Sara Harrison

Hello,
I would like to know what actions the MPCA is finally going to take this year and in the years ahead to prioritize and implement remeidation plans to aggressively remove and prevent toxic green algae and other dangerous pollutants from endangering our lakes and streams. It is well documented that these pollutants can seriously harm and /or kill ducks, birds, beavers, mustrats, etc. It is also well documented that blue green algae can also be very toxic to people and dogs that enter polluted lakes to swim. The restoration of our impaired lakes and water sheds is long overdue and needs to be a top priority for attention this year and in years ahead, before we reach a critical tipping point of no return.

I would appreciate getting some feedback and insight as to what currently is being done and what action plans are being proposed to implement in the year(s) ahead to address the critical issues of restoring the health of our beloved lakes and rivers in Minnesota.

Thank you,
Sara Harrison

David Zierott

What is the primary source of the mercury contamination in these water systems?

Lynn Anderson

The Prairie River should be added to the list of impaired waters as is a prime wild rice waters. Sandy Lake Band of the Mississippi Chippewa and Mille Lacs regularly harvest wild rice from the Prairie River. Wild rice seed has also been harvested from the Prairie River to reseed the restoration of the St. Louis River Estuary.

Wild rice is particularly sensitive to sulfates and needs to be protected.

I urge you to add the Prairie River to the list of impaired waters in Minnesota.

Karen Kill

I am the administrator of Brown's Creek Watershed District. We have been monitoring the water quality of Long Lake in Stillwater 82-0021-00 and would like to have the lake considered for delisting for excess nutrients. Over the past twenty years, Brown's Creek Watershed District has worked with the city of Stillwater, Washington County public works, Mn DOT, and dozens of private landowners to implement over 100 projects in the subwatershed reducing loading by over 150 pounds of phosphorus per year. I would like to discuss this further with staff.

Ryann Geldner

Comment on 2026 Impaired Waters List and Assessment Manual – Need for Biological Monitoring, Nature-Based Solutions, and Chemical Transparency

Hello,

I am submitting comments on the 2026 draft Impaired Waters List and Assessment Manual.

Minnesota's current lake-assessment framework relies heavily on nutrient-only monitoring, which leads directly to alum recommendations even when lakes are impaired for biological reasons. For example, AUID 40-0063-00 (German Lake) is listed as impaired for FishesBio, yet the county monitoring program collects only phosphorus data. Nutrient-only monitoring cannot assess or address biological impairments.

I request that MPCA update the Assessment Manual and TMDL framework to include the following:

Alum should not be used unless external nutrient sources (including agricultural tile drainage) have been addressed first. Internal-loading treatments cannot succeed when external loading continues.

Engineering firms conducting lake studies should be required to evaluate nature-based solutions (wetlands, shoreline restoration, stormwater filtration, cover crops, etc.) before recommending alum. These alternatives are consistent with MPCA's watershed-based approach and often provide longer-term ecological benefits.

A 51% homeowner approval threshold should be required for any chemical treatment in public waters, even algae. Residents should have a voice in decisions that affect long-term ecological health.

MPCA should create a public, statewide database documenting all chemical applications to lakes, including herbicides, algaecides, and alum. This transparency is essential for evaluating cumulative impacts and for understanding long-term ecological trends.

These changes would bring Minnesota's lake-assessment practices into closer alignment with MPCA's own biological-monitoring standards and with EPA guidance on evaluating ecological condition.

Thank you for considering these comments.

Amy Timm

A note about South Whaletail (27-0184-02). The first Alum treatment was in 2023, and another one is planned for 2026. It is meeting standards, but there is not enough data to list the lake as fully meeting and de-listed from the impaired waters list. Watch this lake for a delisting in the next couple of years.

Janette Dean

I support the MPCA prioritizing real, measurable pollution reductions that will allow Minnesotans, fellow Americans and tourists from any country to SAFELY swim, fish and drink clean water in Minnesota. We owe everyone that much as we ask them to live, recreate or visit here!

Dean Borgeson

I support the MPCA prioritizing real, measurable pollution reductions so all Minnesotans can safely swim, fish, and drink clean water!

Francine Tryon

I am concerned about the drinking water in Hoyt Lakes they have said it is safe but it smells bad and taste bad. All of my clothes and my friends clothes have because dinghy from the water. They keep adding chemicals to correct it to make it safe so now you have terrible water with lots of stuff in it.

Laura Scholl

I am very supportive of the MPCA prioritizing real, measurable pollution reductions so all Minnesotans can safely swim, fish, and drink clean water. We must hold each other accountable, using data to back our decision making and support for our local water bodies.

Megan O'Hara

One of MPCA's most important tasks in protecting our precious lakes and rivers is compiling and funding the Impaired Waters list. At a time when our lakes and rivers are under unprecedented pressures from warming climate, invasive species and impacts from lawn and farm chemicals this research has never been more important. Please keep aggressively enacting the Clean Water Act while we can still save our marquee and legendary lakes and rivers.

Scott Schroeder

Kittleson Lake (AUID 60-0327-00) in the Red River of the North - Sandhill River Watershed is indicated as a 2026 delisting for its 2014 nutrients impairment due to restoration activities. However, the MPCA ACT review team determined in May 2024 that the nutrient delisting should be for unknown reasons. Please make this correction for the final 2026 impaired waters list. Submitted by Scott Schroeder, MPCA Northwest Watershed Unit watershed project manager.

George Schneider

I noticed that on the 2026 draft list, Rice Main Lake (Hennepin County - 27-0116-01) is listed on the 2026 Inventory Impaired Waters tab, but not on the 2026 TMDL list. It was listed as Impaired in 2010; shouldn't it be on the 2026 TMDL List?

Grace Butler

I support the MPCA and their purpose and budgeting for establishing standards to keep MN waters safe for recreation and wildlife. The MPCA has done exceptional work in PFAS and chlorine testing, standards and reduction plans.

Catherine-1-I support the MPCA p Fleming

"I support the MPCA prioritizing real, measurable pollution reductions so all Minnesotans can safely swim, fish, and drink clean water"
As the effects of climate change become more and more profound, it is doubly important for us to maintain clean water. Water is the basis for our food and ecosystem for all living things here in Minnesota and not something any of us should ever take for granted. We have the power. We need to use it.

Rachel Workin

The City of Fridley requests that the impairment designation for Rice Creek (07010206-584) be continued through Locke Lake to Rice Creek's confluence with the Mississippi River. Locke Lake is an impoundment of Rice Creek, so the same standards and impairments apply.

Zack Witzel

While reviewing the IWM2023 assessment results an issue was identified with with Stahl's Lake (43010400). The lake is currently listed as Inconclusive Vulnerable in the Assessment Viewer. An error was made while scoring this lake and the wrong model was used. With the correct model applied, Stahl's Lake needs to be listed as Not Supporting Aquatic Life Use.

Leanna Goose

I urge the Minnesota Pollution Control Agency (MPCA) to fully recognize and protect treaty-reserved rights throughout this process. Under Article VI of the United States Constitution, treaties are the supreme law of the land. These treaty-reserved rights remain in full force and cannot be meaningfully exercised without healthy ecosystems, clean water, abundant fish, wild rice, and the continued protection of the natural resources that sustain the cultural, spiritual, subsistence, and economic well-being of the Anishinaabeg.

Fish consumption advisories and water quality standards must reflect this legal and moral responsibility. All waters impaired by mercury contamination should have clear public advisories posted at public access points. People should not be expected to search online databases before fishing. Public notification is an essential public health measure.

Any fish consumption guidance developed within treaty territories must also recognize that Anishinaabeg often consume significantly more fish than the average Minnesotan because fish are a traditional and treaty-protected food source. Risk assessments based solely on average statewide consumption fail to account for the exercise of treaty-reserved rights and therefore do not adequately protect Tribal communities.

The MPCA has indicated that it is considering Minnesota Department of Health guidance regarding allowable levels of PFOS in fish. I urge the agency to reject the premise that PFOS contamination in fish should be considered acceptable. PFAS contamination is widespread throughout Minnesota and within reservations, PFAS persists indefinitely in the environment, bioaccumulates in fish, and poses serious risks to human health. The goal should be preventing contamination, not determining how much contamination people should be expected to tolerate in a traditional food source.

The MPCA must also fulfill its longstanding obligation to implement and enforce Minnesota's wild rice sulfate standard. This standard has existed since 1973 to protect waters capable of supporting wild rice and to reduce conditions that promote the conversion of mercury into methylmercury in aquatic ecosystems. Decades of delayed enforcement have placed both wild rice and fish at unnecessary risk. Strong enforcement of the sulfate standard is essential not only for protecting manoomin but also for reducing mercury contamination in fish and protecting public health.

These protections are especially important given the risks posed by copper-nickel sulfide mining. Ensuring the sulfate standard is upheld now protects wild rice from the dangers of copper-nickel sulfide mining in the future! Extensive scientific research has documented that sulfate pollution threatens wild rice and contributes to conditions that increase methylmercury production. Sulfide mining also presents unique risks because sulfide-bearing ores can generate acid mine drainage and mobilize toxic metals for generations after mining has ended. Unlike temporary economic benefits, contamination of waters, wetlands, groundwater, fisheries, and wild rice can persist for centuries, permanently impairing treaty-protected resources and the exercise of treaty-reserved rights.

The waters within Minnesota's treaty territories are not sacrifice zones. They are the homelands of the Anishinaabeg and provide clean drinking water, healthy fisheries, wild rice, medicinal plants, wildlife, and countless ecological and economic benefits that sustain present and future generations. Climate change is already placing unprecedented stress on these resources, making it even more important that state agencies uphold existing environmental protections rather than weaken or delay them.

The MPCA has both a legal obligation and a public trust responsibility to protect Minnesota's waters. Company profits and short-term economic gains cannot outweigh treaty-reserved rights, which are protected under the Constitution as the supreme law of the land. Protecting clean water, enforcing the sulfate standard, reducing mercury contamination, preventing PFAS pollution, and

respecting Tribal sovereignty are inseparable responsibilities.
I respectfully urge the MPCA to ensure that its decisions fully protect treaty-reserved rights, strengthen protections for fish and water quality, enforce Minnesota's sulfate standard, and reject policies that normalize the contamination of traditional foods. Protecting Minnesota's waters protects the health of all Minnesotans while honoring the treaties and ensuring that future generations inherit healthy lakes, rivers, wild rice waters, and fisheries.

The National Congress of American Indians
Resolution #SEA-25-009

TITLE: Requiring Free Prior and Informed Consent by Corporations, Companies, State and Federal Government Agencies Across the United States, and Globally

WHEREAS, we, the members of the National Congress of American Indians of the United States, invoking the divine blessing of the Creator upon our efforts and purposes, in order to preserve for ourselves and our descendants the inherent sovereign rights of our Indian nations, rights secured under Indian treaties and agreements with the United States, and all other rights and benefits to which we are entitled under the laws and Constitution of the United States and the United Nations Declaration on the Rights of Indigenous Peoples, to enlighten the public toward a better understanding of the Indian people, to preserve Indian cultural values, and otherwise promote the health, safety and welfare of the Indian people, do hereby establish and submit the following resolution; and

WHEREAS, the National Congress of American Indians (NCAI) was established in 1944 and is the oldest and largest national organization of American Indian and Alaska Native tribal governments; and

WHEREAS, Free Prior and Informed Consent (FPIC) is an international human rights standard that affirms the inherent sovereignty and self-determination of Indigenous Peoples, ensuring that no action affecting their lands, territories, resources, cultures or livelihoods proceeds without their freely given consent; and

WHEREAS, Tribal Nations retain the inherent right to self-governance, control over their lands, resources, and cultural heritage, and the ability to make decisions that impact their homelands and treaty territories where Indigenous Peoples maintain the right to hunt, fish, and gather; and

WHEREAS, FPIC affirms that Tribal Nations retain the right to determine their development priorities and exercise self-determination in accordance with their cultural, social, economic, and political systems, in accordance with the United Nations Declaration on the Rights of Indigenous People (UNDRIP); and

WHEREAS, the principle of FPIC is supported by the United Nations and is affirmed in the UNDRIP as well as recognized by the international community as the minimum standard for survival, dignity, and well-being of Indigenous Peoples worldwide, for which the United States has formally expressed support; and

WHEREAS, FPIC requires that consent must be given voluntarily, without coercion, intimidation, or manipulation, and consent must be sought and at the earliest contemplation of a project, before any decision or action is taken and throughout the lifespan of the project when such action that may impact the rights, lands, resources, or livelihoods of Indigenous Peoples, and such consent must be based on accurate and accessible information provided in a language and format that is understandable and culturally appropriate to the intended audience with the consent being explicit, specific, and documented, reflecting the genuine agreement of the affected Indigenous Peoples, taking into account that such consent can be revoked at any time; and

WHEREAS, FPIC must be obtained for all activities, projects, and initiatives that impact Indigenous Peoples rights, lands, resources, and livelihoods; and

WHEREAS, ensuring FPIC is utilized in any project impacting Indigenous Peoples prioritize the inherent rights and federally recognized sovereignty of Tribal Nations to self-governance and self-determination by allowing an impacted Tribal Nation to reject development that could negatively impact the health of its people and homelands; and

WHEREAS, FPIC should apply to all member-states that authorize activities that impact Tribal Nations and shall apply to all companies and government agencies involved in the planning and construction of any projects that may impact Tribal resources and the health of Native American and Alaska Native, thus empowering Tribal Nations to have the final say in protecting their people and resources; and

WHEREAS, FPIC must be sought when a project, such as a proposed mine, is located on, off, or near a reservation, Tribally-owned or controlled lands, ancestral homelands, and lands where Tribal treaty and statutory rights exist, but is close enough to contaminate a Tribal Nation's water supply, watershed, or resources in its treaty territory, allowing Tribal Nations to maintain the chemical, physical, and biological integrity of their waters and resources; and

WHEREAS, FPIC ensures that companies and government agencies cannot bypass the concerns and objections of Tribal Nations by recognizing the importance of Indigenous Knowledge and stewardship of the land, and acknowledging Tribal Nations' inherent rights to protect their territories for the next generations; and

WHEREAS, Tribal Nations decide what projects and plans require their consent, especially any time an environmental impact statement or worksheet is required for a project located on or near a reservation, Tribally-owned or controlled lands, ancestral homelands, and lands where Tribal treaty and statutory rights exist, and any proposed polluting project near reservations and treaty territories must require FPIC before any state or federal permitting process commences; and

WHEREAS, the principle of FPIC upholds self-determination which recognizes and respects the inherent right of Indigenous Peoples to govern themselves, make decisions, and control their lands, resources, and cultural heritage.

NOW THEREFORE BE IT RESOLVED, that the National Congress of American Indians calls on the United States Congress, the legislatures of all of the states, and member-states to enact laws that require Free Prior and Informed Consent (FPIC), while respecting American Indian and Alaska Native self-determination any time a project or development is located on or near reservation lands, Tribally-owned or controlled lands, ancestral homelands, and all other lands and waters where Tribal treaty and statutory rights exist; and

BE IT FINALLY RESOLVED, that this resolution shall be the policy of the NCAI and its member Nations until it is withdrawn or modified by subsequent resolution.

CERTIFICATION

The foregoing resolution was adopted by the General Assembly at the 2025 Annual Convention of the National Congress of American Indians, November 16-21 at the Seattle Convention Center in Seattle, Washington, with a quorum present.

Mark Macarro, President

ATTEST:

Christie L Modlin

Christie Modlin, Recording Secretary

The National Congress of American Indians
Resolution #SEA-25-010

TITLE: Establishing Support for recognizing the Rights of *Manoomin/Psíŋ*; a sacred plant that is central to Indigenous cultures in the Great Lakes region

WHEREAS, we, the members of the National Congress of American Indians of the United States, invoking the divine blessing of the Creator upon our efforts and purposes, in order to preserve for ourselves and our descendants the inherent sovereign rights of our Indian nations, rights secured under Indian treaties and agreements with the United States, and all other rights and benefits to which we are entitled under the laws and Constitution of the United States and the United Nations Declaration on the Rights of Indigenous Peoples, to enlighten the public toward a better understanding of the Indian people, to preserve Indian cultural values, and otherwise promote the health, safety and welfare of the Indian people, do hereby establish and submit the following resolution; and

WHEREAS, the National Congress of American Indians (NCAI) was established in 1944 and is the oldest and largest national organization of American Indian and Alaska Native tribal governments; and

WHEREAS, NCAI Resolution #ANC-22-008, duly adopted at the 2022 Mid Year Convention in Anchorage, Alaska, establishes a policy for the National Congress of American Indians to support the rights of nature legal framework promoted by various Tribal Nations in the United States; and

WHEREAS, as an example, wild rice, known as *Manoomin* in Anishinaabemowin and *Psíŋ* in Dakota, holds profound cultural significance for Native peoples in the Midwest region and is essential to biodiversity and ecosystems health; and

WHEREAS, wild rice holds significant spiritual importance for American Indian communities, as it is not only a staple food but also an aspect of our inherent relationship to the Earth, rooted in Traditional Indigenous Knowledge and fundamental to our identity and ecosystems; and

WHEREAS, Anishinaabeg Nations' treaties with the United States protect the inherent right and responsibility of the Anishinaabeg to harvest wild rice; and

WHEREAS, protecting wild rice is not just an environmental concern, but a matter of honoring treaties, nourishing indigenous bodies and culture, and ensuring that future generations can continue to practice their traditional ways of life; and

WHEREAS, wild rice faces significant threats from climate change, invasive species, pollution, and other human activities, all of which collectively jeopardize its existence; and

WHEREAS, the wild rice plant is especially sensitive to water quality, and can be compromised by various activities, such as mining, as elements such as water flow and temperature are essential for wild rice growth, and preserving the integrity of the wetlands home to wild rice beds is vital to maintaining biodiversity and the overall health of aquatic environments; and

WHEREAS, wild rice is a key indicator of freshwater health, and wild rice lakes are vital ecosystems that support diverse wildlife and plant species; and

WHERERAS, protecting wild rice directly correlates to maintaining water quality and habitat integrity, as wild rice thrives in clean, nutrient-balanced waters; and

WHEREAS, waters home to natural wild rice beds sustain an intricate web of life and also support local communities that depend on healthy ecosystems, and safeguarding wild rice ensures the resilience of freshwater systems.

NOW THEREFORE BE IT RESOLVED, that the National Congress of American Indians (NCAI) supports recognizing the inherent rights of *Manoomin/Psíŋ* (wild rice) to exist and thrive under the same legal framework as the rights of nature recognized in NCAI Resolution #ANC-22-008.

BE IT FINALLY RESOLVED, that this resolution shall be the policy of NCAI until it is withdrawn or modified by subsequent resolution.

CERTIFICATION

The foregoing resolution was adopted by the General Assembly at the 2025 Annual Convention of the National Congress of American Indians, held November 16-21 at the Seattle Convention Center in Seattle, Washington, with a quorum present.

Mark Macarro, President

ATTEST:

Christie Modlin, Recording Secretary

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Climate change contributes to the decline in off-reservation tribal harvest availability in the Great Lakes region

Check for updates

Madeline Nyblade [1,2], Daniel J. Larkin[3], Darren Vogt [4], Rob Croll[5], G.-H. Crystal Ng[1,6], William Joe Graveen[7], Kristen Hanson[7], Hannah Panci[5], Brandon Byrne[5] & Bazile Minogiizhigaabo Panek[8]

Climate change threatens the lifeways of Indigenous Peoples, impacting their rights to self-determination and sovereignty. In the Laurentian Great Lakes region, Indigenous communities have experienced harvest declines of wild rice (Ojibwemowin: Manoomin; Dakodiapi: Psiŋ; Latin: *Zizania palustris*), a sacred aquatic plant central to their culture. Here we analyzed 1985–2020 wild rice density and harvest data in relation to key climate variables. Our results indicate that wild rice stem density in the fall is higher in years that have (1) lower early-summer water levels due to decreased precipitation, and (2) longer lake-ice duration due to colder winter temperatures. Overall, wild rice available for tribal harvest off-reservation has declined regionally by ~5–7% annually—declines that are likely to continue due to anthropogenic climate change, specifically increased early-summer precipitation and warmer winters. This decline has infringed on Indigenous lifeways by reducing off-reservation tribal harvest, a right guaranteed by treaties with the U.S. government.

Climate change disproportionately disrupts Indigenous Peoples' land-based lifeways[1,2], which are legally protected by their inherent rights to self-determination[3] and sovereignty[4]. Despite these outsized impacts and direct consequences for their survival, Indigenous Peoples have been largely excluded from mainstream climate research[5]. For the Indigenous Peoples of the upper Laurentian Great Lakes, concerning climate change impacts on their sacred food[6,7], wild rice (*Zizania palustris* L.), have been observed[8–12] as this region experiences warming exceeding average global rates[13]. For the Ojibwe, one of three Peoples among the Anishinaabeg, wild rice was integral in the prophecy guiding their migration to this region[14] and now serves as a cultural foundation protected for harvest under treaties signed with the United States[6,15,16]. While wild rice is also culturally important for the Dakota, who call it Psiŋ, as well as for other Indigenous Peoples, this paper mostly incorporates Ojibwe perspectives, including the use of the Ojibwemowin word for wild rice, Manoomin[6], with capitalization honoring its personhood[17].

Two centuries ago, Manoomin was abundant across the shallow surface waters of the upper Laurentian Great Lakes region and portions of eastern North America[18,19], but today it has disappeared almost entirely from Michigan[20,21] and from one third of the watersheds in Minnesota and Wisconsin where it was found about a century ago[22] (Fig. 1). Over the last few decades, tribes and inter-tribal organizations have reported continued declines of Manoomin[23,24]; however, detecting recent multi-year trajectories of change and associated impacts on tribal harvesters has been elusive against the backdrop of Manoomin's natural multi-year cycles[25]. Further, studies have identified both land-use and climate changes to be among the general causes for this decline: drainage, ditching, damming, and other water management, coupled with changing precipitation patterns and winter conditions, have together shifted habitats outside of Manoomin's preferred water level niche, favoring other plant species in many places[6,20]. Despite these observations, no formal quantitative assessments of specific relationships between climate conditions and Manoomin abundance have been conducted to date. Filling this knowledge gap informs care for Manoomin in the face of climate change, efforts central to supporting Ojibwe lifeways and upholding treaty obligations.

This study quantifies declines in Manoomin density and harvest over the last three decades, ties these losses to climate disruptions during Manoomin's vulnerable life stages, and shows threats to Indigenous lifeways. To accomplish this, we employed environmental science within both the mainstream ('Western') knowledge system and the Ojibwe gikendaasowin (Ojibwe knowledge system). Environmental science within Ojibwe

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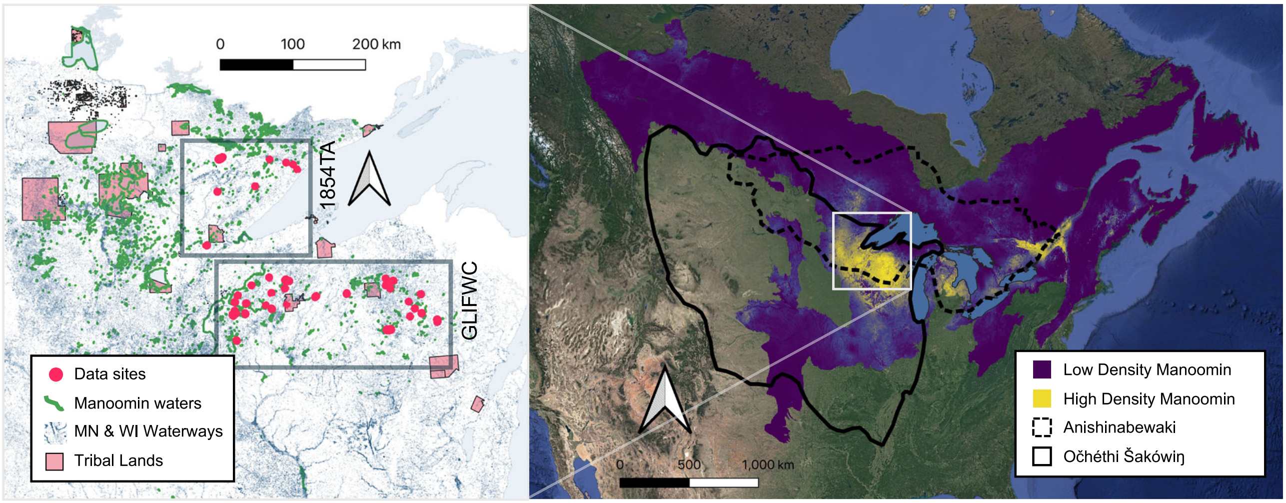

Fig. 1 | Map of study area. Map of data sites at the regional scale (left) and the continental scale (right). Regional scale map also includes Manoomin waters[105,106], Minnesota and Wisconsin waterways[107,108], and tribal lands[109]. The continental scale map also includes modeled Manoomin distribution[110], and the traditional territories of the Anishinaabeg (Ojibwe, Potawatomi, Odawa) and Očhéthi Šakówiŋ (Lakota, Dakota, and Nakota speaking people)[111]. Satellite Imagery: Google, ©2024.

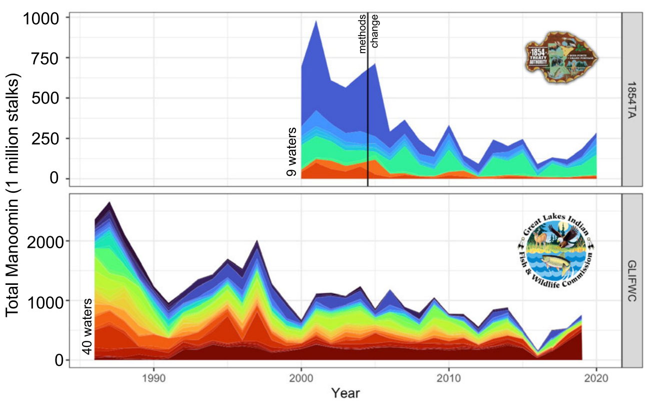

Fig. 2 | Manoomin abundance within study sites. Summed wild rice density through time for both the GLIFWC and 1854 Treaty Authority datasets. Each color represents a different lake. Note the sampling method changed in 2006 for the 1854 Treaty Authority dataset, indicated with a black line. Organization logos reproduced with permission (GLIFWC ©2025, 1854TA ©2025).

gikendaasowin, also referred to here and more generally across different Indigenous knowledge systems as Traditional Ecological Knowledge (TEK), is science embedded in an Indigenous worldview developed through generations of Indigenous Peoples living in close relationship to their homelands[17,26,27]. When invoked together, mainstream science and Ojibwe gikendaasowin deepen our understanding of the Manoomin socio-ecological system in ways unattainable from each one alone[28–30]. Given the dominance of mainstream environmental science within the academy, we strove for equitable collaboration by learning from Indigenous methodologies[31] and leaning on TEK as the 'intellectual scaffold' for our approach[32,33]. Specifically, the fundamental understanding of interconnectedness within TEK directed our tribal-university partnership formation[34,35] and our methodological assumption that knowledge production and colonial power dynamics are inextricably linked with the environment[17,36].

With this methodological grounding, we leveraged local observations, understandings, values, and data from within TEK to generate relevant research questions and hypotheses, inform the appropriate choice of statistical methods, and draw meaningful interpretations of quantitative model outputs (see "Methods"). Tribal priorities and TEK initiated and informed long-term data collection of Manoomin abundance: two inter-tribal organizations, the 1854 Treaty Authority (1854TA)[24] and the Great Lakes Indian Fish and Wildlife Commission (GLIFWC)[23] (Figs. 1 and 2), collected, respectively, 20 years and 34 years of Manoomin density data across a total of 49 historical Manoomin waterbodies in Wisconsin and Minnesota with different sampling methods. In addition, GLIFWC surveyed tribal and non-tribal members on their harvest yields across Wisconsin for 27 years. Knowledge of Manoomin's boom-and-bust abundance patterns and unique local relationships[6] advised our choice of methods: we assessed the density data for periodicity using spectral analysis[37] and for temporal trends and relationships with climate using statistical models that evaluated site-specific, regional, and non-linear relationships[38]. Further observations on Manoomin's sensitivity during early life stages[6] guided our hypotheses that winter, spring, and early-summer conditions would impact Manoomin growth. We engaged both TEK and mainstream science to represent these factors with specific climatic predictor variables. The results show that climate change in this region—specifically, increasing early-summer precipitation, higher mean winter temperatures, decreased snowfall, and shorter ice duration across this region—negatively impacts Manoomin density, contributing to declines in off-reservation harvest and thus threatening Indigenous lifeways.

Results

Manoomin trends over the last three decades

To understand Manoomin's varying abundance through time, both fluctuations and persistent trends in Manoomin density were characterized. Out of 49 waterbodies, 67% had significant multi-year cycles of density ranging from 2 years to 7 years (median cycle = 3 years), and 41% had multi-decadal cycles (median cycle = 20 years) (Supplementary Table 1). Additional modeling (Methods) captured each waterbody's unique temporal patterns and overall regional trends (Fig. 3), explaining 65% and 69% of the deviance in density for the 1854TA and GLIFWC datasets, respectively; 34% for the GLIFWC Wisconsin tribal harvest data; and 23% for the GLIFWC Wisconsin non-tribal harvest data. The regional trend of off-reservation Manoomin density for both datasets was statistically significant over the last two to three decades, with mean annual decrease in density of 6.8% (95% CI [−10.6, −2.8], 1985–2019) and 5.6% (95% CI [−12.0, 1.3], 1998–2020) for the GLIFWC and 1854TA datasets, respectively. Most of this decline was concentrated in the mid-1980s through mid-2000s. In Wisconsin, off-reservation tribal harvest exhibited a statistically significant mean annual decrease of 2.0% (95% CI [−6.4, 2.7], 1992–2019) harvest weight per trip. Non-tribal harvest did not show a net decline over the 1992–2019 analysis window but decreased for a period during 2000–2010, then rebounded.

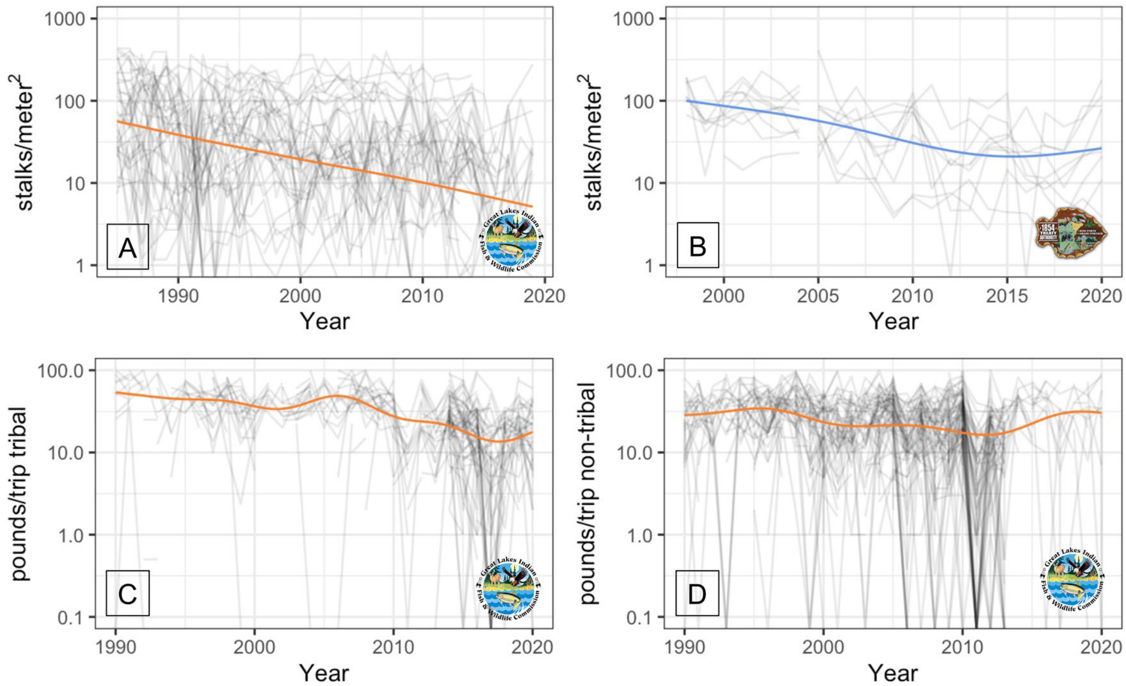

Fig. 3 | Manoomin density and harvest trends. Generalized additive model (GAM) smooth curves for **A** GLIFWC Manoomin density through time, **B** 1854 TA Manoomin density through time, **C** Wisconsin tribal harvest through time, and **D** Wisconsin non-tribal harvest through time. In all plots, gray lines represent raw, waterbody-level data. Solid colored lines are the overall GAM-smoothed curves through time. Organization logos reproduced with permission (GLIFWC ©2025, 1854TA ©2025).

Climate impacts on Manoomin density

The tested hypotheses about regional Manoomin-climate relationships were derived from TEK and constrained by data availability. Specifically, local observations within TEK[6] show connections between longer (multi)decadal periodicities of Manoomin abundance and oscillations of spring and early-summer precipitation, and between cold, snowy winters and high Manoomin abundance. Four hypotheses emerged: higher precipitation during the submerged and floating leaf stages (spring and early summer) decreases density, more days with a minimum temperature above 4° °C (growing degree days) increase density, higher mean winter temperature decreases density, and greater snow accumulation increases density (Table 1).

To test these hypotheses, we modeled Manoomin density through time and in relation to climate datasets[39] (see "Methods", Fig. 4 and Table 1). For both the GLIFWC and 1854TA datasets, higher precipitation in spring and early summer, during Manoomin's floating leaf stage, was associated with lower density (GLIFWC: $p < 0.001$; 1854TA: $p < 0.001$). Precipitation during spring, Manoomin's submerged stage, also had a significant correlation with Manoomin density, but this was a positive correlation for the GLIFWC dataset ($p < 0.001$) and negative for the 1854TA dataset ($p = 0.007$). The effects of growing degree days were also inconsistent across datasets: they had a significant negative correlation with Manoomin density in the GLIFWC dataset ($p = 0.04$) but no significant effect for the 1854TA dataset ($p = 0.09$). Mean winter temperature had a significant negative correlation with Manoomin density for the 1854TA dataset ($p = 0.04$), but the correlation for the GLIFWC dataset was just above the significance threshold ($p = 0.06$). The regional and water-body specific trends through time were significant in both models (GLIFWC $p < 0.001$; 1854TA $p < 0.001$). The effects of snow were consistently positive but not significant for both datasets. This lack of significance may be partly attributable to another term in the model (the site-specific random effects) that captured similar variability as the snow data (Methods), potentially underestimating the strength of the snow-Manoomin relationship. The models explained 76% and 74% of the deviance in the GLIFWC and 1854TA data, respectively.

We further explored in-lake impacts of floating-leaf stage (early-summer) precipitation and dormant stage (winter) conditions on fall Manoomin density using water level data[24] for the waterbodies monitored by 1854TA, and ice duration data[40,41] for lakes nearby the waterbodies monitored by GLIFWC, based on data-type availability (Methods, Fig. 4, Rows 4 and 2, respectively). The results show that shallower water levels during the floating-leaf stage ($p < 0.001$) and longer ice duration ($p < 0.001$) were both positively correlated with Manoomin density (Fig. 4B and 2F, respectively). Water levels for the other growing stages did not have statistically significant effects. Models for both the GLIFWC and 1854TA datasets explained 76% of deviance in the data.

Relevant climate changes for Manoomin

Temporal changes in climate over time were also assessed. All weather variables showed significant change over time ($p < 0.05$) since 1985 (Fig. 5). We additionally increased the analysis window for four records that extended back to1900, and all weather variables were again significant ($p < 0.05$) except for growing degree days (Fig. 5). Winter temperature, snowfall, and submerged stage precipitation have increased on average by 1.5 °C, 20 cm, and 4 cm, respectively, since 1900, with significant non-linearity. Precipitation during the floating-leaf stage has not increased on average over either time scale, but the magnitude of the last peak (2012–2020) increased by 3 cm compared to previous multi-year oscillations since 1900.

Lake-ice duration and water level temporal trends were also evaluated. Generally, ice duration has declined, especially in the late 1990s, and water levels in submerged and floating-leaf stages have increased since 1998 (Fig. 6). All of these variables also exhibit substantial multi-year oscillations.

Relationships with Indigenous harvest

Informed by TEK (see "Methods"), we hypothesized that Manoomin harvested by tribal members increases with Manoomin density. Furthermore, we hypothesized that preceding years' harvest would not negatively impact Manoomin density, as suggested by TEK[6,15] and past studies[42,43], and could possibly even improve future harvest.

To assess these hypotheses, two more models were developed: one investigating the relationship between the weight of Manoomin harvested

Table 1 | Summary of Models and Results

Dormant	October–March	Winter temperature	Manoomin density	Negative	Not significant	Negative
		Ice duration		Positive	Positive	No data
	December–March	Snow		Positive	Positive	Not significant
Submerged	March–May	Precipitation				Negative
		Water levels				Negative
						Not significant
Floating leaf	June–mid July	Precipitation	Manoomin density	Negative	Negative	Negative
		Water levels		Negative	No data	Negative
Emergent–flowering	Mid July–mid August	Precipitation	Manoomin density			Not significant
		Water levels		None	No data	Not significant
Harvest	August–September	Year	Manoomin density	~4-year cycles	2–7 year cycles (67% of waters)	Not enough data
		Year		(Multi)decadal long cycles	10–30 year cycles (41% of waters)	Not enough data
		Year		Decline through time	−6.8% per year	−5.6% per year
		Manoomin abundance	Tribal harvest	Positive	Positive until 250 stalks/m^2	No data
		Previous harvest		None	Positive	No data
		Year	Total harvest	Decline	Tribal: −2.0% per year Non-tribal: variable without significant decline	No data

Summary of hypotheses, modeled variables, and resulting correlations.

by tribal members and Manoomin density, and another investigating the relationship between current-year and previous harvests (see "Methods"). The first model showed a positive correlation between Manoomin density and tribal harvest per trip up to 250 stalks/m^2, after which harvest declined (Fig. 7). It also revealed a significant decline in harvest per trip over time. In the second model, the average harvest per trip for the previous two years had a significant positive correlation with harvest in the current year. In total, these models explained 19% and 52% of total deviance, respectively.

Discussion

The combination of mainstream scientific and TEK monitoring methods provided a robust characterization of Manoomin abundance. The 1854TA approach privileges mainstream science through extensive ground surveys using unbiased, plot-level measurements that yield higher precision of fewer sites with greater time costs. Monitoring conducted by GLIFWC privileges TEK by employing multiple faster, lower-cost methods of aerial photos, harvester surveys, and simplified ground surveys that allow for long-term and widespread measures to cover a greater number of culturally important sites, even if with lower precision[28]. In sum, the 1854TA dataset prioritizes site-level precision with lower regional accuracy, while the GLIFWC datasets prioritize regional accuracy with lower site-level precision. Combined, these models, with their complementary strengths and limitations, provide robust information on status and trends: we can assume confidence in the results when the datasets show agreement, but differing sampling methods may be a cause when they do not. Guided by TEK, both inter-tribal organizations focused on one plant and important 'hot spots' of harvest rather than randomized site selection across multiple species[28]. Therefore, these data do not represent overall ecosystem health or total Manoomin abundance across the region, but instead, regional, off-reservation Manoomin available for Ojibwe harvest.

The short time series lengths (<40 years, 1 data point/year) may weaken the robustness of the multi-year and (multi)decadal oscillations found in Manoomin abundance across the region with spectral analysis, but these variations are consistent with TEK[6,25] and experimental evidence[44,45] of natural cycles. Despite the complexity introduced by this natural interannual variability and site-level variation, models revealed a statistically significant decline of ~5–7% per year in off-reservation Manoomin available for Ojibwe harvest across the region and ~3% per year in off-reservation harvest per trip for tribal members. The similar declines across all datasets suggest robust results, and that declining harvest could be related to declining density. This harvesting trend may also be influenced by demographically aging harvesters' decreased productivity but increased skill, differences in tribal members' on-reservation harvest (which is not accounted for in these data), and/or low sample size[46].

Greater precipitation during the floating leaf stage correlated with reduced Manoomin stem density at the end of the growing season. This relationship was robust to the differences in geography and sampling methods between datasets. Further, the significant negative correlation between high water levels during Manoomin's floating leaf stage and Manoomin density in the 1854TA dataset is consistent with our hypotheses, prior studies[47–51], TEK[6], and historic Ojibwe trade records[18]. High precipitation generally raises water levels, which increases the energy required for Manoomin to reach the surface and photosynthesize[52] and can drown emerging Manoomin stalks[42,53]. Other studies indicate an additional ecological explanation: high water levels decrease seed production[47] by delaying phenology[18,52,54] and therefore, over time, favor perennial species over annually reproducing Manoomin[52]. Together, these results suggest that high precipitation during the floating-leaf stage has caused declines in Manoomin density by raising water levels.

Precipitation and water depth during the submerged life stage had inconclusive, dataset-dependent effects on end-of-season Manoomin stem density. Differing sampling methods could explain the contrasting relationships modeled from each dataset. Alternatively, because Manoomin plants at this life stage are less susceptible to drowning or uprooting, there

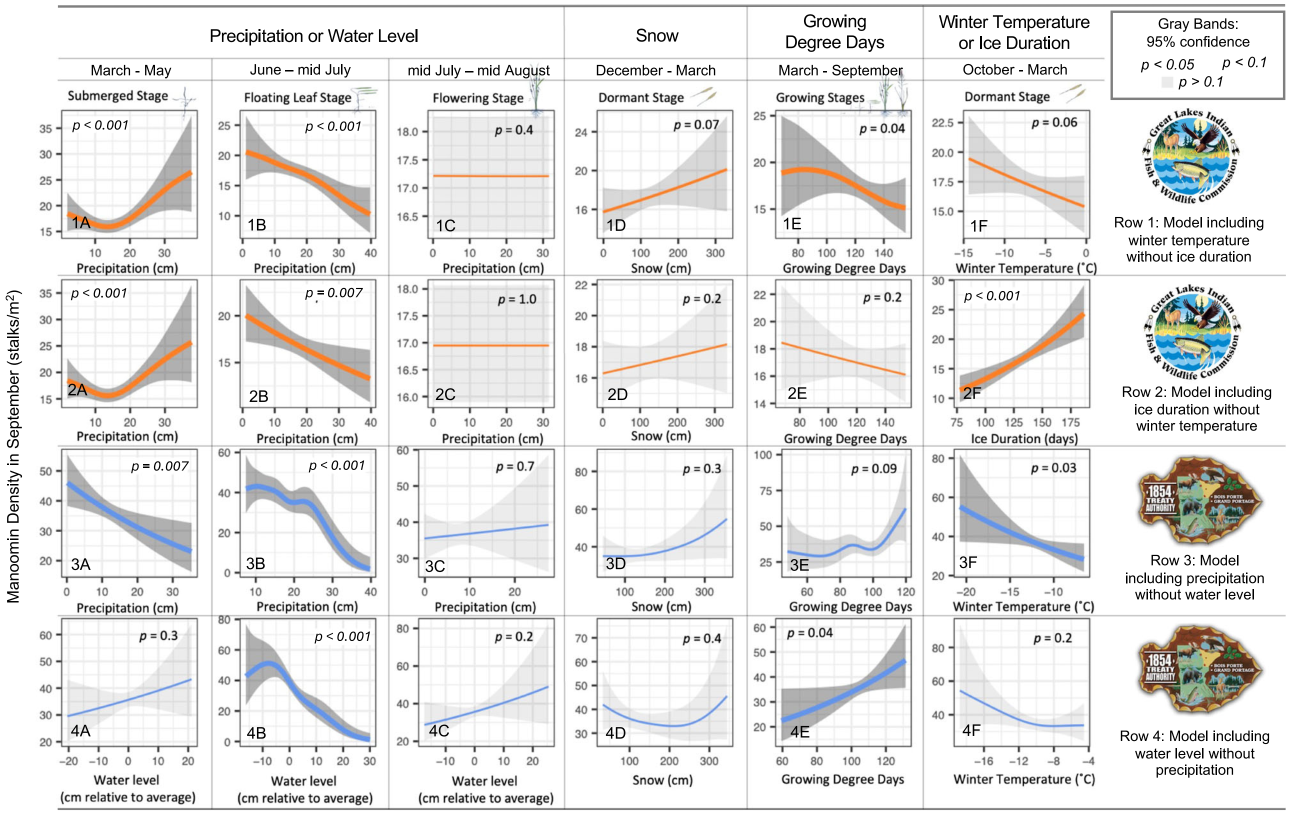

Fig. 4 | Manoomin and climate relationships. Model results (generalized additive model smooth curves) for GLIFWC Manoomin September density (Row 1), GLIFWC Manoomin September density (Row 2), 1854TA Manoomin September density (Row 3), and 1854TA Manoomin September density (Row 4) relationships with seasonal precipitation or water level (Column A, B, and C), snow (Column D), growing degree days (Column E), and winter temperature or ice duration (Column F). Gray bands indicate the 95% confidence intervals. Line and gray band darkness reflects the significance of the modeled relationships, with darker colors and bands indicating statistical significance. Organization logos reproduced with permission (GLIFWC ©2025, 1854TA ©2025).

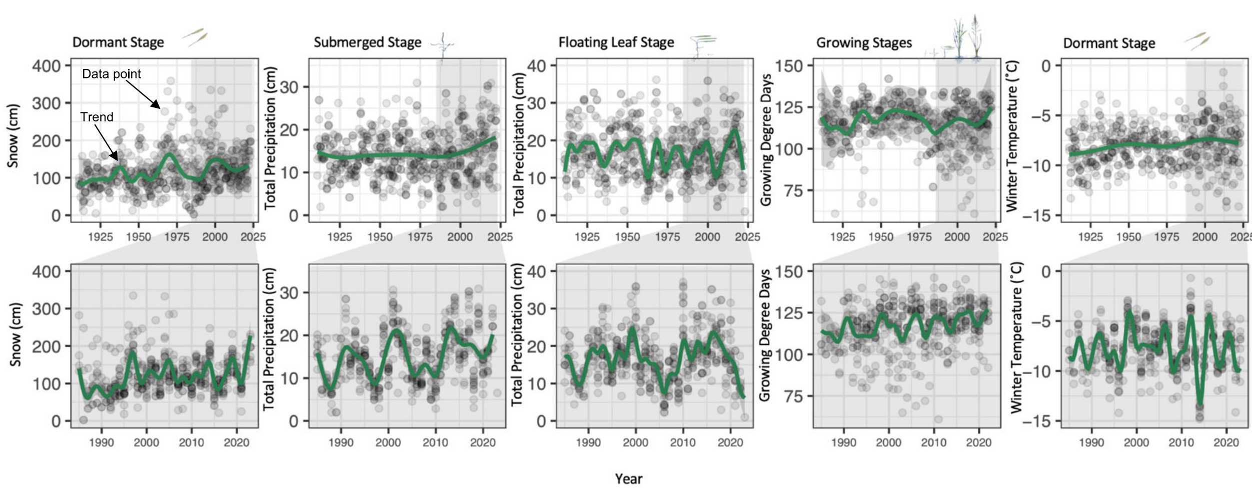

Fig. 5 | Recorded changes in climate variables. Modeled trends (generalized additive model smooth curves) for (top row) climate variables since 1900, and (bottom row) climate variables since 1985. Climate trends are depicted by the graphed line, and climate data points are plotted as circles.

could be subtler, more complex relationships with water levels and precipitation. Higher water levels in the spring submerged stage from spring rains and/or snowmelt may actually benefit Manoomin, as suggested by our GLIFWC model results (Fig. 4, Row 1), because they mix and flush sediments through rice beds, adding nutrients and uncovering seeds, both of which foster initial growth and stabilize long-term abundance[52,55]. However, a correlation with snowfall was not seen for the 1854TA data, possibly because of model structure or because snowfall has an inconsistent, spatially complex, or weak relationship with Manoomin density. Differing sampling methods could be at play here as well. Both precipitation and water levels during the flowering stage were consistently unrelated to Manoomin density, likely because following the floating leaf stage, plants stand above the

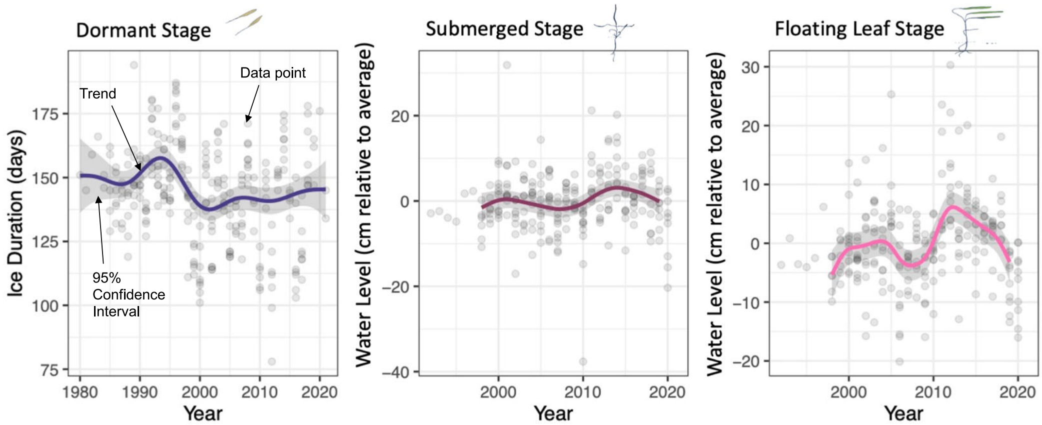

Fig. 6 | Recorded changes in ice duration and water level. Modeled trends (generalized additive model smooth curves) for ice duration, submerged-stage water levels, and floating-leaf stage water levels.

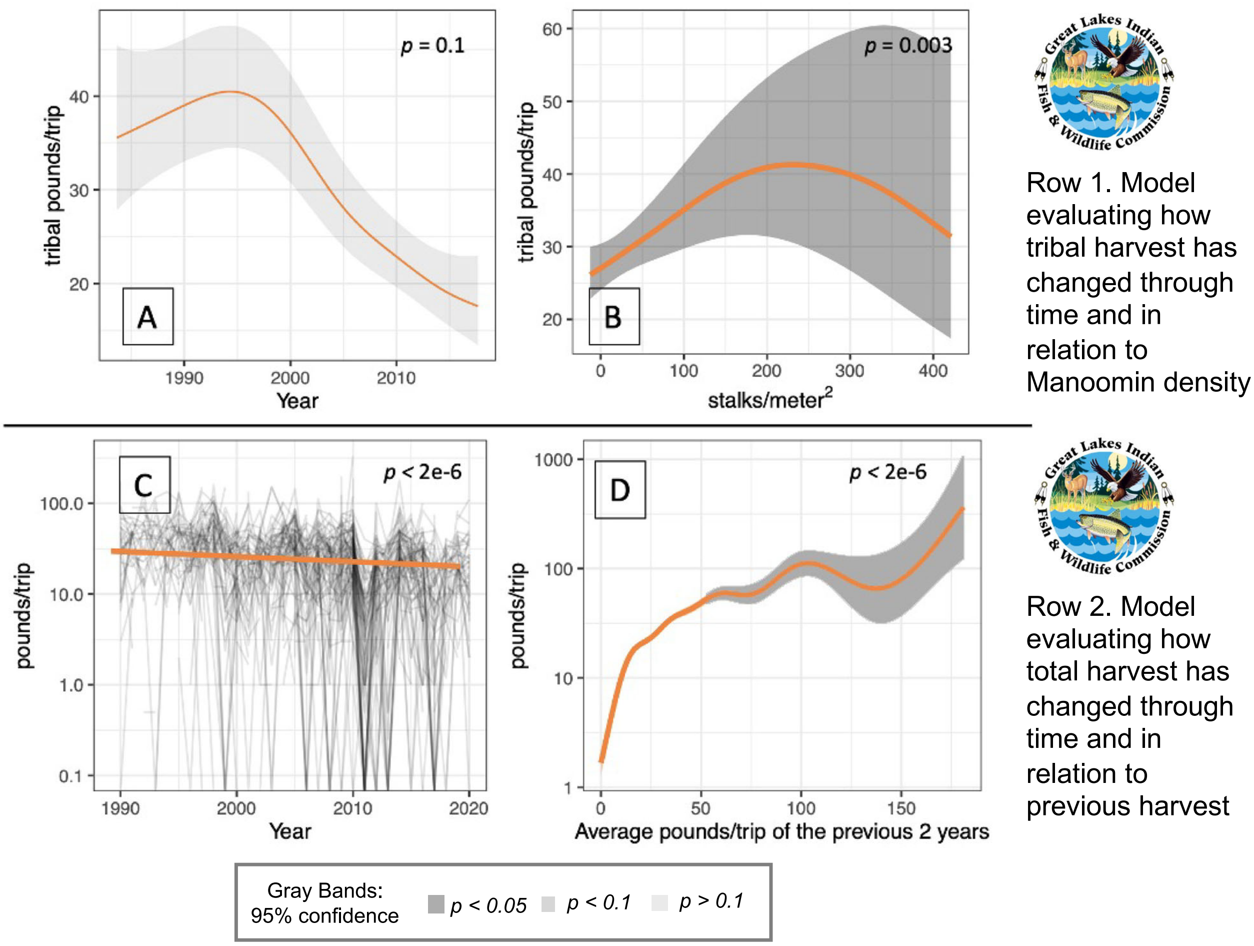

Fig. 7 | Manoomin harvest relationships with density and previous harvest. Model trends (generalized additive model smooth curves) from two models: one including (**A**) tribal harvest through time of study lakes and (**B**) tribal harvest and Manoomin density, and the other including (**C**) harvest through time across all reported lakes and (**D**) previous harvest and current harvest across all lakes. Gray shading around each orange line represents the 95% confidence interval. Organization logo reproduced with permission (GLIFWC ©2025).

water's surface and are physically robust. The lack of precipitation and water level effects for this phenological stage reinforces the TEK understanding that earlier life stages are more sensitive to precipitation and water level.

Colder winter temperatures corresponded with increased Manoomin density at the end of the following growing season for the 1854TA dataset, consistent with observations that Manoomin seeds require seven months at 2.5–5 °C to fully break dormancy and germinate[56] and can withstand temperatures down to and possibly below −10 °C[56,57]. These results suggest that warmer winters likely cause fewer Manoomin seeds to germinate the following year. In addition, colder temperatures may benefit Manoomin relative to perennial plants less tolerant of extreme cold[58]. Although the GLIFWC density data lacked a significant winter-temperature effect, it showed a significant positive correlation with nearby ice duration. Both colder temperatures and longer ice duration generally correspond to thicker lake ice[59]. Thicker lake ice increases the possibility of ice-scouring, which mixes sediment, bringing buried seeds closer to the lakebed surface where they can more readily germinate[18,60]. Ice duration data from nearby lakes likely underestimate ice duration on the Manoomin waters, because these nearby lakes are generally deeper and larger, taking longer to freeze. However, these lakes likely had similar trends in ice durations as the nearby Manoomin waters. Given the limitations of this dataset, further study of lake-ice and Manoomin direct relationships is needed. While our results point to multiple processes through which Manoomin may be vulnerable to milder winters, correlations between growing degree days and Manoomin density were not consistent, suggesting weak or complex relationships and possible impacts of the differing sampling methods.

The quantification of climate, water level, and ice duration relationships with Manoomin is complicated by these variables' changes through time (Fig. 5), which are not accounted for in our models. The relationships between Manoomin density and climate variables, water levels, and ice duration could be spurious correlations; however, multiple lines of evidence across multiple datasets support Manoomin's positive relationship with lower early-summer precipitation, lower early-summer water levels, and colder winters marked by more snow and longer ice duration. It is also possible that time is the variable spuriously correlated, or partially so, resulting in an underestimation of Manoomin's relationship with climate, water level, and ice duration. Additionally, many relationships likely influencing Manoomin density and harvest were excluded from this model, such as lake and watershed morphology, watershed and shoreline land-use, herbivory, diseases, permitting processes, reseeding, restoration, and changing phenology[61].

We did include harvest in our analysis and found that the average harvest from the previous two years had a positive relationship with harvest for the current year. Internal dynamics of the multi-year oscillations of Manoomin density may be driving this trend, causing past average harvests to correlate with present harvests. Alternatively, these data may indicate that human harvest can be beneficial—or at least not harmful—for Manoomin populations, supporting our hypotheses, TEK[6,15], and past studies[42,43]. By removing some of the seeds, harvesting may help thin out beds, possibly reducing transmission of brown spot fungal disease[62]. Manoomin may also benefit from the disturbance caused by harvesters pushing through the rice beds, including agitation of sediments to bring buried seeds to the lakebed surface, and knocking seeds into the water that might have otherwise been eaten by birds. Additionally, harvesters may focus their stewardship efforts on the waterbodies from which they harvest the most, supporting greater future density. Because of this potential relationship, both the aging and decreasing number of harvesters over the last several decades[22] may also contribute to the decline of Manoomin due to loss of harvesting knowledge and practice. Additional research, direct experimentation, and TEK are needed to further understand human harvest relationships with Manoomin abundance.

Trends we detected in climate variables are consistent with those previously reported for the region beyond natural oscillations, including increasing winter temperature, increasing totals and variation in spring and summer precipitation[63], and decreasing ice duration[64,65]. Given the relationships we found between these climate variables and Manoomin density, we conclude that climate change, specifically increases in early-summer precipitation, warmer winter temperatures, and decreases in lake ice duration, has already reduced Manoomin density. Longer climate oscillations, as seen in decadal water level cycles observed in the region[66,67], may also contribute to changes in Manoomin density, as suggested by TEK[68], in addition to the overlying signal of climate change.

Looking to the future, this region is projected to receive increases in spring and early-summer precipitation due to anthropogenic climate change beyond natural oscillations[13,69]. Winter precipitation is expected to increase, but with greater partitioning to rain[13,70], and less and earlier snowmelt[71]. Major Manoomin regions—central Minnesota and the shores of Lake Superior—are projected to experience the sharpest declines in snowfall across the region, reaching about 50% reduction by the middle of the 21st century[70]. The warming trend in mean winter temperatures over the last half of the twentieth century[63] is projected to continue and increase[13,69,70]. Ice duration is projected to further decline by approximately 20 days by 2070[65] and 40 days by the end of the century[65,72]. Given the correlations found between these climate factors and Manoomin density, we expect these projected changes to further threaten Manoomin. Other macrophyte communities, especially in shallow lakes at high latitudes, are facing similar threats with the changing climate[73].

The decline of Manoomin, in part driven by climate change, has and will continue to negatively affect tribal communities. Results show that Wisconsin tribal harvest positively corresponds with Manoomin density (up to 250 stalks/m^2), suggesting declines in Manoomin likely contribute to the lower Wisconsin tribal off-reservation harvest rates since 1992. This trend did not hold for very high Manoomin density (>250 stalks/m^2), likely because of difficulties navigating very dense beds during harvest[74]. Climate change has already and will continue to affect harvest in ways unrelated to stalk density: extremely low water levels in August can prevent canoe access to beds for harvesting[18]; storms can prematurely knock rice off of stalks[19,43]; hot, low-wind conditions during the flowering stage may limit pollination for seed production[18,42] and increase prevalence of brown spot fungal disease[62]; excessively hot conditions during harvest can prevent people from harvesting; and all of this variability can make planning for harvest difficult.

The decline in Manoomin over the last decades has disrupted Ojibwe lifeways, family, and health[75,76]. Manoomin cannot simply be replaced by another plant because it is an "integral glue" connecting political, economic, social, spiritual, intellectual, and physical dimensions of Anishinaabeg society[77]. This loss therefore fails to uphold the inherent rights to self-determination and sovereignty[4] of these Ojibwe Nations, as explicitly promised by treaties with the United States[6,78,79] and more broadly recognized by the UN Declaration of the Rights of Indigenous People[3]. Ojibwe Nations continually address this loss through stewardship, research, partnership, and legal action[34,77,80]. Indigenous Peoples from across the world are also experiencing loss of traditional foods and their connected culture and knowledge systems, all driven in part by climate change[81–83]. These are the very people who lead in climate stewardship through mitigation, sequestration, and storage of carbon[84–86] over one quarter of the world's land surface[87]. The loss of Manoomin thus contributes to the erosion of humanity's collective biocultural diversity essential to producing the transformative knowledge for climate solutions[1,81,85,87–91].

In the face of this threat, people can care for Manoomin by limiting additional stressors (e.g., pollution, pesticides, artificially high water levels from anthropogenic dams, disturbance from motorboats, vegetation removal from lake-front properties, high rates of herbivory, increased sedimentation[6]), as well as respectfully partnering with Ojibwe Nations on restoration, research, harvest, and policy change. Additional strategies supported by this research include lowering water levels during the floating-leaf stage to support growth, lowering water levels during the winter to induce deeper freezes, mixing and/or flushing sediments in the early spring to release nutrients and seeds, and cutting back perennial vegetation that out-competes Manoomin.

Methods

Collaborative process

This research was conducted within the Kawe Gidaa-naanaagadawendaamin Manoomin Research Collaborative, a tribal-university partnership with formalized agreements between four Ojibwe Nations (Fond du Lac Band of Lake Superior Chippewa, the St Croix Indians of Wisconsin, the Mille Lacs Band of Ojibwe, and the Lac du Flambeau Band of Lake Superior Chippewa), two inter-tribal organizations (the Great Lakes Indian Fish and Wildlife Commission and the 1854 Treaty Authority), and a group of interdisciplinary researchers at the University of Minnesota-Twin

Cities[34]. Through this partnership, long-term observations and relational understandings within TEK directed the research questions and hypotheses, the choices of methods, the model development, and the interpretation of results.

From the first three years of collaboration, assessing the impact of climate change on Manoomin abundance was determined to be a collective priority across the tribal partners, especially given the high vulnerability of Manoomin to climate change identified by tribal climate adaptation plans[8–10]. The specific hypotheses for climate change impacts on regional Manoomin abundance were developed from TEK shared through tribal documentation[6,8], monthly project meetings, semi-annual project conferences, knowledge-exchange workshops, and time together paddling through rice beds, harvesting, visiting, in ceremony, and feasting. In addition, we hosted 18 virtual meetings to share and discuss water level, water chemistry, and vegetation data from specific Manoomin waters across the region over the winters of 2021 and 2022. These meetings included 19 tribal resource managers from 6 (inter-)tribal organizations across the region, 2 state resource managers, and 18 university researchers, students, and staff. In the summer of 2022, 35 knowledge-holders representing tribal and state agencies, tribal and non-tribal harvesters, academic institutions, and non-governmental organizations gathered in a workshop[92] and shared the most pressing climate change impacts on Manoomin in their waterbody of concern (Supplementary Fig. 1). All of this knowledge, mediated by data-availability constraints, was iteratively refined into testable hypotheses for this study. Additionally, the relational dynamics emphasized within TEK informed the choice of statistical methods, necessitating tools to assess periodicity and non-linear trends and account for unique relationships within each waterbody. Following the initial modeling process, results were discussed with TEK knowledge-holders to inform model refinement and interpretations: variable calculations were adjusted based on additional local observations, further models were created to look at the relationships in new ways such as past harvest relationships with present harvest, and insights and limitations of the results were revealed.

Ethics and inclusion statement

This project was conducted under formalized agreements, such as memorandums of understanding, where roles and research protocols were established, as determined and directed by the partnering tribal organizations and governments[34]. From conception through publication, this research has included tribal members and tribal government/organization staff to ensure local relevance and reciprocity between university researchers and tribal nations. This includes care taken to strengthen tribal nation and organization capacity through funding tribal partners directly on co-written research grants, as well as sharing access to university resources. Additionally, we included necessary protections and benefit-sharing measures regarding traditional knowledge shared within this project, as directed by the partnering tribal governments and organizations. This research would not have been restricted or prohibited within the setting of university researchers, and in fact environmental protection and biorisk-related regulations in this research setting were stronger than in the setting of university researchers. We followed tribal organization and government guidance to avoid any personal risk to research partners. Lastly, we have carefully taken local and regional research relevant to our study into account within our citations.

Datasets: Manoomin density

Data were obtained from the 1854 Treaty Authority (1854TA) and the Great Lakes Indian Fish and Wildlife Commission (GLIFWC). Each organization has been monitoring Manoomin abundance at the end of the growing season across their respective geographic regions for several decades. The 1854TA monitored Manoomin density and biomass on 9 lakes from 1998 to 2020 by averaging Manoomin stalks and plant height in 20–25 0.5-m^2 plots in each lake[24,93]. Their sampling method changed in 2006 when they transitioned from randomized plot locations within a rice bed to a uniform, gridded set of plots[24]. We assumed this transition from biased to unbiased sampling would influence the data, and therefore included a random-effects term to account for this change by allowing for different slopes and intercepts for each sampling method. This additional random-effects term may be redundant, possibly resulting in more conservative modeled relationships; however, we considered it necessary in order to account for the abrupt discontinuity in methods within the dataset.

GLIFWC has been regularly monitoring Manoomin on 40 waters from 1985 to 2019 through a combination of aerial surveys and on-the-water density measurements[23]. Aerial photos were taken with aircraft-based, hand-held cameras at oblique angles. Boundaries of Manoomin stands in each photo were plotted by hand onto waterbody maps to estimate the total acreage of Manoomin[46]. Given the hand-adjusted oblique angle and difficulty of delineating precise stand extent from an aerial photo, these acreage measurements should be considered estimates with significant error. Manoomin density measurements were made by counting stalks in 20 randomly selected 0.5-m^2 plots within a Manoomin bed on each lake. These values were binned into five categories: (1) 0–20, (2) 20–40, (3) 40–60, (4) 60–80, and (5) 80+ average stems per plot. For this analysis, the median number of stalks per plot was used for each bin (bin 1 = 10 stems/plot, bin 2 = 30 stems/plot, bin 3 = 50 stems/plot, bin 4 = 70 stems/plot, and bin 5 = 90 stems/plot). These binned data reduce variability and do not accurately capture densities above 80 stems per plot. Each stalk density was then multiplied by the Manoomin acreage and divided by the entire waterbody area to estimate an average density.

Although the overall sampling method used by GLIFWC contains more error at the site level than the sampling method used by the 1854TA, the lower-effort and simplicity of the method enabled GLIFWC to maintain a consistent survey of Manoomin abundance of 40 lakes for 34 years, providing a long-term dataset for which trends can be analyzed at a regional and multi-decadal scale with fair confidence. And given the smaller sample size, the 1854TA sampling method likely has greater error at the regional scale. While some error exists within both observational datasets, this error was minimized through robust sampling designs. Jointly analyzing these datasets with complementary geographic coverage and methodological strengths and weaknesses creates opportunities for more robust inferences.

Equations relating Manoomin density and plant height to biomass have been developed[93], but were not used because they would introduce additional assumptions and exclude GLIFWC data that lacked plant height. In total, we had 1507 unique data points across 49 waters across the two datasets to include in our analysis.

Dataset: Manoomin harvest

GLIFWC surveyed state (non-tribal) and tribal harvesters annually in Wisconsin from 1992 to 2019[23]. Harvesters were identified by registrations for rice harvesting permits, which are required for all non-tribal harvesters and for tribal harvesters ages 17–64 harvesting off-reservation. All harvesters who had reported a harvest the previous year and a randomly selected half of those who were registered but did not report a harvest the previous year were contacted via phone or mail and surveyed regarding their number of trips, pounds harvested, and harvesting locations off-reservation for that year. The decline in harvest totals may be due to a decline in the survey response rate reported by GLIFWC staff. Due to this phenomenon, we used pounds per trip harvested as the metric of analysis to quantify the amount of harvest per 'unit effort'[28] given that the declining response rate made it impossible to accurately determine total harvest. In total, we had 2514 unique harvesting data points included for analysis.

Dataset: climate

Daily precipitation, snow accumulation, and maximum and minimum daily air temperature data for 21 different weather stations in the National Weather Service Cooperative Observer Program[39] were obtained from the Midwest Regional Climate Center data portal. The stations were chosen based on closest proximity to each of the Manoomin waters and availability of near-continuous records (>80%) over the study period. These climate variables were aggregated into total precipitation within three life stages of

Manoomin (submerged [Julian day 92–150], floating [Julian day 151–199], flowering/emergent [Julian day 200–229]), number of days in the growing season (Julian day 92–229) with minimum temperature above 4 °C (growing degree days), average preceding winter temperature, and total snow accumulation in the preceding winter (Table 1). Manoomin life stage phenology has likely been changing with climate, which was not accounted for in this analysis. However, all data were aggregated over approximate life stage intervals, and so we assume that small changes in start and end dates for each life stage would have only minor impacts on aggregated totals or averages.

Dataset: ice cover

Because ice-on and ice-off dates were not recorded for the Manoomin waters themselves, ice-on and ice-off data for the closest lake with data extending back to 1985 (with up to a few missing years) were obtained from the National Snow and Ice Data Center (Supplementary Table 1). While nearby lakes likely differed in ice duration due to morphological differences, previous studies have shown location and weather have a greater impact than morphology on ice phenology[94], making nearby lakes a reasonable proxy. Ice duration was calculated by counting the days between ice-on and ice-off records. Ice duration was used as a predictor, rather than ice-on or ice-off dates themselves, because it integrates both freeze-up and break-up date changes into a single metric. Lake ice-on and ice-off dates were used from Crystal Lake, Allequash Lake, Shell Lake, Lake Escanaba, and Trout Lake, and were limited to the 1837 and 1842 Ceded Territories monitored by GLIFWC due to limited data in other regions (Supplementary Table 1).

Dataset: water levels

Bi-weekly water levels were recorded by 1854TA for their 9 Manoomin waters of study from 1998 to 2020[24]. Some water level gauges were placed directly in Manoomin beds while others were placed at easy-access points. To account for this discrepancy, relative water levels were calculated and used for this analysis (deviations from time-averaged values over the entire study period for each growing stage for each lake).

Spectral analysis

Each Manoomin waterbody dataset was individually analyzed to determine the significance and length of Manoomin density cycles, prior to and separate from the modeling of climate and in-lake variables on Manoomin density. To assess the relatively short time series (20–34 data points), we performed the multi-taper method (MTM) on each time series individually to determine significant periodicities[37]. MTM efficiently uses all data and minimizes spectral leakage, making it suitable for the spectral analysis of short datasets. Significance was assessed using an *F*-test, with frequency peaks over 95%, and not exceeding the time series length, considered significant. Frequencies were rounded to the nearest whole number of years for values less than 10 years and rounded to the nearest 10 for values greater than 10 because partial-year periodicities are not likely to occur ecologically, and there is significant error in the estimation of (multi)decadal periodicities given the short dataset. Calculations were performed using the *multitaper* version 1.0-17[95] package in R version 4.3.3[96].

Generalized additive models (GAMs)

GAMs were used to test for Manoomin density, harvest, and climate trends through time, as well as Manoomin-climate relationships. Like generalized linear models, GAMs can assess multiple covariate relationships simultaneously; however, relationships in GAMs are not constrained to be linear. GAMs use smaller basis functions, in this case, cubic splines, added together to make an overall smooth function that can reflect highly non-linear relationships between a variable of interest and multiple predictor variables. The extent of non-linearity is constrained by the maximum number of basis functions, a parameter set within the model (k), and a built-in penalty to avoid overfitting. GAMs were chosen because they not only have the ability to represent non-linear, place-specific, and global relationships[38,97–100]—all dynamics present in the Manoomin eco-hydrologic system as emphasized by TEK[6] and the spectral analysis—but GAMs also maintain a higher degree of interpretability compared to other non-linear models[101], essential for addressing the research questions in a collaborative manner.

Multiple GAMs were constructed to evaluate different hypotheses (see Table 1) using the *mgcv* version 1.9-1[102] package in R version 4.3.3[96]. All GAMs were assessed for an appropriate number of basis functions (smoothness) and data distribution, and lack of significant autocorrelation and concurvity (a nonlinear analog of collinearity). Recommended concurvity thresholds (0.8[103]) were exceeded for the site-specific random effects and total snow. These predictors were retained in the models given our ecological hypotheses and to reflect site-specific variability and the nested sampling design (nonindependence of data arising from multiple plots and repeated sampling of each waterbody).

GAMs were first deployed to assess trends of Manoomin density and harvest. These GAMs included one global smooth curve with time to assess the overall density trend across the region, as well as a random-effects term with time for each waterbody to evaluate site-specific trends (local characteristics of individual Manoomin waters) as emphasized within TEK (Supplementary Table 1). The maximum number of basis functions (k) within each smooth curve was set relatively high ($k = 20$, twice the default) for each model to account for the possibility of oscillations, as verified by the spectral analysis. If the model failed to converge, k was reduced until convergence was achieved. The function *k.check* within the *mgcv* package was then used to verify that k was sufficiently large to represent the non-linear relationships within the data[38]. This function revealed that the effective degrees of freedom of each smooth curve were well below the maximum limit set by k, and therefore model results reasonably account for the non-linearity in the Manoomin system. Given the difference in sampling methods, the 1854TA density dataset ($n = 202$) and the GLIFWC density dataset ($n = 1305$) were modeled separately, as well as the GLIFWC harvest dataset for tribal members ($n = 1234$) and non-tribal members ($n = 1930$) to distinguish the two populations. The average percent change per year was calculated from the derivatives of the smooth curves[104]. Model results are shown in Fig. 3.

Building from this work, smooth curves were added for each climate variable to the GAMs of Manoomin density to test hypothesized relationships (GLIFWC [$n = 1049$]; 1854TA [$n = 188$]). Specifically, smooth curves were added for precipitation total in each of the submerged, floating leaf, and flowering life stages; snowfall and mean air temperature from the preceding fall and winter (October–March); and growing degree days (days above 4 °C preceding fall harvest). Model results are shown in Fig. 4, rows 1 and 3.

These GAMs were augmented further to explore intermediary variables that relate climate and Manoomin density: water level data were added to the previous 1854TA GAM ($n = 204$), and nearby ice duration datasets were added to the previous GLIFWC GAM ($n = 1025$) based on data availability. Water levels were averaged for each life stage. Precipitation and mean winter temperature were then removed from the 1854TA and GLIFWC GAMs, respectively, because these variables were too similar (exceeding concurvity threshold of 0.8[103]) to the water level and ice duration data. Model results are shown in Fig. 4, rows 2 and 4.

GAMs were additionally employed to evaluate relationships with pounds of Manoomin harvested per trip. One GAM assessed the relationships between GLIFWC survey data of Manoomin pounds per tribal harvester and Manoomin density in the same year (Fig. 7B), regional trend through time (Fig. 7A), and random effects for each waterbody ($n = 273$). The second GAM assessed the pounds per trip through time at sites for both tribal and non-tribal harvesters (Fig. 7C) with the previous two years of harvest (Fig. 7D), and the random effects for each waterbody, including all waterbodies with harvesting data, and not just the ones surveyed for Manoomin density ($n = 1282$).

Lastly, GAMs were used to evaluate climate variable trends through time because they have the capacity to simultaneously capture the non-linear (oscillating), site-specific, and regional trends of multiple time series. The climate variable trends were modeled with GAMs for each of the weather station datasets since 1985 ($n = 444$). Four weather stations had data extending back to the early 1900s ($n = 664$), so an additional set of

GAMs was created to assess longer-term trends in these datasets (Fig. 5). Ice duration ($n = 1035$) and water levels ($n = 188$) were additionally modeled with GAMs (Fig. 6). Each GAM assessed regional trends through time (one single smooth curve for all sites) and site-specific trends (different smooth curves for each waterbody).

Data availability

The Manoomin/Psiŋ (wild rice) density datasets analyzed during the current study are available on the 1854 Treaty Authority Website (https://www.1854treatyauthority.org/reports/reports.html), the GLIFWC Website (https://glifwc.org/reports/), and in the EDI Data Portal repository, https://doi.org/10.6073/pasta/69863ce9768c64da5b1392b2c2660661.

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Author contributions

Madeline Nyblade led the collaborative quantitative analysis and the writing for this paper. Daniel J. Larkin advised and reviewed the quantitative analysis, reviewed and edited this paper, and contributed to leadership within the tribal-university collaborative. Darren Vogt led field data collection of Manoomin density in the 9 lakes studied by the 1854 Treaty Authority. He also contributed knowledge that informed the quantitative analysis, reviewed and edited the paper, and participated in the tribal-university collaborative. Rob Croll contributed knowledge that informed the quantitative analysis, reviewed and edited the paper, and participated in the tribal-university collaborative. G.-H. Crystal Ng reviewed the quantitative analysis, reviewed and edited this paper, and contributed to leadership within the tribal-university collaborative. William Joe Graveen contributed knowledge that informed the quantitative analysis, reviewed and edited the paper, and participated in the tribal-university collaborative. Kristen Hansen contributed knowledge that informed the quantitative analysis, reviewed and edited the paper, and participated in the tribal-university collaborative. Hannah Panci contributed knowledge that informed the quantitative analysis, reviewed and edited the paper, and participated in the tribal-university collaborative. Brandon Byrne led more recent field data collection of Manoomin density on the waters studied by the Great Lakes Indian Fish and Wildlife Commission. He also contributed knowledge that informed the quantitative analysis, reviewed and edited the paper, and participated in the tribal-university collaborative. Bazile Minogiizhigaabo Panek contributed knowledge that informed the quantitative analysis, reviewed and edited the paper, and participated in the tribal-university collaborative.

Competing interests

The authors declare no competing interests.

Additional information

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Correspondence and requests for materials should be addressed to Madeline Nyblade.

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Dustin Norman

I am requesting that Locke Lake in Fridley, Anoka County, Minnesota (located approximately 0.25 miles upstream from Manomin Park where Rice Creek enters) be listed as impaired under Class 2 stream standards (Minnesota Rules 7050.0222: https://www.revisor.mn.gov/rules/7050.0222/).

Background: I am a property owner on Locke Lake. I have reviewed 15+ years of official Rice Creek Watershed District monitoring data (submitted to MPCA) for this lake.

Water Quality Violations (RCWD Official Data, 2008-2025):

Phosphorus: 111 µg/L average, vs. Class 2B standard of ≤ 60 µg/L (94% violation rate)
Chlorophyll-a: 37 µg/L average, vs. standard of ≤ 20 µg/L (86% violation rate)
Secchi depth: 0.81m median, vs. standard of ≥ 1.0m (19% below standard)
These violations are persistent, not seasonal anomalies. 2025 data (six phosphorus samples) shows 100% continued violation.

Systemic Impairment Evidence:
Rice Creek (inlet: Long Lake to Locke Lake, AUID 07010206-584) is listed as impaired for fish/macroinvertebrate assemblages under Class 2 standards (https://www.pca.state.mn.us/air-water-land-climate/minnesotas-impaired-waters-list). A water body receiving flows from an impaired stream and violating the same Class 2 aquatic life standards should follow the same impairment designation. The Rice Creek Watershed District has documented that Locke Lake functions as a flow-through system with short hydraulic residence time—essentially a wide spot in the creek, not a traditional lake.

Request:
I respectfully request Locke Lake (Fridley, Anoka County) be added to the 2026 Impaired Waters List.

7050.0222 SPECIFIC WATER QUALITY STANDARDS FOR CLASS 2 WATERS OF THE STATE; AQUATIC LIFE AND RECREATION.

Subpart 1. **General.**

A. The numeric and narrative water quality standards in this part prescribe the qualities or properties of the waters of the state that are necessary for the aquatic life and recreation designated public uses and benefits. If the standards in this part are exceeded in waters of the state that have the class 2 designation, it is considered indicative of a polluted condition which is actually or potentially deleterious, harmful, detrimental, or injurious with respect to the designated uses.

B. Standards for metals are expressed as total metal in this part, but must be converted to dissolved metal standards for application to surface waters. Conversion factors for converting total to dissolved metal standards are listed in subpart 9. The conversion factor for metals not listed in subpart 9 is one. The dissolved metal standard equals the total metal standard times the conversion factor. Water-quality-based effluent limits for metals are expressed as total metal.

C. The tables of standards in this part include the following abbreviations and acronyms:

*	an asterisk following the FAV and MS values or double dashes (--) means subpart 7, item E, applies
(c)	means the chemical is assumed to be a human carcinogen
°C	means degrees Celsius
CS	means chronic standard, defined in part 7050.0218, subpart 3
--	double dashes means there is no standard
°F	means degrees Fahrenheit
FAV	means final acute value, defined in part 7050.0218, subpart 3
HH	in the "basis" column means the standard is human health-based
MS	means maximum standard, defined in part 7050.0218, subpart 3
NA	means not applicable
su	means standard unit. It is the reporting unit for pH
TH	means total hardness in milligrams per liter, which is the sum of the calcium and magnesium concentrations expressed as $CaCO_3$
Tox	in the "basis" column means the standard is toxicity-based

D. Important synonyms or acronyms for some chemicals are listed in parentheses below the primary name.

Subp. 2. **Class 2A waters; aquatic life and recreation.** The quality of class 2A surface waters shall be such as to permit the propagation and maintenance of a healthy community of coldwater aquatic biota, and their habitats according to the definitions in subpart 2c. These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. This class of surface waters is also protected as a source of drinking water. Abbreviations, acronyms, and symbols are explained in subpart 1.

Substance, Characteristic, or Pollutant (Class 2A)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Acenaphthene	µg/L	20	HH	56	112	Tox
Acetochlor	µg/L	3.6	Tox	86	173	Tox
Acrylonitrile (c)	µg/L	0.38	HH	1,140*	2,281*	Tox
Alachlor (c)	µg/L	3.8	HH	800*	1,600*	Tox
Aluminum, total	µg/L	87	Tox	748	1,496	Tox
Ammonia un-ionized as N	µg/L	16	Tox	--	--	NA

The percent un-ionized ammonia can be calculated for any temperature and pH by using the following equation taken from Emerson, K., R.C. Russo, R.E. Lund, and R.V. Thurston, Aqueous ammonia equilibrium calculations; effect of pH and temperature. Journal of the Fisheries Research Board of Canada 32: 2379-2383 (1975):

$$f = \frac{1}{10^{(pk_a - pH)} + 1} \times 100$$

where: f = the percent of total ammonia in the un-ionized state

pk_a= 0.09 + (2730/T) (dissociation constant for ammonia)

T = temperature in degrees Kelvin (273.16° Kelvin = 0° Celsius)

Substance, Characteristic,	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for**

or Pollutant (Class 2A)						MS, FAV
Anthracene	µg/L	0.035	Tox	0.32	0.63	Tox
Antimony, total	µg/L	5.5	HH	90	180	Tox
Arsenic, total	µg/L	2.0	HH	360	720	Tox
Atrazine (c)	µg/L	3.4	HH	323	645	Tox
Benzene (c)	µg/L	5.1	HH	4,487*	8,974*	Tox
Bromoform	µg/L	33	HH	2,900	5,800	Tox
Cadmium, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS in µg/L shall not exceed: exp.(0.7852[ln(total hardness mg/L)]-3.490)

The MS in µg/L shall not exceed: exp.(1.128[ln(total hardness mg/L)]-3.828)

The FAV in µg/L shall not exceed: exp.(1.128[ln(total hardness mg/L)]-3.1349)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total cadmium standards for five hardness values:

TH in mg/L	50	100	200	300	400
Cadmium, total					
CS µg/L	0.66	1.1	2.0	2.7	3.4
MS µg/L	1.8	3.9	8.6	14	19
FAV µg/L	3.6	7.8	17	27	37

Substance, Characteristic, or Pollutant (Class 2A)	Units	CS	Basis for CS	MS	FAV	Basis for MS, FAV

Carbon tetrachloride (c)	µg/L	1.9	HH	1750*	3500*	Tox
Chlordane (c)	ng/L	0.073	HH	1200*	2400*	Tox
Chloride	mg/L	230	Tox	860	1720	Tox
Chlorine, total residual	µg/L	11	Tox	19	38	Tox

Chlorine standard applies to conditions of continuous exposure, where continuous exposure refers to chlorinated effluents that are discharged for more than a total of two hours in any 24-hour period.

Chlorobenzene (Monochlorobenzene)	µg/L	20	HH	423	846	Tox
Chloroform (c)	µg/L	53	HH	1,392	2,784	Tox
Chlorpyrifos	µg/L	0.041	Tox	0.083	0.17	Tox
Chromium +3, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS in µg/L shall not exceed: exp.(0.819[ln(total hardness mg/L)]+1.561)

The MS in µg/L shall not exceed: exp.(0.819[ln(total hardness mg/L)]+3.688)

The FAV in µg/L shall not exceed: exp.(0.819[ln(total hardness mg/L)]+4.380)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total chromium +3 standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Chromium +3, total					
CS µg/L	117	207	365	509	644
MS µg/L	984	1,737	3,064	4,270	5,405
FAV µg/L	1,966	3,469	6,120	8,530	10,797

Substance, Characteristic,	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for**

or Pollutant (Class 2A)						MS, FAV
Chromium +6, total	µg/L	11	Tox	16	32	Tox
Cobalt, total	µg/L	2.8	HH	436	872	Tox
Color value	Pt/Co	30	NA	--	--	NA
Copper, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS in µg/L shall not exceed: exp.(0.620[ln(total hardness mg/L)]-0.570)

The MS in µg/L shall not exceed: exp.(0.9422[ln(total hardness mg/L)]-1.464)

The FAV in µg/L shall not exceed: exp.(0.9422[ln(total hardness mg/L)]-0.7703)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total copper standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Copper, total					
CS µg/L	6.4	9.8	15	19	23
MS µg/L	9.2	18	34	50	65
FAV µg/L	18	35	68	100	131

Substance, Characteristic, or Pollutant (Class 2A)	Units	CS	Basis for CS	MS	FAV	Basis for MS, FAV
Cyanide, free	µg/L	5.2	Tox	22	45	Tox
DDT (c)	ng/L	0.11	HH	550*	1100*	Tox
1,2-Dichloroethane (c)	µg/L	3.5	HH	45,050*	90,100*	Tox

Dieldrin (c)	ng/L	0.0065	HH	1,300*	2,500*	Tox
Di-2-ethylhexyl phthalate (c)	µg/L	1.9	HH	--*	--*	NA
Di-n-octyl phthalate	µg/L	30	Tox	825	1,650	Tox
Endosulfan	µg/L	0.0076	HH	0.084	0.17	Tox
Endrin	µg/L	0.0039	HH	0.090	0.18	Tox
Escherichia (E.) coli	See below	See below	HH	See below	See below	NA

Not to exceed 126 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31.

Ethylbenzene	µg/L	68	Tox	1,859	3,717	Tox

Substance, Characteristic, or Pollutant (Class 2A)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**

Eutrophication standards for class 2A lakes and reservoirs.

Designated lake trout lakes in all ecoregions (lake trout lakes support natural populations of lake trout, *Salvelinus namaycush*):

Phosphorus, total	µg/L	12	NA	--	--	NA
Chlorophyll-a	µg/L	3	NA	--	--	NA
Secchi disk transparency	meters	No less than 4.8	NA	--	--	NA

Designated trout lakes in all ecoregions, except lake trout lakes:

Phosphorus, total	µg/L	20	NA	--	--	NA
Chlorophyll-a	µg/L	6	NA	--	--	NA
Secchi disk transparency	meters	No less than 2.5	NA	--	--	NA

Additional narrative eutrophication standards for class 2A lakes and reservoirs are found under subpart 2a.

Eutrophication standards for class 2A rivers and streams.

North River Nutrient Region:

Phosphorus, total	µg/L	less than or equal to 50
Chlorophyll-a (seston)	µg/L	less than or equal to 7
Diel dissolved oxygen flux	mg/L	less than or equal to 3.0
Biochemical oxygen demand (BOD_5)	mg/L	less than or equal to 1.5

Central River Nutrient Region:

Phosphorus, total	µg/L	less than or equal to 100
Chlorophyll-a (seston)	µg/L	less than or equal to 18
Diel dissolved oxygen flux	mg/L	less than or equal to 3.5
Biochemical oxygen demand (BOD_5)	mg/L	less than or equal to 2.0

South River Nutrient Region:

Phosphorus, total	µg/L	less than or equal to 150
Chlorophyll-a (seston)	µg/L	less than or equal to 35
Diel dissolved oxygen flux	mg/L	less than or equal to 4.5
Biochemical oxygen demand (BOD_5)	mg/L	less than or equal to 3.0

Additional narrative eutrophication standards for class 2A rivers and streams are found under subpart 2b.

Substance, Characteristic, or Pollutant (Class 2A)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Fluoranthene	µg/L	1.9	Tox	3.5	6.9	Tox
Heptachlor (c)	ng/L	0.10	HH	260*	520*	Tox

Heptachlor epoxide (c)	ng/L	0.12	HH	270*	530*	Tox
Hexachlorobenzene (c)	ng/L	0.061	HH	--*	--*	Tox
Lead, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS in µg/L shall not exceed: exp.(1.273[ln(total hardness mg/L)]-4.705)

The MS in µg/L shall not exceed: exp.(1.273[ln(total hardness mg/L)]-1.460)

The FAV in µg/L shall not exceed: exp.(1.273[ln(total hardness mg/L)]-0.7643)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total lead standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Lead, total					
CS µg/L	1.3	3.2	7.7	13	19
MS µg/L	34	82	197	331	477
FAV µg/L	68	164	396	663	956

Substance, Characteristic, or Pollutant (Class 2A)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Lindane (c) (Hexachlorocyclohexane, gamma-)	µg/L	0.0087	HH	1.0*	2.0*	Tox
Mercury, total in water	ng/L	6.9	HH	2,400*	4,900*	Tox
Mercury, total in edible fish	mg/kg ppm	0.2	HH	NA	NA	NA
Methylene chloride (c) Dichloromethane)	µg/L	45	HH	13,875*	27,749*	Tox

Metolachlor	µg/L	23	Tox	271	543	Tox
Naphthalene	µg/L	65	HH	409	818	Tox
Nickel, total	µg/L	equation	Tox/HH	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS shall not exceed the human health-based standard of 297 µg/L. For waters with total hardness values less than 212 mg/L, the CS in µg/L is toxicity-based and shall not exceed: exp.(0.846[ln(total hardness mg/L)]+1.1645)

The MS in µg/L shall not exceed: exp.(0.846[ln(total hardness mg/L)]+3.3612)

The FAV in µg/L shall not exceed: exp.(0.846[ln(total hardness mg/L)]+4.0543)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total nickel standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Nickel, total					
CS µg/L	88	158	283	297	297
MS µg/L	789	1,418	2,549	3,592	4,582
FAV µg/L	1,578	2,836	5,098	7,185	9,164

Substance, Characteristic, or Pollutant (Class 2A)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Oil	µg/L	500	NA	5,000	10,000	NA
Oxygen, dissolved	mg/L	See below	NA	--	--	NA

7.0 mg/L as a daily minimum. This dissolved oxygen standard requires compliance with the standard 50 percent of the days at which the flow of the receiving water is equal to the $7Q_{10}$.

Parathion	µg/L	0.013	Tox	0.07	0.13	Tox
Pentachlorophenol	µg/L	0.93	HH	equation	equation	Tox

The MS and FAV vary with pH and are calculated using the following equations:

The MS in µg/L shall not exceed: exp.(1.005[pH]-4.830)

The FAV in µg/L shall not exceed: exp.(1.005[pH]-4.1373)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For pH values less than 6.0, 6.0 shall be used to calculate the standard and for pH values greater than 9.0, 9.0 shall be used to calculate the standard.

Example of pentachlorophenol standards for five pH values:

pH su	6.5	7.0	7.5	8.0	8.5
Pentachlorophenol					
CS µg/L	0.93	0.93	0.93	0.93	0.93
MS µg/L	5.5	9.1	15	25	41
FAV µg/L	11	18	30	50	82

Substance, Characteristic, or Pollutant (Class 2A)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
pH, minimum	su	6.5	NA	--	--	NA
pH, maximum	su	8.5	NA	--	--	NA
Phenanthrene	µg/L	3.6	Tox	32	64	Tox
Phenol	µg/L	123	Tox	2,214	4,428	Tox
Polychlorinated biphenyls, total (c)	ng/L	0.014	HH	1,000*	2,000*	Tox
Radioactive materials	NA	See below	NA	See below	See below	NA

Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as permitted by the appropriate authority having control over their use.

Selenium, total	µg/L	5.0	Tox	20	40	Tox
Silver, total	µg/L	0.12	Tox	equation	equation	Tox

The MS and FAV vary with total hardness and are calculated using the following equations:

The MS in µg/L shall not exceed: exp.(1.720[ln(total hardness mg/L)]-7.2156)

The FAV in µg/L shall not exceed: exp.(1.720[ln(total hardness mg/L)]-6.520)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of silver standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Silver, total					
CS µg/L	0.12	0.12	0.12	0.12	0.12
MS µg/L	1.0	2.0	6.7	13	22
FAV µg/L	1.2	4.1	13	27	44

Substance, Characteristic, or Pollutant (Class 2A)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Temperature	°C or °F	No material increase	NA	--	--	NA
1,1,2,2-Tetrachloroethane (c)	µg/L	1.1	HH	1,127*	2,253*	Tox
Tetrachloroethylene (c)	µg/L	3.8	HH	428*	857*	Tox
Thallium, total	µg/L	0.28	HH	64	128	Tox
Toluene	µg/L	253	Tox	1,352	2,703	Tox
Toxaphene (c)	ng/L	0.31	HH	730*	1,500*	Tox

1,1,1-Trichloroethane	µg/L	329	Tox	2,957	5,913	Tox
1,1,2-Trichloroethylene (c)	µg/L	25	HH	6,988*	13,976*	Tox
2,4,6-Trichlorophenol	µg/L	2.0	HH	102	203	Tox
Total suspended solids (TSS)	mg/L	10	NA	--	--	NA
TSS standards for class 2A may be exceeded for no more than ten percent of the time. This standard applies April 1 through September 30						
Vinyl chloride (c)	µg/L	0.17	HH	--*	--*	NA
Xylene, total m,p,o	µg/L	166	Tox	1,407	2,814	Tox
Zinc, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS in µg/L shall not exceed: exp.(0.8473[ln(total hardness mg/L)]+0.7615)

The MS in µg/L shall not exceed: exp.(0.8473[ln(total hardness mg/L)]+0.8604)

The FAV in µg/L shall not exceed: exp.(0.8473[ln(total hardness mg/L)]+1.5536

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of zinc standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Zinc, total					
CS µg/L	59	106	191	269	343
MS µg/L	65	117	211	297	379
FAV µg/L	130	234	421	594	758

Subp. 2a. **Narrative eutrophication standards for lakes and reservoirs.**

A. Eutrophication standards for lakes and reservoirs are compared to summer-average data. Exceedance of the total phosphorus and either the chlorophyll-a or Secchi disk transparency standard is required to indicate a polluted condition.

B. It is the policy of the agency to protect all lakes and reservoirs from the undesirable effects of cultural eutrophication. Lakes and reservoirs with a baseline quality better than the numeric eutrophication standards in subpart 2 must be maintained in that condition through the strict application of all relevant federal, state, and local requirements governing antidegradation, the discharge of nutrients from point and nonpoint sources, and the protection of lake or reservoir resources, including, but not limited to:

(1) the antidegradation requirements in parts 7050.0250 to 7050.0335;

(2) the phosphorus effluent limits for point sources, where applicable in chapter 7053;

(3) the requirements for feedlots in chapter 7020;

(4) the requirements for individual sewage treatment systems in chapter 7080;

(5) the requirements for control of stormwater in chapter 7090;

(6) county shoreland ordinances; and

(7) implementation of mandatory and voluntary best management practices to minimize point and nonpoint sources of nutrients.

C. Lakes and reservoirs with a baseline quality that is poorer than the numeric eutrophication standards in subpart 2 must be considered to be in compliance with the standards if the baseline quality is the result of natural causes. The commissioner shall determine baseline quality and compliance with these standards using data and the procedures in part 7050.0150, subpart 5.

D. When applied to reservoirs, the eutrophication standards in this subpart and subpart 2 may be modified on a site-specific basis to account for characteristics unique to reservoirs that can affect trophic status, such as water temperature, variations in hydraulic residence time, watershed size, and the fact that reservoirs may receive drainage from more than one ecoregion. Information supporting a site-specific standard can be provided by the commissioner or by any person outside the agency. The commissioner shall evaluate all data in support of a modified standard and determine whether a change in the standard for a specific reservoir is justified. Any total phosphorus effluent limit determined to be necessary based on a modified standard shall only be required after the discharger has been given notice of the specific proposed effluent limits and an opportunity to request a hearing as provided in part 7000.1800.

E. Eutrophication standards applicable to lakes and reservoirs that lie on the border between two ecoregions or that are in the Red River Valley (also referred to as Lake Agassiz Plains), Northern Minnesota Wetlands, or Driftless Area Ecoregion must be applied on a case-by-case basis. The commissioner shall use the standards applicable to adjacent ecoregions as a guide.

Subp. 2b. **Narrative eutrophication standards for rivers and streams.**

A. Eutrophication standards for rivers and streams are compared to summer-average data or as specified in subpart 2. Exceedance of the total phosphorus levels and chlorophyll-a (seston), five-day biochemical oxygen demand (BOD_5), diel dissolved oxygen flux, or pH levels is required to indicate a polluted condition.

B. Rivers and streams that exceed the phosphorus levels but do not exceed the chlorophyll-a (seston), five-day biochemical oxygen demand (BOD_5), diel dissolved oxygen flux, or pH levels meet the eutrophication standard.

C. For chlorophyll-a (periphyton), the standard is exceeded if concentrations exceed 150 mg/m^2 more than one year in ten.

D. It is the policy of the agency to protect all rivers and streams from the undesirable effects of cultural eutrophication. Rivers and streams with a baseline quality better than the numeric eutrophication standards in subpart 3 must be maintained in that condition through the strict application of all relevant federal, state, and local requirements governing antidegradation, the discharge of nutrients from point and nonpoint sources, including:

(1) the antidegradation requirements in parts 7050.0250 to 7050.0335;

(2) the phosphorus effluent limits for point sources, where applicable, in chapter 7053;

(3) the requirements for feedlots in chapter 7020;

(4) the requirements for individual sewage treatment systems in chapter 7080;

(5) the requirements for control of stormwater in chapter 7090;

(6) county shoreland ordinances; and

(7) implementation of mandatory and voluntary best management practices to minimize point and nonpoint sources of nutrients.

E. Rivers and streams with a baseline quality that does not meet the numeric eutrophication standards in part 7050.0150, subpart 5b, are in compliance with the standards if the baseline quality is the result of natural causes. The commissioner must determine baseline quality and compliance with these standards using data and the procedures in part 7050.0150, subpart 5.

Subp. 2c. **Beneficial use definitions for lotic coldwater aquatic life and habitats (class 2A).**

A. Subitems (1) to (5) apply to the beneficial uses in items B and C:

(1) The designation and attainment of beneficial uses are based on the biological criteria in subpart 2d.

(2) The attributes of species composition, diversity, and functional organization are measured using:

(a) the fish IBI as defined in Fish Data Collection Protocols for Lotic Waters in Minnesota (2017); or

(b) the macroinvertebrate IBI as defined in Macroinvertebrate Data Collection Protocols for Lotic Waters in Minnesota (2017).

(3) Water body types for streams and rivers are defined in the documents referenced in subitem (2).

(4) The following documents are incorporated by reference and are not subject to frequent change:

(a) Calibration of the Biological Condition Gradient for Streams of Minnesota, Gerritsen et al. (2012). The document is available on the agency's website at www.pca.state.mn.us/regulations/minnesota-rulemaking;

(b) Fish Data Collection Protocols for Lotic Waters in Minnesota, Minnesota Pollution Control Agency (2017). The document is available on the agency's website at www.pca.state.mn.us/regulations/minnesota-rulemaking;

(c) Macroinvertebrate Data Collection Protocols for Lotic Waters in Minnesota, Minnesota Pollution Control Agency (2017). The document is available on the agency's website at www.pca.state.mn.us/regulations/minnesota-rulemaking; and

(d) Development of Biological Criteria for Tiered Aquatic Life Uses, Minnesota Pollution Control Agency (2016). The document is available on the agency's website at www.pca.state.mn.us/regulations/minnesota-rulemaking.

(5) The beneficial use subclass designators "e" and "g" are added to the class 2A designator as specific additional designators. The additional subclass designators do not replace the class 2A designator. All requirements for class 2A coldwater stream and river habitats in parts 7050.0222 and 7052.0100 continue to apply in addition to requirements for class 2Ae or class 2Ag coldwater stream and river habitats in part 7050.0222. These subclass designators are applied to lotic waters only.

B. "Exceptional coldwater aquatic life and habitat" or "class 2Ae" is a beneficial use that means waters capable of supporting and maintaining an exceptional and balanced, integrated, adaptive community of coldwater aquatic organisms having a species composition, diversity, and functional organization comparable to the 75th percentile of biological condition gradient level 3 as established in Calibration of the Biological Condition Gradient for Streams of Minnesota, Gerritsen et al. (2012).

C. "General coldwater aquatic life and habitat" or "class 2Ag" is a beneficial use that means waters capable of supporting and maintaining a balanced, integrated, adaptive community of coldwater aquatic organisms having a species composition, diversity, and functional organization comparable to the median of biological condition gradient level 4 as established in Calibration of the Biological Condition Gradient for Streams of Minnesota, Gerritsen et al. (2012).

Subp. 2d. **Biological criteria for lotic coldwater aquatic life and habitats (class 2A).**

Water Body Type	Tier	Class	Assemblage	Biocriterion
Southern coldwater streams	Exceptional	2Ae	Fish	82
	General	2Ag	Fish	50

Northern coldwater streams	Exceptional	2Ae	Fish	60
	General	2Ag	Fish	35
Northern coldwater streams	Exceptional	2Ae	Macroinvertebrates	52
	General	2Ag	Macroinvertebrates	32
Southern coldwater streams	Exceptional	2Ae	Macroinvertebrates	72
	General	2Ag	Macroinvertebrates	43

The biological criteria for lotic coldwater aquatic life and habitats (class 2A) are applicable to perennial and intermittent waters that allow for colonization of fish or macroinvertebrates.

Subp. 3. **Class 2Bd waters.** The quality of class 2Bd surface waters shall be such as to permit the propagation and maintenance of a healthy community of cool or warm water aquatic biota and their habitats according to the definitions in subpart 3c. These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. This class of surface waters is also protected as a source of drinking water. The applicable standards are given below. Abbreviations, acronyms, and symbols are explained in subpart 1.

Substance, Characteristic, or Pollutant (Class 2Bd)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Acenaphthene	µg/L	20	HH	56	112	Tox
Acetochlor	µg/L	3.6	Tox	86	173	Tox
Acrylonitrile (c)	µg/L	0.38	HH	1,140*	2,281*	Tox
Alachlor (c)	µg/L	4.2	HH	800*	1,600*	Tox
Aluminum, total	µg/L	125	Tox	1,072	2,145	Tox
Ammonia un-ionized as N	µg/L	40	Tox	--	--	NA

The percent un-ionized ammonia can be calculated for any temperature and pH by using the following equation taken from Emerson, K., R.C. Russo, R.E. Lund, and R.V. Thurston, Aqueous ammonia equilibrium calculations; effect of pH and temperature. Journal of the Fisheries Research Board of Canada 32: 2379-2383 (1975):

$$f = 1/(10^{(pka-pH)} + 1) \times 100$$

where: f = the percent of total ammonia in the un-ionized state

$pk_a = 0.09 + (2730/T)$ (dissociation constant for ammonia)

T = temperature in degrees Kelvin (273.16° Kelvin = 0° Celsius)

Substance, Characteristic, or Pollutant (Class 2Bd)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Anthracene	µg/L	0.035	Tox	0.32	0.63	Tox
Antimony, total	µg/L	5.5	HH	90	180	Tox
Arsenic, total	µg/L	2.0	HH	360	720	Tox
Atrazine (c)	µg/L	3.4	HH	323	645	Tox
Benzene (c)	µg/L	6.0	HH	4,487*	8,974*	Tox
Bromoform	µg/L	41	HH	2,900	5,800	Tox
Cadmium, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS in µg/L shall not exceed: exp.(0.7852[ln(total hardness mg/L)]-3.490)

The MS in µg/L shall not exceed: exp.(1.128[ln(total hardness mg/L)]-1.685)

The FAV in µg/L shall not exceed: exp.(1.128[ln(total hardness mg/L)]-0.9919)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total cadmium standards for five hardness values:

TH in mg/L	50	100	200	300	400
Cadmium, total					
CS µg/L	0.66	1.1	2.0	2.7	3.4
MS µg/L	15	33	73	116	160
FAV µg/L	31	67	146	231	319

Substance, Characteristic, or Pollutant (Class 2Bd)	Units	CS	Basis for CS	MS	FAV	Basis for MS, FAV
Carbon tetrachloride (c)	µg/L	1.9	HH	1,750*	3,500*	Tox
Chlordane (c)	ng/L	0.29	HH	1,200*	2,400*	Tox
Chloride	mg/L	230	Tox	860	1,720	Tox
Chlorine, total residual	µg/L	11	Tox	19	38	Tox

Chlorine standard applies to conditions of continuous exposure, where continuous exposure refers to chlorinated effluents that are discharged for more than a total of two hours in any 24-hour period.

Chlorobenzene (Monochlorobenzene)	µg/L	20	HH	423	846	Tox
Chloroform (c)	µg/L	53	HH	1,392	2,784	Tox
Chlorpyrifos	µg/L	0.041	Tox	0.083	0.17	Tox
Chromium +3, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS in µg/L shall not exceed: exp.(0.819[ln(total hardness mg/L)]+1.561)

The MS in µg/L shall not exceed: exp.(0.819[ln(total hardness mg/L)]+3.688)

The FAV in µg/L shall not exceed: exp.(0.819[ln(total hardness mg/L)]+4.380)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total chromium +3 standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Chromium +3, total					
CS µg/L	117	207	365	509	644

MS µg/L	984	1,737	3,064	4,270	5,405
FAV µg/L	1,966	3,469	6,120	8,530	10,797

Substance, Characteristic, or Pollutant (Class 2Bd)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Chromium +6, total	µg/L	11	Tox	16	32	Tox
Cobalt, total	µg/L	2.8	HH	436	872	Tox
Copper, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS in µg/L shall not exceed: exp.(0.620[ln(total hardness mg/L)]-0.570)

The MS in µg/L shall not exceed: exp.(0.9422[ln(total hardness mg/L)]-1.464)

The FAV in µg/L shall not exceed: exp.(0.9422[ln(total hardness mg/L)]-0.7703)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total copper standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Copper, total					
CS µg/L	6.4	9.8	15	19	23
MS µg/L	9.2	18	34	50	65
FAV µg/L	18	35	68	100	131

Substance, Characteristic, or Pollutant (Class 2Bd)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**

Cyanide, free	µg/L	5.2	Tox	22	45	Tox
DDT (c)	ng/L	1.7	HH	550*	1,100*	Tox
1,2-Dichloroethane (c)	µg/L	3.8	HH	45,050*	90,100*	Tox
Dieldrin (c)	ng/L	0.026	HH	1,300*	2,500*	Tox
Di-2-ethylhexyl phthalate (c)	µg/L	1.9	HH	--*	--*	NA
Di-n-octyl phthalate	µg/L	30	Tox	825	1,650	Tox
Endosulfan	µg/L	0.029	HH	0.28	0.56	Tox
Endrin	µg/L	0.016	HH	0.090	0.18	Tox
Escherichia (E.) coli	See below	See below	HH	See below	See below	NA

Not to exceed 126 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31.

Ethylbenzene	µg/L	68	Tox	1,859	3,717	Tox

Substance, Characteristic, or Pollutant (Class 2Bd)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**

Eutrophication standards for class 2Bd lakes, shallow lakes, and reservoirs.

Lakes, Shallow Lakes, and Reservoirs in Northern Lakes and Forest Ecoregion

Phosphorus, total	µg/L	30	NA	--	--	NA
Chlorophyll-a	µg/L	9	NA	--	--	NA
Secchi disk transparency	meters	Not less than 2.0	NA	--	--	NA

Lakes and Reservoirs in North Central Hardwood Forest Ecoregion

Phosphorus, total	µg/L	40	NA	--	--	NA
Chlorophyll-a	µg/L	14	NA	--	--	NA
Secchi disk transparency	meters	Not less than 1.4	NA	--	--	NA

Lakes and Reservoirs in Western Corn Belt Plains and Northern Glaciated Plains Ecoregions

Phosphorus, total	µg/L	65	NA	--	--	NA
Chlorophyll-a	µg/L	22	NA	--	--	NA
Secchi disk transparency	meters	Not less than 0.9	NA	--	--	NA

Shallow Lakes in North Central Hardwood Forest Ecoregion

Phosphorus, total	µg/L	60	NA	--	--	NA
Chlorophyll-a	µg/L	20	NA	--	--	NA
Secchi disk transparency	meters	Not less than 1.0	NA	--	--	NA

Shallow Lakes in Western Corn Belt Plains and Northern Glaciated Plains Ecoregions

Phosphorus, total	µg/L	90	NA	--	--	NA
Chlorophyll-a	µg/L	30	NA	--	--	NA
Secchi disk transparency	meters	Not less than 0.7	NA	--	--	NA

Additional narrative eutrophication standards for class 2Bd lakes, shallow lakes, and reservoirs are found under subpart 3a.

Eutrophication standards for class 2Bd rivers and streams.

North River Nutrient Region

Phosphorus, total	µg/L	less than or equal to 50
Chlorophyll-a (seston)	µg/L	less than or equal to 7
Diel dissolved oxygen flux	mg/L	less than or equal to 3.0
Biochemical oxygen demand (BOD_5)	mg/L	less than or equal to 1.5

Central River Nutrient Region

Phosphorus, total	µg/L	less than or equal to 100
Chlorophyll-a (seston)	µg/L	less than or equal to 18
Diel dissolved oxygen flux	mg/L	less than or equal to 3.5
Biochemical oxygen demand (BOD_5)	mg/L	less than or equal to 2.0

South River Nutrient Region

Phosphorus, total	µg/L	less than or equal to 150
Chlorophyll-a (seston)	µg/L	less than or equal to 35
Diel dissolved oxygen flux	mg/L	less than or equal to 4.5
Biochemical oxygen demand (BOD_5)	mg/L	less than or equal to 3.0

Additional narrative eutrophication standards for class 2Bd rivers and streams are found under subpart 3b.

Substance, Characteristic, or Pollutant (Class 2Bd)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Fluoranthene	µg/L	1.9	Tox	3.5	6.9	Tox
Heptachlor (c)	ng/L	0.39	HH	260*	520*	Tox
Heptachlor epoxide (c)	ng/L	0.48	HH	270*	530*	Tox
Hexachlorobenzene (c)	ng/L	0.24	HH	--*	--*	Tox
Lead, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS in µg/L shall not exceed: exp.(1.273[ln(total hardness mg/L)]-4.705)

The MS in µg/L shall not exceed: exp.(1.273[ln(total hardness mg/L)]-1.460)

The FAV in µg/L shall not exceed: exp.(1.273[ln(total hardness mg/L)]-0.7643)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total lead standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Lead, total					
CS µg/L	1.3	3.2	7.7	13	19
MS µg/L	34	82	197	331	477
FAV µg/L	68	164	396	663	956

Substance, Characteristic, or Pollutant (Class 2Bd)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Lindane (c) (Hexachlorocyclohexane, gamma-)	µg/L	0.032	HH	4.4*	8.8*	Tox
Mercury, total in water	ng/L	6.9	HH	2,400*	4,900*	Tox
Mercury, total in edible fish tissue	mg/kg ppm	0.2	HH	NA	NA	NA
Methylene chloride (c) (Dichloromethane)	µg/L	46	HH	13,875*	27,749*	Tox
Metolachlor	µg/L	23	Tox	271	543	Tox
Naphthalene	µg/L	81	Tox	409	818	Tox
Nickel, total	µg/L	equation	Tox/HH	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS shall not exceed the human health-based standard of 297 µg/L. For waters with total hardness values less than 212 mg/L, the CS in µg/L is toxicity-based and shall not exceed: exp.(0.846[ln(total hardness mg/L)]+1.1645)

The MS in µg/L shall not exceed: exp.(0.846[ln(total hardness mg/L)]+3.3612)

The FAV in µg/L shall not exceed: exp.(0.846[ln(total hardness mg/L)]+4.0543)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total nickel standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Nickel, total					
CS µg/L	88	158	283	297	297
MS µg/L	789	1,418	2,549	3,592	4,582
FAV µg/L	1,578	2,836	5,098	7,185	9,164

Substance, Characteristic, or Pollutant (Class 2Bd)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Oil	µg/L	500	NA	5,000	10,000	NA
Oxygen, dissolved	mg/L	See below	NA	--	--	NA

5.0 mg/L as a daily minimum. This dissolved oxygen standard may be modified on a site-specific basis according to part 7050.0220, subpart 7, except that no site-specific standard shall be less than 5 mg/L as a daily average and 4 mg/L as a daily minimum. Compliance with this standard is required 50 percent of the days at which the flow of the receiving water is equal to the $7Q_{10}$.

Parathion	µg/L	0.013	Tox	0.07	0.13	Tox
Pentachlorophenol	µg/L	1.9	HH	equation	equation	Tox

The MS and FAV vary with pH and are calculated using the following equations:

The MS in µg/L shall not exceed: exp.(1.005[pH]-4.830)

The FAV in µg/L shall not exceed: exp.(1.005[pH]-4.1373)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For pH values less than 6.0, 6.0 shall be used to calculate the standard and for pH values greater than 9.0, 9.0 shall be used to calculate the standard.

Example of pentachlorophenol standards for five pH values:

pH su	6.5	7.0	7.5	8.0	8.5
Pentachlorophenol					
CS µg/L	1.9	1.9	1.9	1.9	1.9
MS µg/L	5.5	9.1	15	25	41
FAV µg/L	11	18	30	50	82

Substance, Characteristic, or Pollutant (Class 2Bd)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
pH, minimum	su	6.5	NA	--	--	NA
pH, maximum	su	9.0	NA	--	--	NA
Phenanthrene	µg/L	3.6	Tox	32	64	Tox
Phenol	µg/L	123	Tox	2,214	4,428	Tox
Polychlorinated biphenyls, total (c)	ng/L	0.029	HH	1,000*	2,000*	Tox
Radioactive materials	NA	See below	NA	See below	See below	NA

Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as permitted by the appropriate authority having control over their use.

Selenium, total	µg/L	5.0	Tox	20	40	Tox
Silver, total	µg/L	1.0	Tox	equation	equation	Tox

The MS and FAV vary with total hardness and are calculated using the following equations:

The MS in µg/L shall not exceed: exp.(1.720[ln(total hardness mg/L)]-7.2156)

The FAV in µg/L shall not exceed: exp.(1.720[ln(total hardness mg/L)]-6.520)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total silver standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Silver, total					
CS µg/L	1.0	1.0	1.0	1.0	1.0
MS µg/L	1.0	2.0	6.7	13	22
FAV µg/L	1.2	4.1	13	27	44

Substance, Characteristic, or Pollutant (Class 2Bd)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Temperature	°F	See below	NA	--	--	NA

5°F above natural in streams and 3°F above natural in lakes, based on monthly average of the maximum daily temperatures, except in no case shall it exceed the daily average temperature of 86°F.

1,1,2,2-Tetrachloroethane (c)	µg/L	1.5	HH	1,127*	2,253*	Tox
Tetrachloroethylene (c)	µg/L	3.8	HH	428*	857*	Tox
Thallium, total	µg/L	0.28	HH	64	128	Tox
Toluene	µg/L	253	Tox	1,352	2,703	Tox
Toxaphene (c)	ng/L	1.3	HH	730*	1,500*	Tox
1,1,1-Trichloroethane	µg/L	329	Tox	2,957	5,913	Tox
1,1,2-Trichloroethylene (c)	µg/L	25	HH	6,988*	13,976*	Tox
2,4,6-Trichlorophenol	µg/L	2.0	HH	102	203	Tox
Total suspended solids (TSS)						
North River Nutrient Region	mg/L	15	NA	-	-	NA
Central River Nutrient Region	mg/L	30	NA	-	-	NA
South River Nutrient Region	mg/L	65	NA	-	-	NA

Red River mainstem - headwaters to border	mg/L	100	NA	-	-	NA
TSS standards for the class 2Bd North, Central, and South River Nutrient Regions and the Red River mainstem may be exceeded for no more than ten percent of the time. This standard applies April 1 through September 30						
Total suspended solids (TSS), summer average						
Lower Mississippi River mainstem - Pools 2 through 4	mg/L	32	NA	-	-	NA
Lower Mississippi River mainstem below Lake Pepin	mg/L	30	NA	-	-	NA
TSS standards for the class 2Bd Lower Mississippi River may be exceeded for no more than 50 percent of the time. This standard applies June 1 through September 30						

Substance, Characteristic, or Pollutant (Class 2Bd)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Vinyl chloride (c)	µg/L	0.18	HH	--*	--*	NA
Xylene, total m,p,o	µg/L	166	Tox	1,407	2,814	Tox
Zinc, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS in µg/L shall not exceed: exp.(0.8473[ln(total hardness mg/L)]+0.7615)

The MS in µg/L shall not exceed: exp.(0.8473[ln(total hardness mg/L)]+0.8604)

The FAV in µg/L shall not exceed: exp.(0.8473[ln(total hardness mg/L)]+1.5536)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total zinc standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Zinc, total					
CS µg/L	59	106	191	269	343
MS µg/L	65	117	211	297	379
FAV µg/L	130	234	421	594	758

Subp. 3a. **Narrative eutrophication standards for class 2Bd lakes, shallow lakes, and reservoirs.**

A. Eutrophication standards applicable to lakes, shallow lakes, and reservoirs that lie on the border between two ecoregions or that are in the Red River Valley (also referred to as Lake Agassiz Plains), Northern Minnesota Wetlands, or Driftless Area Ecoregion must be applied on a case-by-case basis. The commissioner shall use the standards applicable to adjacent ecoregions as a guide.

B. Eutrophication standards are compared to summer-average data. Exceedance of the total phosphorus and either the chlorophyll-a or Secchi disk transparency standard is required to indicate a polluted condition.

C. It is the policy of the agency to protect all lakes, shallow lakes, and reservoirs from the undesirable effects of cultural eutrophication. Lakes, shallow lakes, and reservoirs with a baseline quality better than the numeric eutrophication standards in subpart 3 must be maintained in that condition through the strict application of all relevant federal, state, and local requirements governing antidegradation, the discharge of nutrients from point and nonpoint sources, and the protection of lake, shallow lake, and reservoir resources, including, but not limited to:

(1) the antidegradation requirements in parts 7050.0250 to 7050.0335;

(2) the phosphorus effluent limits for point sources, where applicable in chapter 7053;

(3) the requirements for feedlots in chapter 7020;

(4) the requirements for individual sewage treatment systems in chapter 7080;

(5) the requirements for control of stormwater in chapter 7090;

(6) county shoreland ordinances; and

(7) implementation of mandatory and voluntary best management practices to minimize point and nonpoint sources of nutrients.

D. Lakes, shallow lakes, and reservoirs with a baseline quality that is poorer than the numeric eutrophication standards in subpart 3 must be considered to be in compliance with the standards if the baseline quality is the result of natural causes. The commissioner shall determine baseline quality and compliance with these standards using data and the procedures in part 7050.0150, subpart 5.

E. When applied to reservoirs, the eutrophication standards in this subpart and subpart 3 may be modified on a site-specific basis to account for characteristics of reservoirs that can affect trophic status, such as water temperature, variations in hydraulic residence time, watershed size, and the fact that reservoirs may receive drainage from more than one ecoregion. Information supporting a site-specific standard can be provided by the commissioner or by any person outside the agency. The commissioner shall evaluate all data in support of a modified standard and determine whether a change in the standard for a specific reservoir is justified. Any total phosphorus effluent limit determined to be necessary based on a modified standard shall only be required after the discharger has been given notice of the specific proposed effluent limits and an opportunity to request a hearing as provided in part 7000.1800.

Subp. 3b. **Narrative eutrophication standards for rivers, streams, and navigational pools.**

A. Eutrophication standards for rivers, streams, and navigational pools are compared to summer-average data or as specified in subpart 3. Exceedance of the total phosphorus levels and chlorophyll-a (seston), five-day biochemical oxygen demand (BOD_5), diel dissolved oxygen flux, or pH levels is required to indicate a polluted condition.

B. Rivers, streams, and navigational pools that exceed the phosphorus levels but do not exceed the chlorophyll-a (seston), five-day biochemical oxygen demand (BOD_5), diel dissolved oxygen flux, or pH levels meet the eutrophication standard.

C. A polluted condition also exists when the chlorophyll-a (periphyton) concentration exceeds 150 mg/m^2 more than one year in ten.

D. It is the policy of the agency to protect all rivers, streams, and navigational pools from the undesirable effects of cultural eutrophication. Rivers, streams, and navigational pools with a baseline quality better than the numeric eutrophication standards in subpart 3 must be maintained in that condition through the strict application of all relevant federal, state, and local requirements governing antidegradation, the discharge of nutrients from point and nonpoint sources including:

(1) the antidegradation requirements in parts 7050.0250 to 7050.0335;

(2) the phosphorus effluent limits for point sources, where applicable, in chapter 7053;

(3) the requirements for feedlots in chapter 7020;

(4) the requirements for individual sewage treatment systems in chapter 7080;

(5) the requirements for control of stormwater in chapter 7090;

(6) county shoreland ordinances; and

(7) implementation of mandatory and voluntary best management practices to minimize point and nonpoint sources of nutrients.

E. Rivers, streams, and navigational pools with a baseline quality that does not meet the numeric eutrophication standards in part 7050.0150, subpart 5b, are in compliance with the standards if the baseline quality is the result of natural causes. The commissioner must determine baseline quality and compliance with these standards using data and the procedures in part 7050.0150, subpart 5.

Subp. 3c. **Beneficial use definitions for lotic warm or cool water aquatic life and habitats (class 2Bd).**

A. Subitems (1) to (5) apply to the beneficial uses in items B to D:

(1) The designation and attainment of beneficial uses are based on the biological criteria in subpart 3d.

(2) The attributes of species composition, diversity, and functional organization are measured using:

(a) the fish IBI as defined in Fish Data Collection Protocols for Lotic Waters in Minnesota (2017); or

(b) the macroinvertebrate IBI as defined in Macroinvertebrate Data Collection Protocols for Lotic Waters in Minnesota (2017).

(3) Water body types for streams and rivers are defined in the documents referenced in subitem (2).

(4) The following documents are incorporated by reference and are not subject to frequent change:

(a) Calibration of the Biological Condition Gradient for Streams of Minnesota, Gerritsen et al. (2012). The document is available on the agency's website at www.pca.state.mn.us/regulations/minnesota-rulemaking;

(b) Fish Data Collection Protocols for Lotic Waters in Minnesota, Minnesota Pollution Control Agency (2017). The document is available on the agency's website at www.pca.state.mn.us/regulations/minnesota-rulemaking;

(c) Macroinvertebrate Data Collection Protocols for Lotic Waters in Minnesota, Minnesota Pollution Control Agency (2017). The document is available on the agency's website at www.pca.state.mn.us/regulations/minnesota-rulemaking; and

(d) Development of Biological Criteria for Tiered Aquatic Life Uses, Minnesota Pollution Control Agency (2016). The document is available on the agency's website at www.pca.state.mn.us/regulations/minnesota-rulemaking.

(5) The beneficial use subclass designators "e," "g," and "m" are added to the class 2Bd designator as specific additional designators. The additional subclass designators do not replace the class 2Bd designator. All requirements for class 2Bd warm or cool water stream and river habitats in parts 7050.0222 and 7052.0100 continue to apply in addition to requirements for class 2Bde, class 2Bdg, or class 2Bdm warm or cool water stream and river habitats in part 7050.0222. These subclass designators are applied to lotic waters only.

B. "Exceptional cool and warm water aquatic life and habitat, also protected as a source for drinking water" or "class 2Bde" is a beneficial use that means waters capable of supporting and maintaining an exceptional and balanced, integrated, adaptive community of warm or cool water aquatic organisms having a species composition, diversity, and functional organization comparable to the 75th percentile of biological condition gradient level 3 as established in Calibration of the Biological Condition Gradient for Streams of Minnesota, Gerritsen et al. (2012).

C. "General cool and warm water aquatic life and habitat, also protected as a source for drinking water" or "class 2Bdg" is a beneficial use that means waters capable of supporting and maintaining a balanced, integrated, adaptive community of warm or cool water aquatic organisms having a species composition, diversity, and functional organization comparable to the median of biological condition gradient level 4 as established in Calibration of the Biological Condition Gradient for Streams of Minnesota, Gerritsen et al. (2012).

D. "Modified cool and warm water aquatic life and habitat, also protected as a source for drinking water" or "class 2Bdm" is a beneficial use that means waters capable of supporting and maintaining a balanced, integrated, adaptive community of warm or cool water aquatic organisms having a species composition, diversity, and functional organization comparable to the median of biological condition gradient level 5 as established in Calibration of the Biological Condition Gradient for Streams of Minnesota, Gerritsen et al. (2012).

(1) To meet the definition in this item, waters must have been the subject of a use attainability analysis where it is determined that attainment of the class 2Bdg beneficial use is not feasible because of human-induced modifications of the physical habitat. These modifications must be the result of direct alteration to the channel, such as drainageway maintenance, bank stabilization, and impoundments.

(2) Examples of class 2Bdm waters are the stream channel modification activities regulated under:

(a) sections 401 and 404 of the Clean Water Act; or

(b) Minnesota Statutes, chapter 103E.

Subp. 3d. **Biological criteria for lotic warm or cool water aquatic life and habitats (class 2Bd).**

Water Body Type	**Tier**	**Class**	**Assemblage**	**Biocriterion**

Southern rivers	Exceptional	2Bde	Fish	71
	General	2Bdg	Fish	49
Southern streams	Exceptional	2Bde	Fish	66
	General	2Bdg	Fish	50
	Modified	2Bdm	Fish	35
Southern headwaters	Exceptional	2Bde	Fish	74
	General	2Bdg	Fish	55
	Modified	2Bdm	Fish	33
Northern rivers	Exceptional	2Bde	Fish	67
	General	2Bdg	Fish	38
Northern streams	Exceptional	2Bde	Fish	61
	General	2Bdg	Fish	47
	Modified	2Bdm	Fish	35
Northern headwaters	Exceptional	2Bde	Fish	68
	General	2Bdg	Fish	42
	Modified	2Bdm	Fish	23
Low gradient	Exceptional	2Bde	Fish	70
	General	2Bdg	Fish	42
	Modified	2Bdm	Fish	15
Northern forest rivers	Exceptional	2Bde	Macroinvertebrates	77
	General	2Bdg	Macroinvertebrates	49
Prairie and southern forest rivers	Exceptional	2Bde	Macroinvertebrates	63
	General	2Bdg	Macroinvertebrates	31
High-gradient northern forest streams	Exceptional	2Bde	Macroinvertebrates	82
	General	2Bdg	Macroinvertebrates	53
Low-gradient northern forest streams	Exceptional	2Bde	Macroinvertebrates	76

	General	2Bdg	Macroinvertebrates	51
	Modified	2Bdm	Macroinvertebrates	37
High-gradient southern streams	Exceptional	2Bde	Macroinvertebrates	62
	General	2Bdg	Macroinvertebrates	37
	Modified	2Bdm	Macroinvertebrates	24
Low-gradient southern forest streams	Exceptional	2Bde	Macroinvertebrates	66
	General	2Bdg	Macroinvertebrates	43
	Modified	2Bdm	Macroinvertebrates	30
Low-gradient prairie streams	Exceptional	2Bde	Macroinvertebrates	69
	General	2Bdg	Macroinvertebrates	41
	Modified	2Bdm	Macroinvertebrates	22

The biological criteria for lotic warm or cool water aquatic life and habitats (class 2Bd) are applicable to perennial and intermittent waters that allow for colonization of fish or macroinvertebrates.

Subp. 4. **Class 2B waters.** The quality of class 2B surface waters shall be such as to permit the propagation and maintenance of a healthy community of cool or warm water aquatic biota, and their habitats according to the definitions in subpart 4c. These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. This class of surface water is not protected as a source of drinking water. The applicable standards are given below. Abbreviations, acronyms, and symbols are explained in subpart 1.

Substance, Characteristic, or Pollutant (Class 2B)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Acenaphthene	µg/l	20	HH	56	112	Tox
Acetochlor	µg/L	3.6	Tox	86	173	Tox
Acrylonitrile (c)	µg/l	0.89	HH	1,140*	2,281*	Tox
Alachlor (c)	µg/L	59	Tox	800	1,600	Tox

Aluminum, total	µg/L	125	Tox	1,072	2,145	Tox
Ammonia un-ionized as N	µg/L	40	Tox	--	--	NA

The percent un-ionized ammonia can be calculated for any temperature and pH by using the following equation taken from Emerson, K., R.C. Russo, R.E. Lund, and R.V. Thurston, Aqueous ammonia equilibrium calculations; effect of pH and temperature. Journal of the Fisheries Research Board of Canada 32: 2379-2383 (1975):

$$f = 1/(10^{(pka\text{-}pH)} + 1) \times 100$$

where: f = the percent of total ammonia in the un-ionized state

$pk_a = 0.09 + (2730/T)$ (dissociation constant for ammonia)

T = temperature in degrees Kelvin (273.16° Kelvin = 0° Celsius)

Substance, Characteristic, or Pollutant (Class 2B)	Units	CS	Basis for CS	MS	FAV	Basis for MS, FAV
Anthracene	µg/L	0.035	Tox	0.32	0.63	Tox
Antimony, total	µg/L	31	Tox	90	180	Tox
Arsenic, total	µg/L	53	HH	360	720	Tox
Atrazine (c)	µg/L	10	Tox	323	645	Tox
Benzene (c)	µg/L	98	HH	4,487	8,974	Tox
Bromoform	µg/L	466	HH	2,900	5,800	Tox
Cadmium, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS in µg/L shall not exceed: exp.(0.7852[ln(total hardness mg/L)]-3.490)

The MS in µg/L shall not exceed: exp.(1.128[ln(total hardness mg/L)]-1.685)

The FAV in µg/L shall not exceed: exp.(1.128[ln(total hardness mg/L)]-0.9919)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total cadmium standards for five hardness values:

TH in mg/L	50	100	200	300	400
Cadmium, total					
CS µg/L	0.66	1.1	2.0	2.7	3.4
MS µg/L	15	33	73	116	160
FAV µg/L	31	67	146	231	319

Substance, Characteristic, or Pollutant (Class 2B)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Carbon tetrachloride (c)	µg/L	5.9	HH	1,750*	3,500*	Tox
Chlordane (c)	ng/L	0.29	HH	1,200*	2,400*	Tox
Chloride	mg/L	230	Tox	860	1,720	Tox
Chlorine, total residual	µg/L	11	Tox	19	38	Tox

Chlorine standard applies to conditions of continuous exposure, where continuous exposure refers to chlorinated effluents that are discharged for more than a total of two hours in any 24-hour period.

Chlorobenzene (Monochlorobenzene)	µg/L	20	HH	423	846	Tox
Chloroform (c)	µg/L	155	Tox	1,392	2,784	Tox
Chlorpyrifos	µg/L	0.041	Tox	0.083	0.17	Tox
Chromium +3, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations

The CS in µg/L shall not exceed: exp.(0.819[ln(total hardness mg/L)]+1.561)

The MS in µg/L shall not exceed: exp.(0.819[ln(total hardness mg/L)]+3.688)

The FAV in µg/L shall not exceed: exp.(0.819[ln(total hardness mg/L)]+4.380)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total chromium +3 standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Chromium +3, total					
CS µg/L	117	207	365	509	644
MS µg/L	984	1,737	3,064	4,270	5,405
FAV µg/L	1,966	3,469	6,120	8,530	10,797

Substance, Characteristic, or Pollutant (Class 2B)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Chromium +6, total	µg/L	11	Tox	16	32	Tox
Cobalt, total	µg/L	5.0	Tox	436	872	Tox
Copper, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS in µg/L shall not exceed: exp.(0.6200[ln(total hardness mg/L)]-0.570)

The MS in µg/L shall not exceed: exp.(0.9422[ln(total hardness mg/L)]-1.464)

The FAV in µg/L shall not exceed: exp.(0.9422[ln(total hardness mg/L)]-0.7703)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total copper standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Copper, total					
CS µg/L	6.4	9.8	15	19	23

MS µg/L	9.2	18	34	50	65
FAV µg/L	18	35	68	100	131

Substance, Characteristic, or Pollutant (Class 2B)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Cyanide, free	µg/L	5.2	Tox	22	45	Tox
DDT (c)	ng/L	1.7	HH	550*	1,100*	Tox
1,2-Dichloroethane (c)	µg/L	190	HH	45,050*	90,100*	Tox
Dieldrin (c)	ng/L	0.026	HH	1,300*	2,500*	Tox
Di-2-ethylhexyl phthalate (c)	µg/L	2.1	HH	--*	--*	NA
Di-n-octyl phthalate	µg/L	30	Tox	825	1,650	Tox
Endosulfan	µg/L	0.031	HH	0.28	0.56	Tox
Endrin	µg/L	0.016	HH	0.090	0.18	Tox
Escherichia (E.) coli	See below	See below	HH	See below	See below	NA

Not to exceed 126 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31.

Substance, Characteristic, or Pollutant (Class 2B)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Ethylbenzene	µg/L	68	Tox	1,859	3,717	Tox

Substance, Characteristic, or Pollutant (Class 2B)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**

Eutrophication standards for class 2B lakes, shallow lakes, and reservoirs.

Lakes, Shallow Lakes, and Reservoirs in Northern Lakes and Forest Ecoregions

Phosphorus, total	µg/L	30	NA	--	--	NA
Chlorophyll-a	µg/L	9	NA	--	--	NA
Secchi disk transparency	meters	Not less than 2.0	NA	--	--	NA

Lakes and Reservoirs in North Central Hardwood Forest Ecoregion

Phosphorus, total	µg/L	40	NA	--	--	NA
Chlorophyll-a	µg/L	14	NA	--	--	NA
Secchi disk transparency	meters	Not less than 1.4	NA	--	--	NA

Lakes and Reservoirs in Western Corn Belt Plains and Northern Glaciated Plains Ecoregions

Phosphorus, total	µg/L	65	NA	--	--	NA
Chlorophyll-a	µg/L	22	NA	--	--	NA
Secchi disk transparency	meters	Not less than 0.9	NA	--	--	NA

Shallow Lakes in North Central Hardwood Forest Ecoregion

Phosphorus, total	µg/L	60	NA	--	--	NA
Chlorophyll-a	µg/L	20	NA	--	--	NA
Secchi disk transparency	meters	Not less than 1.0	NA	--	--	NA

Shallow Lakes in Western Corn Belt Plains and Northern Glaciated Plains Ecoregions

Phosphorus, total	µg/L	90	NA	--	--	NA
Chlorophyll-a	µg/L	30	NA	--	--	NA
Secchi disk transparency	meters	Not less than 0.7	NA	--	--	NA

Additional narrative eutrophication standards for class 2B lakes, shallow lakes, and reservoirs are found in subpart 4a.

Substance, Characteristic, or Pollutant (Class 2B)	Units	CS	Basis for CS	MS	FAV	Basis for MS, FAV

Eutrophication standards for class 2B rivers and streams.

North River Nutrient Region

Phosphorus, total	µg/L	less than or equal to 50
Chlorophyll-a (seston)	µg/L	less than or equal to 7
Diel dissolved oxygen flux	mg/L	less than or equal to 3.0
Biochemical oxygen demand (BOD_5)	mg/L	less than or equal to 1.5

Central River Nutrient Region

Phosphorus, total	µg/L	less than or equal to 100
Chlorophyll-a (seston)	µg/L	less than or equal to 18
Diel dissolved oxygen flux	mg/L	less than or equal to 3.5
Biochemical oxygen demand (BOD_5)	mg/L	less than or equal to 2.0

South River Nutrient Region

Phosphorus, total	µg/L	less than or equal to 150
Chlorophyll-a (seston)	µg/L	less than or equal to 40
Diel dissolved oxygen flux	mg/L	less than or equal to 5.0
Biochemical oxygen demand (BOD_5)	mg/L	less than or equal to 3.5

Site-specific standards for specified river reaches or other waters are:

Mississippi River Navigational Pool 1 (river miles 854.1 to 847.7 reach from Fridley to Ford Dam in St. Paul)

Phosphorus, total	µg/L	less than or equal to 100
Chlorophyll-a (seston)	µg/L	less than or equal to 35

Mississippi River Navigational Pool 2 (river miles 847.7 to 815.2 reach from Ford Dam to Hastings Dam)

Phosphorus, total	µg/L	less than or equal to 125
Chlorophyll-a (seston)	µg/L	less than or equal to 35

Mississippi River Navigational Pool 3 (river miles 815.2 to 796.9 reach from Hastings Dam to Red Wing Dam)

Phosphorus, total	µg/L	less than or equal to 100
Chlorophyll-a (seston)	µg/L	less than or equal to 35

Mississippi River Navigational Pool 4 (river miles 796.9 to 752.8 reach from Red Wing Dam to Alma Dam). Lake Pepin occupies majority of Pool 4 and Lake Pepin site-specific standards are used for this pool.

Mississippi River Navigational Pools 5 to 8 (river miles 752.8 to 679.1 Alma Dam to Genoa Dam)

Phosphorus, total	µg/L	less than or equal to 100
Chlorophyll-a (seston)	µg/L	less than or equal to 35

Lake Pepin

Phosphorus, total	µg/L	less than or equal to 100
Chlorophyll-a (seston)	µg/L	less than or equal to 28

Crow Wing River from confluence of Long Prairie River to the mouth of the Crow Wing River at the Mississippi River

Phosphorus, total	µg/L	less than or equal to 75
Chlorophyll-a (seston)	µg/L	less than or equal to 13
Diel dissolved oxygen flux	mg/L	less than or equal to 3.5
Biochemical oxygen demand (BOD_5)	mg/L	less than or equal to 1.7

Crow River from the confluence of the North Fork of the Crow River and South Fork of the Crow River to the mouth of the Crow River at the Mississippi River

Phosphorus, total	µg/L	less than or equal to 125
Chlorophyll-a (seston)	µg/L	less than or equal to 27
Diel dissolved oxygen flux	mg/L	less than or equal to 4.0
Biochemical oxygen demand (BOD_5)	mg/L	less than or equal to 2.5

Additional narrative eutrophication standards for class 2B rivers and streams are found in subpart 4b.

Substance, Characteristic, or Pollutant (Class 2B)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Fluoranthene	µg/L	1.9	Tox	3.5	6.9	Tox
Heptachlor (c)	ng/L	0.39	HH	260*	520*	Tox
Heptachlor epoxide (c)	ng/L	0.48	HH	270*	530*	Tox
Hexachlorobenzene (c)	ng/L	0.24	HH	--*	--*	Tox
Lead, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS in µg/L shall not exceed: exp.(1.273[ln(total hardness mg/L)]-4.705)

The MS in µg/L shall not exceed: exp.(1.273[ln(total hardness mg/L)]-1.460)

The FAV in µg/L shall not exceed: exp.(1.273[ln(total hardness mg/L)]-0.7643)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total lead standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Lead, total					
CS µg/L	1.3	3.2	7.7	13	19

MS µg/L	34	82	197	331	477
FAV µg/L	68	164	396	663	956

Substance, Characteristic, or Pollutant (Class 2B)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Lindane (c) (Hexachlorocyclobenzene, gamma-)	µg/L	0.036	HH	4.4*	8.8*	Tox
Mercury, total in water	ng/L	6.9	HH	2,400*	4,900*	Tox
Mercury, total in edible fish tissue	mg/kg ppm	0.2	HH	NA	NA	NA
Methylene chloride (c) (Dichloromethane)	µg/L	1,940	HH	13,875	27,749	Tox
Metolachlor	µg/L	23	Tox	271	543	Tox
Naphthalene	µg/L	81	Tox	409	818	Tox
Nickel, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS in µg/L shall not exceed: exp.(0.846[ln(total hardness mg/L)]+1.1645)

The MS in µg/L shall not exceed: exp.(0.846[ln(total hardness mg/L)]+3.3612)

The FAV in µg/L shall not exceed: exp.(0.846[ln(total hardness mg/l)]+4.0543)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total nickel standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Nickel, total					
CS µg/L	88	158	283	399	509

MS µg/L	789	1,418	2,549	3,592	4,582
FAV µg/L	1,578	2,836	5,098	7,185	9,164

Substance, Characteristic, or Pollutant (Class 2B)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Oil	µg/l	500	NA	5,000	10,000	NA
Oxygen, dissolved	mg/L	See below	NA	--	--	NA

5.0 mg/L as a daily minimum. This dissolved oxygen standard may be modified on a site-specific basis according to part 7050.0220, subpart 7, except that no site-specific standard shall be less than 5 mg/L as a daily average and 4 mg/L as a daily minimum. Compliance with this standard is required 50 percent of the days at which the flow of the receiving water is equal to the $7Q_{10}$. This standard applies to all class 2B waters except for:

(1) those portions of the Mississippi River from the outlet of the Metro Wastewater Treatment Works in Saint Paul (River Mile 835) to Lock and Dam No. 2 at Hastings (River Mile 815). For this reach of the Mississippi River, the standard is not less than 5 mg/L as a daily average from April 1 through November 30, and not less than 4 mg/L at other times; and

(2) the portion of the Minnesota River from the outlet of the Blue Lake wastewater treatment works (River Mile 21) to the mouth at Fort Snelling. For the specified reach of the Minnesota River, the standard is not less than 5 mg/L as a daily average year round.

Parathion	µg/L	0.013	Tox	0.07	0.13	Tox
Pentachlorophenol	µg/L	equation	Tox/HH	equation	equation	Tox

The CS, MS, and FAV vary with pH and are calculated using the following equations:

For waters with pH values greater than 6.95, the CS shall not exceed the human health-based standard of 5.5 µg/L.

For waters with pH values less than 6.96, the CS in µg/L shall not exceed the toxicity-based standard of exp.(1.005[pH]-5.290)

The MS in µg/L shall not exceed: exp.(1.005[pH]-4.830)

The FAV in µg/L shall not exceed: exp.(1.005[pH]-4.1373)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For pH values less than 6.0, 6.0 shall be used to calculate the standard and for pH values greater than 9.0, 9.0 shall be used to calculate the standard.

Example of pentachlorophenol standards for five pH values:

pH su	6.5	7.0	7.5	8.0	8.5
Pentachlorophenol					
CS µg/L	3.5	5.5	5.5	5.5	5.5
MS µg/L	5.5	9.1	15	25	41
FAV µg/L	11	18	30	50	82

Substance, Characteristic, or Pollutant (Class 2B)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
pH, minimum	su	6.5	NA	--	--	NA
pH, maximum	su	9.0	NA	--	--	NA
Phenanthrene	µg/L	3.6	Tox	32	64	Tox
Phenol	µg/L	123	Tox	2,214	4,428	Tox
Polychlorinated biphenyls, total (c)	ng/L	0.029	HH	1,000*	2,000*	Tox
Radioactive materials	NA	See below	NA	See below	See below	NA

Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as permitted by the appropriate authority having control over their use.

Selenium, total	µg/L	5.0	Tox	20	40	Tox
Silver, total	µg/L	1.0	Tox	equation	equation	Tox

The MS and FAV vary with total hardness and are calculated using the following equations:

The MS in µg/L shall not exceed: exp.(1.720[ln(total hardness mg/L)]-7.2156)

The FAV in µg/L shall not exceed: exp.(1.720[ln(total hardness mg/L)]-6.520

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total silver standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Silver, total					
CS µg/L	1.0	1.0	1.0	1.0	1.0
MS µg/L	1.0	2.0	6.7	13	22
FAV µg/L	1.2	4.1	13	27	44

Substance, Characteristic, or Pollutant (Class 2B)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Temperature	°F	See below	NA	--	--	NA

5°F above natural in streams and 3°F above natural in lakes, based on monthly average of the maximum daily temperatures, except in no case shall it exceed the daily average temperature of 86°F.

1,1,2,2-Tetrachloroethane (c)	µg/L	13	HH	1,127	2,253	Tox
Tetrachloroethylene (c)	µg/L	8.9	HH	428	857	Tox
Thallium, total	µg/L	0.56	HH	64	128	Tox
Toluene	µg/L	253	Tox	1,352	2,703	Tox
Toxaphene (c)	ng/L	1.3	HH	730*	1,500*	Tox
1,1,1-Trichloroethane	µg/L	329	Tox	2,957	5,913	Tox
1,1,2-Trichloroethylene (c)	µg/L	120	HH	6,988	13,976	Tox
2,4,6-Trichlorophenol	µg/L	2.0	HH	102	203	Tox

Total suspended solids (TSS)

North River Nutrient Region	mg/L	15	NA	--	--	NA
Central River Nutrient Region	mg/L	30	NA	--	--	NA
South River Nutrient Region	mg/L	65	NA	--	--	NA
Red River mainstem - headwaters to border	mg/L	100	NA	--	--	NA
TSS standards for the class 2B North, Central, and South River Nutrient Regions and the Red River mainstem may be exceeded for no more than ten percent of the time. This standard applies April 1 through September 30						
Total suspended solids (TSS), summer average						
Lower Mississippi River mainstem - Pools 2 through 4	mg/L	32	NA	--	--	NA
Lower Mississippi River mainstem below Lake Pepin	mg/L	30	NA	--	--	NA
TSS standards for the class 2B Lower Mississippi River may be exceeded for no more than 50 percent of the time. This standard applies June 1 through September 30						

Substance, Characteristic, or Pollutant (Class 2B)	**Units**	**CS**	**Basis for CS**	**MS**	**FAV**	**Basis for MS, FAV**
Vinyl chloride (c)	µg/L	9.2	HH	--*	--*	NA
Xylene, total m,p,o	µg/L	166	Tox	1,407	2,814	Tox
Zinc, total	µg/L	equation	Tox	equation	equation	Tox

The CS, MS, and FAV vary with total hardness and are calculated using the following equations:

The CS in μg/L shall not exceed: exp.(0.8473[ln(total hardness mg/L)]+0.7615)

The MS in μg/L shall not exceed: exp.(0.8473[ln(total hardness mg/L)]+0.8604)

The FAV in μg/L shall not exceed: exp.(0.8473[ln(total hardness mg/L)]+1.5536)

Where: exp. is the natural antilogarithm (base e) of the expression in parenthesis.

For hardness values greater than 400 mg/L, 400 mg/L shall be used to calculate the standard.

Example of total zinc standards for five total hardness values:

TH in mg/L	50	100	200	300	400
Zinc, total					
CS μg/L	59	106	191	269	343
MS μg/L	65	117	211	297	379
FAV μg/L	130	234	421	594	758

Subp. 4a. **Narrative eutrophication standards for class 2B lakes, shallow lakes, and reservoirs.**

A. Eutrophication standards applicable to lakes, shallow lakes, and reservoirs that lie on the border between two ecoregions or that are in the Red River Valley (also referred to as Lake Agassiz Plains), Northern Minnesota Wetlands, or Driftless Area Ecoregion must be applied on a case-by-case basis. The commissioner shall use the standards applicable to adjacent ecoregions as a guide.

B. Eutrophication standards are compared to summer-average data. Exceedance of the total phosphorus and either the chlorophyll-a or Secchi disk transparency standard is required to indicate a polluted condition.

C. It is the policy of the agency to protect all lakes, shallow lakes, and reservoirs from the undesirable effects of cultural eutrophication. Lakes, shallow lakes, and reservoirs with a baseline quality better than the numeric eutrophication standards in subpart 4 must be maintained in that condition through the strict application of all relevant federal, state, and local requirements governing antidegradation, the discharge of nutrients from point and nonpoint sources, and the protection of lake, shallow lake, and reservoir resources, including, but not limited to:

(1) the antidegradation requirements in parts 7050.0250 to 7050.0335;

(2) the phosphorus effluent limits for point sources, where applicable in chapter 7053;

(3) the requirements for feedlots in chapter 7020;

(4) the requirements for individual sewage treatment systems in chapter 7080;

(5) the requirements for control of stormwater in chapter 7090;

(6) county shoreland ordinances; and

(7) implementation of mandatory and voluntary best management practices to minimize point and nonpoint sources of nutrients.

D. Lakes, shallow lakes, and reservoirs with a baseline quality that is poorer than the numeric eutrophication standards in subpart 4 must be considered to be in compliance with the standards if the baseline quality is the result of natural causes. The commissioner shall determine baseline quality and compliance with these standards using data and the procedures in part 7050.0150, subpart 5.

E. When applied to reservoirs, the eutrophication standards in this subpart and subpart 4 may be modified on a site-specific basis to account for characteristics of reservoirs that can affect trophic status, such as water temperature, variations in hydraulic residence time, watershed size, and the fact that reservoirs may receive drainage from more than one ecoregion. Information supporting a site-specific standard can be provided by the commissioner or by any person outside the agency. The commissioner shall evaluate all data in support of a modified standard and determine whether a change in the standard for a specific reservoir is justified. Any total phosphorus effluent limit determined to be necessary based on a modified standard shall only be required after the discharger has been given notice of the specific proposed effluent limits and an opportunity to request a hearing as provided in part 7000.1800.

Subp. 4b. **Narrative eutrophication standards for class 2B rivers and streams.**

A. Eutrophication standards for rivers and streams are compared to summer-average data or as specified in subpart 4. Exceedance of the total phosphorus levels and chlorophyll-a (seston), five-day biochemical oxygen demand (BOD_5), diel dissolved oxygen flux, or pH levels is required to indicate a polluted condition.

B. Rivers and streams that exceed the phosphorus levels but do not exceed the chlorophyll-a (seston), five-day biochemical oxygen demand (BOD_5), diel dissolved oxygen flux, or pH levels meet the eutrophication standard.

C. A polluted condition also exists when the chlorophyll-a (periphyton) concentration exceeds 150 mg/m^2 more than one year in ten

D. It is the policy of the agency to protect all rivers, streams, and navigational pools from the undesirable effects of cultural eutrophication. Rivers, streams, and navigational pools with a baseline quality better than the numeric eutrophication standards in subpart 4 must be maintained in that condition through the strict application of all relevant federal, state, and local requirements governing antidegradation, the discharge of nutrients from point and nonpoint sources, including:

(1) the antidegradation requirements in parts 7050.0250 to 7050.0335;

(2) the phosphorus effluent limits for point sources, where applicable in chapter 7053;

(3) the requirements for feedlots in chapter 7020;

(4) the requirements for individual sewage treatment systems in chapter 7080;

(5) the requirements for control of stormwater in chapter 7090;

(6) county shoreland ordinances; and

(7) implementation of mandatory and voluntary best management practices to minimize point and nonpoint sources of nutrients.

E. Rivers, streams, and navigational pools with a baseline quality that does not meet the numeric eutrophication standards in subpart 4 are in compliance with the standards if the baseline quality is the result of natural causes. The commissioner must determine baseline quality and compliance with these standards using data and the procedures in part 7050.0150, subpart 5.

Subp. 4c. **Beneficial use definitions for lotic warm or cool water aquatic life and habitats (class 2B).**

A. Subitems (1) to (5) apply to the beneficial uses in items B to D:

(1) The designation and attainment of beneficial uses are based on the criteria in subpart 4d.

(2) The attributes of species composition, diversity, and functional organization are measured using:

(a) the fish IBI as defined in Fish Data Collection Protocols for Lotic Waters in Minnesota (2017); or

(b) the macroinvertebrate IBI as defined in Macroinvertebrate Data Collection Protocols for Lotic Waters in Minnesota (2017).

(3) Water body types for streams and rivers are defined in the documents referenced in subitem (2).

(4) The following documents are incorporated by reference and are not subject to frequent change:

(a) Calibration of the Biological Condition Gradient for Streams of Minnesota, Gerritsen et al. (2012). The document is available on the agency's website at www.pca.state.mn.us/regulations/minnesota-rulemaking;

(b) Fish Data Collection Protocols for Lotic Waters in Minnesota, Minnesota Pollution Control Agency (2017). The document is available on the agency's website at www.pca.state.mn.us/regulations/minnesota-rulemaking;

(c) Macroinvertebrate Data Collection Protocols for Lotic Waters in Minnesota, Minnesota Pollution Control Agency (2017). The document is available on the agency's website at www.pca.state.mn.us/regulations/minnesota-rulemaking; and

(d) Development of Biological Criteria for Tiered Aquatic Life Uses, Minnesota Pollution Control Agency (2016). The document is available on the agency's website at www.pca.state.mn.us/regulations/minnesota-rulemaking.

(5) The beneficial use subclass designators "e," "g," and "m" are added to the class 2B designator as specific additional designators. The additional subclass designators do not replace the class 2B designator. All requirements for class 2B warm or cool water stream and river habitats in parts 7050.0222 and 7052.0100 continue to apply in addition to requirements for class 2Be, class 2Bg, or class 2Bm warm or cool water stream and river habitats in part 7050.0222. These subclass designators are applied to lotic waters only.

B. "Exceptional cool and warm water aquatic life and habitat" or "class 2Be" is a beneficial use that means waters capable of supporting and maintaining an exceptional and balanced, integrated, adaptive community of warm or cool water aquatic organisms having a species composition, diversity, and functional organization comparable to the 75th percentile of biological condition gradient level 3 as established in Calibration of the Biological Condition Gradient for Streams of Minnesota, Gerritsen et al. (2012).

C. "General cool and warm water aquatic life and habitat" or "class 2Bg" is a beneficial use that means waters capable of supporting and maintaining a balanced, integrated, adaptive community of warm or cool water aquatic organisms having a species composition, diversity, and functional organization comparable to the median of biological condition gradient level 4 as established in Calibration of the Biological Condition Gradient for Streams of Minnesota, Gerritsen et al. (2012).

D. "Modified cool and warm water aquatic life and habitat" or "class 2Bm" is a beneficial use that means waters capable of supporting and maintaining a balanced, integrated, adaptive community of warm or cool water aquatic organisms having a species composition, diversity, and functional organization comparable to the median of biological condition gradient level 5 as established in Calibration of the Biological Condition Gradient for Streams of Minnesota, Gerritsen et al. (2012).

(1) To meet the definition in this item, waters must have been the subject of a use attainability analysis where it is determined that attainment of the class 2Bg beneficial use is not feasible because of human-induced modifications of the physical habitat. These modifications must be the result of direct alteration to the channel, such as drainageway maintenance, bank stabilization, and impoundments.

(2) Examples of class 2Bm waters are the stream channel modification activities regulated under:

(a) sections 401 and 404 of the Clean Water Act; or

(b) Minnesota Statutes, chapter 103E.

Subp. 4d. **Biological criteria for lotic warm or cool water aquatic life and habitats (class 2B).**

Water Body Type	Tier	Class	Assemblage	Biocriterion
Southern rivers	Exceptional	2Be	Fish	71
	General	2Bg	Fish	49
Southern streams	Exceptional	2Be	Fish	66
	General	2Bg	Fish	50
	Modified	2Bm	Fish	35
Southern headwaters	Exceptional	2Be	Fish	74
	General	2Bg	Fish	55
	Modified	2Bm	Fish	33
Northern rivers	Exceptional	2Be	Fish	67
	General	2Bg	Fish	38
Northern streams	Exceptional	2Be	Fish	61
	General	2Bg	Fish	47
	Modified	2Bm	Fish	35
Northern headwaters	Exceptional	2Be	Fish	68
	General	2Bg	Fish	42
	Modified	2Bm	Fish	23
Low gradient	Exceptional	2Be	Fish	70
	General	2Bg	Fish	42
	Modified	2Bm	Fish	15
Northern forest rivers	Exceptional	2Be	Macroinvertebrates	77
	General	2Bg	Macroinvertebrates	49
Prairie and southern forest rivers	Exceptional	2Be	Macroinvertebrates	63
	General	2Bg	Macroinvertebrates	31

High-gradient northern forest streams	Exceptional	2Be	Macroinvertebrates	82
	General	2Bg	Macroinvertebrates	53
Low-gradient northern forest streams	Exceptional	2Be	Macroinvertebrates	76
	General	2Bg	Macroinvertebrates	51
	Modified	2Bm	Macroinvertebrates	37
High-gradient southern streams	Exceptional	2Be	Macroinvertebrates	62
	General	2Bg	Macroinvertebrates	37
	Modified	2Bm	Macroinvertebrates	24
Low-gradient southern forest streams	Exceptional	2Be	Macroinvertebrates	66
	General	2Bg	Macroinvertebrates	43
	Modified	2Bm	Macroinvertebrates	30
Low-gradient prairie streams	Exceptional	2Be	Macroinvertebrates	69
	General	2Bg	Macroinvertebrates	41
	Modified	2Bm	Macroinvertebrates	22

The biological criteria for lotic warm or cool water aquatic life and habitats (class 2B) are applicable to perennial and intermittent waters that allow for colonization of fish or macroinvertebrates.

Subp. 5. [Repealed, 42 SR 441]

Subp. 6. **Class 2D waters; wetlands.**

A. The quality of class 2D wetlands shall be such as to permit propagation and maintenance of a healthy community of aquatic and terrestrial species indigenous to wetlands, and their habitats. Wetlands also add to the biological diversity of the landscape. These waters shall be suitable for boating and other forms of aquatic recreation for which the wetland may be usable. The standards for class 2B waters listed under subpart 4 shall apply to these waters except as listed below:

Substance, Characteristic, or Pollutant	Class 2D standard
Oxygen, dissolved	If background is less than 5.0 mg/L as a daily minimum, maintain background
pH	Maintain background

Temperature	Maintain background
Chloride (Cl)	If background is greater than the class 2B chloride standard, maintain background
Settleable solids	Must not be allowed in concentrations sufficient to create significant adverse impacts on aquatic life

B. "Maintain background," as used in this subpart, means the concentration of the water quality substances, characteristics, or pollutants shall not deviate from the range of natural background concentrations or conditions such that there is a potential significant adverse impact to the designated uses.

C. Activities in wetlands which involve the normal farm practices of planting with annually seeded crops or the utilization of a crop rotation seeding of pasture grasses or legumes, including the recommended applications of fertilizer and pesticides, are excluded from the standards in this subpart and the wetland standards in item A and parts 7050.0225, subpart 2, and 7050.0227. All other activities in these wetlands must meet water quality standards.

Subp. 7. **Additional standards; class 2 waters.** The following additional standards and requirements apply to all class 2 waters.

A. No sewage, industrial waste, or other wastes from point or nonpoint sources shall be discharged into any of the waters of this category so as to cause any material change in any other substances, characteristics, or pollutants which may impair the quality of the waters of the state or the aquatic biota of any of the classes in subparts 2 to 6 or in any manner render them unsuitable or objectionable for fishing, fish culture, or recreational uses. Additional selective limits or changes in the discharge bases may be imposed on the basis of local needs.

B. To prevent acutely toxic conditions, concentrations of toxic pollutants from point or nonpoint sources must not exceed the FAV as a one-day average at the point of discharge or in the surface water consistent with parts 7050.0210, subpart 5, item D; 7053.0215, subpart 1; 7053.0225, subpart 6; and 7053.0245, subpart 1.

If a discharge is composed of a mixture of more than one chemical, and the chemicals have the same mode of toxic action, the commissioner has the option to apply an additive model to determine the toxicity of the mixture using the following equation:

$$\frac{C_1}{FAV_1} + \frac{C_2}{FAV_2} + \ldots\ldots + \frac{C_n}{FAV_n}$$ equals a value of one or more, an acutely toxic condition if indicated

where: C_1 .... C_n is the concentration of the first to the n^{th} toxicant.

FAV_1 .... FAV_n is the FAV for the first to the n^{th} toxicant.

C. To prevent chronically toxic conditions, concentrations of toxic pollutants must not exceed the applicable CS or CC and MS or MC in surface waters outside allowable mixing zones as described in part 7050.0210, subpart 5. The CS or CC and MS or MC will be averaged over the following durations: the MS or MC will be a one-day average; the CS or CC, based on toxicity to aquatic life, will be a four-day average; and the CS or CC, based on human health and applied in water or wildlife toxicity, will be a 30-day average.

D. Concentrations of noncarcinogenic or nonlinear carcinogenic (NLC) chemicals in water or fish tissue from point or nonpoint sources, singly or in mixtures, must be below levels expected to produce known adverse effects. This is accomplished through the application of an additive noncancer health risk index using common health risk index endpoints or health endpoints. Mixtures of chemicals with listed CS or site-specific CC are evaluated using the following approach:

Chemicals must be grouped according to medium (water or fish) and each health endpoint. Chemicals for which no health endpoint is specified are not grouped. Chemicals that are also linear carcinogens must be grouped as described under item E. Using the following equation, a noncancer health risk index must be determined for each group of two or more chemicals that have a common health endpoint listed in this part. To meet the protection objectives in part 7050.0217, the noncancer health risk index must not exceed a value of one.

$$\text{Noncancer health risk index by common health endpoint} = \frac{C_1}{CS_1 \text{ or } CC_1} + \frac{C_2}{CS_2 \text{ or } CC_2} + \ldots + \frac{C_n}{CS_n \text{ or } CC_n} \leq 1$$

where: C_n is the concentration of the first to the n^{th} chemical by common health endpoint and medium

$CS_1 \ldots CS_n$ is the drinking water plus fish consumption and recreation chronic standard (CS_{dfr} or CS_{dev}), fish consumption and recreation chronic standard (CS_{fr}), or fish tissue chronic standard (CS_{ft}) for the first to n^{th} chemical by common health endpoint

$CC_1 \ldots CC_n$ is the drinking water plus fish consumption and recreation chronic criterion (CC_{dfr} or CC_{dev}), fish consumption and recreation chronic criterion (CC_{fr}), or fish tissue chronic criterion (CC_{ft}) for the first to n^{th} chemical by common health endpoint

E. Concentrations of carcinogenic chemicals from point or nonpoint sources, singly or in mixtures, must not exceed an incremental or additional excess risk level of one in 100,000 (10^{-5}) in surface waters or fish tissue. Carcinogenic chemicals will be considered additive in their effect according to the following equation unless an alternative model is supported by available scientific evidence. The additive equation applies to chemicals that have a human health-based chronic standard (CS) or site-specific chronic criterion (CC) calculated with a cancer potency slope factor. To meet the protection objectives in part 7050.0217, the cancer health risk index must not exceed a value of one.

$$\text{Cancer health risk index} = \frac{C_1}{CS_1 \text{ or } CC_1} + \frac{C_2}{CS_2 \text{ or } CC_2} + \ldots + \frac{C_n}{CS_n \text{ or } CC_n} \leq 1$$

where: C_1 .... C_n is the concentration of the first to the n^{th} carcinogen in water or fish tissue

CS_1 ... CS_n is the drinking water plus fish consumption and recreation chronic standard (CS_{dfr}), fish consumption and recreation chronic standard (CS_{fr}), or fish tissue chronic standard (CS_{ft}) for the first to n^{th} carcinogenic chemical

CC_1 .... CC_n is the drinking water plus fish consumption and recreation chronic criterion (CC_{dfr}) fish consumption and recreation chronic criterion (CC_{fr}), or fish tissue chronic criterion (CC_{ft}) for the first to n^{th} carcinogenic chemical

F. When monitoring indicates that chemical breakdown products or environmental degradates are present in surface water or fish tissue, those products must be considered when meeting the objectives for toxic pollutants in part 7050.0217. When no human health-based CS or other MDH health-based guidance is available for the chemical breakdown product, the CS or CC for the parent chemical must be applied for that product. The parent CS or CC must also be applied to evaluate mixtures of chemicals.

G. This item applies to maximum standards (MS), final acute values (FAV), and double dashes (--) in this part and part 7050.0220 marked with an asterisk (*). For carcinogenic or highly bioaccumulative chemicals with BCFs greater than 5,000 or log K_{ow} values greater than 5.19, the human health-based chronic standard (CS) may be two or more orders of magnitude smaller than the acute toxicity-based MS.

If the ratio of the MS to the CS is greater than 100, the CS times 100 must be substituted for the applicable MS, and the CS times 200 must be substituted for the applicable FAV. Any effluent limit derived using the procedures of this item must only be required after the discharger has been given notice of the specific proposed effluent limits and an opportunity to request a hearing as provided in part 7000.1800.

Subp. 8. [Repealed, 32 SR 1699]

Subp. 9. **Conversion factors for dissolved metal standards.**

Metal	Conversion Factor for CS	Conversion Factor for MS and FAV
Cadmium	0.909 1.1017-[(ln TH, mg/L) (0.0418)]	0.946 1.1367-[(ln TH, mg/L) (0.0418)]
Chromium +3	0.860	0.316
Chromium +6	0.962	0.982

Copper	0.960	0.960
Lead	0.791 1.4620-[(ln TH, mg/L) (0.1457)]	0.791 1.4620-[(ln TH, mg/L) (0.1457)]
Mercury	1.0	0.850
Nickel	0.997	0.998
Silver	0.850	0.850
Zinc	0.986	0.978

Conversion factors for cadmium and lead are hardness (TH) dependent. The factors shown in the table above are for a total hardness of 100 mg/L only. Conversion factors for cadmium and lead for other hardness values shall be calculated using the equations included in the table. The dissolved standard is the total standard times the conversion factor.

Statutory Authority: *MS s 14.06; 115.03; 115.44; 116.07*

History: *18 SR 2195; 19 SR 1310; 24 SR 1105; 27 SR 1217; 32 SR 1699; 39 SR 154; 39 SR 1344; 18 SR 2195; 19 SR 1310; 24 SR 1105; 27 SR 1217; 32 SR 1699; 39 SR 154; 39 SR 1344; 41 SR 545; 18 SR 2195; 19 SR 1310; 24 SR 1105; 27 SR 1217; 32 SR 1699; 39 SR 154; 39 SR 1344; 41 SR 545; 42 SR 441; 46 SR 5*

Published Electronically: *July 20, 2023*

Sam Duerksen

Summit lake in Jackson county near Windom, MN needs to be at least added to the impaired list but should be on the list to be tested. This lake has been turned into a green cesspool from ice out to December. I contacted the MPCA in Marshall to have this lake added, that was two years ago. This lake is being destroyed by a feedlot that drains into it. You need to look at this lake and at least acknowledge what you're letting happen.

Justin Johnson

Summit lake, cottonwood county mn, this water stays green year round, its not safe for anything

Tracy Whitney

Conservation Minnesota submits this letter and petition on behalf of 404 members across Minnesota who want the MPCA to prioritize measurable pollution reductions in its clean water funding decisions. This year's draft list of impaired waters shows too many lakes, rivers, and streams remain too polluted to safely swim in, fish from, or drink from. We're encouraged by the agency's proposal to remove 45 impairments from the list — the most removals in a single two-year cycle since the program began in 1992 — which shows that investment in clean water works. At the same time, 46 new bodies of water were added to the impaired list this year, and hundreds more remain impaired by sediment, nutrients, mercury, and other contaminants. Our members, representing communities from Minneapolis and Saint Paul to Duluth, Rochester, Bemidji, and dozens of towns across the state, signed on to the following statement:

"I support the MPCA prioritizing real, measurable pollution reductions so all Minnesotans can safely swim, fish, and drink clean water."

We urge the agency to direct clean water funding toward projects that demonstrably reduce pollution. The full letter and list of signers is attached.

CONSERVATION MINNESOTA

July 21, 2026

Minnesota Pollution Control Agency
520 Lafayette Road N
Saint Paul, MN 55155

Pollution Control Agency,

Minnesota is the Land of 10,000 Lakes—but as we can see from this year's draft list of impaired waters, too many of those lakes, rivers, and streams are too polluted to swim in, fish from, or drink from safely.

We celebrate the progress evident in your proposal to remove 45 impairments from the list—marking the most removals in a single two-year cycle since the program's inception in 1992. It's clear that when we invest in clean water, it works.

But with 46 new bodies of water added to the impaired list this year—and hundreds more remaining impaired by pollution from sediment, nutrients, mercury, and other contaminants—it is critical that Minnesota's clean water funds are put toward projects that demonstrably reduce pollution.

At Conservation Minnesota, we work to protect the people and places Minnesotans love from pollution. An integral part of that work is making sure Minnesota's waters are clean enough for everyone to safely enjoy.

We have collected 404 signatures from our members across the state who want to urge you to prioritize measurable pollution reductions and direct clean water funding to on-the-ground projects that restore our lakes and rivers.

Members have signed on with this statement:

> "I support the MPCA prioritizing real, measurable pollution reductions so all Minnesotans can safely swim, fish, and drink clean water."

Thank you for your consideration,

Nels Paulsen
Policy Director, Conservation Minnesota

Petition Signers

1. Kent Hering, Bemidji
2. Bruce Nicklay, Winona
3. Tracy Whitney, Deephaven
4. Beth Stanford, Winona
5. Jessica Roeder, Duluth
6. Michele Flatau, Duluth
7. Lloyd Schallberg, Duluth
8. William Munson, Saint Paul
9. Joanne Sieck, Rochester
10. Dawn Daehn, Rochester
11. Suzanne Ramthun, Rochester
12. Barry Knapp, Rochester
13. Pamela Jo Pietz, Saint Cloud
14. George Schoephoerster, Saint Cloud
15. Lynn C. Lang, Saint Cloud
16. Keith Hanson, Rochester
17. Joe Chovan, Saint Cloud
18. Amy Sykes, Forest Lake
19. Michael Overend, Cohasset
20. Gabriela Sweet, Saint Paul
21. Lisa Leonard, Minneapolis
22. Steven Oehlerich, Minneapolis
23. Ben Hullander, Shakopee
24. Sharon Lee Schwartz, Stillwater
25. Philip Holtegaard, Lanesboro
26. Gloria Karbo, Minneapolis
27. Alyssa Nash, Saint Paul
28. Maggie Kessell, Saint Paul
29. Corrine Haulotte, Winona
30. William Cedarleaf, Hugo
31. Raymond Bernard, Marine On Saint Croix
32. David Larson, Saint Cloud
33. Mick Jost, Saint Paul
34. Jodie Nelson, White Bear Lake
35. Sheila Dillon, Willmar
36. Rick Priebe, Grand Rapids
37. Gabriela Santiago, Saint Paul
38. Thomas Childs, Babbitt
39. Susan Macpherson, Saint Paul
40. Jan Weber, Saint Paul
41. Alice West, Grand Marais
42. Ryan Baka, Minneapolis
43. Tom Brandes, Plymouth
44. Lori Ekholm, Minneapolis
45. Leon Virden, Minneapolis
46. Patrick Doss-Smith, Albert Lea
47. David Clapper, Duluth
48. Jeanine Smegal, Minneapolis
49. James P Erickson, Saint Paul
50. Ellen Kraft, North Oaks
51. M Jenson, Saint Paul

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Petition Signers (continued)

52 Susan Warner, Paynesville
53 Carol Mertesdorf, Anoka
54 Lauren Kofsky, Minnetonka
55 Julia Vanavery, Ramsey
56 Jim Weigle, Maple Grove
57 Susan Bauer, Saint Paul
58 Alan Epp, Minneapolis
59 Kipling Thacker, Greenwood
60 Lois Nokleby, Hampton
61 Matthew Beckler, Minneapolis
62 Matt Nelson, Saint Paul
63 Anna Paul, Minneapolis
64 Cindy Winters, Mankato
65 Julie Fetch, Champlin
66 Carol Lugg, Woodbury
67 Therese Oconnor, Stewartville
68 Greg Solberg, Roseville
69 Kathy Parkin, Annandale
70 Robert Valente, Lake Elmo
71 Jordan West, Dilworth
72 Brittany Jacobson, Big Lake
73 Marylin Levoir, Minneapolis
74 Nancy Kelly, Minneapolis
75 Harmon Abrahamson, Minneapolis
76 Meagan Wells, Minneapolis
77 Anthony Hirschman, Plymouth
78 Deb Ramirez, Prior Lake
79 Michelle Mcquillen, Chaska
80 Roberta Haskin, Bloomington
81 Susan Lucking, Chaska
82 Lynn Glesne, Miltona
83 John Finazzo, Mound
84 Joan Hughes, Minneapolis
85 Jon Damon, Minneapolis
86 Margaret Beegle, Tucson
87 Jl Charrier, Wayzata
88 Connie Goerke, Maple Grove
89 Anne Clark, Minneapolis
90 Rich Libbey, Grand Rapids
91 Paul Ryals, Stanchfield
92 Dawn Baker, Minneapolis
93 Mark Lex, Scandia
94 Kathryn Glessing, Minneapolis
95 Chuck Addison, Minnetonka
96 Nancy Conger, North Branch
97 Patrick Brueske, Minneapolis
98 Jerome Comeau, Minneapolis
99 Marvin Napgezek, Willmar
100 Elizabeth Spletzer, Minneapolis
101 John Curry, Minneapolis
102 Sue Halligan, Stillwater
103 Myrna Paff, Minneapolis

Petition Signers (continued)

104 Jeanie Lahn, Oro Valley
105 Paul Harris, Moorhead
106 Sandy Strom-Gieseke, Nisswa
107 Susan Benus, Minneapolis
108 Les Gunderson, Perham
109 Gregory Kapphahn, Alexandria
110 Adeline Riha, North Mankato
111 Mandy Senechal, Marine On Saint Croix
112 Donna Lamb, Minneapolis
113 Pam Skinner, Oakdale
114 Susan Chandler, Edina
115 Barbara Ahlstrom, Minneapolis
116 Betsey Porter, Minneapolis
117 Thomas Olmstead, Minneapolis
118 Mark Karstens, Minnetonka
119 Chari Eckmann, Maple Grove
120 John Firkus, Bloomington
121 George Muellner, Minneapolis
122 Susan Wieseler, Burnsville
123 Virginia Huber, Minneapolis
124 Yazmin Gonzalez, Bellflower
125 Barbara Thomborson, Minneapolis
126 Cindy Angerhofer, Circle Pines
127 Laurie Patrick, Hugo
128 John Schmittauer, Millfield
129 Jody Goldstein, Rochester
130 Gretchen Corkrean, Woodbury
131 Stephanie Sarich, Hopkins
132 Mary Texer, Saint Paul
133 Bryan Wyberg, Roseville
134 Kurt Simer, Minneapolis
135 Patrick Keene, Minneapolis
136 Cindy Mcdonald, Hugo
137 Penn Bowen, Mound
138 Kathryn Cox, Jordan
139 Cathy Schuldt, Two Harbors
140 Nina Spelter, Madison
141 Bonnie Fox, Afton
142 River Gordon, Minneapolis
143 Avery Hildebrand, Duluth
144 Staci Revers, Minneapolis
145 Gary Deason, Long Lake
146 David Lien, Colorado Springs
147 Dennis Cuchna, Grand Marais
148 Edward Hubbard, Madison
149 Bruce Hlodnicki, Indianapolis
150 Thomas Mevissen, Andover
151 Tamara Rakow, Rosemount
152 Daniel Erkkila, Duluth
153 Lisa Bey, Stevens Point
154 Dale Anderson, Minneapolis

Petition Signers (continued)

155 Jan Jensen, Minneapolis
156 Barbara Ronningen, Afton
157 Jan Shannon, Hastings
158 Susan Beseke, Maplewood
159 Michelle Horan, Edina
160 Rondi Poderzay, Eveleth
161 Rand Evans, Minneapolis
162 Brian Adams, White Bear Lake
163 Krista Tommerdahl, Circle Pines
164 Stephen La Serra, Stoneham
165 Alena Jorgensen, Temple City
166 Linda Carroll, Spokane
167 Nikki Nafziger, Seattle
168 Susan Thurairatnam, North Olmsted
169 Brenda Johnson, Juneau
170 Lauren Murdock, Santa Barbara
171 Elizabeth Seltzer, Media
172 Lawrence Bogolub, Ely
173 Dianne Hudson, Grand Marais
174 Susan Starr, Oak Grove
175 Kevin Taralseth, Duluth
176 Barbara Green, Minneapolis
177 Chuck Bokinskie, Alexandria
178 Scott Sawyer, Minneapolis
179 Bob Christie, Saint Charles
180 Janice Pray, Alexandria
181 Diane Droeger, Maplewood
182 Don Dainsberg, Eden Prairie
183 Peter Oetliker, Rochester
184 Pierre Lippert, Eagan
185 William Wessinger, Cottage Grove
186 Mary Cousineau, Minneapolis
187 Adam Schwartz-Lowe, Duluth
188 Maren Hackbarth, Zimmerman
189 Steve Poncin, Hastings
190 Holly Ketelsen, Minneapolis
191 Tim Carlson, Andover
192 Darlene Mahowald, Carver
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209 Juliann Rule, Avon
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213 Jean Marquette, Duluth
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216 Kurt Cegielski, Saint Paul
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391 Erich Rutten, Minneapolis
392 Andrea Egbert, Lakeville
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394 Linda Ashland, Minneapolis
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396 Anne S, Saint Paul
397 Cody Fox, Albert Lea
398 Nick S, Hugo
399 Greg Flohaug, Coon Rapids
400 Josh Norman, Saint Paul
401 Lucinda Winter, Minneapolis
402 Jon Rich, Anoka
403 Nancy Graham Rich, Anoka
404 Isabel Istephanous, Saint Paul

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Carrie Clement

Thank you for the opportunity to comment on the MPCA draft 2026 Impaired Waters List (IWL). The Western Lake Superior Sanitary District is submitting comments specifically related to the proposed designation of St. Louis Bay as impaired for sulfates. We appreciate consideration of the comments attached including a formal request to subdivide WID 69-1291-02. The current WID 69-1291-02 should be subdivided into two child WIDs to more appropriately assign the wild rice beneficial use to only the upstream portion where wild rice is present and where habitat suitable for wild rice growth exists.

Resource Renew
The brand of WLSSD

Western Lake Superior Sanitary District
2626 Courtland Street, Duluth, MN 55806
ResourceRenew.com

July 22, 2026

Via Online Public Comment Form

Commissioner Katrina Kessler
Minnesota Pollution Control Agency
520 Lafayette Rd.
Saint Paul, MN 55155-4194

Re: Comments on Impaired Waters List & Request to Subdivide St. Louis Bay into Two Distinct Assessment Units

My name is Carrie Clement and I serve as the Executive Director of the Western Lake Superior Sanitary District (District), publicly known as Resource Renew. The District operates a Water Resource Recovery Facility located in Duluth, MN and serves as the wastewater and solid wastewater authority for the surrounding 530 square mile region. Thank you for the opportunity to comment on the MPCA draft 2026 Impaired Waters List (IWL). The District is submitting comments specifically related to the proposed designation of St. Louis Bay as impaired for sulfates. Wild rice is an important natural resource having spiritual, cultural and agricultural importance and these comments do not detract from protection and restoration efforts. The District's comments are divided into three categories, in order of importance.

Request to Subdivide St. Louis Bay into Two Distinct Assessment Units

While there is documented presence of wild rice in the St. Louis Bay (WID 69-1291-02)[1],(WID) the location of wild rice beds following restoration efforts is limited to Kingsbury Bay and Clough Island, which are both located on the upstream end of the WID. Currently, there is no other identified suitable wild rice bed habitat located within the WID, and there are no documented plans to restore wild rice within the WID aside from Kingsbury Bay and Clough Island, as evidenced by the 1854 Treaty Authority's *St. Louis River Estuary Wild Rice Restoration Monitoring (2015-2025)* report. The *St. Louis*

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[1] It appears that the St. Louis Bay (WID 69-1291-02) has never been formally designated as a "water used for the production of wild rice" pursuant to Minn. R. 7050.0224 or Minn. R. 7050.0470. It is our understanding that it was informally designated as such by MPCA pursuant to the 2024 Assessment Manual. We were not aware of this at the time and therefore did not have an opportunity to review and comment on the informal designation that has led to the proposed impairment listing. As mentioned above, we do not dispute the presence of wild rice in the upstream end of the WID, but it is our understanding that MPCA is generally required to designate beneficial uses via formal rulemaking, which to our knowledge, did not occur in this context. This is another reason to reconsider making an impairment determination now.

River Estuary Manoomin Restoration and Stewardship Plan, updated in 2024[2], acknowledges that "areas with heavy boat traffic may not be suitable as Manoomin restoration sites", which is characteristic of the downstream portion of St. Louis Bay.

The MPCA discusses in the 2026 Assessment Manual that existing WIDs (parent) may need to be subdivided into two or more WIDs (child) and that a waterbody may be divided into two or more WIDs when there is a change in the beneficial use classification. <u>The District formally requests that the MPCA subdivide the current WID into two child WIDs to more appropriately assign the wild rice beneficial use to only the upstream portion where wild rice is present and where habitat suitable for wild rice growth exists.</u> This proposed split also reflects longstanding commercial shipping traffic and shipping corridor management (i.e., dredging, hardened shorelines) in downstream portions of the current WID, which contribute to it being unsuitable as a wild rice habitat. The recommended point of division is the Burlington Northern Santa Fe Railway bridge crossing (i.e., Grassy Point Swing Bridge) as illustrated in Figure 1 below.

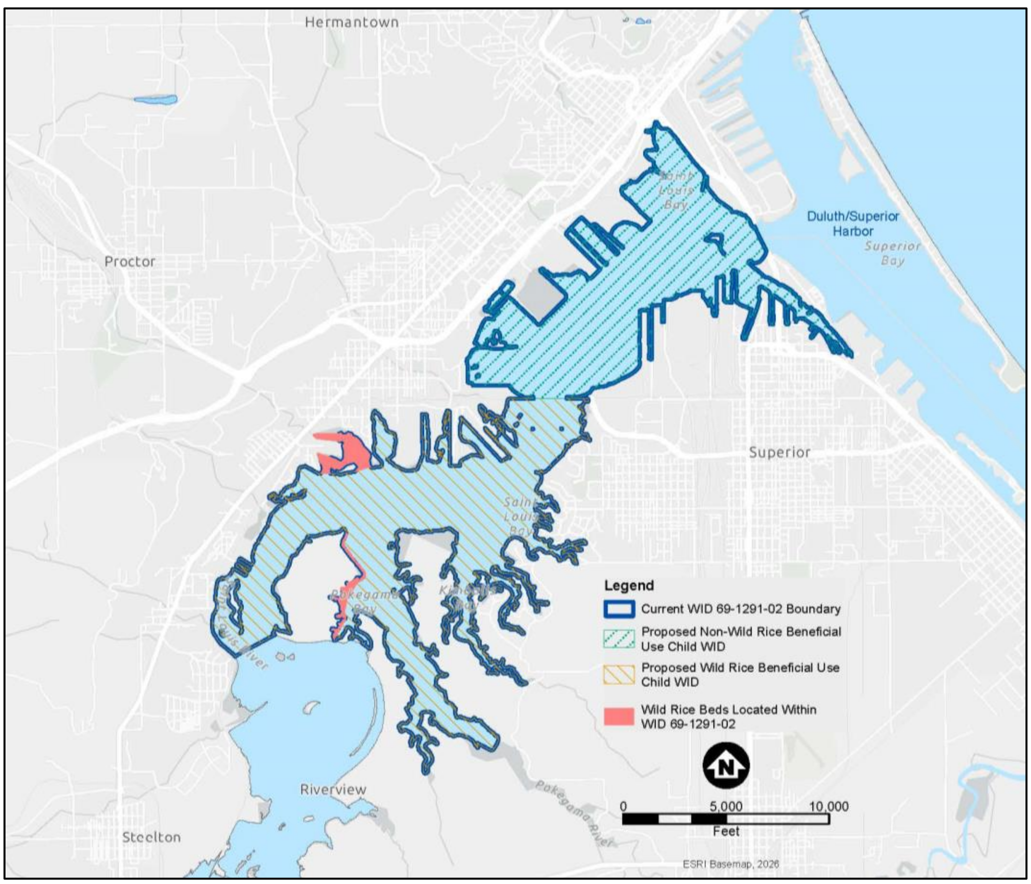

Figure 1 **Recommended Subdivision of WID 69-1291-02 (St. Louis Bay)**

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[2] Wisconsin Department of Natural Resources, S*t. Louis River Estuary Manoomin Restoration and Stewardship Plan*, March 2024, https://dnr.wisconsin.gov/sites/default/files/topic/GreatLakes/St.LouisRiverEstuaryManoominRestorationStewardshipPlan.pdf

The proposed divide protects the existing wild rice beneficial use where it exists and is attainable and honors the designated wild rice restoration areas near Kingsbury Bay and Clough Island without overextending the wild rice beneficial use classification to areas where it does not exist and is likely not attainable due to shoreline modifications and hardening.

Based on the above, we request that, prior to finalizing the impaired waters list, MPCA subdivide the WIDs as described above into two separate child WIDs: one with a wild rice beneficial use, and one without a wild rice beneficial use. After subdividing the WIDs consistent with the above, we request that MPCA revise the impaired waters list and attachment H of the 2026 Assessment Manual to ensure that the new child WID that does not have a designated wild rice beneficial use is not included on the impaired waters list or MPCA lists of water bodies designated as “water used for the production of wild rice.” [3]

Appropriateness of the MPCA Listing St. Louis Bay as Sulfate-Impaired

The proposed subdivision of the WID is justified based on the MPCA’s interpretation of the existing dataset, modeling, and physical characteristics of the St. Louis Bay. In addition, there are questions about the adequacy of the dataset to support an impaired waters designation, even if the WID is not subdivided. To properly assess sulfate concentrations for a potential wild rice production impairment, the 2026 Assessment Manual specifies a dataset of “at least 5 independent observations over the ten most recent years that meet necessary Quality Assurance/Quality Control (QA/QC) requirements and give an unbiased representation of overall conditions throughout the year” (i.e., samples taken during different months across the entire year).

Based on consultation with MPCA staff, the 2025 sulfate assessment that led to the proposed 2026 St. Louis Bay impairment listing was based on the available 2023 historical sulfate data. This data is summarized in the following table.

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[3] If there are concerns regarding the potential migration of sulfate from the proposed downstream child WID into the proposed upstream child WID, the District requests that the MPCA consider the seiche effects modeling results presented to the MPCA in support of its 2022 NPDES/SDS Permit MN0049786 reissuance application. In summary, results from the model simulation using reasonable “worst-case” boundary conditions [i.e., maximum water level fluctuation and low-flow (7Q10) river discharge] indicate that seiche-induced currents are not a factor with respect to potential upstream sulfate migration beyond Grassy Point (i.e., the recommended point of WID division).

WID	Sample Station	Parameter	Sample Date	Analytical Result	Units
69-1291-02	69-1291-02-201	Sulfate, total	6/9/2023	17.1	mg/L
			6/22/2023	22.7	mg/L
			7/13/2023	14.7	mg/L
			8/3/2023	17.2	mg/L
			9/27/2023	24.2	mg/L
			Average	**19.2**	**mg/L**

Based on the provided data, the MPCA met its established minimum dataset of at least five (5) independent observations; however, the dataset only spans four months of a single year, from a single sampling location, and two of the five data points are from the same month (June). This data does not provide a reliable or unbiased representation of conditions over a 10-year period, let alone throughout a single year. The District, requests that the MPCA withdraw its proposed sulfate impairment listing of St. Louis Bay (WID 69-1291-02) until additional data can be collected and evaluated as prescribed in the 2026 Assessment Manual.

This request is also consistent with more recent science related to how, when and in what concentration sulfate negatively impacts wild rice. For example, recent studies show that even when sulfate concentrations were elevated for two consecutive years, wild rice growth and reproduction was not significantly affected by a 100 mg/L sulfate treatment (Pastor et al., 2017). As a result, the current science suggests data from 4 months out of the same year showing that the average sulfate concentrations exceed 10 mg/L is not sufficient to find an impairment to the beneficial use.

Suggesting Development of a Site-Specific Sulfate Water Quality Standard

Separate from the value of subdividing the WID and collecting more data before an impairment designation, St. Louis Bay is a strong candidate for the development of a site-specific sulfate Water Quality Standard. Wild rice within the St. Louis River Estuary was previously in decline but has been increasing in suitable upstream reaches due to restoration efforts. The presence and health of wild rice resulting from ongoing restoration efforts has been rigorously evaluated over the last 10 years by the 1854 Treaty Authority using well-established monitoring methods, including the establishment of dedicated survey points and measuring and recording wild rice density and biomass (including water depth) on a regular basis. Based on successful, documented wild rice restoration efforts over the past 10 years along the St. Louis River Estuary, the current ambient sulfate concentrations in the St. Louis River Estuary (St. Louis Bay (WID 69-1291-02), Spirit Lake (69-1291-03), and the Upper Estuary (69-1291-04)) are protective of the wild rice beneficial use. The District, requests that the MPCA develop a site-specific sulfate standard for the St. Louis Bay (WID 69-1291-02), Spirit Lake (69-1291-03), and the Upper Estuary (69-1291-04).

Importance of a Scientifically Defensible, Practical Approach to Sulfates in St. Louis Bay

Finally, the District notes the high stakes of an impairment designation in an undivided St. Louis Bay. The District's discharges of sulfates are not high as compared to other dischargers around the State, but controlling sulfates down to 10 mg/l would be prohibitively expensive. In 2018, the MPCA conducted an assessment of compliance costs, for an example 10 million gallon day (MGD) facility.[4] Scaling the MPCA's costs estimates to the District's existing 48 MGD discharge would require in the range of $500 million in capital alone, with annual operating costs on the order of $100 million. These are extremely burdensome costs for a publicly-owned facility, and there appears to be no environmental justification for such an expense as explained above.

The District recognizes that costs can be taken into account through the variance process. The District highlights the cost dimension because it is also relevant to the impairment designation decision. Specifically, where the consequences of a sulfate impairment designation would be severe, it is especially important that the decision be based on solid data as to the ambient conditions in the WID, and in relation to wild rice habitat. As discussed, such data are lacking here. The public cost implications of the proposed designation reinforce the advisability of taking one or more of the alternative approaches recommended here.

Thank you for consideration of our comments and requests. We would appreciate the opportunity to meet with MPCA to discuss our comments and requests at the appropriate time.

Sincerely,

Carrie Clement

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[4] MPCA, *Analyzing Alternatives for Sulfate Treatment in Municipal Wastewater* (wq-rule4-15pp), May 2018, https://www.eqb.state.mn.us/sites/eqb/files/documents/MPCA%202018%20Analyzing%20Alternatives%20for%20Sulfate%20Treatment%20in%20Municipal%20Wastewater.%20BOLTON%20MENK.%20BARR.%20wq-rule4-15pp.pdf

Diane Duerksen

Id like to submit Summit Lake in Cottonwood County. In the pic you can see two blue silos. On that location is an old cattle lot that is in use. Its waste runs right into Summit Lake. The lake is always green.

Rob Schilling

Comment letter attached.

sappi

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Via Online Public Comment Form

Commissioner Katrina Kessler
Minnesota Pollution Control Agency
520 Lafayette Rd.
Saint Paul, MN 55155-4194

July 22, 2026

RE: Comments on Impaired Waters List & Request to Subdivide St. Louis Bay into Two Distinct Assessment Units

Sappi Cloquet LLC ("Sappi") submits these comments on the 2026 Draft Impaired Waters List.

Sappi owns and operates a pulp and paper mill in Cloquet, Minnesota, and Sappi comments specifically on the proposed designation of St. Louis Bay as impaired for sulfates. Sappi fully supports and joins the comments filed by the Western Lake Superior Sanitary District (District), publicly known as Resource Renew. Sappi is a significant discharger to the District, and would share in any compliance costs arising from the proposed designation. Sappi further observes that the District has documented procedural defects, data limitations, and other problems with the proposed designation, as well as recommending common sense solutions. In the event the designation proceeds as proposed, Sappi reserves all legal rights.

Thank you for the opportunity to comment on the proposed designation.

Please contact Rob Schilling at 218-879-0638 if you have any questions or comments concerning this issue.

Sincerely,

for JB

Jeffrey Boulden
Managing Director, Cloquet Operations

Chrissy Bartovich

Comment letter attached.

U. S. Steel Corporation
Minnesota Ore Operations
P.O. Box 417
Mt. Iron, MN 55768

July 22, 2026

Minnesota Pollution Control Agency (MPCA)
520 Lafayette Rd N
St. Paul, MN 55155

RE: United States Steel Corporation – Minnesota Ore Operations **Comments on the November 2025 Assessment Guidance Manual for the 2026 305(b) Report and 303(d) Impaired Waters Listing Process**

To Whom it May Concern,

Unites States Steel Corporation (U. S. Steel) appreciates the opportunity to review and comment on the **November 2025 Assessment Guidance Manual: Guidance for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report & 303(d) Impaired Waters List.** We support MPCA's goal of maintaining a transparent, scientifically defensible, and consistent assessment process. After reviewing the Guidance Manual, U. S. Steel has several concerns regarding the transparency, consistency of assessment methodologies, and implementation of the sulfate standard for waters identified as supporting wild rice. The comments and requests are summarized in Attachment A.

U. S. Steel respectfully requests that MPCA address the concerns identified below and revise the Guidance Manual to provide clearer criteria, improved public access to data, and a more transparent framework for future wild rice water designations and sulfate impairment determinations.
Thank you for consideration of these comments.

If you need any additional information, please contact me at clbartovich@uss.com or 218-749-7364.

Sincerely,

Chrissy Bartovich
Sr. Director - Environmental
Minnesota Ore Operations
United States Steel Corporation

Attachment A – Comments

General Comment Regarding Impaired Waters Listings and TMDL Prioritization

First, Minnesota Rules part 7050.0470 designates 24 waters as wild rice waters. In 2017, MPCA proposed rule amendments that included a list of approximately 1,300 waters that were proposed to be designated for a wild rice beneficial use. Those amendments were subsequently withdrawn.

MPCA must undergo formal rulemaking both to establish the Impaired Waters Listings and clarify the beneficial use. MPCA previously understood that rulemaking was, in fact, required for these steps, which is why it undertook rulemaking to list impaired waters in the 2017 proposed rule. Moreover, rulemaking was and still is mandated for clarifying the beneficial use and listing the waters in which the use is protected.

MPCA's current approach would effectively determine which waters are subject to the wild rice beneficial use — and therefore potentially subject to sulfate impairment listings and resulting TMDL and permitting consequences — without the procedural safeguards, administrative record, and public participation required for rulemaking. Because these determinations (if done appropriately, within the correct legal processes) have binding regulatory effect and materially affect the rights and obligations of regulated parties and other stakeholders, they must be adopted through the Minnesota rulemaking process rather than announced through nonbinding guidance or implemented through listing impaired waters without the appropriate rulemaking.

Second, the Guidance Manual explains that placement of a water body on the impaired Waters List (IWL) helps prioritize restoration planning and TMDL development; however, the Manual does not identify any process or timeline associated with development of a TMDL once a waterbody is added to the IWL.

U. S. Steel requests clarification regarding whether the MPCA maintains a schedule, prioritization framework, or expected timeline for initiation and completion of TMDL's following listing.

Data Transparency Concerns – WQX Data Used for Assessments but Not Publicly Available

Section V.B (Data Sources) states that:
"Any data submitted to WQX is used in the assessment process, but is not made available to the public"

The Guidance Manual indicates that impairment decisions may be based on data obtained through the federal Water Quality Exchange (WQX) system, yet data relied upon by MPCA for assessment purposes may not be available for independent public review. If assessment and listing decisions are being made using these datasets, stakeholders should have access to the same underlying information used by MPCA.

MPCA should clarify: why WQX-submitted data used for assessments are not publicly available through MPCA systems; how stakeholders may access all data relied upon in impairment determinations and whether assessment reports will identify all data sources used in making listing decisions. Transparency is important when impairment determinations can results in future permitting, compliance and TMDL obligations.

Wild Rice Designation Concerns – Undefined "Demonstrated Potential"

Appendix H states that waters may be classified as waters used for production of wild rice if they are: "…either an existing wild rice use or those with a demonstrated potential to support sufficient wild rice to attain the beneficial use in the future."

The phase "demonstrated potential" is not defined.

The Guidance Manual provides no criteria, threshold, or methodology explaining how MPCA determines whether a waterbody possesses this potential. Without objective criteria, the designation process lacks transparency and may be applied inconsistently.

U. S. Steel requests that MPCA clearly define:

- What constitutes "demonstrated potential"
- What biological, habitat, hydrologic, or historical evidence is required
- Whether site-specific documentation is made publicly available prior to designation

Inconsistent Use of Wild Rice Density and Population Metrics

Appendix H further states that MPCA does not require a specific wild rice population or density threshold when determining whether a waterbody should be identified as a wild rice water because wild rice populations naturally fluctuate over time.

U. S. Steel finds this position inconsistent with other aspects of sulfate implementation.

If population or density are not relevant when determining whether a waterbody qualifies as a wild rice water, it is unclear why future evaluations of beneficial use attainment, sulfate impacts, or site-specific standards should depend on assumptions regarding wild rice abundance or productivity.

Either:

1. Density and population are relevant metrics and should be incorporated into designation decisions, or
2. Density and population are not relevant metrics and therefore should not be used in subsequent regulatory evaluations.

At minimum, MPCA should explain how these concepts are applied consistently throughout implementation of the wild rice sulfate standard.

Future Wild Rice Listings

Appendix H indicates that future additions of wild rice waters will occur through the biennial Assessment Guidance Manual review process.

U. S. Steel requests clarification regarding whether this will be MPCA's permanent process for adding or removing Class 4A wild rice waters.

If new waters are proposed for designation:

- The supporting data should be publicly available
- The rationale for designation should be documented
- Data sources should be linked directly to each designated waterbody
- Stakeholders should have sufficient opportunity to independently review supporting information prior to final designation decisions.

A transparent administrative record is necessary to support confidence in future listing decisions.

Guidance Manual Methodology Changes

The guidance manual can be updated by the agency between assessment cycles, and those updates can change how waters are evaluated for impairment. However, those changes do not have to go through the same formal rulemaking process that Minnesota rules do. A waterbody could be listed as impaired—or remain listed—not because water quality changed, but because the agency changed its assessment approach. Since these methodology changes are made through guidance rather than rulemaking, stakeholders have fewer opportunities to review, comment on, or challenge the changes before they are implemented.

U. S. Steel requests that any methodological change that could affect whether a waterbody is listed or delisted should be adopted through formal rulemaking.

Sulfate Assessment Methodology

Page 71 references the sulfate standard applicable:
"...during periods when rice may be susceptible to damage by high sulfate levels."

However, the assessment methodology ultimately relies on annual average sulfate concentrations. U. S. Steel is concerned that the discussion throughout the manual emphasizes sulfate impacts during the growing season while the assessment methodology is not specifically tied to periods when wild rice is susceptible to harm.

MPCA should explain how the annual averaging approach is scientifically aligned with the rule language that specifically references susceptibility periods.

Inadequate Data Requirements for Sulfate Impairment Decisions

Page 72 establishes minimum assessment requirements of only five independent observations within a ten-year assessment window. The Manual explicitly states that these five samples could be collected within a single year.

U. S. Steel believes this requirement is insufficient to support an impairment determination with significant regulatory consequences.

The Guidance Manual requires substantially more robust datasets for many other assessment and delisting decisions. For example, site-specific sulfate standard development generally relies upon considerably larger datasets collected over multiple years.

U. S. Steel recommends that sulfate impairment determinations require:

- Collection across multiple years
- Coverage of interannual hydrologic variability
- A dataset representative of long-term conditions

Allowing impairment determinations based on five samples from a single year creates a significant risk that atypical conditions may drive listing decisions.

Additionally, because the underlying data used to support many sulfate listings are not readily accessible, it is difficult for stakeholders to independently evaluate whether the dataset is representative of overall waterbody conditions.

Inadequate Data Requirements

Additionally, The Guidance Manual does not clearly define the minimum data quality, quantity, representativeness, or statistical confidence necessary to support an impairment listing. Without objective standards, datasets could be interpreted differently by different reviewers, creating uncertainty and reducing defensibility of listing decisions.

Appendix H Specific Concerns - Internal Inconsistency Regarding Protection of Wild Rice

Appendix H states:
"The MPCA recognizes the difficulty and costs to control sulfate and wants to ensure that sulfate treatment required of dischargers is being applied where it is crucial to protect wild rice."
U. S. Steel agrees that sulfate controls should be focused where protection of wild rice is demonstrably necessary.

However, MPCA subsequently states that waters may be designated where there is merely a "demonstrated potential" to support wild rice in the future.
These statements appear inconsistent.

Protecting areas that are "crucial" for wild rice suggests a need for documented wild rice resources, whereas inclusion of waters with speculative future potential substantially expands the scope of regulated waters.

The designation of waters such as Dark Lake appears difficult to reconcile with MPCA's stated objective of applying sulfate controls only where they are crucial to protect wild rice resources.
MPCA should reconcile these conflicting statements and clearly explain how the current designation process aligns with the agency's stated policy objective.

Lack of Demonstration Supporting Future Beneficial Use Claims

Appendix H repeatedly references waters that may:
"...support sufficient wild rice for the beneficial use to be met in the future."

Although the term "demonstrated" is used, the Guidance Manual does not identify the evidence required to substantiate such conclusions.

U. S. Steel is concerned that future beneficial-use assumptions may be used to justify regulatory designations without a corresponding demonstration supported by site-specific data.

Where MPCA relies upon future potential as the basis for designation, the agency should provide:

- Site-specific supporting documentation
- Objective technical criteria
- Publicly available datasets
- A transparent explanation demonstrating how beneficial use attainment could reasonably occur in the future.

Without these elements, the designation process appears subjective and difficult to independently verify.

Additional Comment Regarding MPCA's December 2025 Sulfate Research Initiative

In December 2025, MPCA announced that it had begun analysis of background sulfate levels in Minnesota waters and would continue additional sulfate-related research efforts.

U. S. Steel requests clarification regarding whether any findings from these ongoing studies have been incorporated into the 2026 Assessment Guidance Manual or Appendix H.

Specifically, MPCA should identify:

- What sulfate research completed since December 2025 has informed the current guidance;
- Whether background sulfate analyses have affected assessment approaches;
- Whether future revisions to Appendix H are anticipated based on those findings.

Given the importance of sulfate assessments and wild rice designations, stakeholders would benefit from understanding how this evolving science is being incorporated into agency decision-making.

Increased Use of Professional Judgment

Throughout the Manual:

- WAT (Watershed Assessment Team) review,
- PJG (Professional Judgement Group)review,
- Supporting evidence,
- Professional judgment

are repeatedly referenced as assessment tools. More discretion leads to less predictability. This becomes important when discussing wild rice designations, sulfate impairment decisions and delisting evaluations.

Andrew Morley

Please find the attached comments from the Minnesota Chamber of Commerce.

July 22, 2026

The Honorable Katrina Kessler
Commissioner
Minnesota Pollution Control Agency
520 Lafayette Rd.
St. Paul, MN 55155

Commissioner Kessler:

I write on behalf of the Minnesota Chamber of Commerce (Chamber), a statewide organization representing more than 6,300 businesses and more than 500,000 employees throughout Minnesota, commenting on the Minnesota Pollution Control Agency's (MPCA) draft Impaired Waters List (IWL). The Chamber urges MPCA to remove the 16 new waters added that cite sulfate as a stressor from the draft IWL.

The Chamber appreciates efforts made to remove waters from the IWL. The marker of more than 100 impairments removed is a significant milestone and worth celebrating. However, by removing 45 impairments and adding 46, IWL nets an increase of one; Minnesota took a small step backward in its goal.

On December 18, 2025, MPCA announced a pair of studies analyzing sulfate and wild rice waters. One evaluation will review existing science to validate the impacts on wild rice. The other will work with academic experts to understand and document the variation in naturally occurring sulfate levels across the state. Per MPCA's website, the agency anticipates these two analyses will be complete in late 2026.[1] The agency has also posted on its website a "Sulfate natural background study" webinar for July 27, 2026.[2]

The 16 new waters proposed to be impaired due to sulfate to the IWL would total 72 citing sulfate as a stressor. Meanwhile, MPCA has not yet completed the joint studies dedicated to impacts of sulfate on wild rice and prevalence of naturally occurring sulfate levels across the state. Adding these 16 waters prior to MPCA completing its own studies is premature and will have significant economic impacts across the state.

For example, designating St. Louis Bay as impaired and requiring treatment down to the 10 mg/L standard will have significant economic ramifications with little to no environmental benefit. Resource

[1] https://www.pca.state.mn.us/news-and-stories/mpca-begins-analysis-of-background-sulfate-levels-in-minnesota-waters
[2] https://www.pca.state.mn.us/events-and-meetings/sulfate-natural-background-study-2026-07-27

Renew roughly estimates a capital investment of $500 million with perpetual annual operating costs of $100 million.[3] Burdening the state and local taxpayers with such significant costs must come with significant environmental benefits to be worthwhile.

The Chamber urges MPCA to remove the 16 impaired waters from the draft IWL that cite sulfate as a stressor. Listing waters as impaired due to sulfate stressors prior to finalizing research is premature, especially when it will have such a significant economic impact. The U.S. Environmental Protection Agency approves the state's IWL every two years. Another opportunity to list waters as impaired will come in short order.

Waters on IWL are meant to be removed. Therefore, true markers of success are how many waters are taken off the list instead of added. The Chamber urges MPCA to complete its own studies, understand the impacts, and only then make regulatory decisions that have a significant cost to the taxpayer.

Sincerely,

Andrew Morley
Director, Environmental Policy
Minnesota Chamber of Commerce
amorley@mnchamber.com
763-221-7523

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[3] Ms. Carrie Clement to the Honorable Katrina Kessler, July 22, 2026. MPCA SmartComment Portal.

BRANDON ANTOINE

Please see attached documents.

400 W Erie Rd
Marshall, MN 56258
507-237-2676

July 22, 2026

Via Online Public Comment Form

Commissioner Katrina Kessler
Minnesota Pollution Control Agency
520 Lafayette Rd.
Saint Paul, MN 55155-4194

RE: Comments on 2026 Impaired Waters List and Assessment Manual: Request to Remove the Chloride Impairment in Redwood River

I am writing on behalf of Archer Daniels Midland ("ADM") in Marshall, Minnesota, to submit comments on the Minnesota Pollution Control Agency's ("MPCA" or "Agency") 2026 Impaired Waters List ("IWL") and to request that MPCA revise the IWL to remove the chloride impairment in the Redwood River.[1] Additionally, we are writing to submit comments requesting that MPCA revise the 2026 Assessment Manual[2] to ensure it accurately reflects the chloride water quality standard as adopted in Minn. R. 7050.0222. In support of these comments and requests, we have attached a technical memorandum and relevant data prepared by Barr Engineering Co.[3]

ADM has been part of the Marshall community for more than 20 years. We support local farmers by buying their crops, and the 300+ colleagues at our Marshall processing plant transform local corn into sweeteners, animal feed, food, and industrial-grade starch. We take our environmental responsibilities seriously and have invested in our Marshall operations to ensure that we are protecting the Redwood River. We are pleased to inform MPCA that as a result of the collaborative efforts of the Agency, ADM, and the City of Marshall, the Redwood River is no longer impaired for chloride.

Collaborative Effort Leads to Attainment of Chloride Standard in the Redwood River

The Redwood River (the "river") was originally listed as impaired for chloride in 2008. To address that impairment, ADM invested in facility and operational improvements and, with MPCA, implemented a permitting approach in 2010 requiring ADM to meet a stringent 230 mg/L chloride limit in its NPDES permit to ensure compliance with the chloride standard in the river.[4] The City of Marshall ("City") has also made significant investments and worked carefully with the MPCA and ADM to significantly reduce the amount of chloride discharged to the river.

[1] Assessment Unit Identification (AUID) or Water Unit Identification (WID) 07020006-502.
[2] *Assessment Manual, Guidance for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report & 303(d) Impaired Waters List, 2026 Reporting and Listing Cycle* ("2026 Assessment Manual").
[3] Technical Analysis in Support of ADM's Redwood River Chloride Impairment Removal Request, Barr Engineering Co., (July 2026) ("technical memorandum").
[4] ADM's National Pollutant Discharge Elimination System (NPDES) / State Disposal System (SDS) Permit ("NPDES/SDS") Permit No. MN0057037.

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As detailed in the attached technical memorandum, this collaborative effort has successfully brought the Redwood River into compliance with the chloride standard. The data also demonstrates that the river will maintain compliance into the future because of the permitted chloride reductions required and achieved by ADM and the City.[5]

The attached compliance demonstration is based on the application of the adopted chloride standard codified at Minn. R. 7050.0222 and is consistent with the data quality and quantity criteria contained in the 2026 Assessment Manual because it relies upon extensive daily chloride samples taken over the most recent 10 years.[6] The finding that the Redwood River meets the chloride standard and fully supports the designated use is also supported by the assessment criteria found in MPCA's 2024 Assessment Manual.[7]

As a result of the above, ADM respectfully requests that MPCA remove the chloride impairment for the Redwood River (AUID: 07020006-502) from the State's IWL because the river meets the chloride standard and the applicable designated use is fully supported. We believe that the appropriate EPA designation for the de-listing action is Category 2, "the designated use is fully supported. . . parameter meets standards."[8]

Request for Revision of 2026 Assessment Manual to Ensure Consistency with Adopted Chloride Standards

As noted herein and detailed in the technical memorandum, MPCA's 2026 Assessment Manual confusingly misstates the applicable chloride standard and creates an assessment framework for chloride that is inconsistent with and more restrictive than the chloride standard as adopted and codified in Minn. R. 7050.0222.

As MPCA is aware, water quality standards typically have magnitude, duration, and frequency components. In this case, the adopted chronic chloride standard has a magnitude of 230 mg/L, a duration as a 4-day average, and an exceedance frequency of ***not more than once every three years on average*** (emphasis added).[9] As a result, under the adopted chronic standards, a river is in compliance and fully supporting the designated use when there is one exceedance of the standard (but not more than one) in three years on average.

However, MPCA's 2026 Assessment Manual misstates the applicable exceedance frequency for both the chronic and maximum chloride standards by stating that to demonstrate compliance with the chloride standard there

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[5]ADM NPDES/SDS permit no. Permit No. MN0057037; City of Marshall NPDES/SDS Permit No. MN 0022179.
[6] *See* pp. 46 – 47, Table 15, 2026 Assessment Manual (stating that "care must be taken to ensure that the water quality measurements used in assessments provide an adequate representation of pollutant concentrations over the relevant [10-year] time period").
[7] *See* pp. 38 – 39 and Table 15, *Assessment Manual, Guidance for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report & 303(d) Impaired Waters List, 2024 Assessment and Listing Cycle* ("2024 Assessment Manual). As discussed in the technical memorandum, the 2024 Assessment Manual is also inconsistent with and more restrictive than the chloride water quality standard as codified Minn. R. 7050.0222 because it fails to accurately state the exceedance frequency by omitting the words "on average". Despite this inconsistency, the attached compliance demonstration meets the assessment criteria as contained the 2024 Assessment Manual.
[8] Minnesota Pollution Control Agency, *Minnesota's Draft 2026 Impaired Waters List*, wq-iw1-85, "EPA Categories" tab (2026).
[9] Id.; *Ambient Water Quality Criteria for Chloride 1988*, United States Environmental Protection Agency, Office of Water Regulations and Standards Criteria and Standards Division Washington, DC 20460 (EPA 440/5-88-001, Feb.,1988). The same "once in three years on average" exceedance frequency also applies to the Maximum Standard.

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can be "***[n]o exceedances*** *of the chronic* . . . standard for three years or more, and ***no exceedances*** of the Maximum Standard (emphasis added).[10] This language is inconsistent with and more restrictive than the adopted standard because it omits the required "on average" language and it prevents a determination of compliance in the event of only one exceedance of the chronic or maximum standard in three years (on average).[11]

It is unclear to ADM why the 2026 Assessment Manual is inconsistent with adopted standards, but it appears it may be an error for two reasons. First, it is internally inconsistent with respect to the chronic standard because it creates a gap between what is required to show that a water body is impaired ("two or more exceedances") versus what is required to show it is meeting the standard ("no exceedances").[12] Secondly, it is also inconsistent with and more restrictive than the 2024 Assessment Manual, which states that the standard is met and the designated use is supported if there is "***no more than one exceedance*** of the chronic standard in three years" (emphasis added).[13]

We understand that the adopted chloride standard governs the assessment process for the Redwood River and other waterbodies—not the language in the 2026 Assessment Manual, which expressly states that it "is not part of any water quality rule [and] does not have the force of law."[14] Nevertheless, ADM requests that MPCA revise the 2026 Assessment Manual to ensure that it is consistent with the adopted chloride standard to prevent confusion and ensure an accurate assessment process going forward. We recommend and request the following revisions to Table 15 on page 47 of the 2026 Assessment Manual:

Table 15: Impairment determination for aquatic life toxicity standards

Period of record	**Beneficial use–support or beneficial use–impaired**	
	Supporting	**Impaired**
Most recent 10 years	~~No exceedances~~ No more than one exceedance of the Chronic~~, or~~ Acute or Maximum ~~s~~Standard ~~for~~ in three years on average. ~~or more, and no exceedances of the Maximum Standard.~~	Two or more exceedances of the Chronic Standard **and/or Maximum Standard** in three years on average. ~~**and/or** one or more exceedances of the Maximum Standard~~

[10] MPCA 2026 Assessment Manual at p.47.
[11] *Id.*
[12] *Id.*
[13] *Compare* Table 15 of MPCA's 2024 Assessment Manual at p. 39 to Table 15 of MPCA's 2026 Assessment Guidance at p.47.
[14] Section II, B., 2026 Assessment Manual. It would be improper for MPCA to revise an adopted and U.S. EPA approved water quality standard without going through the formal rulemaking process required by state and federal law. For a helpful comparison between the adopted chloride standards, and the interpretations contained in the 2024 and 2026 Assessment Manuals please refer to Table 2 in the technical memorandum.

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Finally, we request a meeting with MPCA to discuss our comments and requests to remove the chloride impairment in the Redwood River and to revise the 2026 Assessment Guidance before the IWL is approved. We believe a meeting would be helpful and facilitate continued collaboration between ADM and MPCA.

Thank you for your attention to this matter, and we appreciate MPCA's support in our efforts to improve the Redwood River.

Sincerely,

CC:
Dana Vanderbosch
Courtney Ahlers
Theresa Haugen
Brandon Montgomery
Kameron Lindsey
Marco Graziani

(Enclosures: Technical Memorandum from Barr Engineering and Data Attachment)

Technical Memorandum

To: Brandon Antoine and Eric McVey, ADM
From: Barr Engineering Co.
Subject: Technical Analysis in Support of ADM's Redwood River Chloride Impairment Removal Request
Date: July 21, 2026
Project: 23421018.01
c: Daniel Marx, Flaherty & Hood, P.A.

1 Executive Summary

This memorandum (memo) presents technical analysis by Barr Engineering Co. (Barr) in support of ADM's request to the Minnesota Pollution Control Agency (MPCA) to remove the chloride impairment status of the Redwood River within the segment described as "T111 R42W S33, west line to Threemile Creek" (Assessment Unit Identification (AUID) or Water Unit Identification (WID) 07020006-502).

This technical evaluation assessment, as detailed in the following sections, finds that:

- The Redwood River segment is no longer chloride-impaired when the in-stream chloride data is compared with the applicable chloride water quality standards found in Minnesota Rules, part 7050.0222, subpart 4 and subpart 7, item C. This finding is also supported when the in-stream chloride data is compared with the aquatic life impairment determination metrics from the MPCA's *Assessment Manual, Guidance for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report & 303(d) Impaired Waters List, 2024 Assessment and Listing Cycle* (MPCA 2024 Assessment Manual; reference (1)). There are some inconsistencies between the MPCA 2024 Assessment Manual's metrics and the adopted chloride standards; however, both the adopted standards and the 2024 Assessment Manual support a finding that the river meets the applicable chloride water quality standards and is no longer chloride-impaired.

- The aquatic life impairment determination metrics from the MPCA's A*ssessment Manual, Guidance for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report & 303(d) Impaired Waters List, 2026 Reporting and Listing Cycle* (MPCA 2026 Assessment Manual; reference (2)) are inconsistent with and more restrictive than both the adopted chloride water quality standards and the MPCA 2024 Assessment Manual's metrics. It is unclear why both the 2024 and 2026 Assessment Manuals' metrics are inconsistent with the adopted chloride standards and also why the 2026 Assessment Manual's metrics are inconsistent with the 2024 Assessment Manual's metrics. Both the 2024 and 2026 Assessment Manuals contain disclaimers in Section II.B. stating that the guidance is a tool for interpretation and application of water quality standards, but "is not part of any water quality rule [and] does not have the force of law." It is possible that the inconsistencies may be the result of an interpretation or other error, and it is recommended that the MPCA consider these discrepancies and revise the 2026 Assessment Manual as necessary for consistency with the adopted chloride water quality standards.

Considered overall, these findings support ADM's request for removal of the chloride impairment from the Redwood River (AUID 07020006-502) based on the river's compliance with the applicable chloride water quality standards in Minnesota Rules, part 7050.0222.

2 Introduction

The "T111 R42W S33, west line to Threemile Creek" segment of the Redwood River (AUID 07020006-502) was listed by the MPCA on Minnesota's Impaired Waters List in 2008 with an aquatic life beneficial use impairment due to chloride (chloride impairment). In May 2023, the U.S. Environmental Protection Agency (USEPA) approved the MPCA's *Redwood River Watershed Total Maximum Daily Load (TMDL) Report* (Redwood River TMDL Report; (reference (3)), which included watershed-wide TMDLs covering total suspended solids, E. coli, chloride, and lake nutrient impairments in the Redwood River Watershed.

Since the listing of this segment of the Redwood River as chloride-impaired in 2008, chloride concentrations in the river segment have decreased. This is due to efforts by the MPCA, ADM Marshall, and the City of Marshall Wastewater Treatment Facility (WWTF) to decrease chloride discharged to the river, including reduction of chloride in ADM Marshall's pretreated discharge to the City of Marshall WWTF.

As described in the MPCA 2026 Assessment Manual (reference (2)), a waterbody can be removed from the impaired waters list if "new and reliable data or information indicates that the water body is now meeting [water quality standards]". Additionally, the MPCA 2026 Assessment Manual (reference (2)) specifies that:

- "interested parties may propose additional assessments during the call for data or public notice of the draft [impaired waters list]";
- "any proposals for assessment outside of their designated assessment year in the watershed schedule must: 1) explain why moving forward with assessment is necessary prior to the waterbody's next watershed assessment year, 2) document how the efficiency and coordination that is lost by deviating from the watershed approach will be offset by a local benefit, and 3) demonstrate that the MPCA's assessment methods in this Guidance Manual were followed for the monitoring, analysis, and comparison of the data against state standards"; and
- "the MPCA reviews any such proposals and makes a determination regarding impairment and listing prior to submitting the draft list to EPA for approval."

Accordingly, ADM is submitting a request to the MPCA to remove the chloride impairment from the Redwood River (AUID 07020006-502) during the public notice of the draft 2026 Impaired Waters List. Assessment of this segment of the Redwood River is needed prior to the waterbody's next watershed assessment year, as the MPCA is moving toward reissuance of ADM Marshall's National Pollutant Discharge Elimination System (NPDES) / State Disposal System (SDS) Permit (NPDES/SDS Permit No. MN0057037), which includes discharge of wastewater to this Redwood River segment. If the MPCA includes more stringent chloride limits in ADM Marshall's NPDES/SDS Permit due to the river's chloride impairment status, it will have a negative impact on the business, its employees, and the surrounding community. Thus, ADM is requesting that the MPCA update the impairment status of the Redwood River segment to reflect that the river is no longer chloride-impaired.

ADM requested assistance from Barr to evaluate and assess available chloride monitoring data in support of its request to remove the chloride impairment from the Redwood River (AUID 07020006-502). This memo documents Barr's technical analysis that includes evaluation of the available chloride data (Section 3) and assessment of whether the data support removal of the chloride impairment from the Redwood River segment (Section 5) in accordance with applicable metrics (Section 4).

3 Summary of Available Chloride Data

ADM Marshall's NPDES/SDS Permit requires in-stream monitoring of the Redwood River upstream and downstream of its discharge at surface water monitoring stations SW001 and SW003, respectively. The locations of these surface water monitoring stations are shown on Figure 1. Per the requirements of ADM Marshall's NPDES/SDS Permit:

- ADM must record weekly chloride concentrations at SW001 when "flow at USGS Redwood River gage is greater than or equal to 15 cfs and the salt stream concentration/recovery system is not discharging" and must record daily chloride concentrations at SW001 when "flow at USGS Redwood River gage is less than 15 cfs or the salt stream concentration/recovery system is discharging"; and

- ADM must record weekly chloride concentrations at SW003 when "flow at USGS Redwood River gage is greater than or equal to 15 cfs and the salt stream concentration/recovery system is not discharging" and must record daily chloride concentrations at SW003 when "flow at USGS Redwood River gage is less than 15 cfs or the salt stream concentration/recovery system is discharging".

In practice, ADM typically records daily chloride concentrations at both SW001 and SW003. ADM reports the results of this in-stream chloride monitoring to the MPCA on its discharge monitoring reports (DMRs). ADM provided the chloride datasets for both SW001 and SW003 to Barr for use in this evaluation.

Barr also downloaded and reviewed publicly available chloride data for the Redwood River (AUID 07020006-502) from the MPCA's Surface Water Data Access tool and the USEPA and U.S. Geological Survey's shared Water Quality Portal. MPCA monitoring stations S002-185 and S001-203 correspond with ADM Marshall's stations SW001 and SW003, respectively.

ADM Marshall's chloride datasets for this Redwood River segment are much more comprehensive than the publicly available chloride datasets and thus were used for this evaluation. The MPCA 2026 Assessment Manual (reference (2)) notes that, for toxic pollutants such as chloride, "because impairment can result from only one or two exceedances, a designation of meeting the standard generally requires extensive monitoring during times when exceedances are most likely to occur." As ADM Marshall's chloride datasets include daily data at SW003 and almost daily data at SW001, they constitute extensive monitoring that includes times when exceedances are most likely to occur, and thus, the data record available for this evaluation should be considered sufficient for reassessment of the Redwood River segment's chloride impairment status.

The MPCA 2026 Assessment Manual (reference (2)) specifies that the "MPCA uses data collected over the most recent 10-year period" with "years of record… based on the USGS water year, October 1 of one year through September 30 of the following year". Accordingly, this evaluation uses data from a period of October 1, 2015 through September 30, 2025.

The chloride datasets used in this evaluation are provided in Attachment 1 in pdf format. This chloride data has previously been provided by ADM to the MPCA via its DMRs; however, the complete datasets can be provided to the MPCA in Excel format upon request.

4 Impairment Assessment Metrics

Minnesota Rules (part 7050.0150, subpart 4, item O) defines "impaired water" or "impaired condition" as "a water body that does not meet applicable water quality standards or fully support applicable beneficial uses, due in whole or in part to water pollution from point or nonpoint sources, or any combination thereof." Minnesota's Class 2 chloride water quality standards for protection of the aquatic life beneficial use were adopted in 1990 and are based on the USEPA's *Ambient Water Quality Criteria for Chloride - 1988* (reference (4)). The Redwood River (AUID 07020006-502) is designated as a Class 2B water. Under Minnesota Rules, part 7050.0222, the applicable Class 2B numeric chronic and maximum standards for chloride are as presented in Table 1.

Table 1 Class 2B Chloride Water Quality Standards

Standard Type	Magnitude	Duration	Frequency
Chronic	230 mg/L [1],[2]	4-day average [2],[3],[4]	Not to be exceeded more than once every 3 years on average [2],[4]
Maximum	860 mg/L [1],[2]	1-day average [3]	Not to be exceeded more than once every 3 years on average [2],[4]

Notes:
[1] Minnesota Rules, part 7050.0222, subpart 4
[2] USEPA *Ambient Water Quality Criteria for Chloride - 1988* (reference (4))
[3] Minnesota Rules, part 7050.0222, subpart 7, item C
[4] USEPA *Technical Support Document for Water Quality-based Toxics Control* (reference (5))

The MPCA 2026 Assessment Manual (reference (2)) states that "a surface water is considered to be 'impaired' if the extent of its exceedances of an applicable [water quality standard] is more than the levels spelled out in [the manual]". The MPCA evaluates impairments to aquatic life toxicity standards using the metrics listed in Table 15 of the MPCA 2026 Assessment Manual (reference (2)), as summarized in Table 2 below.

Notably, the metrics for demonstrating beneficial use-support in the MPCA 2026 Assessment Manual (reference (2)) have changed from and are inconsistent with the MPCA 2024 Assessment Manual (reference (1)), with the 2026 version being more stringent in requiring "no exceedances of the chronic or acute standard for three years or more" rather than "no more than one exceedance of the chronic standard in three years". It is unclear whether this change was intentional, as it was not noted by the MPCA in the 2026 Assessment Manual's list of "2026 revisions of the Guidance Manual" and it introduces a gap between the supporting metric of "no exceedances" and the impaired metric of "two or more exceedances". The impairment determination metrics from Table 15 of the MPCA 2024 Assessment Manual (reference (1)) are also included in Table 2 for comparison (with differences noted in bold italics).

Additionally, the impairment determination metrics from both the MPCA 2026 Assessment Manual (reference (2)) and MPCA 2024 Assessment Manual (reference (1)) are inconsistent with and more restrictive than the adopted chloride water quality standards in Minnesota Rules, part 7050.0222. Metrics based on the adopted chloride water quality standards are also included in Table 2 for comparison with the Assessment Manual metrics (with differences noted in bold italics). The following discrepancies exist between the adopted chloride standards and the Assessment Manual metrics:

- The MPCA 2024 Assessment Manual beneficial use-support metric of "no more than one exceedance of the chronic standard in three years" is generally consistent with the adopted standard of no more than one exceedance of the chronic standard in three years on average, except that it does not specify "on average". For the evaluation presented in this memo, it is assumed that this is an unintentional omission and that the frequency of exceedance should be considered "on average" in accordance with the adopted chronic chloride standard.

- The MPCA 2026 Assessment Manual beneficial use-support metric of "no exceedances of the chronic or acute standard for three years or more" is inconsistent with and more restrictive than the adopted standard of no more than one exceedance of the chronic standard in three years on average. It is unclear why this MPCA 2026 Assessment Manual metric differs from both the adopted chronic chloride standard and the previous MPCA 2024 Assessment Manual metric.

- The MPCA 2026 and 2024 Assessment Manual beneficial use-support metrics of "no exceedances of the maximum standard" are inconsistent with and more restrictive than the adopted chloride standard of no more than one exceedance of the maximum standard in three years on average. It is unclear why these Assessment Manual metrics differ from the adopted maximum chloride standard.

It is unclear why both the 2024 and 2026 Assessment Manuals' metrics are inconsistent with and more restrictive than the adopted chloride standards in Minnesota Rules, part 7050.0222 and also why the 2024 and 2026 Assessment Manual metrics are inconsistent with each other. However, both Assessment Manuals contain disclaimers in Section II.B. stating that: "The Guidance Manual is not part of any water quality rule – it does not have the force of law. It serves to guide the interpretation and application of current WQS that are in water quality rules." (references (1) and (2)). It is possible that the inconsistencies between the adopted chloride standards and the 2024 and 2026 Assessment Manuals may be the result of an interpretation or other error. It is recommended that the MPCA consider these discrepancies and revise the 2026 Assessment Manual as necessary for consistency with the adopted chloride water quality standards. For purposes of the evaluation presented in this memo, it has been assumed that the adopted chloride standards take precedence over the Assessment Manual in alignment with the Assessment Manual's disclaimer.

Table 2 Impairment Determination Metrics for Aquatic Life Toxicity Standards

Source	Period of Record	Beneficial use support or beneficial use impaired	
		Supporting	Impaired
2026 Assessment Manual [1]	Most recent 10 years	***No exceedances*** of the chronic or acute standard for three years or more, and ***no exceedances*** of the Maximum Standard	Two or more exceedances of the Chronic Standard in three years, and/or one or more exceedances of the Maximum Standard
2024 Assessment Manual [2]	Most recent 10 years	***No more than one exceedance*** of the Chronic Standard in three years, and ***no exceedances*** of the Maximum Standard	Two or more exceedances of the Chronic Standard in three years, and/or one or more exceedances of the Maximum Standard
Based on Chloride Water Quality Standards [3]	--	***No more than one exceedance*** of the chronic or maximum standard in three years ***on average***	Two or more exceedances of the chronic or maximum standard in three years ***on average***

Notes:
[1] Based on Table 15 of the MPCA 2026 Assessment Manual (reference (2)).
[2] Based on Table 15 of the MPCA 2024 Assessment Manual (reference (1)).
[3] Refer to Table 1.

5 Findings of Technical Assessment of Redwood River Chloride Impairment

Barr assessed the Redwood River chloride data from stations SW001 and SW003 (Section 3) for compliance with the applicable Class 2B chloride water quality standards using the methodologies and metrics described in the MPCA 2026 Assessment Manual (reference (2)) (Section 4) to evaluate whether the data support the conclusion that the Redwood River segment (AUID 07020006-502) is no longer chloride-impaired.

Data records from October 1, 2015 to September 30, 2025, were evaluated as the most recent 10-year period currently available. Daily chloride results for stations SW001 and SW003 and rolling four-day average chloride results are presented in Attachment 1. The four-day average annual chloride results are presented in Table 3. During this evaluation period, there were no observed exceedances of the maximum standard (860 mg/L) at stations SW001 and SW003, and no observed exceedances of the chronic standard (230 mg/L) at SW001.

Table 3 Annual Summary of 4-day Average Chloride Results for the Redwood River (AUID 07020006-502) from October 1, 2015 to September 30, 2025

Year	Mean 4 day Average Results (mg/L)			Maximum 4 day Average Result (mg/L)			Number of Exceedances of Chronic Standard (based on 4 day Averages)		
	SW001	SW003	Average SW001 & SW003	SW001	SW003	Average SW001 & SW003	SW001	SW003	Average SW001 & SW003
2015*	25	132	83	39	207	116	--	--	--
2016	21	78	50	41	185	100	--	--	--
2017	20	55	37	29	103	63	--	--	--
2018	15	53	34	51	197	106	--	--	--
2019	13	34	23	77	109	92	--	--	--
2020	13	87	50	32	229	122	--	--	--
2021	14	117	66	36	**233**	126	--	2	--
2022	13	125	69	29	229	126	--	--	--
2023	18	134	76	36	**263**	141	--	1**	--
2024	18	78	48	36	221	122	--	--	--
2025*	17	84	51	33	223	111	--	--	--

Red text denotes result exceeds the Chronic Standard (230 mg/L)

* This table summarizes data from October 1, 2015 to September 30, 2025, and thus includes 2015 data only from October 1, 2015 through December 31, 2015 and 2025 data only from January 1, 2025 through September 30, 2025.

** The two chronic standard exceedances at SW003 in 2023 occurred on consecutive days due to one daily sample result >230 mg/L, which resulted in 4-day averages for both days >230 mg/L; because only one daily sample result exceeded 230 mg/L, this should not be considered more than one exceedance for this evaluation. Additionally, this single daily elevated chloride concentration was due to an isolated incident of operator error at ADM that resulted in exceedance of the chloride limit in ADM's NPDES/SDS Permit and thus should be considered an outlier that is not representative of typical or anticipated future operations.

There were no exceedances of the chronic standard at SW003 in 2016 through 2020. There were two chronic standard exceedances at SW003 in 2021, both occurring non-consecutively in August. There were also two chronic standard exceedances at SW003 on consecutive days in November 2023; however, both were due to the same single daily sample result above the chronic standard, which caused the four-day averages for both days to exceed the chronic standard. For the purposes of this evaluation, because the daily river concentration only exceeded the chronic standard for one day in November 2023, the two four-day averages affected should not be considered to be more than one exceedance of the chronic standard. Additionally, it is important context that the single daily elevated river chloride concentration in November 2023 was due to an isolated incident of operator error at ADM that resulted in exceedance of the chloride limit in ADM's NPDES/SDS Permit and thus should be considered an outlier that is not representative of typical or anticipated future operations.

Overall, assessment of the dataset for SW003 from October 1, 2015 to September 30, 2025 finds:

- No exceedances of the maximum standard;
- Three exceedances of the chronic standard in a single three year period (2021 to 2023);

- Two exceedances of the chronic standard in a single year (2021);
- Only one exceedance of the chronic standard in the most recent three year period (due to an isolated incident of ADM operator error); and
- Less than one exceedance of the chronic standard in three years on average.

Based on this assessment:

- The Redwood River segment (WID 07020006-502) is no longer chloride-impaired and supports the beneficial use when the in-stream chloride data (Table 3) is compared with the applicable chloride water quality standards (Table 1 and Table 2) as there has been no more than one exceedance of the chronic standard in three years on average and no exceedances of the maximum standard.
- This finding that the Redwood River segment is meeting the applicable chloride water quality standards and is no longer chloride-impaired is also supported when the in-stream chloride data (Table 3) is compared with the 2024 Assessment Manual metrics (Table 2) as there has been no more than one exceedance of the chronic standard both in three years on average and in the last three years, and no exceedances of the maximum standard.
- The finding that the Redwood River segment is no longer chloride-impaired is also supported when the chloride data (Table 3) is compared with the 2026 Assessment Manual metrics (Table 2) as there have been less than two exceedances of the chronic standard both in three years on average and in the last three years, and no exceedances of the maximum standard. However, the number of exceedances of the chronic standard both in three years on average and in the last three years is within the gap between the impaired metric of "two or more exceedances" and the supporting metric of "no exceedances". As discussed previously, it is unclear why the supporting metric changed from 2024, why there is a gap between the impaired and supporting metrics, and why these metrics differ from the adopted chloride water quality standards. If the single daily elevated river chloride concentration in November 2023 that resulted from an isolated incident of ADM operator error is excluded as an outlier that is not representative of typical or anticipated future operations, then the beneficial use would be supported based on no exceedances of the chronic standard in the last three years.
- The successful reduction of chloride concentrations in this Redwood River segment since its listing as chloride-impaired in 2008 is primarily the result of the MPCA's regulation of chloride discharges from both ADM Marshall (NPDES/SDS Permit MN0057037 reissued in 2011) and the City of Marshall Wastewater Treatment Facility (WWTF) (NPDES/SDS Permit MN0022179 reissued in 2024). Based on the long-term chloride data trends (10 years) and the existing, required controls under ADM Marshall and the City of Marshall WWTF's NPDES/SDS permits, there is reasonable assurance that the Redwood River segment will maintain compliance with the applicable chloride standards in the future.
- The impairment determination metrics for aquatic life toxicity standards (Table 2) presented in the MPCA's 2024 and 2026 Assessment Manuals (references (1) and (2)) are inconsistent with the adopted chloride water quality standards and with each other. The reason(s) for the inconsistencies are unclear; however, it is recommended that the MPCA revise the 2026 Assessment Manual as necessary for consistency with the adopted chloride water quality standards.

6 References

1. MINNESOTA POLLUTION CONTROL AGENCY. Assessment Manual - Guidance for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report & 303(d) Impaired Waters List: 2024 Assessment and Listing Cycle. April 2024.

2. MINNESOTA POLLUTION CONTROL AGENCY. Assessment Manual - Guidance for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report & 303(d) Impaired Waters List: 2026 Reporting and Listing Cycle. November 2025.

3. MINNESOTA POLLUTION CONTROL AGENCY. Redwood River Watershed Total Maximum Daily Load Report: Watershed-wide TMDLs covering TSS, E. coli, chloride, and lake nutrient impairments in the Redwood River Watershed located in the greater Minnesota River Basin. April 2023.

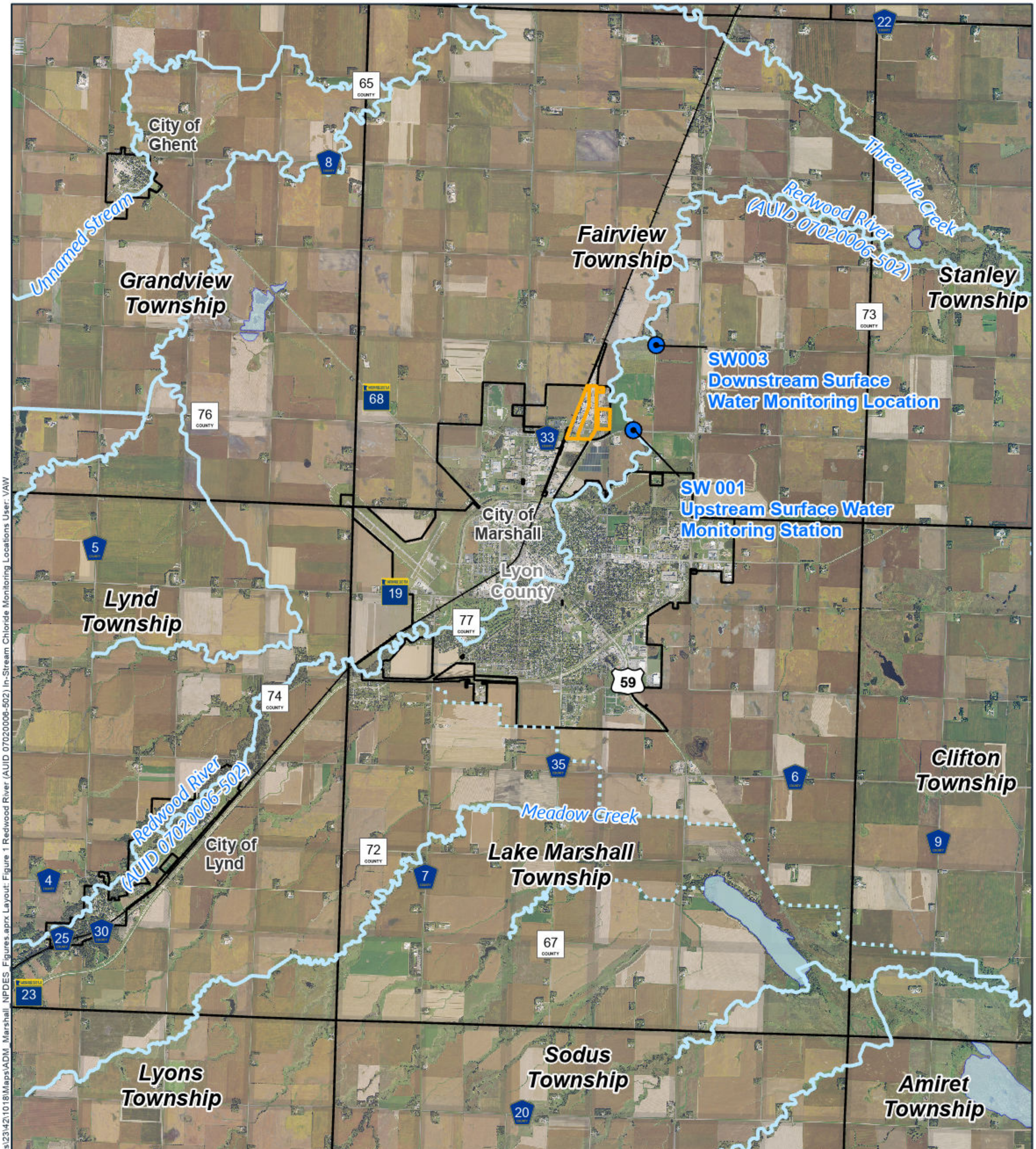
4. U.S. ENVIRONMENTAL PROTECTION AGENCY. Ambient Water Quality Criteria for Chloride - 1988. February 1988.

5. U.S. ENVIRONMENTAL PROTECTION AGENCY. Technical Support Document for Water Quality Based Toxics Control. March 1991.

Figures and Attachments

Figure 1 Redwood River (AUID 07020006-502) In-Stream Chloride Monitoring Locations
Attachment 1 Chloride Data for the Redwood River

Figures



Station Location
Factory Site
Public Water Watercourse
Public Ditch/Altered Natural Watercourse
Public Waters Basins
Minnesota Rail Lines

0 1 2
Miles

Redwood River (AUID 07020006-502) In-Stream Chloride Monitoring Locations
ADM Marshall
FIGURE 1

BARR

Attachments

Attachment 1
Chloride Data for the Redwood River (AUID 07020006-502) from October 1, 2015 to September 30, 2025
ADM Marshall

10-Year DMR Data Set (10/1/2015-9/30/2025)	Total Number of days >860 mg/L		Total Number of days >230 mg/L		
	0	0	4	0	0

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	10/1/2015	106	23	103	29	66
DMR	10/2/2015	107	33	104	29	66
DMR	10/3/2015	111	34	107	30	69
DMR	10/4/2015	116	29	110	30	70
DMR	10/5/2015	146	28	120	31	76
DMR	10/6/2015	128	26	125	29	77
DMR	10/7/2015	124	25	129	27	78
DMR	10/8/2015	120	30	130	27	78
DMR	10/9/2015	137	28	127	27	77
DMR	10/10/2015	154	25	134	27	80
DMR	10/11/2015	127	22	135	26	80
DMR	10/12/2015	174	23	148	25	86
DMR	10/13/2015	195	28	163	25	94
DMR	10/14/2015	198	28	174	25	99
DMR	10/15/2015	188	28	189	27	108
DMR	10/16/2015	188	29	192	28	110
DMR	10/17/2015	165	26	185	28	106
DMR	10/18/2015	155	24	174	27	100
DMR	10/19/2015	211	23	180	26	103
DMR	10/20/2015	230	23	190	24	107
DMR	10/21/2015	169	23	191	23	107
DMR	10/22/2015	208	23	205	23	114
DMR	10/23/2015	222	26	207	24	116
DMR	10/24/2015	151	19	188	23	105
DMR	10/25/2015	166	22	187	23	105
DMR	10/26/2015	160	23	175	23	99
DMR	10/27/2015	197	27	169	23	96
DMR	10/28/2015	162	24	171	24	98
DMR	10/29/2015	118	25	159	25	92
DMR	10/30/2015	146	26	156	26	91
DMR	10/31/2015	152	25	145	25	85
DMR	11/1/2015	159	25	144	25	85
DMR	11/2/2015	193	26	163	26	94
DMR	11/3/2015	193	28	174	26	100
DMR	11/4/2015	163	26	177	26	102
DMR	11/5/2015	186	26	184	27	105
DMR	11/6/2015	196	34	185	29	107
DMR	11/7/2015	176	24	180	28	104
DMR	11/8/2015	170	27	182	28	105
DMR	11/9/2015	178	25	180	28	104
DMR	11/10/2015	156	24	170	25	98
DMR	11/11/2015	187	26	173	26	99
DMR	11/12/2015	173	26	174	25	99
DMR	11/13/2015	157	22	168	25	96
DMR	11/14/2015	157	21	169	24	96
DMR	11/15/2015	145	22	158	23	90
DMR	11/16/2015	176	25	159	23	91
DMR	11/17/2015	115	24	148	23	86
DMR	11/18/2015	73	19	127	23	75

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	11/19/2015	117	31.5	120	25	73
DMR	11/20/2015	86	22	98	24	61
DMR	11/21/2015	87	26	91	25	58
DMR	11/22/2015	116	36	102	29	65
DMR	11/23/2015	94	27	96	28	62
DMR	11/24/2015	83	32	95	30	63
DMR	11/25/2015	82	29	94	31	62
DMR	11/26/2015	92	33	88	30	59
DMR	11/27/2015	218	36	119	33	76
DMR	11/28/2015	179	45	143	36	89
DMR	11/29/2015	102	40	148	39	93
DMR	11/30/2015	111	31	153	38	95
DMR	12/1/2015	124	32	129	37	83
DMR	12/2/2015	110	35	112	35	73
DMR	12/3/2015	150	33	124	33	78
DMR	12/4/2015	97	32	120	33	77
DMR	12/5/2015	89	30	112	33	72
DMR	12/6/2015	110	36	112	33	72
DMR	12/7/2015	116	32	103	33	68
DMR	12/8/2015	96	32	103	33	68
DMR	12/9/2015	96	31	105	33	69
DMR	12/10/2015	84	30	98	31	65
DMR	12/11/2015	78	26	89	30	59
DMR	12/12/2015	63	29	80	29	55
DMR	12/13/2015	57	27	71	28	49
DMR	12/14/2015	78	30	69	28	49
DMR	12/15/2015	65	29	66	29	47
DMR	12/16/2015	74	32	69	30	49
DMR	12/17/2015	89	34	77	31	54
DMR	12/18/2015	151	33	95	32	63
DMR	12/19/2015	125	30	110	32	71
DMR	12/20/2015	63	27	107	31	69
DMR	12/21/2015	81	34	105	31	68
DMR	12/22/2015	80		87	0	87
DMR	12/23/2015	71		74	0	74
DMR	12/24/2015	93		81	0	81
DMR	12/25/2015	90		84	0	84
DMR	12/26/2015	88		86	0	
DMR	12/27/2015	96		92	0	
DMR	12/28/2015	125		100	0	
DMR	12/29/2015	87		99	0	
DMR	12/30/2015	96		101	0	
DMR	12/31/2015	83		98	0	
DMR	1/1/2016	82		87	0	44
DMR	1/2/2016	90		88	0	44
DMR	1/3/2016	96		88	0	44
DMR	1/4/2016	120		97	0	49
DMR	1/5/2016	117		106	0	53
DMR	1/6/2016	111		111	0	56
DMR	1/7/2016	106		114	0	57
DMR	1/8/2016	114		112	0	56
DMR	1/9/2016	106		109	0	55
DMR	1/10/2016	111		109	0	55
DMR	1/11/2016	156		122	0	61
DMR	1/12/2016	135		127	0	64

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	1/13/2016	151		138	0	69
DMR	1/14/2016	150		148	0	74
DMR	1/15/2016	141		144	0	72
DMR	1/16/2016	142		146	0	73
DMR	1/17/2016	140		143	0	72
DMR	1/18/2016	151		144	0	72
DMR	1/19/2016	142		144	0	72
DMR	1/20/2016	151		146	0	73
DMR	1/21/2016	158		151	0	75
DMR	1/22/2016	126		144	0	72
DMR	1/23/2016	116		138	0	69
DMR	1/24/2016	115		129	0	64
DMR	1/25/2016	134		123	0	61
DMR	1/26/2016	131		124	0	62
DMR	1/27/2016	150		133	0	66
DMR	1/28/2016	160		144	0	72
DMR	1/29/2016	155		149	0	75
DMR	1/30/2016	156		155	0	78
DMR	1/31/2016	137		152	0	76
DMR	2/1/2016	127		144	0	72
DMR	2/2/2016	125		136	0	68
DMR	2/3/2016	100		122	0	61
DMR	2/4/2016	110		116	0	58
DMR	2/5/2016	143		120	0	60
DMR	2/6/2016	160		128	0	64
DMR	2/7/2016	170		146	0	73
DMR	2/8/2016	190		166	0	83
DMR	2/9/2016	166		172	0	86
DMR	2/10/2016	201		182	0	91
DMR	2/11/2016	181		185	0	92
DMR	2/12/2016	154		176	0	88
DMR	2/13/2016	150		172	0	86
DMR	2/14/2016	180		166	0	83
DMR	2/15/2016	166		163	0	81
DMR	2/16/2016	192		172	0	86
DMR	2/17/2016	182		180	0	90
DMR	2/18/2016	175		179	0	89
DMR	2/19/2016	166		179	0	89
DMR	2/20/2016	128	36.5	163	37	100
DMR	2/21/2016	97	28.5	142	33	87
DMR	2/22/2016	82	24	118	30	74
DMR	2/23/2016	160	22	117	28	72
DMR	2/24/2016	80	22	105	24	64
DMR	2/25/2016	72	23	99	23	61
DMR	2/26/2016	72	25	96	23	60
DMR	2/27/2016	53	23	69	23	46
DMR	2/28/2016	44	23	60	24	42
DMR	2/29/2016	42	24	53	24	38
DMR	3/1/2016	43	24	46	24	35
DMR	3/2/2016	36	28	41	25	33
DMR	3/3/2016	38	28	40	26	33
DMR	3/4/2016	36	24	38	26	32
DMR	3/5/2016	38	27	37	27	32
DMR	3/6/2016	33	24	36	26	31
DMR	3/7/2016	35	23	36	25	30

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	3/8/2016	30	23	34	24	29
DMR	3/9/2016	32	22	33	23	28
DMR	3/10/2016	29	20	32	22	27
DMR	3/11/2016	31	23	31	22	26
DMR	3/12/2016	34	22	32	22	27
DMR	3/13/2016	32	23	32	22	27
DMR	3/14/2016	29	20	32	22	27
DMR	3/15/2016	29	21	31	22	26
DMR	3/16/2016	27	20	29	21	25
DMR	3/17/2016	41	20	32	20	26
DMR	3/18/2016	29	21	32	21	26
DMR	3/19/2016	37	22	34	21	27
DMR	3/20/2016	35	23	36	22	29
DMR	3/21/2016	39	22	35	22	29
DMR	3/22/2016	42	22	38	22	30
DMR	3/23/2016	40	25	39	23	31
DMR	3/24/2016	48	26	42	24	33
DMR	3/25/2016	46	25	44	25	34
DMR	3/26/2016	44	24	45	25	35
DMR	3/27/2016	45	22	46	24	35
DMR	3/28/2016	45	23	45	24	34
DMR	3/29/2016	44	23	45	23	34
DMR	3/30/2016	38	24	43	23	33
DMR	3/31/2016	40	28	42	25	33
DMR	4/1/2016	37	25	40	25	32
DMR	4/2/2016	39	23	39	25	32
DMR	4/3/2016	42	27	40	26	33
DMR	4/4/2016	39	23	39	25	32
DMR	4/5/2016	44	23	41	24	33
DMR	4/6/2016	44	24	42	24	33
DMR	4/7/2016	44	26	43	24	33
DMR	4/8/2016	45	25	44	25	34
DMR	4/9/2016	40	23	43	25	34
DMR	4/10/2016	44	23	43	24	34
DMR	4/11/2016	48	20	44	23	34
DMR	4/12/2016	43	24	44	23	33
DMR	4/13/2016	42	26	44	23	34
DMR	4/14/2016	56	22	47	23	35
DMR	4/15/2016	94	28	59	25	42
DMR	4/16/2016	52	24	61	25	43
DMR	4/17/2016	48	23	63	24	43
DMR	4/18/2016	51	23	61	25	43
DMR	4/19/2016	54	29	51	25	38
DMR	4/20/2016	47	22	50	24	37
DMR	4/21/2016	46	27	50	25	37
DMR	4/22/2016	41	26	47	26	37
DMR	4/23/2016	38	23	43	25	34
DMR	4/24/2016	43	25	42	25	34
DMR	4/25/2016	48	26	43	25	34
DMR	4/26/2016	44	25	43	25	34
DMR	4/27/2016	44	27	45	26	35
DMR	4/28/2016	36	22	43	25	34
DMR	4/29/2016	36	23	40	24	32
DMR	4/30/2016	34	23	38	24	31
DMR	5/1/2016	35	21	35	22	29

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	5/2/2016	38	21	36	22	29
DMR	5/3/2016			0	0	0
DMR	5/4/2016			0	0	0
DMR	5/5/2016	44	26	41	24	32
DMR	5/6/2016	43	26	44	26	35
DMR	5/7/2016	41	25	43	26	34
DMR	5/8/2016	44	26	43	26	34
DMR	5/9/2016	51	27	45	26	35
DMR	5/10/2016	45	23	45	25	35
DMR	5/11/2016	42	26	46	26	36
DMR	5/12/2016	33	24	43	25	34
DMR	5/13/2016	37	24	39	24	32
DMR	5/14/2016	44	28	39	26	32
DMR	5/15/2016	67	30	45	27	36
DMR	5/16/2016	50	28	50	28	39
DMR	5/17/2016	48	29	52	29	41
DMR	5/18/2016	49	21	54	27	40
DMR	5/19/2016	49	23	49	25	37
DMR	5/20/2016	55	24	50	24	37
DMR	5/21/2016	46	24	50	23	36
DMR	5/22/2016	48	29	50	25	37
DMR	5/23/2016	57	25	52	26	39
DMR	5/24/2016	50	20	50	25	37
DMR	5/25/2016	53	25	52	25	38
DMR	5/26/2016	63	27	56	24	40
DMR	5/27/2016	70	26	59	25	42
DMR	5/28/2016	56	26	61	26	43
DMR	5/29/2016	68	24	64	26	45
DMR	5/30/2016	30	20	56	24	40
DMR	5/31/2016	34	20	47	23	35
DMR	6/1/2016	40	24	43	22	33
DMR	6/2/2016	42.5	23	37	22	29
DMR	6/3/2016	42	22	40	22	31
DMR	6/4/2016	40	24	41	23	32
DMR	6/5/2016	44	25	42	24	33
DMR	6/6/2016	46	26	43	24	34
DMR	6/7/2016	41	23	43	25	34
DMR	6/8/2016	43	23	44	24	34
DMR	6/9/2016	46	23	44	24	34
DMR	6/10/2016	47	25	44	24	34
DMR	6/11/2016	44	23	45	24	34
DMR	6/12/2016	46	24	46	24	35
DMR	6/13/2016	46	22	46	24	35
DMR	6/14/2016	54	24	48	23	35
DMR	6/15/2016	54	31	50	25	38
DMR	6/16/2016	58	24	53	25	39
DMR	6/17/2016	66	28	58	27	42
DMR	6/18/2016	66	34	61	29	45
DMR	6/19/2016	63	24	63	28	45
DMR	6/20/2016	67	23	66	27	46
DMR	6/21/2016	76	23	68	26	47
DMR	6/22/2016	77	25	71	24	47
DMR	6/23/2016	74	23	74	24	49
DMR	6/24/2016	79	25	77	24	50
DMR	6/25/2016	75	22	76	24	50

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	6/26/2016	85	24	78	24	51
DMR	6/27/2016	99	25.5	85	24	54
DMR	6/28/2016	79	25	85	24	54
DMR	6/29/2016	90	26.5	88	25	57
DMR	6/30/2016	138	26	102	26	64
DMR	7/1/2016	125	27	108	26	67
DMR	7/2/2016	118	24	118	26	72
DMR	7/3/2016	127	23	127	25	76
DMR	7/4/2016	124	23	124	24	74
DMR	7/5/2016	146	25	129	24	76
DMR	7/6/2016	144	25	135	24	80
DMR	7/7/2016	95	22	127	24	76
DMR	7/8/2016	118	23	126	24	75
DMR	7/9/2016	121	23	120	23	71
DMR	7/10/2016	38	19	93	22	57
DMR	7/11/2016	89	21	92	22	57
DMR	7/12/2016	78	23	82	22	52
DMR	7/13/2016	81	20	72	21	46
DMR	7/14/2016	89	25	84	22	53
DMR	7/15/2016	89	24	84	23	54
DMR	7/16/2016	83	23	86	23	54
DMR	7/17/2016	54	33	79	26	53
DMR	7/18/2016	26	16	63	24	44
DMR	7/19/2016	30	25	48	24	36
DMR	7/20/2016	32	21	36	24	30
DMR	7/21/2016	41	21	32	21	27
DMR	7/22/2016	42	20	36	22	29
DMR	7/23/2016	40	21	39	21	30
DMR	7/24/2016	41	23	41	21	31
DMR	7/25/2016	50	22	43	22	32
DMR	7/26/2016	50	21	45	22	34
DMR	7/27/2016	51	28	48	24	36
DMR	7/28/2016	54	21	51	23	37
DMR	7/29/2016	65	21	55	23	39
DMR	7/30/2016	62	22	58	23	41
DMR	7/31/2016	61	21	61	21	41
DMR	8/1/2016	79	23	67	22	44
DMR	8/2/2016	73	19	69	21	45
DMR	8/3/2016	80	23	73	22	47
DMR	8/4/2016	93	24	81	22	52
DMR	8/5/2016	82	18	82	21	52
DMR	8/6/2016	75	21	83	22	52
DMR	8/7/2016	82	21	83	21	52
DMR	8/8/2016	89	24	82	21	52
DMR	8/9/2016	113	22	90	22	56
DMR	8/10/2016	125	23	102	23	62
DMR	8/11/2016	55	17	96	22	59
DMR	8/12/2016	37	14	83	19	51
DMR	8/13/2016	102	22	80	19	49
DMR	8/14/2016	115	25	77	20	48
DMR	8/15/2016	130	24	96	21	59
DMR	8/16/2016	119	19	117	23	70
DMR	8/17/2016	134	22	125	23	74
DMR	8/18/2016	150	28	133	23	78
DMR	8/19/2016	56	26	115	24	69

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	8/20/2016	106	26	112	26	69
DMR	8/21/2016	93	23	101	26	64
DMR	8/22/2016	108	21	91	24	57
DMR	8/23/2016	122	22	107	23	65
DMR	8/24/2016	116	22	110	22	66
DMR	8/25/2016	102	22	112	22	67
DMR	8/26/2016	133	25	118	23	71
DMR	8/27/2016	119	31	118	25	71
DMR	8/28/2016	106	22	115	25	70
DMR	8/29/2016	130	23	122	25	74
DMR	8/30/2016	126	26	120	26	73
DMR	8/31/2016	142	22	126	23	75
DMR	9/1/2016	153	23	138	24	81
DMR	9/2/2016	155	25	144	24	84
DMR	9/3/2016	159	31	152	25	89
DMR	9/4/2016	139	22	152	25	88
DMR	9/5/2016	86	17	135	24	79
DMR	9/6/2016	45	15	107	21	64
DMR	9/7/2016	116	25	97	20	58
DMR	9/8/2016	146	25	98	21	59
DMR	9/9/2016	96	19	101	21	61
DMR	9/10/2016	143	24	125	23	74
DMR	9/11/2016	80	23	116	23	70
DMR	9/12/2016	99	26	105	23	64
DMR	9/13/2016	115	27	109	25	67
DMR	9/14/2016	120	26	104	26	65
DMR	9/15/2016	137	26	118	26	72
DMR	9/16/2016	106	23	120	26	73
DMR	9/17/2016	82	24	111	25	68
DMR	9/18/2016	80	27	101	25	63
DMR	9/19/2016	98	30	92	26	59
DMR	9/20/2016	104	26	91	27	59
DMR	9/21/2016	106	28	97	28	62
DMR	9/22/2016	111	28	105	28	66
DMR	9/23/2016	108	24	107	27	67
DMR	9/24/2016	103	24	107	26	67
DMR	9/25/2016	69	20	98	24	61
DMR	9/26/2016	50	24	83	23	53
DMR	9/27/2016	54	25	69	23	46
DMR	9/28/2016	59	24	58	23	41
DMR	9/29/2016	53	23	54	24	39
DMR	9/30/2016	65	28	58	25	41
DMR	10/1/2016	49	23	57	25	41
DMR	10/2/2016	80	23	62	24	43
DMR	10/3/2016	94	22	72	24	48
DMR	10/4/2016	78	28	75	24	50
DMR	10/5/2016	68	21	80	24	52
DMR	10/6/2016	44	22	71	23	47
DMR	10/7/2016	44	21	59	23	41
DMR	10/8/2016	38	22	49	22	35
DMR	10/9/2016	38	24	41	22	32
DMR	10/10/2016	37	25	39	23	31
DMR	10/11/2016	43	22	39	23	31
DMR	10/12/2016	45	23	41	24	32
DMR	10/13/2016	44	23	42	23	33

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	10/14/2016	49	24	45	23	34
DMR	10/15/2016	44	24	46	24	35
DMR	10/16/2016	49	24	47	24	35
DMR	10/17/2016	51	23	48	24	36
DMR	10/18/2016	54	22	50	23	36
DMR	10/19/2016	51	28	51	24	38
DMR	10/20/2016	52	25	52	25	38
DMR	10/21/2016	62	27	55	26	40
DMR	10/22/2016	63	28	57	27	42
DMR	10/23/2016	66	28	61	27	44
DMR	10/24/2016	68	29	65	28	46
DMR	10/25/2016	66	23	66	27	46
DMR	10/26/2016	63	26	66	27	46
DMR	10/27/2016	66	26	66	26	46
DMR	10/28/2016	73	25	67	25	46
DMR	10/29/2016	66	30	67	27	47
DMR	10/30/2016	63	26	67	27	47
DMR	10/31/2016	71	29	68	28	48
DMR	11/1/2016	96	71	74	39	57
DMR	11/2/2016	79	29	77	39	58
DMR	11/3/2016	71	29	79	40	59
DMR	11/4/2016	89	35	84	41	62
DMR	11/5/2016	77	31	79	31	55
DMR	11/6/2016	75	29	78	31	55
DMR	11/7/2016	88	28	82	31	57
DMR	11/8/2016	92	34	83	31	57
DMR	11/9/2016	95	28	88	30	59
DMR	11/10/2016	89	29	91	30	60
DMR	11/11/2016	87	26	91	29	60
DMR	11/12/2016	63	28	84	28	56
DMR	11/13/2016	97	27	84	28	56
DMR	11/14/2016	83	26	83	27	55
DMR	11/15/2016	63	26	77	27	52
DMR	11/16/2016	61	26	76	26	51
DMR	11/17/2016	123	26	83	26	54
DMR	11/18/2016	61	27	77	26	52
DMR	11/19/2016	151	26	99	26	63
DMR	11/20/2016	175	32	128	28	78
DMR	11/21/2016	82	30	117	29	73
DMR	11/22/2016	81	61	122	37	80
DMR	11/23/2016	72	21	103	36	69
DMR	11/24/2016	74	28	77	35	56
DMR	11/25/2016	76	28	76	35	55
DMR	11/26/2016	69	26	73	26	49
DMR	11/27/2016	61	25	70	27	48
DMR	11/28/2016	63	27	67	27	47
DMR	11/29/2016	48	24	60	26	43
DMR	11/30/2016	48	28	55	26	41
DMR	12/1/2016	46	25	51	26	39
DMR	12/2/2016	53	26	49	26	37
DMR	12/3/2016	52	27	50	27	38
DMR	12/4/2016	57	29	52	27	39
DMR	12/5/2016	56	33	55	29	42
DMR	12/6/2016	59	27	56	29	43
DMR	12/7/2016	79	36	63	31	47

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	12/8/2016	96	31	73	32	52
DMR	12/9/2016	66	28	75	31	53
DMR	12/10/2016	70	30	78	31	55
DMR	12/11/2016	58	29	73	30	51
DMR	12/12/2016	48	30	61	29	45
DMR	12/13/2016	56	29	58	30	44
DMR	12/14/2016	69	32	58	30	44
DMR	12/15/2016	69	30	61	30	45
DMR	12/16/2016	63	29	64	30	47
DMR	12/17/2016	54	23	64	29	46
DMR	12/18/2016	56	27	61	27	44
DMR	12/19/2016	59	26	58	26	42
DMR	12/20/2016	45	28	54	26	40
DMR	12/21/2016	64	26	56	27	41
DMR	12/22/2016	72	29	60	27	44
DMR	12/23/2016	59	29	60	28	44
DMR	12/24/2016	86	27	70	28	49
DMR	12/25/2016	74	34	73	30	51
DMR	12/26/2016	76	31	74	30	52
DMR	12/27/2016	53	27	72	30	51
DMR	12/28/2016	63	25	67	29	48
DMR	12/29/2016	57	25	62	27	45
DMR	12/30/2016	52	25	56	26	41
DMR	12/31/2016	55	30	57	26	42
DMR	1/1/2017	50	27	55	26	41
DMR	1/2/2017	37		50	0	25
DMR	1/3/2017	59		51	0	25
DMR	1/4/2017	67		53	0	27
DMR	1/5/2017	76		60	0	30
DMR	1/6/2017	52		64	0	32
DMR	1/7/2017	52		62	0	31
DMR	1/8/2017	55		59	0	29
DMR	1/9/2017	81		60	0	30
DMR	1/10/2017	83		68	0	34
DMR	1/11/2017	95		79	0	39
DMR	1/12/2017	62		80	0	40
DMR	1/13/2017	80		80	0	40
DMR	1/14/2017	97		84	0	42
DMR	1/15/2017	93		83	0	42
DMR	1/16/2017	62		83	0	42
DMR	1/17/2017	107		90	0	45
DMR	1/18/2017	103		91	0	46
DMR	1/19/2017	117		97	0	49
DMR	1/20/2017	76		101	0	50
DMR	1/21/2017	72	28	92	28	60
DMR	1/22/2017	51	25	79	27	53
DMR	1/23/2017	47	23	62	25	43
DMR	1/24/2017	46	21	54	24	39
DMR	1/25/2017	61	24	51	23	37
DMR	1/26/2017	46	31	50	25	37
DMR	1/27/2017	60		53	0	27
DMR	1/28/2017	57		56	0	28
DMR	1/29/2017	54		54	0	27
DMR	1/30/2017	62		58	0	29
DMR	1/31/2017	62		59	0	29

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	2/1/2017	48		57	0	28
DMR	2/2/2017	58		58	0	29
DMR	2/3/2017	65		58	0	29
DMR	2/4/2017	59		58	0	29
DMR	2/5/2017	57		60	0	30
DMR	2/6/2017	66		62	0	31
DMR	2/7/2017	61		61	0	30
DMR	2/8/2017	70		64	0	32
DMR	2/9/2017	84		70	0	35
DMR	2/10/2017	75		73	0	36
DMR	2/11/2017	63		73	0	37
DMR	2/12/2017	62		71	0	36
DMR	2/13/2017	59		65	0	32
DMR	2/14/2017	56		60	0	30
DMR	2/15/2017	56		58	0	29
DMR	2/16/2017	55		57	0	28
DMR	2/17/2017	52	21	55	21	38
DMR	2/18/2017	37		50	0	25
DMR	2/19/2017	34		45	0	22
DMR	2/20/2017	35	16	40	19	29
DMR	2/21/2017	30	17	34	17	25
DMR	2/22/2017	36	18	34	17	25
DMR	2/23/2017	42	18	36	17	27
DMR	2/24/2017	35	19	36	18	27
DMR	2/25/2017	31	24	36	20	28
DMR	2/26/2017	54	21.5	41	21	31
DMR	2/27/2017	44	21	41	21	31
DMR	2/28/2017	46	19	44	21	33
DMR	3/1/2017	40	21	46	21	33
DMR	3/2/2017	47	21	44	21	32
DMR	3/3/2017	55	21	47	21	34
DMR	3/4/2017	55	23	49	22	35
DMR	3/5/2017	40	21	49	22	35
DMR	3/6/2017	55	24	51	22	37
DMR	3/7/2017	49	24	50	23	36
DMR	3/8/2017	72	21	54	23	38
DMR	3/9/2017	60	21	59	23	41
DMR	3/10/2017	63	24	61	23	42
DMR	3/11/2017	116	29	78	24	51
DMR	3/12/2017	56	28	74	26	50
DMR	3/13/2017	111	25	87	27	57
DMR	3/14/2017	84	23	92	26	59
DMR	3/15/2017	69	25	80	25	53
DMR	3/16/2017	70	23	84	24	54
DMR	3/17/2017	66	23	72	24	48
DMR	3/18/2017	56	27	65	25	45
DMR	3/19/2017	51	26	61	25	43
DMR	3/20/2017	55	22	57	25	41
DMR	3/21/2017	52	24	54	25	39
DMR	3/22/2017	52	21	53	23	38
DMR	3/23/2017	55	21	54	22	38
DMR	3/24/2017	51	22	53	22	37
DMR	3/25/2017	51	23	52	22	37
DMR	3/26/2017	51	24	52	23	37
DMR	3/27/2017	52	24	51	23	37

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	3/28/2017	49	23	51	24	37
DMR	3/29/2017	51	24	51	24	37
DMR	3/30/2017	71	31	56	26	41
DMR	3/31/2017	58	26	57	26	42
DMR	4/1/2017	51	29	58	28	43
DMR	4/2/2017	53	26	58	28	43
DMR	4/3/2017	60	22	56	26	41
DMR	4/4/2017	46	23	53	25	39
DMR	4/5/2017	48	21	52	23	37
DMR	4/6/2017	57	22	53	22	37
DMR	4/7/2017	55	22	52	22	37
DMR	4/8/2017	57	27	54	23	39
DMR	4/9/2017	57	29	57	25	41
DMR	4/10/2017	68	25	59	26	43
DMR	4/11/2017	65	25	62	27	44
DMR	4/12/2017	72	25	66	26	46
DMR	4/13/2017	61	27	67	26	46
DMR	4/14/2017	57	29	64	27	45
DMR	4/15/2017	54	23	61	26	44
DMR	4/16/2017	46	22	55	25	40
DMR	4/17/2017	49	22	52	24	38
DMR	4/18/2017	56	28	51	24	38
DMR	4/19/2017	55	25	52	24	38
DMR	4/20/2017	48	24	52	25	38
DMR	4/21/2017	48	26	52	26	39
DMR	4/22/2017	50	28	50	26	38
DMR	4/23/2017	44	25	48	26	37
DMR	4/24/2017	52	23	49	26	37
DMR	4/25/2017	55	24	50	25	38
DMR	4/26/2017	56	25	52	24	38
DMR	4/27/2017	48	23	53	24	38
DMR	4/28/2017	49	26	52	25	38
DMR	4/29/2017	47	24	50	25	37
DMR	4/30/2017	42	27	47	25	36
DMR	5/1/2017	75	30	53	27	40
DMR	5/2/2017	51	28	54	27	41
DMR	5/3/2017	43	31	53	29	41
DMR	5/4/2017	49	28	55	29	42
DMR	5/5/2017	33	22	44	27	36
DMR	5/6/2017	34	22	40	26	33
DMR	5/7/2017	31	22	37	24	30
DMR	5/8/2017	36	25	34	23	28
DMR	5/9/2017	40	24	35	23	29
DMR	5/10/2017	43	23	38	24	31
DMR	5/11/2017	41	24	40	24	32
DMR	5/12/2017	40	24	41	24	32
DMR	5/13/2017	48	29	43	25	34
DMR	5/14/2017	44	29	43	27	35
DMR	5/15/2017	52	25	46	27	36
DMR	5/16/2017	46	18	48	25	36
DMR	5/17/2017	48	22	48	24	36
DMR	5/18/2017	36	20	46	21	33
DMR	5/19/2017	31	18	40	20	30
DMR	5/20/2017	25	18	35	20	27
DMR	5/21/2017	30	17	31	18	24

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	5/22/2017	28	19	29	18	23
DMR	5/23/2017	32	23	29	19	24
DMR	5/24/2017	28	22	30	20	25
DMR	5/25/2017	29	23	29	22	26
DMR	5/26/2017			0	0	0
DMR	5/27/2017	28	21	28	22	25
DMR	5/28/2017	28	21	28	22	25
DMR	5/29/2017	29	22	28	21	25
DMR	5/30/2017	31	21	29	21	25
DMR	5/31/2017	34	21	31	21	26
DMR	6/1/2017	35	23	32	22	27
DMR	6/2/2017	45	23	36	22	29
DMR	6/3/2017	31	26	36	23	30
DMR	6/4/2017	36	24	37	24	30
DMR	6/5/2017	45	26	39	25	32
DMR	6/6/2017	34	21	37	24	30
DMR	6/7/2017	38	20	38	23	31
DMR	6/8/2017	41	21	40	22	31
DMR	6/9/2017			0	0	0
DMR	6/10/2017	39	22	39	21	30
DMR	6/11/2017	43	24	41	22	32
DMR	6/12/2017	35	21	39	22	31
DMR	6/13/2017	35	22	38	22	30
DMR	6/14/2017	36	24	37	23	30
DMR	6/15/2017	39	23	36	23	29
DMR	6/16/2017	39	21	37	23	30
DMR	6/17/2017	45	20	40	22	31
DMR	6/18/2017	33	20	39	21	30
DMR	6/19/2017	39	18	39	20	29
DMR	6/20/2017	40	20	39	20	29
DMR	6/21/2017	41	20	38	20	29
DMR	6/22/2017	49	31	42	22	32
DMR	6/23/2017	37	21	42	23	32
DMR	6/24/2017	52	21	45	23	34
DMR	6/25/2017	39	35	44	27	36
DMR	6/26/2017	45	23	43	25	34
DMR	6/27/2017	48	20	46	25	35
DMR	6/28/2017	47	22	45	25	35
DMR	6/29/2017	48	21	47	22	34
DMR	6/30/2017	51	22	49	21	35
DMR	7/1/2017	52	22	50	22	36
DMR	7/2/2017	53	22	51	22	36
DMR	7/3/2017	58	23	54	22	38
DMR	7/4/2017	59	30	56	24	40
DMR	7/5/2017	51	23	55	25	40
DMR	7/6/2017	64	24	58	25	42
DMR	7/7/2017	60	24	59	25	42
DMR	7/8/2017	50	22	56	23	40
DMR	7/9/2017	62	22	59	23	41
DMR	7/10/2017	68	22	60	23	41
DMR	7/11/2017	70	22	63	22	42
DMR	7/12/2017	80	25	70	23	46
DMR	7/13/2017	84	22	76	23	49
DMR	7/14/2017	98	22	83	23	53
DMR	7/15/2017	87	22	87	23	55

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	7/16/2017	87	26	89	23	56
DMR	7/17/2017	107	22	95	23	59
DMR	7/18/2017	107	25	97	24	60
DMR	7/19/2017	111	21	103	24	63
DMR	7/20/2017	80	20	101	22	62
DMR	7/21/2017	61	17	90	21	55
DMR	7/22/2017	49	17	75	19	47
DMR	7/23/2017	49	19	60	18	39
DMR	7/24/2017	67	25	57	20	38
DMR	7/25/2017	68	25	58	22	40
DMR	7/26/2017	63	21	62	23	42
DMR	7/27/2017	55	25	63	24	44
DMR	7/28/2017	58	20	61	23	42
DMR	7/29/2017	59	20	59	22	40
DMR	7/30/2017	57	20	57	21	39
DMR	7/31/2017	66	22	60	21	40
DMR	8/1/2017	78	22	65	21	43
DMR	8/2/2017	70	23	68	22	45
DMR	8/3/2017	82	23	74	23	48
DMR	8/4/2017	73	22	76	23	49
DMR	8/5/2017	49	26	69	24	46
DMR	8/6/2017	80	26	71	24	48
DMR	8/7/2017	92	24	74	25	49
DMR	8/8/2017	105	31	82	27	54
DMR	8/9/2017	103	23	95	26	61
DMR	8/10/2017	93	22	98	25	62
DMR	8/11/2017	98	21	100	24	62
DMR	8/12/2017	101	22	99	22	60
DMR	8/13/2017	95	22	97	22	59
DMR	8/14/2017	101	20	99	21	60
DMR	8/15/2017	98	41	99	26	63
DMR	8/16/2017	91	21	96	26	61
DMR	8/17/2017	94	22	96	26	61
DMR	8/18/2017	30	18	78	26	52
DMR	8/19/2017	28	20	61	20	41
DMR	8/20/2017	26	20	45	20	32
DMR	8/21/2017	26	20	28	20	24
DMR	8/22/2017	32	24	28	21	25
DMR	8/23/2017	32	17	29	20	25
DMR	8/24/2017	33	18	31	20	25
DMR	8/25/2017	31	26	32	21	27
DMR	8/26/2017	29	20	31	20	26
DMR	8/27/2017	31	20	31	21	26
DMR	8/28/2017	31	21	31	22	26
DMR	8/29/2017	30	21	30	21	25
DMR	8/30/2017	35	22	32	21	26
DMR	8/31/2017	35	20	33	21	27
DMR	9/1/2017	35	22	34	21	28
DMR	9/2/2017	32	21	34	21	28
DMR	9/3/2017	34	21	34	21	28
DMR	9/4/2017	34	24	34	22	28
DMR	9/5/2017	37	21	34	22	28
DMR	9/6/2017	29	26	34	23	28
DMR	9/7/2017	38	22	35	23	29
DMR	9/8/2017	35	24	35	23	29

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	9/9/2017	52	23	39	24	31
DMR	9/10/2017	47	21	43	23	33
DMR	9/11/2017	47	23	45	23	34
DMR	9/12/2017	52	25	50	23	36
DMR	9/13/2017	62	35	52	26	39
DMR	9/14/2017	58	21	55	26	40
DMR	9/15/2017	68	22	60	26	43
DMR	9/16/2017	67	21	64	25	44
DMR	9/17/2017	62	23	64	22	43
DMR	9/18/2017	73	31	68	24	46
DMR	9/19/2017	77	33	70	27	48
DMR	9/20/2017	70	22	71	27	49
DMR	9/21/2017	60	31	70	29	50
DMR	9/22/2017	74	24	70	28	49
DMR	9/23/2017	62	23	67	25	46
DMR	9/24/2017	60	21	64	25	44
DMR	9/25/2017	45	20	60	22	41
DMR	9/26/2017	43	29	53	23	38
DMR	9/27/2017	46	24	49	24	36
DMR	9/28/2017	52	23	47	24	35
DMR	9/29/2017	53	25	49	25	37
DMR	9/30/2017	51	22	51	24	37
DMR	10/1/2017	52	22	52	23	38
DMR	10/2/2017	45	25	50	24	37
DMR	10/3/2017	32	16	45	21	33
DMR	10/4/2017	27	18	39	20	30
DMR	10/5/2017	30	21	34	20	27
DMR	10/6/2017	22	16	28	18	23
DMR	10/7/2017	26	20	26	19	23
DMR	10/8/2017	25	21	26	20	23
DMR	10/9/2017	26	19	25	19	22
DMR	10/10/2017	28	24	26	21	24
DMR	10/11/2017	32	22	28	22	25
DMR	10/12/2017	29	21	29	22	25
DMR	10/13/2017	33	20	31	22	26
DMR	10/14/2017	33	32	32	24	28
DMR	10/15/2017	33	24	32	24	28
DMR	10/16/2017	39	26	35	26	30
DMR	10/17/2017	31	21	34	26	30
DMR	10/18/2017	38	22	35	23	29
DMR	10/19/2017	48	25	39	24	31
DMR	10/20/2017	40	25	39	23	31
DMR	10/21/2017	40	24	42	24	33
DMR	10/22/2017	35	24	41	25	33
DMR	10/23/2017	33	25	37	25	31
DMR	10/24/2017	42	22	38	24	31
DMR	10/25/2017	41	22	38	23	31
DMR	10/26/2017	47	25	41	24	32
DMR	10/27/2017	40	21	43	23	33
DMR	10/28/2017	48	22	44	23	33
DMR	10/29/2017	40	21	44	22	33
DMR	10/30/2017	40	22	42	22	32
DMR	10/31/2017	44	22	43	22	32
DMR	11/1/2017	47	23	43	22	32
DMR	11/2/2017	55	26	47	23	35

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	11/3/2017	46	27	48	25	36
DMR	11/4/2017	50	26	50	26	38
DMR	11/5/2017	44	26	49	26	38
DMR	11/6/2017	45	26	46	26	36
DMR	11/7/2017	59	28	50	27	38
DMR	11/8/2017	44	25	48	26	37
DMR	11/9/2017	52	23	50	26	38
DMR	11/10/2017	58	24	53	25	39
DMR	11/11/2017	62	24	54	24	39
DMR	11/12/2017	46	26	55	24	39
DMR	11/13/2017	51	22	54	24	39
DMR	11/14/2017	55	24	54	24	39
DMR	11/15/2017	52	24	51	24	38
DMR	11/16/2017	61	26	55	24	39
DMR	11/17/2017	44	25	53	25	39
DMR	11/18/2017	57	28	54	26	40
DMR	11/19/2017	49	26	53	26	40
DMR	11/20/2017	55	27	51	27	39
DMR	11/21/2017	55	26	54	27	40
DMR	11/22/2017	60	22	55	25	40
DMR	11/23/2017	50	25	55	25	40
DMR	11/24/2017	47	26	53	25	39
DMR	11/25/2017	45	24	51	24	37
DMR	11/26/2017	43	25	46	25	36
DMR	11/27/2017	46	22	45	24	35
DMR	11/28/2017	54	21	47	23	35
DMR	11/29/2017	60	21	51	22	37
DMR	11/30/2017	58	23	55	22	38
DMR	12/1/2017	39	22	53	22	37
DMR	12/2/2017	48	22	51	22	37
DMR	12/3/2017	53	27	50	24	37
DMR	12/4/2017	60	24	50	24	37
DMR	12/5/2017	58	23	55	24	39
DMR	12/6/2017	99	27	68	25	46
DMR	12/7/2017	75	25	73	25	49
DMR	12/8/2017	94	29	82	26	54
DMR	12/9/2017	70	30	85	28	56
DMR	12/10/2017	54	26	73	28	50
DMR	12/11/2017	73	24	73	27	50
DMR	12/12/2017	38	26	59	27	43
DMR	12/13/2017	67	26	58	26	42
DMR	12/14/2017	65	21	61	24	43
DMR	12/15/2017	78	23	62	24	43
DMR	12/16/2017	47	24	64	24	44
DMR	12/17/2017	69	22	65	23	44
DMR	12/18/2017	80	22	69	23	46
DMR	12/19/2017	71	23	67	23	45
DMR	12/20/2017	80	24	75	23	49
DMR	12/21/2017	85	22	79	23	51
DMR	12/22/2017	122	21	90	23	56
DMR	12/23/2017	102	33	97	25	61
DMR	12/24/2017	81	34	98	28	63
DMR	12/25/2017	84		97	0	49
DMR	12/26/2017	71		85	0	42
DMR	12/27/2017	82		80	0	40

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	12/28/2017	75		78	0	39
DMR	12/29/2017	98		82	0	41
DMR	12/30/2017	100		89	0	44
DMR	12/31/2017	82		89	0	44
DMR	1/1/2018	84		91	0	46
DMR	1/2/2018	99		91	0	46
DMR	1/3/2018	102		92	0	46
DMR	1/4/2018	111		99	0	50
DMR	1/5/2018	112		106	0	53
DMR	1/6/2018	79		101	0	51
DMR	1/7/2018	105		102	0	51
DMR	1/8/2018	118		104	0	52
DMR	1/9/2018	121		106	0	53
DMR	1/10/2018	138		121	0	60
DMR	1/11/2018	118		124	0	62
DMR	1/12/2018	147		131	0	66
DMR	1/13/2018	170		143	0	72
DMR	1/14/2018	140		144	0	72
DMR	1/15/2018	140		149	0	75
DMR	1/16/2018	148		150	0	75
DMR	1/17/2018	160		147	0	74
DMR	1/18/2018	149		149	0	75
DMR	1/19/2018	133		148	0	74
DMR	1/20/2018	138		145	0	73
DMR	1/21/2018	134		139	0	69
DMR	1/22/2018	122		132	0	66
DMR	1/23/2018	126		130	0	65
DMR	1/24/2018	85		117	0	58
DMR	1/25/2018	77		103	0	51
DMR	1/26/2018	139		107	0	53
DMR	1/27/2018	116		104	0	52
DMR	1/28/2018	117		112	0	56
DMR	1/29/2018	122		124	0	62
DMR	1/30/2018	128		121	0	60
DMR	1/31/2018	131		125	0	62
DMR	2/1/2018	127		127	0	64
DMR	2/2/2018	140		132	0	66
DMR	2/3/2018	143		135	0	68
DMR	2/4/2018	151		140	0	70
DMR	2/5/2018	160		149	0	74
DMR	2/6/2018	129		146	0	73
DMR	2/7/2018	147		147	0	73
DMR	2/8/2018	152		147	0	74
DMR	2/9/2018	165		148	0	74
DMR	2/10/2018	174		160	0	80
DMR	2/11/2018	180		168	0	84
DMR	2/12/2018	176		174	0	87
DMR	2/13/2018	173		176	0	88
DMR	2/14/2018	180		177	0	89
DMR	2/15/2018	212		185	0	93
DMR	2/16/2018	192		189	0	95
DMR	2/17/2018	184		192	0	96
DMR	2/18/2018	200		197	0	99
DMR	2/19/2018	210		197	0	98
DMR	2/20/2018	96		173	0	86

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	2/21/2018	99		151	0	76
DMR	2/22/2018	102		127	0	63
DMR	2/23/2018	158		114	0	57
DMR	2/24/2018	141		125	0	63
DMR	2/25/2018	169		143	0	71
DMR	2/26/2018	194		166	0	83
DMR	2/27/2018	172		169	0	85
DMR	2/28/2018	177		178	0	89
DMR	3/1/2018	138		170	0	85
DMR	3/2/2018	172		165	0	82
DMR	3/3/2018	163		163	0	81
DMR	3/4/2018	205		170	0	85
DMR	3/5/2018	104	51	161	51	106
DMR	3/6/2018	42	18	129	35	82
DMR	3/7/2018	46	26	99	32	65
DMR	3/8/2018	79	30	68	31	50
DMR	3/9/2018	60	28	57	26	41
DMR	3/10/2018	60	31	61	29	45
DMR	3/11/2018	75	31	69	30	49
DMR	3/12/2018	87	32	71	31	51
DMR	3/13/2018	65	28	72	31	51
DMR	3/14/2018	58	25	71	29	50
DMR	3/15/2018	62	26	68	28	48
DMR	3/16/2018	57	26	61	26	43
DMR	3/17/2018	47.5	26	56	26	41
DMR	3/18/2018	43.5	24	53	26	39
DMR	3/19/2018	44.5	25	48	25	37
DMR	3/20/2018	34.5	21.5	43	24	33
DMR	3/21/2018	37	24	40	24	32
DMR	3/22/2018	29	22	36	23	30
DMR	3/23/2018	22	18	31	21	26
DMR	3/24/2018	22		28	0	14
DMR	3/25/2018	27	21	25	20	23
DMR	3/26/2018	30	21	25	20	23
DMR	3/27/2018	27	22	27	21	24
DMR	3/28/2018	30	18	29	21	25
DMR	3/29/2018	25	19	28	20	24
DMR	3/30/2018	26	22	27	20	24
DMR	3/31/2018	24	18	26	19	23
DMR	4/1/2018	22	18	24	19	22
DMR	4/2/2018	25	18	24	19	22
DMR	4/3/2018	28.5	20	25	19	22
DMR	4/4/2018	29	20	26	19	23
DMR	4/5/2018	33	19	29	19	24
DMR	4/6/2018	32	23	31	21	26
DMR	4/7/2018	31	21	31	21	26
DMR	4/8/2018	29	24	31	22	27
DMR	4/9/2018	36	23	32	23	27
DMR	4/10/2018	35	21	33	22	28
DMR	4/11/2018	33	21	33	22	28
DMR	4/12/2018	17	11	30	19	25
DMR	4/13/2018	20	13	26	17	21
DMR	4/14/2018	15	14	21	15	18
DMR	4/15/2018	22	14	19	13	16
DMR	4/16/2018	26	13	21	14	17

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	4/17/2018	26	14	22	14	18
DMR	4/18/2018	26.5	16.5	25	14	20
DMR	4/19/2018	27.5	16.5	27	15	21
DMR	4/20/2018	24	24	26	18	22
DMR	4/21/2018	26	18	26	19	22
DMR	4/22/2018	16	12	23	18	21
DMR	4/23/2018	11	7	19	15	17
DMR	4/24/2018	12	8	16	11	14
DMR	4/25/2018	13	11	13	10	11
DMR	4/26/2018	11	11	12	9	11
DMR	4/27/2018	14	10	13	10	11
DMR	4/28/2018	15	10	13	11	12
DMR	4/29/2018	15	10	14	10	12
DMR	4/30/2018	21	15.5	16	11	14
DMR	5/1/2018	20	15	18	13	15
DMR	5/2/2018	20	16	19	14	17
DMR	5/3/2018	23	15	21	15	18
DMR	5/4/2018	19	13	21	15	18
DMR	5/5/2018	22	14	21	15	18
DMR	5/6/2018	24	18	22	15	19
DMR	5/7/2018	24	16	22	15	19
DMR	5/8/2018	24	18	24	17	20
DMR	5/9/2018	28	17	25	17	21
DMR	5/10/2018	31	19	27	18	22
DMR	5/11/2018	32	20	29	19	24
DMR	5/12/2018	29	19	30	19	24
DMR	5/13/2018	31	17	31	19	25
DMR	5/14/2018	30	18	31	19	25
DMR	5/15/2018	35	20	31	19	25
DMR	5/16/2018	31	17	32	18	25
DMR	5/17/2018	35	18	33	18	26
DMR	5/18/2018	37	19	35	19	27
DMR	5/19/2018	33	18	34	18	26
DMR	5/20/2018	32	19	34	19	26
DMR	5/21/2018	38	22.5	35	20	27
DMR	5/22/2018	33.5	19	34	20	27
DMR	5/23/2018	32	17	34	19	27
DMR	5/24/2018	23	18	32	19	25
DMR	5/25/2018	20	17	27	18	22
DMR	5/26/2018	21	18	24	18	21
DMR	5/27/2018	19	19	21	18	19
DMR	5/28/2018	21	26	20	20	20
DMR	5/29/2018	25	18	22	20	21
DMR	5/30/2018	25	18	23	20	21
DMR	5/31/2018	24	17	24	20	22
DMR	6/1/2018	40	15	29	17	23
DMR	6/2/2018	36	23	31	18	25
DMR	6/3/2018	34	17	34	18	26
DMR	6/4/2018	43	17	38	18	28
DMR	6/5/2018	46	18	40	19	29
DMR	6/6/2018	47	18	43	18	30
DMR	6/7/2018	47	17	46	18	32
DMR	6/8/2018	51	18	48	18	33
DMR	6/9/2018	49	18	49	18	33
DMR	6/10/2018	41	18	47	18	32

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	6/11/2018	43	16	46	18	32
DMR	6/12/2018	45	16	45	17	31
DMR	6/13/2018	44	21	43	18	31
DMR	6/14/2018	57	19	47	18	33
DMR	6/15/2018	57	20	51	19	35
DMR	6/16/2018	51	19	52	20	36
DMR	6/17/2018	50	18	54	19	36
DMR	6/18/2018	48	17	52	19	35
DMR	6/19/2018	29	17	45	18	31
DMR	6/20/2018	13	10	35	16	25
DMR	6/21/2018	15	11	26	14	20
DMR	6/22/2018	15	11	18	12	15
DMR	6/23/2018	16	12	15	11	13
DMR	6/24/2018	19	15	16	12	14
DMR	6/25/2018	19	15	17	13	15
DMR	6/26/2018	17	12	18	14	16
DMR	6/27/2018	19	12	19	14	16
DMR	6/28/2018	21	13	19	13	16
DMR	6/29/2018	18	12	19	12	16
DMR	6/30/2018	21	19	20	14	17
DMR	7/1/2018	17	13	19	14	17
DMR	7/2/2018	15	11	18	14	16
DMR	7/3/2018	13	5	17	12	14
DMR	7/4/2018	17	9	16	10	13
DMR	7/5/2018	11	9	14	9	11
DMR	7/6/2018	10	9	13	8	10
DMR	7/7/2018	12	10	13	9	11
DMR	7/8/2018	12	11	11	10	11
DMR	7/9/2018	17	16	13	12	12
DMR	7/10/2018			14	12	13
DMR	7/11/2018	18	13	16	13	15
DMR	7/12/2018	19	12	18	14	16
DMR	7/13/2018	20	14	19	13	16
DMR	7/14/2018	20	13	19	13	16
DMR	7/15/2018	21	12	20	13	16
DMR	7/16/2018	23	13	21	13	17
DMR	7/17/2018	22	18	22	14	18
DMR	7/18/2018	26	19	23	16	19
DMR	7/19/2018	24	13	24	16	20
DMR	7/20/2018	21	12	23	16	19
DMR	7/21/2018	21	15	23	15	19
DMR	7/22/2018	23	14	22	14	18
DMR	7/23/2018	25	16	23	14	18
DMR	7/24/2018	30	17	25	16	20
DMR	7/25/2018	27	16	26	16	21
DMR	7/26/2018	29	16	28	16	22
DMR	7/27/2018	28	18	29	17	23
DMR	7/28/2018	26	15	28	16	22
DMR	7/29/2018	26	15	27	16	22
DMR	7/30/2018	30	17	28	16	22
DMR	7/31/2018	18	31	25	20	22
DMR	8/1/2018	44	21	30	21	25
DMR	8/2/2018	31	14	31	21	26
DMR	8/3/2018	35	15	32	20	26
DMR	8/4/2018	35	15	36	16	26

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	8/5/2018	31	18	33	16	24
DMR	8/6/2018	42	19	36	17	26
DMR	8/7/2018	32	20	35	18	27
DMR	8/8/2018	32	12	34	17	26
DMR	8/9/2018	40	18	37	17	27
DMR	8/10/2018	36	16	35	17	26
DMR	8/11/2018	36	16	36	16	26
DMR	8/12/2018	35	17	37	17	27
DMR	8/13/2018	42	15	37	16	27
DMR	8/14/2018	45	15	40	16	28
DMR	8/15/2018	50	16	43	16	29
DMR	8/16/2018	43	16	45	16	30
DMR	8/17/2018	51	17	47	16	32
DMR	8/18/2018	47	15	48	16	32
DMR	8/19/2018	45	17	47	16	31
DMR	8/20/2018	37	15	45	16	31
DMR	8/21/2018	46	15	44	16	30
DMR	8/22/2018	33	20	40	17	29
DMR	8/23/2018	32	17	37	17	27
DMR	8/24/2018	31	16	36	17	26
DMR	8/25/2018	34	21	33	19	26
DMR	8/26/2018	33	17	33	18	25
DMR	8/27/2018	45	18	36	18	27
DMR	8/28/2018	48	22	40	20	30
DMR	8/29/2018	40	16	42	18	30
DMR	8/30/2018	40	17	43	18	31
DMR	8/31/2018	41	19	42	19	30
DMR	9/1/2018	37	15	40	17	28
DMR	9/2/2018	35	15	38	17	27
DMR	9/3/2018	37	15	38	16	27
DMR	9/4/2018	35	13	36	15	25
DMR	9/5/2018	28	18	34	15	25
DMR	9/6/2018	32	14	33	15	24
DMR	9/7/2018	36	18	33	16	24
DMR	9/8/2018	45	19	35	17	26
DMR	9/9/2018	50	17	41	17	29
DMR	9/10/2018	66	17	49	18	34
DMR	9/11/2018	69	17	58	18	38
DMR	9/12/2018	69	17	64	17	40
DMR	9/13/2018	71	17	69	17	43
DMR	9/14/2018	52	18	65	17	41
DMR	9/15/2018	64	19	64	18	41
DMR	9/16/2018	56	19	61	18	40
DMR	9/17/2018	84	18	64	19	41
DMR	9/18/2018	37	11	60	17	39
DMR	9/19/2018	62	21	60	17	39
DMR	9/20/2018	25	13	52	16	34
DMR	9/21/2018	16	13	35	15	25
DMR	9/22/2018	18	12	30	15	23
DMR	9/23/2018	17	13	19	13	16
DMR	9/24/2018	17	12	17	13	15
DMR	9/25/2018	20	14	18	13	15
DMR	9/26/2018	21	14	19	13	16
DMR	9/27/2018	19	17	19	14	17
DMR	9/28/2018	21	16	20	15	18

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	9/29/2018	25	16	22	16	19
DMR	9/30/2018	25	18	23	17	20
DMR	10/1/2018	24	13	24	16	20
DMR	10/2/2018			25	16	20
DMR	10/3/2018	27	28	25	20	23
DMR	10/4/2018	30	29	27	23	25
DMR	10/5/2018	24	15	27	24	26
DMR	10/6/2018	22	12	26	21	23
DMR	10/7/2018	22	16	25	18	21
DMR	10/8/2018	24	15	23	15	19
DMR	10/9/2018	33	19	25	16	20
DMR	10/10/2018	22	15	25	16	21
DMR	10/11/2018	18	13	24	16	20
DMR	10/12/2018	16	12	22	15	19
DMR	10/13/2018	17	14	18	14	16
DMR	10/14/2018	22	14	18	13	16
DMR	10/15/2018	22	14	19	14	16
DMR	10/16/2018	20	13	20	14	17
DMR	10/17/2018	22	13	22	14	18
DMR	10/18/2018	22	16	22	14	18
DMR	10/19/2018	24	17	22	15	18
DMR	10/20/2018	25	17	23	16	20
DMR	10/21/2018	22	17	23	17	20
DMR	10/22/2018	27	16	25	17	21
DMR	10/23/2018	26	17	25	17	21
DMR	10/24/2018	30	17	26	17	22
DMR	10/25/2018	31	18	29	17	23
DMR	10/26/2018	29	17	29	17	23
DMR	10/27/2018	29	18	30	18	24
DMR	10/28/2018	28	16	29	17	23
DMR	10/29/2018	32	18	30	17	23
DMR	10/30/2018	29	16	30	17	23
DMR	10/31/2018	34	17	31	17	24
DMR	11/1/2018	35	18	33	17	25
DMR	11/2/2018	39	17	34	17	26
DMR	11/3/2018	34	19	36	18	27
DMR	11/4/2018	28	16	34	18	26
DMR	11/5/2018	31	17	33	17	25
DMR	11/6/2018	27	16	30	17	24
DMR	11/7/2018	28	15	29	16	22
DMR	11/8/2018	28	20	29	17	23
DMR	11/9/2018	27	18	28	17	22
DMR	11/10/2018	32	19	29	18	23
DMR	11/11/2018	27	19	29	19	24
DMR	11/12/2018	29	18	29	19	24
DMR	11/13/2018	31	18	30	19	24
DMR	11/14/2018	32	18	30	18	24
DMR	11/15/2018	34	18	32	18	25
DMR	11/16/2018	33	19	33	18	25
DMR	11/17/2018	29	20	32	19	25
DMR	11/18/2018	37	20	33	19	26
DMR	11/19/2018	32	19	33	20	26
DMR	11/20/2018	40	23	35	21	28
DMR	11/21/2018	40	19	37	20	29
DMR	11/22/2018	39	20	38	20	29

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	11/23/2018	36	20	39	21	30
DMR	11/24/2018	35	18	38	19	28
DMR	11/25/2018	35	18	36	19	28
DMR	11/26/2018	45	21	38	19	29
DMR	11/27/2018	46	20	40	19	30
DMR	11/28/2018	33	19	40	20	30
DMR	11/29/2018	44	25	42	21	32
DMR	11/30/2018	44	20	42	21	31
DMR	12/1/2018	40	19	40	21	31
DMR	12/2/2018	44	18	43	21	32
DMR	12/3/2018	48	20	44	19	32
DMR	12/4/2018	42	18	44	19	31
DMR	12/5/2018	45	17	45	18	32
DMR	12/6/2018	44	18	45	18	32
DMR	12/7/2018	47	17	45	18	31
DMR	12/8/2018	45	21	45	18	32
DMR	12/9/2018	42	20	45	19	32
DMR	12/10/2018	42	20	44	20	32
DMR	12/11/2018	43	20	43	20	32
DMR	12/12/2018	43	21	43	20	31
DMR	12/13/2018	40	20	42	20	31
DMR	12/14/2018	49	21	44	21	32
DMR	12/15/2018	42	19	44	20	32
DMR	12/16/2018	41	19	43	20	31
DMR	12/17/2018	46	19	45	20	32
DMR	12/18/2018	51	20	45	19	32
DMR	12/19/2018	49	20	47	20	33
DMR	12/20/2018	44	20	48	20	34
DMR	12/21/2018	47	20	48	20	34
DMR	12/22/2018	46	20	47	20	33
DMR	12/23/2018	47	22	46	21	33
DMR	12/24/2018	46	22	47	21	34
DMR	12/25/2018	53	20	48	21	35
DMR	12/26/2018	43	20	47	21	34
DMR	12/27/2018	50	24	48	22	35
DMR	12/28/2018			49	21	35
DMR	12/29/2018	85	28	59	24	42
DMR	12/30/2018	89	28	75	27	51
DMR	12/31/2018	67	24	80	27	54
DMR	1/1/2019	64		76	27	51
DMR	1/2/2019	64		71	26	49
DMR	1/3/2019	56		63	24	43
DMR	1/4/2019	53		59	0	30
DMR	1/5/2019	52		56	0	28
DMR	1/6/2019	62		56	0	28
DMR	1/7/2019	58		56	0	28
DMR	1/8/2019	66		60	0	30
DMR	1/9/2019	63		62	0	31
DMR	1/10/2019	50		59	0	30
DMR	1/11/2019	49		57	0	29
DMR	1/12/2019	44		52	0	26
DMR	1/13/2019	53		49	0	25
DMR	1/14/2019	55		50	0	25
DMR	1/15/2019	60		53	0	27
DMR	1/16/2019	69		59	0	30

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	1/17/2019	61		61	0	31
DMR	1/18/2019	62		63	0	32
DMR	1/19/2019	60		63	0	32
DMR	1/20/2019	58		60	0	30
DMR	1/21/2019	66		62	0	31
DMR	1/22/2019	61		61	0	31
DMR	1/23/2019	66		63	0	31
DMR	1/24/2019	71		66	0	33
DMR	1/25/2019	72		68	0	34
DMR	1/26/2019	77		72	0	36
DMR	1/27/2019			73	0	37
DMR	1/28/2019	69		73	0	36
DMR	1/29/2019			73	0	37
DMR	1/30/2019			69	0	35
DMR	1/31/2019	95		82	0	41
DMR	2/1/2019	83		89	0	45
DMR	2/2/2019	98		92	0	46
DMR	2/3/2019	79		89	0	44
DMR	2/4/2019	82		86	0	43
DMR	2/5/2019	66		81	0	41
DMR	2/6/2019			76	0	38
DMR	2/7/2019	86		78	0	39
DMR	2/8/2019	109		87	0	44
DMR	2/9/2019	133		109	0	55
DMR	2/10/2019	99	77	107	77	92
DMR	2/11/2019	58	38	100	58	79
DMR	2/12/2019	34	17	81	44	63
DMR	2/13/2019	30	16	55	37	46
DMR	2/14/2019	37	22	40	23	32
DMR	2/15/2019	28	14	32	17	25
DMR	2/16/2019	27	12	31	16	23
DMR	2/17/2019	21	13	28	15	22
DMR	2/18/2019	17	22	23	15	19
DMR	2/19/2019	12	15	19	16	17
DMR	2/20/2019	14	12	16	16	16
DMR	2/21/2019	15	13	15	16	15
DMR	2/22/2019	17	15	15	14	14
DMR	2/23/2019	12	11	15	13	14
DMR	2/24/2019	17	17	15	14	15
DMR	2/25/2019	12	10	15	13	14
DMR	2/26/2019	14	14	14	13	13
DMR	2/27/2019	13	13	14	14	14
DMR	2/28/2019	15	12	14	12	13
DMR	3/1/2019	18	16	15	14	14
DMR	3/2/2019	18	16	16	14	15
DMR	3/3/2019	23	16	19	15	17
DMR	3/4/2019	22	16	20	16	18
DMR	3/5/2019	21	16	21	16	19
DMR	3/6/2019	22	16	22	16	19
DMR	3/7/2019	22	16	22	16	19
DMR	3/8/2019	22	15	22	16	19
DMR	3/9/2019			22	16	19
DMR	3/10/2019			22	16	19
DMR	3/11/2019	17	14	20	15	17
DMR	3/12/2019	19	13	18	14	16

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	3/13/2019	19	15	18	14	16
DMR	3/14/2019	19	13	19	14	16
DMR	3/15/2019	19	14	19	14	16
DMR	3/16/2019	20	14	19	14	17
DMR	3/17/2019	19	12	19	13	16
DMR	3/18/2019	13	12	18	13	15
DMR	3/19/2019	19	10	18	12	15
DMR	3/20/2019	20	16	18	13	15
DMR	3/21/2019	24	17	19	14	16
DMR	3/22/2019	21	15	21	15	18
DMR	3/23/2019	21	14	22	16	19
DMR	3/24/2019	20	15	22	15	18
DMR	3/25/2019	20	15	21	15	18
DMR	3/26/2019	19	14	20	15	17
DMR	3/27/2019	18	13	19	14	17
DMR	3/28/2019	20	15	19	14	17
DMR	3/29/2019	18	13	19	14	16
DMR	3/30/2019	17	12	18	13	16
DMR	3/31/2019	19	14	19	14	16
DMR	4/1/2019	25	11	20	13	16
DMR	4/2/2019	22	19	21	14	17
DMR	4/3/2019	24	16	23	15	19
DMR	4/4/2019	19	12	23	15	19
DMR	4/5/2019	23	12	22	15	18
DMR	4/6/2019	17	10	21	13	17
DMR	4/7/2019	30	13	22	12	17
DMR	4/8/2019	31	26	25	15	20
DMR	4/9/2019	24	17	26	17	21
DMR	4/10/2019	21	15	27	18	22
DMR	4/11/2019	19	13	24	18	21
DMR	4/12/2019	24	15	22	15	19
DMR	4/13/2019	22	13	22	14	18
DMR	4/14/2019	24	13	22	14	18
DMR	4/15/2019	30	13	25	14	19
DMR	4/16/2019	24	12	25	13	19
DMR	4/17/2019	25	15	26	13	20
DMR	4/18/2019	27	14	27	14	20
DMR	4/19/2019	30	16	27	14	20
DMR	4/20/2019	24	17	27	16	21
DMR	4/21/2019	19	15	25	16	20
DMR	4/22/2019	24	15	24	16	20
DMR	4/23/2019	29	12	24	15	19
DMR	4/24/2019	24	14	24	14	19
DMR	4/25/2019	30	14	27	14	20
DMR	4/26/2019	28	14	28	14	21
DMR	4/27/2019	26	12	27	14	20
DMR	4/28/2019	29	13	28	13	21
DMR	4/29/2019			28	13	20
DMR	4/30/2019	30	14	28	13	21
DMR	5/1/2019	44	13	34	13	24
DMR	5/2/2019	50	15	41	14	28
DMR	5/3/2019	46	16	43	15	29
DMR	5/4/2019	44	16	46	15	31
DMR	5/5/2019	44	16	46	16	31
DMR	5/6/2019	56	18	48	17	32

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	5/7/2019	53	21	49	18	34
DMR	5/8/2019	59	16	53	18	35
DMR	5/9/2019	66	16	59	18	38
DMR	5/10/2019	48	13	57	17	37
DMR	5/11/2019	44	13	54	15	34
DMR	5/12/2019	35	15	48	14	31
DMR	5/13/2019	16	10	36	13	24
DMR	5/14/2019	12	11	27	12	20
DMR	5/15/2019	9	7	18	11	14
DMR	5/16/2019	12	9	12	9	11
DMR	5/17/2019	12	8	11	9	10
DMR	5/18/2019	12	13	11	9	10
DMR	5/19/2019	12	7	12	9	11
DMR	5/20/2019	12	9	12	9	11
DMR	5/21/2019	13	10	12	10	11
DMR	5/22/2019	12	11	12	9	11
DMR	5/23/2019	16	9	13	10	12
DMR	5/24/2019	16	10	14	10	12
DMR	5/25/2019	19	11	16	10	13
DMR	5/26/2019			17	10	14
DMR	5/27/2019	21	18	19	13	16
DMR	5/28/2019	24	17	21	15	18
DMR	5/29/2019	23	17	23	17	20
DMR	5/30/2019	25	15	23	17	20
DMR	5/31/2019	20	11	23	15	19
DMR	6/1/2019	29	16	24	15	20
DMR	6/2/2019	23	13	24	14	19
DMR	6/3/2019	31	20	26	15	20
DMR	6/4/2019	26	14	27	16	22
DMR	6/5/2019	24	14	26	15	21
DMR	6/6/2019	30	16	28	16	22
DMR	6/7/2019	29	13	27	14	21
DMR	6/8/2019	33	17	29	15	22
DMR	6/9/2019	32	17	31	16	23
DMR	6/10/2019	33	16	32	16	24
DMR	6/11/2019	32	17	33	17	25
DMR	6/12/2019	34	17	33	17	25
DMR	6/13/2019	37	17	34	17	25
DMR	6/14/2019	31	17	34	17	25
DMR	6/15/2019	33	16	34	17	25
DMR	6/16/2019	34	17	34	17	25
DMR	6/17/2019	32	19	33	17	25
DMR	6/18/2019	34	20	33	18	26
DMR	6/19/2019	34	15	34	18	26
DMR	6/20/2019	30	14	33	17	25
DMR	6/21/2019			33	16	25
DMR	6/22/2019	31	15	32	15	23
DMR	6/23/2019	32	16	31	15	23
DMR	6/24/2019	30	15	31	15	23
DMR	6/25/2019	30	16	31	16	23
DMR	6/26/2019	33	14	31	15	23
DMR	6/27/2019	27	14	30	15	22
DMR	6/28/2019	29	29	30	18	24
DMR	6/29/2019	42	17	33	19	26
DMR	6/30/2019	30	16	32	19	26

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	7/1/2019	25	11	32	18	25
DMR	7/2/2019	22	19	30	16	23
DMR	7/3/2019	24	16	25	16	20
DMR	7/4/2019	19	12	23	15	19
DMR	7/5/2019	23	12	22	15	18
DMR	7/6/2019	17	10	21	13	17
DMR	7/7/2019	30	13	22	12	17
DMR	7/8/2019	31	26	25	15	20
DMR	7/9/2019	24	17	26	17	21
DMR	7/10/2019	21	15	27	18	22
DMR	7/11/2019	19	13	24	18	21
DMR	7/12/2019	24	15	22	15	19
DMR	7/13/2019	22	13	22	14	18
DMR	7/14/2019	24	13	22	14	18
DMR	7/15/2019	30	13	25	14	19
DMR	7/16/2019	24	12	25	13	19
DMR	7/17/2019	25	15	26	13	20
DMR	7/18/2019	27	14	27	14	20
DMR	7/19/2019	30	16	27	14	20
DMR	7/20/2019	24	17	27	16	21
DMR	7/21/2019	19	15	25	16	20
DMR	7/22/2019	24	15	24	16	20
DMR	7/23/2019	29	12	24	15	19
DMR	7/24/2019	24	14	24	14	19
DMR	7/25/2019	30	14	27	14	20
DMR	7/26/2019	28	14	28	14	21
DMR	7/27/2019	26	12	27	14	20
DMR	7/28/2019	29	13	28	13	21
DMR	7/29/2019	30	14	28	13	21
DMR	7/30/2019	30	14	29	13	21
DMR	7/31/2019	29	16	30	14	22
DMR	8/1/2019	28	16	29	15	22
DMR	8/2/2019	30	16	29	16	22
DMR	8/3/2019	27	17	29	16	22
DMR	8/4/2019	37	15	31	16	23
DMR	8/5/2019	40	16	34	16	25
DMR	8/6/2019	42	16	37	16	26
DMR	8/7/2019	43	15	41	16	28
DMR	8/8/2019	43	20	42	17	29
DMR	8/9/2019			43	17	30
DMR	8/10/2019	36	18	41	18	29
DMR	8/11/2019	43	15	41	18	29
DMR	8/12/2019	52	16	44	16	30
DMR	8/13/2019	49	14	45	16	30
DMR	8/14/2019	52	14	49	15	32
DMR	8/15/2019	58	14	53	15	34
DMR	8/16/2019	50		52	0	26
DMR	8/17/2019	53	17	53	15	34
DMR	8/18/2019	25	10	47	14	30
DMR	8/19/2019	24	14	38	14	26
DMR	8/20/2019	28	12	33	13	23
DMR	8/21/2019	28	13	26	12	19
DMR	8/22/2019	33	14	28	13	21
DMR	8/23/2019	34	15	31	14	22
DMR	8/24/2019	41	15	34	14	24

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	8/25/2019	36	18	36	16	26
DMR	8/26/2019	46	23	39	18	29
DMR	8/27/2019	34	14	39	18	28
DMR	8/28/2019	35	20	38	19	28
DMR	8/29/2019	40	14	39	18	28
DMR	8/30/2019	44	13	38	15	27
DMR	8/31/2019	50	15	42	16	29
DMR	9/1/2019	46	16	45	15	30
DMR	9/2/2019	44	16	46	15	31
DMR	9/3/2019	44	16	46	16	31
DMR	9/4/2019	56	18	48	17	32
DMR	9/5/2019	53	21	49	18	34
DMR	9/6/2019	59	16	53	18	35
DMR	9/7/2019	66	16	59	18	38
DMR	9/8/2019	48	13	57	17	37
DMR	9/9/2019	44	13	54	15	34
DMR	9/10/2019	35	15	48	14	31
DMR	9/11/2019	16	10	36	13	24
DMR	9/12/2019	12	11	27	12	20
DMR	9/13/2019	9	7	18	11	14
DMR	9/14/2019	12	9	12	9	11
DMR	9/15/2019	12	8	11	9	10
DMR	9/16/2019	12	13	11	9	10
DMR	9/17/2019	12	7	12	9	11
DMR	9/18/2019	12	9	12	9	11
DMR	9/19/2019	13	10	12	10	11
DMR	9/20/2019	12	11	12	9	11
DMR	9/21/2019	16	9	13	10	12
DMR	9/22/2019	16	10	14	10	12
DMR	9/23/2019	19	11	16	10	13
DMR	9/24/2019			17	10	14
DMR	9/25/2019	21	18	19	13	16
DMR	9/26/2019	24	17	21	15	18
DMR	9/27/2019	23	17	23	17	20
DMR	9/28/2019	25	15	23	17	20
DMR	9/29/2019	20	11	23	15	19
DMR	9/30/2019	21	10	22	13	18
DMR	10/1/2019	23	15	22	13	18
DMR	10/2/2019	24	12	22	12	17
DMR	10/3/2019	25	13	23	13	18
DMR	10/4/2019	25	14	24	14	19
DMR	10/5/2019	24	15	25	14	19
DMR	10/6/2019	18	15	23	14	19
DMR	10/7/2019	21	16	22	15	19
DMR	10/8/2019	21	14	21	15	18
DMR	10/9/2019	23	18	21	16	18
DMR	10/10/2019	25	15	23	16	19
DMR	10/11/2019	23	14	23	15	19
DMR	10/12/2019	23	13	24	15	19
DMR	10/13/2019	22	18	23	15	19
DMR	10/14/2019	26	15	24	15	19
DMR	10/15/2019	27	13	25	15	20
DMR	10/16/2019	27	13	26	15	20
DMR	10/17/2019	27	13	27	14	20
DMR	10/18/2019	24	17	26	14	20

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	10/19/2019	28	17	27	15	21
DMR	10/20/2019	26	15	26	16	21
DMR	10/21/2019	29	16	27	16	22
DMR	10/22/2019	22	12	26	15	21
DMR	10/23/2019	24	15	25	15	20
DMR	10/24/2019	26	16	25	15	20
DMR	10/25/2019	27	16	25	15	20
DMR	10/26/2019	31	18	27	16	22
DMR	10/27/2019	29	16	28	17	22
DMR	10/28/2019	27	15	29	16	22
DMR	10/29/2019	27	15	29	16	22
DMR	10/30/2019	29	17	28	16	22
DMR	10/31/2019	29	16	28	16	22
DMR	11/1/2019	23	13	27	15	21
DMR	11/2/2019	31	20	28	17	22
DMR	11/3/2019	26	14	27	16	22
DMR	11/4/2019	24	14	26	15	21
DMR	11/5/2019	30	16	28	16	22
DMR	11/6/2019	29	13	27	14	21
DMR	11/7/2019	33	17	29	15	22
DMR	11/8/2019	32	17	31	16	23
DMR	11/9/2019	33	16	32	16	24
DMR	11/10/2019	32	17	33	17	25
DMR	11/11/2019	34	17	33	17	25
DMR	11/12/2019	37	17	34	17	25
DMR	11/13/2019	31	17	34	17	25
DMR	11/14/2019	33	16	34	17	25
DMR	11/15/2019	34	17	34	17	25
DMR	11/16/2019	32	19	33	17	25
DMR	11/17/2019	34	20	33	18	26
DMR	11/18/2019	34	15	34	18	26
DMR	11/19/2019	30	14	33	17	25
DMR	11/20/2019			33	16	25
DMR	11/21/2019	31	15	32	15	23
DMR	11/22/2019	32	16	31	15	23
DMR	11/23/2019	30	15	31	15	23
DMR	11/24/2019	30	16	31	16	23
DMR	11/25/2019	33	14	31	15	23
DMR	11/26/2019	27	14	30	15	22
DMR	11/27/2019	29	29	30	18	24
DMR	11/28/2019	42	17	33	19	26
DMR	11/29/2019	30	16	32	19	26
DMR	11/30/2019	37	16	35	20	27
DMR	12/1/2019	30	16	35	16	26
DMR	12/2/2019	40	18	34	17	25
DMR	12/3/2019	35	18	36	17	26
DMR	12/4/2019	35	19	35	18	26
DMR	12/5/2019	35	17	36	18	27
DMR	12/6/2019			35	18	27
DMR	12/7/2019	30	16	33	17	25
DMR	12/8/2019	28	17	31	17	24
DMR	12/9/2019	34	15	31	16	23
DMR	12/10/2019	55	17	37	16	27
DMR	12/11/2019			39	16	28
DMR	12/12/2019			45	16	30

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	12/13/2019	42		49	17	33
DMR	12/14/2019	35		39	0	19
DMR	12/15/2019	48		42	0	21
DMR	12/16/2019	40		41	0	21
DMR	12/17/2019	41		41	0	21
DMR	12/18/2019	49		45	0	22
DMR	12/19/2019	44		44	0	22
DMR	12/20/2019	48		46	0	23
DMR	12/21/2019	42		46	0	23
DMR	12/22/2019	39		43	0	22
DMR	12/23/2019	41		43	0	21
DMR	12/24/2019	35		39	0	20
DMR	12/25/2019	39		39	0	19
DMR	12/26/2019	33		37	0	19
DMR	12/27/2019	35		36	0	18
DMR	12/28/2019	61		42	0	21
DMR	12/29/2019	53		46	0	23
DMR	12/30/2019	41		48	0	24
DMR	12/31/2019	56		53	0	26
DMR	1/1/2020	43		48	0	24
DMR	1/2/2020	40		45	0	23
DMR	1/3/2020	40		45	0	22
DMR	1/4/2020	45		42	0	21
DMR	1/5/2020	38		41	0	20
DMR	1/6/2020	45		42	0	21
DMR	1/7/2020	43		43	0	21
DMR	1/8/2020	44		43	0	21
DMR	1/9/2020	46		45	0	22
DMR	1/10/2020	42		44	0	22
DMR	1/11/2020	54		47	0	23
DMR	1/12/2020	47		47	0	24
DMR	1/13/2020	48		48	0	24
DMR	1/14/2020	43		48	0	24
DMR	1/15/2020	51		47	0	24
DMR	1/16/2020	63		51	0	26
DMR	1/17/2020	65		56	0	28
DMR	1/18/2020	46		56	0	28
DMR	1/19/2020	56		58	0	29
DMR	1/20/2020	69		59	0	30
DMR	1/21/2020	68		60	0	30
DMR	1/22/2020	67		65	0	33
DMR	1/23/2020	68		68	0	34
DMR	1/24/2020	74		69	0	35
DMR	1/25/2020	58		67	0	33
DMR	1/26/2020	83		71	0	35
DMR	1/27/2020	75		73	0	36
DMR	1/28/2020	66		71	0	35
DMR	1/29/2020	64		72	0	36
DMR	1/30/2020	62		67	0	33
DMR	1/31/2020	63		64	0	32
DMR	2/1/2020	46		59	0	29
DMR	2/2/2020	63		59	0	29
DMR	2/3/2020	111		71	0	35
DMR	2/4/2020	52		68	0	34
DMR	2/5/2020	53		70	0	35

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	2/6/2020	57		68	0	34
DMR	2/7/2020	46		52	0	26
DMR	2/8/2020	49		51	0	26
DMR	2/9/2020			51	0	25
DMR	2/10/2020	65		53	0	27
DMR	2/11/2020	56		57	0	28
DMR	2/12/2020	63		61	0	31
DMR	2/13/2020			61	0	31
DMR	2/14/2020			60	0	30
DMR	2/15/2020			63	0	32
DMR	2/16/2020	68		68	0	34
DMR	2/17/2020	79		74	0	37
DMR	2/18/2020			74	0	37
DMR	2/19/2020	76		74	0	37
DMR	2/20/2020	67		74	0	37
DMR	2/21/2020	73		72	0	36
DMR	2/22/2020	67		71	0	35
DMR	2/23/2020			69	0	35
DMR	2/24/2020	71		70	0	35
DMR	2/25/2020	69		69	0	35
DMR	2/26/2020	62		67	0	34
DMR	2/27/2020	62		66	0	33
DMR	2/28/2020			64	0	32
DMR	2/29/2020	54		59	0	30
DMR	3/1/2020	41		52	0	26
DMR	3/2/2020	38	15	44	15	30
DMR	3/3/2020	29	13	41	14	27
DMR	3/4/2020			36	14	25
DMR	3/5/2020	20	15	29	14	22
DMR	3/6/2020	18	10	22	13	18
DMR	3/7/2020	37	10	25	12	18
DMR	3/8/2020	17	10	23	11	17
DMR	3/9/2020	14	11	22	10	16
DMR	3/10/2020	15	12	21	11	16
DMR	3/11/2020	15	13	15	12	13
DMR	3/12/2020	14	10	15	12	13
DMR	3/13/2020	15	11	15	12	13
DMR	3/14/2020	18	11	16	11	13
DMR	3/15/2020	20	15	17	12	14
DMR	3/16/2020	23	15	19	13	16
DMR	3/17/2020	23	14	21	14	17
DMR	3/18/2020	25	13	23	14	19
DMR	3/19/2020	20	15	23	14	19
DMR	3/20/2020	22	14	23	14	18
DMR	3/21/2020	21	13	22	14	18
DMR	3/22/2020	24	12	22	14	18
DMR	3/23/2020	27	15	24	14	19
DMR	3/24/2020	26	13	25	13	19
DMR	3/25/2020	27	13	26	13	20
DMR	3/26/2020	27	15	27	14	20
DMR	3/27/2020	27	16	27	14	21
DMR	3/28/2020	28	16	27	15	21
DMR	3/29/2020	14	18	24	16	20
DMR	3/30/2020	20	15	22	16	19
DMR	3/31/2020	20	14	21	16	18

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	4/1/2020	20	15	19	16	17
DMR	4/2/2020	21	13	20	14	17
DMR	4/3/2020	21	16	21	15	18
DMR	4/4/2020	21	15	21	15	18
DMR	4/5/2020	24	17	22	15	19
DMR	4/6/2020	26	18	23	17	20
DMR	4/7/2020	24	14	24	16	20
DMR	4/8/2020	24	14	25	16	20
DMR	4/9/2020	35	14	27	15	21
DMR	4/10/2020	25	13	27	14	20
DMR	4/11/2020	25	12	27	13	20
DMR	4/12/2020	26	14	28	13	21
DMR	4/13/2020	27	13	26	13	19
DMR	4/14/2020	26	12	26	13	19
DMR	4/15/2020	30	16	27	14	21
DMR	4/16/2020	28	15	28	14	21
DMR	4/17/2020	27	15	28	15	21
DMR	4/18/2020	27	16	28	16	22
DMR	4/19/2020	25	16	27	16	21
DMR	4/20/2020	27	14	27	15	21
DMR	4/21/2020	27	15	27	15	21
DMR	4/22/2020	30	14	27	15	21
DMR	4/23/2020	29	13	28	14	21
DMR	4/24/2020	30	15	29	14	22
DMR	4/25/2020	26	14	29	14	21
DMR	4/26/2020	29	15	29	14	21
DMR	4/27/2020	34	16	30	15	22
DMR	4/28/2020	34	17	31	16	23
DMR	4/29/2020	32	14	32	16	24
DMR	4/30/2020	39	13	35	15	25
DMR	5/1/2020	37	20	36	16	26
DMR	5/2/2020	34	14	36	15	25
DMR	5/3/2020	35	18	36	16	26
DMR	5/4/2020	40	17	37	17	27
DMR	5/5/2020	41	17	38	17	27
DMR	5/6/2020	33	15	37	17	27
DMR	5/7/2020	29	16	36	16	26
DMR	5/8/2020	32	14	34	16	25
DMR	5/9/2020	26	16	30	15	23
DMR	5/10/2020	30	16	29	16	22
DMR	5/11/2020	38	26	32	18	25
DMR	5/12/2020	34	16	32	19	25
DMR	5/13/2020	35	16	34	19	26
DMR	5/14/2020	34	16	35	19	27
DMR	5/15/2020	33	16	34	16	25
DMR	5/16/2020	34	17	34	16	25
DMR	5/17/2020	33	17	34	17	25
DMR	5/18/2020	24	18	31	17	24
DMR	5/19/2020	22	19	28	18	23
DMR	5/20/2020	25	17	26	18	22
DMR	5/21/2020	25	14	24	17	21
DMR	5/22/2020	28	15	25	16	21
DMR	5/23/2020	24	16	26	16	21
DMR	5/24/2020	24	15	25	15	20
DMR	5/25/2020	24	15	25	15	20

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	5/26/2020	28	17	25	16	20
DMR	5/27/2020	28	13	26	15	21
DMR	5/28/2020	30	14	28	15	21
DMR	5/29/2020	37	14	31	15	23
DMR	5/30/2020	29	15	31	14	23
DMR	5/31/2020	26	16	31	15	23
DMR	6/1/2020	34	13	32	15	23
DMR	6/2/2020	39	15	32	15	23
DMR	6/3/2020	41	13	35	14	25
DMR	6/4/2020	39	16	38	14	26
DMR	6/5/2020	36	16	39	15	27
DMR	6/6/2020	29	14	36	15	26
DMR	6/7/2020	33	18	34	16	25
DMR	6/8/2020	34	15	33	16	24
DMR	6/9/2020	30	14	32	15	23
DMR	6/10/2020	39	12	34	15	24
DMR	6/11/2020	40	13	36	14	25
DMR	6/12/2020	42	14	38	13	26
DMR	6/13/2020	42	13	41	13	27
DMR	6/14/2020	41	14	41	14	27
DMR	6/15/2020	41	15	42	14	28
DMR	6/16/2020	45		42	14	28
DMR	6/17/2020	43	17	43	15	29
DMR	6/18/2020	46	18	44	17	30
DMR	6/19/2020	48	18	46	18	32
DMR	6/20/2020	44	15	45	17	31
DMR	6/21/2020	40	16	45	17	31
DMR	6/22/2020	39	15	43	16	29
DMR	6/23/2020	42	13	41	15	28
DMR	6/24/2020	46	13	42	14	28
DMR	6/25/2020	47	15	44	14	29
DMR	6/26/2020	48	16	46	14	30
DMR	6/27/2020	33	14	44	15	29
DMR	6/28/2020	32	13	40	15	27
DMR	6/29/2020	36	14	37	14	26
DMR	6/30/2020	35	14	34	14	24
DMR	7/1/2020	34	15	34	14	24
DMR	7/2/2020	40	14	36	14	25
DMR	7/3/2020	42	15	38	15	26
DMR	7/4/2020	36	15	38	15	26
DMR	7/5/2020			39	15	27
DMR	7/6/2020	44	16	41	15	28
DMR	7/7/2020	23	11	34	14	24
DMR	7/8/2020	32	16	33	14	24
DMR	7/9/2020	34	17	33	15	24
DMR	7/10/2020	36	14	31	15	23
DMR	7/11/2020	14	14	29	15	22
DMR	7/12/2020	34	16	30	15	22
DMR	7/13/2020	44	17	32	15	24
DMR	7/14/2020	47	15	35	16	25
DMR	7/15/2020	52	16	44	16	30
DMR	7/16/2020	52	14	49	16	32
DMR	7/17/2020	36	14	47	15	31
DMR	7/18/2020	50	14	48	15	31
DMR	7/19/2020	54	13	48	14	31

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	7/20/2020	65	18	51	15	33
DMR	7/21/2020	69	18	60	16	38
DMR	7/22/2020	87	18	69	17	43
DMR	7/23/2020	69	17	73	18	45
DMR	7/24/2020	49	14	69	17	43
DMR	7/25/2020	56	13	65	16	40
DMR	7/26/2020	24	11	50	14	32
DMR	7/27/2020	16	7	36	11	24
DMR	7/28/2020	25	13	30	11	21
DMR	7/29/2020	27	11	23	11	17
DMR	7/30/2020	33	17	25	12	19
DMR	7/31/2020	35	17	30	15	22
DMR	8/1/2020	29	12	31	14	23
DMR	8/2/2020	26	12	31	15	23
DMR	8/3/2020	36	13	32	14	23
DMR	8/4/2020	37	14	32	13	22
DMR	8/5/2020	44	13	36	13	24
DMR	8/6/2020	49	13	42	13	27
DMR	8/7/2020	50	13	45	13	29
DMR	8/8/2020	45	12	47	13	30
DMR	8/9/2020	50	15	49	13	31
DMR	8/10/2020	60	16	51	14	33
DMR	8/11/2020	68	19	56	16	36
DMR	8/12/2020	67	13	61	16	39
DMR	8/13/2020	85	13	70	15	43
DMR	8/14/2020	89	18	77	16	47
DMR	8/15/2020	75	16	79	15	47
DMR	8/16/2020	77	14	82	15	48
DMR	8/17/2020	99	15	85	16	50
DMR	8/18/2020	84	15	84	15	49
DMR	8/19/2020	94	17	89	15	52
DMR	8/20/2020	122	17	100	16	58
DMR	8/21/2020	114	17	104	17	60
DMR	8/22/2020	131	17	115	17	66
DMR	8/23/2020	121	17	122	17	70
DMR	8/24/2020	129	17	124	17	70
DMR	8/25/2020	161	20	136	18	77
DMR	8/26/2020	177	20	147	19	83
DMR	8/27/2020	137	20	151	19	85
DMR	8/28/2020	52	25	132	21	77
DMR	8/29/2020	105	17	118	21	69
DMR	8/30/2020	138	14	108	19	64
DMR	8/31/2020	56	17	88	18	53
DMR	9/1/2020	135	16	109	16	62
DMR	9/2/2020	114	13	111	15	63
DMR	9/3/2020	151	15	114	15	65
DMR	9/4/2020	152	15	138	15	76
DMR	9/5/2020	165	14	146	14	80
DMR	9/6/2020	178	15	162	15	88
DMR	9/7/2020	184	16	170	15	92
DMR	9/8/2020	169	15	174	15	95
DMR	9/9/2020	171	13	176	15	95
DMR	9/10/2020	179	19	176	16	96
DMR	9/11/2020	172	20	173	17	95
DMR	9/12/2020	100	18	156	18	87

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	9/13/2020	118	16	142	18	80
DMR	9/14/2020	143	17	133	18	76
DMR	9/15/2020	141	14	126	16	71
DMR	9/16/2020	152	17	139	16	77
DMR	9/17/2020	164	17	150	16	83
DMR	9/18/2020	220	16	169	16	93
DMR	9/19/2020	240	17	194	17	105
DMR	9/20/2020	110	16	184	17	100
DMR	9/21/2020	122	15	173	16	95
DMR	9/22/2020	181	19	163	17	90
DMR	9/23/2020	218	18	158	17	87
DMR	9/24/2020	224	17	186	17	102
DMR	9/25/2020	195	21	205	19	112
DMR	9/26/2020	223	16	215	18	117
DMR	9/27/2020	185	19	207	18	113
DMR	9/28/2020	171	18	194	19	106
DMR	9/29/2020	163	14	186	17	101
DMR	9/30/2020	219	14	185	16	100
DMR	10/1/2020	218	16	193	16	104
DMR	10/2/2020	219	16	205	15	110
DMR	10/3/2020	156	15	203	15	109
DMR	10/4/2020	193	14	197	15	106
DMR	10/5/2020	213	15	195	15	105
DMR	10/6/2020	261	16	206	15	110
DMR	10/7/2020	142	15	202	15	109
DMR	10/8/2020	154	6	193	13	103
DMR	10/9/2020	154	15	178	13	95
DMR	10/10/2020	174	19	156	14	85
DMR	10/11/2020	176	23	165	16	90
DMR	10/12/2020	168	21	168	20	94
DMR	10/13/2020	170	15	172	20	96
DMR	10/14/2020	252	14	192	18	105
DMR	10/15/2020	162	16	188	17	102
DMR	10/16/2020	167	15	188	15	101
DMR	10/17/2020	156	17	184	16	100
DMR	10/18/2020	150	14	159	16	87
DMR	10/19/2020	170	17	161	16	88
DMR	10/20/2020	198	16	169	16	92
DMR	10/21/2020	167	24	171	18	95
DMR	10/22/2020	180	16	179	18	99
DMR	10/23/2020	188	18	183	19	101
DMR	10/24/2020	183	23	180	20	100
DMR	10/25/2020	181	24	183	20	102
DMR	10/26/2020	206	27	190	23	106
DMR	10/27/2020	206	22	194	24	109
DMR	10/28/2020	177	17	193	23	108
DMR	10/29/2020	180	22	192	22	107
DMR	10/30/2020	189	22	188	21	104
DMR	10/31/2020	189	22	184	21	102
DMR	11/1/2020	157	22	179	22	100
DMR	11/2/2020	175	22	178	22	100
DMR	11/3/2020	212	20	183	22	102
DMR	11/4/2020	223	24	192	22	107
DMR	11/5/2020	171	21	195	22	109
DMR	11/6/2020	181	22	197	22	109

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	11/7/2020	171	23	187	23	105
DMR	11/8/2020	180	23	176	22	99
DMR	11/9/2020	143	28	169	24	96
DMR	11/10/2020	127	26	155	25	90
DMR	11/11/2020	151	20	150	24	87
DMR	11/12/2020	158	48	145	31	88
DMR	11/13/2020	174	30	153	31	92
DMR	11/14/2020	132	27	154	31	93
DMR	11/15/2020	91	22	139	32	85
DMR	11/16/2020	111	23	127	26	76
DMR	11/17/2020	127	23	115	24	70
DMR	11/18/2020	142	23	118	23	70
DMR	11/19/2020	137	19	129	22	76
DMR	11/20/2020	140	16	137	20	78
DMR	11/21/2020	141	16	140	19	79
DMR	11/22/2020	134	20	138	18	78
DMR	11/23/2020	141	20	139	18	79
DMR	11/24/2020	148	19	141	19	80
DMR	11/25/2020	135	18	140	19	79
DMR	11/26/2020	134	18	140	19	79
DMR	11/27/2020	137	21	139	19	79
DMR	11/28/2020	137	21	136	20	78
DMR	11/29/2020	139	19	137	20	78
DMR	11/30/2020	237	23	163	21	92
DMR	12/1/2020	189	20	176	21	98
DMR	12/2/2020	135	18	175	20	98
DMR	12/3/2020	160	17	180	20	100
DMR	12/4/2020	145	18	157	18	88
DMR	12/5/2020	177	20	154	18	86
DMR	12/6/2020	130	18	153	18	86
DMR	12/7/2020	174	17	157	18	87
DMR	12/8/2020	200	18	170	18	94
DMR	12/9/2020	148	17	163	18	90
DMR	12/10/2020	158	16	170	17	94
DMR	12/11/2020	144	19	163	18	90
DMR	12/12/2020	165	19	154	18	86
DMR	12/13/2020	253	18	180	18	99
DMR	12/14/2020	226	18	197	19	108
DMR	12/15/2020	182	18	207	18	112
DMR	12/16/2020	166		207	18	112
DMR	12/17/2020	134		177	18	98
DMR	12/18/2020	170		163	18	91
DMR	12/19/2020	168		160	0	80
DMR	12/20/2020	178		163	0	81
DMR	12/21/2020	189		176	0	88
DMR	12/22/2020	188		181	0	90
DMR	12/23/2020	144		175	0	87
DMR	12/24/2020	386		227	0	113
DMR	12/25/2020	172		223	0	111
DMR	12/26/2020	212		229	0	114
DMR	12/27/2020	102	25	218	25	122
DMR	12/28/2020	129		154	25	89
DMR	12/29/2020	139		146	25	85
DMR	12/30/2020	152		131	25	78
DMR	12/31/2020	134		139	0	69

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	1/1/2021	134		140	0	70
DMR	1/2/2021	118		135	0	67
DMR	1/3/2021	124		128	0	64
DMR	1/4/2021	138		129	0	64
DMR	1/5/2021	134		129	0	64
DMR	1/6/2021	135		133	0	66
DMR	1/7/2021	146		138	0	69
DMR	1/8/2021	122		134	0	67
DMR	1/9/2021	118		130	0	65
DMR	1/10/2021	96		121	0	60
DMR	1/11/2021	135		118	0	59
DMR	1/12/2021	148		124	0	62
DMR	1/13/2021	145		131	0	66
DMR	1/14/2021	144		143	0	72
DMR	1/15/2021	129		142	0	71
DMR	1/16/2021	132		138	0	69
DMR	1/17/2021	145		138	0	69
DMR	1/18/2021	133		135	0	67
DMR	1/19/2021	130		135	0	68
DMR	1/20/2021	146		139	0	69
DMR	1/21/2021	127		134	0	67
DMR	1/22/2021	153		139	0	70
DMR	1/23/2021	142		142	0	71
DMR	1/24/2021	203		156	0	78
DMR	1/25/2021	134		158	0	79
DMR	1/26/2021	134		153	0	77
DMR	1/27/2021	134		151	0	76
DMR	1/28/2021	124		132	0	66
DMR	1/29/2021	125		129	0	65
DMR	1/30/2021	150		133	0	67
DMR	1/31/2021	129		132	0	66
DMR	2/1/2021	144		137	0	69
DMR	2/2/2021	141		141	0	71
DMR	2/3/2021	147		140	0	70
DMR	2/4/2021	156		147	0	74
DMR	2/5/2021	167		153	0	76
DMR	2/6/2021	162		158	0	79
DMR	2/7/2021	147		158	0	79
DMR	2/8/2021	167		161	0	80
DMR	2/9/2021	183		165	0	82
DMR	2/10/2021	182		170	0	85
DMR	2/11/2021	205		184	0	92
DMR	2/12/2021	201		193	0	96
DMR	2/13/2021	203		198	0	99
DMR	2/14/2021	frozen		203	0	102
DMR	2/15/2021	254		219	0	110
DMR	2/16/2021	222		226	0	113
DMR	2/17/2021	214		230	0	115
DMR	2/18/2021	179		217	0	109
DMR	2/19/2021	177		198	0	99
DMR	2/20/2021	154		181	0	91
DMR	2/21/2021	122		158	0	79
DMR	2/22/2021	167		155	0	78
DMR	2/23/2021	234		169	0	85
DMR	2/24/2021	196		180	0	90

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	2/25/2021	151		187	0	94
DMR	2/26/2021	123		176	0	88
DMR	2/27/2021	107		144	0	72
DMR	2/28/2021	141		131	0	65
DMR	3/1/2021	132		126	0	63
DMR	3/2/2021	132		128	0	64
DMR	3/3/2021	144		137	0	69
DMR	3/4/2021	116		131	0	66
DMR	3/5/2021	81	17	118	17	68
DMR	3/6/2021	31	11	93	14	54
DMR	3/7/2021	24	11	63	13	38
DMR	3/8/2021	25	13	40	13	27
DMR	3/9/2021	23	15	26	13	19
DMR	3/10/2021	23	16	24	14	19
DMR	3/11/2021	22	14	23	15	19
DMR	3/12/2021	24	13	23	15	19
DMR	3/13/2021	27	17	24	15	20
DMR	3/14/2021	27	14	25	15	20
DMR	3/15/2021	34	16	28	15	22
DMR	3/16/2021	39	16	32	16	24
DMR	3/17/2021	32	16	33	16	24
DMR	3/18/2021	37	14	36	16	26
DMR	3/19/2021	41	16	37	16	26
DMR	3/20/2021	36	18	37	16	26
DMR	3/21/2021	31	19	36	17	27
DMR	3/22/2021	30	18	35	18	26
DMR	3/23/2021	36	21	33	19	26
DMR	3/24/2021	31	20	32	20	26
DMR	3/25/2021	25	16	31	19	25
DMR	3/26/2021	24	16	29	18	24
DMR	3/27/2021	25	16	26	17	22
DMR	3/28/2021	27	17	25	16	21
DMR	3/29/2021	26	17	26	17	21
DMR	3/30/2021	27	18	26	17	22
DMR	3/31/2021	31	18	28	18	23
DMR	4/1/2021	29	19	28	18	23
DMR	4/2/2021	30	20	29	19	24
DMR	4/3/2021	31	19	30	19	25
DMR	4/4/2021	33	18	31	19	25
DMR	4/5/2021	30	18	31	19	25
DMR	4/6/2021	29	16	31	18	24
DMR	4/7/2021	34	21	32	18	25
DMR	4/8/2021	26	17	30	18	24
DMR	4/9/2021	25	17	29	18	23
DMR	4/10/2021	24	16	27	18	23
DMR	4/11/2021	28	17	26	17	21
DMR	4/12/2021	29	19	27	17	22
DMR	4/13/2021	30	18	28	18	23
DMR	4/14/2021	34	19	30	18	24
DMR	4/15/2021	31	17	31	18	25
DMR	4/16/2021	32	17	32	18	25
DMR	4/17/2021	30	20	32	18	25
DMR	4/18/2021	29	17	31	18	24
DMR	4/19/2021	36	19	32	18	25
DMR	4/20/2021	35	17	33	18	25

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	4/21/2021	36	17	34	18	26
DMR	4/22/2021	38	17	36	18	27
DMR	4/23/2021	34	18	36	17	27
DMR	4/24/2021	38	18	37	18	27
DMR	4/25/2021	38	16	37	17	27
DMR	4/26/2021	42	18	38	18	28
DMR	4/27/2021	46	16	41	17	29
DMR	4/28/2021	39	18	41	17	29
DMR	4/29/2021	41	18	42	18	30
DMR	4/30/2021	37	22	41	19	30
DMR	5/1/2021	40	18	39	19	29
DMR	5/2/2021	38	18	39	19	29
DMR	5/3/2021	37	17	38	19	28
DMR	5/4/2021	42	21	39	19	29
DMR	5/5/2021	46	20	41	19	30
DMR	5/6/2021	47	19	43	19	31
DMR	5/7/2021	46	21	45	20	33
DMR	5/8/2021	44	18	46	20	33
DMR	5/9/2021	39	18	44	19	32
DMR	5/10/2021	48	19	44	19	32
DMR	5/11/2021	50	20	45	19	32
DMR	5/12/2021	50	19	47	19	33
DMR	5/13/2021	54	19	51	19	35
DMR	5/14/2021	46	21	50	20	35
DMR	5/15/2021	42	19	48	20	34
DMR	5/16/2021	41	20	46	20	33
DMR	5/17/2021	40	20	42	20	31
DMR	5/18/2021	39	17	41	19	30
DMR	5/19/2021	42	17	41	19	30
DMR	5/20/2021	48	22	42	19	31
DMR	5/21/2021	52	17	45	18	32
DMR	5/22/2021	52	21	49	19	34
DMR	5/23/2021	48	23	50	21	35
DMR	5/24/2021	49	31	50	23	37
DMR	5/25/2021	48	19	49	24	36
DMR	5/26/2021	52	20	49	23	36
DMR	5/27/2021	65	20	54	23	38
DMR	5/28/2021	54	18	55	19	37
DMR	5/29/2021	43	18	54	19	36
DMR	5/30/2021	41	17	51	18	35
DMR	5/31/2021	47	23	46	19	33
DMR	6/1/2021	51	19	46	19	32
DMR	6/2/2021	56	17	49	19	34
DMR	6/3/2021	61	18	54	19	37
DMR	6/4/2021	64	20	58	19	38
DMR	6/5/2021	69	20	63	19	41
DMR	6/6/2021	68	21	66	20	43
DMR	6/7/2021	79	20	70	20	45
DMR	6/8/2021	57	18	68	20	44
DMR	6/9/2021	69	18	68	19	44
DMR	6/10/2021	94	19	75	19	47
DMR	6/11/2021	101	19	80	19	49
DMR	6/12/2021	79	20	86	19	52
DMR	6/13/2021	79	19	88	19	54
DMR	6/14/2021	93	18	88	19	54

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	6/15/2021	118	20	92	19	56
DMR	6/16/2021	116	20	102	19	60
DMR	6/17/2021	135	18	116	19	67
DMR	6/18/2021	119	19	122	19	71
DMR	6/19/2021	156	18	132	19	75
DMR	6/20/2021	146	19	139	19	79
DMR	6/21/2021	148	18	142	19	80
DMR	6/22/2021	106	20	139	19	79
DMR	6/23/2021	159	33	140	23	81
DMR	6/24/2021	142	29	139	25	82
DMR	6/25/2021	135	20	136	26	81
DMR	6/26/2021	132	20	142	26	84
DMR	6/27/2021	126	21	134	23	78
DMR	6/28/2021	123	17	129	20	74
DMR	6/29/2021	123	14	126	18	72
DMR	6/30/2021	109	15	120	17	69
DMR	7/1/2021	132	20	122	17	69
DMR	7/2/2021	137	17	125	17	71
DMR	7/3/2021	172	17	138	17	77
DMR	7/4/2021	163	16	151	18	84
DMR	7/5/2021	161	19	158	17	88
DMR	7/6/2021	149	19	161	18	90
DMR	7/7/2021	131	17	151	18	84
DMR	7/8/2021	155	22	149	19	84
DMR	7/9/2021	148	20	146	20	83
DMR	7/10/2021	184	21	155	20	87
DMR	7/11/2021	167	19	164	21	92
DMR	7/12/2021	181	19	170	20	95
DMR	7/13/2021	192	19	181	20	100
DMR	7/14/2021	149	16	172	18	95
DMR	7/15/2021	152	18	169	18	93
DMR	7/16/2021	160	18	163	18	91
DMR	7/17/2021	158	17	155	17	86
DMR	7/18/2021	155	18	156	18	87
DMR	7/19/2021	187	19	165	18	92
DMR	7/20/2021	122	17	156	18	87
DMR	7/21/2021	166	17	158	18	88
DMR	7/22/2021	220	21	174	19	96
DMR	7/23/2021	194	22	176	19	97
DMR	7/24/2021	122	22	176	21	98
DMR	7/25/2021	224	20	190	21	106
DMR	7/26/2021	207	20	187	21	104
DMR	7/27/2021	130	28	171	23	97
DMR	7/28/2021	160	22	180	23	101
DMR	7/29/2021	143	22	160	23	92
DMR	7/30/2021	152	19	146	23	85
DMR	7/31/2021	159	20	154	21	87
DMR	8/1/2021	214	18	167	20	93
DMR	8/2/2021	230	16	189	18	104
DMR	8/3/2021	230	19	208	18	113
DMR	8/4/2021	258	20	233	18	126
DMR	8/5/2021	169	19	222	19	120
DMR	8/6/2021	118	19	194	19	107
DMR	8/7/2021	192	16	184	19	101
DMR	8/8/2021	220	18	175	18	96

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	8/9/2021	270	17	200	18	109
DMR	8/10/2021	246	18	232	17	125
DMR	8/11/2021	127	18	216	18	117
DMR	8/12/2021	263	17	227	18	122
DMR	8/13/2021	179	18	204	18	111
DMR	8/14/2021	188	18	189	18	104
DMR	8/15/2021	184	18	204	18	111
DMR	8/16/2021	194	21	186	19	103
DMR	8/17/2021	194	20	190	19	105
DMR	8/18/2021	280	19	213	20	116
DMR	8/19/2021	186	20	214	20	117
DMR	8/20/2021	190	20	213	20	116
DMR	8/21/2021	166	19	206	20	113
DMR	8/22/2021	201	17	186	19	102
DMR	8/23/2021	201	86	190	36	113
DMR	8/24/2021	67	10	159	33	96
DMR	8/25/2021	220	18	172	33	103
DMR	8/26/2021	245	19	183	33	108
DMR	8/27/2021	43	11	144	15	79
DMR	8/28/2021	131	14	160	16	88
DMR	8/29/2021	171	14	148	15	81
DMR	8/30/2021	175	16	130	14	72
DMR	8/31/2021	145	13	156	14	85
DMR	9/1/2021	128	12	155	14	84
DMR	9/2/2021	122	13	143	14	78
DMR	9/3/2021	58	13	113	13	63
DMR	9/4/2021	90	13	100	13	56
DMR	9/5/2021	111	14	95	13	54
DMR	9/6/2021	103	13	91	13	52
DMR	9/7/2021	194	16	125	14	69
DMR	9/8/2021	167	16	144	15	79
DMR	9/9/2021	189	18	163	16	90
DMR	9/10/2021	220	19	193	17	105
DMR	9/11/2021	200	22	194	19	106
DMR	9/12/2021	215	18	206	19	113
DMR	9/13/2021	181	17	204	19	112
DMR	9/14/2021	141	14	184	18	101
DMR	9/15/2021	211	15	187	16	102
DMR	9/16/2021	191	14	181	15	98
DMR	9/17/2021	72	13	154	14	84
DMR	9/18/2021	167	14	160	14	87
DMR	9/19/2021	170	16	150	14	82
DMR	9/20/2021	192	16	150	15	83
DMR	9/21/2021	151	16	170	16	93
DMR	9/22/2021	168	15	170	16	93
DMR	9/23/2021	179	15	173	16	94
DMR	9/24/2021	158	16	164	16	90
DMR	9/25/2021	159	16	166	16	91
DMR	9/26/2021	179	14	169	15	92
DMR	9/27/2021	170	17	167	16	91
DMR	9/28/2021	183	17	173	16	94
DMR	9/29/2021	101	18	158	17	87
DMR	9/30/2021	167	16	155	17	86
DMR	10/1/2021	87	19	135	18	76
DMR	10/2/2021	55	20	103	18	60

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	10/3/2021	148	19	114	19	66
DMR	10/4/2021	162	20	113	20	66
DMR	10/5/2021	209	23	144	21	82
DMR	10/6/2021	161	20	170	21	95
DMR	10/7/2021	211	17	186	20	103
DMR	10/8/2021	235	16	204	19	112
DMR	10/9/2021	238	17	211	18	114
DMR	10/10/2021	220	16	226	17	121
DMR	10/11/2021	171	16	216	16	116
DMR	10/12/2021	220	16	212	16	114
DMR	10/13/2021	188	15	200	16	108
DMR	10/14/2021	165	16	186	16	101
DMR	10/15/2021	151	13	181	15	98
DMR	10/16/2021	143	13	162	14	88
DMR	10/17/2021	120	14	145	14	79
DMR	10/18/2021	187	14	150	14	82
DMR	10/19/2021	157	15	152	14	83
DMR	10/20/2021	172	16	159	15	87
DMR	10/21/2021	110	13	157	15	86
DMR	10/22/2021	112	13	138	14	76
DMR	10/23/2021	153	14	137	14	75
DMR	10/24/2021	160	13	134	13	74
DMR	10/25/2021	182	18	152	15	83
DMR	10/26/2021	194	20	172	16	94
DMR	10/27/2021	142	18	170	17	93
DMR	10/28/2021	65	16	146	18	82
DMR	10/29/2021	108	28	127	21	74
DMR	10/30/2021	125	22	110	21	66
DMR	10/31/2021	85	21	96	22	59
DMR	11/1/2021	83	23	100	24	62
DMR	11/2/2021	82	20	94	22	58
DMR	11/3/2021	110	21	90	21	56
DMR	11/4/2021	98	20	93	21	57
DMR	11/5/2021	98	19	97	20	59
DMR	11/6/2021	100	23	102	21	61
DMR	11/7/2021	90	20	97	21	59
DMR	11/8/2021	97	20	96	21	58
DMR	11/9/2021	83	19	93	21	57
DMR	11/10/2021	93	19	91	20	55
DMR	11/11/2021	93	21	92	20	56
DMR	11/12/2021	95	19	91	20	55
DMR	11/13/2021	105	30	97	22	59
DMR	11/14/2021	121	25	104	24	64
DMR	11/15/2021	103	24	106	25	65
DMR	11/16/2021	86	18	104	24	64
DMR	11/17/2021	73	20	96	22	59
DMR	11/18/2021	79	20	85	21	53
DMR	11/19/2021	83	21	80	20	50
DMR	11/20/2021	75	23	78	21	49
DMR	11/21/2021	69	18	77	21	49
DMR	11/22/2021	109	24	84	22	53
DMR	11/23/2021	107	18	90	21	55
DMR	11/24/2021	109	18	99	20	59
DMR	11/25/2021	169	21	124	20	72
DMR	11/26/2021	150		134	19	76

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	11/27/2021	86		129	20	74
DMR	11/28/2021	85		123	21	72
DMR	11/29/2021	102	18	106	18	62
DMR	11/30/2021	94	21	92	20	56
DMR	12/1/2021	126	20	102	20	61
DMR	12/2/2021	110	23	108	21	64
DMR	12/3/2021	113	21	111	21	66
DMR	12/4/2021	60	17	102	20	61
DMR	12/5/2021	93	23	94	21	58
DMR	12/6/2021	112		95	0	47
DMR	12/7/2021	173		110	0	55
DMR	12/8/2021	184		141	0	70
DMR	12/9/2021	173		161	0	80
DMR	12/10/2021	131		165	0	83
DMR	12/11/2021	139		157	0	78
DMR	12/12/2021	97		135	0	68
DMR	12/13/2021	109		119	0	60
DMR	12/14/2021	128		118	0	59
DMR	12/15/2021	151		121	0	61
DMR	12/16/2021	110		125	0	62
DMR	12/17/2021	94		121	0	60
DMR	12/18/2021	72		107	0	53
DMR	12/19/2021	97		93	0	47
DMR	12/20/2021	81		86	0	43
DMR	12/21/2021	78		82	0	41
DMR	12/22/2021	78		84	0	42
DMR	12/23/2021	69		77	0	38
DMR	12/24/2021	84		77	0	39
DMR	12/25/2021	90		80	0	40
DMR	12/26/2021	106		87	0	44
DMR	12/27/2021	98		95	0	47
DMR	12/28/2021	73		92	0	46
DMR	12/29/2021	82		90	0	45
DMR	12/30/2021	79		83	0	42
DMR	12/31/2021	108		86	0	43
DMR	1/1/2022	110		95	0	47
DMR	1/2/2022	101		100	0	50
DMR	1/3/2022	112		108	0	54
DMR	1/4/2022	181		126	0	63
DMR	1/5/2022	127		130	0	65
DMR	1/6/2022	92		128	0	64
DMR	1/7/2022	161		140	0	70
DMR	1/8/2022	148		132	0	66
DMR	1/9/2022	108		127	0	64
DMR	1/10/2022	137		139	0	69
DMR	1/11/2022	191		146	0	73
DMR	1/12/2022	132		142	0	71
DMR	1/13/2022	148		152	0	76
DMR	1/14/2022	117		147	0	74
DMR	1/15/2022	170		142	0	71
DMR	1/16/2022	182		154	0	77
DMR	1/17/2022	186		164	0	82
DMR	1/18/2022	190		182	0	91
DMR	1/19/2022	221		195	0	97
DMR	1/20/2022	176		193	0	97

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	1/21/2022	176		191	0	95
DMR	1/22/2022	161		184	0	92
DMR	1/23/2022	158		168	0	84
DMR	1/24/2022	170		166	0	83
DMR	1/25/2022	159		162	0	81
DMR	1/26/2022	184		168	0	84
DMR	1/27/2022	151		166	0	83
DMR	1/28/2022	137		158	0	79
DMR	1/29/2022	176		162	0	81
DMR	1/30/2022	172		159	0	80
DMR	1/31/2022	162		162	0	81
DMR	2/1/2022	167		169	0	85
DMR	2/2/2022	166		167	0	83
DMR	2/3/2022	167		166	0	83
DMR	2/4/2022	181		170	0	85
DMR	2/5/2022	178		173	0	87
DMR	2/6/2022	169		174	0	87
DMR	2/7/2022	184		178	0	89
DMR	2/8/2022	183		179	0	89
DMR	2/9/2022	262		200	0	100
DMR	2/10/2022	192		205	0	103
DMR	2/11/2022	230		217	0	108
DMR	2/12/2022	162		212	0	106
DMR	2/13/2022	139		181	0	90
DMR	2/14/2022	143		169	0	84
DMR	2/15/2022	127		143	0	71
DMR	2/16/2022	121		133	0	66
DMR	2/17/2022	164		139	0	69
DMR	2/18/2022	160		143	0	72
DMR	2/19/2022	158		151	0	75
DMR	2/20/2022	144		157	0	78
DMR	2/21/2022	135		149	0	75
DMR	2/22/2022	134		143	0	71
DMR	2/23/2022	148		140	0	70
DMR	2/24/2022	143		140	0	70
DMR	2/25/2022	222		162	0	81
DMR	2/26/2022	222		184	0	92
DMR	2/27/2022	238		206	0	103
DMR	2/28/2022	224		227	0	113
DMR	3/1/2022	219		226	0	113
DMR	3/2/2022	101		196	0	98
DMR	3/3/2022	98		161	0	80
DMR	3/4/2022	91		127	0	64
DMR	3/5/2022	61		88	0	44
DMR	3/6/2022	108		90	0	45
DMR	3/7/2022	159		105	0	52
DMR	3/8/2022	96		106	0	53
DMR	3/9/2022	93		114	0	57
DMR	3/10/2022	117		116	0	58
DMR	3/11/2022	131		109	0	55
DMR	3/12/2022	114		114	0	57
DMR	3/13/2022	110		118	0	59
DMR	3/14/2022	162		129	0	65
DMR	3/15/2022	110	18	124	18	71
DMR	3/16/2022	27	14	102	16	59

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	3/17/2022	26	15	81	16	48
DMR	3/18/2022	41	13	51	15	33
DMR	3/19/2022	30	15	31	14	23
DMR	3/20/2022	25	12	31	14	22
DMR	3/21/2022	26	17	31	14	22
DMR	3/22/2022	35	16	29	15	22
DMR	3/23/2022	33	15	30	15	22
DMR	3/24/2022	36	14	33	16	24
DMR	3/25/2022	29	15	33	15	24
DMR	3/26/2022	31	18	32	16	24
DMR	3/27/2022	54	17	38	16	27
DMR	3/28/2022	43	15	39	16	28
DMR	3/29/2022	44	17	43	17	30
DMR	3/30/2022	41	19	46	17	31
DMR	3/31/2022	50	19	45	18	31
DMR	4/1/2022	36	18	43	18	31
DMR	4/2/2022	46	27	43	21	32
DMR	4/3/2022	42	17	44	20	32
DMR	4/4/2022	56	19	45	20	33
DMR	4/5/2022	52	19	49	21	35
DMR	4/6/2022	39	19	47	19	33
DMR	4/7/2022	36	18	46	19	32
DMR	4/8/2022	52	21	45	19	32
DMR	4/9/2022	36	28	41	22	31
DMR	4/10/2022	46	21	43	22	32
DMR	4/11/2022			45	23	34
DMR	4/12/2022	34	18	39	22	31
DMR	4/13/2022	31	16	37	18	28
DMR	4/14/2022	37	21	34	18	26
DMR	4/15/2022	39	19	35	19	27
DMR	4/16/2022	39	19	37	19	28
DMR	4/17/2022	47	19	41	20	30
DMR	4/18/2022	54	20	45	19	32
DMR	4/19/2022	34	19	44	19	31
DMR	4/20/2022	50	37	46	24	35
DMR	4/21/2022	47	27	46	26	36
DMR	4/22/2022	54	27	46	28	37
DMR	4/23/2022	53	26	51	29	40
DMR	4/24/2022	50	26	51	27	39
DMR	4/25/2022	57	25	54	26	40
DMR	4/26/2022	58	26	55	26	40
DMR	4/27/2022	57	27	56	26	41
DMR	4/28/2022	47	24	55	26	40
DMR	4/29/2022	0	21	0	25	12
DMR	4/30/2022	38	24	36	24	30
DMR	5/1/2022	31	21	29	23	26
DMR	5/2/2022	33	20	26	22	24
DMR	5/3/2022	31	21	33	22	27
DMR	5/4/2022	31	21	32	21	26
DMR	5/5/2022	33	21	32	21	26
DMR	5/6/2022	33	21	32	21	27
DMR	5/7/2022	33	23	33	22	27
DMR	5/8/2022	32	21	33	22	27
DMR	5/9/2022	30	20	32	21	27
DMR	5/10/2022	36	23	33	22	27

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	5/11/2022	21	16	30	20	25
DMR	5/12/2022	17	13	26	18	22
DMR	5/13/2022	19	17	23	17	20
DMR	5/14/2022	19	16	19	16	17
DMR	5/15/2022	20	15	19	15	17
DMR	5/16/2022	22	16	20	16	18
DMR	5/17/2022	20	17	20	16	18
DMR	5/18/2022	24	18	22	17	19
DMR	5/19/2022	21	17	22	17	19
DMR	5/20/2022	23	18	22	18	20
DMR	5/21/2022	24	16	23	17	20
DMR	5/22/2022	24	19	23	18	20
DMR	5/23/2022	26	19	24	18	21
DMR	5/24/2022	26	19	25	18	22
DMR	5/25/2022	27	21	26	20	23
DMR	5/26/2022	28	20	27	20	23
DMR	5/27/2022	25	21	27	20	23
DMR	5/28/2022	29	21	27	21	24
DMR	5/29/2022	26	20	27	21	24
DMR	5/30/2022	25	19	26	20	23
DMR	5/31/2022	24	17	26	19	23
DMR	6/1/2022	26	17	25	18	22
DMR	6/2/2022	28	18	26	18	22
DMR	6/3/2022	29	19	27	18	22
DMR	6/4/2022	27	17	28	18	23
DMR	6/5/2022	28	18	28	18	23
DMR	6/6/2022	23	19	27	18	23
DMR	6/7/2022	22	17	25	18	21
DMR	6/8/2022	31	18	26	18	22
DMR	6/9/2022	29	20	26	19	22
DMR	6/10/2022	21	19	26	19	22
DMR	6/11/2022	30	21	28	20	24
DMR	6/12/2022	33	22	28	21	24
DMR	6/13/2022	33	18	29	20	25
DMR	6/14/2022	35	21	33	21	27
DMR	6/15/2022	31	17	33	20	26
DMR	6/16/2022	29	25	32	20	26
DMR	6/17/2022	32	18	32	20	26
DMR	6/18/2022	32	17	31	19	25
DMR	6/19/2022	35	18	32	20	26
DMR	6/20/2022	31	17	33	18	25
DMR	6/21/2022	30	14	32	17	24
DMR	6/22/2022	33	18	32	17	25
DMR	6/23/2022	36	18	33	17	25
DMR	6/24/2022	42	20	35	18	26
DMR	6/25/2022	47	20	40	19	29
DMR	6/26/2022	44	18	42	19	31
DMR	6/27/2022	51	19	46	19	33
DMR	6/28/2022	52	19	49	19	34
DMR	6/29/2022	56	18	51	19	35
DMR	6/30/2022	53	19	53	19	36
DMR	7/1/2022	50	16	53	18	35
DMR	7/2/2022	53	16	53	17	35
DMR	7/3/2022	55	17	53	17	35
DMR	7/4/2022	63	28	55	19	37

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	7/5/2022	71	18	61	20	40
DMR	7/6/2022	65	20	64	21	42
DMR	7/7/2022	50	18	62	21	42
DMR	7/8/2022	63	16	62	18	40
DMR	7/9/2022	66	18	61	18	40
DMR	7/10/2022	73	17	63	17	40
DMR	7/11/2022	73	16	69	17	43
DMR	7/12/2022	72	17	71	17	44
DMR	7/13/2022	69	18	72	17	44
DMR	7/14/2022	55	18	67	17	42
DMR	7/15/2022	66	18	66	18	42
DMR	7/16/2022	82	18	68	18	43
DMR	7/17/2022	100	20	76	19	47
DMR	7/18/2022	109	21	89	19	54
DMR	7/19/2022	117	18	102	19	61
DMR	7/20/2022	121	17	112	19	65
DMR	7/21/2022	119	18	117	19	68
DMR	7/22/2022	91	18	112	18	65
DMR	7/23/2022	113	19	111	18	65
DMR	7/24/2022	116	19	110	19	64
DMR	7/25/2022	116	19	109	19	64
DMR	7/26/2022	144	21	122	20	71
DMR	7/27/2022	145	21	130	20	75
DMR	7/28/2022	168	19	143	20	82
DMR	7/29/2022	164	19	155	20	88
DMR	7/30/2022	174	21	163	20	91
DMR	7/31/2022	176	18	171	19	95
DMR	8/1/2022	176	19.25	173	19	96
DMR	8/2/2022	157	19.75	171	20	95
DMR	8/3/2022	129	20.5	160	19	89
DMR	8/4/2022	205	20.75	167	20	93
DMR	8/5/2022		21.75	164	21	92
DMR	8/6/2022	170	21.5	168	21	95
DMR	8/7/2022	163	21	179	21	100
DMR	8/8/2022	141	20.25	158	21	90
DMR	8/9/2022	139	19.25	153	21	87
DMR	8/10/2022	161	18.75	151	20	85
DMR	8/11/2022	96	18	134	19	77
DMR	8/12/2022	179	17.75	144	18	81
DMR	8/13/2022	130	18.75	142	18	80
DMR	8/14/2022	175	18.25	145	18	82
DMR	8/15/2022	176	18.25	165	18	92
DMR	8/16/2022	174	20	164	19	91
DMR	8/17/2022	186	19	178	19	98
DMR	8/18/2022	185	20	180	19	100
DMR	8/19/2022	158	20.25	176	20	98
DMR	8/20/2022	134	18.25	166	19	93
DMR	8/21/2022	151	18.25	157	19	88
DMR	8/22/2022	158	17.25	150	19	84
DMR	8/23/2022	180	17.75	156	18	87
DMR	8/24/2022	194	19.5	171	18	94
DMR	8/25/2022	152	20	171	19	95
DMR	8/26/2022	165	20.5	173	19	96
DMR	8/27/2022	214	20.25	181	20	101
DMR	8/28/2022	218	19	187	20	104

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	8/29/2022	217	18	204	19	111
DMR	8/30/2022	129	18.25	195	19	107
DMR	8/31/2022	258	18.75	206	19	112
DMR	9/1/2022	216	22	205	19	112
DMR	9/2/2022	158	23	190	21	105
DMR	9/3/2022	285	25	229	22	126
DMR	9/4/2022	142	21	200	23	112
DMR	9/5/2022	136	21	180	23	101
DMR	9/6/2022	221	26	196	23	110
DMR	9/7/2022	173	20	168	22	95
DMR	9/8/2022	203	21	183	22	103
DMR	9/9/2022	177	19	194	22	108
DMR	9/10/2022	194	19	187	20	103
DMR	9/11/2022	207	16	195	19	107
DMR	9/12/2022	230	15	202	17	110
DMR	9/13/2022	206	18	209	17	113
DMR	9/14/2022	228	17	218	17	117
DMR	9/15/2022	213	19	219	17	118
DMR	9/16/2022	144	21	198	19	108
DMR	9/17/2022	290	18	219	19	119
DMR	9/18/2022	133	17	195	19	107
DMR	9/19/2022	197	19	191	19	105
DMR	9/20/2022	236	18	214	18	116
DMR	9/21/2022	152	17	180	18	99
DMR	9/22/2022	187	16	193	18	105
DMR	9/23/2022	185	18	190	17	104
DMR	9/24/2022	170	18	174	17	95
DMR	9/25/2022	206	17	187	17	102
DMR	9/26/2022	256	19	204	18	111
DMR	9/27/2022	201	16	208	18	113
DMR	9/28/2022	162	20	206	18	112
DMR	9/29/2022	172	19	198	19	108
DMR	9/30/2022	275	18	203	18	110
DMR	10/1/2022	188	18	199	19	109
DMR	10/2/2022	220	18	214	18	116
DMR	10/3/2022	189	18	218	18	118
DMR	10/4/2022	195	19	198	18	108
DMR	10/5/2022	218	19	206	19	112
DMR	10/6/2022	85	11	172	17	94
DMR	10/7/2022	268	14	192	16	104
DMR	10/8/2022	176	15	187	15	101
DMR	10/9/2022	175	15	176	14	95
DMR	10/10/2022	172	16	198	15	106
DMR	10/11/2022	179	20	176	17	96
DMR	10/12/2022	184	16	178	17	97
DMR	10/13/2022	190	18	181	18	99
DMR	10/14/2022	181	17	184	18	101
DMR	10/15/2022	178	17	183	17	100
DMR	10/16/2022	155	14	176	17	96
DMR	10/17/2022	165	14	170	16	93
DMR	10/18/2022	183	8	170	13	92
DMR	10/19/2022	166	16	167	13	90
DMR	10/20/2022	181	17	174	14	94
DMR	10/21/2022	156	17	172	15	93
DMR	10/22/2022	161	15	166	16	91

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	10/23/2022	165	14	166	16	91
DMR	10/24/2022	168	16	163	16	89
DMR	10/25/2022	178	16	168	15	92
DMR	10/26/2022	173	15	171	15	93
DMR	10/27/2022	117	16	159	16	87
DMR	10/28/2022	226	18	174	16	95
DMR	10/29/2022	193	14	177	16	97
DMR	10/30/2022	181	19	179	17	98
DMR	10/31/2022	171	14	193	16	105
DMR	11/1/2022	186	16	183	16	99
DMR	11/2/2022	175	17	178	17	97
DMR	11/3/2022	119	14	163	15	89
DMR	11/4/2022	158	17	160	16	88
DMR	11/5/2022	166	16	155	16	85
DMR	11/6/2022	129	17	143	16	80
DMR	11/7/2022	168	13	155	16	86
DMR	11/8/2022	178	13	160	15	88
DMR	11/9/2022	71	21	137	16	76
DMR	11/10/2022	149	17	142	16	79
DMR	11/11/2022	229	19	157	18	87
DMR	11/12/2022	235	16	171	18	95
DMR	11/13/2022	147	15	190	17	103
DMR	11/14/2022	130	13	185	16	101
DMR	11/15/2022	141	14	163	15	89
DMR	11/16/2022	212	12	158	14	86
DMR	11/17/2022	170	29	163	17	90
DMR	11/18/2022	212	15	184	18	101
DMR	11/19/2022	135		182	19	100
DMR	11/20/2022	125		161	22	91
DMR	11/21/2022	124		149	15	82
DMR	11/22/2022	185		142	0	71
DMR	11/23/2022	175		152	0	76
DMR	11/24/2022	179		166	0	83
DMR	11/25/2022	171		178	0	89
DMR	11/26/2022	176	14	175	14	95
DMR	11/27/2022	161	14	172	14	93
DMR	11/28/2022	187	17	174	15	94
DMR	11/29/2022	92	14	154	15	84
DMR	11/30/2022	185		156	15	86
DMR	12/1/2022	246		178	0	89
DMR	12/2/2022	201		181	0	91
DMR	12/3/2022	244		219	0	110
DMR	12/4/2022	206		224	0	112
DMR	12/5/2022	147		200	0	100
DMR	12/6/2022	149		187	0	93
DMR	12/7/2022	225		182	0	91
DMR	12/8/2022	221		186	0	93
DMR	12/9/2022	209		201	0	101
DMR	12/10/2022	179		209	0	104
DMR	12/11/2022	174		196	0	98
DMR	12/12/2022	165		182	0	91
DMR	12/13/2022	181		175	0	87
DMR	12/14/2022	209		182	0	91
DMR	12/15/2022	179		184	0	92
DMR	12/16/2022	239		202	0	101

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	12/17/2022	199		207	0	103
DMR	12/18/2022	186		201	0	100
DMR	12/19/2022	175		200	0	100
DMR	12/20/2022	172		183	0	92
DMR	12/21/2022	200		183	0	92
DMR	12/22/2022	194		185	0	93
DMR	12/23/2022			189	0	94
DMR	12/24/2022	281		225	0	113
DMR	12/25/2022	121		199	0	99
DMR	12/26/2022	182		195	0	97
DMR	12/27/2022	169		188	0	94
DMR	12/28/2022	180		163	0	82
DMR	12/29/2022	203		184	0	92
DMR	12/30/2022	181		183	0	92
DMR	12/31/2022	153		179	0	90
DMR	1/1/2023	148	26	171	26	99
DMR	1/2/2023	192	26	169	26	97
DMR	1/3/2023	170	26	166	26	96
DMR	1/4/2023	182	27	173	26	100
DMR	1/5/2023	201	26	186	26	106
DMR	1/6/2023	180	23	183	26	104
DMR	1/7/2023	175		185	0	92
DMR	1/8/2023	174		183	0	91
DMR	1/9/2023	176	26	176	25	100
DMR	1/10/2023	164	25	172	26	99
DMR	1/11/2023	165	24	170	25	97
DMR	1/12/2023	182		172	0	86
DMR	1/13/2023	196		177	0	88
DMR	1/14/2023	170		178	0	89
DMR	1/15/2023	242		198	0	99
DMR	1/16/2023	155		191	0	95
DMR	1/17/2023	264		208	0	104
DMR	1/18/2023	153		204	0	102
DMR	1/19/2023	184		189	0	95
DMR	1/20/2023	224		206	0	103
DMR	1/21/2023	190		188	0	94
DMR	1/22/2023	203		200	0	100
DMR	1/23/2023	163		195	0	98
DMR	1/24/2023	166		181	0	90
DMR	1/25/2023	167	36	175	36	105
DMR	1/26/2023	211		177	0	88
DMR	1/27/2023	197		185	0	93
DMR	1/28/2023	189		191	0	96
DMR	1/29/2023	184		195	0	98
DMR	1/30/2023	191	28	190	28	109
DMR	1/31/2023	210	25	194	27	110
DMR	2/1/2023	220	22	201	25	113
DMR	2/2/2023	173	21	199	24	111
DMR	2/3/2023	176	21	195	22	109
DMR	2/4/2023	228	21	199	21	110
DMR	2/5/2023	236	23	203	22	112
DMR	2/6/2023	211		213	22	117
DMR	2/7/2023	191		217	22	119
DMR	2/8/2023	223		215	23	119
DMR	2/9/2023	219		211	0	106

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	2/10/2023	168	21	200	21	111
DMR	2/11/2023	97	20	177	21	99
DMR	2/12/2023	154	21	160	21	90
DMR	2/13/2023	204	21	156	21	88
DMR	2/14/2023	203	27	165	22	93
DMR	2/15/2023	231	32	198	25	112
DMR	2/16/2023	138	27	194	27	110
DMR	2/17/2023	124		174	29	101
DMR	2/18/2023	166		165	0	82
DMR	2/19/2023	215		161	0	80
DMR	2/20/2023	209		179	0	89
DMR	2/21/2023	169		190	0	95
DMR	2/22/2023	187		195	0	98
DMR	2/23/2023	201	20	192	20	106
DMR	2/24/2023	158	22	179	21	100
DMR	2/25/2023	152	20	175	21	98
DMR	2/26/2023	200	22	178	21	99
DMR	2/27/2023	216	19	182	21	101
DMR	2/28/2023	233		200	20	110
DMR	3/1/2023	198		212	21	116
DMR	3/2/2023	163	21	203	20	111
DMR	3/3/2023	142	25	184	23	104
DMR	3/4/2023	150	20	163	22	93
DMR	3/5/2023	203	19	165	21	93
DMR	3/6/2023	217	21	178	21	100
DMR	3/7/2023	153	21	181	20	101
DMR	3/8/2023	195	19	192	20	106
DMR	3/9/2023	208	19	193	20	107
DMR	3/10/2023	233	19	197	20	108
DMR	3/11/2023	198	21	209	20	114
DMR	3/12/2023	118	20	189	20	105
DMR	3/13/2023	191	19	185	20	102
DMR	3/14/2023	223	24	183	21	102
DMR	3/15/2023	214	21	187	21	104
DMR	3/16/2023	232	21	215	21	118
DMR	3/17/2023	136	20	201	22	111
DMR	3/18/2023	161	20	186	21	103
DMR	3/19/2023	151	21	170	21	95
DMR	3/20/2023	224	22	168	21	94
DMR	3/21/2023	204	19	185	21	103
DMR	3/22/2023	233	20	203	21	112
DMR	3/23/2023	150	23	203	21	112
DMR	3/24/2023	122	26	177	22	100
DMR	3/25/2023	183	21	172	23	97
DMR	3/26/2023	160	24	154	24	89
DMR	3/27/2023	150	26	154	24	89
DMR	3/28/2023	159	30	163	25	94
DMR	3/29/2023	147	30	154	28	91
DMR	3/30/2023	138	33	149	30	89
DMR	3/31/2023	141	31	146	31	89
DMR	4/1/2023	144	27	143	30	86
DMR	4/2/2023	163	24	147	29	88
DMR	4/3/2023	102	23	138	26	82
DMR	4/4/2023	60	31	117	26	72
DMR	4/5/2023	63	23	97	25	61

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	4/6/2023	57	21	71	25	48
DMR	4/7/2023	40	22	55	24	40
DMR	4/8/2023	31	21	48	22	35
DMR	4/9/2023	26	21	39	21	30
DMR	4/10/2023	19	19	29	21	25
DMR	4/11/2023	15	21	23	21	22
DMR	4/12/2023	47	19	27	20	23
DMR	4/13/2023	11	21	23	20	22
DMR	4/14/2023	14	21	22	21	21
DMR	4/15/2023	15	21	22	21	21
DMR	4/16/2023	16	21	14	21	18
DMR	4/17/2023	19	31	16	24	20
DMR	4/18/2023	14	22	16	24	20
DMR	4/19/2023	21	23	18	24	21
DMR	4/20/2023	21	23	19	25	22
DMR	4/21/2023	23	23	20	23	21
DMR	4/22/2023	21	21	22	23	22
DMR	4/23/2023	24	24	22	23	23
DMR	4/24/2023	26	25	24	23	23
DMR	4/25/2023	25	23	24	23	24
DMR	4/26/2023	21	24	24	24	24
DMR	4/27/2023	29	26	25	25	25
DMR	4/28/2023	32	25	27	25	26
DMR	4/29/2023	25	27	27	26	26
DMR	4/30/2023	38	22	31	25	28
DMR	5/1/2023	32	23	32	24	28
DMR	5/2/2023	36	22	33	24	28
DMR	5/3/2023	37	23	36	23	29
DMR	5/4/2023	40	23	36	23	30
DMR	5/5/2023	37	23	38	23	30
DMR	5/6/2023	34	23	37	23	30
DMR	5/7/2023	36	22	37	23	30
DMR	5/8/2023	43	22	38	23	30
DMR	5/9/2023	45	22	40	22	31
DMR	5/10/2023	47	22	43	22	32
DMR	5/11/2023	48	22	46	22	34
DMR	5/12/2023	41	23	45	22	34
DMR	5/13/2023	40	24	44	23	33
DMR	5/14/2023	26	24	39	23	31
DMR	5/15/2023	24	23	33	24	28
DMR	5/16/2023	26	30	29	25	27
DMR	5/17/2023	25	23	25	25	25
DMR	5/18/2023	27	23	26	25	25
DMR	5/19/2023	26	24	26	25	26
DMR	5/20/2023	29	25	27	24	25
DMR	5/21/2023	30	25	28	24	26
DMR	5/22/2023	31	24	29	25	27
DMR	5/23/2023	36	22	32	24	28
DMR	5/24/2023	38	22	34	23	29
DMR	5/25/2023	38	19	36	22	29
DMR	5/26/2023	38	23	38	22	30
DMR	5/27/2023	37	23	38	22	30
DMR	5/28/2023	46	23	40	22	31
DMR	5/29/2023	27	26	37	24	30
DMR	5/30/2023	47	24	39	24	32

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	5/31/2023	57	23	44	24	34
DMR	6/1/2023	52	22	46	24	35
DMR	6/2/2023	58	22	54	23	38
DMR	6/3/2023	45	22	53	22	38
DMR	6/4/2023	46	23	50	22	36
DMR	6/5/2023	61	22	53	22	37
DMR	6/6/2023		20	51	22	36
DMR	6/7/2023	50	22	52	22	37
DMR	6/8/2023	54	23	55	22	38
DMR	6/9/2023	67	23	57	22	40
DMR	6/10/2023	83	23	64	23	43
DMR	6/11/2023	46	24	63	23	43
DMR	6/12/2023	76	25	68	24	46
DMR	6/13/2023	73	24	70	24	47
DMR	6/14/2023	102	27	74	25	50
DMR	6/15/2023	86	27	84	26	55
DMR	6/16/2023	78	23	85	25	55
DMR	6/17/2023	58	23	81	25	53
DMR	6/18/2023	57	19	70	23	46
DMR	6/19/2023	82	23	69	22	45
DMR	6/20/2023	76	23	68	22	45
DMR	6/21/2023	70	24	71	22	47
DMR	6/22/2023	73	23	75	23	49
DMR	6/23/2023	70	14	72	21	47
DMR	6/24/2023	56	12	67	18	43
DMR	6/25/2023	56	9	64	15	39
DMR	6/26/2023	74	11	64	12	38
DMR	6/27/2023	89	10	69	11	40
DMR	6/28/2023	87	13	77	11	44
DMR	6/29/2023	91	13	85	12	49
DMR	6/30/2023	92	18	90	14	52
DMR	7/1/2023	91	16	90	15	53
DMR	7/2/2023	98	17	93	16	55
DMR	7/3/2023	94	19	94	18	56
DMR	7/4/2023	86	17	92	17	55
DMR	7/5/2023	109	17	97	18	57
DMR	7/6/2023	116	17	101	18	59
DMR	7/7/2023	129	17	110	17	64
DMR	7/8/2023	128	18	121	17	69
DMR	7/9/2023	151	18	131	18	74
DMR	7/10/2023	171	17	145	18	81
DMR	7/11/2023	237	19	172	18	95
DMR	7/12/2023	83	16	161	18	89
DMR	7/13/2023	84	16	144	17	80
DMR	7/14/2023	122	17	132	17	74
DMR	7/15/2023	121	18	103	17	60
DMR	7/16/2023	141	20	117	18	67
DMR	7/17/2023	176	18	140	18	79
DMR	7/18/2023	161		150	19	84
DMR	7/19/2023	168	17	162	18	90
DMR	7/20/2023	197	18	176	18	97
DMR	7/21/2023	183	19	177	18	98
DMR	7/22/2023	150	19	175	18	96
DMR	7/23/2023	110	18	160	19	89
DMR	7/24/2023	118	19	140	19	80

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	7/25/2023	138	20	129	19	74
DMR	7/26/2023	135	24	125	20	73
DMR	7/27/2023	159	20	138	21	79
DMR	7/28/2023	110	20	136	21	78
DMR	7/29/2023	136	20	135	21	78
DMR	7/30/2023	155	19	140	20	80
DMR	7/31/2023	182	18	146	19	83
DMR	8/1/2023	183	31	164	22	93
DMR	8/2/2023	195	18	179	22	100
DMR	8/3/2023	125	20	171	22	97
DMR	8/4/2023	116	23	155	23	89
DMR	8/5/2023	217	18	163	20	92
DMR	8/6/2023	174	18	158	20	89
DMR	8/7/2023	151	16	165	19	92
DMR	8/8/2023	166	18	177	18	97
DMR	8/9/2023	159	19	163	18	90
DMR	8/10/2023	177	19	163	18	91
DMR	8/11/2023	127	25	157	20	89
DMR	8/12/2023	199	19	166	21	93
DMR	8/13/2023	190	20	173	21	97
DMR	8/14/2023	106	20	156	21	88
DMR	8/15/2023	99		149	20	84
DMR	8/16/2023	117	20	128	20	74
DMR	8/17/2023	219	17	135	19	77
DMR	8/18/2023	211	20	162	19	90
DMR	8/19/2023	213	20	190	19	105
DMR	8/20/2023	199	19	211	19	115
DMR	8/21/2023	229	19	213	20	116
DMR	8/22/2023	220	21	215	20	118
DMR	8/23/2023	223	20	218	20	119
DMR	8/24/2023	229	20	225	20	123
DMR	8/25/2023	171	19	211	20	115
DMR	8/26/2023	195	21	205	20	112
DMR	8/27/2023	149	22	186	21	103
DMR	8/28/2023	141		164	21	92
DMR	8/29/2023	163	18	162	20	91
DMR	8/30/2023	154	17	152	19	85
DMR	8/31/2023	199	19	164	18	91
DMR	9/1/2023	174		173	0	86
DMR	9/2/2023	175	20	176	19	97
DMR	9/3/2023	226	20	194	20	107
DMR	9/4/2023	196	20	193	20	106
DMR	9/5/2023	196	20	198	20	109
DMR	9/6/2023	196	25	204	21	112
DMR	9/7/2023	238	21	207	22	114
DMR	9/8/2023	182	20	203	22	112
DMR	9/9/2023	232	20	212	22	117
DMR	9/10/2023	198	21	213	21	117
DMR	9/11/2023	180	21	198	21	109
DMR	9/12/2023	172	19	196	20	108
DMR	9/13/2023	201	20	188	20	104
DMR	9/14/2023	159	21	178	20	99
DMR	9/15/2023	213	20	186	20	103
DMR	9/16/2023	144	20	179	20	100
DMR	9/17/2023	290	21	202	21	111

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	9/18/2023	133	27	195	22	109
DMR	9/19/2023	190	22	189	23	106
DMR	9/20/2023	154	23	192	23	108
DMR	9/21/2023	177	22	164	24	94
DMR	9/22/2023	186	21	177	22	99
DMR	9/23/2023	140	20	164	22	93
DMR	9/24/2023	111	21	154	21	87
DMR	9/25/2023	169	22	152	21	86
DMR	9/26/2023	209	18	157	20	89
DMR	9/27/2023	332	21	205	21	113
DMR	9/28/2023	97	20	202	20	111
DMR	9/29/2023	147	21	196	20	108
DMR	9/30/2023	47	24	156	22	89
DMR	10/1/2023	162	19	113	21	67
DMR	10/2/2023	238	21	149	21	85
DMR	10/3/2023	193	22	160	22	91
DMR	10/4/2023	101	20	174	21	97
DMR	10/5/2023	265	26	199	22	111
DMR	10/6/2023	130	25	172	23	98
DMR	10/7/2023	157	28	163	25	94
DMR	10/8/2023	171	21	181	25	103
DMR	10/9/2023	159	20	154	24	89
DMR	10/10/2023	133	18	155	22	88
DMR	10/11/2023	184	22	162	20	91
DMR	10/12/2023	173	24	162	21	92
DMR	10/13/2023	32	23	131	22	76
DMR	10/14/2023	57	23	112	23	67
DMR	10/15/2023	52	23	79	23	51
DMR	10/16/2023	101	24	61	23	42
DMR	10/17/2023	93	23	76	23	50
DMR	10/18/2023	129	23	94	23	59
DMR	10/19/2023	148	23	118	23	71
DMR	10/20/2023	170	30	135	25	80
DMR	10/21/2023	127	27	144	26	85
DMR	10/22/2023	151	26	149	27	88
DMR	10/23/2023	209	28	164	28	96
DMR	10/24/2023	149	24	159	26	93
DMR	10/25/2023	196	23	176	25	101
DMR	10/26/2023	69	21	156	24	90
DMR	10/27/2023	70	22	121	23	72
DMR	10/28/2023	110	22	111	22	67
DMR	10/29/2023	115	23	91	22	57
DMR	10/30/2023	135	23	108	23	65
DMR	10/31/2023	125	22	121	23	72
DMR	11/1/2023	151	22	132	23	77
DMR	11/2/2023	149		140	0	70
DMR	11/3/2023	154	20	145	21	83
DMR	11/4/2023	141	19	149	20	85
DMR	11/5/2023	147	20	148	20	84
DMR	11/6/2023	167	20	152	20	86
DMR	11/7/2023	163	25	155	21	88
DMR	11/8/2023	143	22	155	22	88
DMR	11/9/2023	151	23	156	23	89
DMR	11/10/2023	138	19	149	22	86
DMR	11/11/2023	137	19	142	21	82

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	11/12/2023	171	28	149	22	86
DMR	11/13/2023	163	23	152	22	87
DMR	11/14/2023	185	21	164	23	93
DMR	11/15/2023	178	20	174	23	99
DMR	11/16/2023	191	20	179	21	100
DMR	11/17/2023	206	19	190	20	105
DMR	11/18/2023	209	20	196	20	108
DMR	11/19/2023	181	17	197	19	108
DMR	11/20/2023	201	19	199	19	109
DMR	11/21/2023	195	19	197	19	108
DMR	11/22/2023	205	16	196	18	107
DMR	11/23/2023	195	22	199	19	109
DMR	11/24/2023	455	20	263	19	141
DMR	11/25/2023	78	21	233	20	127
DMR	11/26/2023	77	20	201	21	111
DMR	11/27/2023	102	21	178	21	99
DMR	11/28/2023	134	22	98	21	59
DMR	11/29/2023	158	22	118	21	70
DMR	11/30/2023	151	21	136	22	79
DMR	12/1/2023	178		155	22	88
DMR	12/2/2023	139		157	22	89
DMR	12/3/2023	95		141	0	70
DMR	12/4/2023	113		131	0	66
DMR	12/5/2023	117		116	0	58
DMR	12/6/2023	110		109	0	54
DMR	12/7/2023	109		112	0	56
DMR	12/8/2023	94		108	0	54
DMR	12/9/2023	90		101	0	50
DMR	12/10/2023	202		124	0	62
DMR	12/11/2023	140		132	0	66
DMR	12/12/2023	107		135	0	67
DMR	12/13/2023	123		143	0	72
DMR	12/14/2023	113		121	0	60
DMR	12/15/2023	121		116	0	58
DMR	12/16/2023	93		113	0	56
DMR	12/17/2023	91		105	0	52
DMR	12/18/2023	110		104	0	52
DMR	12/19/2023	147		110	0	55
DMR	12/20/2023	123		118	0	59
DMR	12/21/2023	139		130	0	65
DMR	12/22/2023	132		135	0	68
DMR	12/23/2023	130		131	0	66
DMR	12/24/2023	104		126	0	63
DMR	12/25/2023	82		112	0	56
DMR	12/26/2023	48		91	0	46
DMR	12/27/2023	52		72	0	36
DMR	12/28/2023	51		58	0	29
DMR	12/29/2023	56		52	0	26
DMR	12/30/2023	60		55	0	27
DMR	12/31/2023	104		68	0	34
DMR	1/1/2024	99	26	80	26	53
DMR	1/2/2024	59	26	81	26	53
DMR	1/3/2024	63	26	81	26	54
DMR	1/4/2024	78	27	75	26	51
DMR	1/5/2024	64	26	66	26	46

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	1/6/2024	54	23	65	26	45
DMR	1/7/2024	73		67	0	34
DMR	1/8/2024	81		68	0	34
DMR	1/9/2024	80	26	72	25	48
DMR	1/10/2024	64	25	75	26	50
DMR	1/11/2024	68	24	73	25	49
DMR	1/12/2024	64		69	0	35
DMR	1/13/2024	61		64	0	32
DMR	1/14/2024	70		66	0	33
DMR	1/15/2024	85		70	0	35
DMR	1/16/2024	115		83	0	41
DMR	1/17/2024	127		99	0	50
DMR	1/18/2024	94		105	0	53
DMR	1/19/2024	146		121	0	60
DMR	1/20/2024	134		125	0	63
DMR	1/21/2024	142		129	0	65
DMR	1/22/2024	173		149	0	74
DMR	1/23/2024	171		155	0	78
DMR	1/24/2024	180		167	0	83
DMR	1/25/2024	152	36	169	36	103
DMR	1/26/2024	119		156	0	78
DMR	1/27/2024	160		153	0	76
DMR	1/28/2024	141		143	0	72
DMR	1/29/2024	90		128	0	64
DMR	1/30/2024	100	28	123	28	75
DMR	1/31/2024	115	25	112	27	69
DMR	2/1/2024	99	22	101	25	63
DMR	2/2/2024	90	21	101	24	63
DMR	2/3/2024	78	21	96	22	59
DMR	2/4/2024	52	21	80	21	51
DMR	2/5/2024	95	23	79	22	50
DMR	2/6/2024	79		76	22	49
DMR	2/7/2024	56		71	22	46
DMR	2/8/2024	63		73	23	48
DMR	2/9/2024	57		64	0	32
DMR	2/10/2024	56	21	58	21	40
DMR	2/11/2024	44	20	55	21	38
DMR	2/12/2024	64	21	55	21	38
DMR	2/13/2024	50	21	54	21	37
DMR	2/14/2024	51	27	52	22	37
DMR	2/15/2024	75	32	60	25	43
DMR	2/16/2024	104	27	70	27	48
DMR	2/17/2024	91		80	29	54
DMR	2/18/2024	67		84	0	42
DMR	2/19/2024	71		83	0	42
DMR	2/20/2024	56		71	0	36
DMR	2/21/2024	91		71	0	36
DMR	2/22/2024	78		74	0	37
DMR	2/23/2024	82	20	77	20	48
DMR	2/24/2024	87	22	85	21	53
DMR	2/25/2024	70	20	79	21	50
DMR	2/26/2024	81	22	80	21	51
DMR	2/27/2024	74	19	78	21	49
DMR	2/28/2024	183		102	20	61
DMR	2/29/2024	114		113	21	67

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	3/1/2024	80	21	113	20	66
DMR	3/2/2024	73	25	113	23	68
DMR	3/3/2024	76	20	86	22	54
DMR	3/4/2024	78	19	77	21	49
DMR	3/5/2024	76	21	76	21	49
DMR	3/6/2024	71	21	75	20	48
DMR	3/7/2024	61	19	72	20	46
DMR	3/8/2024	79	19	72	20	46
DMR	3/9/2024	76	19	72	20	46
DMR	3/10/2024	80	21	74	20	47
DMR	3/11/2024	78	20	78	20	49
DMR	3/12/2024	83	19	79	20	50
DMR	3/13/2024	88	24	82	21	52
DMR	3/14/2024	65	21	79	21	50
DMR	3/15/2024	82	21	80	21	50
DMR	3/16/2024	77	20	78	22	50
DMR	3/17/2024	79	20	76	21	48
DMR	3/18/2024	85	21	81	21	51
DMR	3/19/2024	97	22	85	21	53
DMR	3/20/2024	87	19	87	21	54
DMR	3/21/2024	72	20	85	21	53
DMR	3/22/2024	73	23	82	21	52
DMR	3/23/2024	92	26	81	22	52
DMR	3/24/2024	78	21	79	23	51
DMR	3/25/2024	98	24	85	24	54
DMR	3/26/2024	83	26	88	24	56
DMR	3/27/2024	131	30	98	25	61
DMR	3/28/2024	89	30	100	28	64
DMR	3/29/2024	91	33	99	30	64
DMR	3/30/2024	80	31	98	31	64
DMR	3/31/2024	80	27	85	30	58
DMR	4/1/2024	66	24	79	29	54
DMR	4/2/2024	68	23	74	26	50
DMR	4/3/2024	68	31	71	26	48
DMR	4/4/2024	48	23	63	25	44
DMR	4/5/2024	43	21	57	25	41
DMR	4/6/2024	41	22	50	24	37
DMR	4/7/2024	44	21	44	22	33
DMR	4/8/2024	41	21	42	21	32
DMR	4/9/2024	35	19	40	21	31
DMR	4/10/2024	36	21	39	21	30
DMR	4/11/2024	41	19	38	20	29
DMR	4/12/2024	29	21	35	20	28
DMR	4/13/2024	40	21	37	21	29
DMR	4/14/2024	38	21	37	21	29
DMR	4/15/2024	41	21	37	21	29
DMR	4/16/2024	50	31	42	24	33
DMR	4/17/2024	36	22	41	24	33
DMR	4/18/2024	35	23	41	24	32
DMR	4/19/2024	37	23	40	25	32
DMR	4/20/2024	41	23	37	23	30
DMR	4/21/2024	36	21	37	23	30
DMR	4/22/2024	42	24	39	23	31
DMR	4/23/2024	43	25	41	23	32
DMR	4/24/2024	44	23	41	23	32

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	4/25/2024	42	24	43	24	33
DMR	4/26/2024	38	26	42	25	33
DMR	4/27/2024	40	25	41	25	33
DMR	4/28/2024	41	27	40	26	33
DMR	4/29/2024	30	22	37	25	31
DMR	4/30/2024	29	23	35	24	30
DMR	5/1/2024	27	22	32	24	28
DMR	5/2/2024	29	23	29	23	26
DMR	5/3/2024	28	23	28	23	26
DMR	5/4/2024	30	23	29	23	26
DMR	5/5/2024	29	23	29	23	26
DMR	5/6/2024	33	22	30	23	26
DMR	5/7/2024	31	22	31	23	27
DMR	5/8/2024	29	22	31	22	26
DMR	5/9/2024	31	22	31	22	27
DMR	5/10/2024	32	22	31	22	26
DMR	5/11/2024	32	23	31	22	27
DMR	5/12/2024	30	24	31	23	27
DMR	5/13/2024	38	24	33	23	28
DMR	5/14/2024	32	23	33	24	28
DMR	5/15/2024	35	30	34	25	30
DMR	5/16/2024	36	23	35	25	30
DMR	5/17/2024	35	23	35	25	30
DMR	5/18/2024	35	24	35	25	30
DMR	5/19/2024	39	25	36	24	30
DMR	5/20/2024	37	25	37	24	30
DMR	5/21/2024	32	24	36	25	30
DMR	5/22/2024	34	22	36	24	30
DMR	5/23/2024	31	22	34	23	28
DMR	5/24/2024	30	19	32	22	27
DMR	5/25/2024	30	23	31	22	26
DMR	5/26/2024	31	23	31	22	26
DMR	5/27/2024	30	23	30	22	26
DMR	5/28/2024	35	26	32	24	28
DMR	5/29/2024	32	24	32	24	28
DMR	5/30/2024	37	23	34	24	29
DMR	5/31/2024	40	22	36	24	30
DMR	6/1/2024	34	22	36	23	29
DMR	6/2/2024	33	22	36	22	29
DMR	6/3/2024	31	23	35	22	28
DMR	6/4/2024	33	22	33	22	28
DMR	6/5/2024	31	20	32	22	27
DMR	6/6/2024	37	22	33	22	27
DMR	6/7/2024	32	23	33	22	28
DMR	6/8/2024	37	23	34	22	28
DMR	6/9/2024	36	23	36	23	29
DMR	6/10/2024	39	24	36	23	30
DMR	6/11/2024	35	25	37	24	30
DMR	6/12/2024	39	24	37	24	31
DMR	6/13/2024	40	27	38	25	32
DMR	6/14/2024	42	27	39	26	32
DMR	6/15/2024	41	23	41	25	33
DMR	6/16/2024	36	23	40	25	32
DMR	6/17/2024	35	19	39	23	31
DMR	6/18/2024	28	23	35	22	29

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	6/19/2024	26	23	31	22	27
DMR	6/20/2024	31	24	30	22	26
DMR	6/21/2024	26	23	28	23	26
DMR	6/22/2024	15	14	25	21	23
DMR	6/23/2024	14	12	22	18	20
DMR	6/24/2024	12	9	17	15	16
DMR	6/25/2024	12	11	13	12	12
DMR	6/26/2024	13	10	13	11	12
DMR	6/27/2024	15	13	13	11	12
DMR	6/28/2024	16	13	14	12	13
DMR	6/29/2024	19	18	16	14	15
DMR	6/30/2024	20	16	18	15	16
DMR	7/1/2024	20	17	19	16	17
DMR	7/2/2024	19	19	20	18	19
DMR	7/3/2024	21	17	20	17	19
DMR	7/4/2024	24	17	21	18	19
DMR	7/5/2024	21	17	21	18	19
DMR	7/6/2024	20	17	22	17	19
DMR	7/7/2024	23	18	22	17	20
DMR	7/8/2024	26	18	23	18	20
DMR	7/9/2024	25	17	24	18	21
DMR	7/10/2024	27	19	25	18	22
DMR	7/11/2024	24	16	26	18	22
DMR	7/12/2024	23	16	25	17	21
DMR	7/13/2024	23	17	24	17	21
DMR	7/14/2024	23	18	23	17	20
DMR	7/15/2024	25	20	24	18	21
DMR	7/16/2024	27	18	25	18	21
DMR	7/17/2024			25	19	22
DMR	7/18/2024	23	17	25	18	22
DMR	7/19/2024	25	18	25	18	21
DMR	7/20/2024	24	19	24	18	21
DMR	7/21/2024	30	19	26	18	22
DMR	7/22/2024	31	18	28	19	23
DMR	7/23/2024	33	19	30	19	24
DMR	7/24/2024	33	20	32	19	25
DMR	7/25/2024	37	24	34	20	27
DMR	7/26/2024	35	20	35	21	28
DMR	7/27/2024	33	20	35	21	28
DMR	7/28/2024	33	20	35	21	28
DMR	7/29/2024	34	19	34	20	27
DMR	7/30/2024	40	18	35	19	27
DMR	7/31/2024	41	31	37	22	30
DMR	8/1/2024	37	18	38	22	30
DMR	8/2/2024	37	20	39	22	30
DMR	8/3/2024	35	23	37	23	30
DMR	8/4/2024	33	18	35	20	28
DMR	8/5/2024	34	18	34	20	27
DMR	8/6/2024	34	16	34	19	26
DMR	8/7/2024	35	18	34	18	26
DMR	8/8/2024	38	19	35	18	26
DMR	8/9/2024	39	19	37	18	27
DMR	8/10/2024	39	25	38	20	29
DMR	8/11/2024	40	19	39	21	30
DMR	8/12/2024	42	20	40	21	30

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	8/13/2024	44	20	41	21	31
DMR	8/14/2024	47		43	20	31
DMR	8/15/2024	48	20	45	20	33
DMR	8/16/2024	48	17	47	19	33
DMR	8/17/2024	51	20	48	19	34
DMR	8/18/2024	52	20	49	19	34
DMR	8/19/2024	57	19	52	19	35
DMR	8/20/2024	60	19	55	20	37
DMR	8/21/2024	61	21	57	20	39
DMR	8/22/2024	64	20	60	20	40
DMR	8/23/2024	61	20	61	20	41
DMR	8/24/2024	56	19	60	20	40
DMR	8/25/2024	57	21	59	20	40
DMR	8/26/2024	60	22	58	21	39
DMR	8/27/2024	62		59	21	40
DMR	8/28/2024	60	18	60	20	40
DMR	8/29/2024	52	17	59	19	39
DMR	8/30/2024	50	19	56	18	37
DMR	8/31/2024	50		53	0	27
DMR	9/1/2024	74	20	57	19	38
DMR	9/2/2024	67	20	60	20	40
DMR	9/3/2024	76	20	67	20	43
DMR	9/4/2024	92	20	77	20	49
DMR	9/5/2024	90	25	81	21	51
DMR	9/6/2024	90	21	87	22	54
DMR	9/7/2024	84	20	89	22	55
DMR	9/8/2024	93	20	89	22	55
DMR	9/9/2024	86	21	88	21	54
DMR	9/10/2024	101	21	91	21	56
DMR	9/11/2024	112	19	98	20	59
DMR	9/12/2024	122	20	105	20	63
DMR	9/13/2024	137	21	118	20	69
DMR	9/14/2024	114	20	121	20	71
DMR	9/15/2024	94	20	117	20	69
DMR	9/16/2024	99	21	111	21	66
DMR	9/17/2024	110	27	104	22	63
DMR	9/18/2024	123	22	107	23	65
DMR	9/19/2024	129	23	115	23	69
DMR	9/20/2024	151	22	128	24	76
DMR	9/21/2024	186	21	147	22	85
DMR	9/22/2024	172	20	160	22	91
DMR	9/23/2024	156	21	166	21	94
DMR	9/24/2024	115	22	157	21	89
DMR	9/25/2024	113	18	139	20	80
DMR	9/26/2024	111	21	124	21	72
DMR	9/27/2024	106	20	111	20	66
DMR	9/28/2024	172	21	126	20	73
DMR	9/29/2024	175	24	141	22	81
DMR	9/30/2024	188	19	160	21	91
DMR	10/1/2024	190	21	181	21	101
DMR	10/2/2024	182	22	184	22	103
DMR	10/3/2024	102	20	166	21	93
DMR	10/4/2024	98	26	143	22	83
DMR	10/5/2024	201	25	146	23	85
DMR	10/6/2024	219	28	155	25	90

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	10/7/2024	226	21	186	25	106
DMR	10/8/2024	236	20	221	24	122
DMR	10/9/2024	131	18	203	22	112
DMR	10/10/2024	110	22	176	20	98
DMR	10/11/2024	213	24	173	21	97
DMR	10/12/2024	135	23	147	22	85
DMR	10/13/2024	188	23	162	23	92
DMR	10/14/2024	201	23	184	23	104
DMR	10/15/2024	184	24	177	23	100
DMR	10/16/2024	162	23	184	23	104
DMR	10/17/2024	157	23	176	23	100
DMR	10/18/2024	92	23	149	23	86
DMR	10/19/2024	98	30	127	25	76
DMR	10/20/2024	144	27	123	26	74
DMR	10/21/2024	144	26	120	27	73
DMR	10/22/2024	146	28	133	28	80
DMR	10/23/2024	127	24	140	26	83
DMR	10/24/2024	122	23	135	25	80
DMR	10/25/2024	72	21	117	24	70
DMR	10/26/2024	66	22	97	23	60
DMR	10/27/2024	73	22	83	22	53
DMR	10/28/2024	71	23	71	22	46
DMR	10/29/2024	82	23	73	23	48
DMR	10/30/2024	84	22	78	23	50
DMR	10/31/2024	84	22	80	23	51
DMR	11/1/2024	70		80	0	40
DMR	11/2/2024	88	20	82	21	51
DMR	11/3/2024	86	19	82	20	51
DMR	11/4/2024	85	20	82	20	51
DMR	11/5/2024	110	20	92	20	56
DMR	11/6/2024	124	25	101	21	61
DMR	11/7/2024	137	22	114	22	68
DMR	11/8/2024	149	23	130	23	76
DMR	11/9/2024	138	19	137	22	80
DMR	11/10/2024	115	19	135	21	78
DMR	11/11/2024	115	28	129	22	76
DMR	11/12/2024	129	23	124	22	73
DMR	11/13/2024	88	21	112	23	67
DMR	11/14/2024	90	20	106	23	64
DMR	11/15/2024	101	20	102	21	62
DMR	11/16/2024	95	19	94	20	57
DMR	11/17/2024	104	20	98	20	59
DMR	11/18/2024	116	17	104	19	62
DMR	11/19/2024	48	19	91	19	55
DMR	11/20/2024	101	19	92	19	56
DMR	11/21/2024	112	16	94	18	56
DMR	11/22/2024	98	22	90	19	54
DMR	11/23/2024	98	20	102	19	61
DMR	11/24/2024	115	21	106	20	63
DMR	11/25/2024	105	20	104	21	62
DMR	11/26/2024	138	21	114	21	67
DMR	11/27/2024	129	22	122	21	71
DMR	11/28/2024	72	22	111	21	66
DMR	11/29/2024	131	21	118	22	70
DMR	11/30/2024	115		112	22	67

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	12/1/2024	148		117	22	69
DMR	12/2/2024	157		138	0	69
DMR	12/3/2024	136		139	0	70
DMR	12/4/2024	139		145	0	73
DMR	12/5/2024	167		150	0	75
DMR	12/6/2024	172		154	0	77
DMR	12/7/2024	163		160	0	80
DMR	12/8/2024	147		162	0	81
DMR	12/9/2024	146		157	0	79
DMR	12/10/2024	146		151	0	75
DMR	12/11/2024	153		148	0	74
DMR	12/12/2024	181		157	0	78
DMR	12/13/2024	178		165	0	82
DMR	12/14/2024	197		177	0	89
DMR	12/15/2024	192		187	0	94
DMR	12/16/2024	169		184	0	92
DMR	12/17/2024	130		172	0	86
DMR	12/18/2024	107		150	0	75
DMR	12/19/2024	90		124	0	62
DMR	12/20/2024	67		99	0	49
DMR	12/21/2024	140		101	0	51
DMR	12/22/2024	142		110	0	55
DMR	12/23/2024	146		124	0	62
DMR	12/24/2024	135		141	0	70
DMR	12/25/2024	91		129	0	64
DMR	12/26/2024	83		114	0	57
DMR	12/27/2024	105		104	0	52
DMR	12/28/2024	81		90	0	45
DMR	12/29/2024	90		90	0	45
DMR	12/30/2024	80		89	0	45
DMR	12/31/2024	86		84	0	42
DMR	1/1/2025	82		85	0	42
DMR	1/2/2025	103		88	0	44
DMR	1/3/2025	103		94	0	47
DMR	1/4/2025	142		108	0	54
DMR	1/5/2025	202		138	0	69
DMR	1/6/2025	160		152	0	76
DMR	1/7/2025	184		172	0	86
DMR	1/8/2025	180		182	0	91
DMR	1/9/2025	254		195	0	97
DMR	1/10/2025	112		183	0	91
DMR	1/11/2025	169		179	0	89
DMR	1/12/2025	173		177	0	89
DMR	1/13/2025	143		149	0	75
DMR	1/14/2025	184		167	0	84
DMR	1/15/2025	187		172	0	86
DMR	1/16/2025	189		176	0	88
DMR	1/17/2025	186		187	0	93
DMR	1/18/2025	186		187	0	94
DMR	1/19/2025	181		186	0	93
DMR	1/20/2025	190		186	0	93
DMR	1/21/2025	187		186	0	93
DMR	1/22/2025	117		169	0	84
DMR	1/23/2025	296		198	0	99
DMR	1/24/2025	166		192	0	96

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	1/25/2025	242		205	0	103
DMR	1/26/2025	176		220	0	110
DMR	1/27/2025	189		193	0	97
DMR	1/28/2025	224		208	0	104
DMR	1/29/2025	249		210	0	105
DMR	1/30/2025	228		223	0	111
DMR	1/31/2025	123		206	0	103
DMR	2/1/2025	119		180	0	90
DMR	2/2/2025	83		138	0	69
DMR	2/3/2025	147		118	0	59
DMR	2/4/2025	157		127	0	63
DMR	2/5/2025	192		145	0	72
DMR	2/6/2025	180		169	0	85
DMR	2/7/2025	146		169	0	84
DMR	2/8/2025	152		168	0	84
DMR	2/9/2025	165		161	0	80
DMR	2/10/2025	177		160	0	80
DMR	2/11/2025	175		167	0	84
DMR	2/12/2025	164		170	0	85
DMR	2/13/2025	187		176	0	88
DMR	2/14/2025	176		176	0	88
DMR	2/15/2025	175		176	0	88
DMR	2/16/2025	168		177	0	88
DMR	2/17/2025	163		171	0	85
DMR	2/18/2025	165		168	0	84
DMR	2/19/2025	167		166	0	83
DMR	2/20/2025	177		168	0	84
DMR	2/21/2025	173		171	0	85
DMR	2/22/2025	183		175	0	88
DMR	2/23/2025	208		185	0	93
DMR	2/24/2025	252		204	0	102
DMR	2/25/2025	225		217	0	109
DMR	2/26/2025	110		199	0	99
DMR	2/27/2025	81		167	0	84
DMR	2/28/2025	61		119	0	60
DMR	3/1/2025	83		84	0	42
DMR	3/2/2025	120		86	0	43
DMR	3/3/2025	85		87	0	44
DMR	3/4/2025	107		99	0	49
DMR	3/5/2025	113		106	0	53
DMR	3/6/2025	120		106	0	53
DMR	3/7/2025	121		115	0	58
DMR	3/8/2025	98		113	0	57
DMR	3/9/2025	100		110	0	55
DMR	3/10/2025	76		99	0	49
DMR	3/11/2025	69		86	0	43
DMR	3/12/2025	95		85	0	43
DMR	3/13/2025	97		84	0	42
DMR	3/14/2025	85		87	0	43
DMR	3/15/2025	75		88	0	44
DMR	3/16/2025	102		90	0	45
DMR	3/17/2025	106		92	0	46
DMR	3/18/2025	103		97	0	48
DMR	3/19/2025	91		101	0	50
DMR	3/20/2025	115	19	104	19	61

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	3/21/2025	105	19	104	19	61
DMR	3/22/2025	155	18	117	19	68
DMR	3/23/2025	118	19	123	19	71
DMR	3/24/2025	102	17	120	18	69
DMR	3/25/2025	99	18	119	18	68
DMR	3/26/2025	95	17	104	18	61
DMR	3/27/2025	95	20	98	18	58
DMR	3/28/2025	93	21	96	19	57
DMR	3/29/2025	137	19	105	19	62
DMR	3/30/2025	134	26	115	22	68
DMR	3/31/2025	76	18	110	21	66
DMR	4/1/2025	73	17	105	20	63
DMR	4/2/2025	68		88	20	54
DMR	4/3/2025	102	22	80	19	49
DMR	4/4/2025	56	23	75	21	48
DMR	4/5/2025	49	24	69	23	46
DMR	4/6/2025	54	25	65	24	44
DMR	4/7/2025	51	25	53	24	38
DMR	4/8/2025	55	24	52	25	38
DMR	4/9/2025	54	25	54	25	39
DMR	4/10/2025	48	26	52	25	39
DMR	4/11/2025	41		50	25	37
DMR	4/12/2025	38	29	45	27	36
DMR	4/13/2025	68	25	49	27	38
DMR	4/14/2025	69	26	54	27	40
DMR	4/15/2025	70	23	61	26	44
DMR	4/16/2025	71	25	70	25	47
DMR	4/17/2025	47	32	64	27	45
DMR	4/18/2025	41	26	57	27	42
DMR	4/19/2025	76	23	59	27	43
DMR	4/20/2025	67	33	58	29	43
DMR	4/21/2025	75	24	65	27	46
DMR	4/22/2025	79	24	74	26	50
DMR	4/23/2025	82	25	76	27	51
DMR	4/24/2025	86	25	81	25	53
DMR	4/25/2025	80	24	82	25	53
DMR	4/26/2025	66	25	79	25	52
DMR	4/27/2025	64	24	74	25	49
DMR	4/28/2025	55	13	66	22	44
DMR	4/29/2025	46	22	58	21	39
DMR	4/30/2025	49	25	54	21	37
DMR	5/1/2025	51	26	50	22	36
DMR	5/2/2025	57	26	51	25	38
DMR	5/3/2025	55	26	53	26	39
DMR	5/4/2025	54	32	54	28	41
DMR	5/5/2025	67	28	58	28	43
DMR	5/6/2025	61	26	59	28	44
DMR	5/7/2025	64	26	62	28	45
DMR	5/8/2025	59	26	63	27	45
DMR	5/9/2025	66	25	63	26	44
DMR	5/10/2025	71	26	65	26	45
DMR	5/11/2025	80	30	69	27	48
DMR	5/12/2025	76	30	73	28	51
DMR	5/13/2025	76	33	76	30	53
DMR	5/14/2025	79	31	78	31	54

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	5/15/2025	79	38	78	33	55
DMR	5/16/2025	91	31	81	33	57
DMR	5/17/2025	79	31	82	33	57
DMR	5/18/2025	84	31	83	33	58
DMR	5/19/2025	98	31	88	31	60
DMR	5/20/2025	56	26	79	30	55
DMR	5/21/2025	36	28	69	29	49
DMR	5/22/2025	32	24	56	27	41
DMR	5/23/2025	36	26	40	26	33
DMR	5/24/2025	38	26	36	26	31
DMR	5/25/2025	39	26	36	26	31
DMR	5/26/2025	40	26	38	26	32
DMR	5/27/2025	45	28	41	27	34
DMR	5/28/2025	46	29	43	27	35
DMR	5/29/2025	45	28	44	28	36
DMR	5/30/2025	45	28	45	28	37
DMR	5/31/2025	47	31	46	29	37
DMR	6/1/2025	44	30	45	29	37
DMR	6/2/2025	40	28	44	29	37
DMR	6/3/2025	53	27	46	29	38
DMR	6/4/2025	51	28	47	28	38
DMR	6/5/2025	50	28	49	28	38
DMR	6/6/2025	58	29	53	28	41
DMR	6/7/2025	58	26	54	28	41
DMR	6/8/2025	57	24	56	27	41
DMR	6/9/2025	63	24	59	26	42
DMR	6/10/2025	65	24	61	25	43
DMR	6/11/2025	51	25	59	24	42
DMR	6/12/2025	51	27	58	25	41
DMR	6/13/2025	56	25	56	25	41
DMR	6/14/2025	62	25	55	26	40
DMR	6/15/2025	55	24	56	25	41
DMR	6/16/2025	60	25	58	25	42
DMR	6/17/2025	43	24	55	25	40
DMR	6/18/2025	47	25	51	25	38
DMR	6/19/2025	51	25	50	25	38
DMR	6/20/2025	54	24	49	25	37
DMR	6/21/2025	34	22	47	24	35
DMR	6/22/2025	33	21	43	23	33
DMR	6/23/2025	38	21	40	22	31
DMR	6/24/2025	48	22	38	22	30
DMR	6/25/2025	29	13	37	19	28
DMR	6/26/2025	44	23	40	20	30
DMR	6/27/2025	34	23	39	20	30
DMR	6/28/2025	31	23	35	21	28
DMR	6/29/2025	25	21	34	23	28
DMR	6/30/2025	24	18	29	21	25
DMR	7/1/2025	21	13	25	19	22
DMR	7/2/2025	24	20	24	18	21
DMR	7/3/2025	26	22	24	18	21
DMR	7/4/2025	26	22	24	19	22
DMR	7/5/2025	26	21	26	21	23
DMR	7/6/2025	25	19	26	21	23
DMR	7/7/2025	27	21	26	21	23
DMR	7/8/2025	28	20	27	20	23

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	7/9/2025	30	21	28	20	24
DMR	7/10/2025	33	20	30	21	25
DMR	7/11/2025	33	18	31	20	25
DMR	7/12/2025	31	20	32	20	26
DMR	7/13/2025	30	20	32	20	26
DMR	7/14/2025	30	21	31	20	25
DMR	7/15/2025			30	20	25
DMR	7/16/2025	37	23	32	21	27
DMR	7/17/2025	35	21	34	22	28
DMR	7/18/2025	36	21	36	22	29
DMR	7/19/2025	24	14	33	20	26
DMR	7/20/2025	37	24	33	20	27
DMR	7/21/2025	39	26	34	21	28
DMR	7/22/2025	40		35	21	28
DMR	7/23/2025	43		40	25	32
DMR	7/24/2025	52	24	44	25	34
DMR	7/25/2025	41	21	44	23	33
DMR	7/26/2025	48	22	46	22	34
DMR	7/27/2025	46	22	47	22	35
DMR	7/28/2025	36	18	43	21	32
DMR	7/29/2025	43	22	43	21	32
DMR	7/30/2025			42	21	31
DMR	7/31/2025	45	24	41	21	31
DMR	8/1/2025	38	32	42	26	34
DMR	8/2/2025	46	24	43	27	35
DMR	8/3/2025	46	22	44	26	35
DMR	8/4/2025	55	21	46	25	36
DMR	8/5/2025	60	23	52	23	37
DMR	8/6/2025	44	20	51	22	36
DMR	8/7/2025	50	21	52	21	37
DMR	8/8/2025	42	19	49	21	35
DMR	8/9/2025	50	23	47	21	34
DMR	8/10/2025	51	22	48	21	35
DMR	8/11/2025	57	23	50	22	36
DMR	8/12/2025	55	22	53	23	38
DMR	8/13/2025	68	24	58	23	40
DMR	8/14/2025	69	25	62	24	43
DMR	8/15/2025	61	23	63	24	43
DMR	8/16/2025	31	16	57	22	40
DMR	8/17/2025	28	14	47	20	33
DMR	8/18/2025	24	16	36	17	27
DMR	8/19/2025	21	21	26	17	21
DMR	8/20/2025	25	25	25	19	22
DMR	8/21/2025	28	22	25	21	23
DMR	8/22/2025	35	25	27	23	25
DMR	8/23/2025	34	20	31	23	27
DMR	8/24/2025	37	21	34	22	28
DMR	8/25/2025	41	21	37	22	29
DMR	8/26/2025	43	20	39	21	30
DMR	8/27/2025	45	21	42	21	31
DMR	8/28/2025	46	23	44	21	33
DMR	8/29/2025	43	21	44	21	33
DMR	8/30/2025	47	21	45	22	33
DMR	8/31/2025	48		46	22	34
DMR	9/1/2025	46	22	46	21	34

Data Source	Date	SW003 Chloride Daily (mg/L)	SW001 Chloride Daily (mg/L)	SW003 Chloride 4 day Average (mg/L)	SW001 Chloride 4 day Average (mg/L)	Average SW001/ SW003 4-day Average (mg/L)
DMR	9/2/2025	51	23	48	22	35
DMR	9/3/2025	50	26	49	24	36
DMR	9/4/2025	67	28	54	25	39
DMR	9/5/2025	66	24	59	25	42
DMR	9/6/2025	50	23	58	25	42
DMR	9/7/2025	55	22	60	24	42
DMR	9/8/2025	72	24	61	23	42
DMR	9/9/2025	68		61	23	42
DMR	9/10/2025	79		69	23	46
DMR	9/11/2025	79	24	75	24	49
DMR	9/12/2025	73	23	75	24	49
DMR	9/13/2025	81	23	78	23	51
DMR	9/14/2025	86	23	80	23	52
DMR	9/15/2025	91	23	83	23	53
DMR	9/16/2025			86	23	55
DMR	9/17/2025			89	23	56
DMR	9/18/2025			91	23	57
DMR	9/19/2025	61	23	61	23	42
DMR	9/20/2025	78	25	70	24	47
DMR	9/21/2025	86	22	75	23	49
DMR	9/22/2025	73	28	75	25	50
DMR	9/23/2025	72	27	77	26	51
DMR	9/24/2025	93	24	81	25	53
DMR	9/25/2025	101	23	85	26	55
DMR	9/26/2025	95	24	90	25	57
DMR	9/27/2025	98	24	97	24	60
DMR	9/28/2025	91	23	96	24	60
DMR	9/29/2025	77	22	90	23	57
DMR	9/30/2025	73	23	85	23	54

Commissioner Katrina Kessler
Minnesota Pollution Control Agency
520 Lafayette Rd.
St. Paul, MN 55155-4194

July 22, 2026

Commissioner Kessler,

The Minnesota Pollution Control Agency's draft 2026 Impaired Waters List reinforces the need to reevaluate the state's sulfate wild rice standard. More than one-third of the list includes new lakes, streams, and rivers impaired due to Minnesota's sulfate wild rice standard. Those waters include the Crow River in Stearns County, Hunt Lake in Rice County, and numerous backwater lakes within the Minnesota and Mississippi Rivers.

While the MPCA has said in previous communications that these additional waters do not impact any new facilities, that is a little disingenuous, as 60% of Minnesota's waters flow into previously listed waters in the Lower Mississippi River. The addition of these new impaired wild rice waters could lead to stricter permit limits in the future if the state does not revisit and recalculate the current sulfate wild rice water quality standard. That's why Minnesota AgriGrowth, along with the Coalition of Greater Minnesota Cities, Minnesota Building Trades, and the Range Association of Municipalities and Schools, has strongly encouraged the MPCA to reevaluate the current sulfate water quality standard and examine the high levels of naturally occurring sulfate in groundwater.

Foremost, the high levels of naturally occurring sulfate put the state's water quality standard into question. From Marshall and Cold Spring to Mankato and Shakopee, naturally occurring sulfate levels in groundwater released to a surface water can be 30 to 65 times the state's water quality standard. Numerous facilities have shared this data with the MPCA.

A great example of naturally occurring sulfate is Hunt Lake near Shieldsville, which is being proposed for listing. There are no industrial or municipal discharges to the water body, strongly implying the sulfate must be coming directly from groundwater release.

While the EPA requires the state agency to list waters that do not meet state and federal water quality standards, sulfate data from the Minnesota River, Hunt Lake, and Crow River reinforce the need to conduct a thorough study of naturally occurring background sulfate and to determine whether the current sulfate wild rice standard is accurate and conclusive.

With much appreciation,

Darin Broton
Executive Director
Minnesota AgriGrowth

CGMC Anonymous

On behalf of the Coalition of Greater Minnesota Cities (CGMC), please see the attached comment on the 2026 Impaired Waters List. Thank you.

DEDICATED TO A STRONG GREATER MINNESOTA

July 22, 2026

VIA Public Comment Form

Leya Charles
Impaired Waters List Coordinator
Minnesota Pollution Control Agency
520 Lafayette Road
Saint Paul, MN 55155
impaired.waters.mpca@state.mn.us

RE: CGMC's 2026 Impaired Waters List Comments

I am writing on behalf of the Coalition of Greater Minnesota Cities (CGMC) to comment on the Minnesota Pollution Control Agency's (MPCA or Agency) draft 2026 Impaired Waters List (IWL).

The CGMC represents more than one hundred cities that own and operate municipal wastewater treatment facilities serving residents, industries, and regional economies throughout Greater Minnesota. It is well documented that the compliance costs associated with the 1973 sulfate standard are unaffordable, and that implementation of the standard will have long-term impacts on municipal wastewater infrastructure and on critical business partners and employers in our communities from the agricultural, manufacturing, and mining sectors.

We are particularly concerned that the law and the best available science do not support the proposed sulfate impairment listings in the 2026 draft IWL. For the reasons we elaborate upon in this comment, we request that MPCA withdraw the proposed impairments and the designated waterbodies listed in Appendix H of the supporting Assessment Manual. In addition, we support MESERB's comments and their call on the MPCA to complete the rulemaking the Legislature directed fifteen years ago to update the standard and formally designate the waterbodies that support the wild rice beneficial use before moving forward to implement the standard.

I. The sulfate standard has major economic consequences for Minnesota's cities and businesses.

The downstream consequences of impairment listings for sulfate are severe for the hundreds of municipal and industrial facilities impacted. Most wastewater facilities in cities throughout Greater Minnesota that receive sulfate permit limits based on these listings will require advanced treatment processes, with capital and operation/ maintenance costs ranging from tens to hundreds of millions of dollars, depending on the facility's size and characteristics.[1]

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[1] Minnesota Pollution Control Agency, Statement of Need and Reasonableness, Amendment of the sulfate water quality standard applicable to wild rice and identification of wild rice waters, Minn. R. chapters 7050 and 7053 (2017) ("2017 SONAR") at 182–83 and Exhibit 42. *See also* Bolton & Menk, Inc. & Barr Eng'g Co., *Analyzing*

MPCA's own analysis has concluded that "municipal sulfate treatment is likely to be unaffordable for greater than 97% of municipalities based solely on projected costs."[2] These costs would be in addition to the billions of dollars in existing drinking-water and wastewater infrastructure needs across Minnesota.[3] It is concerning to CGMC that MPCA is implementing a standard that will impose costs of this magnitude on Greater Minnesota.

II. MPCA has repeatedly concluded that the 10 mg/L criterion does not reflect current science.

Additionally, the 10 mg/L criterion in Minn. R. 7050.0224, subp. 2 was adopted in 1973, and MPCA has spent more than a decade in recent years documenting that it no longer reflects the best available science. The Agency acknowledged in its 2017 SONAR that scientific understanding of sulfate chemistry and its effects on wild rice "has greatly improved," and its own research showed that sulfate is not directly toxic to wild rice; sulfide is. The Agency has also stated that no single sulfate value would be protective of wild rice at all sites and told the EPA that the 1973 10 mg/L criterion may be either overprotective or underprotective depending on site conditions.[4] The Attorney General reached the same conclusion in 2016, advising EPA that the standard required substantial revision and was "imprudent to apply," and that compelling permittees to install costly sulfate controls in the meantime would be an expenditure of resources that may ultimately prove unnecessary.[5]

III. The proposed listings and designations were not made through rulemaking.

In the current IWL, MPCA proposes to add 16 waters as sulfate impaired and to identify 52 additional waterbodies as "waters used for the production of wild rice," on top of the approximately 2,400 waterbodies already listed in Appendix H of the 2026 Assessment Manual. None of these waters have been properly designated as wild rice waters through rulemaking. The wild rice sulfate standard applies only to waters "used for the production of wild rice," which are those specifically identified and listed pursuant to Minn. R. 7050.0470. This list can be amended only through chapter 14 rulemaking. The Legislature confirmed this rulemaking requirement in 2011 and again in 2015 by directing MPCA to develop criteria to designate waterbodies as

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Alternatives for Sulfate Treatment in Municipal Wastewater (prepared for the Minn. Pollution Control Agency May 1, 2018).

[2] 2017 SONAR, *supra* note 1, at 212.

[3] Minnesota Pollution Control Agency, *Future Wastewater Infrastructure Needs and Capital Costs*, Report to the Legislature (Jan. 2024) (Doc. No. lrwq-wwtp-1sy24) at 1, 6; Minnesota Pollution Control Agency, *Municipal Wastewater Infrastructure System Needs and Costs*, Report to the Legislature (Jan. 2026) (Doc. No. lrwq-wwtp-1sy26) at 1, 5-6; U.S. EPA, *7th Drinking Water Infrastructure Needs Survey and Assessment* (2023).

[4] Letter from Katrina Kessler, Assistant Commissioner, MPCA, to EPA Region 5 (June 29, 2021) at footnote 1 (acknowledging the 10 mg/L standard may be "overprotective or underprotective" depending on site-specific conditions).

[5] Letter from Lori Swanson, Minnesota Attorney General, to Tinka Hyde, Director, Water Division, EPA Region 5 (Aug. 12, 2016) at 4.

"water used for the production of wild rice" via formal rulemaking.[6] Therefore, MPCA lacks authority to list these waterbodies as impaired for sulfate or to add them to Appendix H because the Agency has never designated them as wild rice waters through rulemaking. Without the designation, the 10 mg/L standard does not apply.

IV. Summary of requested actions regarding sulfate impairments.

For the reasons stated above, the CGMC requests that MPCA withdraw the proposed new sulfate impairments from the draft 2026 IWL and withdraw the proposed wild rice water designations. The CGMC also requests that MPCA comply with the 2011 and 2015 session laws by completing chapter 14 rulemaking to establish criteria for designating waters used for the production of wild rice and to designate those waters via rulemaking before proposing any new sulfate impairments. In any case, the 1973 wild rice sulfate standard must be updated so that any future assessment, listing, permitting, and TMDL decisions rest on a designated use and criteria that reflect the best available science and are adopted through a lawful process.

Thank you for considering these comments. CGMC and its members appreciate MPCA's efforts to address sulfate impairments throughout the state, and request that these efforts reflect the best available science, the law, and the needs and constraints of communities throughout Greater Minnesota.

Sincerely,

Keri J

Keri Johnson, President, Coalition of Greater Minnesota Cities
Councilor, St Peter

[6] 2011 Minn. Laws, 1st Spec. Sess., ch. 2, art. 4, § 32; 2015 Minn. Laws, 1st Spec. Sess., ch. 4, art. 4, § 136. MPCA likewise acknowledged in the 2017 SONAR that it must proceed "via rulemaking" to designate the waters to which the standard applies.

Kyle Axtell (South Washington WD)

South Washington Watershed District (SWWD) recommends removing Fish Lake (82-0093-00) from Minnesota's 2026 Impaired Waters List. Fish Lake was added to the list unexpectedly in 2024 with an impairment for excess nutrients and conversations have taken place previously with MPCA staff about reversing this decision. We were surprised to see it included again on the list in 2026.

Although named Fish "Lake", it is functionally a wetland serving a primary function as a stormwater pond for residential development. The open water pool within the hybrid cattail-dominated waterbody only became permanent after development of the Dancing Waters subdivision in the early 2000's. Its hydrology is primarily supported by stormwater runoff from the surrounding neighborhood. We suspect the impaired waters list mix up has to do with Fish Lake's current designation as a Class 2B warm water habitat. It should be considered a Class 2D wetland. Furthermore, the extensive monitoring data that exists for Fish Lake only exists because SWWD and its partners have sought to learn more about its water chemistry and quality for the purpose of designing projects to protect Powers Lake downstream, which is the true resource of concern in this area of the watershed. Recently, we constructed the Hasenbank Stormwater Park to intercept and infiltrate runoff leaving Fish Lake before it reached Powers Lake.

In summary, we encourage MPCA to remove Fish Lake from the 2026 Impaired Waters List for the reasons above and for consistency with previous agency discussions on the matter.

Arianna Northbird Himango

Please see attached comments submitted on behalf of Fond du Lac Band of Lake Superior Chippewa.

Fond du Lac Band of Lake Superior Chippewa
Resource Management Division

Administration; Conservation Enforcement; Environmental; Fisheries
Forestry; Land Information; Natural Resources; Wildlife

Submitted via online portal (https://mpca.commentinput.com/?id=ZPmRDdtNH) Minnesota Pollution Control Agency
Commissioner Katrina Kessler
520 Lafayette Road Saint Paul, MN 55155

July 21, 2026

RE: Minnesota Clean Water Act Section 303(d) Draft 2026 Impaired Waters List

Dear Commissioner Kessler,

The Fond du Lac Band of Lake Superior Chippewa, a federally recognized tribe with reserved and treaty-ceded lands in northeastern Minnesota, appreciates this opportunity to provide comments on the MPCA Clean Water Act Section 303(D) Impaired Waters List. The Band has been providing substantive comments every biennium on this Clean Water Act process since 1998. Our comments have generally focused on how the state has assessed, listed, and implemented restoration on impaired waters supporting critical treaty-protected resources such as *manoomin* (wild rice) and fish for subsistence and traditional diet.

The Band retains hunting, fishing, and gathering rights on more than 8 million acres of territory in northeastern Minnesota ceded to the United States government under the Treaties of 1837 and 1854[1]. The Band also exercises Treaty Rights in the 1837 and 1842 Ceded Territories of Wisconsin and Michigan. The Band holds Treatment as an Affected State (TAS) status under several sections of the Clean Water Act: §§ 106 (water quality monitoring and protection), 319 (nonpoint source pollution management), 303(c) (federally approved water quality standards), and 401 (water quality certification).

Our comments on the draft 2026 are brief and continue to echo the same concerns for protecting manoomin through implementation and enforcement of the state's sulfate criterion (10 mg/L) applicable to "waters used for the production of wild rice" and ensuring progress on reducing mercury loadings to freshwater systems that result in methylmercury bioaccumulation in fish. We note that, after the US Environmental Protection Agency (EPA) partially disapproved the MPCA's 2020 Impaired Waters List and subsequently established a list of over 30 wild rice waters that are

[1] Great Lakes Indian Fish & Wildlife Commission, "Treaties of 1836, 1837, 1842, 1854, & 1855". https://glifwc.org/sites/default/files/uploads/documents/2025-01/Pocket%20Treaties%20no%20lines.pdf

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not meeting the sulfate criterion, the MPCA has continued to monitor, assess, and list additional wild rice waters that do not meet the sulfate criterion.

This year, the agency has added sixteen more impaired wild rice waters, predominantly in the Minnesota and Mississippi watersheds, but including an additional reach within St. Louis Bay (AUID 69-1291-02). The Band notes that, while there may be permitted dischargers in this vicinity that contribute to elevated sulfate concentrations at this site, the Minnesota Department of Natural Resources (MN DNR) has also extensively studied sulfate sources and loadings throughout the St. Louis River watershed over the past several decades (see, i.e., MN DNR agency studies authored by Michael Berndt and Travis Bavin). They determined conclusively, using stable isotope tracers, that significant sulfate loadings from active taconite mines, processing facilities and tailings basins in the headwaters of the St. Louis River are a major component of the elevated sulfate seen downstream as far as the Fond du Lac Reservation and the St. Louis River estuary.

For this reason, the Band urges MPCA (as it has for decades) to enforce the wild rice sulfate criterion through establishing discharge limits for sulfate within the NPDES/SDS permits currently being reissued for these industrial facilities. While *manoomin* is extremely sensitive to other environmental stressors such as hydrologic alteration, climate change impacts, invasive species, and other human changes to habitat integrity, the only way these impaired waters subject to excess sulfate loading from mining operations can possibly be restored is through curtailment of these obvious, documented pollutant sources. The agency has clear authority under state and federal rules to impose and enforce the federally approved wild rice sulfate criterion through discharge permit limits.

Our other primary concern is for the vast number of mercury-impaired waters remaining on the state's 303(d) list – representing more impaired waters than for any cause other than bioassessments (fish and benthic macroinvertebrates). MPCA has added 38 mercury-impaired waters to the 2026 303(d) list, with most expected to be addressed under the statewide mercury TMDL (Category 4a). However, some mercury-impaired waters have been recategorized to Category 5, indicating the mercury concentration either in the water or in fish tissue is above the threshold expected to be addressed under the statewide mercury TMDL Implementation Plan.

Through our active participation in the Mercury TMDL Implementation Work Group, the Band is well aware of the sector-specific mercury reduction requirements that must occur in order to achieve the overall statewide mercury emissions goal of 793 lbs/year by 2025. This goal was not met. The taconite sector needed to reduce their mercury air emissions by 72% of their 1990 baseline emissions, but most have yet to present or agree to a reduction plan. Requiring more stringent mercury emissions from Minnesota's taconite facilities is an absolutely crucial step toward meeting those statewide TMDL goals. The MPCA has performed calculations indicating the economic feasibility of such reductions in response to the 2023 EPA Taconite NESHAPS rulemaking. With the final rule from the EPA falling short of the controls necessary to meet these TMDL goals, the MPCA still holds the authority to be more stringent than the Clean Air Act as a state agency.

More importantly to the Band, the Category 5 mercury-impaired waters will also never be brought back into compliance without first seeing the statewide TMDL reduction goals fully met, as these waters will require additional regulatory and non-regulatory actions in order to reduce mercury methylation and bioaccumulation sufficiently for unrestricted fish consumption and the protection of wildlife. Most of the waters within the Fond du Lac Reservation as well as those treaty-protected waters where band members exercise treaty fishing rights fall into this category. They require not only fully attaining the statewide mercury TMDL reduction goals but also additional watershed improvements that can reduce mercury loading to the highly methylating environments in northern Minnesota.

In addition to reducing mercury emissions, Continuous Emissions Monitoring Systems (CEMS) should be implemented in place of stack testing to ensure continuous compliance. This CEMS mercury data should also be available and accessible by the public and enforcement agencies. Additionally, isotope stack testing should be conducted to verify the long-touted claims that taconite facility representatives have made regarding how far these mercury emissions travel out of the stacks. We know Minnesota's mercury emissions carry a global footprint, but with the unique water chemistry and watershed processes within our northern regional wetland-dominated ecosystems, we need to dramatically reduce all emissions of mercury for the benefit of all communities here in Minnesota, tribal and non-tribal.

The Band looks forward to seeing greater progress on achieving compliance with human health and ecological protection standards under the Clean Water Act and Minnesota Rules. We again urge the MPCA to prioritize the restoration of mercury impaired waters, and to vigorously exercise the agency's regulatory authorities in issuing protective NPDES permit limits and mercury air emission controls.

Thank you for the opportunity to submit these comments, and for your consideration of these important issues. We look forward to working with MPCA to ensure treaty resources are protected. If you have any questions or discussions of these matters, please contact Arianna Northbird Himango at 218-878-7106 or ariannanorthbirdhimango@fdlband.org.

Sincerely,

Arianna Northbird Himango

Environmental Program Manager

Resource Management Division

Fond du Lac Band of Lake Superior Chippewa

Corey Hanson

Please consider examination of the assignment of regional TSS and RES standards, with input from regional MPCA staff and LGU staff with knowledge of the watershed(s), prior to the Cycle 3 assessment. We have some inconsistencies within the Red Lake River Watershed. A glaring example is the Black River (09020303-529) which has been assigned to the South TSS Region even though it flows into a portion of the Red Lake River that is assigned to the Central TSS Region. I have spoken with several MPCA staff who also see this as an oversight. The Black River would exceed the 30 mg/L Central standard, but meets the 65 mg/L South TSS Region standard. Excess sediment was identified as a stressor of reaches within the Black River subwatershed in the 2015 Red Lake River stressor identification report. The TSS standard for the streams of the Black River subwatershed should be adjusted to the Central standard to protect the downstream waters and the biology that is being affected by excess sediment.

Regarding some of the new E. coli impairments in the Red Lake River Watershed (09020303-539, -536, -526). Some of these are WIDs where monitoring is relatively new or where we had insufficient data for the Cycle 1 assessment. Sources along Kripple Creek (-526) were identified during Cycle 1 as sources of downstream E. coli problems, so a long-term monitoring site was added on that reach.

MESERB Anonymous

On behalf of the Minnesota Environmental Science and Economic Review Board (MESERB), please see the attached comments. Thank you.

MESERB

Minnesota Environmental Science and Economic Review Board

Using science and economics to improve environmental regulations

July 22, 2026

VIA Public Comment Form

Leya Charles
Impaired Waters List Coordinator
Minnesota Pollution Control Agency
520 Lafayette Road
Saint Paul, MN 55155
impaired.waters.mpca@state.mn.us

RE: 2026 Impaired Waters List

Thank you for the opportunity to comment on the Minnesota Pollution Control Agency's ("MPCA" or the "Agency") draft 2026 Impaired Waters List ("IWL"). The following comments are offered on behalf of the Minnesota Environmental Science and Economic Review Board ("MESERB"), a joint powers organization of more than 60 member cities, sanitary districts, and public utilities commissions in Minnesota that own and operate wastewater treatment facilities and hold NPDES permits. MESERB is made up of the operators, technicians, and leadership at municipal wastewater facilities and has worked since 1997 to ensure that regulations affecting wastewater treatment are reasonable, effective, and based on sound science. MESERB members discharge to waters throughout the state and are among those who will be most affected by several of the proposed additions.

Our comments below address several aspects of the proposed 2026 Impaired Waters List, including sulfate impairments and the application of the chloride and other aquatic-life toxicity standards.

I. Sulfate Impairment Comments

Both water and wild rice are important natural resources. MESERB and its members recognize the spiritual, cultural, and agricultural importance of wild rice, and we support efforts to protect and restore it across the state. However, MESERB has long held that the existing outdated 10 mg/L sulfate standard is deeply flawed and likely not the best way to meet that objective. As MPCA is aware, the 1973 standard is expensive to implement at wastewater facilities and outdated in consideration of the best available science.

Regarding the impairments in the current IWL, MESERB is concerned that the proposed sulfate impairment listings are not supported by the law or the best available science for two key reasons. First, the 10 mg/L criterion is one MPCA itself has determined is scientifically outdated and will lead to unnecessarily costly overprotection in some parts of the state and underprotection in others. Second, the underlying wild rice beneficial use designations for the waterbodies MPCA seeks to list as impaired were not finalized through rulemaking as required by state and federal law.

MESERB therefore urges MPCA to withdraw the proposed impairments and the informal beneficial use designations to waterbodies listed in Attachment H of the Assessment Manual. In addition, we call on MPCA to complete the rulemaking the Legislature directed fifteen years ago to update the standard and formally designate the waterbodies that support the wild rice beneficial use before moving forward to implement the standard.

a. MESERB's Concerns with the Sulfate Standard Itself

i. The sulfate standard has major economic consequences for Minnesota's cities and businesses.

Impairment listing has significant consequences; it triggers Total Maximum Daily Load ("TMDL") development, wasteload allocations, and ultimately water quality-based effluent limits in National Pollutant Discharge Elimination System ("NPDES") permits.[1] For sulfate, the downstream consequences of listing are especially severe. There are hundreds of municipal and industrial facilities impacted, and the facilities that receive sulfate permit limits will likely require advanced treatment processes, such as reverse osmosis, membrane separation, and brine evaporation/crystallization. The capital and operation/maintenance costs associated with these treatment processes can range from tens of millions to hundreds of millions of dollars, depending on the size and characteristics of the applicable facility.[2]

MPCA's own analysis concluded that "municipal sulfate treatment is likely to be unaffordable for greater than 97% of municipalities based solely on projected costs."[3] A decade ago, projected capital costs were already in the ballpark of hundreds of millions of dollars for mid-to-large-sized systems to implement sulfate treatment and removal technology.[4] These costs would fall on top of billions of dollars in existing drinking-water and wastewater infrastructure needs across Minnesota.[5] It is concerning to MESERB that MPCA is implementing a standard that will impose costs of this magnitude, even though the Agency's own analysis demonstrates that the standard is inaccurate and could result in unnecessary expenditure.

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[1] 33 U.S.C. § 1313(d)(1)(C); 40 C.F.R. §§ 130.7(c), 122.44(d)(1); Minn. Stat. § 114D.25; Minn. R. ch. 7053.
[2] Minnesota Pollution Control Agency, *Statement of Need and Reasonableness, Amendment of the sulfate water quality standard applicable to wild rice and identification of wild rice waters, Minn. R. chapters 7050 and 7053* (2017) (Doc. No. wq-rule4-15i), at 182–83 and Exhibit 42 [hereinafter *2017 SONAR*].
[3] *Id.* at 212.
[4] Bolton & Menk, Inc. & Barr Eng'g Co., *Analyzing Alternatives for Sulfate Treatment in Municipal Wastewater* (prepared for the Minn. Pollution Control Agency May 1, 2018).
[5] Minnesota Pollution Control Agency, *Future Wastewater Infrastructure Needs and Capital Costs, Report to the Legislature* (Jan. 2024) (Doc. No. lrwq-wwtp-1sy24), at 1, 6; Minnesota Pollution Control Agency, *Municipal Wastewater Infrastructure System Needs and Costs, Report to the Legislature* (Jan. 2026) (Doc. No. lrwq-wwtp-1sy26), at 1, 5; U.S. Envtl. Prot. Agency, *7th Drinking Water Infrastructure Needs Survey and Assessment* (2023).

ii. The Agency itself has acknowledged the standard is outdated and unreliable.

The Clean Water Act and its implementing regulations require that water quality standards, impairment assessments, TMDLs, and NPDES requirements rest on sound scientific rationale and criteria to protect the applicable designated use.[6] The 10 mg/L sulfate criterion in Minn. R. 7050.0224, subp. 2 was adopted in 1973 based on mid-century field observations, and MPCA has spent more than a decade documenting that it does not reflect current science. In its 2017 SONAR, the Agency acknowledged that "the scientific understanding of the chemistry of sulfate in the environment and the mechanisms by which it affects wild rice has greatly improved."[7] MPCA's own research has demonstrated that sulfate is not directly toxic to wild rice, but the problem is actually sulfide; that sulfate's conversion to sulfide depends on site-specific sediment chemistry, including iron and organic carbon; and that there were instances where higher levels of sulfate did not result in high levels of toxic sulfide.[8]

The Agency has stated that "[n]o single sulfate value would be protective of wild rice at all sites,"[9] and acknowledged to the EPA that, depending on site conditions, the 10 mg/L criterion may be either overprotective or underprotective of the wild rice use.[10] The Minnesota Attorney General likewise informed EPA that "MPCA has determined that the Wild Rice Standard is in need of substantial revision and therefore imprudent to apply."[11]

A criterion the Agency has concluded is scientifically outdated and unprotective in some waters and overprotective in others does not protect designated uses using a sound scientific rationale as required by law.[12] The State's own research has shown that the 1973 criterion is scientifically deficient, as the Attorney General stated in 2016 in a formal opinion to EPA, determining that it would be unreasonable to compel permittees to install costly sulfate controls to meet a standard the State expected to change at the time, calling it an "expenditure of resources that may ultimately prove unnecessary."[13] For these reasons, and as elaborated upon throughout this comment, MPCA cannot declare dozens of waters impaired against a numeric criterion that its

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[6] 33 U.S.C. § 1313(c)(2)(A); 40 C.F.R. §§ 131.5(a), 131.6(b)–(c), 131.11(a)(1); 40 C.F.R. § 130.7.
[7] 2017 SONAR, *supra* note 2, at 19.
[8] *See* Letter from Lori Swanson, Minnesota Attorney General, to Tinka Hyde, Director, Water Division, EPA Region 5 (Aug. 12, 2016), at 3 (describing MPCA's 2014 research findings) (reproduced as Enclosure B to Letter from Debra Shore, Regional Administrator, EPA Region 5, to Katrina Kessler, Commissioner, MPCA (Feb. 16, 2022)) [hereinafter *Swanson Letter*]; Minn. Pollution Control Agency, *Analysis of the Wild Rice Sulfate Standard Study: Draft for Scientific Peer Review* (June 2014) (Doc. No. wq-s6-42z).
[9] *Swanson Letter*, *supra* note 8, at 4.
[10] Letter from Katrina Kessler, Assistant Commissioner, MPCA, to EPA Region 5 (June 29, 2021) at footnote 1 (acknowledging the 10 mg/L standard may be "overprotective or underprotective" depending on site-specific conditions).
[11] Swanson Letter, *supra* note 8, at 4.
[12] 33 U.S.C. § 1313(c)(2)(A); 40 C.F.R. §§ 131.6(c), 131.11(a)(1).
[13] Swanson Letter, *supra* note 8, at 4.

own scientists and the State's chief legal officer have all acknowledged does not reliably measure whether the wild rice use in waterbodies throughout the state is actually supported or impaired.

b. MESERB's Procedural Concerns with the Impairments and Underlying Beneficial Use Designations

MESERB's concerns with MPCA's newly proposed sulfate impairments (and many of the already existing impairments) extend from the underlying designation process that determines whether the wild rice sulfate standard applies at all. The Clean Water Act and Minnesota law require MPCA to first establish that a waterbody is assigned the applicable designated use through a formal rulemaking process and then assess whether a waterbody complies with the applicable criteria. MPCA has reversed that required sequence by identifying waters as "water used for the production of wild rice" through the Assessment Guidance, Appendix H, and other informal processes, and then used those informal designations as the basis for impairment determinations outside of rulemaking. Because the affected waters have not been validly designated through rulemaking, the 10 mg/L sulfate standard (regardless of whether it is an *appropriate* water quality standard) is not an *applicable* water quality standard for those waters. Therefore, the impairment listings based on the standard and the procedurally improper beneficial use designations lack a lawful foundation.

i. The proposed sulfate impairments and beneficial use designations are unlawful because MPCA has not properly designated the underlying waters as "water used for the production of wild rice" through rulemaking.

MPCA is proposing to add 16 waters to the current iteration of the Impaired Waters List as impaired for sulfate based on the 10 mg/L sulfate standard. MPCA is also proposing to designate 52 additional waterbodies as "waters used for the production of wild rice," in addition to the approximately 2,400 waterbodies already identified through Appendix H of the 2026 Assessment Manual. The issue with this approach is that MPCA has not designated any of these waters as "water used for the production of wild rice" through rulemaking, as both state and federal law require.[14] Without proper designation through rulemaking, the 10 mg/L standard does not apply to waterbodies outside those enumerated in Minnesota statute with a [WR] identifier, so neither the proposed impairments nor the Appendix H designations apply.

[14] Note that the issue MESERB presents is not that "production of wild rice" is an invalid designated use. The issue MESERB identifies is in how MPCA determines which specific waterbodies carry that use. The Assessment Manual acknowledges that because the standard is "only 'applicable to water used for production of wild rice,'" its application "results in the need for a determination of whether a water is assigned the beneficial use of 'water used for production of wild rice.'" Minnesota Pollution Control Agency, *2026 Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List* (Doc. No. wq-iw1-04n), at 96 [hereinafter *Assessment Manual*]. MESERB's comment assesses what process the law requires MPCA to use to make that determination, which is ultimately rulemaking.

Before assessing a waterbody for compliance with the sulfate standard applicable to waters used for the production of wild rice, MPCA must establish that the waterbody is subject to that designated use through the applicable water quality standards process. Under the Clean Water Act, states are required to establish water quality standards consisting of designated uses and water quality criteria, and those standards must be submitted to and approved by the EPA before they become effective for purposes of the Act.[15] Minnesota law similarly requires MPCA to adopt water quality standards through formal rulemaking procedures.[16]

MPCA has authority to decide where designated uses apply.[17] However, MPCA must exercise that authority through a formal rulemaking process, not through Assessment Guidance or other informal pathways. Minnesota's sulfate standard applies specifically and only to waters "used for the production of wild rice," and does not apply to other waters.[18] The rule itself states that wild rice waters are those "specifically identified [WR] and listed in part 7050.0470, subpart 1,"[19] which can only be amended through chapter 14 rulemaking.[20] The Legislature supported this plain reading of the rule in 2011 and 2015 by directing MPCA to designate the applicable waters, and to develop criteria for doing so, through rulemaking,[21] and MPCA acknowledged in its 2017 SONAR that the Agency must proceed "via rulemaking" to designate the waterbodies to which the standard and wild rice beneficial use apply.[22] Therefore, a water becomes subject to the sulfate standard only after MPCA adds it to the [WR] list in 7050.0470 by rule or through other formal rulemaking process. Until that happens, the standard does not apply, and a waterbody cannot be assessed against the standard or listed as impaired.

Here, none of the waters at issue have been added to the [WR] list pursuant to Minn. R. 7050.0470 or other rulemaking process. MPCA identified them instead through informal processes such by listing them on a website or including them in the Assessment Manual. Therefore, because the 16 waters proposed for impairment listing in the current IWL were never designated as wild rice waters by rulemaking, the 10 mg/L standard does not apply to them, MPCA has no authority to assess them against the standard, and the proposed impairments

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[15] 33 U.S.C. § 1313(c)(2)(A); 40 C.F.R. § 131.3(i) (defining water quality standards as designated uses together with criteria); 40 C.F.R. § 131.21 (state standards not effective for Clean Water Act purposes until approved by EPA).
[16] Minn. Stat. § 115.03, subd. 1(3) (authorizing MPCA to adopt water pollution standards); Minn. Stat. § 116.07, subd. 4 (authorizing rules relating to water quality standards); Minn. Stat. §§ 14.001–14.69 (Minnesota Administrative Procedure Act governing agency rulemaking).
[17] 40 C.F.R. §§ 131.2, 131.3(f), 131.10 (designated uses established and applied through the water quality standards process).
[18] Minn. R. 7050.0224, subp. 2.
[19] *Id.*, subp. 1.
[20] Minn. R. 7050.0140, 7050.0460, 7050.0470; Minn. Stat. § 14.05, subd. 1; 14.02, subd. 4.
[21] 2011 Minn. Laws, 1st Spec. Sess., ch. 2, art. 4, § 32; 2015 Minn. Laws, 1st Spec. Sess., ch. 4, art. 4, § 136.
[22]EPA, *Decision Document Regarding the Sulfate Impaired Waters EPA is Adding to the Minnesota 2020 Clean Water Act Section 303(d) List* (Mar. 26, 2021), at 5–6 [hereinafter *EPA 2021 Decision Document*] (quoting the *2017 SONAR*, *supra* note 2).

should be withdrawn.[23] Additionally, because the 52 waters added in Appendix H of the Assessment Manual were similarly never designated by rule, they should be removed from the Assessment Manual unless and until MPCA designates them through rulemaking. In short, and impairment listing premised on a use that was never lawfully designated is not a lawful exercise of MPCA's authority.[24]

c. Additional concerns with proposed sulfate impairments and the application of the standard as outlined in the 2026 Assessment Manual.

In addition to the above concerns with the underlying standard and designation process, MESERB has identified the following issues with respect to the proposed application of the standard pursuant to the 2026 Assessment Manual.

i. MPCA should reevaluate existing and proposed impairments where there is evidence that wild rice is healthy despite exceedances of the 10 mg/l standard and where sulfate concentrations are highly influenced by ambient concentrations (e.g. the Lower Pools of the Mississippi River).

As discussed above, the 10 mg/L sulfate standard for the protection of naturally growing wild rice is out of date and inappropriate for assessing compliance related to the protection of wild rice. Notwithstanding MPCA's attempt to revise the wild rice sulfate standard in 2017, data are available showing wild rice thriving in waters with elevated concentrations of sulfate. Most

[23] Two additional issues establish that MPCA's informal approach cannot substitute for rulemaking. First, even on its own terms, MPCA's informal test for "current or historical wild rice presence" leaves out the harvest-history, acreage, and rice-density criteria the Legislature directed MPCA to develop and apply, so it does not satisfy the 2011 and 2015 legislative mandates. 2011 Minn. Laws, 1st Spec. Sess., ch. 2, art. 4, § 32(a)–(b); 2015 Minn. Laws, 1st Spec. Sess., ch. 4, art. 4, § 136; *EPA 2021 Decision Document*, *supra* note 22, at 6 (quoting the *2017 SONAR*, *supra* note 2); *cf.* Minn. Pollution Control Agency, *Framework for Developing and Evaluating Site-Specific Sulfate Standards for the Protection of Wild Rice* (Dec. 2023) (Doc. No. wq-s6-66a) [hereinafter *SSS Framework*]. Second, MPCA already attempted the required rulemaking in 2017–18, which was rejected on the merits, and has not been initiated again. The waters list and screening criteria from that rejected rulemaking cannot re-enter the regulatory framework through the impairment-listing process. *EPA 2021 Decision Document*, *supra* note 22, at 7; Minn. Stat. §§ 14.15, 14.381.

[24] Accordingly, any sulfate impairment based solely on MPCA's informal designation of a waterbody as a wild rice water lacks a lawful foundation. Otherwise, MPCA could accomplish administratively what both the Legislature and the Clean Water Act have required it to accomplish through formal water quality standards rulemaking. See 33 U.S.C. § 1313(c); 40 C.F.R. §§ 131.6, 131.10; *EPA 2021 Decision Document*, *supra* note 22, at 7–8 & n.25 (explaining that the Section 303(d) assessment process may not displace the Section 303(c) water quality standards process). EPA has confirmed that Minnesota "has the authority to add additional waters to Minn. R. 7050.0470, subpart 1 but the State has never done so," so EPA's own reviews of the 2014, 2016, and 2018 lists were limited to "the 24 waters specifically designated as wild rice waters in Minn. R. 7050.0470."EPA, Decision Document Regarding the Sulfate Impaired Waters EPA is Adding to the Minnesota 2020 Clean Water Act Section 303(d) List (Mar. 26, 2021) *Id.* at 4, 7–8 & n.26. ("EPA does not believe MPCA has done so at this time"). EPA has also stated that the Section 303(d) process may not be used "to displace the process for establishing and revising water quality standards outlined in CWA § 303(c)." *Id.* at 8 & n.25.

notably, Mississippi River Pools 3–8 have shown a wild rice population that is self-sustaining and productive.[25]

Wild rice that is both self-sustaining and productive is considered healthy. Productive wild rice is wild rice that generates biomass, which is presumably evidenced by the observance of mature wild rice. Since wild rice is an annual plant, the observation of mature wild rice is indicative of a seed bank. Therefore, if wild rice is observed in the same location repeatedly over time, even if there are gaps in appearance, it indicates that the seed bank is established.

There is evidence of wild rice growth in the Mississippi River based on observations made by the USGS, which document the occurrence of wild rice in Mississippi River Pool 3 and upper Pool 4 over a period of 32 years. Those observations show that very dense (>90%) stands of wild rice have exhibited continued long-term growth, with dense stands present throughout the observation period. Since 2000, very dense wild rice stands in Pool 3 increased from approximately 16 acres to approximately 249 acres by 2020. During the same period, wild rice stands in upper Pool 4 increased from no documented acreage to approximately 70 acres. The presence of these mature wild rice stands indicates that the wild rice populations in these locations are both self-sustaining and productive. The long-term persistence and expansion of these populations demonstrate the existence of an ongoing seed bank in the sediment. Thus, these observations show that the beneficial use is being attained in several of the lower Mississippi River Pools.

Additionally, the observed use attainment in these pools is occurring when the average sulfate concentration is reported at 60 mg/L.[26] This showing of attainment of the wild rice designated use while the ambient concentration of sulfate in Pool 3 of the Mississippi River averages 60 mg/L provides a clear indication that the adopted sulfate water quality standard of 10 mg/L to protect wild rice waters is unnecessary, excessively overprotective, and contrary to EPA's *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, which provide that water quality criteria should provide a reasonable degree of protection while avoiding substantial overprotection or underprotection.[27]

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[25] *SSS Framework*, *supra* note 23, at 3–5. MPCA's Framework explains that, for purposes of evaluating site-specific sulfate standards, the Agency interprets "production" to mean ecological production (i.e., the generation of biomass) and requires a demonstration that the waterbody maintains a "wild rice population that is self-sustaining and productive." The Framework further defines a self-sustaining population as one that is regularly present, recurs over time without trending toward extirpation, and maintains an ongoing seed bank, while a productive population exhibits continued annual and long-term biomass production.
[26] *SSS Framework*, *supra* note 23.
[27] EPA states that water quality criteria "should attempt to provide a reasonable and adequate degree of protection" while allowing only "a small possibility of considerable overprotection or underprotection." U.S. Envtl. Prot. Agency, *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* (1985) (PB85-227049), at 5 [hereinafter *1985 Guidelines*].

Further, MPCA has recognized that background sulfate concentrations vary across the state and may exceed the criterion in some waters, and is completing a study for that reason.[28] It is premature for MPCA to list waterbodies as impaired where natural background concentrations exceed the standard—especially in light of the natural background concentration study that MPCA is in the process of completing. If a waterbody is determined not to meet water quality standards due to natural conditions, the waterbody may not need to be included on the IWL, and a TMDL study is not required because the natural background condition becomes the standard.[29]

As a result of the above, MESERB requests that MPCA reevaluate all of the existing and currently proposed sulfate impairments that have resulted from an exceedance of the 10 mg/L standard, but where there is evidence that wild rice is growing and healthy and/or the sulfate concentrations that exceed the 10 mg/L standard are strongly impacted by natural background concentrations. As noted above, many, if not all, of the current and proposed impairments in the lower Mississippi River Pools fall into this category and should be reevaluated by MPCA for either de-listing (if previously listed) or should be removed from the draft IWL if MPCA is proposing to add them for the first time.

ii. MPCA's application of the 10 mg/L criteria as outlined in the 2026 IWL Assessment Manual is inconsistent with the standard and science.

MPCA is not properly applying the adopted standard to determine sulfate impairments because the 10 mg/l standard is only supposed to be applied to the production of wild rice during periods when rice may be susceptible to damage by high sulfate levels.

The 2026 MPCA Draft Impaired Waters List and Assessment Manual notes that Minn. R. 7050.0224, Subp. 2, provides a sulfate standard of "10 mg/L, applicable to water used for the production of wild rice during periods when rice may be susceptible to damage by high sulfate levels."[30] This standard is unlike most other water quality standards, which always apply. Rather, the sulfate water quality standard for the protection of wild rice only applies during periods when rice may be susceptible to damage by high sulfate levels. This language implies that there are periods when wild rice may not be damaged by high levels of sulfate. Yet, the Assessment Manual further states that "[w]aters used for production of wild rice are considered impaired if the average annual sulfate concentration exceeds the water quality standard of 10 mg/L, with statistical significance".[31] This approach is flawed for multiple reasons as identified below.

1. The standard's duration component is inappropriately applied.

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[28] Minn. Pollution Control Agency, *Sulfate Natural Background Study*, https://www.pca.state.mn.us/air-water-land-climate/sulfate-natural-background-study; *see also* Letter from Katrina Kessler, *supra* note 10, at 3, n.1.
[29] Minn. R. 7050.0170; 40 C.F.R. § 130.7(b)(1)(iii); Minn. Pollution Control Agency, *Guidance for Considering Natural Background When Assessing Lakes for Eutrophication* (Oct. 2011) (Doc. No. wq-s1-63).
[30] *Assessment Manual*, *supra* note 14, at 71.
[31] *Id.* at 72.

The Assessment Manual assesses impairment of wild rice production based on the annual average sulfate concentration. This approach was supported in the SONAR, which explains that the MPCA no longer interprets the phrase "periods when the rice may be susceptible to damage" as limited to the wild rice growing season because current scientific understanding indicates that sulfide formation in porewater occurs throughout the year.[32]

As discussed in the SONAR, the rationale for assuming that wild rice is susceptible to damage at all times is because the conversion of sulfate to sulfide in the porewater occurs throughout the year. While this may be true, it is also true that conversion of sulfate to sulfide is dependent upon other factors (iron, carbon), and it is likely also dependent upon the level of oxygen present in the porewater and temperature, since anaerobic bacteria in the sediment make sulfide from the sulfate that penetrates the sediment from the overlying water under anaerobic conditions.

With regard to dissolved oxygen and temperature, the MPCA's Refinements to Minnesota's Sulfate Water Quality Standard to Protect Wild Rice: Technical Support Document [33] explains that seasonal changes in temperature and sulfate concentrations affect sulfate diffusion and bacterial conversion to sulfide. The Technical Support Document notes that higher winter sulfate concentrations may result in less sulfate diffusion into sediment and slower bacterial conversion because of colder temperatures. As temperatures increase in the spring, sulfate diffusion and conversion to sulfide accelerate, even as sulfate concentrations may decline.[34]

Consequently, in systems where the available dilution is reduced in the winter (e.g., rivers and streams), sulfate concentrations are expected to increase in the winter. However, the effect of this increased concentration is mitigated by lower diffusion rates and reduced bacterial conversion. Therefore, it is inappropriate to average winter-time sulfate concentrations with warm-weather sulfate concentrations because the effect of sulfate on porewater sulfide concentration is not the same for these two periods.

The assumption that annual averaging is appropriate as the duration component of the sulfate water quality standard to protect wild rice overlooks the fact that wild rice (Zizania palustris) is an annual plant that starts to germinate shortly after ice-out, with shattering occurring in late

[32] 2017 SONAR, *supra* note 2, at 20 ("Under current rule, the numeric standard applies during periods when the rice may be susceptible to damage." The MPCA explained that it had historically interpreted this phrase as applying only during the wild rice growing season, but that current scientific understanding indicates sulfide formation in porewater occurs throughout the year, leading the MPCA to conclude that "wild rice is susceptible at all times.").
[33] Minnesota Pollution Control Agency, *Refinements to Minnesota's Sulfate Water Quality Standard to Protect Wild Rice: Technical Support Document* (2017) (Doc. No. wq-rule4-15n), at 93 [hereinafter *TSD*].
[34] *Id.* ("if sulfate concentrations are temporarily high for a time in the winter, less sulfate will diffuse into the sediment than under warmer conditions, and bacterial conversion to sulfide will be slow because of the cold." The TSD further explains that as sediment warms, sulfate diffusion and sulfide conversion accelerate, even as sulfate concentrations decline.).

August or early September in most years.[35] Like the seeds of other plants, the seeds of wild rice remain dormant and protected from external influences (such as sulfide concentration) until germination. Thus, the averaging period should run from ice-out to seed deposition (April–September) when the plants are growing.

The effect of sulfate and sulfide concentration on seed germination was investigated by Pastor et al. (2017). Those researchers reported that sulfate exposure concentrations ranging from 0 to 1,600 mg SO_4/L did not affect germination success, mesocotyl lengths, or plant biomass, and that sulfide concentrations ranging from 0 to 2,880 µg/L similarly did not affect germination success or seedling development.[36]

Given that neither sulfate nor sulfide concentration affects seed germination, the concentration of these parameters when wild rice is only present in the form of seeds should not factor into the duration of the water quality standard necessary to protect wild rice.

2. Impairment determinations for wild rice waters are unsupported by more recent studies.

The 2026 Assessment Manual states that the determination of whether a waterbody exceeds the 10 mg/L sulfate standard can be the same as the determination of impairment.[37] This assessment method is not consistent with the best available science.

The mesocosm studies discussed in the SONAR clearly demonstrate that sulfate concentrations can exceed the sulfate standard without causing any detrimental effect to the production of wild rice. The SONAR summarizes these results by explaining that the time required for conversion of sulfate to sulfide was observed in a multi-year mesocosm experiment where sulfate was added at concentrations of 0, 50, 100, 150, and 300 mg/L. The SONAR notes that, although the numeric sulfate standard under the proposed equation would have been 34 mg/L, it was not until the third year of the experiment that wild rice growth and reproduction were significantly affected by the 100 mg/L treatment. The SONAR further explains that the experiment demonstrated a relationship between porewater sulfide and long-term (annual) average sulfate concentrations.[38]

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[35] U.S. Fish & Wildlife Service, *Wild Rice (Zizania palustris)*, https://www.fws.gov/species/wild-rice-zizania-palustris.

[36] Pastor, J., Dewey, B., Johnson, N.W., Swain, E.B., Monson, P., Peters, E.B. and Myrbo, A. (2017), Effects of sulfate and sulfide on the life cycle of *Zizania palustris* in hydroponic and mesocosm experiments. Ecol Appl, 27: (321-336), at 327 [hereinafter *Pastor et al.*] (reporting that sulfate concentrations of 0, 10, 50, 100, 400, and 1,600 mg SO_4/L did not affect germination success, mesocotyl lengths, or plant biomass, and that sulfide concentrations of 0, 96, 320, 960, and 2,880 µg/L did not affect germination success or seedling development).

[37] *Assessment Manual*, *supra* note 14, at 27 ("The determination of exceeding the sulfate standard can be the same as the determination of impairment.").

[38] *2017 SONAR*, *supra* note 2, at 80 (discussing *Pastor et al.*, *supra* note 36 and explaining that wild rice growth and reproduction were not significantly affected by the 100 mg/L sulfate treatment until the third year of the multi-year mesocosm experiment).

These studies show that sulfate concentrations can exceed the sulfate standard as an annual average concentration by a factor of three or more without causing damage to wild rice production. Consequently, impairment cannot be determined simply by showing that the sulfate concentration exceeds 10 mg/L as an annual average standard.

3. MPCA's use of a once- in-10-year exceedance frequency is not consistent with best available science.

The Assessment Manual notes that "a minimum of 5 years of no violation (exceedance) of the Individual Standard Criteria is a critical impairment removal requirement."[39] With regard to return frequency (e.g., the number of times a standard can be exceeded in a specified period of time without causing acute or chronic toxic effects), the SONAR identifies the allowable exceedance frequency for the protection of wild rice from damage due to sulfate as once in ten years.[40] This exceedance frequency is unsupported by the available scientific data and should be conservatively revised to "once in three years on average."

As noted in the Minnesota Rules, frequency means "the number of times a standard can be exceeded in a specified period of time without causing acute or chronic toxic effects on the aquatic community."[41] The SONAR explains that available scientific evidence indicates that even a one-year elevation in sulfide levels above 120 µg/L would not have a long-term negative effect on wild rice growth and reproduction, provided that elevated sulfide concentrations do not persist for multiple sequential years. The SONAR further explains that a wild rice seed bank allows populations to persist despite poor reproduction in a given year because only a portion of dormant seeds germinate annually.[42]

The scientific studies conducted in support of the SONAR demonstrate that even when sulfate concentrations were elevated for two consecutive years, wild rice growth and reproduction were not significantly affected by the 100 mg/L sulfate treatment (approximately three times the proposed standard).[43] These findings make it impossible to justify a "once in ten year" return frequency because two consecutive years at sulfate concentrations three times the proposed

[39] *Assessment Manual*, *supra* note 14, at 73 ("a minimum of 5 years of no violation (exceedance) of the Individual Standard Criteria is a critical impairment removal requirement").
[40] *2017 SONAR*, *supra* note 2, at 82–83 (identifying a ten-year exceedance frequency for the proposed wild rice sulfate standard).
[41] Minn. R. 7050.0218, subp. 3(AA) (defining frequency as "the number of times a standard can be exceeded in a specified period of time without causing acute or chronic toxic effects on the aquatic community").
[42] *2017 SONAR*, *supra* note 2, at 82–83 (explaining that a one-year elevation in sulfide levels above 120 µg/L would not have a long-term negative effect on wild rice growth and reproduction if elevated sulfide levels do not persist for multiple sequential years, and discussing the role of seed banks in maintaining wild rice populations).
[43] *Id.* at 80; *see also Pastor et al.*, *supra* note 36 (discussing the multi-year mesocosm experiment in which the 100 mg/L sulfate treatment did not significantly affect wild rice growth and reproduction until the third year of the experiment).

standard, and ten times the current standard, had no demonstrated effect on plant growth or viable seed production.

The frequency component of the wild rice sulfate standard needs to be considered in light of factors that influence wild rice health and the potential negative impacts of exposure to sulfate. These considerations include:

- Wild rice populations build up a seed bank in the sediment so that only a portion of dormant seeds germinate in any given year. If seed production is not affected, the seed bank will not be adversely affected.
- Neither sulfate concentration (up to 1,600 mg/L) nor sulfide porewater concentration (up to 2,880 µg/L) affects wild rice germination success, mesocotyl lengths, or the masses of the stem plus leaf (if any) and roots. If seed bank germination and growth are not affected, wild rice production will not be affected by one year of elevated sulfate concentration.
- Available scientific evidence supports that even a one-year elevation in sulfide levels in sediment porewater above 120 µg/L would not have a long-term negative effect on wild rice growth and reproduction.[44]

As discussed above and demonstrated by various studies, a single year or two consecutive years of elevated sulfate concentration causes no adverse effects on wild rice germination success, plant growth, or viable seed production. Without demonstrated adverse effects, a restrictive return frequency such as "once in ten years" cannot be justified. These facts support a traditional "once in three years on average" return frequency as a very conservative requirement.

d. Summary of Requested Actions re Sulfate Impairments

For the reasons stated above, MESERB respectfully requests that MPCA: (1) withdraw the proposed new sulfate impairments from the draft 2026 IWL; (2) withdraw the proposed wild rice water designations (including the informal statewide list and the draft lake designation tables) that have never been adopted through rulemaking; (3) revise the 2026 Assessment guidance consistent with our comments in section c above; (4) comply with the 2011 and 2015 session laws by completing chapter 14 rulemaking to establish criteria for designating waters used for the production of wild rice and to designate those waters, before proposing any new sulfate impairments; (5) undertake a comprehensive update of the wild rice sulfate standard itself, so that assessment, listing, permitting, and TMDL decisions rest on a designated use and criteria that reflect current science and are adopted through a lawful process.[45]

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[44] *Pastor et al.*, *supra* note 36, at 327.
[45] 2011 Minn. Laws, 1st Spec. Sess., ch. 2, art. 4, § 32; 2015 Minn. Laws, 1st Spec. Sess., ch. 4, art. 4, § 136; Minn. Stat. §§ 14.05, 14.131–14.15; Minn. Stat. § 115.44, subd. 2.

In summary, protecting wild rice is important to Minnesota and its citizens, and MESERB's members share that goal. However, the protection of wild rice is not advanced by implementing a standard that is outdated and not supported by the best available science. Further side-stepping the public rulemaking process required to designate the wild rice beneficial use diminishes the credibility of the process and opens the door for improper designations that could have significant impacts throughout the state. We urge the Agency to withdraw the proposed sulfate impairment listings and beneficial use designations and to work with municipalities, tribes, and other stakeholders to designate wild rice waters and protect them in a manner that is scientifically sound, transparent, and consistent with the rule of law.

II. MPCA's 2026 Assessment Manual Applies the Chloride Standards and Other Aquatic Life Toxicity Standards in a Manner that is Inconsistent with Adopted Rules

Under the 2026 Assessment Manual methodology,[46] designated uses related to the chloride standard (and other aquatic life-based toxicity standards) will be considered supported if there are *no exceedances* of the chronic or acute standard for three years or more and no exceedance of the Maximum Standard. Impairment will be determined if there are two or more exceedances of the Chronic Standard within three years and/or one or more exceedances of the Maximum Standard.[47] This interpretation is inconsistent with and more restrictive than the adopted chloride standards pursuant to Minn. R. 7050.0222 and U.S. EPA Water Quality Criteria for Chloride.[48]

The adopted chloride standards have a magnitude of 230 mg/L (chronic) and 860 mg/l (acute); a duration as a 4-day average, and an exceedance frequency of *not more than once every three years on average*.[49] As a result, under the adopted chronic standards, a waterbody is in compliance and fully supporting the designated use when there is one exceedance of the standard (but not more than one) in three years on average.

The 2026 Assessment Manual interpretation of the chloride standard is also inconsistent with the 2024 Assessment Manual, which considered uses supported if there was *no more than one exceedance* of the chronic standard in three years and no exceedances of the Maximum Standard.[50] Moreover, both the 2024 and 2026 assessment methodologies are inconsistent with the applicable water quality standards because they fail to account for the standards' frequency component, which is based on exceedances occurring "on average."

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[46] *Assessment Manual*, *supra* note 14, at 47.
[47] *Id.* (emphasis added).
[48] U.S. Envtl. Prot. Agency, Office of Water Regulations and Standards, *Ambient Water Quality Criteria for Chloride — 1988* (Feb. 1988) (EPA 440/5-88-001) [hereinafter *1988 Chloride Criteria*].
[49] *See e.g.,* Minn. R. 7050.0222, subp. 4 and subp. 7, item C (emphasis added); *1988 Chloride Criteria*, *supra* note 48.
[50] Minnesota Pollution Control Agency, *2024 Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List* (Doc. No. wq-iw1-04m), at 47 (emphasis added). The 2024 Assessment Manual is also inconsistent with the adopted chloride standard because it omits "on average" from the exceedance frequency.

Consistent with EPA's *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, federal water quality criteria are based on a three-year average exceedance frequency.[51] The Guidelines explain that aquatic organisms and their uses should generally be protected where the Criterion Continuous Concentration and Criterion Maximum Concentration are not exceeded more than once every three years on average.[52] Minnesota's adopted chloride standard follows this same framework by incorporating an exceedance frequency of not more than once every three years on average. Thus, under the adopted standard, a waterbody remains in compliance where exceedances occur consistent with that average frequency.

As explained in the Guidelines, the exceedance frequency is an average number of exceedances over time, rather than a limitation on any individual exceedance occurring within a specified period.[53] The rationale for considering return frequency as an average is that aquatic systems can tolerate occasional exceedances, including situations where exceedances are clustered, provided that concentrations remain below the criteria for extended periods thereafter.[54]

The Assessment Manual's approach effectively eliminates the averaging component of the frequency determination and instead applies a more restrictive interpretation that treats any exceedance beyond the specified timeframe as an impairment issue. For chloride, this approach is inconsistent with the adopted standard because it omits the required "on average" language and prevents a determination of compliance even where exceedances occur within the frequency allowed by the standard. The same concern applies to other aquatic-life toxicity standards that include an average exceedance frequency component. This approach is inconsistent with the methodology underlying EPA's criteria and the adopted water quality standards for aquatic-life toxicity parameters, including chloride and other toxic pollutants, which allow for exceedances consistent with the applicable average frequency component.

The Agency has not provided any scientific or technical justification to support this more restrictive interpretation of allowable exceedance frequency. Consequently, the EPA approach upon which the criteria were developed and the frequency components incorporated into Minnesota's adopted standards should be used in impairment determinations.

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[51] *1985 Guidelines*, *supra* note 27.
[52] *Id.* at 55 (explaining that aquatic organisms and their uses should generally be protected where the four-day average concentration does not exceed the Criterion Continuous Concentration and the one-hour average concentration does not exceed the Criterion Maximum Concentration more than once every three years on average).
[53] *Id.* at 55.
[54] Id. at 13 (explaining that where exceedances are grouped, several exceedances may occur in one or two years followed by extended periods without exceedances, and that long-term ecological consequences should generally be comparable to evenly spaced exceedances).

As a result, MESERB requests that MPCA revise Table 15 of MPCA's 2026 Assessment Manual as follows:

Table 15: Impairment determination for aquatic life toxicity standards

Period of record	**Beneficial use–support or beneficial use–impaired**	
	Supporting	**Impaired**
Most recent 10 years	No more than one exceedances of the chronic or acute standard for in three years or more on average, and no more than one exceedance of the Maximum Standard in three years on average	~~Two or more~~ More than one exceedance~~s~~ of the Chronic Standard in three years on average, and/or ~~one or~~ more than one exceedance~~s~~ of the Maximum Standard in three years on average

Thank you for your consideration of our comments. We appreciate the MPCA's leadership on these issues and its commitment to evaluate and apply the best available science related to the protection and restoration of Minnesota's natural resources. We look forward to continuing collaboration with MPCA as this process unfolds.

Sincerely,

MINNESOTA ENVIRONMENTAL SCIENCE AND ECONOMIC REVIEW BOARD

Scott Gilbertson
MESERB president
Executive Director, Alexandria Lake Area Sanitary District

Jason Aagenes

Please see attached letter

CLIFFS

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July 22, 2026

Minnesota Pollution Control Agency
520 Lafayette Road North
Saint Paul, Mn 55155-4194

Re: MPCA's November 2025 Assessment Guidance Manual – Guidance for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment: 305(b) Report & 303(d) Impaired Waters List

To Whom it May Concern:

Thank you for the opportunity to provide comments on Minnesota Pollution Control Agency's (MPCA) 2025 Assessment Guidance Manual for determining impaired waters on behalf of Cleveland-Cliffs Inc. (Cleveland-Cliffs). Cleveland-Cliffs wholly owns and operates three taconite mines and processing facilities in Minnesota: United Taconite, Minorca, and Northshore Mining. Cleveland-Cliffs is also the majority owner and operator of a fourth taconite mine and processing facility, Hibbing Taconite. Water discharged from Cleveland-Cliffs' Minnesota operations flows into or through numerous water bodies and streams that may be considered "waters used for production of wild rice" (WUFPOWR) and/or may be listed as impaired. Accordingly, Cleveland-Cliffs is affected by MPCA's use of the Guidance Manual.

Data Availability

Page 22/255 of the November 2025 Assessment Guidance Manual states, *"Any data submitted to WQX is used in the assessment process but is not made available to the public."*

To foster transparency, MPCA should establish an easily accessible, publicly available link for all data from WQX or other sources that MPCA utilizes to determine if a waterbody will be listed for impairment.

Wild Rice Impairment - Sulfate vs. Sulfide

Page 71/255 of the 2025 Assessment Guidance Manual states, *"Due to the (wild rice plants') sensitivity to excessive sulfate during its growing season, sulfate needs to be monitored and limited to allow for adequate plant growth and seed production."*

MPCA should revise this section to clarify that sulfide, not sulfate, is the direct stressor to wild rice, and sulfate is a precursor that can be converted to sulfide under favorable geochemical/sediment conditions and through various sulfate reducing microbial mechanisms. Several peer-reviewed studies historically cited by MPCA found that sulfate concentrations alone does not determine risk; the key factor is whether sulfate is converted into biologically available sulfide.

Although sulfate in the water column is easier to monitor and regulate than sediment sulfide, it is not appropriate to base impairment findings solely on a precursor—sulfate—that converts to the primary stressor, sulfide, at variable rates depending on site-specific geochemical and sediment conditions. Research has demonstrated that sulfate concentrations alone do not directly correlate with adverse impacts to wild rice.

Need for a More Holistic Evaluation of Wild Rice Impairment

Page 72/255 of the 2025 Assessment Guidance Manual states, "*Waters used for production of wild rice are considered impaired if the average annual sulfate concentration exceeds the water quality standard of 10 mg/L, with statistical significance."*

As noted in the previous comment, sulfide not sulfate is a direct stressor to wild rice. MPCA should renew its efforts to establish modern impairment criteria for wild rice that consider multiple factors which affect the overall health of the plant, e.g., iron availability, water level fluctuations, sediment characteristics, nutrient availability, turbidity, water depth, temperature, competition from other plants, and herbivory.

Speculative Inclusion of Waters with "Demonstrated Potential" to Support Wild Rice

Pg 97/255 of the 2025 Assessment Guidance Manual states, *"Thus, the list of waters used for production of wild rice includes waterbodies that we consider to be either an existing wild rice use or those with a demonstrated potential to support sufficient wild rice to attain the beneficial use in the future.*" … *"In addition, waterbodies with documentation of minimal stands or sparse rice that have not and are not currently meeting the use could, in the future, be home to sufficient wild rice to attain the beneficial use, and thus these identified waterbodies will receive waters used for production of wild rice use designations as well. Including these waters on the waters used for production of wild rice list furthers MPCA's goal of wild rice protection in the state." … "The MPCA is therefore applying the Class 4A wild rice beneficial use to waters with documented wild rice presence, current or historical, because it shows the beneficial use either has occurred and is an existing use, or there is a demonstrated potential to support sufficient wild rice for the beneficial use to be met in the future."*

MPCA provides no criteria or description of how "demonstrated potential" is defined. At a minimum, MPCA should develop clear criteria for what type of information is needed to satisfy the "demonstrated potential" requirement. In the absence of such clarity, MPCA should remove this reference from the Guidance Manual.

Conclusion

Cleveland-Cliffs appreciates the opportunity to submit comments to MPCA. Please contact me at 218-744-6037 or Jason.Aagenes@clevelandcliffs.com if you have any questions or require additional information.

Sincerely,

Jason Aagenes

Jason Aagenes

Director, Environmental Compliance – Mining & Pelletizing
Cleveland-Cliffs Inc.

Paul Peltier

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7/22/26

Commissioner Katrina Kessler
Minnesota Pollution Control Agency
520 Lafayette Road
Saint Paul, MN 55155
impaired.waters.mpca@state.mn.us

RE: 2026 Impaired Waters List

Commissioner Kessler,

The Range Association of Municipalities and Schools (RAMS) appreciate the opportunity to comment on the 2026 Impaired Waters List (IWL) and the accompanying Assessment Manual. Our comments will be confined to the impacts of the 10mg/l sulfate standard for waters used for the production of wild rice. This list reinforces the need to revisit and redefine the sulfate wild rice standard. It is of utmost importance that the MPCA understand that the sulfate standard is broken, inaccurate, will not achieve its intended outcome in its current form, and is out of compliance with session law requiring new rulemaking.

We have concerns about the application of the guidance document and will demonstrate that the cost of compliance is too steep for municipalities in the Taconite Assistance Area and other dischargers. We are urging agency reconsideration before it enforces and implements the standard standards. It is important to acknowledge all the factors, including a background study, which the agency is undertaking. By taking this step, the agency can hopefully also choose to reflect on feedback from affected dischargers in Northeastern Minnesota and state-wide. We would appreciate if the MPCA would continue to be in dialogue with RAMS and other affected parties to remedy this broken standard and call for a new rulemaking as required in session law. We would respectfully request responses to the following questions.

1. **St. Louis Bay (AUID 69-1291-02) and the Upper Estuary (AUID**

   The IWL lists St. Louis Bay and the Upper Estuary of Lake Superior as newly impaired for sulfate. This is concerning because many dischargers in our area discharge into the St. Louis River, then this water body.

   We ask: Does new listing imply or require establishment of a TMDL for sulfate for the St. Louis River and its connected waterways?

2. **Delisting and Disenrollment**

   The IWL delists 260 waters. Disappointingly, no impairments for sulfate have been deleted.

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We ask: What instances, if any, have there been of a Minnesota water body that was previously designated for the production of wild rice been delisted or disenrolled as impaired for sulfate?

3. **Comments on the "November 2025 Assessment Manual Guidance for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report & 303(d) Impaired Waters List"**

The idea that any water bodies listed as impaired for sulfate because of the "possibility of being used for the production of wild rice", especially when none such beneficial use currently exists, is preposterous. We are concerned that this test is overly broad and caution agency regulators to not assign beneficial uses to water bodies based on aspirational assumptions especially if there is no existing or historical beneficial use.

Especially concerning is the following:
(Page 96) "The MPCA is taking an expansive approach for identifying waters used for production of wild rice, recognizing that water quality standard protections should be extended to more waters than had been previously recognized. Federal regulations state that "a water quality standard defines the water quality goals of a water body …" (40 CFR 131.2) and that "designated uses are those specified in water quality standards for each water body or segment whether or not they are being attained" (40 CFR 131.3(f)) (emphasis added)."

Rationale: The guidance document does not list exclusionary factors. Nothing in the language of the guidance document would indicate there is a way to exclude a water body from "possibly" hosting wild rice in the future. This leads to a "slippery slope" that the MPCA would use its implied authority to designate any water body in Minnesota as able to host rice and would therefore, if it exceeded the standard of 10, be listed as impaired for the production of wild rice. States must monitor and assess the quality of their waters to identify those that are "impaired", i.e., not fully supporting their beneficial uses. Waters listed as having the "possibility of being used for the production of wild rice" are close to the most "slippery slope". We are wary that this will lead to an administrative overreach and expansive application of additional water bodies in our area that may not have ever had production of wild rice.

We ask: Would waters with no history of wild rice production ever be designated as "for the production of wild rice"? Under what circumstances would a water body with no history of beneficial use, be designated as such in the future?

4. **Cost of Compliance – See Attached *Minnesota Sulfate Removal Cost Analysis* and accompanying maps**

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This standard is very expensive and unduly burdensome to affected dischargers and is not guaranteed to solely achieve its intended outcome. In a 2025 cost estimate update to the May 2018 Minnesota Pollution Control Agency (MPCA) report "*Analyzing Alternatives for Sulfate Treatment in Municipal Wastewater"*, RAMS (in partnership with the Coalition of Greater Minnesota Cities and AgriGrowth) have determined that, using MPCA's own data sets, 695 dischargers, would be subject to the current sulfate standard.

It is extremely concerning to RAMS members, who are affected as identified municipalities, that, to meet the 10mg/l standard, 443 municipal dischargers, 212 industrial dischargers, and over 40 agri-business dischargers statewide would have to implement reverse osmosis (RO) technology. This is a water treatment cost we cannot bear. This cost for a 20-year operations and maintenance (O&M) is between $67,377,000.00 and $386,770,000.00 per facility. Construction of water treatment facilities requires additional extensive environmental review.

Our local governments are under constant pressure to reduce costs and in many cases are making difficult choices with their budgets already. It is not hyperbole to say there is no margin in most of our local government budgets. Needing to construct just one facility would bankrupt most of our communities.

We ask: How will the MPCA incorporate compliance cost estimates into their economic impact modeling when considering economic variance requests or evaluating the prudence and feasibility of a standard for future rulemaking?

Sincerely,

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Minnesota Sulfate Removal Cost Analysis

Comparison of 2018 Report Findings vs. 2025 Updated Costs

Executive Summary

This document compares the findings from the May 2018 Minnesota Pollution Control Agency (MPCA) report *"Analyzing Alternatives for Sulfate Treatment in Municipal Wastewater"* with updated 2025 cost estimates for sulfate removal using Reverse Osmosis (RO) membrane treatment processes.

Key Findings from 2018 Report

The original 2018 study, conducted by Bolton & Menk, Inc. and Barr Engineering Company (Barr), analyzed six case studies for sulfate removal at municipal wastewater treatment plants with varying design flows (0.5 to 10 MGD) and sulfate concentrations. The report evaluated treatment approaches combining biological treatment with RO membrane systems and concentrate management.

Case Study Specifications

The six case studies examined different treatment scenarios:

Case	Biological Treatment	Flow (MGD)	Influent Sulfate (mg/L)	Effluent Sulfate (mg/L)	% Flow by RO
1	Activated Sludge	10	100	10	93%
2	Trickling Filter	2.5	25	10	63%
3	Activated Sludge	2.5	600	100	89%
4	Activated Sludge	0.5	300	10	99%
5	Activated Sludge	0.5	300	100	74%
6	Facultative Pond	0.5	600	250	68%

2018 Cost Estimates

The 2018 report provided detailed cost estimates for sulfate removal using RO membrane treatment and concentrate management. Costs included both capital and operations & maintenance (O&M) expenses. For Cases 1, 3, and 4, the report analyzed concentrate minimization using lime softening or pellet softening followed by secondary RO treatment.

2025 Updated Cost Comparison

The updated 2025 cost analysis shows significant changes from the original 2018 estimates. The following table compares sulfate removal costs and concentrate treatment costs:

Case	Sulfate Removal Capital ($)	Sulfate Removal O&M ($)	Concentrate Capital ($)	Concentrate O&M ($)	20 Yr Present Cost ($)
1	43,101,000	1,930,000	43,329,000	16,681,000	**386,770,000**
2	14,972,000	534,000	20,709,000	4,135,000	**111,029,000**
3	14,424,000	554,000	32,178,000	7,108,000	**170,251,000**
4	9,326,000	112,000	18,606,000	2,189,000	**65,066,000**
5	9,294,000	159,000	15,293,000	2,490,000	**67,377,000**
6	6,948,000	105,000	216,567,000	2,947,000	**72,768,000**

Note: Lime softening is used prior to secondary (concentrate reduction) RO treatment.

Key Cost Changes: 2018 vs. 2025

Comparing the 2018 baseline report with the 2025 updated costs reveals several important trends:

1. Capital Cost Increases: Sulfate removal capital costs have increased across all cases, with Case 1 showing the highest capital investment at $43.1 million (2025 update) compared to $33.8 million in the 2018 report - an increase of approximately 27%.

2. Concentrate Management Costs: Concentrate treatment capital costs vary significantly by case. Case 6 shows the highest concentrate capital cost at $216.6 million, reflecting the complexity of managing concentrate from facultative pond systems with high influent sulfate.

3. 20-Year Present Value: Case 1 has the highest total 20-year present value cost at $386.8 million, driven by the large flow volume (10 MGD) and high percentage of flow requiring RO treatment (93%).

4. Operational Efficiency: Cases 4, 5, and 6 with smaller flow rates (0.5 MGD) show lower absolute costs but higher unit costs due to economies of scale challenges. Case 4 demonstrates the most cost-effective 20-year present value at $65.1 million.

Technical Considerations

The 2018 report emphasized several key technical challenges that remain relevant in 2025:

Concentrate Management Complexity: The management of concentrate generated by RO systems continues to be technically challenging and costly. For Cases 1, 3, and 4, secondary treatment approaches including lime softening, pellet softening, or VSEP (Vibratory Shear Enhanced Process) concentrators are employed to minimize concentrate volume before ultimate disposal.

Membrane Technology Selection: RO provides superior sulfate rejection rates necessary to meet stringent effluent requirements, particularly for Cases 3, 5, and 6 with high influent sulfate concentrations.

Pre-treatment Requirements: Biological treatment upstream of RO systems provides essential pre-treatment to protect membrane integrity. The choice between activated sludge, trickling filters, or facultative ponds significantly impacts overall treatment efficiency and costs.

2018 to 2025 Industry Standard Technologies: A general review of industry standard treatment processes, and potential emerging technologies, for sulfate removal was completed as part of the 2025 update. It was determined that the technologies referenced to prepare cost models in the 2018 Report are still relevant as being the current industry standard for the management of sulfate. To ensure treatment processes are cost effective, there needs to be an ability for treatment components and media to be manufactured.

It should be recognized that treatment technologies are not employable without environmental and health review by state agencies. New technologies will need to be reviewed (though potential pilot scale and/or demonstration-scale reviews) and approved by state agencies prior to implementation of the design and construction phases. This informs emerging technologies will likely have longer implementation periods. Emerging technologies could exhibit implementation periods of five or more years prior to a facility becoming active (commissioned). This assumes a 2-year piloting and permitting phase, 1-year design phase and 2-year construction phase.

Conclusions

The 2025 updated cost analysis demonstrates that sulfate removal from municipal wastewater remains a capital-intensive undertaking with substantial operational expenses. The updated tables reflect cost escalation from 2018 due to inflation, higher material costs, and increased complexity of concentrate management. The treatment technologies presented in the 2018 Report remain the industry standard. These technologies have a defined implementation process that has been previously vetted by state agencies. It is unlikely a new treatment technology will emerge to yield cost savings in the near term since it will need to undergo rigorous state review and require initial specialized manufacturing for processes and components.

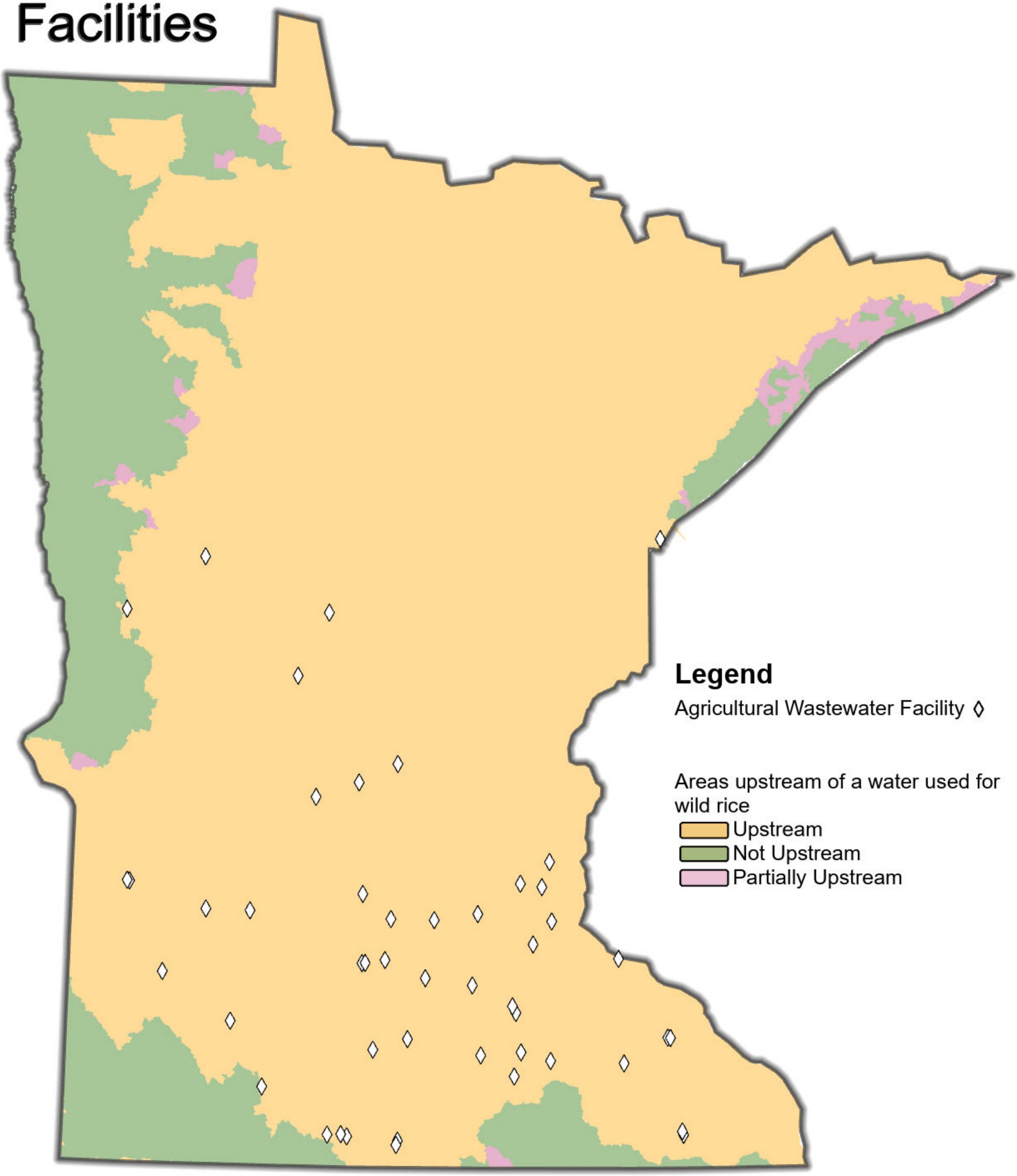
Key conclusions include:

• Total 20-year present value costs range from $65 million to $387 million depending on flow rate, influent sulfate concentration, and required effluent quality.

• Concentrate management often represents 50% or more of total capital costs, underscoring the critical need for effective waste management strategies.

• Economies of scale favor larger facilities, with smaller 0.5 MGD plants facing proportionally higher unit costs.

Minnesota Wild Rice Waters & Wastewater Facilities



Data Sources

DNR Rivers and Lakes - MN Geospatial Commons - https://gisdata.mn.gov/dataset/water-dnr-hydrography - filtered to removed ditches and connections lines
Wastewater Facilities in Minnesota - MN Geospatial Commons - https://gisdata.mn.gov/dataset/util-wastewater-facilities
Waterbodies on MPCA Wild Rice Inventory - MN Geospatial Commons - https://gisdata.mn.gov/dataset/env-wild-rice-inventory-pca - filtered to show upstream sources

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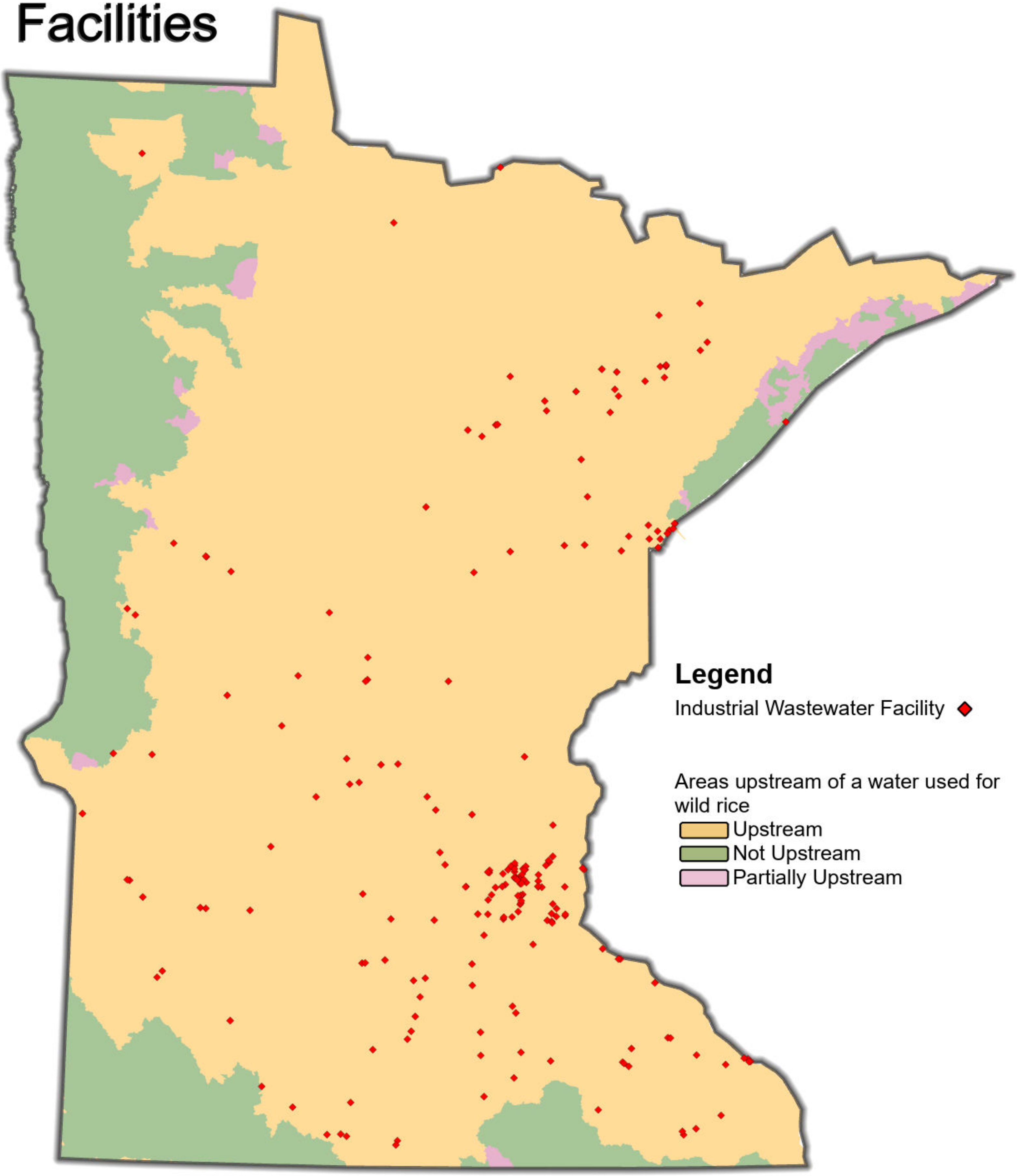

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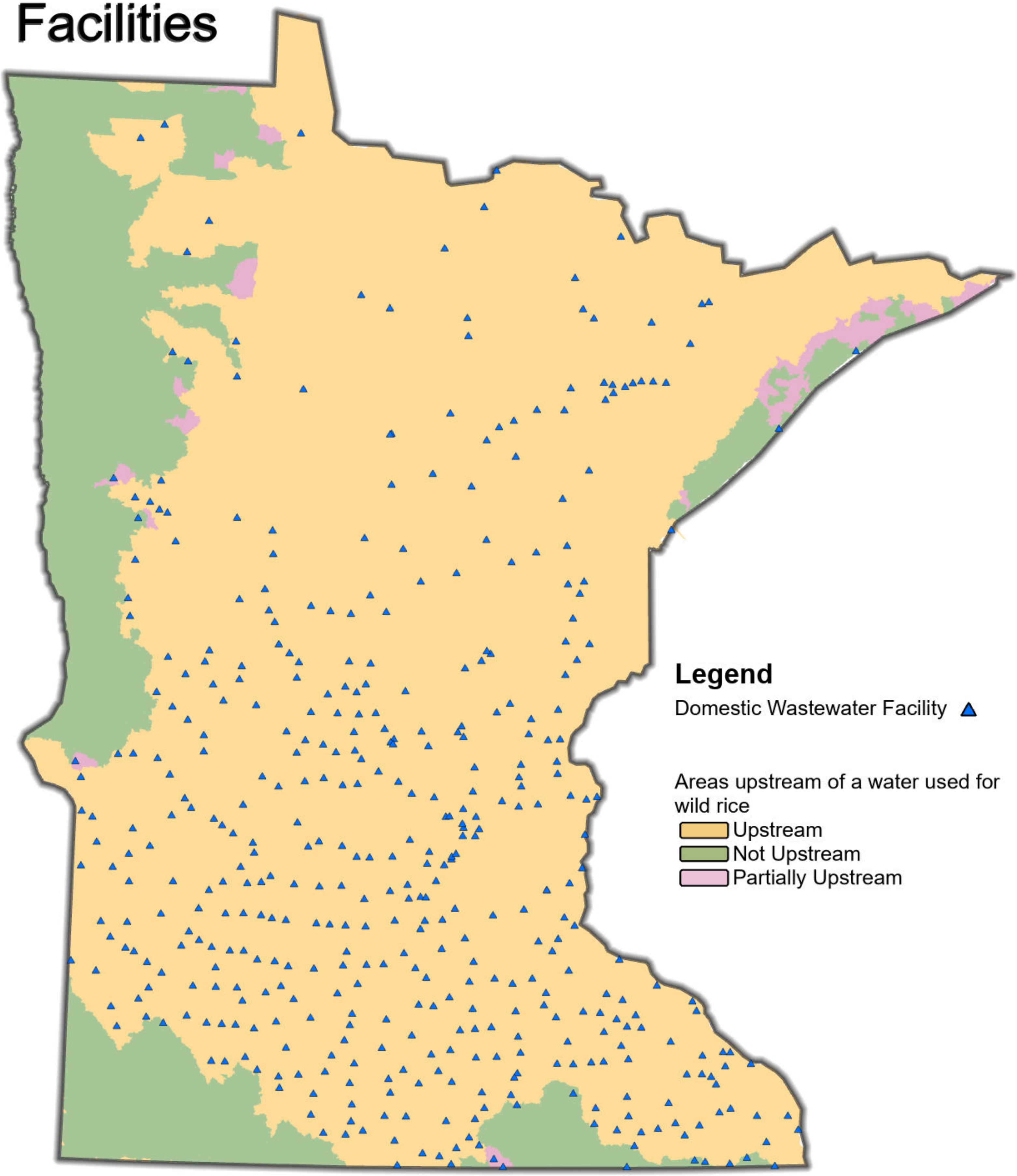

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