Elm Creek Watershed (Upper Mississippi River Basin)

August 2015 MPCA REVIEW DRAFT

elm creek Watershed Management Commission

Minnesota Pollution Control Agency

CLEAN WATER LAND & LEGACY

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Project Partners

The following organizations and agencies contributed to the development of the Elm Creek Watershed Restoration and Protection Strategies document:

Elm Creek Watershed Management Commission:

- City of Champlin
- City of Corcoran
- City of Dayton
- City of Maple Grove
- City of Medina
- City of Plymouth
- City of Rogers

Hennepin County Environment and Energy Department

Three Rivers Park District

Metropolitan Council Environmental Services

Minnesota Department of Agriculture

Minnesota Department of Natural Resources

Minnesota Department of Transportation

Minnesota Pollution Control Agency

University of Minnesota Extension Services

Wenck Associates, Inc.

*Note Regarding Legislative Charge

The science, analysis and strategy development described in this report began before accountability provisions were added to the Clean Water Legacy Act in 2013 (MS114D); thus, this report does not address all of those provisions. When this watershed is revisited (according to the 10-year cycle), the information will be updated according to the statutorily required elements of a Watershed Restoration and Protection Strategy Report.

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Key Terms

Assessment Unit Identifier (AUID): The unique water body identifier for each river reach comprised of the USGS eight-digit HUC plus a three-character code unique within each HUC.

Aquatic life impairment: The presence and vitality of aquatic life is indicative of the overall water quality of a stream. A stream is considered impaired for impacts to aquatic life if the fish Index of Biotic Integrity (IBI), macroinvertebrate IBI, dissolved oxygen, turbidity, or certain chemical standards are not met.

Aquatic recreation impairment: Streams are considered impaired for impacts to aquatic recreation if fecal bacteria standards are not met. Lakes are considered impaired for impacts to aquatic recreation if total phosphorus, chlorophyll-a, or Secchi disc depth standards are not met.

Hydrologic Unit Code (HUC): A Hydrologic Unit Code (HUC) is assigned by the USGS for each watershed. HUCs are organized in a nested hierarchy by size. For example, the Upper Mississippi-Crow-Rum River Basin is assigned a HUC-4 of 070102 and the Twin Cities Watershed is assigned a HUC-8 of 07010206.

Impairment: Water bodies are listed as impaired if water quality standards are not met for designated uses including: aquatic life, aquatic recreation, and aquatic consumption.

Index of Biotic integrity (IBI): A method for describing water quality using characteristics of aquatic communities, such as the types of fish and invertebrates found in the waterbody. It is expressed as a numerical value between 0 (lowest quality) to 100 (highest quality).

Protection: This term is used to characterize actions taken in watersheds of waters not known to be impaired to maintain conditions and beneficial uses of the waterbodies.

Restoration: This term is used to characterize actions taken in watersheds of impaired waters to improve conditions, eventually to meet water quality standards and achieve beneficial uses of the waterbodies.

Source (or Pollutant Source): This term is distinguished from 'stressor' to mean only those actions, places or entities that deliver/discharge pollutants (e.g., sediment, phosphorus, nitrogen, pathogens).

Stressor (or Biological Stressor): This is a broad term that includes both pollutant sources and non-pollutant sources or factors (e.g., altered hydrology, dams preventing fish passage) that adversely impact aquatic life.

Total Maximum Daily Load (TMDL): A calculation of the maximum amount of a pollutant that may be introduced into a surface water and still ensure that applicable water quality standards for that water are met. A TMDL is the sum of the wasteload allocation for point sources, a load allocation for nonpoint sources and natural background, an allocation for future growth (i.e., reserve capacity), and a margin of safety as defined in the Code of Federal Regulations.

What is the WRAPS Report?

The State of Minnesota has adopted a "watershed approach" to address the state's 81 "major" watersheds (denoted by 8-digit hydrologic unit code or HUC). This watershed approach incorporates **water quality assessment, watershed analysis, civic engagement, planning**, **implementation**, and **measurement of results** into a 10-year cycle that addresses both restoration and protection.

As part of the watershed approach, waters not meeting state standards are still listed as impaired and Total Maximum Daily Load (TMDL) studies are performed, as they have been in the past, but in addition the watershed approach process facilitates a more cost-effective and comprehensive characterization of multiple water bodies and overall watershed health. A key aspect of this effort is to develop and utilize watershed-scale models and other tools to help state agencies, local governments and other watershed stakeholders determine how to best proceed with restoring and protecting lakes and streams. This Watershed Restoration and Protection Strategies (WRAPS) report summarizes past assessment and diagnostic work and outlines ways to prioritize actions and strategies for continued implementation.

Purpose	•Support local working groups and jointly develop scientifically-supported restoration and protection strategies to be used for subsequent implementation planning •Summarize Watershed Approach work done to date including the following reports: •*Elm Creek Watershed Stressor Identification Report - 2015* •*Elm Creek Watershed Total Maximum Daily Load Study - 2015*
Scope	•Impacts to aquatic recreation and impacts to aquatic life in streams •Impacts to aquatic recreation in lakes
Audience	•Local working groups (local governments, SWCDs, watershed management groups, etc.) •State agencies (MPCA, DNR, BWSR, etc.)

1. Watershed Background & Description

The Elm Creek watershed is an 8-digit hydrologic unit (HUC) located in the upper Mississippi River Basin. The watershed is approximately 104 square miles, or about 66,400 acres, in extent and lies in northwestern Hennepin County. The watershed includes parts of seven Twin Cities Metro Area municipalities – Medina, Plymouth, Corcoran, Maple Grove, Rogers, Dayton, and Champlin. The entire watershed is within the North Central Hardwood Forest (NCHF) ecoregion. Surface water flows in the watershed are from south and west to north and east. Based on 2010 land use data, only about 25% of the watershed is developed, and the development is clustered in the eastern part of the watershed and along the Interstate 94 corridor (Figure 1). The remainder of the watershed is predominantly agricultural (32.1%) and undeveloped (27.2%). Most of the rural and agricultural (non-developed) land uses are in the upper reaches of the major stream systems draining the area.

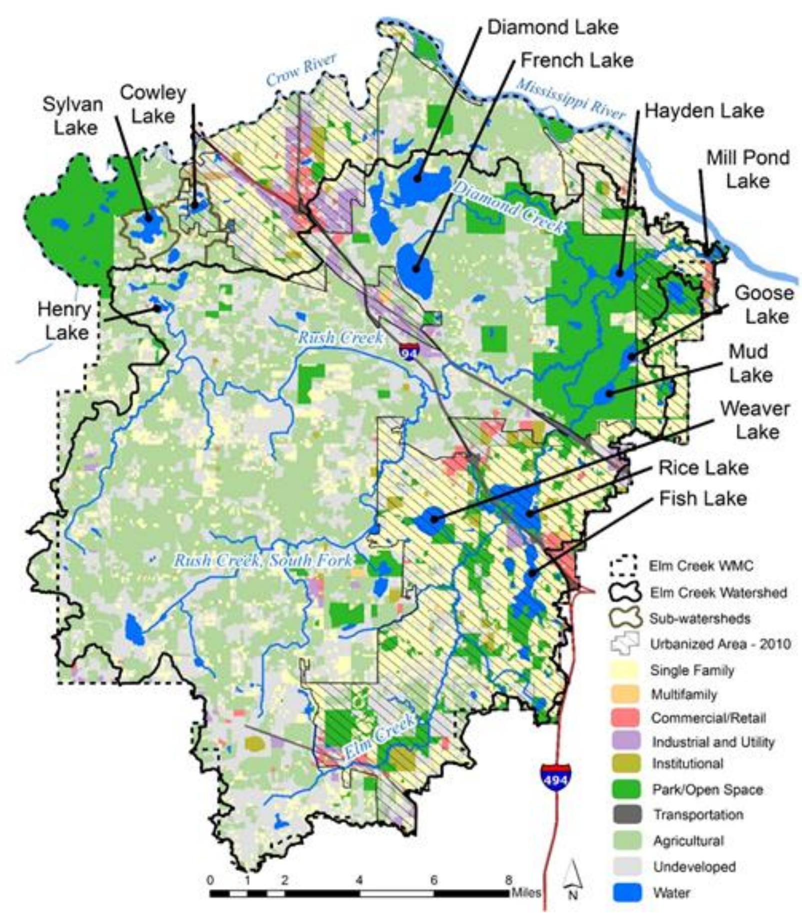


Figure 1. Land cover in the Elm Creek Watershed

Additional Elm Creek Watershed Resources

USDA Natural Resources Conservation Service (NRCS) Rapid Watershed Assessment for the Elm Creek Watershed: [include link to watershed found at: http://www.mn.nrcs.usda.gov/technical/rwa/Assessments/index.html]

Minnesota Department of Natural Resources (DNR) Watershed Assessment Mapbook for the Elm Creek Watershed: [include link to watershed found at: http://www.dnr.state.mn.us/watershed_tool/promo.html]

2. Watershed Conditions

The Elm Creek watershed has a rural and agricultural land use- dominated headwater region that transitions to more suburban/urban land uses in the lower portions of the watershed. Impairments are common throughout the watershed, but the severity of those impairments generally decreases - especially in the stream systems - as one moves from upstream to downstream. Fish Lake and Weaver Lake in Maple Grove are the only two deep lakes in the watershed. The remaining open water bodies in the watershed are either shallow lakes or wetlands. In most cases, these shallow water bodies are moderately to severely degraded. Figure 2 shows the impaired and unimpaired lakes in the watershed as well as the stream reaches that are listed as impaired. Note that the eight digit HUC prefix for all stream AUIDs shown in Figure 2 is 07010206.

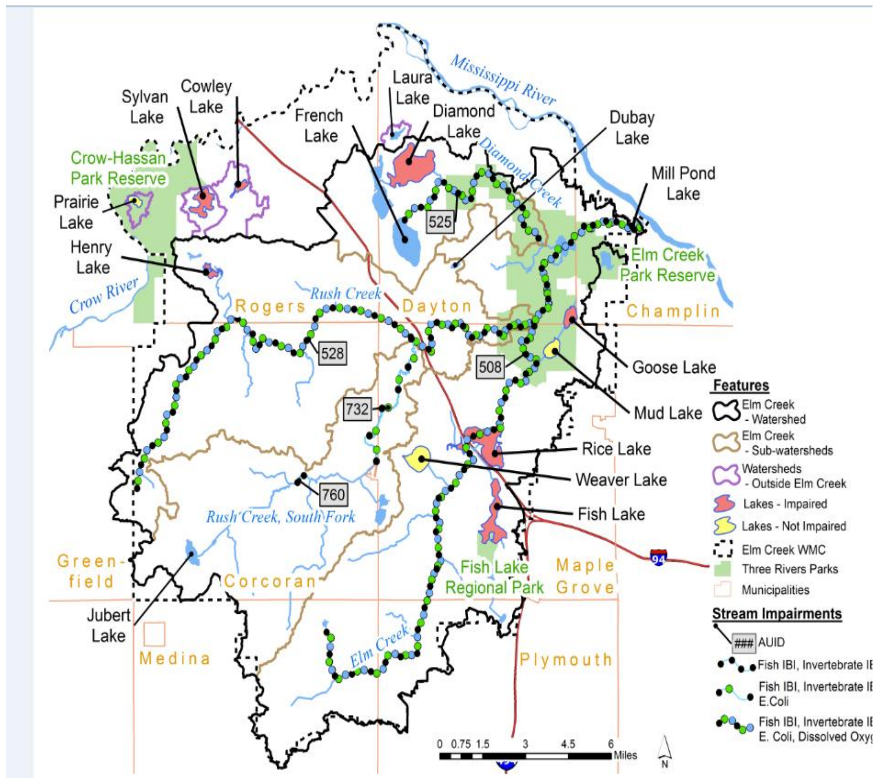


Figure 2. Impaired lakes and stream reaches in the Elm Creek watershed

Not all of the lakes and stream segments (referred to as Assessment Unit IDs or AUIDs) in the watershed were assessed due to insufficient data, limited resource waters, or predominantly channelized stream reaches. What is known about the condition of these streams and lakes including associated pollutant sources is summarized in the following sections.

2.1 Condition Status

Stream conditions throughout the watershed were assessed using a range of parameters including fish and invertebrate indices of biotic integrity, *E. coli*, dissolved oxygen (DO), total suspended solids (TSS), and total phosphorus (TP). Water quality measurements were compared to state water quality standards. Stream conditions and impairment assessment for Elm Creek watershed AUID's are summarized in Table 1. In general, stream quality is lowest in the upper reaches of the watershed that are dominated by rural and agricultural land uses and improves somewhat as one moves downstream into the more developed portion of the watershed. The pattern is similar but less well-defined for lakes, with most of the shallow lakes throughout the watershed severely impaired and the deep lakes (both of which are within the developed portion of the watershed) meeting or close to meeting standards. All of the streams and lakes in the Elm Creek watershed that have been placed on the State of Minnesota's 303(d) list have received TMDL allocations which are summarized in Section 2.4 of this report. Some of the waterbodies in the Elm Creek watershed are impaired by mercury; however, this report does not cover toxic pollutants. For more information on mercury impairments see the statewide mercury TMDL at: www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/special-projects/statewide-mercury-tmdl-pollutant-reduction-plan.html.

Streams

Of the 14 stream AUIDs in the Elm Creek watershed, five reaches were assessed for biotic integrity and none were found to fully support aquatic life. All five of the assessed reaches were identified as impaired for both fish and macroinvertebrate IBI. The remaining AUIDs were found to be intermittent streams and/or have insufficient data to determine aquatic life impairment.

The Elm Creek Watershed Management Commission, MPCA, U.S. Geological Survey, Hennepin County, and Three Rivers Park District have conducted periodic and routine sampling for conventional pollutants at various mainstem and tributary monitoring stations throughout the watershed. Through this monitoring, three reaches were found to be impaired for low DO, four for *E. coli* bacteria, and one for high chlorides.

Table 1. Assessment status of stream reaches in the Elm Creek Watershed, presented (mostly) from west to east

HUC-8 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life				Aq Rec
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Chloride	Bacteria

HUC-8 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life				Aq Rec
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Chloride	Bacteria
Upper Mississippi River (7010206)	-760	Rush Creek, S. Fk. (upper)	Un-named ditch to Co. Ditch 16	Imp	Imp	NA	Sup	NA
	-732	Rush Creek. S. Fk. (lower)	Un-named lake to Rush Creek	Imp	Imp	NA	Sup	Imp
	-528	Rush Creek mainstem	Headwaters to Elm Creek	Imp	Imp	Imp	Sup	Imp
	-525	Diamond Creek	Headwaters (French Lake) to Un-named lake	Imp	Imp	Imp	Sup	Imp
	-058	Elm Creek	Headwaters (Lake Medina) to Mississippi River	Imp	Imp	Imp	Imp	Imp

Sup = found to meet the water quality standard, Imp = does not meet the water quality standard and therefore, is impaired, IF = the data collected was insufficient to make a finding, NA = not assessed

Lakes

All thirteen lakes addressed in this report (nine lakes in the Elm Creek hydrologic watershed plus Sylvan, Cowley, Prairie, and Laura which are included in this project, but actually lie in the North Fork Crow River hydrologic watershed) are classified as 2B waters for which aquatic life and recreation are the protected beneficial uses. Minnesota standards for all Class 2 waters states "... there shall be no material increase in undesirable slime growths or aquatic plant including algae." To evaluate whether a lake is in an impaired condition, the MPCA developed "numeric translators" for the narrative standard for purposes of determining which lakes should be included in the section 303(d) list as being impaired for nutrients. The translators established for TP, chlorophyll-a, and water clarity as measured by Secchi depth. Of the lakes in the Elm Creek watershed project area that were assessed, seven were identified as being impaired for nutrients (Table 2).

Table 2 Assessment status of lakes in the Elm Creek/Crow River Watershed

HUC-8 Subwatershed	Lake ID	Lake	Aquatic Recreation
Elm Creek	27-0125	Diamond Lake	Imp
	27-0118	Fish Lake	Imp
	27-0117	Weaver Lake	Sup
	27-0175	Henry Lake	Imp
	27-0116-01	Rice Lake-Main	Imp
	27-0122	Goose Lake	Imp
	27-0112	Mud	Sup
	27-0165	Jubert	IF
	27-0129	Dubay	IF
Crow River	27-0169	Cowley	Imp
	27-0171	Sylvan	Imp
	27-0177	Prairie	Sup
	27-0123	Laura	IF

Imp = impaired for impacts to aquatic recreation, Sup = fully supporting aquatic recreation,
IF = insufficient data to make an assessment

Two other water bodies – Rice Lake (West Basin) and French Lake-were at one time listed as impaired lakes on the state's 303(d) list. However, Rice Lake (West Basin) was removed from the draft 2012 list because it did not meet the definition of a lake based on hydraulic residence time, and French Lake was removed from the list because a review of its morphometric and other characteristics indicated it to be a wetland system rather than a shallow lake.

2.2 Water Quality Trends

Stream and lake data have been collected periodically by various entities throughout the Elm Creek watershed. Intensive lake water quality monitoring was performed in recent years to support the TMDL analysis, but none of the periods of record for any of the lakes is considered sufficient to provide the basis for reliable trend analysis. Similarly, flow and water quality monitoring at over a dozen sites was conducted to support the TMDL analysis for streams. However, the period of record at all but one of those sites extends only as back as far as 2007 and therefore does not provide a sufficient data set for reliable trend analyses. The exception is the data available from the USGS site on lower Elm Creek, located below the junction with Rush Creek but above that with Diamond Creek. This station provides a 36-year period of record for continuous flow and a 27-year period of record for basic water quality data (including total phosphorus and total suspended solids).

Figure 3 and 4 show the flow-weighted mean concentration values during the runoff season (April through October) by year for total phosphorus (TP) and total suspended solids (TSS) at the USGS gaging station on Elm Creek. The period of record for total phosphorus concentration data is 1988–2014, while the period of record for total suspended solids data at the site is 1991-2014. Non- parametric Mann Whitney U tests were run on each data set to detect significant trends in the data. The results indicate no significant trends in flow-weighted mean concentration values for total phosphorus concentration. However, total suspended solid concentrations from 2000 through 2014 were significantly lower (Significance=0.041) compared to concentrations prior to 2000.

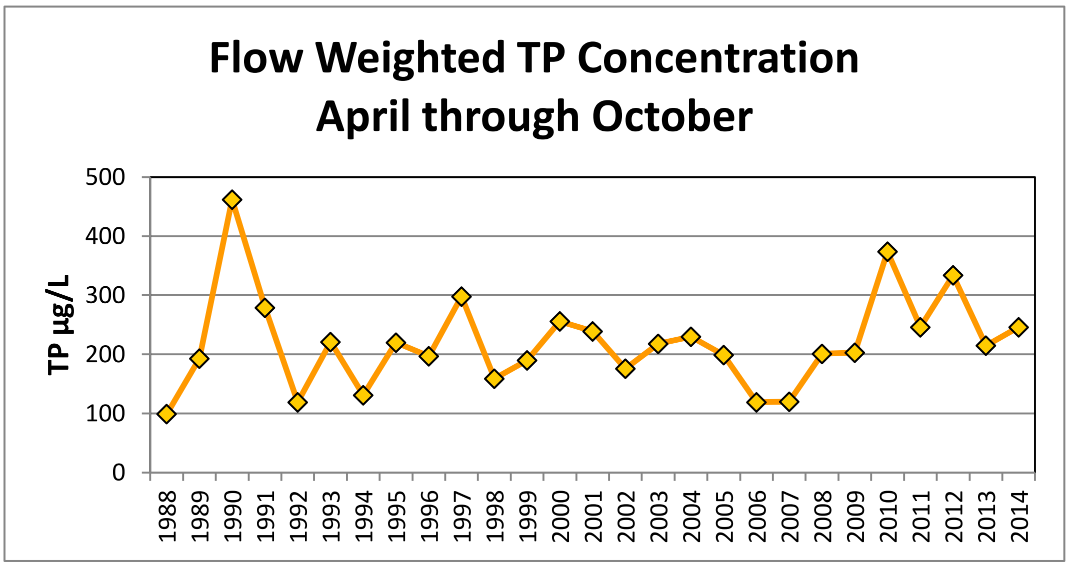


Figure 3. USGS flow weighted total phosphorus (TP) concentration estimated using FLUX analysis for April through October from 1988-2014

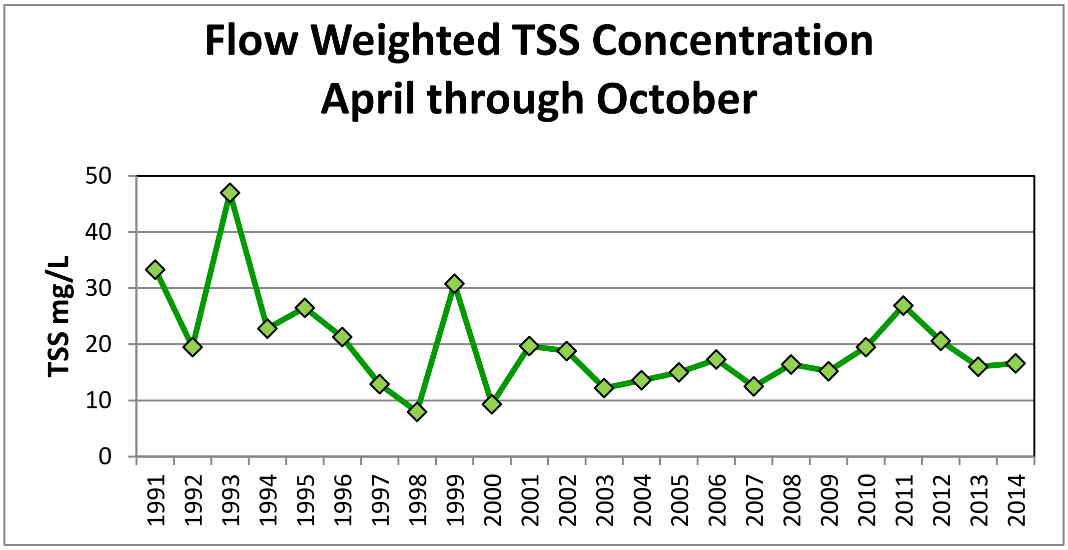


Figure 4. USGS flow weighted total suspended solid (TSS) concentration estimated using FLUX analysis for April through October from 1988-2014

2.3 Stressors and Sources

In order to develop appropriate strategies for restoring or protecting waterbodies the stressors and/or sources impacting or threatening them must be identified and evaluated. Biological stressor identification is done for streams with either fish or macroinvertebrate biota impairments and encompasses both evaluation of pollutants and non-pollutant-related factors as potential stressors (e.g. altered hydrology, fish passage, habitat). Pollutant source assessments are done where a biological stressor ID process identifies a pollutant as a stressor as well as for the typical pollutant impairment listings. Section 3 provides further detail on stressors and pollutant sources.

Stressors of Biologically-Impaired Stream Reaches

There are five stream reaches in the Elm Creek watershed impaired for aquatic life as reflected by the poor biological communities within each reach. In order to identify probably stressors causing these impairments, an intensive evaluation of existing data was conducted by the Elm Creek Watershed Management Commission. The resulting stressor ID report (Lehr 2015) provides the detailed information and weight of evidence to link stressors to the impairments. Potential candidate causes of the impairments that were ruled out based on a review of available data include: pH, water temperature, un-ionized ammonia, organic contaminants, excess nitrate, and heavy metals. Six probable stressors were identified, though the impact of these stressors varies by stream reach. They are: altered hydrology, altered physical habitat, excess sediment, excess phosphorus, low DO, and excess chlorides. Table 3 summarizes the primary stressors for the Elm Creek watershed impaired stream reaches identified in the Elm Creek watershed stressor identification report.

Table 3: Primary stressors to aquatic life in biologically-impaired reaches in the Elm Creek Watershed

HUC-8 Subwatershed	AUID (Last 3)	Stream	Reach Description	Biological Impairment	Primary Stressor					
					Altered Hydrology	Altered Physical Habitat	Excess Sediment	Excess Phosphorus	Low Dissolved Oxygen	Excess Chlorides
7010206 Mississippi River-Twin Cities	508	Elm Creek	Headwaters (Lk Medina 27-0146-00) to Mississippi River	Fish	o	o	o	o	•	/
				Macroinvertebrates	o	o	o	•	o	/
	525	Diamond Creek	Headwaters (French Lk 27-0127-00) to Un-named Lake	Fish	•	•	•	o	•	/
				Macroinvertebrates	o	o	o	•	o	/
	528	Rush Creek, Main Stem	Headwaters to Elm Creek	Fish	•	o	•	o	•	/
				Macroinvertebrates	•	o	•	•	o	/
	732	Rush Creek, South Fork	Un-named lk (27-0439-00) to Rush Creek	Fish	•	•	o	•	•	/
				Macroinvertebrates	•	•	o	•	o	/
	760	Rush Creek, South Fork	Un-named ditch to County Ditch 16	Fish	•	•	•	•	•	/
				Macroinvertebrates	o	•	o	o	•	/

• = Primary Stressor **o** = Secondary Stressor / = Inconclusive Stressor

A brief summary of each of the primary stressors identified in Table 4 is provided below:

Altered Hydrology. This stressor refers to changes in the volume and rate at which water is delivered to the stream channel and conveyed through the system. It also refers to the amount of flow delivered to the stream through groundwater seepage, which helps sustain baseflows in the stream when there is little or no runoff occurring. The Elm Creek system appears to be impacted to various degrees by agricultural and/or urban development and drainage systems which deliver a higher volume of water more rapidly to the stream reaches, creating more rapid and larger changes in flow. In addition, agricultural drainage practices and urban development often decrease the amount of precipitation percolating into the groundwater system, which often decreases the amount of groundwater discharge to the stream to sustain baseflows.

Altered Physical Habitat. Altered hydrologic inputs can also physically change the stream channel. This results in a more uniform cross-section and sediment type, reducing the diversity of stream structure and sediment types available to support a balanced biotic community.

Excess Sediment. Excess sediment, especially fine grained sediment, can fill the cover or void spaces between coarse sediment particles, gravel, etc. These types of habitat are especially valuable for certain types of macroinvertebrates, and can also be prime spawning habitat for some species of fish.

Excess Phosphorus. High phosphorus levels in streams often cause excessive growths of algae and other plants. Because plants use oxygen at night when there is no sunlight, they can reduce the level of dissolved oxygen in the water to levels at which macroinvertebrates and fish are negatively affected. In addition, the periodic die-off of algae and other plants also generates organic material in the system that uses up oxygen when it decomposes.

Low DO. Dissolved oxygen is needed by virtually all macroinvertebrates and fish to survive. Further, macroinvertebrates and fish species typical of higher quality aquatic communities need higher concentrations of oxygen to survive than those of degraded communities.

Pollutant sources

Pollutant sources vary by subwatershed and by stream segment depending on permitted point source dischargers, upstream loading/conditions, near-reach land use and other nonpoint sources throughout the watershed. Potential pollutant sources in the impaired stream/lake watersheds were identified and discussed in the Elm Creek Watershed TMDL (Elm Creek Watershed Management Commission, 2015) and are summarized in Table 4. There are currently nine regulated Small Municipal Storm Sewer System (MS4) General Permit holders (including the road authorities of Hennepin County and MnDOT) in the Elm Creek watershed (Table 5). The Maple Hills Estate Wastewater Treatment Plant (WWTP) is currently the only active wastewater treatment facility in the Elm Creek Watershed (Table 5).

Table 4: Nonpoint Sources in the Elm Creek Watershed project area. Relative magnitudes of contributing sources are

indicated.

HUC-10 Subwatershed	Stream/Reach (AUID) or Lake (ID)	Pollutant	Pollutant Sources										
			Agricultural runoff (from cropland, pasture and/or feedlots)	Livestock overgrazing in riparian	Failing septic systems	Wildlife	Runoff from urban stormwater and/or near-shore dev.	Wetlands	Internal Loading (sediments)	Atmosphere	Point Sources (WWTFs)	Upstream lakes	Streambank/channel
Upper Mississippi River	Rush Creek, S. Fork. (upper) (-760)	TP	●	**O**	○			?					
	Rush Creek, S. Fork. (lower) (-732)	Bacteria	●	**O**	○	○							
		TP	●	**O**	○			?			○		
	Rush Creek Mainstem (-528)	Bacteria	●	**O**	○	○							
		TP	●	**O**	○			?					
	Diamond Creek (-525)	Bacteria	●	**O**	○	○							
		TP	●	**O**	○			?				**O**	
		TSS	**O**	**O**									●
	Elm Creek (-508)	Bacteria	●	**O**	○	○	**O**						
		TP	●	**O**	○		**O**	?					
		TSS	**O**	**O**			**O**						●
		Chloride					●						

Key: ● = High **O** = Moderate ○ = Low ? = present, but contribution to impairment unknown Blank = not a primary source

Table 4 (con't): Nonpoint Sources in the Elm Creek Watershed project area Relative magnitudes of contributing sources are indicated.

HUC-10 Subwater-shed	Stream/Reach (AUID) or Lake (ID)	Pollutant	Pollutant Sources										
			Agricultural runoff (from cropland, pasture and/or feedlots)	Livestock overgrazing in riparian areas	Failing septic systems	Wildlife	Runoff from urban stormwater and/or near-shore dev.	Wetlands	Internal Loading (sediments)	Atmosphere	Point Sources (WWTFs)	Upstream lakes	Streambank/channel
Upper Mississippi River	Fish Lake (27-0118)	TP					**O**		●	○		○	
	Weaver Lake (27-0117)	TP					**O**		**O**	○			
	Henry Lake (27-0175)	TP	●		○				○	○			
	Rice Lake – Main (27-0116-01)	TP	**O**				●		●	○		○	**O**
	Goose Lake (27-0122)	TP					**O**		●	○			
	Diamond Lake (27-0125)	TP	**O**				●		**O**	○			
	Mud Lake (27-0112)	TP					**O**		**O**	○		**O**	
	Jubert Lake (27-0165)	TP	○	?	?				?	○			○
	Dubay Lake (27-0129)	TP	●						?	○			
	Cowley Lake (27-0169)	TP							●	○			
	Sylvan Lake (27-0171)	TP	●	**O**	○				●	○			
	Prairie Lake (27-0177)	TP							○	○			
	Laura Lake (27-0123)	TP	●	?	○				?	○			

Key: ● = High **O** = Moderate ○ = Low ? = present, but contribution to impairment unknown Blank = not a primary source

Table 5. Regulated MS4s and WWTPs in the Elm Creek Watershed project area.

HUC-10 Subwatershed	Point Source			Pollutant reduction needed beyond current permit conditions/limits?	Notes
	Name	Permit #	Type		
7010206- Upper Mississippi River	Maple Hills Estate	MN0031127	Municipal wastewater	Yes	Private wastewater treatment facility located in Corcoran
	City of Champlin	MS400008	Municipal stormwater	Yes	Allocations for reach 508 (*E. coli*, TSS, TP), Goose Lake (TP)
	City of Corcoran	MS400081	Municipal stormwater	Yes	Allocations for reach 732 (*E. coli*, TP), 760 (TP), 528 (*E. coli*, TP), 508 (*E. coli*, TSS, TP), Rice Lake (TP)
	City of Dayton	MS400083	Municipal stormwater	Yes	Allocations for reach 528 (*E. coli*, TP), 525 (*E. coli*, TSS, TP), 508 (*E. coli*, TSS, TP), Diamond Lake (TP), Goose Lake (TP)
	Hennepin County	MS400138	Municipal stormwater	Yes	Allocations for reach 732 (*E. coli*, TP), 528 (*E. coli*, TP), 508 (*E. coli*, TSS, TP), Fish Lake (TP), Rice Lake (TP), Diamond Lake (TP), Goose Lake (TP), Cowley Lake (TP)
	City of Maple Grove	MS400102	Municipal stormwater	Yes	Allocations for reach 732 (*E. coli*, TP), 528 (*E. coli*, TP), 508 (*E. coli*, TSS, TP), Fish Lake (TP), Rice Lake (TP)
	City of Medina	MS400105	Municipal stormwater	Yes	Allocations for reach 732 (*E. coli*, TP), 760 (TP), 508 (*E. coli*, TSS, TP), Rice Lake (TP)
	MNDOT	MS400170	Municipal stormwater	Yes	Allocations for reach 528 (*E. coli*, TP), 508 (*E. coli*, TSS, TP), Fish Lake (TP), Rice Lake (TP), Diamond Lake (TP)
	City of Plymouth	MS400112	Municipal stormwater	Yes	Allocations for reach 508 (*E. coli*, TSS, TP), Fish Lake (TP), Rice Lake (TP)
	City of Rogers	Future MS4	Municipal stormwater	Yes	Allocations for reach 528 (*E. coli*, TP), Diamond Lake (TP), Cowley Lake (TP), Sylvan Lake (TP)

2.4 TMDL Summary

There are seven impaired lakes and five impaired stream reaches that received allocations in the Elm Creek Watershed TMDL study. TMDL allocations and pollutant load reductions from current conditions for each lake and stream reach are summarized in Table 6 and Table 7. Section 3 of this report discusses tools to identify and target the high priority pollutant loading areas and recommended restoration strategies to achieve the reductions required for these impaired lakes and/or stream reaches.

Table 6. Allocations summary for all lake TMDLs in the Elm Creek Watershed.

Major Subwatershed	Lake (ID)	Pollutant	Allocations (lbs/year)								Percent Reduction[1]
			Wasteload Allocation			Load Allocation				MOS	
			WWTPs	Construction & Industrial Stormwater	MS4s	Non-MS4 Watershed Load	Internal Load	Upstream Lakes	Atmosphere	Margin of Safety	
Diamond	Diamond Lake (27-0125)	TP	--	8	406	133	141	--	102	42	72%
Rush	Henry Lake (27-0175)	TP	--	2	0	58	103	_	12	9	81%
S. Fork Rush	Fish Lake (27-0118)	TP	--	21	293	0	1577	--	63	103	14%
	Rice Lake (27-0116)	TP	--	23	576	156	1248	107	82	115	83%
	Goose Lake (27-0122)	TP	--	1	7.4	1	0	--	17	1	81%
North Fork Crow & Mississippi Direct	Sylvan Lake (27-0171)	TP	--	2	25	125	0	--	39	10	84%
	Cowley Lake (27-0169)	TP	--	1	57	24	0	--	9	5	89%

[1] Total percent reduction (all sources) from existing conditions needed to meet TMDL allocations

Table 7. Allocation summary for all stream TMDLs in the Elm Creek watershed project area.

Major Subwatershed	Stream/Reach (AUID)	Pollutant	Flow Zone	*E. coli* allocations (billions org./day) TP & TSS Allocations (lbs/day)						Percent Reduction[1]
				Wasteload Allocation			Load Allocation		MOS	
				WWTPs	Construction & Industrial Stormwater	MS4 Communities	Non-MS4 Watershed Load	Upstream Reach(es)	Margin of Safety	
Diamond	Diamond Creek (528)	*E. coli*	Very High	--	1.15	35.52	36.09	--	3.83	0%
			High	--	0.39	12.19	12.38	--	1.31	0%
			Mid	--	0.15	4.73	4.81	--	0.51	0%
			Low	--	0.06	1.72	1.75	--	0.19	23%
			Very Low	--	0.01	0.37	0.37	--	0.04	0%
		TP	Very High	--	0.20	5.92	3.26	3.35	0.67	64%
			High	--	0.07	2.02	1.12	1.15	0.23	71%
			Mid	--	0.03	0.79	0.43	0.45	0.09	65%
			Low	--	0.01	0.29	0.16	0.16	0.03	66%
			Very Low	--	0.00	0.07	0.03	0.03	0.01	81%
		TSS	Very High	--	60	2561	1199	--	201	0%
			High	--	21	879	411	--	69	30%
			Mid	--	8	341	160	--	27	0%
			Low	--	3	125	58	--	10	0%
			Very Low	--	0.6	26	12	--	2	68%
Rush	Rush Creek (528)	*E. coli*	Very High	0.14	6.85	163.01	266.42	--	22.85	57%
			High	0.14	1.98	47.03	76.86	--	6.60	28%
			Mid	0.14	0.53	12.43	20.34	--	1.75	51%
			Low	0.14	0.07	1.72	2.81	--	.25	66%
			Very Low	0.14	0.00	0.00	0.00	--	0.00	36%
		TP	Very High	0.25	1.20	29.23	44.03	1.27	4.00	79%
			High	0.25	0.35	7.84	12.61	0.37	1.15	76%
			Mid	0.25	0.09	2.15	3.24	0.10	0.31	75%
			Low	0.25	0.01	0.22	0.33	0.01	0.04	81%
			Very Low	0.25	0.00	0.00	0.01	0.00	0.00	93%
South Fork Rush	South Fork Rush Creek (732)	*E. coli*	Very High	0.14	3.29	108.09	96.94	--	10.97	37%
			High	0.14	1.13	36.95	33.14	--	3.76	17%
			Mid	0.14	0.42	13.62	12.22	--	1.39	10%
			Low	0.14	0.14	4.60	4.13	--	0.47	36%
			Very Low	0.14	0.09	3.10	2.78	--	0.32	0%
		TP	Very High	0.25	0.57	16.66	19.22	--	1.92	61%
			High	0.25	0.20	5.55	6.49	--	0.66	77%
			Mid	0.25	0.07	1.98	2.32	--	0.24	81%
			Low	0.25	0.03	0.60	0.70	--	0.08	85%
			Very Low	0.25	0.02	0.36	0.43	--	0.06	66%

Table 7 (con't). Allocation summary for all stream TMDLs in the Elm Creek watershed project area.

Major Subwatershed	Stream/Reach (AUID)	Pollutant	Flow Zone	*E. coli* allocations (billions org./day) TP & TSS Allocations (lbs/day)						Percent Reduction[1]
				Wasteload Allocation			Load Allocation		MOS	
				WWTPs	Construction & Industrial Stormwater	MS4 Communities	Non-MS4 Watershed Load	Upstream Reach(es)	Margin of Safety	
South Fork Rush	South Fork Rush Creek (760)	TP	Very High	--	0.29	3.41	14.50	--	0.96	61%
			High	--	0.10	1.17	4.97	--	0.33	77%
			Mid	--	0.03	0.42	1.82	--	0.12	81%
			Low	--	0.01	0.15	0.63	--	0.04	85%
			Very Low	--	0.01	0.09	0.42	--	0.03	66%
Elm	Elm Creek (508)	*E. coli*	Very High	0.14	5.95	300.33	70.34	--	19.83	19%
			High	0.14	1.86	93.83	21.97	--	6.20	0%
			Mid	0.14	0.51	25.68	6.02	--	1.70	8%
			Low	0.14	0.20	9.90	2.32	--	0.66	25%
			Very Low	0.14	0.09	4.44	1.06	--	0.31	0%
		TSS	Very High	--	453	23687	7279	11690	1511	49%
			High	--	174	4134	3240	3506	582	64%
			Mid	--	81	1690	1325	2004	268	59%
			Low	--	44	1346	1056	345	147	64%
			Very Low	--	29	995	780	45	97	48%
		TP	Very High	0.25	1.51	37.82	35.23	20.79	5.04	77%
			High	0.25	0.58	14.49	13.49	8.00	1.94	71%
			Mid	0.25	0.27	6.64	6.16	3.69	0.90	67%
			Low	0.25	0.15	3.60	3.31	2.02	0.49	64%
			Very Low	0.25	0.09	2.34	2.16	1.34	0.32	53%

[1] Total percent reduction (all sources) from existing conditions needed to meet TMDL allocations

2.5 Protection Considerations and Other Water Bodies

Of the 13 lakes included in this report, seven were assessed by MPCA and determined to be impaired. Of the six remaining lakes, two (Weaver Lake and Mud Lake, both in Maple Grove) were assessed by MPCA and determined to be unimpaired, and four water bodies (Prairie Lake in Rogers, Jubert Lake in Corcoran, and Laura and Dubay Lakes in Dayton) have not yet been assessed. Figure 2 in Section 2 of this report shows the location of these six lakes. In addition, Appendix A presents key lake and watershed information for the six lakes, Appendix B summarizes the historical water quality data available for each lake, and Appendix C show the boundaries of the watershed for each lake. It should be mentioned that two other water bodies – Rice Lake – West Basin (Maple Grove) and French Lake (Dayton) - were at one time listed as impaired on the state's list of impaired waters. However, Rice Lake-West Basin was removed from the list because it did not meet the definition of a lake based on hydraulic residence time, and French Lake –though an important influence on the quality of the headwaters of Diamond Creek- was removed from the list because a review of its morphology and other characteristics indicated it to be a wetland system.

The narratives below summarize the key considerations in protecting water quality in Weaver and Mud lakes. Specific protection strategies for these lakes are described in the restoration and protection strategies tables presented in Section 3.3.

Weaver Lake (Maple Grove). Key findings pertaining to Weaver Lake are as follows:

- Weaver Lake is 152 acres in area with a maximum depth of 57 feet. It is classified as a deep lake. The area draining to the lake is less than 200 acres of largely suburban land uses located in the City of Maple Grove.
- Historical water quality data indicate that the lake met state water quality standards for deep lakes in the North Central Hardwood Forest ecoregion for all three trophic state parameters (TP, chlorophyll a, and water clarity) between 2005 and 2012, and for TP and water clarity in 2013.
- The lake's small watershed and significant depth, as well as management actions already taken to treat direct runoff to the lake and limit the impact of curly leaf pondweed on water quality appears to have resulted in water quality that largely meets state water quality standards.

Key protection components for Weaver Lake are presented in Table 12.

Mud Lake (Maple Grove). Key findings pertaining to Mud Lake are as follows:

- Mud Lake is 79 acres in area with a maximum depth of about 7 feet. It is classified as a shallow lake. The lake itself is located entirely within Three River Park District's Elm Creek Park Reserve, but the 1,353 acre watershed of the lake includes significant suburban developments in Maple Grove and to a lesser extent in Champlin.
- There are only two years of data on water quality of Mud Lake. The data were collected in 2011 and 2012, and the average condition for the two years of record showed the lake met the chlorophyll a and water clarity standards for shallow lakes and was close to meeting the standard for total phosphorus.
- Goose Lake discharges to Mud Lake, and approximately 22% of Mud Lake's total watershed drains through Goose Lake first. Improving water quality in Goose Lake to achieve the TMDL load reduction goal and meet shallow lake water quality standards will help protect water quality in Mud Lake.

Key protection components for Mud Lake are presented in Table 12.

As mentioned previously in this section, there are four water bodies for which limited information is available but that have not yet been assessed for impairment by MPCA. A summary of what is known about these water bodies and recommendations for their future assessment are outlined below. Specific management and protection strategies for these lakes are listed in the restoration and protection strategies tables in Section 3.3.

Lake Dubay (Dayton). Key findings pertaining to Dubay Lake are as follows:

- Lake Dubay is approximately 15 acres in area with a maximum depth estimated at about 7 feet. No lake bathymetry has been developed for the lake, but it is likely to be classified as a shallow lake. The area currently draining to the lake is less than 40 acres of largely agricultural land (mostly row cropped) located entirely within the City of Dayton. There is no public access to the lake.
- Water quality data from 2012 and 2013 indicates that water quality is exceptional and easily meets state water quality standards for shallow lakes in the North Central Hardwood Forest ecoregion for all three trophic state parameters (total phosphorus, chlorophyll a, and water clarity).

Recommendations for future assessment and management of Dubay Lake are presented in Table 10.

Laura Lake (Dayton). Key findings pertaining to Laura Lake are as follows:

- Laura Lake is about 35 acres in area. No lake bathymetry data has been collected for the lake, nor is an estimated maximum depth available for the lake, but the basin size and shape suggest a shallow lake. The area currently draining to the lake is about 140 acres of largely agricultural land (mostly row cropped) located entirely within the City of Dayton. There is no public access to the lake.
- Water quality data from 2013 indicates that the June through September mean concentration value for total phosphorus was well above the state standard for shallow lakes, but that chlorophyll a and water clarity were both better than the state standard.

Recommendations for future assessment and management of Laura Lake are presented in Table 13.

Jubert Lake (Corcoran). Key findings pertaining to Jubert Lake are as follows:

- Jubert Lake is about 64 acres in area, with a maximum depth of 41 feet. About 76% of the lake is less than 15 feet in depth, and the lake is therefore classified as “deep” with regard to the applicable state water quality standards for eutrophication. The area currently draining to the lake is about 1,900 acres of largely agricultural land (mostly row cropped with some livestock operations) located entirely within the City of Corcoran. The lake is at the headwaters of the South Fork-Rush Creek. There is no public access to the lake.
- The only water quality data for the lake is from 2000. That data indicate that water quality in the lakes is degraded, with measured values for total phosphorus, chlorophyll a, and water clarity all significantly worse than the state standards.
- This lake should be further assessed by obtaining bathymetric information, conduct early and late summer aquatic plant surveys, and initiate in-lake water quality monitoring as the opportunity arises. The data is likely to show that the lake should be listed as impaired, and it is

strongly recommended that the lake have a TMDL prepared and implemented for it, both to improve conditions in the lake itself as well as to help in improving water quality downstream in the South Fork of Rush Creek.

Recommendations for future assessment and management of Jubert Lake are presented in Table 11.

Prairie Lake (Rogers). Key findings pertaining to Prairie Lake are as follows:

- Prairie Lake is about 32 acres in area and has a maximum depth of about 8 feet. It is therefore classified as a shallow lake with respect to state water quality standards for eutrophication. The area currently draining to the lake is about 150 acres of native prairie. The lake and its watershed are entirely located within Three River Park District's Crow Hassan Park Reserve in Rogers. There is no developed public access to the lake.

- Water quality data from 2003, 2011, and 2012 indicates that the lake is of exceptional quality from both a water quality and ecological standpoint. The lake easily meets state water quality standards for shallow lakes in the North Central Hardwood Forest ecoregion for all three trophic state parameters (total phosphorus, chlorophyll a, and water clarity).

- Because the lake and its entire watershed are within Crow Hassan Park Reserve, they will be permanently protected from urban development. As a result, the lake may be of value as a minimally impacted reference system.

Recommendations for future assessment and management of Prairie Lake are presented in Table 13.

Finally, there are a number of water bodies about which little or nothing is known. A partial list of some of these water bodies is included below, including the units of government within which these water bodies are located:

- Scott Lake (Corcoran)
- Lehmans Lake (Champlin/Elm Creek Park Reserve)
- Hayden Lake (Dayton/Elm Creek Park Reserve)
- Meadow Lake (Rogers)
- Grass Lake (Dayton and Rogers)

It appears that many of these water bodies are wetlands and/or rapid flow through systems on major streams. None have credible bathymetry nor in-basin water quality data, both of which are essential to support the assessment and analysis of those systems. As a starting point, this data should be collected as opportunities and funding priorities allow.

3. Prioritizing and Implementing Restoration and Protection

The Clean Water Legacy Act (CWLA) requires that WRAPS reports summarize priority areas for targeting actions to improve water quality, identify point sources and identify nonpoint sources of pollution with sufficient specificity to prioritize and geographically locate watershed restoration and protection actions. In addition, the CWLA requires including an implementation table of strategies and actions that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources.

This section of the report provides the results of such strategy development and prioritization. Because much of the nonpoint source strategies outlined in this section rely on voluntary implementation by landowners, land users and residents of the watershed it is imperative to create social capital (trust, networks, and positive relationships) with those who will be needed to voluntarily implement best management practices. Thus, effective ongoing civic engagement is fully a part of the overall plan for moving forward.

There are issues that are not addressed in the strategies tables, such as limited local capacity, funding, and landowner cooperation that can greatly affect the outcomes of this report. If staff and funding resources are limited or nonexistent in the project area, and/or landowner cooperation cannot be secured to implement improvements, it is likely that the strategies and goals laid out in this report will take longer to achieve, or may not be achieved at all. Much of this work relies on reductions from non-regulated actions in the watershed, and in order to achieve those goals local relationships and trust need to be built where they may not currently exist. Therefore, it is important that as these actions are undertaken, all levels (federal, state, and local governments; non-profits; and landowners) continue to find ways to support local entities and individuals to ensure the waterbodies in the Elm Creek Watershed are restored and protected. If this support does not happen, achieving the TMDL reductions and strategies in this report are very unlikely.

3.1 Targeting of Geographic Areas

Targeting has been used at several scales to help identify priority areas in the Elm Creek Watershed project area. The following discussion begins at the state and basin scale and moves to smaller more focused areas based on the specific tools used for this project.

State and Mississippi Basin Scale

The *Minnesota Nutrient Reduction Strategy* was developed in response to concern about excessive nutrient levels that pose a substantial threat to Minnesota's lakes and rivers, as well as downstream waters including the Great Lakes, Lake Winnipeg, the Mississippi River, and the Gulf of Mexico. In recent decades, nutrient issues downstream of Minnesota have reached critical levels, including the effect of nutrients in the Gulf of Mexico which resulted in a dead zone, eutrophication issues in Lake Winnipeg, and algal blooms in the Great Lakes. Several state-level initiatives and actions highlighted the need for a statewide strategy that ties separate but related activities together to further progress in making nutrient reductions. Minnesota conducted both nitrogen and phosphorus assessments to identify nutrient source contributions. The main nutrient sources to the Mississippi River are phosphorus from agricultural cropland runoff, wastewater, and streambank erosion, and nitrogen from agricultural tile drainage and water leaving cropland via groundwater. The associated Phase I milestones for the Mississippi River basin N and P are 20% and 35% reduction from baseline by 2025 respectively. Additional milestones call for 30% (N) and 45% (P) by 2035 and 45% reduction from baseline in N by 2045. The primary tools the State will use to achieve these reductions are the 10 year cycle of watershed assessments and WRAPS studies to identify high-loading areas and priority management areas; enhanced phosphorus and nitrogen reduction strategies for wastewater effluent; facilitating implementation of agricultural BMPs targeted at increasing fertilizer use efficiency, reducing field erosion, and treating tile drainage water; and continued implementation of the stormwater discharge permitting system for MS4s.

The *Nitrogen in Minnesota Surface Waters Strategy* was developed in response to a concern for human health when elevated nitrogen levels reach drinking water supplies. The 10 mg/l nitrate-N drinking water standard established for surface and groundwater drinking water sources and for cold water streams is exceeded in numerous wells and streams. The purpose of this study was to provide an assessment of the science concerning N in Minnesota waters so that the results could be used for current and future planning efforts, thereby resulting in meaningful goals, priorities, and solutions.

More specifically, the purpose of this project was to characterize N loading to Minnesota's surface waters, and assess conditions, trends, sources, pathways, and potential BMPs to achieve nitrogen reductions in our waters. The nitrogen study contains a spreadsheet tool called the NBMP tool (NBMP is described in more detail in the Nitrogen Study Report Chapter F1).

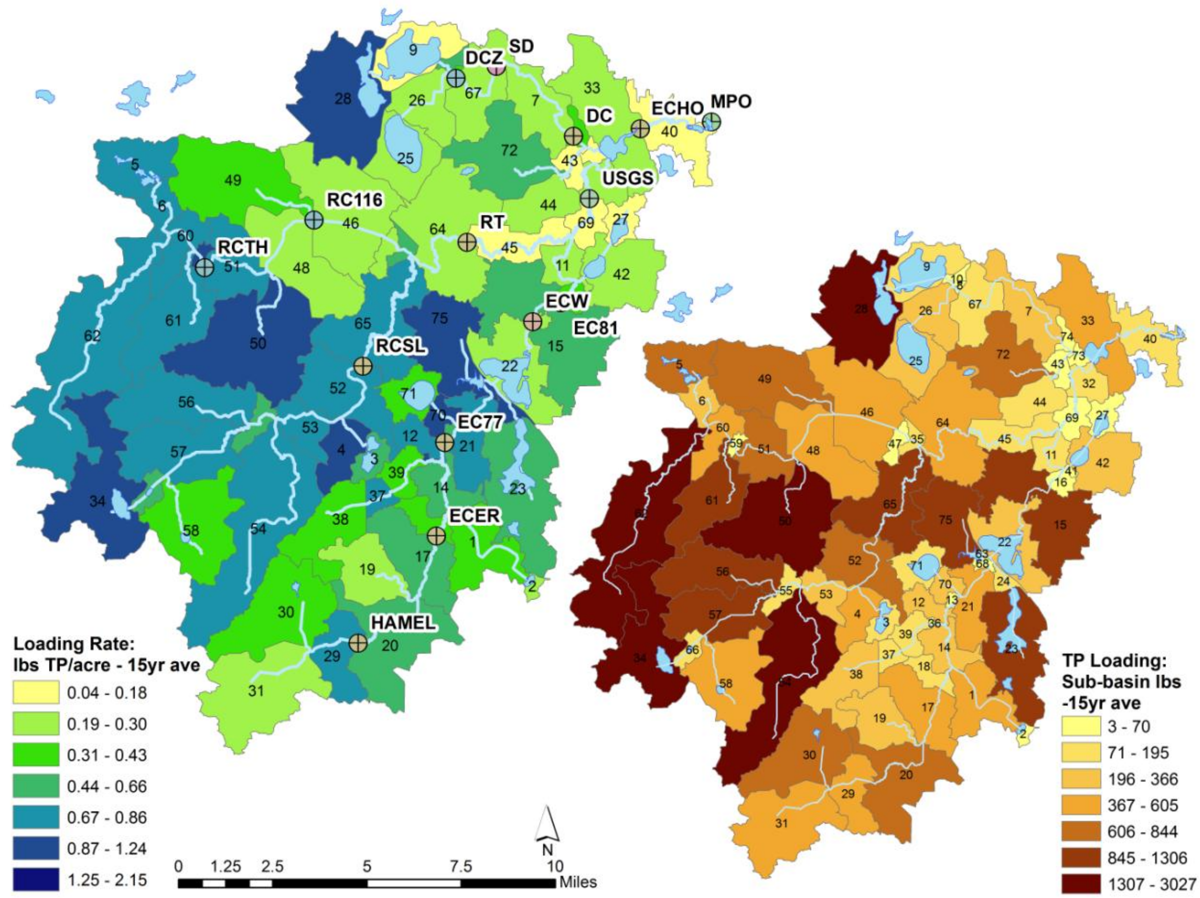
Elm Creek Watershed

Various reports, datasets and GIS tools were developed through the Elm Creek watershed assessment process and the TMDL studies that can be used to identify degraded waterbodies and potential areas to implement restoration and protection strategies. A summary of these resources is presented in the Table 8 below. These resources were developed by various groups and agencies including BSWR, the University of Minnesota Duluth, Minnesota DNR, Three Rivers Park District, and several other agencies. More detailed information on each effort/tool can be obtained from the sources cited in Table 4. It is important to point out that these tools were developed using a wide range of input datasets with different restoration and protection initiatives in mind, ranging from stream shading to sediment and nutrient loading.

A suite of modeling tools was used to support the TMDL development. The Soil and Water Assessment Tool (SWAT) model was chosen as one of the modeling tools to simulate watershed hydrology and water quality to in the Elm Creek watershed. The intended use of the SWAT model was to primarily quantify landscape contributions of water, sediment and nutrients in the Elm Creek Watershed. Landscape loads from SWAT model were then used as an input to other modeling tools (e.g., BATHTUB) to support the simulation of in-stream/in-lake processes in the Elm Creek Watershed.

The SWAT modeling was used to identify subwatersheds that had a higher potential for exporting nutrients and sediment to the downstream resources (Figure 5). The Commission intends to focus its initial implementation efforts in those areas.

Figure 5. Potential TP loading rate by subwatershed as modeled for the TMDLs.



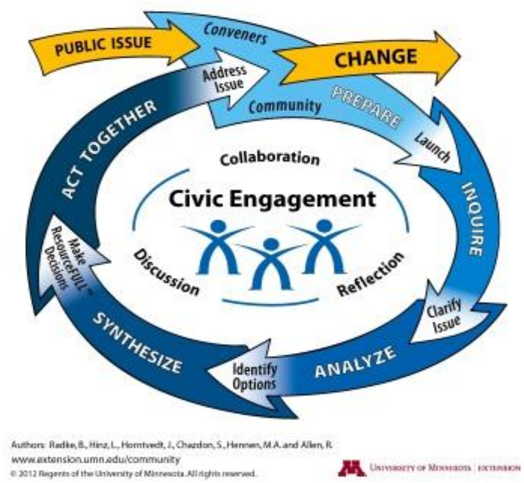
Recently, the Minnesota DNR developed the Watershed Health Assessment Framework (WHAF) which provides a comprehensive overview of the ecological health of Minnesota's watersheds. The WHAF is based on a "whole-system" approach that explores how all parts of the system work together to provide a healthy watershed. The WHAF divides the watershed's ecological processes into five components: biology, connectivity, geomorphology, and hydrology and water quality. A suite of watershed health index scores have been calculated that represent many of the ecological relationships within and between the five components. These scores have been built into a statewide GIS database that is compared across Minnesota to provide a baseline health condition report for each of the 81 major watersheds in the state. The DNR has applied the condition report to larger (HUC-8) watersheds, and more recently has applied the framework at smaller (HUC-12) subwatershed levels. The WHAF may be a helpful resource in monitoring and assessing the health of the watershed as restoration and protection practices are implemented.

Table 8. Prioritization tools.

Tool	Description	How can the tool be used?	Notes	Link to Information and data
Elm Creek SWAT (Soil and Water Assessment Tool) Model	Computer model of watershed processes to show where pollutants originate and which mitigation strategies are most effective	The Elm Creek SWAT model is able to display the phosphorus, sediment and other pollutant export throughout the watershed. The Elm Creek SWAT model was calibrated to observed (monitored) data and can be used to identify pollutant loading hot spots and help determine scenarios for pollution reduction on a subwatershed scale.	The Elm Creek SWAT model was developed for the Elm Creek Watershed TMDL study.	Contact the Three Rivers Park District for SWAT model files and output
Ecological Ranking Tool (Environmental Benefit Index - EBI)	Three GIS layers containing: soil erosion risk, water quality risk, and habitat quality. Locations on each layer are assigned a score from 0-100. The sum of all three layer scores (max of 300) is the EBI score. This higher the score, the higher the value in applying restoration or protection.	Any one of the three layers can be used separately or the sum of the layers (EBI) can be used to identify areas that are in line with local priorities. Raster calculator allows a user to make their own sum of the layers to better reflect local values.	GIS layers are available on the BWSR website.	BWSR
Zonation	A framework and software for large-scale spatial conservation prioritization; it is a decision support tool for conservation planning. This values-based model can be used to identify areas important for protection and restoration.	Zonation produces a hierarchical prioritization of the landscape based on the occurrence levels of features in sites (grid cells). It iteratively removes the least valuable remaining cell, accounting for connectivity and generalized complementarity in the process. The output of Zonation can be imported into GIS software for further analysis. Zonation can be run on very large data sets (with up to ~50 million grid cells).	The software allows balancing of alternative land uses, landscape condition and retention, and feature-specific connectivity responses. (Paul Radomski, DNR, has expertise with this tool.)	CBIG
Restorable Wetland Prioritization Tool	A GIS-based tool developed by the University of Minnesota Duluth and other agencies that uses readily available GIS data consisting of 5 primary layers. The final product is a map showing potential locations for wetland restorations throughout the watershed.	This tool may be used to help identify and prioritize potential wetland restoration areas based on soil type and existing land use.	Hennepin County's Natural Resources Interactive Map also contains "potential" and "probable" wetland locations using similar methods	UMD Hennepin County

Tool	Description	How can the tool be used?	Notes	Link to Information and data
Revised Universal Soil Loss Equation (RUSLE) and Soil Erosion Risk Tool	RUSLE predicts the long term average annual rate of erosion on a field slope based on rainfall pattern, soil type, topography, land use and management practices. A soil erosion risk (similar to RUSLE) tool is available through the Ecological Ranking Tool (EBI) website and uses a subset of RUSLE to determine relative soil erosion risk values on a 0-100 point scale.	The RUSLE model provides an assessment of existing soil loss from upland sources and the potential to assess sediment loading through the application of BMPs. The Soil Erosion Risk Tool provides users with a general sense of the highest potential areas of soil loss in a given watershed/subwatershed.	RUSLE results present maximum amount of soil loss that could be expected under existing conditions and do not represent sediment transport and loading to receiving waters.	RUSLE Soil Erosion Risk Tool
Light Detection and Ranging (LiDAR)	Elevation data in a digital elevation model (DEM) GIS layer. Created from remote sensing technology that uses laser light to detect and measure surface features on the earth.	General mapping and analysis of elevation/terrain. These data have been used for: erosion analysis, water storage and flow analysis, siting and design of BMPs, wetland mapping, and flood control mapping. A specific application of the data set is to delineate small catchments.	The layers are available on the MN Geospatial Information website for most counties.	MGIO

3.2 Civic Engagement



A key prerequisite for successful strategy development and on-the-ground implementation is meaningful civic engagement. This is distinguished from the broader term 'public participation' in that civic engagement encompasses a higher, more interactive level of involvement. Specifically, the University of Minnesota Extension's definition of civic engagement is "Making 'resourceFULL' decisions and taking collective action on public issues through processes that involve public discussion, reflection, and collaboration." A resourceFULL decision is one based on diverse sources of information and supported with buy-in, resources (including human), and competence. Further information on civic engagement is available at: www1.extension.umn.edu/community/civic-engagement/

Accomplishments and Future Plans

A stakeholder participation process was undertaken to obtain input from, review results with, and take comments from the public and interested/affected agencies and local jurisdictions regarding the development and conclusions of the project. The following cities/agencies/interested parties were invited to project meetings and/or received communications regarding the project:

City of Champlin	Hennepin County
City of Corcoran	BWSR
City of Dayton	Met Council Environmental Services
City of Medina	DNR
City of Maple Grove	MnDOT
City of Plymouth	Rice Lake Area Association
City of Rogers	Fish Lake Area Residents Association
Maple Hills Estates	Diamond Lake Association

A Technical Advisory Committee (TAC) comprised of representatives from the cities and agencies listed above was at the core of the public participation process. This group met 14 times between 2011 and December 2014 to review and provide feedback on the technical aspects of the project, including the modeling and technical analysis results, allocation methodologies, and implementation elements. Summaries of each meeting were prepared and distributed to the Elm Creek Watershed Management Commission and all participants, as well as posted on the Commission's web site. All Power Point presentations given at the meetings were posted on the Commission's web site as well.

Project staff also met separately with a number of organizations to explain the purpose of the project, as well as present and discuss project findings, recommendation, and implications. These groups included:

City of Maple Grove Lakes Commission
Rice Lake Area Associations (annual meetings)
Fish Lake Area Residents Associations (annual meetings)
City officials from Dayton and residents around Diamond Lake
City of Champlin Environmental Resources Commission
City of Plymouth Environmental Quality Committee

Finally, a Knowledge, Attitudes, and Practices (KAP) survey was conducted which focused on three agricultural audiences (crop farmers, livestock operators, and horse owners), since the Commission knew relatively little about these stakeholder groups. The methods and results are summarized in Eckman (2013) (Appendix H of the TMDL report).

As part of its 3rd Generation Watershed Management Plan, adopted in 2015 for the period 2015-20125, the Elm Creek Watershed Management Commission has laid out an expanded education and outreach effort. The over-arching goal for this effort is "to educate and engage everyone in the watershed by increasing awareness of water resources, and to create and support advocates willing to protect and preserve the resources in the watershed." Specific priorities include:

- Collaborating with groups such as the West Metro Water Alliance and Blue Thumb to pool education resources to undertake activities in a cost-effective manner and promote consistency in messaging.
- Use the Commission's, member cities', and educational partners' websites and newsletters, social media, co-ops, local newspapers, and cable TV to share useful information with stakeholders on ways to improve water quality.
- Provide opportunities for the public to learn about and participate in water quality activities.
- Provide education opportunities for elected and appointed officials and other decision makers.
- Enhance education opportunities for youth

Specific areas of priority for the period 2015-2017 for education and outreach, organized by stakeholder group, include:

- All stakeholders: Use multiple strategies to deliver simple messages such as "where does our runoff go" and "why are we focused on water quality protection/improvement?"
- Homeowners: Disseminate education materials to all stakeholders about actions they can take to protect and improve water quality, including;
    - Re-directing runoff onto pervious surfaces
    - Cleaning up after pets
    - Keeping organic matter (leaves, grass clippings, seeds, etc.) out of streets, ditches, and storm sewers.

- Lakeshore property owners: Sponsor workshops on the basics of limnology, learning about AIS, and how to undertake lakescaping.
- Elected officials and city staff: Sponsor watershed and water resources training activities such as NEMO (Nonpoint Education for Municipal Officials) for the city councils and planning commissions in the member cities.
- Students: Expand the Watershed PREP fourth-grade program to all elementary schools in the watershed, and begin developing a companion program for older students.
- Agricultural producers and hobbyists: Identify and work with influential persons to spread water quality and BMP messages. Undertake a demonstration project with a co-op.

The Commission intends to budget between $20,000 and $25,000 over the next 5 years to support these and other education and civic engagement initiatives.

3.3 Restoration & Protection Strategies

Specific strategies have been developed and are currently being developed to restore the impaired waters within the Elm Creek watershed and for protecting waters within the watershed that are not impaired. The subwatershed-based implementation strategy tables that follow outline the strategies and actions that are capable of cumulatively achieving the needed pollution load reductions for point and non-point sources, as well as watershed and in-stream improvements to decrease stressors on biological communities throughout the watershed. The tables were developed by reviewing the specific conditions affecting each of the waters and collecting input from the TMDL report and watershed stakeholders. Some of the practices in the restoration and protection strategies tables may be credited as progress toward achieving TMDL WLAs. MS4s and other permitted entities may contact the MPCA to discuss which practices may be credited.

Subwatershed Assessments. The watershed modeling and monitoring completed for the TMDL identified subwatersheds where nutrient and sediment loading potentially occurs at higher rates than average. The Commission will undertake more detailed and systematic subwatershed assessments and modeling to focus load reduction efforts in those high-loading areas where actions such as retrofitting existing ponds with iron-enhanced filter benches, mitigating stream erosion, enhancing stream buffers, improving individual site manure management, or adding new bioinfiltration basins are likely to be most cost-effective.

The subwatershed assessments will identify non-point source problem areas and potential upland BMP projects throughout the various subwatersheds. The in-channel walking surveys/assessments will identify areas of streambank erosion and evaluate riparian vegetation and habitat conditions. Below is a list of the types of urban, rural, and in-channel BMP projects these assessments and surveys will help apply appropriately:

- Tree trenches
- Bioretention/infiltration basins
- Pervious pavement
- Hydrodynamic separators and SAFL Baffles
- Residential raingardens
- Iron enhanced sand filters
- Other stormwater pond retrofits and maintenance
- Conservation and reduced tillage BMPs in sensitive cropland areas
- Water and sediment control basins
- Grassed waterways
- Contour farming
- Stream and edge of field buffers
- Managed livestock access control areas near streams
- Alternative watering sources for livestock
- Pastureland runoff controls/buffers
- Lakeshore restorations
- Tree thinning (in-channel)
- Bank stabilization/restoration
- Re-meandering (in-channel)
- Low-flow channel construction
- Substrate installation (in-channel)
- Fine sediment removal (in-channel)

The Commission will periodically convene an agricultural TAC comprised of federal, state, and local specialists from U of M Extension, Minnesota Department of Agriculture, BWSR, Hennepin County, and other interested parties to craft partnerships in specialized education and other programs and BMPs such as targeted fertilizer application, erosion and sediment control, and manure management. This TAC will also advise the Commission as it completes subwatershed assessments in the agricultural parts of the watershed. The TAC will help identify appropriate implementation actions, and focus their technical expertise and resources on high-loading locations in subwatersheds of focus.

Regulation. The Elm Creek watershed is in land use transition. It is expected that much of the area now in agricultural uses will over the next 10-30 years be converted to suburban and large-lot development. The Commission has enacted more stringent rules and standards for managing runoff rates and volumes and requiring nutrient and sediment load reductions. Developers and redevelopers are now required to infiltrate or abstract 1.1” of runoff from new impervious surface. Where infiltration is not feasible, the new rules require that runoff be filtered before discharge from the site. The rules also establish a performance standard for stormwater quality to achieve a loading reduction as good as or better than that which would be achieved by abstracting 1.1” of runoff depth from new impervious surfaces, or no-net increase in TP or TSS, whichever is lower.

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Table 9. Diamond Creek Subwatershed Restoration and Protection Strategies.

Key for shading: Red = Restoration Strategies; Green = Protection Strategies or Elements for Non-assessed Water bodies

Key for Government Unit Responsibilities: P = Primary/Lead Role; S = Secondary Role; A = Assist as Needed

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see Table 14)	Strategy types and estimated scale of adoption needed to meet final water quality target	Interim 10-yr Milestones	Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
	Waterbody (IDs)	Location and Upstream Influence Counties; Cities and other MS4s		TMDL Baseline Conditions	TMDL Goals / Targets and Estimated % Reduction				Elm Creek WMC	Hennepin County	UMN Extension	MPCA	DNR	MNDOT	MDA	BWSR	NRCS	Three Rivers Park District	City of Dayton	City of Rogers	
Diamond Creek	Diamond Lake (27-0125)	MS4s: Hennepin Co., MNDOT, Dayton, Rogers	Diamond Lake TP	2,871 lbs/yr	832 lbs/yr 73% Reduction	Reduce in-water loading (Lake TP: internal load reduction goal is 630 lbs, 30% of total load reduction goal for lake)	Monitor fish population to determine presence of common carp and other rough fish. Establish removals/barriers as needed	Monitor once every 3-5 years	S				**P**					A	A		2035
							Develop vegetation plan to manage curly-leaf pondweed	Develop plan within 5 years, treat as necessary, monitor annually	S				S						**P**		
							Drawdown and/or internal load (chemical) treatment feasibility studies	Complete studies (5 years), implement findings (10 years)	S				S			S			**P**		
						Improve urban SW mgt. (Lake TP)	Perform urban BMP subwatershed assessment study. Implement 5-10 SW retrofit projects	Complete study (5 years), implement BMPs (10 years)	**P**	S						S		S	S	S	
	Diamond Creek (525)	MS4s: Dayton	Stream *E. coli*	89 – 374 cfu/100ml (monthly geomeans)	0% - 66% reduction depending on month		Implement updated Commission standards for runoff volume and rate control for new development projects throughout watershed	New standards effective January 1, 2015	**P**										**P**	**P**	
						Improve upland/field surface runoff controls (Lake TP, Stream TP/DO, *E. coli*)	Perform rural subwatershed assessments study. Identify and implement 5-10 rural/agricultural BMPs	Implement 1-5 BMPs (5 years), 5-10 BMPs (10 years)	**P**	A	A				A		A	A	S	S	
						Improve fertilizer and manure application mgt. (Lake TP, Stream TP/DO, *E. coli*)	Promote/educate agronomic rates, chemical treatment of manure, and spreading in sensitive areas. Provide resources for soil nutrient testing. Hold 2-5 workshops to engage farmers and provide educational materials	Hold 2-5 workshops and work with 5-10 willing landowners	**P**	**P**	**P**				A	S	A	A	S	S	
			Stream Dissolved Oxygen	Current Phosphorus: 354 µg/L	Phosphorus Goal: 100 µg/L 72% Reduction		Implement non-production animal operation siting and management ordinance as per 2015 approved watershed plan.	Cities adopt ordinance by August 2017	S						S				**P**	**P**	
						Address failing septic systems (Lake TP, Stream TP/DO, E. coli)	Identify and upgrade 100% of the ITPHS systems and systems in the shoreland areas	100% of ITPHS systems upgraded within 10 years		**P**									S	S	
			Stream Fish & Macro IBI	Primary Stressors: Altered Hydrology, Altered Physical Habitat, Excess Sediment, Low DO		Improve riparian vegetation (Stream TP/DO, Stream Biota)	Map and inventory stream buffers on all DNR streams and ditches in watershed	Complete inventory (by July 2016)	S	S			**P**			S		S	S	S	
							Increase riparian buffers and enforce DNR buffer rules on 100% of streams and tributaries.	Buffers in place on public waters by July 2017, on public ditches by November 2018	S	S						A		S	P		

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see Table 14)	Strategy types and estimated scale of adoption needed to meet final water quality target	Interim 10-yr Milestones	Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
	Waterbody (IDs)	Location and Upstream Influence Counties; Cities and other MS4s		TMDL Baseline Conditions	TMDL Goals / Targets and Estimated % Reduction				Elm Creek WMC	Hennepin County	UMN Extension	MPCA	DNR	MNDOT	MDA	BWSR	NRCS	Three Rivers Park District	City of Dayton	City of Rogers	
						Restore/enhance channel (Stream TP/DO, Stream Biota)	Perform stream channel walking survey to identify and implement in-channel BMPs and/or stream corridor baseflow enhancement projects	Complete survey (within 4 years), Complete 2-5 projects within 10 years	**P**	A			S			S		A	A	A	
						Monitor (DO)	Conduct early morning longitudinal DO surveys to determine specific reaches that may be causing low DO in Diamond Creek. Begin developing strategies to restore/improve problem reaches	Conduct surveys within 4 years	**P**	A								A	S		
	Grass Lake (27-0135)	MS4s: Rogers and Dayton	Not assessed, not WQ data	Monitored outflow from lake 302 µg/L (average)	---	Monitor	Collect bathymetry data and monitor water WQ	Monitor as funding and opportunity arises	**P**									A	S	S	
	French Lake (27-0127)	MS4s: Dayton	Not considered a lake by DNR standards	Summer average TP 235 µg/L	--																
	All Streams	MS4s: Hennepin Co., MNDOT, Dayton, Rogers	All Conventional Pollutants																		

Table 10. Rush Creek Subwatershed Restoration and Protection Strategies.

Key for shading: Red = Restoration Strategies; Green = Protection Strategies or Elements for Non-assessed Water bodies

Key for Government Unit Responsibilities: P = Primary/Lead Role; S = Secondary Role; A = Assist as Needed

	Waterbody and Location			Water Quality					Governmental Units with Primary Responsibility														
Major Subwatershed	Waterbody (IDs)	Location and Upstream Influence Counties; Cities and other MS4s	Parameter (incl. non-pollutant stressors)	TMDL Baseline Conditions	TMDL Goals / Targets and Estimated % Reduction	Strategies (see Table 14)	Strategy types and estimated scale of adoption needed to meet final water quality target	Interim 10-yr Milestones	Elm Creek WMC	Hennepin County	UMN Extension	MPCA	DNR	MNDOT	MDA	BWSR	NRCS	Three Rivers Park District	City of Corcoran	City of Dayton	City of Maple Grove	City of Rogers	Estimated Year to Achieve Water Quality Target
Rush Creek	Henry Lake (27-0125)	MS4s: None	Henry Lake TP	908 lbs/yr	183 lbs/yr 80% Reduction	Reduce in-water loading (Lake TP: internal load reduction goal is 103 lbs, 14% of total load reduction goal for lake)	Monitor fish population to determine presence of common carp and other rough fish. Establish removals/barriers as needed	Monitor once every 3-5 years once public access is established	S				**P**									A	2035
							Develop vegetation plan to manage curly-leaf pondweed	Develop plan within 2 years after public access is establsihed, treat as necessary, monitor annually	S				S									**P**	
							Drawdown and/or internal load (chemical) treatment feasibility studies	Complete studies within 4 years after public access is established), implement findings within 8 yrs	S				S			S						**P**	
						Improve urban SW mgt. (All impairments)	Perform urban BMP subwatershed assessment study. Implement SW retrofit projects if appropriate	Complete study (5 years), implement BMPs (10 years)	**P**	A						A			S	S	S	S	
	Rush Creek (528)	MS4s: Corcoran, Dayton, Maple Grove, Rogers, Hennepin County, MNDOT	Stream *E. coli*	30 – 259 cfu/100ml (monthly geomeans)	0% - 57% reduction depending on month		Implement updated Commission standards for runoff volume and rate control for new development projects throughout watershed	New standards effective January 1, 2015	**P**										**P**	**P**	**P**	**P**	
						Improve upland/field surface runoff controls (Lake TP, Stream TP/DO, *E. coli*)	Perform rural subwatershed assessments study. Identify and implement 10-20 rural/agricultural BMPs	Implement 3-5 BMPs (5 years), 10-20 BMPs (10 years)	**P**	A	A				A		A	A				S	
						Improve fertilizer and manure application mgt. (Lake TP, Stream TP/DO, *E. coli*)	Promote/educate agronomic rates, chemical treatment of manure, and spreading in sensitive areas. Provide resources for soil nutrient testing. Hold 2-5 workshops to engage farmers and provide educational materials	Hold 2-5 workshops and work with 5-10 willing landowners	**P**	**P**	**P**				S	S	S		S	S	S	S	
			Stream Dissolved Oxygen	Current Phosphorus: 503 µg/L	Phosphorus Goal: 100 µg/L 80% Reduction		Implement non-production animal operation siting and management ordinance as per 2015 approved watershed plan	Cities adopt ordinance by August 2017	S										**P**	**P**	**P**	**P**	
						Improve livestock mgt. (Lake TP, Stream TP/DO, *E. coli*)	Perform rural subwatershed assessments study. Identify and implement up to 20 livestock/agricultural BMPs	Implement 3-5 BMPs (5 years), 10-20 BMPs (10 years)	**P**	A	A				A		A	A	A	A	A	A	
						Address failing septic systems (Lake TP, Stream TP/DO, *E. coli*)	Identify and upgrade 100% of the ITPHS systems and systems in the shoreland areas	100% of ITPHS systems upgraded within 10 years		**P**									S	S	S	S	
			Stream Fish & Macro IBI	Primary Stressors: Altered Hydrology, Excess Sediment, Low DO		Improve riparian vegetation (Stream	Map and inventory stream buffers on all DNR streams and ditches in watershed	Complete inventory (by July 2016)	S	S			**P**						S	S	S	S	

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see Table 14)	Strategy types and estimated scale of adoption needed to meet final water quality target	Interim 10-yr Milestones	Governmental Units with Primary Responsibility														Estimated Year to Achieve Water Quality Target
	Waterbody (IDs)	Location and Upstream Influence Counties; Cities and other MS4s		TMDL Baseline Conditions	TMDL Goals / Targets and Estimated % Reduction				Elm Creek WMC	Hennepin County	UMN Extension	MPCA	DNR	MNDOT	MDA	BWSR	NRCS	Three Rivers Park District	City of Corcoran	City of Dayton	City of Maple Grove	City of Rogers	
						TP/DO, Stream Biota)	Increase riparian buffers and enforce DNR buffer rules on 100% of streams and tributaries.	Buffers in place on public waters by July 2017, on public ditches by November 2018	S	S								S	P	P	P	P	
						Restore/enhance channel (Stream TP/DO, Stream Biota)	Undertake 1,000 linear foot bank stabilization and erosion control project within Rush Creek reach M downstream of confluence with South Fork Rush Creek. Widen stream along existing alignment, plant native vegetation to prevent erosion.	Complete project within 10 years	S							A		**P**					
							Stabilize and restore approximately 11,000 feet of Rush Creek east of I-94 and west of Fernbook Lane. Restore native vegetation to provide habitat for wildlife, creating natural area for city demonstration	Complete project within 10 years	S							A					**P**		
							Perform stream channel walking survey to identify and implement in-channel BMPs	Complete survey (5 years), Complete 1-5 projects within 10 years	**P**	A								A	S	S	S	S	
						Monitor (DO)	Conduct early morning longitudinal DO surveys to determine specific reaches that may be causing low DO in Rush Creek. Begin developing strategies to restore/improve problem reaches	Conduct survey within 4 years	**P**	A								A	S	S	S	S	
	Lake Dubay (27-0129)	MS4: City of Dayton	None	WQ currently meets state WQ standards	---	Monitor	Obtain bathymetric information, conduct early and late summer aquatic plant surveys, and continue water quality monitoring	Monitor as funding and opportunity arises	**P**									A		S			
						Improve urban SW mgt.	Avoid enlarging the watershed draining to the lake if development occurs in this area of the City of Dayton	Ongoing												**P**			
							Firm application of the Commission's new development standards adopted in 2015 for stormwater management and buffers	New standards effective January 1, 2015	**P**											**P**			
	Meadow Lake (27-0301)	MS4: Rogers	Not assessed, no WQ data	---	---	Monitor	Collect bathymetry data and monitor water WQ	Monitor as funding and opportunity arises	**P**									A				S	
	Stone's Throw Wetland	Corcoran, Rogers	NA	---	---	In-channel restoration (wetland)	Acquire easements and restore 135 acre wetland adjacent to County Ditch #16.	Complete project within 5 years	S	S			S			A			**P**			**P**	

Table 11. South Fork Rush Creek Subwatershed Restoration and Protection Strategies.

Key for shading: Red = Restoration Strategies; Green = Protection Strategies or Elements for Non-assessed Water bodies

Key for Government Unit Responsibilities: P = Primary/Lead Role; S = Secondary Role; A = Assist as Needed

	Waterbody and Location			Water Quality					Governmental Units with Primary Responsibility													
Major Subwatershed	Waterbody (IDs)	**Location** and Upstream Influence Counties; Cities and other MS4s	Parameter (incl. non-pollutant stressors)	TMDL Baseline Conditions	TMDL Goals / Targets and Estimated % Reduction	Strategies (see Table 14)	Strategy types and estimated scale of adoption needed to meet final water quality target	Interim 10-yr Milestones	Elm Creek WMC	Hennepin County	UMN Extension	MPCA	DNR	MNDOT	MDA	BWSR	NRCS	Three Rivers Park District	City of Corcoran	City of Maple Grove	City of Medina	Estimated Year to Achieve Water Quality Target
South Fork Rush Creek	South Fork Rush Creek (732)	MS4s: Corcoran, Maple Grove, Medina, Hennepin County																				2035
			Stream *E. coli* (732)	79 – 342 cfu/100ml (monthly geomeans)	0% - 63% reduction depending on month	Improve urban SW mgt. (All impairments)	Perform urban BMP subwatershed assessment study. Implement 1-4 SW retrofit projects if appropriate	Complete study (5 years), implement BMPs (10 years)	**P**	A						A		A	S	S		
							Implement updated Commission standards for runoff volume and rate control for new development projects throughout watershed	New standards effective January 1, 2015	**P**										**P**	**P**	**P**	
						Improve upland/field surface runoff controls (*E. coli*)	Perform rural subwatershed assessments study. Identify and implement 10-20 rural/agricultural BMPs	Implement 3-5 BMPs (5 years), 10-20 BMPs (10 years)	**P**	A	S					A		A	S	S	S	
						Improve fertilizer and manure application mgt. (*E. coli*)	Promote/educate agronomic rates, chemical treatment of manure, and spreading in sensitive areas. Provide resources for soil nutrient testing. Hold 2-5 workshops to engage farmers and provide educational materials	Hold 2-5 workshops and work with 5-10 willing landowners	**P**	**P**	**P**					S		A	S	S	S	
			Stream Fish and Macro IBI (732)	Primary Stressors: Altered Hydrology, Altered Physical Habitat, Excess Sediment, Excess Phosphorus, Low DO			Implement non-production animal operation siting and management ordinance as per 2015 approved watershed plan	Cities adopt ordinance by August 2017	S	S									**P**	**P**	**P**	
						Address failing septic systems (*E. coli*)	Identify and upgrade 100% of the ITPHS systems and systems in the shoreland areas	100% of ITPHS systems upgraded within 10 years		**P**									S	S	S	
	South Fork Rush Creek (760)	MS4s: Corcoran, Medina, Hennepin County	Stream Fish & Macro IBI (760)	Primary Stressors: Altered Hydrology, Altered Physical Habitat, Excess Sediment, Excess Phosphorus, Low DO		Improve riparian vegetation (Stream Biota)	Map and inventory stream buffers on all DNR streams and ditches in watershed	Complete inventory (by July 2016)	S				**P**									
							Increase riparian buffers and enforce DNR buffer rules on 100% of streams and tributaries.	Buffers in place on public waters by July 2017, on public ditches by November 2018	S	S						A			**P**	**P**	**P**	
						Restore/enhance channel (Stream Biota)	Stabilize and restore approximately 4,500 of Rush Creek north of 101 Avenue, significantly reducing potential for bank erosion and sediment transportation to Elm Creek. Restore native vegetation to provide habitat for wildlife.	Complete project within 10 years.	S	A									P		P	

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see Table 14)	Strategy types and estimated scale of adoption needed to meet final water quality target	Interim 10-yr Milestones	Governmental Units with Primary Responsibility													Estimated Year to Achieve Water Quality Target
	Waterbody (IDs)	**Location** and Upstream Influence Counties; Cities and other MS4s		TMDL Baseline Conditions	TMDL Goals / Targets and Estimated % Reduction				Elm Creek WMC	Hennepin County	UMN Extension	MPCA	DNR	MNDOT	MDA	BWSR	NRCS	Three Rivers Park District	City of Corcoran	City of Maple Grove	City of Medina	
							Perform stream channel walking survey to identify and implement in-channel BMPs and/or stream corridor baseflow enhancement projects	Complete survey (5 years), Complete 2-5 projects within 10 years	**P**	A								A				
						Monitor (DO)	Conduct early morning longitudinal DO surveys to determine specific reaches that may be causing low DO in S. Fork Rush Creek. Begin developing strategies to restore/improve problem reaches	Conduct surveys within 4 years	**P**									A				
	Jubert Lake (27-0135)	MS4s: Corcoran	Not assessed, but likely impaired	No recent monitoring data	---	Monitor	Obtain bathymetric information, conduct early and late summer aquatic plant surveys, and initiate water quality monitoring and assessment.	Monitor as funding and opportunity arises	**P**									A	S			
						Reduce in-water loading	Assess internal loading, initially through collection and analysis of hypolimnetic phosphorus concentrations and dissolved oxygen/temperature profile data, and perhaps later through analysis of intact sediment cores to estimate oxic and anoxic phosphorus release rates	Monitor as funding and opportunity arises	**P**									A	S			
						Improve urban SW mgt.	Avoid enlarging the watershed draining to the lake if development occurs in this area of the City of Dayton	Ongoing	S										**P**			
							Firm application of the Commission's new development standards adopted in 2015 for stormwater management and buffers	New standards effective January 1, 2015	**P**	A									**P**			
	Scott Lake (27-1102)	MS4s: Corcoran	Not assessed, no WQ data	---	---	Monitor	Collect bathymetry data and monitor water WQ	Monitor as funding and opportunity arises	**P**									A	S			
	Wetland DNR# 27-0437	Maple Grove, Corcoran	NA	---	---	In-channel restoration (wetland)	Develop channel protection volume storage, flood storage and associated water quality improvements within wetland complex at Maple Grove/Corcoran boundary by providing extended detention within the storage basin	Complete project within 5 years	S										**P**	**P**		

Table 12. Elm Creek Subwatershed Restoration and Protection Strategies.

Key for shading: Red = Restoration Strategies; Green = Protection Strategies or Elements for Non-assessed Water bodies

Key for Government Unit Responsibilities: P = Primary/Lead Role; S = Secondary Role; A = Assist as Needed

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see Table 14)	Strategy types and estimated scale of adoption needed to meet final water quality target	Interim 10-yr Milestones	Governmental Units with Primary Responsibility																Estimated Year to Achieve Water Quality Target
	Waterbody (IDs)	**Location** and Upstream Influence Counties; Cities and other MS4s		TMDL Baseline Conditions	TMDL Goals / Targets and Estimated % Reduction				Elm Creek WMC	Hennepin County	UMN Extension	MPCA	DNR	MNDOT	MDA	BWSR	NRCS	Three Rivers Park District	City of Champlin	City of Corcoran	City of Dayton	City of Maple Grove	City of Medina	City of Plymouth	
Elm Creek	Fish Lake (27-0118)	MS4s: Maple Grove, Plymouth, Hennepin County, MNDOT	Fish Lake TP	2,261 lbs/yr	2,056 lbs/yr 9% Reduction	Reduce in-lake loading (Rice and Goose Lake TP)	Monitor fish population to determine presence of common carp and other rough fish. Establish removals/barriers as needed	Monitor once every 3-5 years	S				**P**					A				S			2020 for Fish Lake
							Develop vegetation plan to manage curly-leaf pondweed (Rice Lake only)	Develop plan within 2 years, manage as necessary, monitor annually	S													**P**			
							Drawdown and/or internal load (chemical) treatment feasibility studies	Complete studies (1 year for Fish, 3 years for Rice), implement findings (2 years for Fish, 5 years for Rice)	S			S						A				**P**			
	Rice Lake (27-0116)	MS4s: Maple Grove, Plymouth, Medina, Corcoran, Hennepin County, MNDOT	Rice Lake TP	12,551 lbs/yr	2,307 lbs/yr 82% reduction	Improve urban SW mgt. (All impairments)	Perform urban BMP subwatershed assessment study. Implement 10-20 SW retrofit projects	Complete study (3 years), implement BMPs (10 years)	**P**	A									**A**			A	A	A	2035 for Rice Lake, Elm Creek
	Goose Lake (27-0122)	MS4s: Champlin, Dayton, Hennepin County	Goose Lake TP	133 lbs/yr	27 lbs/yr 80% reduction		Implement updated Commission standards for runoff volume and rate control for new development projects throughout watershed	New standards effective January 1, 2015	S										**P**	**P**	**P**	**P**	**P**	**P**	
							Install hydrodynamic separators and SAFL baffles in existing storm sewer circuits in Stonebridge developments (Maple Grove) where construction is not feasible. Will reduce TP loading 50-60%, and TSS loading by 75%-90%.	Complete installations within 5 years	S													P			
						Improve upland/field surface runoff controls (Rice Lake TP, Stream TP/DO, *E. coli*)	Perform rural subwatershed assessments study. Identify and implement 5-10 rural/agricultural BMPs	Implement 1-5 BMPs (5 years), 5-10 BMPs (10 years)	**P**	S	A					A		A	S	A	A	A	S	S	
	Elm Creek (508)	MS4s: Champlin, Corcoran, Dayton, Maple Grove, Medina, Plymouth, Hennepin County, MNDOT	Stream *E. coli*	141 – 263 cfu/100ml (monthly geomeans)	11% - 52% reduction depending on month	Improve fertilizer and manure application mgt. (Rice Lake TP, Stream TP/DO, *E. coli*)	Promote/educate agronomic rates, chemical treatment of manure, and spreading in sensitive areas. Provide resources for soil nutrient testing. Hold 2-4 workshops to engage production and/or hobby farmers and provide educational materials	Hold 2-4 workshops and work with 5-10 willing landowners	**P**	**P**	**P**							S	S	A	A	A	S	S	
			Stream Dissolved Oxygen	Current Phosphorus: 305 μg/L	Phosphorus Goal: 100 μg/L 67% Reduction		Implement non-production animal operation siting and management ordinance as per 2015 approved watershed plan	Cities adopt ordinance by August 2017	S										**P**	**P**	**P**	**P**	**P**	**P**	
						Improve livestock mgt. (Rice Lake TP, Stream TP/DO, *E. coli*)	Perform rural subwatershed assessments study. Identify and implement 5-20 livestock/agricultural BMPs	Implement 1-5 BMPs (5 years), 5-20 BMPs (10 years)	**P**	A	A								S	A	A	S	S	A	

Major Subwatershed	Waterbody and Location: Waterbody (IDs)	Waterbody and Location: **Location** and Upstream Influence Counties; Cities and other MS4s	Parameter (incl. non-pollutant stressors)	Water Quality: TMDL Baseline Conditions	Water Quality: TMDL Goals / Targets and Estimated % Reduction	Strategies (see Table 14)	Strategy types and estimated scale of adoption needed to meet final water quality target	Interim 10-yr Milestones	Elm Creek WMC	Governmental Units with Primary Responsibility: Hennepin County	UMN Extension	MPCA	DNR	MNDOT	MDA	BWSR	NRCS	Three Rivers Park District	City of Champlin	City of Corcoran	City of Dayton	City of Maple Grove	City of Medina	City of Plymouth	Estimated Year to Achieve Water Quality Target
						Address failing septic systems (Rice Lake TP, Stream TP/DO, *E. coli*)	Identify and upgrade 100% of the ITPHS systems and systems in the shoreland areas	100% of ITPHS systems upgraded within 10 years		**P**									S	S	S	S	S	S	
			Stream Fish & Macro IBI	Primary Stressors: Altered Hydrology, Excess Sediment, Low DO		Improve riparian vegetation (Stream TP/DO, Stream Biota)	Map and inventory stream buffers on all DNR streams and ditches in watershed	Complete inventory (by July 2016)	S	S					P				S	S	S	S	S	S	
							Increase riparian buffers and enforce DNR buffer rules on 100% of streams and tributaries.	Buffers in place on public waters by July 2017, on public ditches by November 2018	S	S						A			**P**	**P**	**P**	**P**	**P**	**P**	
						Monitor (DO)	Conduct early morning longitudinal DO surveys to determine specific reaches that may be causing low DO in Elm Creek. Begin developing strategies to restore/improve problem reaches	Conduct surveys within 4 years	P	A									A	S	S	S	S	S	2035
						Restore/enhance channel (Stream TP/DO, Stream Biota)	Undertake 600 linear foot bank stabilization and erosion control project within Elm Creek Reach K. Increase channel area and lower hydraulic shear stress. Increase cross sectional area and meander width, plant disturbed areas with native floodplain forest vegetation to prevent erosion and increase habitat value.	Complete project within 10 years	S	**P**			S									**P**			
							Undertake 1,100 linear foot bank stabilization and erosion control project within Elm Creek Reach O. Construct new channel alignment within floodplain, improve habitat in stream corridor.	Complete project within 10 years	S	A			S					**P**				S			
							Undertake 2,000 linear foot bank stabilization and erosion control project within Elm Creek Reach R. Remove fallen trees to increase channel capacity and reduce bank scour. Reduce channel bank side slopes at existing toe locations, riprap to protect toe of stream bank and native vegetation.	Complete project within 10 years	S	A			S					**P**			S				
							Install rip rap to protect toe of stream bank and native vegetation 3,000 feet from 0.5 mile upstream of Cartway Road to Hayden Lake	Complete project within 10 years	S	A			S					**P**			S				
							Perform stream channel walking survey to identify and implement other in-channel BMPs and/or stream corridor baseflow enhancement projects	Complete survey (4 years), Complete 1-5 projects within 10 years	P	A									A	A	A	A	A	A	

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see Table 14)	Strategy types and estimated scale of adoption needed to meet final water quality target	Interim 10-yr Milestones	Governmental Units with Primary Responsibility																Estimated Year to Achieve Water Quality Target
	Waterbody (IDs)	**Location** and Upstream Influence Counties; Cities and other MS4s		TMDL Baseline Conditions	TMDL Goals / Targets and Estimated % Reduction				Elm Creek WMC	Hennepin County	UMN Extension	MPCA	DNR	MNDOT	MDA	BWSR	NRCS	Three Rivers Park District	City of Champlin	City of Corcoran	City of Dayton	City of Maple Grove	City of Medina	City of Plymouth	
			Stream Chloride (508)			TMDL allocations and reduction strategies have been developed for this reach through the Twin Cities Metropolitan Area Chloride Management Plan. The draft version of this document is available through the MPCA website: http://www.pca.state.mn.us/index.php/view-document.html?gid=22754																			
	Weaver Lake (27-0117)	MS4s: Maple Grove	Not impaired	Summer average TP typically 30 µg/L	Currently meets state standards	Reduce in-water loading	Continue monitoring and management efforts to control curly-leaf pondweed in lake	Continue monitoring and management program	S													**P**			
							Periodically assess internal loading and address through suitable control measures as necessary	Re-assess internal load every 2 years	S													**P**			
						Improve urban SW mgt.	Inventory/assess/maintain key detention basins in watershed – especially the two-cell basin west of lake that receives first-flush diversion runoff	Complete inventory and assessment within 2 years														**P**			
							Initiate intensive street sweeping in the direct drainage of the lake, concentrating first on sweeping every 1-2 weeks of the area in April to remove pollutants that may have accumulated over the winter, in late May and June to remove tree seeds, and in October to remove leaves.	Implement intensive street sweeping program within 5 years	S							S						**P**			
						Monitoring and public outreach	Continue growing season monitoring efforts annually, including monitoring of hypolimnetic phosphorus concentrations and early and late summer aquatic plant surveys.	Monitor annually	S													**P**			
							Implement information, education and outreach effort throughout the watershed to minimize stormwater pollution inputs	2-5 outreach events within 3 years	S		A											**P**			
	Medina (27-0146)	MS4s: Corcoran, Medina	Not considered a lake by DNR standards	---	---																				
	Mud (27-0112)	MS4s: Maple Grove, Champlin	Not impaired	Summer average TP typically 67 µg/L	Currently meets state standards	Improve urban SW mgt.	Work with property owners in the developed portions of the watershed in Maple Grove and Champlin to improve property management practices such as: • Re-directing runoff onto pervious surfaces • Pet waste management • Preventing organic matter (leaves, grass clippings, seeds, etc.) from reaching streets, ditches and storm sewers	Implement 2-5 outreach activities and projects within 3 years	S		A								**P**			**P**			

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see Table 14)	Strategy types and estimated scale of adoption needed to meet final water quality target	Interim 10-yr Milestones	Governmental Units with Primary Responsibility																Estimated Year to Achieve Water Quality Target
	Waterbody (IDs)	**Location** and Upstream Influence Counties; Cities and other MS4s		TMDL Baseline Conditions	TMDL Goals / Targets and Estimated % Reduction				Elm Creek WMC	Hennepin County	UMN Extension	MPCA	DNR	MNDOT	MDA	BWSR	NRCS	Three Rivers Park District	City of Champlin	City of Corcoran	City of Dayton	City of Maple Grove	City of Medina	City of Plymouth	
							Initiate an intensive street cleaning program in areas of the watershed where runoff drains directly to Mud Lake from residential neighborhoods served by curb, gutter and storm sewer	Implement intensive street sweeping program within 5 years	S							S			**P**			**P**			
							Maintain stormwater ponds and help maintain treatment performance	Ongoing maintenance and performance reviews	S										**P**			**P**			
							Pursue BMP retro-fit opportunities in developed portion of the watershed, particularly as art of re-development and street improvement projects to reduce runoff volumes and pollutant loads	Conduct BMP subwatershed assessment within 5 years, Implement projects within 10 years	S	A								A	**P**			**P**			
	Hayden Lake (27-0128)	MS4s: Dayton, Champlin	Not assessed, no WQ data	---	---	Monitor	Collect bathymetry data and monitor water WQ	Monitor as funding and opportunity arises	**P**									A							
	Mill Pond (27-0061)	MS4s: Champlin, Corcoran, Dayton, Maple Grove, Medina, Plymouth, Hennepin County, MNDOT	Not assessed	—	—	In-channel restoration	Implement Elm Creek Dam project to replace the dam and spillway, stabilize streambanks, and provide an emergency Elm Creek bypass, remove accumulated sediment from Mill Pond. It will reduce flood hazards, remove 60 acres from floodplains, improve water quality, provide stabilization for Elm Creek and improve stream/dam access.	Complete project within 3 years	S										**P**						2035

Table 13. North Fork Crow and Mississippi Subwatersheds Restoration and Protection Strategies.

Note: these subwatersheds flow directly to the North Fork Crow River and Mississippi River, but are within Elm Creek WMC's jurisdictional boundary.

Key for shading: Red = Restoration Strategies; Green = Protection Strategies or Elements for Non-assessed Water bodies

Key for Government Unit Responsibilities: P = Primary/Lead Role; S = Secondary Role; A = Assist as Needed

Major Subwatershed	Waterbody and Location: Waterbody (IDs)	Waterbody and Location: **Location** and Upstream Influence Counties; Cities and other MS4s	Parameter (incl. non-pollutant stressors)	Water Quality: TMDL Baseline Conditions	Water Quality: TMDL Goals / Targets and Estimated % Reduction	Strategies (see Table 14)	Strategy types and estimated scale of adoption needed to meet final water quality target	Interim 10-yr Milestones	Elm Creek WMC	Hennepin County	UMN Extension	MPCA	DNR	MNDOT	MDA	BWSR	NRCS	Three Rivers Park District	City of Dayton	City of Rogers	City of Champlin	Estimated Year to Achieve Water Quality Target
North Fork Crow	Sylvan Lake (27-0171)	MS4s: Rogers	Sylvan Lake TP	1,179 lbs/yr	200 lbs/yr 83% Reduction	Reduce in-water loading (Sylvan and Cowley Lake TP)	Monitor fish population to determine presence of common carp and other rough fish. Establish removals/barriers as needed	Monitor once every 3-5 years when/if public access is provided	S				**P**					A		S		2035
							Develop vegetation plan to manage curly-leaf pondweed	Develop plan within 10 years, treat as necessary, monitor annually	S											**P**		
							Drawdown and/or internal load (chemical) treatment feasibility studies	Complete studies (6-8 years), implement findings (10 years)	S									A		**P**		
						Improve urban SW mgt. (Cowley Lake TP)	Implement updated Commission standards for runoff volume and rate control for new development projects throughout watershed	New standards effective January 1, 2015	**P**											**P**		
						Improve upland/field surface runoff controls (Sylvan and Cowley TP)	Perform rural subwatershed assessments study. Identify and implement 1-5 rural/agricultural BMPs	Implement 1-3 BMPs (5 years), 1-5 BMPs (10 years)	**P**	A	A					A				S		
	Cowley Lake (27-0169)	MS4s: Rogers, Hennepin County	Cowley Lake TP	844 lbs/yr	95 lbs/yr 89% reduction	Improve fertilizer and manure application mgt. (Sylvan and Cowley TP)	Promote/educate agronomic rates, chemical treatment of manure, and spreading in sensitive areas. Provide resources for soil nutrient testing. Hold 1-2 workshops to engage farmers and provide educational materials	Hold 1-2 workshops and work with 1-5 willing landowners	**P**	A	A					A				**P**		
							Implement non-production animal operation siting and management ordinance modeled as per 2015 approved watershed plan	City adopts ordinance by August 2017	S											**P**		
						Improve livestock mgt. (Sylvan and Cowley TP)	Perform rural subwatershed assessments study. Identify and implement 1-5 livestock/agricultural BMPs	Implement 1-3 BMPs (5 years), 1-5 BMPs (10 years)	**P**	A						A				S		
						Address failing septic systems (Sylvan and Cowley TP)	Identify and upgrade 100% of the ITPHS systems and systems in the shoreland areas	100% of ITPHS systems upgraded within 10 years	S	**P**										S		
	Prairie Lake (27-0117)	MS4s: None	Not impaired	Summer average TP typically 30 µg/L	Currently meets state standards	Monitor	Conduct early and late summer aquatic plant surveys and continue monitoring WQ	Conduct surveys and monitoring every 2-3 years	**P**									A				

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see Table 14)	Strategy types and estimated scale of adoption needed to meet final water quality target	Interim 10-yr Milestones	Governmental Units with Primary Responsibility													Estimated Year to Achieve Water Quality Target
	Waterbody (IDs)	**Location** and Upstream Influence Counties; Cities and other MS4s		TMDL Baseline Conditions	TMDL Goals / Targets and Estimated % Reduction				Elm Creek WMC	Hennepin County	UMN Extension	MPCA	DNR	MNDOT	MDA	BWSR	NRCS	Three Rivers Park District	City of Dayton	City of Rogers	City of Champlin	
	South Twin Lake (27-0339)	MS4s: None	Not assessed	---	---																	
	Whiteford Lake (27-0172)	MS4s: None	Not assessed	---	---																	
	Laura Lake (27-0123)	MS4s: Dayton	None	WQ currently meets state WQ standards	---	Monitor	Obtain bathymetric information, conduct early and late summer aquatic plant surveys, and continue water quality monitoring	Monitor as funding and opportunity arises	**P**									A				
						Improve urban SW mgt.	Avoid enlarging the watershed draining to the lake if development occurs in this area of the City of Dayton	Ongoing	S										**P**			
							Firm application of the Commission's new development standards adopted in 2015 for stormwater management and buffers	New standards effective January 1, 2015	**P**	A									**P**			
	Lehmans Lake (27-0066)	MS4s: Champlin	Not assessed, no WQ data	---	---	Monitor	Collect bathymetry data and monitor water WQ	Monitor as funding and opportunity arises	**P**									A				
	Fox Creek (07010204-525)	MS4s: Rogers	All Conventional Pollutants	Not Assessed	---	Improve riparian vegetation	Map and inventory stream buffers on all DNR streams and ditches in watershed	Complete inventory (by July 2016)	S	S			**P**						S	S		
							Increase riparian buffers and enforce DNR buffer rules on 100% of streams and tributaries.	Buffers in place on public waters by July 2017, on public ditches by November 2018	S	S						A				**P**	**P**	
						Restore/enhance channel	Provide stabilization and protection along several reaches of streambank at Edison Court, Creekview Drive, and I-94/Hyacinth. Enhance/expand adjacent wetland, reduce sediment transport and provide habitat enhancement and wooded upland protection.	Complete project within 5 years	S				S							**P**		
							Provide stabilization and protection along 600 feet of streambank tributary to Fox Creejk at its headwaters, reducing sediment transport and providing habitat enhancement and wooded upland protection.	Complete project within 5 years	S				S							**P**		
							Perform walking survey of to evaluate streambank erosion, riparian vegetation, habitat conditions, and other problem areas	Complete survey (4 years)	P	A								A		A		

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see Table 14)	Strategy types and estimated scale of adoption needed to meet final water quality target	Interim 10-yr Milestones	Governmental Units with Primary Responsibility													Estimated Year to Achieve Water Quality Target
	Waterbody (IDs)	**Location** and Upstream Influence Counties; Cities and other MS4s		TMDL Baseline Conditions	TMDL Goals / Targets and Estimated % Reduction				Elm Creek WMC	Hennepin County	UMN Extension	MPCA	DNR	MNDOT	MDA	BWSR	NRCS	Three Rivers Park District	City of Dayton	City of Rogers	City of Champlin	
							Target 1-5 priority problem areas identified during walking survey for streambank and/or habitat restoration projects such as tree thinning, bank stabilization, re-meanders, low-flow channel construction, substrate installation, fine sediment removal etc.	Complete 1-5 projects within 10 years	S	**S**						A				P		
Mississippi River	Tributaries	Mississippi Point Park Riverbank Repair in Champlin	NA	NA	NA	Reduce bank/bluff/ravine erosion	Repair and stabilize 500 feet of Mississippi River streambank damaged by recent high waters.	Complete project within 5 years	S	**S**						A					P	

Table 14. Additional restoration and protection strategies to consider, organized by parameter of concern.

Parameter (incl. non-pollutant stressors)	Strategy Key	
	Description	Example BMPs/actions
TSS	Improve upland/field surface runoff controls: Soil and water conservation practices that reduce soil erosion and field runoff, or otherwise minimize sediment from leaving farmland	Cover crops
		Water and sediment basins, terraces
		Rotations including perennials
		Conservation cover easements
		Grassed waterways
		Strategies to reduce flow- some of flow reduction strategies should be targeted to ravine subwatersheds
		Residue management - conservation tillage
		Forage and biomass planting
		Open tile inlet controls - riser pipes, french drains
		Contour farming
		Wetland restoration
		Stripcropping
	Protect/stabilize banks/bluffs: Reduce collapse of bluffs and erosion of streambank by reducing peak river flows and using vegetation to stabilize these areas.	Strategies for altered hydrology (reducing peak flow)
		Streambank stabilization
		Riparian forest buffer
		Livestock exclusion - controlled stream crossings
	Stabilize ravines: Reducing erosion of ravines by dispersing and infiltrating field runoff and increasing vegetative cover near ravines. Also, may include earthwork/regrading and revegetation of ravine.	Field edge buffers, borders, windbreaks and/or filter strips
		Contour farming and contour buffer strips
		Diversions
		Water and sediment control basin
		Terrace
		Conservation crop rotation
		Cover crop
		Residue management - conservation tillage
	Improve forestry management	Proper Water Crossings and road construction
		Forest Roads - Cross-Drainage
		Maintaining and aligning active Forest Roads
		Closure of Inactive Roads & Post-Harvest
		Location & Sizing of Landings
		Riparian Management Zone Widths and/or filter strips
	Improve urban stormwater management [to reduce sediment and flow]	See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Main_Page

Parameter (incl. non-pollutant stressors)	Strategy Key	
	Description	Example BMPs/actions
Nitrogen (TN) or Nitrate	Increase fertilizer and manure efficiency: Adding fertilizer and manure additions at rates and ways that maximize crop uptake while minimizing leaching losses to waters	Nitrogen rates at Maximum Return to Nitrogen (U of MN rec's)
		Timing of application closer to crop use (spring or split applications)
		Nitrification inhibitors
		Manure application based on nutrient testing, calibrated equipment, recommended rates, etc.
	Store and treat tile drainage waters: Managing tile drainage waters so that nitrate can be denitrified or so that water volumes and loads from tile drains are reduced	Saturated buffers
		Restored or constructed wetlands
		Controlled drainage
		Woodchip bioreactors
		Two-stage ditch
	Increase vegetative cover/root duration: Planting crops and vegetation that maximize vegetative cover and capturing of soil nitrate by roots during the spring, summer and fall.	Conservation cover (easements/buffers of native grass & trees, pollinator habitat)
		Perennials grown on marginal lands and riparian lands
		Cover crops
		Rotations that include perennials
Phosphorus (TP)	Improve upland/field surface runoff controls: Soil and water conservation practices that reduce soil erosion and field runoff, or otherwise minimize sediment from leaving farmland	Strategies to reduce sediment from fields (see above - upland field surface runoff)
		Constructed or restored wetlands
		Pasture management
		Restored wetlands
	Reduce bank/bluff/ravine erosion	Strategies to reduce TSS from banks/bluffs/ravines (see above for sediment)
	Increase vegetative cover/root duration: Planting crops and vegetation that maximize vegetative cover and minimize erosion and soil losses to waters, especially during the spring and fall.	Conservation cover (easements/buffers of native grass & trees, pollinator habitat)
		Perennials grown on marginal lands and riparian lands
		Cover crops
		Rotations that include perennials
	Preventing feedlot runoff: Using manure storage, water diversions, reduced lot sizes and vegetative filter strips to reduce open lot phosphorus losses	Open lot runoff management to meet 7020 rules
		Manure storage in ways that prevent runoff
	Improve fertilizer and manure application management: Applying phosphorus fertilizer and manure onto	Soil P testing and applying nutrients on fields needing phosphorus
		Incorporating/injecting nutrients below the soil

Parameter (incl. non-pollutant stressors)	Strategy Key	
	Description	Example BMPs/actions
	soils where it is most needed using techniques which limit exposure of phosphorus to rainfall and runoff.	Manure application meeting all 7020 rule setback requirements
	Address failing septic systems: Fixing septic systems so that on-site sewage is not released to surface waters. Includes straight pipes.	Sewering around lakes
		Eliminating straight pipes, surface seepages
	Reduce in-water loading: Minimizing the internal release of phosphorus within lakes	Rough fish management
		Curly-leaf pondweed management
		Alum treatment
		Lake drawdown
		Hypolimnetic withdrawal
	Improve forestry management	See forest strategies for sediment control
	Reduce Industrial/Municipal wastewater TP	Municipal and industrial treatment of wastewater P
		Upgrades/expansion. Address inflow/infiltration.
	Treat tile drainage waters: Treating tile drainage waters to reduce phosphorus entering water by running water through a medium which captures phosphorus	Bioreactor
	Improve urban stormwater management	See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Main_Page
E. coli	Reducing livestock bacteria in surface runoff: Preventing manure from entering streams by keeping it in storage or below the soil surface and by limiting access of animals to waters.	Strategies to reduce field TSS (applied to manured fields, see above)
		Improved field manure (nutrient) management
		Adhere/increase application setbacks
		Improve feedlot runoff control
		Animal mortality facility
		Manure spreading setbacks and incorporation near wells and sinkholes
		Rotational grazing and livestock exclusion (pasture management)
	Reduce urban bacteria: Limiting exposure of pet or waterfowl waste to rainfall	Pet waste management
		Filter strips and buffers
		See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Main_Page

Parameter (incl. non-pollutant stressors)	Strategy Key	
	Description	Example BMPs/actions
	Address failing septic systems: Fixing septic systems so that on-site sewage is not released to surface waters. Includes straight pipes.	Replace failing septic (SSTS) systems
		Maintain septic (SSTS) systems
	Reduce Industrial/Municipal wastewater bacteria	Reduce straight pipe (untreated) residential discharges
		Reduce WWTP untreated (emergency) releases
Dissolved Oxygen	Reduce phosphorus	See strategies above for reducing phosphorus
	Increase river flow during low flow years	See strategies above for altered hydrology
	In-channel restoration: Actions to address altered portions of streams.	
Chloride	Road salt management	[Strategies currently under development within Twin Cities Metro Area Chloride Management Plan]

4. Monitoring Plan

Progress on the Elm Creek TMDL implementation WRAPS restoration and protection strategies will be measured through regular periodic monitoring of water quality and tracking of the BMP's completed. This will be accomplished through the combined efforts of the organizations receiving allocations as well as the cooperating agencies (notably the Elm Creek Watershed Management Commission and MPCA). The Intensive Watershed Monitoring program conducted by MPCA is expected to provide a large-scale, longer term picture of the degree to which conditions are changing in the Elm Creek watershed. Monitoring by MPCA under this program was last conducted in 2010 and is expected to be undertaken again in 2020 as part of the 10 year monitoring cycle. The Commission adopted a detailed routine monitoring plan as part of its 3rd Generation Watershed Management Plan that includes both routine and as-need monitoring to monitor trends in water quality and to assess progress toward achieving TMDLs.

Lake Monitoring

The Commission's 3rd Generation Watershed Management Plan monitoring plan establishes Sentinel Lakes (Diamond, Fish, Rice, and Weaver Lakes) for annual monitoring due to their visibility and priority as public resources and to represent both deep and shallow lakes, urban and semi-urban. The other impaired lakes (Henry, Goose, Cowley, and Sylvan) and the protection lakes discussed in this report will be monitored at least once every two to three years as access is made available and resources – either through volunteers or under contract with professional staff- are allocated. Lakes are generally monitored for chlorophyll-*a*, total phosphorus, and Secchi disk transparency. Aquatic plant surveys should also be conducted on each lake at approximately five year intervals.

In-lake monitoring will continue as implementation activities are undertaken across the respective watersheds. These monitoring activities will continue until water quality goals are met. Some inflow monitoring has been completed on the inlets to some of the lakes (notably on Elm Creek above Rice Lake) and may be important to continue as implementation activities take place in those subwatersheds.

MDNR will continue to conduct fish surveys on lakes with developed public access (currently Fish Lake and Diamond Lake) as allowed by their regular schedule. Currently, fish surveys are conducted every 5 years.

Stream Monitoring

Stream monitoring in the Elm Creek watershed, which includes Elm Creek, Rush Creek, and Diamond Creek, has been coordinated by the Commission, which partners with the USGS to operate a flow and water quality monitoring station on Elm Creek. The station has a long-term period of record (35+ years) and gauges discharge from about 70 percent of Elm Creek watershed. Other efforts have included those funded by MPCA through a Surface Water Assessment Grant (SWAG) and the TMDL itself to carry out flow and/or water quality monitoring at various sites.

The Commission will continue to partner with the USGS to obtain routine flow and water quality data at the site on Elm Creek. The Commission's 3rd Generation Watershed Management Plan monitoring plan also calls for two additional stream sites per year to be monitored for flow and water quality, rotating among several sites across all four major stream systems so that each site is monitored every two to three years. The Commission will periodically perform longitudinal DO surveys on each DO-impaired stream to better understand DO dynamics in the streams and subreaches and to assess progress toward meeting the state water quality standard of 5 ug/L DO as a daily minimum. In addition, the Commission may from time to time undertake special stream monitoring on other tributaries where necessary, for example to calibrate models or refine subwatershed assessments or to gauge the effectiveness of BMP practices in the watershed.

Stream Biological Monitoring

Biotic communities will continue to be monitored throughout the watershed so that composite metrics can be developed will help determine the need for/effectiveness of stream habitat restoration measures in bringing the watershed into compliance with standards for biota. Fish and macroinvertebrate sampling will be completed every five to ten years during the summer season at each established location until compliance is observed for two consecutive assessments.

Tracking of Best Management Practices

The Elm Creek WMC will work with its member communities to track the number, type, location, load reduction benefits, and costs of BMPs (with an emphasis on structural BMPs) that are implemented in the watershed to address the TMDL and restoration and protection strategies presented in this report. The Commission expects to summarize this information annually and have it available for agencies and interested members of the public.

5. References and Further Information

Eckman, K. 2013. Elm Creek Watershed Management Commission Knowledge, Attitudes, and Practices (KAP) Study Report

Elm Creek Watershed Management Commission. 2015. Elm Creek Watershed TMDL (March 4, 2015 draft report, revised June 5, 2015)

Lehr, R.. 2015. Elm Creek Watershed Stressor Identification Report.

Elm Creek Watershed Reports

All reports referenced in this watershed report are available at the Elm Creek Watershed webpage: *http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/upper-mississippi-river-basin-tmdl/project-elm-creek-watershed-management-organization-watershed-wide-tmdl-protection.html*

Appendix A-Lake and Watershed Information for Non-TMDL Lakes

	Weaver	**Mud**	**Dubay**	**Laura**	**Jubert**	**Prairie**
DNR ID	27-0117	27-0112	27-0129	27-0123	27-0165	27-0177
Surface Area (ac)	152	79	15	35	92	32
Max Depth (ft)	57	7.1	~ 7 (est.)	Unknown	41	8
Mean depth (ft)	21	4.1	Unknown	Unknown	8.4	4.4
Volume (ac-ft)	3152	325	Unknown	Unknown	777	139
Residence Time (yrs)	~ 13	0.51	Unknown	Unknown	Unknown	Unknown
Littoral area (ac)	76	79	15	Unknown	17	32
Littoral area (%)	50%	100%	100%	Unknown	19%	100%
Watershed area (ac)	187	1,353	37	140	1,880	150
Watershed area : lake area ratio	1.2 : 1	17 : 1	2.5 : 1	4 : 1	19 : 1	5 : 1
Municipalities in watershed	Maple Grove	Dayton, Maple Grove, Champlin	Dayton	Dayton	Corcoran	Rogers, Hanover (Entire watershed w/in Crow Hassan Park)
Dominant Watershed Land Use (Existing)	Suburban, park	Suburban, park	Agricultural row crop	Agricultural row crop	Agricultural row crop, livestock	Native prairie

Appendix B-Water Quality Data For Non-TMDL Lakes

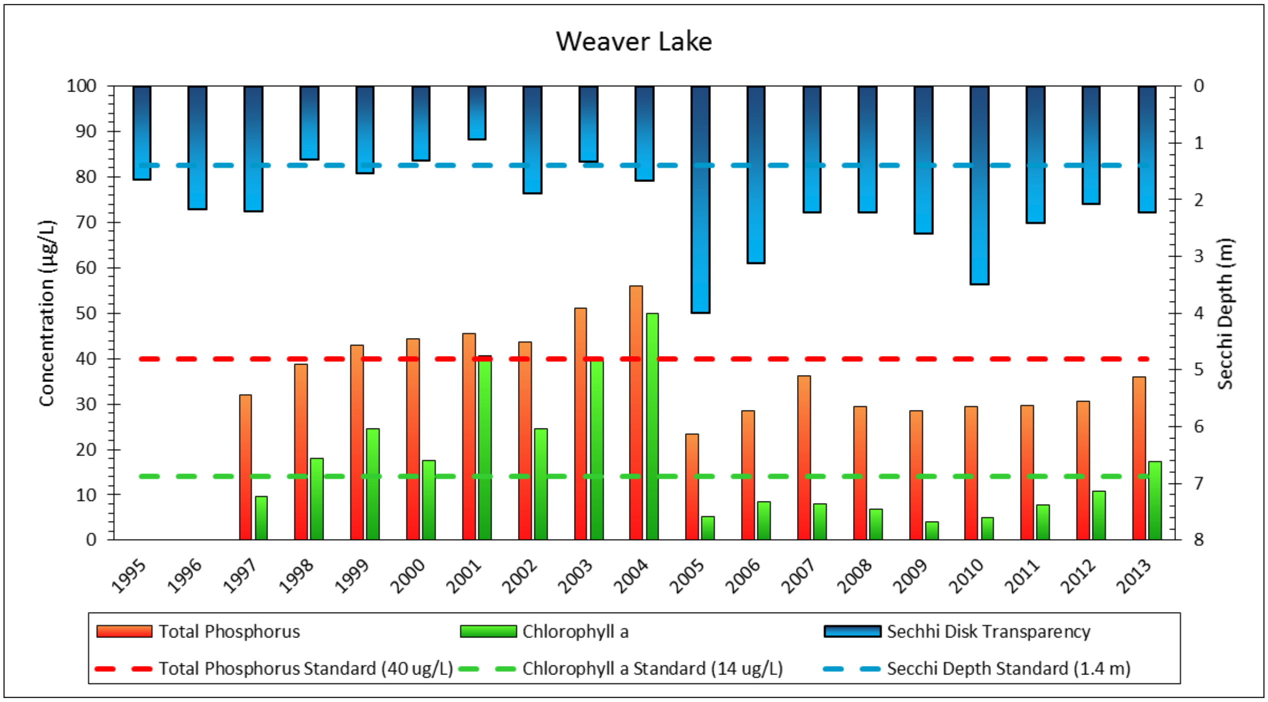

Figure B.1 - Weaver Lake Water Historical Quality Data

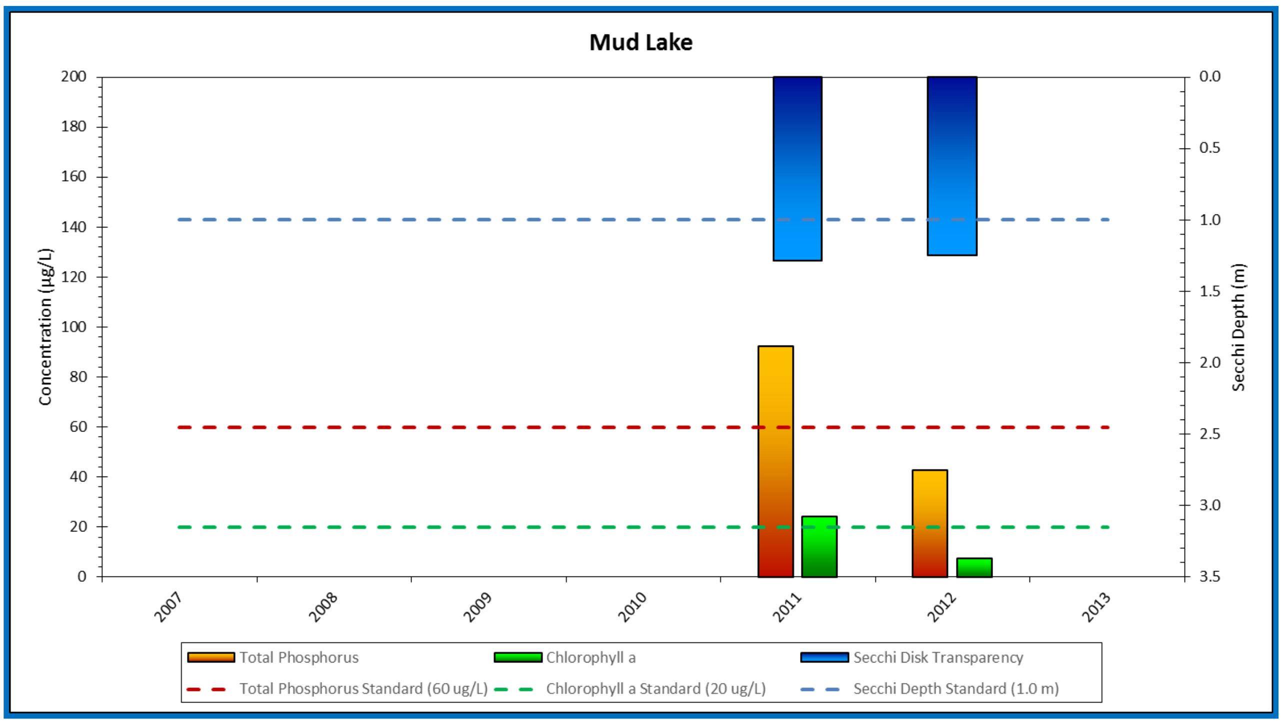

Figure B.2 - Mud Lake Water Historical Quality Data

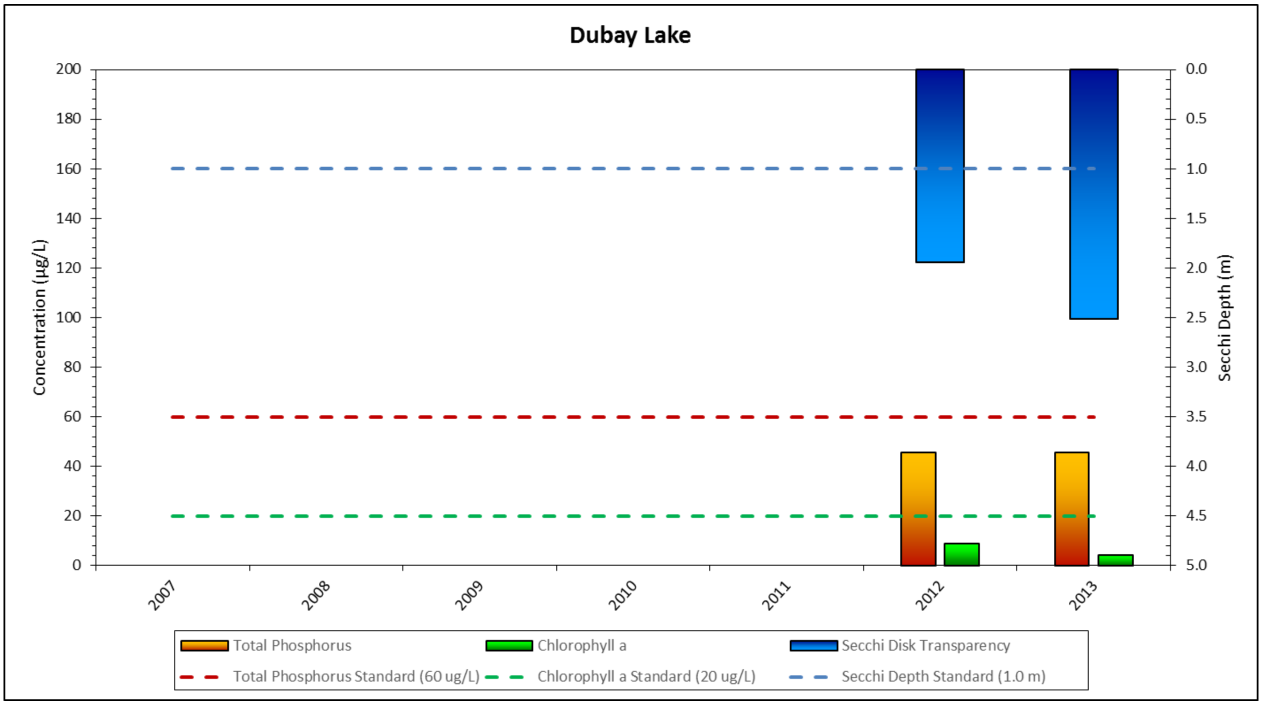

Figure B.3 - Lake Dubay Water Historical Quality Data

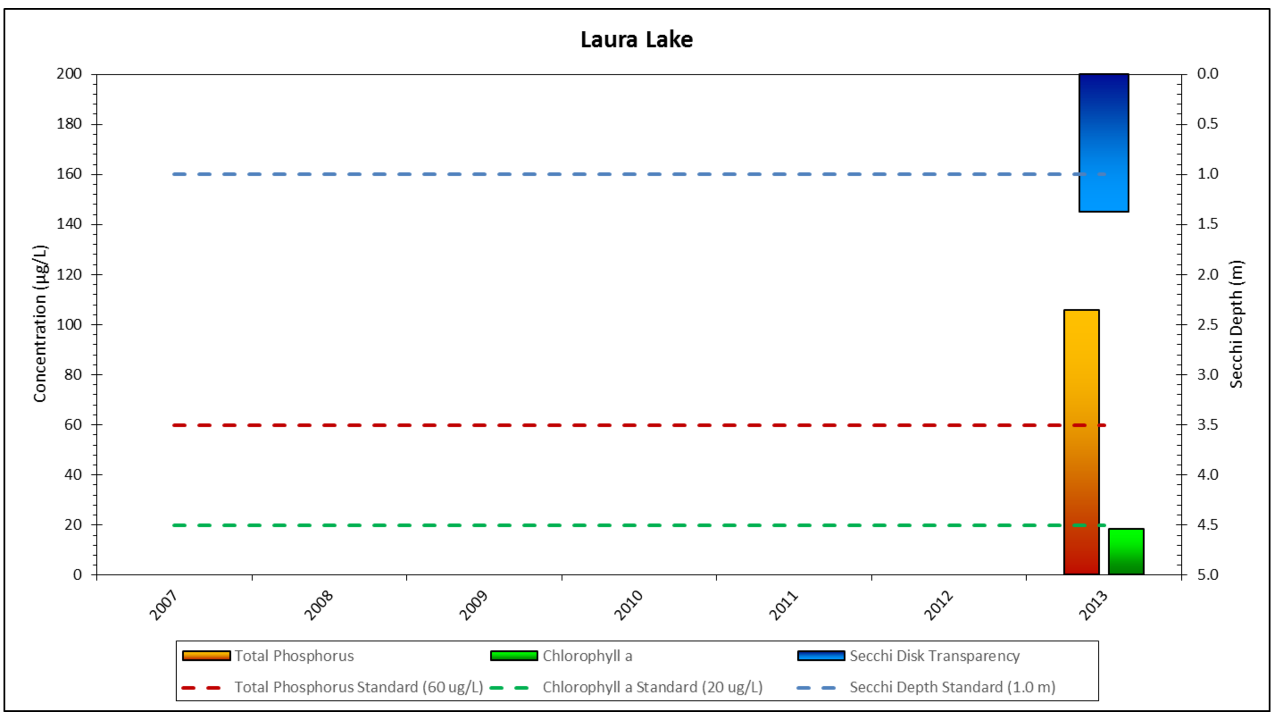

Figure B.4 - Laura Lake Water Historical Quality Data

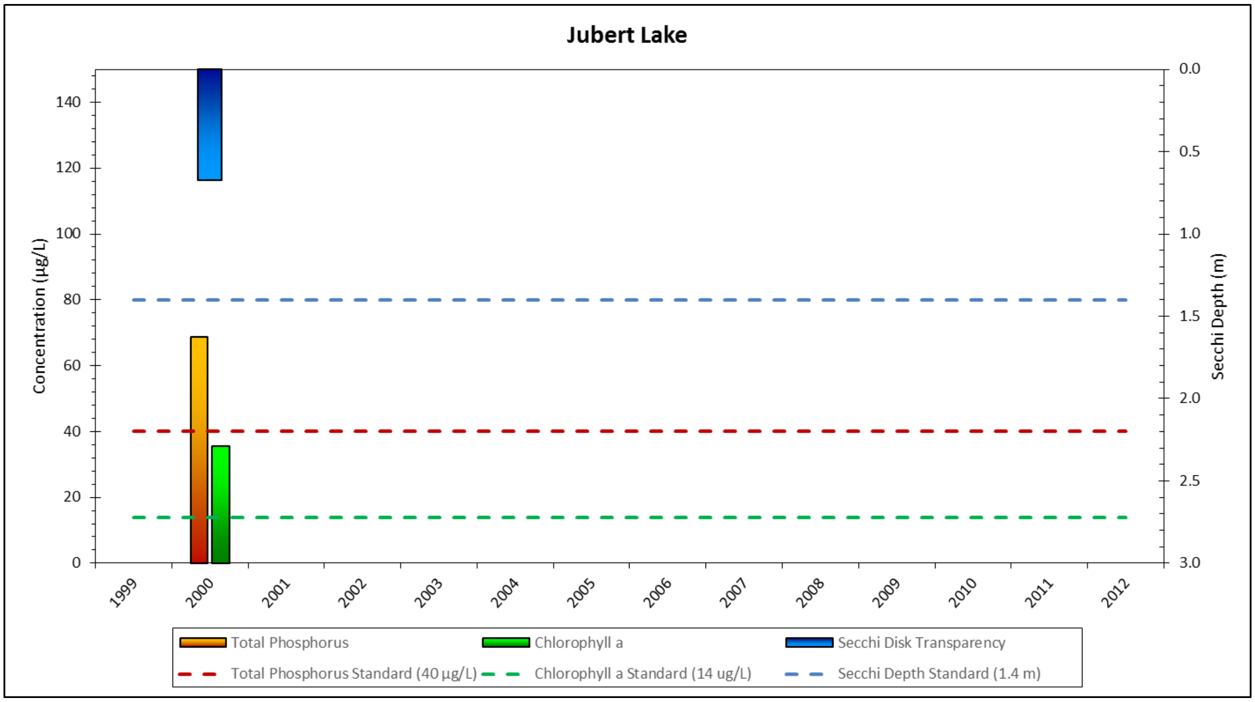

Figure B.5 - Jubert Lake Water Historical Quality Data

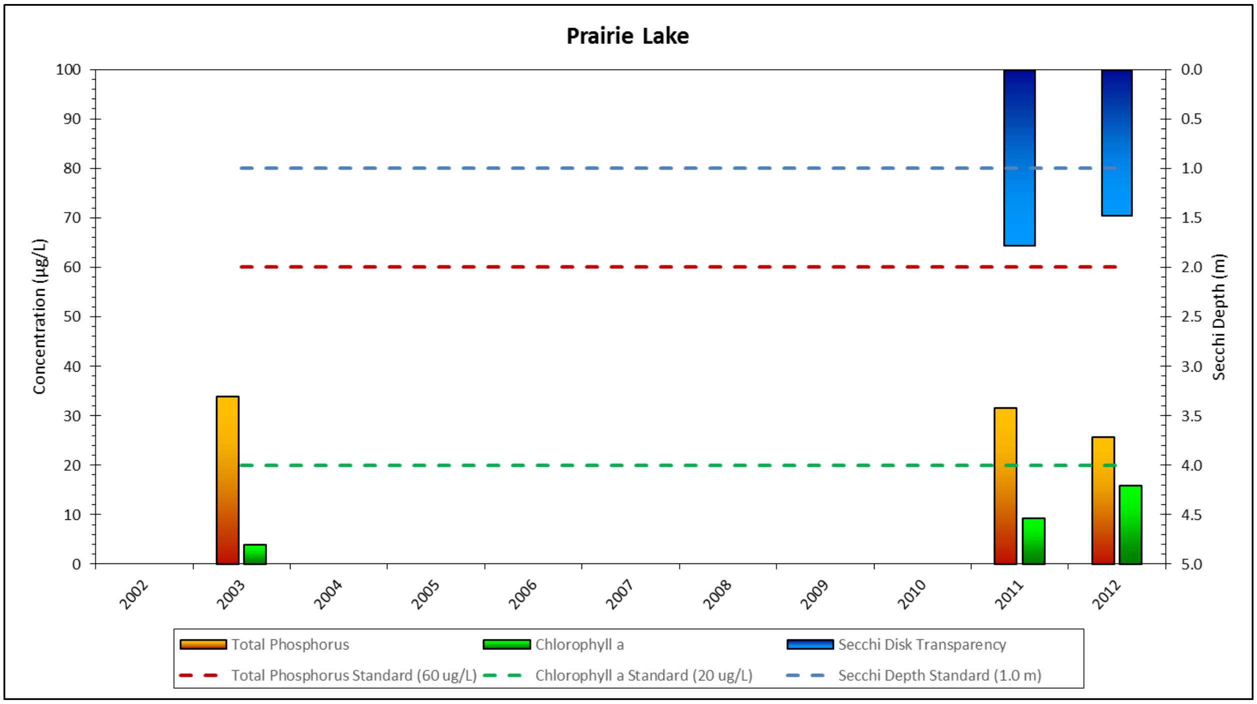

Figure B.6 - Prairie Lake Water Historical Quality Data

Appendix C-Watershed Boundaries For Non-TMDL Lakes

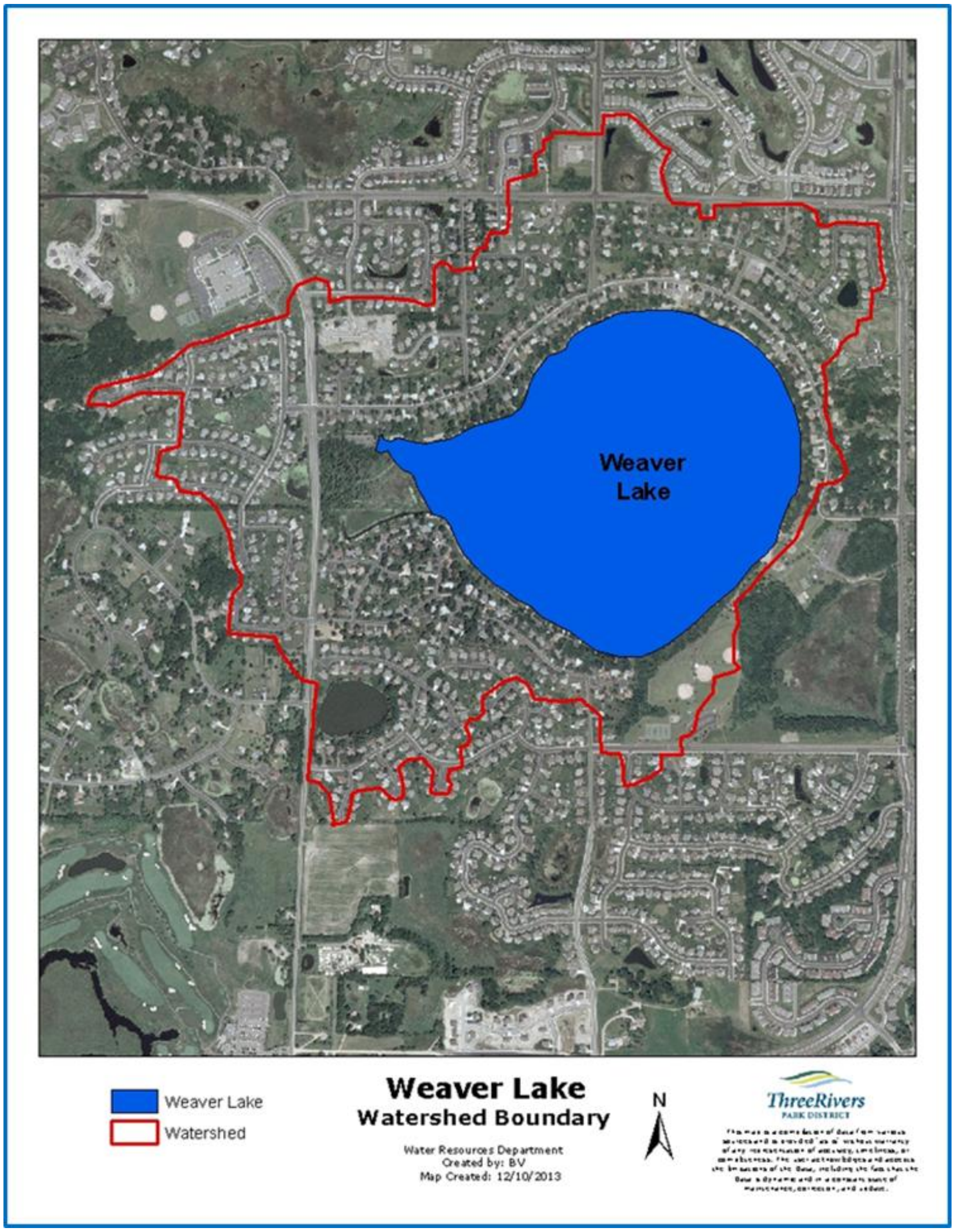

Figure C.1 - Weaver Lake Watershed Boundary

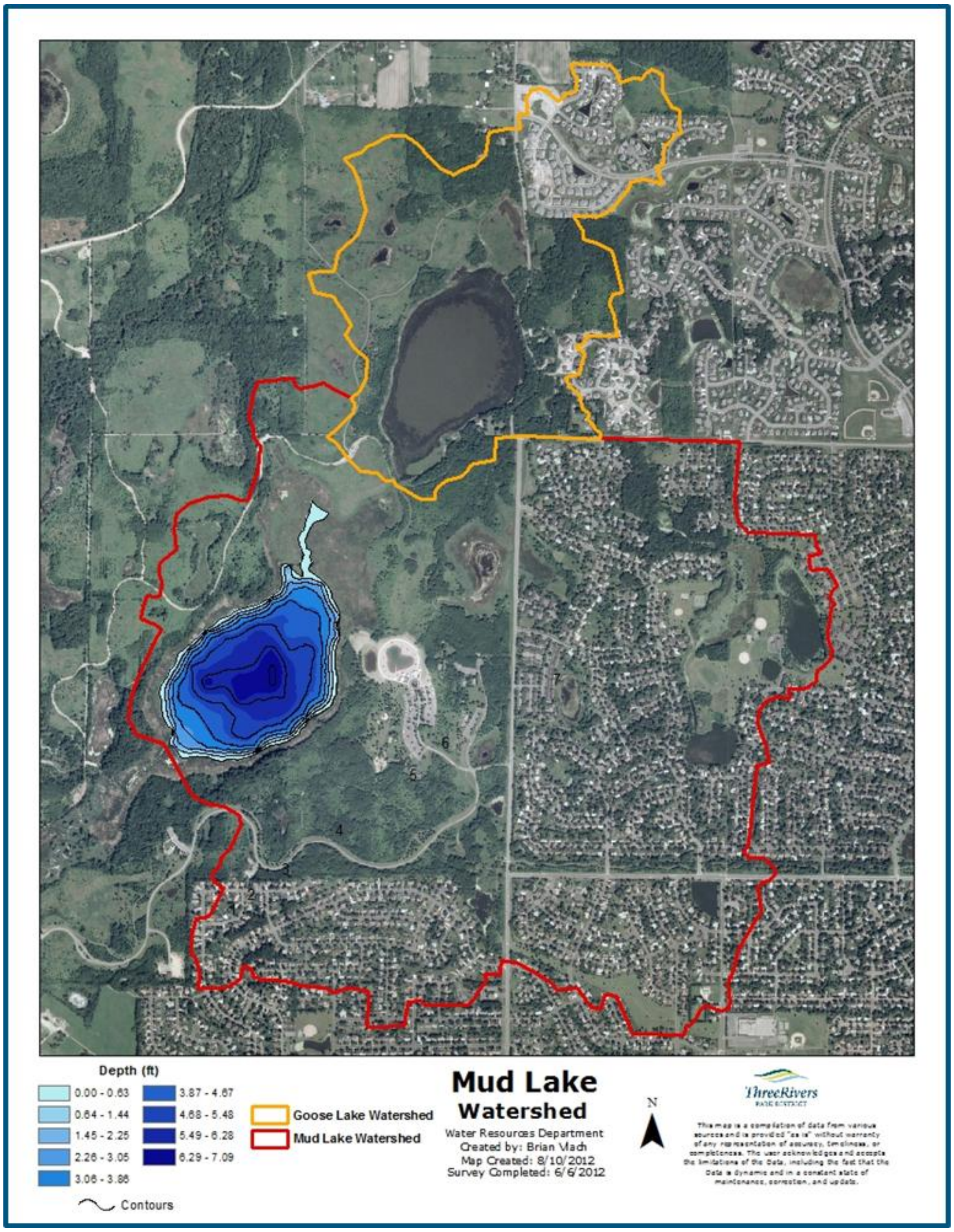

Figure C.2 - Mud Lake Watershed Boundary

Figure C.3 - Lake Dubay Watershed Boundary

Figure C.4 - Laura Lake Watershed Boundary

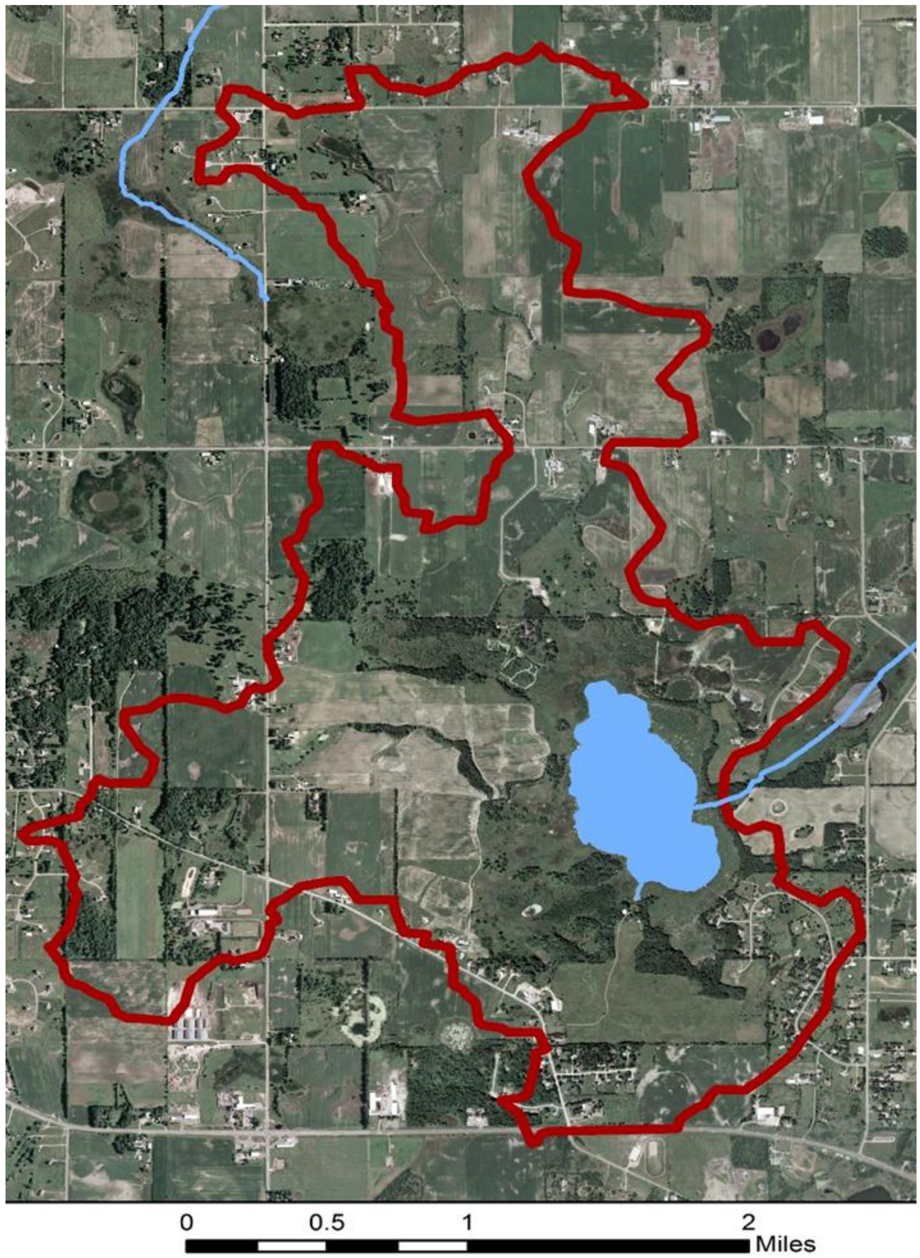

Figure C.5 - Jubert Lake Watershed Boundary

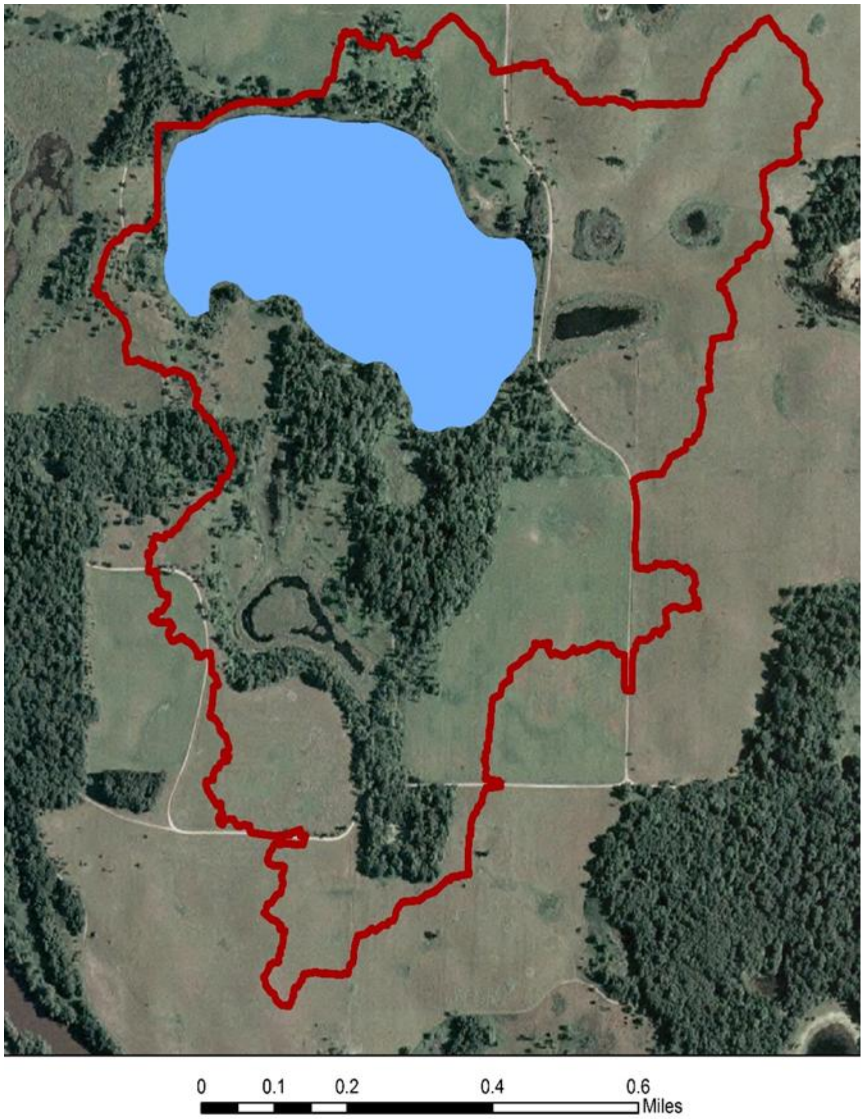

Figure C.6 - Prairie Lake Watershed Boundary