Grant

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Capitol Region Watershed District Nine Key Element Document for Como Lake

This document provides a summary of the EPA's nine key elements information for Como Lake.

MINNESOTA POLLUTION CONTROL AGENCY

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Executive summary

The Capitol Region Watershed District (CRWD) and its partners have a long, sustained planning and implementation history in their efforts to improve the water quality of Como Lake. The history of watershed planning for Como Lake extends back to water management planning required for watershed management organizations in the seven-county Twin Cities metropolitan area by the Minnesota Legislature in 1987. Minn. Stat. ch. 103b.231 requires that metropolitan area watershed plans to be written with the general standards including the time amount covered by the plan, which must extend at least 5, but no more than 10 years, from the date of approval. The plans must include the goals and objectives for the watershed for the 10 years, including an implementation program consistent with the plan. The preferred approach by the locals for planning is to include what can be reasonably accomplished in 10 years. This document is meant to honor that value and to meet the nine key elements (NKE) that are required by EPA for watershed based planning.

The CRWD formed in 1998 and the first watershed management plan was completed in 2000. The second watershed management plan was developed in 2010 with the third plan in 2020. The first Como Lake Management Plan (CLMP) and the first capital improvement project for Como Lake were completed in 2002. The CLMP was last updated in 2019.

A TMDL was developed in 2010 for Como Lake due to nutrient impairment from total phosphorus (TP). The TMDL called for a 60% TP reduction from external sources and a 95% TP reduction from internal sources. The combined percent reduction to achieve the TMDL was 83%. The year 2000 was established as the baseline year for the TMDL calculations. As of the updated CLMP in 2019, the CRWD has accomplished a 20% external load reduction to Como Lake since 2002 through watershed BMPs. In-lake management actions in 2020 included an alum treatment to bind sediment phosphorus and curly-leaf pondweed treatments to reduce phosphorus loading from decaying plants provided an estimated 84% reduction of the internal load to the lake.

A source of pride for the CRWD is that there is a strong group of citizens that are engaged to protect Como Lake. The existing plans have been developed with hours of community involvement and input. This demonstrates the support and commitment of citizens in the watershed, the CRWD, and partners to comprehensive planning and implementation. The addition of the Como Lake Watershed to the Section 319 program will highlight the success of detailed watershed planning at the small watershed scale, particularly in a densely populated, developed, urban center.

Development of a nine key element (NKE) plan in conjunction with the existing CLMP and CRWD plans presented a complex challenge to mesh all of the varied programmatic requirements. The CLMP is a 20-year plan (2019-2039) and is an adaptive management plan that operates on 3-year management cycles to incrementally work toward goals over the twenty-year period. The EPA requires that the 10-year timeline address all of the activities and projects that will be required to meet the reductions needed to meet water quality standards. Part of the NKE plan is to then plan for the means to achieve these goals. While it may not appear to be a significant difference, in practice it becomes difficult to mesh the two ideologies. It is the goal of the CRWD and the MPCA to successfully marry these two approaches to achieve what all federal, state, local organizations, and citizens care about: restoring and protecting water quality in our lakes, streams, rivers, and groundwater. The NKE plan is intended to address all pollutants, sources and solutions in the watershed to reach the reductions needed to achieve and protect water quality standards. For the purposes of the Section 319 grant program, only practices and activities eligible for funding under the EPA 2014 Section 319 program guidance and Minnesota's Nonpoint Source Pollution Program Management Plan (NPSPPMP) are eligible for Section 319 funding. All match activities must be eligible for Section 319 funding, except where noted in the NPSPPMP.

The CLMP is a very extensive plan that is actively used by the CRWD. The goals for the lake are comprehensive and have numeric and narrative objectives that enable progress toward the objectives to be measured and tracked. The goals and objectives are presented in Section 3, starting at page 46, of the plan. Key objectives address phosphorus loading, by in-lake and watershed sources quantitatively. Biology and ecological health objectives are addressed with quantitative and qualitative criteria. The CLMP identifies 54 actions under the categories of in-lake, watershed, and community to be implemented over the next 20 years to achieve the goals of the plan.

This document utilizes the CRWDs details to bridge the gaps needed to meet the NKE requirements. The CLMP is an adaptive management approach for improving Como Lake and its watershed and is accomplished using a short-term implementation plan that is developed every three years. The short-term plan is developed to define the specific projects, programs, and actions for the next three years. These items are much better defined due to the timeframe for implementation and the details of cost, timing, and lead and supporting agencies are known. The CRWD will conduct a thorough evaluation every three years to determine progress towards meeting the CLMP goals and adjust the short-term implementation plan. The CLMP and CRWD watershed management plan for 2020-2030, combined with the documentation described in this memorandum, fully provides the NKE requirements identified by EPA as critical in a watershed plan for achieving improvements in water quality. This document bridges the gap between the details required to meet the NKEs and the CRWD planning processes.

Water quality condition summary

Como Lake is a highly eutrophic shallow lake. Since 2002, it has been listed as impaired for nutrients by the MPCA based on the shallow lake eutrophication standards for the North Central Hardwood Forest Ecoregion (Table 1). Table 2 provides a water quality summary for the lake for the entire monitoring period (1984-2018) and the last 10 years (2008-2018). The long-term mean TP is nearly three times greater than the water quality standard, while the mean Chl-a standard is 1.7 times the water quality standard. Detailed information on the lake's water quality is presented in the CLMP (CRWD, 2019).

Table 1. MPCA shallow lake eutrophication standards for the NCHF ecoregion.

TP (µg/L)	Chl-a (µg/L)	Secchi depth (m)
60	20	1.0

Table 2. Growing season average (May-September) values for total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi depth in Como Lake for the period of record (1984-2018) and the last ten years (2008-2018).

	TP (µg/L)	Chl-a (µg/L)	Secchi depth (m)
Period of Record (1984-2018)	174	34.2	1.4
10-year (2008-2018)	168	32.8	1.0

The 2010 TMDL identified an external TP load reduction target of 60% (Table 3). Original modeling for the 2010 TMDL estimated watershed loads to be 625 lbs TP/year. Recent watershed modeling completed in 2018 for the development of the CLMP identified the existing (baseline) TP load from the watershed 732 pounds/year, an increase from the original TMDL estimate. However, the 60% load reduction target was still found to be valid to meet water quality goals. Based on this new watershed load estimate, the needed load reduction (60% of the baseline) for the watershed is 439 lbs/yr with the allocated load (40% of baseline) being 293 lbs/yr.

In the 2010 TMDL, internal TP loads were estimated to be 1210 lbs/year and called for a target reduction of 95% (Table 3). While the 95% internal TP load reduction target has remained the same, the total annual internal TP load in lbs/year has likely changed since it was modeled for the 2010 TMDL based on the analysis of internal phosphorus sources completed in LimnoTech (2017). Load reductions calculated in the 2010 TMDL were based on the Wisconsin Lake Modeling Suite (WiLMS), which is a screening-level lake water quality model used to evaluate in-lake water quality (CRWD 2002; EOR 2010). This water quality model should be re-calibrated to include direct sediment core measurements of diffusive sediment P flux to confirm the internal load reduction required to meet the in-lake TP target of 60 µg/L. CRWD is currently working to constrain estimates on internal loading with expanded datasets on phosphorus release rates from sediment cores and estimates of anoxia (both duration and areal extent) from continuous dissolved oxygen monitoring.

Table 3. Como Lake TMDL Load Reduction Targets.

TP Source	Target Load Reduction (%)
Internal TP Load	95%
External TP Load	60%

In addition to nutrients, Como Lake was listed as impaired for chloride in 2014. Chloride reduction goals in the CLMP follow the Twin Cities Metro Area (TCMA) Chloride TMDL and TCMA Chloride Management Plan completed in 2016.

Como Lake has also been listed as impaired for mercury since 1998. Mercury emission reduction goals are addressed through the Implementation Plan for Minnesota's Statewide Mercury TMDL (MPCA 2009) at state and regional scales, given that atmospheric deposition of mercury from power plant emissions is uniform across the state of Minnesota.

Implementation strategies

This section describes the activities, schedule, cost, estimated reductions, and milestones/assessment criteria for implementing actions that if completed, would achieve the water quality standards for Como Lake (Table 4) over the next 12 years. The table provides the framework for achieving water quality standards, however full funding and landowner approval would need to be secured. The table, the basis for addressing Elements b. c., f., g., and h. of the NKE, is meant to stand as a clear guide post for future implementation and to be easy to read and understand. The subsequent sections of this document describe the elements of the NKE. Each section will detail how each element is met.

Table 4. Management strategies, implementation activity, schedule, estimated costs, estimated reductions, and measurable outputs for Como Lake (adapted from CRWD WMP)

Management category	Treatment type activity	Schedule	Estimated cost *	Estimated TP reduction (lbs/yr)	Purpose/Goal/Long Term Goal	Milestones (output)	Assessment metrics
Lake	Lake monitoring and data collection (Appendix A)	Annually	$300,000		Knowledge of the trends, responses, and current conditions of Como Lake	Monitoring performed annually Data collected and analyzed	# of lake samples collected Annual data analysis completed
	Como Lake water quality model	2022	$25,000		Increased understanding of Como Lake ecological system dynamics	Model completed and applied appropriately to the planning	Model results used to inform planning
	Como Lake alum treatment	2020; 2030	$200,000	302	Decrease internal phosphorus load to decrease lake water TP concentrations and decreased algal blooms	Need for second alum treatment determined and designed 24,000 gallons of alum applied to Como Lake	Design complete # gallons alum applied # days decreased algal blooms
	Aquatic invasive species management (curly-leaf pondweed control)	Annually	$120,000	404	Reduction of presence of CLP in the lake, allowing for clarity and other aquatic plants	< 10% frequency of occurrence (FOC) of curlyleaf pondweed (CLP)	# % FOC of CLP in Como Lake
	Lake vegetation management plan and implementation	Annually	$120,000		Increased diversity of native aquatic plants to improve ecological conditions of the lake	Plan developed, implementation steps started	# management activities # aquatic plant species # species having FOC >20%
	Development of a balanced fishery target	2021-2026	$60,000		Diverse, healthy fish community in Como Lake	Fishery targets incorporated into CLMP	Fishery targets developed for Como Lake
	Shoreline management plan and implementation	Annually	$180,000		Fully restored and maintained shoreline	Shoreline management plan and lakeshore maintained in a restored state	# feet of lakeshore maintained Annual plan updates
Structural watershed practices (by subwatershed)							
Como B	Innovative treatment facility feasibility study (i.e. spent lime)	2025	$10,000		Develop new treatment technology for improved phosphorus reductions	Completion of study	Completion of feasibility study and study report
	Golf Course Parking Lot Reconstruction (filtration/infiltration) (B1)	2021	$180,000	1.8	Decrease external phosphorus pollutant loading to decrease lake water TP concentrations and decreased algal blooms	Complete installation of filtration/infiltration BMPs with parking lot reconstruction	# acres treated # pounds TP reduced
	Lexington Ave & Como Blvd Intersection (infiltration) (B2)	2027-2032	$125,000	2.6		Complete installation of infiltration BMPs with the reconstruction of intersection	# acres treated # pounds TP reduced
	Como Golf Course BMPs (B1)	2022	$1,200,000	55		Implementation of infiltration and iron-enhanced pond BMPs to reduce phosphorus by 55 lbs/yr and volume by 34 ac-ft/yr	# pounds TP reduced # volume reduced
	Como Pavilion BMPs (B1)	2021	$500,000	3		Collaborate with St. Paul Parks & Recreation to design BMPs Coordinate with parking lot improvements Construct BMPs	# raingardens # pounds TP reduced
	East Como Lake Drive BMPs (B1)	2025-2032	$200,000	5		Green infrastructure practices designed and installed	# green infrastructure practices incorporated # pounds TP reduced
	East Golf Course Ponds IESF (Stormwater Pond Retrofit) (B1)	2023-2030	$500,000	21.7		Plan/designed stormwater retrofit Stormwater pond retrofit completed	# acres treated # pounds TP reduced
	NW Golf Course Pond - IESF Bench (Stormwater Pond Retrofit) (B1)	2020	$200,000	24.2		Plan/designed stormwater retrofit Stormwater pond retrofit completed	# acres treated # pounds TP reduced
	Golf Course Parking Lot Pond - IESF Bench (Stormwater Pond Retrofit) (B1)	2023-2025	$280,000	18.7		Plan/designed stormwater retrofit Stormwater pond retrofit completed	# acres treated # pounds TP reduced

Management category	Treatment type activity	Schedule	Estimated cost *	Estimated TP reduction (lbs/yr)	Purpose/Goal/Long Term Goal	Milestones (output)	Assessment metrics
	Zoo Combo - Filtration Basin & Infiltration Basin (filtration/infiltration) (B5)	2020	$1 million	19.5		Complete installation of filtration/infiltration BMPs with parking lot reconstruction	# acres treated # pounds TP reduced
	Como Pavilion North - Rain Gardens (Bioretention) **(B1)	2021	$100,000	1.6		Raingardens designed Implementation of rain gardens	# acres treated # pounds TP reduced
Como C	Como Pavilion south Regional 2 - Infiltration Stream and Underground Infiltration (infiltration)	2025-2032	$1,130,000	8.9		Design of underground infiltration practice Installation of practice	# acres treated # pounds TP reduced
Como D	McMurray Field Capture and Reuse - Regional Treatment (reuse/infiltration)	2023-2030	$1.4 million	40.3		Coordinate with St. Paul Parks & Recreation to design regional infiltration and stormwater reuse system to irrigate McMurray Field	# acres treated # pounds TP reduced
	Lexington, Como & Horton Ave (filtration/infiltration)	2027--2032	$100,000	5.8		Design of filtration/infiltration practice at Horton and Van Slyke Implementation of design	# acres treated # pounds TP reduced
	Median Rain Garden at Horton and Van Slyke (Bioretention)	2018	$15,000	1.0		Raingarden designed Implementation of rain garden	# acres treated # pounds TP reduced
Como E	Chatsworth St - Regional Treatment (filtration/infiltration)	2027—2032	$500,000	28.9		Design of regional filtration/infiltration practice Installation of practice	# acres treated # pounds TP reduced
	Median Rain Gardens at Argyle and Van Slyke (Bioretention)	2027—2032	$50,000	2.6		Raingarden designed Implementation of rain garden	# acres treated # pounds TP reduced
	Rain gardens (Bioretention)	2027—2032	$10,000	0.3		Raingarden designed Implementation of rain garden	# acres treated # pounds TP reduced
Como F	Nagasaki Road (Bioretention)	2027—2032	$35,000	1.2		Raingarden designed Implementation of rain garden	# acres treated # pounds TP reduced
Como H	Como Blvd Reconstruction - Regional Treatment	2027—2032	$50,000	2.6		Design of regional filtration/infiltration practice Installation of practice	# acres treated # pounds TP reduced
Como J	Como Blvd Reconstruction - Regional Treatment	2027—2032	$45,000	2.5		Design of regional filtration/infiltration practice Installation of practice	# acres treated # pounds TP reduced
Como K	Como Blvd Reconstruction - Regional Treatment	2027—2032	$30,000	2.0		Design of regional filtration/infiltration practice Installation of practice	# acres treated # pounds TP reduced
Como M	Como Blvd Reconstruction - Regional Treatment	2027--2032	$35,000	2.4		Design of regional filtration/infiltration practice Installation of practice	# acres treated # pounds TP reduced
Non-structural watershed	Street sweeping enhancement or similar non-structural implementation activity	Annually	TBD	45	Decrease external phosphorus pollutant loading to decrease lake water TP concentrations and decreased algal blooms	Street sweeping plan and implementation schedule developed and followed	# street sweeping events # sediment removed # phosphorus removed

Management category	Treatment type activity	Schedule	Estimated cost *	Estimated TP reduction (lbs/yr)	Purpose/Goal/Long Term Goal	Milestones (output)	Assessment metrics
	Future permit BMPs	Annually	Permittee costs	81		BMPs implemented and designed to support permit limits	# permits # and type of BMPs implemented # pounds TP reduced
	Potential Structural--Unidentified	2027--2032	TBD	25		Through cooperation with partners, currently unidentified BMPs will be implemented. They could include: rain gardens, filtration/infiltration practices, ponds, wetland restorations and others.	# acres treated # pounds TP reduced
	Conduct Clean Streets program	Annually ($5,000/ year)	$60,000			Target: 300 storm drains adopted and 200 new participants over the 10-year plan; 5,000 lbs. of trash, sediment and organics removed collected in 300 hours per year	# storm drains adopted # new participants # pounds trash, sediment and organics removed # hours
	Trash management planning and implementation for areas surrounding District infrastructure and water and natural resources	2022-Annually ($10,000/ year)	$120,000			Trash management plan developed for watershed infrastructure	# trash collected # trash events held
	Stormwater monitoring and data collection	Annually ($20,000/ year)	$240,000		Evaluate the impact of BMPs on end of pipe results	10 monitoring sites; stormwater quality and quantity data	# runoff samples collected # runoff events sampled
	Emerging contaminants and water quality issues	Annually ($10,000/ year)	$120,000		Obtain a better understanding of new threats to water quality in Como Lake	New monitoring parameters and results	# samples # contaminants logged

*Annual activities costs are described as per plan period, not as an annual basis.

Element a: Source identification

> *An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan), as discussed in item (b) immediately below. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed (e.g., X numbers of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded streambank needing remediation).*
>
> *EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters (2008)*

The internal and external sources of phosphorus to Como Lake are described in Chapter 2 Lake and Watershed Characterization of the CLMP. The results of the Como Lake Water Quality Drivers Analysis Study (LimnoTech 2017) confirmed that internal and external phosphorus loading are the primary drivers of water quality in Como Lake.

The 2010 TMDL estimated both internal and external TP loads and allocations. These estimates were recently updated for the CLMP development with new values using calculations from LimnoTech (2017) and HEI (2018). The revised loads and allocations are shown in Table 5.

Table 5. Phosphorus loads and allocations for Como Lake

Source	Load (lbs/yr)	% of total load	Allocated load (lbs/yr)	Reduction needed (lbs/yr)
Watershed	732	46%	293	439
Atmospheric	20	1%	20	0
Internal	840	53%	42	798
Total	1,592		355	1,237

Internal sources

The primary internal loading mechanisms in the lake are diffusive flux of sediment phosphorus and release of phosphorus from decaying curly-leaf pondweed (CLP) during early-season plant senescence. Given the large contribution of these internal sources, it is critical they are managed to meet internal phosphorus load reduction goals. Other sources of internal phosphorus in Como Lake include bioturbation from benthivore fish species and wind-driven resuspension. From LimnoTech (2017), Table 6 lists the total annual load contributions from each of these sources.

Table 6. Internal phosphorus sources to Como Lake and estimated annual loads (from LimnoTech (2017), p. 81).

Internal source	Estimated load (Lbs TP/year)	Basis if estimate and key assumptions
Diffusive Flux	293-819	The Como Lake: Water Quality Drivers Analysis Study (2017), which assumes that historical dissolved oxygen profiles from shallow Como Lake stations are representative of current conditions. CRWD is currently measuring continuous DO at multiple stations to better constrain this estimate.
Wind-induced resuspension	Indeterminate	This report.
Bioturbation	Indeterminate	This report. Literature estimates on P load from fish are lacking except for carp, which haven't been found in Como Lake in appreciable densities.
Macrophytes (internal)	505	Scaling of Ramsey-Washington Metro Watershed District (2006) rates for Kohlman and Keller Lakes (which are reported to have "abundant" macrophytes) to Como Lake surface area

Since the publication of LimnoTech (2017), CRWD has worked to constrain the estimated range of internal loading from diffusive flux in Table 3 by continuously monitoring dissolved oxygen across the lake. Having a more constrained estimate of diffusive flux is necessary for developing management strategies for addressing it. Using the expanded DO monitoring, recent calculations in 2019 estimated phosphorus loads from diffusive flux to be 335 lbs/yr.

External sources

External phosphorus loads from Como Lake's 13 subwatersheds (Figure 2) enter the lake through an extensive network of storm sewer pipes that discharge directly to Como Lake through twenty-two storm sewer outlets. The CLMP (2019) indicates that BMPs installed to date have netted a reduction of 20% (143 lbs/yr) of TP.

The watershed is a dense urban area of primarily single-family residential area with isolated areas of commercial, institutional, railway, and office areas with 40% of the area being impervious surfaces. The watershed also includes large areas of parkland with Como Regional Park and the Como Golf Course. Baseline (2000) load estimates for the subwatersheds are presented in Table 7. The highest loading subwatersheds are Subwatersheds B and D. Subwatershed B is broken into five smaller catchments. Catchment B1 is the highest loading area, which makes this the critical area. To date, there have been 95 lbs/yr TP reduced by BMP implementation from catchment B1.

According to the CLMP (2019), the pollutant sources "includes trash, leaves, grass clippings, soil, animal waste, fertilizers, automobile fluids, road salt, and other chemicals – anything present on the landscape that can be flushed into a storm drain by rain or snowmelt." (p. 36). The pollutants are carried to the lake via the stormwater conveyance system. The sources of pollution and conveyances are illustrated in Figure 1.

Figure 1. Watershed pollutant sources and pathways (CLMP, 2019, p. 36)

The subwatersheds with the highest loads are the critical areas for targeted implementation activities. Implementation of BMP projects in a fully developed watershed are largely dependent on opportunities presenting themselves. Thus, CRWD will also approach watershed management on a project-by-project basis in all Como Lake subwatersheds as BMP project opportunities become available. Estimates for meeting external load reduction goals in the CLMP take this into consideration by defining four categories of TP load reduction methods. The categories include both potential structural and non-structural BMPs to be implemented in the future: 1) Potential Structural – Identified, 2) Potential Structural – Unidentified, 3) Future Permit BMPs, and 4) Potential Non-Structural. Definitions of each of these four categories are listed in Table 13 (p. 58) of the CLMP. This strategic approach will result in a cumulative watershed TP load reduction necessary for meeting Como Lake water quality goals.

The implementation and management strategies for Como Lake are described in Table 4. The strategies and associated reductions are designed to correspond with the various sources of loading, and their respective contributions, as described in this section.

Figure 2. Subwatersheds (Como A-M) in the Como Lake Watershed (CLMP, 2019)

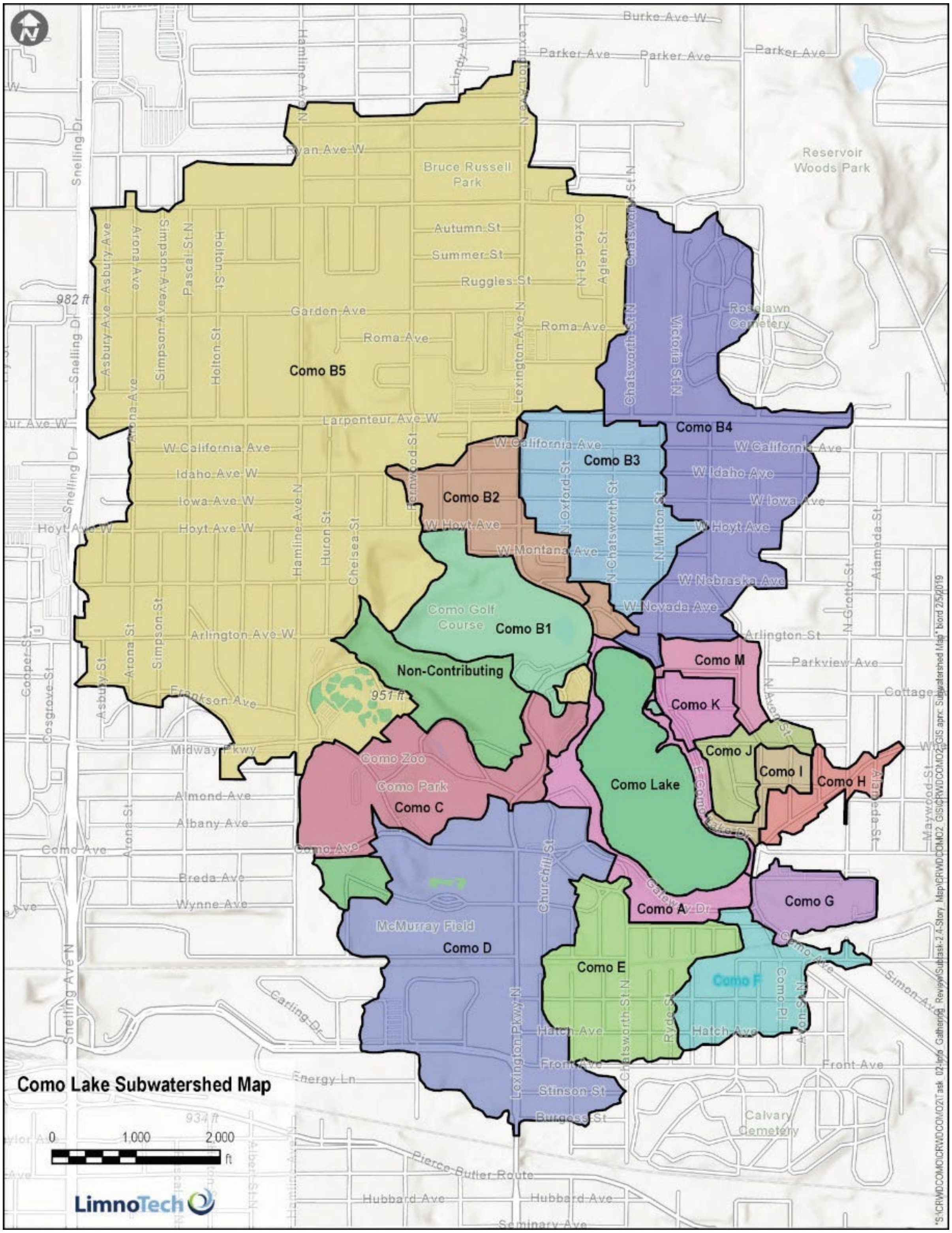


Table 7. Subwatershed TP loads (adapted from Table 5, CLMP)

Subwatershed	Baseline TP Load (Year 2000) (lbs)
Como A	11.2
Como B	388.8
Como C	20.9
Como D	98.3
Como E	41.3
Como F	25.6
Como G	16.2
Como H	10.5
Como I	6.3
Como J	10
Como K	8.1
Como L	0
Como M	9.4
Total	**732.1**

Chloride

The primary source of chloride to Como Lake is from salt that is applied to streets, parking lots, sidewalks, and other paved areas in the Como watershed during the winter months as a deicing agent. Public street applications, commercial applicators, and residential use are the primary sources for deicing agents. The chloride then flushes into the lake through snowmelt runoff and spring rainfall. Management actions for chloride reduction in the watershed are based on the MPCA *TCMA Chloride Management Plan* that was completed in conjunction with the *TCMA Chloride TMDL*. Critical areas representing the largest sources of chloride are streets and parking lots in the watershed.

Sediment

Sediment (silt, sand, clay) entering Como Lake from the watershed is also problematic pollutant source because it accumulates in the lake, subsequently reducing lake volume, creating sediment deltas, and burying aquatic habitat on the lake bottom. Excess sediment can also damage fish gills and inhibit food foraging on the lake bottom for many fish species. In addition, other pollutants such as phosphorus and heavy metals can be transported to the Lake while chemically bound to sediment particles. Como Lake does not currently exceed criteria for turbidity from sediment, but given the correlation to other pollutants of concern and impacts on water quality, the CLMP contains actions that address excess sediment loading. Critical areas include impervious surfaces and construction areas.

Element b. Estimated load reductions

> *An estimate of the load reductions expected for the management measures described under paragraph (c) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (a) above (e.g., the total load reduction expected for dairy cattle feedlots; row crops; or eroded stream banks).*
>
> *EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters (2008)*

The estimated internal and external load reductions for the planned BMPs are described by practice in Table 4. Implementing the management strategies and practices will achieve the reductions needed to meet water quality standards in Como Lake. Load reductions are further broken down by subwatershed (Table 8), and loading source (Table 9).

Internal Load Reductions

An alum treatment was completed on Como Lake in May 2020 that is expected to reduce internal loading from bottom sediments by 90%, or 302 lbs TP/year. A future maintenance treatment may be needed to maintain the effectiveness of the alum.

An extensive lake-wide herbicide treatment to reduce the frequency of curly-leaf pondweed (CLP) was done in the spring of 2020. Maintenance treatments are expected in future years to keep CLP at low levels in Como Lake. CLP management is expected to reduce the phosphorus input from decaying plant matter to less than 10% frequency of occurrence, resulting in an estimated TP reduction of 404 lbs/year.

External Load Reductions

Watershed BMPs will be implemented based on the CLMP Watershed TP Load Reduction Plan and the CLMP list of Potential Structural BMPs from Existing Feasibility Studies as incorporated into Table 8. Implementation of the watershed practices and activities in Table 7 would result in a 68% TP load reduction, which exceeds the load reduction specified in the TMDL (60%). The table includes load reductions already achieved from existing practices and future estimated load reductions from four categories: 1) Potential Structural – Identified, 2) Potential Structural – Unidentified, 3) Future Permit BMPs, and 4) Potential Non-Structural. Definitions of each of these four categories are listed in Table 13 (p. 58) of the CLMP.

Table 8. Watershed Total Phosphorus (TP) Load Reduction Plan

	Baseline TP Load (Year 2000) (lbs)	Existing Practices (Year 2018)	Potential Structural-Identified[a]	Future Permit BMPs[b]	Potential Non-Structural[c]	Reduction Subtotal	Total Target TP Load (lbs)	Total Target Reduction (%)
Como A	11.2	0	0	0	0.8	0.8	10.4	7
Como B	474.3	110.3	130.8	45.4	28.4	314.9	159.4	66
Como C	20.9	2.8	8.9	0	2	13.8	7.1	66
Como D	98.3	5.8	47.1	33.3	3.8	90	8.3	92
Como E	41.3	0	31.8	0	1.9	33.8	7.5	82
Como F	25.6	10	1.2	0.6	1.6	13.4	12.2	52
Como G	16.2	10	0	1.7	0.6	12.3	3.9	76
Como H	10.5	1	2.6	0	0.9	4.5	6	43
Como I	6.3	3.1	0	0	0.7	3.8	2.5	61
Como J	10	0	2.5	0	1.4	3.9	6.1	39
Como K	8.1	0	2	0	1.1	3.1	5	39
Como L	0	0	0	0	0	0	0	0
Como M	9.4	0	2.4	0	1.6	3.9	5.5	42
All	732.1	143	310	81	44.9	498.3	233.8	68

[a] Projects evaluated in existing feasibility studies

[b] Estimated future redevelopment projects subject to CRWD rules

[c] Reduction estimates based on enhanced street sweeping studies. Actual practices may vary.

Table 9 indicates that the estimated load reductions that will occur as a result of BMP implementation and management activities that have been completed to date and planned for implementation as described in this document represents a 77% reduction in the total load to Como Lake. The overall load reduction estimate needed from the TMDL following the updated calculations of watershed and internal loading was 77%. The reductions that are expected from the watershed and internal management activities are likely to result in a shift of the lake from a turbid phase to a clear water phase such that the water quality standard for the lake is expected to be met.

Table 9. Updated baseline TP load estimates and load reduction estimates for BMPs described in Table 4 (reductions rounded to nearest whole number)

	Baseline load (lbs./yr)		TMDL annual allocations	Estimated reductions from completed planned practices	Estimated load after BMPs
Diffusive flux	335			302	33
Aquatic vegetation	505			404	101
Lake (internal) loads		**840**	**37**	**706**	**134**
Atmospheric		**20**	**20**	**0**	**20**
Existing watershed practices				143	
Watershed structural BMPs				229	
Watershed non-structural BMPs				126	
Watershed totals		**732**	**306**	**498**	**234**
Total		**1,592**	**363**	**1,204**	**388**

Chloride reductions

The loading capacity of chloride for Como Lake in the TCMA chloride TMDL was determined to be 994,078 lbs/year. The TMDL utilized a performance-based approach for improved winter maintenance practices and on-going monitoring rather than setting load reduction targets for the chloride sources.

"The performance-based approach TCMA Chloride TMDL does not focus on specific numbers to meet, but rather on making progress with BMPs. Progress is measured by degree of implementation and trends in ambient monitoring. In a traditional approach with numeric targets, progress would be measured by accounting for salt applied and comparing to the targets. The performance-based approach is intended to allow for flexibility in implementation and recognize the complexities involved with winter maintenance. Because the performance-based approach doesn't provide a specific numeric target, a limitation of the approach is that it is not definitive on when enough progress has been made. This can only be determined by continued ambient monitoring that demonstrates compliance with water quality standards" (MPCA, 2016b, p. 39).

Addressing chloride issues are complex due to the need to balance public safety on icy roads with the negative water quality implications. The following actions are recommended to assist in managing chloride in the Como Lake watershed (LimnoTech, 2019, p. 61):

- Promote best winter deicing practices to the community. Promote best winter salt use and deicing practices to residents and business owners through education and outreach in the Como Lake watershed.
- Collaborate with agency partners to promote best deicing practices and support innovations in deicing methods. Continue to work with local partners to promote best practices for snow removal and deicing to reduce road salt application on streets and roads in the Como Lake watershed. Support research on innovative deicing methods and technologies that are more efficient, less impactful on water quality, and promote cost-savings.
- Evaluate and implement options for regulating deicing practices for private applicators. Explore options for requiring private road salt applicators to become an MPCA Certified Applicator by taking the MPCA's Smart Salting Training classes.
- Routinely monitor and analyze chloride concentrations in Como Lake and at storm sewer outlets. Continue to perform routine sampling (April-October) of chloride in the lake and at key

storm sewer outlets discharging to the lake and report upon results. Routine sampling of chloride should occur in the winter months (November-March) during ice-on periods.

Table 4 also lists load reduction strategies and measurable outcomes for other pollutant sources (e.g. chloride, sediment, trash, emerging contaminants):

- Deicing Practices Rule.
- Trash Management Planning for CRWD infrastructure.
- Chloride Reduction Grants.
- District Chloride Source Assessment and Prevention Plan.
- Emerging Contaminants and Water Quality Issues.

Element c. Description of BMPs

> *A description of the BMPs (NPS management measures) that are expected to be implemented to achieve the load reductions estimated under paragraph (b) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas (by pollutant or sector) in which those measures will be needed to implement this plan.*
>
> *EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters (2008)*

This section includes a description of the proposed BMPs and the critical areas. The BMPs that will be implemented are summarized in Table 4. The combination of these practices and management activities will achieve the reductions needed to achieve water quality standards.

BMPs Table 4 represents a compilation of management actions identified in the CLMP, both internal and external, that have been selected for implementation in CRWD's 2020-2030 Watershed Management Plan (WMP) over the next ten years. The table lists the management action, the timeline for implementation, estimated cost, and estimated load reductions. The spreadsheet provides the information needed for the nine key elements of an EPA-approved watershed-based plan in a single location. The spreadsheet provides the milestone table and associated worksheets that incorporate the goals and objectives, activities, schedule, costs, reduction estimates, milestones, and measures for the Como Lake Management Plan. This table represents only a portion of the comprehensive list of all recommended management actions in Table 14 of the CLMP, given the 20-year life of the plan. Table 4 only lists the actions to be completed in the 12-year time frame of this Section 319 small watershed NKE document.

The implementation watershed and internal load activities will meet the estimated reductions required to meet eutrophication water quality standards in Como Lake. The load reductions will be made in the next 12 years, but it is expected that it will take longer for the lake to fully respond to the management activities and achieve ecological balance. The CLMP will be adapted every three years to account for the lake's response.

The management actions are described in Sections 4 and 5 of the CLMP, beginning on page 51. Community action is a large component of the CRWD's activities. The CLMP provides actions for recreation, education and outreach, and partnerships.

Critical Areas

The entire Como Lake watershed is fully developed with residential, commercial, and parkland areas. The total contributing area of the watershed (1,711 acres) and its connectivity to the lake through 22 storm sewer outfalls make the entire watershed a critical area to address for external load reductions. However, it is important to note that in a highly developed urban watershed, finding opportunities to implement watershed management actions are limited and are dependent on opportunities presenting themselves through the initiation of other projects (e.g. street reconstruction or building redevelopment, land use changes, landscape redesign, partnerships, funding sources, and the planning of non-structural activities). As a result, methods for reducing external loads of phosphorus to Como Lake are based on future potential opportunities that may arise rather than definitive existing plans. The implementation of these methods are prioritized in the CLMP depending on the estimated load by subwatershed, so subwatersheds that contribute higher TP loads to the lake take greater priority for management than the lower contributing subwatershed.

Element d. Estimate of financial need

An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement the entire plan (include administrative, Information and Education, and monitoring costs). Expected sources of funding, States to be used Section 319, State Revolving Funds, USDA's Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant Federal, State, local and private funds to assist in implementing this plan.

EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters (2008)

The estimated cost for implementing the NKE portion of the CLMP described in this document is $7 million with estimated costs for the individual activities shown in Table 4. It is expected that 15% or less of the funding will be provided through grants and loans.

The CLMP is a 20-year period plan that has identified that will continue to further the work in the watershed, including maintenance, further implementation, and operations and is expected to exceed $14 million. A detailed estimate of the costs are shown in Figure 14, on page 74 of the CLMP.

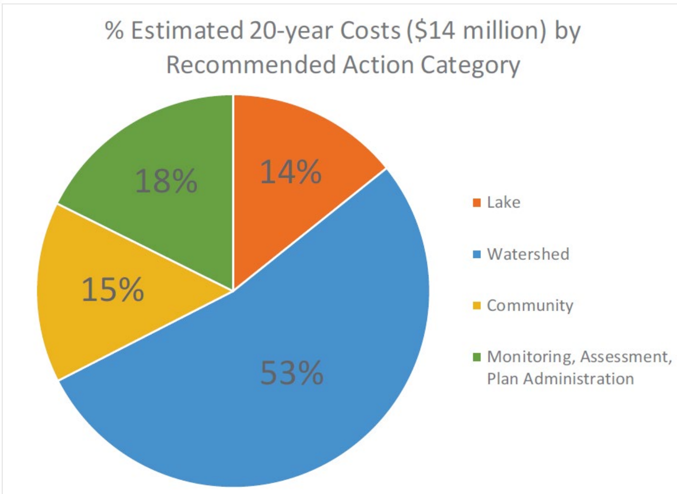
Sources of funding will come from the following primary sources:

1. Property tax levy.
2. Grant funds.
3. Local partner cost-sharing funding.
4. Bonds and loans.

The overall budget of the costs estimated for the CRWD WMP are described in Figure 13 in the plan. Because this NKE document represents an ambitious acceleration of the implementation, it estimated to incur a similar dollar amount and percentage breakdown, albeit over a 12-year period as presented in this NKE document.

Figure 3. Estimated costs from the CRWD WMP (2019)

The CRWD utilizes watershed district staff, city of St. Paul and Ramsey County staff, consultants, and contractors to complete the CLMP activities.



Element e. Education & outreach

> An information/education component that will be implemented to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, implementing AND MAINTAINING the NPS management measures that will be implemented.
>
> EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters (2008)

Education activities are summarized in Table 10. Education and outreach plans for CRWD, adapted from the CLMP (2019) and expanded to 12 years

. These activities will be used to support the implementation described in previous sections and continue to promote the CRWD's goals to educate and engage their community.

Community-based actions are equally as important to the success of the CLMP as internal and external management actions. These actions work to help build stewardship of and pride in Como Lake from both individuals and groups within the community. Community actions for the education and outreach include recreation, education and outreach, and partnership actions.

Public support through sustained community engagement and stewardship is critical for the improvement and projection of Como Lake. Having committed community groups and members that can help further the initiatives of the CLMP and support the work of CRWD and its partners is essential for success. Information, education and understanding of Como Lake, its issues, and the work to improve it form the foundation that supports stewardship. Outreach to the many different communities and user groups provides an opportunity to increase the number and diversity of the people working to improve Como Lake.

The CLMP provides several initiatives for education and outreach, such as workshops, signage, community events, regular communications, access to resources, and support of community groups. Table 10. Education and outreach plans for CRWD, adapted from the CLMP (2019) and expanded to 12 years

, which is adapted from the CRWD's WMP shows which community initiatives are prioritized for 2020-2030. Based on the $7 million, it expected that the total community based outreach will cost approximately $1.1 million over 12 years. This includes all aspects of the outreach and community engagement.

Table 10. Education and outreach plans for CRWD, adapted from the CLMP (2019) and expanded to 12 years

Activities	Schedule	Estimated cost for 12 years	Milestones	Criteria
Host annual community fishing event	Ongoing	$10,000	At least one fishing even planned/year	# community fishing events # repeat participants # new participants

Activities	Schedule	Estimated cost for 12 years	Milestones	Criteria
Provide access for non-motorized boating	Ongoing	Included in existing park programing	Non-motorized boating launch studied, sight selected, constructed	# non-motorized boating accesses
Maintain clear channels for non-motorized boating	Ongoing	$80,000	Channel maintenance	# feet channel cleared
Conduct annual educational workshops or events on watershed and lake protection	Ongoing	$10,00	Lake and watershed protection workshops	# workshops/events # repeat participants # new participants
Develop and install a Como Lake Water Quality Kiosk	2020	$80,000	Site selected, Kiosk developed, installed	# kiosk # kiosk users
Develop and install new educational signage around Como Lake	2020	$80,000	Educational signage designed, sites selected and installed	# signs
Incorporate art and other media as an alternative communication method of Como Lake's water quality	Ongoing	$20,000	Develop alternative methods using arts and media	# alternative communication developed # art activities # participants
Provide regular updates on Como Lake to the community	Ongoing	Included in baseline	Newsletters, emails, articles, radio, social media posts	# of outreach events # posts # articles
Regularly participate in meetings of existing community groups	Ongoing	Included in baseline	Identify opportunities, community groups, contact groups, participate where possible	# opportunities # actual contacts # participation in events
Support an existing community group(s) in their hosting of at least one event each year	Ongoing	$12,000	Identify opportunities, community groups, contact groups, participate	# opportunities # actual contacts # participation in events

Activities	Schedule	Estimated cost for 12 years	Milestones	Criteria
			where possible	
Provide resources (informational and/or supplies) to volunteer groups	Ongoing	$8,000	Identify opportunities, volunteer groups, contact groups, participate where possible	# opportunities # actual contacts # participation in events
Identify and partner with new community institutions in Como Lake improvement efforts	Ongoing	Included in baseline	Identify need for new community institutions, support formation, attend as needed	# opportunities # new community institutions # events attended
Target outreach to recreational users of Como Lake and Como Park	Ongoing	Included in baseline	Specific messages for those who recreate on and around Como Lake	# targeted recreational-related messages
Provide a Como Lake comprehensive online resource to allow the public to access information and updates about Como Lake	Ongoing	Included in Baseline	Develop, update, and maintain online resources	# updates # variety information
Document history, personal stories, and values linked to Como Lake	Ongoing	Included in baseline	Collect, produce, and share community stories	# stories # venues shared
Develop and launch a citizen science campaign with Como area residents, schools, and community groups	Ongoing	$6,000	Identify, recruit, and train volunteers for citizen science	# volunteers # schools participating # residents participating # community groups participating

Element f. Implementation schedule

> *A schedule for implementing the activities and NPS management measures identified in this plan that is reasonably expeditious.*
>
> *EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters (2008)*

Table 4 and Table 10. Education and outreach plans for CRWD, adapted from the CLMP (2019) and expanded to 12 years

provide the schedules of activities planned for implementation and education. All activities planned for the grant period coincide with CRWD's 2020-2030 WMP implementation schedule. Also, the CLMP is an adaptive management plan that adjusts management actions every three years to account for uncertainty in the lake's response to implementation.

There are some BMPs and implementation plans that have less solidified dates for implementation. One of the challenges that CRWD faces is the fact that Como Lake Watershed is fully-developed. Implementation of structural BMPs depends on city and county infrastructure renovation and improvement schedules. The added challenge for scheduling projects is that they need to be planned in tandem with other partners and departments. For example, a parking lot update will wait until the owner is ready for a project. Two to three BMP projects will be targeted for implementation in conjunction with the infrastructure construction every three-year interval of the estimated NKE timeline.

If this plan is fully implemented, it will put into place the reductions estimated to meet water quality standards in 12 years. Schedules may change as new information comes to light, as adaptive management practices signal a need for change, or with the realities of funding and participation.

Element g. Interim milestones

> *A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.*
>
> *EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters (2008)*

Table 4 includes the milestones for the activities planned for implementation. The milestones will help inform the effectiveness of the plan and will provide touchpoints to adjust the plan to ensure progress toward the goals of the CRWD. Load reductions for the projects will be evaluated with actual implementation design. As implementation occurs, the final design of the project may increase or decrease the estimated reductions associated with the practice. As these adjustments are made, the plan will be updated.

The CLMP is an adaptive management plan that operates on a short-term implementation schedule. Actions will be implemented, then monitored and evaluated for success using the milestones identified in Table 4 and in the CLMP. Depending on the outcomes of those actions, the plan will be reevaluated every three years to develop a new set of actions to be implemented.

To measure the success of actions and the response of the lake (i.e. interim milestones), CRWD will implement the "Como Lake & Como Lake Watershed Monitoring Plan" to compare post-project water quality data to the long-term record of baseline data. See Element i and Appendix A for a full description of the monitoring plan.

Element h. Load reduction criteria

A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.

EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters (2008)

The load reduction criteria developed as part of the Como Lake Management Plan and the Como Lake TMDL are 60% for external load and 95% for internal load. These goals are outlined previously in this plan. Table 4 and Table 10. Education and outreach plans for CRWD, adapted from the CLMP (2019) and expanded to 12 years

include criteria to measure effectiveness. More detail can be found in Sections 2.4.1 and 2.4.2 in the CLMP on pages 43-44.

As part of the adaptive management approach progress towards achieving the load reduction criteria will be assessed every 3 years. Taken from Section 1.2 of the CLMP: Management actions will be implemented and regularly monitored to evaluate progress at interim milestones (every three years) so that the direction of the plan can be modified, if needed, to achieve desired goals and objectives (CLMP, 2019, p. 13).

Taking an adaptive management approach acknowledges that a lake is a dynamic living ecosystem that may not respond immediately or fully to management actions as predicted. An adaptive management approach accounts for the uncertainty with implementing management actions and builds in a framework for addressing it. Based on the latest science and other case studies, we can estimate how Como Lake will respond to management actions in the near-term. However, there is inherent uncertainty in the long-term response of Como Lake to management actions due to the complexity of issues contributing to Como Lake's water quality. Therefore, it is unrealistic to plan long-term management actions with a high degree of specificity. In the CLMP, several actions are recommended for short-term implementation in the first three years while several long-term actions are also provided to be considered in the future pending the Lake's response to implementation activities in the near-term. CRWD will update the CLMP short-term implementation plan every three years to define a new set of actions to be implemented over the next three-year cycle within the life of the plan (CLMP, 2019, p. 13).

Element i. Monitoring & evaluation of progress

> *The monitoring & evaluation component to track progress and evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.*
>
> *EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters (2008)*

The CRWD has a comprehensive and extensive monitoring plan found in Appendix A.

Starting in 1984, water quality samples are collected in Como Lake every two weeks throughout the growing season (May through October) by Ramsey County Public Works (RCPW). These water quality samples are collected from the surface and bottom waters at the deepest spot in the Lake. Samples are analyzed by RCPW for the following parameters: total phosphorus (TP), soluble reactive phosphorus, chlorophyll-a (Chl-a), nitrate, ammonium, total Kjeldahl nitrogen, turbidity, and chloride. Secchi depth is also measured during each sampling event along with depth profiles of dissolved oxygen (DO), temperature, pH, and conductivity. Phytoplankton and zooplankton samples are also taken from the lake surface waters. In addition, chloride is measured bi-weekly during the winter ice-covered period at the deepest point in the lake.

Table 11. Como Lake water chemistry parameters collected by RCPW (1984-present) (CLMP, 2017)

Parameters
Ammonia nitrogen
Chloride
Chlorophyll-a
Nitrate
Organic particulate matter (Station 201 only)
Soluble reactive phosphorus
Total alkalinity
Total Kjeldahl nitrogen
Total particulate matter (Station 201 only)
Total phosphorus
Turbidity

In 2017, CRWD began measuring continuous DO with sensors at three monitoring locations in the Lake to measure anoxia near the sediment surface. The sensors are generally deployed from May through October in 2017 and 2018 in order to measure temporal and spatial patterns in anoxia. Quantification of the spatial extent and temporal extent of anoxia in the Lake facilitates estimation of the diffusive flux of phosphorus from the sediments.

Figure 4. Monitoring locations in Como Lake (Como Lake monitoring plan)

In addition, stormwater entering Como Lake from the watershed is monitored at three locations to quantify the pollutants (nutrients, solids, metals, bacteria) entering the lake and the volume of stormwater. Automated samplers take samples during runoff events and sensors measure total flow through storm sewer pipes (Figure 4). These data are used to calibrate the watershed model to determine watershed-wide loads to Como Lake.

Table 12. Monitoring type, collection frequency, time frames, partners and notes (Como Lake Monitoring Plan, 2020)

Data type	Frequency of collection				Years of deployment	Annual/ select years	Collected by	Notes
	Winter	Spring	Summer	Fall				
Chemical/physical data collection	2x/month	2x/month	2x/month	2x/month	1984 -present	Annual	RCPW, CRWD	Depth profile sampling using a sonde (dissolved oxygen, temperature, conductivity and pH) and water quality sampling from the epilimnion, thermocline, and/or hypolimnion. Sampling occurs April - October.
Continuous hypolimnetic data collection	2x/month	15-minute	15-minute	15-minute	2017 -present	Annual	CRWD	Dissolved oxygen, temperature, conductivity, and pH measured from 0.5m off lake bottom at Station 102, 201, and 202. Sampling occurs April - October.
Water temperature data collection	2x/month	15-Minute	15-Minute	15-Minute	1984 -present	Annual	CRWD, RCSWCD	Water temperature collected continuously at 15-minute intervals by CRWD during the open water months. Sampling occurs April - October.
Hypolimnetic winter chloride sampling	2x/month	--	--	--	2018	Annual	CRWD, RCPW	Hypolimnetic winter chloride samples collected from 0.5m off lake bottom at Station 201 using a peristaltic pump. Sampling occurs December - March.
Lake elevations	--	15-Minute	15-Minute	15-Minute	1978 -present	Annual	CRWD, RCSWCD	Lake elevation collected continuously at 15- minute intervals by CRWD during the open water months. Sampling occurs April - October.
Aquatic vegetation point-intercept surveys	--	--	3x per summer	--	1986 -present	Annual	RCSWCD	Data collected on species name, depth, % occurrence, and average abundance. Sampling generally occurs May-September.

Data type	Frequency of collection				Years of deployment	Annual/ select years	Collected by	Notes
	Winter	Spring	Summer	Fall				
Aquatic vegetation biovolume analysis	--	--	3x per summer	--	1986 -present	Annual	RCSWCD	A depth finder is used to assess evenly spaced transects and software determines lake depth and vegetation biomass along each transect. Sampling generally occurs May-September and coincides with vegetation point-intercept surveys.
Phytoplankton data collection	--	2x/month	2x/month	2x/month	1984 -present	Annual	RCSWCD	A composite sample is collected in the upper 2 meters of the water column using a plastic tube. Coincides with Chemical/Physical data collection at Station 201. Sampling occurs April - October.
Zooplankton data collection	--	2x/month	2x/month	2x/month	1984 -present	Annual	RCSWCD	A net tow is lowered down to the thermocline to collect zooplankton samples from the oxygenated layer of the lake. Coincides with Chemical/Physical data collection at Station 201. Sampling occurs April - October.
CLP turion sampling	--	--	--	1x per year	2019 -present	2019	CRWD, RCSWCD	Curly-leaf pondweed turion samples collected using an Eckman dredge in accordance with Como Lake DNR Lake Vegetation Management Plan.
Fisheries survey	--	--	1x per summer in select years	--	1976 -present	1976, 1981, 1986-1991, 1996, 2001, 2006,	DNR, CRWD, consultant	Information on species of fish and relative abundances obtained using various field techniques.

Data type	Frequency of collection				Years of deployment	Annual/ select years	Collected by	Notes
	Winter	Spring	Summer	Fall				
						2011, 2014-2017		
Sediment analysis	1x per winter, select years	--	--	--	2016	2016	CRWD, consultant	Sediment cores collected from Como Lake to determine rates of phosphorus release to characterize internal loading.
Turtle surveys	N/A (not routine monitoring)				2011	2011	District 10 Community Council	Conducted as part of a larger project analyzing various species throughout Como Regional Park.

References

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Appendix A CRWD monitoring plan

Como Lake & Como Lake Watershed Monitoring Plan

PREPARED BY: CRWD   DATE: 11/3/2020

Contents

1. Como Lake and Como Lake Watershed Background

Como Lake is a 70.5 acre urban shallow lake located within Capitol Region Watershed District (CRWD) in St. Paul, MN (Figure 1, Table 1). As part of the larger Como Regional Park, the lake is highly visible and visited, and is popular for walking, biking, bird-watching, and canoeing/kayaking, among other activities. The 1,711 acre Como Lake watershed land uses are primarily residential and parkland. The watershed is divided into 13 subwatersheds that drain to the lake through 22 different stormsewer inlets (Figure 5). Como Lake elevation is regulated by a weir within the outlet structure located at the southeast corner of the lake (Figure 2). Water leaving the lake over this weir flows into the Trout Brook Interceptor storm sewer, which eventually discharges to the Mississippi River. Therefore, not only does the lake function as an aesthetic and recreational resource, but also as an important stormwater management resource.

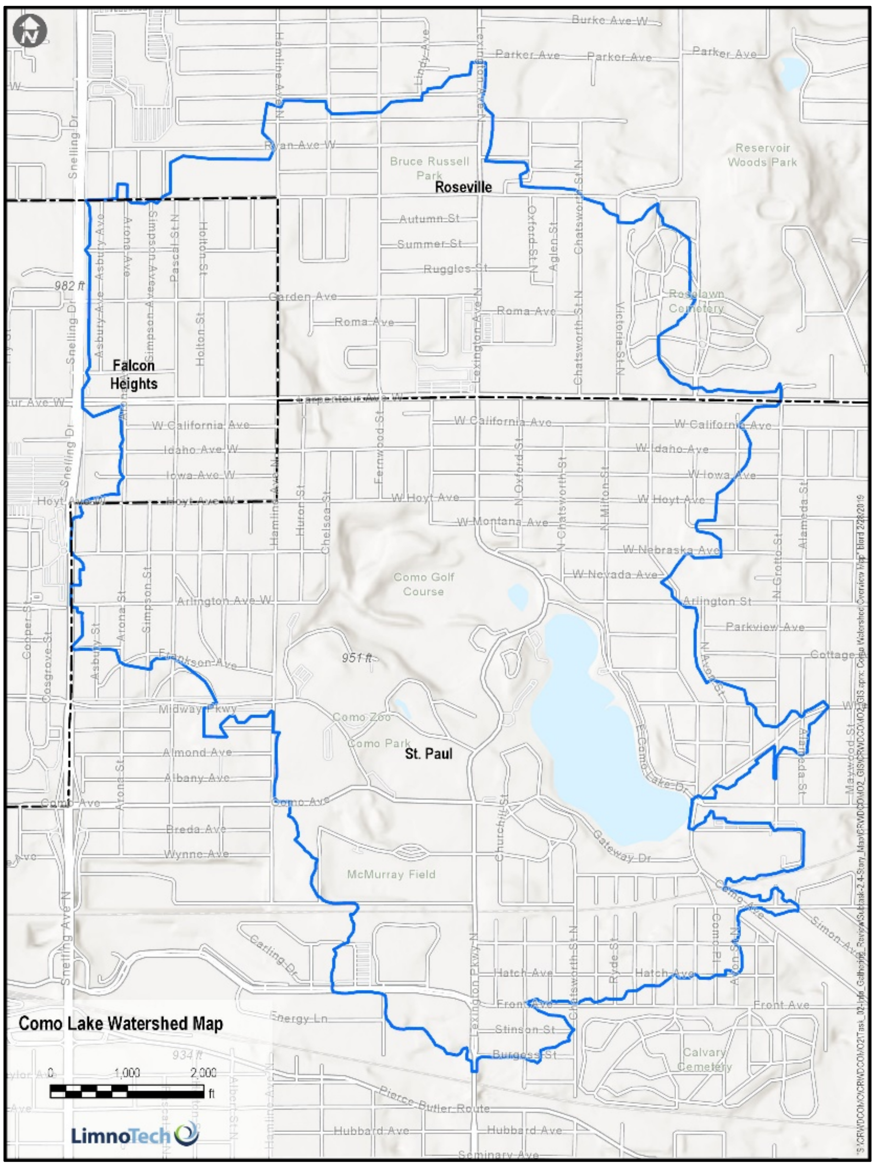

Figure 1: Como Lake Watershed Map.

Table 1: Como Lake Morphometric Details.

Surface Area (acres)	Maximum Depth (ft)	Littoral Area	Volume (acre-ft)	Watershed Area (acres)	Watershed: Lake Area (ratio)
70.5	15.5	97%	469	1,711	24.2

While popular for the many types of recreation listed above, Como Lake has a long history of poor water quality, low diversity, and frequency algal blooms. Como Lake was listed as impaired for mercury in fish tissue in 1998, nutrients in 2002, and chloride in 2014. Degraded water quality in the lake is due not only to internal changes in both water chemistry and biota over time, but to decades of stormwater runoff and legacy land use.

Gaining a complete picture of the factors affecting the water quality of Como Lake requires many different types of monitoring throughout the year. These monitoring practices are divided between in-lake monitoring and watershed monitoring and are described in depth below. The overall goal of both in-lake and watershed monitoring is to provide a complete picture of lake health to better manage Como Lake for its myriad uses.

2. In-lake Monitoring

2.1. Monitoring Goals

To better understand how water quality in Como lake has changed over time, significant monitoring has taken place and continues to occur. Ramsey County (RC) has played a major role in the monitoring and management of Como Lake. Their efforts have created a robust water quality dataset dating back to 1984, providing useful information on baseline conditions, historic trends, and responses to management actions. Ramsey County Public Works (RCPW), Ramsey County Soil and Water Conservation Division (RCSWCD), Minnesota Department of Natural Resources (DNR), and CRWD continue to monitor Como Lake for a multitude of chemical, physical, and biological parameters discussed in greater detail below.

Objective: The overall goal of in-lake monitoring is to fully characterize lake water quality, better understand ecosystem health, and determine the response to any management actions to adaptively manage the lake for both recreation and stormwater management.

2.2. Lake Monitoring Methods

Monitoring Como Lake include methods and schedules for measuring chemical, physical, and biological parameters, each of which are detailed below. Special lake monitoring projects are also described.

2.2.1. Chemical and Physical Monitoring

Bi-monthly Sonde and Water Chemistry Sampling

In-lake water quality monitoring of physical and chemical parameters is conducted at three main stations on Como Lake named Como 102, Como 201, and Como 202 (Figure 2). The three stations correspond to shallow, deep, and intermediate lake depths, respectively (Table 2). Historically, lake water quality data has been collected bi-monthly by RCPW throughout the growing season (May through September), resulting in an average of eight samples for each year. Since 2014, sampling efforts have increased in the spring and fall, resulting in an average of ten sampling days for each year and include sampling points in April and October.

To collect water quality depth profile data, RCPW staff anchor a watercraft at each location and measure depth, temperature, dissolved oxygen, conductivity, and pH at 1.0 meter sampling intervals using a multi-probe. From these recordings, the depths of the epilimnion, thermocline (if applicable), and hypolimnion are recorded. At each location, water transparency is determined with the use of a Secchi disk. Water chemistry samples are also collected at multiple depths along the established depth profile: two from the epilimnion, one from the thermocline, and two from the hypolimnion. Samples are analyzed by RCPW for a suite of parameters (Table 2).

> ***Objective:*** *Water quality data collection gives information about the depth at which the thermocline occurs, helps explain when/how the lake turns over throughout the course of the year, identifies differences in water quality in different lake strata, helps define periods of anoxia, and gives a more complete picture of what is happening in the lake when changes to other parts of lake health are observed.*

Table 2: Como Lake water chemistry parameters collected by RCPW (1984-present).

Parameters
Ammonia nitrogen
Chloride
Chlorophyll-a
Nitrate
Organic particulate matter (Station 201 only)
Soluble reactive phosphorus
Total alkalinity
Total Kjeldahl nitrogen
Total particulate matter (Station 201 only)
Total phosphorus
Turbidity

Figure 2: Como Lake Monitoring Locations.

Table 3: Como Lake Monitoring Location Depths.

Station	Latitude	Longitude	Depth	Category
Station 102	44.98257^0	93.14166^0	6 ft	Shallow
Station 201	44.97953^0	93.14070^0	15 ft	Deep
Station 202	44.97833^0	93.13935^0	10 ft	Intermediate

Continuous Hypolimnetic Sonde Sampling

CRWD conducts hypolimnetic continuous monitoring of dissolved oxygen, conductivity, pH, and water temperature through the use of multiparameter sondes deployed from ~April (ice-out) to ~November (ice-in) at Stations 102, 201, and 202 (Figure 2; Table 3). The sondes are attached by a steel cable to a buoy so that the sensors sit 0.5 meters off the bottom of the lake, which is the representative location at which anoxia can be determined by examining dissolved oxygen data at this depth. At each weekly download, profile measurements are taken with the sonde at each of the three stations at 0.5 meter intervals starting at 0.5 meters and going down to the 0.5 meter increment closest to the lake bottom.

> ***Objective:*** *Using this dissolved oxygen data, the duration and aerial extent of anoxia can be calculated during the growing season in order to estimate the contribution of phosphorus to the lake from internal loading.*

Winter Sonde Monitoring and Chloride Sampling

Winter monitoring is done twice per month during the ice on period, generally December to March by CRWD at Station 102, 201, and 202. Depth profile measurements of dissolved oxygen, conductivity, pH, and water temperature are measured at 0.5 meter intervals starting at 0.5 meters and going down to the 0.5 meter increment closest to the lake bottom. At Station 201, hypolimnetic chloride samples are collected from 0.5 meters off the bottom of the lake using a peristaltic pump and analyzed by the Metropolitan Council Environmental Services laboratory.

> ***Objective:*** *These data allow for a better understanding of periods of anoxia during the winter months, a comparison between the measured amount of hypolimnetic chloride and the corresponding conductivity value measured by the sonde, as well as an understanding of how much chloride accumulates in the lake over the winter months in Como Lake.*

Lake Level and Outflow Monitoring

To better understand the hydrology of Como Lake, lake level and outflow are monitored from ~April (ice-out) to ~November (ice-in). Lake level is measured every 15 minutes using a level logger and corresponding staff gauge located on the south end of the lake just west of the fishing pier (Figure 2). Outflow is monitored using a level logger just upstream of the weir in the outlet structure located on the southeast end of the lake (Figure 2).

> ***Objective:*** *These data give continuous lake elevation throughout the course of the monitoring season and also allow the comparison of elevations seasonally and annually. Knowing when and to what extent the lake is flushing through the outlet structure gives a better understand of what could be happening to water quality, etc within the lake.*

2.2.2. Biological Monitoring

Phytoplankton and Zooplankton Monitoring

Phytoplankton and zooplankton data collection occurs at the same time as biweekly water quality data collection by RCPW from ~April to October at Station 201 (Figure 2; Table 2). For phytoplankton analysis, a composite sample is collected using a plastic tube that is inserted vertically 2 meters into the upper layer of the water column. This sample is emptied into a bucket, thoroughly mixed, and a sub-sample is collected and preserved. To collect a zooplankton sample, a net tow is lowered down to the observed thermocline, allowed to settle, then pulled back up to the water surface at a rate of 1 m/sec. The net and capture bucket are drained, the volume is reduced to 100 mL, and the contents of the capture bucket are poured into a sample container and preserved in a 5% formaldehyde solution. Both samples are stored in a cooler and taken back to the RCPW lab for analysis.

> ***Objective:*** *Phytoplankton and zooplankton monitoring allows for an understanding of the types and overall amounts of different species found in the lake and compare how they change over the course of the year and between seasons/years. This knowledge gives a better understanding of how they interact with the other parts of the lake food chain.*

Aquatic Vegetation Monitoring

Point-Intercept Sampling

Como Lake is surveyed by Ramsey County Soil and Water Conservation Division (RCSWCD) for aquatic vegetation presence and abundance using the point-intercept method. This method consists of using a GPS to pre-select specific monitoring points throughout the full area of the lake (Figure 3). At each evenly spaced (70 m distance) point, a double-tined metal rake is thrown out 1 m from the boat, then dragged back towards, and brought back into, the boat. Plant species are identified and given an abundance ranking based on the amount collected on the rake. Surveys occur three times throughout the course of the growing season: spring, summer, and early fall.

> ***Objective:*** *The overall goal of aquatic vegetation point-intercept sampling is to understand the diversity of plants in the lake, identify invasive plant species, compare the abundance rankings of different species over the course of the year and between seasons to evaluate changes in vegetation type, and observe the effect of any management actions to reduce/remove unwanted vegetation.*

Biovolume Analysis

To collect data on submerged aquatic vegetation as well as data about the lake bottom, RCSWCD uses a depth finder to assess the pre-determined points used for the point-intercept method (Figure 3). The sonar log data collected is then analyzed by CI BioBase software to determine the depth of the lake and the amount of aquatic vegetation (biomass) along each transect. These surveys produce information about lake depth, amount of aquatic vegetation, lake area, bathymetry, and lake water volume. The surveys occur alongside the point-intercept surveys in the spring, summer, and early fall.

Objective: *The overall goal of collecting aquatic vegetation biovolume data is to understand where plants grow and at what depths, understand how much plant material grows in different areas of the lake, compare changes in vegetation biomass throughout the course of the year and between seasons, and observe the effect of any management actions to reduce/remove unwanted vegetation.*

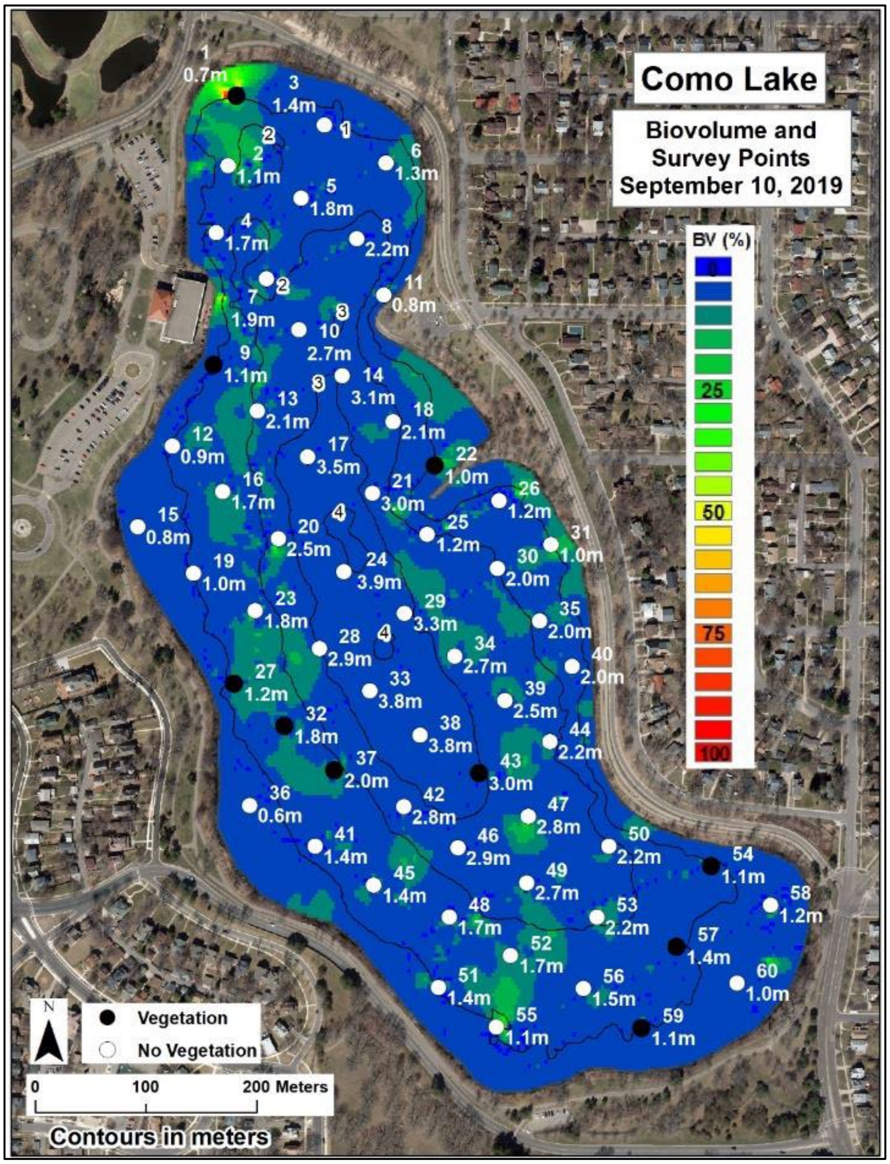

Figure 3: Como Lake biovolume and point-intercept survey points (September 10th, 2019).

Turion Sampling

RCSWCD staff conducted turion sampling on Como Lake in September 2019 following recommendations from the Minnesota DNR in the Como Lake Vegetation Management Plan (2019-2026). Turions are buds of the invasive aquatic plant curly-leaf pondweed that break off the main plant in June and then take seed in the fall to grow new plants under ice over the winter months. Twenty points at depths shallower than 2.5m of the 60 total vegetation sampling points defined for aquatic vegetation monitoring were randomly selected for turion sampling (Figure 4).CLP does not tend to grow at depths beyond 2.5m in Como Lake.

To conduct sampling, an Eckman dredge is lowered to the bottom of the lake where it picks up a sample of the substrate. The volume of sediment is poured into a sieve bucket to drain excess water. The remaining lake sediment is sealed into a gallon plastic bag, labeled with the sample's point source, and taken back to the RCSWCD lab where each sample is analyzed for total turions and partial turions per sampling location. This sampling will be replicated annually as required by the Como Lake DNR Lake Vegetation Management Plan.

> ***Objective:*** *Turion sampling produces prevalence data that, when used in conjunction with data on curly-leaf pondweed abundance, is used to determine treatment locations and evaluate the effectiveness of any treatment that occurs, with the overall goal of reducing the overall amount of curly-leaf in the lake.*

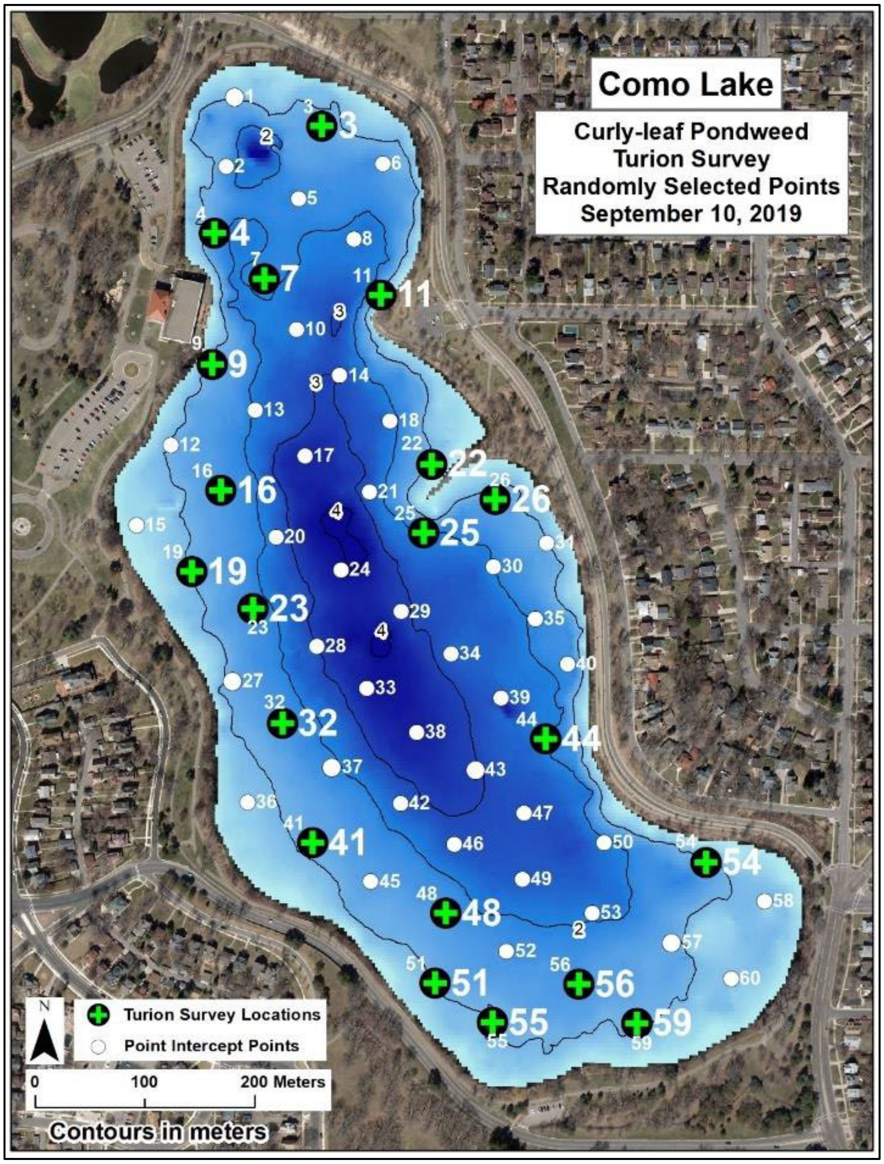

Figure 4: Como Lake turion survey points (September 2019).

Fish Surveys

Fish surveys are conducted every 5 years by the DNR on Como Lake. Through fish surveys, the DNR gains information on the species of fish in a lake to make management decisions and understand changes in lake water quality. Fish are collected using various field techniques based on the type and size of fish to be collected. These survey techniques include: gill netting (to capture larger, predator fish), trap netting (to capture smaller panfish), trawl and shoreline seines (to capture young fish), and electrofishing (to survey for bass, crappies and young walleyes). Once captured, information is recorded on the species, count, weight, and length, as well as how these measures compare to the normal expected range for the species. This information not only gives a good baseline dataset for what kinds of fish are in Como Lake, but can also be compared between years to understand how those populations are changing and what effect annual fish stocking may have on overall fish populations in the lake.

The most recent survey by the DNR on Como Lake occurred in 2016 and consisted of trap and gill netting. Additional supplemental lake surveys have been organized by CRWD to have a larger baseline dataset of fish populations. These additional surveys occurred in 2014 (trap and gill netting), 2015 (trap and gill netting), and 2017 (trap and gill netting; near-shore seining and electrofishing) and could be replicated if warranted in the future.

> ***Objective:*** *Understanding the diversity and quantity of fish populations gives a better understanding of the top level of the lake food chain and its top-down effect on other aquatic animal and plant populations.*

2.2.3. Special Lake Monitoring

Sediment Coring

CRWD with the assistance of Wenck Associates collected sediment cores from two locations (Stations 102 and 201) on Como Lake in February 2016(Figure 2). Three intact cores were collected from each station to determine rates of phosphorus release under aerobic (at Station 102) and anaerobic (at both Station 102 and 201) conditions. Additional sediment cores collected at each station were sectioned vertically to examine differences in physical-textural and chemical characteristics of the sediment.

> ***Objective:*** *These data were collected in order to obtain both aerobic and anaerobic phosphorus release rates for calculating internal loading across the lake area, as well as to understand the characteristics of the sediment for any future in-lake management actions (e.g. alum treatments). This sampling could be replicated in the future as needed.*

Turtle Surveys

During the summer of 2011, the Environment Committee of the District 10 Como Community Council organized a turtle survey of Como lake as part of a larger effort to understand different species' populations in the entire Como Regional Park area. This survey consisted of both a basking study and a trapping study. The basking study consisted of dividing the perimeter of the lake into 13 sections and counting the number of turtles observed in each section during each of 120 samplings day. The trapping study consisted of three, two-week periods where traps were set in three of the 13 sections of the lake denoted in the basking study. The traps were checked and emptied every 48 hours and data was recorded on turtle identification, sex, and carapace length. This study could be replicated in the future as needed.

> ***Objective:*** *Baseline data on turtle populations provides information on the number and types of turtles in the lake, as these are also an important species in the lake's food chain.*

Table 4: In-Lake Monitoring Summary.

Data Type	Frequency of Collection: Winter	Frequency of Collection: Spring	Frequency of Collection: Summer	Frequency of Collection: Fall	Years of Deployment	Annual/Select Years	Collected By	Notes
Chemical/Physical Data Collection	2x/month	2x/month	2x/month	2x/month	1984 - present	Annual	RCPW, CRWD	Depth profile sampling using a sonde (dissolved oxygen, temperature, conductivity and pH) and water quality sampling from the epilimnion, thermocline, and/or hypolimnion. Sampling occurs April - October.
Continuous Hypolimnetic Data Collection	2x/month	15-minute	15-minute	15-minute	2017 - present	Annual	CRWD	Dissolved oxygen, temperature, conductivity, and pH measured from 0.5m off lake bottom at Station 102, 201, and 202. Sampling occurs April - October.
Water Temperature Data Collection	2x/month	15-Minute	15-Minute	15-Minute	1984 - present	Annual	CRWD, RCSWCD	Water temperature collected continuously at 15-minute intervals by CRWD during the open water months. Sampling occurs April - October.
Hypolimnetic Winter Chloride Sampling	2x/month	--	--	--	2018	Annual	CRWD, RCPW	Hypolimnetic winter chloride samples collected from 0.5m off lake bottom at Station 201 using a peristaltic pump. Sampling occurs December - March.
Lake Elevations	--	15-Minute	15-Minute	15-Minute	1978 - present	Annual	CRWD, RCSWCD	Lake elevation collected continuously at 15-minute intervals by CRWD during the open water months. Sampling occurs April - October.
Aquatic Vegetation Point-Intercept Surveys	--	--	3x per summer	--	1986 - present	Annual	RCSWCD	Data collected on species name, depth, % occurrence, and average abundance. Sampling generally occurs May-September.
Aquatic Vegetation Biovolume Analysis	--	--	3x per summer	--	1986 - present	Annual	RCSWCD	A depth finder is used to assess evenly spaced transects and software determines lake depth and vegetation biomass along each transect. Sampling generally occurs May-September and coincides with vegetation point-intercept surveys.
Phytoplankton Data Collection	--	2x/month	2x/month	2x/month	1984 - present	Annual	RCSWCD	A composite sample is collected in the upper 2 meters of the water column using a plastic tube. Coincides with Chemical/Physical data collection at Station 201. Sampling occurs April - October.
Zooplankton Data Collection	--	2x/month	2x/month	2x/month	1984 - present	Annual	RCSWCD	A net tow is lowered down to the thermocline to collect zooplankton samples from the oxygenated layer of the lake. Coincides with Chemical/Physical data collection at Station 201. Sampling occurs April - October.
CLP Turion Sampling	--	--	--	1x per year	2019 - present	2019	CRWD, RCSWCD	Curly-leaf pondweed turion samples collected using an Eckman dredge in accordance with Como Lake DNR Lake Vegetation Management Plan.
Fisheries Survey	--	--	1x per summer in select years	--	1976 - present	1976, 1981, 1986-1991, 1996, 2001, 2006, 2011, 2014-2017	DNR, CRWD, Consultant	Information on species of fish and relative abundances obtained using various field techniques.
Sediment Analysis	1x per winter, select years	--	--	--	2016	2016	CRWD, Consultant	Sediment cores collected from Como Lake to determine rates of phosphorus release to characterize internal loading.
Turtle Surveys	N/A (not routine monitoring)				2011	2011	District 10 Community Council	Conducted as part of a larger project analyzing various species throughout Como Regional Park.

3. Watershed Monitoring

3.1. Monitoring Goals

CRWD began monitoring stormwater runoff in the watershed in 2005 to better understand the types and quantity of pollutants flowing into the lake, as well as the overall quantity of stormflow coming from the surrounding subwatersheds. Because we are unable to monitor all 13 subwatersheds draining to Como Lake, the monitored data from the outlets of three representative subwatersheds are also used for watershed-wide modeling. The monitoring stations of these outlets are monitored for both water quantity and quality and are named Como 7, Como 3, and North Como 3 (Figure 5).

The Como 7 monitoring station was established in 2005 and is located at the outlet of the Como B5 subwatershed, the largest subwatershed (808 acres) in the Como Lake watershed (Figure 5). Land use in this northwest portion of the watershed consists of residential and parkland, as well as runoff from the Como Zoo and a portion of the Como Golf Course.

The Como 3 monitoring station was established in 2009 and is located at the outlet of the Como D subwatershed, the second largest (195 acres) in the Como Lake watershed (Figure 5). Land use in this southwest portion of the watershed consists of industrial, parkland, and residential.

The North Como 3 monitoring station was established in 2018 and is located at the outlet of the Como C subwatershed, the fourth largest (81 acres) in the Como Lake watershed (Figure 5). Land use in this southwest portion of the watershed consists mainly of green space and walkways/parking lots in Como Regional Park. This station was established to gain an understanding of the baseline conditions of stormwater quantity and quality as part of the Como Regional Park Stormwater BMP Feasibility Study prior to any BMPs being built in this subwatershed.

> ***Objective:*** *The overall goal of watershed monitoring in the Como Lake Watershed is to understand the quantity and quality of stormwater entering the lake to understand how this affect's lake water quality, to calculate external loading to the lake, to identify areas for future installments of best management practices, and to inform future management efforts.*

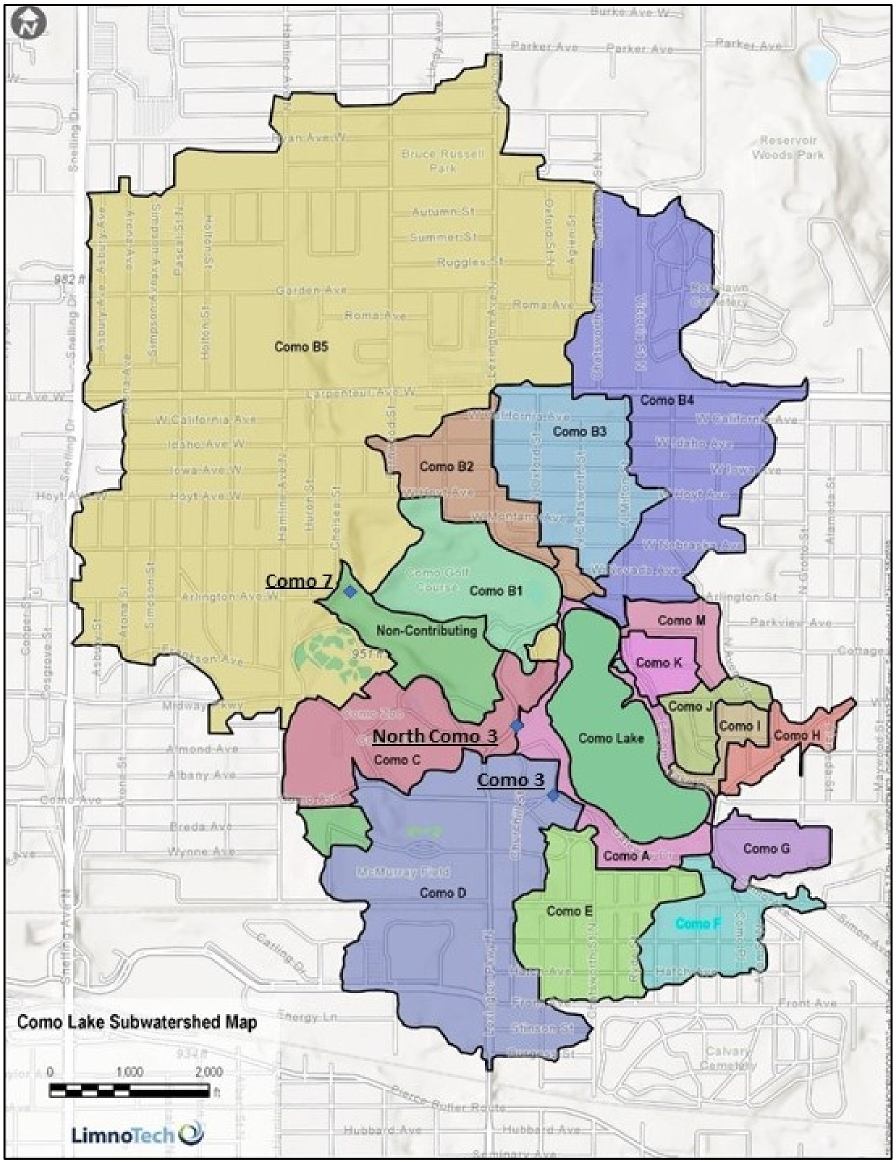

Figure 5: Como Lake Subwatershed Map.

3.2. Watershed Monitoring Methods

3.2.1. Water Quantity

Water quantity is measured at the above three stations using area-velocity sensors that are installed in the center of the pipe and record both water depth and velocity every 5 minutes during storm events. These pipes are dry except under stormflow conditions or other discharges to the system (e.g. sprinkler systems that cause runoff to occur). By relating water depth in the pipe to the area and multiplying by the velocity, discharge can be calculated to understand how much water flows through the pipes and into the lake during storm events. These area-velocity sensors also record data on water temperature. Water quantity monitoring generally occurs from April through October.

Objective: *The goal of water quantity monitoring in subwatershed outlets is to understand how much water enters the lake from the surrounding watershed area.*

3.2.2. Water Quality

Water quality is measured using samples collected during storm events by an automated water sampler. When the flow of water in the pipe reaches a specified depth or velocity trigger, the sampler is engaged to collect water samples until the water falls back below the trigger. The samples are pumped through tubing connected to a sieve attached near the back of the area-velocity sensor in the bottom of the pipe. The collected samples from an entire storm event are combined, mixed, and a single representative sample called a composite sample is obtained. In addition, bacteria grab samples for *Escherichia coli* (*E. coli*) are taken at all three stations during storm events when runoff is generated, and staff are able to visit the stations. These samples are collected by lowering a sterilized sampling bag directly into the flow of stormwater in the pipe and delivered as soon as possible to the Metropolitan Council Environmental Services lab for analysis of a suite of monitoring parameters (Table 5). Storm composite sampling and corresponding storm E. coli grab sampling generally occurs from ~April – October.

In the spring during active snowmelt runoff, grab samples are collected by lowering large grab bottles into the flow of snowmelt and filling a sample container for analysis of a suite of monitoring parameters (Table 5). E. coli grabs are also collected if these can be submitted to the lab within the required timeframe.

Objective: *The overall goal of water quality monitoring is to understand the types and quantity of pollutants entering the lake through stormwater runoff from the surrounding watershed area.*

Table 5: Water quality monitoring parameters.

Parameter
Ammonia nitrogen
BOD (Biological oxygen demand)
Chloride
Hardness
Metals (Copper, Nickel, Lead, Zinc, Cadmium, Chromium)
Nitrate/Nitrite
Ortho-phosphorus
pH
Sulfate
Total dissolved phosphorus
Total dissolved solids
Total Kjeldahl nitrogen
Total phosphorus
Total suspended solids
Volatile suspended solids

Table 6: Watershed Monitoring Summary.

<table>
<tr><th rowspan="2">Station</th><th rowspan="2">Years of Deployment</th><th colspan="3">Water quantity sampling</th><th colspan="3">Water quality sampling</th><th rowspan="2">Additional monitoring</th><th rowspan="2">Collected By</th></tr>
<tr><th>Parameters measured</th><th>~November - March</th><th>~April - October</th><th>Parameters measured</th><th>~November - March</th><th>~April - October</th></tr>
<tr><td>Como 7</td><td>2005 - present</td><td rowspan="3">Level, Velocity, Water temperature</td><td rowspan="3">--</td><td rowspan="3">5-minute data collection frequency during main storm event flow, otherwise 15-minute data collection frequency</td><td rowspan="3">Ammonia nitrogen, BOD, Chloride, E. coli, Hardness, Metals (Copper, Nickel, Lead, Zinc, Cadmium, Chromium), Nitrate/Nitrite, Ortho-phosphorus, pH, Sulfate, Total dissolved phosphorus, Total dissolved solids, Total Kjeldahl nitrogen, Total phosphorus, Total suspended solids, Volatile suspended solids</td><td rowspan="3">Sampling during the winter months only occurs under applicable snowmelt conditions</td><td rowspan="3">Sampling during the field season occurs during applicable runoff events of >0.5" of rainfall</td><td>--</td><td rowspan="3">CRWD</td></tr>
<tr><td>Como 3</td><td>2009 - present</td><td>Continuous conductivity (~March - October)</td></tr>
<tr><td>North Como 3</td><td>2018 - present</td><td>--</td></tr>
</table>