Arrow and Oak River Watershed
Water Quality Report

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Surface water quality data have been collected by the Water Quality Management Section, Manitoba Water Stewardship, to address various issues within the Arrow and Oak River Watershed. Surface water quality data are collected primarily to: 1) assess long-term, ambient water quality trends at routinely monitored sites, and 2) assess ambient water quality through short-term, intensive studies and activities. Results of water chemistry collected from the Arrow and Oak River Watershed represent data that were generated from both long-term water quality site, and from short-term, issue-driven studies. While water quality samples have been collected fairly consistently from some sites, other data collections in the watershed are not as continuous or consistent in either date range, or chemistry. For the purposes of this State of the Watershed Report, the following water quality data and/or comparisons have been analyzed and presented:

- 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

Long-Term Trends - Surface Water Quality

Two long term monitoring stations were initiated in this watershed in 2006; the Oak River four miles west of Wheatland and the Assiniboine River at Highway 21 north of Griswold. There is also a long-term water quality station on the Assiniboine River with a longer historical record, downstream of the watershed at Brandon that is monitored by Manitoba Water Stewardship. Long-term water quality monitoring began at Brandon in 1970. The frequency of sampling reflects the purpose of monitoring water chemistry for long-term changes and trends over the period of record. Water samples were collected and analyzed for a wide range of water chemistry variables at the long-term monitoring station including pesticides, metals, nutrients, general chemistry and bacteria.

In 2001, total phosphorus (TP) and total nitrogen (TN) from all the long-term water quality stations in the province were analyzed for trends using a relatively complex statistical model (Jones and Armstrong 2001). The model identified trends in concentrations of TP and TN after accounting for variations due to river flow. The Assiniboine River at Brandon was included in the 2001 analysis.

TP did not show a statistically significant increasing trend in concentration on the Assiniboine River at Brandon ($p=0.2290$) from 1970 to 1999 (Figure 1). However, TN did show a statistically significant increasing trend ($p=0.0147$, Figure 2).

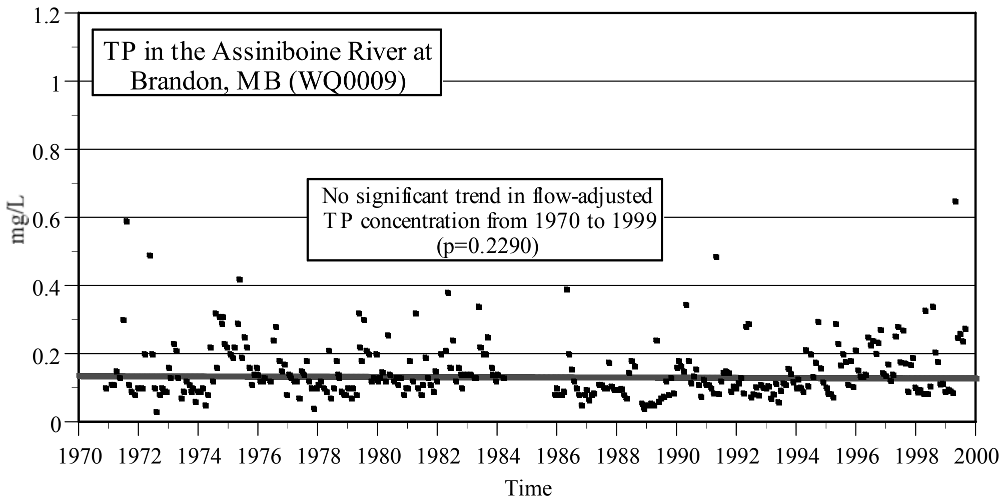


Figure 1: Total phosphorus (TP) in the Assiniboine River at Brandon. The % change in median concentration refers to the median concentration of flow adjusted trend line.

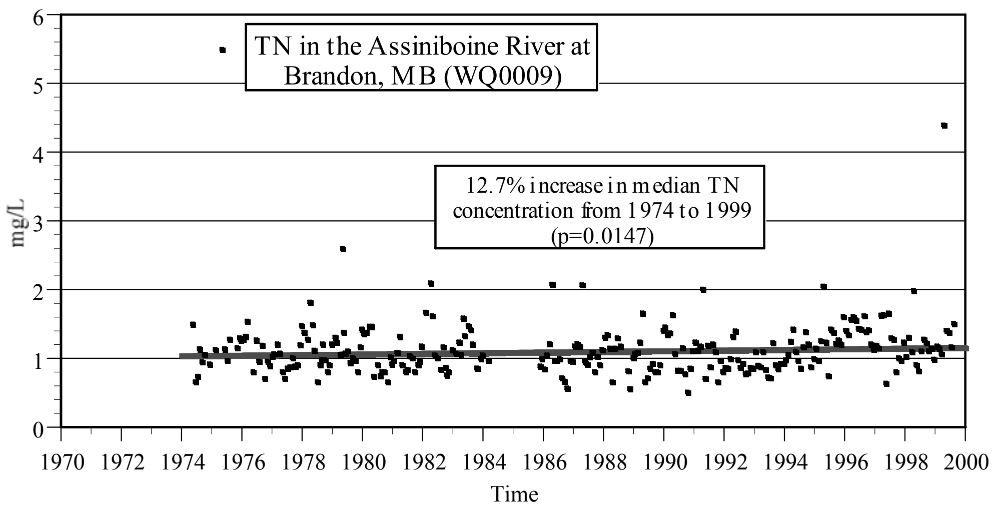


Figure 2: Total nitrogen (TN) in the Assiniboine River at Brandon. The % change in median concentration refers to the median concentration of flow adjusted trend line.

The trend of increasing TN could be attributed to increased non-point source and point source loading from land-use practices such as agricultural activities and municipal lagoon discharges.

Water Quality Index:

Data from the long-term water quality stations can be used to calculate the Water Quality Index. The Canadian Council of Ministers of the Environment (CCME) Water Quality Index is used to summarize large amounts of water quality data into simple terms (e.g., good) for reporting in a consistent manner. Twenty-five variables are included in the Water Quality Index (Table 1) and are compared with water quality objectives and guidelines contained in the Manitoba Water Quality Standards, Objectives, and Guidelines (Williamson 2002 and Table 1).

Table 1. Water quality variables and objectives or guidelines (Williamson 2000, Williamson 1988) used to calculate Water Quality Index (CCME 2000).

Variables	Units	Objective Value	Objective Use

Fecal Coliform MF	**Bacteria/100mL**	**200**	**Recreation**
Ph	**Ph Units**	**6.5-9.0**	**Aquatic Life**
Specific Conductivity	**uS/cm**	**1000**	**Greenhouse Irrigation**
Total Suspended Solids	**mg/L**	**25 (mid range)**	**Aquatic Life**
Dissolved Oxygen	**mg/L**	**5 (mid range)**	**Aquatic Life**
Total or Extractable Cadmium*	**mg/L**	**Calculation based on Hardness (7Q10)**	**Aquatic Life**
Total or Extractable Copper*	**mg/L**	**Calculation based on Hardness (7Q10)**	**Aquatic Life**
Total Arsenic	**mg/L**	**0.025**	**Drinking Water, Health**
Total or Extractable Lead*	**mg/L**	**Calculation based on Hardness (7Q10)**	**Aquatic Life**
Dissolved Aluminum	**mg/L**	**0.1 for pH >6.5**	**Aquatic Life**
Total or Extractable Nickel*	**mg/L**	**Calculation based on Hardness (7Q10)**	**Aquatic Life**
Total or Extractable Zinc*	**mg/L**	**Calculation based on Hardness (7Q10)**	**Aquatic Life**
Total or Extractable Manganese	**mg/L**	**0.05**	**Drinking Water, Aesthetic**
Total or Extractable Iron	**mg/L**	**0.3**	**Drinking Water, Aesthetic**
Total Ammonia as N	**mg/L**	**Calculation based pH**	**Aquatic Life**
Soluble or Dissolved Nitrate-Nitrite	**mg/L**	**10**	**Drinking Water, Health**
Total Phosphorus	**mg/L**	**0.05 in Rivers or 0.025 in Lakes**	**Nuisance Plant Growth**
Dicamba	**ug/L**	**0.006 where detectable**	**Irrigation**
Bromoxynil	**ug/L**	**0.33**	**Irrigation**
Simazine	**ug/L**	**0.5**	**Irrigation**
2,4 D	**ug/L**	**4**	**Aquatic Life**
Lindane	**ug/L**	**0.01**	**Aquatic Life**
Atrazine	**ug/L**	**1.8**	**Aquatic Life**
MCPA	**ug/L**	**0.025 where detectable**	**Irrigation**
Trifluralin	**ug/L**	**0.2**	**Aquatic Life**

The Water Quality Index combines three different aspects of water quality: the 'scope,' which is the percentage of water quality variables with observations exceeding guidelines; the 'frequency,' which is the percentage of total observations exceeding guidelines; and the 'amplitude,' which is the amount by which observations exceed the guidelines. The basic premise of the Water Quality Index is that water quality is excellent when all guidelines or objectives set to protect water uses are met virtually all the time. When guidelines or objectives are not met, water quality becomes progressively poorer. Thus, the Index logically and mathematically incorporates information on water quality based on comparisons to guidelines or objectives to protect important water uses. The Water Quality Index ranges from 0 to 100 and is used to rank water quality in categories ranging from poor to excellent.

- **Excellent (95-100)** - Water quality never or very rarely exceeds guidelines
- **Good (80-94)** - Water quality rarely exceeds water quality guidelines
- **Fair (60-79)** - Water quality sometimes exceeds guidelines and possibly by a large margin
- **Marginal (45-59)** - Water quality often exceeds guidelines and/or by a considerable margin
- **Poor (0-44)** - Water quality usually exceeds guidelines and/or by a large margin

There are limited water quality data for the new monitoring stations initiated in 2006. The Water Quality Index indicated that water quality was "fair" on the Assiniboine River at Highway 21 with a rating of 78 in 2006. Insufficient data were collected to calculate a Water Quality Index for the Oak River. Since routine water quality monitoring is now underway at these two stations within the watershed, the Water Quality Management Section will be able to update the Water Quality Index values each year and provide an ongoing assessment.

While water chemistry has been monitored at the Assiniboine River at Brandon since 1974, certain pesticides that are required to calculate the Water Quality Index were not monitored prior to 1991. Therefore, the Water Quality Index has been calculated from 1991 to present and these indices are represented on Figure 3.

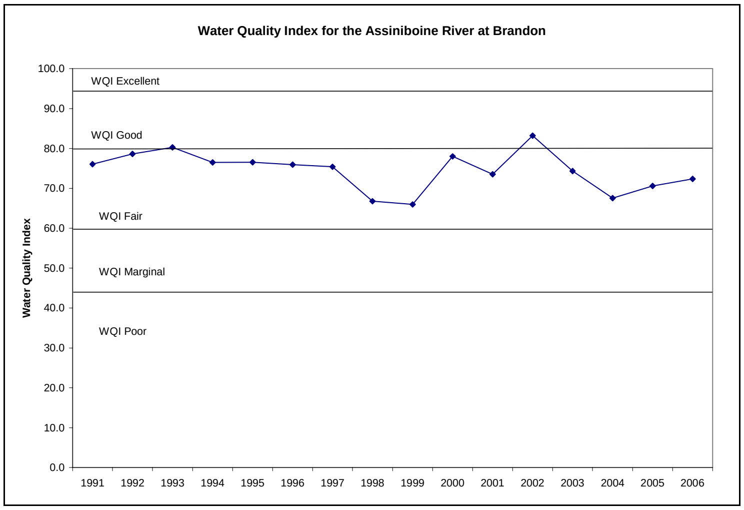


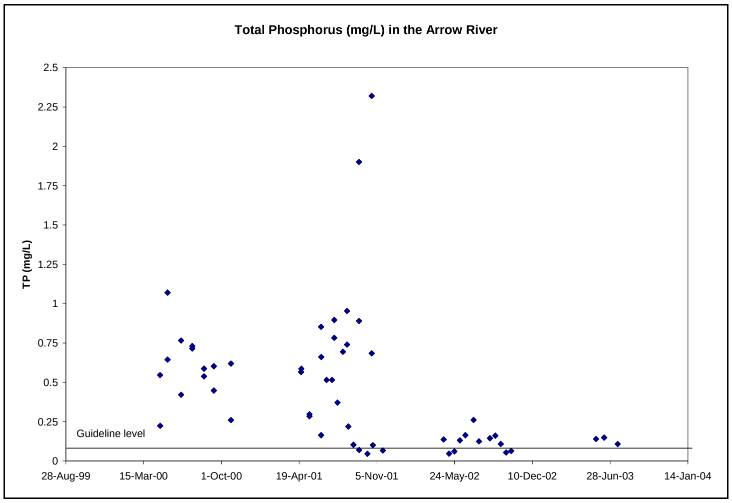
Figure 3. Water Quality Index calculated from 1991 to 2006 for the Assiniboine River at Brandon

In general, the WQI in the Assiniboine River fell within the category of 'Fair' or 'Good'(Figure 3) indicating that water quality is protected with only a minor degree of threat or impairment; and that conditions rarely depart from natural or desirable levels.

Water Quality in the Arrow and Oak Rivers

Total phosphorus consistently exceeded the narrative guideline of 0.05 mg/L in the Arrow and Oak rivers (Figure 4). The province-wide narrative phosphorus guideline of 0.05 mg/L provides general guidance on phosphorus concentrations but will need to be replaced with more ecologically-relevant objectives (See below in Nutrient Section). Other nutrients (ammonia and nitrate/nitrite nitrogen) were within guidelines for the entire period of record. While some water bodies contain naturally elevated concentrations of nutrients due to watershed characteristics, many human alterations impact nutrient loading to the Arrow and Oak rivers.

The amount of dissolved oxygen in the Arrow and Oak rivers rarely declined to critically low levels (Figure 5). Only a couple of samples from the Oak River were analysed for dissolved oxygen and ranged from 4.9 to 6.3 mg/L. Low oxygen can result from the decomposition of organic material such as algae and plants and is exacerbated by ice cover, a time when dissolved oxygen concentrations are less likely to be replenished. Critically low concentrations of dissolved oxygen can result in fish kills and foul smelling water.



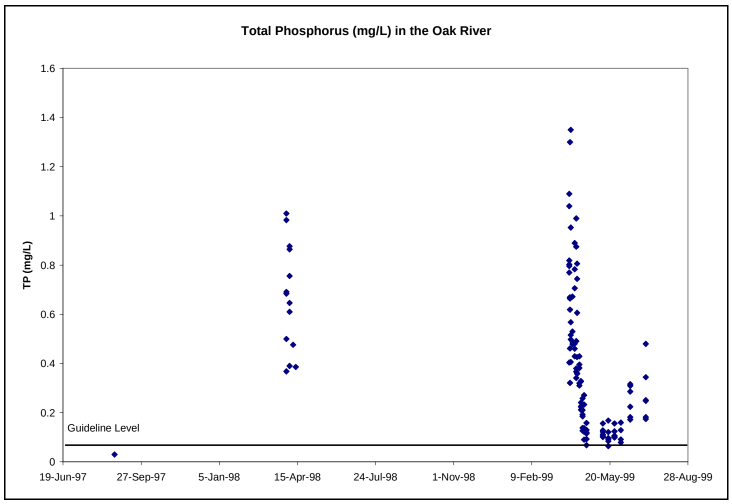


Figure 4. Total phosphorus (mg/L) concentrations from 1999 to 2003 collected from the Arrow and Oak rivers.

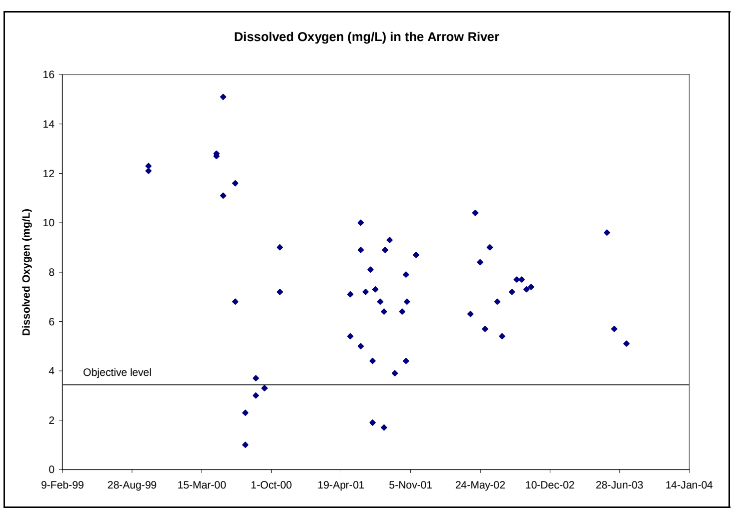
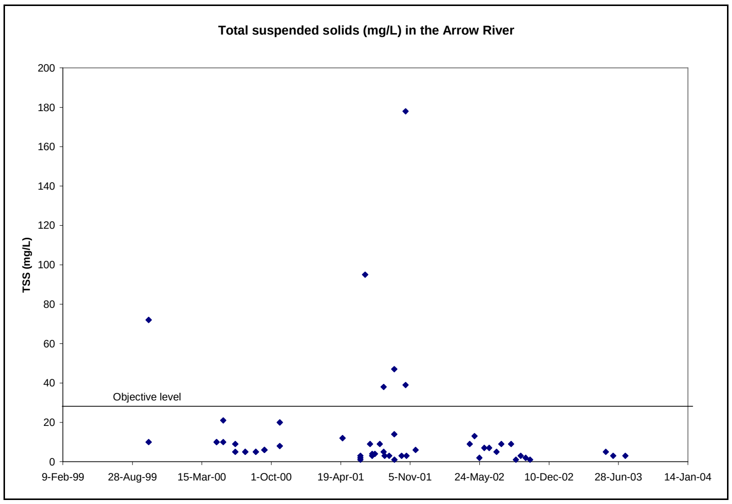


Figure 5. Dissolved Oxygen (mg/L) concentrations from 1999 to 2004 collected from the Arrow River

No pesticide samples were collected in the Arrow and Oak rivers.

Total suspended solids exceeded the objective occasionally in the Arrow River and only once in the Oak River (Figure 6). Total suspended sediments increase after spring runoff, and after summer precipitation events. Overland runoff carries soil, silt, and organic debris all of which will increase the concentration of suspended sediments. Bank erosion will also contribute to increased suspended sediments. Poor land-use practices such as removing vegetated buffer strips from along rivers and smaller tributaries will also increase the overland movement of soil and other debris into the river.



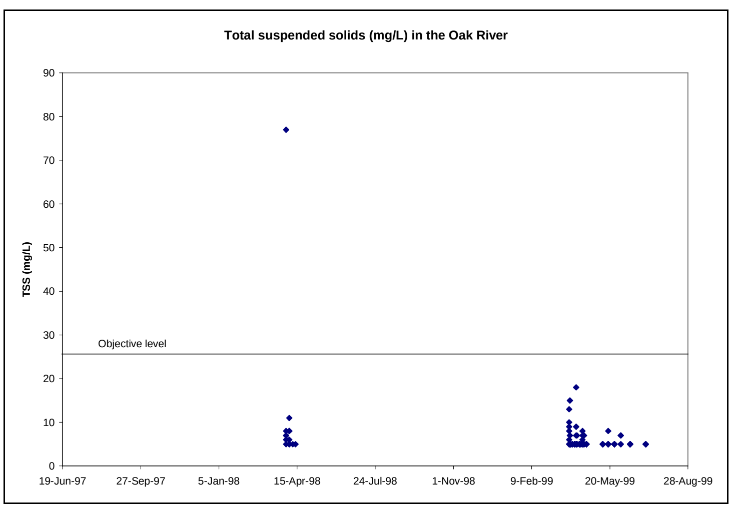


Figure 6. Total suspended solids (mg/L) from 1999 to 2004 collected from the Arrow and Oak rivers at PTH #25. Line indicates the Manitoba Water Quality objective.

Most of the metals either rarely, or did not, exceed their water quality objectives or guidelines. In contrast, iron and manganese exceeded the guidelines in numerous samples over the period of record. 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 discharges from mining operations. Iron can impart a metallic taste and produce a yellow participate in water. Manganese is strongly associated with iron in water and is also naturally found in water from weathering of minerals. High concentrations of manganese can impart an unpleasant taste.

Conductivity occasionally exceeded the water quality objective for irrigation in the Arrow River (Figure 7). In the Oak River, the conductivity of all samples was below the objective for irrigation. Specific conductance or conductivity in water is a measure of the amount of dissolved salts and minerals such as chloride, nitrate, sulphate, sodium, calcium, iron, etc. Conductivity is mostly influenced by soil characteristics of the watershed. Rivers and streams that run through primarily clay soils tend to have higher conductivity because of the presence of materials that ionize when washed into the water. Discharges to rivers and streams, such as municipal discharge, can change the conductivity due to higher levels of sulphate, chloride, and nitrate.

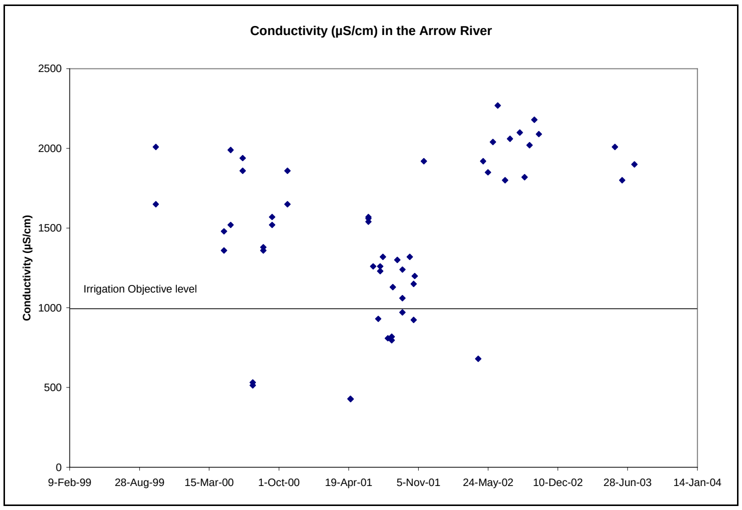


Figure 7. Conductivity (µS/cm) from 1999 to 2004 collected from the Arrow River

The majority of *Esherichia coli* samples collected from the Arrow River remained below the guideline level of 200 organisms per 100 mL of water (Figure 8). Fecal coliform or *E. coli* in surface water are an indication of contamination from a fecal source. While the source of contamination is a warm-blooded animal, these data do not qualify the source.

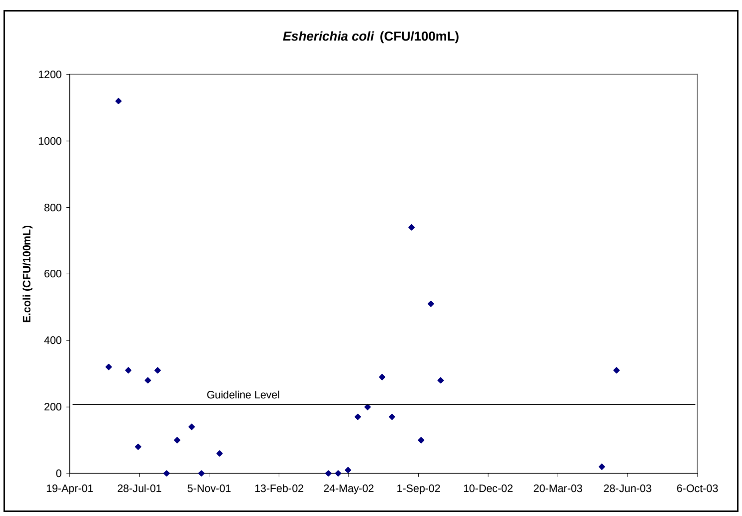


Figure 8: Escherichia coli (CFU/100mL) in the Arrow River

Other Water Quality data from the Watershed

Total phosphorus consistently exceeded the narrative guideline of 0.05 mg/L across the watershed (Figure 9). The province-wide narrative phosphorus guideline of 0.05 mg/L provides general guidance on phosphorus concentrations but will need to be replaced with more ecologically-relevant objectives (See below in Nutrient Section). Other nutrients (ammonia and nitrate/nitrite nitrogen) were within guidelines for the entire period of record. While some water bodies contain naturally elevated concentrations of nutrients due to watershed characteristics, human alterations also impact nutrient loading to this river.

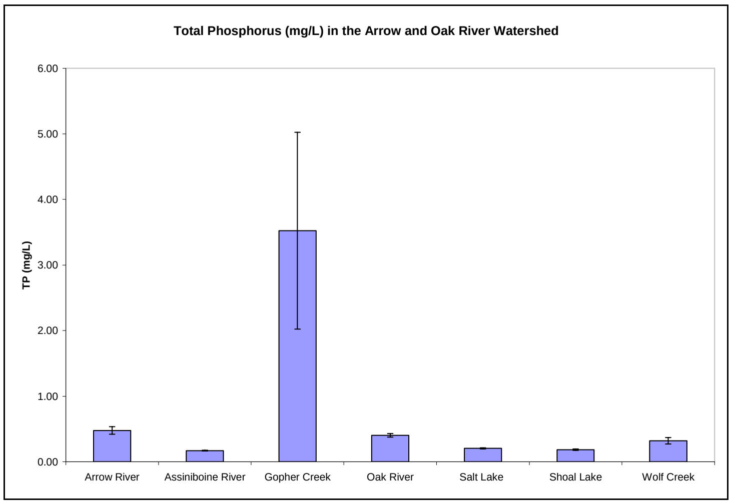


Figure 9: Total Phosphorus (mg/L) in the Arrow and Oak River Watershed

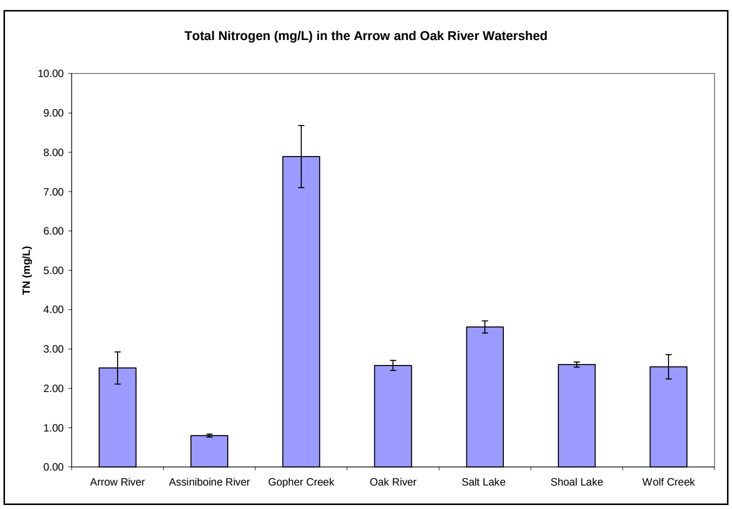


Figure 10: Total Nitrogen (mg/L) in the Arrow and Oak River Watershed

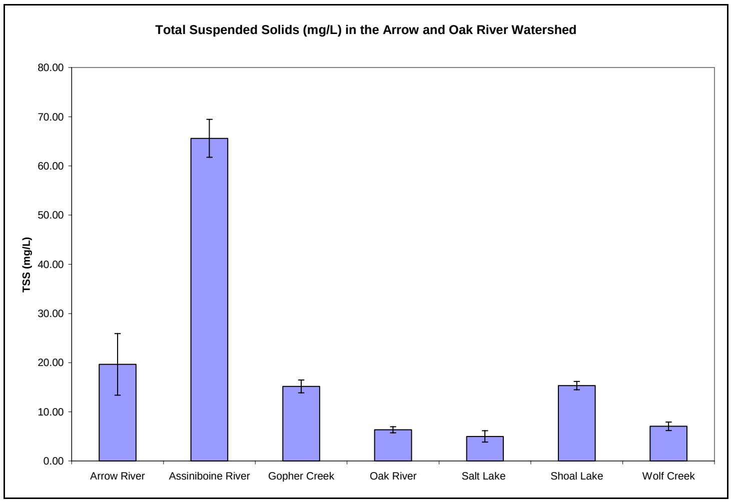


Figure 11: Total Suspended Solids (mg/L) in the Arrow and Oak River Watershed

Nutrients

Nutrient enrichment or eutrophication is one of the most important water quality issues in Manitoba. Excessive levels of phosphorus and nitrogen fuel the production of algae and aquatic plants. Extensive algal blooms can cause changes to aquatic life habitat, reduce essential levels of oxygen, clog fisher's commercial 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.

Studies have shown that since the early 1970s, phosphorus loading has increased by about 10 per cent to Lake Winnipeg and nitrogen loading has increased by about 13 per cent. A similar phenomenon has also occurred in many other Manitoba streams, rivers, and lakes.

Manitobans, including those in the Arrow and Oak River watershed, contribute about 47 % of the phosphorus and 44 % of the nitrogen to Lake Winnipeg (Bourne *et al.* 2002, updated in 2006). About 15 % of the phosphorus and 6 % of the nitrogen entering Lake Winnipeg is contributed by agricultural activities within Manitoba. In contrast, about 9 % of the phosphorus and 6 % of the nitrogen entering Lake Winnipeg from Manitoba is contributed by wastewater treatment facilities such as lagoons and sewage treatments plants.

As part of 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. The Lake Winnipeg Action Plan recognizes that nutrients are contributed by most activities occurring within the drainage basin and that reductions will need to occur across all sectors. Reductions in nutrient loads across the Lake Winnipeg watershed will benefit not only Lake Winnipeg but also improve water quality in the many rivers and streams that are part of the watershed including the Arrow and Oak rivers.

Nutrient reduction targets under the Lake Winnipeg Action Plan are interim targets that reflect the need to take immediate action to reduce nutrient loads to Lake Winnipeg. Manitoba Water Stewardship is working to develop long-term, ecologically-relevant objectives for nutrients in Lake Winnipeg and its contributing basins such as the Arrow and Oak rivers. Long-term, ecologically-relevant objectives will also replace narrative guidelines that are currently applied across Manitoba. However, reducing nutrients across Manitoba, the Arrow and Oak river watershed, and the Lake Winnipeg watershed is a challenge that will require the participation and co-operation of all Manitobans and will involve:

- Implementing expensive controls on nutrients in municipal and industrial wastewater treatment facilities.
- Developing scientifically -based measures to control the application of inorganic fertilizers, animal manure, and municipal sludge to agricultural lands.
- Reducing nutrient contributions from individual cottagers and homeowners.
- Working with our upstream neighbours.

Individual Manitobans can help by taking the following steps:
- Maintain a natural, riparian buffer along waterways. Natural vegetation slows erosion and helps reduce the amount of nitrogen and phosphorus entering lakes, rivers and streams.
- Value and maintain wetlands. Similar to riparian buffers along waterways, wetlands slow erosion and help reduce nutrient inputs to lakes, rivers, and streams. Wetlands also provide flood protection by trapping and slowly releasing excess water while providing valuable habitat for animals and plants.
- Don't use fertilizer close to waterways. Heavy rains or over-watering your lawn can wash nutrients off the land and into the water.
- Use phosphate-free soaps and detergents. Phosphates have been prohibited from laundry detergents but many common household cleaners including dishwasher detergent, soaps, and other cleaning supplies still contain large amounts of phosphorus. Look for phosphate-free products when you are shopping.
- Ensure that your septic system is operating properly and is serviced on a regular basis. It's important that your septic system is pumped out regularly and that your disposal field is checked on a regular basis to ensure that it is not leaking or showing signs of saturation.

Macroinvertebrates

Another indicator of water quality is the density, abundance, and diversity of marcroinvertebrates (organisms without backbones, such as insects and snails, representing a variety of taxa). A number of measurements are used to assess the quality of an aquatic site as being 'non-impaired', 'slightly impaired', 'moderately impaired' or 'severely impaired'. These designations, or biological conditions, depend upon characteristics of the dominant species that are present at the site. Some organisms are intolerant of poor water quality and thus would not be present in severely impacted water while others can tolerate poor water quality. Unfortunately there have not been any macroinvertebrates collected to date in this watershed.

Nutrient Management Regulation

Manitoba is proposing a Nutrient Management Regulation under *The Water Protection Act*. The purpose of the proposed regulation is to protect water quality by encouraging responsible nutrient planning, regulating the application of materials containing nutrients and restricting the development of certain types of facilities in environmentally sensitive areas. When nitrogen and phosphorus are applied to land surfaces in greater amounts than can be used by growing plants, excess nutrients can leach into ground water or run-off into surface water with heavy rainfall, floods, and melting snow.

Manitoba's landscape has been separated into five zones. Zones N1, N2, and N3 consist of land that ranges in agricultural productivity while Zone N4 is generally unproductive land that represents a significant risk of nutrient loss to surface and groundwater. Zone N4 land consists of Canada Land Inventory soil classification 6 or 7 or unimproved organics. Zone N5 consists of urban and rural residential areas.

The proposed regulation also describes a Nutrient Buffer Zone with widths outlined below:

Water Body	A (1)	B (1)
o a lake or reservoir designated as vulnerable	30 m	35 m
o a lake or reservoir (not including a constructed stormwater retention pond) not designated as vulnerable o a river, creek or stream designated as vulnerable	15 m	20 m
o a river, creek or stream not designated as vulnerable o an order 3, 4, 5, or 6 drain or higher o a major wetland, bog, swamp or marsh o a constructed stormwater retention pond	3 m	8 m

(1) Use column A if the applicable area is covered in permanent vegetation. Otherwise, use column B.

Under the proposed regulation, no nitrogen or phosphorus can be applied within Zone N4 or the Nutrient Buffer Zone.

More information on the proposed *Nutrient Management Regulation* is available at http://www.gov.mb.ca/waterstewardship/wqmz/index.html.

Drainage

Although it is recognized that drainage in Manitoba is necessary to support sustainable agriculture, it is also recognized that drainage works can impact water quality and fish habitat. Types of drainage include the placement of new culverts or larger culverts to move more water, the construction of new drainage channels to drain low lying areas, the draining of potholes or sloughs to increase land availability for cultivation and the installation of tile drainage. Artificial drainage can sometimes result in increased nutrient (nitrogen and phosphorus), sediment and pesticide load to receiving drains, creeks and rivers. All types of drainage should be constructed so that there is no net increase in nutrients (nitrogen and phosphorus) to waterways. To ensure that drainage maintenance, construction, and re-construction occurs in an environmentally friendly manner, the following best available technologies, and best management practices aimed at reducing impacts to water quality and fish habitat are recommended.

The following recommendations are being made to all drainage works proposals during the approval process under *The Water Rights Act*:

- There must be no net increase in nutrients (nitrogen and phosphorus) to waterways as a result of drainage activities. Placement of culverts, artificial drainage and construction and operation of tile drains can sometimes result in increased nutrient (nitrogen and phosphorus), sediment and pesticide loads to receiving drains, creeks and rivers.
- Synthetic fertilizer, animal manure, and municipal wastewater sludge must not be applied within drains.

<u>Culverts</u>

- Removal of vegetation and soil should be kept to a minimum during the construction and the placement of culverts.
- Erosion control methodologies should be used on both sides of culverts according to the Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat.
- A strip of vegetation 1 to 3 metres wide should be maintained along drainage channels as a buffer. This will reduce erosion of channels and aid in nutrient removal.

- The proponent should revegetate exposed areas along drainage channels.

Surface Drainage

- 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 (1965), Class 6 and 7 soils should not be drained.
- There should be no net loss of semi-permanent or permanent sloughs, wetlands, potholes or other similar bodies of water in the sub-watershed within which drainage is occurring.
- Erosion control methodologies outlined in Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat should be used where the surface drain intersects with another water body.
- A strip of vegetation 1 to 3 metres wide should be maintained along surface drainage channels as buffers. These will reduce erosion of channels and aid in nutrient removal.
- The proponent should revegetate exposed areas along banks of surface drainage channels.

Tile Drainage

- Discharge from tile drainage should enter a holding pond or wetland prior to discharging into a drain, creek or river.

Manitoba Water Stewardship is working towards the development of an environmentally friendly drainage manual that will provide additional guidance regarding best management practices for drainage in Manitoba.

Summary

1. Long-term trend data indicate that total nitrogen had increased from 1970 to 1999 in the Assiniboine River at Brandon whereas total phosphorus had no significant trend during that same time frame.

2. While most water quality variables were well below their provincial guideline or objective levels for the period of record, total phosphorus remained elevated. Concentration of total phosphorus was consistently above the Manitoba Water Quality Guideline level of 0.05 mg/L for rivers and streams for the entire period of record.

3. The Water Quality Index, which uses numerous variables in the calculations and provides an overall indication of water quality, was generally 'Fair' to 'Good' in the Assiniboine River at Brandon from 1991 to 2006, and 'Fair' to 'Excellent' in the Assiniboine River at Hwy 21 from 2006 to 2007.

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And visit the Department's web site: http://www.gov.mb.ca/waterstewardship

References:

Currie, R.S. and D.A. Williamson. 1995. An assessment of pesticide residues in surface waters of Manitoba, Canada. Canada-Manitoba Agreement on Agricultural Sustainability. Man. Dept. Environ. Report No. 95-08.

Jones, G. and N. Armstrong. 2001. Long-term trends in total nitrogen and total phosphorus concentrations in Manitoba streams. Water Quality Management Section, Water Branch, Manitoba Conservation, Winnipeg, MB. Manitoba Conservation Report No. 2001-07. 154pp.

Hughes, C.E. 2007. In Preparation. Biological condition and water quality of 29 major streams in south and central Manitoba, Canada, 1995 through 2005. Water Quality Management Section, Water Science and Management Branch, Manitoba Water Stewardship, Winnipeg, MB. Manitoba Water Stewardship Report No. 2007-01.

Williamson, D.A. 2002. Final Draft. Manitoba water quality standards, objectives, and guidelines. Manitoba Conservation Report 2002-11. Winnipeg, Manitoba.