be a good water steward. The sandwich board messages can be changed out daily based on weather, time of year, etc.

Canines for Clean Water Campaign

According to US Census data, there were 188,017 households in Minneapolis in 2020. Using American Veterinary Medical Association ownership rates, an estimated 115,500 dogs live within Minneapolis city limits. The US Environmental Protection Agency has calculated the average dog produces 0.75 pounds of waste each day. That means Minneapolis dogs are generating an estimated 87,000 pounds of solid waste each day. Initiated in 2009, Canines for Clean Water is a water quality education program targeting dog owners to build awareness of the impacts of this waste when it is not properly disposed of and empowering people to take action and make a difference.

The Canines for Clean Water movie series returned for summer of 2023. Dogs and their humans were invited to enjoy a night out at the movies at a different park each Thursday evening in August. The movies shown were dog-themed, with fun pre-movie activities like neighborhood dog shows, as well as being joined by Water Quality Educators to learn about the importance of picking up their dog's poop. **Figure 29-7** shows one participant practicing scooping the poop at JD Rivers' Children's Garden. **Figure 29-8** shows two canine participants exiting the stage after showing off their tricks for the judges at the Loring Park movie night.

Figure 29-7. Young participant practicing scooping the poop before the movie night hosted at JD Rivers' Children's Garden.

Figure 29-8. Two canine participants exiting the stage after showing off their tricks for the judges at the movie night hosted at Loring Park.

Both canines and humans were invited to sign the Canines for Clean Water Pledge. Dogs signed with a paw dipped in mud. Most humans preferred to sign their name with a pen, though the fingerprint-in-mud option was available for them as well. Dogs who took the pledge were rewarded with swag. Attractive bandanas with the Canines for Clean Water logo on them were distributed, so that dogs could show their pride in making the commitment to having their owners clean up after them. **Figure 29-9** features three participants taking the Canines for Clean Water pledge before the movie night hosted at Powderhorn park.

Figure 29-9. Three youth take the Canines for Clean Water pledge at the Powderhorn movie night.

Don't Feed the Ducks Campaign

Based on a successful pilot program in 2016 that focused on persuading park patrons to not feed the ducks, the MPRB moved forward with fabrication of permanent education pieces in 2017. In 2023, the largest yellow duck ambassador continued the mission along the Lake Harriet shoreline, adjacent to the seasonal restaurant Bread & Pickle. See **Figure 29-10** for the scale of our giant buoy rubber duck ambassador.

Figure 29-10. Photo of the Lake Harriet rubber duck buoy of the Don't Feed the Ducks Campaign.

The recently redesigned sandwich board signs asking park visitors to not feed the wildlife were also deployed at more locations, including Bde Maka Ska, Lake Harriet, Lake Nokomis, Loring Pond, and Powderhorn Lake. These signs encourage visitors to "photo don't feed" as an alternative way to connect with ducks and geese living around Minneapolis lakes. See **Figure 29-11** for examples of these newly designed signs.

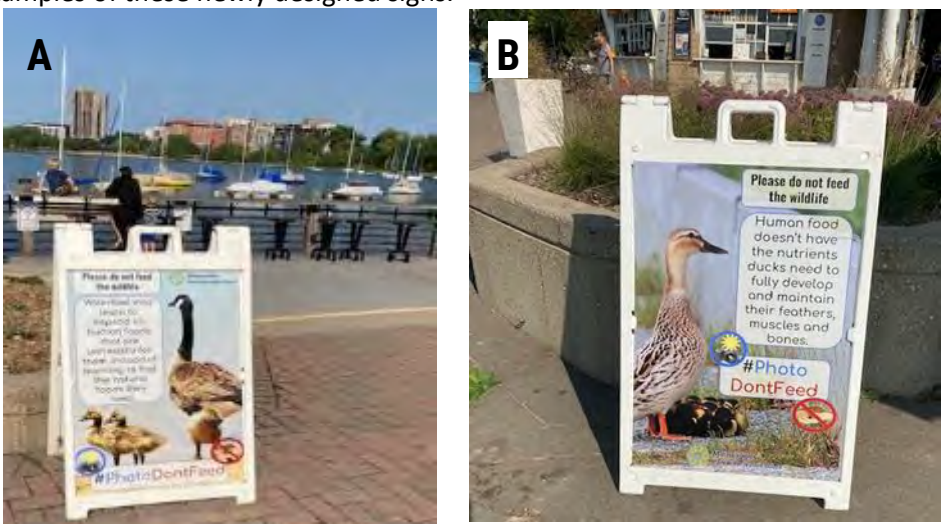


Figure 29-11. Example of goose sign posted at Bde Maka Ska (A), and duck sign at Lake Harriet (B) encouraging people to take pictures rather than offer food to the wildlife with the hashtag #PhotoDontFeed.

Earth day watershed clean-up

Going back more than 25 years, the MPRB Earth Day Watershed Clean-up event has inspired more than 27,000 residents to remove an estimated 190,000 pounds of garbage from Minneapolis parks. **Figure 29-12** shows an example of some of the garbage collected from Minnehaha Regional Park. Trash bags, gloves, and instructions were made available for pick up at participating park sites.

Figure 29-12. One pile of litter collected from Minnehaha Regional Park and bagged for pickup during the 2023 Earth Day Watershed Clean-up.

In 2023, this single-day event engaged 2,076 volunteers at 43 sites throughout the City of Minneapolis to remove trash that might otherwise have ended up in our waterways. It took 5,190 hours to clean up 8,620 pounds of litter in Minneapolis. See the complete list of clean up locations in **Table 29-1**.

Table 29-1. Locations of the 2023 Earth Day Watershed Clean-up.

Earth Day Clean-up Locations		
Armatage Park	Folwell Park	Pearl Park
Bde Maka Ska East	James I. Rice Park	Powderhorn Park
Bde Maka Ska South	Kenny/Grass Lake	Sibley Park
Beltrami Park	Lake Harriet	Sumner Field
Bethune	Lake of the Isles East	Theodore Wirth Beach House
Boom Island	Lake Hiawatha	Theodore Wirth Trailhead
Bryant Square Park	Loring Park	Tower Park
Cedar Lake	Lynnhurst Park	Triangle Park
Chergosky Park	McRae Park	W River Pkwy & 24th
Chute Square	Mill Ruins Park	W River Pkwy & 36th
Creekview Park	Minnehaha Falls	W River Pkwy & 44th
E River Flats Park	Mueller Park	Wabun Picnic Area
East River Parkway	Nicollet Island – St. Anthony Main	Waite Park
Elliot Park	Nokomis	Whittier Park
Father Henn Bluff Park		

Mississippi River Green Team

The Mississippi River Green Team (MRGT), is a conservation-based teen crew engaged in daily hands-on environmental work throughout the summer. The crew consists of up to 18 youth and two supervisors, who work mostly in the natural areas of the Minneapolis Park system, and within the watershed of the Mississippi Watershed Management Organization (MWMO). Typical workdays included visiting park sites, such as B. F. Nelson Park, East Phillips Park, East River Flats, Parade Ice Garden, and North Mississippi Regional Park, to conduct invasive species removal, weed wrenching, planting, watering, and mulching. **Figure 29-13** shows two team members hauling away removed invasive plants from the raingardens at Parade Ice Gardens.

Figure 29-13. Mississippi River Green Team youth hauling away invasive plants they successfully removed from the raingardens in the parking lot of Parade Ice Gardens.

The crew was scheduled for weekly career exposure days designed to provide them with a chance to meet professionals and have experience in a variety of green employment fields. They participated in activities such as stenciling storm drains and delivering literature to raise awareness of the connection between the stormwater in the street to the Mississippi River, studying macroinvertebrates and their connection to water quality, and clearing vegetation from two turtle nesting sites to help emerging baby turtles access water more quickly. They also completed several educational experiences including the Spark'd Studio Summer Video Camp, contributed to the pollinator survey at Heritage Park, participated in the first ecological survey of the newly restored natural areas of Columbia Golf Course, the Stormwater 101 lesson with staff at the MWMO, and learned about the history of the Mississippi River at several locations to explore how humans have impacted and depend on the river. **Figure 29-14** shows a Spark'd Studio staff instructing two MRGT youth in the use of video recording equipment while filming their water quality message at Powderhorn Park.

Figure 29-14. Spark'd Studio staff instruct two Mississippi River Green Team youth staff in use of recording equipment while filming in Powderhorn Park.

The Mississippi River Green Team is made possible through a partnership between the Minneapolis Park & Recreation Board and the Mississippi Watershed Management Organization. The MRGT is also supported by City of Minneapolis Public Works through their contract with *Landbridge Ecological*, which manages vegetation at stormwater Best Management Practices (BMPs) throughout the city. Landbridge and the MRGT's work in 2023 focused on weed and invasive species management at 37th Greenway Raingardens, Heritage Park, Lake Mead, Shingle Creek, and Sumner Field.

Piloted this summer, the Green Infrastructure Inspection Team (GRIIT) was a continuation of the program partnership between the MPRB's Environmental Education staff and the MWMO, as an expansion of the existing MRGT youth employment program. The objectives of GRIIT were to provide field work experience and practical learning on green infrastructure and water quality concepts for the youth staff, in addition to establishing a baseline condition of MPRB stormwater BMPs through team inspections. **Figure 29-15** shows two GRIIT staff clearing an inlet to one of the stormwater management sites in North Mississippi River Regional Park.

Figure 29-15. Two youth staff from the pilot year of GRIIT clearing an inlet to a stormwater management site in North Mississippi Regional Park.

Conducting inspection surveys and completing maintenance work to ensure proper functioning of BMPs kept this small team of three busy all over the city. Inspection surveys included recording issues such as soil erosion, improper or overgrown vegetation, clogged sediment catchments, water flowing in the wrong direction, or not infiltrating quickly enough. The team took photos and detailed notes that were then uploaded to a GIS layer to establish the conditions of each inspected site. Using hand tools, the crew then completed any possible maintenance at the site including removing sediment and pulling invasive plants and trees to help the sites function better.

The overall goal of piloting this program was to create a next step opportunity for youth employees to continue on a path of a green career. Focusing this work opportunity on BMPs and stormwater management was chosen because both the MPRB and MWMO recognize this as a growing area of need both in the continued installation of BMPs in the park system, and the change in rainfall patterns.

2023 Frog & Toad Surveys of Select Stormwater Ponds

The presence and abundance of frogs and toads are a useful indicator of water and habitat quality, as well as short and long-term environmental changes. Standard protocols using calling surveys during peak breeding activity have been used to determine distribution and population trends of frogs and toads by natural resource agencies nation-wide.

The question has been raised whether or not stormwater ponds, constructed to intercept and treat runoff, can also function as a refuge for amphibians. Additionally, the public has voiced concerns about the absence of formerly abundant frogs and toads calling from Hiawatha Golf Course and the surrounding area. To evaluate these concerns, the Minneapolis Park and Recreation Board (MPRB) coordinates frog and toad listening surveys at Lake Hiawatha golf course and select stormwater ponds in Minneapolis.
The purpose of these surveys is to:

1. Determine if any frog and toad species (anurans) are found in or near stormwater ponds.
2. Use the Minnesota Frog and Toad Calling Survey (MFTCS) protocols adapted for Theodore Wirth Park to Identify species and abundance in stormwater ponds.
3. Generate ideas about why or why not species may use stormwater ponds.

Key 2023 Findings
Seven species of frogs and toads - of the 14 species known in MN—have been reported from stormwater sites in Minneapolis since 2016. Not more than three species were found at any single location.

American toads are the most commonly heard and widely distributed among stormwater ponds surveyed. Toads were found in over 50% of years sampled; other species were detected in less than 10%. A full chorus of toads has been documented at ten stormwater ponds, and multiple times in some locations. Toads have been heard at least once in all stormwater ponds. Toads were heard for the first time in West Twin pond in 2023.

In 2022, Cope's gray treefrogs (*Hyla chrysoscelis)* were found at two new locations: Robert's Bird Sanctuary (reference site) and Amelia Pond (southwest of Lake Nokomis). Until 2022, they were only found at Columbia Golf Course near the pond with the widest riparian zone and vegetated with shrubs and small trees. It is important to note numerous individuals were heard at Roberts Bird Sanctuary, while only one or two were heard at the other two locations.

Individual gray treefrogs (*Hyla versicolor*) have been heard intermittently at different stormwater sites since 2016.

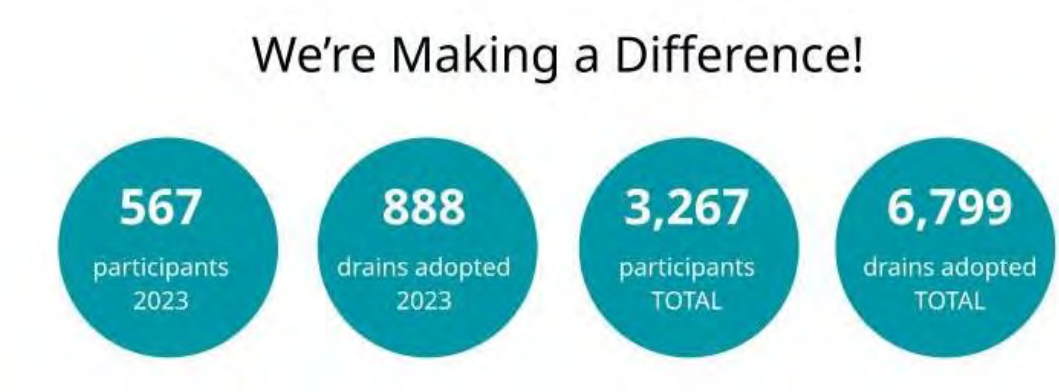
Numerous green frogs (*Lithobates clamitans)* are found in the stormwater pond at Upton Ave N and 52nd Ave N (full choruses have been heard). Until 2023, green frogs have been heard exclusively in the north pond and not anywhere else in the city, including Theodore Wirth Park (2015-22). Individual green frogs were heard in three new locations - two different ponds on Hiawatha Golf course and at Birch Pond during the Wirth Park surveys[1].
The full report can be found in ***Appendix A13 – 2023 Frog & Toad Calling Report***

MINNEAPOLIS ADOPT-A-DRAIN PROGRAM

Since 2016, the Minneapolis Adopt-a-Drain program has empowered Minneapolis residents to take responsibility for storm drains and gutters in their neighborhoods by adopting and keeping them clean. In March 2019, the arrival of a metro-wide website (www.adopt-a-drain.org) was launched to serve all cities in the Twin Cities 7 county area.

Figure 1-14 Adopting a storm drain in Minneapolis

2023 Adopt-a-Drain Program Results



The Minneapolis Adopt-a-Drain Program is the largest program in the United States in terms of number of drains adopted, beating out cities such as San Francisco, Seattle, and Memphis. It continues to grow and posted significant numbers in 2023:

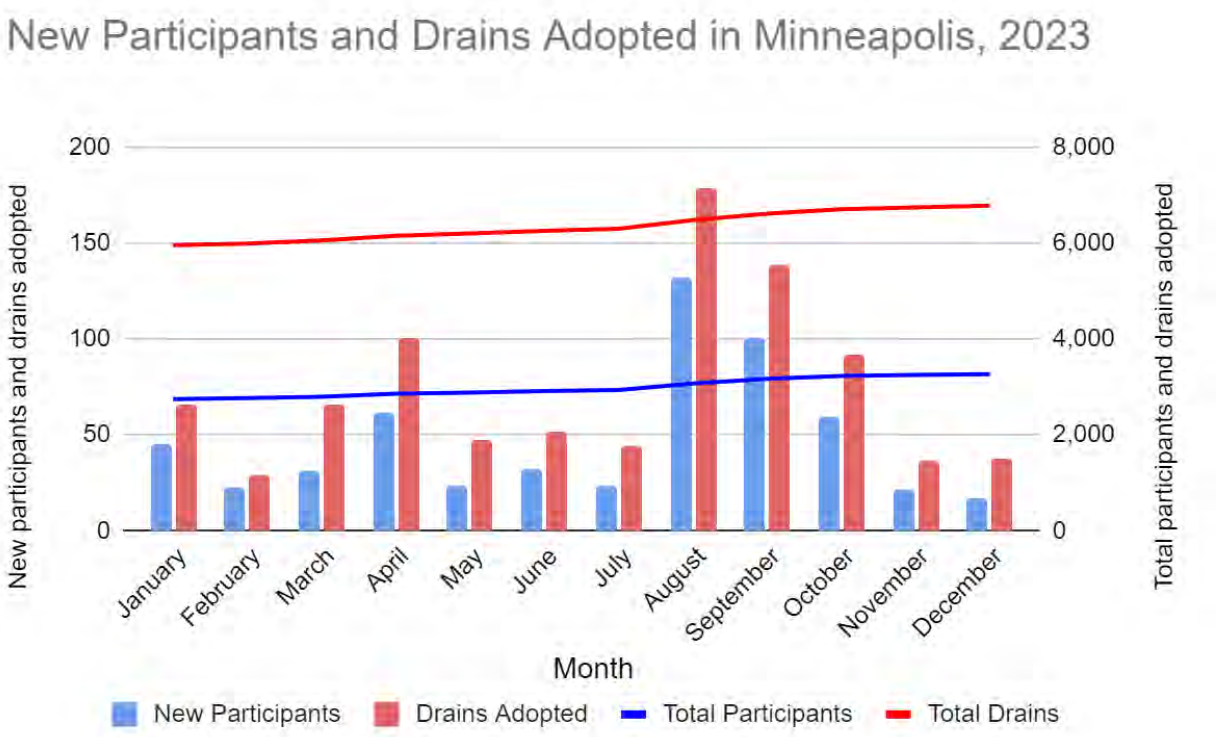
- Minneapolis led all cities in the metro area with 3,267 participants
- 567 new adopters
- 6,799 total storm drains adopted
- 787 Minneapolis participants reported cleanings (24% of all participants)
- Collected 40,014 pounds of debris
- 893 volunteer hours logged

Adopt-a-Drain Mailings and Signs

In 2023, 260 welcome packets were mailed to new program participants. In addition, 157 Minneapolis residents signed up at the Minnesota State Fair. The yard signs provide a secondary touchpoint away from the storm drain, helping to raise awareness and to encourage people to keep storm drains clean. Each program participant receives a welcome packet, which includes: waterbody-specific yard sign and stake, storm drain decals and adhesives, welcome card with safety tips and instructions, an Adopt-a-Drain trash bag, Adopt-a-Drain sticker, smart salting sticker, customized Minneapolis welcome letter, and drain decal application instructions.

Watershed	Packets Mailed
Bassett Creek	5
Bde Maka Ska	13
Diamond Lake	4
Grass Lake	3
Lake Harriet	14
Lake Hiawatha	18
Lake Nokomis	11
Lake of the Isles	24
Minnehaha Creek	35
Mississippi River	115
Powderhorn Lake	4
Shingle Creek	14
Total	**260**

Figure 1-15 Adopt-a-Drain welcome packet for new participants


New Participants and Drains Adopted in Minneapolis, 2023
New participants and drains adopted
Total participants and drains adopted
200
150
100
50
0
8,000
6,000
4,000
2,000
0
January
February
March
April
May
June
July
August
September
October
November
December
Month
New Participants
Drains Adopted
Total Participants
Total Drains

Adopted Drains by Geographic Breakdown: Watershed and Sub-watershed: for 2023

Watershed	Drains adopted	Debris collected (lbs)	Time spent (hours)
Mississippi	3,167	18,641.7	421.9
Minnehaha Creek	2,950	18,146.7	397.0
Bassett Creek	349	1,275.3	34.4
Shingle Creek	331	1,967.0	40.1
West Mississippi	1	0.0	0.0

Drains adopted: *Cumulative total*
Debris collected and time spent: *2023 data only*

Subwatershed	Drains adopted	Debris collected (lbs)	Time spent (hours)
Mississippi River (MWMO)	3,574	20,205.6	465.9
Minnehaha Creek	1,042	8,671.2	167.4
Lake Hiawatha	395	936.2	33.5
Lake of the Isles	244	1,040.0	23.6
Lake Harriet	236	1,714.7	35.8
Bde Maka Ska	235	1,495.9	27.5
Lake Nokomis	212	1,123.8	14.1
Shingle Creek	193	1,173.5	20.1
Bassett Creek Main Stem (Downstream)	154	1,099.3	31.0
Crystal Lake	129	793.5	20.1
Diamond Lake	125	169.9	8.1
Powderhorn Lake	89	723.3	13.2
Grass Lake	86	127.4	4.9
Cedar Lake	47	581.2	6.5
Brownie Lake	9	67.6	19.3
Silver Lake	8	77.6	1.7
Richfield Lake	8	0.0	0.0
Spring Lake	6	0.0	0.0
Grimes Lake	3	20.0	0.7
Legion Lake	2	10.0	0.2
Hart Lake	1	0.0	0.0

Adopted Drains - Geographic Breakdown by Neighborhood, 2023

Neighborhood	Total Participants	Total Adoptions	New Participants 2023	New Adoptions 2023
Howe	120	251	12	14
Audubon Park	113	185	10	14
King Field	108	197	19	24
Standish	105	174	11	13
Linden Hills	99	157	10	13
Fulton	98	162	22	31
Lynnhurst	94	177	14	21
Tangletown	93	193	4	6
Seward	89	147	21	26
Hiawatha	79	195	7	8
Armatage	78	134	9	12
Waite Park	76	141	5	6
Longfellow	74	151	12	13
Cooper	74	147	8	9
Diamond Lake	71	155	10	17
Northrop	71	146	13	20
Windom Park	64	114	4	5
Victory	61	120	8	11
Powderhorn Park	60	138	8	9
Ericsson	60	117	3	4
Lowry Hill East	60	111	25	38
Kenny	59	101	6	7
Minnehaha	57	108	10	13
Keewaydin	56	114	12	23
East Isles	54	111	34	59
Hale	53	115	6	6
Whittier	53	101	19	21
Prospect Park - East River Road	49	124	6	8
Wenonah	49	84	4	6
Holland	46	104	6	17

Adopted Drains - Geographic Breakdown by Neighborhood, 2023 (cont.)

Neighborhood	Total Participants	Total Adoptions	New Participants 2023	New Adoptions 2023
Willard - Hay	43	148	6	9
Page	42	75	4	6
Corcoran	41	92	6	7
Bancroft	41	78	7	9
Central	40	74	4	4
Logan Park	40	64	4	4
South Uptown	39	72	6	10
Bryn - Mawr	39	69	4	5
Sheridan	39	56	9	10
Windom	38	81	5	13
Como	38	69	10	16
East Harriet	38	67	4	8
Lyndale	29	53	5	7
St. Anthony West	28	50	3	4
Morris Park	27	53	4	5
Cleveland	26	90	2	3
Marcy Holmes	25	62	6	10
Webber - Camden	25	37	4	4
St. Anthony East	24	36	5	5
Harrison	23	44	6	7
Field	22	40	4	4
Loring Park	22	33	10	14
Columbia Park	21	53	4	16
Cedar - Isles - Dean	21	50	4	6
Bottineau	21	45	2	2
Regina	21	39	6	7
East Bde Maka Ska	21	33	1	1
Lowry Hill	20	108	4	9
Folwell	20	57	5	7
Near - North	18	183	1	1

Adopted Drains - Geographic Breakdown by Neighborhood (cont.)

Neighborhood	Total Participants	Total Adoptions	New Participants 2023	New Adoptions 2023
Beltrami	18	42	1	1
Bryant	18	38	4	4
Kenwood	18	33	4	8
Shingle Creek	15	34	3	4
Jordan	15	24	2	2
Downtown West	14	29	5	5
Marshall Terrace	14	25	3	3
Hawthorne	13	36	2	3
Lind - Bohanon	13	31	2	3
North Loop	12	31	2	2
Elliot Park	11	16	1	1
Northeast Park	11	16	2	3
East Phillips	10	17	0	0
University of Minnesota	9	15	4	8
Steven's Square - Loring Heights	9	10	1	1
Phillips West	8	34	1	2
McKinley	8	25	1	4
Midtown Phillips	7	14	3	6
Cedar Riverside	7	10	2	4
Nicollet Island - East Bank	6	19	5	15
Ventura Village	6	15	3	9
Downtown East	6	9	2	2
West Maka Ska	5	10	1	2
Sumner - Glenwood	4	8	0	0
Mid - City Industrial	4	4	1	1
Humboldt Industrial Area	2	2	0	0

Participants who have adopted drains in multiple neighborhoods are counted for each, so total of participants may be slightly higher.

* 2023 Near-North and Willard-Hay neighborhoods adoption total includes drains adopted by the community group Seeds to Harvest.

Door Hanging

Between 2016 and 2022, all single-family homes in the City of Minneapolis were door-hangered. No door-hanging was done in 2023.

New Adopt-a-Drain Door / Storm Drain Stenciling Door Hangers

In 2023, the updated double-sided door hanger was used in multiple ways, including:

- Storm Drain Stenciling Program
- Adopt-a-Drain K-12 Outreach Program (in Minneapolis schools)
- Earth Day cleanup events
- National Night Out events
- Litter League clean-up events
- Tabling events at neighborhood organizations

Figure 1-19 Storm drain stenciling program door hanger

2023 Adopt-a-Drain participant survey

In the summer of 2023, in cooperation with Hamline University, a survey was sent to Minneapolis Adopters with eighty-nine participants (16% of adopters) responding. Key findings include that the average Minneapolis Adopt-a-Drain participant is white, female, and around 60 years old. The majority of adopters have a bachelor's degree or higher and own their residence. This is very similar to the demographics of drain adopters in MN as a whole and has remained consistent since 2018. Looking at the Minneapolis adopters who have joined the program since 2021, we see a slightly more diverse group, particularly in terms of gender, income, and home ownership status, but the general profile of the average participant remains the same.

Total annual household income	All Minneapolis respondents		Minneapolis respondents who joined since 2021	
	Number	Percentage	Number	Percentage
More than $100,000	36	41%	12	41%
prefer not to say	13	15%	5	17%

Home ownership status	All Minneapolis respondents		Minneapolis respondents who joined since 2021	
	Number	Percentage	Number	Percentage
I own my residence	77	87%	23	79%
I rent my residence	5	6%	3	10%
I have another arrangement	4	4%	2	7%
I am a landlord	1	1%	0	–
Prefer not to say	1	1%	1	3%

Most adopters learned about the program through events (State Fair or other events) or through communications from the city or their watershed management organization. The main motivation for participating in the program is protecting water quality. When asked about behavior changes that they've made since joining the program, 35% responded with a wide variety of environmental activities, including an increased focus on keeping streets clean and changes to how they take care of their yard. Six percent (6%) indicated that they had already been environmentally active before starting the program.

2023 East Isles and Wedge Neighborhood efforts

Minneapolis Public Works staff worked with a Wedge Neighborhood volunteer to organize Adopt-a-Drain events in the East Isles and Wedge Neighborhoods. This included a competition between the neighborhoods, neighborhood clean-up events, and local businesses that donated prizes for participants in the summer and fall of 2023.

Poster for the East Isles - Wedge Neighborhoods project

Adoptions by neighborhood during the East Isles - Wedge Neighborhood Adopt-a-Drain project from July 13 - October 19, 2023

...w ...ters	New Adoptions
)	50
)	26
3	**76**

2023 Northeast Minneapolis Adopt-a-Drain Challenge

For the 3rd year in a row, Minneapolis Public Works SWS staff worked with a Master Water Steward to organize a challenge involving all 13 Northeast Minneapolis neighborhoods to raise environmental awareness and increase storm drain adoption rates. It involved multi-level competitions where neighborhood organizations recognized monthly "winners" and posted data throughout the challenge.

Figure 1-21 NE Adopt-a-Drain Challenge poster

Adopt-a-Drain Outreach Materials

The City of Minneapolis provided outreach materials to many organizations, including, all MPRB Recreation Centers, kiosks at Minneapolis lakes, Hennepin County libraries, neighborhood organizations.

In 2023, the Adopt-a-Drain tri-fold was updated with new photos and information. These tri-folds and other educational items were distributed to neighborhood organizations, water quality partners, and tabling events. This tri-fold includes a QR code to allow program access from a smartphone or tablet.

2023 **MINNEAPOLIS STORM DRAIN STENCILING PROGRAM**

- 51 storm drain stenciling events
- 384 volunteers participating
- 832 storm drains stenciled
- 1,980 doorhangers distributed
- 149 bags of trash collected
- 4,470 pounds of trash, leaves, and debris removed from storm drain system
- Over 4 pounds of phosphorus removed from lakes, creeks, and the Mississippi River

Storm drain stenciling not only educates volunteers who paint environmentally friendly messages like “FLOWS TO RIVER/LAKE/CREEK – KEEP DRAIN CLEAN” on the storm drains, but also engages residents and people passing by. It’s a great team-building exercise that helps people learn what they can do to improve the quality of the lakes, creeks, and the Mississippi River. The program provides stencils in English, as well as Spanish and Somali languages for certain neighborhoods.

Organizations who participated in storm drain stenciling in 2023 included schools, Cub Scout and Girl Scout troops, neighborhood organizations, places of worship, and individual residents. Business and commercial groups also participated in the program, including groups like Wells Fargo, who’s employees participated in 9 cleanup and stenciling events near their branch locations throughout the year.

Before: *After:*

Storm Drain Stenciling Tri-Fold

In 2023, the Storm drain stenciling tri-fold brochure was updated to include new photos, updated statistics, and updated contact information. The tri-fold also features information about the importance of the cleaning and stenciling storm drains, how the stenciling process works, and a QR code to allow program access from a smartphone or tablet. These tri-folds and other educational items were distributed to residents, neighborhood organizations, and water quality partners and at tabling events.

KEEP YOUR STORM DRAINS CLEAN!

Leaves and Grass
Keep them off sidewalks and streets.

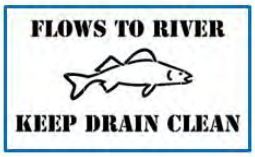
Dirt
Keep soil covered with plants and mulch, especially near sidewalks and driveways.

Pet Waste
Pick up after your pet and dispose of properly.

Trash
Seal your trash bags and keep litter out of the street.

Salt
Always shovel before you salt, remember: **salt only works when it is above 15 degrees**. You only need a little! For colder temperatures use sand or kitty litter.

WHERE DOES YOUR STREET DRAIN TO?



Contact Us
To learn more about Stenciling, visit www.minneapolismn.gov/stenciling or contact florkime.paye@minneapolismn.gov

Minneapolis
City of Lakes

MINNEAPOLIS STORM DRAIN STENCILING PROGRAM

Help Keep Our Waters Clean

METRO BLOOM TRAINING AND ENGAGEMENT PROGRAMS

In 2023, the City of Minneapolis funded and provided project management and oversight for the non-profit Metro Blooms' Resilient Yards Workshops, Sustainable Landcare Training Program, and the Boulevard Bioswale Program.

Metro Blooms partners with communities to create resilient landscapes and foster clean watersheds, embracing the values of equity and inclusion to solve environmental challenges. Working with public and private partners to address long-term sustainability of constructed BMPs Metro Blooms has really made a real difference in our management of these devices.

Figure 1-26 Metro Blooms staff

Staff from Metro Blooms uses sustainable landscape management practices, prioritizing non-chemical methods and battery-operated landscaping equipment to maintain these practices. Metro Blooms provides maintenance and inspections for approximately nearly 100 private and public BMPs in Minneapolis. This support helps the property owners maintain BMPs, stay in compliance with Chapter 54 requirements, and preserve their stormwater utility credit.

2023 Blue Thumb Resilient Yard, Bee Lawns, and Pollinator Yards Workshops

An estimated 90 Minneapolis residents took part in Resilient Yards, Turf Alternatives, Seed Saving, and Sowing, or Community Land Trust workshops in 2023. An additional 918 Minneapolis residents enrolled in the online learning series for the Resilient Yards program.

These workshops continue to adapt to meet new and upcoming issues and remain a successful part of education and engagement programs in the City of Minneapolis.

Minneapolis Neighborhood Rain Garden Program

Metro Blooms worked with the Conservation Corps of Minnesota to install 67 new rain gardens on residential properties in 2023. Partnering with the Holland, Marshall Terrace, Lynnhurst, and Windom Park neighborhoods, the successful program yielded these results:

- Over 2,000 sq. ft. new pollinator habitat 2,500 new plants)
- 300,000 gallons runoff captured per year.
- 120lbs. total suspended solids captured per year.

- 1.75 lbs. total phosphorus removed per year.

Figure 1-27 Conservation Corps crew working on one of the 100 raingardens installed

Lawns to Legumes program

5,918 Minneapolis residents applied for funding through the state grant, and 1,186 grants were awarded. 527 residents completed projects and implemented 168,5112 square feet of new pollinator habitat, including 74,000 sf of lawns, 21,000 sf of meadows, and 72,000 sf of pocket planting areas.

Minneapolis Boulevard Bioswale Program

The Minneapolis Boulevard project is a collaboration and partnership with community leaders and organizations, including Metro Blooms, Metro Blooms Design and Build, Jordan Area Community Council, Sunnyside Peace and Prayer Coalition, Northside Residents Redevelopment Council, and the Liberty Healing Space. These groups conducted transformed 32 boulevards into pollinator gardens that capture runoff.

Four Metro Blooms Environmental Justice advocates door knocked in North Minneapolis, explaining the opportunity to redevelop boulevards into sustainable, vibrant gardens. Interested residents had a consultation with a landscape architect, and detailed information was provided about the boulevards and the healing properties they provide. The advocates would take in participant preferences to decide what to plant, and all residents were invited to join in the planting. After planting, details on watering and maintenance were provided, and residents were asked about satisfaction and feedback.

- 30 properties in North Minneapolis, including three community sites
- 7,584.2 sq. ft. of native plantings and bioswales
- Annual Capture
    - 665,670 gallons runoff
    - 1.67 lbs. total phosphorus
    - 302.6 pounds sediment
- 20 youth, young adults, and community elders participated in Sustainable Landcare training. From that group, environmental and social justice advocates planted and provided training and maintenance support to care for boulevards.
- 300 residents directly engaged through door-knocking, community plantings, and outreach. Additional residents showed interest in participating in the future.

Metro Blooms Survey Results

Metro Bloom sent a survey to all participants who attended one or more of the workshops:

- 73% of respondents installed a native plant, bee lawn, or other planting or clean water practice after attending a workshop. Out of those respondents:
    - 85% installed a native planting
    - 46% installed a bee lawn or a tree/shrub
    - 8% installed a rain garden
- 71% of the respondents who did not install a project said that they plan to install native planting in the future.
- 52% of respondents knew of someone who installed a planting using information they shared with them from the workshop.
- When asked about why they installed a native planting:
    - 96% wanted to create native habitats for pollinators
    - 48% wanted to reduce stormwater runoff
    - 82% wanted to beautify their property

- 56% wanted to be a leader in their neighborhood for environmental issues
- 22% wanted to participate in a local community program
  when asked about why they attended a workshop
- 74% wanted to learn how to create a climate-resilient yard
- 61% wanted to establish an alternative to turf
- 46% wanted to speak 1-on-1 with a Landscape Designer
- 30% wanted to learn how to excavate and plant a rain garden
  59.5% of respondents applied for Lawns to Legumes funding.

INTERPRETIVE SIGNAGE PROGRAM

Stormwater BMPs, by design, blend into the community and are passively enjoyed as parks, gardens, and neighborhood ponds. Residents and businesses that benefit from these BMPs are often unaware of their own contributions to the problem and, more importantly, their potential to be an active part of the solution. Locally designed artwork and online tools created an engaging, visually compelling, and interactive story about the City's network of BMPs.

The City of Minneapolis and HDR developed engaging, site-specific artwork for 26 BMPs and a companion website to supplement and link the signs together. These tools allow viewers to engage with individual sites and how they function and explore ways in which each site connects with and protects

Figure 1-28 Interpretive sign at Lake Mead during a prescribed burn 4/2024

our creeks, lakes, and the Mississippi River.

two more signs were added during 2023 bringing the final project total to 42 signs on 27 stormwater pond sites promoting the City's stormwater management efforts. The signs raise awareness about how these ponds, infiltration basins and rain gardens help protect our waterbodies by improving water quality and reducing flooding.

Local artist Ashley Rades designed the interpretive signs, which are integrated with an interactive website (https://stormwater.minneapolismn.gov/) where users can explore all of the stormwater sites and learn more about how they work. The website was launched in the fall of 2022 and was updated with new content to keep visitors engaged.

CITY OF MINNEAPOLIS SALT MINI-COURSE PROGRAM

The City of Minneapolis Salt Mini-Course was launched in 2021 as an educational resource for residents, small businesses, and organizations. This online program aims to increase awareness of the negative environmental impacts associated with winter de-icing salt while providing best practices for snow and ice removal. Upon completing the course, users take a "*Salt Stewardship Pledge*" to demonstrate their commitment to local clean water and receive a sticker to display their knowledge to their communities.

Figure 1-29 Interpretive sign

CITY OF MINNEAPOLIS STAFF TRAINING

Surface Water & Sewers Employee Training

In 2023, SWS employees attended the following training:

- 10 staff members certified for Erosion & Sediment Control training
- 100 attended HAZWOPER refresher training
- 24 staff members certified for Wastewater Collection System license
- 16 staff members certified for NASSCO PACP/MACP
- 105 staff members attended Confined Space training
- 27 staff members attended GSI training

City Snow and Ice Management

City maintenance supervisors and equipment operators are trained in appropriate winter maintenance practices and procedures. Specific topics covered include guidelines for sand and salt application rates that are based on weather conditions, application techniques, and spreader calibration. All Public Works staff who perform snow and ice control typically attend a pre-winter season, annual review of procedures and best practices. In 2023, the City worked with the MPCA Smart Salting Trainers program. Annual HAZWOPER refresher training covers the recognition and response to hazardous materials or situations. The Division Director is active with the APWA Winter Maintenance Subcommittee and was a contributor and a trainer for the APWA's Supervisor's Winter Maintenance Certificate course.

- 32 staff members attended eight-hour refresher for 40-hour hazardous materials training class
- 201 staff members attended training on the use of salt as presented by watershed organizations

.

MPRB Staff Training

MPRB Snow and Ice Management Training

The MPRB has 30 staff that hold the MPCA's Road Salt Applicators Training Certificate. Individuals who hold this certificate have attended a voluntary training, completed, and passed an associated test, and agreed to voluntarily apply best management practices to reduce chloride impacts. Attendees chose trainings that focused on the type of work they do at MPRB, either application to roads or to small sites (parking lots and sidewalks).

MPRB Integrated Pest Management Training

Golf course foremen, most horticulture staff as well as other MPRB staff, attend the annual Northern Green Expo each January, where they receive updated information on the newest turf and other related research as it applies to fertilizers, pesticides, bio-controls, and other topics. This annual industry event focuses on professional development and networking of outdoor professionals. Topics range from turf management to invasive species updates to landscape design.

All new hires for full-time positions of park keeper, mobile equipment operator (MEO), gardener, golf course park keeper, arborist, service area crew leaders, arborist crew leaders, park operations managers, and forestry foreman are required to obtain their Minnesota Non-Commercial Pesticide Applicator license within 6 months of being hired. Every two years, as mandated by the Minnesota Department of Agriculture, staff attends re-certification training, that is offered and coordinated by the University of Minnesota. This effort is in conjunction with the Minnesota Department of Agriculture.

Other Education Partners

The City of Minneapolis has an official arrangement, through joint power agreements, with the BCWMC and SCWMC to provide financial contributions to the watersheds through an annual assessment. This assessment provides funding for the commissions' administrative operations and their public education programs.

Education-related activities of the BCWMC are guided by their 2015 Watershed Management Plan, specifically its education and outreach policies (Section 4.2.9), and education and outreach plan. The specific activities of the BCWMC public outreach and education program are set annually by the Commission after recommendations are forwarded by the BCWMC Education and Outreach Committee. The SCWMC also conducts education and public outreach activities on behalf of its member cities. SCWMC and BCWMC, along with other west-metro watershed management organizations, are a part of a cooperative education organization known as the West Metro Water Alliance (WMWA). 2023 water education activities for BCWMC, SCWMC, and WMWA can be found in Appendix A2.

CATEGORY TWO: PUBLIC PARTICIPATION AND INVOLVEMENT

PROGRAM OBJECTIVE

The objective of this stormwater management program is to maximize the effectiveness of the City's NPDES program by seeking input from the public.

PROGRAM OVERVIEW

The City of Minneapolis and the MPRB are the joint holders of the NPDES MS4 Permit, and this Annual Report is a coordinated effort by the City and the MPRB. The Permit requires an opportunity for public input in the development of the priorities and programs necessary for compliance.

The Permit requires the implementation of approved stormwater management activities, referred to as Best Management Practices (BMPs). The Stormwater Management Program (SWMP) is based on an adaptive management system by which the Permittees continuously monitor, analyze, and adjust the Program to achieve pollutant reductions. Using the adaptive management approach, revisions to the SWMP are submitted along with the Annual Report.

Each year, the City holds a public hearing at a meeting, prior to submission of the Annual Report. The hearing provides an opportunity for public testimony regarding the Program and Annual Report prior to report submittal to the Minnesota Pollution Control Agency (MPCA). The hearing is officially noticed in the Finance and Commerce publication and publicized through public service announcements on the City cable television channel. This year's public hearing date was at the Public Works and Infrastructure (PWI) Committee meeting on May 2, 2024.

A copy of the presentation, a list of public notice recipients, public comment received, and the staff letter can be found in the City's Legislation Management System (LIMS).

All testimony presented at the public hearing, and all written comments received, are recorded, and given consideration. The comments are included with the Annual Report as Appendix C. A copy of the City Council resolution adopting the Stormwater Management Program and Annual Report Activities is included each year with the submission to the Minnesota Pollution Control Agency. The Stormwater Management Program and the Annual Reports are available for viewing or downloading.

PREVIOUS YEAR ACTIVITIES

The Public Hearing was held on May 2, 2024, which was noticed 30 days in advance. The public was offered an opportunity to speak and provide comments on the SWMP and Annual Report. All public comments received are included in Appendix C of this report.

CATEGORY THREE: ILLICIT DISCHARGE DETECTION AND ELIMINATION

PROGRAM OBJECTIVE

The objective of this program is to minimize the discharge of pollutants to lakes, creeks, wetlands, and the Mississippi River by appropriately responding to spills and to detect, investigate and resolve illegal dumping, and disposal of unpermitted, non-stormwater flows in the City's stormwater drainage system including pavement, gutters, storm drains, catch basins, swales, permitted connections to the storm drain, and other conveyance infrastructure. Illicit discharges may be random, frequent, infrequent, accidental, or other, and may occur anywhere along the stormwater drainage pathways.

PROGRAM OVERVIEW

Dry Weather Flow Screening

In 2023, 68 outfalls were inspected for dry weather flow. No dry weather flow were identified. For more information, please see Appendix B-9.

Typical Hazardous Spill Response

The immediate goals of hazardous spill response are safety, containment of the spill, recovery of hazardous materials, and collection of data for use in assessment of site impacts. Motor vehicle collisions and electrical transformer overloads are examples of accidental releases, and results can include untreated waste and hazardous materials including heavy metals, toxics and solvents.

The life cycle of an event requires personnel from within the City and outside agencies to work as a team, utilizing resources to protect people, the environment, and property. Training and response procedures are coordinated by Regulatory Services, Public Works, and the Fire Department. The Regulatory Services Fire Inspection Specialist III is responsible for coordinating recovery efforts. Events are followed by post-action debriefings to determine the causes of the events, to identify measures to improve the City's response, and to determine the means to limit future occurrences. As the assessment of the event progresses, other departments and/or outside agencies or contractors may become involved. Full procedures are documented in the City of Minneapolis Emergency Action Plan.

For small spills of petroleum products or other vehicle fluids, personnel are dispatched with appropriate equipment to apply sand or floor-dry. Once the spill has been absorbed, it is removed and deposited in a leak-proof container. For large or extremely hazardous spills, a Hazardous Materials Response Team is mobilized and augmented with staff from additional departments, outside agencies and/or contractors if warranted as the event progresses. For spills that reach the Mississippi River or Minneapolis lakes, boats are available for spill response and personnel are trained in boom deployment.

Spills are reported to the MPCA Public Safety Duty Officer, 911 Emergency Communications and, for qualified spills, to the State Duty Officer as required by law.

The protocol used by the Street Maintenance section for handling spills is documented in Appendix A4: Standard Operating Procedure for Vehicle Related Spills.

Emergency Response Program

Minneapolis Regulatory Services utilizes a boat to respond to spills that could impact water resources. A properly equipped boat facilitates addressing these events on the Mississippi River as well as on City lakes. Regulatory Services and Public Works staff are trained in the river deployment of booms, have field experience in the placement of both containment and absorbent types of booms, and have years of experience on the water. These skills, coupled with an extensive knowledge of the Mississippi River, City lakes, landings, and outfalls, provide a high level of protection for our precious natural resources.

Boom Deployment Drill

Additionally, the boat is used to place monitoring and sampling equipment for tracking water quality, identifying points of illegal discharges, outfall assessment, and investigation of complaints that are inaccessible from shore. The City assists the Mississippi Watershed Management Organization (MWMO) in conducting a sampling program of the storm drainage system that drains to the Mississippi River to detect illegal discharges and establish a baseline of chemical, physical, and biological parameters.

Unauthorized Discharges

City Environmental personnel carry out pollution prevention and control activities. Results are achieved through educational efforts, inspections, and coordinated outreach events. These activities include enforcement pursuant to applicable City codes, and coordination with other regulatory agencies at county, state, and federal levels. Enforcement yields identification of the responsible party, documentation of clean-up activities, and endeavors to reduce the flow of pollutants from illegal dumping and disposal. Response is made to reports of unauthorized discharges and illicit connections.

Complaints are received from various sources, including Minneapolis residents, private contractors, City staff, the State Duty Officer, and other government agencies. People with environmental concerns within Minneapolis are directed to contact 311 directly.

Minneapolis Public Works also provides site investigation and mapping assistance for MPCA permit enforcement and compliance programs for other types of discharges.

Facility Inspection Program - Stormwater Pollution Prevention Plans (SWPPP)

The City of Minneapolis has developed a facility inspection program for private, City owned, and other public facilities that store large quantities of both regulated and hazardous materials. Inspectors perform site visits of these facilities to review handling, storage, and transfer procedures as they relate to the site, spill response plans and equipment on site. Minneapolis Fire Inspection Services participates in most of the inspections, reviewing spill response strategies.

Trash Reduction Program

The MPCA has mandated that the city and MPRB implement a structural BMP to capture trash at the 43rd Street outfall, which discharges into Lake Hiawatha at the Hiawatha Golf Course. Prior to the issuance of the new MS4 permit, a floating trash boom capture system was installed at the 43rd Street outfall. This was done through a project partnership with River Network, Freshwater Society, Friends of Lake Hiawatha, Osprey Initiative, the city, and the MPRB with a grant from the Coca-Cola Foundation.

The trash capture system was installed on June 3, 2023**.** The trash capture system is comprised of two layers of floating boom placed in tandem, which are attached to the shore and form a concentric arch from the outfall. The booms capture floatable debris and trash and retain it until it can be manually removed. The trash booms are accessible by canoe, and the accumulated trash is removed by hand, weighed, surveyed, and categorized. All recovered materials are properly disposed of in accordance with all applicable regulations.

In 2023 a total of 138 lbs./37 cubic feet of litter and recyclable material was removed from the litter boom. An additional 127 lbs./21 cubic feet of litter and recyclable material was removed from the lakeshore as part of regular tactical cleanups that occurred throughout the summer and fall monthly between June and November.

PREVIOUS YEAR ACTIVITIES

Spill Response and Training

In 2023, the City received a total of 98 emergency complaints from the State Duty Officer and were responded collectively or individually by the City's various teams (FIS, MES, MFD, or PW streets). Additionally, City's Environmental Services addressed 11 urgent environmental pollution incidents and responded to 321 complaints related to land pollution.

In 2023, Environmental Service, Food Lodging and Pools, and Healthy Homes and Lead Hazard Control departments participated in an eight-hour of hazmat refresher course.

CATEGORY FOUR: CONSTRUCTION RELATED EROSION & SEDIMENT CONTROL

PROGRAM OBJECTIVE

The objective of this stormwater management program is to minimize pollutant discharge through the regulation of construction projects. Regulation addresses erosion and sediment control for private development and redevelopment projects and for public projects completed by the City and the MPRB. Minneapolis Code of Ordinances Air Pollution and Environmental Protection, Chapter 52 Erosion and Sediment Control and Drainage contains erosion and sediment control requirements and other pollution control requirements related to construction site management.

PROGRAM OVERVIEW

Ordinance

In 1996, the Minneapolis City Council amended Title 3 of the Minneapolis Code of Ordinances relating to Air Pollution and Environmental Protection by adding Chapter 52, entitled *Erosion and Sediment Control for Land* Disturbance Activities (now Erosion and Sediment Control and Drainage). In 2023, the City of Minneapolis worked with Stantec Consulting to review the current Chapter 52 language and identify areas that needed to be updated to be in compliance with the City's MS4 permit and opportunities for improvement to enforcement. Changes will be made to Chapter 52 in spring/summer 2024.

Requirements

The City's Erosion and Sediment Control ordinance addresses development sites, demolition projects, and other land disturbing activities. Sites disturbing more than five cubic yards, or 500 sq ft, are required to have an erosion control permit. Erosion and Sedimentation Control (ESC) Permits must be acquired before work starts and must be obtained before a building permit will be issued for the site.

For all disturbances greater than 5,000 sq ft, or 500 cubic yards, an approved erosion control plan is also required for demolition and construction projects before the ESC Permit can be issued. Enforcement continues until sites are 70% vegetated and all temporary erosion and sediment controls are removed.

Enforcement

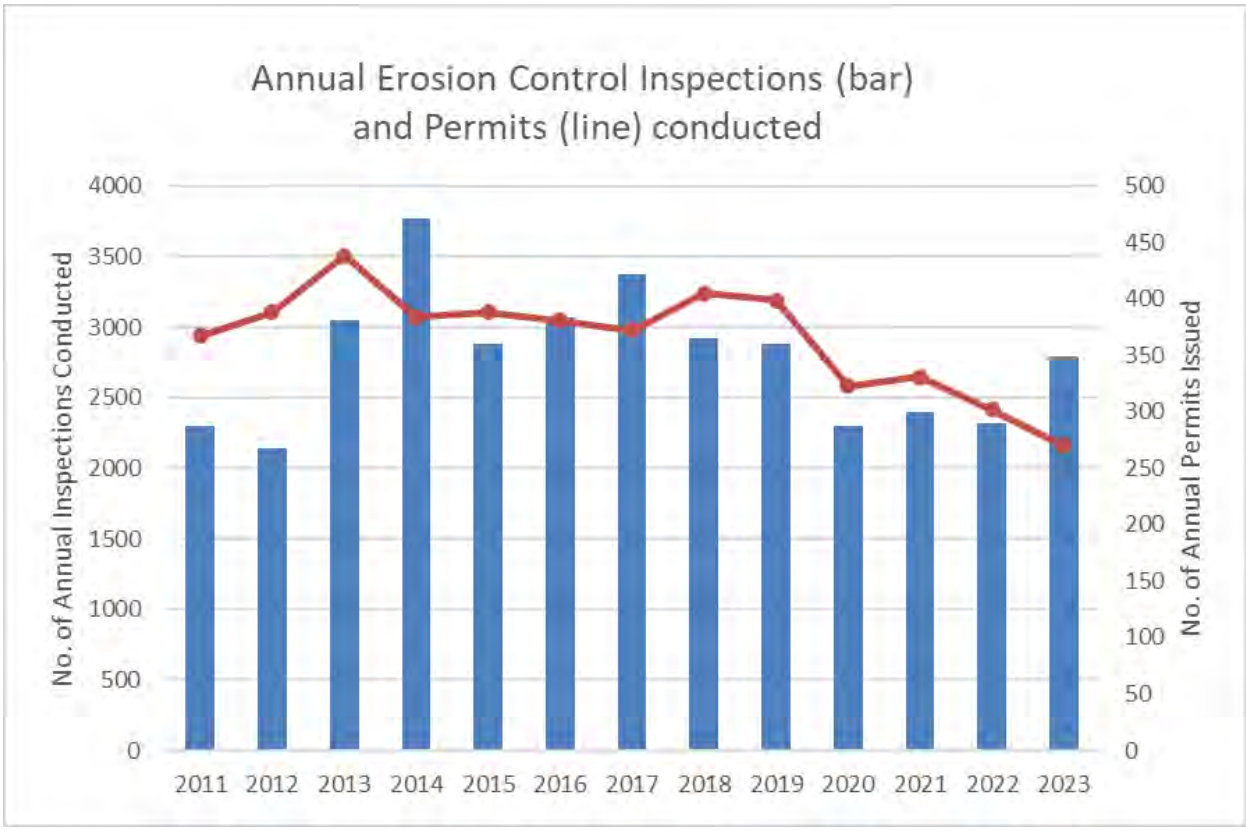
Ongoing site inspections are performed by City of Minneapolis Health Department Environmental Services inspectors. Inspectors may issue advisories, orders to correct and citations (fines). Failure by the permittee to comply with the ordinance will constitute a violation pursuant to Section 52.300. If there is a demonstrated failure to comply, the City reserves the right to terminate an ESC permit at any time. The City then has the option of proceeding with the necessary restoration of the site. This restoration would be done at the expense of the owner/permittee.

PREVIOUS YEAR ACTIVITIES

Generally, since 2011 the number of sediment and erosion control permits issue has remained relatively consistent. While the number of permits issued by the City has been consistent, the number of inspections increased. Minneapolis normally employs four environmental inspectors that address sediment and erosion control enforcement, and the City hires four additional seasonal technicians to

help increase inspection frequency during the busy summer months. Budget cuts in 2020 brought the number of FTE inspectors to 3. New funding identified in late 2023 enabled the City to return to four full-time inspectors in early 2024.

Year	Permits Issued	Inspections	Citations
2023	270	2,794	80



CATEGORY FIVE: POST-CONSTRUCTION STORMWATER MANAGEMENT

PROGRAM OBJECTIVE

The objective of this stormwater management program is to reduce the discharge of pollutants and stormwater runoff from public and private development and redevelopment projects, as compared to conditions prior to construction. Redevelopment of existing sites can lessen the impacts of urbanization of the waters of Minneapolis, since most present land uses were created prior to regulation under the Clean Water Act.

Regulation includes approval of stormwater management including ongoing operation and maintenance commitments. Minneapolis Code of Ordinances Title 3 Air Pollution and Environmental Protection, Chapter 54 - Stormwater Management, contains stormwater management requirements for developments and other land-disturbing construction activities.

PROGRAM OVERVIEW

Stormwater Management Ordinance

In 2021, the Minneapolis City Council amended the Chapter 54 Ordinance Stormwater Management Ordinance, which requires stormwater management plans utilizing permanent stormwater practices for all construction projects disturbing sites greater than 1/2 acre in size. This update to the ordinance went into affect on January 1, 2022. The ordinance updates bring the city's post construction management program into compliance with the current NPDES MS4 Phase I permit.

Development plans are reviewed through the Minneapolis Development Review (MDR) process and approved by the Surface Water & Sewers Division. Operation and Maintenance Plans for BMPs are also required as part of the approval process. Inspections of constructed BMPs are required and performed by the property owner or manager. These annual inspections are reviewed and approved by city staff, before being registered with Environmental Services, which includes a Pollution Control Annual Registration fee.

Pollinator friendly plants at Sanford Middle School infiltration basin

PREVIOUS YEAR ACTIVITIES

The City of Minneapolis tracks and manages compliance for nearly 900 private stormwater management systems that include over 1,500 BMPs on over 600 properties under Chapter 54 of the Minneapolis Code of Ordinances. Chapter 54 implementation has been very effective at seeing BMPs installed as properties develop in Minneapolis.

During 2023, Minneapolis Public Works reviewed 121 private development projects, approving 86 of these projects. 30 of these approved projects were required to comply with Chapter 54 stormwater requirements, with 31 BMPs proposed. 9 non-Chapter 54 projects proposed 10 BMPs. These BMPs will provide rate control, volume control and water quality for approximately 66 acres of land, including 44 acres of impervious area.

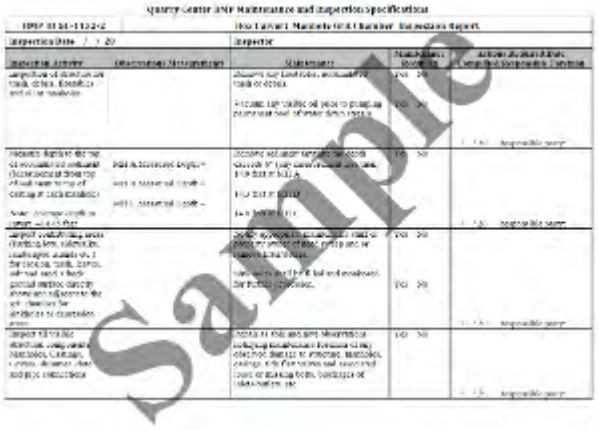
As of January 1, 2022, the City's Chapter 54 ordinance began requiring implementation of stormwater management facilities on public linear projects that disturb at least half an acre. During 2023, two City of Minneapolis linear street reconstruction projects that required compliance with Chapter 54 stormwater requirements were reviewed and approved.

Operations, Maintenance and Reporting

Timely and frequent maintenance on a Chapter 54 rain garden provides spectacular results

All stormwater management devices are required to be inspected by the owner or responsible party as specified in the approved plan. Inspection reports determine and recommend maintenance types, activities, and frequencies to restore the BMP's original design function. Inspection process must lead to a maintenance recommendation including taking no actions if BMP found in full compliance.

Site inspections and maintenance by the property owner are important to the long-term sustainability of any stormwater BMP. With limited staffing to inspect an ever-growing private BMP inventory, it is important to have a site and BMP specific *Operations and Maintenance Plan.* Minneapolis staff recognized this need and developed self-inspection forms. These were paired with onsite training for property owners to better maintain and inspect BMPs with limited regulatory oversight. As better plans are developed using templates and property owners are trained to self-inspections, the hope to increase reporting numbers (currently less than 30% annually).



Current program support is critical as the number of existing private BMP's and additional BMPs in the future, the program's sustainability is challenged by when relying on small site BMP's. Maintenance, regulation, and performance of small site BMP's may not be sustainable or cost effective in the long run. Regional BMPs or pay in-lieu programs that contribute to public BMP's should be examined to efficiently provide stormwater treatment in a fully developed urban environment.

CATEGORY SIX: POLLUTION PREVENTION AND GOOD HOUSEKEEPING FOR MUNICIPAL OPERATIONS

PROGRAM OBJECTIVE

The City of Minneapolis operates its public works systems in a manner that maintains efficient and effective operability, ensures structural integrity, complies with regulatory requirements, and safeguards the ability to prevent impacts to health, safety, property infrastructure, and the environment. This is accomplished through the proper operation and maintenance of structural stormwater management practices, public streets, bridges, and alleys, parks and golf courses, municipal properties, municipal parking lots, and municipal equipment yards.

STORM DRAIN SYSTEM OPERATIONAL MANAGEMENT AND MAINTENANCE

PROGRAM OBJECTIVE

The objective of this NPDES stormwater management program is to minimize the discharge of pollutants through the proper operational management and maintenance of the City's storm drain system, streets, alleys, and municipal property. The City of Minneapolis contributes stormwater runoff to various receiving waters both inside and outside of City boundaries, including Minnehaha Creek, Bassett Creek, Shingle Creek, several lakes, and the Mississippi River. Maps of the drainage areas that have been delineated according to topographic contours and the storm drain system are included in Appendix B. The 2020 population, size of drainage area, and land use percentages by body of receiving water are listed in Appendix A5.

PROGRAM OVERVIEW

The City's storm drain system is managed and maintained by the Operations section of the Public Works Department Surface Water & Sewers (PW-SWS) Division. Design engineering and regulatory issues are managed by the division's Capital and Regulatory sections, respectively.

The City utilizes Maximo™ to compile assets, track work orders, and assist in work scheduling and purchasing.

Brick Egg-type Sewer

Maximo™ identifies the current state of assets and asset attributes (e.g., age, condition, etc.) and utilizing a standardized rating process for assets and asset attributes (e.g., National Association of Sewer Services Companies (NASSCO) Pipeline Assessment and Certification Program (PACP)).

PW-SWS Operations identifies risk areas, criticality of system, and life-cycle costs. This improves future decision making because of data and analysis (e.g., succession planning, level of maintenance response, Capital Improvement Project prioritization), improve documentation and recordkeeping of assets (e.g., Maximo software),

improve coordination and communication, lower long-term operation and maintenance costs, improve regulatory compliance. This is used as a communication tool for staff and regulators for effective information transfer and knowledge retention.

The current staffing level of the PW-SWS Operations section is approximately 143 full-time employees and are key components for achieving the City's overall management goals. This decrease is anticipated to result in a more reactive approach. In the PW-SWS Operations, there are currently 75 permanent, full-time employees working directly within Sewer Maintenance (includes both storm and sanitary personnel), and the remainder work within rehabilitation. General maintenance efforts include checking hours at pump stations, performing pump station maintenance, pipe inspections, pipe cleaning, system repairs, rehabilitation or reconstruction of existing infrastructure, inspection and operation of control structures, operation of pump stations, cleaning of water quality structures, and operational management of stormwater detention ponds.

The table below shows the base operational functions along with the corresponding staffing:

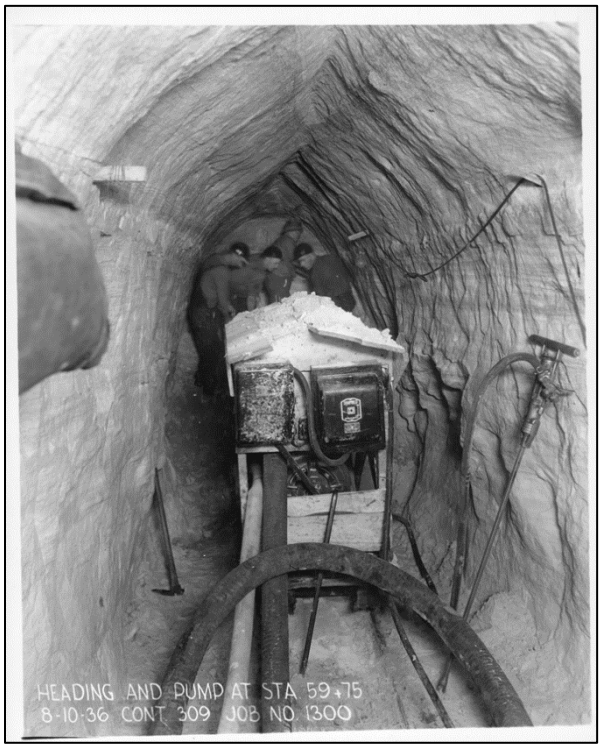
Crews	Staff/crew	Type	Tasks
4	2	Route Truck	Daily pipeline system inspections, complaint response, and resolution to minor system operational problems
5	2	Jet Truck	"As-requested" cleaning of storm system components, routine cleaning of sanitary system pipes, and "as-requested" cleaning of pump/lift stations. Hydro jet-wash technique.
4	2	Jet-Vac Truck	Routine cleaning of storm system infrastructure. Hydro jet-wash technique. Storm sewer cleaning by vacuum removal of sludge and debris build-up.
3	2	TV Truck	Televise and inspect storm drain and sanitary sewer system components. Log and assess condition of televised lines to determine and prioritize rehabilitation and/or repair needs to storm drain and sanitary sewer system components.
0	0	Repairs	Perform medium-sized repairs, requiring minimum excavation, to storm drain and sanitary sewer system pipeline components. May assist in the repair or reconstruction of larger repair/ reconstruction jobs. (This work is contracted out)
2	2	Vac Truck	Vacuum-cleaning of water quality structures, manholes, and catch basins within the storm drain system. Assist in sanitary sewer cleaning by vacuum removal of sludge and debris build-up. Assist in repair/ construction activities using vacuum excavation process. Assist in erosion control compliance using vacuum cleanup of eroded soils and/or cleaning of erosion control structures.

1	0	Rod Truck	Remove roots and foreign objects from sanitary sewer system. Remove large debris from storm drain-pipes and free ice from frozen catch basin leads. (City forces currently do not have enough staff to operate this vehicle)
1	6	Pond & Pump	Operate, maintain, and repair sanitary lift station and stormwater pump stations. Operate and maintain stormwater detention basins.
1	1	Shop	Perform general maintenance and repair to specialty use vehicles and emergency response equipment. Fabricate, as needed, custom metal and wood objects for sewer and storm drain operations. Provide field deliveries of materials, tools, and equipment. Maintain material inventory and fleet management data.

PREVIOUS YEAR ACTIVITIES

2023 Storm Drain Infrastructure cleaning and repair information data

- Completed repairs on 116 catch basins
- Cleaned 2.83 miles of storm drain utilizing hydro-jet washing
- Televised and condition assessed 1.6 miles of storm drain-pipes
- Continued work on the Central City tunnel, which is constructing a new parallel tunnel downtown in order to handle the increased amount of stormwater that has been directed into the tunnel system
- Tracked 877 repairs for catch basins via Maximo asset management system



WATER RESOURCE FACILITIES OPERATIONAL MANAGEMENT AND MAINTENANCE

PROGRAM OBJECTIVE

The objective of this NPDES stormwater management program is to minimize the discharge of pollutants through the proper operational management and maintenance of water resource facilities (stormwater

practices) within the City's storm drain system that affect system flow, rates, quantity, and water quality discharges.

Maintenance

Minneapolis Surface Water & Sewers maintains approximately 644 public BMP systems, including:

- Catch Basins 26,511
- Sump Catch basin 163
- Storm Manholes 20,864
- Grit Chambers 157
- Other Structural Management Practices 487
- Sump manhole 110

PROGRAM OVERVIEW

Stormwater management facilities are part of the City's overall storm drainage system and are managed and maintained by Surface Water & Sewers Operations. These components are routinely inspected and maintained to ensure proper operation and reliability. Frequency of inspections and assigned maintenance efforts are based on both operational experience and incurred environmental events.

By agreement with the City of Minneapolis and the MPRB, the Minnehaha Creek Watershed District monitors the design capacity of several stormwater ponds in Minneapolis and performs dredging and restoration as needed including testing for proper disposal. The MPRB also maintains small scale Park Board stormwater devices including ponds, rain gardens, and pervious pavement.

Vegetated Swale at 25th Ave. SE

Water resource facilities for water quality improvement are separated into five separate categories:

Pre-Treatment Practices

Pretreatment is an integral part of BMP application. In many applications (infiltration and stormwater ponds) the practice would not function properly if pre-treatment is ignored. Pre-treatment techniques are used to keep a BMP from being overloaded, primarily by sediment. Pre-treatment can also be used to dampen the effects of high or rapid inflow, dissipate energy, and provide additional storage. These benefits help overall BMP performance. Types of pre-treatment practices include:

- Settling devices (grit chambers)
- Sump manholes
- Storm Drains – sometimes enhanced with SAFL baffles, forebays, oil / water separators, and vegetated filter strips

Filtration Practices

Filtration BMPs treat urban stormwater runoff as it flows through a filtering medium like sand or an organic material. They are generally used on small drainage areas and are designed for pollutant removal. They are effective at removing TSS, particulate phosphorus, metals, and most organics. They are less effective for soluble pollutants such as dissolved phosphorus, chloride, and nitrate. Most filtration BMPs will achieve some volume reduction, depending on the design and the use of vegetation to promote evapotranspiration. Filtration practices used in the City include rain gardens with underdrains and iron enhanced sand filters.

Vegetated Swale at Redeemer Church

Infiltration Practices

Infiltration BMPs treat urban stormwater runoff as it flows through a filtering medium and into underlying soil, where water percolates into groundwater. This removes pollutants from the runoff, either by being trapped within the practice, or broken down by chemical processes within the first few feet of soil. The filtering media is typically coarse-textured and may contain organic material, as in the case of bio-infiltration BMPs. These practices are primarily designed for removal of stormwater runoff volume and pollutants in that runoff. They are effective at removing TSS, particulate phosphorus, metals, bacteria, nitrogen, and most organics. Soluble pollutants such as chloride and nitrate typically percolate through these BMPs and into underlying groundwater. These BMPs, when designed with no underdrain, include rain gardens, tree trenches (including Silva Cell systems), underground infiltration, and infiltration trenches including dry wells.

12x10 Infiltration Box Culvert Installation

Sedimentation Practices

Sedimentation is the process by which solids are removed from the water column by settling. Sedimentation BMPs include:

- Dry ponds
- Wet ponds
- Wet vaults
- Proprietary devices

Infiltration Box Culvert – inside view

Proprietary hydrodynamic devices are limited to treating small tributary areas while constructed ponds and wetlands can be designed to treat runoff from a larger tributary area. These BMPs provide temporary storage of stormwater runoff and allow suspended solids to settle and be retained by the BMP. These BMPs are effective at removing TSS and any pollutants adsorbed to the solids but that are not effective in removing soluble pollutants or in providing any volume reduction.

Chemical Practices

Stormwater BMPs that employ chemical treatment are typically designed for treatment of a specific pollutant. Phosphorus is the most common pollutant of concern, but chemical treatment may also be employed for nitrogen, metals, and organic pollutants. The City has installed iron-enhanced sand filters which chemically bind phosphorus. Between 1998 and 2001, MPRB treated Cedar Lake, Lake of the Isles, Lake Harriet, and Bde Maka Ska with alum to reduce internal loading of phosphorus in those waterbodies.

Voluntary Green Infrastructure Installation

The City recently updated their GI website, which includes information about what GSI is, types and benefits of GSI, different GSI projects (both completed and under construction) in Minneapolis, and training and guidance documents on effectively implementing GSI.

The City installed green infrastructure projects voluntarily on road projects that were not subject to the stormwater management ordinance. The projects include both sustainable landscaping (SL) and green stormwater infrastructure:

Concrete Rehab – Southside Green Zone GI

- Added 5 bioretention facilities and 3 native planting areas into bump-outs and medians
- Converted approximately 8,000 SF to green infrastructure

Lyndale Ave N Pedestrian Safety Improvement

- Incorporated 10 bioretention facilities into bump-outs and chicanes
- Converted approximately 5,000 SF to green infrastructure

Traffic Projects:

- 2023 HSIP: Added 3 bioretention facilities into bump-outs
- ARPA Traffic Circles: 20 traffic circles planted with native vegetation

Structural Controls

The City also employs structural controls to manage stormwater runoff that are not directly related to water quality, including:

Storm Drain Outfall Inspections

Storm drain outfalls are the structural ends of system pipelines where conveyance of stormwater runoff is discharged into a receiving water bodies. Outfalls are inspected on a 5-year schedule, and evaluate the general condition of structures, determine if any significant erosion has occurred and observe any contaminant discharges. If indications of illicit or contaminated discharges are found, they are reported to Minneapolis Environmental Services for reporting to the Minnesota State Duty Officer for further investigation and resolution. Any identified structural repair or maintenance work is prioritized and scheduled considering available personnel, budget funding, and coordination with other essential operations.

Grit Chamber Construction at Dean Pkwy

Every year, Mississippi Watershed Management Organization (MWMO)samples a number of Mississippi River outfalls as well as conducting visual inspections of those outfalls. Due to staff turnover, the total number of sampling and inspections were not available for 2023; however, will be documented as soon as the information becomes available.

Outfall inspections by staff from Surface Water & Sewer Operations, Environmental Services, and Regulatory Services help to detect contaminated flows in the storm drain system, and maintenance crews routinely inspect and clean storm drain structures. In addition, inspections of flows that generate unusual odors, stains, and deposits are included in the annual tunnel inspection, outfall inspection, and grit chamber inspection and cleaning programs. Suspect flows are reported to Environmental Services inspectors for further investigation. Environmental Services personnel also receive reports of alleged illicit discharges to the storm drain system from the public, other City departments, and various agencies. In 2023, City staff inspected 68 outfall structures for condition. In 2020, the City created an Outfall Working Group that has:

- Compiled all past outfall inspections reports and data bases into one site
- Adopted Survey123 software and provided training on it to use for conducting outfall inspection
- Developed a uniform inspection form for various City staff to use for outfall inspections
- Has developed a protocol for reporting spills, suspected dry flows, and illicit discharges

Pumps & Weirs

These structural devices mechanically affect the flow of stormwater runoff through the storm drain system. Pump stations are inspected regularly for routine operational checks and are annually for detailed condition assessment. Maintenance and/or repairs are performed with routine items being completed as needed and larger items being coordinated into a budgeted pump station operation program. Weirs and outlet structures are inspected and repaired as needed to facilitate their proper operational working order.

Storm Drains

These structural devices located along the City's street system and provide entrance of stormwater runoff into the storm drainage system. Public Works crews look for plugged or damaged structures. Reported damages and / or plugs are given a priority for repair and / or cleaning. Cleaning storm drains, while ensuring proper runoff conveyance from City streets, also removes accumulated sediments, trash, and debris. Augmenting this effort is the street sweeping program that targets the pick-up of street sands, leaves, and debris prior to their reaching storm drains. Repair of damaged storm drains is also a priority, given their location in City streets and ultimate impact to the traveling public. Residents or businesses can adopt storm drains through the Adopt-a-Drain Program, which helps to keep leaves, sediment and garbage out of the storm drain system and local waters.

PREVIOUS YEAR ACTIVITIES

- Monitored and maintained 23 pump stations

DISPOSAL OF REMOVED SUBSTANCES

PROGRAM OBJECTIVE

A key component of the MS4 stormwater management program is collection and disposal of materials removed from the storm drain system and structural controls in a manner that will prevent pollution and that will comply with applicable regulations.

PROGRAM OVERVIEW

Accumulated materials are removed from grit removal structures, storm drains, system piping, and deep drainage tunnels during the process of inspection and cleaning. Removed substances are screened for visual or olfactory indications of contamination. If contamination is suspected, the City's Engineering Laboratory will select representative samples for an environmental analysis. Contaminated substances are disposed of at a MPCA approved landfill or site. Non-contaminated targeted pollutants are disposed of the same way as street sweepings. During cleaning and disposal operations, erosion control measures are applied when needed to prevent removed material from re-entering the storm drain system.

The process for accumulated materials dredged from stormwater ponds is similar. The materials to be dredged from stormwater ponds are tested in advance and disposed of properly according to MPCA guidance.

PREVIOUS YEAR ACTIVITIES

In 2023, Minneapolis Public Works crews removed 349 cubic yards accumulated sediment and debris from grit chambers with 72% of grit chambers maintained in 2023.

Storm Sewer Pipe Jetted

City of Minneapolis Sewer Forces removed material from 75 segments of pipe, totaling 11675 LF in 2023 using Jetting and Jet / Vac equipment. This totals 11675 LF (2.2 miles) of City of Minneapolis directed work for Jetting of the Storm system.

Catch Basin (Storm Drain) Repair

In the 2023 we completed 199 Catch Basin Repairs. We currently have 690 needed catch basin repairs in our asset management system.

Storm Sewer Pipe Televised

City of Minneapolis Forces televised 8,448 LF of Storm sewer in 2023. City of Minneapolis contracted the televising of 0 LF of Storm Sewer in 2023. This totals 8,448 LF (1.6 miles) of Storm Sewer televised in 2023

FACILITY MANAGEMENT

PROGRAM OBJECTIVE

The stormwater management objective of these activities is to prevent or reduce the discharge of pollutants generated at City and MPRB owned facilities. Facilities include but are not limited to:

- Composting sites
- Equipment storage and maintenance
- Hazardous waste disposal
- Hazardous waste handling and transfer
- Landfills
- Solid waste handling and transfer
- Parks
- Pesticide storage
- Public parking lots and ramps
- Public golf courses
- Public swimming pools
- Public works yards
- Recycling sites
- Salt storage yards
- Vehicle storage at maintenance yards
- Materials storage yards

PROGRAM OVERVIEW

Pollutant control is managed through proper storage of materials, routine maintenance, effective application of winter salt and deicers, and installation of structural stormwater management practices. Operations are performed to address public safety while balancing those needs with environmental and cost considerations.

PREVIOUS YEARS ACTIVITIES

In 2016, the City began developing Stormwater Pollution Prevention Plans (SWPPPs) for City and MPRB-owned facilities to reduce the discharge of pollutants into the storm sewer system from municipal and MPRB operations. An inventory of municipal operations facilities has been created which includes over 70 facilities:

- Vehicle and Equipment Maintenance Facilities
- Fleet Services

- Parking Lots and Ramps
- Fire Stations
- Police Stations
- Water Services Facilities
- Stockyards
- MPRB Service Centers
- MPRB Dog Parks

Site specific plans are being developed for each facility which include site maps, operations specific Best Management Practices, and inspection and reporting requirements.

These facility plans will be used to facilitate regular site inspections that will document and correct potential sources of pollution or illicit discharge to the storm sewer system from City or MPRB-owned properties. Inspection frequency will be evaluated based on site specific needs such as continuing or ongoing issues, seasonal site usage, or change in property use. Implementation of the facility management plans will be prioritized based on the highest pollutant potential.

ROADWAYS

PROGRAM OBJECTIVE

The objective of this stormwater management program is to minimize the discharge of pollutants through the proper operation and maintenance of public streets and alleys.

PROGRAM OVERVIEW

Street Sweeping

Minneapolis Public Works employs several street sweeping approaches. Some are citywide, and some vary by area or land use. Curb-to-curb sweeping operations occur citywide in the spring and fall when all city streets are swept systematically (alleys are included in the spring), and temporary parking bans are enforced to aid with sweeping operations.

Operational routines and special methods are employed to address seasonal conditions, and to optimize cleaning. Flusher trucks apply pressurized water to the streets to push sediment and debris to the gutters. Street sweepers follow behind the flusher trucks and clean the gutters. During the fall, leaves are first bunched into piles, and then the leaves are picked up before flushing and sweeping occurs. During the summer, between the spring and fall sweep events, sweepers are assigned to maintenance districts for periodic area sweeping. Downtown and other high traffic commercial areas are swept at night on a weekly basis. In addition, summer sweeping in the Chain of Lakes drainage areas has occurred since 1995 as part of the Clean Water Partnership project. Two sweepers are dedicated to cleaning drainage areas around the Chain of Lakes, and one sweeper is devoted to the Minneapolis Parkway System.

The materials collected from street sweeping are received at two different locations, depending on time of the year and nature of the material. The inorganic materials go to a landfill site in Becker, MN, to be used as daily cover. The Mulch Store in Chaska, MN, receives the City's organics each fall.

New Street Sweeping Signs

In the fall of 2021, the Minneapolis Safety/LMC Committee came up with an idea for different colored street sweeping signs. Numerous color options were considered, and pink ended up being the consensus. A QR code was also incorporated into the rough design. Staff from Public Works, Surface Water & Sewers division supplied additional ideas and messaging regarding the Adopt-a-Drain Program and sweeping up in Minneapolis streets.

Minneapolis Communications was involved for final approval of the new design, with the goal being better visibility and communication for street sweeping. Citywide, Minneapolis deploys over 4,000 signs daily during the 4-week comprehensive sweep. Due to high visibility of the new street sweeping signs, compliance with residents had noticeably improved.

Downtown Improvement Districts

Special service districts are defined areas in Minneapolis where increased levels of service are provided and paid for by the commercial or industrial property owners in the district. One of these special service districts, the Downtown Improvement District (DID) is a business-led non-profit organization with "a mission to make downtown Minneapolis a vibrant and attractive place for recruiting and retaining businesses, employees, residents, shoppers, students, and visitors. This is accomplished by providing services that make the 120-block district cleaner, greener, and safer." The organization is an important partner to the City, carrying out maintenance activities in the downtown public realm that minimize the discharge of pollutants through the proper maintenance of public right-of-way areas. The DID removes trash from sidewalks and operates sweepers for gutters and sidewalks throughout the 120-block district.

Snow and Ice Control

The Minneapolis Transportation, Maintenance, & Repair Division applies salt and sand to City roadways every winter for snow and ice control. Efficient application of de-icing materials appropriately balances three primary concerns: public safety, cost control, and environmental protection.

Reduced material amounts provide a cost savings and are the best practice available for reducing harmful impacts on the environment. Sand harms lakes and streams by disturbing the ecosystems, and in depositing pollutants that bind to sand particles in lake bottoms and streambeds. An accumulation of sand calls for more frequent cleaning of storm drains and grit chambers. Salt (chloride) is harmful to aquatic life, groundwater, and to most plant and tree species. Salt causes corrosive damage to bridges, reinforcement rods in concrete streets, metal structures and pipes in the street, and vehicles.

Within Minneapolis, the following lakes and creeks do not meet standards for concentrations of chlorides set by the MPCA and are considered impaired:

- Bassett Creek
- Brownie Lake
- Diamond Lake
- Loring Lake
- Minnehaha Creek
- Powderhorn Lake
- Shingle Creek
- Spring Lake
- Wirth Lake

Reducing usage of salt was the focus of the Shingle Creek Chloride TMDL Report, which was approved by the EPA in 2007. It placed limits on chlorides (salt) discharged to Shingle Creek**.** Consequently, the City developed improved snow and ice control practices**,** and they are being implemented not only in the Shingle Creek drainage area, but also citywide. These practices are in line with the 2016 Twin Cities Metropolitan Area Chloride Management Plan completed by the MPCA.

Material spreaders are calibrated annually before the winter season. Maintenance yard housekeeping practices are designed to minimize salt/sand runoff, and materials used are tallied daily. Salt stockpiles are stored under cover to minimize potential groundwater contamination and runoff to surface waters.

PREVIOUS YEAR ACTIVITIES

The 2023-2024 winter season was one of the least snowiest on record which required less granular material usage. There were 14 notable events with 29.5 inches for the season, as compared to an average of 50 inches. The most snowfall was observed in March. There were no declared snow emergencies, compared to the annual average of four, and there were 123 days of temperatures at or below freezing by late of April. December saw around 2.28 inches of moisture which was 1.11 inches above normal with some freezing rain in February . The quantities of salt and sand used in snow and ice control are tracked by recording amounts that are delivered by suppliers, and by estimating the quantities that are on-hand daily. Street sweepings are scaled at the disposal site and reported to the City for record purposes only. Leaves picked up are weighed at the contractor's transfer facility in Minneapolis. The statistics for last year's program are as follows:

- 3,213 tons of salt applied to roadways
- 1,954 tons of sand applied to roadways
- 12,702 tons of materials reclaimed during spring and summer street sweeping operations
- 4,568 tons of leaves collected for composting during the fall Citywide sweeping

The City has been tracking the amount of salt applied within the City since 2001, and Minneapolis has continuously reduced the use of salt by 40%.

Figure 6-1 shows the tons of salt applied annually. Figure 6-2 shows the amount of sand and salt applied in the City relative to the days below freezing. Figure 6-3 shows the amount of sand and salt applied in the City relative to the total amount of snowfall. These figures show that there has been an overall reduction in the amount of salt applied in the City. There has also been a reduction in the amount of salt applied relative to both the days below freezing and the inches of snowfall in the City.

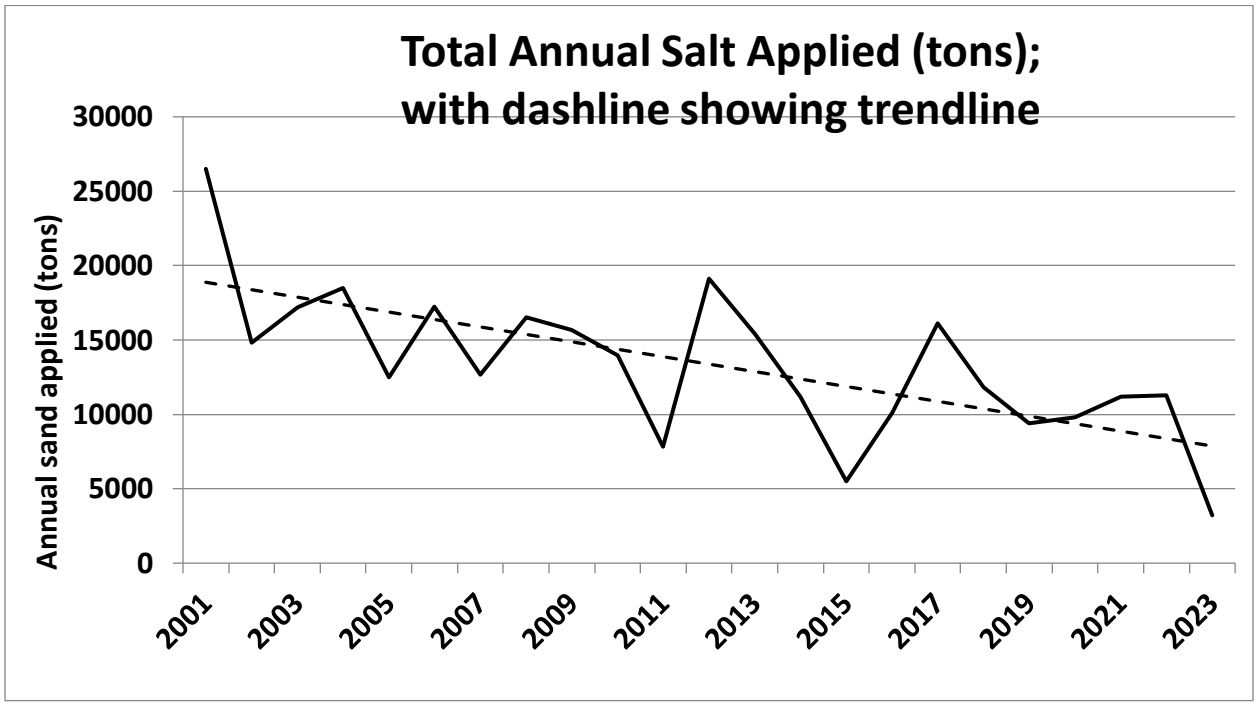


Figure 6.1 Tons of salt applied annually

Figure 6.2 Amount of sand and salt applied relative to the days below freezing

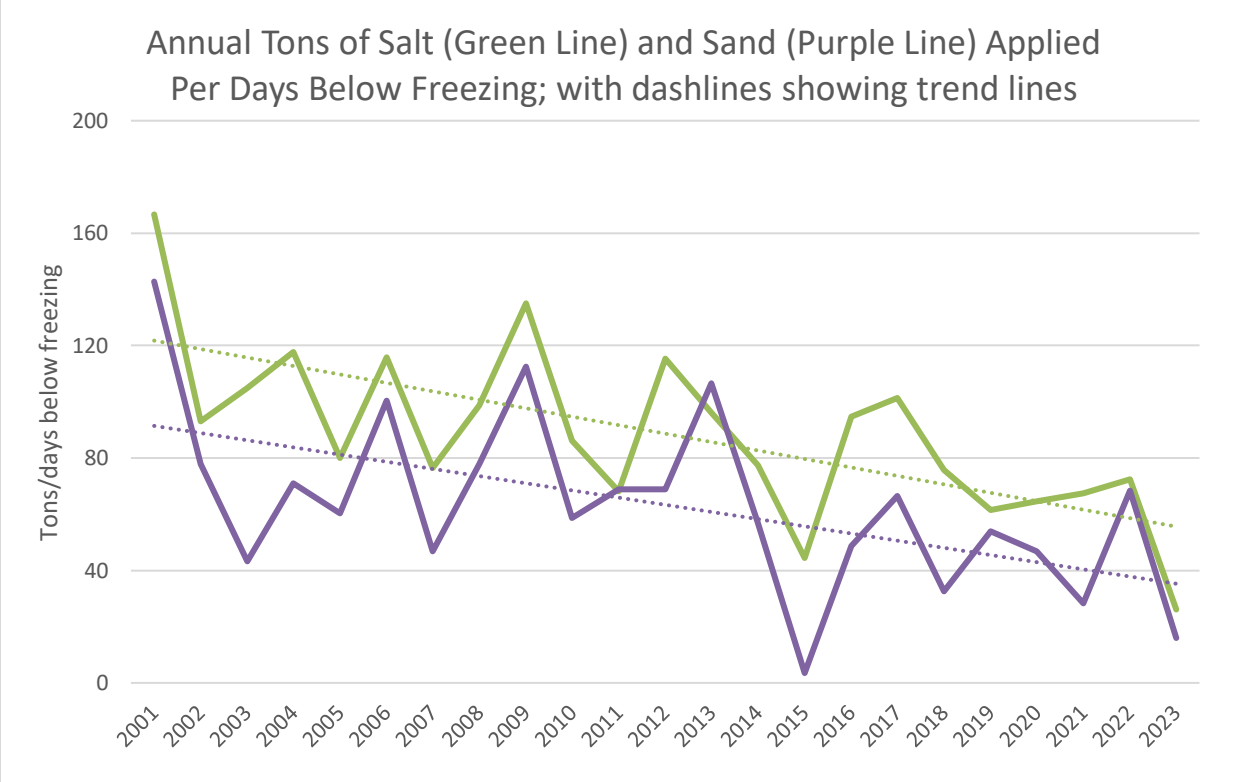
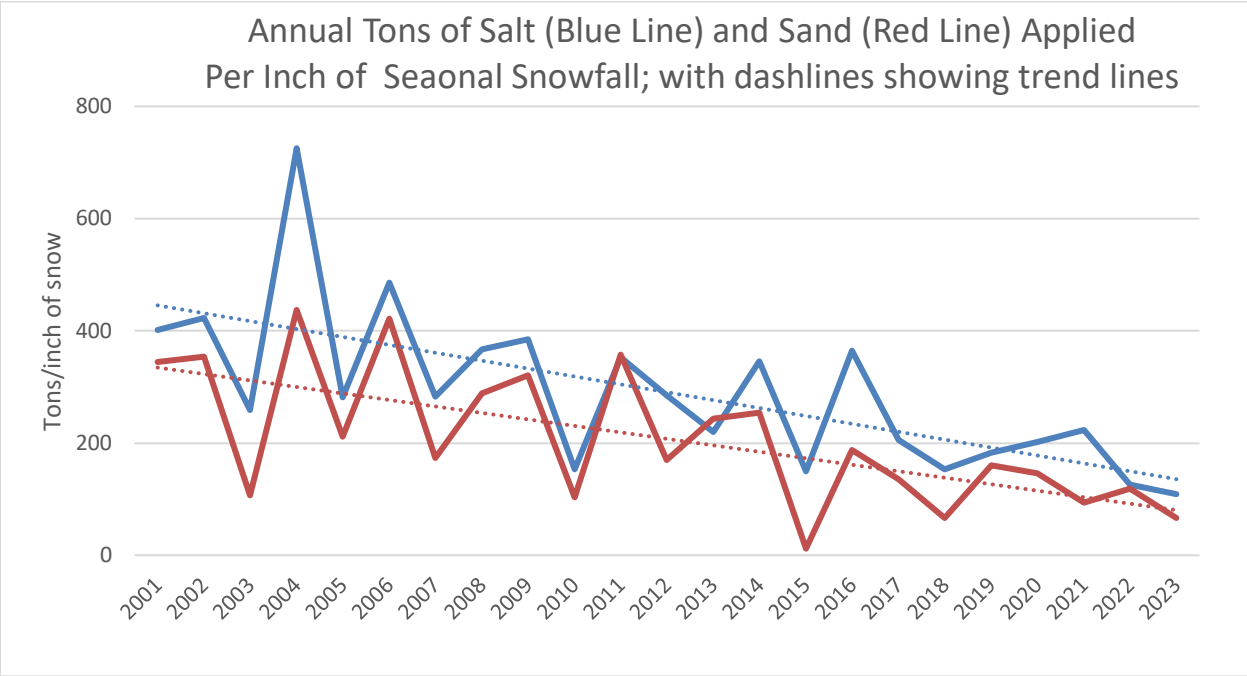


Figure 6.3 Amount of sand and salt applied relative to the total amount of snowfall



Performance Measures

- Amount of materials recovered as a percentage of materials applied: 246 %
- Amount of salt and sand applied relative to total snowfall: 175 tons/inch

VEGETATION MANAGEMENT: PESTICIDES AND FERTILIZER CONTROL

PROGRAM OBJECTIVE

The objective of the Vegetation Management program is to minimize the discharge of pollutants by utilizing appropriate vegetation management techniques and by controlling the application of pesticides and fertilizers.

The City of Minneapolis manages vegetation on 30 sites with over 40 acres, while the MPRB manages 185 park properties totaling 7,089 acres of parkland and water. In addition to providing native vegetation with deep roots that can tolerate both drought and inundation, this vegetation also allows for high infiltration capacity and erosion control protection. High-quality native vegetation also provides invaluable habitat and food to pollinators and other insects, amphibians, and reptiles, as well as birds and small mammals.

PROGRAM OVERVIEW – MPRB PROPERTIES

Integrated Pest Management (IPM) Policy and Procedures

The Minneapolis Park and Recreation Board's Integrated Pest Management policy is included in the MPRB's General Operating Procedures. The IPM Policy establishes thresholds utilized to determine

appropriate course of corrective action for a variety of landscape types including formal gardens, athletic fields, golf courses, and managed natural areas.

Pesticides Use on Park Lands

The MPRB manages 6,817 acres of park land and water in the City of Minneapolis (approximately 18% of the City's 35,244 total land acres). MPRB also owns land outside of the City of Minneapolis.

The use of pesticide products on general park lands is not a routine maintenance practice. Landscape pesticide products may be used during park renovations, to repair athletic fields and golf courses, to control invasive species and noxious weeds, or to address plant health concerns within formal gardens. No cosmetic use of pesticide products is performed on general parkland. In 2016, MPRB banned the use of glyphosate in neighborhood parks. In 2018, the Board of Commissioners placed a moratorium on the use of glyphosate on all MPRB lands.

Invasive Species Control

Conservation Corp working on invasive species control at the Quaking Bog and leafy spurge control at North Mississippi Prairie.

MPRB Environmental Management (Natural Resources) staff use a variety of management techniques to control invasive plants in park natural areas. These techniques include mowing, weed whipping, hand

pulling, the use of biological controls, and targeted herbicide application in accordance with MPRB's Integrated Pest Management Plan. Invasive plant control within the Minneapolis Park System focuses on the species listed in the Minnesota Department of Agriculture's Noxious Weed List. The current State Prohibited Noxious Weed of greatest priority for control due to their prevalence and potential for damage to MPRB Natural Areas are Round Leaf Bittersweet, Canada Thistle, Leafy Spurge, Spotted Knapweed, and Japanese Knotweed of which control efforts are underway.

Biological control agents have been used in the park system to control purple loosestrife, spotted knapweed, and leafy spurge. Biological control agents are insects or pathogens that are native to the invasive plant's country of origin. They are introduced after extensive research has been done by the scientific community. The MPRB partners with Minnesota Department of Agriculture (MDA) and Minnesota Department of Natural Resources (MnDNR), to control invasive plants with biological control agents.

Purple Loosestrife is a major invasive species problem in Minnesota wetlands. Working with the MnDNR the MPRB began a biocontrol program in the early 1990s. Leaf feeding beetles were reared and released into several sites throughout the City. Currently these populations are self-sustaining.

Partnering with MDA, spotted knapweed and leafy spurge biological controls were released in the Cedar Lake Regional Trail Prairie in 2003. Insects that specifically feed on these plants are being used in conjunction with mechanical methods to control spotted knapweed and leafy spurge in the planted prairie.

SCUBA hand harvesting at Wirth Lake

Eurasian watermilfoil, an invasive aquatic plant, is harvested mechanically at Cedar Lake, Lake of the Isles, Bde Maka Ska, and Lake Harriet and harvested by hand via SCUBA at Lake Nokomis and Wirth Lake. Permits for managing Eurasian watermilfoil are obtained annually from the Minnesota Department of Natural Resources. The Environmental Stewardship Division coordinates the Eurasian watermilfoil control program.

When an aquatic invasive species is newly introduced, whether to our region or to a specific area, MPRB staff evaluate management solutions using an integrated pest management approach. Integrated management for the species of concern may include mechanical removal, biological control, or herbicide use.

In fall 2021, MPRB began managing Phragmites australis spp. australis, an invasive species of wetland grass found throughout the Great Lakes Region. Invasive Phragmites can overtake shoreline areas and create unsuitable habitat for desirable plant and animal species. Invasive Phragmites was elevated from

the “restricted” category to the “control” category of the Minnesota Department of Agriculture’s Noxious Weed List in 2021, meaning that MPRB was legally obligated to manage it.. To manage five existing sites of invasive Phragmites in Minneapolis parks, MPRB utilized a strategy recommended by the University of Minnesota that involves alternating imazapyr herbicide treatments and mowing. Mowing alone would not have been an effective management strategy, according to the University of Minnesota. Mowing and herbicide treatments took place in 2022 and 2023 with additional treatments planned for 2024. One additional site containing phragmites was discovered within the park system in 2023; it will be added to the treatment sites in 2024.

Fertilizer Use

In September 2001, the Minneapolis City Council amended Title 3 of the Minneapolis Code of Ordinances (relating to Air Pollution and Environmental Protection) by adding Chapter 55 regarding Lawn Fertilizer in January 1, 2002. The retail sale of fertilizer containing any amount of phosphorus or other compound containing phosphorus, such as phosphates, is prohibited in Minneapolis. The Minnesota Statute allows the use of phosphorus turf fertilizer if an approved and recent test indicates that the level of available phosphorus in the soil is insufficient or if the fertilizer is being applied to newly established turf, but only during the first growing season.

Under certain conditions specified in the Statute, fertilizer use is allowed on golf courses. Fertilization of turf on Minneapolis Park & Recreation Board Property is performed for golf courses, around athletic fields, and in areas of heavy traffic. MPRB staff are required to complete a report for every turf fertilizer application. These records are maintained for a period of 5 years, per state law.

Recordkeeping

MPRB staff who apply pesticides and fertilizers keep records of their applications, as required by the Minnesota Department of Agriculture. Pesticide application records are kept that record the applicator’s license number, pesticide’s EPA registration number, application rate, application area and environmental conditions at time of application.

MPRB conducted pesticide storage audits of nine parks maintenance facilities to identify deficiencies in current storage and recordkeeping processes. Updated Emergency Action Plans for pesticide products stored at the South Side Operations Center and Lyndale Park have been completed, while remaining MPRB facilities are continuing to be developed.

Audubon Cooperative Sanctuary Program (ACSP) for Golf Courses

Audubon International provides comprehensive conservation and environmental education assistance to golf course superintendents and industry professionals through collaborative efforts with the United States Golf Association. The ACSP for golf courses seeks to provide open space benefits by addressing environmental concerns while maximizing golf course opportunities.

Participation in the program requires that golf course staff address environmental concerns related to the potential impacts of water consumption, and chemical use on local water sources, wildlife species, and native habitats. The program also aids in comprehensive environmental management, enhancement and protection of existing wildlife habitats, and recognition for those who are engaged in environmentally responsible projects.

Audubon International provides information to help golf courses with:

- Site Assessment and Environmental Planning
- Outreach and Education
- Water Quality and Conservation
- Resource Management
- Wildlife and Habitat Management

By completing projects in each of the above, the golf course receives national recognition as a Certified Audubon Cooperative Sanctuary. MPRB water resources staff conduct yearly water quality and wetland vegetation monitoring at Theodore Wirth, Meadowbrook, Columbia, Hiawatha and Gross Golf Courses. The data and reports derived from this monitoring are shared with each golf course annually to integrate into their certification application. Additionally, the data is shared with the goal of implementing improvements to plant diversity and water quality, which leads to improved land/water stewardship. Theodore Wirth, Meadowbrook and Gross Golf Courses have completed the ACSP certification process.

PREVIOUS YEAR ACTIVITIES

Currently around 200 MPRB employees hold pesticide applicator licenses, through the Minnesota Department of Agriculture (MDA). MPRB staff continues to reduce the use of pesticides through a variety of initiatives including improved design, plant selection, increased use of mechanical techniques and biological controls.

Turf fertilizer containing phosphorus is only purchased in accordance with the 2002 City and State regulation changes. Regulations require a soil or plant tissue test indicating a phosphorus deficiency or when new turf is being established during its first season.

PROGRAM OVERVIEW – CITY OF MINNEAPOLIS PROPERTIES

The City of Minneapolis maintains vegetation on its properties, including on stormwater management sites for a variety of reasons. These include public safety, preventing erosion, protecting, and improving water quality and ecological function, and creating wildlife habitat. Proper vegetation management will slow water movement, hold or convert pollutants, and enhance infiltration and evapotranspiration within stormwater management facilities like rain gardens and grass swales.

Integrated Pest Management (IPM)

The City uses integrated pest management when addressing pest management on the sites that the City maintains. IPM is a pest management strategy that focuses on long-term prevention or suppression of pest problems with minimum impact on human health, the environment and non-target organisms. In most cases, IPM is directed at controlling pests that have an economic impact on commercial crops. However, in the instance of mosquito control, IPM is used to control nuisance and potentially dangerous mosquito populations. The guiding principles, management techniques and desired outcomes are similar in all cases.

The City complies with the Minneapolis Code of Ordinances Title 11 - Health and Sanitation, Chapter 230 - Pesticide Control and Minnesota Department of Agriculture rules regarding pesticide application by posting plant protectant applications and maintaining the necessary records of all pest management activities completed by the City. The City's specific IPM goals, procedures, and guidelines can be found in Appendix A8.

CATEGORY SEVEN: STORMWATER RUNOFF MONITORING AND ANALYSIS

PROGRAM OBJECTIVES

The purposes of monitoring and analysis under the MS4 permit are to understand and improve stormwater management program effectiveness through adaptive management, characterize pollutant event mean concentrations, estimate effectiveness of devices and practices, and calibrate and verify stormwater models.

PROGRAM OVERVIEW

The MPRB monitors stormwater within Minneapolis to comply with the federal National Pollutant Discharge Elimination System (NPDES) permit. The purpose of this monitoring is to better understand pollutant loads in stormwater runoff and to gain knowledge that can be used to improve the effectiveness of treatment best management practices (BMPs). BMPs include procedures and structures designed to help reduce and capture pollutants in stormwater runoff. In 2023, quarterly grab samples, including snowmelt and rainfall, were collected at seven stormwater sites. Three inlets to Camden Pond as well as the outlet were monitored to better understand the potential water quality benefits of a stormwater pond initially built for flood control. Stormwater from four subwatersheds draining to Powderhorn Lake were monitored to gather information on external pollutant loads that will inform a future diagnostic study of the lake so that pollutant loads can be reduced. Monitoring occurred downstream of continuous deflection separation (CDS) units in the Powderhorn Lake watershed study. Three green infrastructure basins at Hoyer Heights were monitored for soil chemistry in an ongoing study of basin functionality. This section describes work done in the 2023 monitoring season. **Appendix A12** contains full reports on each stormwater monitoring project.

In addition to stormwater monitoring, the Minneapolis Park & Recreation Board executes an extensive lake monitoring program. See the MPRB's Water Resources Report for detailed results. All lakes in the monitoring program are sampled twice per month during summer, and once each in winter, spring, and fall. *Escherichia coli (E. coli)* monitoring per the MPCA's standard is also carried out at the MPRB's 12 official beaches located on six lakes. This monitoring is important for public health and provides indications of elevated bacteria issues. See Chapter 18, Public Beach Monitoring, of the MPRB's Water Resources Report. *E. coli* is a bacterium used to indicate the potential presence of waterborne pathogens that can be harmful to human health. Elevated bacteria levels generally occur in aquatic environments after rain events, when bacteria from various sources are washed into the lakes in stormwater runoff. This section describes work done in the 2023 monitoring season, Appendix A12 contains additional information on the Lakes data.

In 2023, the MPRB monitored for blue-green algae during open-water beach monitoring and year-round lake sampling. Blue-green algae is monitored by reviewing lake risk factor data including chlorophyll-*a*, Secchi readings, and pH, using a Visual Monitoring Index (VMI) and total algae probe, and sending water samples to a contracted lab for cyanotoxin analysis of microcystin, cylindrospermopsin, and anatoxin-*a*. Blue-green algae blooms, otherwise known as harmful algal blooms (HABs), are caused by a photosynthetic microorganism called cyanobacteria. Certain taxa of cyanobacteria have the capability to produce cyanotoxins that can be harmful to wildlife, pets, and humans if ingested. While the process of nutrient loading promotes cyanobacteria growth, warmer temperatures, more intense precipitation events, and longer stratification periods due to climate change will stimulate more intense and frequent future harmful algal bloom events. See Chapter 19, Blue-green algae/Cyanotoxin Monitoring.

PREVIOUS YEARS ACTIVITIES

Stormwater Quarterly Grab Monitoring

The City/MPRB NPDES permit requires quarterly grab samples for NPDES chemistry, pH, *E. coli*, and a pilot project to monitor Fat, Oils, and Grease (FOG). The purpose of monitoring via grab samples is to characterize the seasonality of runoff for parameters that cannot be collected with flow-weighted composite auto-monitoring, such as pH, *Escherichia coli* (*E. coli*), and Fat Oil & Grease (FOG). The condition needed for snowmelt sample collection was a winter snowpack melt event. Conditions for spring, summer, and fall grab sample collection was a rain event greater than 0.10 inches separated by at least 8 hours from other rain events.

Grab samples can be challenging to obtain, as specific timing of rain events in relation to MPRB and lab working hours are required for samples to be collected and analyzed. Ideally, annual quarterly grab monitoring includes: two snowmelt grab samples and one grab sample each in spring, summer, and fall. Quarterly grab monitoring includes pH measurements, and water samples analyzed for *E. coli*, NPDES water chemistry, and Fat Oil and Grease (FOG).The grab water chemistry samples are analyzed for the chemistry parameters outlined in the NPDES permit.

MPRB staff collecting a rainfall grab sample at a Powderhorn Lake monitoring site.

Grab sampling characterizes a point in time of a snowmelt or rain event. The first snowmelt event in a year usually has higher pollutant concentrations than subsequent snowmelt events. Chemical concentrations can change over time throughout a storm event. The beginning of a storm mobilizes fine particles and FOG material previously deposited on hard surfaces. Chemical concentrations can have significant variance between storm events depending on the amount of time since the last precipitation event, since pollutants accumulate on surfaces over time and then wash off in a melt or rain event.

As part of the NPDES permit, a study of quarterly FOG grab sampling was conducted along with regular grab sample monitoring with the intent to sample six sites. The latest NPDES permit prescribed that if a FOG sample was measured greater than 15 mg/L at a site, then that site would continue to be monitored throughout the permit cycle. FOG in stormwater can come from a variety of sources such as: vehicles, industry, food waste, gas stations, etc. Elevated levels of hydrocarbons can be harmful to aquatic plants and animals. It is important to minimize FOG in stormwater through best practices in industry, public education about vehicle maintenance, and the prevention of improper waste disposal.

*Table 7-3. MPRB quarterly grab monitoring sites from 2018-2023. * The 61st & Lyndale site had limited access in the summer of 2018 and all of 2019 due to stormwater pipe replacement and road construction. ** The Pershing site was inaccessible in the summer of 2018 due to lack of manhole access. *** The 61st & Lyndale site was only monitored for winter snowmelt in 2023.*

2018	2019	2020	2021	2022	2023
14th & Park	14th & Park	24th & Elm In N	24th & Elm N	61st & Lyndale	61st & Lyndale***
22nd & Aldrich	22nd & Aldrich	24th & Elm In S	24th & Elm S	Camden In NNW	Camden In NNW
61st & Lyndale*	24th & Elm In N	24th & Elm N Out	61st & Lyndale	Camden In SNW	Camden In SNW
Pershing**	24th & Elm In S	61st & Lyndale	Powderhorn In S	Camden In SW	Camden In SW
	61st & Lyndale*	Powderhorn In S	Powderhorn In SE	Powderhorn In S	Powderhorn In S
	Pershing	Powderhorn In SE	Powderhorn In W	Powderhorn In SE	Powderhorn In SE
	Winter Basin In S	Powderhorn In W		Powderhorn In W	Powderhorn In W
	Winter Basin In W				

In 2023, grab sampling sites were consistent with 2022: three Powderhorn Lake inlets SE, S, and W, three Camden Pond inlets NNW, SNW, and SW, and 61st & Lyndale. The 61st & Lyndale site, which has been sampled solely with grab samples due to its exceedance of FOG levels, was only sampled for winter snowmelt in 2023.

Detailed monitoring methods and results are listed in **Appendix A-12**.

Camden Pond Monitoring

Camden Pond was constructed by the City of Minneapolis in 2007 for flood control purposes. Later, the space around the pond was redesigned as a scenic location by adding plants, benches, and a walking path. Camden Pond is a polymictic pond of 4.09 acres with a maximum depth of 6.4 ft and accumulates sediment at a rate of around 0.44% of its volume per year (Stantec Consulting Services, 2021). As of 2020, only 6.2% of the pond volume had filled with sediment, so the pond has never required dredging. The drainage area of Camden Pond is 235 acres of mainly park and residential land uses, with 75 of those acres being impervious surfaces.

Camden Pond, summer of 2023

Camden Pond was part of the 2020-2021 Minneapolis Park and Recreation Board (MPRB) pond monitoring study and was selected for further monitoring in 2022 based on those study results. Camden Pond was one of the older ponds in the study and showed the highest potential internal phosphorus loading out of all studied ponds. A study of Camden Pond's inlets and outlet began in 2022 with the goal of determining more definitive mass balance, removal efficiency, and nutrient loads. This study aims to provide insight into whether a pond originally intended for flood control purposes could be modified to have positive water quality impacts. This work was continued in the 2023 monitoring season.

The purpose of monitoring the stormwater inlets and outlet of Camden Pond was to:

1. Measure the pollutant loads of the main tributary pipes entering Camden Pond and compare with pollutant loads at the pond outlet.
2. Assess how a pond originally intended for flood control is affecting stormwater quality.
3. Measure the true storage capacity of the pond and compare to its designed capacity.
4. Comply with the National Pollutant Discharge Elimination System (NPDES) Permit provision to monitor stormwater BMPs for the purpose of adaptive management.

Powderhorn Lake Inlet Monitoring

The City of Minneapolis Public Works (MPW) and the Minneapolis Park and Recreation Board (MPRB) developed a major restoration plan for Powderhorn Lake in 1999. In 2001, five continuous deflective separation (CDS) grit chambers were installed to remove solids from stormwater inflow.

MPRB staff collecting stormwater composite samples at a Powderhorn monitoring site, summer of 2023

Despite this and other restoration work, the lake was listed as impaired and placed on the Minnesota Pollution Control Agency (MPCA) list of impaired waters (303(d)list) based on eutrophication and biological indicators in 2001. Powderhorn Lake later trended towards better water quality and met state standards for several years and was then removed from the 303(d) list in 2012. The lake did not meet standards for clarity or chlorophyll-*a* for the next seven years and was subsequently placed back on the list of impaired waters in 2018.

The purpose of monitoring the stormwater inlets into Powderhorn Lake was to:

1. Measure the pollutant load of the main tributaries to Powderhorn Lake. This information can be used to assist in any future external load reduction plans.
2. Troubleshoot the CDS unit functionality, since work done in 2020 discovered that the CDS units were not functioning as designed.
3. Comply with the National Pollutant Discharge Elimination System (NPDES) Permit provision to monitor stormwater best management practices (BMPs) for the purpose of adaptive management.

In 2023, four of the largest Powderhorn Lake watershed inlets were auto-monitored downstream of their CDS units. Current watershed monitoring work at Powderhorn began in 2019. Refer to the Water Resources Report from 2019, 2021, and 2022 (report can be found here) for more information on Powderhorn Lake inlet monitoring. Note that due to the COVID-19 pandemic, 2020 monitoring efforts were shifted to another project. The MPRB also studied CDS and sump units at Powderhorn Lake from 2002-2004 and neighborhood rain garden effectiveness in 2009.

Detailed monitoring methods and results are listed in **Appendix A-12**.

Green Stormwater Infrastructure (GSI) Monitoring

The purpose of GSI monitoring is to better understand how effective these structures are at flood control and reducing the impacts of stormwater runoff. A secondary goal is to assess the performance of different GSI site designs in natural conditions and use that information to enhance future designs. Due to an ordinance change, the City of Minneapolis is building numerous small-footprint infiltration/filtration basins throughout the city. Many of these GSI Best Management Practices (BMPs) treat less than 1 acre of impervious surface. The City of Minneapolis chose the Hoyer Heights GSI to be the focus of monitoring in 2023. This was the third year of monitoring at Hoyer.

The main goals of the projects were to evaluate three methods of infiltration measurement, establish acceptable testing, and to develop protocols for future GSI basins. Many of these goals were met in 2022, where we learned:

- Using surface infiltration tests (such as MODIFIED PHILIP DUNNE - MPDs) were different than measuring sub-surface infiltration rates.
- Visual inspection and MPDs are the simplest, fastest, and most cost-effective tools to indicate basins or sites that need maintenance
- Synthetic Runoff Testing (flooding the basin) and measuring the runoff-soil moisture (using a soil moisture sensor) are cost effective ways to better understand drawdown time and moisture dynamics
- Proper use of underdrains (a bypass for the excess runoff in a basin) in GSIs have the largest impact on their proper function. Underdrains should be capped where they may be needed or eliminated if feasible.

The Hoyer GSI site is in Northeast Minneapolis and includes three different basins located in the same neighborhood, shown below. In 2023, MPRB efforts focused mainly on soil sampling and analysis. Samples were collected twice during the monitoring season from the three Hoyer basins. They drain approximately 0.072 acres of a residential watershed, of which 0.0407 acres are impervious, and were designed primarily for flood control. Hoyer site A is at the southeast corner of 36 ½ Ave NE & Fillmore St NE and has been monitored since 2021. Two additional sites were added to the project in 2022: Hoyer site B at the northwest corner of that same intersection, and Hoyer site C as at the southeast corner of 36 ½ Ave NE & Buchanan St SE. All sites had underdrain caps and boots installed on July 19th, 2022. Each site has a brick-filtered splash pad pretreatment basin and an overflow inlet.

MPRB staff collecting a soil sub-sample at Hoyer A.

This project is a partnership between the City of Minneapolis, Saint Anthony Falls Hydrology Laboratory (SAFL) at the University of Minnesota, the Mississippi Watershed Management Organization (MWMO), and the Minneapolis Park and Recreation Board (MPRB). The funding, survey, and GIS data used in the project were supplied by the City of Minneapolis. Monitoring of rainfall, flow, infiltration tests, and flood functionality tests were the responsibility of both the City and SAFL. Public outreach and education were the responsibility of MWMO. Confined space entry, soil sampling/testing, and monthly observational field inspection data were the responsibility of the MPRB.

Detailed monitoring methods and results are listed in **Appendix A-12.**

Lake Monitoring

In 2023, MPRB scientists monitored 11 of the city's most heavily used lakes. The data collected were used to calculate a Trophic State Index (TSI) score for each of the lakes. Lower TSI scores indicate high water clarity, low levels of algae in the water column, and/or low phosphorus concentrations. Changes in lake water quality can be tracked by looking for trends in TSI scores over time. A negative slope indicates improving water quality, while a positive slope indicates declining water quality. These values are especially important for monitoring long-term trends (10+ years). Historical trends in TSI scores are used by lake managers to assess improvement or degradation in water quality. Trends are also used by

the Minnesota Pollution Control Agency to assess non-degradation goals. Surface water samples were collected on Powderhorn Lake in 2023.

Most of the lakes in Minneapolis fall into either the mesotrophic or eutrophic category. Bde Maka Ska, Harriet, and Wirth Lake are mesotrophic having moderately clear water and potential for hypolimnetic anoxia frequently during the summer. Cedar Lake and Lake of the Isles are eutrophic having an anoxic hypolimnion and potential for nuisance growth of aquatic plants. Nokomis, Loring, and Hiawatha are also eutrophic with high algal productivity. Brownie Lake was also classified as eutrophic but was not sampled in 2023. Powderhorn and Spring Lake are hypereutrophic having dense algae. Blue-green algae dominates the phytoplankton community on both Lake Nokomis and Powderhorn Lake, resulting in periodic appearance of algal scum on these lakes. Scores for Diamond and Grass Lake are not included since these lakes are too shallow to calculate the Secchi portion of the TSI index.

Long term trends in lake water quality can be seen by using the annual average TSI since the early 1990s, **Table 1**. Restoration activities have improved water quality indicators at Bde Maka Ska and Wirth Lake. When data from the last 10 years is looked at for Minneapolis lakes, shown in **Table 2**, Lake Hiawatha and Lake Nokomis have an increasing trend, signifying declining water quality indicators for those lakes. Lake Hiawatha is heavily influenced by inflow from Minnehaha Creek and the lake has poorer water quality during drought years when residence time increases. Between 2021 and 2023 there was less precipitation compared to previous years and the lake had a significant increase in chlorophyll-*a* and total phosphorus, and water clarity has become shallower since 2018. In recent years Lake Nokomis has had higher algal concentrations and has had higher chlorophyll-*a* concentrations and shallower water clarity. In 2021, the water quality trends on Cedar Lake over the past 10 years indicated that the water quality was declining, mainly due to poor water quality noted in the previous 5 years, but since 2021 the lake has been listed as having a stable trend since the water clarity was significantly deeper and chlorophyll-*a* concentrations were lower.

Table 1. Water quality trends in Minneapolis lakes from 1991-2023.

Lakes with Improving Water Quality Indicators	Bde Maka Ska Wirth Lake
Lakes with Stable Trends	Brownie Lake Cedar Lake Lake Harriet Lake Hiawatha

	Lake of the Isles Loring Pond Lake Nokomis Powderhorn Lake Spring Lake
Lakes with Declining Water Quality Indicators	No lakes with declining trend

Table 2. Water quality trends in Minneapolis lakes from 2014-2023.

Lakes with Improving Water Quality Indicators	No lakes with improving trend
Lakes with Stable Trends	Bde Maka Ska Brownie Lake Cedar Lake Lake Harriet Lake of the Isles Loring Pond Powderhorn Lake Spring Lake Wirth Lake
Lakes with Declining Water Quality Indicators	Lake Hiawatha Lake Nokomis

CATEGORY EIGHT: PROGRESS TOWARD WASTE LOAD ALLOCATION FOR APPROVED TMDLS

PROGRAM OBJECTIVES

Total maximum daily loads (TMDLs) are one of the many tools Congress authorized in the Clean Water Act to "restore and maintain the chemical, physical, and biological integrity of the nation's water." The goal of the City's TMDL program is to work closely with the MPCA and other water resource agencies during the study and implementation phases of each TMDL Study which is being conducted for a waterbody that receives stormwater runoff from the Minneapolis MS4 system. Additionally, this program aims to develop and maintain a tracking system to assess and report on the progress towards compliance with TMDL established maximum pollutant discharges.

PROGRAM OVERVIEW

The City of Minneapolis is subject to the following TMDLs for this reporting year:

TMDL project name	Waste Load Allocation type	Percent reduction	Pollutant of concern
Crystal Lake Nutrient TMDL	Categorical		Phosphorus
Minnehaha Creek Lake Hiawatha TMDL	Categorical	N/A	*E. coli*
Minnehaha Creek/Lake Hiawatha TMDL	Individual	31%	Phosphorus
Minnehaha Creek Watershed District Lakes TMDL – Lake Nokomis	Individual	38%	Phosphorus
Silver Lake TMDL	Categorical	17%	Phosphorus
Shingle Creek Aquatic Life, Chloride, *E. Coli* bacteria, Low Dissolved Oxygen TMDL	Categorical	67%	Chloride
Shingle Creek and Bass Creek Biota and Dissolved Oxygen TMDL	Categorical		Nitrogenous biochemical oxygen demand
South Metro Mississippi River TMDL (Metro)	Categorical	0%	TSS
TCMA Chloride TMDL Study	Categorical	N/A	Chloride
Upper Mississippi River: Bacteria	Categorical		*E. coli*
Wirth Lake: Excess Nutrients TMDL	Categorical		Nutrients

CRYSTAL LAKE TMDL: NUTRIENTS

- Membership and Participation in the West Metro Watershed Alliance education campaigns
- Participation in the Adopt-a-Drain Program
- Participation in Storm Drain Stenciling Program
- Membership and Participation in Watershed Partners and Clean Water MN Public Education Programs
- Public Works Street Sweeping program
- Monitoring Program with MPRB
- XPSWMM Systemwide Storm Sewer Model Completed

- Water Quality Model completed
- Implementation of Green Stormwater Infrastructure Program
- Implementation of Chapter 54: Stormwater Management Ordinance for development and redevelopment
- Public Works Storm Sewer Maintenance and Repair Program

MINNEHAHA CREEK - LAKE HIAWATHA TMDL: BACTERIA, NUTRIENTS

- Membership and Participation in the West Metro Watershed Alliance education campaigns
- Participation in the Adopt-a-Drain Program
- Participation in Storm Drain Stenciling Program
- Membership and Participation in Watershed Partners and Clean Water MN Public Education Programs
- Public Works Street Sweeping program
- Monitoring Program with MPRB
- XPSWMM Systemwide Storm Sewer Model completed
- Water Quality Model completed
- Implementation of Green Stormwater Infrastructure Program
- Implementation of Chapter 54: Stormwater Management Ordinance for development and redevelopment
- Implementation of Green Stormwater Infrastructure Program
- Public Works Storm Sewer Maintenance and Repair Program
- Leadership, membership, and participation in Minnesota pathogen Task force
- Development of Stormwater Pathogen Investigation and Prevention Toolbox to identify, prevent, and remediate pathogens in stormwater runoff
- MPRB nuisance goose management program

MINNEHAHA CREEK WATERSHED DISTRICT LAKES – LAKE NOKOMIS TMDL: PHOSPHORUS

- Participation in the Adopt-a-Drain Program
- Participation in Storm Drain Stenciling Program
- Membership and Participation in Watershed Partners and Clean Water MN Public Education Programs
- Public Works Street Sweeping program
- Monitoring Program with MPRB
- XPSWMM Systemwide Storm Sewer Model completed
- Water Quality Model completed
- Implementation of Green Stormwater Infrastructure Program
- Implementation of Chapter 54: Stormwater Management Ordinance for development and redevelopment
- Public Works Storm Sewer Maintenance and Repair Program

SILVER LAKE TMDL: PHOSPHORUS

- Membership and Participation in the West Metro Watershed Alliance education campaigns
- Participation in the Adopt-a-Drain Program
- Participation in Storm Drain Stenciling Program
- Membership and Participation in Watershed Partners and Clean Water MN Public Education Programs

- Public Works Street Sweeping program
- Monitoring Program with MPRB
- XPSWMM Systemwide Storm Sewer Model completed
- Water Quality Model completed
- Implementation of Green Stormwater Infrastructure Program
- Implementation of Chapter 54: Stormwater Management Ordinance for development and redevelopment
- Public Works Storm Sewer Maintenance and Repair Program

SHINGLE CREEK TMDL: AQUATIC LIFE, CHLORIDE, *E. COLI* BACTERIA, LOW DISSOLVED OXYGEN

- Membership and Participation in the West Metro Watershed Alliance education campaigns
- Participation in the Adopt-a-Drain Program
- Participation in Storm Drain Stenciling Program
- Membership and Participation in Watershed Partners and Clean Water MN Public Education Programs
- Public Works equipment upgrades, advancements in de-icing technologies, and staff training
- Public Works Street Sweeping program
- Stormwater Utility Credit program participation requires a chloride management plan

SHINGLE CREEK AND BASS CREEK TMDL: BIOTA AND DISSOLVED OXYGEN

- Membership and Participation in the West Metro Watershed Alliance education campaigns
- Participation in the Adopt-a-Drain Program
- Participation in Storm Drain Stenciling Program
- Membership and Participation in Watershed Partners and Clean Water MN Public Education Programs
- Public Works Street Sweeping program
- XPSWMM Systemwide Storm Sewer Model completed
- Water Quality Model completed

SOUTH METRO MISSISSIPPI RIVER TMDL (METRO): TSS

- Membership and Participation in the West Metro Watershed Alliance education campaigns
- Participation in the Adopt-a-Drain Program
- Participation in Storm Drain Stenciling Program
- Membership and Participation in Watershed Partners and Clean Water MN Public Education Programs
- Public Works Street Sweeping program
- Monitoring Program with MPRB
- Public Works Storm Sewer Maintenance and Repair Program

TWIN CITIES METRO AREA (TCMA) TMDL: CHLORIDE

- Membership and Participation in the West Metro Watershed Alliance education campaigns
- Participation in the Adopt-a-Drain Program
- Participation in Storm Drain Stenciling Program
- Membership and Participation in Watershed Partners and Clean Water MN Public Education Programs
- Public Works equipment upgrades, advancements in de-icing technologies, and staff training

- Public Works Street Sweeping program
- Monitoring Program with MPRB
- Stormwater Utility Credit program participation requires a chloride management plan

UPPER MISSISSIPPI RIVER TMDL: BACTERIA

- Participation in the Adopt-a-Drain Program
- Participation in Storm Drain Stenciling Program
- Membership and Participation in Watershed Partners and Clean Water MN Public Education Programs
- Public Works Street Sweeping program
- Monitoring Program with MPRB
- Implementations of the 2019 Minnehaha Creek Bacterial Source Identification Study
- Leadership, membership, and participation in the MN Pathogen Task Force
- Developing a toolbox for identification, prevention, and remediation of pathogens in stormwater runoff
- Public Works Storm Sewer Maintenance and Repair Program
- MPRB nuisance goose management program

CATEGORY NINE: COORDINATION AND COOPERATION WITH OTHER ENTITIES

PROGRAM OBJECTIVE

The objective of this Stormwater Management Program is to maximize stormwater management efforts through coordination and partnerships with other governmental entities.

PROGRAM OVERVIEW

Coordination and partnerships of the City and the MPRB with other governmental entities include the four watershed organizations in Minneapolis: BCWMC, MWMO, MCWD and SCWMC. Coordination activities and partnerships with other governmental entities also include MnDOT, Hennepin County, MPCA, Minnesota Board of Water and Soil Resources (BWSR), MnDNR, neighboring cities, the Metropolitan Council, the University of Minnesota, and various other entities.

The coordination and partnership activities can include the joint review of projects, joint studies, joint water quality projects, stormwater monitoring, water quality education, and investigation or enforcement activities.

Coordination with the Bassett Creek Water Management Commission (BCWMC)

In 2015, the BCWMC adopted its Third Generation Watershed Management Plan, with Minneapolis and the other eight-member cities as active partners. The BCWMC's Fourth Generation Plan is currently being drafted. Minneapolis provides yearly financial contributions to the BCWMC annual operations budget. The City and the MPRB are also stakeholders with other BCWMC joint power cities in development of several Total Maximum Daily Load (TMDL) studies and implementation plans. Currently Minneapolis and MPRB are coordinating with BCWMC on projects in Bryn Mawr Meadows and the Main Stem of Bassett Creek in Wirth Park.

Coordination with the Minnehaha Creek Watershed District (MCWD)

The MCWD receives revenue through direct taxation against properties within its jurisdiction. MCWD's fourth Generation Watershed Management Plan was adopted on January 11, 2018 and sets priorities for the organization for the period from 2018-2027. The City of Minneapolis and the MPRB are stakeholders in development of TMDL studies and implementation plans, in collaboration with the MCWD and other stakeholders. Minneapolis and MPRB are working together on a more detailed memo of understanding on how the three entities will work together to implement projects in the Minnehaha Creek watershed within Minneapolis.

Coordination with the Mississippi Watershed Management Organization (MWMO)

In 2021, the MWMO adopted its Fourth Generation Watershed Management Plan (2021-2031). The City and MPRB participated in its review. The MWMO delegates stormwater management requirements for new developments and redevelopments to its member cities and does not provide separate project review and approval. The MWMO receives revenue through direct taxation against properties within its jurisdiction. The City and the MPRB partner with the MWMO on many studies and projects.

Coordination with the Shingle Creek Watershed Management Commission (SCWMC)

In May 2023, the SCWMC adopted its Fourth Generation Watershed Management Plan, with Minneapolis and the other member cities as active partners in plan review. Minneapolis provides yearly financial contributions to the SCWMC annual operations budget. The City of Minneapolis and the MPRB are stakeholders with other SCWMC joint power cities in development of TMDL studies and implementation plans.

Coordination with Hennepin County

In 2016, Hennepin County adopted the Natural Resources Strategic Plan (2015-2020), the plan is currently in the process of being updated. The intent of the plan is to guide the county and its partners, including the City, in responding to natural resource issues and developing internal and external policies, programs, and partnerships that improve, protect, and preserve natural resources.

Coordination with the Minnesota Pollution Control Agency (MPCA)

Minneapolis Fire Inspection Services coordinates with the MPCA on Spill Response incidents and investigations and enforcement for incidents of illegal dumping or illicit discharges to the storm drain system.

Minneapolis Public Works coordinates with the MPCA on the various work groups, including the Minnesota Stormwater Manual and surface water/groundwater interactions.

Minneapolis Park & Recreation Board coordinates with the MPCA on various research and data collection efforts on Minneapolis lakes.

Coordination with the US Coast Guard and WAKOTA CARE

Minneapolis Fire Inspection Services coordinates with these agencies on spill response issues, training, and spill response drills. Due to low water conditions and scheduling issues, a Spill Drill did not take place in 2022. Discussions have taken place to coordinate a Spill Drill in 2023 with Minneapolis Fire Department and Minneapolis Public Works.

Coordination with the Minneapolis Park & Recreation Board (MPRB)

In 2020, the Minneapolis Park & Recreation Board adopted an Ecological Systems Plan. This plan included input from Minneapolis Public Works to ensure that the two entities mutual water quality and environmental management goals can be achieved. This plan now serves as the MPRB's principal policy document regarding environmental performance and provides a framework for how environmental considerations can be addressed in ongoing planning, operations, and management efforts at the MPRB. In 2021, MPRB adopted a new comprehensive plan, Parks for All (2021-2036). The plan's environmental sustainability focus area outlines how MPRB will work independently and with Minneapolis and other partners on the preservation of parklands, natural areas, waters, and the urban forest, as well as management, design, operations, and programming of parks through practices that mitigate and adapt to climate change.

PREVIOUS YEAR ACTIVITIES AND ONGOING COORDINATION EFFORTS

MPRB and the City of Minneapolis coordinate stormwater management efforts and coordinate with the watershed management organizations, the watershed district, and other governmental agencies on water quality projects. Minneapolis Public Works and MPRB maintain communications with all watershed management organizations and the watershed district within the City boundaries both jointly and independently.

Interactions take several forms to facilitate communication and provide support:

- Attend selected local board and special issues meetings
- Attend selected education and public outreach committee meetings
- Take part in Technical Advisory Committee meetings
- Inform organizations of upcoming City capital projects to identify projects that may benefit from partnerships
- Provide developers who submit projects for site plan review with information and contacts to meet watershed requirements
- Share information and data regarding storm drainage system infrastructure, watershed characteristics, flooding problems, modeling data, etc.
- The MPRB and the City coordinate and partner with watershed management organizations and state agencies on capital projects and water quality programs. For example:
- A feasibility study began in 2019 for a proposed project that will improve water quality and habitat and increase flood storage in Bassett Creek by dredging accumulated sediment that has collected in the “lagoons” created within the creek in Theodore Wirth Park between Golden Valley Road and Trunk Highway 55. The City of Minneapolis and the MPRB cooperated with BCWMC on the study. The feasibility study was completed in the spring of 2020, and the BCWMC approved the implementation of the project to dredge 3 of the lagoons to a 6-foot depth. Clean Water Funding was also awarded from the MN Board of Soil and Water Resources in 2020. A Hennepin County Opportunity Grant was awarded in 2021. Project construction began in early January 2023, and dredging was completed in March. Site restoration was completed in the summer of 2023.
- MPRB and the City of Minneapolis, along with BCWMC, are working towards the implementation of a stormwater project in Bryn Mawr Meadows. The project was designed and constructed in conjunction with the MPRB's master planning process for this area. The project includes diverting runoff from a 45.1-acre residential area west of the park and low flows from MnDOT’s Penn Pond discharge into new stormwater ponds within the park for a total phosphorus reduction of 30 pounds per year. Additional funding for this project has been contributed by Hennepin County and BWSR. Concept plans were completed in 2021. Construction began in 2022 and was underway throughout much of 2023.
- MPRB and City of Minneapolis along with MWMO are collaborating on common water quality, flood control and habitat improvement goals in MWMO’s 1NE project area. The overall goal of the project is to reduce flooding and reduce pollution to the Mississippi River. Projects are planned on the MPRB’s Colombia Golf Course, MPRB Parkland, and integrated with City of

Minneapolis street projects. Preferred projects have been chosen, and construction started in 2020.

- A phase of the overall project, the Northern Colombia Golf Course and Park BMP project began construction in 2020 with funding from MWMO, BWSR, the City of Minneapolis, and Hennepin County. Due to unexpected high water levels, BMP designs were altered in 2022, and adjustments were made in 2023 so that the constructed basins could become fully operational. Construction of city storm sewer connections to direct additional stormwater runoff to the project area began in 2023 and is ongoing
- Collaboration between MPRB, MCWD, and Minneapolis continued via the master planning process for the Minnehaha Regional Trail corridor along Minnehaha Creek. If preliminary plans are fully implemented, 1.7 miles would be added to the length of the creek, runoff from 1,400 acres of land would be treated, 22 acre-feet of flood storage would be created, and over 400 pounds of phosphorus would be removed from the creek annually. The plan was adopted by the MPRB Board in 2020, laying out priorities for the Minnehaha Creek Corridor within Minneapolis and how the three entities can collaborate to meet common goals of managing stormwater, flooding, streambank stability, and ecology in a heavily used recreation corridor. Community engagement and design for the first project focus area is expected in 2021. Construction led by MPRB in 2022 focused on the improvements of the trail and pedestrian infrastructure, as well as a rain garden.
- Collaboration between MPRB, MCWD, and Minneapolis occurred via the master planning process for the Cedar Lake and Lake of the Isles parks. The master plan was completed in 2022 and was distributed for agency and public comment. The plan was adopted by the MPRB in July of 2023 after comments were incorporated.
- The City's Environmental Services section coordinates with the MPCA regarding investigations and enforcement for incidents of illegal dumping or illicit discharges to the storm drain system.
- Public Works and MPRB staff coordinate with the MPCA, the watershed management organizations, and other stakeholders for Total Maximum Daily Load (TMDL) studies and implementation plans.
- Public Works engages with MPRB, MnDOT, Hennepin County, Metropolitan Council, and watershed management organizations on those entities' capital projects and infrastructure maintenance within the City regarding compliance with NPDES issues.
- Finally, other sections of this NPDES Annual Report provide additional information about other projects or issues on which the permittees have cooperated with other governmental entities.

INTEGRATED INFRASTRUCTURE MANAGEMENT

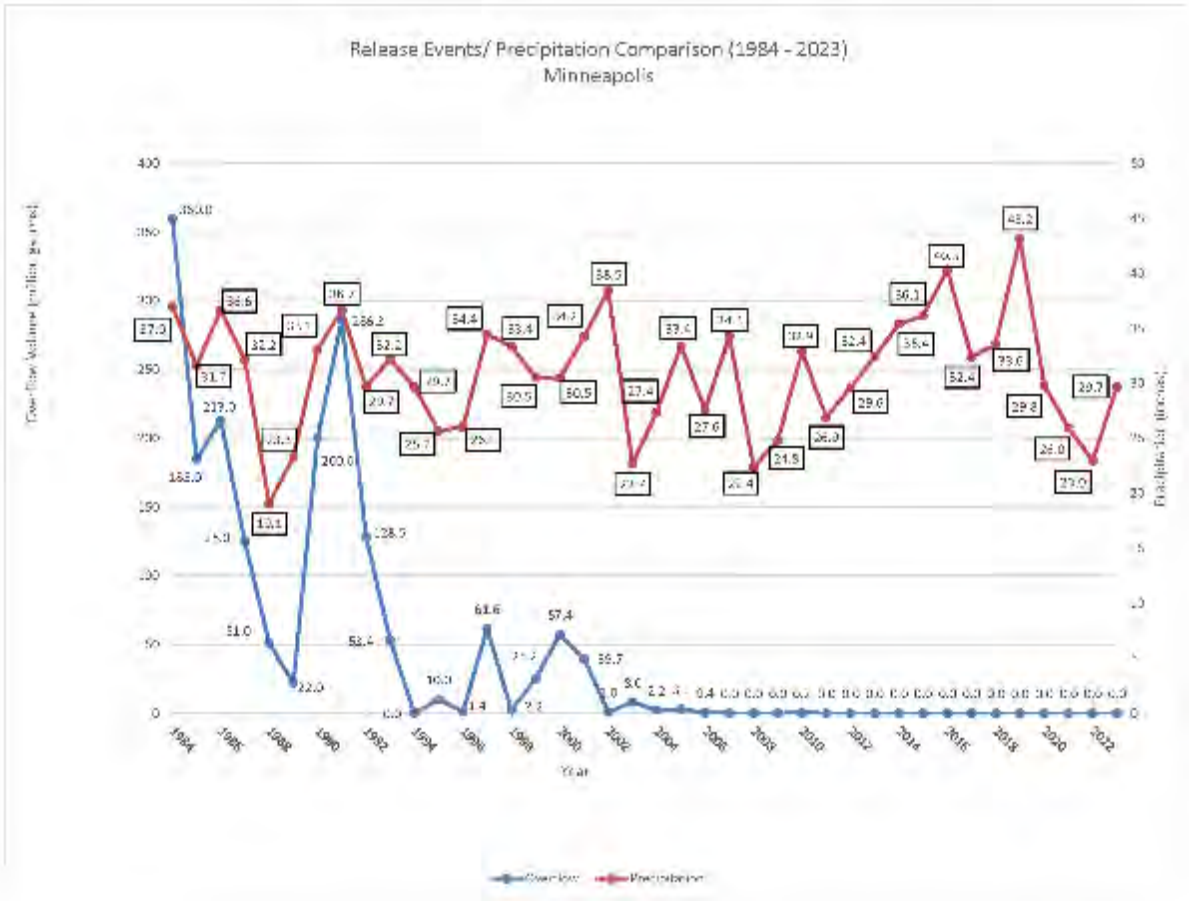
PROGRAM OBJECTIVE

The objective of this program is to prevent the unintentional discharge of untreated sewage from the Minneapolis sanitary sewer system at the regulators located on Metropolitan Council Environmental Services (MCES) Interceptors.

BACKGROUND

Transition to Integrated Infrastructure Management

In 2019**,** Minneapolis transitioned from a Combined Sewer Overflow (CSO) permit to an Integrated MS4 permit. This transition is possible because of the success of the efforts of the City of Minneapolis and MCES to reduce the risk of CSO events through storm drain separation, improvements to hydraulic performance and programs to reduce Inflow & Infiltration (I & I). The chart below shows a dramatic decrease in overflow volume from 1984-2023.



Storm drain separation can add significant flow to the stormwater system where capacity might be limited. Minneapolis is working to address stormwater capacity through the Flood Mitigation and Storm Tunnel Programs mentioned in this report. The addition of stormwater from separation projects has contributed to capacity problems in these systems. The integrated permit allows the City to prioritize work and investment in projects to improve water quality and meet the requirements of the Clean Water Act.

Cooperation with Metropolitan Council Environmental Services (MCES)

The sanitary sewer system from Minneapolis discharges to the Metropolitan Wastewater Plant, which is owned by the Metropolitan Council. Release events from the sanitary or combined sewer system can occur during periods of hydraulic overload caused by extraordinary rainfall or snowmelt events. Release events of this type occur at regulator structures owned by the Metropolitan Council. Each regulator has an associated stormwater outfall to the Mississippi River. Most of these stormwater outfalls are part of a larger storm water network owned and maintained by the City of Minneapolis. Outfalls that bypass directly from the interceptor system are owned by Metropolitan Council.

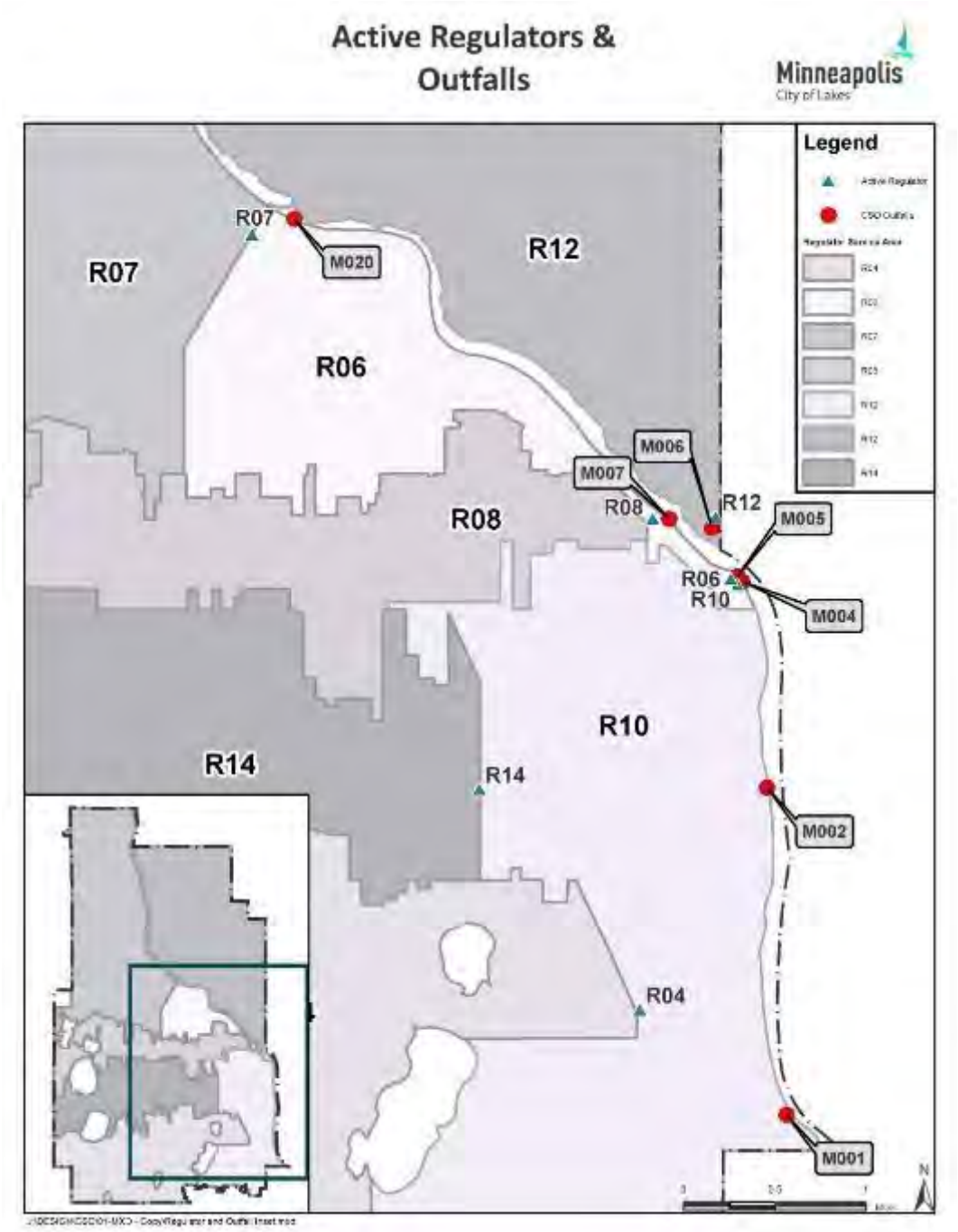
MCES and the City of Minneapolis entered into a cooperative agreement to coordinate ongoing responsibilities for release events with the termination of the joint CSO permit. The cooperative agreement was executed on March 27, 2018. It provides an inventory of regulators and outfalls and clarifies the commitments of each party to invest in, operate and maintain, and reduce Inflow & Infiltration (I & I) in each system. The following tables and map include the locations of active regulators and outfalls.

REGULATOR (Historic CSO Permit)	NAME AND LOCATION	X COORDINATE	Y COORDINATE
R04	Minnehaha Pkwy and 39th Ave S	543110.618	145799.774
R14	East 38th St and 26th Ave S	538476.110	152176.124
R10	Southwest Meters Diversion	545947.525	158095.063
R06	Northwest Meters Diversion	545745.715	158269.413
R12	East Meters Diversion	545309.317	160067.832
R08	East 26th St and Seabury Ave	543494.387	160010.412
R07	Portland Ave S and Washington Ave	531898.897	168232.605

MINNEAPOLIS NPDES OUTFALL	OUTFALL (Historic CSO Permit)	NAME AND LOCATION	X COORDINATE	Y COORDINATE
10-720	M001 (R04)	Minnehaha Tunnel	547368.436	142760.471
10-680	M002 (R14)	East 38th St	546801.334	152225.749
*	M004 (R10)	Southwest Interceptor	546085.529	158191.394
*	M005 (R06)	Northwest Interceptor	545955.556	158342.521
*	M006 (R12)	Eastside Interceptor	545208.244	159734.115

10-610	M007 (R08)	East 26th St	543969.672	160010.388
10-410	M020 (R07)	Chicago Ave S	533124.589	168689.291

**Owned by Metropolitan Council*



PROGRAM OVERVIEW

Studies, Investigations and Monitoring Activities

Studies, investigations, and monitoring activities provide information about inflow and infiltration in the sanitary sewer system. These efforts are accomplished through the I & I Program and the Operation & Maintenance of the sanitary sewer system. Studies include flow monitoring, smoke testing of cross connection, manhole and sewer assessments. Since 2007, 858 miles of sewer smoke testing have been completed.

Capital Improvement Projects

Inflow from the public sewer system is addressed through projects included in the City of Minneapolis Capital Improvement Program, which includes:

- Combined Sewer Overflow Program – projects to reduce inflow by separating storm drains from the sanitary sewer system
- Inflow & Infiltration Removal Program – rehabilitation and repair projects to reduce I & I
- Sanitary Tunnel & Sewer Rehab Program – projects to repair and rehabilitate sanitary sewers, lift stations, tunnels, and access structures.

Since 2002, 201 storm drain separation projects have been identified for the Combined Sewer Overflow Program. Of the identified projects, 157 were completed, separating 630.0 acres of drainage from the sanitary sewer system. The Combined Sewer Overflow Program is a continuation of the 1980s program that separated 4,600 acres of drainage from the sewer system.

The Rainleader Disconnection Program addresses inflow from the private sewer system. Since 2003, 7,426 of 7,622 Rainleader violations have been resolved.

PREVIOUS YEAR ACTIVITIES AND ONGOING COORDINATION EFFORTS

Release Events from the Sanitary or Combined Sewer System

MCES continues to monitor overflow duration and volume at each of the regulators. In 2023, there were zero reported releases to the Mississippi River from the monitored regulators.

Studies, Investigations and Monitoring Activities

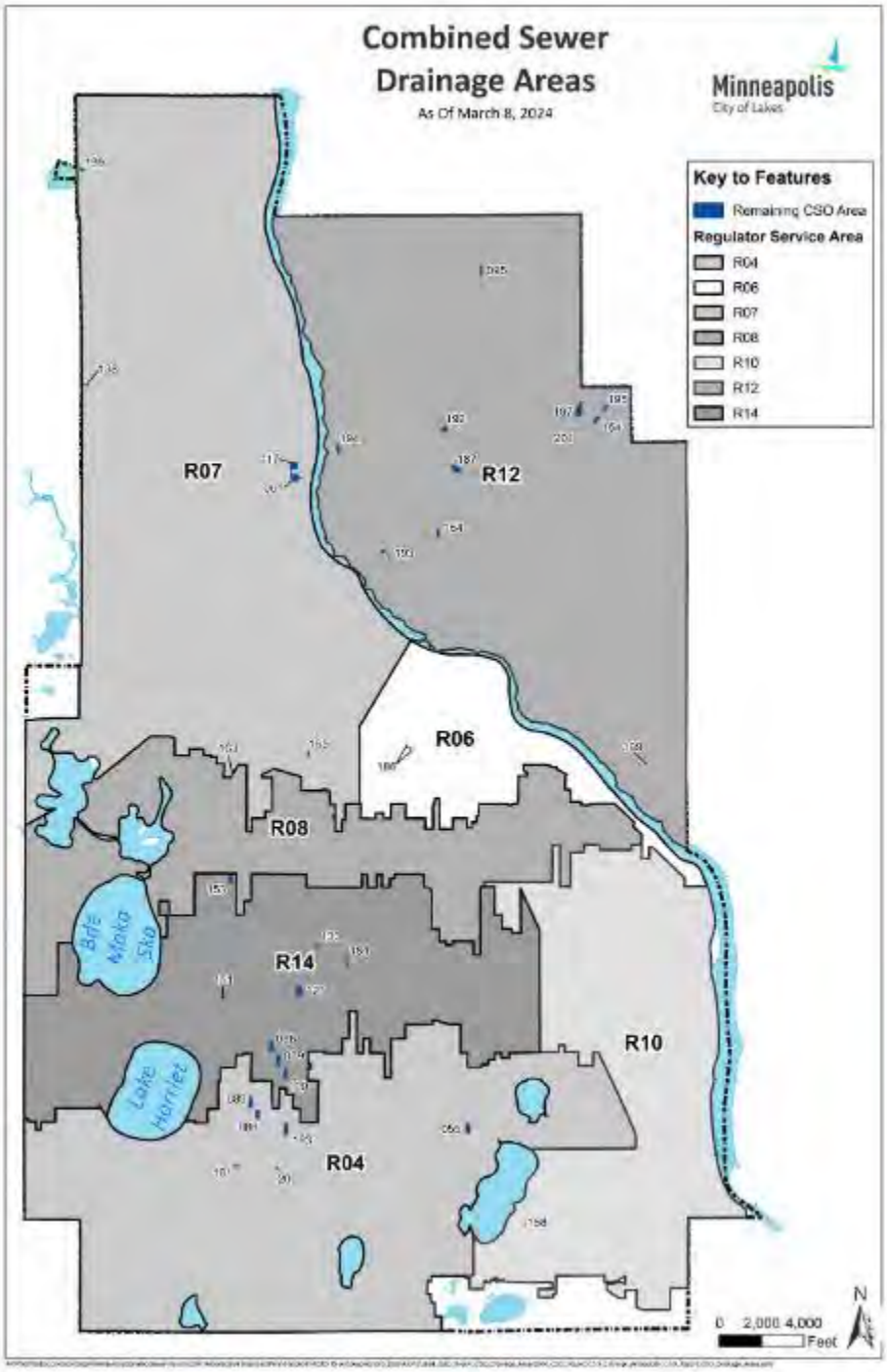
In 2023, Minneapolis continued to invest in studies, investigations, and monitoring activities aimed at identifying sources of inflow and infiltration. These efforts included the following:

- Flow Monitoring: 57 sanitary sewers and 5 rain gages were monitored in 2023. Sewer metering data was reviewed for rainfall dependent inflow and infiltration.
- Smoke Testing: 20.1 miles of sanitary sewer were smoke tested in 2023.
- Suspected Cross Connection Investigations: 8 investigations were completed in 2023. These include suspected connections identified from record drawings, GIS work and routine maintenance of the sewer system.

- Sewer Condition assessments: Televising and NASSCO condition assessments were completed on 6.6 miles of sanitary sewer.

Identified Inflow to the Sanitary Sewer System

An inventory of the drainage areas and sewer sheds of the remaining 33 combined sewer areas is provided in the following map and table:



CSO AREA ID	SEWER SHED	AREA [acres]	LOCATION
1	R07	2.77	22nd Ave N & 2nd St N
55	R04	2.45	Alley west of Cedar Ave & south of 47th St E
69	R14	2.29	Alley west of Pillsbury Ave & north of 43rd St W
86	R14	2.49	Alley east of Grand Ave & north of 42nd St W
88	R04	2.14	Alley west of Harriet Ave & south of 46th St W
89	R04	2.23	Alley west of Garfield Ave & north of 46th St W
95	R12	1.50	Alley north of 33rd Av NE & east of Tyler St NE
109	R14	2.17	Alley east of Pillsbury Ave & south of 43rd St W
117	R07	3.30	2nd St N & 23rd Ave N
121	R14	3.43	Alley north of W 38th St & east of Blaisdell Ave S
133	R14	0.76	Stevens Ave S & 35th St E
138	R07	0.47	Xerxes Ave N & Lowry Ave N
139	R07	0.76	Washburn Ave N & Osseo Rd
151	R14	0.30	38th St W & Dupont Ave S
153	R14	2.00	Alley south of 29th St W, east of Colfax Ave S
154	R12	1.51	Coolidge St NE & 19th Ave NE
158	R10	0.21	24th Ave S & 54½ St E
163	R08	0.23	Hennepin Ave S & Franklin Ave W
164	R12	1.35	Alley south of Spring St NE east of Madison St NE
165	R07	1.23	South of I-94 & 1st Ave S
181	R04	0.51	50th St W & Aldrich Ave S
183	R04	2.66	Alley south of 47th St W, west of Wentworth Ave S
184	R14	1.47	4th Ave S & 36th St E
186	R06	1.13	17th St E & 11th Ave S
187	R12	2.69	14th Ave NE & Van Buren St NE
192	R12	1.67	Monroe St NE & 19th Ave NE
193	R12	1.41	Main St NE & 4th Ave NE
194	R12	1.72	Marshall St NE & 16th Ave NE
195	R12	1.11	Coolidge St NE & 22nd Ave NE
197	R12	4.11	Stinson Blvd & 22nd Ave NE
199	R12	0.18	Arthur Ave SE & Franklin Ave SE
200	R04	0.55	Alley east of Gladstone Ave S & south of 50th St W
201	R12	0.21	19th Ave NE & Stinson Pkwy

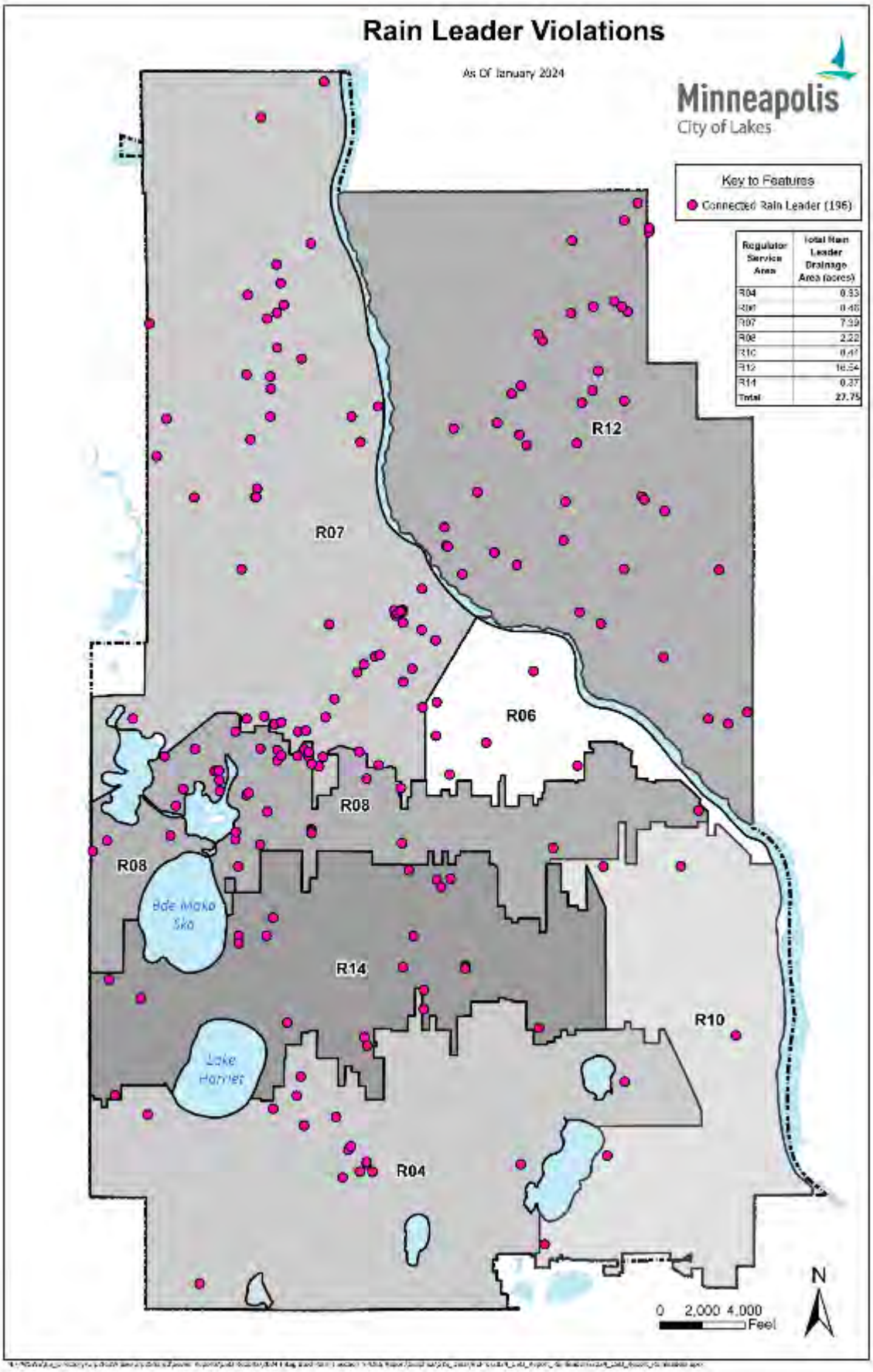
Combined Sewer Overflow / I & I Reduction Projects

Two storm drain separation projects were completed in 2023, eliminating 2.85 acres of direct drainage.

PROJECT NAME	PROJECT LOCATION	DRAINAGE AREA [acres]
CSO 149	Bryant Ave S & 40th St W	1.25
CSO 198	4300 block of 42nd Av S	1.6
	Total:	2.85

Rain Leader Disconnection Program

Inflow from private property through roof drains, area drains, sump pumps, and open standpipes are tracked by parcel. The following map and table summarize parcels with open rain leader violations by sewer shed. In 2023, 74 rain leaders covering 0.74 acres were disconnected.


Rain Leader Violations
As Of January 2024
Minneapolis
City of Lakes
Key to Features
Connected Rain Leader (196)
Regulator Service Area
Total Rain Leader Drainage Area (acres)
R04 0.33
R07 7.39
R08 2.22
R12 16.54
R14 0.27
Total 27.75
R12
R07
R06
R08
R08
Bde Maka Ska
R14
R10
Lake Harriet
R04
N
0 2,000 4,000
Feet

Combined Sewer Drainage Area Percentage

The drainage areas for the storm drain connections to the sanitary sewer system and total sewer shed areas are compared in the table below. The comparison shows these areas are a small fraction of the tributary areas to each regulator and associated outfall.

OUTFALL NUMBER	REGULATOR NUMBER	TOTAL SEWER SHED AREA [acres]	COMBINED SEWER DRAINAGE AREA [acres]	PERCENT COMBINED SEWER AREA [%]
1	R04	5,881.04	10.87	0.18
2	R14	3,973.96	15.28	0.38
4	R10	4,239.58	0.65	0.02
5	R06	1,459.49	1.55	0.11
6	R12	8,322.38	34.00	0.41
7	R08	3,019.47	2.22	0.07
20	R07	8,571.93	15.67	0.18
	Total	**35,467.85**	**80.24**	**0.23**

Sanitary Tunnel & Sewer Rehabilitation Program

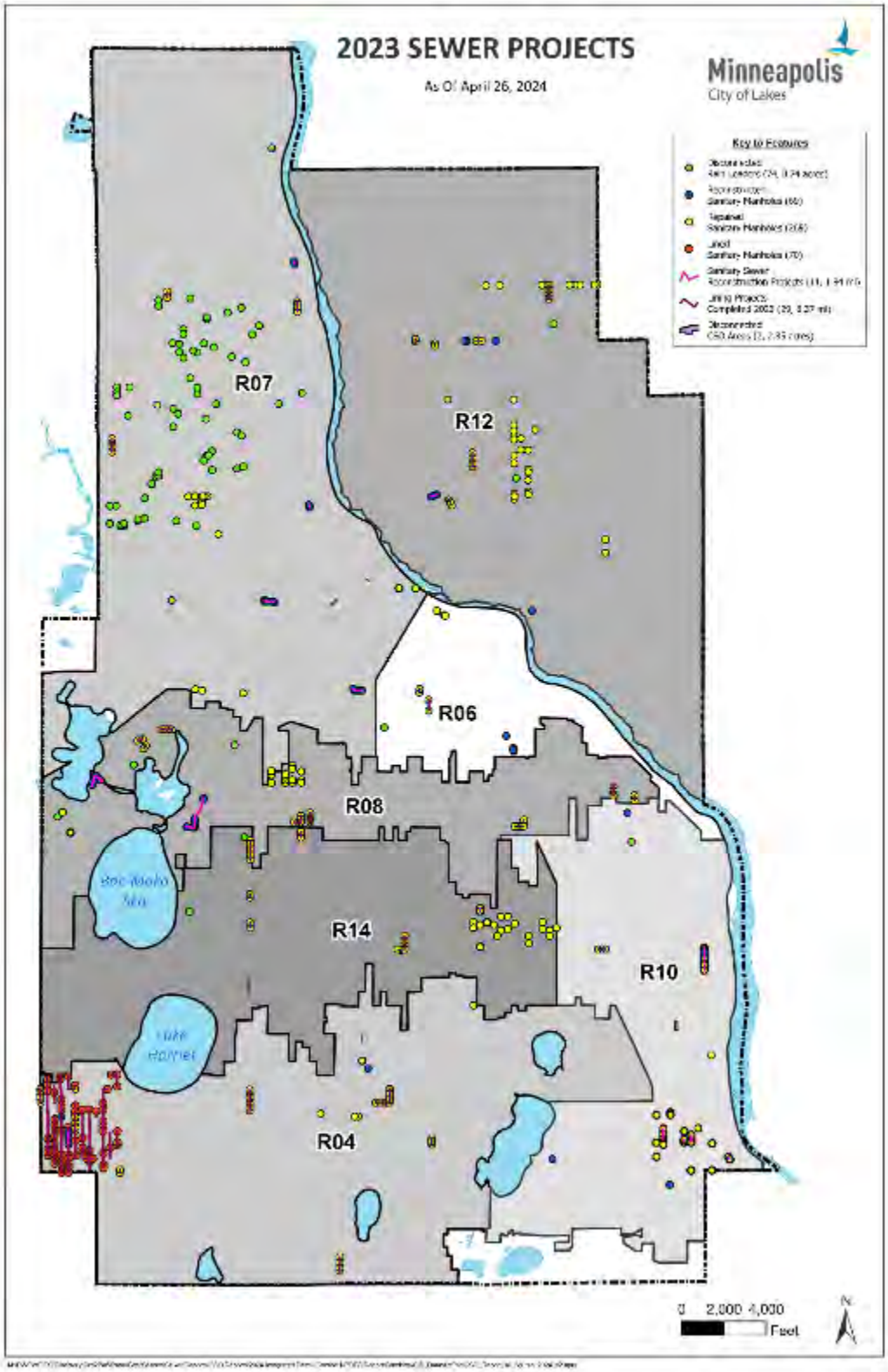
Sewer condition assessment data is used to develop this program. Repairs are prioritized based on structural and maintenance scores, paired with the likelihood and consequence of failure of each sewer. This condition assessment also determines if a sewer should be lined or reconstructed. Reconstruction is needed when sewers have collapsed or are deformed.

- Sewer Lining: Cured-In-Place-Pipe lining (CIPP) is a process to rehabilitate existing sewer pipes, due to age, cracks, or leaks. Sewers are lined by inserting a fiberglass sock that is inverted and cured to an outer pipe with steam. In 2023, 8.37 miles of sanitary sewer and 70 manholes were lined.
- Sewer Reconstruction: Full replacement of a sewer through an open excavation or tunneling for mainline is utilized when that sewer can no longer be rehabilitated. In 2023, 11 sewer construction projects were completed, replacing 1.94 miles of sewer and 69 manholes.
- Manhole Repairs: Includes a range of repairs from mortar work to partial or full reconstruction of manholes. In 2023, 269 repairs to sanitary manholes were completed.

Summary of Annual Expenditures for Program Activities

Sanitary Rehab Projects – Repair and Replacement	$11,554,558
CIPP Lining Projects	$2,536,312
Sewer Separation Projects *	$0
Rain Leader Disconnect Work	$139,000
Flow Metering	$477,077
Smoke Testing	$374,199
Other I & I Studies	$167,642
Total	**$15,248,788**

**Sewer separation project included in repairs total*


2023 SEWER PROJECTS
As Of April 26, 2024
Minneapolis
City of Lakes
Key to Features
R07
R12
R06
R08
R14
R10
R04
Bde Maka Ska
Lake Harriet
0 2,000 4,000
Feet
N

Collaboration with External Partners

MCES and the City of Minneapolis share a commitment to minimize the risk of overflows. A 5-year joint study of the regional wastewater system within Minneapolis was initiated in 2018. The purpose of the study, which is being led by MCES, is to develop a work plan to address hydraulic capacity and provide for continued system reliability and reduced risk of system overflow. The goals of the study include:

- Identify areas within Minneapolis with high rates of I & I
- Identify areas of the MCES system with highest risk of sanitary sewer overflow
- Identify areas where hydraulic capacity is limited in the MCES system
- Identify projects that could lower risks of sewer overflow and increase needed capacity, including consideration of regulator closures
- Reduce I & I contributions to wastewater flows to recover interceptor capacity
- Maximize conveyance and storage capacity in the existing interceptor system
- Identify areas of the City where insufficient storm sewer capacity affects MCES system capacity and reliability
- Develop feasible alternatives to reduce risk of sewer overflows, including evaluation of cost-effectiveness, for capital projects that address the hydraulic capacity, risk of sewer overflow, and sources of I & I identified in the study

Minneapolis also participates in the Metropolitan Councils I & I Surcharge Program. The Surcharge Program is aimed at reducing peak flows from I & I that would require the MCES to construct additional capacity.

APPENDIX A

APPENDIX A2	2023 WMMA / BCWMC / SCWMC EDUCATION & PUBLIC OUTREACH PROGRAM
APPENDIX A4	VEHICLE RELATED SPILLS SOP
APPENDIX A5	STORM DRAINAGE AREAS BY RECEIVING WATER BODY
APPENDIX A8	INTEGRATED PEST MANAGEMENT POLICY
APPENDIX A9	2023 UTILITY RATE RESOLUTION
APPENDIX A10	STORMWATER UTILITY FEE FAQ
APPENDIX A12	MPRB 2023 STORMWATER MONITORING RESULTS & DATA ANALYSIS
APPENDIX A13	2023 FROG & TOAD REPORT

Appendix A

Minneapolis

City of Lakes

Bassett Creek Watershed Management

April 1, 2024

BCWMC Member Cities:
Crystal, Golden Valley, Medicine Lake, Minneapolis, Minnetonka, New Hope, Plymouth, Robbinsdale, St. Louis Park

RE: 2023 Water Education Activities – Letter of Understanding

Dear Member Cities,

This letter is to serve as an official arrangement between the Bassett Creek Watershed Management Commission (BCWMC) and each of the member cities in the watershed. Member cities provide financial contributions to the BCWMC through an annual assessment based on area within the watershed and tax valuation of property in the watershed. In 2023 the total assessment from cities was $617,430. A breakdown of individual city contributions is found in the 2023 BCWMC Operating Budget. Further, watershed commissioners representing member cities participate in, guide, and help implement the programs of the BWCMC, including its public education program.

Education-related activities of the BCWMC are guided by its 2015 Watershed Management Plan, specifically its education and outreach policies (Section 4.2.9), and its overall Education and Outreach Plan found in Appendix B. http://www.bassettcreekwmo.org/document/wmp-plans. The specific activities of the BCWMC public outreach and education program are set annually by the Commission after recommendations are forwarded by the BCWMC Education and Outreach Committee which includes Golden Valley staff.

Gathering Input for 2025 Watershed Management Plan: In 2022 and continuing in 2023, many of the outreach activities were focused on gathering input from groups and the public to help inform the next 10-year watershed management plan. This included a public online survey that opened in June 2022 and had 165 responses by January 2023. Survey responses are summarized in graphics in Appendix A.

Engaging with and gathering feedback from diverse and underserved communities was a focus of this work and was accomplished primarily through presentations and survey feedback at meetings and events in Minneapolis neighborhoods including Jordan Area Community Council, Harrison Neighborhood Association, and Northside Resident Redevelopment Council. In December 2022, the BCWMC approved a policy to compensate individuals with $50 Visa gift cards for providing their time, insights, and expertise to the BCWMC through interviews or small group discussions. Despite numerous attempts to gather input and provide compensation, only one Minneapolis resident provided an interview, in September 2023.

Bassett Creek Watershed Public Open House and Ideas Exchange Event: February 28, 2023
Thirty-four members of the public and BCWMC partners attended the event along with member city staff, BCWMC staff, and BCWMC commissioners and alternates. Free childcare was provided as well. The event included educational materials on water quality and best practices, native plantings, the watershed map, AIS, and BCWMC capital projects. A complete report on the open house is found here.

Public Open Houses for Capital Projects: The BCWMC collaborates with member cities and other partners to inform and gather input from the public on proposed capital improvement projects. In 2023, the BCWMC held three capital project open houses.
Ponderosa Woods Stream Restoration Project, Plymouth - February 13, 2023
Bassett Creek Main Stem Restoration Project, Golden Valley – March 1, 2023
Sochacki Park Water Quality Project, Robbinsdale – July 26, 2023

Low Salt, No Salt Minnesota Campaign Roll Out: The BCWMC was one of several watersheds and cities in Hennepin County that worked with state grant funding and developed a new outreach campaign to reduce winter deicer use. The campaign's target audience is decision makers, like boards or committees, with homeowners associations, townhome associations, and faith based communities. A professional marketing firm created multiple outreach tools for use by watershed staff, city staff, and trained volunteers.
Train the Trainer Event January 30, 2023
Campaign Tools available at www.rpbcwd.org/low-salt-no-salt

Haha Wakpadan Oral History Project: Watershed staff and Chair Cesnik participated in several events over 2022 and 2023 including project updates and partner gatherings. This included partnering in the development of the Haha Wakapdan pronunciation video.

Bassett Creek Watershed Tour: October 2, 2023 – This was a caravan tour primarily for BCWMC commissioners and city staff. Tour stops included Bryn Mawr Meadows Water Quality Improvement Project (Minneapolis), Medley Park Stormwater Treatment Facility (Golden Valley), SEA School – Wildwood Park Flood Reduction Project (Golden Valley), Bassett Creek Main Stem Restoration Project (Golden Valley), Sochacki Park Water Quality Project (Robbinsdale and Golden Valley), Bassett Creek Lagoon Dredging Project (Golden Valley), and a demonstration of the City of Plymouth's high efficiency street sweeper. The tour handout is found here.

AIS Signage Development: The BCWMC partnered with Hennepin County to help develop educational signs on AIS prevention. The signs were developed specifically for fishing piers (for an audience of anglers), and canoe carry in access points. They were completed at the end of 2023 and will be fabricated and installed in collaboration with member cities.

Watershed Map Update: A large, folded paper map of Bassett Creek watershed has been a useful outreach tool since its initial printing in 2015. With supplies running low, in fall 2023 the BCWMC hired a map designer and starting working with its Education Committee to redesign and update the map. A new version of the map is expected summer 2024.

Outreach Events: The BCWMC staff and commissioners participated in several outreach events in 2023, engaging with residents and distributing educational material. Additionally, BCWMC outreach materials were used by city staff and volunteers at other events including National Night Out in the City of Medicine Lake and New Hope Days.

- Discover Plymouth Event, Plymouth – April 15, 2023
- Loppet Foundation Sustainability Fair – April 29, 2023
- Sustainability Day at the Market, Golden Valley – July 30, 2023
- BEAM Grand Opening, Jordan Neighborhood, Minneapolis – September 28, 2023

BCWMC Website - The BCWMC maintained its user-friendly website in 2023 and maintained the information including contact list, meeting calendar, meeting materials, watershed plan, data, and projects. In 2023, there were approximately 8,705 total users and 7,785 engaged.

West Metro Water Alliance (WMWA) Membership – The BCWMC continued its participation in WMWA along with several watershed management and other water-related organizations in the west Metro area. Through WMWA, these organizations collaborated on educational campaigns including the Watershed PREP program aimed at educating 4th grade students about water resources and the impacts of stormwater. Watershed PREP has three individual lessons meeting State education standards. **Lesson 1***, What is a Watershed and Why do We Care?* provides an overview of the watershed concept and is specific to each school's watershed. It describes threats to the watershed. **Lesson 2,** *Water Cycle - More than 2-dimensional,* describes the movement and status of water as it travels through the water cycle.

In 2023, lessons in native plants and the "watershed game" were added to the Watershed PREP program.

In 2023, students from multiple schools in the Bassett Creek watershed participated in the Watershed PREP lessons including 565 students in Lesson 1, 831 students in Lesson 2, and 713 students in Native Plantings and the Watershed Game. Additionally, in May and June, the WMWA Educator worked with Robbinsdale Middle School to clean up and replant a raingarden on the school grounds. This project included students from seventh and eighth grades as well as school and city staff. See Appendix B for details on schools and number of students reached.

In April 2022, WMWA members worked with the member watersheds, Hennepin County and the Minnesota Board of Soil and Water Resources to secure Watershed-Based Implementation Funding (WBIF) grant dollars to pilot a two-year Conservation Education and Implementation position employed by and shared jointly with Hennepin County with 50% of time spent on WMWA and Richfield-Bloomington WMO outreach and implementation, and 50% on Hennepin County outreach. Meetings from April through December 2022 refined the vision and scope for this position.

In spring 2023, Hennepin County hired Grace Barcelow with the title Conservation Specialist. Throughout 2023 Barcelow has created work plans for WBIF funded projects through WMWA, campaigns for pet waste, chloride, and Adopt-A-Drain education, updated the WMWA website, and began implementing outreach to faith-based organizations for chloride consultations. In the Bassett Creek watershed, Barcelow will the Parker's Lake Chloride Reduction Project.

Metro WaterShed Partners Membership & Adopt a Drain —The BCWMC participated as a member of the Metro WaterShed Partners as a general supporter of the program and a financial supporter of the Metro Clean Water Minnesota Media Campaign and the Adopt a Drain Program. Metro Watershed Partners maintains a listserve and a website as forums for information sharing, holds monthly meetings for members to collaborate, and coordinates the Adopt-a-Drain program. In 2023, there were 71 new participants in the Adopt-a-Drain program totaling 100 drains and over a ton of debris collected. An Adopt-a-Drain report specific to BCWMC communities and waterbodies is found in Appendix C.

Partnership with Metro Blooms for Projects in Minneapolis Neighborhoods – Since 2016, the BCWMC has partnered with and supported the Metro Blooms on outreach, engagement, and project installation in Near North neighborhoods in Minneapolis. The projects aim to engage residents and commercial businesses, train youth, and install water quality practices in Minneapolis' Near North neighborhoods. The BCWMC collaborates on grant-funded projects and offers its own financial support. These programs have resulted in engagement with dozens of Minneapolis residents and more than 14 Minneapolis

commercial/institutional property owners. In 2022 and 2023, Phase II of the Lawns to Legumes grant projects resulted in construction and planting of several small native gardens and boulevard swales with total stormwater volume reduction of 1.36 acre-feet/year, reductions of 77 tons of sediment and 1.6 pounds of total phosphorus per year.

Volunteer Monitoring Programs – The BCWMC entered an agreement with the Metropolitan Council to participate in the Citizen Assisted Monitoring Program (CAMP). In 2023, volunteers collected data from 9 locations on 7 lakes in the watershed, including Sweeney (2 sites), Twin, Northwood, Lost, Parkers, and Medicine (2 sites).

Due to your city's financial contributions and close involvement and participation with the BCWMC's activities, the BCWMC's education activities can and should be considered part of the city's implementation of Minimal Control Measures (MCM) 1 and 2 in the MS4 stormwater permit. Please let me know if you have any questions or require further information.

Sincerely,

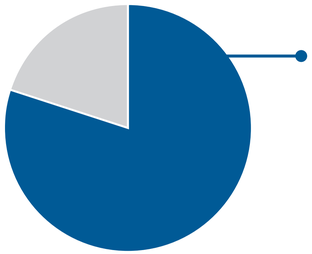
Laura Jester, Administrator

Appendix A

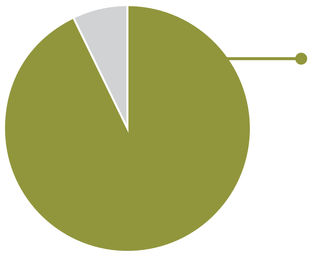
Bassett Creek Public Input Survey Results

Survey open June 2022 – January 2023

165 Respondents



80% indicate natural resources like lakes, streams, and wetlands are very important to their quality of life



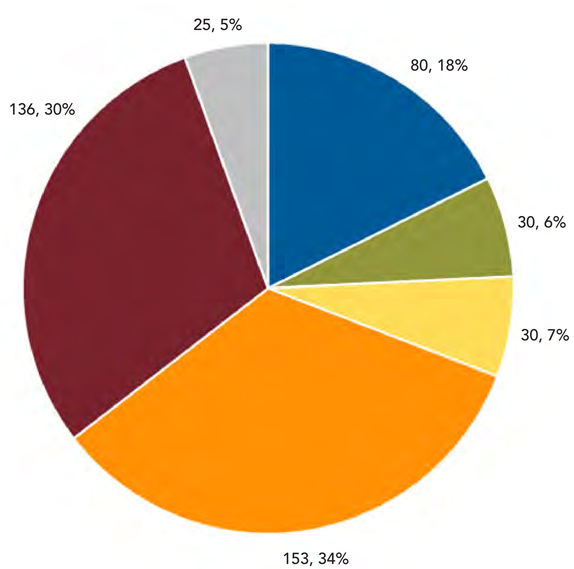
93% of respondents indicate they have adequate access to natural resources in their community; 7% DO NOT have adequate access

SUGGESTIONS

on what could be improved in the watershed included the following:

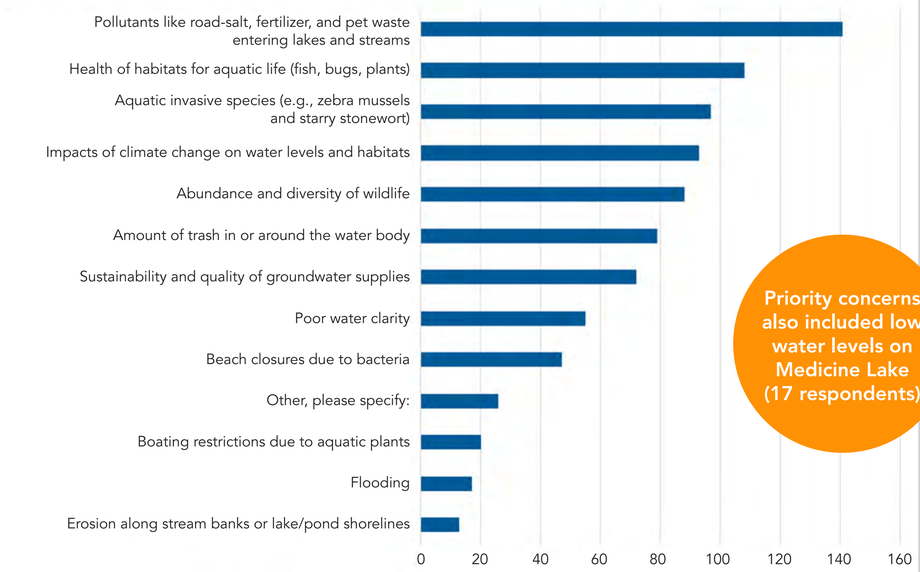
- Less trash in lakes and along streams
- Lower chloride levels (less salt!)
- More logs for turtles
- Less streambank and shoreline erosion
- More education of residents
- Better access to the creek for paddlers and enjoying nature
- Incentives for native plantings and other best practices

How do you interact with the water and natural resources (lakes, streams, wetlands, natural areas) in the BCWMC?



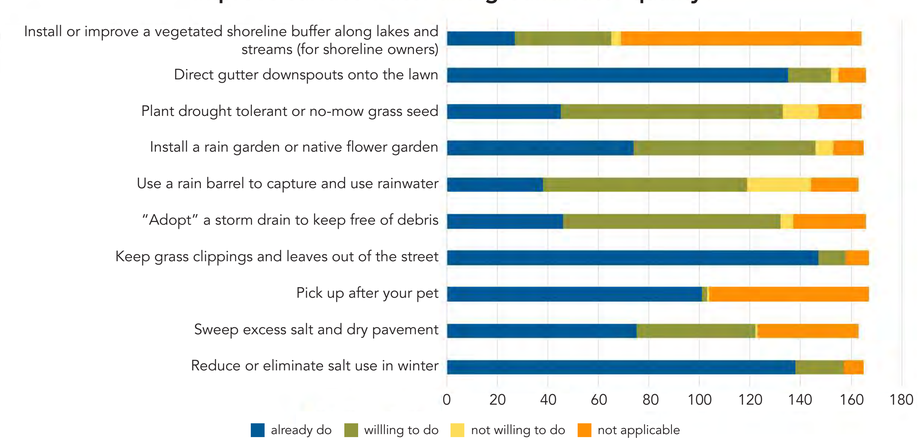
**These results do not include a similar survey about water resources from the City of Plymouth that had 220 responses from across the city, including areas outside the Bassett Creek watershed.*

Of the following, what concerns you about the condition of lakes, streams, and natural areas in the Bassett Creek Watershed? (select top five concerns)



Priority concerns also included low water levels on Medicine Lake (17 respondents)

How willing are you to take the following actions around your home and yard to improve surface water and groundwater quality?



APPENDIX B – WMWA WATERSHED PREP / EDUCATOR ACTIVITY

Table 1. 202 schools and students participating in Watershed PREP classes

Lesson 1: What is a Watershed and Why do we Care?

Date	School	School District	City	Watershed	Classes	Students
3/23	Neill Elementary	Robbinsdale	Crystal	Bassett	2	45
3/29	Greenwood Elementary	Wayzata	Medina	Elm	5	120
4/5	Lakeview Elementary	Robbinsdale	Robbinsdale	Shingle	3	87
4/24	Plymouth Creek	Wayzata	Plymouth	Bassett	2	60
4/26	Woodland Elementary	Osseo	Brooklyn Park	W. Miss	4	105
5/2	Rush Creek	Osseo	Maple Grove	Elm	4	100
5/9	Oxbow Creek	Anoka-Henn	Champlin	W. Miss	6	186
5/11	Zachary Lane Elementary	Robbinsdale	Plymouth	Bassett	3	60
5/23	Kimberly Lane	Wayzata	Plymouth	Bassett	3	93
5/31	Basswood	Osseo	Maple Grove	Elm	5	160
10/6	Noble Elementary	Robbinsdale	Golden Valley	Bassett	2	42
10/13	Weaver Lake	Osseo	Maple Grove	Elm	4	124
10/18	School of Engineering and Arts (SEA)	Robbinsdale	Golden Valley	Bassett	3	81
11/8	Meadowbrook	Hopkins	Golden Valley	Bassett	5	129
11/17	Rogers	Elk River	Rogers	Elm	5	130
12/5	Monroe Elementary	Anoka-Henn	Brooklyn Park	W. Miss	4	100
12/14	Neill Elementary	Robbinsdale	Crystal	Bassett	3	55
12/18	Greenwood Elementary	Wayzata	Medina	Elm	3	141
				Total	**46**	**1818**

Lesson 2: The Incredible Journey

Date	School	School District	City	Watershed	Classes	Students
1/17	Northport Elementary	Robbinsdale	Brooklyn Ctr	Shingle	3	75
1/23	Rice Lake Elementary	Osseo	Maple Grove	Elm	2	30
3/1	Greenwood Elementary	Wayzata	Plymouth	Bassett	5	120
3/21	Neill Elementary	Robbinsdale	Crystal	Bassett	2	45
4/4	Lakeview Elementary	Robbinsdale	Robbinsdale	Shingle	3	87
4/21	Plymouth Creek	Wayzata	Plymouth	Bassett	2	60
4/25	Woodland Elementary	Osseo	Brooklyn Park	W. Miss	4	105
5/1	Rush Creek	Osseo	Maple Grove	Elm	4	100
5/10	Zachary Lane Elementary	Robbinsdale	Plymouth	Bassett	3	60
5/12	Basswood	Osseo	Maple Grove	Elm	5	160
5/22	Kimberly Lane	Wayzata	Plymouth	Bassett	3	93
10/5	Noble Elementary	Robbinsdale	Golden Valley	Bassett	2	42
10/12	Weaver Lake	Osseo	Maple Grove	Elm	4	124
10/25	Meadowbrook	Hopkins	Golden Valley	Bassett	5	215

11/1	Greenwood Elementary	Wayzata	Plymouth	Bassett	5	141
11/16	Rogers	Elk River	Rogers	Elm	5	130
11/20	Zanewood Elementary	Osseo	Brooklyn Park	Shingle	2	50
12/4	Monroe Elementary	Anoka-Henn	Brooklyn Park	W. Miss	4	100
12/13	Neill Elementary	Robbinsdale	Crystal	Bassett	3	55
				Total	**66**	**1792**

Other Classes

Date	School	Class taught	Watershed	Classes	Students
2/14	Ramsey Elementary	Native Plants	Lower Rum	6	144
3/9	Ramsey Elementary	Watershed Game	Lower Rum	1	22
3/24	Neill Elementary	Native Plants	Bassett	2	45
4/6	Lakeview Elementary	Native Plants	Shingle	3	87
4/11	Greenwood Elementary	Native Plants	Bassett	5	120
4/14	Robbinsdale Middle-8th gr	Watershed Game	Bassett	1	30
4/28	Robbinsdale Middle-8th gr	Watershed Game	Bassett	1	30
4/17	Zanewood Elementary	Native Plants	Shingle	3	41
4/27	Woodland Elementary	Native Plants	W. Miss	4	105
5/3	Robbinsdale Middle	Rain Garden Cleanup	Bassett	1	30
5/4	Robbinsdale Middle	Rain Garden Cleanup	Bassett	1	30
5/15	Robbinsdale Middle-7th gr	Native Plants	Bassett	6	145
5/17	Meadowbrook	Watershed Game	Bassett	5	125
5/24	Meadowbrook	Native Plants	Bassett	5	125
5/26	Kimberly Lane	Native Plants	Bassett	3	93
6/1	Robbinsdale Middle	Raingarden Planting	Bassett	6	160
12/1	Jackson Middle School	?	W. Miss	?	?
			Total	53	1332

Appendix C

ADOPT A STORM DRAIN

2023 Bassett Creek Annual Report

We're Making a Difference!

71	100	352	723
participants 2023	drains adopted 2023	participants TOTAL	drains adopted TOTAL

PRELIMINARY DATA, FULL REPORT IN JANUARY, 2024

Drain Cleaning & Collection Data

86 Bassett Creek participants reported cleanings, which represents 24.4% of all Bassett Creek participants

Bassett Creek participants collected 2,222.8 lbs of debris from their adopted storm drains in 2023

Debris Type	Amount (lbs)
Brown Leaves	993.8
Grass and Green Leaves	284.7
Sediment and dirt	761.4
Trash	182.8
Salt	0.0

Month	New Participants	Drains Adopted	Debris collected (lbs)	Time spent (hrs)
January	6	10	30.0	4.1
February	3	3	2.0	4.0
March	3	4	51.6	2.8
April	6	13	140.5	15.1
May	9	11	363.8	5.2
June	1	1	475.0	6.6
July	2	3	147.3	5.0
August	15	19	100.4	4.1
September	19	21	101.2	4.7
October	0	0	266.7	5.5
November	2	6	490.1	9.7
December	5	9	54.2	4.2
TOTALS	**71**	**100**	**2,222.8**	**70.8**

City and Subwatershed

Drains Adopted: Cumulative total

Debris collected: 2023 data only

City	Drains adopted	Debris collected (lbs)	Time spent (hours)
Minneapolis	349	1,274.5	34.1
Golden Valley	128	330.1	15.0
Plymouth	73	141.2	2.4
St. Louis Park	37	265.1	11.8
Crystal	37	4.4	0.2
Robbinsdale	37	104.8	2.6
New Hope	33	34.0	0.7
Minnetonka	20	68.6	4.3

Subwatershed	Drains adopted	Debris collected (lbs)	Time spent (hours)
Bassett Creek Main Stem (Upstream)	101	151.6	9.9
Bassett Creek Main Stem (Downstream)	157	1,110.5	31.0
Grimes Lake	39	133.1	3.5
Plymouth Creek	31	12.0	0.3
Bassett Creek Park Pond	31	29.9	0.6
Medicine Lake Direct	11	9.1	0.6
Medicine Lake South	10	40.0	0.3
Mississippi River	186	156.0	2.7
Sweeney Lake	49	170.9	7.6
Northwood Lake	14	85.6	1.7
Wirth Lake	4	0.0	0.0

Subwatersheds continue on next page.

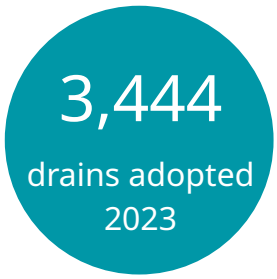
Subwatersheds (continued)

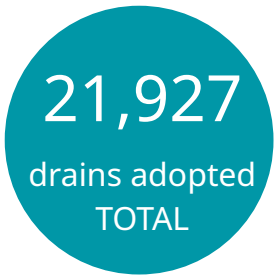
Drains Adopted: Cumulative total

Debris collected: 2023 data only

Subwatershed	Drains adopted	Debris collected (lbs)	Time spent (hours)
Crane Lake	9	16.0	0.5
Medicine Lake NE	4	0.0	0.0
Westwood Lake	21	252.6	10.3
Medicine Lake North	5	0.0	0.0
Lake of the Isles	3	0.0	0.0
Parkers Lake	3	2.0	0.1
Minnehaha Creek	5	13.4	1.5
Cedar Lake	3	40.0	0.3
Spring Lake	6	0.0	0.0
Turtle Lake	2	0.0	0.0
Long Lake	1	0.0	0.0

Minnesota Data





2,813 Minnesota participants reported cleanings, which represents 22.6% of all Minnesota participants

Minnesota participants collected 118,233.2 lbs of debris from their adopted storm drains in 2023

Debris Type	Amount (lbs)
Brown Leaves	63,628.7
Grass and Green Leaves	5,873.8
Sediment and dirt	40,161.5
Trash	8,486
Salt	83.1

Month	New Participants	Drains Adopted	Debris collected (lbs)	Time spent (hrs)
January	131	185	1,378.4	11,278
February	69	123	302.8	11,746
March	102	205	848.1	11,672
April	255	449	14,472.1	20,770
May	155	266	11,818.0	12,649
June	80	132	8,014.1	12,472
July	84	151	7,695.0	9,598
August	459	619	5,977.7	8,000
September	431	594	7,731.6	9,919
October	180	363	12,452.1	17,669
November	132	290	41,956.5	39,220
December	35	67	5,586.9	8,428
TOTALS	**2,113**	**3,444**	**118,233.2**	**173,421**

CITY OF MINNEAPOLIS

Public Works - Street Maintenance Division

Standard Operating Procedure for Vehicle Related Spills (VRS)

March 28, 2022

The purpose of this document is to provide detailed standard operating procedures for the clean-up of VRS sites and the management/disposal of the impacted spill debris.

DEFINITION OF TERMS

9-1-1 : Minneapolis 9-1-1 Dispatch Center for Minneapolis Fire Department

FIS/MES: Fire Inspection Service / Minneapolis Environmental Service

MDO: Minnesota Duty Officer: The MDO Program provides a single answering point for local and state agencies to request state-level assistance for emergencies, serious accidents or incidents, or for reporting hazardous materials and petroleum spills. The MDO is available 24 hours per day, seven days per week.

MPCA: Minnesota Pollution Control Agency

MSMD: Minneapolis Street Maintenance Division (Minneapolis Public Works)

NRC: The National Response Center provided for assistance for non-vehicle related spills when a federal notification is required as directed by FIS/MES / MDO

SWLRT: Southwest Light Rail Transit

VRM: Vehicle Related Material: Petroleum products or other vehicle fluids that are inherently related to vehicular operations. This does not include materials that are being transported by a vehicle, unless the material is clearly labeled as being one of the aforementioned products.

VT: Volumetric Threshold: Minnesota has a 5-gallon minimum quantity for reporting petroleum spills. Spill of all other chemicals or materials in any quantity is reportable.

Spill debris: Sand that has been placed to absorb VRM and subsequently recovered for disposal.

Scenario 1: MPCA informs FIS/MES of VRM spill

The driver of a vehicle involved in a VRM spill is responsible for notifying the MDO at 651-649-5451. If the VT is exceeded, 9-1-1 should also be contacted. The MDO will notify the MPCA Emergency Response Unit and other agencies as required. If the spill is of the size and nature that the Emergency Response Unit determines should be handled by FIS/MES, then the MPCA will notify FIS/MES and provide them with incident details. The FIS/MES representative will decide based on the information how to proceed, and if appropriate (typically VRM in manageable quantities), they would contact MSMD.

The MSMD will dispatch personnel with appropriate equipment to apply sand to the spill site. The sand will be given time to absorb the sand and spill debris (VRM), and then will then be removed by a street sweeper. The VRM will then be deposited at the established disposal site in a designated VRM spill debris pile.

If a secondary sand application is required, the procedure would remain the same. Since the volume of the spill is greater than 5 gallons, a Hazardous Material Spill Data form (see below) must be completed as soon as possible (i.e. within 24 hours or the next business day). The completed form will be sent to the FIS/MES as soon as possible. A final report on the actions taken will be sent to the MPCA from FIS/MES.

Spill Debris Pile Management

Arrangements for disposal of the spill debris pile will be a collaborative effort by the MSMD and the City of Minneapolis Engineering Laboratory. After the spill debris pile reaches a size that becomes difficult to manage within the disposal container, the Engineering Laboratory will be contacted. The spill debris pile will be mechanically blended, and the Engineering Laboratory will select representative samples for laboratory analysis, as per MPCA regulations. The sampling and testing will require approximately one week to complete. After receiving the laboratory analysis data, the spill debris will be disposed of in a manner pre-approved by the MPCA and the Minneapolis Procurement Division.

Scenario II: The MSMD discovers a VRM spill

MSMD personnel discover a spill or are informed of a potential VRM spill from sources other than FIS/MES or MPCA. After arriving at the scene, they determine if the incident is a VRM spill, (possibly from a vehicle collision, a spill from a labeled container, etc.) and determine if the volume of the spill:

- **Less than 5 gallons**: If the spill quantity is judged to be less than 5 gallons, no contact with FIS/MES is necessary. Sand is applied and the procedure will continue as described in Scenario I (i.e. subsequent sanding/sweeping and stockpiling into the spill debris pile). A Hazardous Materials Spill Data form must be completed for record and documentation purposes and retained at MSMD, but is not to be sent to FIS/MES.

- **5 gallons or more**: If the MSMD representative determines that the spill volume is more than 5 gallons of VRM, MSMD must contact FIS/MES, the MDO and 9-1-1. The same procedures for clean up and reporting (using the Hazardous Material Spill Data form) as in Scenario I will be followed. This form must be sent to FIS/MES.

For both cases, the disposal of the VRM spill debris pile is as detailed in Scenario I.

Possible Modifications to Scenario I and II

Regulatory officials may require separate stockpiling of spill debris from specific spill incidents. Separate sampling and laboratory analysis will be required in these cases. This may also be requested to create a distinct tracking mechanism of a given spill of significant quantities and/or from a billable source. This scenario will be determined on a case-by-case basis. The process for disposal will be the same as previous scenarios.

Scenario III: The MSMD becomes aware of a spill of unknown material or composition, non-VRM Spill or material labeled as required reporting to the NRC for spill/release.

The MSMD shall contact 9-1-1, the MDO and FIS/MES before taking any action to clean up a spill of unknown composition. FIS/MES will manage these spills through their contracts with private entities specializing in these activities, or manage and coordinate the cleanup with the MSMD. If FIS/MES cannot be contacted, the MDO should be contacted immediately. FIS/MES and/or the MDO will determine if NRC is to be called.

ADDITIONAL INFORMATION

1. Currently the disposal site for spill debris is behind 198 Aldrich Ave N, Minneapolis MN 55405 during SWLRT construction. The material shall be placed in two 20 cubic-yard leak-proof roll-off containers with a counter-balanced lockable lids at the City site.

2. List of Potential Contacts:
   - **MN Duty Officer - Minnesota Department of Public Safety, Bureau of Criminal Apprehension (BCA):** 651-649-5451 (24 hours a day, 7 days a week)
   - **Fire Inspection Service / Minneapolis Environmental Service (FIS/MES)**

     Steve Kennedy: 612-685-8528 (work)
     Tom Frame: 612-685-8501 (work cell - call, leave a message or text)
     Emergency after-hours contacts:
     Tom Frame: 612-685-8501 (work-cell - call, leave a message or text)
   - **City of Minneapolis Engineering Laboratory**

     Paul Ogren: 612-673-2456
     Chris DeDene: 612-673-2823
   - **Minneapolis Street Maintenance Division (MSMD)**

     Steve Collin: 612-673-5720 (work)
     Gary Long, Jr: 612-673-5720 (work)
     After hours: 612-673-5720 (24 hours a day, 7 days a week)
   - **National Response Center** 800-424-8802

3. MSMD will be responsible for any billing of outside parties for services rendered for the clean-up and disposal of a spill event. The MSMD, FIS/MES and the Engineering Laboratory will develop a system for tracking costs associated with these operations. This information will be distributed as it becomes available.

4. This is a statement of policies and procedures, which will be revised and updated as new information becomes available.

CITY OF MINNEAPOLIS - STREET DEPARTMENT - OIL AND HAZARDOUS MATERIAL SPILL DATA FORM

DATE OF REPORT:	TIME OF REPORT:	NAME & ADDRESS OF RESPONSIBLE PARTY:
DATE OF INCIDENT:	TIME OF INCIDENT:	
POLLUTANT TYPE:	QUANTITY (Units):	CAUSE OF SPILL:
LOCATION:		NAME & NUMBER PERSON OF MAKING REPORT:
AREAS AFFECTED:		
PROBABLE FLOW DIRECTION:		PARTY REPORTING SPILL TO STREET DEPARMENT:
SOIL TYPE:		
WATERS POTENTIALLY AFFECTED:		**CONTACTED: Check and list name/number**
EFFECTS OF SPILL, WAS THERE IMMEDIATE DANGER TO HUMAN LIFE OR PROPERTY:		☐ MN Duty Officer 651-649-5451 ☐ 911 ☐ FIS ☐ MPCA ☐ FIRE ☐ POLICE ☐ OTHER
ACTION TAKEN:		PROXIMITY OF WELLS, SEWERS, BASEMENTS:
CONTAINMENT OF SPILL:		IS THIS FIRST NOTICE REGARDING SPILL?
CONTACT NAME & NUMBER FOR MORE INFORMATION:		

	CLEAN-UP TO DATE	**COMMENTS:**
USED	MATERIALS:	
	LOADERS:	
	TRUCKS:	
	PICK-UP TRUCKS:	
	MACHINE SWEEPERS:	
LABOR	FOREMAN HOURS:	
	MAINTENANCE CREW LEADER:	
	CONSTRUCTION LABORER:	
	OTHER:	

ORIGINAL TO: When job is completed, send original to Street Accounting with daily time when labor/equipment first used.

COPY TO: MPCA NOTIFICATION COPY - send (interoffice or email) to Steve Kennedy (Stephen.kennedy@minneapolismn.gov), FIS, PSC Room 401 and Environmental Services (envservicesinfo@minneapolismn.gov), PSC Room 414

STREET JOB #:	LABOR COST $	
	EQUIPMENT COST $	
	MATERIAL COST $	
	TOTAL COST $	

MINNESOTA DUTY OFFICER

BCA Operations Center

651-649-5451 **1-800-422-0798**

TDD: 1-800-627-3529 **Satellite Phone: 1-254-543-6490**

About the Duty Officer

The Minnesota Duty Officer Program provides a single answering point for local and state agencies to request state-level assistance for emergencies, serious accidents or incidents, or for reporting hazardous materials and petroleum spills. The duty officer is available 24 hours per day, seven days per week.

If there is an immediate threat to life or property, call 911 first.

When to Call the Duty Officer

Examples of incidents the duty officer can assist with include (but are not limited to):

- Natural disasters (tornado, fire, flood etc)
- Requests for National Guard
- Hazardous materials incidents
- Search and rescue assistance
- AMBER Alerts
- Requests for Civil Air Patrol
- Radiological incidents
- Aircraft accidents/incidents
- Pipeline leaks or breaks
- Substances released into the air

Agency Resources Available

State Agencies

- Department of Agriculture
- Department of Commerce
- Department of Education
- Department of Health
- Department of Human Services
- Department of Military Affairs
- Department of Natural Resources
- Department of Transportation
- Minnesota Office of Enterprise Technology
- Minnesota Pollution Control Agency
- Department of Public Safety
  - Bureau of Criminal Apprehension
  - Homeland Security and Emergency Management
  - Minnesota Joint Analysis Center
  - Minnesota State Patrol
  - Office of Pipeline Safety
  - State Fire Marshal
- Other state agencies not listed

Other Resources

- Minnesota Arson Hotline
- Local bomb squads
- Chemical assessment teams
- Emergency response teams
- Fire and rescue mutual aid
- Amateur radio (ARES/RACES)
- Minnesota voluntary organizations
- Fire chiefs assistance teams
- Search-and-rescue dogs
- Interagency Fire Center
- U.S. Air Force Search and Rescue Center

MINNESOTA DUTY OFFICER

BCA Operations Center

1-800-422-0798 **FAX: (651) 296-2300** **(651) 649-5451**

Satellite Phone: 1-254-543-6490

Emergency Notification

If there is a spill of a hazardous material or a petroleum product in Minnesota, you must call:

Local Authorities	**Call 9-1-1 FIRST,** *when there is a threat to life or property*
Minnesota Duty Officer	*If there is a public safety or environmental threat and/or if state agency notification for reportable spills is required*
The National Response Center 1-800-424-8802	*When a federal notification is required*

The following information (if available) will be requested by the Minnesota Duty Officer:

- Name of caller
- Date, time and location of the incident
- Telephone number for call-backs at the scene or facility
- Whether local officials (fire, police, sheriff) have been notified of incident

Additional information will be requested in the following special circumstances:

Making Notification of Spills/Incidents

- Materials and quantity involved in incident
- Incident location (physical address, intersection, etc.)
- Responsible party of incident (property/business owner)
- Telephone number of responsible party
- Any surface waters or sewers impacted
- What has happened and present situation

Requesting State Assistance for Incidents

- Type of assistance requested (informational, specialized team **a**ssets, etc).
- Name of requesting agency/facility
- Materials, quantity and personnel involved in the incident
- Whether all local, county, mutual aid resources been utilized

Storm Drainage Areas by Receiving Waterbody
(within Minneapolis city limits)

Receiving Water	Area (acres)	Impervious %	Population 2020	Agricultural	Airport or Airstrip	Golf Course	Industrial or Utility	Institutional	Major Railway	Mixed Use Commercial	Mixed Use Industrial	Mixed Use Residential	Multifamily	Office	Open Water	Park, Recreational, or Preserve	Retail and Other Commercial	Right of Way	Seasonal/Vacation	Single Family Attached	Single Family Detached	Undeveloped
Mississippi River	20,315.3	57.6%	273,735	0.1%	0.0%	0.9%	9.0%	7.5%	2.3%	0.8%	1.4%	0.9%	5.3%	1.4%	0.1%	7.0%	3.8%	28.8%	0.0%	6.0%	22.7%	1.9%
Minnehaha Creek	3,340.3	38.6%	34,508	0.0%	0.0%	0.7%	0.1%	5.8%	0.0%	0.0%	0.1%	0.2%	0.6%	0.2%	0.0%	13.7%	1.1%	24.3%	0.0%	3.1%	49.8%	0.2%
Bassett Creek	1,630.8	40.8%	17,165	0.1%	0.0%	0.0%	3.8%	3.4%	1.7%	0.1%	0.2%	0.5%	1.1%	0.9%	0.0%	19.9%	0.9%	24.1%	0.0%	4.5%	36.1%	2.8%
Shingle Creek	1,457.7	44.8%	12,662	0.0%	0.0%	0.0%	8.2%	13.1%	3.6%	0.1%	0.0%	0.1%	1.0%	0.1%	0.3%	12.0%	0.8%	19.6%	0.0%	2.5%	37.6%	1.0%
Lake Hiawatha	1,246.7	43.1%	16,617	0.0%	0.0%	10.4%	0.0%	3.1%	0.0%	0.0%	0.0%	0.4%	2.4%	0.1%	0.0%	4.2%	1.7%	27.4%	0.0%	6.7%	43.2%	0.1%
Bde Maka Ska	1,246.0	45.1%	17,273	0.0%	0.0%	12.5%	0.1%	2.6%	0.0%	0.4%	0.0%	1.7%	7.7%	0.6%	0.0%	14.3%	4.0%	20.5%	0.0%	6.7%	28.6%	0.4%
Lake Harriet	1,120.2	39.4%	10,662	0.0%	0.0%	0.0%	0.1%	16.5%	0.0%	0.1%	0.0%	0.3%	1.5%	0.0%	1.1%	12.4%	1.1%	20.3%	0.0%	3.6%	42.8%	0.1%
Lake of the Isles	769.8	44.6%	13,231	0.0%	0.0%	0.0%	0.0%	2.0%	0.0%	0.4%	0.0%	0.9%	9.8%	0.1%	0.3%	17.0%	2.7%	23.8%	0.0%	9.5%	33.1%	0.3%
Lake Nokomis	695.8	35.1%	6,180	0.0%	0.1%	0.0%	0.0%	2.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	26.5%	0.3%	23.1%	0.0%	2.2%	45.3%	0.1%
Diamond Lake	670.9	48.3%	6,966	0.0%	0.0%	0.0%	7.2%	4.9%	0.0%	0.0%	0.6%	0.0%	4.1%	0.2%	0.0%	5.0%	3.5%	29.1%	0.0%	3.3%	41.4%	0.7%
Crystal Lake	421.3	41.8%	6,126	0.1%	0.0%	0.0%	0.0%	3.1%	0.0%	0.0%	0.0%	0.4%	1.4%	0.0%	0.0%	1.4%	0.7%	31.1%	0.0%	2.1%	58.9%	0.9%
Grass Lake	324.7	43.3%	2,928	0.0%	0.0%	0.0%	0.0%	3.1%	0.0%	0.0%	1.8%	0.0%	0.1%	0.0%	0.6%	4.7%	0.4%	29.9%	0.0%	2.1%	57.0%	0.1%
Powderhorn Lake	322.5	43.5%	6,356	0.1%	0.0%	0.0%	0.0%	4.0%	0.0%	0.1%	0.0%	0.3%	4.9%	0.3%	0.1%	17.5%	0.9%	27.4%	0.0%	15.0%	29.2%	0.3%
Cedar Lake	287.8	31.5%	1,804	0.0%	0.0%	0.0%	0.0%	1.9%	0.7%	0.0%	0.0%	0.0%	1.1%	0.1%	1.3%	37.6%	0.3%	18.7%	0.0%	3.8%	34.3%	0.2%
Taft Lake	131.7	42.3%	1,200	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	44.3%	0.0%	3.0%	52.1%	0.4%
Brownie Lake	93.9	40.3%	321	0.0%	0.0%	0.0%	0.0%	0.0%	3.1%	0.0%	0.0%	0.0%	0.2%	28.5%	0.6%	17.6%	0.3%	18.6%	0.0%	5.0%	26.1%	0.0%
Ryan Lake	60.6	42.2%	450	0.0%	0.0%	0.0%	2.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	10.9%	0.0%	28.3%	0.0%	0.3%	50.0%	7.3%
Richfield Lake	57.6	65.1%	372	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	3.4%	0.0%	0.0%	0.0%	28.8%	40.4%	0.0%	0.0%	27.3%	0.0%
Spring Lake	50.0	32.6%	237	0.0%	0.0%	0.0%	0.0%	6.5%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.2%	37.6%	0.0%	15.7%	0.0%	10.4%	28.8%	0.4%
Wirth Lake	40.6	6.1%	32	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	99.8%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%
Birch Pond	38.8	10.3%	5	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Mother Lake	30.5	45.4%	140	0.0%	8.7%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.2%	64.2%	0.0%	2.0%	23.3%	0.3%
Loring Pond	25.4	13.0%	26	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	99.0%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%
Silver Lake	25.0	41.3%	224	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.4%	0.0%	0.0%	0.0%	2.2%	28.3%	0.0%	0.8%	65.3%	0.0%
Hart Lake	3.3	50.3%	18	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	19.2%	52.7%	0.0%	0.0%	24.8%	3.3%
Legion Lake	2.1	43.0%	22	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	40.0%	0.0%	0.0%	60.0%	0.0%
	34,409.3	**50.9%**	**429,260**	**0.1%**	**0.0%**	**1.5%**	**6.0%**	**6.8%**	**1.6%**	**0.5%**	**0.9%**	**0.7%**	**4.1%**	**1.0%**	**0.2%**	**10.0%**	**2.9%**	**26.8%**	**0.0%**	**5.3%**	**30.3%**	**1.4%**

Integrated Pest Management (IPM)
Vegetation Management Policy

Goals

- Public safety
- Prevent erosion
- Protect and improve water quality and ecological function
- Slow water movement, hold or convert pollutants, and enhance infiltration and evapotranspiration
- Conduct preventive maintenance for longevity of infrastructure
- Control invasive species (non-native and selected native species) growth and prevent the production and dispersal of seed
- Create wildlife habitat
- Provide a neat appearance

Herbicide Policy

Public Works – Surface Water & Sewers Division (PW-SWS) has adopted the Integrated Pest Management (IPM) Policy formulated by the Minneapolis Park and Recreation Board (MPRB) to guide the use of herbicides on public lands under their charge. Herbicide use shall be limited as directed in this document.

Management Guidelines

- Perpetuate the original intent of the species planted. On many sites the original intent was to establish a simplified native grassland community. Plant species were selected for their resilience, habitat value and beauty. These plants shall be managed for their proliferation.

- Control [1] all species listed on the MN Noxious Weed List and comply with the MN Noxious Weed Law.

- Control invasive species in order to prevent Public Works sites from becoming sources of invasive weed seed that can disperse and establish on neighboring properties. An example is Canada thistle, which produces copious amounts of wind-blown seed that can easily become a problem on nearby public and private lands.

- Control aggressive species that if allowed to exist on a site will quickly spread and overwhelm the site. Aggressive native species include but are not limited to Canada goldenrod, sandbar willow and cottonwood. Non-native species include but are not limited to Canada thistle,

[1] **Control means manage or prevent the maturation and spread of propagating parts of noxious weeds from one area to another by a lawful method that does not cause unreasonable adverse effects on the environment.** *MN Noxious Weed Law 2013 MS 18.75-18.91*

crown vetch, bird's-foot trefoil, reed canary grass, *Phragmites australis*, spotted knapweed, smooth brome, sweet clover, purple loosestrife, Siberian elm, buckthorn, and Tartarian honeysuckle.

- Control non-native cattails (hybrid and narrow-leaf). They are common weeds in stormwater treatment facilities that may clog inlet and outlet structures, and they reduce habitat function. They are to be controlled when a threat to structures occurs, primarily by cutting the plant below the water surface. Where this is not feasible, as a last resort wick application of an aquatic-safe herbicide may be warranted, however herbicide application over water shall be avoided where practicable.

- Control fast growing, rank, woody species such as willow, Siberian elm and box elder that can quickly establish and form a thicket around stormwater treatment facilities or can cause a public safety issue.

- Control species that are allelopathic [2]. These include but are not limited to spotted knapweed, garlic mustard, and leafy spurge.

Invasive Plant Management Tools (where feasible, use mechanical means such as pulling and mowing, in order to minimize chemical usage)

- Herbaceous Plantings
    - Pulling (preferred)
    - Mowing (preferred)
        - Flail mowing
        - Spot mowing
    - Herbicide application
        - Spot spraying
        - Wick application
- Woody Plants
    - Pulling (preferred)
    - Cutting with stump application of herbicide

[2] **Allelopathic means to produce a chemical in plant tissue that releases into the soil and prevents the growth of most other species**

INTEGRATED PEST MANAGEMENT – ADAPTED FROM MINNEAPOLIS PARK AND RECREATION BOARD POLICY (Revised July 24, 2008)

Integrated Pest Management (IPM) is a pest management strategy that focuses on long-term prevention or suppression of pest problems with minimum impact on human health, the environment and non-target organisms. In most cases, IPM is directed at controlling pests that have an economic impact on commercial crops; however, in the instance of mosquito control, IPM is used to control nuisance and potentially dangerous mosquito populations. The guiding principles, management techniques and desired outcomes are similar in all cases.

A number of concepts are vital to the development of a specific IPM policy goal:

1. Integrated pest management is not a predetermined set of practices, but a gradual stepwise process for improving pest management.
2. Integrated pest management programs use a combination of approaches, incorporating the judicious application of ecological principles, management techniques, cultural and biological controls, and chemical methods to keep pests below levels where they cause economic damage. (Laws of MN, 1989)
3. Implementing an integrated pest management program requires a thorough understanding of pests, their life histories, their environmental requirements and natural enemies, as well as establishment of a regular, systematic program for surveying pests, their damage and/or other evidence of their presence. When treatments are necessary, the least toxic and most target-specific plant protectants are chosen.

The four basic principles of IPM used in designing a specific program are:

1. Know your key pests
2. Plan ahead
3. Scout regularly
4. Implement management practices

Selection of Management Strategies

Selection of Management Strategies pest management techniques include:

- Encouraging naturally occurring biological control
- Adoption of cultural practices that include cultivating, pruning, fertilizing, maintenance and irrigation practices that reduce pest problems
- Changing the habitat to make it incompatible with pest development
- Using alternate plant species or varieties that resist pests
- Limiting monoculture plantings where possible
- Selecting plant protectants with a lower toxicity to humans or non-target organisms

The criteria used for selecting management options include:

- Minimization of health risk to employees and users
- Minimization of environmental impacts (e.g. water quality, non-target organisms)
- Risk reduction (losses to pests, or nuisance/threshold level)
- Ease with which the technique can be incorporated into existing management approaches
- Cost-effectiveness of the management technique

Posting of Plant Protectant Applications

Comply with the City of Minneapolis ordinance regarding pesticide application (Minneapolis Code of Ordinances Title 11 [Health and Sanitation] Chapter 230 [Pesticide Control])

Recordkeeping

Produce and maintain the necessary records of all pest management activities as required by the Minnesota Department of Agriculture.

Weed Control in Upland Plantings, Shrub Beds and Around Trees

Plants are selected and/or replaced in order to provide disease and insect resistant plantings, thereby reducing plant protectant applications. Weeds listed on the State of Minnesota's Noxious Weed List must be controlled as per state statute, and species will be controlled as listed in Management Guidelines above. Mechanical or manual means of weed control will be tried first when feasible. However, due to global climate change, increasing populations of tap-rooted and other perennial weeds are being transported by birds and other means. Pulling or digging of these weeds is usually not successful. Spot spraying of these tap-rooted weeds with a low toxicity herbicide will help prevent flowering, seeding and further dispersal of these pest weeds. Appropriate mulching of upland plantings, shrub beds and around trees will help decrease the number of pest weeds. If control of annual weeds in pathway or mulched areas is required, the proper pre- or post-emergent low toxicity herbicide will be applied on a spot spray basis. Posting of any plant protectant applications will be carried out according to City ordinance.

Turf Areas

PW-SWS follows the Minneapolis Park and Recreation Board's General Parks and Parkways threshold of 50% for broadleaf and/or grassy weeds in turf areas. When it has been determined that this percentage has been reached or exceeded, the appropriate post emergent or pre-emergent herbicide may be applied, preferably on a spot spray basis. Selection of the appropriate herbicide of choice will be determined by trained staff after evaluating the site, the hazard rating of the product and the specific location.

Future Pest Control Issues

With changes in climate, the environment will be subject to many changes, including the arrival of additional pests within open space areas. Following IPM principles, the City will refer to updates in MPRB policy and practice and will work with the appropriate local, state or national agencies to determine the best control approach for these new pests.

Resolution No. 2023R-387 **City of Minneapolis** **File No. 2023-00739**

Author: Koski Committee: Budget Public Hearing: None

Passage: Dec 5, 2023 Publication: DEC 12 2023

RECORD OF COUNCIL VOTE				
COUNCIL MEMBER	AYE	NAY	ABSTAIN	ABSENT
Payne	X			
Wonsley	X			
Rainville	X			
Vetaw	X			
Ellison	X			
Osman	X			
Goodman	X			
Jenkins	X			
Chavez	X			
Chughtai	X			
Koski	X			
Chowdhury	X			
Palmisano	X			

MAYOR ACTION

☑ APPROVED ☐ VETOED

MAYOR

DEC 08 2023

DATE

Certified an official action of the City Council

ATTEST

CITY CLERK

Presented to Mayor: DEC 06 2023 Received from Mayor: DEC 08 2023

Designating the utility rates for water, sewer, stormwater, and solid waste services effective with water meters read on and after January 1, 2024.

Resolved by The City Council of The City of Minneapolis:

Water Rate

Charges commence when the street valve is turned on for water service.

1) Three dollars and seventy-six cents ($3.76) per one hundred (100) cubic feet for customers not otherwise mentioned.

2) Three dollars and ninety-one cents ($3.91) per one hundred (100) cubic feet to municipalities, municipal corporations, villages and customers outside the corporate limits of the city where water service is furnished through individual customer meters.

3) Rates for municipalities, municipal corporations and villages, which are established by contract, shall continue the existing contract basis.

4) In addition to the above rates a fixed charge based on meter size will be billed each billing period or fraction thereof as follows:

Meter Size	Fixed Charge
5/8-inch	$9.00
3/4-inch	$13.50
1-inch	$22.50
1 1/2-inch	$45.00
2-inch	$72.00
3-inch	$144.00
4-inch	$225.00
6-inch	$450.00
8-inch	$720.00
10-inch	$1,035.00
12-inch	$2,970.00

5) The fixed charge for a property serviced by a combined fire/general water service line shall be based on the small side register of the combined meter, provided the volume of water used on the large side register does not exceed 45,000 gallons per year. The volume of water used on the large side register in the previous year will be used to establish the fixed rate in the current year.

   The fixed charge for a property serviced by a combined fire/general water service line shall be based on the large side register of the combined meter, when the volume of water used on the large side register exceeds 45,000 gallons per year. The volume of water used on the large side register in the previous year will be used to establish the fixed rate in the current year.

   The fixed charge for a combined fire/general water service line shall remain in place for the entire year.

6) Fees for the service and inspection of fire protection pipes and meters are based on the size of the service connection as follows:

Fire Line Pipe Size	Annual Fee (1/12 of the annual fee is billed monthly)
1½ inch pipe connection	$40.00
2-inch pipe connection	$40.00
3-inch pipe connection	$50.00
4-inch pipe connection	$80.00
6-inch pipe connection	$160.00
8-inch pipe connection	$250.00
10-inch pipe connection	$360.00
12-inch pipe connection	$1,030.00

Broken fire protection pipes valve seals will be resealed by the Minneapolis Water Treatment and Distribution Services Division.

7) Rates for other services and materials shall be as follows:

Replacement of lost or damaged equipment or new equipment requested by the customer	
Description	**Fee**
• 5/8" Water meter	$50 Materials + $80 per hour
• ¾" Water meter	$170 Materials + $80 per hour
• 1" Water meter	$230 Materials + $80 per hour
• 1 ½" Water meter	$520 Materials + $80 per hour
• 2" Water meter	$750 Materials + $80 per hour
• 3" Water meter	$2040 Materials + $80 per hour
• 4" Water meter	$3260 Materials + $80 per hour
• 6" Water meter	$4670 Materials + $80 per hour
• Water meter reading device	$90 Materials + $80 per hour

Meter spacer and couplings or flanges as required for a meter set	
Meter Size	**Fee**
• 5/8-inch	$20 per pair
• 3/4-inch	$30 per pair
• 1-inch	$40 per pair
• 1 ½-inch	$120 per pair
• 2-inch	$130 per pair
• 6-inch	$1080 per pair
• 8-inch	$1400 per pair
• 12-inch	$1460 per pair
• 16-inch	$1960 per pair

Services	
Description	**Fee**
Water meter testing	$80 per hour
Water meter reading	$40
Posting for water service turn-off-tenant notice	$40
Shut off valve - stop box flushing	$40
Water service turn-on or turn-off	$80
Winter fee to expose and thaw stop box	$40
Water main shut down - 12-inch and smaller	$550
Water main shut down - 16-inch and larger	$990
Water service line repair/replacement assistance	$50
Hydrant sanitation for potable usage	$250
Hydrant assistance for private fire flow testing	$155

Penalties	
Description	**Fee**
Missed Appointment	$80
Water meter tampering	$200
Water meter bypass valve tampering	$500
Unauthorized water service turn-on	$500
Water system valve tampering	$500
Water emergency declaration violation	$90

Equipment Deposits	
Description	**Fee**
Hydrant meter and backflow preventer	$3,200

Permits	
Description	**Fee**
Meter set	$50
Water hydrant	$350

Water Service Taps or Water Service Tap Discontinuations - Materials and Service Fee by Size *		
Tap Size	**Tapping Fee**	**Discontinuation Fee**
• 5/8" x 3/4"	$250	$50
• 3/4 x 3/4"	$260	$50
• 3/4" x 1"	$250	$50
• 1" x 1" (copper)	$290	$50
• 1" x 1" (pitometer)	$280	$50
• 1" x 1 1/4"	$310	$50
• 6" x 2"	N/A	$1170
• 6" x 3"	N/A	$1170
• 6" x 4"	$2030	$2190
• 6" x 6"	$2270	$2190
• 8" x 2"	N/A	$1200
• 8" x 3"	N/A	$1200
• 8" x 4"	$2160	$1150
• 8" x 6"	$2300	$2520
• 8" x 8"	$2990	$2520
• 10" x 2"	N/A	$1290
• 10" x 3"	N/A	$1290
• 10" x 4"	$2100	$1290
• 10" x 6"	$2230	N/A
• 10" x 8"	$2520	N/A
• 12" x 2"	N/A	$1260
• 12" x 3"	N/A	$1260
• 12" x 4"	$2250	$1260
• 12" x 6"	$2530	$1260
• 12" x 8"	$2900	$2580
• 12" x 12"	$4530	$2580
• 16" x 2"	N/A	$1790
• 16" x 3"	N/A	$1790
• 16" x 4"	$2390	$1790
• 16" x 6"	$2580	$1790
• 16" x 8"	$3370	$2960
• 16" x 12"	$5490	$3080
• 16" x 16"	N/A	$3080
• 24" x 2"	N/A	$2720
• 24" x 3"	N/A	$2720
• 24" x 4"	$3160	$2720
• 24" x 6"	$2600	$2720
• 24" x 8"	$3100	$2720
• 24" x 12"	$4980	$2720
• 30" x 4"	$2600	N/A

• 30" x 6"	$2720	N/A
• 30" x 8"	$4680	N/A
• 36" x 4"	$3000	N/A
• 36" x 6"	$3120	N/A
• 36" x 8"	$3630	N/A
• 36" x 12"	$6600	N/A

*The following terms and conditions apply to pipe tapping and tap discontinuation for small and large service connections:

a) When standard methods cannot be used, the City will charge an adjusted fee based upon the specific circumstances.
b) This schedule does not include inspection, excavation, and pavement restoration fees.
c) Modifications may cause additional costs to be incurred by the customer.
d) Sales taxes will be added as applicable.
e) The tapping and discontinuation fees all include the required $50 permit.

Water/Sewer Service Line Repairs Assessment Duration

Property Owners choosing to finance water service line, sanitary service lateral, or storm sewer service lateral repairs and replacements by adding these costs to their property taxes as a special assessment may choose from the following payment terms:

	Payment terms available			
Special Assessment Amount:	5 years	10 years	15 years	20 years
Up to $10,000	Yes	Yes	No	No
Between $10,001 and $15,000	Yes	Yes	Yes	No
Greater than $15,001	Yes	Yes	Yes	Yes

Sanitary Sewer Rate

The sanitary sewer rates to be charged properties within and outside the City of Minneapolis that are served directly by the City of Minneapolis sewer system and that are all served either directly or indirectly by the sewage disposal system constructed, maintained, and operated by the Metropolitan Council Environmental Services under and pursuant to Minnesota Statutes Sections 473.517, 473.519 and 473.521, Sub. 2, are hereby set as follows:

1) The sanitary sewer rate applicable inside the City of Minneapolis is five dollars and thirty-six cents ($5.36) per one hundred (100) cubic feet.

2) In addition, a fixed charge based on water meter size will be billed each billing period or fraction thereof as follows:

Meter Size	Fixed Charge
5/8-inch	$8.30
3/4-inch	$12.45
1-inch	$20.75
1 1/2-inch	$41.50
2-inch	$66.40
3-inch	$132.80
4-inch	$207.50
6-inch	$415.00
8-inch	$664.00
10-inch	$954.50
12-inch	$2,739.00

3) The sanitary sewer rate applicable outside the City of Minneapolis for all sewage flow generated is five dollars and thirty-six cents ($5.36) per one hundred (100) cubic feet when the City of Minneapolis also provides water. In addition, the fixed charge sanitary sewer rate shall be based on meter size per section (b).

4) Sanitary sewer only service outside the City of Minneapolis shall be forty dollars and forty-six cents ($40.46) per month.

5) The sanitary sewer charge for residential property not exceeding three (3) residential units shall be based on the volume of water used during the winter season which is defined as a four (4) month period between December 1 and March 31.

   Residential property not exceeding three (3) residential units with zero usage during the four-month period between December 1 and March 31, the winter average consumption will be established based on the average usage of the property classification.

6) The sanitary sewer charge for residential property exceeding three (3) residential units and all other commercial and industrial property shall be based on measured sewage volume or the total water volume used during the billing period as is appropriate.

Stormwater Rate

The stormwater rate, subject to the provisions in Chapter 510, of the Minneapolis Code of Ordinances, is imposed on every Single-Family Residential Developed Property, Other Residential Developed Property, Non-Residential Developed Property, and Vacant Property, other than Exempt Property, and the owner and non-owner users, and is hereby set as follows:

1) The Equivalent Stormwater Unit (ESU) rate is fifteen dollars and four cents ($15.04). The ESU measurement is 1,530 square feet of impervious area.

2) The stormwater rate imposed on Single-Family Residential Developed Properties shall be categorized into three tiers based on the estimated amount of impervious area as follows:

High – Single-Family Residential Developed Property – greater than one thousand five hundred and seventy-eight (1,578) square feet of estimated impervious area. The ESU shall be 1.25 and the stormwater rate set at eighteen dollars and eighty cent ($18.80).

Medium – Single-Family Residential Developed Property – equal to or greater than one thousand four hundred and eighty-five (1,485) square feet and less than or equal to one thousand five hundred and seventy-eight (1,578) square feet of estimated impervious area. The ESU shall be 1.00 and the stormwater rate set fifteen dollars and four cents ($15.04).

Low – Single-Family Residential Developed Property – less than one thousand four hundred and eighty-five (1,485) square feet of estimated impervious area. The ESU shall be .75 and the stormwater rate set at eleven dollars and twenty-eight cents ($11.28).

3) Stormwater charges for all other properties will be based on the following calculation:
Measured impervious surface in sq. ft. ÷ 1,530 sq. ft. = # of ESU

Or in cases where there is no direct measurement of impervious surface:
(Gross Lot Size in sq.ft. X Runoff Coefficient) ÷ 1,530 sq. ft.= # of ESU
# of ESU X **$ 15.04** = Monthly Fee

The runoff coefficient assumed for each land use category is shown below.

Land Use	Coefficient Applied
Bar-Restaurant-Entertainment	.75
Car Sales Lot	.95
Cemetery w/Monuments	.20
Central Business District	1.00
Common Area	.20
Garage or Misc. Res.	.55
Group Residence	.75
Ind. Warehouse-Factory	.90
Industrial railway	.85
Institution-Sch.-Church	.90
Misc. Commercial	.90
Mixed Comm.-Res-Apt	.75
Multi-Family Apartment	.75
Multi-Family Residential	.40

Land Use	Coefficient Applied
Office	.91
Parks & Playgrounds	.20
Public Accommodations	.91
Single Family Attached	.75
Single Family Detached	ESU
Sport or Rec. Facility	.60
Utility	.90
Vacant Land Use	.20
Vehicle Related Use	.90

Solid Waste Rate

1) The base unit charge shall be thirty dollars and one cent ($30.01) per dwelling unit per month.

2) The cart disposal charge shall be two dollars ($2.00) per month for each small garbage cart assigned to a dwelling unit

3) The cart disposal charge shall be five dollars ($5.00) per month for each large garbage cart assigned to a dwelling unit.

Minneapolis
City of Lakes

Stormwater Frequently Asked Questions

Stormwater Utilities

1. **Why do we need to manage stormwater?**
   Stormwater runoff is water that flows over our yards, streets, sidewalks, buildings, parking lots and other surfaces due to rainfall, snowmelt or irrigation. Stormwater runoff flows into the nearest waters and eventually ends up in our local streams, ponds, lakes and rivers. Stormwater management is essential to maintain the quality of water entering the local water bodies, mitigate flooding and prevent property damage and comply with the federal Clean Water Act regulations.

2. **Why do we have a stormwater utility charge?**
   The Stormwater utility charge (stormwater charge) is used to operate and maintain the City's storm sewer system, mitigate flooding and to implement practices to protect the water quality of receiving waterbodies from the impact of urbanization. The City also has to comply with the regulatory requirements of the City's National Pollutant Discharge Elimination System (NPDES) and Municipal Separate Storm Sewer System (MS4) permit under the Clean Water Act.

3. **What is the basis of my stormwater charge?**
   The stormwater charge is based on the impervious area square footage that is calculated for your parcel.

4. **Is my stormwater charge based on my water consumption?**
   The stormwater charge is NOT based on your monthly Water Consumption. The stormwater charge is based on the ***Impervious Area*** calculated for your parcel.

5. **How is the impervious area calculated for my property?**
   Your property's Impervious Area is calculated as the total area (square feet) of any hard surface area, including buildings, any attached or detached structures, and paved or hardscaped areas, that either prevents or restricts the volume of stormwater, snowmelt or irrigation that can enter into the soil, and thereby causes water to run off the surface. Currently, the City measures impervious area for properties using one of these two approaches:

- **Actual Impervious Area Measurement:** For most of the properties in the City, the impervious area square footage of each property is determined based on actual measurements of impervious surface areas using multiple technologies including aerial imagery and Geographical Information System (GIS) tools.

- **Estimated Impervious Area Using Runoff Coefficient:** For some parcels, the impervious area square footage is estimated by multiplying the property's lot size square footage by a runoff coefficient factor that corresponds with the current land use of the property.

6. **How is the Stormwater rate defined?**
The monthly stormwater rate is defined as a monthly rate per Equivalent Stormwater Unit (i.e. $/ESU). Currently, one ESU equates to 1,530 square feet of impervious area. The City's Fiscal Year 2022 monthly ESU rate is $14.03/ESU. The ESU and ESU rate are established by ordinance or resolution of the City Council and may be amended from time to time by the City Council.

7. **How is the Stormwater Charge calculated?**
The monthly stormwater charge is determined as follows, depending on whether the property is a Single Family Residential Developed property or not.

a. **Single Family Residential Developed Property:** If the property belongs to the Single Family Residential Property class, then the monthly charge is determined as follows:

- First, the parcel's impervious area (in square feet) is determined using one of the two approaches described in Question 5.
- The property is then designated an impervious area tier of Low, Medium, or High, based on the impervious area that is determined for that property.
- The ESUs are then designated based on the impervious area tier.
- Table 1 presents the impervious area tiers, the corresponding range, and the ESUs for each tier.

Table 1: Residential ESUs

Class	Impervious Area (Square Feet)	ESU
Low	<1,485	0.75 ESU
Medium	1,485 to 1,578	1.00 ESU
High	>1,578	1.25 ESU

b. **All Other Properties:** For all other properties in the City, the monthly stormwater charge is determined as follows:

- First, the parcel's impervious area (in square feet) is determined using one of the two approaches described in Question 5.
- Second, the ESU is calculated by dividing the parcel's impervious area by 1,530 square feet
- Third, the Stormwater Charge is calculated by multiplying the ESU by the monthly ESU Rate of $14.03/ESU.

Example (Single Family Residential):

- The Impervious Area of a single family residential property is 2,000 Square Feet
- The designated tier for this property based on impervious area is "High" and therefore the designated ESU **= 1.25 ESUs**
- The calculated monthly stormwater charge is **1.25 X $14.03 = $17.54**

Example (Commercial):

Using an example of a Retail Store:

- The Impervious Area of the store 3,500 Square Feet
- The calculated ESU is **3,500 ÷ 1,530 = 2.29 ESUs**
- The calculated monthly stormwater charge is **2.29 X $14.03 = $32.13**

8. **My property is tax exempt. Do I still have to pay the stormwater charge?**
   Yes. The stormwater charge is a "User Fee" similar to your water, sewer, and electric charges. The stormwater charge is not a tax. Therefore, all tax-exempt parcels that are within the City limits have to pay the stormwater charge.

9. **If my stormwater runoff does not flow into the City's stormwater infrastructure, am I still charged the stormwater?**
   Yes. The City is responsible for the stormwater management of its MS4 system and for maintaining water quality in the surface waters under its NPDES permit. The City's stormwater management program benefits everyone in the City by protecting the City streets and properties from flooding, erosion, pollution problems, property damage, and protects the City and its local surface waters. It also enables the City to comply with federal and state regulatory requirements. Therefore, all parcels in the City are required to pay a stormwater charge.

10. **What can I do to reduce my stormwater charge?**
    You can reduce your stormwater charge by applying for the stormwater credits. Your property may be eligible for a stormwater credit if you apply for stormwater credits and provide supporting requisite documentation to affirm that stormwater runoff or a portion of it from your parcel is managed on-site, consistent with the City's requirements for a property area meeting the standard. See questions 11 through 18 for further information on stormwater credits.

Stormwater Credits

11. **Is there a credit for rain barrels?**
    No. Rain barrels are not considered sufficient stormwater Best Management Practices (BMPs).

12. **Can I get credit for installing a BMP (rain garden, etc.) in the Right-Of-Way/boulevard?**
    Yes. A credit may be granted to properties that employ structural or non-structural best management practices (BMPs) or other stormwater management practices on-site or, if permitted, in the right-of-way, that significantly reduce the quantity or significantly improve the quality of stormwater run-off from their property and the sidewalk that enters the system.

13. **Can I get credit for treating runoff from other properties with my BMP?**
    No. Credit cannot be given for treating impervious area on parcels that you do not own.

14. **If I lost a credit but am now compliant, can I get my credit back?**
    If you once were receiving a credit and that credit was removed, you must ensure that any BMP(s) with which you wish to apply for a credit are functioning properly, that you are compliant with Chapter 54 (if applicable), and that you are current on your utility bills.

    Once you have met these eligibility requirements, you are able to apply for a credit under current Program rules. Depending on when you originally had your credit, and the BMPs and/or area that you are now treating, your credit award amount may differ from the original credit amount.

15. **Can I get my credit awarded retroactively to the date I lost the credit?**
    No. Credit will not be awarded before the date of the most current, complete application submittal, including all necessary documents and materials. Any stormwater utility fees charged during the time a credit was not on the account will not be forgiven or reimbursed.

    Note that you must be current on your utility bill(s) to apply for a credit.

16. **How does the recertification process work?**
    Recertification is required every 5 years for commercial credits. Residential Credits are exempt from recertification.

    The City will send notification to properties that are due for recertification in the year the recertification is due. For more information on the recertification process, please see the recertification section of the Commercial Applicant Guide.

17. **Do credits transfer with ownership change?**
    No, credits do not transfer upon ownership change. However, you are able to apply for credit under current Program rules as long as you meet the requirements and supply all the necessary information and documents in your application submittal. For more information on commercial credit eligibility and application requirements, please see the Commercial Applicant Guide. For more information on

residential credit eligibility and application requirements, please see the webpage: **https://www.minneapolismn.gov/resident-services/utility-services/stormwater/residential-stormwater-credits/**

18. **What does it mean that a credit will apply to "property area meeting the standard"?**
"Property area meeting the standard" means that only those impervious areas on the property where the runoff is being treated in the way that meets the credit type will be eligible for a credit.
For example, if you treat 50% of your impervious area for above and beyond volume reduction credit of 20%, you will be eligible for a 20% credit on 50% of the impervious area on your property. If you treat 100% of the impervious area on your property for this credit type, you would be eligible for a 20% credit on 100% of the impervious area on your property.

Additional details on stormwater credits program are available on the City's website.

APPENDIX A12 MPRB 2023 STORMWATER MONITORING RESULTS & DATA ANALYSIS

Stormwater Quarterly Grab Monitoring

BACKGROUND

As part of the federal Clean Water Act, the Minneapolis Park and Recreation Board (MPRB) and the City of Minneapolis are co-permittees on the Environmental Protection Agency (EPA) issued National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit.

The purpose of monitoring via grab samples is to characterize the seasonality of runoff for parameters that cannot be collected with flow-weighted composite auto-monitoring, such as pH, *Escherichia coli* (*E. coli*), and Fat Oil & Grease (FOG). The condition needed for snowmelt sample collection was a winter snowpack melt event. Conditions for spring, summer, and fall grab sample collection were rain events greater than 0.10 inches separated by at least 8 hours from other rain events.

Grab samples can be challenging to obtain, as specific timing of rain events in relation to MPRB and lab working hours are required for samples to be collected and analyzed. Ideally, annual and quarterly grab monitoring includes two snowmelt grab samples and one grab sample each in spring, summer, and fall. Quarterly grab monitoring includes pH measurements and water samples analyzed for *E. coli*, NPDES water chemistry, and Fat Oil and Grease (FOG). The current NPDES permit (2018-2023) prescribed that if a FOG sample were measured greater than 15 mg/L at a site, then that site would continue to be monitored throughout the permit cycle. NPDES chemistry parameters that are analyzed from grab samples, as required by the NPDES permit, are outlined in **Table 1**.

Grab sampling characterizes a point in time of a snowmelt or rain event. The first snowmelt event in a year usually has higher pollutant concentrations than subsequent snowmelt events. Chemical concentrations can change over time throughout a storm event. The beginning of a storm mobilizes fine particles and FOG material previously deposited on hard surfaces. Chemical concentrations can have significant variance between storm events depending on the amount of time since the last precipitation event, since pollutants accumulate on surfaces over time and then wash off in a melt or rain event.

In 2018 quarterly grabs were collected at sites representing different land use types. Following snowmelt, grab samples could not be collected from the Pershing Park land use site since auto-monitoring equipment was housed in an equipment box on top of the manhole. The 61st & Lyndale site had extensive road construction and stormwater pipe replacement beginning mid-summer 2018 that restricted access.

In 2019, the grab sites were changed to three Powderhorn Lake Inlets: SE, S, and W and the two 24th Ave. SE & Elm St. SE infiltration basin Inlets: N and S. The intention was to continue sampling at the 61st & Lyndale site, but the site was again inaccessible due to the stormwater pipe replacement and road reconstruction.

In 2020, the quarterly grab sites were three Powderhorn Inlets: SE, S, and W , two 24th Ave. SE & Elm St. SE Inlets: N and S, and 61st & Lyndale. In 2020, after several unsuccessful attempts were made, the Powderhorn Inlet N site was deemed physically inaccessible to collect grab samples and dropped from grab sampling. 2020 was also a difficult year for field work with the COVID-19 pandemic restrictions.

In 2021, grab sampling was completed at six sites: Powderhorn Lake Inlets SE, S, and W, 24th & Elm Inlets N and S, and 61st & Lyndale were all successfully monitored.
In 2022, grab sampling included seven sites: three Powderhorn Lake inlets SE, S, and W, three Camden Pond inlets NNW, SNW, and SW, and 61st & Lyndale. Due to a lack of significant storm events in the summer and fall, a grab sample in the fall quarter was unable to be collected in 2022.

In 2023, grab sampling sites were consistent with 2022: three Powderhorn Lake inlets SE, S, and W, three Camden Pond inlets NNW, SNW, and SW, and 61st & Lyndale. The 61st & Lyndale site, which has been sampled solely with grab samples due to its exceedance of FOG levels, was only sampled for winter snowmelt in 2023.

METHODS

GRAB SAMPLING

Grab samples are taken directly from the storm sewer as an aliquot from a clean white 5-gallon bucket on a rope. Alternatively, a modified pool skimmer pole can be used for shallower sewers. The bucket was lowered into the storm sewer and rinsed once before the aliquot was collected. Per sampling protocol, water chemistry sample bottles were rinsed once before sample collection, whereas *E. coli* and FOG sample bottles were not rinsed. FOG samples were collected in amber glass bottles. All samples were stored and transported on ice to the laboratory, along with a field blank. **Table 1** shows the NPDES chemistry parameters analyzed in each sample collected. **Table 2** shows approved methods, reporting limits, and holding times for each parameter as reported by the contract laboratories Instrumental Research, Inc. (IRI) and Pace Analytics.

The pH measurement was analyzed in the field by a hand-held Oakton pH meter (for winter samples), or a YSI Pro10 pH meter (for spring, summer, and fall samples). The Oakton meter malfunctioned and was replaced with the YSI Pro10 in late winter. The pH meters were calibrated prior to sampling using a two-point calibration. In the field, the pH probes were rinsed with the grab sample water and measurements were taken directly from the aliquot.
Grab samples can only be collected when enough flow is present in the pipe. Snowmelt and precipitation need to produce at least 1-inch of stage in the pipe to be sampled. Precipitation events generally need to be greater than 0.10 inches to produce enough runoff. Staff attempted to collect quarterly rainfall grab samples on 4/19/23, 7/26/23, 8/14/23, 9/25/23, 9/29/23, and 10/6/23, shown in **Table 5** and **Table 6**. Not every site was able to be sampled with each precipitation event due to variable flow, but samples were collected wherever possible.
All FOG, NPDES water chemistry, and *E. coli* samples were analyzed at Instrumental Research Incorporated (IRI) Laboratory in Fridley, Minnesota. Metals (copper, zinc, lead) and DOC samples were analyzed by Pace Analytical Laboratory in Minneapolis, MN.

Table 1. Chemistry parameters monitored as required by the NPDES permit.

Parameter	Abbreviation	Units
Chemical Oxygen Demand	COD	mg/L
Chloride, Total	Cl	mg/L
Copper, Total	Cu	µg/L
Dissolved Organic Carbon	DOC	mg/L
***E. coli* (*Escherichia Coli*)**	*E. coli*	MPN/100mL
Fat, Oil, and Grease (FOG)	FOG	mg/L
Hardness	Hard	mg/L
Lead, Total	Pb	µg/L
Nitrite/Nitrate, Total as N	NOx	mg/L
Orthophosphate	OPO4	mg/L
pH	pH	standard unit
Phosphorus, Total	TP	mg/L
Phosphorus, Total Dissolved	TDP	mg/L
Solids, Total Dissolved	TDS	mg/L
Solids, Inorganic Suspended	ISS	mg/L
Solids, Total Suspended	TSS	mg/L
Solids, Volatile Suspended	VSS	mg/L
Total Nitrogen	TN	mg/L
Zinc, Total	Zn	µg/L

Table 2. Analysis method, reporting limit, and holding times for parameters used by Instrumental Research, Inc. and Pace Laboratories (for Cu, Pb, Zn, and DOC).

Parameter	Method	Reporting Limit	Holding Times
Chloride, Total	SM 4500-Cl^- B	2.0 mg/L	28 days
COD	SM 5220-D	20 mg/L	28 days
Copper, Total	EPA 200.8	1 µg/L	6 months
DOC	SM 5310-C-00	1.5 mg/L	28 days
***E. coli* (*Escherichia Coli*)**	SM 9223 B	1 MPN per 100mL	< 24hrs
Fat, Oil, and Grease (FOG)	EPA 1664A	5.0 mg/L	28 days
Hardness	SM 2350 C	5.0 mg/L	6 months
Lead, Total	EPA 200.8	0.10 µg/L	6 months
Nitrite/Nitrate, Total as N	SM 4500-NO_3 E	0.030 mg/L	28 days
Orthophosphate	SM4500-PE	0.003 mg/L	48 hours
pH	SM 4500 H^+ B	0.01 units	15 minutes
Phosphorus, Total	SM 4500-PE	0.010 mg/L	48 hours
Phosphorus, Total Dissolved	SM 4500-PE	0.010 mg/L	48 hours
Solids, Total Dissolved	SM 2540 C	5.0 mg/L	7 days
Solids, Inorganic Suspended	TDS - VSS	5.0 mg/L	7 days
Solids, Total Suspended	SM 2540 D	1.0 mg/L	7 days
Solids, Volatile Suspended	EPA 160.4	2.0 mg/L	7 days
Total Nitrogen	Alk Persulfate Oxidation method	0.500 mg/L	28 days
Zinc, Total	EPA 200.7	20 µg/L	6 months

The 2023 grab sampling sites are shown below. **Figure 1** shows the location of the 61st & Lyndale site. **Figure 2** shows the location of the Camden Pond inlets NNW, SNW, and SW. **Figure 3** shows the location of the Powderhorn Lake inlets SE, S, and W. **Table 3** shows the land use and drainage area for the sample sites at the Powderhorn inlets and 61st & Lyndale. **Table 4** shows land use and drainage area for the sample sites at the Camden inlets.

Figure 1. Aerial photo of the 61st & Lyndale stormwater quarterly grab monitoring site.

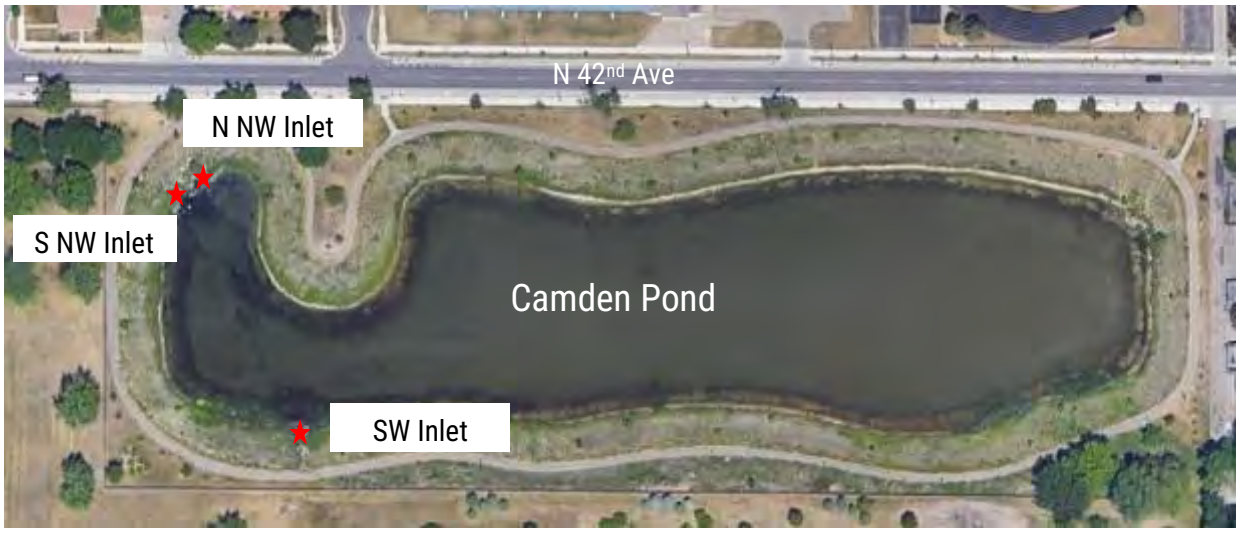


Figure 2. Aerial photo of Camden Pond quarterly grab monitoring sites.

Figure 3. Aerial photo of the Powderhorn quarterly grab monitoring sites.

Table 3. The Powderhorn Inlets SE, S, and W and 61st & Lyndale sites are monitored quarterly for NPDES chemistry, *E. coli*, pH, and FOG, and their location, main land uses, drainage area, and percent of drainage area covered by impervious surfaces.

Site ID	Powderhorn Inlet SE	Powderhorn Inlet S	Powderhorn Inlet W	61st & Lyndale
Location	3421 15th Ave S.	13th Ave S. and E. 35th St.	3318 19th Ave S.	335 ft. east of 61st St and Harriet Ave S.
Land Use	Single-family, right-of-way, park	Single-family, right-of-way	Single-family, right-of-way	Commercial/Industrial
Drainage Area	70.0 acres	81.2 acres	99.4 acres	34.9 acres
Imperviousness	43.9%	49.6%	51.5%	No data

Table 4. The Camden Pond sites monitored for NPDES chemistry, *E. coli*, pH, and FOG, and their location, main land uses, drainage area, and percent of drainage area covered by impervious surfaces.

Site ID	Camden Inlet N NW	Camden Inlet S NW	Camden Inlet SW
Location	4200 Newton Ave N	4200 Newton Ave N	4200 Newton Ave N
Land Use	Single family, right of way	Single family, right of way	Institutional (cemetery)
Drainage Area	10.5	127.8	84.2
Imperviousness	48.0%	44.9%	9.9%

Quality Assurance Practices

A variety of quality assurance quality control (QAQC) measures were taken to ensure defensible data. Ten percent of the samples were laboratory quality assurance samples e.g., duplicates, spikes. A field blank was also generated for each sampling trip and was analyzed for all NPDES chemical parameters. Field blanks consisted of deionized water which accompanied samples from the field sites to the analytical laboratory. All field blank parameters measured below the reporting limits in 2023. As part of the department QAQC program, blind monthly performance samples of known concentration were analyzed by IRI. If any parameter failed to meet the acceptable recovery range, all the data for that parameter would be flagged for the entire month. No parameters were flagged in 2023.

Field measurements were recorded on a field sheet in the 2023 Stormwater Monitoring Field Manual. Electronic data from the laboratory were forwarded to the MPRB in preformatted Excel spreadsheets via email. Electronic data from the laboratory were checked and passed laboratory quality assurance procedures. Protocols for data validity followed those defined in the Stormwater Monitoring Program Manual (MPRB, 2001). For data reported as below the reporting limit, the numerical value was divided by two for statistical calculation purposes. Manual transcription of data was minimized to reduce error introduction. A minimum of 10% of the final data were checked by hand against the raw data sent by the laboratory to ensure there were no errors entering, manipulating, or transferring the data.

A Chain of Custody form accompanied each set of sample bottles delivered to the lab. Each sample container was labeled indicating the date and time of collection, site location, and field personnel initials. Samples were transported to the laboratory on ice in a cooler. The time that each grab sample was collected was recorded onto field sheets. A complete description of methods can be found in the Stormwater Monitoring Program Manual (MPRB, 2001). Common statistics were calculated using Microsoft Excel.

RESULTS AND DISCUSSION

The 2023 quarterly snowmelt grab sampling schedule is shown in **Table 5**. A second winter snowmelt sample was not able to be collected at Powderhorn Inlet SE due to thick ice and snow coverage over the access manhole. The 2023 quarterly precipitation grab sampling schedule and associated precipitation event data are shown in **Table 6**.

The full 2023 grab sample NPDES chemistry results can be found in **Tables A-1** and **A-2** in the **Appendix**. The 2023 grab sampling statistics of geometric mean, arithmetic mean, maximum value (MAX), minimum value (MIN), standard deviation (STDEV), number of samples collected, and the coefficient of variation (COV) are shown in **Table 7** and **Table 8**. The geometric mean is a valuable statistic as it accurately controls for data with a wide range and outliers.

The snowmelt samples show higher concentrations of pollutants as compared to spring, summer, and fall samples, but lower *E. coli* levels. This is expected, as snowmelt is the release of 4-5 months of deposition and debris from the watershed. *E. coli* bacteria do not survive well in colder conditions, and thus tend to have low concentrations in snowmelt samples. The pH ranged from 6.9 to 9.9 across all quarterly grab monitoring sites, with most sites generally registering a higher pH in the colder months.

During February and March of 2023, there were several unusual warming events when temperatures went above freezing for significant amounts of time. This resulted in rain events where rain fell onto accumulated snow, causing snowmelt. It was difficult to sample pure snowmelt for this reason, as it tended to be raining whenever temperatures were high enough for snow to melt. Two of the winter grab samples from 2/14 and 3/31 were taken from such events, **Figure 4**. It is possible that the addition of rain to the melted snow may have slightly diluted the measured parameters.

Figure 4. Water Quality staff collecting a winter grab sample at Powderhorn Inlet S on 2/14/23.

Table 5. Snowmelt grab samples were collected in 2023. X = Grab sample collected. NS = No sample. Note that the events on 2/14 and 3/31 were a mixture of rainfall and snow.

Date	Powderhorn In S	Powderhorn In SE	Powderhorn In W	Camden In N NW	Camden In S NW	Camden In SW	61st & Lyndale
2/14	X	NS	NS	X	X	X	X
3/31	X	X	X	X	X	X	X
4/3	NS	NS	X	NS	NS	NS	X

Table 6. Stormwater rainfall grab samples collected with event data in 2023. Pow = Powderhorn. Cam = Camden. X = Grab sample collected. NS = No sample. Data from the 10/6 storm had to be used due to a lack of alternative sampling opportunities at Camden Inlet SW. 61st & Lyndale was not sampled for precipitation grabs in 2023.

Start Date	Start Time	End Date	End Time	Rain in.	Duration hrs.	Intensity in/hr	Hours since last rain	Pow In S	Pow In SE	Pow In W	Cam In N NW	Cam In S NW	Cam In SW
4/19	5:15	**4/19**	7:15	0.28	2.0	0.140	57	X	X	X	X	X	X
7/26	0:00	**7/26**	8:45	1.27	8.75	0.145	107	X	NS	X	NS	NS	NS
8/13	15:45	**8/14**	13:15	1.60	21.5	0.074	47	NS	X	NS	X	X	X
9/23	16:30	**9/26**	1:30	2.34	57.0	0.041	153	NS	NS	X	X	X	NS
9/29	3:45	**9/29**	10:15	1.18	6.5	0.182	60	X	X	X	NS	NS	NS
10/6	8:30	**10/6**	10:30	0.06	2.0	0.030	15	NS	NS	NS	NS	NS	X

Table 7. 2023 snowmelt grab sampling summary statistics.

	TP mg/L	TDP mg/L	SRP mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	FOG mg/L	*E. Coli* MPN	pH Std Unit	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
MEAN (geometric)	0.389	0.116	0.088	1.92	0.512	74.5	37.9	82.7	28.9	51.7	252	71.3	4.63	634	8.75	17.2	8.56	102	7.78
MEAN (arithmetic)	0.505	0.122	0.100	2.10	0.603	234	56.1	188	50.2	138	466	130	6.60	804	8.77	22.5	13.2	149	8.11
MAX	1.66	0.183	0.156	3.04	1.98	950	232	1191	185	1006	1754	563	22.0	1785	9.90	79.0	39.7	500	12.7
MIN	0.077	0.064	0.018	0.946	0.147	9.00	16.0	4.0	1.00	3.00	62.5	10.0	2.50	134	7.66	3.0	0.250	10.0	3.70
MEDIAN	0.369	0.128	0.109	2.37	0.508	38.0	30.0	68.0	29.0	39.0	226	82.8	2.50	816	8.86	15.7	9.20	107	7.90
STDEV	0.408	0.040	0.044	0.809	0.430	336	63.0	303	52.0	258	554	151	6.54	524	0.624	19.4	10.6	139	2.29
NUMBER	14	14	14	14	14	14	14	14	14	14	14	14	14	7	14	14	14	14	14
COV	0.807	0.325	0.439	0.385	0.713	1.43	1.12	1.61	1.037	1.86	1.19	1.16	0.990	0.651	0.071	0.861	0.808	0.929	0.282

Table 8. 2023 rainfall grab sampling summary statistics.

	TP mg/L	TDP mg/L	SRP mg/L	OPO4 mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	FOG mg/L	*E. Coli* MPN	pH Std Unit	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
MEAN (geometric)	0.146	0.0671	0.0703	0.0631	1.18	0.297	3.02	27.5	18.1	10.7	11.0	71.2	24.7	3.52	5910	7.55	13.4	3.80	33.7	6.75
MEAN (arithmetic)	0.178	0.0749	0.0836	0.0650	1.38	0.454	10.5	50.6	33.2	16.0	17.3	101	33.7	6.88	10120	7.56	17.1	8.10	42.8	7.94
MAX	0.408	0.169	0.161	0.0940	2.33	1.43	120	324	97.3	44.0	62.8	386	102	60.5	24196	8.38	87.0	24.5	111	24.3
MIN	0.0427	0.0310	0.0133	0.0426	0.250	0.0150	1.0	8.0	0.50	1.0	0.00	25.0	10.0	0.900	301	6.92	5.30	0.250	10.0	2.70
MEDIAN	0.188	0.0595	0.0741	0.0601	1.32	0.410	2.0	21.0	25.4	14.4	11.7	50.0	29.6	2.50	7717	7.56	13.4	4.35	38.5	6.90
STDEV	0.105	0.0373	0.0444	0.0175	0.628	0.379	26.6	79.9	30.0	11.9	18.8	102	26.4	13.1	8770	0.371	17.5	8.31	28.9	5.07
NUMBER	20	20	20	8	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
COV	0.588	0.498	0.532	0.269	0.456	0.836	2.53	1.58	0.902	0.746	1.09	1.01	0.783	1.91	0.867	0.0491	1.02	1.03	0.676	0.639

FOG (Fat, Oil, and Grease) Monitoring Study

Beginning in 2018, the FOG Monitoring study was conceptualized as a 2-year study to gather FOG data over the course of the NPDES permit. If no FOG values were found to be greater than 15 mg/L, the study would end. If a FOG value exceeded 15 mg/L, that site would continue to be monitored for FOG. Powderhorn Inlet SE, W, and 61st & Lyndale were the only sites to exceed the 15 mg/L threshold in 2023. Overall, FOG levels in 2023 were generally lower than in the past 5 years of the study. **Table 9** contains FOG data from 2023. **Table 10** contains FOG data from 2022 and 2023. See **Table A-3** in the **Appendix** for FOG data from the entire duration of the permit.

Powderhorn Inlet W registered an unusually high level of FOG on 9/29/23, at 60.5 mg/L. Typically winter snowmelt contains the highest concentrations of FOG, but this sample was taken in the late fall following a series of large rainfall events. On 9/5/23, an empty gasoline can was found at the site by staff, **Figure 5**. Staff reported observing an oily sheen on composite samples and street runoff and smelling gasoline at the site throughout the monitoring season, **Figure 6**. The City of Minneapolis is currently investigating the high levels of FOG found at this site.

Table 9. FOG results from grab samples collected in 2023. Samples over 15 mg/L are in red.

	Snowmelt			Rainfall					
2023	**2/14**	**3/31**	**4/3**	**4/19**	**7/26**	**8/14**	**9/25**	**9/29**	**10/6**
CAM IN NNW	8.80	<5.00		<5.00		<5.00	<5.00		
CAM IN SNW	9.40	<5.00		<5.00		<5.00	<5.00		
CAM IN SW	5.20	<5.00		<5.00		<5.00			12.7
POW IN S	19.6	7.45		7.30	13.4			<5.00	
POW IN SE		<5.00		<5.00		<5.00		<5.00	
POW IN W		<5.00	<5.00	5.30	<5.00		<5.00	60.5	
61st & Lyndale	22.0	<5.00	<5.00						

Figure 5. Empty gasoline were found next to Powderhorn Inlet W on 9/5/23.

Figure 6. Oil sheen on curb runoff at Powderhorn Inlet W on 10/13/23.

Table 10. FOG event dates and grab samples collected from the last 2 years. Data greater than 15 mg/L are in red.

2022 Sites	2/28	3/8	3/15	4/5	5/25	6/13	8/12		
61st & Lyndale	24.7	9.90		<5.00		<5.00	<5.00		
CAM IN NNW			<5.00		<5.00		<5.00		
CAM IN SNW	26.1		<5.00		<5.00		<5.00		
CAM IN SW	<5.00		6.53	<5.00	<5.00		<5.00		
POW IN S	35.5	14.3		<5.00	<5.00		<5.00		
POW IN SE	33.7	15.8		<5.00	<5.00		<5.00		
POW IN W	43.5	7.61		<5.00	<5.00		<5.00		
2023 Sites	**2/14**	**3/31**	**4/3**	**4/19**	**7/26**	**8/14**	**9/25**	**9/29**	**10/6**
61st & Lyndale	22.0	<5.00	<5.00						
CAM IN NNW	8.80	<5.00		<5.00		<5.00	<5.00		
CAM IN SNW	9.40	<5.00		<5.00		<5.00	<5.00		
CAM IN SW	5.20	<5.00		<5.00		<5.00			12.7
POW IN S	19.6	7.45		7.30	13.4			<5.00	
POW IN SE		<5.00	<5.00	<5.00		<5.00		<5.00	
POW IN W		<5.00	<5.00	5.30	<5.00		<5.00	60.5	

CONCLUSIONS

Grab samples of stormwater represent storm event chemistry at a specific point in time. Due to limited holding times and the necessity for glass bottles, some parameters can only be characterized by a grab sample, e.g., pH, *E. coli*, and FOG. Timing of a runoff event is critical for grab sample collection. Flow must occur when staff are available, travel between sites during a storm is possible, and the laboratory is available to receive samples with short holding times like *E. coli*.

In 2023, seven sites were successfully monitored via grabs for NPDES water chemistry, *E. coli*, pH, and FOG. The sites included:

- Camden Pond Inlets N NW, S NW, and SW
- 61st & Lyndale (for winter snowmelt only)
- Powderhorn Inlets SE, S, and W

The 2023 quarterly grab sampling data show that snowmelt generally had high values for all chemical parameters when compared to runoff at other times of the year. Phosphorus, solids, metals, and FOG data were much higher during snowmelt. *E. coli* levels were low for snowmelt and higher in the warmer months. This was expected since *E. coli* are temperature-dependent organisms. All chloride concentrations were high during snowmelt and were lower the rest of the year. The chloride source is likely road salt application over the winter months.

The 2023 pH values ranged between 6.9 and 9.9. The pH values were consistently high at 61st & Lyndale compared to the other sites. High pH values at 61st & Lyndale were likely due to the cement plant located across the street from the sampling location, which produces alkaline runoff.

FOG data have been collected from 2018 to 2023. The only FOG samples that were greater than 15 mg/L were seen during the 2019 to 2023 snowmelt events. The only non-snowmelt FOG sample that exceeded the 15 mg/L threshold was on 9/29/23, when the Powderhorn Inlet W sample measured 60.5 mg/L. It appears that FOG values greater than 15 mg/L generally do not occur outside of snowmelt, with some exceptions. Snowmelt is a unique event that contributes pollution from 4-5 months over a few low-flow events. Snowmelt samples are polluted from material deposited in the watershed over the winter, and it is common to see an oily sheen on a snowmelt grab sample.

APPENDIX – STORMWATER GRAB SAMPLING RESULTS

Table A-1. 2023 snowmelt NPDES chemistry grab sample results. FOG data in red are greater than 15 mg/L. NS = no sample.

Date	Time	Site	TP mg/L	TDP mg/L	SRP mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	FOG mg/L	E. Coli MPN	pH Std Unit	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
2/14	12:02	61st & Lyndale	1.66	0.113	0.076	0.980	0.732	950	160	1191	185	1006	1754	562	22.0	NS	9.90	79.0	25.5	500	10.2
2/14	12:25	POW IN S	0.946	0.139	0.110	2.26	0.403	800	48	304	136	168	1325	316	19.6	NS	9.40	44.2	39.7	373	12.7
2/14	13:00	CAM IN NNW	0.404	0.104	0.018	1.04	0.425	750	46	77.0	32.0	45.0	1248	82.9	8.80	NS	8.80	18.5	6.00	168	7.20
2/14	13:00	CAM IN SNW	0.756	0.125	0.107	2.36	0.275	250	28	212	78.0	134	410	201	9.40	NS	8.90	35.8	21.2	266	9.80
2/14	13:15	CAM IN SW	0.711	0.183	0.152	1.58	0.420	25.0	32	184	56.0	128	100	152	5.20	NS	8.30	15.5	11.3	71.7	10.0
3/31	9:00	61st & Lyndale	0.426	0.080	0.072	2.37	0.476	225	56	203	52.4	151	444	128	<5.00	350	9.33	23.0	7.10	133	7.70
3/31	9:25	POW IN SE	0.347	0.149	0.137	3.04	0.574	28.0	20	59.0	26.0	33.0	105	82.7	<5.00	1785	8.98	17.7	19.7	115	9.50
3/31	9:45	POW IN S	0.354	0.155	0.144	3.01	0.565	29.0	20	55.3	25.3	30.0	115	55.8	7.45	959	8.82	14.3	15.5	102	8.70
3/31	9:55	POW IN W	0.298	0.156	0.149	2.71	0.467	14.0	16	43.3	20.0	23.3	65.0	35.0	<5.00	816	9.22	14.4	15.8	74.0	7.20
3/31	11:00	CAM S NW	0.279	0.174	0.156	2.73	0.676	38.0	28	29.0	13.5	15.5	135	25.8	<5.00	754	8.21	14.2	5.80	53.0	8.10
3/31	11:10	CAM N NW	0.290	0.130	0.110	2.57	0.540	38.0	16	42.4	20.4	22.0	120	28.4	<5.00	833	8.18	10.1	5.20	61.0	7.50
3/31	11:35	CAM IN SW	0.077	0.066	0.056	2.78	1.98	9.0	232	4.00	<2.00	3.00	317	<20.0	<5.00	134	7.66	3.00	<0.50	<20.0	5.20
4/3	10:58	61st & Lyndale	0.384	0.064	0.053	0.946	0.766	110	68	211	48.0	163	319	129	<5.00	NS	9.08	15.8	4.60	112	6.10
4/3	11:40	POW IN W	0.141	0.076	0.064	1.01	0.147	12.5	16	21.8	8.80	13.0	62.5	<20.0	<5.00	NS	8.00	9.50	6.60	50.7	3.70

Table A-2. 2023 rainfall NPDES chemistry grab sample results. FOG data in red are greater than 15 mg/L. NS = Not Sampled.

Date	Time	Site	TP mg/L	TDP mg/L	SRP mg/L	OPO4 mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	FOG mg/L	E. Coli MPN	pH Std Unit	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
4/19	8:50	POW IN SE	0.271	0.132	0.123	NS	1.19	0.454	4.0	16	34.0	19.0	15.0	47.5	41.7	<5.0	2909	7.72	87.0	14.5	52.4	11.5
4/19	9:00	POW IN S	0.408	0.123	0.118	NS	1.72	0.343	4.5	18	97.3	44.0	53.3	50.0	102	7.30	1333	8.38	23.4	24.5	111	8.30
4/19	9:20	POW IN W	0.306	0.100	0.080	NS	1.23	0.322	4.5	16	73.3	33.3	40.0	47.5	58.4	5.30	960	8.21	23.6	24.0	109	8.80
4/19	9:55	CAM IN NNW	0.168	0.104	0.063	NS	1.22	0.390	120	24	11.2	6.40	4.80	290	<20.0	<5.0	1467	6.92	7.00	1.40	39.3	7.80
4/19	10:00	CAM IN SNW	0.305	0.169	0.161	NS	1.48	0.843	30	44	36.0	18.3	17.8	140	42.5	<5.0	2105	7.88	14.1	5.50	58.4	10.4
4/19	10:15	CAM IN SW	0.073	0.066	0.052	NS	1.83	1.43	8.5	216	2.33	2.00	0.333	280	<20.0	<5.0	301	7.41	5.30	<0.5	<20.0	5.10
7/26	8:10	POW IN S	0.279	0.106	0.091	NS	2.33	0.626	9.0	42	23.3	14.7	10.6	122	81.8	13.4	7270	7.57	14.9	5.40	<20.0	24.3
7/26	8:50	POW IN W	0.211	0.031	0.023	NS	1.47	0.058	<2.0	28	25.5	21.0	4.50	82.5	49.5	<5.0	>24196	7.28	11.7	6.90	41.0	13.9
8/14	10:30	CAM IN SNW	0.085	0.074	0.096	NS	0.54	0.186	<2.0	24	9.00	8.00	1.00	50.0	<20.0	<5.0	9208	7.70	12.9	2.40	29.6	4.30
8/14	9:00	POW IN SE	0.059	0.045	0.069	NS	0.25	<0.03	4.5	22	14.0	14.0	0.0	50.0	23.3	<5.0	8164	7.11	8.30	2.30	37.6	13.1
8/14	11:00	CAM IN NNW	0.043	0.031	0.053	NS	<0.5	0.060	<2.0	8	13.0	9.00	4.00	27.5	<20.0	<5.0	>24196	7.68	6.80	2.10	21.1	3.40
8/14	11:15	CAM IN SW	0.064	0.049	0.052	NS	0.59	0.431	3.0	108	1.00	<2.0	0.0	153	<20.0	<5.0	4884	7.63	13.9	<0.5	<20.0	3.60
9/25	14:30	POW IN W	0.124	0.054	0.013	0.043	1.05	0.117	<2.0	26	15.2	6.80	8.40	50.0	20.3	<5.0	24196	6.92	23.4	3.30	36.0	8.50
9/25	15:10	CAM IN SNW	0.124	0.050	0.046	0.094	1.29	0.273	<2.0	16	30.5	14.0	16.5	32.5	<20.0	5.20	8664	7.55	12.6	3.10	28.3	4.10
9/25	15:20	CAM IN NNW	0.089	0.040	0.033	0.061	1.29	0.162	<2.0	8	18.0	5.20	12.8	25.0	<20.0	<5.0	7270	7.60	6.00	1.40	26.0	2.70
9/29	9:00	POW IN SE	0.209	0.097	0.145	0.089	2.09	0.498	<2.0	14	39.0	17.7	21.3	52.5	36.0	<5.0	>24196	7.36	14.8	11.4	48.6	5.90
9/29	9:10	POW IN S	0.217	0.059	0.129	0.062	2.13	0.507	<2.0	20	67.6	28.4	39.2	40.0	42.7	<5.0	19863	7.45	15.9	16.5	56.1	6.90
9/29	9:10	POW IN S Below CDS	0.256	0.053	0.146	0.059	2.19	0.515	<2.0	20	96.8	34.0	62.8	52.5	49.5	6.30	12033	7.34	12.4	21.4	68.8	6.90
9/29	9:30	POW IN W	0.210	0.054	0.125	0.059	2.05	0.529	<2.0	18	55.2	22.0	33.2	47.5	46.3	60.5	15531	7.50	21.3	15.2	52.1	6.40
10/6	10:30	CAM IN SW	0.060	0.060	0.0531	0.054	1.36	1.32	13	324	<1.0	<2.0	0.0	386	<20.0	12.7	3654	7.92	7.30	<0.5	<20.0	2.80

Table A-3. FOG event dates and grab samples collected from all years of the FOG Monitoring Study. Data greater than 15 mg/L are in red.

2018	1/10	1/19	1/26	3/19	3/26	7/12	7/13	10/1	
14th & Park	<5.00	6				<5.00		<5.00	
22nd & Aldrich	8	8		6			<5.00	<5.00	
61st & Lyndale		<5.00	9						
Pershing				<5.00	<5.00				
2019	**12-Mar**	**13-Mar**	**19-Mar**	**20-Mar**	**8-May**	**27-Jun**	**26-Aug**	**12-Sep**	
14th & Park	9	10							
22nd & Aldrich		7							
24th & Elm In N					<5.00	<5.00	<5.00	<5.00	
24th & Elm In S					<5.00	<5.00	<5.00	<5.00	
61st & Lyndale	21	19							
Pershing			<5.00	<5.00					
Winter Basin In S					<5.00	<5.00	6	6	
Winter Basin In W					5	5	5	<5.00	
2020	**24-Feb**	**3-Mar**	**4-Mar**	**7-Jul**	**14-Jul**	**21-Jul**			
24th & Elm In N		<5.00	<5.00		<5.00	<5.00			
24th & Elm In S		<5.00	<5.00		<5.00	<5.00			
24th & Elm N Out					7				
61st & Lyndale				6		<5.00			
POW IN S	31	14		3		<5.00			
POW IN SE		6	6	5		<5.00			
POW IN W	109	13		4		<5.00			
2021	**22-Feb**	**23-Feb**	**24-Feb**	**25-Feb**	**8-Apr**	**27-May**	**14-Jul**	**24-Aug**	
24th & Elm N	11	<5.00			<5.00	<5.00	<5.00	<5.00	
24th & Elm S	14	31			<5.00	<5.00	NS	<5.00	
61st & Lyndale	16	14.8			6	<5.00	<5.00	<5.00	
POW IN S			23	18	5	<5.00	14.7	<5.00	
POW IN SE			14	17	5	11	<5.00	<5.00	
POW IN W	63	85			<5.00	<5.00	9	<5.00	
2022	**28-Feb**	**8-Mar**	**15-Mar**	**5-Apr**	**25-May**	**13-Jun**	**12-Aug**		
61st & Lyndale	24.7	9.90		<5.00		3.64	<5.00		
CAM IN NNW			2.15		<5.00		<5.00		
CAM IN SNW	26.1		4.69		<5.00		<5.00		
CAM IN SW	<5.00		6.53	<5.00	<5.00		<5.00		
POW IN S	35.5	14.3		<5.00	<5.00		<5.00		
POW IN SE	33.7	15.8		<5.00	<5.00		<5.00		
POW IN W	43.5	7.60		<5.00	<5.00		<5.00		
2023	**14-Feb**	**31-Mar**	**3-Apr**	**19-Apr**	**26-Jul**	**14-Aug**	**25-Sep**	**29-Sep**	**6-Oct**
61st & Lyndale	22.0	<5.00	<5.00						
CAM IN NNW	8.8	<5.00		<5.00		<5.00	<5.00		
CAM IN SNW	9.4	<5.00		<5.00		<5.00	<5.00		
CAM IN SW	5.2	<5.00		<5.00		<5.00			12.7
POW IN S	19.6	7.5		7.3	13.4			<5.00	
POW IN SE		<5.0	<5.00	<5.00		<5.00		<5.00	
POW IN W		<5.0	<5.00	5.3	<5.0		<5.00	60.5	

Camden Pond Monitoring

BACKGROUND

Camden Pond was constructed by the City of Minneapolis in 2007 for flood control purposes. Later, the space around the pond was redesigned as a scenic location by adding plants, benches, and a walking path. Camden Pond is a polymictic pond of 4.09 acres with a maximum depth of 6.4 ft and accumulates sediment at a rate of around 0.44% of its volume per year (Stantec Consulting Services, 2021). As of 2020, only 6.2% of the pond volume had filled with sediment, so the pond has never required dredging. The drainage area of Camden Pond is 235 acres of mainly park and residential land uses, with 75 of those acres being impervious surfaces.

Camden Pond, shown in **Figure 1**, was part of the 2020-2021 Minneapolis Park and Recreation Board (MPRB) pond monitoring study and was selected for further monitoring in 2022 based on those study results. Camden Pond was one of the older ponds in the study and showed the highest potential internal phosphorus loading out of all studied ponds. A study of Camden Pond's inlets and outlet began in 2022 with the goal of determining more definitive mass balance, removal efficiency, and nutrient loads. This study aims to provide insight into whether a pond originally intended for flood control purposes could be modified to have positive water quality impacts. This work was continued in the 2023 monitoring season. Monitoring sites are pictured in **Figure 2**.

Figure 1. A photo taken from the southwest side of Camden Pond during July of 2023.

The purpose of monitoring the stormwater inlets and outlet of Camden Pond is to:

1. Measure the pollutant loads of the tributary pipes entering Camden Pond and compare with pollutant loads at the pond outlet.
2. Assess how a pond originally intended for flood control is affecting stormwater quality.
3. Measure the true storage capacity of the pond and compare to its designed capacity.
4. Comply with the National Pollutant Discharge Elimination System (NPDES) Permit provision to monitor stormwater BMPs for the purpose of adaptive management.

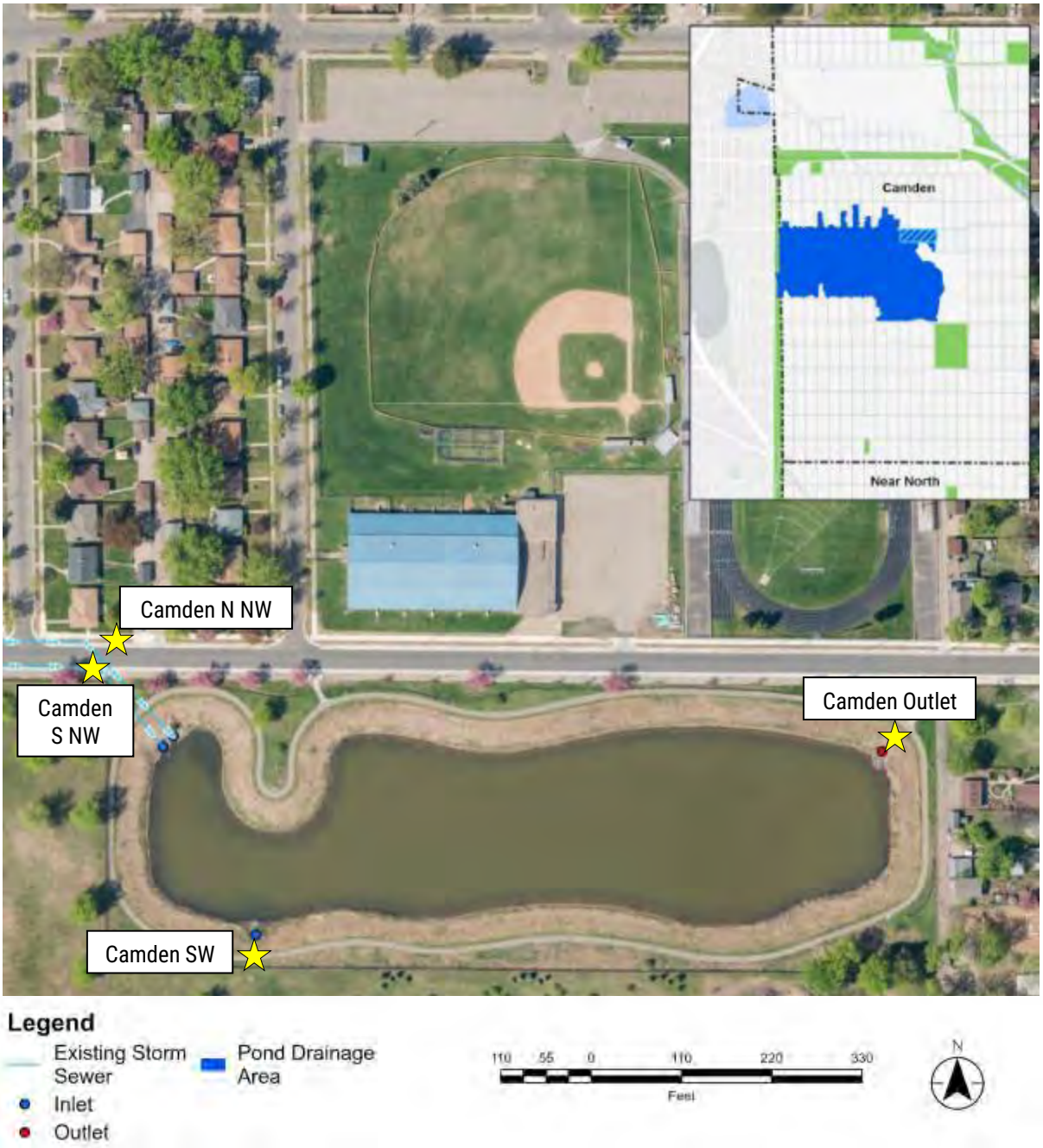


Figure 2. Aerial view of Camden Pond with the four inlet and outlet locations (Stantec Consulting Services, 2021). MPRB monitoring sites are marked with yellow stars.

METHODS

Site Installation

Monitoring equipment at each site included: ISCO 2150 datalogger, 2105ci LTE combined interface module/modem, low-profile area velocity (AV) probe, and a 3700 ISCO sampler complete with tubing and intake strainer. Cables and tubing were anchored with zip ties to the sidewall eyebolts. AV probes and intake strainers were pointed upstream and fastened to the pipe. At Camden Inlets N NW, S NW,

and SW, the strainer and probe were attached to the pipe using a steel spring ring, **Figure 3**. The equipment at Camden Inlets N NW and S NW were hung from eyebolts below grade in the manhole with an above grade antenna. The other two sites, Camden Inlet SW and Camden Outlet, had above grade monitoring boxes with access holes for tubing and cables. Monitoring boxes were rectangular 4 ft x 3 ft x 3 ft locking wooden boxes which safely protected and housed both the sampler and datalogger equipment. The Camden Outlet had an additional 2150 datalogger and AV probe that measured the water level of the pond. The probe was aligned at the same elevation as the invert (bottom) of the outlet pipe. Images of each site can be found in **Figure 4**.

The dataloggers used cell phone modems to remotely upload data to the MPRB ISCO database server from Monday through Friday. An antenna was installed at each site to allow for remote communication with the datalogger. The datalogger could also be remotely programmed to turn the samplers on/off, adjust the level, pacing, and triggers, and to download data.

Equipment installations occurred on May 1 and May 2, 2023. On August 12 the datalogger at Camden Inlet S NW was stolen and the connecting cables and probes were severed. New equipment was installed on August 17 and the theft was reported to the Minneapolis Police Department (MPD). All sites were uninstalled on November 1.

Figure 3. Photo of the spring ring at Camden Inlet S NW in May 2023. The blue arrow points in the direction of water flow.

Sample Collection

The samplers were equipped with 24 one-liter bottles, 3/8-inch inner-diameter vinyl tubing, and an intake strainer that filtered out large particulates. Samplers were multiplexed, and four flow-weighted samples were collected per 1-L bottle, allowing a maximum of 96 samples to be collected over a storm event. A storm event is defined as a storm with greater than 0.10 inches of precipitation separated by eight or more hours from other storms. Some sites were programmed to pulse the samplers at a level trigger threshold after a set volume or pacing had passed. Other sites required a more complex program using hysteresis and flow rate as the trigger. More information about sampler programming can be found in the discussion section of this chapter.

Figure 4. The four Camden Pond monitoring sites: Camden Inlet N NW (A), Camden Inlet S NW (B), Camden Inlet SW (C), and Camden Outlet (D).

Monitoring Parameters and Methods

A list of the chemical parameters required by the NPDES permit for analysis of auto-monitored composite stormwater samples is shown in **Table 1**. NPDES permit-required chemistry methods, reporting limits, and holding times for auto-monitored composite samples used in this project are also shown in this table.

Table 1. The list of required NPDES permit parameters to be monitored. This table shows analysis method, reporting limit, and holding times for parameters analyzed by Instrumental Research Inc. and Pace Laboratories.

Parameter	Abbreviation	Units	Method	Reporting Limit	Holding Time
Chemical Oxygen Demand	COD	mg/L	SM 5220-D	20 mg/L	28 days
Chloride, Total	Cl	mg/L	SM 4500-Cl^- B	2.0 mg/L	28 days
Copper, Total	Cu	µg/L	EPA 200.8	1 µg/L	6 months
Dissolved Organic Carbon	DOC	mg/L	SM 5310-C-00	1.5 mg/L	28 days
Hardness, as CaCO3	Hard	mg/L	SM 2350 C	5.0 mg/L	6 months
Lead, Total	Pb	µg/L	EPA 200.8	0.10 µg/L	6 months
Nitrate/Nitrite, Total as N	NOx	mg/L	SM 4500-NO_3 E	0.030 mg/L	28 days
Orthophosphate	OPO4	mg/L	SM 4500-PE	0.003 mg/L	48 hours
Phosphorus, Total	TP	mg/L	SM 4500-PE	0.010 mg/L	48 hours
Phosphorus, Total Dissolved	TDP	mg/L	SM 4500-PE	0.010 mg/L	48 hours
Solids, Total Dissolved	TDS	mg/L	SM 2540 C	5.0 mg/L	7 days
Solids, Inorganic Suspended	ISS	mg/L	TSS-VSS	5.0 mg/L	7 days
Solids, Total Suspended	TSS	mg/L	SM 2540 D	1.0 mg/L	7 days
Solids, Volatile Suspended	VSS	mg/L	EPA 160.4	2.0 mg/L	7 days
Total Nitrogen	TN	mg/L	Alkaline Persulfate Oxidation	0.500 mg/L	28 days
Zinc, Total	Zn	µg/L	EPA 200.7	20 µg/L	6 months

Quality Assurance Practices

A variety of quality assurance quality control (QAQC) measures were taken to ensure defensible data. Ten percent of the samples were laboratory quality assurance samples e.g., duplicates, spikes. A field blank was also generated for each sampling trip and was analyzed for all NPDES chemical parameters. Field blanks consisted of deionized water which accompanied samples from the field sites to the analytical laboratory. All field blank parameters measured below the reporting limits in 2023. As part of the department QAQC program, blind monthly performance samples of known concentration were analyzed by IRI. If any parameter failed to meet the acceptable recovery range, all the data for that parameter would be flagged for the entire month. No parameters were flagged in 2023.

Field measurements were recorded on a field sheet in the 2023 Stormwater Monitoring Field Manual. Electronic data from the laboratory were forwarded to the MPRB in preformatted Excel spreadsheets via email. Electronic data from the laboratory were checked and passed laboratory quality assurance procedures. Protocols for data validity followed those defined in the Stormwater Monitoring Program Manual (MPRB, 2001). For data reported as below the reporting limit, the numerical value was divided by two for statistical calculation purposes.

Manual transcription of data was minimized to reduce error introduction. A minimum of 10% of the final data were checked by hand against the raw data sent by the laboratory to ensure there were no errors entering, manipulating, or transferring the data.

A Chain of Custody form accompanied each set of sample bottles delivered to the lab. Each sample container was labeled indicating the date and time of collection, site location, and field personnel initials. Samples were transported to the laboratory on ice in a cooler. The time that each grab sample was collected was recorded onto field sheets. A complete description of methods can be found in the Stormwater Monitoring Program Manual (MPRB, 2001). Common statistics were calculated using Microsoft Excel.

RESULTS

Sample Collection

In 2023, stormwater grab and flow-weighted composite samples were collected from storm events ranging from 0.09 to 2.48 inches of precipitation. The NPDES permit requires the collection of two snowmelt grabs, one rainfall grab from the spring, summer, and fall quarters, and ten composite samples from each monitored site. Although the MPRB defines a storm event as having greater than 0.10 inches of precipitation, samples from smaller storms were sometimes included in the data analysis due to the regional drought this year. Snowmelt grab samples were collected from three snowmelt events at the inlet pipe outfalls, **Figure 5**. **Table 2** shows the snowmelt grab samples collected. **Table 3** shows the rainfall grab samples collected, along with precipitation data. Precipitation was measured by a rain gauge at MPRB's Southside Operations Center.

The 2023 NPDES chemical parameter summary statistics for flow-weighted composite samples at the Camden Inlets S NW, SW, and the Outlet site can be seen in **Table 4** through **Table 7**. Due to consistently low flows and persistent equipment issues, no composite samples were collected at Camden Inlet N NW in 2023. The statistics calculated for each site were the geometric mean (GEOMEAN), arithmetic mean, maximum (MAX), minimum (MIN), median, standard deviation (STDEV), number of samples, and coefficient of variation (COV). If parameters measured below the limit of detection, half of the reporting limit value was used for statistical calculations. Full composite sample results from the other three sites can be found in the **Appendix**.

Figure 5. Staff collecting a winter snowmelt grab sample from the Camden Inlet N NW pipe. Snowmelt samples occasionally need to be collected at the pipe outfalls rather than the access manholes due to thick snow/ice coverage and for staff safety.

Table 2. The 2023 snowmelt events sampled or attempted to sample at the three Camden Inlets via grabs. X = grab sample. NS = No Sample.

Date	Camden Inlet N NW	Camden Inlet S NW	Camden Inlet SW
2/14/23	X	X	X
3/31/23	X	X	X
4/3/23	NS	NS	NS

Table 3. The 2023 precipitation events sampled or attempted to be sampled at the three Camden inlets via grabs. X = quarterly grab sample, X/C = Quarterly grab samples with a flow-paced composite. NS = No Sample. Precipitation data was measured by the MPRB weather station located at SSOC.

Start Date	Start Time	End Date	End Time	Rain inches	Duration hours	Intensity in/hour	Hours since last rain	Camden In N NW	Camden In S NW	Camden In SW
4/19/23	5:15	4/19/23	7:15	0.28	2.0	0.14	57	X	X	X
7/26/23	0:00	7/26/23	8:45	1.27	8.75	0.145	107	NS	NS	NS
8/13/23	15:45	8/14/23	13:15	1.60	21.5	0.074	47	X	X	X/C
9/23/23	16:30	9/26/23	1:30	2.34	57.0	0.041	153	X	X	NS
9/29/23	3:45	9/29/23	10:15	1.18	6.5	0.182	60	NS	NS	NS
10/6/23	8:30	10/6/23	10:30	0.06	2.0	0.030	15	NS	NS	X

Composite Sample Chemistry

Table 4. Camden Inlet S NW 2023 composite sample chemistry summary statistics.

	TP mg/L	TDP mg/L	SRP mg/L	OPO4 mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
MEAN (geometric)	0.5148	0.029	0.0377	0.0779	2.61	0.173	1.0	22	142	59.4	81.6	42.5	162	31.1	43.8	118	5.0
MEAN (arithmetic)	0.661	0.029	0.0751	0.136	2.84	0.219	1.0	22	210	78.8	131	42.5	162	31.1	43.8	118	5.0
MAX	1.61	0.029	0.186	0.331	4.05	0.405	1.0	22	436	160	276	42.5	162	31.1	43.8	118	5.0
MIN	0.207	0.029	0.0040	0.0327	1.27	0.039	1.0	22	48.0	25.0	23.0	42.5	162	31.1	43.8	118	5.0
MEDIAN	0.437	0.029	0.0825	0.0436	3.01	0.231	1.0	22	110	45.0	65.0	42.5	162	31.1	43.8	118	5.0
STDEV	0.560	0	0.0731	0.169	1.19	0.132	0	0	188	63.0	125	0	0	0	0	0	0
NUMBER	5	1	5	3	4	5	1	1	5	5	5	1	1	1	1	1	1
COV	0.848	0	0.974	1.25	0.419	0.605	0.00	0.00	0.895	0.800	0.953	0.00	0.00	0.00	0.00	0.00	0

Table 5. Camden Inlet SW 2023 composite sample chemistry summary statistics.

	TP mg/L	TDP mg/L	SRP mg/L	OPO4 mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
MEAN (geometric)	0.265	0.0901	0.0761	0.0663	2.24	0.270	2.17	67.4	50.9	23.2	26.9	112	41.2	16.4	1.46	25.3	7.77
MEAN (arithmetic)	0.421	0.108	0.0881	0.0740	2.59	0.398	3.65	98.4	139	52.5	86.2	142	103	18.4	3.04	31.2	12.0
MAX	1.34	0.257	0.236	0.138	5.84	1.10	11.5	308	429	139	296	383	367	32	11.8	86.1	53.4
MIN	0.0670	0.0474	0.0337	0.0314	1.27	0.0150	1.0	26.0	1.60	1.0	0.600	55.0	10.0	7.60	0.250	10.0	3.40
MEDIAN	0.222	0.0830	0.0670	0.0696	1.75	0.316	1.0	52.0	69.3	35.0	34.2	95.0	25.1	15.8	1.60	23.3	5.75
STDEV	0.426	0.0757	0.0569	0.0391	1.54	0.308	4.03	99.5	158	51.6	109	115	131	8.88	4.02	23.4	15.3
NUMBER	12	10	11	5	12	12	10	10	12	12	12	10	10	10	10	10	10
COV	1.01	0.703	0.646	0.528	0.596	0.773	1.10	1.01	1.14	0.983	1.26	0.809	1.27	0.483	1.32	0.751	1.28

Table 6. Camden Outlet 2023 composite sample chemistry summary statistics.

	TP mg/L	TDP mg/L	SRP mg/L	OPO4 mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
MEAN (geometric)	0.157	0.0223	0.00756	0.0265	2.23	0.0631	30.8	62.1	20.7	18.2	1.95	144	29.5	15.6	0.645	16.5	6.36
MEAN (arithmetic)	0.159	0.0246	0.0191	0.0426	2.30	0.130	36.7	63.1	22.4	19.4	2.94	151	33.1	16.5	0.708	17.7	6.88
MAX	0.211	0.0656	0.0607	0.0680	3.43	0.510	95.0	86.0	36.0	29.0	9.00	267	60.7	28.2	1.20	25.6	12.0
MIN	0.106	0.0136	0.00150	0.0015	1.57	0.0150	15.0	48.0	5.00	4.75	0.250	92.5	10.0	7.90	0.250	10.0	3.80
MEDIAN	0.160	0.0221	0.00419	0.0538	2.10	0.0972	27.0	63.5	22.6	19.5	2.00	139	28.7	14.6	0.670	20.3	5.95
STDEV	0.0267	0.0134	0.0231	0.0243	0.612	0.162	25.4	11.8	7.45	5.80	2.67	52.1	14.7	5.62	0.284	6.12	2.82
NUMBER	14	14	14	13	14	14	14	14	14	14	14	14	14	14	13	14	14
COV	0.168	0.543	1.21	0.570	0.266	1.25	0.691	0.186	0.333	0.298	0.909	0.345	0.445	0.341	0.401	0.346	0.411

Stormwater Hydrographs

The hydrographs for level and flow measured from June through October 27 at the Camden Inlets N NW, S NW, SW, and Camden Outlet are presented in **Figures 6** through **Figures 9**.

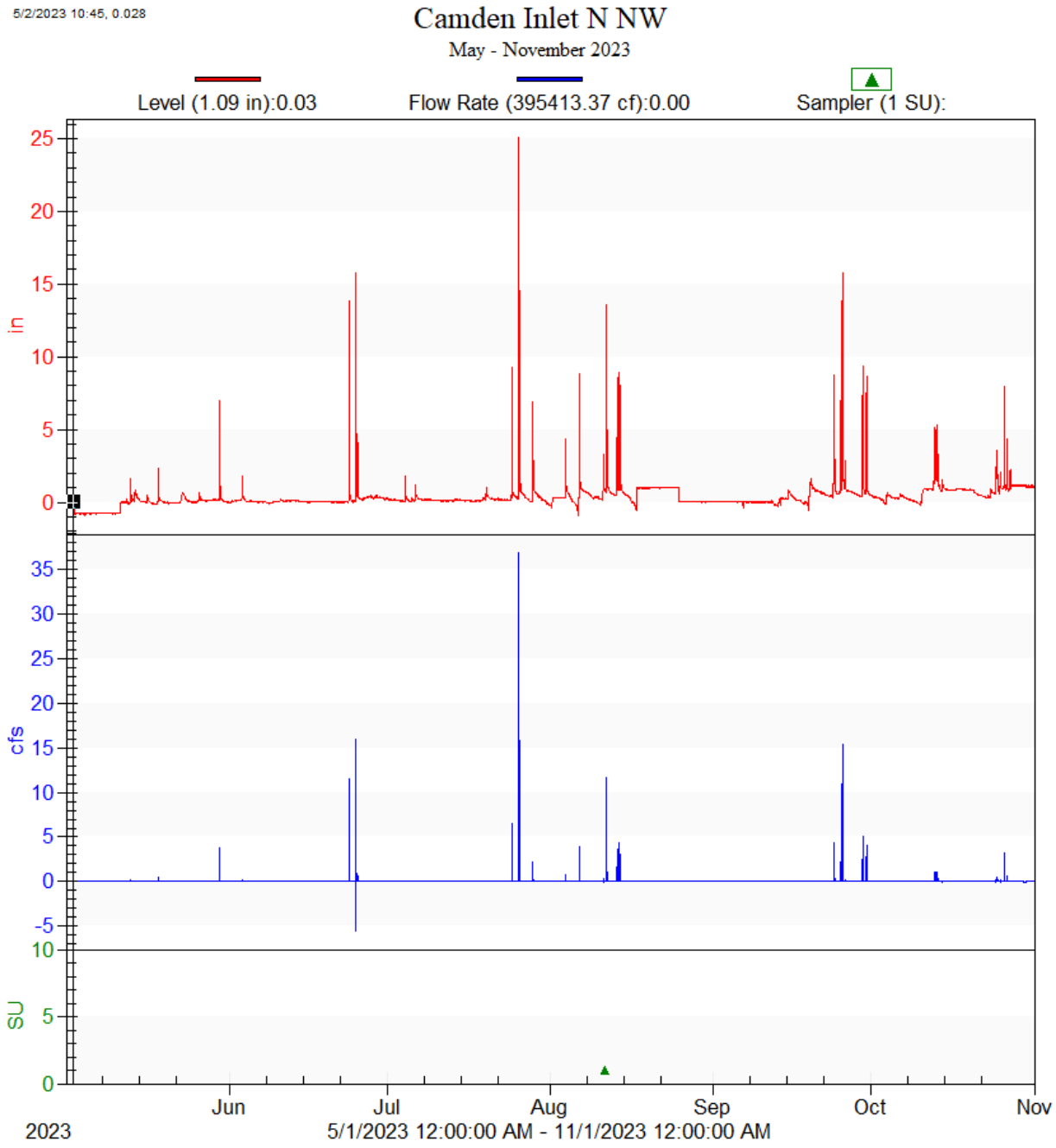


Figure 6. Camden Inlet N NW hydrograph of level and flow from May 2 to November 1, 2023. Green triangles represent when the auto-sampler attempted to take a sample.

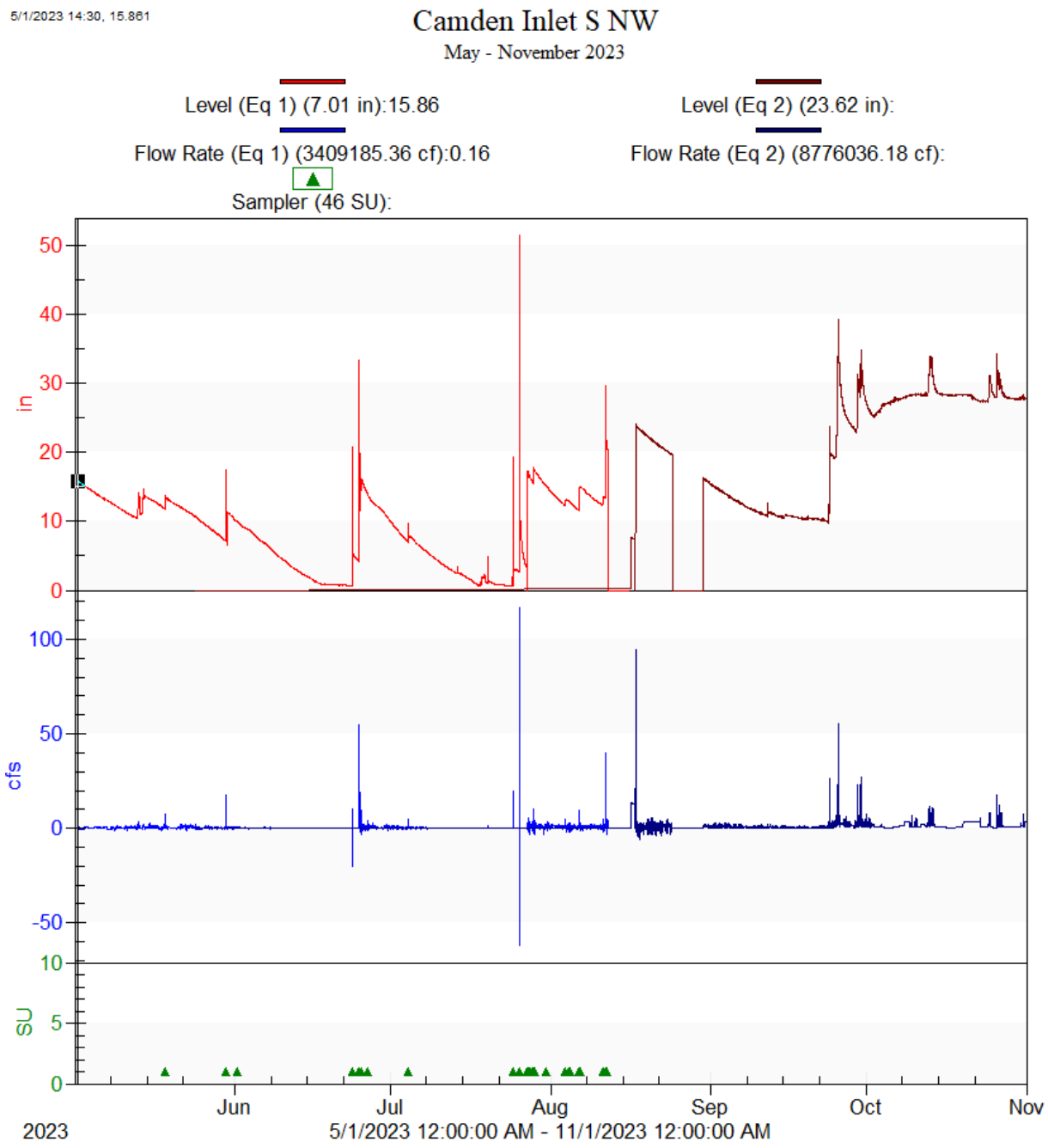


Figure 7. Camden Inlet S NW hydrograph of level and flow from May 1 to November 1, 2023. Green triangles represent when the auto-sampler attempted to take a sample. Note that this site usually has some amount of standing water present. Equipment was programmed to ignore most negative flow data, which is a result of backflowing water. Also, note that two different dataloggers were used during the season due to equipment theft.

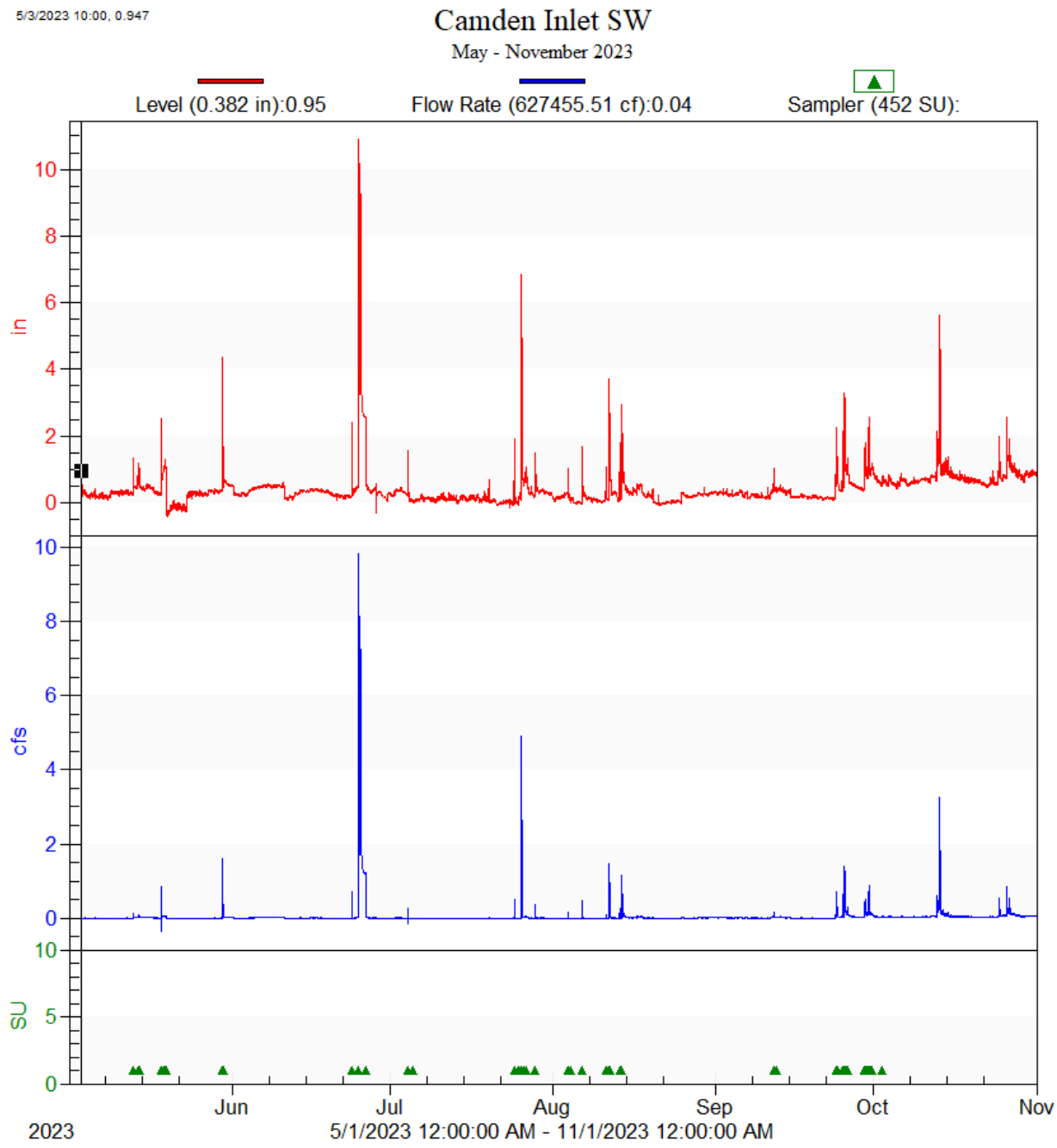


Figure 8. Camden Inlet SW hydrograph of level and flow from May 3 to November 1, 2023. Green triangles represent when the auto-sampler attempted to take a sample. Note that there is always around 0.5 inches of water flowing through the pipe.

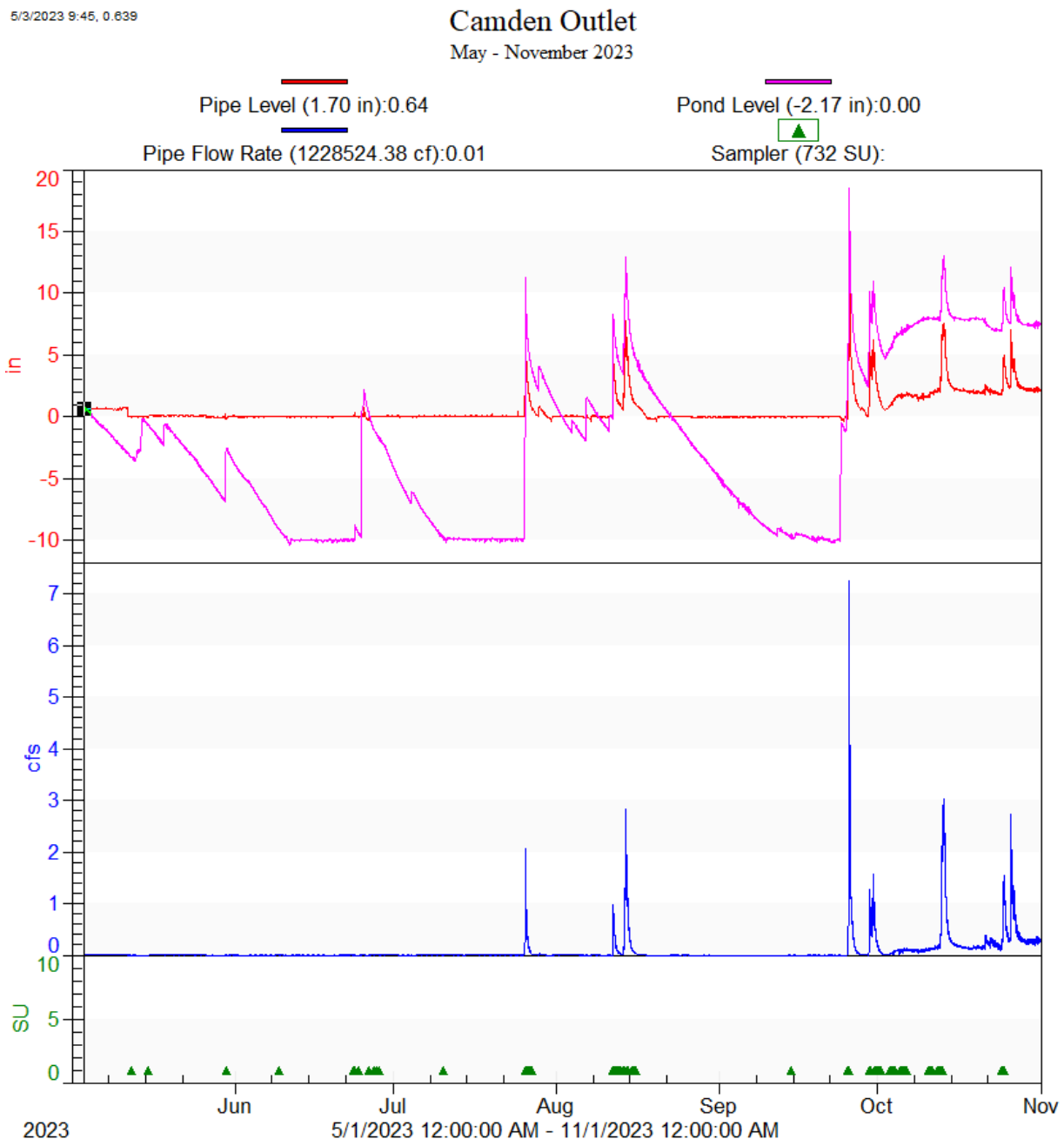
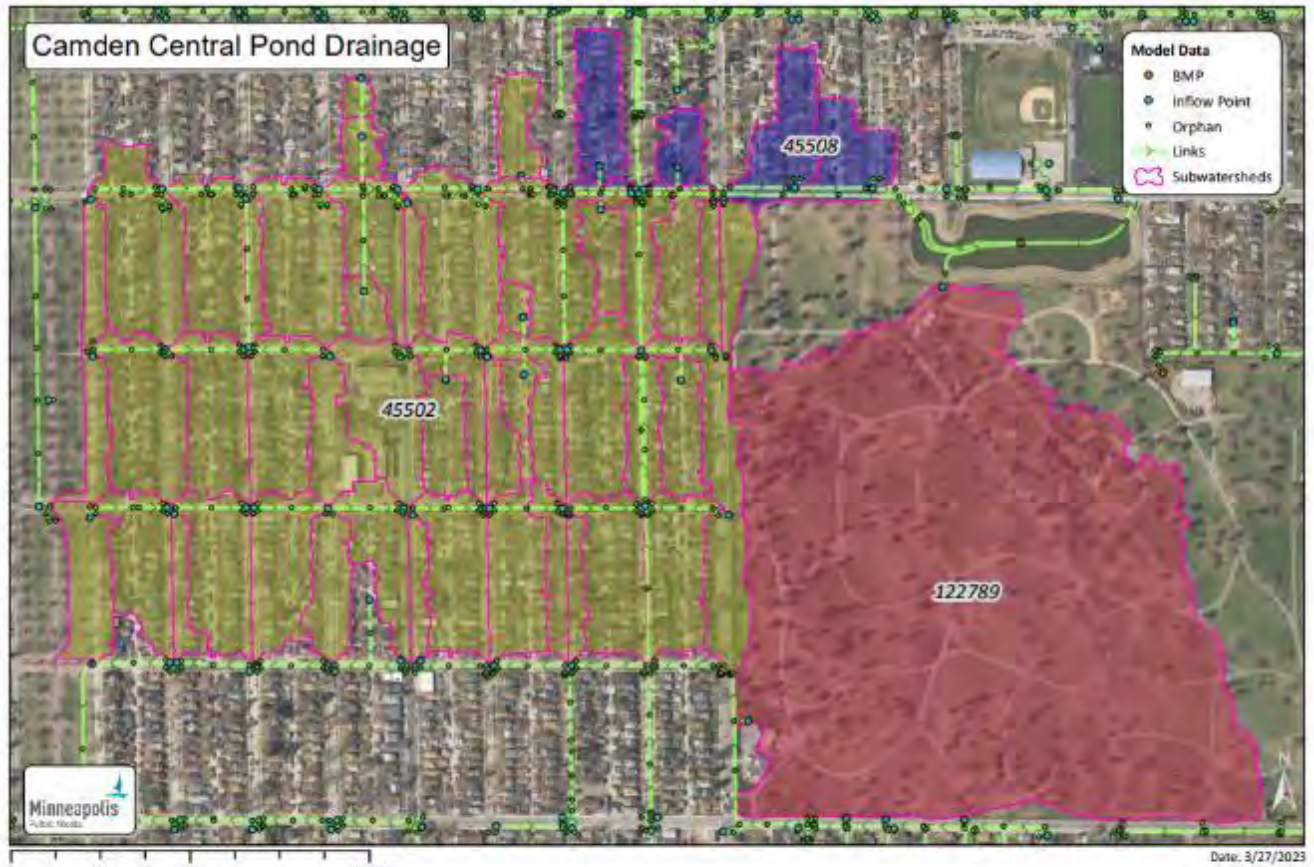


Figure 9. Camden Outlet hydrograph of pond level, pipe level, and pipe flow from May 3 to November 1, 2023. Green triangles represent when the auto-sampler attempted to take a sample. Due to the presence of rip rap at the mouth of the outlet, flow only registered on the pipe probe once the pond level reached ~5 inches. Note that the pond probe could only measure up to -10 inches. There were three occasions during the monitoring season where the true level was even less than that, represented by the flat lines.

Table 7. Composite sampling storm events and corresponding flow data from each monitoring site in 2023. NS = no sample. Precipitation data was measured at the Crystal Airport in Crystal, MN, approximately 4 miles away. Flow data was estimated using the hydrographs generated by the auto-samplers, see Figures 24-5 to 24-8. Outlet Event = an instance where there was no precipitation on that date but the pond was still outflowing, usually from a recent rain event. "Season Total" refers to the monitoring season, from approximately May 1 to November 1.

Event Date	Duration hours	Precip. inches	Hours Since Last Rain	Cam In NNW cf	Cam In SNW cf	Cam In SW cf	Cam Out cf
5/13	20.0	0.40	8	NS	NS	1116	NS
5/14	9.0	0.29	12	NS	NS	2323	NS
5/18	2.0	0.13	88	NS	NS	2275	NS
5/30	3.0	0.16	281	NS	NS	6415	NS
6/25	20.0	0.37	29	NS	166412	220170	NS
7/24	5.0	0.52	114	NS	NS	1,035	NS
7/26	6.0	1.36	31	NS	NS	17073	47833
7/27	Outlet Event		-	NS	NS	NS	7321
8/13	9.0	1.14	46	NS	NS	NS	7530
8/14	13.0	0.45	9	NS	NS	12733	98328
8/15	Outlet Event		-	NS	NS	NS	34805
8/16	Outlet Event		-	NS	NS	NS	4472
9/25	24.0	1.95	13	NS	NS	19908	144345
9/26	1.0	0.01	12	NS	23382	NS	NS
9/29	20.0	1.07	64	NS	300853	11898	42240
9/30	20.0	1.07	64	NS	NS	11149	NS
10/1	Outlet Event		-	NS	NS	NS	20315
10/4	Outlet Event		-	NS	NS	NS	8687
10/6	Outlet Event		-	NS	NS	NS	11273
10/11	Outlet Event		-	NS	NS	NS	18522
10/13	24.0	0.64	150	NS	375862	NS	167666
10/25	10.0	0.74	13	NS	NS	NS	82989
Total Sampled	174.8	9.66	-	0	866,509	306095	696326
Season Total	207	15.9	-	562161	20777158	625328	1221900



ID	Area (acres)	Impervious	Institutional	Multi-Family	Office	Park, Recreational, or Preserve	Retail and Other Commercial	Right of Way	Single Family Attached	Single Family Detached	Undeveloped
45508	10.5	48.0%	5.5%	0.0%	0.0%	0.0%	0.0%	23.4%	0.0%	71.1%	0.0%
45502	127.8	44.9%	5.4%	0.6%	0.1%	2.0%	0.5%	28.1%	1.0%	61.9%	0.2%
122789	84.2	9.9%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Figure 10. Aerial map of Camden Pond showing watershed sizes and land use breakdowns. Map provided by the City of Minneapolis Public Works.

Pollutant Load Tables

Load calculations for each chemical parameter at each site are shown in **Table 8** and **Table 9**. Loads were calculated in pounds for each site by using the P8 and Flux32 modeling programs in combination with measured flow and chemistry data. See the **Discussion** section for more details on modeling techniques. Seasonal flows at each site are shown in **Table 10**. Seasonal loads for each chemical parameter at each site are shown in **Table 11 to 14**.

It should be noted that while these load inputs are from measured data, the flow-weighted samples were only collected from May through the end of October, and the snowmelt samples were grab samples. The flow-weighted sample measurement period had approximately 17.6 inches of precipitation, while the yearly total was 29.7 inches. In 2023, Minneapolis annual precipitation was 1.9 inches lower than the 29-year annual average of 31.6 inches (NWS/NOAA).

Table 8. The 2023 flow totals, calculated pollutant loads, and removal efficiency for Camden Inlets N NW, S NW, SW, and Camden Outlet. Removal efficiency was calculated using data from the three inlets compared to the outlet. Values in red were the highest load for that parameter. Note that a load for OPO4 at Cam NNW could not be calculated due to lack of data.

Parameter	Units	Cam NNW	Cam SNW	Cam SW	Total In	Cam Out	Removal Efficiency
Annual Volume	cf	768636	22701494	1478721	24948851	4175268	-
Annual Runoff	In	20.2	39.9	4.84	-	-	-
TP	Lbs.	12.2	461	25.0	498	49.2	90%
TDP	Lbs.	4.94	75.8	11.1	92	8.63	91%
SRP	Lbs.	2.84	97.2	9.42	109	3.32	97%
OPO4	Lbs.	N/A	112	7.47	119	16.0	87%
TN	Lbs.	75.2	2334	220	2629	800	70%
NOx	Lbs.	19.4	343	156	519	24.3	95%
Cl	Lbs.	2527	29203	1164	32894	12902	61%
Hard	Lbs.	1115	30812	18512	50439	18841	63%
TSS	Lbs.	1899	104248	8049	114196	6566	94%
VSS	Lbs.	862	43218	2557	46636	5758	88%
ISS	Lbs.	1037	62498	5314	68849	935	99%
TDS	Lbs.	6971	74589	30230	111790	49416	56%
COD	Lbs.	1674	28798	6866	37338	11143	70%
Cu	Lbs.	0.506	20.2	1.16	22	4.42	80%
Pb	Lbs.	0.191	9.77	0.899	11	0.238	98%
Zn	Lbs.	3.65	51.5	2.64	58	4.844	92%
DOC	Lbs.	314	8756	841	9911	2433	75%

Table 9. The 2023 load per area calculations for Camden Inlets NNW, SNW, and SW. Values in red indicate the largest load per area for each parameter. Note that a load for OPO4 at Cam NNW could not be calculated due to lack of data.

	Units	Cam NNW	Cam SNW	Cam SW
Area	acres	10.5	127.8	84.2
TP	Lbs./acre	1.16	3.61	0.297
TDP	Lbs./acre	0.470	0.593	0.132
SRP	Lbs./acre	0.271	0.760	0.112
OPO4	Lbs./acre	N/A	0.873	0.0887
TN	Lbs./acre	7.16	18.3	2.61
NOx	Lbs./acre	1.85	2.69	1.86
Cl	Lbs./acre	241	229	13.8
Hard	Lbs./acre	106	241	220
TSS	Lbs./acre	181	816	95.6
VSS	Lbs./acre	82.1	338	30.4
ISS	Lbs./acre	98.8	489	63.1
TDS	Lbs./acre	664	584	359
COD	Lbs./acre	159	225	81.5
Cu	Lbs./acre	0.0482	0.158	0.0138
Pb	Lbs./acre	0.0182	0.0764	0.0107
Zn	Lbs./acre	0.347	0.403	0.0313
DOC	Lbs./acre	29.9	68.5	9.99

Table 10. Seasonal flow data in cf at each Camden site in 2023. Note that November and December were not included in the flow analysis due to lack of corresponding sample data. Winter flows were estimated using P8. Spring flows were a combination of P8 estimations and real flow measurements. Summer and fall flows were from real flow measurements.

Season	Months	Cam NNW cf	Cam SNW cf	Cam SW cf
Winter	Jan, Feb, Mar	120922	1066303	486041
Spring	Apr, May	104156	2535825	389082
Summer	Jun, Jul, Aug	318088	8109282	355129
Fall	Sep, Oct	225645	6790555	248522

Table 11. Seasonal pollutant geomeans and loads at Camden Inlet NNW in 2023. Loads in pounds were calculated by multiplying the seasonal geomean with the seasonal flow (converted to liters) and a conversion factor. Since composite samples were not collected at this site in 2023, all calculations were done using data from snowmelt and rainfall grab samples. Note that this data should be viewed with discretion. Many of the loads were calculated using a low number of data points and likely do not accurately reflect the true seasonal loads.

	Parameter	Units	TP	TDP	SRP	OPO4	TN	NOx	Cl	Hard	TSS	VSS	ISS	TDS	COD	Cu	Pb	Zn	DOC
	Geomean	mg/L	0.342	0.116	0.0450	-	1.63	0.479	169	27.1	57.1	25.5	31.5	387	48.5	0.0137	0.00559	0.101	7.35
	Samples	#	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2
WINTER	**Load**	lbs.	2.58	0.876	0.340	-	12.3	3.62	1274	205	431	193	238	2921	366	0.103	0.0422	0.764	55.5
	Geomean	mg/L	0.168	0.104	0.0628	-	1.22	0.390	120	24.0	11.2	6.40	4.80	290	10.0	0.00700	0.00140	0.0393	7.80
	Samples	#	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
SPRING	**Load**	lbs.	1.09	0.678	0.408	-	7.94	2.54	780	156	72.8	41.6	31.2	1886	65.0	0.0455	0.00910	0.256	50.7
	Geomean	mg/L	0.0914	0.0427	0.0314	0.0535	0.250	0.0599	1.0	8.0	13.0	9.0	4.0	27.5	10.0	0.00680	0.00210	0.0211	3.40
	Samples	#	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SUMMER	**Load**	lbs.	1.82	0.847	0.623	1.06	4.96	1.19	19.9	159	258	179	79.4	546	199	0.135	0.0417	0.419	67.5
	Geomean	mg/L	0.089	0.0401	0.0334	0.0607	1.29	0.162	1.0	8.0	18.0	5.20	12.8	25.0	10.0	0.00600	0.00140	0.0260	2.70
	Samples	#	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
FALL	**Load**	lbs.	1.25	0.565	0.470	0.855	18.1	2.28	14.1	113	254	73.2	180	352	141	0.0845	0.0197	0.366	38.0

Table 12. Seasonal pollutant geomeans and loads at Camden Inlet SNW in 2023. Loads in pounds were calculated by multiplying the seasonal geomean with seasonal flow (converted to liters) and a conversion factor. Note that this data should be viewed with discretion. Many of the loads were calculated using a low number of datapoints and likely do not accurately reflect the true seasonal loads.

	Parameter	Units	TP	TDP	SRP	OPO4	TN	NOx	Cl	Hard	TSS	VSS	ISS	TDS	COD	Cu	Pb	Zn	DOC
	Geomean	mg/L	0.459	0.148	0.129	-	2.54	0.431	97.5	28.0	78.4	32.4	45.6	235	71.9	0.0225	0.0111	0.119	8.91
	Samples	#	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2
WINTER	**Load**	lbs.	30.6	9.82	8.60	-	169	28.7	6487	1864	5219	2160	3034	15661	4788	1.50	0.738	7.90	593
	Geomean	mg/L	0.305	0.169	0.161	-	1.477	0.843	30.0	44.0	36.0	18.3	17.8	140	42.5	0.0141	0.00550	0.0584	10.4
	Samples	#	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
SPRING	**Load**	lbs.	48.2	26.7	25.5	-	234	133	4748	6965	5699	2889	2810	22163	6734	2.23	0.871	9.25	1646
	Geomean	mg/L	0.308	0.0496	0.0298	0.0960	1.32	0.121	1.0	23.0	55.3	29.9	18.1	46.1	40.2	0.0200	0.0103	0.0591	4.64
	Samples	#	3	2	3	1	3	3	2	2	3	3	3	2	2	2	2	2	2
SUMMER	**Load**	lbs.	156	25.1	15.1	48.6	670	61.4	506	11633	27984	15112	9165	23337	20376	10.1	5.19	29.9	2347
	Geomean	mg/L	0.367	0.0495	0.0560	0.0816	2.40	0.258	1.0	16.0	98.7	42.0	56.3	32.5	10.0	0.0126	0.00310	0.0283	4.10
	Samples	#	4	1	4	4	3	4	1	1	4	4	4	1	1	1	1	1	1
FALL	**Load**	lbs.	156	21.0	23.7	34.6	1017	109	424	6783	41828	17795	23877	13777	4239	5.34	1.31	12.0	1738

Table 13. Seasonal pollutant geomeans and loads at Camden Inlet SW in 2023. Loads in pounds were calculated by multiplying the seasonal geomean with the seasonal flow (converted to liters) and a conversion factor. Note that this data should be viewed with discretion. Many of the loads were calculated using a low number of data points and likely do not accurately reflect the true seasonal loads.

	Parameter	Units	TP	TDP	SRP	OPO4	TN	NOx	Cl	Hard	TSS	VSS	ISS	TDS	COD	Cu	Pb	Zn	DOC
	Geomean	mg/L	0.234	0.110	0.0923	-	2.09	0.912	15.0	86.2	27.1	7.48	128	178	39.0	0.00682	0.00168	0.0268	7.21
	Samples	#	2	2	2	0	2	2	2	2	2	2	1	2	2	2	2	2	2
WINTER	Load	lbs.	7.10	3.33	2.80	-	63.5	27.7	455	2614	823	227	3884	5402	1184	0.207	0.0510	0.812	219
	Geomean	mg/L	0.231	0.0928	0.0747	-	2.31	0.282	4.55	122	27.8	14.3	18.5	183	39.9	0.0116	0.00090	0.0223	10.1
	Samples	#	6	5	5	0	6	6	5	5	6	6	5	5	5	5	5	5	5
SPRING	Load	lbs.	5.61	2.25	1.81	-	56.1	6.85	111	2959	675	346	449	4452	969	0.283	0.0218	0.541	245
	Geomean	mg/L	0.328	0.0892	0.0620	0.0607	1.98	0.203	1.44	51.3	62.3	28.2	158	93.3	61.0	0.0189	0.00184	0.0237	6.72
	Samples	#	4	3	4	2	4	4	3	3	4	4	3	3	3	3	3	3	3
SUMMER	Load	lbs.	7.27	1.98	1.37	1.35	43.9	4.50	32.0	1137	1380	624	3504	2068	1353	0.419	0.0407	0.525	149
	Geomean	mg/L	0.115	0.0712	0.0722	0.0628	1.59	0.676	2.65	83.5	8.75	6.18	19.2	124	14.3	0.0139	0.000715	0.0172	4.19
	Samples	#	5	5	5	5	5	5	5	5	5	5	3	5	5	5	5	5	5
FALL	Load	lbs.	1.79	1.10	1.12	0.975	24.6	10.5	41.1	1295	136	95.9	298	1927	223	0.216	0.0111	0.266	65.0

Table 14. Seasonal pollutant geomeans and loads at Camden Outlet in 2023. Loads in pounds were calculated by multiplying the seasonal geomean with the seasonal flow (converted to liters) and a conversion factor. Winter and spring loads could not be calculated due to the lack of corresponding samples from those seasons. Note that this data should be viewed with discretion. Many of the loads were calculated using a low number of data points and likely do not accurately reflect the true seasonal loads.

	Parameter	Units	TP	TDP	SRP	OPO4	TN	NOx	Cl	Hard	TSS	VSS	ISS	TDS	COD	Cu	Pb	Zn	DOC
	Geomean	mg/L	0.168	0.0277	0.00329	0.0598	2.82	0.0169	53.1	58.6	25.8	22.3	2.59	185	44.2	0.0155	0.000809	0.0178	9.71
	Samples	#	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
SUMMER	Load	lbs.	1.86	0.308	0.0366	0.665	31.4	0.188	591	651	287	248	28.8	2053	492	0.173	0.00899	0.198	108
	Geomean	mg/L	0.150	0.0190	0.0141	0.0100	1.86	0.169	20.4	64.8	17.6	15.6	1.58	119	21.7	0.0157	0.000483	0.0156	4.63
	Samples	#	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
FALL	Load	lbs.	9.54	1.21	0.899	0.638	119	10.8	1300	4129	1119	996	101	7572	1384	1.00	0.0307	1.00	295

DISCUSSION

Sampler Programming

Determining the appropriate sampler programming for each site proved to be challenging, as it did in 2022, though some improvements were made. The standard sampler setup for the MPRB is to trigger the sampler when the water level in the pipe reaches 1 inch and then take samples at regular intervals measured in cubic feet (cf). The sample pacing depends on the size of the pipe and the size of the watershed. Programming for each monitoring site was adjusted based on observations of hydrographs produced during storms in 2022 and 2023. The programming for Camden SW and Outlet was generally determined by the end of the 2022 monitoring season. Most rainfall events were sufficiently captured by the sampling spread across the event hydrograph, though larger events still outpaced both sites. High-intensity events tended to overwhelm the sampler, leading to a clustering of samples early on in the storm, after which the sampler would fill with water and be unable to collect samples from the tail end of the storm event.

Camden N NW and S NW proved to be more difficult sites, mainly due to backflow issues. Backflow, in this case, refers to the movement of water upstream from the pond into the storm sewer. This is caused in part by the low slopes of the pipes due to the fact that they are designed as extra storage for the pond under flood conditions. This creates a very difficult situation to monitor, as the back-and-forth movement of water in the pipe confuses the auto-samplers and prevents the collection of samples from the entire storm event. The samplers require a sustained period of positive (downstream) flow in order to stay triggered long enough to collect enough samples for a full chemical analysis. The dataloggers for both sites were programmed to only record positive flow, **Figure 11**, with the goal of cleaning up the flow data. This did not alleviate the sampler issues with backflow but did make the flow data more useable.

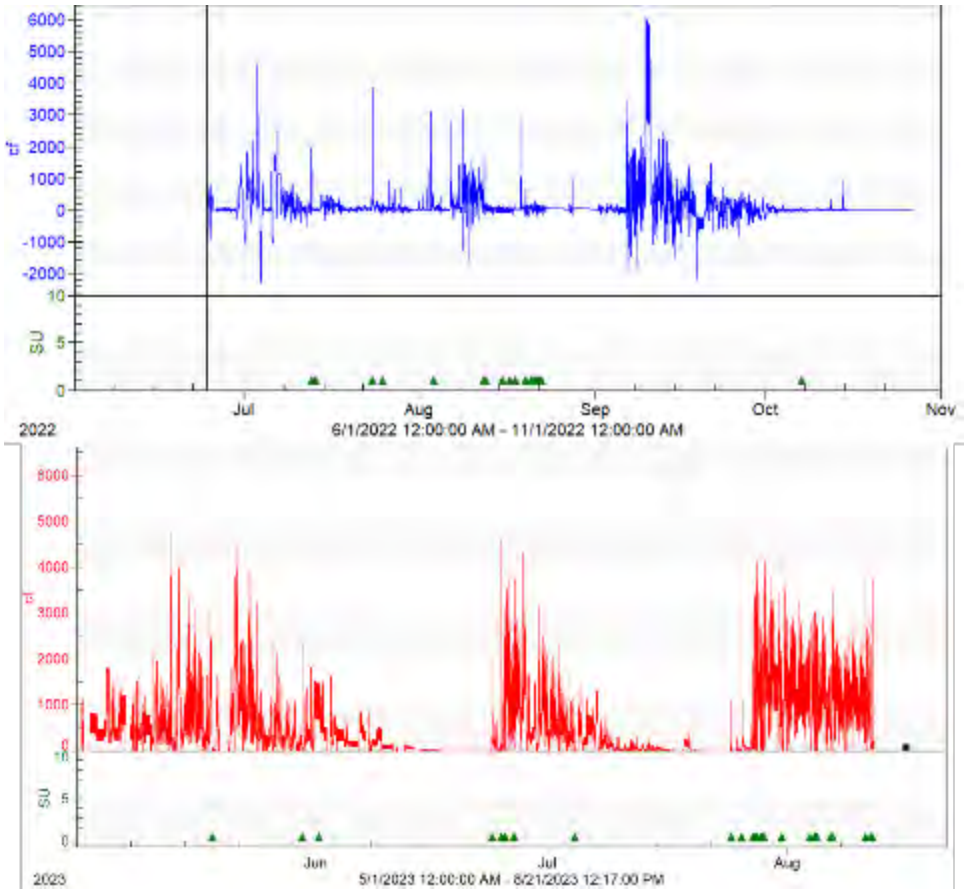


Figure 11. Two graphs comparing flow data in 2022 (blue) with flow data from 2023 (red) at Camden S NW. Note how there are no instances of negative flow in 2023 due to updated datalogger programming. The influence of backflow can still be seen in the areas of the graphs with rapid oscillations.

Pollutant Loading

Pollutant loads were calculated using two different modeling programs: P8 and Flux32. As described in the program manual, P8 is a model for "predicting the generation and transport of stormwater runoff in small urban catchments". Flux32, according to the manual, is an "interactive software designed for use in estimating the transport (load) of nutrients or other water quality constituents past a tributary sampling station over a given period of time." Average daily temperature and hourly rainfall data from the NWS were input into P8 to generate average daily runoff values for the entire year. Estimated runoff values from the non-monitored seasons, approximately January to April and November to December, were combined with the real flow data collected by MPRB monitoring equipment to estimate annual runoff volume. All P8 models were calibrated and verified by comparing estimated storm event data with data from the monitoring equipment. This data and measured stormwater chemistry data was input into Flux32 to calculate a load for each parameter at each site using several calculation techniques.

Six loads per chemical parameter were calculated at each site using different Flux32 regression methods and stratification schemes. The methods used were Method 2, a flow-weighted concentration ratio estimate, and Method 6, a regression applied to individual daily flows. First, two loads, one using each

method, were calculated without any stratification. Then, two loads were calculated using flow-based stratification by breaking the data into two or three strata depending on the number of chemical measurements for that parameter. Lastly, two loads were calculated by stratifying the data by season. Because Flux32 requires that each strata contain a minimum of three chemical measurements, winter and spring measurements often had to be combined into one group due to the lack of data. Out of the six calculated loads, the one with the lowest COV was selected for final reporting and further statistical analyses. When calculating loads, a COV under 0.30 was attempted but not always achieved due to limited data or the presence of outlying values.

Camden Inlet NNW and SNW both had significant issues that reduced the number of samples collected. Having a smaller dataset added more uncertainty to calculated loads and made it difficult to maintain a low COV. The NNW inlet only had five samples, all grabs, from the entire year. Because Flux32 requires three data points per strata, six data points are needed to create stratified models, which are usually more predictive than non-stratified models. All loads calculated for the NNW inlet were unstratified and had an average COV of 0.31 across all parameters. SRP, TN, Cl, Hard, TSS, ISS, TDS, COD, and Zn all had a COV greater than 0.30, and likely do not provide an accurate picture of the loading at that site. Similarly, Camden Inlet SNW had a limited sample set, with five grabs and five composites collected during the monitoring season. Most of the composite samples were of such a low volume that not all chemical analyses could be performed, further limiting the data. Stratified models were created for all parameters except OPO4, Cl, Hard, COD, Cu, Pb, Zn, and DOC. An average COV of 0.25 across all parameters was still achieved, though OPO4, Cl, TSS, ISS, Cu, and Pb each had a COV greater than 0.30.

The largest overall external load to Camden Pond appears to be coming from Camden Inlet SNW, which drains an area of 127.8 acres and receives an estimated annual stormwater volume of 22,701,494 cf. This watershed produced the largest overall load for all chemical parameters, which is consistent with results from 2022. When reframing the calculated loads as load per acre, Camden Inlet NNW had the largest load per area for Cl and TDS, while Camden Inlet SNW had the largest load per acre for all other parameters. Camden Inlet SW had much smaller loads for all parameters when compared to the other two inlets. This is consistent with the differences in land use type between inlets, with the SW sub watershed being mainly comprised of a cemetery with few impervious surfaces.

Many samples were collected at the pond outlet in 2023 allowing for a more accurate calculation of pollutant removal efficiency than in 2022. Most parameters had a removal rate greater than 70%, with the exception of Cl, Hard, TDS, and COD. While nutrients like phosphorus and nitrogen do not appear to be exiting the pond in large quantities, other harmful substances like chloride and dissolved solids are leaving the pond and potentially affecting downstream waterbodies. More years of study will provide a clearer picture of what pollutants are being exported by the pond and why.

Seasonal loads proved difficult to calculate using 2023 data. This was primarily due to the lack of sample data, particularly at Camden Inlet NNW and SNW, which resulted in calculations based on data from a small number of samples, introducing a large margin of error. Additionally, the chemical and flow inputs from Crystal Lake to Camden Inlet SNW were not quantified and thus could not be factored out of subsequent calculations. The large estimated loads for that site are in part due to the fact that the true watershed area would also include the entire watershed of Crystal Lake, in addition to the watershed that directly drains to the SNW pipe. Seasonal loads calculated for Camden Inlet SW and the Outlet were based off of more robust data and are thus more credible. In the next year of study, seasonal loads will be calculated using Flux32 rather than seasonal geometric means and flow-weighted event mean

concentrations. This will allow for greater tuning of generated models and more accurate load estimations.

Study Design

The primary intention of this study was to measure the efficiency of Camden Pond at removing nutrients from stormwater and preventing them from flowing downstream. This was done by measuring stormwater inputs (Camden Inlets N NW, S NW, and SW) and comparing results with measurements from the pond outlet (Camden Outlet). This is of particular interest to the City of Minneapolis since the pond was not built for nutrient removal but rather for flood control purposes. A secondary goal was to assess how much storage capacity the pond truly contained, compared to what was originally calculated by the designers/engineers.

In 2023, progress toward the primary goal of the study was limited by the lack of significant precipitation events, especially early in the monitoring season. The lack of significant and sustained rainfall events made it difficult to collect a robust set of samples from each site; however, during the early fall, the area was bombarded with several large/high-intensity storms which alleviated some of the missed data from earlier in the season. This influx of water also filled the pond enough to outlet, allowing for the collection of samples at that site. The pond outletted more than twenty times during the monitoring season, fourteen of which events were sampled.

Due to the number of outlet events, the secondary goal of calculating the true storage of the pond was able to be completed. Using information from engineering plans, the calculated permanent pool storage volume was determined to be 16.4 acre-feet. This value assumes that pond water reaches the outlet once water level reaches the elevation of the invert (bottom) of the outlet pipe structure. In reality, the pond water level must rise an additional four inches to reach the outlet pipe, due to rip rap obstructing the outlet, **Figure 12**. The rip rap has become overgrown with vegetation that has filled in the gaps between boulders and prevented water from moving through. Due to this blockage, the pond has an additional 1.21 acre-feet of water storage, bringing the permanent pool total up to 17.6 acre-feet.

Figure 12. A photo of Camden Outlet taken on 7/11/23. The outlet structure can be seen on the upper left. Note the rip rap and the vegetation growing between boulders. Some pond water can be seen in the lower right corner.

It should be noted that most of the outlet samples were not triggered by rain events but rather by the inflow of water from Crystal Lake. The MPRB learned in 2023 that Crystal Lake, located about one mile west in the City of Robbinsdale, has an automated outlet pump. When the lake level reaches a certain elevation, the pump activates and pumps lake water into a storm sewer that eventually outfalls into Camden Pond. The pipe that transmits the lake water leads to the Camden S NW monitoring site. In addition to backflow from the pond, that site is also receiving lake water in non-storm events. The samples that are collected at Camden S NW are not pure stormwater, but rather a mixture of storm, pond, and sometimes lake water. This makes it significantly more difficult to analyze water chemistry and make accurate models of flow and nutrient loading.

CONCLUSIONS

Load calculations were completed for each inflowing Camden Pond watershed and removal efficiencies were calculated for the pond outlet.

- Sample size was limited due to the regional drought, which made modeling parameters at Camden Inlet NNW and SNW difficult.
- The watershed draining to Camden Inlet SNW had the largest area, produced the largest raw pollutant loads across all parameters, and had the largest annual volume delivered to the pond.
- Removal efficiencies for most parameters were over 70% indicating the pond was effective at treating stormwater inputs.

The true storage capacity of Camden Pond was assessed in 2023.

- Camden Pond was designed to have 16.4 acre-feet of storage in the permanent pool.
- In reality, the pond actually has an additional 1.21 acre-feet of storage due to the presence of rip rap that prevents the pond from outletting until it reaches around 4 inches above the invert elevation of the outlet pipe.
- Total true permanent pool storage of the pond is around 17.6 acre-feet. This calculation does not include water storage provided by the two street inlet pipes (Cam N NW and S NW), which are designed to hold water for flood control purposes.

Sampler programming and site set-up provided several monitoring challenges in 2023.

- This was the second year the MPRB monitored Camden Pond using auto-samplers.
- Much of the monitoring season was spent troubleshooting equipment and experimenting with sampler programming. This prevented the full provisions of the NPDES permit from being met at all sites.
- The N NW monitoring site proved especially difficult to monitor due to issues with backflow. The MPRB has developed strategies to potentially mitigate this in the future.

NPDES Permit provisions for stormwater monitoring were met or were attempted in 2023.

- All monitoring for the NPDES permit as it applied to this project was attempted to be completed, see **Table 15**. This included continuous flow monitoring starting between May 1 and May 2 and ending on November 1, 2023.
- At least ten flow-weighted composite samples were collected and analyzed for NPDES chemistry at the SW and Outlet sites. Due to technical issues with equipment, the regional drought, and backflow, fewer than ten composite samples were collected at the N NW and S NW sites.
- Quarterly grab samples were collected and analyzed for NPDES chemistry, FOG, and *E.coli* at the three inlets. Grab sampling was not attempted at the pond outlet because rainfall events did not necessarily coincide with outlet events.

Table 15. Summary of stormwater sampling at Camden Pond in 2023. Camden Outlet was not attempted for grab sampling.

Site Name	Camden Inlet N NW	Camden Inlet S NW	Camden Inlet SW	Camden Outlet
# Of grab samples	5	5	5	-
# Of composite samples	0	5	12	14

The MPRB will continue to update the study design and site setup in future years of monitoring.

- Sampling during a year with normal levels of precipitation will allow more study goals to be met.
- The pond level probe will be placed at the lowest possible elevation to account for the low water level of the pond.
- Site sampler pacing will continue to be updated to best fit the generated hydrographs.
- The MPRB will use visual monitoring index at Camden Pond to assess the presence of blue-green algae blooms during the monitoring season.
- MPRB will further study outflow from Crystal Lake to better determine the influence on loading to Camden Pond.

Summary of NPDES Permit Requirements

Table 16. Checklist of every NPDES report requirement that pertains to stormwater monitoring efforts (Sections 30.26 and 30.27) and where the information is located.

Requirement	Location
Estimated pollutant event mean concentrations	Tables 4 to 6
Estimated total annual pollutant load to receiving water(s)	Table 8
Estimated total annual volume of receiving water(s)	Table 8
Estimated effectiveness (e.g., removal efficiency, load reduction, etc.) of structural stormwater BMPs	Table 8
Calibration and verification of stormwater models	Page 23
Continuous flow data	Figure 6 to 9
Sample analytical data identified as storm composite or grab with corresponding flows and storm event periods	Table A-1, A-2, A-4 to A-6, Table 3, 7
Estimate of storm event rainfall which generated the sampled discharge including the approximate duration between the storm event sampled and the end of the previous measurable storm event (greater than 0.10-inch rainfall)	Table 7
Loading calculations: estimated annual and seasonal loads (total phosphorus, chloride, total suspended solids, volatile suspended solids, inorganic suspended solids by difference (TSS - VSS = ISS), and total nitrogen for the continuous monitoring stations;	Tables 8, 9, Tables 11 to 14
Summary information for each site including drainage area and estimated annual total discharge volume, storm event discharge volume, and storm event discharge values that were used to calculate event-scale pollutant loads, runoff yield (inches/year), analyte flow weighted mean concentrations, and analyte annual mean concentrations;	Figure 10, Table 8, Table A-4 to A-6
A map showing receiving waters and representative land use management site locations as described in item 24.4. [Minn. R. 7090]	Figure 10

APPENDIX – CAMDEN POND COMPOSITE SAMPLING RESULTS

Table A-4. Camden Inlet S NW 2023 composite sample chemistry results. NS = Not Sampled. NES = Not Enough Sample.

Date Sampled	Time	Site	TP mg/L	TDP mg/L	SRP mg/L	OPO4 mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
6/25	12:18	Cam In S NW	0.364	NES	0.0889	NS	1.27	0.246	NES	NES	48.0	25.0	23.0	NES	NES	NES	NES	NES	NES
7/26	1:32	Cam In S NW	0.681	0.029	0.0040	NS	3.38	0.0390	<2.0	22	391	133	258	42.5	162	31.1	43.8	118	5.0
9/26	0:14	Cam In S NW	0.207	NES	0.0825	0.0327	NES	0.231	NES	NES	64.8	30.8	34.0	NES	NES	NES	NES	NES	NES
9/29	14:15	Cam In S NW	0.437	NES	0.186	0.0436	2.65	0.173	NES	NES	110	45.0	65.0	NES	NES	NES	NES	NES	NES
10/13	8:45	Cam In S NW	1.61	NES	0.0139	0.331	4.05	0.405	NES	NES	436	160	276	NES	NES	NES	NES	NES	NES

Table A-5. Camden Inlet SW 2023 composite sample chemistry results. NS = Not Sampled. NES = Not Enough Sample.

Date Sampled	Time	Site	TP mg/L	TDP mg/L	SRP mg/L	OPO4 mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
5/13	6:14	Cam In SW	0.288	NES	NES	NS	2.13	0.258	NES	NES	73.5	36	38.0	NES	NES	NES	NES	NES	NES
5/14	7:43	Cam In SW	0.136	0.0830	0.0670	NS	1.27	0.420	5.0	120	18.0	10	8.00	165	12.3	10.5	0.600	22.0	6.60
5/18	13:03	Cam In SW	0.593	0.0910	0.0580	NS	3.76	0.762	4.0	70	228	93.0	135	120	224	15.9	1.70	29.0	13.0
5/19	10:14	Cam In SW	0.0670	0.0540	0.0490	NS	1.40	0.284	11.5	308	2.30	<2.0	1.30	383	<20.0	7.60	<0.50	<20.0	4.50
5/30	7:49	Cam In SW	1.34	0.257	0.236	NS	5.84	<0.030	<2.0	48	286	128	158	97.5	367	31.9	9.10	86.1	53.4
6/24	23:47	Cam In SW	1.06	0.235	0.129	NS	4.29	0.0935	<2.0	48	412	116	296	92.5	259	30.9	11.8	58.3	18.3
7/24	17:31	Cam In SW	0.786	NES	0.0690	NS	4.31	0.188	NES	NES	429	139	290	NES	NES	NES	NES	NES	NES
8/14	2:58	Cam In SW	0.202	0.0474	0.0337	0.0706	1.41	0.225	<2.0	26	85.0	39.0	46.0	57.5	87.7	15.7	2.10	22.8	4.60
9/25	10:50	Cam In SW	0.242	0.112	0.102	0.138	1.64	0.418	<2.0	30	65.0	34.6	30.4	55.0	30.1	15.2	2.10	22.6	6.60
9/25	23:57	Cam In SW	0.104	0.0474	0.0515	0.0314	1.62	0.349	<2.0	30	24.4	12.4	12.0	57.5	<20.0	21.1	0.950	23.8	3.40
9/29	12:44	Cam In SW	0.155	0.0687	0.110	0.0696	1.86	0.673	<2.0	56	40.5	21.0	19.5	77.5	20.2	26.3	1.50	27.7	4.90
9/30	15:57	Cam In SW	0.0875	0.0830	0.0640	0.0604	1.50	1.10	10.0	248	1.60	<2.0	0.600	312	<20.0	8.50	<0.50	<20.0	4.20

Table A-6. Camden Outlet 2023 composite sample chemistry results.

Date Sampled	Time	Site	TP mg/L	TDP mg/L	SRP mg/L	OPO4 mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
7/26	11:13	Cam Out	0.211	0.0310	0.0040	0.0680	2.82	0.0310	95.0	74	36.0	29.0	7.00	267	60.7	13.0	1.10	23.0	12.0
7/27	4:13	Cam Out	0.182	0.0304	0.0044	0.0660	2.12	<0.030	87.5	67	31.0	22.0	9.00	245	49.0	7.90	0.960	25.6	9.50
8/13	1:45	Cam Out	0.154	0.0282	0.0027	0.0558	3.43	<0.030	48.0	56	24.0	23.0	1.00	180	48.2	20.5	0.860	23.4	10.2
8/14	0:46	Cam Out	0.166	0.0266	<0.030	0.0607	3.18	<0.030	46.0	54	24.0	22.0	2.00	175	47.1	19.3	0.720	23.1	10.1
8/15	9:15	Cam Out	0.162	0.0266	0.0037	0.0561	2.99	<0.030	35.0	56	22.0	19.0	3.00	142	36.8	15.5	0.670	<20.0	8.30
8/16	0:15	Cam Out	0.140	0.0240	0.0047	0.0538	2.59	<0.030	35.0	48	20.8	20.0	0.800	135	30.1	22.3	0.640	<20.0	8.60
9/25	14:20	Cam Out	0.199	0.0202	0.0607	<0.030	2.46	0.149	28.0	70	30.8	26.4	4.40	150	40.3	11.7	0.660	21.2	6.80
9/29	15:16	Cam Out	0.165	0.0136	0.0541	0.0034	2.09	0.150	18.0	50	24.0	18.0	6.00	108	27.2	13.9	1.20	20.4	5.10
10/1	13:15	Cam Out	0.131	0.0160	0.0449	0.0031	1.80	0.122	15.0	48	19.0	18.0	1.00	92.5	<20.0	11.2	0.780	<20.0	4.50
10/4	9:45	Cam Out	0.141	0.0150	0.0452	<0.030	1.69	0.0861	15.5	68	23.2	22.4	0.800	97.5	<20.0	28.2	0.600	20.3	4.80
10/6	10:45	Cam Out	0.158	0.0157	<0.030	0.0492	1.87	0.110	18.0	60	19.2	17.0	2.20	105	27.0	14.5	0.510	<20.0	4.30
10/11	10:00	Cam Out	0.164	0.0153	0.0030	0.0411	1.90	0.108	23.5	68	17.8	16.1	1.67	128	26.9	24.1	<0.50	20.0	4.20
10/13	7:01	Cam Out	0.152	0.0160	<0.030	0.0378	1.68	0.510	23.5	78	16.4	14.4	2.00	132	27.1	14.1	<0.50	<20.0	4.10
10/25	2:15	Cam Out	0.106	0.0656	0.0352	0.0568	1.57	0.472	26.0	86	5.0	4.75	0.250	155	23.1	14.6	<0.50	20.3	3.80

Powderhorn Lake Inlet Monitoring

BACKGROUND

The City of Minneapolis Public Works (MPW) and the Minneapolis Park and Recreation Board (MPRB) developed a major restoration plan for Powderhorn Lake in 1999. In 2001, five continuous deflective separation (CDS) grit chambers were installed to remove solids from stormwater inflow, shown spatially in **Figure 4**. Images of the four monitoring sites are shown in **Figure 1**. A drawing of a CDS unit is shown in **Figure 2**. The Powderhorn Lake watersheds are shown in **Figure 3**.

Despite this and other restoration work, the lake was listed as impaired and placed on the Minnesota Pollution Control Agency (MPCA) list of impaired waters (303(d)list) based on eutrophication and biological indicators in 2001. Powderhorn Lake later trended towards better water quality and met state standards for several years and was then removed from the 303(d) list in 2012. The lake did not meet standards for clarity or chlorophyll-*a* for the next seven years and was subsequently placed back on the list of impaired waters in 2018.

The purpose of monitoring the stormwater inlets into Powderhorn Lake was to:

1. Measure the pollutant load of the main tributaries to Powderhorn Lake. This information can be used to assist in any future external load reduction plans.
2. Troubleshoot the CDS unit functionality, since work done in 2020 discovered that the CDS units were not functioning as designed.
3. Comply with the National Pollutant Discharge Elimination System (NPDES) Permit provision to monitor stormwater best management practices (BMPs) for the purpose of adaptive management.

Current watershed monitoring work at Powderhorn began in 2019. In 2023, four of the largest Powderhorn Lake watershed inlets were auto-monitored downstream of the CDS units. Refer to the Water Resources Reports from 2019, 2021, and 2022, found at https://www.minneapolisparks.org/park-care-improvements/water_resources/, for more information on Powderhorn Lake inlet monitoring. Note that due to the COVID-19 pandemic, 2020 monitoring efforts were shifted to another project. The MPRB also studied CDS and sump units around Powderhorn Lake from 2002-2004 and neighborhood rain garden effectiveness in 2009 (MPRB, 2002, 2003, 2004, 2009 Water Resources Report).

Figure 1. Images of the four Powderhorn Lake stormwater monitoring sites.

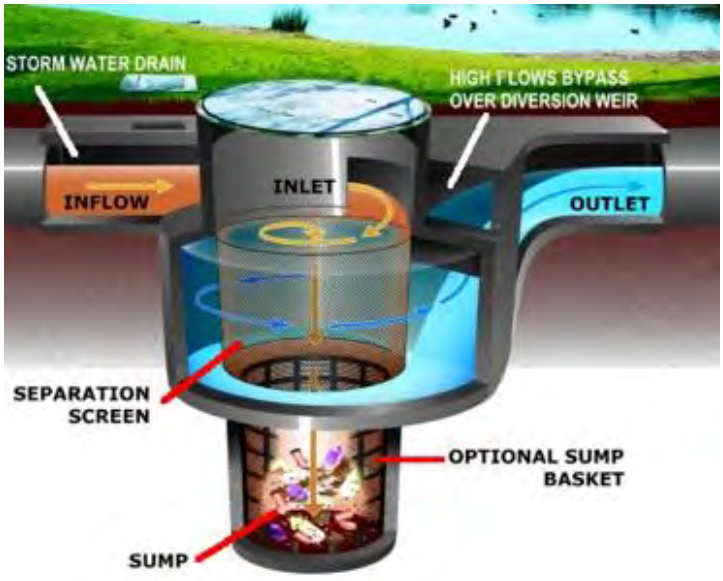


Figure 2. Cross section showing components of a CDS grit chamber unit. Image source: https://prismatech.com.my/products-ecoclean-cds.php.

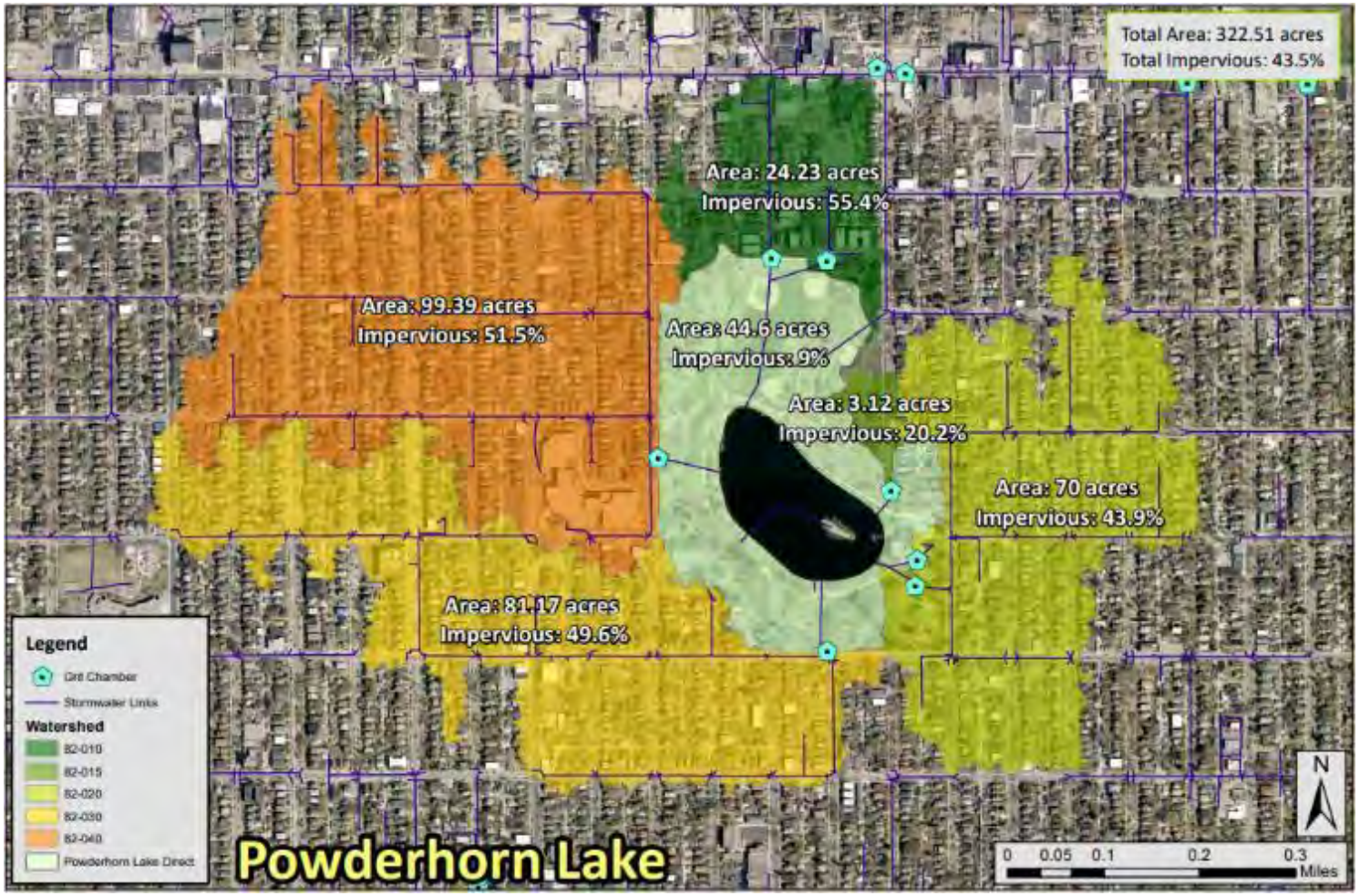


Figure 3. Powderhorn Lake watershed drainage areas are shown with sub-watershed sizes. All inlets have CDS units except the 3.12-acre area which has a sump catch basin. The dark green area in the north contains two CDS units – the MPRB monitors only the eastern one (GC 83), which receives runoff from 12.87 acres. Map provided by the Minneapolis Public Works department.

Figure 4. Map of CDS surrounding Powderhorn Park with Minneapolis Public Works ID numbers.

There are five CDS grit chambers and one sump structure installed in line with stormwater pipes leading to Powderhorn Lake. A sump is a pit that traps solids, typically in a catch basin. **Table 1** shows the Powderhorn CDS grit chambers with Minneapolis Public Works ID numbers, location, and drainage areas for each unit. CDS unit 82 was not monitored since it is adjacent to and has an almost identically sized watershed to CDS unit 83. Sump 85 was not monitored because it makes up only about 1% of the entire Powderhorn watershed, at 3.12 acres and 20.2% impervious surfaces, and likely does not contribute a significant nutrient loading to the lake.

Table 1. A list of the Best Management Practices (BMP's) surrounding Powderhorn Lake, their MPRB name, Minneapolis ID number, BMP type, drainage area, location, and pipe size.

MPRB Site Name	City Grit ID #	BMP Type	Drainage Area Acres	% Impervious Surfaces	Land Use	Runoff Inches/year	Location	Pipe Size Inches
N/A	82	CDS Hydrodynamic Separator	11.4	-	-	-	12th Ave S and Powderhorn Terrace	24
Powderhorn Inlet North	83	CDS Hydrodynamic Separator	12.9	55.4%	Single-family, right of way	13.8	13th Ave S and Powderhorn Terrace	21
Powderhorn Inlet Southeast	84	CDS Hydrodynamic Separator	68.8	43.9%	Single-family, right of way, park	8.88	3421 15th Ave S	36
N/A	85	Sump Manhole	3.10	-	-	-	3329 14th Ave S	15
Powderhorn Inlet South	86	CDS Hydrodynamic Separator	81.2	49.6%	Single family, right of way	8.14	13th Ave S and East 35th Street	30
Powderhorn Inlet West	87	CDS Hydrodynamic Separator	99.4	51.5%	Single family, right of way	8.26	3318 10th Ave S opposite of house #3318	36

METHODS

Site Installation

Monitoring equipment at each of the sites included: ISCO 2150 datalogger, 2105ci LTE combined interface module/modem, low-profile AV probe, and a 3700 ISCO sampler complete with intake tubing and intake strainer. Area velocity (AV) probes and intake strainers were oriented to point upstream, **Figure 5**. The equipment at Powderhorn Inlet North was hung from eyebolts below grade in the manhole, while the other three sites had above-grade monitoring boxes with access holes for tubing and cables drilled through the manhole collars. Cables and tubing were anchored with zip-ties to the sidewall eyebolts or side-iron manhole ladders. Monitoring boxes were rectangular 4 ft x 3 ft x 3 ft locking wooden boxes that protected and housed both the sampler and datalogger equipment. Cable ports were packed with steel wool to deter rodents from entering the monitoring equipment storage boxes.

The dataloggers used cell phone modems to remotely upload data to the MPRB ISCO database server from Monday through Friday. A cell phone antenna was installed at each site to allow communication with the datalogger. The data logger could also be remotely accessed to turn the samplers on/off, adjust the level, pacing, and triggers, or download data.

Sites were installed in late April/early May and began taking samples during a storm event on May 8, 2023. Due to the failure of the manhole structure, equipment at Powderhorn Inlet N was removed from

June 30 to July 17 so the City of Minneapolis could make repairs. All four sites were uninstalled on November 2, 2023.

Figure 5. Photo of the AV probe and intake strainer at Powderhorn Inlet W in April of 2023. The equipment is attached to a stainless-steel plate that is bolted into the pipe. The blue arrow indicates the direction of water flow.

Sample Collection

All samplers were multiplexed and flow-paced, and equipped with 24 one-liter bottles, 3/8 inch inner-diameter vinyl tubing, and an intake strainer. They collected four samples per 1-L bottle, and each sampler contained 24 1-L bottles. This allowed a maximum of 96 samples to be collected over a storm event and create a flow-weighted composite. The MPRB defines a storm event as having more than 0.10 inches of precipitation and being separated from other precipitation events by at least eight hours. The dataloggers were programmed to pulse the samplers after a 1-inch trigger and after a set volume or pacing had passed. The pacing depended on the size of the pipe and typical volume received at the site. In 2023, all monitoring was done downstream of the CDS units to measure nutrient loading to the lake. The samplers collected material less than 3/8 inches in size that bypassed over the internal weir or passed through the CDS chamber screen in addition to flow through the CDS unit. Solid materials greater than 3/8 inches were not sampled, such as leaf litter, cigarette butts, plastic bags, and other debris due to the size of the holes in the intake strainer.

In previous years, the S, SE, and W Inlets had significant bypass flows at the internal CDS overflow weirs. It is believed that in some events bypass was caused by the CDS screens becoming clogged rather than due to flows being higher than the design capacity. When bypass due to clogging occurs, water backs up the upstream pipes past the CDS unit, and sand and solids settle in the upstream pipe. During confined space entries, staff observed large quantities of sediment upstream of the CDS units, especially at

Powderhorn SE. CDS unit bypass and events when solids settled upstream likely occurred several times during the 2023 monitoring season, which had multiple high-volume/high-intensity rainfall events.

Monitoring Parameters and Methods

A list of the chemical parameters required by the 2018- 2023 NPDES permit for analysis of auto-monitored composite stormwater samples is shown in **Table 2**. NPDES permit-required chemistry methods, reporting limits, and holding times for auto-monitored composite samples used in this project are also shown in this table.

Table 2. Chemistry parameters required for auto-monitored stormwater samples by the NPDES permit. Analysis method, reporting limit, and holding times for parameters analyzed by Instrumental Research, Inc. and Pace Analytical.

Parameter	Abbreviation	Units	Method	Reporting Limit	Holding Time
Chemical Oxygen Demand	COD	mg/L	SM 5220-D	20 mg/L	28 days
Chloride, Total	Cl	mg/L	SM 4500-Cl^- B	2.0 mg/L	28 days
Copper, Total	Cu	µg/L	EPA 200.8	1 µg/L	6 months
Dissolved Organic Carbon	DOC	mg/L	SM 5310-C-00	1.5 mg/L	28 days
Hardness, as CaCO3	Hard	mg/L	SM 2350 C	5.0 mg/L	6 months
Lead, Total	Pb	µg/L	EPA 200.8	0.10 µg/L	6 months
Nitrate/Nitrite, Total as N	NOx	mg/L	SM 4500-NO_3 E	0.030 mg/L	28 days
Orthophosphate	OPO4	mg/L	SM 4500-PE	0.003 mg/L	48 hours
Phosphorus, Total	TP	mg/L	SM 4500-PE	0.010 mg/L	48 hours
Phosphorus, Total Dissolved	TDP	mg/L	SM 4500-PE	0.010 mg/L	48 hours
Solids, Total Dissolved	TDS	mg/L	SM 2540 C	5.0 mg/L	7 days
Solids, Inorganic Suspended	ISS	mg/L	TSS-VSS	5.0 mg/L	7 days
Solids, Total Suspended	TSS	mg/L	SM 2540 D	1.0 mg/L	7 days
Solids, Volatile Suspended	VSS	mg/L	EPA 160.4	2.0 mg/L	7 days
Total Nitrogen	TN	mg/L	Alkaline Persulfate Oxidation	0.500 mg/L	28 days
Zinc, Total	Zn	µg/L	EPA 200.7	20 µg/L	6 months

Quality Assurance Practices

A variety of quality assurance quality control (QAQC) measures were taken to ensure defensible data. Ten percent of the samples were laboratory quality assurance samples e.g., duplicates, spikes. A field blank was also generated for each sampling trip and was analyzed for all NPDES chemical parameters. Field blanks consisted of deionized water which accompanied samples from the field sites to the analytical laboratory. All field blank parameters measured below the reporting limits in 2023. As part of the department QAQC program, blind monthly performance samples of known concentration were analyzed by IRI. If any parameter failed to meet the acceptable recovery range, all the data for that parameter would be flagged for the entire month. No parameters were flagged in 2023.

Field measurements were recorded on a field sheet in the 2023 Stormwater Monitoring Field Manual. Electronic data from the laboratory were forwarded to the MPRB in preformatted Excel spreadsheets via email. Electronic data from the laboratory were checked and passed laboratory quality assurance procedures. Protocols for data validity followed those defined in the Stormwater Monitoring Program

Manual (MPRB, 2001). For data reported as below the reporting limit, the numerical value was divided by two for statistical calculation purposes.
Manual transcription of data was minimized to reduce error introduction. A minimum of 10% of the final data were checked by hand against the raw data sent by the laboratory to ensure there were no errors entering, manipulating, or transferring the data.

A Chain of Custody form accompanied each set of sample bottles delivered to the lab. Each sample container was labeled indicating the date and time of collection, site location, and field personnel initials. Samples were transported to the laboratory on ice in a cooler. The time that each grab sample was collected was recorded onto field sheets. A complete description of methods can be found in the Stormwater Monitoring Program Manual (MPRB, 2001). Common statistics were calculated using Microsoft Excel.

RESULTS

Sample Collection

In 2023, stormwater grab and composite samples were collected during storms ranging from 0.06 to 2.36 inches of precipitation. The NPDES permit requires the collection of two snowmelt grabs, one rainfall grab from the spring, summer, and fall quarters, and ten composite samples from each monitored site. Due to the regional drought, samples from storms with less than 0.10 inches of precipitation were sometimes included in the data. **Figure 6** shows a sampling tray containing composite samples. **Figure 7** shows staff collecting grab samples at Powderhorn Inlet S. Snowmelt grab samples were collected from two snowmelt events at Powderhorn Inlets S and W. Only one snowmelt grab could be collected from Powderhorn Inlet SE due to thick ice coverage over the access manhole. Note that Powderhorn Inlet N is not used for grab sampling due to accessibility issues. **Table 3** shows the snowmelt grab samples collected. **Table 4** shows the rainfall grab samples collected. Precipitation was measured by a rain gauge at MPRB's Southside Operations Center located at 3800 Bryant Ave. S. in Minneapolis, MN.

The 2023 summary statistics for the composite samples collected at Powderhorn Inlets N, S, SE, and W can be seen in **Table 5** through **Table 8**. Full composite chemistry data can be found as flow-weighted means in **Tables A-7 to A-10** in the **Appendix.** If parameters resulted in values below the limit of detection, half of the reporting limit value was used for statistical calculations. The statistics calculated for each site were the geometric mean (GEOMEAN), arithmetic mean, maximum (MAX), minimum (MIN), standard deviation (STDEV), number of samples, and coefficient of variation (COV). If a sample was not analyzed and no data are presented it is marked NS for no sample, usually due to low volume. Storm event data and congruent flow data are found in **Table 9**.

Figure 6. Photo of ISCO 3700 autosampler base with flow-weighted composite samples inside.

Table 3. The 2023 snowmelt grab events staff sampled or attempted to sample at three Powderhorn Inlets. X = quarterly grab sample. NS = No Sample. Note that the events on 2/14 and 3/31 were a mixture of rainfall and snowmelt.

Date	Powderhorn In S	Powderhorn In SE	Powderhorn In W
2/14/23	X	NS	NS
3/31/23	X	X	X
4/3/23	NS	NS	X

Table 4. The 2023 rainfall grab events sampled or attempted to be sampled at three Powderhorn Inlets. X = quarterly grab samples. NS = No Sample.

Start Date	Start Time	End Date	End Time	Rain inches	Duration hours	Intensity in/hour	Hours since last rain	Pow In S	Pow In SE	Pow In W
4/19/23	5:15	**4/19/23**	7:15	0.28	2.0	0.140	57	X	X	X
7/26/23	0:00	**7/26/23**	8:45	1.27	8.75	0.145	107	X	NS	X
8/13/23	15:45	**8/14/23**	13:15	1.60	21.5	0.074	47	NS	X	NS
9/23/23	16:30	**9/26/23**	1:30	2.34	57.0	0.041	153	NS	NS	X
9/29/23	3:45	**9/29/23**	10:15	1.18	6.5	0.182	60	X	X	X

Figure 7. MPRB Water Quality staff collecting a grab sample at Powderhorn Inlet S on 9/29/23.

Composite Sample Chemistry

Table 5. Powderhorn Inlet N 2023 composite sample chemistry summary statistics.

	TP mg/L	TDP mg/L	SRP mg/L	OPO4 mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
MEAN (geometric)	0.431	0.136	0.0740	0.0823	2.65	0.118	4.67	28.8	79.5	40.8	36.7	85.3	90.5	31.5	11.6	99.7	22.0
MEAN (arithmetic)	0.566	0.197	0.0961	0.105	3.20	0.260	8.59	32.9	105	51.5	53.3	105	136	35.8	15.4	116	36.8
MAX	1.76	0.780	0.275	0.191	8.50	0.570	28.0	82.0	322	139	183	329	413	92.5	53.3	280	127
MIN	0.140	0.0562	0.0153	0.0172	0.872	0.0150	1.0	16.0	16.0	11.0	5.00	40.0	15.4	14.7	2.40	48.5	6.0
MEDIAN	0.387	0.0920	0.0814	0.0907	2.76	0.277	6.0	26.0	77.0	41.2	42.2	67.5	77.6	30.9	13.8	92.4	24.7
STDEV	0.481	0.213	0.0702	0.0672	2.10	0.220	8.85	19.9	81.1	35.7	46.9	85.3	132	21.4	13.7	73.4	39.7
NUMBER	14	11	13	6	14	14	11	11	14	14	14	11	11	11	11	11	11
COV	0.850	1.09	0.731	0.637	0.655	0.849	1.03	0.604	0.774	0.693	0.879	0.810	0.973	0.598	0.891	0.634	1.08

Table 6. Powderhorn Inlet S 2023 composite sample chemistry summary statistics.

	TP mg/L	TDP mg/L	SRP mg/L	OPO4 mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
MEAN (geometric)	0.893	0.268	0.374	0.0789	3.34	0.0344	4.99	68.0	55.5	33.8	26.3	164	111	22.4	8.63	85.7	36.4
MEAN (arithmetic)	1.46	0.789	0.854	0.302	4.65	0.0925	8.62	75.0	133	65.2	75.8	190	170	22.6	14.3	101	53.2
MAX	3.84	2.40	2.35	0.969	13.7	0.381	23.0	124	657	224	433	352	324	28.3	31.7	168	124
MIN	0.112	0.0387	0.0123	0.0050	0.915	0.0150	1.0	38.0	12.0	8.00	6.00	80.0	24.1	19.6	2.60	44.4	11.1
MEDIAN	1.42	0.236	0.900	0.117	3.33	0.0150	5.25	69.0	43.0	26.2	16.0	165	165	21.3	11.4	96.8	38.9
STDEV	1.23	1.02	0.783	0.452	3.94	0.143	9.81	37.8	203	78.6	138	119	143	3.91	13.9	63.3	50.5
NUMBER	10	5	9	4	10	10	4	4	10	10	9	4	4	4	4	4	4
COV	0.838	1.30	0.917	1.50	0.847	1.54	1.14	0.504	1.52	1.21	1.83	0.627	0.842	0.173	0.976	0.623	0.950

Table 7. Powderhorn Inlet SE 2023 composite sample chemistry summary statistics.

	TP mg/L	TDP mg/L	SRP mg/L	OPO4 mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
MEAN (geometric)	0.448	0.083	0.031	0.0818	2.53	0.102	2.25	27.5	123	61.4	60.0	76.8	124	28.7	17.9	97.6	17.4
MEAN (arithmetic)	0.664	0.135	0.088	0.0934	3.02	0.226	3.43	31.0	179	90.8	88.0	91.7	186	30.9	23.3	117	28.1
MAX	4.03	1.02	0.84	0.141	10.9	0.562	14.5	72.0	916	538	378	300	787	75.9	68.2	377	140
MIN	0.187	0.030	0.004	0.0202	1.19	0.0150	1.00	14.0	33.0	19.5	13.5	45.0	32.9	18.1	5.60	45.1	6.50
MEDIAN	0.341	0.069	0.041	0.101	2.27	0.237	1.75	24.0	105	50.9	56.9	64.4	97.6	28.1	18.4	91.8	12.8
STDEV	0.887	0.227	0.192	0.0390	2.29	0.193	3.57	16.9	205	118	89.3	68.6	195	14.2	18.2	85.7	37.0
NUMBER	18	18	18	7	18	18	18	18	18	18	18	18	18	18	18	18	15
COV	1.34	1.68	2.19	0.417	0.759	0.855	1.04	0.545	1.15	1.30	1.02	0.748	1.05	0.459	0.782	0.732	1.32

Table 8. Powderhorn Inlet W 2023 composite sample chemistry summary statistics.

	TP mg/L	TDP mg/L	SRP mg/L	OPO4 mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
MEAN (geometric)	0.538	0.0680	0.0257	0.0803	2.97	0.0701	2.84	33.8	122	61.9	58.5	79.8	126	33.6	28.7	108	17.3
MEAN (arithmetic)	0.779	0.0857	0.0527	0.101	3.66	0.165	5.20	37.4	192	90.9	101	91.7	178	36.7	45.0	138	22.8
MAX	2.40	0.257	0.171	0.199	9.81	0.523	26.2	88.0	694	302	392	217	442	74.3	144	351	67.4
MIN	0.187	0.0290	0.0030	0.0202	1.42	0.0150	1.0	20.0	29.0	17.0	12.0	37.5	38.6	16.1	6.30	43.2	5.20
MEDIAN	0.411	0.0534	0.0338	0.109	2.46	0.0837	2.75	34.0	97.7	49.3	52.7	72.5	108	32.5	23.5	84.9	13.3
STDEV	0.738	0.0664	0.0577	0.0641	2.70	0.185	6.91	19.1	199	87.9	112	52.6	153	16.6	44.2	107	18.7
NUMBER	14	13	13	7	14	14	14	13	14	14	14	13	13	13	13	13	13
COV	0.948	0.775	1.09	0.637	0.739	1.12	1.33	0.511	1.03	0.966	1.11	0.574	0.857	0.452	0.981	0.778	0.818

Stormwater Hydrographs

The hydrographs for level and flow measured from May through November at the Powderhorn Inlets N, SE, S, and W are presented in **Figures 8** through **Figures 11**.

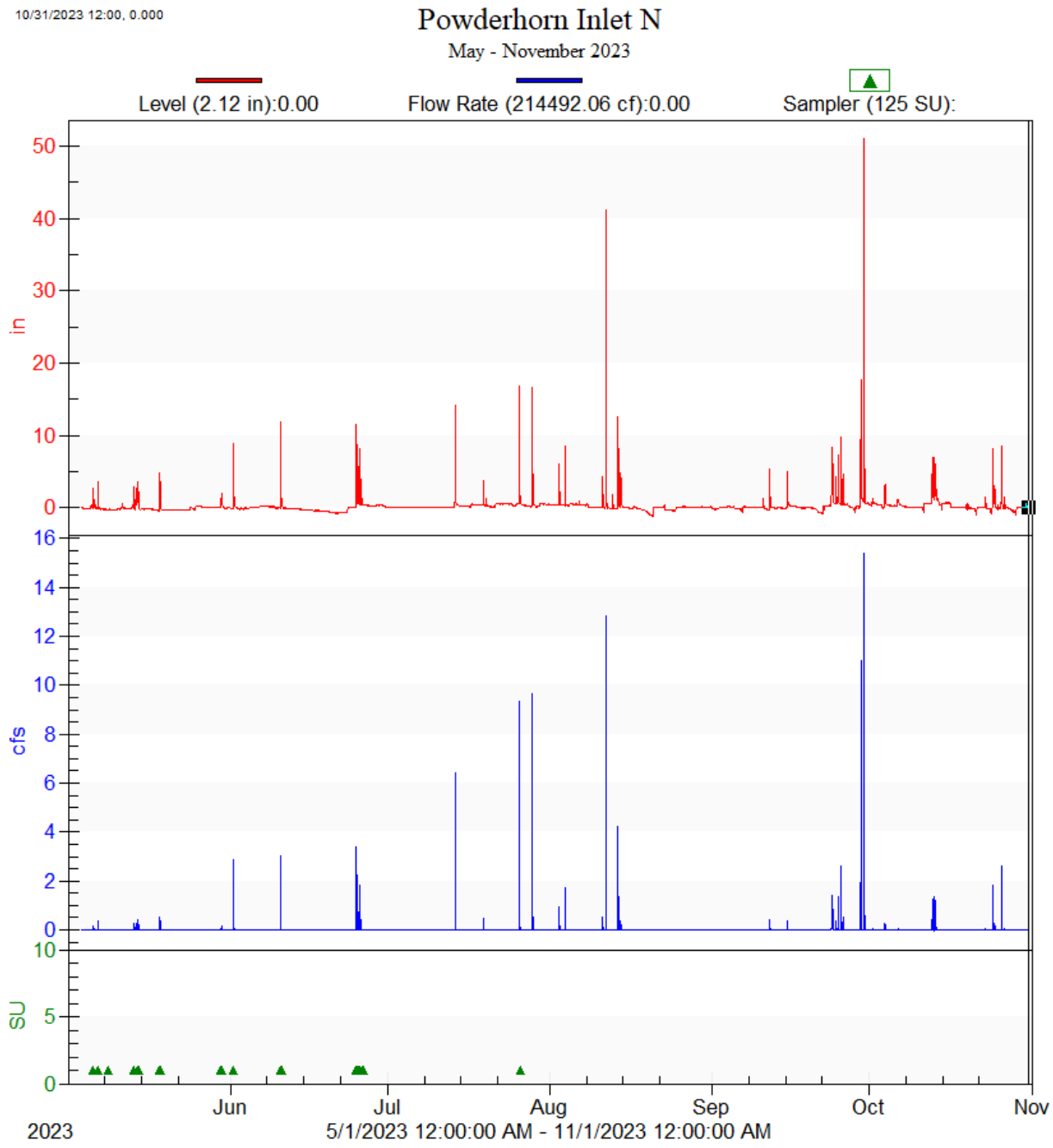


Figure 8. Powderhorn Inlet N hydrograph of level and flow rate from May 3 to November 1, 2023. Green triangles represent when the auto-sampler attempted to take a sample.

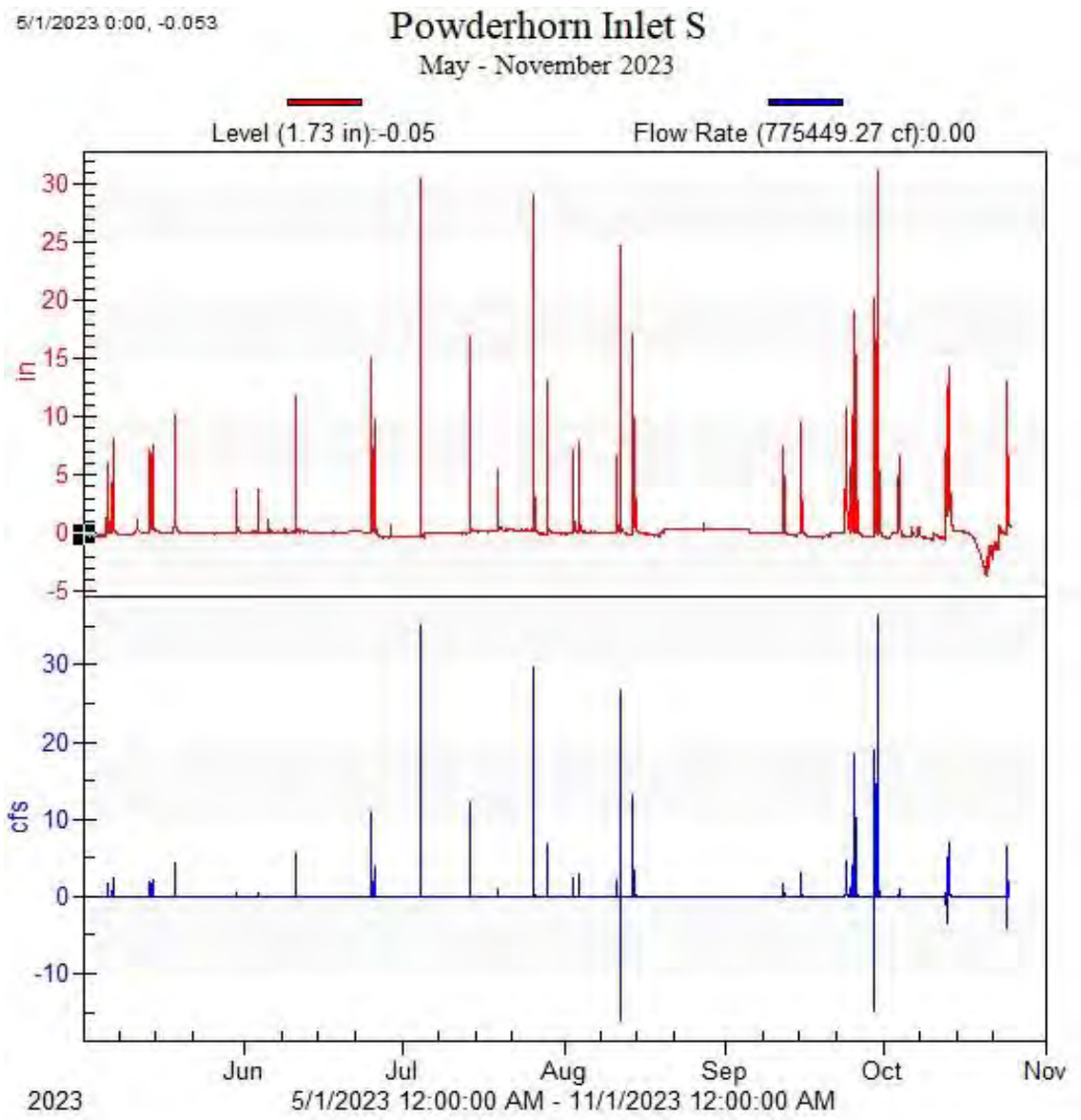


Figure 9. Powderhorn Inlet S hydrograph of level and flow from May 1 to November 1, 2023. Due to software issues, sampler data was not able to be graphed.

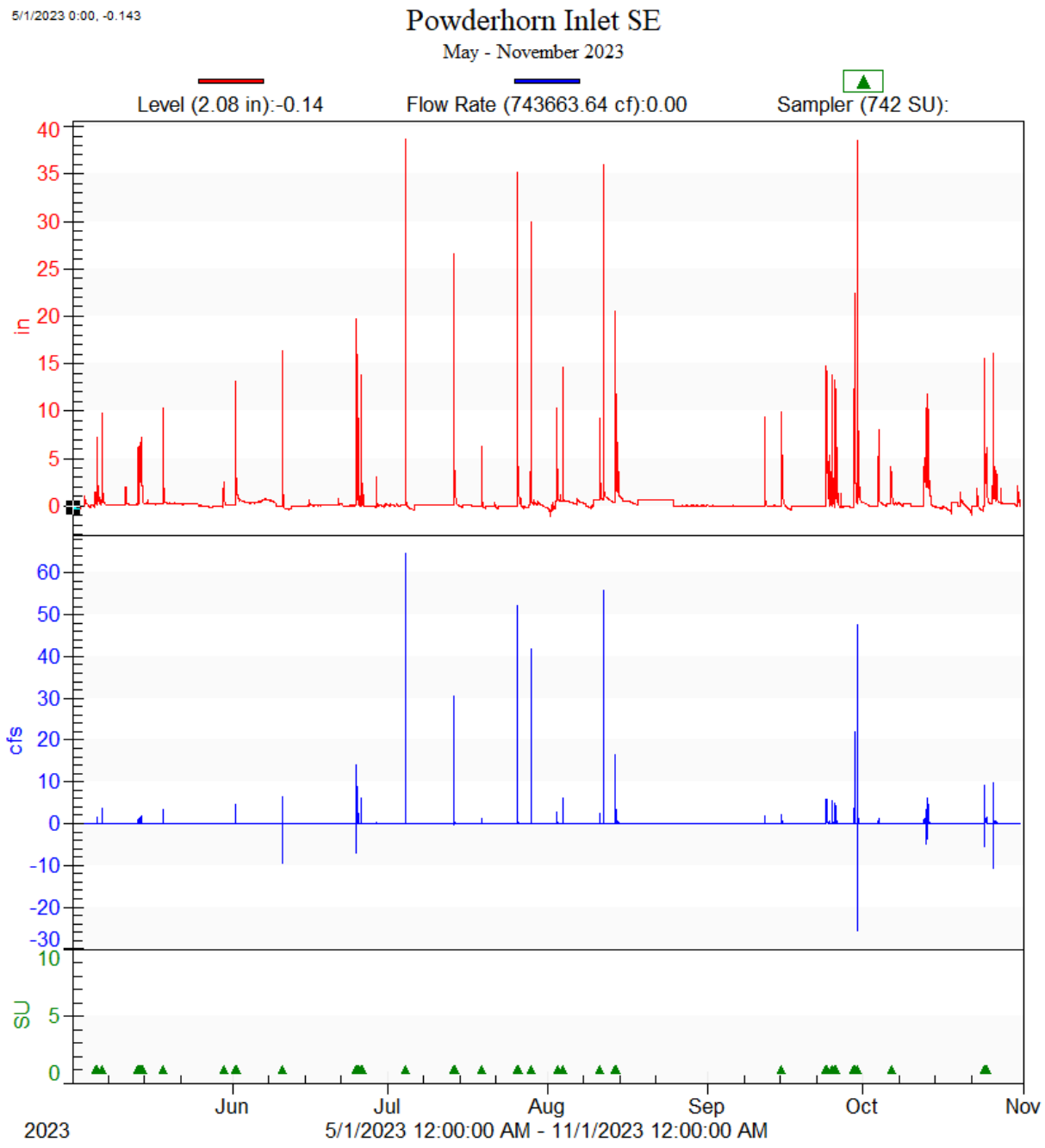


Figure 10. Powderhorn Inlet SE hydrograph of level and flow rate from May 1 to November 1, 2023. Green triangles represent when the auto-sampler attempted to take a sample.

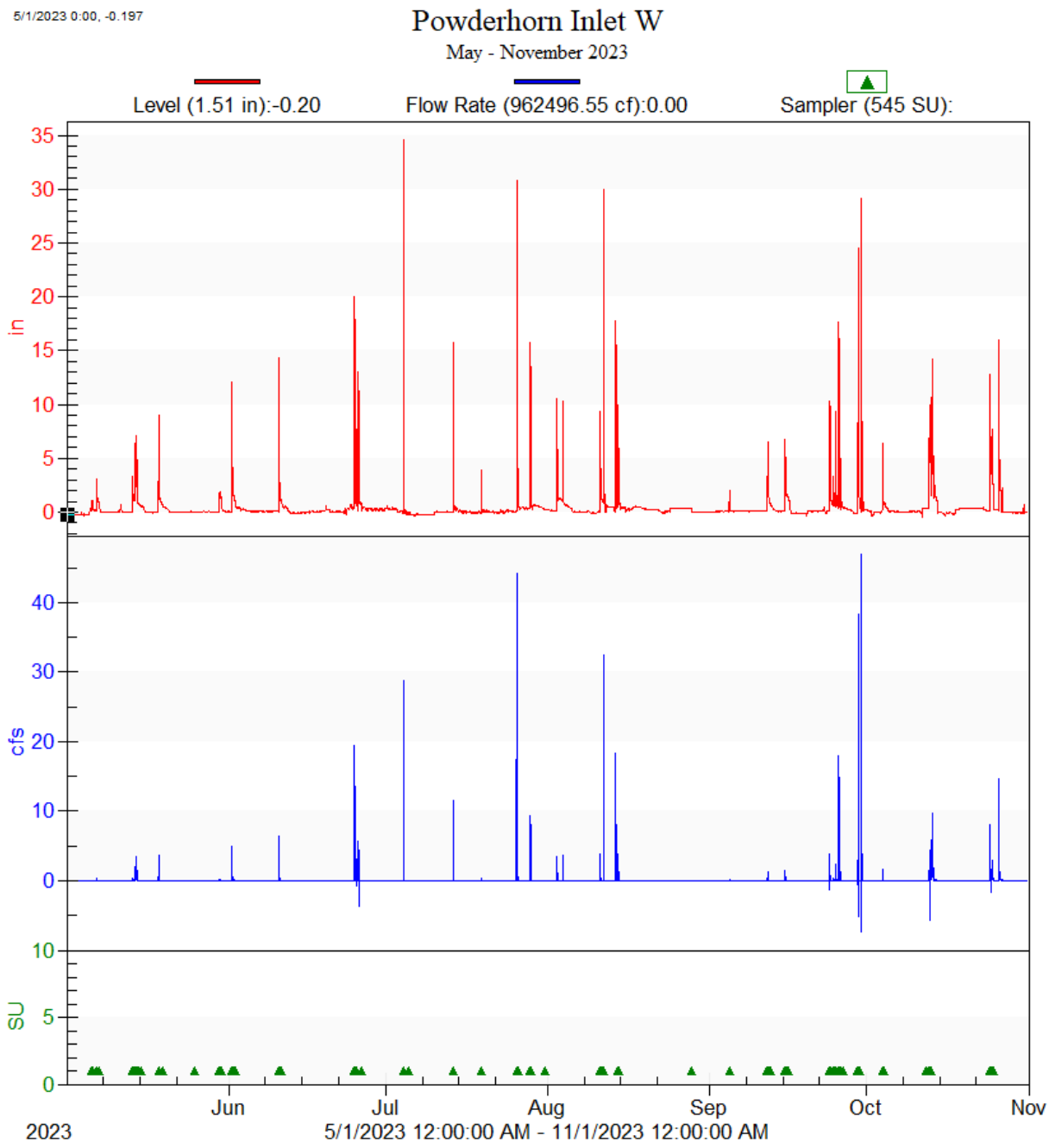


Figure 11. Powderhorn Inlet W hydrograph of level and flow from May 1 to November 1, 2023. Green triangles represent when the auto-sampler attempted to take a sample.

Table 9. 2023 composite sampling storm events and corresponding flow data measured at each monitoring site. NS = no sample. Note that flow data on 6/10 for Pow In SE was disrupted due to equipment issues. Precipitation data was measured at the MPRB Southside Operations Center (SSOC). Flow data was estimated using the hydrographs generated by the auto-samplers, see Figures 8 to 11. "Seasonal Total" refers to the totals from the duration of the auto-monitoring season, roughly May 1 – November 1.

Event Date	Duration hours	Precip. inches	Hours Since Last Rain	Pow In N cf	Pow In S cf	Pow In SE cf	Pow In W cf
5/5	7.50	0.09	191	NS	NS	5,051	NS
5/6	0.25	0.07	23	NS	NS	7,066	NS
5/13	21.25	0.71	54	2,748	NS	7,277	NS
5/14	21.25	0.71	54	12,337	NS	25,921	40,596
5/18	2.25	0.18	97	2,608	NS	NS	NS
5/30	2.25	0.22	279	NS	NS	NS	3,449
6/10	1.25	0.27	226	10,854	12,398	5,709*	12,867
6/25	21.25	1.44	343	15,624	56,102	55,481	87,320
7/4	0.50	0.90	196	NS	50,712	61,283	39,506
7/13	5.50	0.33	226	NS	NS	16,860	12,918
7/26	8.75	1.27	107	NS	NS	118,885	61,846
8/3	1.50	0.34	121	9,953	5,939	22,696	NS
8/11	5.0	1.21	96	46,005	58,420	97,169	63,886
8/14	21.5	1.60	46	24,398	NS	70,530	NS
9/11	1.0	0.22	624	2,075	925	NS	NS
9/15	4.0	0.32	48	1,935	7,430	NS	NS
9/23	57.0	2.34	182	7,404	NS	NS	NS
9/24	57.0	2.34	182	NS	18,593	35,082	6,295
9/25	57.0	2.34	182	11,149	NS	42,370	48,072
9/26	57.0	2.34	182	NS	1,413	NS	3,616
9/29	6.50	1.18	60	21,528	112,221	58,694	81,178
Total Sampled	167.25	12.7	-	168,618	324,153	624,365	461,549
Seasonal Total	485.25	18.9	-	312,853	774,176	927,532	957,423

Load calculations for each chemical parameter at each site are shown in **Table 10** and **Table 11**. Loads were calculated in pounds for each site by using the P8 and Flux32 modeling programs in combination with measured flow and chemistry data. See the Discussion section for more details on modeling techniques. Seasonal flows at each site are shown in **Table 12**. Seasonal loads for each chemical parameter at each site are shown in **Table 13 to 16**.

It should be noted that while these load inputs are from measured data, the flow-weighted samples were only collected from May through the end of October, and the snowmelt samples were grab samples. The flow-weighted sample measurement period had approximately 17.6 inches of precipitation, while the yearly total was 29.7 inches. In 2023, Minneapolis's annual precipitation was 1.9 inches lower than the 29-year annual average of 31.6 inches (NWS/NOAA).

Table 10. The 2023 annual flow totals and load calculations for Powderhorn Inlets N, S, SE, and W. Values in red indicate the largest load for each parameter.

	Units	Pow In N	Pow In S	Pow In SE	Pow In W
Annual Flow	cf	643347	2399052	2257458	2978607
TP	Lbs.	12.6	135	55.8	50.3
TDP	Lbs.	3.94	29.4	18.1	19.4
SRP	Lbs.	2.56	28.0	15.0	18.7
OPO4	Lbs.	2.67	3.30	16.9	24.6
TN	Lbs.	82.8	475	287	436
NOx	Lbs.	11.9	67.4	65.2	109
Cl	Lbs.	135	3366	554	2142
Hard	Lbs.	726	6933	3196	4904
TSS	Lbs.	2517	32409	10966	12864
VSS	Lbs.	1294	13397	5103	5969
ISS	Lbs.	1427	17652	5864	6896
TDS	Lbs.	2488	19527	12695	12574
COD	Lbs.	2678	24873	13829	11563
Cu	Lbs.	0.938	4.28	4.42	4.97
Pb	Lbs.	0.412	3.56	2.92	3.94
Zn	Lbs.	2.76	29.7	9.44	19.2
DOC	Lbs.	616	3354	1785	1834

Table 11. The 2023 load per area calculations for Powderhorn Inlets N, S, SE, and W. Values in red indicate the largest load per area for each parameter.

Parameter	Units	Pow In N	Pow In S	Pow In SE	Pow In W
Area	acres	12.9	81.2	70.0	99.4
TP	Lbs./acre	0.979	1.66	0.797	0.507
TDP	Lbs./acre	0.306	0.362	0.259	0.195
SRP	Lbs./acre	0.199	0.345	0.214	0.188
OPO4	Lbs./acre	0.207	0.0407	0.242	0.248
TN	Lbs./acre	6.44	5.85	4.10	4.39
NOx	Lbs./acre	0.921	0.830	0.932	1.10
Cl	Lbs./acre	10.5	41.5	7.92	21.6
Hard	Lbs./acre	56.4	85.4	45.7	49.3
TSS	Lbs./acre	196	399	157	129
VSS	Lbs./acre	101	165	72.9	60.1
ISS	Lbs./acre	111	217	83.8	69.4
TDS	Lbs./acre	193	241	181	127
COD	Lbs./acre	208	306	198	116
Cu	Lbs./acre	0.0729	0.0527	0.0631	0.0500
Pb	Lbs./acre	0.0320	0.0438	0.0417	0.0396
Zn	Lbs./acre	0.215	0.366	0.135	0.194
DOC	Lbs./acre	47.8	41.3	25.5	18.5

Table 12. Seasonal flow data in cf at each Powderhorn site in 2023. Note that November and December were not included in the flow analysis due to a lack of corresponding sample data. Winter flows were estimated using P8. Spring flows were a combination of P8 estimations and real flow measurements. Summer and fall flows were from real flow measurements.

Season	Months	Pow In N cf	Pow In S cf	Pow In SE cf	Pow In W cf
Winter	Jan, Feb, Mar	128371	553908	443309	693866
Spring	Apr, May	221929	1138614	953430	1396524
Summer	Jun, Jul, Aug	163309	356758	514252	415046
Fall	Sep, Oct	129737	349771	346466	473206

Table 13. Seasonal pollutant geomeans and loads at Powderhorn Inlet N in 2023. Loads in pounds were calculated by multiplying the seasonal geomean with seasonal flow (converted to liters) and a conversion factor.

	Parameter	Units	TP	TDP	SRP	OPO4	TN	NOx	Cl	Hard	TSS	VSS	ISS	TDS	COD	Cu	Pb	Zn	DOC
	Geomean	mg/L	0.421	0.078	0.0663	-	2.28	0.372	3	30	86.7	42.8	43.6	50	15.4	0.0147	0.0024	0.0485	6.3
	Samples	#	3	1	2	0	3	3	1	1	3	3	3	1	1	1	1	1	1
SPRING	**Load**	lbs.	5.83	1.08	0.919	-	31.6	5.16	41.6	416	1201	593	604	693	213	0.204	0.0333	0.672	87.3
	Geomean	mg/L	0.378	0.133	0.0545	0.109	2.22	0.0811	4.26	22.7	70.9	35.7	33.7	73.1	98.8	0.0289	0.0146	0.0956	23.3
	Samples	#	6	5	6	3	6	6	5	5	6	6	6	5	5	5	5	5	5
SUMMER	**Load**	lbs.	3.86	1.36	0.555	1.11	22.6	0.827	43.4	231	723	364	344	745	1007	0.294	0.149	0.974	238
	Geomean	mg/L	0.512	0.155	0.112	0.0623	3.6	0.0926	5.59	36.2	86.6	46.7	36.6	111	118	0.04	0.0127	0.12	26.7
	Samples	#	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4
FALL	**Load**	lbs.	4.15	1.25	0.905	0.505	29.1	0.75	45.3	293	701	378	296	896	959	0.324	0.103	0.974	216

Table 14. Seasonal pollutant geomeans and loads at Powderhorn Inlet S in 2023. Loads in pounds were calculated by multiplying the seasonal geomean with seasonal flow (converted to liters) and a conversion factor.

	Parameter	Units	TP	TDP	SRP	OPO4	TN	NOx	Cl	Hard	TSS	VSS	ISS	TDS	COD	Cu	Pb	Zn	DOC
	Geomean	mg/L	0.579	0.147	0.126	-	2.61	0.477	152	31.0	130	58.7	71.0	390	133	0.0251	0.0248	0.195	10.5
	Samples	#	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2
WINTER	**Load**	lbs.	20.0	5.08	4.36	-	90.3	16.5	5266	1071	4483	2028	2455	13498	4595	0.869	0.858	6.74	363
	Geomean	mg/L	0.408	0.123	0.118	-	1.72	0.343	4.50	18.0	97.3	44.0	53.3	50.0	102	0.0	0.0	0	8.30
	Samples	#	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
SPRING	**Load**	lbs.	29.0	8.73	8.42	-	122	24.4	320	1279	6919	3128	3791	3554	7222	1.66	1.74	7.89	590
	Geomean	mg/L	1.19	0.677	0.501	0.969	3.83	0.0279	10.7	75.9	86.4	48.2	35.6	206	189	0.0210	0.0149	0.0622	54.6
	Samples	#	6	3	6	1	6	6	3	3	6	6	6	3	3	3	3	3	3
SUMMER	**Load**	lbs.	26.5	15.1	11.2	21.6	85.2	0.622	239	1691	1925	1073	792	4599	4209	0.467	0.331	1.38	1216
	Geomean	mg/L	0.404	0.0500	0.167	0.0429	2.50	0.134	1.46	30.1	37.8	21.6	20.6	67.7	44.3	0.0168	0.00753	0.0542	10.6
	Samples	#	7	4	7	5	7	7	4	4	7	7	6	4	4	4	4	4	4
FALL	**Load**	lbs.	8.82	1.09	3.65	0.937	54.5	2.93	31.8	657	826	471	450	1478	967	0.367	0.164	1.18	231

Table 15. Seasonal pollutant geomeans and loads at Powderhorn Inlet SE in 2023. Loads in pounds were calculated by multiplying the seasonal geomean with seasonal flow (converted to liters) and a conversion factor.

	Parameter	Units	TP	TDP	SRP	OPO4	TN	NOx	Cl	Hard	TSS	VSS	ISS	TDS	COD	Cu	Pb	Zn	DOC
	Geomean	mg/L	0.347	0.149	0.137	-	3.04	0.574	28.0	20.0	59.0	26.0	33.0	105	82.7	0.0177	0.0197	0.115	9.50
	Samples	#	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
WINTER	**Load**	lbs.	9.60	4.12	3.79	-	84.1	15.9	775	553	1633	719	913	2905	2288	0.490	0.545	3.18	263
	Geomean	mg/L	0.444	0.0782	0.0223	-	2.29	0.387	6.25	35.5	109	53.2	55.2	81.0	131	0.0359	0.0166	0.104	15.2
	Samples	#	5	5	5	0	5	5	5	5	5	5	5	5	5	5	5	5	4
SPRING	**Load**	lbs.	26.4	4.65	1.33	-	136	23.0	372	2116	6502	3168	3286	4821	7807	2.14	0.985	6.18	905
	Geomean	mg/L	0.514	0.102	0.0329	0.111	2.20	0.0287	2.06	26.6	114	63.2	66.6	84.6	124	0.0273	0.0170	0.0938	23.0
	Samples	#	10	10	10	4	10	10	10	10	10	10	9	10	10	10	10	10	10
SUMMER	**Load**	lbs.	16.5	3.27	1.06	3.56	70.7	0.923	66.1	853	3646	2028	2137	2717	3969	0.876	0.545	3.01	740
	Geomean	mg/L	0.238	0.0642	0.0641	0.0747	2.02	0.335	1.20	18.5	71.5	34.4	36.8	50.3	61.6	0.0227	0.0133	0.0679	8.40
	Samples	#	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
FALL	**Load**	lbs.	5.15	1.39	1.39	1.62	43.7	7.24	26.0	401	1546	745	797	1088	1332	0.492	0.288	1.47	182

Table 16. Seasonal pollutant geomeans and loads at Powderhorn Inlet W in 2023. Loads in pounds were calculated by multiplying the seasonal geomean with seasonal flow (converted to liters) and a conversion factor.

	Parameter	Units	TP	TDP	SRP	OPO4	TN	NOx	Cl	Hard	TSS	VSS	ISS	TDS	COD	Cu	Pb	Zn	DOC
	Geomean	mg/L	0.298	0.156	0.149	-	2.71	0.467	14.0	16.0	43.3	20.0	23.3	65.0	35.0	0.0144	0.0158	0.0740	7.20
	Samples	#	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
WINTER	**Load**	lbs.	12.9	6.76	6.45	-	117	20.2	606	693	1876	866	1009	2816	1516	0.624	0.684	3.21	312
	Geomean	mg/L	0.402	0.0735	0.0467	-	2.04	0.129	4.53	22.4	45.2	23.1	21.3	62.6	28.2	0.0153	0.0100	0.0620	7.47
	Samples	#	4	3	3	0	4	4	4	3	4	4	4	3	3	3	3	3	3
SPRING	**Load**	lbs.	35.0	6.41	4.07	-	178	11.2	395	1954	3940	2013	1857	5455	2462	1.34	0.871	5.41	651
	Geomean	mg/L	0.733	0.0821	0.0158	0.173	3.57	0.0229	3.16	35.8	188	98.7	81.4	102	199	0.0367	0.0397	0.145	26.7
	Samples	#	7	7	7	2	7	7	7	7	7	7	7	7	7	7	7	7	7
SUMMER	**Load**	lbs.	19.0	2.13	0.411	4.48	92.4	0.594	81.9	927	4882	2558	2109	2645	5155	0.952	1.03	3.75	691
	Geomean	mg/L	0.247	0.0510	0.0448	0.0686	1.83	0.244	1.76	27.2	59.5	28.4	30.5	56.9	61.6	0.0270	0.0154	0.0659	9.64
	Samples	#	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
FALL	**Load**	lbs.	7.29	1.51	1.32	2.03	54.1	7.22	52.1	803	1756	840	900	1680	1820	0.796	0.455	1.95	285

DISCUSSION

Pollutant Loading

Pollutant loads were calculated using two different modeling programs: P8 and Flux32. As described in the program manual, P8 is a model for "predicting the generation and transport of stormwater runoff in small urban catchments". Flux32, according to the manual, is an "interactive software designed for use in estimating the transport (load) of nutrients or other water quality constituents past a tributary sampling station over a given period of time." Average daily temperature and hourly rainfall data from the NWS were input into P8 to generate average daily runoff values for the entire year. Estimated runoff values from the non-monitored seasons, approximately January to April and November to December, were combined with the real flow data collected by MPRB monitoring equipment to estimate annual runoff volume. All P8 models were calibrated and verified by comparing estimated storm event data with data from the monitoring equipment. This data and measured stormwater chemistry data was input into Flux32 to calculate a load for each parameter at each site using several calculation techniques.

Six loads per chemical parameter were calculated at each site using different Flux32 regression methods and stratification schemes. The methods used were Method 2, a flow-weighted concentration ratio estimate, and Method 6, a regression applied to individual daily flows. First, two loads, one using each method, were calculated without any stratification. Then, two loads were calculated using flow-based stratification by breaking the data into two or three strata depending on the number of chemical measurements for that parameter. Lastly, two loads were calculated by stratifying the data by season. Because Flux32 requires that each strata contain a minimum of three chemical measurements, winter and spring measurements often had to be combined into one group due to the lack of data. Out of the six calculated loads, the one with the lowest COV was selected for final reporting and further statistical analyses. When calculating loads, a COV under 0.30 was attempted but not always achieved due to limited data or the presence of outlying values.

The largest overall external load to Powderhorn Lake appears to be coming from Powderhorn Inlet S, which drains an area of 81.17 acres and receives an estimated annual stormwater volume of 2,399,052 cf. This watershed produced the largest overall load for the following chemical parameters:

- TP
- TDP
- SRP
- TN
- Cl
- Hardness
- TSS
- VSS
- ISS
- TDS
- COD
- Zn
- DOC

When reframing the calculated loads as load per acre, Powderhorn Inlet N had the largest load for TN, Cu, and DOC. Powderhorn Inlet W had the largest load for OPO4 and NOx, while Powderhorn Inlet S had the highest loads for all other parameters. Powderhorn Inlet SE did not register the highest loads for any parameter, though the loads for OPO4, NOx, and Pb were comparable to the largest estimated load. Certain parameters had consistent seasonal loading trends across sites. Chloride loading was typically highest in the winter, which is consistent with the use of road salt during that time. Phosphorus, nitrogen, COD, and DOC loads were highest in the summer and fall, potentially due to the amounts of organic material contributed by lawn clippings and leaf litter during those seasons. Suspended solids were not as consistent between sites. Powderhorn N had the highest loads during spring, Powderhorn

W had the highest loads during fall, and Powderhorn S and SE had their highest loads during summer. Loading of metals was consistently highest in the summer across all sites.

Powderhorn Inlets S and W should be a high priority in reducing external loading to Powderhorn Lake. It is unclear why these mostly residential watersheds would be producing such a large external nutrient load, but the effects of this nutrient loading on Powderhorn Lake are apparent. Blue-green algae dominates the phytoplankton community in the lake, resulting in frequent appearances of algal scum, **Figure 12**. Cyanotoxins were detected in 2022 and 2023, with microcystin concentrations exceeding the MPCA guidelines (≥6 µg/L) in late July of 2022 resulting in the disruption of recreation activities on the lake. MPRB Environmental Education Powderhorn Lake canoe programming was restricted to just June and July of 2023 rather than the whole summer because the largest blooms mainly occur in the late summer/early fall and can potentially be toxic to humans and animals

Figure 12. A photo of blue-green algae scum on the west shore of Powderhorn Lake on 9/8/23.

Monitoring Challenges

The 2023 stormwater monitoring season posed several challenges. As in 2021 and 2022, 2023 was plagued by persistent drought conditions. These conditions were present during all months except April and May and peaked in the late summer and early fall (USDM 2023). The drought made it difficult to capture a robust set of samples during the monitoring season and limited the number of chemical parameters that could be analyzed. Rainfall events seemed to either be small, short-lived spurts, or torrential downpours. Both scenarios were not ideal for monitoring; transient storms didn't generate enough flow to trigger the samplers, and intense storms often overwhelmed or damaged monitoring equipment.

When stormwater flows through a pipe it is often carrying debris such as leaves, sticks, and trash from the street. The larger objects can sometimes become wrapped around the intake tubing which is suspended in the flow during high intensity events, eventually becoming so heavy that it rips the intake tubing from the strainer on the anchor plate. Due to the intensity of the rainstorms during the late summer and fall, this scenario occurred at least once at every Powderhorn site, resulting in missed samples and data, see **Figure 12**. Additional samples were sometimes missed as MPRB staff worked to diagnose the issue and perform confined space entries to reattach the equipment.

Figure 12. Photos of a disconnected intake tube and debris build up at each Powderhorn site in 2023.

CDS Unit Functionality

The CDS units around Powderhorn Lake have been clogging, leading to sediment deposition in the upstream pipes and within the units themselves. When the units clog, the internal sump becomes anoxic and solids break down into smaller-sized or dissolved material via anaerobic digestion, releasing nutrients and heavy metals. These materials then exit through the CDS screens during the next storm event. A clogged CDS unit provides minimal treatment since water will bypass the unit entirely when it cannot exit through the screen, sending trash and other debris into Powderhorn Lake, as pictured in **Figure 13**. The MPRB and City of Minneapolis have observed that the external side of the CDS screens can become clogged, but there are no access ports to easily clean them.

Figure 13. A photo of trash in Powderhorn Lake was taken on 7/25/23. Scum from a blue-green algae bloom can also be seen in this image.

The CDS units were installed in 2002, when the MPRB performed a three-year CDS efficiency study at Powderhorn Inlet North (GC 83) where composite sampling equipment was installed above and below the CDS unit (MPRB, 2002 Annual Water Resources Report). A level probe was also installed on the CDS diversion weir to measure when stormwater bypassed the unit. The study ultimately found that the CDS unit had a minimal impact on water quality downstream, with an average of 3% reduction of incoming pollutants if no bypass occurred. If bypass did occur, on average the unit exported about 3% more pollutants than it received. CDS bypass occurred during a wide variety of storm sizes, not just the large ones, indicating that it was likely clogged at certain times. During the course of the study, the unit was cleaned 2 to 4 times per year, and bypass would cease for a period of time after each cleaning before recurring once the unit became clogged again.

The functionality of the Powderhorn CDS units was not the primary focus of work performed in 2023; however, some comparisons could still be made using data from composite and grab samples collected from the same storm event. At Powderhorn Inlets S and W, the grab sampling location from the access manhole is upstream of the CDS unit while the composite sampling location is downstream of the CDS and diversion weir. Between 2021 and 2023, eight paired samples were collected from the two sites and compared. Note that grab samples represent a single moment in

time, usually towards the middle or end of the storm event, while composite samples represent a flow-weighted average of the entire event. These types of samples are not directly comparable but can still give a very rough idea of CDS functionality. Note also that there was no area velocity probe installed on the CDS diversion weir to indicate when bypass occurred.

The analysis focused on four parameters: TP, TN, TSS, and COD. These parameters were selected for their significance to stormwater quality research, with TP and TN representing nutrient loading, TSS representing floatable solids and suspended sediment, and COD as an indicator of anaerobic digestion within the CDS. Overall, all parameters had higher values downstream of the CDS than upstream. This difference was especially pronounced for TSS, which had an average downstream increase of 192%. TP increased by 51%, TN increased by 60%, and COD increased by 63%, on average, indicating that anaerobic digestion is likely occurring within the CDS.

On 9/29/23, MPRB staff collected a pair of grab samples upstream and downstream of the Powderhorn Inlet S CDS unit to better assess its functionality. The results were mostly consistent with the grab/composite comparison, though less extreme. TSS increased by 43%, TP increased by 18%, TN increased by 3%, and COD increased by 16%. Still, these results corroborate that the CDS units were likely clogged and thus unable to perform their core function of removing suspended solids from incoming stormwater. The Powderhorn Inlet S unit was later cleaned in October of 2023, with 16 cubic yards of material being removed. The Powderhorn Inlet W unit had 8 cubic yards removed around the same time. Both CDS units have a designed capacity of just 5.6 cubic yards. For reference, one cubic yard is about the size of a standard washing machine.

To reduce the external load to Powderhorn Lake, the CDS units should be retrofit to allow for more thorough cleaning and maintenance of the exterior side of the separation screen. Currently, the units are cleaned around once per year, which does not appear to be frequent enough to prevent clogging related bypass from occurring. When looking at cleaning data from 2019 to 2023, time between CDS cleanings ranged from 246 to 1,007 days, with an average period of 504 days between cleanings. When the unit is clean, it is able to successfully remove large floating solids from stormwater but over time it becomes clogged, leading to system bypass even during events that do not exceed the designed flow capacity. The exterior part of the separation screen is not accessible for cleaning and would require retrofitting to properly maintain. Powderhorn Lake has frequent harmful algae blooms, an excess of trash, and is listed as impaired on the MPCA 303(d) list. More frequent cleaning of the CDS units would allow the capture of more floating and suspended solids from inflowing stormwater, which is the predominant water quality benefit they can provide as they are currently designed.

CONCLUSIONS

Pollutant loads to Powderhorn Lake were calculated using data collected during the monitoring season.

- Load calculations were completed for each monitored subwatershed to Powderhorn Lake and key contributors were identified as the S and W subwatersheds. This information can be used to assist in any future external load reduction plans.
- Powderhorn Inlets S subwatershed had the largest load per acre and the largest load based on total flow. The site had much higher levels of phosphorus compared to the other subwatersheds.

CDS unit functionality was assessed and findings were consistent with previous years of the study.

- Units are effective at filtering stormwater until their external screens clog, allowing stormwater to bypass the units during storm events that do not exceed the designed flow capacity.
- Units should be retrofitted to have maintenance access ports for cleaning of the external screens or replaced with a different design that does not have issues with clogging.
- CDS units require more frequent cleaning and maintenance to increase their benefit to water quality in Powderhorn Lake.

Monitoring challenges mainly included equipment failures from natural causes and a limiting amount of precipitation.

- The Twin Cities area was in a moderate to severe drought for most of the monitoring season, limiting the number of stormwater samples collected.
- Multiple sites had equipment failures that required a confined space entry to fix. These issues mainly stemmed from the number of high-intensity rainstorms during the summer and fall.

Most NPDES permit provisions for stormwater monitoring were met in 2023.

- All monitoring for the NPDES permit as it applied to this project was attempted to be completed, see **Table 17**. Flow monitoring was completed starting between April 27 and May 3 and ending on November 2.
- Ten or more flow-weighted composite samples were collected and analyzed for NPDES chemistry for Inlets N, S, SE, and W. For some samples at Powderhorn Inlet N, S, and W, only a few NPDES parameters could be analyzed due to limited sample volume.
- Quarterly grab samples were taken and analyzed for NPDES chemistry, FOG, and *E. coli* at all sites except Powderhorn Inlet N. Only one snowmelt grab sample was collected at Powderhorn Inlet SE due to accessibility issues.

Table 17. Summary of stormwater sampling at Powderhorn Lake in 2023.

Site Name	Powderhorn Inlet N	Powderhorn Inlet S	Powderhorn Inlet SE	Powderhorn Inlet W
# Of grab samples	-	5	4	6
# Of composite samples	14	10	17	14

Summary of NPDES Permit Requirements

Table 18. Checklist of every NPDES report requirement that pertains to stormwater monitoring efforts (Sections 30.26 and 30.27) and where the information is located. N/A = not applicable. Note that because the focus of this study was not BMP effectiveness, Requirement 4 was not applicable to 2023 efforts.

	Requirement	Location
1	Estimated pollutant event mean concentrations	Table 5 to Table 8
2	Estimated total annual pollutant load to receiving water(s)	Table 10
3	Estimated total annual volume to receiving water(s)	Table 10
4	Estimated effectiveness (e.g., removal efficiency, load reduction, etc.) of structural stormwater BMPs	N/A
5	Calibration and verification of stormwater models	Page 22
6	Continuous flow data	Figure 8 to 11
7	Sample analytical data identified as storm composite or grab with corresponding flows and storm event periods	Table 4, 9, Table A-1, A-2, A-7 to A-10
8	Estimate of storm event rainfall which generated the sampled discharge including approximate duration between the storm event sampled and the end of the previous measurable storm event (greater than 0.10-inch rainfall)	Table 9
9	Loading calculations: estimated annual and seasonal loads (total phosphorus, chloride, total suspended solids, volatile suspended solids, inorganic suspended solids by difference (TSS - VSS = ISS), and total nitrogen for the continuous monitoring stations;	Table 10, 11, Table 13 to 16
10	Summary information for each site including drainage area and estimated annual total discharge volume, storm event discharge volume, storm event discharge values that were used to calculate event-scale pollutant loads, runoff yield (inches/year), analyte flow weighted mean concentrations and analyte annual mean concentrations;	Table 1, 9 Table A-7 to A-10
11	A map showing receiving waters and representative land use management site locations as described in item 24.4. [Minn. R. 7090]	Figure 3

Table A-7. Powderhorn Inlet North 2023 composite sample chemistry results. NS = Not Sampled. NES = Not Enough Sample.

Date Sampled	Time	Site	TP mg/L	TDP mg/L	SRP mg/L	OrthoP Mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
5/13	13:51	Pow In N	0.560	NES	NES	NS	2.58	0.258	NES	NES	142	64.0	78.0	NES	NES	NES	NES	NES	NES
5/14	10:41	Pow In N	0.163	0.0780	0.0500	NES	0.975	0.356	3.0	30	22.5	12.5	10.0	50.0	15.4	14.7	2.40	48.5	6.30
5/18	14:10	Pow In N	0.817	NES	0.0880	NES	4.70	0.561	NES	NES	204	98.0	106	NES	NES	NES	NES	NES	NES
6/10	17:49	Pow In N	1.45	0.310	0.156	NES	6.06	<0.030	2.0	40	322	139	183	110	345	41.8	53.3	224	34.1
6/25	3:45	Pow In N	0.367	0.132	0.100	NES	2.05	0.295	<2.0	18	63.0	28.0	35.0	55.0	78.4	25.6	9.10	64.0	9.10
8/3	23:12	Pow In N	0.289	0.0810	0.0377	NES	2.29	0.502	6.5	20	74.4	34.0	40.4	67.5	69.0	30.9	13.8	93.0	93.0
8/11	3:26	Pow In N	0.407	0.225	0.124	0.191	3.30	0.570	18.0	26	41.0	25.0	16.0	97.5	65.0	29.1	6.30	83.2	24.7
8/14	10:47	Pow In N	0.335	0.0562	0.0235	0.103	1.44	<0.030	6.0	16	128	57.0	71.0	52.5	77.6	20.9	15.6	71.9	9.70
8/14	15:10	Pow In N	0.140	NES	0.0153	0.0657	0.872	<0.030	NES	NES	16.0	11.0	5.00	NES	NES	NES	NES	NES	NES
9/12	0:18	Pow In N	1.76	0.780	0.275	NES	8.50	0.305	28.0	82	138	78.0	60.0	329	413	92.5	21.0	280	127
9/15	9:40	Pow In N	0.627	0.274	0.0814	NES	4.16	<0.030	13.0	52	62.0	48.0	14.0	188	222	39.9	7.70	119	52.6
9/23	23:04	Pow In N	0.498	0.0920	0.0757	0.178	2.97	<0.030	15.0	38	109	65.0	44.0	108	104	31.7	14.4	141	32.0
9/25	16:20	Pow In N	0.223	0.0642	0.0650	0.0172	1.95	0.191	<2.0	16	65.6	26.4	39.2	40.0	36.1	18.4	8.40	57.9	6.00
9/29	9:55	Pow In N	0.287	0.0701	0.158	0.0788	2.95	0.521	<2.0	24	79.6	34.4	45.2	62.5	67.4	47.8	17.0	92.4	10.5

Table A-8. Powderhorn Inlet South 2023 composite sample chemistry results. NS = Not Sampled. NES = Not Enough Sample.

Date Sampled	Time	Site	TP mg/L	TDP mg/L	SRP mg/L	OrthoP mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
6/10	14:45	Pow In S	3.84	2.40	2.35	NS	7.45	<0.030	23.0	124	248	178	70.0	352	324	28.3	31.7	168	124
6/25	13:18	Pow In S	2.00	1.22	1.14	NS	6.31	<0.030	6.0	84	222	114	108	205	255	21.9	19.2	143	54.0
7/5	10:21	Pow In S	2.54	NES	0.305	NS	3.94	<0.030	NES	NES	657	224	433	NES	NES	NES	NES	NES	NES
8/3	21:53	Pow In S	0.538	0.236	NES	NS	2.72	<0.030	NES	NES	28.5	18.8	9.72	NES	NES	NES	NES	NES	NES
8/11	0:11	Pow In S	0.972	NES	0.900	0.969	2.67	<0.030	NES	NES	16.0	10.0	6.00	NES	NES	NES	NES	NES	NES
9/11	23:21	Pow In S	1.87	NES	1.17	NS	13.7	<0.030	NES	NES	44.0	28.0	16.0	NES	NES	NES	NES	NES	NES
9/15	6:08	Pow In S	2.20	NES	1.52	NS	6.15	<0.030	NES	NES	49.0	34.5	14.5	NES	NES	NES	NES	NES	NES
9/24	22:26	Pow In S	0.174	0.0515	0.0123	0.0410	1.23	0.334	4.50	54	12.0	12.0	0.00	125	75.5	20.6	2.60	44.4	23.7
9/26	0:02	Pow In S	0.112	0.0387	0.0357	0.00505	0.915	0.105	<2.0	38	15.6	8.00	7.60	80.0	24.1	19.6	3.50	50.5	11.1
9/29	9:35	Pow In S	0.393	NES	0.250	0.193	1.36	0.381	NES	NES	42.0	24.4	17.6	NES	NES	NES	NES	NES	NES

Table A-9. Powderhorn Inlet Southeast 2023 composite sample chemistry results. NS = Not Sampled. NES = Not Enough Sample. SD = Sample Damaged.

Date Sampled	Time	Site	TP mg/L	TDP mg/L	SRP mg/L	OrthoP mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
5/5	21:26	Pow In SE	0.767	0.122	0.0380	NS	4.26	0.467	14.5	56	290	116	174	145	348	43.6	39.7	270	31.6
5/6	19:09	Pow In SE	0.381	0.0590	0.0180	NS	2.31	0.348	7.50	40	133	60.0	73.0	75.0	176	29.4	18.4	128	12.8
5/14	12:53	Pow In SE	0.228	0.0380	0.0060	NS	1.34	0.245	4.00	36	46.0	25.5	20.5	60.0	48.7	18.5	5.90	63.9	11.5
5/18	16:05	Pow In SE	0.954	0.0810	0.0110	NS	4.01	0.480	5.50	44	258	127	132	113	312	28.8	19.9	104	SD
6/10	15:13	Pow In SE	4.03	1.02	0.840	NS	10.9	<0.030	5.83	72	916	538	378	300	787	75.9	68.2	377	140
6/25	11:02	Pow In SE	0.928	0.190	0.0534	NS	3.96	<0.030	<2.0	24	194	116	78.0	132	244	29.2	22.9	108	37.2
6/25	20:41	Pow In SE	0.687	0.0729	0.0179	NS	2.71	<0.030	<2.0	24	226	92.0	134	70.0	211	31.9	39.1	148	14.0
7/5	12:20	Pow In SE	0.479	0.0500	0.0060	NS	1.19	<0.030	<2.0	18	131	52.6	78.4	67.5	97.3	32.7	26.0	91.0	12.3
7/13	22:35	Pow In SE	1.06	0.222	0.0770	NS	5.63	<0.030	7.00	60	340	154	186	215	486	51.8	62.7	192	86.7
7/26	7:18	Pow In SE	0.301	0.0300	0.0050	NS	2.13	<0.030	2.50	22	88.0	56.0	32.0	47.5	81.7	20.6	10.1	48.0	NES
8/3	23:13	Pow In SE	0.381	0.0515	0.00439	NS	2.68	0.359	<2.0	24	97.2	49.2	48.0	66.3	97.8	26.2	18.1	93.9	NES
8/11	3:50	Pow In SE	0.286	0.115	0.0890	0.141	1.90	0.419	3.00	24	33.0	19.5	13.5	62.5	51.7	20.4	5.60	62.2	17.3
8/14	8:54	Pow In SE	0.228	0.0732	0.0459	0.0894	1.27	<0.030	<2.0	14	50.5	29.0	21.5	47.5	45.1	21.0	8.50	47.4	11.2
9/25	2:02	Pow In SE	0.240	0.0345	0.0126	0.101	1.99	0.220	<2.0	20	88.0	45.2	42.8	45.0	67.6	27.4	16.6	78.9	9.90
9/24	0:45	Pow In SE	0.284	0.0817	0.0449	0.120	1.93	0.229	<2.0	18	91.0	42.0	49.0	50.0	78.5	18.1	18.4	87.2	8.60
9/25	16:09	Pow In SE	0.187	0.0614	0.0792	0.0202	2.23	0.296	<2.0	16	63.6	32.4	31.2	47.5	32.9	20.9	6.00	45.1	6.50
9/29	10:40	Pow In SE	0.300	0.0656	0.166	0.0726	2.39	0.562	<2.0	18	113	48.0	64.8	55.0	77.1	27.1	21.8	92.5	7.60
10/25	2:07	Pow In SE	0.228	0.0638	0.0643	0.109	1.58	0.336	3.00	28	59.6	32.0	27.6	52.5	112	33.3	12.2	70.0	14.2

Table A-10. Powderhorn Inlet West 2023 composite sample chemistry results. NS = Not Sampled. NES = Not Enough Sample.

Date Sampled	Time	Site	TP mg/L	TDP mg/L	SRP mg/L	OrthoP mg/L	TN mg/L	NOx mg/L	Cl mg/L	Hard mg/L	TSS mg/L	VSS mg/L	ISS mg/L	TDS mg/L	COD mg/L	Cu µg/L	Pb µg/L	Zn µg/L	DOC mg/L
5/14	18:04	Pow In W	0.251	0.0520	0.020	NS	1.42	0.390	7.50	44	29.0	17.0	12.0	82.5	38.6	16.1	6.30	43.2	12.8
5/30	9:55	Pow In W	2.40	NES	NES	NS	9.81	<0.030	<2.0	NES	90.0	57.0	33.0	NES	NES	NES	NES	NES	NES
6/10	16:31	Pow In W	2.14	0.257	0.171	NS	8.14	<0.030	26.2	88	403	206	197	217	378	54.4	72.3	306	67.4
6/25	10:35	Pow In W	1.41	0.166	0.0338	NS	5.62	<0.030	4.00	48	395	191	204	145	435	54.2	91.4	276	49.5
7/4	11:23	Pow In W	0.863	0.050	0.0060	NS	2.00	<0.030	<2.0	22	385	163	222	72.5	302	49.0	106	207	19.0
7/13	22:14	Pow In W	1.23	0.109	0.0090	NS	6.33	<0.030	5.00	36	694	302	392	110	442	74.3	144	351	36.3
7/26	2:15	Pow In W	0.391	0.0290	0.0030	NS	2.66	<0.030	<2.0	20	169	75.0	94.0	47.5	120	24.0	23.5	74.0	9.20
8/11	13:55	Pow In W	0.431	0.120	0.0116	0.110	3.24	0.0754	6.00	40	46.0	30.0	16.0	117	94.5	29.9	9.5	71.3	32.7
9/24	3:12	Pow In W	0.445	0.109	0.0485	0.162	2.52	0.0919	12.5	56	71.0	39.0	32.0	142	98.4	27.2	15.4	94.3	21.5
9/25	3:06	Pow In W	0.187	0.0304	0.0040	0.0525	1.62	0.134	2.50	30	42.0	24.5	17.5	70.0	43.0	27.8	10.3	53.6	12.9
9/26	1:58	Pow In W	0.221	0.0534	0.0933	0.0202	1.53	0.201	<2.0	20	85.6	34.8	50.8	47.5	45.6	19.7	27.4	77.2	5.20
9/29	11:04	Pow In W	0.307	0.0495	0.156	0.0522	2.41	0.523	<2.0	20	111	47.6	63.2	45.0	87.1	33.5	41.3	84.9	7.10
10/13	9:26	Pow In W	0.380	0.0317	0.0915	0.199	1.83	0.445	<2.0	28	105	50.9	54.5	37.5	121	34.5	22.0	95.2	13.3
10/25	4:16	Pow In W	0.245	0.0561	0.0381	0.109	2.13	0.358	3.00	34	62.4	35.3	27.1	57.5	108	32.5	15.9	60.2	10.1

Green Stormwater Infrastructure Monitoring

BACKGROUND

Green Stormwater Infrastructure (GSI) is a term that describes a wide variety of practices designed to manage stormwater runoff while also providing environmental benefits. Some examples of GSI include rain gardens, permeable pavements, green roofs, and infiltration planters. The purpose of GSI monitoring is to better understand how effective these structures are at flood control and reducing the impacts of stormwater runoff. A secondary goal is to assess the performance of different GSI site designs in natural conditions and use that information to enhance future designs. Due to an ordinance change, the City of Minneapolis is building numerous small-footprint infiltration/filtration basins throughout the city. Many of these GSI Best Management Practices (BMPs) treat less than 1 acre of impervious surface. The City of Minneapolis chose the Hoyer Heights GSI to be the focus of monitoring in 2023. This was the third year of monitoring at Hoyer.

This project is a partnership between the City of Minneapolis, Saint Anthony Falls Hydrology Laboratory (SAFL) at the University of Minnesota, the Mississippi Watershed Management Organization (MWMO), and the Minneapolis Park and Recreation Board (MPRB). The funding, survey, and geographic information system (GIS) data used in the project were supplied by the City of Minneapolis. The City contracted with Metro Blooms for regular inspections of the basins for maintenance needs and plant health. Public outreach and education were the responsibility of MWMO. Soil sampling and data analysis were the responsibility of the MPRB.

The Hoyer Heights GSI is in Northeast Minneapolis and includes three different basins located in the same neighborhood, shown in **Figure 1**. They drain approximately 0.072 acres of a residential watershed, of which 0.041 acres are impervious, and were designed primarily for flood control. Hoyer A is at the southeast corner of 36 ½ Avenue NE and Fillmore Street NE and has been monitored since 2021. Two additional sites were added to the project in 2022: Hoyer B at the northwest corner of that same intersection, and Hoyer C on the southeast corner of 36 ½ Avenue NE and Buchanan Street SE. All sites had underdrain caps and boots installed on July 19th, 2022. Each site has a brick-filtered splash pad pretreatment basin and an overflow inlet.

Figure 1. The Hoyer A (1), B (2), and C (3) GSI basins, and site locations shown in map view (4).

METHODS

Equipment Setup

In 2021, a Nova Lynx tipping bucket rain gauge was installed at Hoyer A with HOBO Pendant dataloggers, shown in **Figure 2**. HOBO MX2001-01-SS water level loggers were installed at the surface grade of both sites to determine ponding drawdown time. One HOBO MX2001-04-SS water level logger was installed in the underdrain behind a spring ring V-notch weir at Hoyer A.

Figure 2. A rain gauge being installed at the Hoyer A GSI site in 2021.

Soil Sampling

Soil samples were collected twice during the 2023 monitoring season. Spring samples were collected on May 17, and fall samples were collected on October 11. The soil samples were collected from five predetermined sub-sample locations in each basin, consistent with 2022. The sampling protocol was: 1) surface debris was cleared, 2) a 4-inch diameter hole was dug 6 inches of depth, and 3) soil samples were collected with a trowel and placed in Ziploc bags, as shown in **Figure 3**. The bags were labeled with the site name and the date collected and stored in a cooler/refrigerator before being transported to the lab. Soil samples were analyzed individually by the University of Minnesota Soil Lab.

The GSI soil chemistry tests performed at the University of Minnesota Soils Laboratory were:

- Phosphorus (Bray P)

- Loss on ignition – organic matter % (LOI OM)
- Total nitrogen %
- Chloride
- Total solids moisture %
- Total solids %
- Elemental metals, shown in **Table 4**

Figure 3. A soil sub-sample being collected by MPRB staff at the Hoyer A GSI site.

RESULTS

GSI Soil Sample Chemistry

Soil elemental chemistry data were collected monthly in 2021 to create a baseline dataset for each site and have been averaged in the following data tables. In 2022 soil samples were collected only once at each site on 7/12. In 2023, soil samples were collected twice during the monitoring season: once in the spring, and once in the fall. As more stormwater infiltrates, it would be expected that soil chemistry may change over the course of a season or a year. **Table 1** shows the GSI baseline soil sample results for phosphorus, nitrogen, chloride, percent solids, and organic matter compared with data from 2021, 2022, and 2023. **Table 2** shows a list of the elemental chemistry components analyzed at the University of Minnesota Soils Lab. **Table 3a and b** show the elemental chemistry of the GSI soil samples from 2021-2023.

In the spring of 2023, Hoyer A had higher levels of Bray P, LOI OM, chloride, and total solids moisture % than in the fall, which had higher total solids %. The severe regional drought spanning the summer and fall likely influenced the measured decrease in moisture %. Hoyer B followed a

similar pattern, though the LOI OM was slightly higher in the fall than in the spring. Hoyer C was also mostly consistent with A and B but had higher Bray P in the fall compared to the spring. Chloride was a parameter of particular interest, as these GSI sites become buried under sand and salt-laden snow in the wintertime due to their proximity to the street. Each site showed decreased chloride levels in the fall compared to the spring, which suggests that the chloride may be leeching out of the GSI. Each site has a capped underdrain, so it likely that chloride is exiting the GSI via plant uptake and/or groundwater leeching.

Elemental chemistry analysis was only performed on the fall samples in 2023. Results show that Hoyer A had lower levels of every element compared to B and C. Hoyer B was rich with alkaline and transition metals, while Hoyer C had an abundance of alkaline earth metals, nonmetals, and metalloids. No sites registered detectable levels of Rb in 2023.

Compared to 2022 levels, Hoyer A had generally lower element content, though it did increase in Ca, Mg, and S. Hoyer B showed mostly higher elemental levels in 2023, though it decreased in B, Li, Mg, Na, Rb, Si, and Ti. Hoyer C followed a similar trend as Hoyer B with some discrepancies, decreasing in B, Fe, Li, Mo, Rb, Si, Ti, and V, compared to 2022. Overall, Hoyer B and C increased in alkaline earth metals, nonmetals, and transition metals, and decreased in alkaline metals and metalloids. Hoyer A was the only site to increase in nonmetals in 2023.

Table 1. The soil test data from each of the GSI sites from 2021-2023. LOI OM = Loss on ignition - organic matter. NS = No sample. Data from 2021 are averages of data collected from June, July, and August. 2022 data were collected in July. 2023 data were collected in May and October. Total nitrogen was not measured in 2023.

		Bray P mg/kg soil	LOI OM %	Chloride mg/kg soil	Total Nitrogen %N	Total Solids	
						Moisture %	Solids %
2021	**Hoyer A**	49.0	2.05	11.6	0.118	17.0	85.1
	Windom	48.3	1.40	9.80	0.087	6.80	93.2
2022	**Hoyer A**	71.4	4.48	14.2	0.154	10.8	89.1
	Hoyer B	60.6	3.24	13.4	0.122	12.2	87.8
	Hoyer C	65.4	3.62	12.9	0.194	11.4	88.6
	Windom	36.8	2.44	7.27	0.646	7.93	92.1
2023	**Hoyer A - Spring**	83.6	2.72	9.41	NS	9.70	90.3
	Hoyer A - Fall	64.4	2.56	7.56	NS	7.39	92.6
	Hoyer B - Spring	72.0	3.43	10.9	NS	12.9	87.1
	Hoyer B - Fall	54.0	3.48	9.68	NS	14.3	85.7
	Hoyer C - Spring	75.0	4.48	17.4	NS	16.3	83.7
	Hoyer C - Fall	80.0	3.82	9.31	NS	11.9	88.1

Table 2. List of the GSI soil chemistry element symbols, element names, and periodic table groups analyzed at the University of Minnesota Soils Laboratory.

SYMBOL	ELEMENT	GROUP
Al	Aluminum	Basic metal
As	Arsenic	Metalloid
B	Boron	Metalloid
Ba	Barium	Alkaline earth metal
Be	Beryllium	Alkaline earth metal
Ca	Calcium	Alkaline earth metal
Cd	Cadmium	Transition metal
Co	Cobalt	Transition metal
Cr	Chromium	Transition metal
Cu	Copper	Transition metal
Fe	Iron	Transition metal
K	Potassium	Alkaline metal
Li	Lithium	Alkaline metal
Mg	Magnesium	Alkaline earth metal
Mn	Manganese	Transition metal
Mo	Molybdenum	Transition metal
Na	Sodium	Alkaline metal
Ni	Nickel	Transition metal
P	Phosphorus	Nonmetal
Pb	Lead	Transition metal
Rb	Rubidium	Alkaline metal
S	Sulfur	Nonmetal
Si	Silicon	Metalloid
Sr	Strontium	Alkaline earth metal
Ti	Titanium	Transition metal
V	Vanadium	Transition metal
Zn	Zinc	Transition metal

Table 3a. GSI soil elemental chemistry data from 2021-2023. MDL = minimum detection limit. The Limit of Detection (LOD), a batchwise instrument detection limit, is expressed in units of mg/L solution independent of dilution factors used to calculate sample concentrations. Data from 2021 are averages of data collected from June, July, and August. 2022 data were collected in July. Only October data was used in 2023.

Date	Site	Al mg/kg	As mg/kg	B mg/kg	Ba mg/kg	Be mg/kg	Ca mg/kg	Cd mg/kg	Co mg/kg	Cr mg/kg	Cu mg/kg	Fe mg/kg	K mg/kg	Li mg/kg
MDL		0.061	0.011	0.033	0.001	0.0	0.226	0.001	0.001	0.001	0.005	0.032	0.353	0.001
LOD		0.007	0.005	0.002	0.001	0.001	0.156	0.001	0.001	0.001	0.008	0.006	0.021	0.001
	Windom	2484	<0.013	<0.001	25.6	<0.001	10075	<0.001	3.50	7.98	7.92	7945	352	3.62
2021	Hoyer A	2024	<0.013	<0.001	22.7	<0.001	29022	<0.001	2.35	5.85	5.53	6823	345	3.06
	Windom	2839	3.95	4.37	36.6	0.130	7979	0.095	3.60	7.46	8.04	8372	380	3.69
	Hoyer A	2393	1.74	7.84	36.2	0.140	30309	0.110	2.95	8.03	9.03	8101	566	4.04
	Hoyer B	2269	1.93	5.96	30.9	0.100	31573	0.078	2.86	6.83	11.7	7511	463	4.00
2022	Hoyer C	2619	3.30	6.15	40.5	0.120	28141	0.140	3.22	7.54	9.04	9705	499	4.06
	Hoyer A	1798	1.93	0.822	26.4	0.061	32454	0.081	2.71	6.39	6.79	7655	311	2.86
	Hoyer B	3295	2.55	2.02	50.8	0.119	34914	0.114	3.73	10.6	12.8	9670	604	3.85
2023	Hoyer C	2965	3.82	2.40	55.3	0.144	38328	0.150	3.54	9.09	11.2	9070	564	3.55

Table 3b. GSI soil elemental chemistry data from 2021-2023. MDL = minimum detection limit. BDL = Below detection limit. The Limit of Detection (LOD), a batchwise instrument detection limit, is expressed in units of mg/L solution independent of dilution factors used to calculate sample concentrations. Data from 2021 are averages of data collected from June, July, and August. 2022 data were collected in July. Only October data was used in 2023.

Date	Site	Mg mg/kg	Mn mg/kg	Mo mg/kg	Na mg/kg	Ni mg/kg	P mg/kg	Pb mg/kg	Rb mg/kg	S mg/kg	Si mg/kg	Sr mg/kg	Ti mg/kg	V mg/kg	Zn mg/kg
MDL		0.068	0.009	0.001	0.054	0.008	0.023	0.009	0.073	0.020	0.137	0.001	0.005	0.011	0.028
LOD		0.004	0.016	0.001	0.008	0.006	0.018	0.005	0.062	0.012	0.024	0.001	0.004	0.021	0.004
	Windom	401 8	252	<0.001	61.7	8.46	338	5.27	1.39	277	586	9.21	128	11.5	15.6
2021	Hoyer	8069	199	<0.001	82.9	5.35	397	3.98	1.18	600	742.5	18.8	105	9.28	13.5
	Windom	2858	242	0.160	66.4	8.75	327	10.2	15.6	302	877	9.59	129	13.9	24.4
	Hoyer A	9299	254	0.210	154	8.42	436	4.95	3.75	685	1336	22.1	141	9.75	35.1
	Hoyer B	10202	251	0.330	78.8	6.98	440	5.18	13.2	652	1240	18.9	134	9.60	25.4
2022	Hoyer C	8567	321	0.170	69.3	8.27	443	9.46	15.7	673	1313	18.9	128	11.8	29.1
	Hoyer A	9421	236	BDL	61.7	7.89	419	4.25	BDL	821	731	17.56	98.3	6.35	16.7
	Hoyer B	9771	360	0.103	78.4	10.8	540	9.27	BDL	992	1048	23.1	125	12.4	29.9
2023	Hoyer C	10723	384	0.102	74.1	9.44	658	11.7	BDL	1186	1304	26.5	123	11.4	29.1

CONCLUSION

Baseline soil data was collected in 2021, and comparisons were made with data from 2022 and 2023. This data is important to assess how the sites are infiltrating stormwater, identify which contaminants are washing in from the street, and determine if pollutants are accumulating in the infiltration media. Contaminants and nutrients like chloride, phosphorus, nitrogen, and lead are of particular interest due to their association with negative environmental and human impacts. Results from the spring and fall samples in 2023 show that these GSI may be effective at capturing some chloride from winter road salting via plant nutrient uptake and groundwater leeching. Consistently high levels of phosphorus and organic matter speak to the overall health of the plants in these basins. Elemental chemistry results did not vary significantly between 2022 and 2023, except for the reduction of rubidium from all three Hoyer basins. Measured values of Rb were below the minimum detection limit in 2023, but there are likely still trace amounts left in the basins. Monitoring efforts in 2024 will confirm or refute this. Additional years of data will provide more information about nutrient transference and whether or not there are particular pollutants building up at the soil surface.

Lake Monitoring

In 2023, Minneapolis Park and Recreation Board (MPRB) scientists monitored 11 of the city's most heavily used lakes and documented all data in the MPRB Water Resources Report. The data collected were used to calculate a Trophic State Index (TSI) score for each of the lakes. Lower TSI scores indicate high water clarity, low levels of algae in the water column, and/or low phosphorus concentrations. Changes in lake water quality can be tracked by looking for trends in TSI scores over time. In **Table 1** and **Figure 1**, TSI trends for Minneapolis lakes from 1991 to 2023 are shown, and in Table 2, the trend in TSI is shown for Minneapolis lakes for the past ten years. A negative slope indicates improving water quality, while a positive slope indicates declining water quality.

These values are especially important for monitoring long-term trends (10+ years). Historical trends in TSI scores are used by lake managers to assess improvement or degradation in water quality. Trends are also used by the Minnesota Pollution Control Agency to assess non-degradation goals.

Most lakes sampled in Minneapolis are either eutrophic or mesotrophic. Bde Maka Ska, Harriet, and Wirth Lake are mesotrophic having moderately clear water and potential for hypolimnetic anoxia frequently during the summer. Cedar and Lake of the Isles are eutrophic having an anoxic hypolimnion and potential for nuisance growth of aquatic plants. Nokomis, Loring, and Hiawatha are also eutrophic with high algal productivity. Brownie Lake was also classified as eutrophic but was not sampled in 2023. Powderhorn and Spring Lake are hypereutrophic having dense algae. Blue-green algae dominates the phytoplankton community on both Lake Nokomis and Powderhorn Lake, resulting in periodic appearance of algal scum on these lakes. Scores for Diamond and Grass Lake are not included since these lakes are too shallow to calculate the Secchi portion of the TSI index.

Table 1. Water quality trends in Minneapolis lakes from 1991-2023.

Lakes with Improving Water Quality Indicators	Bde Maka Ska Wirth Lake
Lakes with Stable Trends	Brownie Lake Cedar Lake Lake Harriet Lake Hiawatha Lake of the Isles Loring Pond Lake Nokomis Powderhorn Lake Spring Lake
Lakes with Declining Water Quality Indicators	No lakes with declining trend

Table 2. Water quality trends in Minneapolis lakes from 2014-2023.

Lakes with Improving Water Quality Indicators	No lakes with improving trend
Lakes with Stable Trends	Bde Maka Ska Brownie Lake Cedar Lake Lake Harriet Lake of the Isles Loring Pond Powderhorn Lake Spring Lake Wirth Lake
Lakes with Declining Water Quality Indicators	Lake Hiawatha Lake Nokomis

There has been a significant improvement in water quality indicators in **Bde Maka Ska** since the early 1990s (linear regression, $p < 0.05$). Although water quality in Bde Maka Ska has improved over time, TSI scores have slowly been increasing since 2005. The TSI scores between 2017 and 2023 were higher than the previous few years due to higher chlorophyll-*a* and total phosphorus concentrations but were still below the early 1990s scores. In 2023, the TSI score slightly decreased compared to 2022 due to deeper water clarity and lower chlorophyll-*a* concentrations.

Wirth Lake water quality has been improving since 1992, going from a eutrophic system dominated by algal growth to a moderately clear mesotrophic system (linear regression, $p < 0.05$). The TSI score at Wirth Lake slightly increased the past couple years due to shallower water clarity and higher chlorophyll-*a* concentrations.

Most of the Minneapolis lakes have no directional trend in water quality indicators since the early 1990s, which is expected. Decreasing trends in TSI scores, showing improving water quality, occurred when water quality management projects were in place.

- **Lake Harriet** experienced a few years with lower, relatively stable TSI scores following a littoral alum treatment in the mid-2000s, as well as lower TSI scores in 2016 and 2020. The TSI score in Lake Harriet in 2023 was comparable to previous years and there is no significant trend in water quality in either direction (linear regression, $p > 0.05$).
- The water quality in **Cedar Lake** showed improvement following restoration efforts through the late 1990s, but TSI scores have gradually been increasing since that time. The Cedar Lake TSI scores between 2017 and 2021 were the highest they have been since the early 1990s due to shallower water clarity and higher chlorophyll-*a* concentrations. The TSI score decreased over the past couple years due to deeper water clarity and lower chlorophyll-*a* concentrations.
- The water quality in **Lake of the Isles** varies from year to year with lower TSI scores in recent years compared to the early 1990s but there is no significant trend (linear regression, $p > 0.05$). In 2023, the TSI score decreased due to deeper water clarity and lower chlorophyll-*a* and phosphorus levels.

- Previously, water quality in **Lake Nokomis** improved following a biomanipulation project that was completed in 2013. In recent years Lake Nokomis has had higher algal concentrations and increasing TSI scores indicating worsening water quality over the past 10 years (linear regression, $p < 0.05$); however, there is no significant trend since 1992. In 2023, the TSI score decreased again due to deeper water clarity and lower concentrations of chlorophyll-*a* and phosphorus.
- Loring Pond had worsening water quality immediately following a dredging project in 1997; however, between 2000 and 2015 TSI scores decreased indicating improving water quality. Since 2015, the TSI scores in **Loring Pond** have been slowly increasing due to shallower water clarity and higher chlorophyll-*a* concentrations, particularly in 2019, 2020 and 2022. There is no significant trend in Loring Pond water quality in either direction (linear regression, $p > 0.05$).
- **Lake Hiawatha** is heavily influenced by inflow from Minnehaha Creek and the lake has poorer water quality during drought years when residence time increases. Between 2021 and 2023 there was less precipitation compared to previous years and TSI scores have been increasing indicating worsening water quality over the past 10 years (linear regression, $p < 0.05$); however, there is no significant trend since 1992.
- **Powderhorn Lake** has experienced a wide variation in water quality, with the worst TSI scores in the late 1990s and the best scores in the late 2000s. Powderhorn Lake has had poor water quality most years since 2013 because blue-green algae blooms lead to shallow water clarity; however, TSI scores were slightly lower in 2018, 2019, and 2021.
- Water quality in **Spring Lake** is variable and there has been no significant trend in any direction since 1994. Spring Lake is monitored every other year and was monitored in 2023. The TSI score was highest in 2019 due to high chlorophyll-*a* and phosphorus concentrations.
- The water quality in **Brownie Lake** has been relatively stable, with no significant trend in either direction since 1993. Brownie Lake is monitored every other year and was not monitored in 2023.

Diamond Lake and **Grass Lake** are not included in this analysis, since TSI scores are only appropriate for deeper lake systems and there are no water clarity measurements available for these shallow lakes. There are no lakes in Minneapolis with significant declines in water quality indicators since the early 1990s; however, water quality trends over the past 10 years indicate that Lake Hiawatha and Lake Nokomis water quality is declining.

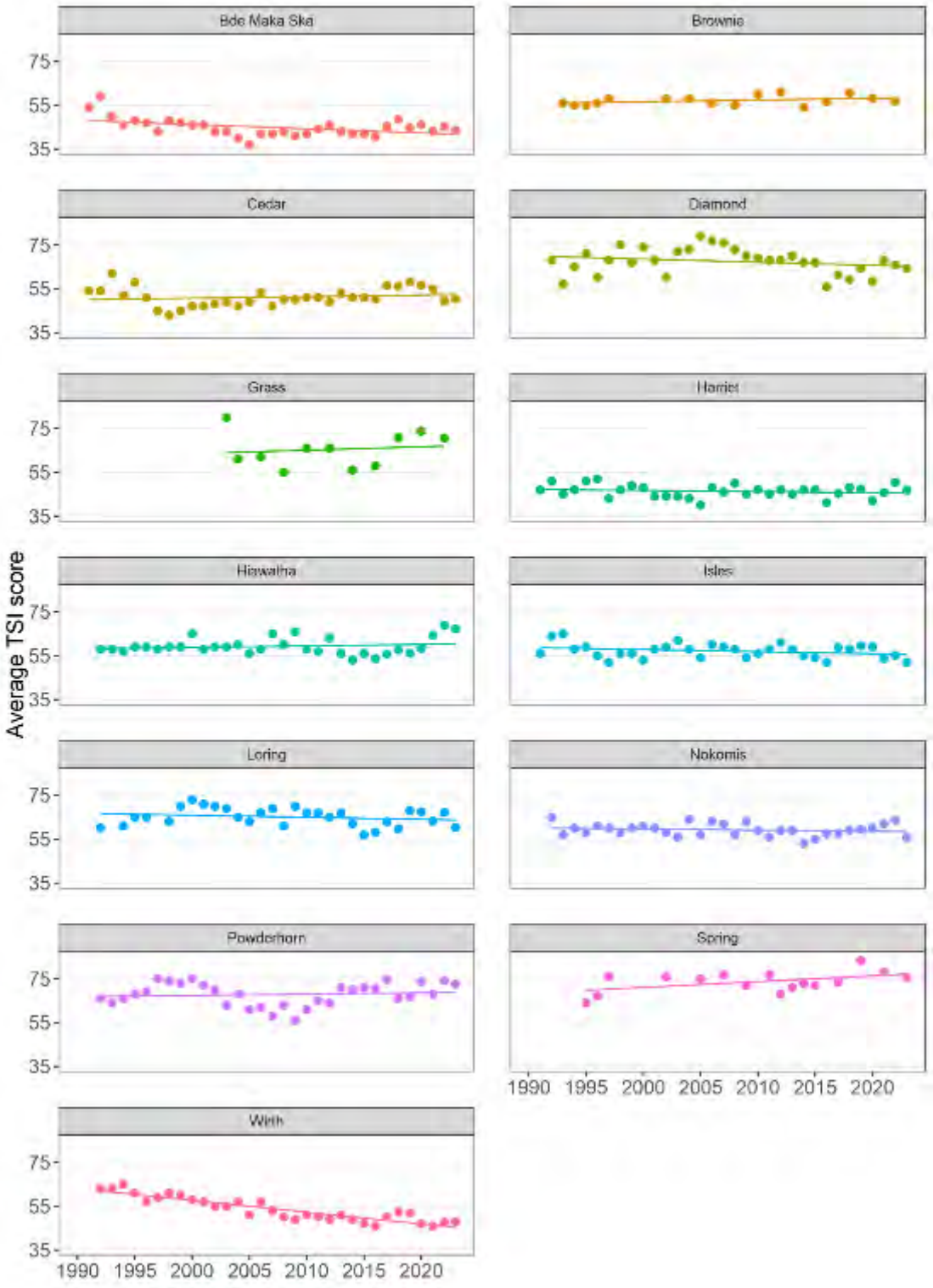


Figure 1. TSI scores and regression analysis for selected Minneapolis lakes 1991–2023. Lower TSI scores indicate high water clarity, low levels of algae in the water column, and/or low phosphorus concentrations. A negative slope indicates improving water quality, while a positive slope indicates declining water quality. Only Bde Maka Ska and Wirth have statistically significant trends ($p < 0.05$).

Results of Frog & Toad Calling Surveys in Minneapolis Stormwater Ponds, 2016–23

American toad (*Anaxyrus americanus*). *Photograph by J. Winkelman*

Prepared for MaryLynn Pulscher, Minneapolis Park & Recreation Board

By Jenny Winkelman

March 2024

Funding for this survey was provided by the City of Minneapolis Department of Public Works.

Winkelman, Jenny. (2023). **Frog and Toad Calling Surveys in Minneapolis Stormwater Ponds, 2016 – 2023**

BACKGROUND AND OBJECTIVES

The presence and abundance of frogs and toads are a useful indicator of water and habitat quality, as well as short and long-term environmental changes. Standard protocols using calling surveys during peak breeding activity have been used to determine distribution and population trends of frogs and toads by natural resource agencies nation-wide.

The question has been raised whether or not stormwater ponds, constructed to intercept and treat runoff, can also function as a refuge for amphibians. Additionally, the public has voiced concerns about the absence of formerly abundant frogs and toads calling from Hiawatha Golf Course and the surrounding area. To evaluate these concerns, the Minneapolis Park and Recreation Board (MPRB) coordinates frog and toad listening surveys at Lake Hiawatha golf course and select stormwater ponds in Minneapolis.

The purpose of these surveys is to:

1. Determine if any frog and toad species (anurans) are found in or near stormwater ponds.
2. Use the Minnesota Frog and Toad Calling Survey (MFTCS) protocols adapted for Theodore Wirth Park to identify species and abundance in stormwater ponds.
3. Generate ideas about why or why not species may use stormwater ponds.

Funding for this project was provided by the City of Minneapolis Department of Public Works.

METHODS

A total of eighteen sites have been surveyed since 2016 and currently seventeen are routinely sampled. Initially two locations were surveyed on Hiawatha Golf Course (2016). In 2018, two ponds on Hiawatha Golf Course and four additional stormwater ponds were sampled (N Upton Ave N at 52nd Ave N, Twin Lakes, and E 37th St and Chicago Ave). Eight locations were added in 2019 to distribute sampling effort around the city. In 2020, the Chicago and E 37 St site was dropped due to a combination of factors: social unrest radiating from Chicago and E 37th St, the presence of a fountain, and lack of amphibian activity.

Roberts Bird Sanctuary north of Lake Harriet was added in 2022. It is a reference site not a stormwater pond.

Survey methods for this study were adapted from the MFTCS survey protocols[1,2]. The relative proximity of sites sampled in the park and objectives of this survey required modifying the protocols. However, the raw data was recorded in a way that can still be compared with MFTCS data. A side by side comparison of the MFTCS and modifications made for this study appears in Appendix 1.

Sampling surveys (runs) were conducted within established time frames and air and water temperatures. Runs were intended to capture calls from frog and toad species (collectively called anurans) breeding in early spring, mid to late spring and summer. At each site, species presence and chorus strength were recorded, based on volume of calling (calling index of 1–3). The calling index is based on hearing one or two anurans (index 1), a few (2) or many (3). In some cases, a “1” is used to indicate a species was seen but not heard, to capture the information that it is present (recorded on data sheets as a “P” for present). Observer bias was reduced in this study by using the same, experienced observer for all surveys. All assistants were given an opportunity to learn Minnesota frog calls online using the USGS NAAMP frog

[1] 2002 Anderson, Y. and R. Baker. Minnesota Frog and Toad Calling Survey, 1996-2002. MN DNR.

[2] Mossman et al., 1998

calling lookup and public quiz[3]. Frog recordings were also listened to between sites to further familiarize and finetune their identification skills.

Calculations and Limitations

Frequency calculations are based on presence and absence (not chorus strength) for the total number of years sampled (between 2015 to 2023).

Calling surveys enable gathering useful comparable information over a large area but are not perfect. Calling surveys are influenced by abiotic factors—especially temperature and precipitation—as well as day of year, time of day, weather, moon phase, drought, distance to and noise from roads, and whether the habitat is natural or built. Calling surveys can miss detecting populations (such as when not heard due to the volume of other sounds and choruses), especially rare species[4].

Repeating surveys (three runs) and assigning calling indexes (1-3) was used to determine species presence, seasonal changes in species composition, and the timing of peak breeding of each species. Observations from different runs are used to show variation of activity between species and not intended as multiple observations of a species (and therefore, not subject to averaging)[5]. Also, chorus strength is not a reliable indicator of abundance. The association between calling index and abundance varies among species and has not been rigorously quantified[6]. For example, all males present may not be calling at the time of the survey and some may call at other times of the day.

FINDINGS

- Seven species of frogs and toads—of 14 species known in MN—have been reported from selected stormwater sites in Minneapolis since 2016 (Table 1). Not more than three species have been found at a single stormwater pond.

[3] USGS Frog Quiz. Last accessed February 25, 2023

[4] Weir et al. 2009

[5] Mossman, et al., 1998

[6] Corn et al., 2011

Table 1. Toad and frog species heard in Minneapolis stormwater ponds, 2016–23.

		Species						
	Total No. species	American Toad *Anaxyrus americanus*[1]	Gray Treefrog *Hyla versicolor*	Cope's Gray Treefrog *Hyla chrysoscelis*	Green Frog *Lithobates clamitans*[2]	Northern Leopard Frog *Lithobates pipiens*[2]	Boreal Chorus Frog *Pseudacris maculata*	Spring Peeper *Pseudacris crucifera*
Species heard from 2016–23*	**7**	+	+	+	+	+	+	+
South Minneapolis								
37th & Chicago[3]	**1**	+						
East Twin Pond (43rd St S and Park Ave)	**2**	+	+					
West Twin Pond (44th St S and Park Ave)	**1**	+						
60th S and 1st —north of 62, west of 35W	**1**	+						
Bde Maka Ska SW ponds	**3**	+	+				+[4]	
Roberts Bird Sanctuary	**3**		+	+		+		
Hiawatha Golf Course, ponds 1-4	**2**	+			+			
Hiawatha Golf Course, corresponds to pond 5	**3**	+	+		+			
Gateway Pond	**1**	+						
Amelia Pond	**2**	+		+				
North Minneapolis								
52nd N and Upton, two ponds	**3**	+[5]	+[5]		+[5]			
Camden Central Pond—42nd N & Morgan	**1**	+						
Columbia Golf Course	**3**	+		+				+[6]
Heritage Park N— north of 55, outlet to Mississippi River	**2**	+				+		
Heritage Park S— south of 55	**1**	+						

* Includes all species seen or heard at each site, including outside of the 5-minute sampling.

[1]The genus *Anaxyrus* was formerly called *Bufo*.

[2] The genus *Lithobates* was formerly called *Rana*.

[3] Not sampled in 2020 due to lack of findings, presence of a fountain, and proximity to where George Floyd was killed.

[4] Heard in a pond across the road at the Bakken Museum.

[5] Pond in North Minneapolis the only location where green frogs have been found every year of the survey. They were found in two ponds at Hiawatha golf course in 2023.

[6] Heard once in 2021. This is the only location where spring peepers have been recorded in Minneapolis during surveys conducted since 2015 (including at Wirth Park).

- The phenology of calling by breeding frogs and toads is shown in Figure 1. American toads (*Anaxyrus americanus*) are the most obvious mid-season breeder (heard 61% of the time during the second run).

The sparse presence of other species (heard <10% of the time at peak breeding activity) is less pronounced but still consistent with what is known for this region[7,8]. Chorus frogs, spring peepers and northern leopard frogs breed earliest in spring. Mid to late spring breeders are toads, and both species of gray treefrogs. The only exclusively summer breeder heard during these surveys was the green frog. Peak breeding activity is influenced by abiotic factors such as when ice melts, temperatures warm, and the amount and timing of rain. Some species such as treefrogs call intermittently even when not breeding.

- American toads are the most commonly heard and widely distributed among stormwater ponds surveyed (Figures 1,2; Table 2). Toads were found in over 50% of years sampled; other species were detected in less than 10% (Figure 2, Table 3). A full chorus (calling index of 3) of toads has been documented at ten stormwater ponds, and multiple times in some locations. Toads have been heard at least once in all stormwater ponds except Robert's Bird Sanctuary (Tables 2,3); it would be surprising if they did not live here, only sampling has not (yet) detected them during breeding.
  Notable in 2023. Toads were heard for the first time in West Twin pond.

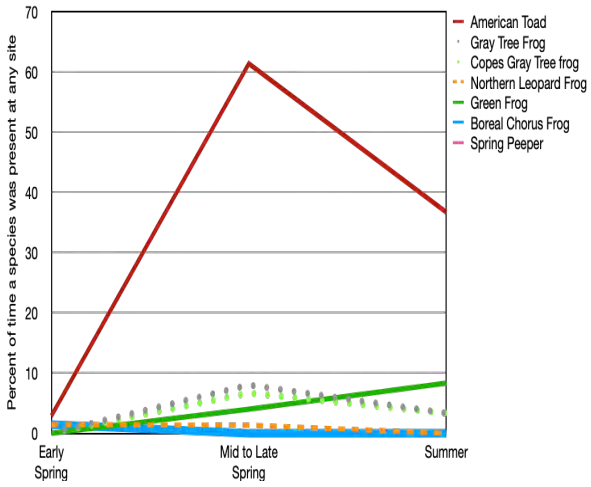


Figure 1. Calling phenology of species during each run (2018-23).

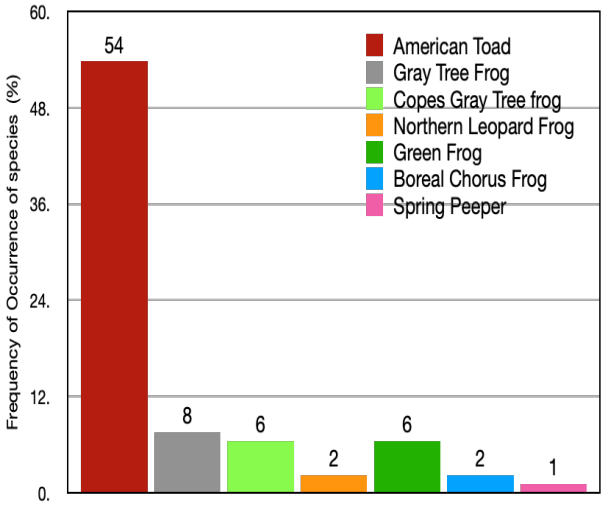


Figure 2. Frequency at which frog and toad species were found across all sites and years (n=93) in Minneapolis stormwater ponds, 2018-23.

In light of how widespread and vocal they are, oddly no toads were detected in 2022 at any sites. It is thought that a second year of drought and abnormally high temperatures early in the season dampened even toad calling in mid spring. Breeding was likely shortened and took place earlier, between the first two runs. Adult toads are largely terrestrial, are mid-season breeders, and are therefore less likely to encounter poor water quality during "first flush" stormwater runoff events in early spring. Adults live mostly on land including in winter, which they spend buried below the frost line. By breeding mid-season, the aquatic development stages (eggs and tadpoles) also avoid the worst water quality in ponds. Consequently, they are more resilient to urbanization as long as other habitat needs are met.

[7] Mossman, et al. 1998

[8] Winkelman, 2024

Herbicide application, burning and fire in upland habitats adjacent to stormwater ponds may disproportionately affect toads as they are terrestrial, except during breeding. (Leopard frogs would also be affected but are not found in stormwater ponds). This is especially important at ponds that are islands of habitat amid a bustling urban core. Of those surveyed, the pond at 60th and 1st is the most isolated with little alternative refuge.

- A single spring peeper (*Pseudacris crucifera*), heard in 2021 at the Columbia Golf Course ponds, is the first and only heard during these surveys. This is highly significant as spring peepers have not been heard anywhere else in Minneapolis since these surveys began in 2015 (suspected but not confirmed in Theodore Wirth Park).

- In 2022, Cope's gray treefrogs (*Hyla chrysoscelis)* were found at two new locations: Robert's Bird Sanctuary (reference site) and Amelia Pond (southwest of Lake Nokomis). Until 2022, they were only found at Columbia Golf Course near the pond with the widest riparian zone and vegetated with shrubs and small trees (probably because mowing is not possible on the steep bank). It is important to note numerous individuals were heard at Roberts Bird Sanctuary, while only one or two were heard at the other two locations.

  Notable in 2023. Cope's gray treefrogs were heard at full chorus for the first time not in Wirth Park[9].

  Cope's gray treefrogs inhabit the edges of woodlands and fields; whereas, gray treefrogs live in predominantly wooded areas. Cope's gray treefrogs are also found, abundantly, in Theodore Wirth Park at a golf course pond, with a diverse, vegetated shoreline near Regency Hospital. The range and numbers of individuals could probably be expanded to other sites, if riparian areas were widened and diversified to include native shrub species. The current practice at golf courses is to mow them as close as possible to the pond edge. Similarly, the number Cope's gray treefrogs at Columbia Golf Course would likely increase by widening and connecting riparian areas among the ponds.

- Individual gray treefrogs (*Hyla versicolor*) have been heard intermittently at different stormwater sites since 2016. In contrast, at Roberts Bird Sanctuary—a reference site—a full chorus has been heard twice (Table 2). This is not surprising given the lack of woodlands around stormwater ponds. They prefer breeding ponds well connected with a wooded upland area, where they live most of the year.

  The prevalence of gray treefrogs at Roberts Bird Sanctuary provides a useful metric for the amount of woodland needed to support gray treefrog populations in Minneapolis. At Roberts Bird Sanctuary, the woods range from about 450—1,000 ft wide, and cover about 35 acres. Given the importance and value of wooded habitat (to birds, carbon sequestration, gray treefrogs and more) there may be opportunities to prioritize, the establishment and natural management of woodland areas that are 450 ft deep along or near water elsewhere in Minneapolis parks (for example along the frequently flooded area on the southwest side of Lake Nokomis west of the parkway).

- Numerous green frogs (*Lithobates clamitans)* are found in the stormwater pond at Upton Ave N and 52nd Ave N (full choruses have been heard). Until 2023, green frogs have been heard exclusively in the north pond and not anywhere else in the city, including Theodore Wirth Park (2015-22).

  Notable in 2023. Individual green frogs were heard in three new locations - two different ponds on Hiawatha Golf course and at Birch Pond during the Wirth Park surveys[10].

  The National Wetland Inventory[11] indicates the pond at 52nd and Upton N has a hydrology dominated by surface water inputs and from streams and wetlands during flooding (called a "lotic pond

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[9] Winkelman, 2024

[10] Winkelman, 2024

[11] NWI Wetland Finder MN DNR. Last accessed on March 9, 2023

throughflow"). Nearby Shingle Creek and Lion's Park Pond may be the source of surface water and the green frogs. The amount of stormwater it receives needs to be explored further; however, in the meantime, it constitutes a unique habitat in the city.

Green frogs (and also Northern leopard frogs) are considered aquatic frogs, and overwinter in water that does not freeze solid, and require an ongoing supply of oxygen, making them dependent on high quality water resources. As a result, they are also more vulnerable to urbanization because unlike anurans that overwinter on land, they can't avoid the toxic concentrated first flush of stormwater in spring.

- Boreal chorus frogs *(Pseudacris maculata*) heard near Bde Maka Ska were actually found only at a small pond at the Bakken Museum about 200 feet away. It is not known at this time whether the pond at the Bakken Museum functions as a stormwater treatment. Nonetheless it may be an important breeding location for and source of chorus frogs.

Table 2. Frequency of occurrence of frog and toad species found in years sampled and the number of times a full chorus was heard, 2018–23 (based on presence; a full chorus had a calling index of 3).

	Percent Occurrence (times in full chorus)						
	American Toad *Anaxyrus americanus*[1]	Gray Treefrog *Hyla versicolor*	Cope's Gray Treefrog *Hyla chrysoscelis*	Green Frog *Lithobates clamitans*[2]	Northern Leopard Frog *Lithobates pipiens*[2]	Boreal Chorus Frog *Pseudacris maculata*	Spring Peeper *Pseudacris crucifers*
South Minneapolis							
East Twin Pond (43rd St S and Park Ave)	**50**	**33**	–	–	–	–	–
West Twin Pond (44th St S and Park Ave)	**17**	–	–	–	–	–	–
60th S and 1st —north of 62, west of 35W	**40 (1)**	–	–	–	–	–	–
Bde Maka Ska SW ponds	**60 (2)**	**20**	–	–	–	**40**	–
Roberts Bird Sanctuary (reference)	–	**67 (2)**	**67 (1)**	–	**33**	**–**	–
Hiawatha Golf Course, ponds 1-4 combined	**60 (2)**[3]	–	–	**20**	–	–	–
Hiawatha Golf Course, corresponds to pond 5	**33 (2)**	**17**	–	**17**	–	–	–
Gateway Pond	**60 (1)**	–	–	–	–	–	–
Amelia Pond	**60 (1)**	–	**20**	–	–	–	–
North Minneapolis							
52nd N and Upton, two ponds[4]	**83 (1)**	**17**	–	**67 (1)**	–	–	–

Camden Central Pond—42nd N & Morgan	**100 (2)**	–	–	–	–	–	–
Columbia Golf Course, combined	**100**	–	**60**	–	–	–	**20**[5]
Heritage Park N— north of 55, outlet to Mississippi River	**100 (4)**	–	–	–	**20**	–	–
Heritage Park S— south of 55	**80 (3)**	–	–	–	–	–	–

[1]The genus *Anaxyrus* was formerly called *Bufo*.

[2] The genus *Lithobates* was formerly called *Rana*.

[3] Full chorus heard in two different years, but not from same pond.

[4] Until 2023, this was the only location where green frogs were found in Minneapolis since 2015.

[5] Heard once in 2021. This is the only location where spring peepers have been found in Minneapolis since 2015.

CONSIDERATIONS FOR MANAGEMENT

The intent of stormwater ponds is to treat runoff prior to discharge, so water quality is intended to be "bad" going in and "better" coming out; stormwater ponds also manage water volume. Amphibians have highly permeable skin and are extremely sensitive to water quality. Deicers (predominantly salts or chlorides) are an inherent part of stormwater runoff especially in the spring, when breeding occurs. Chlorides remain dissolved in water and can only be diluted, not filtered out. Depending on concentration and exposure chlorides harm amphibians, and concentrations may change during a season and overtime. Tolerance to chloride levels varies among species and the developmental state (adults compared to eggs and developing tadpoles)[12].

Habitat management guidelines (HMG) consider the underlying function of stormwater ponds as incompatible with amphibian conservation and discourage their use as a habitat creation strategy[13]. And yet, amphibians are tolerating and using some stormwater ponds as habitat. Much remains to be known about the long term use of stormwater ponds by amphibians, and while conditions are not optimal, wherever possible, opportunities should be sought to manage the ponds in ways that preserve and protect the amphibians found there.

- **Some stormwater ponds are more important than others**. This study helps identify certain ponds as having higher value as amphibian habitat than others. Characteristics of excavated ponds, and their upland areas, that support anurans should be replicated wherever possible (52nd and Upton N, Columbia and Hiawatha golf courses, and Roberts Bird Sanctuary). Ponds that are used by breeding treefrogs, chorus frogs, spring peepers, green frogs and northern leopard frogs should be prioritized. Toads will inherently benefit from other efforts.
- **Water quality.** Nonpoint source pollution (NPS) such as salt, heavy metals, oils, and other chemicals that wash off roads and the surrounding landscape can be deadly to all life stages of amphibians and likely limit their use of stormwater ponds for breeding. Also salt and other pollutants accumulate in ponds intensifying their effects. Preventing NPS at its source through education; intercepting runoff with wide shoreline buffer strips/riparian areas vegetated with deeply rooted native species; maintaining land and water connections to other habitats; and maintaining water levels in ponds are ways to mitigate water quality impacts on amphibians found in stormwater ponds. Impacts of a changing climate are unknown but are not insignificant- heavy storms could benefit amphibians and

[12] Snodgrass and Ownby 2015

[13] Kingsbury, B.A. and J. Gibson (editors). 2011. Habitat Management Guidelines for Amphibians and Reptiles of the Midwestern United States. Partners in Amphibian and Reptile Conservation Technical Publication HMG-1, 2nd Edition. 161 pp.

dilute pollutant concentration, while dry years could have the opposite effect. Learning more about water quality in priority ponds is needed.

- **Irrigation**. At golf course ponds, sprinkler irrigation at night creates a humid microhabitat at golf course pond locations, creating unique habitat conditions, with potential for benefitting amphibians. At the least, a moist environment facilitates amphibian movement between ponds.

- **Golf courses**. Stormwater ponds located in golf courses pose unique opportunities substantially different than for a pond surrounded by residential or commercial development. Golf courses have dedicated staff, surrounding green space, and allow for management choices that improve water quality and enable connecting fragmented habitat. As climate changes, they may become increasingly important for frog and toad habitat. The high visibility, aesthetic standards of manicured green spaces and what is required to maintain it also poses a unique set of challenges. Minimal effort, even reduced effort, is needed to create wider swaths of riparian areas and result in significant benefits to wildlife (see below).

- **Riparian areas.** Wherever possible, an effort should be made to preserve and expand shoreline areas, widen riparian uplands, and create vegetated connections between nearby ponds. Pond designs include creation of upland habitat, but maintenance practices are incrementally reducing them by mowing, evident in plants cut to the tops of the steep slopes (for example at Heritage Park, Central Camden and at the golf courses). This disturbance reduces important habitat and corresponds with invasive species growing at the newly mowed edges. The Columbia Golf Course uses red stakes pounded into the ground surrounding the ponds to delineate mowing edges; however, the intent of stake placement appears to be to prevent mowers from collapsing the shoreline and falling into the pond, than for defining an adequate riparian buffer for habitat.

  Most of the frogs and toads found in Minneapolis spend most of their lives in upland areas and therefore, require different kinds of riparian and upland habitat with trees and shrubs, not just the formulaic traditional native prairie established next to ponds. For example, gray treefrogs require wooded uplands as seen at Roberts Bird Sanctuary. This site also offers a prescription for the size of a woodland (minimum width of 450 ft) needed to support gray treefrogs and can act as a template for other places in the parks.

- **Flooded areas**. Areas that seasonally flood can be managed to naturally function as vernal, or temporary ponds which are amphibian breeding hotspots. These areas can be delineated as lawn-free areas without mowing or leaf removal. Low-lying areas on golf courses, near the Lake Nokomis and Bde Maka Ska stormwater ponds and along parkways are flooded during spring rains and expand amphibian breeding habitat. These wet meadow areas/ vernal ponds (usually managed as turf) are generally warmer (at least three degrees) than the nearby stormwater ponds and when sampled side by side were preferred by calling/breeding toads[14].

- **Climate change**. Three consecutive years of drought (2021–23) have resulted in concentrated breeding activity, low water levels and drying up vernal ponds elsewhere in the city (Wirth Park 2023). Impacts of drought on amphibians in stormwater ponds are not known and likely vary on a pond-by-pond basis. As the climate becomes hotter and drier, this is an important consideration. Depending on their hydrology, some ponds may dry up and pollutants already in ponds may become more concentrated. The flush of pollutants may become more concentrated or occur at different times earlier, during or after breeding. If the latter, the developing stages (eggs and tadpoles) may be jeopardized.

[14] Pers. comm., J. Winkelman, 2019

In addition, erratic weather patterns such as intensive heat very early in spring (2022) alternating with unusually long and cold springs (2023) may destabilize breeding behaviors among anurans.

Wildfire smoke from western Canada resulted in air quality alerts during most of the 2023 frog breeding season. The skin of anurans is permeable and absorbs pollutants from air, water and soil. Furthermore, frogs breathe through their skin. As a result, anurans are particularly vulnerable to pollution in air, soil and water emphasizing the importance of management that supports their life cycle and does not interfere with it (such as dewatering at critical times, see above).

RECOMMENDATIONS MOVING FORWARD

- Continue to conduct surveys. Sampling variability emphasizes the importance of multiyear, ongoing surveys. For example, green frogs were unexpectedly found in 2023. Some sites were recently added and have a shorter sampling history. As stormwater ponds age, negative effects of water quality may intensify and reduce or preclude amphibian use. Likewise, after dredging and maintenance, amphibian use may improve. Long Term surveys will help describe these effects.
- Collect additional habitat and water quality information. Data collected during the worst times for water quality—soon after the first flush in winter—will help establish minimum standards for water quality to support anurans. Measuring and identifying vegetation structure can guide protection and prioritizing improvements.
- Educate land and stormwater managers regarding amphibian habitat considerations when planning and implementing maintenance activities in and around ponds. Share and coordinate information so that changes in survey data can be associated, or not, with maintenance activities.
- Integrate and address anurans in parkwide planning, design, management and maintenance processes, especially in the golf courses and at Roberts Bird Sanctuary. Frogs and toads are wildlife and are now included in the mission of the MPRB[15].

LIST OF ABBREVIATIONS

DNR	Refers to Minnesota Department of Natural Resources
HMG	Habitat management guidelines
MFTCS	Minnesota Frog and Toad Calling Surveys
MN PWI	Minnesota Public Waters Inventory
MPRB	Minneapolis Park & Recreation Board
NAAMP	North American Amphibian Monitoring Program
NPS	Nonpoint source pollution
NWI	National Wetlands Inventory
USGS	United States Geological Survey

[15] The mission of the MPRB is to permanently preserve, protect, maintain, improve, and enhance its natural resources, parkland, and recreational opportunities for current and future generations of our region including people, plants, and wildlife.

GLOSSARY

Anuran	Amphibian without a tail (frogs and toads)
Calling index	Also called “chorus strength”. Rating on a scale of 1–3 where 1=one or two, 2=a few, and 3=many
Chorus strength	Also called “calling index”
Explosive breeding	Concentration of intense breeding activity into short periods of times
First flush	Initial surface runoff in a rainstorm in which pollutants are more concentrated compared to the remainder of the storm. In Minnesota, the first flush in spring from a combination of rain and snowmelt is particularly concentrated because it includes a higher concentration of pollutants accumulated over winter.
Riparian	refers to the area adjacent to a body of water
Run	Sampling window

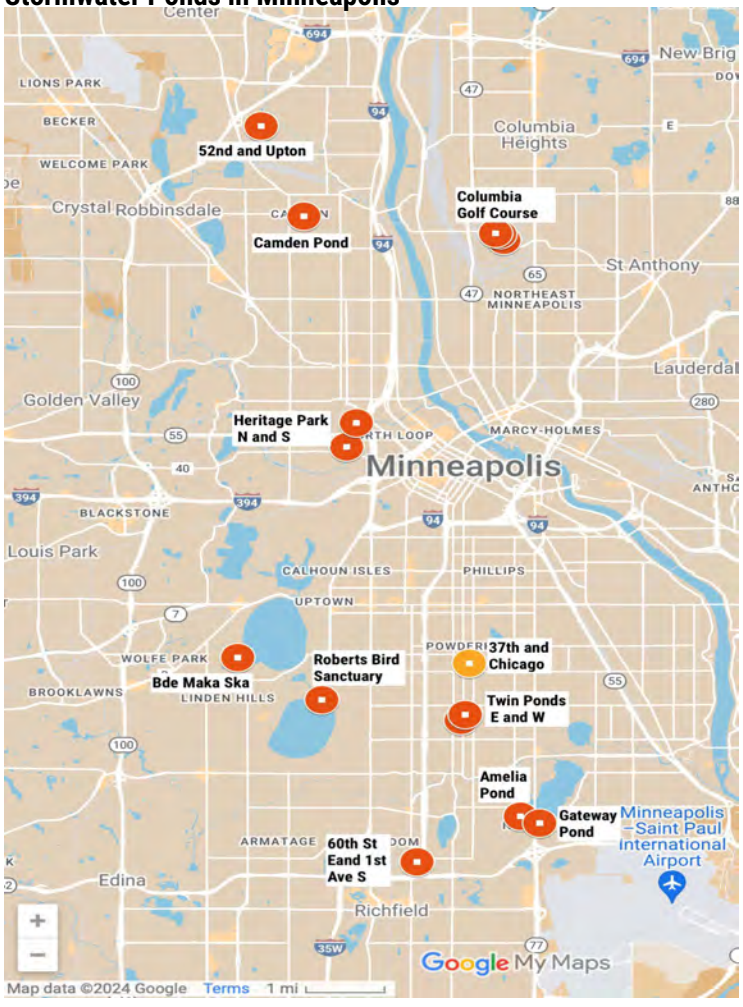
APPENDIX 1 - Comparison of Differences between MFTCS and the Protocol Used in this Survey

	MFTCS	This Survey
Sampling Locations	Randomly assigned and cover a large region. Minimum of 0.5 miles apart.	Not randomly assigned. Limited to Theodore Wirth Regional Park. Locations chosen to align with survey goals Most sites are less 0.5 miles apart.
Data Collection	Measuring water temperature optional; one reading per run used for all sites regardless of location or water source.	Water temperature recorded at all sites, when present and safely accessible.
	Comments limited to one field for all sites and dedicated to how sampling was done (eg., tried to silence frogs at site X).	Additional observations recorded at each location. A field was added to each site for notes about habitat, phenology, weather, etc.
	Records only species heard during the 5-minute listening period. It is optional to note in comments species heard outside of the listening period.	Records frogs and toads **heard** outside of the 5-minute listening period. "P", for present, was used instead of the numeric calling index to distinguish this type of observation from MFTCS protocol in raw data.
	Records only species heard during the 5-minute listening period. Optional to note in comments species seen and not heard.	Records frogs and toads **seen** at a site outside of the 5-minute listening period. P, for present, was used instead of the numeric calling index to distinguish this type of observation from MFTCS protocol.
	Records all species heard during the 5-minute listening period—regardless of distance. Sites are located at least 0.5 miles apart, which prevents hearing calls from another site.	Distinguishes between species heard at the waterbody being sampling site and those heard in the distance (which could be from a nearby sampling site since some are less than a 0.5 mile apart). Calling index for species heard in the distance is denoted by parentheses around the rating, for example (3). Note this is not foolproof as it can

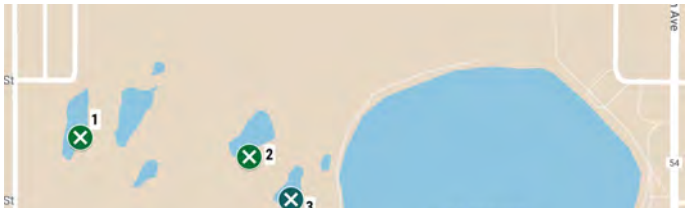
		be hard to discern whether calls are from an adjacent site or on the far side of the location being sampled.

APPENDIX 2 - Locations sampled.

Stormwater Ponds in Minneapolis



Hiawatha Golf Course



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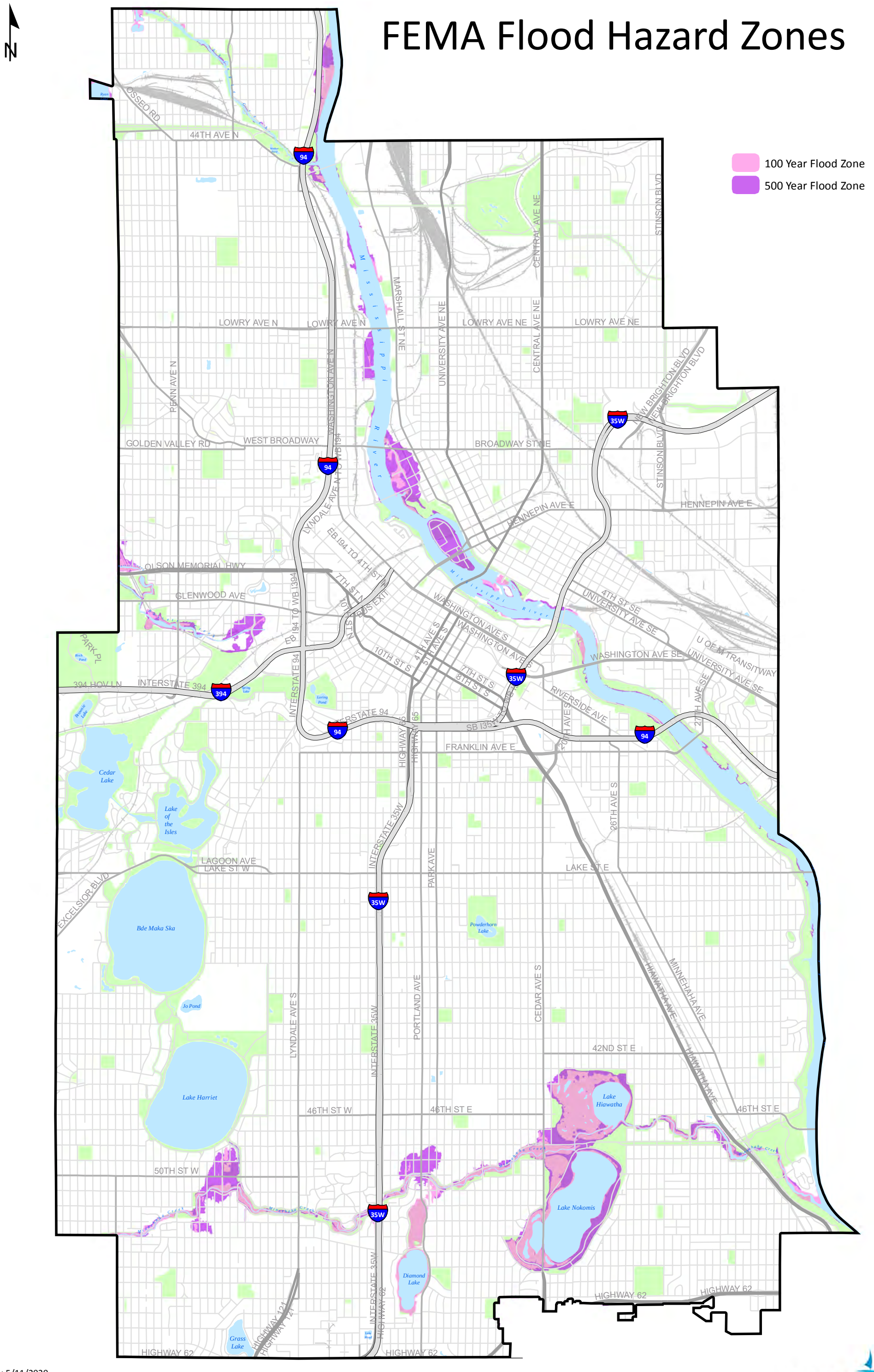
APPENDIX B

Appendix B

FEMA Flood Hazard Zones



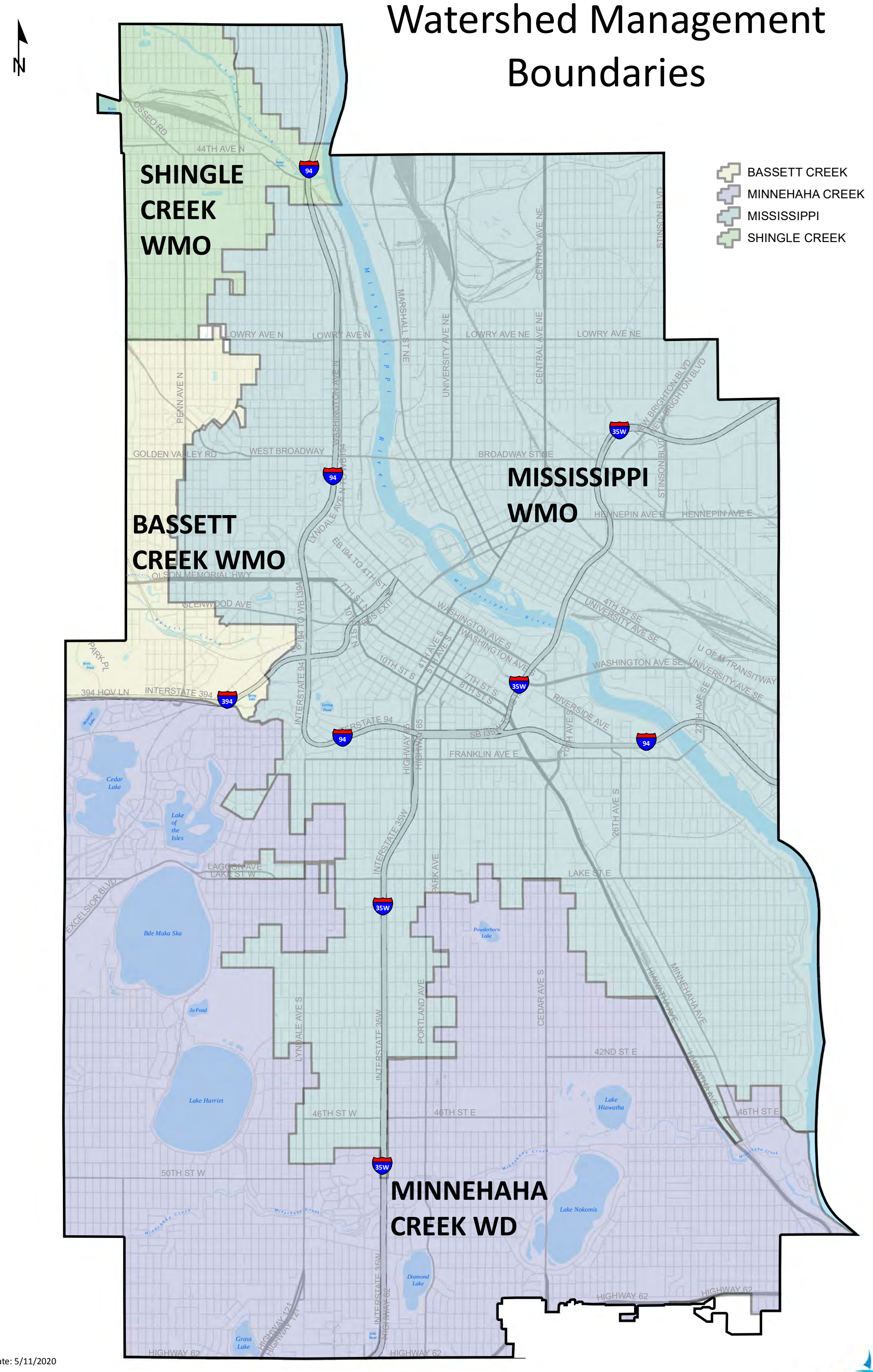
Date: 5/11/2020

Source: National Flood Hazard Layer - Federal Emergency Management Agency
Effective Date : 11-04-2016; Accessed : 06-19-2019

Appendix B1

Minneapolis
Public Works

Watershed Management Boundaries



Date: 5/11/2020

Source: Board of Water and Soil Resources
Effective Date : 02-12-2020
Accessed : 05-06-2020

Appendix B2

Minneapolis Public Works

Pipeshed Drainage Boundaries

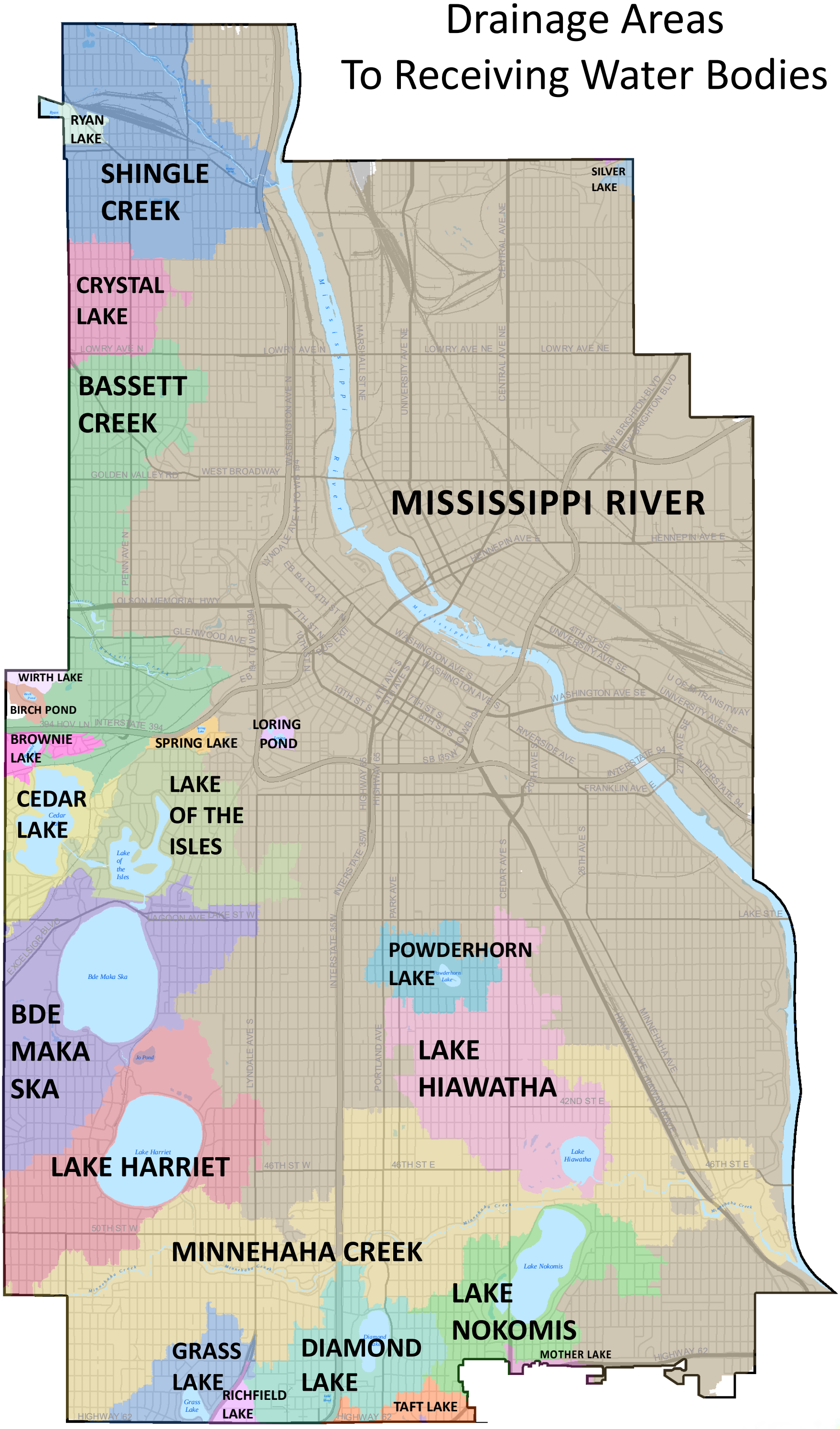
Prefix	Receiving Water
10-XXX	Mississippi River (Mpls)
15-XXX	Mississippi River (UofM)
20-XXX	Shingle Creek
21-XXX	Ryan Lake
40-XXX	Bassett Creek
42-XXX	Wirth Lake
43-XXX	Spring Lake
45-XXX	Loring Pond
51-XXX	Brownie Lake
52-XXX	Cedar Lake
53-XXX	Lake of the Isles
54-XXX	Bde Maka Ska
57-XXX	Lake Harriet
61-XXX	Hart Lake
62-XXX	Silver Lake
63-XXX	Crystal Lake
64-XXX	Legion Lake
65-XXX	Richfield Lake
70-XXX	Minnehaha Creek
71-XXX	Diamond Lake
72-XXX	Lake Nokomis
73-XXX	Taft Lake
74-XXX	Mother Lake
76-XXX	Lake Hiawatha
81-XXX	Birch Pond
82-XXX	Powderhorn Lake
83-XXX	Grass Lake

Date: 4/10/2023
Source: Minneapolis Public Works - Surface Water & Sewers
Effective Date : 04-06-2023; Accessed : 04-10-2023

Appendix B3

Minneapolis Public Works

Drainage Areas To Receiving Water Bodies

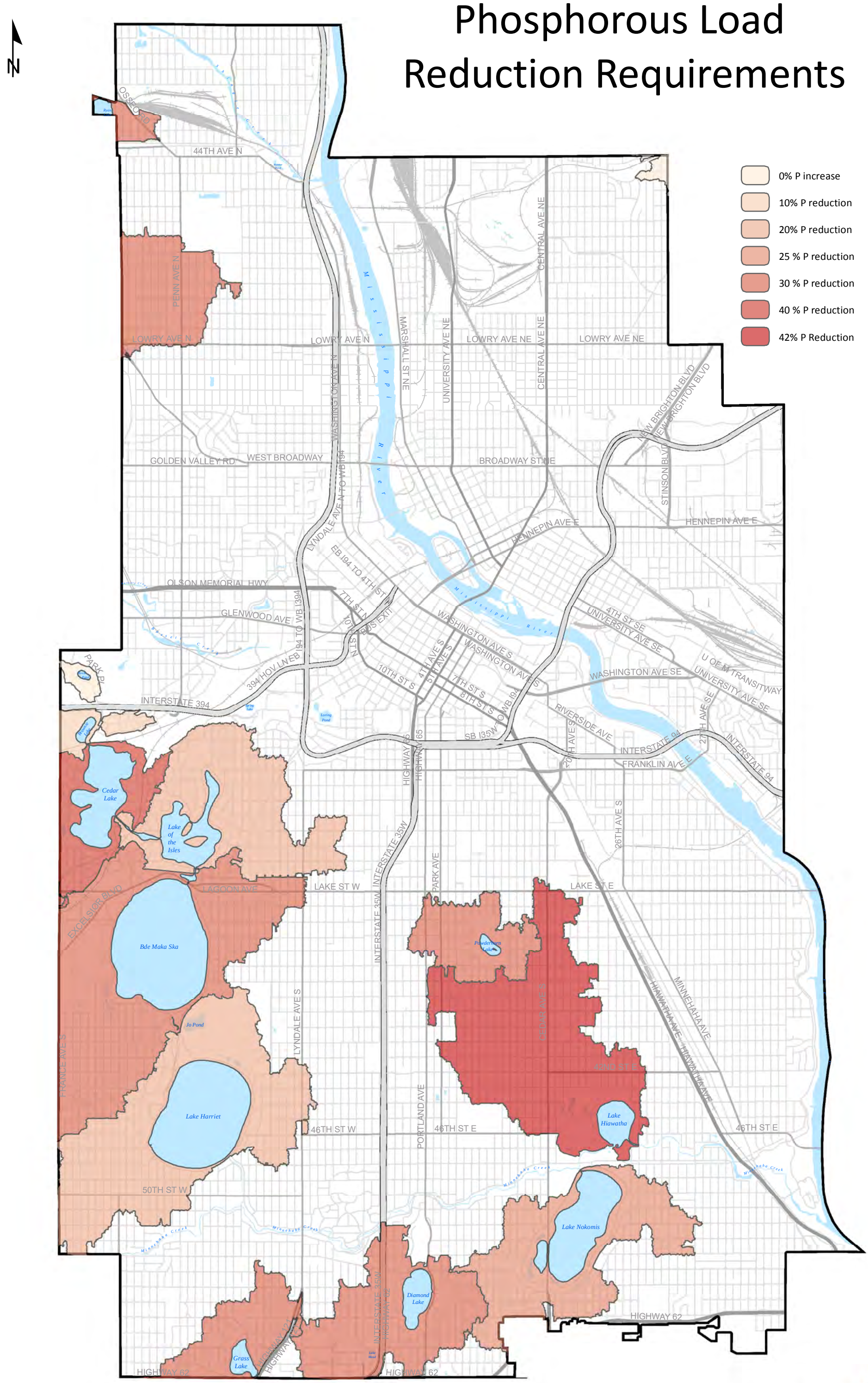


Date: 4/15/2022
Source: Minneapolis Public Works - Surface Water & Sewers
Effective Date : 04-15-2022; Accessed : 04-15-2022

Appendix B4

Minneapolis Public Works

Phosphorous Load Reduction Requirements

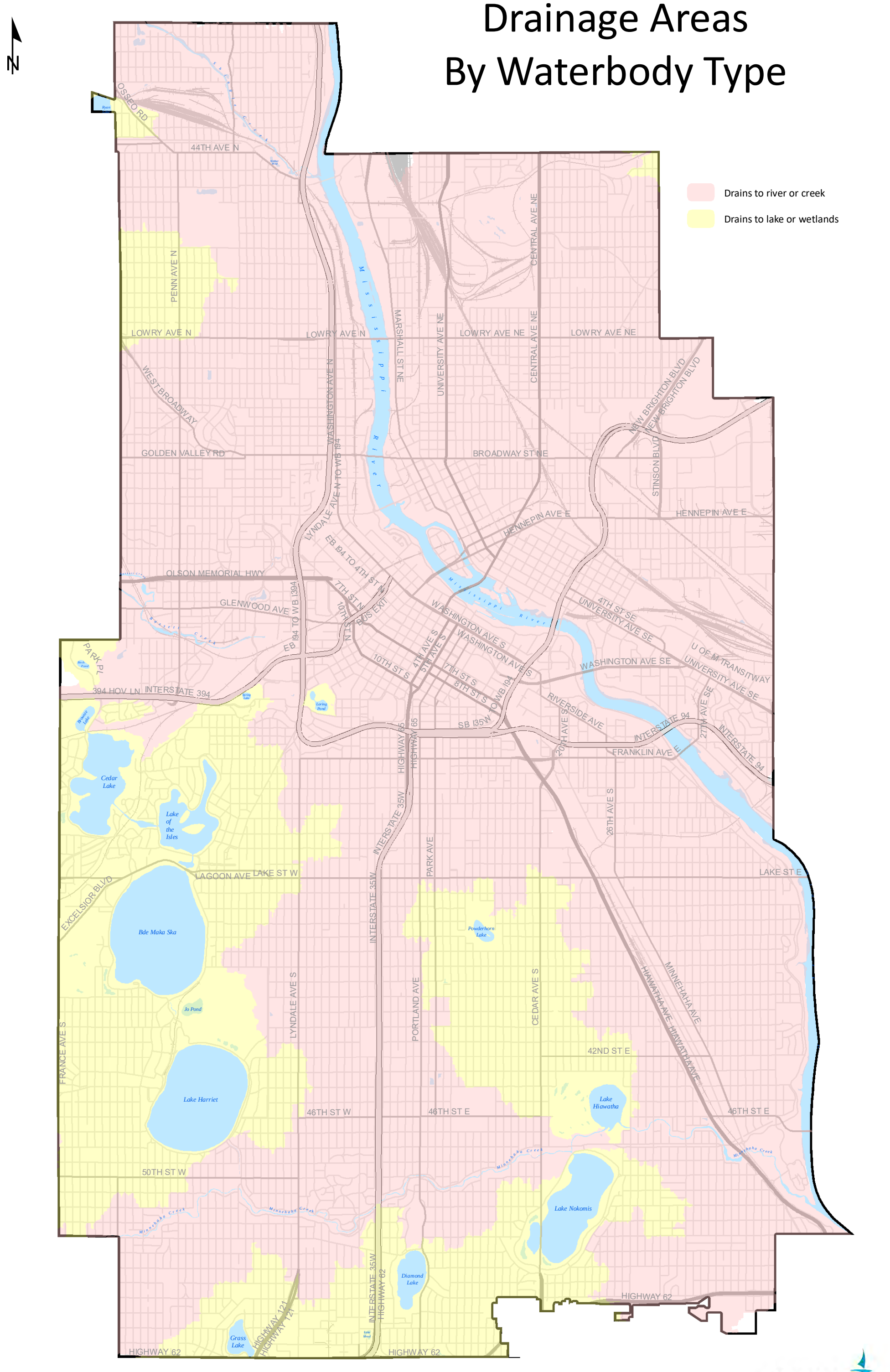


Date: 5/11/2020
Source: Minneapolis Public Works - Surface Water & Sewers

Appendix B5

Minneapolis
Public Works

Drainage Areas By Waterbody Type



Date: 4/15/2022
Source: Minneapolis Public Works - Surface Water & Sewers
Effective Date : 04-15-2022; Accessed : 04-15-2022

Appendix B6

Minneapolis Public Works

Hydrologic / Hydraulic Storm Modeling Status

N

H/H Model Status

- Complete
- In Progress

Document Path: M:\PWSWS\ES_Directory\Grp2PatWrase\Grp2Shared\SewerReports\NPDES Reports\2023 report\GIS_Files\2023_Model_Status.mxd

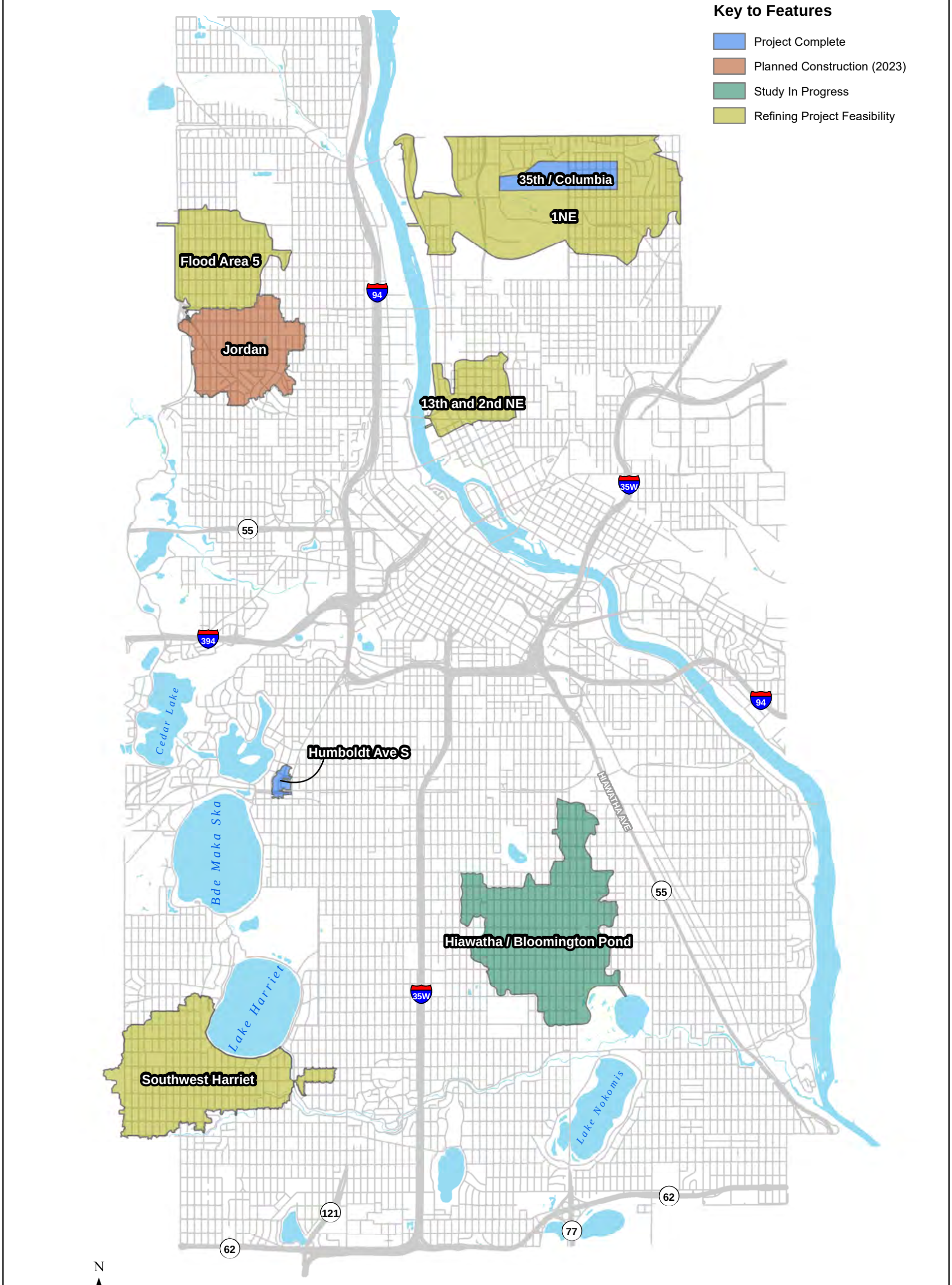
Storm Modeling Status - Appendix B7

Minneapolis
City of Lakes

Surface Water & Sewers Division
Regional Hydrologic / Hydraulic Model
2023 Project Status

4,200 2,100 0 4,200
Feet

Current Flood Mitigation Study Areas



Appendix B8

Minneapolis
City of Lakes

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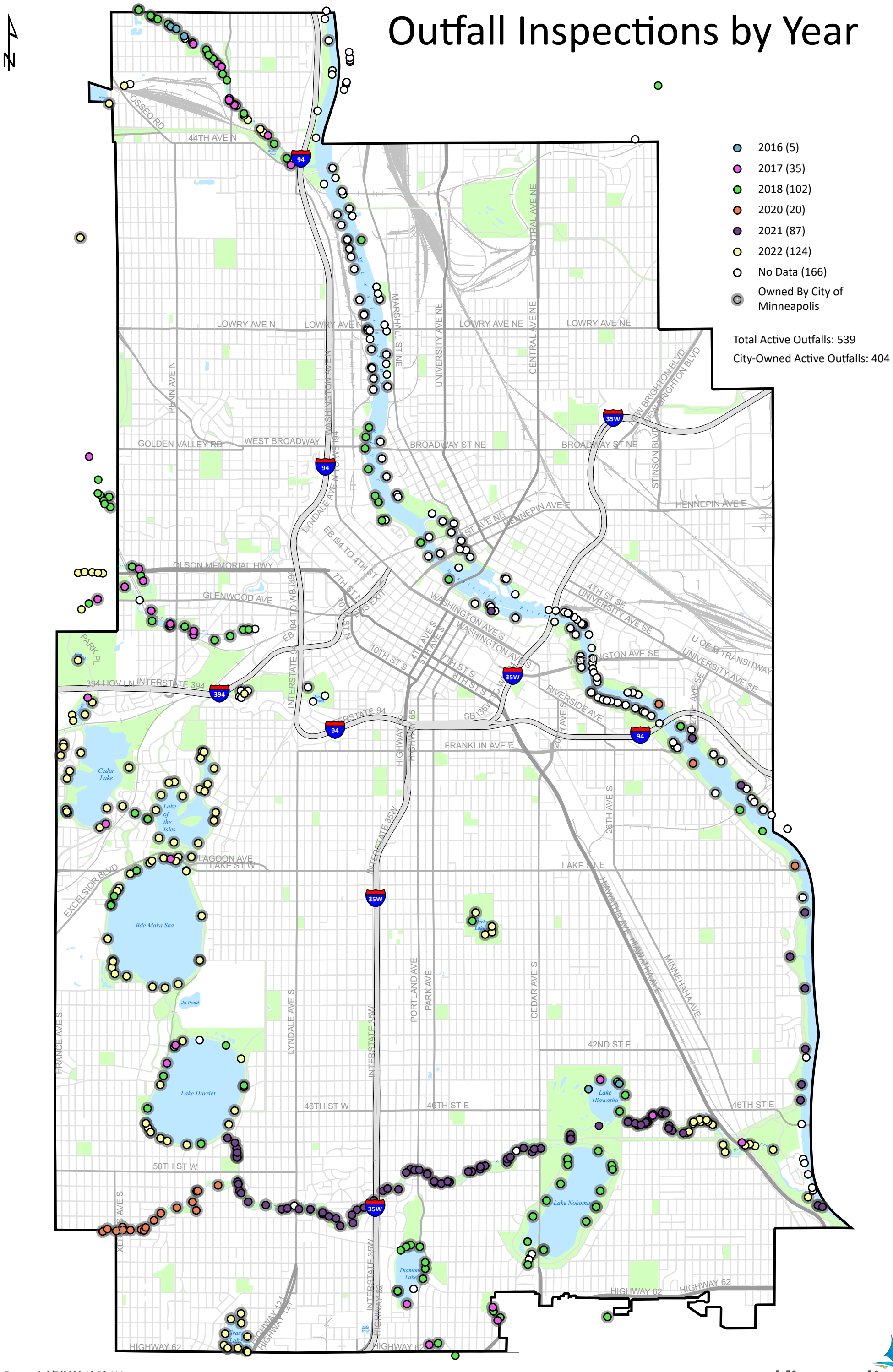
Outfall Inspections by Year



Date Exported: 6/7/2023 10:59 AM

Source: Public Works - Surface Water & Sewers
Effective Date : 1/1/2023

Appendix B9

Minneapolis
Public Works

Appendix C: Public Comment

As part of the NPDES permit process the permittees are required to opportunities for public input on the adequacy of the Stormwater Management Program. This input is gathered annually through written comments and through a public hearing before the Minneapolis City Council. All comments and the response to comments are submitted to the MPCA with the Annual Report.

Notice of the public hearing was sent to environmental groups, related governmental entities, all Minneapolis neighborhood groups, and other interested parties on April 2, 2024, and was also published in Finance and Commerce. This year's public hearing was held on May 2, 2024.

The comments that were received are on the following pages, along with the City's responses, in keeping with permit requirements for the Annual Report.

2023 Program Comments:

In 2024 the City of Minneapolis had one resident with comments on the City/MPRB NPDES MS4 program. This person provided testimony at the city's annual public hearing. The comments can be heard on a recording of that meeting.

The comments were regarding the water quality in Lake of the Isles and the upcoming Hennepin Avenue Road reconstruction project.

There are no program changes proposed based on this public input.