Dauphin Lake Watershed Integrated Watershed Management Plan - Water Quality Report

Prepared by:

Cassie Leclair
Water Quality Management Section
Manitoba Water Stewardship
Winnipeg, Manitoba.

October 2011

Water Quality Investigations and Routine Monitoring:

This report provides an overview of the studies and routine monitoring which have been undertaken by Manitoba Water Stewardship's Water Quality Management Section within the Dauphin Lake watershed.

There are five long term water quality monitoring stations (1974 – 2011) within the Dauphin Lake Watershed. These include Edwards Creek, and the Ochre, Turtle, Valley and Vermillion Rivers. These five long term water quality monitoring stations are sampled on a quarterly basis. Water samples are analyzed for a suite of general chemistry, nutrients, metals, pesticides and bacteria. There are also 58 historic stations, not part of the current long term water quality monitoring program, in which data are available for alternate locations on the five long term rivers, as well as the Wilson River and Mink Creek. It should be noted, the Drifting River becomes the Valley River further downstream, and McKinnon Creek becomes the Turtle River further downstream.

The Dauphin Lake watershed is characterized primarily by agricultural land, both cropland and livestock production, as well as urban and rural centres. All these land uses have the potential to negatively impact water quality, if not managed appropriately. Cropland can present water quality concerns in terms of fertilizer and pesticide runoff entering surface water. Livestock present water quality concerns in terms of wastewater management, manure holding, storage, and application, as well as cattle which are allowed direct access to water bodies. Large centers and rural municipalities present water quality concerns in terms of wastewater treatment and effluent.

There are a number of tributaries which are of concern in the Dauphin Lake watershed. Edwards Creek, and the Ochre, Turtle, Valley and Vermillion Rivers all discharge into Dauphin Lake. Considering a large portion of the Dauphin Lake watershed is agricultural production, as well there are a number of communities situated along these rivers, there is high potential for nutrient and bacteria loading to Dauphin Lake. In addition, the Valley River has been listed as a vulnerable water body in the *Nutrient Management Regulation* under the *Water Protection Act*. Please refer to the section on 'Water Quality Management Zones' for more detailed information with this regard.

Water Quality Index Calculations:

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 (CCME, 2001). 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).

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

Table 1: Water quality variables and objectives or guidelines (Williamson 2002) used to calculate Water Quality Index (CCME 2001).

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	0.08	Aquatic Life
Atrazine	ug/L	1.8	Aquatic Life
MCPA	ug/L	0.025 where detectable	Irrigation
Trifluralin	ug/L	0.2	Aquatic Life

A Water Quality Index was calculated for the five long term water quality monitoring stations. While water chemistry has been monitored at these sites since 1974, certain pesticides that are required to calculate the WQI were not monitored prior to 1992. Therefore, the Water Quality Index has been calculated from 1992 to 2009 and these indices are represented on Figures 1 through 5.

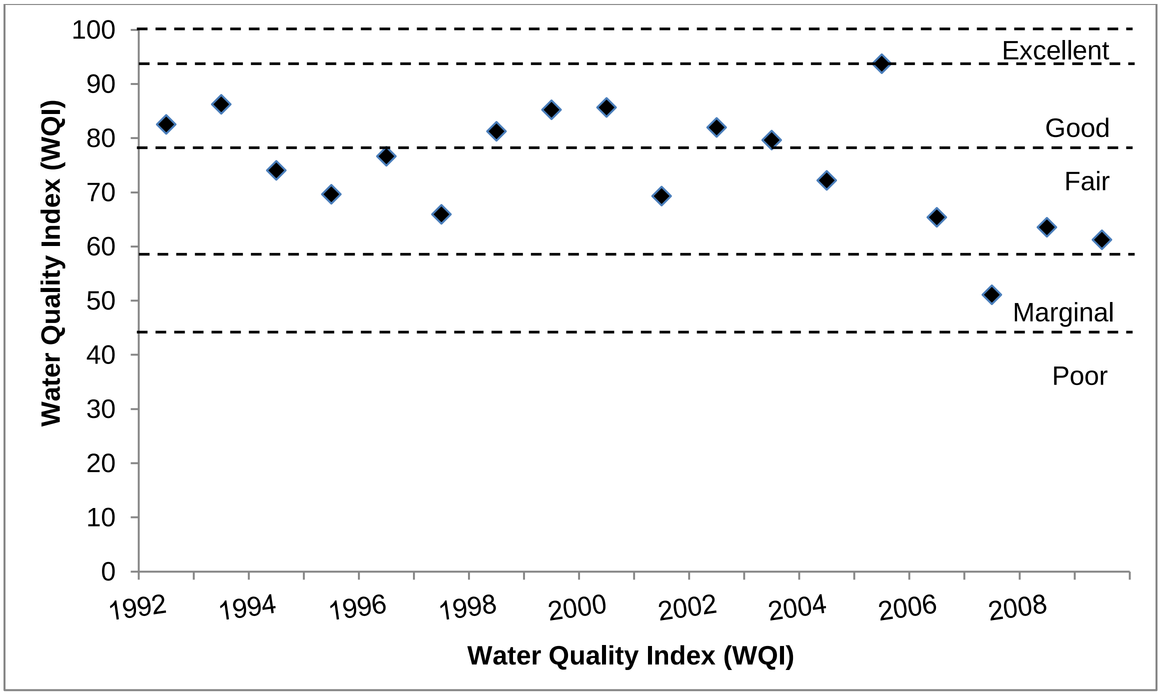

Figure 1: Water Quality Index calculated from 1992 to 2009 for Edwards Creek south of Dauphin.

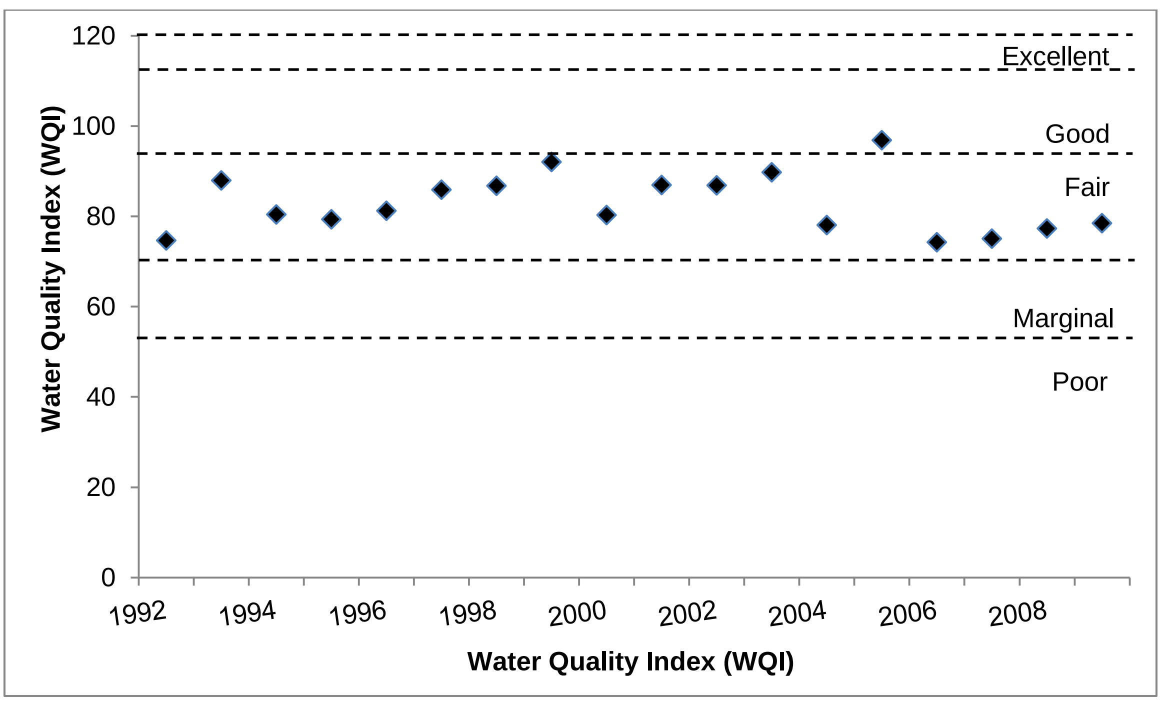

Figure 2: Water Quality Index calculated from 1992 to 2009 for the Ochre River near the community of Ochre River.

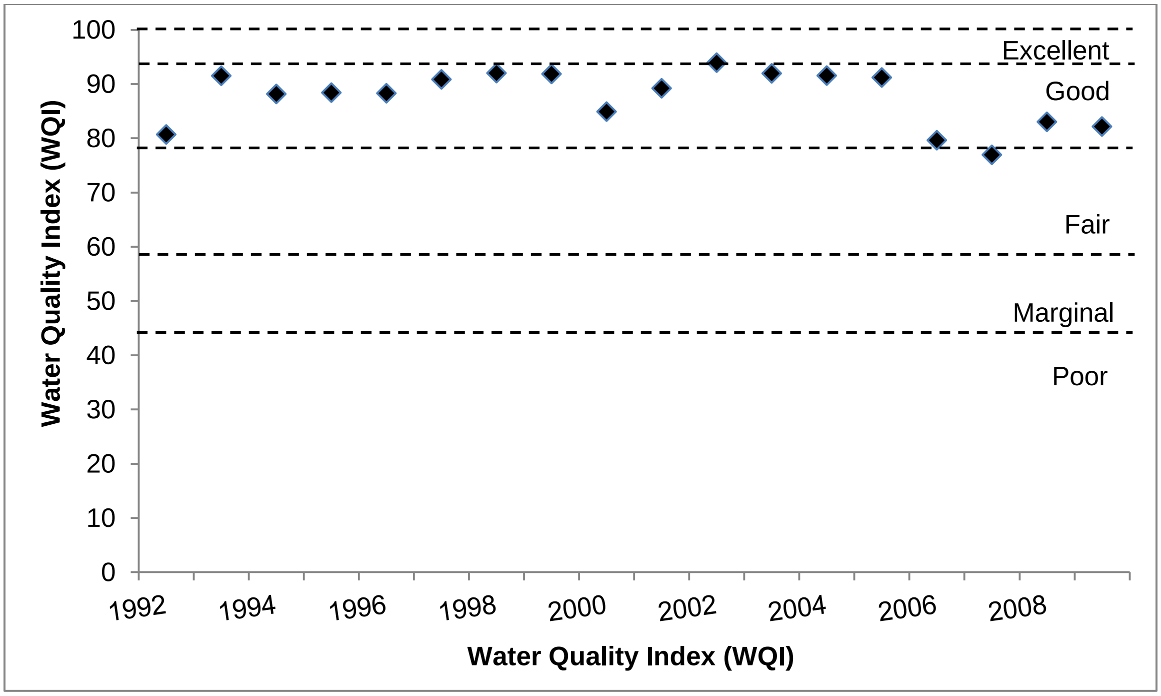

Figure 3: Water Quality Index calculated from 1992 to 2009 for the Turtle River at Ste. Rose du Lac.

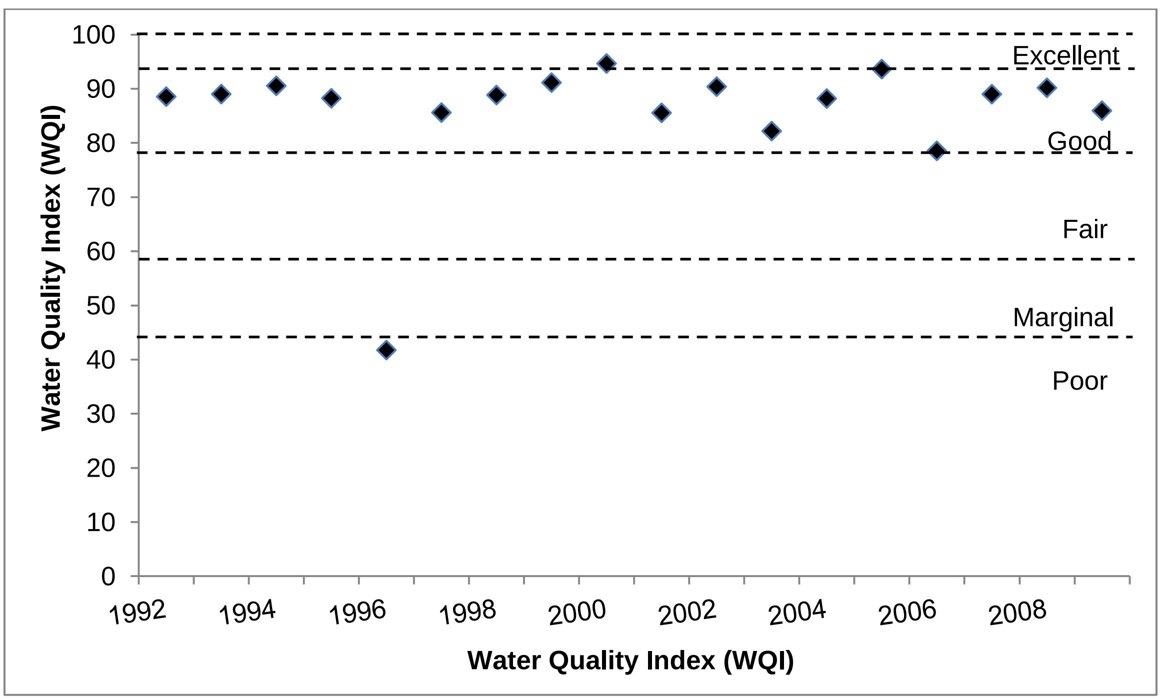

Figure 4: Water Quality Index calculated from 1992 to 2009 for the Valley River north of Dauphin.

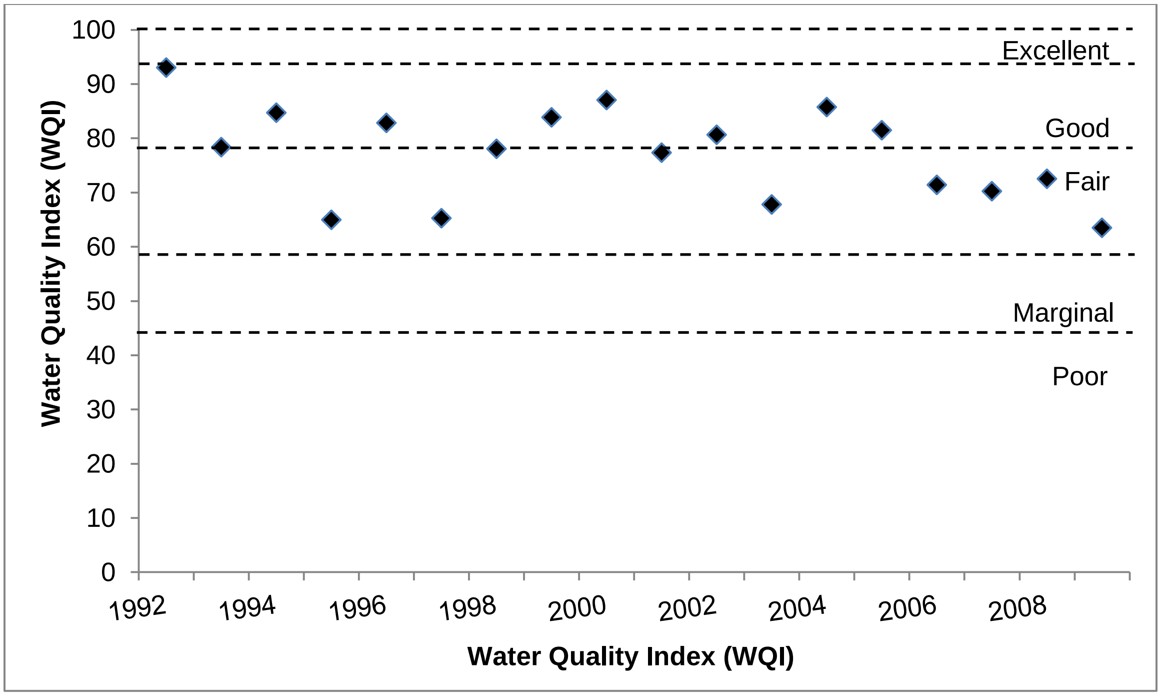

Figure 5: Water Quality Index calculated from 1992 to 2009 for the Vermillion River north of Dauphin.

Typically, the Water Quality Index for the five rivers fell within the categories of fair to good (Figures 1 to 5) indicating that the water quality sometimes exceeded the water quality guidelines for some variables. Total phosphorus is typically responsible for driving down the Water Quality Index, as discussed in more detail below. As well, other water quality parameters will be discussed in greater detail below as a means to explain observed Water Quality Index values. Overall, while some water bodies contain naturally elevated concentrations of nutrients due to watershed characteristics, many human alterations impact nutrient loading to these rivers.

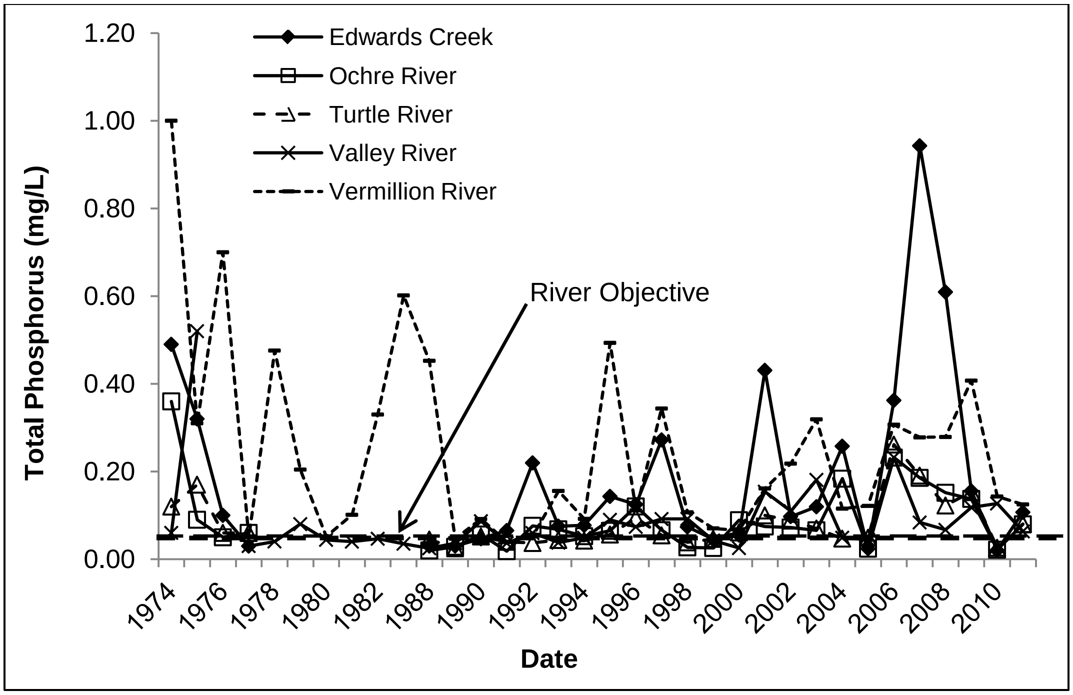

Figure 6: Total phosphorus (mg/L) concentrations from the five long term water quality monitoring sites in the Dauphin Lake watershed between 1974 and 2011.

Figures 6 and 7 illustrate total phosphorus concentrations in the Dauphin Lake watershed. Typically, total phosphorus concentrations were above the Manitoba Water Quality Guideline for rivers of 0.05 mg/L (Williamson 2002). The five long term monitoring sites did not show a distinct increase or decrease over time (figure 6). This is also true for the non-long term monitoring sites which also showed little upstream to downstream trends in total phosphorus concentrations (figure 7). As part of the Lake Winnipeg Action Plan, Manitoba is implementing several strategies to better manage plant nutrients. Part of this Action Plan includes the development of more appropriate site-specific or regional-specific water quality objectives or guidelines for nutrients. In the meantime, the narrative guidelines will be retained for nutrients such as nitrogen and phosphorus until more site specific objectives are developed. It is generally recognized, however, that narrative guidelines for phosphorus likely do not apply to many streams in the Canadian prairie region since other factors such as turbidity, stream velocity, nitrogen, and other conditions most often limit algal growth. As well, relatively high levels of phosphorus in excess of the narrative guidelines may arise naturally from the rich prairie soils. It should be noted that most streams and rivers in southern Manitoba exceed this guideline, in some cases due to the natural soil characteristics in the watershed and/ or due to inputs from human activities and land-use practices.

Figure 7: Mean total phosphorus (mg/L) concentrations for historic monitoring locations not part of the long term water quality monitoring program, in the Dauphin Lake watershed between 1974 and 2007. The different colours indicate different tributaries. Tributaries are listed from south to north along the watershed, and each tributary is listed in order of flow towards Dauphin Lake.

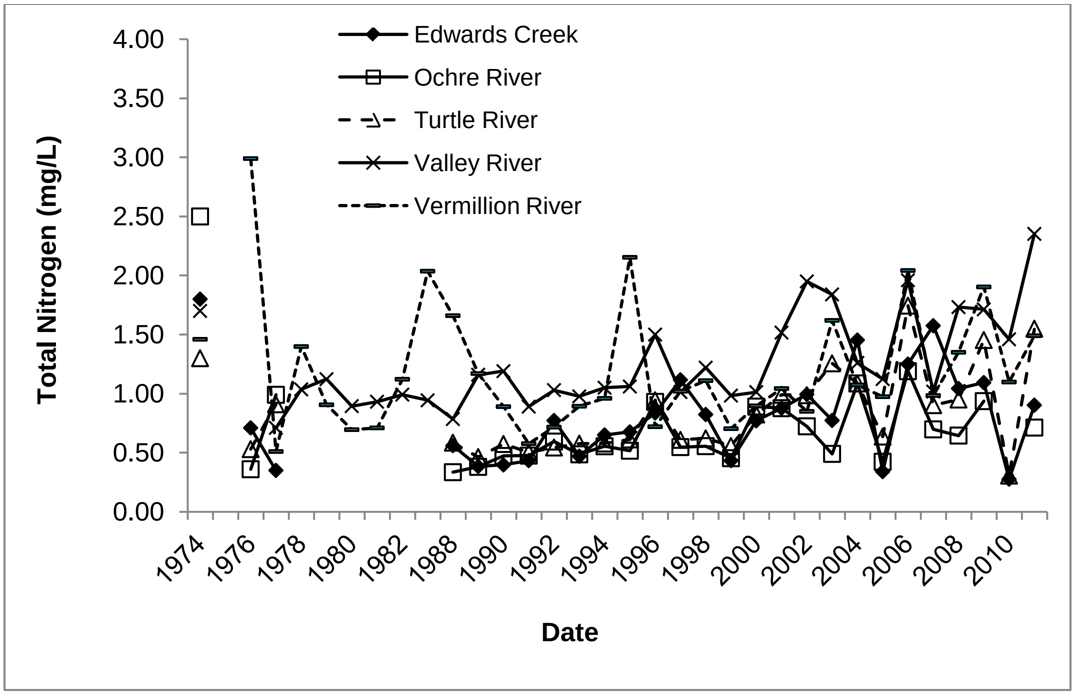

Figure 8: Total nitrogen (mg/L) concentrations from the five long term water quality monitoring sites in the Dauphin Lake watershed between 1974 and 2011.

The narrative objective for total nitrogen states nitrogen should be limited to the extent necessary to prevent nuisance growth and reproduction of aquatic rooted, attached and floating plants, fungi, or bacteria, or to otherwise render the water unsuitable for other beneficial uses (Williamson 2002). Nitrogen and phosphorus are two essential nutrients which stimulate algal growth in Lake Manitoba and its watershed. Figures 8 and 9 illustrate the total nitrogen concentration in the Dauphin Lake watershed. Figure 8 illustrates that on average total nitrogen concentration has increased at all long term sample locations since 1974. Unlike total phosphorus, total nitrogen concentration in most tributaries tends to have lower upstream concentrations, and tends to increase as flow continues downstream to Dauphin Lake (figure 9).

Figure 9: Mean total nitrogen (mg/L) concentrations for historic monitoring locations not part of the long term water quality monitoring program, in the Dauphin Lake watershed between 1974 and 2007. The different colours indicate different tributaries. Tributaries are listed from south to north along the watershed, and each tributary is listed in order of flow towards Dauphin Lake.

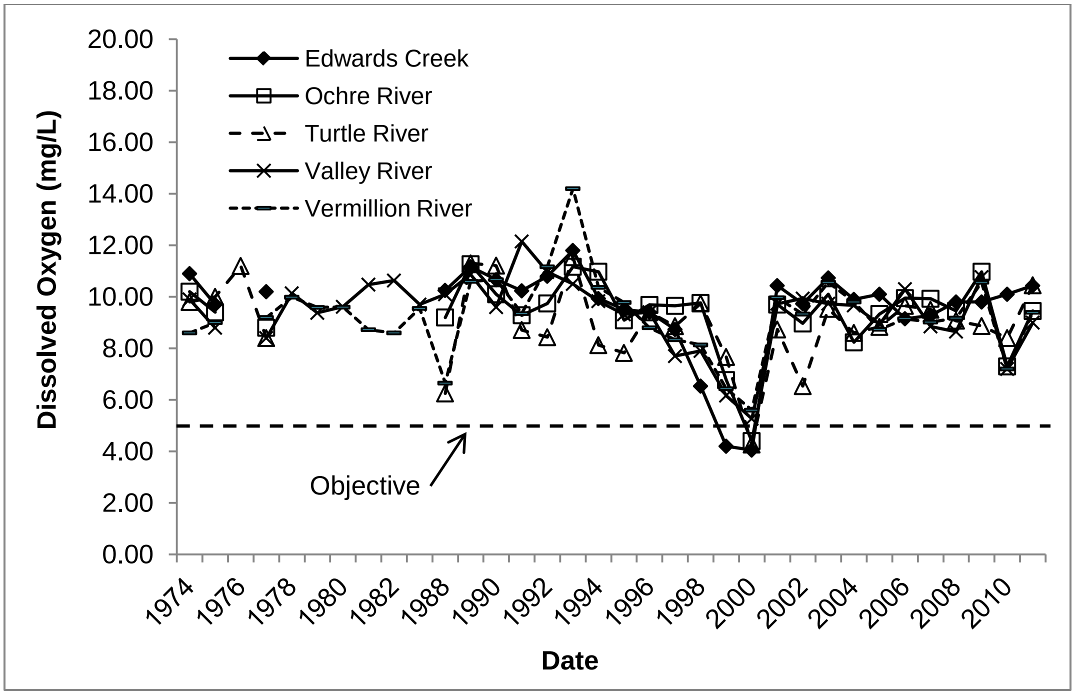

Figure 10: Dissolved oxygen (mg/L) concentrations from the five long term water quality monitoring sites in the Dauphin Lake watershed between 1974 and 2011.

Maintenance of adequate dissolved oxygen levels is essential to the health of aquatic life inhabiting rivers and streams. The monitoring conducted in the Dauphin Lake watershed (Figures 10 & 11) demonstrates that dissolved oxygen levels were almost always above the 5.0 mg/ L Manitoba objective (Williamson 2002). This is with the exception of Edwards Creek in 1999 and in 2000 Edwards Creek, Ochre River, and Turtle River (Figure 10). Low oxygen levels under ice conditions are not uncommon in small prairie rivers, as the decomposition of plant material consumes oxygen from the water. As well, low oxygen levels are not uncommon after a summer of intense algal blooms consuming oxygen from the water column. Overall, there is typically adequate dissolved oxygen in this watershed to support healthy aquatic life.

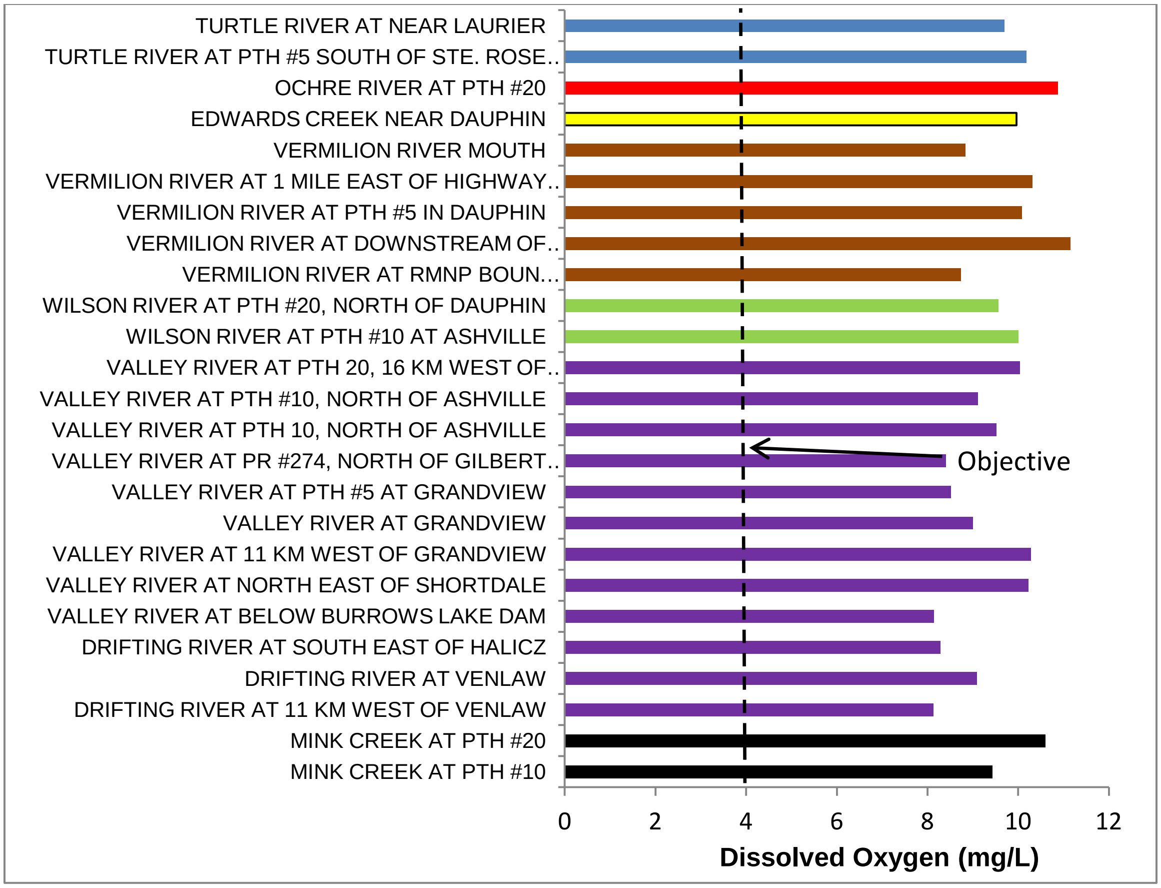

Figure 11: Mean dissolved oxygen (mg/L) concentrations for historic monitoring locations not part of the long term water quality monitoring program, in the Dauphin Lake watershed between 1974 and 2007. The different colours indicate different tributaries. Tributaries are listed from south to north along the watershed, and each tributary is listed in order of flow towards Dauphin Lake.

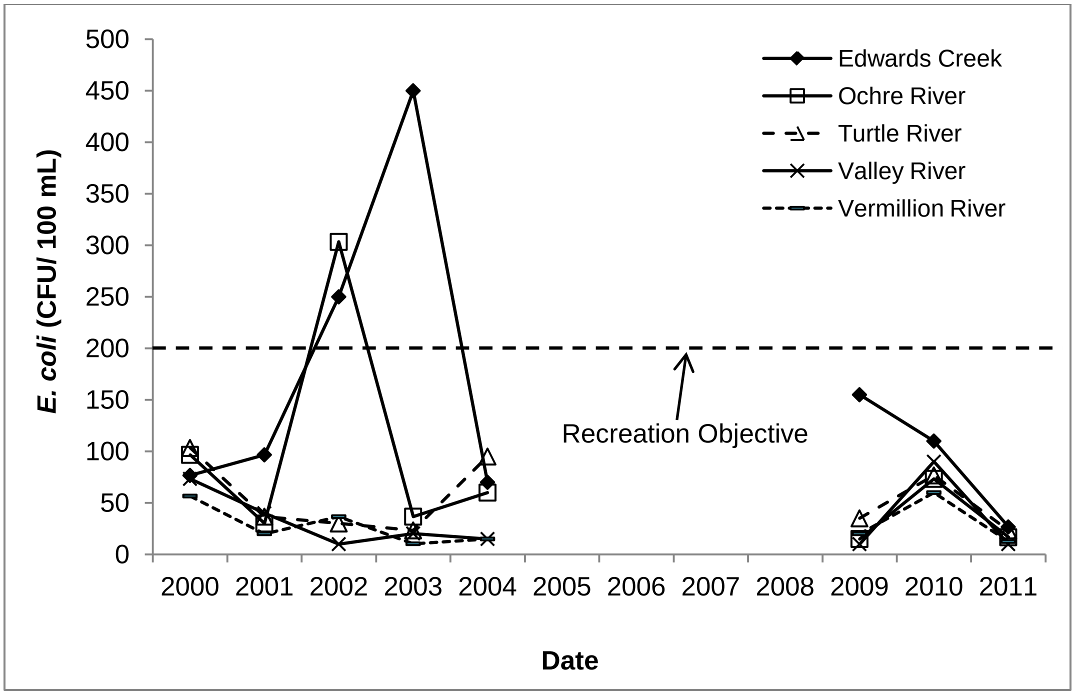

Figure 12: Densities of *Escherichia coli (E. coli*) collected from the five long term water quality monitoring sites in the Dauphin Lake watershed between 2000 and 2011. No data were collected prior 2000 for these monitoring sites.

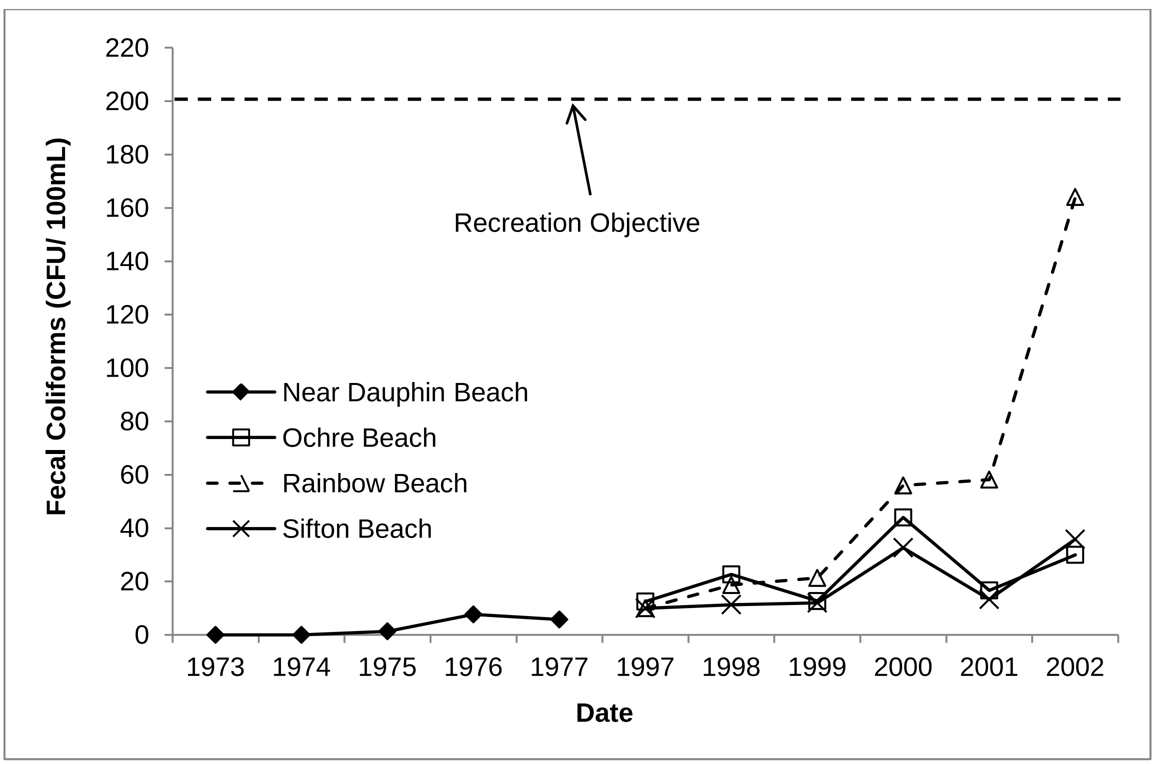

Figure 13: Densities of fecal coliforms collected at four beaches along Dauphin Lake, not part of the long term water quality monitoring program, in the Dauphin Lake watershed between 1973 and 2002.

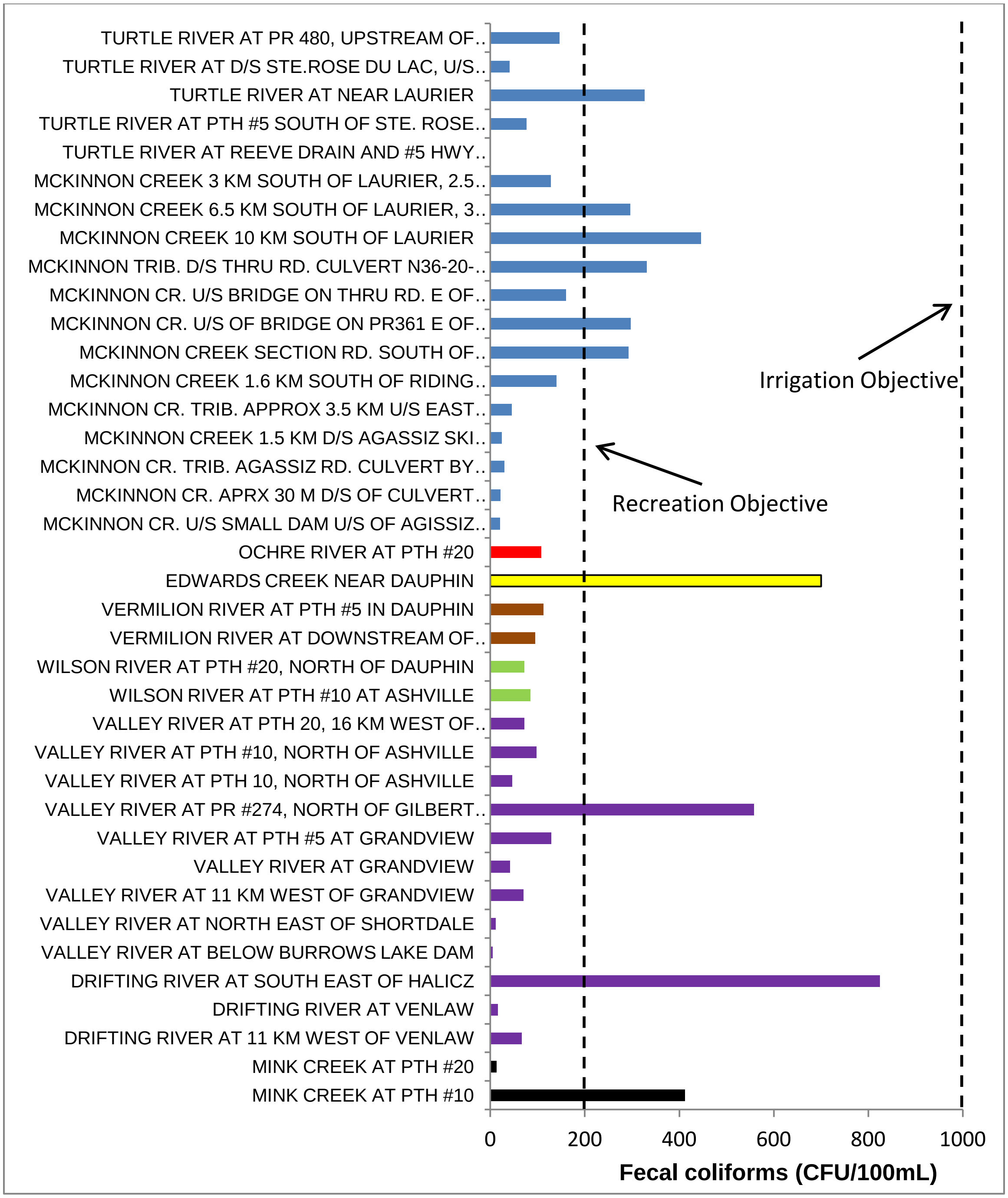

Figure 14: Mean fecal coliform densities (CFU/ 100mL) for historic monitoring locations not part of the long term water quality monitoring program, in the Dauphin Lake watershed between 1974 and 2007. The different colours indicate different tributaries. Tributaries are listed from south to north along the watershed, and each tributary is listed in order of flow towards Dauphin Lake.

Escherichia coli (E. coli) is a bacteria commonly found all warm-blooded animals including humans, livestock, wildlife, and birds. *E. coli* itself does not generally cause illness, but when present in large numbers the risk of becoming ill from other organisms is elevated. The most common illnesses contracted by bathers are infections of the eyes, ears, nose, and throat as well as stomach upsets. Typical symptoms include mild fever, vomiting, diarrhea and stomach cramps. Extensive studies were undertaken by Manitoba Water Stewardship in 2003 to determine the source of occasionally high *E. coli* counts and the mechanism of transfer to Lake Winnipeg beaches. Studies have shown large numbers of *E. coli* present in the wet sand of beaches. During periods of high winds, when water levels are rising in the south basin, these bacteria can be washed out of the sand and into the swimming area of the lake. Research shows less than 10% of *E. coli* found at Lake Winnipeg beaches is from human sources, with the remaining percentage from birds and animals.

Figures 14, 15 and 16 illustrate fecal coliform densities in the Dauphin Lake watershed. In all cases fecal coliform densities were below both the irrigation objective of 1000 CFU/ 100 mL. typically, fecal coliform densities were below the recreation objective of 200 CFU/ 100 mL (Williamson 2002). At no time did the beaches monitored along Dauphin Lake exceed the recreation objective (figure 13). The two long term stations on Edwards Creek and the Ochre River exceeded the recreation objective in 2002 and 2003 (figure 12). A number of locations exceeded the recreation objective for historic tributaries not part of the long term monitoring program, including locations on the Turtle River, McKinnon Creek, Edwards Creek, Valley River, Drifting River and Mink Creek (figure 14).

The majority of pesticides for the long term water quality monitoring sites were below the level of detection, or very close to that limit, and thus did not exceed water quality objectives at most locations. This is with the exception of the pesticides Dicamba and MCPA which exceeded irrigation objectives (0.006 and 0.025 µg/L, respectively) on a few occasions. The irrigation objectives for MCPA were exceeded in the Valley River once in 1996 and again in 2010. Conversely the irrigation objective for Dicamba was exceeded on a number of occasions at multiple long term monitoring stations; the Turtle River in 1989, 1990 and 1991; the Valley River in 1990 and 1994; the Vermillion River in 1990, 1993, 1995, 1998; and Edwards Creek in 1995.

Discussion

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% to Lake Winnipeg and nitrogen loading has increased by about 13%. A similar phenomenon has also occurred in many other Manitoba streams, rivers, and lakes.

Manitobans, including those in the Dauphin Lake 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 Dauphin Lake watershed. The Lake Winnipeg Stewardship Board's 2006 report "Reducing Nutrient Loading to Lake Winnipeg and its watershed: Our Collective Responsibility and Commitment to Action" (LWSB 2006) provides 135 recommendations on actions needed to reduce nutrient loading to the Lake Winnipeg watershed. However, reducing nutrients loading to the Lake Winnipeg watershed, including the Westlake watershed, is a challenge that will require the participation and co-operation of all levels of government and all watershed residents. Ensuring good water quality in the Dauphin Lake watershed and downstream is a collective responsibility among all living in the watershed.

Water Quality Management Zones

In June 2005 *The Water Protection Act* received royal ascension. This Act is intended to enable regulations to be developed for strengthening adherence to water quality standards, for protecting water, aquatic ecosystems or drinking water sources, and to provide a framework for integrated watershed management planning. The first regulation under *The Water Protection Act* — the *Nutrient Management Regulation (see:* www.gov.mb.ca/waterstewardship/wqmz/index.html) —

defines five Water Quality Management Zones for Nutrients to protect water from excess nutrients that may arise from the over-application of fertilizer, manure, and municipal waste sludge on land beyond the amounts reasonably required for crops and other plants during the growing season.

As of January 1, 2009, substances containing nitrogen or phosphorus cannot be applied to areas within the Nutrient Buffer Zone or land within Nutrient Management Zone N4 (Canada Land Inventory Soil Capability Classification for Agriculture Class 6 and 7, and unimproved organic soils). The width of the Nutrient Buffer Zone varies depending upon the nature of the body of water and is generally consistent with those contained in the Livestock Manure and Mortalities Management Regulation (42/98).

The *Nutrient Management Regulation* (MR 62/2008) prohibits the construction, modification, or expansion of manure storage facilities, confined livestock areas, sewage treatment facilities, and wastewater lagoons on land in the Nutrient Management Zone N4 or land in the Nutrient Buffer Zone. Further, the construction, installation, or replacement of an on-site wastewater management system (other than a composting toilet system or holding tank) within Nutrient Management Zone N4 or land in the Nutrient Buffer Zone is prohibited (Part 4: Section 14(1): f).

It is recommended that measures are taken to prevent the watering of livestock in any watercourses to prevent bank erosion, siltation, and to protect water quality by preventing nutrients from entering surface water.

No development should occur within the 99 foot Crown Reserve from the edge of any surface water within the rural municipalities. Permanent vegetation should be encouraged on lands within the 99 foot crown reserve to prevent erosion, siltation, and reduce the amount of nutrients entering surface water.

The Nutrient Management Regulation under *The Water Protection Act*, prohibits the application of a fertilizer containing more than 1% phosphorus by weight, expressed as P_2O_5, to turf within Nutrient Management Zone N5 (built-up area such as towns, subdivisions, cottage developments, etc.) except during the year in which the turf is first established and the following year. In residential and commercial applications, a phosphorus containing fertilizer may be used if soil test phosphorus (using the Olsen-P test method) is less than 18 ppm.

The Nutrient Management Regulation (MR 62/2008) under *The Water Protection Act*, requires Nutrient Buffer Zones (set-back distances from the water's edge) be applied to all rivers, streams, creeks, wetlands, ditches, and groundwater features located across Manitoba including within urban and rural residential areas and within agricultural regions (Table A1 in Appendix 1).

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 a 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.

Conclusions and Recommendations:

1. The Water Quality Index for the five long term water quality monitoring station were typically ‘Fair’ to ‘Good’. The majority of total phosphorus concentrations exceeded objectives, thus impacting the Water Quality Index.

2. Total nitrogen data indicate a steady increase in concentrations from 1974 to 2011. As well, total nitrogen concentrations tend to increase downstream compared to upstream locations along Dauphin Lake tributaries. Therefore, management decisions should focus on nutrient reductions to the Dauphin Lake tributaries to ensure the reduction of phosphorus and nitrogen loading to the Dauphin Lake watershed, and ultimately to Lake Winnipeg.

3. Although *E. coli* and fecal coliform densities typically were below the recreation objectives, management decisions should ensure cattle are excluded direct access to water bodies. This will significantly reduce bacterial contamination and nutrient loading to surface waters in the Dauphin Lake watershed.

4. Overall, strategies need to be implemented to protect and enhance the water quality and habitat in the Dauphin Lake watershed. Best Management Practices should be adopted to reduce nutrient loading to the watershed, and ultimately Lake Winnipeg. Consistent with the interim water quality targets set out in the Lake Winnipeg Action Plan, the Dauphin Lake watershed could consider setting a nutrient reduction goal of 10%.

5. Many steps can be taken to protect the Dauphin Lake watershed and its downstream environment. These include:
   - 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.
   - Where feasible, “naturalize” drainage systems to reduce streambed and stream bank erosion, and allowing opportunities for nutrients to be assimilated and settled out of the stream.
   - 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.

- Reduce or eliminate the use of phosphorus-based fertilizers on lawns, gardens, and at the cottage.
- Choose low phosphorus or phosphorus-free cleaning products.
- Prevent soil from eroding off urban and rural properties and reaching storm drains or municipal ditches.
- Ensure that septic systems are operating properly and are serviced on a regular basis. It's important that septic systems are pumped out regularly and that disposal fields are checked on a regular basis to ensure that they are not leaking or showing signs of saturation.
- Evaluate options for potential reduction of nutrients from municipal wastewater treatment systems. Consider options such as effluent irrigation, trickle discharge, constructed wetland treatment, or chemical treatment to reduce nutrient load to the watershed.
- Review the recommendations in the Lake Winnipeg Stewardship Board 2006 report "Reducing Nutrient Loading to Lake Winnipeg and its Watershed: Our Collective Responsibility and Commitment to Action" with the intent of implementing those that are relevant to the Dauphin Lake watershed.

Contact Information

For more information, please contact:

Water Quality Management Section
Manitoba Water Stewardship
Suite 160, 123 Main St
Winnipeg, Manitoba R3C 1A5
Phone: 204-945-7100
Fax: 204-948-2357

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

References:

Bourne, A., N. Armstrong and G. Jones. 2002 (updated in 2006). A preliminary estimate of total nitrogen and total phosphorus loading to streams in Manitoba, Canada. Manitoba Conservation Report No. 2002-04. Winnipeg, MB, Canada. 49 pp.

Canadian Council of Ministers of the Environment (CCME) 2001. Canadian Environmental Quality Guidelines Water Quality Index. http://www.ccme.ca/assets/pdf/wqi_techrprtfctsht_e.pdf

Canadian Council of Ministers of the Environment (CCME). 2001. Canadian water quality guidelines for the protection of aquatic life: CCME Water Quality Index 1.0, Technical Report. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg. http://www.ccme.ca/assets/pdf/wqi_techrprtfctsht_e.pdf

Eastern Interlake Conservation District (EICD). 2008. Gimli Storm Water Quality Assessment 2008 Report. Produced in partnership with the Rural Municipality of Gimli, Manitoba. 16pp. http://www.eicd.net/assets/gimli%20storm%20water%20report%202008.pdf

Hilsenhoff, W.J. 1988. Rapid field assessment of organic pollution with a family-level biotic index. Journal of the North American Benthological Society 7(1):65-68.

Lake Winnipeg Stewardship Board. (LWSB). 2006. Reducing Nutrient Loading to Lake Winnipeg and its watershed: Our Collective Responsibility and Commitment to Action. A Report to the Minister of Water Stewardship., Manitoba. 78pp. http://www.lakewinnipeg.org/web/downloads/LWSB_December_2006_Report_3.pdf

North/South Consultants Inc. 2007. A summary of the benthic macroinvertebrate fauna (2006 and 2007) from Icelandic River; Washow Bay Creek; Grassmere, Parks, Wavey, Netley, and Willow Creeks; Fish Lake Drain; and Fisher River. 25 pp.

Ralley, W. 2010 Manitoba Water Stewardship. Winnipeg, Manitoba. Personal Communication.

Williamson, D.A., W.E. Ralley, A. Bourne, N. Armstrong, R. Fortin, and C.E. Hughes. 2004. Principal factors affecting *Escherichia coli* densities at Lake Winnipeg beaches. Water Quality Management Section. Manitoba Water Stewardship. Manitoba Water Stewardship Report No. 2004-01. 18pp. http://www.gov.mb.ca/waterstewardship/water_quality/lkwpg_beach_report_interim-040129.pdf

Williamson, D.A., 2002. Manitoba Water Quality Standards, Objective, and Guidelines. Manitoba Conservation. Report 2002-11 http://www.gov.mb.ca/waterstewardship/water_quality/quality/mwqsog_2002.pdf

Appendix 9:
Table A9: The Nutrient Buffer Zone widths as outlined in the Nutrient Management Regulation (MR 62/2008) under *The Water Protection Act*.

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.

A healthy riparian zone is critical to river ecosystem health providing shade, organic inputs, filtering of nutrients and habitat creation (falling trees). Preserving space along rivers gives the river freedom to naturally meander across the landscape and buffers the community from flooding impacts. Reference to the Nutrient Buffer Zone and its significance can be coupled with **Section 3.1.8 – Environmental Policies** which identifies the goals of enhancing surface water and riverbank stability, and the importance of respecting setbacks.

Dauphin Lake Watershed Integrated Watershed Management Plan

Total Suspended Solids Analysis

From the data it appears TSS concentrations have remained relatively constant over time at the five long term water quality monitoring stations. This is with the exception of Edwards Creek and the Vermillion River which have shown pronounced peaks over time, and thus overall have significantly greater TSS concentrations than the other three rivers. In terms of historic data and stations not part of the long term program, the Vermillion River and Wilson River showed the greatest overall TSS concentrations, followed by one location on the Turtle River, Valley River and Edwards Creek.

Prepared by:

Water Quality Management Section

Manitoba Water Stewardship

Winnipeg, Manitoba

November 2011

Total Suspended Solids Analysis

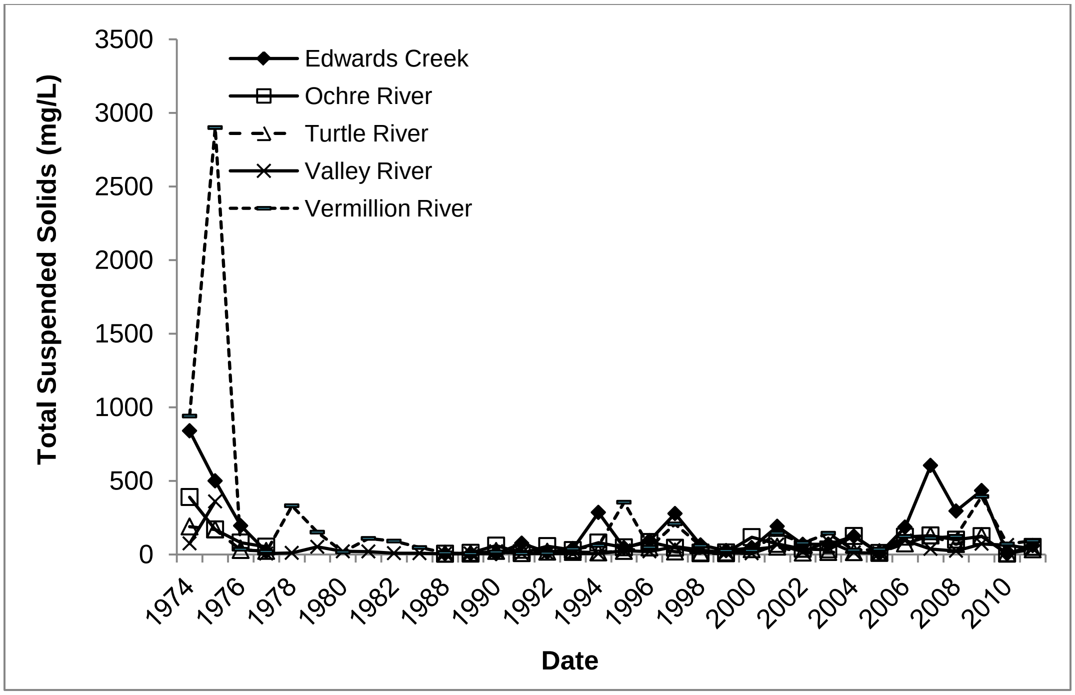

Figure 1: Total suspended solids (mg/L) concentration from the five long term water quality monitoring sites in the Dauphin Lake watershed between 1974 and 2011.

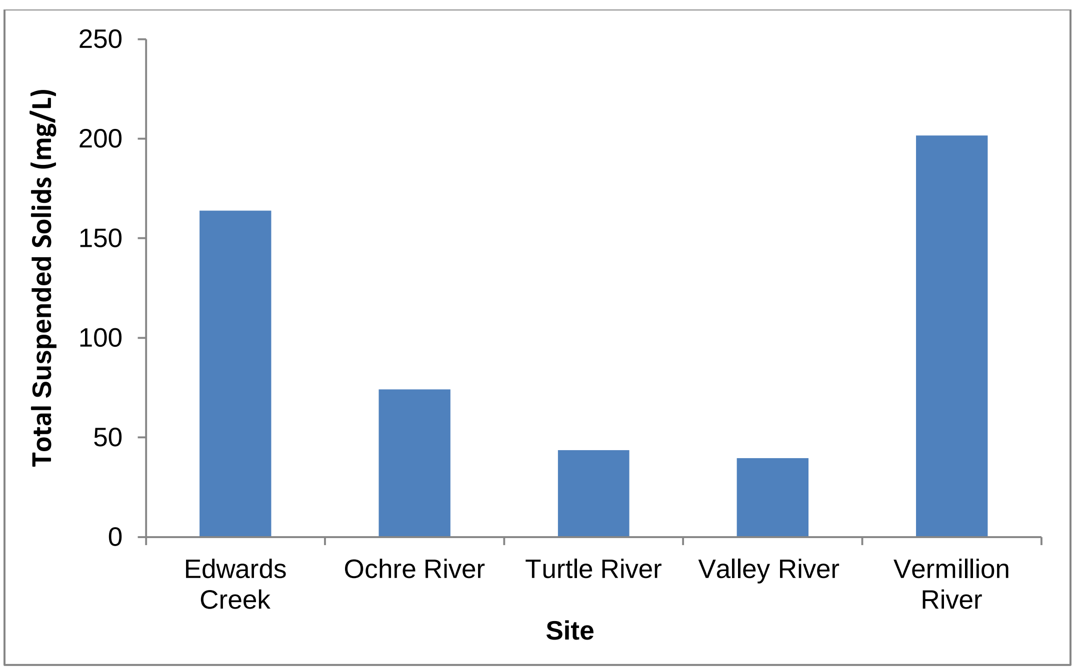

Figure 2: Mean total suspended solids (mg/L) concentrations from the five long term water quality monitoring sites in the Dauphin Lake watershed calculated over the period of 1974 – 2011.

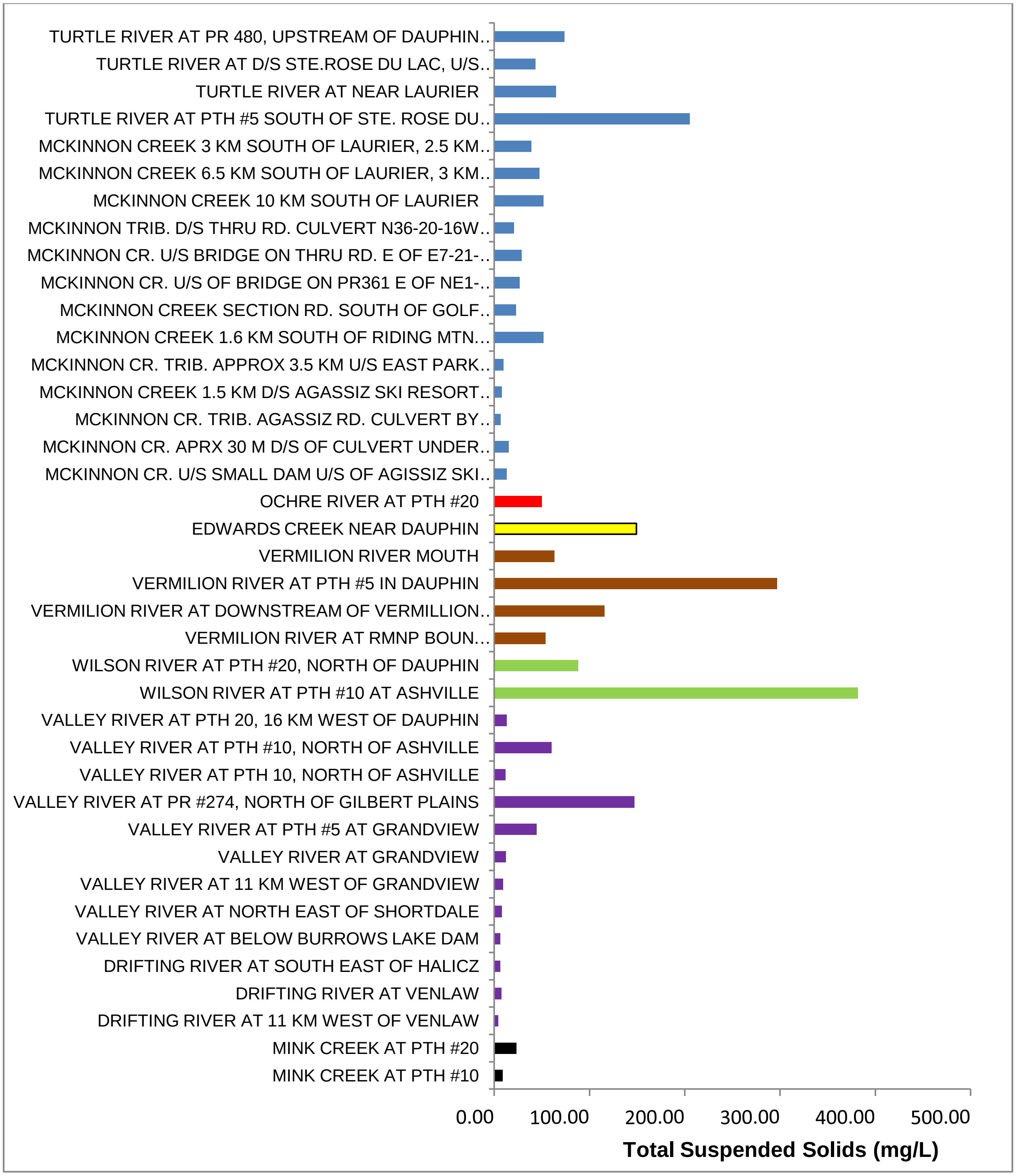

Figure 3: Mean total suspended solids (mg/L) concentration for historic monitoring locations not part of the long term water quality monitoring program, in the Dauphin Lake watershed between 1974 and 2007. The different colours indicate different tributaries. Tributaries are listed from south to north along the watershed, and each tributary is listed in order of flow towards Dauphin Lake.