AGENDA

Lakes Management Committee

Meeting date: 6/30/2025 Start time: 10:00 am End time: 11:30 am

Meeting location: Fairmont City Hall, Upstairs Confrence Room

TIME	DESCRIPTION	PRESENTER
10:00 am	Introductions	Neusch/Oman
10:05 am	**Recap from previous meeting**	Oman
10:15 pm	Curly Leaf Pondweed Timeline	Neusch/Oman
10:30 pm	CLP-Non DNR Permitted Mitigation Strategy Implementation and Data Review	Neusch
10:40 am	**2025 CLP Sampling Report**	**Wersal**
11:00 am	CLP-DNR Permitted Mitigation Strategies	Neusch/Oman
11:10 am	**Low Salt Initiative Presentation**	Connie Fortin, Bolton & Menk
11:20 am	Per- and Polyfluoroalkyl Substances (PFAS) Update	**Neusch**
11:25 am	Nanobubble Technology Discussion	**Oman**
11:30 am	**Adjourn**	**Neusch/Oman**

Included in this packet

1- Curly Leaf Pondweed Management Timeline

2- Curly Leaf Pondweed Pick up contract and data

3- 2025 Curly Leaf Pondweed sampling report, vegetation and turions

4- Harvester Information

5- Low Salt Initiative Information

6- Nanobubble Fact Sheet from DNR

Hannah Neusch
Water Resources Coordinator
(507) 238-3953
hneusch@fairmont.org

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CITY OF FAIRMONT, MN

Curly Leaf Pondweed Management Timeline

FAIRMONT CITY OF FAIRMONT, MN

in partnership with

SWCD MARTIN

Late Summer 2024

Native Plant Survey

This delineation was funded by Martin SWCD. It was outside the window of CLP growth, however it gave us excellent insight on native species which are present in our lakes.

Winter 2024

City Budget Passed

$225,000 Set aside for CLP management in 2025, with funding into 2029.

Early Spring 2025

Contractors Identified

Contractors working with CLP must be certified with the DNR. A pool of certified contractors were selected based on availability and location.

Mid-May 2025

Wholistic Survey

This delineation is also funded by Martin SWCD and is expected to be a survey of CLP in full active growth. This survey is required to apply for a permit to manage CLP. This survey is anticipated to also include core samples of the lake bed to determine density of CLP turions.

Mid-June 2025

Results of Survey Anticipated

Data of the wholistic survey is analyzed, processed, and delivered. This may take up to a month. Timeline is estimated.

Mid-July 2025

Contractors Engaged

RFP sent to contractors identified as certified per the DNR.

Mid-August 2025

Contractor Hired

Contractor selected and hired. By this point CLP has ceased growing and will have died back, eliminating the need for CLP management in 2025. contractor will be scheduled for 2026.

Winter 2025

Apply for Permit

The Invasive Aquatic Plant Management (IAPM) permit is required by the DNR to conduct any type of management of CLP. A Permit will not be approved until there is a delineation of CLP locations and contractor(s) selected.

Spring 2026

Permit Approved

DNR may request changes or modifications to permit application. After discussions with DNR we expect to be issued an approved IAPM permit.

Late Spring 2026

Management Begins

Curly Leaf Pondweed Pickup Data

Contractor Hired: Garrett Myren with Water's Edge

Pickup Began: June 16, 2025 with a curbside pickup service. Pickup continues with both curbside and dockside services, both on Mondays.

Total CLP ermoved: An Estimated 6,000 pounds of CLP has been removed in the past 2 weekends!

The Numbers so far:

Total bags picked up:	Homes serviced:
189 bags	24 homes

Average Weight per bag:	Most bags picked up at one house:
40 pounds	28 bags

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Service Agreement for Curly Leaf Pondweed Pick-Up Service

This Service Agreement is entered into by and between **Waters Edge Fairmont LLC** ("Contractor") and the **City of Fairmont** ("City") for the Curly Leaf Pondweed ("CLP") pick-up service during the summer of 2025. The parties agree to the following terms and conditions:

1. Responsibilities of the City of Fairmont

The City shall ensure that citizens participating in the CLP pick-up service comply with the following requirements:

- CLP must be placed in trash bags.
- Bagged CLP must be placed within 15 feet of the curb.
- Bagged CLP must be at the curb by 8:00 AM on Mondays, and Tuesdays if additional service is required.

2. Services Provided by Waters Edge Fairmont LLC

Contractor shall provide CLP pick-up services on Mondays, and Tuesdays if deemed necessary by mutual agreement, during the summer of 2025, in accordance with the terms outlined herein.

3. Compensation

The City shall compensate Contractor for the CLP pick-up services as follows:

- **$35 per household** for pick-up by road, or
- **$60 per household** for pick-up by dock, or
- A minimum of **$250 per service day** (Mondays and, if applicable, Tuesdays), whichever amount is greater for each day of service.

4. Payment Terms

Payments shall be made by the City to Contractor within 30 days of receipt of an invoice detailing the services provided and the number of households served.

5. Term

This Agreement shall be effective for the summer of 2025, commencing on 6/16/2025 and concluding on 12/31/2025, unless otherwise terminated by mutual agreement or due to breach of contract.

Waters Edge Fairmont LLC
Name:
Title:
Date: _____

City of Fairmont
Name:
Title:
Date: _____

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2025 Fairmont Lakes Curlyleaf Pondweed Delineation Summary



A Delineation Summary Submitted to the Martin County Soil and Watershed District

Ryan M. Wersal, Ph.D., Thomas Zellmer, Pearl Jensen, April Moffett
Department of Biological Sciences
Minnesota State University, Mankato
Aquatic Weed Science Lab

Report: MNSU 0022

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Results

- Delineation surveys were conducted on the Fairmont Chain of Lakes (George Lake, Sisseton Lake, Budd Lake, Hall Lake, and Amber Lake) on May 19, 21, and 23.

- A meander survey pattern was used and a plant rake deployed thoughout the littoral zone (<10 ft water depth) in each lake. The littoral zone was defined based on 2024 survey data.

- A total of 755 points were sampled thoughout the system.

- Curlyleaf pondweed was the dominant species in each lake, and was found at 61% (459 points) of all points samples (Figure 1). Sago pondweed was the dominant native species observed followed by chara sp. and coontail. Native species were only observed in Sisseton Lake, Budd Lake, and Hall Lake.

- Rake abundance (0 = no curlyleaf, 1 = 1/3 of rake covered, 2 = 2/3 of rake covered, and 3 = whole rake covered) was used to visually assess curlyleaf pondweed density. Approximately 40% of all points sampled did not have curlyleaf pondweed present. However, 60% of all sample points had curlyleaf pondweed present, and 26% of all points sampled were assigned a 3 for rake abundance; which means curlyleaf pondweed growth is widespread and dense (Table 1).

Table 1. Numerical distribution of curlyleaf pondweed rake abundance ratings.

Rake Abundance Rating	Sample Points (#)	% of Total Sample Points
0	296	39
1	185	25
2	78	10
3	196	26

- The Fairmont Chain of Lakes consists of 1,141 surface acres of water and from the delineation survey there is an estimated 279 acres (24% of all surface acres) of curlyleaf pondweed system wide.

- George Lake (84 acres) had an estimated 42 acres of curlyleaf pondweed (50% of the total lake area) (Figure 2). Curlyleaf pondweed growth occurred around the entire shoreline and was dense in the northern end of the lake and the shallow bay on the northwest side of the lake. The curlyleaf pondweed was divided into six treatment plots based on location, curlyleaf pondweed density, and shoreline morphometry. Native species were not observed at the time of the delineation in George Lake.

- Sisseton Lake (140 acres) had an estimated 56 acres of curlyleaf pondweed (40% of the total lake area) (Figure 3). Curlyleaf pondweed growth was dense along the entirety of the shoreline an in the large bay at the southern-most end of the lake. Curlyleaf pondweed was divided into four treatment plots comprising three narrow shoreline plots and one plot comprising the large bay at the south end of the lake. Native species were observed at one sample point in Sisseton Lake (Figure 4).

- Budd Lake (224 acres) had an estimated 39 acres of curlyleaf pondweed (17% of the total lake area) and was the lake that had the least amount of curlyleaf pondweed present. (Figure 5). Curlyleaf pondweed growth was most dense along the northern shoreline. Curlyleaf pondweed was divided into four treatment plots comprising four narrow shoreline plots. Native species were observed at multiple sample points along the western shoreline in Budd Lake (Figure 6).

- Hall Lake (513 acres) had an estimated 108 acres of curlyleaf pondweed (21% of the total lake area) (Figure 7). Curlyleaf pondweed growth was most dense along the southern and eastern shorelines. Curlyleaf pondweed was divided into five narrow shoreline treatment plots. Native species were observed at multiple sample points along entire shoreline in Hall Lake (Figure 8).

- Amber Lake (180 acres) had an estimated 34 acres of curlyleaf pondweed (19% of the total lake area) (Figure 9). Curlyleaf pondweed growth was dense along the entirety of the shoreline. Curlyleaf pondweed was divided into four narrow shoreline treatment plots. Native species were not observed in Amber Lake at the time of the delineation survey.

Conclusions and Recommendations

- Curlyleaf pondweed growth is widespread and dense throughout the system. The current depth distribution of curlyleaf pondweed is limited to shallow water depths (1 to 7 ft) due to low water clarity.

- Curlyleaf pondweed management in this system will be complex due to the close proximity and connectedness of the lakes, the lakes are multi-use, and the operational use of a potable water intake. Therefore, an integrated pest management approach is recommended whereby hand-pulling, mechanical harvesting, and herbicide treatments are utilized.

- Hand pulling is the simplest and most widely used methods to control aquatic weed growth and can be performed by wading or from a small boat in shallow water. Snorkeling equipment, surface supplied air systems or SCUBA divers are often used in water greater than 4 to 5 feet deep and for more intensive hand pulling programs. Hand pulling can be a highly selective technique and is usually used as a component of invasive species management programs to target new infestations with low plant density (generally less than 500 stems per acre). It is often an important follow-up strategy to a herbicide treatment program to extend the duration of plant control. Additionally, hand rakes of varying sizes and configurations are manufactured and sold for aquatic weed control. Many of these hand rakes are lightweight aluminum, with rope tethers that are designed to be thrown out into a swim area and dragged back onto shore. Some are designed to cut the weeds instead of raking them back to shore (Chapter 3.4 AERF BMP)

- Mechanical harvesting is generally a slow process, as a regular harvester can cut and remove plants at a rate of about 1 to 4 acres day^{-1} depending on the machine and plant density. Therefore, harvesting the entire 279 acres of curlyleaf pondweed in the Fairmont Chain of Lakes once would take anywhere from 70 to 279 days and would be cost prohibitive and inefficient from a management perspective. Harvesting should target smaller high-traffic areas, lake access points, or near the drinking water intake that would allow for repeated clippings and the greatest chance of success.

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- Mechanical harvesters are not selective and will remove native vegetation along with curlyleaf pondweed. By-catch, or the harvesting of nontarget organisms such as fish, crayfish, snails and frogs along with weeds, may be more of a concern, but the degree or extent of harvesting should be considered. Research on fish catch during mechanical harvesting of submersed vegetation has shown that 15 to 30% of some species of fish can be removed with cut vegetation during a single harvest. If the total area of a lake that is harvested is 1, 5 or 10% of the lake's area, this will likely be of little consequence (Chapter 3.4 AERF BMP)

- Herbicides are widely used for management of curlyleaf pondweed and in Minnesota the herbicides flumioxazin, endothall, and diquat are often permitted for use in management programs. Other herbicides that have shown efficacy on curlyleaf pondweed include copper, fluridone, and penoxsulam. It is important to understand site specific characteristics when selecting herbicides and herbicide rates.

- Overall, research has shown that early season management is crucial to effectively control curlyleaf pondweed and prevent turion production. Most native plant species are still dormant early in the spring, so management at this time prevents damage to many desirable native plants while providing selective control of curlyleaf pondweed. Since effective control early in the season prevents turion production, regrowth of curlyleaf pondweed is reduced the following year.

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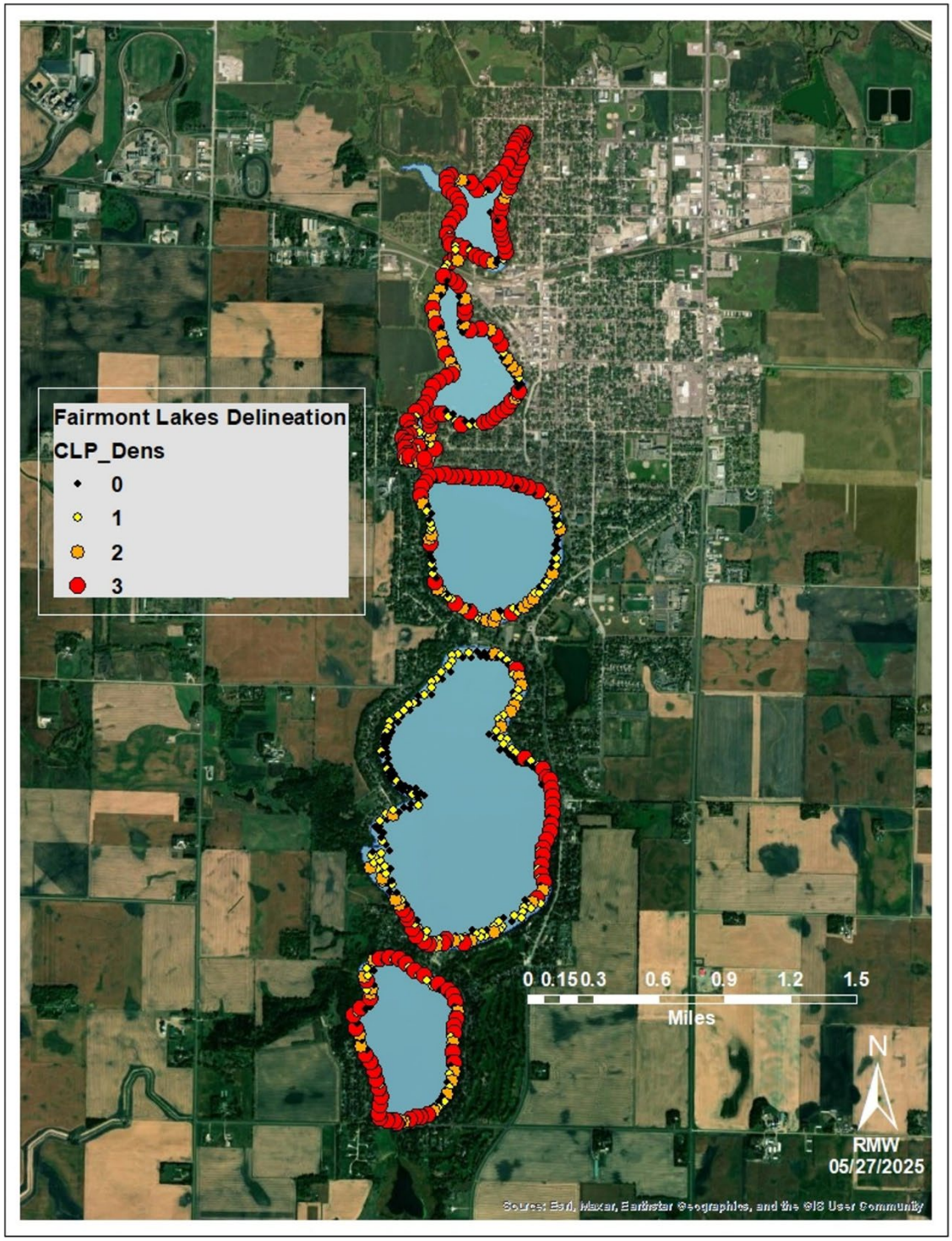


Figure 1. Distribution and abundance of curlyleaf pondweed in the Fairmont Chain of Lakes during the delineation survey conducted in May 2025.

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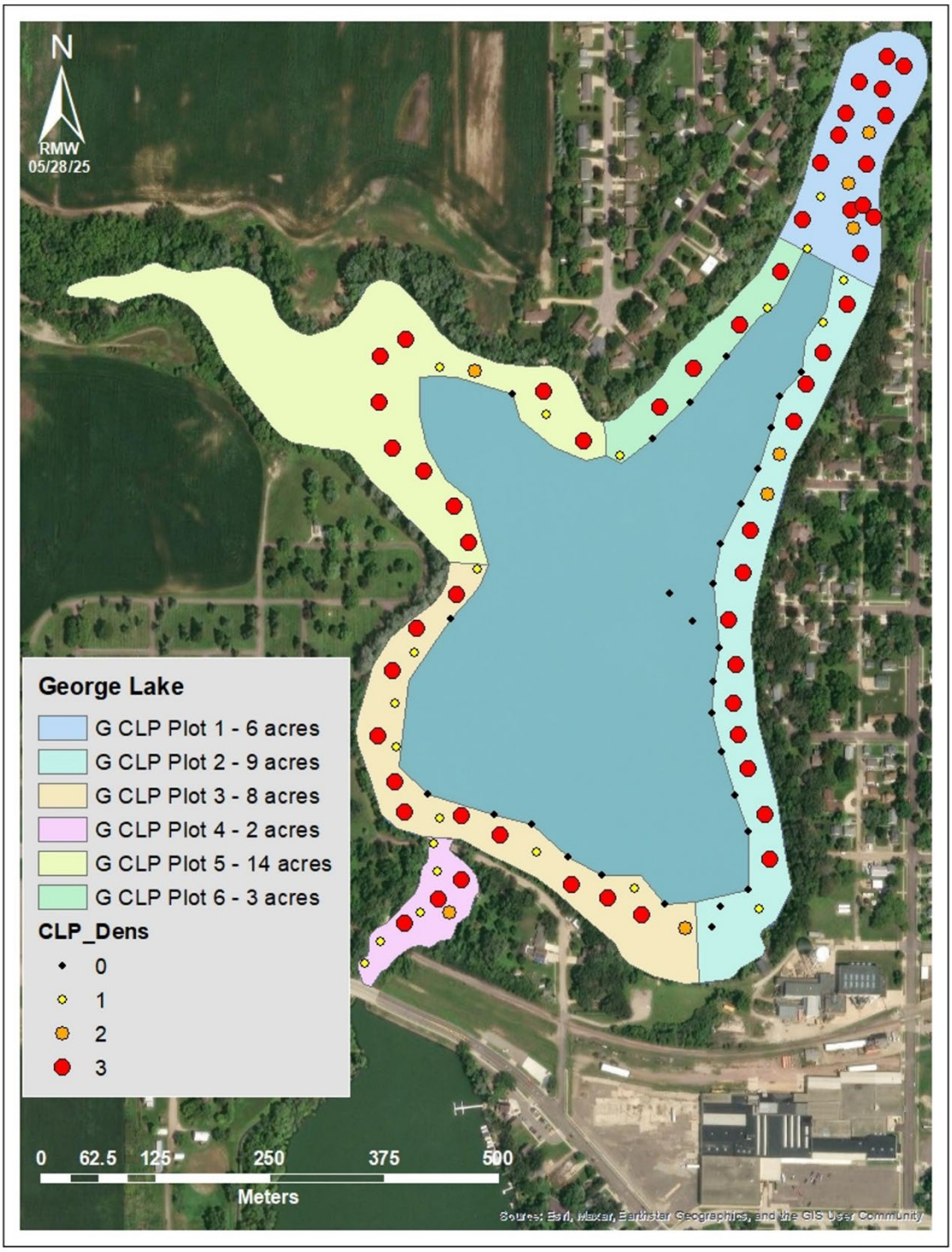


Figure 2. Distribution and abundance of curlyleaf pondweed in George Lake during the delineation survey conducted in May 2025.

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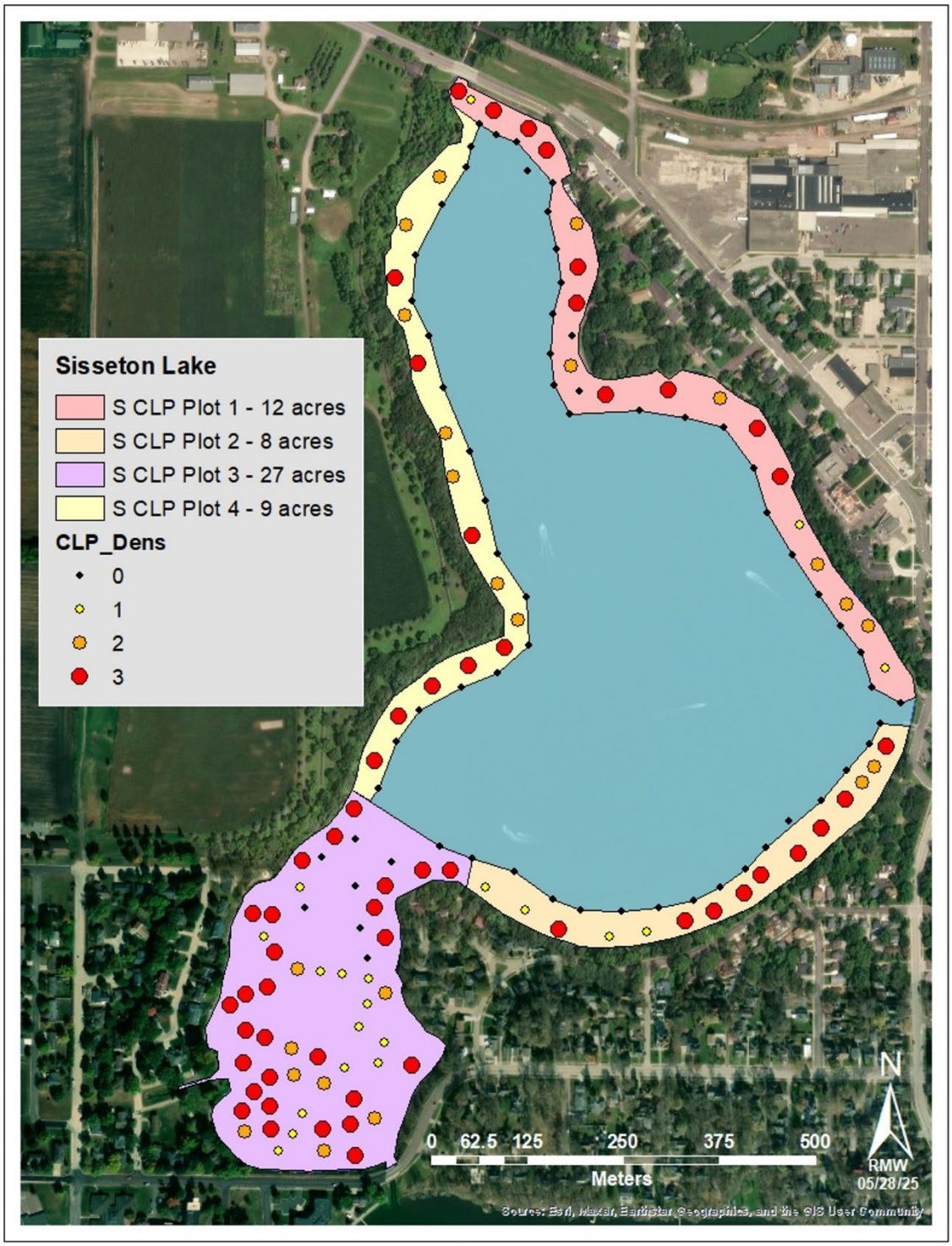


Figure 3. Distribution and abundance of curlyleaf pondweed in Sisseton Lake during the delineation survey conducted in May 2025.

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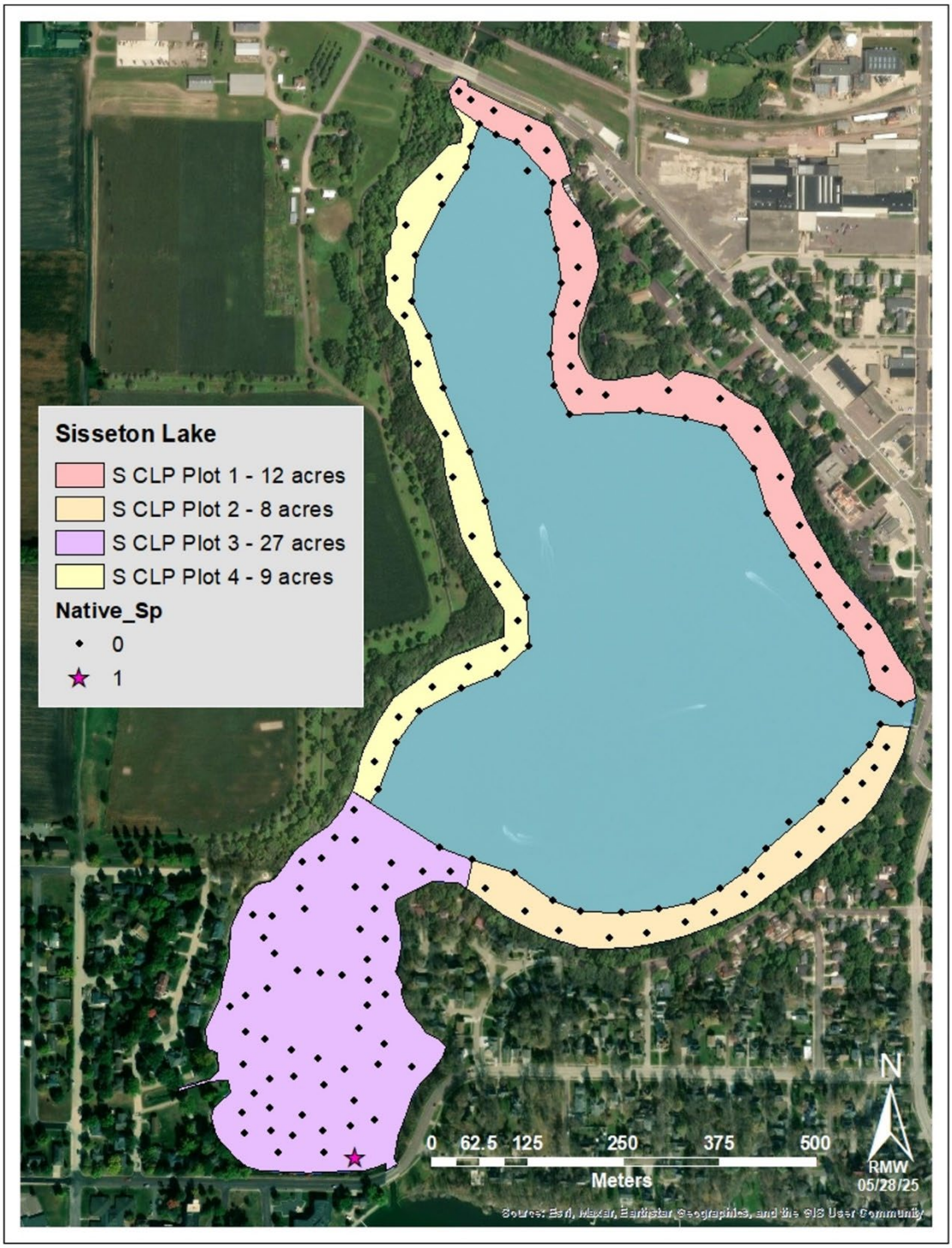


Figure 4. Distribution of native aquatic plant species in Sisseton Lake during the delineation survey conducted in May 2025.

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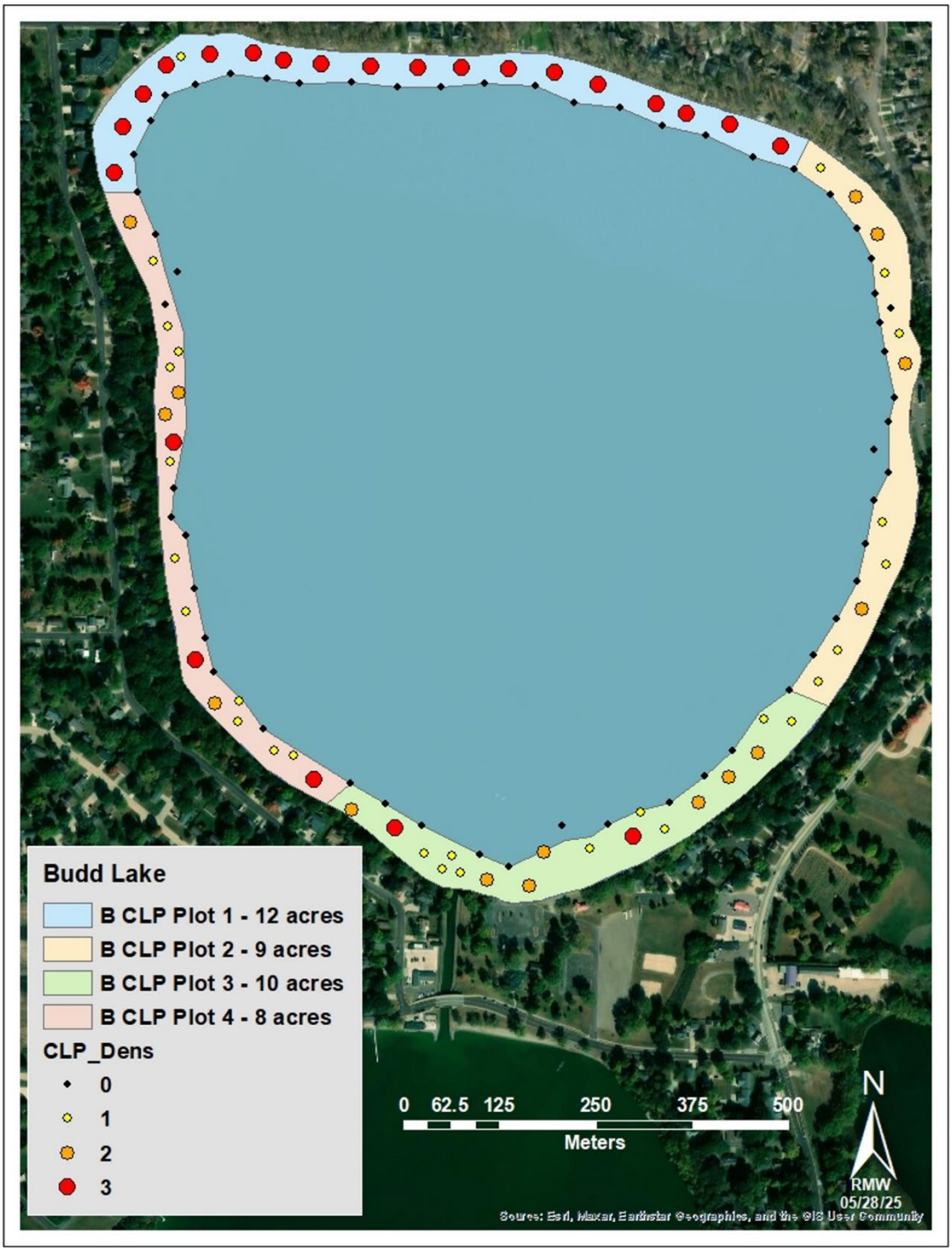


Figure 5. Distribution and abundance of curlyleaf pondweed in Budd Lake during the delineation survey conducted in May 2025.

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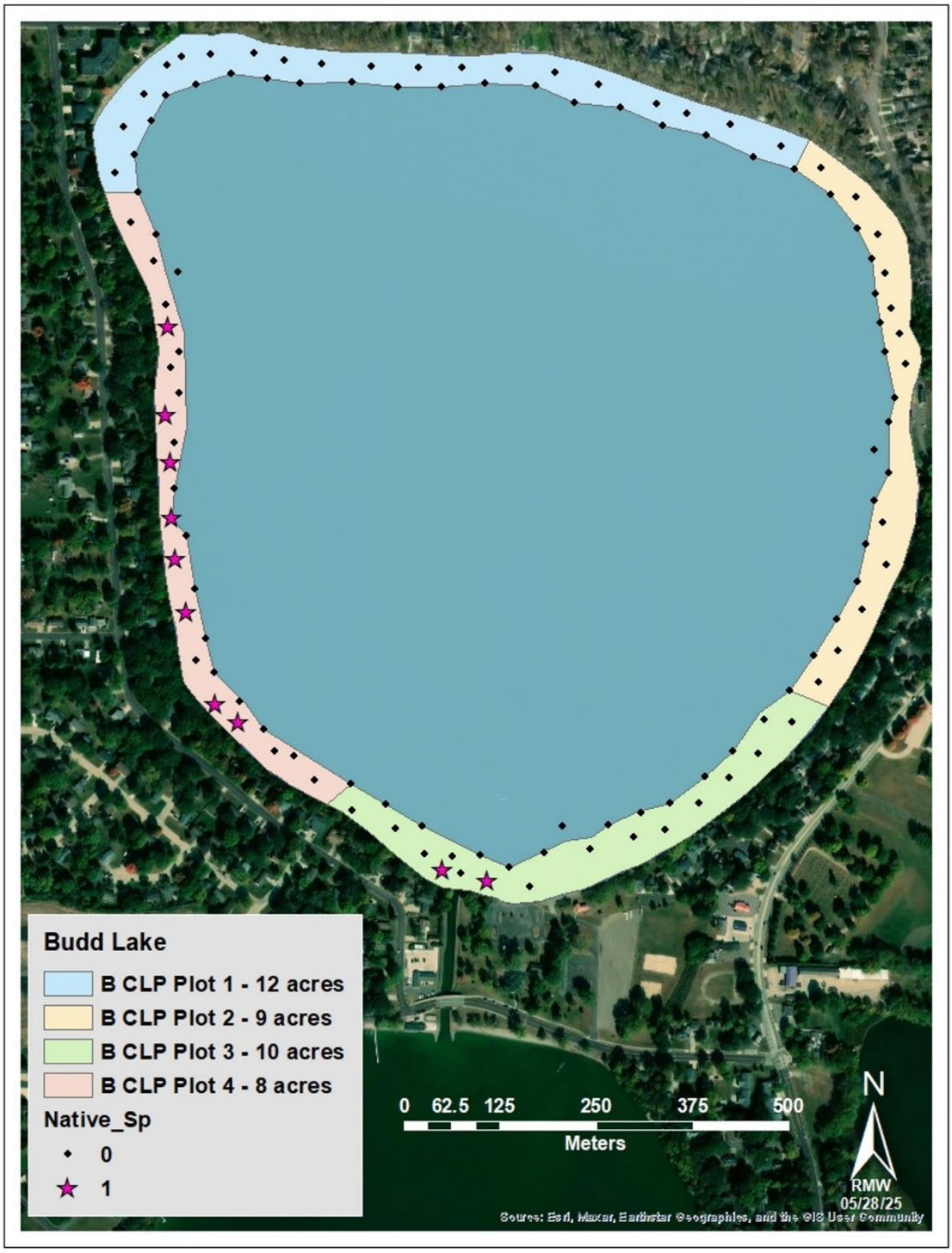


Figure 6. Distribution of native aquatic plant species in Budd Lake during the delineation survey conducted in May 2025.

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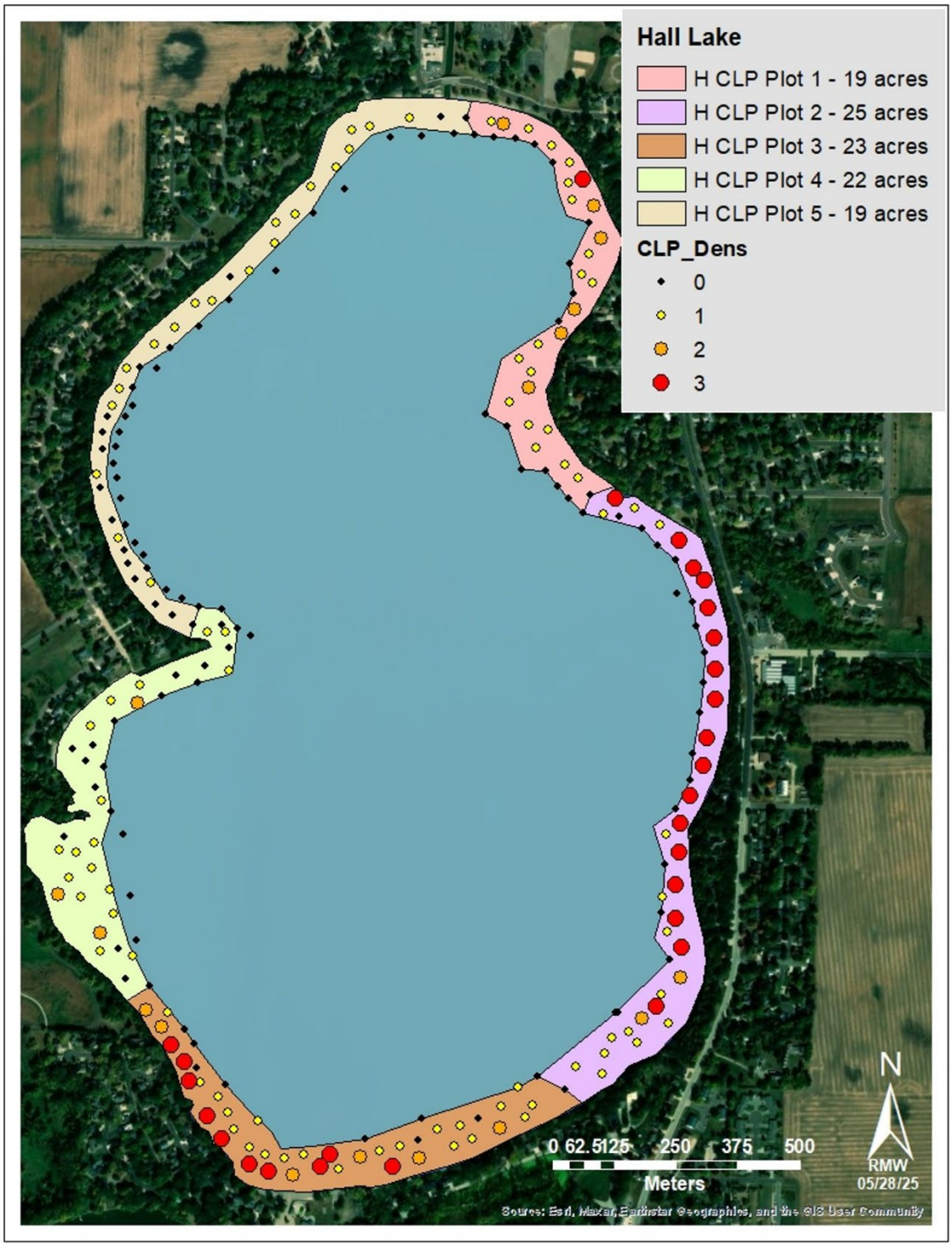


Figure 7. Distribution and abundance of curlyleaf pondweed in Hall Lake during the delineation survey conducted in May 2025.

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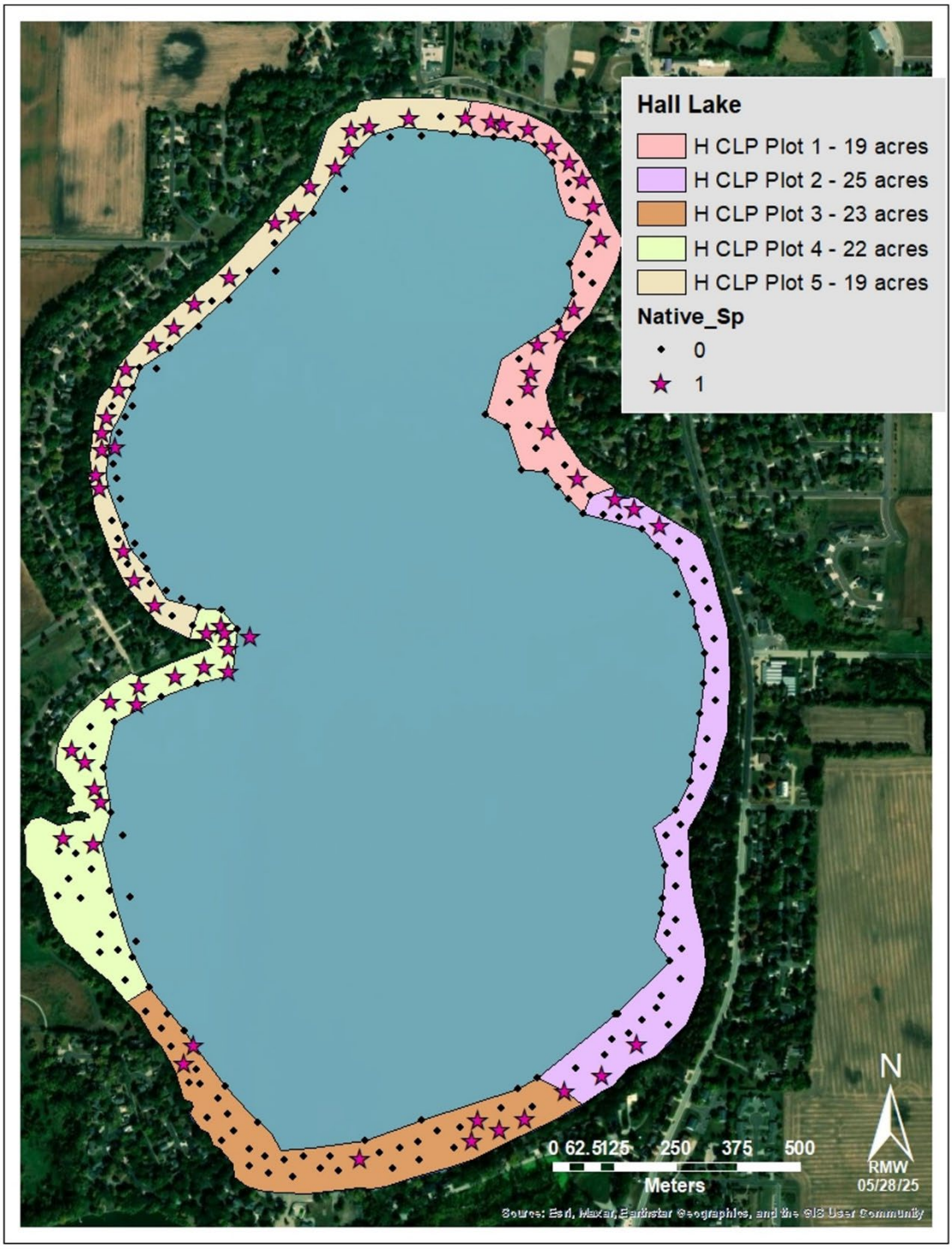


Figure 8. Distribution of native aquatic plant species in Hall Lake during the delineation survey conducted in May 2025.

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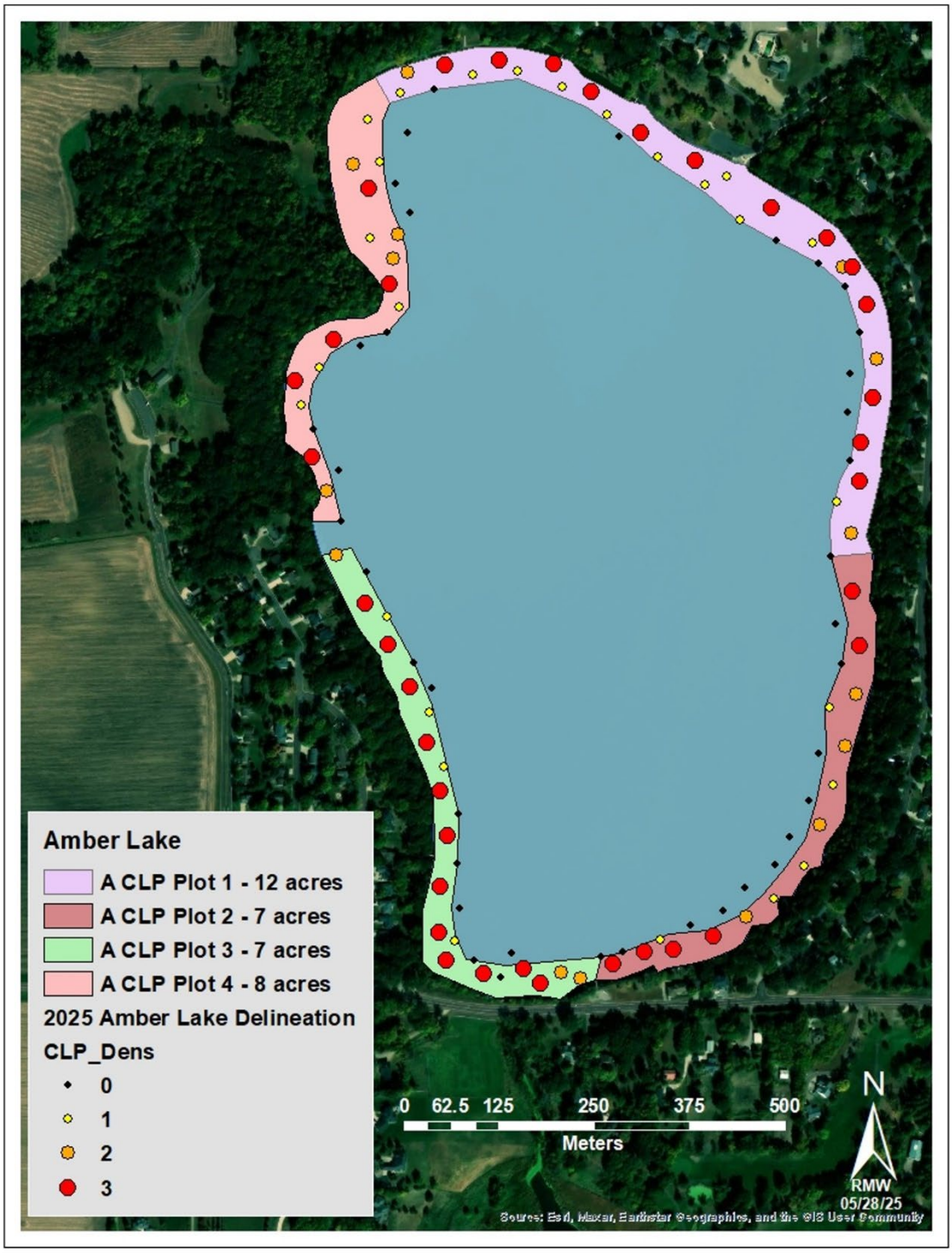


Figure 9. Distribution and abundance of curlyleaf pondweed in Amber Lake during the delineation survey conducted in May 2025.

Outlook

Re: Curlyleaf Pondweed Turion Data

From Hannah Neusch <hneusch@fairmont.org>
Date Mon 6/23/2025 12:29 PM
To Wersal, Ryan M <ryan.wersal@mnsu.edu>; Dustin Benes <dustin.martinswcd@gmail.com>
Cc Pat Oman <poman@fairmont.org>

Ryan,

Thank you for the update. From what you've said it seems the density of turions in our lakes are relatively low in relation to what you've stated for peak turion densities. If I'm reading this correctly, that's good news.

You can call my cell phone for the meeting if teams isn't working for you. It's listed below in my signature as 'text'. I'll put you on speaker.

--

Hannah Neusch
Water Resources Coordinator
City of Fairmont
Call: (507) 238-3953
Text: (507) 432-6041
Office Hours 8am-4:30pm M-F
hneusch@fairmont.org

City of Fairmont's Stormwater Code:
https://library.municode.com/mn/fairmont/codes/code_of_ordinances?nodeId=CICO_CH25UT_ARTIXSTMA

MPCA Construction Stormwater permit overview: https://www.pca.state.mn.us/sites/default/files/wq-strm2-05.pdf

CLEAN WATER ACT MINNESOTA 50 YEARS

From: Wersal, Ryan M <ryan.wersal@mnsu.edu>
Sent: Monday, June 23, 2025 11:12 AM
To: Dustin Benes <dustin.martinswcd@gmail.com>; Hannah Neusch <hneusch@fairmont.org>
Subject: Curlyleaf Pondweed Turion Data

Hannah and Dustin,

My team did the first turion monitoring assessment last week. We chose 1 plot from each lake and collected 20 samples in each plot to assess turion density. Data in the table below represent the average turion density at each plot based on those 20 samples. These data are a good baseline metric for what the turion bank is in each lake as we chose plots based on the highest prevalence of plants. The goal of managing curlyleaf pondweed will be to reduce turion production through management timing and to reduce the turion bank over time. We will be back down in July to sample the same plots again and to conduct the point intercept survey.

Table 1. Mean (± 1 SE) curlyleaf pondweed turion density from select locations in the Fairmont Chain of Lakes, Martin County, MN during June 2025.

Lake	Plot	Turion Density ($N\ m^{-2}$)
George	1	337.5 ± 112.1
Sisseton	3	122.5 ± 35.8
Budd	3	100.0 ± 26.6
Hall	3	42.5 ± 13.7
Amber	3	55.0 ± 14.0

Curlyleaf pondweed primarily reproduces vegetatively via turion production or rhizome elongation. Turions are vegetative structures capable of surviving extreme conditions (i.e. droughts, freezing temperatures, and herbicide treatments) and producing a viable plant capable of reproduction. These structures are typically produced in the weeks prior to plant senescence. In northern populations, curlyleaf pondweed has an atypical growth cycle. It senesces in early summer after turion formation. Turions then fall to the substrate and are dormant throughout the summer. Turions sprout in mid to late fall and plants begin to grow. Plants remain viable under the ice throughout winter. When ice melts, plants start to grow again producing more turions in the spring. In established curlyleaf pondweed populations, including lakes in Minnesota, peak turion densities can range from 1,152 to 3,030 turions m^{-2}.

I am traveling the week of June 30 and do not know if Teams will work where I am at. Is there a phone number that I could call in the event that teams is not working?

Thanks,
Ryan

Ryan M. Wersal, Ph.D.
Associate Professor - Aquatic Weed Science
Biology Graduate Coordinator
Minnesota State University, Mankato
Department of Biological Sciences
141 Trafton Science Center S
Office: 507-389-5728
Email: ryan.wersal@mnsu.edu
https://cset.mnsu.edu/departments/biological-sciences/faculty-and-staff/ryan-wersal/

Shipping Address:
Minnesota State University, Mankato
Department of Biological Sciences

Harvester Info



Aquatic Lake Weed Harvesters

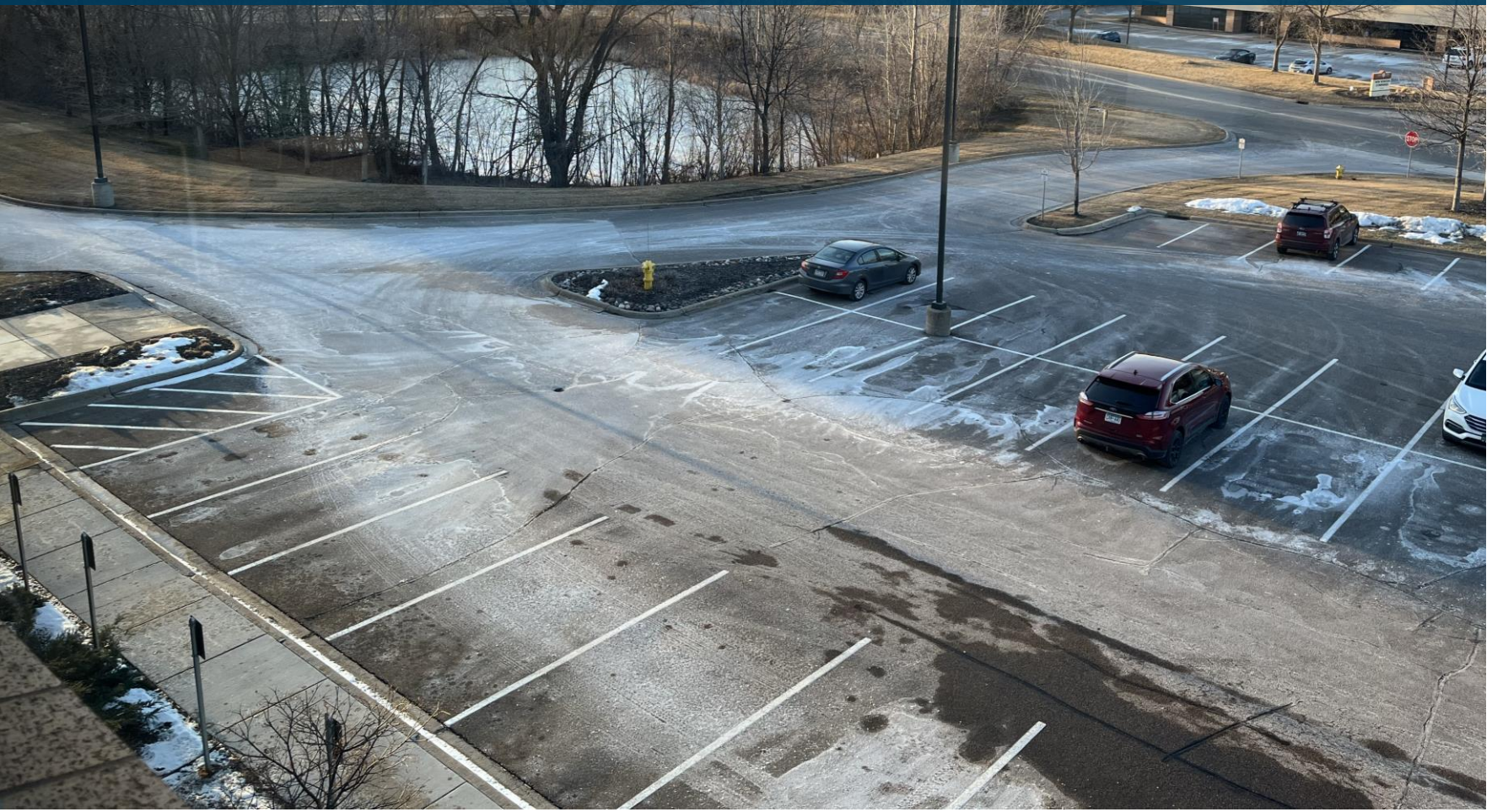
Aquatic harvesters or lake weed harvesters are aquatic machines designed for water management to cut and remove submerged and emergent aquatic plants or lake weeds. This is typically referred to as aquatic weed harvesting. Lake weed harvesters are developed to help maintain inland lakes, rivers, canals, and ponds to remove excessive lake weeds that negatively impact a waterbody's ecology. The true origins of the harvesting industry began with a weed cutter boat built in 1903 by the Hockney Company in Silver Lake Wisconsin. Since their creation in 1903, lake weed harvesters have evolved into pontoon-sized boats for managing smaller bodies of water like ponds and channels to larger-sized aquatic harvesters used to maintain much larger water bodies like lakes and rivers.

Traditional lake weed harvesters are paddle-wheel-driven and employ sickle-cutter technology to efficiently cut and collect submerged and emergent weeds below the water surface. After cutting, the plants are moved up a conveyor and placed in the storage bunk. Once the storage bunk is full, the harvester offloads the collected weeds either directly onto the shore or into a transport barge for larger lakes, ensuring continuous operation and productivity.

Chloride 101

Lakes Management Committee Meeting

June 30, 2025



BOLTON & MENK

Real People. Real Solutions.

LSiD™

Low Salt Solutions

Presenter Introduction



Connie Fortin
Low Salt Strategist



Justin Schmidt, PE, LSIT
Transportation
Project Manager

Chloride: Permanent Pollutant

Toxic to aquatic life: 230 mg/L (U.S.EPA)

IN Chronic standard- calculated based on sulfate and hardness (250-500 mg/L)

MN & IN Drinking water standard 250 mg/L

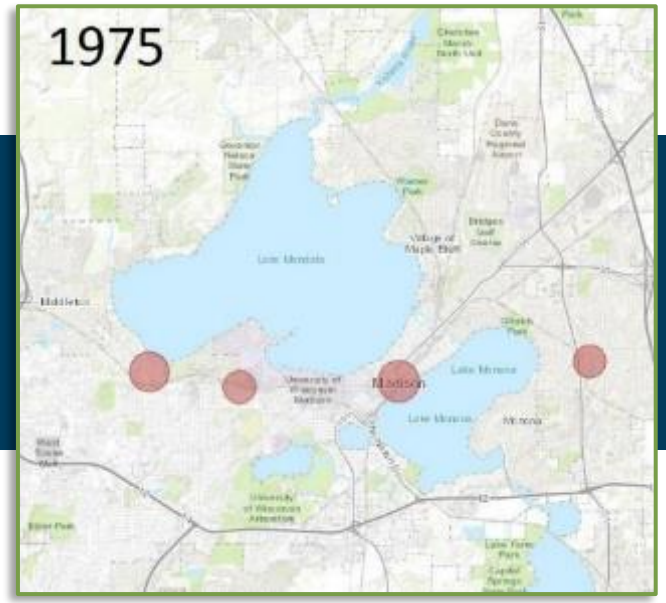
Damages

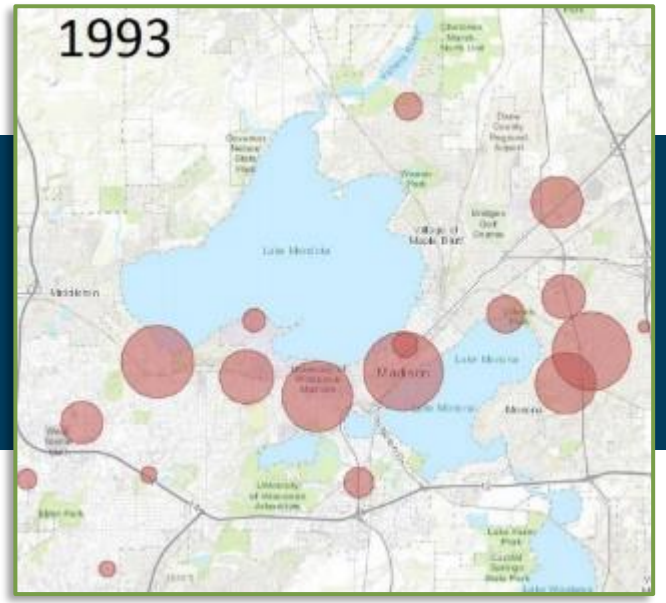
- Infrastructure
- Soils
- Water
- Vegetation
- Wildlife

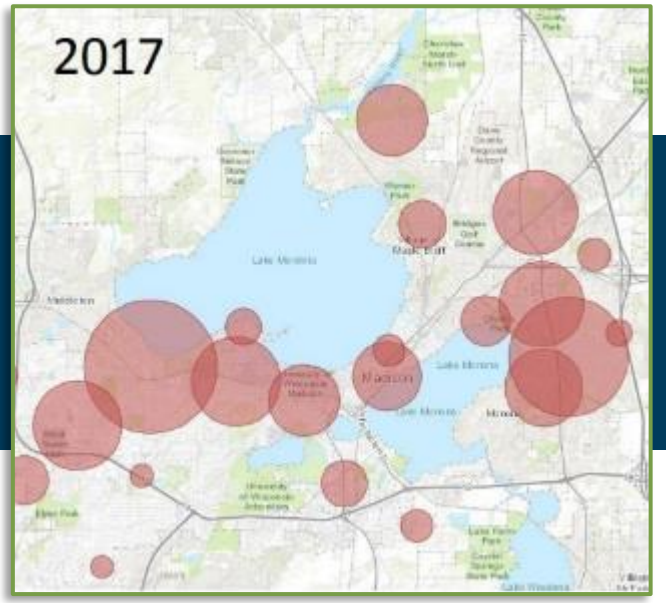


1 teaspoon of salt contaminates
5 gallons of water

Municipal Wells in Madison, WI

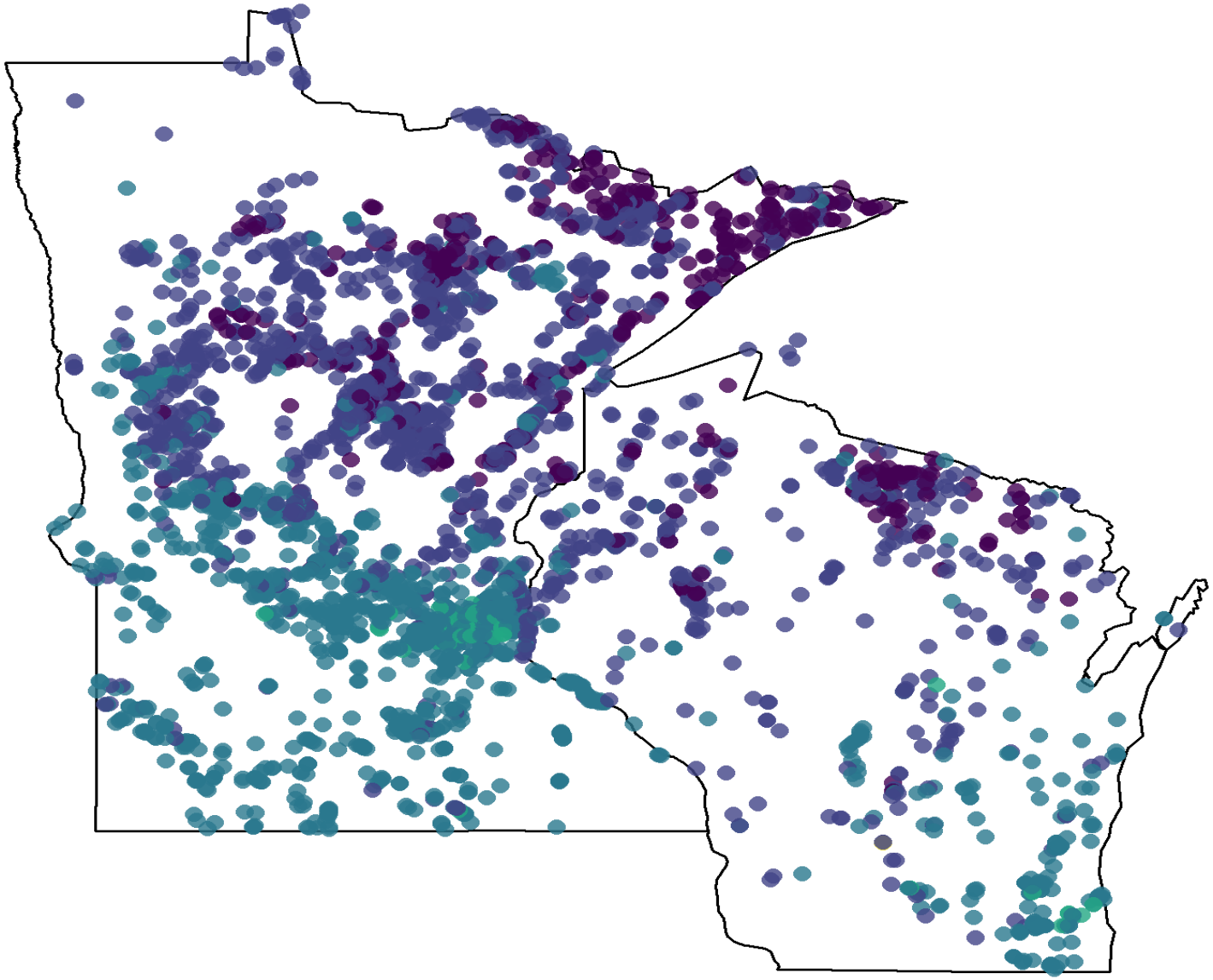






The larger the dot, the more chloride in wells

Source: Phil Gaebler, City of Madison Wisconsin



Chloride in Lakes and Rivers

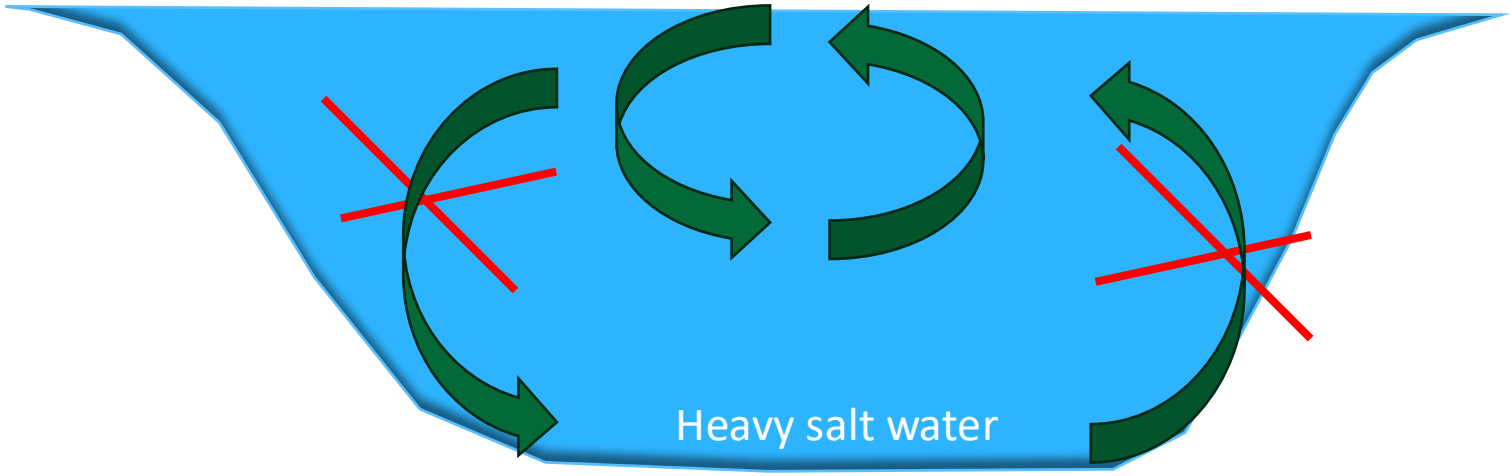
Dr. Hilary Dugan, 2018

This is a one-way trend!

Most Chloride

Least Chloride

Impacts Lake Turnover

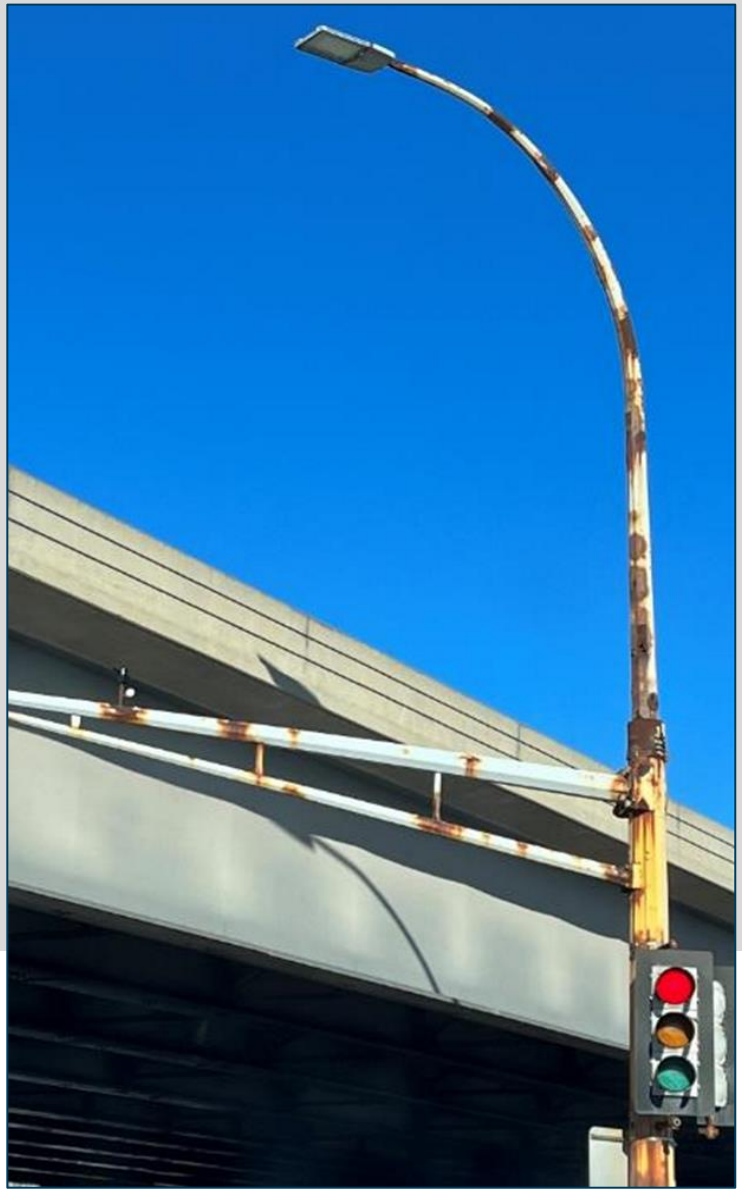


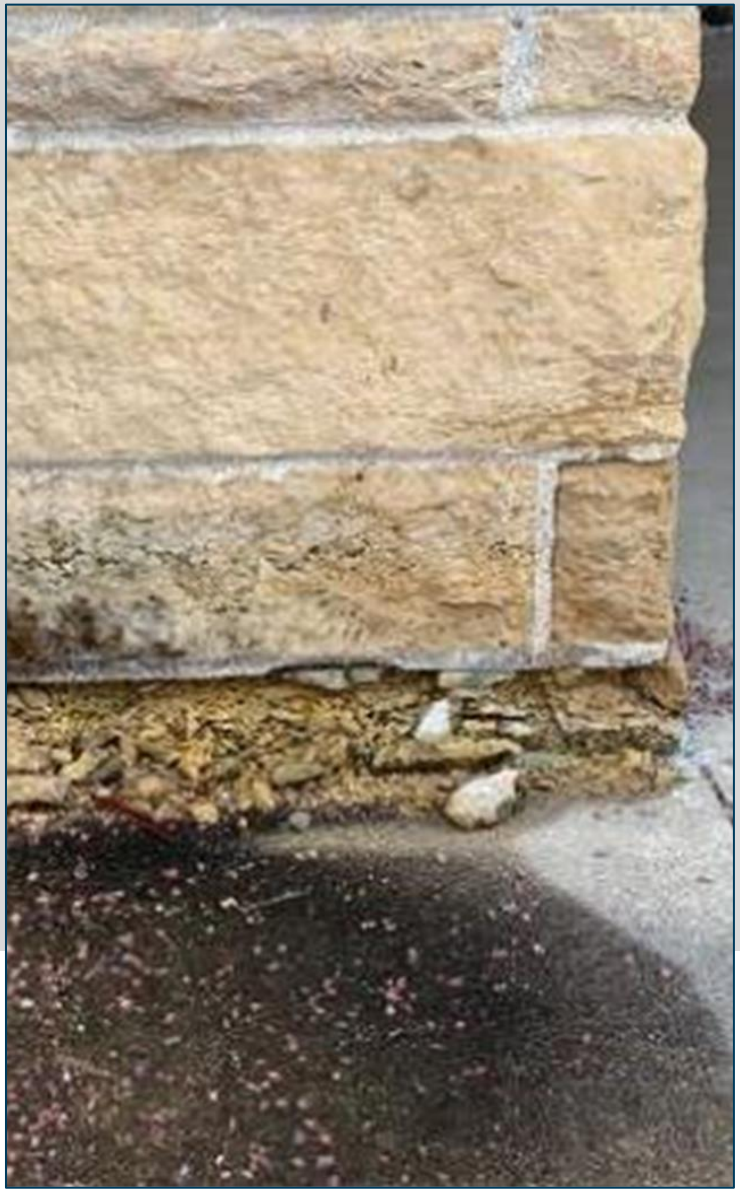
Salty water sinks to the bottom of the lake, affecting its ability to turn over (circulate the water).

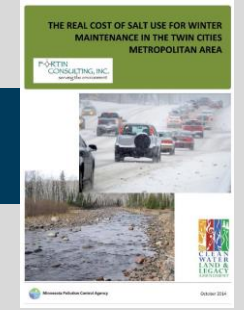
As a result, it can become anoxic- no oxygen in the bottom.

With no oxygen, phosphorus is released from the sediments, causing more plant growth.

Each ton of salt creates $1,700 - $17,000 infrastructure damage







Salt damages soil structure & vegetation





MN Salt Use

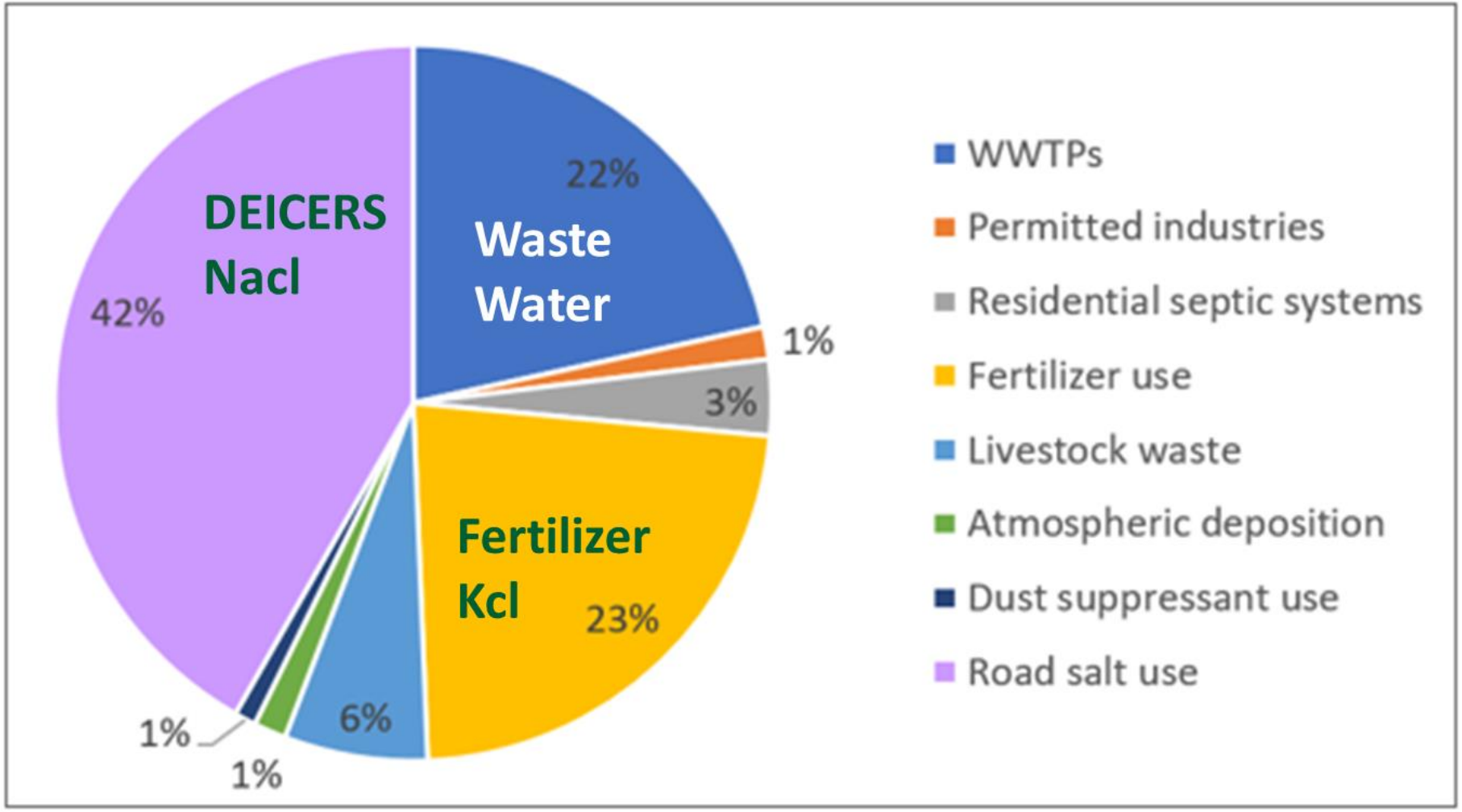


Figure 13: Fraction of annual chloride contributions from major point and nonpoint sources for State of Minnesota (Overbo et al. 2019)



Source: https://www.pca.state.mn.us/sites/default/files/wq-s1-94.pdf

2021

MN became the first state to have a comprehensive chloride management plan

Chloride is a TOP pollutant of concern in Minnesota

Wrestling with Chloride

1. Understand your regions chloride use.
2. Develop strategies to drive down the use of chloride.
3. This will result in long term cost savings and it will help protect your lakes.

Thank you!

We can outwit winter!



Connie Fortin
Low Salt Strategist
Connie.Fortin@bolton-menk.com
612-220-5999



Justin Schmidt, PE, LSIT
Transportation Project Manager
Justin.Schmidt@bolton-menk.com
507-618-7868

Outlook

June FLF Meeting

From Jenzen, Erynn (DNR) <erynn.jenzen@state.mn.us>
Date Mon 6/16/2025 3:26 PM
To Omvig, Jon <jon.omvig@wsp.com>
Cc Hannah Neusch <hneusch@fairmont.org>

1 attachment (207 KB)
2025-05-19-Nanobubble Factsheet_final.pdf;

Good afternoon, Jon,

I just wanted to touch base briefly on the meeting taking place tonight regarding nanobubble/nanovoid technology and provide a bit of additional information to hopefully answer some questions that may be raised at this meeting. I unfortunately won't be able to make it to the meeting in person, but DNR's nanobubble task force has provided the attached fact sheet that will hopefully answer many questions that attendees may have and provide insight into how this technology fits into Minnesota Rules and Statutes as well as offer careful considerations before technology gets ahead of us.

I urge any attendees to see and listen with critical eyes and ears as this technology is generally presented in a sales-pitch fashion. I also wanted to make it clear that there are still many considerations regarding the long-term ecology, chemistry, and physical bed make up that DNR has still not been provided adequate information on to make informed decisions or issue permits – it is unclear at this time what unintended consequences this technology may have on the inherent natural conditions of the basin(s). Additionally, the Fairmont Chain is a larger-scale, flow-through system, whereas most information provided on these technologies has been acquired from small scale, closed basin studies. Given that Budd Lake is also the main source of the City's drinking water, these specifics are even more important. Again, permits are not being issued at this time for this technology (noted in the factsheet).

Thanks, Jon! Have a good rest of your Monday and stay dry!

Erynn Jenzen
Area Hydrologist | Ecological and Water Resources

Minnesota Department of Natural Resources
117 Rogers St
Mankato, MN 56001
Phone: (507) 389-8809
Cell: (507) 456-0007
Email: erynn.jenzen@state.mn.us
mndnr.gov

DEPARTMENT OF NATURAL RESOURCES

Factsheet: Nanobubble Technology in Minnesota Public Waters

What are Nanobubbles?

Nanobubbles are microscopic gas bubbles—typically less than 200 nanometers in diameter—suspended in water. Unlike larger bubbles, nanobubbles do not rise to the surface quickly. Instead, they remain in the water column for extended periods, eventually collapsing and releasing energy that can increase dissolved oxygen (DO) levels and potentially change water chemistry. This has led to growing interest in their use for improving water quality, reducing organic sediments, and limiting algal blooms.

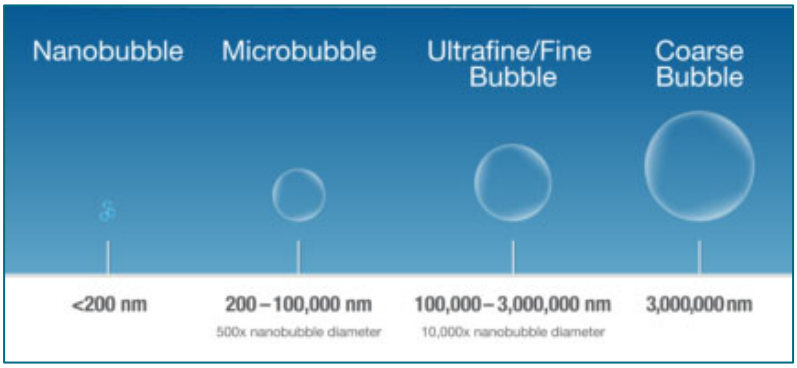


Fig. 1: Nanobubble compared to larger bubbles used for diffused aeration

How Do Nanobubbles Work?

Nanobubble systems are specialized generators that inject gas (often air or oxygen) into water under pressure. The resulting nanobubbles distribute in the water column where they may, under certain conditions:

- Increase oxygen availability to bottom sediments.
- Alter microbial processes.
- Affect nutrient cycling, particularly internal phosphorus loading.
- Suppress certain cyanobacteria species.

Landowners with proposals for Individual Shoreline Aeration are strongly encouraged to wait until the 2026 season for submitting a permit application.

Due to the limited data available on the long-term environmental effects of nanobubble technologies in natural lake systems, the DNR will not be able to issue individual shoreline aeration permits in a timely manner for nanobubble systems in 2025. The Department is taking a precautionary approach to prevent unintended harm to aquatic ecosystems, public safety risks (especially under ice-cover), or interference with existing lake management strategies.

Pilot-Scale Testing: Case-by-Case Review

The DNR is currently evaluating proposals for pilot-scale nanobubble treatments on a limited basis. Each pilot project is reviewed in coordination with multiple state agencies, including the Minnesota Pollution Control Agency (MPCA) when project goals are focused on changes in water quality. Permit applicants must submit a detailed monitoring and evaluation plan that includes:

- A clear statement of the primary treatment goal or objective(s) (e.g., 'muck' reduction, internal nutrient load reduction, cyanobacteria control).
- Anticipated measurable outcomes expected based on the stated project objectives (e.g., lbs. organic matter reduced, percent reduction in phosphorus).
- Gas type used in the nanobubble system (e.g., ozone, air, oxygen) and expected concentration (*e.g. mg/L*).
- Baseline water quality data collected prior to treatment (e.g., dissolved oxygen, sediment oxygen demand, phosphorus levels, etc.) to support post-treatment comparisons.
- A monitoring approach detailing sampling protocols and third-party analysis for transparency and data integrity.
- Evaluation of alternative management strategies and justification for nanobubble use.

Permitting Requirements

In Minnesota, the use of nanobubbles in public waters requires an aeration permit issued by the Department of Natural Resources (DNR) under Minn. R. 6116.0010–6116.0060.

Nanobubble systems, while innovative, function similarly to mechanical aeration and can affect public safety, aquatic life, and water quality. These systems alter natural conditions and may interfere with lake stratification or contribute to unintended consequences in aquatic ecosystems. Permits for all aeration proposals can only be issued when the proposals are consistent with applicable Minnesota Rules and Statutes.

Why This Approach?

The DNR's permitting stance is based on the need for reliable data and understanding of:

- How nanobubble impact natural lakes and reservoirs.
- The effects nanobubbles have on sediment chemistry, nutrient cycling, and aquatic communities.
- Whether benefits, such as reduced internal phosphorus loading, are sustainable and at what scale.
- How emerging technologies can be responsibly applied to align with lake management goals.

Potential Risks of Nanobubble Use

While nanobubble systems may show promise, concerns include:

- Altered habitat conditions for native species.
- Unintended consequences like DO stratification disruption or adverse effects on fish and their food web interactions, plants, invertebrates and zooplankton.
- Accelerated nutrient cycling under certain conditions.

- Depending on the type of gas used in nanobubble systems, it may pose ecological or health risks based on its properties (e.g., ozone, oxygen, carbon dioxide); risks can include stress on aquatic organisms and alterations to water chemistry.
- Lack of peer-reviewed, long-term field data from natural lake systems.

Additional Considerations

- Water clarity alone is not a sufficient or acceptable standalone goal for issuing an aeration permit. Nanobubbles, like fountains or surface agitators, may physically disrupt the area near the system but their effectiveness is reduced outside of the treatment point and may not necessarily address root causes such as internal nutrient loading. In many cases, these systems may simply shift nutrients or algae to untreated portions of the lake, rather than removing or inactivating them.

- Water clarity may improve temporarily due to nanobubbles but is not a regulatory justification unless tied to measurable ecological or public benefits.

- "Muck reduction" claims must be supported with lake-bottom monitoring and could trigger additional permitting (e.g., Public Waters Work Permit) if sediment alteration is anticipated.

- While nanobubble technology presents promising potential for water treatment through both physical and chemical mechanisms, its use in natural lake systems requires careful consideration of site-specific conditions and potential ecological impacts.

- Nanobubble systems are expensive. Ensure that the anticipated water quality and/or habitat improvements justify the cost of nanobubble system installation and operation, and that they provide a reasonable return on investment for end users, particularly in comparison to other available lake management strategies.

Nanobubbles and Lake Management

- Local units of government, lake associations, and private landowners are working closely with various state agencies to improve water quality through a robust Clean Water Fund fueled planning process. If proven effective, Nanobubble technology could be a tool in the toolkit but should be considered in the larger planning process relative to other strategies.

- When possible, the best strategy is to concentrate efforts in the watershed of the lake to keep the lake and its ecosystem healthy and thriving. Keeping excess nutrients and pollutants from reaching the lake in the first place are usually the most effective and cost-effective lake management strategies.