

2018-2028



"S'more Time" (Scott Syring, 2017)

Sherburne County Local Water Management Plan

Prepared by
Sherburne Soil & Water Conservation District

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Acknowledgements

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Participating Stakeholders & Partners

Cities of Becker, Big Lake, Clear Lake, Elk River, Princeton, St. Cloud, & Zimmerman
Elk River Watershed Association
Mississippi River – St Cloud Watershed partnership
Rum River Watershed partnership
Residents and businesses of Sherburne County
Sherburne County Coalition of Lake Associations
Sherburne County Public Works and Planning & Zoning
Townships of Baldwin, Becker, Big Lake, Blue Hill, Clear Lake, Haven, Livonia, Orrock, Palmer & Santiago
United States Fish & Wildlife Service (Sherburne National Wildlife Refuge staff)

Technical Advisory Agencies

Board of Water and Soil Resources
Farm Service Agency
Minnesota Department of Natural Resources
Minnesota Pollution Control Agency
Minnesota Department of Agriculture
Minnesota Department of Health
Natural Resource Conservation Service

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Acronyms

Acronym	What it means
AIS	Aquatic Invasive Species
BMP	Best Management Practice
BWSR	Board of Water and Soil Resources
COLA	Coalition of Lake Associations
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
DWSMA	Drinking Water Supply Management Area
EDRR	AIS Early Detection and Rapid Response
EQB	Environmental Quality Board
EQIP	Environmental Quality Incentives Program
EPA	Environmental Protection Agency
FSA	Farm Service Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Code
HUP	Historically Underserved Producers
LGU	Local Governmental Unit
LWMP	Local Water Management Plan
MAWQCP	Minnesota Agricultural Water Quality Certification Program
MCD	Metro Conservation Districts
MGY	Million gallons per year
MS4	Municipal Separate Storm Sewer System
NEMO	Nonpoint Education for Municipal Officials
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
PCT	Precision Cropping Technologies
PRAP	Performance Review and Assistance Program
SSTS	Subsurface Sewage Treatment Systems
SWCD	Soil and Water Conservation District
TEP	Technical Evaluation Panel
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
WCA	Wetland Conservation Act
WHP	Wellhead Protection Program
WPLMN	Watershed Pollutant Load Monitoring Network
WRAPS	Watershed Restoration and Protection Strategy

1.0 Executive Summary

The waters of Sherburne County are of critical importance to the region’s health, recreational opportunity, and economic / tourism value. Surface waters within the county’s lakes and streams provide recreational opportunity for swimming, angling, water sports, paddling, hunting, nature viewing, or the relaxing pontoon boat cruise. Sherburne County’s groundwater is a valuable resource for agricultural irrigation as well as a drinking water and industrial cooling water source. The numerous wetlands in the county filter pollutants from surface runoff, mitigate flooding, and provide habitat for numerous species of mammals, reptiles, aquatic and terrestrial plants, and birds. The many types of water found here help to define the county’s identity and quality of life; therefore, it is vital that they be protected using efficient and effective approaches and sound scientific principles.

Of course, the quality and quantity of water leaving Sherburne County directly impacts the quality and quantity of water downstream. Water flowing downstream eventually joins the Mississippi River and flows through the twin cities of Minneapolis and St. Paul. Here, there is a heavy reliance on groundwater for drinking and industrial use in the twin cities of Minneapolis and St. Paul. Using groundwater efficiently in Sherburne County, and encouraging infiltration and recharge to replenish groundwater reserves, will decrease stresses on this groundwater usage. As this water flows further downstream it will cover another ~1,850 miles before reaching the Gulf of Mexico, where in 2017, scientists measured the “dead zone”, an area void of aquatic life due excessive pollutants, in the Gulf of Mexico to encompass over 8,770 square miles. This is the largest ever documented dead zone since monitoring began 30 years ago. Reductions must be made to nutrient and sediment contributions from Sherburne County as part of a watershed-wide effort if the goal of reducing the dead zone to 1,950 square miles is to be achieved.

Sherburne County is committed to protecting surface and ground water for its best interests as well as the interests of those downstream. However, many challenges face water management in the county, including rural and urban runoff of pollutants, erosion of shoreline, increasing development pressures, reliance on fertilizer and chemical pesticides/herbicides without regard to alternative nutrient and pest management options, transport of fecal coliform bacteria, a decline in soil and native vegetation health, increasing pressure or use of groundwater, and proliferation of invasive species. Currently, a number of Sherburne waterbodies are listed as impaired for recreational activity, aquatic life or aquatic consumption due to a number of these challenges. Numerous threats exist to upland areas of agriculture, prairie and native forests; impacts to these areas will of course increase runoff and transport of pollutants into area waterways, further exacerbating water impairment issues.

Following a series of public input opportunities and extensive review of scientific and environmental data for Sherburne County waterways, the Sherburne County Local Water Management Plan (LWMP) has identified three priority concerns:

1. Surface Water Quality: “Cumulative impacts of land use in directly connected and/or riparian areas which have a direct impact on surface water quality.”
2. Ground Water Quality and Quantity: “High levels of nitrates in groundwater and quantity in areas identified as sensitive.”

3. Aquatic Invasive Species: “Introduction and spread of aquatic invasive species and their negative effect on water quality, navigation, recreation and fisheries.”

Addressing these concerns will require a multi-faceted approach involving citizen education and outreach, wise rural land management, strategic urban planning, completion of diagnostic / feasibility studies, the forming and continuation of strong partnerships, continued monitoring of environmental variables, and in many ways a change in behavior for residents and visitors of Sherburne County. The Implementation Plan specifies the various approaches Sherburne County will take to address the Priority Concerns, utilizing the variety of approaches outlined above. Each Priority Concern has numerous Objectives, which may be considered the approaches selected to address the concern. Each Objective may be met through the completion of numerous Actions, which are defined and targeted steps that should be taken to reach that Objective. Every effort was made to define the numerous Actions with a targeted goal, responsible party, estimated cost, potential funding source. These variables will help to direct implementation, while also providing direction and a target for achieving success in implementation. The goals and actions presented in the Implementation Plan will encourage partnerships, citizen education, monitoring of Sherburne County waterways, and integration of Best Management Practices on agricultural fields, lake and stream shorelines, city streets and sidewalks, and residential neighborhoods throughout the county.

By outlining the Priority Concerns and strategically developing an Implementation Plan that addresses those concerns, protection and rehabilitation of Sherburne County waters will be achieved in a way that is as cost efficient as possible. It is estimated that the cost of implementation would be \$3,981,000 to fully reach these goals between 2018 and 2028, which is higher than the figure of \$2,956,700 projected within the 2007-2017 Sherburne County LWMP. The activities outlined in this document are consistent with the activities and purpose of the Sherburne County Comprehensive Land Use Plan (2010-2030), which itself was developed with the integration of township planning efforts. The LWMP is also consistent with neighboring county water plans. Though some approaches may vary between counties based upon the priority conditions and local priorities, each county specifies similar approaches that are designed to protect and enhance water resources in their geographic region. Recognizing the importance of working across political boundaries to address water concerns, the concept of water management on a watershed scale is discussed in neighboring plans often, as well as within this plan.

To summarize, the 2018-2028 LWMP explores in detail the challenges water managers face in Sherburne County and outlines what approaches have been identified to meet those challenges. The process in which these determinations were made included input from a variety of county stakeholders as well as officials from local cities, townships, county offices, and numerous state agencies. Implementation of this plan has been defined through specifying the action steps that will be completed, the partners involved, the resources needed, and timeframe of estimated completion. The plan further specifies that success will be measured not only by completing these action steps, but also by leveraging partnerships within and outside of the county to tackle these issues on a watershed scale. Because water flows across jurisdictional and political boundaries, the future of water management in Sherburne County and elsewhere will require a collaborative effort from upstream and downstream interests alike in order to meet water resource goals. Ultimately, collective and numerous small victories achieved in all of Minnesota’s 81 major watershed are necessary in order to meet a statewide goal proposed by Governor Mark Dayton in 2017, which is to improve water quality 25% by the year 2025 (“25 by 25”).

2.0 Introduction

Established in 1856, Sherburne County consists of a 451 square mile (1,168 square kilometer) region lying within east-central Minnesota (Map 1). The county seat of Elk River is located roughly 35-40 miles from the twin cities of Minneapolis and St. Paul. Because of its proximity to the twin cities, the county incorporates a mix of largely rural and agricultural land to the west and northern regions, while the southeast as well as Hwy 69 and Hwy 10 corridors hold urban pockets that are easily accessible to the metropolitan area. Major Sherburne County population centers include Elk River, Becker, Clear Lake, Big Lake, Princeton (partly in Mille Lacs County), St. Cloud (partly in Stearns County) and Zimmerman. The county includes 10 townships including Baldwin, Becker, Big Lake, Blue Hill, Clear Lake, Haven, Livonia, Orrock, Palmer and Santiago.

Population

2015 census data puts the Minneapolis and St. Paul metropolitan area at 3.5 million people. Sherburne County, located just outside the twin cities, has incurred steady growth from 1980-2015, increasing at an average rate of nearly 390 individuals per year. From 1990 to 2000, the county grew by nearly 54%, while growth increased an additional 37% from 2000 to 2010. The Minnesota Department of Administration anticipates continued future growth within Sherburne County, however at a decreased rate from what has been experienced in previous years (Figure 1). Despite the slowing of a growth trend, the US Census Bureau released data in 2017 indicating that Sherburne County had the highest rate of population growth in Minnesota during 2016, at 2.08%. The bulk of this growth occurred in the Cities of Elk River and Big Lake, along with Becker and Big Lake Townships. The estimated 2016 total county population was 92,287 people.

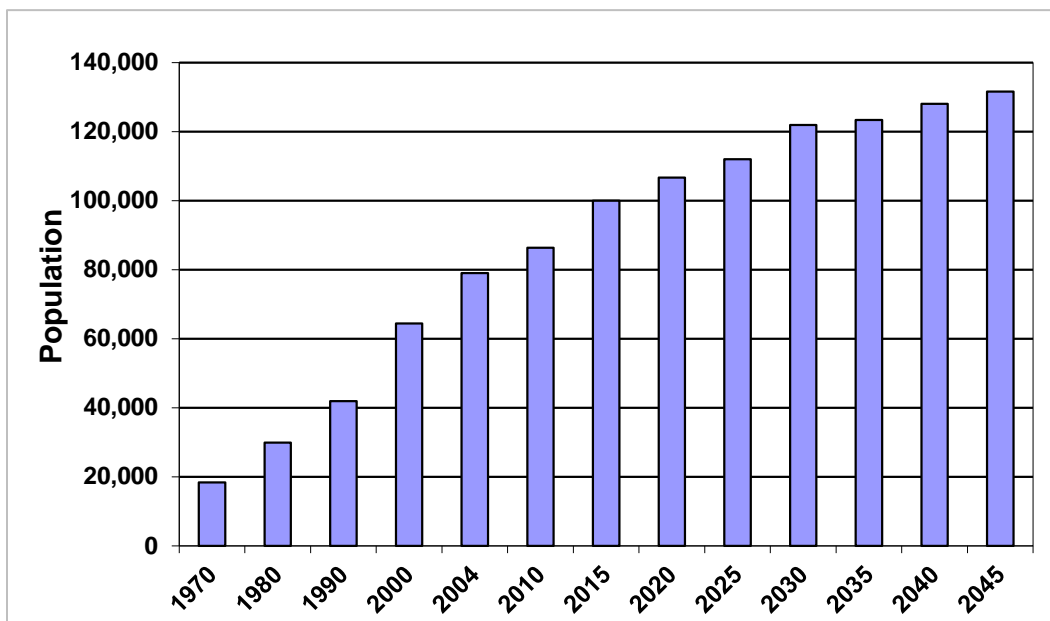
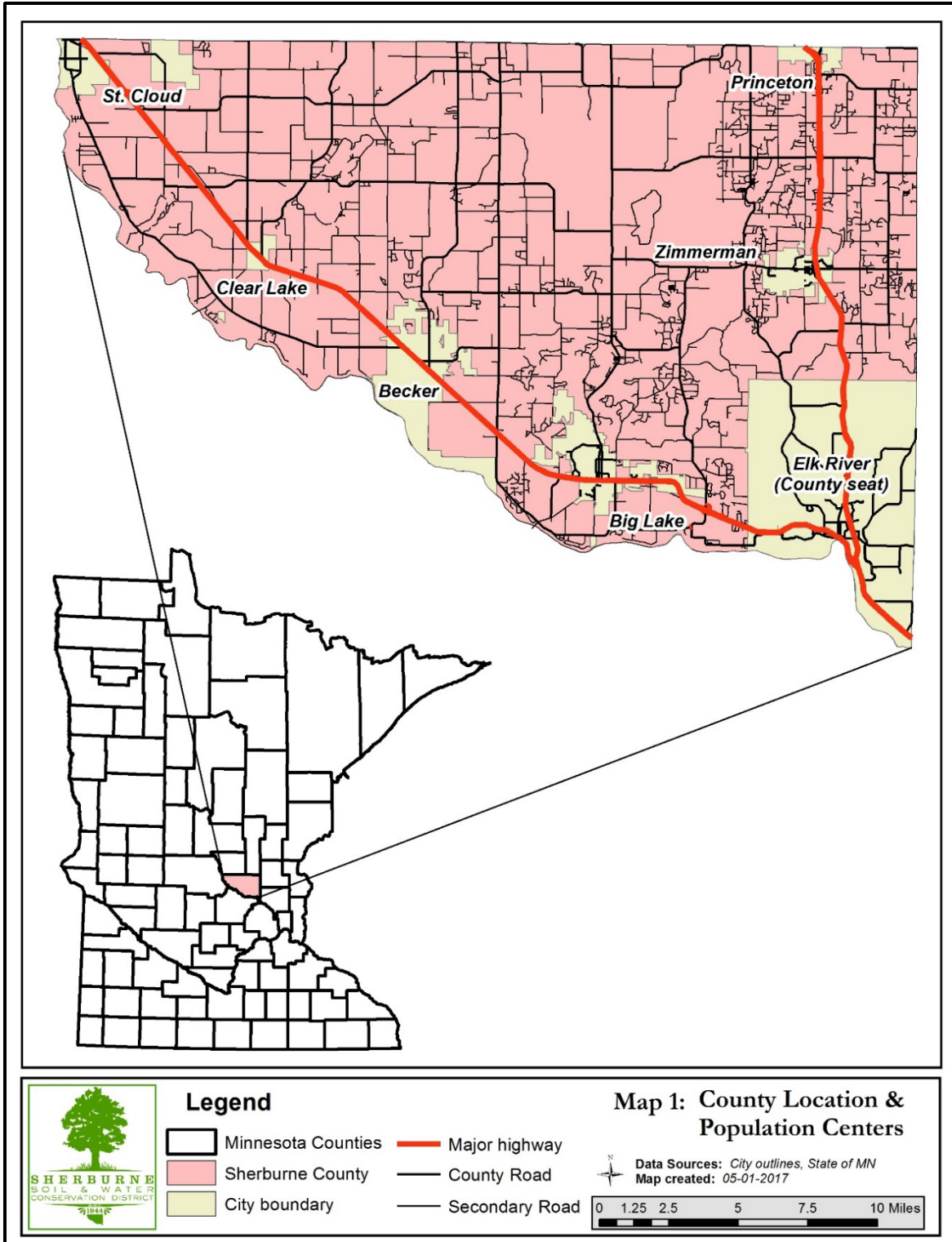


Figure 1: Sherburne County Population Estimates and Trends. Data provided by Sherburne County Auditor / Treasurer Department (1970-2004) and Minnesota Department of Administration State Demographic Center (2010-2045).



Map 1. Sherburne County location and population centers.

Land Use and Zoning

Major land uses in Sherburne County include agriculture (29%), along with vast areas of forest (24%), pasture / grass (21%), and wetlands (19%) exist. Despite being the fastest growing county in Minnesota, urban (residential and developed) areas comprise a small portion of the county (Map 2). A good portion of the natural land is located within the Sherburne National Wildlife Refuge (30,700 acres, or 11% of the county) along with the neighboring Sand Dunes State Forest. As the population of Sherburne County continues to grow, it is anticipated that rural residential and urban developments will continue to slowly replace portions of agricultural land. As previously stated, much of this growth is due to the proximity of the county to the twin cities (major employment centers) and major highways, but also due to local land use policies which allow for rural residential development in the eastern half of the county. These factors will contribute to continued development in the county, resulting in a shift to residential and urban lands from other land uses.

The County Planning and Zoning Department administers the zoning ordinances of Sherburne County. Sherburne County's zoning ordinances allow for the proper classification of land in order to promote health and safety, mitigate traffic congestion, facilitate proper water and sewer practices, and conserve the value of property. Zoning definitions include 11 categories:

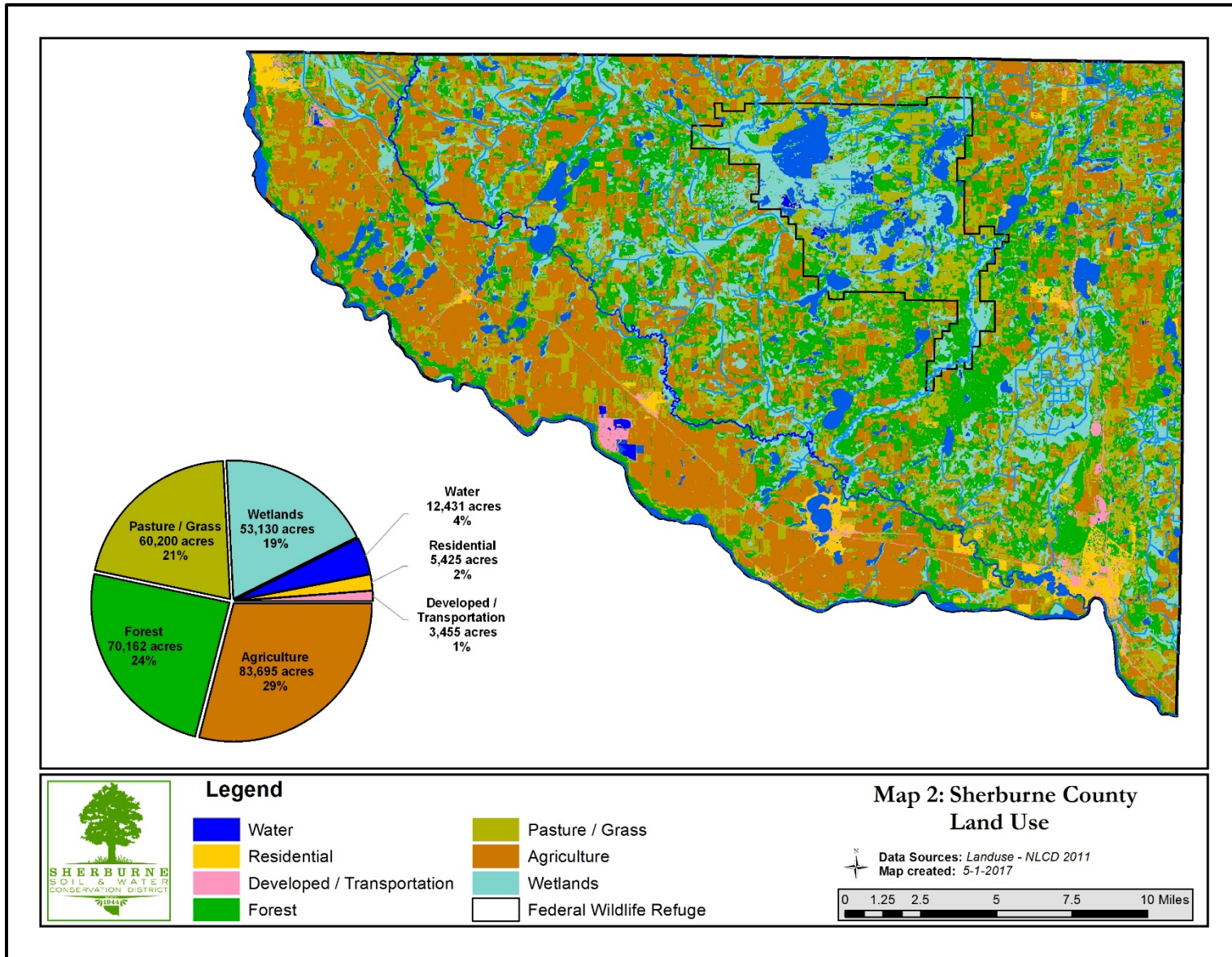
Agricultural District	Residential PUD Overlay District
General Rural District	Floodplain District
Urban Expansion District	Shoreland Overlay District
Commercial District	Shoreland Residential District
Industrial District	Scenic and Recreation River District
Heavy Industrial District	

Zoning decisions are often made with environmental impacts to land, soil and water resources in mind. For example, zoning decisions and variance allowances may take into consideration density of human populations, matters pertaining to sewer systems or underground storage of contaminants, and preservation of natural or scenic areas. Shoreland zoning standards are particularly of interest to water resources because they often include provisions on the level of development or vegetative removal that is allowed in proximity to a waterbody.

Soils and Geology

The county is comprised primarily of sandy soils; Quaternary glacial till, lacustrine sand, various outwash deposits and floodplain alluvium, which were deposited during the last glacial stage of the Pleistocene epoch (Wisconsin stage). The county lies almost completely within the Anoka Sand Plains, a broad area that was formerly a lake. Sand dunes, kettle lakes and tunnel valleys are prominent features. The sandy soils are mostly excessively drained in the county, making for high infiltration rates. These soils are beneficial in some ways; for example, they can be effective at retaining surface water through infiltration into the groundwater table. However sandy soils need to be carefully managed due to the potential for leaching of pollutants. Organic soils are found in the county and are utilized for specialty crops, sod, pasture and wildlife land (wetlands and wet forests).

Bedrock underlie areas of western Sherburne County at a depth of 0-100 feet; in some areas of Haven Township granite bedrock outcrops are visible. In eastern Sherburne County, sedimentary rocks are dominant with bedrock occurring at depths of 50-300 feet below the soil.



Map 2. County Land use Classifications. Spatial data set provided by National Land Cover Database (2011)

Watersheds

The entire county is located within the Mississippi Headwaters Watershed (Hydrologic Unit Code, HUC 0701). At the HUC 8 level, the 691,200 acre Mississippi River – St. Cloud Watershed (MR-SC, HUC 07010203) and Rum River Watershed (HUC 07010207) drain 89% and 11% of Sherburne County, respectively. Roughly 205,000 acres (71%) of the county lies within the Elk River Watershed, a subwatershed of the MR-SC Watershed that originates in Benton County. The Elk River Watershed also drains a significant portion of Benton County (67%) as well as about 3% of Mille Lacs County (Figure 2).

All three watersheds have had numerous, detailed studies conducted to document the surface water conditions as well as plan for their restoration and / or protection. TMDL studies have been completed for both the MR-SC (2015) and Rum River (2017) Watersheds, as well as the Elk River subwatershed (2012). Watershed Restoration and Protection Strategy (WRAPS) studies have been completed on the MR-SC and Rum River Watersheds as well, to accompany the TMDLs. The watersheds differ slightly in their surficial geology and land management, which in turn impacts the land use and the impairments present. For example, cropland irrigation and groundwater nitrate concentrations are of concern in the MR-SC Watershed while this is not known to be of great concern in the Rum River Watershed. The impairments in each watershed and associated goals are discussed further in this document.

In 2015, Sherburne SWCD joined a MPCA program known as the Watershed Pollutant Load Monitoring Network (WPLMN). This program allows for the systematic sampling and pollutant load calculation for the Elk River at a gauging station on County Rd. 15 near Big Lake. In 2017 Sherburne SWCD staff examined data from 2009 (data collected during TMDL studies) as well as 2015 and 2016 (data collected from WPLMN activities) to better understand the river pollutant loads and flow regimes. The resulting report that was drafted in spring 2017 outlines the first detailed understanding that watershed managers have on the exact (not modeled) pollutant loads for the Elk River Watershed. The full report is available on the Elk River Watershed Association website (<https://www.elkriverwatershed.com/>) while a summary is presented on the next page:

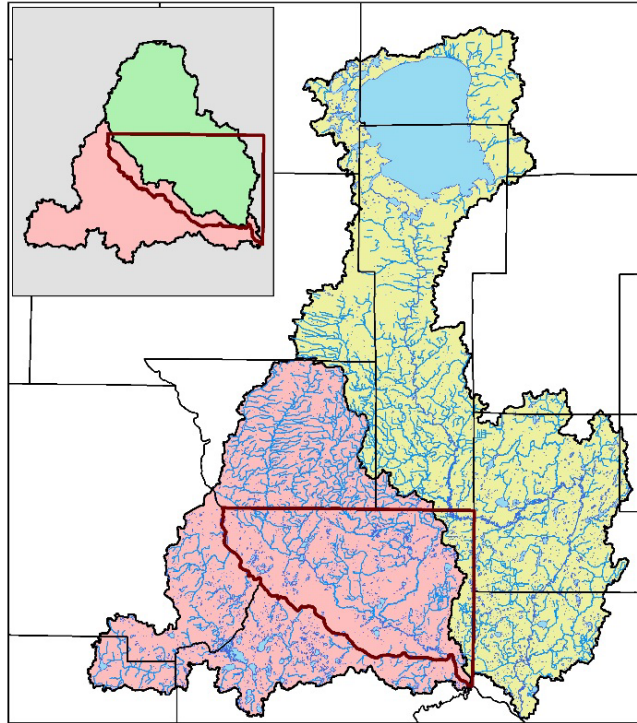


Figure 2: Sherburne County Watersheds. Pictured are the Mississippi River – St. Cloud Watershed (red), Rum River Watershed (yellow) and Elk River Watershed (inset map, green) overlying Sherburne and nearby counties.

Elk River Watershed 2017 Data Analysis Summary:

- 1) Mean flow ranged from 280 cfs to 420 cfs in these three years and total volume ranged from 141,000 acft in 2009 to 213,000 acft in 2016. Stream flow is impacted by precipitation differences in each year but also from the timing of large events which occur and resulting in precipitation falling on partially to mostly saturated soils.
- 2) Concentrations of total phosphorus fell near and mostly under the 100 µg/L criterion for rivers in Minnesota and were consistent in the three years of measurement. The mass of phosphorus (total and dissolved components) changed little from 2009 to 2015, decreasing only slightly despite a 20% increase in flow. With a 27% increase in flow as well as exceptional storm events that fell on saturated soils in 2016 and, the mass of phosphorus transport increased by 37% from 2015 to 2016.
- 3) Total suspended solids increase dramatically between 2009 and 2015, as well as from 2015 to 2016. The increase in precipitation and water volume is responsible for this observation, likely due to increased land-based runoff as well as river bank erosion.
- 4) Nitrogen loading to the Elk River ranged during years 2009 and 2015-2016. Ranges were found to be 445,000 -623,000 lbs total Kjeldahl nitrogen (TKN) and 242,000 – 367,000 lbs nitrite + nitrates.
 - a. TKN loading is largely event-based, following similar fluctuations with total phosphorus. This parameter measures largely particulate, organic based nitrogen.
 - b. NO₂ + NO₃ (nitrite and nitrate) loading does not correspond with rain events – large surface water fluxes appear to dilute this form of nitrogen in the Elk River. During baseflow conditions, NO₂ + NO₃ increases in concentration. Loading is likely correlated more closely with agricultural field applications or groundwater baseflow movement.
- 5) A spatial examination of river stream clarity (transparency) along the Elk River shows a consistent trend amongst all years in which data has been collected. The trend is such that the water entering Big Elk Lake is often clear, but declines in clarity upon leaving the lake. Downstream the water does recover in clarity over time.

Local Climate and Climate Change

From 2000 -2016, Sherburne County received between 29 to 43 inches of rain (Minnesota DNR State Climatology Office, Figure 3). Average precipitation levels remain similar from one side of the county to the other, however large events can impact the county on a local basis as evidenced by the disparity in maximum monthly precipitation totals between St. Cloud on the west side of the county and Elk River on the east side (Figure 3). In general, the months of May-July receive the most precipitation (average of 4+ inches) though the month of September can bring high precipitation amounts as well (2000-2016 average of 3.92 inches). In fact, the highest monthly rainfall total during this time period occurred in September of 2005, where roughly 13.4 inches was recorded in Elk River. Nearly 12 inches fell in May of 2012, representing the second highest monthly recording. Total annual precipitation has increased in the region at 0.4 inches per decade, or 4.2 inches per century, over the past 100 years.

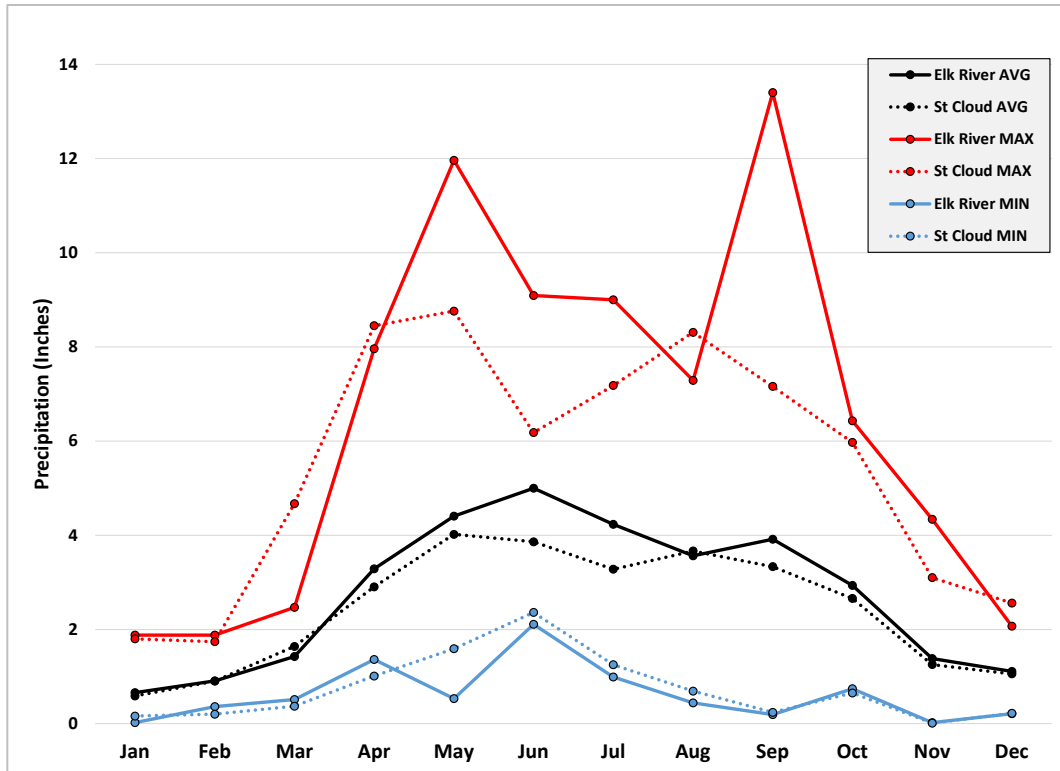


Figure 3: Sherburne County Monthly Precipitation Statistics, 2000 - 2016. Data provided by the MN DNR State Climatology Working Group for two monitoring stations (Elk River and St. Cloud).

Average summer temperatures range between 62°F and 83°F in Sherburne County, while average winter temperatures lies between 3°F and 28°F. The average annual temperature for 1901-2000 was 41.9°F, according to the National Oceanic and Atmospheric Administration (NOAA). Average annual temperatures have increased from 1895-present, at a rate of 0.2°F per decade (Figure 4). Drought and hydrologic conditions are difficult to measure due to the multiple disciplines affected, a diverse geographical and temporal distribution, and many scales of operation. The Palmer Drought Severity Index (PDSI) measures the duration and intensity of long-term drought patterns. Long term drought is cumulative, so antecedent conditions are factored into this index. The Palmer Z Index measures short-term drought on a monthly scale. Finally, the Palmer Crop Moisture Index measures short-term drought on a weekly scale and is typically used to quantify impacts on agriculture. Regional data indicates that both long-term and short term drought conditions may be decreasing, as trends indicate more positive Palmer values (wetter conditions) in recent years with respect to all Palmer indices (Figures 5, 6 and 7).

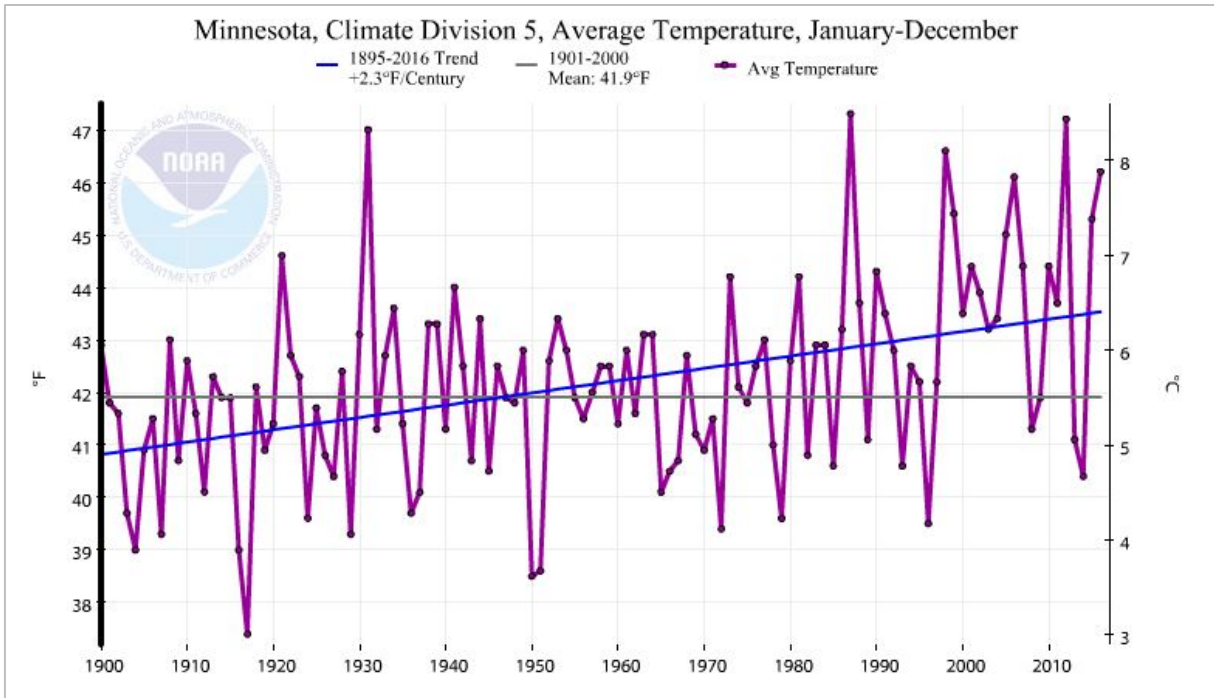


Figure 4: Climate Division 5 Average Temperature, 1895 - 2016. Graph created using NOAA “Climate at a Glance” environmental graphing tool (<https://www.ncdc.noaa.gov/cag>).

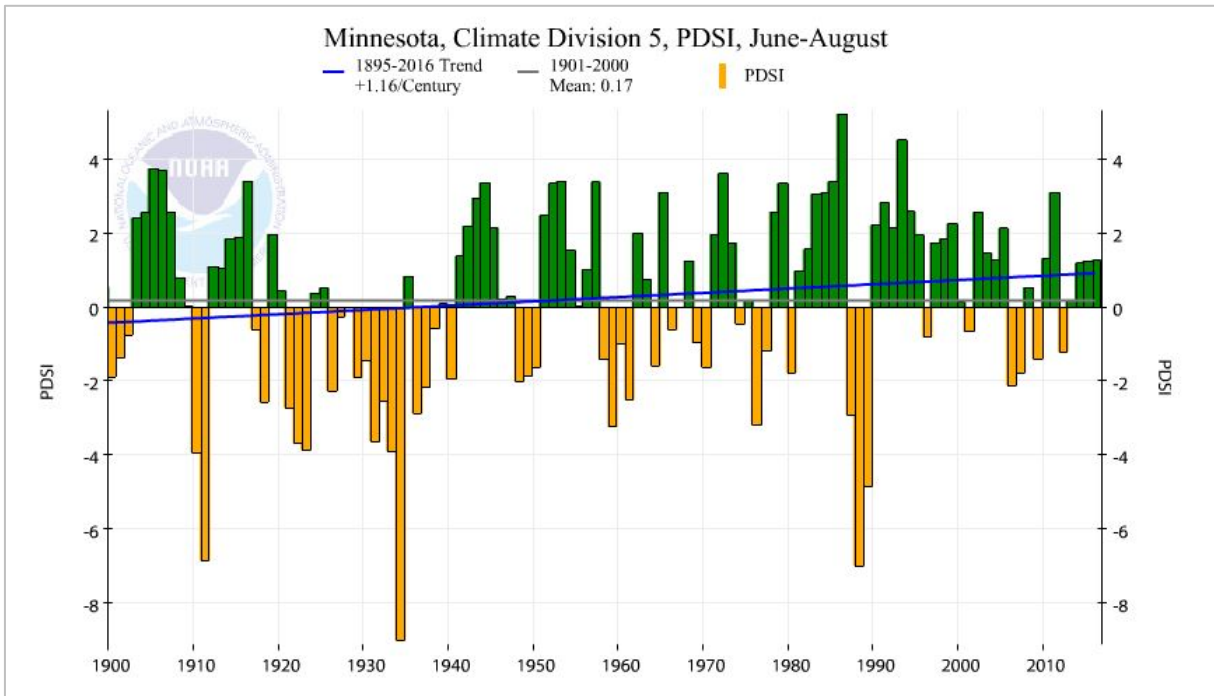


Figure 5: Climate Division 5 Palmer Drought Severity Index, 1895 - 2016. Graph created using NOAA “Climate at a Glance” environmental graphing tool (<https://www.ncdc.noaa.gov/cag>).

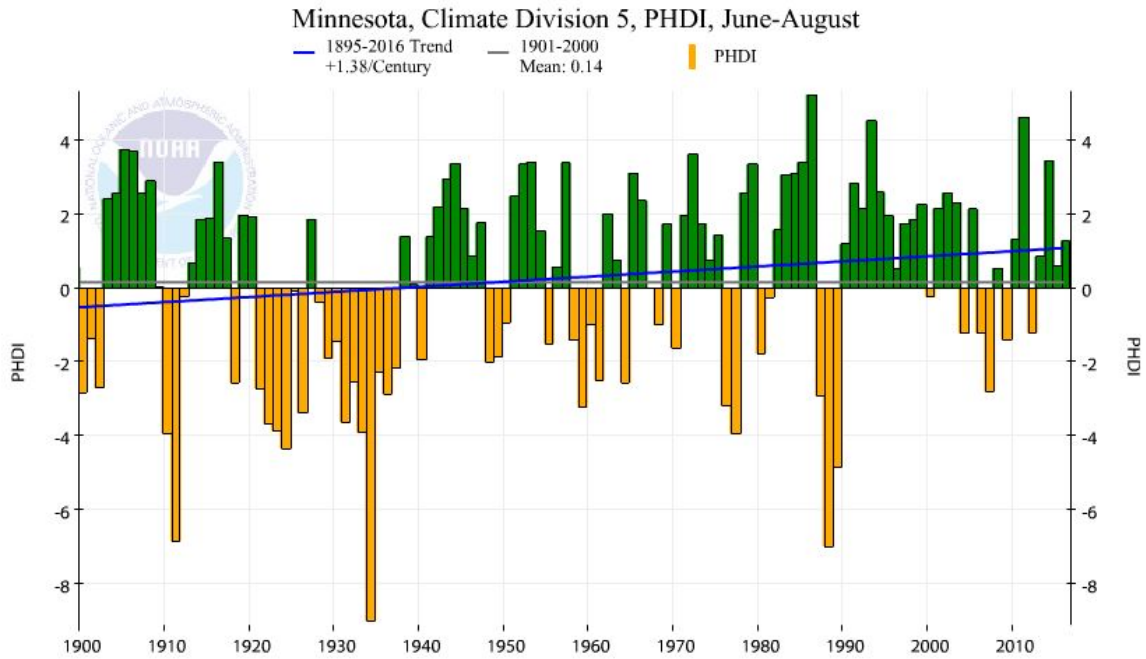


Figure 6: Climate Division 5 Palmer Hydrological Drought Index, 1895 - 2016. Graph created using NOAA “Climate at a Glance” environmental graphing tool (<https://www.ncdc.noaa.gov/cag>).

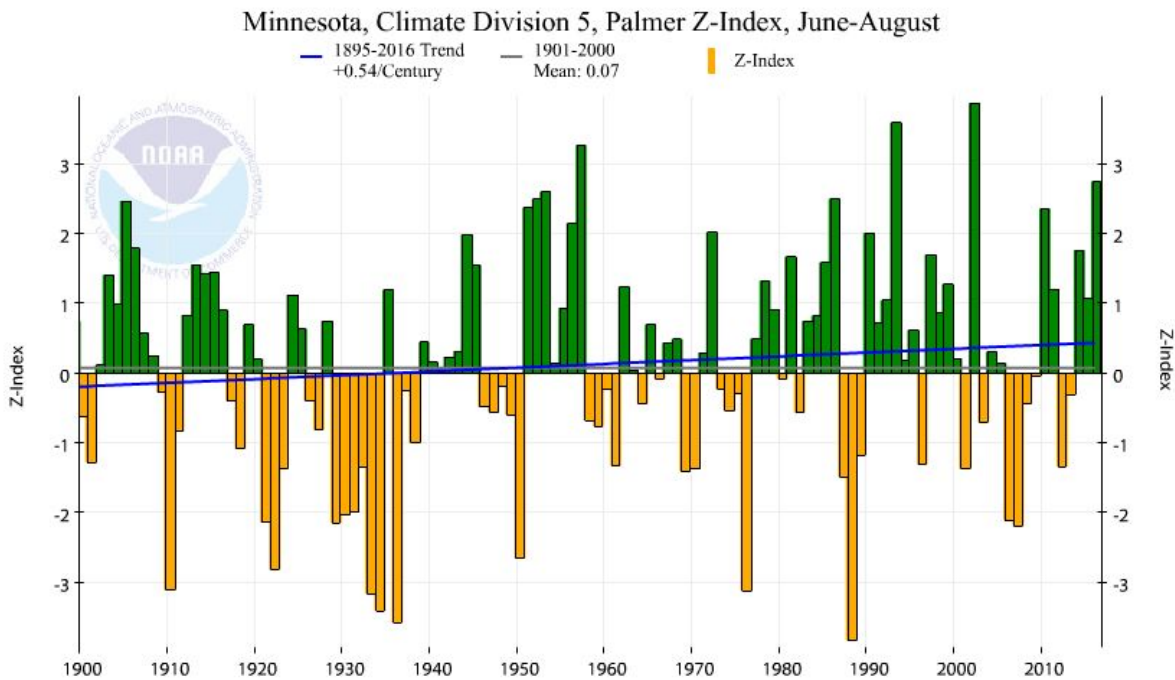


Figure 7: Climate Division 5 Palmer-Z Index, 1895 - 2016. Graph created using NOAA “Climate at a Glance” environmental graphing tool (<https://www.ncdc.noaa.gov/cag>).

As with the data presented in Figures 4-7, much of the United States Midwestern states has shown signs of a steadily increasing average temperature and associated changing climate. These temperature trends are anticipated to continue increasing. Climate models show that the direct effects of climate change in the Midwest will result in warmer and wetter winters, springs heavy with precipitation, and hotter, dryer summers (Melillo et al 2014). Increasing summer temperatures and drought could result in a reduction of water levels in lakes, streams and wetlands. Increasing lake water temperatures become more hospitable to algal species, particularly blue-green algae. And as temperatures rise, bacterial decomposition increases in lakes which reduces dissolved oxygen. The release of nutrients from anoxic lake sediments becomes more common, further exacerbating the algae problem.

Precipitation is expected to come in the form of higher intensity events. This may lead to increased flood events, gully formation, excessive rural runoff and streambank erosion. In communities with impermeable pavement, the amount of surface water runoff increases along with flushing of pet and yard waste. The increase in runoff causes surface water quality issues; however, an increase in surface water runoff also means that less water filtrates through the soil to recharge the groundwater table. Less available groundwater is problematic from a quantity standpoint, but a reduction in recharge also means that pollutants in the groundwater become less dilute and thus further reduce the groundwater quality.

Through the use of groundwater and irrigation, Sherburne County is able to produce many agricultural crops including corn, soybeans and potatoes. These crops will experience added stress with warming summer temperatures. Corn has been shown to experience a decline in yield with increasing temperatures due to a shortening of the reproductive development period (USGCRP 2014). Warmer temperatures and particularly short-term extreme temperatures will stress livestock and large animals. The warmer weather, coupled with standing water and moisture from large precipitation events, will result in an increase in many mosquito and tick-borne diseases.

Climate change has tremendous potential to impact forestry resources as well. For example, many species such as oaks are susceptible to environmental stress such as drought (hotter, dryer conditions for longer periods of time) or waterlogging (extreme events). As another example, longer periods of warmer weather will increase the flight season for Emerald Ash Borer, a terrestrial invasive insect that impacts ash trees. Minnesota has the highest volume of ash trees in the United States and Sherburne County cities hold between 6% and 13% ash trees in their community tree population. Thus, increasing the ecological resilience of forests, prairies and other vegetated communities is important to withstand increased high intensity rainfall events, floods, droughts, and other events related to a changing climate.

Forests and Prairies

Forests and prairies provide numerous environmental benefits, including benefits to water quality. Tree canopies retain rainfall from reaching the soil, fallen leaves slow down stormwater runoff peak flow and velocity, trees remove water from the soil through transpiration, and root system uptake nutrients from the soil and assist in water infiltration. In addition to removing common water nutrient pollutants such as nitrogen and phosphorus, trees may remove metals, pesticides, oils and hydrocarbons from the soil and water runoff. In one study, a sugar maple tree removed 60 mg of cadmium, 140 mg of chromium, 820 mg of nickel and 5,200 mg of lead in a single growing season (Coder, 1996). Researchers in the same study came to the conclusion that for every 5% increase in tree cover area, water runoff is reduced by 2%. Thus, protecting and enhancing tree canopy cover is a high priority for Sherburne County and is an active component of the work the Sherburne SWCD completes. The text that follows describes each of Sherburne County's major forest types.

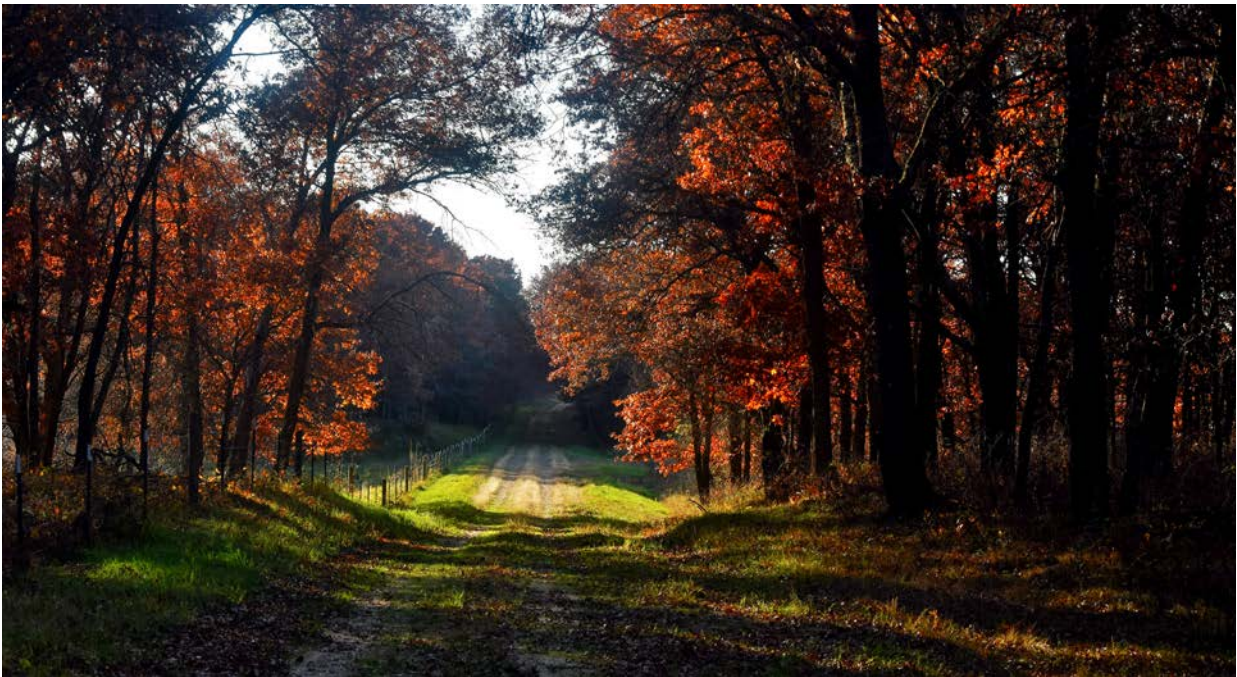


Photo 1: “Fall in the Wild”. Photo submitted by Jennifer Schmidt.

Major Forest Types

Dry Oak Forest is a deciduous forest community dominated by closely spaced pin oak, red oak and crosses of both species that have occurred through natural hybridization. Bur oak often share the canopy, although at greater spacing. The subcanopy includes black cherry, red maple and hackberry. The shrub layer consists of American hazelnut, chokecherry and prickly gooseberry – all of which are increasingly outcompeted by common buckthorn. Where buckthorn invasive is less severe, the herb layer of this forest type is diverse and includes a variety of bedstraw species, Canada mayflower, starry Solomon's seal, wild geranium, wild columbine and Pennsylvania sedge.

Challenges associated with dry oak forests:

- Invasive species: buckthorn, garlic mustard
- Oak wilt
- Bur oak blight
- Residential development

Pine Plantations at various stages make up a second major forest type. After the dust bowl, pine tree planting became almost a movement. At the time, Norway and white pine thrived in the excessively drained soil. They were planted at a close spacing to hold the soil. The close spacing became common practice and as decades passed, so did the opportunity to properly thin the stands for good tree health. As a result the majority of this forest type has gone without the necessary management and over all stand health is suffering. Many have been parceled up into rural residential developments.

Challenges associated with pine plantations:

- Residential development hinders proper management
- Pine bark beetle
- Wind throw

Urban Forests vary greatly in composition and density among the 6 communities within Sherburne County. Each community contains both older residential development with mature trees that create a full canopy and new residential development that has been placed in retired agriculture fields and thus very open and void of mature trees. New developments have tree populations that can be characterized as low in age and species diversity and poor in health. Health problems largely stem from poor choice of plant materials, defective root systems and lack of maintenance. Over all tree diversity is consistent with ideal rule of thumb which stipulates a tree population have no more than 30% any one family, no more than 20% any one genus and no more than 10% any one species. The concern with the population lies in the threats to the major species represented. Retaining tree canopy is critical for minimizing stormwater runoff and the associated pollutant load to surface water. Urban trees also play a major role in facilitating infiltration that recharges groundwater resources.

Challenges in the urban forest:

- Lack of funding for tree maintenance
- Promoting tree diversity (not maple, spruce or apple)
- Adapting to climate change

Urban forest composition is somewhat similar in Sherburne County, as the climate and soils are quite similar. However, each urban population has a slightly different population and size structure. Through random stratified surveys conducted by volunteers in the My Neighborhood Trees program in 2014, the composition of each of Sherburne County's major city urban tree population was determined. The results of these data were entered into i-Tree Streets, a United States Department of Agriculture (USDA) Forest Service created software. i-Tree is able to quantify the structure, risk and environmental services of trees. Using the calculated services one tree of a particular species provides and extrapolating across a known community's tree population, an estimate as to the environmental and aesthetic benefits of the tree

population can be calculated. The graphs in Figures 8 and 9 provide this information for six of Sherburne County's largest communities.

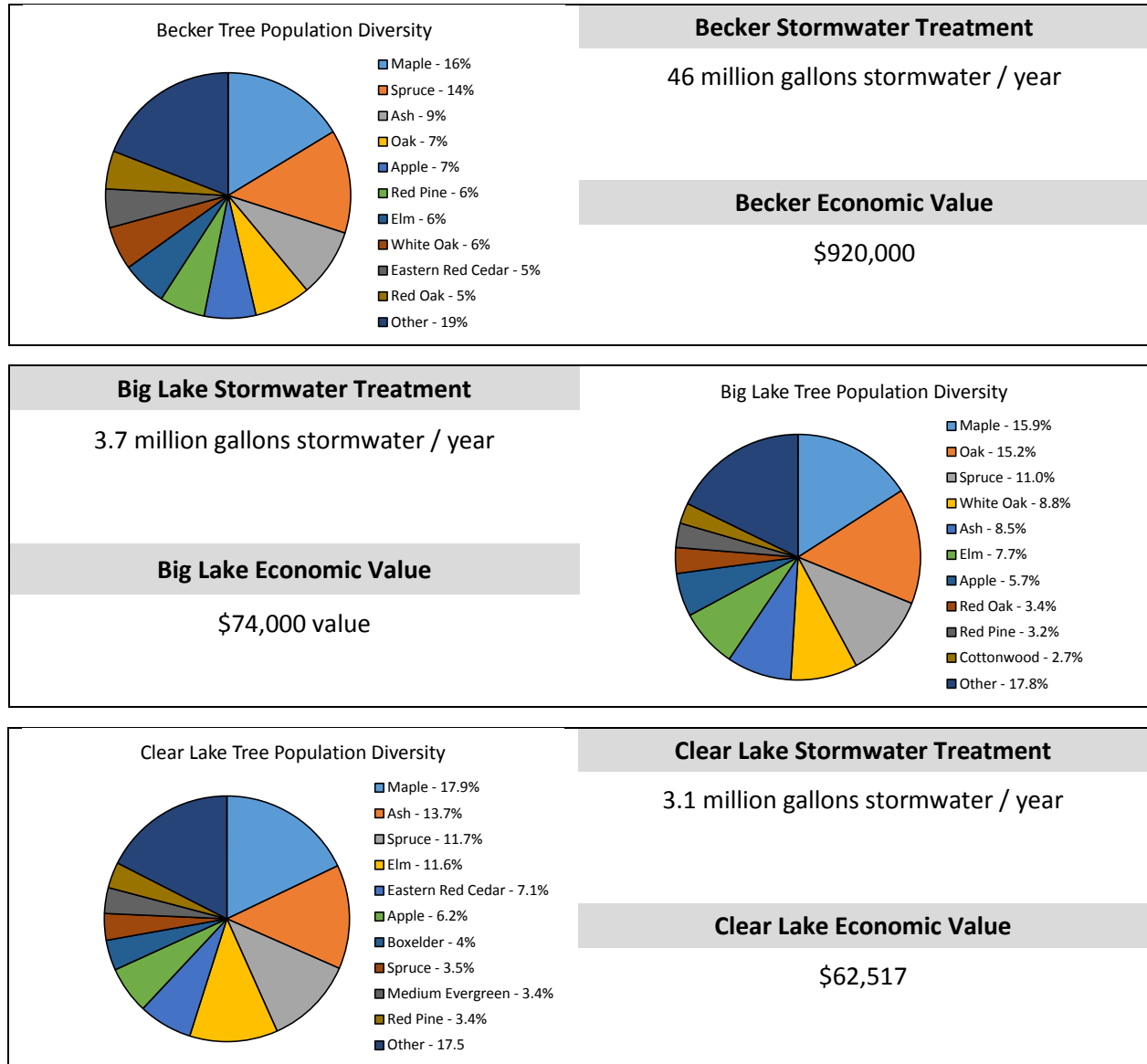


Figure 8: Diversity and financial impact of Sherburne County city tree populations.

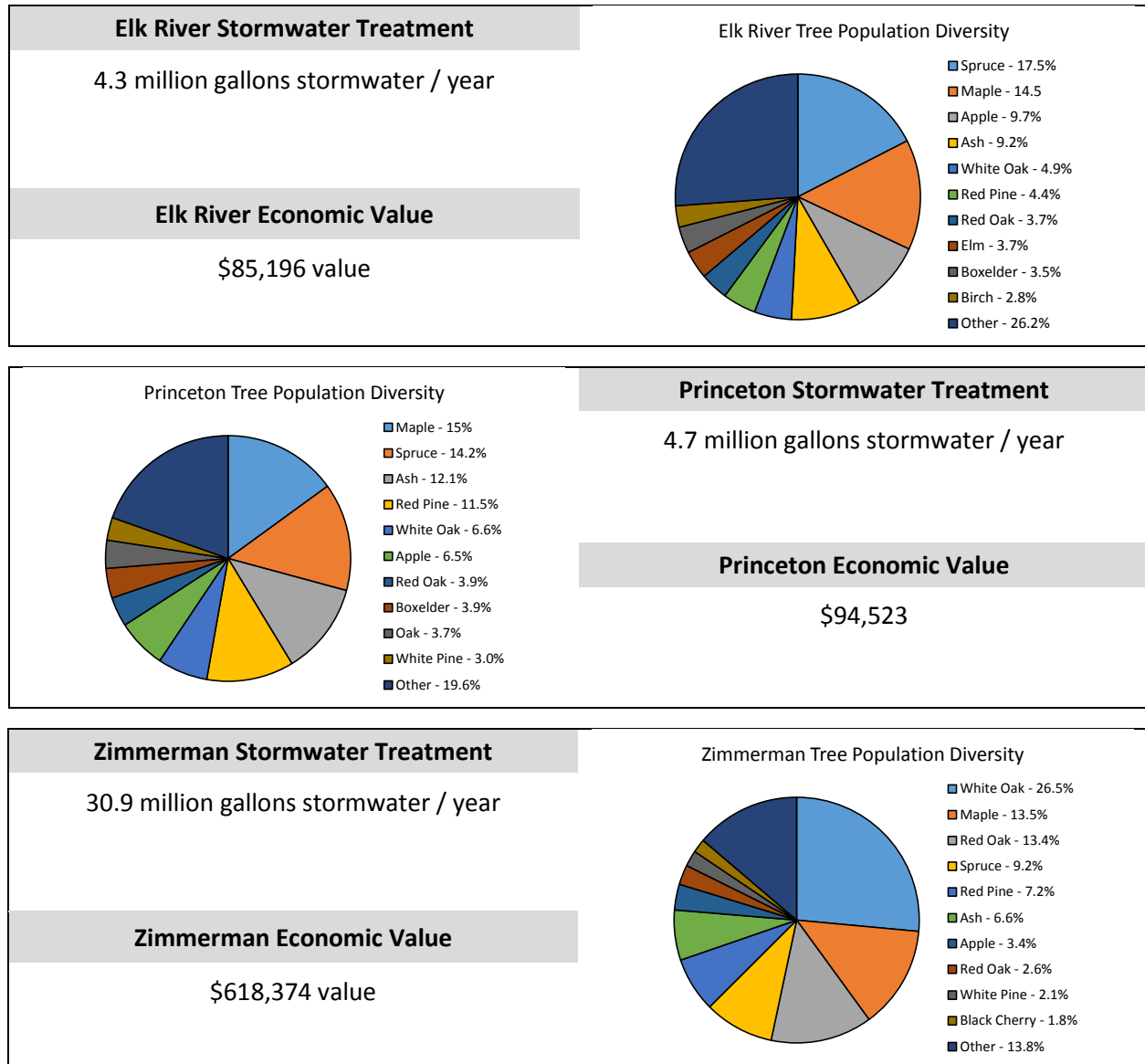


Figure 9: Diversity and financial impact of Sherburne County city tree populations (continued).

Native grasses and shrubs have long been known to intercept as much as 47% - 81% of precipitation whereas native turf grass produces far more water runoff (Weaver 1968). The root systems of native plants grow deeper than non-native species, as much as 5 to 15 feet in some cases. These root systems excel at binding the soil to reduce erosion and increase the percolation of water into the soil. Additionally, native plants are well accustomed to a region’s typical climate regime. This means they can withstand drought and require very little watering once establish. This saves on watering expenses and consumption. The text that follows describes each of Sherburne County’s major prairie types.

Major Native Prairie Types

Native (remnant) short dry prairie is a descriptor that encompasses range of xeric landscapes found throughout the county from barrens prairie to sand and gravel prairie. The soils can be described as excessively drained coarse sand. These areas are typically sparsely vegetated with exposed soil and is critical for the life stages of certain wildlife species. Plants commonly found in these areas include a variety of native warm season grasses such as hairy grama, sand reed grass, little blue stem, porcupine grass and sand dropseed. Diversity of flowering plants make these habitats critical in the protection of pollinators and can number well above 30 species in a single site. Commonly seen are hoary puccoon, leadplant, gray goldenrod, thimble wee, prairie rose and roundheaded bush clover. Much of this prairie type exists in the Sherburne National Wildlife Refuge and the Sand Dunes State Forest.

Planted native short dry prairie is distinguished from the remnant in the species composition, which is much more consistent. The most dominant grass is little bluestem, followed by side-oats grama, blue grama and June grass. Wildflowers vary year to year, dominated by black-eyed Susan, purple prairie clover, white prairie clover, wild lupine, butterfly weed and blazing star. These prairies are established on both public and private property through SWCD cost share programs. Planted prairies are scattered throughout the County on excessively drained coarse sandy soils.

Oak Savanna is a rich, diverse assemblage of grasses, broadleaf plants and widely scattered bur oak trees with sprawling branches. Tree canopy density is highly variable, being as low as 10% and potentially as high as 70%. Most typical density ranges between 25 – 50%. The composition of the understory is correlated to the canopy density and both species typical in a dry oak woodland and a dry prairie are represented. Oak savanna is among the most threatened plant communities in the world. It has dwindled to only a small fraction of the original acreage it once covered, with less than 0.01% of original savannas remaining. Remaining savannas have succeeded into forests with the absence of fire or are restricted to very poor, low fertility soils that were passed over for agriculture.

Planted mesic prairie is most often found as a buffer to surface water and in wetlands. The soils are moderately well – poorly drained. With the higher water holding capacity they are able to support the more robust plants associated with this type of plant community. Typically grasses are dominated by big bluestem and Indian grass, with some switchgrass and prairie cordgrass. Common wildflowers include marsh milkweed, boneset, joe-pye weed and Canada Goldenrod.

All prairie types provide exceptional water quality benefits. Extensive fibrous root systems facilitate infiltration for groundwater recharge and strong dense stem cover slows and filters runoff for surface water protection.

Challenges facing prairie areas:

- Invasive woody species (boxelder, Siberian elm)
- Invasive grasses and broadleaf plants (smooth brome grass, quack grass (short/dry), reed canary grass (mesic), Canada thistle (mesic))
- Herbicide drift
- Pesticide drift
- Lack of prescribed burn management
- Natural forest succession with lack of fire (oak savanna)

Crop Agriculture and Livestock Operations

Sherburne County's extensive, well drained sand plains are not the best medium for crop production. However, with proper organic matter management as well as irrigation a number of crops are able to be grown in the sandy soils. In order of acres of production, Sherburne County's top agricultural commodities include corn for grain, soybeans for beans, vegetables (all), forage land (hay, grass silage, greenchop, etc.) and potatoes. Sherburne County ranks 2nd in potato production and 5th in vegetables within the State of Minnesota. Fertilizer applications are necessary in most cases, and pivot-based irrigation systems are common due to the high permeability of the soils. Cropland production is most common on the western side of the county, as increased urban densities, gravel and rolling topography inhibit cropland production in the eastern half.

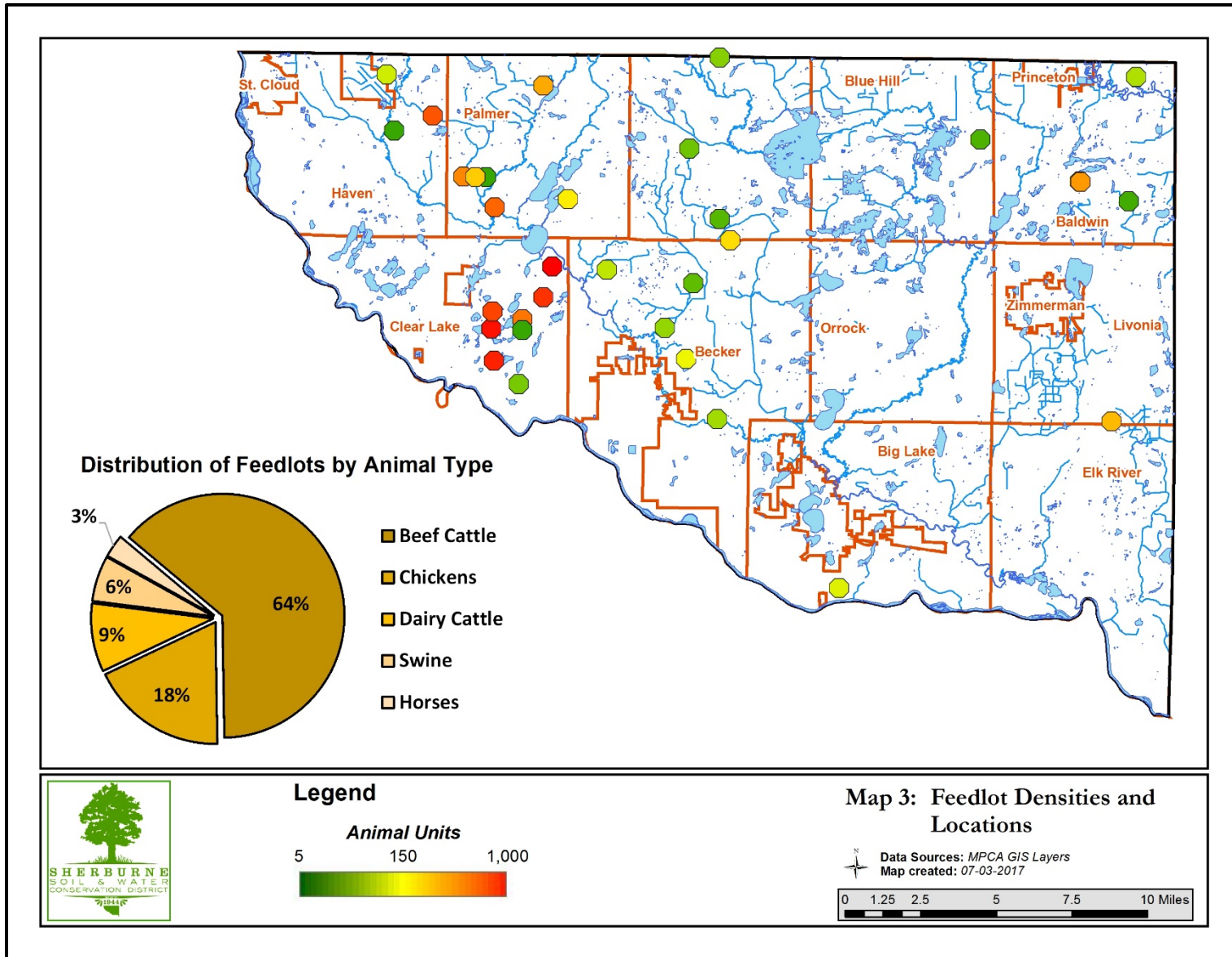
The number of Sherburne County agricultural acres have gradually decreased over time. The number of farms have dropped as well, particularly during recent years. The USDA Census of Agriculture reports a drop of the number of farms from 549 to 455 between 2007 and 2012. At the same time however, yield of crops per acre have increased for many crops. This is consistent with nationwide trends as smaller farms are conglomerated to larger operations and cropping technologies and practices become more efficient, resulting in greater harvests.

Permitted animal feedlots are relatively scarce in Sherburne County, particularly when compared to neighboring Stearns and Benton Counties. Not all feedlots must register with the authority agency, the MPCA. Registration is determined by the location and number of animals at the site. Owners of animals with 10 or more animal units located in a designated shoreland area must register. Additionally, any feedlot that holds 50 animal units or more that is located outside of a shoreland area is required to register. Livestock operations not fitting these two descriptions, or that feed animals primarily by pasturing, are not required to register with the MPCA. However, Sherburne County Zoning Ordinance also requires Land Use permit of Conditional Use Permits for feedlots depending on the zoning district and the thresholds of animal units.

In 2017 there were 33 active MPCA feedlot permits containing roughly 8,075 animal units including chickens, horses, swine, and beef and dairy cattle. The majority (30) of these are in the MRSC watershed, while 3 remain in the Rum River watershed. These numbers do not include smaller (hobby) farms and their animals, which are anecdotally thought to be relatively numerous within the county. Map 3 displays the occurrence and density of feedlot operations in Sherburne County. Though not prevalent through the county, Sherburne County does rank as 1st in pheasant rearing in the State of Minnesota.



Photo 2: "Hands on Learning". A field visit and hands-on education during the 2017 Soil Health Field Day sponsored by Sherburne SWCD and NRCS. Photo by Sherburne SWCD.



Map 3. Feedlot locations, densities, and animal types. Data collected from MPCA spatial data sets.

3.0 Purpose and Scope of the LWMP

The concepts of local water planning in Minnesota go back to 1937, where legislation first outlined shared responsibility of this task between State and local governments. This led to the creation of Minnesota's first soil and water conservation districts (SWCDs). Watershed districts (WDs) were created through legislation passed in 1955. In 1985, the State of Minnesota passed statutes 103B.301 – 103B.335, referred to as the Comprehensive Local Water Management Act. This act encourages counties to work with local and state agencies to develop and implement water management plans for their region. This request is voluntary, however state and federal funding sources require that a county have an adopted local water management plan (LWMP) that is updated every 10 years. In 1989, the Sherburne County Board delegated the responsibility of LWMP development to the Sherburne SWCD Board of Supervisors and staff. The SWCD is supported by Sherburne County staff, primarily those involved in natural resources and planning / zoning. A Sherburne County Water Planning Task Force was convened in March 1990 to assist in crafting the first LWMP in 1992. Since then, a Water Plan Advisory Committee appointed by the SWCD Supervisors and County Board have been meeting to further oversee the updates and implementation of the LWMP.

The Sherburne County LWMP was first created in 1992, and was revised in 1995, 2002, 2007, and 2012. This update, originally due in 2017, was extended through approval by the Minnesota Board of Water and Soil Resources (BWSR) to a new expiration date in February of 2018. Thus, this document may be considered as the sixth generation of strategic local water planning for Sherburne County. The Sherburne County Local Water Plan will provide a comprehensive analysis of local water and land resources while pinpointing targeted and prioritized water management goals and objectives for the next decade (2018 – 2028).

The LWMP process is designed to protect county water resources through a series of scientific dataset analyses, stakeholder input, and alternatives analyses which resulted in the identification of feasible goals, objectives and actions. Specifically, the intent of this plan is to:

1. Identify existing and potential concerns facing the county's water resources
2. Prioritize those concerns through examination of existing data as well as stakeholder feedback
3. Identify opportunities to protect or restore the county's water resources
4. Communicate an implementation plan that specifies the goals and actions the county will pursue

This document's focus is upon the entire area constituting Sherburne County, however some sections of the plan may focus on specific watersheds or sub-watersheds. The importance of considering upstream and downstream waters outside the boundaries of Sherburne County is acknowledged repeatedly throughout this document. As Minnesota water planning evolves from a jurisdictional to a watershed-based planning process (BWSR's "One Watershed, One Plan" model) it will be important to continue existing relationships with neighboring counties and manage waters collaboratively. References to completed watershed based efforts (Mississippi River-St. Cloud Watershed, Elk River Watershed, Rum River Watershed) are noted within several areas of this document. Furthermore, once a watershed-based approach has been established, it will be critical to target efforts strategically within the watershed to obtain measureable results on the most effective practices. Figure 10 graphically displays the guiding principles the Sherburne County Local Water Plan was authored under.

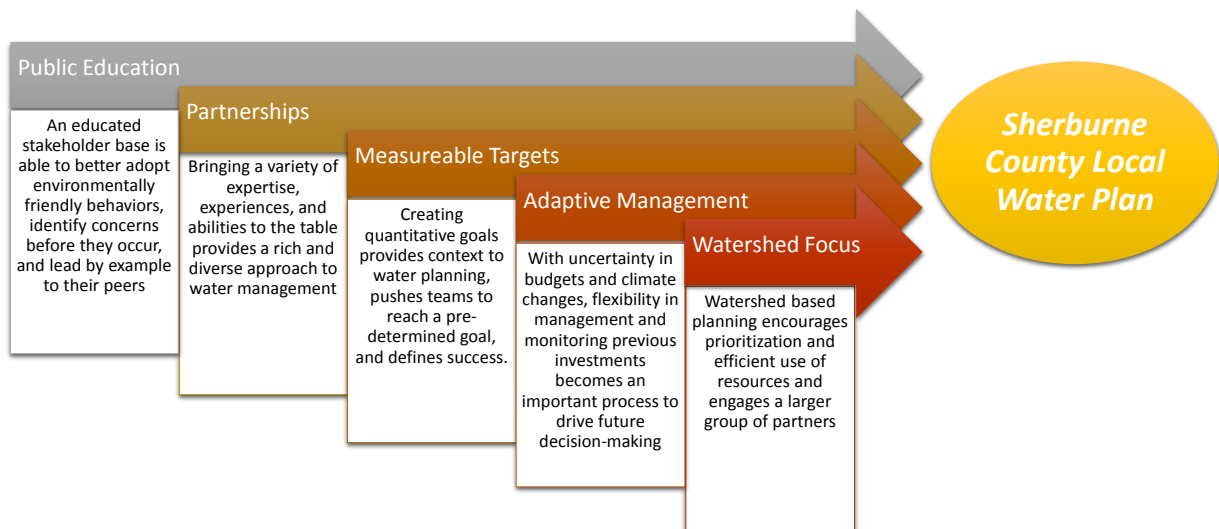


Figure 10: Sherburne County Water Planning Guiding Principles.

2007-2017 Water Plan Review

The 2007-2017 Water Plan was reviewed on an interagency level (SWCD) as well as by an independent outside effort; BWSR staff completed a Performance Review and Assistance Program (PRAP) in fall of 2016. The PRAP program was developed to assess the performance of governmental units (Sherburne County and SWCD) in administering efforts to conserve water and land resources. The Level II PRAP completed in fall 2016 was a routine, interactive review that was intended to evaluate progress on Water Plan implementation, operational effectiveness and partner relationships. A BWSR drafted PRAP Final Report highlights knowledgeable and experienced staff in the County and SWCD as well as a good working relationship between the two agencies. The PRAP report identified several areas for continued improvement:

- County: Review and evaluate environmental protection ordinances
- SWCD: Engage in discussions with NRCS to identify collaboration opportunities
- Both agencies: Move from general to quantifiable outcome goals within the next Water Plan

The 2007-2017 Water Plan identifies three priority concerns which are addressed by three goals, seven objectives and 90 action items. Of the 90 action items, 84 were found by the PRAP to demonstrate ongoing progress, while the remaining six action items had either not started (1) or were dropped as they were no longer applicable (5). The 2007-2017 LWMP specified a total cost of \$2,343,265 for implementation over each five-year period (recall the LWMP is revised/updated every five years); for the 2018 plan, the cost of implementation is estimated at a similar cost of \$2,262,500 over five years. These costs include both Sherburne County and Sherburne SWCD staff time to work on the specified Implementation Plan action items. Additionally, this estimate considers ongoing activities as well as project costs funded through county and state fund allocations as well as anticipated grant awards.

Accomplishments to Date

While the focus of this document centers on the impairments and concerns of the water resources in Sherburne County, it is important to note the accomplishments and successes of efforts completed thus far. Sherburne County has taken a proactive approach in numerous areas that impact water quality in a positive way. Many of these accomplishments were identified during a review of the 2007-2017 Water Plan through the BWSR's (PRAP). The Level II PRAP completed in fall 2016 was a routine, interactive review that was intended to evaluate progress on Water Plan implementation, operational effectiveness and partner relationships.

Strategic Planning / Reporting

- Completion of an Elk River Watershed – Multiple Impairments TMDL Project (2012)
- Development of a 5-year AIS Prevention Work Plan, updated annually (2015)
- Completion of a MR-SC Watershed WRAPS report (2014) and TMDL (2015)
- Development of County & Big Lake Community Lakes Association AIS-EDRR plan (2016)
- Completion of the Upper Mississippi River Bacteria TMDL Study and Protection Plan (2016)
- Completion of a Rum River Watershed WRAPS report and TMDL (2017)
- Updated Lake Management / Vegetation Plans (Orono – 2017, Briggs Chain – 2017)
- Formation of a Coalition of Lake Associations (Sherburne County COLA, 2017)
- Elk River Watershed 2017 Data Compilation report (2017)
- Wellhead Protection Plans (numerous, ongoing)

Data Gathering, Partnerships and Implementation

- Watershed Pollutant Load Monitoring Network partner (2015 - present)
- Implementation and continuation of annual AIS Prevention activities (2015)
- Collaboration with MCD on stormwater retrofit and campus groundwater protocols (2013 - 2017)

Awards and Recognition

- Blue Star Stormwater Management aware - City of Elk River (2016)
- MAWQCP – Four landowners (ongoing)

Grant Funded Activities

- Funding of a full-time Elk River Watershed Technician (Clean Water Funds grant application, 2017)
- Completion of Sub-Watershed Assessment retrofit studies for Lake Orono (2017), Blue Lake (collaborative project with Isanti SWCD, 2017), Birch Lake (2013), and the City of St. Cloud (2011).
- Development of a Groundwater Task Force to address groundwater nitrate concerns (2017)
- Briggs Community Partnership (2014)
- Elk River Watershed Pollution Reduction (2011)
- Elk River Bacteria Reduction (2013)
- St. Cloud Raingardens (2011 & 2013)
- SWCD cost share for shoreline restorations, well-sealing, stormwater and agricultural BMPs (ongoing)

Regulatory Compliance

- Ongoing coordination between Sherburne County and Sherburne CWCD to implement stormwater MS4 requirements (2013)
- Continued education and enforcement of ordinances for solid waste, septic systems, manure handling, floodplains, shorelands, recycling programs, household hazardous waste, (ongoing)
- 99.8% Compliance of the Minnesota Buffer Law (as of July 2017)
- GIS records of ditching systems are up-to-date, maintenance activities conducted through WCA permitting (ongoing)
- Have successfully implemented WCA and have had no net loss of wetlands in county; active wetland TEP review group meets monthly; county maintains permit database (ongoing)
- 2015 the County updated the Zoning Ordinance to include the Stormwater and Illicit discharge language to meet the State's MS4 permit requirements.
- In 2017, the County has taken over administration of the AgBMP Loan program for replacing septic systems and has seen issued 10 loans in the first 6 months for replacing failing systems.
- 33 failing Septic systems have been repaired or replaced in 2017 as a result of the County Zoning Ordinance enforcement process
- In 2017, a policy was implemented for staff to do on-site verification of soils and the separation to the seasonal high water table for all land application of septage prior to issuing permits for land spreading.

4.0 Assessment of Priority Concerns

The adoption of Sherburne County's Priority Concerns followed guidance provided by the BWSR as well as the standards set forth in Minnesota State Statute 103B.312. Details on the public notices, resolutions, public comment opportunities, etc. are outlined within the Priority Concerns Scoping Document (Appendix A). Discussions of the Priority Concerns were held in summer of 2015 and involved several local governmental units (LGU's) as well as state agencies, the Sherburne County Water Plan Advisory Committee, Sherburne SWCD staff, and the general public. Numerous topics were documented, and as discussion continued the topics were consolidated into more specific categories, which were later refined to the three concerns.

A full list of water related discussion topics, including those discussed as part of the priority concern development process, those shared within the Priority Concern Scoping Document agency review, and those discussed during development of the water plan, are outlined in Table 1.

During a September 22, 2015 committee meeting and public open house, the Sherburne County Water Plan Advisory Committee reviewed public and agency comments regarding local water resource matters. From this review, the following priority concerns were selected:

1. Surface Water Quality:
"Cumulative impacts of land use in directly connected and/or riparian areas which have a direct impact on surface water quality."
2. Ground Water Quality and Quantity:
"High levels of nitrates in groundwater and quantity in areas identified as sensitive."
3. Aquatic Invasive Species:
"Introduction and spread of aquatic invasive species and their negative effect on water quality, navigation, recreation and fisheries."

The priority concerns of six nearby counties (Benton, Wright, Mille Lacs, Chisago, Stearns, Isanti) were researched in order to gain understanding of the similarity or difference in concerns with respect to these jurisdictional regions. Surface water and groundwater quality are highlighted in six of six neighboring county's Water Plans. Aquatic invasive species was discussed within only two of the neighboring six county's priority concerns. This topic is still fairly new when compared to other water resource matters, and it is anticipated that with these nearby county's updating their local water plans the troubles that AIS present will be highlighted to a higher degree in the future. Therefore, it was concluded that Sherburne County's Priority Concerns were reasonable and consistent with those concerns identified by nearby county water planners.

Table 1: Summary of Water Plan Concern Discussion Topics

Priority Concern / Issue	Water Plan Advisory Committee	Lake Associations & Districts (COLA)	Townships & Cities	County staff	BWSR	MPCA	Dept of Health	Dept of Agriculture	USFWS	NRCS	SWCD	MN DNR
Agricultural runoff & land management	X	X	X	X					X	X	X	
Agricultural tiling	X							X	X	X	X	
Aquatic invasive species	X	X	X						X		X	X
Communication between agencies	X	X	X			X			X			
Development pressure	X		X	X	X	X						X
Drainage water management	X		X	X				X	X		X	
Enforcement of existing ordinances			X	X						X		
Environmental education	X	X	X	X		X			X	X	X	
Feedlots and livestock operations	X	X				X				X		
Fish passage / hydraulic connectivity								X	X			X
Flooding	X	X	X	X		X			X			
Groundwater quality (drinking water)	X		X		X	X	X			X	X	X
Groundwater quantity					X						X	X
Impaired or degraded lakes and rivers	X	X	X	X		X	X		X		X	X
Irrigation efficiency			X			X				X	X	X
Lake Management		X				X		X			X	
MAWQCP	X						X	X		X	X	
Nitrogen Management	X	X	X	X				X		X	X	
Private land conservation									X			X
Protecting high quality public lands									X		X	X
Riparian vegetation quality / quantity	X	X	X			X			X	X	X	X
Septic systems	X	X	X			X					X	
Stormwater runoff	X	X	X								X	
Surface drinking water protection			X				X					
Unused wells							X					
Urban forestation								X			X	
Water storage	X	X						X				
Wellhead protection							X					
Wetland quality / quantity	X			X		X					X	
Wind / Water Erosion		X						X			X	
Implementation Topic												
Aligning with state priorities					X	X						
Targeted and measurable goals					X	X					X	
TMDL / WRAPS Implementation		X			X	X					X	X
Watershed based approach		X			X	X					X	X

Surface Water Quality

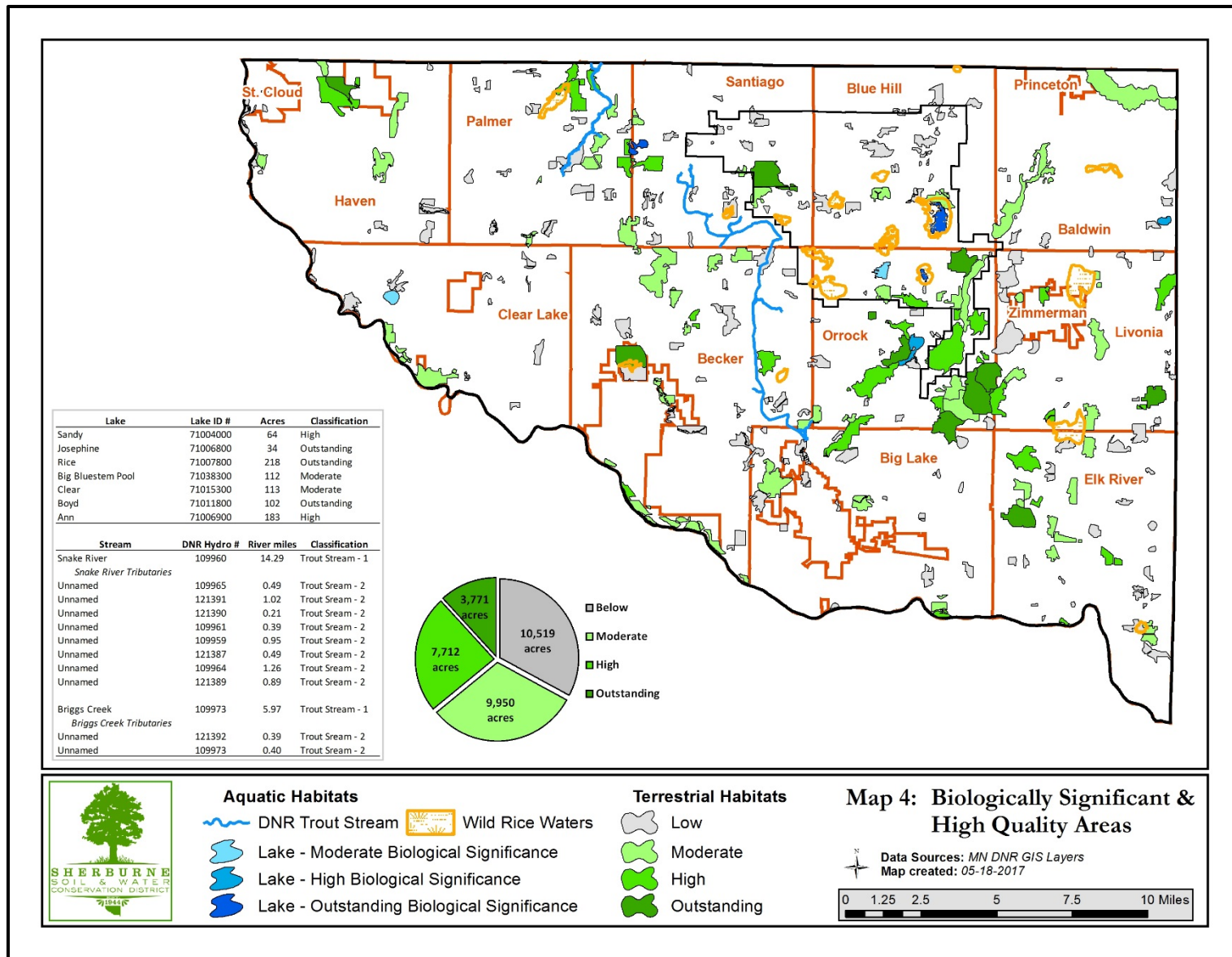
Sherburne County holds 125 named waterbodies, 493 miles of streams, and about 53,000 acres of wetlands. The DNR identifies public (protected) waters and wetland within Sherburne County pursuant to Minnesota Statutes, Section 105.391, Subd. 1 (Appendix B). The county's southern border follows roughly 47 miles of the 2,350 mile Mississippi River, the second-longest river in the United States. Waters in the county vary greatly, from completely undeveloped wetlands, lakes and sloughs within the Sherburne National Wildlife Refuge to highly developed, urban lakes. This section of the water plan outlines and clarifies the current status of the surface water quality in the county, identifying waters of high quality (to be protected) and those of particular concern (to address through restoration).

Habitats of High Quality / Significance

Several areas of Sherburne County habitats are classified as holding rich biodiversity, exceptional fauna, or unique characteristics. Several entities maintain databases of these regions, both for aquatic and terrestrial areas. The Minnesota County Biological Survey (MCBS) tracks sites of biological significance, which include terrestrial and wetland zones. The significance of the biodiversity within the site is determined based upon the number of rare species, quality of native plant communities, size of the site, and context within the landscape. Map 4 displays the acreage of Sherburne County sites of biological significance. A similar system is used by the MN DNR to track lakes. The MN DNR assess lakes across the state and classifies them into categories of Outstanding, High, and Moderate biological significance. As seen in Map 4, several Sherburne County lakes are included in this list. Due to their unique characteristics, these lakes should be prioritized in protection efforts.

One aquatic plant is wild rice that is considered biologically significant, as well as culturally significant, is wild rice (*Zizania spp.*). Minnesota has more acres of wild rice than any other state in the United States, and Sherburne County is known to hold at a minimum 3,420 acres (Map 4). The plant grows best in lakes, streams and marshes where water is between six inches and three feet deep and sediments are soft and organic-rich. It is a grain rich in protein which is estimated by the MN DNR to produce at least \$2 million to the state's economy each year. In addition to a food source for humans, a variety of wildlife enjoy the plant as a source of food and shelter (particularly waterfowl). Wild rice has been the center of the Ojibway Indian diet and culture for centuries; an Ojibway prophecy tells of the tribes following a prophecy from the Creator to a land where food grows on the water, which was the region near Lake Superior where wild rice grows. There are several MN DNR designated wild rice waters within Sherburne County. Because of the plant's rich biological and cultural significance, these waters may soon be subject to sulfate standards, as research is indicating higher sulfate concentrations can be detrimental to early-stage wild rice growth.

In addition to these high quality ecosystems, Sherburne County also contains several MN DNR designated trout streams (which are often considered to be of higher quality). Briggs Creek and the Snake River, as well as several unnamed tributaries, fall under this classification. However, a 2011 MN DNR report on Briggs Creek describes conditions that are unfavorable for trout including warm stream temperatures and little to no suitable spawning substrate (Pelham, 2011). Trout were last observed in the stream in 1980, when yearling brown trout stocking was discontinued. The middle portion of the Snake River contains adequate temperatures to support cold water fishes, however a low gradient and sinuosity coupled with unfavorable substrate composition create unfavorable conditions within the stream (Altena, 2001). Improvements in tree canopy cover, sinuosity, runoff and substrate conditions are necessary to allow these streams to host trout species once again.



Map 4. Biologically Significant and High Quality Areas in Sherburne County. Designations and spatial data sets from MN DNR.

Impaired Waters

Sherburne County experiences both urban and rural land development. Urban development continues to increase as the population steadily grows. The increase of development has occurred not only in the watershed, but along the shorelines of lakes and streams as well. Thus, nutrient loading to the lakes and streams increases. As loading increases to the shallow lakes that are common in Sherburne County, the influence of internal nutrient recycling is exacerbated, and the consequences of increased algae content and aquatic plant mass follows.

The Clean Water Act (1972) requires the State of Minnesota and MPCA to assess all waters to determine if they meet water quality standards, create a list of waters that do not meet these standards, and set pollutant-reduction goals needed to restore these impaired waters (TMDL studies). Waterbodies are assigned “beneficial use classes” and water quality standards were calculated by defining how much of a pollutant can be present before a waterbody no longer can be utilized for its designated use class (Table 2). Currently, a number of lakes and streams in Sherburne County are included on the State of Minnesota’s Impaired Waterbodies list. Map 5 as well as Tables 3 and 4 outline the impaired lake and stream segments, their beneficial use classes, and their respective impairments. Tables 3 and 4 also reference TMDL studies completed in 2007 (statewide mercury TMDL), 2012 (Elk River Watershed TMDL), 2015 (Mississippi River – St. Cloud Watershed TMDL) and 2017 (Rum River Watershed TMDL).

Table 2. Beneficial Use Classes for Minnesota Waters. Adapted from MN Admin Rules Chp. 7050.0140

Class 1: Domestic Consumption	Sources of supply for drinking, culinary or food processing
Class 2: Aquatic Life / Recreation	Fish, amphibians, bathing, boating, or other recreation
Class 3: Industrial Consumption	Industrial processes, cooling water, commercial purposes
Class 4: Agriculture & Wildlife	Stock watering, irrigation, waterfowl or wildlife habitat
Class 5: Aesthetics & Navigation	Transportation, fire prevention, navigation
Class 6: Other Uses & Border Waters	Other uses not listed, waters bordering states or nations
Class 7: Limited Resource Value	Intermittent or low flow waters, protected for secondary use

Mercury contamination represents the largest proportion of impaired waters in Minnesota. The presence of mercury in fish tissue triggers an impairment for Aquatic Consumption. Larger, predatory fish hold the highest concentrations of mercury as the element tends to bioaccumulate up the aquatic food chain. Atmospheric deposition supplies more than 99.5% of the mercury found in the fish tissue from Minnesota lakes. The bulk of this mercury is anthropogenic, though 30% is estimated by the MPCA to be derived from natural sources such as volcanoes. There are no known natural sources in Minnesota, and 90% of mercury deposition is believed to originate from outside of the state. A state-wide mercury TMDL was developed by MPCA and approved by the Environmental Protection Agency in March of 2007. A TMDL Implementation Plan calls for reduction of both water discharges and air emissions from all states, and specifies how progress will be tracked through a Monitoring and Evaluation Plan.

Both of the major watersheds in the county have complete TMDLs (MR-SC, 2015 and Rum River, 2017), in addition to the largest subwatershed in the county (Elk River Watershed TMDL, 2012). These TMDLs estimate loads and pollutant reduction requirements pertaining to nutrient, dissolved oxygen and fecal coliform / *E.coli* impairments. Table 2 and 3 indicate several impaired waterbodies without a TMDL; not included in previous TMDL studies due to budgetary constraints and unfortunate timing. The MR-SC watershed WRAPS report addressed impaired waters up to the 2010 Minnesota Impaired Waters list.

Table 3. Sherburne County impaired lakes or reservoirs.

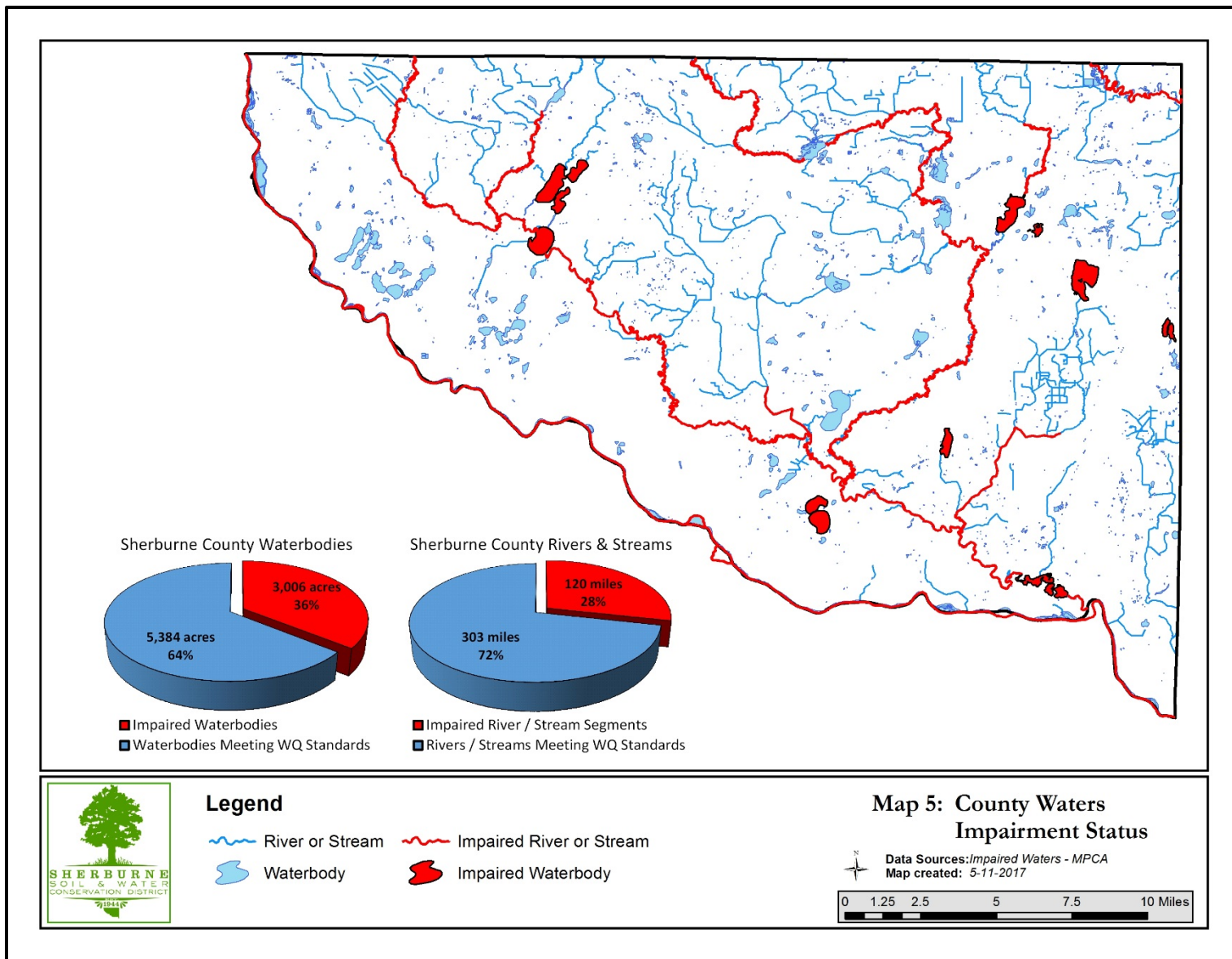
Waterbody	Description	Use Class	Year Listed	DNR Lake #	Affected use	Impairment addressed	TMDL Status
Big Lake	At City of Big Lake	2B, 3C	2007	71-0082-00	Aquatic Consumption	Mercury in fish tissue	Approved (2007)
Birch Lake	6 mi NW of Elk River	2B, 3C	2011	71-0057-00	Aquatic Recreation	Nutrient/Eutrophication Biological Indicators	Approved (2015)
Briggs Lake	3 mi NE of Clear Lake	2B, 3C	2008	71-0146-00	Aquatic Recreation	Nutrient/Eutrophication Biological indicators	Approved (2015)
Diann Lake	5 mi S of Princeton	2B, 3C	2011	71-0046-00	Aquatic Recreation	Nutrient/Eutrophication Biological Indicators	Required
Elk Lake (“Big Elk”)	2 mi NE of Clear Lake	2B, 3C	2006	71-0141-00	Aquatic Recreation	Nutrient/Eutrophication Biological indicators	Approved (2015)
Elk Lake (“Little Elk”)	5 mi SW of Princeton	2B, 3C	2011	71-0055-00	Aquatic Recreation	Nutrient/Eutrophication Biological Indicators	Required
Fremont Lake	2 mi NE of Zimmerman	2B, 3C	2012	71-0016-00	Aquatic Recreation	Nutrient/Eutrophication Biological Indicators	Required
Julia Lake	5 mi NE of Clear Lake	2B, 3C	2008	71-0145-00	Aquatic Recreation	Nutrient/Eutrophication Biological indicators	Approved (2015)
Orono (Upper)	At City of Elk River	2B, 3C	2008	71-0013-01	Aquatic Recreation, Consumption	Nutrient/Eutrophication Biological indicators, Mercury in fish tissue	Approved (mercury, 2007 and nutrients, 2015)
Orono (Lower)	At City of Elk River	2B, 3C	2008	71-0013-02	Aquatic Recreation, Consumption	Nutrient/Eutrophication Biological indicators, Mercury in fish tissue	Approved (mercury, 2007 and nutrients, 2015)
Mitchell Lake	At City of Big Lake	2B, 3C	2007	71-0081-00	Aquatic Consumption	Mercury in fish tissue	Approved (2007)
Rush Lake	3 mi NE of Clear Lake	2B, 3C	2008	71-0147-00	Aquatic Recreation	Nutrient/Eutrophication Biological indicators	Approved (2015)
East Hunter	Lake or Reservoir	2B, 3C	2016	71-0023-00	Aquatic Recreation	Nutrient/Eutrophication Biological Indicators	Completed (2017)
West Hunter	Lake or Reservoir	2B, 3C	2016	71-0022-00	Aquatic Recreation	Nutrient/Eutrophication Biological Indicators	Completed (2017)

Table 4. Sherburne County impaired river and stream segments.

Reach	Description	Use Class	Year Listed	Assessment Unit ID	Affected use	Impairment addressed	TMDL Status
Battle Brook	CD 18 to Elk LK	2C	2006, 2011	07010203-535	Aquatic Life, Aquatic Recreation	Aquatic macroinvertebrate bio-assessments (Low DO), Fish bioassessments, E. coli	Required
Elk River	Mayhew Ck to Rice Cr	2B, 3C	2007, 2012	07010203-507	Aquatic Consumption, Aquatic Recreation	Mercury in fish tissue, E. coli	Approved (mercury 2007), Required (E. coli)
Elk River	Rice Cr to Elk Lk	2B, 3C	2007	07010203-581	Aquatic Consumption	Mercury in fish tissue	Approved (2017)
Elk River	Elk Lk to St. Francis R	2B, 3C	2007, 2012	07010203-579	Aquatic Consumption, Aquatic Life, Aquatic Recreation	Mercury in fish tissue, Fish bioassessment, turbidity, Fecal coliform	Approved (mercury, 2007; fecal coliform and turbidity, 2012). Required (fish)
Elk River	St. Francis R to Orono Lk	2B, 3C	2012	07010203-548	Aquatic Consumption, Aquatic Recreation	Mercury in fish tissue, E. coli	Approved (mercury, 2007) Required (E. coli)
Elk River	Orono Lk to Mississippi R	2B, 3C	2007	07010203-525	Aquatic Consumption	Mercury in fish tissue	Approved (2007)
Mississippi River	University Dr S bridge to St Cloud Dam	1C, 2B, 3C	1999	07010203-575	Aquatic Consumption	Mercury in fish tissue	Approved (2007)
Mississippi River	Sauk R to Clearwater R	1C, 2B, 3C	1999, 2009	07010203-728	Aquatic Consumption, Aquatic Recreation	Mercury in fish tissue, E. coli	Approved (2007), Required (E. coli)
Mississippi River	St. Cloud Dam to Clearwater R	1C, 2B, 3C	1999	07010203-513	Aquatic Consumption	Mercury in fish tissue	Approved (2007),
Mississippi River	Clearwater R to Elk R	1C, 2B, 3C	1999	07010203-510	Aquatic Consumption	Mercury in fish tissue	Approved (2007)
Mississippi River	Clearwater R to Crow R	1C, 2B, 3C	2002	07010203-729	Aquatic Life, Recreation	Fish Bioassessments, Fecal coliform	Required

Table 4 (continued). Sherburne County impaired river and stream segments.

Reach	Description	Use Class	Year Listed	Assessment Unit ID	Affected use	Impairment addressed	TMDL Status
Mississippi River	Elk R to Crow R	1C, 2B, 3C	1998	07010203-503	Aquatic Consumption	Mercury in fish tissue, PCBs in fish tissue	Approved (mercury, 2007) Required (PCBs)
Mississippi River	Crow R to NW Anoka city	1C, 2B, 3C	1998	07010203-567	Aquatic Consumption	Mercury in fish tissue, PCBs in fish tissue	Approved (mercury, 2007) Required (PCBs)
Rice Creek	Rice Lk to Elk R	2C	2011	07010203-512	Aquatic Life, Aquatic Recreation,	DO/Turbidity, E. coli,	Approved (DO, turbidity 2015) Required (E. coli)
Rum River	W BR Rum R to Stanchfield Cr	2B, 3C	1999	07010207-512	Aquatic Consumption	Mercury in fish tissue	Approved (2007)
Snake River	Unnamed Cr to Eagle Lk	1B, 2A, 3B	2012	07010203-529	Aquatic Recreation	E. coli	Approved (2015)
St. Francis River	Headwaters to Unnamed Lk	2B, 3C	2011	07010203-700	Aquatic Life, Aquatic Recreation	Aquatic macroinvertebrate bioassessments, Fish bioassessments, E. coli	Required
St. Francis River	Unnamed Lk to Rice Lk	2B, 3C	2012	07010203-704	Aquatic Life	Fish bioassessment	Required
St. Francis River	Rice Lk to Elk R	2B, 3C	2012	07010203-702	Aquatic Life	Fish bioassessment	Required
Tibbits Brook	Rice Lk to Elk R	2C	2012	07010203-522	Aquatic Recreation	E. coli	Approved (2015)
Snake River	Unnamed Cr to Eagle Lk	1B, 2A, 3B	2012	07010203-529	Aquatic Recreation	E. coli	Approved (2015)
Trott Brook	Headwaters to Rum R	2B, 3C	2015	07010207-680	Aquatic Life	Dissolved oxygen	Approved (2017)



Map 5. Sherburne County Impaired Waters. Data obtained from MPCA databases.

Shoreland Management Standards and Ordinances

The immediate shoreland of lake or stream plays a critical role in the health of that waterbody. A well vegetated shoreland increases the opportunity to filter surface water runoff before it reaches the water, removing pollutants that would otherwise impact the aquatic ecosystem. Additionally, a shoreland that is left in a natural state offers habitat for amphibians, mammals, and birds which in turn help to make a lake a diverse and healthy environment. Development along a shoreland often results in a decrease in beneficial emergent vegetation within the water, such as bulrushes and reed species. These plants are utilized greatly by fish and aquatic insects for spawning, young rearing, food, and cover from predation. As shorelands become developed, often woody structures such as downed trees are removed as well. These structures provide a second type of diverse habitat that allows for fish sanctuary and substrate for insects and algae. The shoreland zone is arguably the most easily controlled area of a watershed that can provide water quality protection, but is unfortunately its potential impacts are often overlooked and as a result this zone can become heavily developed quite quickly.

Lakes and rivers in Sherburne County are classified and managed according to standards set forth at both the state and local level. The State of Minnesota categorizes lakes within one of three shoreland development standard categories. The classification determines the state-minimum shoreland standards for sanitary code, minimum lot size, building setbacks, land use, BMPs, etc. The classification categories include Natural Environment Lakes, Recreational Development Lakes and General Development Lakes. Sherburne County lake classifications can be viewed on the MN DNR's Shoreland Management Lake Classifications website.

Sherburne County includes two rivers that are included on the state's Scenic and Recreational River classifications. The uses and classification of the rivers and their adjacent lands are outlined in the Sherburne County Zoning Map and include the following areas:

- Scenic River Management Zone: All lands within the Scenic River District of the Rum River as identified in Minnesota Regulations NR 2720 and all lands along the Mississippi River which are between the State Highway #24 bridge at Clearwater and the St. Cloud City limits as identified in Minnesota Regulations NR 2420.
- Recreational River Management Zone: All lands along the Mississippi River which are downstream from the State Highway #24 bridge at Clearwater as identified in Minnesota Regulations NR 2420.

Sherburne County Zoning Ordinances includes Section 14 for the Shoreland District. These ordinances govern the permitting processes, variance requests, lot area and width standards, placement and height of structures, setback requirements, shoreland alteration guidance, stormwater management, special provisions, nonconformities, and other aspects pertaining to the shoreline environment. As of fall 2017, these ordinances are being revised; a public comment period will be held in 2018 with incorporation of new shoreline ordinances likely occurring in 2018/2019.

Wetlands

Sherburne County's 53,000 acres of wetlands constitute 50%-80% of the original pre-settlement wetland acreage, a large number considering some counties have lost more than 90% of their original wetlands. Wetlands provide numerous ecosystem benefits, including "hidden" benefits such as playing a critical role in groundwater recharge by providing a holding space for water until it can slowly seep underground. These areas also serve a role in flood control, retaining water that would otherwise flush down streams and rivers and gather at a faster pace. Sedimentation and nutrient control are additional benefits that wetlands provide, often filtering incoming water and producing cleaner water downstream. The wildlife benefits that wetlands produce are immense, with amphibians, mammals, and birds all spending a portion of their lifecycles within wetlands. Wetlands are the most biologically diverse ecosystems on the planet, hosting not only a great variety of mammals, reptiles, insects and birds but a plethora of aquatic and aquatic/terrestrial (transitional) plant species.

The Sherburne National Wildlife Refuge includes the largest contiguous area of wetlands within the county. During pre-settlement times, 44% of the refuge contained wetlands. This number dipped to 34% during the 1930's, when heavier settlement and extensive drainage of the region began. Upon establishment of the refuge and construction of an impoundment system, the wet conditions returned to great portions of the refuge. Today, the total wetland cover represents 46% of the Sherburne National Wildlife Refuge's 30,575 acre area.

The Wetlands Conservation Act (WCA) of 1991 calls for "no net loss" of wetlands, stating that any drained or filled wetlands must be replaced with created or restored wetlands of equal or greater size and quality (Minn. Stat. 103G.222 subd.1). The WCA legislation authorized the Board of Water and Soil Resources (BWSR) to adopt rules regarding wetlands. Since the adoption of WCA, the Sherburne County Zoning Office has been the Local Government Unit (LGU) for this area and is responsible for the administration of WCA rules.



Photo 3: "With Healthy Waters, Nature Grows". Photo submitted by Sanford Smith.

Minnesota Buffer Law and Other Watercourses

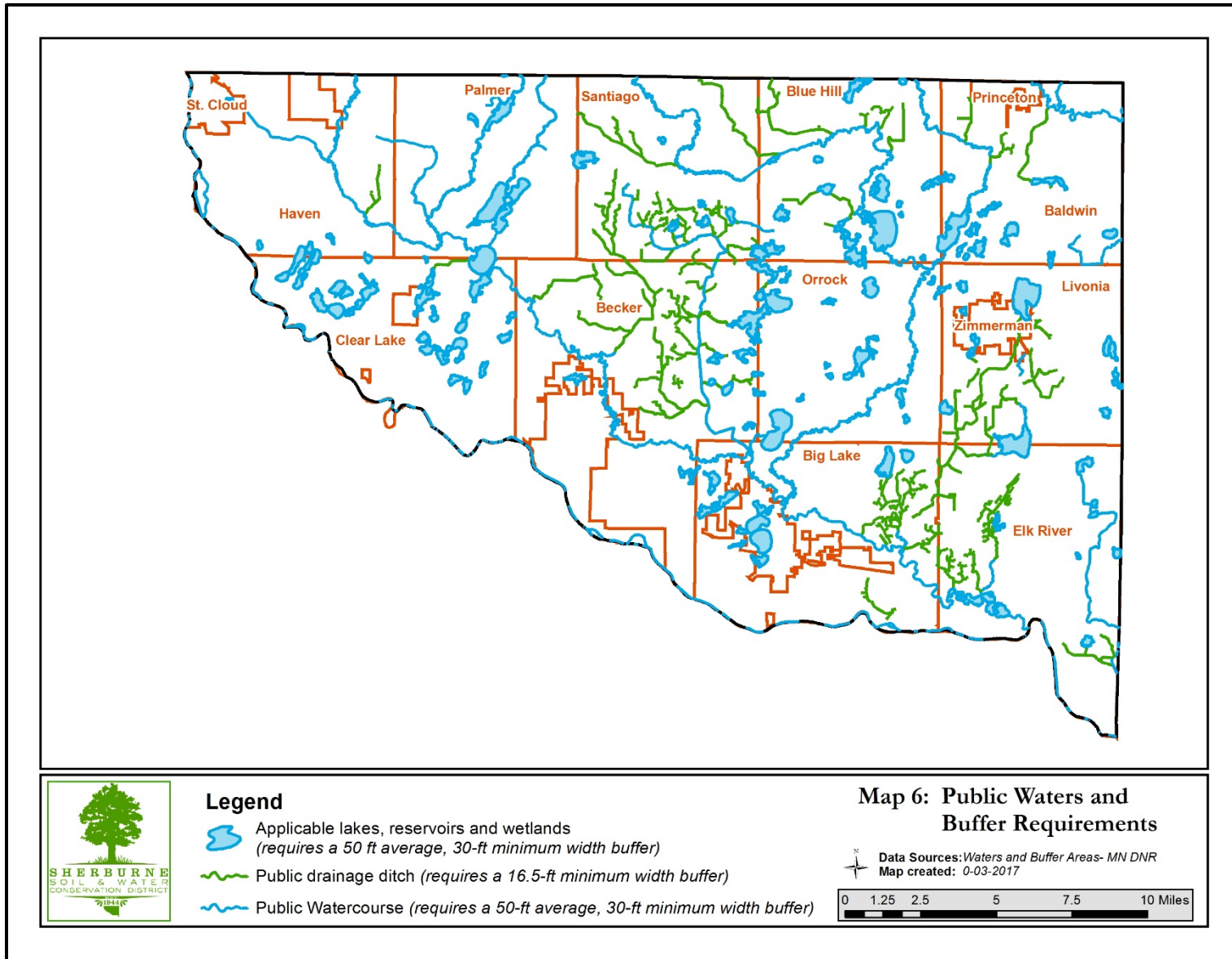
Many of the county's waters are identified and have targeted reduction or protection strategies through a number of measures. For example, the TMDL and WRAPS studies that have taken place in the MR-SC and Rum River Watersheds identified impaired waters slated for restoration as well as high-quality waters prioritized for protection. These waters are largely included within the MN DNR's Public Waters Inventory Maps for Sherburne County and meet criteria set forth in Minnesota Statutes, Section 103G.005.

The Public Waters Inventory Maps formed the basis of the detailed maps produced by the MN DNR for the 2015 Buffer Initiative, later becoming the Minnesota Buffer Law (Chp 85 S.F. 2503). Public drainage systems (ditches) were added to the public waters (primarily rivers, lakes, streams and wetlands) to complete the final map. Public waters require an average of a 50-ft buffer (30-ft minimum) of perennial vegetation while public ditches require a 16.5-ft perennial buffer (Map 6).

Sherburne SWCD reviewed the MN DNR Buffer Maps in fall of 2016 to determine potentially non-compliant and in December 2016, letters were sent to these parcel property owners informing them of the Buffer Law and their potential non-compliance and inviting them to a public meeting held at the City of Elk River Fire Hall on January 16, 2017. SWCD staff notified all property owners of their intent to provide technical and financial assistance as possible. As of July 2017, Sherburne County was estimated to be at 99.8% compliance with the Minnesota Buffer Law.

While the Buffer Law outlines protection measures to be taken for the vast majority of Sherburne County waterbodies, it was acknowledged that some watercourses present in the county that were not considered public waters or a part of the public drainage system. These waterbodies primarily consist of private ditches. However, other permanent or intermittent watercourses might exist which have escaped detection during the Public Waters Inventory identification process. The 2015 Minnesota Buffer Law requires that SWCD's across the state acknowledge and identify these "Other Watercourses" through formal resolution. Following conversations with County Planning and Zoning staff as well as the Sherburne County Water Plan Advisory Committee, the Sherburne SWCD Board of Supervisors passed a resolution describing these watercourses in text form, as opposed to identifying them on a map. Watercourses are purposely defined vaguely within the resolution to encompass the great diversity of potential applications. Thus, the Other Watercourses resolution may address numerous waters that are not included in the MN DNR Buffer Map - lakes, ponds, seasonal ponds, streams, rivers, ditches (private or public), open or non-open water wetlands, intermittent waterways, seeps, dry washes, or "...any area where water flow concentrates (permanent or intermittent flows)..." (Appendix B).

Sherburne SWCD will continue to work with public and private landowners to reach and maintain 100% compliance of Minnesota's Buffer Law. Each county was provided the opportunity to act as the enforcement agent for administering the Buffer Law, and in June 2017 Sherburne County declined this responsibility. Thus, the responsible party for Buffer Law enforcement in Sherburne County lies with the BWSR.



Map 6. Public Waters Inventory and Buffer Requirements. Data obtained from MN DNR.

Agriculture Programs

Numerous agricultural-related programs are overseen by Sherburne SWCD and federal entities such as the Natural Resource Conservation Service (NRCS) and Farm Service Agency (FSA). These programs are aimed at reaching multiple goals, including improving crop yields, preserving soil quantity and quality, and reducing impacts on water resources.

Conservation Reserve Program (CRP) – The CRP provides technical and financial assistance to farmers to address soil and water concerns on their property. This program is administered by the Farm Service Agency (FSA) with Natural Resource Conservation Service (NRCS) providing technical land eligibility determinations, conservation planning and practice implementation. The goal of the program is to reduce erosion, improve water quality, establish wildlife habitat, protect the ability to provide food and fiber and enhance forests and wetlands. This is achieved through encouraging farmers to convert highly erodible cropland or other environmentally sensitive areas to vegetative cover. In return, landowners receive an annual rental payment for the term of a multi-year contract. Cost sharing for cover practices is an element of the program. As of July 2017, Sherburne County had 91 CRP contracts covering 1,114 acres.

Conservation Stewardship Program (CSP) – Where CRP is a program that sets marginal agriculture land aside for habitat and resource benefits, CSP is a program designed for working land. Through the CSP, landowners are able to maintain and improve existing conservation practices as well as adopt new conservation practices to address resource concerns. These concerns may relate to soil, water, air or habitat quality. Annual payments are provided for these initiatives, and CSP is available to any operation size or type of crops produced – so much that the land is currently being operated upon. In July 2017, there were six active CSP contracts in Sherburne County covering 5,727 acres.

Environmental Quality Incentives Program (EQIP) – EQIP is an NRCS administered program which provides financial and technical assistance to agricultural producers to plan and implement conservation practices. Eligibility must be met for the program, but once met producers can receive payment for implementing a number of BMPs on cropland, rangeland, pastureland, non-industrial private forestland and other farm or ranchlands. Contracts may last up to 10 years and payments reach up to an aggregate of \$450,000 per producer. In July 2017, there were nine active EQIP contracts in Sherburne County covering 1,216 acres.

Minnesota Agricultural Water Quality Certification Program (MAWQCP) – The MAWQCP is a voluntary program sponsored by the MDA which recognizes agricultural landowners who take a lead in implementing conservation practices that protect Minnesota's water. By reaching MAWQCP certification, these landowners are deemed to be in compliance with any new water quality rules enacted during their period of certification (regulatory certainty), may promote their business as being protective of water quality (recognition) and can obtain specially designated technical and financial assistance for water quality BMP implementation (technical assistance priority). As of July 2017, Sherburne County has four agricultural producers enrolled within this program.

Women and Historically Underserved Producers (HUP) - 1.6 billion women rely on farming for their livelihoods worldwide and produce more than 50% of the world's food (Root Capital, 2017). In the United States, over 969,000 women identify as farmers and are responsible for production of over 300,000,000 acres of land, providing a \$12.9 billion economic impact. One in four Minnesota farmers are female (27,800 total) and provide a \$397.7 million impact to the state (USDA 2017). However, income differences, property ownership, representation in policy-making organizations, access to resources, and

other disparities exist with female agricultural producers. The same might be said for HUPs, which include socially disadvantaged farmers, beginning and/or limited farmers, or producers with unique circumstances which may exclude them from opportunities to increase business, yield, or conservation measures. With all producers receiving equal access to farming resources and having equal voices in decision-making processes, opportunities for conservation would be more prevalent.

Point Source Discharges

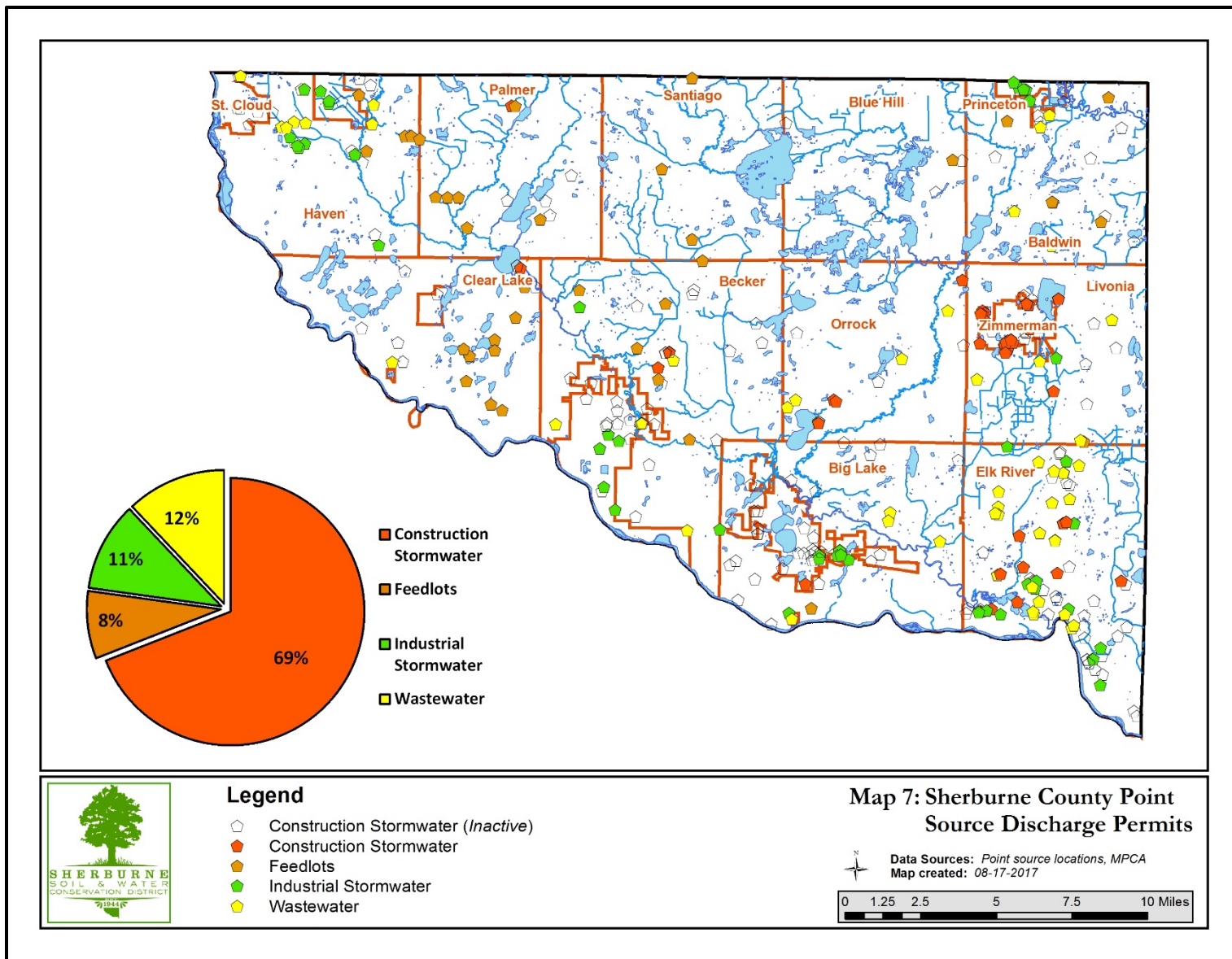
In the State of Minnesota, the MPCA oversees operators of point source discharges. Depending on the type and scope of operation, a permit may be required as well as compliance monitoring and reporting. Permits may be issued through the Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination System (NPDES), as delegated to the MPCA by the EPA, or Minnesota's State Disposal System (SDS). While NPDES program permits generally are for surface water discharges, while SDS permits are primarily issued by the State of Minnesota for non-surface water discharging conditions or for a land application facility. Some examples of operations include municipal, domestic or industrial wastewater discharges, animal feedlots, mining, dredging, ballast water, or others.

As of July 2017, MPCA records indicate that there were 465 active point source discharge permits issued in Sherburne County (Map 7). This number includes discharge permits that ended in 2018 at earliest. Permit categories include construction stormwater, feedlots, industrial stormwater and wastewater, with construction stormwater projects comprising nearly 70% of the total permitted activities.

Municipal Separate Storm Sewer Systems (MS4)

Stormwater runoff can contain a diverse assemblage of pollutants including pesticides, fertilizers, oils, metals, pathogens, road salt, sediment, debris and nutrients. Thus, the management of urban as well as rural stormwater runoff is very important for restoring or protecting surface waters. Local public entities that own or operate a MS4 are in a position to reduce the transport of these pollutants into our lakes and streams. An MS4 is a series of conveyance systems that direct stormwater. These include roads and municipal streets, catch basins, curbs, gutters, ditches, storm drains, etc. These are owned or operated by a public entity. The Clean Water Act and Minnesota Rule 7090 determine which MS4's are subject to stormwater regulations. These determinations are based primarily on population size as well as classification of nearby receiving waters. In the State of Minnesota, the MPCA regulates and permits MS4s and assists these entities in quantifying and managing stormwater pollution. Sherburne County permitted MS4's include Sherburne County, the City of Elk River, City of Big Lake, Big Lake Township, Haven Township and the City of St. Cloud (Map 8). The map indicates locations of "non-traditional" MS4s as well. These would include other areas of primarily impervious surface, such as prison or college / university facilities, airports, Minnesota Department of Transportation projects, etc.

Sherburne SWCD and Sherburne County Planning and Zoning as well as Public Works staff have formed a strong partnership to develop educational programs, outreach opportunities and other initiatives concerning county MS4 permit requirements. These projects include numerous newsletter articles, Nonpoint Education for Municipal Officials (NEMO) events, website developments and public presentations pertaining to stormwater issues. Partnerships have been formed between Sherburne SWCD and several cities, notably Big Lake, Elk River and St. Cloud, to pursue stormwater education initiatives as well as stormwater BMPs in targeted locations.



Map 7. Sherburne County Point Source NPDES/SDS Permit Locations. Data obtained from MPCA.

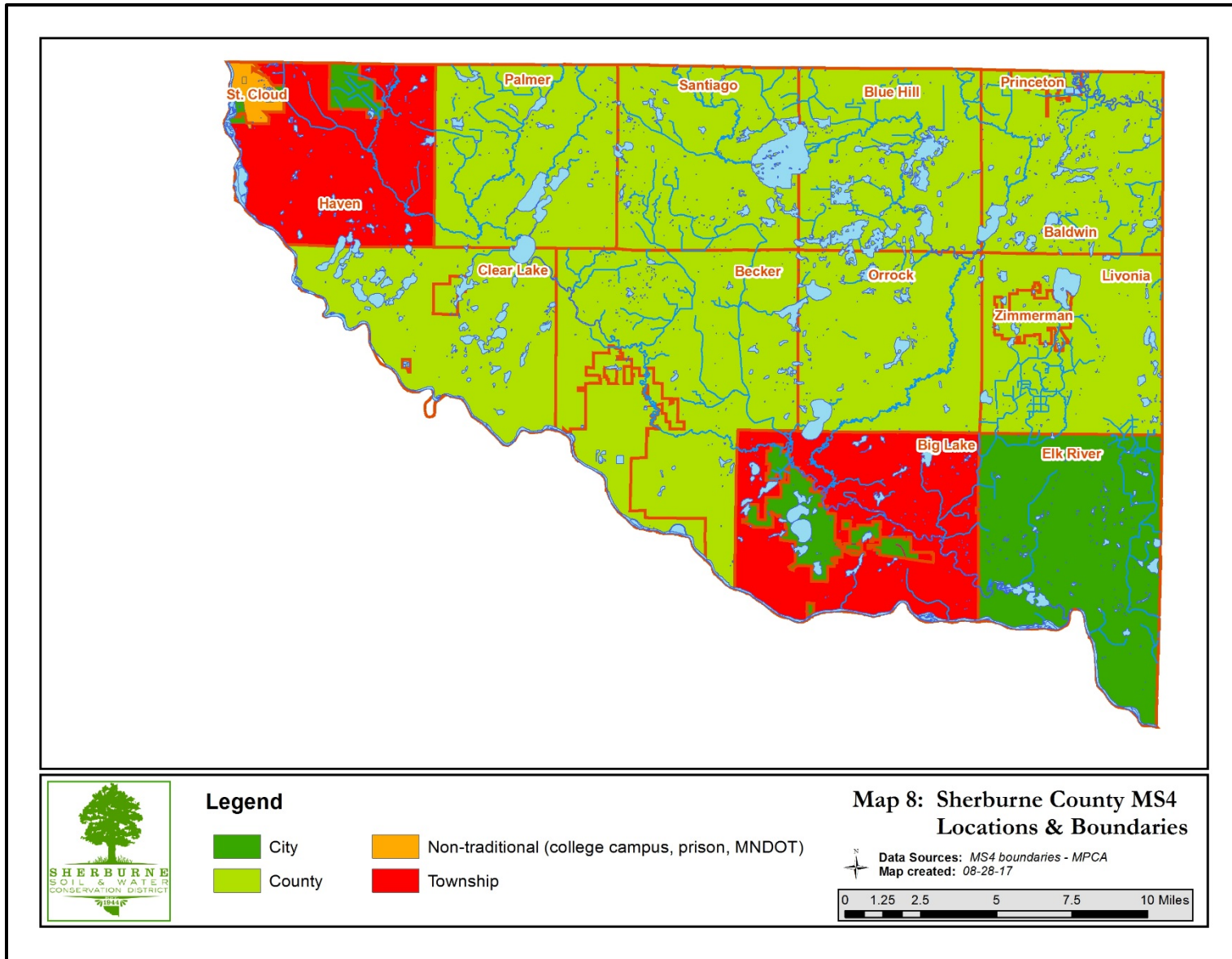
In 2011-2014, a Sub-Watershed Assessment completed by Sherburne SWCD and St. Cloud city staff resulted in the implementation of 35 rain gardens within the Sherburne County portion of the city. In 2015, the City of Elk River updated their Stormwater Management Ordinance Section to comply with MPCA general permit guidelines. The update included Minimal Impact Design Standards (MIDS) and 1.1" of runoff from all new impervious surfaces. Because of their progressive approach to stormwater management, the city of Elk River received the Blue Star Award certification for Excellence in



Figure 4: Sherburne county curb-cut rain garden. Photo by Sherburne SWCD.

Community Stormwater management, an honor received by only 22 Minnesota communities as of early 2017. Also in 2017, the MN Department of Health and Minnesota Rural Water Association awarded Elk River and St. Cloud for outstanding commitment to protecting drinking water resources through protecting groundwater reserves, as well as success in stormwater and wastewater treatment.

Stormwater retrofit assessments were completed by Sherburne SWCD in partnership with Big Lake Township (for Birch Lake's watershed) in 2014, Isanti SWCD (for Blue Lake's watershed in Sherburne/Isanti Counties) and the City of Elk River (for Lake Orono) in 2017. The purpose of the retrofit studies are to identify stormwater pathways and existing pollutant loads, then propose BMPs that fit into existing structures and address the stormwater runoff. These retrofits are modeled and cost-estimated to result in a list of potential projects, ranked by cost effectiveness (\$ per pound pollution reduction). It is anticipated that future stormwater retrofit assessments could be completed.



Map 8. Sherburne County Municipal Separate Storm Sewer System (MS4) boundaries. Data obtained from MPCA

Ground Water Quality & Quantity

Groundwater is a critical yet often an underappreciated resource. The groundwater in Sherburne County is heavily utilized as a drinking water source, a cooling agent in some manufacturing plants and for irrigation of agricultural crops. The surface and groundwater of Sherburne County is intimately linked; surface water lakes, streams and wetlands feed groundwater aquifers while groundwater release allows streams to flow between rain events, lakes to sustain water levels during dry spells, and wetlands to retain their moisture and unique habitat. In order to effectively manage groundwater, the connection between the water both above and below the surface must be clearly understood, as with the role land management plays on this connection. To better understand the geological setting and groundwater resources of Sherburne County, the Sherburne County Geologic Atlas Part A (geology) was completed by the MN DNR in 2013 and Part B was completed in fall of 2017. The Part B atlas describes the hydrogeological setting, water levels, chemistry, pollution sensitivity and use of aquifers in the county.

Sherburne County's highly sandy soils allow for relatively rapid infiltration of water into the ground. This creates a very beneficial situation for reducing surface water runoff and utilization of infiltration-based BMPs. However, sandy soils can be difficult from an agricultural perspective, often lacking the organic matter necessary for some crops and thus requiring nutrient addition and irrigation. Additionally, leaching of pollutants into the groundwater table can become an issue in highly porous soil regions. In 2017, the MDH updated maps that ranked nitrate risk into categories of high, moderate, and low sensitivity based upon a multitude of soil related factors. Nearly 80% of Sherburne County's area ranks at a high or very high hydrogeologic sensitivity. Consequently, nearly 80% of the county area is ranked moderate or high for nitrate leaching risk. The higher concern areas run along the agricultural corridor near the Mississippi River and Highway 10, along with scattered regions within the interior of the county. The eastern portion of the county contains somewhat lower hydrogeologic sensitivity, but more importantly experiences lower nitrate loading,

Groundwater Use

Whereas depletion of surface water is easily identified through visualizing water levels in a stream or lake, our groundwater is hidden from view and so monitoring of this resource is more complicated. Groundwater usage and volumes can be interpolated through mass balance estimations of inputs and outputs (recharge, withdrawal, discharge to rivers, etc.) and monitored through groundwater well elevation measurements.

There are several aquifers lying beneath Sherburne County. The Mt. Simon aquifer, covering eastern Sherburne County and expanding southeast through most of the Minneapolis – St. Paul metro area, is the deepest bedrock aquifer of eastern central Minnesota. The aquifer, between 50 and 200 feet thick in this area, provides drinking water to over 1 million people. Several studies (Berg and Pearson 2013 and Tipping 2011) have shown that the most critical recharge areas for the Mr. Simon-Hinckley aquifer include eastern Sherburne County, as well as northeastern Wright County and southern Isanti County. While the aquifer has seen some depletion in the metro region where water is being withdrawn for municipal and industrial use, it is currently believed the levels have stabilized in other regions. Continued demand will result in an increase in withdrawals, so conservation efforts must be enacted if water table levels are to remain stable.

In 2007, the Environmental Quality Board (EQB) produced a report which estimated water use as a percent of the local supply. Using 2005 data, it was estimated that 45% of Sherburne County's water was being

withdrawn for various use purposes. Extrapolating that dataset across 2030 population and water use consumption estimates, Sherburne County would be at 77% usage (EQB, 2007). At this rate, recharge of county-specific aquifers would still occur. However several counties located down-gradient from Sherburne County are estimated to consume water in excess of their supply. In 2030, it is estimated that Ramsey and Washington will require nearly twice their available water supply, while Hennepin and Dakota counties will reach nearly 100% use of their available supply. These counties will continue to require water from surrounding counties.

Sherburne County likely has substantial water supplies given its geology. The MN DNR has outlined groundwater provinces across the state, based upon the types of bedrock and unconsolidated sediment found in these regions. Igneous and metamorphic bedrock types produce limited groundwater due to their harness (impermeability). Water here is often found in fractures, or in sandstone aquifers that are interbedded within shale layers. Sedimentary rocks on the other hand are permeable and have pore spaces, partings, joints or fractures which hold larger water quantities. Unconsolidated sediments located above bedrock provide much of the aquifer water in Minnesota. Sandy sediments have the largest capacity, while pore space is smaller in clay sediments. Figure 11 displays the generalized groundwater province zones in Minnesota; Sherburne County lies along the border between province 1 and 4. This region provides *Good to Moderate* surficial sand water availability, *Moderate* buried sand water availability and *Good to Limited* Bedrock water availability.

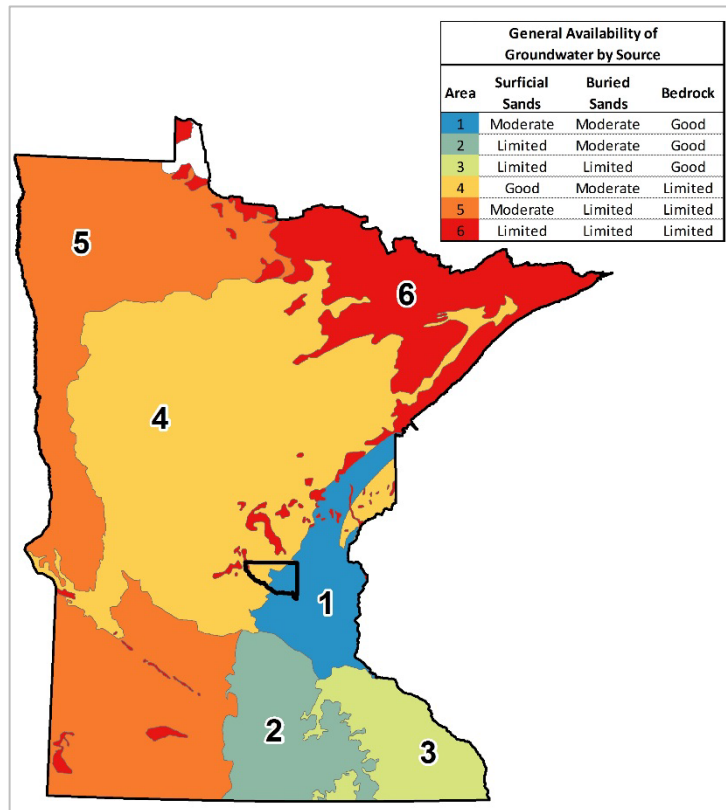


Figure 11: Minnesota groundwater provinces. Adapted from MN DNR. Provinces describe the generalized groundwater availability in three distinct geologic layers. Sherburne County identified in black outline.

Sherburne County lies along the border between province 1 and 4. This region provides *Good to Moderate* surficial sand water availability, *Moderate* buried sand water availability and *Good to Limited* Bedrock water availability.

The MN DNR requires water-use appropriation permits for groundwater withdrawals exceeding 10,000 gallons of water per day or 1 million gallons per year. Once a permit has been established, information is recorded using a permitting and reporting system which allows for volume to be tracked among source aquifers and water use types.

Groundwater usage in Sherburne County is dominated by agricultural irrigation related withdrawals. Since 1988, an average of 9,500 mgy has been withdrawn per year and between 70% and 90% of the annual total has been for agricultural irrigation (Figure 12). Water supply has ranged between 6% and 20% of the annual total. Increasing amounts of groundwater are being pumped for both purposes, though withdrawals for the water supply category has nearly doubled in 2001 - 2015 compared to 1988 – 2000 and currently remain around 1,400 mgy while agricultural irrigation ranges greatly due to differences in annual precipitation.

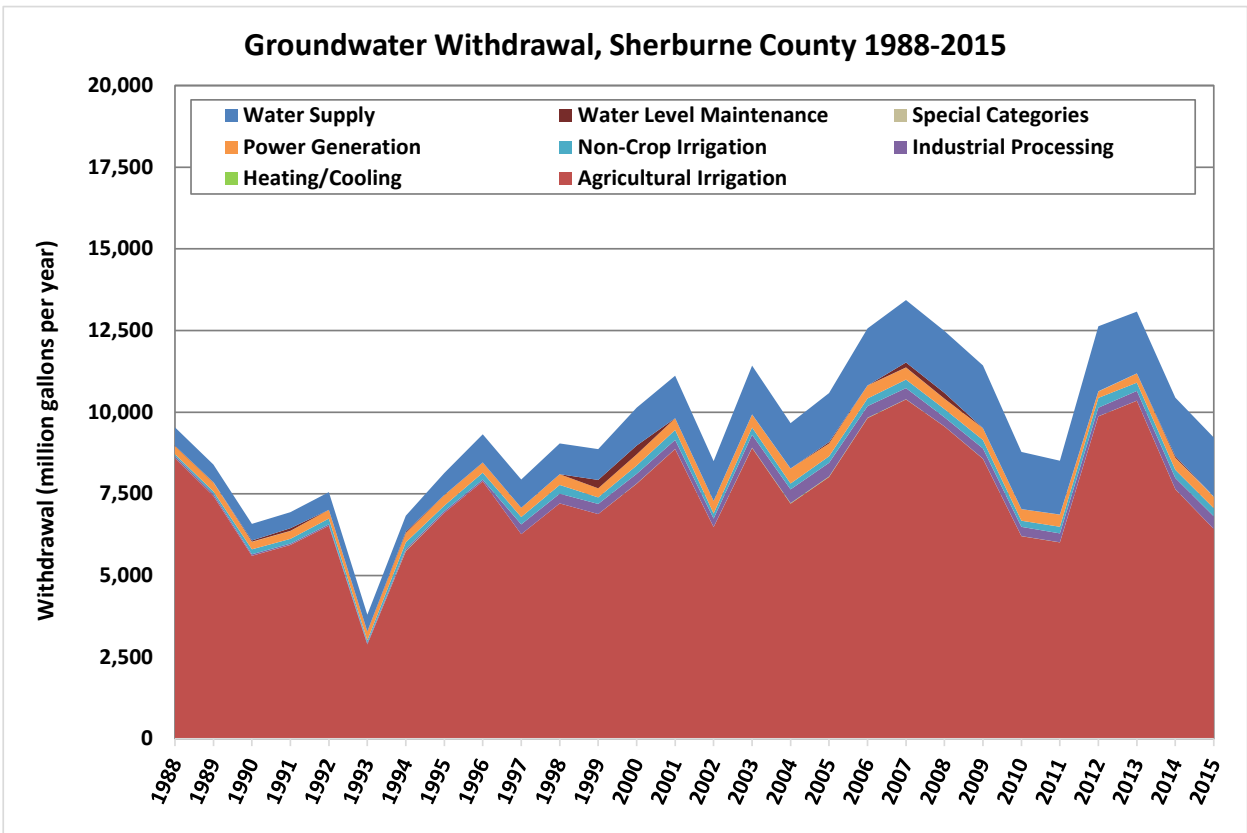


Figure 12: Sherburne County water-use appropriation withdrawals, 1988-2015. Data obtained from MN DNR databases in 2017.

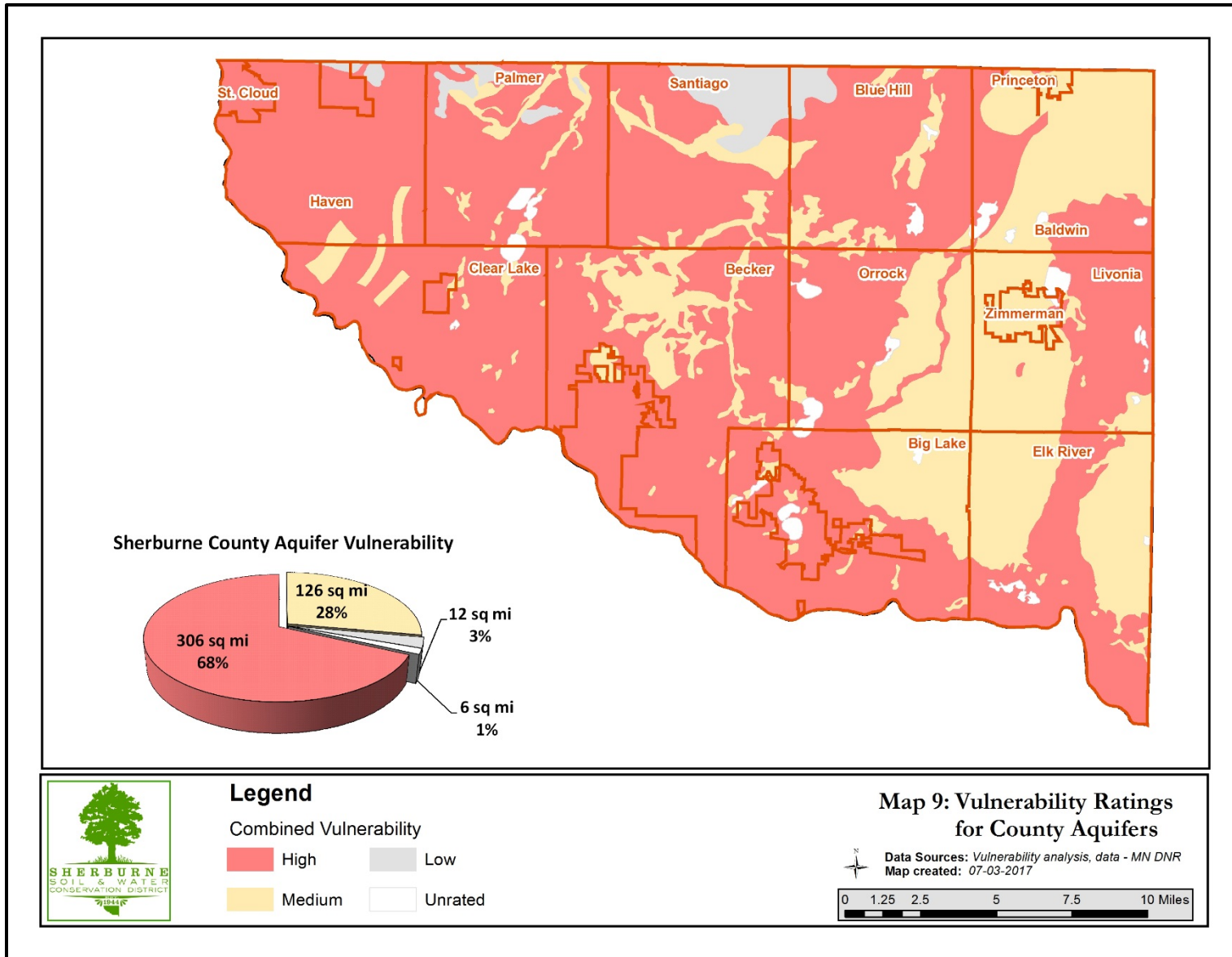
Groundwater Vulnerability and Quality

One cannot discuss Sherburne County's surficial geology or groundwater without discussing the most prominent geological feature – the relatively thick and widespread sand comprising the Anoka sand plains. As previously stated, these sandy glacial deposits cover most of the county. Whereas they aid greatly in flood mitigation and water retention, their permeability also allows for pollutant transport to groundwater systems. The Sherburne Geologic Atlas, Part B, explains in great detail the hydrogeological conditions of the region.

The Geologic Atlas discussions pollutants within the groundwater in great detail as well. In particular, chloride and nitrate-nitrogen (nitrate) are known to exist in relatively high concentrations in a few areas of the county. Presence of these contaminant can be used to indicate both sources of contamination as well as pinpoint areas of pollution sensitivity. In collecting data for the Geologic Atlas, 43 of 110 groundwater well samples exceeded an upper limit background concentration of 5 ppm, indicating anthropogenic (as opposed to naturally occurring) sources of chloride were present. Nitrate was found elevated in 17 of 110 groundwater samples. The presence of these high samples, as well as records of geological setting, indicate areas of regional groundwater vulnerability. The MN DNR has compiled this information to indicate relative vulnerability throughout the county (Map 9).

Nitrate contamination of groundwater wells has been of some concern in Sherburne County, as well as numerous other areas in Minnesota, for some time. The Minnesota Department of Agriculture (MDA) evaluated townships throughout the state that were particularly vulnerable to groundwater contamination and have significant row crop production (a commodity which typically requires nitrogen fertilizer application). In 2013, Sherburne County was selected for a pilot program in which MDA worked with Sherburne SWCD to select townships to implement a nitrate testing project. Becker, Big Lake, Clear Lake, Haven, Parmer and Santiago townships were selected for this program. Sampling began in 2014 and continued in 2015. The final dataset included 1,217 tests from drinking water wells. In Clear Lake and Haven Townships, more than 10% of the wells were over the Health Risk Limit of 10 mg/L of nitrate (11.3% for Clear Lake, 13.8% for Haven Township). One of Sherburne County's Drinking Water Supply Management Areas are located within this region, bringing concern to the drinking water of nearly 700 people.

The MDA is the lead state regulatory agency for nitrogen fertilizer and has authority to regulate its use, if necessary, to protect groundwater quality. The MDA evaluates groundwater in Drinking Water Supply Management Areas as well as rural settings in an effort to assess nitrate concentrations and potential concerns. In 2017, MDA began forming a collaborative group to address the concern of nitrates in Sherburne County groundwater. A Nitrate Local Advisory Team includes members of the agricultural community, MDA, and Sherburne SWCD. The goal of the advisory team is to develop mechanisms to reduce nitrate fertilizer use or infiltration of nitrogen to the water table. This would best be accomplished through implementation of Precision Cropping Technologies (PCT), agricultural BMPs such as cover crops and irrigation water management, and taking particularly sensitive land out of production through programs such as CRP and EQIP. A goal has been set for 80% of cropland acres within Haven and Clear Lake Townships to implement identified nitrogen fertilizer BMPs and alternative management tools by 2020. Additionally, the MDA has recently drafted an updated state-wide nitrogen fertilizer management plan, approved in fall 2015. This plan, unlike its predecessor, includes both discussion of nitrate issues and remedial approaches as well as regulated mitigation guidance.



Map 9. County Aquifer Vulnerability Ratings. Data compiled by MN DNR.

Wellhead Protection & Drinking Water Supply Management Areas

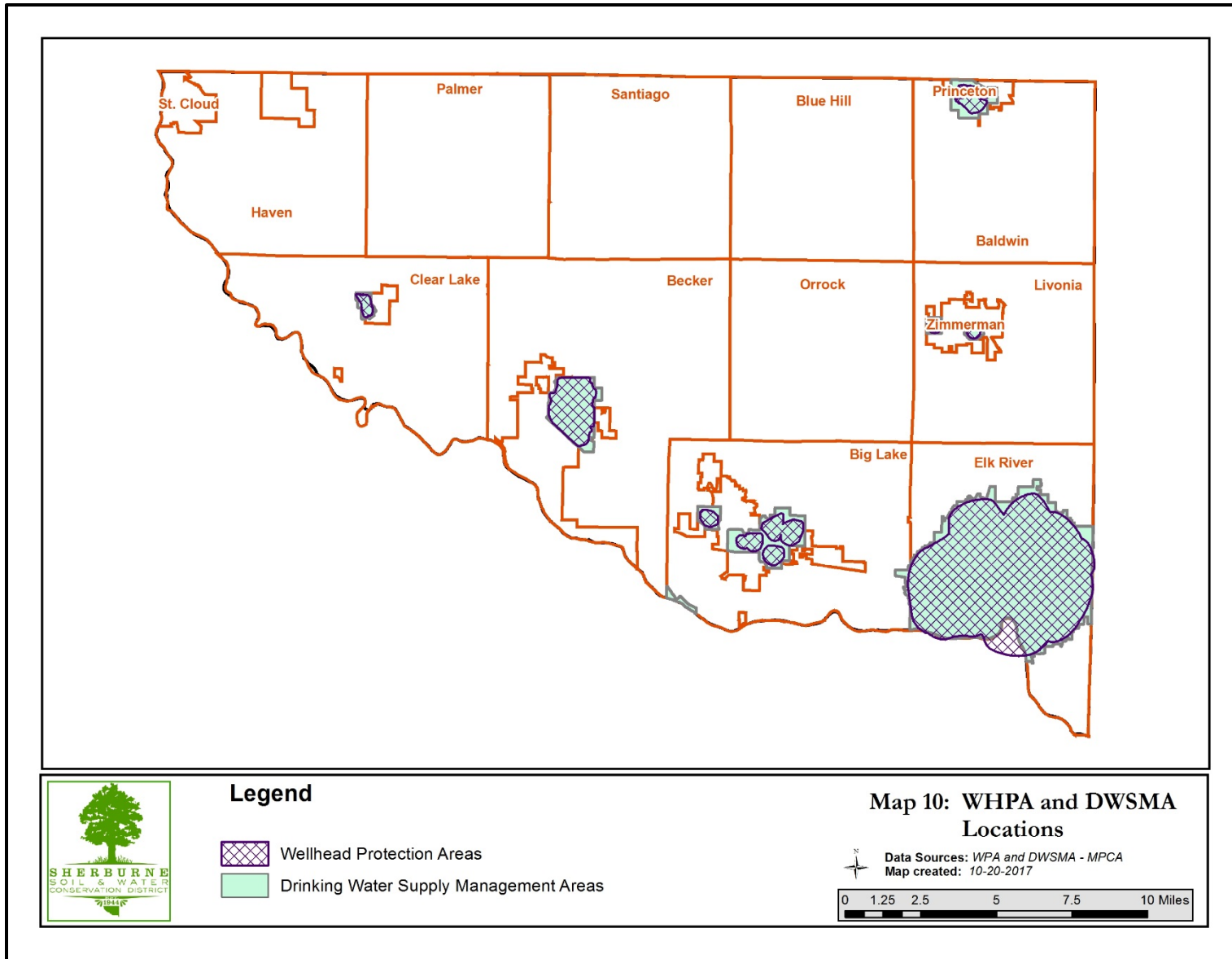
Wellhead Protection Programs (WHP) are required for all public water suppliers and are overseen by the MDH. Drinking Water Supply Management Areas (DWSMAs) are the areas surrounding a public water supply well and includes the wellhead protection area. A WHP involves a delineation of the land area that could influence groundwater and an inventory of all potential drinking water contaminant sources. Typically, existing state regulatory databases and ground based observations are used for this inventory. Potential sources are reviewed to ensure they are managed properly as to not leach contaminants. Effective management may include ordinances, zoning restrictions, land purchases, conservation easements, or BMPs. Contingency planning and education are important components of any WHP. Contingency plans specify the processes for replacing drinking water sources due to contamination of the primary source and must include short and long-term solutions. Sherburne County has 10 areas totaling 19,348 acres that require wellhead protection planning to be completed. The largest region, surrounding Elk River, spans 15,000 acres and is the 13th largest wellhead protection area in Minnesota (Map 10).

Subsurface sewage treatment systems (SSTS)

SSTS are regulated by Minnesota Statutes 115.55 and 115.56. These regulations specify the minimum technical standards for SSTS, provide a framework for local administration for SSTS programs, and establish statewide licensing of SSTS professionals and SSTS products. Additionally, the statutes specify establishment of an SSTS Advisory Committee.

Sherburne County Planning and Zoning is responsible for administering the State Statute requirements in addition to Sherburne County-specific requirements. Requirements pertaining to septic systems are outlined in Sherburne County Zoning Ordinance Section 17.5. A permit is required for SSTS installation or re-configuration, however it is not required for system maintenance such as component replacement, repair, or cleaning. Compliance inspections are required with most property transfers of SSTS that are older than 5 years. Additionally, building permits require that SSTS are newer than 10 years or must have passed a compliance inspection initiated within the past 10 years. Property owners whose septic systems are failing to protect groundwater and/or are deemed an imminent threat to public health (in accordance with MN Rules chapter 7080) are required to repair or replace their systems within a certain period of time. Repair or replacement costs of septic systems can be cost prohibitive. To assist those residents with needed repair or replacement costs, the County implemented the Department of Agriculture' Best Management Practice program (AgBMP program). This program allows the County to act as a "bank" where such repair or replacement costs are assessed against the property owner's taxes for payback.

In 2012 the Briggs Chain Lake Association sponsored a flyover study conducted by A.W. Research Laboratories. An Aerial Lakeshore Analysis and Ground Water Intrusion flyover was completed. A report recommendations on a number of follow-up practices or investigations to pursue in order to improve the water quality of the Briggs Chain lakes. Septic/wastewater investigations were recommended on ~320 properties, while vegetated buffers and berms were recommended on over 500 sites (for each practice). Following the study, volunteers began ground-truthing investigations with willing property owners to investigate some of these recommendations. In 2015, 100 property owners volunteered to have their properties go through the ground-truthing process and 71 of those properties had actions to improve upon. Of these properties, septic system maintenance was recommended for 5.6% while vegetative buffers (37.3%), berms (28%) and storm water work (24.2%) were more common.



Map 10. Wellhead Protection Area (WHPA) & Drinking Water Supply Management Area (DWSMA) locations. Data obtained from MPCA.

Land Application of Septage and Solid Waste

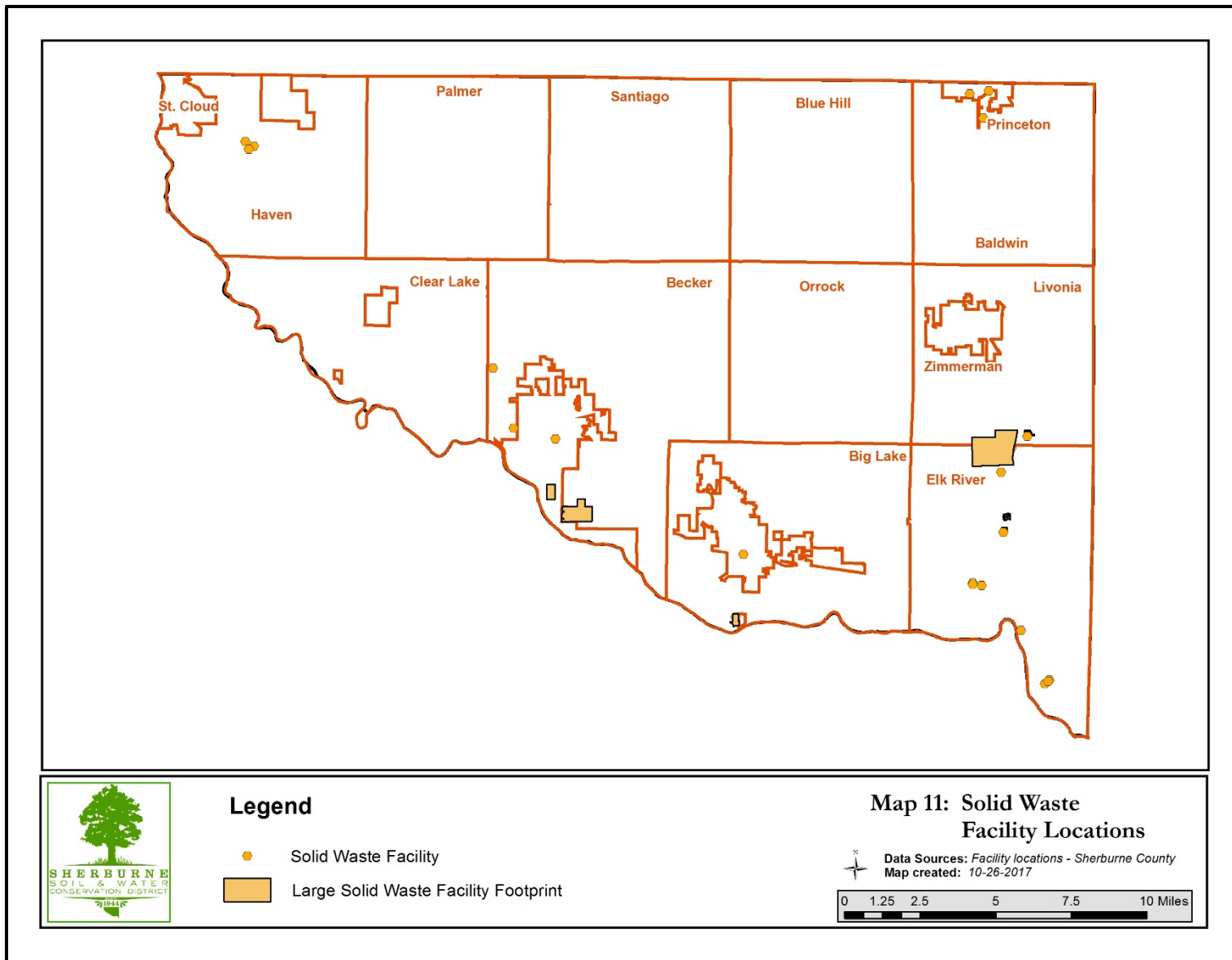
Sherburne County regulates the land application of septage, which are solids and liquids removed from an SSTS such as a septic tank; and, certain solid waste materials such as industrial by products from food and beverage industries. These activities are regulated pursuant to the County's solid waste management ordinance to prevent possible contamination to soils and groundwater. Due to the types of soils that prevail, a 5-foot separation to the seasonal high water table is typically required, (soils that are rated as highly permeable by the Natural Resource Conservation Service). Applicants seeking a permit to land apply are required to notify Zoning staff to arrange a time to meet on site and verify the separation to the seasonal high water table, setbacks, and crop coverage, and other such requirements.

Solid Waste Facilities

Due to the close proximity to the Twin Cities metropolitan area, Sherburne County is the host community to numerous solid waste facilities (Map 11). Solid waste facilities located in the County are currently permitted for the disposal and/or processing of: mixed municipal solid waste (MSW), municipal solid waste combustor ash, construction debris, demolition waste, industrial solid waste, yard waste, recyclables, problem materials, and/or source separated organics. The amount of solid waste generated within Sherburne County is only a small fraction of the waste that is processed and/or disposed of within the County; the majority of waste processed and disposed of in the County is generated and collected outside of the County.

The County is required by Minnesota law to manage solid waste in a manner that protects the state's land, air, water, and other natural resources, and public health by ensuring that certain reduction, separation and recovery, resource recovery, and proper disposal methods of solid waste generated is set forth. This is particularly important in Sherburne County in light of the types of soils that predominate. The County is located within a geologically sensitive region known as the Anoka Sand Plain and as a result, ground water in the County is more susceptible to pollution.

Solid waste facilities, according to Minnesota law, have a duty to protect groundwater. Solid waste landfills are required to install and maintain a water monitoring system compliant with Minnesota law and the County's Solid Waste Management Ordinance. The County's existing solid waste management ordinance provides for additional protective measures above what is required by Minnesota law, in order to minimize the direct and indirect potential impacts that solid waste facilities have on the County and its residents. Further, the County has a history of being proactive and taking the initiative such as requiring demolition debris landfills to install landfill liners and leachate collection systems prior to placement of waste (Minnesota rules do not require demolition debris landfills to install landfill liners and leachate collection systems). Additional precautionary measures have often been taken by the County, including arranging for the sampling and analysis of residential wells located downgradient of the Vonco Big Lake Landfill. These proactive initiatives all ensure that solid waste is managed in such a way as to protect the State's water, air, and land resources. However, all landfills will, at some point, become a source of groundwater pollution. Elk River Landfill is in the final steps of their groundwater investigation of a known leachate plume emanating from that landfill. Sherburne County, in keeping with Minnesota law, manages solid waste in a manner that reduces the overall dependence on indiscriminate landfilling of solid waste.



Map 11. Sherburne County Solid Waste Facilities. Data provided by Sherburne County GIS Department.

Aquatic Invasive Species

Fishes, aquatic plants, invertebrates and even bacteria or viruses brought from other regions pose significant threats to the native environments and species of our lakes and streams. Introduced species can become invasive, meaning they outcompete native species for resources such as light, food, shelter, spawning territory, etc. Some species grow so quickly and rapidly in numbers that they will displace natives or significantly alter the ecology of a lake or stream. For example, zebra mussels (*Dreissena polymorpha*) multiply rapidly in suitable waters and can eventually cover a lake bottom with their sharp, zebra-patterned shells. The shells may injure swimmers and their constant filtering of the water removes beneficial algae, leaving behind undesirable algae and removing a significant portion of the lower end of the aquatic food chain. Plants such as Eurasian water milfoil (*Myriophyllum spicatum*) grow rapidly and outcompete native species for space, light and food. The plant beds may crowd out all other plant species and form dense canopies on a water’s surface. These dense plant beds are difficult to navigate watercraft through and provide poor habitat to other aquatic organisms such as fish.

Current AIS Infestations

Sherburne County lakes and rivers hold several aquatic invasive species (AIS) and thus are listed as being “infested” by MN DNR (Table 5, Map 12). Curly-leaf pondweed (*Potamogeton crispus*) and common carp (*Cyprinus carpio*) are two aquatic invasive species that have been present in Minnesota waters for greater than 100 years. Because of their longevity in the state, MN DNR classifies them still as AIS but does not list a waterbody as being “infested” if it holds these two species. Thus, these two AIS are not tracked as stringently as other AIS such as zebra mussels, Eurasian water milfoil, etc. However, both curly-leaf pondweed and common carp can have negative impacts on lakes and streams upon their introduction.

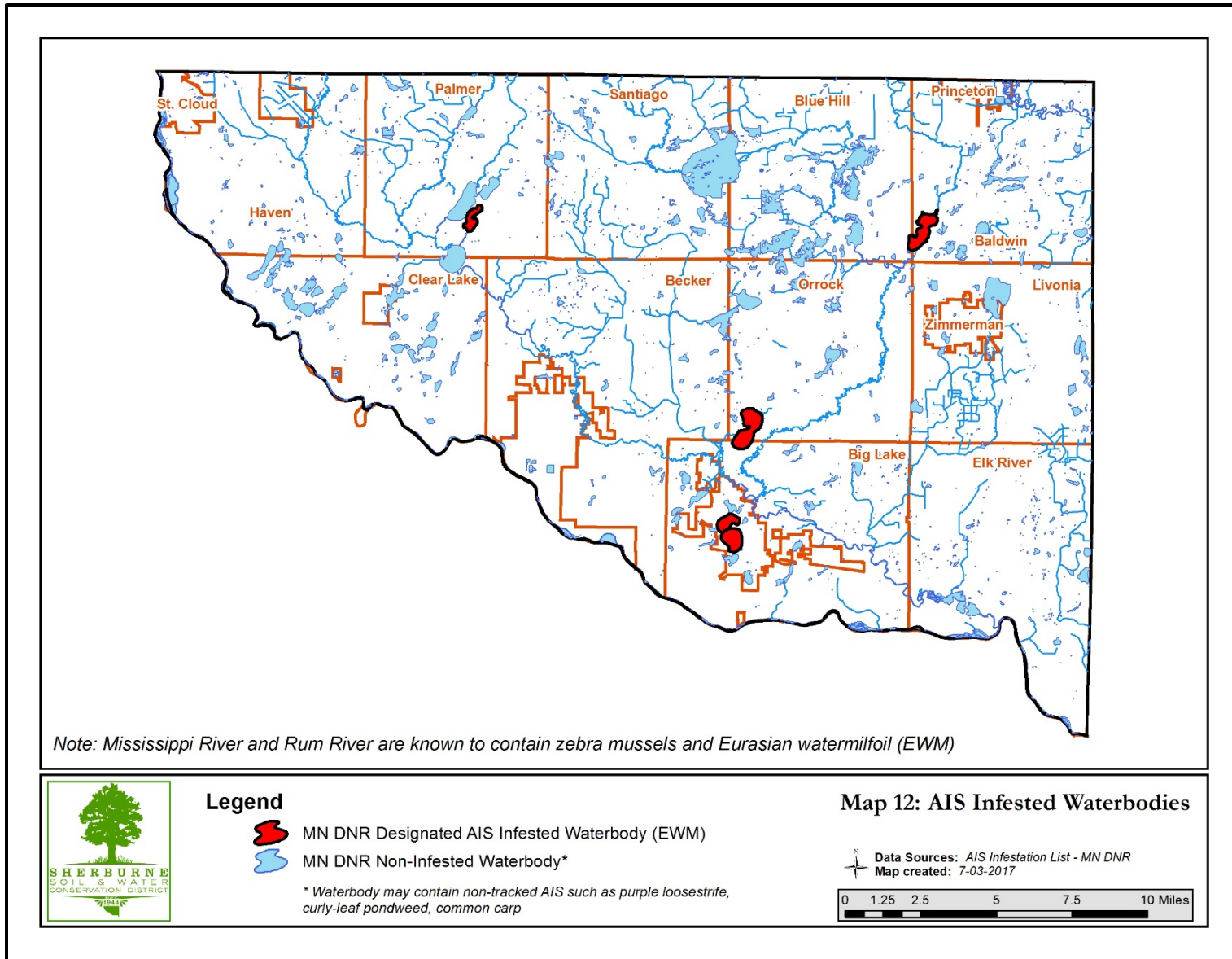
	Waterbody	County	Invasive Species	ID #
MN DNR - Infested Waters	Mississippi River*	Multiple Counties	Zebra mussel, Eurasian watermilfoil	Multiple segments
	Rum River**	Multiple Counties	Zebra mussel, Eurasian watermilfoil	Multiple segments
	Big	Sherburne	Eurasian watermilfoil	710082
	Eagle	Sherburne	Eurasian watermilfoil	710067
	Little Elk	Sherburne	Eurasian watermilfoil	710055
	Mitchell	Sherburne	Eurasian watermilfoil	710081
	Rush	Sherburne	Eurasian watermilfoil	710147

	Waterbody	ID #	Waterbody	ID #	Waterbody	ID #
Curly-leaf pondweed Lakes	Ann Lake	710069	Fremont Lake	710016	Rice Lake	710142
	Big Lake	710082	Julia Lake	710145	Round Lake	710167
	Big Elk Lake	710141	Little Elk Lake	710055	Rush Lake	710147
	Birch Lake	710057	Long Lake	710159	Sandy Lake	710040
	Briggs Lake	710146	Mitchell Lake	710081	Thompson Lake	710096
	Camp Lake	710123	Mosford Lake	710126	West Hunter Lake	710022
	Eagle Lake	710067	Orono Lake	710013		
	East Hunter Lake	710023	Pickerel Lake	710158		

Table 5. Sherburne County AIS waterbodies lists. Databases include MN DNR defined infected waters and curly-leaf pondweed waters in Sherburne County. Accessed from MN DNR databases, Nov 2016.

*includes 500 ft upstream of the mouth of the Pine River in Crow Wing County to the Iowa border and 500 ft upstream tributaries.

**Includes 500 ft upstream into its tributaries



Map 12. County AIS Infested Waterbodies. Data compiled by MN DNR.

AIS Prevention and Management

AIS efforts may be focused on two general categories, either through prevention or through existing population management. AIS prevention efforts focus upon activities that reduce the likelihood of transport and introduction to new waterbodies. Typical activities fall into categories such as education and awareness, early detection monitoring, and watercraft inspections and enforcement. Once an AIS has been established within a waterbody, efforts may shift towards more management-based approaches. These actions would include population monitoring, AIS control, or AIS containment, as well as education on these actions. Successful programs are thought to include both AIS prevention and management; stakeholders must be knowledgeable about the threats AIS pose as well as how to manage the density and reduce the transport of existing AIS populations. It is important that a variety of stakeholders be included in educational initiatives, including lake property owners, transient watercraft users, lake service providers, water related special interest groups, and elected officials.

In 2014 the Minnesota Legislature approved an AIS Prevention Aid (MN Statute 477A.19) which distributes \$10 million annually at the county level. Funds are distributed to counties based upon the number of public watercraft launches and launch parking spaces; in 2017, Sherburne County received \$35,858 for 16 public watercraft launches and \$33,619 for 142 parking spaces - a total of \$69,477. In November of 2014 Sherburne County delegated the Sherburne SWCD the responsibility of developing and implementing a County AIS Prevention Plan. In order to solicit local input on how to spend these funds, an AIS Task Force was created to provide advice on expenditures and program operations for a five year plan. Though the five year plan was established in 2015, the group continues to meet on a regular basis (biannually in 2017) to learn about program accomplishments and provide feedback on adaptive management.



Photo 5. AIS Volunteer. A volunteer collects a zebra mussel veliger sample for Sherburne County's AIS Early Detection Program. Photo by Sherburne SWCD.

The Sherburne County AIS Prevention Work Plan is a five-year plan (2015-2020) that is updated annually to provide context on program developments and adaptive management strategy. Early in the plan's development, the AIS Task Force ranked AIS prevention activities to prioritize the spending of the AIS Prevention Aid funding Sherburne County receives. Spending has since been administered accordingly within categories of Education and Outreach, Early Detection and Rapid Response, Inspections & Enforcement and Special Projects, in addition to Administrative expenses. The Sherburne County AIS Prevention Work Plan details all existing and future projects as they fall under these categories, while a summarized bulleted list is presented below (Table 6).

Table 6. Sherburne County AIS Prevention Activities. Table includes current and ongoing actions.

Administration	Education & Outreach	Early Detection & Rapid Response	Inspections & Enforcement	Special Projects
Program oversight	Lake access signage and billboard rental	Volunteer zebra mussel veliger monitoring	Partnership with Sheriff Water Patrol	Coalition of Lake Associations formation
Correspondence and speaking events	Theater company performances at elementary classrooms	Partnership with Conservation Corps of Minnesota for lake AIS surveys	Hiring Level 1 inspectors to staff public landings	Lake Association / District Grant Program
As needed site visits and AIS plan consultation	AIS flyers and handouts	Assistance on lake group EDRR and AIS management plans	Coordination for AIS Volunteer trainings	AIS Contingency Fund

At the present time, Sherburne SWCD and partners are levying an AIS program that utilizes both a preventative and management based approach. As previously mentioned, several lakes are known to hold Eurasian water milfoil while the vast majority of waters hold curly-leaf pondweed. Of great concern to county stakeholders is the proximity of two particular AIS; zebra mussels and starry stonewort (*Nitellopsis obtuse*). Zebra mussels are found throughout the Mississippi River and also in Lake Sylvia and Clearwater Lake (Wright County) as well as Lake Mille Lacs (Mille Lacs County). Many lakes within the Twin Cities metro hold zebra mussels as well. A substantial population of starry stonewort is known to exist in Lake Koronis, while it is also located in other Stearns County lakes including Grand Lake, Rice Lake and Lake Sylvia. With the evidence of harm these species can bring to lakes and their proximity to Sherburne County, prevention efforts are seen as a vital component of reducing their transport.

Sherburne County’s AIS activities are largely reliant upon money from the State AIS Prevention Aid fund. Should these funds cease, alternative sources of funding would need to be sought after to continue AIS programs. In the event of a discontinuation of the State AIS Prevention Funds, the Sherburne SWCD would continue to implement AIS prevention as funding allowed, seeking partnerships and additional funding sources as appropriate to continue the aforementioned AIS activities.



Photo 6. Custom 2017 AIS promotional items.



Photo 7. Sherburne County Water Patrol Deputy Cole Petroske speaks about AIS laws and cleaning watercraft.

5.0 Implementation Plan

Taking into consideration the Priority Concerns outlined within this document, the Implementation Plan specifies the course of action that Sherburne County partners intend to take in order to address these concerns. Many hours of conversations, meetings, and edits went into the development of the Implementation Plan to ensure that the specified actions are reasonable, efficient, effective and above all address the Priority Concerns that the waters of Sherburne County face.

The tables that follow are divided up between goals, objectives and actions. Each specified goal directly relates to a Priority Concern. The objectives are intended to represent the numerous approaches that must be considered in order to reach the specified goal. Finally, the actions are the targeted and prioritized steps necessary in order for the goals/objectives to be reached. Listed facilitators, funding sources and timeframes are specific to the action specified. While this Water Plan intends to direct management for Sherburne County for the time period of 10 years (2018-2028), a reevaluation of programs and priorities will occur at the five year mark to fine-tune management approaches for the remaining five years of the water plan.

Priority Concern 1: Surface Water Quality
Goal: Protect existing high quality resources and improve quality of impaired waters

Objective 1 - Protect existing waterways through maintaining vegetative buffers and other beneficial vegetative habitats							
Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region	
1 Assist landowners to reach and maintain compliance with 2015 Buffer Law, Minn. Stat 103F.48, on public waters and public drainage ditches	County achieves and maintains 100% compliance	2018-2028	Sherburne SWCD, BWSR	\$10,000 / year	BWSR	County-wide	
2 Promote conservation practices along "other waters" regions as identified within Sherburne SWCD Resolution No. 17.073	Work with county landowners as applicable	2018-2028	Sherburne SWCD	\$1,500 / year	SWCD	County-wide	
3 Maintain the existing level of wetland areas in the County	Administer WCA and consider downstream impacts when determining wetland replacement	Ongoing	Sherburne County Zoning	\$10,000 / year	County	County-wide	
4 Increase proactive review and permitting of wetland projects	Require all new wetland impacts and exempted projects to receive a review and permit from County staff	Initiate in 2018-2019	Sherburne County Zoning	\$10,000 / year	County	County-wide	
5 Maintain County and SWCD presence on WCA Technical Evaluation Panel	One County and one SWCD staff member retained on TEP	Ongoing	Sherburne County Zoning, Sherburne SWCD	\$15,000 / year	County, SWCD	County-wide	
6 Address eroding and sparsely vegetated shorelines and streambanks in the County	Provide technical assistance to 20 landowners per year, cost-sharing when possible	2018-2028	Sherburne SWCD, Sherburne County Zoning, SC COLA	\$8,500 / year	SWCD	County-wide	
7 Complete an inventory of lake and river shorelines to determine level of development and areas of erosion concern	Complete 1-2 lake or river shoreline inventories per year	2018-2028	Sherburne SWCD, Lake Associations & Districts	\$2,000 per lake / river segment	SWCD	County-wide	
8 Enforce regulatory controls for wetland protection in new and redevelopment projects	Monitor all permitted wetland activities	2018-2028	Sherburne County Zoning	\$15,000 / year	County	County-wide	
9 Continue to offer free onsite forestry consultations and provide recommendations for forestry health and water quality benefits	150 consultations per year	2018-2028	Sherburne SWCD	\$12,000 / year	SWCD	County-wide	
10 Develop woodland stewardship plans for county residents	Four plans per year	2018-2028	Sherburne SWCD	\$1,200 / year	SWCD	County-wide	
11 Promote cost-share program for high-value ash canopy preservation	Micro-injection of Emamcectin Benzoate (TreeAge) in approximately 50 - 10" dbh ash trees	Initiate in 2018-2020	Sherburne SWCD	\$5,000 / year	BWSR	Within 10 miles of confirmed EAB infestations, City of Elk River	
12 Conduct legislative outreach for EAB state-wide community forestry program	Partner with MN Shade Tree Advisory Committee's Legislative Committee to organize 1-2 meetings / year	2018-2028	Sherburne SWCD	\$1,500 / year	SWCD	State-wide	
13 Pursue funding for easements on developments around sensitive areas	Identify 2-3 potential projects per year, pursue funding	2018-2028	Sherburne SWCD, NRCS, BWSR	\$2,500 / year	SWCD, Federal	Becker, Big Lake, Clear Lake, Elk River, Princeton and Zimmerman	

Priority Concern 1: Surface Water Quality
Goal: Protect existing high quality resources and improve quality of impaired waters

Objective 2 - Work with local and state partners to strategically monitor and manage water resources							
Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region	
1 Work with partners to inventory dams and culverts to assess hydrologic conditions / areas for improvement	Inventory high priority streams, identify problem sites	2018-2028	DNR, Sherburne SWCD and Sherburne County Public Works	\$5,000 / year	DNR, SWCD, County	St. Francis River, Battle Brook, Rice Creek	
2 Continue to monitor surface water at solid waste facilities in Sherburne County	Continued effort - no net increase in pollutant runoff	2018-2028	Sherburne County Zoning, Sherburne SWCD	\$5,000 / year	County, SWCD	Solid waste facility sub-watersheds	
3 Provide technical and administrative assistance to MPCA on watershed monitoring	Continued data collection through WPLMN, Elk River <i>E. coli</i> monitoring	Continuous	Sherburne SWCD	\$5,000 / year	MPCA, SWCD	Elk River Watershed, County-wide	
4 Encourage volunteer water quality sampling through MPCA's Citizen Lake Monitoring program	Secchi disk and water chemistry testing completed by every active lake association / district, compilation by SWCD	Ongoing	Sherburne SWCD, SC COLA, MPCA	Volunteer time, \$3,000 / year (SWCD staff time)	MPCA, SWCD	County-wide	
5 Establish volunteer-based macroinvertebrate assessment program	Engage local partners and volunteers in a macroinvertebrate assessment program	Initiate in 2018-2020	Sherburne SWCD, USFWS, local teachers	\$3,000 / year	SWCD	Elk River, St. Francis River, Trott Brook	
6 Identify needs for initial or updated TMDL studies as appropriate	Ensure all county waterbodies have TMDL reports and remediation plan	2018-2028	Sherburne SWCD, MPCA	\$50,000 / waterbody	MPCA	Elk River Watershed	
7 Work with Mississippi River - St. Cloud Watershed partners on 2019 WRAPS monitoring and strategic plan	Complete and implement an updated WRAPS plan for watershed	2019	Sherburne SWCD, Sherburne County Zoning, MR-SC Watershed Partners	\$49,500	MPCA	MR-SC Watershed	
8 Work with Mississippi River - St. Cloud Watershed partners to complete One Watershed, One Plan Strategic Planning Project	Complete and implement a 1W1P for watershed	Initiate within 2018-2025	Sherburne SWCD, Sherburne County Zoning, MR-SC Watershed Partners	\$70,000	BWSR	MR-SC Watershed	
9 Work with Rum River partners to complete One Watershed, One Plan Strategic Planning Project	Complete and implement a 1W1P for Rum River Watershed	Initiate within 2018-2025	Sherburne SWCD, Sherburne County Zoning, Rum River	\$10,000	BWSR	Rum River Watershed	

Priority Concern 1: Surface Water Quality
Goal: Protect existing high quality resources and improve quality of impaired waters

Objective 3 - Prioritize restoration of waterbodies with excessive nutrient, fecal coliform and dissolved oxygen impairments							
Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region	
1	Implement activities identified within the Rum River Watershed TMDL for impaired waterbodies	Complete three projects targeting impaired waterbodies	2018-2028	Sherburne SWCD, Sherburne County, Cities / Townships	\$5,000 / project	BWSR	West & East Hunter Lake, Trott Brook and Blue Lake Watersheds
2	Implement activities identified within the MR-SC Watershed TMDL for impaired waterbodies	Complete five projects targeting impaired waterbodies	2018-2028	Sherburne SWCD, Sherburne County, Cities / Townships	\$5,000 / project	BWSR	ERWA watershed, nutrient impaired waterbody sub-watersheds
3	Address Tier 1 and Tier 2 Priority Zone sources of bacteria in the Elk River Watershed	Address five source sites through BMP implementation	2018-2028	Sherburne SWCD, ERWA	\$2,500 / project	BWSR	Elk River Reach 579, Tier 1 and Tier 2 Priority Zones
4	Address Tier 1 and Tier 2 Priority Zone sources of nutrient and sediment loss in the Elk River Watershed	Address five source sites through BMP implementation	2018-2028	Sherburne SWCD, ERWA	\$3,000 / project	BWSR	Tier 1 and Tier 2 Priority Zones
5	Host small / hobby farm nutrient and pasture management events	Coordinate an educational event every 3-4 years	2018-2028	Sherburne SWCD, ERWA	\$2,500 per event	BWSR	Elk River Watershed
6	Engage in diagnostic/feasibility studies to quantify and address in-lake sources of nutrients for impaired lakes	Support studies for carp removal, sediment-phosphorus mitigation and water level management	2018-2028	Sherburne SWCD, SC COLA	\$25,000 / per project	BWSR	Impaired lakes, DNR classified shallow lakes

Objective 4 - Increase stormwater treatment capacity through ordinance enforcement, strong partnerships and BMP implementation							
Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region	
1	Form County partnership to collaboratively meet and exceed MS4 SWPPP objectives	Quarterly Sherburne County Stormwater Partnership meetings	2018-2028	MS4s, Sherburne County & SWCD	\$4,000 / year	County, SWCD	County and City MS4's
2	Collaborate with Townships to determine appropriate changes to rainfall accommodation for development on new standard plats	Assess current ordinances for rainfall accommodation and determine feasibility for increasing standards	2018-2028	Sherburne County Zoning, Sherburne Townships, Sherburne SWCD	\$3,000	County, SWCD	Developing areas in Elk River Watershed
3	Provide commentary on proposed variances with regards to shoreline health, impervious surfaces, stormwater runoff, and other environmental considerations.	Review and comment upon 100% of variance requests, giving the Board of Adjustments information on environmental impacts	2018-2028	Sherburne County, Sherburne SWCD	\$8,000 / year	County, SWCD	Sherburne County
4	Reduce overdevelopment and impervious surface of county lake and river (public waters) shoreland districts.	Encourage 100% of all new development and redevelopment projects to comply with existing shoreland district impervious surface standards	2018-2028	Sherburne County, Sherburne SWCD	Shared cost with Objective 4, Action 3 (above)	County, SWCD	Sherburne County
5	Complete Subwatershed Analysis (SWA) on priority urban water resource areas	Complete three SWA's on sensitive, high priority water resource areas	2018-2028	Sherburne SWCD, Cities, SC COLA	\$8,000 / SWA	BWSR	Major cities, urban regions of prominent County lakes
6	Partner with MS4s to implement BMPs identified in SWAs, WRAPS or other priority-identifying reports	Implement BMPs in three subwatersheds	2018-2028	Sherburne SWCD, Cities	\$10,000 / project	BWSR, State	Subwatersheds identified in SWAs or similar

Priority Concern 1: Surface Water Quality
Goal: Protect existing high quality resources and improve quality of impaired waters

Objective 5 - Understand and mitigate rural runoff through inventories and promotion of soil health practices							
Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region	
1 Establish baseline precision agricultural and soil health practices inventory	Survey top 15 county agricultural producers	Complete in 2018-2019	Sherburne SWCD, NRCS	\$4,000 / year	SWCD, Federal	MRSC Watershed, County-wide	
2 Promote adoption of soil health practices	Include in educational programs (2x per year), increase use in applicable priority regions	2018-2028	Sherburne SWCD, NRCS	\$5,000 / year	SWCD, Federal	MRSC Watershed, County-wide	
3 Promote and increase MAWQC program	Increase by an average of 1,000 acres per year, use advertising and EQIP-RCPP incentives	2018-2028	Sherburne SWCD, NRCS	\$4,000 / year	SWCD, Federal	MRSC Watershed, County-wide	

Objective 6 - Engage citizens, public officials and contractors through educational mailings, presentations and programs							
Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region	
1 Provide stormwater related educational opportunities for County and City staff as well as locally elected representatives	Host annual MS4 partners meeting; host a NEMO or other educational opportunity bi-annually	2018-2028	Sherburne SWCD, Sherburne County Public Works	\$7,500 / year	SWCD, County	MS4 Regions	
2 Expand use of advanced scheduling tools for irrigation management	Introduce tools to prospective users through educational trainings, pamphlets and consultations	2018-2028	Sherburne SWCD, NRCS	\$3,500 / year	SWCD, Federal	MRSC Watershed, County-wide	
3 Explore program for Sherburne County contractor license training	Determine suitability / feasibility of a training program requirement for contractors who work in County	2018-2028	Sherburne County Zoning	\$3,000 / year	County	Sherburne County	

Objective 7 - Update and manage county drainage systems, implement BMPs where possible							
Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region	
1 Identify water quality BMP retrofit opportunities along public ditch systems	Identify three potential sites, work with landowner to implement one project	2018-2028	Sherburne SWCD, Sherburne County	\$3,000 / year \$50,000 / project	BWSR, Federal	County ditch system upstream of impaired waters	
2 Encourage water storage feasibility projects aiming to mitigate or minimize the occurrence of flooding	Evaluate feasibility of 1-2 projects	2018-2028	Sherburne SWCD, Sherburne County, Lake Associations & Districts	\$4,000 / project	SWCD, County	Elk River Watershed	

Priority Concern 2: Groundwater Quality & Quantity
Goal: Reduce overall usage as well as groundwater contaminants / pollutants

Objective 1 - Mitigate occurrence of high nitrate concentrations in groundwater							
Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region	
1 Continue a free nitrate testing and low-cost drinking water testing opportunity for county residents	Maintain free nitrate testing at Sherburne SWCD, low-cost drinking water tests through Sherburne County	2018-2028	Sherburne SWCD, MDA, Nitrate Task Force	\$8,000 / year	SWCD, County	Prioritize irrigation wells and Clear Lake / Haven Townships.	
2 Assist with implementation of a County-wide Nitrate Management Plan	Coordinate 1 education event and implement 2-3 field based BMPs per year	Begin in 2018	Local Advisory Team, MDA, NRCS, Sherburne SWCD, Sherburne County	\$25,000 / year	SWCD, BWSR, Federal	Prioritize Clear Lake / Haven Townships, then county-wide	
3 <i>Dual purpose action, also proposed under Priority 1, Objective 5, Action 2:</i> Promote adoption of soil health practices	Include in educational programs (2x per year), increase use in applicable priority regions	2018-2028	Sherburne SWCD, NRCS	\$5,000 / year	SWCD, Federal	MRSC Watershed, County-wide	

Objective 2 - Support protection of WHPAs and DWSMAs, increase smart utilization of groundwater							
Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region	
1 Support protection of wellhead protection areas and DWSMAs through zoning ordinances	All land use decisions must consider proximity and impacts on WPAs and DWSMAs	2018-2028	Sherburne County Zoning, Townships, Cities	\$2,000 / year	County	Sherburne County WPAs and DWSMAs	
2 Expand use of advanced scheduling tools for irrigation management	Introduce tools to prospective users through educational events and consultations, seek cost-sharing as applicable	2018-2028	Sherburne SWCD, NRCS	\$5,000 / year	SWCD	MRSC Watershed, County-wide	
3 Address abandoned wells through education and cost-share opportunities for capping	Publicize education on wells, retain funds for well sealing cost-share	2018-2028	Sherburne SWCD, Sherburne County, Nitrate Task Force	\$4,000 / year	MDA, SWCD	Clear Lake / Haven Townships, Wellhead Protection Areas	
4 Implement protocol for public campus groundwater conservation (utilize Campus Groundwater Protocol)	Complete 1 groundwater usage study following completion of protocol	2018-2020	Sherburne SWCD	\$20,000 / project	BWSR	Public campuses	

Objective 3 - Enforce septic system regulations and incentivize proactive system maintenance							
Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region	
1 Enforce Sherburne County ordinances for meeting SSTS compliance	100% ordinance enforcement on new and failing systems	2018-2028	Sherburne County Zoning	\$20,000 / year	County	County-wide	
2 Promote and administer AgBMP Loan program and promote low-income MPCA grant program for failing SSTS replacement	Promote 4x annually through newsletter mailings and electronic resources; compliance on all failing systems	2018-2028	Sherburne County Zoning, Sherburne SWCD	\$10,000 (staff time & expenses)	County	Riparian areas, County-wide	
3 Educate riparian and other landowners on SSTS maintenance practices	Distribute educational materials annually, integrate SSTS discussions into two presentations annually	2018-2028	Sherburne SWCD, Sherburne County Zoning, SC COLA	\$4,000 / year	SWCD, County, City	Target riparian properties and other sensitive areas	

Priority Concern 2: Groundwater Quality & Quantity
Goal: Reduce overall usage as well as groundwater contaminants / pollutants

Objective 4 - Educate public employees, private contractors and landowners on groundwater quality BMPs and opportunities

Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region
1 Provide resources to contractors for stormwater alternatives, infiltration-based BMPs and bioengineering restoration practices	Distribute educational materials annually, hold biannual forum	2018-2028	Sherburne SWCD, Sherburne County, University of Minnesota	\$7,500 / year (staff time and expenses)	SWCD, County	Sherburne County
2 Expand education efforts for citizens on nitrate issues	Include nitrate discussion in annual agricultural outreach event	Ongoing	Nitrate Local Advisory Team, MDA, Sherburne SWCD	\$2,000 / year	SWCD	Prioritize Clear Lake / Haven Townships, increase effort on county level
3 Explore program for Sherburne County contractor license training	Determine suitability / feasibility of a training program requirement for contractors who work in County	2018-2028	Sherburne County Zoning	\$3,000 / year	County	Sherburne County

Objective 5 - Pursue groundwater monitoring opportunities in priority areas and established trend sites.

Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region
1 Continue to monitor ground water at solid waste facilities in Sherburne County	Continued effort - no net increase in pollutant groundwater plumes	2018-2028	Sherburne County Zoning, Sherburne SWCD	\$5,000 / year	County, SWCD	Solid waste facility sub-watersheds
2 Partner with state agencies to monitor groundwater in long-term trend wells	Active participation in DNR ObsWells program as well as MPCA, MDA or other agency monitoring projects as applicable	2018-2028	Sherburne SWCD, MPCA, DNR, MDA	\$2,000 / year	SWCD	Sherburne County

Priority Concern 3: Aquatic Invasive Species
Goal: Prevent the introduction and mitigate impact of AIS to Sherburne County waters

Objective 1 - Target high-use public access lakes for AIS Volunteer education, Level 1 inspections and Sheriff's Department Water Patrol presence annually

Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region
1 Utilize State AIS Prevention funds to maintain a presence at high use public accesses	8 public access points and / or 1,000+ hours total	Ongoing program 2018-2028	Sherburne SWCD	\$14,000 / year	County AIS Prevention	County-wide, high use public access points
2 Coordinate AIS volunteers to provide AIS education at public access points; implement incentive program to bolster program	Recruit 12+ volunteers annually, promote incentive program to increase participation	Develop in 2018	Sherburne SWCD, SC COLA	\$5,000 / year	County AIS Prevention	County-wide, high use public access points
3 Continue Sherburne Sheriff's Department Water Patrol presence and education on County lakes	Water Patrol monitor lakes and focus on AIS education 3 weekends per year	Ongoing program 2018-2028	Sherburne County Sheriff's Department, Sherburne SWCD	\$3,000 / year	County AIS Prevention	High use public waterbodies

Objective 2 - Continue to conduct AIS monitoring activities on 12+ public access lakes annually

Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region
1 Levy local volunteers to conduct zebra mussel veliger early detection monitoring on high-use lakes	12+ lakes monitored annually	Ongoing program 2018-2028	Sherburne SWCD, volunteers	\$2,500 / year	County AIS Prevention	County-wide high use lakes
2 Provide annual coordinated AIS training and monitoring opportunities	Facilitate 1 annual event	Ongoing program 2018-2028	Sherburne SWCD, SC COLA, volunteers	\$2,000 / year	County AIS Prevention	County-wide high use lakes

Objective 3 - Increase county stakeholder's exposure to AIS educational materials and references

Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region
1 Communicate AIS education and County prevention efforts to residents and visitors through annually coordinated educational initiatives	Reach 1,000+ students, 5+ lake property owner events, and numerous residents & non-residents annually	Ongoing program 2018-2028	Sherburne SWCD	\$7,500 / year	County AIS Prevention	County-wide residents and visitors
2 Arrange for county resident exposure to AIS experts and current research	Host expert presentations/workshops or subsidize resident conference registrations (goal is 2 events)	2018-2028	Sherburne SWCD, MN DNR	\$500 / year	SWCD	County-wide, focus on COLA members

Priority Concern 3: Aquatic Invasive Species
Goal: Prevent the introduction and mitigate impact of AIS to Sherburne County waters

Objective 4 - Assist county lake groups with AIS strategic planning and management

Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region
1 Assist lake association / district strategic management planning of native and non-native species through annual grant program	Administer \$20,000 (roughly 25% of 2017 AIS Prevention funds) annually	Ongoing program 2018-2028	Sherburne SWCD	\$22,000 / year	County AIS Prevention	County-wide
2 Assist lake associations / districts with creation or updates of Lake Vegetation Management Plans	Assist 1-2 lake associations/districts per year in updating or developing a vegetative or comprehensive plan	Complete by 2028	Sherburne SWCD	\$2,500 / year	County AIS Prevention	County-wide
3 Facilitate partnerships in AIS education, outreach, research and management	Partner with Sherburne COLA on at least 1 AIS activity annually	2018-2028	Sherburne SWCD, SC COLA	\$4,000 / year	SWCD	County-wide residents and visitors

Objective 5 - Levy local and statewide partnerships to foster innovative approaches to prevent AIS introduction and movement

Action	Targeted Goal	Timeframe	Facilitator(s)	Projected Cost	Funding Source	Priority Region
1 Investigate feasibility of watercraft decontamination, centralized watercraft cleaning station(s), or public access cleaning stations/kiosks	Determine sustainable financing mechanism and logistical feasibility for decontamination or cleaning station(s)	2018 - 2027	Sherburne SWCD, AIS Task Force, SC COLA, Sherburne County, MN DNR	\$50,000 (up front), \$35,000 / year (maintenance & staff)	AIS Prevention, other grant opportunities	County-wide residents and visitors
2 Develop and maintain relationships with peer AIS agencies and local management groups	SWCD, COLA and interested volunteers attend 2-3 AIS networking sessions annually	Ongoing program 2018-2028	Sherburne SWCD, AIS Task Force, SC COLA, MN DNR	\$2,500 / year	AIS Prevention, other grant opportunities	Sherburne County, MRSC and Rum River Watersheds, State of Minnesota
3 Maintain diverse working group to advise on AIS matters (lake front owners, bait shop owners, fishermen, etc.)	AIS Task Force - meet 2x per year	2018-2028	Sherburne SWCD, AIS Task Force, SC COLA	\$3,500 / year	SWCD	County-wide

6.0 Literature Cited and Relevant Studies

- Altena, E. 2011. Snake River Stream Survey Report. MN DNR Division of Fish and Wildlife, Section of Fisheries. 16 pp.
- Berg, J.A. and S.R. Pearson. 2013. South-Central Minnesota Groundwater Monitoring of the Mt. Simon Aquifer – Phase 2. Minnesota Department of Natural Resources Publication. Available: http://files.dnr.state.mn.us/publications/waters/south_central_mn_gw_monitoring_phase2.pdf
- Coder, K.D. 1996. Identified Benefits of Community Trees and Forests. University of Georgia Cooperative Extension Service – Forest Resources Publication FOR 96-39.
- Environmental Quality Board and MN Department of natural Resources. 2007. Use of Minnesota’s Renewable Water Resources: Moving Toward Sustainability. 26 pp. Available: <https://www.eqb.state.mn.us/sites/default/files/documents/UseofMinnesotasRenewableWaterResourcesApril2007.pdf>
- Erickson, A.J., Gulliver, J.S and P.T. Weiss. 2012. Capturing phosphates with iron enhanced sand filtration. Water Resources. June 2012, 46(9):3032-3042.
- Erickson, A.J., J.S. Gulliver, P.T. Weiss. 2015. Monitoring an Iron-Enhanced Sand Filter Trench for the Capture of Phosphate from Stormwater Runoff. SAFL Project Report No. 575, University of Minnesota, Minneapolis, MN, September 2015. Available: <http://hdl.handle.net/11299/175078>.
- Melillo, J.M., Richmond, T.C. and G.W. Yohe, Eds. 2014. Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 841 pp. doi: 10.7930/J0Z31WJ2. Available <http://nca2014.globalchange.gov/downloads>
- Minnesota Pollution Control Agency. 2007. Minnesota Statewide Mercury Total Maximum Daily Load. 75 pp. Available: March 27, 2007.
- Minnesota Pollution Control Agency. 2015. Mississippi River – St. Cloud Watershed TMDL. 210 pp. Available: <https://www.pca.state.mn.us/sites/default/files/wq-iw8-46e.pdf>
- Moeller, J. and C.A. Pomeroy. 2009. BMP and LID Whole Life Cost Models, Version 2.0. Water Environment & Reuse Foundation. Available <https://www.werf.org/a/Ka/Search/ResearchProfile.aspx?WebsiteKey=00bc0f55-bb85-4522-b31f-64e876cfd07d&ReportId=SW2R08>
- Pelham, M. 2011. Briggs Creek Stream Survey Report. MN DNR Division of Fish and Wildlife, Section of Fisheries. 13 pp.
- Root Capital Website. 2017. www.rootcapital.org/our-impacts/women-agriculture-initiative. Accessed September 2017.
- Tipping, R.G. 2011. Distribution of vertical recharge to upper bedrock aquifers Twin Cities Metropolitan Area. Minnesota Geological Survey, Metropolitan Council Project Report (submitted), 74 p.
- United States Department of Agriculture (USDA). 2017. Women in Agriculture website: www.usda.gov/our-agency/initiatives/women-agriculture. Accessed September 2017.
- USGCRP (2014) Pryor, S. C., D. Scavia, C. Downer, M. Gaden, L. Iverson, R. Nordstrom, J. Patz, and G. P. Robertson, 2014: *Ch. 18: Midwest. Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 418-440.

Relevant Studies, Resources and Reports

1. Birch Lake Sub Watershed Assessment. 2014. Available at Sherburne SWCD office.
2. Briggs Chain of Lakes Association Flyover Report. 2012. Available:
<https://www.briggslakechainassociation.com/flyover-project>
3. Elk River Sub Watershed ER04W Stormwater Retrofit Assessment. 2011. Available at Sherburne SWCD office.
4. Elk River Watershed TMDL Final Report. 2012. Available:
<https://www.pca.state.mn.us/sites/default/files/wq-iw8-14e.pdf>
5. Elk River Watershed TMDL Implementation Plan. 2012. Available:
<https://www.pca.state.mn.us/sites/default/files/wq-iw8-14c.pdf>
6. Lake Orono Sub-Watershed Assessment. 2017. Available at Sherburne SWCD office.
7. Mississippi River – St. Cloud WRAPS Project. 2015. Available:
<https://www.pca.state.mn.us/water/watersheds/mississippi-river-st-cloud>
8. Mississippi River – St. Cloud Watershed TMDL Study. 2015. Available:
<https://www.pca.state.mn.us/water/watersheds/mississippi-river-st-cloud>
9. Rum River WRAPS Project. 2017. Available:
<https://www.pca.state.mn.us/water/watersheds/rum-river>
10. Rum River TMDL Study. 2017. Available: <https://www.pca.state.mn.us/water/watersheds/rum-river>
11. Sherburne County AIS Prevention Work Plan. 2015 (last updated 2017). Sherburne Soil and Water Conservation District. Available: <http://www.sherburneswcd.org/aquatic-invasive-species-ais.html>
12. Sherburne County Comprehensive Plan. 2011. Available:
<https://www.co.sherburne.mn.us/zoning/pz/compplan.php>
13. Sherburne County Zoning Ordinances. Available:
<http://www.co.sherburne.mn.us/zoning/pz/zoningord.php>
14. Sherburne National Wildlife Refuge Comprehensive Conservation Plan. 2015. Available:
<https://www.fws.gov/midwest/planning/sherburne/index.html>
15. Upper Mississippi River Bacteria TMDL Study and Protection Plan. 2016. Available:
<https://www.pca.state.mn.us/sites/default/files/wq-iw8-08e.pdf>

