Silver Lake Watershed Management Plan

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Length of Plan: 10 years

Submitted by: Dickinson Soil & Water Conservation District

Contact: Ryan Ransom
Dickinson SWCD
2412 17th St.
Spirit Lake, IA 51360
Ph: (712) 336-3782, Ext. 3

****The Silver Lake Watershed Management Plan will be updated on a 3-year basis, beginning in June of 2014.**

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1. Project Mission

The goal of the Silver Lake Watershed Project is to work to improve the water quality of Silver Lake to support multiple uses, to benefit fish and wildlife resources, and to maximize the quality of life for those who use it. To achieve these results, the watershed project must reduce sediment and phosphorous from reaching Silver Lake.

Previously, the Osceola Soil & Water Conservation District (SWCD), the Dickinson Soil & Water Conservation District (SWCD), the Dickinson County Clean Water Alliance (CWA), and the Silver Lake Park Improvement Association (SLPIA) have jointly participated in a Water Quality Assessment for the Silver Lake Watershed in an effort to determine where the water quality concerns for Silver Lake could be determined. These organizations have jointly pursued the protection and improvement of water quality in the Silver Lake Watershed since 1999.

The Dickinson SWCD has developed an intensive plan to reduce sediment and phosphorous loading to Silver Lake. The Osceola SWCD has already implemented the first phase of this plan. This includes a Watershed Improvement Review Board (WIRB) project focused on restoring 5% of the watershed to wetland and upland habitat. The 319/WSPF grant is the 2nd part of the plan. This project will assist landowners in the watershed with implementation of best management practices in key locations in the watershed. By using the combination of these two programs, it is hoped we will be able to reduce phosphorous loading into the lake by 58%, which will be enough to remove this lake from the impaired waters list.

Dickinson County Water Quality Commission was established in 2001 to provide a steady funding source, using local money as a match to state and federal revenues for water quality projects for lakes in Dickinson County. This one-of-a-kind organization in the state is comprised of 18 commissioners who represent the county and its ten municipalities. Among the many objectives of the WQC are: to bring a minimum of $3 in federal, state and private matching funds to communities that are looking for money to improve water quality. In the first year of operation in 2001, the WQC had a pool of $100,000 to grant to water quality projects to improve lakes in Dickinson County. In each subsequent year, the WQC has administered $200,000 in water quality projects. To date the Water Quality Commission has awarded nearly 1 million dollars in grant funds that have been matched with over 14 million dollars by the grantees. The 28-E agreement that created the WQC is in effect until 2009, and automatically renews for a two-year period thereafter.

Dickinson County Clean Water Alliance coordinates the efforts of governmental agencies, non-profit and private organizations through the help of a branch of the Dickinson County Soil and Water Conservation District (SWCD). Its slogan is "united to keep our lakes alive." The CWA is an uncommon federation of over 60 groups working in harmony to protect the water resources of the area. The CWA was formed in 1990 by the Dickinson County SWCD and the INHF, the area lake protective associations and the Iowa DNR. They continue to coordinate activities for water quality.

The long-range strategic plan developed by the CWA has identified four main watershed goals for lakes in Dickinson County:

- Native biological diversity is respected and encouraged
- Infiltration practices are promoted throughout the watershed
- Impaired waters are protected and improved
- High quality waters are maintained and improved

The Alliance recognizes that a successful watershed approach to protecting and enhancing the water quality in the Great Lakes region requires clearly identifying needs and goals, selection of management alternatives based on good science, and a genuine stakeholder partnership. The Alliance promotes a voluntary conservation program driven by landowners, lake and park users, and public and private organizations that will reduce or prevent negative impacts to water, land, and economic resources within Dickinson County.

Support for the Silver Lake Watershed Project is tremendous. The members of the Clean Water Alliance fully support this project. Groups and individuals in Lake Park and around Silver Lake are excited about the opportunities this project will bring them. Landowners in the watershed are already investigating the opportunities available to them as a result of this project.

Silver Lake Park Improvement Association has a mission to protect and enhance water quality in Silver Lake. Other protective associations in Dickinson County have agreed to assist the Silver Lake Park Improvement Association in its efforts. The oldest of these is the Okoboji Protective Association, which celebrated its 100th anniversary in the summer of 2005. Many of the lake associations' projects are held around their individual lakes (e.g. clean-ups, education classes for Girl Scouts & Boy Scouts.)

Iowa Lakeside Laboratory (ILL) is a year-round environmental education facility with over 40 buildings on a 143-acre campus on West Lake Okoboji. Classes held at the lab serve numerous students from various universities throughout the state. Iowa Lakeside Laboratory is responsible for conducting the CLAMP water monitoring in Silver Lake.

Iowa DNR Northwest Regional Headquarters houses the Spirit Lake Fish Hatchery, and is the only cool water hatchery in the state. This hatchery is noted for its walleye, northern pike and muskellunge production which help to sustain healthy game fish populations in the lakes, streams and reservoirs of Iowa. The DNR regional headquarters also has offices dedicated to management of fisheries and wildlife resources in NW Iowa and the research of Iowa's natural lakes. Personnel from this office are analyzing the new Light Detection and Ranging (LiDAR) data as well as performing the GIS assessment for the watershed. This data will be used to determine future environmental planning.

Figure 1.1: Silver Lake sunset

2. Watershed Characteristics

Location

The Silver Lake watershed is an area of about 18,050 acres located in northwest Iowa and southwest Minnesota. Approximately 50 percent of the watershed lies within Dickinson County, Iowa, 45 percent of the watershed in Osceola County, Iowa, and the remainder within Jackson County, Minnesota. Silver Lake is a major recreational lake for Iowa residents and visitors from adjacent states. Agricultural runoff containing sediment, fertilizers, pesticides, herbicides, and feedlot waste negatively influence the water quality. Urbanization contributes pollution from stormwater run-off, and there is some suspicion that there are a number of private sewage disposal systems within the watershed area that are improperly installed or not properly maintained.

The drainage area to Silver Lake is a 17,025-acre watershed, not including the surface area of the lake. The moderately large lake to watershed ratio of 16.5 to 1 indicates that watershed characteristics have a significant potential impact on water quality of the lake.

Silver Lake

Silver Lake is a natural glacial lake. The watershed of Silver Lake is rather large compared to the lake area. The total lake watershed is 18,055 acres with a total lake area of 1,033. Silver Lake is typical of the shallow glacial till lakes from the last glacial period.

Silver Lake is listed on the State of Iowa's FY2002 and FY2004 Section 303(d) List of Impaired Waters for turbidity (transparency) and algae. Both of these impairments stem from an extremely large sediment and nutrient load that is derived from the watershed, and later re-suspended by wave action and rough fish activity in the lake itself. Low turbidity is a result of excess suspended solids (sediment), while the high frequency of algae blooms (including blue-green algae containing cyanobacteria) can be attributed to elevated phosphorus levels. Silver Lake was also listed as a "Priority Lake" in the September 2002 State Non-point Management Program for Iowa. According to a 5-year study of Iowa's public Lakes, Silver Lake ranks in the bottom 25th percentile for average chlorophyll A concentrations, Secchi depth, average Carlson TSI, and average total phosphorous. By examining Silver Lake's position in the bottom 25th percentile of this list, it is evident that some of the poorest water quality in Iowa's public lakes can be found here.

IDNR Waterbody ID	IA 06-LSR-03105-L_0
10 Digit Hydrologic Unit Code (HUC)	1023000302
10 Digit HUC Name	West Fork Little Sioux River
Location	Dickinson County, S28, T100N, R38W
Latitude	43.5
Longitude	-95.3
Designated Uses	A1 – Primary contact recreation B(LW) – Aquatic life (lakes and wetlands) C – Drinking water supply HH – Human health (fish consumption)
Tributaries	West Branch Little Sioux River and one unnamed tributary
Receiving Waterbody	West Branch Little Sioux River
Lake Surface Area	1,032 acres (excludes Trappers Bay)
Maximum Depth	9.8 feet
Mean Depth	6.7 feet (excludes Trappers Bay)
Lake Volume	6,894 acre-feet
Length of Shoreline	9.61 miles (50,730 feet)
Watershed Area (excludes lake)	17,025 acres
Watershed: Lake Ratio	16.5:1
Lake Residence Time	121 days (estimated)

Table 2.1: Location/characteristics of Silver Lake and associated watershed

Land Use

The predominant land use in the Silver Lake Watershed is row crop agriculture, most of which is in a corn-soybean rotation. There is some cropland in a corn-soybean-oats-meadow rotation, but this accounts for only five percent of the total cropland in the watershed. Conservation Reserve Program (CRP) ground makes up a very small portion (less than one percent) of the area typically in crop production. Other land uses include farmsteads, timber, grasslands, wildlife area, urban, and roads. Table 1.2 reports the generalized land uses by acre and by percentage of watershed. Figure 1.1 shows a more detailed distribution of land use throughout the watershed.

The total land use breakdown for the Silver Lake Watershed is as follows:

General Land Use	Description	Area (Acres)	% of Watershed
Row Crops	corn, beans, oats, alfalfa, CRP	14,521.1	85.3
Conservation Areas	timber, grassland, wildlife areas	1,471.3	8.6
Farmsteads	homes, yards	269.3	1.6
Water	wetlands, ponds (excludes lake)	320.5	1.9
Urban/Roads	residential, commercial, roads	442.8	2.6
Total		**17,025**	**100.0**

Table 2.2: Land Use data for 2007

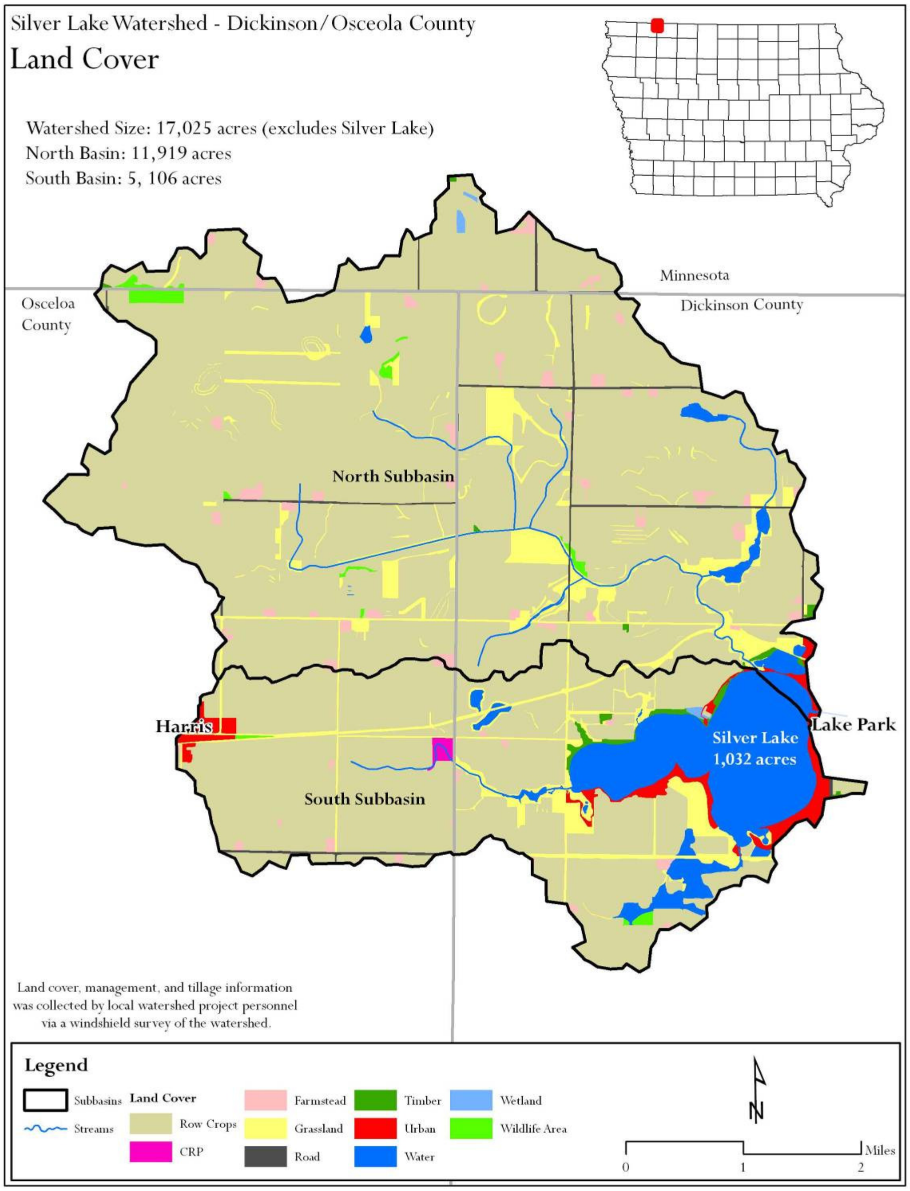


Figure 2.1: Land use distribution map (IDNR)

In addition to the parks and recreational facilities within the county, one of the state's most interesting natural area, the Silver Lake Fen, is located on the West edge of Silver Lake. The fen is one of the rarest forms of habitat in the State and perhaps one of the least well-known systems in Iowa. The Iowa Department of Natural Resources owns and operates 38 public areas, including the Silver Lake Fen, encompassing 19,911 acres within Dickinson County.

Population Dynamics

As of the census of 2000, in Dickinson County, Iowa there were 16,424 people, 7,103 households and 4,759 families residing in the county. The median income for a household in the county was $39,020 and the median income for a family was $47,739. The per capita income for the county was $21,929; 6 percent of the population and 4 percent of families were below the poverty line including, 6 percent of those under the age of 18 and 7 percent of those age 65 and older. (U.S. Census Bureau, 2000)

As of the census of 2000, in Osceola County, Iowa there were 7,003 people, 3,012 households and 1,943 families residing in the county. The median income for a household in the county was $34,274, and the median income for a family was $41,977. The per capita income for the county was $16,463. About 6 percent of families and 7 percent of the population were below the poverty line, including 7.9 percent of those under age 18 and 9.8 percent of age 65 or over. (U.S. Census Bureau, 2000)

Climate
The climate of the Silver Lake region is classified as humid-continental. Seasonal temperatures range from highs of 110 degrees Fahrenheit to lows of -40 F, while daily variations may be as much as 50 F. Annual precipitation is 27.62 inches, two-thirds of which falls between May and September. Summer precipitation ranges from severe storms to occasional drought. High summer temperatures produce evaporation levels typical of the prairies, discouraging forest growth.

The average frost free season is approximately 150 days, with a maximum growing season of 225 days from March 29 to November 9. The climate is dry enough to have aided the development of the prairie soils and humid enough to support a highly productive agricultural economy.

Geology
Geological events have been a primary driver in the natural features of the region, which in turn have influenced the development pattern. The simple geological resource (lakes) of the area is a reason the lakes have developed as a tourist and recreational area. The geologic history of the area has affected the surface contours of the land, the formation of soil types, location of minerals, groundwater, lake basins and stream channels. During the ice ages, massive glaciers moved across the region, carrying with them boulders, gravel, sand and clay and organic remains. As the glaciers melted, millions of tons of debris were deposited (glacial drift). The glacial drift forms a 200-to 300-foot cover over the region's bedrock.

The glacial drift in the Silver Lake area was deposited in the Wisconsin Age of the Pleistocene Epoch. The Wisconsin glacier was the last of at least three major ice sheets to cover the area. The Des Moines lobe of the Wisconsin glacier, which originated in the Keewatin District west of Hudson Bay in Canada, pushed down into north-central Iowa across an area 70 to 80 miles wide. As the glaciers receded, the glaciers occasionally left large blocks of ice, which melted and formed basins for future lakes. The rugged bottom of West Okoboji Lake in Dickinson County suggests it may have been formed in this manner.

Water from the melting glaciers also cut new drainage patterns in the deposits below the ice. Outwashes of sand and gravel were carried by streams that drained glacial melt and deposited it in the valleys, which the glaciers had formed. Underlying the glacial drift are shales and sandstone created in the Cretaceous Age. The shales vary in thickness and are found exceeding several hundred feet just north of the northern boundary of the watershed. The sandstones vary in thickness but generally do not exceed the thickness of the shales.

Below the Cretaceous units, data regarding the age of the soil is limited. However, it appears that Ordovician and Cambrian Age sediment underlie the Cretaceous units in the southeastern half of the watershed. A few miles north of the northern boundary there also exists a buried northwest-southeast trending quartzite ridge of Pre-Cambrian Age.

Soils

Soils in the Silver Lake watershed are derived from Wisconsin (glacial) till on the Cary Lobe, within the Des Moines Lobe landform region. Depressional and calcareous soils are common in the region. The topography of the region is relatively flat, with some gently rolling hills and depressed areas that form isolated basins within the watershed. In its natural state, the watershed contained many wetlands in these low-lying depressed areas. However, due to its topography and poorly drained soils, approximately 85 percent of the watershed is tile drained, which enables the land to be agriculturally productive.

The heavier textured glacial soils occur within the Silver Lake watershed. These soils are not as erosive as the predominantly lighter textured loess soils found 50 miles to the southwest, but the soils do erode–especially during periods of abnormal rainfall or excessively high winds. Water erosion takes a toll on the steeper lands that are being row-cropped. The flatter land is more subject to wind erosion when it is left over winter without a cover of crop residue. The predominant soil types are listed below:

Soil Name	Description	Typical Slopes (%)
Nicollet	loam, somewhat poorly drained	1-3
Okoboji	silty clay loam, very poorly drained	0-1
Clarion	loam, moderately eroded, well drained	2-9
Webster	silty clay loam, poorly drained	0-2
Canisteo	silty clay loam, poorly drained	0-2

Table 2.3: Silver Lake Watershed predominant soil types. Courtesy of NRCS.

There are four major soil associations within the watershed. The major and minor soils are listed in order of importance below. Two associations may contain the same soils, but in a different pattern.

Wadena - Estherville

The Wadena – Estherville association consists of soils that are medium to moderately coarse textured, gently sloping (2 to 5 percent). The association developed from glacial outwash and is shallow to deep to calcareous and gravel. The soils are prone to drought when sand and gravel are within 15 to 30 inches of the surface. Minimum tillage is an excellent conservation practice to use here, since it retains moisture in the surface soil and slows wind erosion.

Webster - Clarion – Nicollet

These soils occur in a small portion of the watershed; one area is at the northern tip and one at the southern edge. The area is typified by level to gently undulating (0-5 percent slopes) medium and moderately fine textured soils that are developed from glacial till. There may be pond spots and high lime areas.

This has low potential as a sediment producing area because of its gentle slopes. Simple conservation practices such as contouring, strip cropping and minimum tillage are all that may be needed to keep erosion in check. Occasionally, terraces may be recommended on steeper slopes.

Clarion – Nicollet - Webster

This association is characterized by gently undulating to gently rolling (2 to 9 percent) slopes. The soils are developed from glacial till and are medium and moderately fine textured. This area is used extensively as farmland. Some steeper slopes and wet areas are in permanent pasture. Conservation measures would include contouring, contour stripping, stubble mulching and minimum tillage with terraces on steeper slopes.

Clarion - Storden – Okoboji

The Clarion soils occupy the greater portion of this association. They are dark brown, loamy, well-drained soils occupying an upland position on gently undulating to steep slopes. The Storden soils occur on the steeper slopes and knobs, usually above the Clarion soils on the landscape. Most of the larger permanent pastures are in the areas of predominately Storden soils, since they are not as well suited to faming operations as is Clarion. The Okoboji soils are dark, deep and poorly drained. They occupy potholes or small depressions within the association and ordinarily require artificial drainage to be productive farmland.

Conservation measures on this association, principally Clarion and Storden, consist of contouring, strip cropping, mulch tillage and terraces. Terracing is usually difficult because of short, irregular slopes (Dankert, 1980).

Topography

The topography of the watershed can be characterized as gently rolling. Lakes and wetlands lie within the hollows of the terrain. Runoff from precipitation drains into the lakes, evaporates, or percolates into the soil where it recharges the groundwater. Water draining into the lakes and streams carry contaminants from the land, which affect the water quality of the lakes.

Surface Water

Surface waters consist of tributaries, streams, drainage ditches, and lakes that make up the Little Sioux River drainage basin. The Little Sioux River and several associated tributaries flow year-round through the county. Most creeks are intermittent and carry water only in periods of heavy rainfall or spring thaw. Runoff in these watercourses is directly related to the annual precipitation rate.

Groundwater Resources

The Dakota sandstone and the Ordovician and Cambrian Age sandstones are the most important of the deep flow systems. The well source in the watershed is mainly from the Dakota sandstone aquifer. The wells in the region average 130-500 feet in depth. The gradient of the groundwater is generally south, although local high water levels are found throughout the area following land surface contours. Ground water highs are found below the hills to the east and west of West Okoboji Lake, and east of East Okoboji Lake. Topographic high areas are recharge areas and low lying marshes and wetlands are discharge areas.

Shallow flow systems found in glacial drift have the most impact on area lakes and streams. Depth to the water table near the lakes varies from flowing springs to depths 50 feet below the ground surface. In areas adjacent to the Little Sioux River, the contour configuration indicates the river receives groundwater discharge. The lakes also receive base flow from groundwater.

Pollutant Sources
The primary threats to the water quality of Silver Lake are sedimentation, excess nutrients, human and livestock waste, stormwater contaminants and loss of natural wetlands. Agricultural runoff contributes contaminants such as sediment, commercial fertilizers, pesticide, herbicides and animal wastes. Potential spills of hazardous waste and invasion of aquatic invasive species are also a concern.

The prairie potholes and marshes adjacent to Silver Lake are ground water recharge areas, and serve as a natural filtration system by filtering and capturing contaminants carried in stormwater runoff, and infiltrating runoff from surrounding developed land. In the past, wetlands have been drained in favor of agriculture uses and urban development, but it has more recently been recognized that wetlands are an integral part of a complex ecological system.

Increased urban development has presented stormwater quality and quantity problems. Urban stormwater runoff carries contaminants such as sediment, excess nutrients, pesticides and herbicides, heavy metals, and road salt. There is increasing pressure on drinking water supplies by the growing permanent population base and an expanding summer seasonal population. Good water quality is vital to the region's economy and quality of life for those who visit or live within the area.

3. Water Quality Monitoring

A number of different factors affect water quality in the Silver Lake region. Activities in the watershed dictate the quality of water reaching the lake. The size and depth of the lake also influence the water quality. Large lakes with large volumes of water can dilute nutrients from the watershed. Shallow lakes, such as Silver Lake, are susceptible to mixing and disturbance of the bottom sediments which allow nutrients to be released to the water column, while deep lakes don't experience as much mixing and stirring of the bottom sediments.

Local Watershed Monitoring

Beginning in 2007, the Dickinson Soil & Water Conservation District formed a partnership with the Silver Lake Park Improvement Association (SLPIA) and the Dickinson County Water Quality Commission to conduct an on-going monitoring program at key locations within the Silver Lake Watershed. Although several years of in-lake monitoring data were available, little effort had been given to monitoring the quality of water entering the lake from its watershed.
The partnership realized that if they were to expect financial assistance for the installation of conservation best management practices (BMP's) and other water quality improvements, they would need data from the watershed itself. To date, this data has been used to provide a baseline in evaluating the overall health of the watershed, as well as helping pinpoint critical areas which should be targeted with incentives for the implementation of BMP's.

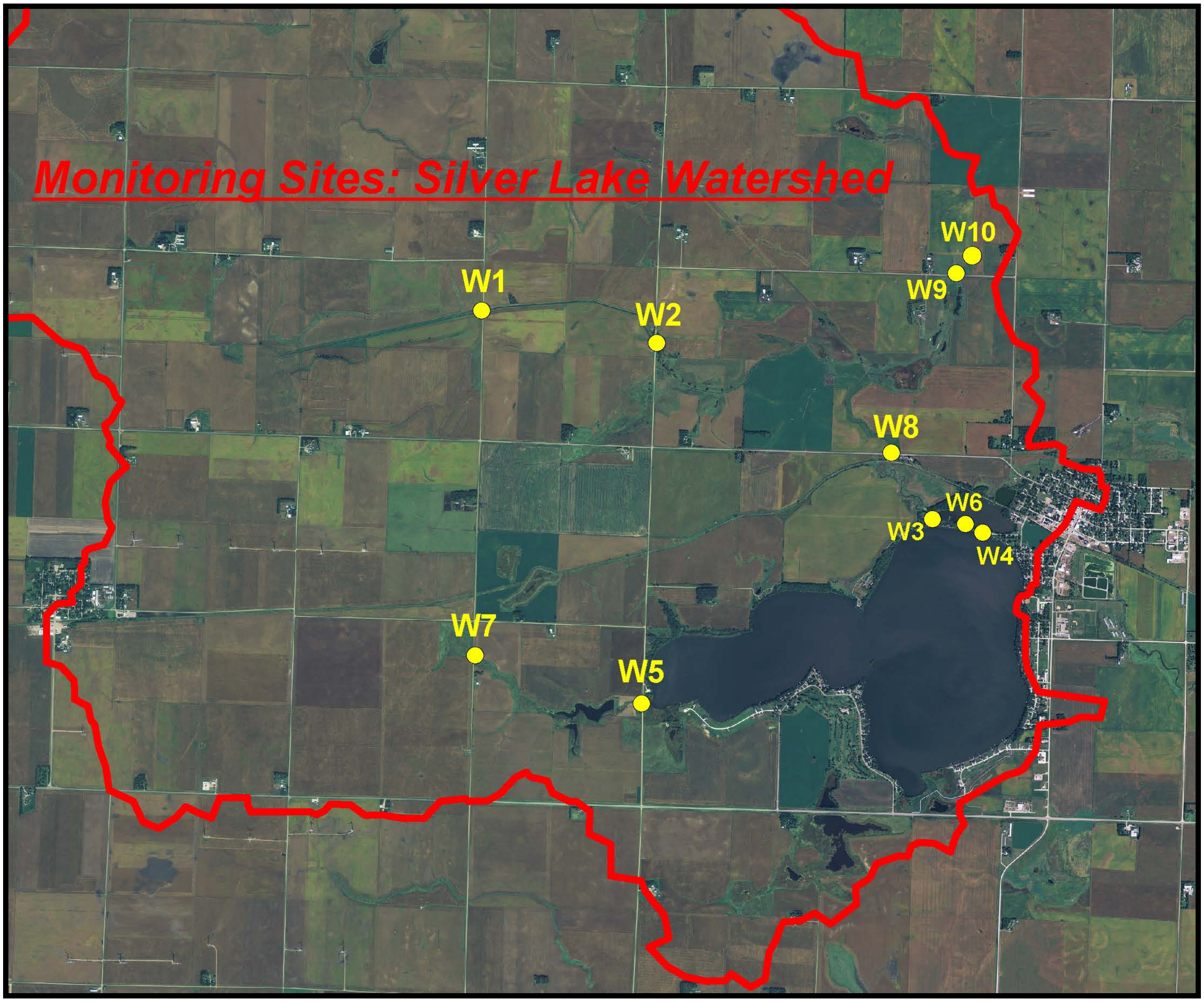
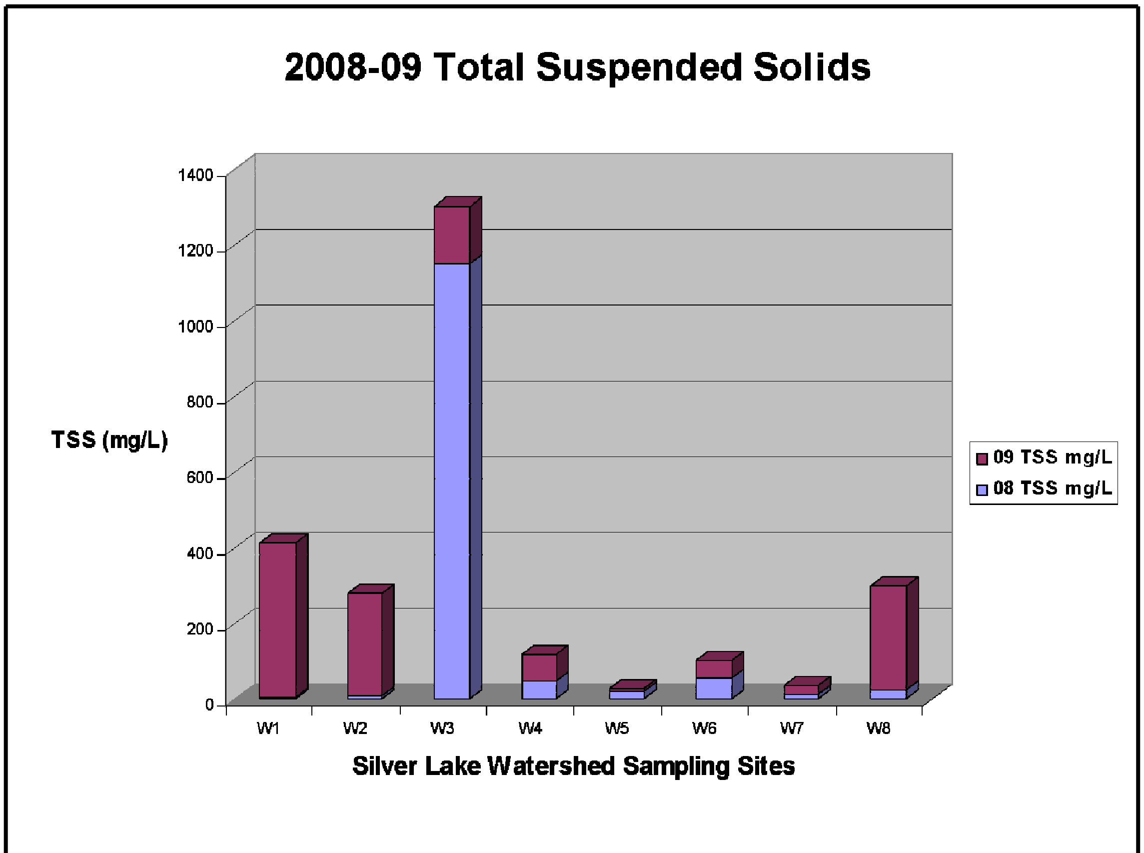


Figure 3.1: Silver Lake Watershed monitoring locations

Parameter	2007
Total Suspended Solids	17.9
Total Phosphorus as P (µg/L)	201.6
Total Nitrogen as N (mg/L)	6.04
E. Coli Upper	368.5

Table 3.1: 2007 Silver Lake Watershed monitoring summary results



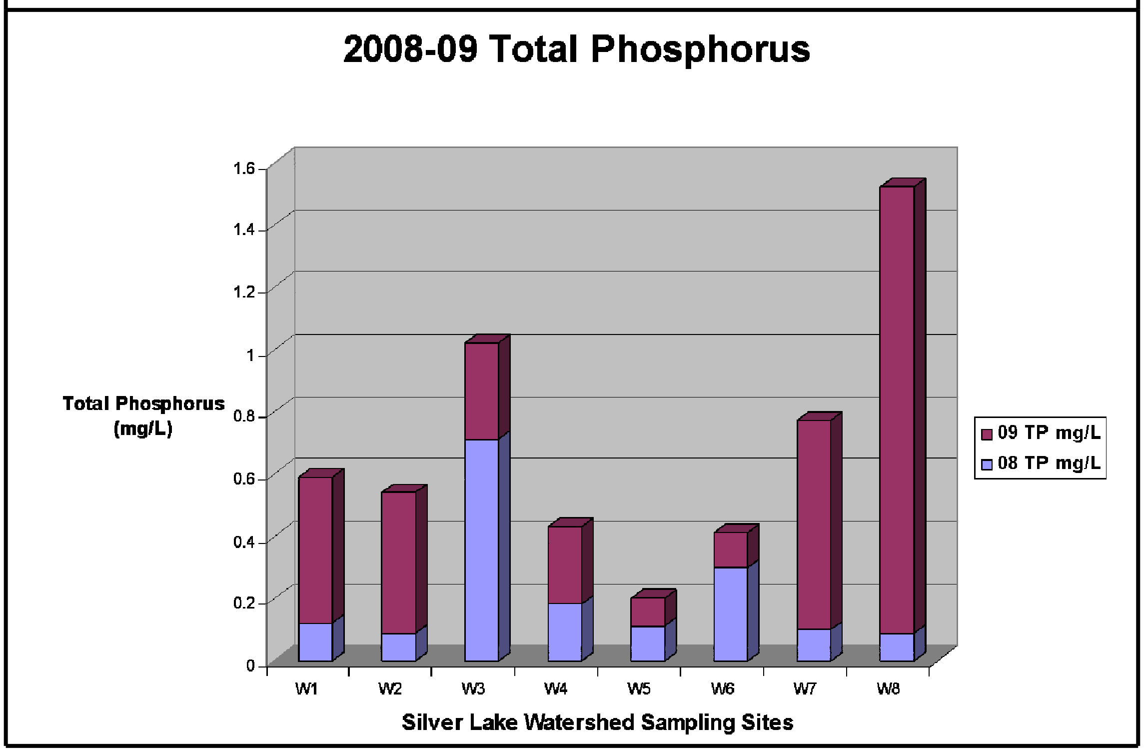


Figure 3.2: 2008-09 Avg. TSS and TP per Silver Lake Watershed sampling sites

Cooperative Lakes Area Monitoring Project (CLAMP)
CLAMP began in 1999 as an inspiration of the Friends of Lakeside Lab, local lake organizations and the Dickinson County Clean Water Alliance. The goal was to address the need for a long-term, unified approach to monitoring Dickinson County lakes. CLAMP is coordinated by Iowa Lakeside Laboratory, and supported by many local partners.

Over 100 volunteers have trained and participated in CLAMP since its inception in 1999. CLAMP volunteers sample nine lakes in Dickinson County: Big Spirit Lake, Center Lake, East Okoboji Lake, Little Spirit Lake, Lower Gar Lake, Lake Minnewashta, Silver Lake, Upper Gar Lake, and West Okoboji Lake. Volunteers collect field data including secchi depth, dissolved oxygen and temperature, and collect water samples for laboratory analysis including total nitrogen, ammonia nitrogen, total phosphorus, chlorophyll “a”, phytoplankton and Microcystin analysis.

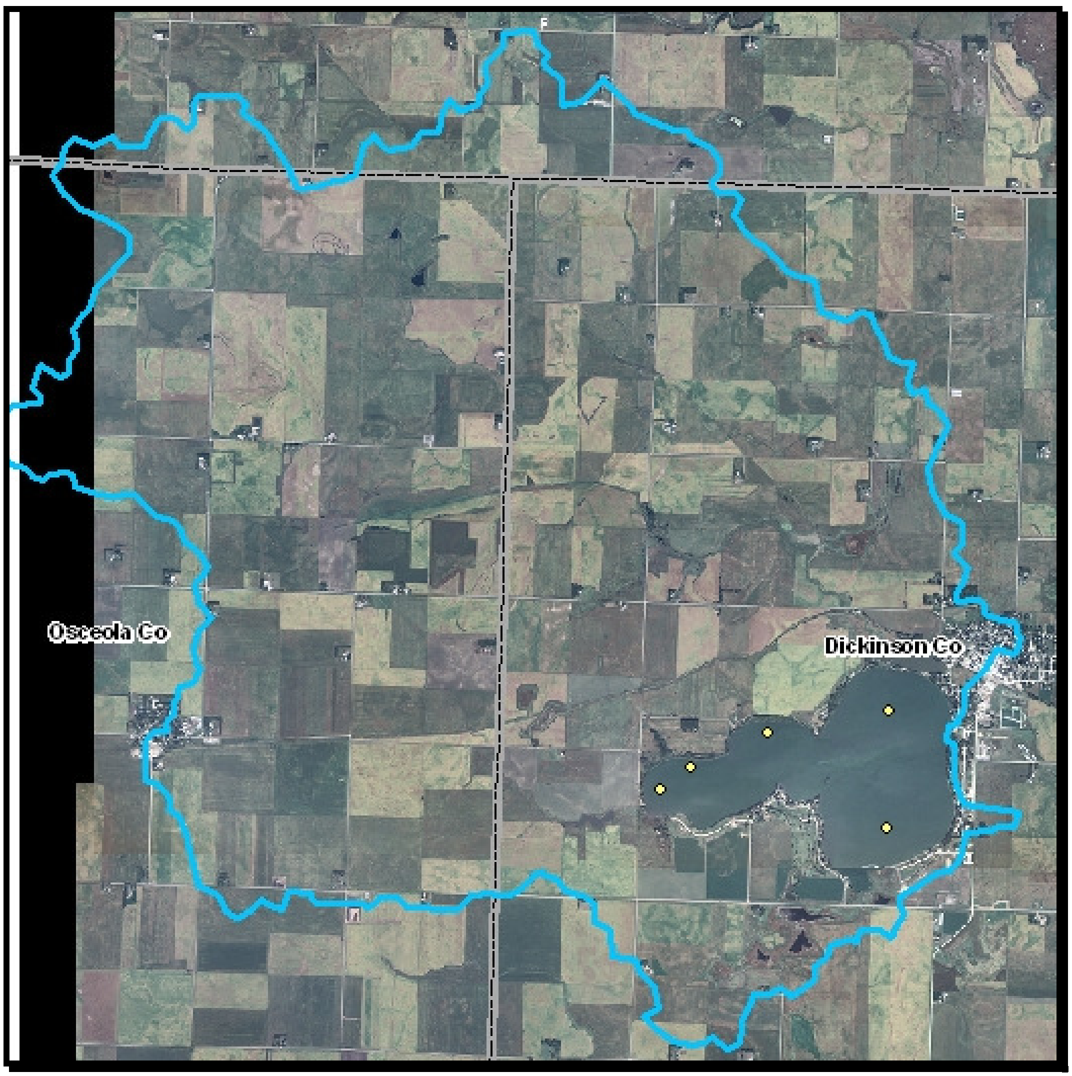


Figure 3.3: CLAMP monitoring locations on Silver Lake

Parameter	2007	2006	2005
Secchi Disk Depth (m)	0.7	0.6	0.7
Temperature(°C)	22.3	22.6	22.7
Dissolved Oxygen (mg/L)	8.5	8.7	8.1
Dissolved Oxygen Saturation (%)	96.9	100.0	94.1
Chlorophyll a (μg/L)	58.0	60.3	143.9
Total Phosphorus as P (μg/L)	83	95	118
Total Nitrogen as N (mg/L)	2.31	3.34	2.99
Microcystin (ng/L)	8.4	3.0	1.9
Carlson Trophic State Index (Secchi)*	66	67	65
Carlson Trophic State Index (Chl a)*	70	71	79

Table 3.2: 2005-2007 water monitoring results in Silver Lake (CLAMP)

Year/ Principal Investigator	Sampling Period	Number sampling sites	Total samples collected	Avg. Total P (mg/L)	SE
1979 Bachmann	June -- October	1	10	**0.097**	**0.012**
1990 Bachmann	5/26 -- 7/28	1	9	**0.105**	**0.004**
1999 CLAMP	7/30 -- 8/26	4	12	**0.123**	**0.008**
2000 CLAMP	6/6 -- 8/22	4	23	**0.164**	**0.015**
2001 CLAMP	6/5 -- 8/28	4	28	**0.209**	**0.017**
2002 CLAMP	6/11 -- 8/20	4	24	**0.185**	**0.029**
2003 CLAMP	6/10 -- 8/19	4	24	**0.170**	**0.017**

Table 3.3: CLAMP data median values 1979-2003

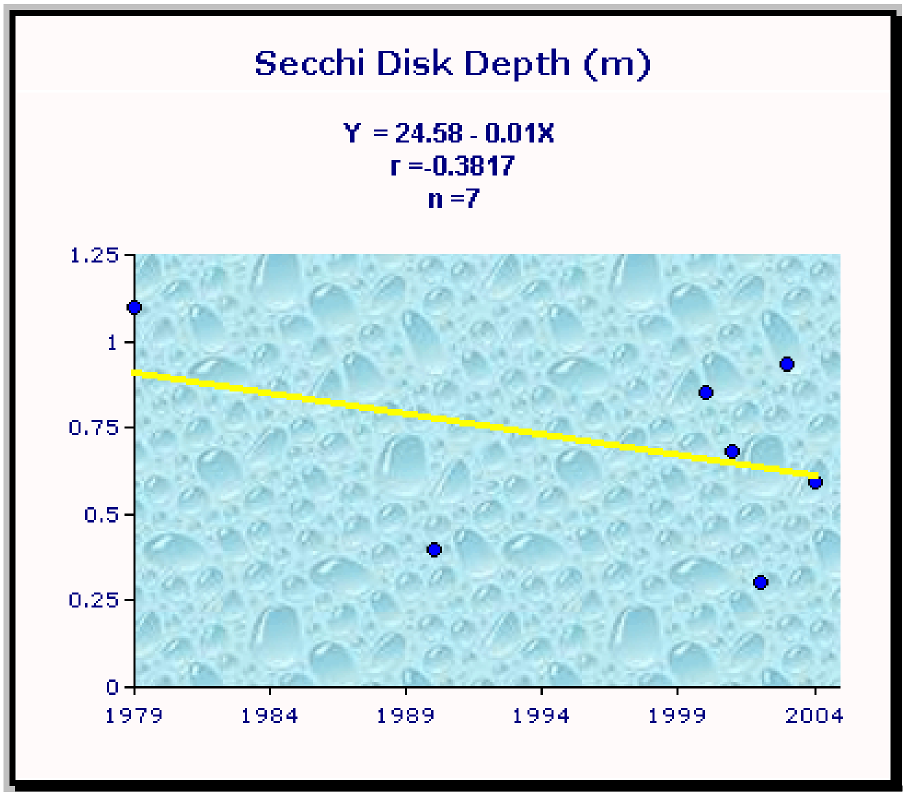


Figure 3.4: 1979-2004 trend in Secchi Depth

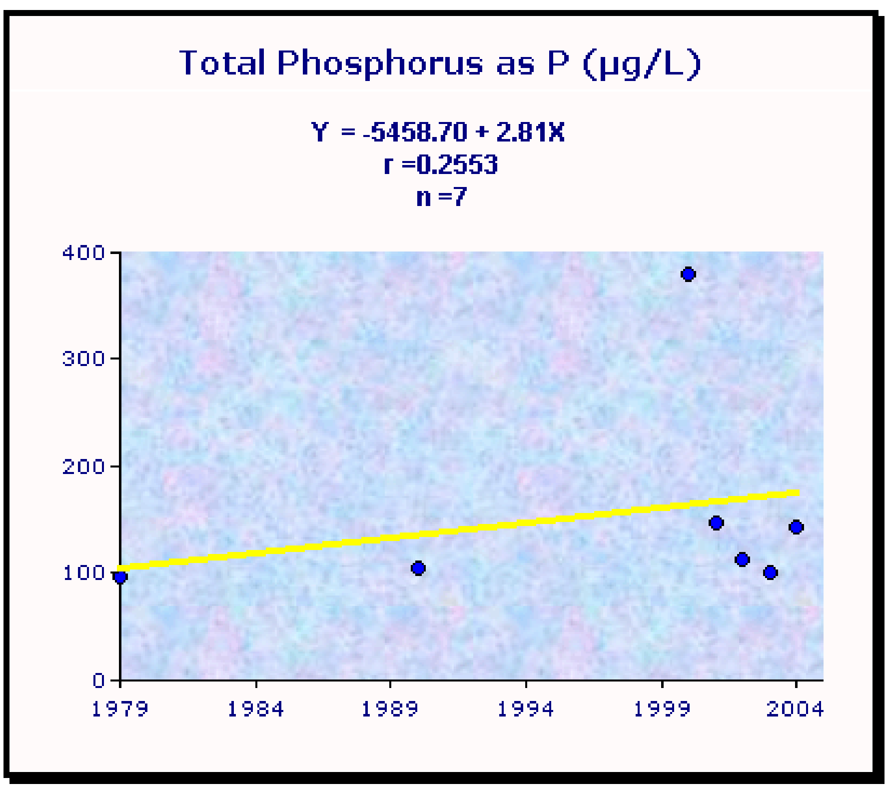


Figure 3.5: 1979-2004 trend in Total Phosphorus

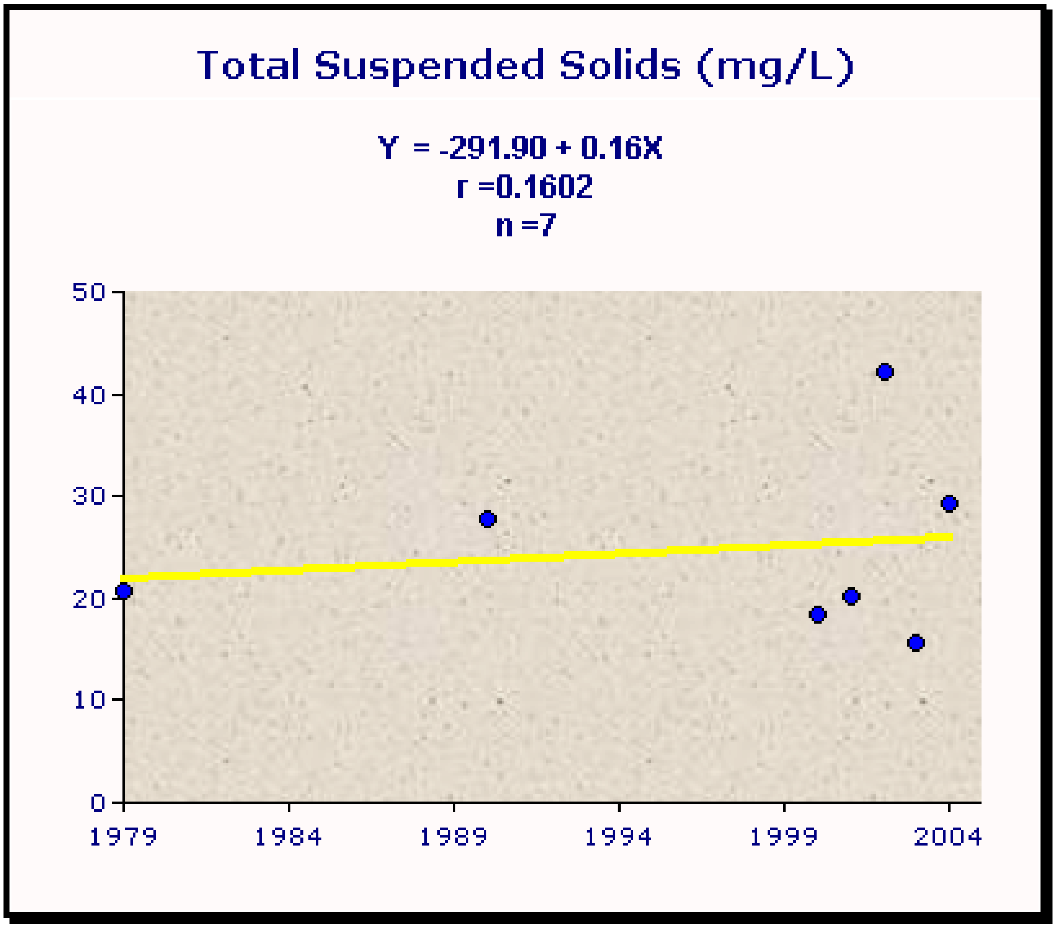


Figure 3.6: 1979-2004 trend in Total Suspended Solids

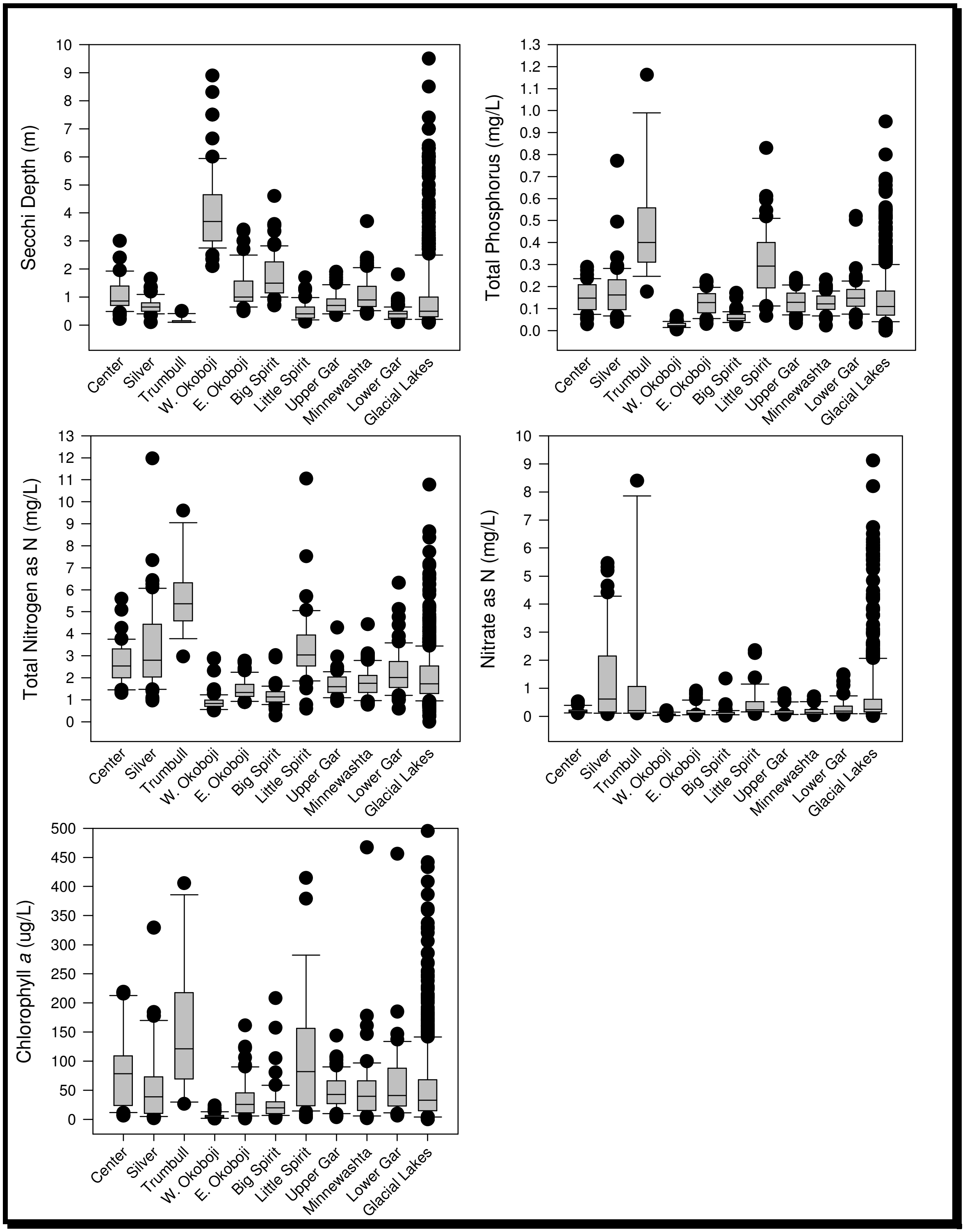


Figure 3.7: 1999-2006 Dickinson County CLAMP data

Silver Lake CLAMP Data Summary

Secchi depth ranged from 0.1 m to 1.7 m, with the deepest Secchi depths occurring in the spring, and the shallowest in late summer. Overall, Secchi depths in Silver Lake were shallower than most other CLAMP lakes and similar to the median for all monitored, glacial lakes in Iowa (Figure 3).

Total phosphorus concentrations ranged form 0.03 mg/L to 0.3 mg/L. The median total phosphorus concentration for Silver Lake was higher than all other CLAMP lakes with the exception of Trumbull and Little Spirit and higher than the median for all monitored, glacial lakes. Total nitrogen concentrations in Silver Lake were also higher than most other CLAMP lakes and the median for all monitored, glacial lakes (Figure 3).

Chlorophyll *a* concentrations ranged from 3 µg/L to 753 µg/L. The median chlorophyll *a* concentration for Silver Lake was similar to Upper Gar, Minnewashta, and Lower Gar as well as the median for all monitored, glacial lakes (Figure 3).

Trophic State

The large amount of water quality data collected by CLAMP can be difficult to evaluate. In order to analyze all of the data collected it is helpful to use a trophic state index (TSI). A TSI condenses large amounts of water quality data into a single, numerical index. Different values of the index are assigned to different concentrations or values of water quality parameters.

The most widely used and accepted TSI, called the Carlson TSI, was developed by Bob Carlson (1977). Carlson's TSI is a set of mathematical equations created from relationships between summertime total phosphorus, chlorophyll *a*, and Secchi disk transparency for numerous lakes. Using this method a TSI score can be generated by just one of the three measurements. Carlson TSI values range from 0 to 100. Each increase of 10 TSI points (10, 20, 30, etc.) represents a doubling in algal biomass. Data for one parameter can also be used to predict the value of another.

The Carlson TSI is divided into four main lake productivity categories: *oligotrophic* (least productive), *mesotrophic* (moderately productive), *eutrophic* (very productive), and *hypereutrophic* (extremely productive). The productivity of a lake can therefore be assessed with ease using the TSI score for one or more parameters. Mesotrophic lakes, for example, generally have a good balance between water quality and algae/fish production. Eutrophic lakes have less desirable water quality and an overabundance of algae or fish. Hypereutrophic lakes have poor water quality and experience frequent algal blooms and hypolimnetic anoxia.

Carlson's TSI can be used to classify the CLAMP lakes. West Okoboji and Big Spirit have the lowest TSI scores in Dickinson County, indicating they are the least productive. Little Spirit Lake and Silver Lake have the highest TSI scores indicating they are the most productive. Most lakes are in the *eutrophic* category based on Carlson's TSI.

"Ambient Lake Monitoring Program"

The Iowa Department of Natural Resource's ambient lake monitoring program began in 2000. One hundred thirty-one lakes located throughout the state are monitored between 3 and 5 times during the summer by Iowa State University (2000-2007) and University of Iowa Hygienic Laboratory (2005-2007). Big Spirit, Little Spirit, East Okoboji, West Okoboji, Lower Gar, Upper Gar, Minnewashta, Center, and Silver Lake are all monitored as part of this program. Through the ambient lake monitoring program the lakes are monitored for a number of physical, chemical, and biological parameters. Physical parameters include: temperature, dissolved oxygen, specific conductivity, pH, Secchi depth, turbidity, total suspended solids, total fixed suspended solids, and total volatile suspended solids. Chemical parameters include: total nitrogen, nitrate + nitrite, ammonia, total phosphorus, soluble reactive phosphorus, silica, alkalinity, total organic carbon, and total dissolved solids. Biological parameters include: chlorophyll *a*, phytoplankton biomass and composition, and zooplankton biomass and composition. The ambient monitoring program characterizes current water quality in the monitored lakes and will provide an opportunity to track trends in lake water quality.

The ambient lake monitoring program differs from the CLAMP program in that the samples are collected and analyzed by professionals. The ambient program, however, only samples the lakes three to five times throughout the summer, while the CLAMP program is able to sample the lakes more frequently. The ambient program also only samples one location on the lake (deep spot) so that the data from each lake can be compared to other lakes in the state. The CLAMP program samples multiple locations on each lake, which allows for a more complete spatial characterization of the lakes.

The ambient program tests for more parameters than are feasible through the CLAMP program. This allows for a greater understanding of the characteristics of each of the lakes. The CLAMP program includes Secchi depth, total phosphorus, total nitrogen, nitrate plus nitrite nitrogen, and chlorophyll *a*, which are all explained above. The additional parameters monitored by the ambient lake monitoring program are explained below.

Physical Parameters

Temperature and Dissolved Oxygen (DO) profiles are measured at the sampling location. A probe is lowered in the water column and a reading is taken at regular intervals to determine if the lake is thermally stratified. Thermal stratification occurs when surface waters warm and the density difference between the cooler, deeper water and the warm surface water prevents mixing. One potential consequence of thermal stratification is anoxia (or low oxygen conditions) in the hypolimnion (the deep cold water area) due to respiration. Hypolimnetic anoxia can lead to release of phosphorus from the sediment which can lead to algae blooms. The extent of thermal stratification depends on several factors including depth, wind fetch, wind exposure, and spring temperatures. West Okoboji is the only lake in the Iowa Great Lakes that stratifies regularly. The other lakes are too shallow and are susceptible to mixing by the windy conditions in that area of the state.

Turbidity is a reduction in clarity that results from the presence of suspended particles. Turbidity usually consists of inorganic particles, such as sediment, and organic particles, such as algae. In general, the lakes in the Iowa Great Lakes region have lower turbidities than other natural lakes in the state with the exception of Little Spirit, Lower Gar, Upper Gar and Silver Lake.

Total Suspended Solids (TSS) includes all suspended particles in water that will not pass through a filter. Big Spirit (6 mg/L) and West Okoboji (2.3 mg/L) have low concentrations of TSS when compared to other natural lakes. Lower Gar (21.1 mg/L) and Silver Lake (17.1 mg/L) have the highest TSS concentrations of the Iowa Great Lakes.

Total Organic Carbon (TOC) is the sum of all organic carbon from decaying organic material, bacterial growth, metabolic activities of living organisms, and chemicals. (Humic acid, fulvic acid, amines, and urea are types of natural organic matter. Detergents, pesticides, fertilizers, herbicides, industrial chemicals, and chlorinated organics are examples of synthetic sources of organic carbon.) TOC can be used as a measure of organic contamination. Little Spirit (18.5 mg/L) and Center (14.6 mg/L) have relatively high levels of TOC (above the 75^{th} percentile for all monitored, natural lakes).

All other lakes in the Iowa Great Lakes with the exception of Silver Lake fall below the 25th percentile for all monitored natural lakes.

Specific Conductivity is a measure of the ability of a solution to electrical flow. Specific conductivity is an indirect measure of the presence of dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron, and can be used as an indicator of water pollution. The higher the specific conductivity, the higher the amount of dissolved ions in the water. Silver Lake (629 µS/cm) and Center (571 µS/cm) have the highest median specific conductance among the Iowa Great Lakes, which was above the 75th percentile for all monitored, natural lakes. Big Spirit (480 µS/cm) and West Okoboji (466 µS/cm) had the lowest median specific conductance among the Iowa Great Lakes.

Chemical Parameters

Soluble Reactive Phosphorus (SRP) is the form of phosphorus that is directly taken up by algae and therefore constitutes the fraction of total phosphorus that is available for immediate uptake by algae. In phosphorus limited situations this form should be low to undetectable, as is the case in Big Spirit (0.003 mg/L) and West Okoboji (0.003 mg/L). As SRP increases, it implies that phosphorus is either not needed by algae or it is being supplied at a rate that is faster than the rate of biologic uptake. Little Spirit (0.09 mg/L), Silver Lake (0.04 mg/L) and East Okoboji (0.04 mg/L) have relatively high SRP levels when compared to other monitored, natural lakes in Iowa (greater than the 75th percentile).

Biological Parameters

Phytoplankton wet mass and composition are measured to get a better understanding of the biological dynamics of each lake. Phytoplankton or algae are the photosynthetic organisms that form the base of the food chain in lakes. The median phytoplankton wet mass ranged from 9.1 mg/L in West Okoboji to 36.0 mg/L in Upper Gar. Silver Lake had a lower median concentration than the median for all monitored, natural lakes in Iowa (39.7 mg/L). Most phytoplankton samples were dominated by Cyanobacteria, which often dominate summer plankton in productive lakes.

Lake Name	Secchi Depth (m)	Total Phosph-orus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Nitrate +Nitrite (mg/L)	Chloroph-yll *a* (ug/L)	Dissolved Oxygen (mg/L)
Silver Lake	**0.6**	**0.114**	**0.043**	**1.4**	**0.111**	**2.183**	**14**	**8.7**

Lake Name	Turbidity (NTU)	Total Suspended Solids (mg/L)	Total Organic Carbon (mg/L)	Total Fixed Suspended Solids (mg/L)	Total Volatile Suspended Solids (mg/L)	pH	Alkalinity (mg/L)	Specific Conductivity (uS/cm)
Silver Lake	**33.9**	**17.1**	**9.4**	**11.4**	**6.1**	**8.4**	**151**	**629**

Lake Name	Phytoplankton Wet Mass (mg/L)	Zooplankton Wet Mass (mg/L)	Carlson Trophic State Index (Secchi)	Carlson Trophic State Index (Total Phosphorus)	Carlson Trophic State Index (Chlorophyll)
Silver Lake	**21.1**	**169.5**	**68**	**72**	**56**

Table 3.4: 1999-2006 median values in CLAMP monitoring data

Nutrient Budget Summary
Lake nutrient budgets indicated that rainfall and dry deposition are major sources of total phosphorous (TP) and total nitrogen (TN) to the Iowa Great Lake. Surface water runoff contributes a substantial proportion of nutrients to the lake, but there is considerable annual variability in contribution from runoff depending on the amount of precipitation between dry and wet years.

Generally, Silver Lake's sediment appears to be a source of nutrients to the water column. The sediment in Silver Lake does not settle to the bottom, never to be seen again, as it does in West Okoboji. Rather, the sediment in Silver Lake, and other shallow lakes of its kind, is re-circulated by wind and wave action, prop disturbance, and the "rooting" of rough fish such as carp and buffalo.

The significance of this circulation of sediment is that it carries with it the essential nutrient, phosphorous, that is a major producer of algae. Because the sediment continues to bring the phosphorous to the surface it is a constant source of nutrient for algae, which then grows, dies and settles to the bottom only to be circulated again the next time there is a significant wind. In addition, there is additional phosphorus being brought into the lake via the three major drainage ditches and through the Lake Park storm sewer system.

Stratification
Data collected through the ambient lake monitoring program indicated that Silver Lake does not stratify regularly. Silver Lake is too shallow and susceptible to mixing by the windy conditions in the NW part of the state along the Buffalo Ridge, the windiest part of the Midwest.

Turbidity
In general, Silver Lake has a higher turbidity and concentration of total suspended solids (TSS) than other natural lakes in the state. Silver Lake ranks in the bottom 25^{th} percentile for average chlorophyll A concentrations, Secchi, average Carlson TSI, and average total phosphorous.

Higher turbidity increases water temperatures because suspended particles absorb more heat. This, in turn, reduces the concentration of dissolved oxygen (DO) because warm water holds less DO than cold. Higher turbidity also reduces the amount of light penetrating the water, which reduces photosynthesis and the production of DO.

Sources of turbidity include soil erosion, waste discharge, urban runoff, eroding stream banks, large numbers of bottom feeders (such as carp), which stir up bottom sediments, and excessive algal growth.

Cyanobacteria
Sometimes called blue-green algae, Cyanobacteria are organisms that naturally occur in fresh, brackish, and marine water. Cyanobacteria have many characteristics of bacteria, but they also contain chlorophyll, and can photosynthesize like algae and plants. Cyanobacteria often have a blue-green color, which is why they are also called blue-green algae. Cyanobacteria come in many sizes and shapes including microscopic single cells as well as filaments and colonies that are easily visible to the naked eye.

Photo 3.1: Cyanobacteria in Silver Lake, Dickinson County.
Photo courtesy of J. Graham, U.S. Geological Survey.

Cyanobacteria occur naturally in most lakes, but under the right conditions they are capable of excessive growth causing massive accumulations (called blooms) of the algae. Many different factors may lead to Cyanobacteria blooms including excessive nutrients, low light levels, elevated temperatures, and low water levels. Cyanobacteria blooms are unsightly and contribute to low dissolved oxygen levels and reduced water quality. In addition, Cyanobacteria have the potential to produce toxins (called cyanotoxins) that are potent enough to poison aquatic and terrestrial organisms, including animals and humans. Alteration, degradation, and eutrophication of aquatic ecosystems has lead to an increasing occurrence of Cyanobacteria blooms worldwide. Blooms have occurred everywhere from Brazil to China, Australia to the United States. During 2006, Cyanobacteria recently made the news in at least twenty-one states, including seven Midwestern states; Minnesota, Wisconsin, Illinois, Iowa, Missouri, Kansas, and Nebraska. Even more startling is the statistic that at least 33 States have anecdotal reports of human or animal poisonings associated with cyanotoxins.

Photos 3.2 & 3.3: Cyanobacteria blooms in Silver Lake. Photos courtesy of Steve Anderson.

There are many different ways that the algae can be transferred between ecosystems, including flow from one lake to the next or from one reservoir to the next, transport of live cells or spores by animals, and people, and transport of spores by wind. There are several factors complicating our understanding of how and how often Cyanobacteria are transferred among water bodies including: Cyanobacteria spores may be dormant in lake sediments for many years, or the Cyanobacteria may typically be present in the water column at levels that are too low to detect until conditions become ideal for Cyanobacteria growth. Transfer probably isn't as much of a concern in Silver Lake as water quality – from what biologists can see most of the lakes have the same Cyanobacteria species present, although the dominant species may vary from lake to lake.

Concerns
There are four main concerns with Cyanobacteria:

1. Cyanobacteria may potentially produce taste-and-odor compounds and toxins that are poisonous to both aquatic and terrestrial organisms.
2. Cyanobacteria blooms may form in warm, slow-moving waters that are rich in nutrients, such as fertilizer runoff or septic tank overflows.
3. Cyanobacteria blooms in Silver Lake may occur at any time, but most often occur in mid-late summer or early fall.
4. Unsightly, potentially toxic Cyanobacteria blooms may lead to a loss of recreational revenue. In addition, treating drinking water supplies with taste-and-odor problems associated with Cyanobacteria are costly.

Solutions
A long-range strategic plan developed by the Dickinson Clean Water Alliance has identified four main watershed goals for Silver Lake and other lakes in Dickinson County:

1. Native biological diversity is to be respected and encouraged.
2. Infiltration practices are promoted throughout the watershed.
3. Impaired waters are protected and improved.
4. High quality waters are maintained and improved.

These goals will assist in reduction of the number of occurrences of Cyanobacteria blooms. They can be achieved by protecting and improving water quality. This will reduce sediment and nutrient loads, as well as decrease the high nutrient conditions favored by the Cyanobacteria. The occurrence of native aquatic plants that are stimulated by water quality improvements will also serve as nutrient sinks, in effect lessening the opportunity for Cyanobacteria growth.

4. Information & Education

The Silver Lake Watershed Project will undoubtedly be faced with a significant challenge of involving all stakeholders who have a vested interest in the project, and ensuring that these stakeholders continue to work together as a cohesive unit. Simply maintaining a positive focus and direction for the project will require a large amount of planning and leadership during each phase of the project. The Silver Lake Watershed Management Plan will be best implemented in phases, but only if those phases are implemented concurrently. In other words, the best option for Silver Lake is to implement each phase of the project in a reasonable timeframe.

A successful Information & Education component of the Silver Lake Watershed Project will be a vital link necessary if the partners expect to accomplish the water quality goals of this project. The I&E portion of the project will focus on two primary topics. The first topic will center around the issues and concerns facing the Silver Lake Watershed, as well as the lake itself. We feel it is essential to inform the public as to why the water quality of Silver Lake has diminished so much in recent years. This understanding will provide a platform for these residents to develop their own reasoning for how and why they should help to implement conservation practices in their own backyard or operation.

The second communications goal of the Silver Lake Watershed Project is to ensure that all stakeholders in the Silver Lake Watershed know what they can do to protect and preserve the water quality of the lake through their actions. Building on their knowledge of why the lake needs their support, we will also provide the information necessary for homeowners, landowners, and other residents to realize that everybody in the Silver Lake Watershed can be a part of the water quality project, no matter the scale of their efforts. In return, we hope that these people will start to devise a plan based on what they themselves could be doing to protect or enhance the water quality of this drainage. To accomplish these goals, we will implement the following action items:

Action Item 1: *Publish a notice of each planning meeting at least 7 days prior to the meeting.*

- ✓ Pay for ads in local newspapers.
- ✓ Submit press releases to area radio stations.
- ✓ Schedule presentation by project coordinator or other keynote speaker.
- ✓ Encourage local reporters and columnists to attend the meetings themselves.
- ✓ Invite local elected officials.
- ✓ Send group e-mails to project partners.
- ✓ Mail postcards to key partner groups or entities.
- ✓ Post meeting information on the Dickinson County Clean Water Alliance website.
- ✓ Provide contact information for interested citizens not able to attend.
- ✓ Achieve maximum participation from all stakeholders.

Action Item 2: *Issue press releases following each meeting.*

- ✓ Give credit to local agencies and other partners in attendance.
- ✓ Cover successes of each meeting.
- ✓ Remind public of recurring meetings and other watershed project activities.

Action Item 3: *Hold quarterly meetings after initial starting date of watershed project.*

- ✓ Advertise meetings to maximize participation (refer to Action Item #1).
- ✓ Update stakeholders and attendees of project status.
- ✓ Outline future goals and challenges facing the project.
- ✓ Inform stakeholders and residents of how they can improve water quality.
- ✓ Demonstrate gaps in funding or areas where local assistance may be needed.
- ✓ Update improvements and conservation implementation in watershed.
- ✓ Remind public or recurring meetings and other watershed project activities.

Action Item 4: *Establish a website for the Silver Lake Watershed Project.*

- ✓ Advertise website URL along with other project contact info.
- ✓ Post a link for the Silver Lake Watershed Project on the CWA website.
- ✓ Provide background info on Silver Lake.
- ✓ Explain water quality issues, pollutant sources, and conservation challenges.
- ✓ Provide a link to the TMDL for Silver Lake.
- ✓ List contact info for local agency personnel.
- ✓ List project partners and funding sources.
- ✓ Maintain a list of goals, benchmarks, and achievements of the project.
- ✓ Update website monthly to include recent developments and opportunities.

Action Item 5: *Generate fact sheets and brochures highlighting project opportunities.*

- ✓ Demonstrate which BMP's will help the watershed.
- ✓ List sources of technical assistance and cost-share providers.
- ✓ Inform stakeholders how they can start their improvements.

- ✓ Develop specialized handouts for various targeted audiences: local landowners, absentee landowners, grain/livestock producers, homeowners, lakeshore owners.

Action Item 6: *Conduct educational presentations for varying target audiences.*

- ✓ Public informational meetings
- ✓ Landowner meetings
- ✓ Silver Lake Park Improvement Association (annual & monthly meetings)
- ✓ Dickinson County Water Quality Commission (monthly meetings)
- ✓ Dickinson County Earth Day Celebration (April)
- ✓ Lake Park Farmer's Appreciation Days (August)
- ✓ Dickinson County Outdoor Education Day (September), Kettleson-Hogsback
- ✓ Osceola County Outdoor Education Day (September), Willow Creek
- ✓ Harris-Lake Park Community Schools

Action Item 7: *Maintain a core Technical Advisory Committee (TAC) for the project.*

- ✓ Local professionals
- ✓ Field office staff
- ✓ Stakeholders
- ✓ Basin Coordinators
- ✓ Hold regular meetings
- ✓ Assist project coordinator in setting objectives and goals of project.
- ✓ Help guide strategy and implementation of project.
- ✓ Assist in public outreach

I&E Measures of Success

- ▪ Mail annual surveys to landowners & Lake Park citizens, inquiring of their knowledge, understanding, and willingness to participate in the Silver Lake Watershed Project.
- ▪ Incorporate a sign-up sheet at each public meeting asking how the attendee was made aware of the meeting.
- ▪ Monitor landowner participation at meetings and the interest of each in specific conservation programs. Make special note of newly interested individuals, as well as those whom have seemed to lose interest.
- ▪ Monitor SLPIA membership trends, particularly new members and former members who did not renew memberships.

Interested Parties/Stakeholders:

Stakeholders in this plan are varied and come from all lifestyles. The bottom line for each stakeholder is that they have a stake in what happens with Silver Lake. There are five groups of Stakeholders that have been identified. Those five groups are federal, State, local government, Non-governmental Organizations, and private citizens.

Federal Stakeholders:

- U.S. EPA, Region 7, Non-point Source Region Headquarters (Section 319 Non-point Source Pollution Program)
- U.S. Fish and Wildlife Service, Desoto Bend Wildlife Area (Private Lands Biologist)

- USDA, Natural Resources Conservation Service, Dickinson and Osceola Counties (Wetlands Restoration Program, Wildlife Habitat Incentive Program, Environmental Quality Incentives Program)
- USDA, Farm Service Agency, Dickinson and Osceola Counties (Conservation Reserve Program)

- *State & Local Stakeholders:*
- Iowa Department of Natural Resources, bureaus of Fisheries, Wildlife, and Water Resources (Private Lands Wildlife Biologist)
- Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation, Field Services Bureau. (Resource Enhancement and Protection Funds, Watershed Protection Funds, Iowa Financial Incentives Program, Watershed Improvement Review Board)
- Iowa Department of Economic Development
- Local Government Stakeholders:
- City of Lake Park
- Dickinson Soil and Water Conservation District, Commissioners (Local Grants)
- Osceola Soil and Water Conservation District, Commissioners (Local Grants)
- Dickinson County, Supervisors
- Schools, Harris Lake Park School District (Future Farmers of America)
- Sanitary Sewer District, City of Lake Park
- Public Utilities, Alliant Energy and City of Lake Park
- Non-governmental Organizations:
- Silver Lake Park Improvement Association, Scott Mitchell, Chairman (Private Funding)
- Iowa Natural Heritage Foundation, Mark Ackelson, Chairman (Easement funds)
- The Nature Conservancy, Susanne Hickey, Private Lands Biologist (Habitat Restoration Program)
- Pheasants Forever, John Linquist, Regional Representative (Build A Wildlife Area)
- Ducks Unlimited, Dr. John Synhorst (Wetland Restoration Assistance)
- Lake Park Outdoors Club (private funding)
- Osceola County Sportsman Club (private funding)
- Dickinson County Clean Water Alliance, John H. Wills, Coordinator (Coordination and local funding)
- Dickinson County Water Quality Commission, Brad Jones, Chairman (Water Quality Grants)
- Private Citizens:
- Property owners
- Fishermen
- Hunters
- Investors
- Farmers
- Developers
- Boaters
- Swimmers

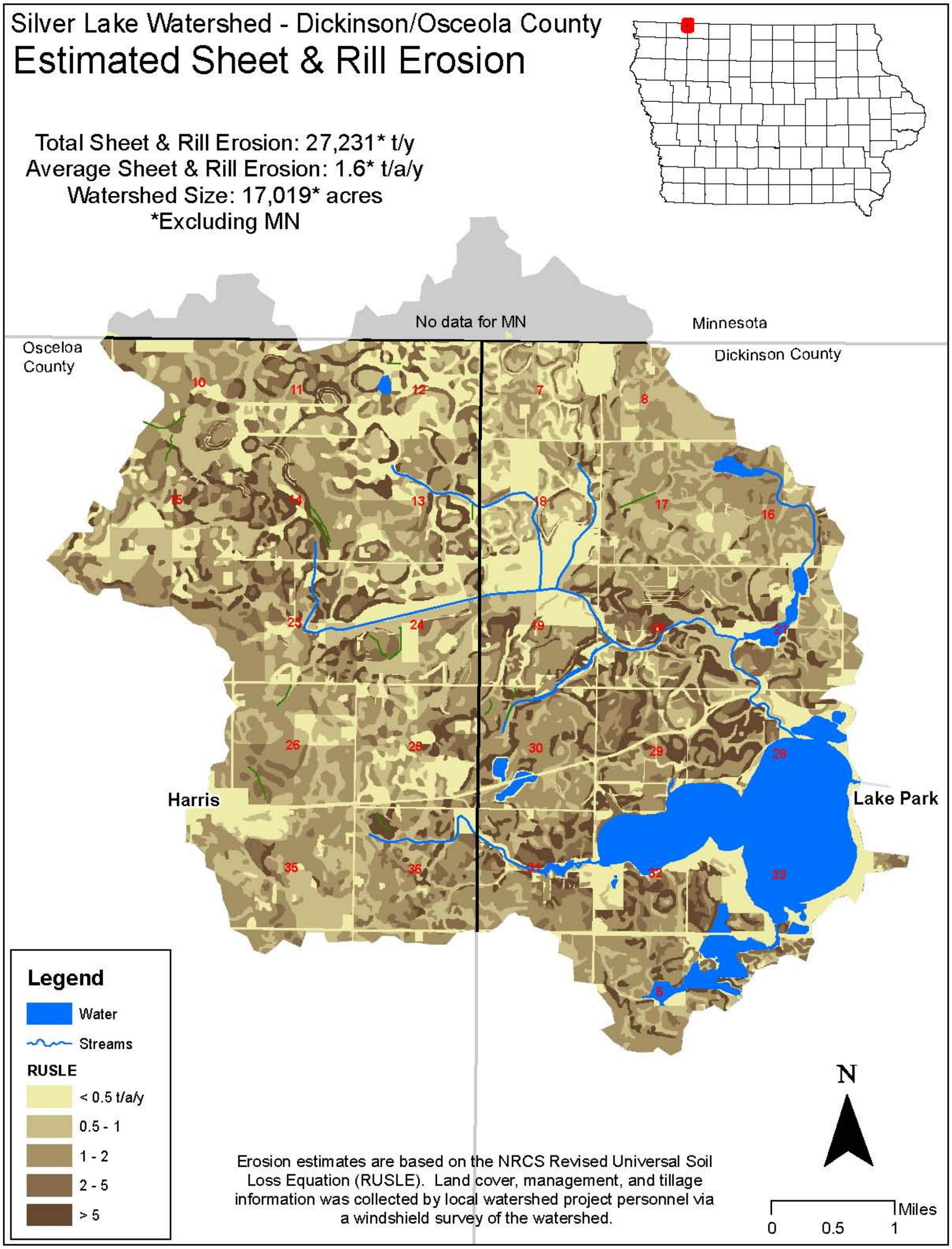
5. Sediment/Nutrient Loading

Using the Revised Universal Soil Loss Equation (RUSLE) developed by NRCS, it has been estimated that an average of 0.06 tons/acre/year of soil is delivered to Silver Lake. These figures only account for sheet and rill erosion, and do not factor in gully-type erosion. Therefore, this model calculates a total sediment delivery (with sheet and rill erosion) of 1,089 tons per year to Silver Lake. Using RUSLE2 we are able to see a part of the sediment delivery problem, but not a complete picture. When considering sediment and erosion one must account for gully erosion as well. In some instances, a gully can produce more tons of erosion per acre than an entire field.

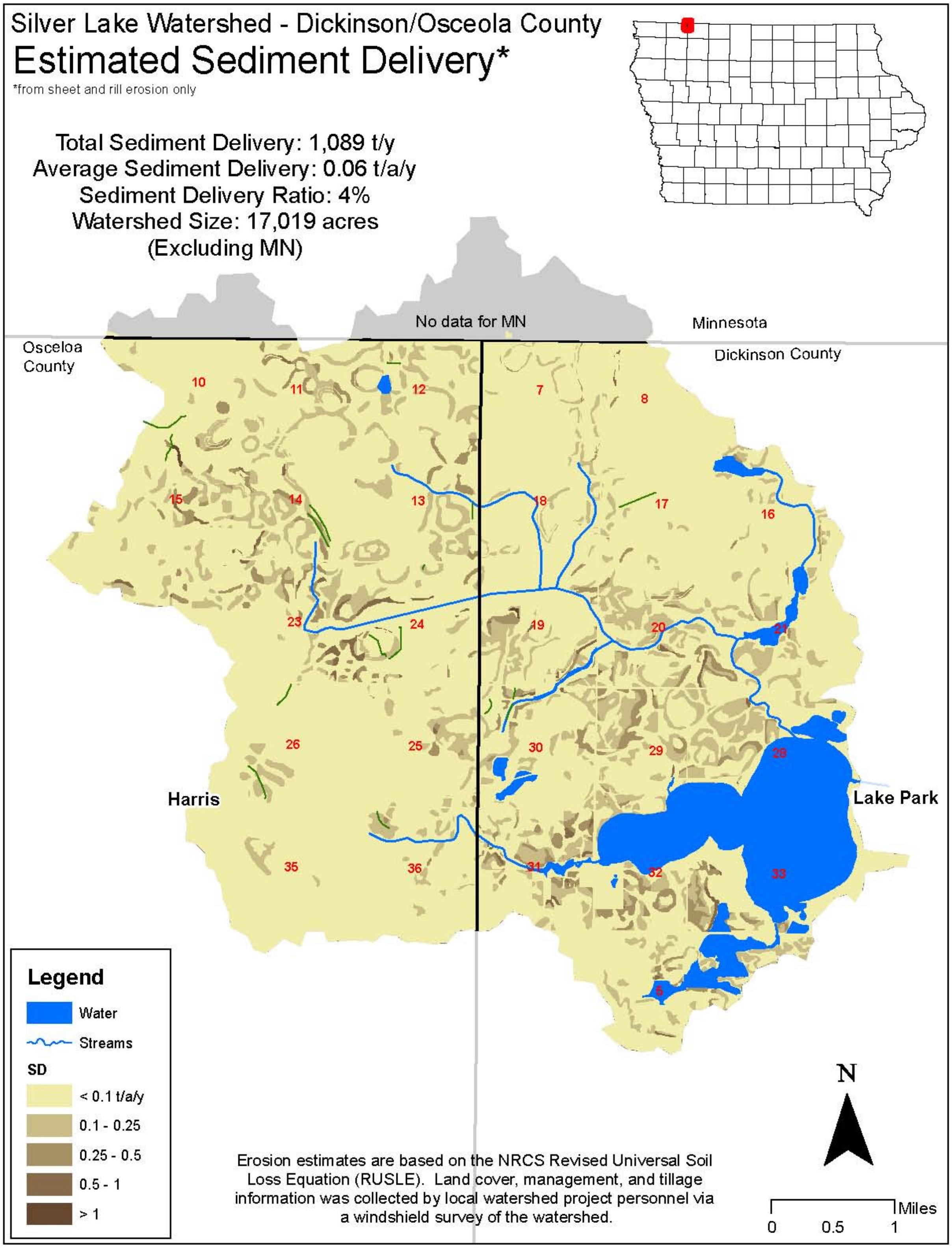
Because of the topography in the Silver Lake Watershed, grassed waterways and sediment basins are the most practical method for controlling gully erosion on row crop acres. Although they provide a very effective means of erosion control, some producers feel that grassed waterways take too many acres out of production. We feel that additional cost-share through the watershed project will be enough to mitigate this sentiments. In recent years, producers in Dickinson and Osceola Counties have realized a shift toward larger equipment and more linear rows as part of their operation. The result of this shift has been a heightened interest in sediment basins, and no interest in traditional terraces. Although not applicable in every location, sediment basins give landowners a viable erosion control option that requires a minimal sacrifice of production acres, and allows them to farm across the contour of the land. For these reasons, we feel that grassed waterways and sediment basins are the most logical choices for controlling point sources of gully erosion in the Silver Lake Watershed.

Analysis has identified over 50 areas in the watershed where gullies have begun to form. These gullies are providing direct sedimentation and in large amounts in comparison to the rest of the field. In these 50 sites, if grassed waterways and sediment basins were built the reduction of sedimentation would be a vast improvement. An important note is that these gullies are not included in any of the following sediment delivery models because RUSLE2 does not account for gully erosion, only sheet and rill erosion.

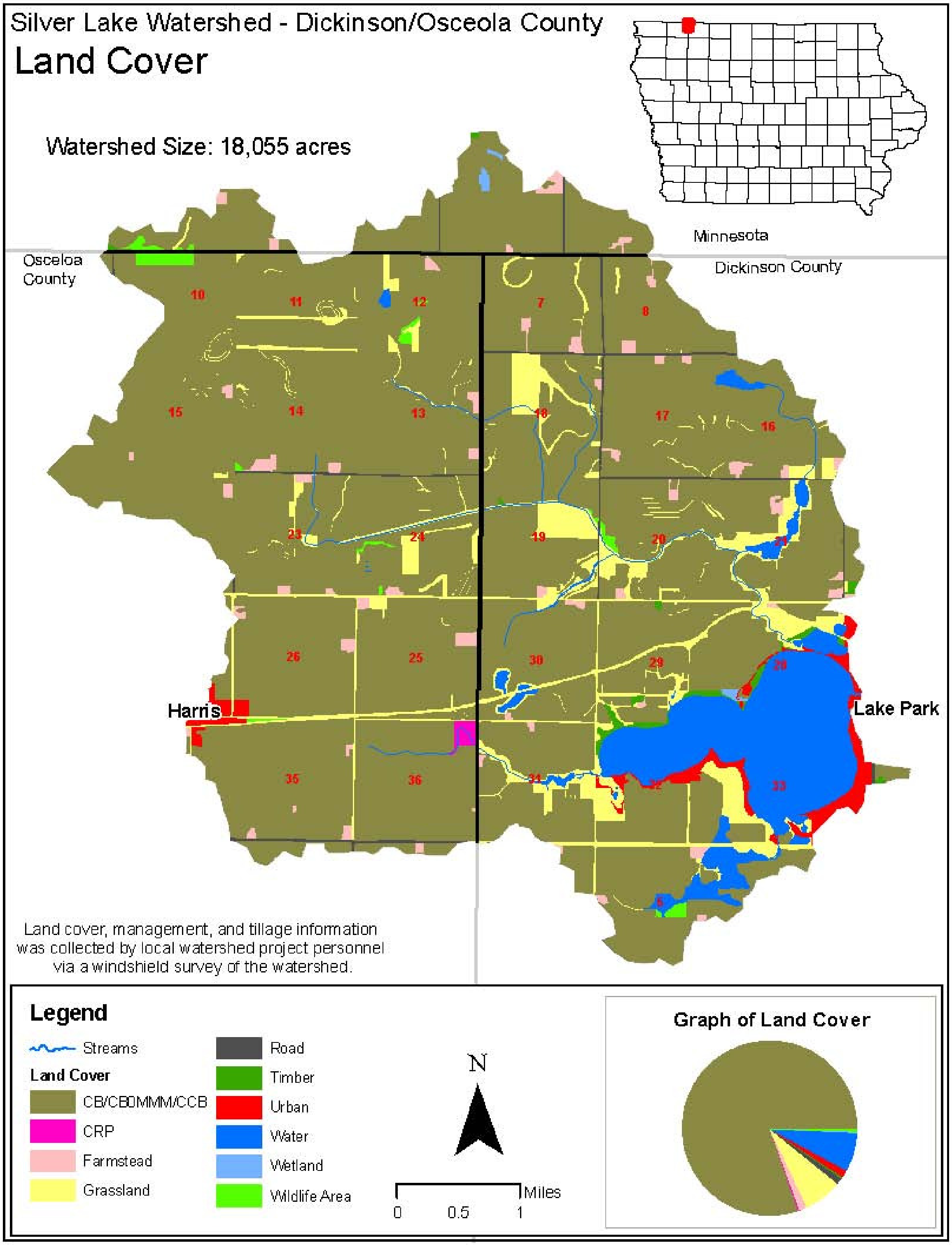
By coupling the RUSLE2 modeling with GIS technology, we see the total sediment delivery to Silver Lake from only sheet and rill erosion is 1,089 tons per year (see Map 5.1). The average sediment delivery (excluding gully erosion) is .06 tons per acre per year. This means there is more sediment delivery than we can currently account for moving toward Silver Lake.



Map 5.1: Estimated Sheet & Rill Erosion in Silver Lake Watershed (Iowa DNR)



Map 5.2: Estimated Sediment Delivery to Silver Lake, Dickinson County (Iowa DNR)



Map 5.3: 2007 Land Use Modeling in Silver Lake Watershed (Iowa DNR)

6. Pollutant Load

Silver Lake is listed on the State of Iowa's Impaired Waters List for sediment and water clarity. A Total Maximum Daily Load (TMDL) for Turbidity has recently been completed by the Iowa DNR. According to this document, inorganic suspended solids and high phosphorous levels are the cause of the poor water quality conditions documented within the lake, which frequently result in excessive algal blooms. These conditions are affecting the Class A1 (Primary Contact Recreation) and the Class B(LW) (Aquatic Life) designated uses. Data from the Iowa Lakes Information System shows that out of 132 lakes surveyed, Silver Lake ranked 104th for turbidity, 102nd for total phosphorus, and 100th for secchi disk reading.

Nonpoint sources of phosphorous and sediment loading from the watershed are the primary pollutants causing the impairment. With the bulk of the watershed in some form of agricultural production, the majority of these loads most likely stem from those acres in row crop production. Soil erosion as a result of crop production aids in the transport of phosphorous to the lake. This phosphorous-laden sediment is often enriched by the land application of nutrients and manure during production. These contaminants are also likely transported through an extensive tile drainage system that has been installed to drain the landscape for increased crop production. The TMDL for Silver Lake suggests that the two largest sources of phosphorus loading to Silver Lake are runoff from row crop agriculture (46.1 percent) and phosphorus that is recycled within the lake (39.0 percent), which is often called internal loading.

In shallow lakes that have accumulated large amounts of sediment at the lake bottom over time, phosphorus can mix into the water column from these sediments. Silver Lake is shallow, susceptible to wind-induced mixing, provides power-boating and personal watercraft recreation, and has a large carp and bullhead population. All of these facts support the assumption that internal TP loading is problematic. The water quality model for Silver Lake indicated that internal loading comprises approximately 39 percent of the existing TP load. This relative contribution is consistent with internal loading rates reported for other shallow lakes in Iowa.

According to the TMDL written for Silver Lake, the existing annual average TP load to Silver Lake from April 2005 through March 2008 was estimated to be 19,980 lbs/yr, or 54.7 lbs/day. The existing daily maximum TP load is estimated at 107.8 lbs/day.

The existing average annual TP load to Silver Lake is an estimated 19,980 lbs/year. The justified TP target load, also referred to as the loading capacity, is 8,499 lbs/yr (average annual) and 45.9 lbs/day (maximum daily). To meet the target loads, a reduction of 11,481 lbs/yr, or 57.5 percent, is required.

The following table shows the estimated contribution of each pollutant source to the total phosphorus load entering Silver Lake on an annual basis. Also shown are load reductions for each pollutant source that would provide a practical solution to reducing the total phosphorus load entering Silver Lake down to an acceptable level.

Source of Total Phosphorus	Existing Load (lb/yr)	LA (lb/yr)	Load Reduction (%)
Row Crops	9,217	3,226	65
Conservation Areas	180	162	10
Farmsteads	76	76	0
Urban/Roads	164	123	25
Groundwater	2,158	2,158	0
Geese	45	45	0
Septic Systems	66	2	97
Atmospheric Deposition	276	276	0
Internal Load	7,798	1,560	80
Total	**19,980**	**7,627**	**61.8**

Table 6.1: Estimated TP loading to Silver Lake, and desired loading reductions.

7. Agricultural Load Reductions

In order to decrease the incoming pollutant load and resolve the listed impairment of Silver Lake, a wide variety of conservation practices will need to be utilized. The majority of the phosphorus and sediment that enter Silver Lake is from agricultural land uses and internal recycling; however, some urban area drains to the lake as well. Therefore, potential practices for water quality improvement in Silver Lake are grouped into three groups: agricultural, urban, and in-lake. One of the primary sources of existing total phosphorus loads to Silver Lake is runoff from row crop agriculture.

Many conservation practices used in agriculture are designed to reduce erosion and/or capture sediment before it reaches a stream or lake. Because a large portion of phosphorus is adsorbed to sediment, practices that reduce erosion and sediment transport will also reduce TP loads. Water quality improvement alternatives implemented in row crop areas should include structural practices such as sediment control structures, wetlands, grass waterways, and terraces.

Nonstructural conservation practices such as contour farming, no-till and strip-till farming, diversified crop rotation methods, and use of a winter cover crop will also be considered. To obtain reductions in the phosphorus and sediment loads necessary to meet water quality targets, these practices should be focused where they are needed most, in areas of the watershed with the highest potential for contributing sediment and phosphorus loads to the lake. Highest priority will be given to areas that exhibit significant erosion and sediment delivery rates, and do not currently have an erosion control practice in place(refer to Section 10 of this document, Targeted Implementation, for maps of these areas). We will also encourage landowners and producers to adopt a variety of techniques and practices which will enhance reductions in sediment and phosphorus loading to Silver Lake.

Management of livestock manure and synthetic fertilizer are additional agricultural BMP's that will be used to reduce pollutant loads entering Silver Lake. It is well-documented that incorporation of applied manure and fertilizer into the soil by knife or injection equipment reduces phosphorus, nitrate, and bacteria levels in runoff from application areas. Knife and injection application will be presented to producers as a more efficient, cost-effective application technique than broadcast application. Although application rates are much slower with these techniques, we will stress that more of the nutrients are available for crop growth, and less for runoff with these practices.

We will also stress strategic timing and correct application rates of manure fertilizers to livestock producers, particularly those determined to continue broadcast techniques. It will also be emphasized that practices such as broadcast application, applying to frozen/snow-covered ground, and applying before heavy rainfall are all very inefficient ways to utilize livestock-derived nutrient inputs, and can have very serious consequences in terms of water quality, particularly bacteria and nutrient loading.

Following is a list of ag-based BMP's & load reductions:

BMP	Units	TP Load Reduction per Unit	Total TP Load Reduction
CRP Incentive	125 ac	2 lb/yr	250 lb/yr
Grassed Waterways	3,000 ft	0.1 lb/yr	300 lb/yr
Sediment Basins	25	10 lb/yr	250 lb/yr
No /Ridge/ Strip Till Incentive	1,750 ac	0.9 lb/yr	1,575 lb/yr
Wetland Restoration	250 ac	16 lb/yr	4,000 lb/yr
Rock Tile Intakes	115	3 lb/yr	345 lb/yr
		Total TP Reduction:	**6,720 lb/yr**

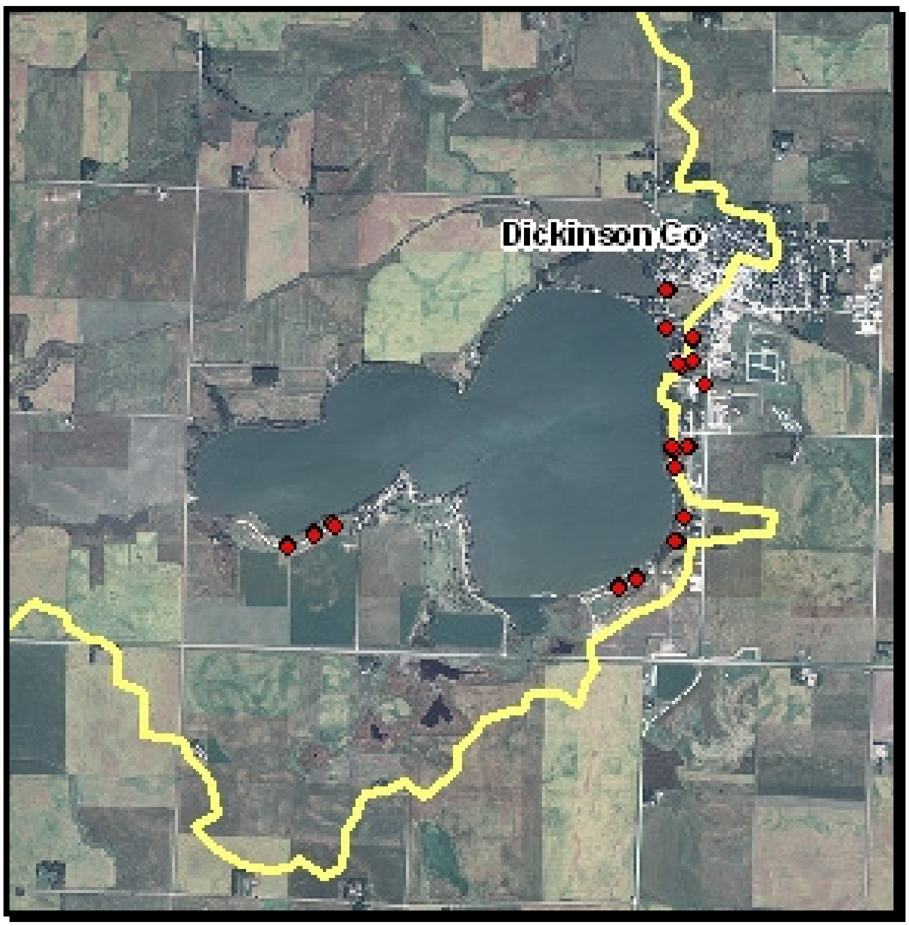
Table 7.1: Ag-based practices as part of the watershed project.

8. Urban Load Reductions

Urban areas in Dickinson County have been expanding at a significant rate in comparison to other rural counties in Iowa. The majority of this urban expansion has taken place in the Iowa Great Lakes Region. However, recent lakeshore and urban development in the City Lake Park has begun to change this. With the recent addition of two new developments, Lake Park has put itself on the map as having a significant potential for additional urban development. Future plans in these new areas calls for even more progression adjacent to or near the lakeshore of Silver Lake.

A majority of the existing City of Lake Park drains away from Silver Lake and is outside the actual watershed boundary. The biggest portion of Lake Park does not negatively affect Silver Lake. Existing houses on the lakeshore and those within the boundary of the watershed have the potential for negative impact on the lake. As with any urban areas, the primary problems are sediment from construction, lawn fertilizers and pesticides, lawn clippings, and chemicals associated with household residences.

Storm sewer inlets within the incorporated area of Lake Park, for the most part, drain away from the lake and out of the watershed. The following map shows the location of each storm sewer within the incorporated city which drains to the lake, and functions as a direct conduit for pollutants entering the lake.



Map 8.1: Lake Park storm sewer inlets entering Silver Lake

With the addition of new developments surrounding Silver Lake, there will likely be a rise in storm sewer installations as well. Other than the lake itself, there are few places for storm water to flow, which means storm sewer drainage may become a larger concern for the Silver Lake Watershed.

Sanitary Sewer
The sanitary sewer system in Lake Park was recently expanded to include all lakeshore properties with traditional septic systems, as well as new developments along the south shoreline of Silver Lake.

The city of Lake Park, Iowa DNR, and Dickinson County SWCD worked diligently over seven years to ensure the entire city of Lake Park was able to connect to the sanitary sewer. In 2003, Lake Park implemented an extension to ensure that all residents adjacent to Silver Lake had access to the system. As of 2008, only one or two houses out of approximately 35 had not been connected to this sanitary sewer system. The city of Lake Park is in the process of taking action to get the remaining residences connected.

There is only one residence directly adjacent to the north shoreline of Silver Lake, and this residence has an individual septic system. There is only 1 known system in the remainder of the watershed that has been suspected of not functioning correctly. However, further investigation of existing septic systems in the rural portion of the watershed will be necessary if we are to achieve the respective load reduction from septic systems established in Table 6.1.

Urban Residential Development
Because most of Lake Park is not situated within the Silver Lake watershed boundary, the urban component of the watershed has a relatively small impact on the water quality of Silver Lake. Although the realized impact of urban development on water quality may be small, it does offer an opportunity for measureable load reductions as part of the water quality project. Maybe even more importantly, project involvement in the urban sector should produce an environment of community service and conservation that will spread to other landowners in the watershed.

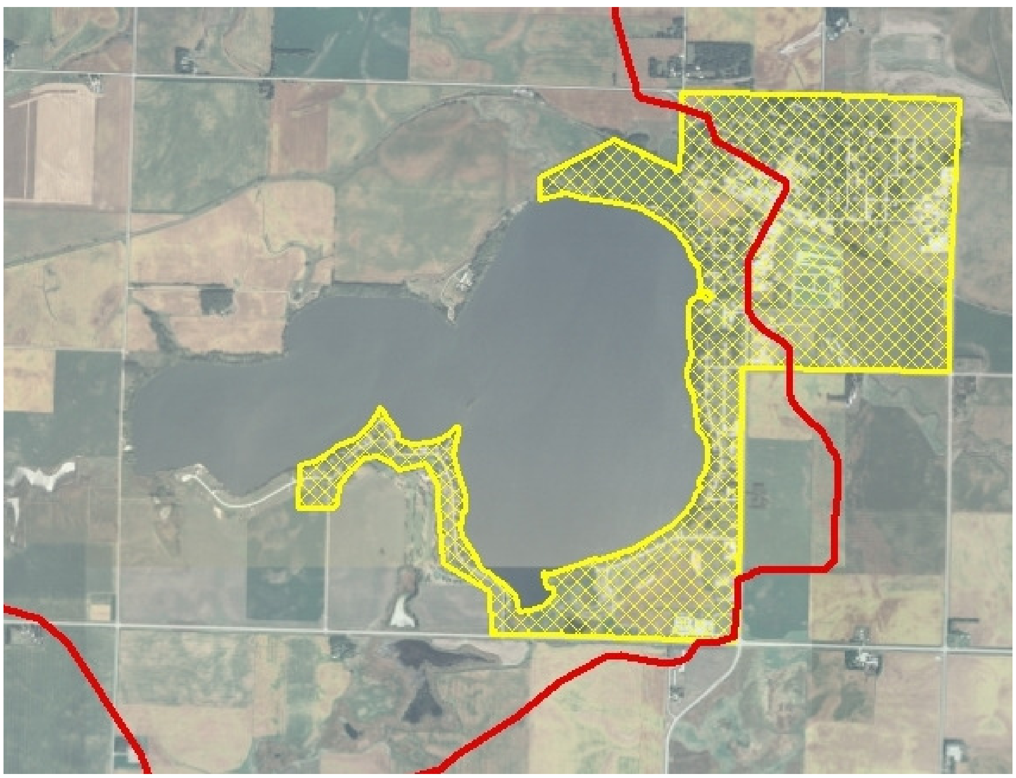
Urban BMP's such as rain gardens, biocells, soil quality restoration, native landscaping, and pervious paving will be promoted in this area as an opportunity for residents of Lake Park to participate in the water quality project. Individual contact with homeowners and business owners will be a vital component of practice implementation in this area. These residents will be offered up to 50% cost share (with a maximum of $2,000 per project) for implementation of urban BMP's on their property, but only if that property is located within the watershed boundary.

One area of concern in the urban sector is the potential for future sub-divisions. At present these areas are obviously undefined, but if erected, would most assuredly benefit from water quality protections offered through ordinances passed by the city of Lake Park requiring storm water management based on water quality and flood control parameters. Although Lake Park's storm sewer systems are designed for flood control, these systems are not held to quantitative water quality restrictions.

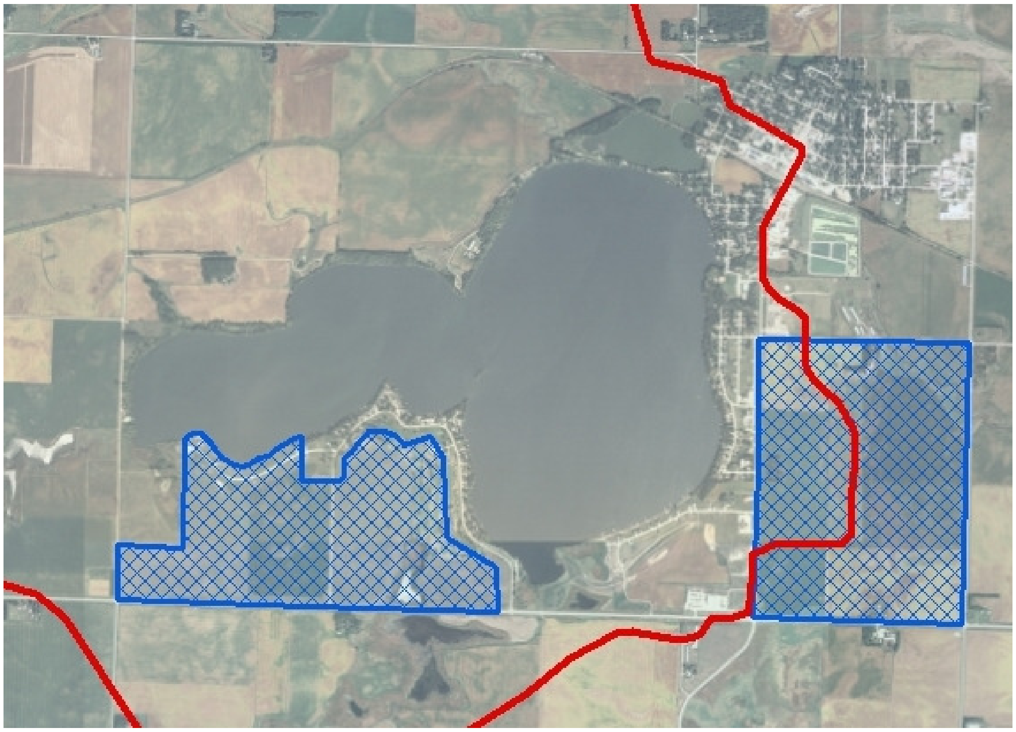
As development around Silver Lake intensifies, Lake Park will have the opportunity to make further water quality strides by adopting a low impact development ordinance similar to that of other cities in Dickinson County. The Silver Lake project coordinator would have the opportunity to work with the Lake Park City Council and other groups to facilitate such an ordinance.

Incorporated Area

The current incorporated areas in the City of Lake Park are shown below in Map 8.2. As you can see, most of the city does not fall within the watershed boundary of Silver Lake. These areas have remained constant until just a few years ago when the entire south shore of Silver Lake was annexed into the city along with 2 large developments. There are future annexation plans and future developments already in the works. Map 8.3 shows current future annexation plans, however, there are even more annexation plans in the works than what is shown. **Only properties within the red watershed boundary will be eligible for cost-share incentives thru the Silver Lake Watershed Project.**



Map 8.2: Current incorporated area of Lake Park (yellow) vs. watershed boundary (red)



Map 8.3: Potential incorporated area of Lake Park (blue) vs. watershed boundary (red).

BMP	Units	TP Load Reduction per Unit	Total TP Load Reduction
Urban BMP's	20	2.5 lb/yr	50 lb/yr
		Total TP Reduction:	**50 lb/yr**

Table 8.1: Expected TP load reductions achieved via urban BMP's [based on mid-range estimates from EPA & the Nationwide Urban Runoff Program (NURP)]

9. In-lake Load Reductions

Shoreline Restoration

In 2009 and 2010, the Dickinson SWCD conducted several shoreline restoration projects along the banks of Silver Lake and the Iowa Great Lakes. The focus of these projects has been the introduction and establishment of native upland plants in areas where bank erosion has become a problem, and the establishment of emergent vegetation in areas where the shoreline is particularly susceptible to the erosive force of wave action.

Because of development and other alterations in land usage along the shores of Silver Lake, many of the uplands directly adjacent to the lake have developed erosion issues in recent years. Upland hillsides once were cloaked in a carpet of native prairie grasses are now protected by only a smattering of hardwoods and an understory dominated by invasive species such as sumac and buckthorn. The lack of ground cover offered by hardwoods and shade tolerant species such as buckthorn leaves the soil and slopes surrounding Silver Lake extremely susceptible to soil erosion by water, at times resulting in gully erosion.

Although shoreline and bank erosion issues can be found on each side of the lake, they are particularly glaring along the north and east shorelines of the lake. The north shoreline of the lake, including the north end of West Bay, is dominated by steep slopes and the occasional cut bank for most of its length. This steep gradient does lessen near Trapper's Bay, along the northeast side of the lake. Much of this north shoreline is state-owned, and managed by the Iowa Department of Natural Resources. District staff has already spoken with Iowa DNR local staff concerning potential management measures along this segment of shoreline. The steep gradient and thick vegetation in this area may serve to complicate erosion control practices along this side of the lake.

Map 9.1: Priority shoreline areas along Silver Lake (shown in red).

Because of its steep slopes, the east shoreline of Silver Lake also presents some challenges concerning shoreline and bank erosion. The majority of this shoreline is privately owned, although a city park is also located in this segment. Presently, much of this shoreline is "rip-rapped" with large rock. Several homeowners have also fortified their banks with retaining walls and similar structures. Bank erosion uphill of the lake is the primary erosion issue in these areas. Because of this, we will promote shoreline restoration via seeding of native upland vegetation and emergent aquatic species. This seeding will serve as an effective shoreline management tool, and a complement to the rock riprap already in place in many of these areas.

Rough Fish Removal
Rough fish species such as common carp and buffalo spend the vast majority of their time "grubbing" through the bottom substrate of a lake while feeding on organic matter, benthic organisms, and zooplankton. These fish are also notorious for spawning in the shallow bays and tributaries of natural lakes. Spawning activity in these bays often results in large amounts of aquatic vegetation being uprooted by aggressive adult fish.

As more aquatic plants are uprooted, re-suspension of bottom sediments caused by feeding activity will become more pronounced, particularly in shallow waters. Further loss of native aquatic vegetation occurs as turbidity worsens and available sunlight becomes scarce.

Controlling common carp and other rough fish species can be extremely challenging, typically in shallow, nutrient rich lakes such as Silver Lake. We plan to use the physical removal of adult fish as the primary management tool for controlling rough fish within Silver Lake. Coupled with the construction of fish barriers between Silver Lake and key rough fish spawning habitat, we hope to reduce this population to a level in which their aggregate impact on the water quality within Silver Lake is minimized.

To remove these rough fish, we will utilize the local commercial fishing industry. This industry thrives off of harvesting carp and buffalo from Midwestern waters, and shipping them to eastern markets for human consumption. These crews use large seine nets to trap huge quantities of fish just below the surface of the lake. After each seine haul, the rough fish are transported to a nearby cannery for processing, while desirable gamefish species are returned to the lake, unharmed.

Although the use of commercial fishing will not allow us to fully exterminate the rough fish population of Silver Lake (as opposed to treatment with a poison such as rotenone), it will allow us to effectively reduce their population without destroying valuable gamefish species in the process. Utilizing this industry also provides us with an extremely cost-effective management tool for controlling these fish.

Load Reductions via Fish Removal
To date, there is no concrete data providing an estimate of the rough fish (common carp & buffalo) population in Silver Lake. Fisheries staff from the Iowa DNR is in the early stages of completing a population survey that will provide us with such data. What we do know is that the rough fish population in Silver Lake is very large, and dominates the aggregate biomass of all fishes in Silver Lake.

After discussions with Mike Hawkins, a local fisheries biologist with the Iowa Department of Natural Resources, a reasonable estimate for the biomass composition of rough fish species in lakes similar to Silver Lake is between **300-400 pounds of rough fish/acre of lake surface area.**

Water quality data collected before and after rough fish removal projects in Iowa indicates that a "tipping point" for water quality can be reached if the rough fish biomass can be reduced to around **100 lbs/acre.**

Based on these estimates, it is reasonable to conclude that if approximately **300 lbs/acre** of rough fish can be taken from Silver Lake, we would likely reduce the rough fish biomass of Silver Lake to less than the **100 lb/acre "tipping point."**

Given the surface area of Silver Lake is just over **1,000 acres**, we chose to use **300,000 pounds of rough fish** as a target goal for the total biomass removal as part of the Silver Lake Watershed Project.

The next step toward a "rough fish removal goal" was to reach an estimate for the phosphorus (P) load reduction achieved by removing approximately 300,000 pounds of rough fish biomass. In order to estimate these reductions, a literature review on the nutrient composition of cyprinid fishes was conducted.

Based on available data, the median range of P composition in the biomass of cyprinid fishes is **2.28%.** Using a **2.28%** composition, we can assume an in-lake load reduction of **6,840 pounds P** by removing 300,000 pounds of cyprinid biomass.

Data on nutrient composition of cyprinids also provided an estimate for percent nitrogen (N) in cyprinid biomass. The median range of N composition in the biomass of cyprinid fishes is **10.5%.** This would equate to an in-lake load reduction of **31,500 pounds N** following the removal of 300,000 pounds of cyprinid biomass.

Below is a list of literature excerpts used to develop calculations on the nutrient composition of cyprinid fishes:

"Larger fish had higher percent C and lower percent N and P. However, differences in whole fish C, N, and P chemistry were small. Cyprinids had the following mean composition: carbon, 46%; nitrogen, 9.7%; and phosphorus, 1.5% (Sterner 2000)."

"The mean SD elemental content across all fishes (n=170) was 10.35% + 1.29% for N and 3.05% + 0.82% for P while the N:P ratio was 8.00 + 2.14 (Dantas 2007)."

"Elemental content averaged across all 20 species of fish (n=192) was 45.1% for C, 11.3% for N, and 2.45% for P (Tanner 2000)."

Nutrient	*% Cyprinid Biomass Composition (Range)*	*% Cyprinid Biomass Composition (Median of Range)*	*Nutrient Load Reduction (Silver Lake)*
Phosphorus (P)	1.5-3.05	2.28	6,840 lbs
Nitrogen (N)	9.7-11.3	10.5	31,500 lbs

Table 9.1: Literature results for cyprinid nutrient composition estimates, with associated nutrient load reductions to Silver Lake assuming 300,000 pounds of rough fish biomass removal.

While physically removing 300,000 pounds of cyprinid biomass will provide us with a measurable nutrient load reduction, we expect Silver Lake to realize additional water quality improvements as an indirect result of this removal.

The most valuable of these indirect benefits will be a long-term, sustained reduction of sediment and nutrient loading within Silver Lake. As rough fish removal progresses, we expect to see a positive response in turbidity within the lake. Aquatic vegetation will quickly respond as more available sunlight enters the water column. As aquatic plants in the shallows start to respond, they will further reduce sediment re-suspension from the substrates in which they are rooted. As more rough fish are eliminated, and aquatic vegetation re-establishes itself, we expect the in-lake sediment and phosphorus load reductions to be exponential.

Fish Removal Costs
Commercial fishing crews can often harvest as much as 200,000 pounds of adult rough fish from one body of water in a year before reaching a point of "diminishing returns" in relation to the amount of fish harvested from each seine haul. Although our aggregate goal for removal is 300,000 pounds, this removal will be accomplished over a period of 5 years. Because of this, it is very unlikely that a commercial operation will require any compensation on a per pound basis for removing these fish. Due to the possibility of market fluctuations or unforeseen difficulties in removing these fish from Silver Lake, we are prepared to offer a commercial operation an annual bonus of $5,000 for reaching the fish removal goal during each year of the project.

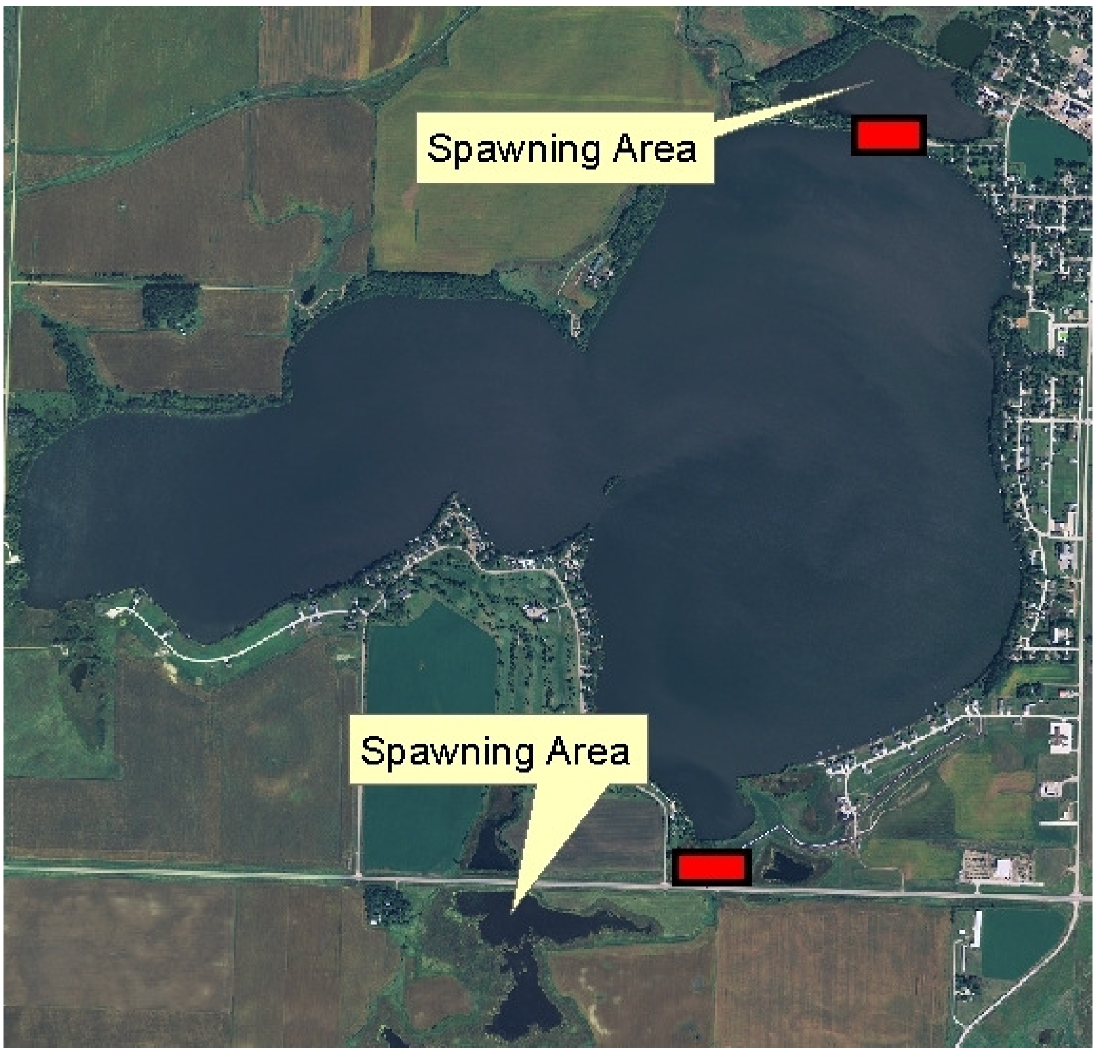
Project Year	Rough Fish Biomass Removed (lbs)	319/WSPF Expenses	Total Project Expenses
5	75,000	0	$5,000
6	75,000	0	$5,000
7	50,000	0	$5,000
8	50,000	0	$5,000
9	25,000	0	$5,000
10	25,000	0	$5,000
Total:	300,000	0	$30,000

Table 9.2: Financial expenses of rough fish removal in project years 5-10.

Fish Barriers
Common carp prefer to conduct their spawning activity in shallow, secluded bays and wetlands that connect to larger lake basins. By selecting such spawning habitat, adult carp are able to shelter their offspring from many predatory fishes that favor deep-water habitat. In doing so, these young fish often avoid significant mortality by predation during the most vulnerable period of their life.

Two areas directly adjacent to Silver Lake have been identified as prime spawning habitat for common carp. These areas include Trapper's Bay on the north end of the main lake, as well as a shallow wetland complex connected to the south side of the main lake basin. By preventing adult carp and buffalo from reproducing in these areas, their offspring will be forced to survive in the main lake basin. Predation by northern pike, walleye, and white bass will be much more significant in this area.

We feel that excluding adult rough fish from their preferred spawning habitat is a necessary complement to the physical removal of these species from Silver Lake. It will most likely be impossible to completely eliminate common carp and buffalo from Silver Lake without the use of a chemical treatment. However, by aggressively removing adult fish and limiting future recruitment from shallow spawning areas, we believe the overall population can be significantly reduced. In time, this in-lake work will provide the necessary link between upstream watershed improvement, and realized water quality benefits in Silver Lake itself.



Map 9.1: Planned location of fish barriers (red) constructed between the main body of Silver Lake and adjacent rough fish spawning habitat.

Shallow Lakes Restoration
In order to delist Silver Lake from the 303(d) Impaired Waters List, it may be necessary to employ shallow lakes restoration techniques other than wetland restoration, shoreline restoration, and rough fish removal. Although we believe that load reductions established in the Silver Lake TMDL are attainable via BMP implementation(watershed) and aggressive rough fish removal(in-lake), most of this data is based upon modeling. We understand that additional in-lake management may be needed in order to bridge the gap between estimated load reductions via modeling, and realized water quality benefits in Silver Lake itself.

Several years of an information/education campaign involving the shallow lakes restoration program may be required before citizens in the Silver Lake area would be willing to endorse some of the concepts involved with this program. Over the past decade, the Iowa DNR has gained valuable insight into the mechanisms that drive water quality and aquatic life in Iowa's shallow lakes. Restoration of these ecosystems requires an adaptive management approach utilizing a variety of complimentary techniques. These techniques are geared toward emulating pre-settlement conditions. The goal is to shift the lake from a turbid system with limited aquatic vegetation, to a clear water system dominated by macrophytes (aquatic plants).

Shallow lakes restoration techniques include:

- Wetland restoration to emulate natural lake hydrology.
- Water level management to establish rooted aquatic vegetation.
- Shoreline stabilization to reduce erosion and establish and sustain aquatic plants.
- Fisheries management to reduce bottom-feeding rough-fish species (common carp).

BMP	Units	TP Load Reduction per Unit	Total TP Load Reduction
Shoreline Restoration (Native seedings)	5,000 ft	0.1 lb/yr	500 lb/yr
Rough Fish Removal	300,000 lb	0.0228 lb/yr	6,840 lb/yr
Fish Barriers	2	N/A	N/A
		Total TP Reduction:	**7,340 lb/yr**

Table 9.3: In-lake practices and P load reductions as part of the watershed project.

10. Project Goals

The main goals of the Silver Lake Watershed Project are below:

- Significantly reduce watershed sources of sediment loading to Silver Lake by the implementation of agricultural and urban BMP's.
- Significantly reduce watershed sources of nutrient loading, particularly phosphorus, by the implementation of agricultural and urban BMP's.
- Significantly reduce re-suspension of sediment and phosphorus within Silver Lake via shoreline stabilization, fisheries management, and other shallow lakes restoration techniques.

The Silver Lake TMDL demonstrates a need to accomplish these goals before Silver Lake can be considered for removal from the 303d listing.

Implementation Goals

The TMDL written for Silver Lake states: "No single BMP will be able to reduce pollutant loads to Silver Lake. Rather, a comprehensive package of BMP's will be required to address poor water transparency that has caused "aesthetically objectionable conditions" and impaired primary contact recreation." The majority of the phosphorus and sediment entering Silver Lake is from agricultural land uses and internal recycling; however, some urban area drains to the lake as well. Therefore, potential BMPs for water quality improvement in Silver Lake are grouped into three components: agricultural, urban, and in-lake.

Given the wide variety of BMP's necessary to meet the load reductions for Silver Lake, we have devised a 10-year implementation schedule for the watershed project. As the project progresses, it may be necessary to edit the implementation plan based on the success of certain practices, or a lack of funding in particular program areas.

Below is the 10-year implementation schedule for the Silver Lake Watershed Project. This schedule will accompany the plan throughout the duration of the project, and lay the groundwork for a successful watershed project.

Years 1-2

BMP	Units	TP Load Reduction per Unit	Total TP Load Reduction
CRP Incentive	25 ac	2 lb/yr	50 lb/yr
Shoreline Restoration	1000 ft	0.1 lb/yr	100 lb/yr
Grassed Waterways	500 ft	0.1 lb/yr	50 lb/yr
Sediment Basins	4	10 lb/yr	40 lb/yr
No /Ridge/ Strip Till Incentive	200 ac	0.9 lb/yr	180 lb/yr
Wetland Restoration*	200 ac	16 lb/yr	3,200 lb/yr
Rock Tile Intakes	20	3 lb/yr	60 lb/yr
Urban BMP's	10	2.5 lb/yr	25 lb/yr

Years 3-4

BMP	Units	TP Load Reduction per Unit	Total TP Load Reduction
CRP Incentive	25 ac	2 lb/yr	50 lb/yr
Shoreline Restoration	1000 ft	0.1 lb/yr	100 lb/yr
Grassed Waterways	500 ft	0.1 lb/yr	50 lb/yr
Sediment Basins	5	10 lb/yr	50 lb/yr
No /Ridge/ Strip Till Incentive	150 ac	0.9 lb/yr	135 lb/yr
Wetland Restoration*	50 ac	16 lb/yr	800 lb/yr
Rock Tile Intakes	15	3 lb/yr	45 lb/yr
Urban BMP's	10	2.5 lb/yr	25 lb/yr

Years 5-6

BMP	Units	TP Load Reduction per Unit	Total TP Load Reduction
CRP Incentive	25 ac	2 lb/yr	50 lb/yr
Shoreline Restoration	1000 ft	0.1 lb/yr	100 lb/yr
Grassed Waterways	500	0.1 lb/yr	50 lb/yr
Sediment Basins	5	10 lb/yr	50 lb/yr
No /Ridge/ Strip Till Incentive	600 ac	0.9 lb/yr	540 lb/yr
Rock Tile Intakes	50	3 lb/yr	150 lb/yr
Rough fish Removal*	150,000 lb	0.0228 lb/yr	3,420 lb/yr
Fish Barriers	2	N/A	N/A

Years 7-8

BMP	Units	TP Load Reduction per Unit	Total TP Load Reduction
CRP Incentive	25 ac	2 lb/yr	50 lb/yr
Shoreline Restoration	1000 ft	0.1 lb/yr	100 lb/yr
Grassed Waterways	750	0.1 lb/yr	75 lb/yr
Sediment Basins	6	10 lb/yr	60 lb/yr
No /Ridge/ Strip Till Incentive	500 ac	0.9 lb/yr	450 lb/yr
Rock Tile Intakes	15	3 lb/yr	45 lb/yr
Rough fish Removal*	100,000 lb	0.0228 lb/yr	2,280 lb/yr

Years 9-10

BMP	Units	TP Load Reduction per Unit	Total TP Load Reduction
CRP Incentive	25	2 lb/yr	50 lb/yr
Shoreline Restoration	1000 ft	0.1 lb/yr	100 lb/yr
Grassed Waterways	750	0.1 lb/yr	75 lb/yr
Sediment Basins	5	10 lb/yr	50 lb/yr
No /Ridge/ Strip Till Incentive	300 ac	0.9 lb/yr	270 lb/yr
Rock Tile Intakes	15	3 lb/yr	45 lb/yr
Rough fish Removal*	50,000 lb	0.028 lb/yr	1,140 lb/yr

Tables 10.3-10.7: Scheduled BMP units & load reductions for project years 1-10.

Project Composite: *BMP Load Reductions*

BMP	Units	TP Load Reduction per Unit	Total TP Load Reduction
CRP Incentive	125 ac	2 lb/yr	250 lb/yr
Shoreline Restoration	5,000 ft	0.1 lb/yr	500 lb/yr
Grassed Waterways	3,000 ft	0.1 lb/yr	300 lb/yr
Sediment Basins	25	10 lb/yr	250 lb/yr
No /Ridge/ Strip Till Incentive	1,750 ac	0.9 lb/yr	1,575 lb/yr
Wetland Restoration	250 ac	16 lb/yr	4,000 lb/yr
Rock Tile Intakes	115	3 lb/yr	345 lb/yr
Urban BMP's	20	2.5 lb/yr	50 lb/yr
Rough fish Removal	300,000 lb	0.0228 lb/yr	6,840 lb/yr
Fish Barriers	2	N/A	N/A
		Total TP Reduction:	**14,110 lb/yr**

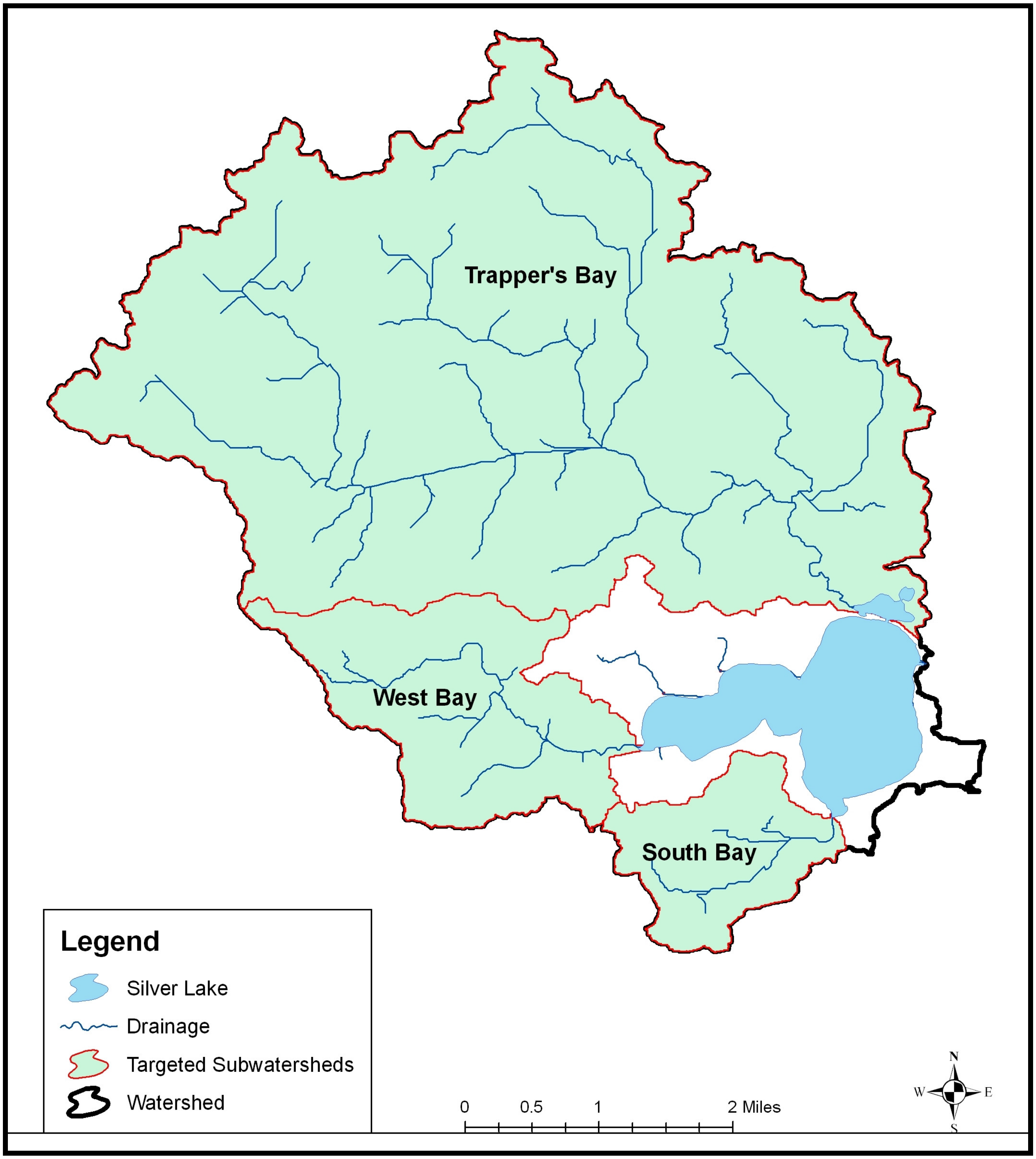
Table 10.8: Scheduled BMP units & TP load reduction project composites.

11. Targeted Implementation

Following are comprehensive Resource Management Plans for each of the three sub-watersheds which comprise the Silver Lake Watershed.

Although each sub-watershed has its own unique set of characteristics and challenges, the general plan to treat each area will be similar in many ways. BMP's such as residue and nutrient management, grassed waterways, filter strips, sediment basins, and rock tile intakes will be used to reduce soil erosion and impede sediment and nutrient delivery to the various drainages of the Silver Lake Watershed.

To accompany these erosion and sediment delivery control practices, we will also focus on wetland restoration in key locations. This involves the first phase of the comprehensive plan to remove Silver Lake from the State of Iowa 303(d) Impaired Waters List, which is already in motion. Not only do wetlands capture and hold excess sediment and nutrients upstream of Silver Lake, but they also offer a significant decrease in flow velocity following rainfall events. These wetlands will act as a crucial filter for pollutant loads not captured with erosion control practices.



Map 11.1: Subwatersheds that comprise the Silver Lake Watershed.

West Bay Resource Management Area (RMA)

Objective – Restore the designated uses of Silver Lake by the reduction of sediment and nutrient loads leaving the West Bay RMA.

Restoration Planning Components

Watershed Practices

Analysis has identified two priority wetland restorations in this RMA (Map 9.2). These wetland restorations have the potential to effectively intercept 1,564 acres (84% of the RMA) of primarily agricultural runoff. In lieu of restoration of these priority wetlands, analysis has identified alternative locations for sediment basins and/or constructed wetlands. Discussions with individual landowners will be used to determine if these practices are more feasible. In the event neither a wetland restoration nor sediment basin can be achieved, we will explore other practice options in order to reduce sediment loss from the property.

Modeling has identified 4.5 miles of concentrated flow areas within the West Bay RMA (Map 9.3). By installing grassed waterways within each of these areas, approximately 50 acres of upland buffers can be created, and sediment loss from these areas significantly reduced.

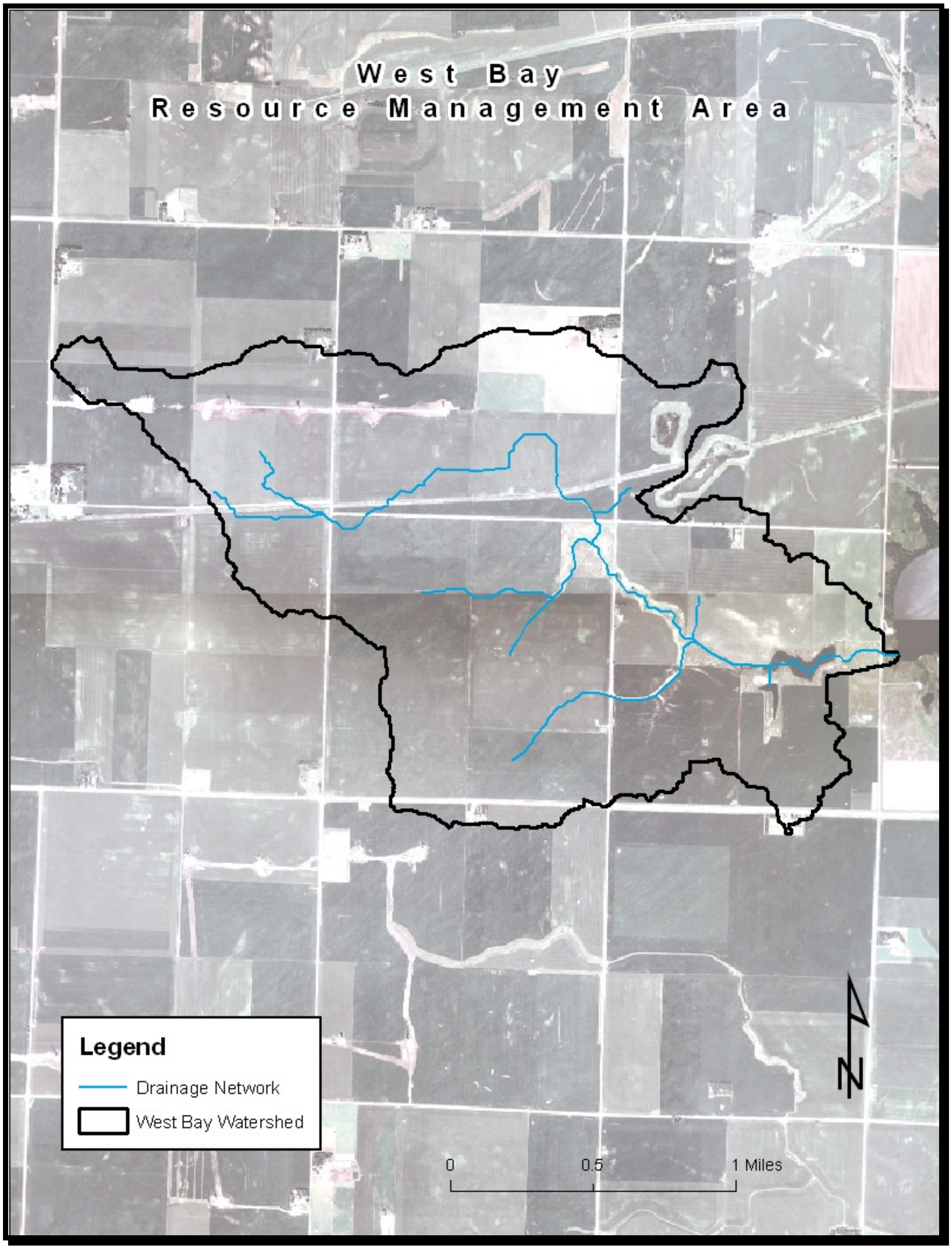
Analysis has shown 16 agricultural fields devoted to row crop production that exceed sediment loss thresholds (Map 9.5). These fields, totaling 907 acres, account for 50% or more of the sediment loss within this RMA. By implementing conservation/minimum tillage practices on these fields, this sediment loss could be significantly reduced. Sediment loss can be effectively reduced on over 140 row crop acres by implementing alternative practices (i.e. permanent vegetation, sediment basins, and conservation tillage) where field slope is greater than seven percent. Another 46 acres have been identified and should have alternate land practices implemented because their slope is greater than 15% (Map 9.4).

A total of 1,658 acres are currently being utilized for the production of corn and soybeans within the West End RMA. A nutrient and pesticide management plan should be set up with each individual landowner to ensure that over application and runoff of nutrients and pesticides is minimized. A plan should also be put into place to protect field tile intakes from excessive nutrients and sediment. Rock tile intakes with an additional 50 foot vegetative buffer should be discussed and if possible, implemented at all tile intake locations within this RMA.

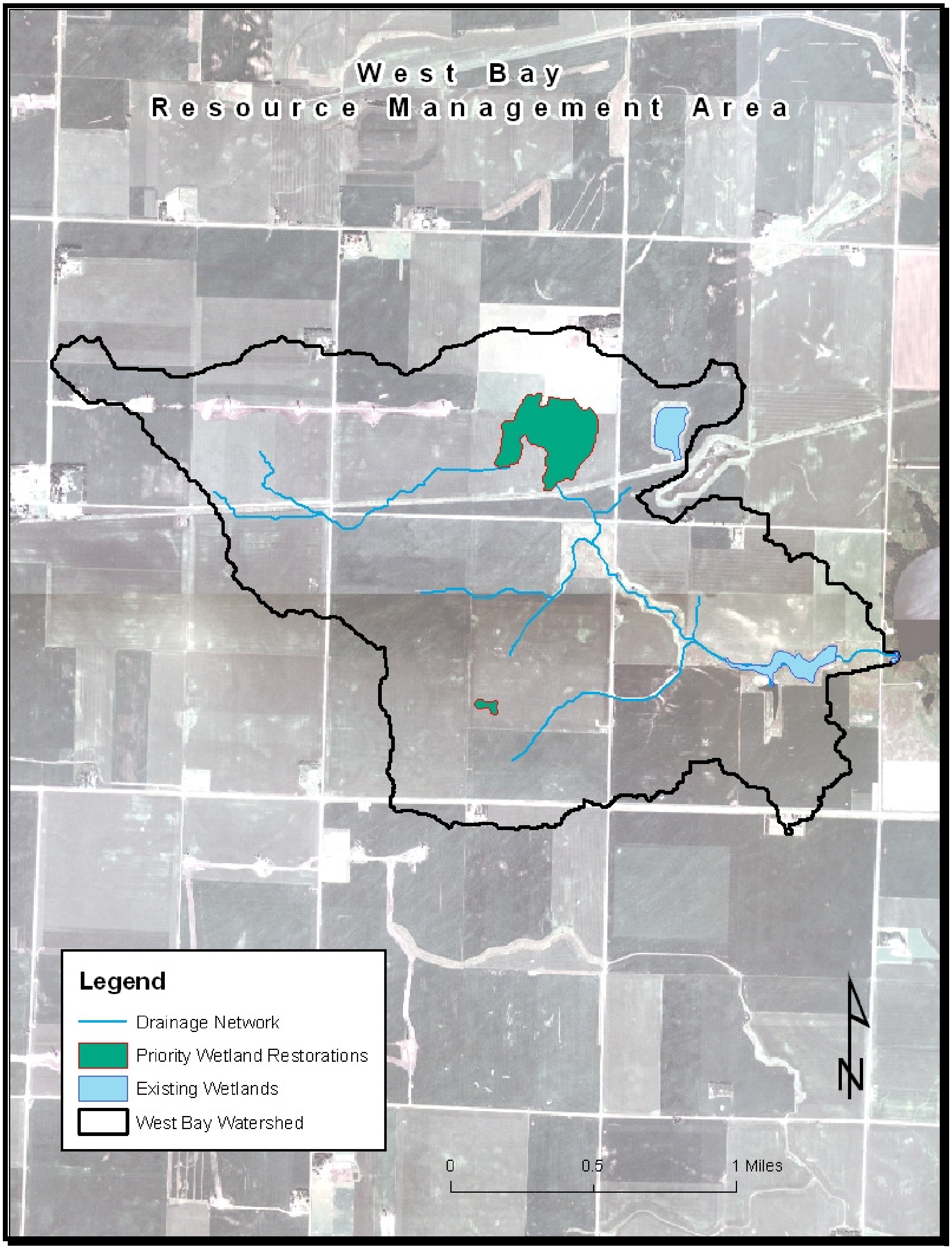
West Bay RMA Practice Implementation

BMP	Units	TP Load Reduction per Unit	Total TP Load Reduction
CRP Incentive	25 ac	2 lb/yr	50 lb/yr
Grassed Waterways	500 ft	0.1 lb/yr	50 lb/yr
Sediment Basins	5	10 lb/yr	50 lb/yr
No /Ridge/ Strip Till Incentive	400 ac	0.9 lb/yr	360 lb/yr
Wetland Restoration	25 ac	16 lb/yr	400 lb/yr
Rock Tile Intakes	25	3 lb/yr	75 lb/yr
		Total TP Reduction:	**985 lb/yr**

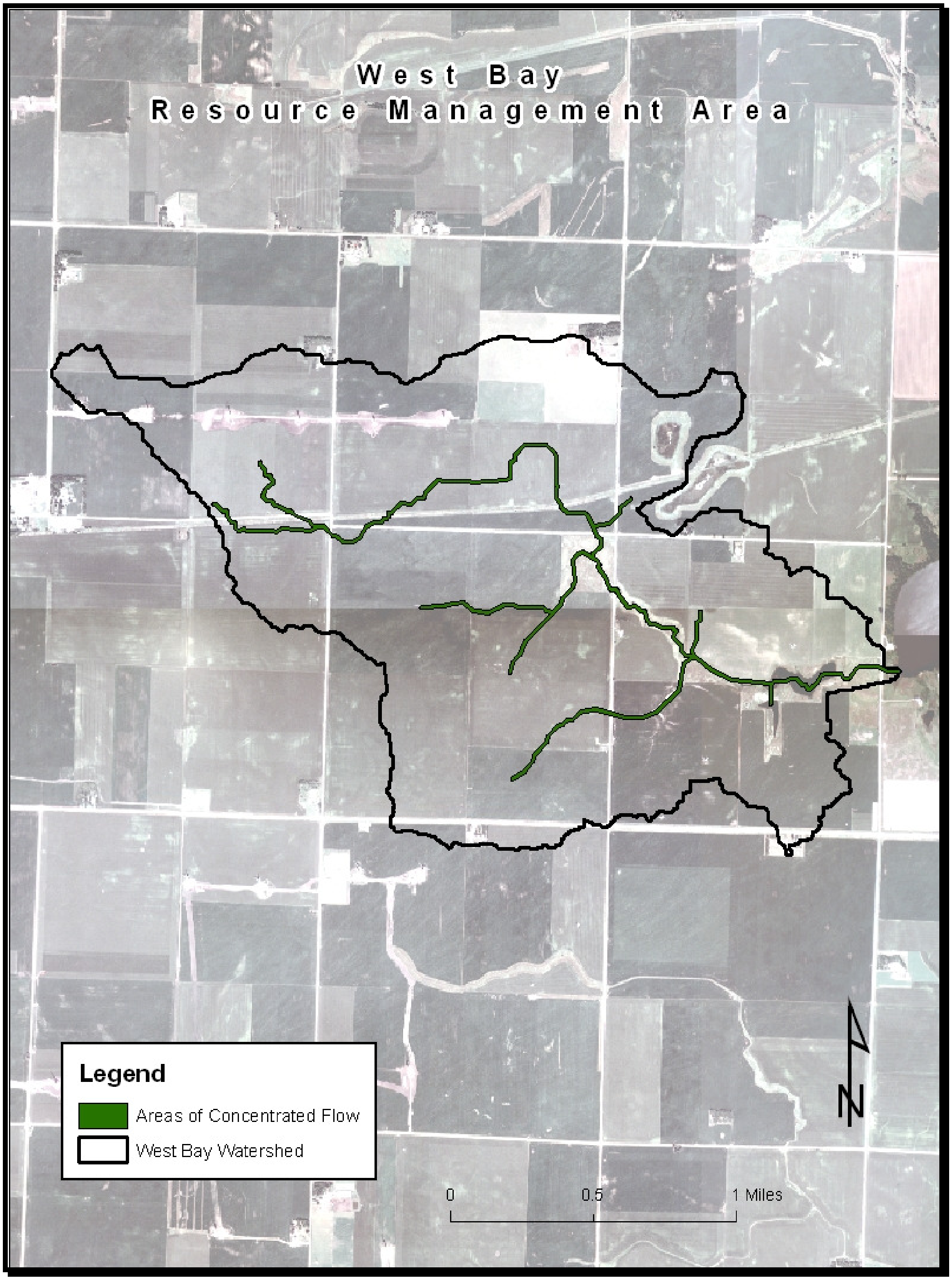
Table 11.1: BMP's & TP load reductions in West Bay RMA



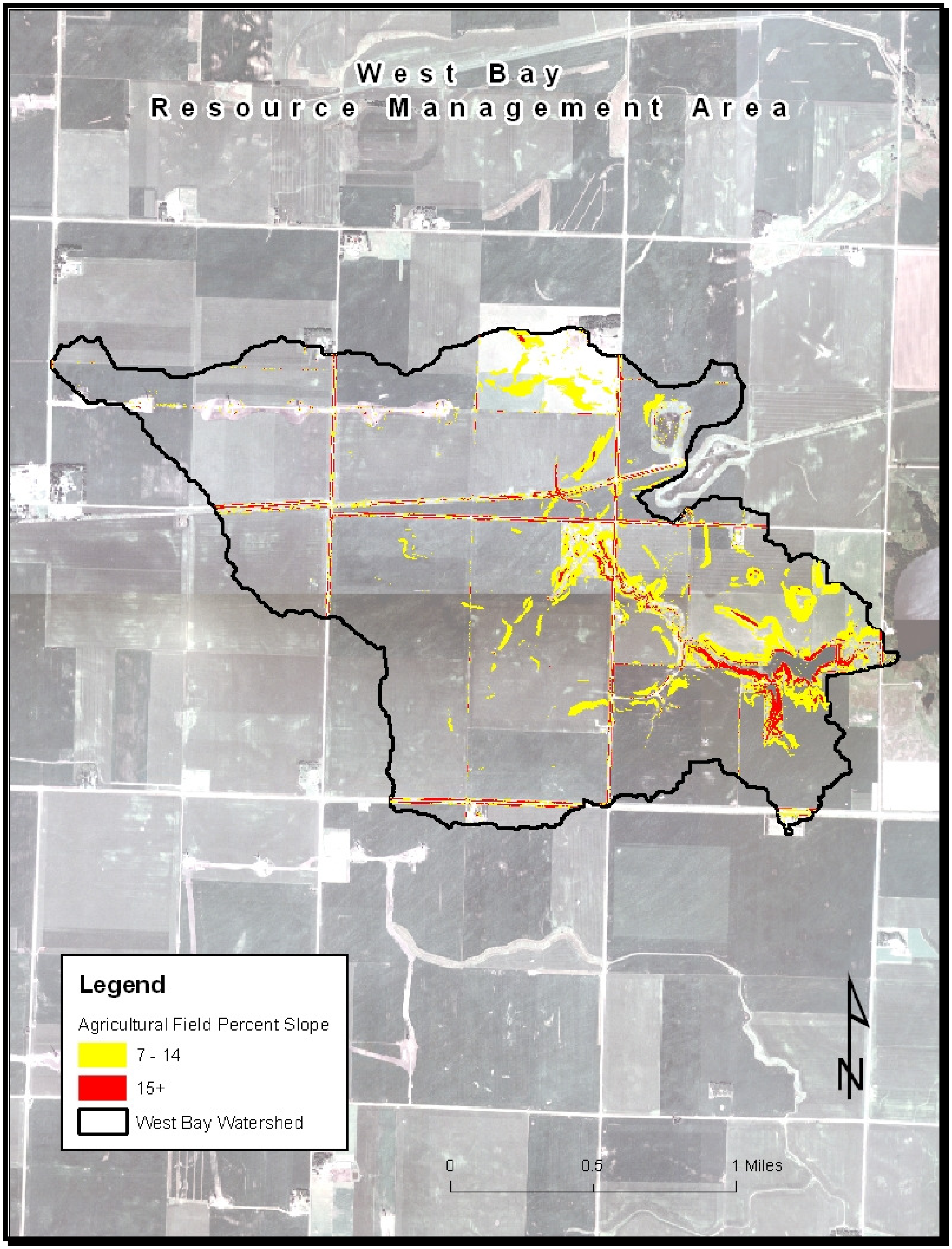
Map 11.2: West Bay drainage



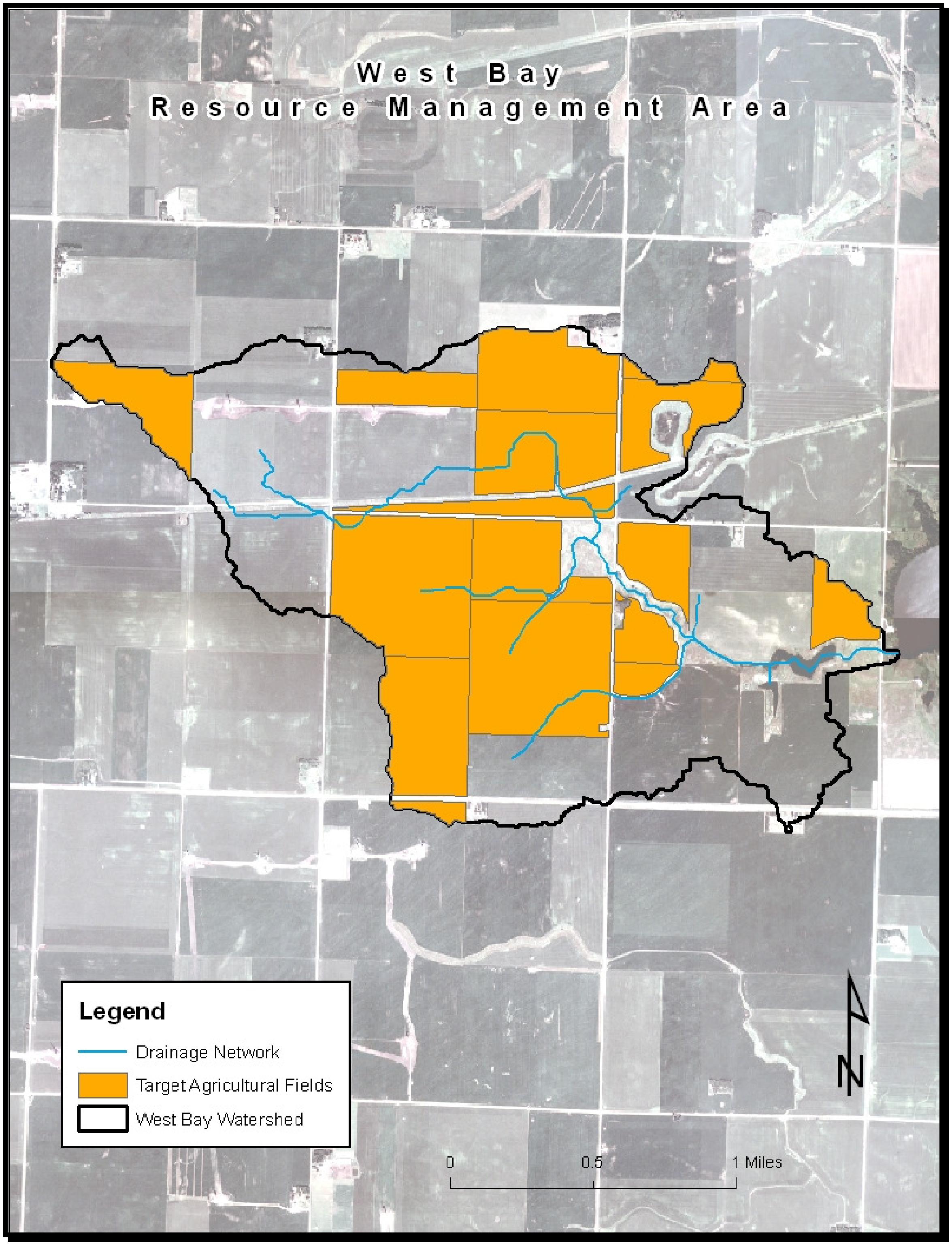
Map 11.3: West Bay wetland basins



Map 11.4: West bay concentrated surface flow



Map 11.5: West Bay highly erodible slopes



Map 11.6: West Bay agricultural fields of highest priority

Trapper's Bay Resource Management Area (RMA)

Objective – Restore the designated uses of Silver Lake by the reduction of sediment and nutrient loads leaving Trapper's Bay RMA.

<u>Restoration Planning Components</u>

Watershed Practices
Analysis has identified four priority wetland restorations in this RMA (Map 9.7). These wetland restorations have the potential to effectively intercept 4,830 acres (46% of the RMA) of primarily agricultural runoff.

To complement these four priority wetland restorations, there are many other restorable wetlands in this RMA that will receive attention. Restoration of these smaller wetlands would lessen the pressure on the highest priority wetlands. A stair-stepped approach using wetland restorations and sediment basins will help maximize the effective lifetime of these practices, and ensure an efficient use of project funding for the Silver Lake Watershed Project.

Modeling has identified 36 miles of concentrated flow areas within the Trapper's Bay RMA (Map 9.8). By installing grassed waterways within each of these areas, over 300 acres of upland buffers can be restored, and significant reductions in soil erosion and sediment loading achieved.

Analysis has shown 99 agricultural fields devoted to row crop production that exceed sediment loss thresholds (Map 9.10). A total of over 5,400 acres, these fields account for at least 50% of the sediment loss within the targeted watershed. By implementing conservation/minimum tillage programs on these acres, soil erosion and sediment loss could be further reduced.

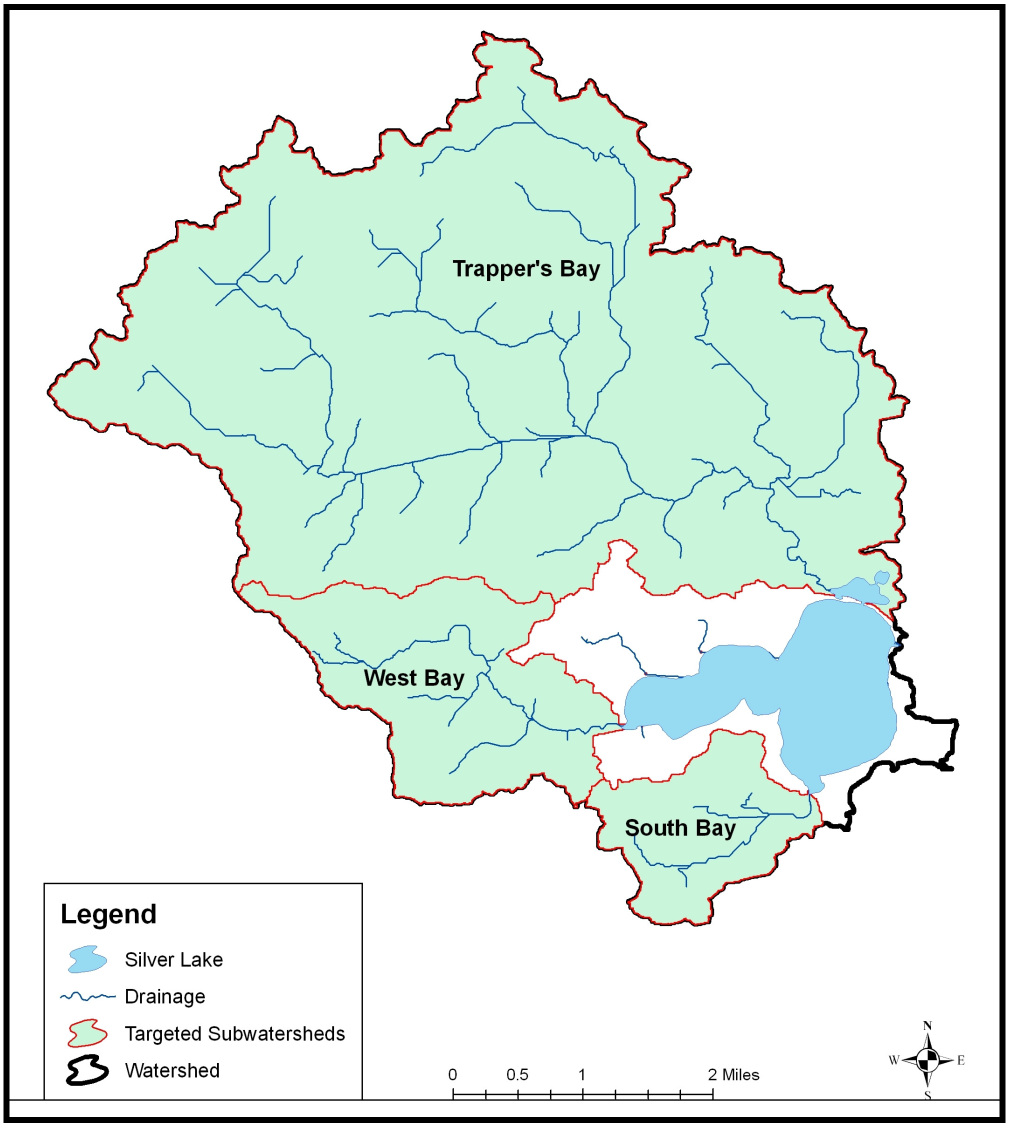
Sediment loss can be reduced on 1,037 row crop acres by implementing alternative practices (i.e. permanent vegetation, sediment basins, and conservation tillage) where field slope is greater than 7%. Another 290 acres have been identified as highly susceptible to erosion because of a slope greater than 15% (Map 9.9), and should be an even higher priority for alternative BMP's.

A total of 9,951 acres are currently being utilized for the production of corn and soybeans within the Trapper's Bay RMA. Technical assistance for writing nutrient and pesticide management plans will be provided for each landowner in order to minimize excess or poorly timed applications. In order to filter water entering tile drainage systems, we will push rock tile intakes with 50 foot vegetative buffers to be implemented at all logical tile intake locations within the watershed.

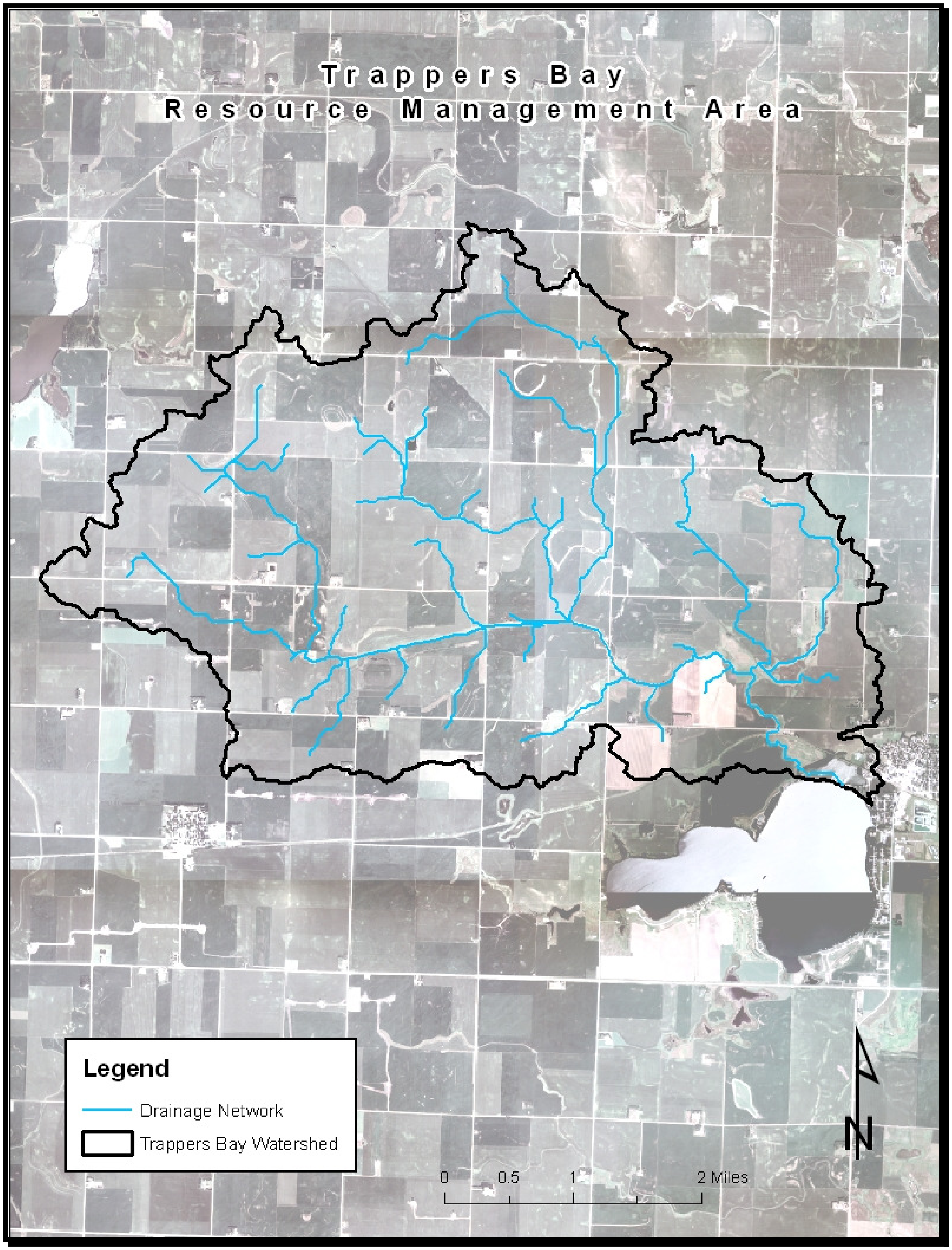
Trapper's Bay RMA Practice Implementation

BMP	Units	TP Load Reduction per Unit	Total TP Load Reduction
CRP Incentive	90 ac	2 lb/yr	180 lb/yr
Grassed Waterways	2,200 ft	0.1 lb/yr	220 lb/yr
Sediment Basins	19	10 lb/yr	190 lb/yr
No /Ridge/ Strip Till Incentive	1,100 ac	0.9 lb/yr	990 lb/yr
Wetland Restoration	215 ac	16 lb/yr	3,440 lb/yr
Rock Tile Intakes	85	3 lb/yr	255 lb/yr
		Total TP Reduction:	**5,275 lb/yr**

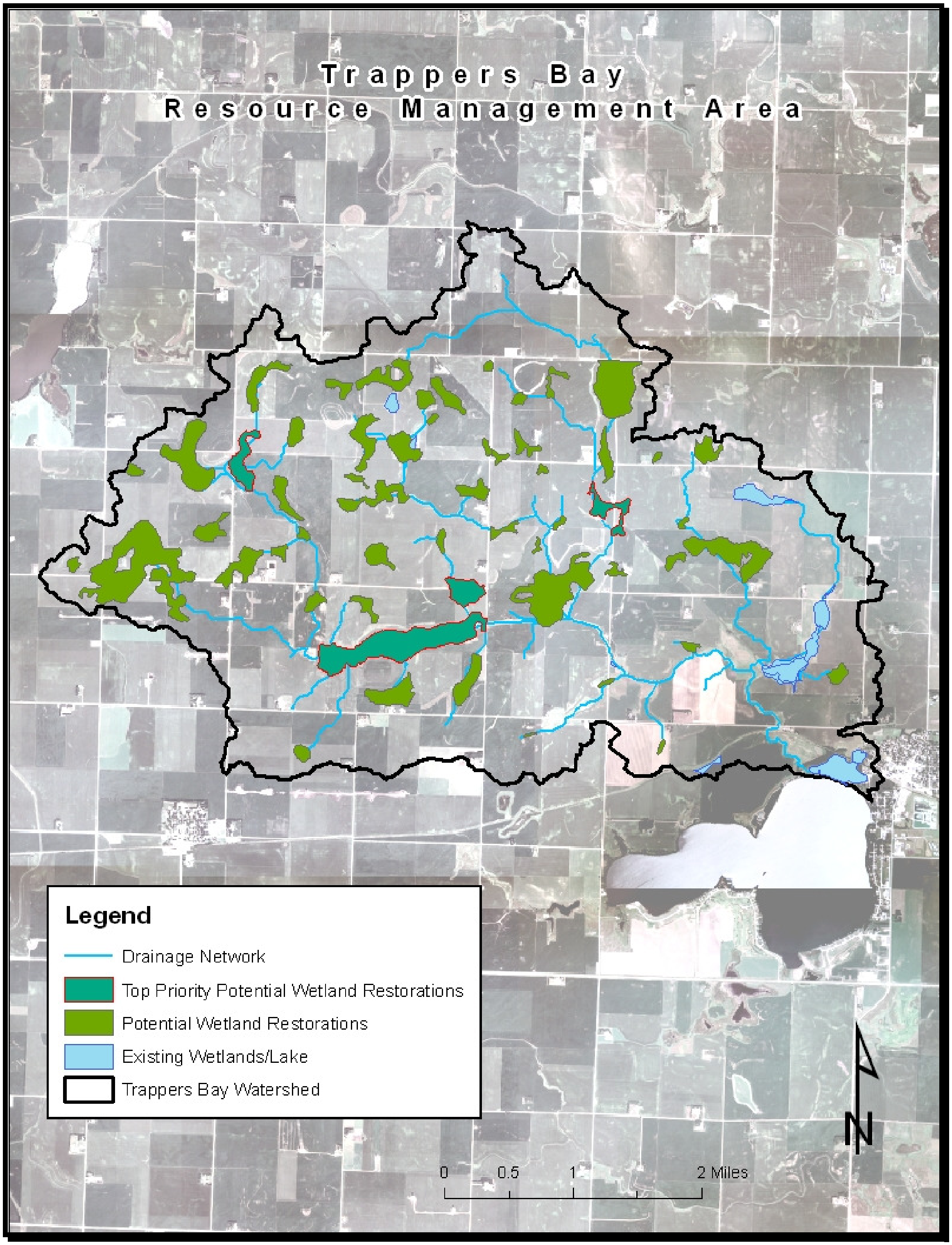
Table 11.2: BMP's & TP load reductions in Trapper's Bay RMA



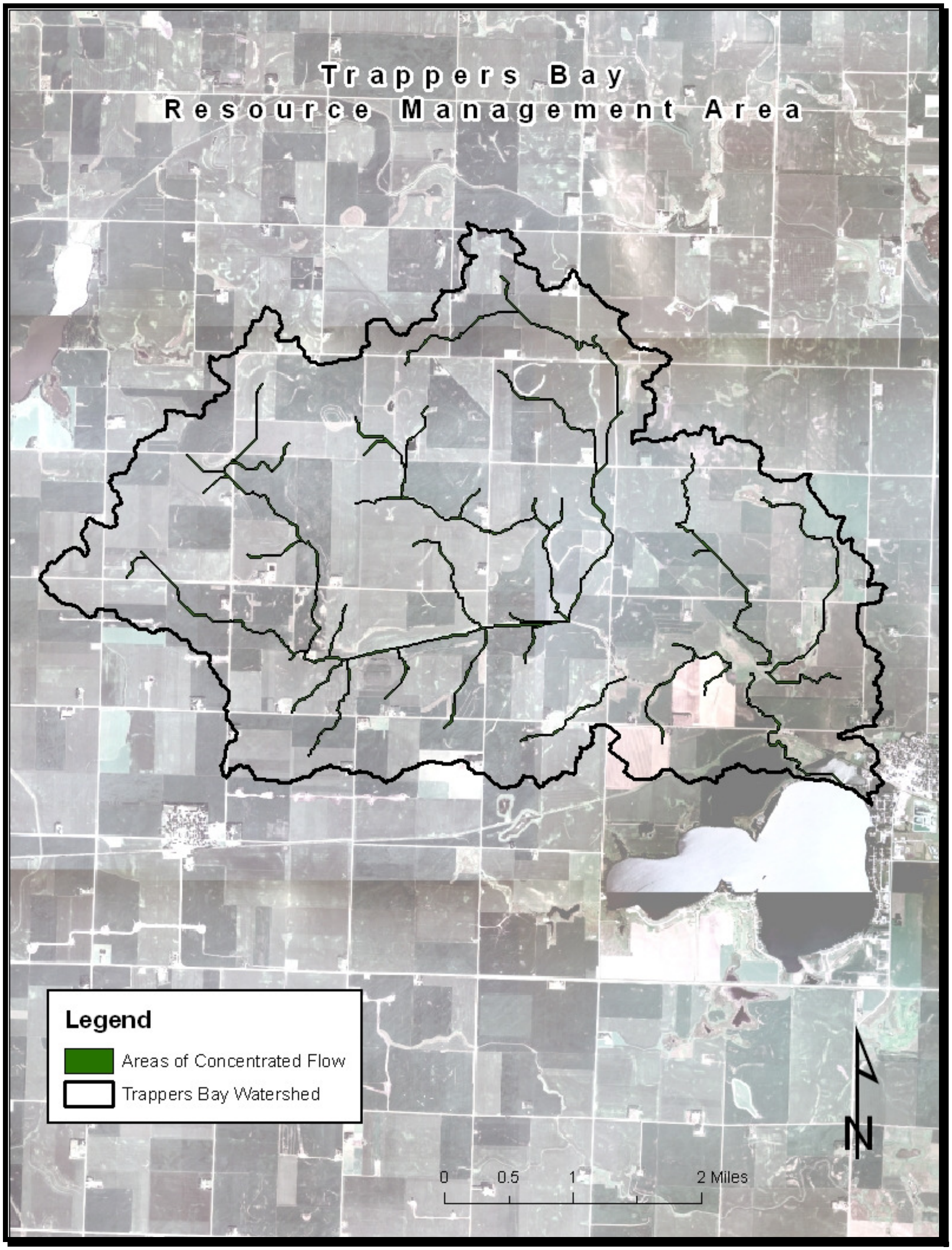
Map 11.6: Subwatersheds that comprise the Silver Lake Watershed.



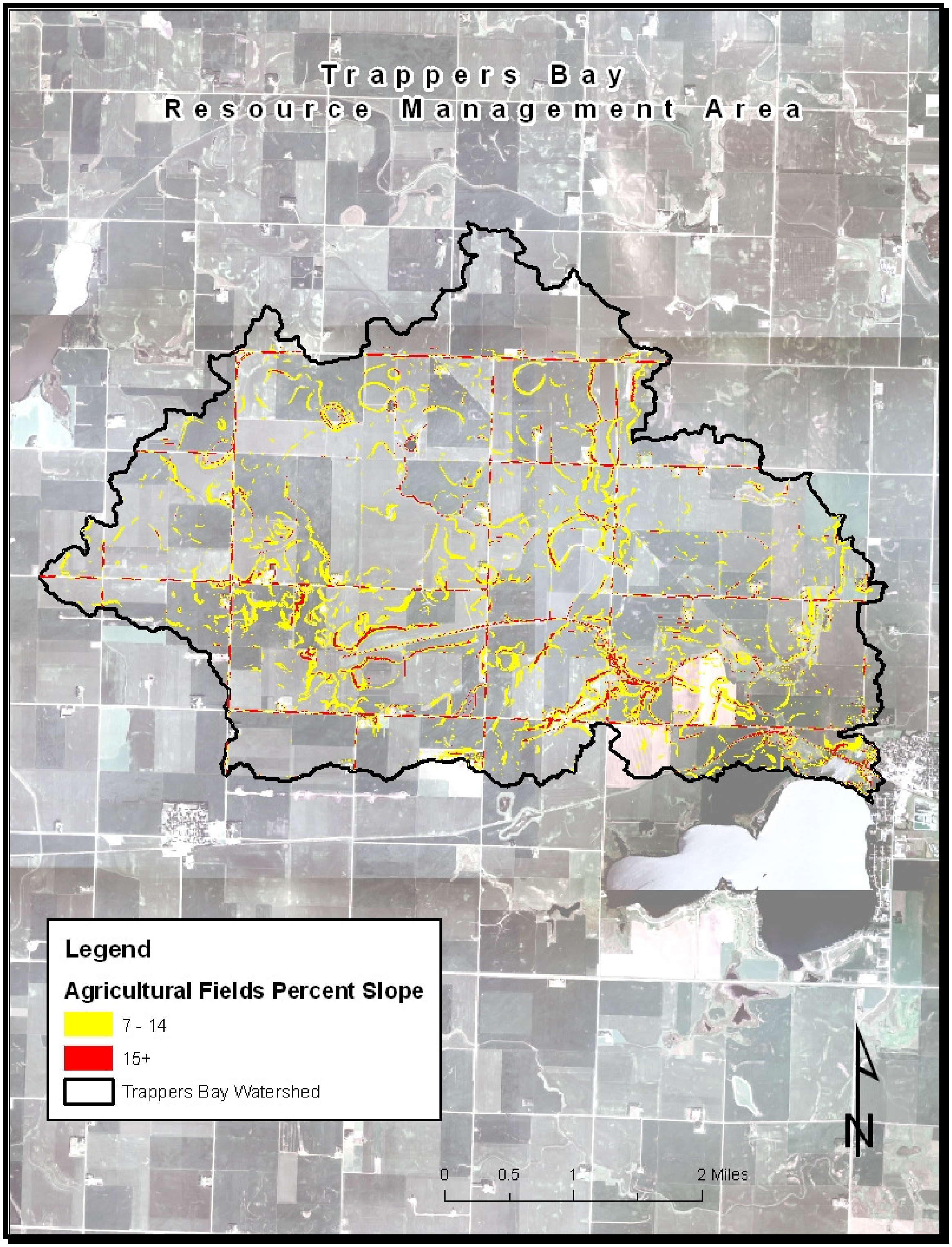
Map 11.7: Trapper's Bay drainage



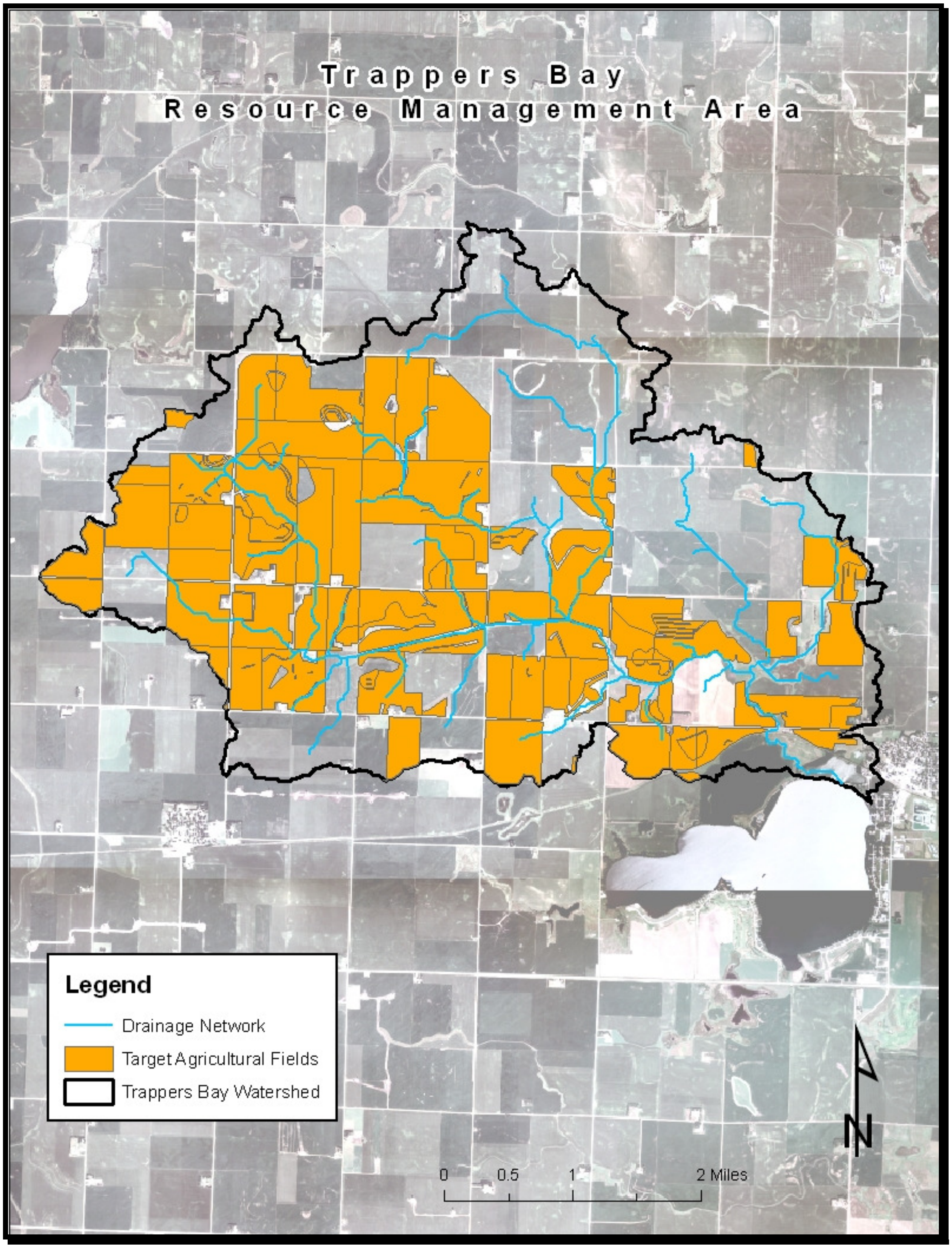
Map 11.8: Trapper's Bay wetland basins



Map 11.9: Trapper's Bay concentrated surface flow



Map 11.10: Trapper's Bay highly erodible slopes



Map 11.11: Trapper's Bay agricultural fields of highest priority

South Bay Resource Management Area (RMA)

Objective – Restore the designated uses of Silver Lake by the reduction of sediment and nutrient loads leaving the South Bay RMA.

<u>Restoration Planning Components</u>

Watershed Practices
Analysis has identified two priority wetland restorations in this RMA (Map 9.13). These wetlands would increase the sediment and nutrient catchment currently realized by the existing wetland chain in this RMA, and have the potential to effectively intercept sediment from 78 acres (8% of the RMA). If these wetlands cannot be restored, alternative BMP's will be encouraged.

GIS modeling has identified 1.5 miles of concentrated flow areas within the South Bay RMA. If no permanent vegetation exists, the installation of grassed waterways in these areas would create an additional 13 acres of vegetative cover to control gully erosion and sediment delivery.

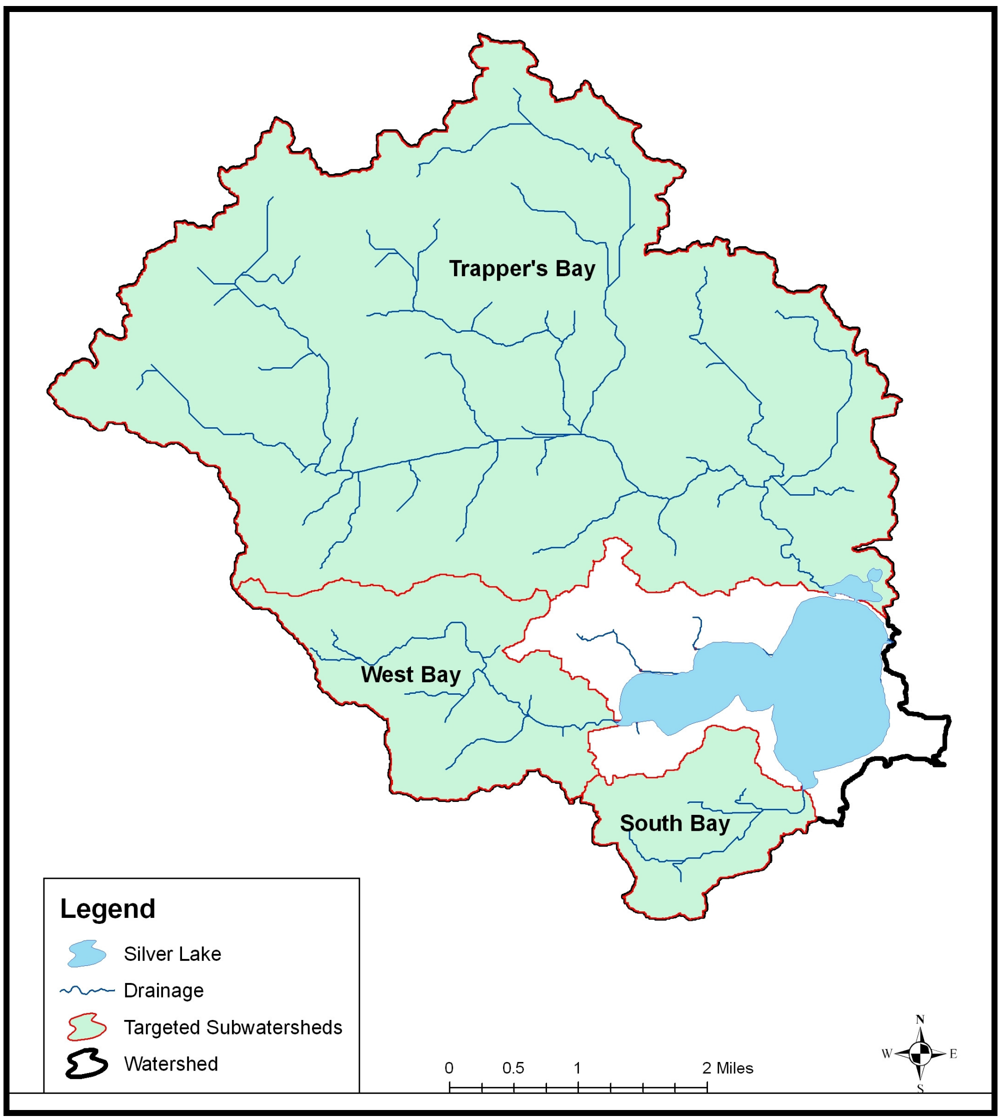
GIS analysis has also pinpointed 7 row crop fields which exceed sediment loss thresholds (Map 9.16). These fields, totaling 427 acres, account for more than 50% of the sediment loss within this RMA. By implementing conservation/minimum tillage programs on these acres, sediment losses from these fields would be significantly reduced.
Sediment loss can be reduced on 136 row crop acres by implementing alternative practices (i.e. permanent vegetation, sediment basins, and reduced tillage) in areas where field slope is greater than 7%. An additional 25 acres in this RMA is characterized by a slope of greater than 15% (Map 9.15). These acres will be of highest priority for conservation practices which establish permanent vegetative cover, if such is not already present.

A total of 710 acres are currently being utilized for the production of corn and soybeans within the South End RMA. Technical assistance for writing nutrient and pesticide management plans will be provided for each landowner in order to minimize excess or poorly timed applications. In order to filter water entering tile drainage systems, we will push for rock tile intakes with 50 foot vegetative buffers to be implemented at all logical tile intake locations within the watershed.

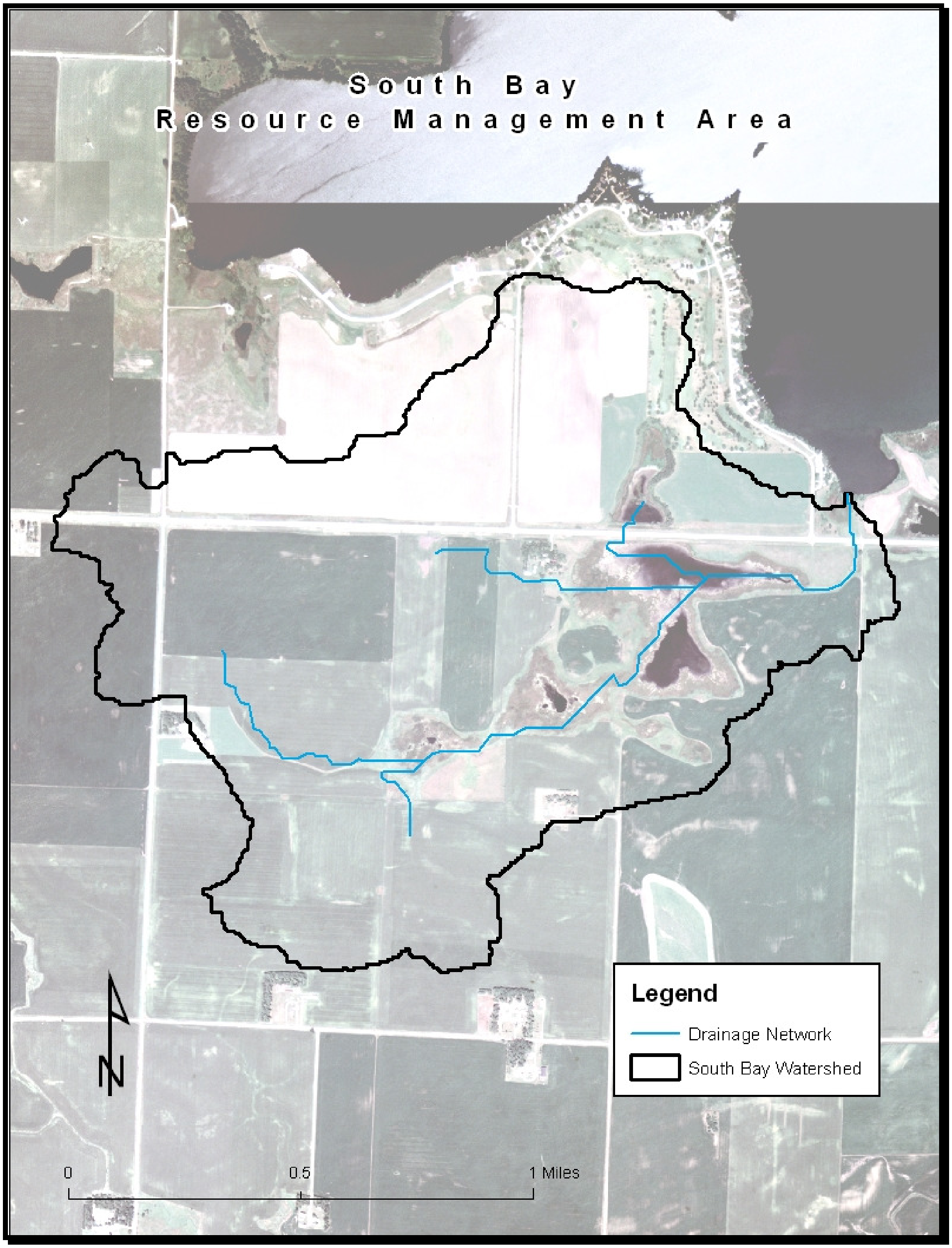
South Bay RMA Practice Implementation

BMP	Units	TP Load Reduction per Unit	Total TP Load Reduction
CRP Incentive	10 ac	2 lb/yr	20 lb/yr
Grassed Waterways	300 ft	0.1 lb/yr	30 lb/yr
Sediment Basins	1	10 lb/yr	10 lb/yr
No /Ridge/ Strip Till Incentive	250 ac	0.9 lb/yr	225 lb/yr
Wetland Restoration	10 ac	16 lb/yr	160 lb/yr
Rock Tile Intakes	5	*3 lb/yr*	15 lb/yr
		Total TP Reduction:	**460 lb/yr**

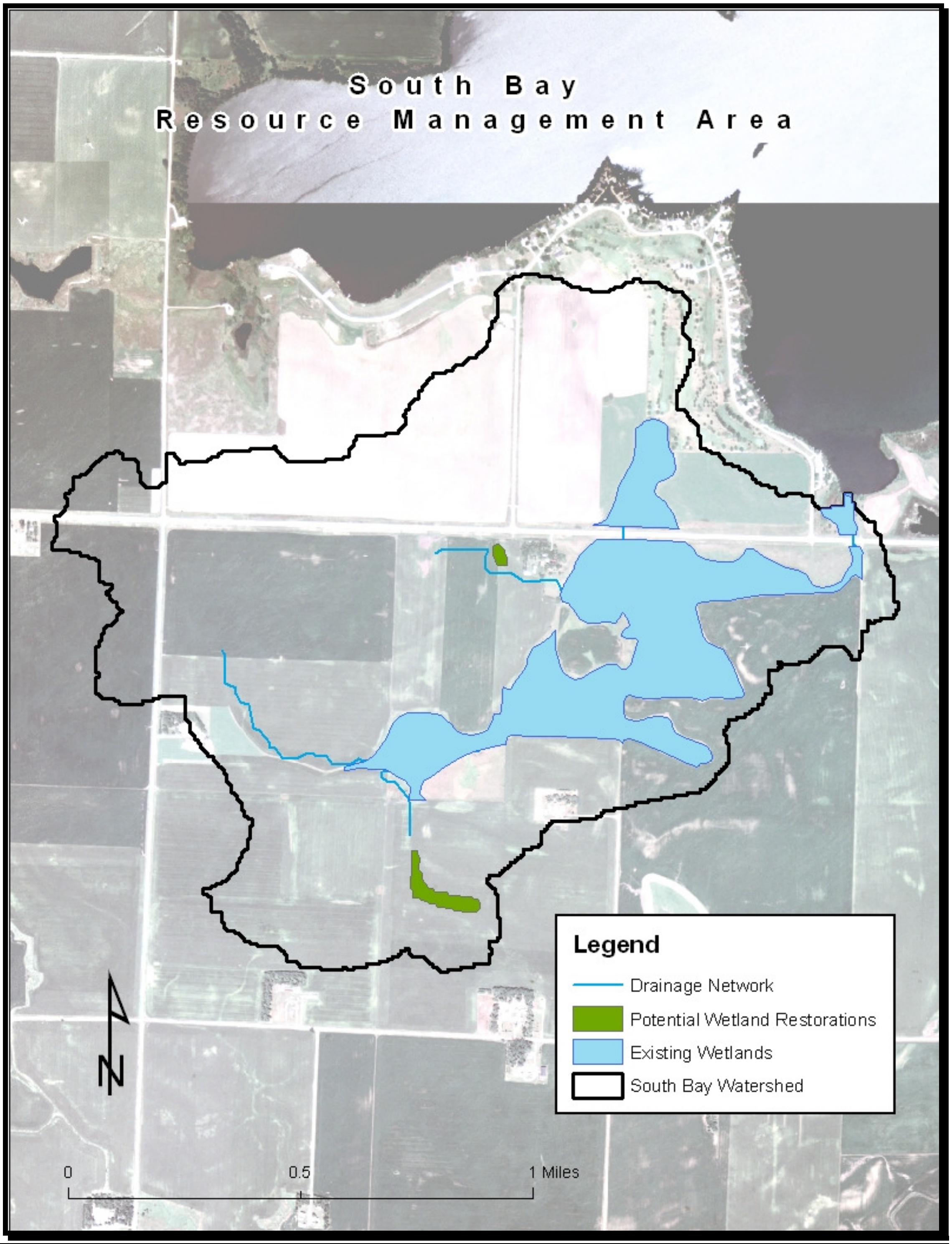
Table 11.3: BMP's & TP load reductions in South Bay RMA



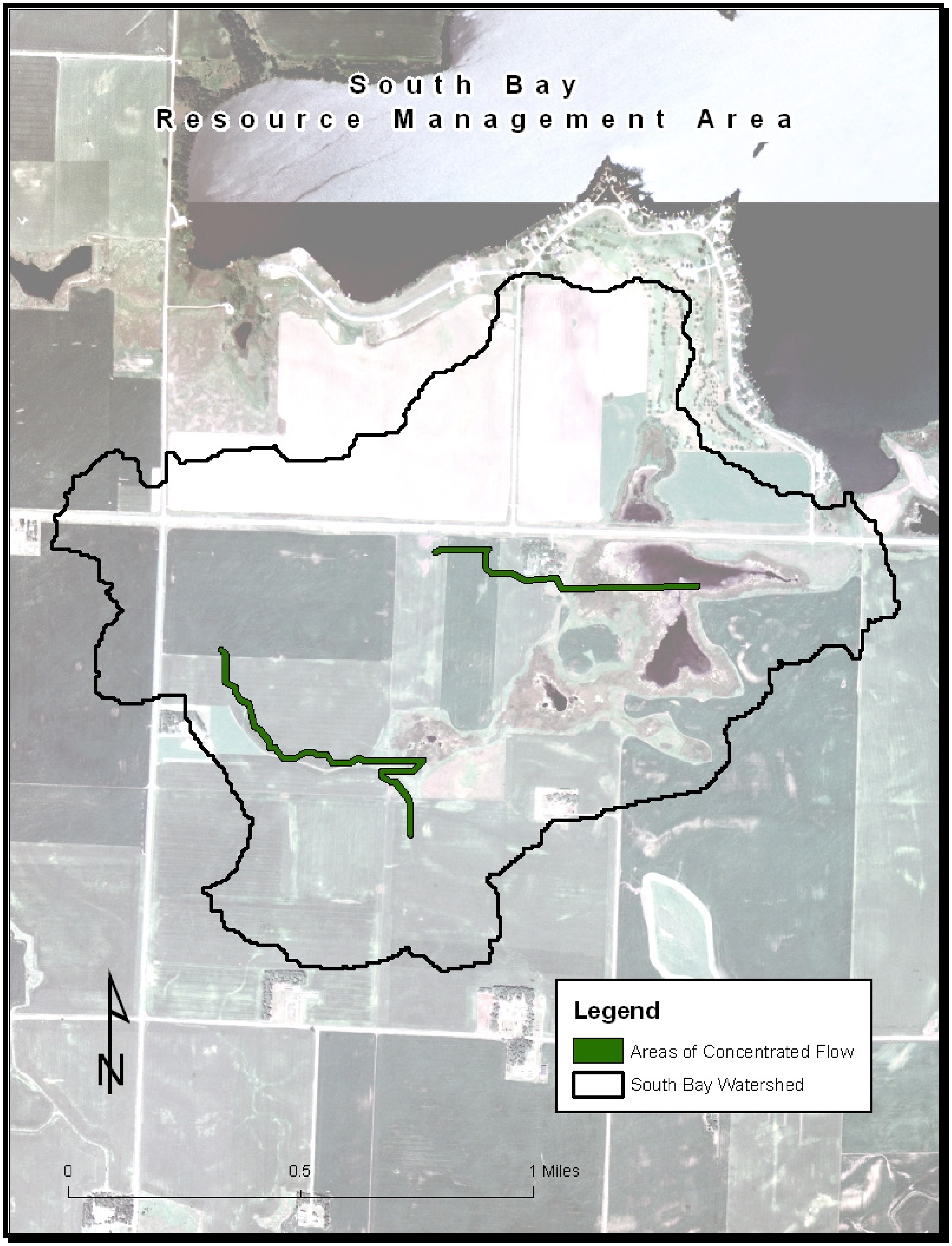
Map 11.12: Subwatersheds that comprise the Silver Lake Watershed.



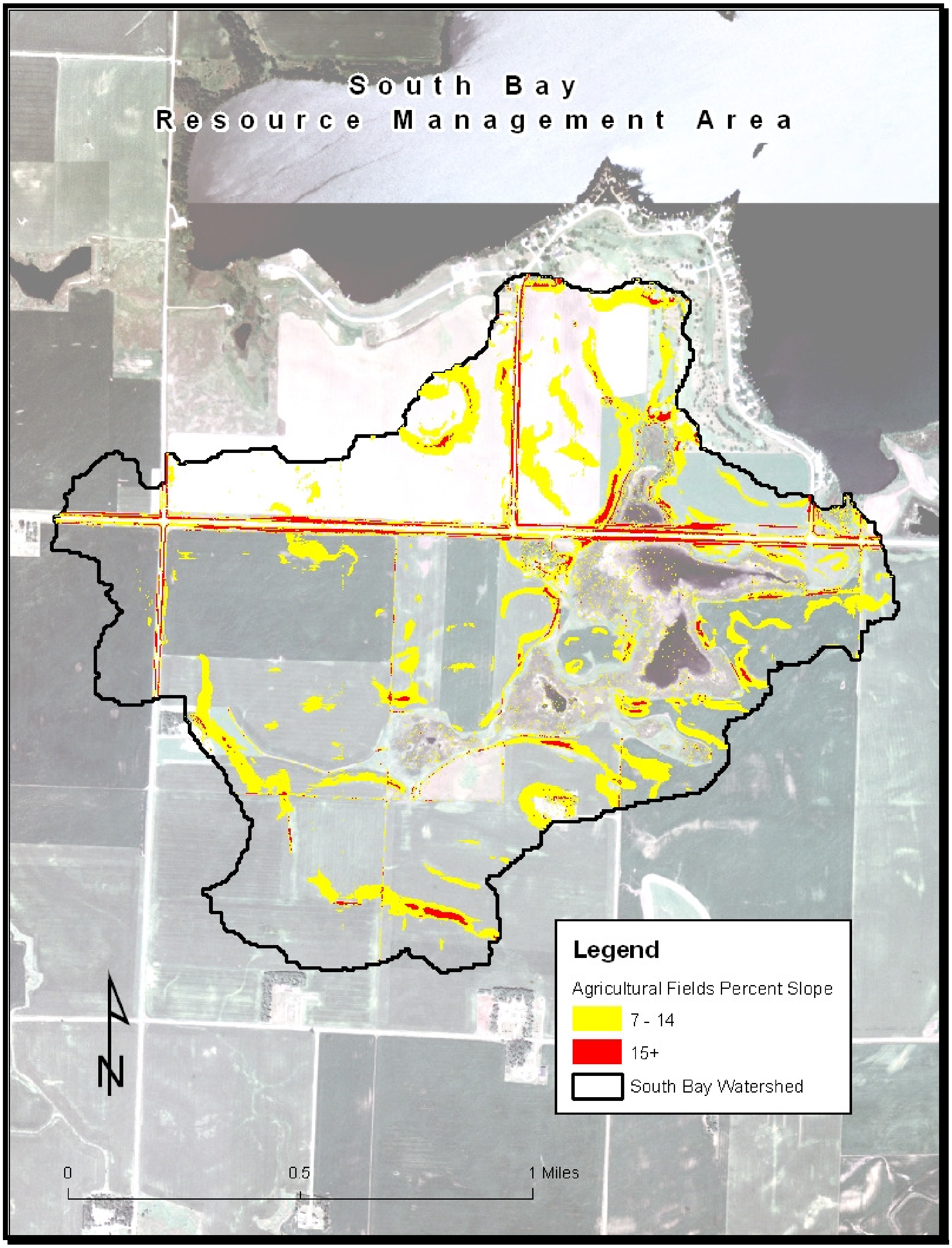
Map 11.13: South Bay drainage



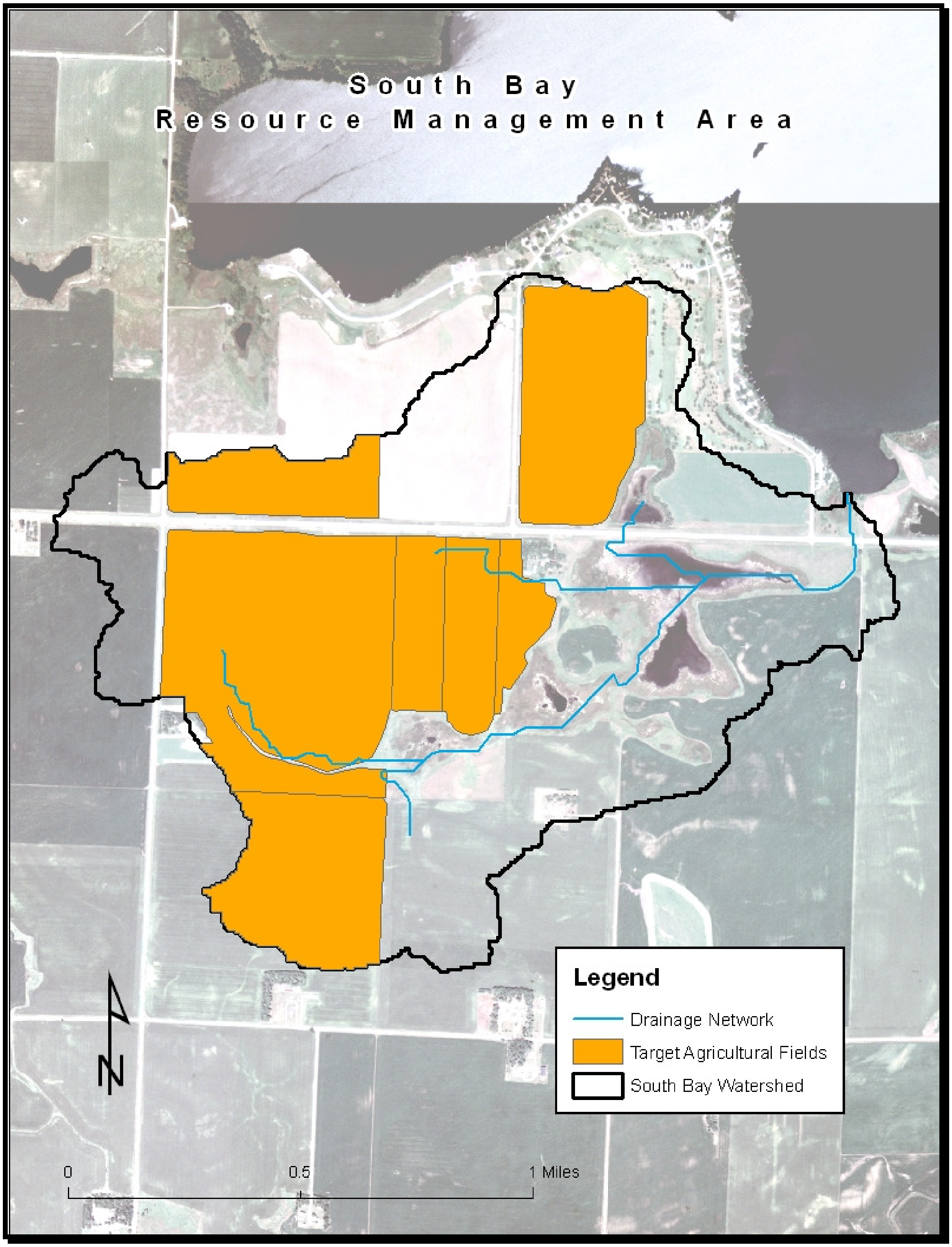
Map 11.14: South Bay wetland basins



Map 11.15: South Bay concentrated surface flow



Map 11.16: South Bay highly erodible slopes



Map 11.17: South Bay agricultural fields of highest priority

12. Wetland Prioritization

Wetland Restoration

The Silver Lake Watershed was historically characterized by a unique patchwork of potholes, permanent wetlands, and shallow lakes, most of which have been drained for agricultural production and other development. These areas, which once stored and filtered water, have been reduced to straightened drainage ditches and a network of drainage tile leading to the lake.

The main goal of a successful restoration is to renew the natural hydrology of a wetland, while also restoring the vegetation regime native to that habitat. Vegetation is restored using native prairie seeding on the uplands, and seeding hydric plants on the wetland itself. In order to enhance water quality improvements, we will focus our restoration efforts on large, shallow wetlands capable of capturing and filtering a large volume of water.

Many of these wetland restorations may require earthen dikes, artificial structures, and/or water level manipulation in an attempt to maximize water quality benefits, and to avoid drainage conflicts with neighboring landowners.

Sediment Basins

Sediment basins consist of an earthen structure with a tile intake on the uphill side, and are used to slow and filter the downhill surface runoff from a give drainage area. These basins are often constructed in row crop fields, and many producers consider them a favorable alternative to terraces. This is due to the fact that a sediment basin can be built to align with planted rows, where a true terrace is designed to follow the natural contour of a particular field.

Sediment basins will be promoted as an alternative or a compliment to wetland restorations, and will serve as an attractive option to offer landowners who might be uninterested in taking acres out of production in the name of wetland restoration. A more intense examination of the topography and a discussion with each individual landowner will be necessary in order to determine which conservation practice will best serve their land and operation.

Grade Stabilization Structures

Grade stabilization structures are earthen dams typically constructed perpendicular to a gully or ravine. These structures essentially cut the slope length of a gully or ravine in half, which drastically reduces the erosive downhill force of water flowing through these gullies. Grade stabilizations will be promoted as a viable alternative to sediment basins and terraces in certain scenarios where the aforementioned practices may not fit the topography, or may not provide enough stability to withstand the flow coming from a particular drainage area. In the past, grade stabilizations have been accepted as an effective practice for minimizing soil loss from non-crop ravines and gullies that have exhibited an inherent pattern of gully erosion in the past.

Wetland Prioritization

Below is a chart prepared utilizing GIS assessment of watershed drainage and potential wetland restorations in the Silver Lake Watershed. Although several of these wetlands are currently functioning, a large majority of them have been drained for agricultural production. Based on topography and soil type, we are still able to determine the exact location of these pre-settlement wetlands.

Although these drained wetlands rarely pond water and are planted to cash crops each year, they still hold the potential to become high-quality wetlands given the proper restoration and management. With this chart, we are able to determine which of these restorations would provide the greatest water quality benefit for Silver Lake. This information has provided us an extremely beneficial management tool when determining which restorations will allow our project the highest water quality improvements per dollar invested.

This chart allows us to calculate how many acres would be impacted by a particular restoration, as well as an estimate of sediment delivery reduction and nutrient catchment. Following each restoration project, we can run new calculations factoring in that improvement. Because restoration of a high priority wetland may alter the priority of others, our focus may shift following key restorations.

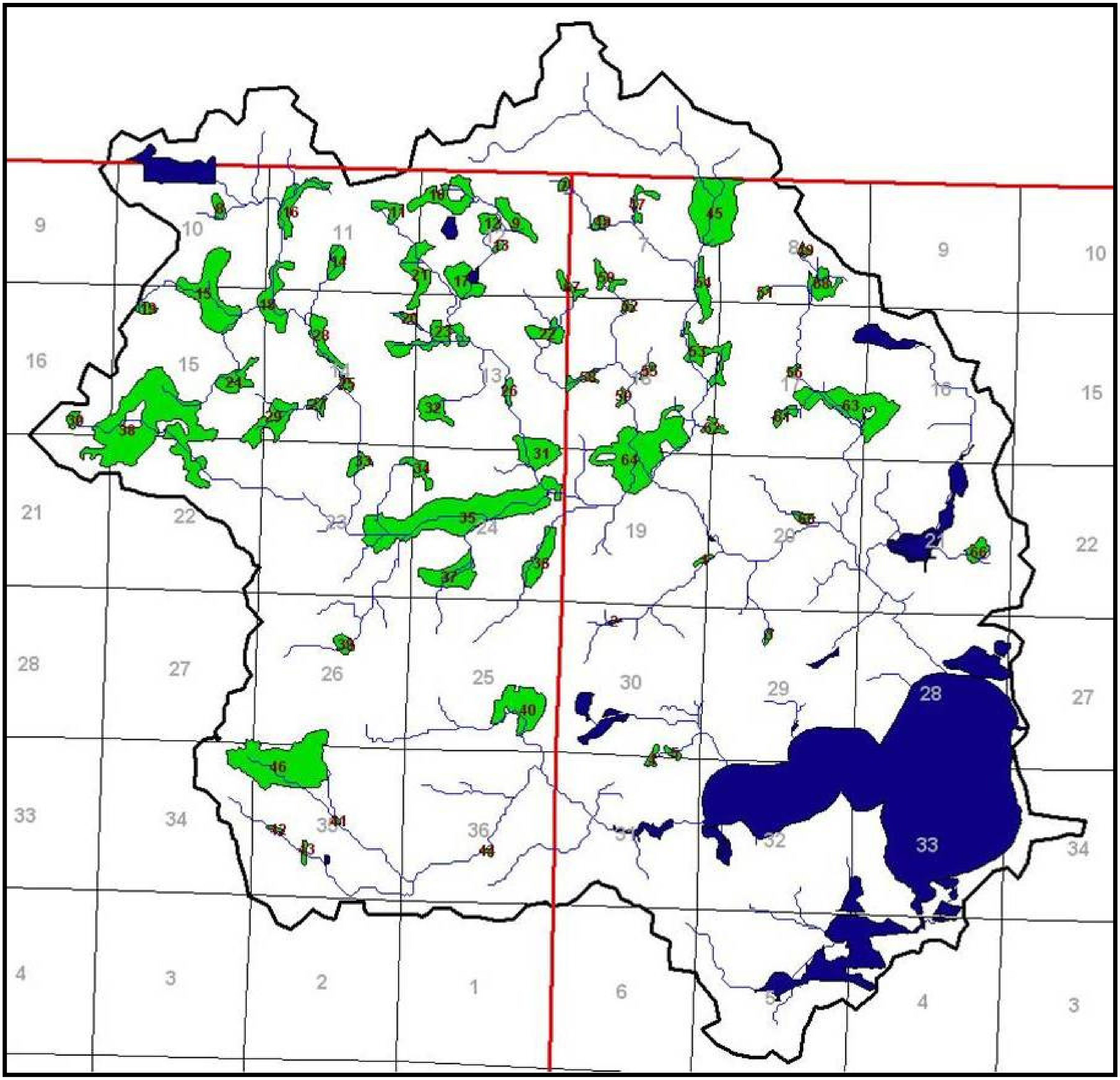


Figure 12.1: Restorable wetlands (green) in the Silver Lake Watershed, numbered by water quality priority.

Silver Lake Watershed Wetland Prioritization

Wetland ID Green = Dickinson Blue = Osceola	Flows into	Flows into	Flows into	Flows into	Flows into	Flows into	Flows into	Flows into	Water shed Area (acres)	Wetland Size (acres)	Watershed minus wetland (acres)	Watershed to Wetland Ratio	Watershed Ratio < 75:1	GIS/RUSLE Priority	R
64									8,430.4	99.8	8,330.6	83.5			
35	64								5,219.0	149.8	5,069.2	33.9	*	1	
33	35	64							2,115.6	9.4	2,106.2	225.2			
25	33	35	64						1,991.8	4.3	1,987.5	462.3			
28	25	33	35	64					1,682.7	17.8	1,664.9	93.8			
53	64								1,519.4	25.1	1,494.2	59.4	*	2	
54	53	64							1,425.3	15.8	1,409.5	89.2			
18	25	28	33	35	64				1,391.6	31.1	1,360.4	43.7	*	4	
31	35	64							1,255.4	29.4	1,226.0	41.8	*	5	
44									1,070.3	1.7	1,068.6	637.2			
26	31	35	64						1,070.0	5.4	1,064.6	198.1			
45	54	53	64						955.1	75.2	879.8	11.7	*	6	
23	26	31	35	64					840.5	30.1	810.4	26.9	*	10	
63									845.4	66.0	779.3	11.8	*	9	
16	18	28	25	33	35	64			678.0	24.2	653.9	27.1	*	8	
59	64								566.5	2.5	564.0	224.9			
15	18	28	25	33	35	64			554.3	64.8	489.4	7.5	*	11	
56	63								468.1	2.7	465.4	170.5			
40									493.6	44.9	448.7	10.0	*	19	
1									465.0	31.4	433.5	13.8	*	7	
41	44								396.9	1.6	395.4	252.0			
36	64								348.2	24.4	323.8	13.3	*	13	
58	59	64							328.0	7.4	320.6	43.3	*	14	
68	56	63							302.8	18.0	284.9	15.9	*	26	

43	44	0							283.3	3.1	280.2	90.7		
27	25	33	35	64					270.3	6.1	264.2	43.5	*	12
47	54	53	64						270.6	8.2	262.4	32.1	*	20
13	23	26	31	35	64				263.4	2.7	260.7	96.9		
24	15	18	28	25	33	35	64		264.4	18.6	245.8	13.2	*	15
12	13	23	26	31	35	64			226.7	10.1	216.6	21.4	*	27
48	47	54	53	64					209.0	5.3	203.7	38.4	*	25
37	35	64							226.4	32.4	194.1	6.0	*	17
22	58	59	64						192.2	15.1	177.1	11.7	*	21
66									183.0	9.8	173.2	17.6	*	28
39	35	64							174.7	8.0	166.7	20.9	*	35
29	27	25	33	35	64				192.1	30.2	161.9	5.4	*	18
24	23	26	31	35	64				264.4	18.6	245.8	13.2	*	15
42	43	44							156.5	2.0	154.5	75.8		
2	1								152.5	1.3	151.2	120.4		
65									135.7	4.8	130.9	27.3	*	23
38	35	64							305.5	178.1	127.3	0.7		
61	63								123.4	7.5	115.9	15.5	*	30
14	28	25	33	35	64				125.4	13.6	111.8	8.2	*	29
7	48	47	54	53	64				96.3	3.4	92.9	27.5	*	31
49	68	56	63						92.7	2.9	89.8	30.8	*	40
10	12	13	23	26	31	35	64		114.4	31.4	83.0	2.6	*	32
3									82.6	2.0	80.6	39.5	*	22
34	35	64							74.7	10.9	63.8	5.9	*	24
8	16	18	28	25	33	35	64		70.5	6.8	63.8	9.4	*	34
11	21	23	26	31	35	64			73.7	10.2	63.5	6.2	*	36
9	12	13	23	26	31	35	64		78.1	18.2	59.9	3.3	*	42
52									62.1	2.7	59.3	21.6	*	43
32	26	31	35	64					72.4	17.7	54.7	3.1	*	33

5									56.7	3.3	53.4	16.3	*	37	
53									1,519.4	25.1	1,494.2	59.4	*	2	
55	59	64							52.3	3.4	48.9	14.4	*	38	
19	15	18	28	25	33	35	64		42.1	5.8	36.4	6.3	*	47	
51	68	56	63						38.5	2.2	36.2	16.3	*	48	
30	38	35	64						40.7	5.0	35.7	7.2	*	39	
38	24	15	18	28	25	33	35	64	305.5	178.1	127.3	0.7			
50									41.4	10.4	31.0	3.0	*	46	
62	64								36.8	6.0	30.8	5.1	*	44	
4									34.3	4.0	30.2	7.5	*	41	
67	22	58	59	64					36.8	7.9	28.9	3.7	*	45	
46	41	44							131.8	105.4	26.5	0.3			
20	23	26	31	35	64				16.9	4.8	12.1	2.5	*	49	

Table 12.1: Prioritization and expected benefits of potential wetland restorations in the Silver Lake Watershed.

13. Technical & Financial

Technical Assistance

In order to achieve the goals established in this management plan, it will be necessary to utilize a variety of state and federal agencies, local groups, and other resource professionals. The project coordinator will be required to report project status to these groups on a regular basis, and to request their assistance as needed. Maintaining a healthy, working relationship with these groups will provide an additional measure of project success.

1. **Dickinson Soil & Water Conservation District (SWCD)**
    - Commissioner Board
    - Clean Water Alliance Coordinator
2. **Osceola Soil & Water Conservation District (SWCD)**
    - Commissioner Board
3. **United States Department of Agriculture (USDA)**
    - Natural Resources Conservation Service (NRCS)
        - State Office
            - Public Affairs Specialist
        - Sioux City (Area 1) Office
            - Resource Conservationist
            - Soil Scientist
            - Program Specialist
            - Easement Specialist
            - Engineer(s)
        - Spirit Lake (Dickinson) Field Office
            - District Conservationist
            - Resource Conservationist
            - Soil Conservation Technician
            - Office space & equipment
            - Vehicle & field equipment
        - Sibley (Osceola) Field Office
            - District Conservationist
            - Resource Conservationist

- Farm Service Agency (FSA)
    - Conservation Reserve Program (CRP) Technician
        - Spirit Lake/Sibley Field Offices

4. Iowa Department of Ag & Land Stewardship (IDALS)

- Division of Soil Conservation (DSC)
    - Watershed Protection Program (Water Resource Bureau)
        - Regional Basin Coordinator
    - Soil Conservation Committee
    - Watershed Improvement Review Board (WIRB)
    - Field office staff
        - Technician
        - Urban Conservationist
        - Secretary

5. United States Environmental Protection Agency (EPA)

- Region 7
    - Watershed Planning & Implementation Branch

6. Iowa Department of Natural Resources (IDNR)

- Watershed Improvement Program
    - Basin Coordinator
    - Grant Coordinator
    - Project Officer
    - TMDL Staff
    - GIS Technician
- Lakes Restoration Program
- Fisheries Bureau (Spirit Lake Field Office)
    - Fisheries Biologist
- Wildlife Bureau (Spirit Lake Field Office)
    - Wildlife Biologist
    - Private Lands Biologist

7. Technical Advisory Committee (TAC)

- Local resource professionals

8. Silver Lake Park Improvement Association (SLPIA)

- Board members

9. Pheasants Forever

- Regional Representative (western Iowa)

- Local chapter leaders
- Farm Bill Biologists

10. Ducks Unlimited

- Local chapter leaders
- Engineers

11. Iowa Soybean Association (ISA)

- Watershed Protection Program
    - State Watershed Coordinator

12. Dickinson County Conservation Board

- Director
- Naturalist

13. Osceola County Conservation Board

- Director

Financial Inventory
The following tables provide a financial summary for the first 10 years of the Silver Lake Watershed Project.

Years 1-2

BMP	Units	319/WSPF Expenditures	Total Expenditures
Staff	-	$83,350	$94,700
Information/Education	-	$1,500	$4,000
Supplies	-	$1,350	$2,000
Travel & Training	-	$2,250	$2,500
CRP Incentive	25 ac	$1,250	$2,900
Shoreline Restoration	1000 ft	$4,500	$11,300
Grassed Waterways	500 ft	$510	$1,751
Sediment Basins	4	$1,160	$4,000
No /Ridge/ Strip Till Incentive	200 ac	$1,062	$14,062
Wetland Restoration	200 ac	0	$4,390,400
Rock Tile Intakes	20	$2,000	$4,000
Urban BMP's	10	0	$20,000

Years 3-4

BMP	Units	319/WSPF Expenditures	Total Expenditures
Staff	-	$92,200	$94,700
Information/Education	-	$2,000	$4,000
Supplies	-	$1,500	$2,000
Travel & Training	-	$1,500	$2,000
CRP Incentive	25 ac	$1,250	$2,900
Shoreline Restoration	1000 ft	$4,500	$11,300
Grassed Waterways	500 ft	$510	$1,751
Sediment Basins	5	$1,450	$5,000
No /Ridge/ Strip Till Incentive	150 ac	$796	$10,546
Wetland Restoration	50 ac	0	$1,097,600
Rock Tile Intakes	15	$1,500	$3,000
Urban BMP's	10	0	$20,000

Years 5-6

BMP	Units	319/WSPF Expenditures	Total Expenditures
Staff	-	$92,200	$94,700
Information/Education	-	$2,000	$4,000
Supplies	-	$1,500	$2,000
Travel & Training	-	$1,500	$2,000
CRP Incentive	25 ac	$1,250	$2,900
Shoreline Restoration	1000 ft	$4,500	$11,300
Grassed Waterways	500	$510	$1,751
Sediment Basins	5	$1,450	$5,000
No /Ridge/ Strip Till Incentive	600 ac	$3,186	$42,186
Rock Tile Intakes	50	$5,000	$10,000
Rough fish Removal	150,000 lb	0	$10,000
Fish Barriers	2	0	$40,000

Years 7-8

BMP	Units	319/WSPF Expenditures	Total Expenditures
Staff	-	$47,350	$94,700
Information/Education	-	$2,000	$4,000
Supplies	-	$1,500	$2,000
Travel & Training	-	$1,500	$2,000
CRP Incentive	25 ac	$1,250	$2,900
Shoreline Restoration	1000 ft	$4,500	$11,300
Grassed Waterways	750	$765	$2,626
Sediment Basins	6	$1,740	$6,000
No /Ridge/ Strip Till Incentive	500 ac	$2,655	$35,155
Rock Tile Intakes	15	$1,500	$3,000
Rough fish Removal	100,000 lb	0	$10,000

Years 9-10

BMP	Units	319/WSPF Expenditures	Total Expenditures
Staff		$47,350	$94,700
Information/Education		$2,000	$4,000
Supplies		$1,500	$2,000
Travel & Training		$1,500	$2,000
CRP Incentive	25 ac	$1,250	$2,900
Shoreline Restoration	1000 ft	$4,500	$11,300
Grassed Waterways	750	$765	$2,626
Sediment Basins	5	$1,450	$5,000
No /Ridge/ Strip Till Incentive	300 ac	$1,592	$21,092
Rock Tile Intakes	15	$1,500	$3,000
Rough fish Removal	50,000 lb	0	$10,000

Tables 13.1-13.5: Scheduled BMP units & TP load reductions for years 1-10.

Project Composite: ***Financial Expenditures***

BMP	Units	319/WSPF Expenditures	Other Expenses	Total Expenses
Staff	-	$362,450	$111,050	$473,500
Information/Education	-	$9,500	$10,500	$20,000
Supplies	-	$7,350	$2,650	$10,000
Travel & Training	-	$8,250	$2,250	$10,500
CRP Incentive	125 ac	$6,250	$356,250	$362,500
Shoreline Restoration	5,000 ft	$22,500	$34,000	$56,500
Grassed Waterways	3,000 ft	$3,065	$7,442	$10,507
Sediment Basins	25	$7,250	$17,750	$25,000
No /Ridge/ Strip Till Incentive	1,750 ac	$9,300	$113,750	$123,050
Wetland Restoration	250 ac	0	$5,488,000	$5,488,000
Rock Tile Intakes	115	$11,500	$11,500	$23,000
Urban BMP's	20	0	$40,000	$40,000
Rough fish Removal	300,000 lb	0	$30,000	$30,000
Fish Barriers	2	0	$40,000	$40,000
	Total Costs:	**$447,415**	**$6,265,142**	**$6,712,557**

Table 13.6: Scheduled BMP units & composite expenditures.

14. Measurable Milestones

In order to gauge the progress of the watershed project, we will use the following milestones as checkpoints following each 2-year period of the project. These checkpoints mimic the project goals for BMP implementation established in Tables 9.4-9.8.

BMP	Year 2	Year 4	Year 6	Year 8	Year 10	Project Composite
CRP Incentive	25 ac	25 ac	25 ac	25 ac	25	125 ac
Shoreline Restoration	1000 ft	1000 ft	1000 ft	1000 ft	1000 ft	5,000 ft
Grassed Waterways	500 ft	500 ft	500 ft	750 ft	750 ft	3,000 ft
Sediment Basins	4	5	5	6	5	25
No /Ridge/ Strip Till Incentive	200 ac	150 ac	600 ac	500 ac	300 ac	1,750 ac
Wetland Restoration*	200 ac	50 ac	-	-	-	250 ac
Rock Tile Intakes	20	15	50	15	15	115
Urban BMP's	10	10	-	-	-	20
Rough fish Removal*	-	-	150,000 lb	100,000 lb	50,000 lb	300,000 lb
Fish Barriers	-	-	2	-	-	2

Table 14.1: Measurable milestones for BMP implementation, project years 1-10.

Water Quality Goals (Watershed)

Project status will be evaluated regularly to encourage consistent progress, and determine if project objectives are being met. Watershed monitoring data will be used to evaluate the success of the Silver Lake Watershed Project by estimating annual load reductions of sediment and phosphorus.

Below is a table outlining water quality milestones in the Silver Lake Watershed we expect to see as a direct result of conservation practices installed as part of the project. Continued watershed monitoring will be necessary in order to gauge the aggregate impact of the project.

In order to gauge the success of practice implementation during the project, we will evaluate load reductions observed via monitoring every 3 years. By evaluating this data during 3-year intervals, we hope to minimize the natural error typically associated with a water monitoring data set.

Due to a significant wetland restoration component during the first 3 years of the project, we expect to achieve the largest load reduction following this period. We expect this reduction will be approximately **40% (2,708 lbs P),** of the **total TP load reduction goal (6,770 lbs P)** derived from watershed BMP's.

Because wetland restorations will be replaced by smaller-scale practices throughout the remainder of the project, it would follow that watershed load reductions in years 4-10 will become smaller as time progresses.

Project Year(s)	TP Load Reduction (% of watershed total)	Observed TP Load Reduction (lbs)
1-3	40	2,708
3-6	25	1,692
6-9	25	1,692
10	10	678
Total:	***100***	***6,770***

Table 14.2: Project goals for TP load reductions in the watershed.

Water Quality Goals (In-lake)

The TMDL written for Silver Lake established in-lake water quality goals that should be attainable using a combination of practice implementation in the watershed, as well as aggressive fisheries management and shoreline restoration in Silver Lake itself. By maintaining an active in-lake monitoring program, we will be able to observe the realized water quality benefits in Silver Lake as the project progresses.

Three key indicators of in-lake water quality (Secchi depth, chlorophyll-a, and total phosphorus) will be evaluated at 3-year intervals throughout the project, and again following Year 10. Mean values during these intervals will be matched against mean values from 2001-2011, which have not yet been tabulated.

Following is a table highlighting in-lake improvements that we expect to see at each project interval. Although many watershed BMP's will have been installed by Year 3, we do not expect to see a marked in-lake response at that point. More significant improvements will be realized following project years 6, 9, and 10. These observations will reflect upon the positive impacts achieved through large-scale removal of rough fish during project years 5 & 6.

In-lake Water Quality Improvements by Project Checkpoint							
Parameter	**1999-2011 Median**	**Year 3 Gain**	**Year 6 Gain**	**Year 9 Gain**	**Year 10 Gain**	**Total Gain**	**Target Median**
Secchi Depth (m)	0.68	5%	15%	15%	10%	45%	0.95
Chlorophyll-a (ug/L)	44	5%	5%	10%	5%	20%	34
Total Phosphorus (ug/L)	120	5%	15%	15%	10%	45%	66

Table 14.3: In-lake improvements through Project Year 10.

15. Extended Watershed Monitoring

Going forward, we plan to utilize four different water monitoring components in order to create a complete picture of water quality progress in the Silver Lake Watershed, as well as the lake itself. These four components include baseline monitoring, event-based monitoring, implementation performance monitoring, and in-lake monitoring. These four components, and the role of each in current and future monitoring efforts, are further explained below.

Monitoring Component #1**:* ***Baseline Monitoring

- Conducted twice per month during growing season.
- 7-8 sites monitored, more added as needed.
- Build upon baseline monitoring that has already been conducted.
- Conducted before, during, and after project implementation.
- Continue through length of the project, and a minimum of 2 years after.
- Sampling efforts led by project coordinator.
- Additional data obtained from IOWATER volunteer program.
- Water samples submitted for testing at Iowa Lakeside Laboratory.
- Samples analyzed for suspended solids, phosphorus, nitrate/nitrite, E. coli bacteria, pH, water temperature, and turbidity.

Monitoring Component #2**:* ***Event-based Monitoring

- Install ISCO samplers at critical watershed sites.
    - Focus on points of concentrated flow downstream of key sub-basins along Ash Island Drainage Ditch, as well as the mouth of Trapper's Bay.
    - Intercept data from significant runoff events, regardless of timing.
    - Funded thru EPA 319.
- Provide valuable data to be compared with baseline monitoring data.
    - Demonstrate a unique snapshot of sediment & nutrient loading.
    - May show loading variation between low and high stream flows.
- Project coordinator will monitor additional sites of interest not covered by ISCO samplers.
    - South Bay inlet, West Bay inlet, outlet, and sampling locations along Ash Island Drainage Ditch not monitored by ISCO samplers.
    - Utilize turbidity and other cost-effective parameters.

- Samples taken following storm events exceeding 1 inch of rainfall.

***Monitoring Component #3*: Implementation Performance Monitoring**

- Monitor downstream of BMP's implemented as part of watershed project.
  - Focus on more significant practices such as wetland restorations and sediment basins/waterways implemented in a series.
  - Limit performance monitoring to 1 or 2 practices in each RMA.
  - Compare baseline data from before and after implementation.
  - Use ISCO samplers where applicable.
    - Collect data from large rainfall/runoff events.
- Observe changes in load reductions from specific BMP's.
  - Monitor benefits of individual BMP's versus BMP's implemented in series.
- Several years of monitoring may be necessary to observe a trend in post-implementation performance.
- Plot observed load reductions (monitoring) versus expected load reductions (TMDL/watershed management plan).

Monitoring	# of Sites	Samples per Year	Per Unit Cost	Event Cost	Annual Cost
Baseline	7	11	$72	$504	$5,544
Practice Performance	3	11	$72	$216	$2,376
				Total:	$7,920

Table 15.1: Locally funded watershed monitoring expenses.

16. Future Funding Sources

Despite our initial efforts, many years of work may be needed to protect the Silver Lake Watershed. We are confident that our initial efforts will evoke cooperation and assistance from a variety of local organizations, as well as state and federal agencies. Following is a list of funding sources, technical assistance providers, and partners that we hope to involve in the Silver Lake Watershed Project. Many of these sources have already contributed to the project in some way, and most have promised additional assistance moving forward.

Funding Sources (Grant and Program)

1. **Iowa Department of Ag & Land Stewardship (IDALS)**
    - WSPF/WPF Program
    - Watershed Improvement Review Board (WIRB) grant funding
    - Conservation Reserve Enhancement Program (CREP)
    - Division of Soil Conservation (DSC)
        - State cost-share
            - Grassed waterways, sediment basins, terraces, farmstead windbreaks
2. **Environmental Protection Agency (EPA)**
    - Section 319 Program
3. **State of Iowa**
    - Resource Enhancement and Protection (REAP) Program
4. **United States Department of Agriculture (USDA)**
    - Wetland Reserve Program (WRP)
    - Conservation Reserve Program (CRP)
        - General Sign-up
            - Highly erodible acres
        - Continuous Sign-up practices
            - Wetland restorations/buffers, filter strips, riparian buffers, contour buffers, grassed waterways, field windbreaks
    - Environmental Quality Incentives Program (EQIP)
    - Wildlife Habitat Incentives Program (WHIP)
5. **Dickinson County, Iowa**
    - Water Quality Commission (WQC)
        - Water quality grants
    - County Conservation Board (CCB)
6. **Iowa Department of Natural Resources (IDNR)**
    - Lakes Restoration Program
    - Land acquisition
7. **Iowa Natural Heritage Foundation (INHF)**
    - Land acquisition
8. **Dickinson Soil & Water Conservation District (SWCD)**

9. Osceola Soil & Water Conservation District (SWCD)

10. Silver Lake Park Improvement Association (SLPIA)

- Water Monitoring
- Information & education

11. Pheasants Forever

- 4 local chapters
  - Monetary donations
  - Native seed/shrub donations

12. Iowa Soybean Association (ISA)

- "Soybean Check-off" funding

13. Osceola County, Iowa

- Sportsman's Club
- County Conservation Board (CCB)

14. Silver Lake Sportsman's Club

- Monetary donations

15. Ducks Unlimited

- Monetary donations

16. Local Residents/Businesses

- Private donations

17. References

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