



Lesser Slave Watershed 2021 Water Monitoring Report and Five-Year Trend Assessment



Prepared for: Lesser Slave Watershed Council

Prepared by: Palliser Environmental Services Ltd.

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1.0 INTRODUCTION

There is an ongoing concern in the Lesser Slave Lake watershed regarding water quality. Algal blooms have occasionally been observed in the lake. These blooms, if persistent, may degrade future water quality for aquatic life and for recreation activity. The internal source of phosphorus in Lesser Slave Lake was estimated to be 65% of the total phosphorus load. Major tributaries to the lake were identified as the main source of external phosphorus load (contributing about 25% of the load) (Hutchinson Environmental 2015). In addition to phosphorus, sediment loading to the lake is a concern. Sediment accumulation at the mouths of rivers creates sandbars or spits and shallow water.

Historic water monitoring programs have not been implemented consistently through time, resulting in water quality data that varies by site, the frequency in number of samples collected annually, and different parameters collected. Inconsistent data collection limits the ability to establish and understand baseline conditions or long-term trends, and/or plan mitigation strategies to improve water quality. Past monitoring efforts have not been consistent, leading to questions regarding the findings and relevance to current conditions.

In 2017, the Lesser Slave Watershed Council initiated a comprehensive water monitoring program in the Lesser Slave watershed. The monitoring program was initiated in response to Recommendation 10.3.3 z in the Lesser Slave Integrated Watershed Management Plan (PESL 2018). The recommendation proposed a comprehensive, long-term water monitoring program be implemented for tributaries to Lesser Slave Lake, with the objectives to:

- Collect baseline data
- Evaluate water quality condition in comparison to relevant federal and provincial guidelines, and existing historic data
- Establish site-specific water quality objectives when sufficient data becomes available (at least five years)

This report summarizes the results of the fifth year (2021) of water monitoring data collected by the Lesser Slave Watershed Council.

2.0 BACKGROUND

2.1 Overview of Water Quality

The LSWC water quality program monitors routine parameters (water temperature, dissolved oxygen, pH, conductivity, phosphorus (total and dissolved), nitrogen (total, organic and inorganic), total suspended solids, and fecal coliform bacteria. A short description (sources, concerns) of some of the water quality parameters is provided below.

Conductivity Conductivity is the measure of minerals (e.g., sodium, chloride, magnesium, potassium) dissolved in the water (total dissolved solids), or the salinity. Sources can include soil and mineral weathering, surface runoff from saline soils, groundwater discharge, municipal and industrial effluents, agricultural runoff and aerosol fallout. Excessive salts added to soils may interfere with extraction of water by plants. High total dissolved solids may also affect taste and palatability of drinking water and at high concentrations may have a laxative effect. High conductivity water is also undesirable in most industrial process waters. EC is measured as the resistance of a solution to electrical flow; therefore, the

purer the water is (i.e., the lower its salinity) the greater its resistance to electrical flow will be. Conductivity is expressed as micro Siemens per centimetre ($\mu\text{S}/\text{cm}$) (Cole 1994). The 'safe' irrigation guideline for electrical conductivity is $\leq 1000 \mu\text{S}/\text{cm}$ (GoA 2018).

Total Phosphorus and Dissolved Phosphorus Phosphorus is an essential nutrient required for plant growth. Sources of phosphorus can include animal manures (e.g., cattle, waterfowl), commercial inorganic fertilizers, sewage treatment plants, food processing plants, urban runoff, atmospheric deposition, and natural concentrations found in soils and bottom sediments. Total phosphorus (TP) measures the nutrient in all forms whether particulate or dissolved, organic or inorganic. Dissolved phosphorus (DP) indicates the phosphorus not associated with sediment particles. Dissolved phosphorus is a closer measure of the nutrient more readily available for plant growth, though the phosphorus in particulate form is potentially available through time. The particulate phosphorus concentration gives an indication of the sediments suspended in the water column.

Excessive nutrients in water can cause eutrophic conditions with increased algae and weed growth. In some circumstances, increased plant abundance can change the chemistry of the water, affect oxygen concentrations (through photosynthesis / respiration and decay of organic matter), affect aesthetics and affect the physical movement of water. Dense growths of filamentous algae and aquatic plants can physically block culverts and clog water intakes. Certain strains of algae can impart an off-taste to drinking water and in some instances blue-green algae produce a toxin that can cause toxicity and health issues for humans, livestock and waterfowl (Cole 1994). Until 2014, Alberta had a total phosphorus guideline of 0.050 mg/L for the protection of aquatic life but changed the guideline to the narrative "phosphorus concentrations should be maintained so as to prevent detrimental changes to algal and aquatic plant communities, aquatic biodiversity, oxygen levels, and recreational quality." Future monitoring effort is required to establish water quality objectives for tributaries in the Lesser Slave watershed.

Nitrogen Total Nitrogen (TN) is the sum of nitrate-nitrogen ($\text{NO}_3\text{-N}$), nitrite-nitrogen ($\text{NO}_2\text{-N}$), ammonia-nitrogen ($\text{NH}_3\text{-N}$) and organically bonded nitrogen. Total nitrogen should not be confused with total kjeldahl nitrogen (TKN) which is the sum of ammonia-nitrogen plus organically bound nitrogen but does not include nitrate-nitrogen or nitrite-nitrogen. There is no PAL guideline for TKN and the guideline for total nitrogen is a narrative similar to total phosphorus.

Nitrate and nitrite nitrogen are mobile, dissolved forms of nitrogen. Nitrate is the principal and most stable form of inorganic nitrogen in aquatic environments. Nitrate is a plant nutrient; however, elevated concentrations can result in the excessive growth of algae and aquatic plants. High concentrations of nitrate can also pose a toxic risk for infants and livestock. The chronic PAL guideline for nitrate is 3.0 mg/L and the acute PAL guideline is 124 mg/L (GoA 2018). Nitrite is an intermediate form in the nitrification/denitrification pathway; it is usually found in low concentrations because of its instability in the presence of oxygen. Chronic and acute nitrite PAL guidelines vary with chloride.

Total Suspended Solids Total suspended solids (TSS) is a measure of the suspended particles such as silt, clay, organic matter, plankton and microscopic organisms which are held in suspension in water. Suspended solids can transport nutrients and contaminants (e.g., metals) downstream and may be aesthetically undesirable. Excessively high TSS in irrigation water can cause the formation of crusts on top of the soil which can inhibit water infiltration and plant emergence, and impede soil aeration. The formation of films on plant leaves can reduce sunlight and impede photosynthesis. TSS residues can reduce the marketability of some leafy crops such as lettuce. High TSS can interfere with the treatment

of drinking and industrial process water. As high concentrations of TSS settle out the capacity of lakes, reservoirs and rivers can be lowered, requiring dredging and higher maintenance costs. Total suspended solids concentrations are expressed as milligrams per litre (mg/L) of water.

The potential effects of elevated suspended sediment and sediment deposition on fish and fish habitat include:

- irritation and damage to fish gills, resulting in fish coughing and increased respiration;
- behavioural responses such as altered movement of fish (e.g., short-term to long-term habitat avoidance);
- decline in feeding success as turbidity increases and as sedimentation progresses, which negatively affects primary and secondary production;
- increased embeddedness from sediment deposition altering the porosity of coarse substrate types which can alter spawning habitats and impair egg development and fry emergence;
- increased stress and reduced disease resistance; and,
- alteration of benthic invertebrate habitat and production (Anderson *et al.* 1996, Robertson *et al.* 2006, Levesque and Dube 2007).

Fecal Coliform Bacteria Fecal coliform bacteria (FCB) are specific to the intestinal tracts of warm-blooded animals (e.g., cattle, birds, pets etc.) and humans and are thus a more specific test for animal waste or sewage contamination. *Escherichia coli* are one species of fecal coliform bacteria. Bacterial contamination also indicates potential viral and parasitic contamination which can affect drinking water, irrigation and recreation. FCB can be a concern for fresh garden produce particularly leafy crops such as lettuce. Fecal coliform bacteria levels are expressed as the number of bacteria colonies per 100 mL of water (cfu/100 mL). The irrigation guideline for fecal coliform bacteria is 100 cfu/100 mL (GoA 2018). The recreation guideline for fecal coliform bacteria (*Escherichia coli*) is ≤ 100 cfu/100 mL (geometric mean, 30-d interval) and ≤ 320 cfu/100 mL (statistical threshold, no more than 10% of samples should exceed over a 30-d interval) (GoA 2018).

3.0 METHODS

3.1 Field Sampling

Grab samples were collected approximately every two weeks from late-April to July, and monthly (August-October) at sixteen sites (Figure 1). Three sites were monitored to represent the upper, middle and lower reaches of the Driftpile River, Swan River, East Prairie and South Heart River. Two sites were monitored to represent the upper and middle reaches of the West Prairie River. The Grouard Channel (upstream of Lesser Slave Lake) and the Lesser Slave River (downstream of Lesser Slave Lake) was also monitored at the same frequency. The Lesser Slave River site was added in 2021. In 2021, the LSWC sampled on April 26/27/28, May 11/12, May 25/26/27, June 8/9/10, June 22/23, July 6/7/8, July 20/21, August 17/18, September 14/15 and October 19/20. Note that sampling in 2018 and 2020 was initiated in May compared to April in 2017, 2019 and 2021.

LSWC staff completed the field sampling. Grab samples were collected at each site with sterile bottles supplied by ALS Laboratories (Edmonton). Samples were only collected when flows could be visually detected. Sample bottles were submersed to mid-depth by hand or using a sample pole (with sample bottle attached) when the water was deep or fast-flowing. Sample bottles for fecal coliform bacteria were prefilled with the required preservative. Total nutrient, total metal, total mercury and chromium

(total and hexavalent) samples had preservative added after collection. The water samples were kept on ice in coolers and shipped to ALS Laboratories in Edmonton. ALS Laboratories is **CALA**¹ accredited for criteria and standards established by the Association under their Certificate of Laboratory Proficiency.

Samples were analysed using **APHA**² approved methods for routine parameters (e.g., chloride, alkalinity), nutrients (total phosphorus (TP), total dissolved phosphorus (TDP), nitrate+nitrite nitrogen (NO₃+NO₂-N), total kjeldahl nitrogen (TKN) and total nitrogen [TN; calculated]), total suspended solids (TSS) and fecal coliform bacteria (FCB).

Field measurements (*in situ*) were taken for water temperature, pH, conductivity, dissolved oxygen and percent oxygen saturation using a HACH® HQD Portable Meter, Rugged 101 probe series.

Additional samples were collected on April 27/28, May 25/26, June 22/23, July 20/21, August 17/18, September 14/15 and October 19/20 at the Swan River (upper, middle and lower sites), upper West Prairie River, middle East Prairie River and middle Driftpile River for metals analysis (total and dissolved). Sampling for metals analysis from 2017 to 2019 only included the Swan River sites. The West Prairie River, East Prairie River and Driftpile River were added as metal analysis sites in 2020 to provide reference sites to compare to the Swan River sites. Seven metals samples were collected at each site from 2018 to 2021, compared to 5 samples at each site in 2017.

3.2 Streamflow Data

Daily mean streamflow data for 2017 to 2021 was retrieved from the Alberta Environment and Parks (AEP) Monitoring Section for sites listed in Table 1. Streamflow data is considered “Near Real Time Flows (NRT)” and are best estimates available at the time. This data may differ from Water Survey of Canada (WSC) data that will be posted in the future (G. Rojas, pers. comm.). All streamflow data should be considered interim, until the Water Survey of Canada validation is complete.

Table 1. Streamflow gauging stations, Lesser Slave Lake watershed, and missing data (dates and days) for the period April 1 to October 31, 2017 to 2021.

Site (Station Name)	2017	2018	2019	2020	2021
Driftpile River near Driftpile (07BH003)	None	Apr 1-29; May 1-7; Jun 12-20 (45 d)	Apr 1-30 (30 d)	Apr 1-28; Oct 17- 31 (43 d)	Apr 1-30; May 29- Jun 2; Jul 22 (36 d)
Swan River near Kinuso (07BJ001)	Apr 8-11; Jul 1; Aug 25; Oct 15, 19, 28- 29 (10 d)	Apr 1-9; May 15- 31; Jun 1-4 (50 d)	Apr 1-30; Aug 12; Sep 10, 11; Oct 23- 28 (39 d)	Apr 1-30; Oct 26- 31 (36 d)	Apr 1-29 (29 d)
Swan River near Swan Hills (07BJ003)	None	Apr 1-30; May 1-8; Jun 12-14, 16-30; Jul 1-2, 5-31; Aug 1-2 (60 d)	Apr 1-28; May 24- Jun 13; Jun 29-Jul 8; Jul 25, 26; Aug 13-Sep 10 (90 d)	Apr 1-27; Oct 26- 31 (33 d)	Apr 1-30 (30 d)
East Prairie River near Enilda (07BF001)	Aug 16, 17; Oct 16 (3 d)	Apr 1-30; May 1-8; Jun 6 (39 d)	Apr 1-30 (30 d)	Apr 1-27; Sep 4; Oct 26-31 (34 d)	Apr 1-29 (29 d)
West Prairie River near High Prairie (07BF002)	May 17 (1 d)	Apr 1-30; May 1-8; Jun 13; Jul 18; Aug 14-31 (68 d)	Apr 1-May 8; Oct 9- 11; Oct 28, 29 (43 d)	Apr 1-28; Oct 26- 31 (34 d)	Apr 1-29; Aug 2- 24; Sep 3-22 (72 d)

¹ **CALA** – Canadian Association for Laboratory Accreditation Inc.

² **APHA** – American Public Health Association

Site (Station Name)	2017	2018	2019	2020	2021
South Heart River near Big Prairie Settlement (07BF905)	None	Apr 1-30; May 1-8 (38 d)	Apr 1-May 8; Oct 29 (39 d)	Apr 1-28; Sep 4; Oct 26-31 (35 d)	Apr 1-28; Jul 22; Aug 17-23 (36 d)
South Heart River near Peavine (07BF010)	May 3-13, 18, 20- 31; Jun 1, 5-8; Jul 6, 15; Aug 12, 13, 15 (34 d)	Apr 1-30; May 1- 15, 18, 24; Jun 20, 22; Aug 3-16, 21- 31; Sep 1-30; Oct 1-31 (135 d)	Apr 1-May 8; Aug 5-16; Sep 12-Oct 31 (100 d)	Apr 1-28; Oct 17- 31 (43 d)	Apr 1-28 (28 d)
Average missing days per station (range)	7 (0 - 34)	62 (38 - 135)	53 (30 - 100)	37 (33 - 43)	37 (28 - 72)

Streamflow data for the April 1 to October 31 monitoring period was isolated from the AEP data set. Streamflow data collection for the April 1 to October 31 period contains missing data; therefore, the datasets are incomplete (Table 1). In 2017, there was only an average of 7 missing days per station (range: 0 to 34 days). Missing streamflow data was substantial in 2018 when there was an average of 62 missing days per station (range: 38 to 135 days) and 2019 when there was an average of 53 missing days per station (range: 30 to 100 days). In 2020, there was an average of 37 missing days per station (range: 33 to 43 days). In 2021, there was an average of 37 missing days per station (range: 28 to 72 days). A substantial period of missing data each year limits the comparison of streamflow between years.

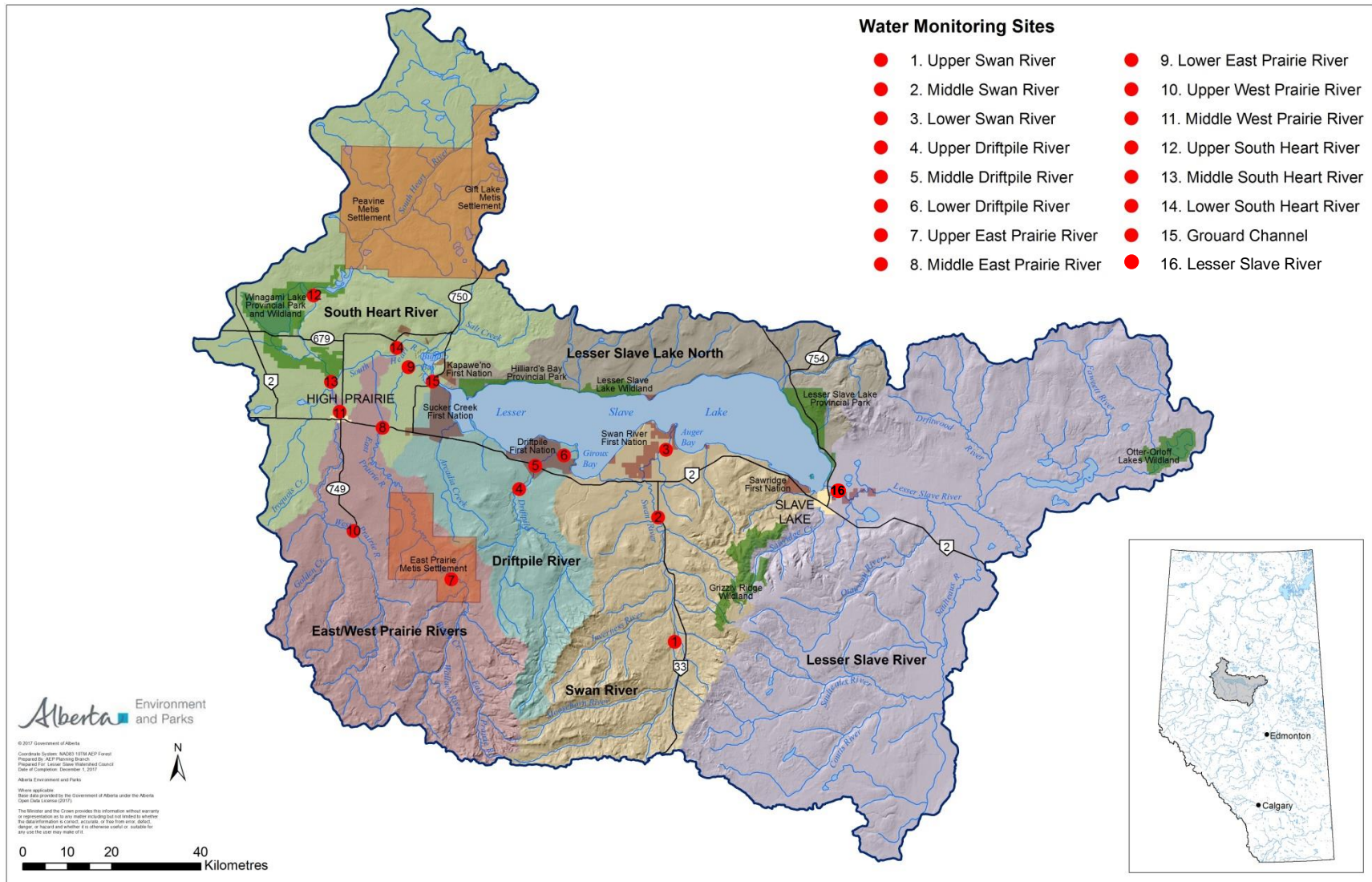


Figure 1. Water quality monitoring site locations in the Lesser Slave watershed, April-October, 2017 to 2021.

3.3 Precipitation Data

Daily precipitation data for the period April 1 to October 31 was retrieved from Alberta Agriculture and Forestry's website (<http://agriculture.alberta.ca/akis/alberta-weather-data-viewer.jsp>). Fourteen weather stations are located in the Lesser Slave watershed including two stations in the Town of Slave Lake (Figure 2). Precipitation data for the monitoring period April through October was available for seven sites: Peavine, High Prairie AGDM, High Prairie Banana Belt, Slave Lake, Slave Lake RCS, House Mountain Lookout and Flattop Lookout. Incomplete precipitation data was available for Gift Lake Auto, Salt Prairie Auto, Kinuso Auto, Salteaux Auto, Swan Dive Auto and Enilda Auto; therefore, these sites were excluded from further consideration in this report. Marten Hills Auto was also excluded as its location was not as relevant as other sites in the watershed.

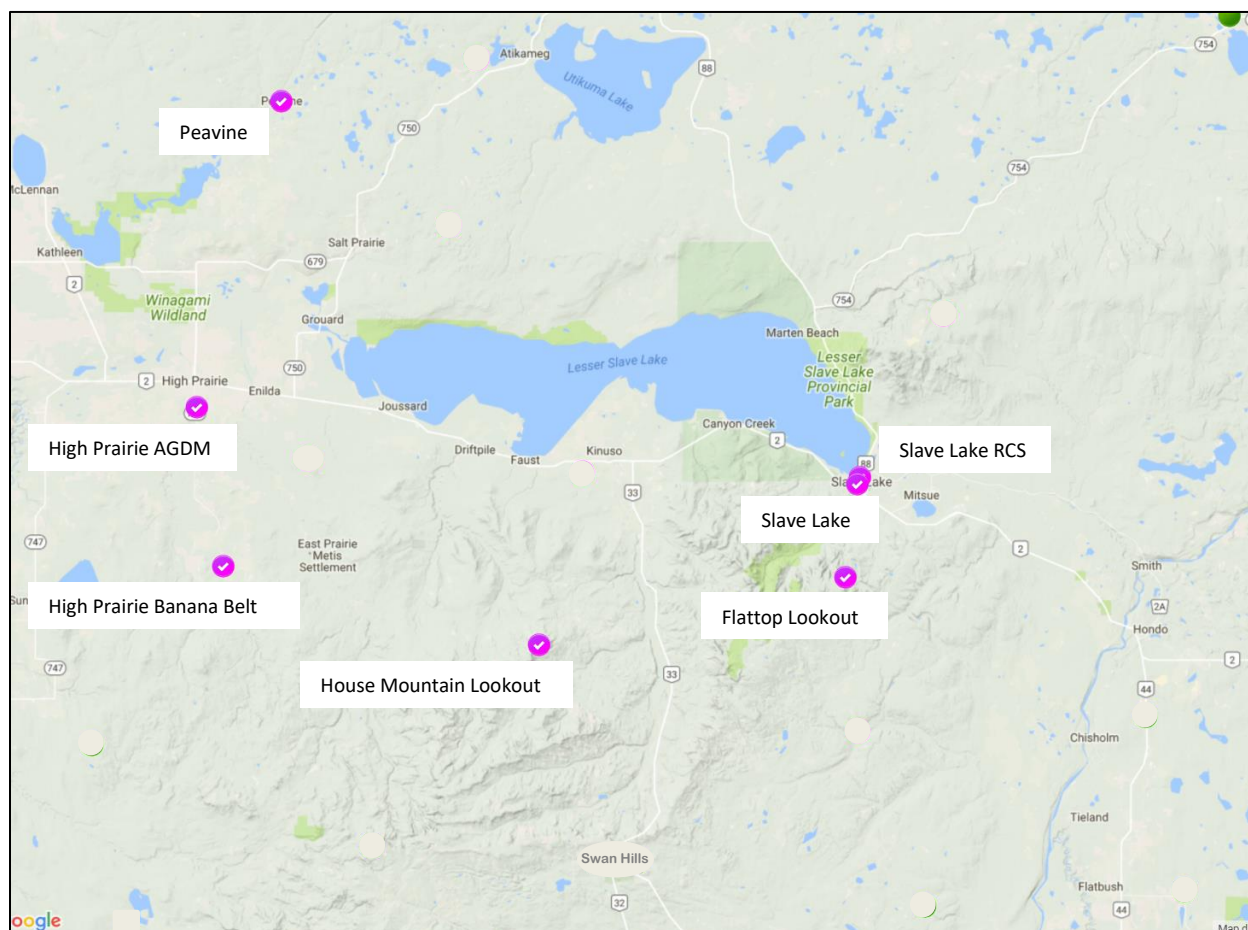


Figure 2. Weather stations in the Lesser Slave watershed.

3.4 Data Handling and Analysis

3.4.1 2021 Annual Water Quality Report

Median and range statistics were calculated for the water quality data using Microsoft Excel 2019. Water quality data was compared to applicable provincial surface water quality guidelines where possible (GoA 2018). Where provincial guidelines were not available, federal Canadian Council of Ministers of the Environment (CCME) guidelines were used. Comparisons were also made to historic data presented in the Lesser Slave Integrated Watershed Management Plan (PESL 2018) (Table 3).

A simple Pearson's correlation analysis was used to determine if there were linear relationships among total phosphorus, total suspended sediment and streamflow (discharge). The strength of a correlation was determined as:

- +/-1: a perfect positive/negative linear relationship
- +/- 0.7 to <1.0: a strong positive/negative linear relationship
- +/- 0.3 to <0.7: a moderate linear relationship
- +/- >0.0 to <0.3: a weak linear relationship
- 0.0: no linear relationship

3.4.2 Five-Year Trend Assessment

A one-way ANOVA was used to determine if there were significant differences of site means ($P \leq 0.05$) within a river (i.e., upper, middle and lower) for the five years (2017 to 2021) of water quality data combined. The Tukey HSD *post hoc* test was used to test which site means were significantly different ($P \leq 0.05$) within a river.

The Mann-Kendall Test was used to determine whether time series data had consistently increasing or decreasing monotonic trends. The Mann-Kendall test is a non-parametric test that does not require the data be normally distributed or linear. The test does require that there is no autocorrelation. The test can be used to find trends for as few as four samples; however, with only a few data points, the test has a high probability of not detecting a trend when one is present. To detect a true trend the minimum number of recommended data points is 8 to 10. The Mann-Kendall test was used to detect if trends existed for water quality parameters from 1991-92, 2012-13 and 2017 to 2021 ($N = 6$ or 7) (Table 17). The Mann-Kendall tests were completed using the Microsoft® Excel based GSI Mann-Kendall Toolkit (Connor *et al.* 2012). The metrics used to describe the trend are summarized below. Only the trends 'increasing' and 'decreasing' were considered statistically significant ($P < 0.05$).

Statistical Metrics Used in GSI Mann-Kendall Toolkit (Connor *et al.* 2012)

S Statistic	Confidence In Trend	Trend	Trend Symbol
$S > 0$	$CF > 95\%$	Increasing	↑
$S > 0$	$95\% \geq CF \geq 90\%$	Probably Increasing	↗
$S > 0$	$CF < 90\%$	No Trend	NT
$S \leq 0$	$CF < 90\%$ and $COV \geq 1$	No Trend	NT
$S \leq 0$	$CF < 90\%$ and $COV < 1$	Stable	—
$S < 0$	$95\% \geq CF \geq 90\%$	Probably Decreasing	↘
$S < 0$	$CF > 95\%$	Decreasing	↓

S Statistic – Indicates whether concentration trend vs time is generally decreasing or increasing (negative or positive S value)
COV – coefficient of variation (standard deviation / mean), COV is used to establish 'no trend' (highly variable concentration vs time) and 'stable' (relatively constant concentration)
CF – confidence factor ($1 - p$ value), CF is inversely proportional to p (i.e., $CF > 95\% = p < 0.05$) and is a measure of confidence for rejecting null hypothesis of no trend vs time

3.5 Missing Data

From 2017 to 2021, occasionally water quality data was missed at some sites due to poor road conditions, laboratory error, missed or late courier deliveries and locked gates (Table 2).

Table 2. Missing water quality data, 2017 to 2021.

Sites	Date	Parameter	Reason
middle Driftpile River	April 25, 2017	TDP	Laboratory reporting error; value removed from analysis.
upper & middle Swan River	May 24, 2017	EC, Nutrients, TSS, FCB	Courier did not deliver one of the coolers to the laboratory
lower East Prairie River	May 24, 2017	EC, Nutrients, TSS, FCB	Road washed out; site inaccessible
lower East Prairie River	June 18, 2018	All	Site inaccessible due to flooding
lower Swan River	July 4, 2018	EC, nutrients, TSS, FCB, metals	Site inaccessible due to flooding
lower Swan River	April 17, 2019	EC, nutrients, TSS, FCB, metals	Site inaccessible.
lower Swan River	June 17, 2020 June 29, 2020	EC, nutrients, TSS, FCB, metals (June 29)	Site inaccessible due to poor road conditions
Grouard Channel upper, middle & lower South Heart River upper & middle West Prairie River upper & middle East Prairie River	June 30, 2020	FCB	Courier delivery late, hold time exceedance
upper Driftpile River	July 30, 2020	EC, nutrients, TSS, FCB	Site not accessed due to locked gate
upper & lower Driftpile River	Sept 16, 2020	EC	--
middle East Prairie River	June 22, 2021	metals	total and dissolved metals collected at upper East Prairie River instead of middle site
lower East Prairie River	July 7, 2021	nutrients, TSS, FCB, <i>in situ</i> water quality	--
Lesser Slave River	Aug 18, 2021	water temperature, dissolved oxygen, oxygen saturation	Probe malfunction
Grouard Channel upper, middle & lower South Heart River upper & middle West Prairie River upper, middle & lower East Prairie River	Sept 14, 2021	FCB	Laboratory error, sites were not re-sampled
upper, middle & lower Swan River Lesser Slave River upper, middle & lower Driftpile River	Sept 15, 2021	FCB	Laboratory error, sites were re-sampled on Sept 22 for FCB

From 2018 to 2020, missing data at the Lower Swan River site probably resulted in an under-estimation of the median and maximum total phosphorus and total suspended solids concentrations at the Lower site when compared to the Upper and Middle sites.

Table 3. Historic water quality data for the main tributaries to Lesser Slave Lake, open-water season (May-October), and applicable provincial water quality guidelines (PESL 2018).

Indicator	Statistic	South Heart		West Prairie	East Prairie	Driftpile		Swan		Alberta Surface Water Quality Guidelines (GoA 2018; CCME 2012)
		1991-92	2012-13	2012-13	2012-13	1991-92	2012-13	1991-92	2012-13	
		N=9	N=12	N=12	N=12	N=11	N=12	N=11	N=11	
pH	Median ^a	7.73	8.31	8.03	8.30	7.40	8.00	7.30	7.87	6.5 to 9.0
Conductivity, µS/cm	Median ^a	309	243	187	177	149	127	168	136	<1,000 for safe irrigation
Temperature, °C	Median	16.5	12.7	12.8	13.4	16.2	13.9	15.6	14.5	<22 ^b
	Minimum	12.0	0.9	3.3	1.3	0.7	1.6	0.8	2.5	
	Maximum	21.5	21.3	21.7	22.6	21.7	23.1	20.0	22.6	
Dissolved Oxygen, mg/L	Median	-	8.36	9.95	9.62	9.00	9.72	8.60	9.60	≥5.0 (acute daily minimum) ≥6.5 (chronic 7-day average) ≥9.5 (spawning)
	Minimum	-	6.05	8.23	7.94	8.00	7.54	8.16	7.80	
	Maximum	-	15.87	13.85	16.04	13.18	15.32	12.89	12.18	
Total Phosphorus, mg/L	Median	0.094	0.143	0.053	0.076	0.040	0.051	0.048	0.060	Where site-specific nutrient objectives do not exist: Nitrogen (total) and phosphorus concentrations should be maintained to prevent detrimental changes to algal and aquatic plant communities, aquatic biodiversity, oxygen concentration, and recreational quality.
	Minimum	0.050	0.079	0.028	0.028	0.022	0.020	0.026	0.031	
	Maximum	0.190	0.838	1.150	1.120	0.129	0.873	0.173	0.084	
Total Dissolved Phosphorus, mg/L	Median	0.027	0.024	0.018	0.013	0.016	0.012	0.015	0.012	
	Minimum	0.015	0.012	0.006	0.004	0.007	0.005	0.010	0.009	
	Maximum	0.058	0.064	0.033	0.032	0.021	0.025	0.016	0.023	
Total Nitrogen, mg/L	Median	1.197	1.187	0.859	0.565	0.482	0.546	0.431	0.518	
	Minimum	1.052	0.724	0.411	0.249	0.281	0.262	0.275	0.201	
	Maximum	1.955	2.762	3.786	2.972	0.976	7.878	0.832	2.110	
Nitrate+Nitrite Nitrogen, mg/L	Median	0.039	0.032	0.009	0.009	0.003	0.006	0.002	0.012	Nitrite-Nitrogen: Varies with Chloride Nitrate-Nitrogen: 3 (chronic 30-d average); 124 (acute instantaneous maximum)
	Minimum	0.002	0.003	0.003	0.003	0.001	0.003	0.001	0.003	
	Maximum	0.083	0.072	0.086	0.152	0.026	0.148	0.032	0.093	
Total Suspended Solids, mg/L	Median	10	-	-	-	14	-	21	-	Clear Flow Period: Max. increase of 25 mg/L from background for short-term exposure (e.g., 24-h period). Max. average increase of 5 mg/L from background for longer term exposures (e.g., inputs lasting between 24 h and 30 d). ^c High Flow Period: Max. increase of 25 mg/L from background at any time when background is between 25 and 250 mg/L. Should not increase more than 10% of background when background is ≥ 250 mg/L. ^c
	Minimum	5	-	6	12	2	-	4	-	
	Maximum	132	-	1170	1150	128	-	187	-	
Fecal coliform Bacteria, cfu/100 mL	Median	20	-	-	-	15	-	60	-	≤100 cfu per 100 mL (irrigation)
	Minimum	4	-	-	-	2	-	20	-	
	Maximum	264	-	-	-	200	-	200	-	

^aN ranges from 9 to 12; ^bTemperature is an objective based on historical data from 1991-92 and 2012-13; ^cTSS guideline is relevant to instream construction

4.0 2021 WATER MONITORING RESULTS

4.1 Precipitation

Table 4 summarizes the precipitation data for the seven weather stations in the Lesser Slave watershed. Total precipitation during the monitoring period (April to October) varied from west to east, and north to south in the Lesser Slave watershed (Table 4). In 2021, less precipitation was recorded at weather stations in the north (262.7 to 327.0 mm at Peavine, High Prairie AGDM, Slave Lake RCS and Slave Lake) compared to weather stations in the south (381.0 to 531.7 mm at High Prairie Banana Belt, Flat Top Lookout, and House Mountain Lookout). This trend was also observed in 2019 and 2020. In 2021, House Mountain Lookout had the most precipitation (531.7 mm) and Peavine had the least precipitation (262.7 mm).

Table 4. Monthly total precipitation (mm) at Lesser Slave watershed, April-October, 2017 to 2021. Refer to Figure 2 for station locations.

Weather Station	Year	April	May	June	July	August	September	October	Total
Peavine	2017	37.5	41.6	43.4	42.6	53.0	54.9	42.7	315.7
	2018	18.3	9.9	127.0	119.4	52.9	23.1	19.4	370.0
	2019	14.7	4.7	87.5	148.2	44.3	32.8	27.0	359.2
	2020	8.6	35.4	134.0	67.9	39.5	16.6	32.3	334.3
	2021	28.9	55.9	32.2	28.0	62.8	38.9	16.0	262.7
High Prairie AGDM	2017	36.8	61.8	66.6	82.2	50.3	62.7	36.6	397.0
	2018	18.9	14.6	108.5	119.5	31.5	26.7	30.3	350.0
	2019	27.7	17.9	98.6	120.5	56.4	44.7	38.4	404.2
	2020	8.9	62.1	117.3	93.3	83.2	10.7	25.6	401.1
	2021	15.3	72.9	41.8	26.1	83.1	40.9	15.1	295.2
High Prairie Banana Belt	2017	63.3	68.5	52.5	52.0	39.7	103.9	38.4	418.3
	2018	26.3	22.5	133.0	135.3	35.2	31.0	37.4	420.7
	2019	21.1	23.4	155.8	90.1	53.4	43.2	44.7	431.7
	2020	11.3	67.3	115.2	96.4	49.5	12.9	22.4	375.0
	2021	20.5	92.3	45.3	53.2	74.1	77.3	18.3	381.0
Slave Lake RCS	2017	57.1	36.4	72.9	169.1	17.6	32.1	54.5	439.7
	2018	18.5	9.1	128.7	76.0	50.4	38.6	26.3	347.6
	2019	14.2	4.2	76.6	130.5	88.6	37.2	49.2	400.5
	2020	3.9	50.5	90.1	86.2	34.2	10.0	43.1	318.0
	2021	31.6	98.6	41.2	32.7	66.0	19.2	20.8	310.1
Slave Lake	2017	73.5	42.3	86.9	170.4	20.7	34.9	54.0	482.7
	2018	13.8	11.3	134.9	85.4	56.2	40.3	21.1	363.0
	2019	12.3	4.9	91.3	156.3	105.9	46.5	49.2*	466.4
	2020	3.0	58.8	104.2	64.8	44.7	14.1	38.5	328.1
	2021	22.4	109.8	44.6	36.4	73.1	21.0	19.7	327.0
Flattop Lookout	2017	119.0	61.7	86.2	153.8	20.8	86.5	105.6	633.6
	2018	29.8	27.3	169.2	119.1	60.9	66.8	45.6	518.7
	2019	25.6	32.2	103.9	168.5	81.8	49.8	71.0	532.8
	2020	26.0	72.9	132.4	127.3	37.1	12.0	69.7	477.4
	2021	52.1	125.7	64.1	26.8	69.1	36.0	33.8	407.6
House Mountain Lookout	2017	103.2	80.9	151.9	140.6	45.7	132.7	112.1	767.1
	2018	41.4	32.9	249.3	144.1	91.6	77.3	66.8	703.4
	2019	57.0	42.6	194.1	199.7	77.0	64.1	77.4	711.9
	2020	39.0	96.0	136.0	168.0	46.0	16.1	54.6	555.7
	2021	62.4	132.0	84.0	69.0	74.0	82.2	128.1	531.7

* Note: Slave Lake 2019 October data missing. Data from Slave Lake RCS 2019 October used.

In 2021, six of seven weather stations had the lowest total precipitation since 2017 and total precipitation at High Prairie Banana Belt was the second lowest. Generally, total precipitation was the highest in 2017. Precipitation in 2020 was the second lowest of the five years. Overall, precipitation in 2021 was 9.8% less than 2020, 23.9% less than 2019, 18.2% less than 2018 and 27.2% less than 2017.

Generally, the months of June, July and October had below average precipitation across the seven weather stations in 2021 (Table 4). The months of May and August generally had above average precipitation in 2021 whereas the months of April and September had average precipitation (Table 4).

Widespread and substantial precipitation events (>20 mm) occurred throughout the Slave Lake watershed on May 28, August 31 and September 1. The Peavine weather station registered only 1 precipitation event greater than 20 mm (August 31) from April to November, whereas House Mountain Lookout had seven events greater than 20 mm. The five other weather stations had 2 or 3 precipitation events greater than 20 mm.

4.2 Streamflow

Average daily streamflow data for 2017 through 2021 are shown in Figures 3 to 8 for the main tributaries to Lesser Slave Lake.

At the Driftpile River (near Driftpile) in 2021, average daily streamflow for the May-October monitoring period was 5.5 m³/s (Figure 3). This was the lowest average daily flow recorded during the monitoring period 2017-2021 (table inset). Peak daily flow was 54.8 m³/s (May 28) and was the lowest from 2017 to 2021. Generally, peak flows result from snowmelt (May in 2017), or following rain events (July in 2018 and 2019, June 2020, May and September 2021). In 2021, significant high flows (>90 m³/s) occurred on May 28; however, flows greater than 90 m³/s likely occurred between May 29 and June 2 but flow data was missing. Low flows (<3 m³/s) prevailed from June 26 to September 1 and September 8 to October 31.

Year	Driftpile River (May-Oct)	
	Average Daily Discharge	Peak Daily Discharge
2017	9.7	82.5
2018	7.0	149.0
2019	10.6	186.0
2020	14.0	100.0
2021	5.5	54.8

At Swan River, average daily streamflow for the 2021 May-October monitoring period was 2.4 m³/s at the Swan Hills site and 16.1 m³/s at the Kinuso site (Figure 4). Average daily flow at the Kinuso site in 2021 was the lowest of the five years. Peak daily discharge occurred on May 28 at the Swan Hills site (27.5 m³/s) and on May 29 at the Kinuso site (298.0 m³/s). The peak daily discharge at both sites was within the range of the previous four years.

Year	Swan River (May-Oct)			
	Average Daily Discharge		Peak Daily Discharge	
	Swan Hills	Kinuso	Swan Hills	Kinuso
2017	3.8	22.9	29.7	176.0
2018	1.5	23.3	23.4	498.0
2019	3.2	37.9	17.4	507.0
2020	4.7	27.3	22.7	228.0
2021	2.4	16.1	27.5	298.0

Generally, peak discharge occurs in mid- to late-May (2017, 2019, 2021) or early-to-mid June (2018, 2020). Note there were larger periods of missing data at the Swan Hills sites periodically through 2018 and 2019. In 2021, other significant flows at Kinuso (>100 m³/s) occurred on May 19/20 and May 28/30 in response to rainfall events. In 2021, periods of prolonged low streamflow (<3 m³/s) at the Kinuso site occurred from July 9-14, July 26-August 31, September 23-October 24 and October 30-31.

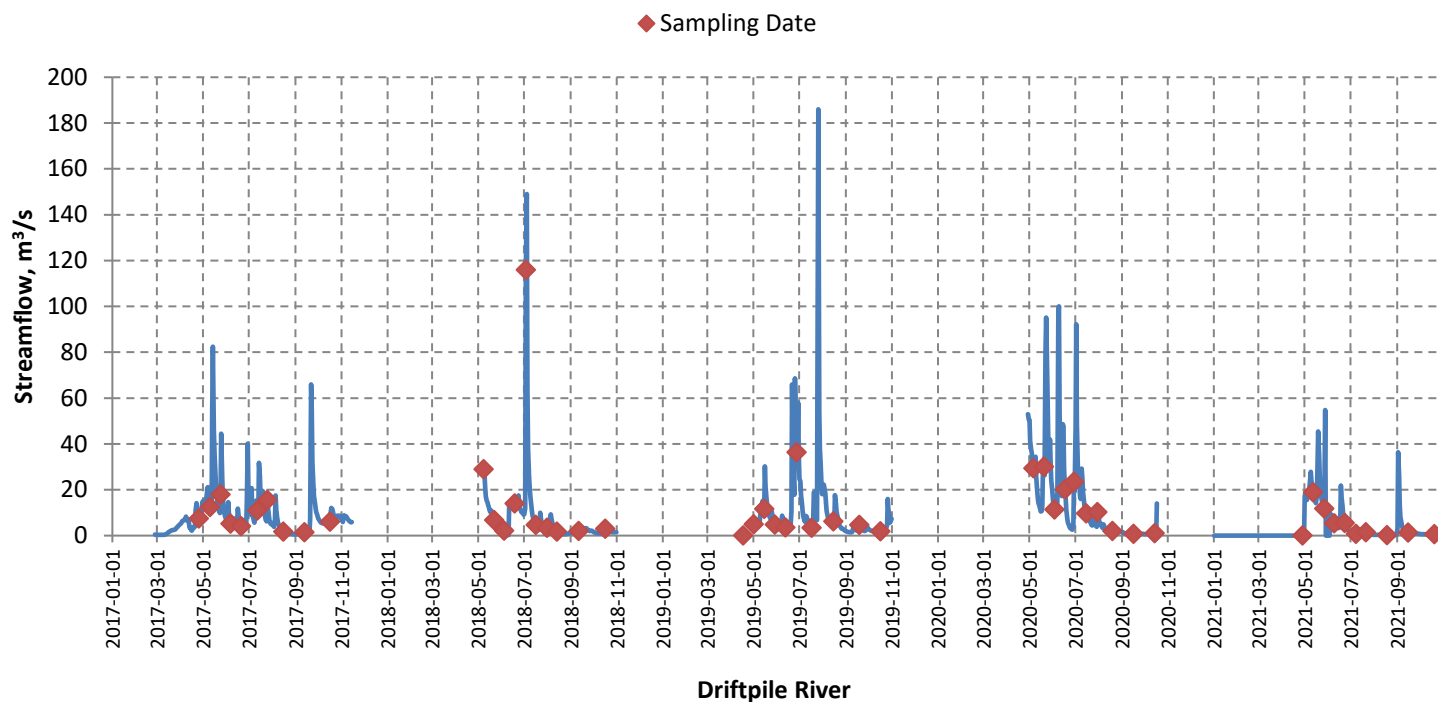


Figure 3. Average daily streamflow at Driftpile River, 2017-2021 (Near real-time flows (NRT) provided by AEP 2018, 2019, 2020, 2021, 2022).

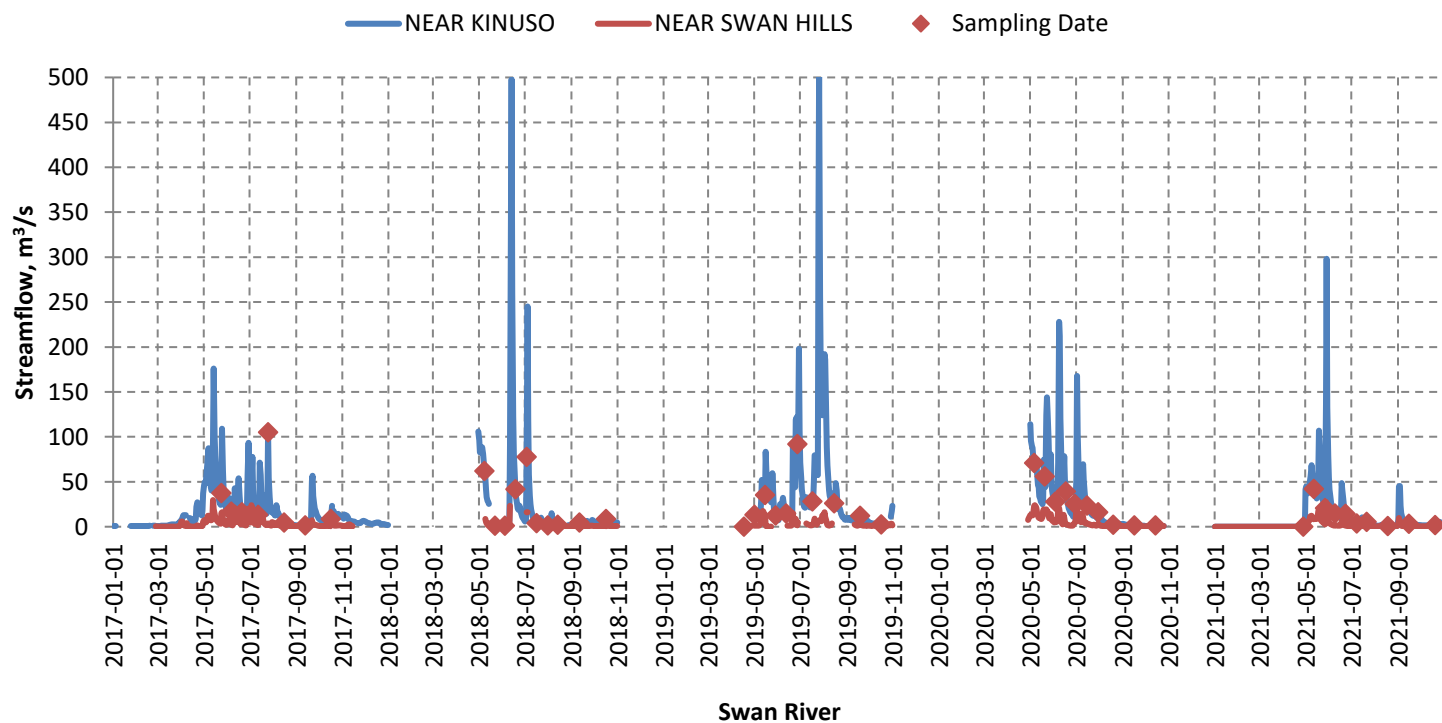


Figure 4. Average daily streamflow at Swan River, 2017-2021 (NRT-Flows provided by AEP, 2018, 2019, 2020, 2021, 2022).

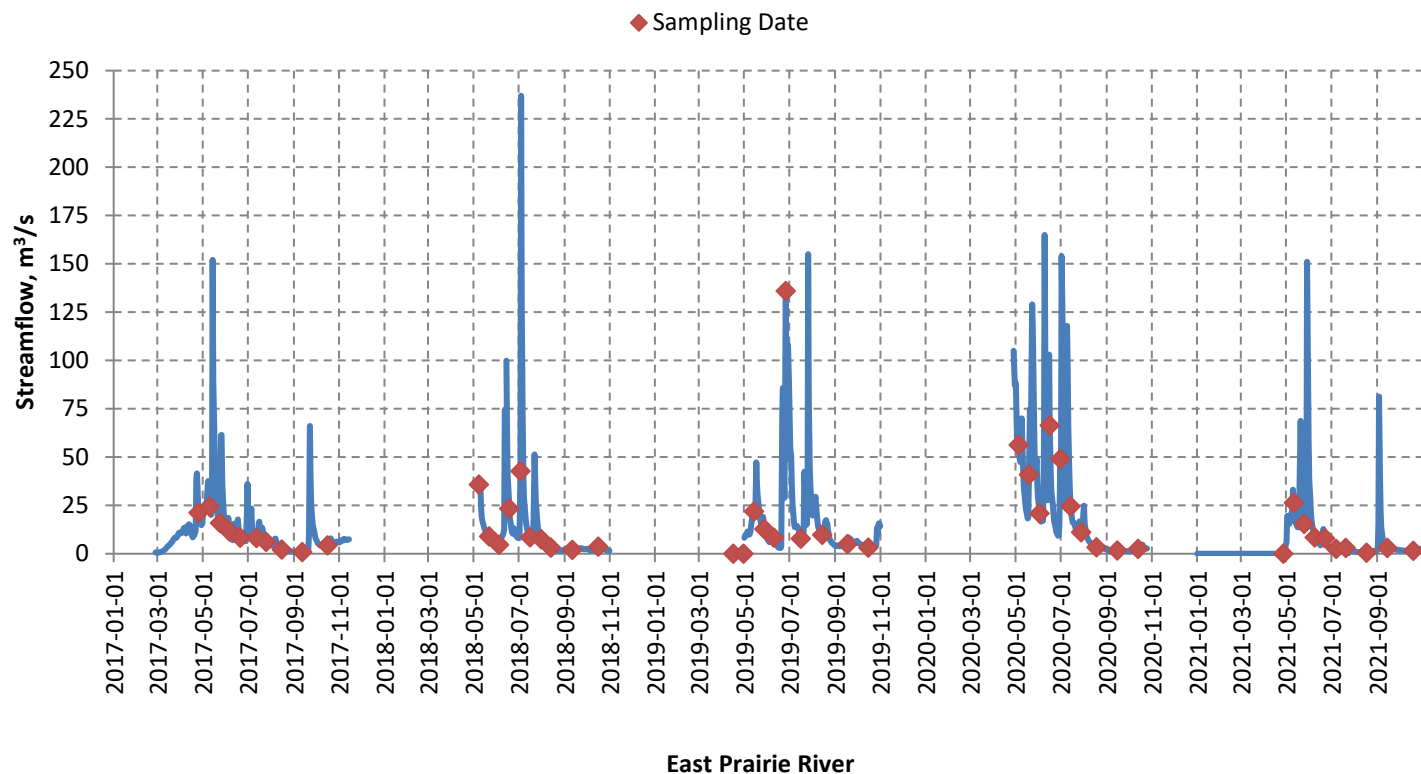


Figure 5. Average daily streamflow at East Prairie River, 2017-2021 (NRT-Flows provided by AEP, 2018, 2019, 2020, 2021, 2022).

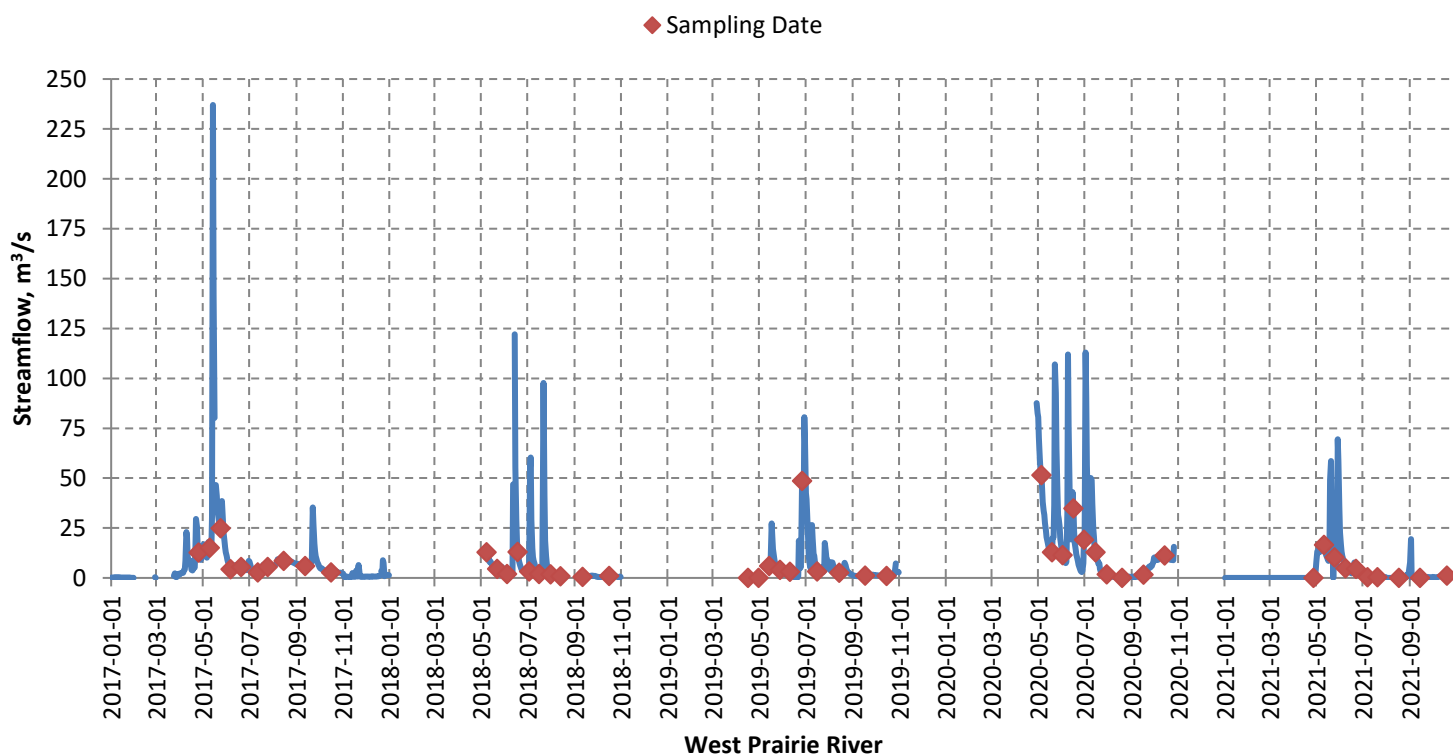


Figure 6. Average daily streamflow at West Prairie River, 2017-2021 (NRT-Flows provided by AEP, 2018, 2019, 2020, 2021, 2022).

At the East Prairie River (near Enilda), average daily streamflow for the May-October monitoring period was 8.6 m³/s in 2021, which was the lowest of the five years (table inset). Peak daily discharge occurred on May 29 (151.0 m³/s) and was the lowest of the five years. In previous years, peak daily discharge occurred in May (2017), June (2020) and July (2018 and 2019). In 2021, other significant flows (>100 m³/s) were recorded on May 30 and September 3 (Figure 5). The May and September high flow was due to significant rainfall events. In 2021, periods of prolonged lower streamflow (<3 m³/s) occurred from June 30 to July 19, July 22 to September 1 and September 13 to October 31.

Year	East Prairie River (May-Oct)	
	Average Daily Discharge	Peak Daily Discharge
2017	12.8	152.0
2018	11.6	234.0
2019	16.8	155.0
2020	23.5	165.0
2021	8.6	151.0

At West Prairie River (near High Prairie), average daily streamflow for the May-October monitoring period was 6.3 m³/s in 2021 and was the lowest of the five years (2019 also had an average flow of 6.3 m³/s). Peak daily discharge occurred on May 29 (69.4 m³/s) in response to a rainfall event and was the lowest peak discharge from 2017 to 2021. Periods of lower flow (<3 m³/s) occurred from June 29 to July 22, July 24 to August 25 and September 23 to October 18 (Figure 6).

Year	West Prairie River (May-Oct)	
	Average Daily Discharge	Peak Daily Discharge
2017	10.7	237.0
2018	6.9	122.0
2019	6.3	80.6
2020	15.6	113.0
2021	6.3	69.4

At South Heart River, average daily streamflow for the May-October monitoring period was 0.83 m³/s at Peavine and 10.3 m³/s at Big Prairie Settlement. Both average discharges were the lowest of the five years. Peak daily discharge occurred on May 9 (4.6 m³/s) at Peavine and on May 31 (70.3 m³/s) at Big Prairie Settlement (Figure 7). In 2021, peak daily discharge was the lowest of the five years at Peavine and the second highest of five years at Big Prairie Settlement.

Year	South Heart River (May-Oct)			
	Average Daily Discharge		Peak Daily Discharge	
	Peavine	BP Settle.	Peavine	BP Settle.
2017	1.0	10.4	8.4	57.8
2018	6.4	16.5	28.5	57.9
2019	3.4	11.7	30.0	53.8
2020	14.3	36.6	62.3	120.0
2021	0.83	10.3	4.6	70.3

At Lesser Slave River (near Lesser Slave Lake outlet), average daily streamflow for the May-October monitoring period was 56.4 m³/s in 2021 with a peak daily discharge of 81.7 m³/s (June 16). Other substantial daily flows occurred on June 17 (78.3 m³/s) and July 23 (73.5 m³/s) (Figure 8). The high flows in June and July occurred in response to precipitation.

Year	Lesser Slave River (May-Oct)	
	Average Daily Discharge	Peak Daily Discharge
2021	56.4	81.7

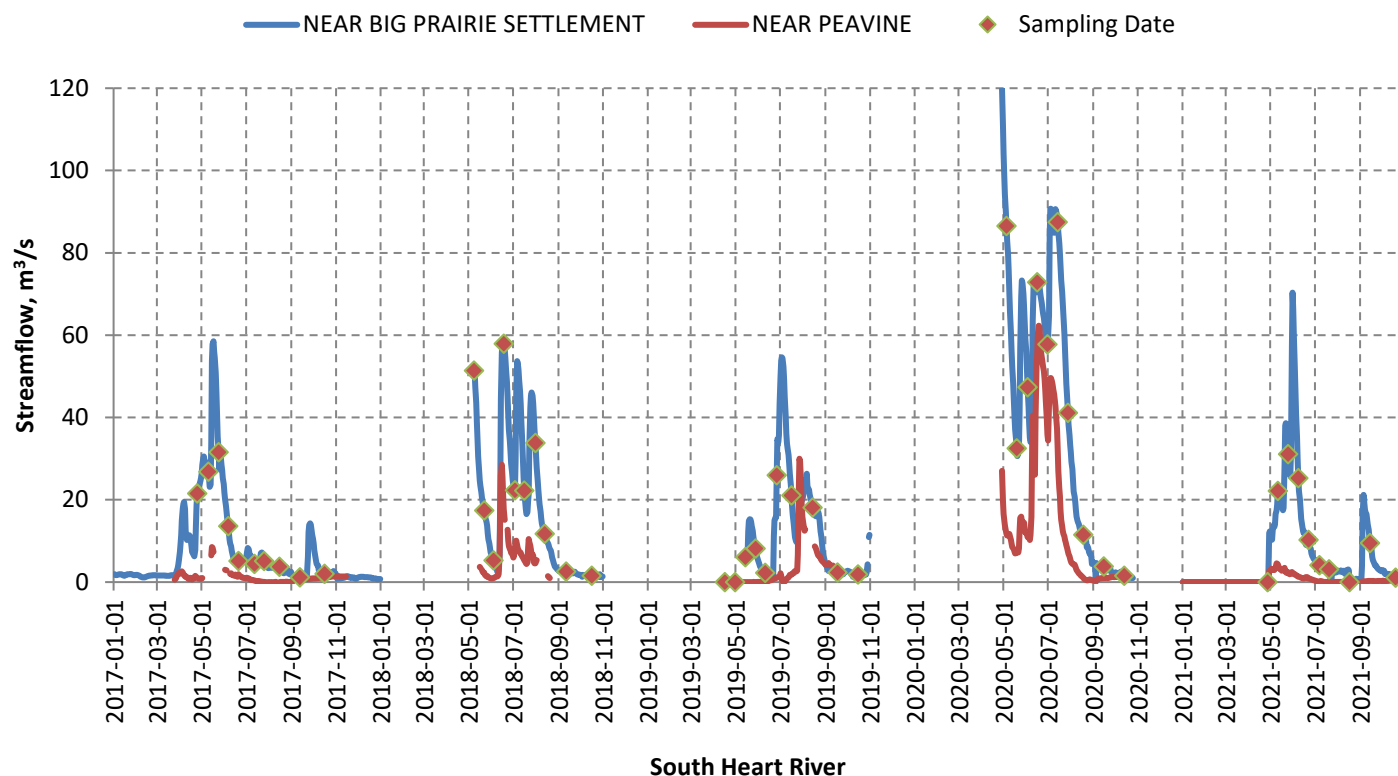


Figure 7. Average daily streamflow at South Heart River, 2017-2021 (NRT-Flows provided by AEP, 2018, 2019, 2020, 2021, 2022).

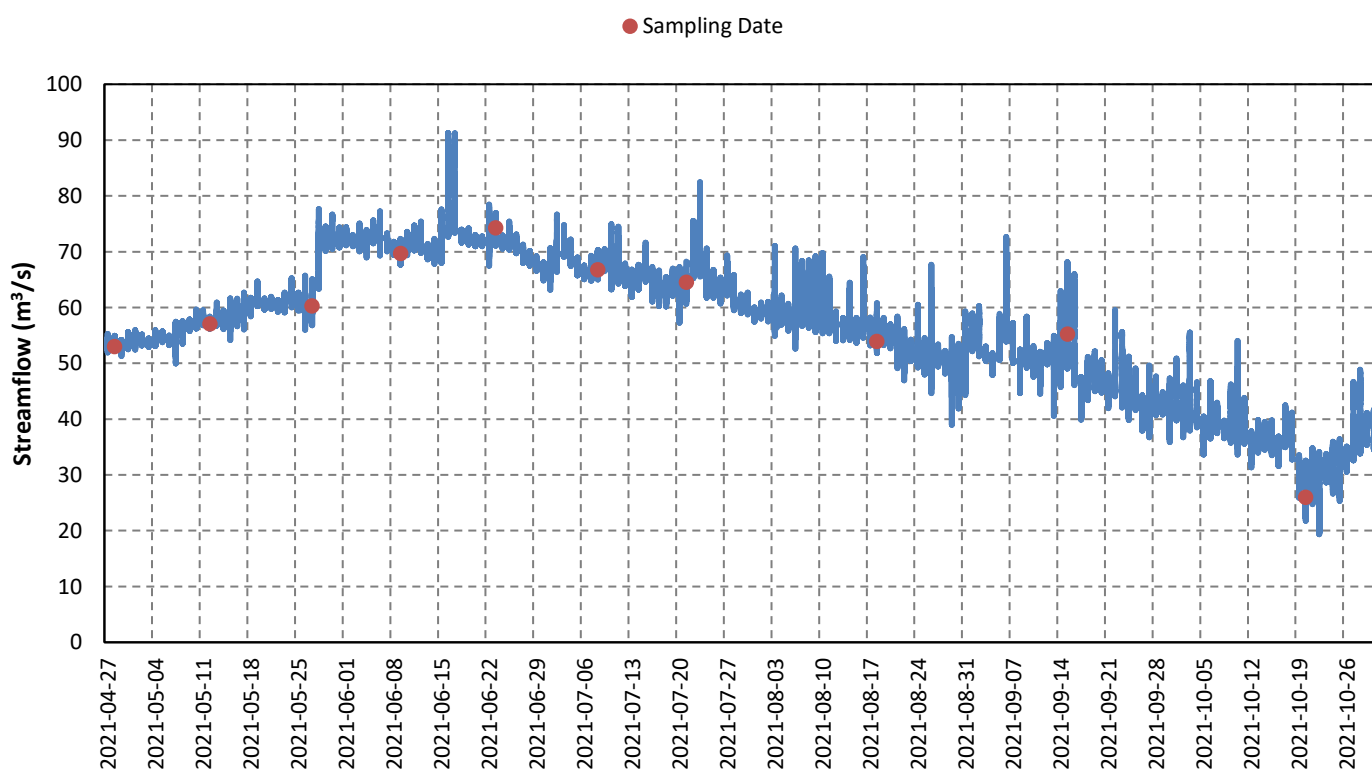


Figure 8. Average daily streamflow at Lesser Slave River, 2021 (NRT-Flows provided by AEP 2022).

4.3 Routine Parameters

4.3.1 Swan River

The median water temperature ranged from 10.9 to 13.0°C at the Swan River sites (maximum water temperature range: 21.4 to 23.4°C) (Table 5). Maximum water temperatures in 2021 were the warmest of the five years at the Swan River sites. The maximum water temperature at the lower and middle sites (23.1 and 23.4°C) exceeded the water temperature objective (<22°C) on July 8th.

At the Swan River sites, median pH ranged from 7.74 to 8.05 (Table 6). The median pH at upper and lower Swan River in 2021 was the lowest of the five years. Maximum pH values ranged from 8.19 to 8.28. In 2021, all of the pH samples from the three Swan River sites met the provincial guideline for the protection of aquatic life (≥6.5 to ≤9.0).

Median dissolved oxygen concentrations ranged from 9.29 to 10.11 mg/L (minimum DO range: 7.32 to 8.61 mg/L) (Table 7). The medians and all dissolved oxygen samples complied with provincial guidelines for the protection of aquatic life at the three Swan River sites. Maximum dissolved oxygen concentrations in 2021 were the highest of the five years at the upper and middle Swan River sites.

Median specific conductivity values ranged from 195 to 204 µS/cm at the Swan River sites in 2021 (maximum conductivity range: 276 to 377 µS/cm) (Table 8). The maximum conductivity at each of the three sites in 2021 was the highest of the five years. In 2021, all samples at all sites met the provincial guideline for safe irrigation (≤1,000 µS/cm) (GoA 2018).

4.3.2 Driftpile River

At the Driftpile River sites, the median water temperature ranged from 13.4 to 13.8°C (maximum water temperature range: 23.8 to 25.9°C) (Table 5). Maximum water temperatures in 2021 were the warmest of the five years at the three Driftpile sites. The maximum water temperatures at the three sites exceeded the water temperature objective (<22°C) on July 8th.

The median pH ranged from 7.80 to 7.95 at the Driftpile River sites (Table 6) and all pH samples at all sites met the provincial guideline for the protection of aquatic life (PAL) (≥6.5 to ≤9.0). Maximum pH values ranged from 8.01 to 8.28.

Median dissolved oxygen concentrations ranged from 9.28 to 9.99 mg/L at the Driftpile River sites (minimum DO range: 7.77 to 8.83 mg/L) (Table 7). The medians and all dissolved oxygen samples complied with provincial guideline for the protection of aquatic life at the Driftpile River sites. The maximum dissolved oxygen concentration in 2021 was the highest of the five years at the upper Driftpile River site.

Median specific conductivity ranged from 193 to 209 µS/cm at the Driftpile River sites (maximum conductivity range: 355 to 479 µS/cm) (Table 8). The maximum conductivity at each of the three sites in 2021 was the highest of the five years. All samples met the provincial guideline for safe irrigation (<1,000 µS/cm) (GoA 2018) in 2021.

4.3.3 East Prairie River

The median water temperature ranged from 14.0 to 15.3°C at the East Prairie River sites (Table 5). Maximum water temperatures at the upper site (23.9°C) and middle site (25.9°C) exceeded the water temperature guideline (<22°C) on July 7th and were the warmest of the five monitoring years. The water temperature at the middle site on June 22nd (22.7°C) also exceeded the temperature objective.

The median pH ranged from 8.03 to 8.20 at the East Prairie River sites. All pH samples from all sites met the provincial guideline for the protection of aquatic life (PAL) (≥ 6.5 to ≤ 9.0) (Table 6). Maximum pH values ranged from 8.30 to 8.89.

At the East Prairie River sites, the median dissolved oxygen concentration ranged from 9.29 to 9.66 mg/L (minimum DO range: 8.02 to 8.27 mg/L) (Table 7). The median DO at the upper site was the lowest of five years. The medians and all samples of dissolved oxygen complied with provincial guideline for the protection of aquatic life at the East Prairie River sites. The maximum dissolved oxygen concentrations in 2021 were the highest of the five years at the middle and lower sites.

Median specific conductivity ranged from 238 to 272 $\mu\text{S}/\text{cm}$ at the East Prairie River sites (maximum conductivity range: 431 to 507 $\mu\text{S}/\text{cm}$) (Table 8). In 2021 the median conductivity at the upper and middle sites was the highest of the five years, and the maximum conductivity at all sites was the highest of the five years. In 2021, all samples at the East Prairie River met the provincial guideline for safe irrigation ($<1,000$ $\mu\text{S}/\text{cm}$) (GoA 2018).

4.3.4 West Prairie River

At the West Prairie River, the median water temperature was 11.6°C (upper site) and 13.0°C (middle site) (maximum water temperature: 18.6 and 20.9°C) (Table 5). The maximum water temperature at both sites was below the water temperature objective.

The median pH was 8.07 at the upper West Prairie River site and 7.97 at the middle site (Table 6). The maximum pH was 8.58 at the upper site and 8.57 at the middle site. In 2021, all pH samples from West Prairie River sites met the provincial guideline for the protection of aquatic life (≥ 6.5 to ≤ 9.0).

The median dissolved oxygen was 9.60 mg/L at the upper West Prairie River site and 9.71 mg/L at the middle site (minimum DO: 8.14 and 8.16 mg/L, respectively) (Table 7). The medians and all samples of dissolved oxygen complied with guidelines for the protection of aquatic life at the West Prairie River sites in 2021.

The median specific conductivity was 182 $\mu\text{S}/\text{cm}$ at the upper West Prairie River site and 213 $\mu\text{S}/\text{cm}$ at the middle site in 2021 (maximum conductivity: 551 and 681 $\mu\text{S}/\text{cm}$, respectively) (Table 8). The maximum conductivity at both West Prairie River sites in 2021 was the highest of the five years. In 2021, all samples met the provincial guideline for safe irrigation ($<1,000$ $\mu\text{S}/\text{cm}$) (GoA 2018).

4.3.5 South Heart River and Grouard Channel

Median water temperature ranged from 14.1°C at the lower South Heart River site to 15.8°C at the upper site in 2021 (Table 5). Maximum water temperature ranged from 20.3°C at the lower site to 21.4°C at the middle site. The maximum water temperature at all South Heart River sites was below the water temperature objective.

The median pH ranged from 7.90 to 8.28 at the South Heart River sites (Table 6). Maximum pH values ranged from 8.27 to 8.97. In 2021, all of the pH samples met the provincial guideline for the protection of aquatic life (≥ 6.5 to ≤ 9.0) at each of the three sites.

Median dissolved oxygen concentrations ranged from 7.63 to 10.24 mg/L at the South Heart River sites in 2021 (minimum DO range: 6.07 to 7.69 mg/L) (Table 7). The medians and all individual samples complied with provincial guidelines for the protection of aquatic life with the exception of three samples at the lower South Heart River site collected on June 22, July 7 and August 17 (6.37, 6.07 and 6.46 mg/L, respectively); these samples did not meet the chronic guideline (≥ 6.5 mg/L: chronic 7-day average).

In 2021, median specific conductivity ranged from 319 to 428 $\mu\text{S}/\text{cm}$ at the South Heart River sites (maximum conductivity range: 395 to 451 $\mu\text{S}/\text{cm}$) (Table 8). The median conductivity at each of the South Heart River sites in 2021 was the highest of the five years. All conductivity samples met the provincial guideline for safe irrigation ($\leq 1,000$ $\mu\text{S}/\text{cm}$) (GoA 2018).

At the Grouard Channel, the median water temperature was 14.6°C (range: 1.9 to 21.9°C) (Table 5). The maximum water temperature in 2021 was the warmest of the five monitoring years at the Grouard Channel but did not exceed the water temperature objective. The median pH at the Grouard Channel was 8.02 (range: 7.57 to 8.60) and met the provincial guideline for the protection of aquatic life (Table 6). At the Grouard Channel, the median dissolved oxygen concentration was 8.82 mg/L (range: 8.24 to 11.07 mg/L) in 2021 (Table 7). The median and all samples of dissolved oxygen at the Grouard Channel complied with guidelines for the protection of aquatic life. The median conductivity was 327 $\mu\text{S}/\text{cm}$ (range: 228 to 385 $\mu\text{S}/\text{cm}$) (Table 8). Both the median and maximum conductivity in 2021 was the highest of the five years. All conductivity values met the provincial guideline for irrigation water quality.

4.3.6 Lesser Slave River

At the Lesser Slave River in 2021, the median water temperature was 13.6°C (range: 4.3°C to 19.9°C) (Table 5). The maximum water temperature did not exceed the water temperature objective. The median pH at the Lesser Slave River was 8.05 (range: 7.86 to 8.29) and met the provincial guideline for the protection of aquatic life (Table 6). The median dissolved oxygen concentration was 11.28 mg/L (range: 7.77 to 13.0 mg/L) in 2021 (Table 7). The median and all samples of dissolved oxygen complied with guidelines for the protection of aquatic life at the Lesser Slave River. The median conductivity was 172 $\mu\text{S}/\text{cm}$ (range: 116 to 187 $\mu\text{S}/\text{cm}$) (Table 8); all conductivity values met the provincial guideline for irrigation water quality.

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Table 5. Water temperatures at Lesser Slave Lake tributaries, April to October, 2017 to 2021. Red values indicate a guideline exceedance.

Site	2017				2018				2019				2020				2021			
	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max
upper Swan	10	11.1	0.3	13.8	10	12.3	2.8	17.8	10	9.90	1.60	14.20	10	10.0	2.2	18.3	10	10.9	0.8	21.4
middle Swan	10	12.8	1.4	17.4	10	14.9	3.9	20.6	10	11.30	2.80	16.90	10	11.7	4.3	21.3	10	12.6	0.8	23.1
lower Swan	10	13.6	2.7	17.5	9	17.5	4.9	20.5	9	13.50	3.70	19.70	8	11.6	3.6	22.5	10	13.0	2.5	23.4
upper Driftpile	10	14.9	4.2	18.1	10	16.1	5.6	22.1	10	12.30	2.30	20.30	9	11.5	4.7	21.0	10	13.4	1.6	25.6
middle Driftpile	10	14.3	2.9	17.4	10	16.0	4.7	21.5	10	11.95	2.30	20.80	10	12.9	4.2	22.7	10	13.7	2.0	25.9
lower Driftpile	10	15.1	3.6	16.7	10	15.6	4.7	20.4	10	12.00	3.00	20.80	10	12.7	3.1	22.9	10	13.8	2.1	23.8
upper East Prairie	10	15.4	4.4	19.0	10	16.0	4.0	24.0	10	11.55	2.70	21.10	10	11.9	3.9	23.2	10	15.3	2.6	23.9
middle East Prairie	10	17.2	4.0	21.8	10	16.1	4.1	23.6	10	12.60	3.60	21.50	10	13.8	4.4	24.4	10	14.7	3.5	25.9
lower East Prairie	9	17.1	2.0	18.3	9	14.6	3.9	22.3	10	13.55	3.30	20.10	-	-	-	-	9	14.0	2.9	20.9
upper West Prairie	10	13.0	1.6	18.4	10	13.8	4.0	20.2	10	10.65	0.80	16.70	10	11.6	2.2	18.2	10	11.6	2.0	18.6
middle West Prairie	10	14.3	2.2	20.3	10	14.6	3.7	21.4	10	12.05	1.80	18.40	10	13.1	4.1	21.4	10	13.0	2.1	20.9
upper South Heart	10	17.1	4.6	19.9	10	16.0	3.8	21.0	10	14.70	4.90	20.20	10	15.3	7.3	21.6	10	15.8	4.0	21.3
middle South Heart	10	16.0	3.7	19.7	10	16.0	3.3	21.3	10	14.00	3.40	20.90	10	14.6	4.3	20.4	10	14.3	2.9	21.4
lower South Heart	10	15.1	2.0	23.5	10	15.6	4.0	22.0	10	13.00	2.70	21.00	10	14.3	5.1	21.8	10	14.1	1.7	20.3
Grouard Channel	10	17.3	1.3	21.7	10	16.2	3.7	21.5	10	14.65	3.10	20.70	10	15.4	4.8	21.7	10	14.6	1.9	21.9
Lesser Slave River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	13.6	4.3	19.9

Table 6. pH at Lesser Slave Lake tributaries, April to October, 2017 to 2021. Red values indicate a guideline exceedance.

Site	2017				2018				2019				2020				2021			
	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max
upper Swan	10	8.02	7.34	8.72	10	8.14	7.59	8.51	10	8.47	7.65	8.97	10	8.01	7.46	8.37	10	7.94	7.34	8.23
middle Swan	10	8.14	7.88	11.56	10	7.95	7.44	8.94	10	8.35	7.59	9.44	10	7.84	6.65	8.08	10	8.05	7.68	8.28
lower Swan	10	7.96	7.68	8.23	9	7.85	7.29	8.33	9	8.34	7.64	8.66	8	7.88	7.72	8.01	10	7.74	6.50	8.19
upper Driftpile	10	8.09	7.51	8.79	10	8.07	7.26	8.48	10	8.44	7.47	8.76	9	7.84	7.19	8.16	10	7.95	7.27	8.28
middle Driftpile	9	8.15	7.70	9.67	10	8.03	7.27	8.31	10	8.22	7.38	8.93	10	7.74	6.96	8.14	10	7.87	7.52	8.18
lower Driftpile	10	8.00	7.70	8.82	10	7.65	7.12	8.04	10	8.26	7.36	8.69	10	7.87	7.04	8.10	10	7.80	7.05	8.01
upper East Prairie	10	8.18	7.64	8.74	10	8.15	7.67	8.50	10	8.60	7.64	9.43	10	7.95	6.47	8.24	10	8.20	7.76	8.30
middle East Prairie	10	7.98	7.71	8.18	10	8.12	7.66	8.74	10	8.42	7.58	9.07	10	7.89	6.89	8.29	10	8.03	7.75	8.52
lower East Prairie	9	7.68	7.32	8.27	9	7.84	7.13	8.65	10	8.08	7.49	9.51	-	-	-	-	9	8.08	7.57	8.89
upper West Prairie	10	7.76	7.45	10.01	10	7.86	7.45	8.46	10	8.42	7.15	9.15	10	7.80	7.16	8.08	10	8.07	7.10	8.58
middle West Prairie	10	7.87	7.59	8.04	10	7.99	7.62	8.36	10	8.45	6.94	8.92	10	7.93	7.36	8.11	10	7.97	7.53	8.57
upper South Heart	10	8.11	7.50	8.57	10	8.00	7.69	8.12	10	8.72	7.39	9.65	10	7.82	6.93	8.13	10	8.28	7.49	8.97
middle South Heart	10	8.01	7.79	8.22	10	8.06	7.87	8.27	10	8.55	7.83	9.46	10	7.89	7.43	8.13	10	8.03	7.88	8.27
lower South Heart	10	7.85	7.50	8.95	10	7.83	7.38	8.56	10	8.32	7.91	10.00	10	7.87	6.88	8.53	10	7.90	7.59	8.48
Grouard Channel	10	7.76	7.56	9.25	10	7.71	7.11	8.13	10	8.24	7.27	8.99	10	7.83	6.53	8.10	10	8.02	7.57	8.60
Lesser Slave River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	8.05	7.86	8.29

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Table 7. Dissolved oxygen at Lesser Slave Lake tributaries, April to October, 2017 to 2021. Red values indicate a guideline exceedance.

Site	2017				2018				2019				2020				2021			
	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max
upper Swan	10	9.90	9.40	11.90	10	10.31	8.21	11.86	10	10.71	9.16	12.59	10	10.32	8.79	12.59	10	10.11	8.61	12.91
middle Swan	10	9.70	8.72	11.20	10	9.45	7.38	11.73	10	10.33	8.75	12.18	10	9.99	8.33	12.22	10	9.72	7.75	12.82
lower Swan	10	8.90	8.51	11.60	9	8.49	7.08	11.56	9	9.45	8.13	11.52	8	9.79	7.97	12.40	10	9.29	7.32	12.31
upper Driftpile	10	9.35	8.70	11.90	10	9.45	7.74	12.13	10	10.28	8.36	12.56	9	10.10	9.19	12.90	10	9.99	8.83	12.92
middle Driftpile	10	10.01	8.80	11.60	10	9.25	7.50	11.70	10	10.18	8.19	12.38	10	9.68	8.11	12.54	10	9.49	8.36	11.99
lower Driftpile	10	8.90	8.10	11.40	10	8.73	6.88	11.52	10	9.77	7.83	11.74	10	9.38	7.70	12.34	10	9.28	7.77	11.95
upper East Prairie		10.54	8.70	11.36	10	9.48	7.30	11.74	10	10.49	8.30	12.66	10	9.66	8.05	12.55	10	9.43	8.27	12.38
middle East Prairie	10	9.83	8.20	11.69	10	8.98	7.20	11.94	10	9.78	8.08	12.32	10	9.48	7.67	12.80	10	9.66	8.02	13.13
lower East Prairie	9	8.77	7.43	11.69	9	7.70	4.61	11.44	10	9.24	6.02	12.11	-	-	-	-	9	9.29	8.27	12.92
upper West Prairie	10	10.25	8.40	11.76	10	9.04	7.19	10.80	10	9.65	8.26	12.50	10	9.43	7.87	12.13	10	9.60	8.14	11.91
middle West Prairie	10	10.20	8.40	11.00	10	9.12	7.46	11.62	10	9.85	8.37	12.37	10	9.35	8.15	12.52	10	9.71	8.16	12.42
upper South Heart	10	9.98	8.90	11.29	10	9.39	7.80	11.58	10	10.24	8.58	12.12	10	9.78	8.38	11.36	10	10.24	7.69	12.08
middle South Heart	10	9.05	8.00	10.56	10	8.39	6.87	11.55	10	8.79	7.20	12.51	10	8.27	6.92	11.99	10	8.60	7.11	11.81
lower South Heart	10	8.34	7.34	10.01	10	7.44	4.05	11.38	10	8.26	5.31	12.25	10	6.89	4.63	11.64	10	7.63	6.07	11.63
Grouard Channel	10	8.69	7.00	10.61	10	6.93	3.88	11.20	10	8.15	5.96	11.57	10	5.14	1.86	10.44	10	8.82	8.24	11.07
Lesser Slave River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	11.28	7.77	13.07

Table 8. Conductivity at Lesser Slave Lake tributaries, April to October, 2017 to 2021.

Site	2017				2018				2019				2020				2021			
	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max
upper Swan	9	130	85	217	10	175	66	215	10	136	102	172	10	144	80	232	10	202	103	276
middle Swan	9	119	64	226	10	168	65	212	10	121	80	174	10	135	75	247	10	195	87	311
lower Swan	9	111	65	268	9	186	66	256	9	138	92	215	8	152	76	311	10	204	86	377
upper Driftpile	8	114	65	245	10	169	58	217	10	134	71	195	8	109	78	249	10	193	85	355
middle Driftpile	10	113	69	269	10	183	63	249	10	143	66	211	10	132	83	318	10	203	87	394
lower Driftpile	9	120	63	297	10	194	64	300	10	148	68	229	9	155	84	312	10	209	86	479
upper East Prairie	9	197	114	313	10	271	89	339	10	188	89	263	10	175	91	344	10	272	115	431
middle East Prairie	10	186	93	362	10	250	93	378	10	191	104	297	10	186	99	407	10	264	117	492
lower East Prairie	9	197	111	374	9	247	160	377	10	197	113	305	-	-	-	-	9	238	129	507
upper West Prairie	10	149	71	352	10	191	73	394	10	144	71	229	10	134	67	407	10	182	90	551
middle West Prairie	10	188	88	457	10	243	90	490	10	184	90	332	10	224	91	509	10	213	116	681
upper South Heart	10	336	294	419	10	266	253	422	10	345	281	432	10	236	199	424	10	375	347	395
middle South Heart	10	359	300	407	10	327	252	422	10	353	298	501	10	321	237	451	10	428	385	451
lower South Heart	10	232	126	337	10	274	136	388	10	271	169	386	10	285	150	347	10	319	217	426
Grouard Channel	10	217	146	289	10	276	152	367	10	237	167	351	10	296	170	337	10	327	228	385
Lesser Slave River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	172	116	187

4.4 Phosphorus

4.4.1 Swan River

In 2021, the median total phosphorus (TP) concentration ranged from 0.010 mg/L at the upper Swan River to 0.040 mg/L at the lower site (maximum TP range: 0.050 mg/L at the upper site to 0.084 mg/L at the lower site) (Table 9). In 2021, median and maximum total phosphorus concentrations were the lowest recorded during the five years of monitoring at all Swan River sites. There was a moderate, positive linear relationship between total phosphorus and total suspended solids at the Swan River (Pearson's correlation: $r=0.32$). There was a strong correlation between streamflow and total phosphorus ($r=0.79$) and a weak relationship between streamflow and total suspended solids ($r=0.26$).

Total dissolved phosphorus was generally less than the detection limit of the analytical equipment (0.020 mg/L) at the three Swan River sites. The median and minimum total dissolved phosphorus concentration was 0.010 mg/L at all three sites, and the maximum TDP increased from the upper site (0.021 mg/L) to lower site (0.030 mg/L) (Table 10).

4.4.2 Driftpile River

In 2021, the median TP concentration ranged from 0.030 mg/L at the upper Driftpile River to 0.040 mg/L at the lower site (maximum TP range: 0.055 mg/L at the upper site to 0.104 mg/L at the lower site) (Table 9). In 2021, median and maximum total phosphorus concentrations at the middle and lower Driftpile River were the lowest of the five years. There was a strong, positive linear relationship between total phosphorus and total suspended solids at the Driftpile River (Pearson's correlation: $r=0.90$). Similarly, there was a strong correlation between streamflow and total phosphorus ($r=0.76$) and streamflow and total suspended solids ($r=0.85$).

The median total dissolved phosphorus was 0.010 mg/L at all three Driftpile River sites. The maximum total dissolved phosphorus was similar at all Driftpile River sites (maximum range: 0.030 mg/L at the upper site to 0.037 mg/L at the lower site) (Table 10).

4.4.3 East Prairie River

In 2021, the median TP concentration ranged from 0.010 mg/L at the upper East Prairie River to 0.110 mg/L at the lower site (maximum TP range: 0.079 mg/L at the upper site to 0.293 mg/L at the middle site) (Table 9). Median and maximum TP concentrations in 2021 were the lowest of the five years at the upper East Prairie River site. The median TP concentration at the middle site was the lowest of five years. There was a strong, positive linear relationship between total phosphorus and total suspended solids at the East Prairie River (Pearson's correlation: $r=0.96$). Similarly, there was a strong correlation between streamflow and total phosphorus ($r=0.79$) and streamflow and total suspended solids ($r=0.82$).

Total dissolved phosphorus (TDP) was often less than the detection limit of the analytical equipment (0.020 mg/L) at the East Prairie River sites. The median total dissolved phosphorus was 0.010 mg/L at all three sites. The maximum TDP ranged from 0.028 mg/L at the upper site to 0.038 mg/L at the middle East Prairie River site (Table 10).

4.4.4 West Prairie River

The median TP concentration was 0.039 mg/L at the upper West Prairie River site and 0.050 mg/L at lower site in 2021 (maximum TP: 0.174 mg/L at the upper site and 0.282 mg/L at the middle site) (Table 9). In 2021, median and maximum TP concentrations were the lowest of the five years at the upper and middle West Prairie River sites. There was a strong, positive linear relationship between total

phosphorus and total suspended solids at the West Prairie River (Pearson's correlation: $r=0.98$). Similarly, there was a strong correlation between streamflow and total phosphorus ($r=0.92$) and streamflow and total suspended solids ($r=0.91$).

The median total dissolved phosphorus concentration ranged from 0.010 mg/L at the upper West Prairie River site to 0.015 mg/L at the middle site (maximum TDP range: 0.041 mg/L at the upper site to 0.051 mg/L at the lower site) (Table 10).

4.4.5 South Heart River and Grouard Channel

The median TP concentration ranged from 0.082 mg/L at the middle South Heart River site to 0.130 mg/L at the lower site (maximum TP range: 0.155 mg/L at the upper site to 0.173 mg/L at the lower site) (Table 9). The median and maximum TP concentrations at the three South Heart River sites were within the range of the previous four years with the exception of maximum TP at the middle site which was the lowest of the five years. There was a moderate, positive linear relationship between total phosphorus and total suspended solids at the South Heart River (Pearson's correlation: $r=0.56$). There was a moderate correlation between streamflow and total phosphorus ($r=0.36$) and a weak relationship between streamflow and total suspended solids ($r=0.24$).

The median total dissolved phosphorus ranged from 0.036 mg/L at the lower South Heart River site to 0.051 mg/L at the upper site (maximum TDP range: 0.061 mg/L at the middle site to 0.076 mg/L at the upper site) (Table 10).

At the Grouard Channel, the median TP concentration was 0.130 mg/L (range: 0.041 to 0.319 mg/L) in 2021 (Table 9). The median and maximum TP at the Grouard Channel in 2021 was within the range of the previous four years. The median TDP was 0.033 mg/L (range: 0.010 to 0.044 mg/L) (Table 10). There was a strong, positive linear relationship between total phosphorus and total suspended solids at the Grouard Channel (Pearson's correlation: $r=0.95$).

4.4.6 Lesser Slave River

At the Lesser Slave River, phosphorus concentrations were generally low compared to headwater tributary sites. The median TP was 0.010 mg/L (range: 0.010 to 0.033 mg/L) (Table 9). The median, minimum and maximum TDP at Lesser Slave River in 2021 were 0.010 mg/L (Table 10).

Table 9. Total phosphorus concentrations at Lesser Slave Lake tributaries, April to October, 2017 to 2021.

Site	2017				2018				2019				2020				2021			
	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max
upper Swan	9	0.034	0.010	0.127	10	0.030	0.010	0.619	10	0.026	0.010	0.091	10	0.052	0.010	0.230	10	0.010	0.010	0.050
middle Swan	9	0.034	0.010	0.410	10	0.039	0.029	0.940	10	0.035	0.010	0.137	10	0.053	0.010	0.172	10	0.030	0.010	0.065
lower Swan	9	0.050	0.029	1.060	9	0.048	0.034	0.170	9	0.044	0.027	0.172	8	0.050	0.025	0.227	10	0.040	0.026	0.084
upper Driftpile	8	0.039	0.010	0.148	10	0.047	0.028	0.970	10	0.039	0.026	0.160	9	0.051	0.022	0.294	10	0.030	0.010	0.055
middle Driftpile	10	0.053	0.020	0.118	10	0.051	0.030	1.290	10	0.040	0.027	0.217	10	0.062	0.010	0.345	10	0.030	0.010	0.077
lower Driftpile	9	0.045	0.024	0.108	10	0.046	0.031	1.280	10	0.043	0.030	0.305	10	0.078	0.010	0.357	10	0.040	0.027	0.104
upper East Prairie	9	0.025	0.010	0.110	10	0.029	0.010	1.590	10	0.035	0.010	0.304	10	0.059	0.010	0.540	10	0.010	0.010	0.079
middle East Prairie	10	0.086	0.010	0.241	10	0.076	0.032	0.480	10	0.090	0.043	0.983	10	0.271	0.021	0.604	10	0.060	0.010	0.293
lower East Prairie	9	0.073	0.025	0.129	9	0.071	0.031	0.180	10	0.125	0.037	0.413	-	-	-	-	9	0.110	0.010	0.281
upper West Prairie	10	0.051	0.037	0.500	10	0.062	0.016	1.060	10	0.052	0.022	0.761	10	0.093	0.026	0.293	10	0.039	0.023	0.174
middle West Prairie	10	0.055	0.030	0.362	10	0.065	0.024	0.333	10	0.061	0.023	1.050	10	0.110	0.025	0.504	10	0.050	0.010	0.282
upper South Heart	10	0.092	0.064	0.239	10	0.097	0.019	0.137	10	0.078	0.035	0.114	10	0.223	0.103	0.317	10	0.095	0.051	0.155
middle South Heart	10	0.094	0.072	0.193	10	0.144	0.043	0.282	10	0.074	0.056	0.195	10	0.242	0.189	0.386	10	0.082	0.054	0.160
lower South Heart	10	0.153	0.109	0.602	10	0.138	0.089	0.229	10	0.118	0.080	0.218	10	0.144	0.109	0.215	10	0.130	0.102	0.173
Grouard Channel	10	0.118	0.039	0.248	10	0.107	0.046	0.341	10	0.104	0.069	0.199	10	0.137	0.071	0.245	10	0.130	0.041	0.319
Lesser Slave River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	0.010	0.010	0.033

Table 10. Total dissolved phosphorus concentrations at Lesser Slave Lake tributaries, April to October, 2017 to 2021.

Site	2017				2018				2019				2020				2021			
	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max
upper Swan	9	0.010	0.010	0.031	10	0.010	0.010	0.028	10	0.010	0.010	0.024	10	0.010	0.010	0.012	10	0.010	0.010	0.021
middle Swan	9	0.010	0.010	0.026	10	0.016	0.010	0.030	10	0.010	0.010	0.027	10	0.010	0.010	0.025	10	0.010	0.010	0.029
lower Swan	9	0.010	0.010	0.028	9	0.023	0.010	0.035	9	0.010	0.010	0.028	8	0.010	0.010	0.025	10	0.010	0.010	0.030
upper Driftpile	8	0.010	0.010	0.080	10	0.025	0.010	0.032	10	0.010	0.010	0.030	9	0.010	0.010	0.034	10	0.010	0.010	0.030
middle Driftpile	9	0.010	0.010	0.028	10	0.025	0.010	0.035	10	0.010	0.010	0.029	10	0.017	0.010	0.031	10	0.010	0.010	0.036
lower Driftpile	9	0.010	0.010	0.041	10	0.025	0.010	0.033	10	0.016	0.010	0.026	10	0.016	0.010	0.034	10	0.010	0.027	0.037
upper East Prairie	9	0.010	0.010	0.021	10	0.010	0.010	0.238	10	0.010	0.010	0.025	10	0.010	0.010	0.052	10	0.010	0.010	0.028
middle East Prairie	10	0.010	0.010	0.067	10	0.024	0.010	0.054	10	0.016	0.010	0.264	10	0.010	0.010	0.064	10	0.010	0.010	0.038
lower East Prairie	9	0.010	0.010	0.010	9	0.037	0.010	0.092	10	0.010	0.010	0.054	-	-	-	-	9	0.010	0.010	0.037
upper West Prairie	10	0.023	0.010	0.042	10	0.025	0.010	0.047	10	0.022	0.010	0.033	10	0.017	0.010	0.103	10	0.010	0.010	0.041
middle West Prairie	10	0.022	0.010	0.132	10	0.028	0.010	0.066	10	0.022	0.010	0.039	10	0.016	0.010	0.248	10	0.015	0.010	0.051
upper South Heart	10	0.051	0.010	0.165	10	0.069	0.010	0.187	10	0.040	0.010	0.075	10	0.146	0.010	0.216	10	0.051	0.020	0.076
middle South Heart	10	0.034	0.010	0.165	10	0.052	0.010	0.082	10	0.037	0.010	0.147	10	0.100	0.010	0.202	10	0.039	0.021	0.061
lower South Heart	10	0.023	0.010	0.169	10	0.050	0.010	0.088	10	0.038	0.021	0.052	10	0.054	0.010	0.149	10	0.036	0.010	0.062
Grouard Channel	10	0.010	0.010	0.120	10	0.051	0.010	0.279	10	0.036	0.010	0.059	10	0.056	0.010	0.181	10	0.033	0.010	0.044
Lesser Slave River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	0.010	0.010	0.010

4.5 Nitrogen

The most significant portion of total nitrogen concentrations observed at all sites was in the organic form (as indicated by total Kjeldahl nitrogen). Therefore, the following section focuses on total nitrogen (Table 13). Nitrate-nitrite nitrogen and total Kjeldahl nitrogen results are presented in Table 11 and Table 12, respectively. Nitrate-nitrite nitrogen median concentrations were typically less than the detection limit at all sites.

4.5.1 Swan River

In 2021, the median total nitrogen (TN) concentration was similar at all three Swan River sites (range: 0.27 to 0.28 mg/L). The maximum TN concentration ranged from 0.66 mg/L at the upper site to 0.92 mg/L at the lower site (Table 13).

4.5.2 Driftpile River

The median TN concentration ranged from 0.31 mg/L at the upper Driftpile River site to 0.43 mg/L at the lower site in 2021 (maximum TN range: 0.86 mg/L at the upper site to 0.99 mg/L at the middle site) (Table 13).

4.5.3 East Prairie River

In 2021, the median TN concentration ranged from 0.30 mg/L at the upper East Prairie River site to 0.56 mg/L at the lower site (maximum TN range: 1.03 mg/L at the upper site to 1.67 mg/L at the lower site) (Table 13).

4.5.4 West Prairie River

In 2021, the median TN concentration was 0.66 mg/L at the upper West Prairie River site and 0.78 mg/L at the middle site (maximum TN: 1.24 mg/L at the upper site and 1.84 mg/L at the lower site) (Table 13).

4.5.5 South Heart River

At the South Heart River in 2021, the median TN concentration ranged from 1.02 mg/L at the middle South Heart River site to 1.38 mg/L at the upper site (maximum TN range: 1.43 mg/L at the middle site to 4.36 mg/L at the lower site) (Table 13).

4.5.6 Grouard Channel

At Grouard Channel, the median TN concentration was 1.15 mg/L (range: 0.79 to 1.63 mg/L) (Table 13).

4.5.7 Lesser Slave River

At Lesser Slave River, the median TN concentration was 0.49 mg/L (range: 0.10 to 1.36 mg/L) (Table 13).

4.6 Total Suspended Solids (TSS)

4.6.1 Swan River

In 2021, the median total suspended solids (TSS) concentration ranged from 7.9 mg/L at the middle Swan River site to 23.2 mg/L at the lower site (maximum TSS range: 59.6 mg/L at the upper site to 267 mg/L at the lower site) (Table 14). In 2021, median TSS concentration at the middle Swan River site was the lowest of the five years, and the maximum TSS concentration at the upper site was the lowest of the five years.

Table 11. Nitrate+nitrite nitrogen concentrations at the Lesser Slave Lake tributaries, April to October, 2017 to 2021.

Site	2017				2018				2019				2020				2021			
	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max
upper Swan	9	0.011	0.011	0.025	10	0.011	0.003	0.011	10	0.011	0.003	0.011	10	0.011	0.011	0.034	10	0.011	0.011	0.011
middle Swan	9	0.011	0.011	0.044	10	0.011	0.003	0.040	10	0.011	0.011	0.067	10	0.011	0.011	0.084	10	0.011	0.011	0.099
lower Swan	9	0.011	0.011	0.045	9	0.011	0.003	0.041	9	0.011	0.011	0.028	8	0.011	0.011	0.091	10	0.011	0.011	0.109
upper Driftpile	8	0.011	0.010	0.025	10	0.011	0.011	0.049	10	0.011	0.011	0.054	9	0.011	0.011	0.052	10	0.011	0.011	0.102
middle Driftpile	10	0.011	0.011	0.027	10	0.011	0.011	0.031	10	0.011	0.011	0.049	10	0.011	0.011	0.059	10	0.011	0.011	0.143
lower Driftpile	9	0.011	0.011	0.198	10	0.011	0.011	0.025	10	0.011	0.011	0.062	10	0.011	0.011	0.059	10	0.011	0.011	0.173
upper East Prairie	9	0.011	0.011	0.057	10	0.011	0.011	0.080	10	0.011	0.011	0.062	10	0.011	0.011	0.102	10	0.011	0.011	0.165
middle East Prairie	10	0.011	0.011	0.075	10	0.011	0.011	0.075	10	0.011	0.011	0.340	10	0.011	0.011	0.115	10	0.011	0.011	0.273
lower East Prairie	9	0.011	0.011	0.040	9	0.011	0.011	0.044	10	0.011	0.011	0.068	-	-	-	-	9	0.011	0.011	0.266
upper West Prairie	10	0.011	0.011	0.061	10	0.011	0.011	0.030	10	0.011	0.011	0.025	10	0.011	0.011	0.038	10	0.011	0.011	0.111
middle West Prairie	10	0.011	0.011	0.040	10	0.011	0.011	0.035	10	0.011	0.011	0.062	10	0.011	0.011	0.045	10	0.011	0.011	0.227
upper South Heart	10	0.011	0.011	0.111	10	0.022	0.011	0.081	10	0.011	0.010	0.084	10	0.053	0.011	0.138	10	0.011	0.011	0.098
middle South Heart	10	0.011	0.010	0.239	10	0.032	0.011	0.146	10	0.011	0.010	0.124	10	0.081	0.011	0.196	10	0.011	0.011	0.180
lower South Heart	10	0.023	0.011	0.095	10	0.011	0.011	0.239	10	0.011	0.011	0.025	10	0.038	0.011	0.103	10	0.038	0.011	0.270
Grouard Channel	10	0.011	0.011	0.067	10	0.011	0.011	0.054	10	0.011	0.010	0.027	10	0.011	0.011	0.041	10	0.011	0.011	0.088
Lesser Slave River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	0.011	0.011	0.060

Table 12. Total Kjeldahl nitrogen concentrations at Lesser Slave Lake tributaries, April to October, 2017 to 2021.

Site	2017				2018				2019				2020				2021			
	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max
upper Swan	9	0.230	0.100	0.690	10	0.325	0.100	1.280	10	0.415	0.100	0.900	10	0.540	0.100	1.660	10	0.28	0.10	0.66
middle Swan	9	0.270	0.100	1.570	10	0.395	0.100	1.370	10	0.550	0.260	1.150	10	0.570	0.200	0.860	10	0.27	0.10	0.77
lower Swan	9	0.400	0.100	3.430	9	0.410	0.100	0.780	9	0.500	0.400	1.140	8	0.490	0.100	0.930	10	0.28	0.10	0.84
upper Driftpile	8	0.370	0.100	0.990	10	0.610	0.300	2.980	10	0.575	0.100	1.420	9	0.580	0.100	1.480	10	0.31	0.10	0.80
middle Driftpile	10	0.455	0.100	1.030	10	0.675	0.220	1.100	10	0.500	0.100	1.710	10	0.580	0.100	1.670	10	0.35	0.10	0.92
lower Driftpile	9	0.450	0.100	1.120	10	0.520	0.240	1.290	10	0.545	0.100	1.400	10	0.645	0.100	1.970	10	0.42	0.10	0.91
upper East Prairie	9	0.100	0.100	0.830	10	0.390	0.100	1.010	10	0.425	0.100	1.100	10	0.535	0.300	0.900	10	0.30	0.10	0.92
middle East Prairie	10	0.485	0.100	1.700	10	0.555	0.280	1.090	10	0.565	0.100	3.250	10	1.080	0.450	1.970	10	0.54	0.22	1.44
lower East Prairie	9	0.520	0.380	1.800	9	0.500	0.240	1.260	10	0.765	0.100	1.730	-	-	-	-	9	0.55	0.25	1.50
upper West Prairie	10	0.760	0.490	1.710	10	0.715	0.310	1.100	10	0.755	0.500	1.600	10	0.925	0.500	1.890	10	0.66	0.39	1.18
middle West Prairie	10	0.805	0.560	1.890	10	0.725	0.360	1.520	10	0.655	0.300	1.860	10	1.215	0.450	1.560	10	0.78	0.30	1.74
upper South Heart	10	1.425	0.670	2.240	10	1.150	0.890	1.620	10	1.330	0.640	2.040	10	1.445	0.950	1.940	10	1.33	0.77	1.69
middle South Heart	10	1.295	0.720	2.070	10	1.295	0.910	1.900	10	1.155	0.370	2.030	10	1.550	0.840	2.130	10	1.02	0.63	1.43
lower South Heart	10	1.240	0.910	3.650	10	1.205	0.960	1.570	10	1.055	0.700	5.750	10	1.375	1.150	2.150	10	1.20	0.89	4.29
Grouard Channel	10	0.860	0.340	2.420	10	1.040	0.560	1.520	10	0.870	0.100	1.820	10	1.300	0.700	1.520	10	1.12	0.71	1.55
Lesser Slave River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	0.49	0.10	1.36

Table 13. Total nitrogen concentrations at Lesser Slave Lake tributaries, April to October, 2017 to 2021.

Site	2017				2018				2019				2020				2021			
	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max
upper Swan	9	0.230	0.100	0.690	10	0.325	0.100	1.280	10	0.415	0.100	0.900	10	0.555	0.100	1.660	10	0.28	0.10	0.66
middle Swan	9	0.270	0.100	1.570	10	0.395	0.100	1.370	10	0.550	0.260	1.150	10	0.600	0.200	0.860	10	0.27	0.10	0.85
lower Swan	9	0.400	0.100	3.430	9	0.410	0.100	0.790	9	0.500	0.400	1.140	8	0.490	0.100	1.020	10	0.28	0.10	0.92
upper Driftpile	8	0.370	0.100	0.990	10	0.610	0.300	2.980	10	0.575	0.100	1.420	9	0.580	0.100	1.480	10	0.31	0.10	0.86
middle Driftpile	10	0.455	0.100	1.030	10	0.685	0.220	1.130	10	0.500	0.100	1.710	10	0.610	0.100	1.670	10	0.35	0.10	0.99
lower Driftpile	9	0.450	0.100	1.120	10	0.520	0.240	1.290	10	0.545	0.100	1.460	10	0.645	0.100	1.970	10	0.43	0.10	0.98
upper East Prairie	9	0.100	0.100	0.830	10	0.390	0.100	1.010	10	0.425	0.100	1.100	10	0.580	0.300	0.900	10	0.30	0.10	1.03
middle East Prairie	10	0.485	0.100	1.730	10	0.555	0.280	1.160	10	0.565	0.100	3.290	10	1.105	0.450	2.000	10	0.54	0.31	1.61
lower East Prairie	9	0.520	0.380	1.800	9	0.500	0.240	1.310	10	0.765	0.100	1.730	-	-	-	-	9	0.56	0.25	1.67
upper West Prairie	10	0.760	0.490	1.710	10	0.715	0.310	1.130	10	0.755	0.500	1.600	10	0.925	0.520	1.890	10	0.66	0.39	1.24
middle West Prairie	10	0.805	0.560	1.930	10	0.725	0.360	1.550	10	0.655	0.300	1.920	10	1.215	0.450	1.560	10	0.78	0.30	1.84
upper South Heart	10	1.425	0.780	2.350	10	1.165	0.920	1.700	10	1.370	0.660	2.040	10	1.545	0.980	1.980	10	1.38	0.77	1.69
middle South Heart	10	1.295	0.720	2.310	10	1.305	1.030	2.050	10	1.155	0.370	2.150	10	1.660	1.040	2.170	10	1.02	0.63	1.43
lower South Heart	10	1.260	0.910	3.700	10	1.220	0.980	1.630	10	1.055	0.700	5.770	10	1.380	1.210	4.000	10	1.22	0.93	4.36
Grouard Channel	10	0.860	0.340	2.420	10	1.070	0.560	1.520	10	0.870	0.100	1.820	10	1.320	0.700	1.560	10	1.15	0.79	1.63
Lesser Slave River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	0.49	0.10	1.36

4.6.2 Driftpile River

At the Driftpile sites, the median TSS concentration ranged from 7.3 mg/L at the upper Driftpile River site to 19.8 mg/L at the lower site (maximum TSS range: 44.2 mg/L at the upper site to 106 mg/L at the lower site) (Table 14); maximum TSS concentrations occurred during May. In 2021, median and maximum TSS concentrations at the Driftpile River sites were the lowest of the five years.

4.6.3 East Prairie River

The median TSS concentration ranged from 8.7 mg/L at the upper East Prairie River site to 101 mg/L at the lower site (maximum TSS range: 114 mg/L at the upper site to 453 mg/L at the lower site) (Table 14); maximum TSS concentrations occurred in May. The median and maximum TSS concentrations at the upper and middle sites in 2021 were the lowest of the five years. The median TSS concentration at the lower site was the highest of five years.

4.6.4 West Prairie River

The median TSS concentration was 11.7 mg/L at the upper West Prairie River site and 16.0 mg/L at the middle West Prairie site (maximum TSS range: 217 mg/L at the upper site and 385 mg/L at the middle site) (Table 14). The maximum TSS concentrations occurred in May. In 2021, the median TSS concentration and maximum TSS concentration at the upper and middle West Prairie River sites was the lowest of the five years.

4.6.5 South Heart River and Grouard Channel

The median TSS concentration ranged from 4.8 mg/L at the upper South Heart River site to 38.0 mg/L at lower site (maximum TSS range: 13.2 mg/L at the upper site to 156 mg/L at the lower site) (Table 14). In 2021, the TSS maximum concentration at middle site (42.6 mg/L) was the lowest in five years. Median and maximum TSS concentration at the upper and lower sites were within the range of the previous four years.

At Grouard Channel, the median TSS concentration was 51.1 mg/L (range: 6.6 to 222 mg/L) (Table 14); maximum TSS occurred in May. The median TSS concentration in 2021 was the highest of the five years.

4.6.6 Lesser Slave River

At the Lesser Slave River in 2021, the median TSS concentration was 7.0 mg/L (range: 1.5 to 29.0 mg/L) (Table 14). The maximum TSS occurred in September at the Lesser Slave River.

4.7 Fecal Coliform Bacteria (FCB)

4.7.1 Swan River

In 2021, the median fecal coliform bacteria count at the Swan River ranged from 17 cfu/100 mL at the upper site to 24 cfu/100 mL at the lower site (maximum FCB range: 54 cfu/100 mL at the upper site to 120 cfu/100 mL at the middle site) (Table 15). The median FCB counts at the three Swan River sites generally met the guideline for irrigation (≤ 100 cfu/100 mL). One of 10 samples at the middle Swan River site exceeded the irrigation guideline (≤ 100 cfu/100 mL) in 2021.

4.7.2 Driftpile River

The median FCB count ranged from 7 cfu/100 mL at the lower Driftpile River site to 16 cfu/100 mL at the middle site (maximum FCB range: 32 cfu/100 mL at the middle site to 44 cfu/100 mL at the upper and lower sites) (Table 15). The median FCB counts and all samples at the three Driftpile River sites met the guideline for irrigation (≤ 100 cfu/100 mL) in 2021.

4.7.3 East Prairie River

The median FCB count ranged from 14 cfu/100 mL at the upper East Prairie River site to 62 cfu/100 mL at the middle site (maximum FCB range: 26 cfu/100 mL at the upper site to 260 cfu/100 mL) at the middle site (Table 15). The median FCB counts at the East Prairie River sites met the guideline for irrigation (≤ 100 cfu/100 mL). Four of nine samples at the middle site and one of eight samples at the lower site exceeded the irrigation guideline.

The median FCB count (14 cfu/100 mL) at the upper East Prairie River site in 2021 was within the range of FCB counts from 2017 to 2020 (11 to 30 cfu/100 mL). The 2021 maximum FCB count at the upper site (26 cfu/100 mL) was lower compared to 2017 to 2020 (44 to 520 cfu/100 mL) (Table 15).

The median FCB count (62 cfu/100 mL) at the middle East Prairie River site in 2021 was within the range of FCB counts from 2017 to 2020 (38 to 64 cfu/100 mL). The 2021 maximum FCB count at the middle site (260 cfu/100 mL) was higher compared to 2017 to 2020 (110 to 210 cfu/100 mL) (Table 15).

4.7.4 West Prairie River

The median FCB count was 39 cfu/100 mL at the middle West Prairie River site and 40 cfu/100 mL at the upper site (maximum FCB: 150 cfu/100 mL at the middle site and 200 cfu/100 mL at the upper site) (Table 15). The median FCB counts at the West Prairie River sites met the guideline for irrigation (≤ 100 cfu/100 mL). Two of 9 samples exceeded the irrigation guideline at each of the upper and middle sites.

The 2021 median FCB count (40 cfu/100 mL) at the upper West Prairie River site was lower compared to 2017 to 2020 (48 to 110 cfu/100 mL); the 2021 maximum at the upper site (200 cfu/100 mL) was generally in the low range compared to 2017 to 2020 (100 to 810 cfu/100 mL) (Table 15).

At the middle West Prairie River site, the 2021 median FCB count (39 cfu/100 mL) was lower compared to the 2017 to 2020 median range (64 to 145 cfu/100 mL); the 2021 maximum at the middle site (150 cfu/100 mL) was in the low range compared to 2017 to 2020 (130 to 810 cfu/100 mL) (Table 15).

4.7.5 South Heart River and Grouard Channel

The median FCB count ranged from 2 cfu/100 mL at the upper South Heart River site to 37 cfu/100 mL at the lower site (Table 15). Median FCB counts in 2021 were similar to 2017 to 2021 (< 67 cfu/100 mL). The maximum FCB count ranged from 24 cfu/100 mL at the upper site to 340 cfu/100 mL at the lower site. The median FCB counts at all three South Heart River sites met the guideline for irrigation (≤ 100 cfu/100 mL). One of 9 samples at the lower site exceeded the irrigation guideline.

In 2021 at the Grouard Channel, the median FCB count was 8 cfu/100 mL (range: 1 to 33 cfu/100 mL) (Table 15). The median FCB count and all samples collected in 2021 met the guideline for irrigation (≤ 100 cfu/100 mL). The median FCB count in 2021 (8 cfu/100 mL) was within the range of 2017 to 2020 FCB counts (3 to 20 cfu/100 mL). The maximum FCB count in 2021 (33 cfu/100 mL) was lower compared to 2017 to 2020 (48 to 140 cfu/100 mL) (Table 15).

4.7.6 Lesser Slave River

In 2021, the median fecal coliform count was 6 cfu/100 mL, and ranged from 1 to 30 cfu/100 mL at the Lesser Slave River (Table 15). The median FCB count and all samples at the Lesser Slave River met the guideline for irrigation (≤ 100 cfu/100 mL).

Table 14. Total suspended solids concentrations (mg/L) at Lesser Slave Lake tributaries, April to October, 2017 to 2021.

Site	2017				2018				2019				2020				2021			
	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max
upper Swan	9	8	2	183	10	19	2	1,160	10	29	2	130	10	60	2	305	10	8.5	1.5	59.6
middle Swan	9	12	2	1,030	10	11	5	2,110	10	22	2	196	10	43	2	354	10	7.9	1.5	74.8
lower Swan	9	31	3	3,060	9	16	7	257	9	36	4	271	8	28	2	342	10	23.2	5.8	267
upper Driftpile	8	15	2	254	10	14	3	2,230	10	18	2	220	9	32	2	172	10	7.3	1.5	44.2
middle Driftpile	10	39	2	153	10	18	6	3,570	10	19	2	315	10	47	2	504	10	12.0	3.0	78.2
lower Driftpile	9	37	5	136	10	16	4	3,380	10	28	7	551	10	60	2	259	10	19.8	1.5	106
upper East Prairie	9	15	2	168	10	9	4	3,200	10	35	2	737	10	55	2	923	10	8.7	1.5	114
middle East Prairie	10	83	2	445	10	37	5	576	10	85	7	1,410	10	177	2	971	10	34.8	3.8	419
lower East Prairie	9	36	6	125	9	21	9	65	10	98	12	769	-	-	-	-	9	101	6.4	453
upper West Prairie	10	24	7	200	10	31	7	541	10	33	4	1,650	10	104	3	438	10	11.7	1.5	217
middle West Prairie	10	18	2	451	10	17	6	440	10	38	4	1,280	10	98	6	735	10	16.0	1.5	385
upper South Heart	10	3	2	16	10	5	4	12	10	5	2	9	10	4	2	11	10	4.8	1.5	13.2
middle South Heart	10	15	7	75	10	72	8	125	10	13	6	79	10	93	11	294	10	17.5	12.6	42.6
lower South Heart	10	75	26	818	10	30	21	144	10	39	12	450	10	27	2	84	10	38.0	18.6	156
Grouard Channel	10	25	5	270	10	15	4	143	10	21	6	230	10	10	2	79	10	51.1	6.6	222
Lesser Slave River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	7.0	1.5	29.0

Table 15. Fecal coliform bacteria counts (cfu/100 mL) at Lesser Slave Lake tributaries, April to October 2017 to 2021. Red values indicate a guideline exceedance.

Site	2017				2018				2019				2020				2021			
	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max	N	Median	Min	Max
upper Swan	9	22	1	120	10	13	1	420	10	11	1	73	10	21	3	160	10	17	1	54
middle Swan	9	46	5	250	10	31	9	620	10	32	1	64	10	45	10	210	10	10	4	120
lower Swan	9	110	5	870	9	20	7	65	9	42	8	64	8	43	10	90	10	24	2	100
upper Driftpile	8	20	8	160	10	12	1	2,400	10	9	1	72	9	10	1	120	10	9	2	44
middle Driftpile	10	20	3	200	10	16	1	220	10	10	1	52	10	39	8	200	10	16	1	32
lower Driftpile	9	71	3	210	10	15	1	1,100	10	15	1	90	10	31	5	110	10	7	1	44
upper East Prairie	9	11	1	44	10	30	1	520	10	22	1	50	9	12	3	90	9	14	2	26
middle East Prairie	10	45	5	200	10	43	7	110	10	38	17	210	9	64	10	120	9	62	13	260
lower East Prairie	9	64	20	220	9	25	2	190	10	73	4	460	-	-	-	-	8	39	9	120
upper West Prairie	10	110	20	330	10	48	10	810	10	68	16	256	9	60	26	100	9	40	21	200
middle West Prairie	10	145	20	330	10	98	11	330	10	66	17	810	9	64	10	130	9	39	27	150
upper South Heart	10	5	1	10	10	1	1	4	10	2	1	10	9	6	1	50	9	2	1	24
middle South Heart	10	64	5	200	10	30	1	330	10	14	1	41	9	20	12	160	9	10	2	52
lower South Heart	10	67	10	1,400	10	17	2	360	10	44	10	580	9	30	10	126	9	37	4	340
Grouard Channel	10	20	5	48	10	3	1	54	10	11	1	100	9	10	2	140	9	8	1	33
Lesser Slave River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	6	1	30

4.8 Metals

4.8.1 General

Appendix B-2 and B-3 contains the raw metals data for the upper, lower and middle Swan River sites, upper West Prairie River, middle East Prairie River and middle Driftpile River sites. The following discussion highlights the metals that exceeded the chronic or acute provincial protection of aquatic life (PAL) guidelines during the five-year water monitoring program where guidelines have been specified (GoA 2018).

In 2021 there were fewer metal exceedances at the three Swan River sites (2-4 exceedances) compared to 2017 to 2020 (3-10 exceedances) (Figure 9). Dissolved iron and hexavalent chromium exceeded the chronic PAL guideline at all Swan River sites and 2021 was the first year that hexavalent chromium exceeded chronic guidelines. Dissolved aluminum exceeded the PAL guideline at the middle site and dissolved aluminum and total mercury exceeded the PAL guideline at the lower site (Figure 9). There were no guideline exceedances of total arsenic, total boron, total cadmium, total copper, total lead, total nickel, total selenium, total silver, total uranium, total zinc, dissolved zinc or dissolved manganese at the Swan River sites.

In 2021 there were fewer metal exceedances at the West Prairie, East Prairie and Driftpile river sites (4-5 exceedances) compared to 2020 (7-8 exceedances) (Figure 9). Metal analysis results indicated that four metals exceeded the provincial guidelines for the protection of aquatic life (PAL) at the upper West Prairie River site, five metals exceeded guidelines at the middle East Prairie River site and four metals exceeded guidelines at the middle Driftpile River site (Figure 9). Three metal exceedances were common to the three sites: total mercury, dissolved aluminum and dissolved iron. Total lead exceeded the guideline at upper West Prairie River and middle East Prairie River. Hexavalent chromium exceeded the PAL at the middle Driftpile River and total copper exceeded the guideline at the middle East Prairie River. There were no guideline exceedances of total arsenic, total boron, total cadmium, total copper, total nickel, total selenium, total silver, total uranium, total zinc, dissolved zinc or dissolved manganese at the West Prairie, East Prairie or Driftpile river sites.

4.8.2 Total Arsenic

In 2021, total arsenic ranged from 0.99 to 1.77 µg/L with a median of 1.29 µg/L at the three Swan River sites. There were no exceedances of the total arsenic chronic guideline (5 µg/L) at the Swan River sites in 2021 (Appendix B-2).

Similarly in 2021, no sample (0%) exceeded the chronic total arsenic guideline and no samples (0%) had total arsenic concentrations below the detection limit of the analytical equipment at the upper West Prairie River (median: 1.18 µg/L; range 1.02 to 1.67 µg/L), at the middle East Prairie River (median: 1.44 µg/L; range 1.29 to 2.46 µg/L), and the middle Driftpile River (median: 1.42 µg/L; range 1.16 to 1.81 µg/L) (Appendix B-3).

In previous years, total arsenic was detected above the chronic guideline at the lower Swan River in 2017, and at the upper and middle Swan River in 2018 (Figure 9). Total arsenic was also detected above the chronic guideline at the middle East Prairie River and middle Driftpile River in 2020.

Arsenic ranks as the 53rd element in abundance in the earth's crust, and is more common in the earth's crust than are other common elements such as mercury, cadmium and silver (CCREM 1987). Smelting, refining industries and combustion of fossil fuels, especially coal are anthropogenic sources of arsenic.

Arsenic is used in metallurgical applications and in manufacturing wood preservatives. Arsenic compounds are also used in herbicide, pharmaceutical, and glass manufacturing. The largest natural source of arsenic entering surface waters is that from weathered rocks and soils. Levels of total arsenic in uncontaminated surface waters are generally less than 2 µg/L (CCME 2001). The estimated amount of arsenic released to the global environment annually as a result of human activities is about twice that reaching the environment from weathering. Most of the arsenic reaching the environment is sorbed by soils and sediment (CCREM 1987).

4.8.3 Total Cadmium

In 2021, total cadmium concentrations at the Swan River sites ranged from 0.0118 to 0.0343 µg/L with a median of 0.0249 µg/L. None of the samples (0%) exceeded the chronic total cadmium guideline. None of the samples had total cadmium concentrations below the detection limit of the analytical equipment (Appendix B-2).

Similarly in 2021, no sample (0%) exceeded the chronic total cadmium guideline and no sample (0%) had total cadmium concentrations below the detection limit of the analytical equipment at upper West Prairie River (median 0.0303 µg/L; range: 0.0183 to 0.0593 µg/L); at middle East Prairie River (median: 0.0235 µg/L; range: 0.0132 to 0.0740 µg/L), and at middle Driftpile River (median: 0.0288 µg/L; range: 0.0133 to 0.0402 µg/L).

Since 2017, 2021 was the only year in which there was no exceedance of the cadmium protection of aquatic life guidelines (Figure 9).

Cadmium is a naturally occurring metal found in mineral deposits and is distributed widely at low concentrations in the environment. Across the Prairie Provinces, cadmium concentrations in freshwater range from <0.1 to 112 µg/L (an extreme value) and average concentrations range from 0.2 to 0.3 µg/L (CCME 2014). Typical background dissolved cadmium concentrations in freshwaters of the United States ranged from 0.002 to 0.08 µg/L (Mebane 2010). Total cadmium in the Slave Lake watershed may be due to industrial uses and natural occurrences. Cadmium enters the environment as a result of both natural processes (weathering and erosion of rock and soils, natural combustion from volcanoes and forest fires) anthropogenic sources (mining, agriculture, urban activities, and waste streams from industrial processes, manufacturing, coal ash ponds/pits, fossil fuel combustion, incineration and municipal effluent) (USEPA 2016). Primary industrial uses are for the manufacturing of batteries, pigments, plastic stabilizers, metal plating, alloys and electronics. Human sources, such as mining and urban areas are responsible for contributing approximately 90% of cadmium found in surface waters (USEPA 2016).

Fathead minnows had a 96 h LC50³ (acute) when exposed to 10.1 µg/L of cadmium (CCME 2014). Salmonids appear more sensitive to cadmium with Rainbow Trout, Brown Trout and Bull Trout having a 96 h LC50 at cadmium concentrations from 0.47 to 1.97 µg/L while Arctic Grayling and Mountain Whitefish have a 96 h LC50 with cadmium concentrations between 4.89 to 4.92 µg/L (CCME 2014).

³ 96 h LC50 - Standard measure of the toxicity used to determine the lethal concentration (LC) of the surrounding medium that will kill half of the sample population (50%) of a specific test-animal in a specified period (96 hours) through exposure.

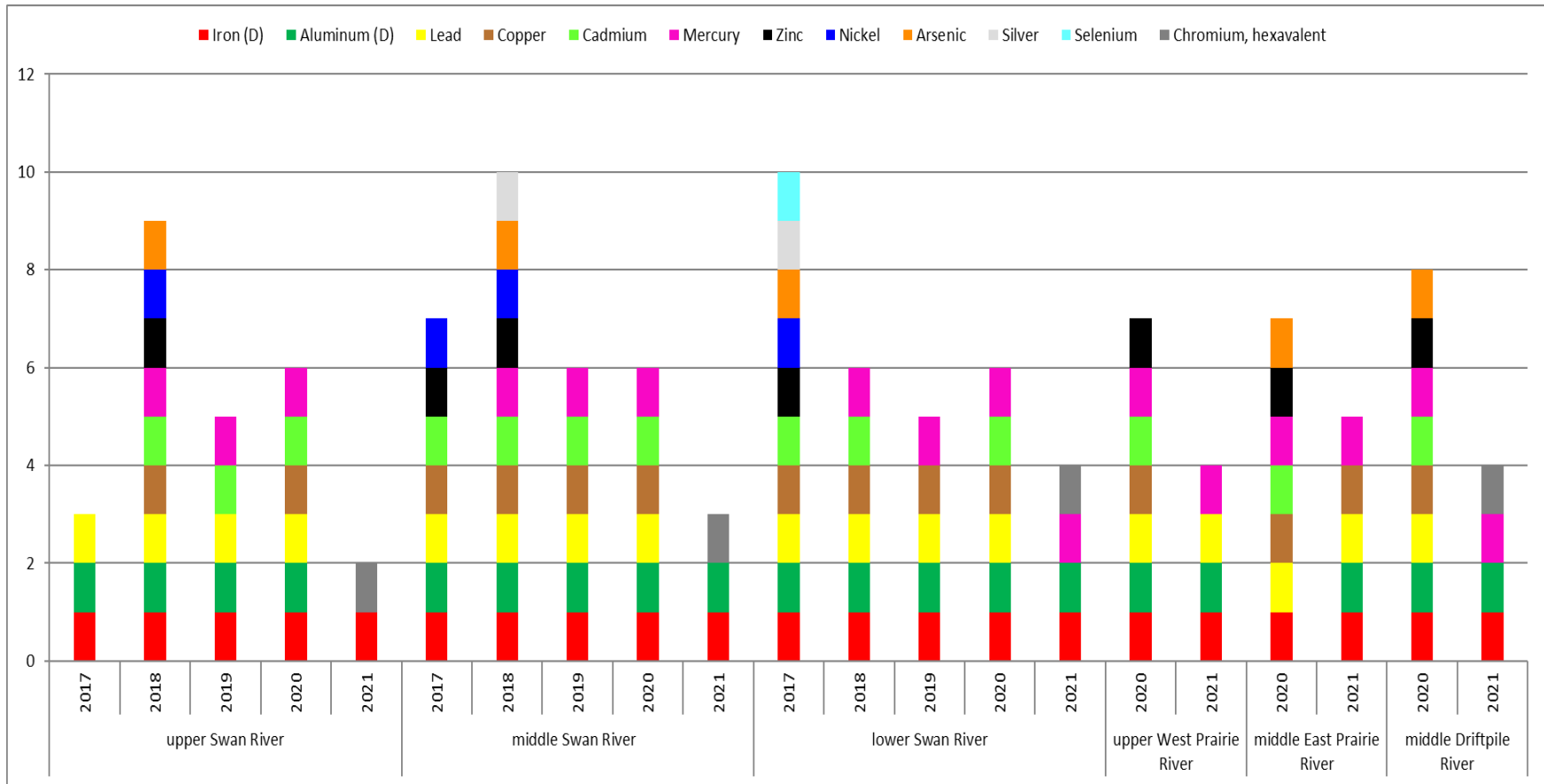


Figure 9. Number of metals that exceeded protection of aquatic life (PAL) guidelines at tributaries to Lesser Slave Lake, 2017 to 2021. Sample sizes: 2017 (N=5), 2018 (N=7), 2019 (N=7), 2020 (N=7) and 2021 (N=7). Hexavalent chromium was not analysed in 2017.

4.8.4 Total Copper

The median total copper concentration at the Swan River sites in 2021 was 2.19 µg/L (range: 0.78 to 3.70 µg/L). None of the 21 samples (0%) collected at the Swan River sites in 2021 exceeded the acute or chronic total copper guideline (7 µg/L) and, and no sample had total copper concentrations below the detection limit of the analytical equipment (Appendix B-2). Since 2017, 2021 was the only year in which there was no exceedance of copper protection of aquatic life guidelines at the Swan River (Figure 9).

Similarly in 2021, no sample (0%) exceeded the acute or chronic total copper guideline and no sample (0%) had total copper concentrations below the detection limit of the analytical equipment at upper West Prairie River (median 3.38 µg/L; range: 1.48 to 5.07 µg/L) and at the middle Driftpile River (median: 2.71 µg/L; range: 1.28 to 4.33 µg/L (Appendix B-3).

In 2021 at middle East Prairie River, total copper ranged from 1.32 to 7.33 µg/L with a median of 3.15 µg/L. One of the 7 samples (14%) marginally exceeded the chronic guideline by a factor of 1.05 times, and no sample (0%) had total copper concentrations below the detection limit (Appendix B-3).

Total copper in the Slave Lake watershed may be due to natural occurrences and industrial uses. Copper is an abundant trace element found in the earth's crust and is a naturally occurring element that is generally present in surface waters. Copper enters aquatic systems through aerial deposition or surface runoff. Because of its affinity for particulate matter, mainly fractions of iron, manganese oxides, and organic matter, copper tends to accumulate in sediments (CCME 1999). At 11 interprovincial border sites in the prairies, total copper concentrations varied from below detection to 85 µg/L; most median values were around 3 µg/L with some median values as high as 8 µg/L (AEP 1996).

4.8.5 Total Lead

The median total lead concentration at the Swan River sites in 2021 was 0.293 µg/L (range: 0.063 to 0.794 µg/L). None of the 21 samples (0%) exceeded the chronic total lead guideline (1 to 7 µg/L), and no sample (0%) had total lead concentrations below the detection limit of the analytical equipment (Appendix B-2). Since 2017, 2021 was the only year in which there was no exceedance of total lead protection of aquatic life guidelines at the Swan River (Figure 9).

In 2021 at upper West Prairie River, total lead ranged from 0.083 to 1.38 µg/L with a median of 0.530 µg/L and two of 7 samples (29%) exceeded the chronic total lead guideline by a factor of 1.3 to 1.4 times. At middle East Prairie River, the median total lead concentration was 0.457 µg/L (range: 0.062 to 2.30 µg/L) and two of 7 samples (29%) exceeded the chronic guideline by a factor of 1.3 to 2.3 times. At middle Driftpile River, median total lead concentration was 0.440 µg/L (range: 0.177 to 0.719 µg/L) and none of the 7 samples (0%) exceeded the chronic guideline. None of the 7 samples (0%) at the three sites had total lead concentrations below the detection limit of the analytical equipment (Appendix B-3).

Lead ranks as the 36th element in order of abundance based on its concentration in the earth's crust (igneous rocks). Anthropogenic input of lead to the environment outweighs all natural sources. In Canada, the primary use of lead is the production of acid-storage batteries. The second largest use was in the manufacture of chemical compounds, particularly alkyl lead additives (i.e., leaded gasoline). Leaded gasoline was largely phased out of use in Canada by 1990. Lead and its compounds are also used in electroplating, metallurgy, construction materials, coatings and dyes, electronic equipment, plastics, veterinary medicines, fuels, radiation shielding, ammunition, corrosive-liquid containers, paints, glassware, fabricating storage tank linings, transporting radioactive materials, solder, piping, cable sheathing, roofing and sound attenuators (CCREM 1987). Soluble lead, whether natural or from

industrial sources is removed from solution by association with sediments and suspended particulates, such as organic matter, hydrous oxides and clays.

4.8.6 Total Mercury

Total mercury at the Swan River sites in 2021 ranged from <0.005 to 0.0072 µg/L with a median of 0.0025 µg/L. One of the 21 samples (5%) exceeded the chronic total mercury guideline (0.005 µg/L) at the lower Swan River site by a factor of 1.4 times in May. Twenty of the 21 samples (95%) had total mercury concentrations below the detection limit of the analytical equipment (Appendix B-2). Since 2018, total mercury concentrations have exceeded the PAL guideline at the Swan River.

In 2021 at upper West Prairie River, total mercury ranged from <0.005 to 0.0098 µg/L (median of 0.0025 µg/L) and two of 7 samples (29%) exceeded the chronic total mercury guideline by 1.2 and 2.0 times. Four of the 7 samples (57%) had total mercury concentrations below the detection limit of the analytical equipment (Appendix B-3).

At middle East Prairie River (2021), total mercury ranged from <0.005 to 0.0105 µg/L (median of 0.0025 µg/L). Two of 7 samples (29%) exceeded the chronic guideline by a factor of 1.7 to 2.1 times and five of the 7 samples (71%) had total mercury concentrations below the detection limit (Appendix B-3).

At middle Driftpile River (2021), total mercury ranged from <0.005 to 0.0078 µg/L (median: 0.0025 µg/L) and one of 7 samples (14%) exceeded the chronic guideline by a factor of 1.6 times. Six of the 7 samples (86%) had total mercury concentrations below the detection limit (Appendix B-3). Total mercury exceeded the PAL guidelines at the West Prairie, East Prairie and Driftpile rivers in 2020 and 2021 (Figure 9).

Mercury occurs naturally, but significant amounts enter ecosystems through anthropogenic emissions and discharges. Natural sources of mercury include geological mercury deposits, rock weathering, forest fires and other wood burning. The primary anthropogenic sources of mercury in Canada include: metal smelting; coal-burning power plants; municipal waste incineration; sewage and hospital waste incineration; fossil fuel combustion; cement manufacturing; and, mercury waste in landfills (CCME 2003a). Total mercury concentrations in surface waters of western Canada range from <0.02 to 0.24 µg/L (CCREM 1987). In freshwater habitats, mercury compounds sorb to particulate matter and to sediment. Mercury sorption onto sediments is an important process for determining its abiotic fate in the aquatic environment. Sediment binding capacity is related to organic content. Mercury tends to combine with sulphur in anaerobic bottom sediments (CCREM 1987).

4.8.7 Total Zinc

In 2021, total zinc ranged from <3.0 to 10.3 µg/L with a median of 1.5 µg/L at the three Swan River sites. There were no exceedances of the total zinc guideline at the Swan River sites in 2021 (Appendix B-2). Zinc exceeded protection of aquatic life (PAL) guidelines at the Swan River in 2017 and 2018 (Figure 9).

In 2021 at upper West Prairie River, total zinc ranged from <3.0 to 10.4 µg/L (median: 3.7 µg/L), and at middle East Prairie River, it ranged from <3.0 to 13.7 µg/L (median: 3.2 µg/L). There were no exceedances of the total zinc guideline at the upper West Prairie River and middle East Prairie River sites in 2021 (Appendix B-3). Three of the 7 samples (43%) had total zinc concentrations below the detection limit of the analytical equipment at both sites (Appendix B-3).

At middle Driftpile River (2021), total zinc ranged from <3.0 to 6.9 µg/L (median: 4.2 µg/L). Similar to West Prairie and East Prairie rivers, there were no exceedances of the total zinc guideline at the middle

Driftpile River site in 2021 (Appendix B-3). Two of the 7 samples (29%) had total zinc concentrations below the detection limit. Total zinc exceeded the PAL guideline in 2020 at the West Prairie, East Prairie and Driftpile rivers in 2020 (Figure 9).

Zinc is the fourth most common metal in use, after iron, aluminum, and copper. Approximately half of mined zinc is used as an anti-corrosion agent by coating (galvanizing) iron or steel to protect the metals against corrosion. Galvanization is used on chain-link fencing, culverts, guard rails, cathodic anodes, suspension bridges, light posts, metal roofs, heat exchangers, and car bodies. The occasional exceedance of total zinc guidelines at the Swan, West Prairie, East Prairie and Driftpile river sites is probably due to anthropogenic uses. Surface water total zinc concentrations have been found to range from 0.1 to 139 µg/L in the Athabasca region of Alberta (CCME 2018).

4.8.8 Hexavalent Chromium

At the Swan River sites in 2021, hexavalent chromium ranged from 0.25 to 1.82 µg/L with a median of 0.25 µg/L (N=21). Three of 21 samples (14%) exceeded the chronic hexavalent chromium guideline (1 µg/L) by a factor of 1.2 to 1.8 times. The three hexavalent chromium exceedances occurred on October 20, 2021 (Appendix B-2). Seventeen (17) of the 21 samples (81%) had a hexavalent chromium concentration below the detection limit. Since 2018, 2021 was the only year when hexavalent chromium exceeded the chronic PAL guidelines at the Swan River (Figure 9).

In 2021 at the upper West Prairie River and middle East Prairie River sites, the hexavalent chromium median was 0.25 µg/L and each sample was 0.25 µg/L (N=7). No samples exceeded the hexavalent chromium guideline. Seven (7) of the 7 samples (100%) had a hexavalent chromium concentration below the detection limit at each site (Appendix B-3).

At the middle Driftpile River in 2021, hexavalent chromium ranged from 0.25 to 2.22 µg/L (median: 0.25 µg/L) (N=7). One of seven samples (14%) exceeded the chronic hexavalent chromium guideline (1 µg/L) by a factor of 2.2 times. The hexavalent chromium exceedance occurred on October 20, 2021 (Appendix B-3). Six (6) of the 7 samples (86%) had a hexavalent chromium concentration below the detection limit.

Chromium ores have not been mined in Canada since the early 1900s. Approximately 74,000 t of chromium-containing compounds were imported into Canada in 1991. The metallurgical, refractory and chemical industries are the primary users of chromium. The metallurgical uses of chromium include production of stainless steels, alloy cast irons and nonferrous alloys. In the chemical sector, hexavalent chromium is used in pigments. A major industrial use of hexavalent chromium is in metal finishing and as an anti-corrosive agent in waters for cooling towers, oil drilling and power plants. Other uses of chromium are as catalysts and in applications such as textiles, toners for printers, magnetic tapes and dietary supplements. Hexavalent chromium is released into the environment as a result of many of these industrial uses, as well as from the production and combustion of fossil fuels, and the smelting and refining of nonferrous base metals.

Hexavalent chromium is the principal species found in surface waters and aerobic soils while trivalent chromium dominates in mildly reducing environments such as sediments and wetlands. The highly oxidizing potential, high solubility and ease of permeation of biological membranes makes hexavalent chromium more toxic than trivalent chromium. While chromium can bioconcentrate to some extent in aquatic plants, it does not seem to bioaccumulate in fish or invertebrates and chromium body burden remain low even in contaminated water (CCME 1999). Generally, hexavalent chromium concentrations <5 µg/L are likely to result in nil to slight chronic adverse effects on aquatic life, concentrations >5 to 110 µg/L are likely to have moderate chronic adverse effects on aquatic life and concentrations >110 µg/L

are likely to have higher chronic adverse effects on aquatic life (ECCC 2017). Rainbow Trout chronic and acute toxicity endpoints for hexavalent chromium are approximately 100 µg/L (CCME 1999). The median surface water hexavalent chromium concentration from 2003 to 2015 in Alberta was 0.16 µg/L (range: 0.01 to 70.4 µg/L) (ECCC 2017, unpublished data).

4.8.9 Dissolved Aluminum

At the Swan River sites in 2021, dissolved aluminum ranged from 3.3 to 67.8 µg/L (median: 24.8 µg/L). Four of 21 samples (19%) exceeded the chronic dissolved aluminum guideline (50 µg/L) by a factor of 1.0 to 1.4 times. The dissolved aluminum exceedances occurred in late-April to late-June (Appendix B-2).

In 2021 at upper West Prairie River, dissolved aluminum ranged from 2.1 to 97.2 µg/L (median: 60.7 µg/L). Four of 7 samples (57%) exceeded the chronic dissolved aluminum guideline (50 µg/L) by a factor of 1.2 to 1.9 times (Appendix B-3). At middle East Prairie River, dissolved aluminum ranged from 0.5 to 55.1 µg/L (median: 16.9 µg/L). One of the 7 samples (14%) exceeded the chronic guideline by a factor of 1.1 times (Appendix B-3), and one of the 7 samples (14%) had a dissolved aluminum concentration below the detection limit.

At middle Driftpile River in 2021, dissolved aluminum ranged from 3.1 to 101 µg/L (median: 45.9 µg/L) and two of 7 samples (29%) exceeded the chronic guideline by a factor of 1.4 to 1.6 times. One of 7 samples (14%) marginally exceeded (101 µg/L) the acute guideline (100 µg/L) (Appendix B-3).

Since 2017, dissolved aluminum exceeded PAL guidelines at all of the monitoring sites (Figure 9).

In the Earth's crust, aluminum is the most abundant metallic element (8.1% by weight) and the third most abundant of all elements (after oxygen and silicon). The amount of aluminum found naturally in the environment exceeds aluminum from anthropogenic sources (CCME 2003b). The high aluminum concentrations in the Swan River are probably naturally occurring. Research indicates that aluminum is substantially less toxic at higher pH (>6.6) and water hardness (>10 mg/L) (USEPA 2009). At the Swan River sites, pH and water hardness in 2021 ranged between 6.50 to 8.28 and 41.2 to 109 mg/L, respectively. At the West Prairie, East Prairie and Driftpile river sites, pH and water hardness in 2021 ranged between 7.10 to 8.58 and 43.5 to 234 mg/L, respectively.

4.8.10 Dissolved Iron

At the Swan River sites in 2021, dissolved iron ranged from 198 to 1,660 µg/L (median: 636 µg/L). Twenty of 21 samples (95%) exceeded the chronic dissolved iron guideline (300 µg/L) by a factor of 1.1 to 5.5 times. Dissolved iron exceeded the chronic PAL guideline at the upper and lower sites on all sample dates. Iron ranged from 342 to 925 µg/L at the upper site, from 198 to 1,390 µg/L at the middle site and from 472 to 1,660 µg/L at the lower site (Appendix B-2).

At upper West Prairie River (2021), dissolved iron ranged from 109 to 1,420 µg/L (median: 506 µg/L) and six of 7 samples (86%) exceeded the chronic dissolved iron guideline (300 µg/L) by a factor of 1.1 to 4.7 times (Appendix B-3). At middle East Prairie River, dissolved iron ranged from 25 to 463 µg/L (median: 341 µg/L); four of 7 samples (57%) exceeded the guideline by a factor of 1.1 to 1.5 times (Appendix B-3).

At middle Driftpile River (2021), dissolved iron ranged from 169 to 1,400 µg/L (median: 583 µg/L) and six of 7 samples (86%) exceeded the guideline by a factor of 1.8 to 4.7 times (Appendix B-3).

Since 2017, dissolved iron exceeded PAL guidelines every year at all of the monitoring sites (Figure 9).

Iron is the fourth most common element in the earth's crust and is the most widely used of all the metals, accounting for 95% of worldwide metal production. Iron is naturally released into the environment from weathering of sulphide ores (pyrite, FeS_2) and igneous, sedimentary and metamorphic rocks. Iron is also released into the environment by human activities, mainly from the burning of coke and coal, acid mine drainage, mineral processing, sewage, landfill leachates, iron-related industries and the corrosion of iron and steel (CCREM 1987). The presence of elevated concentrations of iron at the Swan, West Prairie, East Prairie and Driftpile rivers is probably due to natural occurrences and industrial uses.

4.8.11 Metals Discussion

Hutchinson Environmental (2015) reported on metal concentrations in Lesser Slave Lake tributaries for samples collected in May and July (2008-2010). Hutchinson Environmental (2015) found that the Swan River had fewer metals exceeding guidelines (8) compared to the Driftpile River (10 metals exceeding guidelines) and West Prairie and East Prairie rivers (9 metals exceeding guidelines). Metals commonly exceeding guidelines in all rivers were total cadmium, total copper, total lead, total manganese, total mercury, total silver, dissolved aluminum and dissolved copper (Hutchinson Environmental 2015).

Metals sampling in 2020 and 2021 yielded similar results to the 2008-2010 study. There were fewer metal exceedances at the Swan River sites compared to the West Prairie, East Prairie and Driftpile rivers. Four metals exceeded provincial guidelines at the Swan River sites in 2021 (total mercury, hexavalent chromium, dissolved aluminum and dissolved iron). Six metals exceeded provincial guidelines at the West Prairie, East Prairie and Driftpile River (total copper, total lead, total mercury, hexavalent chromium, dissolved aluminum and dissolved iron). Three metal exceedances were common to the three rivers: total mercury, dissolved aluminum and dissolved iron. Total lead exceeded guidelines at upper West Prairie River and middle East Prairie River. Hexavalent chromium exceeded the PAL at the middle Driftpile River and total copper exceeded the guideline at the East Prairie River.

Hutchinson Environmental (2015) noted a strong correlation between metal concentrations and elevated suspended solids concentrations, which tended to increase with high streamflow (R^2 ranged from 0.92 to 0.99). This corresponds to the most recent findings (2017 to 2021) as the highest metal concentrations and largest number of metals exceeding the protection of aquatic life (PAL) guidelines occurred in years with the highest maximum TSS and the lowest metal concentrations/exceedances occurred in years with the lowest maximum TSS concentration.

Hutchinson Environmental (2015) noted an increasing trend in total metal concentrations and a decreasing trend in dissolved metal concentrations from upstream to downstream in 2008-2010 for the Swan River. In 2020 and 2021 total metals tended to increase in the downstream direction at the Swan River; however, dissolved metals did not show a trend. Hutchinson Environmental (2015) suggested that trends in metal concentrations may be due to changes in soil characteristics. The Swan River originates in the upper foothills where soils are dominated by brunisolic gray luvisol, and flows north into the central mixed-wood natural region where soils are primarily organic.

5.0 FIVE-YEAR ASSESSMENT

A five-year trend assessment was completed using the 2017 to 2021 data set available through the Lesser Slave Lake Tributary Monitoring Program. Between site comparisons for each tributary were also made using a one-way ANOVA to determine if water quality was significantly different between sites (Table 16). The historical data set (1992-93; 2012-13) was included in the assessment to increase the probability of detecting a trend using Mann-Kendall analysis (see Section 3.4 Data Handling and Analysis). Pearson's correlations were calculated between total phosphorus and total suspended solids to better understand nutrient transport mechanisms; correlations from the previous five annual reports (2017-2021) were reported at each river. The following summarizes trends that were observed for select water quality parameters at each of the Lesser Slave Lake tributaries. Results of the within stream site comparisons is presented in Table 16. Results of the Mann-Kendall analysis are presented in Tables 17 to 20. See Appendix D for notes regarding Box and Whisker Plot interpretation.

5.1 Swan River

Water Temperature Water temperature generally increased from the upper Swan River site to the lower site. From 2017-2021, water temperature generally met the objective (22°C) at all sites. At the middle Swan River, 1 of 50 samples (2%) exceeded the objective and at the lower Swan River, 2 of 46 (4%) exceeded the objective. The 2017 to 2021 comparison between monitoring locations, indicates significant differences in mean water temperature between the upper (10.0°C) and lower (12.9°C) sites (one-way ANOVA; $P \leq 0.05$) (Table 16). A 'probably decreasing' (probably improving) trend was detected for median water temperature at the lower Swan River (Table 17).

pH Minimum and maximum pH values nearly always met provincial guidelines for the protection of aquatic life (6.5 to 9.0). At the middle Swan River, 4 of 50 samples (8%) exceeded the maximum pH guideline. The 2017 to 2021 comparison between monitoring locations indicates significant differences in mean pH between the middle (8.17) and lower (7.90) sites (one-way ANOVA; $P \leq 0.05$) (Table 16). 'No trend' was detected for pH at the middle Swan River and the lower Swan River had pH that was 'stable' (Table 17).

Dissolved Oxygen Dissolved oxygen concentration always met provincial guidelines for the protection of aquatic life (chronic: ≥ 6.5 mg/L; acute: ≥ 5.0 mg/L) at the three Swan River sites. The 2017 to 2021 comparison between monitoring locations indicates significant differences in mean dissolved oxygen between the upper (10.48 mg/L) and lower (9.50 mg/L) sites (one-way ANOVA; $P \leq 0.05$) (Table 16). A 'stable' trend was detected in minimum dissolved oxygen concentrations at both the middle and lower Swan River sites, and no trend was detected for either median or maximum concentrations (Table 17).

Conductivity Conductivity values were always well below the irrigation guideline ($\leq 1,000$ $\mu\text{S}/\text{cm}$) at the three Swan River during the monitoring period. The 2017 to 2021 comparison between monitoring locations indicates there were no significant differences in mean conductivity between the upper, middle and lower sites (one-way ANOVA; $P > 0.05$) (Table 16). 'No trend' was detected for conductivity at the middle Swan River and the lower Swan River had conductivity that was 'probably increasing' (Table 17).

Table 16. Summary of 2017-2021 water quality data. A bolded probability (P) indicates significantly different site mean(s) within a river. Along a row and within a river, site means without a letter in common are significantly different ($P \leq 0.05$; one-way ANOVA).

Parameter	1-way ANOVA	Swan River			Driftpile River			East Prairie River			West Prairie River		South Heart River		
		upper	middle	lower	upper	middle	lower	upper	middle	lower	upper	middle	upper	middle	lower
Water Temperature	N	50	50	46	49	50	50	50	50	37	50	50	46	49	49
	median	10.9	12.6	13.4	13.7	13.4	13.6	13.6	14.7	14.5	12.4	13.6	16.0	15.2	14.7
	mean	10.0 ^a	11.8 ^{a,b}	12.9 ^b	13.0	13.0	12.9	13.0	14.4	13.3	11.2	12.6	14.3	13.8	13.8
	P	0.04			0.99			0.49			0.19		0.85		
pH	N	50	50	46	49	50	50	50	50	37	50	50	50	50	50
	median	8.10	8.05	7.90	8.04	7.99	7.91	8.17	8.05	7.89	7.96	7.95	8.02	8.05	7.92
	mean	8.08 ^{a,b}	8.17 ^b	7.90 ^a	7.87	8.01	7.88	8.15	8.07	7.97	7.97	7.98	8.13	8.11	8.05
	P	0.03			0.55			0.21			0.92		0.71		
Dissolved Oxygen	N	50	50	46	49	50	50	50	50	37	50	50	50	50	50
	median	10.17	9.91	9.14	9.79	9.81	9.17	9.74	9.54	8.98	9.59	9.66	9.72	8.64	7.97
	mean	10.48 ^a	10.04 ^{a,b}	9.50 ^b	10.15 ^a	9.90 ^{a,b}	9.45 ^b	10.09 ^a	9.76 ^{a,c}	8.88 ^b	9.78	9.82	9.89 ^a	8.94 ^b	8.05 ^c
	P	0.002			0.03			0.002			0.86		0.0000001		
Conductivity	N	49	49	45	46	50	48	49	50	37	50	50	50	50	50
	median	142	136	147	136	142	153	203	207	232	159	204	317	359	275
	mean	155	149	166	152	165	174	218	229	246	192 ^a	250 ^b	319 ^a	360 ^b	269 ^c
	P	0.40			0.86			0.43			0.03		0.00000002		
Total Phosphorus	N	49	49	45	47	50	49	49	50	37	50	50	50	50	50
	median	0.028	0.034	0.048	0.039	0.045	0.047	0.030	0.082	0.080	0.055	0.060	0.100	0.121	0.135
	mean	0.054	0.074	0.088	0.074	0.092	0.103	0.093	0.162	0.101	0.128	0.136	0.117	0.141	0.150
	P	0.48			0.71			0.14			0.84		0.08		
Total Dissolved Phosphorus	N	49	49	45	47	50	49	49	50	37	50	50	50	50	50
	median	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.022	0.023	0.055	0.045	0.038
	mean	0.012 ^a	0.014 ^{a,b}	0.016 ^b	0.018	0.023	0.018	0.017	0.025	0.023	0.023	0.029	0.069 ^a	0.056 ^{a,b}	0.044 ^b
	P	0.01			0.44			0.046			0.25		0.02		
Total Nitrogen	N	49	49	45	47	50	49	49	50	37	50	50	50	50	50
	median	0.34	0.41	0.42	0.52	0.54	0.54	0.39	0.58	0.56	0.74	0.78	1.35	1.26	1.24
	mean	0.39	0.49	0.49	0.60	0.58	0.61	0.44 ^a	0.80 ^b	0.69 ^{a,b}	0.82	0.93	1.37	1.32	1.54
	P	0.40			0.93			0.0008			0.15		0.20		
TSS	N	49	49	45	47	50	49	49	50	37	50	50	50	50	50
	median	16.8	14.4	24.6	11.4	18.8	28.2	15.6	55.2	38.1	28.9	20.3	4.5	20.6	39.0
	mean	66.2	107.7	132.6	86.1	131.0	139.6	148.0	176.4	90.3	117.9	126.4	5.2 ^a	46.5 ^b	75.6 ^{b,c}
	P	0.63			0.82			0.50			0.86		0.0001		
FCB	N	49	49	45	47	49	49	47	48	36	48	48	48	48	48
	median	20	34	31	10	20	20	14	48	50	68	69	2	20	34
	mean	36	59	65	74	29	59	32 ^a	72 ^{a,b}	78 ^b	106	104	6 ^a	40 ^{a,b}	99 ^b
	P	0.34			0.59			0.01			0.92		0.003		

Table 17. Water quality trend analysis for Swan River, 2017-2021.

Indicator	Statistic	Swan River (lower) ^a						Trend	Swan River (middle) ^b						Trend
		2012-13	2017	2018	2019	2020	2021		1991-92	2017	2018	2019	2020	2021	
		N=11	N=9	N=9	N=9	N=8	N=10		N=11	N=9	N=10	N=10	N=10	N=10	
Temperature, °C	Median	14.5	13.6	17.5	13.5	11.6	13.0	↘	15.6	12.8	14.9	11.30	11.7	12.6	–
	Min	2.5	2.7	4.9	3.7	3.6	2.5	–	0.8	1.4	3.9	2.80	4.3	0.8	NT
	Max	22.6	17.5	20.5	19.7	22.5	23.4	NT	20.0	17.4	20.6	16.90	21.3	23.1	NT
pH, Value	Median	7.87	7.96	7.85	8.34	7.88	7.74	–	7.30	8.14	7.95	8.35	7.84	8.05	NT
Dissolved Oxygen, mg/L	Median	9.60	8.90	8.49	9.45	9.79	9.29	NT	8.60	9.70	9.45	10.33	9.99	9.72	NT
	Min	7.80	8.51	7.08	8.13	7.97	7.32	–	8.16	8.72	7.38	8.75	8.33	7.75	–
	Max	12.18	11.60	11.56	11.52	12.40	12.31	NT	12.89	11.20	11.73	12.18	12.22	12.82	NT
Specific Conductivity, µS/cm	Median	136	111	186	138	152	204	↗	168	119	168	121	135	195	NT
Total Phosphorus, mg/L	Median	0.060	0.050	0.048	0.044	0.050	0.040	↓	0.048	0.034	0.039	0.035	0.053	0.030	–
	Min	0.031	0.029	0.034	0.027	0.025	0.026	↘	0.026	0.010	0.029	0.010	0.010	0.010	–
	Max	0.084	1.060	0.170	0.172	0.227	0.084	NT	0.173	0.410	0.940	0.137	0.172	0.065	NT
Total Dissolved Phosphorus, mg/L	Median	0.012	0.010	0.023	0.010	0.010	0.010	–	0.015	0.010	0.016	0.010	0.010	0.010	–
	Min	0.009	0.010	0.010	0.010	0.010	0.010	NT	0.010	0.010	0.010	0.010	0.010	0.010	–
	Max	0.023	0.028	0.035	0.028	0.025	0.030	NT	0.016	0.026	0.030	0.027	0.025	0.029	NT
Total Nitrogen, mg/L	Median	0.518	0.400	0.410	0.500	0.490	0.280	–	0.431	0.270	0.395	0.550	0.600	0.27	NT
	Min	0.201	0.100	0.100	0.400	0.100	0.100	NT	0.275	0.100	0.100	0.260	0.200	0.10	–
	Max	2.110	3.430	0.790	1.140	1.020	0.920	–	0.832	1.570	1.370	1.150	0.860	0.85	–
Nitrate+Nitrite Nitrogen, mg/L	Median	0.012	0.011	0.011	0.011	0.011	0.011	–	0.002	0.011	0.011	0.011	0.011	0.011	NT
	Min	0.003	0.011	0.003	0.011	0.011	0.011	NT	0.001	0.011	0.003	0.011	0.011	0.011	NT
	Max	0.093	0.045	0.041	0.028	0.091	0.109	NT	0.032	0.044	0.040	0.067	0.084	0.099	↑
Total Suspended Solids, mg/L	Median	–	31	16	36	28	23.2	–	21	12	11	22	43	7.9	–
	Min	–	3	7	4	2	5.8	–	4	2	5	2	2	1.5	–
	Max	–	3060	257	271	342	267	NT	187	1,030	2,110	196	354	74.8	NT
Fecal Coliform Bacteria, cfu/100 mL	Median	–	110	20	42	43	24	–	60	46	31	32	45	10	↘
	Min	–	5	7	8	10	2	NT	20	5	9	1	10	4	–
	Max	–	870	65	64	90	100	NT	200	250	620	64	210	120	–
^a Lower site data from 2017-2021 is comparable to 2012-13 historic data. ^b Middle site data from 2017-2021 is comparable to 1991-92 historic data. Trends (Mann-Kendall): ↑ Degrading trend, ↗ probably degrading trend (increasing concentration with exception of dissolved oxygen where an increase in concentration represents an improving trend); ↓ Improving trend, ↘ probably improving trend (decreasing concentration with the exception of dissolved oxygen where a decrease in concentration represents a degrading trend); – Stable trend; NT No Trend															

Total Phosphorus In all years, except 2020, total phosphorus concentrations tended to increase from the upper to lower Swan River sites (Figure 10). However, there were no significant differences in mean total phosphorus between the upper, middle and lower site for the period 2017 to 2021 (one-way ANOVA; $P > 0.05$) (Table 16). There was a generally a strong, positive linear relationship between total phosphorus and total suspended solids at the Swan River from 2017-2021 (median Pearson's correlation: $r = 0.96$; range: $r = 0.32$ to 0.99).

At the lower Swan River site, the median TP concentration was 0.048 mg/L (range: 0.040 to 0.050 mg/L) for the period 2017 to 2021, which was lower than the historic 2012-13 median (0.060 mg/L, Table 3 and 9). At the lower Swan River site, a 'probably decreasing' trend was detected for minimum TP concentration and a 'decreasing' trend was detected for median TP concentration (Table 17). The maximum TP concentration at the lower Swan River site (2017 to 2021) was 1.060 mg/L (range: 0.084 to 1.060 mg/L) which was higher than the historic maximum TP recorded in 2012-13 (0.084 mg/L); however, 'no trend' was detected.

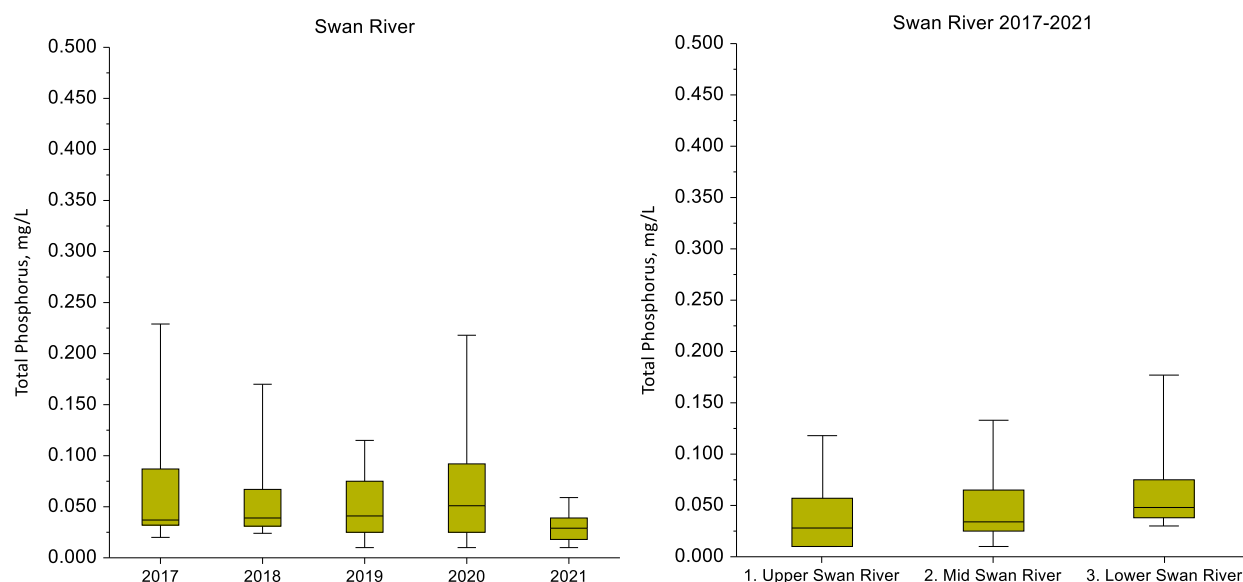


Figure 10. Total phosphorus by year with all sites combined (a), and by site (b) for the 2017-2021 monitoring period.

At the middle Swan River site, the median TP concentration was 0.034 mg/L (median range: 0.030 to 0.053 mg/L) for the period 2017 to 2021, which was lower compared to the historic⁴ 1991-92 median (0.048 mg/L, Table 3 and 9). A 'stable' trend in minimum and median TP concentration was detected. The maximum TP concentration at the middle Swan River site (2017 to 2021) was 0.940 mg/L (range: 0.065 to 0.940 mg/L), which was slightly lower compared to the historic 1991-92 maximum TP (0.173 mg/L). 'No trend' was detected in maximum TP concentration (Table 17).

There was a significant difference in mean **total dissolved phosphorus** concentration between the upper (0.012 mg/L) and lower (0.016 mg/L) sites for the period 2017-2021 (one-way ANOVA; $P \leq 0.05$) (Table 16). A 'stable' trend in TDP was detected in minimum TDP concentration and the lower and

⁴ For the Swan River, samples were collected at Hwy 2 near Kinuso (AB07BJ0010) in 1991-92, corresponding to the middle Swan River site from 2017 to 2021. In 2012-13, samples were collected near the confluence with Lesser Slave Lake (AB07BHJ0020), corresponding to the lower Swan River site from 2017 to 2021.

middle Swan River sites, as well as in the median TDP concentration at the middle Swan River site. 'No trend' was detected in the median TDP concentration at the lower Swan River site, or in the maximum TDP concentration at both sites (Table 17).

Total Nitrogen There were no significant differences in mean total nitrogen between the upper, middle and lower site for the period 2017 to 2021 (one-way ANOVA; $P>0.05$) (Table 16).

At the lower Swan River site, the median TN concentration was 0.420 mg/L (median range: 0.280 to 0.500 mg/L) from 2017 to 2021, and was lower than the historic 2012-13 median (0.518 mg/L, Table 3 and 13). The maximum TN concentration at the same site (3.430 mg/L) (maximum range: 0.790 to 3.430 mg/L), was higher compared to the historic 2012-13 maximum (2.110 mg/L, Table 3 and 13). A 'stable' trend in median and maximum TN concentration was detected at the lower Swan River site, and 'no trend' was detected in the minimum TN concentration (Table 17).

At the middle Swan River site, the median TN concentration was 0.410 mg/L (median range: 0.270 to 0.600 mg/L) from 2017 to 2021, which was similar to the historic 1991-92 median (0.431 mg/L, Table 3 and 13). The maximum TN concentration at the same site (1.570 mg/L) (maximum range: 0.85 to 1.570 mg/L) was higher than the 1991-92 maximum TN (0.832 mg/L). A 'stable' trend was detected in minimum and maximum TN concentration at the middle Swan River site, and 'no trend' was detected in median TN concentration (Table 17).

At the lower Swan River site, a 'stable' trend was detected in median **nitrate+nitrite N** concentration, and 'no trend' was detected in minimum and maximum concentrations. At the middle Swan River site, 'no trend' in median and minimum nitrate+nitrite N concentration, and an 'increasing' trend in maximum concentration was detected (Table 17).

Total Suspended Solids Although maximum TSS concentrations tended to increase from the upper to lower site (Figure 11), there were no significant differences in mean total suspended solids concentrations between the upper, middle and lower site for the period 2017 to 2021 (one-way ANOVA; $P>0.05$) (Table 16).

At the lower Swan River site, the median TSS concentration was 24.6 mg/L (median range: 16 to 36 mg/L) from 2017 to 2021. No historic TSS concentration is available for comparison at this site. The maximum TSS concentration was 3,060 mg/L (maximum range: 257 to 3,060 mg/L) from 2017 to 2021. A 'stable' trend was detected in median and minimum TSS concentrations at the lower Swan River site, and 'no trend' was detected in maximum concentration (Table 17).

At the middle Swan River site, the median TSS concentration was 14.4 mg/L (median range: 7.9 to 43 mg/L) from 2017 to 2021, which was slightly lower compared to the historic 1991-92 median (21 mg/L, Table 3). The maximum TSS concentration (2,110 mg/L) (maximum range: 74.8 to 2,110 mg/L) from 2017 to 2021 was higher compared to the 1991-92 TSS maximum (187 mg/L). A 'stable' trend was detected in median and minimum TSS concentrations at the middle Swan River site, and 'no trend' was detected in the maximum concentration (Table 17).

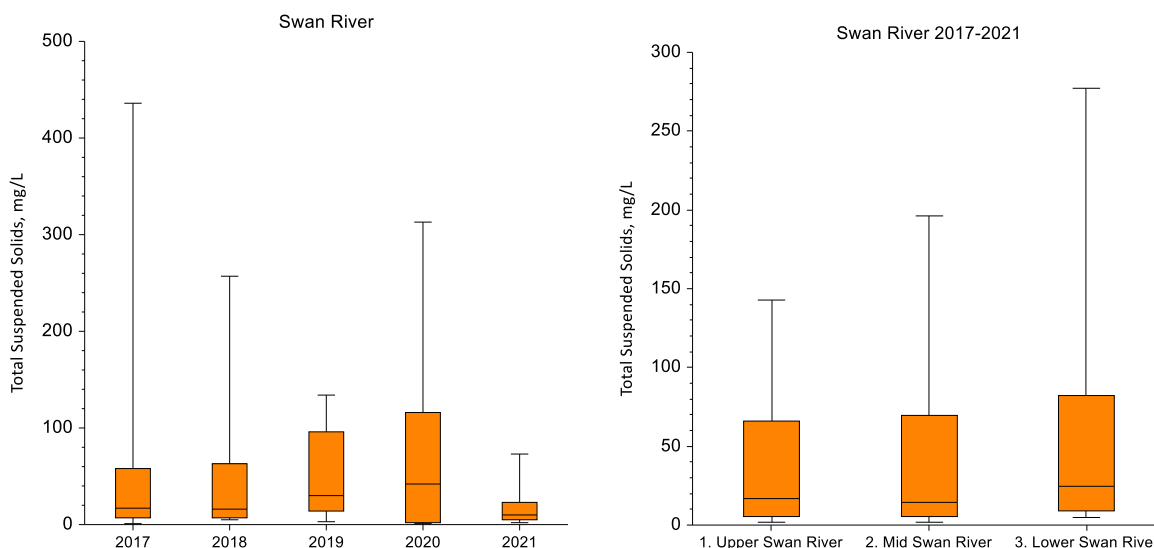


Figure 11. Total suspended solids by year with all sites combined (a), and by site (b) for the 2017-2021 monitoring period.

Fecal Coliform Bacteria There were no significant differences in mean fecal coliform bacteria counts between the upper, middle and lower site for the period 2017 to 2021 (one-way ANOVA; $P > 0.05$) (Table 16).

At the lower Swan River site, the median FCB count was 31 cfu/100 mL (median range: 20 to 110 cfu/100 mL) from 2017 to 2021. A 'stable' trend in median FCB count was detected at the lower Swan River site, and 'no trend' in minimum or maximum counts was detected (Table 17). Four of 45 samples (9%) exceeded the irrigation guideline (≤ 100 cfu/100 mL) from 2017 to 2021 at the lower site.

At the middle Swan River site, the median FCB count was 34 cfu/100 mL (median range: 10 to 46 cfu/100 mL) from 2017 to 2021 and was less than the historic 1991-92 median (60 cfu/100 mL; Table 3). Maximum FCB counts 620 cfu/100 mL (maximum range: 64 to 620 cfu/100 mL) from 2017 to 2021 was higher compared to 1991-92 data (200 cfu/100 mL; Table 3 and 15). A 'probably decreasing' trend was detected for median FCB counts at the middle Swan River, and 'stable' trends detected for minimum and maximum counts (Table 17). Seven of 49 samples (14%) exceeded the irrigation guideline (≤ 100 cfu/100 mL) from 2017 to 2021 at the middle site.

5.2 Driftpile River

Water Temperature Water temperature generally met the objective of $\leq 22^{\circ}\text{C}$ at all sites. From 2017 to 2021, 2 of 50 samples (4%) at the middle and lower Driftpile River did not meet the water temperature objective, and 2 of 49 samples (4%) did not meet the objective at the upper site. There were no significant differences in mean water temperature between the upper, middle and lower sites for the period 2017 to 2021 (one-way ANOVA; $P > 0.05$) (Table 16).

pH Minimum and maximum pH values nearly always met provincial guidelines for the protection of aquatic life (6.5 to 9.0); 1 of 49 samples (2%) exceeded the maximum pH guideline at middle Driftpile River (9.67). There were no significant differences in mean pH between the upper, middle and lower

sites for the period 2017 to 2021 (one-way ANOVA; $P > 0.05$) (Table 16). 'No trend' was detected for pH at the middle Driftpile River and the lower Driftpile River had pH that was 'stable' (Table 18).

Dissolved Oxygen Dissolved oxygen concentrations always met the provincial guideline for the protection of aquatic life (chronic: > 6.5 mg/L; acute: > 5.0 mg/L) at the three Driftpile River sites from 2017 to 2021. There was a significant difference in mean dissolved oxygen concentration between the upper (10.15 mg/L) and lower (9.45 mg/L) sites for the period 2017 to 2021 (one-way ANOVA; $P \leq 0.05$) (Table 16). A 'stable' trend in median dissolved oxygen concentration was detected at the lower Driftpile River site, and 'no trend' detected in minimum or maximum dissolved oxygen concentrations. At the middle Driftpile site, 'no trends' were detected in either the median, minimum or maximum concentrations (Table 18).

Conductivity Conductivity values were always well below the irrigation guideline ($\leq 1,000$ $\mu\text{S}/\text{cm}$) at the three Driftpile River sites from 2017 to 2021. There were no significant differences in mean conductivity between the upper, middle and lower sites for the period 2017 to 2021 (one-way ANOVA; $P > 0.05$) (Table 16). 'No trend' was detected for conductivity at the middle Driftpile River and the lower Driftpile River had conductivity that was 'probably increasing' (Table 18).

Total Phosphorus Total phosphorus concentrations tended to increase from the upper Driftpile River site to the lower Driftpile River site (Figure 12); however, there were no significant differences in mean total phosphorus concentration between the upper, middle and lower sites for the period 2017 to 2021 (one-way ANOVA; $P > 0.05$) (Table 16). There was a strong, positive linear relationship between total phosphorus and total suspended solids at the Driftpile River from 2017-2021 (median Pearson's correlation: $r = 0.82$; range: $r = 0.81$ to 0.97).

At the lower Driftpile River site, the median TP concentration was 0.047 mg/L (median range: 0.040 to 0.078 mg/L) from 2017 to 2021, and was less than the historical⁵ 2012-13 median (0.051 mg/L, Table 3 and 9). The maximum TP concentration at the same site was 1.280 mg/L (maximum range: 0.104 to 1.280 mg/L), which was higher than the historical TP maximum 2012-13 (0.873 mg/L). A 'stable' trend in median and maximum TP concentrations was detected at the lower Driftpile site, and 'no trend' was detected for minimum TP concentrations (Table 18).

There were no significant differences in mean **total dissolved phosphorus** between the upper, middle and lower sites for the period 2017 to 2021 (one-way ANOVA; $P > 0.05$) (Table 16). A 'stable' trend was detected for median total dissolved phosphorus concentration at the lower Driftpile River, as well as a 'probably increasing' trend in minimum TDP concentration and 'no trend' in maximum TDP concentration (Table 18).

⁵ For the Driftpile River, samples were collected at Hwy 2 (AB07BH0010) in 1991-92, corresponding to middle Driftpile River site from 2017 to 2021. In 2012-13, samples were collected at the Driftpile River near the confluence with Lesser Slave Lake (AB07BH0020), corresponding to the lower Driftpile River site from 2017 to 2021.

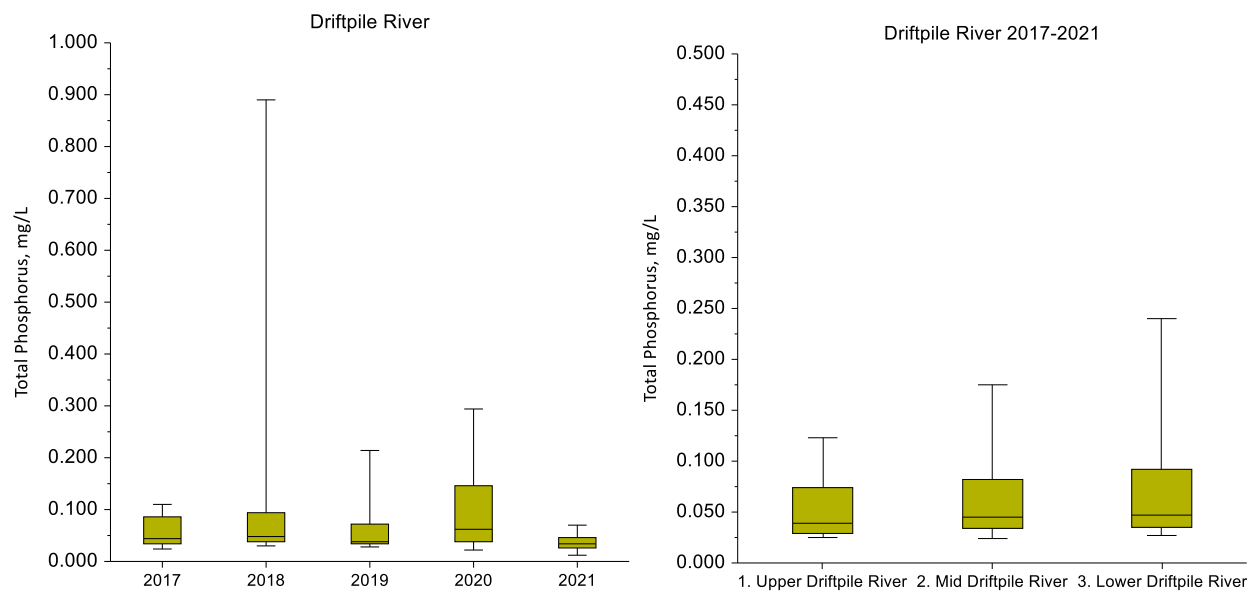


Figure 12. Total phosphorus by year with all sites combined (a), and by site (b) for the 2017-2021 monitoring period, Driftpile River.

At the middle Driftpile River site, the median TP concentration was 0.045 mg/L (median range: 0.030 to 0.062 mg/L) from 2017 to 2021, and was similar to the historical 1991-92 median (0.040 mg/L, Table 3 and 9). The maximum TP concentration was 1.290 mg/L (maximum range: 0.077 to 1.290 mg/L) from 2017 to 2021 and was slightly higher than the historical 1991-92 maximum (0.129 mg/L). A 'stable' trend in median and minimum TP concentration was detected at the middle Driftpile site, and 'no trend' was detected in maximum concentration (Table 18).

At the middle Driftpile site, a 'stable' trend in median **total dissolved phosphorus** concentration was detected, as well as 'no trend' in minimum TDP was detected, and an 'increasing' trend in maximum TDP concentrations (Table 18).

Total Nitrogen There were no significant differences in mean total nitrogen between the upper, middle and lower sites for the period 2017 to 2021 (one-way ANOVA; $P > 0.05$) (Table 16). The median TN concentration at lower Driftpile River site was 0.540 mg/L (median range: 0.43 to 0.645 mg/L) from 2017 to 2021 and was similar to the historic⁶ 2012-13 median (0.546 mg/L, Table 3 and 13). The maximum TN concentration was 1.970 mg/L (maximum range: 0.98 to 1.970 mg/L) from 2017 to 2021, which was considerably lower than the historic maximum TN in 2012-13 (7.878 mg/L). A 'stable' trend in median and minimum TN concentration was detected at the lower Driftpile site, and 'no trend' was detected in maximum concentration (Table 18).

⁶ For the Driftpile River, samples were collected at Hwy 2 (AB07BH0010) in 1991-92, corresponding to the middle Driftpile River site from 2017 to 2021. In 2012-13, samples were collected near the confluence with Lesser Slave Lake (AB07BH0020), corresponding to the lower Driftpile River site from 2017 to 2021.

Table 18. Water quality trend analysis at the middle Driftpile River and lower Driftpile River, 2017-2021.

Indicator	Statistic	Driftpile River (lower) ^a						Trend	Driftpile River (middle) ^b						Trend
		2012-13	2017 ^c	2018	2019	2020	2021		1991-92	2017	2018	2019	2020	2021	
		N=12	N=9	N=10	N=10	N=10	N=10		N=11	N=10	N=9	N=10	N=10	N=10	
Temperature, °C	Median	13.9	15.1	15.6	12.0	12.7	13.8	–	16.2	14.3	16.0	11.95	12.9	13.7	–
	Min	1.6	3.6	4.7	3.0	3.1	2.1	–	0.7	2.9	4.7	2.30	4.2	2.0	NT
	Max	23.1	16.7	20.4	20.8	22.9	23.8	NT	21.7	17.4	21.5	20.80	22.7	25.9	NT
pH, value	Median	8.00	8.00	7.65	8.26	7.87	7.80	–	7.40	8.15	8.03	8.22	7.74	7.87	NT
Dissolved Oxygen, mg/L	Median	9.72	8.90	8.73	9.77	9.38	9.28	–	9.00	10.01	9.25	10.18	9.68	9.49	NT
	Min	7.54	8.10	6.88	7.83	7.70	7.77	NT	8.00	8.80	7.50	8.19	8.11	8.36	NT
	Max	15.32	11.40	11.52	11.74	12.34	11.95	NT	13.8	11.60	11.70	12.38	12.54	11.99	NT
Specific Conductivity, µS/cm	Median	127	120	194	148	155	209	↗	149	113	183	143	132	203	NT
Total Phosphorus, mg/L	Median	0.051	0.045	0.046	0.043	0.078	0.040	–	0.040	0.053	0.051	0.040	0.062	0.030	–
	Min	0.020	0.024	0.031	0.030	0.010	0.027	NT	0.022	0.020	0.030	0.027	0.010	0.010	–
	Max	0.873	0.108	1.280	0.305	0.357	0.104	–	0.129	0.118	1.290	0.217	0.345	0.077	NT
Total Dissolved Phosphorus, mg/L	Median	0.012	0.010	0.025	0.016	0.016	0.010	–	0.016	0.010	0.025	0.010	0.017	0.010	–
	Min	0.005	0.010	0.010	0.010	0.010	0.027	↗	0.007	0.010	0.010	0.010	0.010	0.010	NT
	Max	0.025	0.041	0.033	0.026	0.034	0.037	NT	0.021	0.028	0.035	0.029	0.031	0.036	↑
Total Nitrogen, mg/L	Median	0.546	0.450	0.520	0.545	0.645	0.43	–	0.482	0.455	0.685	0.500	0.610	0.35	–
	Min	0.262	0.100	0.240	0.100	0.100	0.10	–	0.281	0.100	0.220	0.100	0.100	0.10	–
	Max	7.878	1.120	1.290	1.460	1.970	0.98	NT	0.976	1.030	1.130	1.710	1.670	0.99	NT
Nitrate+Nitrite Nitrogen, mg/L	Median	0.006	0.011	0.011	0.011	0.011	0.011	NT	0.003	0.011	0.011	0.011	0.011	0.011	NT
	Min	0.003	0.011	0.011	0.011	0.011	0.011	NT	0.001	0.011	0.011	0.011	0.011	0.011	NT
	Max	0.148	0.198	0.025	0.062	0.059	0.173	–	0.026	0.027	0.031	0.049	0.059	0.143	↑
Total Suspended Solids, mg/L	Median	-	37	16	28	60	19.8	–	14	39	18	19	47	12.0	NT
	Min	-	5	4	7	2	1.5	–	2	2	6	2	2	3.0	NT
	Max	-	136	3,380	551	259	106	NT	128	153	3,570	315	504	78.2	NT
Fecal Coliform Bacteria, cfu/100 mL	Median	-	71	15	15	31	7	–	15	20	16	10	39	16	–
	Min	-	3	1	1	5	1	–	2	3	1	1	8	1	NT
	Max	-	210	1,100	90	110	44	NT	200	200	220	52	200	32	–

^aLower site data from 2017-2021 is comparable 2012-13 historic data. ^bMiddle site data from 2017-2021 is comparable to 1991-92 historic data.
Trends (Mann-Kendall): ↑ Degrading trend, ↗ probably degrading trend (increasing concentration with exception of dissolved oxygen where an increase in concentration represents an improving trend); ↓ Improving trend, ↘ probably improving trend (decreasing concentration with the exception of dissolved oxygen where a decrease in concentration represents a degrading trend); – Stable trend; NT No Trend

At the middle Driftpile River site, the median TN concentration was 0.540 mg/L (median range: 0.35 to 0.685 mg/L) from 2017 to 2021, which was slightly higher compared to the historic 1991-92 median (0.482 mg/L, Table 3 and 13). The maximum TN concentration was 1.710 mg/L (maximum range: 0.99 to 1.710 mg/L) from 2017 to 2021, which was higher compared to the historic 1991-92 maximum TN (0.976 mg/L). Similar to the lower Driftpile site, a 'stable' trend in median and minimum TN concentration was detected at the lower Driftpile site, and 'no trend' was detected in maximum concentration (Table 18).

At the lower Driftpile site, 'no trend' in median or minimum nitrate+nitrite N concentration, and a 'stable' trend in maximum concentration was detected (Table 18). At the middle Driftpile River site, 'no trend' in the median or minimum nitrate+nitrite N concentration, and an 'increasing' trend in maximum concentration was detected (Table 18).

Total Suspended Solids Total suspended solids concentration tended to increase from the upper Driftpile River site to the lower Driftpile River site (Figure 13); however, there were no significant differences in mean total suspended solids between the upper, middle and lower sites for the period 2017 to 2021 (one-way ANOVA; $P > 0.05$) (Table 16).

At the lower Driftpile River site, the median TSS concentration was 28 mg/L and the maximum concentration was 3,380 mg/L from 2017 to 2021. There are no historic values available to compare the current median and maximum values. 'Stable' trends were detected in the median and minimum TSS concentrations, an 'no trend' was detected for the maximum concentration (Table 18).

At the middle Driftpile River site, the median TSS concentration was 19 mg/L (median range: 12.0 to 47 mg/L) from 2017 to 2021, which was slightly higher compared to the 1991-92 median (14 mg/L, Table 3). The maximum TSS concentration was 3,570 mg/L at the middle Driftpile River site (maximum range: 78.2 to 3,570 mg/L) from 2017 to 2021, which was substantially higher compared to the 1991-92 maximum (128 mg/L). 'No trends' were detected for the median, minimum or maximum TSS concentrations at the middle Driftpile River site (Table 18).

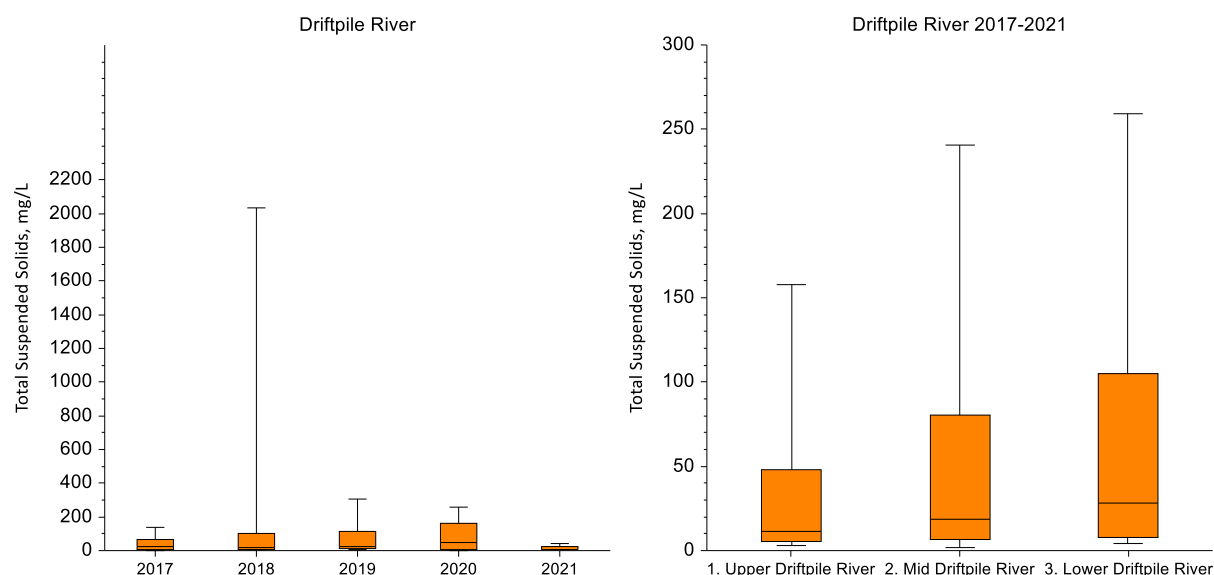


Figure 13. Total phosphorus by year with all sites combined (a), and by site (b) for the 2017-2021 monitoring period, Driftpile River.

Fecal Coliform Bacteria There were no significant differences in mean fecal coliform counts between the upper, middle and lower sites for the period 2017 to 2021 (one-way ANOVA; $P > 0.05$) (Table 16).

The median FCB count at the upper Driftpile River site was 10 cfu/100 mL (median range: 9 to 20 cfu/100 mL). Three of 47 samples (6%) exceeded the irrigation guideline (≤ 100 cfu/100 mL), 2017 to 2021.

The median FCB count at the middle Driftpile River site was 20 cfu/100 mL (median range: 10 to 39 cfu/100 mL) from 2017 to 2021, which was higher compared to the 1991-92 median (15 cfu/100 mL, Table 3). The maximum FCB count was 220 cfu/100 mL (maximum range: 32 to 220 cfu/100 mL) from 2017 to 2021, which was the same as the 1991-92 maximum (200 cfu/100 mL) (Table 3 and 15). Two of 50 samples (4%) exceeded the irrigation guideline (≤ 100 cfu/100 mL), 2017 to 2021.

At the lower Driftpile River site, the median FCB count was 20 cfu/100 mL (median range: 7 to 71 cfu/100 mL) from 2017 to 2021. A 'stable' trend in median and minimum FCB counts, and 'no trend' in maximum count was detected at the lower Driftpile River (Table 18). Six of 49 samples (12%) exceeded the irrigation guideline (≤ 100 cfu/100 mL) from 2017 to 2021 at the lower site.

5.3 East Prairie River

Water Temperature Water temperature generally met the objective of $\leq 22^{\circ}\text{C}$ at all sites. From 2017 to 2021, 2 of 50 samples (4%) at the upper East Prairie River site did not meet the water temperature objective, 5 of 50 samples (10%) did not meet the objective at the middle site, and 1 of 37 samples (3%) did not meet the objective at the lower site. There was no significant difference in mean water temperature between sites for the period 2017-2021 (one-way ANOVA; $P > 0.05$) (Table 16).

pH Minimum and maximum pH generally met provincial guidelines for the protection of aquatic life (6.5 to 9.0); 3 of 50 samples (6%) exceeded the pH guideline at the upper East Prairie site, 1 of 50 samples (2%) exceeded the maximum guideline at the middle site, and 2 of 37 samples (5%) exceeded the maximum guideline at the lower site. There was no significant difference in mean pH between sites for the period 2017-2021 (one-way ANOVA; $P > 0.05$) (Table 16). The pH at the East Prairie River was 'stable' (Table 19).

Dissolved Oxygen Dissolved oxygen concentrations nearly always met the protection of aquatic life guidelines (chronic: ≥ 6.5 mg/L; acute: ≥ 5.0 mg/L); 1 of 37 samples (3%) did not meet the acute guideline at the lower East Prairie River (4.61 mg/L), and 5 of 37 samples (15%) did not meet the chronic guideline. There were significant differences in mean dissolved oxygen between the upper (10.09 mg/L) and lower (8.88 mg/L) sites, and between the middle (9.76 mg/L) and lower (8.88 mg/L) sites from 2017 to 2021 (one-way ANOVA; $P > 0.05$) (Table 16). Median and minimum DO concentration was 'stable' and the maximum DO concentration showed 'no trend' at the East Prairie River (Table 19).

Conductivity Conductivity values were always well below the irrigation guideline ($\leq 1,000$ $\mu\text{S}/\text{cm}$) at the three East Prairie River sites from 2017 to 2021. There was no significant difference in mean conductivity between sites for the period 2017-2021 (one-way ANOVA; $P > 0.05$) (Table 16). There was 'no trend' for conductivity at the East Prairie River (Table 19).

Total Phosphorus Total phosphorus tended to increase from the upper East Prairie site to the middle East Prairie site (Figure 14). There was no significant difference in mean total phosphorus between sites for the period 2017-2021 (one-way ANOVA; $P > 0.05$) (Table 16). There was a strong, positive linear relationship between total phosphorus and total suspended solids at the East Prairie River from 2017-2021 (median Pearson's correlation: $r = 0.94$; range: $r = 0.87$ to 0.97).

At the upper East Prairie site, the median TP concentration was 0.030 mg/L (median range: 0.010 to 0.059 mg/L) from 2017 to 2021. Maximum TP concentration was 1.590 mg/L (maximum range: 0.079 to 1.590 mg/L).

At the middle East Prairie site, the median TP concentration was 0.082 mg/L (median range: 0.060 to 0.271 mg/L) from 2017 to 2021, which was somewhat higher compared to the historic median⁷ (2012-13: 0.076 mg/L, Table 3 and 9). The maximum TP concentration was 0.983 mg/L (maximum range: 0.241 to 0.983 mg/L) from 2017 to 2021, and was lower compared to the historic 2012-13 maximum (1.120 mg/L). 'No trend' was detected in median TP concentration, and a 'stable' trend was detected in the minimum and maximum TP concentration at the middle East Prairie site (Table 19).

At the lower East Prairie site, the median TP concentration was 0.080 mg/L (median range: 0.071 to 0.125 mg/L) from 2017 to 2021. The maximum TP concentration was 0.413 mg/L (maximum range: 0.129 to 0.413 mg/L), which was substantially less compared to the middle East Prairie site (0.983 mg/L).

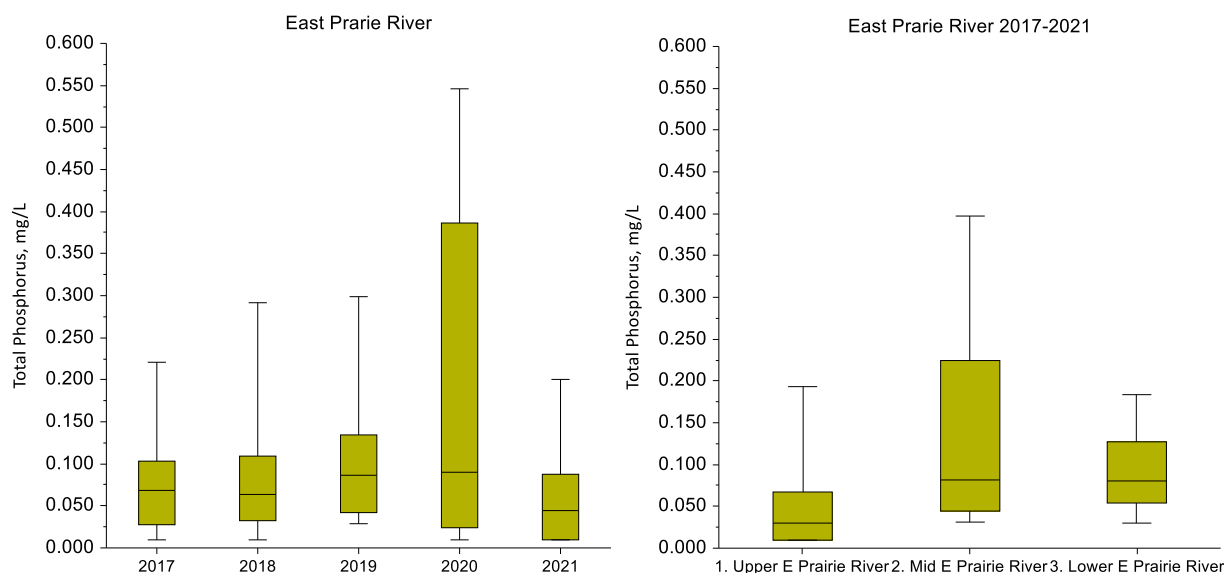


Figure 14. Total phosphorus by year with all sites combined (a), and by site (b) for the 2017-2021 monitoring period, East Prairie River.

There was no significant difference in mean **total dissolved phosphorus** between East Prairie River sites for the period 2017-2021 (one-way ANOVA; $P > 0.05$) (Table 16). A 'stable' trend in median TDP concentration, and 'no trend' in minimum and maximum concentrations were detected at the middle site (Table 19).

⁷ For the East Prairie River, samples were collected at Hwy 2 (AB07BF0285) in 2012-13, corresponding to the middle East Prairie River site from 2017 to 2021.

Table 19. Water quality trend analysis for the East Prairie and West Prairie rivers, 2017-2021.

Indicator	Statistic	East Prairie River (middle) ^a						Trend	West Prairie River (middle) ^a						Trend
		2012-13	2017	2018	2019	2020	2021		2012-13	2017	2018	2019	2020	2021	
		N=12	N=10	N=10	N=10	N=10	N=10		N=12	N=10	N=10	N=10	N=10	N=10	
Temperature, °C	Median	13.4	17.2	16.1	12.6	13.8	14.7	–	12.8	14.3	14.6	12.1	13.1	13.0	–
	Min	1.3	4	4.1	3.6	4.4	3.5	NT	3.3	2.2	3.7	1.8	4.1	2.1	–
	Max	22.6	21.8	23.6	21.5	24.4	25.9	NT	21.7	20.3	21.4	18.4	21.4	20.9	–
pH, value	Median	8.30	7.98	8.12	8.42	7.89	8.03	–	8.03	7.87	7.99	8.45	7.93	7.97	–
Dissolved Oxygen, mg/L	Median	9.62	9.83	8.98	9.78	9.48	9.66	–	9.95	10.20	9.12	9.85	9.35	9.71	–
	Min	7.94	8.20	7.20	8.08	7.67	8.02	–	8.23	8.40	7.46	8.37	8.15	8.16	–
	Max	16.04	11.69	11.94	12.32	12.80	13.13	NT	13.85	11.00	11.62	12.37	12.52	12.42	NT
Specific Conductivity, µS/cm	Median	177	186	250	191	186	264	NT	187	188	243	184	224	213	NT
Total Phosphorus, mg/L	Median	0.076	0.086	0.076	0.090	0.271	0.060	NT	0.053	0.055	0.065	0.061	0.110	0.050	NT
	Min	0.028	0.010	0.032	0.043	0.021	0.010	–	0.028	0.030	0.024	0.023	0.025	0.010	↗
	Max	1.120	0.241	0.480	0.983	0.604	0.293	–	1.150	0.362	0.333	1.050	0.504	0.282	–
Total Dissolved Phosphorus, mg/L	Median	0.013	0.010	0.024	0.016	0.010	0.010	–	0.018	0.022	0.028	0.022	0.016	0.015	–
	Min	0.004	0.010	0.010	0.010	0.010	0.010	NT	0.006	0.010	0.010	0.010	0.010	0.010	NT
	Max	0.032	0.067	0.054	0.264	0.064	0.038	NT	0.033	0.132	0.066	0.390	0.248	0.051	NT
Total Nitrogen, mg/L	Median	0.565	0.485	0.555	0.565	1.105	0.54	NT	0.859	0.805	0.725	0.655	1.215	0.78	–
	Min	0.249	0.100	0.280	0.100	0.450	0.31	NT	0.411	0.560	0.360	0.300	0.450	0.30	–
	Max	2.972	1.730	1.160	3.290	2.000	1.61	–	3.786	1.930	1.550	1.920	1.560	1.84	–
Nitrate+Nitrite Nitrogen, mg/L	Median	0.009	0.011	0.011	0.011	0.011	0.011	NT	0.009	0.011	0.011	0.011	0.011	0.011	NT
	Min	0.003	0.011	0.011	0.011	0.011	0.011	NT	0.003	0.011	0.011	0.011	0.011	0.011	NT
	Max	0.152	0.075	0.075	0.340	0.115	0.273	NT	0.086	0.040	0.035	0.062	0.045	0.227	NT
Total Suspended Solids, mg/L	Median	-	83	37	85	177	34.8	–	-	18	17	38	98	16.0	–
	Min	12	2	5	7	2	3.8	–	6	2	6	4	6	1.5	–
	Max	1,150	445	576	1,410	971	419	–	1,170	451	440	1,280	735	385	–
Fecal Coliform Bacteria, cfu/100 mL	Median	-	45	43	38	64	62	NT	-	145	98	66	64	39	↘
	Min	-	5	7	17	10	13	NT	-	20	11	17	10	27	–
	Max	-	200	110	210	120	260	NT	-	330	330	810	130	150	–

^aMiddle site data from 2017-2021 is comparable to 2012-13 historic data. **Trends (Mann-Kendall):** ↑ Degrading trend, ↗ probably degrading trend (increasing concentration with exception of dissolved oxygen where an increase in concentration represents an improving trend); ↘ Improving trend, ↖ probably improving trend (decreasing concentration with the exception of dissolved oxygen where a decrease in concentration represents a degrading trend); – Stable trend; NT No Trend

Total Nitrogen There was a significant difference in mean total nitrogen concentrations between the upper (0.44 mg/L) and lower (0.80 mg/L) sites for the period 2017-2021 (one-way ANOVA; $P \leq 0.05$) (Table 16).

At the upper East Prairie site, the median TN concentration was 0.390 mg/L (median range: 0.100 to 0.580 mg/L) from 2017 to 2021. Maximum TN concentration was 1.100 mg/L (maximum range: 0.830 to 1.100 mg/L).

The median TN concentrations at middle East Prairie was 0.580 mg/L (median range: 0.485 to 1.105 mg/L) from 2017 to 2021, and was similar to the historic median⁸ (2012-13: 0.565 mg/L, Table 3 and 13). The maximum TN concentration was 3.290 mg/L (maximum range: 1.160 to 3.290 mg/L) from 2017 to 2021, and was higher compared to the historic 2012-13 median (2.972 mg/L). 'No trend' was detected for median, minimum and maximum TN concentrations at the middle East Prairie River site (Table 19).

At the lower East Prairie site, the median TN concentration was 0.560 mg/L (median range: 0.500 to 0.765 mg/L) from 2017 to 2021. The maximum TN concentration was 1.800 mg/L (maximum range: 1.310 to 1.800 mg/L).

Total Suspended Solids There was no significant difference in mean TSS concentration between sites for the period 2017-2021 (one-way ANOVA; $P > 0.05$) (Table 16; Figure 15).

At the upper East Prairie site, the median TSS concentration was 16 mg/L (median range: 9 to 55 mg/L) from 2017 to 2021. Maximum TSS concentration was 3,200 mg/L (maximum range: 114 to 3,200 mg/L).

At the middle East Prairie River site, the median TSS concentration was 55 mg/L. The minimum TSS concentrations was 2 mg/L (minimum range: 2 to 7 mg/L) from 2017 to 2021, which was lower compared to the historic⁹ 2012-13 minimum (12 mg/L, Table 3). The maximum TSS concentrations at the middle East Prairie River site was 1,410 mg/L (maximum range: 419 to 1,410 mg/L) from 2017 to 2021, which was higher compared to the historic 2012-13 maximum (1,150 mg/L) (Table 3, Table 14). A 'stable' trend was detected for median, minimum and maximum TSS concentrations at the middle East Prairie River site (Table 19).

At the lower East Prairie site, the median TSS concentration was 38 mg/L (median range: 21 to 101 mg/L) from 2017 to 2021. The maximum TSS concentration was 769 mg/L (maximum range: 65 to 769 mg/L).

⁸ For the East Prairie River, samples were collected at Hwy 2 (AB07BF0285) in 2012-13 which corresponds to the middle East Prairie River site from 2017-2021.

⁹ For the East Prairie River, samples were collected at Hwy 2 (AB07BF0285) in 2012-13 which corresponds to the middle East Prairie River site from 2017-2021.

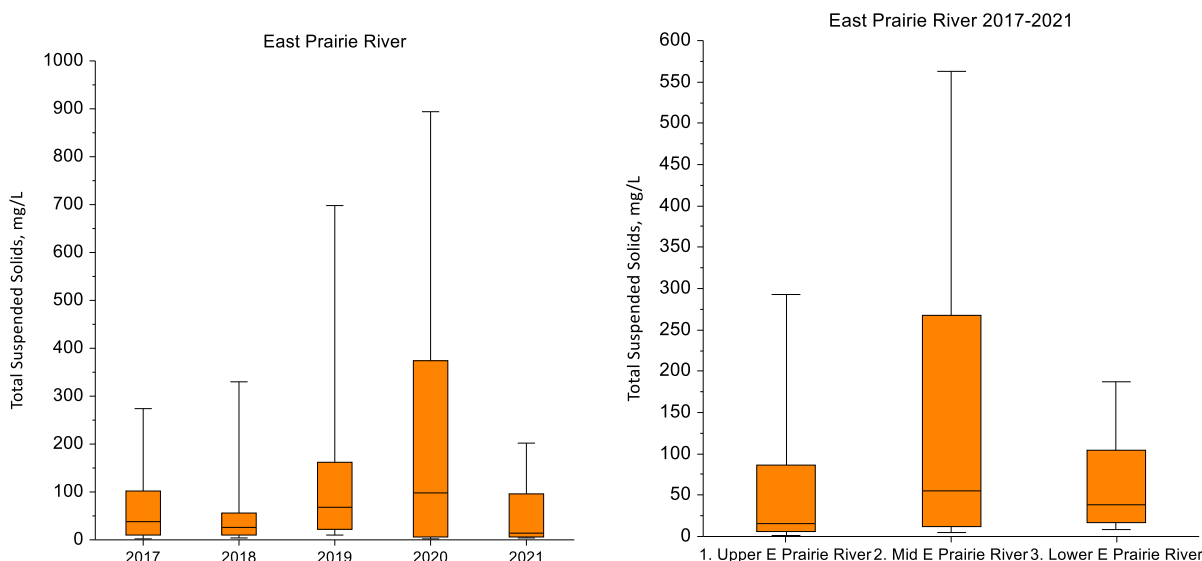


Figure 15. Total suspended solids concentration by year with all sites combined (a), and by site (b) for the 2017-2021 monitoring period, East Prairie River.

Fecal Coliform Bacteria Fecal coliform bacteria counts tended to increase from the upper East Prairie River site to lower site. There was a significant difference in mean fecal coliform bacteria counts between the upper (32 cfu/100 mL) and lower (78 cfu/100 mL) sites for the period 2017-2021 (one-way ANOVA; $P \leq 0.05$) (Table 16).

At the upper East Prairie site, the median FCB count was 14 cfu/100 mL (median range: 11 to 30 cfu/100 mL) from 2017 to 2021. Maximum FCB count was 520 cfu/100 mL (maximum range: 26 to 520 cfu/100 mL). One of 47 samples (2%) exceeded the irrigation guideline (≤ 100 cfu/100 mL) from 2017 to 2021.

At the middle East Prairie River site, the median FCB count was 48 cfu/100 mL (median range: 38 to 64 cfu/100 mL). The maximum FCB count at the middle East Prairie River site was 260 cfu/100 mL (maximum range: 110 to 260 cfu/100 mL) from 2017 to 2021. There was 'no trend' detected for the median, minimum and maximum FCB count at the East Prairie River. Twelve of 48 samples (25%) exceeded the irrigation guideline (≤ 100 cfu/100 mL) from 2017 to 2021 at the middle site.

At the lower East Prairie site, the median the FCB count was 50 cfu/100 mL (median range: 25 to 73 cfu/100 mL) from 2017 to 2021. The maximum FCB count was 460 cfu/100 mL (maximum range: 120 to 460 cfu/100 mL). Nine of 36 samples (25%) exceeded the irrigation guideline (≤ 100 cfu/100 mL) from 2017 to 2021 at the lower site.

5.4 West Prairie River

Water Temperature Water temperature always met the objective of $\leq 22^{\circ}\text{C}$ at the two West Prairie River sites from 2017 to 2021. There was no significant difference in mean water temperature between sites for the period 2017-2021 (one-way ANOVA; $P > 0.05$) (Table 16).

pH All minimum pH values met provincial guidelines for the protection of aquatic life (6.5 to 9.0) at the West Prairie River sites. One of 50 samples (2%) exceeded the maximum pH guideline at upper West

Prairie River from 2017-2021. There was no significant difference in mean pH between sites for the period 2017-2021 (one-way ANOVA; $P>0.05$) (Table 16). The pH at the West Prairie River was 'stable' (Table 19).

Dissolved Oxygen Dissolved oxygen concentrations always met provincial guidelines for the protection of aquatic life (chronic: ≥ 6.5 mg/L; acute: ≥ 5.0 mg/L) at the West Prairie River sites. There was no significant difference in mean dissolved oxygen between sites for the period 2017-2021 (one-way ANOVA; $P>0.05$) (Table 16). Median and minimum DO concentrations were 'stable and the maximum DO was showed 'no trend' at the West Prairie River (Table 19).

Conductivity Conductivity values were always well below the irrigation guideline ($\leq 1,000$ $\mu\text{S}/\text{cm}$) at the West Prairie River sites during the monitoring period. There was a significant difference in mean conductivity between the upper (192 $\mu\text{S}/\text{cm}$) and middle (250 $\mu\text{S}/\text{cm}$) sites for the period 2017-2021 (one-way ANOVA; $P>0.05$) (Table 16). There was 'no trend' for conductivity at the West Prairie River (Table 19).

Total Phosphorus There was no significant difference in mean total phosphorus concentration between the upper and middle West Prairie River sites for the period 2017-2021 (one-way ANOVA; $P>0.05$) (Table 16, Figure 16). There was a strong, positive linear relationship between total phosphorus and total suspended solids at the West Prairie River from 2017-2021 (median Pearson's correlation: $r=0.98$; range: $r=0.91$ to 0.98).

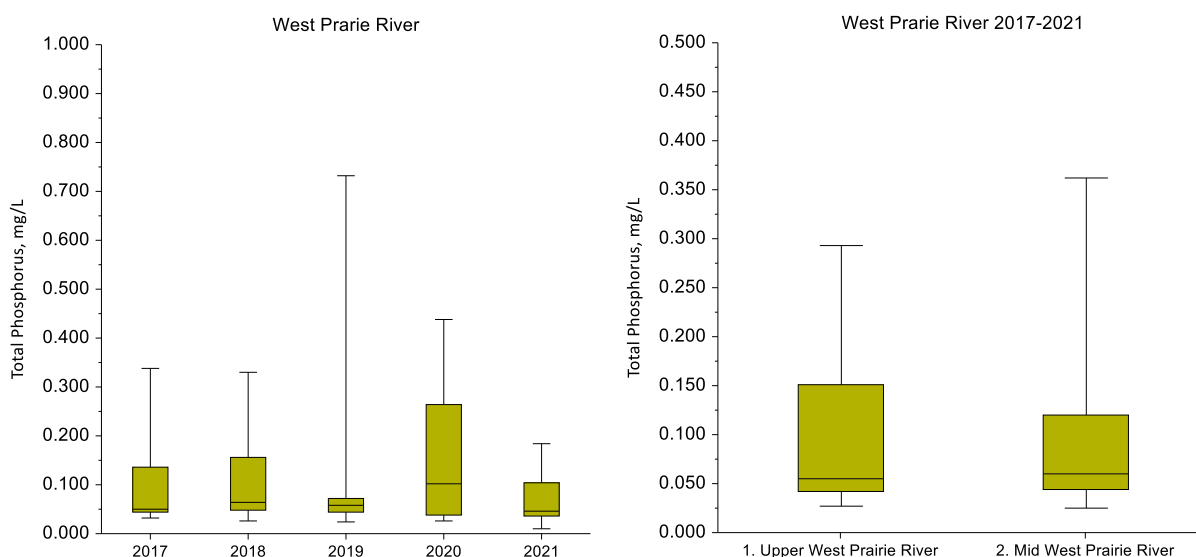


Figure 16. Total phosphorus concentration by year with all sites combined (a), and by site (b) for the 2017-2021 monitoring period West Prairie River.

At the upper West Prairie site, the median TP concentration was 0.055 mg/L (median range: 0.039 to 0.093 mg/L) from 2017 to 2021. Maximum TP concentration was 1.060 mg/L (maximum range: 0.174 to 1.060 mg/L).

The median TP concentrations at the middle West Prairie River site was 0.060 mg/L (median range: 0.050 to 0.110 mg/L) from 2017 to 2021, and was higher compared to the historic¹⁰ 2012-13 median (0.053 mg/L, Table 3 and 9). The maximum TP concentration was 1.050 mg/L (maximum range: 0.282 to 1.050 mg/L) from 2017 to 2021, and was lower than the historic 2012-13 maximum (1.150 mg/L) at the middle West Prairie River site. 'No trend' was detected in the median TP concentration at the middle West Prairie River site, a 'probably decreasing' trend was detected for minimum TP, and a 'stable' trend was detected for maximum TP concentration (Table 19).

There was no significant difference in mean **total dissolved phosphorus** between sites for the period 2017-2021 (one-way ANOVA; $P>0.05$) (Table 16).

Total Nitrogen There was no significant difference in mean total nitrogen concentration between West Prairie River sites for the period 2017-2021 (one-way ANOVA; $P>0.05$) (Table 16).

At the upper West Prairie, the median TN concentration was 0.740 mg/L (median range: 0.660 to 0.925 mg/L) from 2017 to 2021. Maximum TN concentration was 1.890 mg/L (maximum range: 1.130 to 1.890 mg/L).

At the middle West Prairie River, the median TN concentrations was 0.780 mg/L (median range: 0.655 to 1.215 mg/L) from 2017 to 2021, and was lower compared to the historic¹¹ 2012-13 median (0.859 mg/L, Table 3 and 13). The maximum TN concentration was 1.930 mg/L (maximum range: 1.550 to 1.930 mg/L) from 2017 to 2021, and was substantially lower compared to the historical 2012-13 median (3.786 mg/L). A 'stable' trend was detected for median, minimum and maximum TN concentrations at the middle West Prairie River site (Table 19).

Total Suspended Solids There was no significant difference in mean total suspended solids concentration between West Prairie River sites for the period 2017-2021 (one-way ANOVA; $P>0.05$) (Table 16; Figure 17).

At the upper West Prairie site, the median TSS concentration was 29 mg/L (median range: 12 to 104 mg/L) from 2017 to 2021. Maximum TSS concentration was 1,650 mg/L (maximum range: 200 to 1,650 mg/L).

At the middle West Prairie River site, the median TSS concentration was 20 mg/L (median range: 16 to 98 mg/L). The minimum TSS concentration was 2 mg/L (minimum range: 2 to 6 mg/L) from 2017 to 2021, and was lower compared to the historic¹² 2012-13 minimum (6 mg/L, Table 3). The maximum TSS concentration was 1,280 mg/L (maximum range: 385 to 1,280 mg/L) from 2017 to 2021, and was slightly higher compared to the 2012-13 maximum (1,170 mg/L). A 'stable' trend was detected for median, minimum and maximum TSS concentrations at the middle West Prairie River site (Table 19).

¹⁰ For the West Prairie River, samples were collected near High Prairie WSC gauge (AB07BF0165) in 2012-13 which is the same location as the middle West Prairie River site sampled from 2017 to 2021.

¹¹ For the West Prairie River, samples were collected near High Prairie WSC gauge (AB07BF0165) in 2012-13 which is the same location as the middle West Prairie River site sampled from 2017 to 2021.

¹² For the West Prairie River, samples were collected near High Prairie WSC gauge (AB07BF0165) in 2012-13 which is the same location as the middle West Prairie River site from 2017 to 2021.

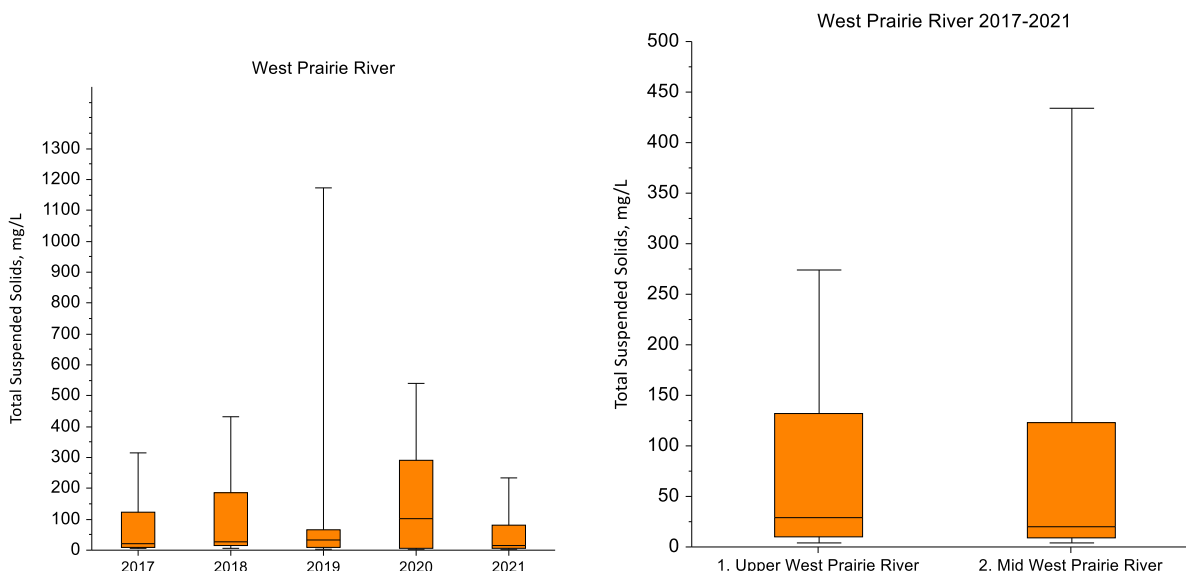


Figure 17. Total suspended solids concentration by year with all sites combined (a), and by site (b) for the 2017-2021 monitoring period West Prairie River.

Fecal Coliform Bacteria There was no significant difference in mean fecal coliform bacteria counts between West Prairie River sites for the period 2017-2021 (one-way ANOVA; $P > 0.05$) (Table 16).

At the upper West Prairie River site, the median FCB count was 68 cfu/100 mL (median range: 40 to 110 cfu/100 mL) from 2017 to 2021. Maximum FCB count was 810 cfu/100 mL (maximum range: 100 to 810 cfu/100 mL). Fifteen of 48 samples (31%) did not meet the irrigation guideline (< 100 cfu/100 mL) from 2017 to 2021.

At the middle West Prairie River site, the median FCB count was 69 cfu/100 mL (median range: 39 to 145 cfu/100 mL). The maximum FCB count at the middle West Prairie River site was 810 cfu/100 mL (maximum range: 130 to 810 cfu/100 mL) from 2017 to 2021. There is no historic median, minimum and maximum FCB for the 2012-13 period to compare results. An 'improving' trend in median fecal coliform bacteria counts was detected, and a 'stable' trend was detected for minimum and maximum FCB counts at the middle West Prairie River site (Table 19). Seventeen of 48 samples (35%) did not meet the irrigation guideline (≤ 100 cfu/100 mL) from 2017 to 2021.

5.5 South Heart River

Water Temperature Water temperature nearly always met the objective of $<22^{\circ}\text{C}$ at all sites during the 2017 to 2021 monitoring period; 1 of 50 samples (2%) exceeded the objective at the lower South Heart River site. There were no significant differences in mean water temperature between South Heart River sites for the period 2017 to 2021 (one-way ANOVA; $P>0.05$) (Table 16).

pH All minimum pH values met provincial guidelines for the protection of aquatic life ($6.5 \geq 9.0$) at the South Heart River sites. Maximum pH exceeded the guideline at all South Heart River sites in 2 of 50 samples (4%) at each site. There were no significant differences in mean pH between South Heart River sites for the period 2017 to 2021 (one-way ANOVA; $P>0.05$) (Table 16). There was 'no trend' for pH at the South Heart River (Table 20).

Dissolved Oxygen Dissolved oxygen concentration nearly always met provincial guidelines for the protection of aquatic life (chronic: ≥ 6.5 mg/L; acute: ≥ 5.0 mg/L); at the lower South Heart River site, 12 of 50 samples (24%) did not meet the chronic guideline, and 3 of 50 samples (6%) did not meet the acute guideline. Significant differences in mean dissolved oxygen concentrations were observed between the upper (9.89 mg/L), middle (8.94 mg/L) and lower (8.05 mg/L) sites (one-way ANOVA; $P>0.05$) (Table 16). A 'probably degrading' trend was detected for median dissolved oxygen concentration, and a 'stable' trend was detected for minimum and maximum DO concentrations at the lower South Heart River (Table 20).

Conductivity Conductivity values were always well below the irrigation guideline ($\leq 1,000$ $\mu\text{S}/\text{cm}$) at the South Heart River sites during the monitoring period. Significant differences in mean conductivity values were determined between the upper (319 $\mu\text{S}/\text{cm}$), middle (360 $\mu\text{S}/\text{cm}$) and lower (269 $\mu\text{S}/\text{cm}$) sites (one-way ANOVA; $P>0.05$) (Table 16). There was 'no trend' for conductivity at the South Heart River (Table 20).

Total Phosphorus Median total phosphorus concentrations tended to increase from upper South Heart River site to the lower site; however, there was no significant difference in mean total phosphorus concentrations between sites for the period 2017-2021 (one-way ANOVA; $P>0.05$) (Table 16; Figure 18). There was generally a moderate, positive linear relationship between total phosphorus and total suspended solids at the South Heart River from 2017-2021 (median Pearson's correlation: $r=0.60$; range: $r=0.51$ to 0.84).

At the upper South Heart River site, the median TP concentration was 0.100 mg/L (median range: 0.078 to 0.223 mg/L) from 2017 to 2021. Maximum TP concentration was 0.317 mg/L (maximum range: 0.114 to 0.317 mg/L).

At the middle South Heart River site, the median TP concentration was 0.121 mg/L (median range: 0.074 to 0.242 mg/L) from 2017 to 2021. Maximum TP concentration was 0.386 mg/L (maximum range: 0.160 to 0.386 mg/L).

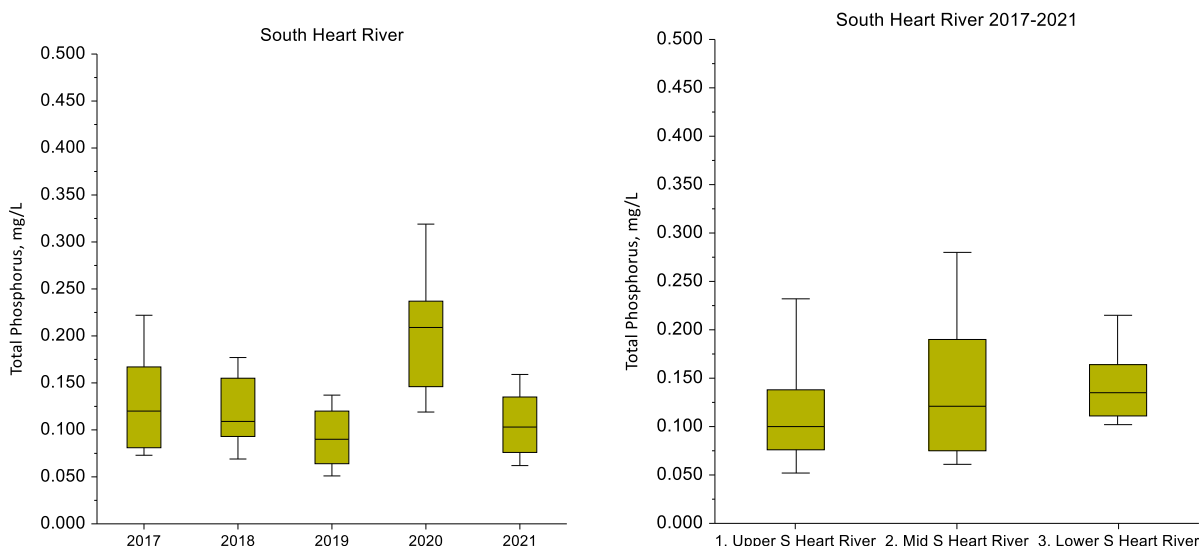


Figure 18. Total phosphorus concentration by year with all sites combined (a), and by site (b) for the 2017-2021 monitoring period, South Heart River.

At the lower South Heart River site, the median TP concentrations was 0.135 mg/L (median range: 0.118 to 0.153 mg/L) from 2017 to 2021, and was higher than the historical¹³ 1991-92 median (0.094 mg/L) and similar to the historical 2012-13 median (0.143 mg/L) (Table 3 and 9). The maximum TP concentration at the lower South Heart River site was 0.602 mg/L (maximum range: 0.173 to 0.602 mg/L) from 2017 to 2021, and was higher than the 1991-92 maximum (0.190 mg/L) and lower than the 2012-13 maximum (0.838 mg/L) (Table 3 and 9). A 'probably increasing' trend was detected for minimum TP concentration, and a 'probably decreasing' trend was detected for maximum TP concentration at the lower South Heart River (Table 20). 'No trend' was detected for the median TP concentration at lower South Heart River (Table 20).

The 2017 to 2021 comparison indicates significant differences in mean total dissolved phosphorus between the upper South Heart River (0.069 mg/L) and lower South Heart River (0.044 mg/L) sites (one-way ANOVA; $P \leq 0.05$) (Table 16).

Total Nitrogen There were no significant differences in mean total nitrogen concentrations between the upper, middle and lower sites for the period 2017 to 2021 (one-way ANOVA; $P > 0.05$) (Table 16).

At the upper South Heart River site, the median TN concentration was 1.350 mg/L (median range: 1.165 to 1.545 mg/L) from 2017 to 2021. Maximum TN concentration was 2.350 mg/L (maximum range: 1.690 to 2.350 mg/L).

At the middle South Heart River site, the median TN concentration was 1.260 mg/L (median range: 1.020 to 1.660 mg/L) from 2017 to 2021. Maximum TN concentration was 2.310 mg/L (maximum range: 1.430 to 2.310 mg/L).

¹³ For the South Heart River, samples were collected about 3 km upstream of Buffalo Bay (AB07BF0030) in 1991-92 and 2012-13 which corresponds to the lower South Heart River site from 2017 to 2021.

Table 20. Water quality trend analysis at the lower South Heart River, 2017-2021.

Indicator	Statistic	South Heart River (lower) ^a							Trend
		1991-92	2012-13	2017	2018	2019	2020	2021	
		N=9	N=12	N=10	N=10	N=10	N=10	N=10	
Temperature, °C	Median	16.5	12.7	15.1	15.6	13.0	14.3	14.1	–
	Min	12.0	0.9	2.0	4.0	2.7	5.1	1.7	–
	Max	21.5	21.3	23.5	22.0	21.0	21.8	20.3	–
pH, value	Median	7.73	8.31	7.85	7.83	8.32	7.87	7.90	NT
Dissolved Oxygen, mg/L	Median	-	8.36	8.34	7.44	8.26	6.89	7.63	↘
	Min	-	6.05	7.34	4.05	5.31	4.63	6.07	–
	Max	-	15.87	10.01	11.38	12.25	11.64	11.63	–
Specific Conductivity, µS/cm	Median	309	243	232	274	271	285	319	NT
Total Phosphorus, mg/L	Median	0.094	0.143	0.153	0.138	0.118	0.144	0.130	NT
	Min	0.050	0.079	0.109	0.089	0.080	0.109	0.102	↘
	Max	0.190	0.838	0.602	0.229	0.218	0.215	0.173	↘
T. Dissolved Phosphorus, mg/L	Median	0.027	0.024	0.023	0.050	0.038	0.054	0.036	NT
	Min	0.015	0.012	0.010	0.010	0.021	0.010	0.010	–
	Max	0.058	0.064	0.162	0.088	0.052	0.149	0.062	NT
Total Nitrogen, mg/L	Median	1.197	1.187	1.260	1.220	1.055	1.380	1.22	NT
	Min	1.052	0.724	0.910	0.980	0.700	1.210	0.93	NT
	Max	1.955	2.762	3.700	1.630	5.770	4.000	4.36	↘
Nitrate+Nitrite Nitrogen, mg/L	Median	0.039	0.032	0.023	0.011	0.011	0.038	0.038	–
	Min	0.002	0.003	0.011	0.011	0.011	0.011	0.011	↘
	Max	0.083	0.072	0.095	0.239	0.025	0.103	0.270	NT
Total Suspended Solids, mg/L	Median	10	-	75	30	39	27	38.0	↘
	Min	5	-	26	21	12	2	18.6	–
	Max	132	-	818	144	450	84	156	–
Fecal Coliform Bacteria, cfu/100 mL	Median	20	-	67	17	44	30	37	NT
	Min	4	-	10	2	10	10	4	NT
	Max	264	-	1400	360	580	126	340	–

^aLower site data from 2017-2021 is comparable to 1991-92 and 2012-13 historic data. **Trends (Mann-Kendall):** ↗ Degrading trend, ↘ probably degrading trend (increasing concentration with exception of dissolved oxygen where an increase in concentration represents an improving trend); ↖ Improving trend, ↗ probably improving trend (decreasing concentration with the exception of dissolved oxygen where a decrease in concentration represents a degrading trend); – Stable trend; NT No Trend

At the lower South Heart River site, the median TN concentration was 1.240 mg/L (median range: 1.055 to 1.380 mg/L) from 2017 to 2021, and was similar to the historic¹⁴ 1991-92 median (1.197 mg/L, Table 3) and the 2012-13 median (1.187 mg/L, Table 3). The maximum TN concentration was 5.770 mg/L (maximum range: 1.630 to 5.770 mg/L) from 2017 to 2021, and was higher compared to 1991-92 maximum (1.955 mg/L) and 2012-13 maximum (2.762 mg/L) (Table 3 and 13). A 'probably increasing' trend was detected for maximum TN concentration at the lower South Heart River (Table 20).

Total Suspended Solids Total suspended solids concentration tended to increase from the upper South Heart River site to the lower site; a significant difference in mean total suspended solids concentration was determined between the upper site (5.2 mg/L) and middle site (46.5 mg/L), and between the upper site and lower site (75.6 mg/L) (one-way ANOVA; $P \leq 0.05$) (Table 16; Figure 19).

At the upper South Heart River, the median TSS concentration was 5 mg/L (median range: 3 to 5 mg/L) from 2017 to 2021. Maximum TSS concentration was 16 mg/L (maximum range: 9 to 16 mg/L).

At the middle South Heart River, the median TSS concentration was 21 mg/L (median range: 13 to 93 mg/L) from 2017 to 2021. Maximum TSS concentration was 294 mg/L (maximum range: 75 to 294 mg/L).

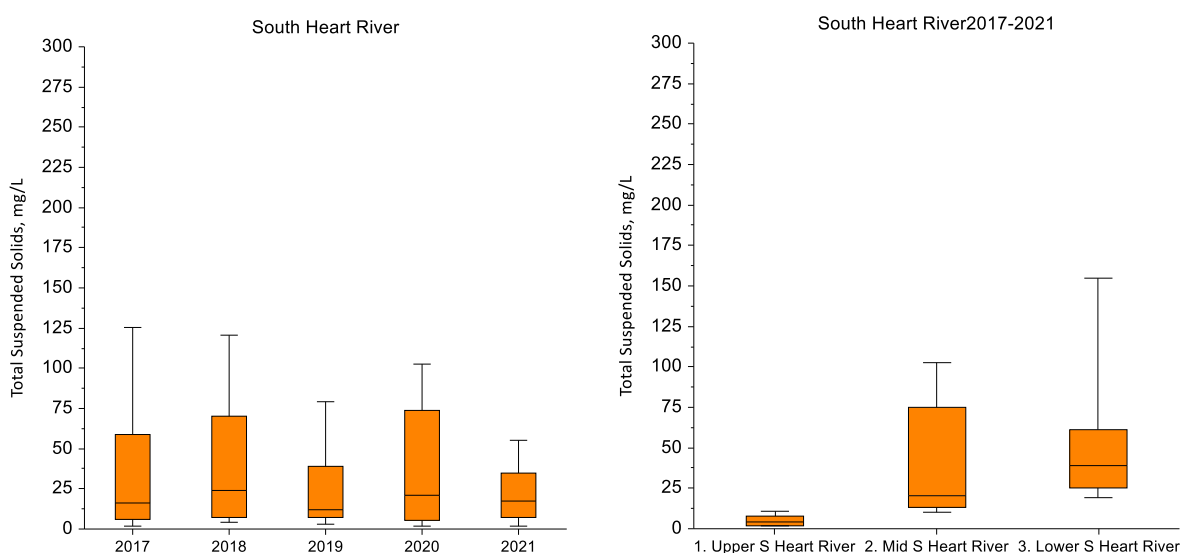


Figure 19. Total suspended solids concentration by year with all sites combined (a), and by site (b) for the 2017-2021 monitoring period, South Heart River.

At the lower South Heart River, the median TSS concentration was 39 mg/L (median range: 27 to 75 mg/L) from 2017 to 2021, and was higher compared to the historic¹⁵ 1991-92 median (10 mg/L). Maximum TSS concentration was 818 mg/L (maximum range: 84 to 818 mg/L) from 2017 to 2021 was higher compared to the 1991-92 maximum (132 mg/L) (Table 3 and 14). A 'probably increasing' trend was detected for median total suspended solids at the South Heart River (Table 20).

¹⁴ For the South Heart River, samples were collected about 3 km upstream of Buffalo Bay (AB07BF0030) in 1991-92 and 2012-13 which corresponds to the lower South Heart River site from 2017 to 2021.

¹⁵ For the South Heart River, samples were collected about 3 km upstream of Buffalo Bay (AB07BF0030) in 1991-92 and 2012-13 which corresponds to the lower South Heart River site from 2017 to 2021.

Fecal Coliform Bacteria Maximum fecal coliform bacteria counts tended to increase from the upper South Heart River site to the lower site; a significant difference in mean FCB counts occurred between the upper (6 cfu/100 mL) and lower (99 cfu/100 mL) sites for the period 2017-2021 (one-way ANOVA; $P \leq 0.05$) (Table 16).

At the upper South Heart River, the median FCB count was 2 cfu/100 mL (median range: 1 to 5 cfu/100 mL) from 2017 to 2021. The maximum FCB count was 50 mg/L (maximum range: 4 to 50 cfu/100 mL). No samples exceeded the irrigation guideline (≤ 100 cfu/100/mL) from 2017 to 2021 at the upper site.

At the middle South Heart River, the median FCB count was 20 cfu/100 mL (median range: 10 to 64 cfu/100 mL) from 2017 to 2021. Maximum TSS concentration was 330 cfu/100 mL (maximum range: 41 to 330 cfu/100 mL). Four of 48 samples (8%) exceeded the irrigation guideline (≤ 100 cfu/100 mL) from 2017 to 2021 at the middle site.

At the lower South Heart River, the median FCB count was 34 cfu/100 mL (median range: 17 to 67 cfu/100 mL) from 2017 to 2021, and was higher compared to the historic 1991-92 median (20 cfu/100 mL, Table 3). The maximum FCB count was 1,400 cfu/100 mL (maximum range: 126 to 1,400 cfu/100 mL) from 2017 to 2021, and was higher compared to the 1991-92 maximum (264 cfu/100 mL) (Table 3 and 15). Eight of 48 samples (17%) exceeded the irrigation guideline (≤ 100 cfu/100 mL) from 2017 to 2021 at the lower site. 'No trend' in median and minimum FCB counts was detected from 2017 to 2021 at lower South Heart River, and maximum FCB counts were 'stable' (Table 20).

5.6 Grouard Channel

Mann Kendall analysis was not applied to the Grouard Channel because there was no historic reference to include in the analysis. The overall general water quality trends are reported below.

Routine Parameters Water temperature always met the objective of $<22^{\circ}\text{C}$ at the Grouard Channel during the 2017 to 2021 monitoring period. Minimum and maximum pH values generally met provincial guidelines for the protection of aquatic life ($6.5 \geq 9.0$) at the Grouard Channel. One of 50 samples (2%) did not meet the maximum pH guideline from 2017 to 2021. Dissolved oxygen concentration usually met provincial guidelines for the protection of aquatic life (chronic: ≥ 6.5 mg/L; acute: ≥ 5.0 mg/L); 13 or 50 samples (26%) did not meet the chronic guideline, and 7 of 50 samples (14%) did not meet the acute guideline at Grouard Channel from 2017 to 2021. Conductivity values were always well below the irrigation guideline ($\leq 1,000$ $\mu\text{S}/\text{cm}$) at the Grouard Channel from 2017 to 2021.

Nutrients The median TP concentration was 0.111 mg/L (median range: 0.104 to 0.137 mg/L) from 2017 to 2021 (Figure 20). Maximum TP concentration was 0.341 mg/L (maximum range: 0.199 to 0.341 mg/L). The median TN concentration was 1.090 mg/L (median range: 0.860 to 1.320 mg/L) from 2017 to 2021 at the Grouard Channel. Maximum TN concentration was 2.420 mg/L (maximum range: 1.520 to 2.420 mg/L).

Total Suspended Solids At the Grouard Channel, the median TSS concentration was 15 mg/L (median range: 10 to 51 mg/L) from 2017 to 2021 (Figure 21). Maximum TSS concentration was 270 mg/L (maximum range: 79 to 270 mg/L).

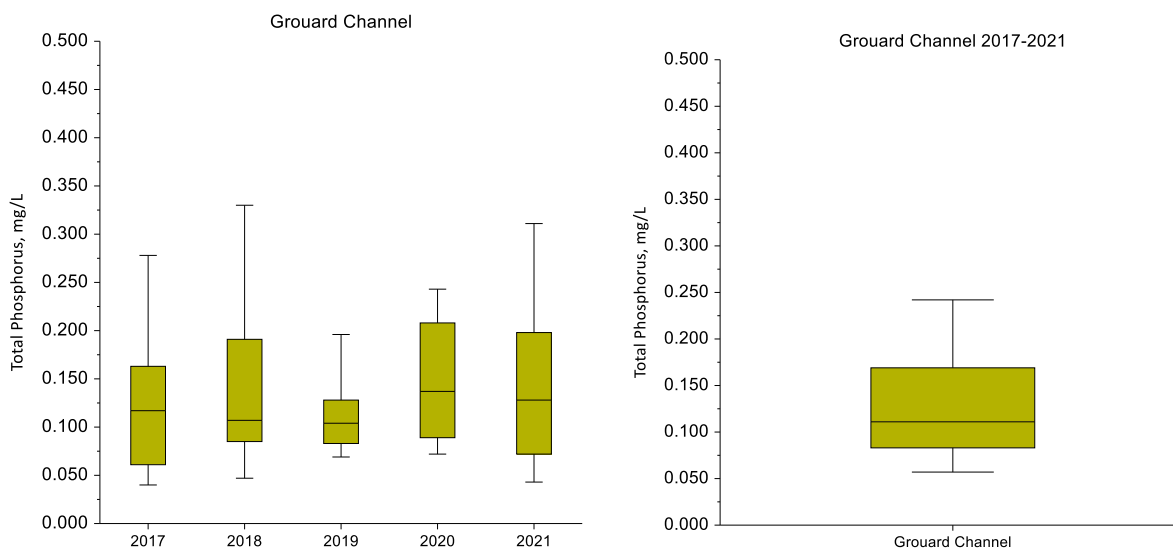


Figure 20. Total phosphorus concentration by year with all sites combined (a), and by site (b) for the 2017-2021 monitoring period, Grouard Channel.

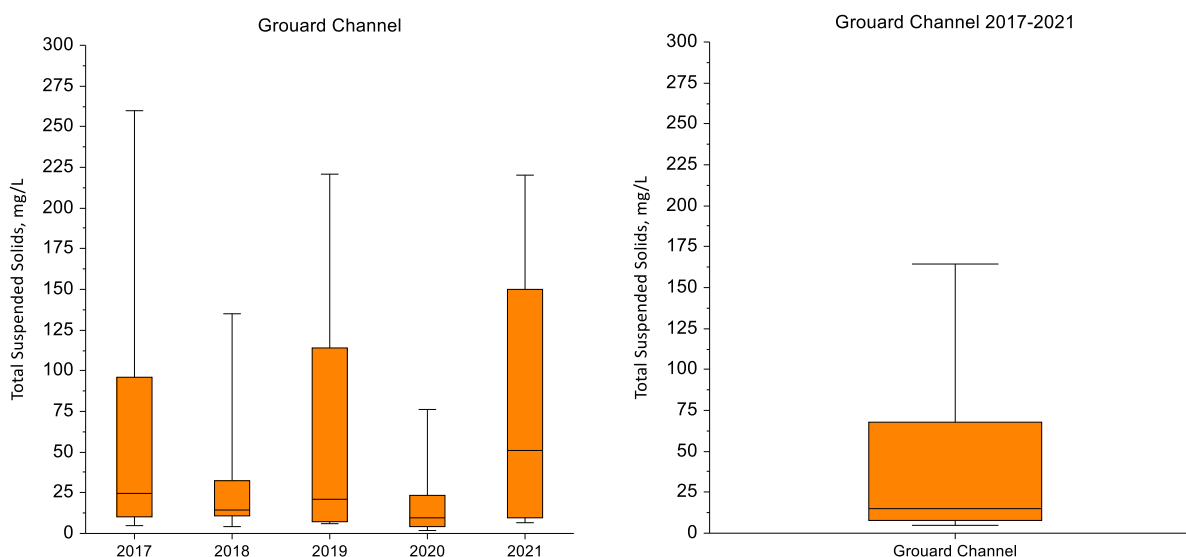


Figure 21. Total suspended solids concentration by year with all sites combined (a), and by site (b) for the 2017-2021 monitoring period, Grouard Channel.

Fecal Coliform Bacteria At the Grouard Channel, the median FCB count was 10 cfu/100 mL (median range: 3 to 20 cfu/100 mL) from 2017 to 2021. The maximum FCB count was 140 mg/L (maximum range: 33 to 140 cfu/100 mL). One of 48 samples (2%) exceeded the irrigation guideline (≤ 100 cfu/100 mL) from 2017 to 2021.

6.0 SUMMARY

This report summarized the water monitoring data collected in 2021 as part of the Lesser Slave Lake Tributary Monitoring Program, compiled and assessed the metals data collected at select sites, and assessed five-year trends observed from 2017 to 2021. Variations in water quality were observed at the tributaries to Lesser Slave Lake, with differences likely due to a combination of channel morphology, river gradients, and differences in land use/human disturbance between catchments (Hutchinson Environmental 2015).

2021 Monitoring Year In 2021, data collected from seven weather stations in the watershed showed that precipitation during the monitoring season was the lowest of the five years. Precipitation in 2021 was 9.8% less than 2020, 23.9% less than 2019, 18.2% less than 2018 and 27.2% less than 2017. Dry conditions were reflected in the water quality

The 2021 monitoring year marked the first year of water quality data collection at the Lesser Slave River. All temperature, pH, conductivity, dissolved oxygen and fecal coliform bacteria samples met objectives and guidelines. Median (0.010 mg/L) and maximum (0.033 mg/L) total phosphorus concentrations were generally low compared to other upstream tributaries. Median (7.0 mg/L) and maximum (29.0 mg/L) TSS concentrations were also generally low compared to other upstream tributaries.

Metals Several metals exceeded the PAL guidelines at the Swan River in 2021. Two metal exceedances (i.e., hexavalent chromium and dissolved iron) were common to all three Swan River sites, while the dissolved aluminum exceedance was unique to the middle Swan River, and dissolved aluminum and total mercury exceedances were unique at to the lower Swan River.

The upper West Prairie River, the middle East Prairie River, and the middle Driftpile River sites each had several metal exceedances in 2021. Three metal exceedances were common to the three rivers: total mercury, dissolved aluminum and dissolved iron. Total lead exceeded the guideline at upper West Prairie River and middle East Prairie River. Hexavalent chromium exceeded the PAL at the middle Driftpile River and total copper exceeded the guideline at the middle East Prairie River. There were fewer metal exceedances at the Swan River in 2020 and 2021 compared to the Driftpile, East Prairie and West Prairie rivers. This was a similar result to the 2008-10 metals study (Hutchinson Environmental 2015).

Five-Year Assessment A few noteworthy trends were detected from the analysis of the monitoring data; note that the lack of clear trends observed for several parameters (as indicated by 'No Trend') may be due to the small sample size (N=6 or N=7) which decreases the power of the Mann Kendall test. The following highlights a few key trends from the five-year analysis.

Spatial trends (between sites at individual tributaries)

- At the Swan River, five of nine water quality parameters showed no statistical differences among sites, 3 parameters (temperature, dissolved oxygen and total dissolved phosphorus) differed between the upper and lower site
- At the East Prairie River, six of nine water quality parameters showed no statistical differences among sites
- Eight of nine water quality parameters showed no statistical differences among sites at the Driftpile River and West Prairie River

- Four of nine water quality parameters showed no significant differences in mean concentrations between sites at the South Heart River; the greatest difference was observed between the upper and lower sites

Water Quality Trends

- Median water temperature is probably decreasing at the lower Swan River, and is considered stable at the middle Swan River, the middle West and East Prairie rivers, and the lower South Heart River. For maximum water temperature, 'Stable' trends were detected at the lower South Heart River and middle West Prairie River, and no trend was detected at the Swan River sites.
- A 'decreasing' (degrading) trend was detected in median dissolved oxygen concentration at the lower South Heart River, and a 'Stable' trend detected in maximum concentration at the same site. 'Stable' trends were also detected for median dissolved oxygen at middle West Prairie and middle East Prairie rivers.
- A 'decreasing' (improving) trend was detected for median TP concentration and a 'probably decreasing' (probably improving) trend was detected for the maximum TP concentration at the lower Swan River. A stable trend was detected for median TP concentration at the middle Swan River site, and for maximum TP concentration at the middle West Prairie and middle East Prairie rivers.
- A 'stable' trend was detected for median TN concentrations at the lower Swan River and Driftpile River sites. No trend was detected in the median TN concentration at the East and West Prairie rivers, and South Heart River.
- Median TSS concentrations were 'stable' at the Swan River sites, lower Driftpile, and middle East and West Prairie rivers. An 'probably increasing' (probably degrading) trend in median TSS was detected at the lower South Heart River.
- At middle Swan River, a 'probably decreasing' (probably improving) trend in median FCB counts was detected, and a 'decreasing' (improving) trend detected at middle West Prairie River for the same.

Metals

- The metals most often exceeding guidelines at the six select monitoring sites were dissolved iron, dissolved aluminum, total lead, total mercury, total copper and total cadmium. The highest metal concentrations and largest number of metals exceeding the protection of aquatic life (PAL) guidelines occurred in years with the highest maximum TSS; the lowest metal concentrations/exceedances occurred in years with the lowest maximum TSS concentration.

7.0 RECOMMENDATIONS

The LSWC should continue to implement the water monitoring program at tributaries to Lesser Slave Lake in 2022. Multiple years of data, representing wet, dry and average precipitation years are needed to firmly establish water quality trends at the tributaries to Lesser Slave Lake. To firmly establish trends, the number of recommended data points for the Mann-Kendall Test is 8 to 10 years.

7.1 Monitoring Program

Care should be taken to minimize missing data points to improve assessment of trends between sites on the same river, and between the main tributaries to Lesser Slave Lake. Poor road access to the lower Swan River from 2018 to 2020 has resulted in at least one missing sample. These missing samples typically occur from Mid-April to early-July when flows are high and water quality poor (i.e., high concentrations of total phosphorus, TSS and total metals) and missing samples may lead to an under-estimation of water quality values or concentrations. The LSWC may want to consider a short-term rental of a UTV or ATVs during the early part of the sampling season that would allow access on any road that is in poor condition for truck access.

7.1.1 Water Temperature Monitoring

Water temperature objective ($<22^{\circ}\text{C}$) exceedances have occurred at East Prairie River in 2018, 2020 and 2021. A 'spot' measurement of water temperature may not be reflective of actual daily maximum temperatures due to infrequent samples and timing of sample collection. The LSWC may want to consider deploying continuous temperature data loggers (e.g, Hobo®) at the East Prairie River site to determine seasonal water temperature trends. The temperature data could be compared to the general water temperature objective for Lesser Slave Lake tributaries ($<22^{\circ}\text{C}$) and to temperature preferences for fish species observed in the East Prairie River.

The LSWC may also want to consider temperature monitoring at the Swan River and Driftpile River as water temperature objective exceedances were also recorded at these tributaries.

A more conservative water temperature objective should apply to the Swan River ($<20^{\circ}\text{C}$) to support the recovery of Arctic Grayling habitat.

7.1.2 Potential Removal of Similar Monitoring Sites

The 5-year analysis of water quality data (completed using one-way ANOVA at each tributary) assessed whether data collected at different landscape positions (i.e., upper, middle or lower positions) resulted in significant differences in quality. The LSWC may consider removing monitoring sites from the 2022 program if two sites were determined to be similar. The following sites may be considered for removal from the 2022 water monitoring program:

Swan River: Five of nine water quality parameters (conductivity, TP, TN, TSS, FCB) showed no statistical differences among sites. Three water quality parameters (water temperature, DO and TDP) showed statistical differences between the upper and lower sites. pH had a statistical difference between the middle and lower sites. Therefore, the middle Swan River site could reasonably be removed.

Driftpile River: Eight of nine water quality parameters (temperature, pH, conductivity, TP, TDP, TN, TSS, FCB) showed no statistical differences among sites. Dissolved oxygen had a statistical difference between the upper and lower sites. The three Driftpile River sites are closely located within 13 km of each other (straight-line distance). Therefore, the middle Driftpile River site could reasonably be removed.

East Prairie River: Six of nine water quality parameters (temperature, pH, conductivity, TP, TDP, TSS) showed no statistical differences among sites. Fecal coliform bacteria had a statistical difference between the upper and lower site. Total nitrogen had a statistical difference between the upper and middle site and dissolved oxygen was statistically lower at the lower site versus the middle and upper

site. The lower and middle sites are closer together (15 km) than the middle and upper sites (38 km). There is historical water quality data (2012-13) for the middle site. LSWC staff have reported accessibility and road safety concerns for the lower East Prairie site. Therefore, the lower East Prairie River site could reasonably be removed.

West Prairie River: Eight of nine water quality parameters (temperature, pH, DO, TP, TDP, TN, TSS, FCB) showed no statistical differences between the upper and middle site. Conductivity had a statistical difference between the upper and middle sites. The middle site has historical water quality data from 2012-13. Therefore, the upper West Prairie River site could reasonably be removed.

South Heart River: Four of nine water quality parameters (temperature, pH, TP, TN) showed no statistical differences between the upper, middle and lower site. Dissolved oxygen and conductivity were statistically different between the upper, middle and lower sites. Total dissolved phosphorus and fecal coliform bacteria were statistically different between the upper and lower sites. The upper site had statistically lower TSS compared to both the middle and lower sites. The lower site has historical water quality data from 1991-92 and 2012-13. Therefore, the middle South Heart River site could reasonably be removed.

7.1.3 Additional Monitoring Sites to Consider

There may be opportunities to add additional tributaries to the water monitoring program if funding and logistic/labour requirements allow. The following suggests tributaries that may be considered in the 2022 program:

- **Saulteaux River:** A tributary to the Lesser Slave River. The Saulteaux River could be accessed from Highway 2 and there appears to be sampling sites near the bridge. This site has a flow gauging station site located at the bridge. There is limited historical water quality data from 2005-06.
- **Otauwau River:** A tributary to the Lesser Slave River. The Otauwau River could be accessed from Highway 2 and there appears to be sampling sites near the bridge. There is limited historical water quality data from 2005-06.
- **Driftwood River:** A tributary to the Lesser Slave River. The Driftwood River could be accessed from Township Road 723A. There is limited historical water quality data from 2005-06.
- **Marten Creek:** Enters the northeast corner of Lesser Slave Lake. Marten Creek could be accessed from Highway 88. There is limited historical water quality data from early 1990s.

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APPENDIX A. WATER MONITORING SAMPLE LOCATIONS, 2017-2021.

Location	Northing	Easting
upper Swan River	54°59'33.05"N	115°17'59.99"W
middle Swan River	55°14'38.66"N	115°21'37.15"W
lower Swan River	55°22'49.72"N	115°19'59.54"W
upper Driftpile River	55°17'53.64"N	115°51'7.59"W
middle Driftpile River	55°20'45.84"N	115°47'45.08"W
lower Driftpile River	55°22'3.04"N	115°41'40.59"W
upper East Prairie River	55° 6'51.26"N	116° 5'14.94"W
middle East Prairie River	55°25'4.98"N	116°20'22.00"W
lower East Prairie River	55°32'29.50"N	116°15'6.29"W
upper West Prairie River	55°12'29.69"N	116°26'7.68"W
middle West Prairie River	55°26'55.62"N	116°29'36.91"W
upper South Heart River	55°40'57.20"N	116°35'44.34"W
middle South Heart River	55°30'31.71"N	116°31'34.40"W
lower South Heart River	55°34'47.24"N	116°17'41.27"W
Grouard Channel	55°30'48.13"N	116° 9'54.21"W
Lesser Slave River	55°17'41.93"N	114°44'39.61"W

APPENDIX B. WATER QUALITY DATA, 2021.

Appendix B-1: Routine Water Quality Data. Red values are half the detection limit when reported values were less than the detection limit.

Site	Date	Time	pH units	Cond $\mu\text{S}/\text{cm}$	DO mg/L	Oxygen Sat. %	Temp $^{\circ}\text{C}$	TP mg/L	TDP mg/L	NO ₃ -N mg/L	NO ₃ -N+NO ₂ -N mg/L	NO ₂ -N mg/L	TKN mg/L	TSS mg/L	TN mg/L	FCB cfu/100 mL
upper West Prairie River	27-Apr-21	9:10	7.10	135.9	11.31	91.4	2.3	0.100	0.041	0.111	0.111	0.005	0.84	76.8	0.95	21
upper West Prairie River	11-May-21	9:30	8.24	90	11.90	95.0	6.1	0.174	0.040	0.054	0.054	0.005	1.18	217	1.24	21
upper West Prairie River	25-May-21	9:05	7.83	114.6	9.43	93.2	11.5	0.097	0.010	0.010	0.011	0.005	0.82	90.8	0.82	31
upper West Prairie River	08-Jun-21	9:35	7.82	186	9.64	96.0	11.4	0.037	0.010	0.010	0.011	0.005	0.39	7.8	0.39	32
upper West Prairie River	22-Jun-21	9:15	7.73	157.8	8.14	95.3	18.6	0.039	0.010	0.010	0.011	0.005	0.55	21.2	0.55	44
upper West Prairie River	07-Jul-21	9:15	8.05	388	8.28	96.4	18.0	0.032	0.010	0.010	0.011	0.005	0.59	4.8	0.59	80
upper West Prairie River	20-Jul-21	9:25	8.15	424	9.68	102.1	16.3	0.023	0.010	0.010	0.011	0.005	0.72	1.5	0.72	190
upper West Prairie River	17-Aug-21	9:15	8.09	551	9.05	92.6	12.7	0.024	0.010	0.010	0.011	0.005	0.58	7.2	0.58	200
upper West Prairie River	14-Sep-21	9:25	8.27	178.5	9.56	95.7	11.7	0.041	0.025	0.010	0.011	0.005	0.83	15.6	0.83	-
upper West Prairie River	19-Oct-21	9:30	8.58	343	11.91	94.3	2.0	0.039	0.024	0.010	0.011	0.005	0.45	1.5	0.45	40
middle West Prairie River	27-Apr-21	9:50	7.84	154.4	12.42	96.1	2.1	0.117	0.051	0.227	0.227	0.005	0.99	73	1.22	27
middle West Prairie River	11-May-21	10:15	8.10	116.1	10.42	95.0	8.6	0.282	0.038	0.100	0.100	0.005	1.74	385	1.84	39
middle West Prairie River	25-May-21	9:40	7.53	133	9.61	95.6	12.4	0.116	0.010	0.010	0.011	0.005	0.96	137	0.96	46
middle West Prairie River	08-Jun-21	10:10	7.71	221	9.60	98.4	13.5	0.048	0.020	0.010	0.011	0.005	0.3	21	0.3	34
middle West Prairie River	22-Jun-21	9:50	7.72	203.7	8.27	99.5	20.0	0.055	0.010	0.010	0.011	0.005	0.6	16.4	0.61	74
middle West Prairie River	07-Jul-21	9:55	8.03	470	8.16	98.2	20.9	0.028	0.010	0.010	0.011	0.005	0.81	5.8	0.81	150
middle West Prairie River	20-Jul-21	10:00	8.07	592	8.93	97.9	16.6	0.010	0.010	0.010	0.011	0.005	0.79	1.5	0.79	150
middle West Prairie River	17-Aug-21	10:00	8.20	681	9.80	104.5	15.5	0.010	0.010	0.010	0.011	0.005	0.64	5	0.64	34
middle West Prairie River	14-Sep-21	10:05	7.90	204.5	10.13	101.3	12.2	0.043	0.023	0.010	0.011	0.005	0.76	15.6	0.76	-
middle West Prairie River	19-Oct-21	10:05	8.57	448	12.05	96.2	3.3	0.051	0.023	0.010	0.011	0.005	0.61	12	0.61	30
upper South Heart River	27-Apr-21	10:55	7.49	347	10.77	87.8	4.0	0.135	0.076	0.098	0.098	0.005	1.26	5.4	1.36	0.5
upper South Heart River	11-May-21	11:25	7.76	393	10.82	104.8	10.9	0.155	0.067	0.010	0.011	0.005	1.69	7	1.69	2
upper South Heart River	25-May-21	10:45	7.81	372	9.60	101.3	14.6	0.103	0.060	0.037	0.004	0.005	1.16	1.5	1.19	0.5
upper South Heart River	08-Jun-21	11:05	8.32	365	9.57	105.6	16.8	0.080	0.054	0.010	0.011	0.005	0.77	1.5	0.77	6
upper South Heart River	22-Jun-21	10:55	8.16	356	9.70	111.0	17.4	0.068	0.040	0.024	0.024	0.005	0.93	1.5	0.95	24
upper South Heart River	07-Jul-21	10:55	8.24	377	9.02	109.9	21.3	0.051	0.035	0.010	0.011	0.005	1.08	4.2	1.08	0.5

Lesser Slave Watershed 2021 Water Monitoring Report

Site	Date	Time	pH units	Cond μ S/cm	DO mg/L	Oxygen Sat. %	Temp $^{\circ}$ C	TP mg/L	TDP mg/L	NO ₃ -N mg/L	NO ₃ -N+NO ₂ -N mg/L	NO ₂ -N mg/L	TKN mg/L	TSS mg/L	TN mg/L	FCB cfu/100 mL
upper South Heart River	20-Jul-21	11:00	8.38	393	7.69	86.3	17.6	0.073	0.048	0.060	0.060	0.005	1.51	1.5	1.57	6
upper South Heart River	17-Aug-21	11:05	8.97	362	11.77	132.6	17.8	0.124	0.055	0.010	0.011	0.005	1.64	13.2	1.64	5
upper South Heart River	14-Sep-21	11:05	8.47	378	10.85	115.9	14.8	0.096	0.043	0.010	0.011	0.005	1.42	7.4	1.42	-
upper South Heart River	19-Oct-21	11:35	8.39	395	12.08	101.2	5.1	0.094	0.020	0.010	0.011	0.005	1.39	11.2	1.39	2
middle South Heart River	27-Apr-21	10:15	8.17	451	11.81	93.4	2.9	0.160	0.080	0.180	0.180	0.005	1.22	18	1.4	5
middle South Heart River	11-May-21	10:45	7.94	445	9.76	93.8	10.6	0.118	0.061	0.010	0.011	0.005	1.43	26.4	1.43	10
middle South Heart River	25-May-21	10:10	8.05	385	8.94	92.2	14.0	0.123	0.051	0.090	0.090	0.005	1.17	42.6	1.26	2
middle South Heart River	08-Jun-21	10:30	8.05	402	8.96	94.2	14.5	0.097	0.051	0.010	0.011	0.005	0.63	17	0.63	6
middle South Heart River	22-Jun-21	10:15	7.88	450	7.11	85.5	20.4	0.087	0.036	0.010	0.011	0.005	0.85	18	0.86	6
middle South Heart River	07-Jul-21	10:20	8.01	418	6.98	85.0	21.4	0.070	0.041	0.010	0.011	0.005	1.03	15	1.03	44
middle South Heart River	20-Jul-21	10:25	7.99	432	7.62	84.2	17.1	0.070	0.025	0.026	0.026	0.005	0.95	16.2	0.97	52
middle South Heart River	17-Aug-21	10:25	8.27	412	8.14	88.5	16.4	0.054	0.023	0.010	0.011	0.005	1.13	15.2	1.13	12
middle South Heart River	14-Sep-21	10:30	7.99	427	8.25	85.0	13.4	0.061	0.028	0.010	0.011	0.005	0.97	12.6	0.97	-
middle South Heart River	19-Oct-21	10:30	8.08	428	11.29	90.0	3.3	0.077	0.021	0.010	0.011	0.005	1.01	20.2	1.01	12
lower South Heart River	27-Apr-21	11:30	8.22	224	11.57	89.3	1.7	0.143	0.059	0.070	0.070	0.005	4.29	37.6	4.36	4
lower South Heart River	11-May-21	12:10	7.59	216.5	8.84	86.4	10.2	0.102	0.039	0.010	0.011	0.005	1.24	38.4	1.24	37
lower South Heart River	25-May-21	11:20	7.72	227	7.73	78.1	13.1	0.136	0.026	0.045	0.045	0.005	1.15	56.8	1.19	59
lower South Heart River	08-Jun-21	11:45	7.61	298	7.27	77.1	15.0	0.141	0.041	0.042	0.042	0.005	0.89	19.6	0.93	4
lower South Heart River	22-Jun-21	11:35	7.76	339	6.37	76.4	20.3	0.119	0.031	0.063	0.063	0.005	0.97	42	1.03	38
lower South Heart River	07-Jul-21	11:30	8.00	339	6.07	71.5	19.6	0.164	0.038	0.010	0.011	0.005	1.27	60.2	1.27	20
lower South Heart River	20-Jul-21	11:35	8.48	373	7.52	84.0	17.6	0.131	0.033	0.010	0.011	0.005	1.41	30.8	1.41	340
lower South Heart River	17-Aug-21	11:50	7.90	426	6.46	71.2	17.2	0.112	0.031	0.023	0.023	0.005	1.92	18.6	1.94	26
lower South Heart River	14-Sep-21	11:40	7.90	255	7.89	80.6	13.0	0.102	0.062	0.270	0.270	0.005	0.99	33.6	1.01	-
lower South Heart River	19-Oct-21	12:10	8.21	349	11.63	91.7	2.9	0.173	0.010	0.034	0.034	0.005	1	156	1.04	40
Grouard Channel	27-Apr-21	12:00	7.90	252	10.93	83.6	1.9	0.319	0.052	0.010	0.011	0.005	1.55	205	1.55	7
Grouard Channel	11-May-21	13:15	7.95	285	9.41	95.1	13.1	0.140	0.044	0.010	0.011	0.005	1.18	73.4	1.18	4
Grouard Channel	25-May-21	12:05	7.57	228	8.76	87.5	12.7	0.243	0.025	0.005	0.052	0.005	1.51	222	1.56	33
Grouard Channel	08-Jun-21	12:40	7.69	274	8.26	87.9	15.3	0.125	0.035	0.076	0.076	0.005	0.71	25	0.79	8
Grouard Channel	22-Jun-21	12:50	8.09	385	8.39	103.3	21.3	0.131	0.030	0.074	0.074	0.005	1.12	66	1.19	0.5

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Grouard Channel	07-Jul-21	12:05	8.15	369	8.24	101.2	21.9	0.077	0.039	0.010	0.011	0.005	0.89	6.6	0.89	20
Grouard Channel	20-Jul-21	12:05	8.60	378	8.92	98.7	17.0	0.041	0.010	0.010	0.011	0.005	1.12	7	1.12	16
Grouard Channel	17-Aug-21	12:25	8.32	385	8.32	90.3	16.1	0.058	0.034	0.010	0.011	0.005	0.9	10.2	0.90	0.5
Grouard Channel	14-Sep-21	12:10	8.19	265	8.88	92.5	13.8	0.108	0.031	0.010	0.011	0.005	1.09	36.2	1.09	-
Grouard Channel	19-Oct-21	12:45	7.76	378	11.07	89.9	4.0	0.183	0.010	0.088	0.088	0.005	1.54	132	1.63	20
upper East Prairie River	27-Apr-21	13:40	8.23	182.3	12.12	95.7	2.6	0.046	0.026	0.165	0.165	0.005	0.58	23.4	0.75	2
upper East Prairie River	11-May-21	14:10	7.76	115.4	11.41	101.1	6.9	0.079	0.028	0.106	0.106	0.005	0.92	114	1.03	11
upper East Prairie River	25-May-21	13:00	7.90	172.4	10.20	101.2	11.8	0.036	0.010	0.010	0.011	0.005	0.42	29.8	0.42	14
upper East Prairie River	08-Jun-21	14:20	8.04	234	9.25	100.4	16.0	0.023	0.010	0.010	0.011	0.005	0.10	12	0.10	14
upper East Prairie River	22-Jun-21	13:45	7.97	241	8.27	103.1	21.4	0.010	0.010	0.010	0.011	0.005	0.26	11	0.26	8
upper East Prairie River	07-Jul-21	12:55	8.17	377	8.44	108.7	23.9	0.010	0.010	0.010	0.011	0.005	0.33	6.4	0.33	20
upper East Prairie River	20-Jul-21	13:45	8.30	362	9.01	100.2	16.9	0.010	0.010	0.010	0.011	0.005	0.25	4.4	0.25	26
upper East Prairie River	17-Aug-21	14:15	8.24	431	9.29	105.6	18.0	0.010	0.010	0.010	0.011	0.005	0.21	5	0.21	18
upper East Prairie River	14-Sep-21	13:30	8.24	302	9.56	102.1	14.5	0.010	0.010	0.010	0.011	0.005	0.53	5.8	0.53	-
upper East Prairie River	19-Oct-21	14:05	8.27	371	12.38	102.9	4.4	0.010	0.010	0.010	0.011	0.005	0.10	1.5	0.10	2
middle East Prairie River	27-Apr-21	14:30	7.75	164.6	11.93	96.1	3.5	0.088	0.038	0.273	0.273	0.005	0.85	66.2	1.13	16
middle East Prairie River	11-May-21	15:00	7.93	116.7	10.44	97.6	9.5	0.293	0.032	0.169	0.169	0.005	1.44	419	1.61	22
middle East Prairie River	25-May-21	13:40	7.64	153.6	9.38	98.6	14.6	0.086	0.010	0.010	0.011	0.005	0.69	92	0.69	240
middle East Prairie River	08-Jun-21	13:35	7.88	257	9.68	102.9	14.8	0.082	0.020	0.010	0.011	0.005	0.31	52.4	0.31	62
middle East Prairie River	22-Jun-21	14:30	7.91	213.8	8.02	101.0	22.7	0.071	0.010	0.010	0.011	0.005	0.35	58.8	0.36	160
middle East Prairie River	07-Jul-21	13:40	8.17	420	8.18	108.6	25.9	0.044	0.010	0.010	0.011	0.005	0.49	8.4	0.49	140
middle East Prairie River	20-Jul-21	14:30	8.40	421	9.34	103.0	16.9	0.031	0.010	0.010	0.011	0.005	0.67	11.6	0.67	260
middle East Prairie River	17-Aug-21	15:05	8.42	492	9.78	114.6	19.8	0.010	0.010	0.010	0.011	0.005	0.33	6	0.33	18
middle East Prairie River	14-Sep-21	14:15	8.13	270	9.63	101.3	14.5	0.045	0.023	0.010	0.011	0.005	0.59	17.2	0.59	-
middle East Prairie River	19-Oct-21	15:00	8.52	405	13.13	110.8	5.4	0.037	0.010	0.120	0.120	0.005	0.22	3.8	0.34	13
lower East Prairie River	27-Apr-21	12:30	8.89	178	11.90	93.5	2.9	0.200	0.037	0.266	0.266	0.005	1.13	202	1.39	9
lower East Prairie River	11-May-21	12:30	7.57	129.2	10.04	93.4	9.2	0.281	0.031	0.170	0.170	0.005	1.5	453	1.67	38
lower East Prairie River	25-May-21	11:40	7.70	152.2	9.25	93.5	13.1	0.107	0.010	0.010	0.011	0.005	0.63	101	0.63	40
lower East Prairie River	08-Jun-21	12:15	7.64	238	9.02	96.4	15.5	0.142	0.035	0.010	0.011	0.005	0.39	105	0.39	38

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lower East Prairie River	22-Jun-21	11:55	7.92	216.2	8.27	99.9	20.9	0.110	0.010	0.010	0.011	0.005	0.55	137	0.56	120
lower East Prairie River	No sample															
lower East Prairie River	20-Jul-21	12:30	8.44	478	8.71	96.7	17.3	0.020	0.010	0.010	0.011	0.005	0.41	6.4	0.41	82
lower East Prairie River	17-Aug-21	12:50	8.52	507	10.80	110.6	16.8	0.010	0.010	0.010	0.011	0.005	0.25	6.6	0.25	55
lower East Prairie River	14-Sep-21	12:35	8.08	435	9.29	97.3	14.0	0.056	0.022	0.010	0.011	0.005	0.79	14.2	0.79	-
lower East Prairie River	19-Oct-21	13:05	8.49	420	12.92	105.1	4.0	0.034	0.010	0.010	0.011	0.005	0.28	8.8	0.28	26
upper Swan River River	28-Apr-21	10:35	7.94	196.9	12.64	96.3	0.8	0.027	0.021	0.010	0.011	0.005	0.39	13.6	0.39	5
upper Swan River River	12-May-21	10:35	7.34	102.5	11.50	100.4	5.5	0.050	0.010	0.010	0.011	0.005	0.66	59.6	0.66	3
upper Swan River River	27-May-21	10:15	7.77	133.7	10.12	98.9	10.2	0.021	0.010	0.010	0.011	0.005	0.34	17.3	0.34	20
upper Swan River River	09-Jun-21	10:30	7.93	171.5	10.09	99.2	10.9	0.021	0.010	0.020	0.011	0.005	0.10	9.4	0.10	14
upper Swan River River	23-Jun-21	10:20	7.94	123.2	9.29	102.9	16.0	0.010	0.010	0.010	0.011	0.005	0.10	7.6	0.10	26
upper Swan River River	08-Jul-21	10:15	8.20	231	8.61	106.6	21.4	0.010	0.010	0.010	0.011	0.005	0.22	1.5	0.22	44
upper Swan River River	21-Jul-21	10:25	8.10	206.4	9.16	102.7	16.1	0.010	0.010	0.010	0.011	0.005	0.38	5	0.38	28
upper Swan River River	18-Aug-21	10:10	8.21	276	9.82	105.1	14.1	0.010	0.010	0.010	0.011	0.005	0.35	3.2	0.35	54
upper Swan River River	15-Sep-21	10:25	8.23	233	10.20	103.1	10.9	0.010	0.010	0.010	0.011	0.005	0.10	10.6	0.10	0.5
upper Swan River River	20-Oct-21	10:20	7.82	250	12.91	163.3	2.2	0.010	0.010	0.010	0.011	0.005	0.10	1.5	0.10	4
middle Swan River	28-Apr-21	11:20	8.26	148.9	12.82	97.7	0.8	0.035	0.029	0.099	0.099	0.005	0.35	10	0.45	5
middle Swan River	12-May-21	11:15	7.68	87.1	11.38	99.7	6.8	0.065	0.010	0.080	0.080	0.005	0.77	74.8	0.85	9
middle Swan River	27-May-21	11:00	7.84	129.5	9.61	97.7	12.6	0.034	0.010	0.010	0.011	0.005	0.44	19.9	0.44	5
middle Swan River	09-Jun-21	11:00	7.89	167.5	9.82	98.5	12.5	0.030	0.010	0.010	0.011	0.005	0.10	11.2	0.10	40
middle Swan River	23-Jun-21	11:00	7.86	145.1	9.01	101.9	17.7	0.031	0.010	0.010	0.011	0.005	0.10	10.4	0.10	120
middle Swan River	08-Jul-21	10:55	8.03	244	7.75	97.7	23.1	0.024	0.010	0.010	0.011	0.005	0.3	1.5	0.3	33
middle Swan River	21-Jul-21	11:05	8.06	222	8.75	97.9	17.3	0.022	0.010	0.010	0.011	0.005	0.38	5.8	0.38	17
middle Swan River	18-Aug-21	10:55	8.28	311	9.49	104.5	16.5	0.010	0.010	0.010	0.011	0.005	0.10	5	0.10	10
middle Swan River	15-Sep-21	11:00	8.09	232	9.92	101.0	12.5	0.024	0.010	0.010	0.011	0.005	0.23	4.2	0.23	4
middle Swan River	20-Oct-21	11:05	8.14	267	12.47	100.4	3.2	0.022	0.010	0.010	0.011	0.005	0.10	3.2	0.10	4
lower Swan River	28-Apr-21	12:10	7.81	149.8	12.31	96.8	2.8	0.050	0.030	0.109	0.109	0.005	0.35	21.8	0.46	20
lower Swan River	12-May-21	12:00	7.67	86.1	10.36	96.5	8.9	0.084	0.010	0.079	0.079	0.005	0.84	106	0.92	7
lower Swan River	27-May-21	11:35	7.48	125.1	9.39	96.1	13.0	0.039	0.010	0.010	0.011	0.005	0.3	32.5	0.3	10

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lower Swan River	09-Jun-21	12:00	7.38	180.7	9.18	92.8	12.9	0.053	0.010	0.010	0.011	0.005	0.10	26.6	0.10	18
lower Swan River	23-Jun-21	11:50	6.50	144.2	7.32	97.3	19.4	0.041	0.010	0.010	0.011	0.005	0.22	24.6	0.22	36
lower Swan River	08-Jul-21	11:55	7.55	281	7.74	99.2	23.4	0.060	0.010	0.010	0.011	0.005	0.38	6	0.38	32
lower Swan River	21-Jul-21	11:45	7.81	227	8.71	98.3	17.9	0.038	0.010	0.010	0.011	0.005	0.4	17.8	0.4	28
lower Swan River	18-Aug-21	11:45	7.83	377	8.94	97.3	16.0	0.026	0.010	0.010	0.011	0.005	0.10	267	0.10	44
lower Swan River	15-Sep-21	11:40	7.91	248	10.16	102.5	12.2	0.034	0.022	0.010	0.011	0.005	0.26	5.8	0.26	100
lower Swan River	20-Oct-21	11:45	8.19	303	12.28	97.6	2.5	0.031	0.024	0.010	0.011	0.005	0.25	8	0.25	2
upper Driftpile River	28-Apr-21	14:10	8.00	136.7	12.92	99.1	1.6	0.039	0.030	0.102	0.102	0.005	0.36	9.4	0.46	5
upper Driftpile River	12-May-21	13:55	7.27	85.3	11.17	101.2	7.8	0.055	0.010	0.065	0.065	0.005	0.8	44.2	0.86	23
upper Driftpile River	27-May-21	13:30	7.84	127.4	9.65	98.9	12.5	0.027	0.010	0.010	0.011	0.005	0.49	9.7	0.49	5
upper Driftpile River	09-Jun-21	14:35	7.89	174	9.54	100.5	14.2	0.032	0.010	0.010	0.011	0.005	0.10	11.4	0.10	44
upper Driftpile River	23-Jun-21	13:50	7.82	131.4	8.83	102.4	19.0	0.034	0.010	0.010	0.011	0.005	0.27	8.2	0.27	28
upper Driftpile River	08-Jul-21	13:45	0.35	292	8.91	118.4	25.6	0.026	0.010	0.010	0.011	0.005	0.29	6.4	0.29	8
upper Driftpile River	21-Jul-21	13:40	8.26	264	9.59	110.2	18.5	0.010	0.010	0.010	0.011	0.005	0.42	1.5	0.42	29
upper Driftpile River	18-Aug-21	14:00	8.28	355	11.10	122.6	16.7	0.021	0.010	0.010	0.011	0.005	0.2	3.8	0.2	10
upper Driftpile River	15-Sep-21	13:30	8.23	212	10.33	105.5	12.6	0.030	0.021	0.010	0.011	0.005	0.33	5.2	0.33	4
upper Driftpile River	20-Oct-21	13:10	8.16	289	12.03	98.2	3.5	0.026	0.010	0.010	0.011	0.005	0.24	4.6	0.24	2
middle Driftpile River	28-Apr-21	13:35	7.74	143.1	12.10	98.0	2.0	0.051	0.036	0.143	0.143	0.005	0.45	17.2	0.59	5
middle Driftpile River	12-May-21	13:20	7.52	87.1	11.17	100.0	7.7	0.077	0.010	0.068	0.068	0.005	0.92	78.2	0.99	12
middle Driftpile River	27-May-21	13:00	7.71	129.9	9.52	98.0	13.0	0.034	0.010	0.010	0.011	0.005	0.49	17.3	0.49	20
middle Driftpile River	09-Jun-21	14:10	7.76	182.8	9.41	98.5	14.3	0.046	0.010	0.010	0.011	0.005	0.10	25.6	0.10	32
middle Driftpile River	23-Jun-21	13:25	7.68	136.4	8.53	99.3	19.3	0.040	0.010	0.010	0.011	0.005	0.35	18.6	0.35	30
middle Driftpile River	08-Jul-21	13:20	7.98	320	8.36	111.1	25.9	0.026	0.010	0.010	0.011	0.005	0.34	3.2	0.34	20
middle Driftpile River	21-Jul-21	13:20	8.18	291	9.45	108.1	18.4	0.010	0.010	0.010	0.011	0.005	0.56	3	0.56	25
middle Driftpile River	18-Aug-21	13:40	8.12	394	9.45	104.0	16.5	0.010	0.010	0.010	0.011	0.005	0.2	5.4	0.20	5
middle Driftpile River	15-Sep-21	13:05	7.99	224	10.05	100.9	11.8	0.034	0.021	0.010	0.011	0.005	0.35	6.8	0.35	2
middle Driftpile River	20-Oct-21	13:30	8.09	311	11.99	98.2	3.9	0.028	0.010	0.010	0.011	0.005	0.27	4.8	0.27	0.5
lower Driftpile River	28-Apr-21	13:10	7.82	138.4	12.49	96.4	2.1	0.071	0.037	0.173	0.173	0.005	0.54	28.2	0.71	5
lower Driftpile River	12-May-21	13:00	7.05	86	10.61	97.8	8.9	0.104	0.010	0.066	0.066	0.005	0.91	106	0.98	8

Lesser Slave Watershed 2021 Water Monitoring Report

Site	Date	Time	pH units	Cond μ S/cm	DO mg/L	Oxygen Sat. %	Temp $^{\circ}$ C	TP mg/L	TDP mg/L	NO ₃ -N mg/L	NO ₃ -N+NO ₂ -N mg/L	NO ₂ -N mg/L	TKN mg/L	TSS mg/L	TN mg/L	FCB cfu/100 mL
lower Driftpile River	27-May-21	12:35	7.66	132.7	9.25	95.3	13.3	0.035	0.010	0.010	0.011	0.005	0.55	30.9	0.55	20
lower Driftpile River	09-Jun-21	13:45	7.69	191.4	9.06	94.3	14.2	0.049	0.020	0.010	0.011	0.005	0.10	30.2	0.10	12
lower Driftpile River	23-Jun-21	13:00	7.38	135.5	8.11	94.8	19.5	0.053	0.010	0.010	0.011	0.005	0.47	33	0.47	44
lower Driftpile River	08-Jul-21	12:55	7.78	341	7.77	100.6	23.8	0.035	0.010	0.010	0.011	0.005	0.4	4.4	0.4	0.5
lower Driftpile River	21-Jul-21	13:00	8.00	307	8.84	99.8	17.7	0.027	0.010	0.020	0.011	0.005	0.44	7.8	0.46	28
lower Driftpile River	18-Aug-21	13:05	7.90	479	9.31	100.4	15.7	0.031	0.010	0.010	0.011	0.005	0.27	1.5	0.27	6
lower Driftpile River	15-Sep-21	12:35	7.91	226	9.99	99.2	11.5	0.038	0.010	0.010	0.011	0.005	0.36	11.4	0.36	6
lower Driftpile River	20-Oct-21	12:40	8.01	342	11.95	95.9	2.9	0.032	0.010	0.010	0.011	0.005	0.33	4	0.33	4
Lesser Slave River	28-Apr-21	13:35	7.86	187	13.06	99.5	4.3	0.010	0.010	0.032	0.032	0.005	0.77	4	0.81	7
Lesser Slave River	12-May-21	10:00	7.95	168	13.07	107.8	7.9	0.010	0.010	0.032	0.032	0.005	0.60	5.2	0.63	0.5
Lesser Slave River	26-May-21	13:30	7.94	170	12.15	111.4	12.3	0.010	0.010	0.040	0.04	0.005	0.27	5.8	0.31	0.5
Lesser Slave River	10-Jun-21	11:10	8.29	116	10.59	101.8	14.5	0.033	0.010	0.060	0.06	0.005	0.10	8.8	0.10	0.5
Lesser Slave River	22-Jun-21	11:00	8.09	179	10.71	117.0	19.9	0.010	0.010	0.010	0.011	0.005	0.31	26.2	0.31	4
Lesser Slave River	06-Jul-21	13:30	8.03	172	7.77	110.6	21.0	0.010	0.010	0.010	0.011	0.005	0.51	3.2	0.51	0.5
Lesser Slave River	21-Jul-21	9:15	8.01	168	9.21	97.1	18.8	0.010	0.010	0.010	0.011	0.005	0.47	1.5	0.47	30
Lesser Slave River	18-Aug-21	9:45	8.16	177				0.010	0.010	0.010	0.011	0.005	1.36	8.16	1.36	13
Lesser Slave River	15-Sep-21	14:00	8.07	175	11.28	107.9	13.6	0.031	0.010	0.010	0.011	0.005	0.33	29	0.33	10
Lesser Slave River	20-Oct-21	10:30	8.07	171	12.82	99.1	5.2	0.023	0.010	0.010	0.011	0.005	0.55	9.4	0.55	15

Abbreviations: Cond = Specific Conductivity; DO = Dissolved Oxygen; Oxygen Sat = Oxygen Saturation; Temp = Water Temperature; TP = Total Phosphorus; TDP = Total Dissolved Phosphorus; NO₃-N = Nitrate NO₂-N = Nitrite; NO₃-N+NO₂-N = Nitrate + Nitrite; TKN = Total Kjeldahl Nitrogen; TSS = Total Suspended Solids; TN = Total Nitrogen; FCB = Fecal Coliform Bacteria

Appendix B-2: Total Metals Data at Swan River Sites, April-October 2021.

Site	Date	Time	TOTAL METALS											
			Mercury (µg/L)	Aluminum (µg/L)	Antimony (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Boron (µg/L)	Cadmium (µg/L)	Calcium (mg/L)	Hexavalent Chromium (µg/L)	Chromium (µg/L)	Copper (µg/L)	
upper Swan River	28-Apr-21	10:35	0.0025	284	0.16	1.02	65.7	5	0.0242	20.8	0.25	0.43	1.89	
upper Swan River	26-May-21	10:15	0.0025	338	0.15	0.99	49.7	12	0.0251	14.1	0.25	0.52	2.5	
upper Swan River	23-Jun-21	10:20	0.0025	188	0.21	1.15	57.3	11	0.0171	18	0.25	0.35	2.33	
upper Swan River	21-Jul-21	10:25	0.0025	231	0.2	1.44	69.5	11	0.0199	23.7	0.25	0.45	2.36	
upper Swan River	18-Aug-21	10:10	0.0025	26.9	0.12	1.51	79.7	14	0.0165	28.4	0.25	0.14	0.96	
upper Swan River	15-Sep-21	10:25	0.0025	78.8	0.15	1.45	67.4	5	0.0214	25.2	0.25	0.25	1.44	
upper Swan River	20-Oct-21	10:20	0.0025	64.3	0.11	1.25	78.9	5	0.0118	26.9	1.24	0.17	0.99	
middle Swan River	28-Apr-21	11:20	0.0025	420	0.14	1.03	57.2	13	0.0320	14.8	0.25	0.64	2.45	
middle Swan River	26-May-21	11:00	0.0025	265	0.15	1.02	52.4	15	0.0264	13.3	0.25	0.50	2.78	
middle Swan River	23-Jun-21	11:00	0.0025	765	0.23	1.32	62.8	14	0.0343	14.5	0.25	1.14	3.17	
middle Swan River	21-Jul-21	11:05	0.0025	270	0.18	1.52	72.9	15	0.0249	23.1	0.25	0.53	2.19	
middle Swan River	18-Aug-21	10:55	0.0025	41.2	0.14	1.28	81.8	22	0.0154	32.5	0.25	0.31	1.15	
middle Swan River	15-Sep-21	11:00	0.0025	76.2	0.13	1.68	70.2	18	0.0221	23.7	0.25	0.31	1.66	
middle Swan River	20-Oct-21	11:05	0.0025	23.6	0.05	1.13	77.8	19	0.0122	28.5	1.5	0.17	0.78	
lower Swan River	28-Apr-21	12:10	0.0025	452	0.2	1.14	60.9	13	0.0317	14.8	0.25	0.70	2.95	
lower Swan River	26-May-21	11:35	0.0072	548	0.17	1.26	57.2	14	0.0251	12.8	0.25	0.88	3.52	
lower Swan River	23-Jun-21	11:50	0.0025	554	0.21	1.51	66.5	13	0.0313	14.9	0.25	0.98	3.7	
lower Swan River	21-Jul-21	11:45	0.0025	347	0.2	1.65	84.9	16	0.0289	23.9	0.25	0.61	2.53	
lower Swan River	18-Aug-21	11:45	0.0025	42.3	0.13	1.36	116	22	0.0265	43.6	0.25	0.16	1.24	
lower Swan River	15-Sep-21	11:40	0.0025	114	0.17	1.77	80.3	16	0.0322	25.4	0.25	0.35	1.94	
lower Swan River	20-Oct-21	11:45	0.0025	43.1	0.05	1.29	90.9	22	0.0217	38.9	1.82	0.16	1.04	
Notes:														
			0.0183	Red fill indicates exceedance of chronic and acute Protection of Aquatic Life guidelines										
			0.019	Red font indicates exceedance of chronic Protection of Aquatic Life guidelines										
			Total copper - chronic PAL guideline only applies to water with a hardness ≥ 50 mg/L CaCO ₃											
			Total cadmium, total copper, total lead, total nickel, dissolved zinc and dissolved manganese PAL guidelines vary with hardness (see GoA 2018, CCME 2018 and CCME 2019 to determine appropriate PAL guidelines)											

Appendix B-2: Total Metals Data at Swan River Sites, April-October 2021.

Site	Date	Time	TOTAL METALS										
			Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)	Selenium (µg/L)	Silver (µg/L)	Sodium (mg/L)	Uranium (µg/L)	Zinc (µg/L)
upper Swan River	28-Apr-21	10:35	1330	0.360	3880	126	2.98	1660	0.121	0.005	12.1	0.408	3.1
upper Swan River	26-May-21	10:15	933	0.425	2610	48.4	3.17	1180	0.098	0.005	6.74	0.231	3.3
upper Swan River	23-Jun-21	10:20	782	0.266	3150	35.6	3.11	1310	0.115	0.005	8.88	0.26	1.5
upper Swan River	21-Jul-21	10:25	987	0.293	3890	54	3.56	1690	0.128	0.005	11.5	0.33	1.5
upper Swan River	18-Aug-21	10:10	1220	0.069	5030	74.9	3.39	1980	0.096	0.005	13.7	0.335	1.5
upper Swan River	15-Sep-21	10:25	1150	0.140	4510	71.1	2.88	1540	0.102	0.005	11.5	0.319	1.5
upper Swan River	20-Oct-21	10:20	1700	0.129	5210	140	2.75	1650	0.058	0.005	13.7	0.455	1.5
middle Swan River	28-Apr-21	11:20	1810	0.417	2970	127	4.02	1860	0.097	0.005	8.77	0.31	4.1
middle Swan River	26-May-21	11:00	1220	0.536	2640	67.6	4.09	1460	0.11	0.005	6.84	0.252	10.3
middle Swan River	23-Jun-21	11:00	1500	0.452	2960	60	5.05	1610	0.161	0.01	7.98	0.286	4
middle Swan River	21-Jul-21	11:05	1370	0.375	4030	78.2	4.16	2000	0.121	0.005	11.2	0.376	1.5
middle Swan River	18-Aug-21	10:55	672	0.134	6220	98.8	3.21	2400	0.091	0.005	14.2	0.455	1.5
middle Swan River	15-Sep-21	11:00	1870	0.196	4760	77.2	4.01	1910	0.1	0.005	11.1	0.358	1.5
middle Swan River	20-Oct-21	11:05	2300	0.079	6070	55.9	2.99	1990	0.094	0.005	13.4	0.401	1.5
lower Swan River	28-Apr-21	12:10	2110	0.592	3080	72	47.5	2040	0.106	0.01	8.78	0.318	4.6
lower Swan River	26-May-21	11:35	1680	0.794	2650	57.8	4.72	1560	0.14	0.005	6.59	0.259	5.8
lower Swan River	23-Jun-21	11:50	1810	0.713	3170	82.6	5.65	1630	0.131	0.005	7.49	0.302	5.3
lower Swan River	21-Jul-21	11:45	1890	0.572	4500	264	4.81	2180	0.16	0.012	11.3	0.533	4.3
lower Swan River	18-Aug-21	11:45	1650	0.063	8860	378	4.29	2900	0.109	0.005	13.5	1.19	1.5
lower Swan River	15-Sep-21	11:40	2090	0.271	5240	75.2	4.11	1970	0.111	0.005	10.1	0.59	1.5
lower Swan River	20-Oct-21	11:45	2870	0.123	7150	146	3.44	2230	0.097	0.005	13	0.754	3.6

Notes:

0.0183	Red fill indicates exceedance of chronic and acute Protection of Aquatic Life guidelines
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0.019	Red font indicates exceedance of chronic Protection of Aquatic Life guidelines
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Total copper - chronic PAL guideline only applies to water with a hardness ≥ 50 mg/L CaCO_3	
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Total cadmium, total copper, total lead, total nickel, dissolved zinc and dissolved manganese PAL guidelines	
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vary with hardness (see GoA 2018, CCME 2018 and CCME 2019 to determine appropriate PAL guidelines)	
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Appendix B-2: Dissolved Metals Data at Swan River Sites, April-October 2021.

Site	Date	Time	DISSOLVED METALS										
			Mercury (µg/L)	Aluminum (µg/L)	Antimony (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Boron (µg/L)	Cadmium (µg/L)	Calcium (mg/L)	Chromium (µg/L)	Copper (µg/L)	
upper Swan River	28-Apr-21	10:35	0.0025	35.9	0.14	0.65	56.7	5	0.0115	20	0.15	1.36	
upper Swan River	26-May-21	10:15	0.0025	44.1	0.15	0.71	44.1	5	0.0092	14.1	0.16	1.86	
upper Swan River	23-Jun-21	10:20	0.0025	30.4	0.2	0.95	53.4	5	0.01	18.5	0.17	1.99	
upper Swan River	21-Jul-21	10:25	0.0025	39.1	0.2	1.17	62.5	12	0.0116	21.1	0.12	1.70	
upper Swan River	18-Aug-21	10:10	0.0025	5.2	0.13	1.36	80.1	17	0.0098	29.4	0.5	0.93	
upper Swan River	15-Sep-21	10:25	0.0025	10.2	0.15	1.27	62.3	5	0.0091	26.6	0.5	1.18	
upper Swan River	20-Oct-21	10:20	0.0025	4.6	0.005	0.88	65.1	13	0.0075	27.1	0.5	0.63	
middle Swan River	28-Apr-21	11:20	0.0025	67.8	0.13	0.64	49.4	12	0.0162	14.2	0.23	1.83	
middle Swan River	26-May-21	11:00	0.0025	51.4	0.15	0.75	46.7	12	0.0143	12.8	0.24	2.22	
middle Swan River	23-Jun-21	11:00	0.0025	55.7	0.2	0.92	54.2	14	0.0189	15.1	0.25	2.50	
middle Swan River	21-Jul-21	11:05	0.0025	24.8	0.19	1.15	65	16	0.0122	21.6	0.11	1.71	
middle Swan River	18-Aug-21	10:55	0.0025	3.4	0.13	0.95	81.5	24	0.0025	33.3	0.5	0.88	
middle Swan River	15-Sep-21	11:00	0.0025	17.9	0.1	1.51	68.9	14	0.0153	21.8	0.14	1.52	
middle Swan River	20-Oct-21	11:05	0.0025	3.5	0.005	0.89	69.5	19	0.0061	27.6	0.5	0.60	
lower Swan River	28-Apr-21	12:10	0.0025	61	0.11	0.7	51	14	0.0147	14.5	0.23	2.18	
lower Swan River	26-May-21	11:35	0.0025	47.5	0.17	0.67	45.5	11	0.0103	12.4	0.23	2.39	
lower Swan River	23-Jun-21	11:50	0.0025	45.7	0.19	0.9	54	13	0.0141	15.1	0.25	2.69	
lower Swan River	21-Jul-21	11:45	0.0025	20.4	0.18	1.08	72.2	18	0.0138	22.8	0.11	1.74	
lower Swan River	18-Aug-21	11:45	0.0025	3.3	0.12	0.89	113	24	0.0135	44.4	0.5	1.07	
lower Swan River	15-Sep-21	11:40	0.0025	19	0.16	1.46	79.6	16	0.0161	26.8	0.14	1.71	
lower Swan River	20-Oct-21	11:45	0.0025	3.4	0.005	0.95	78.7	18	0.0086	32.8	0.5	0.69	
Notes:													
			0.0183	Red fill indicates exceedance of chronic and acute Protection of Aquatic Life guidelines									
			0.019	Red font indicates exceedance of chronic Protection of Aquatic Life guidelines									
			Total copper - chronic PAL guideline only applies to water with a hardness ≥ 50 mg/L CaCO ₃										
			Total cadmium, total copper, total lead, total nickel, dissolved zinc and dissolved manganese PAL guidelines vary with hardness (see GoA 2018, CCME 2018 and CCME 2019 to determine appropriate PAL guidelines)										

Appendix B-2: Dissolved Metals Data at Swan River Sites, April-October 2021.

Site	Date	Time	DISSOLVED METALS										
			Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)	Selenium (µg/L)	Silver (µg/L)	Sodium (mg/L)	Uranium (µg/L)	Zinc (µg/L)
upper Swan River	28-Apr-21	10:35	603	0.101	3660	102	2.55	1550	0.096	0.005	11.2	0.392	0.5
upper Swan River	26-May-21	10:15	342	0.107	2480	25.5	2.61	1100	0.114	0.005	6.92	0.193	0.5
upper Swan River	23-Jun-21	10:20	385	0.094	3180	202	2.83	1280	0.121	0.005	8.91	0.236	0.5
upper Swan River	21-Jul-21	10:25	485	0.094	3560	34.9	3.35	1540	0.107	0.005	10.5	0.347	0.5
upper Swan River	18-Aug-21	10:10	813	0.025	5000	45.4	3.15	1990	0.085	0.005	13.6	0.332	0.5
upper Swan River	15-Sep-21	10:25	834	0.072	4300	35.9	2.53	1570	0.097	0.005	11.3	0.326	0.5
upper Swan River	20-Oct-21	10:20	925	0.025	4750	52.9	2.14	1520	0.075	0.005	13.5	0.404	0.5
middle Swan River	28-Apr-21	11:20	848	0.145	2870	104	3.48	1750	0.083	0.005	8.69	0.264	1
middle Swan River	26-May-21	11:00	539	0.146	2450	32.5	3.46	1390	0.115	0.005	6.92	0.2	0.5
middle Swan River	23-Jun-21	11:00	602	0.148	2830	28.5	4.33	1470	0.136	0.005	7.92	0.241	0.5
middle Swan River	21-Jul-21	11:05	636	0.117	3880	14	3.81	1930	0.149	0.005	10.9	0.382	0.5
middle Swan River	18-Aug-21	10:55	198	0.025	6250	33.2	2.86	2380	0.109	0.005	13.9	0.433	0.5
middle Swan River	15-Sep-21	11:00	1380	0.103	4940	46.2	3.77	2010	0.126	0.005	11.8	0.303	0.5
middle Swan River	20-Oct-21	11:05	1390	0.025	5380	16.2	2.54	1890	0.084	0.005	13.4	0.353	0.5
lower Swan River	28-Apr-21	12:10	866	0.154	3200	7.5	3.85	2090	0.063	0.005	9.21	0.255	0.5
lower Swan River	26-May-21	11:35	472	0.16	2490	8.13	3.62	1430	0.131	0.005	6.77	0.174	0.5
lower Swan River	23-Jun-21	11:50	532	0.159	2890	24.7	4.33	1500	0.152	0.005	7.21	0.224	0.5
lower Swan River	21-Jul-21	11:45	793	0.144	4220	83.9	4.06	2050	0.113	0.005	10.6	0.516	0.5
lower Swan River	18-Aug-21	11:45	575	0.025	8730	314	3.85	2820	0.12	0.005	13.2	1.17	0.5
lower Swan River	15-Sep-21	11:40	1370	0.146	5100	40.1	3.82	2060	0.14	0.005	10.4	0.571	0.5
lower Swan River	20-Oct-21	11:45	1660	0.025	6520	26.3	2.94	2100	0.089	0.005	13.1	0.669	0.5

Notes:

0.0183 Red fill indicates exceedance of chronic and acute Protection of Aquatic Life guidelines

0.019 Red font indicates exceedance of chronic Protection of Aquatic Life guidelines

Total copper - chronic PAL guideline only applies to water with a hardness ≥ 50 mg/L CaCO_3

Total cadmium, total copper, total lead, total nickel, dissolved zinc and dissolved manganese PAL guidelines

vary with hardness (see GoA 2018, CCME 2018 and CCME 2019 to determine appropriate PAL guidelines)

Appendix B-2: Miscellaneous Water Quality Data at Swan River Sites, April-October 2021.

Site	Date	Time	MISCELLANEOUS PARAMETERS							Notes:
			Total Dissolved Solids (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Hardness CaCO3 (mg/L)	Sulfate SO4 (mg/L)	Bicarbonate HCO3 (mg/L)	Alkalinity CaCO3 (mg/L)	
upper Swan River	28-Apr-21	10:35	96.1	2.54	0.052	65	9.26	97.4	79.8	
upper Swan River	26-May-21	10:15	61	0.96	0.055	45.4	4.88	62.1	50.9	
upper Swan River	23-Jun-21	10:20	81.1	1.63	0.070	59.3	5.6	85.2	69.8	
upper Swan River	21-Jul-21	10:25	95.5	1.14	0.035	67.3	6	166	86	
upper Swan River	18-Aug-21	10:10	127	0.72	0.087	94	5.62	144	118	
upper Swan River	15-Sep-21	10:25	113	0.82	0.071	84.1	5.76	128	105	
upper Swan River	20-Oct-21	10:20	120	0.84	0.064	87.2	7.11	134	110	
middle Swan River	28-Apr-21	11:20	71.6	1.55	0.044	47.3	6.69	71.9	58.9	
middle Swan River	26-May-21	11:00	58.5	0.91	0.053	42.1	4.43	60	49.2	
middle Swan River	23-Jun-21	11:00	67.2	1.29	0.059	49.4	4.19	69.8	57.2	
middle Swan River	21-Jul-21	11:05	99.8	1.11	0.048	69.9	6.11	110	90.4	
middle Swan River	18-Aug-21	10:55	141	1.7	0.096	109	5.53	157	129	
middle Swan River	15-Sep-21	11:00	104	0.99	0.079	74.8	5.41	116	95.3	
middle Swan River	20-Oct-21	11:05	123	1.23	0.079	91.1	5.8	138	113	
lower Swan River	28-Apr-21	12:10	72.5	1.55	0.045	49.4	6.83	70.4	57.7	
lower Swan River	26-May-21	11:35	56.7	0.87	0.052	41.2	4.48	57.3	47	
lower Swan River	23-Jun-21	11:50	65.6	1.22	0.057	49.6	4.31	67.8	55.6	
lower Swan River	21-Jul-21	11:45	110	1.29	0.048	74.3	5.96	128	105	
lower Swan River	18-Aug-21	11:45	176	1.7	0.088	147	5.63	200	164	
lower Swan River	15-Sep-21	11:40	114	1.1	0.074	87.9	5.87	127	104	
lower Swan River	20-Oct-21	11:45	140	1.67	0.0076	109	6.02	157	129	
Provincial Protection of Aquatic Life (PAL) Guidelines for Metals (Total and Dissolved) and Other Parameters.										
Parameter	PAL Guideline		Parameter	PAL Guideline		Parameter	PAL Guideline			
	Chronic	Acute		Chronic	Acute		Chronic	Acute		
Total Mercury	0.005	0.013	Total Selenium	2.0		Alkalinity (mg/L)	20			
Total Arsenic	5.0		Total Silver	0.25		Chloride (mg/L)	120	640		
Total Boron	1,500	29,000	Total Uranium	15	33	Fluoride (mg/L)	0.12			
Total Cadmium	0.07 to 0.22	0.83 to 3.1	Total Zinc	30		Sulfate (SO ₄) (mg/L)	218 to 309			
Hexavalent Chromium	1.0		Dissolved Aluminum	50	100	Notes: 1) All guidelines are µg/L unless noted. 2) All guidelines are provincial (GoA 2018) except dissolved zinc and dissolved manganese (federal: CCME 2018)				
Total Copper	7	6.5 to 23.0	Dissolved Iron	300						
Total Lead	1.0 to 5.1		Dissolved Manganese	240 to 430	3056 to 9336					
Total Nickel	16 to 94	145 to 840	Dissolved Zinc	15 to 52	82 to 206					

Appendix B-3: Total Metals Data at West Prairie, East Prairie and Driftpile River Sites, April-October 2021.

Site	Date	Time	TOTAL METALS											
			Mercury (µg/L)	Aluminum (µg/L)	Antimony (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Boron (µg/L)	Cadmium (µg/L)	Calcium (mg/L)	Hexavalent Chromium (µg/L)	Chromium (µg/L)	Copper (µg/L)	
upper West Prairie River	27-Apr-21	9:10	0.0098	1090	0.19	1.67	70.5	13	0.0593	15.1	0.25	1.73	4.86	
upper West Prairie River	25-May-21	9:05	0.0062	1070	0.18	1.60	66.2	16	0.0512	13.5	0.25	1.87	5.07	
upper West Prairie River	22-Jun-21	9:15	0.005	416	0.17	1.18	54.5	15	0.0303	17.9	0.25	0.87	3.51	
upper West Prairie River	20-Jul-21	9:25	0.0025	32.2	0.24	1.02	104	23	0.0183	46.3	0.25	0.11	1.57	
upper West Prairie River	17-Aug-21	9:15	0.0025	59.8	0.15	1.16	142	40	0.0275	66.4	0.25	0.26	1.48	
upper West Prairie River	14-Sep-21	9:25	0.0025	363	0.16	1.41	69.9	18	0.0363	22.1	0.25	0.73	3.38	
upper West Prairie River	19-Oct-21	9:30	0.0025	79.8	0.12	1.15	77.1	21	0.0291	40.2	0.25	0.28	1.64	
middle East Prairie River	27-Apr-21	14:30	0.0105	651	0.26	1.64	69.1	11	0.0489	18.7	0.25	1.1	4.88	
middle East Prairie River	25-May-21	13:20	0.0084	1520	0.24	2.46	94.5	14	0.0740	17.9	0.25	2.49	7.33	
upper East Prairie River	22-Jun-21	13:45	0.0025	271	0.23	1.29	71.3	12	0.0251	26	0.25	0.54	3.15	
middle East Prairie River	20-Jul-21	14:30	0.0025	72	0.29	1.44	91	14	0.0145	47.4	0.25	0.12	1.53	
middle East Prairie River	17-Aug-21	15:05	0.0025	30.8	0.23	1.36	104	22	0.0132	57	0.25	0.12	1.45	
middle East Prairie River	14-Sep-21	14:15	0.0025	335	0.24	1.80	79.9	13	0.0235	29.9	0.25	0.68	3.43	
middle East Prairie River	19-Oct-21	15:00	0.0025	58	0.14	1.40	79	33	0.0186	46.7	0.25	0.14	1.32	
middle Driftpile River	28-Apr-21	13:35	0.0078	485	0.17	1.17	59	12	0.0389	15.3	0.25	0.8	2.86	
middle Driftpile River	26-May-21	13:00	0.0025	401	0.16	1.16	56.4	14	0.0288	14.7	0.25	0.7	4.33	
middle Driftpile River	23-Jun-21	13:25	0.0025	503	0.21	1.53	65	13	0.0402	15.5	0.25	0.94	3.78	
middle Driftpile River	21-Jul-21	13:20	0.0025	82.2	0.20	1.42	88.5	17	0.0205	30.8	0.25	0.2	1.33	
middle Driftpile River	18-Aug-21	13:40	0.0025	63.8	0.16	1.38	116	30	0.0133	44.2	0.25	0.2	1.34	
middle Driftpile River	15-Sep-21	13:05	0.0025	183	0.21	1.81	79.5	16	0.0300	23.7	0.25	0.53	2.71	
middle Driftpile River	20-Oct-21	13:30	0.0025	43.8	0.13	1.67	103	15	0.0174	29	2.22	0.2	1.28	
Notes:														
			0.0183	Red fill indicates exceedance of chronic and acute Protection of Aquatic Life guidelines										
			0.019	Red font indicates exceedance of chronic Protection of Aquatic Life guidelines										
			Total copper - chronic PAL guideline only applies to water with a hardness ≥ 50 mg/L CaCO ₃											
			Total cadmium, total copper, total lead, total nickel, dissolved zinc and dissolved manganese PAL guidelines vary with hardness (see GoA 2018, CCME 2018 and CCME 2019 to determine appropriate PAL guidelines)											

Appendix B-3: Total Metals Data at West Prairie, East Prairie and Driftpile River Sites, April-October 2021.

Site	Date	Time	TOTAL METALS											
			Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)	Selenium (µg/L)	Silver (µg/L)	Sodium (mg/L)	Uranium (µg/L)	Zinc (µg/L)	
upper West Prairie River	27-Apr-21	9:10	2750	1.38	3340	108	6.72	2540	0.71	0.022	7.71	0.507	10.4	
upper West Prairie River	25-May-21	9:05	2290	1.31	2940	57.8	7.24	1710	0.197	0.019	6.33	0.448	10.4	
upper West Prairie River	22-Jun-21	9:15	1250	0.568	3700	81	4.69	1320	0.178	0.005	8.14	0.411	4.9	
upper West Prairie River	20-Jul-21	9:25	544	0.083	11000	81.5	4.29	2390	0.205	0.005	13.6	1.52	1.5	
upper West Prairie River	17-Aug-21	9:15	934	0.119	14100	78	6.11	3430	0.185	0.005	15	2.21	1.5	
upper West Prairie River	14-Sep-21	9:25	1470	0.530	4960	56.6	5.87	1380	0.224	0.01	11.2	0.475	3.7	
upper West Prairie River	19-Oct-21	9:30	1710	0.189	8500	76.2	4.42	2020	0.175	0.005	14	1.01	1.5	
middle East Prairie River	27-Apr-21	14:30	2010	1.28	3450	85.5	5.81	2310	0.181	0.022	7.29	0.527	12.1	
middle East Prairie River	25-May-21	13:20	3490	2.30	3580	136	8.59	2290	0.247	0.025	6.83	0.49	13.7	
upper East Prairie River	22-Jun-21	13:45	980	0.457	4410	43.5	3.67	1630	0.163	0.005	10.3	0.624	3.2	
middle East Prairie River	20-Jul-21	14:30	356	0.129	9990	60.2	2.79	2650	0.188	0.005	13.5	2.45	1.5	
middle East Prairie River	17-Aug-21	15:05	390	0.062	11300	90.8	3.11	3180	0.166	0.005	16.7	2.29	1.5	
middle East Prairie River	14-Sep-21	14:15	1360	0.616	5500	43.2	4.81	2030	0.182	0.005	11	1.16	4.5	
middle East Prairie River	19-Oct-21	15:00	1290	0.141	8250	62.1	2.65	2180	0.087	0.005	14.2	1.69	1.5	
middle Driftpile River	28-Apr-21	13:35	1790	0.481	3200	101	4.57	2040	0.134	0.013	6.73	0.347	5.2	
middle Driftpile River	26-May-21	13:00	1340	0.524	3170	55.7	4.66	1620	0.164	0.005	5.85	0.319	5.5	
middle Driftpile River	23-Jun-21	13:25	1610	0.719	3270	52.9	6.06	1530	0.198	0.013	6.16	0.393	6.9	
middle Driftpile River	21-Jul-21	13:20	893	0.182	5730	65.4	3.49	2540	0.15	0.005	10.2	0.573	1.5	
middle Driftpile River	18-Aug-21	13:40	814	0.179	9550	184	3.51	3190	0.121	0.005	13.3	0.89	4.2	
middle Driftpile River	15-Sep-21	13:05	1690	0.440	4940	92.1	5.1	1880	0.16	0.005	8.55	0.537	1.5	
middle Driftpile River	20-Oct-21	13:30	2330	0.177	7710	90.5	3.66	2470	0.126	0.005	11.8	0.772	3.7	
			Notes:											
			0.0183	Red fill indicates exceedance of chronic and acute Protection of Aquatic Life guidelines										
			0.019	Red font indicates exceedance of chronic Protection of Aquatic Life guidelines										
			Total copper - chronic PAL guideline only applies to water with a hardness ≥ 50 mg/L CaCO ₃											
			Total cadmium, total copper, total lead, total nickel, dissolved zinc and dissolved manganese PAL guidelines vary with hardness (see GoA 2018, CCME 2018 and CCME 2019 to determine appropriate PAL guidelines)											

Appendix B-3: Dissolved Metals Data at West Prairie, East Prairie and Driftpile River Sites, April-October 2021.

Site	Date	Time	DISSOLVED METALS										
			Mercury (µg/L)	Aluminum (µg/L)	Antimony (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Boron (µg/L)	Cadmium (µg/L)	Calcium (mg/L)	Chromium (µg/L)	Copper (µg/L)	
upper West Prairie River	27-Apr-21	9:10	0.0066	97.2	0.28	0.61	44.6	15	0.022	14.9	0.34	2.49	
upper West Prairie River	25-May-21	9:05	0.0025	63.3	0.14	0.7	43.5	15	0.0199	13.1	0.31	2.88	
upper West Prairie River	22-Jun-21	9:15	0.0025	60.7	0.15	0.84	48.4	18	0.017	17.1	0.36	2.86	
upper West Prairie River	20-Jul-21	9:25	0.0025	29.9	0.24	1.05	109	26	0.0199	50.5	0.2	1.53	
upper West Prairie River	17-Aug-21	9:15	0.0025	2.1	0.15	0.85	135	36	0.0143	69	0.11	1.33	
upper West Prairie River	14-Sep-21	9:25	0.0025	72.4	0.15	1.1	59.4	19	0.0204	20.5	0.34	2.73	
upper West Prairie River	19-Oct-21	9:30	0.0025	18.3	0.005	1.04	81.7	23	0.0224	39.7	0.18	1.56	
middle East Prairie River	27-Apr-21	14:30	0.0025	55.1	0.3	0.7	45.4	14	0.0153	18.8	0.22	2.91	
middle East Prairie River	25-May-21	13:20	0.0025	18.4	0.18	0.74	49.5	11	0.0077	15.4	0.18	3.38	
upper East Prairie River	22-Jun-21	13:45	0.0025	26.3	0.22	0.98	65.5	13	0.0123	26	0.16	2.53	
middle East Prairie River	20-Jul-21	14:30	0.0025	2.5	0.3	1.14	91.7	17	0.0025	53.3	0.13	1.33	
middle East Prairie River	17-Aug-21	15:05	0.0025	0.5	0.22	1.1	100	19	0.0088	58.6	0.5	1.23	
middle East Prairie River	14-Sep-21	14:15	0.0025	16.9	0.22	1.3	70.8	14	0.0121	31	0.15	2.58	
middle East Prairie River	19-Oct-21	15:00	0.0025	3.9	0.12	0.88	84.9	14	0.0076	48.4	0.5	1.18	
middle Driftpile River	28-Apr-21	13:35	0.0052	80.3	0.19	0.75	49.8	12	0.0204	15.1	0.31	1.93	
middle Driftpile River	26-May-21	13:00	0.0025	70.5	0.16	0.81	49	12	0.0166	14.3	0.28	2.39	
middle Driftpile River	23-Jun-21	13:25	0.0025	101	0.2	1.02	55.2	12	0.0203	15.8	0.35	3.04	
middle Driftpile River	21-Jul-21	13:20	0.0025	5.3	0.2	1.28	83.5	18	0.0114	29.4	0.5	1.15	
middle Driftpile River	18-Aug-21	13:40	0.0025	3.1	0.15	0.96	116	33	0.0079	45.1	0.5	1.69	
middle Driftpile River	15-Sep-21	13:05	0.0025	45.9	0.2	1.58	75.8	16	0.0185	22.1	0.24	2.29	
middle Driftpile River	20-Oct-21	13:30	0.0025	5.9	0.12	1.24	87.2	19	0.0113	34.3	0.5	0.91	
Notes:													
			0.0183	Red fill indicates exceedance of chronic and acute Protection of Aquatic Life guidelines									
			0.019	Red font indicates exceedance of chronic Protection of Aquatic Life guidelines									
			Total copper - chronic PAL guideline only applies to water with a hardness ≥ 50 mg/L CaCO ₃										
			Total cadmium, total copper, total lead, total nickel, dissolved zinc and dissolved manganese PAL guidelines vary with hardness (see GoA 2018, CCME 2018 and CCME 2019 to determine appropriate PAL guidelines)										

Appendix B-3: Dissolved Metals Data at West Prairie, East Prairie and Driftpile River Sites, April-October 2021.

Site	Date	Time	DISSOLVED METALS											
			Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)	Selenium (µg/L)	Silver (µg/L)	Sodium (mg/L)	Uranium (µg/L)	Zinc (µg/L)	
upper West Prairie River	27-Apr-21	9:10	506	0.181	3010	49.6	4.19	2360	0.153	0.005	7.85	0.363	1	
upper West Prairie River	25-May-21	9:05	330	0.117	2620	4.21	4.94	1530	0.181	0.005	6.39	0.298	0.5	
upper West Prairie River	22-Jun-21	9:15	484	0.137	3610	3.38	4.18	1270	0.174	0.005	8.05	0.355	1.6	
upper West Prairie River	20-Jul-21	9:25	593	0.025	11200	82.9	4.49	2650	0.167	0.005	14.7	1.58	8	
upper West Prairie River	17-Aug-21	9:15	109	0.025	15100	199	5.7	3510	0.218	0.005	15.7	2.43	0.5	
upper West Prairie River	14-Sep-21	9:25	786	0.181	4770	15.5	4.95	1260	0.186	0.005	9.84	0.478	0.5	
upper West Prairie River	19-Oct-21	9:30	1420	0.12	9100	6.81	4.13	2170	0.136	0.005	14.8	1.02	1.7	
middle East Prairie River	27-Apr-21	14:30	393	0.183	3280	20.8	3.86	2240	0.15	0.005	7.59	0.398	0.5	
middle East Prairie River	25-May-21	13:20	218	0.097	3000	4.82	4.23	1900	0.189	0.005	6.83	0.218	0.5	
upper East Prairie River	22-Jun-21	13:45	341	0.118	4480	11.8	3.24	1650	0.192	0.005	10.7	0.594	0.5	
middle East Prairie River	20-Jul-21	14:30	37	0.025	10300	1.79	2.75	3030	0.167	0.005	14.8	2.42	0.5	
middle East Prairie River	17-Aug-21	15:05	25	0.025	11600	38.4	2.69	3180	0.199	0.005	15.9	2.39	0.5	
middle East Prairie River	14-Sep-21	14:15	463	0.151	5880	11.4	3.64	1960	0.211	0.005	11	1.25	0.5	
middle East Prairie River	19-Oct-21	15:00	408	0.025	9060	8.31	2.61	2490	0.101	0.005	15.4	1.71	0.5	
middle Driftpile River	28-Apr-21	13:35	765	0.18	3110	79	3.88	2020	0.147	0.005	6.75	0.34	1.2	
middle Driftpile River	26-May-21	13:00	559	0.156	3030	25.7	3.93	1510	0.142	0.005	5.76	0.274	1.3	
middle Driftpile River	23-Jun-21	13:25	583	0.268	2980	16	4.83	1400	0.18	0.005	5.98	0.33	5.3	
middle Driftpile River	21-Jul-21	13:20	527	0.067	5670	7.16	3.37	2550	0.124	0.005	10.3	0.62	1.4	
middle Driftpile River	18-Aug-21	13:40	169	0.025	9540	134	3.33	3150	0.149	0.005	12.7	0.868	1.4	
middle Driftpile River	15-Sep-21	13:05	1070	0.205	4720	76	4.58	1980	0.16	0.005	9.13	0.558	0.5	
middle Driftpile River	20-Oct-21	13:30	1400	0.082	6960	37	3.16	2300	0.096	0.005	11.7	0.651	1.2	
Notes:														
			0.0183	Red fill indicates exceedance of chronic and acute Protection of Aquatic Life guidelines										
			0.019	Red font indicates exceedance of chronic Protection of Aquatic Life guidelines										
			Total copper - chronic PAL guideline only applies to water with a hardness ≥ 50 mg/L CaCO ₃											
			Total cadmium, total copper, total lead, total nickel, dissolved zinc and dissolved manganese PAL guidelines vary with hardness (see GoA 2018, CCME 2018 and CCME 2019 to determine appropriate PAL guidelines)											

Appendix B-3: Misc. Water Quality Data at West Prairie, East Prairie and Driftpile River Sites, April-October 2021.

Site	Date	Time	MISCELLANEOUS PARAMETERS							Notes:
			Total Dissolved Solids (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Hardness CaCO ₃ (mg/L)	Sulfate SO ₄ (mg/L)	Bicarbonate HCO ₃ (mg/L)	Alkalinity CaCO ₃ (mg/L)	
upper West Prairie River	27-Apr-21	9:10	135	<0.50	0.036	49.6	8.11	57.8	47.4	1) The June 22 water sample was taken at the upper East Prairie River site.
upper West Prairie River	25-May-21	9:05	54.6	<0.50	0.04	43.5	6.81	49	40.2	
upper West Prairie River	22-Jun-21	9:15	73.2	<0.50	0.039	57.6	5.96	75.5	61.9	
upper West Prairie River	20-Jul-21	9:25	203	0.8	0.096	172	14.5	212	181	
upper West Prairie River	17-Aug-21	9:15	273	2.09	0.094	234	17.5	283	250	
upper West Prairie River	14-Sep-21	9:25	85.6	<0.50	0.043	70.8	7.5	84.8	69.5	
upper West Prairie River	19-Oct-21	9:30	169	0.74	0.065	137	14.1	179	147	
middle East Prairie River	27-Apr-21	14:30	151	0.68	0.05	60.5	8.74	69.1	56.6	
middle East Prairie River	25-May-21	13:20	67.9	<0.50	0.055	50.8	8.64	65.3	53.5	
upper East Prairie River	22-Jun-21	13:45	109	<0.50	0.067	83.4	7.27	120	98.1	
middle East Prairie River	20-Jul-21	14:30	206	1.19	0.105	176	12.1	217	186	
middle East Prairie River	17-Aug-21	15:05	229	1.29	0.112	194	15.1	234	206	
middle East Prairie River	14-Sep-21	14:15	126	0.6	0.062	102	10.9	131	107	
middle East Prairie River	19-Oct-21	15:00	196	1.31	0.076	158	15.5	209	172	
middle Driftpile River	28-Apr-21	13:35	70.3	<0.50	0.041	50.5	8.22	69.9	57.3	
middle Driftpile River	26-May-21	13:00	61.1	<0.50	0.047	48.2	6.8	107	49.5	
middle Driftpile River	23-Jun-21	13:25	62.1	<0.50	0.049	51.7	5.44	62	50.8	
middle Driftpile River	21-Jul-21	13:20	130	0.56	0.06	96.8	9.03	146	120	
middle Driftpile River	18-Aug-21	13:40	182	1.27	0.104	152	11.4	200	164	
middle Driftpile River	15-Sep-21	13:05	99	<0.50	0.062	74.6	8.72	106	87.2	
middle Driftpile River	20-Oct-21	13:30	146	0.59	0.09	114	10.5	161	132	

Provincial Protection of Aquatic Life (PAL) Guidelines for Metals (Total and Dissolved) and Other Parameters.

Parameter	PAL Guideline		Parameter	PAL Guideline		Parameter	PAL Guideline	
	Chronic	Acute		Chronic	Acute		Chronic	Acute
Total Mercury	0.005	0.013	Total Selenium	2.0		Alkalinity (mg/L)	20	
Total Arsenic	5.0		Total Silver	0.25		Chloride (mg/L)	120	640
Total Boron	1,500	29,000	Total Uranium	15	33	Fluoride (mg/L)	0.12	
Total Cadmium	0.08 to 0.32	0.93 to 5.0	Total Zinc	30		Sulfate (SO ₄) (mg/L)	218 to 429	
Hexavalent Chromium	1.0		Dissolved Aluminum	50	100	Notes: 1) All guidelines are µg/L unless noted. 2) All guidelines are provincial (GoA 2018) except dissolved zinc and dissolved manganese (federal: CCME 2018)		
Total Copper	7	7.3 to 37.0	Dissolved Iron	300				
Total Lead	1.0 to 7.0		Dissolved Manganese	180 to 390	3205 to 14041			
Total Nickel	16 to 94	145 to 840	Dissolved Zinc	21 to 79	87 to 334			

APPENDIX C. FIVE-YEAR TREND ASSESSMENT SUMMARY STATISTICS.

Monitoring Location	Statistic	pH Units	TDS mg/L	Cond μ S/cm	DO (mg/L)	%DO	Temp	TP	TDP	NO3-N	NO3-N+NO2-N	NO2-N	TKN	TSS	TN	FC
Upper Swan River	N	50	28	49	50	50	50	49	49	49	49	49	49	49	49	49
	Min	7.34	61	66	8.21	76.70	0.30	0.010	0.010	0.010	0.003	0.005	0.100	1.5	0.100	1
	Max	8.97	191.5	276	12.91	163.30	21.40	0.619	0.031	0.034	0.034	0.005	1.660	1160	1.660	420
	Median	8.10	126	142	10.17	99.80	10.85	0.028	0.010	0.010	0.011	0.005	0.340	16.8	0.340	20
	90th Percentile	8.51	154.9	220	12.43	105.15	16.26	0.105	0.021	0.010	0.011	0.005	0.702	138.2	0.702	77
Mid Swan River	N	50	29	49	50	50	50	49	49	49	49	49	49	49	49	49
	Min	6.65	58.5	64	7.38	69.80	0.80	0.010	0.010	0.010	0.003	0.005	0.100	1.5	0.100	1
	Max	11.56	202	311	12.82	104.50	23.10	0.940	0.030	0.099	0.099	0.005	1.570	2110	1.570	620
	Median	8.05	125	136	9.91	97.85	12.55	0.034	0.010	0.010	0.011	0.005	0.400	14.4	0.410	34
	90th Percentile	8.83	153.2	227	11.94	101.44	17.89	0.127	0.026	0.044	0.044	0.005	0.922	185.6	0.970	126
Lower Swan River	N	46	25	45	46	46	46	45	45	46	46	46	45	45	45	45
	Min	6.50	56.7	65	7.08	78.00	2.50	0.025	0.010	0.010	0.003	0.005	0.100	1.5	0.100	2
	Max	8.66	267	377	12.40	103.00	23.40	1.060	0.035	0.109	0.109	0.005	3.430	3060	3.430	870
	Median	7.90	138	147	9.14	95.95	13.40	0.048	0.010	0.010	0.011	0.005	0.410	24.6	0.420	31
	90th Percentile	8.34	178.6	268	11.58	99.30	19.55	0.171	0.027	0.043	0.043	0.005	0.816	269.4	0.868	106
Upper East Prairie River	N	50	6	49	50	50	50	49	49	49	49	49	49	49	49	47
	Min	6.47	109	89	7.30	83.90	2.60	0.010	0.010	0.010	0.011	0.005	0.100	1.5	0.100	1
	Max	9.43	230	431	12.66	112.20	24.00	1.590	0.238	0.165	0.165	0.005	1.100	3200	1.100	520
	Median	8.17	178	203	9.74	100.80	13.60	0.030	0.010	0.010	0.011	0.005	0.390	15.6	0.390	14
	90th Percentile	8.68	223.5	340	12.13	105.62	21.13	0.192	0.024	0.066	0.066	0.005	0.902	271.4	0.902	49
Mid East Prairie River	N	50	19	50	50	50	50	50	50	50	50	50	50	50	50	48
	Min	6.89	60.5	93	7.20	80.50	3.50	0.010	0.010	0.010	0.011	0.005	0.100	1.5	0.100	5
	Max	9.07	274	492	13.13	114.60	25.90	0.983	0.264	0.340	0.340	0.005	3.250	1410	3.290	260
	Median	8.05	143	207	9.54	99.55	14.70	0.082	0.010	0.010	0.011	0.005	0.580	55.15	0.580	48
	90th Percentile	8.52	255.6	381	11.79	108.42	21.89	0.402	0.038	0.099	0.099	0.005	1.471	458.1	1.615	166
Lower East Prairie River	N	37	8	37	37	37	37	37	37	37	37	37	37	37	37	36
	Min	7.13	72.5	111	4.61	56.40	2.00	0.010	0.010	0.010	0.011	0.005	0.100	5.7	0.100	2

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	Max	9.51	266	507	12.92	110.60	22.30	0.413	0.092	0.266	0.266	0.010	1.800	769	1.800	460
	Median	7.89	148.5	232	8.98	92.20	14.50	0.080	0.010	0.010	0.011	0.005	0.550	38.1	0.560	50
	90th Percentile	8.57	216.3	394	11.54	101.12	19.92	0.169	0.053	0.036	0.042	0.005	1.254	166.6	1.342	170
Upper Driftpile River	N	49	1	46	49	49	49	47	47	47	47	47	47	47	47	47
	Min	7.19	144	58	7.74	83.90	1.60	0.010	0.010	0.010	0.010	0.005	0.100	1.5	0.100	1
	Max	8.79	144	355	12.92	122.60	25.60	0.970	0.080	0.102	0.102	0.005	2.980	2230	2.980	2400
	Median	8.04	144	136	9.79	100.30	13.70	0.039	0.010	0.010	0.011	0.005	0.520	11.4	0.520	10
	90th Percentile	8.50	144	248	12.13	109.96	19.82	0.116	0.030	0.046	0.046	0.005	1.078	149.8	1.078	78
Mid Driftpile River	N	49	17	50	50	50	50	50	50	50	50	50	50	50	50	50
	Min	6.96	46.7	63	7.50	80.40	2.00	0.010	0.010	0.010	0.011	0.005	0.100	1.5	0.100	1
	Max	9.67	249	394	12.54	111.10	25.90	1.290	0.230	0.143	0.143	0.005	1.710	3570	1.710	220
	Median	7.99	148	142	9.81	98.85	13.40	0.045	0.010	0.010	0.011	0.005	0.510	18.75	0.540	20
	90th Percentile	8.646	198	280	11.92	104.33	20.26	0.151	0.031	0.033	0.033	0.005	0.994	205.4	0.994	69.3
Lower Driftpile River	N	50	2	48	50	50	50	49	49	49	49	49	49	49	49	49
	Min	7.04	153	63	6.88	80.20	2.10	0.010	0.010	0.010	0.011	0.005	0.100	1.5	0.100	1
	Max	8.82	174	479	12.49	101.10	23.80	1.280	0.041	0.198	0.198	0.005	1.970	3380	1.970	1100
	Median	7.91	163.5	153	9.17	94.75	13.60	0.047	0.010	0.010	0.011	0.005	0.540	28.2	0.540	20
	90th Percentile	8.34	171.9	302	11.52	99.11	19.55	0.221	0.030	0.057	0.057	0.005	1.154	215	1.154	110
Upper West Prairie River	N	50	21	50	50	50	50	50	50	50	50	50	50	50	50	48
	Min	7.10	50	67	7.19	76.70	0.80	0.016	0.010	0.010	0.011	0.005	0.310	1.5	0.310	10
	Max	10.01	317	551	12.50	103.60	20.20	1.060	0.103	0.111	0.111	0.010	1.890	1650	1.890	810
	Median	7.96	152	159	9.59	94.65	12.35	0.055	0.022	0.010	0.011	0.005	0.740	28.9	0.740	68
	90th Percentile	8.54	255	388	11.77	98.62	17.28	0.292	0.040	0.032	0.032	0.005	1.108	237.6	1.141	203
Mid West Prairie River	N	50	9	50	50	50	50	50	50	50	50	50	50	50	50	48
	Min	6.94	56.5	88	7.46	77.80	1.80	0.010	0.010	0.010	0.010	0.005	0.300	1.5	0.300	10
	Max	8.92	345	681	12.52	107.90	21.40	1.050	0.248	0.227	0.227	0.005	1.890	1280	1.930	810
	Median	7.95	143	204	9.66	96.75	13.60	0.060	0.023	0.010	0.011	0.005	0.780	20.3	0.780	69
	90th Percentile	8.57	289.8	458	11.77	102.77	19.10	0.362	0.051	0.041	0.041	0.005	1.560	390.5	1.565	163
Upper South Heart River	N	50	8	50	50	50	50	50	50	50	50	50	50	49	50	48
	Min	6.93	21.4	199	7.69	71.80	3.80	0.019	0.010	0.010	0.004	0.005	0.640	1.5	0.660	1

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	Max	9.65	258	432	12.12	132.60	21.60	0.317	0.216	0.138	0.138	0.019	2.240	15.7	2.350	50
	Median	8.02	214.5	317	9.72	102.30	16.00	0.100	0.055	0.010	0.011	0.005	1.295	4.5	1.350	2
	90th Percentile	8.74	246.1	397	11.56	111.21	19.72	0.224	0.164	0.089	0.090	0.005	1.693	9.24	1.761	10
Mid South Heart River	N	50.00	9	50	50.00	50.00	50.00	50.000	50.000	50.000	50.000	50.000	50.000	50	50.000	48
	Min	7.43	222	237	6.87	69.90	2.90	0.043	0.010	0.010	0.010	0.005	0.370	6.4	0.370	1
	Max	9.46	328	501	12.51	99.60	21.40	0.386	0.202	0.220	0.239	0.029	2.130	294	2.310	330
	Median	8.05	237	359	8.64	91.20	15.20	0.121	0.045	0.010	0.011	0.005	1.235	20.6	1.260	20
	90th Percentile	8.53	271.2	445	11.32	95.23	19.77	0.266	0.120	0.117	0.140	0.015	1.801	99.31	1.915	85
Lower South Heart River	N	50	9	50	50	50	50	50	50	50	50	50	50	50	50	48
	Min	6.88	82.9	126	4.05	49.30	1.70	0.080	0.010	0.010	0.010	0.005	0.700	1.51	0.700	2
	Max	10.00	244	426	12.25	99.30	23.50	0.602	0.169	0.270	0.270	0.016	5.750	818	5.770	1400
	Median	7.92	159	275	7.97	80.65	14.70	0.135	0.038	0.015	0.011	0.005	1.235	38.95	1.240	34
	90th Percentile	8.67	191.2	373	10.89	95.37	19.94	0.215	0.074	0.078	0.079	0.005	2.069	145.2	2.293	196
Grouard Channel	N	50	9	50	50	50	50	50	50	50	50	50	50	50	50	48
	Min	6.53	92	146	1.86	22.80	1.30	0.039	0.010	0.005	0.010	0.005	0.100	1.5	0.100	1
	Max	9.25	192	385	11.57	111.20	21.90	0.341	0.279	0.088	0.088	0.005	2.420	270	2.420	140
	Median	7.90	153	272	8.15	82.10	15.50	0.111	0.035	0.010	0.011	0.005	1.085	14.85	1.090	10
	90th Percentile	8.44	184.8	367	10.64	98.90	20.76	0.235	0.090	0.046	0.052	0.005	1.522	145.4	1.560	32

APPENDIX D. BOX AND WHISKER PLOT INTERPRETATION.

Box and whisker plots graphically represent the range of values in a data set, where:

- The lower end of the whisker represents the 10th percentile (i.e., 90% of the data had a value that was greater than the 10th percentile value).
- The box represents the range of data from the 25th percentile (bottom of the box) to the 75th percentile (top of the box). The line bisecting the box represents the 50th percentile or the median value. The bottom of the box represents the 25th percentile (i.e., 75% of the data had a value that was greater than the 25th percentile value).
- The top of the whisker is the 90th percentile value.

