Westlake Watershed Integrated Watershed Management Plan- Water Quality Report

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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 Westlake watershed.

The Westlake watershed does not contain any long term water quality monitoring stations, as the area has few major tributaries running through it making it difficult to establish long term stations in which to monitor. The available water quality data from the Westlake watershed is primarily historical (1973 – 1977), with some recent data (2004-2009), from five locations along Lake Manitoba and one location on the Waterhen River.

The area is characterized by three major land management practices; mixed crop hay land, marsh-wetland, and pasture area for beef cattle production. The latter two, marshland and pasture area are the dominant land uses in the area. Mixed crop hay land can present water quality concerns in terms of fertilizer runoff during periods of intense precipitation. Pasture area and beef cattle production can present water quality concerns during manure application to cropland and manure storage. Conversely, the marsh-wetland areas will have a positive impact on water quality, as wetlands are highly effective filters which significantly reduce sediment loading, and nitrogen and phosphorus concentrations through plant uptake and soil microbial metabolic processes. In addition, un-fertilized hay land can act as a riparian buffer zone to reduce sediment and nutrients from entering adjoining water bodies, such as Lake Manitoba.

The water body of largest concern in the Westlake watershed is Lake Manitoba, as the area surrounding the lake is primarily agricultural production yielding a high potential for nutrient and bacteria loading. In addition, the *Nutrient Management Regulation* under the *Water Protection Act* lists Lake Manitoba as a vulnerable water body. Please refer to the section on 'Water Quality Management Zones' for more detailed information with this regard.

Statistical means comparisons (ANOVA) were not conducted on water quality data, as insufficient data were available, hence, only means and trends are shown.

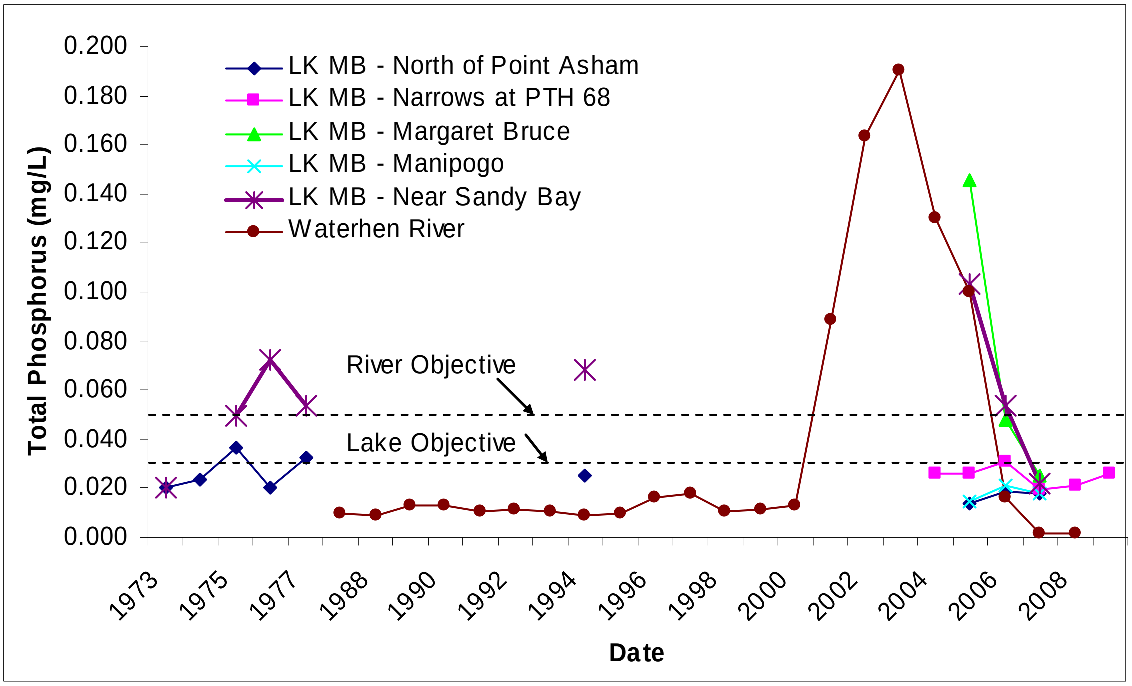

Figure 1: Total phosphorus (mg/L) concentrations from five locations on Lake Manitoba and one location on the Waterhen River in the Westlake watershed between 1973 and 2009.

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 1 illustrates total phosphorus in the Westlake watershed. Typically, total phosphorus concentrations were below both the Manitoba Water Quality Guideline for rivers, 0.05 mg/L, and lakes, 0.03 mg/L (Williamson, 2002). However, the period from 2002 to 2006 showed peak phosphorus concentrations in the Waterhen River, Lake Manitoba near Sandy Bay, and Lake Manitoba at Margaret Bruce, which exceeded both the river and lake objectives. Interestingly, by 2007 all six locations show total phosphorus concentrations well below both the river and lake objectives.

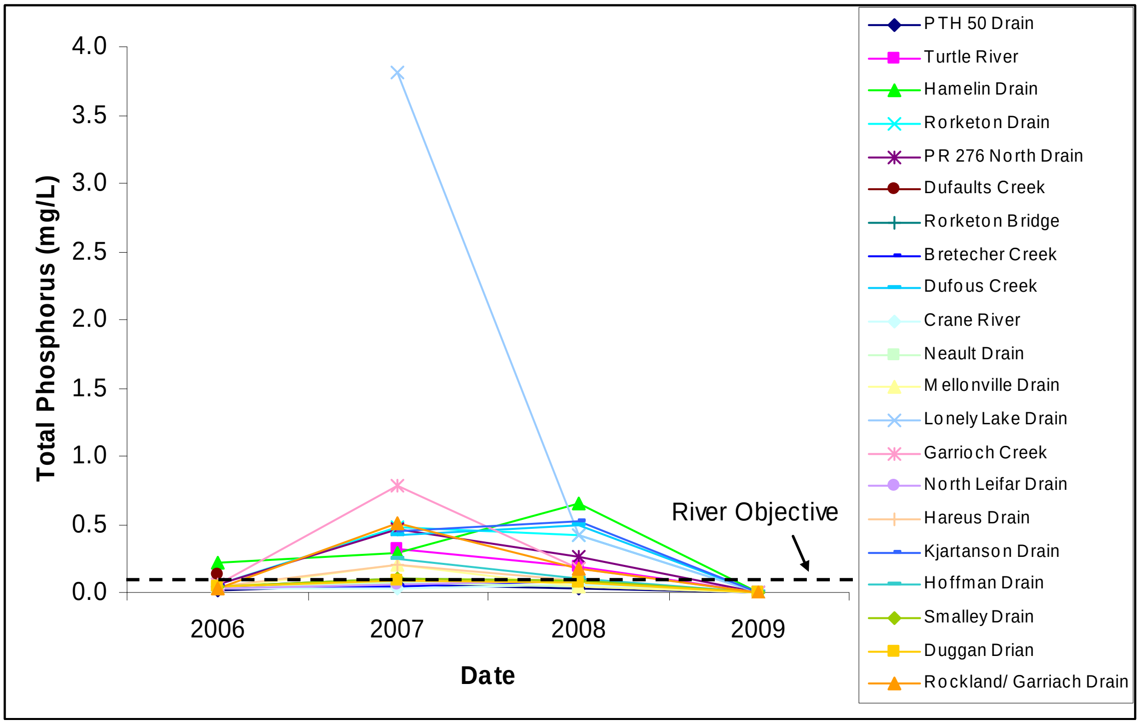

Figure 2: Total phosphorus (mg/L) concentrations from 21 locations across the Alonsa Conservation District. Data collected by the Alonsa Conservation District for an independent study.

Figure 2 illustrates total phosphorus data collected by the Alonsa Conservation District for an independent study on the impact of direct cattle access to water bodies in the Westlake Watershed. Data indicate almost all 21 sites exceeded the Tier III Manitoba Water Quality Guideline of 0.05 mg/ L (Williamson, 2002). Compared to the total phosphorus in Figure 1, drains throughout the Alonsa Conservation District are significantly impacted by phosphorus loading. Therefore, management decisions should focus on reducing phosphorus loading to drains in the Westlake watershed, and ensure a continued decrease in total phosphorus concentrations to Lake Manitoba and the Waterhen River to below the 0.05 mg/L objective.

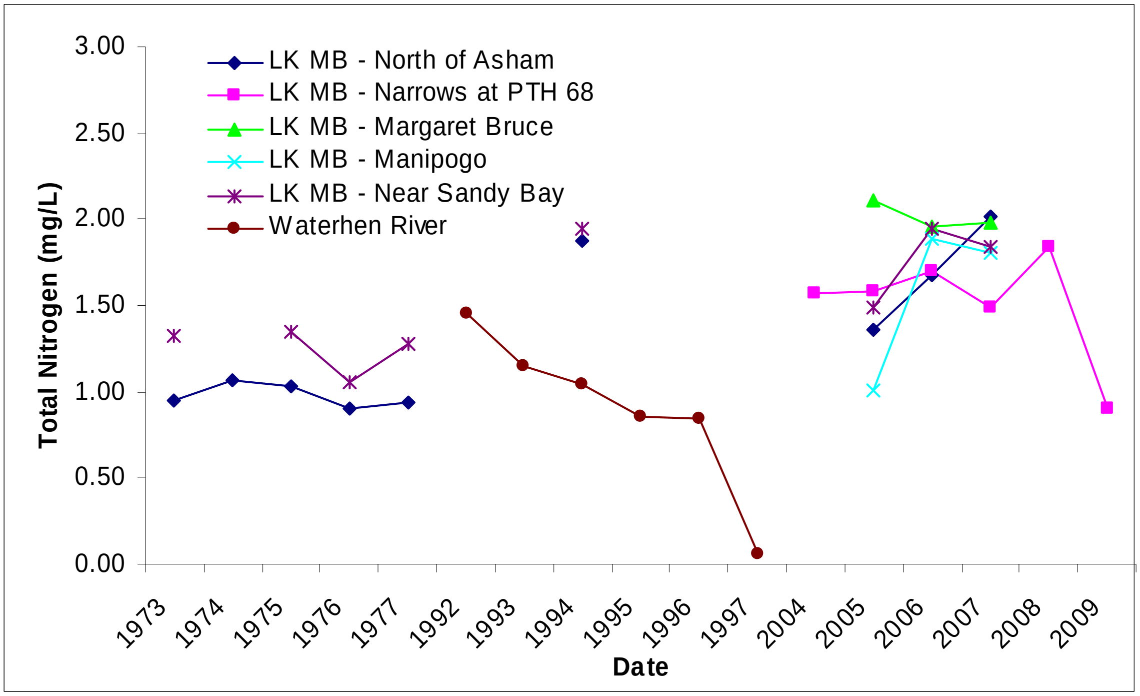

Figure 3: Total nitrogen (mg/L) concentrations from five locations on Lake Manitoba and one location on the Waterhen River in the Westlake watershed between 1973 and 2009.

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. Figure 3 illustrates the total nitrogen concentration in the Westlake watershed. Since 1973 total nitrogen has increased at most locations. However, since 2006 total nitrogen tends to decrease at all locations except Lake Manitoba North of Point Asham, in which no samples have been taken since 2007. Also, the Waterhen River has shown a steady decrease in nitrogen concentration since sampling began in 1992.

Figure 4 illustrates total nitrogen data collected by the Alonsa Conservation District. Compared to total nitrogen in figure 3, the majority of drains around the Alonsa Conservation District are significantly impacted by nitrogen loading. Although there has been a decline in total nitrogen concentration from 2008 to 2009, management decisions should ensure continued reduction of nitrogen loading to these drains, and the Westlake watershed.

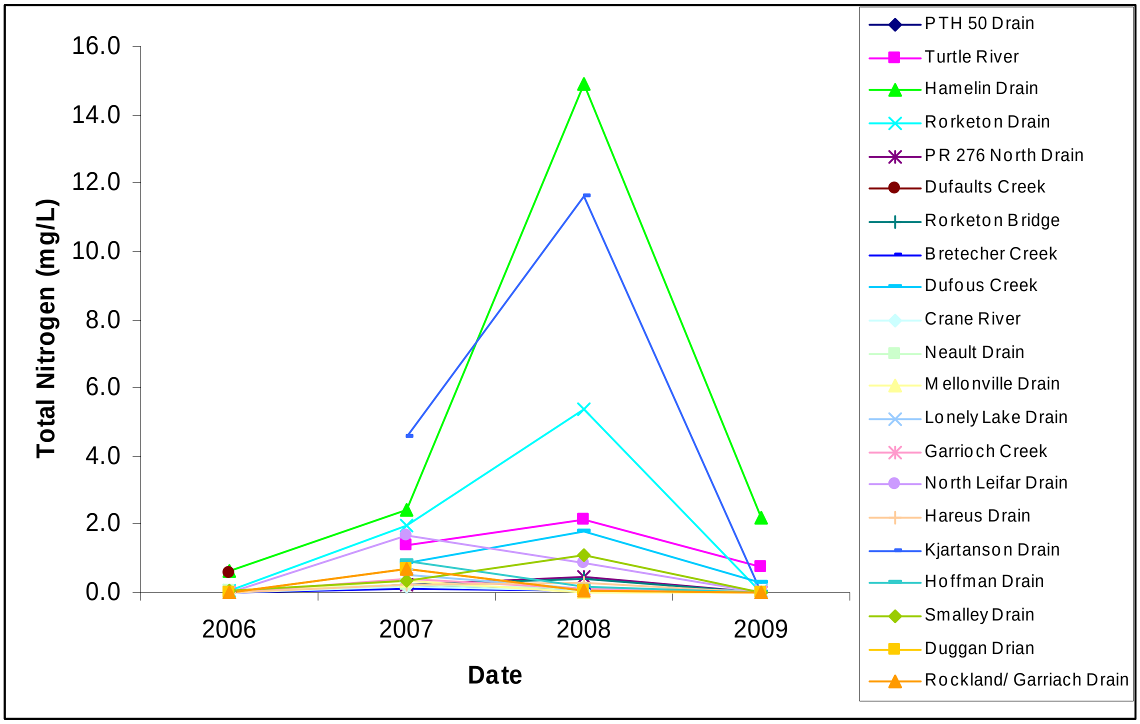

Figure 4: Total nitrogen (mg/L) concentrations from 21 locations across the Alonsa Conservation District. Data collected by the Alonsa Conservation District for an independent study.

Maintenance of adequate dissolved oxygen levels is essential to the health of aquatic life inhabiting streams. The monitoring conducted in the Westlake watershed (Figure 5) demonstrates that dissolved oxygen levels are generally above the 5.0 mg/ L Manitoba objective (Williamson, 2002). The only exception was in 2000 when dissolved oxygen levels dropped below the objective during late fall, and early spring while the river was still frozen. 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.

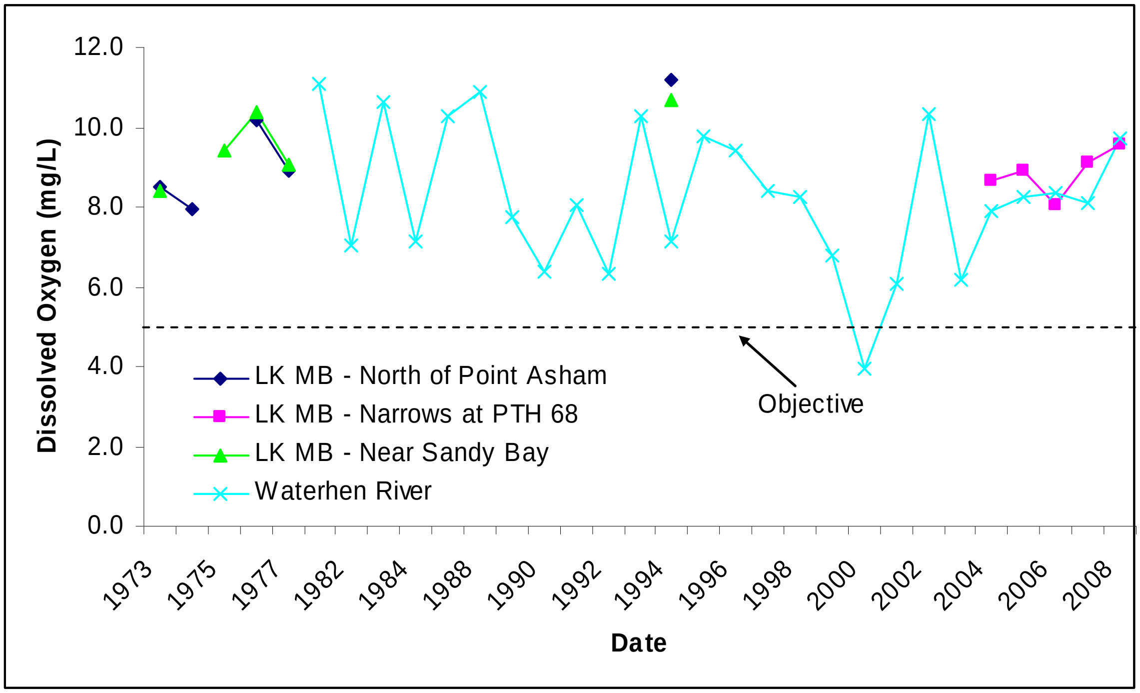

Figure 5: Dissolved oxygen (mg/L) concentrations from three locations on Lake Manitoba and one location on the Waterhen River in the Westlake watershed between 1973 and 2008.

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.

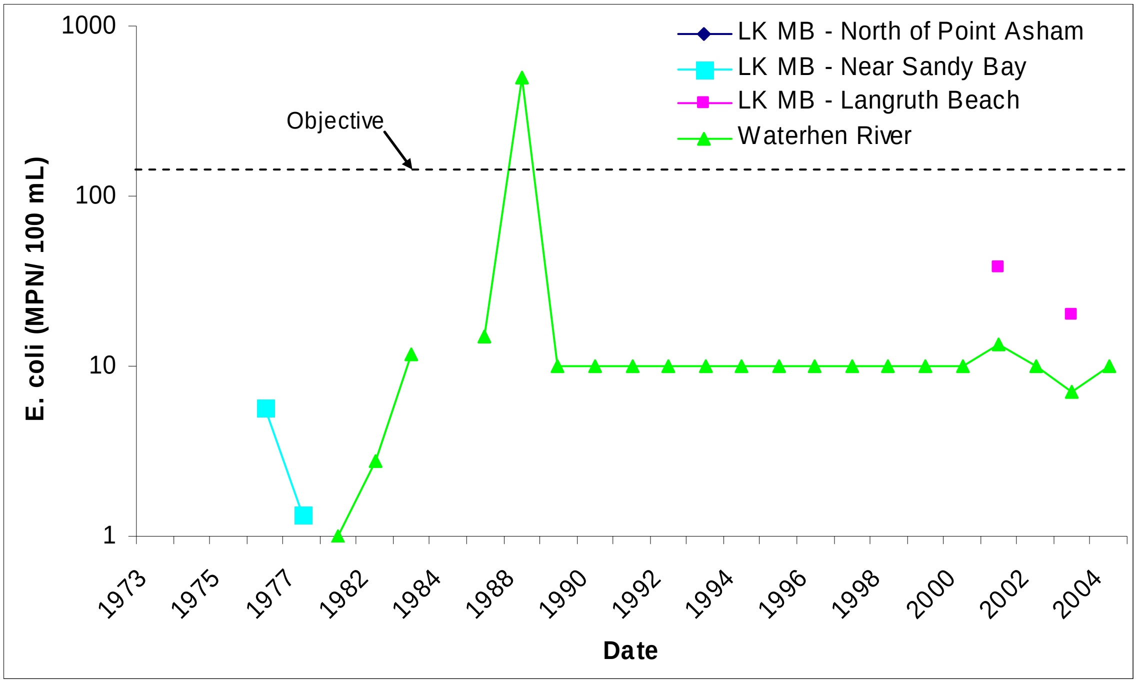

Figure 6: Densities of *Escherichia coli (E. coli*) collected from three locations on Lake Manitoba and one location on the Waterhen River between 1973 and 2009. Values were 0.0 MPN/ 100 mL for all North of Point Asham samples collected. The objective is 200 MPN per 100 mL.

Figure 6 shows *E. coli* densities from two locations on Lake Manitoba, Sandy Bay and Langruth Beach, in the Westlake watershed. Data collected for Lake Manitoba North of Point Asham from 1973 – 1977 were all found to be zero MPN/ 100 mL. Overall, the results indicate bacteria densities in this watershed are well below both the irrigation objective of 1000 MPN/ 100 mL, and the body contact recreation objective of 200 MPN/ 100 mL. This was with the exception of the Waterhen River in 1988 in which there was a large spike in *E. coli* to nearly 500 MPN/ 100 mL. However typically, both *E. coli* and fecal coliforms were within the guideline in this area.

Figure 7 shows *E. coli* densities from 21 locations across the Alonsa Conservation District. The results indicate bacteria densities are again typically well below both the irrigation objective (1000 *E. coli* / 100 mL), and body contact objective (200 *E. coli* / 100 mL). This is with the exception of the Turtle River and PR 276 North Drain in 2007, in which *E. coli* counts were above the detection limit of 200 CFU/ 100 mL.

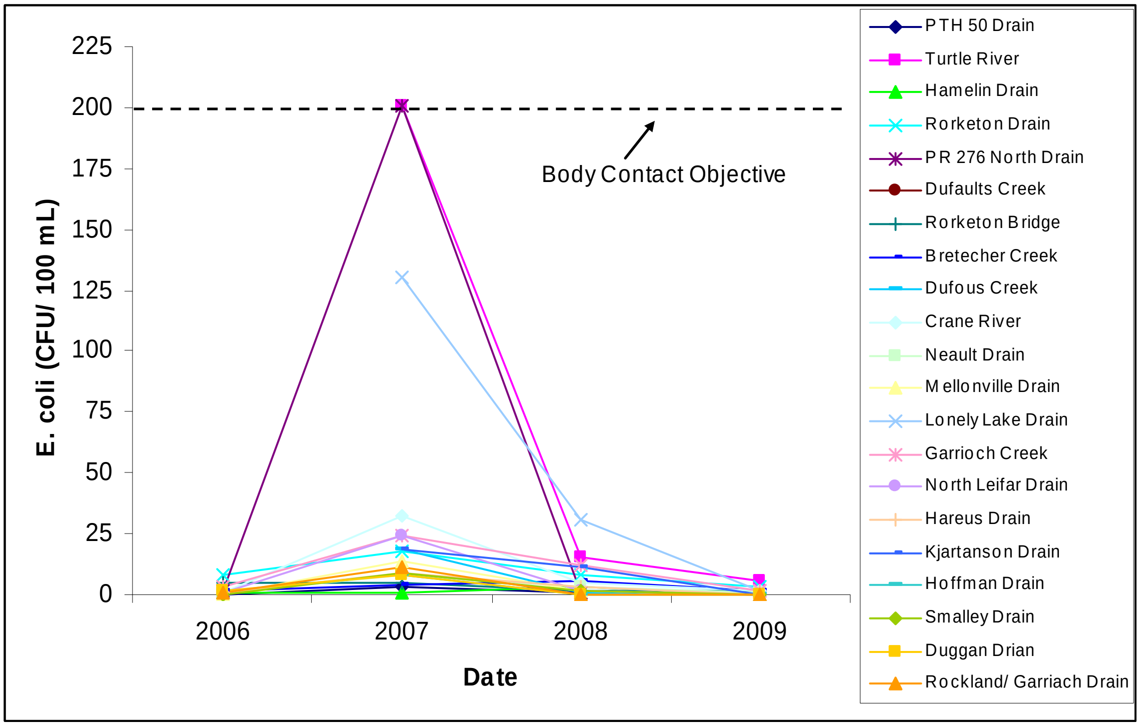

Figure 7: Densities of *Escherichia coli* (*E. coli*) collected from 21 locations across the Alonsa Conservation District. Data collected by the Alonsa Conservation District for an independent study.

Pesticide data was available for Lake Manitoba at the Narrows and the Waterhen River. Pesticide concentrations were almost always below the level of detection, or very close to that limit, and at no time did the results from either location exceed water quality objectives.

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

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

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

Unfortunately there is not yet sufficient data collected for the Westlake watershed in order to calculate a water quality index for this site. The CCME guidance document states that the WQI should not be run with less than four parameters and four sampling visits per year. As more data is collected, this index can be used as a tool to report on water quality conditions in the Westlake watershed.

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 Westlake 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 Lake Manitoba and the Westlake 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 Westlake 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 A6 in Appendix 6).

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.

Culverts

- 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. Data collected illustrate in the last couple years total phosphorus and nitrogen concentrations tend to be decreasing in the Westlake watershed. Data collected by the Alonsa Conservation District typically showed larger concentrations of nutrients than present in Lake Manitoba and the Waterhen River. Therefore, management decisions should focus on nutrient reductions to drains in the Westlake watershed, to ensure the continued reduction of phosphorus and nitrogen loading to Lake Manitoba.

2. Although *E. coli* densities typically are below the 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 Westlake watershed.

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

4. Many steps can be taken to protect the Westlake 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 Westlake watershed.

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

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Appendix 1:

Table A1: Total phosphorus (mg/L) concentrations collected from the Westlake watershed for five locations on Lake Manitoba and one location on the Waterhen River between 1973 and 2009.

Date	Lake Manitoba					Waterhen River
	North of Point Asham	Narrows at PTH 68	Margaret Bruce	Manipogo	Near Sandy Bay	
1973	0.020	-	-	-	0.020	-
1974	0.023	-	-	-	-	-
1975	0.037	-	-	-	0.050	-
1976	0.020	-	-	-	0.073	-
1977	0.032	-	-	-	0.053	-
1987	-	-	-	-	-	0.010
1988	-	-	-	-	-	0.009
1989	-	-	-	-	-	0.013
1990	-	-	-	-	-	0.013
1991	-	-	-	-	-	0.010
1992	-	-	-	-	-	0.012
1993	-	-	-	-	-	0.010
1994	0.025	-	-	-	0.068	0.009
1995	-	-	-	-	-	0.010
1996	-	-	-	-	-	0.016
1997	-	-	-	-	-	0.018
1998	-	-	-	-	-	0.011
1999	-	-	-	-	-	0.012
2000	-	-	-	-	-	0.013
2001	-	-	-	-	-	0.089
2002	-	-	-	-	-	0.163
2003	-	-	-	-	-	0.190
2004	-	0.026	-	-	-	0.130
2005	0.014	0.026	0.146	0.015	0.104	0.100
2006	0.018	0.031	0.048	0.021	0.054	0.017
2007	0.018	0.019	0.025	0.018	0.022	0.002
2008	-	0.021	-	-	-	0.002
2009	-	0.026	-	-	-	-

Appendix 2:

Table A2: Total nitrogen (mg/L) concentrations collected from the Westlake watershed for five locations on Lake Manitoba and one location on the Waterhen River between 1973 and 2009.

	Lake Manitoba					
Date	**North of Point Asham**	**Narrows at PTH 68**	**Margaret Bruce**	**Manipogo**	**Near Sandy Bay**	**Waterhen River**
1973	0.955	-	-	-	1.320	-
1974	1.070	-	-	-	-	-
1975	1.037	-	-	-	1.353	-
1976	0.898	-	-	-	1.055	-
1977	0.937	-	-	-	1.280	-
1992	-	-	-	-	-	1.457
1993	-	-	-	-	-	1.153
1994	1.870	-	-	-	1.950	1.043
1995	-	-	-	-	-	0.850
1996	-	-	-	-	-	0.840
1997	-	-	-	-	-	0.055
2004	-	1.570	-	-	-	-
2005	1.360	1.587	2.110	1.010	1.485	-
2006	1.670	1.696	1.954	1.890	1.950	-
2007	2.010	1.487	1.980	1.810	1.840	-
2008	-	1.843	-	-	-	-
2009	-	0.904	-	-	-	-

Appendix 3:

Table A3: *E. coli* densities (CFU/ 100 mL) and Fecal coliforms (MPN/ 100 mL) collected from the Westlake watershed for three locations on Lake Manitoba and one location on the Waterhen River between 1973 and 2004.

Date	Lake Manitoba			Waterhen River
	North of Point Asham	Near Sandy Bay	Langruth Beach	
	MPN/ 100 mL	CFU/ 100 mL	CFU/ 100 mL	MPN/ 100 mL
1973	0.000	0.000	-	-
1974	0.000		-	-
1975	0.000	0.000	-	-
1976	0.000	5.750	-	-
1977	0.000	1.333	-	-
1981	-	-	-	1.000
1982	-	-	-	2.800
1983	-	-	-	11.714
1984	-	-	-	0.000
1987	-	-	-	15.000
1988	-	-	-	494.667
1989	-	-	-	10.000
1990	-	-	-	10.000
1991	-	-	-	10.000
1992	-	-	-	10.000
1993	-	-	-	10.000
1994	-	-	-	10.000
1995	-	-	-	10.000
1996	-	-	-	10.000
1997	-	-	-	10.000
1998	-	-	-	10.000
1999	-	-	-	10.000
2000	-	-	-	10.000
2001	-	-	38.000	13.333
2002	-	-	-	10.000
2003	-	-	20.000	7.000
2004	-	-	-	10.000

Appendix 4:

Table A4: Dissolved oxygen (mg/L) concentrations collected from the Westlake watershed for three locations on Lake Manitoba and one location on the Waterhen River between 1973 and 2008.

Date	Lake Manitoba			Waterhen River
	North of Point Asham	Narrows at PTH 68	Near Sandy Bay	
1973	8.500	-	8.400	-
1974	7.950	-	-	-
1975	-	-	9.400	-
1976	10.175	-	10.375	-
1977	8.900	-	9.050	-
1981	-	-	-	11.080
1982	-	-	-	7.050
1983	-	-	-	10.638
1984	-	-	-	7.150
1987	-	-	-	10.300
1988	-	-	-	10.900
1989	-	-	-	7.733
1990	-	-	-	6.367
1991	-	-	-	8.033
1992	-	-	-	6.310
1993	-	-	-	10.300
1994	11.200	-	10.700	7.114
1995	-	-	-	9.750
1996	-	-	-	9.433
1997	-	-	-	8.400
1998	-	-	-	8.267
1999	-	-	-	6.800
2000	-	-	-	3.967
2001	-	-	-	6.067
2002	-	-	-	10.333
2003	-	-	-	6.167
2004	-	8.633	-	7.900
2005	-	8.925	-	8.250
2006	-	8.040	-	8.350
2007	-	9.100	-	8.080
2008	-	9.567	-	9.700

Appendix 5:

Table A5: Total phosphorus (mg/L), total nitrogen (mg/L) and *E. coli* (CFU/ 100 mL) collected from 21 locations across the Alonsa Conservation District. Data collected by the Alonsa Conservation District for an independent study.

	Total Phosphorus (mg/L)				**Total Nitrogen (mg/L)**				***E. coli* (CFU/ 100 mL)**			
PTH 50 Drain	**2006**	**2007**	**2008**	**2009**	**2006**	**2007**	**2008**	**2009**	**2006**	**2007**	**2008**	**2009**
Turtle River	0.02	0.051	0.033	0.020	0.014	0.161	0.135	0.005	0	3	1	0
Hamelin Drain	-	0.324	0.186	0.089	-	1.380	2.120	0.726	-	201	15	6
Rorketon Drain	0.211	0.286	0.646	0.960	0.639	2.400	14.900	2.190	1	1	3	0
PR 276 North Drain	0.058	0.476	0.421	0.031	0.054	1.970	5.350	0.005	8	18	8	3
Dufaults Creek	0.053	0.464	0.259	0.023	0.008	0.221	0.447	0.005	2	201	1	0
Rorketon Bridge	0.128	-	-	-	0.586	-	-	-	2	-	-	-
Bretecher Creek	0.044	0.096	0.084	0.020	0.019	0.254	0.392	0.005	5	5	2	2
Dufous Creek	0.049	0.043	0.087	0.025	0.005	0.108	0.045	0.005	2	4	6	2
Crane River	-	0.424	0.495	0.051	-	0.888	1.810	0.285	-	19	1	0
Neault Drain	0.022	0.029	0.051	0.035	0.005	0.174	0.033	0.005	1	32	5	2
Mellonville Drain	0.036	0.076	0.041	0.032	0.057	0.212	0.092	0.005	1	8	3	1
Lonely Lake Drain	0.035	0.206	0.046	0.031	0.005	0.374	0.005	0.005	0	14	2	0
Garrioch Creek	-	3.81	0.425	0.095	-	0.542	0.119	0.029	-	130	31	2
North Leifar Drain	0.057	0.778	0.169	0.047	0.014	0.426	0.091	0.010	3	24	12	2
Hareus Drain	0.033	0.063	0.092	0.034	0.010	1.650	0.878	0.005	1	24	2	0
Kjartanson Drain	0.041	0.198	0.086	0.026	0.006	0.208	0.288	0.005	1	9	3	0
Hoffman Drain	-	0.454	0.518	0.047	-	4.540	11.600	0.005	-	19	11	0
Smalley Drain	-	0.244	0.108	0.037	-	0.925	0.153	0.005	-	8	0	0
Duggan Drain	0.043	0.101	0.094	0.051	0.033	0.330	1.080	0.005	0	9	2	0
Rockland/ Garriach Drain	0.047	0.083	0.072	0.038	0.006	0.694	0.043	0.005	2	8	0	0

Appendix 6:
Table A6. 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.