Minnesota Department of Natural Resources
Minnesota Board of Water and Soil Resources

Program Process and Project Evaluations

Appendix A: 2023 Legacy Fund Restoration Evaluation Report

May 2024

Minnesota Department of Natural Resources
Minnesota Board of Soil and Water Resources
Restoration Evaluations
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Legislative Charge
Parks and Trails Fund: M.S. 85.53, Subd. 5.
Outdoor Heritage Fund: M.S. 97A.056, Subd. 10.
Clean Water Fund: M.S. 114D.50, Subd. 6.

As requested by Minnesota Statute 3.197: This report cost $5,700 to prepare, including staff time, printing, and mailing expenses.

Upon request, this material will be made available in an alternative format such as large print, Braille, or audio recording. Printed on recycled paper.

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Legislative Charge and Statutory Requirements

Parks and Trails Fund: M.S. 85.53, Subd. 5.

The commissioner of natural resources may convene a technical evaluation panel comprised of five members, including one technical representative from the Board of Water and Soil Resources, one technical representative from the Department of Natural Resources, one technical expert from the University of Minnesota or the Minnesota State Colleges and Universities, and two other representatives with expertise related to the project being evaluated. The commissioner may add a technical representative from a unit of federal or local government. The members of the technical evaluation panel may not be associated with the restoration, may vary depending upon the projects being reviewed, and shall avoid any potential conflicts of interest. Each year, the commissioner may assign a coordinator to identify a sample of up to ten habitat restoration projects completed with parks and trails funding. The coordinator shall secure the restoration plans for the projects specified and direct the technical evaluation panel to evaluate the restorations relative to the law, current science, and the stated goals and standards in the restoration plan and, when applicable, to the Board of Water and Soil Resources' native vegetation establishment and enhancement guidelines. ***The coordinator shall summarize the findings of the panel and provide a report to the chairs of the respective house of representatives and senate policy and finance committees with jurisdiction over natural resources and spending from the parks and trails fund***. The report shall determine if the restorations are meeting planned goals, any problems with the implementation of restorations, and, if necessary, recommendations on improving restorations. The report shall be focused on improving future restorations. Up to one-tenth of one percent of forecasted receipts from the parks and trails fund may be used for restoration evaluations under this section.

Outdoor Heritage Fund: M.S. 97A.056, Subd. 10.

The commissioner of natural resources and the Board of Water and Soil Resources must convene a technical evaluation panel comprised of five members, including one technical representative from the Board of Water and Soil Resources, one technical representative from the Department of Natural Resources, one technical expert from the University of Minnesota or the Minnesota State Colleges and Universities, and two representatives with expertise in the project being evaluated. The board and the commissioner may add a technical representative from a unit of federal or local government. The members of the technical evaluation panel may not be associated with the restoration or enhancement, may vary depending upon the projects being reviewed, and shall avoid any potential conflicts of interest. Each year, the board and the commissioner may assign a coordinator to identify habitat restoration or enhancement projects completed with outdoor heritage funding. The coordinator shall secure the plans for the projects specified and direct the technical evaluation panel to evaluate the restorations and enhancements relative to the law, current science, and the stated goals and standards in the project plan and, when applicable, to the Board of Water and Soil Resources' native vegetation establishment and enhancement guidelines. ***The coordinator shall summarize the findings of the panel and provide a report to the chair of the Lessard-Sams Outdoor Heritage Council and the chairs of the respective house of representatives and senate policy and finance committees with jurisdiction over natural resources and spending from the outdoor heritage fund.*** The report shall determine if the restorations and enhancements are meeting planned goals, any problems with the implementation of restorations and

enhancements, and, if necessary, recommendations on improving restorations and enhancements. The report shall be focused on improving future restorations and enhancements. At least one-tenth of one percent of forecasted receipts from the outdoor heritage fund must be used for restoration and enhancements evaluations under this section.

Clean Water Fund: M.S. 114D.50, Subd. 6.

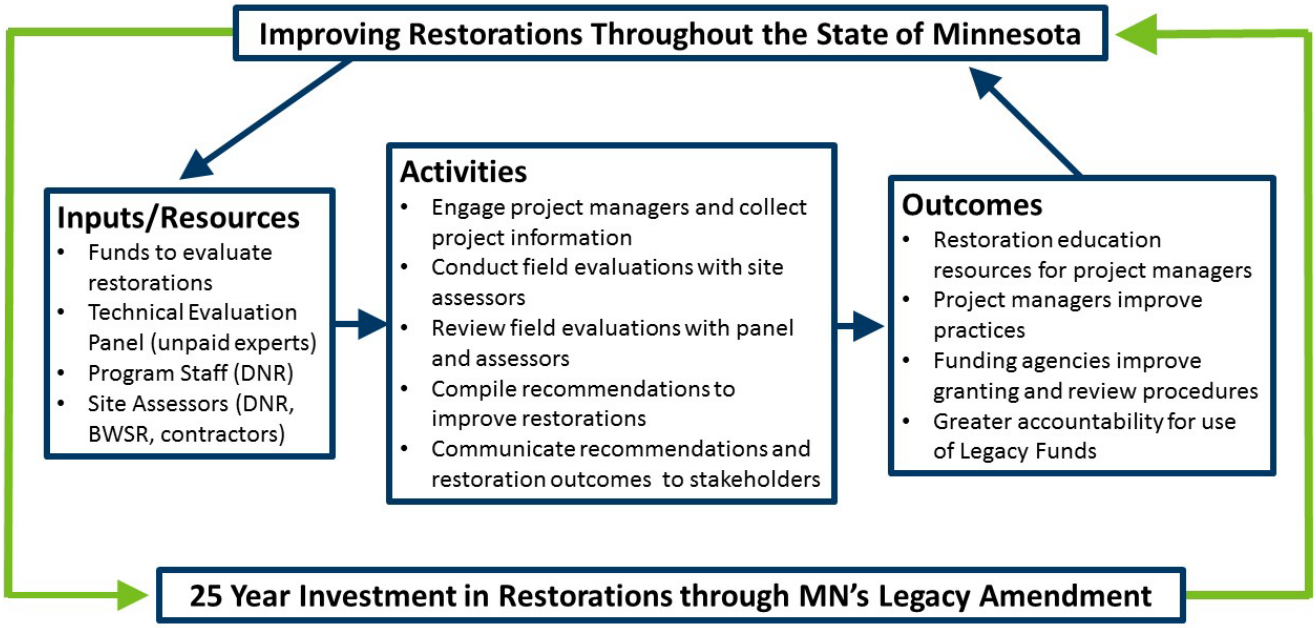
The Board of Water and Soil Resources may convene a technical evaluation panel comprised of five members, including one technical representative from the Board of Water and Soil Resources, one technical representative from the Department of Natural Resources, one technical expert from the University of Minnesota or the Minnesota State Colleges and Universities, and two representatives with expertise related to the project being evaluated. The board may add a technical representative from a unit of federal or local government. The members of the technical evaluation panel may not be associated with the restoration, may vary depending upon the projects being reviewed, and shall avoid any potential conflicts of interest. Each year, the board may assign a coordinator to identify a sample of habitat restoration projects completed with clean water funding. The coordinator shall secure the restoration plans for the projects specified and direct the technical evaluation panel to evaluate the restorations relative to the law, current science, and the stated goals and standards in the restoration plan and, when applicable, to the Board of Water and Soil Resources' native vegetation establishment and enhancement guidelines. ***The coordinator shall summarize the findings of the panel and provide a report to the chairs of the respective house of representatives and senate policy and finance committees with jurisdiction over natural resources and spending from the clean water fund.*** The report shall determine if the restorations are meeting planned goals, any problems with the implementation of restorations, and, if necessary, recommendations on improving restorations. The report shall be focused on improving future restorations. Up to one-tenth of one percent of forecasted receipts from the clean water fund may be used for restoration evaluations under this section.

Evaluation Process

State law directs the DNR and BWSR to convene an expert panel to evaluate restorations completed with Clean Water Land and Legacy Funds. The evaluations include directly engaging project managers and are completed by third party experts to identify gaps and capture lessons learned from restorations. The agencies use this information to improve restorations throughout the state.

Program Model

The Restoration Evaluation Program was developed with the ultimate goal of improving restorations throughout the state. The diagram below outlines the inputs, activities, and outcomes of the program and our continued investment in improving restorations.



Roles and Responsibilities

Evaluation Panel

Statute directs the evaluation panel to:

- Evaluate restorations relative to the law, current science, and the stated goals and standards in the restoration plan
- Provide findings on the evaluations, determining whether restorations are meeting planned goals, identify problems with implementation of restorations and, provide recommendations on improving restorations

Members of the panel are unpaid experts chosen to fulfill statutory requirements and provide needed expertise in a variety of ecosystems and restoration techniques.

Program Staff

The program staff are responsible for coordinating site assessments, program administration and managing the work of the panel. They are directed in statute to:

- Identify restoration projects completed with Parks and Trails, Outdoor Heritage, and Clean Water Funds
- Secure restoration plans for selected projects
- Summarize the findings of the panel
- Provide reports to the legislature

The staff also promote and document continuous improvement in restorations. Staff work with the panel and agencies to identify and promote actions and provide guidance for implementing improved restorations. DNR and BWSR have assigned staff to ensure consistency in program implementation. The staff are currently housed in DNR's Ecological and Water Resources Division.

Site Assessors

The site assessors are responsible for conducting site assessments. Site assessors are selected based on knowledge of restoration practices and work closely with program staff in assessing project plans, conducting field evaluations, and participating in panel reviews. Site assessors include:

- State agency staff
- Local government staff
- Federal agency staff
- Private contractors

Services provided by assessors are negotiated using contracts, State Interagency Agreements, or work assignments.

Project Managers

Project managers are expected to actively participate in the evaluation process. Project managers provide the necessary project background and attend field evaluations when possible to:

- Identify project work sites
- Provide project context
- Answer assessor questions

It is necessary to acknowledge the diversity of managing organizations and their scope and focus when evaluating projects.

Example project managers for the three Legacy Funds.

Clean Water Fund

- Soil and Water Conservation District manager or technician
- Watershed District staff
- Watershed Management Organization staff
- County Water Resources of Environmental Services staff
- City Water Resource staff

Outdoor Heritage Fund

- State agency staff (DNR, BWSR)
- Federal agency staff (USFWS)
- County conservation and land management staff
- Watershed District staff
- Nongovernmental wildlife organizations

Parks and Trails Fund

- MN DNR Parks and Trails Division, resource management staff
- Metro Regional Parks managers, including county park systems and Three Rivers Park District
- Greater Minnesota park managers

Evaluation Methods

Project Selection

Program staff update the pool of eligible restoration projects on an annual basis. For each fund projects are eligible if they are complete and contain restoration or enhancement work. Projects evaluated represent a variety of habitat types and geographic distributions of restorations in the state.

Projects are selected in relative proportion to each Fund's appropriation to restoration evaluations. Many grants and appropriations fund restoration activities at multiple project sites. A smaller subsample of project sites is typically evaluated.

Site Assessments

DNR, BWSR and the panel developed a simple and consistent process to facilitate evaluations. To the extent possible the evaluation process engages project managers in conducting site visits and communicating lessons learned. Facilitating an inclusive evaluation process with project managers increases the transfer of knowledge between field practitioners and agencies, ultimately improving restorations.

A site evaluation form was developed to provide project information and address evaluation requirements directed by law. This form describes site assessors' observations of project effectiveness, estimated outcomes based on current conditions and application of current science.

Field visits include inspecting the project's structural components and plant communities. Restored plant communities may take several years or even decades to mature. Evaluations are based on observations of the present and projected conditions relative to the project goals. Assessments of project sites do not represent an overall evaluation of the larger program or Fund.

Restoration science is continually evolving. Best practices are an area of ongoing discussion between practitioners, researchers, agencies, and stakeholders. Site assessors and the panel evaluate projects based on methods commonly considered to be within the range of current science.

Legacy Fund Attributes and Requirements

Each of the Legacy Funds has a distinct focus on restoration and specific requirements for projects.

	Clean Water Fund	Outdoor Heritage Fund	Parks and Trails Fund
Fund Purpose	*protect, enhance, and restore water quality in lakes, rivers, and streams and protect groundwater from degradation*	*restore, protect, and enhance wetlands, prairies, forests, and habitat for fish, game, and wildlife*	*support parks and trails of regional or statewide significance*
Primary Restoration Goal	Restore water quality	Restore specific wildlife habitat types	Ecological restoration of specific habitat types
Guidance for project types and locations	Local water management plan, TMDL Implementation plans, or Watershed Restoration and Protection Strategies	Statewide or national wildlife habitat plans	State or Regional Park natural area management plans
Funding source for restoration projects	Competitive grants administered by BWSR	Appropriation to project manager; recommended by Outdoor Heritage Council, or Conservation Partners grants administered by MN DNR	MN DNR appropriation: resource management, or Met Council appropriation: County Regional Park System, Three Rivers Park District
Statutory Requirements	MS 114D.50 Subd. 4. (a) *include measurable outcomes, as defined in section 3.303, subdivision 10, and a plan for measuring and evaluating the results. A project must be consistent with current science and incorporate state-of-the-art technology.*	Different appropriation years are subject to different requirements but all include: • *Prepare and retain an ecological restoration and management plan* • *Use current conservation science to achieve the best restoration* • *Establishment of diverse plant species* Appropriations in 2009 and 2010 also included. • *Plant vegetation or sow seed only of ecotypes native to Minnesota.*	MS *85.53 Subd. 2* (a) *include measurable outcomes, as defined in section 3.303, subdivision 10, and a plan for measuring and evaluating the results. A project or program must be consistent with current science and incorporate state-of-the-art technology*

1 Grassy Point Habitat Restoration

Project Background

Latitude/Longitude: 15T 564923.92m E, 5175030.06m N

Project Manager / Organization: Melissa Sjolund, Minnesota Department of Natural Resources

Fund: OHF

Fiscal Year Funds: 2014, 2016, 2017

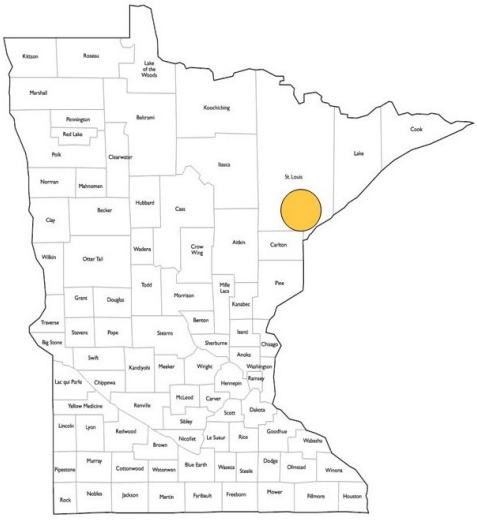
Project Start Date: 2017

Project Complete Date: 2021

Predominant Habitat type: Aquatic Habitat

Additional Habitat types: Wetland

Project Status: Post Establishment Phase



County: St. Louis

Primary Activity: Wetland Restoration

Project Size: 106 acres

Project Goals and Planning

(Site Assessment Preparation from Plan Sets and Documents)

1. ***What are the specific project components, management actions, or treatments?***
   Excessive wood waste and sediments were mechanically removed from Grassy Point to restore the wetland complex to a bathymetry condition similar to other less impacted sheltered bays in the St. Louis River estuary. Wood waste and excavated sediment was used to construct a new island complex within Grassy Point consisting of two islands that shelter a portion of the restored wetland from excessive wind and wave energy. The inlet from Keene Creek was stabilized with grade control structures following the removal of wood waste.
2. ***What project plans or project decision details are available? Who retains these plans?***
   An engineering construction plan set along with a design memo was developed for the project along with a Quality Assurance Project Plan (QAPP) and a long-term monitoring and maintenance plan. A health impact assessment was completed for the proposed project to evaluate potential public health implications of the restoration project both during and following construction. The Minnesota Department of Natural Resources – Lake Superior and St. Louis River Program retains copies of the project documentation.
3. ***What are the stated goals of the project? List quantifiable measures of success if identified?***
   The project had three goals:
   - Restore coastal marsh habitat by removing legacy sawmill wood waste to establish desired bathymetry.

- Improve the wetland substrate to establish native aquatic vegetation and benthic macroinvertebrate habitat.
- Create a shallow sheltered bay complex using excavated sawmill wood waste material to construct islands that support native terrestrial vegetation.

Specific measures of project success include:

- Approximately 130,000 cubic yards of wood waste and sediment removed.
- 17 acres of terrestrial habitat (islands) created.
- 106 acres of coastal wetland habitat restored.
- 1 acre of deep, off-channel fish habitat created.

4. What are the desired outcomes of achieving the stated goals?

The desired outcome was the removal of a legacy impairment, wood waste, that was negatively impacting both wetland bathymetry and substrate quality. Removing wood waste resulted in improved substrate, aquatic plant re-establishment, increased circulation and water flow through the wetland complex with an improved connection with the St. Louis River. Sediment from another project within the St. Louis River AOC was beneficially re-used as biomedium to enhance the substrate and accelerate the aquatic plant community recovery. Aquatic habitat was improved or created, including deep off-channel fish habitat and two new islands. Recreational access for small boats was improved.

5. ***Are plans available?*** **Yes** ***Have project maps been created?*** **Yes**

If yes, provide relevant examples in "site maps" and list maps provided:

Grassy Point/Kingsbury Bay Restoration, Minnesota DNR, Duluth, MN – Developed by Barr Engineering**.**

Pre-project conditions

Proposed contours

As-built contours following completion of the construction project

6. List and briefly describe best management practices, standards, guidelines identified in plans.

Creating an island to act as a wind and wave barrier for the shallow sheltered bay – Many of the shallow sheltered bays in the St. Louis River estuary have a natural land feature that creates a wind and wave break, thus allowing for areas of reduced energy, which is important for aquatic plant growth and provides habitat diversity not found in the main channel of the river.

Increasing water circulation between the main river channel, the sheltered bay, and the inlet stream – Wetlands in this portion of the St. Louis River estuary are strongly influenced by both the river current and the changing elevations of Lake Superior, creating somewhat of a freshwater tidal-like interaction. Increasing the opportunity for water circulation by removing wood waste and sediments encourages the exchange of nutrients and sediments, processes that maintain habitat quality, and connect aquatic organisms to different habitat types.

Beneficial re-use of wood waste and sediments – Material excavated from Grassy Point was used to create two islands within Grassy Point, instead of exporting the material to a disposal site. High-quality, organic sediments were transported to the site from another St. Louis AOC project to act as a biomedium, which accelerated both aquatic and terrestrial restoration efforts. Lower project costs and added value were a result of beneficially re-using material.

Deep water off-channel habitat – Providing deep water habitat off the main St. Louis River channel provides additional habitat diversity to the overall river system.

Stabilizing the inlet at Keene Creek with a grade control – Removing accumulated material at the mouth of Keene Creek was important to provide increased water flow and circulation through Grassy Point, but

altering the channel bed could have resulted in negative impacts such as erosion upstream. Installing a grade control reduces the potential for impacts.

Project Implementation

(Questions for Site Manager and Cooperating Professionals)

7. ***Were alterations made to the plan during project implementation?***
   Yes
   Prior to construction, several rounds of bidding were required to meet the state's contracting requirements and for bids to fit within MNDNR's construction budget. The design and bid documents were scaled down and compartmentalized through alternate bid items through subsequent bid requests to fall within the available budget.
   A stone toe berm was designed and added to the shoreline adjacent to the St. Louis River main channel during the initial construction stages to provide stability and reduce wind and wave erosion on the newly placed material on the island.
   The Grassy Point project occurred simultaneously with the Kingsbury Bay restoration project with material from Kingsbury Bay coming to Grassy Point to be used for top cover on the islands and to enhance substrate quality in open water areas where wood waste removal occurred. The final elevations for the islands at Grassy Point were contingent on the amount of material generated from Kingsbury Bay. Several areas on the larger Grassy Point island were below the proposed elevations due to the final limited amount of material from Kingsbury Bay.
8. ***In what ways did alterations change the project outcome?***
   The alterations had little negative impact on the project outcome. Changing how the project was bid out allowed the project to be contracted and moved forward under the available budget. Breaking construction tasks into alternate items allowed the project to be scaled as changes occurred. During the bidding and construction process, additional funds were obtained that allowed for construction to meet the desired outcomes.
   The stone toe berm was necessary to provide a foundation for long-term stabilization along the shoreline that sees the most wave and wind energy. The amount of shoreline with hard armoring was minimized and will provide a long-term barrier for the sheltered bay.
   Having less material available to build islands in Grassy Point did not significantly reduce the overall island footprint. Final elevations in some areas were below the proposed elevations. In areas designed to be above the high water elevation, a lower final elevation will likely not have an impact overall impact on the plant community that develops due to the relatively small difference (one to three feet). In areas where the final elevation is between the average lake elevation and high water elevation, vegetation may be more characteristic of emergent wetlands, but will add diversity to the habitats on the islands. Establishment by invasive cattails may be an issue in the future in the lower elevation areas, but the implementation of the long-term monitoring and maintenance plan may reduce any potential impact.

Site Assessment

Field Review Date: **8/17/2023**

Field Visit Attendees: Melissa Sjolund – MNDNR, Ben Nicklay – MNDNR, Jeramy Pinkerton – MNDNR.

9. ***Surrounding Landscape Characteristics:***

Grassy Point is located in the lower St. Louis River estuary. It is a shallow sheltered bay adjacent to the main channel of the St. Louis River. The adjacent land use is mixed residential, light commercial and marine industrial mixed with natural areas in the neighborhoods.

10. ***Site Characteristics:***

a. Soil Series:

Native river sediments consisting of sand, muck, and other soft sediments. The two islands were created from sawmill wood waste mechanically removed from the wetland and covered with sediment removed from another St. Louis River AOC project, Kingsbury Bay.

b. Topography:

Water depths throughout Grassy Point range from 2 to 4 feet throughout most of the shallow bay. The deep water off-channel area ranges from 6 to 8 feet deep. The two created islands are relatively flat with maximum elevations approximately 6 feet above the average water surface.

c. Hydrology:

Grassy Point is a sheltered bay on the St. Louis River. Water depth and hydrology are influenced primarily by the elevation and seiche of Lake Superior and the St. Louis River. Keene Creek, a small stream enters the bay to provide additional water flow, especially during storm events.

d. Vegetation: Plant Communities, Dominant Species & Invasives % Cover:

The majority of Grassy Point is open water habitat with limited emergent vegetation throughout. A ring of emergent vegetation is present along the perimeter where shallower water depths are present. As part of the follow-up companion project, the new islands were planted with a mixture of native shrubs and trees along with native seed mixes to provide future habitat for migratory songbirds.

11. ***Is the plan based on current science?*** Yes

Several extensive feasibility and investigative studies were completed prior to the development of the design including geotechnical analysis and conceptual designs. MNDNR formed a Restoration Site Team (RST) compromised of local experts, researchers, stakeholders, and natural resource managers at the start of the conceptual design process to provide input, review, and recommendations to the ultimate design.

12. ***List indicators of project goals at this stage of the project:***

Indicators of project goals include:

- Removal of legacy wood waste from the majority of the proposed areas within Grassy Point.
- Increased and improved water depths throughout the open water portion of Grassy Point.
- The creation of two islands within Grassy Point, which provides enhances the shallow, sheltered bay nature of Grassy Point.

13. ***Does the implementation of the project plan allow for achieving proposed goals?***

Yes. Goals outlined at the start of the project have been achieved. The success of those goals has triggered additional companion projects to further enhance either ecological or recreational components including establishing native vegetation on the newly created islands, creating hemi-marsh habitat in areas within Grassy Point where wood waste was not present. Hemi-marsh habitat is physically connected to restored open water habitats, further increasing water circulation and habitat diversity within Grassy Point. Forested areas outside of the marine construction portion of the project were enhanced through tree removal to thin the canopy and create gaps for plantings that increased tree species and age class diversity.

14. ***Are proposed future steps, including long term management, practical and reasonable?***
    Yes. A long-term management plan for Grassy Point has been developed. MNDNR and stakeholders are developing/have developed management responsibilities for potential issues that have developed.
15. ***What were potential challenges to the project and were there opportunities for improvement? Are corrections or modifications needed to achieve proposed goals?***
    Prior to restoration, Grassy Point was dominated by invasive cattails that developed in shallow areas where wood waste and sediment was present. Cattails were removed in areas where excavation occurred, and the resulting water depths will likely prevent immediate re-colonization. Complete cattail removal was not a goal of the project so there are areas where cattails are present within the site. Remaining cattail stands will provide a source of material for re-colonizing and invading areas within the bay where substrate type and water depth allow. The challenge in the future will be monitor cattail expansion and potentially treat cattails in certain areas to prevent them from reducing water circulation or negatively impacting habitat.
    The opportunities for improvement for the Grassy Point project were limited. The design and implementation did a good job of maximizing efforts to restore two projects simultaneously in the AOC. Subsequent work at Grassy Point was conducted at the conclusion of this project. Large marine construction projects are difficult and complex. Including the companion project work in the scope of the main restoration of Grassy Point would potentially have made the project more complex and reduced the overall impact. The main project set the stage for efficient and effective follow-up companion projects that align with larger AOC and estuary restoration goals.
16. ***Are follow-up assessments by the Restoration Evaluation Program needed? Explain.***
    No. The project is well-supported by stakeholders within the St. Louis River estuary and AOC to be monitored and assessed for continued success. If further action is required, it is anticipated that local stakeholders would identify and initiate action.
17. ***Additional comments on the restoration project.***
    Completing one major restoration project is a difficult task. Completing two projects simultaneously (Grassy Point and Kingsbury Bay) while coordinating activities at Kingsbury Bay that directly impact the final results at Grassy Point is an accomplishment. Adaptive management was a key to the success of the project. Powerlines run through the project area that required a qualified observer to be present when equipment was working near them was an unexpected obstacle that resulted in increased cost and coordination. The project sponsors did a good job navigating the challenges.

Project Evaluation

Projects can be designated as likely to not meet proposed outcomes, minimally meet proposed outcomes, meet proposed outcomes, or exceed proposed outcomes with a low, medium, or high degree of confidence in the determination.

18. ***The project has:***
    Achieved the stated goals.
19. ***The project will:***
    Meet proposed outcomes.
    Confidence of outcome determination:
    High.
20. ***Provide explanation of reason(s) for determination.***

The project met the immediate desired outcomes of restoring bathymetry in the Grassy Point wetland complex and beneficially re-using wood waste and sediment to create islands. The project sponsors adapted to changes and obstacles during construction successfully. With a long-term monitoring and maintenance plan in place along with a group of vested stakeholders, outcomes at Grassy Point appear to set up for continued success, even if continued adaptive management is required.

21. Site Assessor(s) conducting field review:

Mark Pranckus, EOR

Site Maps, Project Plans or Vegetation Tables

Figure 1. Aerial map of pre-construction conditions for Grassy Point in the red box along the right hand side of the map and Kingsbury Bay in the red box along the left hand side of the map. Dredged material from Kingsbury Bay was taken to Grassy Point and used as biomedium to improve aquatic and terrestrial vegetation growth post-restoration.

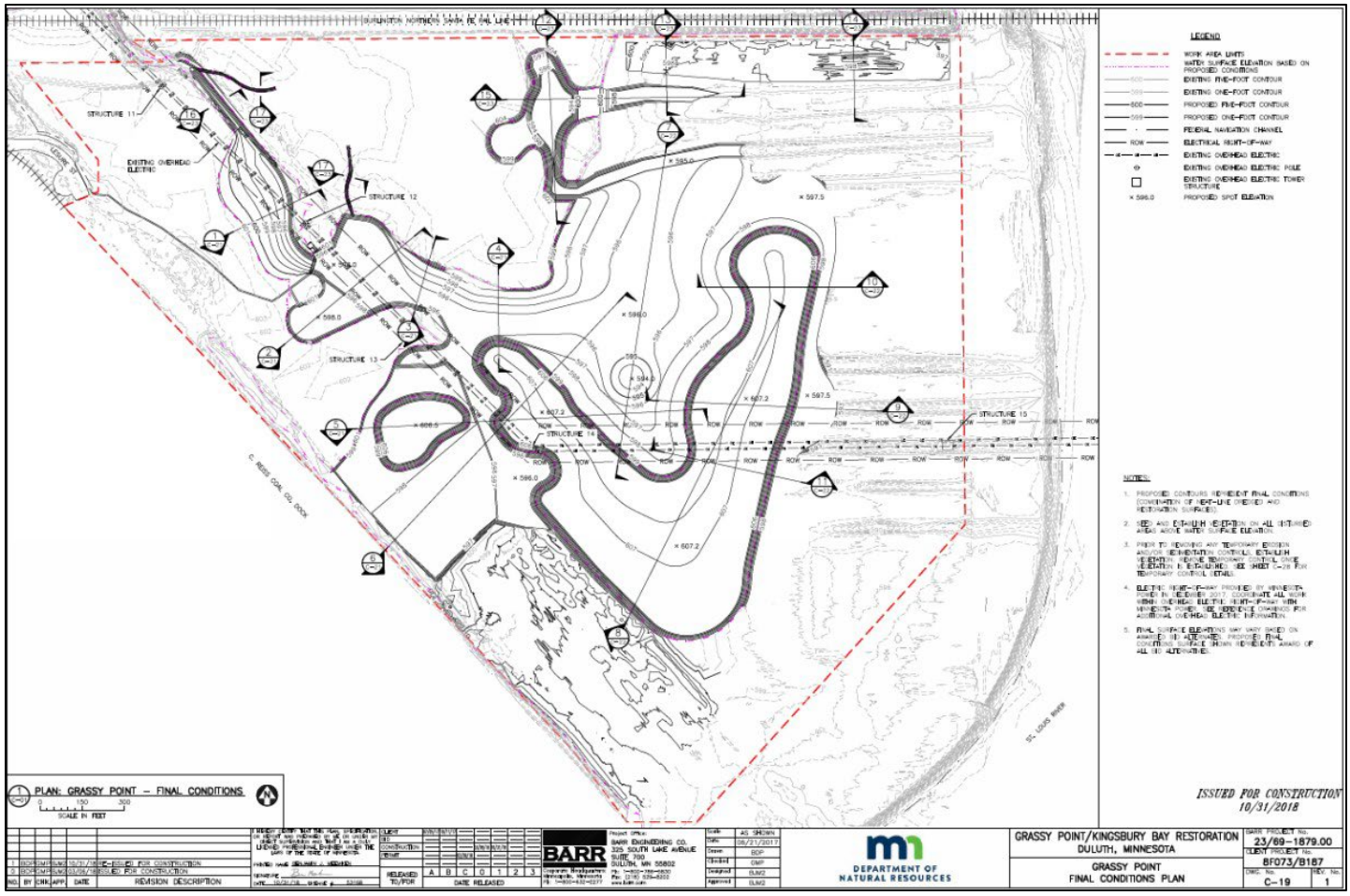


Figure 2. Proposed elevations for Grassy Point for two island creation features and the restoration of bathymetry within the open water portion of the wetland complex.

Figure 3. As-built condition contours for Grassy Point following restoration. (Contours were overlaid on an aerial photo taken from prior to restoration).

Figure 4. Aerial photo sequence of Grassy Point prior to construction (2019), during construction (2020), and following construction (2021). Photo sequence provided by MNDNR Lake Superior and St. Louis River Program.

Site Photographs

Photo 1. Aerial view of vegetation growing on legacy wood waste and sediment in Grassy Point. Photo provided by the Minnesota Lake Superior Coastal Program via MNDNR Lake Superior and St. Louis River Program.

Photo 2. Example of legacy wood waste present in Grassy Point resulting from historic sawmill operations located in the bay disposing material into the wetland. Photo provided by MNDNR Lake Superior and St. Louis River Program.

Photo 3. Aerial view of island construction at Grassy Point. A stone berm was established on the shoreline adjacent to the main St. Louis River channel to reduce erosion and set the perimeter. Photo provided by MNDNR Lake Superior and St. Louis River Program.

Photo 4. Example of wood waste excavated from the portions of Grassy Point that were deepened to restore the open water wetlands to a bathymetry similar to reference conditions being installed to build one of the two islands being created for the project. Photo provided by MNDNR Lake Superior and St. Louis River Program.

Photo 5. Aerial view of operations to place material excavated from Kingsbury Bay as a biomedium within the open water portions of the Grassy Point wetland complex. Photo provided by 1854 Treaty Authority via MNDNR Lake Superior and St. Louis River Program.

Photo 6. Aerial view of the larger Grassy Point island post-restoration in 2021. Photo provided by MNDNR Lake Superior and St. Louis River Program.

Photo 7. Aerial view of the interior of the Grassy Point wetland complex where legacy wood waste was removed to create deeper water depths more similar to historic and reference conditions. The mouth of Keene Creek in the upper right hand corner of the photo was dredged to increase water flow through the wetland. Photo provided by MNDNR Lake Superior and St. Louis River Program.

Photo 8. Example of the shoreline on the larger Grassy Point island that faces the main St. Louis River channel. A stone toe was added during construction to prevent wind and wave erosion. Photo taken by M. Pranckus (EOR) on August 17, 2023.

Photo 9. Example of the shoreline of the larger Grassy Point island that is within the sheltered bay. No stone toe was initially used to prevent wind and wave erosion. Photo taken by M. Pranckus (EOR) on August 17, 2023.

Photo 10. Example of minor shoreline erosion occurring along a portion of the larger Grassy Point island. Minor erosion may be expected as waves crash against a new shoreline that is not hard armored with stone or has existing vegetation. Over time, erosion may result in a bank angle that is stable and balances natural rates of erosion and deposition. Photo taken by M. Pranckus (EOR) on August 17, 2023.

Photo 11. Example of where minor shoreline erosion is occurring on the larger Grassy Point island showing how the island was created using wood waste excavated from the project area and the top layer of biomedium excavated from Kingsbury Bay. Photo taken by M. Pranckus (EOR) on August 17, 2023.

Photo 12. Example of vegetation that was installed on the Grassy Point island following restoration to improve habitat for migratory songbirds. Re-vegetation efforts were not included as a portion of the Grassy Point restoration project, but done as a separate project by a separate sponsor so an assessment of the vegetation was not included in this evaluation. Photo taken by M. Pranckus (EOR) on August 17, 2023.

Photo 13. Example of the open water habitat created by removing legacy wood waste, which reduced water depths and aquatic habitat in the shallow, sheltered bay. Accumulated wood waste, sediments, and invasive cattail vegetation reduced water circulation between the bay, the St. Louis River, and Keene Creek. Photo taken by M. Pranckus (EOR) on August 17, 2023.

2 Interstate Island Avian Habitat Restoration

Project Background

Latitude/Longitude: 15 T 568033 E 5177682 N

Project Manager / Organization: Melissa Sjolund, Minnesota Department of Natural Resources, Gini Breidenbach, Minnesota Land Trust

Fund: OHF

Fiscal Year Funds: 2017, 2018, 2019

Project Start Date: 2020

Project Complete Date: 2021

Predominant Habitat type: Aquatic Habitat

Additional Habitat types: Stream

Project Status: Post Establishment Phase

County: St. Louis

Primary Activity: Stream/River Restoration

Project Size: 8.4 acres

Project Goals and Planning

(Site Assessment Preparation from Plan Sets and Documents)

1. ***What are the specific project components, management actions, or treatments?***
   Interstate Island was expanded through beneficial re-use of dredged material from the St. Louis River to increase overall island size that had been decreasing due to erosion and increase the island elevation to prevent flooding from negatively impacting colonial water bird nesting habitat. Additionally, Common Tern nesting habitat was protected to prevent depredation by gull species that also use the island for nesting. Vegetation plantings occurred post-restoration to enhance water bird nesting habitat.
2. ***What project plans or project decision details are available? Who retains these plans?***
   Engineering construction plan set along with a design memo were developed for the project. A monitoring and maintenance plan for post-restoration was also developed to guide future management. The Minnesota Department of Natural Resources – Lake Superior and St. Louis River Program retains copies of the project documentation.
3. ***What are the stated goals of the project? List quantifiable measures of success if identified?***
   The project was to restore and protect critical nesting habitat for Common Term and stopover habitat for Piping Plover. Specific measures of project success include:
   - 6.7 acres of colonial water bird nesting habitat restored or enhanced above the high water design elevation of 605.5 feet above sea level.
   - 8.4 acres of habitat restored or enhanced above the Ordinary High Water Line elevation of 602.8 feet above sea level.

- 2,934 feet of natural shoreline restored or enhanced above the Ordinary High Water Line.
- 52,624 cubic yards of dredged materials beneficially re-used.

4. What are the desired outcomes of achieving the stated goals?

The desired outcome was to ensure that at least 5.5 acres of colonial water bird nesting habitat was protected by raising a portion of the elevation of Interstate Island to elevations above high water levels. Gull exclusion fencing was replaced to further the probability of Common Tern nesting success.

5. ***Are plans available?*** **Yes** ***Have project maps been created?*** **Yes**

If yes, provide relevant examples in "site maps" and list maps provided:

Interstate Island topography prior to restoration
Plan view of the conceptual design in 2019
Plan view and site layout for spring 2020 construction
Plan view and site layout for fall 2020 construction

6. List and briefly describe best management practices, standards, guidelines identified in plans.

Gull exclusion fencing – Gull species that also use the island for nesting have a negative impact on the nesting success of Common Tern. Installing fencing structures along with posts and string to deter gulls is an important component. Adding rock piles and berms as additional cover within the Common Tern nesting provides the type of habitat needed for this species.

Rock berms and driftwood for erosion control – The purpose of the project was to increase the available nesting habitat for Common Tern. The island is located on the main channel of the St. Louis River estuary near the inlet into Lake Superior. The area is wind-swept with wave energy due to the wide-open nature of the estuary at that point along with the erosive power of the river. Suitable nesting habitat for Common Tern includes sandy substrate relatively free of vegetation. Using rock berms and driftwood to break wind and wave energy is an appropriate approach to reducing erosion that causes loss of island elevation and size, while allowing the shoreline to be shaped by dynamic processes.

Shorebird habitat planting – A follow-up companion project after the restoration Interstate Island's size and elevations was completing some planting in discrete areas to provide habitat for other migratory shorebirds and waterbirds such as Piping Plover. The addition of planting areas on the island was the result of continued engagement with technical stakeholders in the area and discussing what could be done on the island for additional species. For example, Piping Plover use the island during migration as stopover habitat after Common Terns have left the island. Having areas of short, herbaceous vegetation with reduced predation risks provides birds important habitat that can be limited in this area of their migration route.

Using modeling to inform project design – Project designs were based on hydrodynamic and sediment transport modeling conducted by the US Army Corps of Engineers (USACE). Final design slopes were designed to be steeper, and the footprint of the island was wider with the anticipation that the slopes would naturally erode and come to a dynamic equilibrium where areas of the island were eroding or building due to erosion and deposition at relatively equal rates.

Using Lake Superior water levels that reflect future unpredictability – The design used a reference elevation of 605.5 IGLD85, which reflects an additional foot above the highest historic water elevation for Lake Superior. Using a conservative design elevation increases island protection and resiliency under future Lake Superior conditions including storm surges and elevated water levels. It also provides that Common Tern nesting habitat stays dry, which is a biological component, and allows for future management to be above the regulated ordinary high water elevation, making regulatory approval simpler, if needed.

Project Implementation

(Questions for Site Manager and Cooperating Professionals)

7. ***Were alterations made to the plan during project implementation?***
   Yes
   Material to re-build the island came from routine and strategic dredging by the USACE to maintain the navigational channels within the Duluth-Superior Harbor. The project had a minimum goal of providing at least 5.5 acres of area for Common Tern nesting habitat. Due to the nature of dredging operations, the project sponsors had to commit to accepting more suitable material than needed, if additional dredging was required to meet navigational channel goals. In other words, USACE was willing to provide suitable material to increase the size of the island, but navigational maintenance goals also had to be met as part of providing source material.
8. ***In what ways did alterations change the project outcome?***
   The goal of creating at least 5.5 acres of Common Tern nesting habitat was exceeded by 1.2 acres on Interstate Island due to meeting the USACE's navigational goals. Committing to accepting material from the USACE required an adaptive management approach and understanding the decision making processes by other stakeholders involved in the project.

Site Assessment

Field Review Date: **8/17/2023**

Field Visit Attendees: Melissa Sjolund – MNDNR, Ben Nicklay – MNDNR, Jeramy Pinkerton – MNDNR, Gine Breidenbach, Minnesota Land Trust.

9. ***Surrounding Landscape Characteristics:***
   Interstate Island is an artificial island created in the St. Louis River from dredged materials in the mid-1930s. Originally nearly 33 acres in size, it has decreased due to sand fill mining in the 1960s and wind and wave erosion over time. The island is located in the middle of the St. Louis River estuary positioned between the cities of Duluth and Superior, Wisconsin within the actively industrial working Twin Ports Harbor.
10. ***Site Characteristics:***
    a. ***Soil Series:***
    Primarily sand excavated from the St. Louis River Harbor.
    b. ***Topography:***
    The island is relatively flat. Elevation ranges from 602 ft (IGLD) to 608 ft (IGLD).
    c. ***Hydrology:***
    The small island is directly influenced by the water level of Lake Superior. The majority of the island is considered upland because it is above elevation 602.8 ft (IGLD).
    d. ***Vegetation: Plant Communities, Dominant Species & Invasives % Cover:***
    Over 95 percent of the island is considered bare to sparse vegetation currently. The exclosure for Common Tern nesting was sparsely vegetated, primarily with annual, weedy species that developed after the Common Tern nesting season. Vegetation will be removed within the exclosure prior to the following nesting season to provide the appropriate habitat. Areas on the island within the State of

Minnesota were primarily barren, sand and gravel shoreline. A portion of the island in Wisconsin was planted with herbaceous vegetation using separate (non-Minnesota funds), but was still sparsely vegetated due to sandy nature of the soils.

11. ***Is the plan based on current science?*** Yes

    The physical design of the island restoration was based on complex hydrodynamic and sediment transport modeling along with an understanding of historic and future Lake Superior water levels. Rock berms, rock piles, and driftwood were used as physical barriers to encourage deposition within the dynamic island setting.

    Habitat elements for Common Tern, Piping Plover, and other migratory shorebirds was based on regional expertise in identifying critical needs and applying restoration in an adaptive management manner.

    A monitoring and maintenance plan is in place with identified funding mechanisms by the US Fish and Wildlife Service to ensure long-term success of the project.

12. ***List indicators of project goals at this stage of the project:***

    The area of Common Tern nesting habitat was exceeded by 1.2 acres or 22%.

    Gull exclusion fencing structures are in place and functioning properly.

    Companion projects such as additional planting outside of the core Common Tern nesting area have been completed to benefit Piping Plover and other migratory shorebirds.

13. ***Does the implementation of the project plan allow for achieving proposed goals?***

    Yes. The project has increased the available nesting habitat for Common Tern and increased stopover habitat for Piping Plover and other shorebirds. The island is located in the dynamic setting of the St. Louis River estuary and Lake Superior. The design incorporates elements that acknowledge that the shoreline will be dynamic and long-term sustainability comes from an equilibrium between erosion and deposition.

14. ***Are proposed future steps, including long term management, practical and reasonable?***

    Yes. There is a monitoring and maintenance plan in place with management funding identified by the US Fish and Wildlife Service. The area is high priority for both resource managers in Minnesota, Wisconsin, the federal government, and local technical experts.

15. ***What were potential challenges to the project and were there opportunities for improvement? Are corrections or modifications needed to achieve proposed goals?***

    Project implementation was scheduled to start in spring 2020 prior to the COVID pandemic and the resulting stay-at-home orders and guidelines. The first phase of the project was constructed in spring 2020 as project sponsors, supporting consultants, and selected contractors had to navigate changing and uncertain health and safety protocols and uncertainty related to whether work would be authorized to proceed. Overcoming initial challenges related to the onset procedures associated with the pandemic were a success.

    The island lies on the state line between Minnesota and Wisconsin. A challenge was thinking about the island holistically, but delineating where and how funds were spent between the two states. Additionally, each state along with federal agencies such as the USACE and US Fish and Wildlife had separate processes and priorities. It was a challenge to manage multiple interests.

    Having a clear line delineated in the field was important to ensure that funds dedicated for Minnesota were implemented in Minnesota. Reference points in the field were identified and used by field staff during implementation.

16. ***Are follow-up assessments by the Restoration Evaluation Program needed? Explain.***

No. The project is well-supported by stakeholders within the St. Louis River estuary and AOC to be monitored and assessed for continued success. If further action would be required, it is anticipated that local stakeholders would identify and initiate action.

17. ***Additional comments on the restoration project.***
    The design to increase Common Tern nesting habitat and improve migratory shorebird stopover habitat is relatively simple. The implementation was complex because it required bringing multiple stakeholders with shared interests in the project together, but each stakeholder had their own respective process or priority. The project stakeholders did an amazing job of navigating difficulties caused by a global pandemic, project uncertainty, and the moving parts of different project partners.

Project Evaluation

Projects can be designated as likely to not meet proposed outcomes, minimally meet proposed outcomes, meet proposed outcomes, or exceed proposed outcomes with a low, medium, or high degree of confidence in the determination.

18. ***The project has:***
    Exceeded the stated goals.
19. ***The project will:***
    Meet proposed outcomes.
    Confidence of outcome determination:
    High.
20. ***Provide explanation of reason(s) for determination.***
    The project met the immediate desired outcome of protecting at least 5.5 acres of Common Tern nesting habitat above the OHWL of 602.8 ft (IGLD85) and installing gull exclusion fencing to replace existing fencing that was in place. The long-term success of the project will come from a combination of the design elements such as rock berms and driftwood and continued attention by multiple stakeholders to make sure the island that is critical for Common Tern, Piping Plover, and other migratory shorebirds continues into the future.
21. ***Site Assessor(s) conducting field review:***

    Mark Pranckus, EOR

Site Maps, Project Plans or Vegetation Tables

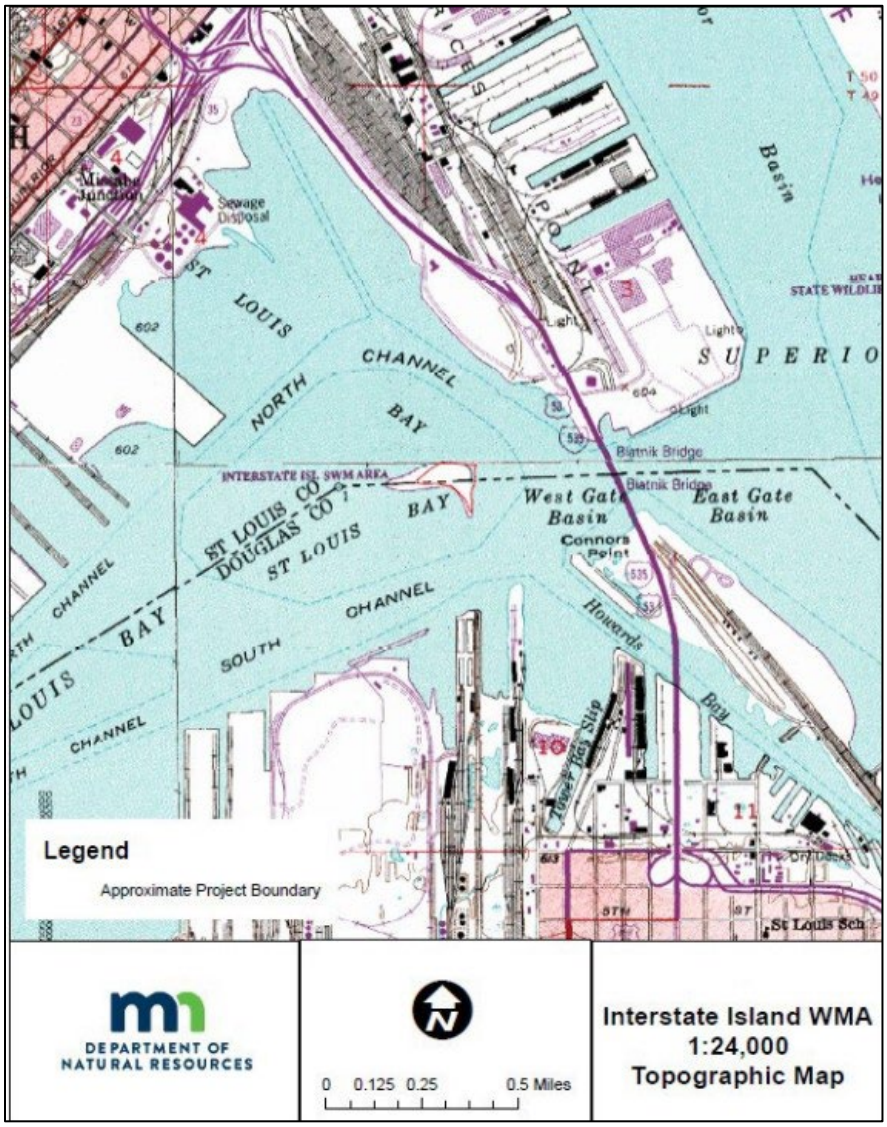


Figure 5. Topographic map showing the location of Interstate Island as being positioned directly on the state line between Minnesota and Wisconsin.

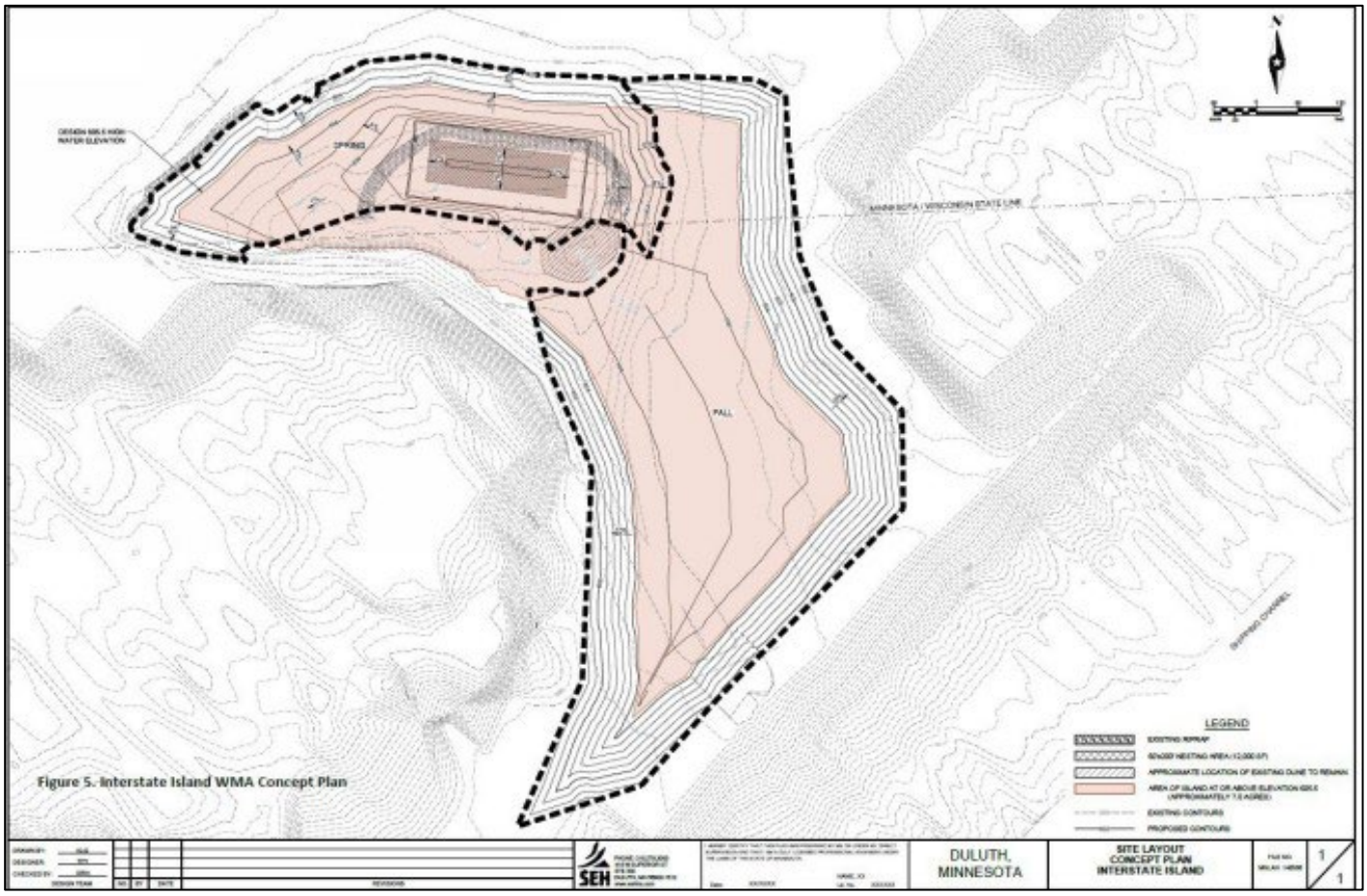


Figure 6. Proposed conceptual design conditions for Interstate Island restoration.

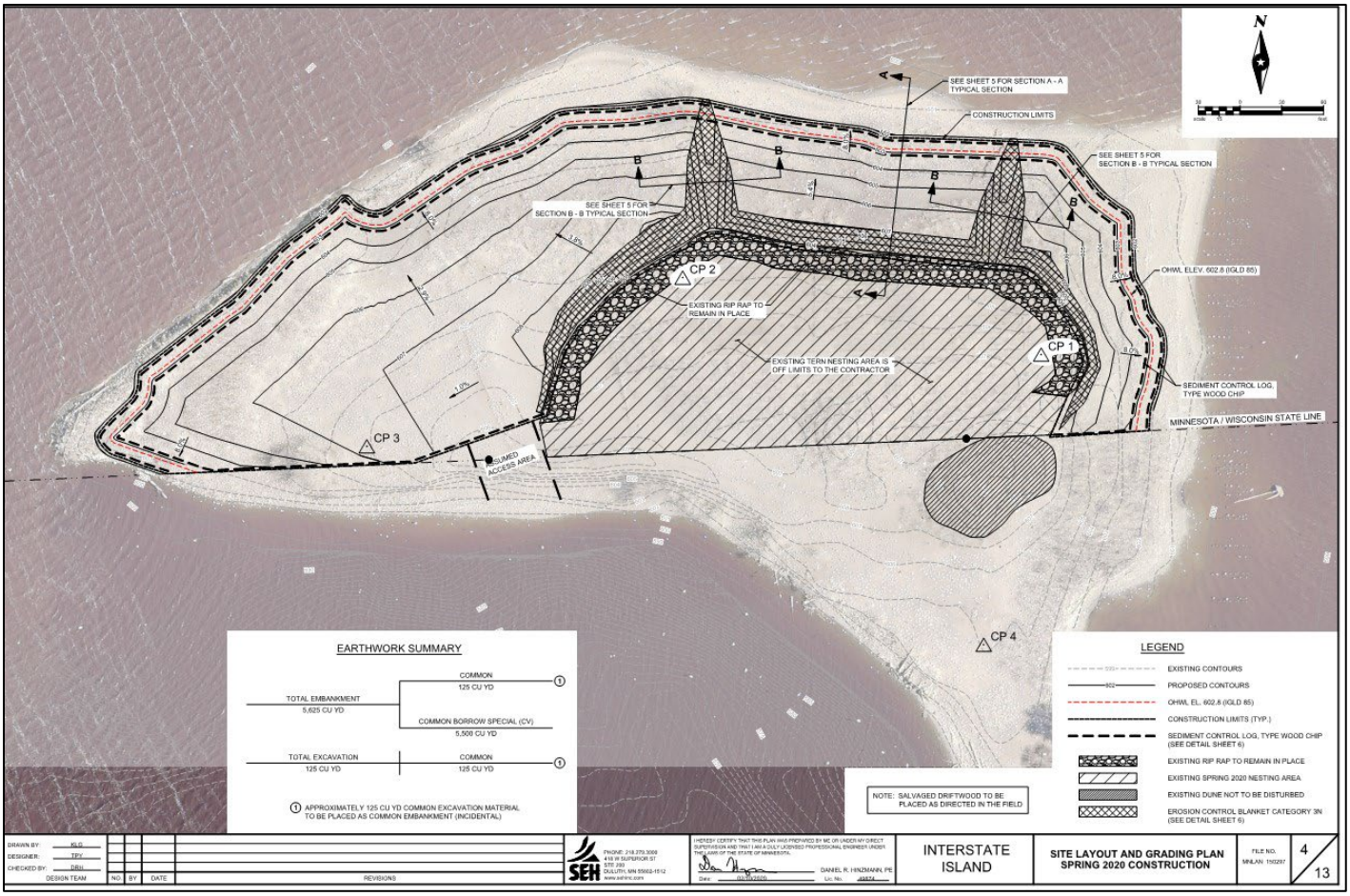


Figure 7. Proposed final design conditions for Interstate Island restoration. Features include expanding the island size and using rip rap and erosion control blanket to minimize and reduce erosion from wind energy.

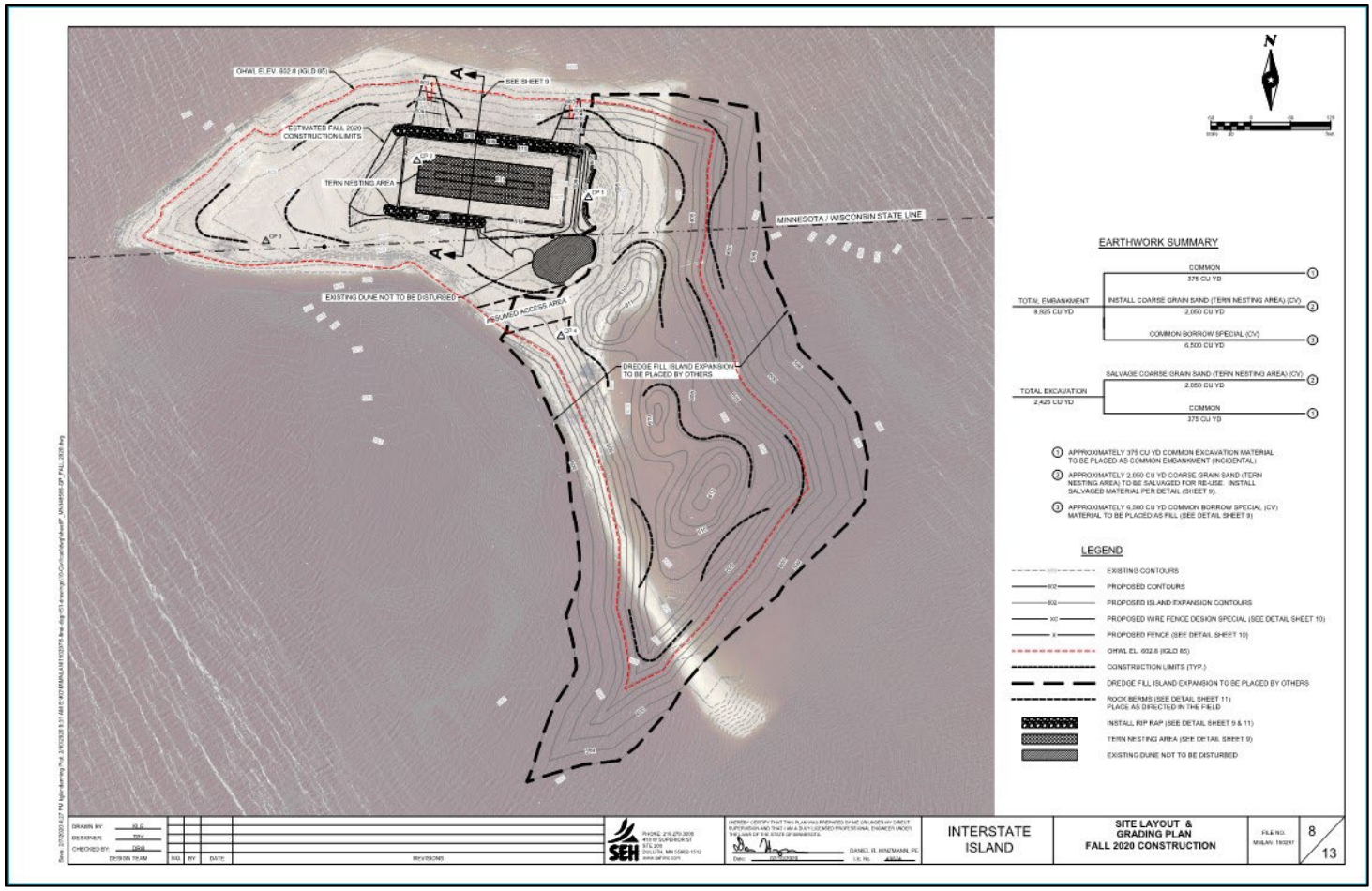


Figure 8. Proposed final design plan for Interstate Island restoration showing features designed to promote nesting for Common Terns.

Site Photographs

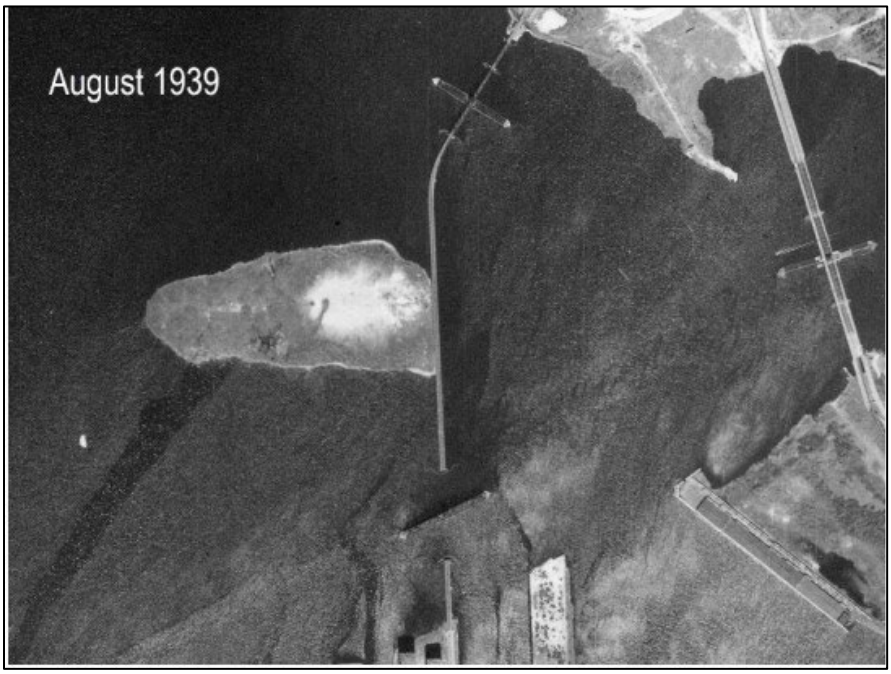


Photo 14. Aerial photo from 1939 showing the early footprint of Interstate Island after it was created and before sanding mining activities in the 1960s and wind and wave erosion reduced its overall size.

Photo 15. Aerial photo from 2019 showing the footprint of Interstate Island prior to design and construction. Previous efforts had occurred to stabilize the island size for migratory birds.

Photo 16. Aerial photo from 2021 following completion of construction at Interstate Island. Photo is from the Minnesota side of the island looking towards Superior, Wisconsin. Photo provided by JF Brennan via Minnesota Land Trust.

Photo 17. Aerial view looking down on Interstate Island after construction of fencing structures installed to provide nesting habitat for Common Terns where nest and chick predation by gulls would be reduced. Photo provided by SEH via Minnesota Land Trust.

Photo 18. Looking at the nesting fence structures intended to reduce predation by gulls on Common Tern nests. String and posts along with fencing discourage gulls from landing. Vegetation is removed on an annual basis within the nesting areas to meet Common Tern nesting requirements. Photo provided by M. Pranckus (EOR) 8/17/2023.

Photo 19. Looking the nesting fence structure along with a rip rap berm intended to reduce wind erosion on Interstate Island. Photo provided by M. Pranckus (EOR) 8/17/2023.

Photo 20. Looking at the shoreline of a restored Interstate Island. Driftwood and a rock berm are structures used to reduce wind and wave erosion and provide habitat for shorebirds. Photo provided by M. Pranckus (EOR) 8/17/2023.

Photo 21. Example of habitat within fence nesting structure for Common Tern on Interstate Island. Common Tern need nearly bare soil for nesting. Posts and strings discourage gulls from landing within the nesting areas. Photo provided by Fred Strand via Minnesota Land Trust.

Photo 22. Example of the sandy and rocky shoreline following restoration of Interstate Island. Driftwood was intentionally and randomly placed to provide habitat for migratory shorebirds and reduce wind and wave erosion. Photo provided by M. Pranckus (EOR) 8/17/2023.

Photo 23. Example of posts installed outside of the nesting fence structures. As part of a post-restoration adaptive management strategy plant plugs were installed to enhance migratory shorebird habitat for Piping Plover. Posts are intended to reduce gull nest predation and Canada Goose herbivory. Photo provided by M. Pranckus (EOR) 8/17/2023.

Legacy Fund Restoration Evaluations

Kingsbury Bay Restoration

Project Background

Latitude/Longitude: 15 T 568033 E 5177682 N

Project Manager / Organization: Melissa Sjolund, Minnesota Department of Natural Resources

Fund: OHF

Fiscal Year Funds: 2014, 2016, 2017

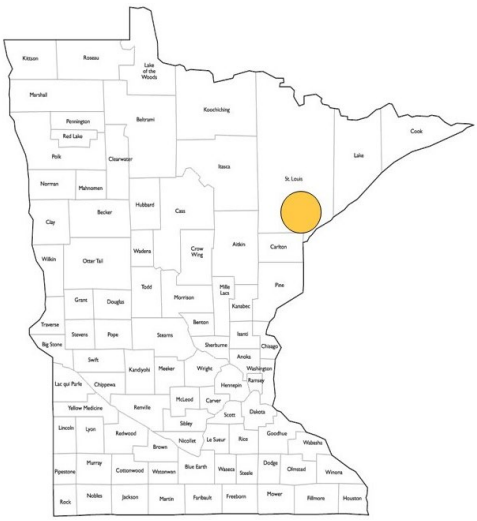
Project Start Date: 2017

Project Complete Date: 2021

Predominant Habitat type: Aquatic Habitat

Additional Habitat types: Stream

Project Status: Post Establishment Phase



County: St. Louis

Primary Activity: Stream/River Restoration

Project Size: 77 acres

Project Goals and Planning

(Site Assessment Preparation from Plan Sets and Documents)

1. ***What are the specific project components, management actions, or treatments?***
   Excessive sediments and invasive narrow-leaved cattail vegetation was mechanically removed from Kingsbury Bay to restore the bay bathymetry to a condition similar to pre-1961. A portion of the dredged material was beneficially re-used on two other restoration projects within the St. Louis River Area of Concern (AOC).
2. ***What project plans or project decision details are available? Who retains these plans?***
   An engineering construction plan set along with a design memo was developed for the project along with a Quality Assurance Project Plan (QAPP) and a long-term monitoring and maintenance plan. The Minnesota Department of Natural Resources – Lake Superior and St. Louis River Program retains copies of the project documentation.

3. ***What are the stated goals of the project? List quantifiable measures of success if identified?***
   The project goals were to remove excess sediments and vegetation from the Kingsbury Bay to create more open water habitat with variable depths and to use high-quality, organic sediment excavated from Kingsbury Bay at two other sites within the AOC to promote restoration of benthic aquatic plants and invertebrates.
   Specific measures of project success include:
   - Approximately 126,000 cubic yards of sediment removed.
   - 12 acres of exotic vegetation mechanically removed.
   - 77 acres of coastal wetland habitat restored.
   - 3 acres of deep, off-channel fish habitat created.
4. ***What are the desired outcomes of achieving the stated goals?***
   The desired outcome was to increase the amount of open water habitat at Kingsbury Bay to a depth that prevented re-colonization by invasive wetland vegetation and promoted the re-establishment of native submerged and emergent aquatic vegetation, including wild rice. The restored bathymetry would increase water flow and circulation within the bay. Deep water off-channel habitat would be improved along with recreational access. High quality sediments generated from restoration at Kingsbury Bay will be used to accelerate restoration at other sites within the AOC.
5. ***Are plans available?*** **Yes** ***Have project maps been created?*** **Yes**
   If yes, provide relevant examples in "site maps" and list maps provided:
   Grassy Point/Kingsbury Bay Restoration, Minnesota DNR, Duluth, MN – Developed by Barr Engineering**.**
   Pre-project conditions
   Proposed contours
   As-built contours following completion of the construction project

6. ***List and briefly describe best management practices, standards, guidelines identified in plans.***
   Removal and disposal of invasive aquatic vegetation – Narrow-leaved cattail was removed and disposed of at an upland facility to prevent further spread within the St. Louis AOC.
   Beneficial re-use of sediments – High-quality, organic sediments were transported to two other project locations within the St. Louis River AOC, which resulted in lower project costs and added value because restoration at the other sites was accelerated.
   Deep water off-channel habitat – Providing deep water habitat off the main St. Louis River channel provides additional habitat diversity to the overall river system.

Project Implementation

(Questions for Site Manager and Cooperating Professionals)

7. ***Were alterations made to the plan during project implementation?***
   Yes
   Prior to construction, several rounds of bidding were required to meet the state's contracting requirements and for bids to fit within MNDNR's construction budget. The design and bid documents were scaled down and compartmentalized through alternate bid items through subsequent bid requests to fall within the available budget.

The Kingsbury Bay project occurred simultaneously with the Grassy Point restoration project with material from Kingsbury Bay going to Grassy Point to be used for top cover on the islands and to enhance substrate quality in open water areas where wood waste removal occurred. Sediment removal quantities at Kingsbury Bay were below estimated quantities for removal, which resulted in not as much material being available for Grassy Point. Meeting the design contours for Kingsbury Bay was the priority and that objective was achieved. Additional sediment removal to meet the needs of Grassy Point would have caused additional expense with limited benefit to Kingsbury Bay.
The deep water habitat location was adjusted in the field to be moved closer to an existing public fishing pier to allow anglers to benefit from additional habitat features that may attract fish.

8. ***In what ways did alterations change the project outcome?***
The alterations had little negative impact on the project outcome. Changing how the project was bid out allowed the project to be contracted and moved forward under the available budget. Breaking construction tasks into alternate items allowed the project to be scaled as changes occurred. Desired depths and amount of sediment were removed from Kingsbury Bay. Having less sediment available for island creation at Grassy Point did not significantly impact that project's outcome. Moving the deep water habitat location does not impact the ecological function of the deep water habitat because it is still located in a sheltered area off the main channel and provides fish refuge to rest out of the current or seek deeper water in the shallow bays during winter periods. Re-locating the deep water habitat closer to the public access pier did improve angler access. Anecdotal reports indicate anglers are catching walleye and freshwater drum on a regular basis, which can encourage public support for similar types of projects in the future.

Site Assessment

Field Review Date: **8/17/2023**

Field Visit Attendees: Melissa Sjolund – MNDNR, Ben Nicklay – MNDNR, Jeramy Pinkerton – MNDNR.

9. ***Surrounding Landscape Characteristics:***
Kingsbury Bay is located in the lower St. Louis River estuary. It is a shallow sheltered bay adjacent to the main channel of the St. Louis River. The adjacent land use is mixed residential, light commercial and industrial mixed with natural areas in the neighborhoods and along the bluff slopes.

10. ***Site Characteristics:***
    a. ***Soil Series:***
    Native river sediments consisting of sand, muck, and other soft sediments.
    b. ***Topography:***
    Water depths throughout Kingsbury Bay range from 2 to 4 feet throughout most of the shallow bay. The deep water off-channel area ranges from 6 to 8 feet deep.
    c. ***Hydrology:***
    Kingsbury Bay is a sheltered bay on the St. Louis River. Water depth and hydrology is influenced primarily by the elevation and seiche of Lake Superior and the St. Louis River. Kingsbury Creek, a small stream enters the bay and deposited the sediment that was removed during restoration.
    d. ***Vegetation: Plant Communities, Dominant Species & Invasives % Cover:***

The majority of Kingsbury Bay is open water habitat with limited emergent vegetation throughout. A ring of emergent vegetation is present along the perimeter where shallower water depths are present. As part of the companion project, wild rice is being re-established in the bay following restoration.

11. ***Is the plan based on current science?*** Yes
    Several extensive feasibility and investigative studies were completed prior to the development of the design including geotechnical analysis and conceptual designs.
12. ***List indicators of project goals at this stage of the project: Yes***
    Indicators of project goals include:
    - An extensive cattail marsh has been covered to open water shallow sheltered bay habitat.
    - Increased and improved water depths throughout the open water portion of Kingsbury Bay.
    - Creation of a deep water habitat area that is accessible to shore-based anglers, resulting in increased recreational opportunities.
    - Conditions adequate for companion and follow-up projects to begin that further improve the ecological and recreational resources of Kingsbury Bay.
13. ***Does the implementation of the project plan allow for achieving proposed goals?***
    Yes. Goals outlined at the start of the project have been achieved. The success of those goals haas triggered additional companion projects to further enhance either ecological or recreational components including wild rice seeding, a new public fishing pier, interpretative signage, and wayfinding benches.
14. ***Are proposed future steps, including long term management, practical and reasonable?***
    Yes. A long-term management plan for Kingsbury Bay has been developed. MNDNR and stakeholders are developing/have developed management responsibilities for potential issues that have developed. MNDNR and other stakeholders have also begun the process of addressing sediment sources within the Kingsbury Creek watershed to reduce sediment loading into the restored bay.
15. ***What were potential challenges to the project and were there opportunities for improvement? Are corrections or modifications needed to achieve proposed goals?***
    Kingsbury Bay is located adjacent to a campground. During construction, every effort was made to avoid conflicts resulting from noise, equipment, and increased traffic, with the public and campground users. The selected contractor was open to modifying their means and methods, as much as possible, and also provided monitoring equipment to verify noise level estimates.
    Prior to restoration, Kingsbury Bay was dominated by invasive cattails that developed in shallow areas where sediment was present. Cattails were removed in areas where excavation occurred, and the resulting water depths will likely prevent immediate re-colonization. Complete cattail removal was not a goal of the project so there are areas where cattails are present within the site. Remaining cattail stands will provide a source of material for re-colonizing and invading areas within the bay where substrate type and water depth allow. The challenge in the future will be monitor cattail expansion and potentially treat cattails in certain areas to prevent them from reducing water circulation or negatively impacting habitat.
    The opportunities for improvement for the Kingsbury Bay project were limited. The design and implementation did a good job of maximizing efforts to restore two projects simultaneously in the AOC. The Kingsbury Bay project focused on addressing the major impairments within the bay and set the stage for additional companion projects to occur at the conclusion of the main project. Large marine construction projects are difficult and complex. Including the companion work in the scope of the main

restoration of Kingsbury Bay would potentially have made the project more complex and reduced the overall impact.

16. ***Are follow-up assessments by the Restoration Evaluation Program needed? Explain.***
    No. The project is well-supported by stakeholders within the St. Louis River estuary and AOC to be monitored and assessed for continued success. If further action is required, it is anticipated that local stakeholders would identify and initiate action.
17. ***Additional comments on the restoration project.***
    Completing one major restoration project is a difficult task. Completing two projects simultaneously (Kingsbury Bay and Grassy Point) while coordinating activities at Kingsbury Bay that directly impact the final results at Grassy Point is an accomplishment. Adaptive management was a key to the success of the project. Construction took place over three construction seasons and was broken into three phases, which helped to keep the work manageable and use lessons learned the previous year into making the next year more efficient and effective.

Project Evaluation

Projects can be designated as likely to not meet proposed outcomes, minimally meet proposed outcomes, meet proposed outcomes, or exceed proposed outcomes with a low, medium, or high degree of confidence in the determination.

18. ***The project has:***
    Achieved the stated goals.
19. ***The project will:***
    Meet proposed outcomes.
    Confidence of outcome determination:
    High.
20. ***Provide explanation of reason(s) for determination.***
    The project met the immediate desired outcomes of restoring bathymetry in Kingsbury Bay to historic conditions and beneficially re-using sediment to create islands at another project site within the estuary. The project sponsors adapted to changes and obstacles during construction successfully. With a long-term monitoring and maintenance plan in place along with a group of vested stakeholders, outcomes at Kingsbury Bay appear to set up for continued success, even if continued adaptive management is required.

21. ***Site Assessor(s) conducting field review:***

    Mark Pranckus, EOR

Site Maps, Project Plans or Vegetation Tables

Figure 9. Aerial map of pre-construction conditions for Kingsbury Bay in the red box along the left hand side of the map and Grassy Point in the red box along the right hand side of the map. Dredged material from Kingsbury Bay was taken to Grassy Point and used as biomedium to improve aquatic and terrestrial vegetation growth post-restoration.

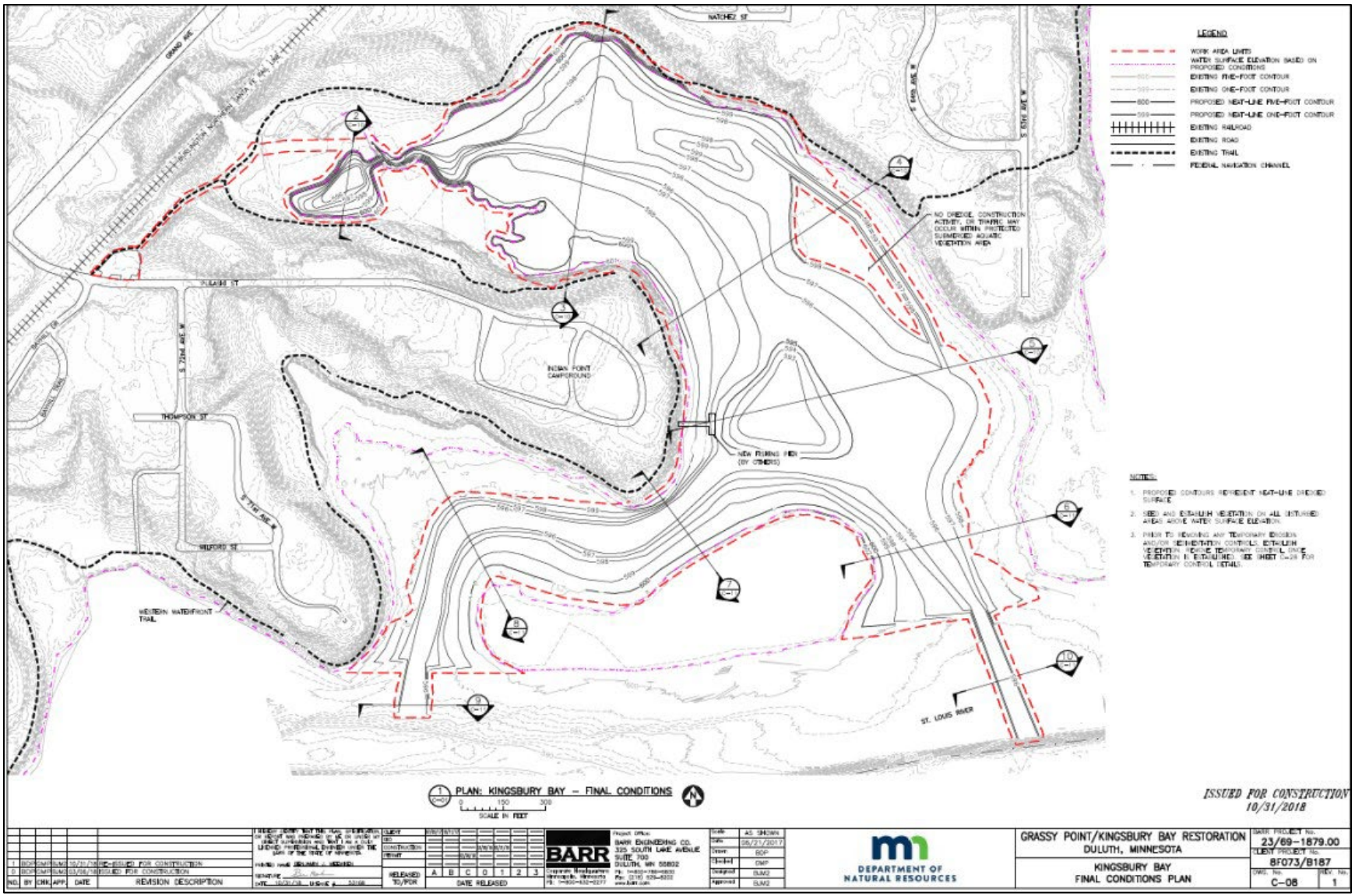


Figure 10. Proposed elevations for Kingsbury Bay to restore bathymetry (water depths) to a historical condition.

Figure 11. As-built condition contours for Kingsbury Bay following restoration. (Contours were overlaid on an aerial photo taken from prior to restoration)

Site Photographs

Photo 24 Aerial view of Kingsbury Bay prior to removal of sediments and accumulated cattail vegetation. Photo provided by 1854 Treaty Authority via MNDNR Lake Superior and St. Louis River Program.

Photo 25. Aerial view of Kingsbury Bay following removal of sediments and accumulated cattail vegetation. Photo provided by 1854 Treaty Authority via MNDNR Lake Superior and St. Louis River Program.

Photo 26. Example of excavation activities to removal cattail vegetation for off-site disposal at Kingsbury Bay. Photo provided by MNDNR Lake Superior and St. Louis River Program.

Photo 27. Example of excavation activities to removal accumulated sediment following cattail vegetation removal at Kingsbury Bay. Material was loaded in a barge and deposited at the Grassy Point restoration site on the St. Louis River. Photo provided by MNDNR Lake Superior and St. Louis River Program.

Photo 28. Example of the open water sheltered bay habitat created by the restoration project. A monoculture of cattails would have been present in this view prior to construction. Photo taken by M. Pranckus (E0R) on August 17, 2023.

Photo 29. Example of the open water sheltered bay habitat created by the restoration project and the follow-up companion project to establish wild rice along the periphery of the bay. Wild rice is seeded in cages in the orange fence. Photo taken by M. Pranckus (EOR) on August 17, 2023.

Photo 30. Example of wild rice seeding that is occurring along the periphery of Kingsbury Bay following removal of cattails and accumulated sediment. Wild rice is seeded annually and protected from herbivory by Canada geese until the rice has seeded out. Wild rice seeding is a follow-up companion project facilitated by completing the overall removal of vegetation and sediments in Kingsbury Bay. Photo taken by M. Pranckus (EOR) on August 17, 2023.

Photo 31. An existing public access fishing pier was present along the Kingsbury Bay project boundary. A planned deep water habitat feature was re-located during construction to be closer to the pier so anglers could be easily benefit from habitat restoration efforts associated with the project. Photo taken by M. Pranckus (EOR) on August 17, 2023.

3 Perch Lake Habitat Restoration Project

Project Background

Latitude/Longitude: 46.66024, -92.2535472

Project Manager / Organization: Daryl Peterson, Minnesota Land Trust

Fund: OHF

Fiscal Year Funds: 2017, 2018, 2019, 2022

Project Start Date: 2018

Project Complete Date: 2023

Predominant Habitat type: Aquatic Habitat

Additional Habitat types: Wetland

Project Status: Establishment Phase

County: St. Louis

Primary Activity: Wetland Restoration

Project Size: 22 acres

Project Goals and Planning

(Site Assessment Preparation from Plan Sets and Documents)

1. ***What are the specific project components, management actions, or treatments?***
   Excessive sediments were mechanically removed from Perch Lake and an adjacent ditch between Perch Lake and the St. Louis River to improve fish habitat. Sediment removal included creating areas of deep water habitat, coastal marsh, and hemi-marsh. Spawning gravel was added in select areas where sediment removal occurred to further improve habitat. To improve the hydrologic and hydraulic connection with the St. Louis River, a new culvert underneath a state highway and recreation trail will be installed. The culvert will allow for improved fish and aquatic organism passage, as well as increase water circulation and exchange with the St. Louis River.
2. ***What project plans or project decision details are available? Who retains these plans?***
   Engineering construction plan sets for both the sediment removal phase of the project and the culvert installation phase of the project along with a supporting design memo for the sediment removal phase. The Minnesota Department of Natural Resources – Lake Superior and St. Louis River Program retains copies of the project documentation.
3. ***What are the stated goals of the project? List quantifiable measures of success if identified?***
   The project goals were to remove excess sediments from Perch Lake to improve fish habitat, increase water circulation between the St. Louis River and Perch Lake, improve fish and wildlife passage between the St. Louis River and Perch Lake, and restore/enhance coastal marsh wetland habitat.
4. ***What are the desired outcomes of achieving the stated goals?***

The desired outcome is to re-connect Perch Lake to the St. Louis River and restore processes that allowed for the continuous exchange of fish, wildlife, sediments, and organic matter between the bay and the main river that was severely impacted when a railroad and a state highway were constructed through the area. By removing excess accumulated sediment and improving the connection between Perch Lake and the river, restored processes should sustain improved habitat conditions.

5. ***Are plans available?*** **Yes** ***Have project maps been created?*** **Yes**
   If yes, provide relevant examples in "site maps" and list maps provided:
   Aerial view with proposed treatment locations
   2021 aerial view prior to restoration
   2023 aerial view following restoration
   Construction sheet – Plan view of proposed treatments for sediment removal.
   Construction sheet – Plan view of hemi-marsh creation locations.
   Construction sheet – Plan view of proposed culvert installation location.
   Aerial view with contractor proposed modification to hemi-marsh layout.
6. ***List and briefly describe best management practices, standards, guidelines identified in plans.***
   Deep water off-channel habitat – Providing deep water habitat off the main St. Louis River channel provides additional habitat diversity to the overall river system. Positioning the deep water area within the projected circulation path between the two connections to the river will encourage scour that should maintain water depths and allows for flow that prevents dissolved oxygens levels from reaching a level that negatively impacts the fish community.
   Restoration of coastal marsh wetlands – Removing sediment to a depth that prohibits cattail establishment but allows for emergent vegetation to grow is a typical sediment removal practice. Additionally, the designed depth for the coastal marsh wetland restoration allowed for the water column to remain oxygenated through wind and wave energy circulation, which reduces the potential for the biological oxygen demand by microbes to reduce dissolved oxygen levels to levels that negatively impact fish.
   Creation of hemi-marsh wetland habitat – Creating shallow openings in dense emergent wetland vegetation such as cattail stands benefits marsh birds. Hemi-marsh shape that maximizes the ratio of hemi-marsh perimeter length to total area is recommended by local avian experts. Connecting hemi-marshes to the adjacent body of water allows for water circulation and fish and wildlife access.
   Spawning gravel additions – Gravel is an important substrate for spawning with several species of fish in the St. Louis River. Adding spawning gravel in areas where the current processes don't allow for natural recruitment of gravel or where gravel isn't present is a common fish habitat improvement practice.
   Increased water circulation through improved connection with the St. Louis River – Perch Lake is separated from the St. Louis River by Highway 23, but was historically a sheltered, backwater bay with a greater connection to the river. Removing Highway 23 or installing a large bridge to restore the historical connection was not feasible. Installing a large 16-foot culvert improves the connection. Positioning the culvert on the downstream half of Perch Lake along with maintaining the existing culvert mirrors the type of connection dynamics present in many sheltered bays in the estuary. Providing two connecting points promotes water circulation.

Project Implementation

(Questions for Site Manager and Cooperating Professionals)

7. ***Were alterations made to the plan during project implementation?***
   Yes
   Due to the multiple stakeholders and multiple project types (sediment removal, hemi-marsh creation, and a culvert installation under a state highway, the project was broken into parts and phases during design to keep progress moving. Project scope items were grouped into similar tasks with individual items being designed and phased relatively independently from each other.
   The shape and layout of the hemi-marsh was modified from the original design by the contractor. The design was intended to be modified once a contractor was selected. The contractor and the project sponsor collaborated on the best final approach to accomplish the desired outcome.
   During the sediment removal phase, there was a discrepancy between the planned quantities to be removed and the actual amount of sediment that was present. Removing the designed amount of material would have resulted in either a substantial financial loss to the contractor without a change of scope or a significant additional cost to the project via a change order to address the removal more sediment. The contractor, a consultant, and the project sponsor evaluated options and decided that the discrepancy was not an error and that the best course was to reduce the footprint of a portion of the project and not increase the overall cost.
8. ***In what ways did alterations change the project outcome?***
   The alterations did not have a negative impact on the project outcome. Breaking the project out into phases had a positive outcome because it allowed project partners to work within their technical strengths. For example, the US Army Corps of Engineers (USACE) led the sediment removal design, which falls within their core services and mission. Making the culvert installation a separate project allowed the project sponsor to obtain services from a third party consultant that had expertise in road and culvert design that could meet the specifications required by MN/DOT. Modifying the layout of the hemi-marsh from the original design was a minor alteration. Working directly with the contractor during construction to identify opportunities to accomplish the design outcome while modifying the means and methods is a valuable tool to have on most restoration projects. Reducing the footprint of the deep water and coastal wetland portions of the project did not negatively impact the outcome. Deep water habitat was created for off-channel fish refuge once the culvert is installed. Sediment was removed from a significant portion of Perch Lake to restore coastal wetland and reduce the potential for low dissolved oxygen levels from impacting fish.

Site Assessment

Field Review Date: 8/18/2023

Field Visit Attendees: Melissa Sjolund – MNDNR, Ben Nicklay – MNDNR, Jeramy Pinkerton – MNDNR, Daryl Peterson – Minnesota Land Trust.

9. ***Surrounding Landscape Characteristics:***
   Perch Lake is located in the upper St. Louis River estuary. It is a shallow sheltered bay adjacent to the main channel of the St. Louis River. The adjacent land use is mixed residential with natural areas in the neighborhoods and along the bluff slopes.

10. ***Site Characteristics:***
    a. ***Soil Series:***

Native river sediments consisting of sand, muck, and other soft sediments.

b. Topography:

Water depths throughout Perch Lake range from 2 to 4 feet throughout most of the shallow bay. The deep water off-channel area ranges from 8 to 10 feet deep.

c. Hydrology:

Perch Lake is a sheltered bay on the St. Louis River. Water depth and hydrology is influenced primarily by the St. Louis River. There are no well-defined inlet streams. Overland flow from the adjacent bluff slopes or from concentrated flow from road drainage are the other surface water inputs.

d. Vegetation: Plant Communities, Dominant Species & Invasives % Cover:

The majority of Perch Lake is open water habitat with limited emergent vegetation in the areas where sediment removal occurred. The northeast portion of the bay where sediment removal did not occur is dominated by submergent and emergent native vegetation. In the eastern portion of the bay where hemi-marsh was created, dense cattail stands are present.

11. ***Is the plan based on current science?*** Yes

Several extensive feasibility and investigative studies were completed prior to and during the development of the design including sediment geotechnical analysis, sediment transport modeling, and conceptual designs. The culvert installation was required to meet MN/DOT's standards because the culvert is under a state highway and MN/DOT will assume ownership when construction is complete.

12. List indicators of project goals at this stage of the project:

All work outlined in the first phase of the restoration is complete. Sediment has been removed from all four proposed areas within Perch Lake (deep water, coastal marsh, hemi-marsh, and a connecting ditch). Spawning gravel has been added to the areas identified in the plans. At the time of the evaluation, MNDNR was preparing to begin construction oversight on the installation of the culvert.

13. Does the implementation of the project plan allow for achieving proposed goals?

Yes. The goals outlined at the start of the project under the first phase have been achieved. The second phase, the culvert installation, was in the process of starting construction. The completion of the second phase will likely trigger additional work by project partners in the future including improving parking and access at the adjacent public access area and improving trail access.

14. Are proposed future steps, including long term management, practical and reasonable?

Yes. The previous and ongoing work at Perch Lake helps to restore processes such as the improved connection to the St. Louis River that should maintain the features that were constructed. There are many stakeholders within the St. Louis River estuary who are vested in the Perch Lake project. Future needs will likely be proactively identified and addressed before solutions become more complex.

15. What were potential challenges to the project and were there opportunities for improvement? Are corrections or modifications needed to achieve proposed goals?

Having a project that has solutions that rely on expertise from separate technical areas along with project partners that have different processes, jurisdictions, and priorities was a significant challenge. Breaking the project into two phases by the type of work proposed allowed for project partners to focus on their processes and priorities and technical providers to focus on developing designs. The project sponsors kept consistency between the project teams and overall project goals. It appears that most opportunities were optimized. For example, the culvert installation is being constructed between two MN/DOT projects on State Highway 23 that will allow for MN/DOT and the City of Duluth to plan for improvements to the area under conditions that have already improved Perch Lake rather than

completing work and needing to disturb newly completed construction. The project team was able to adapt to changes without compromising the proposed project goals.

16. ***Are follow-up assessments by the Restoration Evaluation Program needed? Explain.***
    No. The project is well-supported by stakeholders within the St. Louis River estuary and AOC to be monitored and assessed for continued success. If further action were required, it is anticipated that local stakeholders would identify and initiate action.
17. ***Additional comments on the restoration project.***
    This project is a good example of adapting to the strengths and needs of project partners while keeping the ultimate desired outcomes in focus. Project partners included federal, state, and local governments along with a non-governmental organization and private industry.

Project Evaluation

Projects can be designated as likely to not meet proposed outcomes, minimally meet proposed outcomes, meet proposed outcomes, or exceed proposed outcomes with a low, medium, or high degree of confidence in the determination.

18. ***The project has:***
    Achieved the stated goals.
19. ***The project will:***
    Meet proposed outcomes.
    Confidence of outcome determination:
    High.
20. ***Provide explanation of reason(s) for determination.***
    The immediate desired outcome of improving the connection between Perch Lake and the St. Louis River through the installation of a culvert was about to begin following the initial site assessment. All indicators are that the installation will be complete by the end of 2023. The first phase of the project to remove sediment and restore/create deep water, coastal marsh and hemi-marsh habitat achieved the initial outcome of habitat creation. By improving the hydrologic exchange between Perch Lake and the St. Louis River, the processes that should maintain those habitat features has been restored to the extent possible.
21. ***Site Assessor(s) conducting field review:***

    Mark Pranckus, EOR

Site Maps, Project Plans or Vegetation Tables

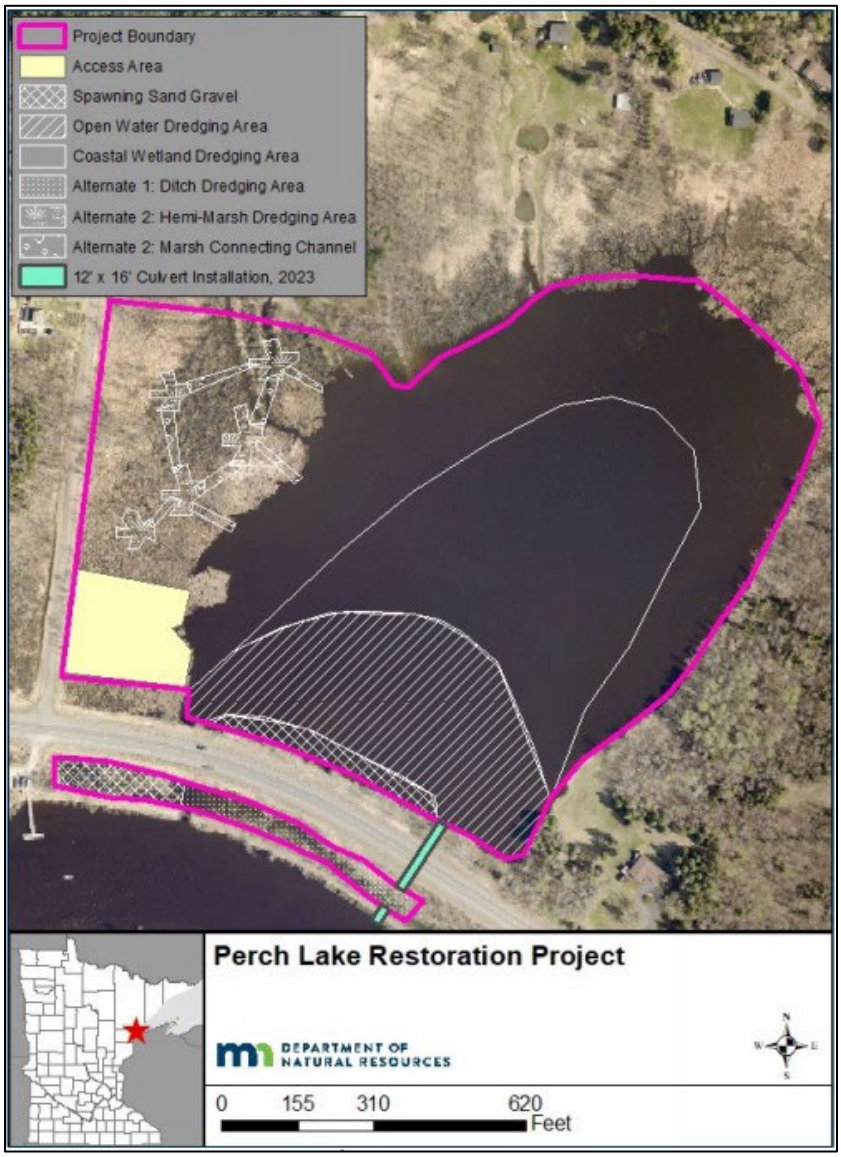


Figure 12. Aerial map showing where work occurred as part of the Perch Lake restoration project.

Figure 13. Aerial view from 2021 showing Perch Lake prior to restoration. Most of Perch Lake is covered in floating and submerged aquatic vegetation during the growing season, indicative of the shallow depths. Aerial photo courtesy of Google Earth (accessed October 2023).

Figure 14. Aerial view from 2023 showing Perch Lake post-restoration. Areas along the eastern edge of the wetland show the hemi-marsh creation. Aerial photo courtesy of Google Earth (accessed October 2023).

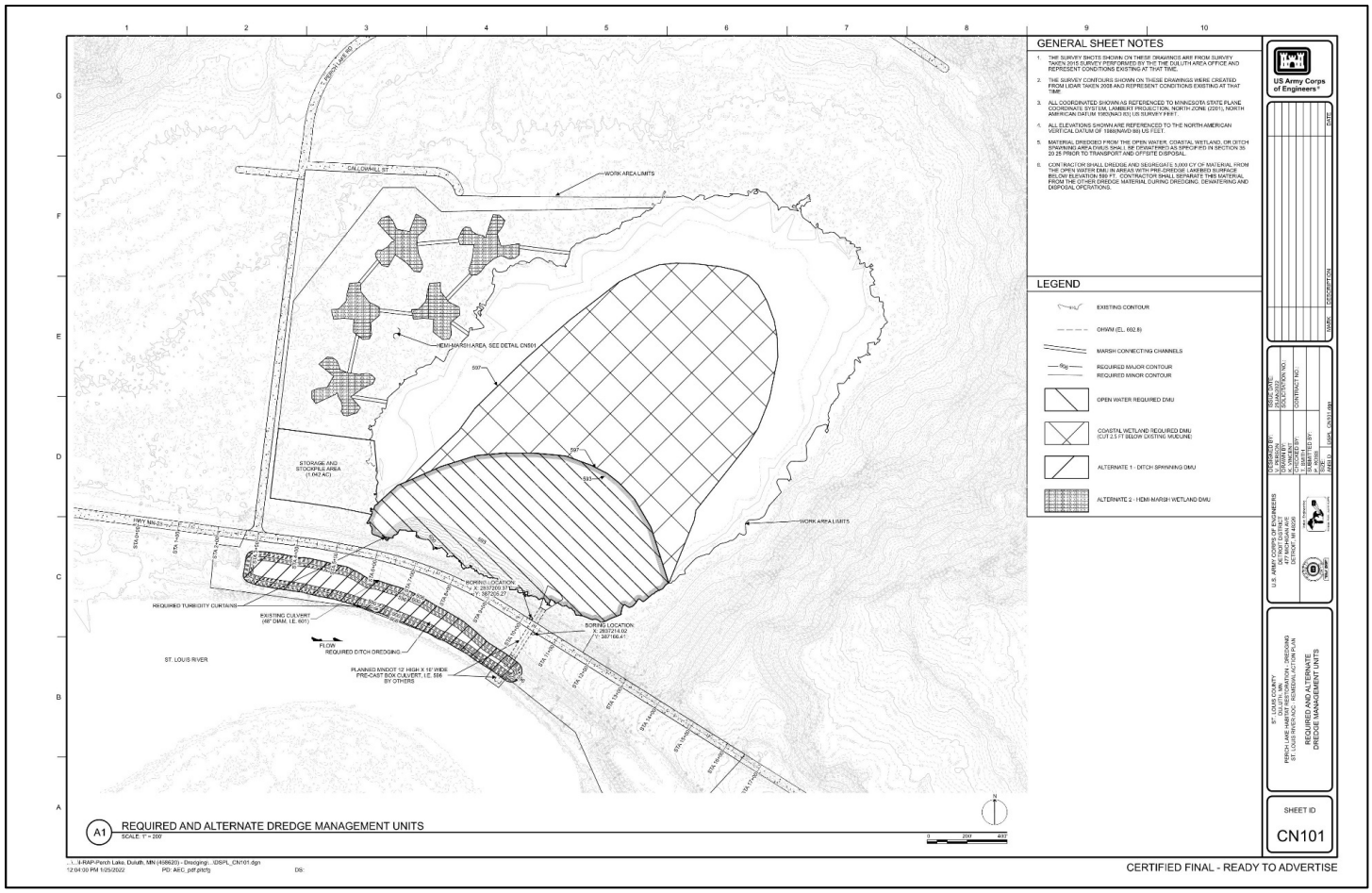


Figure 15. Plan view of sediment removal phase for Perch Lake restoration including deep water, coastal wetland, and hemi-marsh restoration. As part of the project the narrow ditch separating the main channel of the St. Louis River and the existing culvert to Perch Lake was also dredged to improve fish spawning habitat and recreational access once the new culvert is installed.

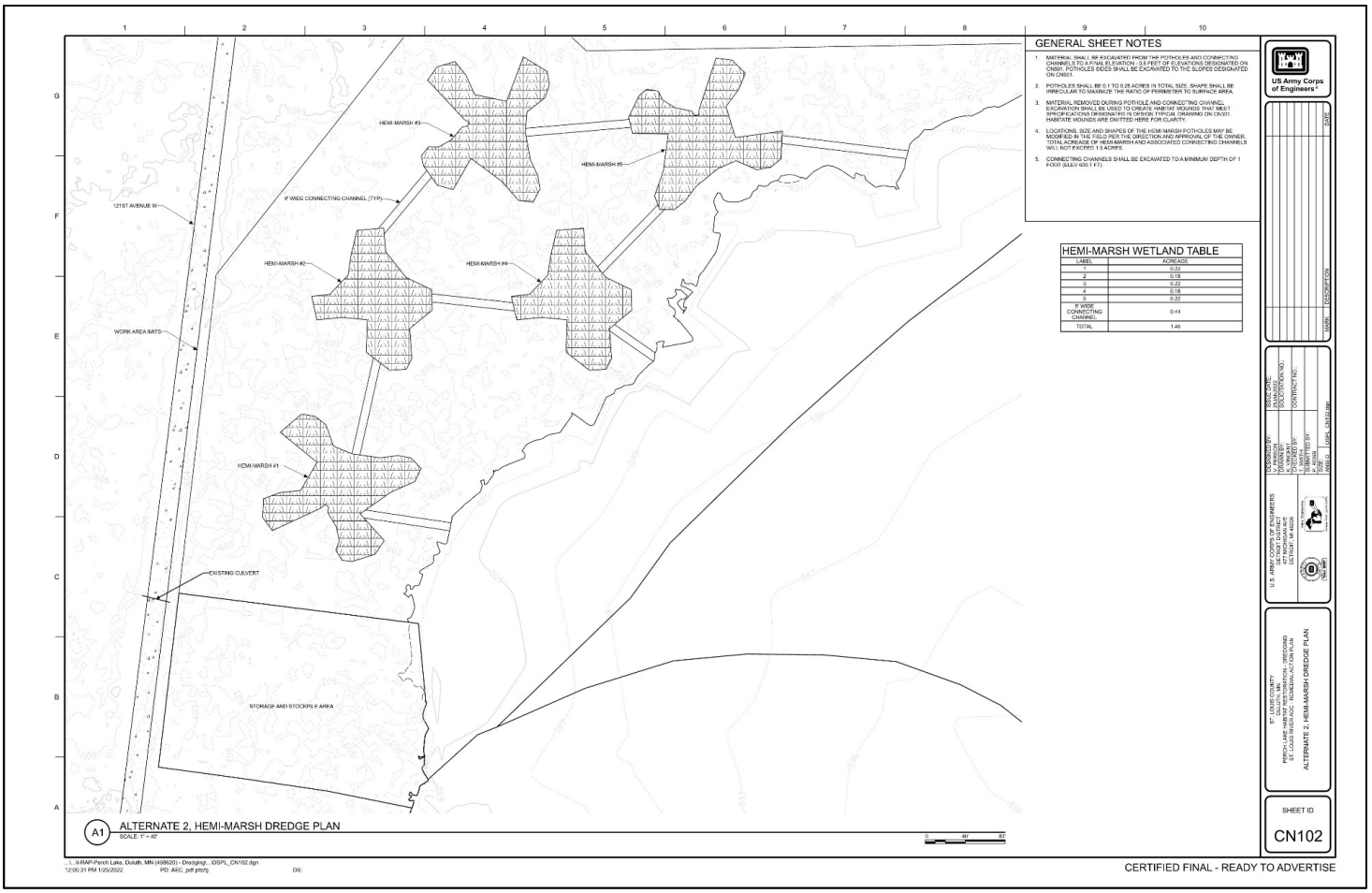


Figure 16. Plan view of hemi-marsh locations for Perch Lake restoration.

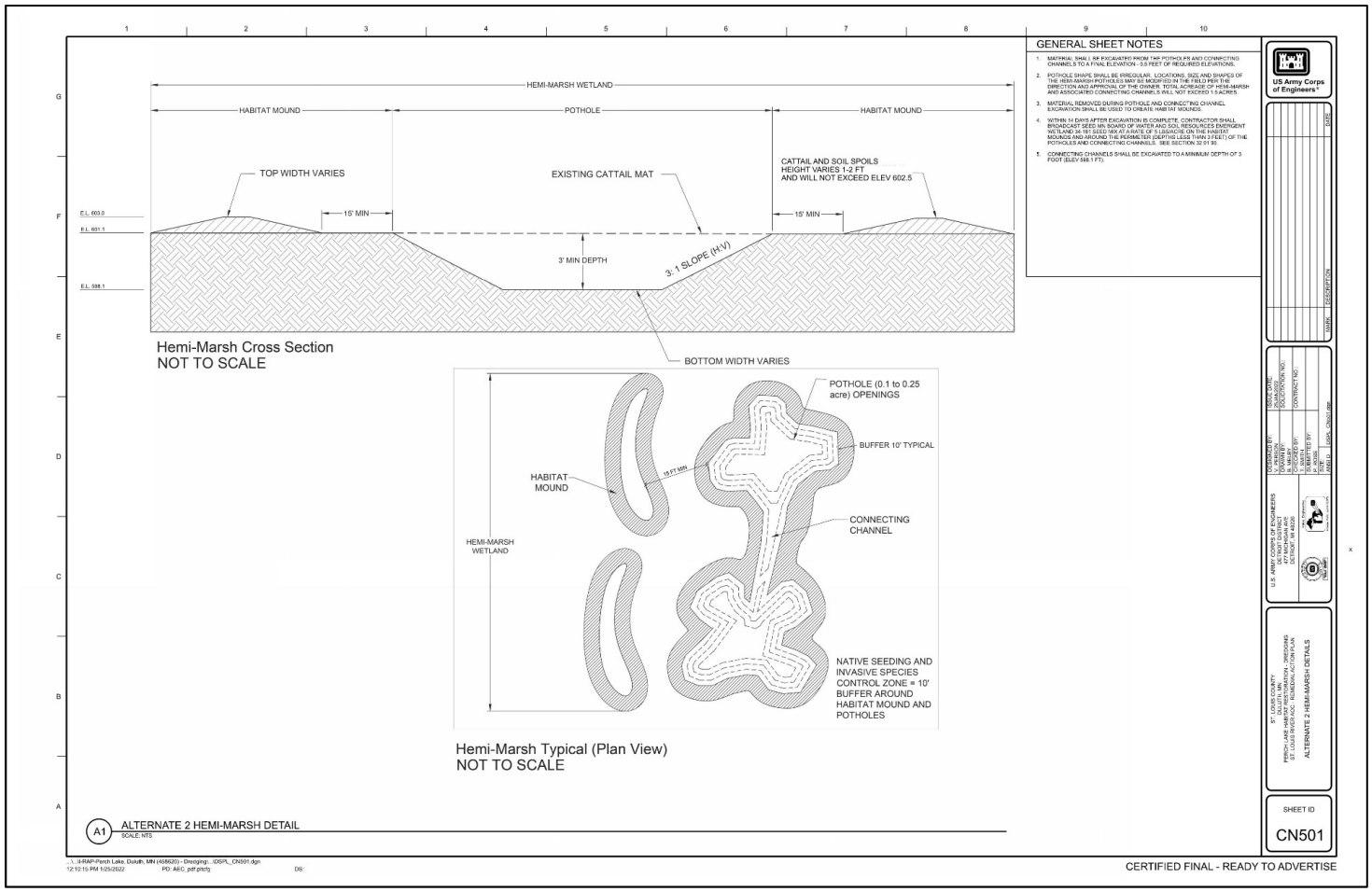


Figure 17. Construction details for hemi-marsh and habitat mound features proposed for Perch Lake.

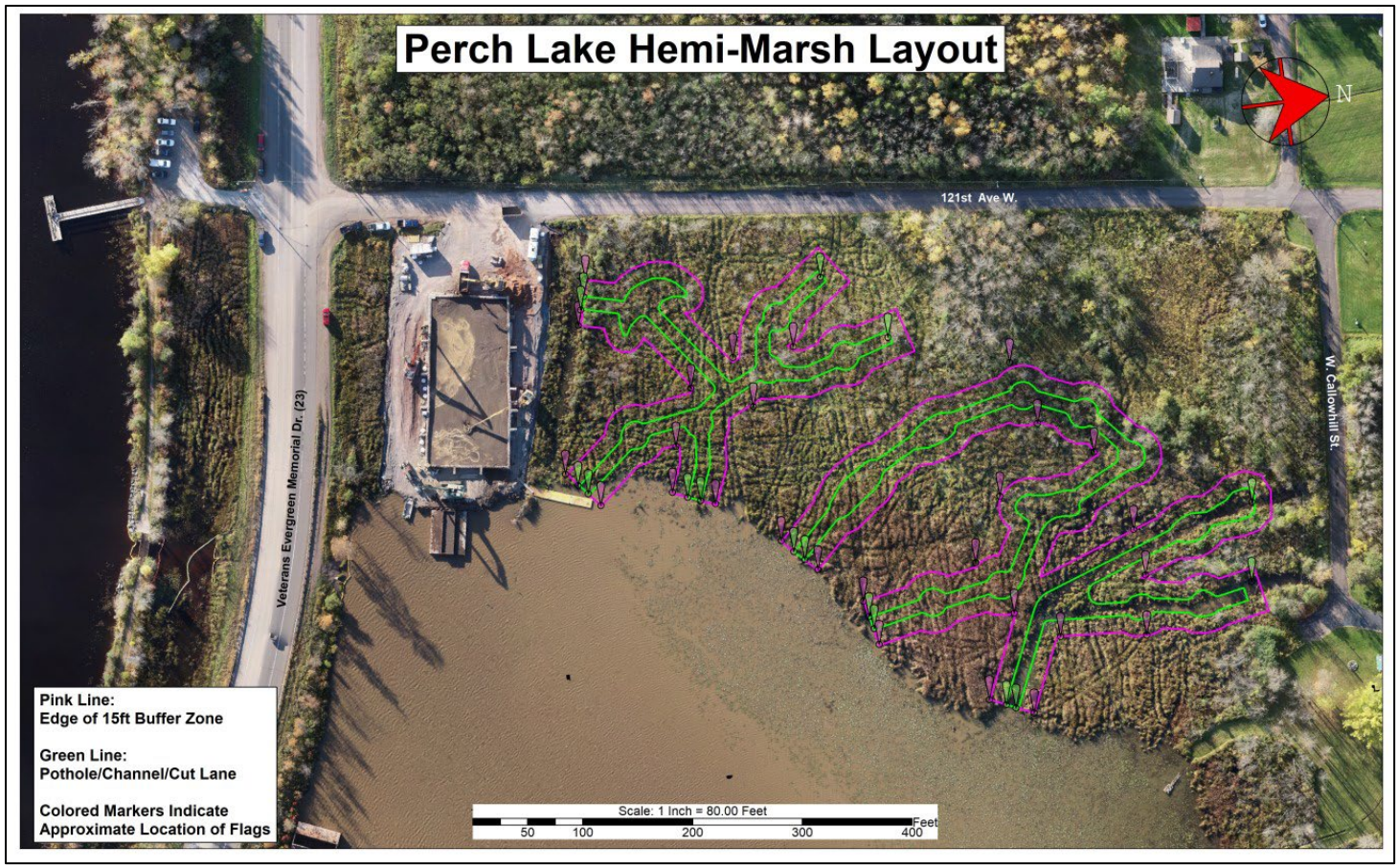


Figure 18. Proposed layout of the hemi-marsh construction areas provided by the awarded contraction prior to implementation.

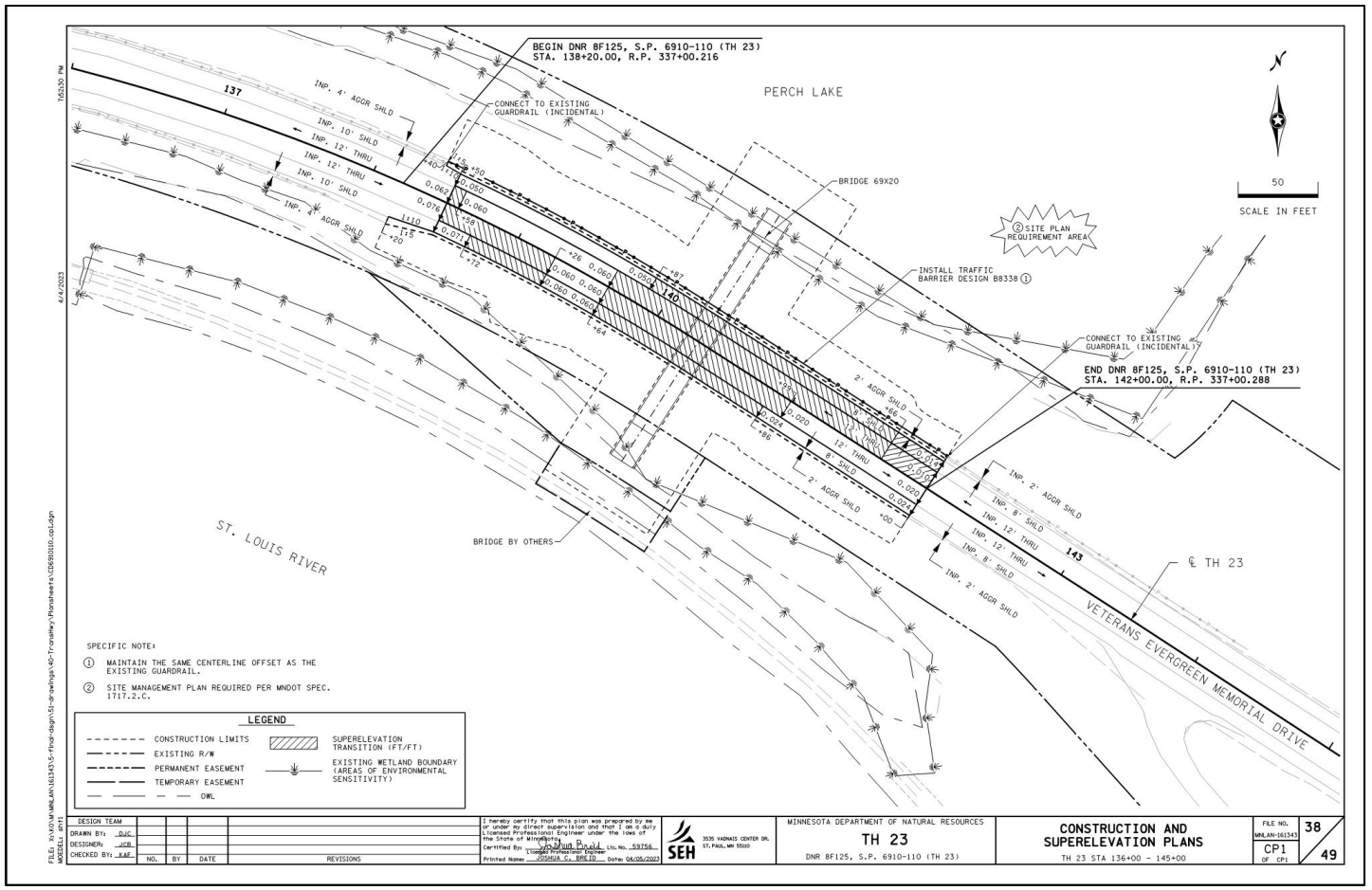


Figure 19. Plan view of the proposed new culvert installation under State Highway 23.

Site Photographs

Photo 32. Overlooking Perch Lake at the existing culvert inlet following sediment removal. The culvert is the only connection between Perch Lake and the St. Louis River. Photo taken by M. Pranckus (EOR) on August 18, 2023.

Photo 33. Overlooking Perch Lake following sediment removal. Prior to restoration, much of the open water area would be covered with submergent and floating aquatic vegetation. Photo taken by M. Pranckus (EOR) on August 18, 2023.

Photo 34. Example of hemi-marsh that was created by excavating open water areas in densely vegetated marsh areas. These open water areas are important to provide habitat for marsh birds. Photo taken by M. Pranckus (EOR) on August 18, 2023.

Photo 35. Example of habitat mounds created in conjunction with hemi-marsh creation. The mounds are composed of material excavated for the open water areas. The mounds slightly increase in elevation compared to the surrounding wetlands, which are important for wildlife use. Photo taken by M. Pranckus (EOR) on August 18, 2023.

Photo 36. Example of sediment removal operations to restore Perch Lake bathymetry. Photo provided by Jeramy Pinkerton, MNDNR.

Photo 37. Example of the existing culvert outlet connecting Perch Lake with the St. Louis River. This culvert will remain in place following the installation of the new culvert at a second location under State Highway 23. Photo taken by M. Pranckus (E0R) on August 18, 2023.

Photo 38. Looking at the existing culvert between Perch Lake and the St. Louis River via a narrow ditch. Water along with fish and other aquatic organisms, sediments, and nutrients are required to pass through this narrow pipe as the only connection. The newly installed culvert will be approximately four times wider than this culvert. Photo taken by M. Pranckus (EOR) on August 18, 2023.

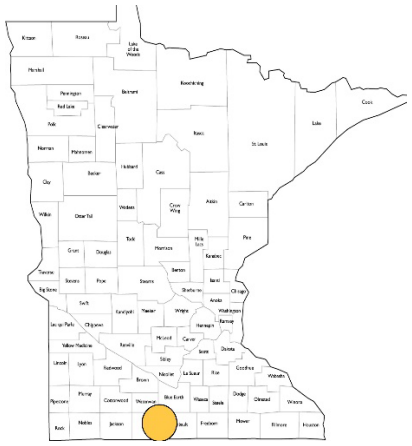
Photo 39. Looking at the future location of the new culvert crossing under State Highway 23. The new culvert will be 16 feet wide, or four times the width of the existing culvert and provide the ability for water to flow through Perch Lake, similar to other shallow sheltered bays along the St. Louis River. Photo taken by M. Pranckus (EOR) on August 18, 2023.

Photo 40. Installation of the new culvert connecting Perch Lake with the St. Louis River. The photo was taken after the initial site assessment visit. Photo provided by Jeramy Pinkerton, MNDNR.

Photo 41. Example of the equipment access pad post-construction. Timber mats were placed on wetland vegetation to minimize impact during construction. Photo taken by M. Pranckus (EOR) on August 18, 2023.

4 Fairmont Chain of Lakes Habitat Restoration

Project Background



Latitude/Longitude: 43.622754, -94.490422

Project Manager / Organization: Current project manager, Hannah Neusch / City of Fairmont. Manager during project implementation, Troy Nemmers.

Fund: OHF

Fiscal Year Funds: FY20

Project Start Date: 2019

Project Complete Date: 2022

Predominant Habitat type: Wetland

Additional Habitat types: Stream , Prairie / Savana / Grassland

Project Status: Establishment Phase

County: Martin

Primary Activity: Wetland Restoration; Prairie Restoration

Project Size: 35 acres (6 Wetland, 29 Prairie)

Project Goals and Planning

(Site Assessment Preparation from Plan Sets and Documents)

1. ***What are the specific project components, management actions, or treatments?***

   Restore and reconnect two floodplain wetlands along Dutch Creek. Native prairie plantings in former cattle grazing areas, removal of invasive species along the Dutch Creek corridor, and restoration of a highly eroded portion of the creek channel utilizing natural vegetation.

2. ***What project plans or project decision details are available? Who retains these plans?***
   Habitat Restoration and Nitrate Bioireactor – Barr Engineering
   Fairmont Habitat Concept G – City of Fairmont

3. ***What are the stated goals of the project? List quantifiable measures of success if identified?***
   Create spawning habitat for northern pike to increase the population in the Fairmont Chain of lakes. Expectation was that northern pike will use the site in years of spring high water. Increase habitat for the Blanding's Turtle, a rare species in the area.
4. ***What are the desired outcomes of achieving the stated goals?***
   Enhanced predator population in Fairmont chain will reduce populations of abundant, undesirable fish species: common carp and yellow bass. Increase recreation and fishing opportunities in the Fairmont

Chain of Lakes. The Fairmont chain of lakes is also a drinking water source. This project is additionally intended to improve water quality in the chain of lakes through nutrient reduction.

5. ***Are plans available?*** **Yes** ***Have project maps been created?*** Yes
   If yes, provide relevant examples in "site maps" and list maps provided:
   Project Location
   Habitat Concept
6. ***List and briefly describe best management practices, standards, guidelines identified in plans.***
   Toe-wood erosion control system to stabilize streambank along with wetland vegetation seeding.
   Restored basins with variable wetland hydrology: installation of a diversion weir and cross vanes to allow fish passage and variable water levels.
   Upland areas seeded with native prairie plant species, including local source ecotype, to benefit pollinator species. Revegetation also included trees, shrubs, live stakes, and herbaceous plugs.

Project Implementation

(Questions for Site Manager and Cooperating Professionals)

7. ***Were alterations made to the plan during project implementation?***
   No
8. ***In what ways did alterations change the project outcome?***

Site Assessment

Field Review Date: 10/19/2023

Field Visit Attendees: Wade Johnson, Carli Wagner, Jon Lore – DNR ; Hannah Neusch, Tyler Cowing – City of Fairmont

9. ***Surrounding Landscape Characteristics:***
   Agricultural use – cattle grazing and row crops. Urban development – located within city limits of Fairmont.
10. ***Site Characteristics:***
    a. ***Soil Series:***
    Loam with some areas of higher clay content in the wetland and stream portions
    b. ***Topography:***
    Gentle slopes on converted agricultural lands. Stream banks were heavily eroded and steep from past use by cattle. The constructed wetland is approximately 8 feet deep at full capacity.
    c. ***Hydrology:***
    Dutch Creek flows into Hall Lake, part of the Fairmont Chain of lakes used for drinking water by the city. Most upstream reaches from the project site have been channelized through agricultural lands.
    d. ***Vegetation: Plant Communities, Dominant Species & Invasives % Cover:***
    Site surrounded by active and fallow agricultural fields and ruderal species in riparian corridor. Vegetative cover within the project site consists primarily of recently seeded and planted prairie and wetland species, mixed with common early successional weed species.
11. ***Is the plan based on current science?*** Yes
    Practices employed are based on current science:

- Streambank stabilization using toewood and live stakes in a Vegetated Reinforced Soil Slope (VRSS) and rock inlet.
- Wetland basins were designed and installed to provide flood attenuation and fish spawning habitat.
- Upland seeded areas treated with twice with glyphosate herbicide and broadcast seeded with appropriate native seed mixes.

12. ***List indicators of project goals at this stage of the project:***
    No evidence of northern pike spawning has occurred yet but there has been limited connectivity due to prolonged drought conditions. In the southern lot, native prairie plantings appear to be on track to strong establishment. These areas received two 'establishment mows' during the growing season to suppress weed seed and improve sunlight at the soil layer. The north lot is dominated by weeds, mainly Canada thistle and Reed canary grass. This north lot did not meet contracted planting specifications and is receiving extended establishment maintenance including cool-season overspray followed by burn off or mulch mowing of the dead sprayed vegetation and a drill seeding in those areas.
13. ***Does the implementation of the project plan allow for achieving proposed goals?***
    Yes, spawning habitat, increased wetland habitat and improved vegetative cover for water quality has been achieved on this site. The toewood and live staked stabilized streambank is well established, providing habitat and stability in this high energy area of the project.
14. ***Are proposed future steps, including long term management, practical and reasonable?***
    Yes, monitoring sedimentation within the restored basins with cleanout and revegetation as needed. An initial contract is in place for a 3-year vegetation management plan with a qualified restoration contractor, this will continue upland management including weed control, burns, watering, and overseeding. The City of Fairmont is establishing a new contract with a qualified restoration contractor to continue maintenance in future years. Monitoring of spawning activity is planned in future years to identify how the new habitat is being utilized.
15. ***What were potential challenges to the project and were there opportunities for improvement? Are corrections or modifications needed to achieve proposed goals?***
    Weather conditions and water levels delayed completion of grading during any wet periods, however, following a COVID hiatus, much of the project was completed during the dry summer/fall of 2021.
    Carp immediately began utilizing the newly created spawning habitat, but since pike spawn earlier the expectation is that carp will only minorly affect the pike spawning process.
    The north lot seeded areas will require more intensive management to establish adequate native plant cover.
16. ***Are follow-up assessments by the Restoration Evaluation Program needed? Explain.***
    No, the structural habitat and hydrologic components of the project are well established. Ongoing management of vegetation is being managed City landowners.
17. ***Additional comments on the restoration project.***
    Ceasing cattle grazing throughout this section of stream corridor is a significant improvement to the stability and water quality. This project also incorporated a nitrate bioreactor using other funding sources from the Environment Natural Resources Trust Fund. This additional targeted water quality improvement benefits the overall habitat goals.

Project Evaluation

Projects can be designated as likely to not meet proposed outcomes, minimally meet proposed outcomes, meet proposed outcomes, or exceed proposed outcomes with a low, medium, or high degree of confidence in the determination.

18. ***The project has:***
    Achieved the stated goals.
19. ***The project will:***
    Meet proposed outcomes.
    Confidence of outcome determination:
    Medium.
20. ***Provide explanation of reason(s) for determination.***
    The creation of off-channel deep water pools for spawning habitat is a benefit to fisheries within the Fairmont Chain of Lakes. The vegetatively stabilized section of streambank, and additional off channel pond created additional water storage. The site should be monitored for fisheries/spawning use in years where the habitat is accessible. The pond depth should also be monitored in coming years after multiple flow through events to gauge the depth has not be lost through sedimentation.
21. ***Site Assessor(s) conducting field review:***

    Wade Johnson – MN DNR

Site Maps, Project Plans or Vegetation Tables

Figure 20 Aerial view of project's south lot facing south with Dutch Creek and the offline habitat wetland pond left of the image. Photo taken in December 2021.

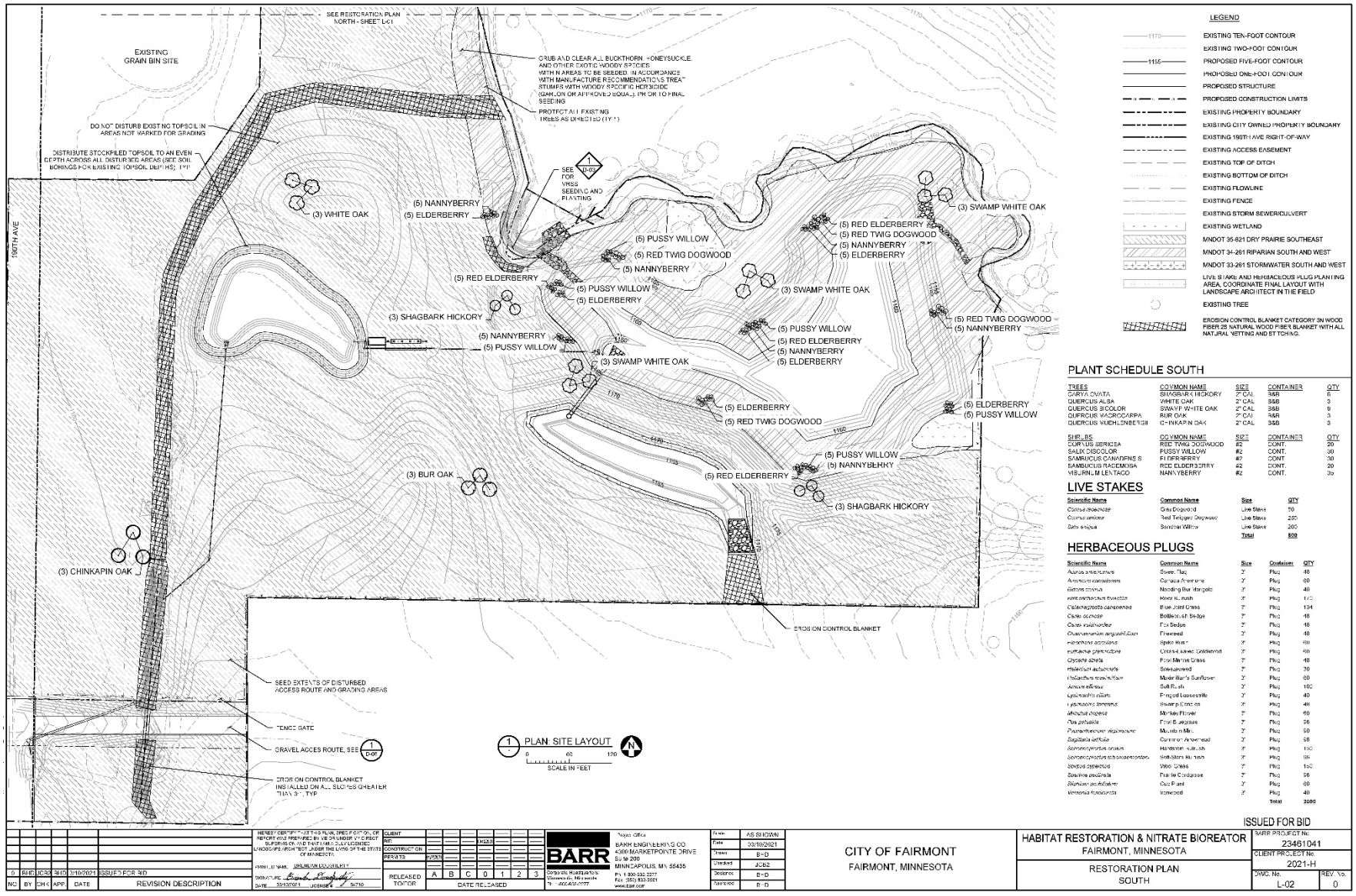


Figure 21 Plan set page of south restoration and pike spawning area showing planting areas.

Table 1 Dutch Creek vegetation meander 10/19/2023. Areas include upland seeding/planting and wetland perimeter.

Scientific Name	Common Name	Cover Range	Species Planted/Seeded	Species Status
Graminoids				
Andropogon gerardii	big bluestem	*5-25%*	Yes	Native
Bouteloua curtipendula	side-oats grama	*1-5%*	Yes	Native
Bromus inermus	Smooth brome	*1-5%*	No	Nonnative
Carex sp	Sedge	*1-5%*	-	-
Echinochloa crus-galli	barnyard grass	5-25%	No	nonnative
Elymus canadensis	nodding wild rye	*5-25%*	Yes	Native
Elymus trachycaulus	slender wheatgrass	*1-5%*	Yes	Native
Elymus virginicus	Virginia wild rye	*1-5%*	Yes	Native
Koeleria macrantha	Junegrass	*5-25%*	Yes	Native
Spartina pectinata	prairie cordgrass	*1-5%*	Yes	Native
Panicum virgatum	switchgrass	*1-5%*	Yes	Native
Panicum capilare	Witchgrass	*1-5%*	No	Native
Phalaris arundinacea	*Reed canary grass*	*1-5%*	No	Invasive
Poa sp	Bluegrass	*1-5%*	No	Native
Schizachyrium scoparium	little bluestem	*5-25%*	Yes	Native
Setaria pumila	yellow foxtail	*1-5%*	No	Invasive
Sorghastrum nutans	Indian grass	*5-25%*	Yes	Native
Scirpus atrovirens	Dark green bulrush	*1-5%*	Yes	Native
Scirpus cyperinus	Woolgrass	*1-5%*	Yes	Native
Sporobolus heterolepis	prairie dropseed	*1-5%*	Yes	Native
Forbs				
Achillea millefolium	common yarrow	*1-5%*	Yes	Native
Asclepias syriaca	common milkweed	*1-5%*	No	Native
Asclepias tuberosa	Butterfly milkweed	*1-5%*	No	Native
Asclepias verticillata	whorled milkweed	*1-5%*	Yes	Native
Artemisia ludoviciana	White Sage	*0-1%*	No	Native
Bidens vulgata	common beggarticks	5-25%	No	Native
Cirsium arvense	Canada Thistle	5-25%	No	Nonnative
Chenopodium album	Lamb's-quarters	1-5%	No	Nonnative
Conyza canadensis	Canadian Horseweed	1-5%	No	Native

Scientific Name	Common Name	Cover Range	Species Planted/Seeded	Species Status
Coreopsis palmata	Prairie Coreopsis	1-5%	Yes	Native
Dalea candida	White Prairie Clover	1-5%	Yes	Native
Dalea purpurea	Purple Prairie Clover	1-5%	Yes	Native
Equisetum arvense	field horsetail	1-5%	No	Native
Heliopsis helianthoides	Common Ox-eye	*5-25%*	Yes	Native
Helenium autumnale	sneezeweed	1-5%	Yes	Native
Lactuca canadensis	Wild Lettuce	1-5%	No	Nonnative
Lespedeza capitata	round-headed bush clover	1-5%	Yes	Native
Lobelia siphilitica	Blue Lobelia	1-5%	Yes	Native
Melilotus alba	White Sweet Clover	1-5%	No	Nonnative
Monarda fistulosa	Wild Bergamot	1-5%	Yes	Native
Monarda punctata	horsemint	1-5%	Yes	Native
Penstemon grandiflorus	large-flowered beard tongue	1-5%	Yes	Native
Physostegia virginiana	Obedient Plant	1-5%	Yes	Native
Plantago major	Common Plantain	1-5%	No	Nonnative
Polygonum spp.	smartweed	1-5%	No	Native
Rudbeckia hirta	Black-eyed Susan	*5-25%*	Yes	Native
Rudbeckia laciniata	tall coneflower	1-5%	Yes	Native
Rumex crispus	Curly Dock	1-5%	No	Nonnative
Solidago canadensis	Canada Goldenrod	1-5%	No	Native
Solidago rigida	Stiff Goldenrod	*5-25%*	Yes	Native
solidago nemoralis	gray goldenrod	1-5%	Yes	Native
Symphyotrichum oolentangiense	skyblue aster	1-5%	Yes	Native
Symphyotrichum sericeum	silky aster	1-5%	Yes	Native
Symphyotrichum novae-angliae	New England aster	1-5%	Yes	Native
Taraxacum officinale	Dandelion	1-5%	No	Nonnative
Tradescantia bracteata	bracted spiderwort	1-5%	Yes	Native
Urtica dioica	Nettle	1-5%	No	Nonnative
Verbena hastata	blue vervain	1-5%	Yes	Native
Vitis riparia	wild grape	1-5%	No	Native

Scientific Name	Common Name	Cover Range	Species Planted/Seeded	Species Status
Zizia aptera	heart-leaved alexanders	1-5%	Yes	Native
Zizia aurea	golden alexanders	1-5%	Yes	Native
Trees / Shrubs				
Carya ovata	Shagbark Hickory	0-1%	Yes	Native
Cornus serica	Red Twig Dogwood	1-5%	Yes	Native
Populus deltoides	Cottonwood	1-5%	No	Native
Quercus bicolor	Swamp White Oak	0-1%	Yes	Native
Quercus macrocarpa	Bur Oak	0-1%	Yes	Native
Salix interior	Sandbar Willow	1-5%	Yes	Native
Sambucus canadensis	Black Elderberry	0-1%	Yes	Native
Sambucus racemosa	Red Elderberry	0-1%	Yes	Native
Ulmus pumila	Siberian elm	1-5%	No	Invasive
Viburnum lentago	Nannyberry	1-5%	Yes	Native

Site Photographs

Figure 22 Restored section of Dutch Creek. Live staked willow and other wetland vegetation was well-established in the Vegetated Reinforced Soil Slope (VRSS) and installed toe wood was well-covered below water level. Site visit 10/19/2024.

Figure 23 Rock inlet to spawning habitat wetland.

Figure 24 Spawning habitat wetland facing northwest towards inlet.

Figure 25 Caged Oak tree in South planting area.

Figure 26 Caged Oak tree in northern planting area.

5 Bone and Moody Lake Carp Barriers

Project Background

Latitude/Longitude: 45.291801, -92.865092

Project Manager / Organization: Doug Thomas/ Comfort Lake - Forest Lake Watershed District

Fund: OHF - CPL

Fiscal Year Funds: 2011

Project Start Date: 2011

Project Complete Date: November 2012

Predominant Habitat type: Aquatic Habitat

Additional Habitat types:

Project Status: Post Establishment Phase

County: Washington

Primary Activity: Lake Shore Enhancement

Project Size: 256 acres

Project Goals and Planning

(Site Assessment Preparation from Plan Sets and Documents)

1. ***What are the specific project components, management actions, or treatments?***
   This project involved installation of two low velocity fish barriers. One barrier at the inlet of Bone Lake (between Moody and Bone lakes) and a second barrier at the outlet of Bone Lake in order to restrict common carp migrations. These low velocity barriers were designed to be an almost complete fish migration barrier.
2. ***What project plans or project decision details are available? Who retains these plans?***
   CPL grant applications, work plan, and accomplishment reports were available from MDNR. Comfort Lake – Forest Lake Watershed District retains carp survey, aquatic vegetation, Bone Lake Fish Barrier Improvements design, and water quality monitoring reports.
3. ***What are the stated goals of the project? List quantifiable measures of success if identified?***
   Project goals include “controlling the proliferation of rough fish by using future mechanical harvesting in combination with the barriers to control rough fish at populations” as mentioned in the grant application.
4. ***What are the desired outcomes of achieving the stated goals?***
   Project objectives stated in the grant application are to “provide for the long-term enhancement of the native aquatic vegetation, a high quality fishery, and improved water quality”.
5. ***Are plans available?*** **Yes** ***Have project maps been created?*** **Yes**

If yes, provide relevant examples in "site maps" and list maps provided:
A map of the project area**,** CPL FY11-040 Bone & Moody Lakes Low Velocity Fish Barriers, is provided at the end of this evaluation.

6. ***List and briefly describe best management practices, standards, guidelines identified in plans.***
Sediment control BMPs including rock construction entrance, silt fence, and silt curtains details are outlined in the plan set. Continued active common carp management is occurring and is a best management practice for controlling carp populations.

Project Implementation

(Questions for Site Manager and Cooperating Professionals)

7. ***Were alterations made to the plan during project implementation?***
Yes
The initial project planned for installation of three barriers, however after further inspection engineering determined that a barrier upstream of Moody Lake was not feasible.
8. ***In what ways did alterations change the project outcome?***
Only two barriers were constructed, however it is difficult to know how this affected common carp populations.

Site Assessment

Field Review Date: **3/1/2024**

Field Visit Attendees: Anna Varian (Stantec), Wade Johnson (MDNR), Blayne Eineichner (Comfort Lake-Forest Lake Watershed District)

9. ***Surrounding Landscape Characteristics:***
Bone Lake is located in rural Scandia, MN with most of the lakeshore, except the northwest corner, developed with homes. Moody Lake is located in rural Chisago, MN with sparse development surrounding the lake.
10. ***Site Characteristics:***
    a. ***Soil Series:***
    Open Water
    b. ***Topography:***
    The land surrounding Bone and Moody lakes is generally flat.
    c. ***Hydrology:***
    Bone Lake (82005400) is 221.45 acres with 124 acres of littoral area and a maximum depth of 30 feet. Moody Lake (13002300) drains to Bone Lake and is 45.33 acres with 22 acres of littoral area a mean depth of 10 feet and a maximum depth of 48 feet (MDNR).
    d. ***Vegetation: Plant Communities, Dominant Species & Invasives % Cover:***
    State Seed mix 35-241 and 35-221 were used for final restoration; however, vegetation was not assessed during the site visit due to the timing of the site visit being outside of the growing season.
11. ***Is the plan based on current science?*** Portions
It is widely known that common carp contribute to water quality issues, especially in shallow lakes and reducing their populations can improve water quality conditions in these lakes. Reducing populations

often requires multiple approaches and population maintenance. Removing adult carp, aerating shallow lakes to prevent predator winter kill, and preventing or reducing access to spawning habitat are approaches known to help control carp populations. However, this barrier design was experimental and was the first implementation of the design approach at this scale as indicated by the designer's website.

12. ***List indicators of project goals at this stage of the project:***
    The structures were constructed as anticipated; however, they did not function as desired. A retrofit was installed in 2015. Carp surveys were conducted in 2015 and carp densities were estimated for Bone Lake. No carp were sampled in Moody Lake during this survey, but this was likely due to the inability of getting an electrofishing boat into Moody which is the preferred method of common carp sampling. Carp surveys were not conducted prior to installation of the barriers so it is difficult to know what affect the barriers had on the population. Since this barrier was installed and issues were identified a retrofit was installed and indicators of those project goals are reviewed within another evaluation.
13. ***Does the implementation of the project plan allow for achieving proposed goals?***
    Yes, the plan to manage carp through barriers and removals will help control common carp populations.
14. ***Are proposed future steps, including long term management, practical and reasonable?***
    Proposed future steps included mechanical removal and yes carp removal is a practical and reasonable method for reducing the population.
15. ***What were potential challenges to the project and were there opportunities for improvement? Are corrections or modifications needed to achieve proposed goals?***
    A design with more than expected maintenance activities was a challenge to this project. A simple metal grate system at the inlet and outlet would have provided the same functions (allowing water to pass but preventing some fish movement) with occasional debris removal maintenance. The system implemented proved to be more difficult to maintain with frequent clogging and turtle mortality.
16. ***Are follow-up assessments by the Restoration Evaluation Program needed? Explain.***
    No, a retrofit has been implemented at this site and will be evaluated as a separate project.
17. ***Additional comments on the restoration project.***
    Unfortunately, due to staff turnover the staff that initiated the project are no longer working with these agencies, so the rationale behind the initial design will remain unknown.

    The Comfort Lake – Forest Lake Watershed District worked closely with MDNR fisheries to determine if fish barriers were appropriate for this system. Native fish movement is always a concern when proposing to add barriers. The barriers did not pose a concern to MDNR fisheries, native fish in those connecting habitats were healthy and had access to the habitats needed to complete their life cycle. Unfortunately, many of our aquatic ecosystems have been invaded by invasive and non-native species that have disrupted or severely harmed the native ecosystem. Placing a barrier can be a difficult decision where it must be determined if continued connectivity, or removal/reduction/prevention of invasive species is better for the native ecosystem. Depending on the species and habitats present, in some cases it may be best for the native ecosystem to remove connectivity in order to recover; maintaining connectivity may not provide much help for the native ecosystem if the system is severely degraded by invasives.

Project Evaluation

Projects can be designated as likely to not meet proposed outcomes, minimally meet proposed outcomes, meet proposed outcomes, or exceed proposed outcomes with a low, medium, or high degree of confidence in the determination.

18. ***The project has:***
    Minimally achieved the stated goals.
19. ***The project will:***
    Likely not meet proposed outcomes.
    Confidence of outcome determination:
    High.
20. ***Provide explanation of reason(s) for determination.***
    The barrier structures were constructed as planned; however, they did not function as desired. When water levels were low the barriers were functioning as desired; however, high water levels overwhelmed the system and a retrofit had to be added to the design in 2015 to ensure blockage of common carp.
21. ***Site Assessor(s) conducting field review:***

    Anna Varian - Stantec

Site Maps, Project Plans or Vegetation Tables

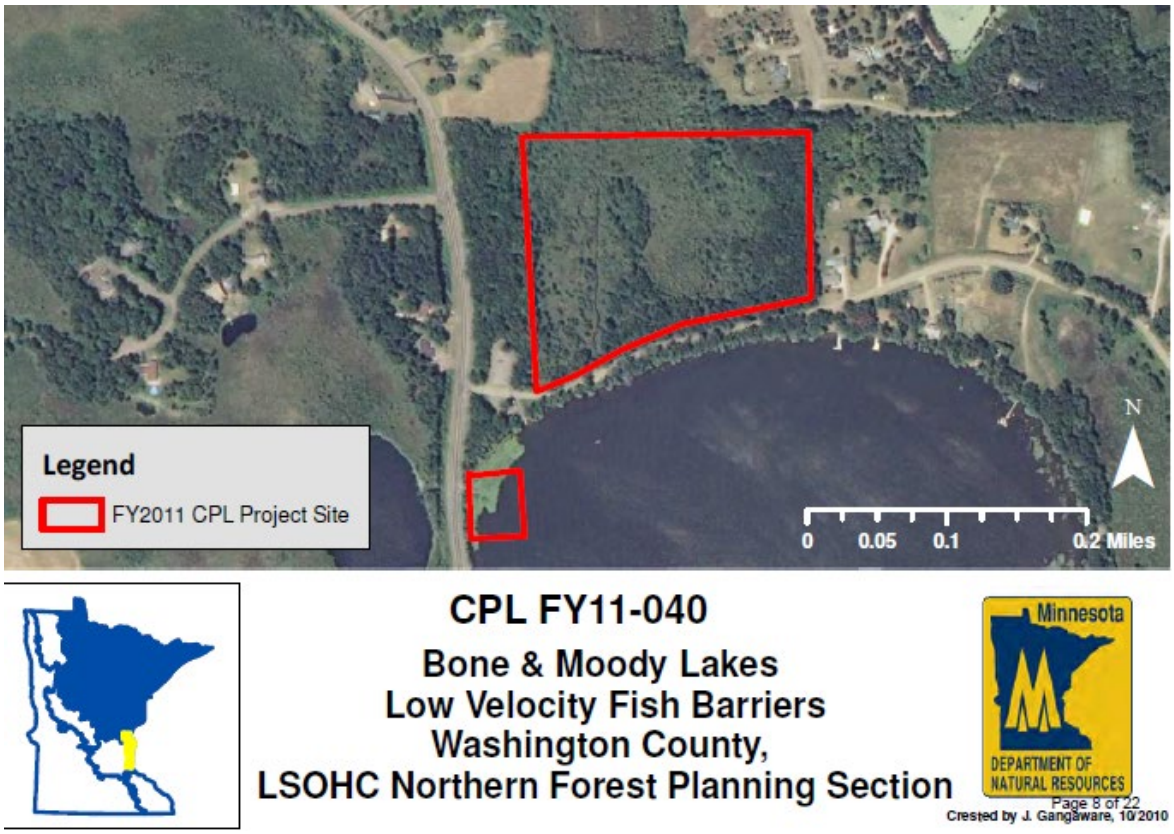


Figure 27. Map of project Site**.** Source: CPL grant application

Site Photographs

Photo 42. Barrier with retrofit at inlet of Bone Lake, photo taken during site visit 3/1/24.

6 Bone and Moody Lake Carp Barriers

Project Background

Latitude/Longitude: 45.291801/-92.865092

Project Manager / Organization: Mike Kinney/ Comfort Lake - Forest Lake Watershed District

Fund: OHF - CPL

Fiscal Year Funds: 2015

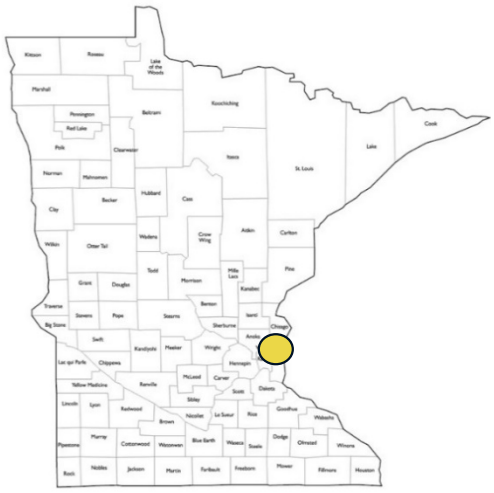
Project Start Date: March 2015

Project Complete Date: June 2015

Predominant Habitat type: Aquatic Habitat

Additional Habitat types:

Project Status: Post Establishment Phase



County: Washington

Primary Activity: Lake Shore Enhancement

Project Size: 256 Acres

Project Goals and Planning

(Site Assessment Preparation from Plan Sets and Documents)

1. ***What are the specific project components, management actions, or treatments?***
   This project involved retrofitting existing fish barriers with additional structures to prevent carp migration during high flows.
2. ***What project plans or project decision details are available? Who retains these plans?***
   CPL grant applications, work plan, and accomplishment reports were available from MDNR. Comfort Lake – Forest Lake Watershed District retains carp survey, aquatic vegetation, and water quality monitoring reports.
3. ***What are the stated goals of the project? List quantifiable measures of success if identified?***
   No project goals were stated in the grant application specifically for this retrofit but it can be assumed that the original goal of "controlling the proliferation of rough fish by using future mechanical harvesting in combination with the barriers to control rough fish populations" is still applicable.
4. ***What are the desired outcomes of achieving the stated goals?***
   Project objectives stated in the original CPL application are to "provide for the long-term enhancement of the native aquatic vegetation, a high-quality fishery, and improved water quality".
5. ***Are plans available?*** **Yes** ***Have project maps been created?*** **Yes**
   If yes, provide relevant examples in "site maps" and list maps provided:
   A map of the project area**,** CPL FY11-040 Bone & Moody Lakes Low Velocity Fish Barriers, is provided at the end of this evaluation.

6. ***List and briefly describe best management practices, standards, guidelines identified in plans.***
   The Watershed District worked closely with MDNR Fisheries and with local carp experts to design and implement the barrier system. Continued active common carp management is occurring and is a best management practice for controlling carp populations.

Project Implementation

(Questions for Site Manager and Cooperating Professionals)

7. ***Were alterations made to the plan during project implementation?***
   No
8. ***In what ways did alterations change the project outcome?***

Site Assessment

Field Review Date: **3/1/2024**

Field Visit Attendees: Anna Varian (Stantec), Wade Johnson (MDNR), Blayne Eineichner (Comfort Lake-Forest Lake Watershed District)

9. ***Surrounding Landscape Characteristics:***
   Bone Lake is located in rural Scandia, MN with most of the lakeshore, except the northwest corner, developed with homes. Moody Lake is located in rural Chisago, MN with sparse development surrounding the lake.

10. ***Site Characteristics:***
    a. ***Soil Series:***
    Open Water
    b. ***Topography:***
    The land surrounding Bone and Moody lakes is generally flat.
    c. ***Hydrology:***
    Bone Lake (82005400) is 221.45 acres with 124 acres of littoral area and a maximum depth of 30 feet. Moody Lake (13002300) drains to Bone Lake and is 45.33 acres with 22 acres of littoral area a mean depth of 10 feet and a maximum depth of 48 feet (MDNR).
    d. ***Vegetation: Plant Communities, Dominant Species & Invasives % Cover:***
    Additional seeding was added to the initial barrier, state Seed mix 35-241 and 35-221 were used; however, vegetation was not assessed during the site visit due to the timing of the site visit being outside of the growing season.
11. ***Is the plan based on current science?*** Yes
    This retrofit design with metal bars is a standard common carp barrier design. It is widely known that common carp contribute to water quality issues, especially in shallow lakes and reducing their populations can improve water quality conditions in these lakes. Reducing populations often requires multiple approaches and population maintenance. Removing adult carp and preventing or reducing access to spawning habitat are two approaches known to help control carp populations.
12. ***List indicators of project goals at this stage of the project:***

Water quality parameters are measured at a number of lakes with the Watershed District including Bone and Moody. Phosphorus, chlorophyll-a, and Secchi disk readings all show an improving trend in both lakes. Common carp surveys were conducted in Moody and Bone Lakes in 2015. No carp were sampled in Moody, but this was likely due to the inability of getting an electrofishing boat into Moody which is the preferred method of common carp sampling. Sampling in Bone Lake resulted in a biomass estimate of 122.1 kg/ha which is above the 100kg/ha threshold suggested by Bajer et al. (2009). It is unknown if any carp surveys were conducted prior to barrier installation so making conclusions based on this one survey is difficult.

13. ***Does the implementation of the project plan allow for achieving proposed goals?***
    Yes. Continuing to manage carp through barriers and removals as well as implementing other watershed improvements will help reduce carp populations and improve water quality within the watershed.
14. ***Are proposed future steps, including long term management, practical and reasonable?***
    Yes. The Watershed District is currently drafting a comprehensive AIS management plan that will include a schedule for rotational carp surveys. Continuing carp management as well as implementing other water quality improvement projects throughout the watershed will help reduce carp populations and improve water quality within the watershed.
15. ***What were potential challenges to the project and were there opportunities for improvement? Are corrections or modifications needed to achieve proposed goals?***
    The challenge was retrofitting an existing structure. The result is similar to other carp barriers across the state. No further corrections are needed.
16. ***Are follow-up assessments by the Restoration Evaluation Program needed? Explain.***
    No. Carp management is continuing as anticipated within the watershed and there are future plans for additional watershed work to help further improve water quality.
17. ***Additional comments on the restoration project.***
    The Comfort Lake – Forest Lake Watershed District worked closely with MDNR fisheries to determine if fish barriers were appropriate for this system. Native fish movement is always a concern when proposing to add barriers. The barriers did not pose a concern to MDNR fisheries, native fish in those connecting habitats were healthy and had access to the habitats needed to complete their life cycle. Unfortunately, many of our aquatic ecosystems have been invaded by invasive and non-native species that have disrupted or severely harmed the native ecosystem. Placing a barrier can be a difficult decision where it must be determined if continued connectivity, or removal/reduction/prevention of invasive species is better for the native ecosystem. Depending on the species and habitats present, in some cases it may be best for the native ecosystem to remove connectivity in order to recover; maintaining connectivity may not provide much help for the native ecosystem if the system is severely degraded by invasives.

Project Evaluation

Projects can be designated as likely to not meet proposed outcomes, minimally meet proposed outcomes, meet proposed outcomes, or exceed proposed outcomes with a low, medium, or high degree of confidence in the determination.

18. ***The project has:***
    Achieved the stated goals.
19. ***The project will:***

Meet proposed outcomes.

Confidence of outcome determination:

Medium.

20. ***Provide explanation of reason(s) for determination.***

    The barrier structures were installed as planned. Successful carp management requires multiple approaches and long-term commitments. The Watershed District is currently drafting a comprehensive AIS management plan that will include a schedule for rotational carp surveys. Continued carp management including surveys, removals, aeration, and other watershed improvements should lead to improved water quality within the watershed.

21. ***Site Assessor(s) conducting field review:***

    Anna Varian - Stantec

Site Maps, Project Plans or Vegetation Tables

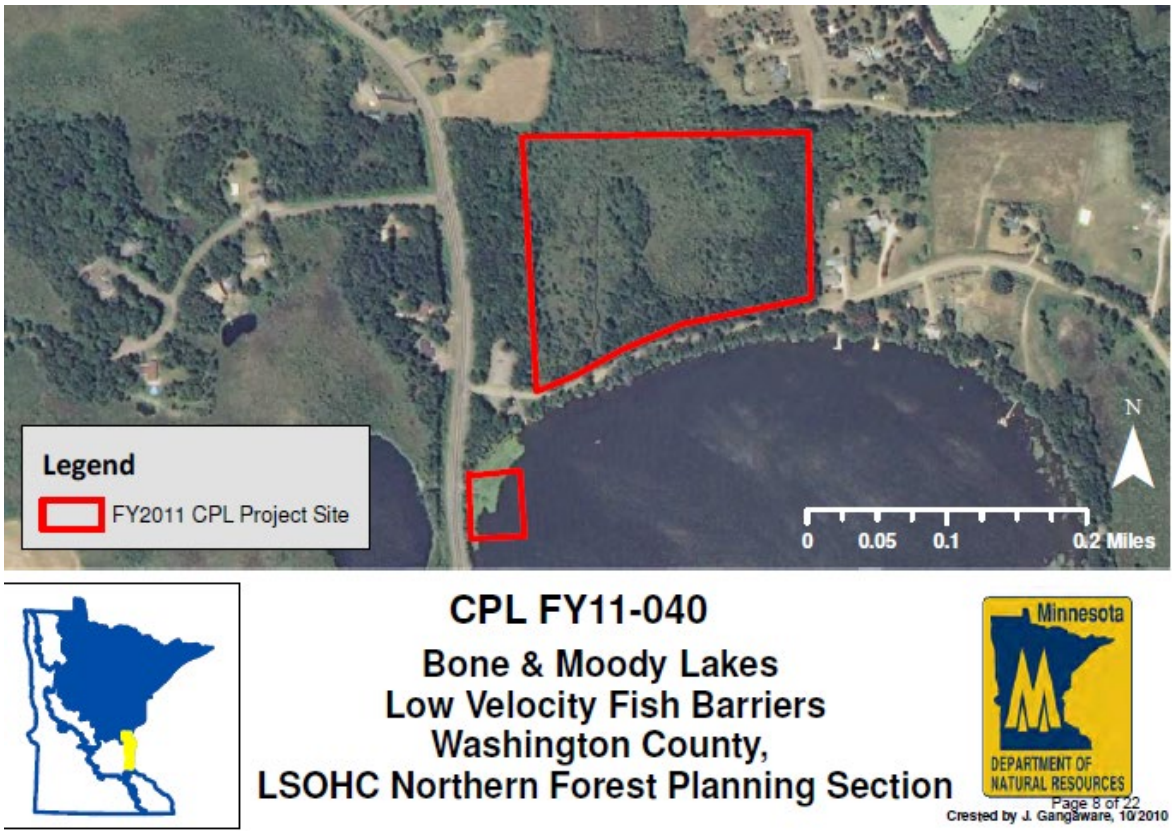


Figure 28 Map of project Site**.**

Site Photographs

Photo 43 Barrier with retrofit at inlet of Bone Lake, photo taken during site visit 3/1/24.

7 Typo and Martin Lakes Carp Barriers

Project Background

Latitude/Longitude: 45.385136/-93.085739

Project Manager / Organization: Jamie Schurbon / Anoka Conservation District

Fund: OHF - CPL

Fiscal Year Funds: 2014, 2017

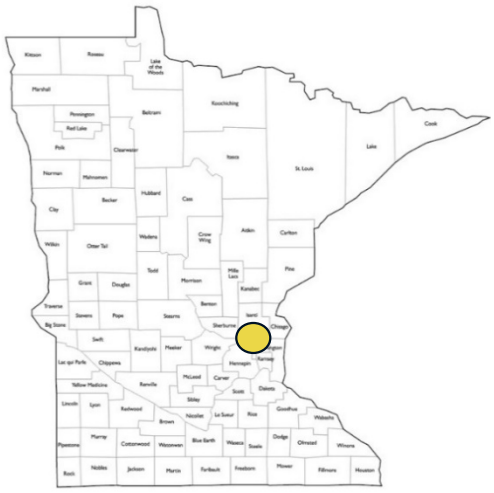
Project Start Date: April 2014

Project Complete Date: July 2017

Predominant Habitat type: Aquatic Habitat

Additional Habitat types:

Project Status: Post Establishment Phase



County: Anoka

Primary Activity: Lake Shore Enhancement

Project Size: 528 acres

Project Goals and Planning

(Site Assessment Preparation from Plan Sets and Documents)

1. ***What are the specific project components, management actions, or treatments?***
   This project involved the installation of 4 common carp barriers at the inlets and outlet of Martin Lake and outlet of Typo Lake. Two of the four barriers (between Typo and Martin Lake) have removable grates that are removed to allow game fish such as northern pike to access spawning grounds and put back into place prior to carp movement.
2. ***What project plans or project decision details are available? Who retains these plans?***
   Martin and Typo Lakes Carp Management Report and Future Management Feasibility Assessment, September 2019. CPL grant accomplishment reports 2015, 2017. Lake Water Quality Report. Project work plans and designs. These documents are retained by MDNR and the Anoka Conservation District
3. ***What are the stated goals of the project? List quantifiable measures of success if identified?***
   The barriers will, as stated in the work plan, "a) prevent seasonal carp migration between favored spawning areas (Typo Lake and tributary creeks) and overwintering areas (Martin Lake), thereby reducing their populations. b) Make commercial carp harvests more effective by preventing escape to surrounding waterbodies and recolonization after harvest". Expected quantitative outcomes include a reduction of carp populations over time and reducing internal phosphorus loading in Typo Lake by 50% (a reduction of 501 lbs/yr) and an additional 250 lbs/yr downstream in Martin Lake.
4. ***What are the desired outcomes of achieving the stated goals?***

Qualitative outcomes include improvements to aquatic plant abundance, shift the fishery toward greater game fish biomass and improve usage of the lakes by waterfowl and other wildlife.

5. ***Are plans available?*** **Yes** ***Have project maps been created?*** **Yes**
   If yes, provide relevant examples in "site maps" and list maps provided:
   A carp barrier locations map is provided below in site maps.
6. ***List and briefly describe best management practices, standards, guidelines identified in plans.***
   BMPs identified in plans include silt curtain and temporary coffer dam details. Standards includes bar spacing of barriers. Continued active common carp management is occurring and is a best management practice for controlling carp populations.

Project Implementation

(Questions for Site Manager and Cooperating Professionals)

7. ***Were alterations made to the plan during project implementation?***
   No

8. ***In what ways did alterations change the project outcome?***

Site Assessment

Field Review Date: **3/1/2024**

Field Visit Attendees: Anna Varian (Stantec), Wade Johnson (MNDNR), and Jamie Schurbon (Anoka SWCD)

9. ***Surrounding Landscape Characteristics:***
   The lakes are located in rural Anoka County. The southern half of Typo Lake is populated with houses while the northern half is mostly natural shoreline. Martin Lake's shoreline is densely populated with homes.
10. ***Site Characteristics:***
    a. ***Soil Series:***
    Open Water
    b. ***Topography:***
    The land surrounding the lakes is generally flat.
    c. ***Hydrology:***
    Martin Lake (02003400) is 232 acres with 140 acres of littoral area and a maximum depth of 20 feet. Typo Lake (30000900) is 298 acres with 298 acres of littoral areas and a maximum depth of 6 feet. Island Lake and Typo Lake both flow into Martin Lake which then flows into the West Branch Sunrise River and into the St. Croix River.
    d. ***Vegetation: Plant Communities, Dominant Species & Invasives % Cover:***
    N/A
11. ***Is the plan based on current science?*** Yes
    It is widely known that common carp contribute to water quality issues, especially in shallow lakes. Reducing carp populations can improve water quality conditions. Reducing populations often requires

multiple approaches and population maintenance. Removing adult carp and preventing or reducing access to spawning habitat are two approaches known to help control carp populations.

12. ***List indicators of project goals at this stage of the project:***
    Carp biomass has been reduced by 40% in Typo Lake and 30% in Martin lake through removals (2017-2019) and migration prevention. The MPCA and Anoka Conservation District conduct water quality monitoring on Typo and Martin Lakes. The 2023 water quality report includes a trend analysis of water quality in both Typo and Martin Lakes that shows statistically significant improvements in both lakes. Martin Lake's average total phosphorus over the last five years has improved to close to the state impairment standard.
13. ***Does the implementation of the project plan allow for achieving proposed goals?***
    Yes. Continuing to manage carp through barriers and removals as well as implementing other watershed improvements will help reduce carp populations and improve water quality within the watershed.
14. ***Are proposed future steps, including long term management, practical and reasonable?***
    Yes. The Conservation District has a good working relationship with the township that manages the carp barriers and MDNR fisheries. It is important that the barriers are maintained and that removal grates are in place at the correct times of the year, this relationship ensures that. It's also important that carp management continues to remove existing adult fish and assess successful spawning and year class strength. Carp surveys and removals have occurred since the barriers have been put in place and the Conservation District acknowledges that carp management will be an ongoing process within these lakes and is dedicated to this long-term management. Additionally, the District is implementing several other projects within this watershed to help improve water quality within the lakes.
15. ***What were potential challenges to the project and were there opportunities for improvement? Are corrections or modifications needed to achieve proposed goals?***
    Challenges included designing and installing site specific barriers, the project overcame those challenges and installed barriers with different designs and slightly different maintenance needs at each site. As a result of overcoming these challenges Anoka Conservation District is advising other watershed and conservation districts with their barrier plans. No corrections are needed.
16. ***Are follow-up assessments by the Restoration Evaluation Program needed? Explain.***
    No. Carp management is continuing as anticipated within the watershed and there are future plans for additional watershed work to help further improve water quality.
17. ***Additional comments on the restoration project.***
    The Anoka County Conservation District worked closely with MDNR fisheries to determine if fish barriers were appropriate for this system. Native fish movement is always a concern when proposing to add barriers. In this case to accommodate some native fish movement, two of the four barriers are only in place during common carp migration times, the Anoka Conservation District works closely with MDNR Fisheries to determine exactly when those barriers need to be in place. The two full-time barriers did not pose a concern to MDNR fisheries, native fish in those connecting habitats were healthy and had access to the habitats needed to complete their life cycle. Unfortunately, many of our aquatic ecosystems have been invaded by invasive and non-native species that have disrupted or severely harmed the native ecosystem. Placing a barrier can be a difficult decision where it must be determined if continued connectivity, or removal/reduction/prevention of invasive species is better for the native ecosystem. Depending on the species and habitats present, in some cases it may be best for the native ecosystem to remove connectivity in order to recover; maintaining connectivity may not provide much help for the native ecosystem if the system is severely degraded by invasives.

Overall, Anoka Conservation District is dedicated to long-term management of the common carp population and dedicated to additional watershed work that is needed to ensure continued water quality improvements. This long-term management and collaborating projects are key to the success of carp barrier projects.

Project Evaluation

Projects can be designated as likely to not meet proposed outcomes, minimally meet proposed outcomes, meet proposed outcomes, or exceed proposed outcomes with a low, medium, or high degree of confidence in the determination.

18. ***The project has:***
    Achieved the stated goals.
19. ***The project will:***
    Meet proposed outcomes.
    Confidence of outcome determination:
    High.
20. ***Provide explanation of reason(s) for determination.***
    Carp biomass has been reduced by 40% in Typo Lake and 30% in Martin lake through removals and migration prevention. Water quality has seen significant improvements over the years including reductions in phosphorus with Martin Lake's average total phosphorus over the last five years improving to close to the state impairment standard. The Anoka County Conservation District is committed to improving water quality within the watershed by continuing carp management and pursuing additional projects within the watershed
21. ***Site Assessor(s) conducting field review:***

    Anna Varian - Stantec

Site Maps, Project Plans or Vegetation Tables

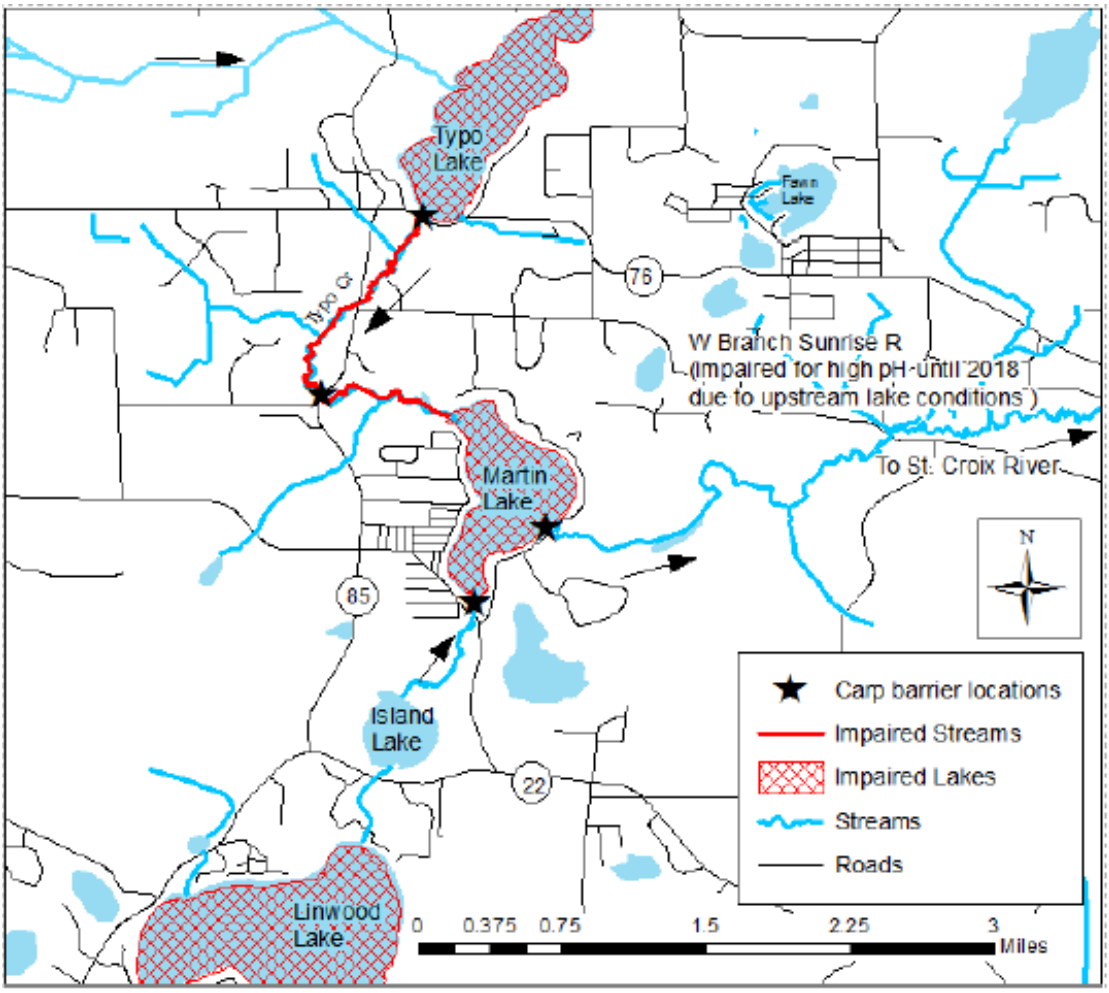


Figure 29 Carp barrier locations. (Source: Martin and Typo Lakes Carp Management Report and Future Management Feasibility Assessment, 2019, Carp Solutions and Anoka Conservation District

Site Photographs

Photo 44. Martin Lake inlet barrier, photo taken during site visit 3/1/24.

Photo 45. Martin Lake outlet barrier, photo taken during site visit 3/1/24.

Photo 46. Typo Creek barrier with barrier grates not currently in place, photo taken during site visit 3/1/24.

Photo 47. Typo Lake outlet barrier with barrier grates not currently in place, photo taken during site visit 3/1/24.

8 Spring Lake Carp Management

Project Background

Latitude/Longitude: 44.6921, -93.4924

Project Manager / Organization: Maggie Karschinia / Prior Lake – Spring Lake Watershed District

Fund: OHF - CPL

Fiscal Year Funds: 2017

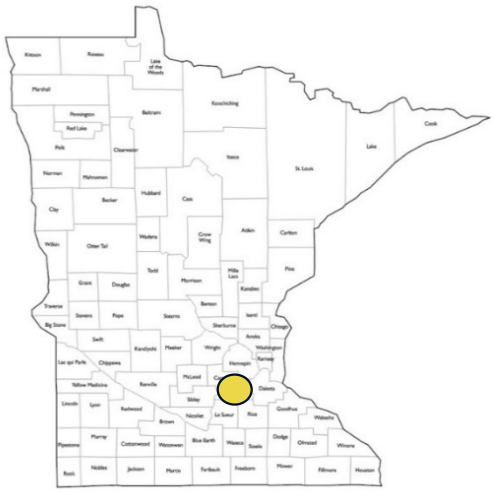
Project Start Date: May 2017

Project Complete Date: June 2017

Predominant Habitat type: Aquatic Habitat

Additional Habitat types:

Project Status: Post Establishment Phase



County: Scott

Primary Activity: Lake Shore Enhancement

Project Size: 590 acres

Project Goals and Planning

(Site Assessment Preparation from Plan Sets and Documents)

1. ***What are the specific project components, management actions, or treatments?***
   This project involved the installation of a seasonal common carp barrier and passive integrated transponder (PIT) tag antenna at the same location to track carp movement near the barrier and better establish migration timing.
2. ***What project plans or project decision details are available? Who retains these plans?***
   CPL grant documents were available from MDNR. The Prior Lake – Spring Lake Watershed District's Integrated Pest Management Plan for Common Carp (2023) as well as other documents and carp management information is available on the Watershed District's website.
3. ***What are the stated goals of the project? List quantifiable measures of success if identified?***
   The goal was to reduce the common carp population in Spring Lake.
4. ***What are the desired outcomes of achieving the stated goals?***
   The expected outcomes of common carp management along with other watershed improvements are ecological improvements in Spring Lake and a common carp population that is below damaging levels.
5. ***Are plans available?*** **No** ***Have project maps been created?*** **Yes**
   If yes, provide relevant examples in "site maps" and list maps provided:
   A map including the location of the barrier is included below.
6. ***List and briefly describe best management practices, standards, guidelines identified in plans.***

Continued active common carp management is occurring and is a best management practice for controlling carp populations.

Project Implementation

(Questions for Site Manager and Cooperating Professionals)

7. ***Were alterations made to the plan during project implementation?***
   Yes
   The barrier was found to not be functioning as expected in 2017 and during re-installation of the barrier in spring 2018 modifications to the barrier were made. A potential breach in the barrier was identified which led to adjustments to the paddle system. High water caused the stream to flood and provide access for carp around the barrier and so temporary net walls were installed on either side of the barrier
8. ***In what ways did alterations change the project outcome?***
   These alterations improved the chances of stopping upstream migration of carp.

Site Assessment

Field Review Date: **N/A**

Field Visit Attendees: N/A

9. ***Surrounding Landscape Characteristics:***
   Spring Lake's shoreline is densely populated with homes and the surrounding areas is partially dense suburbs and partially agricultural land.
10. ***Site Characteristics:***
    a. ***Soil Series:***
    Open water.
    b. ***Topography:***
    The land surrounding is generally flat.
    c. ***Hydrology:***
    Spring Lake (70005400) is 592 acres with 290 acres of littoral area and a maximum depth of 37 feet. A few small lakes and ponds flow into Spring Lake, which then flows into Upper Prior Lake, Lower Prior Lake, and eventually to the Minnesota River.
    d. ***Vegetation: Plant Communities, Dominant Species & Invasives % Cover:***
    N/A
11. ***Is the plan based on current science?*** Yes
    It is widely known that common carp contribute to water quality issues, and reducing their populations can improve water quality conditions in these lakes. Reducing populations often requires multiple approaches and population maintenance. Removing adult carp and preventing or reducing access to spawning habitat are two approaches known to help control carp populations.
12. ***List indicators of project goals at this stage of the project:***
    The barrier was installed as anticipated; however, it did not function as desired. Radio tagged fish were located above the barrier after installation. The barrier was removed in 2019 and a push trap was installed to trap carp at that location.
13. ***Does the implementation of the project plan allow for achieving proposed goals?***

Yes, the plan to manage carp through barriers and removals will help control common carp populations.

14. ***Are proposed future steps, including long term management, practical and reasonable?***
    Yes, the watershed district's integrated pest management plan for common carp is thorough and practical. Proposed future steps include mechanical removal, carp surveys, barriers, and bluegill stocking.
15. ***What were potential challenges to the project and were there opportunities for improvement? Are corrections or modifications needed to achieve proposed goals?***
    The challenge was trying to put a barrier in a stream channel. There was no culvert available or other pinch point to add a barrier to which is a more common method of barrier installation. Modifications were made to the barrier to improve its ability to stop carp migration and eventually the barrier was replaced with a different structure.
16. ***Are follow-up assessments by the Restoration Evaluation Program needed? Explain.***
    No, the drum barrier is no longer in use.
17. ***Additional comments on the restoration project.***
    The Prior Lake - Spring Lake Watershed District is dedicated to managing carp populations long-term, they've developed a detailed integrated pest management plan with plans for surveys and removals years into the future. Native fish movement is always a concern when proposing to add barriers. Unfortunately, many of our aquatic ecosystems have been invaded by invasive and non-native species that have disrupted or severely harmed the native ecosystem. Placing a barrier can be a difficult decision where it must be determined if continued connectivity, or removal/reduction/prevention of invasive species is better for the native ecosystem. Depending on the species and habitats present, in some cases it may be best for the native ecosystem to remove connectivity in order to recover; maintaining connectivity may not provide much help for the native ecosystem if the system is severely degraded by invasives.

Project Evaluation

Projects can be designated as likely to not meet proposed outcomes, minimally meet proposed outcomes, meet proposed outcomes, or exceed proposed outcomes with a low, medium, or high degree of confidence in the determination.

18. ***The project has:***
    Not achieved the stated goals.
19. ***The project will:***
    Likely not meet proposed outcomes.
    Confidence of outcome determination:
    High.
20. ***Provide explanation of reason(s) for determination.***
    The barrier structure was constructed as planned; however, it did not function as desired. Tagged carp were determined to be passing through the barrier, multiple modifications to the barrier were needed and eventually it was removed.
21. ***Site Assessor(s) conducting field review:***

    Anna Varian - Stantec

Site Maps, Project Plans or Vegetation Tables

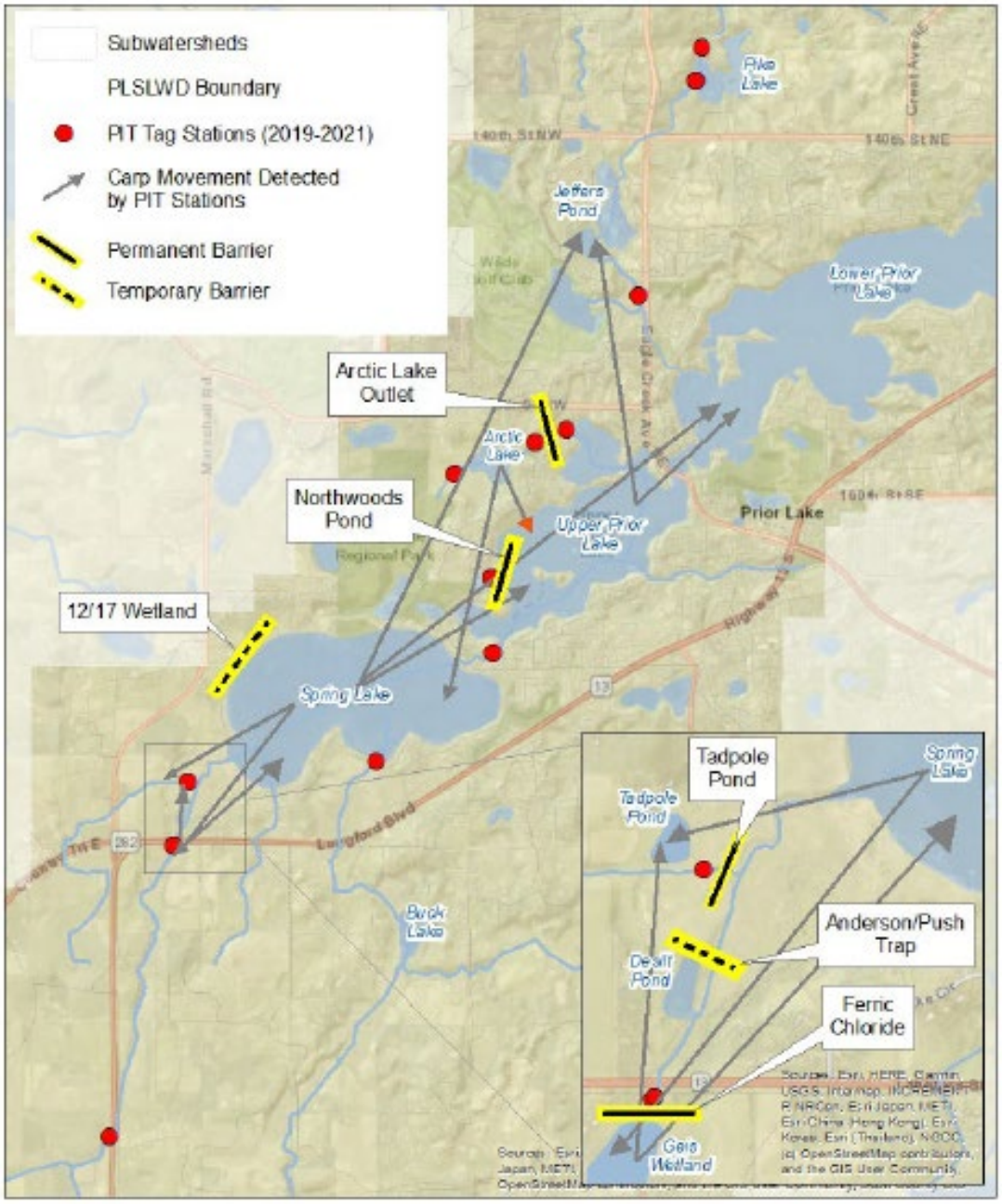


Figure 30 Map of barrier locations on Spring Lake and Prior Lake system, the Anderson/Push Trap at the mouth of Desilt Pond is the general location of the drum barrier evaluated in this report. Source: 2023 Integrated Pest Management Plan for Common Carp, prepared by WSB.

9 Shields Lake Fish Barrier

Project Background

Latitude/Longitude: 45.26773, -92.94592

Project Manager / Organization: Mike Kinney / Comfort Lake – Forest Lake Watershed District

Fund: OHF - CPL

Fiscal Year Funds: 2017

Project Start Date: 2017

Project Complete Date: August 2019

Predominant Habitat type: Aquatic Habitat

Additional Habitat types:

Project Status: Post Establishment Phase

County: Washington

Primary Activity: Lake Shore Enhancement

Project Size: 1 acre

Project Goals and Planning

(Site Assessment Preparation from Plan Sets and Documents)

1. ***What are the specific project components, management actions, or treatments?***
   This project involved adding an additional structure to an existing electric fish barrier to prevent common carp migration between Forest Lake and Shields Lake.
2. ***What project plans or project decision details are available? Who retains these plans?***
   CPL grant applications, work plan, and accomplishment reports were available from MDNR. Comfort Lake – Forest Lake Watershed District retains carp survey reports.
3. ***What are the stated goals of the project? List quantifiable measures of success if identified?***
   The goal of the project is to prevent the movement of rough fish between Forest Lake and Shields Lake.
4. ***What are the desired outcomes of achieving the stated goals?***
   The desired outcome as stated in the grant application is to "preserve the sport fishery and water quality of Forest Lake."
5. ***Are plans available?*** **No** ***Have project maps been created?*** **No**
   If yes, provide relevant examples in "site maps" and list maps provided:

6. ***List and briefly describe best management practices, standards, guidelines identified in plans.***
   The Watershed District worked closely with MDNR Fisheries and with local carp experts to design and implement the barrier system. This design with metal bars at a culvert is a standard common carp

barrier design. Continued active common carp management is occurring and is a best management practice for controlling carp populations.

Project Implementation

(Questions for Site Manager and Cooperating Professionals)

7. ***Were alterations made to the plan during project implementation?***
   No

8. ***In what ways did alterations change the project outcome?***

Site Assessment

Field Review Date: **3/1/2024**

Field Visit Attendees: Anna Varian (Stantec), Wade Johnson (MDNR), Blayne Eineichner (Comfort Lake-Forest Lake Watershed District)

9. ***Surrounding Landscape Characteristics:***
   Forest Lake is a popular recreational lake with a shoreline that's densely populated with homes. Upstream, Shields Lake is partially natural shoreline and partially bordered by a golf course.
10. ***Site Characteristics:***
    a. ***Soil Series:***
    Open Water
    b. ***Topography:***
    The land surrounding the project area is generally flat.
    c. ***Hydrology:***
    Shields Lake (82016200) is 30 acres with 22 acres of littoral area and a maximum depth of 27 feet. Shields Lake flows into Forest Lake (82015900) a 2,271 acre lake with 1,531 acres of littoral area and a maximum depth of 37 feet.
    d. ***Vegetation: Plant Communities, Dominant Species & Invasives % Cover:***
    N/A
11. ***Is the plan based on current science?*** Yes
    This design with metal bars is a standard common carp barrier design. It is widely known that common carp contribute to water quality issues, especially in shallow lakes and reducing their populations can improve water quality conditions in these lakes. Reducing populations often requires multiple approaches and population maintenance. Removing adult carp, aerating shallow lakes to prevent winter kill of game species, and preventing or reducing access to spawning habitat are approaches known to help control carp populations.
12. ***List indicators of project goals at this stage of the project:***
    The barrier structure is still in place and appears to be functioning as intended with only minimal maintenance. Carp surveys and removal efforts are continuing on Shields Lake. In 2018 a common carp abundance survey was conducted and in 2019 and 2022 removal efforts took place. Carp biomass in

Shields Lake has been reducing over the course of these surveys. A carp survey was completed in Forest Lake in 2023 and carp densities were found to be below the 100kg/ha threshold.

13. ***Does the implementation of the project plan allow for achieving proposed goals?***
    Yes. Continuing to manage carp through barriers and removals, as well as aerating Shields Lake to prevent winter kill of predator fish, and implementing other watershed improvements will help reduce carp populations and improve water quality within the watershed.
14. ***Are proposed future steps, including long term management, practical and reasonable?***
    Yes. Maintaining the barrier and continuing to manage carp through removals and surveys as well as lake aeration in Shields Lake will help reduce carp populations and improve water quality within the watershed. The Watershed District is currently drafting a comprehensive AIS management plan that will include a schedule for rotational carp surveys.
15. ***What were potential challenges to the project and were there opportunities for improvement? Are corrections or modifications needed to achieve proposed goals?***
    Challenges included an initial contract decline by a contractor due to rising steel prices, this delayed fabrication and installation by two years. No modifications are needed.
16. ***Are follow-up assessments by the Restoration Evaluation Program needed? Explain.***
    No. Carp management is continuing as anticipated within the watershed.
17. ***Additional comments on the restoration project.***
    The Comfort Lake – Forest Lake Watershed District worked closely with MDNR fisheries to determine if fish barriers were appropriate for this system. In addition to the barrier evaluated here a new barrier has been installed at the outlet of Forest Lake. Native fish movement is always a concern when proposing to add barriers. The barriers did not pose a concern to MDNR fisheries, native fish in those connecting habitats were healthy and had access to the habitats needed to complete their life cycle. Unfortunately, many of our aquatic ecosystems have been invaded by invasive and non-native species that have disrupted or severely harmed the native ecosystem. Placing a barrier can be a difficult decision where it must be determined if continued connectivity, or removal/reduction/prevention of invasive species is better for the native ecosystem. Depending on the species and habitats present, in some cases it may be best for the native ecosystem to remove connectivity in order to recover; maintaining connectivity may not provide much help for the native ecosystem if the system is severely degraded by invasives.

Project Evaluation

Projects can be designated as likely to not meet proposed outcomes, minimally meet proposed outcomes, meet proposed outcomes, or exceed proposed outcomes with a low, medium, or high degree of confidence in the determination.

18. ***The project has:***
    Achieved the stated goals.
19. ***The project will:***
    Minimally meet proposed outcomes.
    Confidence of outcome determination:
    Medium.
20. ***Provide explanation of reason(s) for determination.***

The goal of blocking rough fish migration between Shields and Forest Lake was successfully met with the barrier installed; however, assessing the success of the desired outcome of preserving the sport fishery and water quality in Forest Lake is difficult. Continued maintenance of the barrier, aeriation of Shields Lake and carp survey and removal efforts in Shields Lake will help control the carp population and prevent migration into Forest Lake. A common carp survey was conducted in 2023 in Forest Lake and found carp densities to currently be below the 100kg/ha threshold.

21. ***Site Assessor(s) conducting field review:***

Anna Varian - Stantec

Site Photographs

Photo 48. Barrier between Shields Lake and Forest Lake, photo taken during site visit 3/1/24.

10 MN DNR Inspiration Peak

Project Background

Latitude/Longitude: Lat. 46.136321, Lon -95.573760

Project Manager / Organization: Cindy Lueth, Resource Specialist, SR; MN DNR Parks & Trails

Fund: PTF

Fiscal Year Funds: 2015-2022

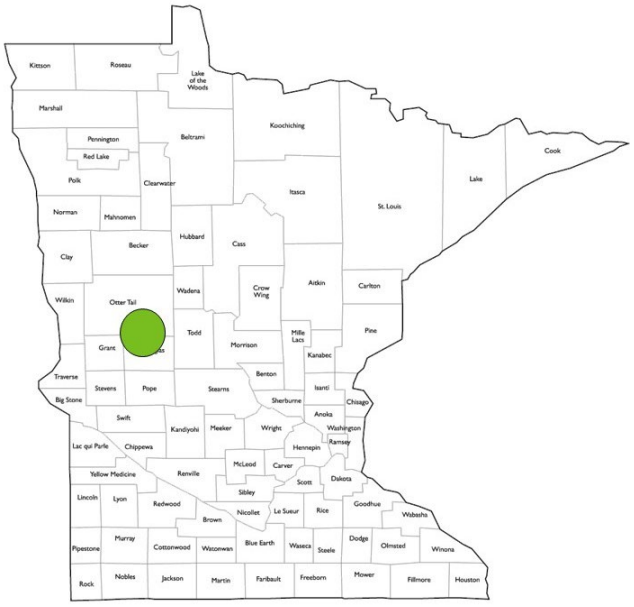
Project Start Date: 2015

Project Complete Date: 2022

Predominant Habitat type: Prairie / Savanna / Grassland

Additional Habitat types:

Project Status: Post Establishment Phase



County: Otter Tail

Primary Activity: Prairie Enhancement

Project Size: Approximately 15 acres

Project Goals and Planning

(Site Assessment Preparation from Plan Sets and Documents)

1. ***What are the specific project components, management actions, or treatments?***
   Restoration of dry, sand-gravel prairie and oak woodland at Inspiration Peak through forestry mowing, mowing and spot foliar treatment of invasive, nonnative herbaceous and woody plants.
2. ***What project plans or project decision details are available? Who retains these plans?***
   State Parks & Trails Resource Specialists plan and conduct work on an annual basis. Work plans are developed for each park/site, adjusted annually and implemented as time and site conditions allow. No project-specific design plans were developed for this project.
3. ***What are the stated goals of the project? List quantifiable measures of success if identified?***
   The long-term goal is for the sand-gravel hill prairie to be returned to "pre-European settlement" conditions, to the best of DNR's ability.
4. ***What are the desired outcomes of achieving the stated goals?***
   The desired outcome as related by MN DNR Resource Specialist is to reach a point of "maintenance" status where management activities might include occasional prescribed fire, woody stem removal and light weed control. DNR staff recognize that buckthorn will never be 100% eliminated from either site due to the presence of seed-bearing trees in neighboring properties.

5. ***Are plans available?*** No ***Have project maps been created?*** Yes
   If yes, provide relevant examples in "site maps" and list maps provided:
   A map was developed by MN DNR staff that summarizes by-year (and in some cases by invasive species) management activities from 2015 to 2022.
6. ***List and briefly describe best management practices, standards, guidelines identified in plans.***

Project Implementation

(Questions for Site Manager and Cooperating Professionals)

7. ***Were alterations made to the plan during project implementation?***
   No
   No specific longitudinal plan was created for restoration of this area. However, some adjustments were made during parks staff annual resource planning efforts, employing adaptive management in response to response of the site vegetation to management, weather, available labor and equipment, and other factors.
8. ***In what ways did alterations change the project outcome?***
   Employment of adaptive management allowed for adjustment of applied tools, timing and methods to keep the effort on a positive restoration/improvement trajectory.

Site Assessment

Field Review Date: 7/18/2023

Field Visit Attendees: Cindy Lueth, MN DNR Parks and Trails Resource Specialist; Gina Quiram, MN DNR; Paul Bockenstedt, Stantec

9. ***Surrounding Landscape Characteristics:***
   Inspiration Peak has approximately 200 feet of elevation change from the peak of the hill to the lowest point (of the State Wayside) and the peak is about 310 feet higher than the surrounding landscape. Vegetation on the slopes/shoulders of Inspiration Peak is mostly a Bur Oak Woodland with approximately seven acres of Dry Sand Gravel Prairie on the highest points. As related by MN DNR staff, species of wildlife in the area are common and typical of bur oak woodland and dry sand-gravel prairie. One state-listed plant species is known to occur here.
10. ***Site Characteristics:*** Soils here are moderately well drained and well drained.
    a. Soil Series:
    Lida-Two Inlets Complex eight to 30 percent slopes. USDA NRCS Soil Survey soil series description has soil textures at surface as sandy loam and loamy sand. However, coarse sand and gravels were observed at the soil surface, particularly in the open prairie areas.
    b. Topography:
    The site is characterized by moderately steep to steep slopes.
    c. Hydrology:
    The site is a hilltop prairie surrounded by oak woodland. There are no wetlands or perennial streams present in the project area.
    d. Vegetation: Plant Communities, Dominant Species & Invasives % Cover:

The open areas on the hilltop are characterized by moderate to good quality dry prairie (UPs13b – Dry Sand-Gravel Prairie). Moderate quality prairie areas are dominated by a mix of native grasses and forbs, nonnative grasses, as well as woody brush/small trees (including smooth sumac, red raspberry, wolfberry, and buckthorn). The managed oak woodland edges are characterized by relatively young to mid-sized bur oak (generally two to eight inches in diameter) with native (red raspberry, sumac, buckbrush) and nonnative (buckthorn) brush common, as well as both prairie and oak woodland herbaceous species present with composition varying based on density of brush present at the time when vegetation management was initiated.

11. ***Is the plan based on current science?*** Yes
    The tools, methods, and timing of work were conducted within the range of practices that are currently considered as effective for invasive woody brush management (including buckthorn management).
12. ***List indicators of project goals at this stage of the project:***
    The total amount of brush cover in portions of the prairie that had been dominated by invasive brush prior to project start has been significantly reduced with remaining brush cover mostly represented by wolfberry and red raspberry. The bur oak woodland fringes around the prairie have also seen a significant reduction in total brush cover with remaining brush being less dense and shorter than pre-management.
13. ***Does the implementation of the project plan allow for achieving proposed goals?***
    The work that has been conducted at this site over the last seven years is part of a longer-term effort to restore the prairie and oak woodland (savanna) along the slopes of Inspiration Peak within the State Wayside and has contributed to the probability of reaching the goals for this site.
14. ***Are proposed future steps, including long term management, practical and reasonable?***
    Yes. Future work will be conducted as resources allow and is anticipated to include additional initial woody invasive brush management further into the oak woodland areas, as well as follow-up mow/spot spray to build on progress made in areas where previous initial restoration efforts have been made.
15. ***What were potential challenges to the project and were there opportunities for improvement? Are corrections or modifications needed to achieve proposed goals?***
    Limited funding and resources to implement initial restoration in new acres as well as maintaining previous restoration areas poses a challenge/risk to sustaining early gains. No corrections/modifications are recommended at this time – this site/project benefits from having regular assessment and annual work planning by MN DNR Parks & Trails staff.
16. ***Are follow-up assessments by the Restoration Evaluation Program needed? Explain.***
    Not likely, although it may be beneficial to follow up on the results of ongoing efforts to further reduce woody brush in prairie area and make progress further into oak woodland areas down slope from the prairie openings.
17. ***Additional comments on the restoration project.***
    This project has benefitted in part from the dedication of a particular MN DNR Parks & Trails employee who has taken a personal interest in and ownership of ecological restoration at this site.

Project Evaluation

Projects can be designated as likely to not meet proposed outcomes, minimally meet proposed outcomes, meet proposed outcomes, or exceed proposed outcomes with a low, medium, or high degree of confidence in the determination.

18. ***The project has:***
    Achieved the stated goals.
19. ***The project will:***
    Meet proposed outcomes.
    Confidence of outcome determination:
    High.
20. ***Provide explanation of reason(s) for determination.***
    This site/project benefits from having regular assessment and annual work planning by MN DNR Parks & Trails staff, although there are limited ongoing financial resources across the State Park (and Wayside) system, DNR staff have been able to pace restoration work appropriately with available resources to maintain past restoration work at this site.
21. ***Site Assessor(s) conducting field review:***

    Paul Bockenstedt, Stantec

Site Maps, Project Plans or Vegetation Tables

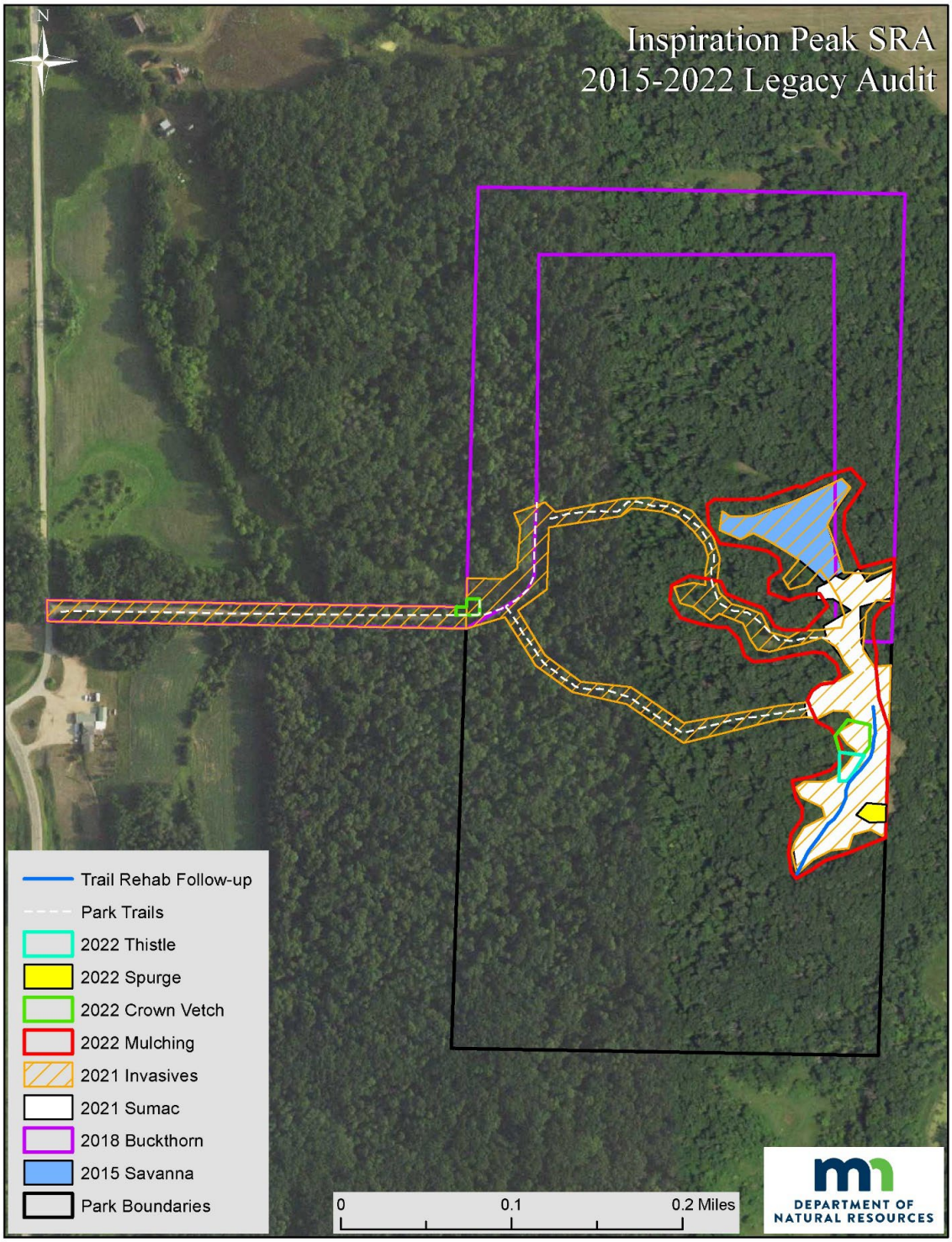


Figure 31 Map of Inspiration Peak project site indicating type of vegetation management work conducted by year (source: MN DNR Parks and Trails Resource Specialist).

Table 2 Inspiration Peak vegetation meander survey results[1].

Scientific Name	**Common Name**	**Cover Class**	**Seeded? (Y/N)***	**Status**
Achillea millefolium	Yarrow	0-1%	No	Native
Agastache foeniculum	blue hyssop	0-1%	No	Native
Allium stellatum	prairie onion	0-1%	No	Native
Ambrosia artemisiifolia	prairie sage	0-1%	No	Native
Amelanchier alnifolia	saskatoon juneberry	1- 5%	No	Native
Amorpha canescens	leadplant	5-25%	No	Native
Andropogon gerardii	big bluestem	1- 5%	No	Native
Anemone patens var. multifida	pasqueflower	0-1%	No	Native
Antennaria plantaginifolia	plantain-leaved pussytoes	0-1%	No	Native
Apocynum androsaemifolium	spreading dogbane	5-25%	No	Native
Artemisia absinthium	absinthe wormwood	0-1%	No	Native
Artemisia campestris subsp. caudata	field sagewort	0-1%	No	Native
Asclepias lanuginosa	woolly milkweed	0-1%	No	Native
Asclepias syriaca	common milkweed	1- 5%	No	Native
Asclepias viridiflora	tall green milkweed	0-1%	No	Native
Asparagus officinalis	asparagus	0-1%	No	Nonnative
Bouteloua curtipendula var. curtipendula	side-oats grama	5-25%	No	Native
Bouteloua gracilis	blue grama	0-1%	No	Native
Bromus inermis	smooth brome	5-25%	No	Nonnative
Campanula rotundifolia	harebell	1- 5%	No	Native
Carduus acanthoides subsp. acanthoides	plumeless thistle	0-1%	No	Nonnative
Carex inops subsp. heliophila	sun-loving sedge	1- 5%	No	Native
Carex pensylvanica	Pennsylvania sedge	1- 5%	No	Native
Celastrus scandens	climbing bittersweet	0-1%	No	Native
Cerastium arvense	field chickweed	0-1%	No	Native
Cirsium flodmanii	Flodman's thistle	0-1%	No	Native
Comandra umbellata	bastard toadflax	0-1%	No	Native
Dalea candida	white prairie clover	0-1%	No	Native
Dalea purpurea var. purpurea	purple prairie clover	1- 5%	No	Native
Dichanthelium oligosanthes subsp. oligosanthes	Scribner's panic grass	1- 5%	No	Native
Echinacea angustifolia	narrow-leaved purple coneflower	0-1%	No	Native
Elymus repens	quackgrass	1- 5%	No	Nonnative
Fragaria virginiana	common strawberry	0-1%	No	Native
Galium boreale	northern bedstraw	1- 5%	No	Native
Hesperostipa spartea	porcupine grass	1- 5%	No	Native
Heterotheca villosa	hairy golden aster	1- 5%	No	Native
Heuchera richardsonii	alumroot	0-1%	No	Native
Koeleria macrantha	junegrass	1- 5%	No	Native
Lactuca canadensis	Canada wild lettuce	0-1%	No	Native
Liatris punctata var. punctata	dotted blazing star	1- 5%	No	Native
Lithospermum incisum	narrow-leaved puccoon	0-1%	No	Native

Scientific Name	Common Name	Cover Class	Seeded? (Y/N)*	Status
Maianthemum racemosum subsp. racemosum	common false Solomon's seal	1- 5%	No	Native
Mirabilis albida	hairy four o'clock	0-1%	No	Native
Monarda fistulosa	wild bergamot	1- 5%	No	Native
Muhlenbergia cuspidata	Plains muhly	1- 5%	No	Native
Nassella viridula	green needle grass	0-1%	No	Native
Oenothera biennis	common evening primrose	0-1%	No	Native
Oxytropis lambertii var. lambertii	Lambert's locoweed	0-1%	No	Native
Panicum virgatum	switchgrass	0-1%	No	Native
Parthenocissus vitacea	woodbine	1- 5%	No	Native
Pediomelum esculentum	prairie turnip	0-1%	No	Native
Penstemon grandiflorus	large-flowered beard tongue	0-1%	No	Native
Physalis virginiana	Virginia ground cherry	0-1%	No	Native
Poa compressa	Canada bluegrass	1- 5%	No	Nonnative
Potentilla arguta subsp. arguta	tall cinquefoil	1- 5%	No	Native
Prunus serotina	black cherry	0-1%	No	Native
Prunus virginiana	chokecherry	1- 5%	No	Native
Quercus ellipsoidalis	northern pin oak	1- 5%	No	Native
Quercus macrocarpa	bur oak	1- 5%	No	Native
Ratibida pinnata	gray-headed coneflower	0-1%	No	Native
Rhus glabra	smooth sumac	5-25%	No	Native
Rosa arkansana	prairie rose	0-1%	No	Native
Rubus idaeus var. strigosus	red raspberry	5-25%	No	Native
Rudbeckia hirta var. pulcherrima	black-eyed susan	0-1%	No	Native
Schizachyrium scoparium var. scoparium	little bluestem	1- 5%	No	Native
Solidago nemoralis	gray goldenrod	0-1%	No	Native
Solidago speciosa	showy goldenrod	1- 5%	No	Native
Sorghastrum nutans	Indian grass	1- 5%	No	Native
Sporobolus heterolepis	prairie dropseed	0-1%	No	Native
Symphoricarpos occidentalis	wolfberry	5-25%	No	Native
Symphyotrichum ericoides var. ericoides	heath aster	1- 5%	No	Native
Taraxacum officinale	common dandelion	0-1%	No	Native
Toxicodendron radicans subsp. negundo	common poison ivy	1- 5%	No	Native
Tradescantia bracteata	bracted spiderwort	0-1%	No	Native
Verbena stricta	hoary vervain	0-1%	No	Native
Vicia americana	American vetch	0-1%	No	Native
Viola palmata var. pedatifida	bearded birdfoot violet	0-1%	No	Native
Viola sororia	common blue violet	0-1%	No	Native
Zanthoxylum americanum	prickly ash	1- 5%	No	Native

** While a small area of native seeding was conducted at this site as part of a gully erosion repair project, the vast majority of native plant species are remnant.*

[1] Meander survey in evaluation area exceeded 45 minutes.

Site Photographs

Photo 49 Picture of the north portion of the project area looking through a narrows that leads to a larger hilltop prairie opening. Invasive brush management has opened up the prairie as well as clearing the shrub layer back into the oaks. Smooth sumac resprouts persist in the center of the photo (narrows) but is being managed on an ongoing basis. Native prairie graminoids and forbs are responding positively to the more open conditions. Leadplant (foreground) is a codominant in portions of this remnant sand-gravel hill prairie. Photo taken 7/18/2023.

Photo 50 Hilltop area in the northernmost portion of the prairie, looking north. The areas on the left side of the photograph have been actively managed to reduce invasive brush – In this case buckbrush (*Symphoricarpos*). In other areas where brush is being "feathered back" on the prairie edge and into the oak woodland, smooth sumac and red raspberry are common. Photo taken 7/18/2023.

Photo 51 View looking southeast showing the relative size and density of smooth sumac following management. Photo taken 7/18/2023.

Photo 52 South portion of the north-south ridge, looking south-southeast. The prairie extending to the south of this point supports high quality sand-gravel prairie, including conservative and rare plant species. The lower right portion of the photo shows cut tree saplings placed to discourage visitors from using a foot trail that had significant rill/gully erosion that MN DNR staff recently repaired. Photo taken 7/18/2023.

Photo 53 View of a forb rich portion of the remnant dry, sand-gravel prairie. Feathering back of invasive brush has taken place along the edge of the oak woodland in the background. Photo taken 7/18/2023.

Photo 54 A sweat bee on flowering lead plant. Numerous pollinators were observed utilizing diverse floral resources during the site visit. Photo taken 7/18/2023.

11 MN DNR Lake Carlos State Park Prairie Restoration

Project Background

Latitude/Longitude: Lat. 45.999449, Lon. -95.336097

Project Manager / Organization: Cindy Lueth, Resource Specialist, SR; MN DNR Parks & Trails

Fund: PTF

Fiscal Year Funds: 2017-2022

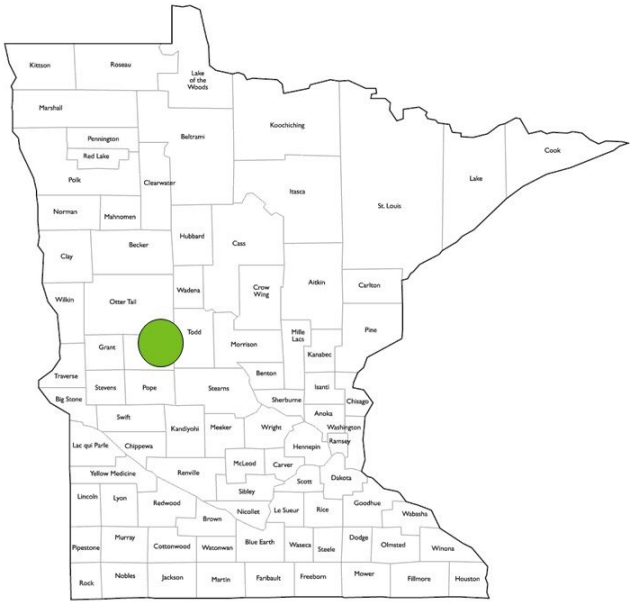
Project Start Date: 2018

Project Complete Date: 2022

Predominant Habitat type: Prairie / Savanna / Grassland

Additional Habitat types: Wetland

Project Status: Post Establishment Phase



County: Douglas

Primary Activity: Prairie Restoration

Project Size: Approximately 2 acres

Project Goals and Planning

(Site Assessment Preparation from Plan Sets and Documents)

1. ***What are the specific project components, management actions, or treatments?***
   Restoration of wet meadow/wet prairie and mesic prairie in an area that had patchy second-growth tree cover and a ground layer dominated by invasive, nonnative grasses (i.e., smooth brome, Kentucky bluegrass, reed canary grass and others). Restoration site preparation included invasive tree management (cut/treat/remove), prescribed burn and treatment of nonnative grasses with herbicide. Site preparation activities were followed by broadcast seeding of a diverse mix of native grasses, sedges, rushes, and forbs. Seed used in the restoration was bulk harvested wet-mesic seed from Glendalough State Park.
2. ***What project plans or project decision details are available? Who retains these plans?***
   No project-specific design plans were created for this project. State Parks & Trails Resource Specialists plan and conduct work on an annual basis based on Park resource management plans. Implemented work is documented and retained by Parks staff. Work plans are developed for each park/site, adjusted annually and implemented as time and site conditions allow.
3. ***What are the stated goals of the project? List quantifiable measures of success if identified?***

The long-term goal for this prairie restoration was to convert the pre-existing stand of early successional trees and nonnative grasses to a native-dominated prairie reconstruction. There are no known quantifiable measures of success.

4. ***What are the desired outcomes of achieving the stated goals?***
   The desired outcome is to reconstruct diverse and stable wet meadow/wet prairie and mesic prairie.
5. ***Are plans available?*** No ***Have project maps been created?*** No
   If yes, provide relevant examples in "site maps" and list maps provided:
   No maps were provided, and none known to have been specifically created for this small project site. However, MN DNR does track work through management records and GIS mapping.
6. ***List and briefly describe best management practices, standards, guidelines identified in plans.***
   None provided.

Project Implementation

(Questions for Site Manager and Cooperating Professionals)

7. ***Were alterations made to the plan during project implementation?***
   No
   No specific plan is known to have been created for restoration of this area. No apparent significant alterations were made to implementation plans with the possible exception of slight modification of timing/sequencing of grow-in management activities.
8. ***In what ways did alterations change the project outcome?***
   Not applicable – site preparation and grow-in maintenance activities were largely executed as planned.

Site Assessment

Field Review Date: 7/18/2023

Field Visit Attendees: Cindy Lueth, MN DNR Parks and Trails Resource Specialist; Gina Quiram, MN DNR; Paul Bockenstedt, Stantec

9. ***Surrounding Landscape Characteristics:***
   This relatively small project site occurs on a slight southeast-facing slope and swale, bounded by a paved park road on the northwest and gravel roads on the south and east sides.
10. ***Site Characteristics:*** Soils here are moderately well drained and well drained.
    a. Soil Series:
    Soil at the project site is mapped as Nebish loam. Typical profile for Nebish loam is described as loam and fine sandy loam in the top nine inches, with clay loam layer between approximately nine and 26 inches with loam below 26 inches.
    b. Topography:
    The site is characterized by relatively shallow slopes (less than eight percent slope) on the west side and a convex sidehill swale on the east side.
    c. Hydrology:
    The west side of the site is upland. The east side of the site is a wet swale that varies from several inches of water to dry, depending on season of year and recent rainfall.
    d. Vegetation: Plant Communities, Dominant Species & Invasives % Cover:

Vegetation of the surrounding area can generally be characterized as open woodland comprised of a mix of patchy to open second growth hardwood trees with scattered native brush species. The ground layer as reconstructed is composed primarily of native species with just a few areas that still have residual patches of nonnative grasses and forbs.

11. ***Is the plan based on current science?*** Yes
    The tools, methods, and timing of work were conducted within the range of practices that are currently considered to be effective for facilitating native herbaceous cover establishment in an old field setting with scattered trees.
12. ***List indicators of project goals at this stage of the project:***
    Spot treatment has prevented re-establishment of tree/brush seedlings and saplings. Overall native cover and species richness is good to very good for this type of setting, particularly in light of the pre-existing herbaceous cover being previously comprised overwhelmingly of nonnative, invasive grasses.
13. ***Does the implementation of the project plan allow for achieving proposed goals?***
    Yes, persistence in management and applying adaptive management when appropriate have been effective in achieving the goal of establishing a diverse representation of native grasses, sedges, rushes and forbs.
14. ***Are proposed future steps, including long term management, practical and reasonable?***
    Yes. Future work will be conducted as resources allow and is anticipated to include additional woody invasive brush management if new trees/shrubs are pioneer into the site, as well as follow-up mow/spot spray to continue limiting expression of invasive, nonnative grasses.
15. ***What were potential challenges to the project and were there opportunities for improvement? Are corrections or modifications needed to achieve proposed goals?***
    Limited funding and resources to implement initial restoration in new acres as well as maintaining previous restoration areas poses a challenge/risk to sustaining early gains. No corrections/modifications are recommended at this time – this site/project benefits from having regular assessment and annual work planning by MN DNR Parks & Trails staff.
16. ***Are follow-up assessments by the Restoration Evaluation Program needed? Explain.***
    Not likely. This project has largely achieved its goal using a generally practiced management tools/methods.
17. ***Additional comments on the restoration project.***

Project Evaluation

Projects can be designated as likely to not meet proposed outcomes, minimally meet proposed outcomes, meet proposed outcomes, or exceed proposed outcomes with a low, medium, or high degree of confidence in the determination.

18. ***The project has:***
    Achieved the stated goals.
19. ***The project will:***
    Meet proposed outcomes.
    Confidence of outcome determination:
    High.
20. ***Provide explanation of reason(s) for determination.***

This site/project benefits from having regular assessment and annual work planning by MN DNR Parks & Trails staff, although there are limited ongoing financial resources across the State Park and Trail system, DNR staff have been able to maintain the gains made on this restoration project.

21. Site Assessor(s) conducting field review:

Paul Bockenstedt, Stantec

Site Maps, Project Plans or Vegetation Tables

Figure 32 Map of approximate project area for Lake Carlos PTF Prairie Restoration. Meander survey in each evaluation area exceeded 25 minutes and resulted in complete visual coverage of each area (i.e., meander paths were no more than 50 feet from nearest adjacent meander path).

Table 3 Lake Carlos State Park prairie restoration vegetation meander survey results[1].

Scientific Name	**Common Name**	**Cover Class**	**Seeded? (Y/N)***	**Status**
Acer negundo var. negundo	boxelder	1-5%	No	Native
Agastache foeniculum	blue giant hyssop	1-5%	Yes	Native
Agrostis stolonifera	spreading bentgrass	1-5%	No	Nonnative
Andropogon gerardii	big bluestem	5-25%	Yes	Native
Anemone canadensis	Canada anemone	0-1%	Yes	Native
Anemone cylindrica	long-headed thimbleweed	0-1%	Yes	Native
Apocynum cannabinum	American hemp	1-5%	Yes	Native
Asclepias syriaca	common milkweed	0-1%	?	Native
Berteroa incana	hoary alyssum	0-1%	No	Nonnative
Bromus ciliatus	fringed brome	0-1%	Yes	Native
Bromus inermis	smooth brome	1-5%	No	Nonnative
Carex bebbii	Bebb's sedge	1-5%	Yes	Native
Carex lacustris	lake sedge	1-5%	Yes	Native
Cirsium arvense	Canada thistle	0-1%	No	Nonnative
Conyza canadensis	horseweed	0-1%	No	Native
Cornus sericea	red-osier dogwood	1-5%	No	Native
Crepis tectorum	yellow hawk's beard	0-1%	No	Nonnative
Echinochloa crus-galli	cockspur barnyard grass	1-5%	No	Nonnative
Elymus repens	quackgrass	1-5%	No	Nonnative
Equisetum arvense	field horsetail	1-5%	No	Native
Erigeron annuus	annual fleabane	0-1%	No	Native
Eupatorium perfoliatum	common boneset	1-5%	Yes	Native
Fraxinus pennsylvanica	green ash	0-1%	No	Native
Gentiana andrewsii	bottle gentian	0-1%	Yes	Native
Geum canadense	white avens	0-1%	?	Native
Helianthus grosseserratus	sawtooth sunflower	1- 5%	Yes	Native
Heliopsis helianthoides var. scabra	oxeye	0-1%	Yes	Native
Juglans nigra	black walnut	0-1%	No	Native
Juncus canadensis	Canada rush	0-1%	Yes	Native
Lactuca canadensis	Canada wild lettuce	0-1%	No	Native
Leersia oryzoides	rice cut grass	1-5%	Yes	Native
Linaria vulgaris	butter-and-eggs	0-1%	No	Nonnative
Lobelia siphilitica	great lobelia	0-1%	Yes	Native
Lycopus americanus	Sherard's bugleweed	0-1%	Yes	Native
Lythrum alatum var. alatum	wing-angled loosestrife	0-1%	Yes	Native
Melilotus alba	white sweet clover	1-5%	No	Nonnative
Monarda fistulosa	wild bergamot	1-5%	Yes	Native
Muhlenbergia frondosa	swamp muhly grass	1-5%	?	Native
Muhlenbergia racemosa	marsh muhly grass	0-1%	Yes	Nonnative
Onoclea sensibilis	sensitive fern	0-1%	No	Native
Oxalis stricta	yellow wood sorrel	0-1%	No	Nonnative

Scientific Name	**Common Name**	**Cover Class**	**Seeded? (Y/N)***	**Status**
Panicum virgatum	switchgrass	1-5%	Yes	Native
Pedicularis lanceolata	swamp lousewort	0-1%	Yes	Native
Phalaris arundinacea	reed canary grass	1-5%	No	Nonnative
Poa pratensis subsp. pratensis	Kentucky bluegrass	5-25%	No	Nonnative
Populus tremuloides	quaking aspen	1-5%	No	Native
Pycnanthemum virginianum	Virginia mountain mint	0-1%	Yes	Native
Rhus glabra	smooth sumac	1-5%	No	Native
Rubus idaeus var. strigosus	red raspberry	1-5%	No	Native
Rudbeckia hirta var. pulcherrima	black-eyed Susan	0-1%	Yes	Native
Rumex verticillatus	whorled water dock	0-1%	No	Native
Salix bebbiana	Bebb's willow	1-5%	No	Native
Salix interior	red willow	0-1%	No	Native
Schizachyrium scoparium var. scoparium	little bluestem	1-5%	Yes	Native
Scirpus atrovirens	dark green bulrush	1-5%	Yes	Native
Solidago gigantea	giant goldenrod	1-5%	?	Native
Solidago rigida subsp. rigida	stiff goldenrod	1-5%	Yes	Native
Sorghastrum nutans	Indian grass	5-25%	Yes	Native
Spartina pectinata	prairie cordgrass	1-5%	Yes	Native
Symphyotrichum novae-angliae	New England aster	0-1%	Yes	Native
Symphyotrichum oolentangiense	Sky blue aster	1-5%	Yes	Native
Thalictrum dasycarpum	tall meadow-rue	0-1%	Yes	Native
Toxicodendron radicans subsp. negundo	common poison ivy	1-5%	No	Native
Tragopogon dubius	yellow goat's beard	0-1%	No	Nonnative
Typha latifolia	broad-leaved cattail	0-1%	No	Native
Ulmus americana	American elm	0-1%	No	Native
Verbascum thapsus	common mullein	0-1%	No	Nonnative
Verbena hastata	blue vervain	1-5%	Yes	Native
Vernonia fasciculata	bunched ironweed	0-1%	Yes	Native
Vicia americana	American vetch	0-1%	?	Native

**Because no records were avaliable on species that were purchased and seeded, the table was developed with the authors knowledge for which species would have likely been purchased or harvested.*

[1] *Meander survey in evaluation area exceeded 25 minutes.*

Site Photographs

Photo 55 View of mesic prairie portion of project area, looking toward the northwest. Site preparation for this area included selective tree and shrub removal, prescribed burn and herbicide application to control previously dominant nonnative grasses. Photo taken 7/18/2023.

Photo 56 View from north portion of the restoration, looking south. This area has a high percentage of total cover from native grasses. Photo taken 7/18/2023.

Photo 57 from the wet meadow/wet prairie swale looking northwest. The native forbs boneset, marsh milkweed, and sawtooth sunflower are prominent in the foreground of the photo. Photo taken 7/18/2023.

Photo 58 View of mesic prairie portion of project area, looking toward the west. This portion of the site was densely vegetated with a 2 – 4 foot tall mix of forbs and grasses.

12 MN DNR Lake Carlos State Park Woodland Restoration

Project Background

Latitude/Longitude: Lat. 46.001311, Lon. -95.338153

Project Manager / Organization: Cindy Lueth, Resource Specialist, SR; MN DNR Parks & Trails

Fund: PTF

Fiscal Year Funds: 2020-2022

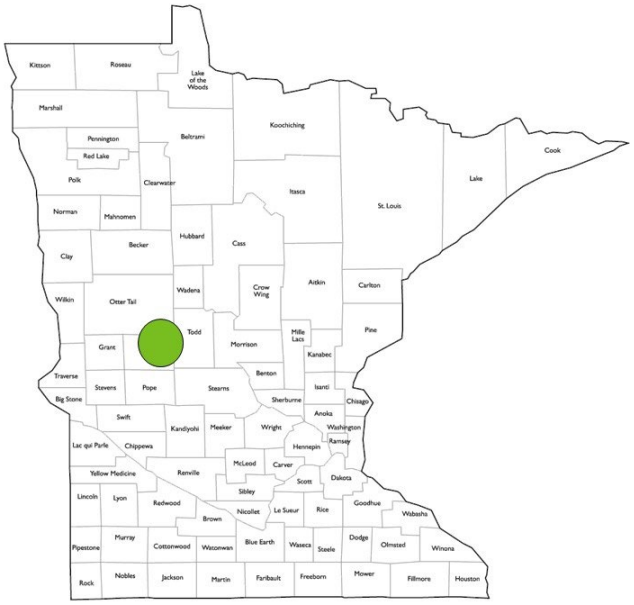
Project Start Date: 2021

Project Complete Date: 2022

Predominant Habitat type: Forest

Additional Habitat types:

Project Status: Post Establishment Phase



County: Douglas

Primary Activity: Forest Enhancement

Project Size: Approximately 1.4 acres

Project Goals and Planning

(Site Assessment Preparation from Plan Sets and Documents)

1. ***What are the specific project components, management actions, or treatments?***
   Restoration of oak (mixed hardwood) woodland at Lake Carlos State Park through forestry mowing and multiple follow-up mowings, interspersed with spot foliar treatment of invasive, nonnative woody regrowth.
2. ***What project plans or project decision details are available? Who retains these plans?***
   No project-specific design plans were created for this project. State Parks & Trails Resource Specialists plan and conduct work on an annual basis. Work plans are developed for each park/site, adjusted annually and implemented as time and site conditions allow.
3. ***What are the stated goals of the project? List quantifiable measures of success if identified?***
   The long-term goal for this woodland area is to suppress nonnative, invasive brush (with particular focus on common buckthorn and nonnative honeysuckle).
4. ***What are the desired outcomes of achieving the stated goals?***
   The desired outcome as related by MN DNR Resource Specialist is to reach a point of "maintenance" status where management activities might include occasional prescribed fire, woody stem removal and light weed control. With the reduction in nonnative, invasive brush, the goal is to see an increase in

cover of desirable native plant species and improved plant diversity and habitat value. DNR staff recognize that buckthorn will never be 100% eliminated from this site due to the presence of seed-bearing trees in neighboring properties.

5. ***Are plans available?*** No ***Have project maps been created?*** No
   If yes, provide relevant examples in "site maps" and list maps provided:
   No maps were provided, and none known to have been specifically created for this project. However, MN DNR does track work through management records and GIS mapping.
6. ***List and briefly describe best management practices, standards, guidelines identified in plans.***
   No plan was provided.

Project Implementation

(Questions for Site Manager and Cooperating Professionals)

7. ***Were alterations made to the plan during project implementation?***
   No
   No specific plan is known to have been created for restoration of this area. However, some adjustments were made during parks staff annual resource planning efforts, employing adaptive management in response to response of the site vegetation to management, weather, available labor and equipment, and other factors, including adding growing season mowing with foliar herbicide application. Alterations involved conducting additional growing season mowings to further set back woody growth.
8. ***In what ways did alterations change the project outcome?***
   Employment of adaptive management allowed for adjustment of applied tools, timing and methods to keep the effort on a positive restoration/improvement trajectory.

Site Assessment

Field Review Date: 7/18/2023

Field Visit Attendees: Cindy Lueth, MN DNR Parks and Trails Resource Specialist; Gina Quiram, MN DNR; Paul Bockenstedt, Stantec

9. ***Surrounding Landscape Characteristics:***
   This relatively small project site occurs on a slight south-facing slope, bounded by a park gravel road on the east, foot trail on the north and overhead utility line on the west.
10. ***Site Characteristics:*** Soils here are moderately well drained and well drained.
    a. Soil Series:
    Soil at the project site is mapped as Nebish loam. Typical Nebish loam soil profile is loam and fine sandy loam in the top nine inches, with clay loam layer between approximately nine and 26 inches with loam below 26 inches.
    b. Topography:
    The site is characterized by relatively shallow slopes (less than eight percent slope).
    c. Hydrology:
    The site is in an upland woodland setting with soils classified as well drained. No wetlands or surface waters are present.
    d. Vegetation: Plant Communities, Dominant Species & Invasives % Cover:

Vegetation of the area can generally be characterized as oak woodland. The specific, small project area is comprised of a mix of second-growth hardwood trees, as well and native and nonnative brush species. The ground layer is composed a mix of native and nonnative species with some areas being native dominated, some areas are nonnative dominated, and others a mix.

11. ***Is the plan based on current science?*** Yes
    The tools, methods, and timing of work were conducted within the range of practices that are currently considered to be effective for invasive woody brush management (including buckthorn management).
12. ***List indicators of project goals at this stage of the project:***
    Looking at adjacent unmanaged areas and using the assumption that the project area had similar plant species composition and three-dimensional structure, the managed area has significantly lower amounts of nonnative brush and substantially higher total herbaceous cover.
13. ***Does the implementation of the project plan allow for achieving proposed goals?***
    Yes, persistence in management and applying adaptive management when appropriate have been effective in achieving the goal of reaching a point of "maintenance" status where management activities might include occasional prescribed fire, woody stem removal and light weed control.
14. ***Are proposed future steps, including long term management, practical and reasonable?***
    Yes. Future work will be conducted as resources allow and is anticipated to include additional initial woody invasive brush management further into the oak woodland areas, as well as follow-up mow/spot spray to build on progress made in areas where previous initial restoration efforts have been made.
15. ***What were potential challenges to the project and were there opportunities for improvement? Are corrections or modifications needed to achieve proposed goals?***
    Limited funding and resources to implement initial restoration in new acres as well as maintaining previous restoration areas poses a challenge/risk to sustaining early gains. No corrections/modifications are recommended at this time – this site/project benefits from having regular assessment and annual work planning by MN DNR Parks & Trails staff.
16. ***Are follow-up assessments by the Restoration Evaluation Program needed? Explain.***
    Not likely. This project has largely achieved its goal using a generally practiced management tools/methods.
17. ***Additional comments on the restoration project.***
    This sustainability of gains made in this project should be good since there are parks staff and partners such as the Sentencing to Service program available to continue management.

Project Evaluation

Projects can be designated as likely to not meet proposed outcomes, minimally meet proposed outcomes, meet proposed outcomes, or exceed proposed outcomes with a low, medium, or high degree of confidence in the determination.

18. ***The project has:***
    Achieved the stated goals.
19. ***The project will:***
    Meet proposed outcomes.
    Confidence of outcome determination:
    High.
20. ***Provide explanation of reason(s) for determination.***

This site/project benefits from having regular assessment and annual work planning by MN DNR Parks & Trails staff, although there are limited ongoing financial resources across the State Park and Trail system, DNR staff have been able to pace restoration work appropriately with available resources to maintain past restoration work at this site.

21. Site Assessor(s) conducting field review:

Paul Bockenstedt, Stantec

Site Maps, Project Plans or Vegetation Tables

Figure 33 Map of approximate project area for Lake Carlos PTF Woodland Restoration. Meander survey in each evaluation area exceeded 25 minutes and resulted in complete visual coverage of each area (i.e., meander paths were no more than 50 feet from nearest adjacent meander path).

Table 4 Lake Carlos State Park woodland restoration vegetation meander survey results[1].

Scientific Name	**Common Name**	**Cover Class**	**Status**
Acer ginnala	Amur maple	1-5%	Nonnative
Acer negundo var. negundo	box elder	5-25%	Native
Achillea millefolium	yarrow	1-5%	Native
Ageratina altissima var. altissima	white snakeroot	1-5%	Native
Amphicarpaea bracteata	hog peanut	5-25%	Native
Anemone virginiana	tall thimbleweed	1-5%	Native
Apocynum androsaemifolium	spreading dogbane	1-5%	Native
Asclepias syriaca	common milkweed	1-5%	Native
Bromus inermis	smooth brome	5-25%	Nonnative
Carduus nutans	nodding thistle	0-1%	Nonnative
Carex blanda	charming sedge	1-5%	Native
Carex brevior	short sedge	1-5%	Native
Carex rosea	starry sedge	1-5%	Native
Cirsium arvense	Canada thistle	1-5%	Nonnative
Cornus racemosa	gray dogwood	1-5%	Native
Crataegus macracantha	large-thorned hawthorn	0-1%	Native
Desmodium canadense	Canada tick trefoil	0-1%	Native
Desmodium glutinosum	pointed-leaved tick trefoil	1-5%	Native
Dryopteris carthusiana	spinulose shield fern	0-1%	Native
Elymus hystrix	bottlebrush grass	1-5%	Native
Erigeron annuus	annual fleabane	0-1%	Native
Euthamia graminifolia	grass-leaved goldenrod	5-25%	Native
Fraxinus nigra	black ash	1-5%	Native
Fraxinus pennsylvanica	green ash	5-25%	Native
Galium triflorum var. triflorum	sweet-scented bedstraw	0-1%	Native
Juglans nigra	black walnut	1-5%	Native
Lactuca canadensis	Canada wild lettuce	0-1%	Native
Lathyrus venosus var. intonsus	veiny pea	0-1%	Native
Lonicera tatarica	tartarian honeysuckle	1-5%	Nonnative
Melilotus alba	white sweet clover	1-5%	Nonnative
Melilotus officinalis	yellow sweet clover	1-5%	Nonnative
Muhlenbergia racemosa	marsh muhly grass	1-5%	Native
Oenothera biennis	common evening primrose	0-1%	Native
Parthenocissus vitacea	woodbine	5-25%	Native
Phalaris arundinacea	reed canary grass	1-5%	Nonnative
Poa pratensis subsp. pratensis	Kentucky bluegrass	1-5%	Nonnative
Prunus serotina	black cherry	5-25%	Native
Rhamnus cathartica	common buckthorn	1-5%	Nonnative
Rhus glabra	smooth sumac	5-25%	Native
Ribes missouriense	Missouri gooseberry	1-5%	Native
Solidago gigantea	giant goldenrod	5-25%	Native

Scientific Name	**Common Name**	**Cover Class**	**Status**
Symphyotrichum ontarionis var. ontarionis	Ontario aster	0-1%	Native
Toxicodendron radicans subsp. negundo	common poison ivy	5-25%	Native
Trifolium pratense	red clover	1-5%	Nonnative
Viburnum lentago	nannyberry	1-5%	Native
Vicia americana	American vetch	0-1%	Native
Vitis riparia	wild grape	1-5%	Native
Zanthoxylum americanum	prickly ash	5-25%	Native

[1] *Meander survey in evaluation area exceeded 25 minutes.*

Site Photographs

Photo 59 View of project area from gravel road, looking southwest. Area was brush mowed and was spot foliar sprayed for invasive woody brush resprouts in the weeks prior to field visit (indicated by yellow vegetation in left center of photo). Photo taken 7/18/2023.

Photo 60 View from approximate center of project looking northeast. Area was brush mowed and was spot foliar sprayed for invasive woody brush resprouts in the weeks prior to field visit (indicated by yellow vegetation in left center of photo). Photo taken 7/18/2023.

Photo 61 View of a portion of the project area with thick regrowth of smooth sumac (approximately six to eight feet tall) following brush mowing. Photo taken 7/18/2023.

Photo 62 A view of the two to three foot tall shrub regrowth in the treated area. Photo taken 7/18/2023.

Photo 63 Portion of the project area that was recently spot foliar sprayed to treat common buckthorn (shrub in center of photo) and poison ivy (red foliage in foreground). Despite still being green at the time of the field visit, the buckthorn leaves showed signs of herbicide uptake (leaf wilting and cupping). Photo taken 7/18/2023.

Photo 64 View of a portion of the forestry mowed project area that showed limited regrowth of woody vegetation and vigorous growth of herbaceous species that were present before brush mowing began.

Photo 65 A view of an untreated area immediately adjacent to the project area which likely gives a good indication of the density of brush and small trees prior to brush mowing and follow-up foliar treatment management in the project area.

13 Blue Lake Priority Action Plan Phase 2

Project Background

Lake Name, DOW #: Blue, 30010702

Project Manager / Organization: Tiffany Determan / Isanti SWCD

Fund: CWF

Fiscal Year Funds: FY-22

Primary Activity: Alum Treatment

Latitude/Longitude: 45.473607, -93.502132

County: Isanti

Project Start Date: 2022

Project Complete Date: In progress

Project Status: Treatment Phase

Lake Characteristics

Lake Area (acres): 296

Watershed size (acres): 7207

Watershed to Lake Area: 24

Osgood Index: 3

Average Residence Time (years): 1

Depth Mean / Max (feet): 14 / 31

% Littoral Area: 52

Water Quality Metric	*Pre-Treatment Conditions (2013 - 2019)*	*Treatment Year (2022)*	*Post-Treatment Conditions (2023)*	*Projected/Target*
Total Phosphorous (µg/L)	39 (SD = 8, *n* = 6)	24	35	31
Chlorophyll-a (µg/L)	19 (SD = 14, *n* = 7)	26	15	
Secchi Disk - Summer Average (m)	2.66 (SD = 1.41, *n* = 7)	5.72	2.12	

Seasonal Water Quality Trends: Mean (standard deviation, n = # of years with data) shown.

Project Goals and Planning

1. ***Problem Identification (Levels of Impairment):*** Blue Lake is not currently impaired, however average summer growing season total phosphorus (TP) concentrations are close to exceeding State standards and chlorophyll-a concentrations commonly exceed State standards. The diagnostic study concluded that an alum treatment could reduce internal phosphorus loading to Blue Lake by as much as 500 pounds per year depending on the size of the treatment area and the amount of alum applied.
2. ***Previous and/or Ongoing Water Quality Improvement Efforts:*** To date, Isanti SWCD and other partners have implemented eight urban BMPs throughout the watershed that were identified in the stormwater retrofit analysis. These projects were the top rated BMPs identified in terms of cost/benefit in the stormwater retrofit analysis and have reduced sediment and phosphorus loads to Blue Lake by approximately 36 lbs/yr and 16,943 lbs/yr, respectively. Additionally, several BMPs are under construction or are currently being planned in the Blue Lake watershed that will further reduce sediment and phosphorus loading to Blue Lake.
3. ***Project Justification:*** Internal loading accounts for 45% (595 lbs/yr) of the load
4. ***What partners or agencies were involved with proposal and technical planning? What were the contributions?*** The Isanti County Soil and Water Conservation District, Board of Water and Soil Resources, Wenck (Stantec)
5. ***Alum Feasibility study:*** Blue Lake Alum Treatment Feasibility Study, 02/05/2021
    a. ***Phosphorus & Water Budget:*** 45% internal, 38% watershed, 8% Septic Systems, 5% Atmosphere, and 4% curly-leaf pondweed
    b. ***Data Basis:*** Blue Lake Alum Treatment Feasibility Study
    c. ***Monitoring Performed:*** Intact sediment cores were collected by Wenck (Stantec) at three locations in Blue Lake in the fall of 2020 using a gravity sediment coring device equipped with an acrylic core liner (6.5-cm ID and 50-cm length). Cores extend radially from the deepest location at 30 ft (st 30), 25 ft (st 25) and 20 ft (st 20). Sediment cores from each station were transported to the University of Wisconsin - Stout Discovery Center Laboratory where they were sectioned vertically at 2-cm intervals over the upper 10-cm to evaluate variations in sediment physical-textural and chemical characteristics, including phosphorus fractionation. Additionally, sediment cores were analyzed in the lab for phosphorus release under anoxic conditions.
    d. ***Internal P Load (%):*** 45%
    e. ***Estimated duration of effectiveness:*** 13-17 Years
6. ***What are the stated goals of the project? List quantifiable measures of success if identified.***

The alum treatment will reduce TP by 590 pounds/year. A target concentration of 31 micrograms/liter (µg/L) is being used as a surrogate measurement for the 590-pound phosphorus load reduction.

7. ***What are the desired outcomes of achieving the stated goals?*** The Rum River WRAPS report (MPCA 2017) identified Blue Lake as a Type A (highest priority) protection lake and recommended a surface water total phosphorus (TP)concentration target/goal of 31 µg/L. This target is based on the 25th percentile of the standard deviation of Blue Lake's historical dataset.
8. ***List and briefly describe best management practices, criteria, guidelines identified in plans.*** The selected scenario for Blue Lake included a buffered application in which 65,768 gallons of alum plus 32,884 gallons of sodium aluminate (buffer) would be applied to areas ≥ 20-feet covering 73-acres. Half of the alum dose was applied in applied in 2022, and the remaining half will be applied in 2024. On September 13-14, 2022, a total of 32,884 gallons of alum plus 16,442 gallons of sodium aluminate (buffer) were applied to the target treatment area (≥ 20 ft) in Blue Lake.

Project Implementation

Alum Treatment Overview

Treatment Description	Date	Dosage	Buffered or non-buffered	pH monitoring
Initial Dose	9/13 – 9/14/2022	32, 884 gallons of Aluminum Sulfate and 16, 444 gallons of sodium aluminate	Buffered	Yes
Second dose	Planned for 2024			

Assessment

9. ***Is the plan based on current science?*** Yes
10. ***Does the lake meet the characteristics of a lake where in-lake treatment is likely to be successful?*** Somewhat, Huser et. al. (2015) compiled and analyzed data for 114 lakes treated with alum to identify factors driving longevity of post-treatment water quality improvements. They identified three key factors that affected treatment longevity: 1) total alum dose; 2) lake morphometry (as measured by the Osgood Index); and 3) watershed to lake area ratio. Blue Lake has an Osgood Index rating of 4.2. An Osgood Index of 6 generally represents the point where lakes are stratified or polymictic. While the lake appears to show strong stratification and periods of anoxia at the deep hole, stratification may be weaker in other areas. Further, the watershed to lake ratio is 26:1. Lakes with watershed to lake area ratios ranging from 20:1 to 30:1 are influenced by both watershed and internal nutrient sources. A

review of bottom hardness data shows an accumulation of soft sediments near the northern portion of Blue Lake.

11. ***Is biological monitoring data available? Does this data indicate concerns for impacts on the biota or potential threats to the effectiveness of the treatment?*** Yes, there are aquatic vegetation and fisheries surveys available. No specific carp surveys have been completed on the lake but DNR Fisheries staff indicated they expect very low carp populations in this lake. DNR staff completed a pre-treatment aquatic plant survey and plans to repeat the survey post-treatment. The presence of curly-leaf pondweed (CLP) on top of areas with soft sediment suggests the potential for phosphorus release, even in shallow areas of the lake that were not treated with alum. CLP is likely contributing to the internal load of the lake during the mid-summer die back (senescence) when the nutrients tied up in CLP biomass are released. Total phosphorus lost via CLP senescence is not immediately returned to the sediment. The precise contribution may be widely variable from year to year. For a point of reference, a 2011 TMDL study of Crystal, Keller, and Lee Lake found that CLP senescence contributed approximately 1.09 pound of phosphorus per acre annually.
12. ***Were project goals met / are they on the path to being met?*** In progress
    a. ***If no, is follow-up planned to achieve proposed goals?*** The second half of the dose is planned for 2024. Progress towards goals should be re-evaluated following this second application.
13. ***What were potential challenges to the project? Describe opportunities for improvement.*** Larger watershed to lake area ratio, low Osgood Index score, presence of invasive species, especially curly-leaf pondweed are all complicating factors.
14. ***Additional comments on the restoration project.***

    Collect additional sediment cores and conduct continuous dissolved oxygen monitoring in the shallow area of the lake. It's possible that these areas are going anoxic at night.

Project Evaluation

Goals are the discrete, measurable results of implementing the restoration actions. Outcomes are the desired system changes that the project is intended to affect. Projects can be designated as likely to not meet, minimally meet, meet, or exceed proposed goals and outcomes with a low, medium, or high degree of confidence in the determination.

15. ***The project has:***
    Minimally achieved the stated goals.
16. ***The project will:***
    Minimally support proposed outcomes.
    Confidence of outcome determination:
    Low.
17. ***Provide explanation of reason(s) for determination.***

A target concentration of 31 micrograms/liter (µg/L) is being used as a surrogate measurement for the 590-pound phosphorus load reduction. A review of 2023 water quality data as presented on the MPCA Surface Water Data Viewer identified an in-lake concentration of 35 µg/L. This is an improvement over existing conditions prior to the treatment. However, there was a slight increase in sediment release rates at Station 25 from 2020 to 2023. This is concerning.

18. ***Assessor(s) conducting review:***

    Joe Pallardy – EOR

Site Maps and Other Data

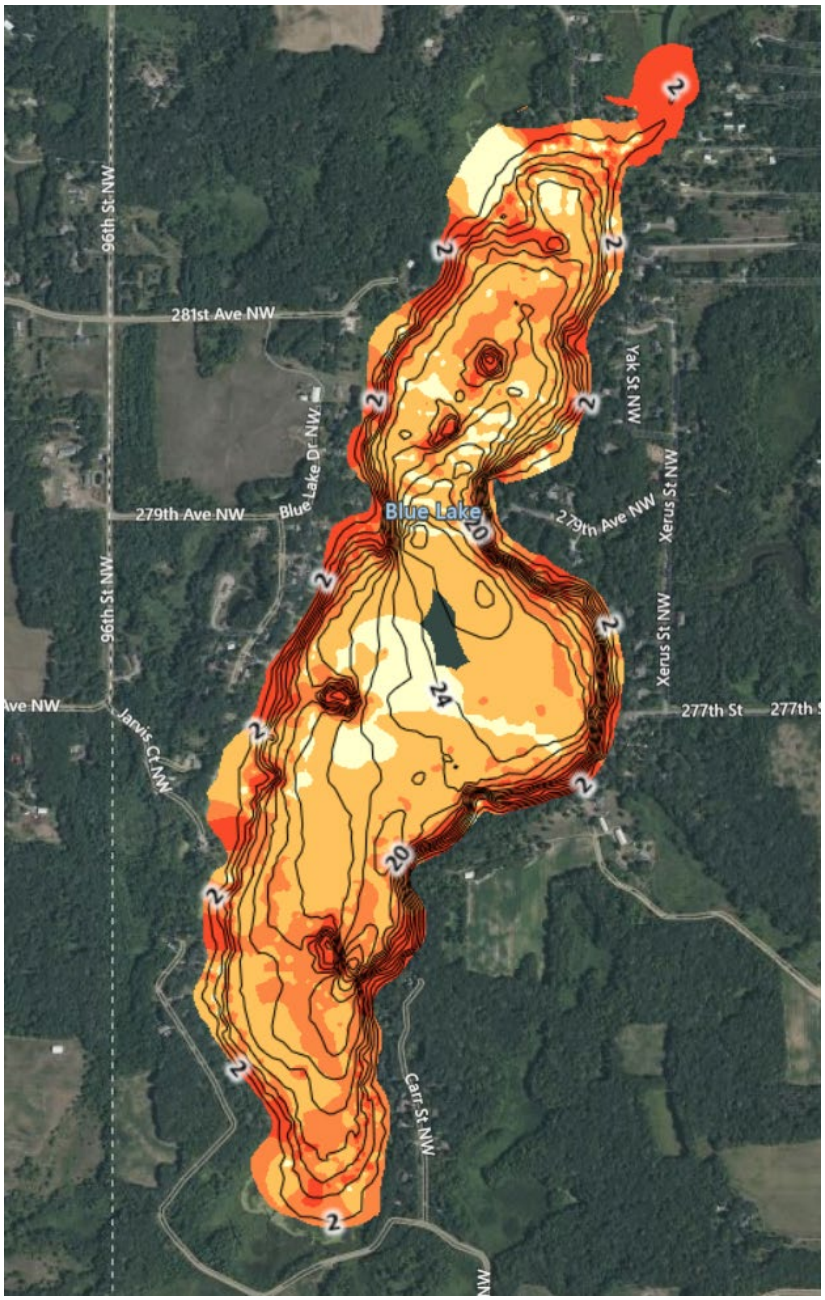


Figure 34 Bathymetric map of Blue Lake showing results of bottom hardness survey

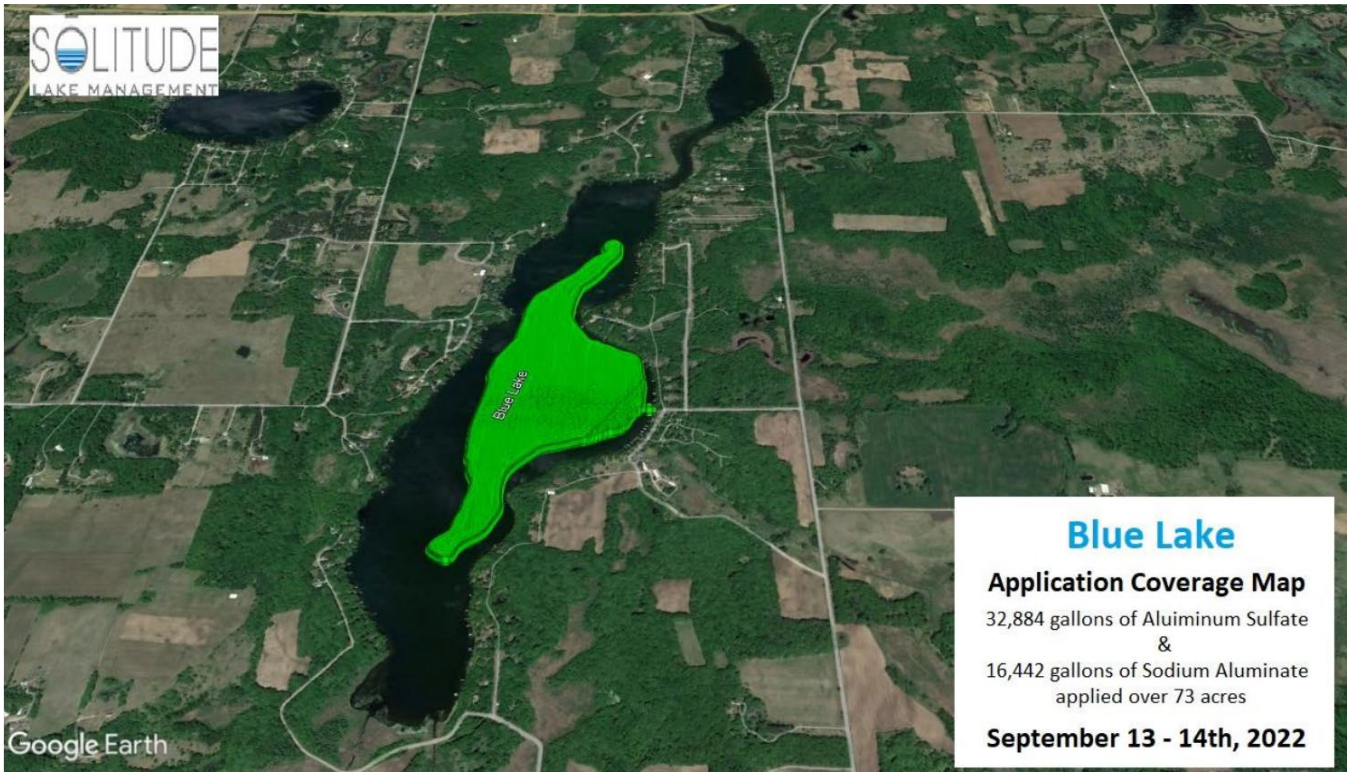


Figure 35 Application coverage map for 2022 alum treatment in Blue Lake

14 Clean Water Assistance Grant - City of Apple Valley

Project Background

Lake Name, DOW #: Pond EVR P12, 19022500

Project Manager / Organization: Jessica Schaum / City of Apple Valley

Fund: CWF

Fiscal Year Funds: FY-13

Primary Activity: Alum Treatment

Latitude/Longitude: 44.754627, -93.177924

County: Dakota

Project Start Date: 2013

Project Complete Date: 2016

Project Status: Long-term Monitoring Phase (3+ years)

Lake Characteristics

Lake Area (acres): 5.7 acres

Watershed size (acres): 40 acres

Watershed to Lake Area: 7

Osgood Index: 6

Average Residence Time (years): 0.038 years

Depth Mean / Max (feet): 3 / 4 feet

% Littoral Area: 100%

Water Quality Metric	*Pre-Treatment Conditions (2006 - 2012)*	*Treatment Year (2013)*	*Treatment Year (2014)*	*Post-Treatment Conditions (2015 - 2018)*	*Projected /Target*
Total Phosphorous (µg/L)	**270** (SD = 140, *n* = 7)	**122**	**65**	**119** (SD = 33, *n* = 4)	**150**
Chlorophyll-a (µg/L)	**170** (SD = 108, *n* = 7)	**65**	**25**	**75** (SD = 41, *n* = 4)	
Secchi Disk - Summer Average (m)	**1.47** (SD = 0.72, *n* = 6)	**2.23**	**2.75**	**2.19** (SD = 0.91, *n* = 4)	

Seasonal Water Quality Trends: Mean (standard deviation, n = # of years with data) shown.

Project Goals and Planning

NOTE: This is a storm water pond treatment thus the monitoring and outcomes are not the same as an in-lake treatment and should be considered an external load treatment to a downstream lake, similar to a watershed BMP.

1. ***Problem Identification (Levels of Impairment):*** In 2002, Farquar and Long Lakes were placed on the impaired waters list due to high phosphorus levels that caused algal blooms and reduced water clarity. A TMDL was approved in 2009 for the two lake system and determined approximately 66% (205lbs annually) of the phosphorus entering Long Lake from the overall watershed came from the Public Water 19022500 drainage area. Subsequently, the TMDL Implementation plan for the two lake system recommended a178.5lb annual phosphorus reduction from Public Water 19022500 to achieve water quality goals.
2. ***Previous and/or Ongoing Water Quality Improvement Efforts:***. The grant also included the installation of an iron enhanced sand filter to the banks of the pond (38lb reduction). When water levels increase after rain events, water would flow through the filter before leaving the pond. Particulate phosphorus would be removed as water passes through the sand and dissolved phosphorus would chemically bind to the iron in the filter.
3. ***Project Justification:*** The City of Apple Valley is proposing a combination of two enhancements to Public Water 19022500 to achieve a 61lb reduction in phosphorus
4. ***What partners or agencies were involved with proposal and technical planning? What were the contributions?*** City of Apple Valley
5. ***Alum Feasibility study:*** Alum Dose Calculation for EVR P12 and EVR-P170
    a. ***Phosphorus & Water Budget:*** These are stormwater ponds and the alum treatment for these ponds acts as an external load reduction for downstream lakes thus this section is not applicable.
    b. ***Data Basis:*** NA
    c. ***Monitoring Performed:*** NA
    d. ***Internal P Load (%):*** NA
    e. ***Estimated duration of effectiveness:*** NA
6. ***What are the stated goals of the project? List quantifiable measures of success if identified.*** Phased applications of aluminum sulfate (alum) were applied to the pond (23lb reduction); the alum application will be distributed over several years to maintain healthy pH levels in the pond.
7. ***What are the desired outcomes of achieving the stated goals?*** The TMDL Implementation plan for the two external load reductions from the IESF and the alum treatment recommended a 178.5lb annual

phosphorus reduction from Public Water 19022500 to achieve water quality goals in Farquar and Long Lakes. Public Water 19022500 will also benefit from the project. Water clarity will improve after application of alum and promote growth of aquatic plants, improving wildlife habitat and aesthetics.

8. ***List and briefly describe best management practices, criteria, guidelines identified in plans.*** Please see table below.

Project Implementation

Alum Treatment Overview

Treatment Description	Date	Dosage	Formulation	pH
Spring 1 2013	**5/9/2013**	**2000**	**Non-buffered**	***Yes***
Spring 2 2013	**6/3/2013**	**830**	**Non-buffered**	***Yes***
Spring 2014	**5/28/2014,5/29/2014**	**660**	**Non-buffered**	***Yes***
Fall 2014	**10/9/2014**	**330**	**Non-buffered**	***Yes***
2016	**No exact date**	**330**	**Non-buffered**	***Yes***

Assessment

9. ***Is the plan based on current science?*** Yes
10. ***Does the lake meet the characteristics of a lake where in-lake treatment is likely to be successful?*** It is a stormwater pond thus the longevity of the alum treatment is short due to the high influent loads and the function of the stormwater pond.
11. ***Is biological monitoring data available? Does this data indicate concerns for impacts on the biota or potential threats to the effectiveness of the treatment?*** There are concerns that this pond is acting as a nursery for goldfish which can disturb sediments and shorten the longevity of the alum treatment even further.
12. ***Were project goals met / are they on the path to being met?*** The goals were stated as load reductions to a down stream water body. The way to do that is to provide follow up sediment cores which were not completed. The water quality in the pond seems to have improved during treatment year (2013-2016) which the TP became increasing in subsequent years. The load reduction to downstream waterbodies needs to be confirmed by follow up sediment cores.
    a. ***If no, is follow-up planned to achieve proposed goals?***

13. ***What were potential challenges to the project? Describe opportunities for improvement.*** None provided
14. ***Additional comments on the restoration project.***

Project Evaluation

Goals are the discrete, measurable results of implementing the restoration actions. Outcomes are the desired system changes that the project is intended to affect. Projects can be designated as likely to not meet, minimally meet, meet, or exceed proposed goals and outcomes with a low, medium, or high degree of confidence in the determination.

15. ***The project has:***
    Minimally achieved the stated goals.
16. ***The project will:***
    Minimally support proposed outcomes.
    Confidence of outcome determination:
    Low.
17. ***Provide explanation of reason(s) for determination.***
    There is no follow up monitoring of the sediments, and the longevity of this treatment is short. There was a series of alum treatments over several years however, it is unclear if these follow up treatments will be done in the future to maintain the load reductions.
18. ***Assessor(s) conducting review:***

    Anne Wilkinson, PhD EOR inc

15 LMRWMO WRAPS Internal Phosphorus Loading Control: Lake Augusta

Project Background

Lake Name, DOW #: Augusta, 19008100

Project Manager / Organization: Joe Barten / Lower Mississippi River Watershed Management Organization

Fund: CWF

Fiscal Year Funds: FY-16

Primary Activity: Alum Treatment

Latitude/Longitude: 44.87825985, -93.15716943

County: Dakota

Project Start Date: 2016

Project Complete Date: 2019

Project Status: Long-term Monitoring Phase (3+ years)

Lake Characteristics

Lake Area (acres): 46 acres

Watershed size (acres): 494 acres

Watershed to Lake Area: 11

Osgood Index: 5

Average Residence Time (years): 2 years

Depth Mean / Max (feet): 33 / 16 feet

% Littoral Area: 37%

Water Quality Metric	*Pre-Treatment Conditions (2007 - 2016)*	*Treatment Year (2017)*	*Post-Treatment Conditions (2018 - 2021)*	*Projected/Target*
Total Phosphorous (µg/L)	**177** (SD = 31, *n* = 5)	**113**	**131** (SD = 24, *n* = 4)	*40*
Chlorophyll-a (µg/L)	**90** (SD = 36, *n* = 2)	**99**	**144** (SD = 20, *n* = 2)	14
Secchi Disk - Summer Average (m)	**0.29** (SD = 0.06, *n* = 7)	**0.43**	**0.29** (SD = 0.06, *n* = 2)	1.4

Seasonal Water Quality Trends: Mean (standard deviation, n = # of years with data) shown.

Project Goals and Planning

1. ***Problem Identification (Levels of Impairment):*** Lake Augusta is included on the MPCA's 303(d) list as impaired for aquatic recreation due to excessive nutrients. Analysis performed as part of the LMRWMO's 2012-2013 WRAPS study identified internal loading (i.e., phosphorus release from lake sediment) as the primary source of phosphorus in both lakes.
2. ***Previous and/or Ongoing Water Quality Improvement Efforts:*** These reductions will meet the load reductions identified in the WRAPS and TMDL report and are essentially the only feasible options to achieve MPCA water quality standards in these lakes. The watersheds to these lakes are not densely developed and stormwater best management practices are already present, reducing phosphorus loading to the lakes from external sources.
3. ***Project Justification:*** 87% of TP load from internal sources (sediment)
4. ***What partners or agencies were involved with proposal and technical planning? What were the contributions?*** LMRWMO
5. ***Alum Feasibility study:*** None, project predates feasibility study requirement
    a. ***Phosphorus & Water Budget:*** 87% internal, 11% watershed, and 2% direct watershed
    b. ***Data Basis:*** LMRWMO WRAPS data from 2007-2009 for water budget.
    c. ***Monitoring Performed:*** Barr Engineering collected sediment cores from both lakes and performed phosphorus fractionation of the samples to determine the dosing amounts. The LMRWMO has continued to perform water monitoring on the lake since the application through the CAMP program. Additional water monitoring has also been performed in 2018 and 2019 by consultants to determine the effectiveness of the alum treatment on Lake Augusta.
    d. ***Internal P Load (%):*** 87%
    e. ***Estimated duration of effectiveness:*** 20 years
6. ***What are the stated goals of the project? List quantifiable measures of success if identified.***
    The alum treatment will reduce internal phosphorus loading by 80% or more resulting in phosphorus load reductions of 252 lbs/year. The goal of this project is consistent with the following state priorities: 1.) Restore those waters that are closest to meeting state water quality standards - Summer average water quality in Sunfish Lake measured from 2006-2012 intermittently meets the MPCA's standards for total phosphorus, chlorophyll a, and Secchi disc depth and, 2.) Restore and protect water resources for public use and public health, including drinking water - This project was identified in the LMRWMO Watershed Restoration and Protection Strategies (WRAPS) study to preserve existing uses and restore aquatic recreation uses for these lakes.

7. ***What are the desired outcomes of achieving the stated goals?*** After alum treatment, expected to meet state water quality standards.
8. ***List and briefly describe best management practices, criteria, guidelines identified in plans.*** There was not a specific feasibility study done for this alum treatment project. At the time, feasibility studies were not required. They became a requirement after this project was approved. There is however a Watershed Restoration and Protection Study (WRAPS) study that was completed in 2014. This study looked at 5 total lakes, including Sunfish. The study did recommend and inform the alum treatments. Nothing was provided to confirm the alum treatment dose.

Project Implementation

Alum Treatment Overview

Treatment Description	Date	Dosage	Formulation	pH
Alum treatment	April 25, 2017	**Unknown**	**Unknown**	***Yes***

Assessment

9. ***Is the plan based on current science?*** Portions because there is no feasibility study provided.
10. ***Does the lake meet the characteristics of a lake where in-lake treatment is likely to be successful?*** Yes, it is a deep lake, with the majority of the loading from internal sources, and stormwater BMPs are already in place.
11. ***Is biological monitoring data available? Does this data indicate concerns for impacts on the biota or potential threats to the effectiveness of the treatment?*** It appears the Cormorants are contributing tons of feces to the lake annually, causing water quality issues. The population has steadily increased in the last decade.
12. ***Were project goals met / are they on the path to being met?*** The potential sediment phosphorus release rate determined in 2013 was 2.16 mg/m2/day, while the evaluation of the change in summer phosphorus levels in the hypolimnion of Lake Augusta during 2019 corresponded with a sediment phosphorus release rate of 0.45 mg/m2/day. The difference in these phosphorus release rates was consistent with what was expected and represents a 79% internal load reduction, which is directly comparable with the assumption contained in BWSR grant work plan. However, the water quality in Lake Augusta has not improved as expected and there have been follow up studies to determine what is contributing to this.

a. ***If no, is follow-up planned to achieve proposed goals?*** The LMRWMO is undergoing a comprehensive study of the lake to identify long term implementation actions to improve lake water quality and a lake outlet and water quality improvement report has been completed. Based on the lake assessment and calibrated watershed and in-lake water quality modeling, the following watershed Best Management Practices (BMPs) and in-lake management practices are recommended to substantially reduce the respective phosphorus loadings and enhance recreational suitability of the lake: 1) Install an outlet to control water levels for Lake Augusta 2) Install structural BMPs and/or pretreatment protection measures to prevent sediment delivery and reduce nutrient loading into the lake with design(s) intended to meet water quality goals. Untreated stormwater runoff from the southeast outfall and undertreated runoff from the northeast inlet to Lake Augusta are prioritized for implementation. Though specific large structural BMPs are identified though this study, any structural or non-structural BMPs in the watershed to reduce nutrient loading to the lake are considered beneficial and are recommended. 3) Remove dead trees from the lake shoreline as the first large step to discourage cormorant population establishment and control summer TP loads. Other strategies may need to be considered to deter the cormorant population from roosting at Lake Augusta, should removal of the dead trees be insufficient. 4) Include stabilization/restoration of surrounding shoreline that will be exposed as a separate project.

13. ***What were potential challenges to the project? Describe opportunities for improvement.*** Given wet weather patterns and high lake levels, there were significant changes and data gaps since the previous modeling and in-lake alum treatment. Additionally, It appears the Cormorants are contributing tons of feces to the lake annually, causing water quality issues, which did not show up in previous studies, and which the population has steadily increased in the last decade.
14. ***Additional comments on the restoration project.***

Project Evaluation

Goals are the discrete, measurable results of implementing the restoration actions. Outcomes are the desired system changes that the project is intended to affect. Projects can be designated as likely to not meet, minimally meet, meet, or exceed proposed goals and outcomes with a low, medium, or high degree of confidence in the determination.

15. ***The project has:***
    Minimally achieved the stated goals.
16. ***The project will:***
    Minimally support proposed outcomes.

Confidence of outcome determination:

Medium.

17. ***Provide explanation of reason(s) for determination.***

    There is evidence that the sediment release rate has been reduced, however the lake water quality is not responding as expected. Additional studies and management have been recommended to achieve water quality goals.

18. ***Assessor(s) conducting review:***

    Anne Wilkinson, PhD EOR inc

16 LMRWMO WRAPS Internal Phosphorus Loading Control: Sunfish Lake

Project Background

Lake Name, DOW #: Sunfish, 19005000

Project Manager / Organization: Joe Barten / Lower Mississippi River Watershed Management Organization

Fund: CWF

Fiscal Year Funds: FY-16

Primary Activity: Alum Treatment

Latitude/Longitude: 44.87553242, -93.09777587

County: Dakota

Project Start Date: 2016

Project Complete Date: 2019

Project Status: Long-term Monitoring Phase (3+ years)

Lake Characteristics

Lake Area (acres): 46 acres

Watershed size (acres): 332 acres

Watershed to Lake Area: 7

Osgood Index: 6

Average Residence Time (years): 1 year

Depth Mean / Max (feet): 9 / 32 feet

% Littoral Area: 88%

Water Quality Metric	*Pre-Treatment Conditions (2007 – 2016)*	*Treatment Year (2017)*	*Post-Treatment Conditions (2018 - 2022)*	*Projected/Target*
Total Phosphorous (µg/L)	**42** (SD = 14, *n* = 10)	**18**	**16** (SD = 4, *n* = 5)	40
Chlorophyll-a (µg/L)	**31** (SD = 13, *n* = 9)	**3**	**3** (SD = 1, *n* = 4)	14
Secchi Disk - Summer Average (m)	**1.83** (SD = 0.61, *n* = 10)	**3.36**	**3.50** (SD = 0.73, *n* = 4)	1.4

Seasonal Water Quality Trends: Mean (standard deviation, n = # of years with data) shown.

Project Goals and Planning

1. ***Problem Identification (Levels of Impairment):*** 90% of TP load from internal sources (sediment)
2. ***Previous and/or Ongoing Water Quality Improvement Efforts:*** In addition to the alum treatment, the LMRWMO will implement a voluntary rain barrel program, a shoreline buffer survey on Sunfish Lake to identify potential locations for improvements, and targeted communication with residents to encourage buffer enhancement. These efforts will further reduce the phosphorus reaching the lake from external sources
3. ***Project Justification:*** Due to the very limited external load, 90% of TP load from internal sources (sediment).
4. ***What partners or agencies were involved with proposal and technical planning? What were the contributions?*** Sunfish Lake alum treatment project will be completed in partnership with the Cities of Mendota Heights, Sunfish Lake, and local property owners.
5. ***Alum Feasibility study****:* None, project predates feasibility study requirement
    a. ***Phosphorus & Water Budget:*** Total phosphorus load is 179 lbs/year, 90% of which is from internal sources, (161 lbs/year)
    b. ***Data Basis:*** Sunfish Lake has been monitored since 2006 through the CAMP program
    c. ***Monitoring Performed:***
    d. ***Internal P Load (%):*** 90%
    e. ***Estimated duration of effectiveness:*** Due to the very limited external load, alum treatment of these lakes is expected to be effective for 20 years or more.
6. ***What are the stated goals of the project? List quantifiable measures of success if identified.***
   Alum treatment will reduce internal phosphorus loading by 80% or more, approximately 129 lbs/year
7. ***What are the desired outcomes of achieving the stated goals?*** This project seeks to improve water quality in both lakes by treating the internal phosphorus load with aluminum sulfate (alum), with the ultimate goal of removing Sunfish Lake from the Impaired Waters list. Improved water quality will also improve lake aesthetics and habitat in both lakes. The goal of this project is consistent with the following state priorities:

   1. Restore those waters that are closest to meeting state water quality standards - Summer average water quality in Sunfish Lake measured from 2006-2012 intermittently meets the MPCA's standards for total phosphorus, chlorophyll a, and Secchi disc depth.

   2. Restore and protect water resources for public use and public health, including drinking water - This project was identified in the LMRWMO Watershed Restoration and Protection Strategies (WRAPS) study to preserve existing uses and restore aquatic recreation uses for these lakes.

8. ***List and briefly describe best management practices, criteria, guidelines identified in plans.***

   There was not a specific feasibility study done for this alum treatment project. At the time, feasibility studies were not required. They became a requirement after this project was approved. There is however a Watershed Restoration and Protection Study (WRAPS) study that was completed in 2014. This study looked at 5 total lakes, including Sunfish. The study did recommend and inform the alum treatments. Nothing was provided to confirm the alum treatment dose.

Project Implementation

Alum Treatment Overview

Treatment Description	Date	Dosage	Formulation	pH
Alum Treatment	April 28, 2017	***unknown***	**Non-buffered**	**Yes**

Assessment

9. ***Is the plan based on current science?*** Portions, because there is no feasibility provided.
10. ***Does the lake meet the characteristics of a lake where in-lake treatment is likely to be successful?*** *Yes, it is a deep lake, with most of the loading from internal sources, and stormwater BMPs are already in place.*
11. ***Is biological monitoring data available? Does this data indicate concerns for impacts on the biota or potential threats to the effectiveness of the treatment?*** None provided
12. ***Were project goals met / are they on the path to being met?*** *Yes, see table 1 above but to confirm the magnitude reduction follow up coring is needed evaluate the change in release rate.*
    a. ***If no, is follow-up planned to achieve proposed goals?*** None noted
13. ***What were potential challenges to the project? Describe opportunities for improvement.*** None noted
14. ***Additional comments on the restoration project.***

Project Evaluation

Goals are the discrete, measurable results of implementing the restoration actions. Outcomes are the desired system changes that the project is intended to affect. Projects can be designated as likely to not meet, minimally meet, meet, or exceed proposed goals and outcomes with a low, medium, or high degree of confidence in the determination.

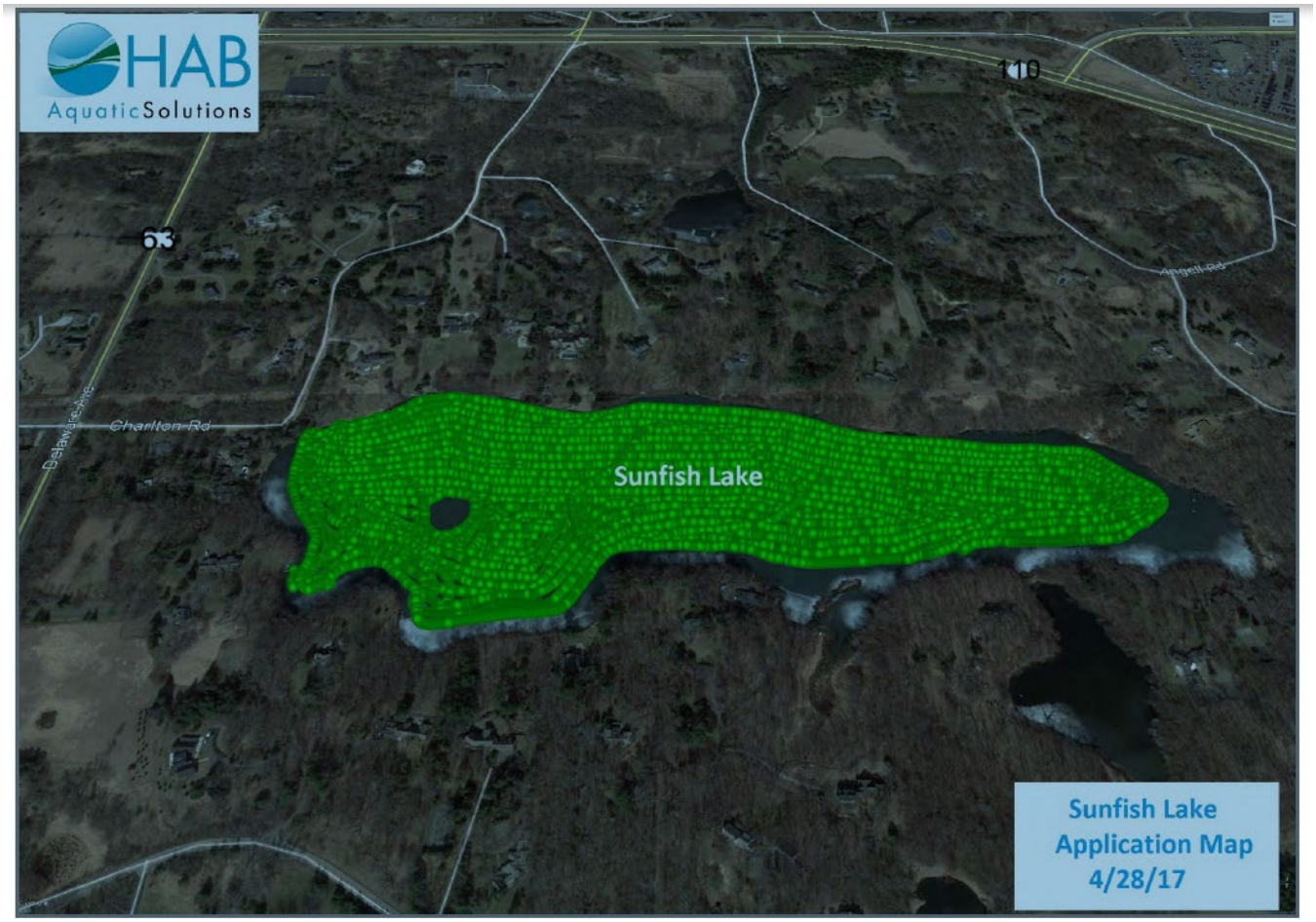
15. ***The project has:***

Achieved the stated goals.

16. ***The project will:***
    Support proposed outcomes.
    Confidence of outcome determination:
    High.
17. ***Provide explanation of reason(s) for determination.***
    The follow up sediment coring will be beneficial however the lake has been delisted and is meeting the stated goals.
18. ***Assessor(s) conducting review:***

    Anne Wilkinson, EOR, PhD

Map



Sunfish Lake alum application coverage map by contractor

Figure 36 Map of Sunfish Lake with alum application coverage for the 2017 treatment.

17 Elm Creek WMC Internal Phosphorus Loading Control: Fish Lake, Hennepin County

Project Background

Lake Name, DOW #: Fish, 27011800

Project Manager / Organization: Brian Vlach, Three Rivers Parks District / Elm Creek Watershed Management Commission

Fund: CWF

Fiscal Year Funds: FY-17

Primary Activity: Alum Treatment

Latitude/Longitude: 45.092131, -93.463331

County: Hennepin

Project Start Date: 2017

Project Complete Date: 2019

Project Status: Long-term Monitoring Phase (3+ years)

Lake Characteristics

Lake Area (acres): 238 acres

Watershed size (acres): 2585 acres

Watershed to Lake Area: 11

Osgood Index: 6

Average Residence Time (years): 2 years

Depth Mean / Max (feet): 20 / 61 feet

% Littoral Area: 34%

Water Quality Metric	*Pre-Treatment Conditions (2007 - 2016)*	*Treatment Year (2017)*	*Post-Treatment Conditions (2018 - 2022)*	*Projected/Target*
Total Phosphorous (µg/L)	**45** (SD = 6, *n* = 10)	**45**	**24** (SD = 5, *n* = 3)	**40**
Chlorophyll-a (µg/L)	**24** (SD = 7, *n* = 10)	**17**	**16** (SD = 7, *n* = 3)	**14**
Secchi Disk - Summer Average (m)	**1.39** (SD = 0.34, *n* = 10)	**1.85**	**2.38** (SD = 0.60, *n* = 5)	**1.4**

Seasonal Water Quality Trends: Mean (standard deviation, n = # of years with data) shown.

Project Goals and Planning

1. ***Problem Identification (Levels of Impairment):*** aquatic recreation impairment due to excessive nutrients
2. ***Previous and/or Ongoing Water Quality Improvement Efforts:*** The Fish Lake Area Residents Association (FLARA) will continue their effort to improve shoreline buffers around the lake on private property as well as continue to improve general stormwater management practices. The City of Maple Grove is incorporating stormwater pollutant load reductions into its street re-construction projects in the watershed and is examining use of high efficiency street sweepers to intensively clean streets in high priority areas to reduce the pollutant load available for wash-off. Over 76% of the Fish Lake watershed is served by ponds or other stormwater quality treatment features. The watershed is nearly entirely developed with low connected impervious cover (<22%), which limits additional cost-effective stormwater treatment options. Two significant watershed capital improvement projects elsewhere in the Elm Creek watershed have already been completed in partnership with member communities, generating a phosphorus load reduction of almost 220 lbs./yr at a capital cost of $1.36 million dollars
3. ***Project Justification:*** 70% of the total phosphorus load is estimated to be from internal phosphorus loading based on the 2016 TMDL, which requires nearly a 19.6% reduction in the internal phosphorus load to meet the TMDL targets (a 309.5 lb/y reduction in internal phosphorus loading).
4. ***What partners or agencies were involved with proposal and technical planning? What were the contributions?*** Three Rivers Park District; Elm Creek WMC; William James at UW-Stout; City of Maple Grove; Fish Lake Area Residents Association
5. ***Alum Feasibility study:*** A 2013 alum dosage study was completed in 2013, which evaluated alum dosing on Fish Lake sediments and quantified phosphorus fractions to determine appropriate alum dose
    a. ***Phosphorus & Water Budget:*** TMDL states internal phosphorus load 70% of total
    b. ***Data Basis:*** redox-sensitive sediment phosphorus + alum titration to determine dose
    c. ***Monitoring Performed:*** sediment coring
    d. ***Internal P Load (%):*** 70
    e. ***Estimated duration of effectiveness:*** Not stated; 2022 data indicate sediment release of phosphorus
6. ***What are the stated goals of the project? List quantifiable measures of success if identified.*** Reduction in internal phosphorus load by 310 lbs/yr***.*** Attainment of NCHF eutrophication standards for deep lakes.

Watershed-wide TMDL for the Elm Creek watershed. The end point for the Fish Lake TMDL was based on the state water quality standard for deep lakes in the NCHF ecoregion set by MPCA, plus a margin of safety. The approach and results are presented in the Elm Creek WMC TMDL and modeling appendices.

7. ***What are the desired outcomes of achieving the stated goals?*** Reduced density and duration algal blooms and attainment of state eutrophication standards for deep lakes in the NCHF ecoregion
8. ***List and briefly describe best management practices, criteria, guidelines identified in plans.*** A comprehensive alum evaluation analysis was conducted to determine the appropriate site-specific alum dose for Fish Lake, based on the redox-sensitive phosphorus fractions in the sediments. This was a non-buffered application to Fish Lake, which has high buffering capacity as alkalinity was measured in the dosing determination.

Project Implementation

Alum Treatment Overview

Treatment Description	Date	Dosage	pH
Application 1	***Sept 18-21, 2017***	***95349 gallons applied to 241.4 acres***	**Monitored by applicator**
Application 2	**Aug 5-8, 2019**	**95,079 applied to 240.3 acres**	**Monitored by applicator**

Assessment

9. ***Is the plan based on current science?*** Yes
10. ***Does the lake meet the characteristics of a lake where in-lake treatment is likely to be successful?*** yes, pre-alum design work indicated 70% of the total phosphorus load is from internal sediment phosphorus release
11. ***Is biological monitoring data available? Does this data indicate concerns for impacts on the biota or potential threats to the effectiveness of the treatment?*** aquatic plant monitoring has been conducted pre- and post-alum treatment. The raw data provided but was not analyzed as this was beyond the scope of the restoration evaluation. No summary information was provided.
12. ***Were project goals met / are they on the path to being met?*** Available reports indicate TP is lower post-treatment compared to pre-treatment conditions. 2022 data indicate that TP is lower than previous years as reported in TMDL
    a. ***If no, is follow-up planned to achieve proposed goals?*** Unknown.
13. ***What were potential challenges to the project? Describe opportunities for improvement.*** Unknown
14. ***Additional comments on the restoration project.***

    The alum treatments appeared to have mitigated some release of sediment phosphorus. However, with 70% of the load derived from the sediments and very high redox-P concentrations, multiple treatments will likely be needed over time to fully bind with the available sediment phosphorus. The 2022 hypolimnetic SRP data indicates that the sediments were releasing phosphorus which accumulated in the hypolimnion, presumably until thermal mixing occurred.

Project Evaluation

Goals are the discrete, measurable results of implementing the restoration actions. Outcomes are the desired system changes that the project is intended to affect. Projects can be designated as likely to not meet, minimally meet, meet, or exceed proposed goals and outcomes with a low, medium, or high degree of confidence in the determination.

15. ***The project has:***
    Minimally achieved the stated goals.
16. ***The project will:***
    Minimally support proposed outcomes.
    Confidence of outcome determination:
    Medium.
17. ***Provide explanation of reason(s) for determination.***
    The alum dosing was based on redox-sensitive phosphorus and sediments were titrated with alum in the lab at UW-Stout to determine the site-specific dose needed for Fish Lake. In addition, sediment traps were employed to quantify the Al-P binding capacity ratio to evaluate adaptive management opportunities with the 2nd treatment.

With 70% of the total phosphorus load from internal sediment loading, the alum treatment will effectively suppress sediment phosphorus release but attained of water quality standards will depend on the longevity of the treatment and continued reductions from watershed loads.

The only post-treatment data provided was collected in the summer 2022 which showed lower TP and SRP compared to pre-treatment years (data shown in TMDL); however, there is an increasing trend in SRP accumulation in the hypolimnion of Fish Lake which directly points to internal sediment P release under anoxic conditions – this may indicate that another alum treatment is needed for Fish Lake.

18. Assessor(s) conducting review:

Dendy Lofton, PhD, CLM; Senior Associate/Limnologist with Stantec

Map and Other Data

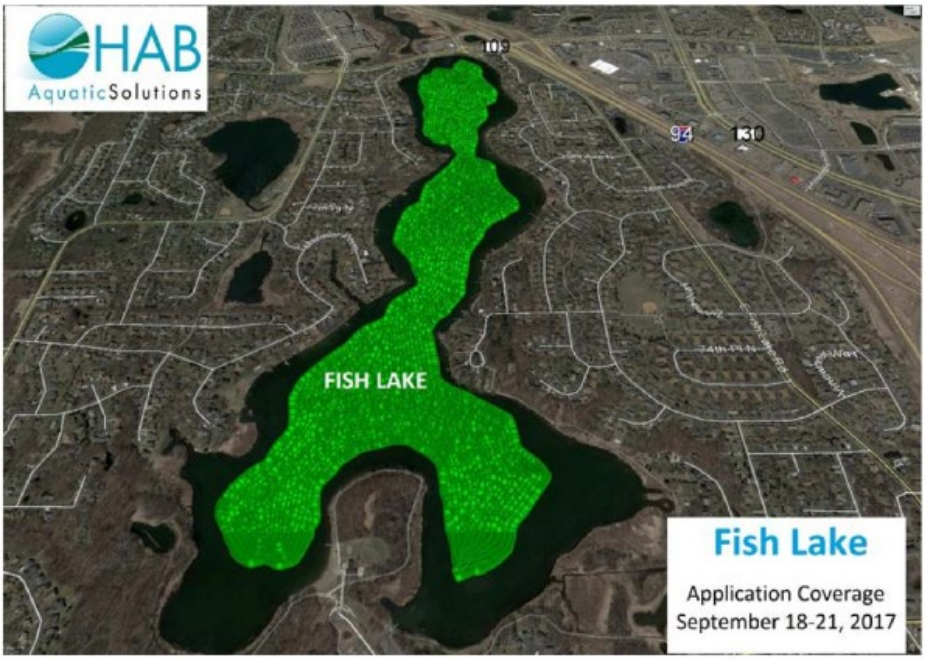


Figure 37. Alum application area for Fish Lake (2017).

Curlyleaf pondweed point-intercept surveys have been collected pre- and post-alum treatment, but no summary data was provided, only the raw data was provided in the evaluation.

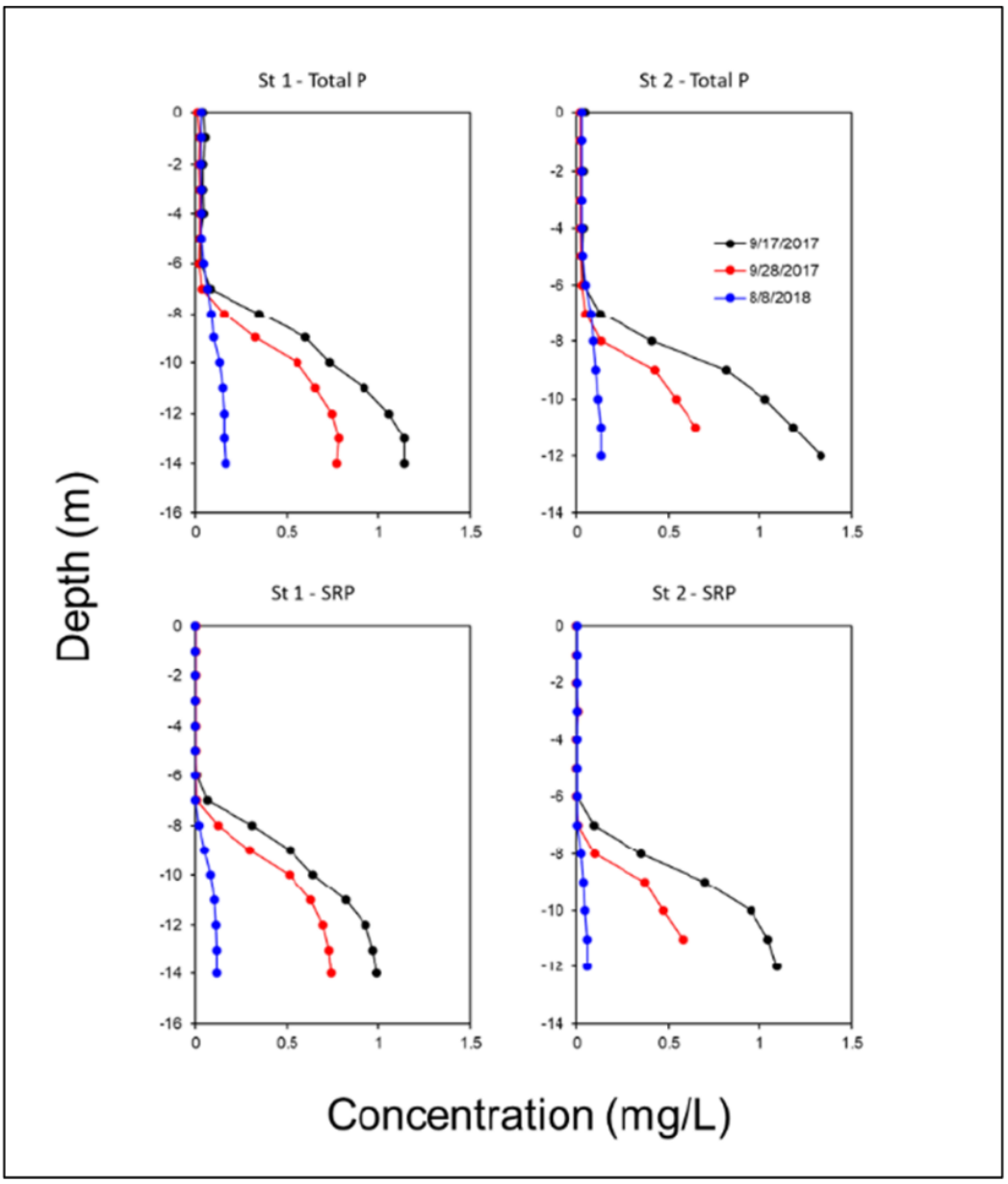


Figure 4: Hypolimnetic vertical variations in total phosphorus and soluble reactive phosphorus concentrations for station 1 and 2 that occurred prior to and after the alum treatment in September of 2017.

Figure 38. Pre-alum treatment (2017) and post-alum treatment (2018) total phosphorus (TP) and soluble reactive phosphorus (SRP) in the water column of Fish Lake. The data clearly show a reduction in hypolimnetic TP and SRP following the first half of the treatment.

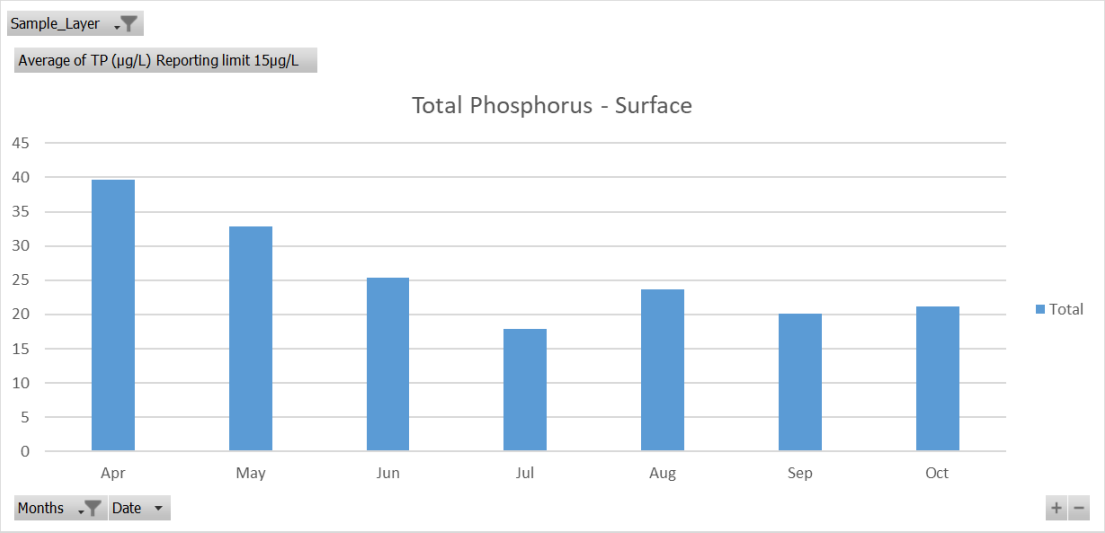


Figure 39. 2022 Surface total phosphorus monthly average concentration.

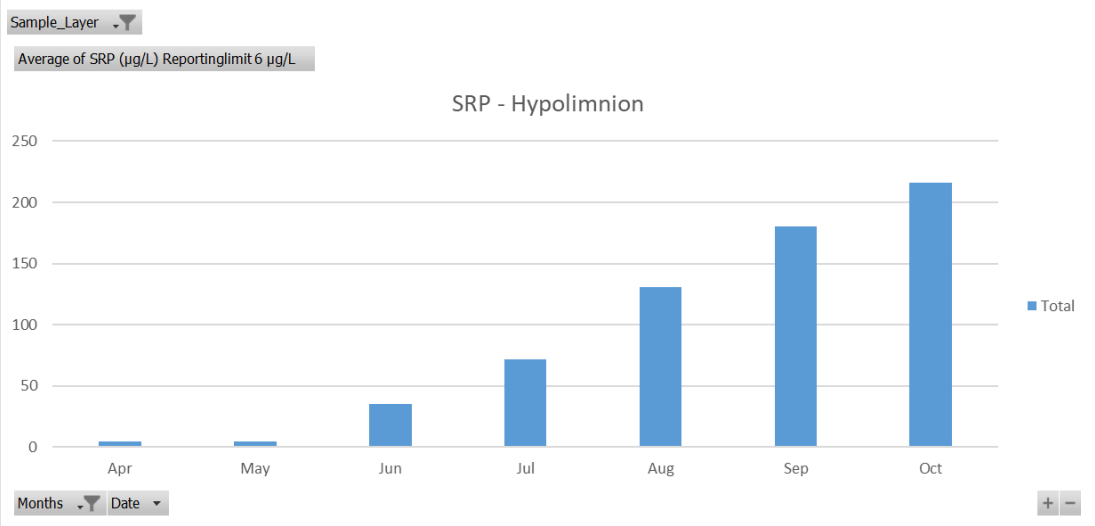


Figure 40. 2022 Hypolimnetic soluble reactive phosphorus monthly average concentration.

18 Shields Lake Stormwater Harvest and Irrigation Reuse System and Alum Treatment

Project Background

Lake Name, DOW #: Shields, 82016200

Project Manager / Organization: Mike Kinney / Comfort Lake – Forest Lake Watershed District

Fund: CWF

Fiscal Year Funds: FY-17

Primary Activity: Alum Treatment

Latitude/Longitude: 45.252917, -92.944935

County: Washington

Project Start Date: 2017

Project Complete Date: 2019

Project Status: Long-term Monitoring Phase (3+ years)

Lake Characteristics

Lake Area (acres): 30 acres

Watershed size (acres): 955 acres

Watershed to Lake Area: 32

Osgood Index: 6

Average Residence Time (years): < 1 year

Depth Mean / Max (feet): 7 / 26 feet

% Littoral Area: 86%

Water Quality Metric	*Pre-Treatment Conditions (2007 - 2018)*	*Treatment Year (2019)*	*Post-Treatment Conditions (2020 - 2023)*	*Projected/Target*
Total Phosphorous (µg/L)	**218** (SD = 58, *n* = 8)	**129**	**44** (SD = 14, *n* = 3)	
Chlorophyll-a (µg/L)	**46** (SD = 15, *n* = 7)	**56**	**14** (SD = 10, *n* = 4)	
Secchi Disk - Summer Average (m)	**0.89** (SD = 0.30, *n* = 9)	**0.75**	**1.87** (SD = 0.56, *n* = 4)	

Seasonal Water Quality Trends: Mean (standard deviation, n = # of years with data) shown.

Project Goals and Planning

1. ***Problem Identification (Levels of Impairment):*** Shields Lake is currently on the impaired waters list for excess nutrients/eutrophication and is the single largest contributor of phosphorus to Forest Lake. Flow and water quality monitoring of 16 tributaries to Forest Lake was initiated in March of 2016 as part of the Forest Lake CWP Diagnostic Study. Preliminary load calculations from the first three months of this monitoring identified Shields Lake as the largest, single source of flow (35% of the total monitored flow) and phosphorus load (25% of the total monitored load) to Forest Lake.
2. ***Previous and/or Ongoing Water Quality Improvement Efforts:*** Installation of irrigation reuse system; stormwater harvesting pond; carp and curlyleaf pondweed monitoring/management
3. ***Project Justification:*** High internal phosphorus loading. For Shields Lake to achieve an in-lake phosphorus concentration goal of 60 µg/L, the total phosphorus load needs to be reduced by 912 lb/yr from both watershed sources (35% of the total load) and in-lake sediment sources (65% of the total load).
4. ***What partners or agencies were involved with proposal and technical planning? What were the contributions?*** Comfort Lake Forest Lake WD; EOR; St Croix Research Station
5. ***Alum Feasibility study:*** Project predates feasibility study requirement
    a. ***Phosphorus & Water Budget:*** NA
    b. ***Data Basis:*** Work plan states "Paleolimnological sediment core data, previously collected by the St. Croix Watershed Research Station on behalf of CLFLWD, will be reviewed and analyzed by EOR to develop an appropriate dosing plan for Shields Lake in 2017." This is an uncommon approach and the basis for alum dosing is not very specified in the materials provided. Contemporary approaches base alum dosing on redox-sensitive, or biologically available, phosphorus fractions in sediments.
    c. ***Monitoring Performed:*** Post-treatment monitoring in accordance with District's routine monitoring protocols
    d. ***Internal P Load (%):*** 65
    e. ***Estimated duration of effectiveness:*** 10 years
6. ***What are the stated goals of the project? List quantifiable measures of success if identified.***

    Completion of the whole-lake alum treatment is estimated to result in a reduction of roughly 913 pounds per year in the phosphorus load to Shields Lake, reducing internal sediment phosphorus loading to natural background levels. This is anticipated to achieve the CLFLWD's long-term water quality goal for Shields Lake and result in a clear water state for the lake. Additionally, completion of this project is anticipated to reduce phosphorus loads to Forest Lake by up to 250 pounds per year.

For Shields Lake to achieve an in-lake phosphorus concentration goal of 60 µg/L, the total phosphorus load needs to be reduced by 912 lb/yr from both watershed sources (35% of the total load) and in-lake sediment sources (65% of the total load).

7. ***What are the desired outcomes of achieving the stated goals?*** Alum treatment in Shields Lake anticipated to reduce internal phosphorus loads by 912 lbs/year and in combination with watershed reduction efforts will achieve in-lake phosphorus concentration goal of 60 µg/L.
8. ***List and briefly describe best management practices, criteria, guidelines identified in plans.***

   The alum dose calculations provided indicate that the alum dose was based on an older methodology which was to base the dose on phosphorus flux rather than on the mass of phosphorus fractions in the sediments.

Project Implementation

Alum Treatment Overview

Treatment Description	Date	Dosage	pH
Application 1	*Oct 25-27, 2019*	15,315 gallons aluminum sulfate 7,560 gallons sodium aluminate	Unknown. No pH logs provided for first application.
Application 2	*Sept 21-23, 2020*	15,315 gallons aluminum sulfate 7,560 gallons sodium aluminate	Optimal range maintained during application according to applicator logs

Assessment

9. ***Is the plan based on current science?*** No
10. ***Does the lake meet the characteristics of a lake where in-lake treatment is likely to be successful?*** Yes, with internal phosphorus loading being approximately 65% of the total phosphorus load, sediment phosphorus inactivation using alum is warranted.
11. ***Is biological monitoring data available? Does this data indicate concerns for impacts on the biota or potential threats to the effectiveness of the treatment?*** Common carp and curlyleaf pondweed are monitored and managed as part of the holistic lake management for this system. No biological impacts are expected from an alum treatment if pH is maintained in the optimal range (6.5 – 9) during application. It is not common for biological communities to be assessed for impacts due to the

treatment other than monitoring pH, but carp and aquatic plants (especially AIS species) are often assessed as part of holistic lake management efforts.

12. ***Were project goals met / are they on the path to being met?*** The 2022 monitoring report indicates that TP and chl-a are lower since the alum treatment compared to pre-treatment conditions. The stated project goals are: Alum treatment in Shields Lake anticipated to reduce internal phosphorus loads by 912 lbs/year and in combination with watershed reduction efforts will achieve in-lake phosphorus concentration goal of 60 µg/L.
    a. ***If no, is follow-up planned to achieve proposed goals?*** NA
13. ***What were potential challenges to the project? Describe opportunities for improvement.*** NA
14. ***Additional comments on the restoration project.***

    The alum dose calculations provided indicate that the alum dose was based on an older methodology which was to base the dose on phosphorus flux rather than on the mass of phosphorus fractions in the sediments. Often the older methods result in underdosing, so ongoing monitoring of phosphorus in the surface and bottom waters will be needed to evaluate effectiveness of the treatment.

Project Evaluation

Goals are the discrete, measurable results of implementing the restoration actions. Outcomes are the desired system changes that the project is intended to affect. Projects can be designated as likely to not meet, minimally meet, meet, or exceed proposed goals and outcomes with a low, medium, or high degree of confidence in the determination.

15. ***The project has:***
    Minimally achieved the stated goals.
16. ***The project will:***
    Minimally support proposed outcomes.
    Confidence of outcome determination:
    Medium.
17. ***Provide explanation of reason(s) for determination.***
    The monitoring data report from 2022 shows a reduction in surface TP and chlorophyll-a in the years following the alum treatment along with a reduction in bottom water orthophosphate. Continued suppression of internal sediment P release will be needed to sustain lower surface TP and chlorophyll-a conditions along with watershed P load reduction efforts. Recent post-alum application monitoring data is encouraging.

    The goal for achieving the eutrophication standards appears on track to attain that goal based on post-treatment monitoring data. The goal for a 912 lbs/year reduction in internal P loading and Forest Lake by up to 250 pounds per year do not appear to have been estimated yet, so we cannot determine if these goals have been met.
18. ***Assessor(s) conducting review:***

    Dendy Lofton, PhD, CLM; Senior Associate/Limnologist with Stantec

Map and Other Data

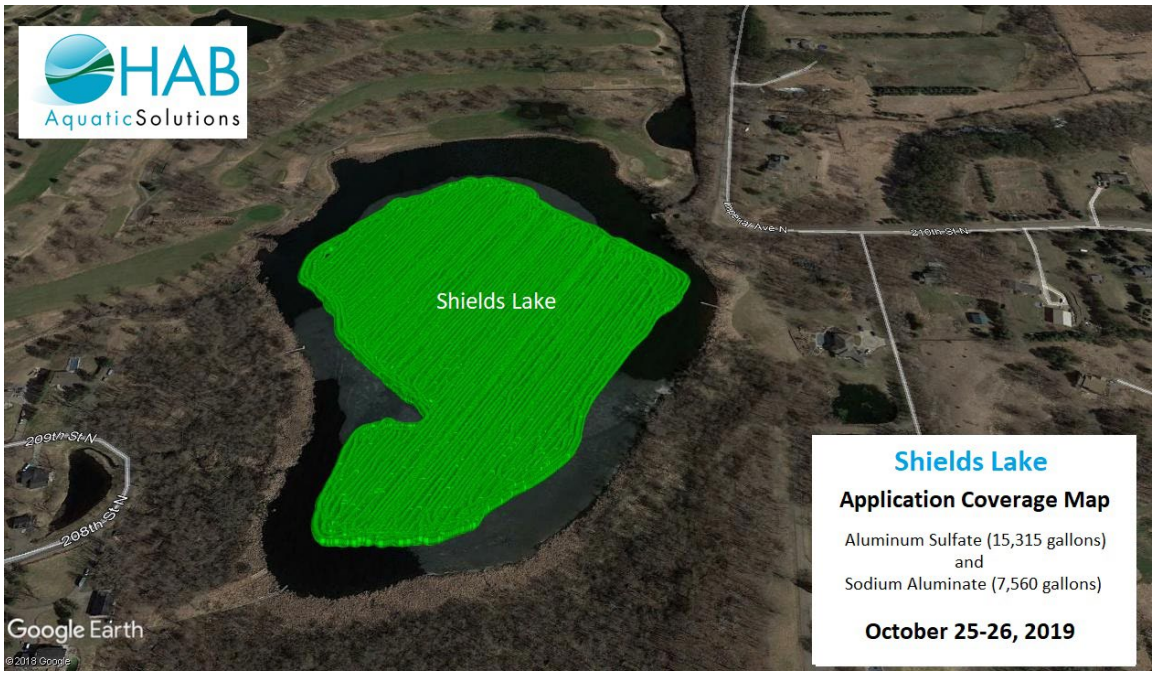


Figure 41. Application area for 2019 alum application to Shields Lake.

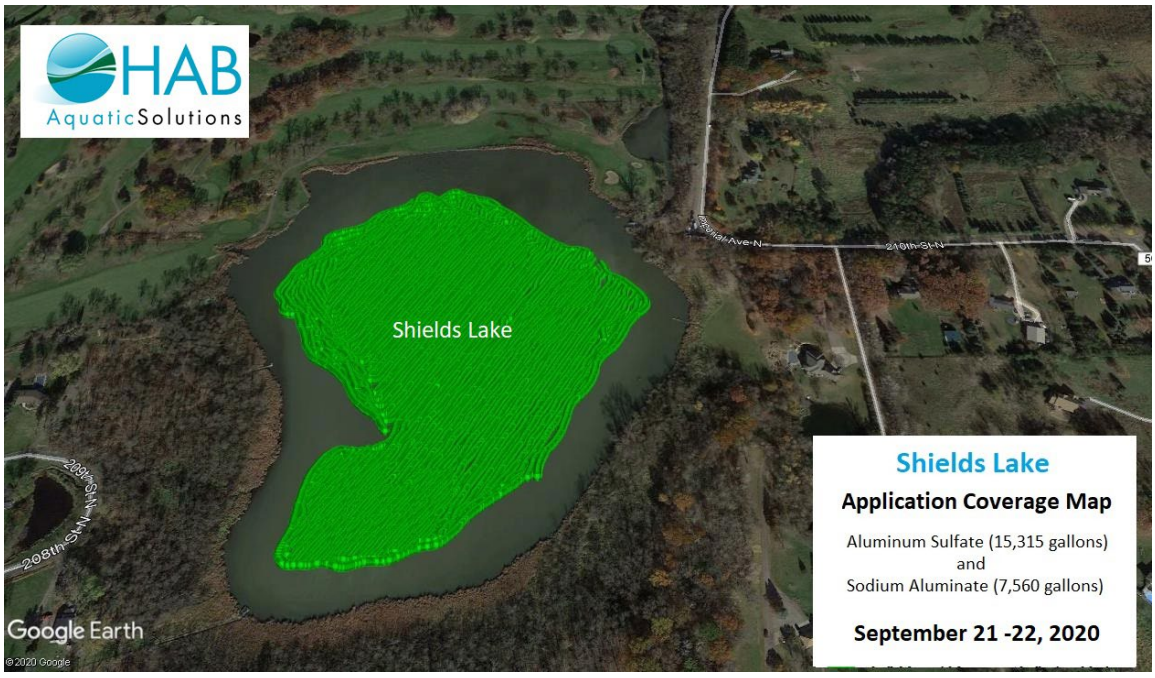
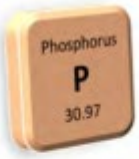


Figure 42. Application area for 2020 alum application to Shields Lake.

SHIELDS LAKE

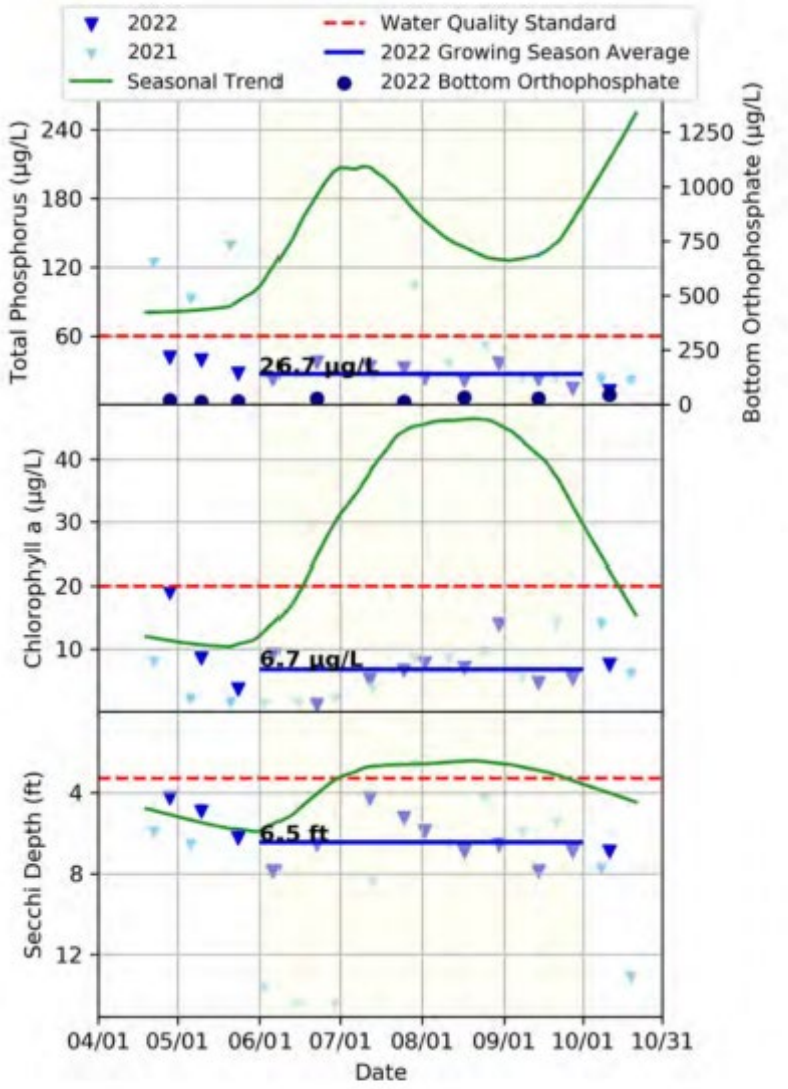
2022 Surface Water Quality Summary

Nutrients:
June-Sept. Average Total Phosphorus (TP, µg/L)



Algae:
June-Sept. Average Chlorophyll-a (Chl-a, µg/L)

Clarity:
June-Sept. Average Secchi Depth (Secchi, ft)



State standards are shown with a dashed red line. Phosphorus = 40 µg/L, Chlorophyll-a = 14 µg/L, Secchi Depth = 4.6 feet. Sample points are shown in black dots. Points above the line are worse than the State standard. Points below the line are better than the State standard.

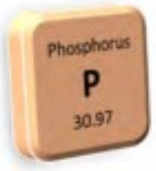
Figure 43. 2022 Surface water quality trends in Shields Lake.

SHIELDS LAKE

Historical Water Quality Summary

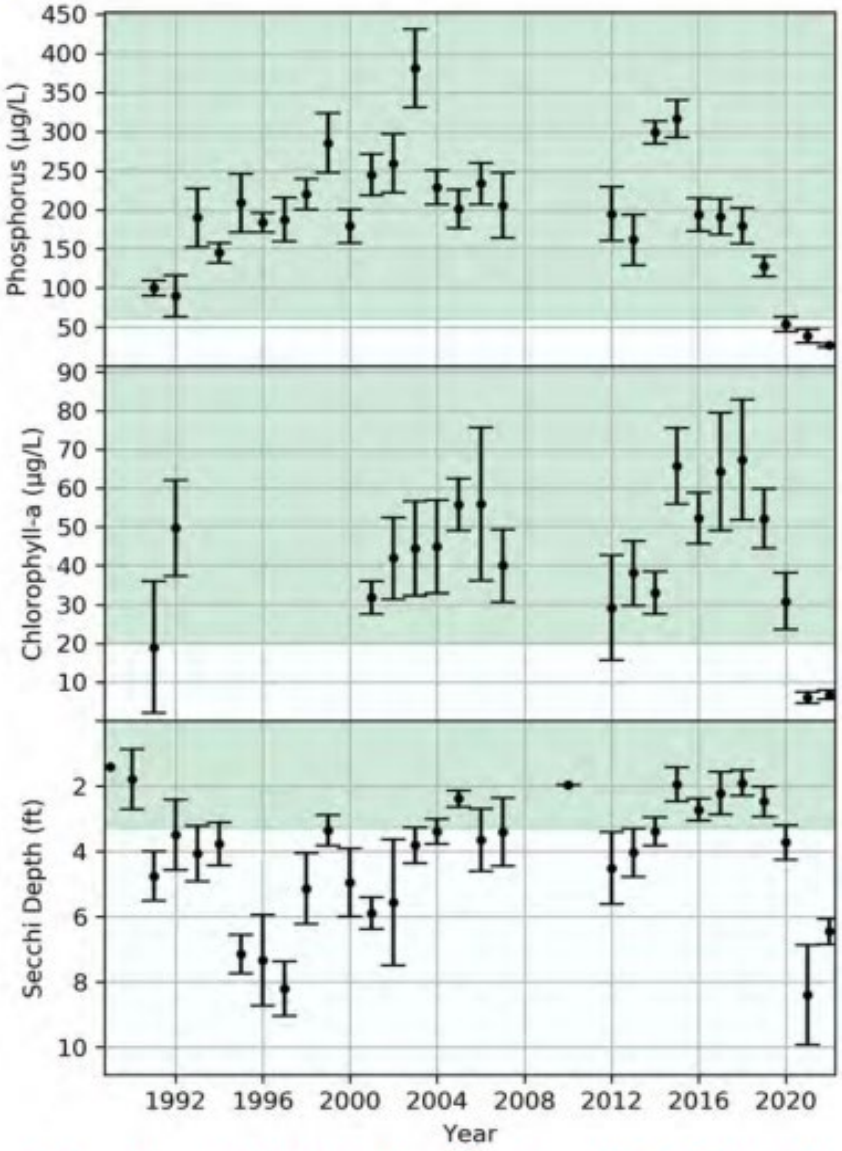
	Phosphorus (µg/L)	Chl-a (µg/L)	Secchi (feet)
State Standard	<60	<20	>3.3
10-year Average (2013-2022)	**160.9**	**41.6**	**3.7**
2040 District Goal	<60	n/a	>4.3
5-year Average (2018-2022)	**84.4**	**31.9**	**4.7**

Nutrients:
June-Sept. Average Total Phosphorus (TP, µg/L)



Algae:
June-Sept. Average Chlorophyll-a (Chl-a, µg/L)

Clarity:
June-Sept. Average Secchi Depth (Secchi, ft)



State standards are shown with a dashed red line. Phosphorus = 40 µg/L, Chlorophyll-a = 14 µg/L, Secchi Depth = 4.6 feet. Sample points are shown in black dots. Points above the line are worse than the State standard. Points below the line are better than the State standard.

Figure 44. Historical surface water quality trends in Shields Lake.

19 Alimagnet Lake Stormwater Improvement Project

Project Background

Lake Name, DOW #: Pond LA2-A, 19011700

Project Manager / Organization: Travis Thiel / Vermillion River Watershed Joint Powers Organization

Fund: CWF

Fiscal Year Funds: FY-17

Primary Activity: Alum Treatment

Latitude/Longitude:

County: Dakota

Project Start Date: 2017

Project Complete Date: 2019

Project Status: Long-term Monitoring Phase (3+ years)

Lake Characteristics

Lake Area (acres): 3.30

Watershed size (acres): 146.1 acres

Watershed to Lake Area: 44.3

Osgood Index: NA

Average Residence Time (years): NA

Depth Mean / Max (feet): 2.54 ft

% Littoral Area: 100

Water Quality Metric	*Pre-Treatment Conditions (2010-2016)*	*Treatment Year (2017)*	*Post-Treatment Conditions (2018-2023)*	*Projected/Target*
Total Phosphorous (µg/L)	221	170	136	No in-pond targets
Chlorophyll-a (µg/L)	94.6	285.2	91.6	No in-pond targets
Secchi Disk - Summer Average (m)	NA	NA	NA	No in-pond targets

Seasonal Water Quality Trends: Mean (standard deviation, n = # of years with data) shown.

Project Goals and Planning

NOTE: This is a storm water pond treatment thus the monitoring and outcomes are not the same as an in-lake treatment and should be considered an external load treatment to a downstream lake, similar to a watershed BMP.

1. ***Problem Identification (Levels of Impairment):*** This treatment LA2-A is one of 4 proposed stormwater treatments to remove external loading to Alimagnet lake. Phosphorus is the nonpoint pollution concern that will be the focus of this project, which will improve the condition of Alimagnet Lake. The benefit of the overall project is that it will achieve more than half (58%) of the required waste load allocation (WLA) reduction for all MS4s for Alimagnet Lake.
2. ***Previous and/or Ongoing Water Quality Improvement Efforts:*** This project is part of four stormwater projects in the Aligmagnet watershed. The goals are based on the implementation of all four treatments.
3. ***Project Justification:*** Phosphorus is the nonpoint pollution concern that will be the focus of this project, which will improve the condition of Alimagnet Lake. The benefit of the overall project is that it will achieve more than half (58%) of the required waste load allocation (WLA) reduction for all MS4s for Alimagnet Lake. By implementing the proposed project, progress would be made on restoring an impaired water, and completion would assist the City of Burnsville in addressing its TMDL WLA reduction. Progress toward achieving the water quality standard on Alimagnet Lake also assists with phosphorus reduction TMDL goals for East Lake, a downstream lake in Lakeville. Alimagnet Lake's load allocation reduction identified in the East Lake TMDL will be achieved with the proposed project. Downstream of East Lake, the project would help protect the Vermillion River from nutrient impairment and would address the restoration of Lake Pepin.
4. ***What partners or agencies were involved with proposal and technical planning? What were the contributions?*** The VRWJPO, in partnership with the City of Burnsville.
5. ***Alum Feasibility study:***. Lake Alimagnet water quality improvements feasibility
    a. ***Phosphorus & Water Budget:*** These are stormwater ponds and the alum treatment for these ponds acts as an external load reduction for downstream lakes thus this section is not applicable.
    b. ***Data Basis:*** NA
    c. ***Monitoring Performed:*** NA
    d. ***Internal P Load (%):*** NA
    e. ***Estimated duration of effectiveness:*** 3 years
6. ***What are the stated goals of the project? List quantifiable measures of success if identified.***

This alum treatment in combination with the other three stormwater projects will reduce phosphorus by 62 lbs/yr, which will be 100% of the total external load to be reduced for the Alimagnet Lake TMDL. The project will address 100% of Burnsville's WLA reduction as well as all MS4s WLA reduction for the Alimagnet Lake TMDL.

7. ***What are the desired outcomes of achieving the stated goals?*** The goals established for Alimagnet Lake are to reduce phosphorus in Alimagnet Lake by 167.5 lbs.
   The goals established for East Lake are to reduce phosphorus in East Lake by 410.2 lbs.
   The goals established for Mississippi River/Lake Pepino is a 45% Phosphorus load reduction per Nutrient Reduction Strategy and Lake Pepin TMDL.
8. ***List and briefly describe best management practices, criteria, guidelines identified in plans.***

Project Implementation

Alum Treatment Overview

Treatment Description	Date	Dosage	Buffer or Non-buffered	pH
Initial treatment	**No date**	**640 alum gals** **640 buffer gals**	***Buffered, 1:1***	**Not provided**

Assessment

9. ***Is the plan based on current science?*** Portions, because of the unconventional buffering ratio.
10. ***Does the lake meet the characteristics of a lake where in-lake treatment is likely to be successful?*** It is a stormwater pond thus the longevity of the alum treatment is short due to the high influent loads and the function of the stormwater pond.
11. ***Is biological monitoring data available? Does this data indicate concerns for impacts on the biota or potential threats to the effectiveness of the treatment?*** None provided
12. ***Were project goals met / are they on the path to being met?*** Nothing provided
    a. ***If no, is follow-up planned to achieve proposed goals?***
13. ***What were potential challenges to the project? Describe opportunities for improvement.*** None provided
14. ***Additional comments on the restoration project.***

The buffer was applied at a 1:1 ration which is not standard. It should have been applied at a 2:1 ratio. I would like to see the justification for this unconventional dosing.

Project Evaluation

Goals are the discrete, measurable results of implementing the restoration actions. Outcomes are the desired system changes that the project is intended to affect. Projects can be designated as likely to not meet, minimally meet, meet, or exceed proposed goals and outcomes with a low, medium, or high degree of confidence in the determination.

15. ***The project has:***
    Minimally achieved the stated goals.
16. ***The project will:***
    Minimally support proposed outcomes.
    Confidence of outcome determination:
    Low.
17. ***Provide explanation of reason(s) for determination.***

There is no follow up monitoring of the sediments and the longevity of this treatment is short and The feasibility study sates this treatment cycle will result in 3 treatment applications over a ten-year treatment cycle and is estimated to remove approximately 24 to 48 pounds of phosphorus annually. However, it is unclear if these follow up treatments will be done and what happens past those ten years to maintain phosphorus reductions.

18. ***Assessor(s) conducting review:***

    Anne Wilkinson, PhD EOR inc.

20 Alimagnet Lake Stormwater Improvement Projects (2)

Project Background

Lake Name, DOW #: Pond LA3-A

Project Manager / Organization: Travis Thiel / Vermillion River Watershed Joint Powers Organization

Fund: CWF

Fiscal Year Funds: FY-17

Primary Activity: Alum Treatment

Latitude/Longitude: 44.74118007, -93.2658454

County: Dakota

Project Start Date: 2017

Project Complete Date: 2019

Project Status: Long-term Monitoring Phase (3+ years)

Lake Characteristics

Lake Area (acres): 14 acres

Watershed size (acres): 96 acres

Watershed to Lake Area: 7

Osgood Index: 8

Average Residence Time (years): 1 year

Depth Mean / Max (feet): NA / 14 feet

% Littoral Area: 93%

Water Quality Metric	*Pre-Treatment Conditions (2007 - 2016)*	*Treatment Year (2017)*	*Post-Treatment Conditions (2018 - 2023)*	*Projected/Target*
Total Phosphorous (µg/L)	**47** (SD = 12, *n* = 10)	**50**	**25** (SD = 8, *n* = 5)	No in-pond targets
Chlorophyll-a (µg/L)	**20** (SD = 9, *n* = 9)	**71**	**12** (SD = 13, *n* = 6)	No in-pond targets
Secchi Disk - Summer Average (m)	**1.48** (SD = 0.44, *n* = 10)	**1.06**	**2.03** (SD = 0.67, *n* = 6)	No in-pond targets

Seasonal Water Quality Trends: Mean (standard deviation, n = # of years with data) shown.

Project Goals and Planning

NOTE: This is a storm water pond treatment thus the monitoring and outcomes are not the same as an in-lake treatment and should be considered an external load treatment to a downstream lake, similar to a watershed BMP.

1. ***Problem Identification (Levels of Impairment):*** This treatment LA3-A is one of 4 proposed stormwater treatments to remove external loading to Alimagnet lake. Phosphorus is the nonpoint pollution concern that will be the focus of this project, which will improve the condition of Alimagnet Lake. The benefit of the overall project is that it will achieve more than half (58%) of the required waste load allocation (WLA) reduction for all MS4s for Alimagnet Lake.
2. ***Previous and/or Ongoing Water Quality Improvement Efforts:*** This project is part of four stormwater projects in the Aligmagnet watershed. The goals are based on the implementation of all four treatments.
3. ***Project Justification:*** Phosphorus is the nonpoint pollution concern that will be the focus of this project, which will improve the condition of Alimagnet Lake. The benefit of the overall project is that it will achieve more than half (58%) of the required waste load allocation (WLA) reduction for all MS4s for Alimagnet Lake. By implementing the proposed project, progress would be made on restoring an impaired water, and completion would assist the City of Burnsville in addressing its TMDL WLA reduction. Progress toward achieving the water quality standard on Alimagnet Lake also assists with phosphorus reduction TMDL goals for East Lake, a downstream lake in Lakeville. Alimagnet Lake's load allocation reduction identified in the East Lake TMDL will be achieved with the proposed project. Downstream of East Lake, the project would help protect the Vermillion River from nutrient impairment and would address the restoration of Lake Pepin
4. ***What partners or agencies were involved with proposal and technical planning? What were the contributions?*** The VRWJPO, in partnership with the City of Burnsville.
5. ***Alum Feasibility study:*** Lake Alimagnet water quality improvements feasibility
    a. ***Phosphorus & Water Budget:*** These are stormwater ponds and the alum treatment for these ponds acts as an external load reduction for downstream lakes thus this section is not applicable.
    b. ***Data Basis:***
    c. ***Monitoring Performed:***
    d. ***Internal P Load (%):***
    e. ***Estimated duration of effectiveness:*** 3 years
6. ***What are the stated goals of the project? List quantifiable measures of success if identified.***

This alum treatment in combination with the other three stormwater projects will reduce phosphorus by 62 lbs/yr, which will be 100% of the total external load to be reduced for the Alimagnet Lake TMDL. The project will address 100% of Burnsville's WLA reduction as well as all MS4s WLA reduction for the Alimagnet Lake TMDL.

7. ***What are the desired outcomes of achieving the stated goals?*** The goals established for Alimagnet Lake are to reduce phosphorus in Alimagnet Lake by 167.5 lbs.
   The goals established for East Lake are to reduce phosphorus in East Lake by 410.2 lbs.
   The goals established for Mississippi River/Lake Pepino is a 45% Phosphorus load reduction per Nutrient Reduction Strategy and Lake Pepin TMDL.
8. ***List and briefly describe best management practices, criteria, guidelines identified in plans.***

Project Implementation

Alum Treatment Overview

Treatment Description	Date	Dosage	Formulation	pH
Initial treatment	**No date**	**1,160 alum gals** **1,160 buffer gals**	***Buffered, 1:1***	**Not provided**

Assessment

9. ***Is the plan based on current science?*** Portions, because of the unconventional buffer ratio.
10. ***Does the lake meet the characteristics of a lake where in-lake treatment is likely to be successful?*** *No,* It is a stormwater pond thus the longevity of the alum treatment is short due to the high influent loads and the function of the stormwater pond.
11. ***Is biological monitoring data available? Does this data indicate concerns for impacts on the biota or potential threats to the effectiveness of the treatment?*** None provided
12. ***Were project goals met / are they on the path to being met?*** Nothing provided
    a. ***If no, is follow-up planned to achieve proposed goals?***
13. ***What were potential challenges to the project? Describe opportunities for improvement.*** None provided.
14. ***Additional comments on the restoration project.***

The buffer was applied at a 1:1 ration which is not standard. It should have been applied at a 2:1 ratio. I would like to see the justification for this unconventional dosing

Project Evaluation

Goals are the discrete, measurable results of implementing the restoration actions. Outcomes are the desired system changes that the project is intended to affect. Projects can be designated as likely to not meet, minimally meet, meet, or exceed proposed goals and outcomes with a low, medium, or high degree of confidence in the determination.

15. ***The project has:***
    Minimally achieved the stated goals.
16. ***The project will:***
    Minimally support proposed outcomes.
    Confidence of outcome determination:
    Low.
17. ***Provide explanation of reason(s) for determination.***

There is no follow up monitoring of the sediments and the longevity of this treatment is short. The feasibility study states this treatment cycle will result in 3 treatment applications over a ten-year treatment cycle and is estimated to remove approximately 24 to 48 pounds of phosphorus annually. However, it is unclear if these follow up treatments will be done and what happens past those ten years to maintain phosphorus reductions.

18. ***Assessor(s) conducting review:***

    Anne Wilkinson, PhD EOR inc.

21 Moody Lake Alum Treatment

Project Background

Lake Name, DOW #: Moody, 13002300

Project Manager / Organization: Mike Kinney / Comfort Lake – Forest Lake Watershed Management District

Fund: CWF

Fiscal Year Funds: FY-18

Primary Activity: Alum Treatment

Latitude/Longitude: 45.301385, -92.866743

County: Chisago

Project Start Date: 2018

Project Complete Date: 2020

Project Status: Long-term Monitoring Phase (3+ years)

Lake Characteristics

Lake Area (acres): 45 acres

Watershed size (acres): 2661 acres

Watershed to Lake Area: 59

Osgood Index: 7

Average Residence Time (years): 1 year

Depth Mean / Max (feet): 10 / 48 feet

% Littoral Area: 49%

Water Quality Metric	*Pre-Treatment Conditions (2006 - 2017)*	*Treatment Year (2018)*	*Treatment Year (2019)*	*Post-Treatment Conditions (2020 -2023)*	*Projected/Target*
Total Phosphorous (µg/L)	**121** (SD = 34, *n* = 10)	**94**	**61**	**35** (SD = 3, *n* =3)	
Chlorophyll-a (µg/L)	**62** (SD = 20, *n* = 10)	**70**	**43**	**14** (SD = 4, *n* = 4)	
Secchi Disk - Summer Average (m)	**0.72** (SD = 0.11, *n* = 10)	**0.61**	**0.72**	**1.82** (SD = 0.85, *n* = 4)	

Seasonal Water Quality Trends: Mean (standard deviation, n = # of years with data) shown.

Project Goals and Planning

1. ***Problem Identification (Levels of Impairment):*** Moody Lake is impaired for excessive nutrients
2. ***Previous and/or Ongoing Water Quality Improvement Efforts:*** livestock/cattle exclusion project and wetland restoration in Subwatershed NBL12 near 250th Street and Lofton Avenue; feedlot project in a drainage area west of Moody Lake in Subwatershed NBL18 near 245th Street and Lofton Ave; rough fish (bullheads) were removed in 2009; winter aerator installed on Moody Lake; fish barriers installed on Bone Lake; alum treatment of several ponds with high internal P loading rates that also drain into Moody Lake were to be treated with alum (no documentation of whether that project was implemented beyond the planning phase); herbicide treatments in Moody Lake for curlyleaf pondweed management
3. ***Project Justification:*** internal P loading estimated to be 36% of the total load with extremely high hypolimnetic TP concentrations in 2006
4. ***What partners or agencies were involved with proposal and technical planning? What were the contributions?*** CLFLWD; EOR
5. ***Alum Feasibility study:*** 2012 Internal Load Treatment Options Study. No alum dosing information provided nor was any sediment phosphorus data provided.
    a. ***Phosphorus & Water Budget:*** Yes, developed by Wenck in 2007, adapted version reported in Moody Lake Internal Load Treatment Options.
    b. ***Data Basis:*** unknown. Data/information not provided.
    c. ***Monitoring Performed:*** application states that sediment cores were collected but that data was not provided
    d. ***Internal P Load (%):*** 36
    e. ***Estimated duration of effectiveness:*** 10 years
6. ***What are the stated goals of the project? List quantifiable measures of success if identified.***
   Estimated reduction in 324 lbs/yr, based on 88% reduction of the existing internal P load estimate of 368 lbs/yr. In-lake water quality goal of 40 ug/L of phosphorus.
7. ***What are the desired outcomes of achieving the stated goals?*** achieve in-lake TP target of 40 ug/L
8. ***List and briefly describe best management practices, criteria, guidelines identified in plans.***
   The alum dose calculations provided indicate that the alum dose was based on an older methodology which was to base the dose on phosphorus flux rather than on the mass of phosphorus fractions in the sediments.

Project Implementation

Alum Treatment Overview

Treatment Description	Date	Dosage	pH
One application	**October 21-24, 2019**	**15,500 gallons alum + 7,750 gallons sodium aluminate**	**No info provided**

Assessment

9. ***Is the plan based on current science?*** It is not clear from the information provided. No alum dosing information provided nor was any sediment phosphorus data provided. The provided information states that application states that sediment cores were collected but that data was not available for review.
10. ***Does the lake meet the characteristics of a lake where in-lake treatment is likely to be successful?*** Yes, small area and internal loading rates were found to be 26-41% of the total phosphorus load to the lake. Reducing loads from Moody Lake serves to improve water quality in downstream waterbodies as well
11. ***Is biological monitoring data available? Does this data indicate concerns for impacts on the biota or potential threats to the effectiveness of the treatment?*** Common carp and curlyleaf pondweed are monitored and managed as part of the holistic lake management for this system. No biological impacts are expected from an alum treatment if pH is maintained in the optimal range (6.5 – 9) during application. It is not common for biological communities to be assessed for impacts due to the treatment other than monitoring pH, but carp and aquatic plants (especially AIS species) are often assessed/managed as part of holistic lake management efforts.
12. ***Were project goals met / are they on the path to being met?*** 2022 summer mean TP below the 40 ug/L standard
    a. ***If no, is follow-up planned to achieve proposed goals?*** NA
13. ***What were potential challenges to the project? Describe opportunities for improvement.*** Unknown
14. ***Additional comments on the restoration project.***

The alum dose calculations provided indicate that the alum dose was based on an older methodology which was to base the dose on phosphorus flux rather than on the mass of phosphorus fractions in the sediments. Often the older methods result in underdosing, so ongoing monitoring of phosphorus in the surface and bottom waters will be needed to evaluate effectiveness of the treatment. Hypolimnetic phosphorus will need to be monitored for evidence of P accumulation in summer – at which time another alum treatment may be warranted. Pre-treatment sediment release rates were quantified, so I would recommend collection of sediment cores to quantify post-treatment sediment P release rates to compare to pre-treatment conditions.

Project Evaluation

Goals are the discrete, measurable results of implementing the restoration actions. Outcomes are the desired system changes that the project is intended to affect. Projects can be designated as likely to not meet, minimally meet, meet, or exceed proposed goals and outcomes with a low, medium, or high degree of confidence in the determination.

15. ***The project has:***
    Achieved the stated goals.
16. ***The project will:***
    Support proposed outcomes.
    Confidence of outcome determination:
    Medium.
17. ***Provide explanation of reason(s) for determination.***
    2022 hypolimnetic orthophosphate is significantly lower under post alum treatment conditions compared to pre-treatment conditions; 2022 mean growing season surface TP was also below the standard of 40 ug/L.
18. ***Assessor(s) conducting review:***

    Dendy Lofton, PhD, CLM; Senior Associate/Limnologist with Stantec

Maps and Other Data

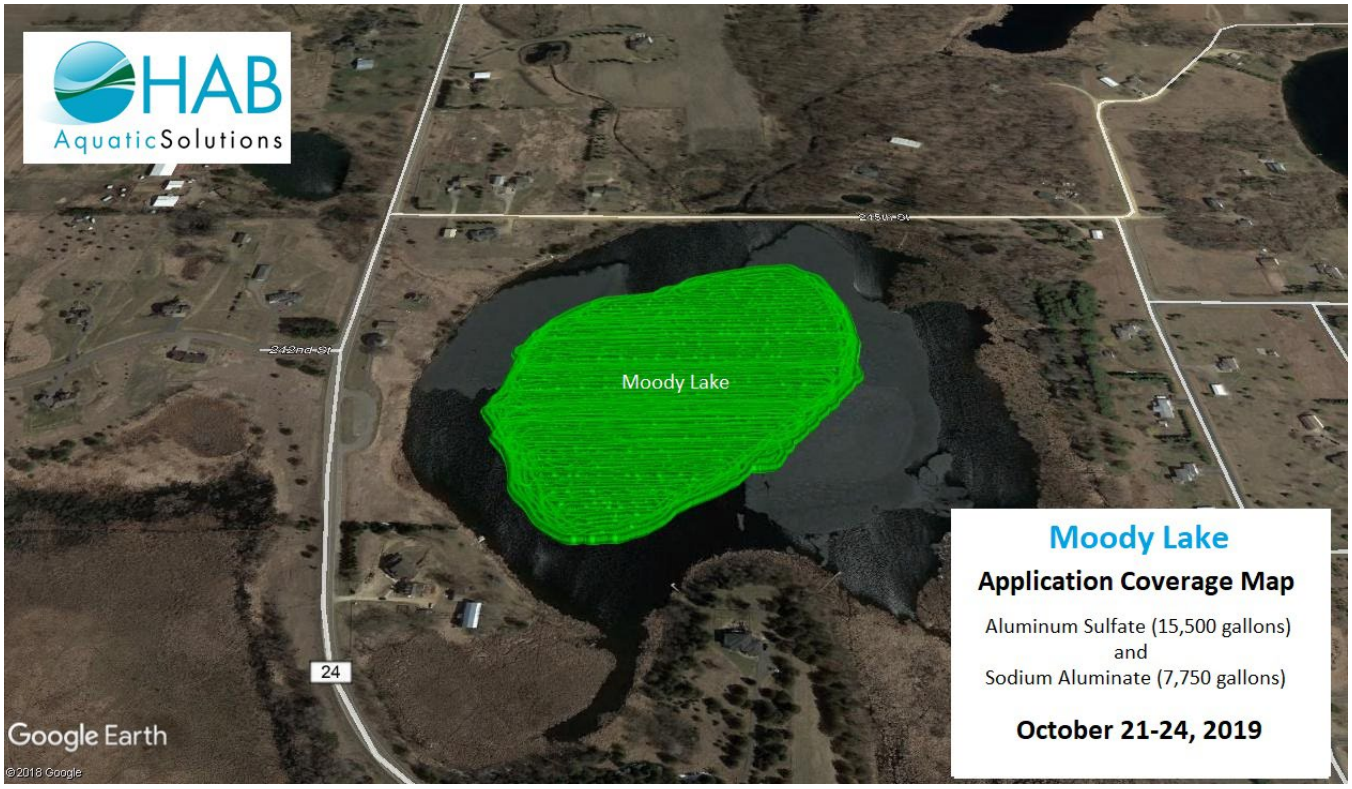


Figure 45. Alum application area for Moody Lake (2019).

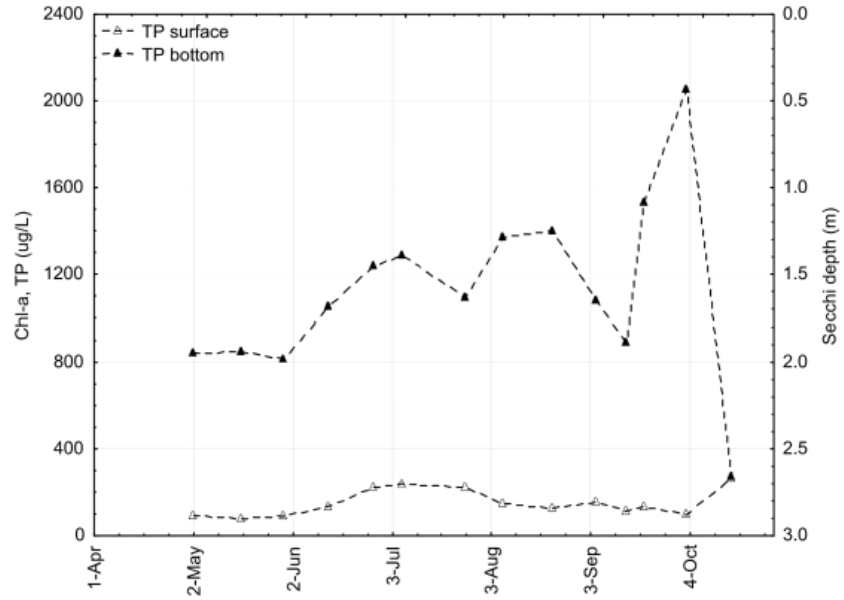


Figure 13. Seasonal trend of surface and bottom TP, 2006

Figure 46. Surface and hypolimnetic TP in 2006, prior to alum treatments. Hypolimnetic TP was extremely high indicating high rates of sediment P release.

Lake	Date	Bottom Ortho-P (mg/L)
Moody	7/17/2020	0.016
Moody	7/23/2020	0.017
Moody	8/11/2020	0.013
Moody	8/31/2020	0.013
Moody	9/17/2020	0.013

Table 5. Hypolimnetic orthophosphate data collected from Moody Lake in 2020. 2020 Hypolimnetic ortho-P was very low indicating that the alum treatments were effectively suppressing internal P release rates in 2020.

Table 9. Total Phosphorus 5-Year Average and progress to 2040 goals in all District Lakes

Lakes (in order of increasing TP)	Existing 5-year Average TP (2018-2022) [µg/L]	Years of Data	2040 District TP Goal
Keewahtin Lake	15.3	5	20 ✓
Third Lake	15.5	2	60 ✓
Lendt Lake	15.6	2	60 ✓
Bone Lake	24.9	5	30 ✓
Forest Lake (West)	26.3	5	30 ✓
Comfort Lake	27.0	5	30 ✓
Second Lake	27.5	4	60 ✓
Twin Lake	27.8	1	60 ✓
Forest Lake	32.7	5	30
Forest Lake (East)	33.1	5	30
Forest Lake (Middle)	38.7	5	30
Heims Lake	39.0	1	60 ✓
Little Comfort Lake	42.2	5	30
School Lake	43.1	4	60 ✓
Elwell Lake	43.1	2	60 ✓
Moody Lake	55.9	5	40
Birch Lake	83.8	3	60
Shields Lake	84.4	5	60
Nielson Lake	86.9	1	60
Fourth Lake	87.4	1	60
Sea Lake	n/a	0	60

Table 6. Total phosphorus (TP) existing 5-year average in all District Lakes compared to 2040 District-wide TP goal.

Table 7. Progress towards State Water Quality Standards

Lakes (In order of increasing TP)	Total Phosphorus (µg/L)			Chlorophyll-a (µg/L)			Secchi Depth (ft)		
	2013 - 2022 Average	Years of Data (N)	Standard	2013 - 2022 Average	Years of Data (N)	Standard	2013 - 2022 Average	Years of Data (N)	Standard
GENERAL LAKES									
Keewahtin	13.9	10	40 ✓	2.7	10	14 ✓	14.3	10	4.6 ✓
Comfort *	30.2	10	40 ✓	13.8	10	14 ✓	5.7	10	4.6 ✓
Bone *	32.1	10	40 ✓	17.2	10	14	4.9	10	4.6 ✓
Forest	33.0	10	40 ✓	15.4	10	14	6.0	10	4.6 ✓
Little Comfort *	48.3	10	40	19.4	10	14	5.3	10	4.6 ✓
Moody *	81.6	10	40	43.2	10	14	3.0	10	4.6
SHALLOW LAKES									

Table 7. Progress towards attainment of water quality standards in District lakes.

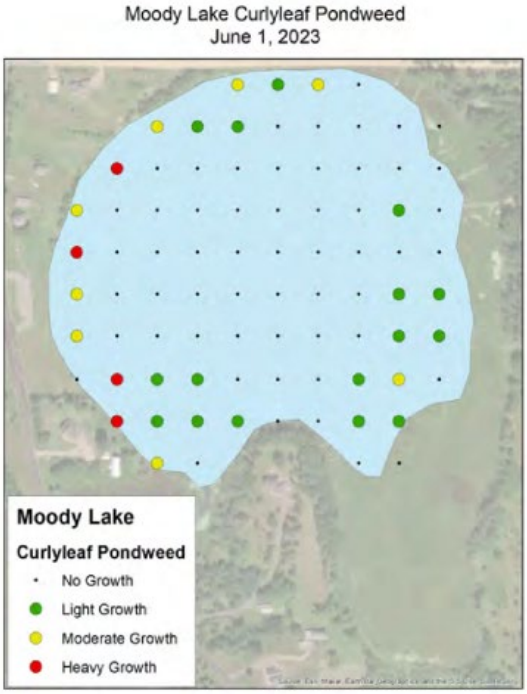


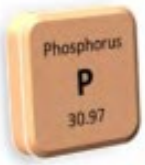
Figure 4. Curlyleaf pondweed coverage for Moody Lake on June 1, 2023. Key: black dots = no growth, green dot = light growth, yellow dots = moderate growth, and red dots = heavy growth.

Table 8. Curlyleaf pondweed coverage in Moody Lake (2023).

MOODY LAKE

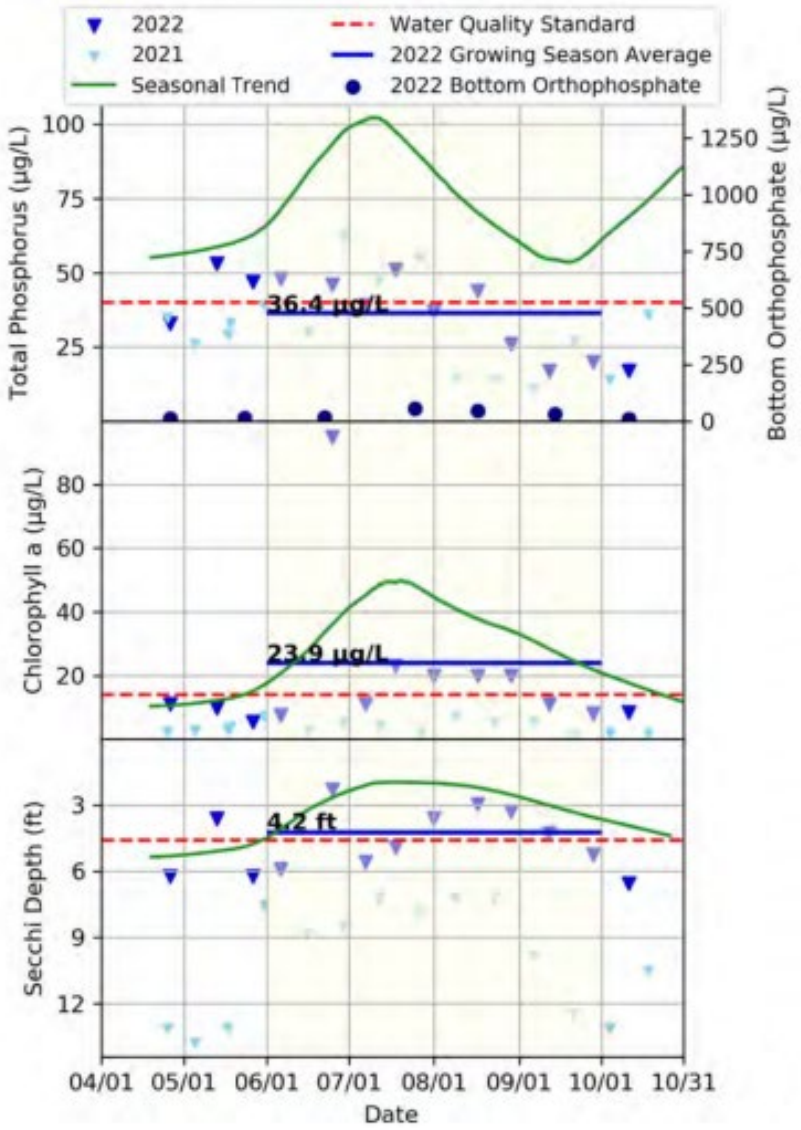
2022 Surface Water Quality Summary

Nutrients:
June-Sept. Average Total Phosphorus (TP, µg/L)



Algae:
June-Sept. Average Chlorophyll-a (Chl-a, µg/L)

Clarity:
June-Sept. Average Secchi Depth (Secchi, ft)



State standards are shown with a dashed red line. Phosphorus = 40 µg/L, Chlorophyll-a = 14 µg/L, Secchi Depth = 4.6 feet. Sample points are shown in black dots. Points above the line are worse than the State standard. Points below the line are better than the State standard.

Figure 47. Moody Lake 2022 water quality summary.

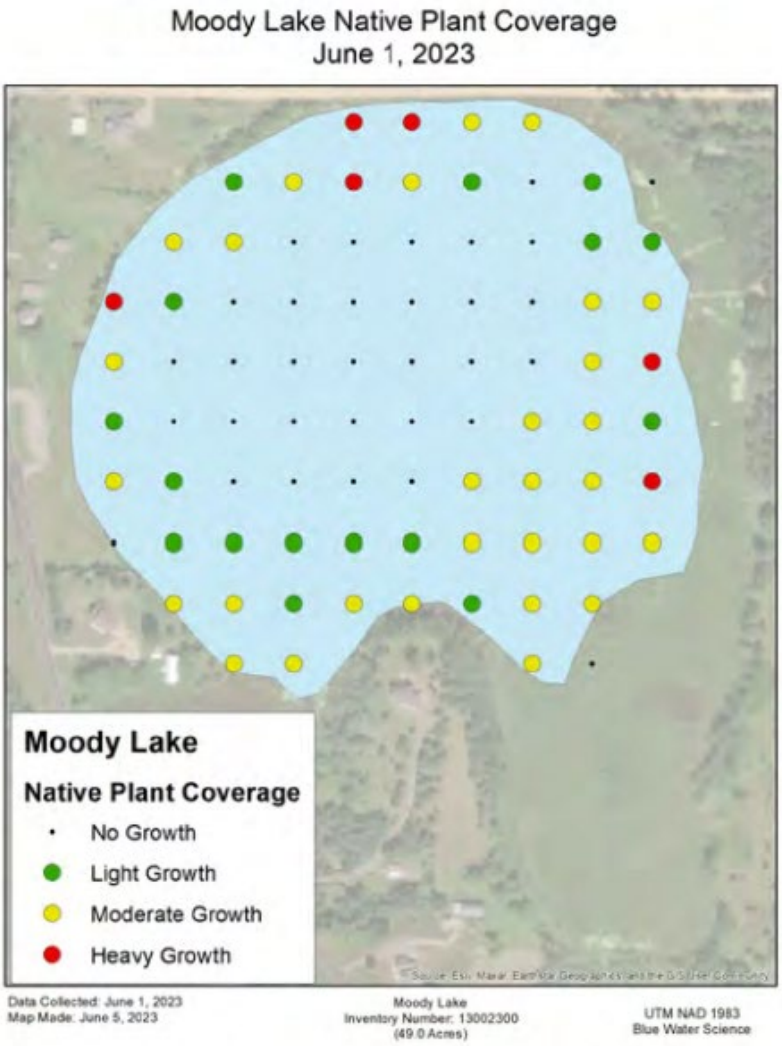


Figure 48. Native plant coverage in Moody Lake (2023).

22 Bass Lake Internal Load Reduction

Project Background

Lake Name, DOW #: Bass, 27009800

Project Manager / Organization: Amy Juntunen / Shingle Creek Watershed Management Commission

Fund: CWF

Fiscal Year Funds: FY-18

Primary Activity: Alum Treatment

Latitude/Longitude: 45.0549827, -93.43325865

County: Hennepin

Project Start Date: 2018

Project Complete Date: 2021

Project Status: Long-term Monitoring Phase (3+ years)

Lake Characteristics

Lake Area (acres): 182 acres

Watershed size (acres): 3085 acres

Watershed to Lake Area: 17

Osgood Index: 3

Average Residence Time (years): 0.47

Depth Mean / Max (feet): 8 / 31 feet

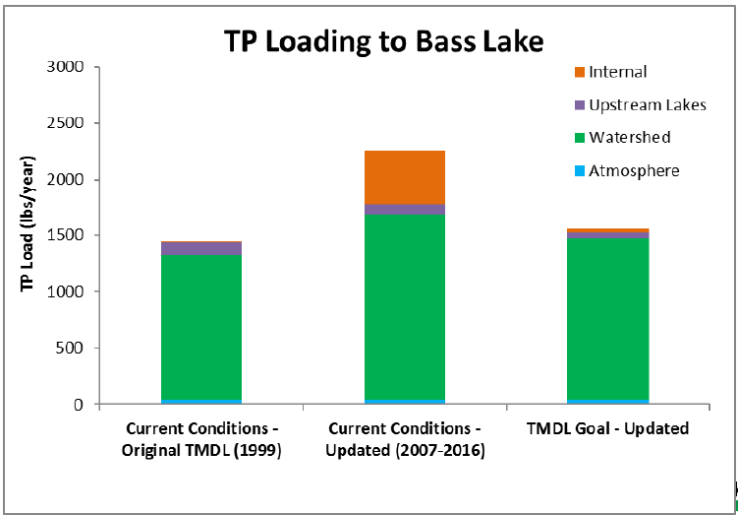
% Littoral Area: 81%

Water Quality Metric	*Pre-Treatment Conditions (2010 - 2019)*	*Treatment Year (2020)*	*Post-Treatment Conditions (2021 - 2022)*	*Projected/Target*
Total Phosphorous (µg/L)	**67** (SD = 22, *n* = 6)	**40**	**26** (SD = 5, *n* = 2)	65
Chlorophyll-a (µg/L)	**45** (SD = 17, *n* = 5)	**36**	**13** (SD = 3, *n* = 2)	
Secchi Disk - Summer Average (m)	**1.28** (0.54, *n* = 10)	**1.44**	**2.51** (SD = 0.18, *n* = 2)	1.43

Seasonal Water Quality Trends: Mean (standard deviation, n = # of years with data) shown.

Project Goals and Planning

1. ***Problem Identification (Levels of Impairment):*** Bass, Schmidt, and Pomerleau Lakes are part of a three-lake chain in the City of Plymouth, all of which were listed in 2002 as Impaired Waters for excess nutrients.
2. ***Previous and/or Ongoing Water Quality Improvement Efforts:*** Substantial watershed nutrient load reductions have been implemented, and Schmidt Lake has been removed from the303(d) list. Internal phosphorus load continues to be a significant issue in Bass and Pomerleau.
3. ***Project Justification:*** From a broader perspective, the Bass Lake subwatershed is approximately ten percent of the entire Shingle Creek watershed, and is its headwaters. Bass Lake discharges into Bass Creek, which has low dissolved oxygen and impaired biota. Excess sediment oxygen demand, at least a portion of which originates from nutrients contributed from watershed or streamflow sources, contributes to that demand. Low DO and nutrient enrichment are also stressors identified in the Bass and Shingle Creeks Stressor ID. Reducing the nutrient concentration and load in Bass Lake outflow will also help improve water quality and biotic integrity in Bass Creek. Shingle Creek is formed at the confluence of Bass and Eagle Creeks, so some of those benefits may extend downstream to Shingle as well.
4. ***What partners or agencies were involved with proposal and technical planning? What were the contributions?*** Shingle Creek Watershed District
5. ***Alum Feasibility study:*** Bass and Pomerleau Lakes Alum Dosing Feasibility and Cost Estimate
    a. ***Phosphorus & Water Budget:***



b. ***Data Basis:*** In 2017 the Commission completed a TMDL Five Year Review, summarizing progress to date and updating the nutrient budgets and targets using more recent and complete monitoring data

c. ***Monitoring Performed:*** Sediment cores were collected in 2010 and 2013 to provide dosage and potential release rate. The release rate from the sediment cores are combined with DO monitoring

d. ***Internal P Load (%):*** 21%

e. ***Estimated duration of effectiveness:*** 20 years

6. ***What are the stated goals of the project? List quantifiable measures of success if identified.*** Internal phosphorus load from the sediments continues to be a significant issue in Bass and Pomerleau, and alum treatments are proposed to reduce 90-95% of internal phosphorus loading. A 90-95% decrease in internal phosphorus load, or about 455 pounds per year on Bass Lake.

7. ***What are the desired outcomes of achieving the stated goals?*** After treatment, both lakes are expected to be at or close to the water quality standard. The Commission's goal is for all three lakes in the chain to be delisted by 2022. In Bass Lake, a 0.45 m increase in clarity from 0.98 m to 1.43 m, and a reduction in summer averageTP concentration from 80 µg/L TP to 65 µg/L. This aligns with the statewide priority of "restore[ing] those waters that are closest tomeeting state water quality standards."

8. ***List and briefly describe best management practices, criteria, guidelines identified in plans.*** See table below.

Project Implementation

Alum Treatment Overview

Treatment Description	Date	Dosage	Buffered/Non-buffered	pH
Initial Dose	5/15/2019	**34,006**	**N*on-buffered***	**monitored**
Second Dose	10/12/2020	**34,006**	**N*on-buffered***	**monitored**

Assessment

9. ***Is the plan based on current science?*** Yes

10. ***Does the lake meet the characteristics of a lake where in-lake treatment is likely to be successful?*** Yes, substantial nutrient reductions have been achieved in the watershed. The Osgood index is low, however there was anoxia present near the sediments.

11. ***Is biological monitoring data available? Does this data indicate concerns for impacts on the biota or potential threats to the effectiveness of the treatment?*** Additional plant management is needed to meet the goals. To date there have been three CLP treatments but the status of the current vegetation community is unknown.
12. ***Were project goals met / are they on the path to being met?*** This project is now complete and is transitioning to ongoing maintenance. They have completed two alum treatments and three curly-leaf pondweed (CLP) treatments. Final sediment cores confirm that sediment release in Bass has been reducedfrom an average 0f 10.9 g/m2/day to just under 1.0 g/m2/day. The lake is slated to be delisted in 2024.
    a. ***If no, is follow-up planned to achieve proposed goals?***
13. ***What were potential challenges to the project? Describe opportunities for improvement.*** Curly Leaf Pond weed community
14. ***Additional comments on the restoration project.***

    The proposed alum treatments on Bass and Pomerleau followed by aquatic vegetation management as necessary will improve water quality and clarity so that the lakes will be at or very close to meeting state water quality standards. Along with additional watershed load reductions to be completed separately, these projects are an essential component of achieving Impaired Waters delisting. Post alum treatment they have completed three curly leaf pondweed treatments. It is unclear how much watershed improvements have been completed.

Project Evaluation

Goals are the discrete, measurable results of implementing the restoration actions. Outcomes are the desired system changes that the project is intended to affect. Projects can be designated as likely to not meet, minimally meet, meet, or exceed proposed goals and outcomes with a low, medium, or high degree of confidence in the determination.

15. ***The project has:***
    Achieved the stated goals.
16. ***The project will:***
    Support proposed outcomes.
    Confidence of outcome determination:
    High.
17. ***Provide explanation of reason(s) for determination.***
    The follow up sediment cores show a reduction from 10.9g/m2/day to just under 1 g/m2/day and they have performed the necessary vegetation management. The lake is being evaluated for delisting in 2024.
18. ***Assessor(s) conducting review:***

    Anne Wilkinson, PhD

23 Pomerleau Lake Internal Load Reduction

Project Background

Lake Name, DOW #: Pomerleau 27010000

Project Manager / Organization: Amy Juntunen / Shingle Creek Watershed Management Commission

Fund: CWF

Fiscal Year Funds: FY-18

Primary Activity: Alum Treatment

Latitude/Longitude: 45.05255048, -93.46609572

County: Hennepin

Project Start Date: 2018

Project Complete Date: 2021

Project Status: Long-term Monitoring Phase (3+ years)

Lake Characteristics

Lake Area (acres): 26 acres

Watershed size (acres): 294 acres

Watershed to Lake Area: 11

Osgood Index: 10

Average Residence Time (years): 0.73 year

Depth Mean / Max (feet): 11 / 26 feet

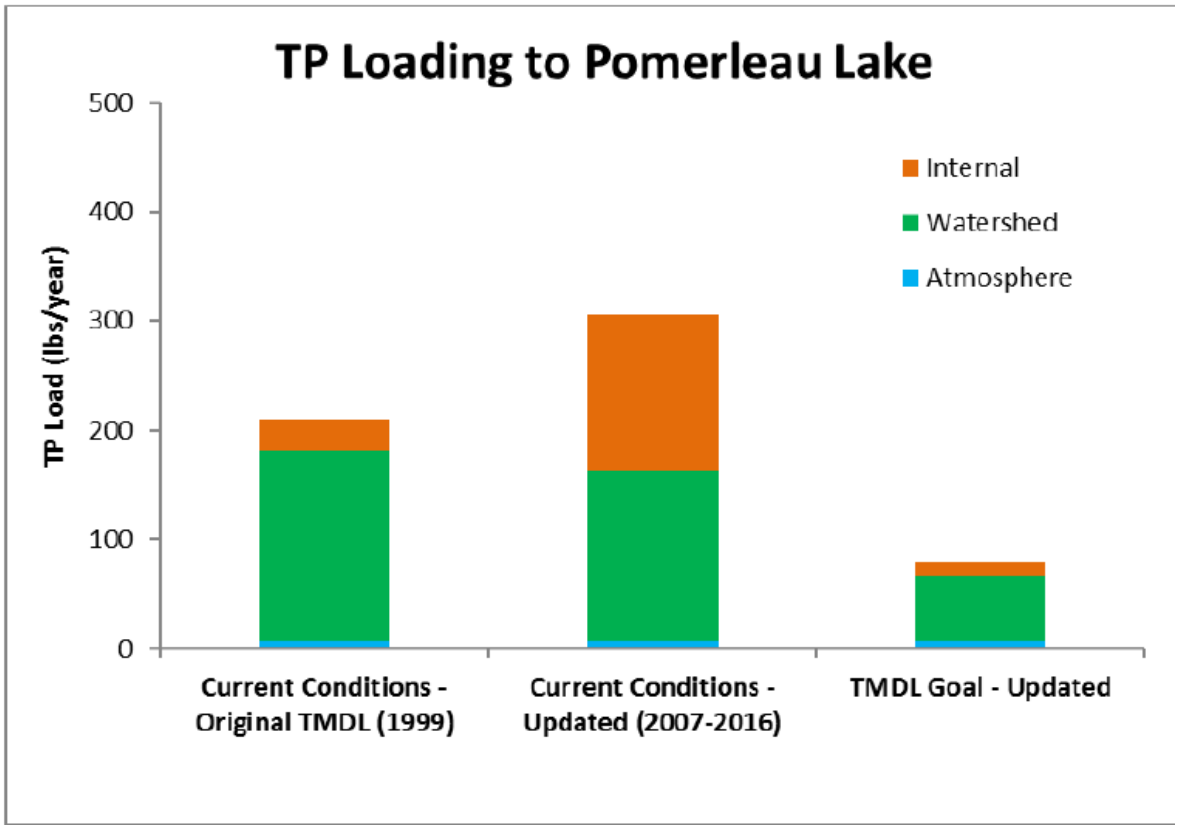
% Littoral Area: 69%

Water Quality Metric	*Pre-Treatment Conditions (2010 - 2019)*	*Treatment Year (2020)*	*Post-Treatment Conditions (2021)*	*Projected/Target*
Total Phosphorous (µg/L)	**75** (SD = 50, *n* = 8)	**22**	**16**	70
Chlorophyll-a (µg/L)	**19** (SD = 12, *n* = 8)	**6**	**4**	29
Secchi Disk - Summer Average (m)	**2.21** (SD = 0.60, *n* = 6)	**2.89**	**3.48**	

Seasonal Water Quality Trends: Mean (standard deviation, n = # of years with data) shown.

Project Goals and Planning

19. ***Problem Identification (Levels of Impairment):*** Pomerleau Lakes are part of a three-lake chain in the City of Plymouth, all of which were listed in 2002 as Impaired Waters for excess nutrients.
20. ***Previous and/or Ongoing Water Quality Improvement Efforts:*** Substantial watershed nutrient load reductions have been implemented, and Schmidt Lake has been removed from the303(d) list. Internal phosphorus load continues to be a significant issue in Bass and Pomerleau.
1. ***Project Justification:*** Pomerleau Lakes are part of a three lake chain in the City of Plymouth, all of which were listed in 2002 as Impaired Waters for excess nutrients. Substantial watershed nutrient load reductions have been implemented, and Schmidt Lake has been removed from the303(d) list. Internal phosphorus load continues to be a significant issue in Bass and Pomerleau
2. ***What partners or agencies were involved with proposal and technical planning? What were the contributions?*** Shingle Creek Watershed District
3. ***Alum Feasibility study:*** Bass and Pomerleau Lakes Alum Dosing Feasibility and Cost Estimate
    a. ***Phosphorus & Water Budget:***



b. ***Data Basis:*** In 2017 the Commission completed a TMDL Five Year Review, summarizing progress to date and updating the nutrient budgets and targets using more recent and complete monitoring data

c. ***Monitoring Performed:*** Sediment cores were collected in 2010 and 2013 to provide dosage and potential release rate. The release rate from the sediment cores are combined with DO monitoring

d. ***Internal P Load (%):*** 47%

e. ***Estimated duration of effectiveness:*** 20 years

4. ***What are the stated goals of the project? List quantifiable measures of success if identified.*** Internal phosphorus load from the sediments continues to be a significant issue in Bass and Pomerleau, and alum treatments are proposed to reduce 90-95% of internal phosphorus loading. A 90-95% decrease in internal phosphorus load, or 135 pound or 60% of the total annual reduction required in Pomerleau.

1. ***What are the desired outcomes of achieving the stated goals?*** Pomerleau is tributary to Bass Lake, so reducing outflow load will result in additional annual load reductions to Bass. Lake response modeling suggests that post application summer TP concentration in Bass Lake would fall from 80 µg/L TP to 65 µg/L. In Pomerleau Lake, summer TP concentration could be reduced from 103 µg/L TP to 70 µg/L.

2. ***List and briefly describe best management practices, criteria, guidelines identified in plans.*** See table below.

Project Implementation

Alum Treatment Overview

Treatment Description	Date	Dosage	Formulation	pH
Initial Dose	5/13/2019	***8,099***	***Non-buffered***	***monitored***
Second Dose	October 2020	***8,099***	***Non-buffered***	***monitored***

Assessment

3. ***Is the plan based on current science?*** Yes

4. ***Does the lake meet the characteristics of a lake where in-lake treatment is likely to be successful?*** Yes, substantial nutrient management has been completed in the watershed. The Osgood index is within the optimal range.

5. ***Is biological monitoring data available? Does this data indicate concerns for impacts on the biota or potential threats to the effectiveness of the treatment?*** The CLP community.
1. ***Were project goals met / are they on the path to being met?*** Yes, This project is now complete and is transitioning to ongoing maintenance. Pomerleau has been reduced from 11.8 g/m2/day to undetectable, well meeting the project's 90% reduction goal. The lake is slated to be delisted in 2024.
    a. ***If no, is follow-up planned to achieve proposed goals?***
2. ***What were potential challenges to the project? Describe opportunities for improvement.*** Curly Leaf Pond weed community
3. ***Additional comments on the restoration project.***

    The proposed alum treatments on Bass and Pomerleau followed by aquatic vegetation management as necessary will improve water quality and clarity so that the lakes will be at or very close to meeting state water quality standards. Along with additional watershed load reductions to be completed separately, these projects are an essential component of achieving Impaired Waters delisting. Post alum treatment they have completed three curly leaf pondweed treatments. It is unclear how much watershed improvements have been completed

Project Evaluation

Goals are the discrete, measurable results of implementing the restoration actions. Outcomes are the desired system changes that the project is intended to affect. Projects can be designated as likely to not meet, minimally meet, meet, or exceed proposed goals and outcomes with a low, medium, or high degree of confidence in the determination.

4. ***The project has:***
   Achieved the stated goals.
5. ***The project will:***
   Support proposed outcomes.
   Confidence of outcome determination:
   High.
6. ***Provide explanation of reason(s) for determination.***
   The follow up sediment cores show a reduction from 11.8 g/m2/day to undetectable and they have performed the necessary vegetation management. The lake is being evaluated for delisting in 2024.
7. ***Assessor(s) conducting review:***

   Anne Wilkinson, EOR inc

24 Keller Lake Alum Treatment

Project Background

Lake Name, DOW #: Keller, 19002500

Project Manager / Organization: Daryl Jacobson / Black Dog Watershed Management Organization

Fund: CWF

Fiscal Year Funds: FY-19

Primary Activity: Alum Treatment

Latitude/Longitude: 44.726562, -93.25092

County: Dakota

Project Start Date: 2019

Project Complete Date: 2021

Project Status: Monitoring Phase (1-2 years)

Lake Characteristics

Lake Area (acres): 55 acres

Watershed size (acres): 344

Watershed to Lake Area: 6

Osgood Index: 2

Average Residence Time (years): 1 year

Depth Mean / Max (feet): NA / 7 feet

% Littoral Area: 100%

Water Quality Metric	*Pre-Treatment Conditions (2007 - 2018)*	*Treatment Year (2019)*	*Post-Treatment (2020)*	*Treatment Year (2021)*	*Post-Treatment Conditions (2022-2023)*	*Projected/Target*
Total Phosphorous (µg/L)	**91** (SD = 24, *n* = 12)	**41**	**43**	**45**	**34**	**60**
Chlorophyll-a (µg/L)	**57** (SD = 41, *n* = 11)	**25**	**18**	**14**	**10** (SD = 6, *n* = 2)	**20**
Secchi Disk - Summer Average (m)	**0.80** (SD = 0.50, *n* = 12)	**1.32**	**1.23**	**1.48**	**1.50** (SD = 0.23, *n* = 2)	**1**

Seasonal Water Quality Trends: Mean (standard deviation, n = # of years with data) shown.

Project Goals and Planning

1. ***Problem Identification (Levels of Impairment):*** Keller Lake was identified as a priority in the plan because it is an impaired water body that has good potential for attaining its lake water quality goals/standards following the implementation of the plan activities. In addition to the expected water quality benefits for Keller Lake, the TMDL study estimated that a 40 pound phosphorus load reduction to Crystal Lake could be realized on an annual basis from Keller Lake meeting the goals/standards.
2. ***Previous and/or Ongoing Water Quality Improvement Efforts:*** BMPs were implemented since the completion of the Keller Lake TMDL and the estimated annual phosphorus removals. The estimated total phosphorus removals achieved by projects implemented since the completion of the TMDL is approximately 159 pounds per year
3. ***Project Justification:*** To achieve the total phosphorus reduction required by the TMDL, the city of Apple Valley (and Dakota County) needs to further reduce the phosphorus loading to Keller Lake by 57 pounds per year, based on updated P8modeling (Barr, 2017).
4. ***What partners or agencies were involved with proposal and technical planning? What were the contributions?*** Black Dog WMO (BDWMO) and cities of Burnsville and Apple Valley
5. ***Alum Feasibility study:*** Keller Lake In-Lake Treatment Feasibility Study
    a. ***Phosphorus & Water Budget:*** The TMDL report (Barr, 2011) estimated that internal load accounted for 40% of the annual phosphorus load during an average year and called for the following total phosphorus load reductions for Keller Lake:a) 52% reduction in the external load (wasteload allocation, or WLA) from the tributary area to Keller Lake b)The load allocation (LA) represents a 77% reduction in the existing portion of the phosphorus load (that is almost entirely made up of internal load)
    b. ***Data Basis:*** Phosphorus budget is based on critical water year (2006) modeling from Keller Lake TMDL. The dosing plan is based on five sediment cores that were collected on May 10, 2018 in Keller Lake.
    c. ***Monitoring Performed:*** Five sediment cores that were collected on May 10, 2018 in Keller Lake to prescribe the dose.
    d. ***Internal P Load (%):*** 40%
    e. ***Estimated duration of effectiveness:*** 15 years
6. ***What are the stated goals of the project? List quantifiable measures of success if identified.***
    At a minimum, the proposed in-lake aluminum application is expected to reduce the annual average TP load to Keller Lake by 80% or 186 lbs/yr**.**

7. ***What are the desired outcomes of achieving the stated goals?*** The proposed in-lake aluminum application represents most of the remaining TP load reduction that will be required to ensure that the shallow lake standards can be met in Keller Lake ona consistent basis.
8. ***List and briefly describe best management practices, criteria, guidelines identified in plans.*** See table below.

Project Implementation

Alum Treatment Overview

Treatment Description	Date	Dosage	Buffer/No Buffer	pH
First dose	June 5 2019	14,005 gal alum 7,104 gal buffer	Buffer	Yes
Second dose	September 21-22 2021	25,047 gal alum 12,626 gal buffer	Buffer	Yes

Assessment

9. ***Is the plan based on current science?*** Yes
10. ***Does the lake meet the characteristics of a lake where in-lake treatment is likely to be successful?*** They addressed the external load before addressing the internal load which extends the longevity of the treatment. However the Osgood index is low and this is a shallow lake thus the alum treatment may achieve the intended outcomes and the expected longevity. Additionally, the dose had to be increased due to rough fish populations.
11. ***Is biological monitoring data available? Does this data indicate concerns for impacts on the biota or potential threats to the effectiveness of the treatment?*** The alum dose was increased due to the presence of rough fish. Rough fish can affect the longevity and effectiveness of alum treatments. More information is needed to compare the most recent survey to the dosing calculation to determine if the dose was appropriate and the status of the rough fish population.
12. ***Were project goals met / are they on the path to being met?*** Yes, according to table 1, but to confirm the magnitude of reduction follow up coring is needed evaluate the change in release rate.
    a. ***If no, is follow-up planned to achieve proposed goals?*** Another 11 lbs/yr will be addressed through a watershed-based/funded project in 2020
13. ***What were potential challenges to the project? Describe opportunities for improvement.*** Prior to the second phase, a significant population of goldfish was identified and assessed by a contractor working for the City of Burnsville. While the goldfish biomass had not yet been determined at the time of the second phase of alum treatment, as a precaution Barr Engineering Co. increased the alum and sodium

aluminate dosage consistent with literature that documents that the presence of rough fish tend to mobilize an increased layer of sediment with the expectation that this would better ensure that the life expectancy of the treatment would correspond with the Work Plan. The depth of treatment was increased to 10 cm to counteract the impact of the goldfish population.

14. ***Additional comments on the restoration project.***

Project Evaluation

Goals are the discrete, measurable results of implementing the restoration actions. Outcomes are the desired system changes that the project is intended to affect. Projects can be designated as likely to not meet, minimally meet, meet, or exceed proposed goals and outcomes with a low, medium, or high degree of confidence in the determination.

15. ***The project has:***
    Minimally achieved the stated goals.
16. ***The project will:***
    Support proposed outcomes.
    Confidence of outcome determination:
    Medium.
17. ***Provide explanation of reason(s) for determination.***
    There have been four years of WQ data since the first dose application that show the project is meeting the target concentration. However there has not been sediment coring data so show the reduction in release rate and the Al-bound layer could be affected by the rough fish present.
18. ***Assessor(s) conducting review:***

    Anne Wilkinson, EOR, PhD

25 Upper Prior Lake Alum Treatment

Project Background

Lake Name, DOW #: Upper Prior, 70007200

Project Manager / Organization: Emily Dick / Prior Lake – Spring Lake Watershed District

Fund: CWF

Fiscal Year Funds: FY-20

Primary Activity: Alum Treatment

Latitude/Longitude: 44.714984, -93.445065

County: Scott

Project Start Date: 2020

Project Complete Date: 2022

Project Status: Long-term Monitoring Phase (3+ years)

Lake Characteristics

Lake Area (acres): 386 acres

Watershed size (acres): 16048 acres

Watershed to Lake Area: 42

Osgood Index: 2

Average Residence Time (years): 0.7 years

Depth Mean / Max (feet): 8 / 40 feet

% Littoral Area: 81%

Water Quality Metric	*Pre-Treatment Conditions (2010 - 2019)*	*Treatment Year (2020)*	*Post-Treatment Conditions (2021 - 2022)*	*Projected/Target*
Total Phosphorous (µg/L)	**65** (SD = 14, *n* = 10)	**19**	**20**	**60**
Chlorophyll-a (µg/L)	**44** (SD = 20, *n* = 10)	**18**	**11**	**20**
Secchi Disk - Summer Average (m)	**1.24** (SD = 0.35, *n* = 10)	**1.63**	**2.61** (SD = 0.92, *n* = 2)	**1**

Seasonal Water Quality Trends: Mean (standard deviation, n = # of years with data) shown.

Project Goals and Planning

1. ***Problem Identification (Levels of Impairment):*** Exceed eutrophication standards. Between June and August 2019, Total Phosphorus exceeded 95 ug/L (60 ug/L is the state standard); Secchi depth was less than 0.8 meters (1.0 m is the state standard) and chlorophyll-a exceeded 100 mg/L (20 is the state standard
2. ***Previous and/or Ongoing Water Quality Improvement Efforts:*** curlyleaf pondweed treatments, carp removals; alum treatments on Spring Lake, which drains into Upper Prior Lake
3. ***Project Justification:*** The 2012 TMDL Implementation Plan indicated that there were three causes of phosphorus loading in Upper Prior--loading from Spring Lake and upstream lakes (42%), internal loading within Upper Prior (50%) and septic systems and atmospheric load (8%)
4. ***What partners or agencies were involved with proposal and technical planning? What were the contributions?*** University of St. Thomas conducted paleolimnological sediment core analysis. St. Croix Watershed Research Station analyzed sediment cores for phosphorus fractionation analysis to quantify the mass of biologically available sediment phosphorus (i.e. the mobile fractions likely to diffuse from sediments).
5. ***Alum Feasibility study:*** Upper Prior Lake Alum Treatment Feasibility Study. Prepared for PLSLWD by EOR in 2019
    a. ***Phosphorus & Water Budget:*** budget estimated during TMDL; 50% of TP load from internal loading; 42% of the load is from upstream lakes;
    b. ***Data Basis:*** redox sensitive sediment phosphorus fractions
    c. ***Monitoring Performed:*** sediment cores
    d. ***Internal P Load (%):*** 50
    e. ***Estimated duration of effectiveness:*** 10 years
6. ***What are the stated goals of the project? List quantifiable measures of success if identified.***
   The goal is to reduce the internal loading of Upper Prior Lake by 571 lbs/year
7. ***What are the desired outcomes of achieving the stated goals?*** To meet overall state standards for Total Phosphorus (60 ug/l), Chlorophyll A (20 ug/l) and Secchi Depth (1.0) from all sources.
8. ***List and briefly describe best management practices, criteria, guidelines identified in plans.***
   Buffered alum application split into different doses by zone. The original dosing described in the grant application was based on two applications alum over time. No dosing calculations and limited statements of assumptions in the dose estimates. However, the dose was based on redox sensitive phosphorus which follows current alum dosing calculation practices.

Project Implementation

Alum Treatment Overview

Treatment Description	Date	Dosage	pH
Treatment 1 See table below for dosing by zone)	**May 26 – June 3 2020**	**132,343 gal alum + 66,398 gal sodium aluminate**	pH monitored during application
Treatment 2	Not yet applied		

Revised 2020 treatment application and HAB costs:

Revised Upper Prior Lake 2020 Alum Dose:						$1.59/gal		$4.60/gal	
Treatment Zone	Al dose (g/m^2)	Alum (gal/ac)	Buffer (gal/ac)	Acres	Liquid Alum (gal)	Liquid Alum Cost ($)	S.A. Buffer (gal)	S.A. Buffer ($)	Cost ($)
Zone 1	61.8	490.5	245.3	230	112,815	$179,376	56,408	$259,475	$438,850
Zone 2	57.2	454.0	227.0	43	19,522	$31,040	9,761	$44,901	$75,941
Mobilization									$27,570
TOTAL				273	132,337	$210,416	66,169	$304,375	$542,361
								Grant:	$542,375

Assessment

9. ***Is the plan based on current science?*** Yes
10. ***Does the lake meet the characteristics of a lake where in-lake treatment is likely to be successful?*** Yes. 50% of the load from internal sources and based on current science for dosing.
11. ***Is biological monitoring data available? Does this data indicate concerns for impacts on the biota or potential threats to the effectiveness of the treatment?*** carp and aquatic plant data have been collected pre- and post-alum treatment; no concerns for biological impacts due to treatment although plant density may increase in some areas with great water clarity and light penetration
12. ***Were project goals met / are they on the path to being met?*** Partially. It appears as though the lake is meeting water quality standards based on 2021-2022 data as shown in the water quality metrics table. The other stated goal is to reduce the internal loading of Upper Prior Lake by 571 lbs/year. No evidence or information was provided relative to this goal.
    a. ***If no, is follow-up planned to achieve proposed goals?*** Unknown
13. ***What were potential challenges to the project? Describe opportunities for improvement.*** Unknown
14. ***Additional comments on the restoration project.***

Only a portion of the prescribed dose has been applied and watershed loads persist. Meeting, and sustaining, goals will require application of the full prescribed dose and continued efforts to reduce watershed loads and lower carp density.

Project Evaluation

Goals are the discrete, measurable results of implementing the restoration actions. Outcomes are the desired system changes that the project is intended to affect. Projects can be designated as likely to not meet, minimally meet, meet, or exceed proposed goals and outcomes with a low, medium, or high degree of confidence in the determination.

15. ***The project has:***
    Minimally achieved the stated goals.
16. ***The project will:***
    Likely not support proposed outcomes.
    Confidence of outcome determination:
    Low.
17. ***Provide explanation of reason(s) for determination.***
    Only a portion of the prescribed dose has been applied and watershed loads persist. Meeting goals will require application of the full prescribed dose and continued efforts to reduce watershed loads and carp density.
18. ***Assessor(s) conducting review:***

    Dendy Lofton, PhD, CLM; Senior Associate/Limnologist with Stantec

Map and Other Data

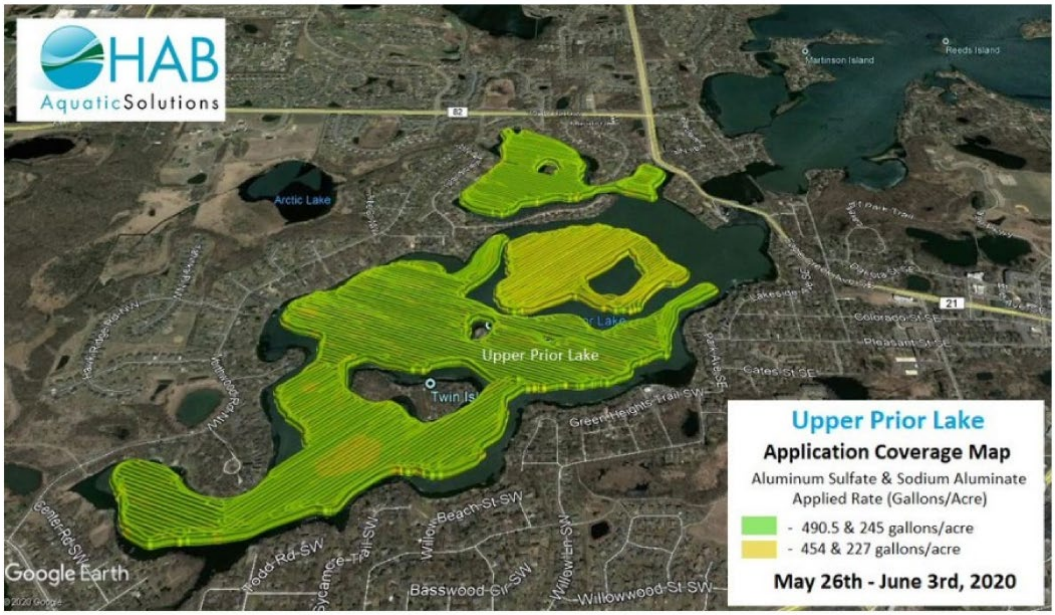


Figure 49. Application area for Upper Prior Lake (2020).

Raw data files for carp surveys were provided but no summary tables are available. Plant surveys were conducted in 2022 on Upper Prior Lake to evaluate the plant area cover (PAC).

UPPER PRIOR LAKE

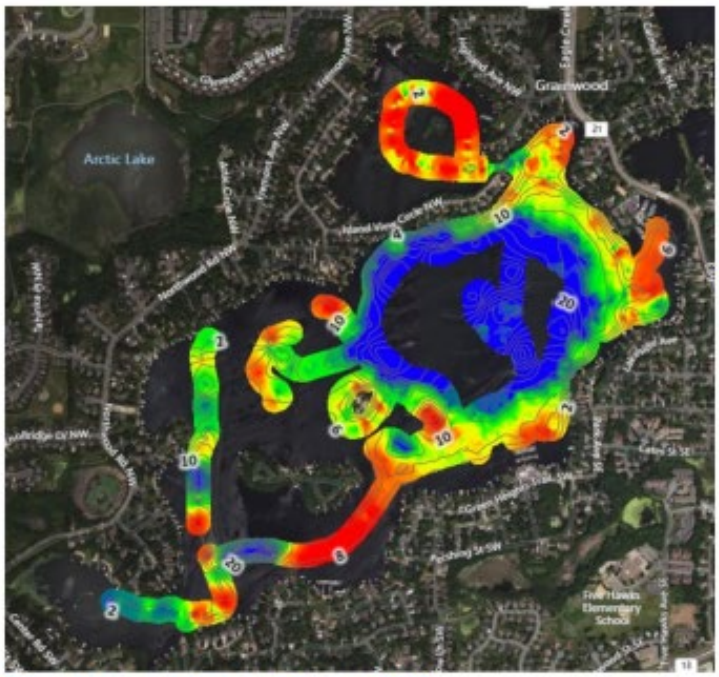


Figure 7. Upper Prior Lake – Summer 2022

PAC: 36% *
Surface Area: 416 acres
Average Depth: 10 feet
Maximum Depth: 43 feet
Watershed Area: 16,038 acres
Impairment Status: Impaired for excess nutrients
Upper Prior Lake Report Card

Upper Prior Lake has historically had trouble meeting water quality standards. Consequently, summer PAC before 2020 averaged only 12%. In recent years (2020 – 2022), water quality standards have begun to drastically improve through intensive carp management efforts and an alum treatment. See more about lake improvement projects on page 17.

*PAC results on Upper Prior Lake in 2022 may be abnormally low due to the technical difficulties in the field that resulted in an incomplete scan of the lake. The sonar was not able to penetrate through the thick vegetation when water depths reached below about 10'. Manual adjustments were completed to reflect actual conditions using BioBase software. Adjusted datapoints may not be as representative of vegetation density and depth conditions as unadjusted areas.

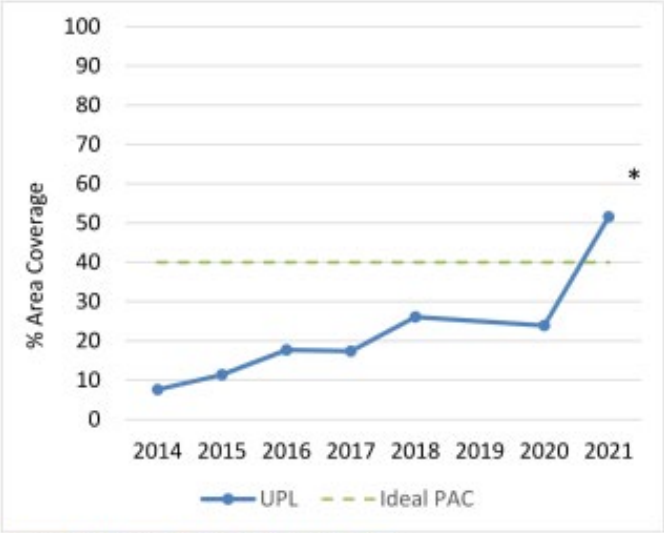


Figure 7. Upper Prior Lake Historic PAC

Figure 50. Aquatic plant trends in Upper Prior Lake.

26 Lake Wassermann Internal Load Management

Project Background

Lake Name, DOW #: Wassermann, 10004800

Project Manager / Organization: Becky Christopher / Minnehaha Creek Watershed District

Fund: CWF

Project Start Date: 2020

Primary Activity: Alum Treatment

Latitude/Longitude: 44.841344, -93.67389

County: Hennepin

Fiscal Year Funds: FY-20

Project Complete Date: 2022

Project Status: Monitoring Phase (1-2 years)

Lake Characteristics

Lake Area (acres): 170 acres

Watershed size (acres): 2879 acres

Watershed to Lake Area: 17

Osgood Index: 4

Average Residence Time (years): 1 year

Depth Mean / Max (feet): 10 / 41 feet

% Littoral Area: 73.17%

Water Quality Metric	*Pre-Treatment Conditions (2011 - 2020)*	*Treatment Year (2021)*	*Post-Treatment Conditions (2022)*	*Projected/Target*
Total Phosphorous (µg/L)	**83** (SD = 11, *n* = 10)	**5**	**18**	N/A, This application targets internal release of phosphorus. An exact post-treatment concentration has not been determined. A 2011 TMDL quantified a total reduction of 442 lb/yr.
Chlorophyll-a (µg/L)	**49** (SD = 8, *n* = 10)	**51**	**34**	
Secchi Disk - Summer Average (m)	**0.94** (SD = 0.15, *n* = 10)	**1.48**	**1.24**	

Seasonal Water Quality Trends: Mean (standard deviation, n = # of years with data) shown.

Project Goals and Planning

1. ***Problem Identification (Levels of Impairment):*** In 2012, the Minnesota Pollution Control Agency (MPCA) listed Wassermann Lake as impaired for excess nutrients. Water quality in Wassermann Lake has not met State of Minnesota water quality standards since monitoring efforts began in 2002. Total phosphorus (TP) and chlorophyll-a (chl-a) appear to be closely related; however, TP concentrations is the only parameter that has experienced a significant decrease in the past 10 years. Water clarity, as measured by secchi depth and chlorophyll-a, have not exhibited a significant trend. These data suggest that phosphorus reduction projects that have been implemented are making an improvement, but the in-lake response to phosphorus reduction is not clear.

2. ***Previous and/or Ongoing Water Quality Improvement Efforts:*** Since 2015, MCWD has invested substantially in the restoration of Wassermann Lake through both watershed and in-lake management activities. A list of these activities is provided below: SMCHB Habitat Restoration Program, Laketown 9th Wetland Restoration, Wassermann West Park and Alum Treatment, stormwater permitting improvements, and implementation of Downtown Victoria stormwater ponds. Further, MCWD has implemented the State's most comprehensive common carp management program, effectively reducing common carp on Wassermann from over five times the target threshold to approximately 57 kg/ha, which achieves the target population to minimize ecological damage and addressed internal loading due to resuspension of sediment by common carp. Our achievement on this project ensures that common carp are controlled to a level where they will not impact the effectiveness of alum treatment.

3. ***Project Justification:*** Sediment phosphorus release in Wassermann Lake accounts for 374 lbs P/year; equivalent to approximately 50% of the total annual phosphorus budget (753 lbs/year). The goal of the alum treatment is to drive 90% of mobile phosphorus (redox-P) to an inactive form of phosphorus to reduce phosphorus release rates by 90%.

4. ***What partners or agencies were involved with proposal and technical planning? What were the contributions?*** *Minnehaha Creek Watershed District (MCWD), Board of Water and Soil Resources (BWSR), Wenck (Stantec), City of Victoria. The MCWD and its partners, including the City of Victoria, the Lessard Sams Outdoor Heritage Council, BWSR, and others have invested substantially in the restoration of Wasserman Lake through both watershed and in-lake management practices, and enhancement of recreation use of Wassermann Lake to expand public enjoyment to a broad cross section of the community. Furthermore, the Six Mile Creek-Halsted Bay Subwatershed has been identified as a priority focal geography by MCWD's Board of Managers, where the District will focus its capital improvement program over the current ten year plan cycle.*
5. ***Alum Feasibility study:*** Wassermann Internal Load Management Feasibility Study, 8/28/2019

    a. ***Phosphorus & Water Budget: See Table 37 from 2011 TMDL***

Table 37. Wassermann Lake Percent Load Reductions, Future (Ultimate) Municipal Boundaries

Load estimates from MS4s include construction and industrial stormwater loads within the MS4 boundaries.

Source	Existing Load[1] (lbs/yr)	Allowable Load[2] (lbs/yr)	% Reduction
Internal/unidentified load	505	63	88%
Atmospheric deposition	44	44	0%
Non-regulated stormwater runoff	55	51	7.2%
City of Victoria	147[3]	124	16%
Carver County	2.5	1.3	48%
Total:	753	283	62%

[1]Takes into account attenuation by Pierson Lake
[2]Includes drainage in entire watershed
[3]Existing load based on land use and land cover, summed up according to future/ultimate municipal boundaries

    b. ***Data Basis: 1) Wassermann Alum Treatment Feasibility Study. 2) MCWD Lakes TMDL – Lake Nokomis, Parley Lake, Lake Virginia, Wassermann Lake***

c. ***Monitoring Performed:*** In 2013, MCWD collected sediment cores from Wassermann Lake to quantify the internal load from sediment phosphorus. Additional cores were collected in 2020. MCWD will continue to use lake-bed sediment analysis to determine the optimal dosage amount and locations to maximize efficiency of the treatment. Monitoring data collected to date is already showing a trend towards improved water quality. Future sediment analysis will provide confirmation that the treatment goals are being achieved and may lead to an adjustment on the volume of the second treatment to meet water quality goals. Water quality and vegetation surveys were conducted in 2023 to evaluate the lake response.

d. ***Internal P Load (%):*** This application targets phosphorus, specifically, internal release of phosphorus. A 2011 TMDL attributes 505 lb/yr of phosphorus to internal loading from sediment release, carp sediment resuspension, physical wind mixing, and phosphorus release from decaying curly leaf pondweed and assigns an 88% reduction to this source, for a total reduction of 442 lb/yr. In 2013, MCWD collected sediment cores were collected in Wasserman Lake to quantify the internal load from sediment phosphorus (374 lbs P/yr). Therefore, the combination of carp sediment resuspension, curly leaf pondweed, and wind resuspension are responsible for 131 lbs P/yr, which has been addressed by reducing the common carp population to 57 kg/ha and implementing measures to maintain carp at that level.

e. ***Estimated duration of effectiveness:*** 50 years

6. ***What are the stated goals of the project? List quantifiable measures of success if identified.***

   Sediment phosphorus release in Wassermann Lake accounts for 374 lbs P/yr, and the alum treatment is expected to reduce internal release by 90% for a total reduction of 336 lbs P/yr. This accounts for 75% of the required internal load reduction. The remaining internal load allocation was attributable in large part to resuspension of sediment by common carp, which has been addressed through the district's common carp management program. Therefore, this alum treatment, in combination with the completed carp management work, is expected to achieve the TMDL allowable internal load of 63 lbs P/yr.

7. ***What are the desired outcomes of achieving the stated goals?*** This project fits within the context of an overall aquatic habitat restoration program that not only improves water quality, but also enhances aquatic vegetation and fisheries, having cascading benefits up the entire food chain. Through the District's carp management work, Lake Wassermann has seen a 1.2-foot increase in maximum depth of plant growth and a 20% increase in submerged aquatic vegetation (SAV)coverage in the littoral area. These observations were anticipated to occur with carp management activities.

8. ***List and briefly describe best management practices, criteria, guidelines identified in plans.***

   The selected scenario for Wasserman Lake included a buffered application in which 27,000 gallons of alum plus 13,500 gallons of sodium aluminate (buffer) would be applied to areas ≥ 15-feet covering 53-acres. Half of the alum dose was applied in applied in 2021, and the remaining half was applied in 2022.

Project Implementation

Alum Treatment Overview

Treatment Description	Date	Dosage	Buffered or non-buffered	pH *(yes or no)*
First Dose	**Fall 2021**	**13,500 Gallons of Alum (369 gal/ac) 6,750 Gallons of Sodium Aluminate (18 gal/ac)**	**Buffered**	**Yes**
Second Dose	**Fall 2022**	**13,500 Gallons of Alum (369 gal/ac) 6,750 Gallons of Sodium Aluminate (18 gal/ac)**	**Buffered**	**Yes**

Assessment

9. ***Is the plan based on current science?*** Yes
10. ***Does the lake meet the characteristics of a lake where in-lake treatment is likely to be successful?*** *Yes*
11. ***Is biological monitoring data available? Does this data indicate concerns for impacts on the biota or potential threats to the effectiveness of the treatment?*** Biological data is available. MCWD has implemented the State's most comprehensive common carp management program, effectively reducing common carp on Wassermann from over five times the target threshold to approximately 57 kg/ha. Further, Lake Wassermann has seen a 1.2-foot increase in maximum depth of plant growth and a 20% increase in submerged aquatic vegetation (SAV)coverage in the littoral area.
12. ***Were project goals met / are they on the path to being met? Yes***
    a. ***If no, is follow-up planned to achieve proposed goals?*** *Yes. MCWD staff is collecting additional cores*
13. ***What were potential challenges to the project? Describe opportunities for improvement.***
14. ***Additional comments on the restoration project.***

Project Evaluation

Goals are the discrete, measurable results of implementing the restoration actions. Outcomes are the desired system changes that the project is intended to affect. Projects can be designated as likely to not meet, minimally meet, meet, or exceed proposed goals and outcomes with a low, medium, or high degree of confidence in the determination.

15. ***The project has:***
    Minimally achieved the stated goals.
16. ***The project will:***
    Minimally support proposed outcomes.
    Confidence of outcome determination:
    Medium.

17. ***Provide explanation of reason(s) for determination.***

    Wasserman is a good candidate for the success of the alum treatments. Table 1 shows an improvement in water quality, however follow up sediment cores are needed to confirm phosphorus reduction goals and longevity estimates are met.

18. ***Assessor(s) conducting review:***

    Joe Pallardy, EOR

Map and Other Data

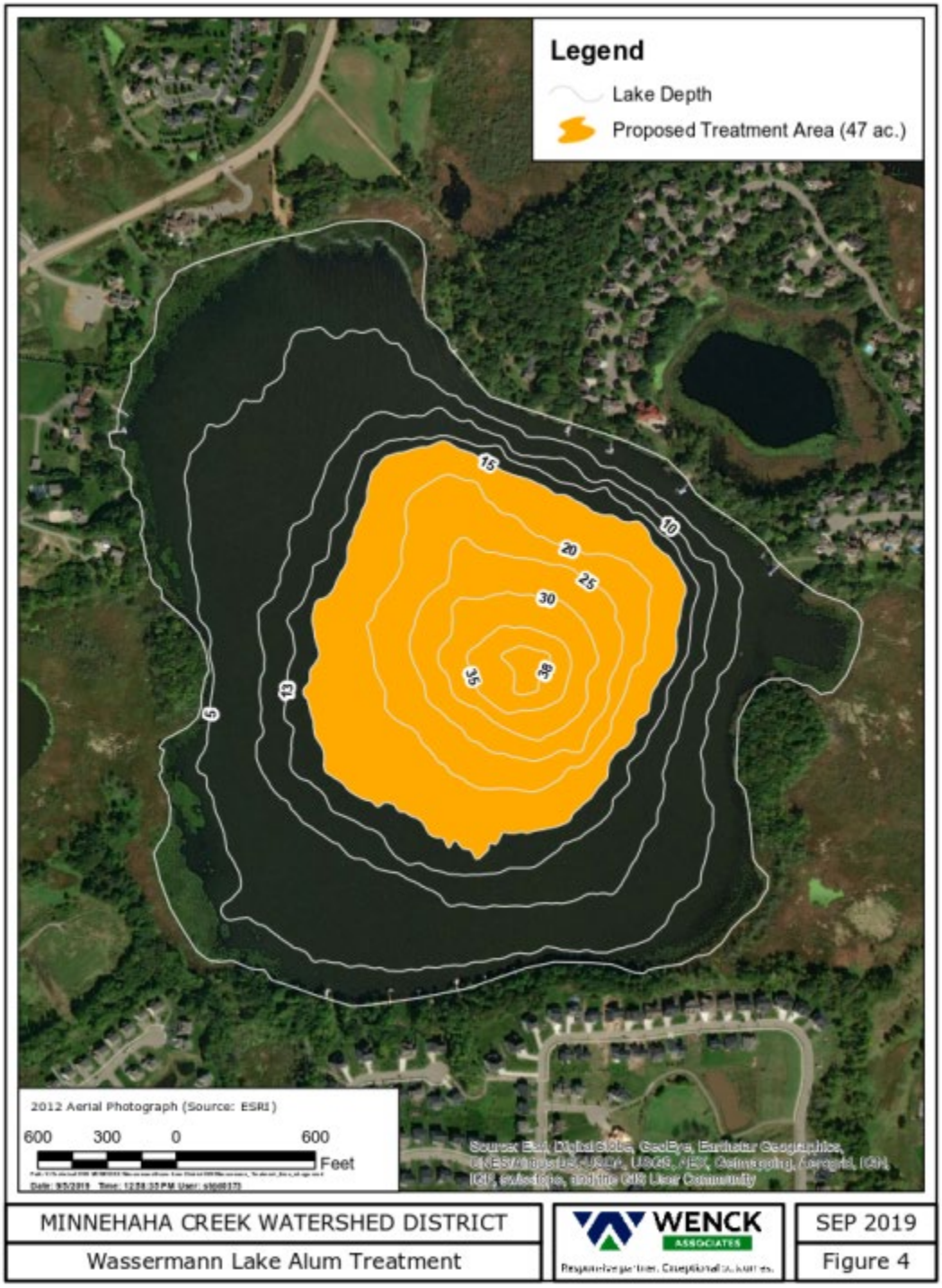


Figure 51. Map of proposed alum treatment area in Moody Lake.

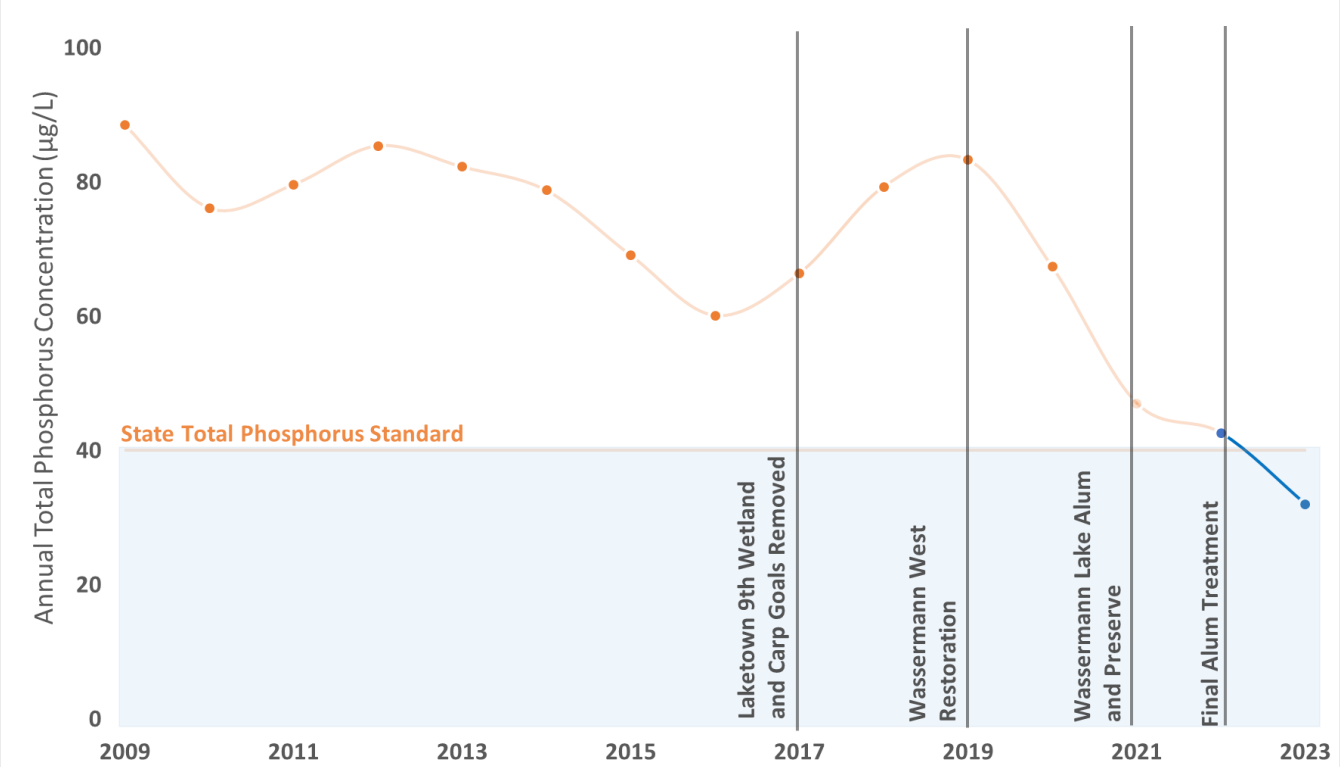


Figure 52. Annual total phosphorus concentration in Lake Wasserman and lake improvement efforts over time.

27 Serpent Lake Targeted Watershed Demo

Project Background

Lake Name, DOW #: Unnamed (Cranberry), 18043300

Project Manager / Organization: Crow Wing County SWCD

Fund: CWF

Fiscal Year Funds: FY-14

Primary Activity: Alum Treatment

Latitude/Longitude: 46.480152, -93.896325

County: Crow Wing

Project Start Date: 2014

Project Complete Date: 2018

Project Status: Long-term Monitoring Phase (3+ years)

Lake Characteristics

Lake Area (acres): 13 acres

Watershed size (acres): 150

Watershed to Lake Area: 11

Osgood Index: Not available

Average Residence Time (years): Not available

Depth Mean / Max (feet): Not available

% Littoral Area: Not available

Water Quality Metric	*Pre-Treatment Conditions (2004 - 2012)*	*Treatment Year (2016)*	*Post-Treatment Conditions (2017 - 2022)*	*Projected/Target*
Total Phosphorous (µg/L)	**91** (SD = 11, *n* = 6)	**97**	**34** (SD = 14, *n* = 6)	
Chlorophyll-a (µg/L)	**62** (SD = 44, *n* = 3)	**15**	**11** (SD = 8, *n* = 5)	
Secchi Disk - Summer Average (m)	**1.85** (SD = 0.24, *n* = 2)	**1.98**	**2.03** (SD = 0.26, *n* = 6)	

Seasonal Water Quality Trends: Mean (standard deviation, n = # of years with data) shown.

Project Goals and Planning

1. ***Problem Identification (Levels of Impairment):*** High P loads to Serpent Lake
2. ***Previous and/or Ongoing Water Quality Improvement Efforts:***
3. ***Project Justification:*** Goal of treatment was to reduce loads from Unnamed (aka Cranberry) Lake to downstream Serpent Lake; available information provided for this evaluation indicates that TP exceeded frequently 100 ug/L pre-treatment however no information was provided on sediment P chemistry or alum dosing assumptions.
4. ***What partners or agencies were involved with proposal and technical planning? What were the contributions?*** EOR, Crow SWCD
5. ***Alum Feasibility study:*** None, project predates feasibility study requirement
    a. ***Phosphorus & Water Budget:*** NA
    b. ***Data Basis:*** not provided
    c. ***Monitoring Performed:*** uncertain
    d. ***Internal P Load (%):*** not provided
    e. ***Estimated duration of effectiveness:*** 10 years
6. ***What are the stated goals of the project? List quantifiable measures of success if identified.*** Reduce flow weighted mean TP concentration at the Cranberry Lake outlet to Serpent Lake from 173 ug/L to 20 ug/L (representing an 88% reduction). In-lake TP concentrations should remain low (~40 µg/L) and similar in both the surface and bottom waters while the alum treatment is effective
7. ***What are the desired outcomes of achieving the stated goals?*** reduced P load to downstream Serpent Lake; attainment of 40 ug/L TP target
8. ***List and briefly describe best management practices, criteria, guidelines identified in plans.*** buffered alum application to Unnamed “Cranberry” Lake to reduce P loads to downstream Serpent Lake. No information was provided on the dosing calculations, basis or assumptions beyond this excerpt: “In June 2015, EOR collected detailed lake depth data (bathymetry) and four 20 cm long sediment cores from the deepest point in Cranberry and Little Cranberry Lakes (3 from Cranberry Lake and 1 from Little Cranberry Lake). These cores were sliced into ten 1 cm intervals and analyzed for total phosphorus and iron-adsorbed phosphorus by Minnesota Valley Testing Labs. The sediment phosphorus concentration data was used by EOR to determine a treatment dose of 7,000 gallons of alum and 3,500 gallons of sodium aluminate, which is expected to inactivate sediment phosphorus in the upper 2.6 inches of sediment over an area of 8.94 acres in Cranberry Lake.”

Project Implementation

Alum Treatment Overview

Treatment Description	Date	Dosage	pH
T*reatment 1*	*June 7, 2016*	7,090 gal aluminum sulfate + 3,546 gal of sodium aluminate	pH reportedly maintained above 6.0 during application. The pH prior to and morning after the application was 7.74 and 7.21, respectively

Assessment

9. ***Is the plan based on current science?*** Portions
10. ***Does the lake meet the characteristics of a lake where in-lake treatment is likely to be successful?*** Yes. Documents provided indicate high loads to downstream Serpent Lake but no information on internal sediment P release rates were provided. Water quality in Cranberry Lake appears to have improved compared to pre-treatment conditions. It is unclear if the goals for reducing loads to downstream Serpent Lake are being met. The Al-P binding ratio is only 2.5, which is lower than the range of 10 to 100 that is more commonly applied. Likewise, the treatment depth used in the calculations was only 2. 6 cm, whereas 4-6 cm treatment depths are more common. The method of alum dosing calculation appears unconventional.
11. ***Is biological monitoring data available? Does this data indicate concerns for impacts on the biota or potential threats to the effectiveness of the treatment?*** not provided
12. ***Were project goals met / are they on the path to being met?*** Uncertain with info provided; Cranberry Lake water quality has improved, but not clear if downstream load reduction goals to Serpent Lake are being met
    a. ***If no, is follow-up planned to achieve proposed goals?***
13. ***What were potential challenges to the project? Describe opportunities for improvement.*** Al-P binding ratio too low, which will reduce treatment longevity.
14. ***Additional comments on the restoration project.***

    This project's goal was to reduce phosphorus loads to downstream Serpent Lake. A few TP data points were provided (immediately before and after the application) but there is not recent information to document performance since the treatment. Consequently, attainment of project goals are unknown beyond improved water quality in Cranberry Lake.

Project Evaluation

Goals are the discrete, measurable results of implementing the restoration actions. Outcomes are the desired system changes that the project is intended to affect. Projects can be designated as likely to not meet, minimally meet, meet, or exceed proposed goals and outcomes with a low, medium, or high degree of confidence in the determination.

15. ***The project has:***
    Minimally achieved the stated goals.
16. ***The project will:***
    Likely not support proposed outcomes.
    Confidence of outcome determination:
    Low.
17. ***Provide explanation of reason(s) for determination.***
    The assumed Al-P binding ratio in the dosing calculations was only 2.5. Historically, ratios of at least 10:1 have been applied, but often ratios are greater than 50:1 and up to 100:1.
18. ***Assessor(s) conducting review:***

    Dendy Lofton, PhD, CLM; Senior Associate/Limnologist with Stantec

Map and Other Data

A week following the alum treatment, TP was significantly lower than pre-treatment concentrations. No additional post-treatment data summaries were provided.

Table 1. Cranberry Lake Total Phosphorus Concentration Data Summary (2004-2016)

Year	June-September Average TP Concentration (µg/L)	June TP Concentration (µg/L)
2004	81	105
2005	101	91
2006	78	143
2010	97	190
2011	106	290*
2012	95	141**
2004-2012 Average	**93**	**174**
2016	Before alum treatment	155
	After alum treatment	39

* Average of two samples: 501 and 80 µg/L

** Average of two samples: 164 and 117 µg/L

Table 9. Cranberry Lake total phosphorus annual average summary.

Serpent Lake Diagnostics Study Modeling Results

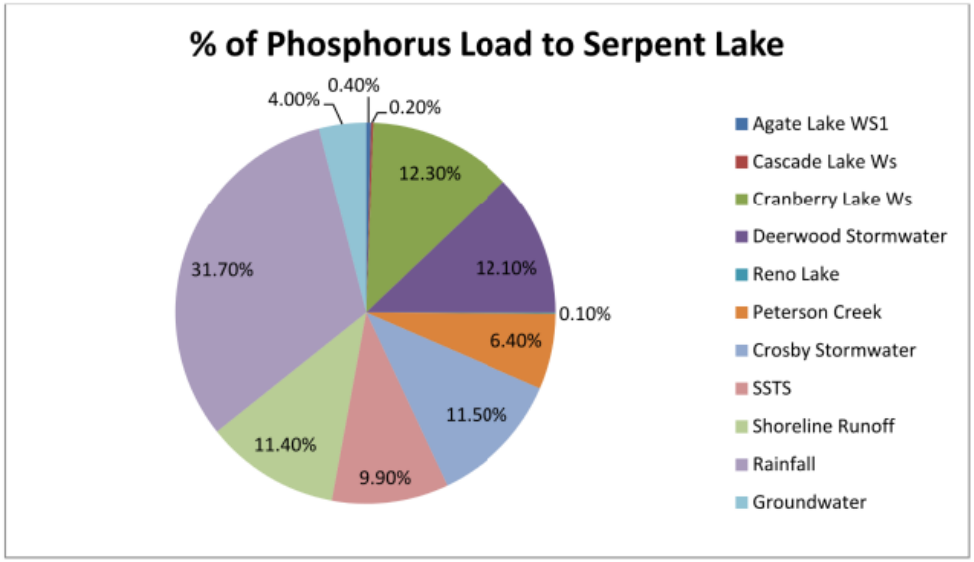


Figure 53. Modeled phosphorus loads to Serpent Lake.

	Load		
Subwatershed	**kg/yr**	**lb/yr**	**% total**
Agate Lake WS1	0.9	1.98	0.40%
Cascade Lake Ws	0.3	0.66	0.20%
Cranberry Lake Ws	26	57.32	12.30%
Deerwood stormwater	25.6	56.44	12.10%
Reno Lake	0.2	0.44	0.10%
Peterson Creek	13.6	29.98	6.40%
Crosby Stormwater	24.3	53.57	11.50%
SSTS	21	46.30	9.90%
Shoreline Runoff	24	52.91	11.40%
Rainfall	67	147.71	31.70%
Groundwater	8.4	18.52	4.00%
Total	211.30	465.84	100.00%
Outlet - Discharge	44.4	97.885128	-21.2

Table 10. Subwatershed load summary.