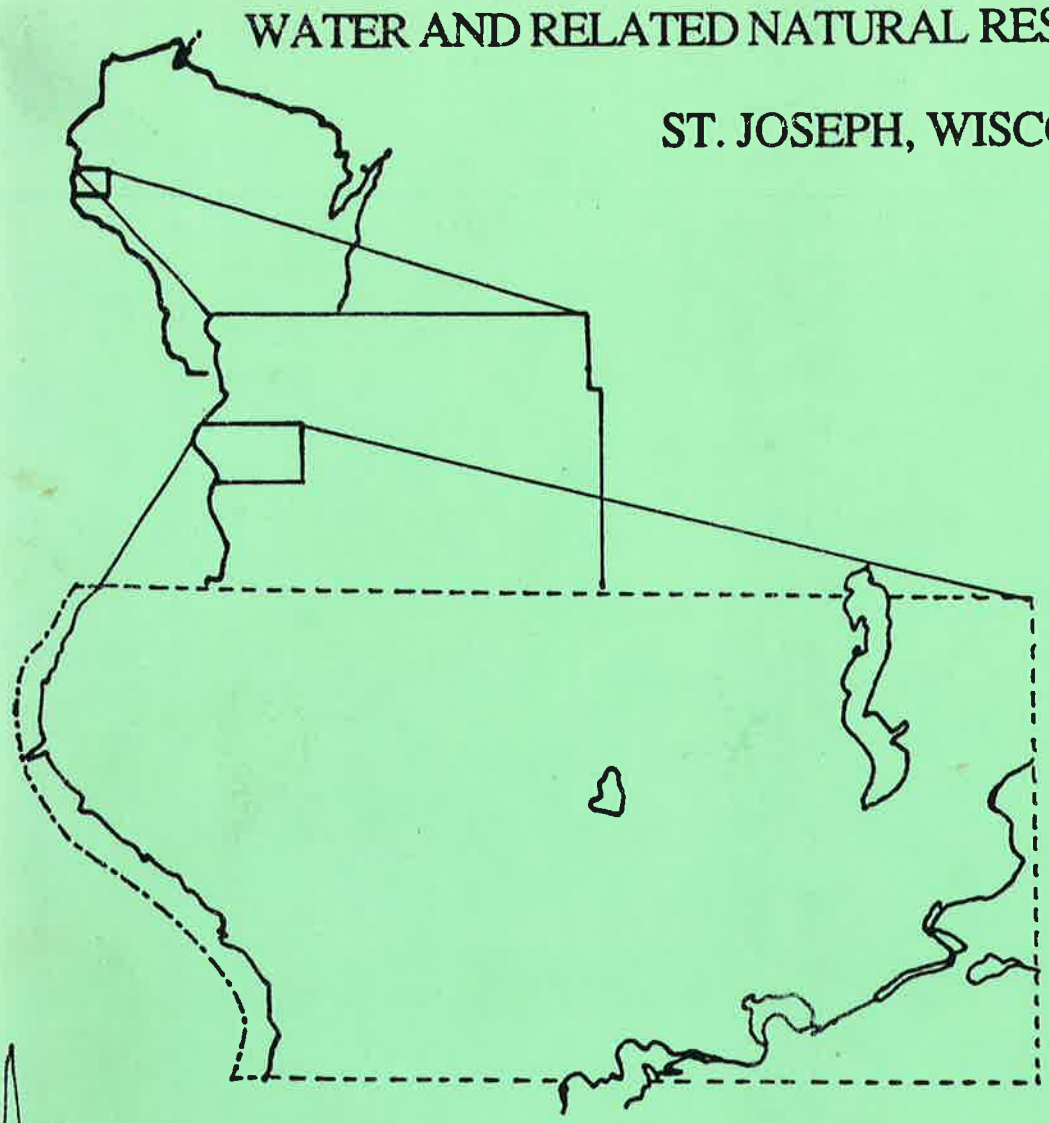
WATER AND RELATED NATURAL RESOURCES INVENTORY

ST. JOSEPH, WISCONSIN



University of Minnesota
NRES-5100 Senior Seminar
St. Paul, Minnesota
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PREFACE

This document was prepared by students enrolled in a senior seminar course for Recreation Resource Management and Natural Resources students in the colleges of Agriculture and Natural Resources, University of Minnesota. The general scope of the course was to address an issue dealing with a new bridge proposed to span the St. Croix River between Stillwater, Minnesota and the Town of St. Joseph, Wisconsin.

This report provides an overview of the water resources of St. Joseph, Wisconsin. It has been prepared to aid the St. Joseph Town Board and St. Croix County Planning and Zoning officials, who are producing a new St. Joseph community development plan. The community plan is intended to address the issues related to the coming of the bridge. Designed as a reference manual, the format of the report is meant to encourage use by all parties, not necessarily only resource managers. The report includes maps and figures to enable conceptualizing the complex material herein.

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EXECUTIVE SUMMARY

A current proposal for the construction of a four lane bridge over the St. Croix Wild and Scenic Riverway between Stillwater, Minnesota and the Town of St. Joseph, Wisconsin, has the potential for greatly increasing the population of St. Joseph, Wisconsin.

The Town of St. Joseph is a predominantly rural community, with high quality natural resources, making it an attractive bedroom community to Twin Cities area residents. In order for the Town of St. Joseph to effectively address the potential changes to the area, a community development plan is being prepared. St. Croix County Planning and Zoning, along with the St. Joseph Town Board is publishing this plan. The University of Minnesota Natural Resources and Environmental Studies Seminar has undertaken a water resource inventory to aid St. Joseph in the production of this plan. In order to effectively address future changes to St. Joseph, it will be necessary to identify the current quality status of their natural resources.

The results of this inventory include the discovery of a very diverse soil resource and the production of maps showing slopes and soil permeability in St. Joseph. St. Joseph has over 100 different soil types with irregular regions of highly permeable soils and steep slopes.

The groundwater supply is abundant and of high quality. Several sensitive areas were discovered where groundwater protection measures and/or land use conservation practices will be necessary. St. Joseph has high quality lakes, a trout stream, two rivers and many wetlands. In addition to the current water quality data being generated for Bass Lake through an extensive study, it will be important to establish some baseline quality for the other lakes. It is likely that St. Joseph lakes and rivers will be an additional attraction to potential home owners looking for a more rural atmosphere outside of the Twin Cities.

During the inventory process it was learned that St. Joseph does have several resource protection programs in place. These programs are offered through county, state and federal agencies. The majority are not mandatory and those that are required are often not strictly enforced. It was evident that the natural resources within St. Joseph are of high quality. It will be important in the future for this community to retain the high quality of their resources through more stringent ordinance enforcement, comprehensive land use planning and program implementation. An increase in development is imminent. However, with proper management strategies, the quality of the natural resources in St. Joseph need not be reduced.

INTRODUCTION

Severe traffic congestion in the city of Stillwater and the surrounding communities on both sides of the St. Croix River has lead to the proposed construction of a four lane bridge over the St. Croix Wild and Scenic Riverway. The proposed bridge will span the river between Stillwater, Minnesota and the Town of St. Joseph, Wisconsin, connecting Minnesota State Highway 36 and Wisconsin State Trunk Highway 35/64. Refer to Figure 1 for more specific information on the location. After construction, the bridge will ease traffic flow between St. Joseph, Wisconsin and Stillwater, Minnesota.

In light of improved access to the Town of St. Joseph, a group of St. Joseph citizens has expressed concern over increased pressure to suburbanize the predominantly rural community. To responsibly cope with future growth opportunities, the community board along with county zoning and planning officials are preparing a new community development plan for St. Joseph.

The new community development plan will include an inventory of the resources of the area, revised zoning plans and a comprehensive resource management plan. To accomplish this, a new zoning map was prepared and a survey of public opinion was conducted. This report on the water resources of St. Joseph will further aid in the preparation of the community development plan.

This report includes an inventory of the water resources and other natural resource characteristics such as soils, geology, use of the water resources, and a review of current management strategies and controlling ordinances related to water resources. The report concludes with suggestions that may be useful for preparing a community development plan that will maintain the current level of water quality.

Figure 1: TOWN OF ST. JOSEPH

GEOGRAPHY

The Town of St. Joseph, Wisconsin is located in west central Wisconsin, on the St. Croix River in St. Croix County (Figure 1). St. Joseph is unique in that it includes portions of four Townships and Ranges, including; T. 30 N.-R. 20 W., T. 30 N.-R 19 W., T. 29 N.-R. 20 W., and T. 29 N.-R. 19 W (Figure 1). Because St. Joseph extends the boundaries of a single township, it is referred to as the Town of St. Joseph. Throughout this text, the shorter form, St. Joseph is frequently used.

POPULATION AND DEVELOPMENT

St. Joseph's 32.1 square miles is predominantly rolling agricultural land supporting row crops. This is quickly changing, however, as the population base is shifting to young professionals commuting to the Twin Cities and surrounding suburbs. Already 58% of the residents work in Minnesota with 36% working in managerial or professional jobs and 36% being between the ages of 24 to 44 years (St. Joseph Community Opinion Survey 1991).

The population of St. Joseph is not only young, but new to the area, with 45% of residents having been in St. Joseph for 10 years or less (Public Opinion Survey 1991). These statistics suggest that St. Joseph is a community whose rapid population growth is largely comprised of young professionals who work in Stillwater, the Twin Cities and surrounding suburbs.

St. Joseph's attractive rolling scenery, rural atmosphere and location near the Twin Cities and Stillwater make it an attractive bedroom community. The rural appearance attracts many new residents. The overwhelming consensus of residents is a desire to maintain St. Joseph's rural atmosphere through the use of strong controls placed on further development (Public Opinion Survey 1991).

With the proposed new bridge, maintaining a rural St. Joseph will be a significant challenge. The new bridge will span the St. Croix River, connecting Minnesota State Highway 36 and Wisconsin State Trunk Highway 35/64. This will facilitate access from the Twin Cities to St. Croix County Roads E and V which will allow unhindered traffic flow throughout St. Joseph.

Without the addition of the new bridge, the population of St. Joseph is predicted to increase its current 2,657 by 50% by the year 2010 (U.S. Dept. of Commerce 1991). Estimates of population growth with the bridge in place have not been determined, but it is the position of St. Croix County Zoning and Planning officials that development is expected to occur as fast as city and county officials will allow. A desire to responsibly oversee the predicted growth has prompted the decision of St. Croix Planning officials and the St. Joseph Town Board to prepare a community development plan. The plan is intended to pursue economic growth while protecting the natural resources of the community.

HYDROLOGIC CYCLE

Driven by solar energy, the hydrologic cycle is the continual circulation of water between the land, atmosphere and oceans. Water enters the atmosphere by evaporation from soils and water bodies and by transpiration from plants. The water is then redistributed to the land and oceans in various forms of precipitation. Water may run off of the land surface into lakes where it may be stored. It can seep deep into the soil to recharge groundwater supplies. Rivers also receive water during storm events and convey the water to oceans or other water bodies. Depending on the intensity of precipitation, slope, and the permeability of the soils, a portion of rainwater will infiltrate through the soils directly into groundwater. Water may also be taken up by plants and animals directly, where it is used in metabolic processes or be transpired back into the atmosphere (Brooks 1991).

The significance of the hydrologic cycle for purposes of water resource management lies within the changes undergone by water as it passes through the cycle. Water acts as a vehicle for the movement of contaminants and sediment. As water infiltrates through the soils, many of the contaminants will be filtered out through a complex purification process. Some contaminants, however, will concentrate in waters such as lakes, wetlands, and deep aquifers. As water enters the atmosphere through evapotranspiration, it is also purified as many contaminants will not evaporate with the water (Brooks 1991).

The hydrologic cycle also causes many changes of the land surface. The weathering of rock and soils, the erosion of mountains and farmland the creation of deltas and wetlands and the location of vegetative communities is all dependent on the driving energy of the hydrologic cycle and the distribution of its impacts. Water resource management must, therefore, consider the distribution and magnitude of the energy contributed to a system by the hydrologic cycle of the region. Knowledge of the hydrologic cycle may contribute information the potential for erosion, the sustainable yield from groundwater supplies, the species of plants most likely to flourish, the likelihood of flooding, and the potential for contamination of groundwater.

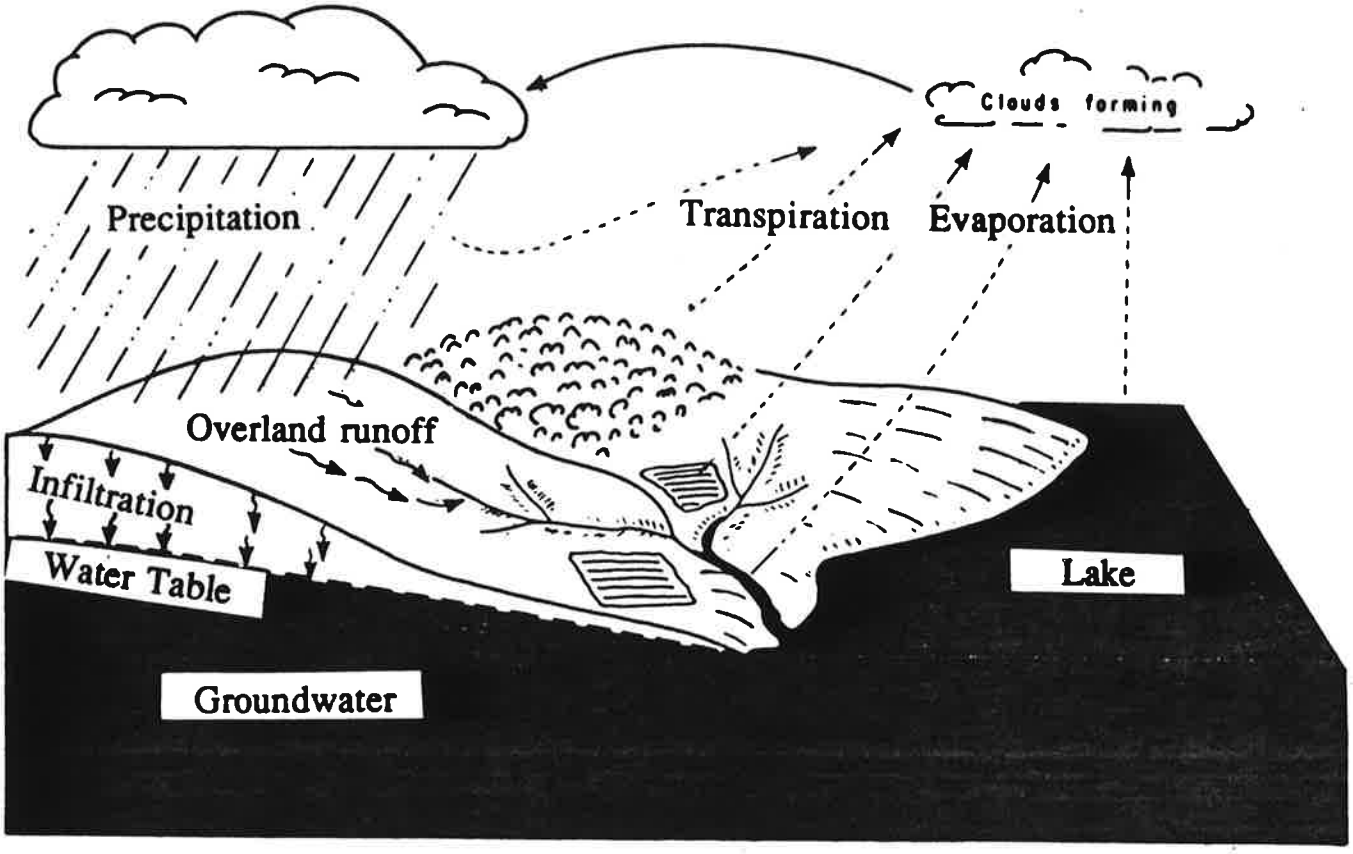


Figure 2 The hydrologic cycle

Source: Heath, Ralph C.

CLIMATE

St. Joseph has a Continental Climate which is characterized by well-marked temperature seasons. Winters in St. Joseph are long and cold with up to 58 days of temperatures as low or lower than 0 degrees F. Summers are warm with occasional high humidity. Up to 34 days of 90 degree F weather has been recorded in St. Joseph during the summer, and humidity averages 55 to 80 percent throughout a summer day. St. Joseph's average precipitation is 29.57 inches per year. High and low pressure systems that start in the West and move Eastward bring Northwest winds November through April, and Southeast winds May through October. The varying weather in St. Joseph is caused by the pressure systems moving through this area (St. Croix County Soil Survey 1978).

Climatic processes such as wind, rain, and heat, acting on rocks, sediments, and geologic materials will form soil (Munns and Singer 1987). Soil formation is important in considering water quality because certain characteristics of soils determine whether the soil can modify contaminants before groundwater is polluted. Soil characteristics can also determine whether pollutants will run off soils and into surface water sources. Because St. Joseph is concerned with their groundwater quality, understanding the processes affecting groundwater is essential to protecting it.

GEOLOGY

Rocks and soils are the primary factors controlling the movement and storage of groundwater. Rocks that are porous and allow water to move freely are said to be permeable. These water bearing rocks consist either of unconsolidated deposits or consolidated rocks (Heath 1989). Unconsolidated material consists of different sized particles ranging from clay to boulder size. The larger the particle size, the more it can hold and transport sub-surface water. Consolidated rock is the typical bedrock that underlies unconsolidated material. Consolidated rock allows water movement if well fractured. Granite is an example of such a rock type. Semiconsolidated rocks, which are rocks that have both pores and fractures, also exist. Such rocks include dolomites and sandstones. These rocks allow water transport through their pores and fractures. The specific geology of a region plays an important role in determining water resource quantity and quality in that area.

GEOLOGIC STRATIGRAPHY OF ST. JOSEPH

Pre-Cambrian bedrock is the oldest and lowest layer of bedrock in the St. Joseph area. This rock layer is found beneath the entire region, and is made up of crystalline and sedimentary rocks. Pre-Cambrian bedrock is significant due to its low permeability. This impermeable layer marks the lower limit of groundwater movement in the St. Joseph area (Borman 1976).

Above Pre-Cambrian bedrock are the younger Cambrian system rocks which consist primarily of sandstone. Sandstone has moderate permeability and supports ground water movement. Resting above this system are the Ordovician rocks, the upper most bedrock layer. This layer includes in ascending order: the Prairie du Chien group, consisting mainly of dolomite, the St. Peter Sandstone, and the Galena-Platteville unit, which also consists largely of dolomite (Williams 1989 and Borman 1976). Dolomite is a fractured carbonate rock which has fairly high permeability for groundwater flow.

The upper surface of the bedrock in St. Joseph ranges from 485 to 915 feet above sea level and is located 50 to 400 feet below the land surface. Figure 3 in the Groundwater section shows an east/west cross-sectional view of St. Joseph and how the bedrock surface would be seen if the above glacial till were removed. This cross-section will be addressed further, but it is significant to note the raised bedrock in the western half of St. Joseph and the bedrock valley in the central part

of the town. This significant change in bedrock elevation is due to a mid continental rift system running through the region (Williams 1989). This raised bedrock also has an affect on the thickness of the sandstone aquifer as mentioned in the Groundwater section.

The contours and shape of the bedrock surface are due to pre-glacial erosion and glacial activity that have taken place. Glacial deposits, from the Quaternary period, overlie the bedrock in the St. Joseph area. These deposits are comprised of unconsolidated sand and gravel deposited mostly as an end moraine, with some pitted outwash in the southeastern part of the town, as seen in Map 4 in the Groundwater section. This glacial moraine was formed by the Superior lobe during Wisconsin glaciation, which receded 14,000 years ago, and is responsible for the rolling and hummocky terrain of the region. The unconsolidated material reaches maximum depths of up to 400 feet where a glacial end moraine was deposited in the bedrock valley area of St. Joseph.

Many closed depressions occur over the land surface of St. Joseph. These depressions are formed from glaciation. As glaciers receded, large ice chunks were left in areas, and these created depressions known as kettles. These depressions exist over much of the terrain in St. Joseph and many are now occupied by lakes and marshes, as seen in the Surface Water section. Some closed depressions in the extreme east and west parts of St. Joseph may be sinkholes created from karst development (Huffman 1992). This development takes place in areas with highly soluble bedrock, such as dolomite in the St. Joseph area, and results in depressions and fissures that cut into the bedrock. Lying above the unconsolidated material in St. Joseph is a productive layer of soil.

SOIL RESOURCES

Soil is composed of mineral material, organic matter, biological organisms, air, and water. It is formed through geologic as well as climatic and biological processes (Brady 1984). A cross section of soils in any area reveals layers. These layers are referred to as horizons and they vary in depth. A, B, C, and R horizons are the main layers. The A horizon is the top portion of the soil where humus collects and high biological activity occurs. As rainwater passes through the A horizon, it picks up dissolved and suspended material and carries them down to the lower horizons. Various materials may end up in the B horizon which is known as the zone of accumulation. If the material does not stop in the B horizon it may pass through to the C horizon and into groundwater. The C horizon is not greatly changed by soil formation and is composed of unconsolidated parent material. The underlying bedrock is known as the R horizon (Munns and Singer 1987).

Soil acts as a filter, adsorbing or modifying contaminants from municipal, industrial, and agricultural sources (Brady 1984). The longer a contaminant is retained in the soil the better chance it has of being modified. The soil's pH and attractive forces influence the likelihood of contaminants to be retained or broken down in the soil. Each soil has unique characteristics that allows it to retain or modify contaminants. Consequently, some soils are better contaminant filters than others.

Permeability is the movement of water through soil and is reported in number of inches per hour. Permeability is determined by the size, number and interconnectedness of soil pores, soil water content, and the nature of the soil surface. Because clays and clay loams have smaller pores, they are less permeable. Sandy soils have rapid permeability because they have large, well connected pores. The more permeable a soil is, the faster it can transmit water and/or contaminants in the water through the soil to the groundwater (Munns and Singer 1987). Soil permeability rates in St. Joseph are indicated (Map 1) as 6 to 20 inches per hour which is very rapid, 2 to 6 inches per hour which is rapid, and .6 to 2 inches per hour which is moderately rapid. Permeability not only affects the ability of infiltrating water to reach the water table, but also the time that it takes to get there. Residence time in less permeable soils is greater and allows more complete biological and chemical breakdown of contaminants.

St. Joseph has a vast array of soils. Due to this fact, differing permeability rates are scattered throughout the Town (Map 1). The bluffline on the western edge of St. Joseph has a rapid permeability rate. Caution must be used on soils with very rapid, rapid, and moderately rapid permeabilities to prevent groundwater contamination.

Cation exchange capacity (CEC) and pH are also important in identifying soils with good filtering capabilities. CEC is the measure of the capacity of a soil particle to adsorb cations such as sodium, magnesium, potassium, calcium, aluminum, and other metals. CEC has not been identified for the Town of St. Joseph in this report. The St. Croix County Soil Survey should be consulted for more specific information.

The pH of the soil will affect chemical and biological processes that breakdown contaminants as well as influence the properties of the contaminant itself. For instance, some pesticides break down more readily in soils with a lower pH (higher acidity). Many biological organisms are sensitive to pH and their ability to modify contaminants is affected by different pH levels. Also, the solubility of many contaminants changes with differences in pH. Soluble contaminants are more likely to leach into groundwater supplies. For information on the interrelationships of these factors under a given circumstance, consultation with a soil scientist is appropriate.

In addition to the filtering capacity of soils, other limiting factors should be considered during the planning process. Slope is perhaps the most obvious physical consideration. Slope is the inclination of the land surface from the horizontal. As the slope increases so does the erosion hazard and runoff velocity (Munns and Singer 1987). An analysis of St. Joseph's soil characteristics reveals a very high correlation between these three factors. For the purposes of planning, St. Joseph can use the slope map to indicate areas where erosion hazards and runoff potentials are severe.

St. Joseph's topography consists of rolling hills and hummocky terrain, which is why slope gradients range from 0 to 35 percent. A wide band of moderate slopes is apparent in the central part of Town (Map 2). The bluffline on the western part of Town has severe slopes of 20 to 35 percent. The severe slopes on the bluff can be a possible source of pollution to the St. Croix River due to the flow of runoff into the water. Caution must be used on sites that have extreme and moderate slopes in order to protect the quality of the water resources in St. Joseph.

Soil erosion and runoff are both sources of surface water contamination. Soil erosion can occur from water running on the surface soil and picking up soil particles. Any contaminant on the soil surface can be washed into a nearby body of water with runoff (Munns and Singer 1987). Erosion reduces soil water holding capacity and removes organic matter, mineral particles, and nutrients from the soil, and may transport them to water bodies. These additions are detrimental to the water (Munns and Singer 1987). The degree that severe slopes will result in erosion problems and high runoff is directly related to the amount and type of vegetation on the slope.

The blufflines show a severe erosion problem, which is typical for an area with rapid runoff and steep slopes. The soil on the bluffs in the western part of St. Joseph has the potential of being washed into the St. Croix River. The vegetation on the bluffline is a major force preventing erosion. Development of areas in St. Joseph with severe erosion and runoff patterns should be planned carefully to avoid possible contamination to surface water.

The soils of St. Joseph have been categorized by dominant soils (Map 3). The soils map was created by evaluating 40 acre parcels of land. The most dominant soil type in the 40 acre parcel was chosen to represent that parcel. In parcels containing soil types that had relatively equal measures of land, the most severe soil was used to represent the 40 acres. Because St. Joseph contains a vast array of soils, this was decided to be the best method of evaluation. This map can be used for planning purposes in St. Joseph. For further information on the development of this map refer to the methodology section of the appendix. For additional soil characteristics of St. Joseph see Table 1. For exact information of a site in St. Joseph consult the St. Croix County Soil Survey.

TABLE 1. A: SOIL CHARACTERISTICS OF ST. JOSEPH

Map Symbols	Soil Types	Slope %	Permeability inches per hour Surface	Subsoil
AmB	Amery Loam	2 to 6	0.6 to 2.0	0.6 to 2.0
AmC2	Amery Loam	6 to 12, eroded	0.6 to 2.0	0.6 to 2.0
AmD2	Amery Loam	12 to 20, eroded	0.6 to 2.0	0.6 to 2.0
AmE2	Amery Loam	20 to 30, eroded	0.6 to 2.0	0.6 to 2.0
AnC2	Amery - Cromwell Sandy Loam	6 to 12, eroded	0.6 to 2.0	0.6 to 2.0
AnD2	Amery - Cromwell Sandy Loam	12 to 25, eroded	0.6 to 2.0	0.6 to 2.0
AoA	Antigo Silt loam	0 to 2	0.6 to 2.0	0.6 to 6.0
AoB	Antigo Silt loam	2 to 6	0.6 to 2.0	0.6 to 6.0
ApC2	Arland Sandy Loam	6 to 12, eroded	2.0 to 6.0	0.6 to 6.0
ApD2	Arland Sandy Loam	12 to 25, eroded	2.0 to 6.0	0.6 to 6.0
BrB	Burkhardt Sandy Loam	1 to 6	2.0 to 6.0	2.0 to 20.0
BrC2	Burkhardt Sandy Loam	6 to 12, eroded	2.0 to 6.0	2.0 to 20.0
BxB	Burkhardt - Sattre Complex	2 to 6	2.0 to 6.0	2.0 to 20.0
BxC2	Burkhardt - Sattre Complex	6 to 12, eroded	2.0 to 6.0	2.0 to 20.0
BxD2	Burkhardt - Sattre Complex	12 to 30, eroded	2.0 to 6.0	2.0 to 20.0
CoC2	Chetek - Onamia Complex	6 to 12, eroded	2.0 to 6.0	2.0 to 20.0
CoD2	Chetek - Onamia Complex	12 to 20, eroded	2.0 to 6.0	2.0 to 20.0
CoE	Chetek - Onamia Complex	20 to 30	2.0 to 6.0	2.0 to 20.0
DcC2	Dakota - Pillot Complex	6 to 12, eroded	0.6 to 2.0	0.6 to 20.0
DkB	Dickman Sandy Loan	2 to 6	2.0 to 6.0	6.0 to 20.0
EmE	Emmert Loamy Sand	12 to 35	2.0 to 6.0	> 20.0
Fe	Fluvaquents		Variable	Variable
FoB	Freeon Silt Loam, Heavy Substratum	2 to 6	0.6 to 2.0	0.2 to 2.0
GoB	Gotham Loamy Fine Sand	2 to 6	6.0 to 20.0	6.0 to 20.0
HrB	Hubbard Loamy Sand	0 to 6	6.0 to 20.0	6.0 to 20.0
HsB	Hubbard Loamy Sand,Loamy Substratum	0 to 6	6.0 to 20.0	0.2 to 2.0
HsC	Hubbard Loamy Sand,Loamy Substratum	6 to 12	6.0 to 20.0	0.2 to 2.0
HuA	Huntsville Silt Loam	0 to 3	0.6 to 2.0	0.6 to 2.0
JeB	Jewett Silt Loam	2 to 6	0.6 to 2.0	0.6 to 2.0
JeC2	Jewett Silt Loam	6 to 12, eroded	0.6 to 2.0	0.6 to 2.0
JsB	Jewett Silt Loam, Sandy Substratum	2 to 6	0.6 to 2.0	0.6 to 20.0

TABLE 1.B: SOIL CHARACTERISTICS OF ST. JOSEPH

Map Symbols	Soil Types	Slope %	Permeability inches per hour Surface	Subsoil
OmB	Onamia Loam	2 to 6	0.6 to 2.0	0.06 to 20.0
OmC2	Onamia Loam	6 to 12, eroded	0.6 to 2.0	0.06 to 20.0
OnC2	Onamia - Antigo Complex	6 to 12, eroded	0.6 to 2.0	0.06 to 20.0
OnD2	Onamia - Antigo Complex	12 to 25, eroded	0.6 to 2.0	0.06 to 20.0
OtB	Otterholt Silt Loam	2 to 6	0.6 to 2.0	0.6 to 2.0
OtC	Otterholt Silt Loam	6 to 12	0.6 to 2.0	0.6 to 2.0
PiA	Pillot Silt Loam	0 to 3	0.6 to 2.0	0.6 to 20.0
PmB	Plainfield Loamy Sand	2 to 6	6.0 to 20.0	6.0 to 20.0
PmC	Plainfield Loamy Sand	6 to 12	6.0 to 20.0	6.0 to 20.0
PmD	Plainfield Loamy Sand	12 to 20	6.0 to 20.0	6.0 to 20.0
PoB	Port Byron Silt Loam	2 to 6	0.6 to 2.0	---
RnD2	Ritchey Silt Loam	12 to 20, eroded	0.6 to 2.0	0.6 to 2.0
RoE	Ritchey Soils and Rock Outcrop	20 to 35	0.6 to 2.0	0.6 to 2.0
RpB	Rockton Silt Loam	2 to 6	0.6 to 2.0	0.6 to 2.0
SaB	Santiago Silt Loam	2 to 6	0.6 to 2.0	0.6 to 2.0
SaC2	Santiago Silt Loam	6 to 12, eroded	0.6 to 2.0	0.6 to 2.0
ScC2	Santiago - Antigo Complex	6 to 12, eroded	0.6 to 2.0	0.6 to 2.0
ScD2	Santiago - Antigo Complex	12 to 25, eroded	0.6 to 2.0	0.6 to 2.0
ShB	Sattre Loam	2 to 6	0.6 to 2.0	0.6 to 20.0
ShC2	Sattre Loam	6 to 12, eroded	0.6 to 2.0	0.6 to 20.0
SiA	Sattre Silt Loam	0 to 2	0.6 to 2.0	0.6 to 20.0
SiB	Sattre Silt Loam	2 to 6	0.6 to 2.0	0.6 to 20.0
Ud	Udifluvents		Variable	Variable

TABLE 1.C: SOIL CHARACTERISTICS OF ST. JOSEPH

Map Symbols	Erosion Hazard	Runoff	Water Holding Capacity inches per inch of soil	
			Surface	Subsoil
AmB	Slight	Slow	0.12 to 0.22	0.11 to 0.14
AmC2	Moderate	Medium	0.12 to 0.22	0.11 to 0.14
AmD2	Severe	Rapid	0.12 to 0.22	0.11 to 0.14
AmE2	Severe	Rapid	0.12 to 0.22	0.11 to 0.14
AnC2	Moderate	Medium	0.12 to 0.22	0.11 to 0.14
AnD2	Severe	Rapid	0.12 to 0.22	0.11 to 0.14
AoA	Slight	Slow	0.22 to 0.24	0.14 to 0.22
AoB	Slight	Slow	0.22 to 0.24	0.14 to 0.22
ApC2	Moderate	Medium	0.16 to 0.18	0.05 to 0.17
ApD2	Severe	Rapid	0.16 to 0.18	0.05 to 0.17
BrB	Slight	Slow	0.13 to 0.15	0.02 to 0.14
BrC2	Moderate	Medium	0.13 to 0.15	0.02 to 0.14
BxB	Slight	Slow	0.13 to 0.15	0.02 to 0.14
BxC2	Moderate	Medium	0.13 to 0.15	0.02 to 0.14
BxD2	Severe	Rapid	0.13 to 0.15	0.02 to 0.14
CoC2	Moderate	Medium	0.13 to 0.15	0.02 to 0.19
CoD2	Severe	Rapid	0.13 to 0.15	0.02 to 0.19
CoE	Very Severe	Very Rapid	0.13 to 0.15	0.02 to 0.19
DcC2	Moderate	Medium	0.20 to 0.22	0.02 to 0.19
DkB	Slight	Slow	0.12 to 0.15	0.02 to 0.11
EmE	Severe	Rapid	0.06 to 0.10	0.02 to 0.10
Fe	Slight	Slow	Variable	Variable
FoB	Slight	Slow	0.22 to 0.24	0.14 to 0.19
GoB	Slight	Slow	0.09 to 0.12	0.07 to 0.12
HrB	Slight	Slow	0.10 to 0.12	0.05 to 0.07
HsB	Slight	Slow	0.09 to 0.11	0.11 to 0.22
HsC	Slight	Slow	0.09 to 0.11	0.11 to 0.22
HuA	Moderate	Slow	0.22 to 0.24	0.11 to 0.19
JeB	Slight	Slow	0.22 to 0.24	0.08 to 0.19
JeC2	Moderate	Medium	0.22 to 0.24	0.08 to 0.19
JsB	Slight	Slow	0.22 to 0.24	0.02 to 0.19

TABLE 1.D: SOIL CHARACTERISTICS OF ST. JOSEPH

Map Symbols	Erosion Hazard	Runoff	Water Holding Capacity inches per inch of soil	
			Surface	Subsoil
OmB	Slight	Slow	0.20 to 0.22	0.02 to 0.18
OmC2	Moderate	Medium	0.20 to 0.22	0.02 to 0.18
OnC2	Moderate	Medium	0.20 to 0.22	0.02 to 0.18
OnD2	Severe	Rapid	0.20 to 0.22	0.02 to 0.18
OtB	Slight	Slow	0.22 to 0.24	0.20 to 0.22
OtC	Moderate	Medium	0.22 to 0.24	0.20 to 0.22
PiA	Slight	Slow	0.22 to 0.24	0.02 to 0.22
PmB	Slight	Slow	0.10 to 0.12	0.06 to 0.08
PmC	Slight	Slow	0.10 to 0.12	0.06 to 0.08
PmD	Slight	Slow	0.10 to 0.12	0.06 to 0.08
PoB	Slight	Slow	0.22 to 0.24	---
RnD2	Severe	Rapid	0.22 to 0.24	0.17 to 0.19
RoE	Mod. to VSevere	Med.toVRapid	0.22 to 0.24	0.17 to 0.19
RpB	Slight	Slow	0.22 to 0.24	0.15 to 0.22
SaB	Slight	Slow	0.22 to 0.24	0.11 to 0.19
SaC2	Moderate	Medium	0.22 to 0.24	0.11 to 0.19
ScC2	Moderate	Medium	0.22 to 0.24	0.11 to 0.19
ScD2	Severe	Rapid	0.22 to 0.24	0.11 to 0.19
ShB	Slight	Slow	0.22 to 0.24	0.02 to 0.17
ShC2	Moderate	Medium	0.22 to 0.24	0.02 to 0.17
SiA	Slight	Slow	0.22 to 0.24	0.02 to 0.17
SiB	Slight	Slow	0.22 to 0.24	0.02 to 0.17
Ud	Slight	Slow	Variable	Variable

GROUNDWATER

GENERAL DESCRIPTION

Groundwater is the only utilized source of drinking water in the Town of St. Joseph. It is important for St. Joseph to have adequate knowledge concerning the quantity and quality of this naturally occurring resource. Underground water is all water found beneath the land surface. This water is found in two zones. The unsaturated zone is found immediately below the land surface and is distinguished by pore spaces between rocks and soil that are filled with air and water in varying amounts. The saturated zone is found below the unsaturated zone and has pore spaces completely filled with water. This saturated zone is termed groundwater and is the zone that wells and springs obtain their water from. As briefly described in the Geology section, groundwater can move through unconsolidated and consolidated rock. This movement is determined by the porosity and permeability of the rock material. Porosity is defined as the ability of rock and soil to store water, and can be determined by the number of open spaces, pores, cracks, crevices and fractures in the rock material. Porosity is important to groundwater flow only if the pores are connected. Permeability is the ability of rock to transmit water and is a measure of the interconnection among open spaces. Both of these factors are necessary for groundwater to move in the groundwater system.

Groundwater flows according to the hydraulic gradient in an area. In an unconfined aquifer the hydraulic gradient is predominantly determined by the change in head that exists, and the head is determined by the height of the water table. The direction of groundwater flow is from a higher gradient to a lower one. Groundwater topography is a replica of surface topography, and to an extent this is true in St. Joseph. Map 4 shows the water table of St. Joseph. The general direction of groundwater movement can be determined from the water table contours, with groundwater traveling perpendicular to the decreasing contours, shown as arrows on the map. This map shows the east to west flow of groundwater through the Town, with some anomalies, such as in Section 23 in the northwestern corner of St. Joseph, where water flows southeast before it flows west. This general flow direction is significant since all of the water that enters the groundwater system in St. Joseph (that is not utilized by wells or vegetation) will flow toward the St. Croix River. A water table map reflects the given heights of averages obtained from data collected over a period of several years, and therefore is only an estimation at any given time. The water table is not a static surface and its elevation changes constantly in relation to the amount of precipitation and water use. Map 4 illustrates generalized water table trends over St. Joseph, and should not be used for accurate site specific water table depths.

ST. JOSEPH AQUIFERS

St. Joseph has two principle water supplying aquifers. The first aquifer is a sand and gravel aquifer, and is located in the Quaternary glacial deposits. This aquifer is unconfined and consists of saturated, unconsolidated sand and gravel. The second major aquifer is located in saturated bedrock above the Pre-Cambrian layer. This aquifer is also unconfined and consists of saturated sandstone and dolomite.

The locations of the sand and gravel aquifer and the sandstone aquifer are shown in Figure 3. This East-West cross-section of St. Joseph identifies the bedrock layer below the unconsolidated layer, with the water table marking the boundary of saturation. On this cross-section, the sand and gravel aquifer is located in unconsolidated sand and gravel below the water table. The sand and gravel aquifer is thickest in the bedrock valleys that occur in the area. The sandstone aquifer is located in bedrock below the water table line and is closest to the surface where the bedrock is raised. These aquifers are hydraulically connected, with water flowing freely between them (Collins, 1992). This hydraulic connection is significant since there are no barriers to contamination between the aquifers. If the sand and gravel aquifer becomes contaminated, the sandstone aquifer can become contaminated.

In areas around Houlton, the water table is located in the raised sandstone bedrock, and no groundwater exists in the unconsolidated sand and gravel. However, in other areas such as west of Perch Lake, the sand and gravel aquifer reaches a thickness of over 300 feet (Figure 3). Although groundwater is found below all of the St. Joseph area, the depth to the water table varies greatly between regions, ranging from zero to over 200 feet, resulting in differing yields of water to local wells.

Groundwater Yield to St. Joseph Aquifers

The sand and gravel aquifer is found under approximately two-thirds of St. Joseph. In this aquifer, groundwater is found in appreciable amounts. Well yields in the western half of St. Joseph are around 1000 gallons per minute. These high yields occur mainly in the bedrock valley (Figure 3). In the northwestern part of St. Joseph (in the Houlton area) yields drop off to zero for this aquifer since the sandstone bedrock is raised above the water table (Figure 3). In the eastern half of St. Joseph, yields from the sand and gravel aquifer vary from zero east of Perch Lake, to over 1000 gallons per minute in the extreme northeast. On the whole, "Well yields sufficient for domestic use are obtainable wherever the sand and gravel aquifer is present" (Borman 1976). Flow rates across St. Croix County for the sand and gravel aquifer are estimated to be between 7 and 670 feet per day (Borman 1976). Specific flow rates for St. Joseph have not been measured (Collins 1992).

The sandstone aquifer is found under the entire St. Joseph area. This aquifer is capable of groundwater yields over 500 gallons per minute, with probable yields over 1000 gallons per minute in the eastern one-third and western one-third of the Town, where the bedrock is raised. The sandstone aquifer is better able to meet the needs of high-capacity wells, because of "...its generally great saturated thickness and total head" (Borman 1976). It is also from this sandstone aquifer that domestic users in Houlton (where the sand and gravel aquifer is not present) obtain their well water. Flow rates across St. Croix County for the sandstone aquifer are estimated to be between 1 and 270 feet per day. The higher flow rates are found in areas where fractured dolomite allows groundwater to flow rapidly through the rock (Borman 1976).

GROUNDWATER QUALITY

Maintaining quality groundwater in any area is important, but it is essential in St. Joseph since groundwater is the only utilized source of drinking water. The treatment of groundwater is an expensive and difficult process, and it is easier and cheaper to maintain the quality of the groundwater then to treat it once it has been contaminated.

The groundwater quality in St. Joseph is good and falls within standards set by Wisconsin Statutes NR 140. Table 2 lists a sample of wells in St. Joseph along with their measured quality. These well locations are shown on Map 4. The characteristics listed include health related contaminants such as nitrates and fecal coliform as well as aesthetic qualities related to the color and taste of the water such as chlorine, iron, and hardness.

TABLE 2: SELECTED WELL WATER QUALITY OF ST. JOSEPH

Well #	Section	N - NO3 mg/L	CL mg/L	Iron mg/L	pH	Hardness
752	20	<0.1	1.0	<0.1	8.2	210
764	21	6.0	16.0	0.1	8.0	250
732	22	<0.1	<1.0	0.1	8.0	180
703	22	<0.1	1.0	0.3	8.0	226
704	23	0.6	8.0	0.1	8.0	238
705	24	1.0	1.0	0.0	7.9	232
755	24	7.0	13.0	<0.1	8.2	236
706	25	<0.1	1.0	0.4	8.0	187
753	26	2.3	4.0	0.0	8.0	290
756	27	1.0	4.0	0.0	8.3	202
708	27	2.2	12.0	<0.1	8.0	254
709	27	0.1	<1.0	0.4	8.0	228
744	29	0.8	2.0	0.0	8.2	196
771	30	0.1	<1.0	0.1	8.2	200
734	31	2.0	8.0	0.0	8.0	222
750	32	<0.1	<1.0	0.3	8.1	184
763	32	<0.1	<1.0	<0.1	8.1	172
770	33	2.1	1.0	0.0	8.2	190
768	34	<0.1	1.0	2.0	8.0	191
769	34	6.2	12.0	<0.1	8.1	234
767	34	<0.1	<1.0	0.0	8.1	213
758	35	0.4	15.0	9.0	7.8	228
710	35	1.8	3.0	<0.1	8.1	202
711	36	0.1	<1.0	0.3	8.1	200
754	4	1.0	1.0	0.0	8.3	192
766	6	1.5	1.0	<0.1	8.0	164
170	8	2.6	2.0	<0.1	9.0	125

Samples collected February 17, 18, and 19, 1989, by E.C. Lawson and G.S. Steinhart
Chemical analyses performed by K.L Lund

Public health groundwater quality standards (WIDNR)

Nitrate + Nitrite	10 ppm or 10 mg/l
Chlorine	250 mg/l
Iron	0.3 mg/l
Hardness	121 to 180 mg/l (Hard)
	+ 180 mg/l (Very Hard)

High levels of nitrates in the drinking water can be a health concern since it can cause methemogobinemia. This condition prevents a baby's blood from carrying oxygen, also termed "blue babies." An upper limit of 10 parts per million (ppm) has been set by Wisconsin Administrative Code, NR 140, and all of the wells in the sample fall at or below this limit. However, at least one well in the Houlton area (not shown in Table 2) had a nitrate level of 10 ppm, with several others at or above 4 ppm. High nitrate concentrations can indicate contamination of the groundwater from septic tank seepage, feedlot run-off, and fertilizer use.

Fecal coliform bacteria are derived from the feces of humans and warm-blooded animals. These bacteria enter the groundwater mainly through agricultural runoff and sewage discharge. Humans can contract diseases and illness such as typhoid fever, hepatitis, and dysentery from drinking water with high levels of fecal coliform. Standards for drinking water are 1 fecal coliform per 1000 milliliters (Mitchell 1986). St. Joseph currently does not have a regular procedure for collecting well data concerning fecal coliform (Huffman 1992) and data could not be found regarding it for this report.

Chlorine is found in most naturally occurring groundwater in Wisconsin at levels around 5 milligrams per liter (mg/l). When chlorine levels reach 250 mg/l, however, the water will have a noticeably bad taste. Increased chlorine concentration can be a sign of industrial and domestic waste contamination in the groundwater. All of the wells in the sample from St. Joseph fall below 16 mg/l.

Iron is another substance that naturally occurs in groundwater and is not associated with health related issues. Higher levels of iron in drinking water can be objectionable since it can affect the taste and also leave stains on fabrics. A limit of 0.3 mg/l has been recommended by the U.S. Public Health Service (Borman 1976). Four wells from the sample have concentrations greater than the recommended limit, with well number 758 in section 35 T. 30 N. R. 19 W. having 30 times the recommended limit.

The hardness of domestic water is a common term associated with groundwater sources. Groundwater hardness is caused by high concentrations of calcium and magnesium. Hardness can be objectionable because at higher levels it leaves scaly deposits on the inside of pipes and hot water heaters as well as retards the cleaning action of soaps and detergents (Borman 1976). Water hardness is often associated with water that has been in contact with dolomite. St. Joseph has a

high level of water hardness since dolomite is common in the bedrock and the sand and gravel deposits. The U.S. Geological Survey lists groundwater hardness as calcium and magnesium carbonates between 121 and 180 mg/l, and very hard at levels above 180 mg/l. All of the wells tested in the sample fall in the hard and very hard categories. Further information regarding groundwater quality standards as well as enforcement are outlined in Wisconsin Administrative Code, Chapter NR 140.

GROUNDWATER FINDINGS

The total head of groundwater, including saturated thickness of both the sand and gravel aquifer and the sandstone aquifer together ranges from 400 to 950 feet throughout St. Joseph. Due to this thickness of the aquifers, "groundwater volume is sufficient to supply the water needs of St. Joseph into the future, even for industrial needs" (Collins 1992).

Groundwater quality in St. Joseph is relatively good, meeting drinking water standards in most areas. However, concerns do exist in areas with high septic system density, such as in Houlton and in areas with relatively shallow groundwater as shown on Map 5. These areas may have higher groundwater contamination concerns. A specific area that has a higher susceptibility to groundwater contamination is Houlton. Although Houlton is located over 150 feet above the groundwater Table, its permeable soils and the fact that the underlying bedrock has cracks and fissures, allowing relatively easy access for contaminants to enter the groundwater system (Collins, 1992). This coupled with the fact that Houlton has a higher density of septic tanks is the probable reason for the elevated nitrate levels found in some of the area wells.

Adequate information on groundwater flow rates and elevation levels is lacking for the St. Joseph area (Collins 1992). For example, the water table elevation map (Map 4) shows a channel in the western part of St. Joseph, in section 25, that appears that it could receive preferential groundwater flow. This channelized flow could contain more concentrated levels of contaminants. However, the degree of water table elevation error for this area is great (shown by the dotted line on Map 4), and this channel may not even exist. This example points out some of the problems in drawing conclusions from scant data.

SURFACE WATER

WATERSHEDS

A watershed is the area drained by a defined water body or collection of water bodies. The

watershed is considered by many resource management professionals to be the ideal resource management unit. Watersheds are as close to a self contained system as nature will allow. Resource managers are better able to consider all of the side effects of their management decisions as a result. Unfortunately, political boundaries and watershed boundaries seldom coincide. To manage on this basis requires extensive communication and cooperation between different political entities.

St. Joseph is located within the Kinnickinnick River Sub-basin which is the watershed that encompasses the Willow River, the Kinnickinnick River and their tributaries (see Figure 4). On a larger scale map, the watershed may be further subdivided into subwatersheds (see Map 6). This map indicates the flow of the average annual precipitation of 29.57 inches that falls within the Town of St. Joseph. For information on the formation and limitations of Map 6 refer to the Methodology section in the Appendix.

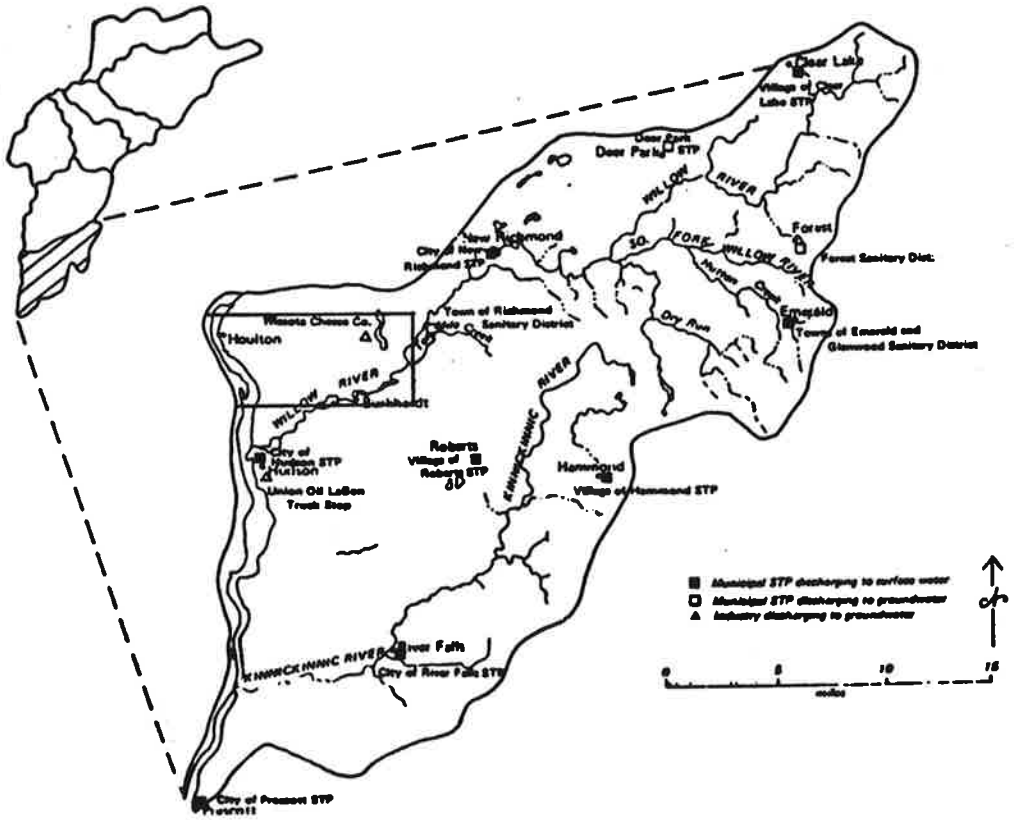


Figure 4: Kinnickinnick Watershed

Source adapted from: St.Croix River Basin Areawide Management Plan, 1980

It is incorrect to believe that all of the water that falls within the Perch Lake Subwatershed is conveyed into Perch Lake. Actually, precipitation may take many pathways and the subwatersheds delineation only shows where water would flow if it were all maintained as surface runoff. A more complete picture of the surface water resources of St. Joseph is given on a Map 6. Map 6 includes wetland areas and closed depressions in addition to the major water bodies previously shown. Each wetland and closed depression has its own micro-watershed. Realizing this, the six subwatersheds become collections of related mirco-watersheds. The following table, (Table 3) lists the characteristics of each of the six subwatersheds.

TABLE 3: SUBWATERSHED CHARACTERISTICS OF ST. JOSEPH

Names	Area Acres	Area Mile ^{2}	Residences	Wetlands	Closed Depressions
Willow River	5389	8.42	152	30	24
Central Wetlands	4646	7.26	163	68	60
St. Croix River	4576	7.15	357	24	50
Bass Lake	2752	4.30	149	31	5
Perch Lake	2669	4.17	184	39	14
Southeast Wetlands	514	.80	1	6	14
Totals	20546	32.1	1006	198	167

The preceding table reveals that there are a total of 198 wetlands and 167 closed depressions identifiable using USGS topographic maps and 1991 ASCS aerial slides. The number of residences within each subwatershed, as shown on a 1988 map provided by St. Croix County Planning are also tabulated. The following table (Table 4) exhibits additional data that illustrates the relative densities of these features.

TABLE 4: FEATURE RELATIVE DENSITY OF ST. JOSEPH SUBWATERSHEDS

Names	Acres per Residences	Acres per Wetland	Acres per Closed Depression	Residences per Wetland	Residences per Closed Depression
Willow River	35.45	179.63	224.54	5.07	6.33
Central Wetlands	28.50	68.32	77.43	2.40	2.72
St. Croix River	12.82	190.67	91.52	14.88	7.14
Bass Lake	18.47	88.77	550.40	4.81	29.8
Perch Lake	14.51	68.44	190.64	4.72	13.14
Southeast Wetlands	514	85.67	36.71	0.17	0.07
Average	20.42	103.77	123.03	5.08	6.02

Because the information in the tables is difficult to comprehend all at once, a system of ranking may be used to simplify analysis. For example, the subwatersheds can be assigned a value from 1-6 according to ascending densities of the various features. A number 1 would be assigned to those areas with the least acreage per feature and a number 6 to those with the greatest acreage per feature. By summing the values for each area, the relative stress on surface water resources and vulnerability of groundwater as a result of these features can be compared relative to each other. The following table illustrates how this system might be used.

TABLE 5: RANKING OF RELATIVE DENSITIES

Names	Willow River	Central Wetlands	St. Croix River	Bass Lake	Perch Lake	Southeast Wetlands
Acres per Residence	5	4	1	3	2	6
Acres per Wetland	5	1	6	4	2	3
Acres per Closed Depression	5	2	3	6	4	1
Residences per Wetland	2	5	1	3	4	6
Residences per Closed Depression	4	5	3	1	2	6
Totals	21	17	14	17	14	22

Those areas with the highest ranking would be the best for development in terms of the features listed. Unfortunately Table 4 neglects many essential considerations and needs to be expanded. It is based on total area of both land and water and would be improved if it were converted to consider only the developable land area. These areas may be determined by eliminating surface water areas, areas with very steep slopes, areas with highly permeable soils and high water tables, areas designated as public parks or areas that are already well developed. As is, the numbers provided by this analysis do not aid in the formation of decisive decision making because they are all fairly similar.

Variations to this method also allow prioritizing of different features by giving them higher gross values. For instance, depth to water table could be assigned a range from 2-12, using even numbered increments. This would give depth to water table greater weight in the final value. Priorities could also be altered to consider different potential land uses. For some land uses permeability could be given the most weight and for other land uses it could be ignored altogether. The prioritization will vary depending on assessment needs.

Watershed Findings

St. Joseph can be subdivided into six subwatersheds which allows for analysis of the area to be conducted on a base that better internalizes the effects of development activity. By dividing St. Joseph into subwatersheds, regional analysis is made easier and the distribution of limiting features and characteristics between the watersheds is made possible. The alternative is to generalize the densities of the limiting features as if they were consistent throughout St. Joseph. This would not allow for identification of promising or problem areas for development.

LAKES AND RIVERS

One of the attractions to living within the Town of St. Joseph is the lakes and rivers. These water resources provide fishing, boating, picnicking and camping, available on one or all of the five lakes and two rivers. They also provide an aesthetically pleasing environment.

The lakes and rivers included within St. Joseph, which are described in this section are: 1) Bass Lake, 2) Little Falls Pond, 3) Mounds Flowage, 4) Perch Lake, 5) Furger Lake, and 6) Willow River, see Map 6. This section includes all navigable surface waters greater than six feet in depth. Surface waters less than six feet deep are considered wetlands by the Wisconsin

Department of Natural Resources (WIDNR) and are included in the section titled Wetlands. For example, Dry Dam Lake, Bright Lake and Frog Pond are not included as lakes, but rather as wetlands. A waterway is navigable if it has bed and banks, and it is possible to float a canoe or other small craft in it at some time during the year (WIDNR 1982). Burkhardt Mill Pond, which was an impoundment pond resulting from a dam located on the Willow River, has recently been dewatered because the dam was deemed unsafe and thus removed. For this reason the Burkhardt Mill Pond is no longer a lake and is part of the Willow River channel. Obviously missing from this list is the St. Croix River, which borders the Town of St. Joseph to the west. The St. Croix River will be addressed in a separate report entitled "Protecting Water Quality in the St. Croix River: A Planning Guide for St. Joseph, Wisconsin".

The water quality of each of the water bodies is identified when possible in the following subsections. A widely accepted method of lake quality classification is the assignment of a trophic status index. The indices include oligotrophic, mesotrophic and eutrophic. An oligotrophic lake generally exhibits clear water and sufficient oxygen levels throughout the year in the cold water bottom zone, called the hypolimnion. Some shallower oligotrophic lakes may experience oxygen reductions in the hypolimnion during the summer. These lakes generally accommodate game fish, such as walleye, trout and northern pike. Mesotrophy refers to moderately clear water but an increasing probability of decreased oxygen levels during the summer months. Game fish are still prevalent, however there is generally an increase in bottom feeders, such as bullheads, carp and suckers. Eutrophic lakes exhibit decreased water clarity, oxygen depletion within the hypolimnion during the summer, algal blooms, and dense macrophyte beds which can become problems for boats. The fish population is generally made up of bottom feeders (WIDNR 1991). Lakes approach a eutrophic state as part of the natural aging process. This process can be accelerated by human activities, which is referred to as cultural eutrophication. Cultural eutrophication is the enrichment of water, usually by phosphorus, from activities such as increased sedimentation due to agricultural runoff. Additional sources of phosphorus originate from urban runoff, including lawn fertilizers, discharge from malfunctioning septic systems, and runoff from roads.

The trophic status index is based on three measurements. The first is the summer mean chlorophyll a concentration, which is a measurement of the amount of aquatic vegetation. Also included is the summer mean total phosphorus concentration in surface samples. Phosphorus is a nutrient required by plants and is generally their limiting factor. Finally, the summer mean Secchi disk depths, which are used to measure water clarity. There are other chemical analyses that indicate water quality that are also included for Bass Lake. These other analysis are not included in this report but are available through the Eau Claire office of the WIDNR.

Various chemical analyses are done to determine water quality of a lake. The most common include dissolved oxygen, fecal coliform, pH, biological oxygen demand (BOD), temperature, total phosphorus, Kjeldahl nitrogen and/or nitrates, turbidity, chlorophyll a, and total solids. A description of the parameters and reasons for these particular analyses are included in the appendix.

Most of the lakes included are considered hardwater lakes. Hardness refers to the mineral content of the lake water. This is the result of geologic formations in and surrounding the water bodies (WIDNR 1991).

Included on the following table, Table 6, the acreage, depth and shoreline length are noted.

TABLE 6: ACREAGE, DEPTH AND SHORE LINE LENGTH OF LAKES AND RIVERS, WITHIN THE TOWN OF ST. JOSEPH

		Total Area (acre)	Max Depth (feet)	Mean Depth (feet)	Shore Line (miles)
Bass Lake	T. 30 N., R. 19 W., Sec 14,23,26	417	37	NA	6.6
Fruger Lake	T. 30 N., R. 19 W., Sec 35	21	7	NA	NA
Little Falls Pond	T. 29 N., R. 19 W.	159	16	10	3.6
Mounds Flowage	T. 29, 30 N., R. 19 W.	57	40	10	4.3
Perch Lake	T. 31 N., R. 18 W.	43	63	34	1.3
St. Croix River	T. 31 N.,R.19 W., Sec 6 to T.30 N., R. 20W., Sec 22	575*	NA	NA	10.8**
Willow River	T. 31 N.,R.15 W., Sec 18 to T.29N., R. 20W., Sec 24	291	NA	NA	40**

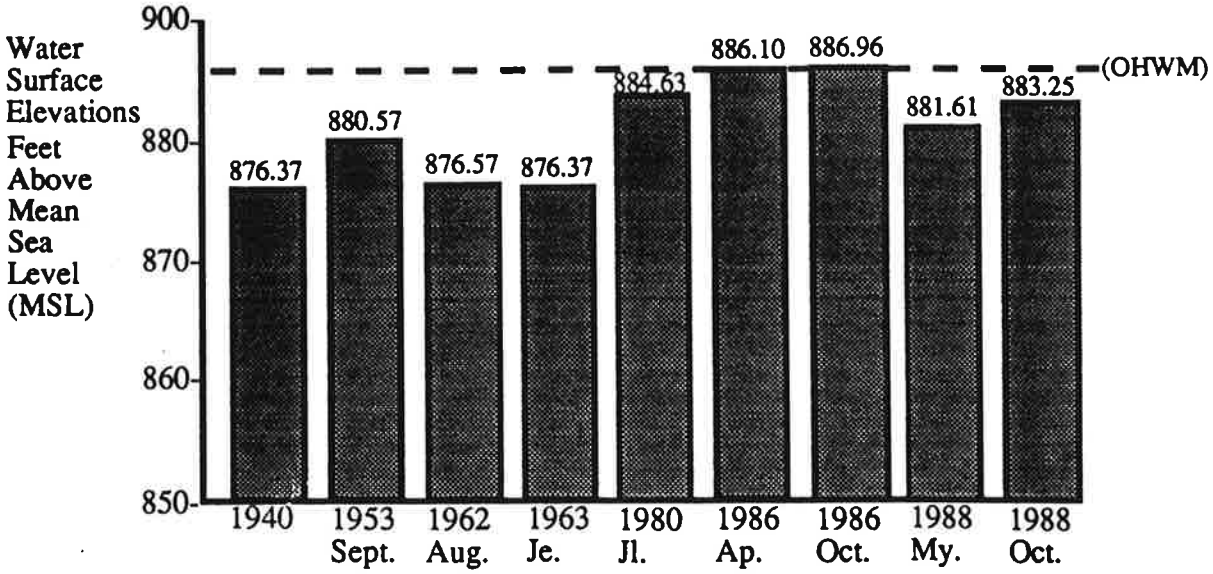
* In Wisconsin Only
** River Length

Bass Lake

Bass Lake is included within the Town of St. Joseph except for the northern tip, which is in Somerset Township. The 417 acres of Bass Lake make it the largest lake in St. Joseph, surrounded by 100 developed riparian properties. The majority of these riparian properties are wooded lots. These lots include 44 seasonal homes and 56 permanent homes. Each lot is a minimum of 100 feet in width and no less than three acres in total size (WIDNR 1991). These standard lot sizes provide for a less cluttered shoreline.

Bass Lake is a land-locked, hardwater seepage lake. It is subject to fluctuating water surface elevations due to increases or decreases in annual rainfall, as well as increases or decreases in groundwater elevations. The groundwater is both a source of water for the lake as well as an outflow.

The ordinary high water mark for this lake is 886.1 feet above mean sea level (MSL). This elevation was established by the WIDNR in April, 1986 and again confirmed in May, 1988. The lake levels have been known to reach as high as 886.96 MSL, which occurred on October 13, 1986. The most recent water surface elevation was determined in July, 1990, which was 881.3 MSL. The lowest elevation recorded was during the 1940's, 876.37 MSL, this represents a fluctuation of 10.59 feet in less than 50 years (Koich 1992). The amount of fluctuation in the water surface elevations is very unusual, but not altogether rare for seepage lakes. The Hudson Star-Observer reported in May, 1976, that many Bass Lake residents were experiencing water in their basements and failing septic systems due to high water (Hudson Star-Observer 1976). These same problems were again seen in 1986, when the lake level reached its highest known elevation to date. Figure 5, following, depicts the fluctuating lake levels.



The ordinary high water mark (OHWM) was established in 1986 at 886.1 feet (MSL)

Figure 5: BASS LAKE WATER SURFACE ELEVATIONS

If future development is to occur along the shores of Bass Lake it is imperative that the landowner be made aware of the highest known water levels of Bass Lake prior to the construction of a septic system. Flooding can result in direct effluent discharge into the lake due to failing septic systems causing economic loss and ecological damages.

A specific management plan for the fisheries of Bass Lake was developed by the WIDNR in 1989. The plan includes the following objectives: 1) double the number of largemouth bass that are greater than 12 inches; 2) increase the number of walleye to five adult fish per acre; and 3) improve the growth rate of panfish to attain an average higher than the average for the State of Wisconsin. Bass Lake is currently showing mean length of identical age classes of bluegills (a type of panfish) under the State average. At age three, the bluegills in Bass Lake are 3.3 inches, whereas the State average is 4.9 inches. By age seven Bass Lake bluegills mean length equals that of the State average of 7.5 inches. In order to meet these objectives the WIDNR has implemented a 14 inch size limit on largemouth bass. A 15 inch size limit has been put in place for walleye, and walleye fingerlings will be stocked every other year. These size restrictions were put in place in 1989 and will be evaluated in 1996 to determine if the program was successful (Engel 1991 and 1992). This type of management is called biomanipulation. Further information regarding the exact intent of this program can be obtained from the Baldwin office of the WIDNR.

The species of panfish occurring in Bass Lake are bluegills, black crappies, perch, pumpkinseeds and yellow bullheads. Carp and white suckers are also present. Muskrats, nesting mallards and blue-winged teal utilized the wetlands bordering the lake (WIDNR 1960).

There is currently a diagnostic and feasibility study being done by the WIDNR and the West Central Wisconsin Regional Planning Commission on Bass Lake, to determine the current water quality of the lake. Information currently available is reported in the Bass Lake Diagnostic and Feasibility Study section.

Little Falls Pond

Little Falls Pond is a hardwater flowage, the result of a drainage impoundment located on the Willow River. It has a navigable inlet from the Willow River and a public access on the south shore. The lake is situated entirely within the Willow River State Park, which includes picnic areas and a camping site right on the lake. The lake is completely surrounded by mixed hardwoods. There is very limited development at the present time which will persist due to the existence of the park designation. The most recent surface water elevation is listed on the United States Geologic Survey (USGS) Quadrangle Map from 1974 as 742.0 feet, using 1927 North American Datum (NAD). A datum is an established reference line of a known elevation. The control gates on the impoundment associated with Little Falls Pond are normally kept closed to maintain this elevation and to prevent flooding downstream (Koich 1992).

The flowage supports perch, black crappies, bluegills, pumpkinseeds and yellow bullheads, otherwise referred to as panfish. Largemouth bass, carp and white suckers are also common. Walleye are present but are not in abundance. The WIDNR monitors fish populations of the flowage and will stock panfish and largemouth bass when it is necessary to supplement the populations. Mallards, blue-winged teal, wood ducks, hooded mergansers and Canada geese may be found nesting near the inlet (WIDNR 1960).

The water quality data on Little Falls Pond is insufficient to make any quality judgements at this time. Impoundments generally have higher nutrient concentrations because as the river meets the impoundment, flow is slowed and the sediment load is dropped. This increases productivity of the water body and results in eutrophication (Mitchell 1986). At this time there is not enough information to designate the trophic status of Little Falls Pond.

Mounds Flowage

Mounds Flowage is a hardwater drainage impoundment located on the Willow River, and is also included partially within Willow River State Park, upstream from the Little Falls Pond. The lake is bordered by wooded areas to the south and east, and agriculture to the north and west. Steep slopes occur adjacent to the flowage. There is a small amount of development surrounding this flowage. Access is possible at the upper end of the flowage, via the Willow River. The surface water elevation is generally kept stationary through the operation of the impoundment. Two different elevations were found in the WIDNR lake files, 901.61 feet MSL from June, 1982 and 893.0 feet NAD from 1974 (Koich 1992). The actual reason for the difference in these two elevations was not known. It could be that operation of the dam changed hands resulting in different operational procedures. Also the use of different datums, or reference points, will result in varying elevation determination methods and subsequently different elevations.

The fish population of Mounds Flowage includes largemouth bass, perch, bluegills, black crappies, pumpkinseeds and black bullheads. Northern pike, white suckers and redhorse are also found. Stocking of panfish and largemouth bass is done when the WIDNR determines the populations need to be increased. The flowage is a nesting area for mallards and wood ducks (WIDNR 1960).

Mounds Flowage also lacks water quality data. And like Little Falls Pond, it is the result of an impoundment. In addition, there are agricultural lands adjacent to this water body which contribute sediment and increase the likelihood of eutrophication. As with Little Falls Pond however, there is not enough data to support any determination of the current trophic status.

Perch Lake

Perch Lake is a landlocked, hardwater seepage lake and is subject to fluctuating water levels as is Bass Lake. Perch Lake has the greatest maximum depth of any lake in St. Croix County, which is 63 feet (WIDNR, 1960). The surrounding areas are well wooded and slightly developed. A public access and beach are located at the south end of the lake. No ordinary high water mark has been established for Perch Lake to date. The surface water elevations recorded with the WIDNR vary from 88.05 feet in June, 1981, to 91.63 feet in April, 1986, both using an assumed datum. Current water levels are significantly lower than last reported due to droughty conditions in St. Croix County during the last few years (Koich 1992).

Perch Lake is managed by the WIDNR primarily to maintain brook and rainbow trout. Populations of walleye, largemouth bass, bluegills, black crappies, pumpkinseeds, green sunfish, yellow bullheads, carp and white suckers are also prevalent within the lake. Stocking of walleye, largemouth bass, and panfish is done as deemed necessary to maintain their abundance. Puddle and diver ducks, such as blue-winged teal or hooded mergansers, are known to use the lake during migratory periods, though they seldom nest on the lake (WIDNR 1960).

The water quality of Perch Lake has not been tested since May, 1960. The data gathered at that time therefore, will not be included. It should be noted however, that according to several WIDNR personnel working in the St. Joseph area, this lake has a higher quality of water than most lakes in the State of Wisconsin (Engel 1991). Seepage lakes generally do exhibit better water clarity and are less eutrophic than drainage lakes (Mitchell 1986). Through the use of the Agriculture Stabilization and Conservation Service (ASCS) aerial slides of July, 1991, it was apparent that Perch Lake was not green, as were many of the smaller, shallower lakes. In fact, it appeared to be clearer than Bass Lake, which is considered a high quality mesotrophic lake (WIDNR 1991). Algal blooms will appear green and are usually associated with eutrophic lakes. Based on these findings Perch Lake can be considered an oligotrophic lake. Future monitoring of this lake is necessary to confirm this trophic status.

There is limited development surrounding Perch Lake at this time, however, with such a high quality resource residents will likely be drawn to this area in the future. To maintain and protect this lake several community operations can occur. Such programs include a land stewardship program, which is utilized to educate lake home owners of the benefits of certain practices which maintain high quality lakes. These include maintenance of septic systems, the inclusion of natural vegetation along the shoreline and limited lawn fertilizer use. Another type of lake management technique is the formation of a lake association or municipality, such as exists at Bass Lake. Information regarding this type of program is available through the WIDNR.

Furger Lake

Furger Lake is a hardwater seepage lake again subject to fluctuating water levels due to changes in annual precipitation and groundwater levels. It is subject to winter fish kills due to the shallow waters and resulting winter freeze-out (WIDNR 1960). There is very little development surrounding this water body. The entire surrounding landscape is forested except for the northeast section. During July, 1991, it appeared to have a significant algal bloom, apparent from ASCS slides depicting a very green color. Surface water elevations for Furger Lake vary from 94.91 feet in June, 1982, to 95.47 feet in 1986, using an assumed datum (Koich 1992).

Due to the shallowness of Furger Lake and the annual freezing of the lake, a fish population is not abundant. Annual fish kills result from the winter freeze-out. Mallards do utilize the lake for nesting (WIDNR 1960). No water quality data exists for Furger Lake. The lake is heavily vegetated and an algal bloom was identified in aerial slides of July, 1991. Eutrophic lakes have high nutrient levels and are likely to have algal blooms. It is safe to say that this lake can be considered eutrophic. A water quality monitoring project would be required to confirm this assessment. However, because of the small size of the lake this type of project is likely not economically feasible.

Willow River

The Willow River meanders from the east central to south central portion of the Town of St. Joseph. Two dams are located on the river within the borders of St. Joseph, which result in Mounds Flowage and Little Falls Pond. The river provides excellent trout fishing above Mounds Flowage. A large portion of the river is included in the Willow River State Park. The entire river is over 40 miles long, of which, 25.6 miles are designated as trout stream. The mean low flow is 59.0 cubic feet per second, but this is greatly increased with spring run-off. The Willow River drains into the St. Croix River south of the Town of St. Joseph. The entire length of the river is well wooded and supports over 1400 acres of wetlands (WIDNR 1960).

Over half of the Willow River is considered trout water, including brown trout, brook trout and rainbow trout. Brown trout are the most prevalent species. Other fish species include northern pike, walleye, largemouth bass, bluegills, perch, black crappies, pumpkinseeds, green sunfish and a variety of forage fish. The river is managed primarily for trout, which are stocked by the WIDNR based on annual fish populations and the subsequent need for additional input to maintain the species (WIDNR 1960 and 1991). The portion of the Willow River upstream from the Little Falls

No water quality data was found for the Willow River.

Bass Lake Diagnostic And Feasibility Study

Water quality monitoring began on Bass Lake in 1986, as part of the WIDNR's Long Term Trends Monitoring Program. The monitoring is very extensive. Portions of the results to date will be included in this report to provide an overview of the existing water quality of the lake. Additional information is available from the WIDNR. The following study review was extracted from a draft report from the WIDNR and West Central Regional Planning Commission dated November 14, 1991.

To determine trophic status of Bass Lake, the summer mean chlorophyll a concentrations were measured. These concentrations ranged from 5.67 to 8.80 ug/l or parts per billion (ppb). Lakes with concentrations in this range appear clear or blue and have good water quality.

Total phosphorus concentrations found in Bass Lake surface samples ranged from 10 to 20 ppb, which is generally associated with good water quality conditions. Total Kjeldahl Nitrogen concentrations were 0.63 mg/l, or parts per million (ppm) during the summer and 0.67 ppm during the fall turnover. These two elements are necessary for plant growth and lake fertility. However, increased plant growth and high lake fertility results in decreased water clarity, decreased dissolved oxygen content and increased water temperature. These physical and chemical changes result in a dominant fish species moving from game fish to "trash" fish. When the total Kjeldahl Nitrogen to total phosphorus ratio exceeds 15:1 plant growth is generally limited by the amount of available phosphorus. During sampling years 1988 to 1990, the ratio of Kjeldahl Nitrogen to total phosphorus ranged from 37.6:1 to 52.7:1, indicating that phosphorus is the critical nutrient limiting

plant growth. Therefore, maintenance of trophic status depends on controlling phosphorus inputs into the lake (WIDNR 1991). Water clarity, which is determined through the use of a Secchi disk, ranges from 1.9 to 2.7 meters. Lakes with good water quality general exhibit ranges of 2.3 to 3.3 meters.

Through a series of equations based on summer mean values determined for chlorophyll a, Secchi disk and phosphorus, an index value is established. These values are included in Tables 7 and 8. It is apparent from the tables that Bass Lake consistently falls within the low range of mesotrophic or the high range of oligotrophic. Either trophic status indicating good water quality.

TABLE 7: TROPHIC STATUS INDEX OF BASS LAKE

Year	Chlorophyll a	Secchi Disk	Phosphorus
1986	45.1	45.3	49.8
1987	45.9	45.6	43.2
1988	46.4	48.6	43.3
1989	46.9	46.6	42.5
1990	46.4	50.7	45.4
Mean	46.1	47.4	44.8
SD	0.4	3.2	0.3

TSI = 40 to 50: Mesotrophic; water moderately clear, increasing probability of oxygen depletion in cold bottom water zone during summer.

TSI = 30 to 40: Oligotrophic; clear water, oxygen sufficient throughout the year in the cold bottom water zone in deep lakes, shallow lakes can exhibit anoxic conditions in the cold bottom water zone during the summer.

Adapted from: WIDNR 1991

TABLE 8: TROPHIC STATUS INDEX OF BASS LAKE BASED ON CHLOROPHYLL A CONCENTRATIONS

TROPHIC STATUS INDICES BASED ON CHLOROPHYLL A

	Oligotrophic	Mesotrophic	Eutrophic
National Academy of Science (1972)	0 to 4.0	4.0 to 10.0	> 10 .0
Dobsen, et al (1974)	0 to 4.4	4.4 to 8.8	> 8.8
Lake Survey EPA-NES (1978)	0 to 7.0	7.0 to 12.0	> 12.0
Hern, et al (1981)	0 to 2.3	2.3 to 6.4	> 6.4

BASS LAKE CHLOROPHYLL A CONTENT; SUMMER MEAN

Year	Chlorophyll a (ppb)
1986	4.5
1987	5.0
1988	5.4
1989	5.7
1990	5.3
Mean	5.2

These same three parameters are also used to determine the overall water quality of a lake. Included Table 9 are the ranges established and the results from Bass Lake.

TABLE 9: WATER QUALITY CLASSIFICATION FOR BASS LAKE

Water Quality Index	Approximate Water Clarity Equivalent (m)	Approximate Tot. Phosphorus Equivalent (ppb)	Approximate Chlorophyll a Equivalent (ppb)	Approximate TSI Equivalent
Excellent	>6.0	<1.0	<1.0	<34.0
Very Good	3.0 - 6.0	1.0 - 10.0	1.0 - 5.0	34.0 - 44.0
Good	2.0 - 3.0	10.0 - 30.0	5.0 - 10.0	44.0 - 50.0
Fair	1.5 - 2.0	30.0 - 50.0	10.0 - 15.0	50.0 - 54.0
Poor	1.0 - 1.5	50.0 - 150.0	15.0 - 30.0	54.0 - 60.0
Very Poor	<1.0	>150	>30.0	>60.0

source: WIDNR (1990)
Lillie and Mason (1983)
Carlson (1977)

From Tables 7, 8 and 9 it is evident that Bass Lake is an excellent quality, mesotrophic lake. The maintenance of these determinations will depend on future land use practices surrounding the lake.

Bass Lake is a highly alkaline lake. Bedrock underlying the southern portion of the lake includes Prairie du Chien dolomite, which is associated with high alkalinity. Mean chloride concentrations ranged from 5.0 to 5.5 ppm, and were within the expected range of 3 to 10 ppm for this part of Wisconsin (WIDNR 1991). Chlorides are a natural product of the weathering of soils and bedrock and are also present in rainwater. Non-natural sources include septic system effluent and road salt, however, levels present in Bass Lake do not indicate input from these sources.

An aquatic macrophyte survey was also conducted on Bass Lake to determine the distribution of aquatic plants. The water quality of a lake is one of several factors that will affect this distribution. Bass Lake was found to have a diverse population of aquatic plants. The plants were distributed throughout the littoral zone and not dominated by any one species. Comparisons of surveys done in 1987 and 1990 indicated stability in the plant community, no loss of diversity and no dramatic changes in frequency of occurrence or abundance (WIDNR 1991).

The aquatic macrophyte study identified one area of concern in the northern bay, where the boat landing is located. Evidence was found of disturbance from cattle being in the water. The evidence included cattle feces as well as photos taken on several dates during the summer. Although the number of cattle is not large, less than ten on a hot summer afternoon, the effects of their presence are being seen on this portion of the lake. The disturbance was characterized by increased turbidity and mats of duckweed, which are good indicators of high nutrient levels. The duckweed was not present anywhere else in the lake. The degradation of the plant community can also create an opening for Eurasian milfoil which may occur at the adjacent boat landing. In addition, the shift of the aquatic macrophytes from desirable species with limited tolerance ranges, to less desirable species having wide ranges of tolerances, as does Eurasian milfoil, creates a habitat where this exotic species would become easily established and difficult to remove (WIDNR 1992).

WETLANDS

Wisconsin Statutes [s. 23.32(1)] define a wetland as "an area where water is at, near or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation, and which has soils indicative of wet conditions." Wetlands often occupy the transitional zone between permanently wet and generally dry environments (Finlayson 1991). They share

characteristics of both environments. The Town of St. Joseph is comprised of a rolling to hummocky surface with many kettles and pits, also referred to as potholes. It is this type of surface geography that results in the sporadic occurrence of wetlands (Map 6).

Wetlands serve many purposes, and are no longer thought of as wasteland. The functions of wetlands include: 1) the filtering of nutrients and sediments, keeping lakes and streams clean, 2) reducing flood damage by storing runoff from heavy rains and snow melt, 3) providing homes to waterfowl, songbirds, pheasants, furbearers, and some rare or endangered animal and/or plant species, 4) acting as a buffer adjacent to uplands, protecting them from wave and current erosion, and 5) providing scenic benefits and open spaces (Environmental Protection Agency 1988). Some wetlands are recognized as direct links to the water table, exposing groundwater to risks of contamination if the wetland vegetation is degraded and unable to filter out harmful elements and compounds.

The following types of areas are excluded from the wetland section, but are included in the section entitled Lakes and Rivers or Watersheds: 1) areas of open water or submerged aquatic vegetation in lakes greater than six feet deep, 2) areas of flowing open water or submerged aquatic vegetation in the main and primary channels of rivers or streams, 3) depressions which do not exhibit aquatic vegetation or include standing water at any time during the year, and 4) sinkholes, which are direct links to the water table.

St. Joseph has numerous wetlands. The majority lie in the north central part of the Town. According to one source there are 41 acres of wetlands within the Town of St. Joseph (St. Croix County 1987). This number will fluctuate depending on annual precipitation. In addition, much of the wetland acreage is wet only during early spring, and can be farmed without filling or draining.

Some water bodies within the Town of St. Joseph have been given names that imply they are lakes. These water bodies include Bright Lake and Dry Dam Lake. The depth of these lakes is under six feet, therefore they are included in this section as wetlands.

Wetlands have been located by reviewing the USGS Topographic maps, Wisconsin Wetland Inventory (WWI), aerial photos and aerial slides from the ASCS. By comparison of these sources the resulting map was completed, Map 6. Many of the wetlands acreage found on the WWI included areas less than two acres. These wetlands were not included if they were not visible on the aerial slides and photos from the ASCS office. Although these areas are in fact wetlands according to the WWI, it was apparent from the ASCS materials that they are currently cropland. Because

these areas are no longer supporting hydrophytic vegetation the definition of wetland no longer applies. It should be kept in mind however, that during wet years many more wetlands may appear. The areas suspected of reverting back to wetlands are also included on Map 6, as the lighter colored bordered areas. These areas often are called closed depressions. Further identification of potential wetland sites can be verified through reference to the "St. Croix County Soil Survey", which will depict hydric or wet soil types.

The zoning ordinance adopted by St. Joseph provides some protective measures for wetlands greater than five acres located adjacent to shorelines. The WIDNR does attempt to oversee any activity that is to occur in these wetlands. Without field verification it is difficult to determine which of the wetlands mapped are in fact five acres or more. It appears from the slides obtained from the ASCS that the majority of the wetlands within St. Joseph are in fact less than five acres. However, even these small wetlands aid in the filtering of water moving downward toward the water table and the aquifers. Because aquifers are the sole source of drinking water for the community special attention must be given to the areas functioning as entrance points to the groundwater.

With the impending arrival of development the residents of St. Joseph may want to determine to what extent they can afford to allow new construction to encroach the existing wetland areas.

ORDINANCE REVIEW

The ordinances included in this section are those of St. Croix County, that have been adopted by the Town of St. Joseph, the State of Wisconsin and the United States Federal Government. This is not a complete listing of all ordinances but rather a brief review of those ordinances that address the water resources of St. Joseph. Additional research may uncover other ordinances or statutes enforced by either federal agencies or the State of Wisconsin. Any federal or state ordinances and codes provide a lower limit to resource protection. Additional restrictions can be developed by the Town Board or St. Croix County, as they deem necessary. Specific codes are included in more detail in the appendix.

ST. CROIX COUNTY SANITARY CODE

The sanitary code of St. Croix County includes the requirement of a sanitary permit prior to starting work on any structure or facility requiring a private sewage system. Any application for a sanitary permit shall be provided with written notice of the maintenance program at the time of permit issuance by the county zoning administrator. Every three years after installation of a private sewage system the owner must provide the county with certification that the system is in proper operating condition based on the inspection of a specified inspector (St. Croix County 1986).

The sanitary code provides protection for the future with all new development, however there appears to be no maintenance program established for existing septic systems. This can increase the risk of these systems contributing to the degradation of surface and groundwater, if not properly maintained. Also, enforcement of the code is difficult and not adequately provided for either with funds or staff.

ST. CROIX COUNTY ZONING CODE

A conservancy district has also been established within this code. This district has been established to preserve and perpetuate in an open state certain areas such as lowland swamps, marshes and wetlands, floodplains and stream beds, slopes, bluffs, wooded areas and other areas of aesthetic value which, because of unique physical features, are deemed desirable to be retained

for the benefit of this and future generations. The regulations of the conservancy district are not only intended to preserve and perpetuate open space land and water areas, but also to protect the community and the county from costs and consequences which may be incurred when unsuitable development occurs in such areas (St. Croix County 1986).

The inclusion of a conservancy district offers opportunities to protect those areas that the community of St. Joseph determines would benefit from such measures. Currently there are no areas included in the conservancy district. However, the Willow River State Park, located in the south central portion of St. Joseph, does not allow any residential or commercial development (Kubler 1992). This is not zoned as a conservancy district, but is an area within St. Joseph where natural resources are protected for future generations.

A complete copy of the zoning ordinance can be reviewed by contacting the St. Croix County Planning and Zoning Office.

Through the review of the natural resources included within the Town of St. Joseph, the authors have come up with some areas that could be considered as conservancy districts. These areas are included in the St. Joseph Findings section.

SHORELAND ZONING

The purpose of this ordinance is to reduce the effects of poorly planned shorelands and bluff area development. The shoreland ordinance includes regulations of tree cutting, filling, grading, lagooning and dredging in order to prevent detriment to navigable waters within the county, or within the Town of St. Joseph. Setbacks have been established at least 75 feet from all points along the normal high water mark set by the Wisconsin Department of Natural Resources, unless otherwise specified by floodplain zoning. A conservancy district has also been included in shoreland areas to provide additional protective measure for wetlands or groundwater at or near the surface. The conservancy district is similar to that provided for in the general zoning ordinance (St. Croix County 1991).

Specifically addressed within this ordinance are shoreland-wetland districts which are of five acres or greater, designated on the Wisconsin Wetlands Inventory. Also addressed separately, but within the shoreland ordinance, is a St. Croix River Valley district (St. Croix County 1991).

The shoreland zoning code provides thorough protection of surface water and surrounding shoreline and wetlands. The St. Croix County Shoreland Ordinance was adopted in 1967 and revised in 1986. The lots developed prior to 1967 are not subject to these provisions except as they apply to property improvements or additions.

The lakes of St. Joseph, especially Bass Lake, have constantly fluctuating water surface elevations. Although an ordinary high water mark (OHWM) is established for Bass Lake, it is only a reference point and lakes levels have risen above it on several occasions. Flooding can result in malfunctioning of septic systems, causing effluent discharge into the lake and degrading its quality. The most recently established OHWM was in 1986. Most of the riparian property was already built by this date. Practices to effectively protect Bass Lake, or other lakes with fluctuating water levels, are not addressed in this ordinance.

A riparian development and shoreland zoning audit was conducted on Bass Lake by the WIDNR. A draft report of the findings was made available on May 14, 1991. The audit was conducted to produce a comprehensive record of all current land uses and development on shoreland properties on Bass Lake, to identify suspected violations of shoreland rules and to assess the effectiveness of local shoreland zoning, permitting and enforcement (WIDNR 1991). A complete record of current land uses was documented with maps, survey forms, photos and videos and will be useful for the lake district, residents and zoning officials. The WIDNR Eau Claire office can provide information on access to this information. Approximately two-thirds of the residential development audited was found to have violations of the shoreland regulations, either with or without permits. The extent of these violations is also available through the Eau Claire office of the WIDNR.

With regard to local enforcement of shoreland zoning, 30 permits were reviewed in the Town of St. Joseph: many were brief and incomplete. About one-third of the permits lacked drawings or site plans, and two-thirds did not indicate where the project was located in relation to the lake. None of the permits reviewed indicated whether the activity involved the removal of shore vegetation (WIDNR 1991).

A septic audit of 85 sites was also included in this report. Of the sites investigated, 63 did not have failing systems, 5 are failing and 17 are consistently failure prone, seasonally failure prone or periodically failure prone. Septic system effluent is known to increase the rate of eutrophication. As was indicated in the Bass Lake Diagnostic and Feasibility Study, disturbance to the lake as a result of these effluents is undetectable (WIDNR 1991).

WELL CONSTRUCTION AND PUMP INSTALLATION

The purpose of this code is to establish uniform minimum standards and methods of procuring and protecting groundwater supplies safe for human consumption and food preparation through adequate construction of wells and reservoirs and installation of pumping equipment. Specific sections of this code address well location, design and construction and sampling. These are included in more detail in the appendix (WIDNR 1985).

All of the ordinances and rules applying to well and septic systems are very complete. Each includes design specifications for various conditions. This is a difficult process to enforce and is only completely successful with unlimited funds for enforcement. With St. Joseph depending entirely on private septic systems it is very important to have these codes set to maintain high quality ground and surface water. Not included is the maintenance and routine checking of existing systems that may have become noncompliant. It is provided however, that once a system is found to be noncompliant the system must be removed or repaired within one year at the maximum.

STANDARDS AND CRITERIA FOR THE LOWER ST. CROIX NATIONAL SCENIC RIVERWAY

The purpose of the standards and criteria set forth in Chapter 83 are to reduce the adverse effects of poorly planned shoreland and bluff area development, to prevent pollution and contamination of surface and groundwaters, to prevent excessive soil erosion and to uphold, enforce and enforce other standards developed to maintain and preserve the natural characteristics and exceptional scenic values of the Lower St. Croix River Valley in a manner consistent with the National Wild and Scenic Rivers Act, the Federal Lower St. Croix River Act of 1972 and the Wisconsin Lower St. Croix River Act (WIDNR 1984).

The National Wild and Scenic St. Croix Riverway is addressed only briefly in this section and not at all in the preceding sections. A Separate study is being conducted by University of Minnesota students entitled "Protecting Water Quality in the St. Croix River: A Planning Guide for St. Joseph, Wisconsin" that specifically addresses the stretch of the St. Croix River that borders the Town of St. Joseph.

GROUNDWATER QUALITY

The purpose of Chapter NR140 is to establish groundwater quality standards for substances detected in or having the probability of entering the groundwater resources of the state. Specifications include scientifically valid procedures for determining if the standards have been attained or exceeded, to specify procedures for establishing points of standards of application and for the evaluation of monitoring data The primary objective is protecting public health (WIDNR 1985). Specific sections and subchapters within Chapter NR140 include procedures of enforcement when standards are exceeded. Indicator parameters for groundwater standards and preventative action limits are outlined as well. Monitoring techniques and the appropriate laboratories are included as well (WIDNR 1985).

Because groundwater is the sole source of drinking water in the Town of St. Joseph, a high priority for the entire community must be to ensure that these rules are enforced and standards maintained.

PRIVATE SEWAGE SYSTEMS

The underlying purpose of the private sewage system code is to achieve basic goals in environmental health and safety accomplished by proper siting, design, installation, inspection, and maintenance of private sewage systems. If a failing system is identified it shall be corrected or its use discontinued within that period of time required by county or departmental order, with a maximum time limit of one year (State of Wisconsin 1990). Specifically addressed by this code are issues such as soil type, required distance from surface water and tank capacity. Specific seepage disposal is addressed in the Wisconsin Administrative Code, Wisconsin Department of Natural Resources, Chapter NR113.

For the future, development within St. Joseph seems to be addressed very well in terms of written laws or codes. All new construction must meet the codes currently enforced, but enforcement of these codes does not appear to be particularly strong.

ORDINANCE ENFORCEMENT AND PROGRAM IMPLEMENTATION

Storm water drainage, urban erosion control, agricultural erosion control, water quality, and wetland protection are all issues that receive additional attention in St. Croix County. As a result of the porous soils and steep topography of areas of St. Croix County, intensive management of water and soil becomes more critical than in areas of less dramatic topography. Management of these resources is administered through a variety of programs and agencies. The hierarchy and responsibilities of the agencies involved with water resource management are shown in the Government section in the Appendix. The following is a summary of information gathered during personal interviews with County Zoning Officials and Land Conservation Department (LCD) staff members.

SUBDIVISION REVIEW

When plans for a new development are complete, the engineering firm that prepared them sends the plans to County Zoning. Zoning then forwards the plans to the LCD where the storm water and erosion control plans are reviewed. The LCD staff reviews the plans to ensure that the storm water will be properly routed to storage pools of adequate size, and that appropriate steps will be taken to reduce erosion. They then assess the accuracy of the plans and report any inconsistencies. Finally, the LCD forms recommendations; often requesting plan revisions and documentation of the erosion control practices that will be used as well as suggesting additional erosion control measures. The review is not a mandatory process and the recommendations are not enforceable by law but are formulated to enable the developer to take conservation measures if the developer desires to comply. Adherence to the recommendations is strongly encouraged by County Zoning who is the construction permit issuer. The primary document from which erosion control practices are taken is "Minimizing Erosion in Urbanizing Areas" provided by the USDA Soil Conservation Service.

SANITARY PROGRAM

County Zoning also oversees the construction and maintenance of septic systems through a permitting process. Plans must be submitted to County Zoning for all new septic systems being built. Soils tests are performed and if the site and plans are acceptable, a sanitary permit is issued.

During property transfers, County Zoning performs soils tests to assure the proper maintenance of systems. Tests will also be conducted, free of charge, upon request if a problem is suspected. Landowners are currently required to have their septic systems inspected every three years and supply St. Croix County Zoning with the results, but this is not enforced (Nelson 1992).

SOLID WASTE PROGRAM

The solid waste program is also administered by the County Zoning Office and involves the oversight of salvage yards, junk yards and liquid waste disposal. Testing on these sites is only done by request.

ANIMAL WASTE ORDINANCE

The animal waste ordinance regulates the construction of storage facilities for animals wastes, and is administered by the County Zoning Office. The LCD prepares a waste utilization plan that must be followed. Compliance is assured by an annual review (Sander 1992).

FARM PLANNING

Farm planning is offered by the county to farmers who are interested in managing their farms to protect their topsoil and water resources. Staff of the Land Conservation Department and Soil Conservation Service (SCS) help the farmer to design a system of farming which may include grassed waterways, crop rotation and selection, terraces, sediment basins, gully stabilization, filter strips, windbreaks, and contouring. Designing of the plan is free of charge, but implementation is the responsibility of the farmer, who may choose to pursue cost share options (Sander 1992).

COST SHARE PROGRAMS

The United States Department of Agriculture, Agricultural Stabilization and Conservation Service (USDA ASCS) offers cost share money for the construction of filter strips, shelterbelts, windbreaks, sediment basins, grassed waterways, diversions, terraces and other structures designed to preserve and protect water and soil resources. They also offer money for the implementation of conservation practices such as contour strip cropping, no-till, stream protection, and off season seeding of highly erodible cropland. These structures and practices are designed by both LCD and SCS staff (Sander 1992).

CONSERVATION RESERVE PROGRAM

Perhaps the most widely known USDA ASCS program is the Conservation Reserve Program (CRP). The CRP goal is not only to reduce erosion on highly erodible land, but to reduce crop production, improve water quality, enhance wildlife habitat and help meet the timber needs of the future. Although eligibility is predominantly limited to highly erodible cropland, wetland areas are currently receiving substantial attention (USDA 1989).

The program pays farmers an annual per acre amount, not to exceed the local rental rate of comparable land, for the land that they choose to put into a 10-15 year conservation contract/easement. The farmer then has the responsibility to establish:

- permanent tame or native specie cover,
- permanent wildlife habitat,
- shallow water areas for wildlife,
- forest tree plantations,
- or vegetative filter strips.

In addition to the maximum annual payment of $50,000 from the USDA for placing the land into the CRP, the farmer may receive up to a 50% cost share from the Commodity Credit Corporation for implementing one of the above practices (USDA 1989).

The CRP is administered by the USDA ASCS, with field work performed by SCS staff. The $50,000 maximum annual payment includes all other USDA cost share programs. More information on the program can be obtained through your local ASCS or SCS office.

WATER BANK

Water Bank is similar to the CRP. Like the CRP, Water Bank pays farmers to put certain tracts of land into conservation contracts. Unlike the CRP, Water Bank prioritizes the maintenance of habitat on open water. Water Bank is a program of the USDA and is administered by the ASCS.

Water Bank involves 10 year contracts on open water or cattail marshes of at least 2 acres. These two acres must be accompanied by at least 8 upland acres for nesting habitat. The mixture of upland and wetland is necessary and the minimum total area is 10 acres. Adequate nesting cover must be established by the farmer if it does not already exist. ASCS will cost share establishment costs.

Water Bank is currently not an option in all townships. The State ASCS approves townships for Water Bank eligibility. Because of limited funds, not all proposed contracts are granted. A committee with members from ASCS, SCS, DNR, and US Fish and Wildlife Service prioritizes proposed contracts in eligible counties at the state level. Contracts are funded according to decreasing priority until the money is totally allotted (USDA 1990).

WETLAND PROTECTION

Currently, the alteration of wetland areas is legally very difficult to accomplish. Depending on whether or not the wetland is considered navigable, the presiding authority differs. The SCS presides over wetlands that are not classified as navigable, and the WIDNR over those that are navigable. If alterations to an existing wetland are desired, an applicant must obtain written approval of his/her plan from the WIDNR, the Army Corps of Engineers, County Zoning, and the SCS. Because legislation on this issue is rapidly changing, interested parties should contact their local SCS or WIDNR offices for updated information. Shoreland and floodplain alterations are also subject to a joint review by the WIDNR and St. Croix County Zoning (Nelson 1992 and Sander 1992).

Wetland restoration is another avenue for the enhancement of water resources. Depending on the goals of the landowner, this principle authority differs. The US Fish and Wildlife Service and/or the WIDNR assists the landowner if the intent is providing fish and wildlife habitat. The Army Corps of Engineers assists if the goal is water flow augmentation, and the SCS assists if the concern is for water quality and erosion control. Although assistance in the design of a project is available without charge, construction responsibilities lie with the landowner. Wetland restoration is currently excluded from cost share programs (Sander 1991).

ST. JOSEPH FINDINGS AND SUGGESTIONS

SOILS

-St. Joseph has over 100 different soil types.
-St. Joseph has some highly permeable soils as well as areas of severe slope, as shown on maps found in the Soils section.

GROUNDWATER

-Groundwater flows in a general east-west direction and is a component of St. Croix River base flow.
-Groundwater can be found in significant quantities below all of St. Joseph. The two primary aquifers that provide St. Joseph with its drinking water have the capability to meet the water quantity needs of domestic and industrial use into the 21st century.
-Information on groundwater flow rates and direction is lacking in St. Joseph. More testing is needed to better assess groundwater movement.
-The quality of groundwater in St. Joseph is good with a few exceptions as noted in the Groundwater section. The question of whether the groundwater quality can be protected with regards to increasing development, needs to be addressed. The Houlton area specifically is susceptible to groundwater contamination due to its permeable soils and shallow depth to bedrock.
-More testing is needed to assess fecal coliform levels in St. Joseph.

SURFACE WATER

Watersheds

-St. Joseph can be subdivided into six subwatersheds.
-Subwatersheds can be a useful unit in water resource management because they facilitate analysis.

Lakes and Rivers

-St. Joseph has two major lakes with high water quality; Bass Lake and Perch Lake.
-Several other major lakes in St. Joseph have diminished water quality; Furger Lake, Little Falls Pond, and Mounds Flowage.

-Due to the projected increase in development, surface water resources will face quality degradation if appropriate measures are not taken.
-Thorough water quality data are available only for Bass Lake as a result of an on going diagnostic and feasibility study being conducted by the WIDNR and the West Central Wisconsin Regional Planning Commission.
-Results of the study indicate an area of aquatic vegetation degradation on the northern shore of the lake. Also discovered is the fact that phosphorus is the limiting agent in plant growth in the lake.
-Because water bodies are often focal points for residential development, their water quality status should be determined to enable responsible management.
-The development of a lake shore association or municipality, similar to that in place at Bass Lake is encouraged for the current residents surrounding Perch Lake.

Wetlands

-There are 198 identified wetlands scattered unevenly throughout St. Joseph.
-Activities affecting wetlands are closely regulated by many laws and ordinances. Current legislation does not allow drainage, filling or burning of wetlands unless mitigated.

ORDINANCES AND ENFORCEMENT

-Current local, county, and state ordinances are sufficient in addressing the management of water resources. In some cases, current enforcement does not reflect the intent of the ordinances. A more thorough review of enforcement practices may be desirable to ensure that current water quality is maintained.

PROGRAMS

-Technical assistance and several cost share programs are available to those interested in implementing conservation plans. The Land Conservation Department in Baldwin should be contacted for specific information, beyond that offered in this text.

INTEGRATED RESOURCE FINDINGS

Although many concerns have been noted in each of the preceding sections, an analysis of the interrelations between the topics reveals additional considerations.

A review of permeability, and depth to the water table reveals areas where groundwater is sensitive to contamination. Map 7 shows areas that exhibit soils with high permeability and a shallow depth to the water table. These characteristics result in a groundwater resource being vulnerable to water quality degradation. The existence of wetlands and closed depressions within these areas can increase the potential for reduced water quality. Both wetlands and closed depressions often represent a direct entry point to groundwater. Surrounding land uses also affect the likelihood of groundwater contamination.

Map 8 has been included showing residentially developed areas which are important for two reasons. First, they represent contamination sources due to urban runoff and septic leaching. Second, they are important when considering future zoning. The use of these areas is predetermined, and will not change in the foreseeable future.

Monitoring sensitive areas will enhance the ongoing protection of groundwater. Special concerns include intense agricultural use without conservation measures in place, as well as population centers. The high quality of water resources currently found in St. Joseph necessitates extra precautions when dealing with future lands uses in these areas.

Monitoring and ordinance enforcement can be supplemented through the formation of lake associations. Lake associations can be useful for educating lake shore residents on proper management practices, reporting violations to proper authorities, and performing basic water monitoring.

Ordinances adopted by St. Joseph currently provide for land to be placed under conservancy status. Land under this designation may be developed for recreation, or left in its natural state. Areas with high sensitivity to groundwater contamination, steep slopes, wetlands, and/or near high density development should be considered for conservancy.

APPENDIX

METHODOLOGY

Map 1: Soil Permeability of St. Joseph

Map 1 was made by categorizing the soils of St. Joseph into three groups; 0.6-2.0, 2.0-6.0, and 6.0-20 inches per hour. The soils with these characteristics were then identified as they are described in the St. Croix County Soil Survey. The categorized soils were then transferred to a mylar base map and digitized by the St. Croix County mapping technician.

Map 3: Town of St. Joseph Soils

A soils map of St. Joseph has been made from the information in the St. Croix County Soil Survey. The soils map was created by evaluating 40 acre parcels of land. The most dominant soil type in the 40 acre parcel was chosen to represent that parcel. In parcels containing soil types that had relatively equal measures of land, the most severe soil was used to represent the 40 acres. Because St. Joseph contains a vast array of soils, this was decided to be the best method of evaluating the soils. There are 54 different soils on this map, and 23 different series. A soil series consists of soils that are alike in all major profile characteristics. The first two letters in the map symbol represent the soil series (see Table 1). The third letter represents the percentage of slope; A = 0 to 2%, B = 2 to 6%, C = 6 to 12%, D = 12 to 20%, and E = 20 to 25%. The map symbols with a 2 at the end represent eroded soils. Since the soils have been generalized into 40 acre plots for ease in identification of possible groundwater contamination areas, this information cannot be used for site specific information. For site specific information consult the St. Croix County Soil Survey in conjunction with on site soil borings and analysis.

Map 4: Town of St. Joseph Groundwater Features

Information on the bedrock underlying St. Joseph was obtained by the USGS through core samples. Map 4 shows the surface geology of St. Joseph and was produced by gathering information from USGS data on St. Croix County (Borman 1976).

Information for this map came from the Wisconsin Geological and Natural History Survey Misc. map 32, 1990. The Survey examined well constructor reports and checked them against each other. The most reliable and useful data was then used for each section. Some springs and lakes were used when these water tables were not perched or mounded. Sporadic well locations over the area and fluctuation of the water table make water table elevations accurate to within 0.5 miles of the land surface on a horizontal plane in areas with closely located sample wells, and 1.0 mile of the land surface in areas where well samples were less frequent. The arrows on the map give the general direction of subsurface flow.

Town of St. Joseph Sample Well Locations

Table 2 lists sampled quality data, and Map 4 the location of these 26 wells. This information was collected in 1989 by E.C. Lawson and G.S. Steinhart, and chemical analyses were performed by K.L. Lund.

Map 5: Town of St. Joseph Depth to Groundwater

Map 5 shows generalized groundwater depths for St. Joseph. This map was completed through the use of a USGS topographic map of St. Joseph, along with the groundwater elevation map. The two elevations were then subtracted from each other and the difference was taken to be the depth to the groundwater table. The criteria 0 to 10 feet, 11 to 60 feet, and greater than 60 feet below the land surface, are used to distinguish "high", "medium", and "low" susceptibility to groundwater contamination.

Map 6: Town of St. Joseph Surface Water Features

Map 6 was made by utilizing methods described in a mapping procedure manual provided by the Minnesota Department of Natural Resources (MNDNR) entitled "State of Minnesota Watershed Boundaries: 1979." "Hydrologic Unit Mapping and Digitizing" by the USDA Soil Conservation Service, September 1990 was also used.

7.5 minute USGS topographic quadrangles from the Bureau of Engineering were used as a base on which to draw. No minimum drainage area was used for the initial delineation of the subwatershed. Delineation was done by following the contours of highest elevation or by cutting halfway between adjacent contours of equal, but highest elevation. Watershed boundaries always

cross perpendicular to elevation lines and never run parallel to adjacent lines of different elevation. Where hills fell in the path of the watershed boundary, they were cut in half. Where roads, trails and railroads were located along ridges they were used as the watershed boundary. Although no county ditch maps were available because the area has natural drainage, culverts were assumed where natural drainage would necessitate them. The shortest saddle distance between hills or ridges along the watershed boundary was used. Once the subwatersheds were delineated, they were merged to a more uniform size. The Central Wetlands Subwatershed was originally subdivided into four sections. They were merged not only to attain a more uniform size, but because they did not drain into a central water body. The identified features were then transferred to a mylar base map and digitized by the St. Croix County mapping technician.

Wetlands and Closed Depressions of St. Joseph

7.5 minute USGS topographic quadrangles from the Bureau of Engineering were used as the base on which to draw. All identifiable closed depressions and wetlands were identified. On USGS topographic quadrangles, closed depressions are shown as areas of low elevation where elevation lines form a complete circle. These areas are differentiated from hills by surrounding elevation trends and by small dashes drawn perpendicular to the elevation line toward the center of the depression. Wetlands are shown on topographic maps as closed depressions that have been colored in blue. The identified closed depressions were then compared to the Closed Depression Map of St. Croix County, Wisconsin prepared by the University of Wisconsin, River Falls 1991. The revised map was then cross referenced to 1991 ASCS aerial slides by a County Technician. Some wetland areas not shown on either the USGS topographic map or the closed depression map that were apparent in aerial slides were added to the final map. These features were then transferred to a mylar base map and digitized by the St. Croix County mapping technician.

The total number of wetlands tabulated in the table 4, 5 and 6 represents the number of individual shaded closed depressions. The lakes and rivers were not included in the count. The total number of closed depressions represents the smallest unit of unshaded closed depressions that do not contain wetlands within them. Larger closed depression systems are included to better illustrate the hydrology of the land surface but were not included in the count.

Figure 3: East/West Cross-Section of St. Joseph, Wisconsin

Figure 3 was created by taking elevation, groundwater, and bedrock data from a line drawn east to west across St. Joseph (since the groundwater flows in a general east to west direction towards the St. Croix River. This cross section also shows the relative locations of the sand and gravel and sandstone aquifers.

SUMMARY OF WATER QUALITY PARAMETERS

Dissolved Oxygen (DO)

Dissolved oxygen is an essential element for the maintenance of healthy lakes and rivers. Most aquatic plants and animals need oxygen dissolved in the water for survival. For example, pike and trout require medium to high levels of DO to live, while carp and catfish can flourish in waters of low DO. Waters with consistently high DO generally exhibit healthy and stable aquatic ecosystems. Algal blooms are known to occur in water with low DO.

The depletion of DO is linked to the accumulation wastes of once live plants and animals as well as the feces of animals (organic wastes). These wastes often originate from agricultural feed lots, other agricultural runoff, and septic systems (Mitchell, 1986).

pH

The pH value of water is a measure of hydrogen ion concentration. If water contains more hydrogen ions, H+,, than OH ions the water is considered acidic. If water contains more OH-ions than H+ ions, it is considered basic. In the U.S., natural water supplies generally have a pH between 6.5 and 8.5. Some fish species are sensitive to changes in pH, such as brook trout, generally the range is from 6.5 to 7.5. Carp and suckers tolerate a fairly wide range of pH, 6.0 to 9.0.

Biological Oxygen Demand (BOD)

Biological oxygen demand (BOD) is an indirect measure of the amount of organic material in water. By recording the amount of oxygen that is used in a sample by decay processes, it is possible to estimate the amount of organic matter as well as the presence and number of decay bacteria and organisms. Natural organic matter inputs result from leaf fall, and primary production in the water body. Anthropogenic organic pollution sources include industrial, agricultural runoff, feed lots, septic system, lawn fertilizers, and pet wastes. The reasons to monitor BOD are very similar to those for DO.

Temperature

Many of the physical, biological and chemical characteristics of a lake are dependent upon temperature. The temperature will affect oxygen concentrations, photosynthesis rates, metabolic rates of organisms and sensitivity of organisms (Mitchell, 1986).

The rate of photosynthesis and plant growth increase with temperature. Increased growth of certain algae will also occur with increases in temperature. Trout and other aquatic species are sensitive to water temperature, preferring cold water. Carp and suckers are not as sensitive to changes in temperature.

Water temperatures can be affected by humans in various ways. For example, erosion caused by removing trees and other vegetation, or poor farming practices can increase the suspended solids in the lake. These suspended solids make the water more turbid, or cloudy, which enables the absorption of the Sun's rays, warming the water.

Total Phosphorus

Phosphorus is a necessary element for life within the water. It is most often the limiting factor for the growth of plants. Excessive phosphorus causes extensive algal growth, called algal blooms. Algal blooms color the water pea green and are symptomatic of cultural eutrophication.

Cultural eutrophication is an enrichment of water, usually by phosphorus, from human activities. The most common sources of phosphorus include human and animal wastes, and human disturbances of the land adjacent to the lake and its vegetation. Malfunctioning septic systems are also sources of phosphorus but less so because phosphorus readily adsorbs to soil particles and is held tightly. Lawn fertilizers are another source of phosphorus when conveyed by surface run-off (Mitchell, 1986).

Lakes that experience increased phosphorus inputs result in fish species changing from bass, walleye, pike and bluegill to carp and suckers, which are much more tolerant to the effects of increased phosphorus.

Nitrogen

Nitrogen is a fundamental plant nutrient and is required by all living plants and animals. Nitrogen is released into a lake through the decomposition of dead plants and animals and the excretions of living animals. Poorly functioning septic systems are an additional source of nitrogen. Storm-water runoff containing nitrates from lawn and crop fertilizers are responsible for some increases in nitrate levels of lakes (Mitchell, 1986). Nitrogen is measured in many forms.

Nitrate Nitrogen

High levels of nitrate nitrogen can cause a condition called methemoglobinemia. This condition prevents a baby's blood from carrying oxygen, this causes a bluish discoloration in the skin and is very dangerous, thus the term "blue-babies."

Water Clarity

Because light is the most critical factor affecting the growth of plants, water clarity is important. Water clarity is an element included in the trophic status index. The method of measurement is through the use of a Secchi disk. This disk is lowered into the lake until it is no longer visible and this depth is recorded. Generally, lakes with good water quality will exhibit a Secchi disk reading of from 3.2 to 3.3 meters (WIDNR, 1991). High levels of water clarity indicate limited abundance of bottom feeders and cooler water temperatures.

Turbidity

Turbidity is the result of suspended solids in the water. Turbidity is the opposite of clarity. At high levels of turbidity, water loses its ability to support a diversity of aquatic organisms. Waters become warmer as heat is absorbed by the particulate in the water column. Suspended solids may clog fish gills, reduce growth rates and impair resistance to disease.

Turbidity is generally the result of soil erosion and abundant bottom feeders (carp) which stir up bottom sediments. The Secchi disk measurement for water clarity is correlated with Jackson Turbidity Units to establish a turbidity value (Mitchell, 1986).

Total Solids

This water quality measurement includes both suspended solids and dissolved solids. High concentrations of total solids can decrease the current level of water quality. It can lead to a decrease in water clarity and photosynthesis, and can bind with toxic compounds and increase in water temperature.

Chlorophyll a

Chlorophyll a measurements quantify the amount of photosynthetically active organisms in a water body. Algae and macrophytic vegetation are the source of the chlorophyll that is extracted and measured. This measure is used to assess the approximate rate of primary productivity of a water body.

ORDINANCE SUMMARY

Shoreland Zoning, Chapter 17. St. Croix County Zoning Ordinance. Effective 10/01/85, revisions 05/24/91.

17.28 Tree cutting regulations: (1) regulation of tree cutting along shores of navigable waters is a necessity to protect scenic beauty, control erosion and reduce effluent and nutrient flow from the shoreland.

17.29 Filling, grading, lagooning and dredging: (1) filling, grading and lagooning or dredging which would result in substantial detriment to navigable waters by reason of erosion, sedimentation or impairment of fish and aquatic life shall hereby be prohibited.

17.31 Setbacks: (2) all buildings and structures, except piers and wharves, shall be set back at least 75 feet from all points along the normal high water elevation and two feet above the normal high water elevation unless otherwise specified by floodplain zoning provision.

17.33 Conservancy district: (1) wetlands are areas where groundwater is at or near the surface much of the year. Tamaracks, sphagnum moss, sedges, cattails, reed and bullrushes are typical wetland vegetation types. Wetlands are seldom suitable for building for the following reasons: (a) septic tank system will not function because of high groundwater, (b) water supplies are often polluted by septic tank wastes that have not been adequately absorbed by the soil, (d) wetlands provide spawning grounds and wildlife habitat. The natural plant and animal communities found here provide ecological balance to the water course, (e) to maintain safe and healthful conditions, prevent water pollution, protect fish spawning grounds and aquatic life and preserve shore cover and natural beauty, building development in wetlands should be limited. (2) Permitted uses include: (a) grazing; (b) harvesting wild crop, sustainable yield forestry, hunting, trapping, fishing, wildlife preserves, historic or scenic preserves, nonresidential buildings, raising waterfowl, minnows, etc..., hiking or bridle trails, accessory uses - parks, picnic areas, golf courses, etc... Special exceptions are granted with consideration of natural character of land for its value to wildlife, water conservation, flood control, forestry or other purpose appropriate to physical characteristics of the land.

17.34 Shoreland-Wetland district: (1) this district shall include all shorelands and wetlands which are of five acres or greater designated on the Wisconsin Wetlands Inventory Maps. (2) Purpose is to maintain safe and healthful conditions, prevent water pollution, protect fish spawning

grounds and wildlife habitat, preserve shore cover and natural beauty and control building and development in wetlands whenever possible. When development is permitted in a wetland, the development should occur in a manner that minimizes adverse impacts upon the wetland.

17.36 St. Croix River Valley district: (1) Purposes are: a) reduce the adverse effects of poorly planned shorelands and bluff area development; b) provide pollution and contamination of surface and groundwaters and soil erosion; c) provide sufficient space on lots for sanitary facilities; d) minimize flood damage; e) maintain property values; and f) preserve and maintain the exceptional scenic and natural characteristics of the water and related land of the Lower St. Croix River Valley in a manner consistent with the National Wild and Scenic Rivers Act, the Federal Lower St. Croix River Act and the Wisconsin Lower St. Croix River Act. (2) b) Compliance: no development of land or water shall hereafter be implemented and no use, structure or part thereof shall be located, erected, moved, reconstructed, extended, enlarged, converted or structurally altered without full compliance with provisions of this section and all other applicable local, state and federal regulations.

Wisconsin Administrative Code, Wisconsin Department of Natural Resources. Chapter NR112. Well Construction and Pump Installation. Effective 10/01/75, revisions 10/85.

Purpose: establish uniform minimum standards and methods of procuring and protecting groundwater supply safe for human consumption and food preparation through adequate construction of wells and reservoirs and installation of pumping equipment. Govern the location, construction and maintenance of the above and supervise well drillers and pump equipment installers. Applicability: applies to all new and existing private water supplies, high capacity water systems, school water systems, public water systems, except those serving greater than 15 living units. The following sub-chapters indicate specific rules as indicated.

NR112.07 Well location: highest point on the premises, protected against surface water flow and flooding; eight feet between well or reservoir and storm or sanitary building; may be located on floodplain outside of floodway, on floodway with permit.

NR112.08 Well design and construction: specific to aquifer and overlying geologic formations.

NR112.16 Sampling: all wells used for drinking or food preparation must be sampled and tested upon completion of construction or re-construction.

NR112.20 Well disposal of pollutants: use of a well for disposal of solid wastes, sewage or surface or wastewater drainage is prohibited.

Wisconsin Administrative Code, Wisconsin Department of Natural Resources. Chapter NR118. Standards and Criteria for the Lower St. Croix National Riverway. Effective 2/84.

Rules are necessary to reduce the adverse affects of poorly planned shoreland and bluff area development, to prevent pollution and contamination of surface and groundwaters to soil erosion, to provide sufficient space on lots for sanitary facilities, to minimize flood damage, to maintain property values and to preserve and maintain the exceptional scenic and natural characteristics of the water and related land of the Lower St. Croix River valley in a manner consistent with the National Wild and Scenic River Act (P.L. 90-542), the Federal Lower St. Croix River Act of 1972 (P.L. 92-560) and the Wisconsin Lower St. Croix River Act (Chapter 197, Laws of Wisconsin, 1973). The code includes lists of permitted uses, conditional uses and the agencies involved in enforcement. The enforcement agencies include the St. Croix County Planning Department, Department of Natural Resources, Regional Planning Commission, St. Joseph Town Board, and the Minnesota-Wisconsin Boundary Area Commission.

Density standards allow for no more than one dwelling per unit per acre, however, St. Joseph has a three acre minimum. Setbacks are greater than or equal to 100 feet from the ordinary high water mark and no less than 40 feet from the bluffline, whichever is greater, for incorporated areas. St. Joseph is unincorporated, therefore the following setbacks apply at the present time: no less than 200 feet from the ordinary high water mark or no less than 100 feet from the bluffline, whichever is greater. No structures are allowed on slopes facing the St. Croix River that are greater than 12 percent. No structures can be higher than 35 feet above the ground. Vegetative management provisions specify that vegetation must be managed to maintain the essential character, quality and density for existing growth. Use compatible native species is required within 200 feet landward of the ordinary high water mark or 40 feet from the bluffline. No tree or shrub removal is allowed unless insect it is infested, diseased or poses a safety hazard. Filling and grading is not allowed in excess of the natural topography without submittal and approval, including re-planting types and density. All buildings must be colored with earth or wood tones. Any private sewage

systems must meet the provision of any state or local provisions, whichever is the most restrictive. Approval must be obtained from the Wisconsin Department of Natural Resources.

Wisconsin Administrative Code, Wisconsin Department of Natural Resources. Chapter NR140. Groundwater Quality. Effective 10/01/85.

Chapter NR140 is intended to establish groundwater quality standards for the State of Wisconsin. The rules included apply to all facilities, practices and activities which may affect groundwater quality.

NR140.12 lists the enforcement standards and preventative action limits. The regulatory agency, the WIDNR, will review all facilities reporting levels in excess of the preventative action limits. These limits are generally one half the value of the enforcement standards.

NR140.26 includes responses required when an enforcement standard is attained or exceeded.

NR140.20 provides for the establishment of background water quality at a facility where monitoring is required. The facilities regulated by the WIDNR are listed under chapter 144, 146 or 147, Wisconsin Statutes. Within the Town of St. Joseph, the sewage lagoon located at the mobile home park in Houlton is regulated by the WIDNR.

NR140.24 outlines the parameters used for establishing preventative action limits.

State of Wisconsin, Chapter 83. Private Sewage Systems. Drafted 09/01/90.

The underlying purpose of Chapter 83 is to achieve basic goals in environmental health and safety accomplished by proper siting, design, installation, inspection, and maintenance of private sewage systems. Failing System: once a failing system is identified it shall be corrected or its use discontinued within that period of time required by county or departmental order, with a maximum time limit of one year.

The county shall review soil test reports for proposed private sewage disposal systems and verify the data reported. All plans and specifications for sewage systems must include: 1) plot plan; 2) reference points, which include a vertical elevation point, horizontal elevation point and a benchmark; 3) soil data; 4) occupancy; 5) other specifications such as pumps and controls,

elevation differences, pipe friction loss, pump performance curve, pump model and manufacturer; and 6) cross section. The county is responsible for all private sewage system inspections after construction is completed. The county is also responsible for violation investigation and the submittal of abatement orders to the district attorney or attorney general for enforcement. A site evaluation, which must be completed for construction of any private sewage system is to include soil conditions, properties and permeability, depth to zones of soil saturation, depth to bedrock, slope, landscape position, all setback requirement and the potential for flooding.

A soil absorption system shall not be located on a land slope of greater than 25% and must be located at least 20 feet from the crown of a land slope that is greater than 25%. Where the sites are subject to broad regional water tables, such as areas of sandy soils, the fluctuations over the several year cycle shall be considered. Site requirements: (1) soil absorption site location shall be located at a point lower than the surface grade of any nearby water well or reservoir on the same or adjoining property, shall not be less than ten feet from a water service, five feet from an occupiable structure in the soil absorption area that is downslope from the structure; 15 feet from an occupiable structure for a subsurface system that is upslope from the structure and five feet from other structures; 25 feet from a structure for an above grade system that is upslope from the structure; 50 feet from any water well or reservoir except where greater separation distances are required and 50 feet from the high water mark of any lake, stream or other watercourse. Surface waters shall be diverted away from any soil absorption site on the same or neighboring sites. (2) where groundwater, bedrock or impermeable soils exist there shall be a minimum of three feet of soil between the bottom of the soil absorption system and high groundwater, or bedrock. Impermeable soils shall not exist at the depth of the proposed soil absorption system and for at least three feet below the proposed bottom of the soil absorption system. Other considerations must be given to percolation rates, soils maps and filled areas, which are further explained in this particular section of the chapter.

Specific septic tank capacity is expressed for one and two family residences based on the number of bedrooms. Septic systems shall not be installed within: two feet of any structure or its appendage, ten feet of a water service, 15 feet of any pool, 25 feet of any well, reservoir or high water mark of any lake, stream, pond or flowage. If a tank is installed in groundwater, adequate anchoring provisions shall be made to counter the buoyant forces. Septic tanks and other treatment

tanks shall be emptied whenever the sludge and scum occupies one-third of the tank's liquid capacity. Specific seepage disposal is addressed in the Wisconsin Administrative code, Chapter NR113. Prior to the issuance of a sanitary permit for the installation of a holding tank, the owner shall provide to the local government unit and the county a copy of the servicing contract. Other design specifications and more specific rules are outlined further throughout this code.

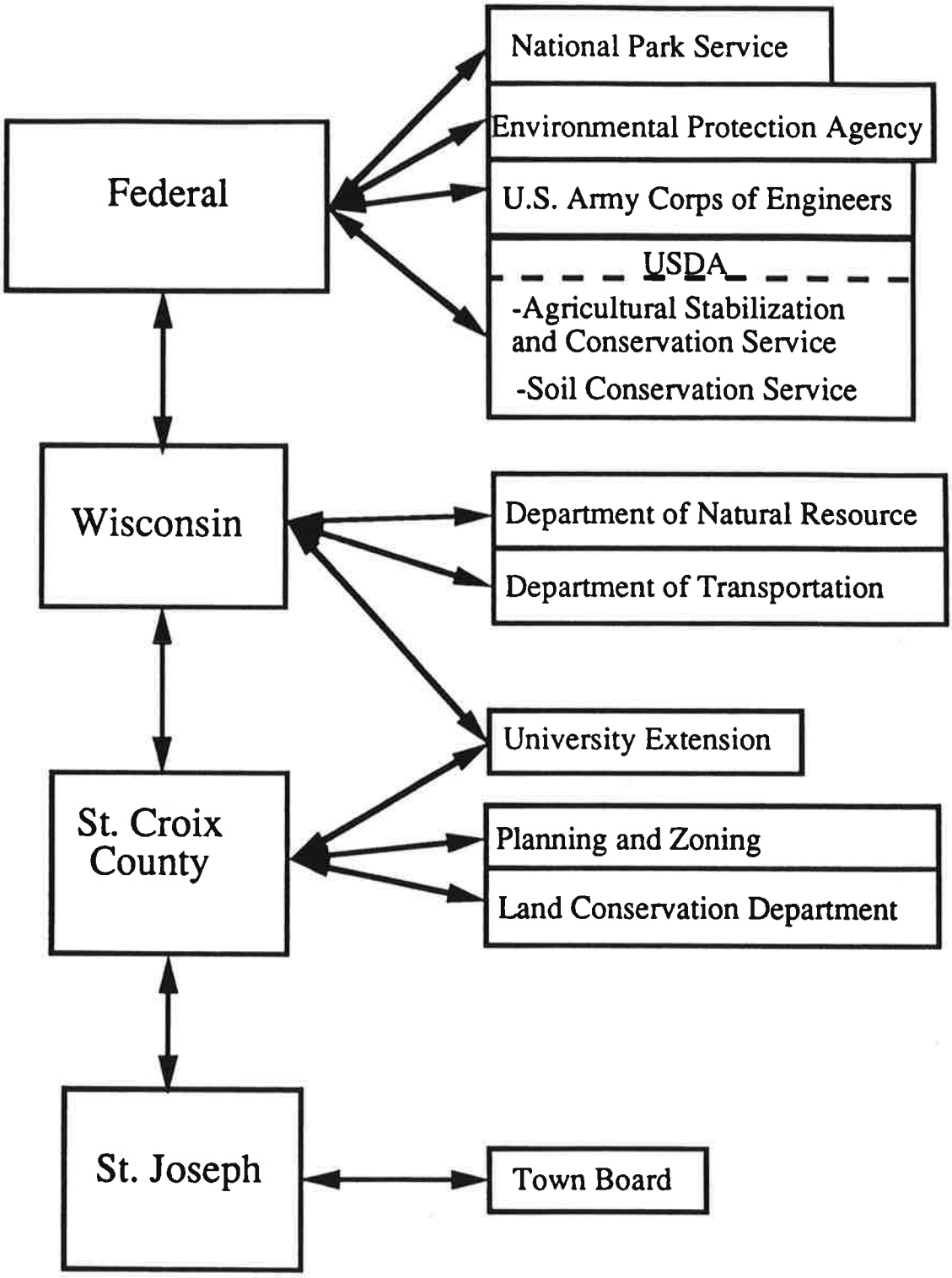


Figure 6: GOVERNMENT STRUCTURE

GOVERNMENT STRUCTURE AND RESPONSIBILITIES

Agency	Responsibilities
Town of St. Joseph St. Joseph Town Board	-Local government activities
St. Croix County Planning and Zoning	-Develop agriculture Water Quality Management Plan -Develop and enforce erosion control and water quality ordinances pertaining to construction projects -Issue construction permits -Enforce sanitary program
Land Conservation Department	-Develop animal waste disposal plans -Develop erosion control plans
State Department of Natural Resources	-Manage fisheries and wildlife -Monitor lake water quality -Issue permits for developments under state jurisdiction
Department of Transportation	-Monitor water quality at the time of road construction
University Extension Office	-Educate public on conservation issues -Administer solid waste educational program
Minnesota Pollution Control Agency	-Issue NPDES permits for point source effluent toxicity

GOVERNMENT STRUCTURE AND RESPONSIBILITIES

Agency	Responsibilities
Federal Environmental Protection Agency	-Devise standards for drinking water -Monitor ground and surface water quality
U.S. Army Corp. of Engineers	-Regulate some wetland alteration -Design and construct water control structures
National Park Service	-Monitor water quality for the St. Croix River -Regulate recreational congestion
USDA Soil Conservation Service	-Wetland Protection -Wetland Restoration -Design conservation structures and plans
Agriculture Stablization and Conservation	-Fund Conservation Reserve Program (CRP) -Fund Water Bank -Administer funds for other cost share programs

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GLOSSARY

algal bloom- An explosive increase in the algae within an area.

anthropogenic- Originating from human activities.

anoxic- Lacking oxygen.

aquifer- A sand, gravel, or rock formation capable of storing or conveying a reasonable supply of water to a well or spring.

bedrock- Consolidated solid rock, overlain in most places by soil or rock fragments.

biomanipulation- Adjusting the fish species composition in a lake as a restoration technique.

bluffline- A line along the top of a slope, connecting the points at which the slope, proceeding away from the river or adjoining channel, becomes less than 12%.

CFS- Cubic feet per second, the measured rate of water flow.

Cambrian- System of rocks formed in the Cambrian period; 500 to 620 million years ago.

chlorophyll a- A pigment produced by aquatic plants; used to assess the trophic status of a water body.

Continental Climate- A climatic region characterized by well-marked temperature seasons.

datum- A stationary line of known elevation.

dewatered- Having been drained.

effluent- The discharge of industrial or urban waste into the environment.

end moraine- Glacial till deposited by the terminal edge of a glacier, leading to rolling topography

erosion- The wearing away of the land surface by running water, wind, ice or other agent, and by such processes as gravitational creep.

eutrophication- The natural or artificial aging process consisting of nutrient enrichment of a water body. An increase in aquatic plants and low oxygen content are results of this process.

fecal coliform bacteria- A group of bacteria found in the intestinal tract of humans and animals, and also found in the soil. While harmless in your intestines, coliform bacteria are commonly used as indicators of the presence of pathogenic organism.

fill- The placement of unconsolidated materials, such as sands and gravels, to increase the distance from the ground surface to the water table.

flowage- An artificially enclosed body of water; generally the result of a structure such as a weir or dam.

grading- Leveling of the ground surface.

groundwater- Water in the zone of saturation where all openings in rocks or soil are filled with water, the upper surface of which forms the water table.

hardwater- Water with a high dissolved mineral content.

herbicides- Chemicals used to kill undesirable vegetation.

hummocky- A topographic landscape feature of small, rounded hills and depressions.

humus- That more or less stable fraction of soil organic matter remaining after the major portion of added plant and animal residues have decomposed.

hydrophytic- A plant adapted to live in water or very wet habitats.

hypolimnion- The cold bottom layer of a lake during the summer months.

impermeable soil- A soil that does not allow water to penetrate it.

impoundment- An artificially enclosed body of water; typically with fluctuating water levels and high turbidity.

infiltration- The downward entry of the water in the soil. This is distinct from percolation, which is movement of water through soil layers or material.

kettles- Depressions in the topography due to receding glacial activity.

leaching- The removal of soluble material from soil or other material by percolating water.

limiting factors- Any factor in the environment of an organism such as phosphorus, that exhibits a positive relationship between substance availability and organism population.

littoral zone- The shallow areas around a lake's shoreline dominated by aquatic plants.

macrophyte- A large aquatic plant.

mesotrophic- Waters having intermediate levels of primary productivity or intermediate levels of the minerals required for green plants.

navigable waterway- A bed and banks are present, and a canoe or other small water craft can be floated in it during sometime of the year. Specific to Wisconsin.

nonpoint source pollution- Pollution arising from a ill-defined source, such as runoff from cultivateed fields, grazing land, or urban areas.

oligotrophic- Waters having low primary productivity, low nutrient content and a hypolimnion that does not become depleted of oxygen during the summer.

ordinary high water mark (OHWM)- A mark left on the landscape as the result of water being at the level for a long enough span of time to produce the mark; typically include scour lines along the shore, water lines on the trunks of trees, etc.

Ordovician- Period of time rocks formed following the Cambrian period, 390 to 500 million years ago.

permeability- (as it relates to groundwater) Ability of a rock to transmit water.

permeability- (as it relates to soil) The number of inches per hour that water moves through the soil.

phytoplankton- Suspended microscopic algal cells such as diatoms.

pits- A geologic formation resulting in depressions in the landscape.

pitted outwash- Stratified glacially deposited material of gravel, sand and/or silty clay, that is well sorted through stream deposition.

point source pollution- Pollution arising from a well defined origin, such as a discharge from an industrial plant.

porosity- openings in rock able to store water

Pre-Cambrian- Period of history of rock formation prior to the Cambrian period, more than 620 million years ago.

productivity- Organic fertility of a given area or habitat.

Quaternary- Period of geologic development less than 70 million years ago.

recharge- Process that moves water from the Earth's surface into the ground to become groundwater.

rift- A fault or fold occurring in a geologic structure.

riparian- Pertaining to the bank area of streams, rivers or lakes.

run-off- The water that flows off the land surface without soaking downward.

Secchi disk- Generally a alternately black and white marked disk lowered into a water body until it is not visible to record the depth of water clarity.

sediment basin- a shallow excavation which receives rainfall runoff and slows it, allowing the sediment load to settle.

sediment load- The amount of particulate matter, such as soil particles, being carried by water, wind or ice.

seepage lake- A lake that has only overland flow, direct precipitation and groundwater as its water source. Without inlets or outlets.

sewage lagoon- An artificially created body of water used as a depository and filtering system for solid wastes.

shelterbelt- Plantings of trees to protect dwellings from winds.

sinkholes - A kettle like depression that is directly linked to groundwater.

slope- The inclination of the land surface from a horizontal point.

soil horizon- A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes.

soil series- Soils that are alike in all major profile characteristics.

spawning grounds- The area within a water body where a fish will go to produce and/or lay her eggs.

stratigraphy- The position and order of sequence of geologic layers.

sub-basin- A tract of country drained by a designated section of a river and its tributaries.

sub-watershed- The drainage area of a defined water body, collection of water bodies or portion of a water body, including streams, lakes and other wetlands.

sustainable yield forestry- The management of a forest in such a way as to harvest a modest crop year after year without depletion of the resource.

tectonic- A geologic feature that causes folding or faulting to occur.

terrace- A structure that reduces the gradient of a slope by creating alternating areas of level ground with slopes in between.

tailwater- The pool of water immediately downstream from a structure, such as a dam, that generally exhibits a lower elevation than the water preceding the structure.

topography- The configuration of a surface, including its relief, the position of its streams, lakes, roads, cities, etc.

transpiration- The metabolic process of plants that converts carbon dioxide, nutrients and water to sugars and starches.

trophic status- The nutrient status of a body of fresh water; levels include from lowest to highest nutrient level oligotrophic, mesotrophic, eutrophic. Trophic status is generally measured by phosphorus content, algal abundance (chlorophyll a) and depth of light penetration.

turbidity- Cloudiness of water resulting from high levels of suspended matter, usually the result of a disturbance to the bottom of a water body.

ug/l- Micrograms per liter or parts per billion (ppb), a chemical or biological measurement.

unconfined aquifer- An aquifer that has no confining layers above it, resulting in groundwater that is under normal atmospheric pressure.

water holding capacity- The capacity of a soil to hold water.

watershed- The whole region or area contributing to the supply of a river or lake; drainage area.

windbreak- Plantings of trees perpendicular to the prevailing winds intended to slow wind velocities in large open areas. A method of reducing erosion.

Map 1

TOWN OF ST. JOSEPH SOIL PERMEABILITY

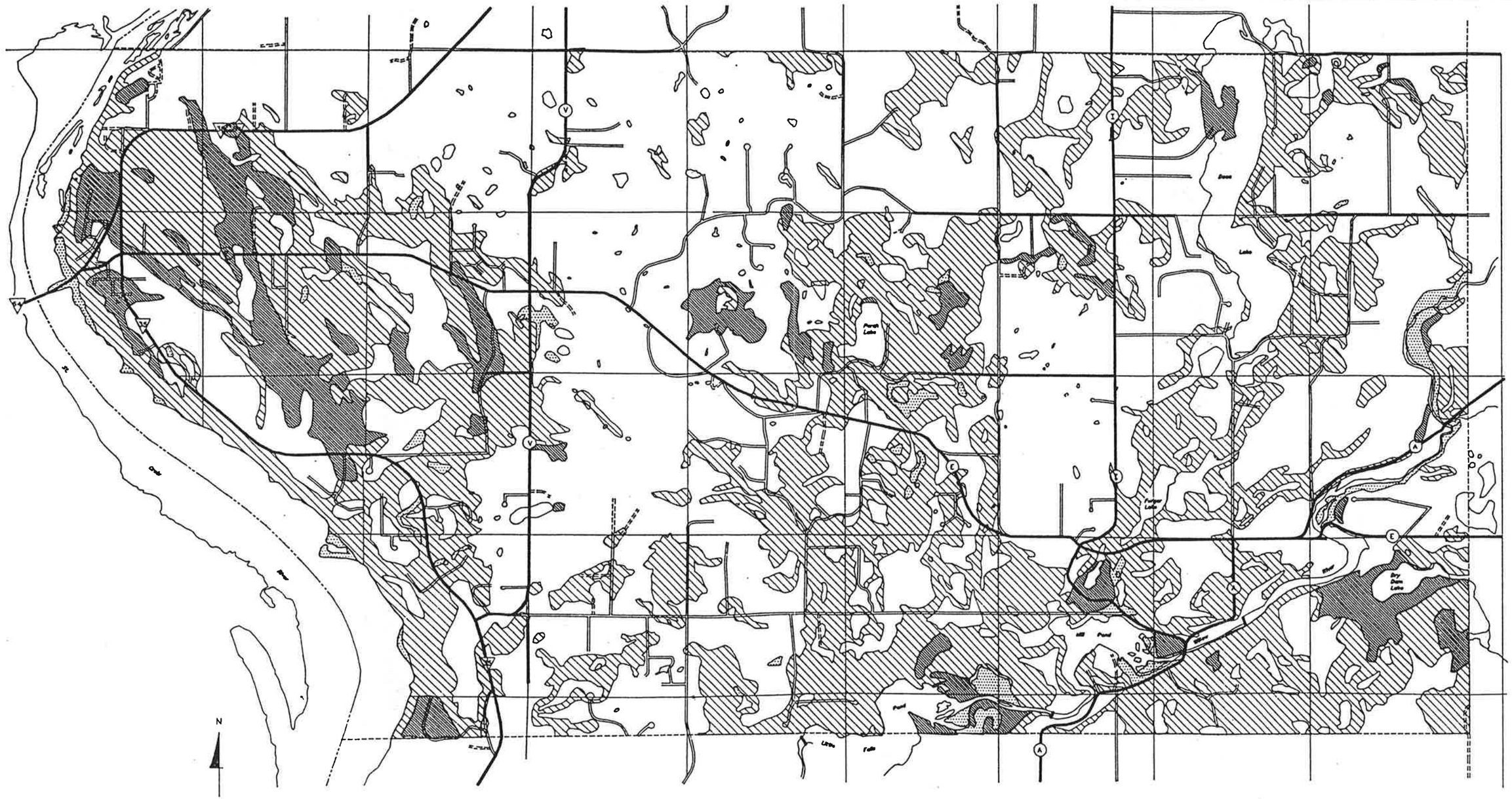
PERMEABILITY RATES

= 0.6 - 2.0 inches an hour

= 2.0 - 6.0 inches an hour

= 6.0 - 20 inches an hour

= variable

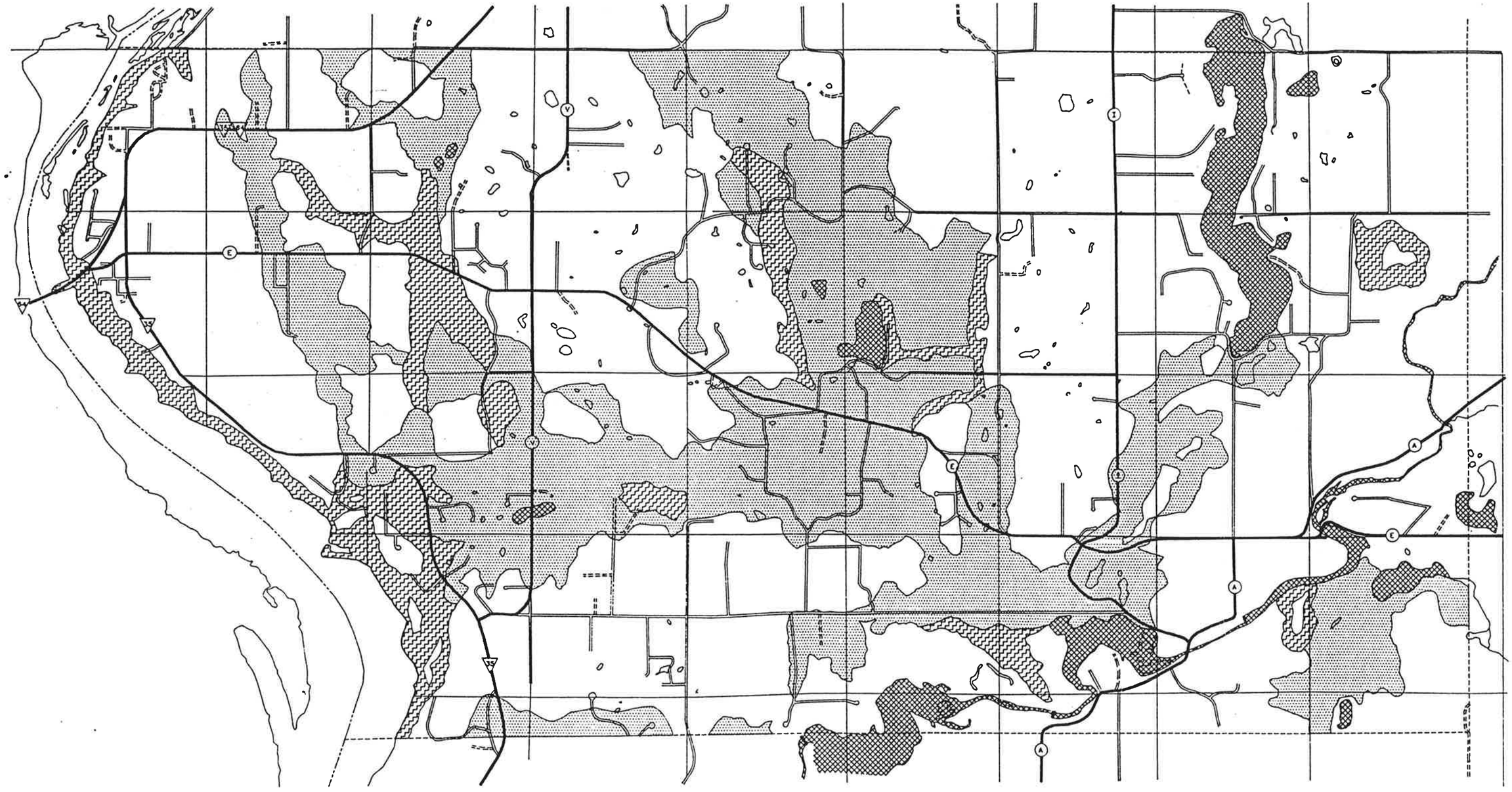


11 A

Map 2

TOWN OF ST. JOSEPH SLOPES

LEGEND
- Slight
- Moderate
- Extreme
- Water



11 B

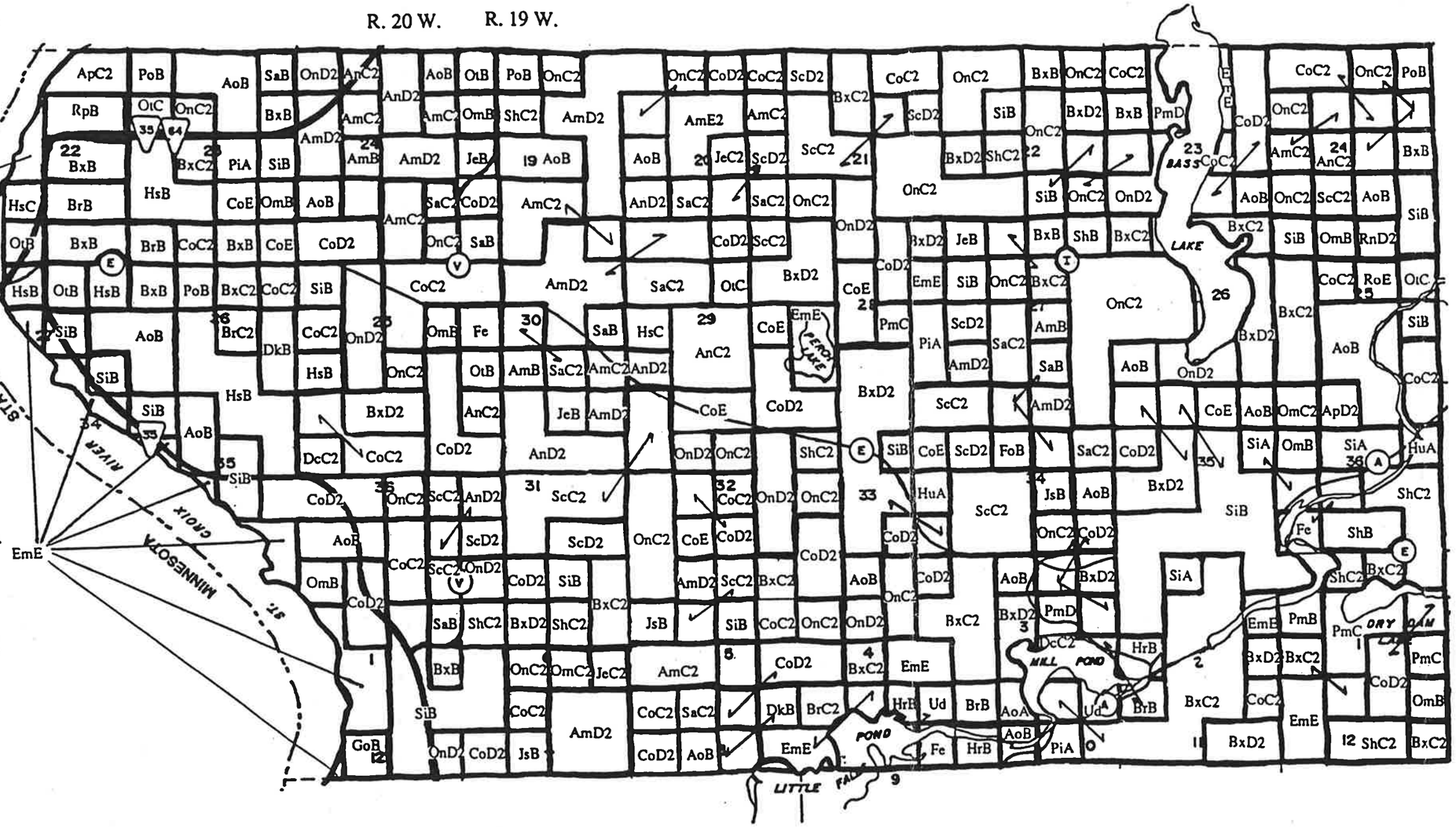
TOWN OF ST. JOSEPH SOILS

Map 3

R. 20 W. R. 19 W.

T. 30 N.

T. 29 N.



LEGEND

Ⓔ County Highway

35 State Trunk Highway

N

0 1/4 1/2 1 1 miles

LEGEND

SEE TABLE 1 IN THE SOILS SECTION FOR IDENTIFICATION OF THESE SOILS.

TOWN OF ST. JOSEPH
GROUNDWATER FEATURES

Map 4

WATER TABLE ELEVATION

760' ——— Average elevation of water table in feet – accurate within 0.5 miles on the land surface

740' - - - - Average elevation of water table in feet – accurate within 1.0 mile on the land surface

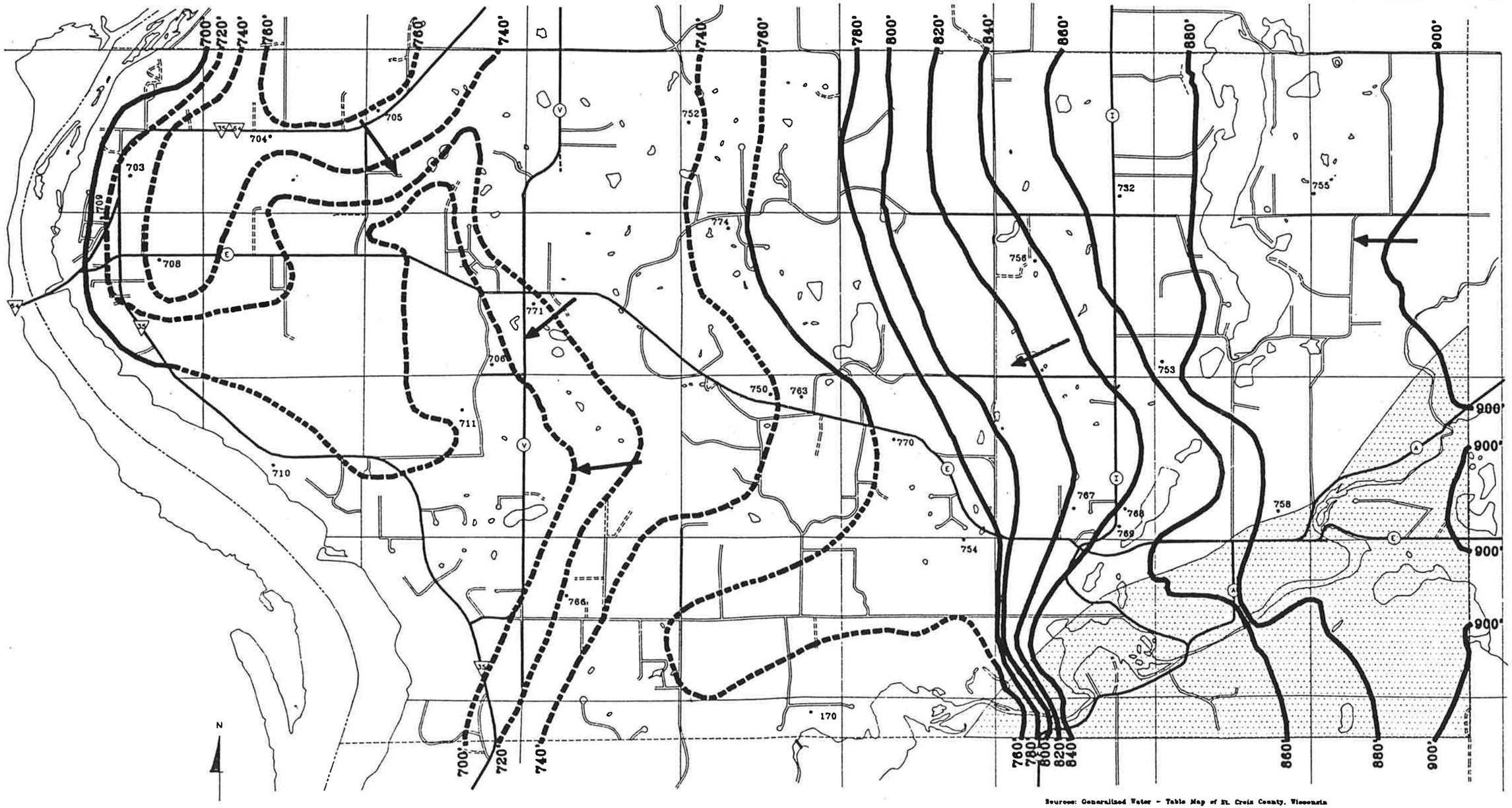
◄——— General direction of groundwater flow

• 766 = Well number and location

SURFACE GEOLOGY

End moraine

Pitted outwash



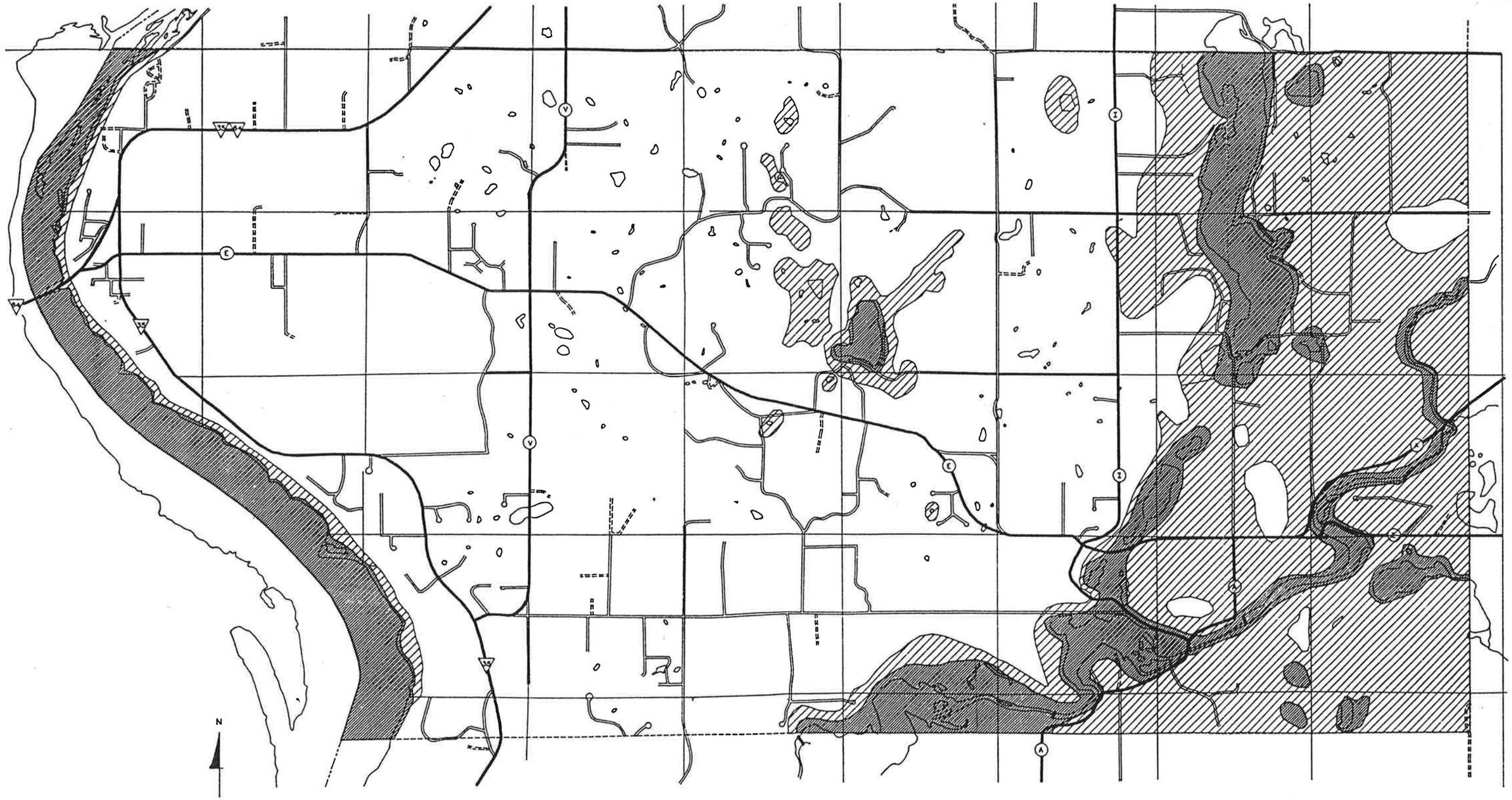
Sources: Generalized Water – Table Map of St. Croix County, Wisconsin
Geological and Natural History Survey Misc. Map 32.1990.
Berman, R.G. Ground – Water Resources of St. Croix County, Wisconsin, USGS, Figure 4. 1976

Map 5

TOWN OF ST. JOSEPH DEPTH TO GROUNDWATER

LEGEND

- 0 to 10 feet below the land surface
- 11 to 60 feet below the land surface
- > 60 feet below the land surface



Map 6

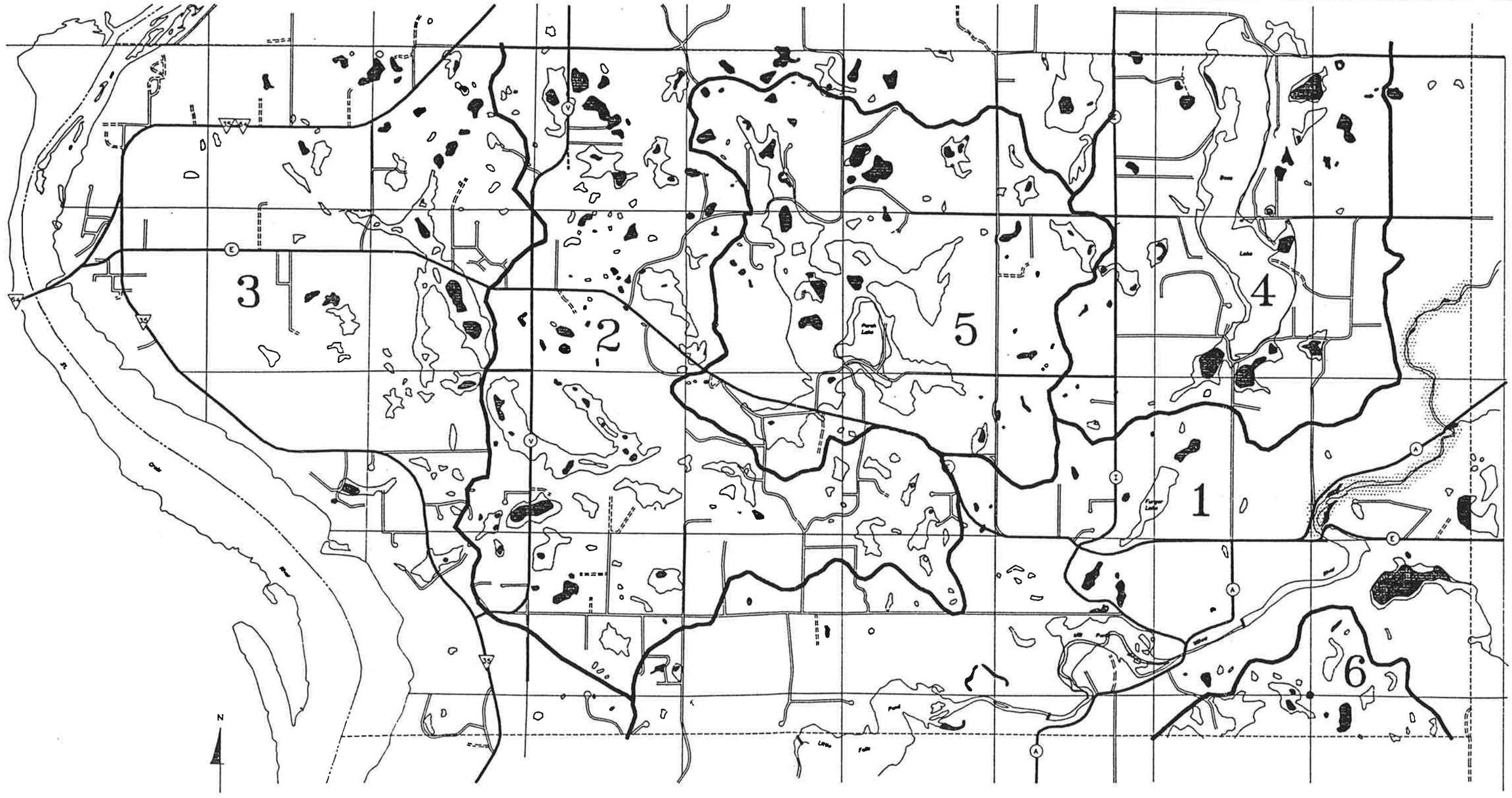
TOWN OF ST. JOSEPH SURFACE WATER FEATURES

LEGEND

- Wetlands
- Closed Depressions
- Class II Designated Trout Stream
- Subwater Shed Boundaries

SUBWATER SHED NAMES

1 = Willow River
2 = Central Wetlands
3 = St. Croix River
4 = Bass Lake
5 = Perch Lake
6 = Southeast Wetlands



TOWN OF ST. JOSEPH
GROUNDWATER SUSCEPTIBILITY TO CONTAMINATION

Map 7

GROUNDWATER SUSCEPTIBILITY

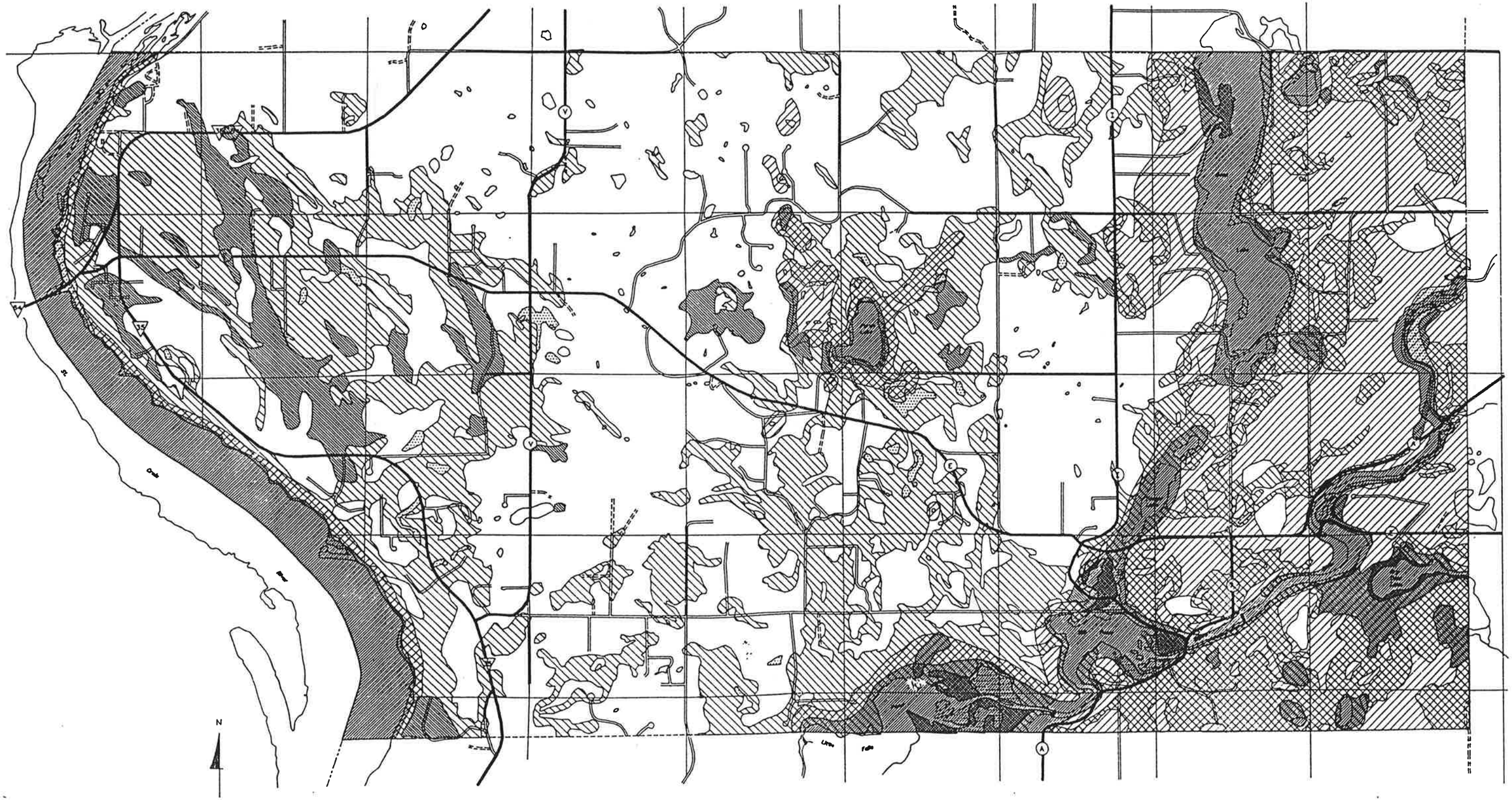
- Severe
- Moderate
- Slight

PERMEABILITY RATES

- = 0.6 - 2.0 inches an hour
- = 2.0 - 6.0 inches an hour
- = 6.0 - 20 inches an hour
- = variable

LEGEND

- 0 to 10 feet below the land surface
- 11 to 60 feet below the land surface
- > 60 feet below the land surface



Map 8

TOWN OF ST. JOSEPH RESIDENTIALLY DEVELOPED AREAS