Arrow – Oak River

State of the Watershed Report

June 2008

Table of Contents_Toc200775019

Introduction

Welcome to the Arrow-Oak River State of the Watershed Report. This report is a summary of resource and environmental management issues for our watershed based on available data from resource and environmental experts. The purpose of this document is two-fold, first as a tool to help inform watershed residents about the conditions and the "health" of our watershed, and second, as a starting point for setting priorities to address environment issues.

This State of the Watershed Report, although it is important, is not an end itself. The State of the Watershed Report is an important first step that is intended as the basis for an Integrated Watershed Management Plan. This management plan will guide the development and delivery of land and water conservation programming in our watershed over the next 10 years.

This report is organized into five different chapters, with each chapter dealing with a different aspect of the watershed, including: Surface Water, Ground Water, Soils, Habitat, and Drinking Water Protection. Each chapter is organized into two distinct parts, the first part containing background data and the second half outlining the resource and environment issues that were identified as well as the management recommendations that experts in the field have provided in order to address the issue.

As you read through this document ask yourself "**What are the resource and environment issues that concern me the most?"** Public consultations will be held across our watershed and it is important for you to come out and voice your opinion on which of these issues are most important and should be dealt with first. This is critical, as the opinions of you and the other residents of the watershed will determine how conservation agencies will spend their money and efforts on addressing resource and environment issues.

Watershed Overview[1]

The Arrow-Oak Watershed (Figure 1) is home to approximately 10,000 people. The watershed covers approximately 1.3 million acres from its headwaters just South of Riding Mountain National Park and extending south of the Trans Canada highway to the Town of Oak Lake. In terms of natural cover, the Arrow-Oak watershed is characterized by the Boreal ecosystem in its northern reaches and transitions to an Aspen Parkland dominated ecosystem in the south.

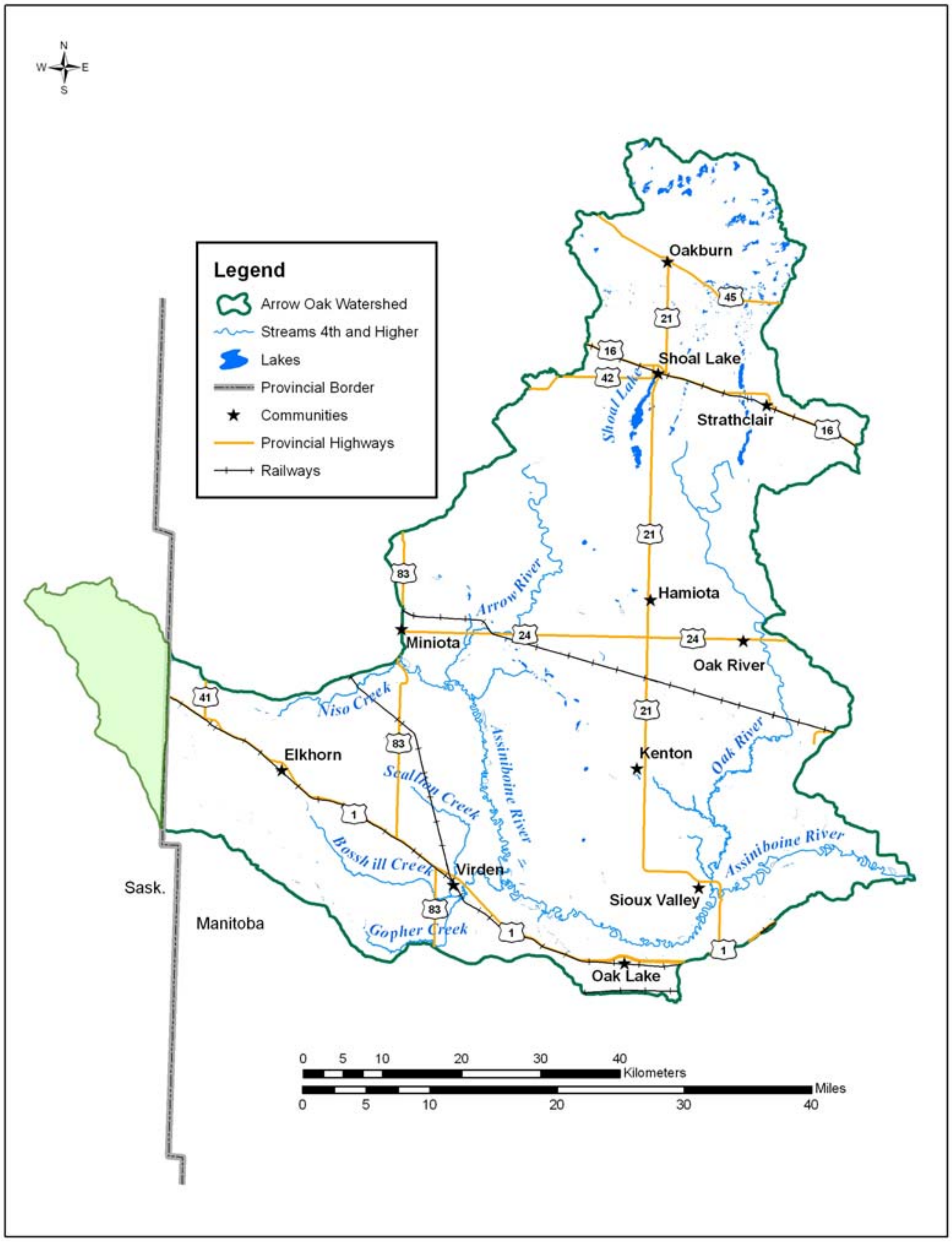


Figure 1: Watershed Overview

[1] Submitted by Manitoba Water Stewardship, Manitoba Agriculture, Food and Rural Initiatives, and Prairie Farm Rehabilitation Administration

Land Use/Land Cover

The land cover classification of the watershed has been interpreted from satellite imagery using computerized classification techniques. Individual land uses were classified and grouped into seven classes: annual crop land, forage, grassland, trees, wetlands, water, urban and transportation. Land cover information was collected between 1999 & 2002.

The Arrow-Oak River watershed is home to many different types of agricultural activities. From the headwater areas of the Arrow-Oak, farms are defined as mainly mixed operations focused on grain and cattle. As one moves southward to the Shoal Lake – Hamiota Area, farming operations become larger grain operations with some specialized (PMU) operations. At the bottom of the watershed near the Lenore-Kenton area, there is a greater focus on livestock and forage production. Agriculture is an extremely important contributor to the economy in the Arrow-Oak River watershed. Gross Farm Receipts, or the income from all farm related goods and services, totaled nearly $179,000,000 in the 2001 year. While the number of farms and the total acres farmed have been steadily decreasing since 1972, the average farm size had increased.

Land Management Practices

Zero tillage is a conservation management practice that has become widely accepted, and it has been adopted by many producers in the watershed. In fact, most producers in the watershed are moving their farming operations toward zero tillage. According to Census information, 1991 was the first year reported to have approximately 13,882 acres in no till management. In 2001, this number jumped to 67,797 acres reported. Combining this with conservation tillage numbers, residue management made up 34% of the farming practices on cropland in 1972. This jumped to 55% as identified in the 2001 Census Data, representing a 21% increase in the uptake of conservation management practices over the thirty year period.

Within the 2001 Census, the three biggest crops identified within the watershed were Spring Wheat (27%), Oilseeds (19%), and Cereal Grains (18%).

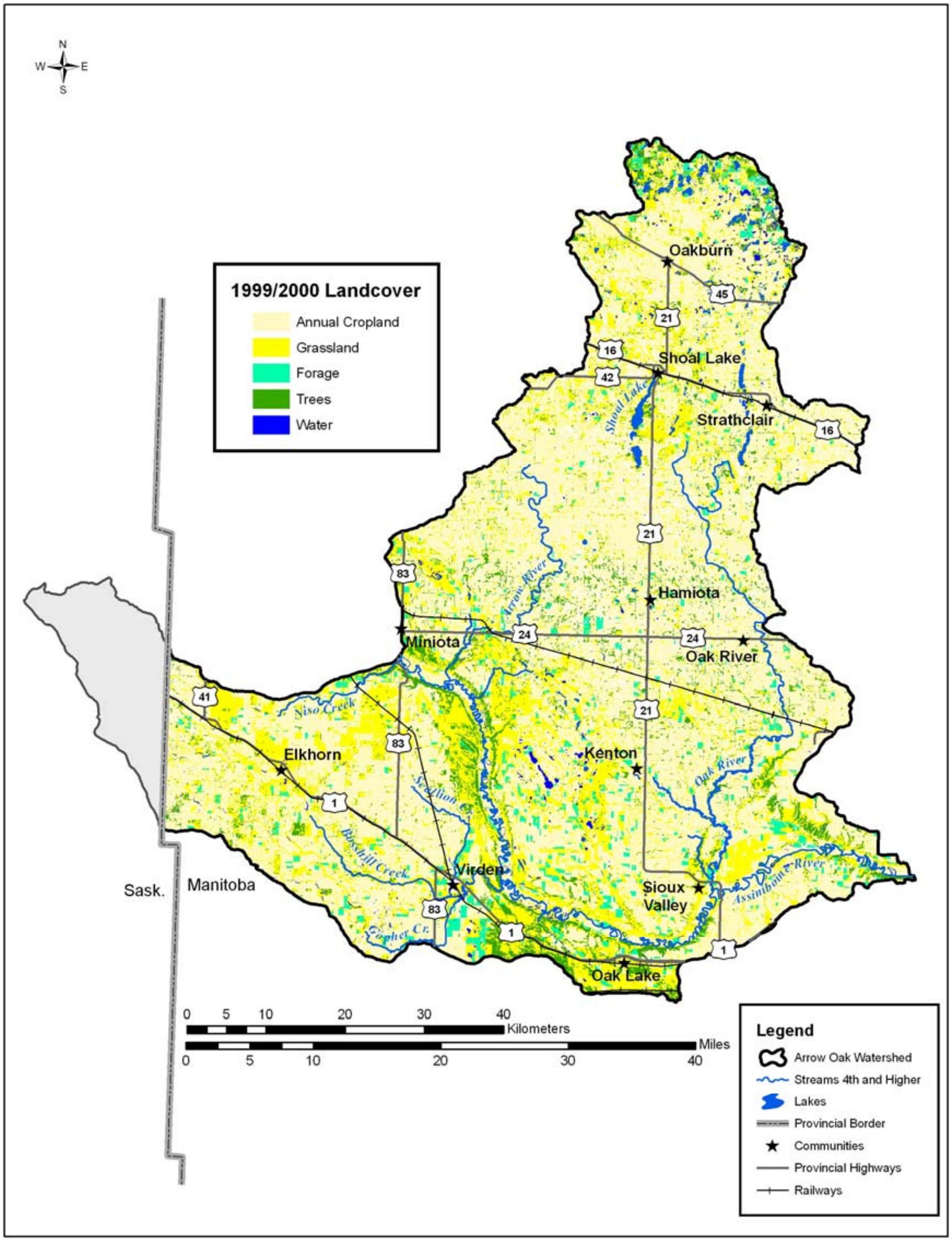


Figure 2: Land Use/Land Cover

Topography and Elevation

Significant changes in elevation occur throughout the watershed (Figure 3), with values ranging from 670 metres above sea level (masl) in the northern portion of the watershed, down to 350 masl in the Assiniboine River valley. The greatest local relief is found in the glacial melt water channels associated with the Assiniboine River and some of the tributaries. Valley bottoms can be up to 60m below the surrounding land surface.

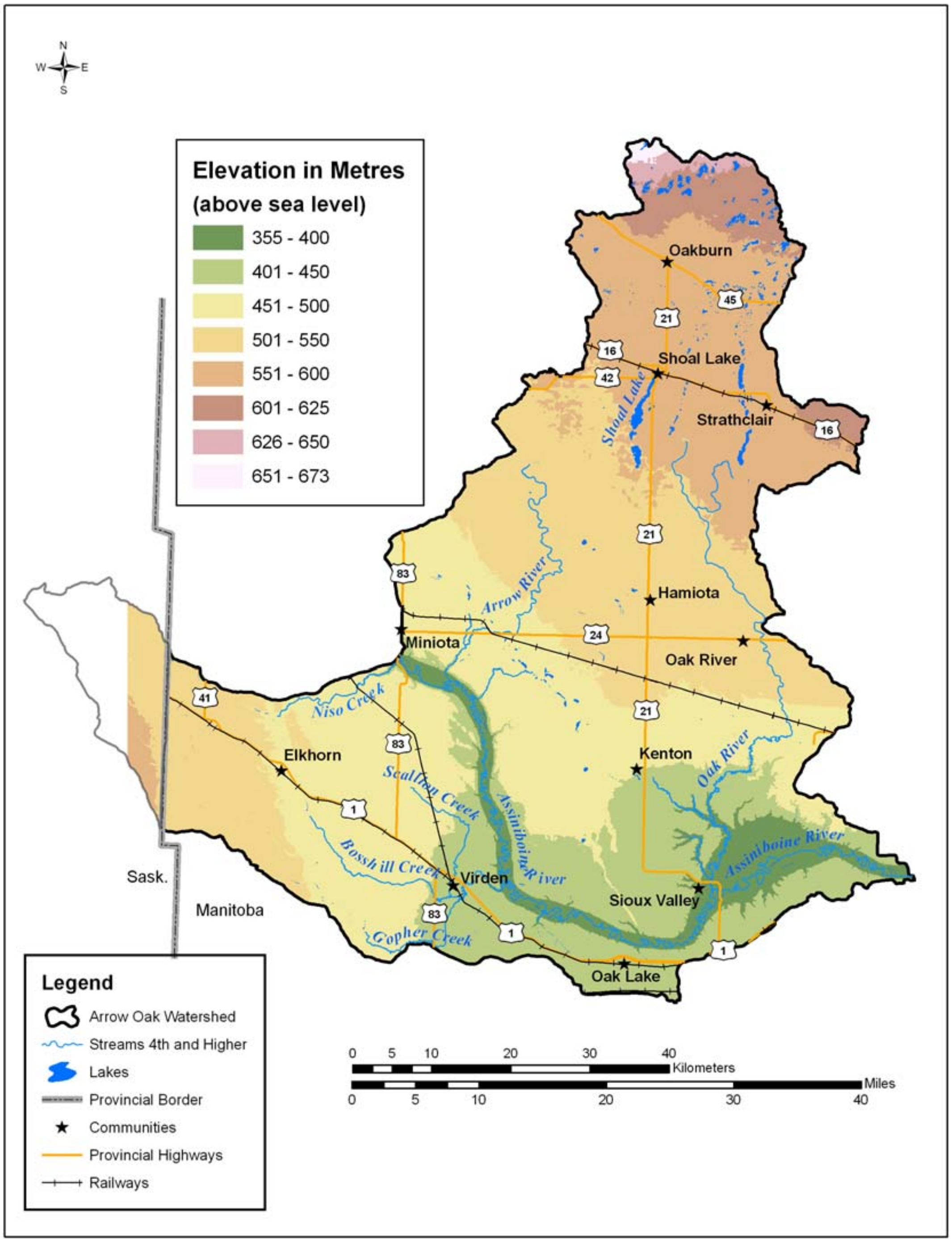
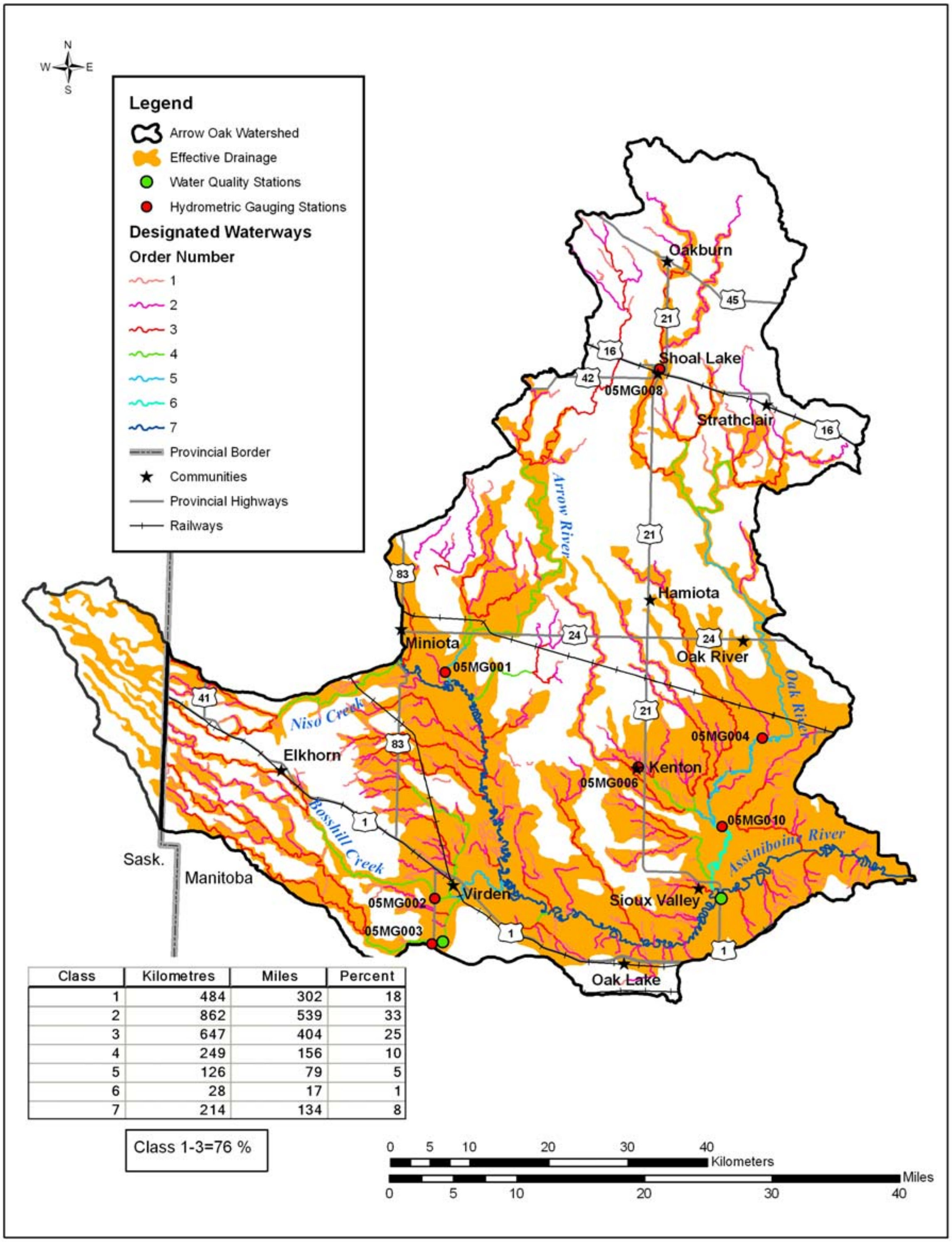


Figure 3: Digital Elevation Model

Surface Water[2]



Class	Kilometres	Miles	Percent
1	484	302	18
2	862	539	33
3	647	404	25
4	249	156	10
5	126	79	5
6	28	17	1
7	214	134	8

Figure 4: Gauging Station Locations and Effective Drainage Area

[2] Submitted by Manitoba Water Stewardship

There are seven Water Survey of Canada stream flow gauging stations located in the watershed (Figure 4). Stream flow data has been collected at these stations within the Oak River Watershed for varying time periods since 1959. The water survey gauging stations were operated annually during the period March through October up until the mid 1990s. In 1994, the operating period was reduced to the spring freshet period only, namely March through May.

The following table shows maximum daily discharge at various frequencies, i.e. 1% is a 1 in 100 year event, where as 50% column shows what can be expected once in every two years. It is interesting to note that M.B. Highways generally design infrastructure to accommodate 1% events and most municipal governments design for the 10% (1 in 10 year event).

Table 1: Frequency of Maximum Daily Discharge

Station Name	Station Number	Period Of Record	Years of Data	Gross Area (mi2)	Maximum Daily Discharges (cfs) 1%	2%	3%	5%	10%	20%	30%	50%
Arrow River Near Arrow River	05MG001	1959-1995 R	37	258.8	5261	4061	3443	2722	1854	1126	766	392
Bosshill Creek Near Virden	05MG002	1959-1976 R 1977-1996 C	39	72.6	1600	1151	925	678	410	211	126	51
Gopher Creek Near Virden	05MG003	1959-1996 R	38	115.1	1628	1208	992	756	491	280	184	89
Kenton Creek Near Kenton	05MG006	1962-1993 R	32	17.7	477	385	335	274	200	134	99	59
Oak River Near Bradwardine	05MG010	1966-1983 R 1959-1965,1984-1992 C	34	712.7	2941	2383	2101	1737	1314	936	731	487
Oak River Near Shoal Lake	05MG008	1965-1994 R	42	143.7	470	371	318	256	180	115	82	46
Oak River Near Rivers	05MG004	1959-182,1984-2000 R 1983 C	30	445.4	1465	1190	1038	862	639	441	335	208

Note: R - recorded

Gross and Effective Drainage Areas

The gross drainage area boundary is defined as the topographic limit of the watershed, commonly called the drainage divide. This area might be expected to contribute runoff under extremely wet conditions. The effective drainage area is that portion of the watershed that can be expected to contribute runoff to the main stream during a median (1:2 year event) runoff year. This area excludes marsh and slough area and other natural storage areas, which would prevent runoff from reaching the main stream in a year of average runoff.

Table 2: Gross & Effective Drainage Areas

Station Name	Station Number	EDA (mi2)	GDA (mi2)	EDA/GDA Ratio
Arrow River Near Arrow River	05MG001	76	258.8	0.29
Bosshill Creek Near Virden	05MG002	37.7	72.6	0.52
Gopher Creek Near Virden	05MG003	64.8	115.1	0.56
Kenton Creek Near Kenton	05MG006	13.2	17.7	0.75
Oak River Near Bradwardine	05MG010	273.3	712.7	0.38
Oak River Near Shoal Lake	05MG008	29.7	143.7	0.21
Oak River Near Rivers	05MG004	138.1	445.4	0.31

The effective to gross drainage area ratio is an indication of how well an area is drained. Areas with a higher EDA/GDA ratio have less water storage on the landscape, meaning that water is removed more quickly. When water is removed quickly from the landscape there is a higher peak flow rate which may result in flooding downstream, greater erosion rates, siltation and water quality degradation, and a greater susceptibility to drought.

Stream Runoff Characteristics

The daily discharge data for the gauging stations were statistically analyzed to determine runoff characteristics for the watershed. The majority of the runoff occurs during the months of March-May, and there is very little flow in the fall and winter months. Prairie streams are often intermittent, in that they flow very briefly in the springtime and only after exceptional rainfalls only in most years. Stream flow on the prairies varies considerably over the months and years. On the major watercourses, spring flooding is more significant than flooding from summer precipitation events. Smaller drainage areas (less than 10 mi^2) are sensitive to rainfall events, and localized flooding can occur in the smaller poorly drained areas of the watershed from excessive rainfall.

Surface Water Management

Under *The Water Rights Act*, Water Control Works are defined as any dyke, dam, surface or subsurface drain, drainage, improved natural waterway, canal, tunnel, bridge, culvert borehole or contrivance for carrying or conducting water that (a) temporarily or permanently alters or may alter the flow or level of water, including but not limited to water in a water body, by any means, including drainage, or (b) changes or may change the location or direction of flow of water, including but not limited to water in a water body, by any means, including drainage.

With respect to drainage, one area of concern within this watershed is the creation of new drainage works and maintenance of historic drainage works without authorization under *The Water Rights Act.* The authorization process allows for consideration of impacts in project design and operation.

Issues at the forefront in this watershed include flood protection for the Town of Strathclair and management of the Salt Lakes water levels, including the impact of flows from the Town of Strathclair directed to Salt Lakes. Another issue is the ability (or inability) of the Oak River system to transport runoff to the Assiniboine River without affecting a wide floodplain along the way. The Oak River system, like many other watercourses in the study area, is not deeply incised and has a limited capacity to transport runoff without flooding of a large floodplain of mainly agricultural lands. Agricultural operations are effected by the timing of the runoff event and may also experience longer term impacts when flood waters are trapped and cannot return to the channel following a flood event due to the presence of a high point of land.

Surface Water Management Plans (SWMP) and Land Use Management Plans (LUMP) are directly related in that the aspects of one plan influence the other. For example, if a SWMP dictates that development (drainage) of CLI Soils Class 6w not be undertaken, this would influence the options for land use on those soils. Stakeholders in the IWMP process should consider developing a Surface Water Management Plan which, if approved, would influence land development and use in the watershed. Approval of the province should be garnered for SWMPs, just as it is for IWMPs, in order to influence authorization of proposed drainage projects. Given that this watershed is inter-provincial in nature, consideration should be given to coordination and communication between agencies involved with construction or authorization of water control works in both jurisdictions.

With respect to dams, many dams have been constructed within the study area and authorized under the act based on the terms of agreements with private landowners. Many of these agreements are reaching an end and, as a result, the water control projects are being decommissioned. In most cases, the decommissioning of a dam results in restoration to pre-project (natural) conditions. Consideration should be given to offsetting any reductions in water storage or the ability of wetlands to temporarily store peak flows and reduce sediment transfer downstream which may occur as a result of project decommissioning.

With respect to construction of any surface or subsurface water control works, efforts should be made to prevent erosion of soils or transport of nutrients which may increase nutrient transfer into the receiving water body.

Water Allocation

Withdrawals of more than 5,500 imperial gallons/day (25,000 Litres/day) require a water rights licence from the Water Use Licensing Section of Water Stewardship. In addition, withdrawals in excess of 162 acre-feet per year (200 cubic decametres/year) trigger a requirement for an Environment Act Licence issued by the Environmental Approvals Branch of Manitoba Conservation. Water used for domestic purposes, such as a private well, does not require licensing. The intent of water rights licensing is to protect the interests of licensees, domestic users, the general public and the environment with respect to the use or diversion of water or the construction and operation of water control works under licence.

When licensing specific projects there are a number of factors considered in the assessment including: analysis of stream flow data, riparian needs, the water use requirements of senior water users, domestic needs, and in-stream flow requirements. For groundwater projects, this determination is based on an assessment of hydrogeological information including; geological information on aquifers, aquifer sustainable yield estimates and water allocation budgets, where available, as well the water use requirements of senior users and domestic needs.

Aquifer or stream water budgets have not been established for the Oak River watershed; therefore, the total amount of water available for allocation in the watershed has not been determined. Important water supplies in the watershed include the Assiniboine River and its many tributaries, as well as the Assiniboine Buried Valley Aquifer and the Rocanville Buried Valley Aquifer. Despite the watershed’s abundant surface water supplies, residents of this watershed generally use groundwater. The buried valley aquifers, in particular, seem to offer significant groundwater development potential.

There are presently 19 surface water projects on file with the Water Licensing Branch in the Oak River watershed of which six are for livestock watering, twelve are for irrigation purposes, and one surface water sourced municipal system in the watershed, a rural distribution pipeline, allocated 9.7 ac-ft per year. There are presently34 groundwater projects on file with the Water Licensing Branch in the Oak River Watershed, of which 17 are for livestock watering, seven for irrigation purposes, one for other purposes, and nine groundwater source municipal distribution systems in the watershed, mostly small villages and Hutterite colonies, but also including the Town of Virden which is allocated 960 ac-ft per year.

The following tables present all of the projects on file with the Water Licensing Branch for licensing in the Oak River watershed:

Table 3: Licenses Issued

Purpose	Licences		Total Licences
	Groundwater	Surface Water	
Agricultural	13	2	15
Industrial	0	0	0
Irrigation	2	6	8
Municipal	8	1	9
Other	0	0	0
Total	**23**	**9**	**32**

Table 4: Applications Received

Purpose	Applications		Total Applications
	Groundwater	Surface Water	
Agricultural	3	2	5
Industrial	0	0	0
Irrigation	2	4	6
Municipal	1	0	1
Other	0	2	2
Total	**6**	**8**	**14**

Table 5: Allocations

Purpose	Allocated Under Licence (ac-ft)		Total Allocation (ac-ft)
	Groundwater	Surface Water	
Agricultural	148.9	28.2	177.1
Industrial	0.0	0.0	0.0
Irrigation	384.0	553.4	937.3
Municipal	569.9	10.0	579.9
Other	0.0	0.0	0.0
Total	**1102.8**	**591.6**	**1694.4**

Water Quality

Water quality describes the chemical, biological and physical characteristics of water. Manitoba standards, objectives, and guidelines for many water quality variables have been developed to protect water quality for various purposes including irrigation, recreation, and the protection of aquatic life.

Water quality is monitored at many sites throughout Manitoba to identify changes and examine long term trends in water quality variables. Although many sites throughout the Arrow-Oak Watershed have been sampled for water quality, the following sites have been selected to represent the watershed for the purposes of this report:

- Arrow River (1999 to 2003)
- Assiniboine River (1965 to 2006)
- Gopher Creek (1978 to 1983, 1997 to 2006)
- Oak River (1997 to 1998)
- Salt Lake (2002)
- Shoal Lake (1987 and 1998)
- Wolf Creek (1998 to 1999)

Samples collected from these sites were analyzed for nutrient, metal, and pesticide concentrations as well as general chemistry variables. Most water quality variables examined in these waterways were generally within Manitoba Water Quality Standards, Objectives, and Guidelines. Pesticides were rarely detected but always within provincial guidelines. With the exception of iron and manganese, concentrations of all metals were within provincial guidelines.

Densities of *Escherichia coli* (*E. coli*) exceeded guideline levels from numerous samples collected from a station in Gopher Creek. Some of these higher densities were likely due to discharge from the Virden wastewater treatment facility which is located approximately 600 m upstream from the sampling station. Concentrations of phosphorus and nitrogen at this site and near the confluence with the Assiniboine River (sampled from 1978 to 1983) were also elevated compared to upstream sites in Gopher Creek. Conductivity, dissolved oxygen and total suspended solids at these sites in the Gopher Creek were also likely affected by discharge from the Virden wastewater treatment facility. For additional information on water quality impacts to Gopher Creek due to wastewater discharge, please refer to ‘Assessment of Virden Sewage Treatment Facility Discharges to Gopher Creek’ (Beck 1985).

Total Phosphorus

At sites throughout the Arrow-Oak Watershed, phosphorus concentrations consistently exceeded the Manitoba water quality guideline of 0.05 mg/L. The provincial phosphorus concentration guideline is based on the concentration above which nuisance plant and algae growth occurs, but Manitoba Water Stewardship is currently developing new guidelines that will be more ecologically relevant to watersheds and water bodies in Manitoba.

Conductivity

Conductivity in the Gopher Creek frequently exceeded the water quality objective for irrigation (1,000 µS/cm). Conductivity data is not available for Shoal Lake, Arrow River, Oak River, Wolf Creek, Salt Lake, or Assiniboine River within the Arrow-Oak Watershed. Conductivity in water is a measure of the concentration of dissolved salts and minerals such as chloride, nitrate, sulphate, sodium, calcium, and iron. Conductivity is primarily influenced by soil characteristics of the watershed. Rivers and streams that flow through clay soils tend to have higher conductivity because of the presence of materials that ionize when washed into the water. Industrial and municipal discharges to rivers and streams can change the conductivity due to higher concentrations of sulphate, chloride, and nitrate.

Dissolved Oxygen

Dissolved oxygen concentrations in the Arrow and Oak Rivers and in Shoal Lake rarely declined below the minimum Manitoba water quality objective of 5 mg/L. However, dissolved oxygen concentrations measured in Gopher Creek, Salt Lake, and Wolf Creek were often below this objective. Low concentrations of dissolved oxygen can cause fish kills and foul smelling water. Low dissolved oxygen can result from the decomposition of organic material such as algae and plants, and is exacerbated during ice cover due to a reduced potential for oxygen replenishment.

Total Suspended Solids

With the exception of the Assiniboine River, the concentration of total suspended solids (TSS) did not exceed 25 mg/L in any of the water bodies examined in the Arrow-Oak Watershed. TSS in the Assiniboine River in the Arrow-Oak Watershed consistently exceeded 50 mg/L. Due to natural variation in suspended solids between sites, Manitoba Water Quality Standards, Objectives and Guidelines outlines a maximum change in TSS from background concentrations instead of an absolute objective that would be applicable to all sites. Since background concentrations have not yet been estimated in water bodies within Manitoba, the TSS objective of 25 mg/L is being used in the interim. Runoff from precipitation events in the spring and summer carries soil, silt, and organic debris, all of which could increase the concentration of suspended solids in the rivers and streams within the Arrow-Oak Watershed. Bank erosion will also contribute to increased suspended sediments. Land-use practices such as removing vegetated buffer strips from along rivers and smaller tributaries also increase the overland movement of soil and other debris into the river.

Metals

Although metals were only examined in the Assiniboine River, and for only a few samples in Gopher Creek, Oak River, and Salt Lake, iron and manganese concentrations consistently exceeded the aesthetic guideline for drinking water. Iron and manganese commonly exceed guidelines in surface water throughout southern Manitoba. Iron is naturally released to surface waters through weathering of iron bearing minerals but significant amounts are also released through industrial processes, corrosion of iron and steel, and mining effluents. Manganese is associated with iron in water and is also naturally found in water from weathering of minerals. High concentrations of iron and manganese in water can impart an unpleasant taste, and can produce a yellow precipitate; both of these concerns can be mitigated through the treatment of drinking water. Other metals examined rarely or never exceeded guidelines.

Water Quality in the Shoal Lake

An in-depth nutrient study was conducted on Shoal Lake in 1987 after a number of blue-green algae outbreaks occurred in the lake. The study was requested by Shoal Lake town and municipal councils and conducted by the province to determine the severity of the nutrient-loading and identify the sources of the nutrients which led to the algae outbreaks. The study found that Shoal Lake is currently considered hypereutrophic (extremely nutrient rich) with excessive external loading. The nutrient sources identified in the study are outlined in Figure 5.

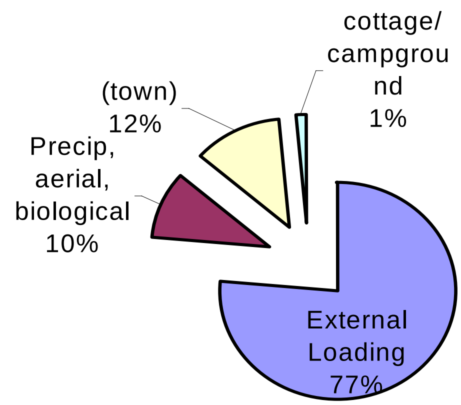


Figure 5: Nutrient Inputs to Shoal Lake

Management Concerns

1. Surface Water Management and Drainage

Currently water has largely been managed at the farm or individual field scale, often without any form of comprehensive long-term planning. Stakeholders in the IWMP process should consider developing a Surface Water Management Plan which, if approved, would influence land development and use in the watershed. Approval of the province should be garnered for SWMPs, just as it is for IWMPs, in order to influence authorization of proposed drainage projects.

Recommended Actions

- A surface water management plan should be developed through a partnership with all stakeholders in the watershed.
- Prominent issues to be considered in the plan should include: flood protection for the town of Strathclair, management of the water levels on Salt Lakes, and flooding on the Oak River.

2. Nutrient Enrichment

Nutrient enrichment is one of the most important water quality issues in Manitoba. Excessive levels of nitrogen and phosphorus fuel the production of algae and aquatic plants. Extensive algal blooms can cause changes to aquatic life habitat, reduce essential levels of oxygen, clog commercial fishermen’s nets, interfere with drinking water treatment facilities, and cause taste and odour problems in drinking water. In addition, some forms of blue-green algae can produce highly potent toxins.

Since the early 1970s, phosphorus loading has increased by about 10 % to Lake Winnipeg and nitrogen loading has increased by about 13 %. As part of the Lake Winnipeg Action Plan, the Province of Manitoba is committed to reducing nutrient loading to Lake Winnipeg to those levels that existed prior to the 1970s.

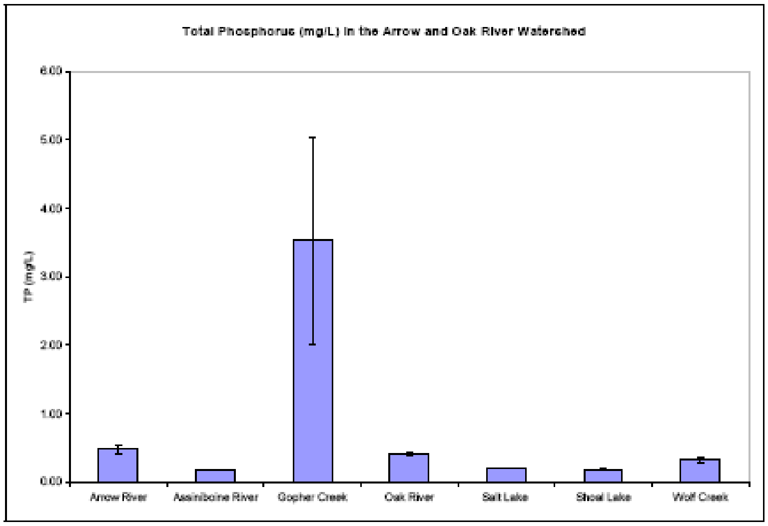


Figure 6: Total Phosphorus in the Arrow-Oak

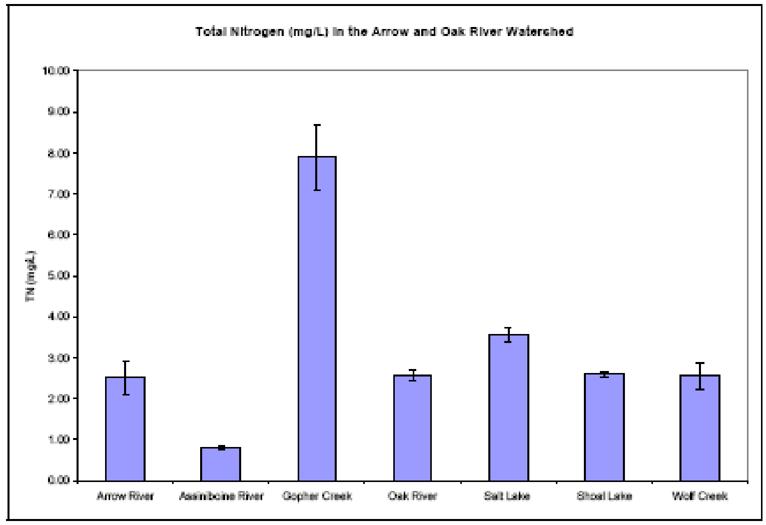


Figure 7: Total Nitrogen in Arrow-Oak

Recommended Actions

- There should be no net loss of semi-permanent sloughs, wetlands, potholes, or other similar bodies of water in the watershed within which drainage is occurring. Wetlands act as nutrient sinks and help reduce nutrient input to waterways.
- Ensure that drainage maintenance, construction, and re-construction occurs in an environmentally friendly manner, following best available technologies, and best management practices (BMPs) aimed at reducing impacts to water quality and fish habitat. Some key BMPs for drainage include:
  - Surface drainage should be constructed as shallow depressions and removal of vegetation and soil should be minimized during construction.
  - Based on Canada Land Inventory Soil Capability Classification for Agriculture, Class 6 and 7 soils should not be drained.
  - Removal of vegetation and soil should be kept to a minimum during the construction and placement of culverts.
  - Exposed areas along banks of surface drainage channels should be re-vegetated.
  - Erosion control methodologies outlined in the Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat should be used where the surface drain intersects with another water body and on both sides of culverts.
  - Discharge from tile drainage should enter a holding pond or wetland prior to discharging into a drain, creek, or river.
- Maintain healthy, natural riparian vegetated buffers along waterways. A strip of vegetation one to three metres wide should be maintained along drainage channels as a buffer. This will reduce erosion of channels and aid in nutrient removal.
- As proposed in the Nutrient Management Regulation under *The Water Protection Act*, no nutrients can be applied to lands that are designated as zone N4 for nutrients or in nutrient buffer zones as defined in the Regulation.
- Within our watershed, Gopher Creek was identified as the stream with the highest nitrogen and phosphorus levels. The Gopher Creek watershed should be targeted for nutrient reduction programs to improve water quality. The watershed could also serve as a pilot project for nutrient reduction programming across the wider watershed.

Ground Water[3]

Groundwater is water that fills the pores and fractures in the ground. At some point as water recharges the soil and moves down through the profile all of the pore space will be saturated. The surface where this occurs is called the water table. Not only must sediment or rock be saturated to recover groundwater, it must also be permeable enough to allow the water to move at a reasonable rate. Because these properties are largely controlled by the material the water is moving through the geology of the formations are important in understanding water movement. Additionally the natural water quality which the water acquires is highly dependent upon the materials it flows through.

Groundwater moves from higher elevation to lower elevation or from higher pressure to lower pressure. During recharge water moves vertically through the soil and shallow geologic horizons until it reaches the water table. Under ambient conditions, groundwater typically moves quite slowly. In a prairie pothole landscape, sloughs will focus recharge into localized flow systems. In these settings the water table may be high under the sloughs; the amount of recharge coming from sloughs will greatly depend upon the location of the slough in the landscape and the material underlying the slough.

A geologic formation from which economically significant quantities of water flows to a spring or can be pumped for domestic, municipal, agricultural or other uses is called an aquifer. Aquifers can be separated vertically by less permeable layers; layers that do not readily allow water flow or act as barriers to flow. These confining layers are called aquitards. In an unconfined aquifer the water table and consequently the amount of water in storage, changes over the seasons or longer climatic periods as water levels fluctuate in response to recharge or discharge from the aquifer.

Bedrock Aquifer

The Odanah member of the Pierre Shale Formation consists of brittle layers of rock separated by of softer clay layers, commonly bentonite. Fractures can form within the brittle layers which store and transmit water. The Odanah forms the uppermost bedrock unit beneath most of the watershed. The Odanah is present throughout the northern and western part of the watershed and has been eroded in parts of the south and southeast. The soft Millwood shale aquitard underlies the Odanah and forms the uppermost bedrock unit in areas where the Odanah has been eroded. For all practical purposes the Millwood formation does not transmit water. For potable groundwater exploration the top of the Millwood shale should adequately define the base of exploration throughout most of the watershed. Groundwater from bedrock below this will be increasingly saline and non-potable.

Wells completed into the Odanah shale range from a few metres below ground to approximately 100m depth. Water supply from these wells varies from place to place and ranges from less than adequate to more than adequate for most domestic needs. Driller's well test yields from the Odanah shale vary from less than 0.04 Ls^{-1} to more than 10 Ls^{-1} and averages 1.6 Ls^{-1}. The total

[3] Submitted by Manitoba Water Stewardship

dissolved solids (TDS) of the Odanah ranges from just over 300 to 12,000 mgL^{-1} and averages 2,160 mgL^{-1}. Higher TDS waters are present in an area between Shoal Lake and Hamiota and in the southern and western areas of the watershed. There is a general relationship of deeper wells tending to have higher dissolved solids although in some areas relatively shallow wells can have very high TDS.

The dissolved constituents primarily consist of sodium, (Na) calcium (Ca), magnesium (Mg), sulphate (SO_4), bicarbonate (HCO_3) and occasionally chloride (Cl). Higher TDS waters contain a proportionally greater amount of Na and Cl. Hardness ranges from 50 to 5,800 mgL^{-1} $CaCO_3$ (approximately 3 to 340 grains per gallon) and averages just under 500 mgL^{-1} $CaCO_3$. Iron and manganese range from less than detection to greater than 10 mgL^{-1} and greater than 2 mgL^{-1}, respectively, with average concentrations of 3.0 mgL^{-1} for iron and 0.6 mgL^{-1} manganese. This corresponds to almost 14% of the Fe (aesthetic objective = 0.3 mgL^{-1}) and 19% of the Mn (0.05 mgL^{-1}) sample results above the aesthetic value for drinking water quality. The following analytes are above the aesthetic guidelines for drinking water: 23% of the samples for sodium (500 mgL^{-1}), 13% for sulphate (500 mgL^{-1}), and 18% for chloride (250 mgL^{-1}). The Health-based limit was exceeded in 5% of 76 samples for nitrate (10 mgL^{-1} as N), 21% of 29 samples for coliform bacteria and 0% of the 29 E. coli samples. There are only two relatively comprehensive analysis including metals or other health-based parameters in the database. There were no other guideline exceedances for groundwater from the shale within the provincial database.

Valleys cut into the bedrock may contain permeable sediment. These valleys may be in-filled with Tertiary age sediments and/or Quaternary (glacial) sediments which may form aquifers. The glacial Assiniboine River has cut into the underlying bedrock during glacial melt; the lower portion has been in-filled with alluvial sediments. Other buried valleys have been partially traced within the watershed. Additional work on locating and mapping buried valleys is required to better define their properties.

Sand & Gravel Aquifers

Within glacial and recent sediments, aquifers are formed as sand and gravel within or at the base of glacial till, at the ground surface or near surface from glacial outwash or alluvial sand deposited from modern or ancient rivers. Most sand and gravel aquifers within the watershed consist of buried lenses of sand and or gravel (Figure 1). Unconfined sand aquifers are found in an area between Hamiota and Virden, around Virden, near Rivers and Beulah. The Oak Lake aquifer is present on the extreme southern part of watershed. There is an extensive buried aquifer between Rivers and Birtle going through Hamiota. There are large areas of the watershed where sand and gravel aquifers are sparsely distributed.

Well yield from sand and gravel aquifers is variable, and where aquifers are present is generally adequate for individual domestic uses. About two-thirds of the wells are reported to yield greater than 0.37 Ls^{-1} (5 gpm). The average reported well yield is 2.2 Ls^{-1} and there is potential in some aquifers for high capacity wells.

A relatively high percentage of groundwater samples from sand and gravel aquifers exceed one or more of the drinking water aesthetic objectives. Aesthetic objectives apply to constituents in the water that impart a taste, colour or odour that may affect the enjoyment or acceptance of that water. Sixty-one percent of 418 samples exceed the aesthetic objectives for iron (0.3 mgL^{-1}) and 72% of 391 samples exceeded the objective for manganese (0.05 mgL^{-1}). Drinking water guidelines for aesthetic objective was exceeded in 80% of the TDS (500 mgL^{-1}), 28% of the sodium (200 mgL^{-1}), 36% of the sulphate (500 mgL^{-1}), 7% of the chloride (250 mgL^{-1}) in the samples measured. There are approximately 20 relatively complete chemistry analyses in the database that include a comprehensive metal analysis. Of these results aluminum, antimony, barium, boron, cadmium, chromium, copper, uranium and zinc are all below drinking water guideline concentrations; 1% of 358 fluoride samples is above the guideline value of 1.5 mgL^{-1}, 3 of 23 samples for arsenic (0.010 mgL^{-1}), one of 21 for lead (0.01 mgL^{-1}), and 1 of 18 for selenium (0.01 mgL^{-1}) are above the health guidelines. The Health-based limit was exceeded in 9% of 387 samples analysed for nitrate (10 mgL^{-1} as N).

Total coliform bacteria are routinely detected in private well water. The presence of coliform bacteria is an indicator that the factors may exist where there are pathways for well water to be contaminated with water from the ground surface or from near surface. Thirty-two percent of 144 samples had detectable coliform bacteria. E. coli is an indicator of contamination from a faecal source; four percent of the 153 samples had measurable E. coli. Well owners that have had positive bacteria results need to assess their well for security and maintenance, and proximity to potential sources of contamination. Fact sheets are available from the province to help in sampling and interpreting the results of tests.

Groundwater Use

Driller logs specify the intended water use for new production wells. The well use can be recorded as a single or multiple uses. Within the Arrow/Oak River watershed there are 2,057 wells with a recorded well use. The well use consists of 1,130 domestic, 256 livestock, 551 combined domestic and livestock, 80 municipal, and 40 used for industry, air conditioning, irrigation and other uses. Over 80% of the wells provide water to private domestic applications (Figure 8).

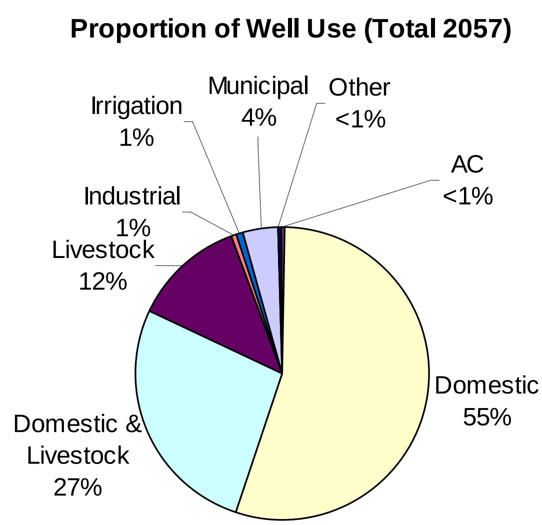


Figure 8: Proportion of production well use within the watershed: over 80% of the wells provide private domestic water supplies.

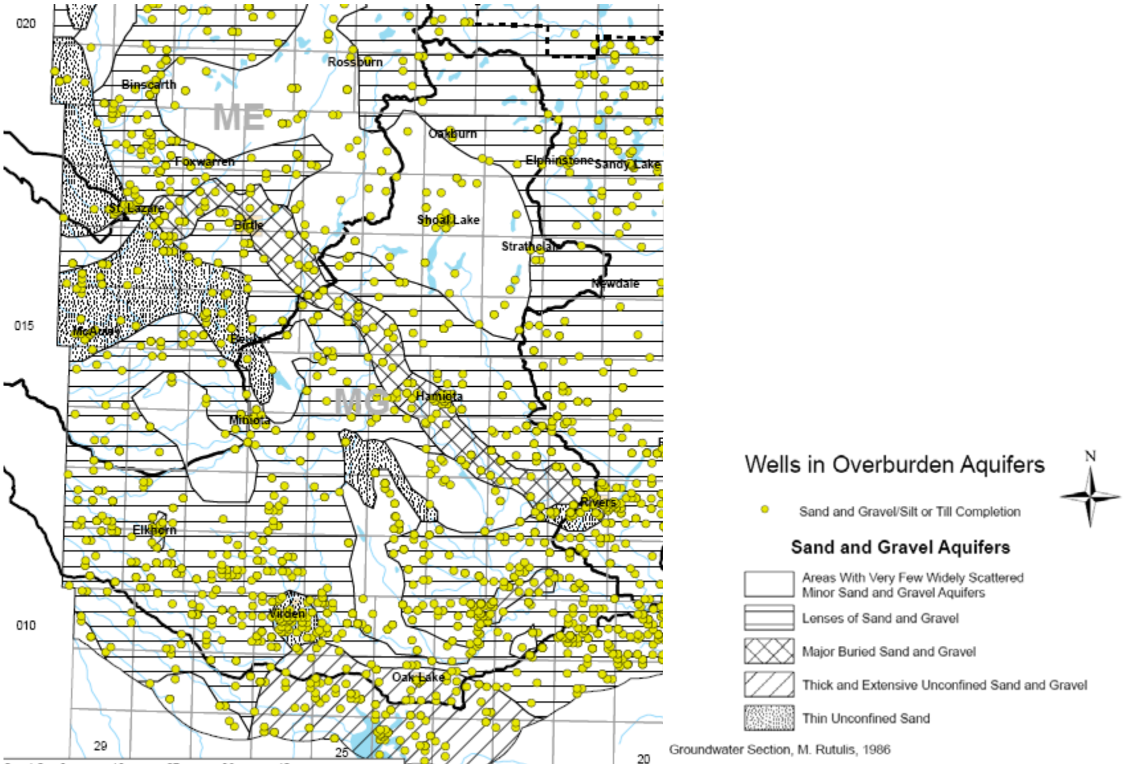


Figure 10: Diagram showing locations of wells completed into overburden material. Throughout most of the area overburden aquifers consist of buried lenses of sand and gravel. A thick unconfined aquifer cuts through the watershed at Hamiota; unconfined aquifers are present in the southern part of the watershed. Large areas of the watershed have sparse distribution of sand and gravel aquifers (after Rutulis 1986).

Management Concerns

1. Data Gaps

Groundwater forms the base flow to streams. When run off from the land surface ceases, the water sustaining the flow of the streams comes from groundwater. The contribution of base flow to streams and rivers has not been well quantified nor has any water quality impact from these waters. Regional scale stratigraphic and hydrogeologic mapping and compilation would be beneficial in providing an increased knowledge of the extent, properties and relationships between stratigraphy, aquifers and surface water.

The province has undertaken groundwater investigations within this watershed resulting in a number of test holes being completed; however, there currently are no groundwater monitoring points established. There is also a lack of information on many water quality parameters for some of the groundwater sources, including many solutes with drinking water guidelines. Well log and groundwater information is stored by the Groundwater Management Section, Manitoba Water Stewardship. Results from past well surveys indicate that only about half of the wells in service are recorded and the accuracy of the location of the majority of wells is to the quarter section on which it is drilled. The knowledge of accurate well location is an important step in identifying sites for future well sealing. The province does not have access to well surveys conducted by other organizations; additional information on wells and locations would be beneficial in managing the province's groundwater resources.

Recommended Actions/Actions Currently Underway

- A well inventory for the watershed should be completed. It should include GPS coordinates, information on well construction and rudimentary water quality.
- Comprehensive groundwater chemistry should be completed on wells selected during the well inventorying process.
- The Groundwater Management Section is committed to completing new set of digital maps based on the watershed scale.
- The Groundwater Management Section is currently evaluating the provincial monitoring well network to determine where there are redundancies or areas that could benefit from new or additional monitoring locations. This watershed will be included in that evaluation.

2. Wellhead Protection

Previous well surveys by Manitoba and other provinces show that well location, construction and maintenance are important factors in man-made water quality problems. Many of the parameters measured that lead to less than desirable potable water quality such as TDS or hardness, occur naturally and not the result of man's influence on the environment. However there are local impacts commonly measured in well water throughout the province.

Recommended Actions

- Owners of private wells should be encouraged to self-assess or have their well assessed for physical conditions that may affect water quality such as poor wellhead conditions, well construction, location or maintenance.
- Water testing should be encouraged for all drinking water sources on a regular basis.
- Well specific assessments should be conducted on community or municipal wells to determine the vulnerability during the development of well head protection policies. As a minimum the individual characteristics of each well, aquifer and geology should be considered to assess vulnerability.

3. Abandoned Wells

Wells are often located in areas of convenience, in the same general areas as potential contamination sources. Neglected, abandoned or unused wells can act as a direct conduit for contaminants from the surface to enter aquifers.

Recommended Action

- Abandoned wells should be sealed to lessen the potential spread of contaminants to an aquifer.

4. Sustainable Groundwater Development

Sustainable yield values are not available for aquifers in this area.

Recommended Actions

- High use groundwater withdrawals require assessment on an individual project basis.

Source Water Protection Assessment[4]

Drinking Water Background

Clean, potable drinking water is critical for human life and, therefore, a necessity for prosperous sustainable communities. Drinking water sources can be sorted into 3 types: public systems contain 15 or more service connections, semi-public systems contain less than 15 service connections but are not private systems (e.g. a school or hospital with it's own well), and private systems that supply water to only one private residence. The Arrow-Oak River Watershed contains 7 public drinking water sources (Table 1). No semi-public sources were identified and private sources were not examined, as comprehensive data is unavailable.

The Guidelines for Canadian Drinking Water Quality were established to provide an indication of drinking water quality from a health and aesthetic perspective. Some of these guidelines have been adopted as drinking water standards under Manitoba's Drinking Water Safety Act.

Table 6: Drinking Water Sources

Public Water Treatment Plant	Guidelines for Canadian Drinking Water Quality Health Exceedence	Guidelines for Canadian Drinking Water Quality Aesthetic Exceedence	Population Served (Approximate)
HAMIOTA		TDS	850
KENTON		TDS	300 (~60% on rural water pipeline)
OAK RIVER			200 (~20% on rural water pipeline)
SHOAL LAKE		TDS, Sulphate, Manganese, Sodium	800
STRATHCLAIR			300
VIRDEN	Arsenic	TDS, Iron, Manganese, Sodium	3100
WALLACE, R.M. of			450 (~65% on rural water pipeline)

As Table 6 shows, there is one public water source that exceeds the Guidelines for Canadian Drinking Water Quality and Manitoba's Drinking Water Quality Standard. The water for Virden exceeds the standard of 0.01 mg/L for arsenic. Since arsenic has been adopted as one of the drinking water quality standards in Manitoba, the water supplier has until March 1st, 2012, to meet the standard pursuant to Manitoba's drinking water regulations.

[4] Submitted by Manitoba Water Stewardship, Manitoba Water Services Board and Manitoba Conservation

Aesthetic quality guidelines are in place to address factors such as taste, odour and colour, which, although they do not affect human health, may affect public acceptance of drinking water. Four water sources exceed the aesthetic guidelines for Canadian Drinking Water Quality for parameters such as Total Dissolved Solids (TDS), iron, sulphate, manganese, and sodium. Since aesthetic guidelines are in place to ensure public acceptance of drinking water and not to protect human health, these aesthetic exceedences should be considered lower priority issues.

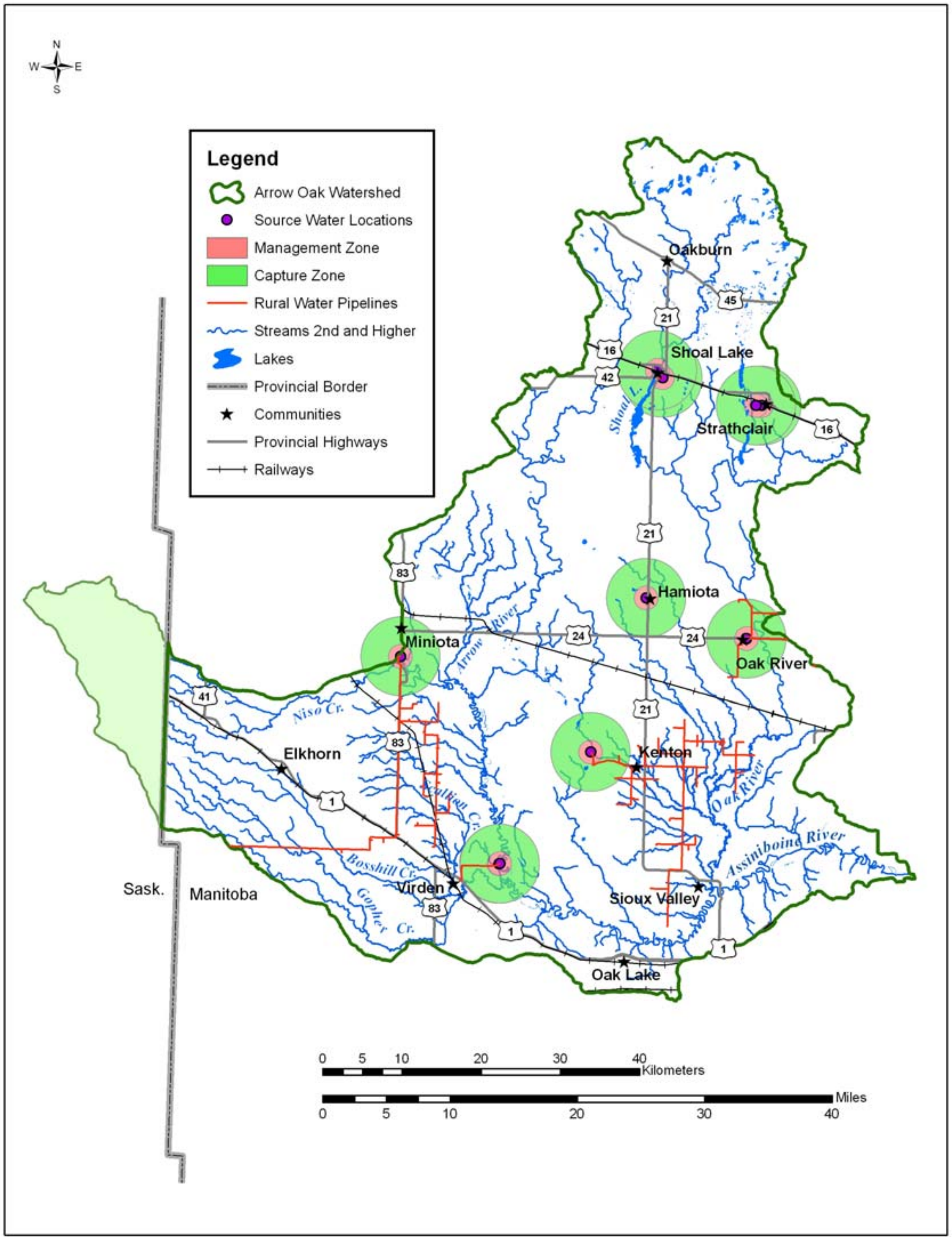


Figure 11: Drinking Water Sources

Potential Pollutants

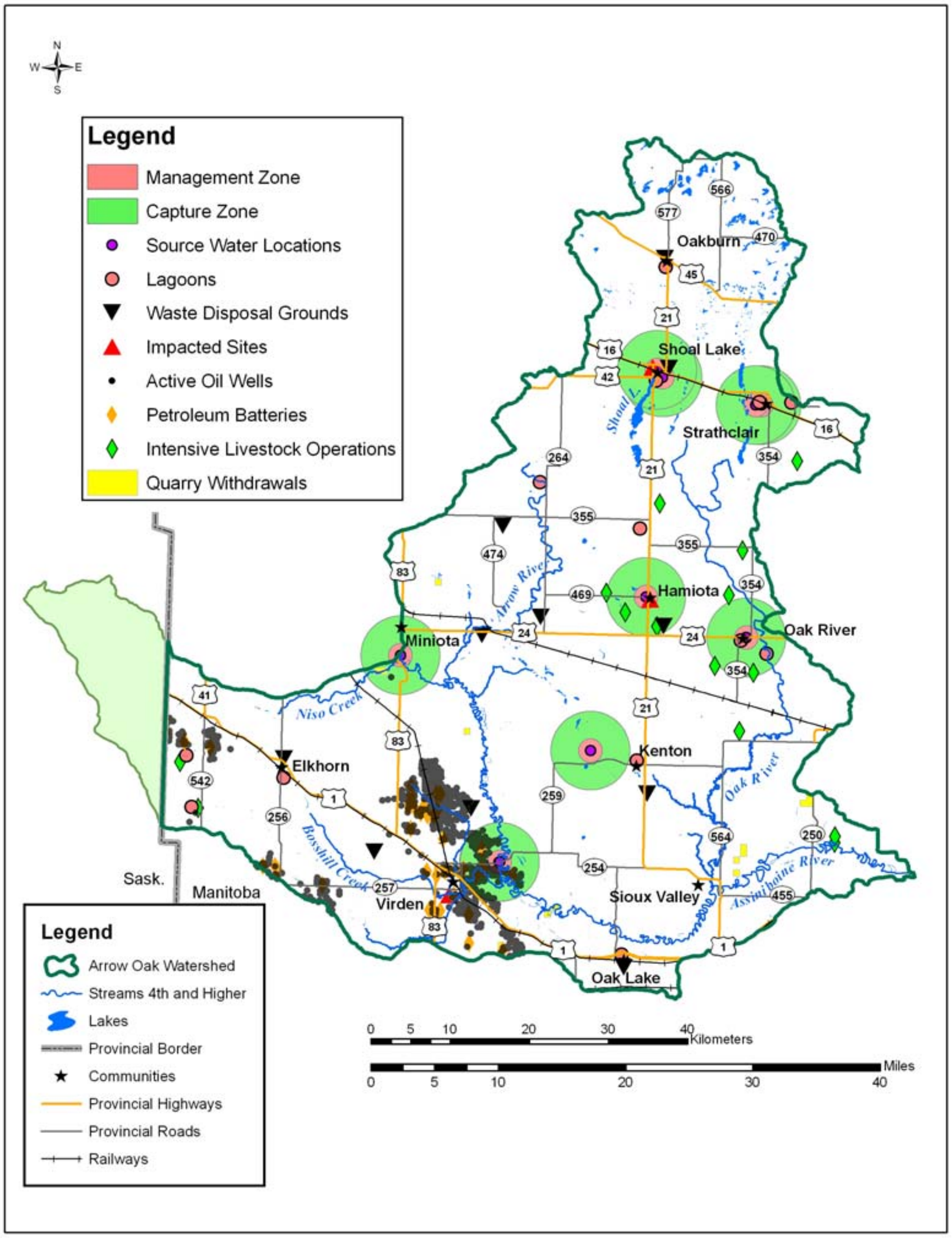


Figure 12: Potential Pollutants

It is an accepted fact that drinking water must be of a high quality – nobody wants to drink water that tastes odd or may negatively impact our health. Unfortunately, many human activities and natural processes on the landscape can, or potentially can, impact the quality of our drinking water sources. It is impossible to capture all of the potential risks to drinking water quality; this section attempts to capture those potential threats that are most serious or most likely to pose a hazard to drinking water sources.

It is important to recognize that when a potential pollutant risk exists the best solution may not necessarily be to just eliminate the risk. For example, a highway upstream of drinking water intake poses a potential risk from a spill of hazardous goods, this does not mean that the highway should be closed – a comprehensive spill response plan could be sufficient to protect the drinking water source, and human health, from any contamination.

It is also critical to remember that the management of a given operation (waste disposal ground, intensive livestock operation, oil well or other facility) is as important as the presence of the operation. A well managed operation which operates according to beneficial management practices (BMPs) is low risk even if it is large. A poorly managed operation which does not follow BMPs is higher risk even if it is small.

Trends

- Upgrading of treatment and distribution facilities throughout the watershed to comply with provincial regulations
- Rural water pipelines are becoming more common
    - Moving from private sources to a public source – it becomes easier to ensure drinking water standards are adhered to

Management Concerns

1. Drinking Waters Exceeding the Guidelines for Canadian Drinking Water Quality related to Health

Within the Arrow-Oak River watershed, one public water supply exceeded the health based guidelines or standard. Virden's water exceeded the level of 0.01mg/L for arsenic. Under current regulations this municipality has until March 1, 2012 to comply with the standard for arsenic established under the Drinking Water Safety Act.

Recommended action

- An engineering assessment is required in order to determine how best to address the high levels of arsenic and comply with provincial regulations

2. Drinking Water Susceptibility

One of the key factors that affect drinking water quality is the quality of the untreated water at the intake location. This source water will naturally vary in quality due to natural processes; the potential also exists for human activities to introduce pollutants, bacteria, and pathogens, which may harm human health.

A standardized methodology has been adopted for the province of Manitoba, which will allow for relative comparison of susceptibility of drinking water sources across the province. It is important to note that this method only checks for the presence of a potential pollutant in proximity to a water source. It is not a measure of risk, different levels of risk are associated with different potential pollutant sources - further investigation is required in order to determine risk levels.

Table 7: Drinking Water Susceptibility

Public Water Source	**Source**	**Well Type**	**Drinking Water Susceptibility**	**Factors Impacting Susceptibility Rating**
HAMIOTA	well	Confined	Medium	Disturbance, highways x4, impacted sites, waste disposal grounds, intensive livestock operations x2
KENTON	well	Unconfined	High	Disturbance, unconfined aquifer in management zone
OAK RIVER	well 2	Confined	Medium	Disturbance, wastewater treatment lagoon x2, intensive livestock operation, highway
	well 3	Confined	Medium	Disturbance, wastewater treatment lagoon x2, intensive livestock operation, highway
SHOAL LAKE	primary well 2	Confined	Medium	Highway x7, railway, impacted site, waste disposal grounds, wastewater treatment lagoon
	back-up well 1	Confined	Medium	Highway x7, railway, impacted site, waste disposal grounds, wastewater treatment lagoon
STRATHCLAIR	well 1	Confined	Medium	Disturbance, highway, railway, waste disposal grounds, wastewater treatment lagoons x2
	well 2	Confined	Medium	Disturbance, highway, railway, waste disposal grounds, wastewater treatment lagoons x2
VIRDEN	well 1	Confined	Low	Petroleum storage battery x3, highway, Oil well x133, ozonation (-1 rating)
	well 2	Confined	Low	Petroleum storage battery x3, highway, Oil well x133, ozonation (-1 rating)
RURAL MUNICIPALITY OF WALLACE	well	Confined (?)	Medium	Quarries x3, highways x2, oil well, wastewater treatment lagoon, waste disposal grounds

NOTE: All uncertain status wells (?) are assumed to be unconfined for the purposes of assessment

It is critical to recognize that a high or moderate susceptibility rating does not mean that water from these sources is unsafe. The source water protection assessment only indicates the relative susceptibility of the water source to pollution that may not be fully treated all of the time. Thus, a water source, which is rated with a high susceptibility, is not unsafe to drink; it is simply subject to more potential pollutants than a moderate or low susceptibility water source.

Recommended action

- Kenton's water supply was identified as being highly susceptible – a more detailed assessment should be done for this water source
- Steps should be taken to address the potential pollutant sources for each water source
- Obtain more detailed data on the identified potential pollutant sources

Data Gaps

- The susceptibility rating does not include any measure of probability from indicators – it simply checks for the presence of indicators – probability information would lend greater precision to Source Water Protection Assessment
- All semi-public water sources in the watershed should be identified
- Many potential pollutant sources in the watershed could not be identified and located, for example, location of septic fields/tanks, storm water outfalls, petrochemical/chemical storage, livestock access to water sources

Habitat[5]

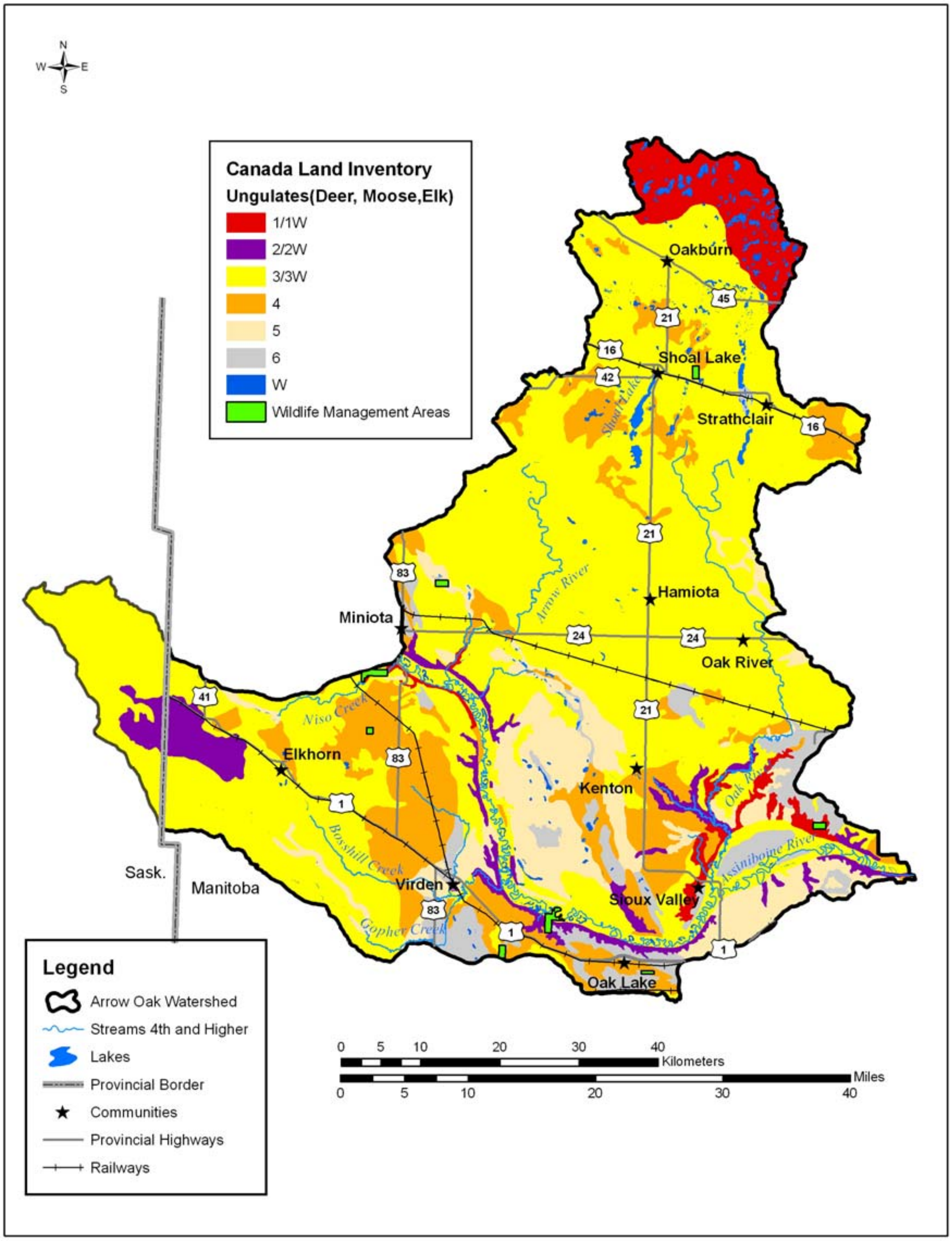


Figure 13: Habitat Suitability

[5] Submitted by Manitoba Conservation, Ducks Unlimited Canada, Manitoba Water Stewardship, Manitoba Habitat Heritage Corporation and Canadian Wildlife Service

The Canada Land Inventory Classification (CLI) System is a measure of the quality of habitat for ungulate populations (Figure 1). The CLI system also provides a good indication of upland habitat quality in general.

Native Wildlife Species

The Oak River Watershed provides important habitat for a diversity of wildlife species. White Tailed deer is the most common and populous ungulate species in the watershed, while elk, and moose also commonly inhabit portions of the watershed. Populations of ungulates are generally considered healthy and support both eco tourism and hunting opportunities. Black Bear inhabit the watersheds however population estimates for bear are difficult to determine although the population is generally considered to be healthy and expanding in some areas. A variety of furbearers including beaver, muskrat, coyote, red fox, timber wolves, mink, fisher (and others) are found within the watersheds as well as numerous small mammals. In excess of 200 bird species can be found in the aspen parkland region.

Non-Native Species

Invasive species are plants, animals, or other organisms that are growing out of their country or region of origin and are out-competing or even displacing native organisms. These “unwanted invaders” have become a major threat to the world’s ecosystems, and Manitoba’s lands and waters are no exception. In addition to environmental damage, invasive terrestrial plants (weeds) such as leafy spurge cost Manitobans millions of dollars each year in control, management, decreased land values and lost agricultural production. These plants are more competitive than native plants and are often the first to colonize disturbed lands. They can be spread or introduced by global and regional movement of goods and people via air, rail, water, or roads. In particular, waterways are a main conduit for spread of invasive plants because herbicide restrictions near water limit control options, and water has the ability to carry seeds long distances to new areas. For these reasons it is important to leave areas near water as undisturbed as possible.

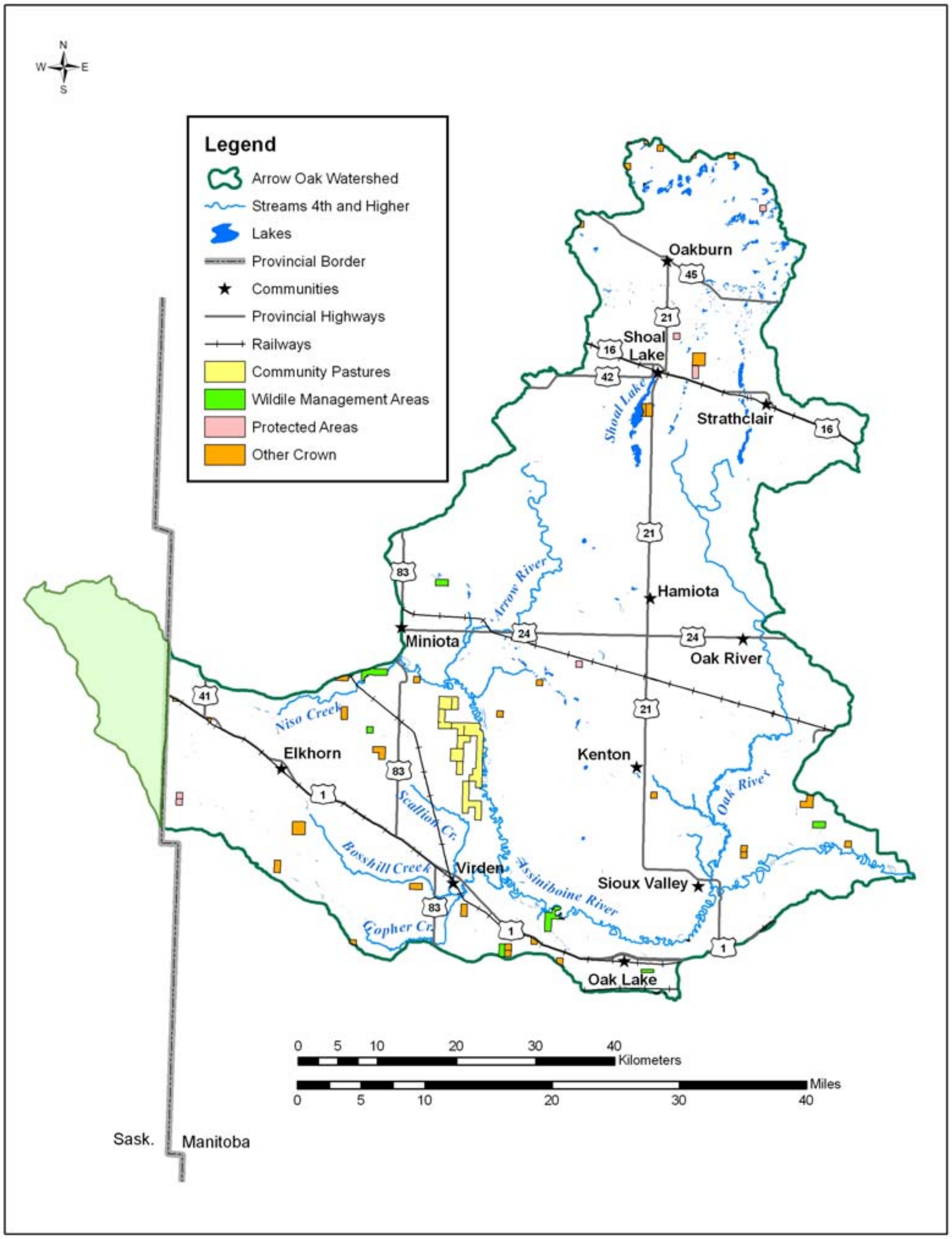


Figure 14: Crown Lands

Crown Lands

Private and public lands provide key wildlife habitat within the watersheds. The crown owns approximately 1 % of the land within the watershed. Crown land uses include community pastures, provincial parks, and wildlife management areas. Of the 18,360 acres of crown lands, 7,200 acres is in community pastures, 4,600 acres is for other agriculture use and 5,500 acres is designated for use by wildlife.

Rare, Threatened and Endangered Species

The Manitoba Conservation Data Centre is Manitoba's authoritative source for information on plant, animal and native plant communities that are rare, threatened or endangered species. There have been 76 occurrences where species at risk have been sighted in the watershed, 35 being plant records (affecting 23 species), 38 animal records (seven species), two snake hibernacula and one native plant communities. Animal species that have been sighted are – Baird's Sparrow, Burrowing Owl, Sprague's' Pipit, Ferruginous Hawk, Loggerhead Shrike and Mule Deer. Plant communities include the Dakota Skipper, Smooth Goosefoot and Western Spiderwort. Figure 15 illustrates the areas of where these occurrences have taken place. The majority of these occurrences have occurred in the Routledge and Oak Lake sandhills area of the watershed.

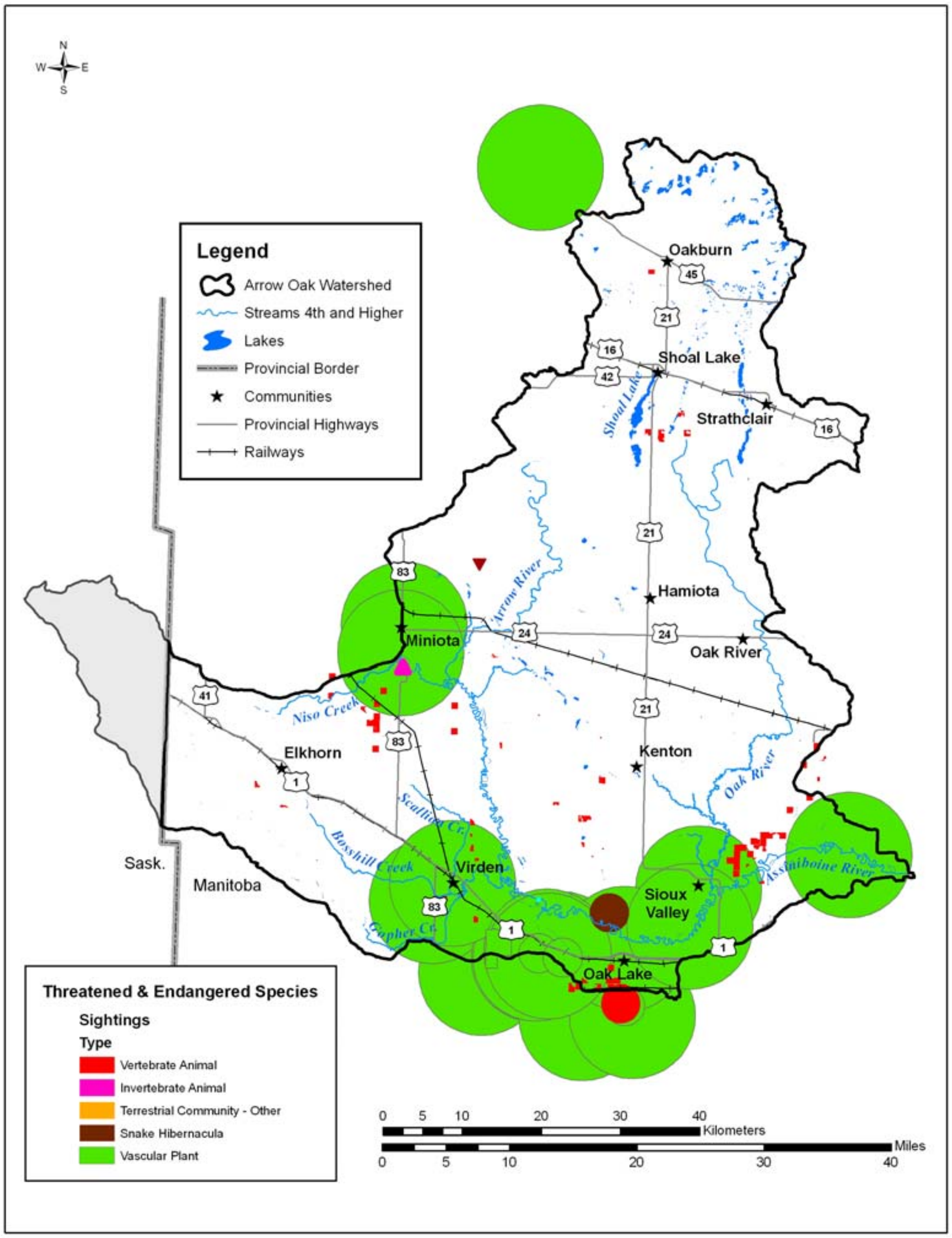


Figure 15: Rare, Threatened and Endangered Species

Riparian Habitats

Riparian areas are key areas for protecting watershed health. These transitional areas between upland and water bodies/waterways provide a variety of functions in a watershed. They provide key habitat for wildlife and play an important role with respect to movement of wildlife. The maintenance/ protection of connective habitat, such as riparian areas and other habitat corridors between larger habitat areas, is important for the maintenance of wildlife populations.

Key indicators for riparian habitat are the loss of natural vegetation and stream bank erosion; unfortunately, very little riparian data exists for the watershed. There are 1,620 miles of waterways in the watershed and 77% of these are Class 1-3 waterways. To get an approximation of the land cover that exists along the waterways in the watershed, a quick land cover analysis was conducted along a 50 m buffer of the waterways. This study revealed that 32 % of the waterways riparian areas are cropland, 48 % have grassland and 9 % woodland cover. Further work is needed to assess the condition of natural vegetation as well as determine areas where vegetation has been lost and is currently subject to erosion. Given the total length of waterways in the watershed and the impact healthy riparian areas have on overall watershed health, actions will need to be prioritized based on potential threat and benefit to watershed health.

Wetlands

Wetlands are depressions on the landscape that retain water for varying periods of time. There are different types and sizes of wetlands ranging from small, shallow temporary wetlands to deep, large permanent wetlands. Each type of wetland plays a significant role in the ecology of the watershed and it is very important to maintain the appropriate mixture of these wetland types to maintain the ecological function of the watershed. Temporary and seasonal wetlands typically hold water for only a week to couple of months, yet are very important to waterfowl as they warm up first in the springtime and provide a valuable food source for waterfowl. They also provide much needed pair space in the springtime for breeding waterfowl. The deeper semi-permanent and permanent wetlands typically hold water for the duration of the growing season/year round and provide much needed brood rearing water for breeding waterfowl as well as safe areas to stage and moult.

In addition to providing habitat for fish, waterfowl and wildlife, wetlands provide a variety of functions and benefits to the watershed. Wetlands improve water quality by filtering 70-90 % of sediment, nutrients and bacteria from receiving waters. They also assist in reducing the impacts of flood and drought by capturing water and releasing it slowly. Wetlands also allow water to percolate through soils and recharge groundwater supplies.

A 1986 wetland inventory conducted by Ducks Unlimited Canada (DUC) revealed that there are approximately 60,000 wetland basins in the watershed covering an area of about 95,500 acres. Most of these wetlands (78%) are quite small; under 2 acres in size, however, the larger wetlands (>2 acres in size) comprise most of the wetland area (74%).

To assist in identifying areas that are key to waterfowl on the prairies, DUC developed a GIS based statistical model. This model generates a map of estimated breeding pairs per square mile (Figure 16). This model shows that 65% of the watershed has an estimated breeding pair density of 20 pairs/mi^2 or greater, making this watershed very important to the continental breeding population of waterfowl.

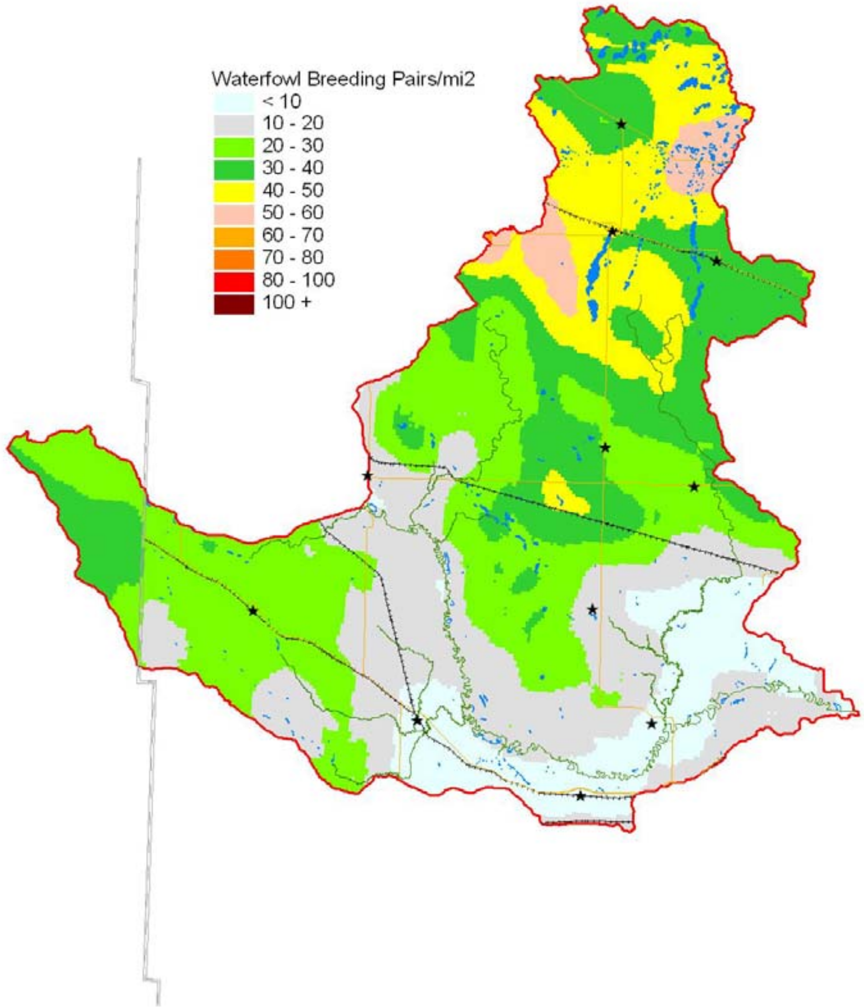


Figure 16: Waterfowl Breeding Density

Fisheries

In this watershed, four lake aeration systems on Shoal Lake 1 and 2, Kenton Reservoir and Patterson Lake, have been installed to create recreational fisheries on water bodies that have been impacted by human activities. Numerous other water bodies are stocked on a regular basis with indigenous fish species or salmonoids. These stocked and aerated lakes provide significant recreational and economic opportunities.

Five COSEWIC listed fish species are known to be present in this watershed and they are Lake Sturgeon, Maple Leaf Mussel, Silver Chub, Chestnut Lamprey and Big Mouth Buffalo.

Data Trends

- There are a variety of data sets available to assess the trend in habitat. At the watershed scale, the Ag Census data provides a good estimate of landscape change. This data suggests that there has been roughly a 50 % loss of native habitats in the area from 1951 to 2001.

- Wetland habitat loss and degradation is highly variable across the landscape and the quantity of wetland areas impacted fluctuates over time. Current, detailed wetland loss studies suggest that 70% of wetlands on the prairies have been either lost or degraded.
- A CWS study from 1985-2002, indicates an average wetland loss of 6 % in transects taken in our Assiniboine 4 watershed study area during this time period.
- Recent studies by Ducks Unlimited Canada found that from 1968 to 2005 64% of wetlands in the Smith Creek (Shell River watershed) and 76% of wetlands in the Broughton's Creek sub-watersheds (Little Saskatchewan watershed) have either been lost or degraded.
- A further cause of concern is that not only has a significant portion of native habitat already been lost on the landscape, but evidence suggests that this loss is continuing. Despite efforts from a variety of conservation agencies, the current rate of habitat loss exceeds the rate of preservation and restoration.

Management Concerns

1. Habitat loss, fragmentation and degradation

Numerous studies and sources indicate a significant portion of wildlife including aquatic habitats have been lost or degraded, and that this loss continues at a rate greater than preservation and restoration efforts. Preserving a mosaic of interconnected habitat in the watershed is the key to maintaining biodiversity.

Recommended Actions

- **Habitat restoration and retention** – Actions should be taken to preserve and restore native habitat throughout the watershed. Prioritization should be given to key fish, waterfowl and wildlife, as well as habitat which support rare, threatened and endangered species.
- Efforts should be made to ensure that corridors are available and that habitat is not preserved in isolated blocks.

2. Loss & Draining of Wetlands

Presently drainage is occurring without regard for ecological significance of wetlands. In addition to the negative ecological consequences, these uncoordinated drainage activities have negative implications for water quality and quantity.

Recommended Actions

- **Adopt a no net-loss of wetlands policy in the watershed –** A majority of the naturally occurring wetlands in our watershed have already been lost and existing wetlands continue to see losses due to drainage and in-filling. Preventing further loss of wetlands is important to maintain ecological and hydrological function in the watershed. It is ultimately a better approach to protect existing wetlands now vs. restoring them in the future. This policy should be incorporated into the existing drainage licensing process.

3. Riparian Habitat

Presently, there is very little information on the condition of riparian areas for the watershed. As well, there are concerns with the encroachment and elimination of riparian habitat by human activities. As a result, nutrient and sediment loading has increased and many water bodies are experiencing accelerated eutrophication and related problems (algae blooms, summer and winter fish kills). Another riparian concern is the ongoing channelization and drain maintenance in this watershed. The increase in speed and water volumes result in bank erosion on receiving water courses and it is also facilitating the transport of nutrients and sediments. This is exacerbated by the naturally rolling terrain in this watershed.

Recommended Actions

- **Riparian Assessment –** Actions should be taken to conduct a watershed-wide riparian assessment, to identify areas in need of restoration or management. Priority should be given to source water areas, important recreational water bodies and key fish habitat waterways.
- **Riparian Management –** Define objectives for maintaining healthy riparian areas. Priorities should be given to source waters, key fish, waterfowl and wildlife areas, areas which support rare, threatened and endangered species, as well as areas identified in the riparian impact assessment study outlined above. Attention should be given to drain maintenance and channelization activities to ensure adequate vegetation is maintained to prevent soil erosion and subsequent nutrient and sediment transport.

4. Aquatic Ecosystem Health

There is concern that natural and human induced changes to the quantity and timing of water flow are altering and impairing the health and sustainability of aquatic and riparian ecosystems. Specifically, some of the streams in our watershed are suffering from periods of low water flow which fall below the historical flows for the stream at specific times of year. These shortfalls of water influence all components of the ecosystem from highly visible sport fish such as Walleye or Northern Pike down to aquatic insects and micro-organisms. Water flow can vary due to a number of causes including natural variations in weather and long-term shifts in climate. Water flow is also modified by anthropogenic activities such as water withdrawals and land use activities, land drainage and water impoundment, that alter the timing and quantity of water flow.

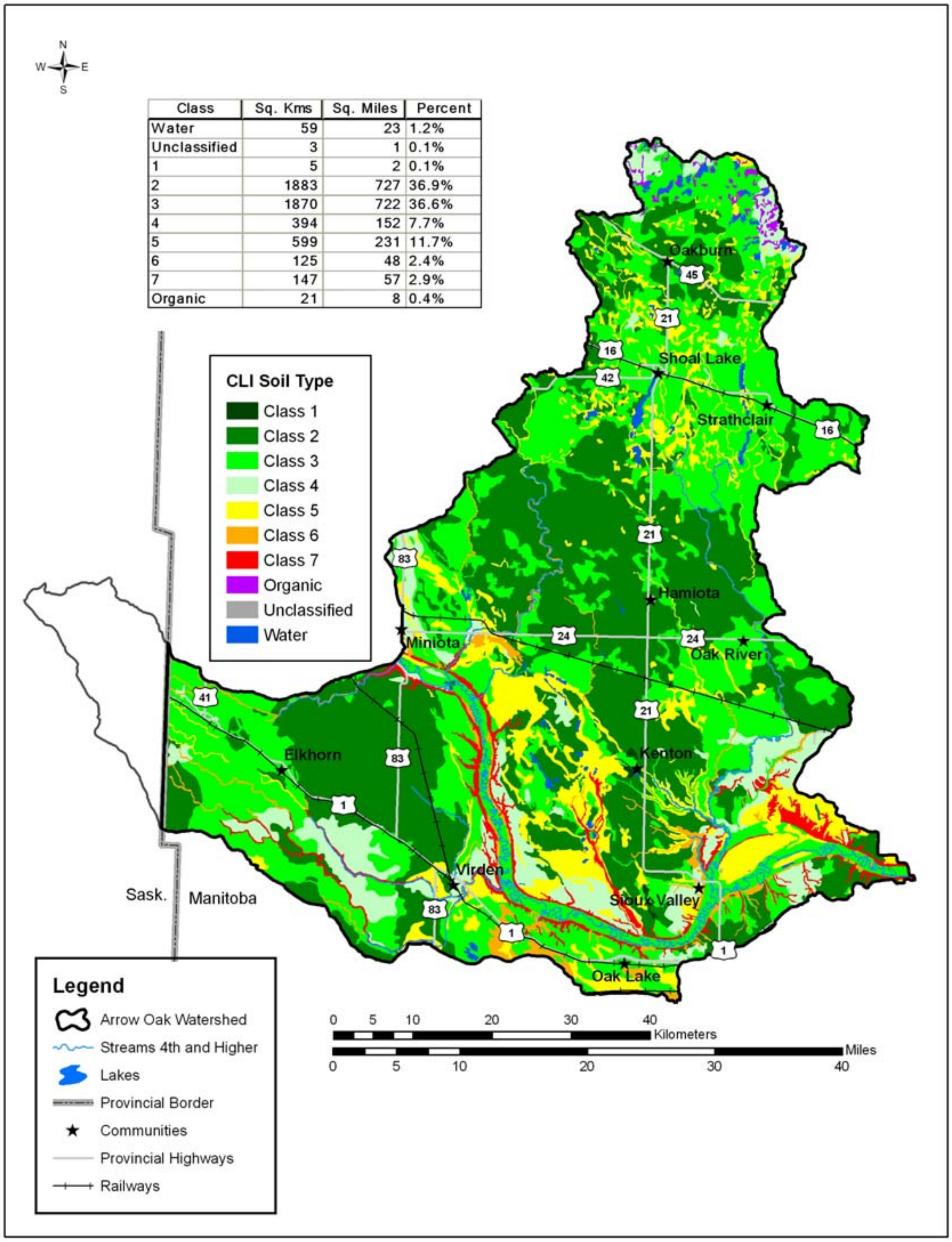
Recommended Actions

- In-stream flow needs assessments should be done on all major watercourses in the watershed – the Arrow and Oak Rivers should be high priorities. These assessments should go beyond providing single annual targets for in-stream flow needs and instead provide targets on a seasonal or monthly basis so that use of the water resources can more closely mimic a natural system.

Data Gaps

- Detailed invasive species data is not available for the watershed
- Detailed information on riparian habitat is unavailable

Soils[6]



Class	Sq. Kms	Sq. Miles	Percent
Water	59	23	1.2%
Unclassified	3	1	0.1%
1	5	2	0.1%
2	1883	727	36.9%
3	1870	722	36.6%
4	394	152	7.7%
5	599	231	11.7%
6	125	48	2.4%
7	147	57	2.9%
Organic	21	8	0.4%

Figure 17: Agricultural Suitability

---

[6] Submitted by Manitoba Agriculture, Food and Rural Initiatives and Prairie Farm Rehabilitation Administration

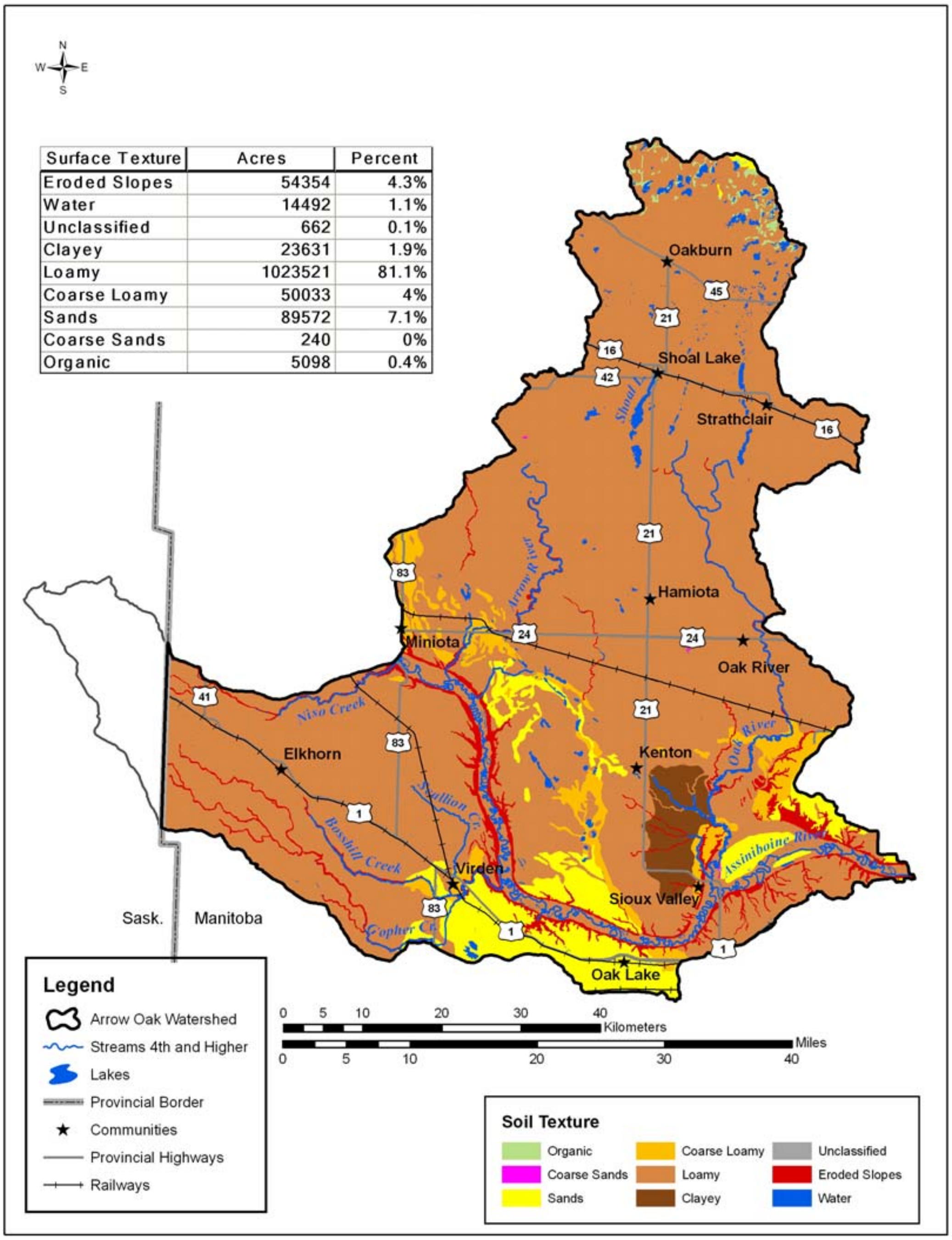
NOTE: "Riparian Areas Most at Risk of Soil Erosion" Submitted by the Conservation Districts as members of the Watershed Planning Advisory Team

Agricultural Capabilities

Agricultural capability is best described as the ability of the land to support the production of agricultural crops. Not all land can be used in the same manner and it varies according to soil type, topography, stoniness, soil moisture deficiency, and low fertility, to name only a few of the potential limitations. Classes have been established and range from one to seven, with class one offering the highest potential productivity and class seven offering the lowest potential productivity (Figure 17).

Soil Surface Texture

Soil surface texture strongly influences the soil's ability to retain moisture, its general level of fertility, and the ease or difficulty of cultivation. Sandy soils are often characterized by a loose or single-grained structure which is very susceptible to wind erosion. On the other hand, clay soils have a high proportion of very small pore spaces which hold moisture tightly. Clay soils are usually fertile because they are able to retain plant nutrients better than sandy soils; however, they transmit water very slowly and are therefore susceptible to



Surface Texture	Acres	Percent
Eroded Slopes	54354	4.3%
Water	14492	1.1%
Unclassified	662	0.1%
Clayey	23631	1.9%
Loamy	1023521	81.1%
Coarse Loamy	50033	4%
Sands	89572	7.1%
Coarse Sands	240	0%
Organic	5098	0.4%

Figure 18: Surface Soil Texture

excess moisture conditions.

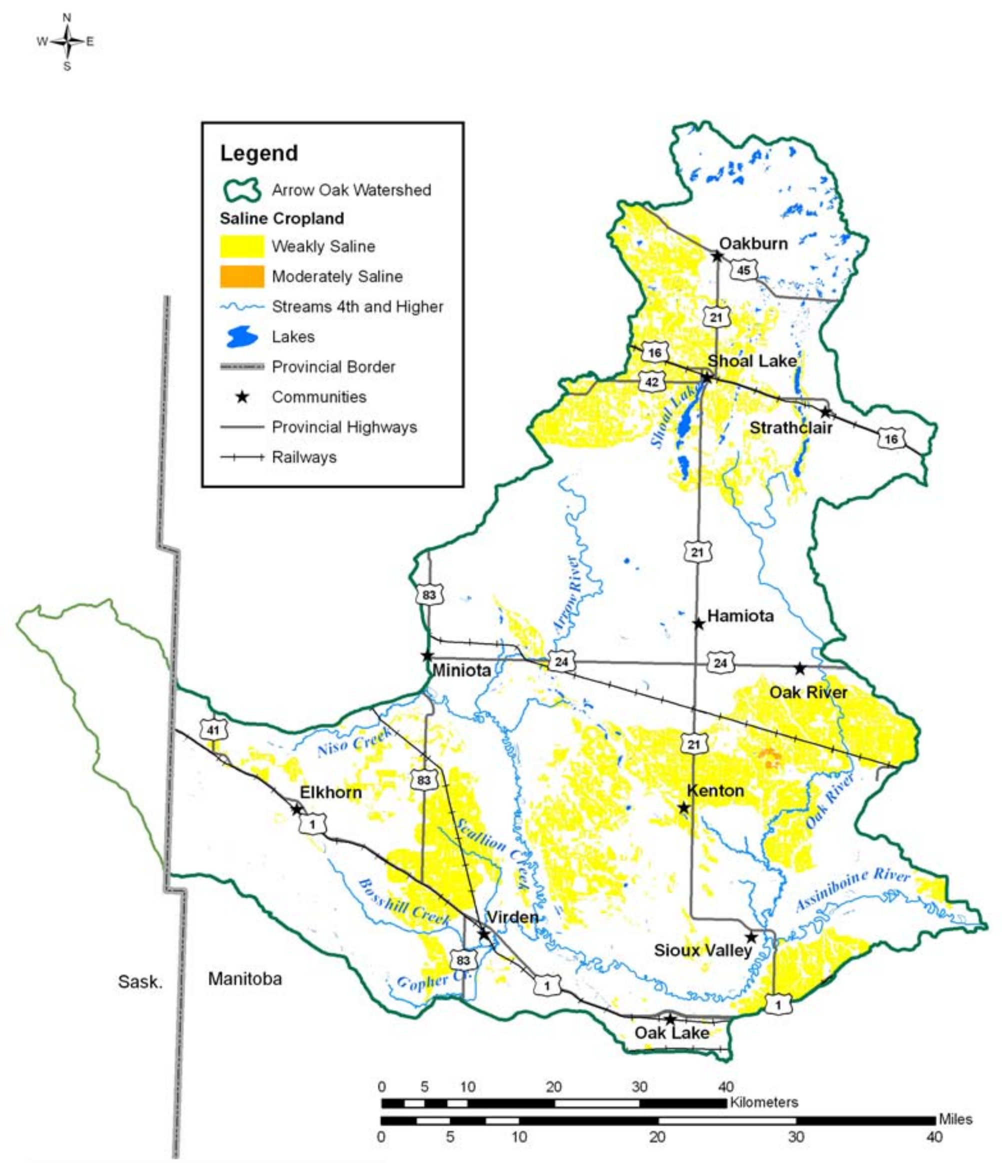
The predominant soil surface texture within the watershed is loamy (77%). Loamy soil is a mixture of clay, silt, and sand particles. Sandy soils account for 7% of the soils in the study area and are located at the south end of the watershed along the Assiniboine River and what is considered to be the Arrow River Hills. Erodible slopes make up 4% of the lands found within the watershed and are located along the Assiniboine River valley walls and associated waterways.

Management Concerns

1. Soil Salinity

Soil salinity is a limitation where plant growth is reduced due to the presence of soluble salts in soil. These soluble salts hold water more tightly limiting the ability of plants to extract water from the soil. As a result, many plants will exhibit symptoms of droughtiness, even when the soil is relatively moist.

Currently 207,283 acres of weakly saline land is in annual crop production, weakly saline soils are located in the pothole regions around Shoal Lake, an area extending between the Elkhorn Virden area, and an area situated between the Lenore – Kenton in the eastern portion



Level	Acres	Percent
Weakly Saline	206,621	16.38%
Moderately Saline	662	0.05%

Figure 19: Soil Salinity on Cropland

of the watershed area. The presence of moderately saline soils tends to be located north of Bradwardine in an area that has imperfectly drainage. Salinity is an increasing problem within the watershed in recent years. Salinity problems are also influenced by the weather; however the problems can be more evident in both dry and wet years.

Recommended Actions

- Efforts should be made to encourage landowners to convert saline prone areas to permanent cover, which will reduce water movement to the soil surface.
- Use saline tolerant species (wheat grasses, clover, alfalfa, etc) that will gradually reduce salt levels in identified saline areas.
- Within identified saline areas, offer incentive programs that i) reduce on farm drainage of the prairie potholes, ii) encourage the development of buffer establishment around wetlands, iii) and incentives to maintain wetland complexes.
- Adoption of zero-till or conservation tillage practices in wetter areas will help reduce salts moving up the soil profile.

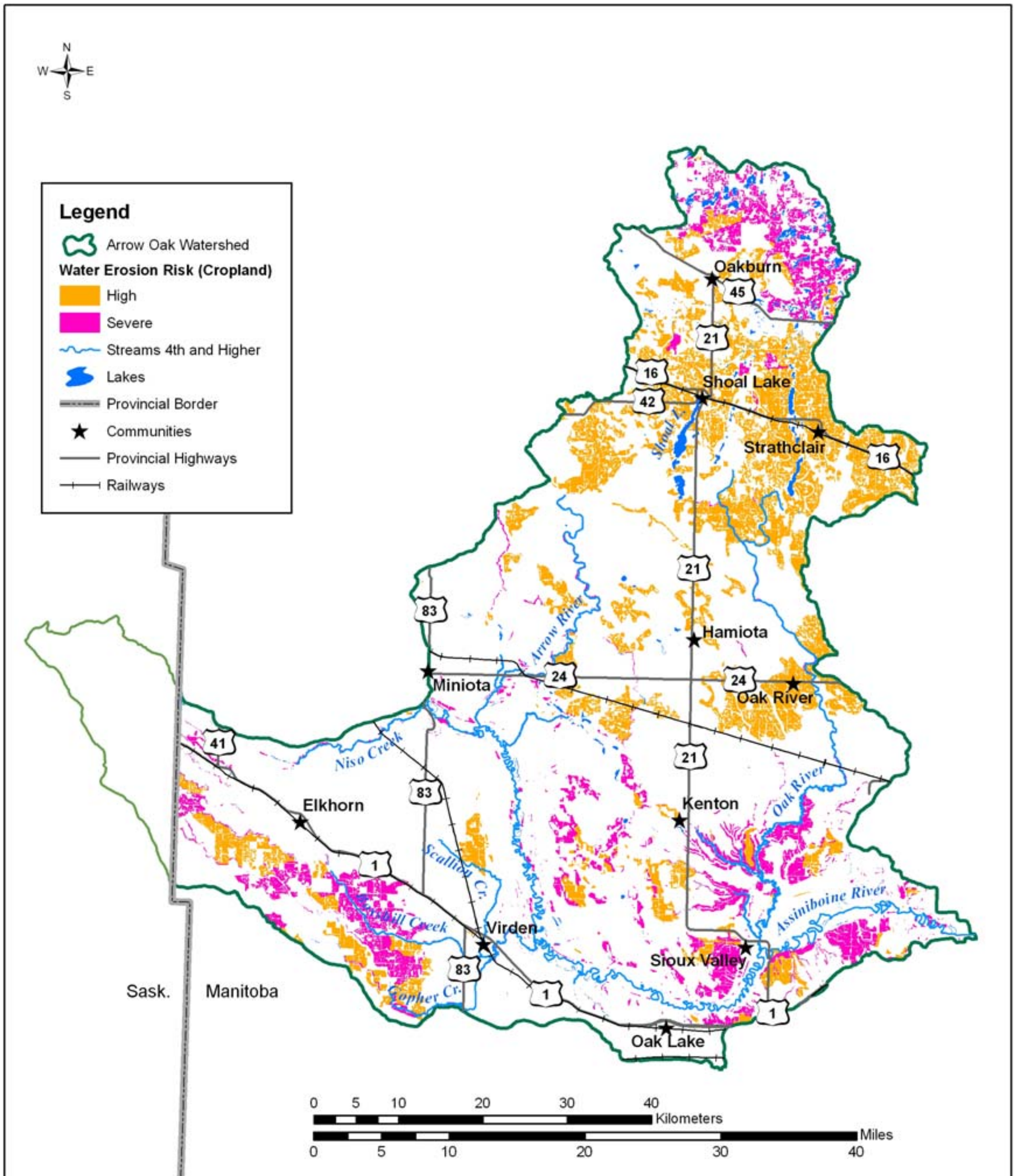
2. Water Erosion

Water erosion is the removal of soil particles by water. Water erosion often removes topsoil, the soil layer best fitted to support life. Any reduction in the quantity of topsoil reduces the soil's ability to produce a crop by reducing its fertility and its ability to accept and store water and air. Water laden with eroded soil or sediment has negative consequences for aquatic life and downstream infrastructure.

According to the water erosion risk classification for bare soils, water erosion can be a concern within this watershed. Approximately 238,217 acres of the watershed are classified as cropland having a high to severe risk for water erosion. Areas with severe risk are found mainly along the Assiniboine River Valley walls, along some of the tributaries, and the northern portions of the watershed where there is a rolling type of topography. It is important to note that water erosion risk is based upon bare soil, management practices such as zero till, or conversion to permanent cover will significantly reduce the risk of erosion.

Recommended Actions

- Surface water management and ephemeral wetland retention is important in reducing flood peaks and stream bank and streambed erosion. Overly rapid land drainage may result in downstream flooding and erosion.
- Consider establishing grassed runways in areas where water erosion has been noted or significant slope exists.
- Riparian areas should be managed in order to minimize stream bank erosion.
- Adopt conservation tillage practices to protect the soil surface.
- Consider the establishment of permanent cover – sensitive areas may be taken out of annual crop production for forage production, pasture production, or as a set aside for non-agricultural uses. It may be most beneficial to establish permanent cover on headlands or at points where soil and water are likely to exit the property.



Risk	Acres	Percent
High	160,679	12.7%
Severe	77,538	6.1%

Figure 20: Water Erosion Risk Map

3. Wind Erosion

Wind erosion is the removal of soil particles by wind. Wind erosion removes topsoil, the most exposed to wind and the soil layer best fitted to support life. Any reduction in the quantity of topsoil reduces the soil's ability to produce a crop by reducing its fertility and its ability to accept and store water and air.

The majority of the Arrow-Oak watershed is at low or negligible risk to wind erosion. There are, however, some significant areas the south on sandy soils, which are at high to sever risk of wind erosion. There are approximately 53,604 acres of cropland that fall under the category of high or severe wind erosion risk. It is important to note that this wind erosion risk is based upon bare soil, management practices such as zero till, or conversion to permanent cover will significantly reduce the risk of erosion.

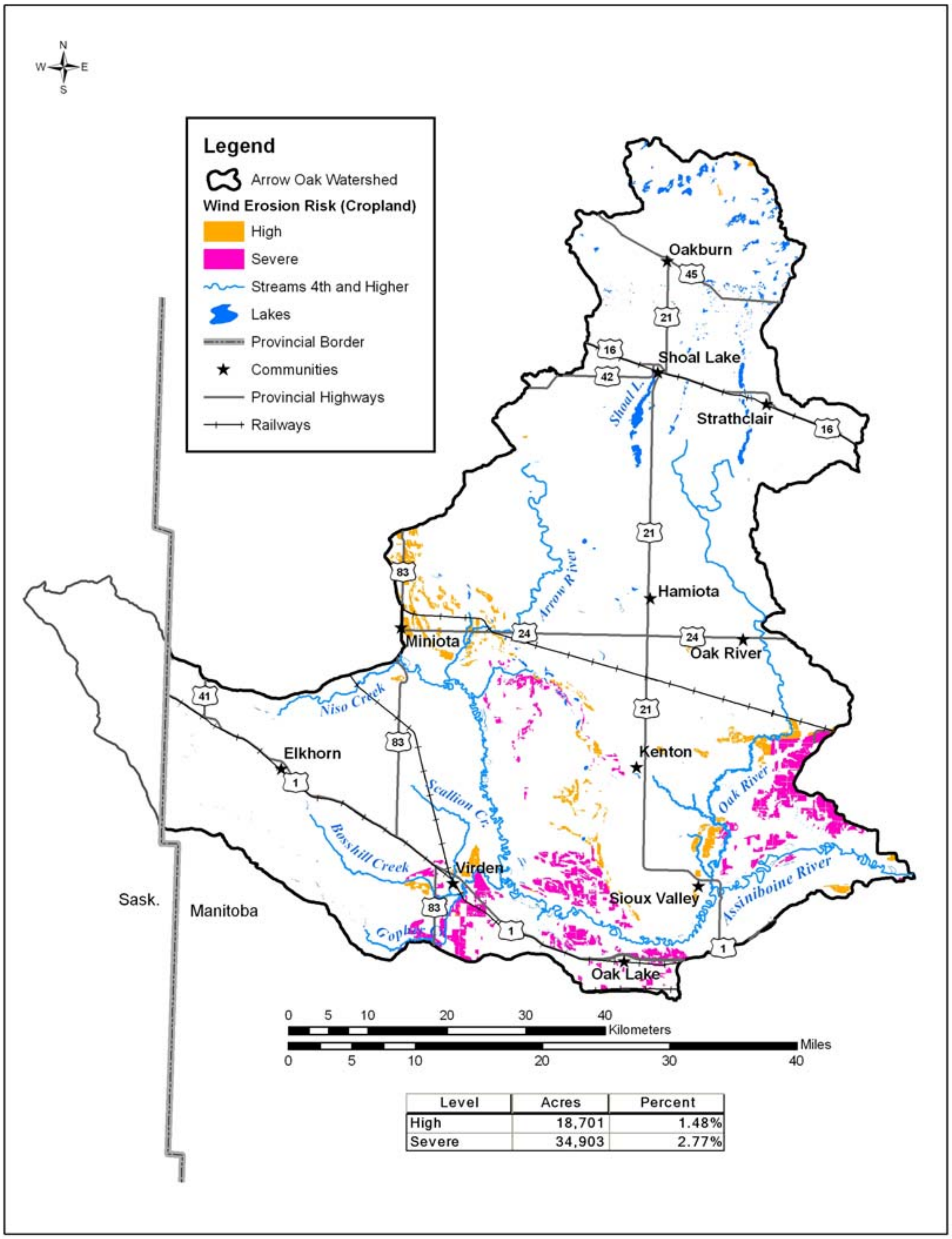


Figure 21: Wind Erosion Risk Map

Recommended Actions

- Maintain adequate crop residue cover (at least 35% cover just after seeding for most soils, and at least 65% cover for soils highly susceptible to soil erosion) - standing stubble is 1.6 times more effective at controlling wind erosion than flat stubble.
- Establish cover crops, such as fall rye. If it is not feasible to plant a cover crop on the entire field, plant on headlands (field perimeter), or on/beside the most susceptible areas
- Establish shelterbelts to reduce wind erosion by reducing wind velocity in the area. Shelterbelts should be planted perpendicular to prevailing winds. If planting shelterbelts in the middle of a field is not feasible due to equipment access, consider planting shelterbelts on the north and west edges of the field perimeter to reduce the effects of prevailing winds.

Riparian Areas most at Risk of Soil Erosion

In our watershed, the vast majority of stream flow occurs during the spring freshet, and a large number of smaller streams are dry for the remainder of the year. This analysis captures the streams which are most at risk to in-stream erosion by highlighting streams which flow through cropland areas which are also subject to high/severe water erosion risk and do not have sufficient riparian buffers in place.

Water laden with eroded soil or sediment has negative consequences for aquatic life and downstream infrastructure. Soil erosion will also contribute to nutrient loading in a watercourse. Currently there are approximately 37 miles of the waterways that have been identified as being at high risk of erosion (Figure 22).

It should be noted that this analysis is a new approach to capture the convergence of land use, water erosion risk, streams, and riparian buffers; with the intent of identifying areas which most urgently require riparian buffers. These target areas were selected by first extracting the streams which flow through areas identified as “cropland” (initially using satellite imagery) and then further refined by selecting only stretches of streams that flow through areas identified as being at high or severe risk of water erosion. Finally, aerial photos were used to verify that the stream actually flows through cropland and did not have any type of riparian buffer present. Since this is a new type of analysis, it should be utilized carefully and with adequate ground truthing before making programming decisions.

Recommended Actions

- Ensure that all streams, including small intermittent streams, have sufficient cover in the waterways
- Ensure that vegetated buffers appropriate to stream size are maintained and restored

Data Gaps

- All maps are based upon reconnaissance level soil information. Reconnaissance level data is not sufficient for site-specific analysis. When utilizing this existing data ground-truthing is required before making programming decisions.

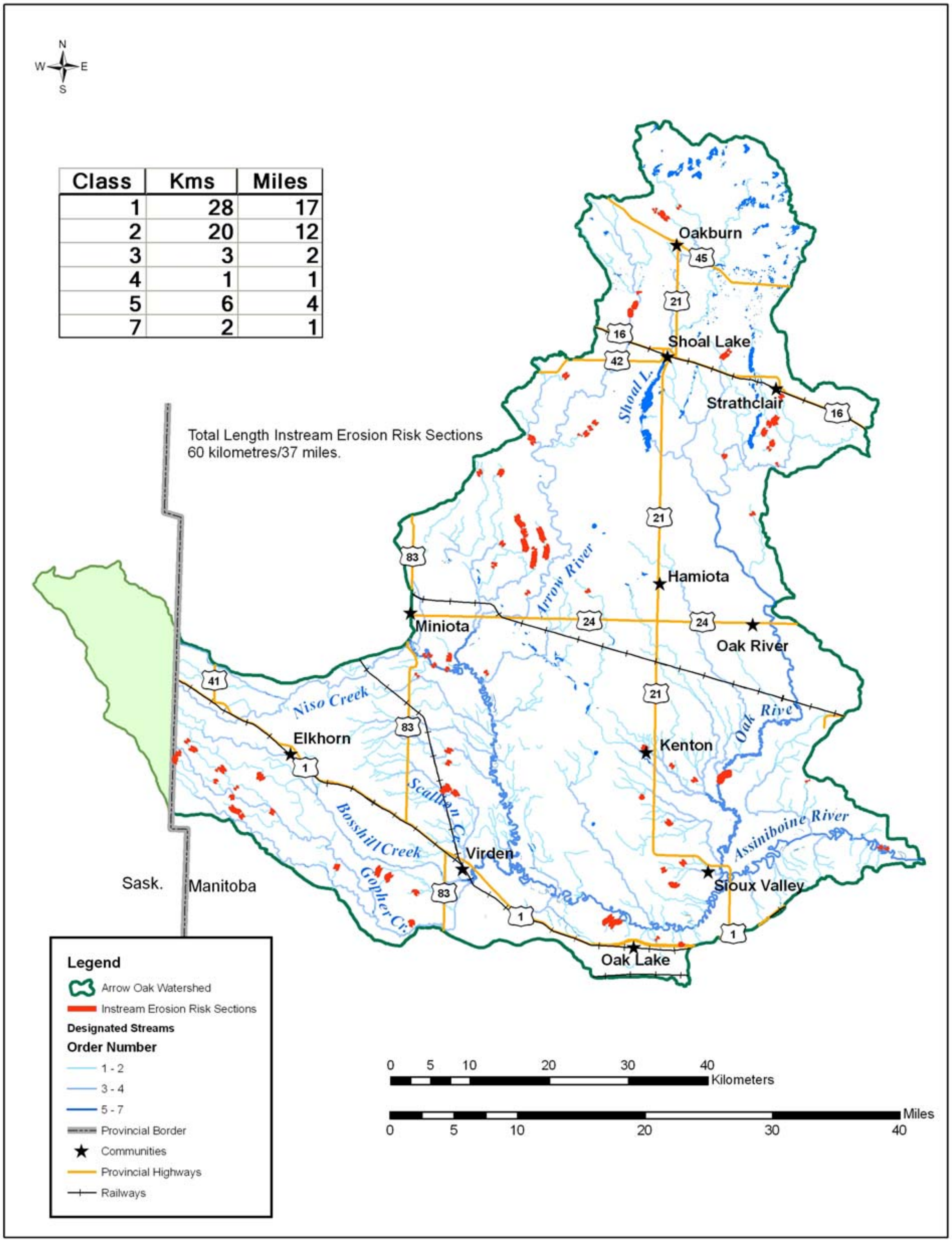


Figure 22: In-stream erosion risk map

Summary of Resource Management Concerns & Recommended Actions

A. Surface Water

1. Surface Water Management and Drainage

Currently water has largely been managed at the farm or individual field scale, often without any form of comprehensive long-term planning. Stakeholders in the IWMP process should consider developing a Surface Water Management Plan.

Recommended Actions

- A surface water management plan should be developed through a partnership with all stakeholders in the watershed.
- Prominent issues to be considered in the plan should include: flood protection for the town of Strathclair, management of the water levels on Salt Lakes, and flooding on the Oak River.

2. Nutrient Enrichment

Nutrient enrichment is one of the most important water quality issues in Manitoba. Excessive levels of nitrogen and phosphorus fuel the production of algae and aquatic plants. Since the early 1970's, phosphorus loading has increased by about 10 % to Lake Winnipeg and nitrogen loading has increased by about 13 %. As part of the Lake Winnipeg Action Plan, the Province of Manitoba is committed to reducing nutrient loading to Lake Winnipeg to those levels that existed prior to the 1970's.

Recommended Actions

- There should be no net loss of semi-permanent sloughs, wetlands, potholes, or other similar bodies of water in the watershed within which drainage is occurring. Wetlands act as nutrient sinks and help reduce nutrient input to waterways.
- Ensure that drainage maintenance, construction, and re-construction occurs in an environmentally friendly manner, following best available technologies, and best management practices (BMPs) aimed at reducing impacts to water quality and fish habitat. Some key BMPs for drainage include:
    - Surface drainage should be constructed as shallow depressions and removal of vegetation and soil should be minimized during construction.
    - Based on Canada Land Inventory Soil Capability Classification for Agriculture, Class 6 and 7 soils should not be drained.
    - Removal of vegetation and soil should be kept to a minimum during the construction and placement of culverts.
    - Exposed areas along banks of surface drainage channels should be re-vegetated.

    - Erosion control methodologies outlined in the Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat should be used where the surface drain intersects with another water body and on both sides of culverts.
    - Discharge from tile drainage should enter a holding pond or wetland prior to discharging into a drain, creek, or river.
- Maintain healthy, natural riparian vegetated buffers along waterways. A strip of vegetation one to three metres wide should be maintained along drainage channels as a buffer. This will reduce erosion of channels and aid in nutrient removal.
- As proposed in the Nutrient Management Regulation under *The Water Protection Act*, no nutrients can be applied to lands that are designated as zone N4 for nutrients or in nutrient buffer zones as defined in the Regulation.
- Within our watershed, Gopher Creek was identified as the stream with the highest nitrogen and phosphorus levels. The Gopher Creek watershed should be targeted for nutrient reduction programs to improve water quality. The watershed could also serve as a pilot project for nutrient reduction programming across the wider watershed.

B. Ground Water

1. Data

Current lack of data regarding the location of wells (active or abandoned), contribution of groundwater to stream base-flow, aquifer delineation and groundwater quality poses challenges in the understanding and management of groundwater.

Recommended Actions/Actions Currently Underway

- A well inventory for the watershed should be completed. It should include GPS coordinates, information on well construction and water quality.
- Comprehensive groundwater chemistry should be completed on wells selected during the well inventorying process.
- The Groundwater Management Section is committed to completing new set of digital maps based on the watershed scale.
- The Groundwater Management Section is currently evaluating the provincial monitoring well network to determine where there are redundancies or areas that could benefit from new or additional monitoring locations. This watershed will be included in that evaluation.

2. Wellhead Protection

Well location, construction and maintenance are important factors in man-made water quality problems; there are local impacts commonly measured in well water throughout the province.

Recommended Actions

- Owners of private wells should be encouraged to self-assess or have their well assessed for physical conditions that may affect water quality such as poor wellhead conditions, well construction, location or maintenance.

- Water testing should be encouraged for all drinking water sources on a regular basis.
- Well specific assessments should be conducted on community or municipal wells to determine the vulnerability during the development of well head protection policies. As a minimum the individual characteristics of each well, aquifer and geology should be considered to assess vulnerability.

3. Abandoned Wells

Wells are often located in areas of convenience, in the same general areas as potential contamination sources. Neglected, abandoned or unused wells can act as a direct conduit for contaminants from the surface to enter aquifers.

Recommended Action

- Abandoned wells should be sealed to lessen the potential spread of contaminants to an aquifer.

4. Sustainable Groundwater Development

Sustainable yield values are not available for aquifers in this area.

Recommended Action

- High use groundwater withdrawals require assessment on an individual project basis.

C. <u>Source Water Protection</u>

1. Drinking Waters Exceeding the Guidelines for Canadian Drinking Water Quality related to Health

Within the Arrow-Oak River watershed, one public water supply exceeded the health based guidelines or standard. Virden's water exceeded the level of 0.01mg/L for arsenic.

Recommended action

- An engineering assessment is required in order to determine how best to address the high levels of arsenic and comply with provincial regulations

2. Drinking Water Susceptibility

There are 11 public water sources in the watershed – Kenton's water supply was identified as being highly susceptible to potential pollution.

Recommended action

- Kenton's water supply was identified as highly susceptible – a more detailed assessment should be done for this water source
- Steps should be taken to address the potential pollutant sources for each water source

- Obtain more detailed data on the identified potential pollutant sources

D. Habitat

1. Habitat loss, fragmentation and degradation

Habitat loss continues at a rate greater than preservation and restoration efforts.

Recommended Action

- Preserve and restore native habitats throughout the watershed. Priority should be given to key fish, waterfowl, and wildlife habitats, as well as those habitats that support rare, threatened, and endangered species.
- Efforts should be made to ensure that corridors are available and that habitat is not preserved in isolated blocks.

2. Loss & Draining of Wetlands

Presently draining of wetlands is occurring without regard to ecological significance. In addition to the negative ecological consequences, these uncoordinated drainage activities have negative impacts to water quality and quantity.

Recommended Action

- **Adopt a no net-loss of wetlands policy in the watershed –** A majority of the naturally occurring wetlands in our watershed have already been lost and existing wetlands continue to see losses due to drainage and in-filling. Preventing further loss of wetlands is important to maintain ecological and hydrological function in the watershed.

3. Riparian Habitat

Riparian areas are being lost through encroachment by human activity.

Recommended Actions

- Conduct a watershed-wide riparian assessment, to identify areas in need of restoration or management. Priorities should be given to source water areas, important recreational water bodies, and key fish habitat.
- Establish, maintain, or improve vegetative cover in riparian areas. Priority should be given to source waters, key fish, waterfowl, and wildlife areas, areas which support rare, threatened, and endangered species, as well as areas identified in the riparian impact assessment study outlined above.
- Actions should be taken to determine the ecological in-stream flow needs of the Little Saskatchewan River to ensure the ecological health of this watercourse is maintained.

4. Aquatic Ecosystem Health

There is concern that natural and human induced changes to the quantity and timing of water flow are altering and impairing the health and sustainability of aquatic and riparian ecosystems. Specifically, some of the streams in our watershed are suffering from periods of low water flow which fall below the historical flows for the stream at specific times of year.

Recommended Actions

- In-stream flow needs assessments should be done on all major watercourses in the watershed – the Arrow and Oak Rivers should be high priorities.

E. Soils

1. Soil Salinity

Currently 207,283 acres of weakly saline land is in annual crop production.

Recommended Actions

- Encourage conversion of saline areas to permanent cover.
- Use saline tolerant species that will gradually reduce salt levels in soil in identified saline areas.
- Offer incentive type programs that reduce on farm drainage of the prairie potholes, encourage the development of buffer establishment around wetlands, and maintain wetland complexes.
- Promote adoption of zero-till or conservation tillage practices.

2. Water Erosion Risk

Approximately 238,217 acres of the watershed are classified as cropland having a high to severe risk for water erosion

Recommended Actions

- Surface water management and ephemeral wetland retention is important in reducing flood peaks and stream bank and streambed erosion.
- Establish grassed runways in areas where water erosion has been noted or significant slope exists.
- Riparian areas should be managed in order to minimize stream bank erosion.
- Adopt conservation tillage practices to protect the soil surface.
- Consider the establishment of permanent cover – sensitive areas may be taken out of annual crop production for forage production, pasture production, or as a set aside for non-agricultural uses.

3. Wind Erosion

There are approximately 53,604 acres of cropland that are at high or severe wind erosion risk in the watershed.

Recommended Actions

- Maintain adequate crop residue cover.
- Establish cover crops.
- Establish shelterbelts.

4. Riparian Areas most at Risk of Soil Erosion

There are approximately 37 miles of the waterways that have been identified as being at high risk of erosion.

Recommended Actions

- Ensure that all streams, including small intermittent streams, have sufficient cover in the waterways
- Ensure that vegetated buffers appropriate to stream size are maintained and restored

Thank you for taking the time to review this document. Your comments are extremely valuable to us. We have included this sheet to capture your comments, after reading the document, please consider the following points, record your thoughts and submit them to us.

1. What are the resource management concerns most important to you?
2. Why and where are they a concern to you?
3. What do you feel we should be doing in our management plan to address these concerns?