Introduction

Description of the Study Area

The Watonwan River Major Watershed is one of the twelve major watersheds of the Minnesota River Basin. It is located in south central Minnesota within Blue Earth, Brown, Cottonwood, Jackson, Martin, and Watonwan counties (Figure 1). Predominate land use within the watershed is agriculture including cultivation and feedlot operations. Urban land use areas include the cities of Madelia, St. James, Mountain Lake and other smaller communities.

The Watonwan River Major Watershed area is a region of gently rolling ground moraine, with a total area of approximately 878 square miles or 561,620 acres. The watershed is subdivided using topography and drainage features into 59 minor watersheds ranging in size from 2,014 acres to 41,138 acres with a mean size of approximately 9,519 acres. The Watonwan River Major Watershed drainage network is defined by the Watonwan River and its major tributaries: the South Fork of the Watonwan River, the North Fork of the Watonwan River, St. James Creek, and Perch Creek. Other smaller streams, public and private drainage systems, lakes, and wetlands complete the drainage network. The lakes and other wetlands within the Watonwan River Watershed comprise about 1% of the watershed. The total length of the stream network is 1,074 miles, of which 685 miles are intermittent streams and 389 miles are perennial streams. A total of 368 miles of named streams exist within the Watonwan River Watershed. Of the 368 miles of named streams, 311 miles are perennial and 57 miles are intermittent. Table 1 reports the named streams of the Watonwan River Major Watershed showing tributaries indented[1].

Table 1. Named Streams and Stream Miles Within the Watonwan River Major Watershed.

Stream Name	Total Perennial Miles	Total Intermittent Miles	Total Stream Miles
Watonwan River	103.0	10.2	113.2
St. James Creek	20.1	6.8	26.9
Butterfield Creek	20.8	4.3	25.1
Perch Creek	37.3	0.0	37.3
Mink Creek	9.5	1.8	11.3
Spring Branch Creek	4.0	14.1	18.1
Elm Creek	2.4	0.0	2.4
South Fork of Watonwan River	69.9	2.7	72.6
Willow Creek	8.6	5.8	14.4
Spring Brook	0.0	7.3	7.3
North Fork of Watonwan River	35.2	4.1	39.3
Totals	310.8	57.1	367.9

The mainstem of the Watonwan River flows west to east toward its confluence with the Blue Earth River near Garden City, approximately one mile south of the Rapidan Reservoir in Blue Earth County and 16.3 river miles upstream from the confluence of the Blue Earth and the Minnesota Rivers. As the mainstem of the Blue Earth River flows north-northeast from its confluence with the Watonwan River, it is joined by the Le Sueur River, another major tributary, approximately 3.3 river miles from its confluence with the Minnesota River. The drainage network and watersheds of the Watonwan, Blue Earth and Le Sueur Rivers define a sub-basin of the Minnesota River Basin referred to as the Greater Blue Earth River Watershed. Figure 1 illustrates the relative locations of the Watonwan, Blue Earth, and Le Sueur Rivers.

Figure 1. Watonwan River Major Watershed.

Historical Summary of Research Related to the Watonwan River Watershed

The Watonwan River is a tributary to the Minnesota River. The Minnesota River has been studied extensively during the past fifteen years. The Phase I Diagnostic Study, which began in 1996, is the most recent study of the Watonwan River and its' tributaries within a watershed context. This study was not the beginning of watershed research in this region. Previously, many studies and projects have contributed to the collection of data and knowledge. The focus of this summary is to review a few of the historical milestones related to watershed management in the Watonwan River Watershed.

Since the 1930's, there has been an increased interest in land conservation practices with the assistance of local, state and federal conservation groups. The passage of the Water Pollution Control Act in 1948 has dramatically controlled point source discharges from industrial and wastewater treatment plants. Into the 1960's, with the growth of the environmental movement, surface water and ground water were targeted areas of pollution.

The Corps of Engineers initiated "The Upper Mississippi River Comprehensive Basin Study", in response to a resolution adopted in 1962 by the Committee on Public Works of the United States Senate[2]. Approval of the "Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources," was an important federal statement. These policies and standards were utilized to investigate, create and recommend a structure for future resource planning at the basin level. The Upper Mississippi River Comprehensive Basin Study gave a brief summary of problem areas and ranked them accordingly. A summary of the results can be found in Appendix V.

The region was subdivided to identify areas with significant needs and problems according to time period. The time periods were divided into the following: short-range (to 1980), intermediate-range (1981 to 2000), and long-range (2001 to 2020). The Upper Mississippi River Comprehensive Basin Study ranked the Minnesota River Basin as a priority area for investigating the problems and needs of water and land resources in the short-range time period. The Upper Minnesota River ranked eighth, and the Lower Minnesota River ranked tenth out of nineteen areas[2]. The Lower Minnesota River includes the Blue Earth River Subbasin (currently referred to as the Greater Blue Earth River Watershed, which is comprised of the Blue Earth, Le Sueur, and Watonwan Rivers). The needs and problems identified included: water supply; water quality; flood and sediment damage; commercial navigation; recreational opportunity; and environmental preservation[2]. These items were then incorporated into priority action items.

In 1970, the United States Department of Agriculture (USDA) approved a request made by the Minnesota State Soil and Water Conservation Commission to study rivers in the Southern Minnesota River Basin[3] (Appendix W). Participating agencies included the Soil Conservation Service, United States Forest Service, and the United States Economic Research Service. These agencies were to complete an inventory collecting and interpreting data, information, and results in the Blue Earth River Subbasin.

In 1971, the Minnesota State Legislature established the Southern Minnesota Rivers Basin Commission[3]. The commission utilized information from local citizens, local, state, and federal agencies to investigate and survey watersheds in the Blue Earth River Subbasin to create an Inventory Report. These coordination efforts were the initial advances towards the development of a comprehensive plan for environmental conservation regarding land and water resources. The Phase I Study included an inventory of natural resources and identification of problems and needs. The Phase II Study involved a detailed investigation for the development of strategies, analysis of strategies and the recommendation of feasible solutions.

In January 1972, the above agencies prepared the Inventory Report of the Greater Blue Earth River Basin. A summary of the water and land resource problems identified in the inventory included[3]:

1. Flood damage to agricultural crops on approximately 28,000 acres of land.
2. Drainage improvements would benefit 600,000 acres of agricultural cropland.
3. Reduced soil fertility due to erosion and sedimentation. Roadside, streambank, and lake shore erosion cause sedimentation problems.
4. Continuous study is needed to determine actual and potential effects of pollution on the quality of resources, natural and man made. Accelerated pollution of many subbasin lakes and streams.
5. Water supply shortages were not apparent in the basin. Further study is needed to define future water needs in the basin.
6. Approximately 30,000 acres of agricultural land were characteristically dry.
7. Deterioration of the natural environment. Environmental planning involves everyone.

Selected priority areas for Watershed Investigation Reports and Watershed Evaluation Reports in the Blue Earth River Subbasin are located in Table 2, which included the South Fork of the Watonwan River and Butterfield Creek.

Table 2. Selected Priority Areas for Watershed Investigation Reports and Watershed Evaluation Reports in the Greater Blue Earth River Basin in 1971[3].

Priority Group I	Priority Group II
South Fork of the Watonwan River Watershed	Butterfield Creek Watershed
Maple River Watershed	Elm Creek Watershed
Dutch Creek Watershed	East Fork of the Blue Earth River
Cobb and Little Cobb Watersheds	
Union Slough Watershed	

In June 1972, the Upper Mississippi River Basin Coordinating Committee submitted the completed Upper Mississippi River Comprehensive Basin Study to the United States Water Resources Council[4]. The study provided a structure for the development and management of water and related land resources in the Upper Mississippi River Basin. A summary of the water and land resource problems identified in the Greater Blue Earth River Basin was included in the Minnesota River Basin section. The proposal suggested the development of a regional or river basin plan, coordinated by a river basin commission or other federal-state interagency organization. The focus was to concentrate on needs and desires within the next 10-15 years, following the guidelines established by the Water Resources Council.

The Southern Minnesota River Basin Commission in 1977 submitted the Minnesota River Basin Report (Appendix X). The Minnesota River Basin Report was to be used by the state of Minnesota to[4]:

1. Help formulate the Minnesota River Basin portion of the State Land and Water Resource Plan.
2. Assist the USDA in making the most effective use of the Land and Water Conservation Development Program.
3. Serve as a guide in coordinating water and related land resource development programs and projects of local, state, and federal agencies, and private groups and individuals.
4. Aid in setting priorities for water resources development within the Minnesota River Basin.

Local County Water Planning efforts were initiated in 1985. The purpose of such a plan was to provide a guide for individuals and groups to follow who are involved in water planning. The third generation of local water plans is under revision for most counties. Watershed management will be incorporated into these plans.

In 1985, a Waste Load Allocation (WLA) study was completed on the lower 25 miles of the Minnesota River. This WLA called for a 40 percent reduction in Biochemical Oxygen Demanding (BOD) material in the Minnesota River. A reduction in BOD has been linked to phosphorus. Subsequently, a phosphorus reduction strategy has been proposed for the Minnesota River Basin.

The Minnesota River Assessment Project (MRAP) began in 1989, which involved more than 30 local, state, and federal government agencies. The study was a comprehensive biological, chemical, and physical watershed assessment of the Minnesota River Basin. Flow monitoring data and water quality data were collected on the mainstem of the Minnesota River including its main tributaries. Table 3 indicates the water quality data collected on the Watonwan River Watershed near its outlet at Garden City (Site 22)[5].

Table 3. MRAP Results Indicating the Average Concentrations and Approximate Ranges of Select Water Quality Parameters for the Watonwan River Watershed at Garden City.

Parameter	Average	Approximate Range
Total Suspended Sediment Concentration	100 mg/l	0 to 500 mg/l
Total Phosphorus Concentration	0.65 mg/l	0.3 to 1.6 mg/l
Nitrite-Nitrate Nitrogen Concentration	11 mg/l	0 to 20 mg/l
BOD	3.5mg/l	1.5 to 7 mg/l

The Greater Blue Earth River Watershed has a large impact on the Minnesota River, which contributes to the pollution of the Mississippi River. The results of this study indicated that the Blue Earth River contributes 46% of the flow to the Minnesota River at Mankato, while delivering 55% of the suspended sediment load, and 69% of the nitrate-nitrogen load[6]. Sediment yields from the Blue Earth River Watershed were three to four times higher compared to the yields upstream at the confluence of the Blue Earth River from 1990 to 1992[6]. The nitrate concentrations in the Blue Earth River and its major tributaries frequently exceeded the Federal Drinking Standard of 10mg/l, with peak concentrations exceeding 20mg/l[6]. The fecal coliform bacteria results exceeded the standard in 32% of the samples collected from the Blue Earth River. Total phosphorous concentrations were highly elevated (200-500ug/l) during runoff periods resulting in the load deliveries of up to 15 tons/day to the Minnesota River[6]. Seventy-four percent of the samples exceeded 100ug/l in total phosphorous and 30% of the samples exceeded 100 ug/l in dissolved ortho-phosphorous[6]. A more detailed section of the results is located in Appendix Y.

The study concluded that in order to attain a 40% reduction in BOD levels in the Minnesota River, an aggressive broad-based implementation program would be needed. The major areas of pollution to be addressed were identified as the following: bacterial contamination, sedimentation, nutrient enrichment, toxic substances, and watershed hydrologic alterations. MRAP made general recommendations on each of these pollutant areas and a final report was published in 1994.

The 40% biochemical oxygen demanding substance (BOD) and total suspended solids (TSS) reduction goals for the Minnesota River will be partitioned between each of the Minnesota River tributaries. A reduction goal for the Watonwan River will be refined through this modeling process, but until that time, the 40% reduction goal is an appropriate target.

MRAP also called for the measurement and ranking of the most significant sources of pollution according to each sub watershed for implementation activities. These monitoring results indicate that the Watonwan's average nitrate concentration is the third highest in the Minnesota River Basin. This Watonwan Phase I Clean Water Partnership study was designed based on MRAP and other previous studies.

The Minnesota River Basin Water Quality Overview reports data from 1968 to 1994 by various federal and state agencies that collected water quality monitoring data to provide a comprehensive framework to understand watersheds with the largest regional effects (Appendix Z). Sampling locations were located mostly at the mouth of major tributaries near the point where they enter the Minnesota River. Results indicated that the Watonwan River Watershed contributed 4.3% of the sediment, 5.4% of the phosphorous, and 11.7% of the nitrates in the Minnesota River Basin[7].

Currently, the entire Minnesota River is in the process of being modeled using the Hydrologic Simulation Program - FORTRAN (HSPF) model, by the Minnesota Pollution Control Agency. HSPF is a watershed delivery/instream-processing model. The purpose for running HSPF is to partition the 40% reduction in BOD called for by the Waste Load Allocation (WLA) on the lower Minnesota River. Once completed, the model will be used in developing load reduction to target levels for each major tributary. The sampling sub watersheds for this Watonwan project were sited to correspond with the watershed partitioning used in the HSPF modeling.

It is obvious that there has been a considerable amount of assessment, research and implementation in the region since the 1930's. However, the approach to watershed management in the past utilized the top-down approach, which has proven itself unsuccessful. The perspective of today's approach to watershed management is from the bottom-up, generating local interest and ownership within the watershed. Local citizens have been engaging in these activities for a number of years. The Minnesota River Citizens Advisory Committee was formed in 1992 to provide local input from a diverse group of citizens about the Minnesota River. In 1999, the Watonwan River Watershed, formerly the Watonwan WILL (Watershed Implementation from the Local Level) Committee was formed to specifically target efforts within a smaller geographical area. In addition, the re-organization, communication, and flexibility of local, state and federal agencies and government in watershed management will contribute, establish and maintain the necessary technical support for the citizens. Continuous efforts involving local citizens, local, state, and federal governments and agencies will advance watershed management.

Summary of Information for the Watonwan River Watershed

Introduction

The Minnesota River and its tributaries are waters of concern for the state of Minnesota. The Minnesota River currently does not meet federal water quality standards and is a major source of pollution to the Mississippi River. The overriding public policy goal of the state of Minnesota, enunciated by former Governor Arne Carlson in September of 1992, is to restore the Minnesota River to fishable and swimmable conditions in 10 years (2002).

Local development throughout the Watonwan River Watershed places a high priority on water quality issues. County Comprehensive Local Water Plans have indicated that area residents rank water quality as a top priority for their local communities. County water issues in the Watonwan River Major Watershed are ranked by priority. The ranking of each County's water issues is included in the summaries of the County Comprehensive Local Water Plan Goals and Objectives (Appendix C).

Water Resources Integrity

"We need to see the rivers in their entirety."[8] Watersheds are dynamic, continually changing towards a relatively stable equilibrium. This balance may be interrupted by natural or unnatural conditions. Watershed management requires careful, flexible planning and implementation to fit the physical, chemical and biological characteristics of the waters of concern. The environmental movement has placed a demand on "ecosystem management" to be an integral component of natural resources management in urban and rural settings. Ecosystem management provides an appropriate link between the natural unit of the hydrosphere, the watershed, and the need for environmentally sensitive management of the nation's land and water resources.[9]

Population

Throughout recent years rural Minnesota has been impacted by emigration. According to the 1990 Census, the total population of the Watonwan River Watershed is 19,375. Table 4 indicates an estimate by decade of the population in the Watonwan River Watershed from 1940 to 1990 (United States Census Bureau). Over the past fifty years, the population of the Watonwan River Watershed has fluctuated (Table 5). A percent change of the population in the Watonwan River Watershed was also calculated. From 1950 to 1960 the population increased slightly, however, from 1960 to 1990 the population has continued to decrease. Overall, the watershed has experienced a decline in population with an aging population. A detailed description of the cities and townships within the Watonwan River Watershed is located within each sub watershed description. Population data are located in Appendix F.

Table 4. Total Estimated Population from 1940-1990 in the Watonwan River Watershed, Including Cities and Townships.

Year	Population
1940	24,588
1950	23,880
1960	24,356
1970	22,092
1980	21,037
1990	19,375

Table 5. Estimated Percent Change in Population Within the Watonwan River Watershed by Decade.

Time Frame	Percent Change
1940-1950	-2.88
1950-1960	+1.99
1960-1970	-9.30
1970-1980	-4.78
1980-1990	-7.90

Urban Economics

Improving water quality in the Watonwan River Watershed is associated with urban economics and improving the quality of life. An increase in local commitment towards improved water quality can attract and enhance local businesses and development for residents and nonresidents throughout the area. Local residents may be more inclined to spend their time and resources in their local urban sector versus traveling outside their home area. However, there is an increased aging population, located in smaller rural communities within the Watonwan River Watershed. This aging population survives on fixed incomes, making changes such as septic upgrades an economic challenge. In addition, the economics of this region is tied closely to sustainable agriculture, companies and communities relying on the agricultural sector. An overall collection of local efforts can enhance the development and sense of pride and ownership linked to regional economics and environmental quality in the Watonwan River Watershed.

Agricultural Economics[10]

The natural resources and climate in south central Minnesota is favorable for crop production. Corn and soybeans make up the majority of agricultural crops, generating the highest average yields in the state. The relatively flat landscape is conducive to large farms. Therefore, farmers in the area have been able to take advantage of modern machinery and weed control methods to substantially increase the acreage farmed, spreading fixed assets over more bushels produced, resulting in lower unit costs of production. Recent advances in planting equipment with high residue tolerance, especially drills compared to 30 inch rows, offer a 10-15% yield boost for soybeans. Also, new weed control technologies have made it possible to plant soybeans in high residue without sacrificing yield. However, it is still common to fall-till soybean stubble intended for corn, which greatly increases erosion potential.

Farmers are succeeding in reducing unit cost of production, which helps to maintain net income in a period of sustained low prices caused by global competition. Farmers have little or no influence on the market price of their output. It is by reducing prices that they can achieve higher net income. Corn and soybean production provides the base of which the regional economy is devoted to converting these basic foodstuffs into higher value products. This includes feed mills, corn/soy processing and the livestock and meat processing industry.

Poultry and hogs are the predominant types of livestock in this region. Poultry has become fully industrialized, and vertically integrated with producers tied to feed manufacturers and/or meat processors by specific contracts at a large scale. The hog sector is rapidly going the same way, with more vertical integration among feed suppliers, producers, and meat packers. This is resulting in a more uniform and regular supply of hogs and poultry to the processor, and production efficiencies throughout the marketing chain resulting from better coordination and economies of scale. Recently, prices for hogs have plummeted, and recovered somewhat, which may be due to the new industrial structure where production is less responsive to market price signals because more is marketed through contracts instead of through open market.

Agriculture impacts the environment in a number of ways. First, farms with larger equipment increase soil compaction, often using deep tillage to break up compaction, potentially increasing erosion. Second, large livestock operations concentrate the production of manure, and odors. However, they also have a greater capability to use modern technology to design runoff controls, and test and apply manure. Third, food processors can be the main sources of point source phosphorous in the basin. Phosphorous management plans and/or pretreatment will be required to meet phosphorous goals for the basin.

The greatest challenge is to develop and implement pollutant-reduction best management practices (BMPs) that are consistent with the global environment in which agriculture competes. Natural resource use can be efficiently enhanced, according to the University of Minnesota recommendations. Pollutant loads generated at the primary and secondary (crop and livestock) stages of agricultural production can be reduced. Pollution prevention and improved industrial resource utilization at the tertiary stage (food processing) can also be developed.

Indications are that agriculture will continue to develop from a mass commodity industry driven by production economics to a producer of differentiated products in a demand-driven sector. Biotechnology will result in the ability to customize crops such as corn and soybeans for specific end-uses. Retailers will demand such products, and the food industry will respond. Groups of farmers, as individuals or co-op members will produce to specifications, receiving a price premium for the quality of their product.

Biotechnology is also likely to enable producers worldwide to produce food more efficiently in challenging environments, therefore, export markets for traditional commodities may gradually be depleted as more countries become self-sufficient in basic foodstuffs. This would keep a lid on prices, including land prices. The niche markets will generate some opportunities for farm production that can capture higher prices. However, improving technology will reduce overseas demand for basic foodstuffs. As a result, different types of foods are substitutes for each other, so competition will put an upper bound on premium available to farmers.

Agricultural Drainage

When the first settlers arrived, much of the Watonwan River Watershed was covered with water year-round, in the form of small, shallow, weedy lakes called sloughs or potholes. The land in this condition was unsatisfactory for fishing, aesthetic purposes, and cultivation. These lakes and sloughs were useful in water retention, which helps to prevent flooding, but many of these areas have been drained with only a few of the larger lakes remaining. Rich, easily cultivated soil needs warmth, moisture and an ample growing season to produce first-class farm crops. Overall, farmland drainage can improve farm profits, aid local economies and increase property tax bases[11]. Fortunately, well-coordinated climatic conditions make this possible and help to justify the characterization of the Watonwan River Watershed as one of the most fortuitously endowed agricultural regions of the world.

Drainage maintenance throughout the Watonwan River Watershed has been costly. A collection of drainage information for each county within the Watonwan River Watershed is located in the County Water Plans (Appendix C). The collection of drainage maintenance data, including cost and frequency of repairs is critical within the watershed to determine priority sites and utilize alternative methods to prevent future problems. Advances in tiling technology have allowed landowners to improve existing installations (tiling at closer distances) and drain new lands at an accelerating pace[11]. In some cases, these new installations are overwhelming the capacity of existing ditch systems to handle the flow of water during peak periods.

The political environment of drainage varies throughout the watershed. The local County Commissioners have different views on what to do with existing systems. Now that some drainage systems are approaching an age of 70 to 100 years, they are not functioning efficiently due to the design or system exhaustion. Some decision makers believe that water storage to the landscape is important both for the environment and the functioning of the existing drainage system. Others believe our deteriorating tile should be replaced and even increased in capacity. Surface tile intakes present another problem. These intakes can provide relatively direct conduits for the movement of sediment and other pollutants into surface waters. Amendments to existing laws could allow alternative drainage systems to develop thereby helping drainage and environmental protection become more compatible in the Watonwan River Watershed.

Public Drainage

There are a total of 749 miles of public drainage ditch systems in the Watonwan River Watershed. Of this total, 101 miles are open ditches and 648 miles are public tile. Public drainage is augmented by extensive private tiling, which contributes to the increased movement of water throughout the watershed.

Table 6. Public Drainage in the Watonwan River Watershed.

Sub Watershed	Stream Name	Miles Public Open Ditch	Miles Public Ditch Tile	Total Miles Public Ditch System
WP1	Watonwan River	29	72	101
WS1	Watonwan River	3	47	50
WT1	Perch Creek	8	95	103
WT2	South Fork Watonwan River	9	105	115
WT3	Judicial Ditch 13	22	108	130
WT4	St. James Creek	6	69	74
WT5	Watonwan River	5	87	92
WT6	Tributary to South Fork Watonwan River	10	42	52
Unsampled Area		9	23	32
Total		101	648	749

Crop Residue Survey Results

Crop Residue Management is an effective approach to reduce and prevent erosion. Crop residue from the previous year protects soil from the impact of raindrops and allows the soil to capture water thus reducing and preventing runoff. Each county conducts a crop residue survey in the spring to estimate the percentage of corn planted into greater than 15% residue and soybeans planted into greater than 30% residue. The results are used to determine the percent of cropland meeting the residue targets. Table 7 indicates crop residue survey results for the counties located in the Watonwan River Watershed from 1995-1999 from the transect survey results collected by the Soil and Water Conservation Districts and analyzed by the Board of Water and Soil Resources (BWSR)[12].

According to Table 7, Blue Earth County has decreased notably in the percentage of cropland meeting residue targets in the past few years, with the lowest value of all counties within the Watonwan River Watershed. Brown and Watonwan Counties crop residue survey results have remained fairly constant, slightly fluctuating over the past five years. Cottonwood, Jackson, and Martin Counties have shown fluctuating increases in the percentage of cropland meeting the target residue. A summary table of all participating counties in the crop residue survey is located in Appendix AA.

Table 7. Crop Residue Survey Results for the Counties Located in the Watonwan River Watershed from 1995-1999.

County	1995 % of Cropland Meeting Residue Targets	1996 % of Cropland Meeting Residue Targets	1997 % of Cropland Meeting Residue Targets	1998 % of Cropland Meeting Residue Targets	1999 % of Cropland Meeting Residue Targets
Blue Earth	41	59	51	11	6
Brown	17	26	33	23	17
Cottonwood	59	67	73	62	70
Jackson	21	38	61	57	66
Martin	56	66	78	63	76
Watonwan	40	46	NA	38	29

Fertilizer and Pesticide Use

The use of chemicals by the agricultural and urban sector can affect surface water and groundwater from the runoff that occurs. The 1999 Minnesota Agricultural Statistics published by the U.S. Department of Agriculture contains data related to fertilizer and pesticide use for corn and soybeans, which are the major crops in the Watonwan River Watershed[13]. A summary of this information is located in Appendix BB.

The following results reflect fertilizer and pesticide use for corn. In Minnesota, 96% of the cropland had nitrogen applied. Nitrogen was applied at 125 pounds per acre. Phosphate was applied to 91% of the cropland, which was applied at 52 pounds per acre.

The following results reflect pesticide use for corn. Herbicides were applied to 97% of the cropland throughout the state of Minnesota, and insecticides were applied to 10% of the land. Dicamba and Atrazine were two of the most common types of herbicides applied to the land. Dicamba was applied at a rate of 0.37 pounds per year, and Atrazine was applied at 0.65 pounds per year.

The following results reflect fertilizer use for soybeans. In Minnesota, 18% of the cropland had nitrogen applied. Nitrogen was applied at 23 pounds per acre. Phosphate was applied to 17% of the cropland at 33 pounds per acre.

The following results reflect pesticide use for soybeans. Herbicides were applied to 97% of the cropland throughout the state of Minnesota, and insecticides were negligible. Glyphosate, Imazamox, Imazethapyr, Pendimethalin, and Trifluralin were the most common types of herbicides applied at 0.960, 0.030, 0.030, 1.230, and 0.880 pounds per year, respectively.

Streambank Erosion/ Stream Blockades

Additional monitoring is needed to quantify streambank erosion in order for the counties within the Watonwan River Watershed to develop a streambank erosion control program to correct existing problems and prevent future complications. An inventory of river blockades throughout the Watonwan River Watershed is needed for the removal and relocation of selected blockades to control streambank erosion. These monitoring results, along with additional water quality parameters, can provide direction and a focus of efforts to address critical water quality issues in the Watonwan River Watershed.

Stream Use Classification

The Minnesota Pollution Control Agency (MPCA), Water Quality Division classifies the waters of the state to designate appropriate water uses[14]. Specific stream classifications in the Watonwan River Watershed are shown in Table 8. Virtually all other creeks, streams, and rivers in the watershed are classified for all uses except domestic consumption. The following is a listing of the classification of the waters by use:

Class 1	Domestic Consumption
Class 2	Aquatic Life and Recreation
Class 3	Industrial Consumption
Class 4	Agriculture and Wildlife
Class 5	Aesthetic Enjoyment and Navigation
Class 6	Other Uses
Class 7	Limited Resource Value

Table 8. Stream Use Classification in the Watonwan River Watershed.

Stream Name	Location	Classification
Butterfield Creek	T106N, 107, R31, 32, 33	2C
County Ditch No. 63, Hanska	T108, R30, S11, 12, 14, 17, 18, 19, 20, 21, 22, 23, 27, 28	7
Judicial Ditch No 6, Hanska	T107, R30, S4, T108, R30, S28, S33	7
Judical Ditch 10, Hanska	T108, R30, S1 T109, R30, S35, 36	7
Mink Creek	T104N, R30, 31	2C
Perch Creek	T104, 105, 106, R29, 30	2C
St. James Creek (excluding Class 7 segment)	T105, 106, R31, 32, 33	2C
St. James Creek, St. James	T106, R31, S5, 7, 8, 18 T107, R31, S21, 22, 28,32, 33	7
Spring Branch Creek	T106, R29, 30	2C
Unnamed Ditch, Truman	T104, R30, S2, 11 T105, R30, S25, 26, 35	7
Unnamed Ditch, Lewisville	T105, R30, S3 T106, R30, S14, S23, 26, 34, 35	2C
Willow Creek	T104, 105, R31, 32	2C

Protected Flow

According to the Minnesota Department of Natural Resources, the Watonwan River does not have an established "interim" protected flow. The 1983 flow of 14 cfs (cubic feet per second) is used. However, at the mouth of the Watonwan River on the Blue Earth River, located between Garden City and Rapidan in Blue Earth County, the Watonwan's average discharge is 30 cubic feet per second.

Shoreland Classification and Protected Waters

The Shoreland Management Zoning Classification of lakes are based on current DNR approved shoreland ordinances.

Natural Environment – This classification is intended for those waters needing a significant amount of protection because of their unique natural characteristics or their unsuitability for development and sustained recreational use. They are usually shallower lakes, with marginal soil that can be eroded easily. They are also assigned the more restrictive development standards.

Recreational Environment – This classification is intended for those waters that are larger in size than natural environment lakes, but still need protection. Development can occur on these lakes, but special considerations have to be used to help achieve minimal impact for the lake.

General Development – This classification is intended for those bodies of water which are at the present highly developed or which, due to their location, may be needed for high density development in the future. The lakes are able to withstand high levels of activity because of the type of soil or other features inherent to the lake. These lakes are assigned the least restrictive development standards.

The Protected Water Inventory (PWI) Classification include:

P – Protected (Public-Water)
W – Protected (Public Waters) Wetland
N – Not Protected Water or Wetland
A – Protected Water or Wetland in Adjacent County; not protected in the indicated County
R – Renumbered; water has been assigned a legal Protected Waters Inventory number different from historic Bulletin 25 identification number.

Lakes

There are a total of 36 named lakes in the watershed covering approximately 7,219 acres. There are also 19 unnamed lakes, which cover approximately 499 acres. Lake location can benefit the water quality of down gradient streams within a watershed by providing a sink for nutrients and sediment. However, lakes need to be protected from excessive pollutants as well. Information pertaining to the lakes in the Watonwan River Watershed is located in Table 9.

Table 9. County, Acres, Shoreland Class and PWI Class for Lakes in the Watonwan River Watershed.

Name	County	Acres	Shoreland Class	PWI Class
Arnolds Lake	Cottonwood	46.42	Natural Environment	P
Bartsh Lake	Cottonwood	63.64	Natural Environment	P
Bat Lake	Cottonwood	138.41	Natural Environment	P
Bergdahl Lake	Watonwan	96.21	Natural Environment	P
Bingham Lake	Cottonwood	270.42	General Development	P
Bullhead Lake	Watonwan	80.38	Natural Environment	W
Butterfield Lake	Watonwan	54.87	Natural Environment	P
Case Lake	Watonwan	36.99	Natural Environment	W
Cottonwood Lake	Watonwan	95.35	Natural Environment	P
Curry Slough	Watonwan	21.70	Natural Environment	W
Eagle Lake	Cottonwood	105.08	Natural Environment	P
Emerson Lake	Watonwan	399.78	Not in shoreland program	N
Ewy Lake	Watonwan	82.80	Natural Environment	W
Fedje Lake	Watonwan	187.11	Natural Environment	P
Fish Lake	Jackson	411.32	Recreational Development	P
Irish Lake	Watonwan	169.86	Natural Environment	P
Kansas Lake	Watonwan	392.88	Recreational Development	P
Lake Hanska	Brown	1,827.47	SL Mgt. Waters-Brown Co.	P
Linden Lake	Brown	271.13	SL Mgt. Waters-Brown Co.	P
Long Lake	Cottonwood	101.05	Natural Environment	P
Long Lake	Watonwan	260.88	Recreational Development	P
Maiden Lake	Cottonwood	29.96	Natural Environment	W
Mary Lake	Watonwan	124.68	Natural Environment	P
Mountain Lake	Cottonwood	236.69	Recreational Development	P
Mud Lake	Watonwan	42.55	Natural Environment	P
Mulligan Marsh	Watonwan	9.62	Multiple	P
Nelson Lake	Watonwan	27.05	Not in shoreland program	N
Parso Lake	Cottonwood	113.87	Natural Environment	P
Perch Lake	Martin	172.81	Natural Environment	P
Round Lake	Martin	42.37	Natural Environment	P
School Lake	Watonwan	136.06	Natural Environment	P
St. James Lake	Watonwan	244.47	Recreational Development	P
Sulem Lake	Watonwan	185.14	Natural Environment	P
Swan Lake	Cottonwood	13.30	Natural Environment	P
Wilson Lake	Watonwan	118.04	Natural Environment	W
Wood Lake	Watonwan	608.31	Multiple	P
Total Acres		7218.67		

Fishery Surveys

The Watonwan River was once noted for good smallmouth bass fishing. Although the Minnesota Department of Natural Resources (MN DNR) does not have survey data to show the decline of this popular species, it has been noted by anglers. Currently the only major gamefish species that maintain naturally reproducing populations in the Watonwan River are channel catfish and northern pike. Walleye fry are stocked in the river, however, they will only produce a successful year class on occasion.

Factors contributing to the demise of the smallmouth bass and the difficulty of other gamefish species are the flashy nature of the stream system, and heavy silt loads in the spring. The Rapidan Dam also prevents any upstream migration from the Minnesota River's diverse fish community.

The MN DNR has conducted four stream surveys on the mainstem of the Watonwan River. The initial survey was conducted in 1980-1981, with resurveys following in 1984, 1989, and 1999. These surveys show a steady decline in the smallmouth bass population. Copies of the standard reports are available from the Waterville Fisheries Station. The methodology used for stream surveys is contained in the publication titled, "Minnesota Stream Survey Manual (1978)." The purpose of this summary is to acknowledge the fisheries resource in the Watonwan River, and to help all that are involved to improve fishing opportunities for the public. A summary of the fishery surveys is located in Appendix I.

Utilizing data from the Stream Surveys conducted by the Minnesota Department of Natural Resources (MDNR), additional characteristics of the mainstem of the Watonwan River can be analyzed. These characteristics are located in Table 10.

Table 10. Physical Characteristics of the Mainstem of the Watonwan River According to Stream Surveys.

Station Number	River Miles	Width (from Mouth)	Depth (feet)	Sinuosity (feet)	Gradient (ft./mile)	Bank Height Range (feet)
1	7.6	96	1.5	1.3	3.9	12 – 20
2	13.2	79	2.3			7 – 10
3	18.1	54	1.4			6 – 15
4	29.3	96	3.9	1.8	2.6	5 – 80
5	36.8	42	1.6			5 – 12
6	66.4	13	0.5	2.0	6.5	6 – 15
7	81.6	8.6	1.0			6 – 10
8	93.2	9.9	ND			5 – 10

The Minnesota Department of Natural Resources conducted Stream Surveys from 1980-1981.

The Stream Management Plan defines the mainstem of the Watonwan River according to type, fish species management, ecological classification, goals, and operational plans for stream miles 0-60. The following items are abstracted directly from the stream management plan:

Stream Type:	Warm Water
Ecological Classification:	II-C,B,D
Species Managed:	Walleye, Channel Catfish, Northern Pike
Stocking Plan:	700,000 Walleye fry every odd year

The long-range goals of the mainstem of the Watonwan River for fish management are to, "Maintain a quality stream fishery for channel catfish and provide an additional fishery for walleye." The specific goal for walleye is, "greater than 10 fish/hour of electrofishing with at least 3 year classes represented." The operational plan of the MDNR includes walleye fry stocking, population assessments every 5 years, and cooperation with watershed improvement efforts.

The MN DNR staff conducted an initial survey on the mainstem of the Watonwan River in 1980-1981 for inventory and fish management. Data collected from eight stations included: type and number of fish, physical stream characteristics, and general land use information. A stream reach of about 600 to 1,000 feet was assessed at each station. Fish were sampled using trap-nets or electroshocking equipment. The type and abundance of common invertebrates was assessed. Select water quality data were also collected from sites 1,4,7 and 8 in September of 1981.

The following stream reaches have been utilized for stream management purposes: 0-29.3 miles, 29.3-41.0 miles and 41.0-99.3 miles. The middle reach has experienced moderate channel changes. Table 11 shows channelization in the following areas, with a total of 6.6 channelized miles, which may not represent the entire length of the channelized reaches.

Table 11. Channelized Reaches on the Mainstem of the Watonwan River.

Mainstem Stream Reach	Miles Channelized
43.8 - 44.0	0.2
48.0 - 48.7	0.7
50.0 - 51.0	1.0
52.0 - 52.7	0.7
53.0 - 53.7	0.7
59.5 - 53.7	0.8
61.1 - 61.8	0.7
68.0 - 68.5	0.5
80.9 - 81.5	0.6
85.0 - 85.7	0.7

Table 12 indicates the data collected from the MN DNR’s Initial Fish Survey Data on the mainstem of the Watonwan River conducted in 1980-1981. Dominance was assessed by the number and biomass of the fish species present, and does not represent a more detailed method for assessing fish community dominance.

Table 12. Minnesota Department of Natural Resources (MN DNR) Initial Watonwan River Fishery Survey, Select Information.

Station	River Miles (from mouth)	Dominant Fish Present
1	7.6	Carp, Bullhead, White Sucker
2	13.2	Silver Redhorse, Northern Redhorse, Walleye
3	18.1	Redhorse species, Northern Hogsucker
4	29.3	Carp, Quillback, Bigmouth Buffalo
5	36.8	Black Bullhead, White Sucker
6	66.4	White Sucker, Creek Chub, Fathead Minnow
7	81.6	Creek Club
8	93.2	Northern Pike, Creek Chub

An attempt was made to re-establish smallmouth bass in the Watonwan River. Yearling sizes were stocked in 1961. In all other years, fingerlings were stocked (1962,63, 74, 77-79, and 81). However, no smallmouth bass were recovered during this survey. Special efforts were taken to assess smallmouth bass at Garden City, but none were recovered. It was noted that although the Blue Earth River has a strong channel catfish population, none were observed in the Watonwan River. Most fishing on the Watonwan River occurs in late spring and fall. The reach from Madelia downstream (River miles 0-29.3) is fished the heaviest. Good catches of walleyes (up to 3 pounds) and northern pike (up to 6 pounds) can be acquired. Light fishing pressure is reported from Madelia to La Salle. The upper portions of the river favor forage and rough fish, with some northern pike. Lastly, an ammonia spill in November 1981 caused a large fish kill in the lower reaches of the Watonwan River.

A resurvey was conducted in October of 1984. Fishery characteristics were assessed at two sites at Garden City, as well as 6 upstream sites. The upstream stations (7 and 8) were not sampled due to extremely low water conditions. The boom shocker was not used due to these conditions. Trap nets, hoop nets, and a backpack shocker were used for this resurvey.

Comparisons from 1981 to 1984 include the following: Silver Redhorse, Quillback Carpsucker, and Central Stonerollers were taken in 1984, but were not taken in 1981. Interviews with anglers indicate that fishing has declined since 1981. In 1984, the following species were sampled for the first time: Black Crappie, White Crappie, Channel Catfish, Tadpole Madtom, Green Sunfish, Spotfin Shiner, and Iowa Darter. Gamefish sampled included thirteen channel catfish, five white crappie, three northern pike, and one walleye.

In 1982, the MN DNR planted 26 smallmouth bass in the Watonwan River. No smallmouth bass were recovered in 1984. There were no reports of any smallmouth bass caught. In 1983, 1 million walleye fry were stocked. There were reports of walleyes in Kansas Lake, a tributary to St. James Creek, which may have come from the 1983 fry stocking.

The resurvey in June through August of 1989 confirmed that the Watonwan River's fish population is dominated by non-gamefish species (redhorse, suckers, bullheads, carp, and minnow species) previously observed in 1981 and 1984. Eight stations were assessed in 1989 by MDNR Fisheries staff. Water temperatures observed on July 21, 1989 ranged from a minimum of 69 to a maximum of 89 degrees Fahrenheit. This resurvey included a detailed description of aquatic plant species such as spikerush, arrowhead, and softstem bulrush that were present. Also, a detailed taxonomic listing of common invertebrates was included in the 1989 report. A DC backpack, boom or stream shocker was used for fish sampling; no trap nets or hoop nets were used. Two 500-foot stream reaches were sampled at Garden City. These two reaches have a "braided rapids" section, and both channels were shocked.

The number of game species sampled included the following at all stations: Channel Catfish (4), Northern Pike (13), Green Sunfish (13), Walleye (5), and Yellow Perch (7). All of the channel catfish recovered were at the lower four stations. It is believed that these findings are due to migration from the Blue Earth River, which has a good channel catfish population. There is no change in the smallmouth bass population from the earlier surveys. There were no recoveries of walleyes from the 1983 stocking. The authors of the 1989 report are uncertain if a fishable walleye population can be maintained. More small fish were sampled in 1989 than 1984 or 1982. This is probably due to the fact that small fish are more apt to be caught by electrofishing, than by nets with mesh sizes from 3/8 to ¾ inch.

Species that were first observed in 1984, but absent in 1989 include the following: Black Crappie, White Crappie, Freshwater Drum, Highfin Carpsucker, and Iowa Darter. Species that were sampled for the first time in 1989 include the following: Spottail Shiner, Blacknose Dace, Brook Stickleback, and Slenderhead Darter.

Heavy fishing pressure was reported just below the dam at Lake Hanska. Generally, fishing has been poor, and is probably related to the low water conditions during 1989. MDNR staff summarizes that smallmouth bass management in the Watonwan River has been unsuccessful. They attribute this tentatively to "…low flows and pollution." Pertaining to walleyes, staff suggests a similar management practice of stocking, as was conducted in the upper Blue Earth River in 1989.

In September of 1999, a MN DNR fish survey crew conducted a fish population assessment on the mainstem of the Watonwan River to evaluate the fish community. This assessment was done to provide data for better stream management. The 8 stations were duplicated from the previous surveys, except station 31 was located 3.8 miles upstream from the mouth. Stations 2-4 were sampled utilizing a boom shocker. At all other sites, a backpack shocker was used.

This assessment showed no real change in the composition of the fish community in the mainstem of the Watonwan River. Carp were dominant at 4 of the 8 sampling stations. Redhorse species, as well as suckers and bullheads, dominated most stations. At station #1 near Garden City, 30 yearling channel catfish and 1 adult were recovered. Only 4 other channel catfish were sampled (from station 4 downstream only). Other gamefish recovered during this assessment include 15 Walleye (Stations 2-7), 5 Northern Pike (Stations 3,6,8), and 20 Yellow Perch (Stations 2,6,7,8). The Yellow Perch species was mostly sampled at either station 7 or 8. Station 7 is near the outlet of Mountain Lake. Mountain Lake was reclaimed in October of 1988, and stocked with perch and largemouth bass.

Fisheries staff believes that Lake Hanska contributes a significant amount of walleye to the Watonwan River. Current management for Lake Hanska includes walleye stocking (1.7 million fry) 3 out of 4 years. Since Lake Hanska watershed is large compared to the lake surface area (17.5:1), the outlet is often overflowing. Fishing at the outlet is reported to be good between May and June of most years.

Recreation

There are recreational values related to improving the river systems in the Watonwan River Watershed. Communities are connected to the river systems through a variety of activities including: historic, cultural, scenic, wildlife management areas, boat and canoe accesses, camp sites, hiking and biking trails. The Minnesota River Comprehensive Recreational Guidance Document and Trail Corridor Concept Plan was developed for the state of Minnesota to serve as a tool for the people of the Minnesota River Basin to manage and enhance the quality and quantity of recreational opportunities in communities (Appendix G).

Many residents in the community are avid fishing enthusiasts connecting them to the rivers and lakes. However, many feel that there has been a decline in the quality of fishing. Therefore, restoration efforts throughout the Watonwan River Watershed can provide local people and many others with another recreational resource to be utilized, allowing for economic improvement throughout the watershed. The Minnesota Department of Natural Resources (MN DNR) has managed the Watonwan River as a fishery for walleye, catfish, and northern pike.

Other sources of recreation and value to the Watonwan River Major Watershed include wetland ecosystems and wildlife management areas that support a diversity of wildlife and provide additional economic benefits to the area. The Watonwan River Valley and riparian wetlands serve as an important wildlife corridor. Local residents, as well as those visiting, can enjoy the recreational opportunities that these sites offer. Active sportsmen’s groups within the watershed have the ability to contribute to the economic well being of the watershed by supporting these efforts.

Recreational Land Uses and Parks

There are a variety of recreational uses throughout the Watonwan River Watershed including fishing, swimming, picnicking, camping, canoeing, and hiking. The location of parks in Brown, Cottonwood, Martin, and Watonwan Counties enable local citizens and tourists to enjoy these resources in the communities and increase local revenue. Canoe routes are designated reaches used by the public. The recreational lands and parks are identified in Table 13.

Table 13. Recreational Land Uses and Parks in the Watonwan River Watershed.

Facility Name	County	Location	Acres	Resource Type
Public Access	Blue Earth	Watonwan River (3)		Water Access-Trailer
Lake Hanska County Park	Brown	T108N R31W S 28, S33, S34	140	Fishing, Swimming, Picnicking, Camping, Hiking
Public Access	Brown	Lake Hanska (3)		Water Access-Trailer
Mountain County Park	Cottonwood	T105N, R34W, S2	24	Picnicking, Hiking, Swimming
Mountain Lake Park	Cottonwood	T105N, R34W, S		Swimming, Picnicking, Hiking
Trail	Cottonwood			Walking Trail
Public Access	Cottonwood	Mountain Lake		Water Access-Carry In/Trailer
Public Access	Cottonwood	Bat Lake		Water Access-Carry In
Public Access	Cottonwood	Swan Lake		Water Access-Carry In
Public Access	Cottonwood	Fish Lake		Water Access-Trailer
Perch Lake County Park	Martin	T104N, R30W, S19	30	Fishing, Swimming, Camping Picnicking, Hiking
Eagles Nest County Park	Watonwan	T106N, R31W, S13, S14	80	Fishing, Picnicking, Canoeing, Hiking
Kansas Lake County Park	Watonwan	T105N, R32W, S5, S8	12	Fishing, Picnicking, Public Access
Tiell County Park	Watonwan	T105N, R31W, S23		Swimming, Picnicking
Watonwan Sportsman's County Park	Watonwan	T105N, R32W, S10	4	Fishing, Picnicking, Public Access
Tiell Park (St. James)	Watonwan	T105N, R31W, S23		Swimming, Picnicking
Public Access	Watonwan	Sulem Lake		Water Access-Carry In
Public Access	Watonwan	Butterfield Lake		Water Access-Carry In/Trailer
Public Access	Watonwan	Kansas Lake		Water Access-Trailer
Public Access	Watonwan	Long Lake		Water Access-Trailer
Public Access	Watonwan	St. James Lake		Water Access-Trailer
Public Access	Watonwan	Spring Branch Lake		Water Access-Carry In
Public Access	Watonwan	Watonwan River		Water Access-Carry In
Public Access	Watonwan	Fedji Lake		Water Access-Trailer

Wildlife Management Areas

There are 31 Wildlife Management Areas (WMAs) located in the watershed, covering approximately 4,245 acres (Table 14). These Wildlife Management Areas increase the amount of wildlife and recreation in the watershed, and in some cases have the potential to improve water quality. The asterisk (*) indicates a wildlife management area located in two different counties.

Table 14. Wildlife Management Areas Located in the Watonwan River Watershed.

County	Name	Township-Range-Section	Acres	Use
Brown	Emerson	T108N, R30W, S34, S35	118	Hunting/Hiking
Brown	Lake Hanska	T108N, R31W, S33	5	Hunting/Hiking
Brown	Wood Lake	T108N, R33W, S33, S34 T107N, R33W,S12 *(Watonwan)	260*	Fishing/Hunting/Hiking
Brown	Southeast Hanska	T108N, R32W, S29	124	
Brown	Northwest Hanska	T108N, R32W, S17	2	
Brown	Mulligan	T108N-, R33W, S34, S35, S36 T107N, R33W, S12 T107N, R32W, S6 *(Watonwan)	602*	Hunting/Hiking
Cottonwood	Banks		127	
Cottonwood	Bennett	T105N, R35W, S24 T105N, R34W, S19	348	Hunting/Hiking
Cottonwood	Delft		260	
Cottonwood	Little Swan		411	
Cottonwood	Carpenter			
Cottonwood	Mountain Lake	T106N, R34W, S30	87	Fishing/Hunting/Hiking
Cottonwood	Regehr	T105N, R34W,S1 T106N, R34W, S36	65	Hunting/Hiking
Martin	Perch Creek	T104N, R30W, S5,S6, S7, S18	498	Fishing/Hunting/Hiking
Martin	Willow Creek	T104N, R31W, S6	70	Fishing/Hunting/Hiking
Martin	Exceder	T104N, R31W, S20	99	Hunting/Hiking
Martin	Gleam	T104N, R31W, S16	28	Hunting/Hiking
Martin	Ambrust	T104N, R30W, S30	65	Hunting/Hiking
Watonwan	Wood Lake	T107N, R33W, S12	260*	Fishing/Hunting/Hiking
Watonwan	Voss	T107N, R32W, S21	40	Hunting/Hiking
Watonwan	Ewy Lake	T106N, R33W, S1	227	Hunting/Hiking
Watonwan	Bergdahl	T107N, R30W, S11	177	Hunting/Hiking
Watonwan	Wilson	T107N, R30W, S9		
Watonwan	Tierney	T106N, R30W, S11	56	Hunting/Hiking
Watonwan	Madelia	T106N, R30W, S19	159	Hunting/Hiking
Watonwan	Lewisville	T106N, R30W, S20	94	Fishing/Hunting/Hiking
Watonwan	Case	T106N, R30W, S12	33	Hunting/Hiking
Watonwan	Rosendale	T106N, R31W, 29	20	Hunting/Hiking
Watonwan	Turtle	T105N, 32W, S9	10	Hunting/Hiking
Watonwan	W.R. Taylor Memorial		159	
Watonwan	Watline		101	

Unique Features and Scenic Areas

The focus of the Minnesota Department of Natural Resources, Division of Ecological Services is to collect, analyze and deliver ecological information to the public, creating a better understanding and appreciation of unique ecosystems, and their importance for a sustainable quality of life. Information is collected into a database regarding rare resources and exotic species, to identify, locate, and manage those species.

The Watonwan River Watershed is primarily located in the Prairie Grassland Community. Dry Prairies, Dry Oak Savannas, Mesic Prairies, Wet Prairies, and Calcareous Seepage Fens are natural communities found in the watershed. Prior to European settlement, the prairie was dominated primarily by tall grass such as big bluestem, sparsely vegetated areas, and many wetlands. Along many of the stream floodplains there were forests of silver maple, elm, cottonwood, and willow. Typical animal species included the bison, elk, upland sandpiper and the sandhill crane. However, since European settlement, the original state of the ecosystem has been altered for agriculture and urbanization.

Historical Sites

There are a variety of official historical sites located throughout the watershed. The Minnesota River Comprehensive Guidance Document and Trail Corridor Concept Plan lists historical sites located in the Watonwan River Watershed. Table 15 indicates the official historical sites located in the Watonwan River Watershed. Locations of these sites can be found in Appendix G.

Table 15. Historical Sites in the Watonwan River Watershed.

County	Resource Type	Description
Brown	Museum	Sleepy EyeDepot Museum
Brown	Historic Site	Osmrud-Torgrimson Regiment Station
Brown	Fort Hill	Site of Ninth Minnesota Regiment Station
Brown	Historic Site	Indian Burial Grounds
Cottonwood	Historic Site	Heritage House
Cottonwood	History Center	Mountain Lake Historic Center
Watonwan	Historic Site	Younger Brothers
Watonwan	Historical Museum	Watonwan County Historical Society Museum
Watonwan	Historic Site	Fort Cox
Watonwan	Historic Buildings in St. James	1896 J.M.G. Price Residence
Watonwan	Historic Buildings in St. James	The Opera House
Watonwan	Historic Buildings in St. James	1914 Offerdahl Residence
Watonwan	Historic Buildings in St. James	1891 William and Mary Schoffman Residence
Watonwan	Historic Buildings in St. James	1883 Episcopal Church
Watonwan	Historic Buildings in St. James	1920 Railroad Depot
Watonwan	Historic Buildings in St. James	Watonwan County Courthouse
Watonwan	Historic Site	Site of Park Hotel
Watonwan	Historic Site	Godahl Store
Watonwan	Historic Site	Army Road
Watonwan	Historic Site	Camp Watonwan and Post Office
Watonwan	Historic Site	Rosendale Church
Watonwan	Historic Site	Ole Bosrud Incident
Watownan	Historic Site	Ashippun Post Office
Watonwan	Historic Site	First Brick Courthouse in Watonwan City
Watonwan	Citizenry of Madelia	

Human Health

The ecological integrity of the Watonwan River and its tributaries are directly connected to human health. There is a need to upgrade and continue monitoring feedlots; to upgrade and develop urban storm water management plans; to upgrade and monitor individual septic treatment systems; to upgrade unsewered communities; and to upgrade and monitor waste water treatment facilities and industries. Additional indicators of water quality to protect human health require involvement and awareness throughout the watershed. The development and maintenance of a consistent, current database of these continual efforts is important to the health of the rivers, which are connected to human health throughout the Watonwan River Watershed.

Point Source Discharges

There are six WasteWater Treatment Facilities (WWTF), three Water Treatment Plants (WTP), and three major industries in the Watonwan River Watershed. These point sources can have a direct impact on the receiving waters within the watershed, based on the millions of gallons per year (mgy) that they discharge. A description of treatment, flow and receiving waters is located in Table 16.

Table 16. Point Source Discharges Located in the Watonwan River Watershed.

Name	County	Pop.	Type	Treatment	Flow (mgy)	Receiving Water	Comments
Butterfield	Watonwan	570	WWTF	Stabilization Ponds	44.4	Butterfield Creek	Provides treatment for Butterfield Foods
Madelia	Watonwan	2233	WWTF	Activated Sludge	239	Watonwan River	Provides treatment of Tony Downs Foods
Mountain Lake	Cottonwood	1899	WWTF	Stabilization Ponds	56.8	Mountain Lake Creek	
Neuhof Hutterite Community	Cottonwood	150	WWTF	Stabilization Ponds	1.5	Ditch to S. Fork Watonwan River	
St. James	Watonwan	4440	WWTF	Activated Sludge	380	Watonwan River	Industries: Swift Eckrridge, Tony Downs Olson Industries, St. James Automotive, Cottonwood Co. Landfill Leachate
Truman	Martin	1288	WWTF	Activated Sludge	41.1	Perch Creek	
Lewisville	Watonwan	292	WTP	Filter Backwash	0.3	Ditch to Perch Creek	
Madelia	Watonwan	2233	WTP	Filter Backwash	0.78	Watonwan River	
Truman	Martin	1288	WTP	Filter Backwash	0.26	Perch Creek	
La Salle Foods	Watonwan		Industry	Noncontact Cooling Water	4.38	Watonwan River	Used to cool industrial processes
Olson Industries	Watonwan		Categorical Industry	Metals Pretreatment	0.52	St. James WWTF to Watonwan River	Industrial user of the St. James WWTF
St. James Auto.	Watonwan		Categorical Industry	Metals Pretreatment	2.66	St. James WWTF	Industrial user of the St. James WWTF

Unsewered Communities

There are 15 unsewered communities in the Watonwan River Watershed with failing Individual Septic Treatment Systems (ISTS). These failing systems pose a serious threat to the rivers in the watershed from the input of fecal coliform bacteria, phosphorous, and biological oxygen demanding substances. This is of particular importance since residents in the rural sector do not have centralized wastewater treatment systems and rely entirely on ISTS. Many of the cities and areas are directly connected to tile lines, streams, rivers and lakes. Table 17 identifies the population, location by county, flow and receiving waters.

Table 17. Unsewered Communities Located in the Watonwan River Watershed.

Name	County	Pop.	Type	Treatment	Flow (mgy)	Receiving Water	Comments
Bingham Lake	Cottonwood	154	Unsewered	Failing ISTS	3.08	Trib. S Fork Watonwan	Connecting to Windom
Darfur	Watonwan	152	Unsewered	Failing ISTS	2.7	Ditch to Watonwan	Planning WWTF
La Salle	Watonwan	94	Unsewered	Failing ISTS	1.88	Watonwan River	
Lewisville	Watonwan	292	Unsewered	Failing ISTS	5.84	Ditch to Perch Creek	
Odin	Watonwan	123	Unsewered	Failing ISTS	2.31	S. Fork Watonwan	
Ormsby	Watonwan	151	Unsewered	Failing ISTS	4.62	Ditch to Watonwan	
Delft	Cottonwood	25	Unsewered	Failing ISTS	0.0015	Swan Lake	Unincorporated Area
Fish Lake	Jackson	115	Unsewered	Failing ISTS	0.007	Fish Lake	Unincorporated Area
Garden City	Blue Earth	230	Unsewered	Failing ISTS	0.014	Watonwan River	Unincorporated Area
Godahl	Watonwan	60	Unsewered	Failing ISTS	0.0036	Ditch to Lake Hanska	Unincorporated Area
Grogan	Watonwan	35	Unsewered	Failing ISTS	0.0021	Trib. S. Fork Watonwan	Unincorporated Area
Long Lake	Watonwan	200	Unsewered	Failing ISTS	0.012	Long Lake	Unincorporated Area
Mountain Lake	Cottonwood	10	Unsewered	Failing ISTS	0.0006	Mountain Lake Creek	Unincorporated Area
South Branch	Watonwan	30	Unsewered	Failing ISTS	0.0018	Ditch S. Fork Watonwan	Unincorporated Area
Sveadhal	Watonwan	40	Unsewered	Failing ISTS	0.0024	Ditch to Watonwan	Unincorporated Area

Landfills/Dump Sites

The information pertaining to the landfill and dump sites in the Watonwan River Watershed are compiled from the 1980 Outstate Dump Inventory (ODI). The information has been updated when needed. The list includes municipal solid waste disposal facilities, industrial surface impoundments, and closed dump sites in outstate Minnesota. There are a total of 17 dump sites in the Watonwan River Watershed, over half (62.5%) are located in Watonwan County (see Table 18).

Table 18. Dump Sites Located in the Watonwan River Watershed.

Name	County	City	MPCA ID
Garden City Dump	Blue Earth	Garden City	MNOD10000112
Albin Township Dump	Brown	Albin Township	MNOD10000120
Delft Dump	Cottonwood	Delft	MNOD10000214
Mountain Lake Dump	Cottonwood	Mountain Lake	MNOD10000213
Mountain Lake Township Dump	Cottonwood	Mountain Lake Township	MNOD10000212
Ormsby Dump	Martin	Galena Township	MNOD10000656
Truman Dump	Martin	Truman	MNOD10000649
Adrian Dump	Watonwan	Darfur	MNOD10001304
Butterfield Dump	Watonwan	Butterfield	MNOD10001305
Darfur Dump	Watonwan	Darfur	MNOD10001306
Darfur Demolition Dump Site	Watonwan	Darfur	MNOD10001309
Lewisville Dump	Watonwan	Lewisville	MNOD10001302
Old Madelia Dump	Watonwan	Madelia	MNOD10001310
New Madelia Dump	Watonwan	Madelia	MNOD10001308
Odin Dump	Watonwan	Odin	MNOD10001303
Riverdale Dump	Watonwan	La Salle	MNOD10001307
St. James Dump	Watonwan	St. James	MNOD10001301

Solid Waste Sites

There are a total of three solid waste sites in the Watonwan River Watershed (Table 19). These facilities have permits to handle and dispose of solid wastes.

Table 19. Solid Waste Sites Located in the Watonwan River Watershed.

Name	County	City	MPCA ID
Prairieland Resource Recovery Composting	Martin	Truman	MNSW00000357
Curry Sanitation	Watonwan	St. James	MNSW00000507
Watonwan County Sanitary Landfill	Watonwan	St. James	MNSW00000081

Potential Superfund Site

The Madelia Tire Fire Site poses the only threat as a potential or actual hazardous waste site, which currently has the possibility to be added to the federal and state Superfund list in the Watonwan River Watershed. The information is derived from the U.S. Environmental Protection Agency's nationwide database. Additional information can be found in Table 20.

Table 20. Potential Superfund Site in the Watonwan River Watershed.

Name	County	City	MPCA ID
Madelia Tire Fire Site	Watonwan	Madelia	MND985766906

Industries Involved in the Voluntary Investigation Clean Up Program

Two industries listed in Table 21 are involved in a Voluntary Investigation Clean Up Program. Staff from the Minnesota Pollution Control Agency provides technical review of the investigation and any remedial activities, if necessary. The program has been successful with investigation and clean up. The investigation process may lead to no clean up in specific cases.

Table 21. Industries Involved in the Voluntary Investigation Clean Up Program.

Name	County	City	MPCA ID
St. James Automotive	Watonwan	St. James	MND087673851
Thermogas	Watonwan	St. James	MNPT00005850

Former CERCLIS Site

There is one site in the Watonwan River Watershed that have no further remedial action planned (Table 22). The St. James Sewage Sludge Disposal Site has been removed from the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS).

Table 22. Former CERCLIS Site in the Watonwan River Watershed.

Name	County	City	MPCA ID
St. James Sewage Sludge Disposal Site	Watonwan	St. James	MND981532864

Hazardous Waste Generator/Investigation Clean Up Site

Olson Engineering, listed in Table 23, is the only hazardous waste generator/investigation clean up site in the Watonwan River Watershed.

Table 23. Hazardous Waste Generator/Investigation Clean Up Site.

Name	County	City	EPA ID
Olson Engineering	Watonwan	St. James	MND064757065

History of the Project

The Blue Earth River Basin Implementation Framework is a diagnostic study of the Blue Earth River and Watonwan River Major Watersheds funded through Minnesota's Pollution Control Agency (MPCA) as a Phase I Clean Water Partnership. A concurrent study, the Le Sueur River Implementation Framework, is a diagnostic study of the Le Sueur River Major Watershed, also funded through the Clean Water Partnership program. These two projects are similar in structure and together comprise the study area of the Greater Blue Earth River Watershed. Both projects are sponsored by the South Central Minnesota County Comprehensive Water Planning Project (SCMCCWPP), a 13 county joint powers that has been in existence since 1987. The project representative, designated by SCMCCWPP resolution, is Dr. Henry Quade of Minnesota State University, Mankato, Water Resources Center (MSUWRC). Contributing sponsors of the Blue Earth River Basin Implementation Framework include Blue Earth, Brown, Cottonwood, Faribault, Freeborn, Jackson, Martin, and Watonwan counties (County Water Planners and Soil and Water Conservation Districts), the U.S. Geological Survey (USGS), the City of Mankato and MSUWRC. Hydrologic and water quality monitoring was conducted cooperatively by the USGS, MSUWRC, and county personnel. The Watonwan River Major Watershed portion of the diagnostic study includes Blue Earth, Brown, Cottonwood, Jackson, Martin, and Watonwan county personnel. The project workplan, *Blue Earth River Basin Implementation Framework Workplan*, was developed by MSUWRC and approved by the MPCA. The original time line for the project was 1996 – 1998. Due to the scale of this project, it was extended until 2000.

Following the completion of the sampling season, a watershed technical committee met periodically to review and recommend analysis procedures for the Watonwan River Watershed assessment. The Watonwan River Watershed Team, formerly WILL, includes a cross section of locals (watershed view) and agency (basin view) personnel, is the recipient of this report. The watershed team developed the implementation plan (goals and strategies) in response to the diagnostic study findings.

Purpose of the Project

Numerous water quality studies have been conducted in the Watonwan River Watershed, but none of this scale. The purpose of this project includes the following goals:

1. Characterize sediment, phosphorus, nitrogen and bacteria concentration and loading for the Watonwan River and selected tributaries during periods of base flow and storm event flow in order to identify priority areas.
2. Create a Geographic Information System (GIS) for the Watonwan River Watershed to provide spatial natural resources data for each sampling sub watershed. The GIS will a.) characterize the watershed through spatial analysis of the landscape, b.) provide a means of displaying data as maps to inform and educate the watershed team, agencies, organizations and citizens, c.) accommodate on-going analysis of the watershed through the comparison and correlation of past and present natural resource data to water quality data, and d.) serve as a tool for the continued planning and management of natural resources in the watershed.
3. Determine the relationship of the Watonwan River Watershed to the Greater Blue Earth River Watershed.
4. Determine the relationship of the Watonwan River Watershed to the Minnesota River.

The Minnesota River Assessment Project (MRAP) indicated that sediment is the major contributor of pollutant loading in the Minnesota River Basin and is related to flow, therefore, sediment is the parameter of analytical focus. The diagnostic report will be used to develop the goals and strategies of the Watonwan River Watershed Implementation Plan. The implementation plan contains water chemistry goals based on both local and basin (or statewide) scale interest. At the basin scale, mass loads of pollutants leaving the mouth of the Watonwan River are of primary concern. At the local scale, pollutant concentrations for a particular stretch of river may be more important. These goals will therefore be a partnership of bottom up (watershed view) and top down (basin view) with ownership by both resulting in compatible goals and strategies for the Watonwan River Watershed.

Project Milestones

A more detailed description of the project milestones for the Watonwan and Blue Earth River Watersheds is contained in the *Blue Earth River Implementation Framework Workplan*.

Work Plan Development	
Establish Resource Committee	5/95 to 12/95
Initial Draft Preparation	5/95 to 12/95
Review	12/95 to 3/96
Final Plan	2/96 to 12/96
Hydrologic Monitoring: Primary and Secondary Sites	
Activate Eight Monitoring Sites (Hydrology and Water Quality)	4/96 to 11/96
River Rating Curve Development	4/96 to 11/96
Final Hydrology Report	11/96 to 6/97
Water Quality Monitoring: Primary and Secondary Sites	
Sampling of Primary Sites	4/96 to 11/96
Sampling of Secondary Sites	4/96 to 11/96
Water Quality Analysis	4/96 to 12/96
Final Water Quality Report (Primary or Secondary)	12/96 to 6/97
Hydrologic Monitoring; Tertiary Sites	
Establish and Prepare Sites, Training	6/95 to 3/96
Establish Estimated Rating Curves	4/96 to 11/96
Volunteer Stage Height Reading	4/96 to 12/96
Volunteer Rain Gauge Reading	5/96 to 11/96
Report to MSU	12/96 to 6/97
Water Quality Monitoring: Tertiary Sites	
Training of County Personnel	6/95 to 4/96
Collecting of Samples and Delivery to MSU	4/96 to 11/96
Water Quality Analysis	4/96 to 12/96
Final Water Quality Report (Tertiary)	12/96 to 6/97
Watershed Assessment	
Develop Soils GIS Layer	5/95 to 6/97
Develop Point Source Outfall Layer	5/95 to 6/97
Develop Feedlot Layer	5/95 to 6/97
Obtain and Incorporate State Land-Use Layer	5/95 to 6/97
Develop Hydrologic Layer	6/97 to 8/97
Develop Water Quality Layer	6/97 to 8/97
Data Analysis	
GIS Analysis of Monitoring Site Watersheds	6/97 to 3/98
Development of Transport Curves for Primary and Secondary Sites	6/97 to 3/98
Determine Relationships of Hydrology and Transport Curves to Watershed	7/97 to 3/98
Run HSPF Models	6/97 to 3/98
Implementation Plan	
Diagnostic Report to Resource Committee	1/98 to 3/98
Identification of Priority Areas and Parameters	3/98 to 4/98
Recommendations of Priority Areas/Parameters	4/98 to 5/98
Recommendations Resource Needs and Existing Program Limitations	4/98 to 5/98
Fiscal Management	5/95 to 6/98

Project Budget

The total cost of the project for the Watonwan and Blue Earth River Watersheds was $728,921. Of this amount, $348,269 was funded by a Clean Water Partnership Grant, the remaining $380,652 was in-kind contributions from a variety of sponsors. A more detailed description of the project budget for the Watonwan and Blue Earth River Watersheds is located in the *Blue Earth River Implementation Framework Workplan*. The total project budget summary is outlined in Table 24.

Table 24. Project Budget for the Watonwan and Blue Earth River Watersheds.

Program Element	Cost	In-Kind	Cash
Work Plan Development	$ 22,913	$ 16,034	$ 6,879
Hydrologic Monitoring: Primary and Secondary Sites	$ 15,982	$ 8,430	$ 7,552
Water Quality Monitoring: Primary and Secondary Sites	$ 99,112	$ 35,259	$ 63,853
Hydrologic Monitoring: Tertiary Sites	$ 208,616	$ 163,918	$ 44,698
Water Quality Monitoring: Tertiary Sites	$ 55,721	$ 42,053	$ 13,668
Watershed Assessment	$ 151,463	$ 34,963	$ 116,500
Data Analysis	$ 132,797	$ 47,838	$ 84,959
Implementation Plan	$ 33,742	$ 23,582	$ 10,160
Fiscal Management	$ 8,575	$ 8,575	$ 0
Total	$ 728,921	$ 380,652	$ 348,269

Methods

Site Selection

A core group of county, state, and federal personnel met in 1995 to select sampling sites based on hydrologic divisions of the Watonwan, Blue Earth, and Le Sueur River Watersheds (the three major watersheds of the Greater Blue Earth River Watershed) in order to track the contributions from the various tributaries. The sampling sites were designated as primary sites (the mainstem of the river), secondary sites (main tributaries) or tertiary sites (smaller tributaries). The sampling sites selected for the Watonwan River Major Watershed in the following sub watersheds are described in Table 25, and shown in Figure 2.

Table 25. Sub Watershed Description, Stream Name, and Sampling Site Location.

Sub Watershed	Stream Name	Sampling Site Location
WP1	Watonwan River	County Road 13 above Garden City
WS1	Watonwan River	Township Road above South Fork Confluence
WT1	Perch Creek	County Road 31
WT2	South Fork Watonwan River	County Road 13
WT3	Judicial Ditch 13	Township Road
WT4	St. James Creek	Township Road
WT5	Watonwan River	Township Road
WT6	Tributary to South Fork Watonwan River	County Road 5

Figure 3 illustrates the hierarchical nature of the sampling sites and their sub watersheds indicating WP1 as the primary site for the Watonwan River. The mainstem of the Watonwan River at sampling site WP1 receives all flow and water quality contributions from the secondary sub watershed WS1 (Watonwan River), which includes St. James Creek (WT4), and the Watonwan River (WT5), and the remaining smaller tertiary sub watersheds. Sampling sub watersheds and area are shown in Table 26.

Table 26. Sampling Sites and Sub Watershed Area.

Sub Watershed	Individual Sub Watershed Acres	Sub Watersheds Contributing to Site	Sub Watershed Cumulative Acres
WP1	71,482	All	544,543
WS1	60,362	WS1, WT4, WT5	216,000
WT1	96,232		96,232
WT2	94,304	WT2, WT6	127,814
WT3	33,016		33,016
WT4	78,630		78,630
WT5	77,008		77,008
WT6	33,510		33,510

An unsampled area of 17,077 acres is located in the Watonwan River Watershed. These acres contribute to the sampling site BP1 in the Blue Earth River Watershed.

Figure 2. Sampling Sites and Watersheds of the Watonwan River Major Watershed.

Figure 3. Direction of Flow from the Sampling Sub Watersheds.

Water Quality Monitoring

The monitoring plan for the Watonwan River Major Watershed was developed in conjunction with the Blue Earth River and Le Sueur River Major Watersheds. The monitoring plan for the three watersheds includes identical sampling protocol and sampling period. The size of the project areas as well as budget constraints limited the number of sampling sites, as well as stream data collected on water quality parameters tested.

The Watonwan River Watershed monitoring plan was developed to measure water quality and flow for the Watonwan River and other designated streams in the watershed. The Watonwan River monitoring plan in Section 6 of the *Blue Earth River Implementation Framework Workplan* describes the parameters and frequency of monitoring. A full complement of water quality parameters was tested including phosphorus, nitrate and sediment for the primary and secondary sites. The tertiary sites were sampled at the same frequency as the primary and secondary sites but the water quality parameters tested were limited. The water quality parameters for the primary, secondary and tertiary sites are listed in Table 27.

Table 27. Water Quality Parameters Sampled.

Parameter	Primary Sites	Secondary Sites	Tertiary Sites
Suspended Grain Size	X	X	X
Total Suspended Solids (TSS)	X	X	X
Total Suspended Volatile Solids (TSVS)	X	X	
Total Phosphorus (not filtered) (TP)	X	X	
Total Dissolved Phosphorus (filtered) (TDP)	X	X	
Ortho Phosphorus(filtered) ($P\text{-}PO_4$)	X	X	
Ammonia (filtered) ($N\text{-}NH_3$)	X	X	
Nitrate + Nitrite (filtered) ($N\text{-}NO_3/NO_2$) Referenced in report as $N\text{-}NO_3$	X	X	
Chemical Oxygen Demand (COD)	X	X	
Chlorophyll-a (CHL-a)	X	X	
Fecal Coliform Bacteria	X	X	
pH	X	X	
Total Kjeldahl Nitrogen (TKN)	X	X	
Temperature	X	X	
Dissolved Oxygen (DO)	X	X	
Turbidity	X	X	X
Conductivity	X	X	X

Field Analysis	EPA Method Number
	Standard Methods-16th ed.
Conductivity	120.1
Dissolved Oxygen (DO)	360.1

The stream monitoring included water quality and flow measurements completed by multiple teams. The primary site (WP1), which is located on the Watonwan River, is a USGS gauging station with rating and sampling done by the USGS. The secondary site (WS1), which is also located on the Watonwan River, was rated by the USGS, with water quality sampling and stream height gauging done by MSUWRC. The six tertiary sites were rated by MSUWRC. The County Water Planners and the SWCD staff were trained by the USGS and MSUWRC to provide consistency in the collection of stream water levels and water quality samples. MSUWRC and county personnel surveyed the tertiary sites. The survey data were digitized to develop a cross section and reference table with monitoring reference information for each tertiary site. A site sheet was created for each tertiary site with the site location, cross section, and reference table for sampling depth based on the height of water utilizing a staff gauge or measurement tape value.

Water Quality Collection

Water quality samples were collected using standard USGS water sampling methods for the primary and secondary sites with a depth-integrated water sampler. Water quality collection at the tertiary sites was performed using a modified grab method of sampling. The modified sampling method consisted of two water sample collection options: 1) using a one or two liter sample bottle attached to a long PVC pole that was inserted vertically into the water column; or 2) using a bucket attached to a long rope that was dropped vertically into the water column. The water samples were not depth integrated but instead were collected just below the surface to mid-depth of the water column over the deepest point of stream to ensure adequate flow throughout the sampling season. The sampling site location, as indicated by the cross section diagram of the site, was marked on the bridge structure to provide a consistent sampling site location.

Water quality sampling was performed by the USGS at the primary site, by MSUWRC staff at the secondary site, and by the County Water Planners and SWCD staff at the tertiary sites. Field data sheets for sampling sites are found in Appendix CC. Table 27 lists the water quality parameters tested by site designation.

The samples were analyzed at the state certified Environmental Quality Lab at Minnesota State University, Mankato. The QA/QC Manual is on file at the lab. All lab analyses were EPA approved methods as specified in the Code of Federal Regulations Clean Water Program, Title 40, Section 136.3 (Appendix DD). Table 28 lists the water quality parameters and analysis methods.

Table 28. Water Quality Analysis Methods.

Laboratory Analysis	EPA Method Number
Suspended Grain Size	USGS Method
Total Suspended Solids (TSS)	160.2
Total Suspended Volatile Solids (TSVS)	160.4
Total Phosphorus(not filtered) (TP)	365.1 (Lachat 10-115-01-1-C BlockDigestion)
Total Dissolved Phosphorus(filtered) (TDP)	365.1 (Lachat 10-115-01-1-C BlockDigestion)
Ortho Phosphorus(filtered) ($P\text{-}PO_4$)	365.1 (Lachat Method 10-115-01-1-A & -B)
Total Kjeldahl Nitrogen (TKN)	351.2 (Lachat 10-107-06-2-E Block Digestion)
Ammonia (filtered) ($N\text{-}NH_3$)	350.1(Lachat Method 10-107-06-1-B)
Nitrate + Nitrite (filtered) ($N\text{-}NO_3/NO_2$)	353.2 (Lachat Method 10-107-04-1-C & -A)
Chemical Oxygen Demand (COD)	HACH Reactor Digestion Method 410.4
Chlorophyll-a (CHL-a)	1002G (Standard Methods-16th ed.)
Fecal Coliform Bacteria	909C (Standard Methods-16th ed.)
Turbidity	180.1 (Hach-turbidimetric)
pH	150.1
Field Analysis	EPA Method Number
	Standard Methods-16th ed.
Conductivity	120.1
Dissolved Oxygen (DO)	360.1

Precipitation

The South Central Minnesota County Comprehensive Water Planning Project (SCMCCWPP) Volunteer Rain Gauge Network is located in the 13 county region in and near the project area. The extensive network of volunteers collected the precipitation data used for the project (Figure 4). An average daily rainfall record was created using the available data from the rain gauge sites within the sampled sub watersheds. The number of sites within the sampling sub watersheds varied from one to six sites. Because the rain gauge readers record precipitation at various times of the day, the daily precipitation data may be recorded for up to 24 hours after the rainfall had occurred. The precipitation recorded represents a total amount for the proceeding 24-hour period. Additional information pertaining to the Rain Gauge locations and data are found in Appendix EE.

Discharge Ratings

Stream discharge measurements were collected to determine the hydrologic conditions of the project area. The discharge data provided the foundation to calculate the yield and total loading estimates for several pollutants. Additionally, the data were used to characterize each sub watershed's hydrologic response to storm events. Discharge is reported as cubic feet/second.

The USGS has collected stream data on the Watonwan River since 1976. The river has reached its flood record of 13,900 cfs (cubic feet per second) in 1993. The USGS obtained discharge measurements at the primary and secondary sampling sites following USGS methodology, using Price or Pygmy current meters (Appendix FF). The USGS used the 1996 project data as well as historic data to develop the rating curves for the primary and secondary sampling sites.

MSUWRC collected water discharge measurements at the tertiary sites following USGS methodology using Price or Pygmy current meters. Due to sampling difficulties, the tertiary site, WT3 (Judicial Ditch 13) was surveyed with a transit. The water volume (flow) on Judicial Ditch 13 at sampling site WT3 was calculated using Meaning's equation. Table 29 summarizes discharge measurement collection.

Figure 4. Rain Gauge Site Locations of the Watonwan River Major Watershed.

Table 29. Stream Flow Data Collection Methods.

Sub Watersheds	Water Level Devices and Methods	Discharge Measurements Equipment and Organization	Rating Curve Development
Primary	USGS Gauging Station	Price current meter USGS	USGS
Secondary	USGS wire-weight gauge	Price current meter USGS	USGS
Tertiary	Staff gauge or surveying rod	Pygmy or Price Current meter MSUWRC	MSUWRC

Data Management and Statistics

Flow Calculation and Hydrographs

The rating curve is the relationship between the depth of the water and the amount of discharge (cubic feet per second). The discharge is calculated by measuring the flow at multiple points across the stream at a particular stage. The rating curve is created by measuring the discharge at a number of different water depths (stages) and plotting the data to produce a curve.

The Watonwan River at primary site WP1 was located at a USGS gauging station with continuous flow data. The USGS compiled the data record to obtain a daily average flow. The primary site data did not require any further modifications. The USGS prepared a rating curve for the sampling site WP1.

Stage height measurements were obtained by MSUWRC for the Watonwan River at the secondary site, WS1, using a stationary USGS wire-weight gauge. These stage height measurements were recorded during each sampling session and at regular intervals between baseline and storm event sampling. The USGS prepared a rating curve for this sub watershed. This rating curve was used to create a hydrograph as discussed below.

The County Water Planners and Soil and Water Conservation District staff collected stream height data at the tertiary sites. The data collections involved numerous sampling periods done at various hours of the day. Water height observations were made at the same time as water quality data collection and at regular intervals between water sampling periods. The measurements were made using a standard metric fiberglass-surveying rod, measuring from a known location at each sampling site. The distance of the known point to the water surface was recorded.

The hydrograph readings recorded at the secondary and tertiary sites were used to develop daily stream flow data for each site. These data were plotted as stage height (y-axis) and date/time (x-axis) for the days in the sampling season. Through electronic means, curves were drawn through the plotted data. This process smoothed the somewhat fragmented site data. The result was a continuous line that approximated the hydrograph for each site. The resulting chart image was exported and then sampled electronically using a digitizing program to obtain a discharge record for each day of the sampling season[15]. Additional information pertaining to the discharge relationships for the primary, secondary and tertiary sites is located in Appendix FF.

Load and Yield Calculations

Flow data is used to calculate the yield and load of water quality parameters. Water quality constituent (pollutant) load is calculated using the equation:

$$\frac{\text{flow} * \text{concentration}}{\text{time}} = \text{load (pounds or tons)}$$

Water quality constituent (pollutant) yield is calculated using the equation:

$$\frac{\text{load}}{\text{Sub watershed acres}} = \text{yield (pounds/acre or tons/acre)}$$

The yield of pollutants expressed as pounds per acre or tons per acre of watershed normalizes the data allowing the comparison among watersheds with varying area. The yield and relative magnitude of the water quality parameters tested will provide needed information in the selection of priority management areas by the watershed team. Flow records allow runoff response time or "flashiness" of a watershed to be understood providing a crucial piece of information when selecting the Best Management Practices (BMPs) for the implementation plan. Loading for all water quality parameters at the primary and secondary sites and for the TSS at tertiary sites was calculated by using FLUX, a model developed by the U.S. Army Corps of Engineers[16].

Watershed Assessment

Geographic Information System

The Geographic Information System (GIS) for the Greater Blue Earth River Watershed was created using ARC/INFO Version 7.1.2 on a SUN Ultra 30 workstation by MSUWRC. All data were analyzed in ARC/INFO except feedlot data, which were developed using ArcView. Base layers were developed by digitizing data or by acquiring data from other groups such as counties in the watershed, South Central Minnesota County Comprehensive Water Planning Project (SCMCCWPP), Minnesota Department of Transportation (MnDOT), Minnesota Department of Natural Resources (MDNR), Land Management Information Center (LMIC), Minnesota Pollution Control Agency (MPCA), Minnesota Board of Water and Soil Resources (BWSR), Minnesota Department of Agriculture (MDA), University of Minnesota (U of M), Natural Resources Conservation Service (NRCS), United States Geological Survey (USGS), and United States Fish and Wildlife Service (USFWS). Scale of the spatial data ranged from 1:8,000 to 1:24,000. Databases were developed and joined with the spatial data. Although the GIS was used to analyze data related to ground conditions during the 1996 water monitoring period, most data were pre-1996, resulting in best estimate ground conditions for the monitoring period.

The GIS base layers used in the project include hydrographic data (streams, public ditch systems, lakes); watershed boundaries (major, minor, sampling, lake); sampling sites; National Wetlands Inventory wetlands; precipitation; land cover/land use; feedlots; Conservation Reserve Program (CRP); transportation (roads and road easements); soils; slope; water quality (TSS); and other boundaries (county, township, section, municipal). A summary of the data is listed below.

1. Land Cover/Land Use: The following GIS coverages were combined to represent the 1996 landscape. The base coverage, Minnesota Land Use and Cover - Agricultural and Transition Areas, represents ground conditions during the years, 1988 – 1990. The National Wetlands Inventory (NWI) wetland data represent the time period, 1979-1988. County based CRP parcel coverages from 1996 were obtained from the Minnesota Department of Agriculture. Spatial road data were obtained from the Minnesota Department of Transportation (MN DOT) Base Map '98.

2. Feedlots: The feedlot site locations represent data compiled from county based feedlot information. Counties provided spatial data and attribute information or provided hard copy maps of feedlot locations. Feedlot data may be historic or current. A composite inventory was completed to display a general picture of animal operations, including historic and present day locations. These data were compiled using ArcView.

3. Hydrography: Streams, lakes, public drainage ditch systems, and watershed (major, minor, lake) boundary data provide the base map hydrographic data obtained from the 13 County ARC/INFO GIS developed by the MSUWRC. Sampling sites were located on and digitized from 7.5 minute USGS topographic quadrangle maps. Sampling watersheds were delineated from sampling site locations to intersect preexisting minor watershed boundaries onto the quadrangle maps using height of land and drainage information. Sampling sites and watersheds were digitized and ARC/INFO coverages were created. The National Wetlands Inventory, obtained from the State of Minnesota, was reviewed and updated by the MDNR in 1991-1994.

4. Precipitation: Precipitation data for the sampling watersheds were generated using data collected by the SCMCCWPP Rain gauge Network. Data were entered into the HIDEN program using the State Climatology methodology. Grid files were created from the HIDEN data, using Surfer (Golden Software). The ARC/INFO sample shed file was used to incorporate the sampling shed data with the grid files. Grids were created by month and combined using the grid math command to develop a cumulative total for the monitoring period (April 1, 1996 through November 21, 1996). The precipitation results are reported as the average volume of water in inches that fell within each sampling shed area (square meter inches/square meters) by month and by total monitoring period.

5. Soil: Soil data from the SSIS program generated files at the U of M were converted to township based EPPL7 files by U of M. These data were processed by BWSR to compile the data into county based ARC/INFO coverages. MSUWRC appended the MnDOT county boundary arcs into each county soil coverage to complete the necessary edge matching. County soil files were completed for Blue Earth, Brown, Cottonwood, and Watonwan Counties using the SSIS data. ARC/INFO soil coverages were obtained for Jackson and Martin Counties from LMIC. The MSU Water Resources Center appended the MnDOT county boundary arcs into the county soil coverages to complete the necessary edge matching between counties. The ARC/INFO county soil coverages were map joined to create a composite ARC/INFO soil coverage for the Greater Blue Earth River Watershed.

6. Slope: The USGS DEMS were used to create an ARC/INFO grid for the entire Greater Blue Earth River Watershed. The grid was converted to a polygon coverage with four slope classes: 0%, > 0% <= 3%, > 3% <= 6%, > 6%. Major watershed and sampling watershed boundaries were unioned to the slope coverage.

7. Stream gradient: Points were digitized at the intersection of the primary sub watershed stream with each 10 foot elevation contour (USGS 24,000 series topographic maps). These data were used to create elevation change attribute information for each stream segment. Stream segment length as miles was used to calculate change in elevation (feet) per stream mile. Subsequent calculations determined weighted stream gradient. The percent of each stream segment (based on 10 foot or less elevation change) to the total length of the primary stream was calculated. The calculated feet/mile was then multiplied by its percent of the stream. All stream segment values were then summed to calculate the weighted stream gradient for the primary sub watershed stream.

GIS Analysis

Additional ARC/INFO coverages were created from various combinations and queries of the base GIS layers at the direction of the watershed technical committee. Three buffer coverages were constructed from the stream coverage to define 16 foot, 99 foot, and 300 foot riparian areas for each stream in each sampling watershed. The three buffer coverages were used to create a representation of the riparian zone and extended riparian zones for selected coverages. Table 30 summarizes the additional coverages created.

Table 30. Derived GIS Coverages for the Watonwan River Major Watershed.

Coverage Created	Coverage(s) Used
Updated Land Cover/Land Use	Minnesota Land Use - Agricultural and Transition Areas 1996 MDA CRP parcels National Wetlands Inventory wetlands 1998 MnDOT road and road easements Sampling watersheds
Land Cover/Land Use Riparian Zones	Land Cover/Land Use (Updated) 16, 99, 300 Foot Clip
Land Cover/Land Use And Highly Erodible Lands	Land Cover/Land Use (Updated) Soil
Land Cover/Land Use And Highly Erodible Lands Riparian Zones	Land Cover/Land Use (Updated) Soil 16, 99, 300 Foot Clip
Land Cover/Land Use And Hydric Soil	Land Cover/Land Use (Updated) Soil
Land Cover/Land Use And Lakeshed	Land Cover/Land Use (Updated) Lakeshed
Potential Restorable Wetland Areas	Soil National Wetlands Inventory wetlands
Revised Universal Soil Loss Equation (RUSLE)	Land Cover/Land Use (Updated) Soil
Revised Universal Soil Loss Equation (RUSLE) Riparian Zones	Land Cover/Land Use (Updated) Soil 16, 99, 300 Foot Clip
Slope	USGS DEM Sampling watersheds
Slope Riparian Zones	USGS DEM Sampling watersheds 16, 99, 300 Foot Clip
Stream Gradient	Stream Open Ditch Sampling watersheds

Soil Erosion Potential

The soil erosion potential was calculated using the Revised Universal Soil Loss Equation (RUSLE) for sheet and rill erosion predictions. The RUSLE equation is A = R FACTOR * K FACTOR * L S FACTOR * C FACTOR * P FACTOR where A is equal to the computed soil loss in tons/acres/year. Corn/soybean rotation, moderate residue cover, with no special practices were applied to all cultivated land acres in the watersheds. The factors and values used are listed as follows:

R FACTOR (Rainfall and runoff)
120 Blue Earth, Cottonwood, Watonwan Counties
121 Brown County
124 Jackson County
125 Martin County

K FACTOR (Soil erodibility)
K values assigned by specified soil unit and adjusted for RUSLE zone 100 B/C
0.17 adjusted to 0.15
0.20 adjusted to 0.17
0.24 adjusted to 0.22
0.28 adjusted to 0.26
0.32 adjusted to 0.30
0.37 adjusted to 0.35
0.43 adjusted to 0.40

LS FACTOR (Slope length and steepness)
LS value assigned to a specified soil unit

C FACTOR (Cover and management)

0.16	cultivated land
0.02	grassland/CRP
0.003	forested
0.26	urban and industrial
0.15	farmsteads and other rural developments
0.45	gravel pits and open mines
0.0	lakes and deeper water wetlands
0.0	shallow or "seasonal" wetlands (e.g. types 1, 2, and 3) = 0.003

P FACTOR (Support practice)
1.0 Assume no special practices on any cultivated land (a constant of 1)

Potential Restorable Wetlands

The potential restorable wetland areas were identified using the soil land capability classification. Soils were regrouped using the IIIw or IVw soils to represent the drained and potentially restorable wetlands and the Vw, VIw, VIIw, VIIIw soils to represent present wetlands. Other soil land capability classifications were grouped as non-potentially restorable wetlands or as water.