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Truro Creek; Photo: Paul Mutch

ASSINIBOINE WEST
WATERSHED DISTRICT

2023 regional report



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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 H₂SO₄ 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 H₂SO₄.

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.

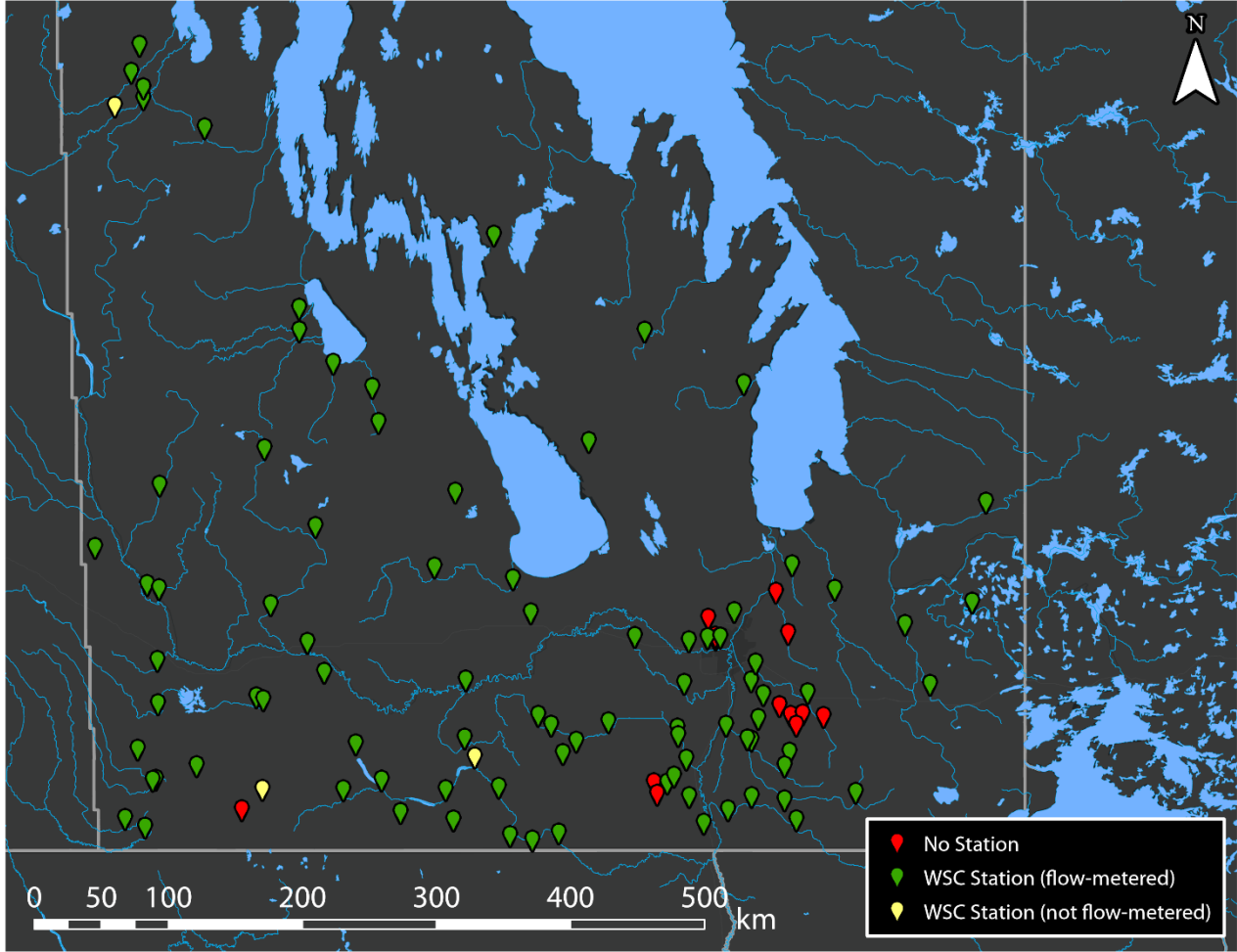


Figure 1: Map of LWCBMN sampling sites in 2023. Locations shown provided at least one sample. Colours indicate nearby station type.

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 blanks². 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 three². 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.

Assiniboine West Watershed District

The Assiniboine West Watershed District (AWWD) is located in western Manitoba along the Manitoba-Saskatchewan border. The Assiniboine River is the main waterway in this region, receiving water from many tributaries. The primary land use in AWWD is agriculture, specifically annual cropland and forage grasslands (Assiniboine-Birdtail State of the Watershed Report, 2008). In addition to agricultural activities, wastewater treatment plants and lagoons in municipalities throughout AWWD contribute phosphorus to local waterways. Major municipalities include Virden, Russel and Miniota.

[AWWD Website \(myawwd.ca\)](http://myawwd.ca)

[AWWD Watershed Plans \(myawwd.ca/resources\)](http://myawwd.ca/resources)

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 conditions¹. As well, from March to May 2023, a historically important period for phosphorus export, most of southern Manitoba experienced moderately to extremely dry conditions².

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.

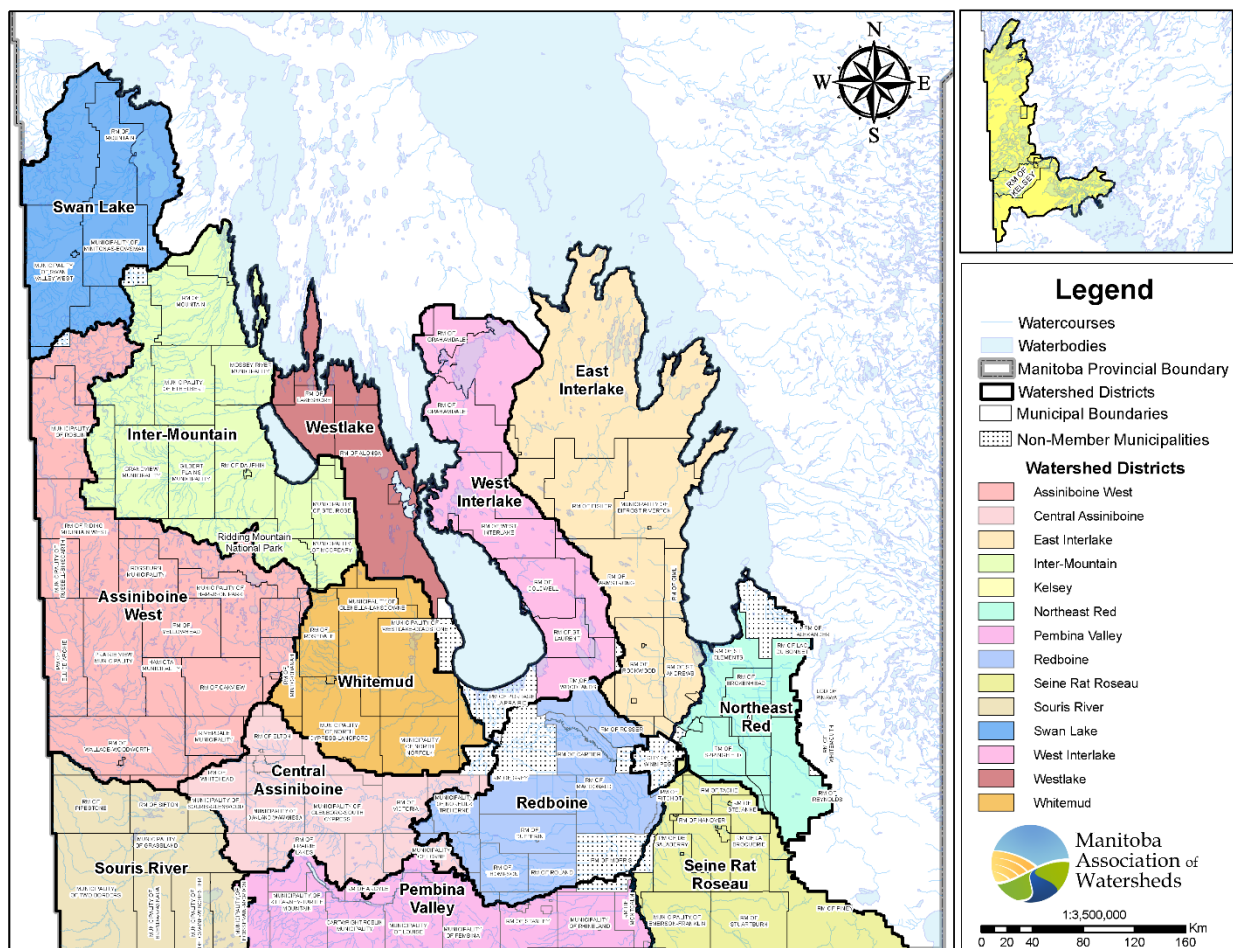


Figure 2: Manitoba Watershed District Boundaries. There are 14 total watershed districts. Map provided by Manitoba Association of Watersheds (updated July 2022).

2023 Results – Assiniboine West Summary

Table 2: Summary of LWCBMN results in Assiniboine West. Letters correspond to drainage areas in Figure 3. Data shown represents sites with sampling efforts adequate to calculate loads/exports. ¹See 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	Arrow River Near Arrow River	05MG001	560.27	NA	Gross	2.71	0.05
B	Assiniboine River Near Brandon	05MH001	84843.70	4878.18	Incr.	243.92	0.50
C	Assiniboine River Near Miniota	05ME006	75214.90	73881.25	Incr.	282.35	0.04
D	Birdtail River Near Birtle	05ME003	1092.22	NA	Gross	4.28	0.04
E	Gopher Creek Near Virden	05MG003	302.42	NA	Gross	4.51	0.15
F	Little Saskatchewan River Near Horod	05MF024	667.94	NA	Gross	1.69	0.03
G	Little Saskatchewan River Near Rivers	05MF018	3887.91	3219.97	Incr.	17.99	0.06
H	Scissor Creek at McCauley	05ME009	241.49	NA	Gross	4.04	0.17

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

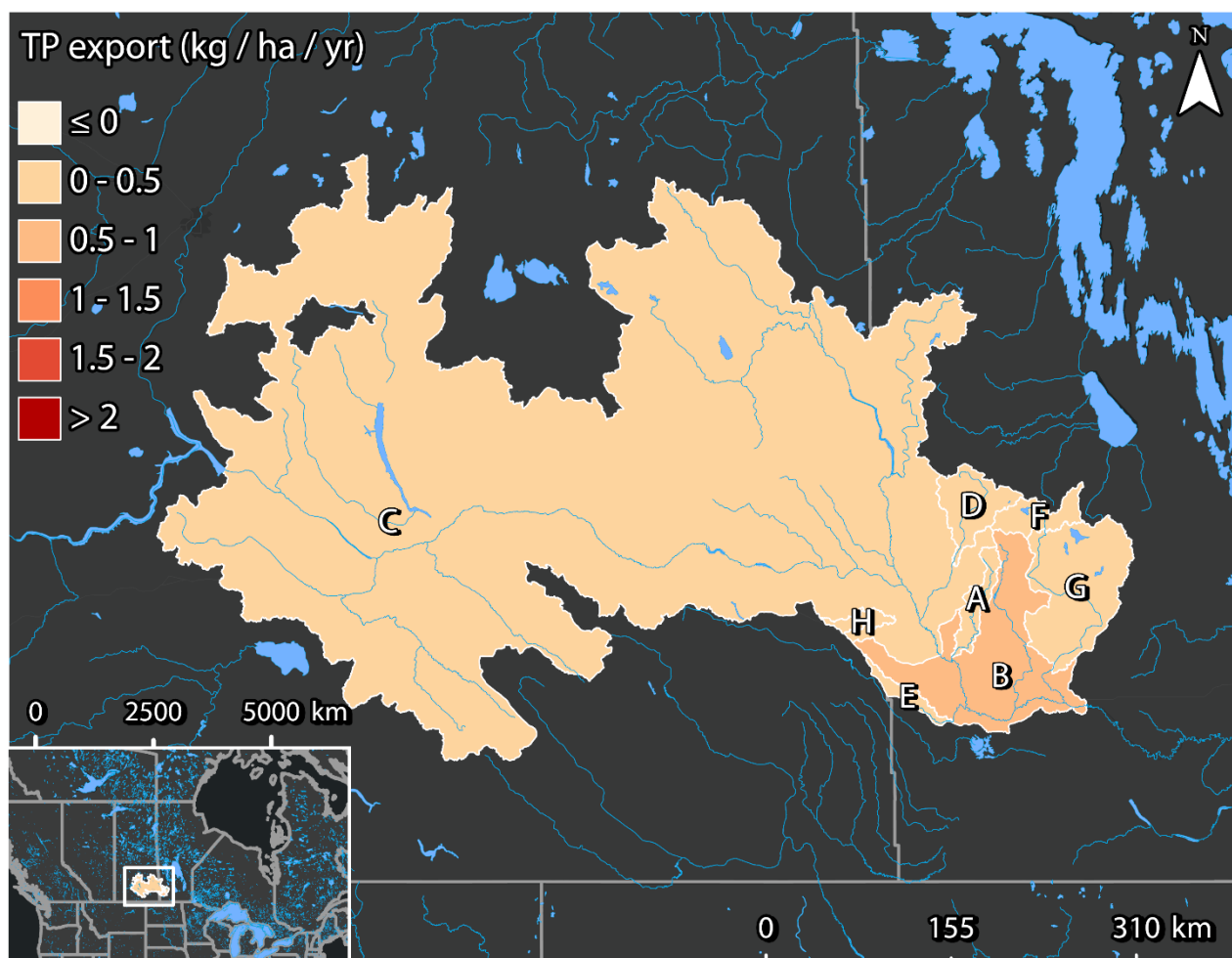


Figure 3: 2023 LWCBMN TP Export Hotspots in Assiniboine West. Letters correspond to sites listed in Table 2.

2023 Results – Individual Sites

Arrow River near Arrow River

Arrow River is part of the larger Arrow-Oak watershed. The Arrow River portion of the watershed flows south into the Assiniboine River. The drainage area contains a largely agricultural area with mainly annual cropland (Arrow-Oak State of the Watershed Report, 2008). This sampling site is located at Water Survey of Canada station 05MG001, near Arrow River. The sampling effort provided excellent coverage to calculate TP loads and exports.

Table 3: Indices of discharge and phosphorus from Arrow River near Arrow River (05MG001).

Arrow River Near Arrow River - 2023	
Gross/Incremental	Gross
Drainage area (km ²)	560.3
Water load (km ³ /year)	0.01
Water export (mm/year)	10.7
Spring water load	90.06%
Spring TP load	94.96%
TP load (tonnes P/year)	2.7
TDP load (tonnes P/year)	2.3
TP export (kg P/ha/year)	0.05
TDP export (kg P/ha/year)	0.04
% of TP as TDP	83.43%

ARROW RIVER NEAR ARROW RIVER

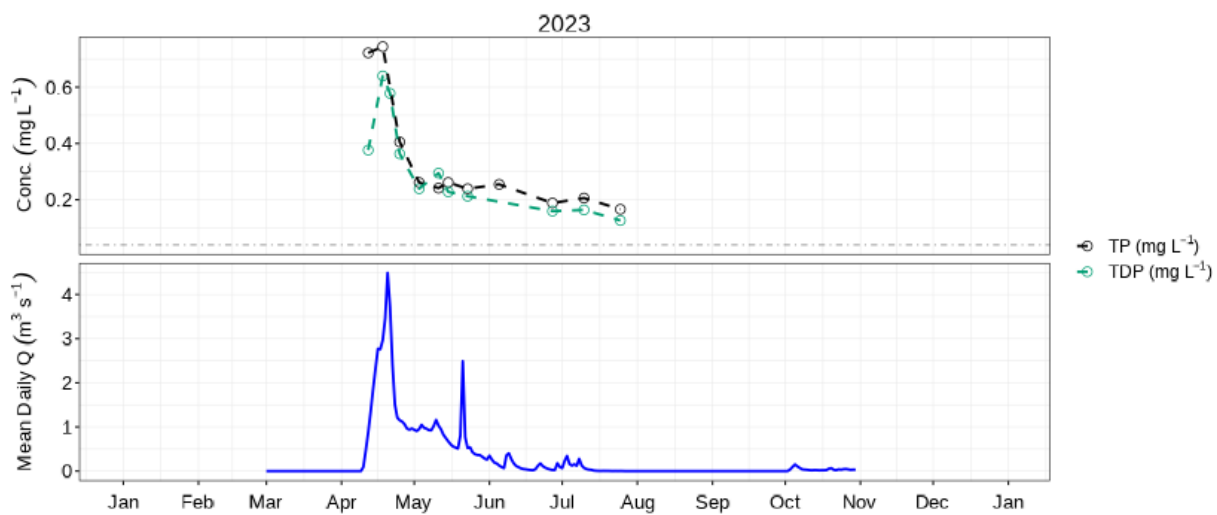


Figure 4: Mean daily discharge (blue) with TP (black) & TDP concentration (green) at Arrow River near Arrow River (05MG001).

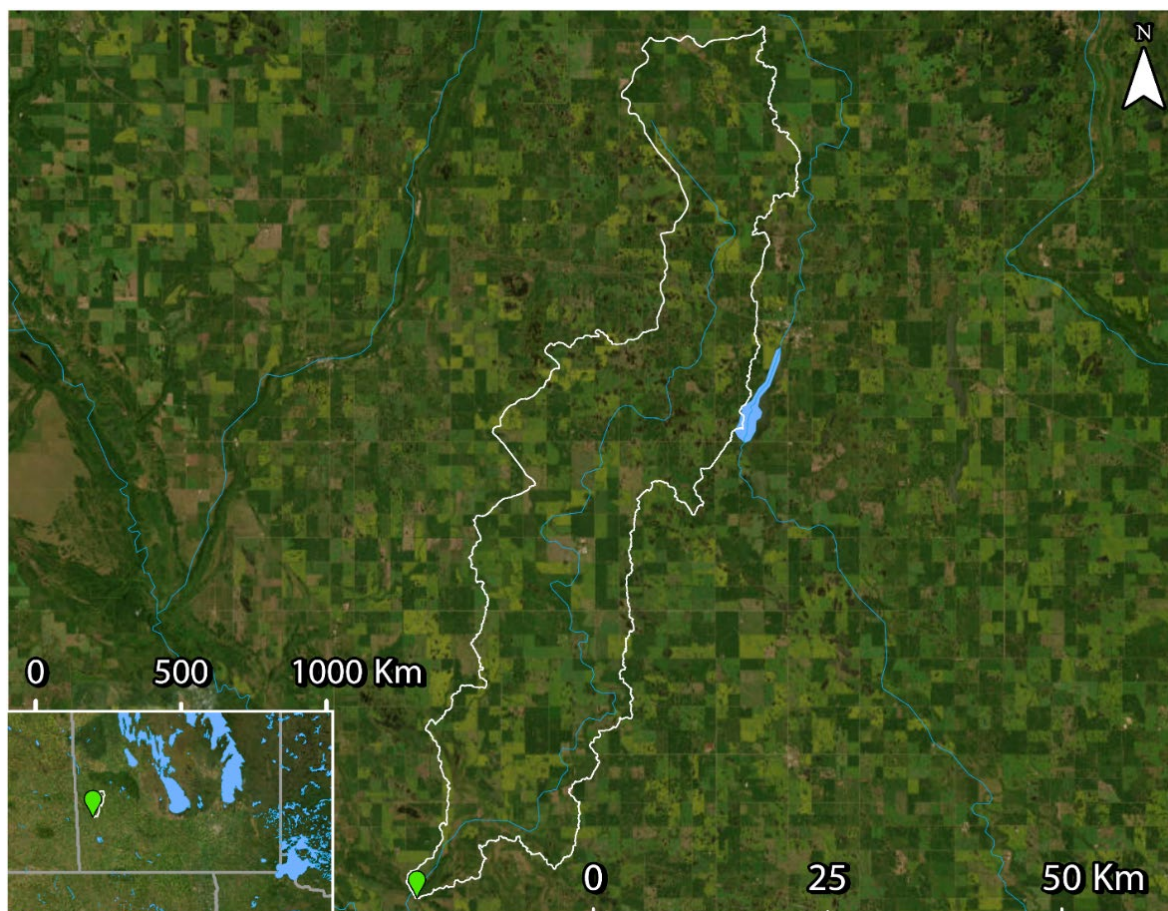


Figure 5: WSC station 05MG001 (green) and drainage area polygon (white - source: WSC). LWCBMN samples directly at the WSC station.

Assiniboine River near Brandon

This sampling is located along the Assiniboine River near Brandon MB. This sampling site is located at Water Survey of Canada station 05MH001, in the northern part of Brandon, MB. 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 Assiniboine River near Brandon (05MH001). See Supplemental Figure 1 for gross calculations.

Assiniboine River Near Brandon - 2023	
Gross/Incremental	Incremental
Drainage area (km ²)	4878.2
Water load (km ³ /year)	0.27
Water export (mm/year)	54.8
Spring water load	52.56%
Spring TP load	63.23%
TP load (tonnes P/year)	243.9
TDP load (tonnes P/year)	81.1
TP export (kg P/ha/year)	0.50
TDP export (kg P/ha/year)	0.17
% of TP as TDP	32.74%

ASSINIBOINE RIVER NEAR BRANDON

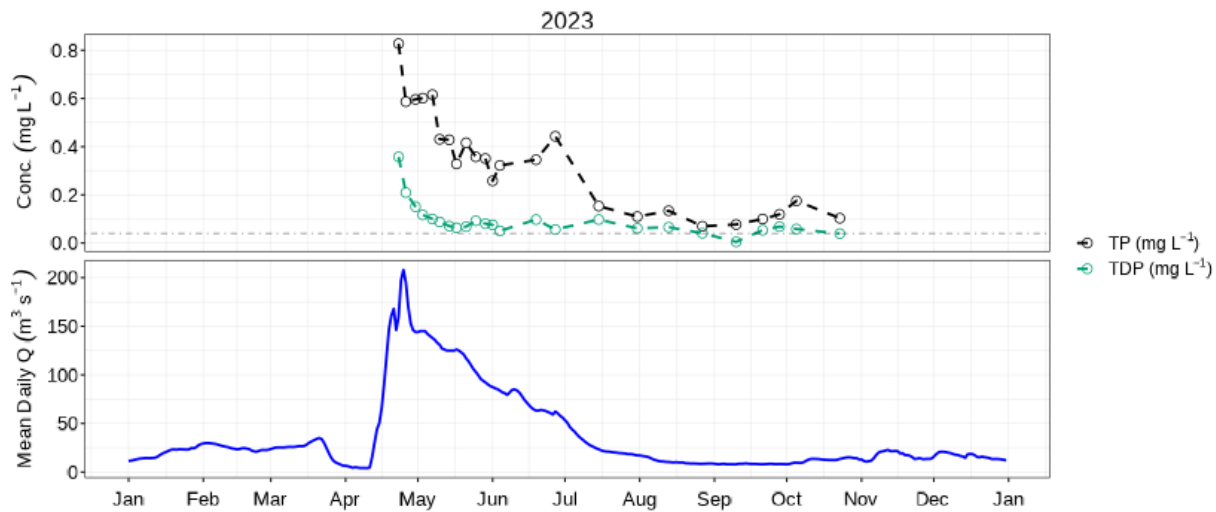


Figure 6: Mean daily discharge (blue) with TP (black) & TDP concentration (green) at Assiniboine River near Brandon (05MH001).

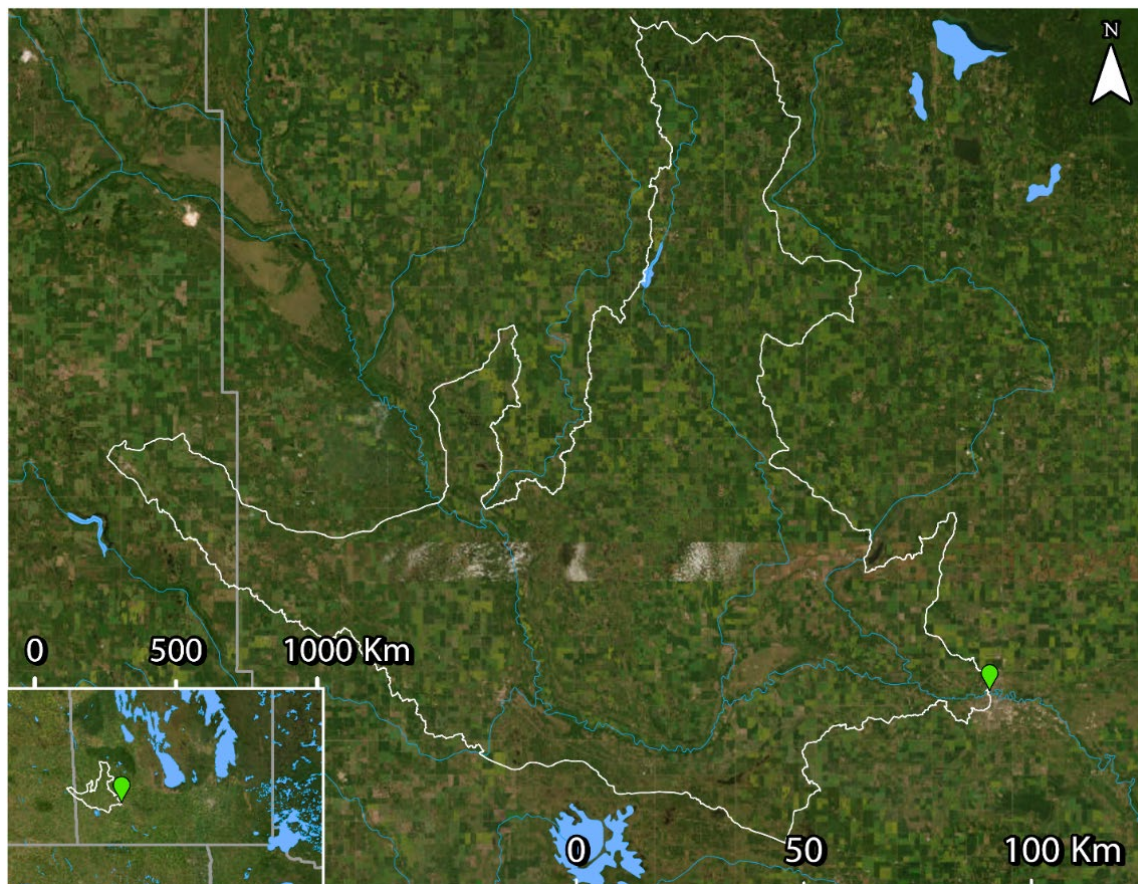


Figure 7: WSC station 05MH001 (green), and incremental drainage area polygon (white - source: WSC). See Supplemental Table 1 for upstream drainage areas used to calculate incremental area. LWCBMN samples directly at the WSC station

Assiniboine River near Miniota

This is the midstream sampling site along the Assiniboine River for this region. The majority of the drainage area is located in Saskatchewan. This sampling site is located at Water Survey of Canada flow meter 05ME006, near Miniota, MB. The sampling effort provided excellent coverage to calculate TP loads and exports.

Table 5: Indices of discharge and phosphorus from the incremental drainage area of Assiniboine River near Miniota (05ME006). See Supplemental Table 2 for gross calculations.

Assiniboine River Near Miniota - 2023	
Gross/Incremental	Incremental
Drainage area (km ²)	73881.3
Water load (km ³ /year)	0.72
Water export (mm/year)	9.8
Spring water load	60.52%
Spring TP load	76.84%
TP load (tonnes P/year)	282.4
TDP load (tonnes P/year)	82.4
TP export (kg P/ha/year)	0.04
TDP export (kg P/ha/year)	0.01
% of TP as TDP	30.20%

ASSINIBOINE RIVER NEAR MINIOTA

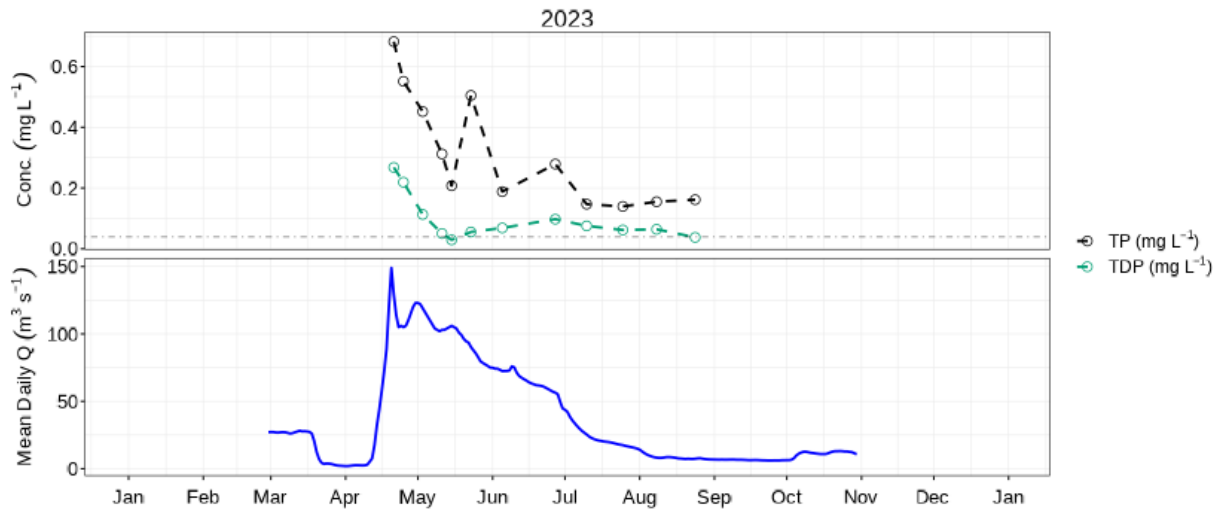


Figure 8: Mean daily discharge (blue) with TP (black) & TDP concentration (green) at Assiniboine River near Miniota (05ME006).

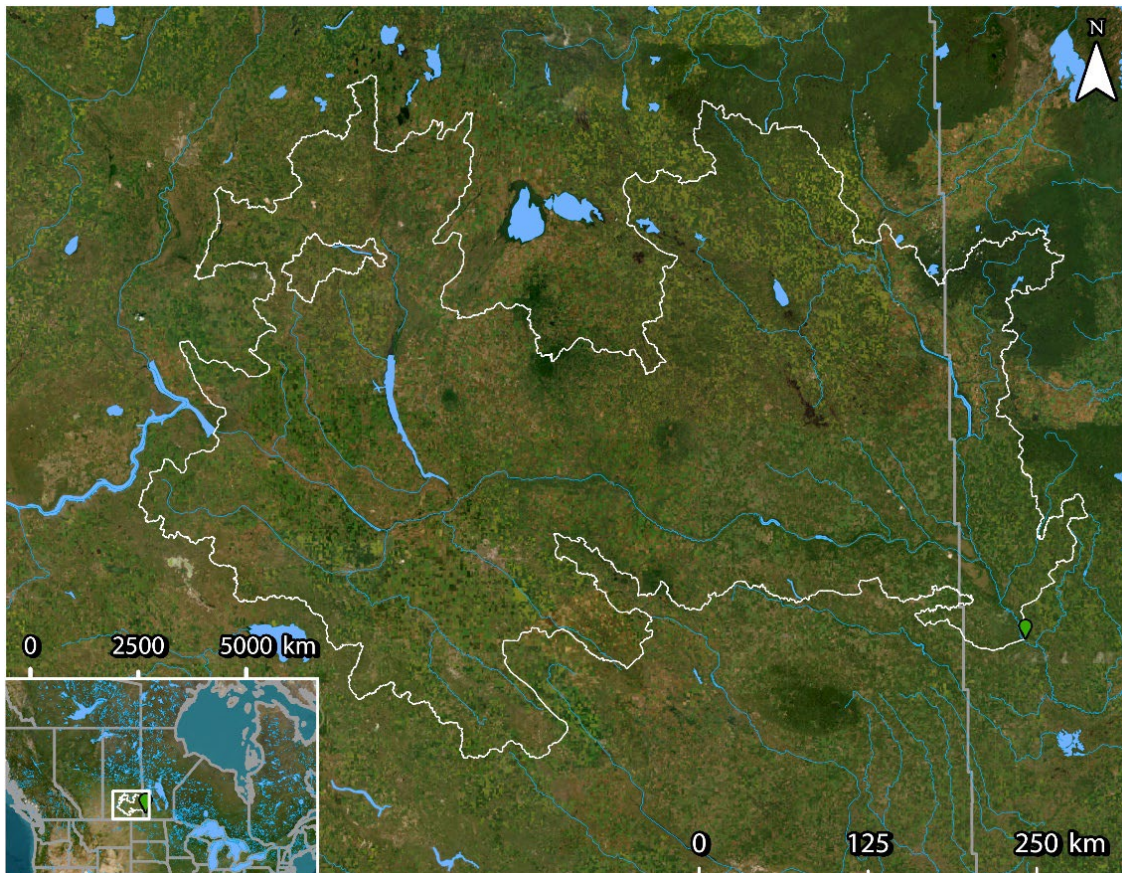


Figure 9: WSC station 05ME006 (green), and incremental drainage area polygon (white - source: WSC). See Supplemental Figure 2 for upstream drainage areas used to calculate incremental area. LWCBMN samples directly at the WSC station.

Birdtail River near Birtle

Birdtail River flows south-southwest into the Assiniboine River. This sampling site is located at Water Survey of Canada flow meter 05ME003, located about 14 km north-northeast of Birtle, MB. The sampling effort provided excellent coverage to calculate TP loads and exports.

Table 6: Indices of discharge and phosphorus from the gross drainage area of Birdtail River near Birtle (05ME003).

Birdtail River Near Birtle - 2023	
Gross/Incremental	Gross
Drainage area (km ²)	1092.2
Water load (km ³ /year)	0.04
Water export (mm/year)	36.0
Spring water load	84.53%
Spring TP load	86.73%
TP load (tonnes P/year)	4.3
TDP load (tonnes P/year)	1.6
TP export (kg P/ha/year)	0.04
TDP export (kg P/ha/year)	0.02
% of TP as TDP	38.44%

BIRDTAIL RIVER NEAR BIRTLE

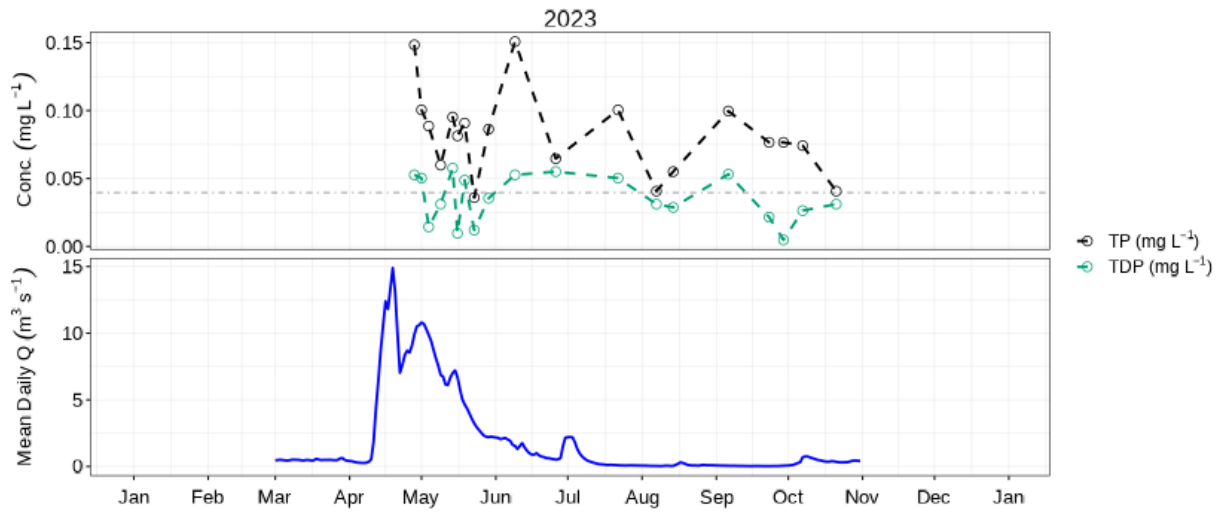


Figure 10: Mean daily discharge (blue) with TP (black) & TDP concentration (green) at Birdtail River near Birtle (05ME003).

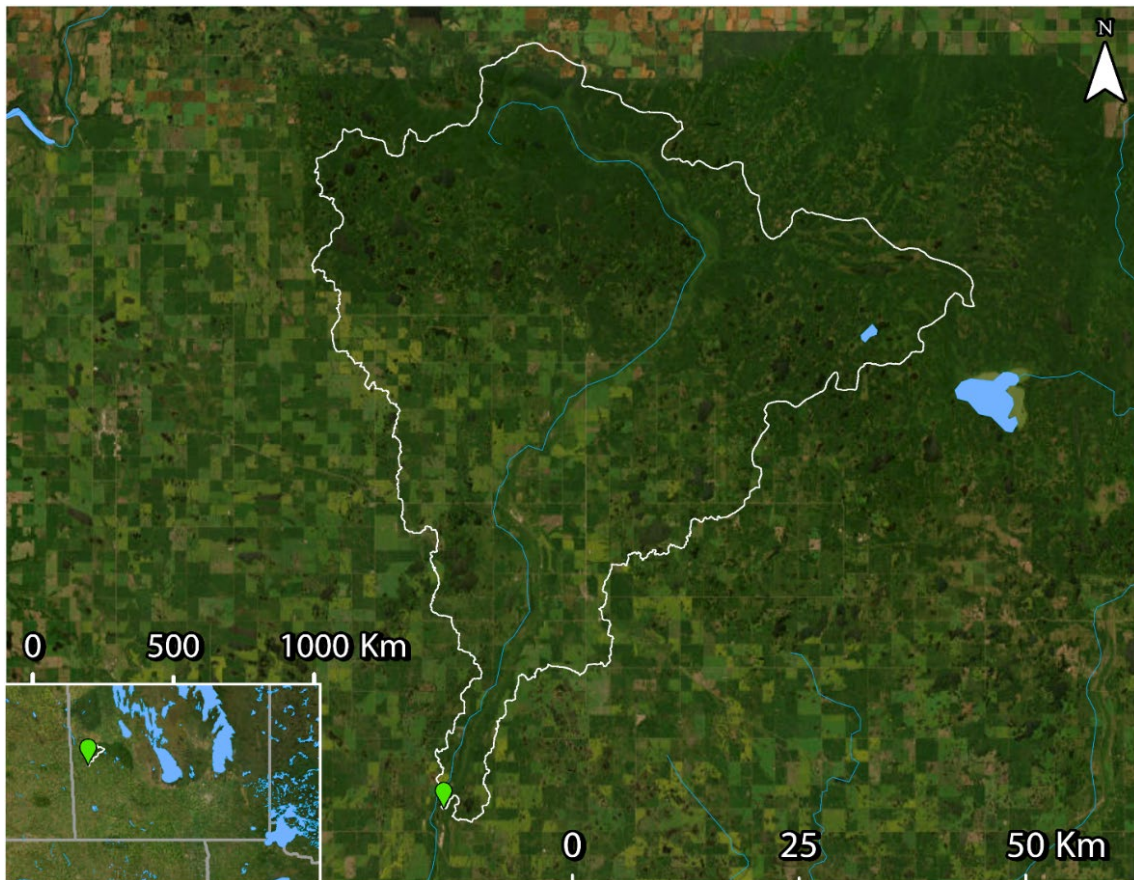


Figure 11: WSC station 05ME003 (green) and drainage area polygon (white – source: WSC). LWCBMN samples directly at the WSC station.

Gopher Creek near Virden

Gopher Creek flows east into the Assiniboine River. The drainage area for this sampling site drains a largely agricultural area, with portions in both Manitoba and Saskatchewan. This sampling site is located at Water Survey of Canada flow meter 05MG003, near Virden, MB. The sampling effort provided adequate coverage to calculate TP loads and exports.

Table 7: Indices of discharge and phosphorus from the gross drainage area of Gopher Creek near Virden (05MG003).

Gopher Creek Near Virden - 2023	
Gross/Incremental	Gross
Drainage area (km ²)	302.4
Water load (km ³ /year)	0.01
Water export (mm/year)	22.3
Spring water load	95.63%
Spring TP load	97.16%
TP load (tonnes P/year)	4.5
TDP load (tonnes P/year)	4.1
TP export (kg P/ha/year)	0.15
TDP export (kg P/ha/year)	0.13
% of TP as TDP	90.22%

GOPHER CREEK NEAR VIRDEN

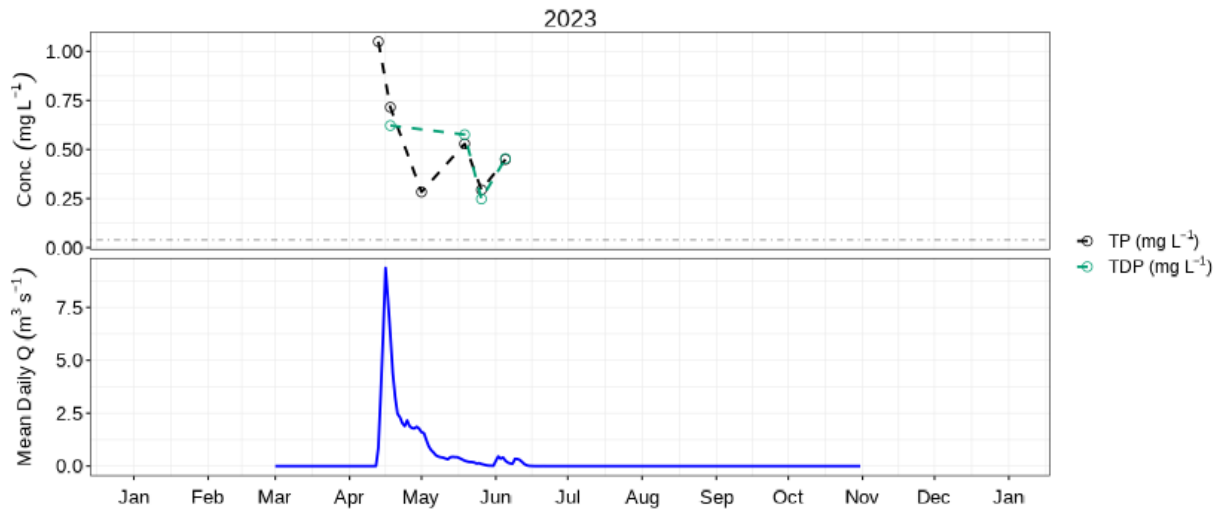


Figure 12: Mean daily discharge (blue) with TP (black) & TDP concentration (green) at Gopher Creek near Virden (05MG003).

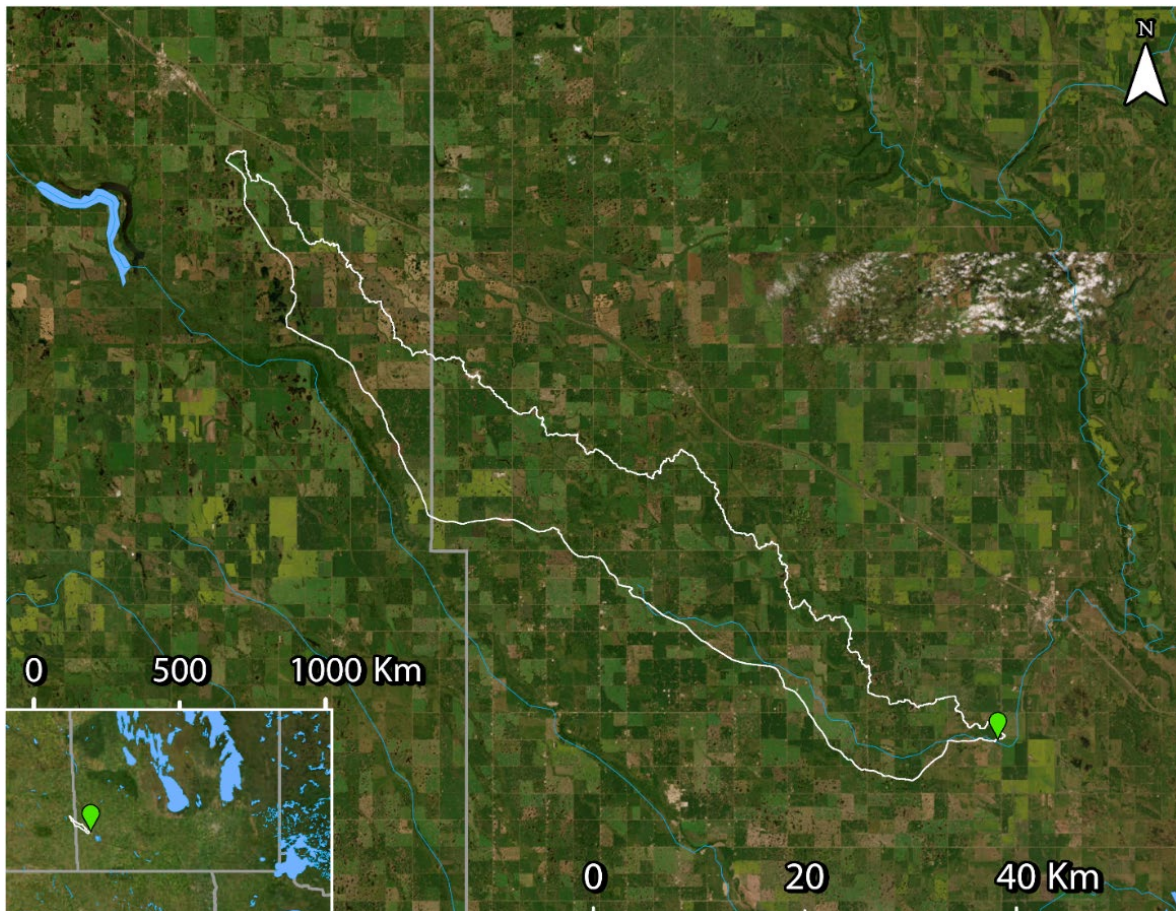


Figure 13: WSC station 05MG003 (green) and drainage area polygon (white - source: WSC). LWCBMN samples directly at the WSC station.

Little Saskatchewan River near Horod

Little Saskatchewan River flows south into the Assiniboine River. This sampling site is located at Water Survey of Canada flow meter 05MF024, just south of Riding Mountain Provincial Park. It is the most northern Little Saskatchewan River site. The sampling effort provided excellent coverage to calculate TP loads and exports.

Table 8: Indices of discharge and phosphorus from the gross drainage area of Little Saskatchewan River near Horod (05MF024).

Little Saskatchewan River Near Horod - 2023	
Gross/Incremental	Gross
Drainage area (km ²)	667.9
Water load (km ³ /year)	0.02
Water export (mm/year)	32.8
Spring water load	75.18%
Spring TP load	64.12%
TP load (tonnes P/year)	1.7
TDP load (tonnes P/year)	1.5
TP export (kg P/ha/year)	0.03
TDP export (kg P/ha/year)	0.02
% of TP as TDP	90.45%

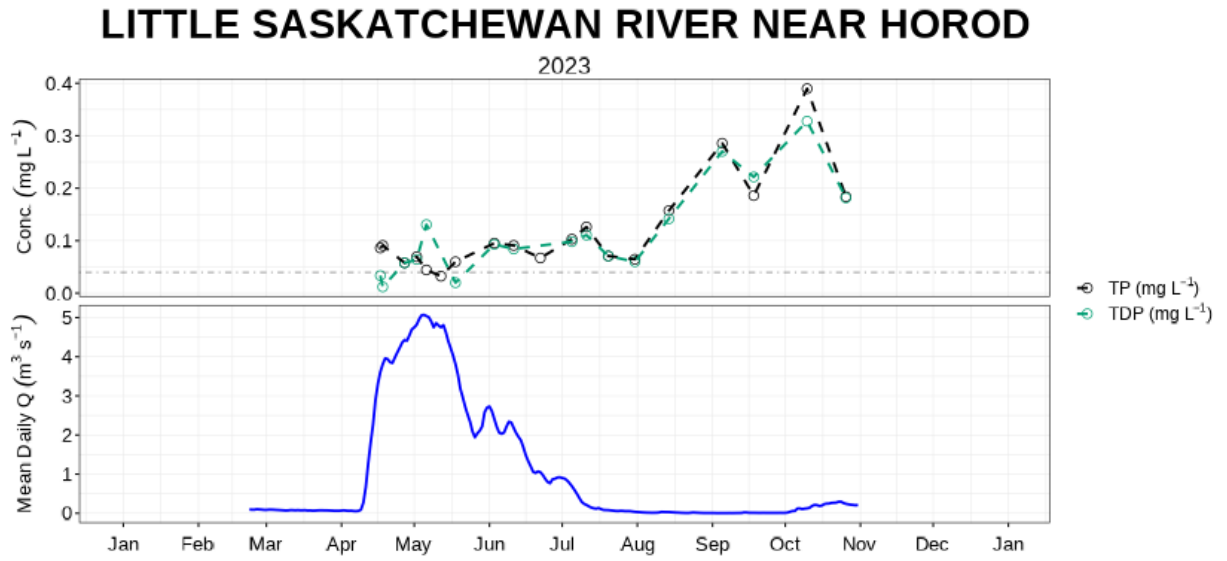


Figure 14: Mean daily discharge (blue) with TP (black) & TDP concentration (green) at Little Saskatchewan River near Horod (05MF024).



Figure 15: WSC station 05MF024 (green) and drainage area polygon (white – source: WSC). LWCBMN samples directly at the WSC station.

Little Saskatchewan River near Rivers

Little Saskatchewan River flows south into the Assiniboine River. This sampling site is located at Water Survey of Canada flow meter 05MF018, roughly 25 km northwest of Brandon, MB. The sampling effort provided excellent coverage to calculate TP loads and exports.

Table 9: Indices of discharge and phosphorus from the incremental drainage area of Little Saskatchewan River near Rivers (05MF018). See Supplemental Table 3 for gross calculations.

Little Saskatchewan River Near Rivers - 2023	
Gross/Incremental	Incremental
Drainage area (km²)	3220.0
Water load (km³/year)	0.08
Water export (mm/year)	23.5
Spring water load	72.04%
Spring TP load	84.79%
TP load (tonnes P/year)	18.0
TDP load (tonnes P/year)	7.1
TP export (kg P/ha/year)	0.06
TDP export (kg P/ha/year)	0.02
% of TP as TDP	43.77%

LITTLE SASKATCHEWAN RIVER NEAR RIVERS

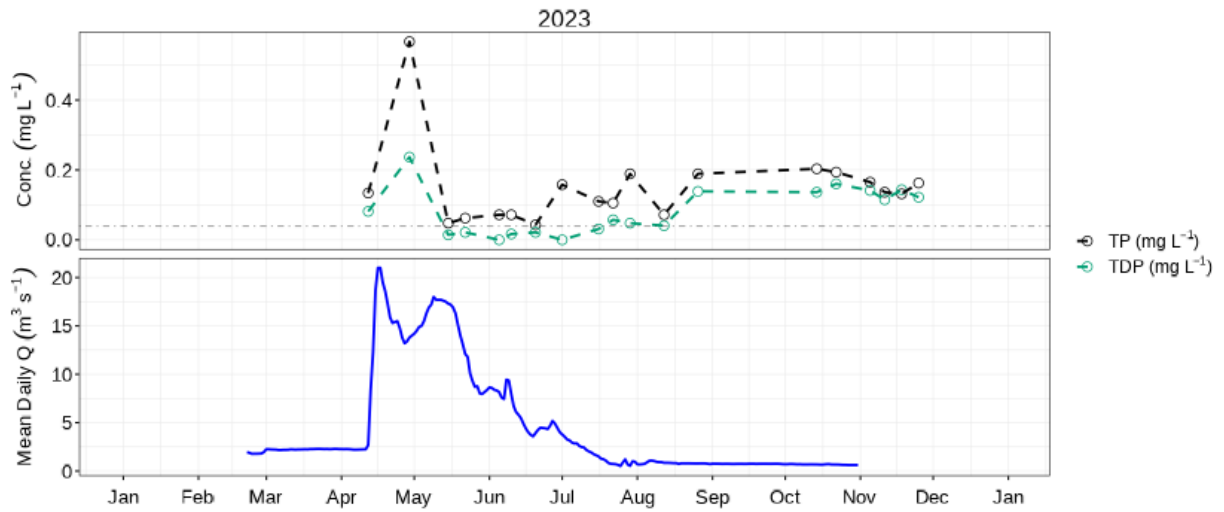


Figure 16: Mean daily discharge (blue) with TP (black) & TDP concentration (green) at Little Saskatchewan River near Rivers (05MF018).

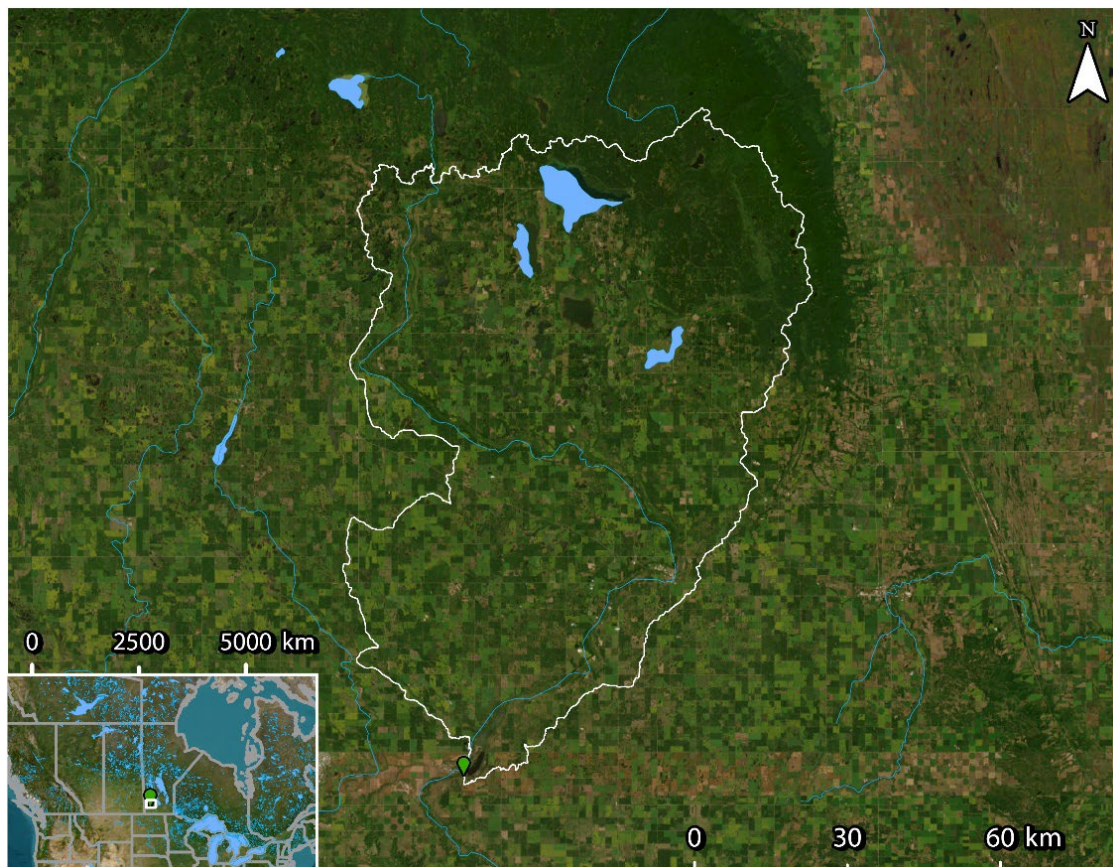


Figure 17: WSC station 05MF018 (green), and incremental drainage area polygon (white - source: WSC). See Supplemental Figure 3 for upstream drainage areas used to calculate incremental area. LWCBMN samples directly at the WSC station.

Scissor Creek at McAuley

Scissor Creek flows east into the Assiniboine River. This sampling site is located at Water Survey of Canada flow meter 05ME009, just north of McAuley. The sampling effort provided excellent coverage to calculate TP loads and exports.

Table 10: Indices of discharge and phosphorus from the gross drainage area of Scissor Creek at McAuley (05ME009).

Scissor Creek At Mcauley - 2023	
Gross/Incremental	Gross
Drainage area (km ²)	241.5
Water load (km ³ /year)	0.01
Water export (mm/year)	22.0
Spring water load	98.75%
Spring TP load	98.73%
TP load (tonnes P/year)	4.0
TDP load (tonnes P/year)	3.8
TP export (kg P/ha/year)	0.17
TDP export (kg P/ha/year)	0.16
% of TP as TDP	93.77%

SCISSOR CREEK AT MCAULEY

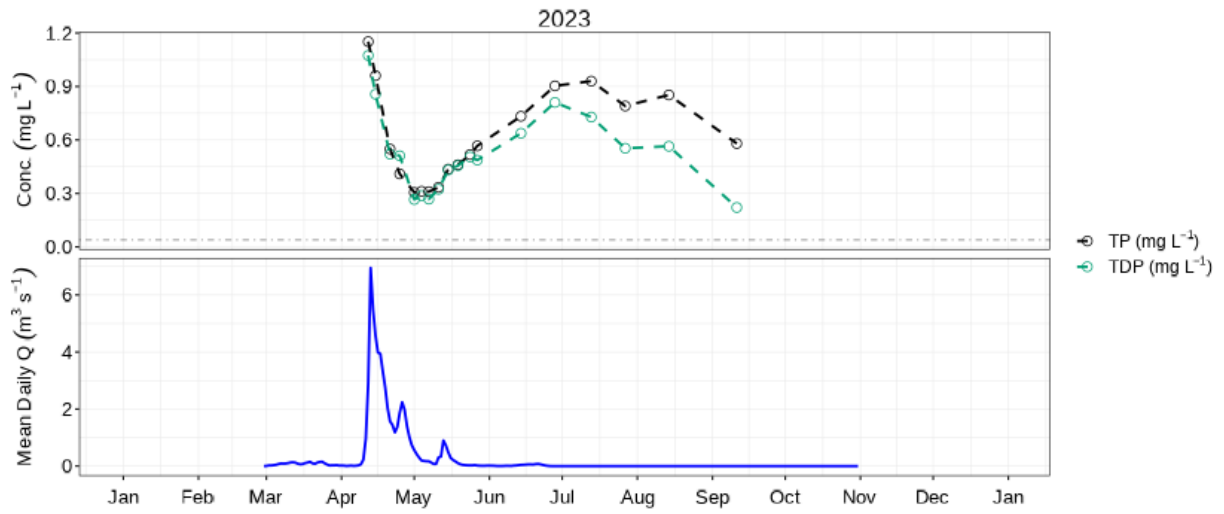


Figure 18: Mean daily discharge (blue) with TP (black) & TDP concentration (green) at Scissor Creek at McAuley (05ME009).

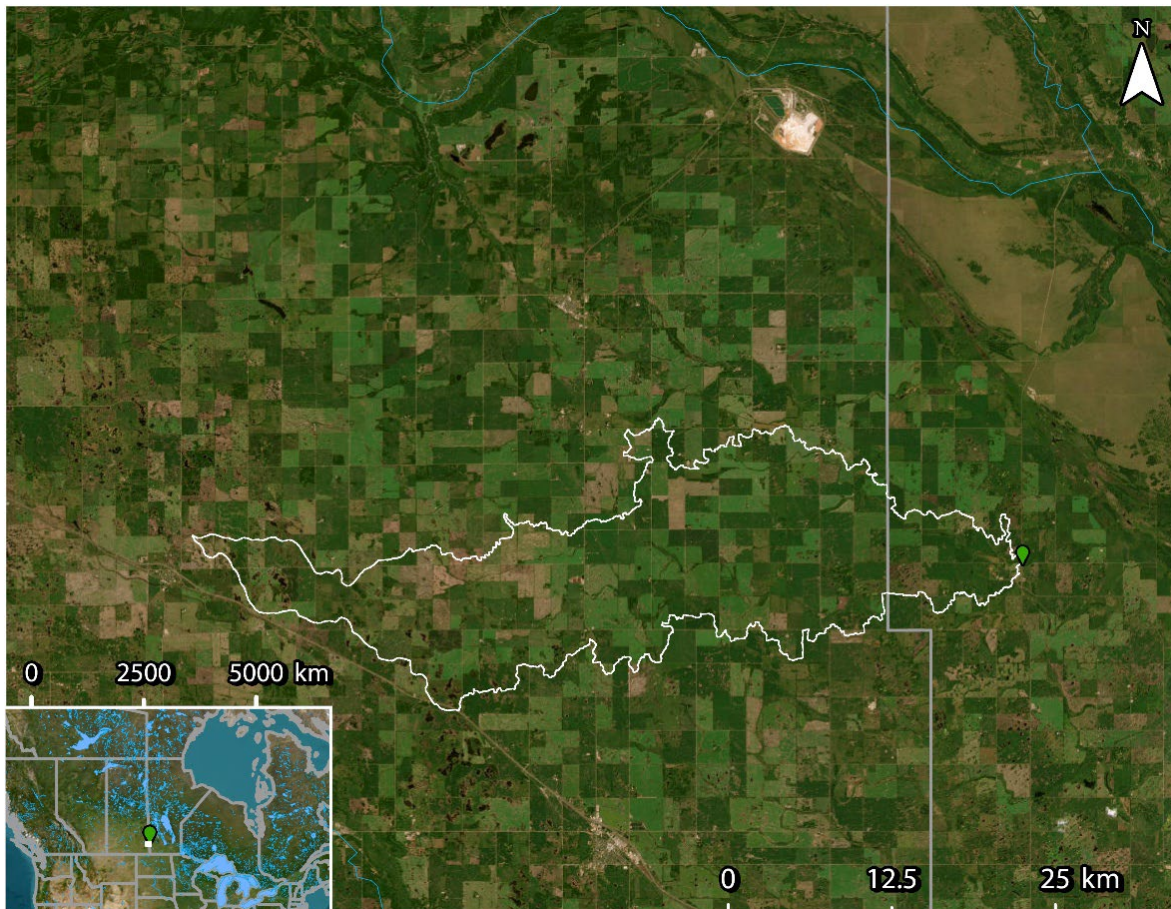


Figure 19: WSC station 05ME009 (green) and drainage area polygon (white – source: WSC). LWCBMN samples directly at the WSC station.

Sites without capacity for load/export calculation

Little Saskatchewan River near Minnedosa

Little Saskatchewan River flows south into the Assiniboine River. This sampling site is located at Water Survey of Canada flow meter 05MF001, roughly 25 km northwest of Brandon, MB. There was insufficient data to calculate TP loads and exports.

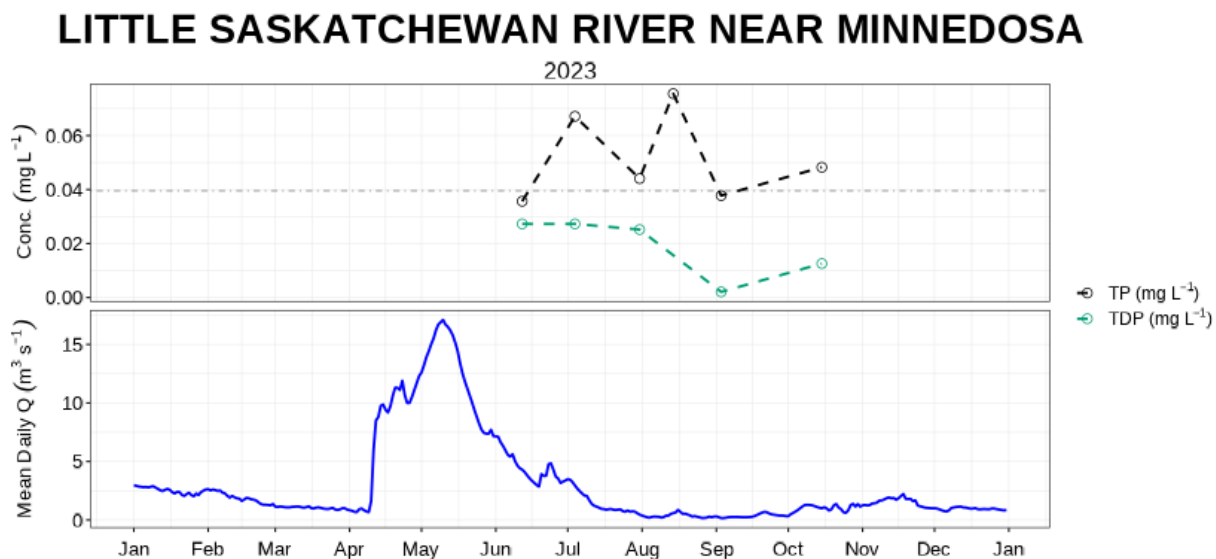


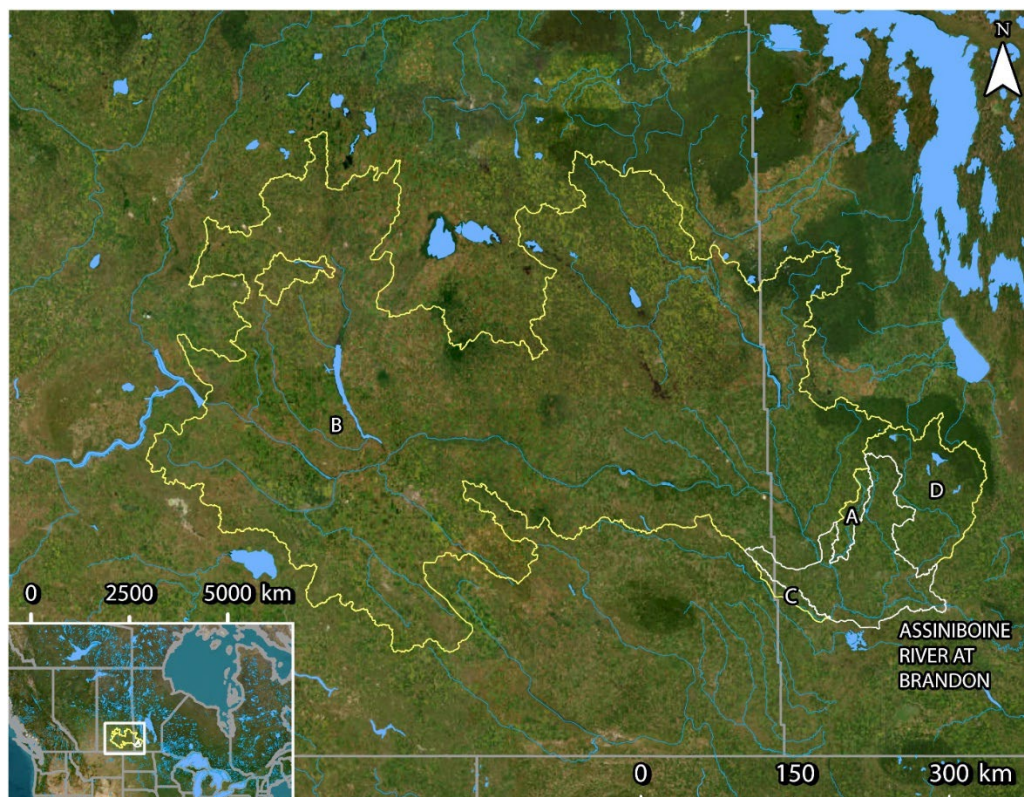
Figure 20: Mean daily discharge (blue) with TP (black) & TDP concentration (green) at Little Saskatchewan River near Minnedosa (05MF001).

Incremental Calculations

Assiniboine River near Brandon

Supplemental Table 1: Indices of discharge and phosphorus from the gross drainage area of Assiniboine River near Brandon (05MH001).

Assiniboine River Near Brandon - 2023	
Gross drainage area (km ²)	84843.7
Water load (km ³ /year)	1.1
Water export (mm/year)	13.5
TP load (tonnes P/year)	561.5
TP export (kg P/ha/year)	0.07
TDP load (tonnes P/year)	183.8
TDP export (kg P/ha/year)	0.02



Supplemental Figure 1: Incremental drainage area in white and upstream drainage area in yellow. Incremental values are calculated by subtracting "Arrow River near Arrow River" (A – 05MG001), "Assiniboine River near Miniota" (B – 05ME006), "Gopher Creek near Virden" (C – 05MG003), and "Little Saskatchewan River near Rivers" (D – 05MF018), from "Assiniboine River near Brandon" (05MH001) values.

Assiniboine River near Miniota

Supplemental Table 2: Indices of discharge and phosphorus from the gross drainage area of Assiniboine River near Miniota (05ME006).

Assiniboine River Near Miniota - 2023	
Gross drainage area (km ²)	75214.9
Water load (km ³ /year)	0.77
Water export (mm/year)	10.2
TP load (tonnes P/year)	290.7
TP export (kg P/ha/year)	0.04
TDP load (tonnes P/year)	87.8
TDP export (kg P/ha/year)	0.01

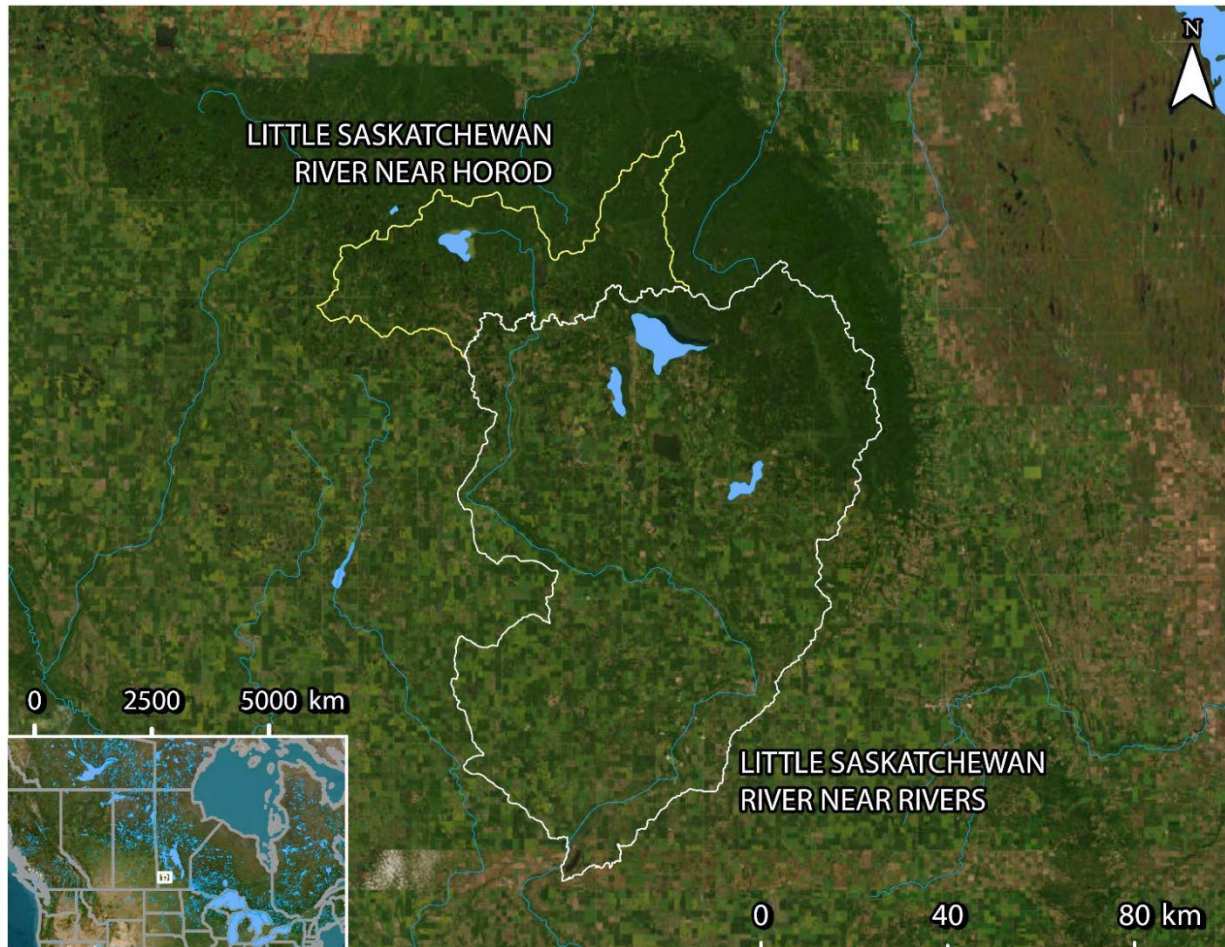


Supplemental Figure 2: Incremental drainage area in white and upstream drainage area in yellow. Incremental values are calculated by subtracting “Birdtail River near Birtle” (A – 05ME003) and “Scissor Creek near McAuley” (B – 05ME009) from gross “Assiniboine River near Miniota” (05ME006) values.

Little Saskatchewan River near Rivers

Supplemental Table 3: Indices of discharge and phosphorus from the gross drainage area of Little Saskatchewan River near Rivers (05MF018).

Little Saskatchewan River Near Rivers - 2023	
Gross drainage area (km ²)	3887.9
Water load (km ³ /year)	0.10
Water export (mm/year)	25.1
TP load (tonnes P/year)	19.7
TP export (kg P/ha/year)	0.05
TDP load (tonnes P/year)	8.6
TDP export (kg P/ha/year)	0.02



Supplemental Figure 3: Incremental drainage area in white and upstream drainage area in yellow. Incremental values are calculated by subtracting “Little Saskatchewan River near Horod” (05MF024) from gross “Little Saskatchewan River near Rivers” (05MF018) values.

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.

LWF proudly acknowledges the following funders

This project was undertaken with the financial support of
Ce projet a été réalisé avec l'appui financier de



Canada
Water Agency

Agence de l'eau
du Canada



Foundation



TD Friends of the
Environment Foundation

Lake Winnipeg Foundation    

107 - 62 Hargrave St, Winnipeg, MB, R3C 1N1
Treaty 1 Territory & Homeland of the Métis Nation
info@lakewinnipegfoundation.org | 204-956-0436