LWF LAKE WINNIPEG FOUNDATION

Truro Creek; Photo: Paul Mutch

WEST INTERLAKE WATERSHED DISTRICT

2023 regional report

WIWD

Lake Winnipeg Community-Based Monitoring Network: Overview

The Lake Winnipeg Community-Based Monitoring Network (LWCBMN), coordinated by the Lake Winnipeg Foundation (LWF), mobilizes volunteers and watershed partners to collect water samples across Manitoba to measure phosphorus concentration. Phosphorus is the nutrient responsible for blue-green algae blooms on Lake Winnipeg. Phosphorus comes from diverse sources across the watershed, including municipal wastewater and agricultural runoff.

Different sub-watersheds contribute different proportions of Lake Winnipeg's total phosphorus load. With the help of a strong network of watershed partners and volunteers, this long-term monitoring program is identifying phosphorus hotspots – localized areas that contribute higher amounts of phosphorus to waterways than other areas. Targeting actions to reduce phosphorus loading in hotspots will reduce the amount of phosphorus entering Manitoba's lakes and rivers and improve the health of Lake Winnipeg.

Snow melts, floods and heavy rainfall events are responsible for most of the phosphorus that is flushed from the land and carried into our waterways. LWCBMN samples frequently throughout the season, and particularly during the spring melt, to ensure we capture phosphorus runoff during these high-water events.

Most LWCBMN sampling is conducted at stations where water flow is continuously monitored by the Water Survey of Canada (WSC). By tracking flow online using the WSC's provisional real-time data, the network can notify partners volunteers and across the watershed to ensure frequent sampling during peak flows.

Sites with flow data can be coupled with LWCBMN data to calculate **phosphorus loads**. We need several samples throughout the season, corresponding to changes in flow, to accurately calculate these loads. Phosphorus loads can subsequently be used to calculate **phosphorus export**, based on the area of the watershed.

Phosphorus load is the total amount of phosphorus flowing past a sample site over a given period, expressed as tonnes per year.

Phosphorus export is the amount of phosphorus exported by each hectare of land in a year, expressed as kg/ha/y.

Sample Collection & Site Map

Water samples are collected using a weighted sampling device that collects source water directly into a 500 mL Nalgene polyethylene bottle. The sampling device is lowered into the water just before it hits the bottom, the bottle is filled, then brought back to the surface. It is rinsed three times prior to sample collection. From the collection bottle, a 60 mL Nalgene polyethylene bottle containing 1 mL 4N H_2SO_4 is filled with unfiltered water. Next, 20 mL is drawn into a syringe, and filtered through a 45 µm filter into a 25 mL scintillation vial containing 0.1 mL of 4N H_2SO_4.

In 2023, 1563 unfiltered water samples and 1516 filtered water samples were collected and analyzed from 107 sites. Of these 107 sites, 88 are located near flow-metered WSC stations, 3 are located near non-flow-metered WSC stations, and 16 are not located near any stations.

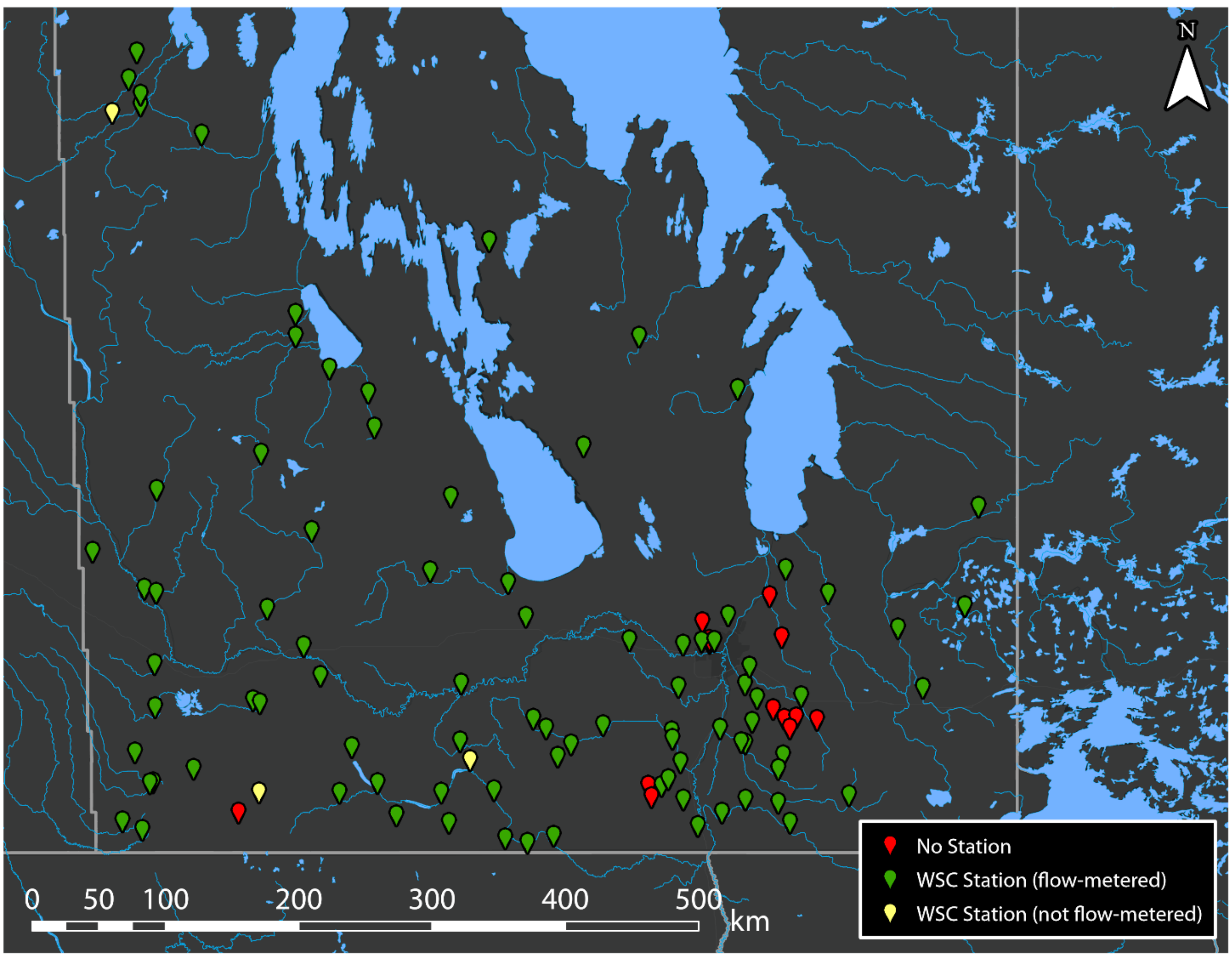

Figure 1: Map of LWCBMN sampling sites in 2023. Locations shown provided at least one sample. Colours indicate nearby station type.

Laboratory & Data Analysis

Analytical methods

LWCBMN water samples are analysed for both total and dissolved phosphorus concentration, a two-step procedure involving first the chemical digestion/conversion of all phosphorus forms to orthophosphate (PO_4^{3-}) followed by the analysis of the concentration of PO_4^{3-}. The digestion procedure is patterned after USGS Water-Resources Investigations Report 03-4174. The concentration of PO_4^{3-} in the sample was determined following Murphy & Riley (1962). The result of this method is determination of the concentration of total phosphorus (TP) (for whole water samples) and total dissolved phosphorus (TDP) (for case of syringe filtered water samples) both reported in mg/L. There are occasionally instances where the reported TDP concentration is slightly higher than the reported TP concentration. While this is not physically possible, these discrepancies are common in environmental datasets largely due to analytical variability, sample processing variability, and detection limits. These discrepancies are generally negligible and should not be impacting the reliability of annual load/export calculations.[1]

We do not directly measure particulate phosphorus, but it can be inferred by the difference between total and dissolved phosphorus concentration. In the data tables we show both total and dissolved phosphorus loads/exports, as well as the TDP/TP ratio, which indicates the proportion of annual total phosphorus load/exports which are in dissolved form. Higher percentages indicate that dissolved phosphorus composes a larger fraction of the total phosphorus load/export.

Laboratory partnership & proficiency testing

Laboratory analysis on LWCBMN water samples was conducted in partnership with Dr. Nora Casson at her laboratory at the University of Winnipeg. Quality assurance of laboratory methods for the determination of total phosphorus was completed on samples sent from Proficiency Testing Canada. Proficiency testing, conducted every 6 months, allows us to assess the quality of our results as compared to the results of other laboratories across the country. Since November 2023, we have received excellent passing grades on these tests, highlighting the consistency and accuracy of our laboratory methods.

Limit of detection

With 2023 data we began determining the limit of detection (LOD) for our laboratory methods. The LOD is “the lowest concentration level that can be determined to be statistically

[1] (U.S. Environmental Protection Agency (EPA) (1993). *Methods for the Determination of Inorganic Substances in Environmental Samples.)*

different from an analytical blank"[1]. A commonly used method for estimating the LOD is by assessing the standard deviation of blanks[2]. In our analytical process, we prepare blanks using deionized water and analyze them identically to our samples. Then, we calculate the standard deviation of the blanks and multiply this by three[2]. The LOD tells us that any result higher than the LOD has a 99.7% probability of being clearly distinguishable from random noise in the analysis.

The LOD for 2023 data is 0.0395 mg/L. We have decided to use a common method for treating values lower than the LOD for the load/export calculations and hotspot maps, which is to convert these values to half of the LOD. However, on the graphs and in the DataStream dataset, we have retained all the original values for full transparency (while showing a line on the graphs to indicate the LOD and describing the LOD in the DataStream dataset).

Load and export calculation methods

Our laboratory results provide a record of the phosphorus concentrations for every day that water samples were collected, but we are equally interested in reporting the load of phosphorus each year in each watershed that we sample. To create this record, we multiply concentrations by the volume of water that flowed past the station every day, using flow data from Water Survey of Canada (WSC) stations.

WSC's provisional real-time flow data undergoes additional quality assurance and quality control processes and is later published as historical data. Historical data is released by WSC as the approved version of the data, with notes about site characteristics or considerations affecting data quality. Our 2023 data analysis used approved historical flow data.

For each station, gaps between concentration observations are filled by linear interpolation to create a continuous daily record. For the WSC flow record before or after the first or last water sample collected, we estimate the missing daily mean concentrations to be equal to the first or last measured concentration, respectively. These measured and estimated daily concentrations are then multiplied by daily flow to calculate daily phosphorus loads. Daily phosphorus loads are summed together to calculate seasonal and annual phosphorus loads

Larger watersheds generate greater river flow and typically larger phosphorus loads. Comparing the intensity of phosphorus sources, especially among watersheds of varying sizes, is possible through the calculation of average load exported from each unit area of the watershed. Hence, we also report phosphorus export, which is simply the annual load divided by the watershed area that contributed to this load.

The export per unit area is indicative of the relative intensity of the sources generating phosphorus export, even among watersheds of different sizes. This is why we display maps of phosphorus export (and not load) in this report. Hotspots identified in these reports export

[1] Long, G. L., & Winefordner, J. D. (1983). Limit of Detection: A Closer Look at the IUPAC Definition. Analytical Chemistry, 55(7), 712A–724A.
[2] U.S. EPA (2009). Definition and Procedure for the Determination of the Method Detection Limit (MDL). 40 CFR Part 136, Appendix B.

several times more phosphorus per hectare than non-hotspot watersheds. Identifying hotspots can help focus phosphorus reduction programs to where they will have the greatest impact.

LWCBMN By the Numbers - 2023

Table 1: Summary of 2023 LWCBMN sampling activity by region.

Region	Number of sites	Number of samples	Site with highest regional total phosphorus (TP) export (kg/ha/y)	Mean % of spring* water load	Mean % of spring* TP load
Assiniboine West	9	134	Assiniboine River Near Brandon - 0.50	76.80	83.32
Central Assiniboine	2	45	Cypress River Near Bruxelles - 0.64	98.71	99.59
City of Winnipeg	5	122	Sturgeon Creek At St. James Bridge - 0.29	87.54	93.33
East Interlake	3	15	Grassmere Creek Drain Near Middlechurch - 0.12	83.19	96.03
Inter-Mountain	5	105	Ochre River Near Ochre River - 0.10	72.98	87.05
Northeast Red	5	58	Devils Creek Near Libau - 0.19	88.00	93.78
Pembina Valley	18	312	Riviere Aux Marais Near Christie - 1.08	93.03	93.83
Redboine	12	188	Roseisle Creek Near Roseisle - 1.09	87.72	88.52
Souris River	12	66	NA[1]	86.91	NA[1]
Seine Rat Roseau	20	253	Joubert Creek Near Pansy - 0.62	89.48	92.85
Swan Lake	6	130	North Duck River At Cowan - 0.097	61.31	73.36
West Interlake	2	15	Burnt Lake Drain Northwest Of Lundar - 0.022	46.68	60.03
Whitemud	4	59	Whitemud River Near Westbourne - 0.10	85.03	87.71
Winnipeg River	4	61	Bird River Outlet of Bird Lake - 0.028	62.09	52.00

*LWCBMN defines "Spring" as March 1 to May 31, inclusive.

Raw data (phosphorus concentration and water flow) is available online at LakeWinnipegDataStream.ca, an open access hub for sharing water data.

[1] In 2023, no sites in the Souris River region had sufficient data to calculate loads/exports.

West Interlake Watershed District

Established in 2008, the West Interlake Watershed District (WIWD) is located on the eastern shores of Lake Manitoba. WIWD is home to approximately 7,854 watershed residents living in the municipalities of Armstrong, Coldwell, Grahamdale, St. Laurent, West Interlake and Woodlands. The dominant land uses in the area are annual crops and livestock.

WIWD Website (wiwd.ca)

Southwest Interlake Integrated Watershed Management Plan (wiwd.ca/uploads/southwest_interlake_iwmp_dec2018_final.pdf)

Characteristics of the 2023 Field Season

2023 was a very dry year in southern Manitoba. In the past 12 months prior to October 2023, most of southern Manitoba experienced moderately to severely dry conditions[1]. As well, from March to May 2023, a historically important period for phosphorus export, most of southern Manitoba experienced moderately to extremely dry conditions[2].

The mean peak discharge date across all LWCBMN sites with analyzed water samples was April 19, 2023 (with a standard deviation of 24.26 days). In 2023, an average of 83.48% of stream discharge occurred in the spring (March 1 – May 31) across LWCBMN sites (with a standard deviation of 16.74%). During snowmelt, safety concerns may prevent or hinder sampling from occurring at some sites. As a result, some load/export calculations may be less accurate than they would be had sampling remaining frequent during these times.

[1] https://www.gov.mb.ca/sd/pubs/water/drought/2023/drought_conditions_report_oct.pdf
[2] https://www.gov.mb.ca/sd/pubs/water/drought/2023/drought_conditions_report_may.pdf

Manitoba Watershed District Map

Manitoba's watershed districts are crucial partners contributing to the success of LWCBMN. In addition to assisting with sample collection, each district brings valuable community connections and a wealth of regional expertise to the network, helping us contextualize and better understand the data.

In 2023, 12 watershed districts participated in LWCBMN activities: Assiniboine West, Central Assiniboine, East Interlake; Inter-Mountain; Northeast Red, Pembina Valley, Redboine, Souris River, Seine Rat Roseau, Swan Lake, West Interlake, and Whitemud.

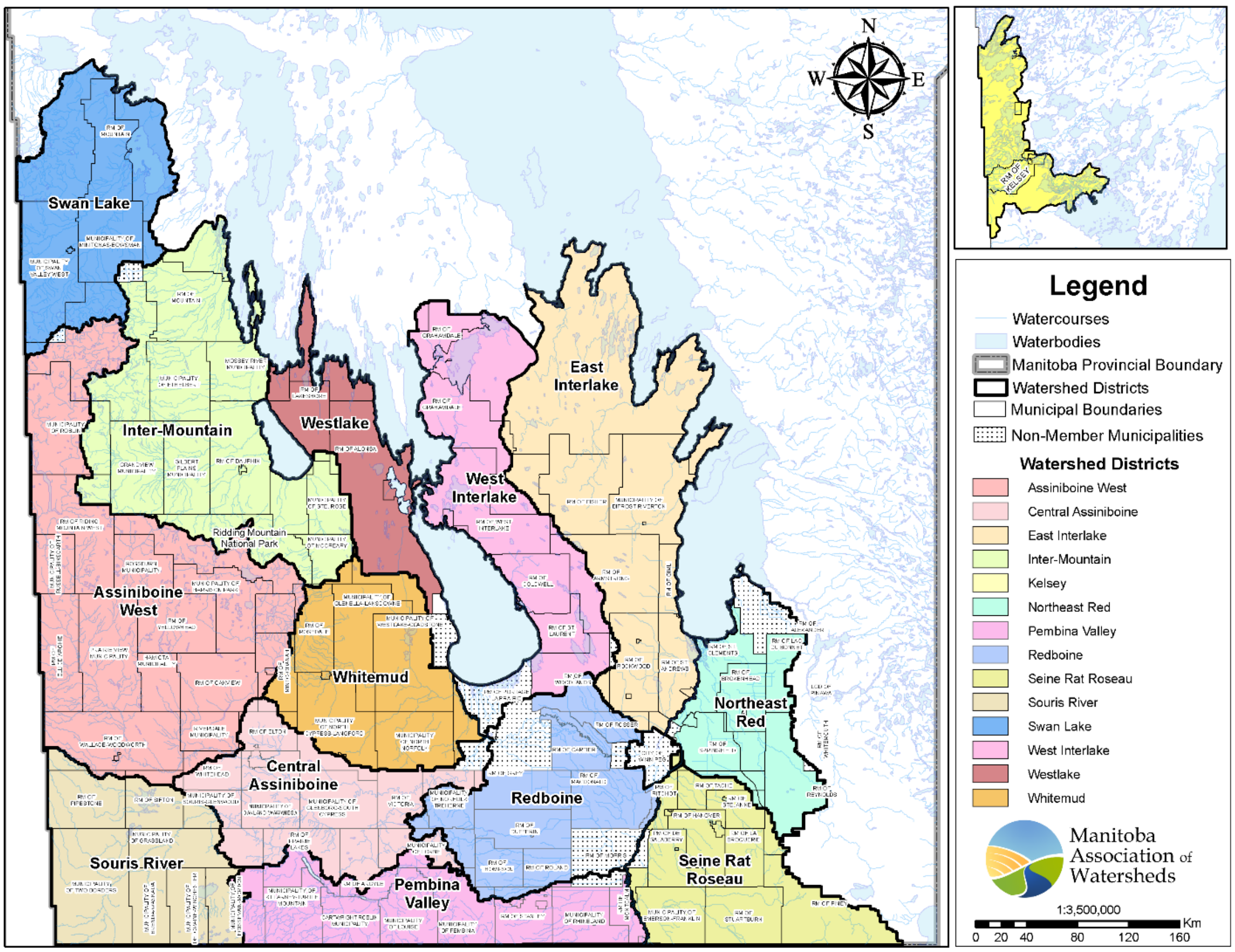

Figure 2: Manitoba Watershed District Boundaries. There are 14 total watershed districts. Map provided by Manitoba Association of Watersheds (updated July 2022).

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2023 Results – West Interlake Summary

Table 2: Summary of LWCBMN results in West Interlake. Letters correspond to drainage areas in Figure 3. Data shown represents sites with sampling efforts adequate to calculate loads/exports. [1]See footnotes for explanation of acronyms/abbreviations.

	Site Name	WSC Station	GDA (km2)	IDA (km2)	Gross/ Incr.	TP load (tonnes/y)	TP export (kg/ha/y)
A	Burnt Lake Drain Northwest Of Lundar	05LN006	384.81	NA	Gross	0.85	0.02
B	Fairford River Near Fairford	05LM001	79786.90	60595.36	Incr.	115.26	0.02

To compare results to other years of data, please see LWCBMN regional reports online at https://lakewinnipegfoundation.org/lwcbmn-regional-reports

[1] WSC = Water Survey of Canada.
GDA = gross drainage area (i.e., the total watershed area).
IDA = incremental drainage area (i.e., the total watershed area minus the total watershed area of any contained upstream sites with data adequate for load/export calculation).
Gross/Incr. = whether or not the adjacent TP load/export listed is from the gross or incremental ("Incr.") drainage area of a site.

2023 Results – Hotspot Map

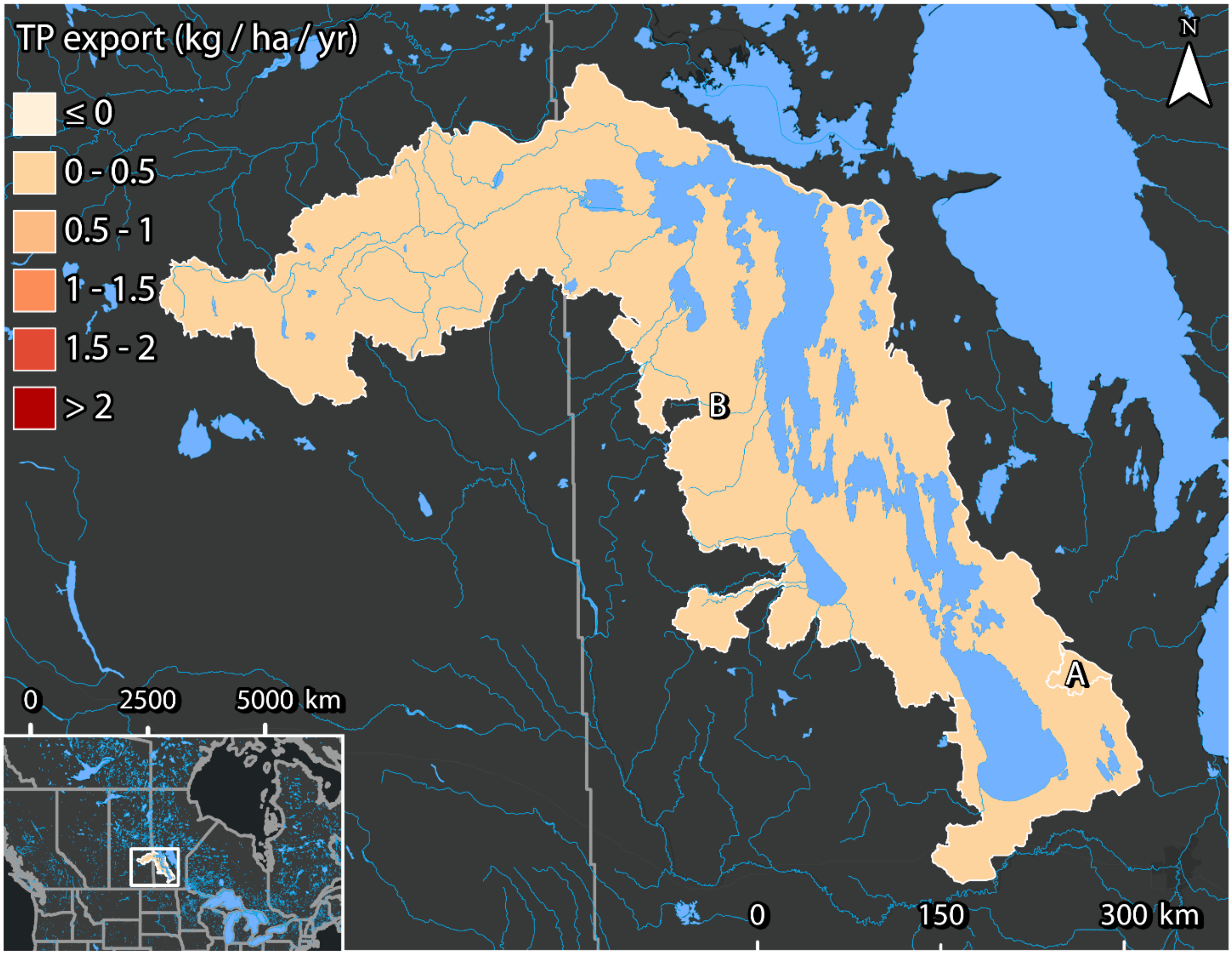


Figure 3: 2023 LWCBMN TP Export Hotspots in West Interlake. Letters correspond to sites listed in Table 2.

2023 Results – Individual Sites

Burnt Lake Drain northwest of Lundar

Burnt Lake Drain is downstream of Swan Creek, which is located just northeast of the south basin of Lake Manitoba, as well as northwest of Lundar, MB. This sampling site is located at Water Survey of Canada flow meter 05LN006. The sampling effort provided excellent coverage to calculate TP loads and exports.

Table 3: Indices of discharge and phosphorus from the gross drainage area of Burnt Lake Drain northwest of Lundar (05LN006).

Burnt Lake Drain Northwest Of Lundar - 2023	
Gross/Incremental	Gross
Drainage area (km^2)	384.8
Water load (km^3/year)	0.01
Water export (mm/year)	22.1
Spring water load	80.31%
Spring TP load	88.65%
TP load (tonnes P/year)	0.85
TDP load (tonnes P/year)	0.45
TP export (kg P/ha/year)	0.02
TDP export (kg P/ha/year)	0.01
% of TP as TDP	52.56%

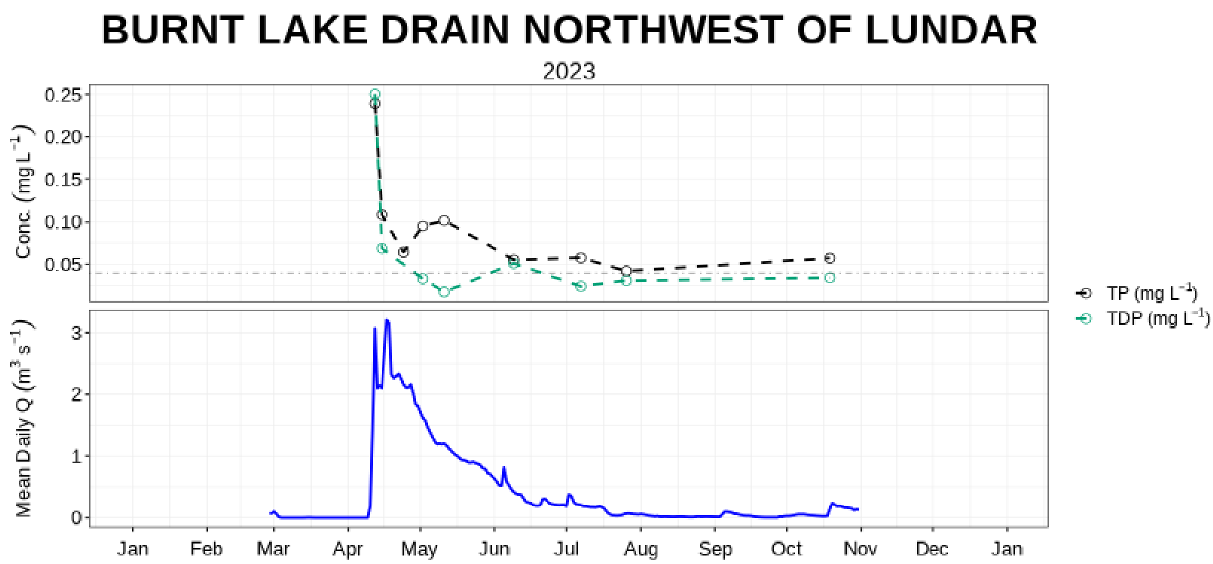


Figure 4: Mean daily discharge (blue) with TP (black) & TDP concentration (green) at Burnt Lake Drain northwest of Lundar (05LN006).

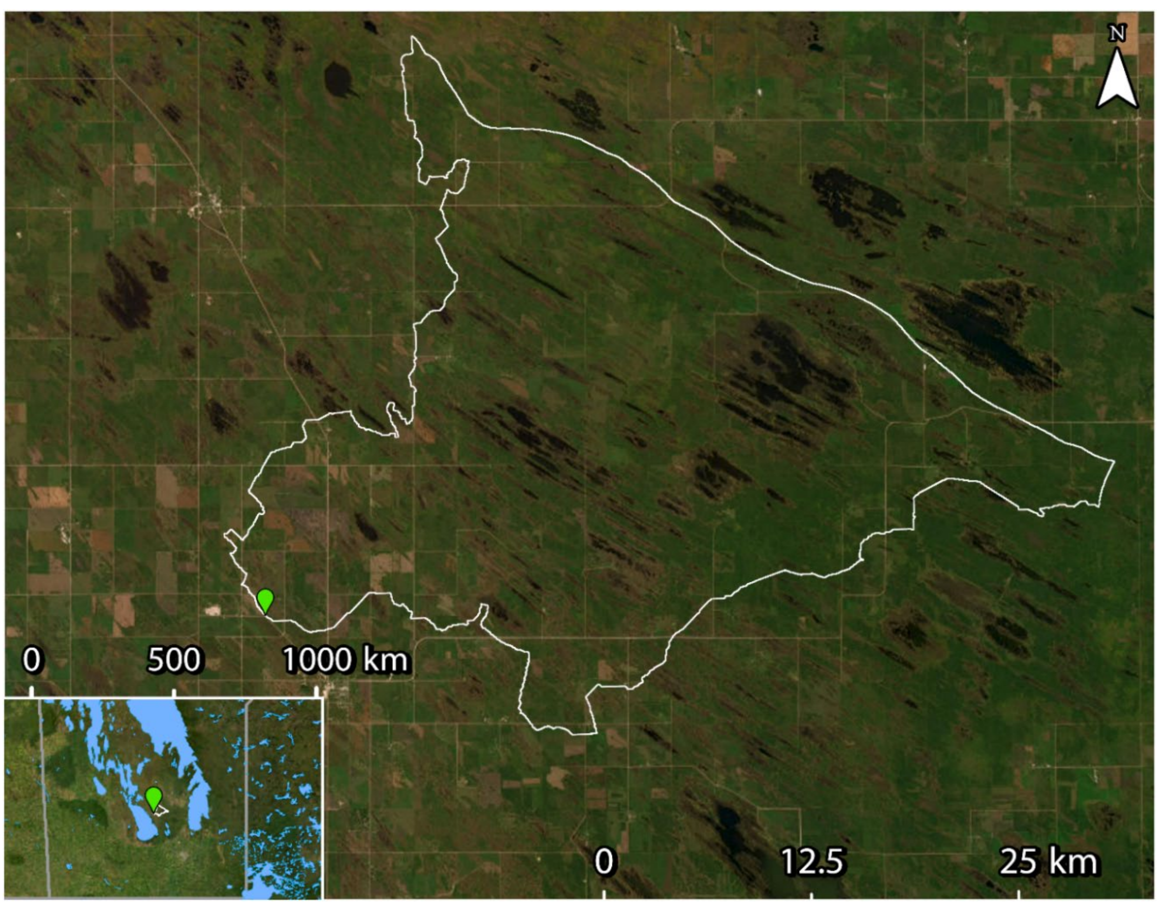


Figure 5: WSC station 05LN006 (green) and drainage area polygon (white - source: WSC). LWCBMN samples directly at the WSC station.

Fairford River near Fairford

The Fairford River originates from the north basin of Lake Manitoba, flowing north into Pineimuta Lake and east into Lake St. Martin. This sampling site is located at Water Survey of Canada flow meter 05LM001. The sampling effort provided excellent coverage to calculate TP loads and exports.

Table 4: Indices of discharge and phosphorus from the incremental drainage area of Fairford River near Fairford (05LM001). See Supplemental Table 1 for gross calculations.

Fairford River Near Fairford - 2023	
Gross/Incremental	**Incremental**
Drainage area (km^2)	**60595.4**
Water load (km^3/year)	**2.3**
Water export (mm/year)	**38.5**
Spring water load	**29.86%**
Spring TP load	**31.40%**
TP load (tonnes P/year)	**115.3**
TDP load (tonnes P/year)	**50.2**
TP export (kg P/ha/year)	**0.02**
TDP export (kg P/ha/year)	**0.01**
% of TP as TDP	**45.66%**

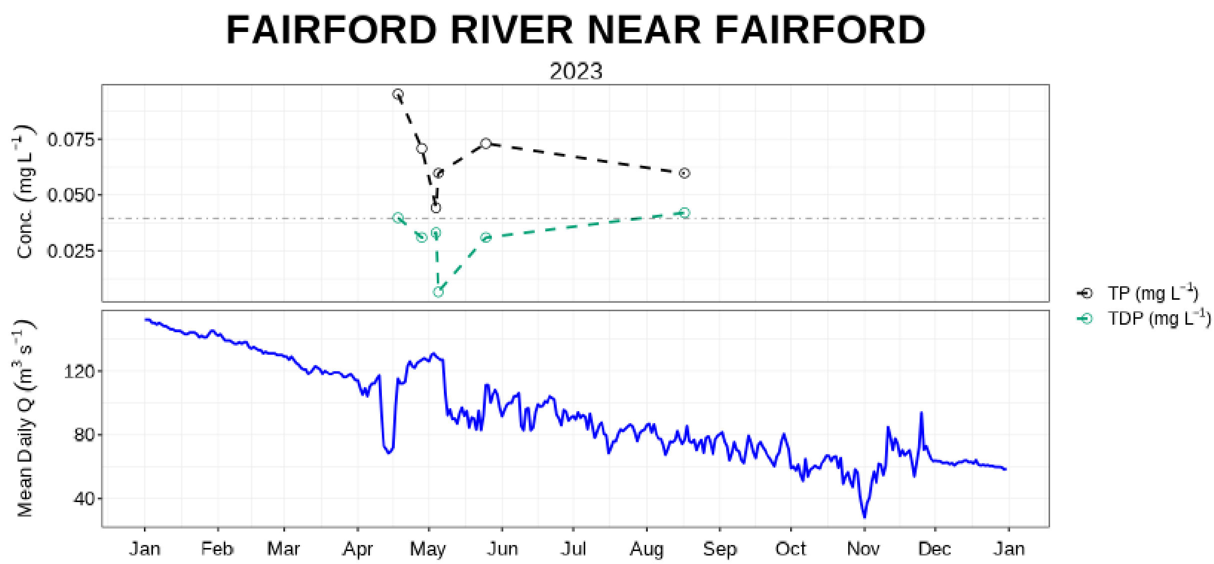


Figure 6: Mean daily discharge (blue) with TP (black) & TDP concentration (green) at Fairford River near Fairford (05LM001).

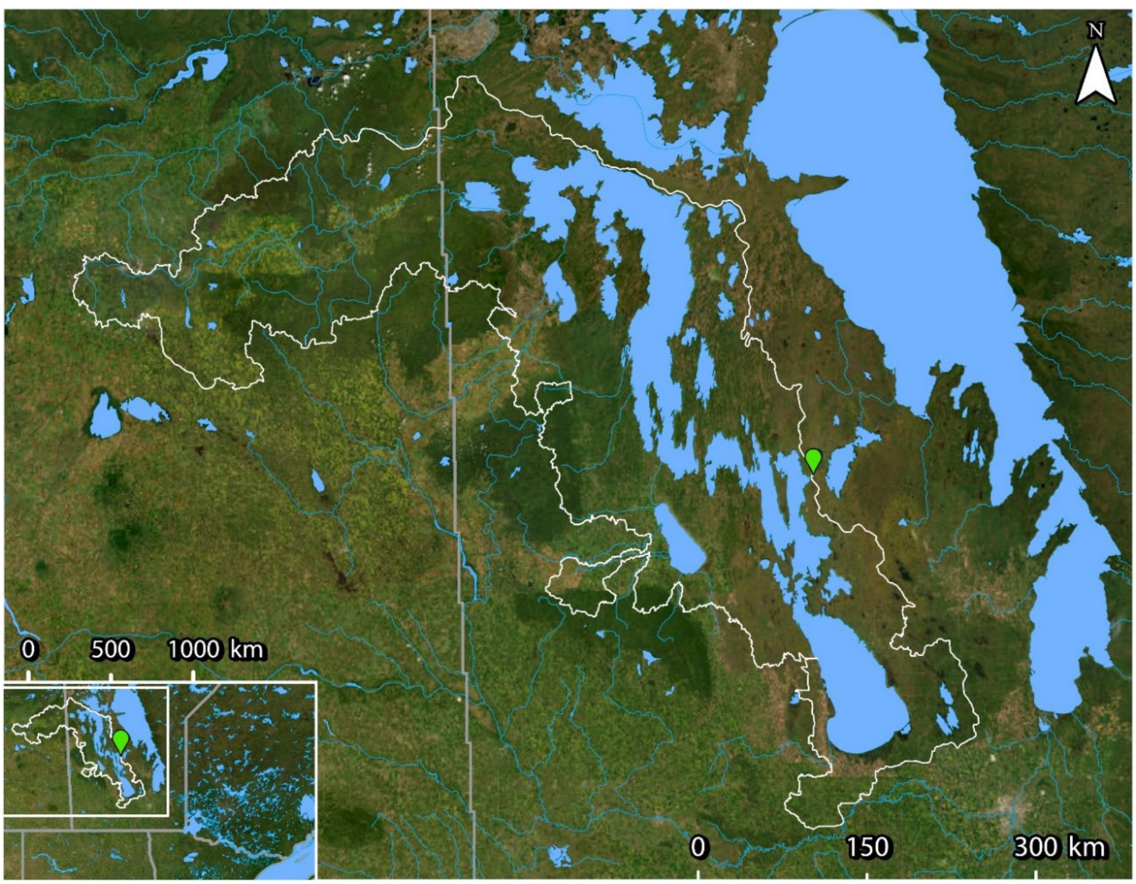


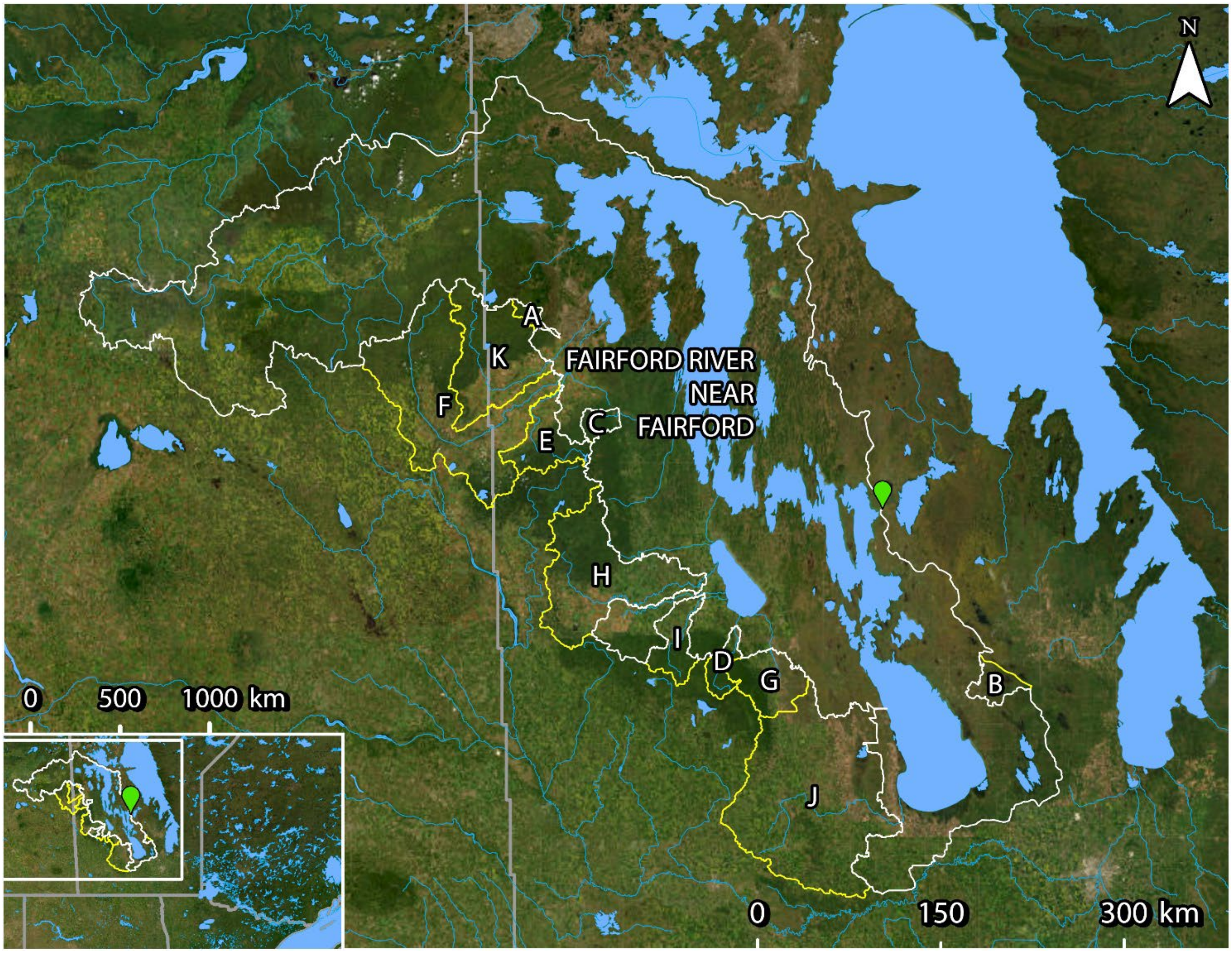
Figure 7: WSC station 0505LM001 (green), and incremental drainage area polygon (white - source: WSC). See Supplemental Figure 1 for upstream drainage areas used to calculate incremental area. LWCBMN samples directly at the WSC station.

Incremental Calculations

Fairford River near Fairford

Supplemental Table 1: Indices of discharge and phosphorus from the combined gross drainage area and stream discharge of Fairford River near Fairford (05LM001).

Fairford River Near Fairford - 2023	
Gross drainage area (km^2)	79786.9
Water load (km^3/year)	2.9
Water export (mm/year)	36.9
TP load (tonnes P/year)	232.9
TP export (kg P/ha/year)	0.03
TDP load (tonnes P/year)	106.3
TDP export (kg P/ha/year)	0.01



Supplemental Figure 1: Incremental drainage area in white and upstream drainage areas in yellow. Incremental values are calculated by subtracting gross "Birch River near Birch River"[1] (A), "Burnt Lake Drain Northwest of Lundar" (B), "North Duck River near Cowan"[1] (C), "Ochre River at Ochre River"[2] (D), "Roaring River near Minitonas"[1] (E), "Swan River near Minitonas"[1] (F), "Turtle River near Laurier"[2] (G), "Valley River near Dauphin"[2] (H), "Vermillion River near Dauphin"[2] (I), "Whitemud River near Westbourne"[3] (J), and "Woody River near Bowsman"[1] (K) values from "Fairford River near Fairford" values.

[1] See 2023 LWCBMN Swan Lake report for data from this site.

[2] See 2023 LWCBMN Intermountain report for data from this site.

[3] See 2023 LWCBMN Whitemud report for data from this site.

Map Sources

Drainage area polygons

Primarily, and whenever possible, drainage area polygons were taken from the Water Survey of Canada's (WSC) National Hydrometric Network Basin Polygons. Released in 2024, this dataset contains drainage area polygons for over 98% of the active and discontinued WSC stations. We have updated the maps and the drainage area information from the previously released version (in 2022) to this dataset (note: most polygons have either barely changed or not changed at all).

Link:
https://collaboration.cmc.ec.gc.ca/cmc/hydrometrics/www/HydrometricNetworkBasinPolygons/

Secondarily, when no WSC drainage area polygons were available, or when it was necessary to enable accurate incremental calculations, we used drainage area polygons from the Total Gross Drainage Areas of the Agriculture and Agri-Food Canada (AAFC)'s Watersheds Project – 2013

Link: https://open.canada.ca/data/en/dataset/67c8352d-d362-43dc-9255-21e2b0cf466c

Due to the required use of drainage area polygons from two different datasets, some polygons may slightly overlap. Hotspot maps, as a result, have a few instances where a drainage area is visually cut off. However, most of these instances are very minor, and we display all watersheds in their full extent on each sampling site's individual section.

Map layers

Satellite imagery used in all maps is from the World Imagery map layer (Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community). World Imagery provides one meter or better satellite and aerial imagery in many parts of the world and lower resolution satellite imagery worldwide.

Lake and river map data used in all maps is from North America Environmental Atlas (Lakes, Rivers). The North American Environmental Atlas – Lakes & Rivers datasets display area hydrographic features (Lakes: major lakes and reservoirs; Rivers: major rivers, streams, and canals) of North America at a reference spatial scale of 1:1,000,000. Credits: Commission for Environmental Cooperation (CEC). 2023. "North American Atlas – Lakes and Rivers". Natural Resources Canada (NRCan), Instituto Nacional de Estadística y Geografía (INEGI), Comisión Nacional del Agua (CONAGUA), U.S. Geological Survey (USGS). Ed. 3.0, Vector digital data [1:1,000,000].

The **Lake Winnipeg Community-Based Monitoring Network** (LWCBMN) is a collaborative, long-term phosphorus monitoring program designed to identify localized phosphorus hotspots where action is required to improve Lake Winnipeg water quality. LWCBMN mobilizes citizen volunteers and watershed partners to collect water samples across Manitoba, generating robust water-quality data that is useful to community practitioners, academic researchers, government scientists and policy-makers alike. Focusing research, resources and action in phosphorus hotspots is necessary to reduce phosphorus loading to Lake Winnipeg.

LWCBMN is delivered in partnership with Manitoba's watershed districts, LWF's science advisors, volunteer citizen scientists and Dr. Nora Casson's laboratory at the University of Winnipeg. Thank you to all who make this network possible!

The **Lake Winnipeg Foundation** (LWF) advocates for change and coordinates action to improve the health of Lake Winnipeg. Combining the commitment of our grassroots membership and the expertise of our science advisors, LWF is nationally recognized for our unique capacity to link science and action. Our goal is to ensure policy and practices informed by evidence are implemented and enforced.

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