Phosphorus Source Assessment of the Roberds Lake Watershed

Cannon River Watershed Partnership
December 2007
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Executive Summary

"If present conditions and inputs continue, a gradual worsening of the lake's condition and suitability for recreation will result. The lake is a reflection of its watershed." – MPCA, Lake Assessment of Roberds Lake, 1994

The landscape of the Cannon River watershed contains many lakes, two major rivers and countless streams and wetlands. The surface water landscape in the watershed is a direct result of glacial activity. The lakes are principally located in the northwestern portion of the watershed. Roberds Lake water quality is poor relative to other lakes in the North Central Hardwood Forest ecoregion. The summer water clarity averages less than two feet. Soil erosion and nutrient runoff from its watershed has made Roberds Lake non-supporting of swimming and it is classified as hypereutorphic. The overall enrichment of nutrients has accelerated the aging of the lake resulting in poor water quality such as heavy algal blooms throughout the summer, dense macrophyte beds, low water clarity due to low light penetration, summer fish kills, and a dominance of rough fish.

In order to reduce the frequency and severity of the algal blooms, the input of phosphorus to the lake must be reduced. As the quotation above illustrates, we have know for at least 13 years that phosphorus input is a major problem for this lake. Identifying where the phosphorus is coming from as specifically as possible is a necessary step.

The overall goals of the proposed project were to:

1. Assess the sources of phosphorus to Roberds Lake and suggest possible strategies to reduce these sources.
2. Create a systematic approach to conduct phosphorus source assessments on the remaining lakes in the Cannon River watershed.

The Cannon River Watershed Partnership (CRWP) received a Conservation Partners and Environmental Partnership Grant from the Minnesota Department of Natural Resources (DNR) to conduct this phosphorus source assessment. The entire Roberds Lake watershed includes the French Lake and Kelly-Dudley lake watersheds as well. The French Lake watershed had been looked at previously. For this project we decided to focus on the eastern quadrant of the Roberds Lake watershed which is the area closest to Roberds Lake as we felt that area probably had the greatest impact on the lake. We also captured the water quality from the upper portions of the entire watershed by looking at the inlet from French Lake creek to Roberds Lake. For the remainder of this report we will refer to this area as "the watershed". The grant period was from July 1, 2006 – December 31, 2007. CRWP worked with local partners to gather existing data and create GIS based maps of this information. Presenting this data in a visual format such as the GIS based maps helps to more easily "see" areas of potential problems. The watershed does not have any permitted point sources of phosphorus. Therefore, we needed to create an inventory of the nonpoint sources such as agricultural fields, feedlots, septic systems, residential stormwater runoff, and natural background. We also decided that in addition to monitoring the lake water quality as many of the inlet streams as possible would be monitored for phosphorus to help determine which areas may need the most attention. The Rice County Planning and Zoning office provided septic system record summaries, feedlot information and GIS layers. The Rice County Soil and Water Conservation District (SWCD) assisted with a review of aerial photos and partial ground truthing of possible gully erosion and evaluation of buffer potential with respect to conservation programs. CRWP gathered data from these partners, created GIS maps, selected and organized water quality monitoring, reviewed shoreland uses from the lake, conducted a windshield survey of fall tillage practices, attempted to collected data regarding possible phosphorus loss from individual sites, created soil erosion and phosphorus loss estimate examples, and hosted a public meeting for watershed residents. Data on restorable wetlands was obtained from the US Fish and Wildlife Service/Ducks Unlimited Restorable Wetlands Inventory proejct. The Roberds Lake Club members and residents assisted with water sample collection from the lake and some inlet streams along with providing a history of the area. A survey of the curlyleaf pondweed problem areas was conducted by Freshwater Scientific Services, LLC.

Public participation was an important part of the project. CRWP sent out a mailing in November, 2006 to inform residents of what we were working on and to request their input on possible pollutant sources. A presentation about the project was made to the Roberds Lake Club at their Annual Meeting in April, 2007. Several of the club members offered assistance in sample collection and brought issues regarding lake water quality to our attention. A meeting to discuss our findings, ask for public comment, and present some suggestions for the future was held on November 14, 2007. A mailing was also sent to landowners with cropland in early November 2007 inviting them to provide data so that CRWP could run the Minnesota Phosphorus Index Model to estimate risk of phosphorus loss from individual fields.

A list of recommended action steps is included at the end of the report. As all types of land use contribute to the phosphorus problem, they will all need to play a role in the solution. A strong and sustained effort on the part of residents, government and concerned parties will be needed in order for any progress to be made. CRWP feels that the lessons learned from this process have provided us with a good template that can be used on other lakes in our watershed. Many thanks to all those who helped us along the way!

Background

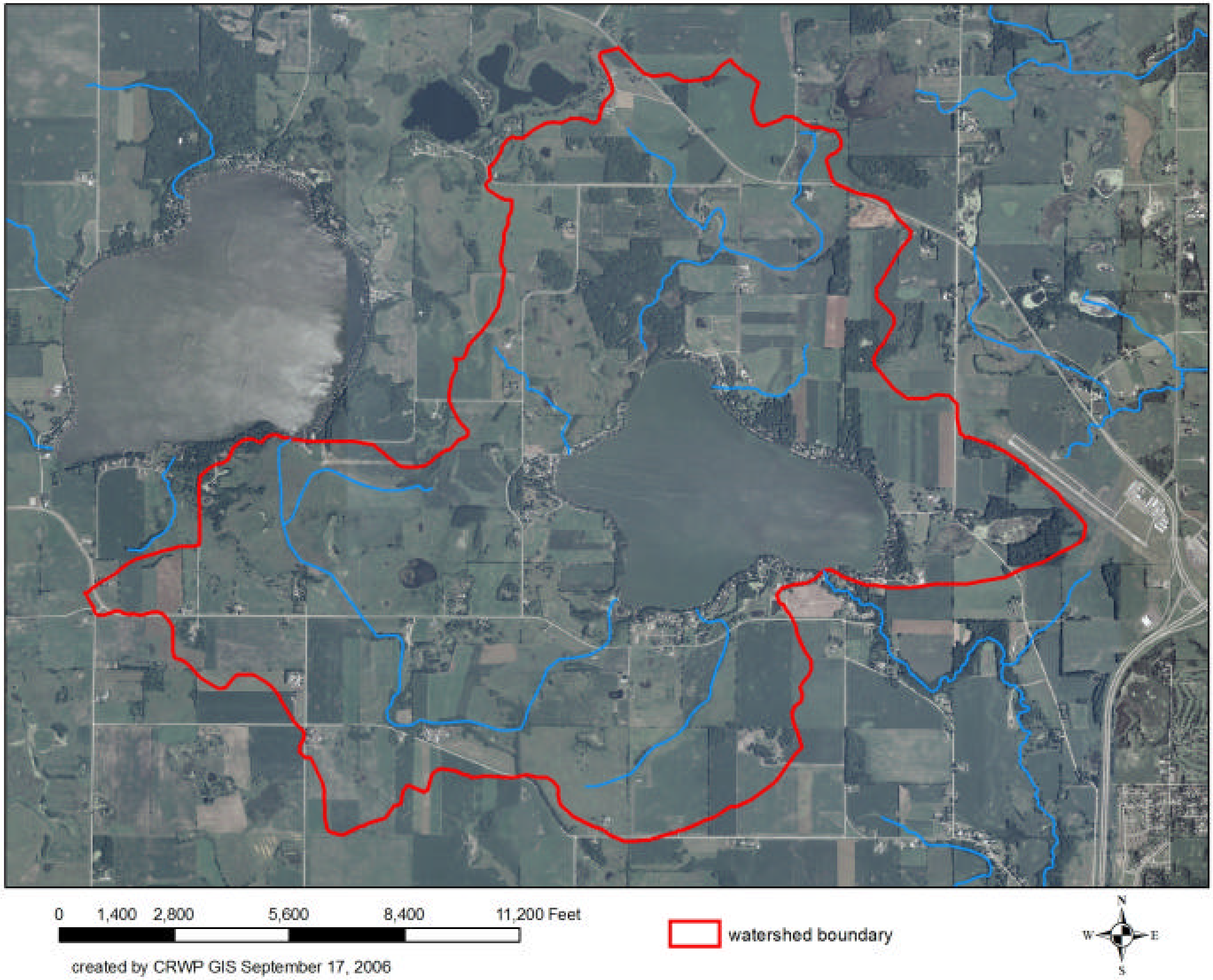
The Lake

According to the Minnesota Pollution Control Agency 1994 Lake Assessment, Roberds Lake has a surface area of 654 acres and 5 miles of shoreline. Minnesota Department of Natural Resources lists the lake area as 625 acres. The total watershed is 8025 acres yielding a watershed to lake ratio of 14:1. This includes land around French Lake and Kelly and Dudley lakes as these lakes drain to Roberds. For this project, we focused on the land area directly around Roberds and accounted for input from the other lakes by assessing inflow to Roberds Lake from French Lake Creek that flows out of French Lake. The maximum depth of the lake is 43 feet with an average depth of approximately 13 feet. Overall the lake is rather shallow and has a large wind fetch, which means that the lake tends to mix quite easily (MPCA, 1994). The littoral zone covers approximately 63% of the lake. There are five inlet streams and one outlet. There are also many intermittent ditches and culverts that drain to the lake. A map of the watershed area we focused on is shown in Figure 1. Roberds Lake is located just within the border of the North Central Hardwood Forest (CHF) ecoregion with the Western Corn Belt Plains (WCP) ecoregion to the south. Soils belong to the Lester-Heyden associations which are moderately steep loams that were formed in upland glacial till. Permeability of the soil is moderate and the water table is below 10 ft. Runoff is moderate to rapid and potential for erosion can be severe. (MPCA, 1994)

Phosphorus

Phosphorus is an essential element for plant growth and crop production. In soil and water phosphorus does not exist on its own, but as a phosphate molecule (phosphorus and oxygen). Orthophosphate is the form of phosphate that is readily available for uptake by plants. Total phosphorus in water is all of the phosphorus in solution regardless of its form. Phosphorus may be dissolved in runoff water (soluble or dissolved phosphorus) or it can be associated with soil or organic matter particles (particulate phosphorus). (Randall, 2002). While both nitrogen and phosphorus are needed for plant growth, phosphorus is usually the nutrient in short supply, also know as the limiting factor. Even a slight addition of phosphorus can result in increased algal growth and low dissolved oxygen (EPA, 1997). Phosphorus in the lake contributes to excessive algal growth and severe algal blooms that inhibit aquatic recreation. This thick algal cover may also block out light and limit the growth of native plants.

Figure 1 - Watershed Boundary


0 1,400 2,800 5,600 8,400 11,200 Feet
watershed boundary
N
W
E
S
created by CRWP GIS September 17, 2006

Sources of phosphorus include: agriculture, municipal sewage treatment plants, individual septic treatment systems (ISTS), decaying plant material, runoff from urban areas and construction sites, stream bank erosion, and wildlife. An example of these sources and how phosphorus cycles through the natural system can be seen in Figure 2. A report was completed by Barr Engineering in 2004 that examined the phosphorus sources in Minnesota watersheds. This report describes how the amount of phosphorus from nonpoint sources varies depending on the flow conditions. The following are statewide examples and will vary by region. When conditions are dry and flow is low the total phosphorus comes primarily from: cropland and pasture runoff, atmospheric deposition, ISTS and unsewered communities, urban runoff, and non-agricultural rural runoff. The contribution form tile drainage, and stream banks is negligible. As flow increases to a more "average" condition the contribution from stream bank erosion increases significantly. The amount from cropland and pasture runoff showed some increase, urban runoff decreased somewhat, while ISTS and atmospheric deposition decrease significantly. Under wet, high flow conditions, stream bank erosion is the major source contributing approximately 40% of total phosphorus, followed by cropland and pasture runoff. Atmospheric deposition, non-agricultural rural runoff, urban runoff, ISTS, and tile drainage all play minor roles. The contribution from feedlots was minimal under all conditions.

Figure 2 - The Phosphorus Cycle

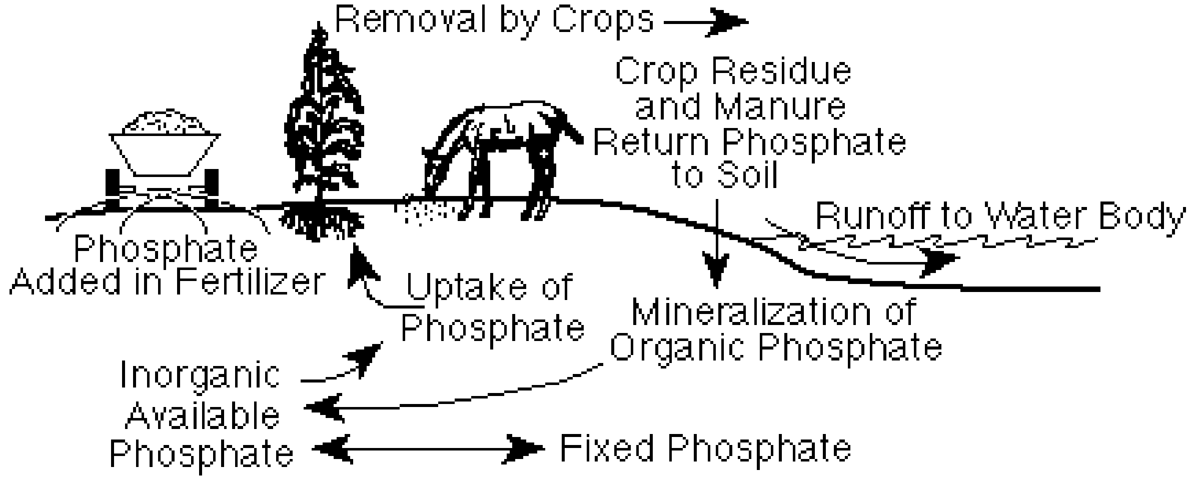


Diagram from The Nature of Phosphorus in Soils, Busman et.al. University of Minnesota Extension, 2002, FO-06795-GO

Data

Historical Data

Data on the in-lake water quality goes back to the early 1970's and has been collected by participants in the Citizen Lake Monitoring Program (CLMP), the Minnesota Pollution Control Agency (MPCA), and Rice County. The primary parameters collected have been Secchi depth, total phosphorus, and chlorophyll-a, with limited sampling for dissolved oxygen and temperature. The Minnesota Department of Natural Resources (DNR) conducts a fish survey every five years with the most recent having been done in 2003.

Conversations with longtime residents indicate that lily pads were once prevalent around the shoreline however that situation has changed. In 1972 a DNR report stated that aquatic plants are almost totally lacking in the lake proper. A plant survey conducted in the summer of 1992 found that curlyleaf pondweed (Potamogeton *crispus*), was the most abundant species.

MPCA Lake Assessment

The Minnesota Pollution Control Agency (MPCA) conducted a lake assessment during the summer of 1992 which was published in June 1994. The Lake Assessment Program (LAP) is designed to assist lake associations or municipalities in the collection and analysis of baseline water quality data for the purpose of assessing the current trophic status of their lake. Total Phosphorus (TP), Chlorophyll-a (Chl-a), and Secchi disk measurements showed water quality poorer than other lakes in the North Central Hardwood Forest (CHF) ecoregion. Chlorophyll-a is a plant pigment and is used as a surrogate measure for algae in the water. Secchi disk measurements are a measure of water clarity. Samples were collected five times from May – Sept, 1992. Mean summer concentrations were: TP = 150 µg/L, Chl-a = 64 µg/L, and Secchi depth of 3.6 feet. As a basis of comparison, the MPCA considers a minimally impacted reference lake in the CHF to have a TP concentration of 23-50 µg/L. Based on this data Roberds Lake was deemed to be eutrophic to hypereutorphic.

During the lake assessment the MPCA conducted modeling using MINLEAP to predict TP concentrations. MINLEAP was developed by MPCA staff based on an analysis of data collected from a set of representative minimally-impacted lakes for each ecoregion (MPCA, 1994). In this case, the model predicted values much lower than what was actually measured. Contributions of nutrients from sediment during summer may provide explanation for this discrepancy (MPCA, 1994). The area where Roberds Lake is located is a more fertile portion than other parts of the CHF which may contribute to the eutrophication problems (MPCA, 1994). Three sources of nutrients were identified as potential problems in the immediate watershed: livestock feedlots near the lake shore, failing on-site sewage treatment systems, and lawn fertilizers that contain phosphorus.

Very little monitoring has been done on the inlet streams. Four samples were taken in August 1990 for TP with the following results: Northeast = 600 µg/L (Misgen Bay), South = 290 µg/L (Chappius Trail), Southwest = 640 µg/L (French Lake Creek) and West = 630 µg/L (Public Access). The TP Concentrations of the input streams are very high. These values suggested that high P sources, such as direct feedlot drainage or direct wastewater inputs are occurring in addition to nonpoint sources (MPCA, 1994).

Some of the recommendations from the MPCA lake assessment were:

1. Citizen Lake Monitoring Program should continue at site 101 (Secchi depths).
2. Lake Association should provide educational info to homeowners re: lawn maintenance and shoreline protection.
3. Any development in the immediate watershed should be completed so that the impacts to lake water quality are minimized
4. Wetland removal or major land use alterations that change the drainage or flow patterns should be discouraged

Department of Natural Resources Lake Surveys

The following review of the lake survey data is provided by Hugh Valiant, DNR Area Fisheries Manager, Waterville, Minnesota.DNR Fisheries lake surveys were conducted in 1950, 1955, 1975, 1983, 1986 (fish only), 1988, 1998 and 2003. The next survey will take place in 2008.

Fish

Roberds has not been a completely stable fish habitat over the past 50+ years. Winterkill was documented in 1955-56 (many local lakes winterkilled that winter e.g. Shields, West Jefferson), 1974-75, 1976-77. Stable-habitat fish species that are typically abundant in bass-panfish situations have generally been abundant but fish species characteristic of unstable habitats, primarily black bullheads, have been more abundant from time to time than would normally be expected. For example, black bullheads were caught at 42.5/gill nets and 163.25/trap nets in 1988. The DNR does not routinely monitor winter dissolved oxygen in Roberds so it is possible that some winter anoxia has occurred in years other than the ones listed. Carp are not sampled very effectively in the standard gill net and trap net gear used in these surveys. Carp tend to increase in abundance in a big way following winterkill as a result of strong immigration skills and fecundity as opposed to low-oxygen tolerance. Roberds is essentially open to fish movement from upstream and downstream fish habitats. Therefore, carp have no doubt proliferated following winterkill events and have likely been a factor in concerns expressed over the decades about poor water clarity and nuisance phytoplankton. Depending on survey timing relative to recent winterkills, we sometimes capture carp, for example 15 1-lb carp/trap net in 1975 following the 1974-1975 winterkill which is a big number.

The abundance of various fishes looked fairly typical for local bass-panfish situations in the most-recent 2003 survey. For example, bluegills were caught at 22/trap net, close to median abundance for this type of lake. Range over the years 1 (1975 following winterkill) to 94. Freshwater drum were caught at 10/trap net in 2003, which is high for the lake class but typical for these hypereutorphic local lakes.

Aquatic macrophytes

In 1950, sago was "common", narrowleaf pondweeds were "abundant" and yellow water lily was "rare." The 1955 surveyor described submergent aquatics as "almost totally lacking." Roberds was apparently treated annually with copper sulphate at that time to control nuisance algae. Subsequent surveys describe submergent and floating-leaf macrophytes as rare. Curlyleaf pondweed (*Potamogeton crispus*) is a phenomenon of recent decades.

Angler use

DNR has counted fish houses on Roberds and other area lakes one day every winter going back to 1980. It gives some indication of angler use. Cedar, French, Mazaska, Roberds and Shields are almost always the top five for Rice County. French is generally higher than the other four. Highest one-day weekday count for Roberds was 303 in 1988.

Current Project Data

During this project, lake water samples were collected three times in 2006 (July-September) and six times in 2007 (June-September). Samples were collected from the first 2 meters of water using an integrated sampler and were analyzed by the Minnesota Department of Health (2006), MVTL (2006) and RMB Environmental Laboratories (2007) for TP and Chl-a. Secchi measurements were taken a total of 20 times during this period. There are five inlet streams to Roberds Lake. Site inspections were done in the spring of 2007 to determine feasibility of collecting water samples for TP analysis. Due to little rainfall and low flow through mid August samples were only collected on a limited basis from three of the sites. Figure 3 shows the sampling locations.

Results for the in-lake samples are presented in Table 1. Median values for Site 101 in 2006 were 369 µg/L TP, 157 µg/L Chl-a, and 0.61 m for Secchi depth. In 2007 median values were 379 µg/L TP, 122 µg/L Chl-a, and 0.61 m for Secchi depth. The TP and Chl-a values are based on three sets of samples in 2006 and six sets of samples in 2007. These values far exceed the typical summer ecoregion values for the CHF as reported by the MPCA (MPCA, 2003) of 23 -50 µg/L TP, 5-22 µg/L Chl-a, and 1.5 – 3.2 m for Secchi depth. This is not a new trend for Roberds Lake as data back to 1970 indicated similar levels of these parameters. This data is displayed graphically in Figures 4-6.

Figure 3 - Sampling Locations

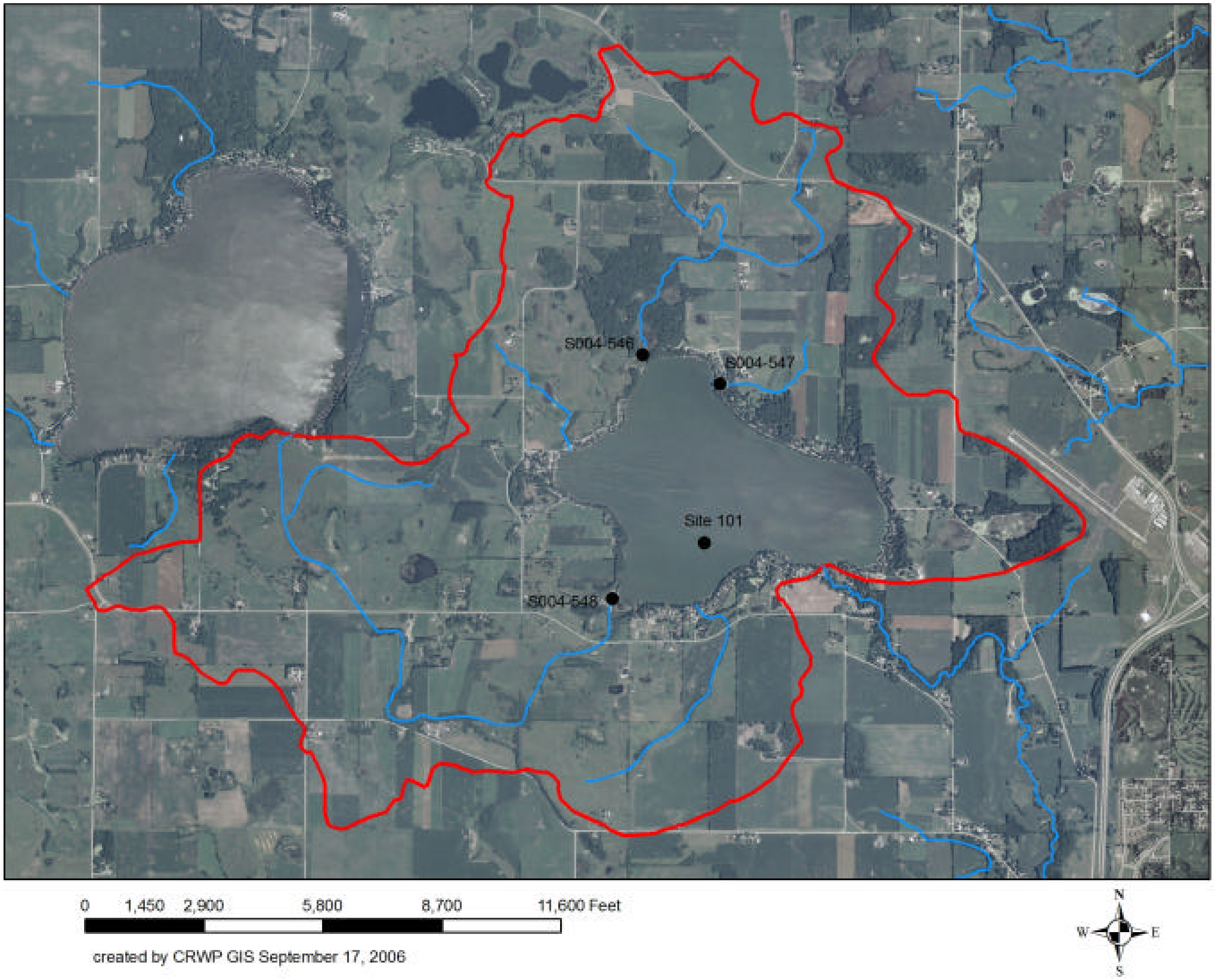


Table 1- Sampling Results Site 101

Date	TP (µg/L)	Chl-a (µg/L)	Secchi (m)
5/7/2006	NA	NA	1.52
5/29/2006	NA	NA	2.59
6/12/2006	NA	NA	1.68
7/18/2006	208	69.3	0.76
8/14/2006	369	177	0.46
8/21/2006	NA	NA	0.46
9/25/2006	442	157	0.3
10/9/2006	NA	NA	0.3
4/29/2007	NA	NA	1.22
5/3/2007	NA	NA	0.91
5/28/2007	NA	NA	1.07
6/1/2007	177	25	1.37
6/15/2007	NA	NA	1.22
6/20/2007	NA	NA	0.61
6/24/2007	263	121	0.61
7/16/2007	469	144	0.46
8/5/2007	376	123	0.3
8/16/2007	NA	NA	0.15
8/26/2007	382	180	0.3
9/16/2007	434	32	0.15

Figure 4- Site 101 Sampling Results for Total Phosphorus

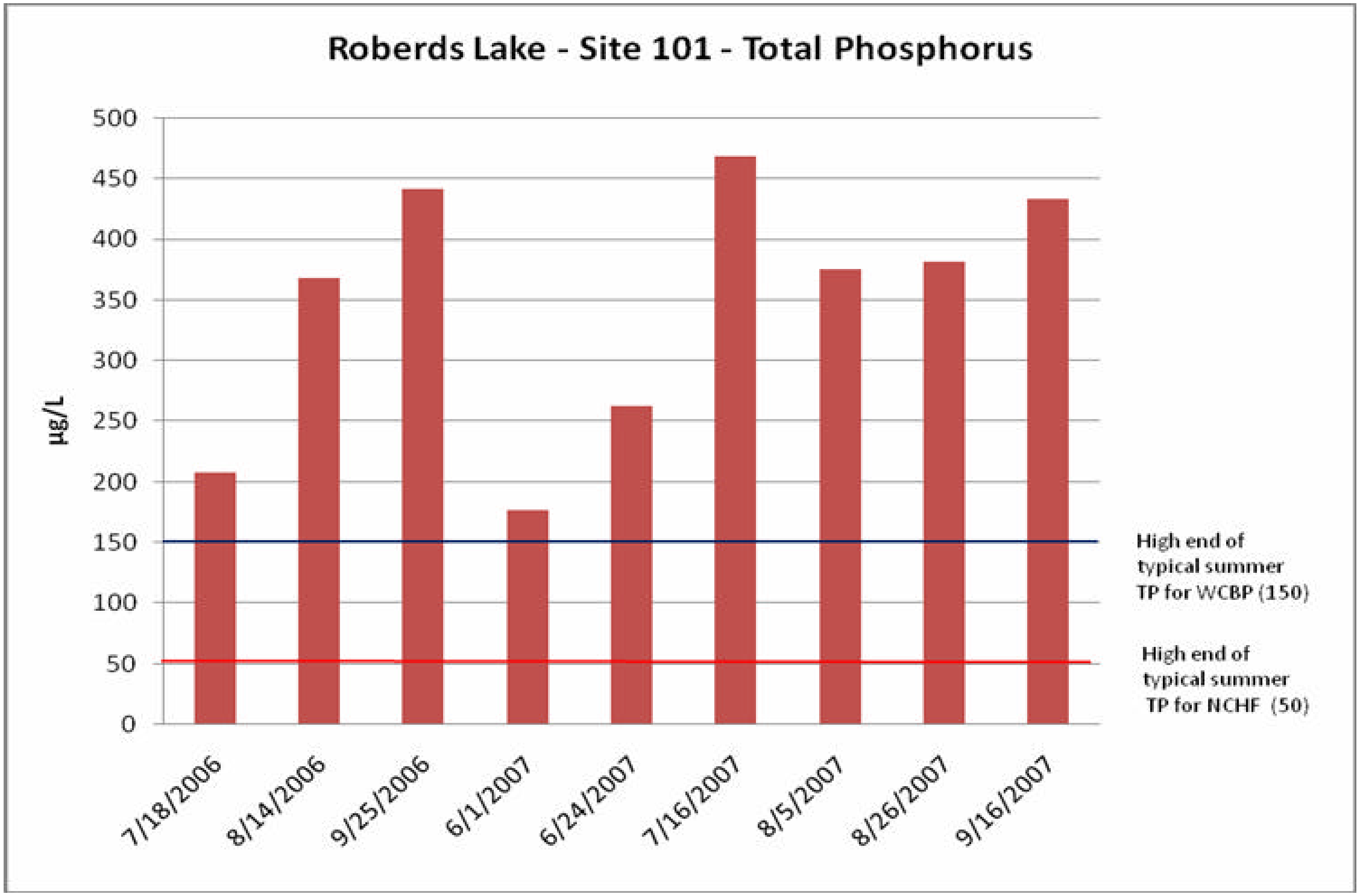


Figure 5 - Site 101 Sampling Results for Chlorophyll-a

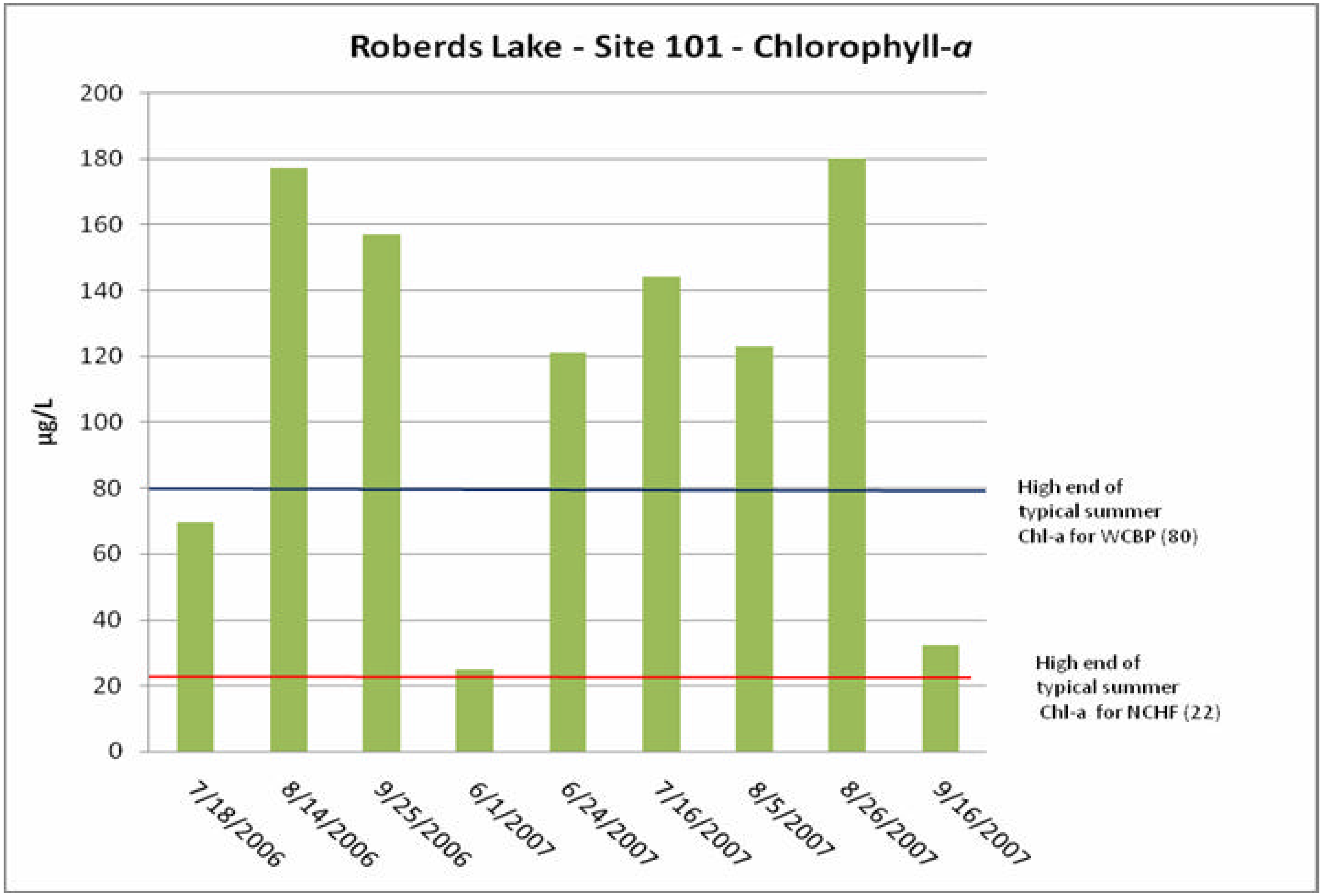
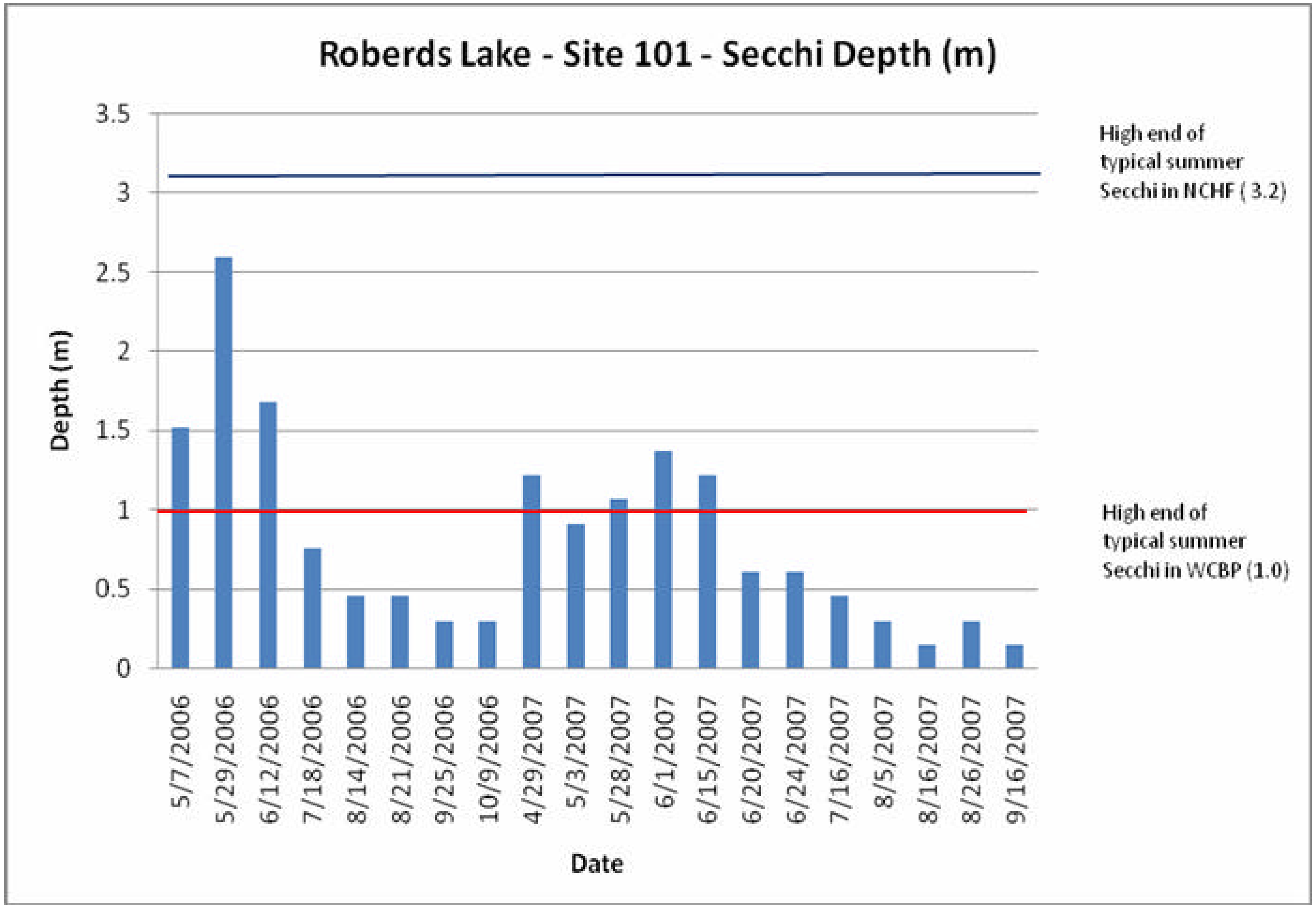


Figure 6 - Site 101 Secchi Disk Results

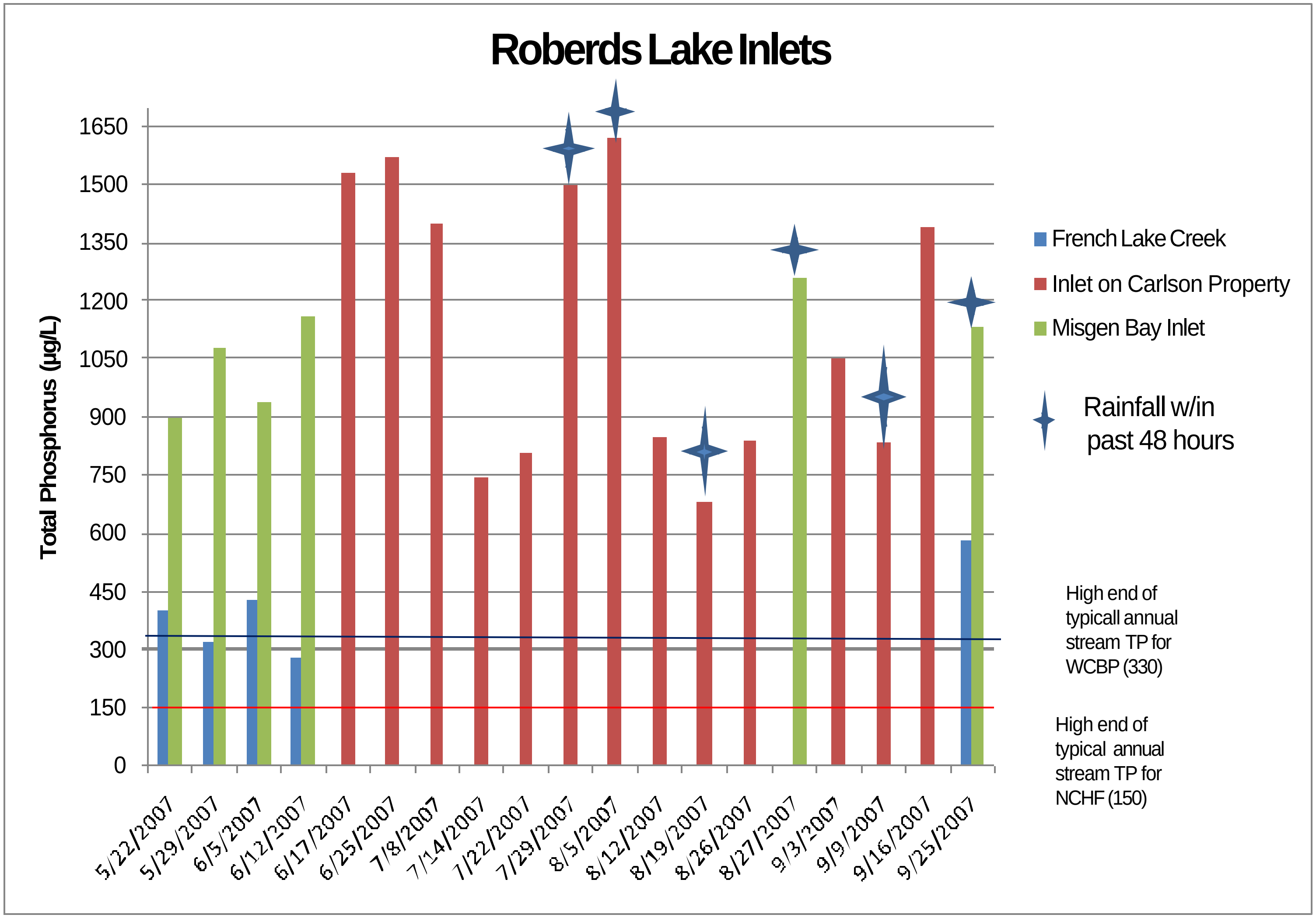


Members of the Roberds Lake Club collected grab samples one time a week when there was water flowing at their inlet stream sites. No flow data was collected therefore loading values are not able to be calculated. Sampling of the inlet streams showed extemely high levels of TP as seen in Table 2 and Figure 7. Typical annual stream water TP values for the CHF range from 60 – 150 µg/L (MPCA, 2003). Median values for the inlets to Roberds Lake were: 1050 µg/L (S004-546), 1105 µg/L (S004-547), and 402 µg/L (S004-548). Unfortunatley samples were not collected on the same dates due to low flow conditions and when the volunteers started sampling. However, these results do show that a significant amount of phoshporus is entering the lake from these inlets.

Table 2 - Total Phosphorus Concentrations (µg/L) from Inlet Streams in 2007

Date	Inlet on Misgen Bay (S004-547)	Inlet on Carlson Property (S004-546)	French Lake Creek Inlet (S005-548)
5/22/07	897	NA	402
5/29/07	1080	NA	320
6/5/07	939	NA	429
6/12/07	1160	NA	280
6/17/07	NA	1530	NA
6/25/07	NA	1570	NA
7/8/07	NA	1400	NA
7/14/07	NA	744	NA
7/22/07	NA	808	NA
7/29/07	NA	1500	NA
8/5/07	NA	1620	NA
8/12/07	NA	849	NA
8/19/07	NA	683	NA
8/26/07	NA	838	NA
8/27/07	1260	NA	NA
9/3/07	NA	1050	NA
9/9/07	NA	834	NA
9/16/07	NA	1390	NA
9/25/07	1130	NA	582

Figure 7- Total Phosphorus from Inlet Streams 2007



Land Cover

The concept of actions on the land affecting the quality of the water is clearly evident in the case of Roberds Lake. During pre-settlement times the land in the watershed was primarily hardwood forest with some wet prairie. Today's land use is a much different picture as can be seen in the land use maps in Figures 8 and 9. The primary land uses today are cultivated land (56%), grassland (26%), and deciduous forest (11.7%). Rural residential and farmsteads make up approximately 4% of land use. Wetlands are only 1.25%.

Each of the differing types of land uses contributes varying amounts of phosphorus runoff. Phosphorus export coefficients represent the expected annual amount of phosphorus transported per unit of source (Heiskary, 1994). Table 3 presents the range of coefficients used by the MPCA for assessment of phosphorus inputs to Minnesota lakes (Heiskary, 1994). Looking at these values it is clear that forest lands contribute the least amount of phosphorus to the lake. Urban or developed land can contribute as much as cultivated land depending on the situation. The values for feedlots are assuming there is no containment of runoff from the sites. This situation is usually not the case and will be discussed more below. The maps in figures 8 and 9 illustrate a dramatic change in land use types from forest to cultivated land and developed areas. This in turn results in an increase in the amount of phosphorus that leaves the land and enters the streams and the lake. Another important point is that no one land use is responsible for the problem - all landowners and land uses contribute to the phosphorus export.

Table 3- Phosphorus export coefficients based on land use

Land Use	Range of Phosphorus Export Coefficients (kgP*ha*yr)
Forest and wetlands	0.08 - 0.2
Precipitation	0.2 - 0.4
Pasture	0.2 – 0.8
Urban	0.3 – 1.2
Cultivated	0.3 – 1.2
Feedlot (without containment)	150 - 450

Figure 8- Presettlement land use

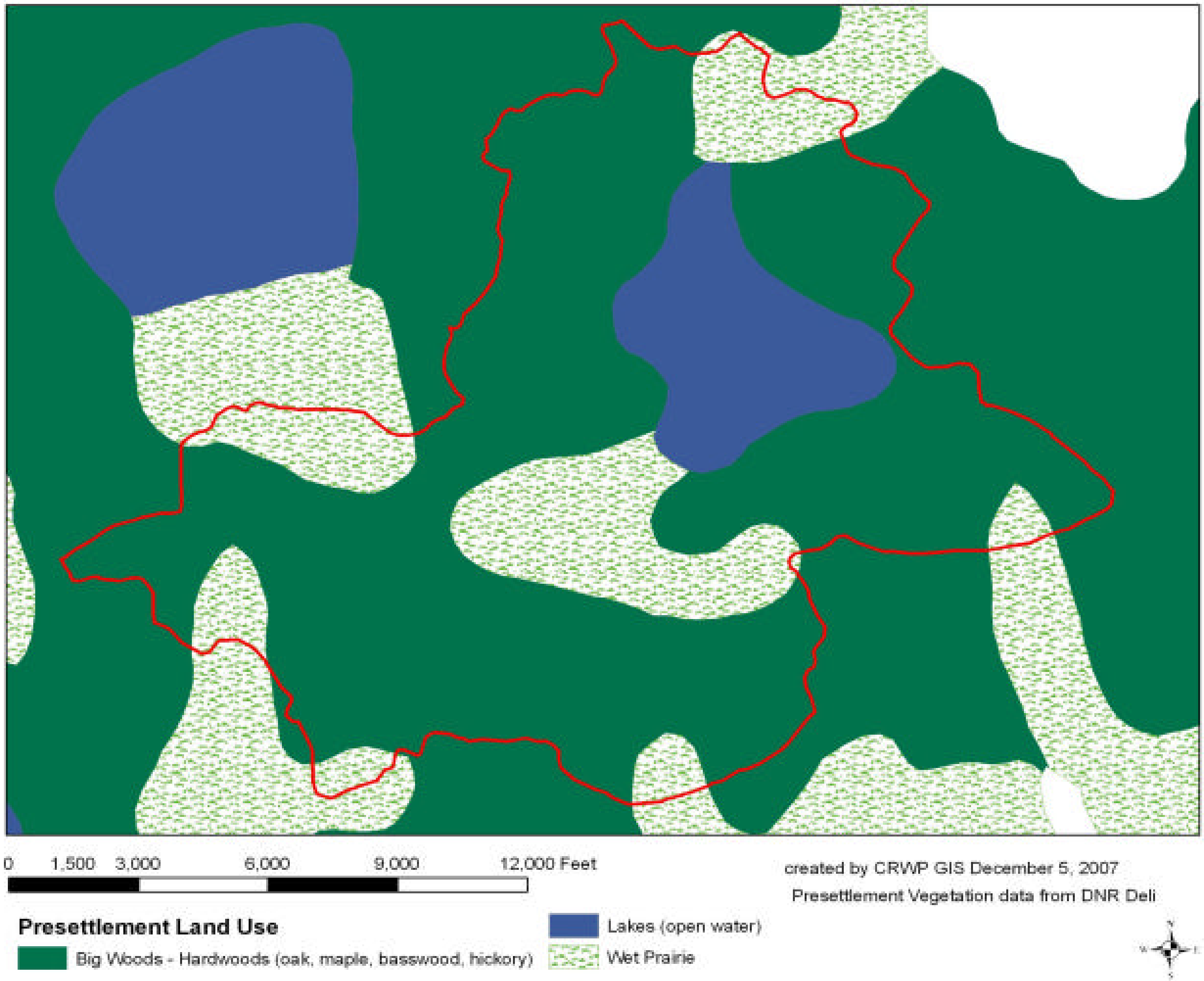
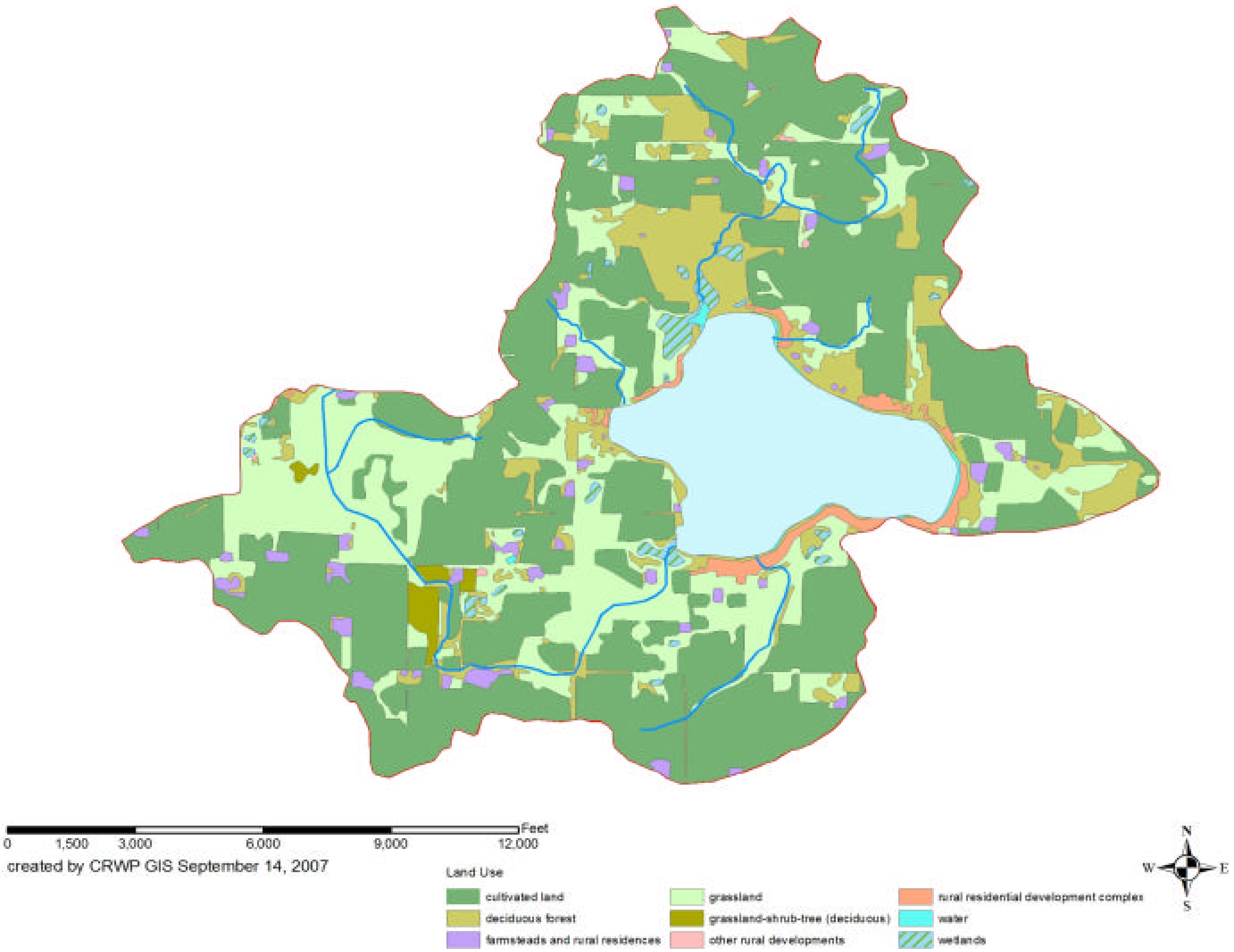


Figure 9 - Current Land Use


Feet
0
1,500
3,000
6,000
9,000
12,000
created by CRWP GIS September 14, 2007
Land Use
cultivated land
deciduous forest
farmsteads and rural residences
grassland
grassland-shrub-tree (deciduous)
other rural developments
rural residential development complex
water
wetlands
N
S
E
W

Source Assessment

For the purpose of this report we have categorized the potential phosphorus sources into four areas: rural residential, agricultural, natural, and in-lake sources. The in-lake sources are not part of the upland contribution, but they do contribute phosphorus to the lake and should be considered.

Rural Residential

The land immediately around Roberds Lake is mostly developed with the exception of the north/northwest area. In the early 1900's Roberds Lake was the place many residents of Faribault and the surrounding area went for summertime fun (Misgen,1995). There are currently 108 single family residences and 59 seasonal homes around the lake (personal communication Rice County Planning and Zoning, December 6, 2007). Rural residential areas make up approximately 4% of land use, however these areas do still contribute phosphorus to the lake through stormwater runoff and septic systems.

Stormwater

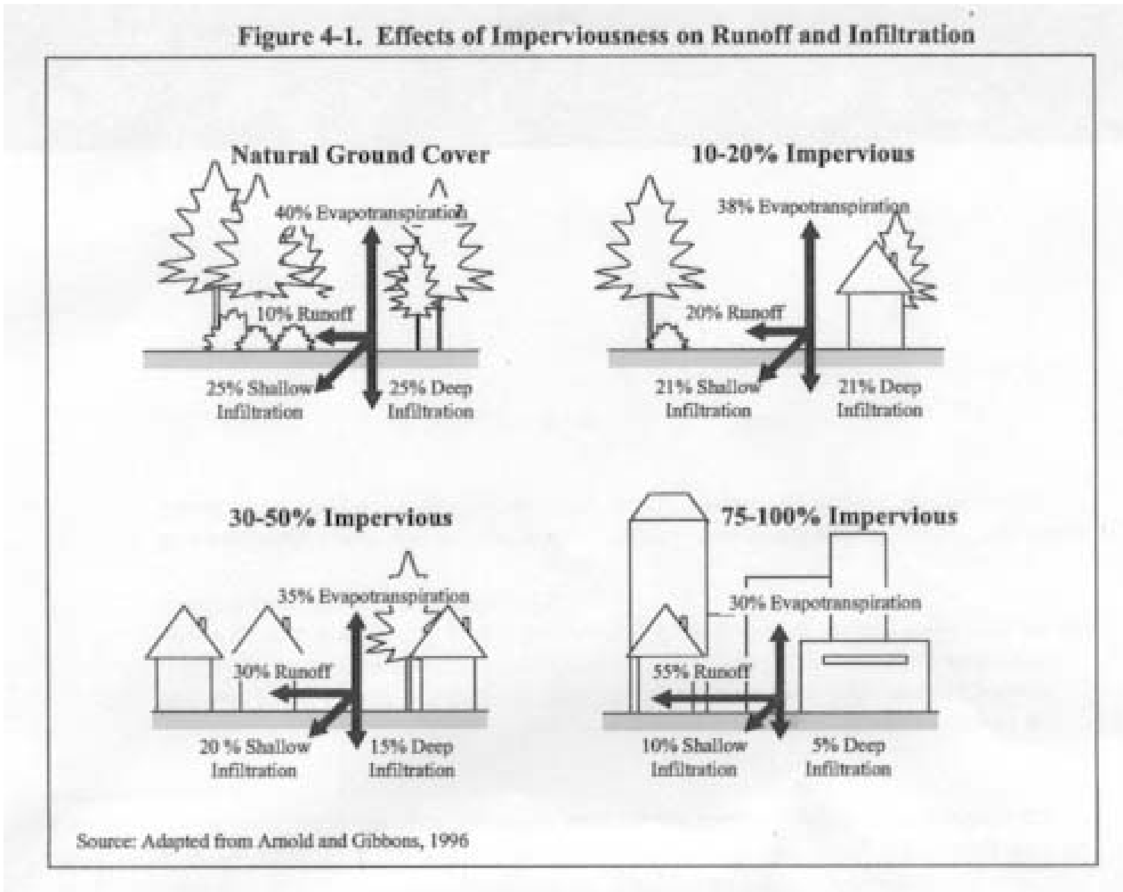
Stormwater is an all-inclusive term that refers to any of the water running off of the land's surface after a rainfall or snowmelt event (State of MN Stormwater Manual, 2005). Rainfall and snowmelt can be transported off the land via sewer systems or by running off of impervious surfaces (roads, parking lots, etc.) to receiving waters such as streams, rivers and lakes. As natural lands are developed the land cover changes from mostly pervious surfaces to a majority of impervious surfaces. Pervious surfaces allow rainwater and snowmelt to infiltrate into the ground becoming groundwater, evaporate into the air, or to be used by plants and trees (evapotranspiration), with a small amount running off the surface. As this land cover is changed to impervious surfaces the percent of surface runoff can increase dramatically. Concentration of pollutants is directly related to the degree of development in a watershed (EPA, 1999). More development results in an increase in the amount of impervious surface and runoff generated, and a decrease in infiltration and evapotranspiration (EPA, 1999) as shown in Figure 10.

Stormwater flow into water bodies adds an excess volume of water, increases the velocity of the runoff water, and adds pollutants. Increases in flow volume and speed are important because they lead to stream bank erosion, reduction in stream bank vegetation, widening of the stream channel and increased flooding. Pollutants such as phosphorous, sediment, hydrocarbons, fecal material and others can harm organisms that live in the water and pose a hazard to people who recreate in the water. Phosphorous spurs algae growth in lakes and streams, turning the water cloudy and greenish. By some calculations, one pound of phosphorous can produce 300-700 pounds of algae, which creates undesirable conditions for aquatic recreation.

Under natural conditions, the trees and plants along the lakeshore slow the flow of water and allow water to infiltrate. As people have moved from towns to the lakes, we have brought with us the idea that our lake front yards should be the same as our in-town yards.

Many homes have manicured lawns all the way down to the lake. There are paved driveways, sidewalks and patios. This situation allows for water that flows over the surface to pick up fertilizer, dirt and other pollutants and flow right into the lake. Viewing the lakeshore by boat, it was readily apparent that there is little natural shoreland left around Roberds Lake.

Figure 10 - Effects of Imperviousness on Runoff and Inflitration



(taken from the EPA Preliminary Data Summary of Urban Storm Water Best Management Practices, 1999)

Zoning and Future Development

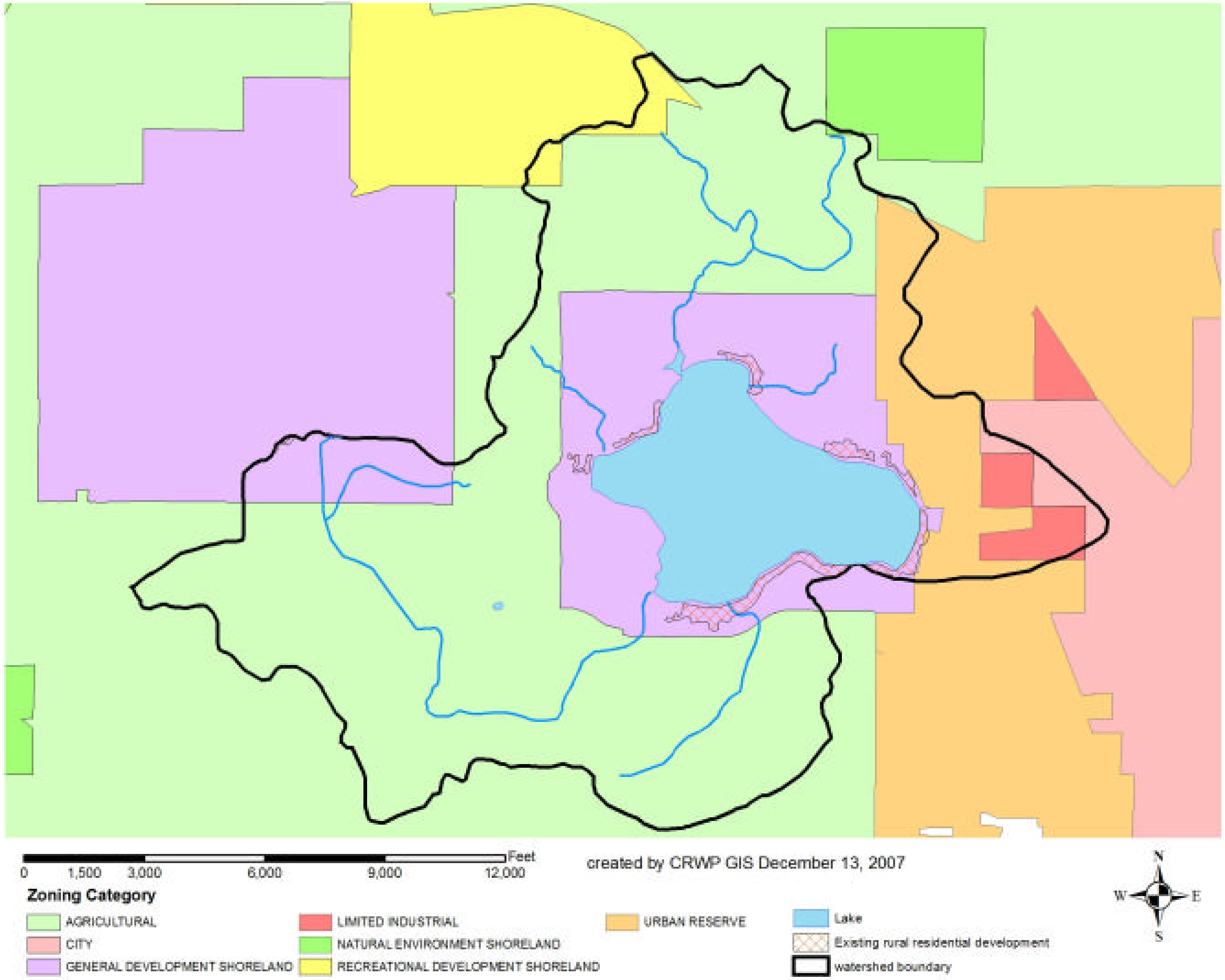
"The percentage of land in developed land uses can be expected to play a very significant role in determining the water quality of a lake…..its influence may be equivalent to or greater than that of cultivated land." (MPCA, 2005)

The land immediately adjacent to the lake has been developed around most of the lake. There are some areas where homes are grouped closely together and others that have more space. Some homes are right at the waters edge. A county road is within feet of the east side of the lake and there are other streets and a county road on the south, west and north sides.

Zoning districts in the watershed are depicted in Figure 11. The greatest percent of the land is zoned for agricultural uses. "Agricultural Use" is defined as real or personal property used for the production of crops, tillage, husbandry or farming, including but not limited to, fruit and vegetable production, tree farming, livestock, poultry, dairy products or poultry products, but not a facility primarily engaged in processing agricultural products. The other two major zoning districts are an area around the lake that is zoned General Development Shoreland and an area to the east zoned as Urban Reserve. Shoreland is land defined on the official zoning map, and generally extending: (1) One thousand (1,000) feet from the ordinary high water level of a lake, pond, or flowage; and (2) three hundred (300) feet from a river or stream or the landward extent of a floodplain. Shoreland may also be defined by a physical feature such as a ridgeline, change in topography, or roadway that generally parallels the shoreline, or by the boundary of an existing developed area. Uses allowed in the general development and urban reserve districts include such things as: single-family detached and attached dwellings, multifamily dwellings, facility for supervised residential program, agricultural uses, campgrounds (public and private), water-oriented commercial recreation, parks, recreation areas, walking and bicycling trails.

In 2005 the Minnesota Department of Natural Resources, under direction of Governor Pawlenty, convened a group of citizens and other interested parties to develop "alternative shoreland standards". As of the writing of this report, these are voluntary standards. The DNR will begin rulemaking in January 2008 to update the shoreland standards and these alternative standards will be considered in that process. The alternative standards require such things as: shoreline buffers, prohibit the use of fertilizer in the shore impact zone, prohibit new feedlots in shoreland, provide stormwater management standards, prohibit access lots for owners of nonriparian parcels, do not allow density increases, and lay out requirements on conservation subdivision development. In July, 2007 Rice County updated the Shoreland Districts (Chapter 516) and Shoreland Planned Unit Developments (Chapter 517) chapters of the county zoning ordinances. These ordinances cover such topics as: setbacks of structures from the shoreline, percent of impervious cover allowed, allowing controlled access lots, erosion control, agricultural uses within the shoreland district, allowing density increases for certain practices in planned unit developments, and limited stormwater management within planned unit developments. It is CRWP's opinion that the county ordinances do less to control phosphorus input to the lake from development pressure than the alternative shoreland standards would.

Figure 11 - Zoning Districts



Feet
0
1,500
3,000
6,000
9,000
12,000
created by CRWP GIS December 13, 2007
N
W
E
S
Zoning Category
AGRICULTURAL
CITY
GENERAL DEVELOPMENT SHORELAND
LIMITED INDUSTRIAL
NATURAL ENVIRONMENT SHORELAND
RECREATIONAL DEVELOPMENT SHORELAND
URBAN RESERVE
Lake
Existing rural residential development
watershed boundary

Septic Systems

Individual Septic Treatment Systems (ISTS) refers to a sewage treatment and disposal system located on a property, using subsurface soil treatment and disposal for an individual home or establishment (Barr, 2004). The properties in the Roberds Lake watershed are all outside the existing reach of municipal wastewater treatment from the city of Faribault. A group of homes on the north side of the lake are part of the Misgen Bay Utility cluster system which is a septic system used by more than one home. The remainder of homes and resorts have some sort of individual system.

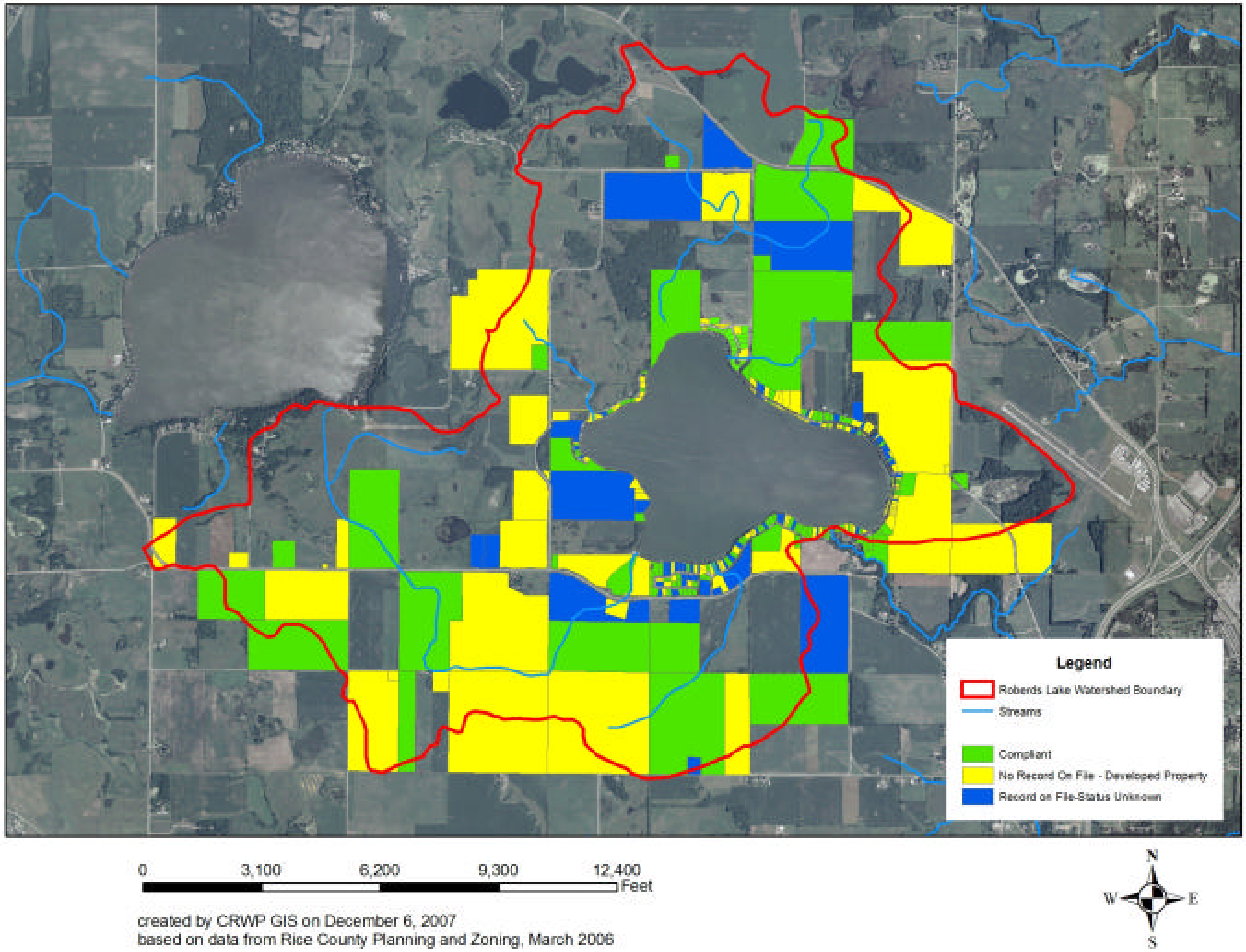
ISTS typically consist of a septic tank and a soil absorption drain field. There is a significant concentration of phosphorus present in the wastewater treated by an ISTS. Sources of phosphorus into the system are: automatic dishwasher detergent, toothpaste and other dental care products, food soils and garbage disposal wastes, and ingested human wastes (Barr, 2004). On a per capita basis the phosphorus load from these sources has been estimated at 0.8845 kg/year (Barr, 2004). In the 2004 Barr report it was assumed that conforming septic systems could remove 90 percent of the total phosphorus loading while failing systems only removed 70 percent. Contribution of phosphorus from straight pipes is potentially 9lbs of phosphorus/year. This amount is based on 3 lbs of phosphorus per year per person and an average of three people in a residence (personal communication, Doug Malchow, December 20, 2007).

The status of these systems has been an area of concern dating back for some time. The 1994 MPCA Lake Assessment notes they are an issue and makes reference to a 1986 report by Rice County stating the same concerns. In order to get a more accurate picture of the septic situation, Rice County Planning and Zoning conducted a review of their existing septic records through October 2006. The systems were grouped into three categories:

1. In compliance
2. Record on file but status uncertain
3. No record on file

There were 280 dwelling parcel records on file. Of these approximately 50% of the systems appear to be in compliance, 25% of the systems have a record on file but the status is uncertain, and 25% have no record on file. Some of the systems with a record on file but with uncertain status are listed as “dry wells” and are considered imminent public health threats. A map showing the status of the systems is found in Figure 12.

Figure 12 - Septic System Status



Agriculture

Tillage

Cultivated land makes up over half the land use in the watershed (Figure 9), therefore the type of tillage and cropping systems used on this land are important to consider when determining phosphorus inputs. Soil erosion and runoff from snowmelt and rainfall carry soil particles, with phosphorus attached to them, into the streams and lakes. According to the most recent Rice County Soil Survey the hazard of water erosion is greater than the hazard of wind erosion in Rice County (USDA, 2001). When water runs across the soil or through subsurface flow it may have a significant amount of dissolved phosphorus. Phosphorus is extracted from the soil and plant matter and dissolves in the runoff water. Subsurface flow typically has less phosphorus because the phosphorus in the water will sorb to the soil as the water percolates through the soil profile. Therefore, surface runoff is a larger contributor of phosphorus that subsurface flow (Busman, 2002).

When agriculture was first developing in Rice County there was excessive soil erosion that contributed a large amount of sediment to lakes and streams (USDA, 2001). Current potential for gully erosion was assessed by the Rice SWCD in the Roberds Lake watershed using 2005 Ortho Imagery to identify all possible sources of ephemeral gully erosion. Sections 9, 10, 14-23, and 27-30 of Wells Township were carefully reviewed using the aerial photography. Land within the lakeshed identified as a potential source of soil erosion was field verified as soon as fall harvest was complete, during November 2007. Overall, there were few sites with the potential of ephemeral gully erosion occurring. Most of the land was already naturalized (pasture, meadow, wetland, forest or prairie). Areas that appeared to have a potential gully forming were later verified by a site visit and were not significant sources of erosion. Only a few problem areas were noted within the watershed. We did observe conservation minded farming in some instances, where alfalfa was planted on highly-erodible land and at the base of the same hill corn was planted on the contour. Overall, it was not easy to find major sources of gully erosion occurring in the watershed.

Special care needs to be taken in areas where there is highly erodible soil. Potential erodibility is based on default values for rainfall amount and intensity, percent and length of slope, surface texture and organic matter, permeability, and plant cover. A map showing the land considered to be highly erodible land is presented in Figure 13. Much of the highly erodible land is actively being cultivated. Highly erodible cropland enriched with fertilizer and manure/nutrient inputs has a higher probability of degrading surface water quality due to greater runoff and soil losses (Busman, 2002).

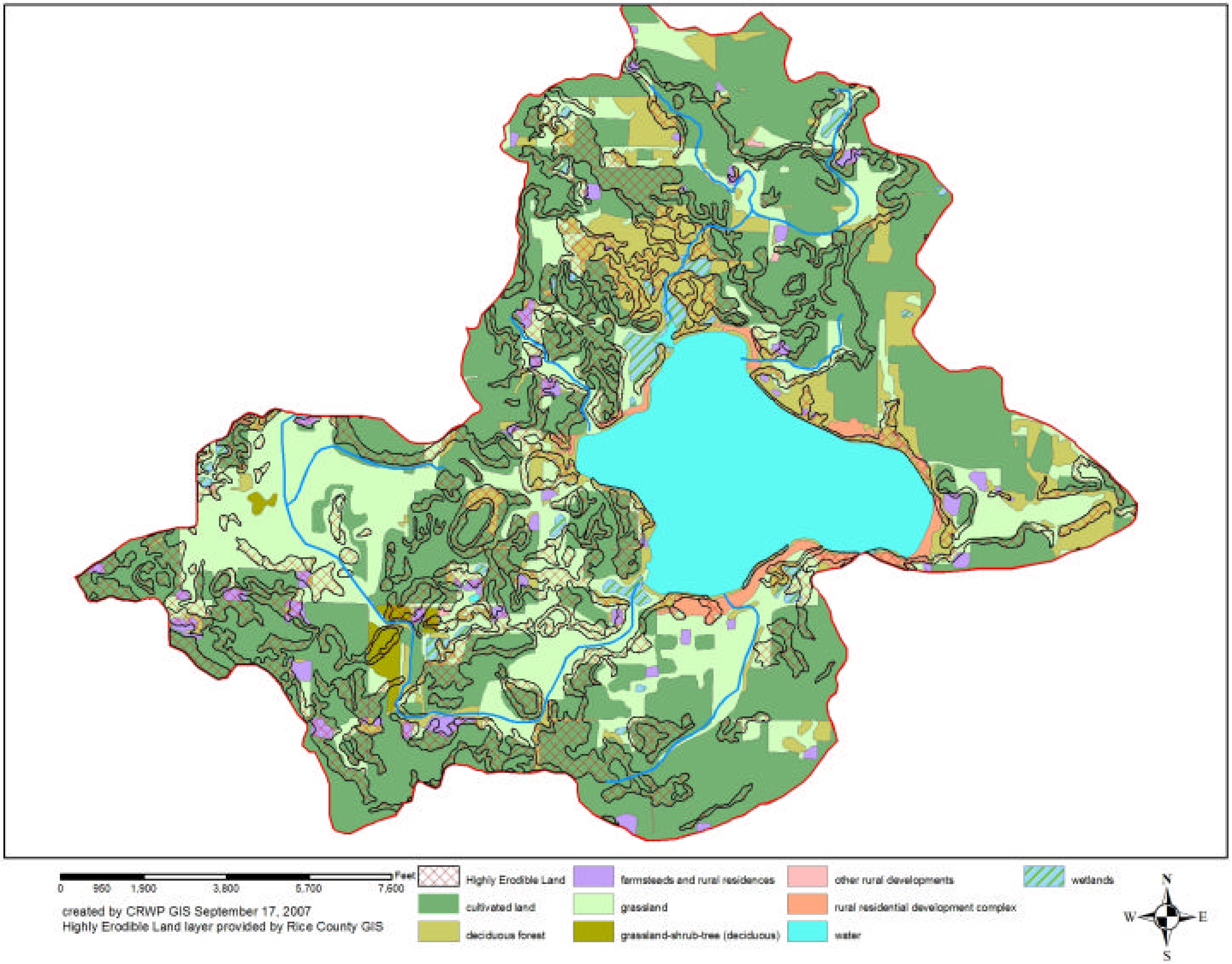
Sheet erosion is defined as the removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff (USDA, 2001). While gully erosion did not appear to be a problem in this watershed, sheet erosion is still a potential source of phosphorus to the surface water. A windshield survey was conducted in November 2007 to assess fall tillage practices. The majority of tilled fields had been moldboard plowed, with chisel tillage being the second most common practice. Both of these tillage practices result in minimal residue in place and expose a high percentage of soil increasing the sheet erosion potential.

CRWP attempted to collect site specific data from 20 producers in the watershed to try and model the soil and phosphorus losses from their fields. Unfortunately, we only had one producer contact us about doing this and it was too late to collect current soil samples. The lack of participation may have been because CRWP did not build a relationship with the producers early on to get their buy in as to the importance of the project and need for this data. It may also be that the producers felt this was an intrusive process and did not want to share their information.

In order to develop some idea of what sort of soil loss may be occurring in the watershed, CRWP staff used the Revised Universal Soil Loss Equation 2 (RUSLE2) to show some "what if" scenarios using the types of tillage and soils found in the watershed. Examples of these management scenarios, potential soil loss (tons/acre/year) and fuel costs can be found in Appendix A. The management scenarios are based on the assumption of a corn/soybean rotation which is typical in the area. We used the five soil types that are most predominant in the area and ran the model for each type. The type of soil, slope steepness, erosion potential and management practice are all part of the resulting soil loss estimates. Steepness of slope is a significant factor. For example on clay loamy soils with an average slope of 2.0 % the soil loss ranges from 1.9 tons/acre/year for moldboard plowing to 0.20 tons/acre/year for no-till. When we change the average slope to 14% on loamy soils the soil loss ranges from 17 tons/acre/year for moldboard plowing to 1.3 tons/acre/year for no-till. These estimates show the significant reduction in soil and therefore phosphorus loss that could occur by converting tillage practices.

Site specific data must be gathered directly from producers in order to conduct more detailed modeling of soil and phosphorus loss. Contact with producers early on in such a project may result in greater willingness to share data and participate in this process. Refining the modeling will help to pinpoint the "hotspots" where soil and phosphorus loss are occurring so that efforts to reduce these losses can be most effective.

Figure 13 - Highly erodible land


0 950 1,900 3,800 5,700 7,600 Feet
created by CRWP GIS September 17, 2007
Highly Erodible Land layer provided by Rice County GIS
Highly Erodible Land
cultivated land
deciduous forest
farmsteads and rural residences
grassland
grassland-shrub-tree (deciduous)
other rural developments
rural residential development complex
water
wetlands
N
W
E
S

Nutrient Management

The application of chemical fertilizer to fields to enhance crop production is common in southeast Minnesota. The theory of more being better or adding excess nutrients to ensure that there will be enough has not worked well for water quality. According to Rehm (2002) in Minnesota most agricultural soils contain from 100 to about 4,000 pounds of total phosphorus per acre. The native soils in this area usually have a high level of available phosphorus therefore phosphate is usually only needed in small amounts in fertilization programs. There is no economic or environmental justification for adding phosphorus to the soil system when the phosphorus soil test is 20 ppm or higher (Bray test) or 16 ppm or higher (Olsen test) (Rehm, Lamb, 2002).

The risk of phosphorus loss in runoff is influenced by the rate, method and the time of application; source of phosphorus used; the amount and duration of rainfall; and amount of vegetative cover. Most of the annual phosphorus loss in runoff can often be attributed to one or two intense storms especially during times of minimal crop cover (Busman, 2002). Most of the phosphorus lost is attached to soil particles that can be picked up by runoff over the land.

The Minnesota Phosphorus Index (P Index) is a tool that can be used to assess the risk of phosphorus loss from a given field. CRWP had hoped to be able to run this model on fields in the watershed. The data required to run the model includes such information as tillage practices, soil test data, and cropping history which must be obtained from the owners/operators of the land. CRWP sent out letters requesting this information from twenty of the landowners in the watershed with farming operations, but as of the writing of this report only one producer was interested and due to the ground freezing the soil samples were not able to be collected.

An example scenario of the Minnesota Phosphorus Index was run by CRWP to look at various tillage scenarios over one crop rotation cycle on Lester Loam 106D2 soils. This type of soil has an average slope of 14% and length of 120 ft. The management scenarios used are the same as those for the RUSLE2 model noted above. The following assumptions were made and used in each scenario: field distance to surface water was 50 ft., no fertilizer or manure was applied, the phosphorus soil test level using the Bray soil test was 20 ppm, tillage orientation was up/down slope, that cover after tillage was 5-20%, and there were no depressions or sediment traps. These assumptions may not be exactly what is happening at this time in the watershed, but the point of this exercise was to show how changes in tillage can have significant results in reducing the risk of phosphorus loss from a field. Results are presented in Table 4. Work should continue with landowners and operators in the watershed to encourage them to allow this or similar types of modeling to be undertaken so that phosphorus loss can be estimated and reduction strategies implemented.

Table 4 - Results from example scenarios of the Minnesota Phosphorus Index on Lester Loam soils

Management Scenario	Minnesota P Index Score
Corn: Fall Moldboard Plow, Spring Tillage Soybeans: Fall Moldboard Plow, Spring Tillage	7.11, Very High Risk. Multiple and possibly large improvements in management practices are recommended
Corn: Fall Chisel Plow, Spring Tillage; Soybeans: Fall Chisel Plow, Spring Tillage	6.16, Very High Risk. Multiple and possibly large improvements in management practices are recommended
Corn: No Fall Tillage, Spring One Pass Field Cultivate; Soybeans: Fall Chisel Plow, Spring Tillage	5.25, High Risk. Moderate improvements in management are recommended to reduce the risk of P losses.
Corn: No Fall Tillage, Spring One Pass Field Cultivate; Soybeans No-Till	3.12, Medium Risk. Small improvements in management may be necessary to lower the risk of P losses. Avoid management practices that increase the risk of P losses.
Corn: No-Till/Strip-Till; Soybeans: No-Till/Strip Till	1.69, Low Risk. Minor management changes are recommended.
Corn No-Till; Soybeans No-Till	0.91, Very Low Risk. No management changes are recommended.

Feedlots

Feedlots contribute phosphorus to surface water through land application of manure and open lot runoff during rainfall or from snowmelt. A windshield survey of the registered feedlots was conducted by the Rice County Feedlot Officer and CRWP staff in October, 2007. The following summary of this survey has been provided by Wade Schulz, Rice County Feedlot Officer.

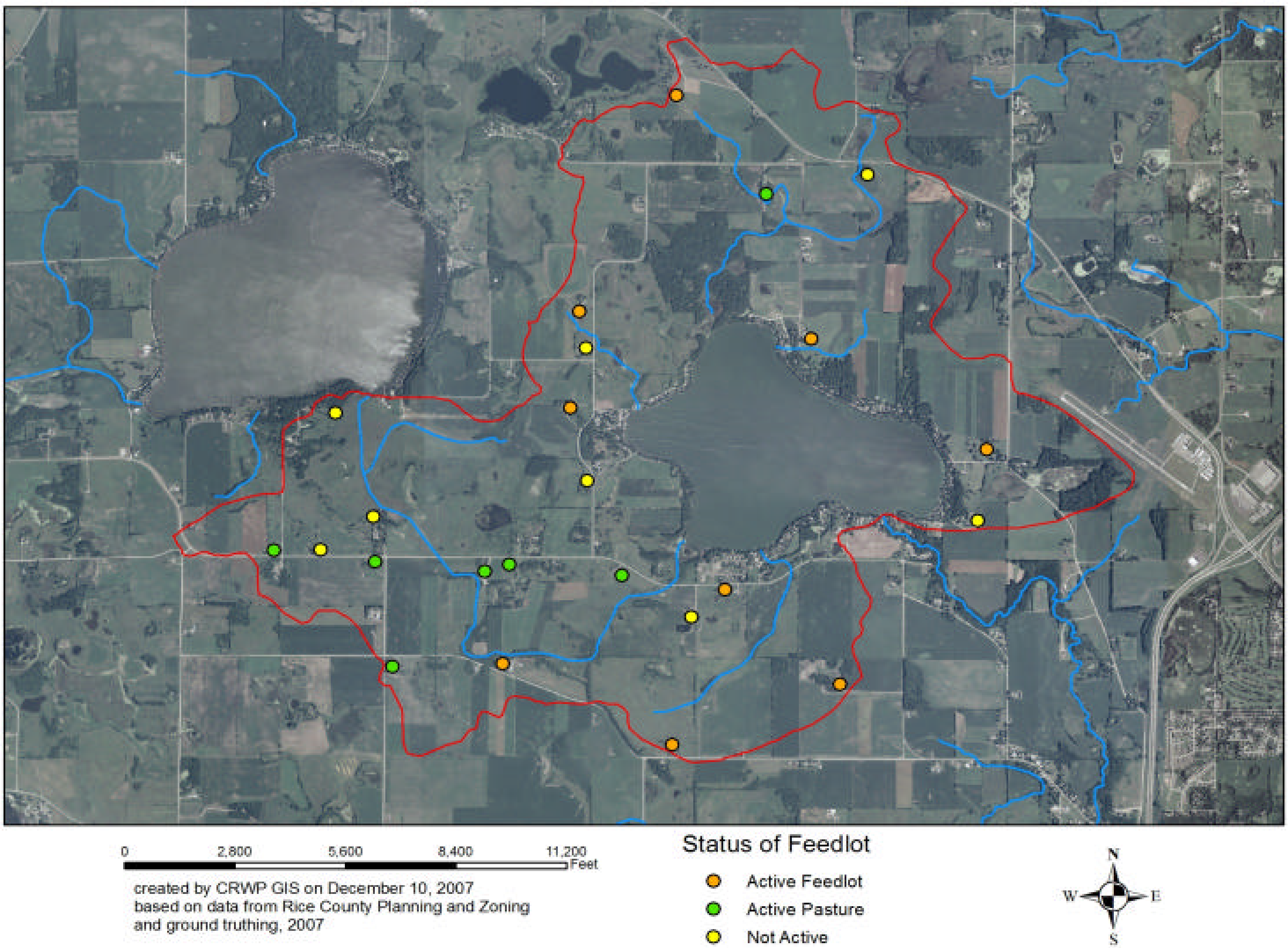
During our survey we found that of the 30 sites that are registered to have animals, currently, one third of them do not have any animals and the sites looked unused for a number of years. A reason for this may be that during the original Rice County feedlot registration, landowners were encouraged to register their sites for a potential number of animals even if they did not have animals at that time. Another reason may be that the site was registered for the number of animals onsite in 1997 and since then, the animals have been removed. Most of the larger (non-hobby) sized farms in production remain active feedlot sites. Smaller hobby-sized sites that are registered as feedlots appeared to be less active. Ten of the 30 facilities in the area currently can be considered pasture operations. While these sites can be considered pasture operations currently, lack of management may result in open-lot feedlot conditions. Figure 14 depicts the locations and types of the feedlots based on activity.

Most of the feedlots in the watershed that are active have dairy cows followed by beef. There are a small number of horses and other livestock as well. Each of these types of animals generates a different amount of phosphorus in their manure. The annual phosphorus generation per animal unit (AU) is estimated to be 33.5 lbs/AU for beef cattle, 47.8 lbs/AU for dairy cows, and 26.6 lbs/AU for swine (Barr,2004). Adding up all the animal units that the feedlots in the watershed are registered for results in: all beef = 342 AU, all dairy = 922 AU, all swine = 16 AU. These numbers are high end estimates as not all the registered feedlots are operating at their registration numbers or even have any animals at all. Based on these numbers the potential for phosphorus generation could be: 11,457 lbs of P/yr from beef cattle, 44,072 lbs of P/yr from dairy cows, and 426 lbs of P/yr from swine. While these are potentially large amounts of phosphorus generated, the amount of phosphorus that leaves the feedlot is typically minimal. The Board of Water and Soil Resources developed a model (based on an equation to estimate annual loadings and annual runoff) that predicted between 0.1 and 1.1 percent of phosphorus generated at feedlots with inadequate runoff controls will enter surface waters (Barr, 2004). Several of the active feedlots in the watershed are close to streams and attention should be paid to these sites to ensure they are doing everything possible to control runoff from the sites.

Many of active feedlots are on a schedule for compliance with Minnesota State Water Quality Standards, through a voluntary program called the Open Lot Agreement. The Open Lot provision offers a gradual and flexible approach for smaller feedlots to reduce manure-contaminated runoff into waters of the state (MPCA, 2005). Partial improvements are to be made by October 2005 with the work to be completed by October 2010.

Land application of manure from feedlots is another notable source of pollution that can affect surface water quality. As chemical fertilizer costs increase, more producers see manure as a resource and their source of nutrients. The risk of surface water pollution increases when manure is applied to high phosphorus soils, steep slopes, or land near lakes, streams, ditches, wetlands, or open tile intakes (MPCA,2005). There are many variables that contribute to run-off from land application of manure such as: rate, method and timing of application, distance from water features, slope of fields and soil types of where manure is applied. Minnesota Rules 7020 limit manure application based on nitrogen and phosphorus amounts found in the manure and in the soils. Minnesota also restricts manure application near water features through the use of manure application setbacks and set incorporation time limits.

Figure 14 - Status of Feedlots in 2007



Status of Feedlot
Active Feedlot
Active Pasture
Not Active
0
2,800
5,600
8,400
11,200
Feet
created by CRWP GIS on December 10, 2007
based on data from Rice County Planning and Zoning
and ground truthing, 2007
N
S
E
W

All Rice County registered feedlot sites have manure management plans that were submitted at the time of registration. Manure management plans need to meet minimum standards set out in Minnesota Rules 7020. Management plans were required to document that appropriate acreage was available to feedlot owners to land apply nutrients from the manure generated on site. These plans are to be updated when: a permit is required, when a pollution hazard is identified, the operation changes, and also when ownership changes. There are not requirements to periodically update plans. When plans are not being followed a new plan is required. Spreading records are typically reviewed when a feedlot is inspected. Current practice in Rice County is to conduct random inspections with some prioritization of areas of high concern (personal communication, Wade Schulz, December 10, 2007).

Animal agriculture has been present in the watershed for the better part of a century. Prior to the more recent feedlot regulations and water quality standards, there was little regulation regarding where manure could be stored or how it needed to be land applied. Residents report that in the past cows were allowed access to the lake in some areas. This has most certainly resulted in high soil phosphorus concentration in the watershed. It may be that as feedlots are meeting the requirements of the Open Lot Agreement, the phosphorus leaving the lots may be built up in the soils from past application. Individual fields and feedlots would need to be soil tested to determine the exact concentrations.

Natural Sources

Phosphorus is found in soils as a mineral and from the breakdown of organic material. Wetlands are typically considered to be features that help to remove phosphorus from water, however they can also be a contributing source. Dry conditions allow for wetland soils to become drier and oxidized. This enhances the decomposition of organic material in the soils and high nutrient concentrations and loads can be flushed out as water level returns to normal (personal communication, Pat Baskfield, November 8, 2007). This may account for the high total phosphorus concentrations at the Inlet on Carlson property site in 2007.

Atmospheric deposition of phosphorus (both wet and dry) can come from pollen, soil erosion, oil and coal combustion and fertilizers. Some of these sources are man-made however, they are in the atmosphere. MPCA estimated values for this source are relatively small (Heiskary, 1994).

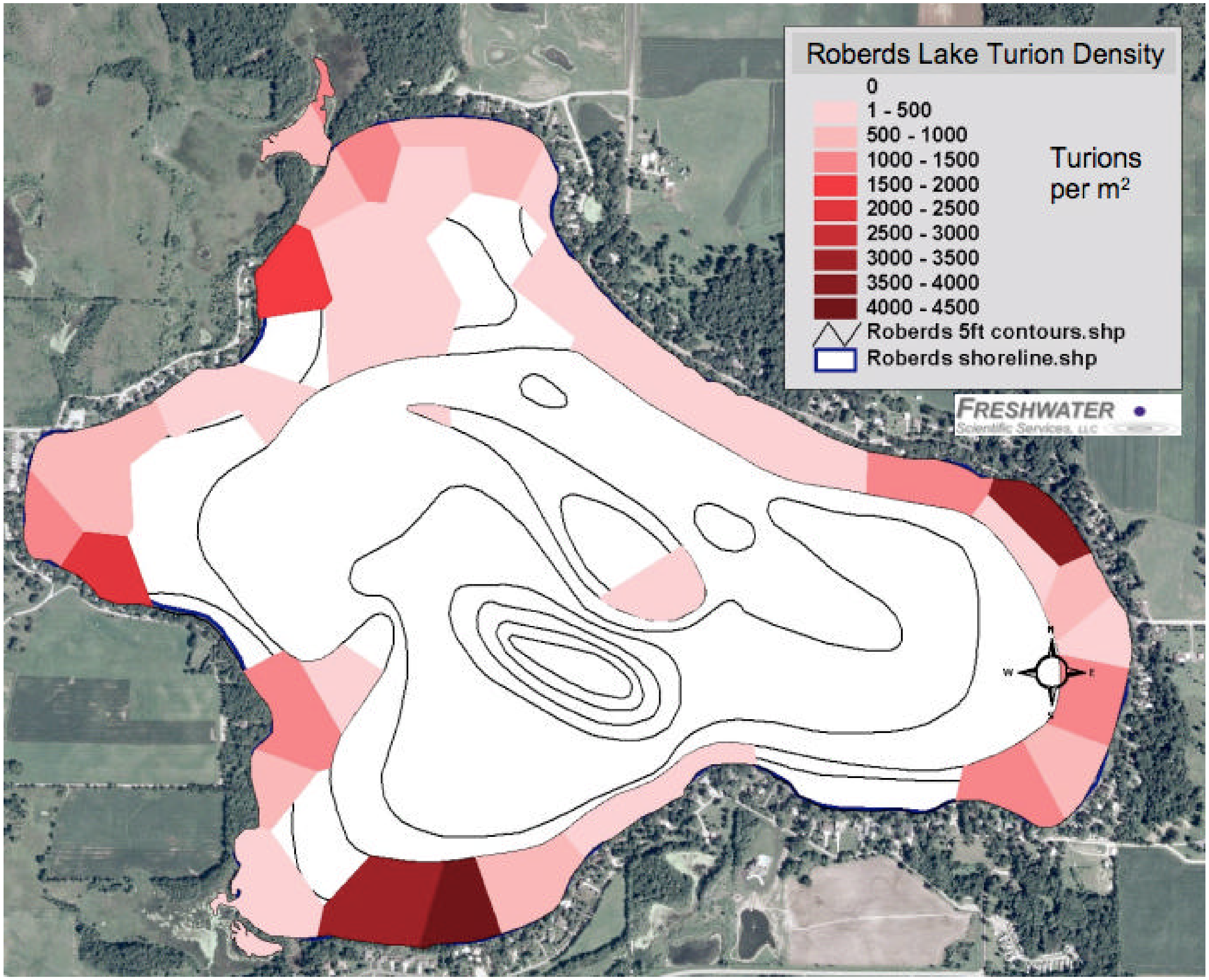
Streambank erosion can also make significant contributions of sediment and phosphorus to the inlets and lake. As noted in the 2004 Barr report, the contribution of phosphorus from streambank erosion in the Lower Mississippi River Basin is minimal under low flow conditions but increases to 47% under average conditions. Under wet, high flow conditions, it is the major contributor at almost 74%. The inlet stream monitoring for this project took place under low flow conditions. CRWP staff conducted a visual assessment of parts of the inlets that were accessible on some private land and public land. It appeared that the French Lake Creek inlet was the only one that showed signs of previous streambank erosion.

Internal Loading

According to Heiskary (1994) and others internal loading from the sediments can be a major phosphorus source in lakes that mix continuously (polymictic) in the summer or those that stratify intermittently. In the summer of 1992, when temperature measurements were taken to determine the extent of lake stratification, it was found that the lake did not thermally stratify (MPCA, 1994). The suggested reasons for this were that it was a cool year and atmospheric temperature affect water quality, and that the lake is rather shallow with a large wind fetch allowing it to mix easily. This mixing can bring phosphorus released from the sediment to the surface for uptake by algae. Low dissolved oxygen at the bottom of the lake results in more phosphorus being released from the soil. Dissolved oxygen and temperature sampling were not part of this current project but should be considered in the future as the sediment contributions are looked at more closely.

A second significant source of internal loading to the lake is the decomposition of curlyleaf pondweed. Residents on the lake have known that curlyleaf was a problem, but did not have an accurate assessment of the extent of the problem. As part of this project, a survey was conducted by Freshwater Scientific Services, LLC in October 2007 of the curlyleaf turions in the lake sediment. The goal of the survey was to provide both localized and whole-basin assessment of the turion distribution and density to quantify the level of infestation and provide insight for future management projects. Figure 15 depicts the concentrations of turions around the lake. The results indicate that the turion bank is generally very dense in areas shallower than 10 feet. A complete copy of this survey is attached as Appendix B.

Figure 15 - Roberds Lake Curlyleaf Turion Density



The Future

The lake is a reflection of its watershed. What we do on the land affects the water. It's the connection between the land and the water.

It may appear redundant to convey this point so many times, but it is the single most important message of this report. The Roberds Lake watershed is an example of the harm that we, humanity, have done and can do to a watershed without meaning to do so. The residents in the early 1900's built homes where they and their families could enjoy the lake and natural setting. A hundred years later people still move to the area for this reason. Farmers built barns, raised livestock, and grew crops to feed their families and a growing nation. These practices still go on today. Unfortunately, all that we have done has occurred without knowing, or perhaps not carefully considering what will happen to the water quality. Now we know and that is half the battle. The clean-up of water in Roberds Lake will not happen quickly. It may take decades to see any improvement. However, if the process does not start now it is guaranteed to only get worse. This process will take a sustained effort by those who live in the area, those who regulate the activities in the watershed, and those who come to enjoy the lake. If we all do a little together we can accomplish a lot.

The following sections are suggestions on actions that could be undertaken to improve water quality. It is suggested that a more detailed lake management plan be written as well. A list of resources to assist with this are provided in Appendix C.

Who will do the work?

Perhaps the most important piece to improving the lake water quality is to have a committed group of citizens willing to lead the effort. There are many resources available both written and personal who can help make the process easier. A list of potential partners is provided in Table 5. This list should be considered a starting point as there are most likely many other groups that would be willing to assist. A logical choice to lead this effort would be the lake club as they have the greatest stake in improvement of the water as it is where they live.

Table 5 - Potential Partners in Lake Improvement

Organization	Contact Information	Role
Cannon River Watershed Partnership	David Legvold – Executive Director Beth Kallestad – Watershed Analyst Aaron Wills – Community Wastewater Facilitator Hilary Ziols – Outreach Coordinator 8997 Eaves Avenue Northfield, MN 55057 (507) 786-8400	- Provide educational opportunities regarding water quality, land management, tillage options, and septic systems. -Conduct water quality monitoring. -Run Minnesota Phosphorus Index model -Assist with Total Maximum Daily Load development. -Assist with grant writing and carrying out implementation projects.
Minnesota Department of Natural Resources	Hugh Valiant – Area Fisheries Manager 50317 Fish Hatchery Road PO Box 86 Waterville, MN 560096 (507) 362-4223	- Conduct lake surveys - Manage fish populations
	Wendy Crowell DNR Ecological Resources 500 Lafayette Road, Box 25 St. Paul, MN 55155 Phone: (651) 259-5085 www.dnr.state.mn.us/grants/habitat/lakewide.html	-Pilot project grants for Eurasian watermilfoil or Curlyleaf Pondweed on a lake wide basis.
	John Hiebert, Shoreland Habitat Coordinator Minnesota DNR 500 Lafayette Road, Box 20 St. Paul, MN 55155 Phone: (651) 259-5212 www.dnr.state.mn.us/grants/habitat/shoreland.html	-Grant funds and assistance with designing shoreland restoration projects through shoreland habitat block grants
Minnesota Pollution Control Agency	Justin Watkins 18 Wood Lake Drive SE Rochester, MN 55904 (507) 281-7763	-Provide technical expertise regarding collection of water quality data and modeling - Assist with development of Total Maximum Daily Load and provide funding. - Provide funding and assistance managing future implementation projects

Organization	Contact Information	Role
Minnesota Waters	720 West St. Germain, Suite 143 St. Cloud, MN 56301 1-800-515-5253 www.mnwaters.org	-Empower and mobilize citizens through projects and activities to improve water quality. -Organizational capacity development for lake groups.
Roberds Lake Club	Larry Churchill – Club Mayor Sharmayne Cross – Club Treasurer	-Lead improvement projects -Spread the word to the residents about projects - Volunteer labor on shoreland restoration and monitoring projects - Host educational opportunities regarding water quality topics. -Organize subgroups to work on specific topics such as agriculture, septic systems, etc. - Raise funds for projects - Talk with elected officials
Rice County Planning and Zoning	Julie Runkel - Director Wade Schulz – Feedlot Officer Marilee DeGroot – Environmental Health Program Administrator Jennifer Mocol Johnson – Water Planner 320 3rd St. N.W., Suite 9 Faribault, MN 55021 (507) 332-6113	-Responsible for shoreland zoning ordinance revisions - Feedlot inspections, manure management planning - Septic system inspections and upgrading options -Assistance with lake management plan development, monitoring, and restoration projects -Able to apply for state funding for implementation projects.
Rice County Soil and Water Conservation District and USDA/NRCS	Steve Pahs – Manager Nicole Lehman – District Technician Tim Labs – Wetland Conservation Act Adam Arndt – Nutrient Management Tom Coffman – NRCS Manager 1810 30th St. NW Faribault, MN 55021 (507) 332-5408	-Determine eligibility for enrollment in Conservation Reserve programs. -Assist with design and installation of water and erosion control structures. -Provide information on wetland restoration. -Assist with development of nutrient management plans.
University of Minnesota Extension Services	Brad Carlson County Extension Educator 320 NW Third St., Suite 7 Faribault, MN 55021	-Provide information and assistance with tillage system options - Provide information and assistance with manure and nutrient management.

Activities

As the potential phosphorus sources were separated into categories so too are suggested activities for ways to reduce phosphorus input to the lake. All of these actions will take time and money. Funds may be available from grants through the Minnesota Pollution Control Agency, Minnesota Department of Natural Resources, the Minnesota Legislative Citizen Commission on Minnesota Resources, USDA/NRCS, private foundations, conservation clubs, and the lake club. Developing a lake management plan with realistic goals that are reviewed as to status of progress is recommended. CRWP recommends a group be formed of the lake club, SWCD, county planning and zoning, township officials, and CRWP that meets on an annual basis at minimum to discuss implementation projects, coordinate activities, review progress, and discuss funding opportunities. There are many pieces to this puzzle and when they are put together they should yield the desired result. The ultimate goal of improved water quality will take a long time, however small steps must be taken or the situation will only get worse. These lists should be considered a starting point and should be modified as needed.

Rural Residential

1. Evaluate residential properties to determine stormwater runoff potential. Suggest steps to reduce volume and redirect flow through actions such as moving drain spouts, installing rain barrels, rain gardens, pervious pavement, etc.

2. Educational activities to ensure all residents are aware of the State of Minnesota law regulating the use of lawn fertilizers containing phosphorus.

3. Educational activities to encourage residents to compost leaf and grass clippings so they are less likely to end up in the lake.

4. Encourage all residents to use phosphorus free dishwasher detergent. Contact manufacturers for trial samples and distribute them to all residents.

5. Install natural shoreland vegetation. The Minnesota Department of Natural resources has grant funds available for shoreland planting. This could be a joint effort of the lake club and the county.

6. Meet with developers in the area to encourage them to design new homes /developments with as little impervious area as possible.

7. Work with the county planning and zoning office, county commissioners, Minnesota DNR, and state legislature to adopt the alternative shoreland standards that the Minnesota DNR has drafted.

8. Hire a consultant to review possible options for stabilizing the eroded bluff on the northeast section of the lake. At present, the county has no plan for dealing with this issue (personal communication, Dennis Luebbe, Rice County Highway Department, November 9, 2007). Developing possibilities and cost estimates would be beneficial in determining future actions.

9. Work with the Rice County Planning and Zoning office to inspect septic systems and find solutions to upgrade systems where it is needed.

10. Encourage all residents to pump their septic systems frequently. Short training sessions could be offered so all homeowners understand how their systems work and the necessity of maintenance.

Agriculture

"Management strategies to remediate water quality problems associated with P losses from the landscape will be most effective if used on high-risk, sensitive or source areas within a watershed rather than implementing general strategies over a broad area. General management practices that can be focused in these high-risk areas include minimizing erosion and runoff, avoiding P additions to very high testing soils where a crop response is unlikely, and incorporating or injecting P inputs (fertilizer and manure) below the soil surface." (Busman,2002)

A study was done on Clear Lake in Iowa looking at how soil-test phosphorus levels and management practices affected phosphorus loads in an agricultural watershed (Klatt, 2003). They found the amount of fertilizer application was uneven and often excessive across the watershed. Their survey of soil-test phosphorus showed that 46 to 83% of fields had test levels that did not recommend phosphorus fertilization for crop production. Their conclusions were that using a P Index to estimate phosphorus loss from fields, reducing the amount of phosphorus added to areas that showed high soil phosphorus levels, and adoption of improved soil conservation practices should improve water quality and the profitability of crop production in their watershed and others with similar conditions. The Roberds Lake watershed is certainly similar to the Clear Lake, Iowa watershed and could benefit from applying their recommendations.

Activities that should take place now in this watershed include:

Tillage and Crop Management

1. Consideration by agricultural producers of tillage methods that would leave more residue on fields and expose less soil. Reducing soil erosion is a key strategy.

2. An evaluation of the needs of producers regarding equipment and crop management should be conducted; perhaps form a subgroup of producers as part of the lake club. It may be possible for equipment to be designed or purchased that could be shared by producers to help reduce the cost and risk of changing tillage systems.

3. Soil samples should be collected and the Minnesota Phosphorus Index or similar model run to estimate risk of phosphorus loss from fields and determine which areas need to have changes in management.

4. Decreasing the area of cropland within 100 m (~300 ft) of surface waters, which corresponds to land retirement programs such as those promoted in the Conservation Reserve and Conservation Reserve Enhancement Programs.

5. Producers should be encouraged to work with the Rice County Soil and Water Conservation District, the Area NRCS office and University of Minnesota Extension to determine what conservation practices could be implemented on their working lands and what resources are available to help them do so. To prevent sheet and rill erosion, and ephemeral gully erosion from occurring sediment basins and terraces can be installed. Ephemeral gully erosion can contribute significant amounts of contaminated sediment to receiving bodies of water. One of the preferred methods of the Rice County SWCD in resolving ephemeral gully erosion is to install sediment basins. Sediment basins temporarily store runoff and convey it underground to a safe and stable outlet. The basins generally trap 80-90% of eroded sediment and allow the producer to spread it back on the hill top. To control sheet and rill erosion terraces are constructed across the slope on the contour. Basins are preferred over traditional terraces, because they use less farmable land. (personal communication, Nicole Lehman, Rice SWCD, November 2007).

Feedlots

1. Using the total number of animals registered on a particular feedlot for planning will allow for better outcomes for future projects. For example, a feedlot may have a registration for 50 beef cows; however, they may only stock 20 beef cows at their site at any one time. An assumption should be made in this case that 50 beef cows is the maximum amount of animals allowed at the site. (personal communication, Wade Schulz, November 28, 2007)

2. Operators should be in compliance with the Open Lot Agreement by 2010. It may be useful to meet with the operators to find out what can be done to assist them in this process.

Nutrient and Manure Management

1. Feedlot operators should review their manure management plans, if they are not already doing so, and ensure they are being followed. Revisions should be made if necessary.

2. Educational opportunities should be provided regarding manure and fertilizer. Increased reduction could come from improved phosphorus fertilizer and manure management – follow U of M recommendations more consistently.

3. In addition to the requirements of the state, there are also recommendations for voluntary practices regarding manure management such as immediate incorporation on all land that slopes toward streams, even if the land is more than 300 feet from the stream and has vegetative buffers (MPCA, 2005).

Natural Sources

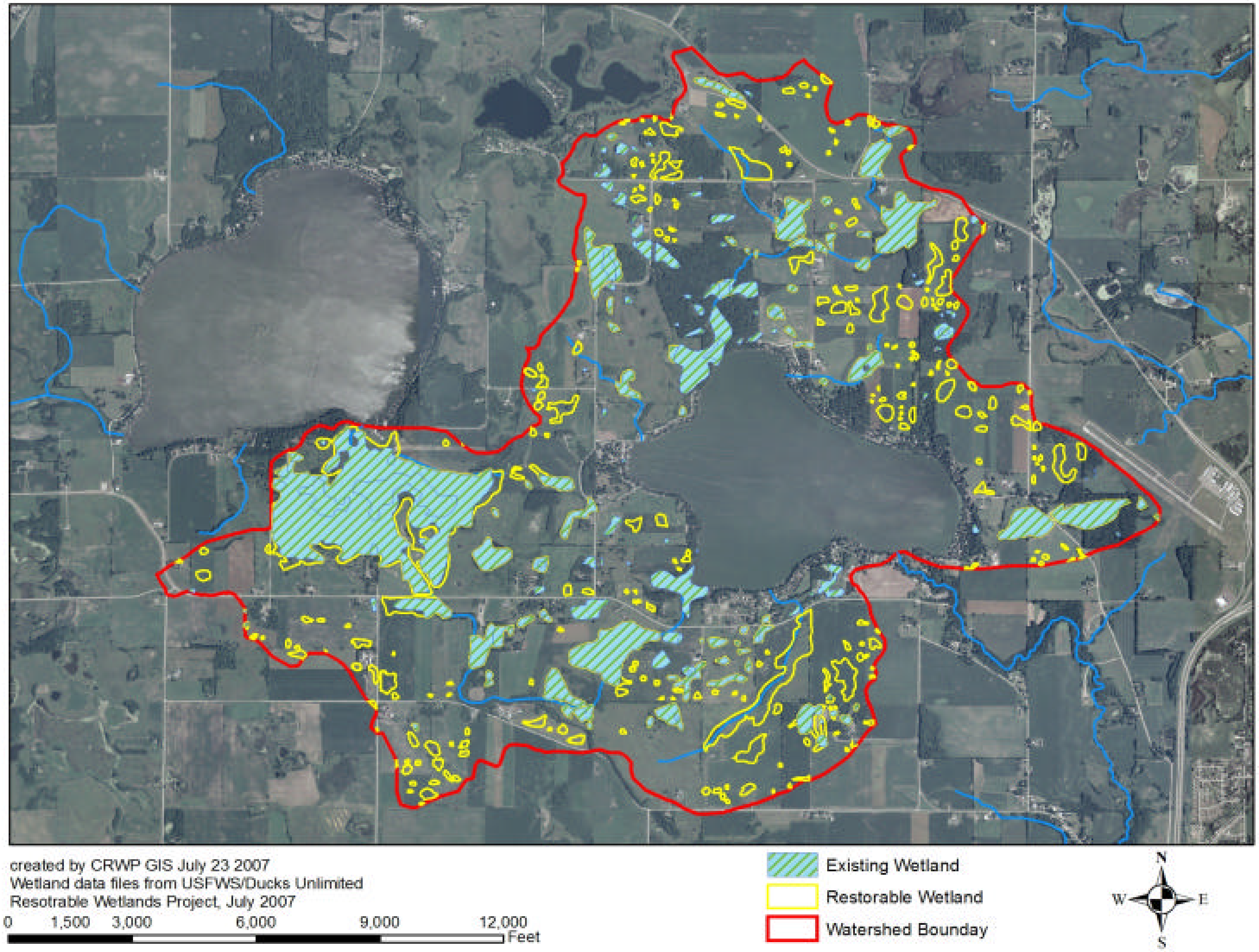
Wetlands

The amount of wetlands in Minnesota has decreased dramatically since presettlement times. Wetlands provide many useful functions such as:

1. Storage of excess water during floods
2. Filtering sediments, nutrients and toxic substances before they enter lakes rivers and streams
3. Habitat for fish and wildlife
4. Public recreation
5. Groundwater recharge

The monitoring done in 2007 showed high phosphorus concentrations from the wetland area on the north side of the lake. The causes for this are uncertain. There may be an excessive amount of phosphorus in the soils of the wetland from past activities. Novak suggests that the concentrations may remain high for some time until the phosphorus stored in the wetland soils have a chance to work their way through the system (Novak, 2004). It will be important to continue monitoring this situation to see what phosphorus concentrations are like under normal and wet conditions. There are many opportunities in the watershed to convert land back into wetlands. Figure 16 depicts some possibilities for this watershed. As land owners consider how they want to use their properties, the opportunity to convert these restorable wetland areas needs to be considered. Funding is available in some situations through state and federal conservation programs. Educational materials could be sent out to landowners with restorable wetlands asking them to consider this option.

Figure 16 - Restorable Wetlands



Atmospheric Deposition

Soil dust is estimated to be the largest source of atmospheric phosphorus. Therefore, reducing soil dust, particularly from wind erosion from agricultural fields, through the application of wind erosion best management practices (shelterbelts, no till planting, use of cover crops, etc.) should be a high priority.

Streambank erosion

Several methods can be implemented to help reduce streambank erosion:

1. Careful land use planning that considers the potential adverse impacts associated with increased runoff volumes.
2. Well-designed stream road crossings that consider the potential hydrodynamic changes to the systems.
3. Exclusion or controlled access of pastured animals and preservation of riparian vegetation.
4. Rotational grazing practices could be implemented.

In-lake

The contribution of phosphorus from the sediment can represent a significant part of the phosphorus load to a lake and, in some cases, may be the major source of phosphorus. An alum treatment of the lake to help reduce internal loading of phosphorus from the sediments may be necessary (personal communication, Dick Osgood, Osgood Consulting, December 3, 2007). Prior to making this determination sediment cores of the lake need to be analyzed and a cost benefit analysis conducted. If internal phosphorus is a major source, it is because of the history of excessive external loads. The only permanent solution is to reduce external loading.

Curlyleaf pondweed is a significant problem in the lake both aesthetically, for recreation, and as a phosphorus source. The Minnesota DNR has a pilot grant program to try out whole lake treatments for reducing curlyleaf. The application and description of the information needed to qualify for this program can be found at: www.dnr.state.mn.us/grants/habitat/lakewide.html. A step that could be taken to qualifying for this program would be to conduct an aquatic vegetation survey.

Monitoring

Water quality monitoring of the lake and inlet streams should continue. The lake should be sampled for May through September for the following parameters: total phosphorus, orthophosphorus, chlorophyll-a, and Secchi depth. Dissolved oxygen and temperature measurements at varying depths should also be taken to see what the potential is for phosphorus release from the sediment and to see if the lake is stratifying. The inlet streams should be sampled for total phosphorus and possibly orthophosphorus. Flow measurements and water level measurements to determine flow rates should be taken which would allow the conversion of concentrations into loading values. This would help to determine how much phosphorus is coming off a given area per year. All of this data will be useful in determining if the water quality is changing. It will also help position the lake to complete a Total Maximum Daily Load

(TMDL) study with the MPCA. The TMDL study sets allocations of phosphorus to the different sources we have identified. Having a TMDL completed qualifies the area for funding for implementation projects.

Applicability for Future Source Assessment Projects

One of the overall goals of this project was to create a systematic approach to conduct phosphorus source assessments on the remaining lakes in the Cannon River watershed. Groups such as CRWP and lake associations are very interested in learning what the phosphorus sources are so that we may devote our efforts to mitigating these sources. The more knowledge we have that specifies sources the more effectively we can use our limited resources to address them. Over the course of this project we have learned things that worked and what could have been done differently. The following is a summary of these lessons:

What worked?

1. Paper records review provided a good summary of the status of septic systems in the watershed.
2. The maps provide a useful visual description of the situation especially the septic and feedlots maps.
3. The windshield survey of the feedlots was important to confirm the ones in operation. If we had just looked at the number of registered feedlots the significance of feedlots as a phosphorus source would have been different.
4. The lake club members and interested residents provided much needed background and assistance collecting water samples.
5. Meeting with the lake club at the start of the project to describe what we would do and towards the end to present some findings was useful in gaining their support and interest in carrying out the activities that will be needed to improve the lake water quality.

What could be done differently?

1. Better communication with project partners prior to the start of the project to ensure the activities accurately reflect abilities and time available from the partners.
2. Build relationships with producers early in the project. Data that was needed to run the MN Phosphorus Index or to have assessed potential phosphorus loss from feedlots need to be collected from the operators. Soil test and specific tillage information cannot be gathered without permission from the producers.
3. Allow time and budget to work with producers to check status of compliance with manure management plans.
4. Conduct monitoring for at least two seasons on inlets as well as in-lake water. Monitor the streams from snowmelt till the end of September and collect flow data if possible. Collect dissolved oxygen and temperature data in the lake to look at lake phosphorus release potential and stratification.

Overall this type of project can provide very useful data to help plan and act on strategies to reduce phosphorus from entering lakes and streams. It was done using mostly existing information so the cost is not high. Now that we have a template and ideas on how to make improvements, replication should be considered on lakes throughout the watershed.

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