Carver Creek Lakes

(Hydes, Goose, Winkler, & Miller)

TMDL Implementation Plan

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1.0 Introduction

1.1 Purpose

This Total Maximum Daily Load (TMDL) study addresses a nutrient impairment in the Carver Creek lakes. The goal of this TMDL is to quantify the pollutant reductions needed to meet the state water quality standards for nutrients in Goose, Hydes, Miller, and Winkler Lakes, in Carver County, Minnesota. The Carver Creek Lakes TMDL for nutrients is being established in accordance with section 303(d) of the Clean Water Act, because the State of Minnesota has determined these waters in the Carver Creek watershed exceed the state established standards for nutrients.

This TMDL provides waste load allocations (WLAs) and load allocations (LAs) for four lakes in the Carver Creek watershed. The Minnesota Pollution Control Agency (MPCA) has recently approved new numeric standards which provide a new standard for both deep and shallow lakes. Based on these new state standards for nutrients, the TMDL establishes a numeric target of 60 ug/L total phosphorus concentration for all shallow lakes in the North Central Hardwood Forest ecoregion representing Goose, Miller, and Winkler Lakes. The TMDL establishes a numeric target of 40 ug/L total phosphorus concentration for all deep lakes in the North Central Hardwood Forest ecoregion representing Hydes Lake.

1.2 Problem Identification

Goose, Hydes, and Miller Lakes were placed on the 2002 Minnesota State 303(d) list of impaired waters, and Winkler Lake on the 2004 list. Each was identified for impairment of aquatic recreation (swimming) due to excess nutrients. Goose, Miller, and Winkler Lakes are designated by the Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Natural Resources (MnDNR) as shallow lakes. However, Winkler Lake's morphometry, extent of littoral zones, ecological communities, and lack of public access are more characteristic of a wetland. This would change its designated use and the required standards for nutrient concentrations set by the state.

Goose, Hydes, and Miller Lakes are larger lakes with more opportunities for recreation, including public access. Carlson TSI indices show that a Carlson Trophic Status (TSI) of less than 60 is conducive to swimming (Carlson R.E., 1996). Goose Lake has an overall average TSI of 75 during a sampling period from 2000 to 2007. Hydes and Miller Lakes have a TSI of 77 and 86, respectively for a sampling period from 2000 to 2007. Highest TSI phosphorus numbers were 92 for Winkler Lake. As these indices point out, all lakes have poor water quality and will require reductions in phosphorus loads to improve the water quality to a state that will allow for recreational activities.

2.0 TMDL Summary

2.1 Impaired Waters

The MPCA has included Goose, Hydes, and Miller Lakes on the 2002 and Winkler Lake on the 2004 State of Minnesota 303(d) list of impaired waters list (Table 2.1). The lakes are impaired for excess nutrients, which inhibit the beneficial use of aquatic recreation.

Table 2.1. Impaired waters in the Carver Creek chain of lakes.

LAKE	DNR LAKE #	AFFECTED USE	YEAR LISTED	POLLUTANT OR STRESSOR
Goose	10-0089	Aquatic recreation	2002	Excess nutrients
Hydes	10-0088	Aquatic recreation	2002	Excess nutrients
Miller	10-0029	Aquatic recreation	2002	Excess nutrients
Winkler	10-0066	Aquatic recreation	2004	Excess nutrients

2.2 Defining Minnesota Water Quality Standards

2.2.1 State of Minnesota Standards

The protected beneficial use for all lakes is aquatic recreation (swimming). Table 2.2 outlines the previous state standards that were used to determine that Goose, Hydes, Miller, and Winkler Lakes should be placed on the 303(d) list of impaired waters in Minnesota. In May 2008, the MPCA approved new numerical thresholds based on ecoregions and lake morphometry that will better determine impairment of Minnesota lakes (Table 2.3). The new rules take into account nutrient cycling differences between shallow and deep lakes, resulting in more refined standards for Minnesota lakes (MPCA 2005).

MPCA researchers found regional patterns in numbers of lakes, lake water quality, morphometry, and watershed characteristics among these ecoregions. For example, lakes of the Northern Lakes and Forests ecoregion have significantly lower total phosphorus and chlorophyll than lakes in the Western Corn Belt Plains ecoregion. Furthermore, the MPCA discovered through lake-user surveys that user perception of water quality varied by ecoregions. This has led to ecoregion-specific criteria for phosphorus and, in general, helped to clarify expectations and goals for protecting lakes in Minnesota (WOW web 2008).

Table 2.2. Previous state standards for class 2B waters (NCHF ecoregion) compared to the Carver Creek Lakes 2007 summer means.

Impairment Designation	TP (µg/L)	Chlorophyll-a (µg/L)	Secchi Depth (m)
Full Use	<40	<15	≥1.6
Review	40 – 45	NA	NA
Impaired	>45	>18	<1.1
Goose	103	134	0.4
Hydes	155	53	1.4
Miller	226	78	0.6
Winkler	381	31	0.5

According to the MPCA, Goose, Miller, and Winkler are considered "shallow" lakes, and Hydes is a "deep" lake. Because Carver County falls within the North Central Hardwood Forest (NCHF) ecoregion (Figure 2.1), those standards are used.

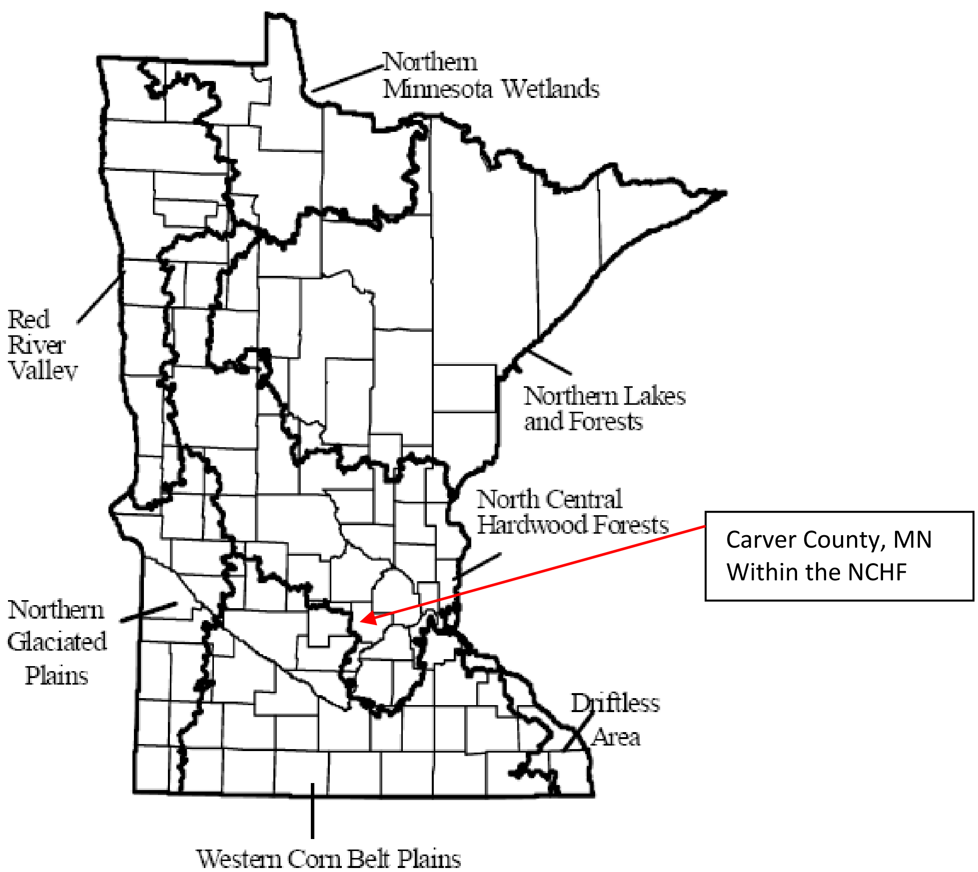

Figure 2.1. Map of Minnesota's ecoregions.

Table 2.3. State standards for protecting Class 2B waters. Values are summer averages (June 1 through September 30).

	NORTH CENTRAL HARDWOOD FOREST	
Parameters	**Shallow**[1]	**Deep**
TP concentration (µg/L)	60	40
Chl-a concentration (µg/L)	20	14
Secchi disk transparency (meters)	>1.0	>1.4

[1]Shallow lakes are defined as lakes with a maximum depth of 15 feet or less, or with 80% or more of the lake area shallow enough to support emergent and submerged rooted aquatic plants (littoral zone).

2.3 Current Water Quality

Water quality in Minnesota lakes is often evaluated using three associated parameters: TP, chlorophyll-a, and Secchi depth. Phosphorus is typically the limiting nutrient in Minnesota lakes, meaning that algal growth will increase with increased phosphorus. However, there are cases where phosphorus is widely abundant and the lake becomes limited by the availability of nitrogen. In lakes within the Carver Creek Watershed, phosphorus is the limiting nutrient.

Chlorophyll-a is the primary pigment in aquatic algae and has been shown to have a direct correlation with algal biomass. Since chlorophyll-a is a simple measurement, it is often used to evaluate algal abundance rather than expensive cell counts.

Secchi depth is a physical measurement of water clarity taken by lowering a white disk until it can no longer be seen from the surface. Greater Secchi depths indicate less light-refracting particulates in the water column and better water quality; conversely, high TP and chlorophyll-a concentrations point to poor water quality. Measurements of these three parameters are interrelated and can be combined into an index that describes water quality. A summary of Carver Creek Lake water quality is presented in Figures 2.2 – 2.4.

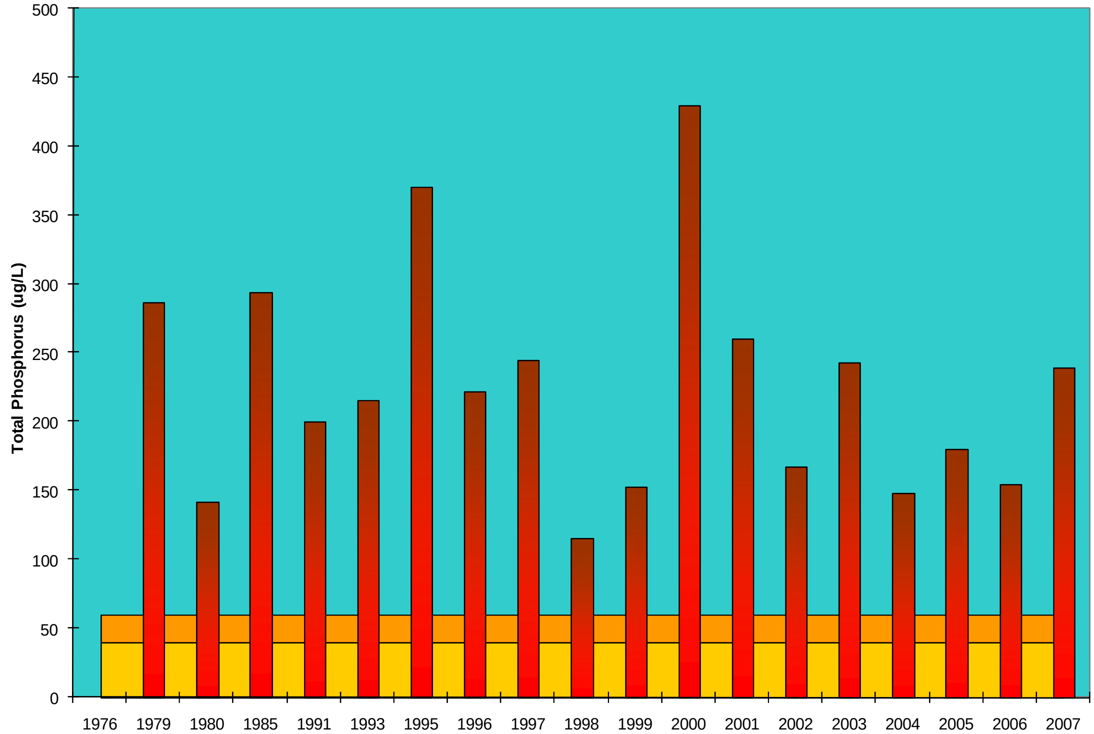

Figure 2.2. Summer mean (June - September) TP (µg/L) for Carver Creek Lakes.

The yellow bar in Figure 2.2 represents the current standard for TP in Minnesota NCHF Class 2B deep waters (<40 ug/L). The orange bar behind it represents the standard for the same ecoregion, but for shallow lakes (<60 ug/L).

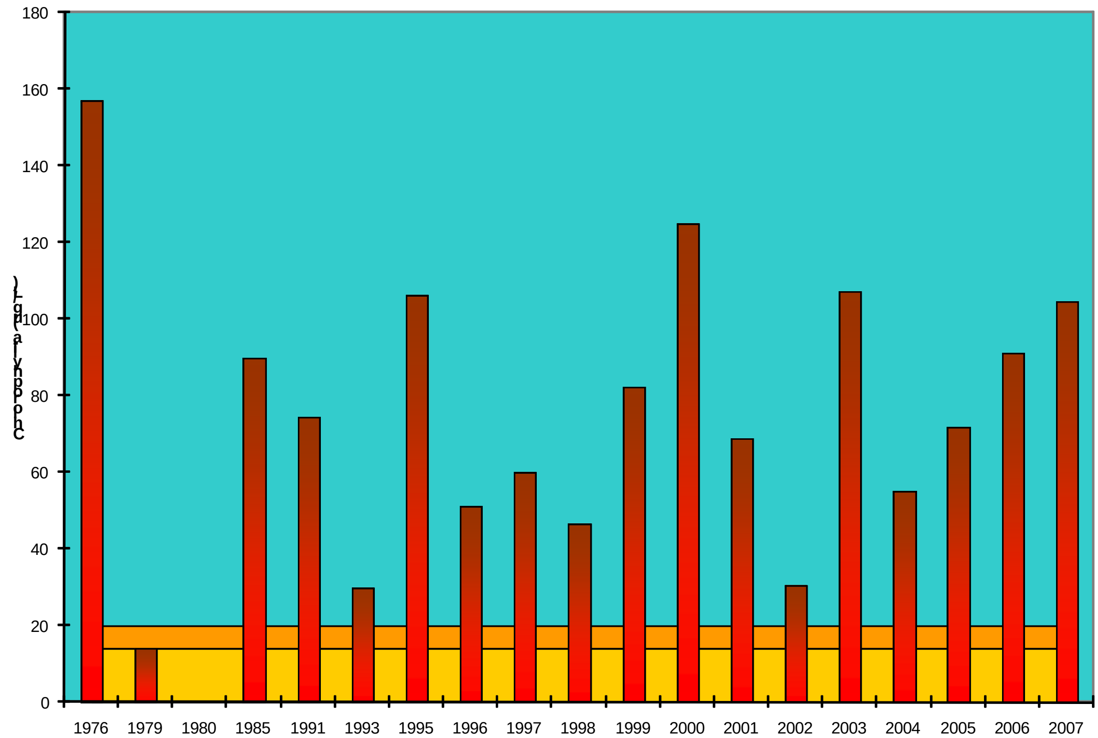

Figure 2.3. Summer mean (June - September) Chlorophyll-a (µg/L) for Carver Creek Lakes.

The yellow bar in Figure 2.3 represents the current standard for chlorophyll-a in Minnesota NCHF Class 2B deep waters (<14 ug/L). The orange bar behind it represents the standard for the same ecoregion, but for shallow lakes (<20 ug/L).

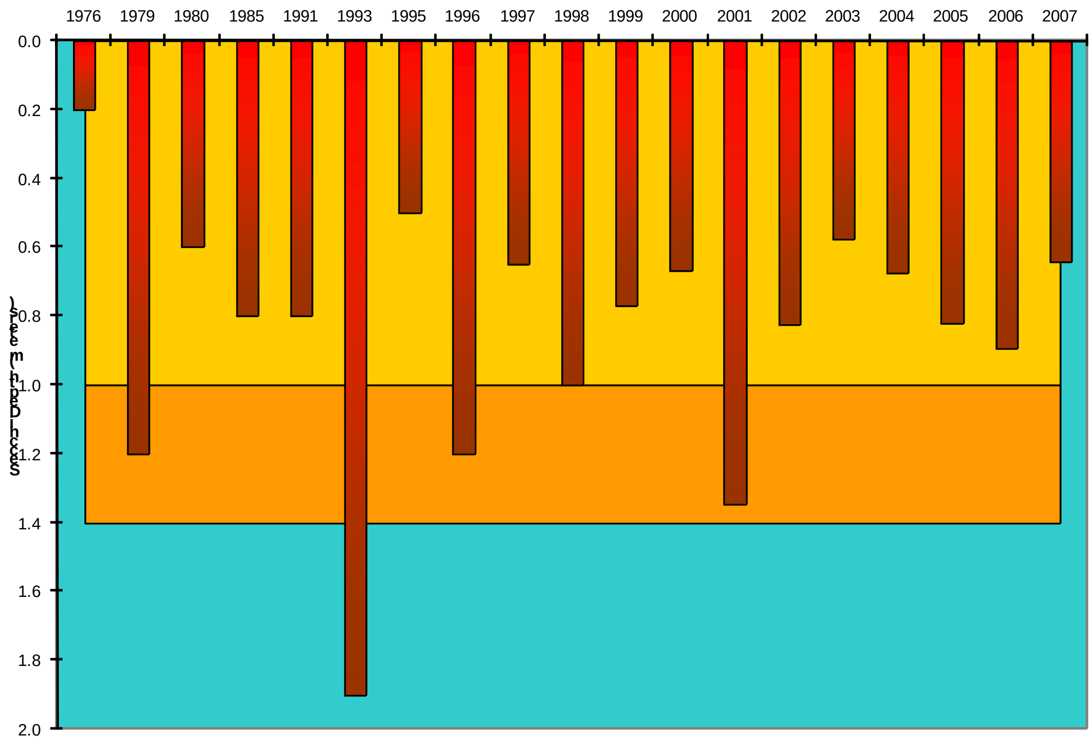

Figure 2.4. Summer mean (June - September) Secchi depth (meters) for Carver Creek Lakes.

The orange bar in Figure 2.4 represents the current standard for Secchi depth in Minnesota NCHF Class 2B deep waters (>1.4 meters). The yellow bar in front of it represents the standard for the same ecoregion, but for shallow lakes (>1.0 meters).

2.4 Carver Creek Lake Endpoints

Determining appropriate goals and endpoints for lake water quality is an essential part of the TMDL process. The Carver Creek lakes were listed as impaired based on the standards of the NCHF ecoregion. The following standards will be set as water quality goals for the Carver Creek Lakes:

2.4.1 Goose Lake

Goose Lake is technically defined by the MPCA as a shallow lake in the NCHF ecoregion. Maximum depth of the lake is 10 feet and a 100 percent littoral area fulfill the MPCA's "Shallow Lakes" definition with the maximum depth less than 15 feet, or a littoral area that is greater than 80 percent. Goose Lake is a shallow lake and is subject to the NCHF shallow lake numeric target of 60 µg/L TP.

2.4.2 Hydes Lake

Hydes is technically defined by the MPCA as a deep lake in the NCHF ecoregion. Maximum depth of the lake is 18 feet with a 75 percent littoral area. Therefore the final goal for TP will be set at the NCHF deep lake standard of 40 µg/L.

2.4.3 Miller Lake

Miller Lake is technically defined by the MPCA as a shallow lake in the NCHF ecoregion. Maximum depth of the lake is 14.1 feet and a 98 percent littoral area fulfill the MPCA's "Shallow Lakes" definition with the maximum depth less than 15 feet, or a littoral area that is greater than 80 percent. Agriculture is the current dominant land use within and surrounding the Miller Lake watershed. A study conducted by Fandrei et al. and literature cited in a report conducted by the MPCA (2005) indicate that in-lake TP concentrations vary positively with increased percentage of land in agricultural areas, which correlates strongly with Miller Lake that has agricultural land use around 60 percent. Growing season TP levels in Miller Lake have been recorded as high as 700 µg/L. Finally, studies indicate that Miller Lake acts as a large sediment pond for the entire Carver Creek watershed, resulting in extremely high nutrient and sediment retention. With high agricultural land use, highly ditched networks within the lakeshed, and a high "area to lake" ratio, Miller Lake will use the NCHF TP standard of 60 µg/L.

2.4.4 Winkler Lake

Winkler Lake is technically defined by the MPCA as a shallow lake in the NCHF ecoregion. Maximum depth of the lake is 3 feet and a 100 percent littoral area fulfill the MPCA's "Shallow Lakes" definition with the maximum depth less than 15 feet, or a littoral area that is greater than 80 percent. Agriculture is the current dominant land use within and surrounding the Winkler Lake watershed. Growing season TP levels in Winkler Lake have been recorded as high as 1,192 µg/L in the last ten years. The 60 µg/L nutrient standard goals for NCHF shallow lakes will be applied until the wetland status of the lake can be reviewed.

2.4.5 Conclusion

This TMDL has been established with the intent to implement all the appropriate activities that are not considered greater than extraordinary efforts. But these proposed goals will require aggressive action. Upon initial implementation, subsequent monitoring will determine the feasibility in moving to the next level. If all appropriate BMPs and activities have been implemented and the lakes still do not meet their goals, Carver County staff will reevaluate the TMDL and work with the MPCA to develop more appropriate site-specific standards for the lakes.

2.5 Qualitative Lake Conditions

Aside from the numeric water quality goals, other issues must be considered when determining end points or desired conditions for the Carver Creek Lakes. Management strategies will focus on restoring the lakes to conditions that support a diverse and native aquatic plant (macrophyte) community. These types of lakes are characterized by low rough fish populations, clearer water, higher wildlife values, and positive feedback mechanisms that help maintain a balanced ecosystem (Scheffer 1998). These types of feedback mechanisms help maintain the plant dominated clear water state of shallow lakes. A shift from the algae dominated state to the clear water, native macrophyte dominated state should be a qualitative goal for all of the Carver Creek Lakes.

Another goal is to improve public perception of the recreational suitability of Hydes, Miller, and Winkler Lakes. Public surveys were conducted to assess public perception of the recreational suitability of these lakes. The results of the surveys will be used to identify goals appropriate for increasing the public perception of recreational suitability.

3.0 Watershed and Lake Characterization

3.1 Carver Creek Lakes Watershed Description

Carver Creek Watershed is located in central Carver County, encompassing roughly 55,000 acres and parts of three cities. Land use in the watershed is predominately agriculture (54 %, 29,880 acres), with small portions of developed and natural areas scattered around (10%, and 18%, respectively).

Goose Lake Subwatershed is located in the north-western portion of Carver Creek Watershed and the direct watershed covers 2,001 acres, excluding the lake. The outlet of Goose Lake flows into Lake Waconia. Land use in this area is agriculture, which accounts for 48% of all land.

Hydes Lake Subwatershed is located within the western portion of Carver Creek; the direct watershed covers 839 acres, excluding the lake. The lake is the second largest surface area included in this TMDL. Major land use around the subwatershed is agriculture (58%, 1952 acres). The outlet of Hydes Lake flows into Rice Lake and eventually down to Winkler Lake, a distance close to three miles traveling along the creek.

Miller Lake has the largest direct drainage area of all lakes included in this TMDL. The subwatershed covers over 14,500 acres. The watershed does include parts of Waconia and Cologne, but the majority of the land is used for agriculture (60%). The lake has acted as a sediment trap for Carver Creek, which explains the high yearly sedimentation rates.

Winkler Lake Subwatershed is southeast of Hydes Lake, but still within the western end of Carver Creek. As is the case of all four lakes reported within this TMDL, the major land use is agriculture (70%). Direct drainage into the lake covers close to 3,120 acres, but with the inclusion of Rice Lake that is between Hydes and Winkler Lakes, the drainage area more than doubles to 7,700 acres. Winkler Lake outlets to Carver Creek and eventually drains to Miller Lake, the last significant body of water for Carver Creek before emptying into the Minnesota River.

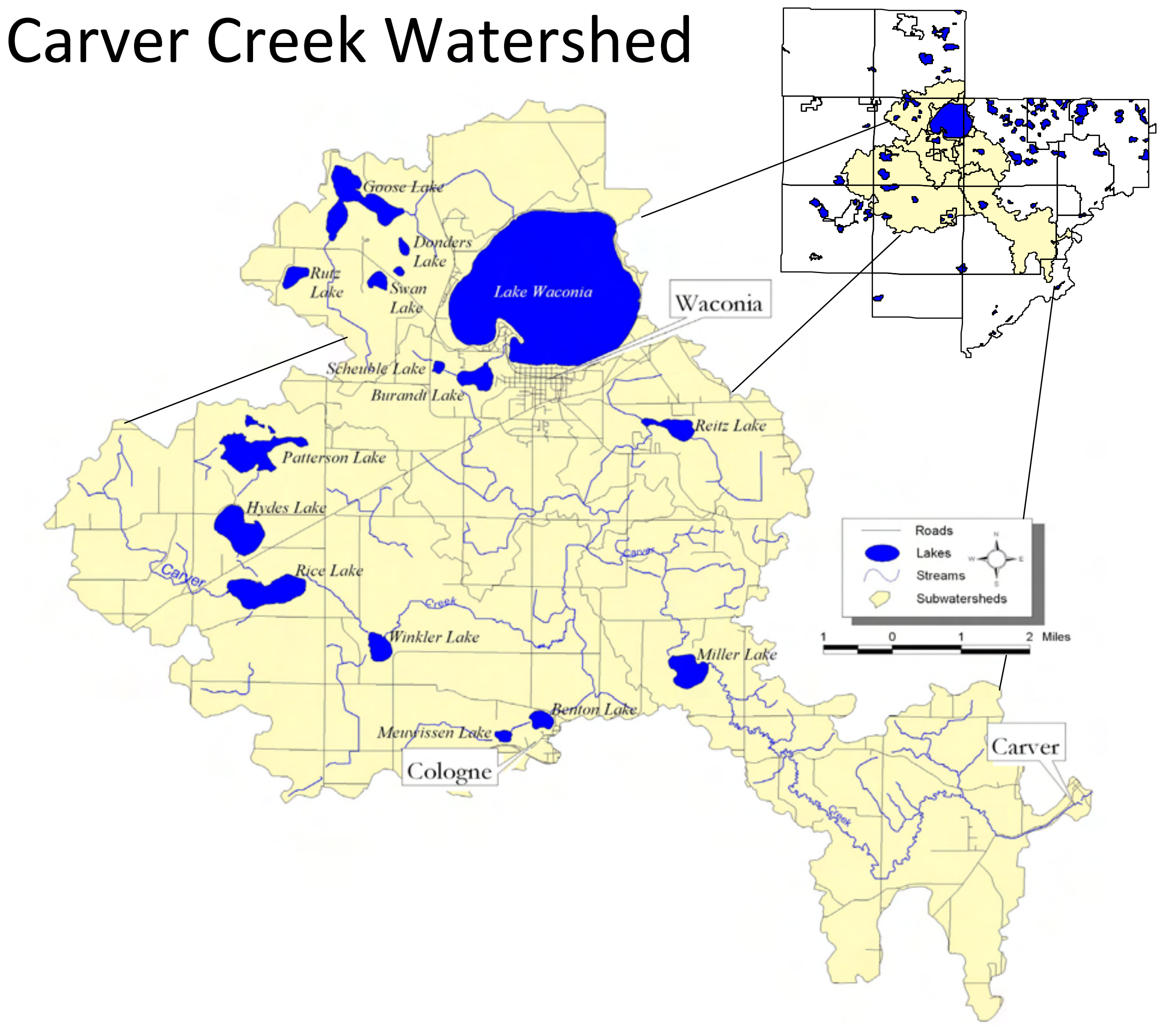

Figure 3.1. Carver Creek lakes and watershed.

Table 3.1. Lake characteristics of the Carver Creek Lakes.

Parameter	Goose Lake	Hydes Lake	Miller Lake	Winkler Lake
Surface Area (ac)	333	216	141	73
Average Depth (ft)	5	8	10	1.5 (est.)
Maximum Depth (ft)	10	18	14	3 (est.)
Volume (ac-ft)	1,443	1,788	1,028	137
Residence Time (days)	182 - 256	109 - 186	15 - 37	15 - 27
Littoral Area (%)	100	76	100	100
Watershed (excluding lake) (ac)	1,949	834	14,645	3,125
Lakeshed: Lake Area	6:1	4:1	104:1	43:1

3.1.1 Goose Lake

Goose Lake is a shallow lake, with a maximum depth of approximately 10 feet and a mean depth of 5 feet (Table 3.1). In accordance with lake assessment values, it is hypereutrophic, with a 10 year summer mean TP concentration of 138 µg/L, chlorophyll-a concentrations of 76 µg/L, and an average Secchi depth of 1.64 feet. Annual averages of TP, chlorophyll-a, and Secchi depth have fluctuated since monitoring data have been collected, and the lake is not currently meeting the MPCA's water quality standards for shallow lakes.

Goose Lake has a direct watershed of 2,001 acres, excluding the lake. The indirect watersheds are made up of three shallow lake/wetlands that flow intermittently into Goose Lake via the tributaries (Figure 3.2). Goose Lake discharges into a series of wetlands before entering Lake Waconia which then discharges into Carver Creek before flowing southeast into the Minnesota River.

Table 3.2. DNR protected waters in the Goose Lake watershed.

Waterbody	DNR Number	Classification[1]	303(d) List
Rutz	10-0080	Shallow Lake	2006
Swan	10-0128	Wetland	N/A
Donders	10-0079	Wetland	N/A

1 Surface water classification according to MCPA February 2006 document; Factors for differentiating among lakes, shallow lakes and wetlands.

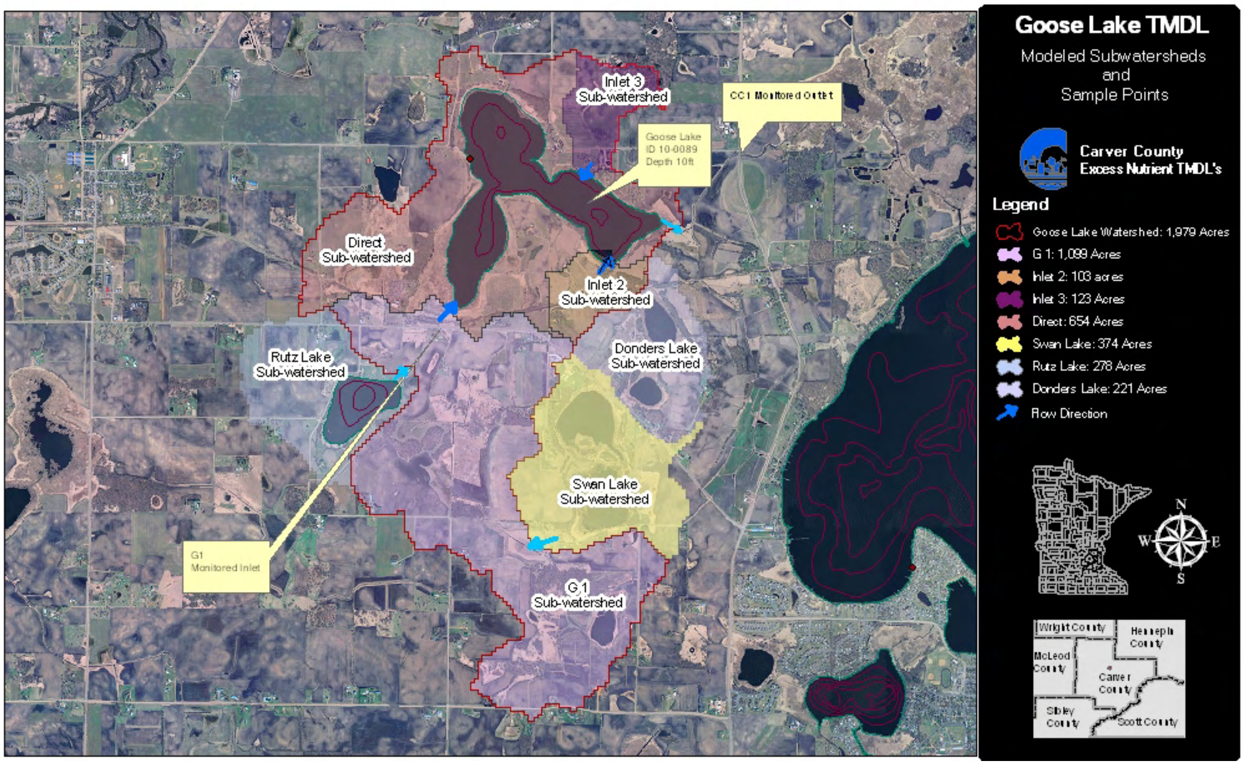

Figure 3.2. Map of Goose Lake watershed and subwatersheds.

3.1.2 Hydes Lake

Hydes Lake is relatively shallow, with a maximum depth of approximately 18 feet and a mean depth of 8 feet (Table 3.1). In accordance with lake assessment values, it is hypereutrophic, with a 10 year summer mean TP concentration of 164 µg/L, chlorophyll-a concentrations of 46 µg/L, and an average Secchi depth of 4.9 feet. Annual averages of TP, chlorophyll-a, and Secchi depth have fluctuated since monitoring data have been collected, and the lake is not currently meeting the MPCA's water quality standards for shallow lakes.

Hydes Lake has a direct watershed of 839 acres, excluding the lake and an indirect watershed from Patterson Lake, a shallow lake/wetland that is located less than one mile away, which is 2,292 acres. Only one major inlet flows intermittently into Hydes Lake from Patterson Lake (Figure 3.3).

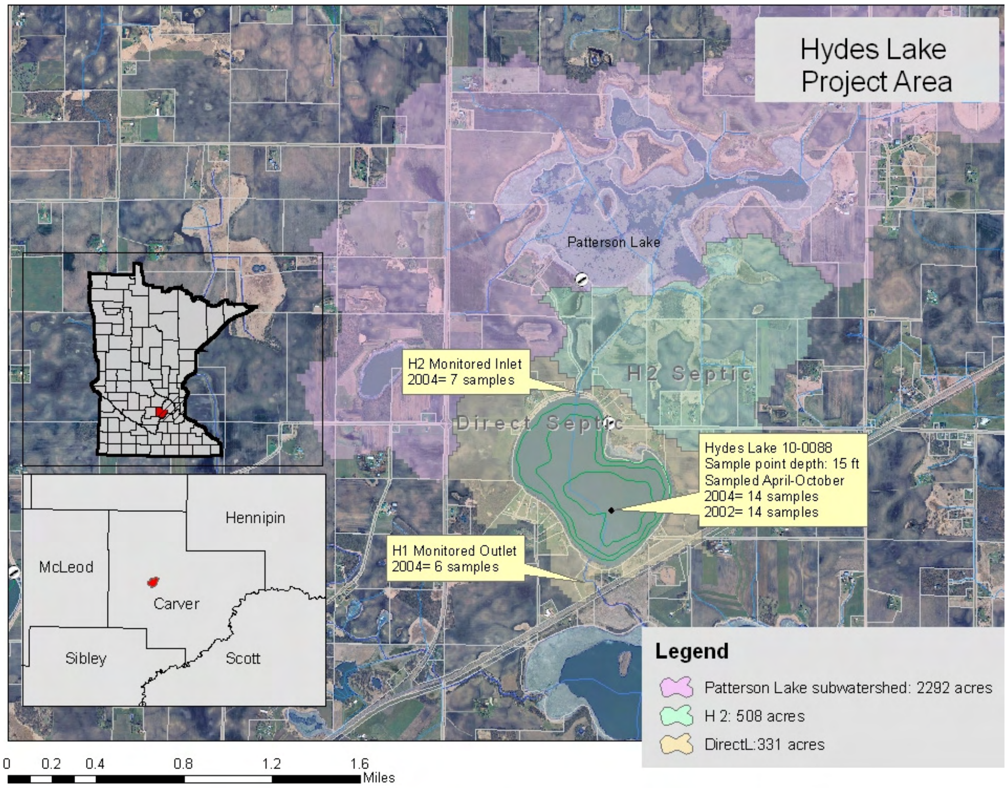

Figure 3.3. Hydes Lake watershed with Patterson Lake watershed to the north.

3.1.3 Miller Lake

Miller Lake is shallow, with a maximum depth of approximately 14 feet and a mean depth of 7 feet (Table 3.1). In accordance with lake assessment values, it is hypereutrophic, with a 10 year summer mean TP concentration of 259 µg/L, chlorophyll-a concentrations of 56 µg/L, and an average Secchi depth of 3.0 feet. Annual averages of TP, chlorophyll-a, and Secchi depth have fluctuated since monitoring data have been collected, and the lake is not currently meeting the MPCA's water quality standards for shallow lakes.

Miller Lake has a direct watershed of 14,654 acres, excluding the lake (Figure 3.4). The lake area to lakeshed area ratio is 1:102, indicating that the lakeshed has the potential to contribute extremely high nutrient loads to the lake. The Miller Lake direct watershed contains one major inlet, Carver Creek, which drains a majority of the watershed (14,260 acres). Miller Lake has another much smaller, intermittent, low-flow inlet draining a small area to the west of the lake. Ultimately, four lakes drain directly to Miller Lake via the tributaries of Carver Creek (Burandt, Benton, Winkler, and Reitz). While nutrient loading from these lakes was considered in TMDL development, the discussion throughout the TMDL will focus on the direct watershed of Miller Lake.

The lake has acted as a large sediment pond for Carver Creek, accumulating up to one inch of sediment in years of heavier rainfall.

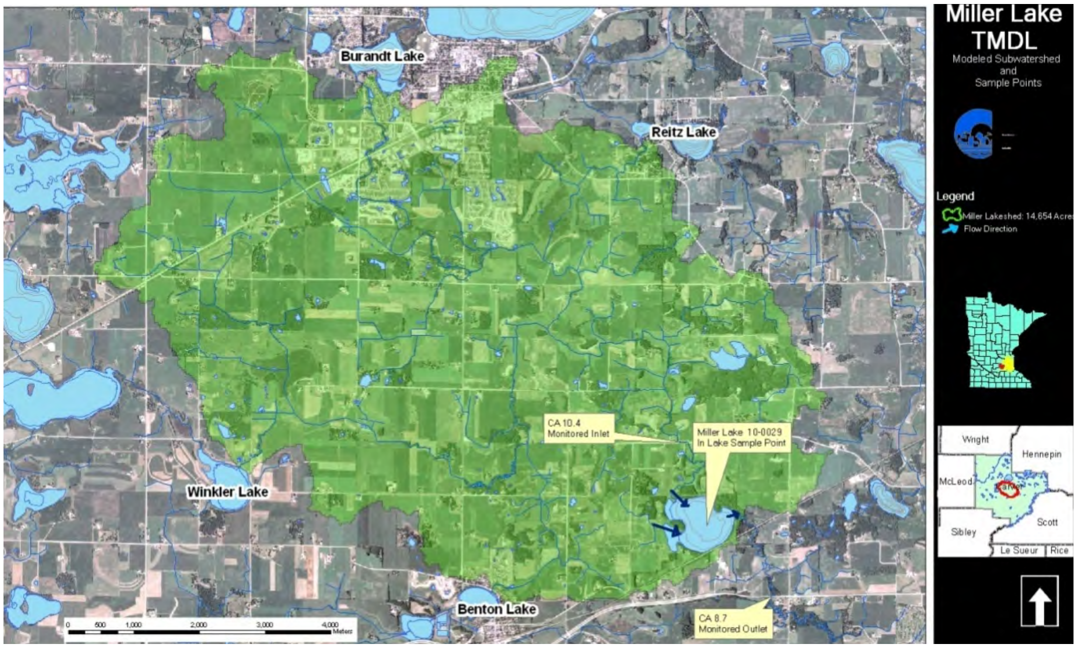

Figure 3.4. Miller Lake watershed

3.1.4 Winkler Lake

Winkler Lake is shallow, with a maximum depth of approximately 3 feet and a mean depth of 1.5 feet (Table 3.1). In accordance with lake assessment values, it is hypereutrophic, with a 10 year summer mean TP concentration of 466 µg/L, chlorophyll-a concentrations of 99 µg/L, and an average Secchi depth of 1.6 feet. Annual averages of TP, chlorophyll-a, and Secchi depth have fluctuated since monitoring data have been collected, and the lake is not currently meeting the MPCA's water quality standards for shallow lakes.

Winkler Lake has a direct watershed of 3,118 acres, excluding the lake (Figure 3.5). Within this area there are three inlets (drainage ditches) entering from the NW, SW and E parts of the lake. The northwest inlet flows in from Rice Lake, a public ditch to the southwest discharges treated wastewater from Bongards' wastewater treatment plant into Winkler Lake, and a small wetland drains in from the east. Rice Lake drains to Winkler Lake via the northwest subwatershed. This indirect drainage into Winkler Lake is roughly 4,580 acres in size and contains both Rice Lake and its subwatersheds.

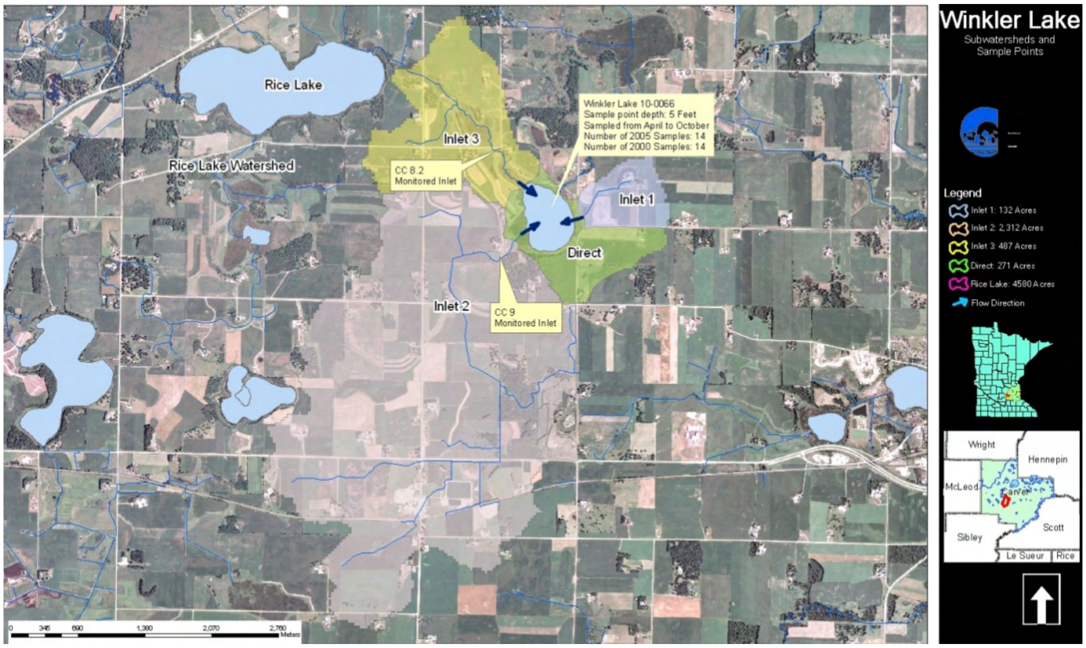

Figure 3.5. Winkler Lake watershed, subwatershed, and sampling points.

3.2 Land use

Land use percentages are similar for the four direct watersheds compared to Carver Creek Watershed. Agriculture is the major land usage for the entire area ranging from 54 percent in Goose Lake to 74 percent in Winkler Lake. In this report direct watersheds are considered to be those areas draining to the lake without first passing through another lake.

Land use changes between 2005 and 2020 are partly due to the different methodology used to determine each classification. Any changes seen in wetland land use or developed land are largely a reflection of this difference in methodology. Wetland “reductions” in 2020 do not account for any mitigation of wetlands lost during development. Developed land use does not include farmsteads, which were classified as agricultural land use for the 2020 Land Use data.

3.2.1 Goose Lake

Land use in the direct watershed is primarily tilled agriculture (Figure 3.7, Table 3.7). There are approximately 41 homes in the direct watershed with subsurface sewage treatment systems (SSTS). A GIS review showed that 13 of those 41 SSTS (~30 %) had no permits on file. According to the 2000 feedlot inventory data, three feedlots exist in the direct watershed with 148 animal units. 2020 Land use projections indicate that there will be minimal to no change.

Table 3.7. Goose Lake Watershed 2005 Land Use.

Land Use	Goose Lake Direct		Rutz Lake		Swan Lake		Donders Lake	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Agriculture	1,250	54%	225	67%	166	40%	284	42%
Developed	117	5%	25	8%	20	5%	31	5%
Natural	255	11%	21	6%	59	14%	92	14%
Wetland	327	14%	6	2%	68	17%	138	20%
Water	362	16%	57	17%	97	24%	128	19%
Total	**2,311**	**100%**	**335**	**100%**	**411**	**100%**	**673**	**100%**

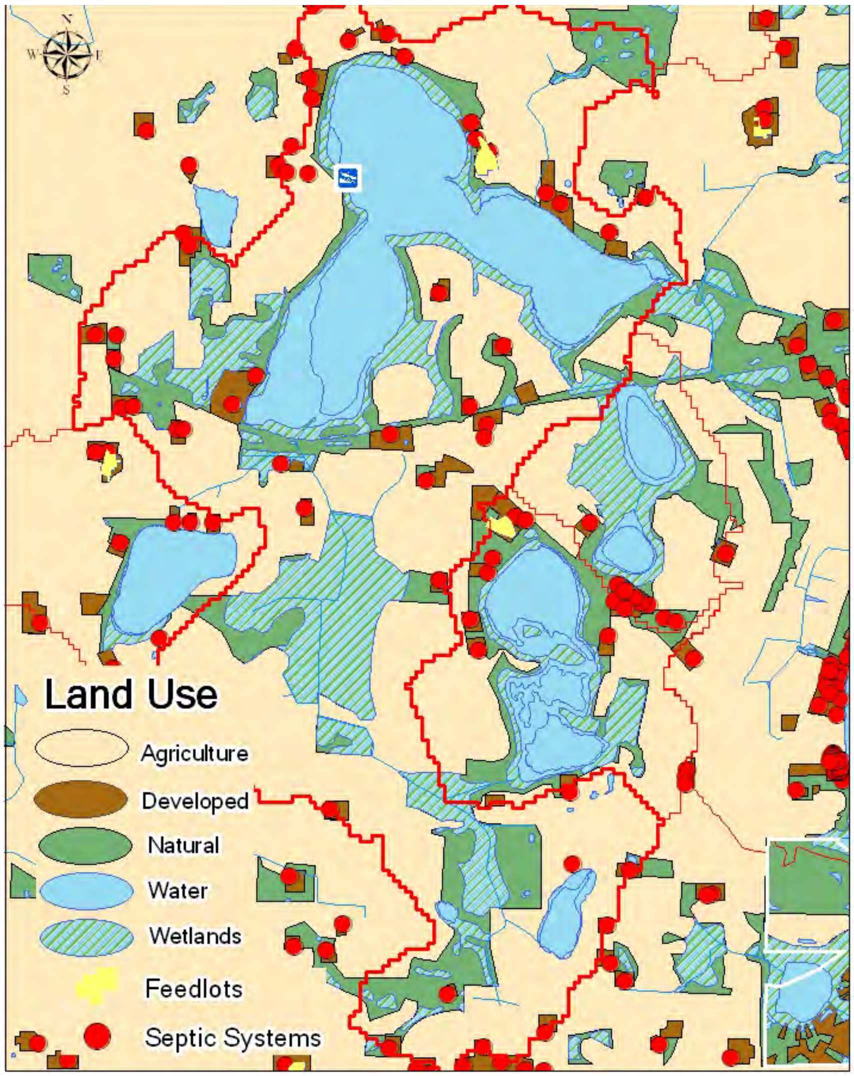

Figure 3.7. Goose Lake watershed land use (2000).

Land use surrounding lakes in the indirect watershed that flow into Goose Lake ultimately impact its water quality. As such, a GIS review was conducted to determine land use characteristics in these areas (Table 3.7 and 3.8). During this review, it was determined that three separate subwatersheds ultimately drain to Goose Lake: Rutz lake, Swan lake and Donders Lake. Nearly 50 percent of the indirect watersheds are in agricultural conditions and to this point there are no plans for future development (Table 3.8). In addition there are approximately 34 homes within the three indirect watersheds collectively, all with onsite SSTS. Two homes with SSTS did not have permits on file. According to the feedlot inventories done in 2000, five feedlots containing approximately 1,057 animal units are located within the indirect watersheds.

Table 3.8. Goose Lake Watershed 2020 Land Use

Land Use	Goose Lake Direct		Rutz Lake		Swan Lake		Donders Lake	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Agriculture	1,373	59%	245	73%	196	48%	301	45%
Developed	64	3%	20	6%	20	5%	30	4%
Natural	262	11%	60	18%	45	11%	82	12%
Wetland	309	13%	7	2%	113	28%	183	27%
Water	303	13%	3	1%	37	9%	78	12%
Total	**2,311**	**100%**	**335**	**100%**	**411**	**100%**	**673**	**100%**

3.2.2 Hydes Lake

Current land use in the direct watershed is primarily tilled agriculture. There are approximately 28 homes existing in the watershed, all with on-site individual septic treatment systems. Nineteen of the homes are on the lake front (within 300 feet of the shoreline). One feedlot exists in the watershed containing approximately 47 animal units. In looking at land use in 2020, agricultural land uses will increase slightly. It should be noted that wetlands show a decrease, but this land use study did not take into account mitigation for lost wetland acres. (Figure 3.8, Table 3.9).

Table 3.9. Current and predicted land use in the Hydes Lake watershed.

Land Use	2005		2020		Percent Change
	Acres	Percent	Acres	Percent	
Agriculture	562	53%	628	60%	6%
Developed	64	6%	45	4%	-2%
Natural	79	8%	80	8%	0%
Wetland	128	12%	82	8%	-4%
Water	220	21%	219	21%	0%
Total	**1,054**	**100%**	**1,054**	**100%**	**0%**

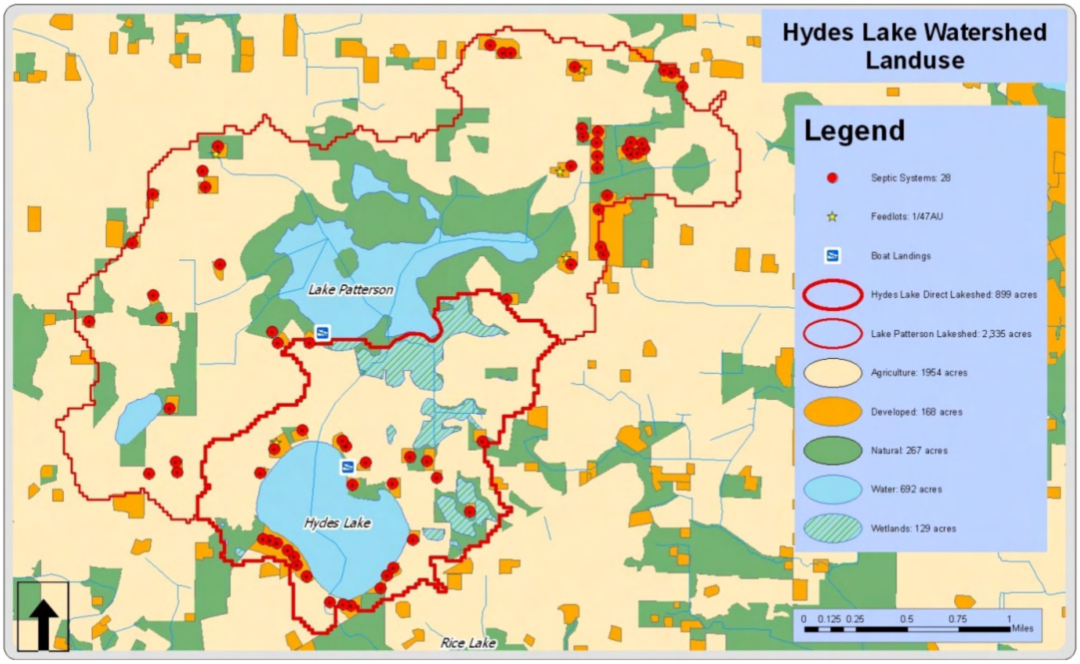

Figure 3.8. Hydes Lake 2005 land use.

3.2.3 Miller Lake

Current land use in the watershed is primarily tilled agriculture (Figure 3.9, Table 3.10). The cities of Waconia and Cologne are partially within the direct watershed boundaries. Approximately 5,500 property parcels exist in the direct watershed; however, the land surrounding Miller Lake is minimally developed with only one home located within 300 feet of the lake. Currently 29 feedlots exist in the watershed containing approximately 2,279 animal units. None of the existing feedlots are regulated under the National Pollutant Discharge Elimination Permit System (NPDES) permit system. 2020 Comprehensive Plans indicate that there will be an increase in development reducing both the percent wetland and natural areas. As in previous sections, the reduction in wetlands should not be a point of concern due to the lack of accounting for mitigation in this study (Table 3.10).

Table 3.10. Miller Lake Watershed Land Use

Land Use	2005		2020		Percent Change
	Acres	Percent	Acres	Percent	
Agriculture	8,806	60%	9,445	64%	4%
Developed	1,774	12%	2,094	14%	2%
Natural	2,553	17%	2,108	14%	-3%
Wetland	1,512	10%	992	7%	-4%
Water	143	1%	153	1%	0%
Total	**14,788**	**100%**	**14,791**	**100%**	**0%**

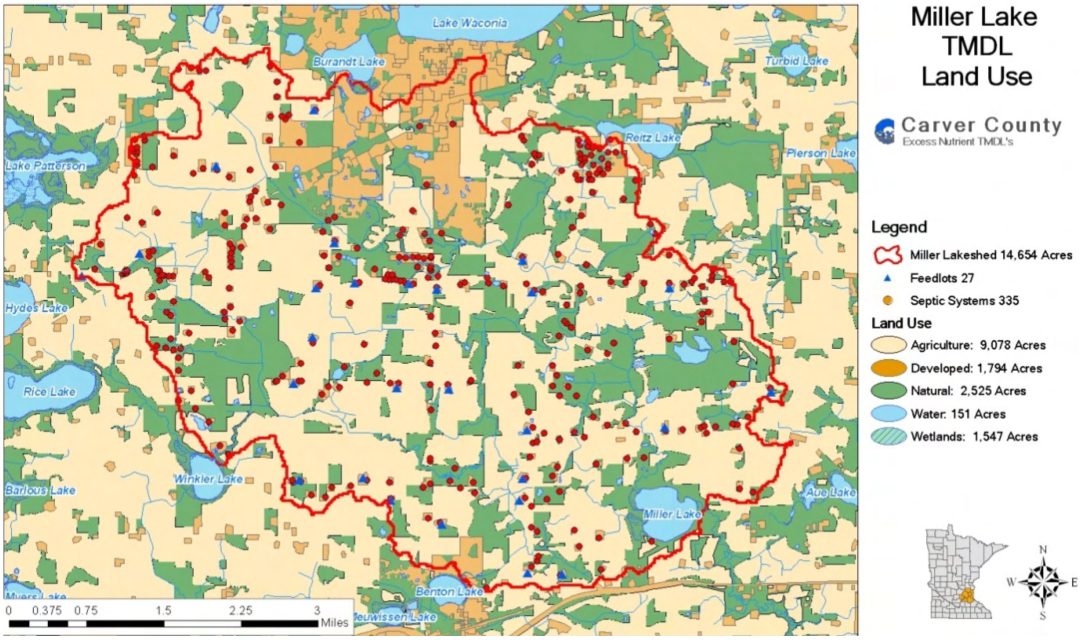

Figure 3.9. Miller Lake 2005 land use.

3.2.4 Winkler Lake

The 3,171-acre watershed surrounding Winkler Lake is and has historically been predominantly agricultural (Figure 3.10, Table 3.11). Looking at future land use (2020), a slight increase in agriculture will occur. There are currently 69 homes in the direct watershed all with on-site septic systems. In addition, there are 11 feedlots in the watershed containing approximately 1,373 animal units.

Table 3.11. Winkler Lake 2005 Land Use

Land Use	Winkler Lake	
	Acres	Percent
Agriculture	2,366	74%
Developed	204	6%
Natural	289	9%
Wetland	266	8%
Water	73	2%
Total	**3,197**	**100%**

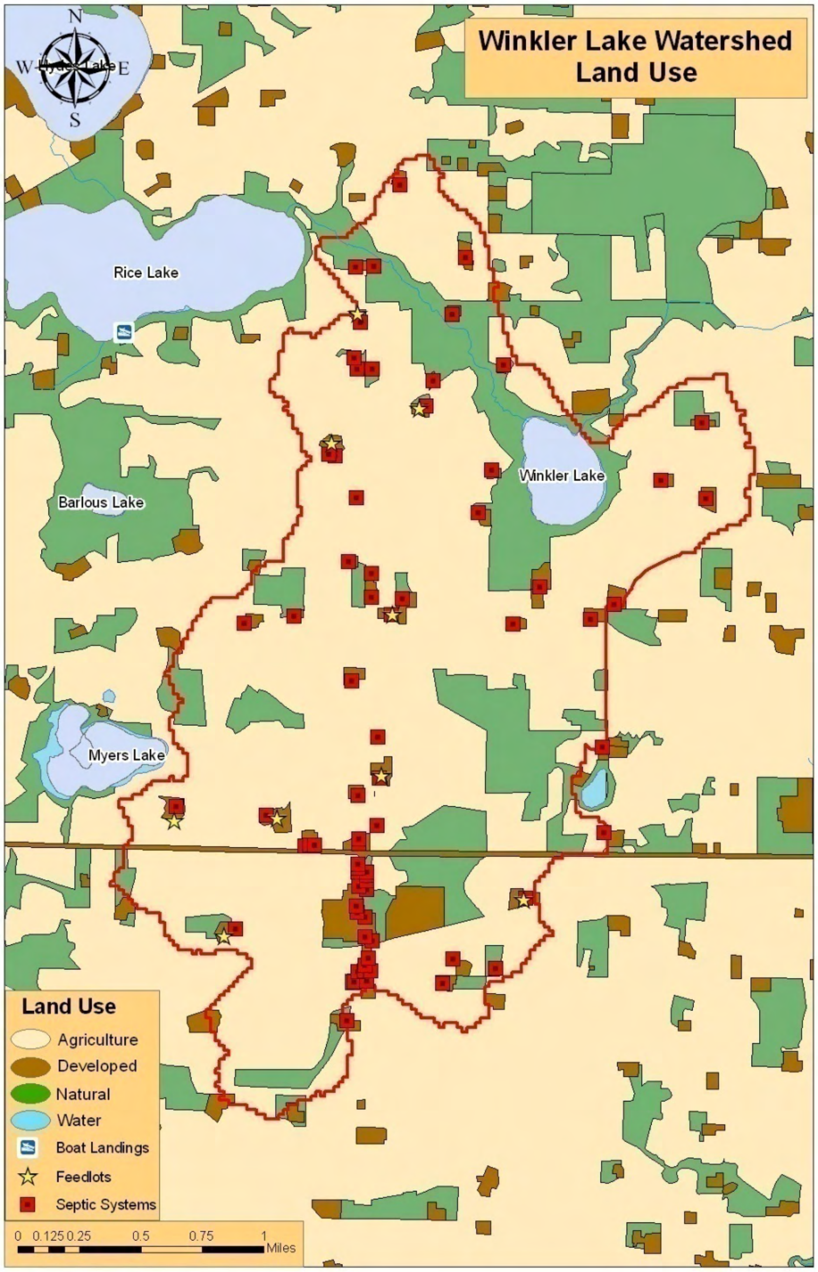

Figure 3.10. Winkler Lake 2005 land use.

4.0 PUBLIC PATICIPATION

4.1 Introduction

The County has an excellent track record with inclusive participation of its citizens, as evidenced through the public participation in completion of the Carver County Water Management Plan, approved in 2001. The County has utilized stakeholder meetings, citizen surveys, workshops and permanent citizen advisory committees to gather input from the public and help guide implementation activities. The use of this public participation structure will aid in the development of this and other TMDLs in the County.

4.2 Technical Advisory Committee

The Water, Environment, & Natural Resource Committee (WENR) was established as a permanent advisory committee. The WENR is operated under the County's standard procedures for advisory committees. The WENR works with staff to make recommendations to the County Board on matters relating to watershed planning.

The make-up of the WENR is as follows:

1 County Board Member
1 Soil and Water Conservation District Member
5 citizens – (1 appointed from each commissioner district)
1 City of Chanhassen (appointed by city)
1 City of Chaska (appointed by city)
1 City of Waconia (appointed by city)
1 appointment from all other cities (County Board will appoint)
2 township appointments (County Board will appoint– must be on existing township board.)
4 other County residents (1 from each physical watershed area – County)

The full WENR committee received updates on the TMDL process from its conception in 2004.

As part of the WENR committee, two sub-committees are in place and have held specific discussions on Excess Nutrient TMDLs. These are the Technical sub-committee and the Policy/Finance sub-committee. Sub-committee review meetings:

Goose Lake	8 June 2005, 13 July 2005, and 13 September 2005
Hydes Lake	8 June 2005, 13 July 2005, and 13 September 2005
Miller Lake	8 June 2005, 13 July 2005, 30 January 2006, and 28 November 2006
Winkler Lake	8 June 2005, 13 July 2005, and 30 January 2006

TMDL progress, methods, data results and implementation procedures were presented and analyzed at the WENR meetings mentioned above. Committee members commented on carp removal possibilities, sources, internal loading rates, and future monitoring plans. All issues commented on were considered in the development of the Draft TMDL.

4.3 Public Meetings

Stakeholders that would be impacted by the Carver Creek Lake TMDL will be given the opportunity to voice their opinions of the TMDL. Stakeholder involvement involved the following components; public survey, public meeting, and personal meetings.
Public meetings are to be held upon the review of the DRAFT TMDL by the Minnesota Pollution Control Agency (MPCA). This occurrence will reduce the need to have multiple public meetings to address requested revisions in the DRAFT TMDL as recommended by the MPCA.

4.3.1 Goose Lake

An open house was held on September 1, 2005 for landowners within the Goose Lake watershed. Prior to that, 132 surveys were sent to landowners inquiring about lake uses and perceptions. 14 surveys were returned and of those 81 percent were lakeshore owners. 11 people attended the meeting and filled out surveys. The following is a summary of the user survey and comments received during the meeting:

- Sources attendees were concerned about were geese, curly leaf pondweed, feedlots, agricultural and lawn run off, and rough fish.
- The public was very supportive of the process and would like to know what we need from them. They would like to see Goose Lake attain a swimmable status again.
- Some landowners were interested in the dredging and channelization of the water courses that, prior to disturbance, did not allow other watersheds to flow into Goose Lake (Rutz and Swan Lakes).
- The public was very concerned about feedlots and manure management.
- 50 % of lake users indicated that their uses of the lake are interfered with by aquatic plants and/or algae.
- 43 % of surveyors indicate that their perception of the lake is currently "no swimming, boating ok" while 21 % perceive the lake to be unusable.

4.3.2 Hydes Lake

An Open House was held on September 1st, 2005 for landowners within the Hydes Lake watershed. Previous to the meeting, landowners were sent surveys inquiring upon lake uses and perceptions. Although 107 invitations were sent out, 18 people attended the meeting and completed surveys, with 72 percent of those being lakeshore owners. The following is a summary of the user survey and comments received during the meeting:

- Sources attendees were concerned about were affects of geese, curly leaf pondweed, feedlots and rough fish.
- Landowners were very supportive but asked "How much money are we as property owners on the lake going to have to pay?" They are concerned that lake property owners would be expected to come up with large sums of money.
- Attendees were hopeful that in the future "their" lake would be swim-able once again.
- Uses of the lake at this point were indicated to be swimming, boating, waterskiing, hunting and wildlife observation.
- 72 % of users believe that their use of the lake is interfered with by aquatic plants and/or algae.
- Additional management practices brought up were alum treatments and dredging.

4.3.3 Miller Lake

A user perception survey was sent out to landowners inquiring upon lake uses and perceptions in July of 2006. Due to the high volume of homes within the lakeshed and lack of public access on the lake only landowners within one mile of the lake were sent surveys. 75 surveys were sent out and 13 surveys were returned. Of the surveys returned, one was a lakeshore owner. Many of the comments were incorporated throughout the TMDL. Below is a list of general comments, concerns respondents had for the lake and thoughts on what may be causing excess nutrients in the lake.

- Should add a public access/boat landing as most of the lake is isolated from general public.
- Tile lines from agriculture/ farms dump nutrients, pesticides and silt into the lake.
- Runoff from fertilizer used in nearby yards contributes to nutrient loading.
- Carp may be causing increased nutrients.

4.3.4 Winkler Lake

A user perception survey was sent out to landowners inquiring upon lake uses and perceptions in October of 2008. Surveys were sent to homeowners within a one mile radius of the lakeshore. Fifty five surveys were sent out and 5 were returned. Out of all the surveys, only 1 was a lakeshore owner. Below is a general list of comments and concerns that homeowners had about the lake.

- Observation of the wildlife around the lake was the most important aspect for recreational use.
- Runoff from adjacent fields is seen as a deterrent to water quality of Winkler Lake.
- Residents within the lakeshed feel that Bongards' Creamery have had a negative impact to Winkler Lake due to discharges from production.

5.0 Recommended Phosphorus Management Strategies

5.1 Lake Strategies

Based on the Four Lakes TMDL, it will be necessary to address the internal and external loading when considering how to manage these lakes. As previously stated to meet the goals of the TMDL, including all lakes a reduction of up to 95% in the phosphorus load is needed. With the appropriate level of staffing, funding, BMPs and management options, this is a feasible effort.

It should be noted that as part of another Carver, Bevens, and Silver Creek TMDL CCWMO is currently implementing a fecal coliform reduction plan that focuses on minimizing runoff and thus reducing fecal coliform (or E. coli) bacteria numbers. A number of the BMPs targeted and implemented in this plan will provide a cumulative reduction of phosphorus to the lakes within Carver, Bevens and Silver Creek watersheds. With that said, the two main contributors of indicator bacteria are feedlot sources as well as SSTS. Failing SSTS are not mentioned in this plan because we feel they are adequately addressed in the Carver, Bevens, and Silver Creek TMDL Implementation Plan.

To reach the reduction goals CCWMO will be the lead on the implementation of the Four Lake Excess Nutrient TMDL and will rely largely on its current Water Management Plan which identifies the Carver SWCD as the local agency for implementing BMPs. Although CCWMO will champion the plan, in some instances individual stakeholders (i.e. Cities of Waconia and Cologne) will be ultimately responsible for implementing the identified BMPs. These activities will be included in the NPDES Phase II Permits that the stakeholders hold (both CCWMO and Cities'), and activities will be reported annually.

CCWMO realizes that each of the following tasks relates to corresponding reduction strategies and that the tasks must be completed based on acceptance, staff and funding availability. Hence, this implementation plan's activities will commence upon the availability of funding. To accomplish this, the tentative timelines were set for each task to correspond with the project goals. The timelines are defined as: Short Term - 0-5 years from the inception of the plan, Medium Term - 5-12 years from the inception of the plan and Long Term - greater than 12 years or on-going from the inception of the plan.

External Load

Direct runoff from each lake's watershed will decrease the quality of water in the Lake. Thus, areas that will be targeted heaviest for implementation will include each lake's watershed and direct inflow.

Internal Load

Internal sources of phosphorus have an impact on water quality in each of the lakes and will undoubtedly need to be addressed in this TMDL, knowing that we must first manage external sources of phosphorus. Attacking and controlling external factors first will give us a better opportunity to achieve the goals in the implementation plan and corresponding TMDL. When we are confident that external sources are controlled, internal sources will be attacked and managed adaptively to bring us to the final goal of the TMDL.

5.2 External Loading Reduction Strategies

External loading reduction strategies include a variety of agricultural and urban BMPs. Examples of agricultural BMPs are reduced tillage, buffer strips, nutrient management, manure management, grassed waterways, contour farming, and terraces. Urban BMP examples include stormwater detention basins, street sweeping, rain gardens, shoreline restorations, and enhanced infiltration (e.g., core aeration of grassy areas).

Buffer strips along ditches, streams, wetlands and lakes can reduce nutrient runoff from agricultural cropland. Areas of high erosion potential or wetland restoration identified in each lake's subwatershed will be targeted for these practices.

Areas with the greatest potential to pollute surface water will be targeted for BMP establishment first. In non-MS4 areas, BMP establishment will be on a voluntary basis. State and federal grant monies will be solicited by CCWMO to cost share BMP establishment and incentives if needed.

The interim and final goals for reducing external phosphorus are indicated in Table 5.1.

Table 5.1. Interim and Final reduction goals for the Four Lakes TMDL.

	Current External Load (kg/yr)	Interim Goal (ug/L)	Interim goal load (ug/L)	% reduction needed	Final Goal (ug/L)	Final Goal Load (ug/L)	Total % reduction needed
Goose	319	90	206	36	60	103	68
Hydes	153	60	73	52	40	29	81
Miller	2296	90	1878	18	60	937	59
Winkler	532	90	115	78	60	43	92

Target Watersheds: Hydes, Goose, Miller and Winkler Lakes Subwatersheds

Timeline: Long Term

Estimated total cost of all tasks: $5,271,000

5.2.1 Agricultural Cropland Runoff Control and Storage BMPs

Task 1. Identify and prioritize key erosion/restoration areas within the Lake watersheds. Identification will be based on monitoring results, Geographical Information Systems data for vulnerable or erosion-prone soils, and/or visual inspections of field conditions.

1) Responsible Parties:	CCWMO, Carver SWCD, NRCS
2) Timeline:	Short Term
3) Estimated Cost:	$12,500
4) Lakes included:	Hydes, Goose, Miller, Winkler

Task 2. Identify and educate landowners through meetings, brochures, Carver County quarterly newspaper (The Citizen), Carver County Website, and various workshops.

1) Responsible Parties:	CCWMO, Carver SWCD
2) Timeline:	Long Term
3) Estimated Cost:	$25,000
4) Lakes included:	Hydes, Goose, Miller, Winkler

Task 3. Design and implement cropland BMPs to reduce phosphorus inputs to each lake. BMPs will be targeted on land identified as significant contributors of phosphorus and sediment. Agricultural BMPs will be designed and implemented to reduce sediment and nutrients into each lake. Examples could be but are not limited to nutrient management, crop residue management, and other practices utilized by the Carver SWCD and NRCS and identified in the NRCS field handbook available electronically at www.nrcs.usda.gov/technical/efotg/.

1) Responsible Parties:	CCWMO, Carver SWCD, NRCS
2) Timeline:	Long Term
3) Estimated Cost:	$750,000
4) Lakes included:	Hydes, Goose, Miller, Winkler

Task 4. Design and implement practices that will reduce sediment and nutrients into each lake by installing buffer strips, wetland restorations, alternate rock inlets or other water retention devices and/or practices identified by qualified staff.

1) Responsible Parties:	CCWMO, Carver SWCD, NRCS
2) Timeline:	Long Term
3) Estimated Cost:	$750,000
4) Lakes included:	Hydes, Goose, Miller, Winkler

Task 5. Design and implement practices that will reduce sediment and nutrients into each lake by installing wetland restorations. Targeted wetland restoration projects have been identified in Hydes Lake inlet restoration (100K), North Patterson Lake restoration (780K), Goose lake south inlet restoration (200K), Miller Lake northeast restoration (310K), and Winkler Lake restoration and re-meander (300k).

1) Responsible Parties:	CCWMO, Carver SWCD, NRCS
2) Timeline:	Long Term
3) Estimated Cost:	$1,690,000
4) Lakes included:	Hydes, Goose, Miller, Winkler

Task 6. Design and implement practices that will reduce sediment and nutrients into each lake by innovative design technology and practices including but not limited to "bio-reactor run-off structures" to treat tile discharge and in-line ditch sediment control structures along with other technologies as they are identified by qualified staff.

1) Responsible Parties:	CCWMO, Carver SWCD, NRCS
2) Timeline:	Long Term
3) Estimated Cost:	$780,000
4) Lakes included:	Hydes, Goose, Miller, Winkler

5.2.2 Animal Manure/Feedlot Management

Animal manure management and to a lesser extent feedlot run-off will be examined and appropriate measures will be taken to ensure that these activities do not result in a phosphorus load entering each lake. Many of the practices are also outlined in the NRCS field handbook and will be utilized again to control any problem areas that are encountered or previously identified in our modeling.

Task 1. Identify potential areas and contact landowners to inform them of funding and projects that they can initiate to benefit each lake and their properties.

1) Responsible Parties:	CCWMO, Carver SWCD
2) Timeline:	Long Term
3) Estimated Cost:	$5000
4) Lakes included:	Hydes, Goose, Miller, Winkler

Task 2. Identify and educate landowners through meetings, brochures, Carver County quarterly newspaper (The Citizen), Carver County Website, and various workshops.

1) Responsible Parties:	CCWMO, Carver SWCD

2) Timeline:	Long Term
3) Estimated Cost:	$25,000
4) Lakes included:	Hydes, Goose, Miller, Winkler

Task 3. Work directly with the landowners that have feedlots or land application of manure on their properties. For active feedlots the MINNFARM computer software will be used to identify potential pollution problems. Current NRCS technical practices and standards will be used for feedlot pollution abatement and manure application.

1) Responsible Parties:	CCWMO, Carver SWCD
2) Timeline:	Long Term
3) Estimated Cost:	$140,000
4) Lakes included:	Hydes, Goose, Miller, Winkler

5.2.3 Urban/Development Runoff

Improved management of urban runoff, particularly from lakeshore properties and those properties within the each lake's direct watershed will reduce phosphorus loading to the Lake. Urban/developed phosphorus runoff management will include but is not limited to the following components; installation of rain gardens, street sweeping, removal of leaf litter from streets, installation of shoreline buffers, stabilization of eroding lakeshore infiltration/detention ponds, erosion and sediment control and utilizing low impact development techniques.

Urban development often brings about an increase in impervious surface due to new roads, rooftops, parking lots, channelization and piping. These surfaces do not let rain water soak into the ground so large amounts of water run into storm sewers which empty into nearby water bodies. In addition, monitoring and modeling has indicated that urban pollutant loads are directly related to watershed imperviousness. CCWMO requires filtration/bio-retention treatment for new development and promotes and encourages reduction in runoff and increased infiltration in re-development and retrofits. CCWMO addresses the use of components such as infiltration ponds, silt fencing and minimization of new impervious surfaces in the County Water Management Plan and Rules. CCWMO will continue to take lead on ensuring preventative measures are installed during construction as well as retrofits and will evaluate increased standards in the update of its Plan and Rules.

Task 1. Utilize Carver County's GIS to identify potential project areas and "hotspots" within the Lakes' subwatersheds. Hotspots are defined as areas that have high potential to deliver phosphorus lakes based on such factors as area of impervious cover and lack of stormwater BMPs. This will be followed up with evaluating and identifying what practices identified above or from the Minnesota Stormwater BMP Manual should be considered. Costs associated with identified projects are not included in the figure below and will be added to this plan at a later time.

1) Responsible Parties:	CCWMO, Carver SWCD, City of Waconia
2) Timeline:	Long Term
3) Estimated Cost:	$50,000
4) Lakes included:	Hydes, Goose, Miller, Winkler

Task 2. Identify landowners that either have properties contributing to the impairment or have the potential to reduce the impairment and provide education/outreach through meetings, brochures, Carver County Website, and various workshops.

1) Responsible Parties:	CCWMO, Carver SWCD, City of Waconia
2) Timeline:	Long Term
3) Estimated Cost:	$25,000
4) Lakes included:	Hydes, Goose, Miller, Winkler

Task 3. Design and implement urban BMPs to reduce phosphorus inputs to the Lake based on interest of targeted landowners and available monies through the County's Low Cost Cost Share Program. BMPs including but not limited to rain gardens, shoreline restorations and urban BMPs will be designed and implemented to reduce phosphorus inflows into each lake.

1) Responsible Parties:	CCWMO, Carver SWCD, City of Waconia
2) Timeline:	Long Term
3) Estimated Cost:	$550,000
4) Lakes included:	Hydes, Goose, Miller, Winkler

Task 4. Identify current and future street sweeping schedules that the Cities have in place and if necessary conduct a load analysis to determine optimum level of sweeping necessary. If necessary, work with the city to implement a continual spring and fall schedule for sweeping within the subwatersheds. The City has identified this BMP in both the Local Water Management Plan and the SWPPP.

1) Responsible Parties:	CCWMO, Carver SWCD, City of Waconia
2) Timeline:	Medium Term
3) Estimated Costs:	$12,000
4) Lakes included:	Miller

Task 5. Identify current and future stormwater pond clean out schedules within the subwatershed to ensure proper operation and maintenance schedules are in place. A maintenance plan is included in the City's Local Water Management

Plan. If necessary, work with the City to develop and implement a schedule that targets ponds that are less effective due to design or maintenance concerns, and areas that will more adequately treat run-off. In addition, we could also identify and retrofit any current stormwater ponds within the subwatersheds that could be updated with current standards.

1) Responsible Parties:	CCWMO, Carver SWCD, City of Waconia
2) Timeline:	Medium Term
3) Estimated Costs:	$400,000
4) Lakes included:	Miller

Task 6. All currently undeveloped land within the each lake's Watershed will be required to meet current and any amended stormwater standards including volume reduction and runoff treatment. Review and updates of both the CCWMO plan and ordinances will include the pollutant reduction methods needed for the Four Lake TMDL. The City plan and SWPPP will need to be updated to meet any revised CCWMO plans and ordinances. Additional LID practices will be encouraged during the site design and review process. Costs will focus on the development and evaluation of CCWMO plan, ordinances, City plan, and SWPPP. Incentives will be considered in order to promote these practices.

1) Responsible Parties:	CCWMO, Carver SWCD, City of Waconia
2) Timeline:	Long Term
3) Estimated Costs:	$50,000
4) Lakes included:	Hydes, Goose, Miller, Winkler

5.2.4 Canada Goose Management

During recent years, residents within Carver Creek have reported larger numbers of Canada geese utilizing the lakes and surrounding lands. Managing a healthy population of geese within the subwatersheds is a step towards stabilizing in-lake phosphorus concentrations. Canada geese populations tend to exponentially increase in metro areas due to the natural tendency to nest and rear young relatively close to the original location that they were reared and the low pressures of mortality (i.e. protected from hunting and predation). While these areas are not considered to be in the Metro Area, hunting is still relatively light around the subwatersheds due to the location of nearby farms, houses, parks, and developed areas.

Task 1. Determine the population of migratory and resident Canada geese and the actual contribution of phosphorus from fecal pellets to each waterbody.

1) Responsible Parties:	CCWMO, MnDNR
2) Timeline:	Long Term
3) Estimated Costs:	$22,500

4) Lakes included: Goose, Hydes, Miller, Winkler

Task 2. Educate land owners of the use of native buffers along shoreline to help reduce the amount of geese utilizing shoreline for feeding and nesting.

1) Responsible Parties: CCWMO
2) Timeline: Long Term
3) Estimated Costs: $10,000
4) Lakes included: Goose, Hydes, Miller, Winkler

Task 3. If deemed necessary, implement a goose harassment/removal program in coordination with the Minnesota Department of Natural Resources.

1) Responsible Parties: CCWMO, MnDNR
2) Timeline: Long Term
3) Estimated Costs: $4,000 per removal
4) Lakes included: Goose, Hydes, Miller, Winkler

5.3 Internal Loading Reduction Strategies

Based on monitoring and modeling results and meetings all parties involved have determined that controlling and reducing internal loading of phosphorus will play a major role in meeting the determined reductions. Internal phosphorus loading could be reduced by the implementation of the following methods: fish barriers, rough fish control, removal of invasive aquatic plants and establishment of native vegetation, motorized boat wake restrictions, alum dosing. Furthermore, reductions to the external load will aid in diluting and flushing out of the nutrient rich sediments in each lake and will minimize future internal loading.

CCWMO will partner with the Minnesota Department of Natural Resources (MDNR) to determine possible fish barrier sites and feasibility. Possible barrier sites include the inlets and the outlets of each lake. The purpose would be to prevent carp from utilizing surrounding wetland areas as breeding grounds. In addition to the barriers, CCWMO will coordinate with the MDNR and University of Minnesota to determine if rough fish removal is necessary.

Native aquatic plants would promote improved water quality by minimizing re-circulation of bottom sediments, competing with algae for nutrients, and providing habitat for zooplankton (which eat algae). CCWMO and Carver SWCD will pursue a partnership with the MDNR to reduce the invasive species currently present and establish a healthy native aquatic plant population in areas of the lake less than 15 feet in depth.

Motorized boat traffic wake restrictions could aid in the reduction of in-lake nutrient re-circulation, especially in shallow area of each lake. The mixing is a result of wind mixing, rough fish rooting and boat motors in areas less than 10 feet in depth. In lakes with DNR access, use by motor boats can be moderate on the weekends and restricting speed near the shoreline may yield a reduction in sediment/nutrient re-suspension in shallow areas of the lake and also would reduce the erosion impacts the waves have on shoreline and should be looked at more closely.

Aluminum sulfate (Alum) is a chemical addition that forms a non-toxic precipitate with phosphorus. The alum binds with water column phosphorus, precipitates to become part of the lake sediments making that phosphorus unavailable for algal growth. Alum also forms a barrier between lake sediments and the water to restrict phosphorus release from the sediments. CCWMO will inquire if alum or any other internal manipulation is a viable option and if so will establish the treatment area and dosing rates.

The interim and final goals for the reducing internal phosphorus are indicated below:

	Current Internal Load (kg/yr)	Interim Goal (ug/L)	Interim goal load (ug/L)	% reduction needed	Final Goal (ug/L)	Final Goal Load (ug/L)	Total % reduction needed
Goose	245	90	206	36	60	111	68
Hydes	397	60	189	52	40	76	81
Miller	104	90	85	18	60	42	59
Winkler	2013	90	435	78	60	162	92

Target Locations: Hydes, Goose, Miller, and Winkler Lakes Subwatersheds
Timeline: Long Term
Estimated total cost of all tasks: $2,982,500

5.3.1 In-Lake Strategies

Task 1. Identify fish barrier sites and the possibility of rough fish removal success. If fish removal is deemed beneficial begin a program to adequately address the goal of the TMDL.

1) Responsible Parties CCWMO, MDNR
2) Timeline: Short Term
3) Estimated Cost: $450,000
4) Lakes included: Hydes, Goose, Miller, Winkler

Task 2. Chemical or mechanical removal of invasive aquatic plant species and replace with diverse native aquatic plant species.

1) Responsible Parties	CCWMO, Carver SWCD, MDNR
2) Timeline:	Long Term
3) Estimated Cost:	$275,000
4) Lakes included:	Hydes, Goose, Miller, Winkler

Task 3. Determine if designation of near shore wake-restricted zones is necessary and determine appropriate actions and steps for implementation, including signage and education.

1) Responsible Parties	CCWMO
2) Timeline:	Short Term
3) Estimated Cost:	$12,500
4) Lakes included:	Hydes, Goose, Miller, Winkler

Task 4. Implement aluminum sulfate (ALUM) or other viable treatment options to reduce internal phosphorus loading. Also consider and schedule long term treatment options as suggested by state agencies and/or consultants.

1) Responsible Parties	CCWMO, Carver SWCD, MDNR
2) Timeline:	Long Term
3) Estimated Cost:	$600,000
4) Lakes included:	Hydes, Goose, Miller, Winkler

Task 5. Determine the feasibility of drawing down the lakes or other viable mechanical options (aeration, barely straw, dredging, iron filings, etc) to reduce phosphorus loading. Implement if feasible and funding is available.

1) Responsible Parties	CCWMO, Carver SWCD, MDNR
2) Timeline:	Long Term
3) Estimated Cost:	$700,000
4) Lakes included:	Hydes, Goose, Miller, Winkler

Task 6. Several of the impaired water bodies are shallow and have accumulated several feet of nutrient laden sediment. To cost effectively implement several of the practices outline above it may be necessary to explore innovative ways to remove this material. Dredging, vacuuming or other options will be explored and undertaken if proven to be cost effective.

1) Responsible Parties	CCWMO, Carver SWCD, MDNR
2) Timeline:	Long Term
3) Estimated Cost:	$900,000
4) Lakes included:	Hydes, Goose, Miller, Winkler

Task 7. Ongoing monitoring of all Lakes as outlined in section 6.5**.**

1) Responsible Parties: CCWMO
2) Timeline: Long Term
3) Estimated Costs: $45,000
4) Lakes included: Hydes, Goose, Miller, Winkler

5.4 Project Timeline and Measurable Milestones

5.4.1 Timeline

The first priority of the implementation plan will be to address each of the short term goals identified in the external and internal reduction strategies, followed by medium and long term goals. Many of the tasks involved in implementing these goals will overlap and complement one another while others may not need to be completed after initial assessment or pertinent information is made available. Each task will ultimately be completed as resources and opportunities present themselves, which could allow some long and medium term tasks to be completed sooner rather than later. Many of the tasks identified as "Long Term" may actually start immediately but will be ongoing throughout the life of the project and perhaps beyond.

5.4.2 Measurable Milestones

As noted above, our measureable milestone will be ultimately bringing Hydes, Goose, Miller, and Winkler Lakes into compliance with state water quality standards by 2030. Along the way our first milestone will be measured in-lake phosphorus concentration at 60 ug/L by the year 2020 and long term positive trend indicating that changes being made are working.

As we progress through implementation and it appears that our completed tasks are not providing enough treatment to reach our interim and final goals we would utilize Bathtub (as outlined in the Four Lake TMDL) with up to date data and land use information to identify new hot spots and problem areas that may not have been previously addressed. If discrepancies are identified, the implementation plan will be updated.

6.0 Reasonable Assurance

6.1 Introduction

When establishing a TMDL, reasonable assurances must be provided demonstrating the ability to reach and maintain water quality endpoints. Several factors control reasonable assurances, including a thorough knowledge of the ability to implement BMPs, as well as the overall effectiveness of the BMPs. Carver County is positioned to implement the TMDL and ultimately achieve water quality standards.

6.2 Carver County

The Carver County Board of Commissioners (County Board), acting as the Water Management Authority for the former Bevens Creek (includes Silver Creek), Carver Creek, West Chaska Creek, East Chaska Creek, and South Fork Crow River watershed management organization areas, has established the "Carver County Water Resource Management Organization" (CCWMO). The purpose of establishing the CCWMO is to fulfill the County's water management responsibilities under Minnesota Statute and Rule. The County chose this structure because it will provide a framework for water resource management as follows:

- Provides a sufficient economic base to operate a viable program.
- Avoids duplication of effort by government agencies.
- Avoids creation of a new bureaucracy by integrating water management into existing County departments and related agencies.
- Establishes a framework for cooperation and coordination of water management efforts among all of the affected governments, agencies, and other interested parties.
- Establishes consistent water resource management goals and standards for at least 80% of the county.

The County Board is the "governing body" of the CCWMO for surface water management and the entire county for groundwater management. In function and responsibility the County Board is essentially equivalent to a joint powers board or a watershed district board of managers. The watersheds of Hydes, Goose, Miller, and Winkler Lakes are part of the CCWMO.

In order to fulfill legislative requirements or surface and groundwater, Carver County developed a Water Management Plan that was adopted in 2001. The goal of the Plan is to protect, preserve and manage the county's surface and groundwater systems in the midst of rapid growth and intensive agricultural activity. The plan presents sustainable and equitable methods to reach that goal by providing guidance and specific standards for decision-makers, residents, landowners, educators, and implementing staff at the local level. Within the Water Management Plan, there are twelve priority areas the county has identified needing immediate and continued action. These include:

Subsurface Sewage Treatment Systems (SSTS), Feedlots, Construction Site Erosion and Sediment Control, Stormwater Management, Land Use Practices for Urban and Rural Areas, Water Quality Assessment, Wetland Management, Groundwater, Natural Resource Management, Education, TMDLs, and Solid Waste.

Multiple county departments help implement the CCMWO plan. The Carver County Board of Commissioners is the governing board. The Water, Environment, and Natural Resources (WENR) Committee acts as the citizen advisory board and the Planning & Water Management department are responsible for administration, implementation and coordination. Implementation is also the responsibility of Environmental Services, University of Minnesota Extension, and the Carver Soil & Water Conservation District (SWCD).

The County is uniquely qualified through its zoning and land use powers to implement corrective actions to achieve TMDL goals. The County has stable funding for water management each year, but will likely need assistance for full TMDL implementation in a reasonable time frame, and will continue its baseline-monitoring program. Carver County has established a stable source of funding through a watershed levy in the CCWMO taxing district (adopted 2001). This levy allows for consistent funding for staff, monitoring, and engineering costs, as well as on the ground projects.
The County has also been very successful in obtaining grant funding from local, state and federal sources due to its organizational structure.

Carver County recognizes the importance of the natural resources within its boundaries, and seeks to manage those resources to attain the following goals:

1. Protect, preserve, and manage natural surface and groundwater storage and retention systems.
2. Effectively and efficiently manage public capital expenditures needed to correct flooding and water quality problems.
3. Identify and plan for means to effectively protect and improve surface and groundwater quality.
4. Establish more uniform local policies and official controls for surface and groundwater management.
5. Prevent erosion of soil into surface water systems.
6. Promote groundwater recharge.
7. Protect and enhance fish and wildlife habitat and water recreational facilities.
8. Secure the other benefits associated with the proper management of surface and ground water.

Water management involves the following County agencies: Carver County Land and Water Services Division; Carver County Extension; and the Carver Soil and Water Conservation District (SWCD). The County Land and Water Services Division is responsible for administration of the water plan and coordinating implementation. Other departments and agencies will be called upon to perform water management duties that fall within their area of responsibility. These responsibilities may change as the need arises. The key entities meet regularly as part of the Joint Agency Meeting (JAM) process to coordinate priorities, activities, and funding.

6.3 Regulatory Approach

6.3.1 Watershed Rules

Water Management Rules establish standards and specifications for the common elements relating to watershed resource management including: Water Quantity; Water Quality; Natural Resource Protection; Erosion and Sediment Control; Wetland Protection; Shoreland Management; and Floodplain Management. Of particular benefit to nutrient TMDL reduction strategies are the stormwater management and infiltration standards which are required of new development in the CCWMO. The complete water management rules are contained in the Carver County Code, Section 153. The Rules will be evaluated, updated and enforced along with the watershed plan to address TMDLs where needed.

6.3.2 NPDES Permits

The MPCA issues NPDES permits for Point Source discharges into waters of the state. These permits have both general and specific limits on pollutants that are based on water quality standards. Permits regulate discharges with the goals of protecting public health and aquatic life, and assuring that every facility treats wastewater. More information about permits, water quality data, and other MPCA programs can be found on the agency's Web site: http://www.pca.state.mn.us/water.

MS4s that have been designated by the MCPA for permit coverage under Minn. R. ch. 7090 are required to obtain a NPDES/SDS stormwater permit. The stormwater Program for MS4s is designed to reduce the amount of sediment and pollution that enters surface and ground water from storm sewer systems to the maximum extent practicable. As part of the permit the city of Waconia will be required to develop and implement a stormwater pollution prevention program (SWPPP) to reduce the discharge of pollutants from their storm sewer system. The SWPPPs are required to cover six "minimum control measures" to ensure adequate stormwater management and pollution prevention. Measures include:

1) Public education and outreach.
2) Public participation/involvement.
3) Illicit discharge, detection and elimination.
4) Construction site runoff control.
5) Post-construction site runoff control, and
6) Pollution prevention/good housekeeping.

For more information visit the MPCA Web site:
http://www.pca.state.mn.us/water/stormwater/stormwater-ms4.html.

6.4 Non-Regulatory Approaches

6.4.1 Education

The implementation of this Plan relies on three overall categories of activities: Regulation, Incentives, and Education. For most issues, all three means must be part of an implementation program.

The County has taken the approach that regulation is only a supplement to a strong education and incentive based program to create an environment of low risk. Understanding the risk through education can go a long way in preventing problems. In addition, education, in many cases, can be a simpler, less costly and more community-friendly way of achieving goals and policies. Education efforts can provide the framework for more of a "grass roots" community plan implementation, while regulation and incentives traditionally follow a more "top-down" approach. It is recognized, however, that education by itself will not always meet intended goals, has certain limitations, and is characteristically more of a long-term approach. To this end, Carver County created the Environmental Education Coordinator position in 2000. This position has principal responsibility for development and implementation of the water education work plan.

Several issues associated with the water plan were identified as having a higher priority for educational efforts. These were identified through discussions with the advisory committees, based on ease of immediate implementation and knowledge of current problem areas and existing programs. The higher priority objectives are not organized in any particular order. The approach to implement the Four Lake TMDL will mimic the education strategy of the water plan. Each source reduction strategy will need an educational component, and will be prioritized based on the number of landowners, type of source, and coordination with existing programs.

6.4.2 Incentives

Many of the existing programs on which the water management plan relies are incentive-based programs offered through the County and the Carver SWCD. Some examples include: state and federal cost share funds directed at conservation tillage, crop nutrient management, rock inlets, conservation buffers, and low interest loan programs for SSTS upgrades. Reducing nutrient sources will need to rely on a similar strategy of incorporating incentives into implementing practices on the ground. After the approval of the TMDL by the EPA and the County enters the implementation phase, it is anticipated that we will apply for monies to assist landowners in the application of BMPs identified in the Implementation Plan.

6.5 Effectiveness Monitoring

Regular bi-weekly (April – October) in lake monitoring of Hydes, Goose, Miller and Winkler Lakes will continue as identified in the Water Plan and will be conducted at least every other year in order to adequately asses water quality trends in each lake. In-lake collection includes collection of water column profiles (temperature, dissolved oxygen) and discrete water sample collection from the surface including phosphorus, Secchi dish depths, total nitrogen, and chlorophyll-a. However, after implementation of nutrient reduction strategies a stepped-up approach of monitoring will be conducted including integrated depth sampling as well as in-let and outlet sampling to gain an even better handle on how well the implementation plan is working. Adaptive management relies on the County conducting additional monitoring as BMPs are implemented in order to determine if the implementation measures are effective and how effective they are. A sediment core of each lake will be taken providing funding exists, the information extracted from the core will help us to more accurately target the needs of each lake and contributing watershed as well as give us an overall goal for our Adaptive management strategies.

Additional areas that may be monitored include; hypolimnetic sampling to aid in determining internal load reductions, sampling at the lake inlets/outlets during the spring when flow is highest, additional samples in strategic areas, and land use change monitoring. Inflow/outflow monitoring will be initiated during and after implementation of the TMDL to quantify external load reductions as will hypolimnetic sampling. Automated stream samplers will be established at the primary outflow where continuous flow data is needed and composite samples collected during rainfall runoff events. Samples will be analyzed for total phosphorus, total nitrogen and total suspended solids. The flow and water quality data will be used to estimate phosphorus loading to the lake to confirm the TMDL reductions.

Furthermore, assessment of the stormwater discharge may be monitored to better grasp the nutrient loads caused by runoff from surrounding land. This monitoring will assist in evaluating the success of projects and identify changes needed in management strategies. Revision of management and monitoring strategies will occur as needed.

7.0 Adaptive Management

The phosphorus allocations represented in this TMDL represent aggressive goals; consequently, implementation will be conducted using adaptive management principles. These principals are a systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices. In active adaptive management, managers design practices so as to discriminate between alternative models, and thus reveal the "best" management action. This sometimes involves testing practices that differ from "normal", in order to determine how indicators will respond over a range of conditions. In passive adaptive management, managers select the "best" management option, assuming that the model on which the predictions are based is correct. Both passive and active adaptive management require careful implementation, monitoring, evaluation of results, and adjustment of objectives and practices. Active adaptive management usually allows more reliable interpretation of results, and leads to more rapid learning.

The criteria outlined in section 5.0 of the implementation plan will rely on monitoring for measuring our progress towards active adaptive management, while some passive adaptive management will be tracked through modeling efforts. Adaptive management is appropriate because it is difficult to predict the phosphorus reduction that will occur from implementing strategies with the scarcity of information available to demonstrate expected reductions. Limited reduction research is available for BMPs at this time, but this is expected to change in the next several years as state agencies and local experience provide more accurate reduction data. The County has and will continue to look at viable tools that will help to predict and measure the actual reductions that installation of a particular BMP may have.

Future technological advances may alter the specific course of actions detailed here. Continued targeted monitoring based on a project work plan and “course corrections” responding to monitoring results are the most appropriate strategy for attaining the water quality goals established in this TMDL.