SASKATCHEWAN

Water Security Agency

Spring Runoff Forecast

March 1, 2022

Prepared by: Flow Forecasting and Operations Planning - Water Security Agency

General Overview

The Water Security Agency (WSA) is preparing for the 2022 spring runoff by issuing this runoff forecast. The spring runoff potential for the province, as of March 1, 2022 is shown in Figure 1. Forecasted peak levels for select lakes and reservoirs are included in Table 1, and peak flow estimates for select watercourses are included in Table 2.

Fall moisture conditions, snowpack water content and rate of melt are the primary factors that influence snowmelt runoff. While we have a good understanding of the fall conditions and the snow accumulation season is nearing its end, it is too early to be able to predict the conditions at melt. For this reason, this forecast assumes normal/average conditions going forward through to the conclusion of the spring snowmelt event. Above normal snowfall over the remaining weeks of winter and/or a rapid melt could increase runoff yields significantly. The opposite is true for below normal snowfall going forward and/or a slow melt.

As detailed in WSA's Conditions at Freeze-up Report, which was released in November 2021, due to hot and dry conditions throughout 2021, most of the province went into winter with drier than normal moisture conditions. The driest area was central, around Saskatoon and extending in a south westerly direction towards Rosetown, down through Leader and then to the Maple Creek area. In these areas, exceptional agricultural drought conditions existed prior to freeze up.

Snow accumulations to date have generally been near to above normal across most of southern Saskatchewan. The exception is the southwest where many areas have very little snow present at this time. Central areas of the province and the Regina area currently have received above normal snowfall. In central Saskatchewan, where the snowpack is near or even slightly above normal, below normal runoff is expected as a result of the dry conditions at freeze-up.

As shown in Figure 1, snowmelt runoff is projected to be below to well below normal across the southwest. The exception is northern parts of the North Saskatchewan River Basin and eastern parts of the Saskatchewan River Basin where a near to above normal runoff response is expected this spring. In the southeast, the runoff response is anticipated to range from below normal in western portions of the Qu'Appelle River Basin, to above normal in the Regina area.

The eastern portion of the Churchill River Basin is expected to see a well above normal runoff response. The remainder of the basin is expected to see a near to above normal runoff response this spring. While flows are forecasted to be above normal in the basin, flooding is not expected at this time. The remainder of the north is expected to see a near normal snowmelt runoff response.

For the most part, water supplies from the province's major reservoirs are expected to be adequate in 2022; however, shortages may occur in the southwest. Some agricultural water supply issues could develop or worsen within drier areas if lack of moisture persists through the spring. This is particularly true in the southwest.

Desirable summer operating levels are expected at most recreational lakes within the province in 2022. The exception is likely to be Last Mountain Lake, which is currently lower than desirable due to drier than normal conditions in 2021 and an expectation for below normal snowmelt runoff from the lake's headwater areas. WSA will maximize diversions from the Qu'Appelle River into Last Mountain Lake during the spring melt to bring the water level as close as possible to desirable levels.

The snowpack over the alpine headwaters of the Saskatchewan River is generally above to well above normal at this time. However, with minimal snow over the foothills and plains portions of the basin, below normal inflows are expected into Lake Diefenbaker in early spring. This may result in lower than desirable water levels prior to the start of the mountain snowmelt in May. Lake Diefenbaker is currently at a near normal level for this time of year and is expected to be close to full by the end of August if summer rainfall over the headwaters is near normal.

Cover Photo: Beaver River near Dorintosh, March 2, 2022
Credit: Troy Watt, WSA

WSA will continue to monitor the 2022 spring runoff conditions across Saskatchewan. If warranted, further updates will be issued as the spring runoff progresses.

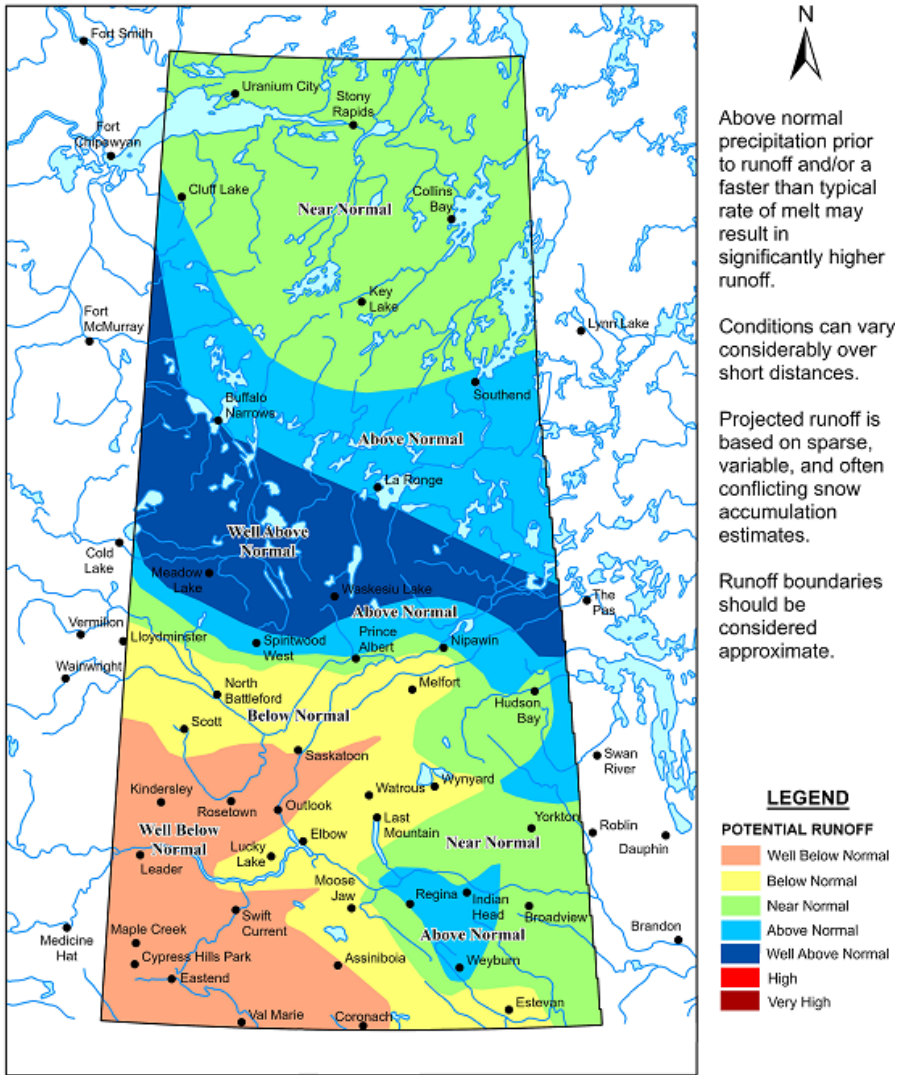

Figure 1: Spring Runoff Potential as of March 1, 2022

Category	Description	Approximate Frequency of Expected Flow
Well Below Normal	Little to no runoff is expected	<< 1:2 year event
Below Normal	Some runoff is expected	< 1:2 year event
Normal	Flows are expected to be average and will generally not exceed channel capacity in most reaches	≈ 1:2 year event
Above Normal	Flows from snowmelt runoff will exceed natural channel capacity in some areas	≈ 1:5 year event
Well Above Normal	Significant out of channel flow and some flooding will likely occur	≈ 1:10 year event
Very High	Significant flooding is likely to occur	≈ 1:25 year event or greater

- Above normal precipitation prior to runoff (especially if it occurs as rainfall) and/or a faster than normal melt could result in significantly higher runoff than presently forecast.
- Mid-winter melt events or rain events on frozen soils can increase runoff yields and estimates from snowmelt accumulation.
- Below normal precipitation prior to runoff and/or a slow melt could result in significantly lower runoff than presently forecast.
- Figure 1 applies to local runoff as opposed to the main stem river flows on major systems such as the Qu'Appelle and Saskatchewan rivers.
- This forecast is based on limited data and should be used as a general guide for large geographical areas. Local conditions may vary significantly from the regional conditions and boundaries. Figure 1 should be considered as approximate.
- Ice jamming can result in out-of-bank flows and flooding, even for below normal flows.

Fall Conditions

Due to minimal runoff in spring 2021 followed by a hot and dry summer, most agricultural areas of the province entered winter with soil moisture conditions that were drier than normal. Conditions were driest starting in the central area of the province around Saskatoon and extending in a south westerly direction towards Rosetown, and down through Leader and Maple Creek. In these areas, exceptional agricultural drought conditions were present at freeze-up.

Below normal rainfall was also observed across the north through the 2021 growing season.

In the agricultural region of the province, where conditions at freeze-up were much drier, the infiltration capacity of the soils and storage capacity within wetland areas will be high, reducing the risk of above normal snowmelt runoff in the spring.

In fall 2021, WSA developed a map (Figure 2) illustrating the risk of hydrological drought in 2022. This map reflects moisture conditions present at freeze-up in 2021.

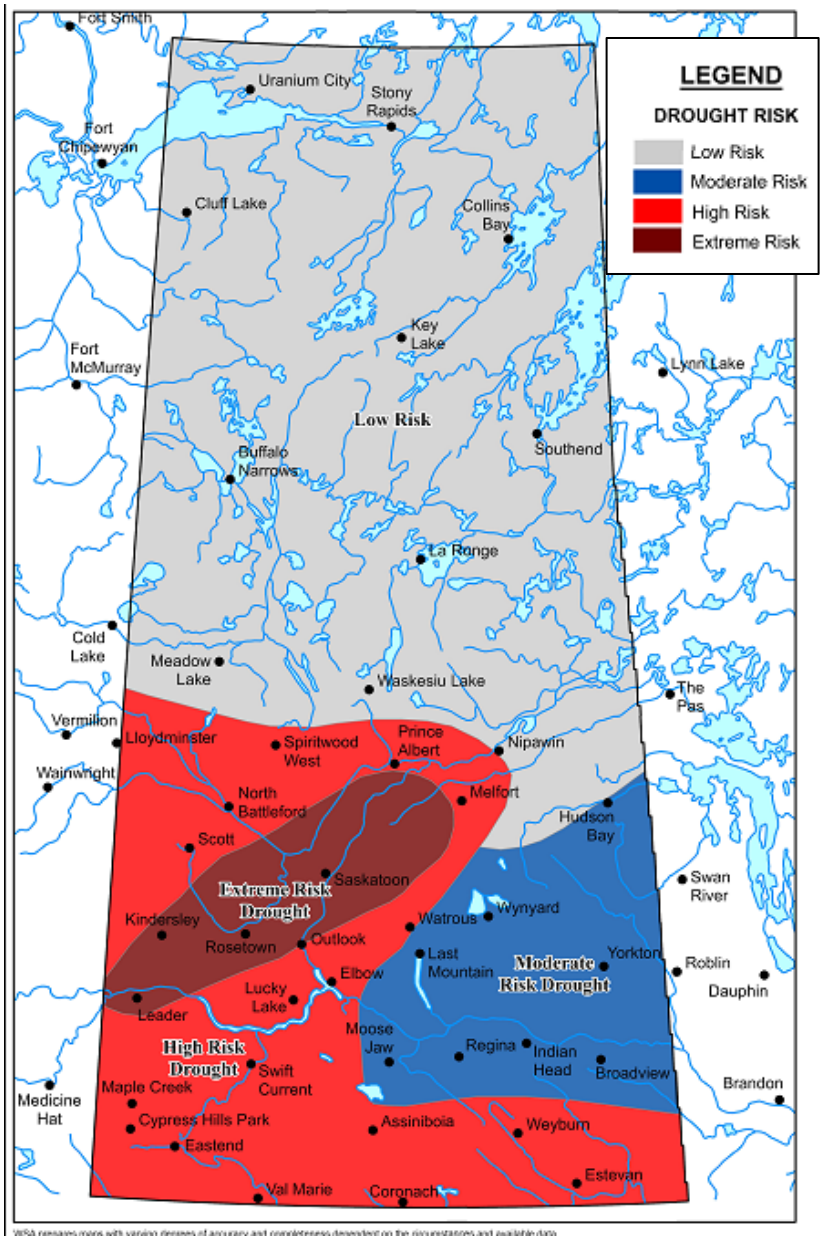

Figure 2: Hydrological Drought Risk as of October 2021

Early Winter 2021/2022 Precipitation

Point snowfall data, mapped as a per cent of normal, is provided in Figure 3. Since this map is based on a relatively small number of sites across Saskatchewan and given there are challenges to measuring point snowfall data in a windy environment and losses occur during the winter period, it may not be an accurate representation of the water equivalent available for runoff. While this map is not the most accurate depiction of snowpack available for runoff, it provides a general snapshot of the snowfall.

Figure 3 shows that winter snowfall has been near normal across much of southern Saskatchewan except for southwest and portions of the province where snowfall has been below normal and northern areas of the agricultural region where snowfall has been above normal. Some mid-winter melt has also occurred across the southwest, with a large area being snow free or nearly snow free prior to the third week of February. The Regina area has also received above normal snowfall throughout the winter.

Environment and Climate Change Canada produces a snow water equivalent map generated using satellite passive microwave signals. Their March 1, 2022 map is provided as Figure 4. This product aligns well with the snow surveys completed by WSA over southern Saskatchewan. While the data to verify its applicability over northern Saskatchewan is not available, it does appear to be overestimating snow water equivalents in the far north.

WSA completed point snow course surveys between February 10 and 25. This data, which is provided in Figure 5, is believed to be the best available information on snow water equivalents at the time of the surveys.

Overall, central areas of the province, covering the southern most extent of the boreal forest and northern portions of the agricultural region, and some areas in the southwest, have received above normal snowfall thus far. Much of southwestern Saskatchewan has received below normal snowfall.

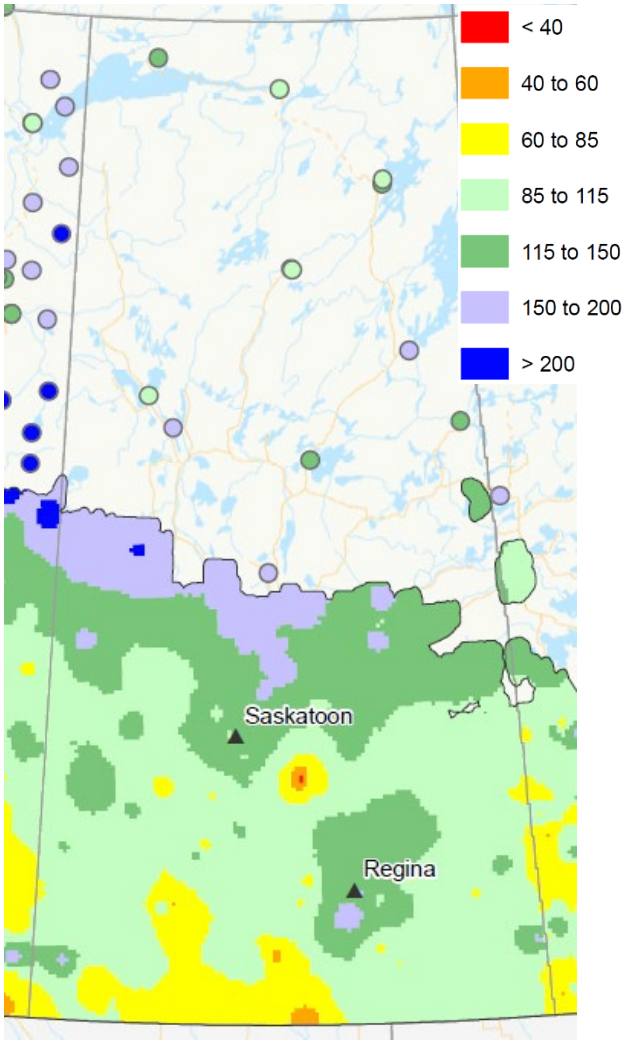

Figure 3: Per cent Normal Winter Precipitation
November 1, 2021 to February 27, 2022
(Map Courtesy of Agriculture and Agri-Food Canada)

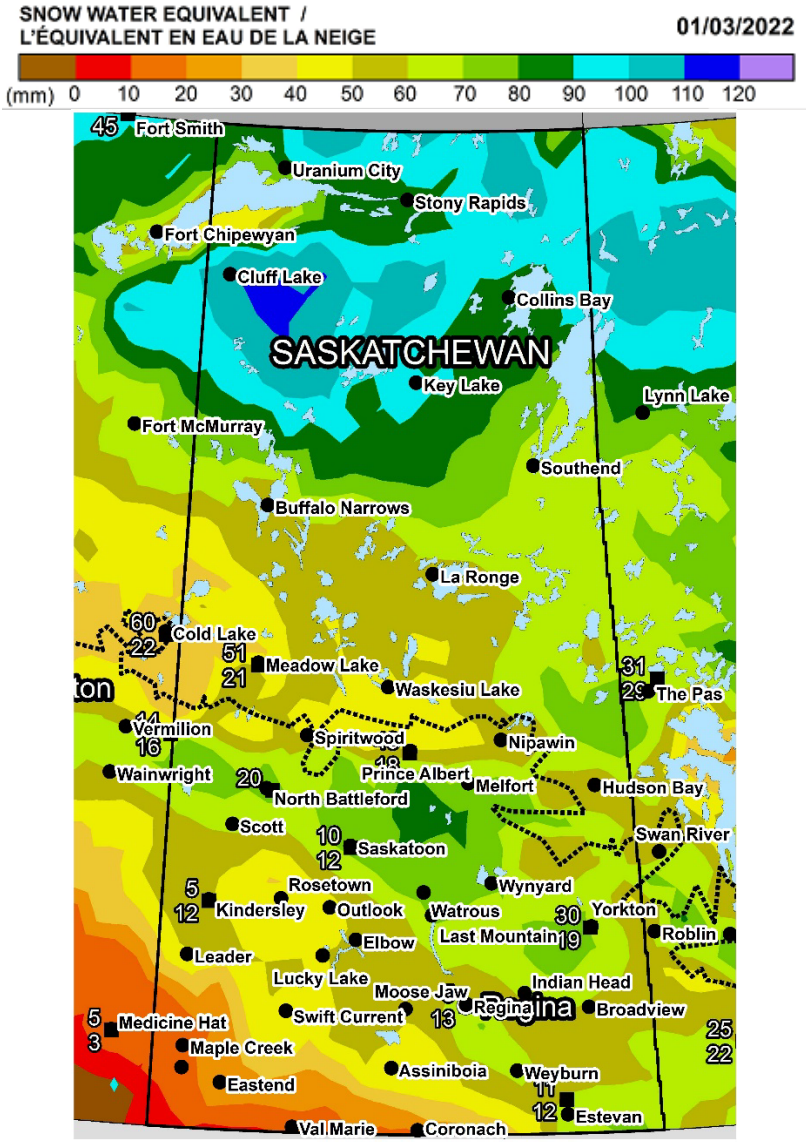

Figure 4: March 1, 2022 Passive Microwave Snow Water Equivalent Map
(Map Courtesy of Environment and Climate Change Canada)

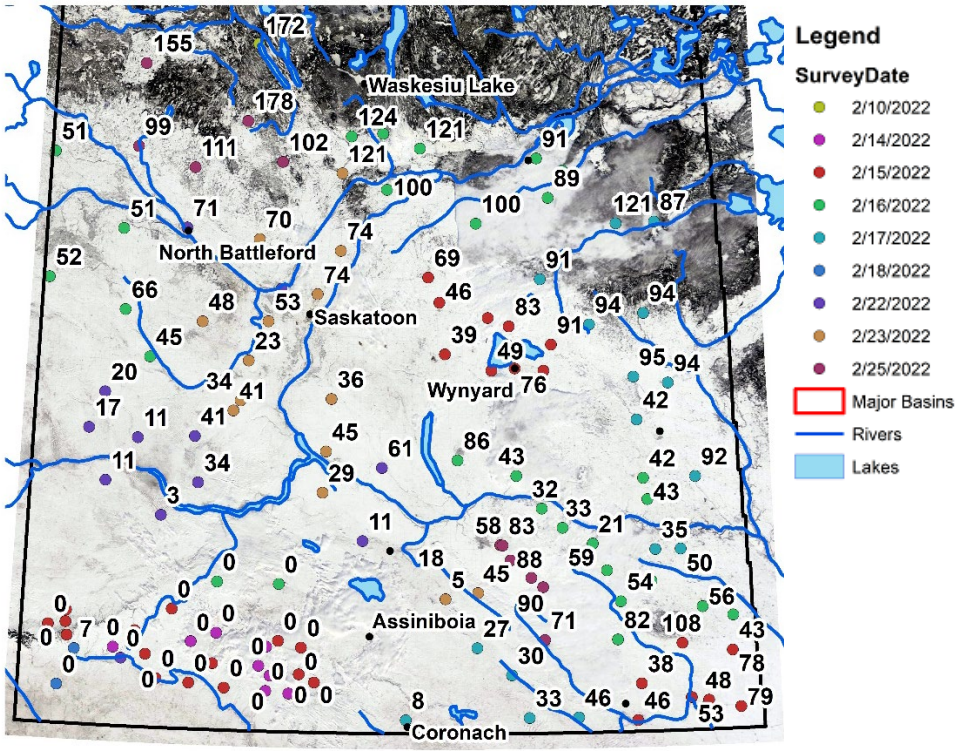

Figure 5: WSA Snow Survey Data – Snow Water Equivalent in mm
(background image is Feb 25, 2022)

Long Range Forecasts

Most long-range forecasts are predicting near normal precipitation for much of the province for March, April and May. The only exception is the southeast portion of the province where slightly above normal precipitation is favoured by the models. Most models are predicting near normal temperatures over the southeast portion of the province and below normal temperatures across the remainder of Saskatchewan over the next three months.

The multi-model ensemble mean forecasts are based on five numerical weather prediction models from the US and Canada. Three-month spatial anomaly maps (departure from climate normal) for precipitation (Figure 6) and temperature (Figure 7) covering the March 1 to May 31 forecast period are provided. These maps represent the average solutions of the five models.

It is important to note that seasonal weather forecasts are largely unreliable; however, the ensemble approach is regarded as an extremely effective way of quantifying prediction uncertainty and is proven to produce better forecasts compared to a deterministic/single model approach. When the models are in agreement, confidence is higher.

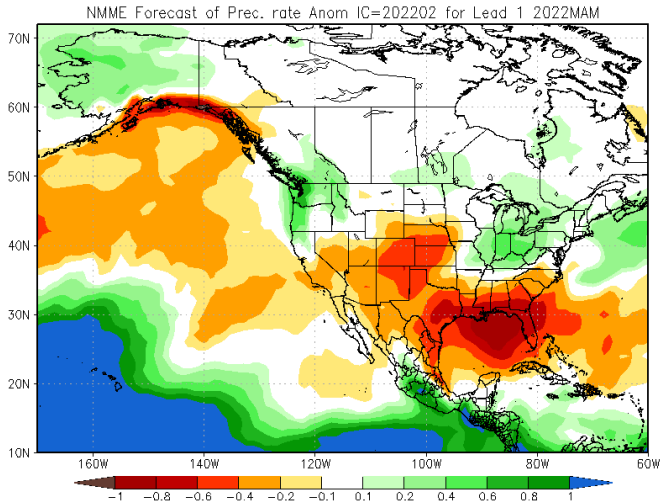

Figure 6: Multi Model Ensemble Precipitation Anomaly Forecast (March 1 to May 31, 2022)
Map Courtesy of the US National Weather Service

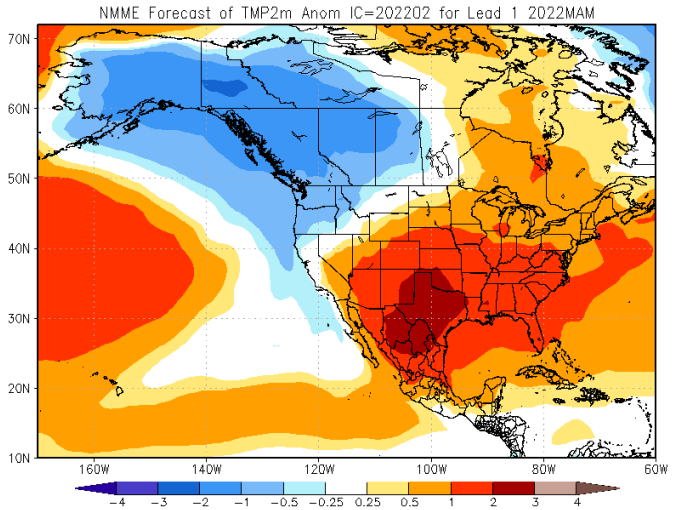

Figure 7: Multi Model Ensemble Temperature Anomaly Forecast (March 1 to May 31, 2022)
Map Courtesy of the US National Weather Service

Water Supply Outlook

Most reservoirs and dugouts in the south and central portions of the province went into winter at below to well below normal levels because of the dry conditions throughout 2021. With the forecasted snowmelt inflows, most reservoirs in the southeast and across central Saskatchewan are expected to be within their desirable operating ranges following the snowmelt. The exception is the Souris River Basin reservoirs (Rafferty, Boundary and Grant Devine), Avonlea Reservoir, Reid Lake and Thompson Lake which, based on the current forecast, are unlikely to fill from snowmelt runoff. In the southwest, without significant late winter precipitation, it is likely that surface water supply shortages will be experienced in 2022. In particular, reservoirs in the Maple Creek Basin are not expected to fill in spring 2022 unless there is significant late season precipitation.

Summary of Major River Systems

See Figure 8 for a map of Saskatchewan's major drainage basins.

Souris Basin

Both Rafferty Reservoir and Grant Devine Lake are below their February 1 drawdown target elevations. Based on current conditions within the basin and the volumetric runoff forecasts, non-flood operations, under the 1989 Canada-US Agreement on Flood Control and Water Supply in the Souris River Basin, are in effect. As such, no additional drawdown of these reservoirs is required prior to the spring runoff. The snowmelt runoff response is expected to generally be near normal across the Moose Mountain Creek basin. Due to a below normal snowpack and dry conditions in the fall, the Long Creek Basin and the lower portion of the Souris River are expected to observe a below normal runoff response in 2022. The headwater areas of the Souris River, namely the area above Weyburn, is expected to see an above normal snowmelt runoff response. This is promising for the filling of Nickle Lake; however, with the dry conditions over the last couple of years, Rafferty Reservoir is not expected to fill in 2022.

Based on current conditions, none of the major reservoirs in the basin are expected to fill in 2022. It is anticipated that reservoir releases during the spring runoff period will be limited to what may be required to meet international apportionment obligations. Any releases to satisfy these international obligations will be made from Grant Devine Dam.

Detailed forecasts for the Souris River Basin are developed on or near the first and fifteenth of each month, beginning in February, up until the snowmelt runoff event. These forecasts can be found on www.wsask.ca.

Saskatchewan River Basin

Lake Diefenbaker was about 1.5 m below its median level in fall 2021. Throughout the winter, inflows into Lake Diefenbaker have been slightly above normal and outflows were maintained at below normal rates. The operating plan is to draw the reservoir down to around 550.5 m by March 15. Near normal releases are likely to continue throughout both March and April.

With minimal snowpack over the foothill and prairie portions of the South Saskatchewan River Basin, inflows to Lake Diefenbaker are expected to be below normal in early spring. While outflows from Lake Diefenbaker will be minimized during the ice break-up period on the North Saskatchewan River, Lake Diefenbaker may see lower than normal levels through the month of April.

Snow observations completed by Alberta Environment and Parks at higher elevations within the alpine headwaters of the basin are currently showing an above to well above normal snowpack for both the North and South Saskatchewan River headwaters. The snowpack in the Rockies does not typically peak until late May or early June at the upper altitudes; therefore, conditions can change between now and

the melt and snowpack could end up being closer to normal if there is minimal snowfall over the next two months. Additionally, high flows on the system are largely driven by significant summer rainfall events in June and July. At this time, assuming near normal precipitation over southern Alberta through the summer months, Lake Diefenbaker levels are expected to be near normal this summer.

Flows on the North Saskatchewan River are above normal for this time of year. With the below normal releases from Lake Diefenbaker, flows have been below normal to throughout the winter on the Saskatchewan River.

Due to the above normal snowpack over tributary catchments located to the north of the North Saskatchewan River, there is an increased potential for a dynamic ice breakup event, including ice jamming, on the North Saskatchewan River and Saskatchewan River this spring. Ice jam events typically occur in mid-April on this system with increasing temperatures, but these events can occur as early as the final week of March or as late as the first week in May. Ice jam events are difficult to predict, but with the current conditions, there is an increased likelihood that a dynamic ice breakup event similar to that seen in 2020 will occur. Ice jam events are never the same and ice could jam and release differently than what was observed in 2020. Additionally, a slow melt event could result in a benign ice breakup.

Qu'Appelle System

Most of the lakes in the Qu'Appelle River Basin have maintained a near normal water level throughout the winter months. The exception is Last Mountain Lake which, due to below normal inflows in 2020 and 2021 and above normal evaporative losses, is currently about 28 cm below its median water level for this time of year.

Pasqua-Echo lakes are maintaining a relatively high water level for this time of year. With the dry conditions in fall 2021, WSA elected to retain most of the stoplogs in the structure over the winter to minimize the risk of lower than desirable levels in 2022. WSA will monitor this closely to ascertain if stoplogs need to be removed prior to the melt event.

The current expectation for the Qu'Appelle River System is for a below normal runoff response above Buffalo Pound Lake, above normal for the Wascana Creek sub-basin, and near normal for the remainder of the basin. Operations will maximize diversions into Last Mountain Lake by minimizing the flow through the Craven Control Structure during the runoff event. This will improve levels at Last Mountain Lake. It is also believed that there will be sufficient runoff below Craven to bring the lower lakes up to their desirable summer operating levels. The exception being Round Lake which will not have its levels managed in 2022.

Churchill System

During the 2021 growing season, the basin received below normal precipitation; however, due to wet conditions in 2020, the flows and water levels remained high across much of the basin. With the well above normal snowpack, eastern portions of the basin are expected to see a well above normal runoff response in 2022. The remainder of the basin is anticipated to see a near to above normal runoff response. Since the largest events within the basin are generally the result of significant rainfall events, flooding is not expected at this time. Flows are expected to remain above to well above normal into the summer months and significant rainfall would likely result in flood related issues. In advance of the snowmelt event, WSA will be increasing outflows from La Ronge Dam. WSA also anticipates the need to manage significant inflows at Makwa and Cowan dams.

Quill Lakes

Both Big Quill and Little Quill lakes are currently at an elevation of 519.57 m. This is their lowest pre-spring runoff level since 2014 and is 0.38 m lower than the pre-spring level in 2021. While the snowpack within the Quill Lakes Basin is above normal, particularly to the north

of the lakes, considering the dry conditions at freeze-up, a near normal inflow is expected from the snowmelt in 2022. Based on current conditions, the Quill lakes are forecasted to increase by about 0.12 m in response to snowmelt inflows in 2022. This will result in a peak of about 519.7 m. With average climatic conditions in 2022, the Quill lakes water levels will continue to decline and potentially become disconnected and begin to act as individual lakes again rather than a single large lake.

Old Wives Lake

Runoff potential is expected to be well below normal for most of the Old Wives Lake Basin in spring 2022. This is a result of dry soil moisture conditions at freeze-up and below normal snow accumulations.

With the below normal snowpack above Thomson Lake and the dry conditions throughout 2021, the reservoir is not expected to fill in spring 2022. As such, a pre-runoff release at Lafleche Dam is not planned.

Flows on the Notukeu River are also expected to be below normal.

Frenchman River

Snowmelt runoff yields within the Frenchman River Basin are generally expected to be well below normal in 2022. With current conditions, and the expectation of normal conditions going forward, it is anticipated that Eastend, Huff and Newton reservoirs will fill in spring 2022.

Battle, Middle, Lodge Creeks

With the dry fall and below normal snowpack in southeastern Alberta and the southwestern corner of Saskatchewan, the expectation is that there will be a well below normal snowmelt inflow into both Middle Creek Reservoir and Altawan Reservoir in 2022.

Maple Creek

In the Maple Creek Basin, the snowpack is generally well below normal as a result of mid-winter melt events. This has resulted in well below normal inflows expected at all reservoirs in the basin (Junction, McDougald, Harris, and Downie) in the spring. At this time, it is unlikely that the reservoirs in the basin will fill in this spring, potentially reducing irrigation deliveries.

Swift Current & Rush Lake Creeks

The Swift Current Creek Basin was drier than normal at freeze-up in 2021 and has received a below normal snowpack this winter. As such, a below normal runoff is expected. With the current conditions, Reid Lake is not expected to fill from the snowmelt runoff this spring.

Highfield Reservoir is approximately 45 per cent full and may not fill during the snowmelt period. Highfield Reservoir will continue to be operated lower in spring 2022 during the ongoing construction activity at the dam.

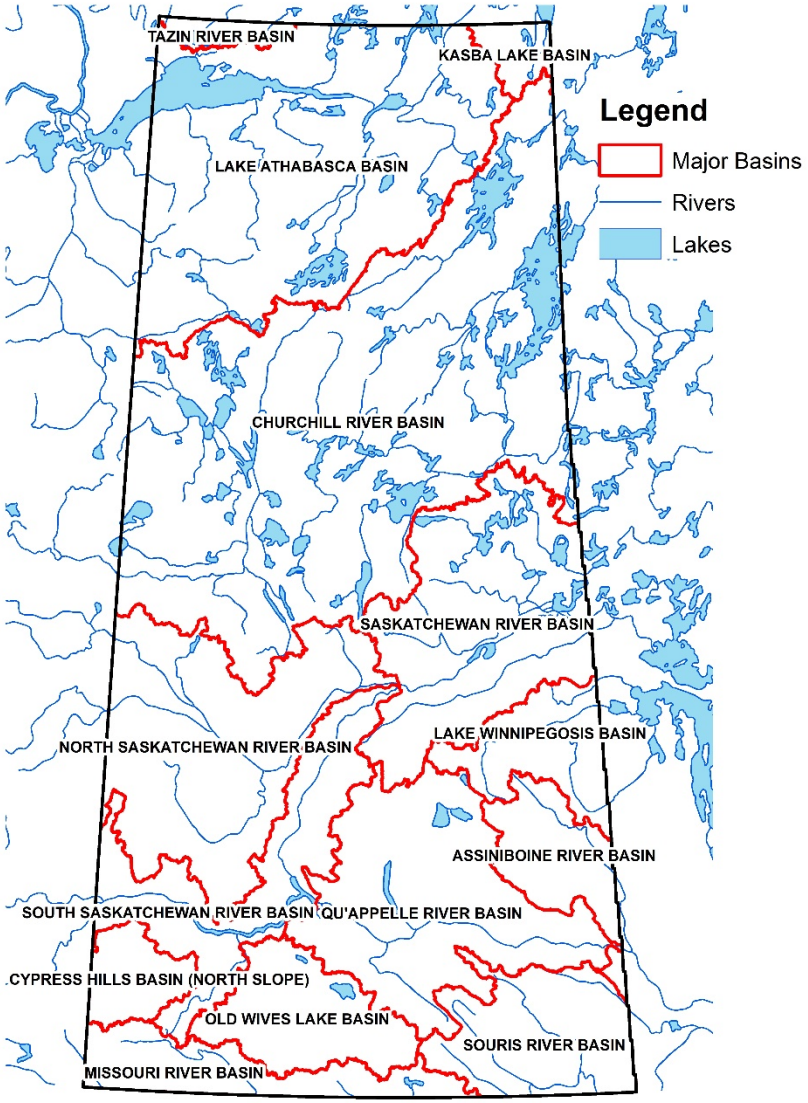

Figure 8: Major Drainage Basins in Saskatchewan

Next Forecast

The Water Security Agency will issue a Spring Snowmelt Forecast in early April unless runoff is underway.

Table 1: Provincial Forecast for Saskatchewan – March 2022

Lake	2022 March 1st Level (metres)	Forecast* 2022 Peak Spring Levels (metres)	Shoreline [1] Level/FSL (metres)	Normal Summer Level (metres)	2021 Peak (metres)	Recorded Historical Extreme	
						Level (metres)	Year
Anglin	515.43	515.7	515.4	515.3	515.6	516.05**	2013
Big Quill	519.58	519.7	521.47 (spill)	515	520.02	520.92	2017
Boundary Reservoir	558.61	559.2	560.83	560.5	559.17	561.15	1979
Buffalo Pound	509.38	509.5	509.9	509.4	509.59	511.45	1974
Candle Lake	494.27	494.5	494.5	494.4	494.38	495.25	1973
Cookson Reservoir	751.07	751.2	753	752.5	752.17	753.35	1979
Crooked	450.73	450.8	452.3	451.7	451.75	454.40**	2014
Echo and Pasqua	478.91	479.1	479.3	479.1	479.12	480.98	2011
Fishing	529.34	529.8	529.7	528.5	529.78	530.92	2011
Good Spirit	483.63	484.2	484.6	484.6	484.18	485.68**	2010
Grant Devine	560.56	560.8	562.0	561.5	561.03	566.58**	2011
Jackfish	529.36	529.4	529.4	529.4	529.64	530.0	1985
Katepwa and Mission	478.26	478.4	478.7	478.3	478.29	479.58	2011
La Ronge	364.22	364.4	364.1	364.4	364.36	364.98**	2020
Last Mountain	489.58	490.1	490.7	490.2	489.92	492.09	1955
Moose Mountain	619.55	619.3	620.3	620.4	619.94	621.9	2011
Nickel Lake	561.78	563.0	563.0	562.75	562.48	564.0	2011
Rafferty	547.75	547.8	550.5	550	548.56	554.05**	2011
Round	441.72	442.0	443.28	442.4	441.89	445.70**	2014
Wascana	570.63	570.8	570.6	570.5	570.66	572.23	1974

* These forecasted peaks are based on a typical spring precipitation and rate of melt. Above normal precipitation and/or rapid melt may result in significantly higher levels.

** Occurred after spring runoff during summer event(s).

[1] The “Shoreline Level” and “Full Supply Level” refer to the highest elevation before spill occurs

Table 2: Spring Runoff Forecast

Basin and Location	March 2022 Forecast*		2021 Spring Peak Flow (m^3/s)	Historical		
	Peak Flow (m^3/s)	Peak Flow Frequency		Normal Year	Recorded Maximum Spring	
				Flow (m^3/s)	Flow (m^3/s)	Year
ASSINIBOINE RIVER BASIN						
Assiniboine River at Sturgis	30	1:2	9.8	30	111	1995
Whitesand River near Canora	36	1:2	3.2	36	247	1995
Assiniboine River at Kamsack	120	1:4	24	78	488	1995
QU'APPELLE RIVER BASIN						
Qu'Appelle River near Lumsden	30	1:2	20	30	436	1974
Qu'Appelle River below Craven	2	<1:2	4.7	19	141	1974
Qu'Appelle River below Loon Creek	10	<1:2	5.3	24	163	2011
Qu'Appelle River near Hyde	50	1:3	7.5	32	254	2011
Qu'Appelle River near Welby	60	1:3	16	40	345	2011
Moose Jaw River above Thunder Creek	12	<1:2	0.2	24	252	1974
Moose Jaw River at Burdick	10	<1:2	0.7	30	368	1974
Wascana Creek at Regina	30	1:5	0.9	10	102	1974
Lanigan Creek above Boulder Lake	3	<1:2	0.5	4.7	56	2006
Pheasant Creek near Abernethy	7	1:2	0.3	6.9	47	1976
Cutarm near Spy Hill	6	1:2	0.3	5.6	35	1955
BEAVER RIVER BASIN						
Beaver River near Dorintosh	170	1:5	62	92	654	1962
LAKE WINNIPEGOSIS BASIN						
Red Deer River near Steen	20	1:2	4.2	20	102	1972
Red Deer River near Erwood	160	1:2	60	150	878	2006

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NORTH SASKATCHEWAN RIVER BASIN						
North Saskatchewan River near Deer Creek	1100	1:2	350	900	1660	1974
Eagle Creek near Environ	4	<<1:2	5.4	12	136	1970
North Saskatchewan River at Prince Albert	1200	1:2	510	1100	3880	1974
SASKATCHEWAN RIVER BASIN						
White Fox River near Garrick	70	1:5	58	26	160	1974
Torch River near Love	90	1:5	15	43	170	1955
Carrot River near Armley	40	<1:2	66	71	377	1974
Carrot River near Smoky Burn	150	<1:2	150	200	816	1972
SWIFT CURRENT CREEK BASIN						
Swift Current Creek below Rock Creek	10	< 1:2	11	18	85	1955
Rushlake Creek above Highfield Reservoir	2	< 1:2	4.7	7.4	38	1969
SOURIS RIVER BASIN						
Long Creek near Noonan	2	<1:2	0.0	50	183	2011
Yellow Grass Ditch near Yellow Grass	10	1:3	3.5	12	79	2011
Souris River at Ralph	4	<1:2	0.0	25	118	1979
Jewel Creek	1	1:2	0.0	2.4	44	2011
Moose Mountain above Grant Devine Lake	20	1:2	0.5	17	99	2011
Souris River near Sherwood	10	<1:2	0.8	32	388	1976
OLD WIVES LAKE BASIN						
Notukeu Creek near Vanguard	7	<< 1:2	8.4	25	210	1952
Wood River near Lafleche	1	<< 1:2	1.0	35	292	1952

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	Peak Flow (m^3/s)	Peak Flow Frequency		Normal Year	Recorded Maximum Spring	
				Flow (m^3/s)	Flow (m^3/s)	Year
MISSOURI RIVER BASIN						
Battle Creek at Alberta Boundary	2	< 1:2	5.2	4.6	20	1985
Battle Creek near Consul	3	< 1:2	3.5	5	65	1967
Lodge Creek at Alberta Boundary	8	< 1:2	34	14	110	1952
Frenchman River near Ravenscrag	6	< 1:2	14	30	200	1955
Denniel Creek near Val Marie	2	< 1:2	1.0	9	43	2011
East Poplar River above Cookson Reservoir	2	< 1:2	0.6	5	30	1982

* These forecasted values are based on typical spring precipitation and typical rate of melt. Above normal precipitation and/or rapid melt may result in significantly higher flows.
** Occurred after spring runoff during summer event(s).