Technical Memo

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To: Shingle Creek WMC Commissioners

From: Ed Matthiesen, P.E.
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Date: April 16, 2019

Subject: Crystal Lake Management Plan Feasibility and Cost Estimate

INTRODUCTION AND BACKGROUND

Crystal Lake is a 126-acre nutrient-impaired lake located in the city of Robbinsdale. It is popular among anglers, and there are several city parks abutting the lake as well as a regional bike trail. There is a public boat landing on the south end and a fishing pier on the north end. Summer ten-year average TP concentration is 63 ug/L compared to the deep lake standard of 40 ug/L. The excessive concentration of phosphorous causes nuisance algae blooms and has inhibited the growth of aquatic plants, limiting fish habitat and the aesthetic appeal of the lake. The carp in the lake mobilize phosphorus-containing sediment on the bottom as they feed, impacting water clarity and causing further phosphorus release. This is becoming an even greater issue as carp increase in density in the lake. Reduction in the in-lake phosphorus concentration and the carp population is needed to promote a healthy ecosystem and bring a greater recreational appeal to the lake.

The Crystal Lake Nutrient TMDL was approved in 2008, and the cities of Robbinsdale and Minneapolis and Hennepin County have been actively implementing BMPs in the lakeshed. The TMDL requires a 90% decrease in TP from internal sources (255 pounds) and a 59% decrease from watershed sources (256 pounds). In 2016 the Shingle Creek Watershed Management Commission completed a TMDL Progress Review. It estimated that the cities and county had achieved about 73 pounds of the required annual 256 pound TP wasteload reduction. The city of Crystal also installed and continues to run a hypolimnetic withdrawal flocculation treatment facility in Lakeview Terrace Park, which has averaged the removal of 147 pounds per year over the three years it's been in service. However, when the hypolimnetic water withdrawn for treatment becomes anoxic, the system produces a foul smell, which is not acceptable to the park users or the adjacent residential neighborhood. When there are odor issues, the system is switched over to epilimnetic withdrawal, which is less efficient at controlling phosphorus from sediment release.

In addition to nutrient issues, a recent carp assessment estimated the current mean biomass of carp in Crystal Lake as about 126 kg/ha. Research suggests that high densities of common carp can reduce submersed aquatic vegetation coverage, lower water fowl populations, and increase turbidity. These impacts begin to occur when the carp population exceeds a 100 kg/ha critical density threshold (Bajer et al. 2009). Crystal Lake does not currently sustain a robust aquatic vegetation community, likely limited

by the presence of carp and excess turbidity. Curly-leaf pondweed is known to be present in the system, although currently at low densities.

PROPOSED PROJECT

The purpose of the proposed Crystal Lake Management Plan Project is to improve the water quality and ecological integrity of Crystal Lake and to restore beneficial uses and progress the lake toward achieving the state water quality standard for TP. As the largest lake in the city of Robbinsdale and with significant adjacent park acreage and a public access, it is a popular destination for water recreation and fishing. The proposed project takes a whole-lake management approach, significantly reducing internal phosphorus release from sediments, reducing the carp population to a more manageable carrying capacity, and as water clarity improves, encouraging the restoration of a healthy native plant community and addressing the potential increase in invasive aquatic plant populations.

Lake Alum Treatment. The first component of the project is a lake alum treatment to seal the sediments and reduce the need and frequency of withdrawing from the hypolimnion. Upon application, alum forms a flocculant that binds with phosphorus to form an aluminum phosphate compound that can no longer be used as food by algae. As the flocculant slowly settles, some phosphorus is removed from the water column, along with other suspended particles. On the bottom of the lake, the flocculant forms a layer that acts as a phosphorus barrier. To maximize the effectiveness of the alum treatment, it would be performed in two doses. Initial sediment cores would be used to compute the effective dose, and water column DO measurements would be used to identify the anoxic zone and the limits of alum treatment. One-half the recommended dose would be applied the first year, and additional sediment cores taken and evaluated. Based on the initial results, dosing for the second treatment may be adjusted. Following the second treatment, a final set of sediment cores would be used to confirm the effectiveness of the treatment at reducing the sediment release rate.

Rough Fish Management. The second component is carp harvesting to reduce the population to a level well below the impairment threshold. An initial carp assessment has already been completed in September 2018. The assessment concluded that the carp biomass was just above the critical impairment threshold, but more importantly that the carp were relatively small in size. This suggests that carp issues in the lake are likely to worsen as they grow and reproduce. Prior to the alum treatment, the carp population assessment would be repeated and RTF tags placed in a sample of the fish for radio tracking to determine their overwintering locations. Based on an initial carp assessment, approximately 3,500-4,000 kg of carp will need to be removed from the lake to reduce the population density below the 100 kg/ha density threshold. The Commission will work with the commercial fisherman assigned to this area to harvest carp and other undesirable rough fish.

Submersed Aquatic Vegetation (SAV) Management. Following alum treatment and carp removal, the project objective is to restore a healthy native aquatic vegetation community by treating invasive plants as water quality improves and take any necessary management steps to keep the lake healthy and native. Previously completed aquatic vegetation surveys show an extreme lack of submersed aquatic vegetation, with few native pondweed species common in healthy shallow and deep lakes throughout Minnesota.

As water clarity improves post alum treatment and carp removal, a positive vegetative response would be anticipated. Exactly what that would look like is unknown at this time. A desirable outcome would be

one in which a diverse community of native vegetation becomes established, out-competing aquatic invasive species (AIS) but remaining below nuisance levels. However, because AIS have been observed in the lake during plant surveys and anecdotal evidence suggests these species used to be at nuisance levels along the northwest shore, the possibility exists that AIS may try to reestablish, requiring active management. The Commission will monitor submersed aquatic vegetation for invasive aquatic plants and manage those by using spot treatments.

ESTIMATED LOAD REDUCTION

The current internal load is estimated to be 284 lbs/yr TP. Alum treatments dosed correctly can achieve a 90-95% reduction in sediment release. The goal of the Crystal Lake alum treatment is a 90% reduction, or 255 pounds TP reduction per year, which is the TMDL internal load reduction requirement. This improvement would allow the flocculation system to focus on reducing phosphorus in the epilimnion, which would help treat the watershed load and extend the life of the alum treatment.

Rough fish as SAV management have less direct nutrient reduction impacts, but are important for biotic integrity in the lake. Fewer carp stirring up the bottom sediments should result in less sediment and pollutants being contributed from the bottom of the lake, improving clarity. The rough fish management goal is the removal of 4,000 kg of carp from the lake. The effective removal of invasive SAV species does promote growth of a healthy natural ecosystem, which would also be beneficial to the fish community.

PROJECT TASKS, COST AND SCHEDULE

The project has been broken down into five general tasks, which are described below and for which the cost is shown in Table 1. This project has been awarded a EPA/MPCA Section 319 grant for funding in 2020, and matching funds will be levied in September 2019 for the Commission's share. If this project proceeds in 2020, Table 2 shows an estimated schedule.

Objective 1: Reduce Phosphorus Levels in Crystal Lake

Task 1: Dosing and Effectiveness Monitoring. Initial sediment cores will be taken from the lake in approximately February 2020 and evaluated for redox-P by Professor Bill James at the Center for Limnological Research and Rehabilitation at UW-Stout. The results will allow the calculation of a maximum initial dosage for alum. Dissolved oxygen profiles previously taken on Crystal Lake will be used to establish the treatment area. Additional cores and DO profiles will be taken following the initial alum dose and results used to make any necessary adjustments to application rates and areas. A final set of cores taken following the second application will be evaluated to verify that the desired reductions have been achieved. Responsible party(ies): Commission Engineer, Bill James

Task 2: Alum Application. The first dose of aluminum sulfate treatment would be applied in Spring 2021. The second dose would likely be applied in Spring 2022. Responsible party(ies): The City of Robbinsdale will act as contracting agent for this publicly bid project, in consultation with the Engineer.

Task 3: Water Quality Monitoring. The Commission's engineer will perform follow-up water quality monitoring in 2021 and 2022 to document changes in water quality and clarity. The lake will be

monitored for surface and bottom TP, SRP, chl-a, and Secchi depth and DO and temperature profiles, bimonthly from late May to late September. This data will be compared to historical monitoring data to help evaluate project effectiveness. Prior to undertaking monitoring the Commission will work with the MPCA to prepare a QAPP establishing monitoring procedures. A Crystal Lake monitoring station is already established in EQuIS, and collected data will continue to be uploaded as required.

Objective 2: Carp Removal

Task 1: Carp Population Assessment and Tracking. The previously-conducted carp assessment will be updated by the Commission's engineer using electrofishing techniques. During this assessment 10-15 carp will be tagged with radio transmitter markers. The tagged carp will periodically be tracked using portable trackers to identify overwintering locations. Following removals, a follow-up carp assessment will be completed to verify that the density goal has been achieved. This task includes coordination and permitting with the DNR.

Task 2: Commercial Fish Removal. The Commission will contract with the commercial fishermen assigned to this area to remove and sell or dispose of carp. The primary carp removal effort will be in late winter 2021, just prior to the first alum dose. Additional removals may occur in later, smaller efforts depending on the results of the follow-up population assessment.

Objective 3: Invasive Species Management

Task 1: Field Surveys and Permit Application. The Commission's Engineer will perform submersed aquatic vegetation (SAV) surveys in May and September 2020, 2021, and 2022. If invasive species management is required, the engineer will obtain necessary permits from and prepare required reports to the DNR.

Task 2: Herbicide Spot Treatments. Spot treatments for invasive plan species will conducted as necessary in 2020, 2021, and 2022. Responsible party(ies): Commission Engineer.

Objective 4: Administration/Semiannual and Final Reports

Semiannual reports will be completed and submitted to MPCA by February 1st and August 1st each year during the Grant term. A final report will be submitted to MPCA within 30 days from the end of the Grant. The final report will set forth dosing calculations and document treatment applied; detail monitoring data collected pre- and post-project; the results of the before and after population carp assessment and record biomass removed from the lake; and document SAV treatment. Best Management Practices will be reported each year they are implemented by February 1st to the Statewide eLINK data system. Invoices will be submitted to MPCA at least quarterly. Methods and findings will be compiled into a final technical report that will be submitted as part of the Final Report for this grant. Responsible party(ies): Commission Engineer

Table 1. Estimated project cost.

Objective and Task	Grant	Commission	Total
Objective 1: Reduce Phosphorus Levels in Crystal Lake			
Task 1: Dosing and effectiveness monitoring	$35,846.00		$35,846.00
Task 2: Alum application	112,916.00	$100,000.00	212,916.00
Task C: Water quality monitoring	13,222.00	200.00	13,422.00
Objective 2: Carp Removal			0.00
Task A: Carp population assessment and tracking	13,582.00	8,000.00	21,582.00
Task 2: Commercial carp removal	10,632.00	20,000.00	30,632.00
Objective 3: Invasive Species Management			0.00
Task A: Field surveys and permit application	19,740.00		19,740.00
Task B: Herbicide spot treatments		26,240.00	26,240.00
Objective 4: Admin/Semi-Annual/Final Reports			0.00
Task A: Administration/Semi-Annual/Final Reports	10,128.00		10,128.00
TOTAL	**$216,066.00**	**$154,440.00**	**$370,506.00**

Table 2. Project schedule.

Component	Activity	Month/Year
Internal Loading (sediment)	Sediment coring	February 2020
	Laboratory sediment analysis	March 2020
	Reporting, alum dosing & monitoring	April-May 2020
Fish Population Management	Field survey	June 2020
	Permit procurement, report	June 2020
	Analysis & Discussion of Next Steps	June 2020
	Permit procurement	July 2020
	Commercial carp removal	July 2020
Internal Loading (sediment)	Alum application	September/2020
	Follow-up water quality monitoring	Sept 2020-Oct 2021
	Follow-up sediment coring	February/2021
Aquatic Plant Management	Post-alum application & herbicide field surveys	May & Sept 2021
	Permit procurement	May 2021
	Herbicide spot treatments	June 2021
	Reports	June & October 2021
Internal Loading (sediment)	Second alum application	September 2021
Fish Population Management	Post-alum application field survey	Aug-Sept 2021
Internal Loading (sediment)	Final sediment coring & water quality monitoring	February/2022

FEASIBILITY

This Crystal Lake Management Plan addresses the primary sources of internal phosphorus loading by reducing phosphorus release from the sediments via an alum treatment that will accomplish the entire internal load reduction required by the Crystal lake Nutrient TMDL. Biotic health will be improved by the removal of rough fish and aquatic invasive submersed aquatic vegetation. This proposed project is feasible and cost effective.