AGENDA

Lakes Management Committee

Meeting date: 9/17/2025 Start time: 9:00 am End time: 10:30 am

Meeting location: Fairmont City Hall, Upstairs Confrence Room

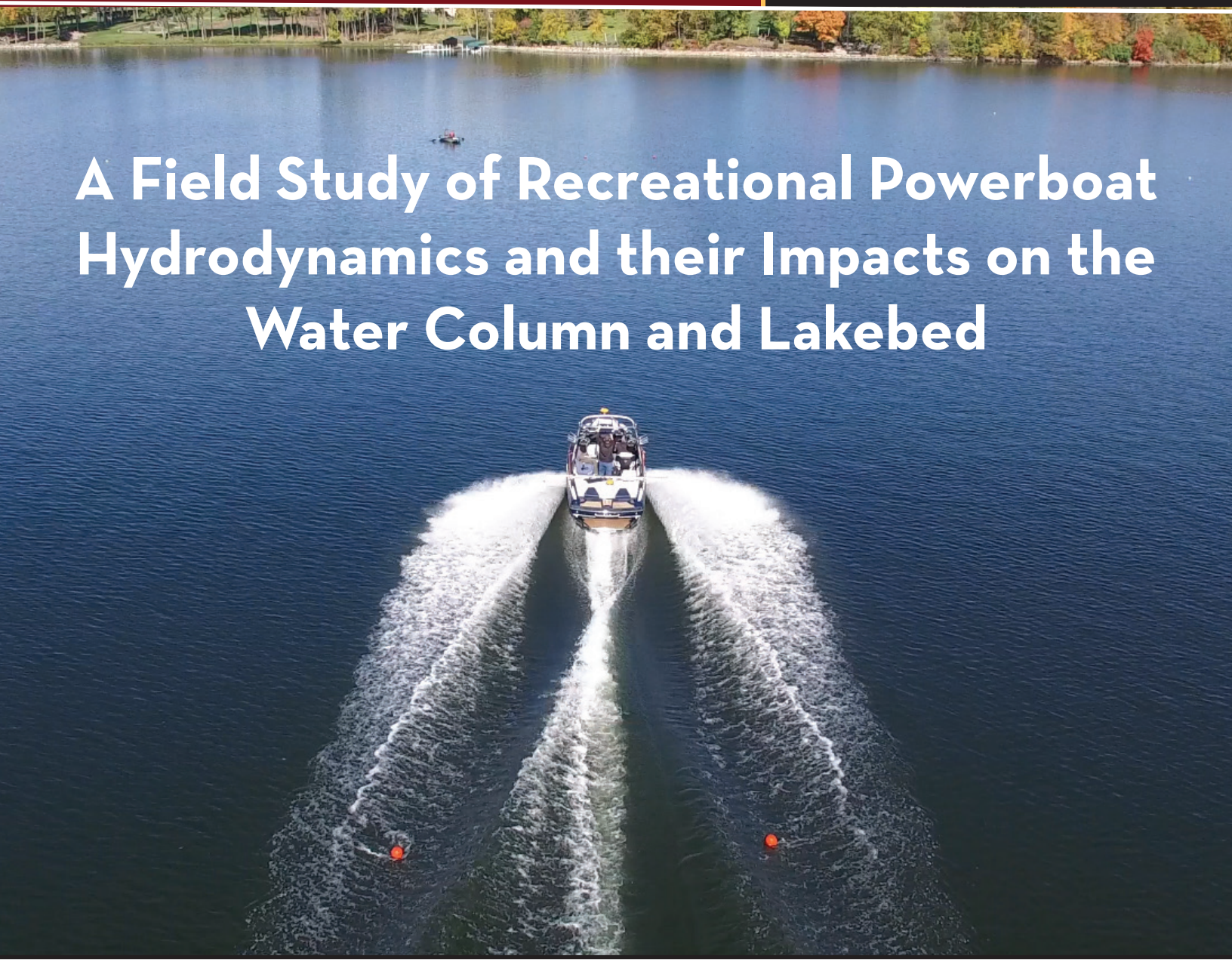
TIME	DESCRIPTION	INTRODUCTION
9:00 am	**Begin Meeting** • **Recurring Meeting Dates**	Neusch/Oman
9:05 am	Sediment Loading-CD 28 & Dutch Creek	Benjamin Lundeen-Statewide Monitoring Coordinator, MPCA
9:20 am	**Funding Options for Large Scale Projects** • **Rock Arch Rapids**	Courtney Phillips-Program and Project Manager, Shell Rock River Watershed District
9:40 am	**CLP Timeline/CLP RFP for Harvesting**	**Neusch/Oman**
9:50 am	Invasive Carp Management Discussion • Rendering Plants	Neusch
10:00 am	**Wakeboat Lakebed Impact Study**	**Neusch/Oman**
10:15 am	SWCD Project Proposal • Wetland Restoration • Water and Sediment Control Basin • Saturated Buffer	**Jesse Walters, Martin SWCD**
10:20 am	**DNR Lake Grades**	**Neusch**
10:30 am	**Other/Adjourn**	

FAIRMONT
CITY OF FAIRMONT, MN

University of Minnesota
Saint Anthony Falls Laboratory

Published
July 2025

A Field Study of Recreational Powerboat Hydrodynamics and their Impacts on the Water Column and Lakebed



College of Science & Engineering

Authors:
Andrew Riesgraf, Jeffrey Marr, William Herb, Matthew Lueker, Jessica Kozarek

REPORT

cse.umn.edu/safl z.umn.edu/healthy_waters z.umn.edu/powerboats

Motivation and Objectives

The recreational use of powerboats continues to increase along with increased boat size, horsepower, and new wake-enhancing technologies. This has led to concerns about the impacts of boating on the aquatic environment. In particular, the impacts of wakeboats operating in wakesurfing mode is a topic of intense public interest. This field-based study was motivated by a need to better understand the environmental impacts within the water column and at the lakebed of different types of recreational powerboats traversing under their typical modes of operation.

The objectives were to: 1) clarify and define the various hydrodynamic phenomena that are created by a recreational powerboat in motion, and how these phenomena vary with water depth and mode of operation, 2) investigate the depth of penetration and duration of emission gases (e.g., engine exhaust bubbles), 3) investigate the water column velocities and depth of penetration of the bow, stern, and transverse waves and their potential to resuspend lakebed sediment, 4) Investigate the propeller wash velocity and depth of penetration, and the potential to resuspend lakebed sediment, 5) investigate the effects of repeated boat passage on thermal stratification and mixing in the water column, 6) capture underwater and aerial video of the hydrodynamic phenomena and any subsequent impacts (e.g., sediment resuspension). This study generated a wealth of data that we used to develop recommendations for the minimum operational depth that recreational powerboats, under their typical modes of operation, should maintain to minimize impacts to the lakebed.



Design

A total of seven recreational powerboats were tested including two deck boats with outboard engines (Hurricane SS203, StarCraft Limited 2000), three bowriders with inboard/outboard engines (Sea Ray SPX190, Cobalt R5, Cruisers Yachts 34GLS), and two wakeboats with inboard engines (Nautique Super Air G23 Paragon, Malibu Wakesetter VLX). These boats are representative of those commonly operated on lakes and rivers.

Testing was performed during two fieldwork campaigns that took place in 2022 and 2023. For each campaign, acoustic-based sensors that measured pressure and velocities through the water column and at the lake bottom were deployed on the lakebed in two different locations and at two different depths. In total, data were collected at four locations of different water depths (9, 14, 16, 27 ft). Additional data were collected including various water quality parameters and lakebed sediment samples. In 2023, we also deployed underwater cameras and an aerial drone.

The boats were tested under two operational conditions that are representative of their typical usage (Figure 1). For the non-wakeboats (deck and bowrider) this was displacement mode (leisure cruise) and planing mode (cruising), and for the wakeboats this was semi-displacement mode (surfing) and planing mode (cruising). The boats were driven directly over the measurement sensors (Figure 2) a total of five times for each operational condition to gather replicate data for statistical analysis.

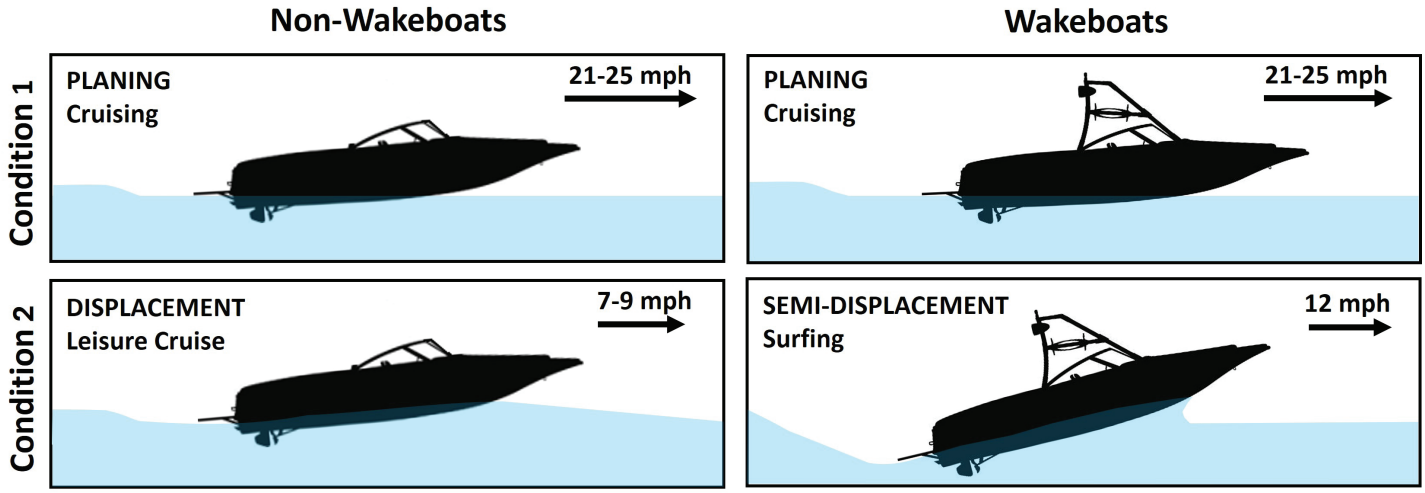


Figure 1. Illustration of the operational conditions testing in this study.



Figure 2. Wakeboat in semi-displacement mode (surfing) being driven over an acoustic-based sensor that measured water pressures and velocities through the water column and at the lake bottom.



This report identifies three distinct hydrodynamic phenomena produced by common recreational powerboats that have the potential to impact the water column and lakebed.

Findings

This report identifies three distinct hydrodynamic phenomena produced by common recreational powerboats that have the potential to impact the water column and lakebed: 1) bow and stern pressure waves, 2) transverse gravity waves, and 3) propeller wash (Figure 3).

1) Bow and Stern Pressure Waves – As the hull moves through the water, it creates elevated pressure at the bow. At the stern, water that was pushed out of the way by the hull rebounds upward creating reduced pressure. The bow and stern pressure waves merge to form a single wave motion that can extend deep below the boat and, depending on depth, can interact with the lakebed and/or submerged aquatic vegetation. The short-duration bow and stern waves were found to be the primary hydrodynamic phenomena that initiates the movement of lakebed sediments but were not sufficient to cause sustained sediment resuspension.

2) Transverse Gravity Waves – Boats that operate below planing speeds form transverse gravity waves. While most boaters are familiar with the divergent waves that make a V-shape wake behind the boat; transverse waves are less obvious, and thus less familiar. These waves have crests that are perpendicular to the travel direction of the boat and move at approximately the same speed as the boat, so they appear, from a passenger's perspective, to be a stationary feature of the wake. Transverse waves can penetrate deep into the water column, persist for several minutes after the boat has passed, and generate velocities large enough to resuspend and entrain lakebed sediment.

3) Propeller Wash – Most recreational boats in use today are powered by an internal combustion engine that generates power to rotate a propeller. The spinning propeller creates a highly complex 3-dimensional jet of water, defined as propeller wash, that pushes the boat through the water. The engine exhaust is injected into the propeller wash as entrained bubbles. The bubbles interact with the propeller wash by dampening energy and proving buoyancy. Because the boat is moving, the direction of the propeller wash is altered by a crossflow effect - the propeller wash plume bends in a direction opposite the boat travel. The cumulative effect of the exhaust bubbles and crossflow limit the penetration depth of the propeller wash. However, propeller wash was shown to impact the water column for several minutes after the boat pass and, under certain modes of operation, contributed to the resuspension and entrainment of bottom sediment. It was further observed that propeller wash can directly cause shearing and complete uprooting of submerged aquatic vegetation under certain operating conditions.

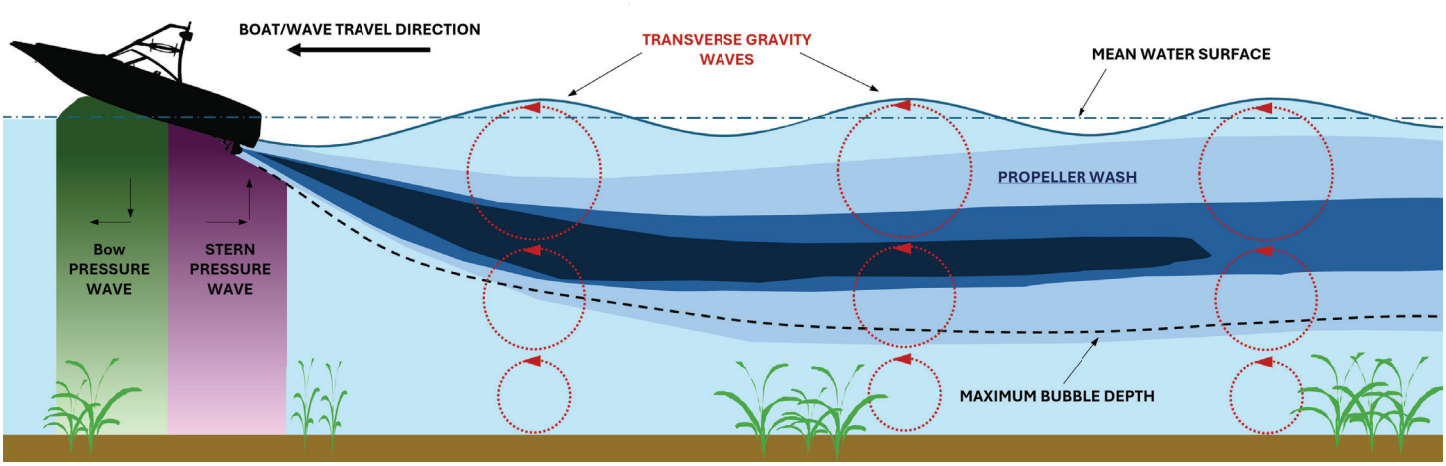


Figure 3. Illustration of the three hydrodynamic phenomena produced by a powerboat and how they interact with the water column beneath the boat.

We found that the velocities of the hydrodynamic phenomena and their depths of penetration are tightly linked to how the boat is being used.

- In planing mode (Condition 1 - cruising), the bow and stern pressure wave velocities were large enough to disturb lower density sediments (e.g., detritus, silt) at depths >10 ft; however, the absence of transverse waves and minimal propeller wash velocities at depths ≥10 ft prevented the sediments from resuspending and entraining in the water column.
- In displacement mode (Condition 2 – leisure cruising), the bow and stern pressure wave velocities were large enough to disturb sediments at depths >10 ft; however, the transverse wave and propeller wash velocities were minimal at depths ≥10 ft, which prevented these sediments from being resuspended and entrained in the water column.
- Wakeboats in semi-displacement mode (Condition 2 - surfing) produce all three phenomena at greater magnitudes compared to the other test conditions. The bow and stern pressure wave velocities were large enough to disturb lakebed sediments to depths of approximately 20 ft. The transverse wave velocities were capable of disturbing fine sediments down to a depth of 15-16 ft. By 20 ft deep the transverse wave velocities had decreased to near zero. The propeller wash velocities were significant down to depths of ~10 ft. After the initial prop wash jet, propeller wash currents were predominately moving towards the water surface (upwelling), which likely played a significant role in the sustained sediment suspension and entrainment into the water column. Below a depth of ~15 ft, propeller wash velocities decreased to near zero. Underwater video and aerial drone video confirmed that lakebed sediment (detritus) had resuspended at a depth of 14 ft.

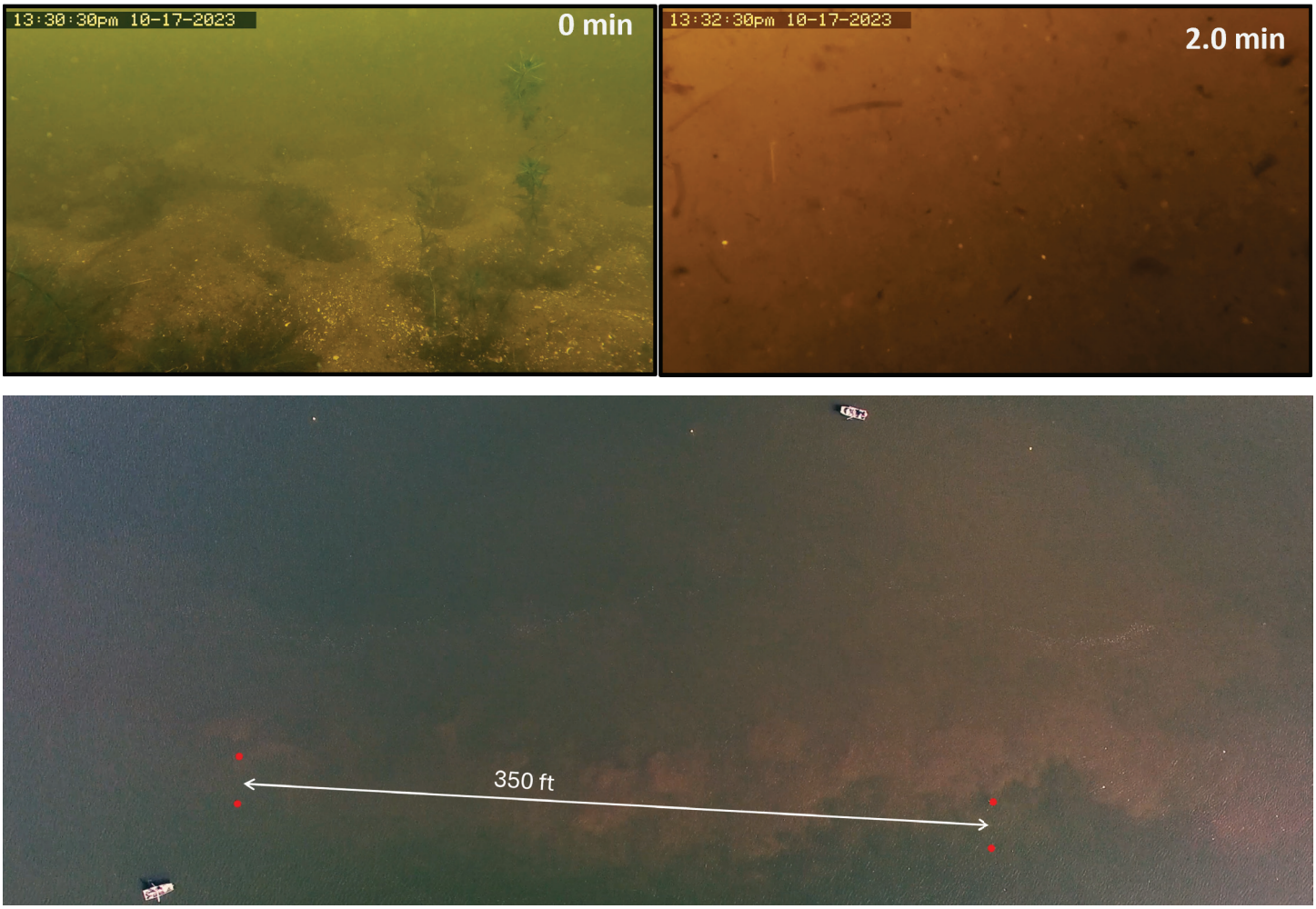


Figure 4. (Upper) Underwater video screenshots taken in 9 ft of water during the first pass of the Malibu VLX Wakesetter in surfing mode. The left image was taken immediately before the boat arrived and the right image was taken two minutes after the boat had passed. (Lower) Aerial video screenshot captured one hour after the first pass of the Malibu VLX Wakesetter under surfing conditions. The distance between the red buoys (data collection locations) is 350 ft.

Recommendations

Depth of Operation to Limit Impacts on the Lake Environment

Although these hydrodynamic phenomena are not fully visible from the water surface, powerboats can create large waves and currents that can extend deep into the water column and, depending on the water depth, can disturb the thermal regime, submerged aquatic vegetation, and lakebed. To minimize impacts to the lakebed, we provide the following depth recommendations for recreational powerboats operating in their typical modes:

- ***Recommended depth of operation for planing mode (cruising).*** Recreational boats, like the ones studied in this project, should operate in 10 ft of water or greater when planing to minimize impacts on the lakebed.

- ***Recommended depth of operation for non-wakeboats and wakeboats in displacement mode (leisure cruising).*** Recreational boats, like the ones studied in this project, should operate in 10 ft of water or greater when in sustained displacement mode to minimize impacts on the lakebed.

- ***Recommended depth of operation for wakeboats in semi-displacement mode (surfing).*** Wakeboats should operate in 20 ft of water or greater when in semi-displacement mode to minimize impacts to the lake bottom.

UNIVERSITY OF MINNESOTA
Saint Anthony Falls Laboratory



2 SE 3rd Avenue
Minneapolis, MN 55414

Research questions: marrx003@umn.edu
Media inquiries: erdma158@umn.edu

cse.umn.edu/safl
cse.umn.edu/saf l/Healthy_Waters

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

Funding provided by the Minnesota Environment and Natural Resources Trust Fund.

From: Jesse Walters <jesse.martinswcd@gmail.com>
Sent: Wednesday, August 20, 2025 1:07 PM
To: Hannah Neusch <hneusch@fairmont.org>
Cc: Pat Oman <poman@fairmont.org>
Subject: Project Proposal

Hannah,

I have attached a concept map of a project I'd like to propose. The location is all within the newly seeded area of Cedar Creek Park near the bike/walking path. The proposal includes:

1: Wetland Restoration - Reduces flooding & reduces pollutants.

2: Water & Sediment Control Basin: Reduces flooding, reduces pollutants (including sediment, fertilizers and pesticides)

3: Saturated Buffer: Reduces Nitrates

This project also addresses a problem area that is shared with the neighboring landowner to the West. Over the years there has been unmanageable flooding & erosion. This project would take care of the current issues and make improvements to help remove sediment & nutrients.

We are able to reimburse the project at a 100% cost share rate.

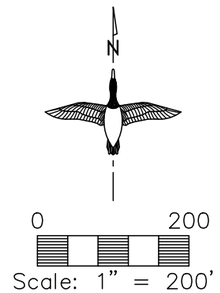
If the City is agreeable, I can solicit bids. Once we have chosen a bid/contractor I will need the City to sign a cost share application. My board will then approve the cost share application. We will oversee construction with the designing engineers from our Technical Service Area team. Upon project completion, the City will pay the contractor and receive 100% reimbursement for project costs.

I have already discussed the project with the neighboring landowner and tenant. They are supportive of the project as proposed.

Let me know if you need anything else from me. I can be available on August 25th if needed.

--
Jesse Walters
Outreach Coordinator
Martin Soil & Water Conservation District
507-235-6680 Ext. 118
923 North State Street, Suite 110, Fairmont, MN 56031

CONCEPT PLAN VIEW



LEGEND

- FE — FIELD EDGE, EXISTING
- PL — PROPERTY LINE
- TILE, EXISTING, APPROX. LOCATION
- CONTOUR, EXISTING
- CONTOUR, PROPOSED
- TILE INTAKE, PROPOSED
- TILE, PROPOSED
- HDPE DUAL WALL, PROPOSED
- TILE REMOVAL TRENCH

BM#1 LOCATED ON TOP OF 60" CONCRETE INTAKE STRUCTURE ON WEST SIDE OF WALKING PATH

ELEV. = 1197.24

CONCEPT DESIGN NOTES:

WETLAND BASIN RESTORATION

WATERSHED AREA = 11.5 ACRES
WETLAND MAX POOL AREA = 2.1 ACRES AT ELEVATION 1204.4
RATIO OF WATERSHED AREA TO POOL AREA = 5.5

THE BASIN OVERFLOWS EAST AT ELEVATION 1204.4

THE TOPOGRAPHY AND AERIAL IMAGERY SUGGEST THE DRAIN TILE IN THIS BASIN WOULD NOT EXTEND OFF THE PROPERTY. BLOCKING AND/OR REMOVAL OF PARTS OF THE EXISTING DRAIN TILE SYSTEM WOULD RESTORE THE NATURAL HYDROLOGY TO THE BASIN.

THE WATERSHED TO THE BASIN IS LIKELY NOT LARGE ENOUGH TO SUPPORT CONSISTENT STANDING WATER. THE WETLAND BASIN WOULD BE SEASONALLY WET.

NEED TO ASSESS THE CONDITION OF THE NATURAL OVERFLOW ELEVATION, TO DETERMINE IF GRADING WORK IS NECESSARY TO PROVIDE A FLAT, STABLE SURFACE OUTLET.

CONCEPT DESIGN NOTES:

WATER AND SEDIMENT CONTROL BASIN

WATERSHED AREA = 13.1 ACRES
DESIGN STORM 10-YR, 24-HR PEAK FLOW RATE
EXISTING CONDITION 29.0 CFS
PROPOSED CONDITION 1.4 CFS

EMBANKMENT AND INTAKE WOULD BE SITUATED ON CITY PROPERTY.

PONDING WOULD OCCUR ON THE BARKER PROPERTY. WASCOB INTAKE AND DRAIN TILE SYSTEM DESIGNED TO DRAIN THE BASIN IN 24 HOURS AT MAXIMUM DEPTH. 5" DIA. SUPPORT DRAIN TILE WOULD BE INSTALLED IN THE BASIN. THE WASCOB WOULD HAVE A SEPARATE OUTLET INTO THE RAVINE SYSTEM.

SATURATED BUFFER

CONNECT TO EXISTING 6" DIA. DRAIN TILE THAT OUTLETS AT RAVINE.

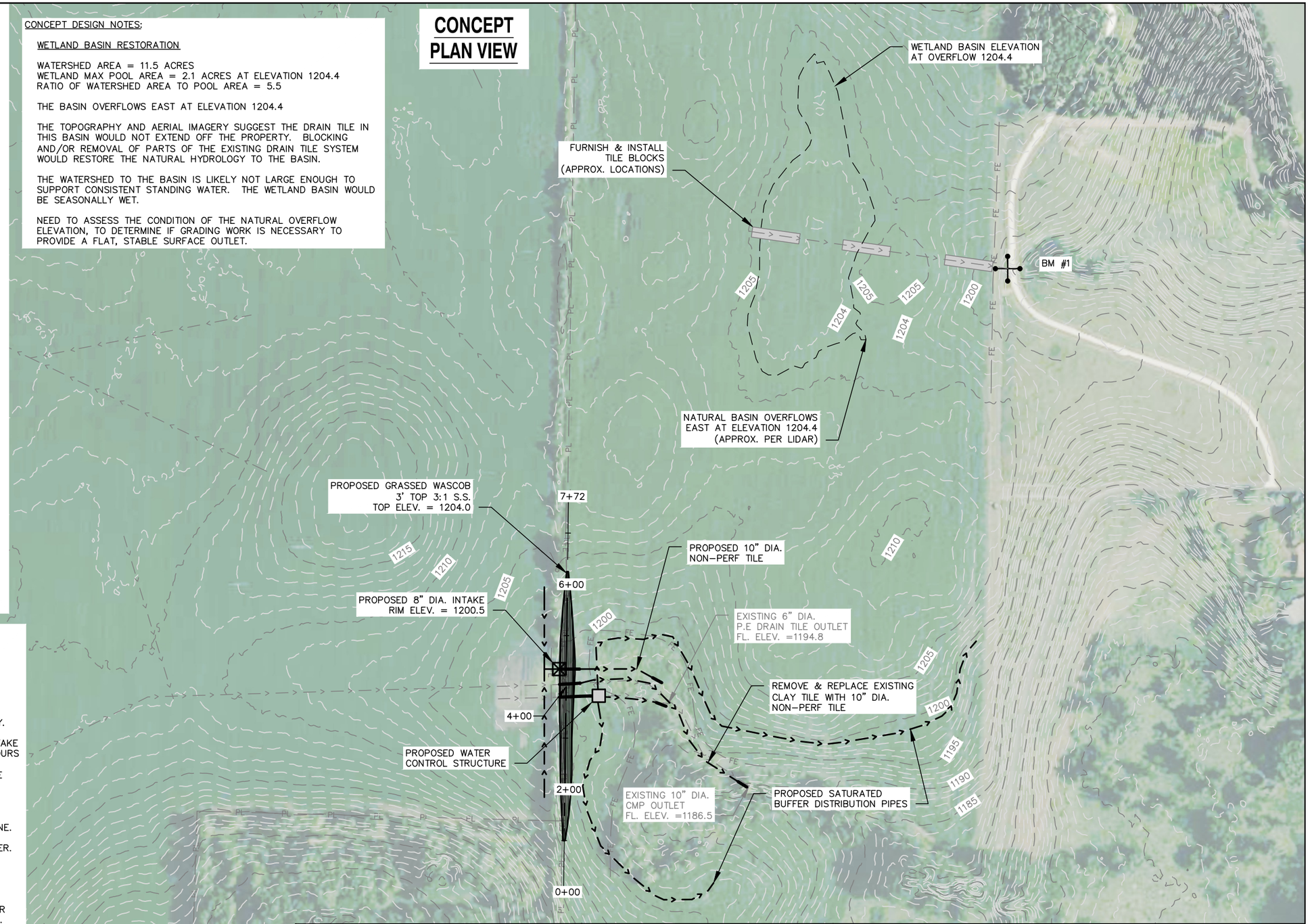
WASCOB DRAINAGE WOULD NOT DRAIN THROUGH SATURATED BUFFER.

SHOWING A STRUCTURE AND DISTRIBUTION LINES ALONG THE ELEVATION 1199 CONTOUR, WITH WATER TABLE ELEVATION SET TO APPROX. ELEVATION 1198.

EXISTING DRAIN TILE THAT RUNS THROUGH THE SATURATED BUFFER AREA WOULD NEED TO BE REPLACED WITH NON-PERFORATED PIPE.

NO INFORMATION KNOWN AS TO THE EXISTING 10" DIA. CMP OUTLET THAT IS LOCATED FURTHER DOWNSTREAM IN THE RAVINE CHANNEL. EXCAVATION FOR TILE INVESTIGATION WOULD BE NECESSARY TO LOCATE THE DRAIN TILE AND ADJUST THE PLAN AS NEEDED.

SOME SOIL PROBE WORK WOULD BE NEEDED TO VERIFY THERE ARE NO SAND OR GRAVEL LENSES LOCATED WITHIN THE PROPOSED SATURATED BUFFER. IF THESE TYPES OF SOILS ARE PREVALENT IN THE AREA THE SATURATED BUFFER WILL NOT FUNCTION.



GPS	
UNITS	US SURVEY FEET
COORDINATE SYSTEM	UTM 15 NORTH
DATUM	NAD83 (2011)(MOL)
GEOID	GEOID03 (CONUS)

SURVEY	
Surveyed	Date
BAJ	4/22/25
Drawn	Date
BAJ	6/24/25
Checked	Date

I HEREBY CERTIFY THAT THIS PLAN WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

PRINT NAME: RYAN T. JONES

SIGNATURE: _____

DATE: _____ LICENSE # 44622

SOUTH CENTRAL TECHNICAL SERVICE AREA
1160 S. VICTORY DRIVE
MANKATO, MINN.
(507) 345-1051

CITY OF FAIRMONT

CEDAR CREEK PARK

CONCEPT PLAN

SHEET 1 of 1

ADVERTISEMENT

ENVIRONMENT

A ‘C’ ranking for the Minneapolis Chain of Lakes is a triumph of environmental restoration

AUGUST 16, 2025



Beachgoers take in the setting sun in July at Cedar Lake South Beach in Minneapolis. (Anthony Soufflé/The Minnesota Star Tribune)

The most visited natural destination in Minnesota lies in its most densely developed region.

By Greg Stanley
The Minnesota Star Tribune

ADVERTISEMENT

Comment Gift Share Listen

The summer clouds over Cedar Lake in Minneapolis looked like they could go either way. A pair of kayakers getting ready to launch smiled at the mist in the air and decided to chance the rain. Nearby, a fisherman leaned against a tree and cast. Behind him, an old

yellow Lab pulled its owner down a walking path that circled the lake. A steady stream of joggers followed, and cyclists, who shouted “on your left,” with the backdrop of the Minneapolis skyline.

The most visited slice of nature in Minnesota isn’t in a state or national park. It’s not an old-growth forest or patch of surviving prairie. It’s the chain of four lakes that starts with Cedar and ends with Lake Harriet in the heart of Minneapolis.

Listen: Reporter Greg Stanley discusses these stories in our podcast "Worth It," hosted by Nicole Norfleet.

Until about 30 years ago, the Chain of Lakes seemed like it would be lost, to be slowly strangled by all the pollution and runoff of the metropolis that grew up around it. A forward-thinking project that started then – the largest of its kind at the time in U.S. history – reversed decades of environmental degradation. The benefits of that work continue today.

“Those investments occurred at a great time to make sure these lakes didn’t reach a tipping point,” said Michael Hayman, the director of project planning for the Minnehaha Creek Watershed District. “And they’ve been very stable ever since.”



Ducks and people, such as Andrew Branson fishing on an August Sunday, coexist on Lake of the Isles. (Anthony Soufflé/The Minnesota Star Tribune)

Making the grade

The Minnesota Department of Natural Resources started issuing grades and scores to about 3,000 lakes in 2023. The grades, for the first time, give residents and local governments an easy to way to look up the condition of their lake and compare it to others without needing to scour through reams of pollution data. A searchable database of every lake with a grade was built by the DNR’s Watershed Health Assessment Framework program.

The letter grade, from A+ to F – based on a 0 to 100 score – denotes the health of a lake and how far it has fallen from what a lake of its size, depth and region should be. A lake’s score is based on how polluted it is, whether fish and native plants survive, and the development on its shoreline and watershed.

There are 11,842 lakes in Minnesota, many of which are too remote or small to have been consistently studied. Biologists scored every lake that has enough data, which tended to be the biggest and most popular. Lake Superior, Lake of the Woods and other border lakes were omitted.

The handful of Minnesota lakes that received the best grades, and overall scores in the high 90s, are still almost natural, with very little pollution or marks of human intrusion.

The four lakes in the Minneapolis chain – Cedar, Lake of the Isles, Bde Maka Ska and Harriet – were all given C’s. In some parts of the state, more wooded and natural than Minneapolis, a C could be cause for alarm. For a series of lakes that collect all the stormwater from tens of thousands of homes and businesses, and hundreds of miles of some of the busiest roads in the state, the scores are remarkable. They highlight a sharp turnaround from when the chain was at a crisis point.

The problem

By the 1990s, the lakes were in bad condition and getting worse. The marshes, woods and prairies that once surrounded the chain had long been drained away and paved. Native plants were dying off, likely because sunlight wasn’t penetrating the murky water, said Rachael Crabb, the water resources supervisor for the Minneapolis Park Board. Water clarity was declining. Algae blooms were frequent.

Citizens urged the city to take action, writing in the Star Tribune that Brownie Lake, which flows into Cedar, was “indeed on its deathbed – less a living environment than a chemical sink.” On Cedar Lake, citizens complained of “turbidity, ammonia smells, fish kills and swimmer’s itch.”

Related Coverage



ENVIRONMENT

Where only carp can thrive: Meet Ocheda, one of the unhealthiest lakes in Minnesota



ENVIRONMENT

This lake can lay claim to the title of fishiest in Minnesota



ENVIRONMENT

Look up the health of your favorite lake

Unless major changes were made, experts warned, the water would continue to get worse and the lakes would end up on the state’s infamous impaired waters list. In a matter of years, the chain could be overrun by nutrients and bacteria to the point where it would be unsafe to swim. Large numbers of fish and other aquatic life would die off.

The main culprit, as it often is in fresh water, was phosphorus.

In fresh water, certain bacteria and algae usually have an abundance of everything they need to thrive, bloom and take over a lake, except for phosphorus.

With every wetland drained and home, parking lot and street built, Minnesotans were shooting more and more phosphorus into the Chain of Lakes. Algae and cyanobacteria were taking full advantage.

A Minnesota Pollution Control Agency report found that Cedar Lake, the first in the chain, had nearly three times the phosphorus it had before development. Along with that phosphorus, a toxic stew of pet waste, fertilizers, pesticides, chemicals and oils was piped directly into the lakes from lawns and streets through stormwater systems.



Paddleboaders on Cedar Lake on an August Sunday. Without the conservation efforts of previous decades, such activity would be impossible by now due to pollution. (Anthony Soufflé/The Minnesota Star Tribune)

Answering the call

While the lakes are inside Minneapolis city boundaries, much of the land that drains into the lakes is outside the city’s jurisdiction.

It was immediately clear that Minneapolis would not be able to fix the problem alone. Spurred on by citizens, the city formed a Clean Water Partnership with several agencies and organizations including the Minneapolis Park and Recreation Board, St. Louis Park, Edina and the Minnehaha Creek Watershed District.

They divided up the $12.4 million cost of the restoration project and started work in 1995. First, they found the key areas where much of the pollution was entering the chain, which happened to be on parkland already publicly owned.

They restored Cedar Meadows, an old marsh on the western end of Cedar Lake that was covered up and filled in with dredge spoils in 1918. A walking bridge crosses the marsh now, where thriving cattails and native plants soak up hundreds of pounds of phosphorus a year before it can enter the lake.

In St. Louis Park, the partners dredged out phosphorus-laden silt from the bottom of Twin Lakes, a small lake upstream of the chain. They also dug out a small pond just upstream of Twin Lakes, to help settle out nutrients and pollution.

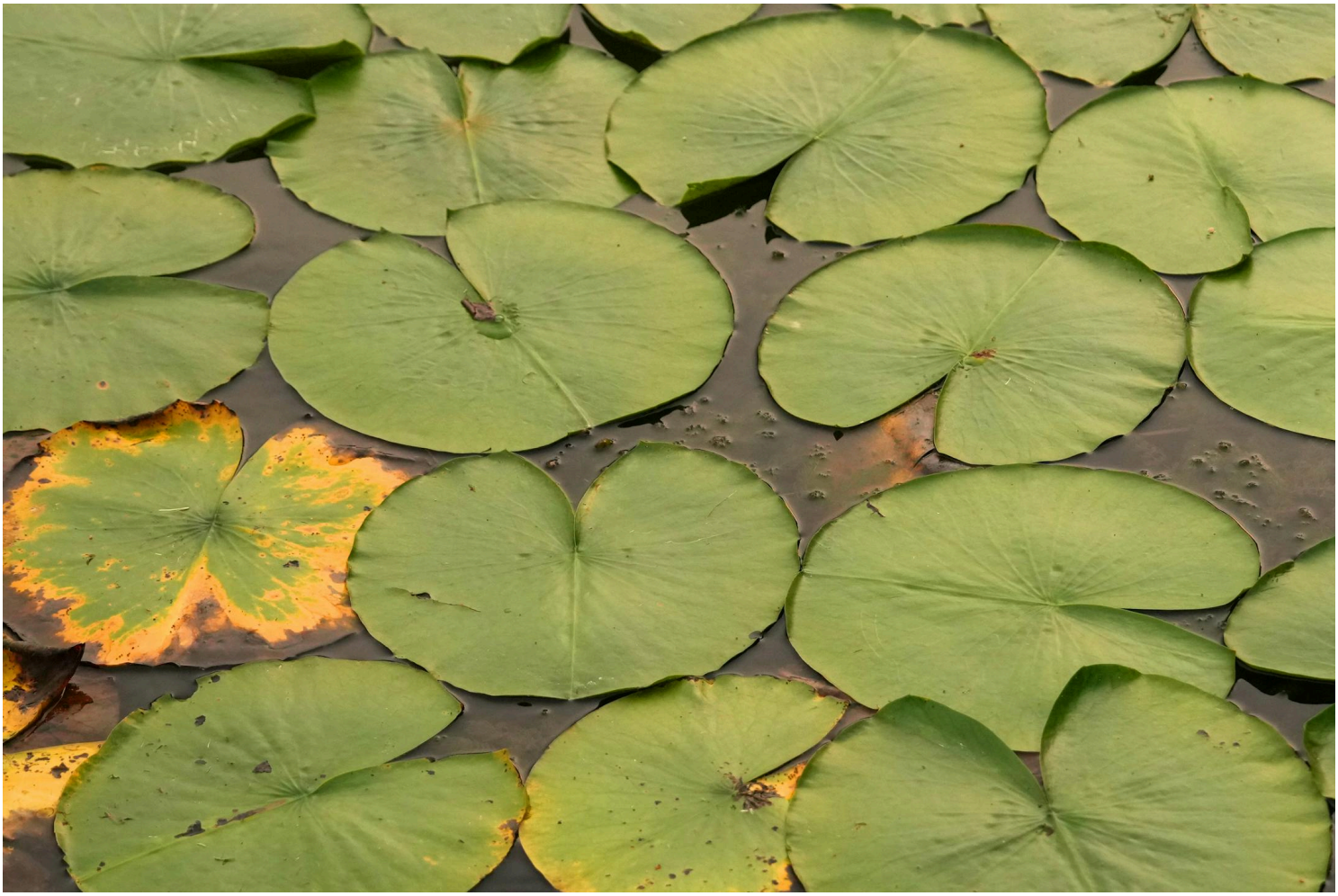
On Bde Maka Ska, the group excavated three ponds that function as a wetland near the southwest shore. The ponds allow the nutrient- and chemical-laden water entering the lake to settle, leaving toxins and phosphorus behind while cleaner water passed through.

The city also increased its street sweeping program and started a public education campaign to cut down on the pesticides, grass trimmings and fallen leaves washing into the lakes. As grass and leaves decompose in water, they feed bacteria and algae that remove oxygen, suffocating fish. Grit chambers were added to stormwater pipes to create choke points that slow down the incoming water, allowing the nutrients and trash to settle into a black sludge. The sludge is eventually vacuumed away and taken to a landfill.

Once the incoming tide of pollutants was dealt with, the partnership went about getting rid of the excess phosphorus that had built up in the lakes over the decades. They did it by spraying alum over the water. Alum binds to dissolved phosphorus as it sinks, taking the nutrient out of the water column and planting it firmly on the bottom of the lake, where algae and bacteria cannot feed off it.

The results were rapid.

By 2003, the water was clearer in all four lakes. Native plants received sunlight again. Cedar Lake’s phosphorus numbers were back to near-natural levels. Bde Maka Ska, Harriet and Lake of the Isles were close.



Lily pads on Cedar Lake, where levels of phosphorus were managed back to near-natural numbers. (Anthony Soufflé/The Minnesota Star Tribune)

Many restoration projects are successes if they can stop 10 or 20 pounds of phosphorus from entering a lake. The Environmental Protection Agency estimates the work in the 1990s has been stopping 600 pounds from entering the chain every year since.

The lakes have needed periodic work since the project finished. The Watershed District has spent about $500,000 regularly dredging the ponds and wetlands that were installed. It also spends about $35,000 a year maintaining vegetation along the shores. The Park Board has received a little more than $8 million from the state’s Outdoor Heritage Fund since 2010 to install paths and fishing docks and to stabilize the chain’s shorelines.

The Park Board also chips in about $450,000 a year to help the city maintain, design and improve its stormwater infrastructure and street sweeping program to keep nutrients and trash out of Minneapolis lakes.

The lakes still have their problems. Beaches close periodically because of E. coli or blue-green algae outbreaks. Sodium from road salt has been threatening urban lakes in Minnesota for the past 20 years. The chain remains in a watershed that has been almost entirely developed and paved.

That development, and the high stormwater flow that results, puts stress on fish and habitat that is difficult to reverse, Crabb said.

The C’s that the chain received reflect their relatively high water-quality scores and low scores for aquatic life metrics. The water quality alone of Bde Maka Ska would have earned the lake a B. But its biology score was a D+.

“Our parkland area is so small compared to undeveloped land around outstate lakes,” Crabb said. “All Minneapolis lakes score lower on biodiversity and species richness and habitat quality portions of the metric. That’s not unexpected for lakes within 15 minutes of a major cities’ downtown and habitats that receive large stormwater inputs.”

As winters get warmer, the lakes have less ice coverage, which has lengthened the growing season for bacteria and plants. Blue-green algae blooms, which often look like bright-green pea soup and can kill dogs, are increasing, at least partly due to the longer growing season, Crabb said.

But on a Saturday morning in July, none of those problems was evident as the rain held off and the sun peeked out over Bde Maka Ska. The paths were busy with dozens of joggers, while picnic benches were filled under the shade of old oak trees. Four sailboats slowly circled the deep waters. Under a fishing pier, small bluegill lazily swam in the shallow, clear water.

A pair of spiny softshell turtles crawled from the water onto the sand of one of the beaches. A man trying to take a picture scared them, and they sprinted back into the water faster than one might think a turtle could. The man left, and one of the turtles watching from the water crawled back out to the beach and rested in the sun, as though it decided that while the lake may be a little crowded, all in all, everything was OK.



Rental canoes on the shore of Bde Maka Ska, which sees plenty of activity every day thanks to conservation work started in the 1990s. (Anthony Soufflé/The Minnesota Star Tribune)

✦ ABOUT THE WRITER

Greg Stanley
REPORTER

Greg Stanley is an environmental reporter for the Minnesota Star Tribune. He has previously covered water issues, development and politics in Florida's Everglades and in northern Illinois.

See More ›

More from Environment See More ›

ENVIRONMENT
St. Paul foundry will install new equipment to settle pollution case

DEPARTMENT OF NATURAL RESOURCES

Watershed Health Assessment Framework (WHAF): Lakes

Use Guide

Open the WHAF for Lakes Application

Option 1: Launch the WHAF for Lakes application through the main WHAF map.

- Click on the map to set your location.
- Open 'Charts and Reports'.
- Select the scale you want to use to investigate a list of lakes.
- Click the **WHAF for Lakes** button.

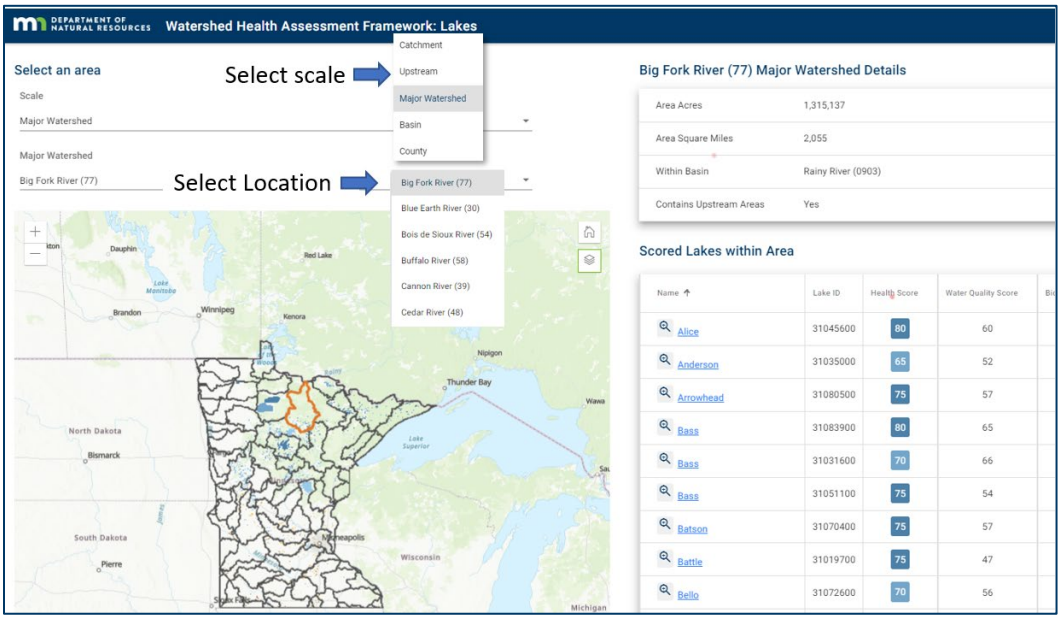
Option 2: Launch the WHAF for Lakes application directly in your browser.

- The default map displays the major watershed boundaries.
- Select a major watershed from the map or select from the **Major Watershed** dropdown list.
- Or select a different exploration boundary from the scale dropdown list.

Option 3: Select a Specific Lake

- Launch the WHAF for Lakes application.
- Open Menu (Upper right corner).
- Select **Lake Details.**
- **Lake Search** is now active in the upper left.
- Enter a lake name or lake ID number and select your lake from the list.

Select an Area



- Select a new area to refresh your list of lakes.
- Use **Scale** to select a new exploration boundary (Catchment, Upstream, Major Watershed, Basin, County).
- Use the map or the second dropdown list to select a location at that scale.
- At the catchment or upstream scale, you can also enter a catchment number to zoom to that location.
- Depending on your screen width, your search results may appear to the right of the map or below the map.

Map Tool Set

Map tools with scale boundary selected:

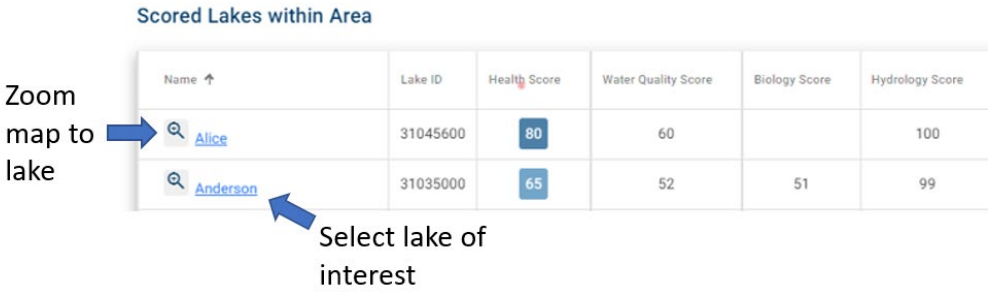


Scored Lakes within Area

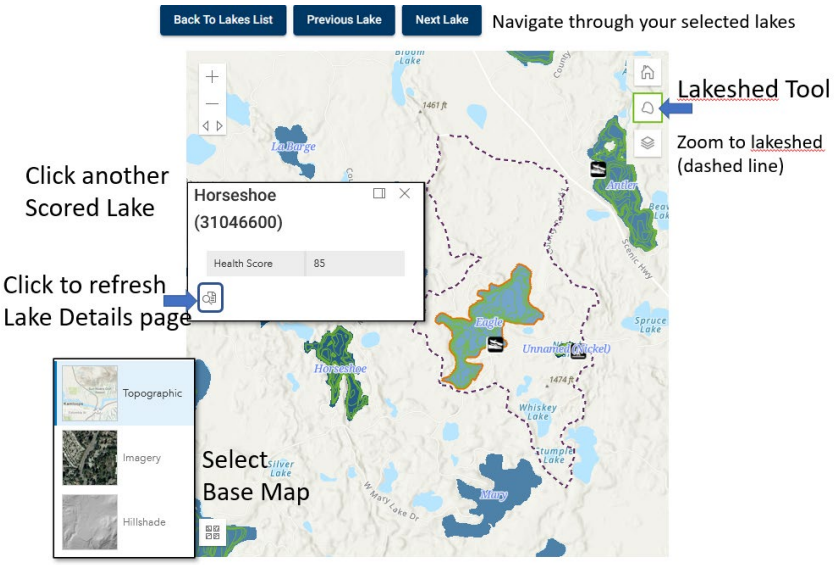
The table lists all the lakes with a health score that fall within your selected boundary. The table includes the overall Health Score and the three Component Scores that are averaged to create that value. A Lake Health Grade and other basic lake characteristics are also included in the table. The table can be sorted on any header field. The table can also be downloaded as an Excel or comma-delimited text (CSV) file.

Select a lake from the list

- Use the magnifier icon to **zoom the map** to that lake.
- Click a lake name in the table to open **Lake Health Details** for that lake.



After selecting a lake, the map will zoom to that lake and the Lakeshed Tool will appear:



Select a new lake from the map.

- Use the map to zoom or pan to select another scored lake.
- Click the button in the popup (bottom left) to select a new lake.
- This will recenter the map and refresh the lake details page.

Lake Health Summary Page

Explore the Health Summary for your selected lake. There is an overall Lake Health Score along with sub-scores for each component. The summary page also displays the mean (average), minimum, and maximum health scores for all the lakes found within your major watershed. Those values can help you compare your lake to the other lakes in the same major watershed. Scroll down the summary page for tables that hold additional basic information about your lake.



Component Pages

Use the tabs (top-right or below the map) to navigate to each Lake Health component page and to a Stewardship page for your lake.

- For example, click 'Water Quality' to open a new page that shows how your lake scored for different aspects of water quality.
- Use the **Learn More** buttons to understand each health concern and how the data was used.
- Click Stewardship for information on risks and opportunities to improve and protect lake health.

Creating a Lake Health Score

The diagram (next page) shows of the hierarchy of inputs into each Lake Health Score. The arrows show how scoring metrics are used to calculate each of the index scores; and how index scores are then combined into one score for each component. The mean of the three component scores becomes the overall Lake Health Score.

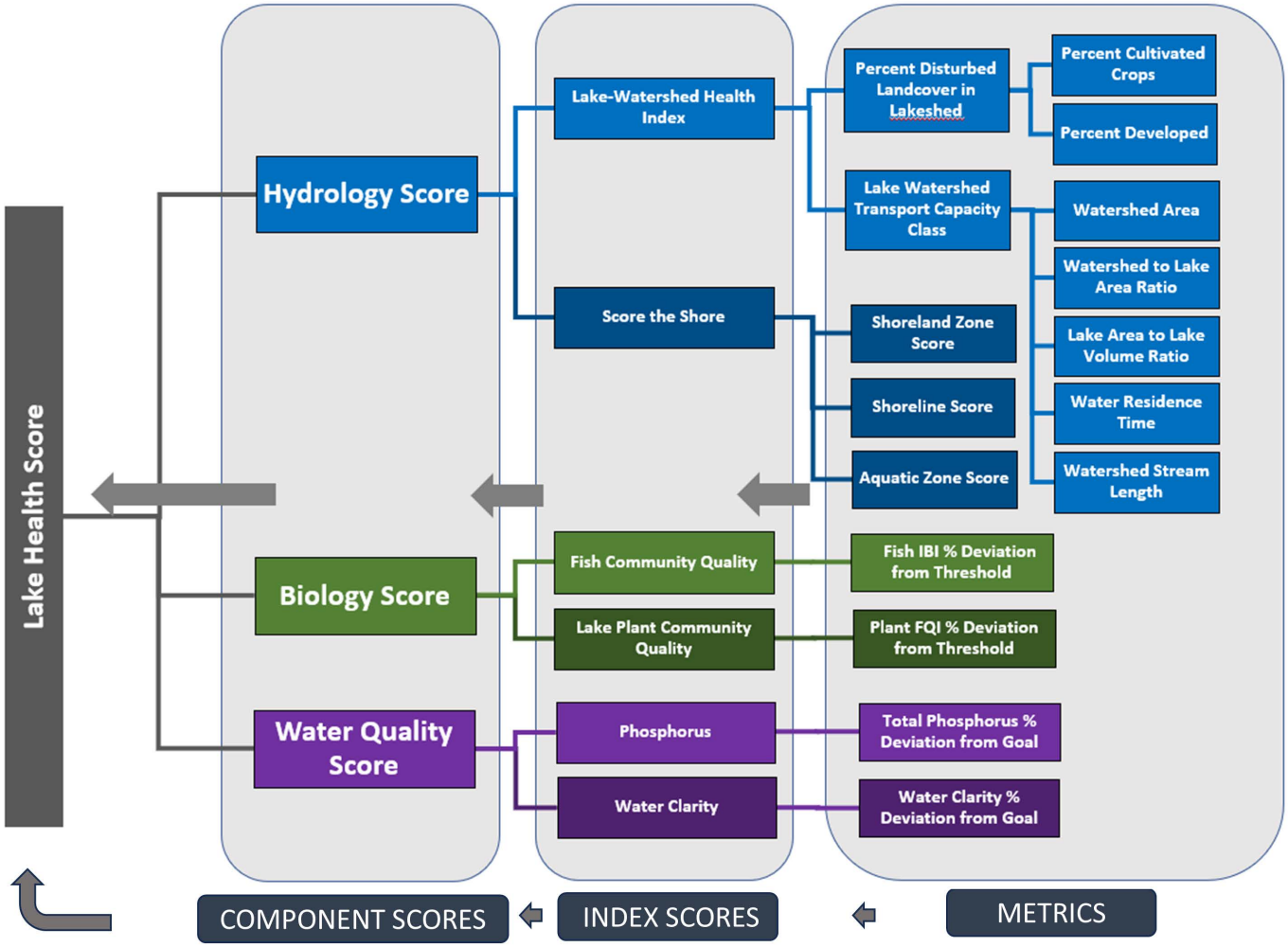


Diagram showing hierarchy of data values used to create the Lake Health Score

List of Lake Health Score Data Inputs:

- **Lake Health Score**
  - **Water Quality Score**
    - Phosphorus Score (WQ Score input #1)
      - Total Phosphorus % Deviation from Goal
    - Water Clarity Score (WQ Score input #2)
      - Water Clarity % Deviation from Goal
  - **Biology Score**
    - Fish Community Quality Score (Biology Score input #1)
      - Fish IBI % Deviation from Threshold
    - Lake Plant Community Quality Score (Biology Score input #2)
      - Plant FQI % Deviation from Threshold
  - **Hydrology Score**
    - Lake-Watershed Health Index (Hydrology Score input #1)

- Percent Disturbed Landcover in Lakeshed
    - Percent Cultivated Crops
    - Percent Developed
- Lake Watershed Transport Capacity Class
    - Watershed Area
    - Watershed to Lake Area Ratio
    - Lake Area to Lake Volume Ratio
    - Water Residence Time
    - Watershed Stream Length
- Score the Shore (Hydrology Score input #2)
    - Shoreland Zone Score
    - Shoreline Zone Score
    - Aquatic Zone Score

Lake Health Scores and Grades

There are almost 3000 lakes in Minnesota that have been given an overall Lake Health Score using the data described above. The overall scores can range from 0 to 100.

The figure shows of the distribution of scores for the 2939 lakes evaluated for lake health across Minnesota. The figure shows overall Lake Health as well as each contributing component (Water Quality, Biology, and Hydrology). The 'box and whisker' plot is included to compare lake scores. The center black line within each box depicts the median score. Black box extends from the 25th percentile at the bottom to the 75th at the top (i.e., the interquartile range). The black 'whiskers' help identify outliers (whiskers end at 1.5x the interquartile range). Each individual-colored circle in the box plot below represents the score of a single lake.

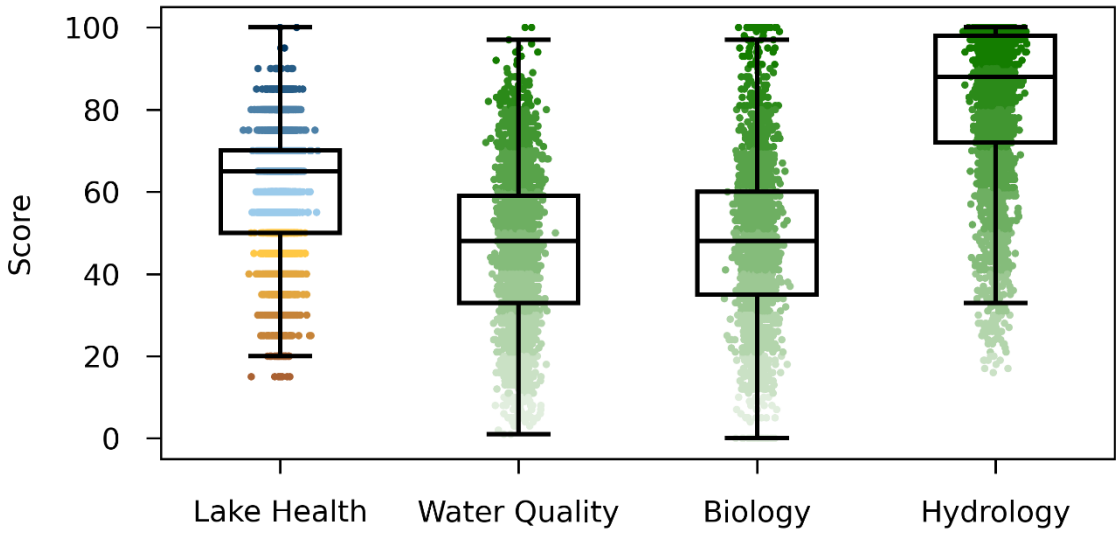
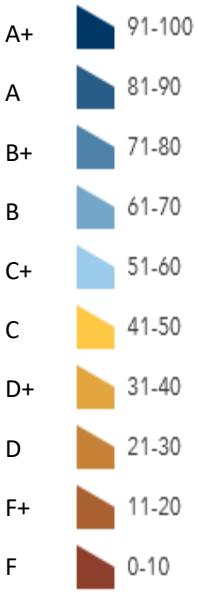


Figure showing distribution of lake health and component scores across Minnesota

Overall health scores converted to grades:

The overall Lake Health Score is then converted to a health grade to help compare your lake to others nearby or across all of Minnesota. This grade is designed to represent lake health for a single snapshot in time and to be a starting point to learning about the different components and conditions that are influencing the health of Minnesota lakes.



An A+ grade is only obtained by 4 lakes in Minnesota. This indicates the highest health condition considering available data and that the lake should be valued and protected with strong stewardship actions.

The majority of Minnesota lakes fall within the A-B range (51%). These lakes should be monitored and protected so that risks in their shoreland and lakeshed areas are minimized to keep this healthy condition into the future.

Many lakes are graded between a C+ and D+ (44%). This overall grade results from a wide range of input scores. It is particularly important to explore details about each input to understand which conditions are creating risk or health impacts as well as finding opportunities to protect good conditions.

D-F lakes make up about 6% of the scored lakes. This grade indicates the need to take action to improve the health condition. It may also indicate a high level of risk that may further degrade a lake if not addressed or mitigated for.

What action should be taken to support lake health?

No matter what grade a lake currently receives, all of Minnesota's lakes require stewardship actions to keep them as healthy as possible, improve lake health when there are challenges, and address risks that may already exist or are expected to emerge.

It is important to remember that lake health is influenced by conditions in and near the lake as well as conditions and activities across the broader landscape or 'lakeshed'.

Suggestions for Action:

- Lakeshore owners can take action on your own property to provide benefits for fish, wildlife, habitat and water quality.
    - Learn more about why maintaining and restoring natural shorelines is beneficial.
    - Apply best management practices on shoreland properties to support lake health.
    - Participate in the Score your Shore survey for lakeshore property owners to self-assess lakeshore habitat and find suggestions for lakeshore friendly actions.
    - Join forces with your neighbors or lake association to make a bigger impact.

- Natural resource professionals can compare lake health and prioritize actions for different management objectives.
    - Identify and protect high quality resources, take action on public lands to build resilience to future risks.
    - Educate others on actions that have the greatest impact on lake health.
    - Form partnerships to restore lake health to lower quality systems, address existing risks and impairments.
- For local officials and decision makers
    - Consider mitigation measures for projects that directly increase risk to a lake.
    - Identify high value lake resource and protect conditions that are contributing to lake health.
    - There are many programs and initiatives that seek to restore conservation lands.
    - Use lakeshed boundaries when considering an increase in impervious surface, contaminant sources, or vegetation removal; which lakes could potentially be impacted by the increased risk?

Questions and comments can be sent to WHAF.DNR@state.mn.us.

Name	Health Score	Health Grade	Water Quality Score	Biology Score	Hydrology Score	Acres	Lakeshed Acres	Shore Miles	County	Impairments
Amber	35	D+	27	0	77	182	687	2.2	Martin	Fish bioassessment, Nutrients
Big Twin	50	C	40	33	78	461	1,150	6.1	Martin	Fish bioassessment, Mercury in fish, Nutrients
Budd	25	D	31	8	41	228	15,325	2.2	Martin	Fish bioassessment, Nutrients, PCBs in fish
Cedar	35	D+	28	25	54	707	24,303	9.5	Martin	Fish bioassessment, Nutrients
Clam	20	F+	20	0	44	71	788	1.5	Martin	None
East Chain	20	F+	23	16	24	481	36,442	5.9	Martin	Nutrients
Fish	40	D+	29	24	67	156	1,016	2.5	Martin	Fish bioassessment, Nutrients
Fox	40	D+	24	29	71	951	4,030	11.3	Martin	Fish bioassessment, Nutrients
George	35	D+	31	12	68	83	763	2.6	Martin	Nutrients
Hall	30	D	31	19	47	548	13,872	4.1	Martin	Fish bioassessment, Nutrients
Ida	50	C	20	45	89	138	349	2.7	Blue Earth	Nutrients
Imogene	45	C	30	24	87	186	717	2.4	Martin	None
Independence	55	C+	37	43	78	99	265	1.5	Jackson	Mercury in fish
Iowa	25	D	25	12	39	478	9,772	8.5	Martin	Nutrients
Rice	50	C	25		77	266	1,043	4	Faribault	Nutrients
Sisseton	35	D+	30	26	48	138	27,974	2.8	Martin	Fish bioassessment, Nutrients
South Silver	40	D+	36	13	77	252	684	4	Martin	Fish bioassessment
South Walnut	35	D+	50	29	19	388	73,291	4.8	Faribault	None
Walnut	45	C	27	16	86	719	1,405	4.4	Faribault	None
Watkins	25	D	10	27	33	247	3,258	4.9	Martin	None
Willmert (main bay)	30	D	31	14	44	335	3,609	3.3	Martin	None

Benjamin Lundeen Presentation Slides

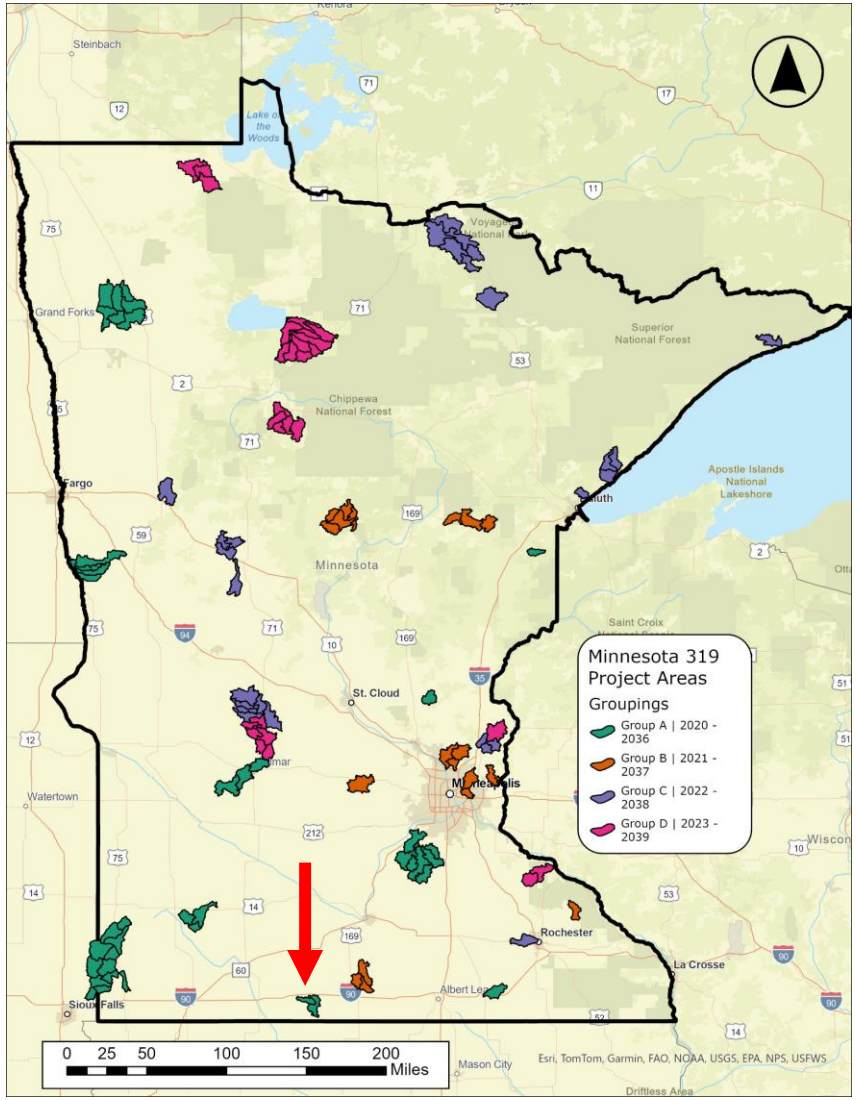
Effectiveness Monitoring

Dutch Creek & Martin County Ditch 28
Sept. 17th, 2025

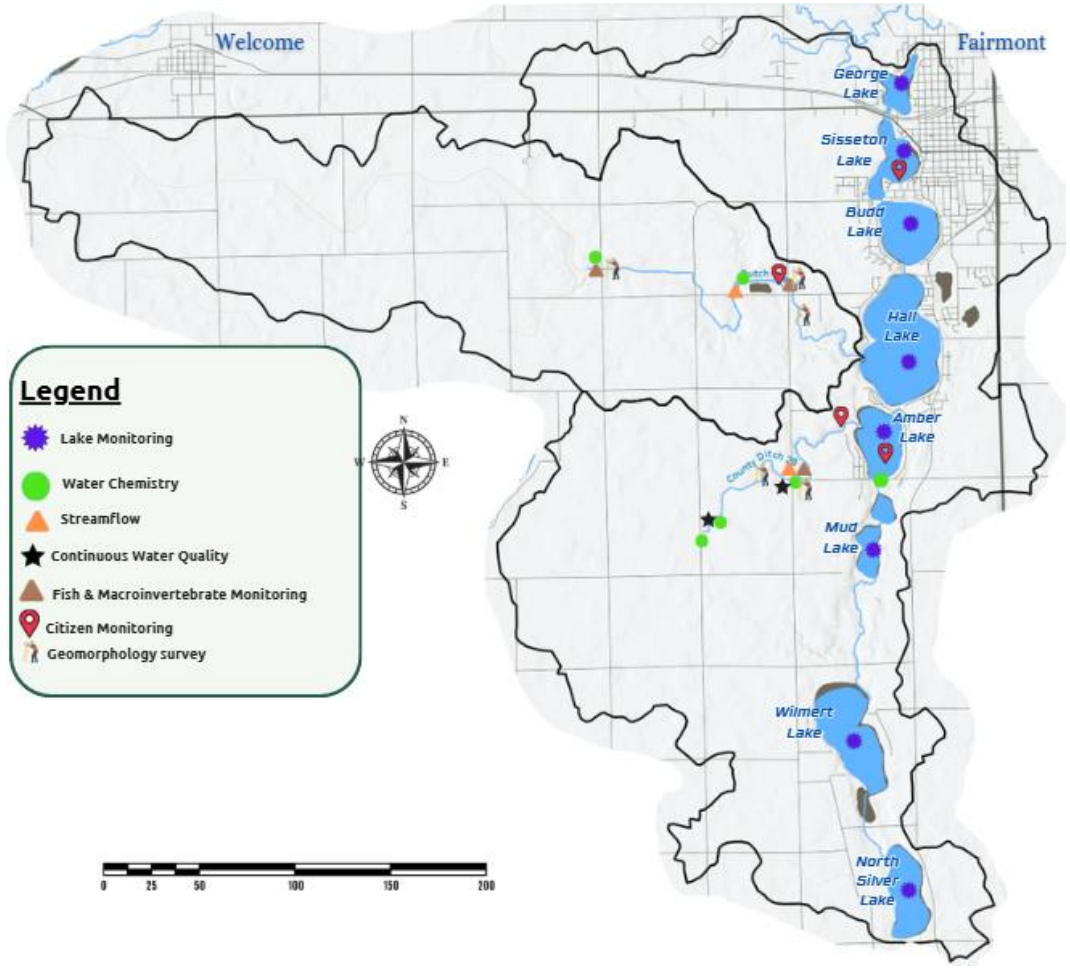
Ben Lundeen | Statewide Monitoring Coordinator
Minnesota Pollution Control Agency
Brainerd, MN

Current Status of 319 in Minnesota

- There are 35 Section 319 small watershed “projects” within the State:
  - Comprising 115 HUC 12 subwatersheds
- Phase roll-out of watersheds:
  - Group A | 2020 - 2036
  - Group B | 2021 - 2037
  - Group C | 2022 - 2038
  - Group D | 2023 - 2039

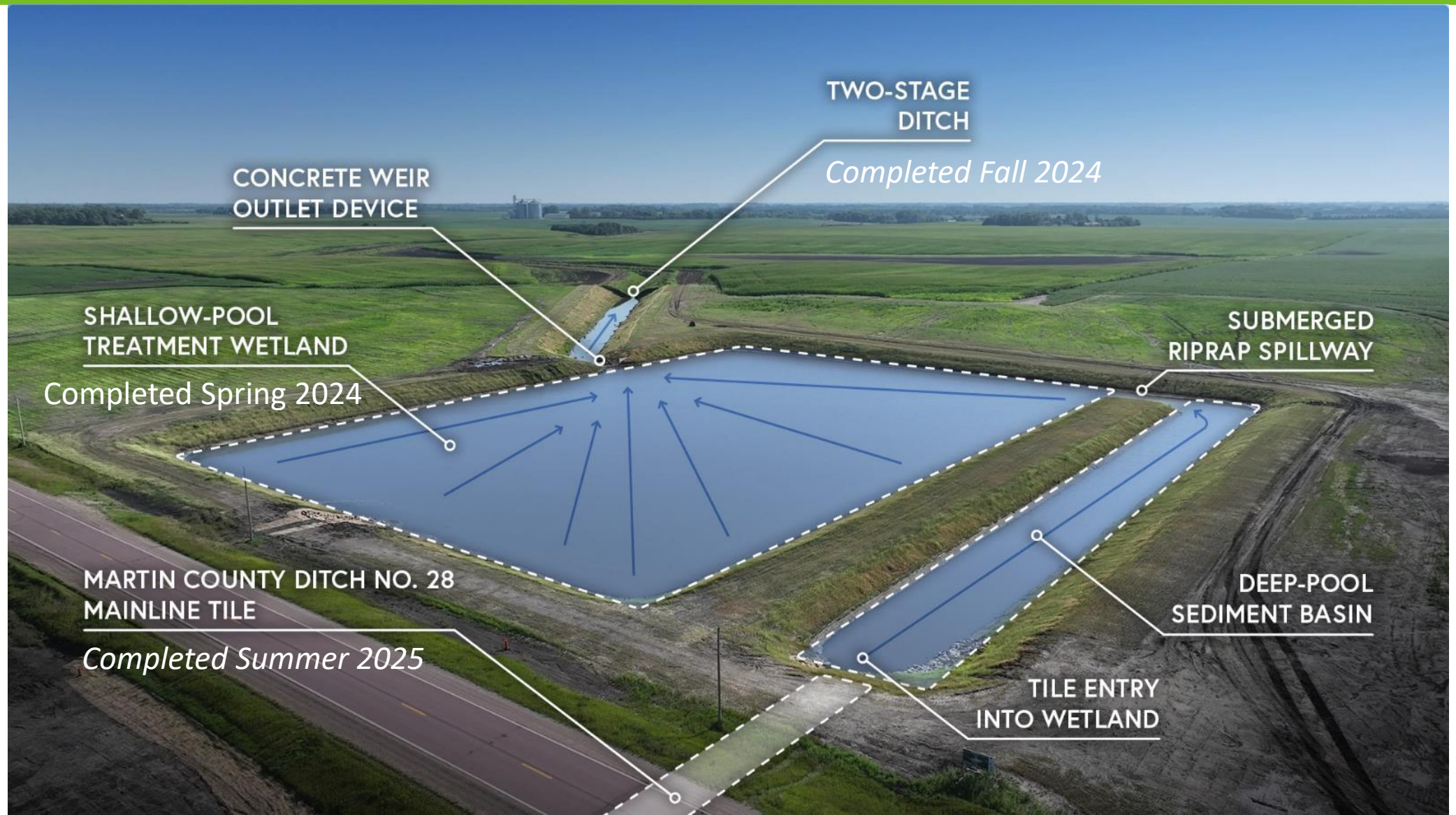


Fairmont Chain of Lakes 319 Monitoring Overview



- Partnership of Martin SWCD, MPCA and MDA.
- Monitoring conducted by Martin Soil and Water Conservation District. 15-20 sample events/year.
- Samples analyzed for TSS, TP, DOP, NO2+NO3-N, TKN and E.coli at Minnesota Valley Testing Laboratory in New Ulm, MN.
- MPCA funding (319) for sample collection (Martin SWCD) and laboratory analysis (MVTL). Also providing flow measurements.
- Continuous flow and nitrate monitoring conducted by MDA.
- Time series data available through the MDA OneRain website. A dashboard that provides an overview of the project will be developed this winter.

Martin County Ditch Nutrient Treatment Train



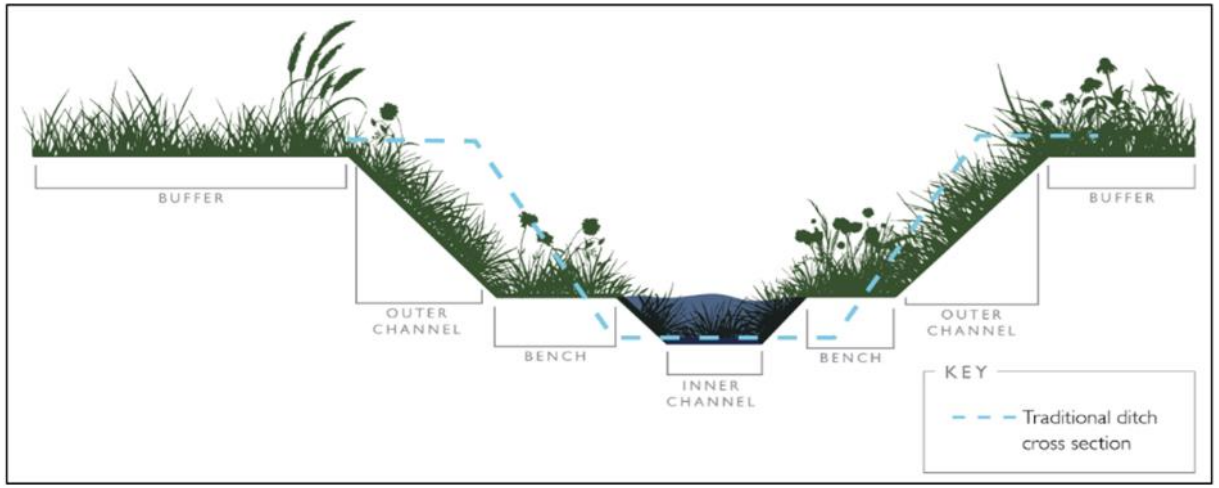
Source: ISG, Inc.

Estimated Annual Nutrient and Sediment Reductions (ISG Inc.)

Nutrient Treatment Wetland
- 10,400 pounds of nitrate
- 300 pounds of phosphorus
- 22 tons of sediment



Two-Stage Ditch
- 2,300 pounds of nitrate
- 160 pounds of phosphorus
- 6 tons of sediment



Projected annual pollutant reductions to Amber Lake
- **12,287 pounds of nitrate**
- **463 pounds of phosphorus**
- **29 tons of sediment**

Martin County Ditch 28

- Sites were established to track “effectiveness” of practice:
  - Story map of project
- 4 sites that MPCA, MDA, and Martin SWCD are monitoring within this EPA 319 project:
  - North tile inlet
  - South tile inlet
  - Weir outlet
  - CD28 @ 190th Ave
  - Main tile inlet









Main New Inlet – CD28 Pond Inlet

Current Monitoring Overview

- Site serves as gage for outlet main tile inlet to sediment basin
- Current Sensors installed
  - Velocity meter
  - Nico Trios - NO2/NO3 - 2026
  - Water temperature - 2026
  - Cellular trail camera
  - Water quality grab samples bi-weekly:
    - TKN, NO2+NO3-N, DOP TP, TSS, *E. coli*
  - Verizon modem connected to OneRain
    - Updated every 30 minutes







Weir Outlet

Current Monitoring Overview

- Site is at the outlet of a new sediment basin project
- Current Sensors installed
  - Bubbler for stage & discharge
  - Nico Trios - NO2/NO3
  - Water temperature
  - Tipping bucket - Precipitation
  - Cellular trail camera
  - Water quality grab samples bi-weekly:
    - TKN, NO2+NO3-N, DOP TP, TSS, *E. coli*
  - Verizon modem connected to OneRain
    - Updated every 30 minutes







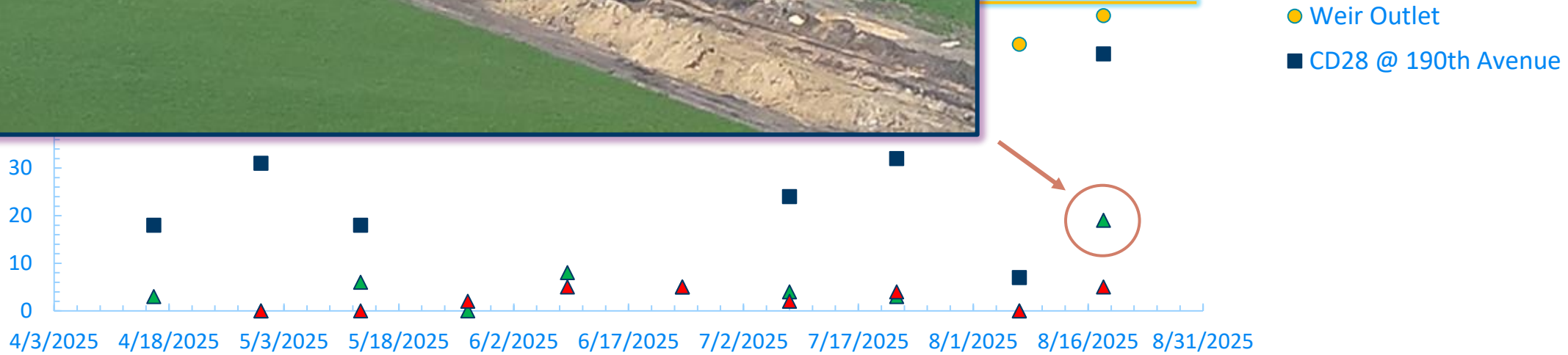
CD28 @ 190th Avenue

Current Monitoring Overview

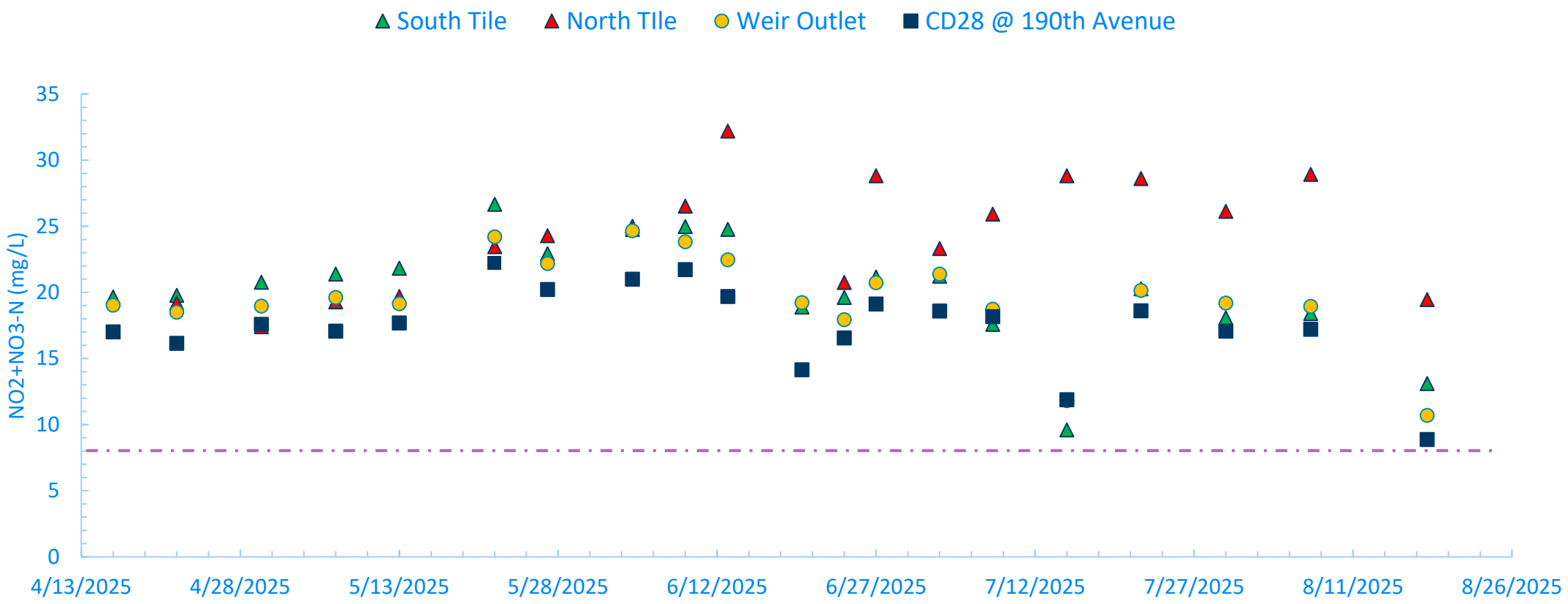
- Site is at the outlet above locations and outlet of two-stage ditch
- Current Sensors installed
  - Radar for stage
  - Flow monitoring - discharge
  - FTS DTS-12 Turbidity sensor (15 min intervals)
  - Nico Trios - NO2/NO3 -2026
  - Water temperature
  - Cellular trail camera - 2026
  - Water quality grab samples bi-weekly:
    - TKN, NO2+NO3-N, DOP TP, TSS, *E. coli*
  - Verizon modem connected to OneRain (*coming soon)*

Results | Total Suspended Solids

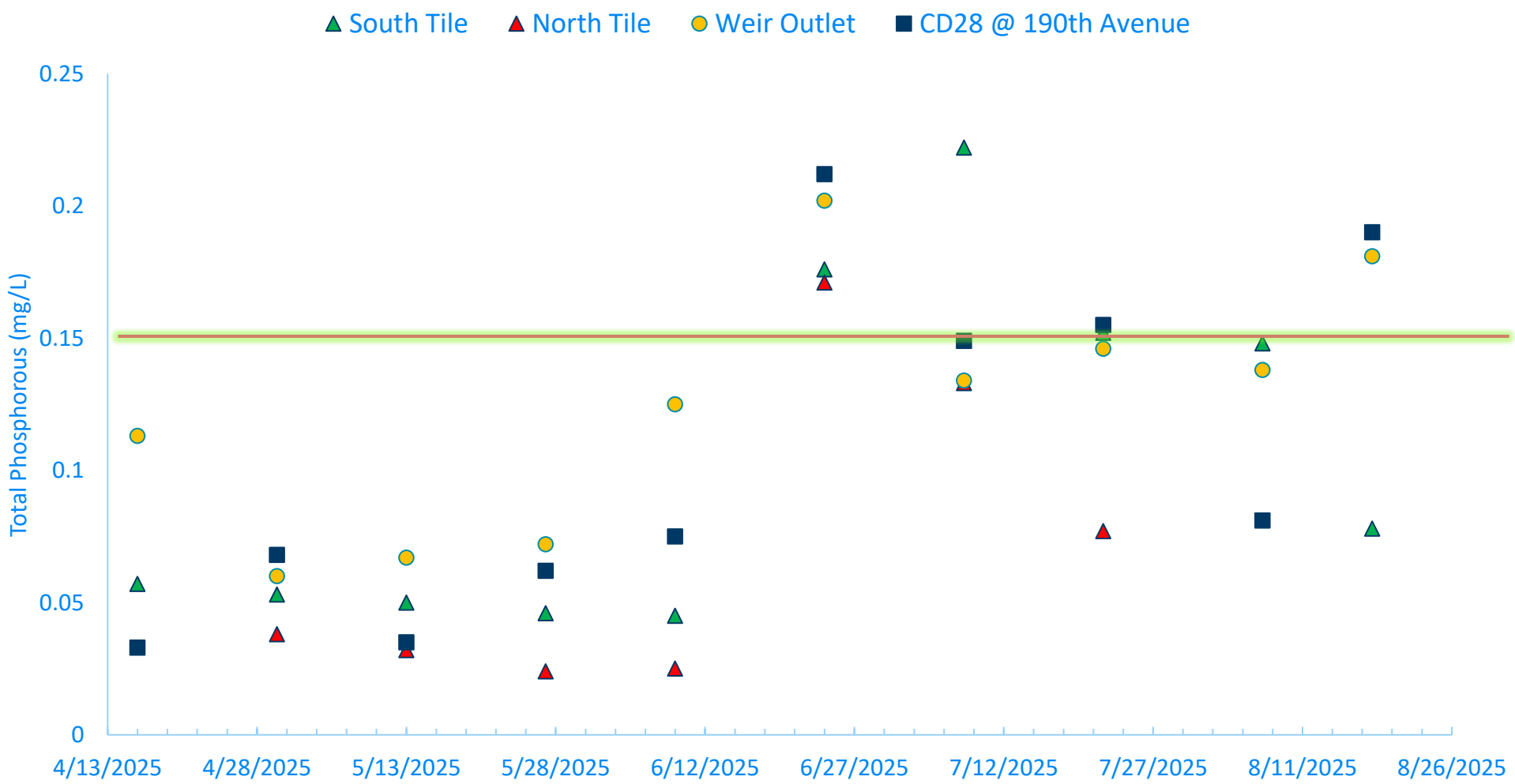




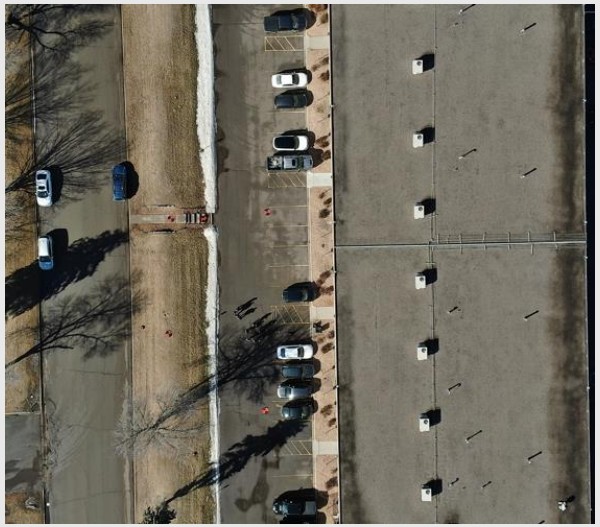
2025 Water Quality Monitoring Results
NO2+NO3-N

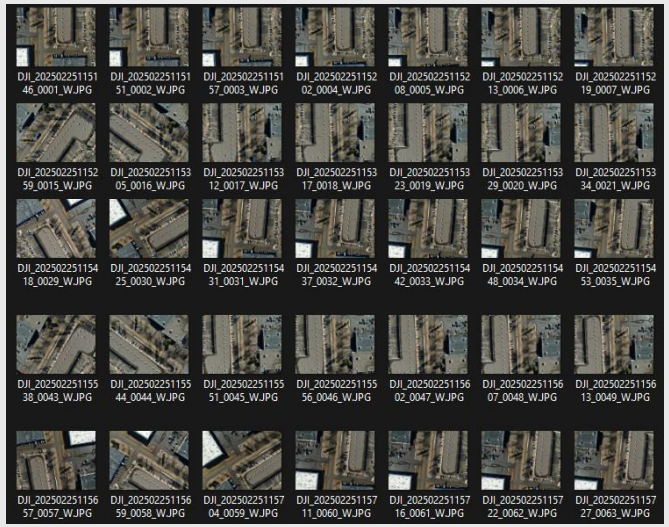


2025 Water Quality Monitoring Results
Total Phosphorous



Drone Imagery Basics

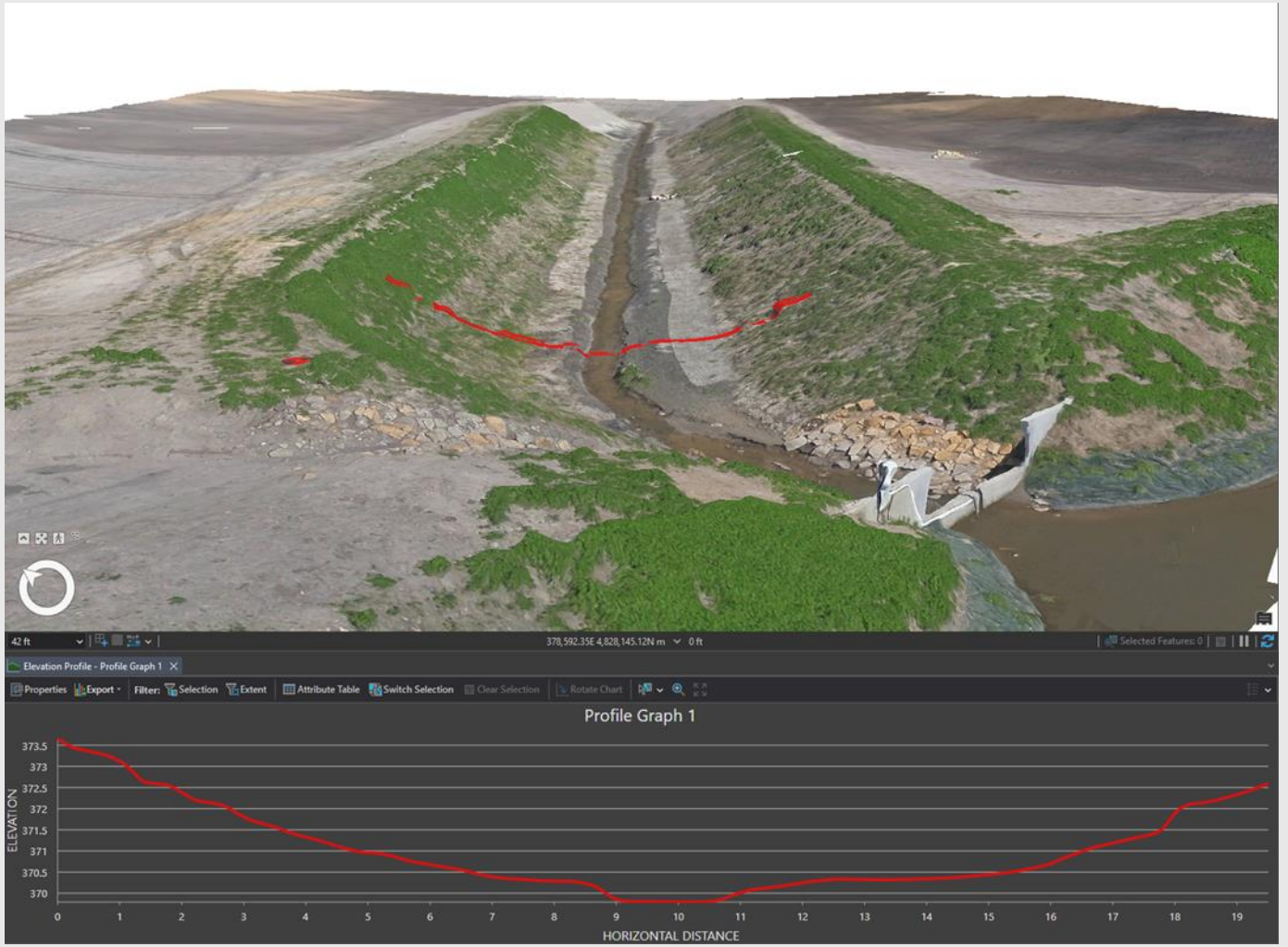


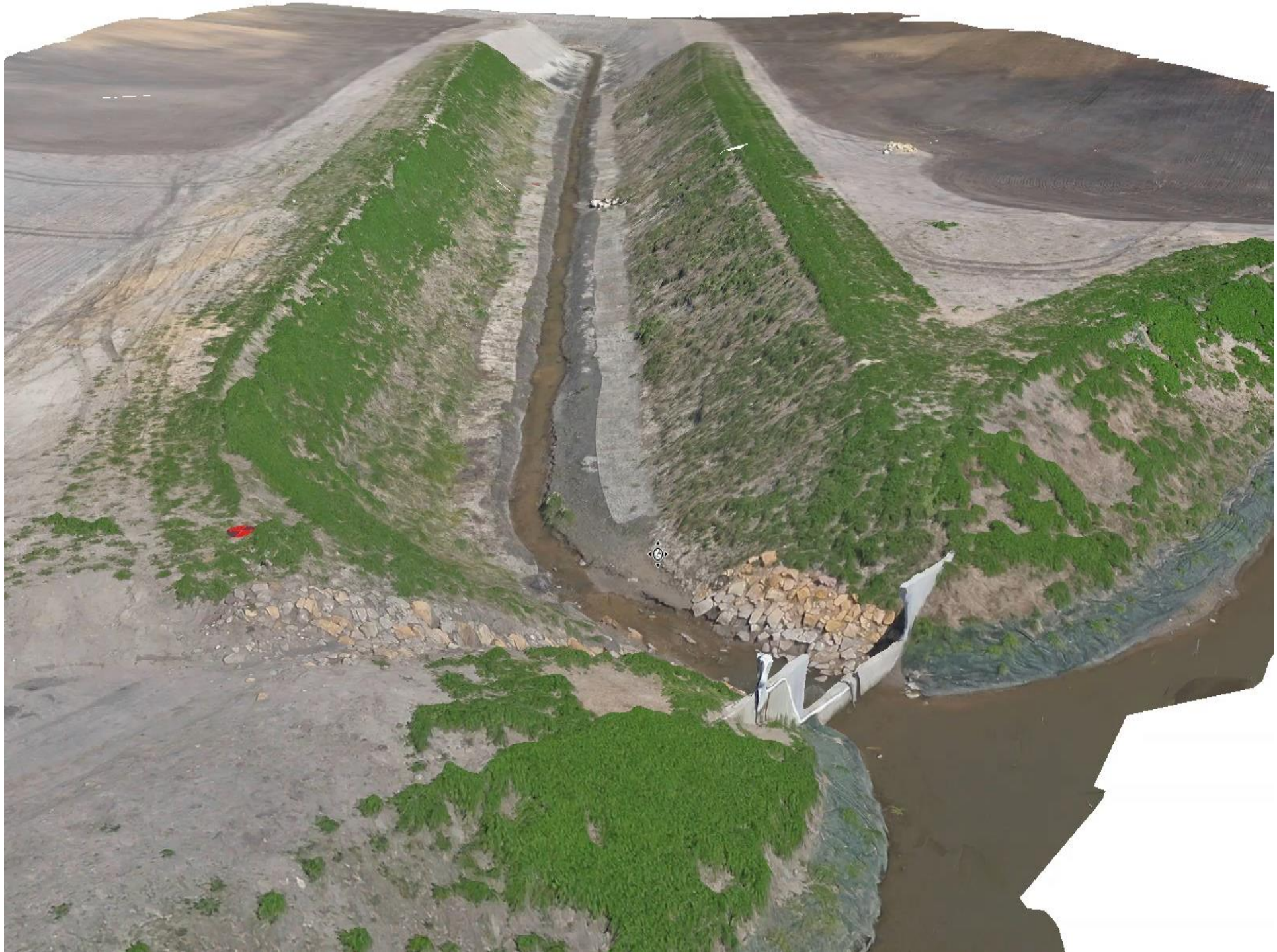


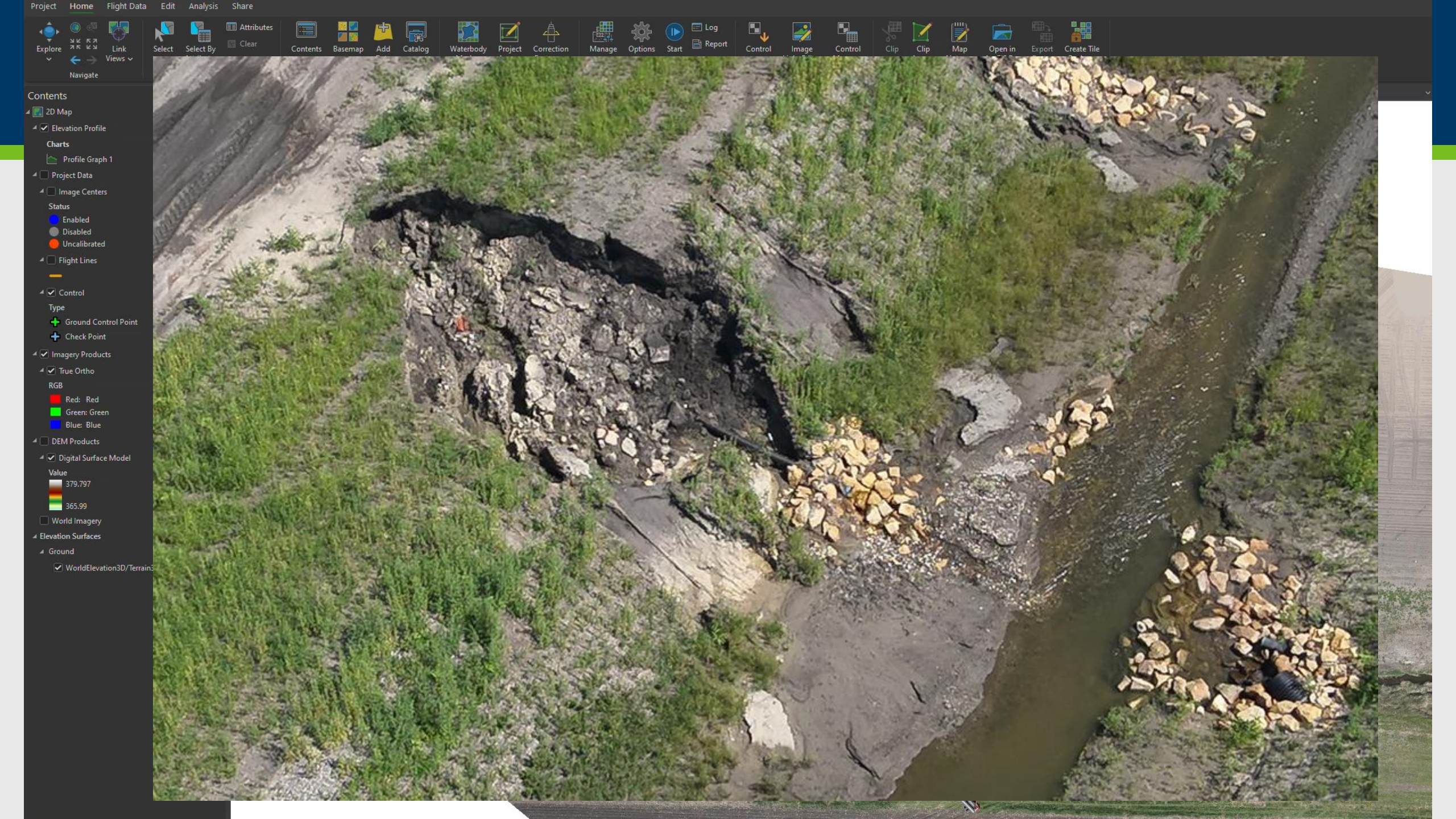


Drone Imagery Products







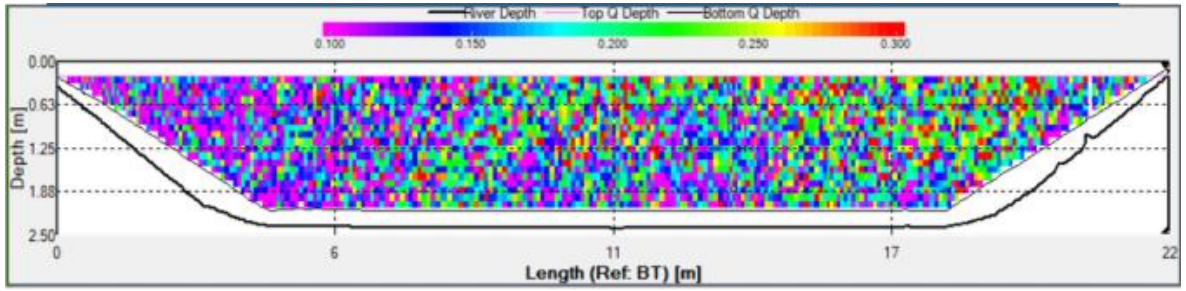

Project
Home
Flight Data
Edit
Analysis
Share
Explore
Navigate
Link Views
Select
Select By
Attributes
Clear
Contents
Basemap
Add
Catalog
Waterbody
Project
Correction
Manage
Options
Start
Log
Report
Control
Image
Control
Clip
Clip
Map
Open in
Export
Create Tile
Contents
2D Map
Elevation Profile
Charts
Profile Graph 1
Project Data
Image Centers
Status
Enabled
Disabled
Uncalibrated
Flight Lines
Control
Type
Ground Control Point
Check Point
Imagery Products
True Ortho
RGB
Red: Red
Green: Green
Blue: Blue
DEM Products
Digital Surface Model
Value
379.797
365.99
World Imagery
Elevation Surfaces
Ground
WorldElevation3D/Terrain3

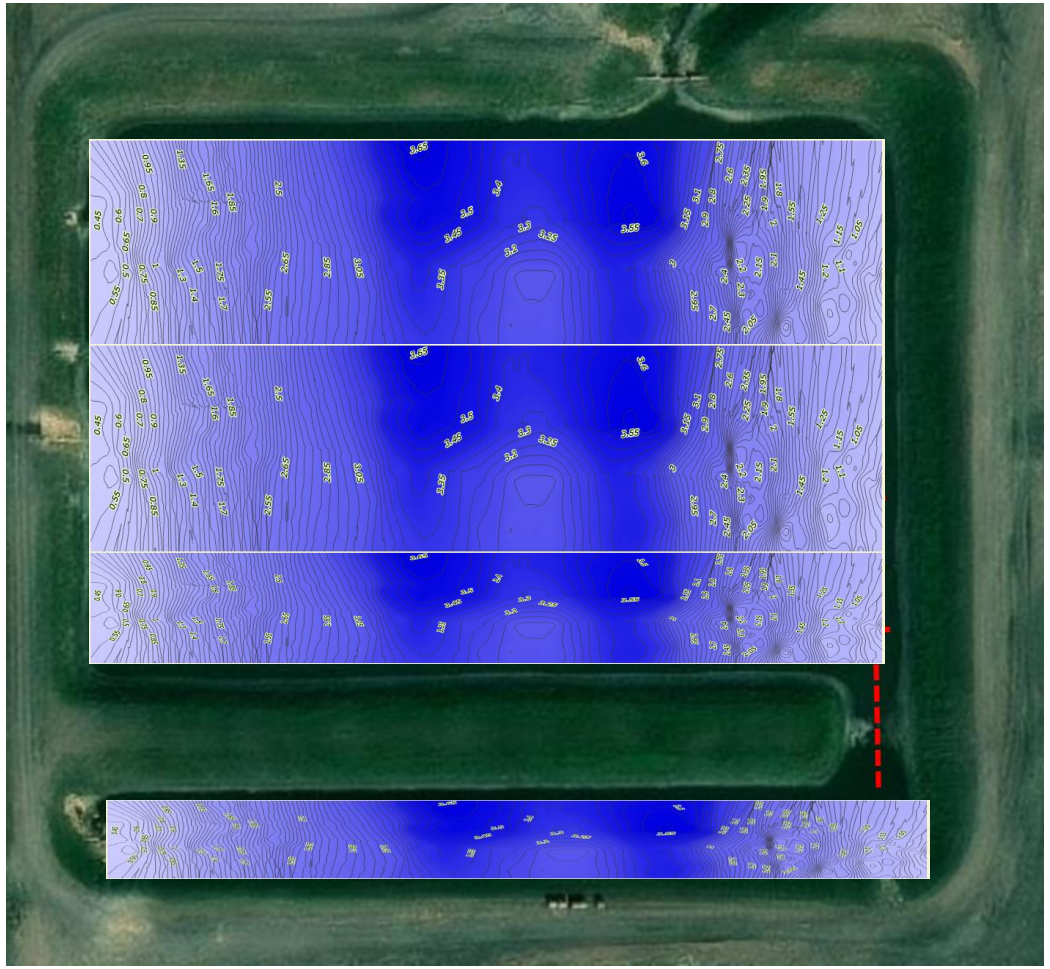
Sediment loading within Basin

- Beginning fall 2025
- Yearly bathymetric surveys of sediment basin



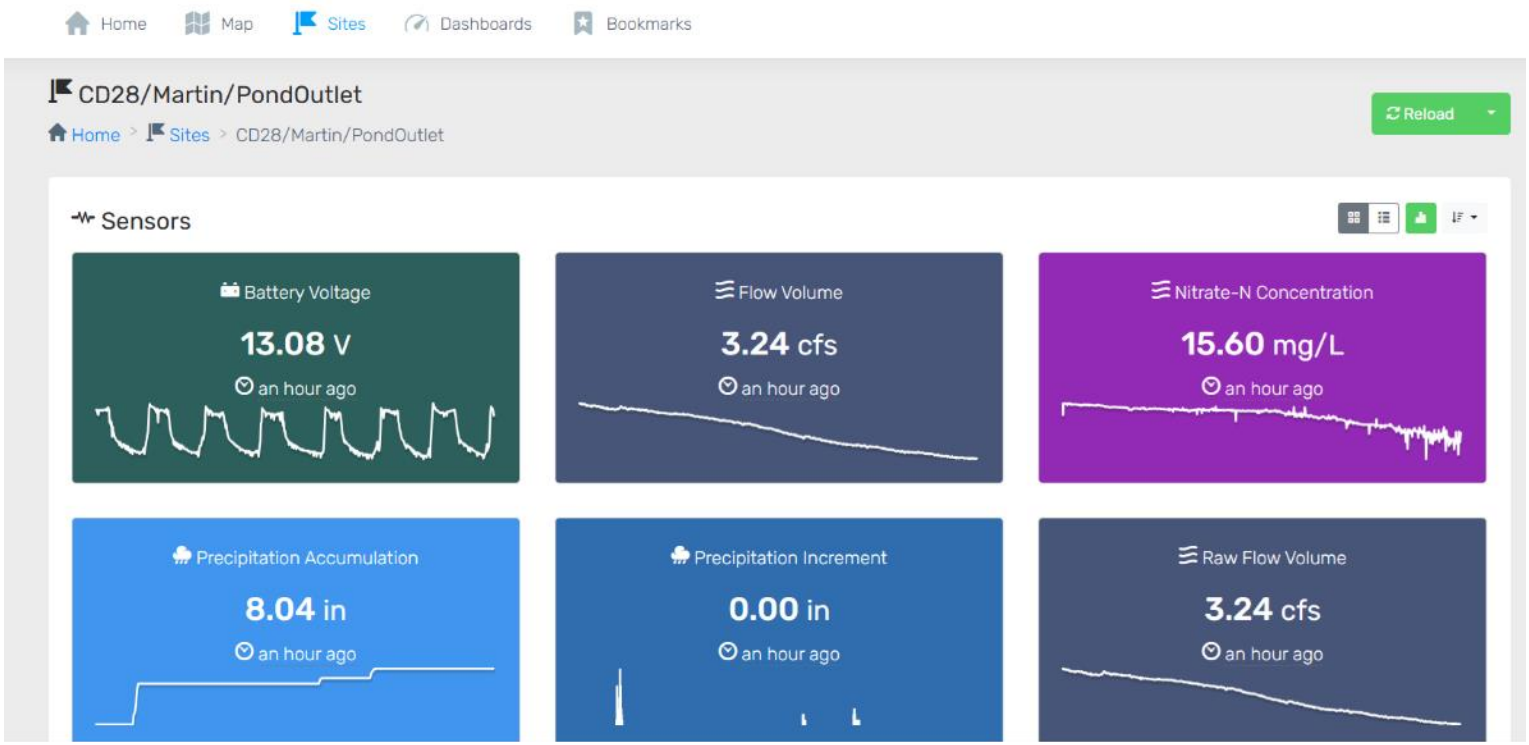
SonTek-RS5 ADCP





Near real-time data: mda.onerain.com

- Precipitation, water level, provisional flow, and water temperature.
- Updated every 30 minutes
  - Select “Sites”
  - Scroll to bottom of page and select “SW Mon/Dutch Creek/DC1”



Weir Outlet Site - https://mda.onerain.com/site/?site_id=68&site=3f333b61-4432-4751-83d5-f5fb73bf6211