ALBERTA-NWT TRANSBOUNDARY
WATER QUANTITY TECHNICAL REPORT
FOR SLAVE AND HAY TRANSBOUNDARY RIVERS

2020 | 2021

Government of
Northwest Territories

A technical companion report to the

Alberta – Northwest Territories Bilateral Management Committee Annual Report to Ministers, 2020-21

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English

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French

Kīspin ki nitawihtīn ē nīhīyawihk ōma ācimōwin, tipwāsinān.
Cree

Tłı̨chǫ yatı k'ę̀ę̀. Dı wegodı newǫ dè, gots'o gonede.
Tłı̨chǫ

ʔerıhtł'ís Dëne Sųłıné yatı t'a huts'elkër xa beyáyatı theʔą ʔat'e, nuwe ts'ën yółtı.
Chipewyan

Edı gondı dehgáh got'ı̨e zhatıé k'ę́ę́ edatł'éh enahddhę nıde naxets'é edahłí.
South Slavey

K'áhshó got'ı̨ne xədə k'é hederı ʔedı̨htl'é yerınıwę nídé dúle.
North Slavey

Jii gwandak izhii ginjìk vat'atr'ijąhch'uu zhit yinohthan jì', diits'àt ginohkhìi.
Gwich'in

Uvanittuaq ilitchurisukupku Inuvialuktun, ququaqluta.
Inuvialuktun

ᑖᒃᑯᐊ ᑎᑎᖅᑲᐃᑦ ᐱᔪᒪᒍᕕᒋᑦ ᐃᓄᒃᑎᑐᓕᖅᓯᒪᓗᑎᒃ, ᐅᕙᑦᑎᓐᓄᑦ ᐅᖄᓚᔪᓐᓇᖅᑐᑎᑦ.
Inuktitut

Hapkua titiqqat pijumagupkit Inuinnaqtun, uvaptinnut hivajarlutit.
Inuinnaqtun

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Executive Summary

The 2020 Alberta-Northwest Territories Transboundary Water Quantity Technical Report provides an overview of 2020 hydrology and water quantity data in the Hay and Slave River basins. Total annual streamflows on both the Hay and Slave Rivers were much higher than historical average, at 200% of normal on the Hay River and 137% of normal on the Slave River. On the Slave River, annual consumptive use was well below the 2.0 billion m^3 threshold, at 1.2 billion m^3. The pre-defined threshold of 2.0 billion m^3 remained at 1.9% of the long-term mean annual streamflow. There were no inter-basin transfers of water outside the Mackenzie River basin. The total volume of groundwater and surface water allocated in the Hay River basin exceeded 2.5% of the natural flows at the border in four months (January, February, March, and April) in 2020. This exceeded Trigger 1 and prompted analysis of the actual water use. The actual water use for all months was determined to be below 1% of natural flows at the border, well below the Trigger 2 threshold of 4%.

1.0 Introduction

In 2015, the Government of Alberta and the Government of the Northwest Territories signed a Bilateral Water Management Agreement to cooperatively manage shared transboundary waters. As part of the Alberta (AB)-Northwest Territories (NWT) Bilateral Water Management Agreement (the Agreement), a Bilateral Management Committee (BMC) was established, which is responsible for implementing and reporting on the Agreement.

This Water Quantity Technical Report is a companion report to the BMC's fifth annual report, *Working Together to Manage our Shared Waters, Alberta-Northwest Territories Bilateral Management Committee Annual Report to Ministers 2020-2021*. This report provides an overview of the hydrology of the shared waterways between AB and the NWT, analyzes 2020 water quantity data as compared to historical data, and analyzes 2020 data against interim objectives and triggers. For a summary of the information in this technical report, refer to the Surface Water Quantity section of the Committee's fifth annual report.

1.1 Water quantity monitoring and derived datasets

The interim transboundary objectives and triggers of the Agreement are based on "desktop analysis" of available datasets: long-term monitoring of streamflow, water allocations for use, as well as reporting data for actual water use in Alberta. The Water Survey of Canada (WSC), a section of Environment and Climate Change Canada (ECCC), is the agency responsible for hydrometric measurements and associated data in Canada. The WSC partners with provinces and territories to cost-share hydrometric monitoring.

Water use is tracked through water allocation permitting systems in AB and NWT. For the analysis in this report, key data on upstream uses in Alberta, licensed under Alberta's *Water Act*, (e.g., total annual allocation, return flow, type of use, location of use) were obtained from Alberta's Environmental Management System. The Alberta Energy Regulator (AER) regulates uses under the *Water Act* for the upstream oil, gas and coal sectors, and Alberta Environment and Parks (AEP) regulates uses for all other sectors.

Almost all water licences require the licensee report the actual water use. Many licences have been updated to require online reporting to Alberta's Water Use Reporting System. Monthly, and in some cases daily, reporting data are provided by the licensees according to deadlines specified in their licence documents. This electronic database was queried for the water uses in the Hay River basin in Alberta, for Trigger 2 analysis. Table 1 lists the locations of monitoring and derived flow datasets.

Table 1: Hay and Slave River flow monitoring sites and derived flow datasets for assessment of interim objectives and triggers.

Monitoring Station/ Assessment Point	Site Status and/or description of data	Purpose
Hay River near Town of Hay River (flow monitoring, 1963-present; level monitoring, 2002-present)	• Continuous monitoring since July 1963, one incomplete month (July 2010) • Drainage Area: 51,700 km²; coordinates of hydrometric station: 60.743 N, 115.8596 W	• To derive estimated flow at the border.
Hay River near AB-NWT Border (level monitoring, 1986-present)	• Intermittent monitoring between 1986 and 1998, and continuous measurements from 2004 to present. • Drainage area: 48,800 km²; coordinates of hydrometric station: 60.0039 N, 116.9721 W	• To obtain drainage area for estimating flow at the border.
Hay River at the AB-NWT Border (calculated/derived flow)	• This value is calculated by reducing the flow to the smaller drainage area at the border, which is 94 percent of the flow near the town of Hay River	• To derive estimated flow at the border.
Hay River at the AB-NWT Border (estimated natural flow)	• This value is calculated by adding the upstream monthly surface water and groundwater allocation total for locations in the basin to the 'Hay River at the AB-NWT Border (calculated flow estimate)' above.	• To derive naturalized flow at the border, to assess Trigger 1 for the Hay River basin.
Hay River at the AB-NWT Border (estimated natural flow)	• This value is calculated by adding the upstream monthly surface water and groundwater actual or estimated consumptive use for locations in the basin to the 'Hay River at the AB-NWT Border (calculated flow estimate)' above.	• To derive naturalized flow at the border, to assess Trigger 2 for the Hay River basin.
Slave River at Fitzgerald (flow monitoring, 1960-present)	• Intermittent monitoring 1921-1922, 1930-1931, and 1953-1958 • Continuous daily monitoring since May 1959, ten incomplete months (2011-2020)	• To assess whether the two billion cubic metres (m^3) consumptive use threshold becomes significantly different from 1.9 percent of the long-term average annual flow.

1.2 Water quantity triggers, objectives, and daily flow conditions

The Agreement commits Alberta and the NWT to establish and implement transboundary water quantity objectives and monitoring according to the Risk Informed Management approach. Classification of water bodies considers the level of upstream development and other factors including the extent of traditional use and drinking water use in downstream communities, observed changes in the hydrology of a basin, and the sensitivity of the related ecosystem. Both the Hay and Slave rivers are designated as "Class 3" water bodies, which require the development and monitoring of site-specific objectives. Because the Hay and Slave rivers are the only rivers designated as Class 3, this report will focus on these basins.

A transboundary water quantity objective refers to the minimum amount of water calculated at the border that the upstream Party must pass to the downstream Party. This minimum amount of water must satisfy the needs for the ecological integrity of the aquatic ecosystem. After these needs are determined by AB and NWT, the remainder is water available for human use and shared equally. For the Hay River, the interim ecological integrity needs and water available for human use are based on a "modified desktop method" and can be found in Appendix D of the Agreement. AB and NWT have agreed to defer the determination of the needs for the Ecological Integrity of the Aquatic Ecosystem in the Slave River.

1.3 Slave River triggers and objectives

Because the volume of water allocated to human use is very low compared to the total annual volume of discharge on the Slave River, and there is insufficient information to determine the needs for Ecological Integrity of the Aquatic Ecosystem, water quantity objectives for the Slave River have not yet been set. According to the Agreement, the following situations would trigger further discussions:

- Annual consumptive use in Alberta reaches two billion cubic metres;
- Two billion cubic metres (2 km^3) becomes significantly different from 1.9% of the long-term average annual streamflow; or
- 50% of the consumptive use in Alberta is for use outside of the Mackenzie River basin.

Alberta's current annual allocation, of both surface and groundwater in the Slave River basin, is used as an estimate for annual consumptive use. Based on assessment of water use as part of Alberta's water management program under Alberta's *Water Act*, the actual use of water in a given year is often 50 percent or less of the two billion cubic metres allocated.

The allocation is the maximum volume allowed, assuming no low flow restrictions. The maximum volume for a licence includes consideration of emergency water demands in addition to typical annual needs for the long-term operation of the diversion. Low flow restrictions are specific to each licence and are not included in the maximum annual diversion volume. For more details on an individual licensee's conditions for water use, licence documents can be accessed online through Alberta's 'Authorization Viewer'.

1.4 Hay River triggers and objectives

For the Hay River, objectives and triggers have been set on an interim basis. The interim objective is for 95% of the natural flow to pass from Alberta to the NWT each month. Natural flow is the amount of water flowing through a river if no water is stored, removed or diverted. Two triggers have been defined. Triggers are specific conditions that will require a response, such as further discussion on flow objectives or refinements to calculations, or more detailed work on determining ecosystem needs. The two interim water quantity triggers are:

- Trigger 1: If the volume of water allocated is greater than 2.5% of the monthly natural flow at the border, or half of Alberta's share of water, in at least one month, further work is done to evaluate Trigger 2.
- Trigger 2: If the water actually used is greater than 4% of the monthly natural flow at the border, or 80% of Alberta's share of the water, further data and research on ecosystem needs will be discussed.

The analysis of water allocated (Trigger 1) or water used (Trigger 2) includes all types of Alberta *Water Act* licences (i.e. long-term licences, temporary diversions, and traditional agricultural registrations) for surface water and groundwater. It also includes a licence held by AEP for annual net water balance losses from Hutch Lake, a lake created for wildlife management.

The monthly allocation is determined by distributing annual allocation evenly. The only exception was for evaporative losses at Hutch Lake, which was distributed proportional to evaporation rates throughout the year, with higher values in summer and zero values in winter months as ice cover and snow cover on the lake prevent an evaporative flux. The distribution was based on shallow lake evaporation estimates (Table 2) calculated with climate data from High Level, AB.

Table 2: Hutch Lake monthly shallow lake evaporation. Shallow lake evaporation estimates are based on average monthly Morton's model estimates from 1972-2009. The dataset can be found in 'Evaporation and Evapotranspiration in Alberta, April 2013' ISBN: 9781-4601-1121-5 (On-line). Evaporation estimates for the months of January, February, November and December were set to zero.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evaporation (mm)	-2	-1	15	59	106	131	132	96	41	11	-4	-3
Evaporation (mm)	0	0	15	59	106	131	132	96	41	11	0	0
% Distribution	**0**	**0**	**3**	**10**	**18**	**22**	**22**	**16**	**7**	**2**	**0**	**0**
Hutch Lake Licence (m^3)												
960,052	0	0	24,367	95,843	172,192	212,803	214,428	155,948	66,603	17,869	0	0

In order to estimate the monthly natural flow, the total monthly allocation is added to the monthly flow at the border for Trigger 1. For Trigger 2, the monthly estimated and monthly reported use are added to the monthly flow. This assumes a direct, instantaneous effect of all diversions throughout the basin. This is a simplified and conservative estimate; it does not consider routing of each diversion, residence time or storage in lakes or wetlands, and when it would reach the border if not diverted.

2.0 Hay River

2.1 Hydrology of the Hay River basin

The Hay River (Figure 1) drains an area of approximately 51,300 km^2, primarily in northwestern Alberta, and also a small area in northeastern British Columbia and southern NWT. The Hay River flows into Great Slave Lake at the Town of Hay River. The majority of the basin is comprised of peatland (i.e., muskeg) terrain (Stanley and Gerrard, 1991), before the river drops over Alexandra Falls in the southern NWT. The peatland acts as a sponge for the basin; it helps to slow down snowmelt and rain water, which means they take longer to reach a river than in other environments (e.g., Canadian Shield).

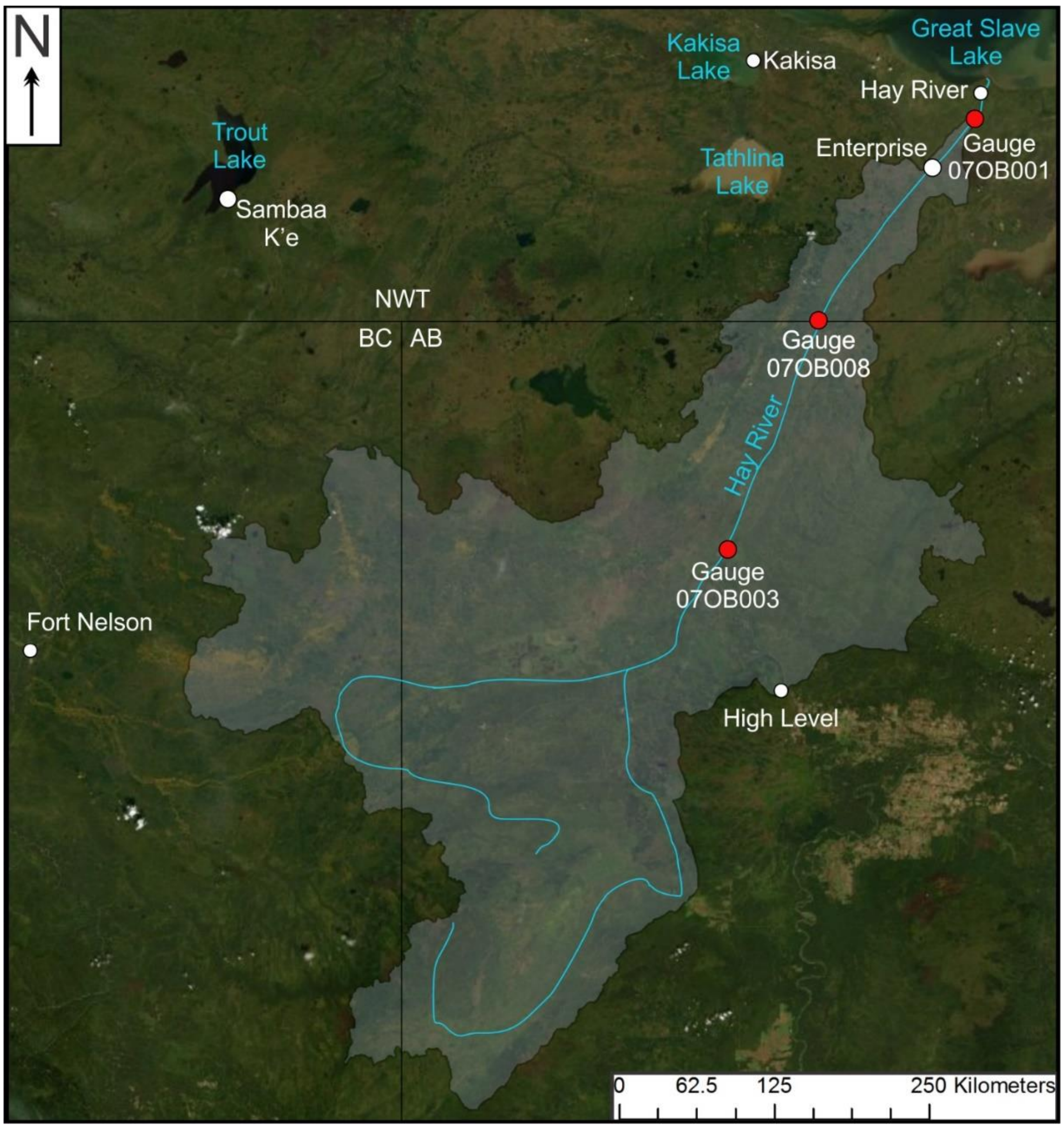

Figure 1: Map of the Hay River basin, including Water Survey of Canada hydrometric gauges on the Hay River. Note that the superimposed renderings of the river network are for illustrative purposes only.

Mean annual runoff on the Hay River is 66 mm. Approximately a third of the basin, in the north, is underlain by sporadic discontinuous permafrost (Brown et al., 1997; Pawley and Utting, 2018). There is ongoing work between the Parties to better determine how climate change is affecting permafrost distribution in this region, and what impact this is expected to have on basin discharge. One possible impact that permafrost thaw is already having on basin discharge is increasing groundwater inputs. Analyzing changes to winter flow rates in the basin can help determine whether this is the case (e.g. Figure 2b). Despite small increases to winter baseflow, total annual runoff on the Hay River has not significantly changed over time (Figure 2a).

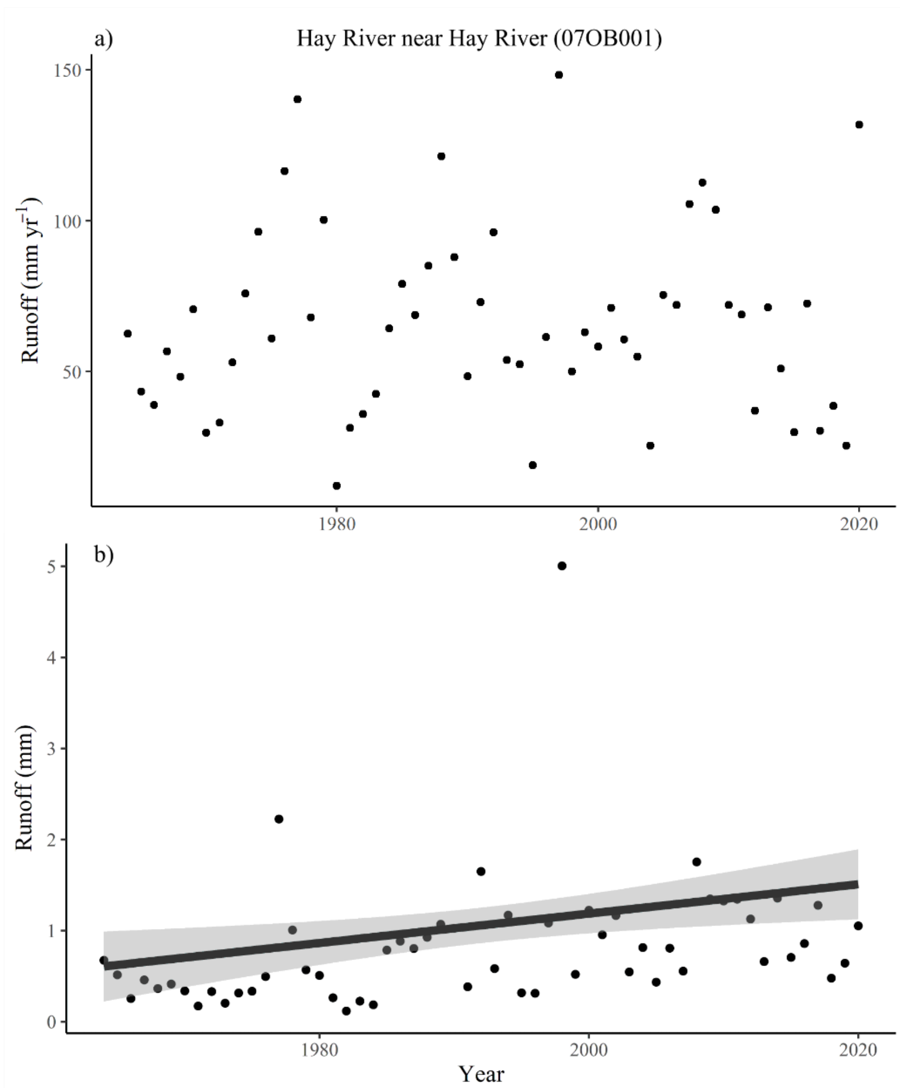

Figure 2: Runoff in the Hay River basin: (a) annual runoff (mm) and (b) late-winter runoff (mm; 01 Jan to 31 Mar) for the Hay River. In Figure 2b, the trend line indicates statistically significant increases (0.01 mm yr^{-1}) in winter runoff ($p < 0.01$) calculated using the Mann-Kendall trend test, WSC data 1963 to 2020.

Finally, of note for the Hay River is that, because it is a north-flowing river, snowmelt and river ice breakup begins in the south and moves north, often hitting competent ice. When this happens, ice-jam flooding can occur as the ice jam acts as a dam and water backs up behind it. Flooding of this type is common in the Town of Hay River. More detail on the hydrology of the Hay River basin, including the effects of peatland and permafrost thaw, can be found in the *2018 and 2019 Alberta-NWT Transboundary Water Quantity Technical Report* (Connon and de la Chevrotière, 2021).

2.2 Hay River hydrology, allocation, and use data for 2020

Total annual streamflow[1] on the Hay River was much higher than the historical average in 2020 (200% of normal); see also Figure 3**Error! Reference source not found.**. Cumulatively, over the whole year, 2020 saw the third largest total discharge of any year on record for the Hay River near the town of Hay River for the period 1964-2020 (n=57 years) (Figure 2a). The amount of discharge (around 10 billion m^3) over the whole year was about four times more than over a normal year (2.5 billion m^3).

There are three communities around the Hay River basin that have climate data: Hay River, High Level, and Fort Nelson (see Figure 1). In 2020, the climate station at Fort Nelson had missing data, so those data are not included here. The cumulative precipitation at Hay River and High Level was above average for 2020 (Figure 3). The Town of Hay River received a large rainfall event in July 2020. Precipitation in both Hay River and High Level was higher than normal in July, August and September.

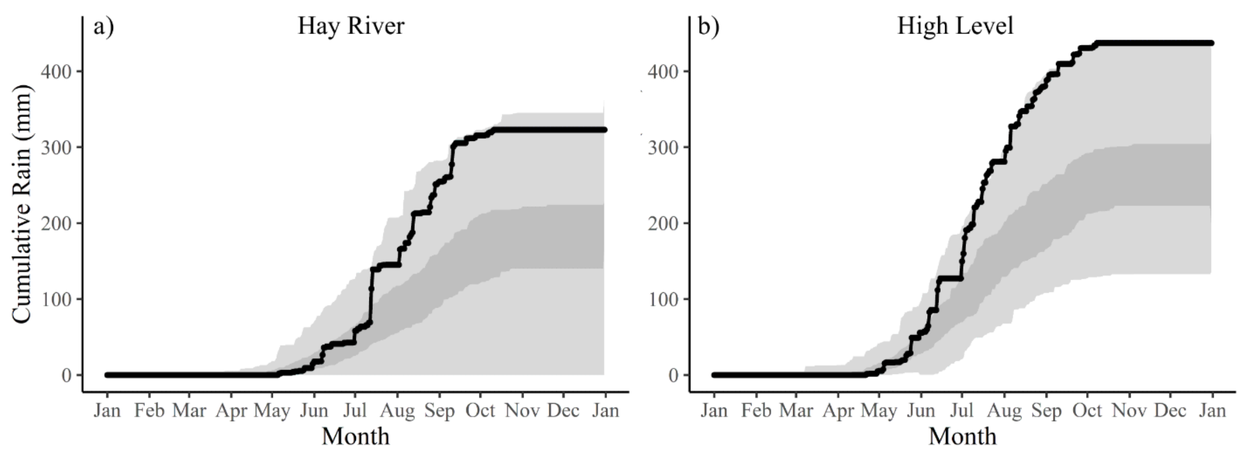

Figure 3: Cumulative precipitation (falling as rain) curves for communities in and adjacent to the Hay River basin for 2020: (a) Hay River and (b) High Level.

In 2020, spring freshet peaked in early May at around 600 $m^3\ s^{-1}$ (Figure 4). The timing and magnitude of the snowmelt peak was about average and the recession limb from this event also followed a normal trajectory during the month of May. Rain events in late May brought water

[1] Total annual streamflow is the total volume of water that passes through a river over the course of one year. This is a function of the total amount of precipitation that falls on a basin.

levels above average by mid-June. Continued rain events through June and July continued to raise the Hay River to much higher than average levels and flow rates. The year's flow peaked on 14th July at 890 $m^3 s^{-1}$, an all-time-high for that day of the year. Following this peak, flow largely receded – but did remain above average – for the remainder of the year, albeit with some relatively higher flows again in late August that reached rates of around 500 $m^3 s^{-1}$ in response to rain events. Water levels remained higher than average in the fall and freeze-up period.

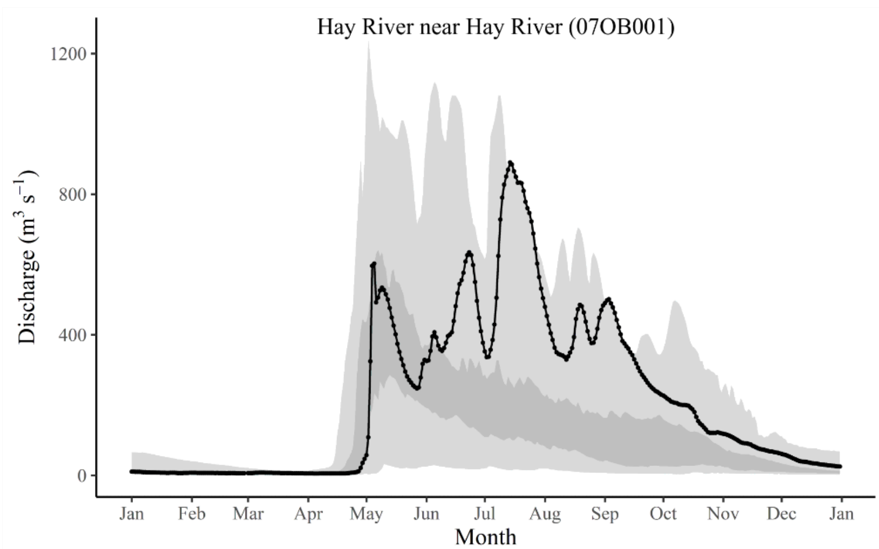

Figure 4: The Hay River discharge for 2020 relative to the historic average range (depicted as the interquartile range), and minimum and maximums.

For the Hay River in 2020, Trigger 1 was exceeded for four months (January, February, March, and April); see Figure 5a. Trigger 1 is reached when monthly allocations are greater than 2.5% of natural flow at the border. Because the annual allocation is divided evenly between all months, not accounting for any licensee conditions or measures during low flow months, this means that there is a higher chance of exceeding the Trigger 1 threshold during low flow months. Because Trigger 1 was reached in 2020, the resulting action was to evaluate actual water use as a percentage of natural flow at the border (Trigger 2). Figure 5b shows that actual water use was well below the threshold of 4.0% in all months.

Trigger 2 includes the same long-term allocations, temporary diversions, and traditional agricultural registrations for surface water and groundwater as in Trigger 1; but, instead of using the allocation volume, it uses actual water use data submitted by licensees to Alberta's online Water Use Reporting System (WURS). As there is no reporting for the wildlife management licence for Hutch Lake, the same monthly volumes, as used for Trigger 1, were used for Trigger 2.

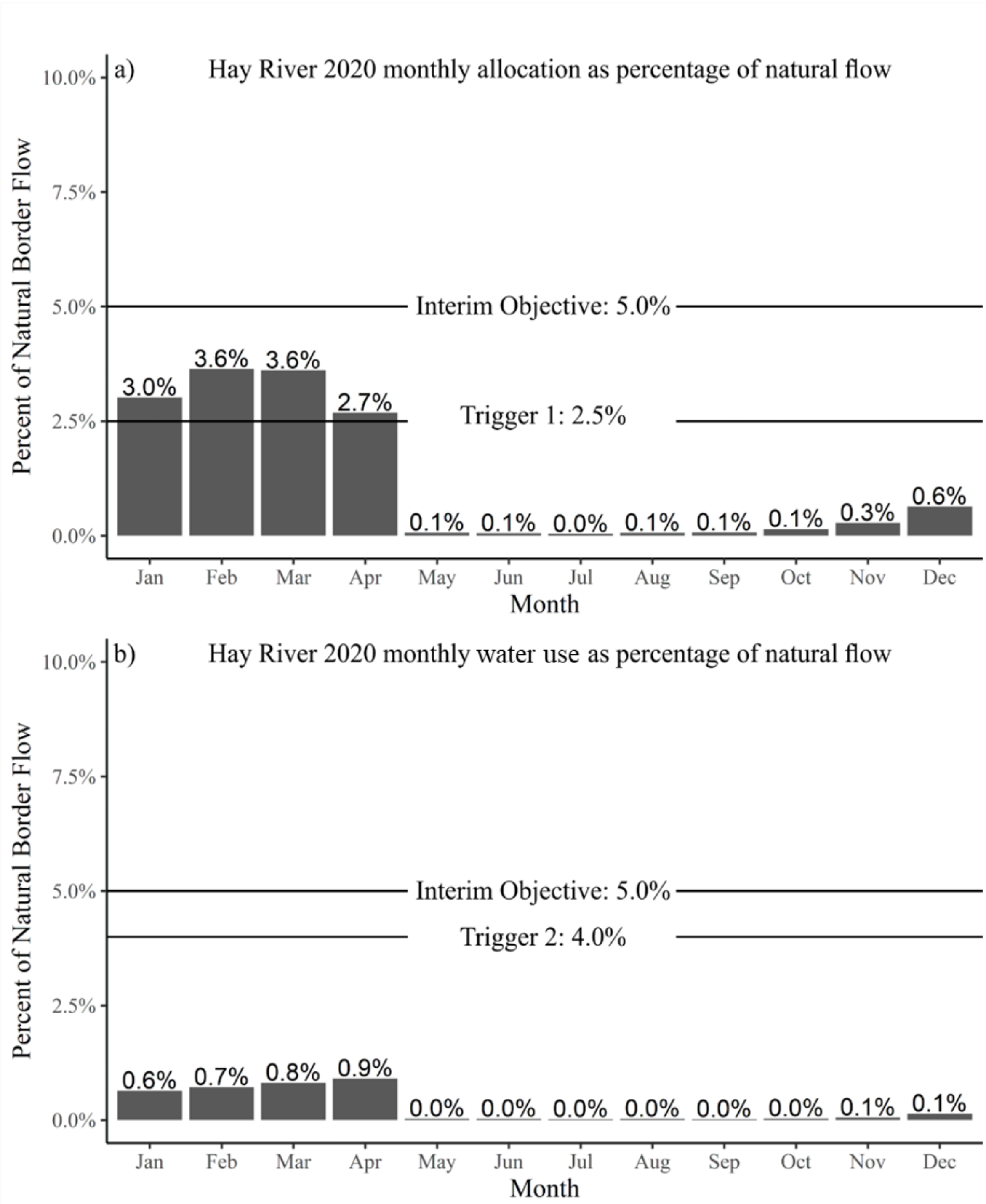

Figure 5: Consumptive water use in the Hay River. (a) Trigger 1: Hay River 2020 monthly allocation as percentage of natural flow and (b) Trigger 2: Hay River 2020 monthly use estimate as percentage of natural flow

Not all licensees are required to submit actual water use data to WURS. For example, the Alberta Energy Regulator recently began requiring reporting for new temporary diversion licences (TDLs); but it is not required for other sectors regulated by Alberta Environment and Parks (e.g. forestry, transportation, and downstream oil and gas activities). Beginning in 2017, further details of the reporting by sector were included in the AB-NWT annual report.

Table 3 provides reporting data for surface water and groundwater licences by sector for 2020. The reporting rates were similar to previous years. The upstream oil and gas sector reported 99 percent of the allocations by volume (one percent higher than in 2017, 2018 and 2019). The reporting rate is nearly 100 percent for sectors required to report. There are two licences for the 'Urban' sector, one of which is for the Dene Tha' First Nation, which does not require reporting to WURS. "Water Management" licences, and the one "Environmental" licence do not have reporting requirements. The "Environmental" licence is for the creation of Hutch Lake for wildlife management.

Table 3: Reporting for surface water and groundwater licences by sector for 2020

Sector	Number of Licences and TDLs with Reports	Total Number of TDLs, Licences, & Registrations	Allocation of Licences with Reports (m^3)	Total Allocation (m^3)	Percentage of Allocation Volume with Reports (%)
Surface Water					
Upstream Oil & Gas	207	222	4,173,170	4,209,033	99.1
Environmental	0	1	0	960,052	0.0
Urban	1	2	296,040	602,040	49.2
Forestry	0	171	0	275,875	0.0
Downstream Oil & Gas	2	3	42,600	44,600	95.5
Construction & Transportation	0	42	0	74,305	0.0
Recreation	0	1	0	19,720	0.0
Traditional Use	0	21	0	1,451	0.0
Water Management	0	2	0	10	0.0
Groundwater					
Suburban/Rural	2	2	972,828	972,828	100.0
Upstream Oil & Gas	3	9	23,725	39,295	60.4
Municipal	1	1	3,650	3,650	100.0

Of the available actual use data from WURS, far less than the maximum allocation volume was used. In 2020, 14.4 per cent of the surface water allocation, 3.5 per cent of the groundwater allocation, and 12.9 per cent of the total allocation volume of both surface water and groundwater was used.

In order to estimate the monthly natural flow for Trigger 2, the actual water use was added to the monthly volume of flow at the border. When WURS data on actual use was not available, consumption was estimated at 25.8 per cent for 2020. This estimated consumption calculation followed the same procedure as in the analysis for the previous four years (2016-2019). In 2016, it was agreed by NWT and AB to conservatively assume the consumption as double the reported use for both surface water and groundwater (i.e., 12.9% x 2 = 25.8%). The exception to this estimation was for the Hutch Lake environmental licence, for which consumption was assumed to be the long-term monthly evaporation rates, the same procedure as used to evaluate Trigger 1.

3.0 Slave River

3.1 Hydrology of the Slave River basin

The Slave River drains an area of approximately 606,000 km^2 (at the WSC gauging site), which includes three major sub-basins (Peace, Athabasca, Fond-du-Lac), as well as the Peace-Athabasca Delta/Lake Athabasca complex (
Figure). The basin is large and is comprised of three major physiographical regions, each with varying hydrological processes. These include: 1) Western Cordillera, made up of the Rocky Mountains to the west, containing peaks exceeding 2,000 m with glaciers covering the mountain tops; 2) Canadian Shield, occupying the portion of the basin in northwestern Saskatchewan and southern NWT, which is comprised of lakes and valley-wetlands interspersed by bedrock; and 3) Interior Plains, consisting of boreal forest, wetlands, and lakes (Woo and Thorne, 2003). Annual precipitation is greatest in the mountainous southwest and declines to the northeast. Runoff in the Slave River watershed is highlighted by high flows in the spring resulting from snowmelt, as well as both responses to convectional and frontal rain events in the summer and fall (Woo and Thorne, 2003).

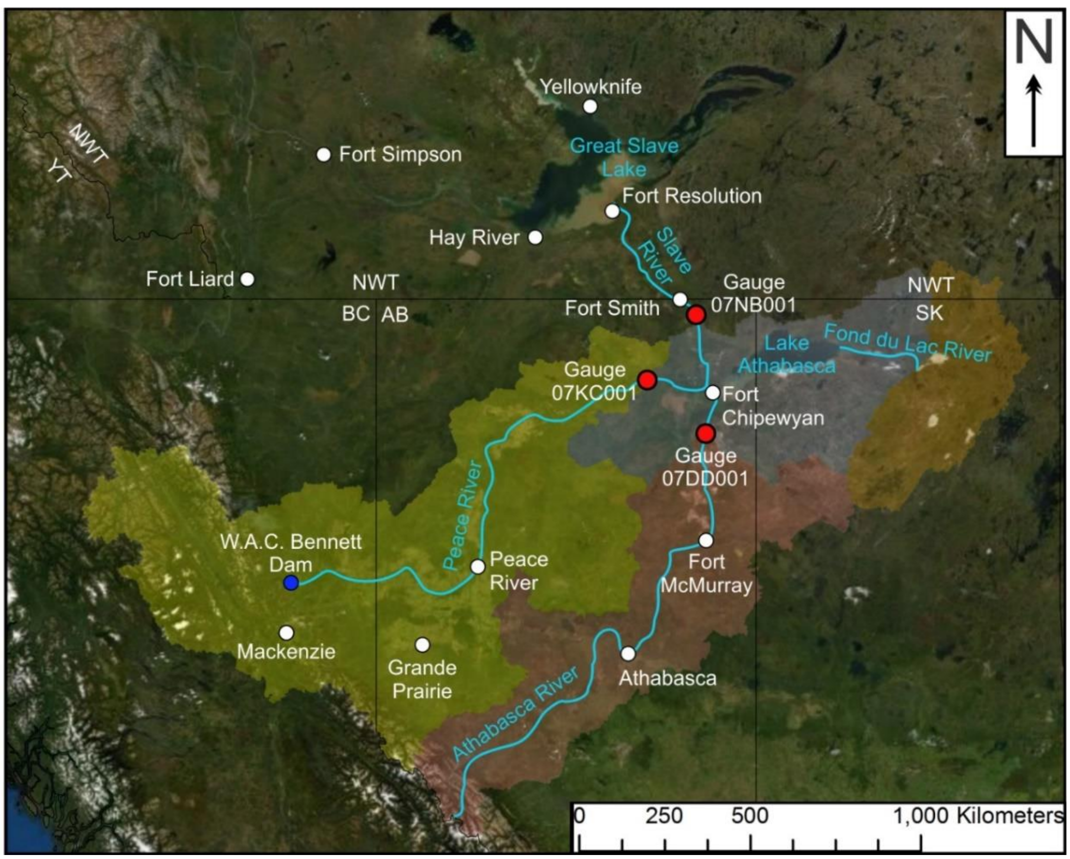

Figure 6: Map of the Slave River basin, upstream of the Water Survey of Canada gauging station at Fitzgerald, AB (07NB001). This map delineates the three major sub-basins of the Slave River watershed: a) Peace River basin (gauge 07KC001); b) Athabasca River basin (gauge 07DD001); and c) Fond du Lac River basin (Saskatchewan).

Mean annual runoff is 223 mm on the Peace River, 145 mm on the Athabasca River, and 173 mm on the Slave River. These values are all much higher than the comparatively low mean annual runoff in the Hay River basin (66 mm). The runoff response for each basin is a function of basin physiography and is described in more detail in Woo (2012).

The gauge at the outlet of the Peace River (07KC001) provides an integrated response of the effects of flow regulation resulting from the Williston Reservoir (41 km^3), as well as the predominantly snowmelt driven response from tributaries downstream (Woo and Thorne, 2003). Construction on the W.A.C. Bennett Dam and filling of Williston Reservoir was completed in 1972. A comparison of flow regimes prior to and after regulation shows a larger magnitude of flows in the winter period, along with a smaller snowmelt peak and lower flow volumes throughout the summer (Prowse and Beltaos, 2002) (Figure 7).

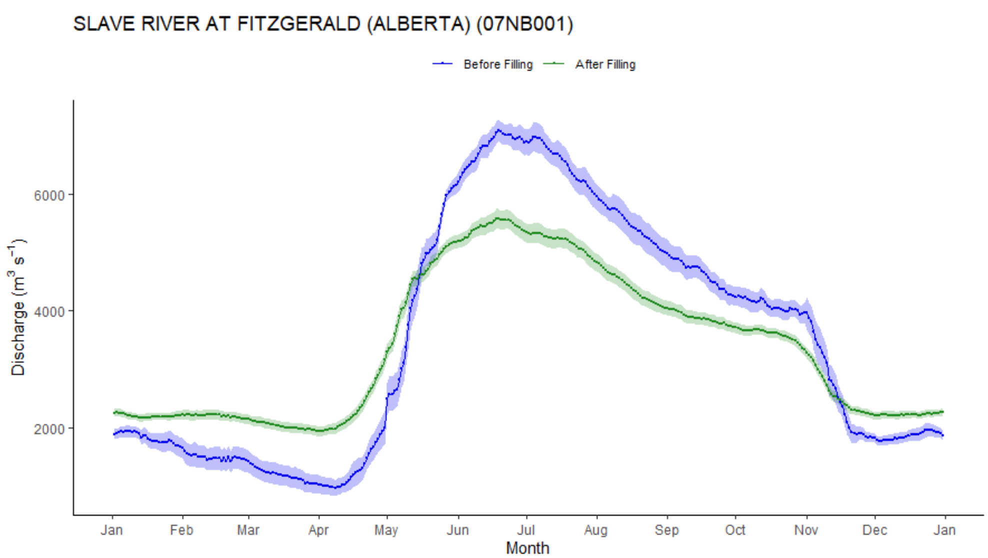

Figure 7: Mean daily discharge and water level for the Slave River, averaged from 1959 to 1968 (blue) and 1972 to 2019 (green).

3.2 Slave River hydrology, allocation, and use data for 2020

In 2020, annual flow on the Slave River was well above average (137% of normal), see Figure 8. The total annual flow for the year 2020 was the third highest over the 1972-2020 period on record. Flow rates were approximately average from January to April, and with minimal fluctuations over this period. Towards the end of April, flow quickly rose, with a large and early response to snowmelt runoff, to levels well above average for that time of year. Hydrometric data were not available from May 1st to June 23rd, inclusive. This was likely due to ice displacing the sensor; and Covid-19 restrictions meant the hydrometric gauge could not be visited to restore the sensor. Using estimated data to infill this period (see below section about the approach taken to infill the record with estimated data), it is apparent that flow rates and water levels fluctuated from late May to early July, but generally flow was much higher than average throughout the summer. Periods of flow rate rise (e.g. late May, mid-June, and early July) were in response to rainfall events, and the peaks of these events each saw the highest daily flow rates on record for those days of the year. Flow rates began to recede again from early July onwards, but the flow remained relatively high – well above average – for the remainder of the year.

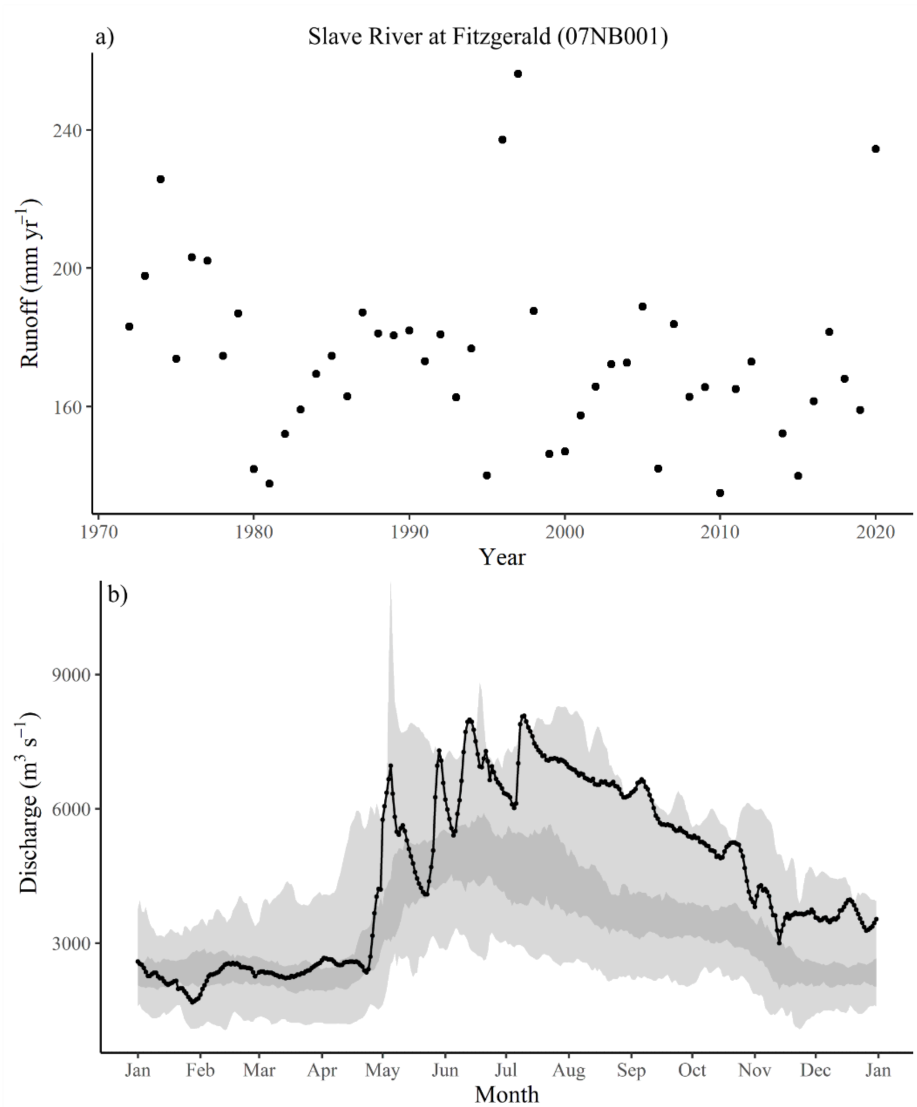

Figure 8: Hydrology of the Slave River: (a) Annual runoff (mm) from 1972 to 2020; there is no significant change in annual runoff volume over this period ($p > 0.05$). (b) Slave River discharge for the year 2020 relative to the historic average range (depicted as the interquartile range), and minimum and maximums; these data include estimated discharge for the period May 1-June 23 to infill this period of time when the hydrometric gauge was not functioning.

The hydrological analysis for Great Slave Lake for 2020 (ECCC, 2020), led by Environment and Climate Change Canada in conjunction with the Government of the Northwest Territories, was carried out to try to understand and explain record high water levels on Great Slave Lake (since records began in the 1930s) in the summer and fall of 2020. They found that flows on the Peace River exceeded the 75th percentile for much of the summer of 2020, while flows on the Athabasca River for summer 2020 were the largest on record. Overall, the flow of the Slave River was higher than normal due to high flows from both the Peace and Athabasca Rivers.

The year 2020 saw well above normal – and, in some places, record high – precipitation in northern parts of Alberta and in the Peace-Athabasca Delta region in summer 2020, and in particular in August 2020. Fort Chipewyan and Fort Smith received above average precipitation over the year, due in large part to high precipitation in August at these locations (Figure 9). Sites further west – at Grande Prairie and Mackenzie – received approximately average levels of precipitation over the year.

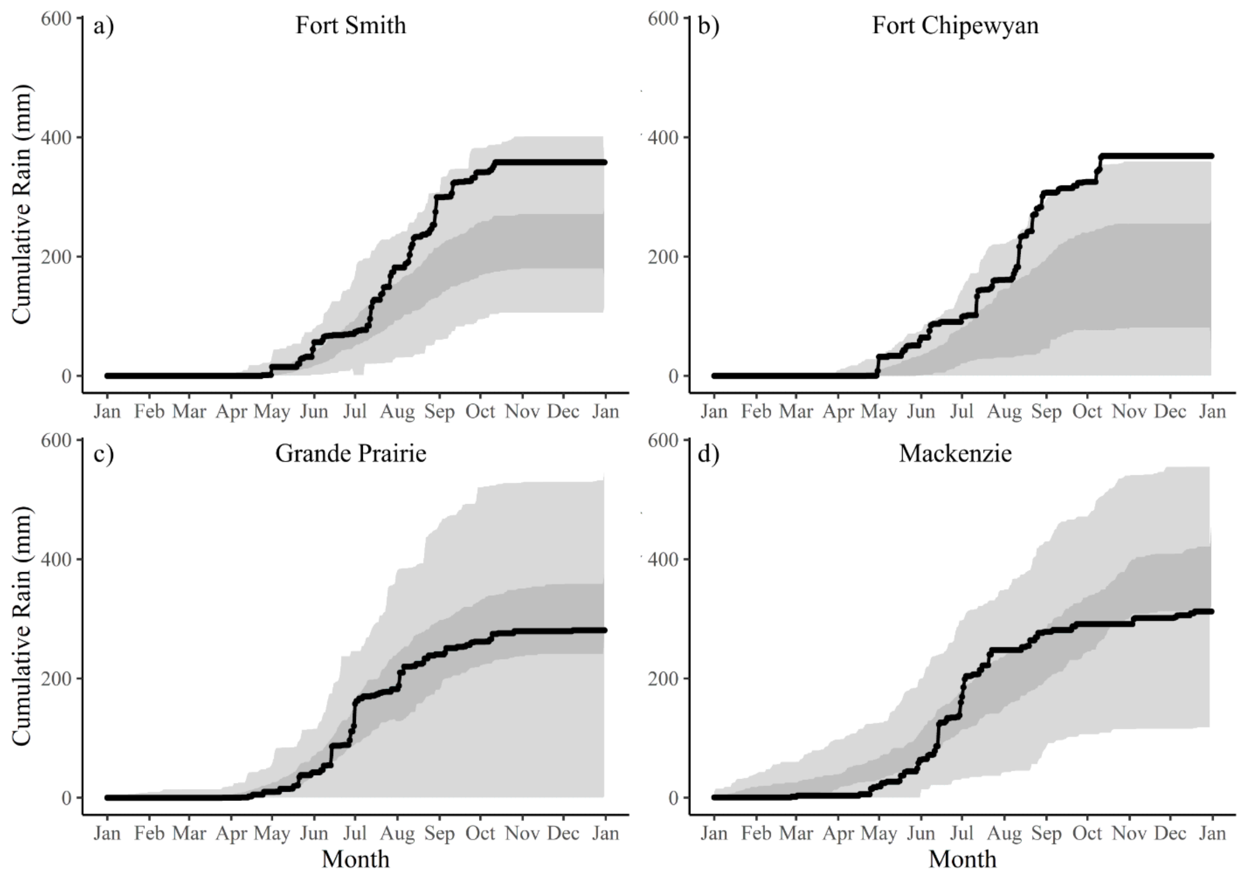

Figure 9: Cumulative precipitation curves for select communities in the Slave River basin: (a) Fort Smith (NWT); (b) Fort Chipewyan (AB); (c) Grande Prairie (AB); (d) Mackenzie (BC) for 2020. Data were collected from Environment and Climate Change Canada climate stations.

Surface water and groundwater allocations and flows for 2020 are depicted in Table 4. The two billion cubic meter (2 km^3) consumptive use threshold remained at 1.9% of the long-term annual flow of the Slave River for 2020. Among Alberta's allocation, 84.5% was allocated to surface water licences and 15.5% to groundwater licences.

Table 4: Comparison of Slave River basin allocations and mean annual flows. Note that values in the table are presented in km^3 (1 km^3 of water is equivalent to 1 billion m^3).

Parameter	2020 (km^3 $year^{-1}$)	2019 (km^3 $year^{-1}$)	2018 (km^3 $year^{-1}$)	2017 (km^3 $year^{-1}$)	2016 (km^3 $year^{-1}$)	2015 (km^3 $year^{-1}$)
Surface water allocation	1.019	1.074	0.935	0.862	0.906	0.904
Groundwater allocation	0.188	0.204	0.183	0.167	0.17	0.178
Total allocation	1.206	1.277	1.118	1.03	1.075	1.082
Consumptive use threshold	2.0	2.0	2.0	2.0	2.0	2.0
Actual flow volume	141.9	96.3	102.3	110	97.7	84.8
Mean annual flow (from 1972)	105.8	105	105.2	105.3	105.2	105.3

Infilling the hydrometric record with estimated data: approach taken

Several approaches (linear interpolation, model runs, statistical relationship with neighbouring stations) were explored to fill the missing hydrometric data from the Slave River. Since the data gap was for almost two months, an approach using linear interpolation was ruled out as it would not be able to capture the variability within this lengthy period. There is no comprehensive hydrological model for the basin that can accurately capture all hydrological processes and responses, therefore model-generated hydrometric data was also ruled out as an approach. Statistical relationships between hydrometric data records from other stations in the region (on the Peace and Athabasca Rivers) were explored.

The analysis of correlation between the Slave River at Fitzgerald (07NB001) and the Peace River at Peace Point (07KC001) for a 30-year period from 1990 to 2019 showed a correlation of 0.59. A similar relationship with the Athabasca River at Fort McMurray (07DA001) for the same 30-year period yielded a slightly higher correlation of 0.62. It was also investigated if better relationships could be achieved over the 30-year period for just the months of May and June (since the data gap occurred over these two months), but a lower correlation was observed. The Athabasca River at Embarras Airport (7DD001) station, which is downstream of the station at Fort McMurray and therefore closer to the Slave River, has continuous data for a shorter period of time (from Aug 2014 onwards). Nevertheless, the correlation analysis revealed a relatively higher correlation (0.68) between Athabasca River at Embarras Airport and Slave River at Fitzgerald, compared to other available stations. Therefore, a statistical relationship developed between these two stations was used to infill the missing data for the Slave River.

4.0 Next steps

Daily flow conditions, for both the Slave and Hay rivers, will continue to be tracked and reported relative to historical data, and aggregated for reporting on interim water quantity objectives and triggers. The methodologies for analyzing water quantity data will be refined when needed.

5.0 References

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