A Proposed Regulation under the Water Protection Act

Nutrient Concentration and Loading Targets for Lake Winnipeg and its Tributaries

Public Consultation Document

Winter 2020

Introduction: Nutrient Challenges

The Government of Manitoba is committed to protecting, maintaining, and improving the health of aquatic ecosystems and water resources across the province. Manitoba is leading by example in developing and implementing legislation protecting surface waters from the impacts of nutrient pollution. The Sustainable Watersheds Act, which received royal assent in June 2018, amended The Water Protection Act to enable the development of nutrient targets for Lake Winnipeg and its tributaries and committed Manitoba to reporting regularly on progress towards implementing the targets.

In Manitoba, and in many other jurisdictions across the world, nutrients continue to be one of the more important and challenging water quality issues. Nutrient concentrations in rivers and lakes are increasing resulting in more frequent and intense algal blooms such as those observed on Lake Winnipeg. The lake has experienced an increasing frequency and severity of cyanobacterial blooms, at times covering more than 10,000 square kilometers of the lake surface area. Actions to improve water quality in Lake Winnipeg are challenging given the many small sources of nutrients across the one million square kilometer basin. Virtually all activities across the Lake Winnipeg basin contribute nutrients to the lake, including point sources such as wastewater and industrial discharges and non-point source runoff from agriculture, golf courses, urban and cottage areas.

About half of the nutrients in Lake Winnipeg originate from within Manitoba with the remaining nutrients being contributed from upstream jurisdictions (i.e., Ontario, Saskatchewan, Alberta, North Dakota, Minnesota, and a small area of South Dakota and Montana). The Red River contributes the largest load of nutrients to Lake Winnipeg and therefore, has been the primary focus for nutrient management strategies and nutrient reduction on a provincial and international scale. However, other major tributaries discharging into the lake (Winnipeg, Saskatchewan, Dauphin) also contribute a significant proportion of nutrient load and streamflow to the lake. Strong action on many fronts across the Lake Winnipeg basin will be required to reduce nutrient loading and improve water quality in Lake Winnipeg and the rivers and streams flowing into the lake.

The proposed regulation under The Water Protection Act would establish nutrient loading targets for the four major tributaries (Red, Winnipeg, Saskatchewan, and Dauphin Rivers) flowing into Lake Winnipeg and nutrient concentration targets for total phosphorus and total nitrogen in Lake Winnipeg.

Expected Outcomes

Establishing and achieving nutrient concentration targets in Lake Winnipeg and nutrient loading targets for major tributaries flowing into Lake Winnipeg would:

- Provide science based benchmarks for measuring progress towards nutrient reduction activities in Manitoba and in upstream jurisdictions.
- Support the derivation of watershed specific nutrient load targets for smaller rivers and streams flowing into the Red, Winnipeg, Dauphin, and Saskatchewan Rivers.
- Improve water quality in Lake Winnipeg by reducing the duration, frequency, and intensity of nuisance and harmful algal blooms.
- Boost Manitoba's economy by improving ecosystem services such as for recreation, drinking water, and protection of aquatic life (e.g., fish).
- Provide leadership within Manitoba, nationally and internationally in the development of a regulatory framework for implementation of nutrient reduction targets in aquatic ecosystems.

Background

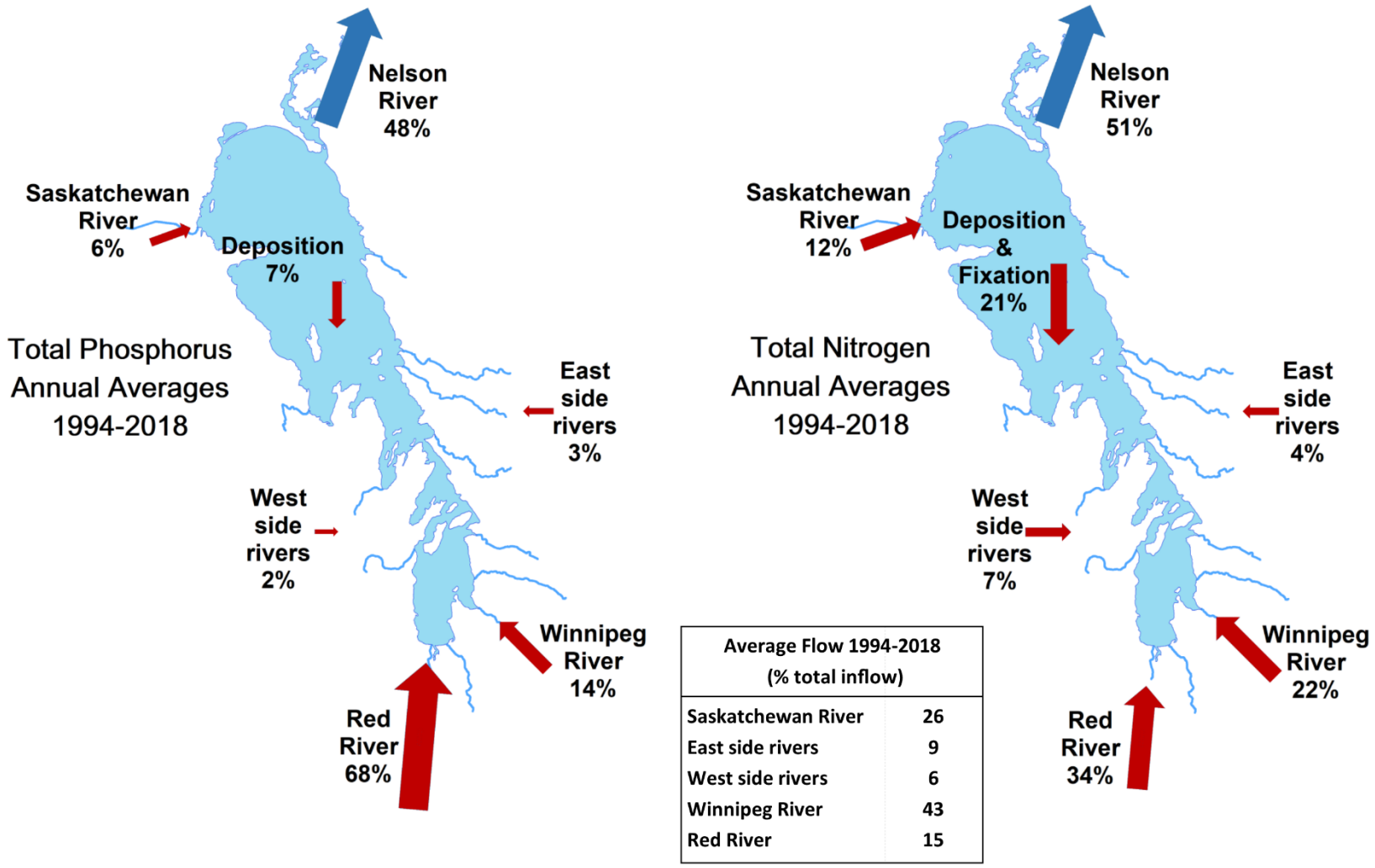
The gradual but steady increase in nitrogen and phosphorus over the past several decades is one of the single, largest water quality challenges facing jurisdictions all over the world, including Manitoba. Although nutrients are vital for healthy lakes and rivers, excessive concentrations can lead to algal blooms that spoil drinking water, ruin beaches, reduce property values, and damage fish and other aquatic life. In addition, some forms of blue green algae or cyanobacteria can produce highly potent toxins that can harm animals (e.g., livestock, pets) and humans.

Over the past several decades, significant progress has been made to reduce nutrient contributions to surface waters through legislation, implementing changes on the landscape, supporting research and monitoring, as well as engaging the public. However, nutrient concentrations in Lake Winnipeg and its tributaries remain elevated and further guidance is required to reduce nutrient loads and improve water quality.

Establishing and implementing nutrient targets is expected to help our collective nutrient reduction efforts by helping to guide future nutrient reduction activities and the implementation of best management practices, to identify priorities, and to track progress and outcomes over time.

Where do nutrients come from in Lake Winnipeg?

Nutrients come from virtually all of our activities across the large Lake Winnipeg watershed that stretches from Alberta to Ontario and south into North Dakota, Minnesota, and South Dakota. Of all major tributaries, the Red River contributes the largest quantities of nutrients to Lake Winnipeg. Between 1994 and 2018, the Red River contributed approximately 68 per cent of the total phosphorus load and 34 per cent of the total nitrogen load to Lake Winnipeg on average; despite only contributing about 17 per cent of the total inflow to the lake (Figure 1). The Winnipeg River contributed nearly half of the flow to Lake Winnipeg, and approximately 14 per cent of the total phosphorus load and 22 per cent of the total nitrogen load. The Saskatchewan River contributed approximately 6 per cent of the total phosphorus load and 12 per cent of the total nitrogen load to Lake Winnipeg, and contributes approximately one quarter of the inflow to the lake. Nutrients also come from other sources. For example, it has been estimated that up to 7 per cent of the total phosphorus in Lake Winnipeg originates from atmospheric deposition (e.g., dust and rainfall). Atmospheric deposition and nitrogen fixation by algae is estimated to contribute approximately 21 per cent of the total nitrogen load to the lake. Nutrients that flow into Lake Winnipeg may settle out in to the sediments of the lake and can then become mixed back into the water in the future. The Nelson River is the only outlet from Lake Winnipeg. However, it has been estimated that only approximately one half of the nutrient load exits the lake through the Nelson River indicating a significant amount of nutrient retention within the lake and its sediments. A summary of estimated annual total phosphorus and total nitrogen loading to Lake Winnipeg from Manitoba and upstream jurisdictions is provided in Table 1.



Average Flow 1994-2018 (% total inflow)	
Saskatchewan River	26
East side rivers	9
West side rivers	6
Winnipeg River	43
Red River	15

Figure 1. Estimated total phosphorus and total nitrogen loads, and flow to Lake Winnipeg (1994-2018)

Table 1. Summary of estimated annual total phosphorus and total nitrogen loads to Lake Winnipeg from Manitoba and from upstream jurisdictions (1994-2018 average).

	Phosphorus Load		**Nitrogen Load**	
	Tonnes per year	Per cent Contribution	Tonnes per year	Per cent Contribution
Upstream Jurisdictions	**3,745**	**52**	**37,415**	**39**
United States - Red River	2,397	33	16,604	18
United States - Souris River	199	3	1,174	1
Saskatchewan and Alberta - Assiniboine, Qu'Appelle and Saskatchewan River	223	3	1,738	2
Ontario and United States - Winnipeg River	853	12	16,508	17
Ontario - Other East Side Lake Winnipeg Rivers	73	1	1,391	1
Manitoba Sources	**3,442**	**48**	**57,406**	**61**
Total Lake Winnipeg Nutrient Load	**7,187**	**100**	**94,822**	**100**

Nutrient concentration targets for Lake Winnipeg

The proposed regulation under The Water Protection Act would include nutrient concentration targets for Lake Winnipeg that are based largely on work done through the University of Regina. Paleolimnological records used to reconstruct historical water quality conditions in Lake Winnipeg indicated that total phosphorus concentrations increased from 0.015 mg/L in the 1800s, to more than 0.05 mg/L in the early 1990s, to more than 0.1 mg/L in the present day. Similarly, a shift in the algal community structure occurred in the south basin of the lake over the past three decades, as evidenced by more frequent nitrogen-fixing cyanobacteria blooms. In an effort to reduce the frequency and severity of cyanobacteria blooms, a total phosphorus concentration target of 0.05 mg/L is recommended to return Lake Winnipeg to conditions similar to those in the 1990s (Table 2). A total nitrogen concentration target of 0.75 mg/L is recommended to ensure that the ratio of nitrogen to phosphorus in the lake will not promote the growth of potentially nitrogen-fixing algal blooms (that is, cyanobacteria that can use nitrogen from the atmosphere) (Table 2). If nutrient concentration targets of 0.75 mg/L TN and 0.05 mg/L TP are achieved, this would result in an N:P ratio of 33:1 which helps to ensure that the lake is, on average, phosphorus limited.

Nutrient concentration targets would be applied as follows:

- Based on the average concentration of total nitrogen and total phosphorus measured in the south (including the narrows) and north basins of Lake Winnipeg.
- Applied as an annual average for the open water season (May 1st to October 31st).
- The Lake Winnipeg Research Consortium and Environment and Climate Change Canada are important partners in the work to collect water samples from Lake Winnipeg.

Table 2. Total phosphorus and total nitrogen concentration targets for the south basin (including narrows) and north basin of Lake Winnipeg.

Location	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)
Lake Winnipeg – South Basin and Narrows	0.05	0.75
Lake Winnipeg – North Basin	0.05	0.75

How do the proposed targets compare to current nutrient concentrations in Lake Winnipeg?

In July 2020, Manitoba published a Nutrient Status and Trends Report documenting Lake Winnipeg nutrient concentrations and loads (Agriculture and Resource Development 2020). While variability between years occurs, nutrient concentrations have not increased or decreased significantly between 1999 and 2018 (Figure 2). In general, total phosphorus concentrations in the south basin and narrows are approximately two times higher than the phosphorus target of 0.05 mg/L. Meanwhile, concentrations in the north basin have been below the phosphorus target in most years. Significant reductions in phosphorus concentrations in the south basin and narrows will be required to achieve the phosphorus concentration target. Similarly, nitrogen concentrations vary from year to year and since 2012, have been below the nutrient concentration target of 0.75 mg/L in the north basin and close to the target in the south basin and narrows.

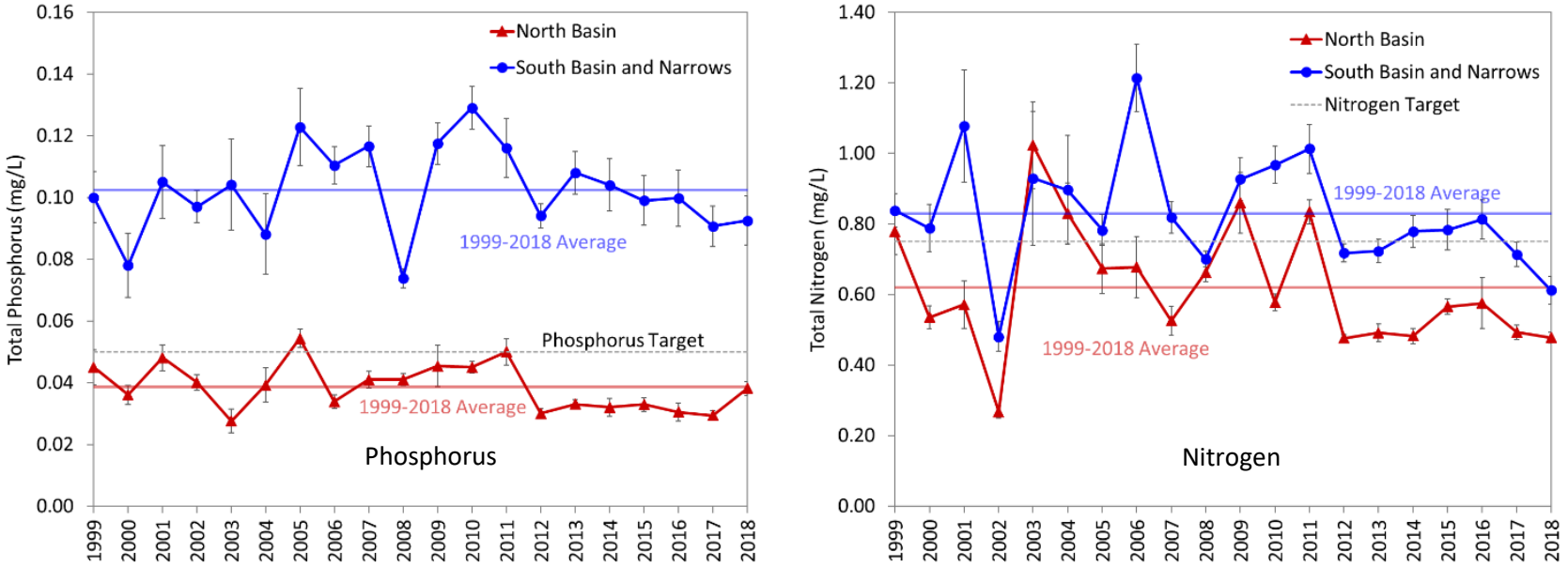


Figure 2. Total phosphorus concentrations (left) and total nitrogen concentrations (right) in the north basin and south basin and narrows of Lake Winnipeg, 1999 to 2018 (average during the open water season)

Nutrient loading targets for Lake Winnipeg tributaries

The proposed regulation under The Water Protection Act would include nutrient load (i.e., total phosphorus and total nitrogen) targets for the four main tributaries flowing into Lake Winnipeg (Table 3). Nutrient load targets were developed based on the nutrient concentration targets described above, and a water quality model for Lake Winnipeg developed by Environment and Climate Change Canada. Although the Red River is the primary contributor of nutrients to Lake Winnipeg, the modelling work showed that additional nutrient reductions from other tributaries were necessary to meet the nutrient concentration targets in Lake Winnipeg over the long-term. Indeed, all major tributaries play an important role influencing nutrient concentrations and phytoplankton dynamics in Lake Winnipeg.

Nutrient loading targets would be applied as follows:

- Nutrient loads are calculated with nutrient concentration and streamflow. Methods are as described in the 2011 State of the Lake report.
- Water quality monitoring stations are the Red River (at Selkirk), Saskatchewan River (at Grand Rapids), Winnipeg River (at Pine Falls), and Dauphin River (upstream of Anama Bay).
- Manitoba Hydro is an important partner in monitoring river water quality including on the Saskatchewan and Winnipeg Rivers. Streamflows are monitored through the Canada-Manitoba Hydrometric Agreement with Environment and Climate Change Canada, Manitoba Infrastructure and Manitoba Hydro as the key partners.

Table 3. Annual nutrient loading targets for the four main tributaries flowing into Lake Winnipeg.

Location	Total Phosphorus Load Target (tonnes/year)	Total Nitrogen Load Target (tonnes/year)
Red River at Selkirk	2,800	19,050
Saskatchewan River at Grand Rapids	340	8,960
Winnipeg River at Pine Falls	1,050	19,450
Dauphin River upstream of Anama Bay	60	4,550

How do the proposed nutrient loading targets compare to current nutrient loads flowing into Lake Winnipeg?

The increase in nutrient concentrations and increasing frequency and severity of algal biomass in Lake Winnipeg since the mid-1990s has been partially attributed to increased precipitation and runoff, more frequent flooding, and increased river flows (particularly in the Red River). A comparison of nutrient load targets to measured historical loads to Lake Winnipeg from each main tributary show that during wet years, meeting the nutrient targets will be challenging. Annual nutrient loads in the Red River (Figure 3), Saskatchewan River (Figure 4), and Dauphin River (Figure 5) exceeded the total phosphorus and total nitrogen load targets during most years between 1994 and 2018. Except in high annual flow years, nutrient loads in the Winnipeg River were similar to nutrient load targets between 1994 and 2018 (Figure 6). Nevertheless, the most significant nutrient reductions are required in the Red River which contributes the largest load of nutrients to Lake Winnipeg. The proposed nutrient load reduction targets for the four major tributaries will provide a way to measure and track progress over time.

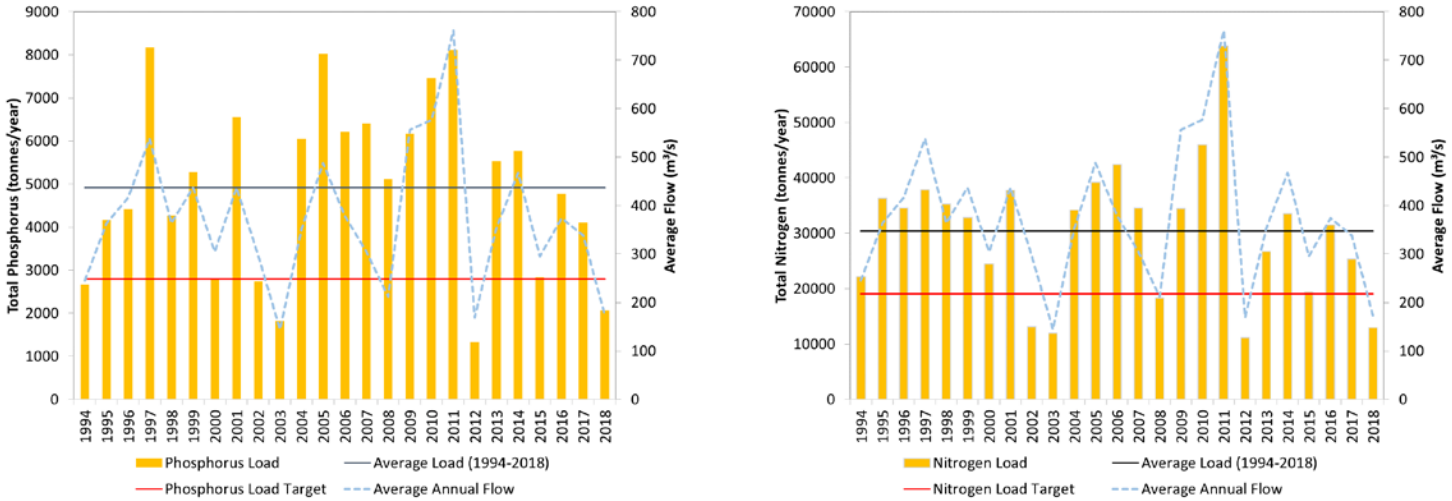


Figure 3. Annual total phosphorus and total nitrogen loads (tonnes/year) and flows in the Red River (at Selkirk), 1994 to 2018 compared to the proposed nutrient loading targets.

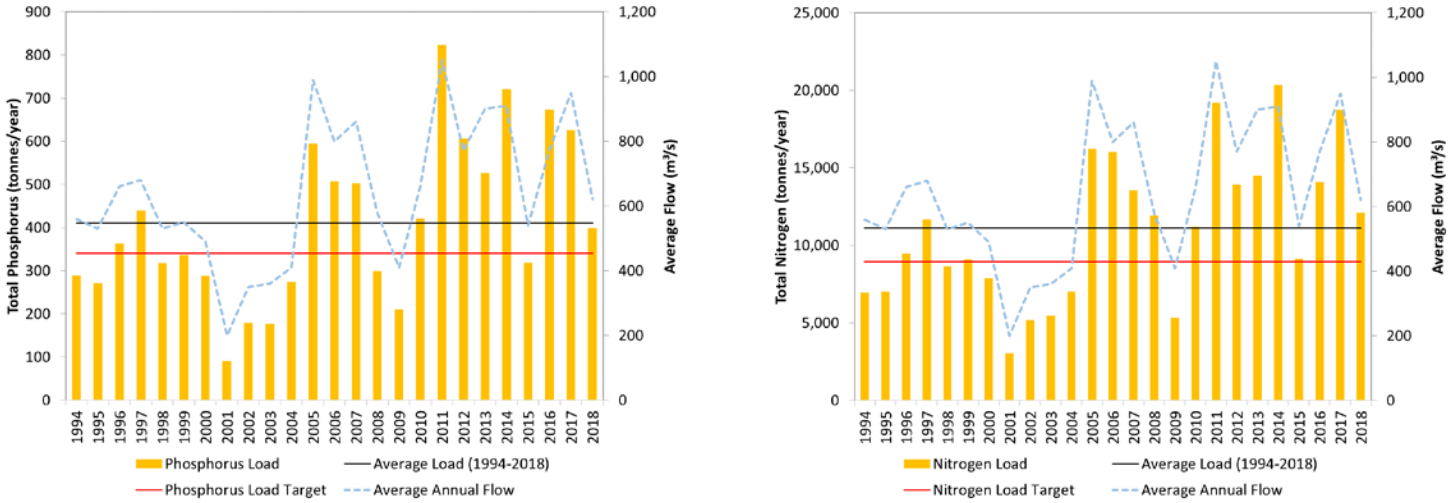


Figure 4. Annual total phosphorus and total nitrogen loads (tonnes/year) and flows in the Saskatchewan River (at Grand Rapids), 1994 to 2018 compared to the proposed nutrient loading targets.

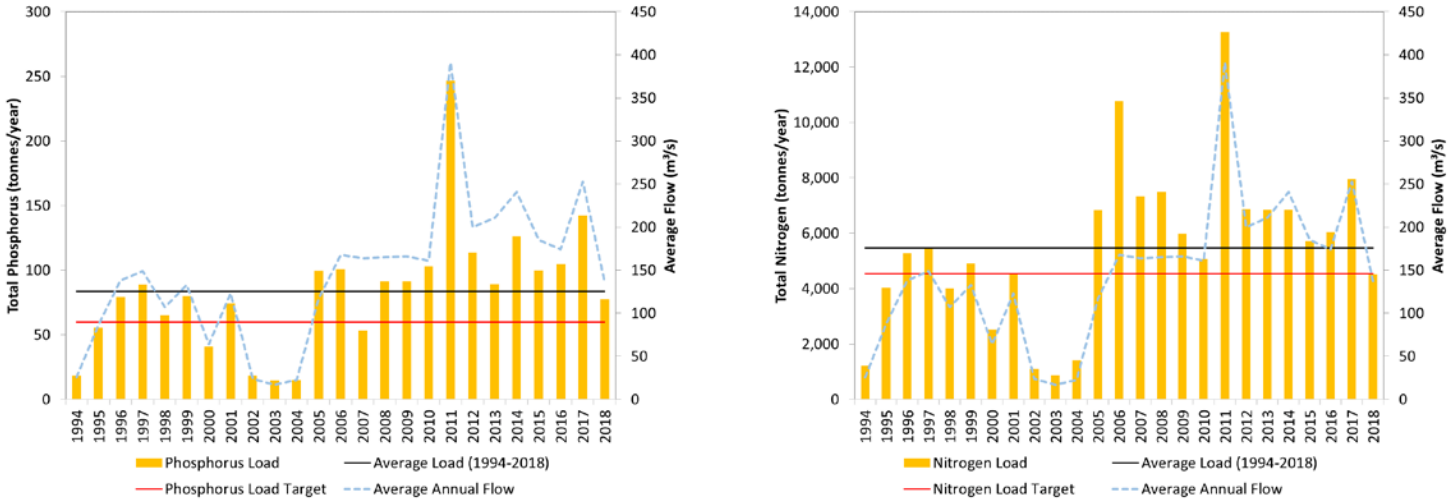


Figure 5. Annual total phosphorus and total nitrogen loads (tonnes/year) and flows in the Dauphin River (upstream of Anama Bay), 1994 to 2018 compared to the proposed nutrient loading targets.

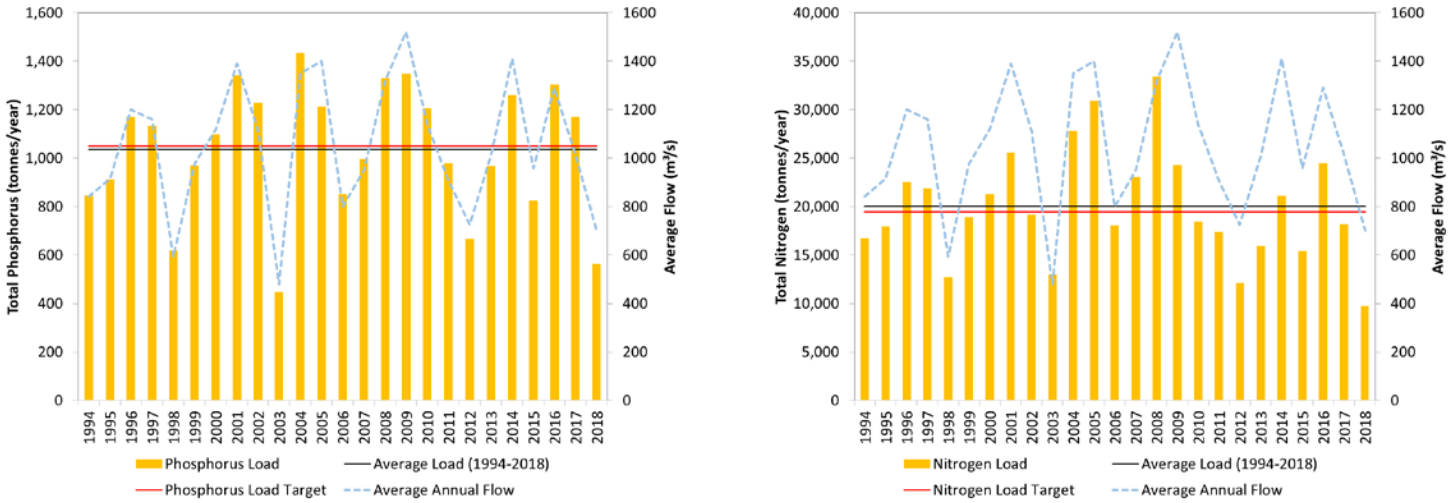


Figure 6. Annual total phosphorus and total nitrogen loads (tonnes/year) and flows in the Winnipeg River (at Pine Falls), 1994 to 2018 compared to the proposed nutrient loading targets.

Importance of controlling phosphorus and nitrogen to prevent harmful and nuisance algal blooms

Over the past two decades, there has been increasing support in the scientific community that both nitrogen and phosphorus need to be controlled to reduce algal blooms and the production of toxins in freshwater, estuarine, and coastal marine ecosystems. Other jurisdictions are developing nutrient reduction strategies and adopting water quality criteria (as targets, objectives, standards or benchmarks) that include both phosphorus and nitrogen. Since the early 2000s, the Government of Manitoba has considered both nitrogen and phosphorus in nutrient reduction strategies. You can learn more about the need to reduce both phosphorus and nitrogen to improve water quality and protect water resources in Manitoba streams, rivers, lakes, estuaries, and coastal marine ecosystems at www.manitoba.ca/lakewinnipeg.

How will the nutrient targets impact fish production in Lake Winnipeg?

Algal blooms can negatively impact fish and other aquatic life. As algal blooms die and decompose, they consume oxygen and in extreme conditions, can reduce oxygen concentrations to below those required to support fish and other aquatic life. While oxygen concentrations are generally relatively high in Lake Winnipeg (in part because the lake is shallow and well mixed), oxygen-depleted waters have been occasionally observed in the deepest portions of the north basin of the lake. However, fish production may also be positively linked to nutrient concentrations in Lake Winnipeg. Algae form the base of the food chain in freshwater lakes and therefore, fuel fish production. Analyses completed by the department suggest that there is a relationship between modelled total phosphorus concentrations and commercial Walleye yield in Lake Winnipeg between 1979 and 2001 when the commercial harvest was not meaningfully restricted. While other factors influence fish production and commercial fish yield such as harvesting pressure, aquatic invasive species, and spawning conditions, a reduction in nutrient concentrations in Lake Winnipeg could contribute to a reduction in commercial fish yield. Relationships between nutrients, algal blooms, and fish production are complex and will be considered as part of Manitoba's adaptive management approach.

How are Manitobans working together reduce nutrients?

While the proposed regulation under The Water Protection Act would establish nutrient targets for Lake Winnipeg and its tributaries, activities to reduce nutrient loading to Lake Winnipeg are already underway, and in some cases, regulated through other provincial legislation as well as work being advanced through inter-provincial agreements.

Given that half of the nutrients (and 70% of the water flows) to Lake Winnipeg originate from outside of Manitoba, a critical component for improving the water quality in the Lake Winnipeg watershed involves collaboration with external jurisdictions. Manitoba works with a number of transboundary water organizations including the International Joint Commission (IJC) and the Prairie Provinces Water Board (PPWB) to protect

and maintain water quality and the health of Manitoba's aquatic ecosystems across the Lake Winnipeg watershed. For example, the Prairie Provinces Water Board has adopted nitrogen and phosphorus objectives for eastward flowing streams in the Lake Winnipeg watershed including the Saskatchewan, Assiniboine and Qu'Appelle Rivers that flow into Manitoba from Saskatchewan. More recently, the International Joint Commission's International Red River Board developed nutrient concentration objectives and load targets for the Red River at the US/Canada border. The International Joint Commission has subsequently recommended the objectives and targets to the US and Canadian federal governments with the mandate to establish water quality objectives at the US-Canada border. Since the Red River contributes about 68 percent of the nutrient load to Lake Winnipeg, implementation of nutrient concentration objectives and load targets for the Red River at the US/Canada border could lead to a significant improvement in water quality.

In November 2011, Manitoba registered the Manitoba Water Quality Standards, Objectives and Guidelines Regulation under The Water Protection Act and released an updated technical document including standards, objectives, and guidelines for application across Manitoba. Included for the first time in the Manitoba Water Quality Standards, Objectives and Guidelines were Water Quality Standards for nutrients for industrial and municipal wastewater effluents discharged to a water body. Under the Water Quality Standards, Objectives, and Guidelines Regulation, large and medium-sized municipal and industrial wastewater treatment facilities are required to meet a 1.0 mg/L total phosphorus standard. In addition, major facilities are required to meet a 15 mg/L total nitrogen standard when building new, upgrading, or expanding. As a result of this regulation, upgrades to wastewater treatment facilities are already underway or have been completed for many facilities in Manitoba to meet the wastewater standards for nutrients. The Cities of Brandon and Headingley have completed upgrades to their wastewater facilities to remove phosphorus and nitrogen and upgrades are underway for the City of Selkirk. Funding was recently announced for upgrades to the City of Portage la Prairie's wastewater treatment facility which includes substantial industrial contributions. On average, more than 73 % of wastewater facilities in Manitoba discharging more than 820 kilograms of phosphorus are now meeting a 1 mg/L total phosphorus limit.

The City of Winnipeg is the single largest point source contributor of nutrients to the Red River and Lake Winnipeg. Over the past 10 years, the City of Winnipeg has been working to reduce nutrient discharges from their wastewater treatment facilities. For example, the City has upgraded its West End Water Pollution Control Centre to meet the 1 mg/L phosphorus and 15 mg/L nitrogen standards and construction is underway on similar upgrades to the South End Water Pollution Control Centre. Significant upgrades are still required to the North End Water Pollution Control Centre, one of the oldest and largest wastewater treatment facilities in Canada. The City of Winnipeg and the Province of Manitoba are working together to accelerate improvements to reduce nutrients in wastewater originating from this facility.

Other efforts to reduce nutrient concentrations in Manitoba surface waters includes regulating phosphorus in cleaning products (e.g., detergents) and cosmetic fertilizers. Cleaning products often contain large amounts of phosphorus which end up in wastewater treatment plants and ultimately surface waters. In 2010, The Water Protection Act was amended to regulate phosphorus content in cleaning products such as dishwashing detergent.

Current action underway to reduce nutrients in surface runoff includes nutrient applications to land which are regulated under the Nutrient Management Regulation and the Livestock Manure and Mortalities Management Regulation, both of which regulate the application of nutrients to frozen soil. Nutrients are essential for crop production and the 4R nutrient stewardship program helps producers to apply the right amount of nutrients at the right time, right place, and from the right source. Other actions aimed at improving water quality include initiatives such as the Sustainable Agriculture Incentives Program, which is available to agricultural producers to advance the adoption of on-farm Beneficial Management Practices (BMPs). These BMPs improve agri-ecosystem resilience to climate change, deliver ecological goods ands services such as improved water quality and enhance the environmental sustainability of farm operations in Manitoba. To be eligible, farmers are required to complete an Environmental Farm Plan, which is a voluntary, confidential, self-assessment of a producer's own farm or ranch delivered in partnership with Keystone Agricultural Producers. Environmental farm planning helps farmers to manage risk on their farm operations with respect to water quality and supply, soil health, air quality and biodiversity. Environmental Farm Planning began in Manitoba in 2004 and is currently supported through the Canadian Agricultural Partnership.

Manitoba is also supporting the implementation of beneficial management practices through GRowing Outcomes in Watersheds (GROW) and the Conservation Trust. Both Funds reduce nutrient loading and improve aquatic ecosystem health through support for farmers to implement projects that maintain or improve local watershed health and work for their operations. Manitoba's Watershed Districts are leading the implementation of GROW and through their integrated watershed management plans are identifying and implementing actions across their watersheds that will improve water quality and reduce nutrient loading.

In 2017, the Government of Manitoba released the made-in-Manitoba Climate and Green Plan which provided a strategic framework aimed at supporting Manitoba's economy while protecting the environment for future generations. The Plan was built on four pillars (climate, jobs, water, and nature) and 16 keystones designed to combat and adapt to climate change. The plan includes a number of commitments regarding improving water quality and reducing nutrients including protecting wetlands, improving wastewater treatment, and implementing precision agriculture. A relatively new area of research suggests that climate change and nutrient rich lakes are linked in ways that we are just beginning to understand. Nutrient rich lakes can generate greenhouse gases (e.g., methane, carbon dioxide, nitrous oxide) and release them to the atmosphere which could further accelerate climate change.

One of the tools being considered to reduce nutrients and improve water quality is Water Quality Trading (WQT). Water Quality Trading, a market-based approach that works alongside wastewater regulation, may provide a framework that allows trading of water quality credits (such as limits or caps on nutrient discharges) to reduce nutrients from both point and non-point sources. Under this approach, wastewater treatment facilities in non-compliance (that is, exceeding nutrient discharge limits) can purchase environmentally equivalent (or superior) pollution reductions from an alternate source (such as another point or non-point source), often at a lower cost. Water quality targets would be required to establish a water quality trading program in Manitoba.

Application

It is important to note that the nutrient concentration and load targets in the proposed regulation under The Water Protection Act would establish benchmarks and a guide for nutrient reduction activities. However, any future changes to other regulatory measures regarding nutrients such as nutrient standards for wastewater or limits on the application of nutrients to land would be subject to specific consultation as part of the proposed regulatory changes.

Adaptive Management

Adaptive management will be required to measure and evaluate the effectiveness of implementation of the nutrient concentration and load targets. As part of the adaptive management framework, Manitoba will assess and evaluate implementation of the targets as well as changing conditions within Lake Winnipeg and its tributaries (including related to nutrient concentrations, algal bloom frequency and severity, and fish production). The targets may require adjustments based on what is learned over time or as conditions change. Factors such as climate change, increasing human population, and changes in land use may provide additional challenges to reducing the transport of nutrients to surface waters into the future in Manitoba. Moreover, the introduction of zebra mussels to Lake Winnipeg may further exacerbate cyanobacterial blooms through changes to food web structure and nutrient cycling.

Water quality monitoring will be critical to further understand nutrients, algal blooms and their toxins in Lake Winnipeg and its tributaries. Since the 1970s, the Province of Manitoba has operated a long-term water quality monitoring program on major streams and rivers. Approximately 65 stations are monitored throughout the year including the Red River (at Selkirk), Saskatchewan River (at Grand Rapids), Winnipeg River (at Pine Falls) and Dauphin River (upstream of Anama Bay). The Province of Manitoba also maintains an active long-term water quality monitoring program on Lake Winnipeg, in partnership with the Lake Winnipeg Research Consortium (LWRC) and others. Up to 65 stations on the lake are monitored for more than 100 physical, chemical, and biological variables during the spring, summer, and fall. Winter samples are collected through ice in partnership with Environment and Climate Change Canada. In addition to water quality monitoring, water quantity information is collected through the Canada-Manitoba Hydrometric Agreement and these data are used to provide streamflow and nutrient load estimates for Lake Winnipeg tributaries.

Consultation

We want to hear from you. Please send us your thoughts and suggestions to help refine Manitoba's proposed Nutrient Targets Regulation under The Water Protection Act. Comments can be provided through the Manitoba Regulatory Consultation Portal at https://reg.gov.mb.ca/home.