2017 Fall Conditions Report

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Hydrologic Forecast Centre

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EXECUTIVE SUMMARY

In the Canadian prairies, flooding is most common in the spring as the snowfall accumulated through the winter begins to melt and run off. Spring flood risk is a combination of a number of different factors some of which are determined in the fall, during the winter, and during the spring period. The fall conditions report describes the state of various factors for which data is available, that affect potential spring runoff and flood risk. The three key factors covered in this report are the soil moisture at the time of freeze-up, base flows on rivers and water levels on lakes prior to spring runoff, and, to a lesser extent, long term forecasted winter precipitation as a general indication of probable future weather. As a downstream jurisdiction Manitoba's flood risk in some watersheds is determined in part by the conditions in upstream jurisdictions including Saskatchewan and North Dakota.

One major factor that affects spring runoff potential is the soil moisture at the time of freeze-up. The soil moisture before freeze-up is largely determined by the accumulated summer and fall precipitation. All river basins in Manitoba have received normal to below normal precipitation between May and October. The Assiniboine River, Qu'Appelle River and Souris River watersheds have all received below normal precipitation. Southeastern Manitoba, including the Whiteshell Lakes area and the Interlake region also received below normal precipitation during the same time period. The Red River watershed in the United States received near normal precipitation on most parts of the watershed, except the northern and northwestern parts which received below normal precipitation. The Red River watershed in Manitoba received below normal precipitation. The upstream watersheds of the Saskatchewan River and the northern watersheds of the Lake Winnipegosis basin have received near normal precipitation. The southern watersheds of the Lake Winnipegosis basin, including the Dauphin Lake basin, received below normal precipitation during the same period.

Due to the fall and summer precipitation patterns, the soil moisture before freeze-up is normal to below normal for the watersheds of most of Manitoba's rivers. The soil moisture is below normal for the Assiniboine River, Qu'Appelle River, and Souris River watersheds, and for the Manitoba portion of the Red River watershed. The soil moisture is near normal for most of the Red River watershed in the United States except the northern part of the watershed, which has below normal soil moisture. The Saskatchewan River basin, the Lake Winnipegosis basin, southeastern

Manitoba, and the Interlake region have normal to below normal soil moisture. Soil moisture is generally near normal in northern Manitoba. Normal to below normal soil moisture indicates a lower risk of major spring flooding within these river basins but flooding is still strongly dependent on future weather conditions, including winter and spring precipitation, as well as melt conditions. Soil moisture in most Manitoba river basins is generally drier than the soil moisture observed in recent years such as 2014, 2015 and 2016.

Another major factor that affects the potential spring flood risk is the base flow on rivers and the water levels on lakes prior to the spring runoff. Higher base flows and water levels indicate a higher risk of spring flooding as there is more water already in the system before runoff occurs. Base flows on most rivers are near normal for this time of the year. The Assiniboine River, the Souris River, the Qu'Appelle River and the Red River are all at normal flows for this time of the year. The only exceptions are the Saskatchewan River and the Carrot River, which are at above normal base flows.

Most major lakes, with the exception of Lake Winnipeg, are at above normal levels for this time of the year. Lake Winnipegosis, Dauphin Lake and Lake Manitoba are at the upper decile level for this time of the year. Lake Manitoba is at the upper end of its operating range, and the outflows out of the lake are at the maximum possible flows. Base flows are above normal on the Waterhen River, the Fairford River and the Dauphin River due to the above normal lake levels contributing to these rivers. The water level in the Shellmouth Reservoir is now being drawn down to create storage space for spring runoff waters. Lake Winnipeg is at near normal level and within the operating range. Lake St. Martin is below flood stage.

The forecasted winter precipitation is also another indicator of the potential for spring flooding. Though long term weather forecasts are not very reliable, they provide an indication of potential future snowfall amounts. Environment Canada's latest long term (November-December-January) precipitation forecast indicates precipitation amounts will be above normal for most of Manitoba and Saskatchewan. There is no clear trend in the precipitation forecast after January. The US National Weather Service (NWS) Climate Prediction Center also forecasts above normal precipitation for the Red River basin and the Souris River basin. The US National Weather Service (NWS) Climate Prediction Center also forecasts above normal precipitation for January to April for the Red River watershed and the Souris River watershed, in contrast to Environment Canada's forecast which does not show a clear trend. If above normal precipitation within these watersheds occurs, it will lead to a high risk of major spring flooding. The Hydrologic Forecast Centre (HFC)

of Manitoba Infrastructure works in collaboration with Environment Canada, the National Weather Service (NWS), and flood forecasters in neighbouring jurisdictions to regularly monitor the winter precipitation patterns throughout these watersheds.

For normal (average) winter weather conditions, water levels for major lakes and flows on major rivers have been forecast for the winter period. The Assiniboine River is forecasted to remain at near normal flows until the spring runoff. This is mainly due to the sustained release of outflows from the Shellmouth Reservoir, which will reduce the level in the reservoir in preparation for spring runoff. The Red River is expected to at remain near normal flows until the spring runoff. Flows on the Waterhen River, Fairford River and Dauphin River will remain very high due to the high lakes levels from where these rivers originate. Lake Manitoba is expected to remain near 812.0 ft throughout the winter. Lake Winnipegosis will remain near 832.4 ft throughout the winter. Lake St Martin is expected to reach near 801.5 ft before the spring runoff.

It is not very practical or feasible to provide a long term flood forecast for spring 2018 as conditions could change significantly during the coming months. Drier soil moisture conditions and near normal base flow conditions indicate a relatively lesser risk of major spring flooding. However, higher spring flooding risks could always develop if heavy winter precipitation occurred, or if a fast melt rate or heavy spring rainfall were to occur in early spring. A single major weather storm, similar to the one that occurred in April 1997, or the one that occurred in the summer of 2014, could cause major flooding in Manitoba.

The near normal to below normal soil moisture conditions, the near normal river base flow and lake water level conditions, and the near normal to above normal future precipitation forecasts indicate the probable chance of moderate flooding at some locations within Manitoba. However, looking back at some of the most significant historic flood events, each flood is caused by a combination of unique circumstances. There is a risk of over-estimating or under-estimating the flood potential if one considers the conditions and available precipitation four months in advance of the spring runoff. The Hydrologic Forecast Center will continue to monitor the watershed conditions closely and will release spring flood outlooks through the winter as required.

BACKGROUND

The spring runoff potential is generally dependent on six major factors:

1. Winter precipitation;
2. Soil moisture at freeze-up;
3. Effective spring rain (April rainfall);
4. Melt rate;
5. Frost index; and
6. Base-flow conditions.

Historically, all of the above factors have contributed to spring runoffs, including major floods and extremely low runoffs. The combination of these factors is generally unique for each specific year and for each specific watershed across the province. Generally, the soil moisture at freeze-up, winter precipitation, and base flow conditions are well known before spring melt and give a very strong indication of flood or low-flow potential.

SUMMER AND FALL PRECIPITATION

Almost all of the major river basins which flow through Manitoba (the Assiniboine River, the Red River, the Saskatchewan River, the Souris River and the Qu'Appelle River) have received normal to below normal precipitation between May and October. The Interlake region, Whiteshell Lakes region, the Assiniboine River basin and the Souris River basin have all received below normal precipitation between May and October. The Red River received normal to below normal precipitation. The Qu'Appelle River received below normal to well below normal precipitation during the same period. The northern basins, including the Saskatchewan River, have received near normal precipitation. Figure 1 shows the precipitation received between May and October as a percent of precipitation normal.

In total, the Souris River, the Assiniboine River, Whiteshell Lakes and the Interlake region received between 220 to 320 mm of rain between May and October (Figure 2). The Red River, the upper Saskatchewan River and the Lake Winnipegosis basins received between 320 to 450 mm of rain during this period. The Qu'Appelle River basin was one of the driest areas and has

only received less than 220 mm of rain during the same period. Most of northern Manitoba and northern Saskatchewan received over 320 mm of rain.

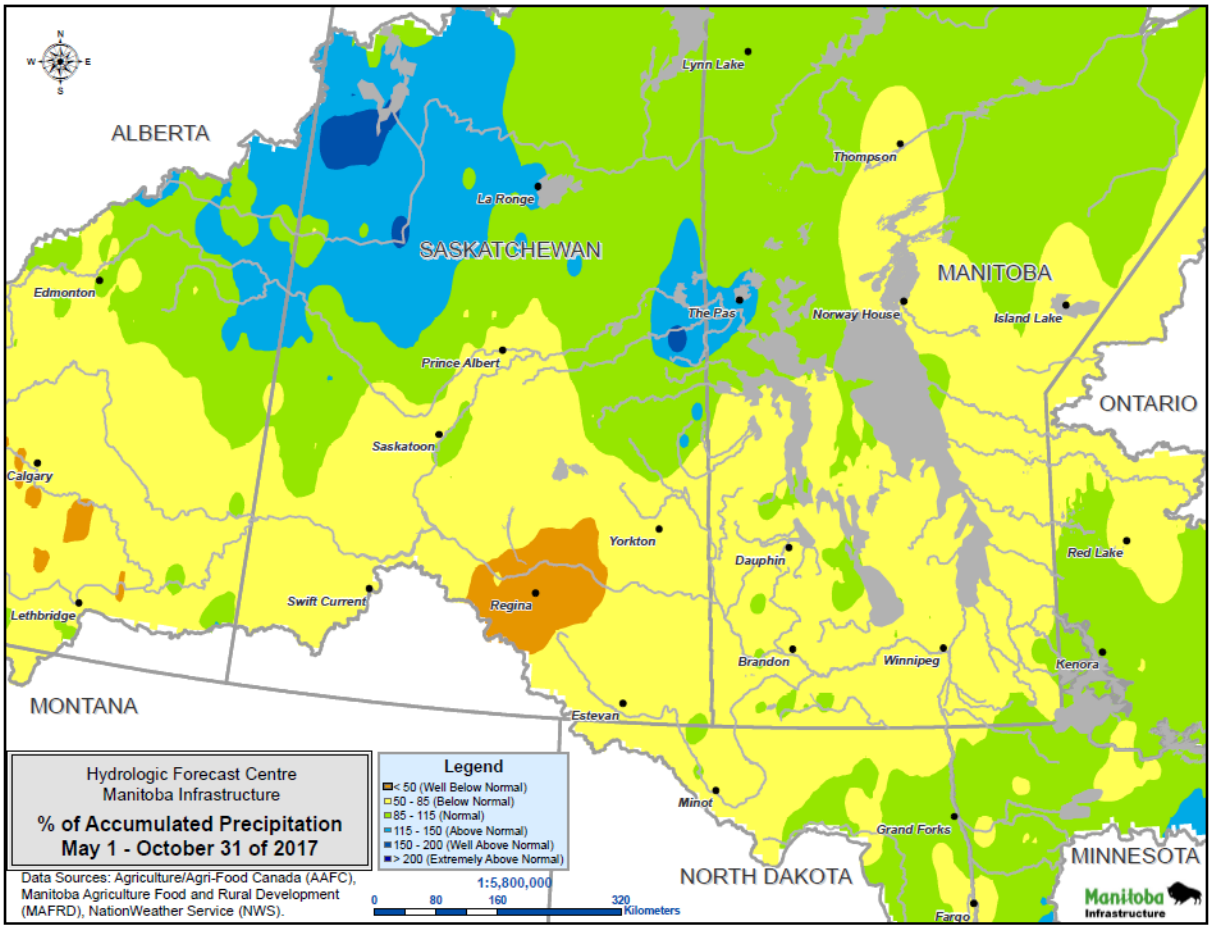

Figure 1. Percent Normal Precipitation (%) from May 1 to Oct 31, 2017.

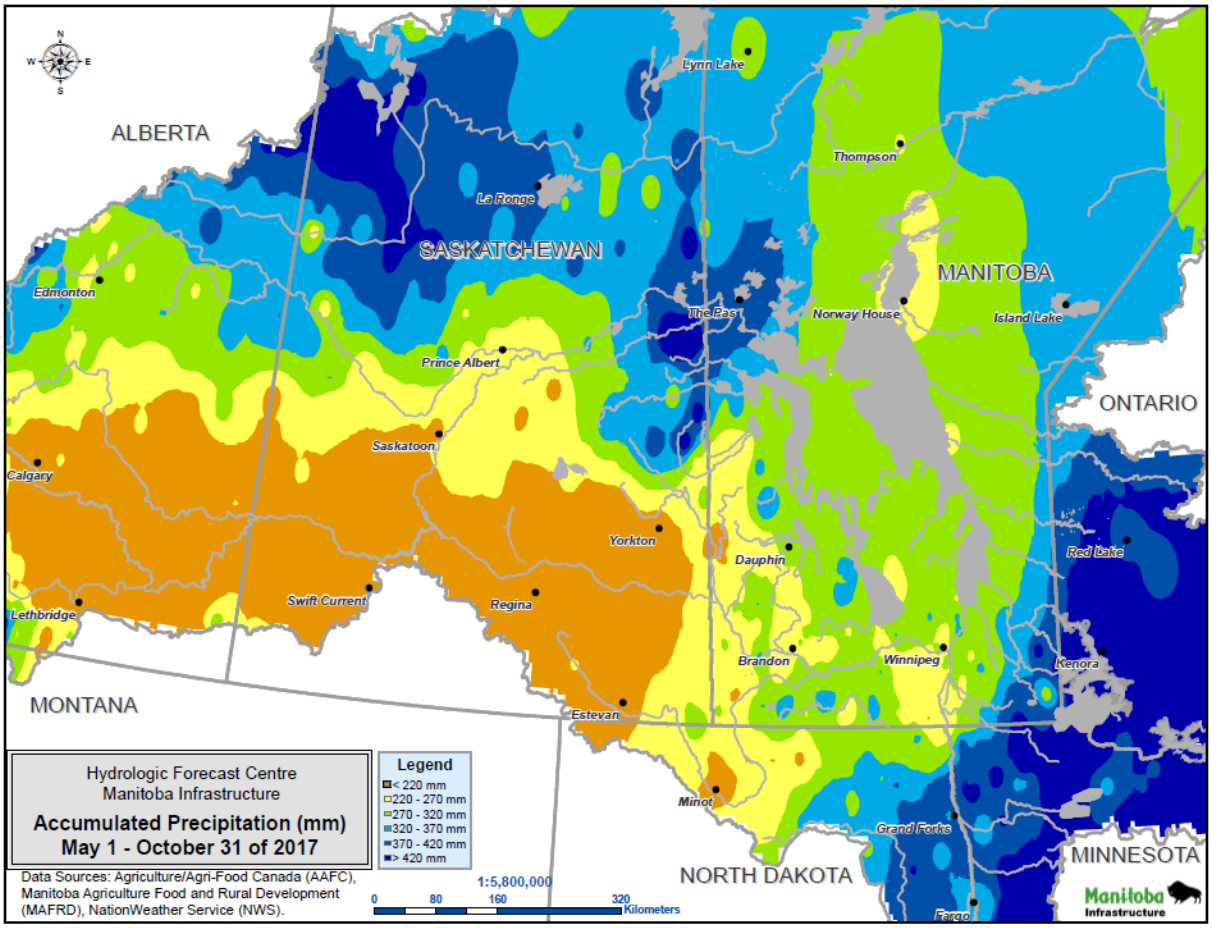

Figure 2. Total Accumulated Precipitation (mm) from May 1 to Oct 31, 2017.

SOIL MOISTURE CONDITIONS

A number of different tools have been used to determine the soil moisture at freeze-up. The most common method, which has been used for years, is Manitoba's MANAPI model which is expressed by the API (Antecedent Precipitation Index) method. This method uses the recorded precipitation at a large number of meteorological stations throughout the various basins. The API index map for the fall of 2017 is shown in Figure 3; it shows the API as a percent of normal. The API model indicates the amount of summer and fall rain (May to October) that remains in the soil layer and has yet to contribute to runoff. It is a model that indicates the degree of saturation in the soil.

Manitoba Agriculture also collects soil moisture measurements in the top 30 cm of the soil through its automatic weather monitoring stations located at various places across the province. These results, which are in percent of soil saturation. are shown in Figure 4. The other common method is the Airborne Gamma Survey, which uses radiation technology from low-flying aircraft to determine the soil moisture within the top 20 cm of soil. The Gamma Survey has been conducted in the southern and southwestern Manitoba basins and the results are shown on Figure 5.

The API model results (shown on Figure 3) indicate that soil moisture is normal to below normal for all Manitoba basins. The soil moisture is below normal in the Assiniboine River, the Souris River and the Qu'Appelle River basins. The soil moisture is generally normal to below in the Red River basin, the Lake Winnipegosis basin, the Interlake regions and the Whiteshell Lakes area. The soil moisture is generally near normal in northern Manitoba and northern Saskatchewan, including the Saskatchewan River basin.

Soil moisture measurements collected in the top 30 cm through monitoring sensors installed at weather stations by Manitoba Agriculture indicate the soil moisture is dry to adequate for most of Manitoba. The map of soil moisture presented as soil saturation levels is shown in Figure 4. In Figure 4, saturation levels less than 30% is indicated as very dry, saturation levels between 30% and 50% is indicated as dry, saturation levels between 50% and 70% is indicated as adequate, saturation levels between 70% and 90% is indicated as wet, and saturation levels in excess of 90% is indicated as very wet. As shown in the figure, soil saturation in the top 30 cm of the soil is dry in southwestern Manitoba, much of central Manitoba and the Interlake region, the Swan River area, and part of southeastern Manitoba. Soil saturation is adequate in most of eastern Manitoba, some portions of southern Manitoba and some portions of western Manitoba. The soil saturation level in most areas of the province is drier than the saturation level observed in most recent years.

The Airborne Gamma Survey conducted between October 22 and November 09 (Figure 5) indicated under 35% saturation in the upper 20 cm of the soil in most southern and southwestern areas of the province. Saturation is below 30% in the Souris River and the Qu'Appelle River basins, with some localized areas being less than 20% saturation. Saturation in the Red River basin is generally between 25% and 35%. The moisture content at the top 20 cm is significantly affected by the amount of rain that occurred a few days prior to the survey. Regardless, the degree of saturation observed by the Gamma survey shows near normal conditions on the Red River basin and below normal (drier) conditions on the Souris River and the Qu'Appelle River basins.

The NWS Climate Prediction Center, through its soil moisture monitoring and modelling works, indicated near normal to below normal soil moisture for the Red River basin and below normal soil moisture for the Souris River basin (Figure 6).

In summary, soil moisture in most Manitoba basins in the fall of 2017 is generally normal to below normal. All model results and various measurements confirmed that the Assiniboine River, the Souris River and the Qu'Appelle River basins are drier than normal. The Red River, the Lake Winnipegosis, the Saskatchewan River basins and the Interlake region have normal to drier than normal soil moisture conditions.

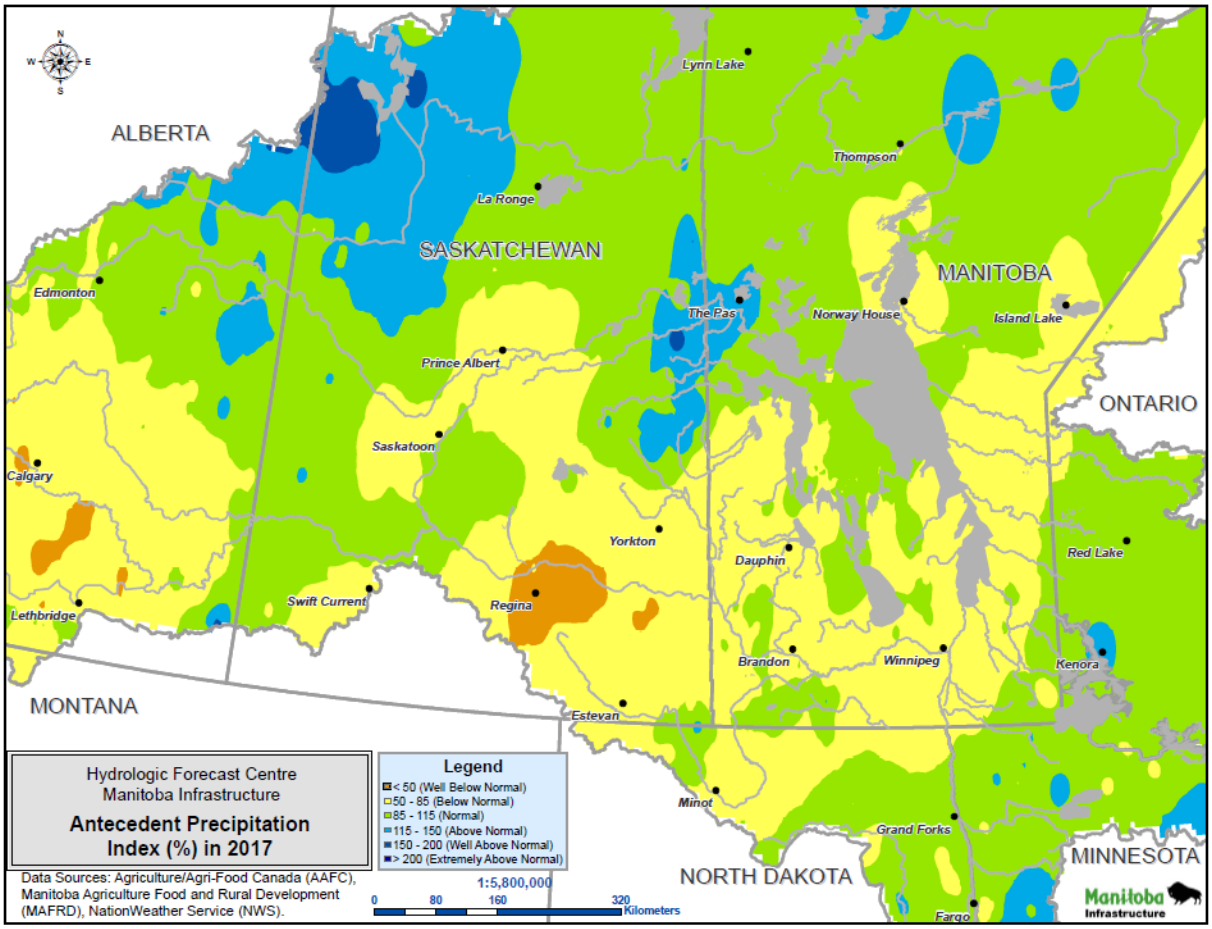

Figure 3 Antecedent Precipitation Index for 2017.

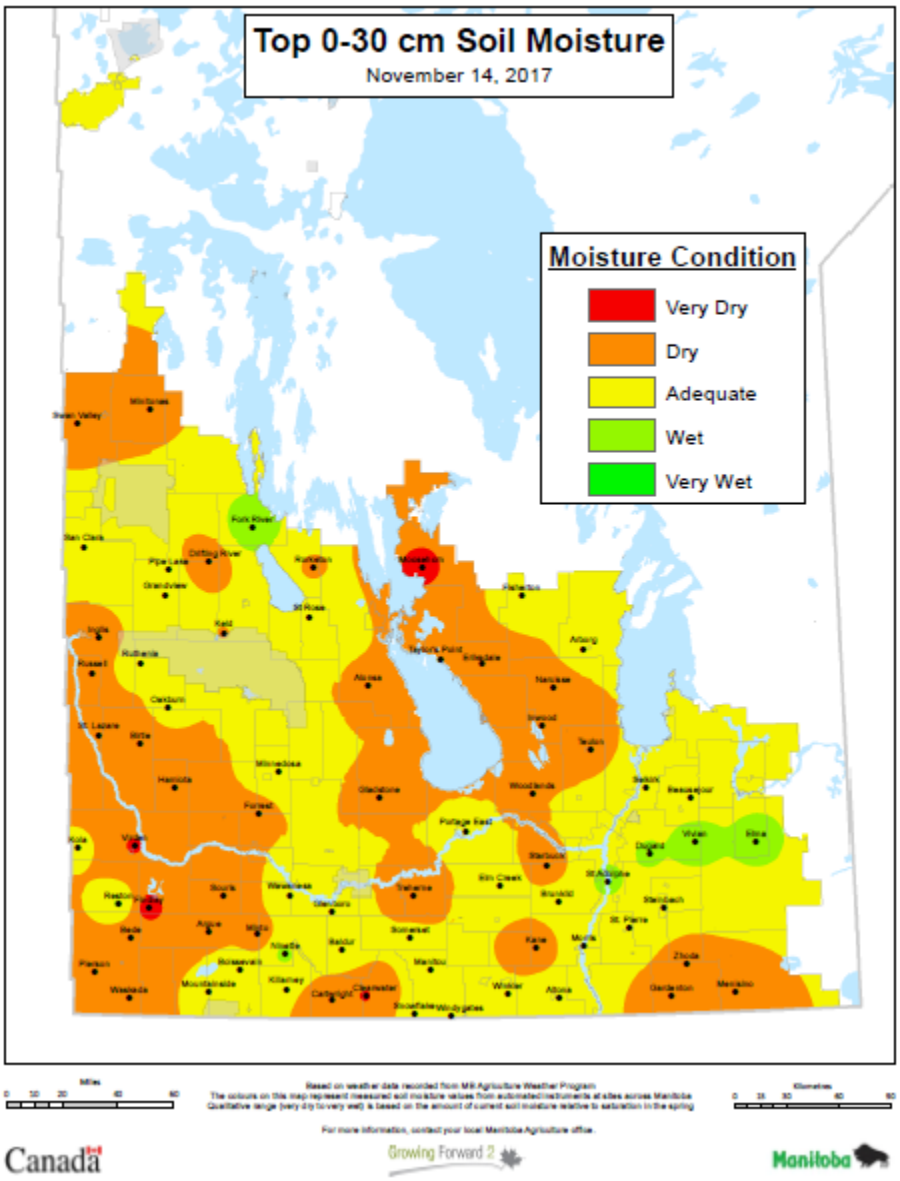

Figure 4. Soil moisture in top zone (0 to 30 cm) based on field measurements.

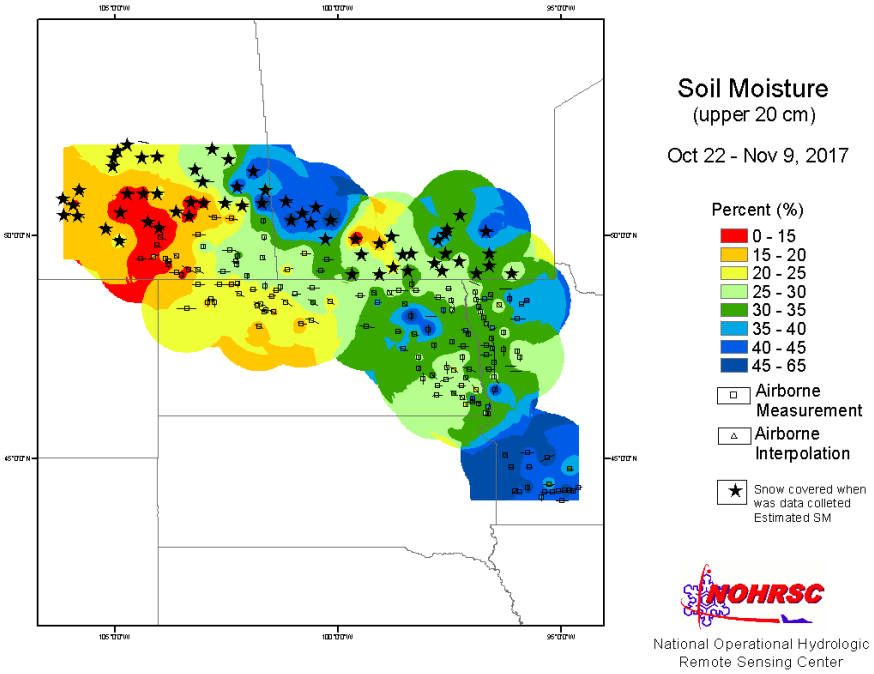

Figure 5. Soil Moisture from Gamma Survey conducted between Oct 22 and Nov 09, 2017.

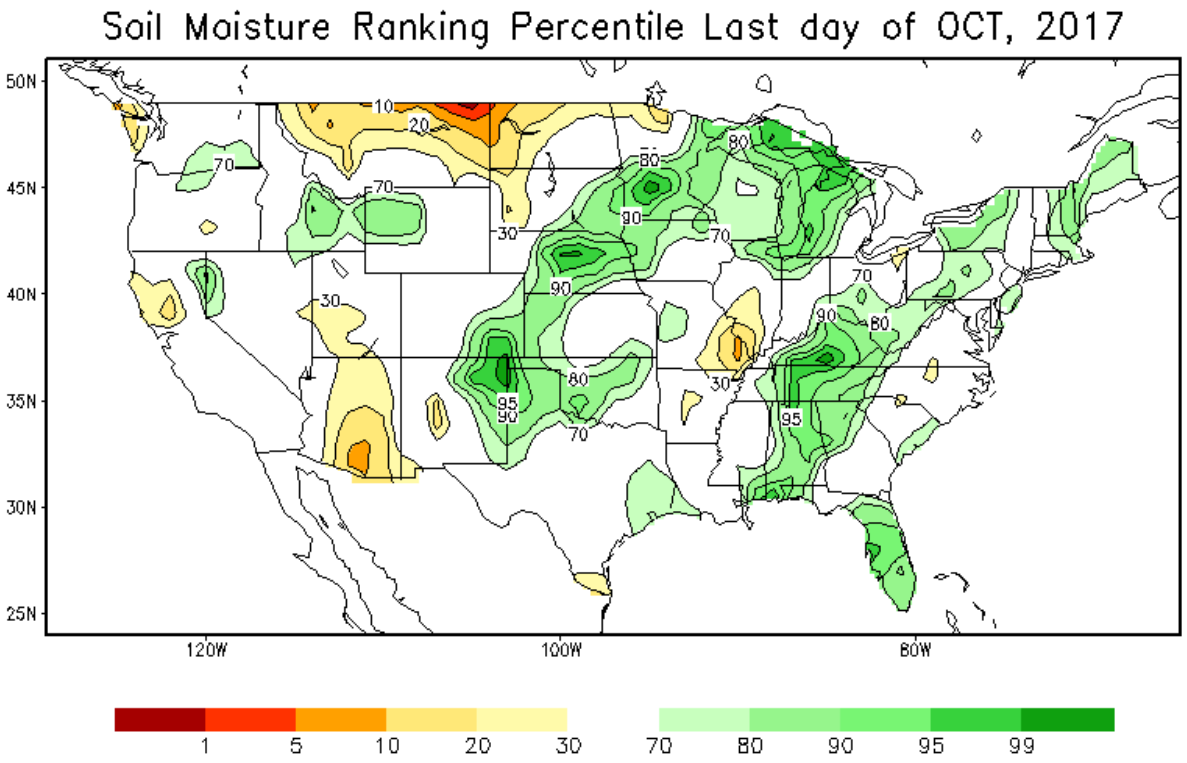

Figure 6. Calculated soil moisture ranking percentile, from the NWS.

BASE CONDITIONS

Rivers

Most of the major rivers have near normal flows for this time of year, except the Waterhen River, the Fairford River and the Dauphin River which have above normal flows because of the high upstream lake levels. Flows on the Red River, the Assiniboine River, the Souris River and the Qu'Appelle River are all at near normal for this time of the year. The Saskatchewan River and the Carrot River are at above normal flows. Hydrographs for the major rivers are shown in Figures 7 to 19. These figures show the measured or estimated flows on the rivers on November 15, 2017. Near normal base flows indicate near normal ground saturations or near normal soil moisture content. Current flows for main rivers at selected locations are listed in Table 1.

Table 1. Flows for main rivers at selected locations as of November 15, 2017.

Rivers	Location	Flow (cfs)	Normal Flows in November 15 (cfs)
Red River	Emerson	2,137	2,198
	Ste. Agathe	2,700	2,556
Assiniboine River	Russell	392	310
	Miniota	741	607
	Brandon	595	639
	Holland	1,063	834
	Headingley	1,232	740
Shellmouth Dam Release	Shellmouth	375	
Souris River	Wawanesa	46	65
	Melita	33	56
	Souris	42	63
Qu'Appelle River	Welby	220	264
Fairford River	Near Fairford	8,115	1,932
Dauphin River	Near Dauphin	7,901	1,429
Waterhen River	Near Waterhen	7,000	2,461
Lake St. Martin Emergency Out. Channel	Lake St. Martin	0	

Lakes

With the exception of Lake Winnipeg, all major lakes (Lake Manitoba, Lake Winnipegosis, Dauphin Lake and Lake St. Martin) are above normal for this time of the year. Lake Winnipegosis, Lake Manitoba and Lake St. Martin are above the upper decile level for this time of the year. Dauphin Lake is at the upper decile level. The upper decile level, which is also called the 90 percentile level, indicates historic recorded levels were less than the current level for 90% of the time; or past levels equalled or exceeded the current level on average once in 10 years. Lake Winnipeg is within the operating range and is also at the median level for this time of the year. Lake Manitoba is at 812.34 ft, which is near the upper end of the operating range of 812.5 ft. Lake St. Martin is at 801.38 ft, below the flood stage of 801.7 ft. Water level hydrographs for these lakes are shown on Figures 20 to 24. The inflow into Lake of the Prairies (Shellmouth Reservoir) is at the median condition for this time of the year. This is in contrast to the past few years when the inflows were extremely high as the soil was so saturated. Lake of the Prairies (Shellmouth Reservoir) is being operated in consultation with the Shellmouth Liaison Committee (SLC). The lake level on November 15th was 1398.89 ft. The reservoir operating guidelines recommend that the lake level be drawn down to between 1386 and 1400 ft depending on the spring runoff forecast. Regular spring runoff forecasts will be issued and the lake level will be dropped to the appropriate level before the spring runoff. Figure 25 shows the lake levels, reservoir inflows, and reservoir release from October 4th to November 15th. It also shows the inflow forecast, and the lake level forecast assuming current outflows are maintained. As ground and weather conditions change, the spring runoff forecast will change and a new extended forecast will be released.

FORECASTED LAKE LEVELS AND RIVER FLOWS OVER THE WINTER PERIOD

River flows through the winter (which are also called base flows) are extremely hard to forecast due to the frozen ground conditions and the effect of ice on flows and levels on rivers and lakes. The forecasted levels and flows throughout the winter period on selected lakes and rivers are shown in Figures 7 to 24. The Assiniboine River is forecasted to remain at near normal flows and levels in the period prior to the spring runoff. This is partly due to the sustained release of outflows from the Shellmouth Reservoir in order to reduce the level in the reservoir in preparation for spring runoff. The Red River is expected to remain at normal flows and levels in the period prior to the

spring runoff. Flows on the Waterhen River, the Fairford River and the Dauphin River will remain very high due to the high lake levels just upstream of these rivers.

Lake Manitoba is expected to remain near 812.0 ft throughout the winter. Lake Winnipegosis will remain near 832.4 ft throughout the winter. Lake St. Martin is expected to reach 801.5 ft before the spring runoff. The lake levels as of November 15, 2017 and the expected levels by March 31, 2018 (before the 2018 spring runoff) are given in Table 2.

Table 2. November 15 lake levels and the expected levels by March 31, 2018 (before the 2018 spring runoff).

Lakes	November 15, 2017 Level (ft)	Operating Range or Long Term Average (ft)	Expected Level by March 31, 2018 (ft)
Lake Manitoba	812.34	810.5 – 812.5	812
Lake Winnipeg	714.01	711 – 715	
Lake St. Martin	801.38		801.5
Lake Winnipegosis	832.56	830.5	832.4
Dauphin Lake	854.48	853.0 – 854.8	854.0 - 854.5
Whitewater Lake	1632.0	1628	1631.7
Shellmouth	1398.89		

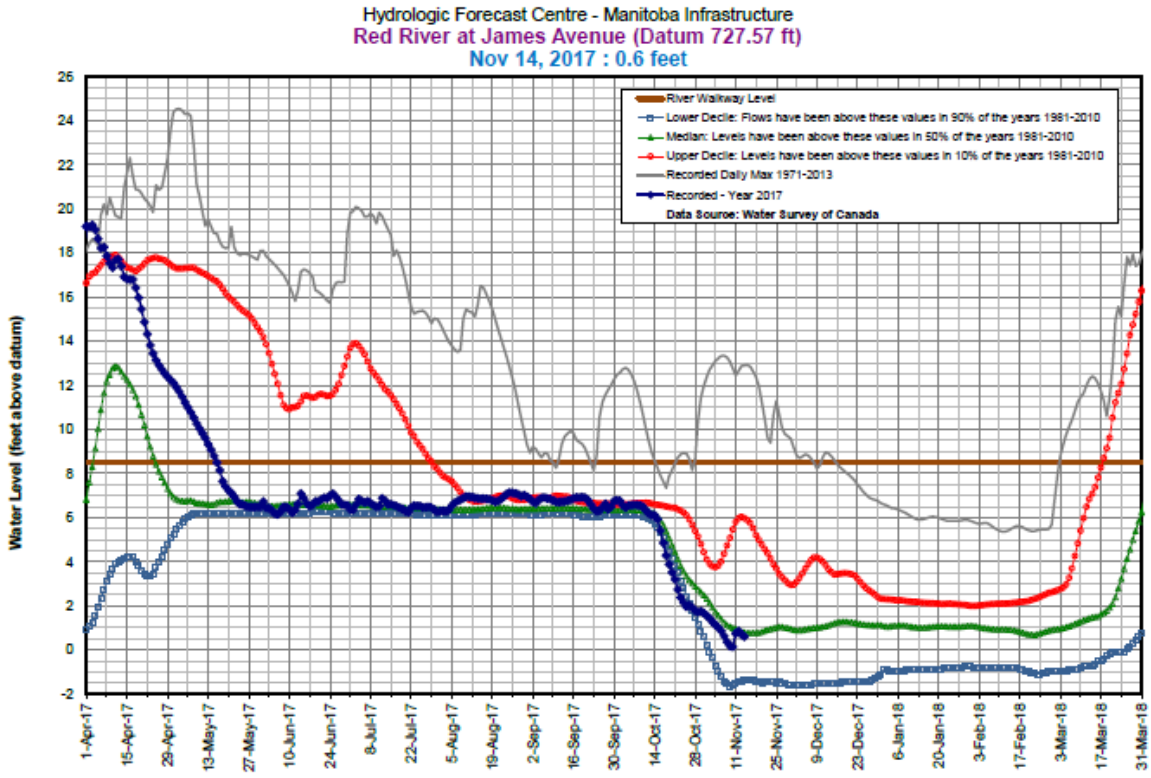

Figure 7. Red River Water Levels at James Avenue.

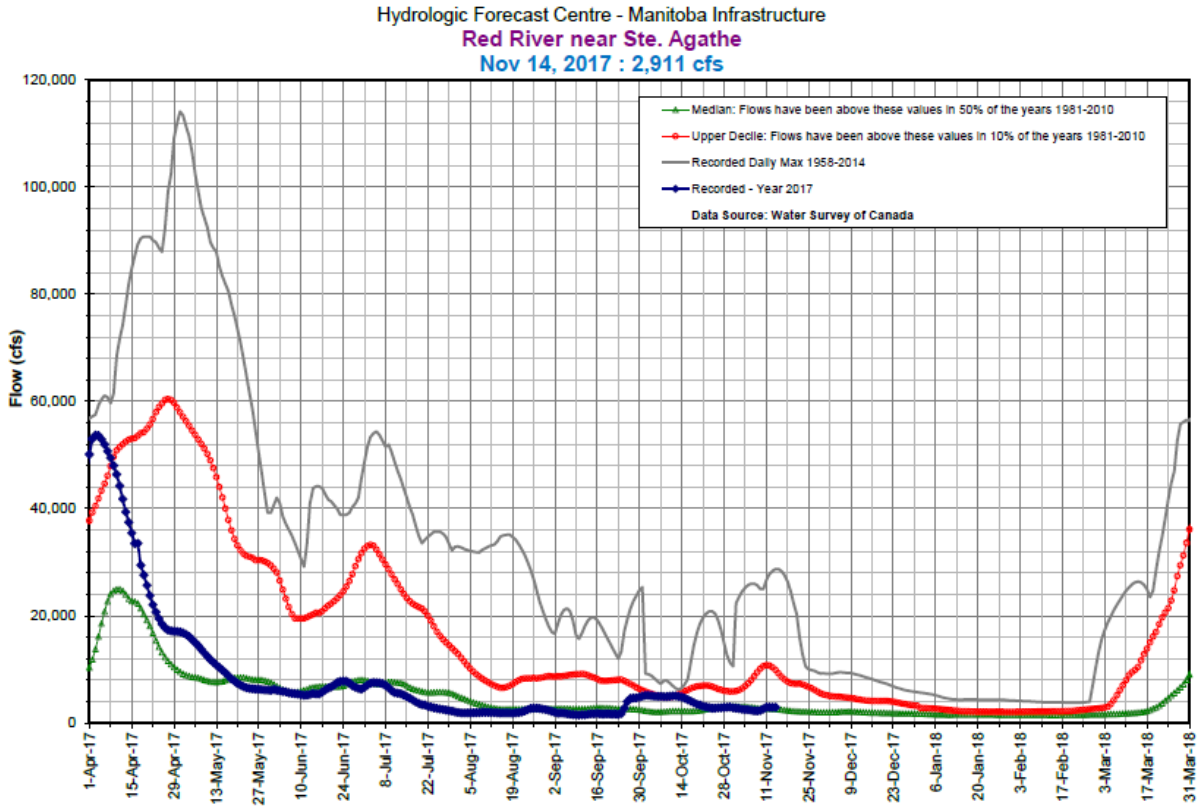

Figure 8. Red River Flows near Ste. Agathe.

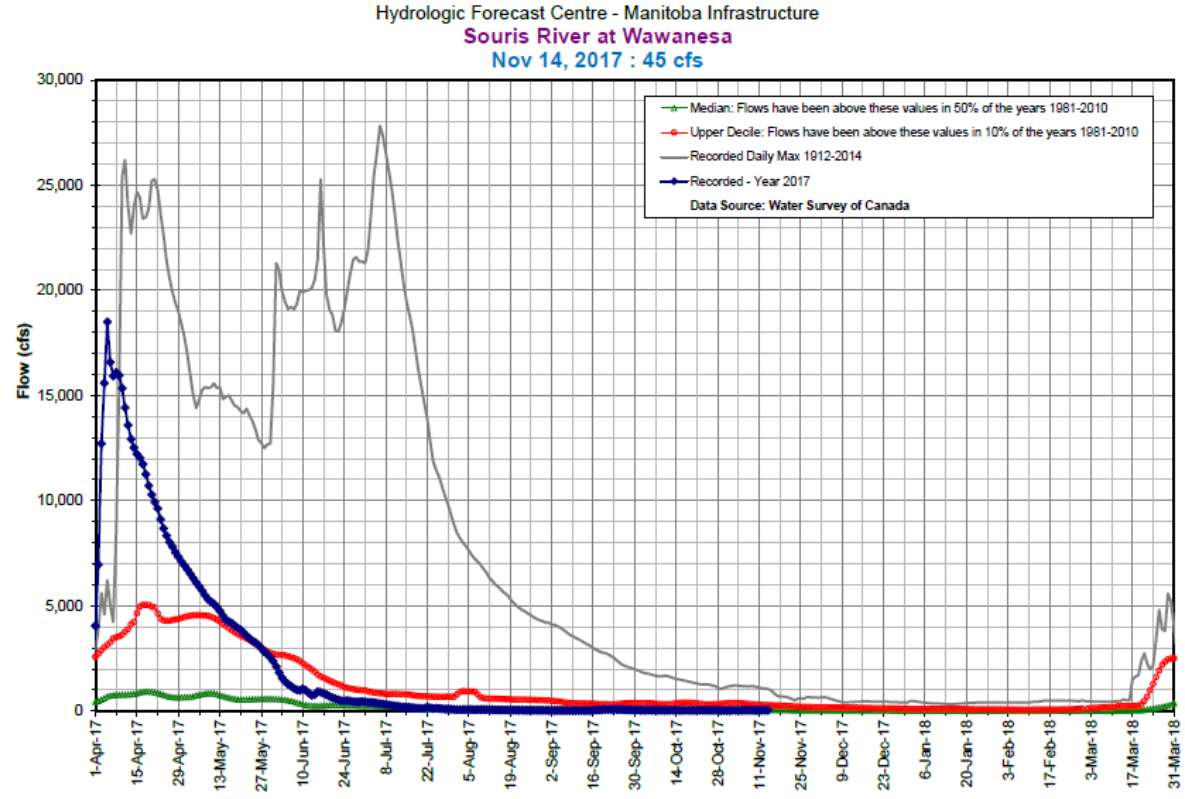

Figure 9. Souris River Flows at Wawanesa.

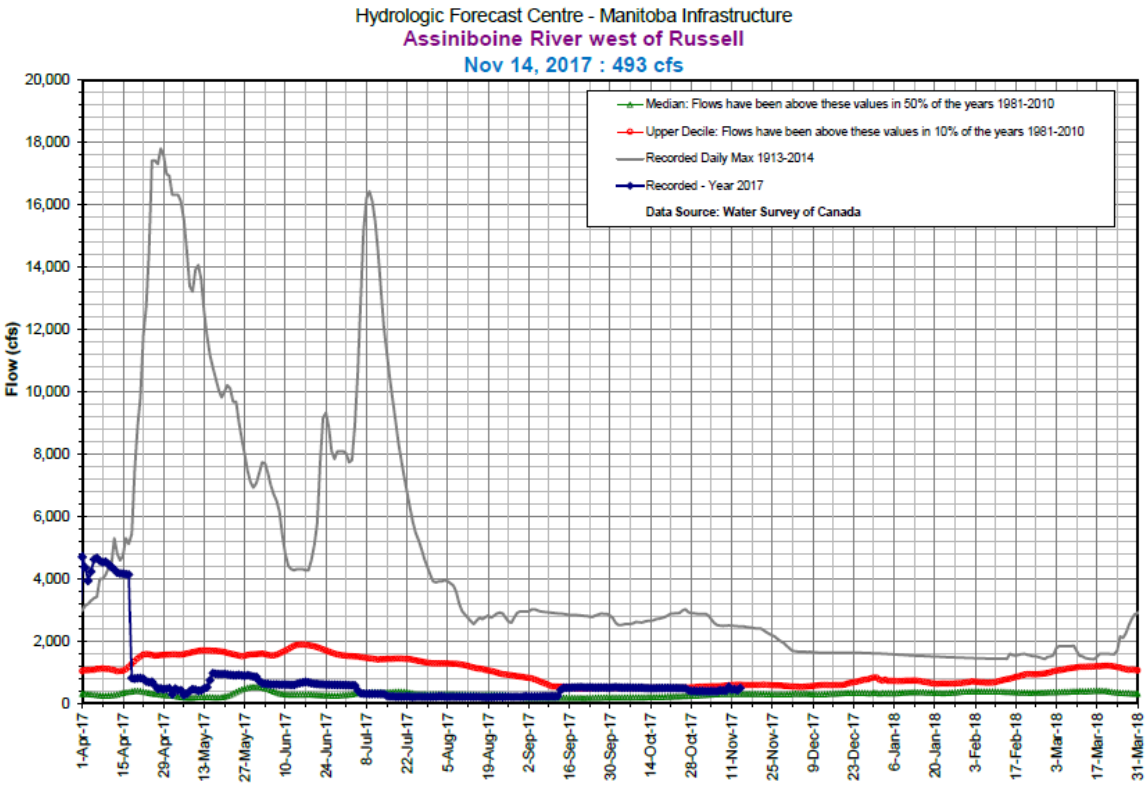

Figure 10. Assiniboine River Flows west of Russell.

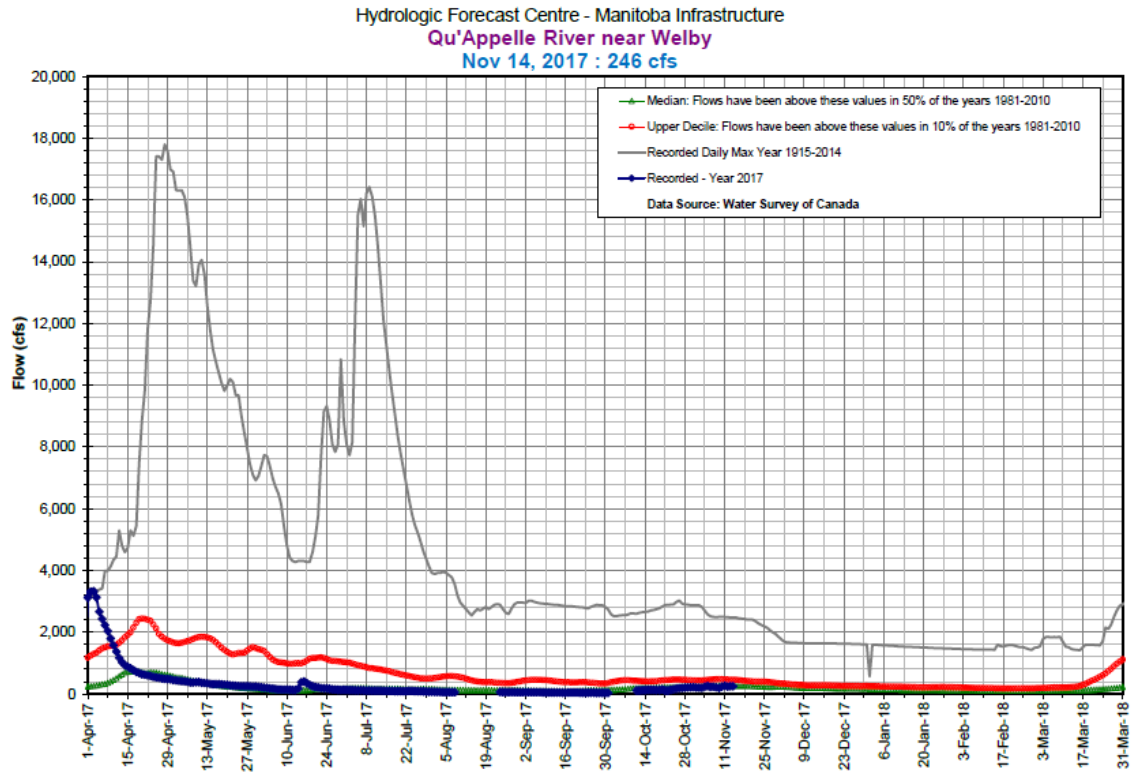

Figure 11. Qu'Appelle River Flows near Welby.

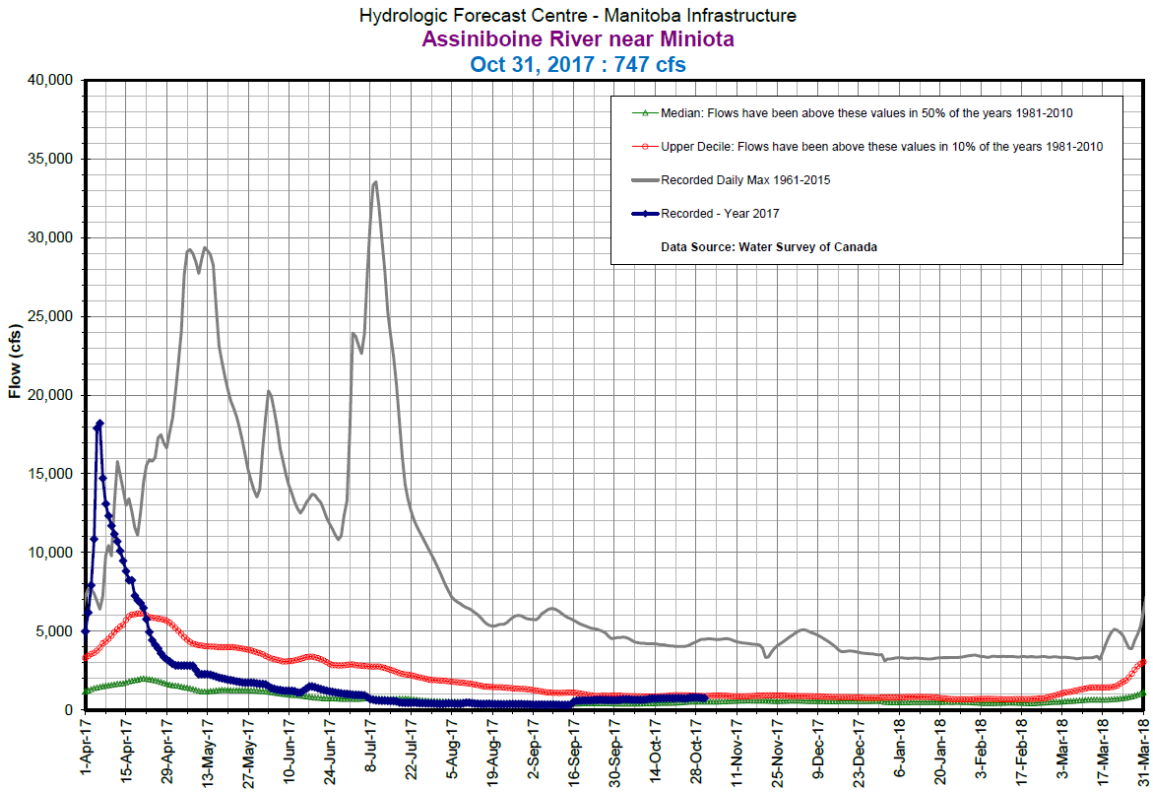

Figure 12. Assiniboine River Flows near Miniota.

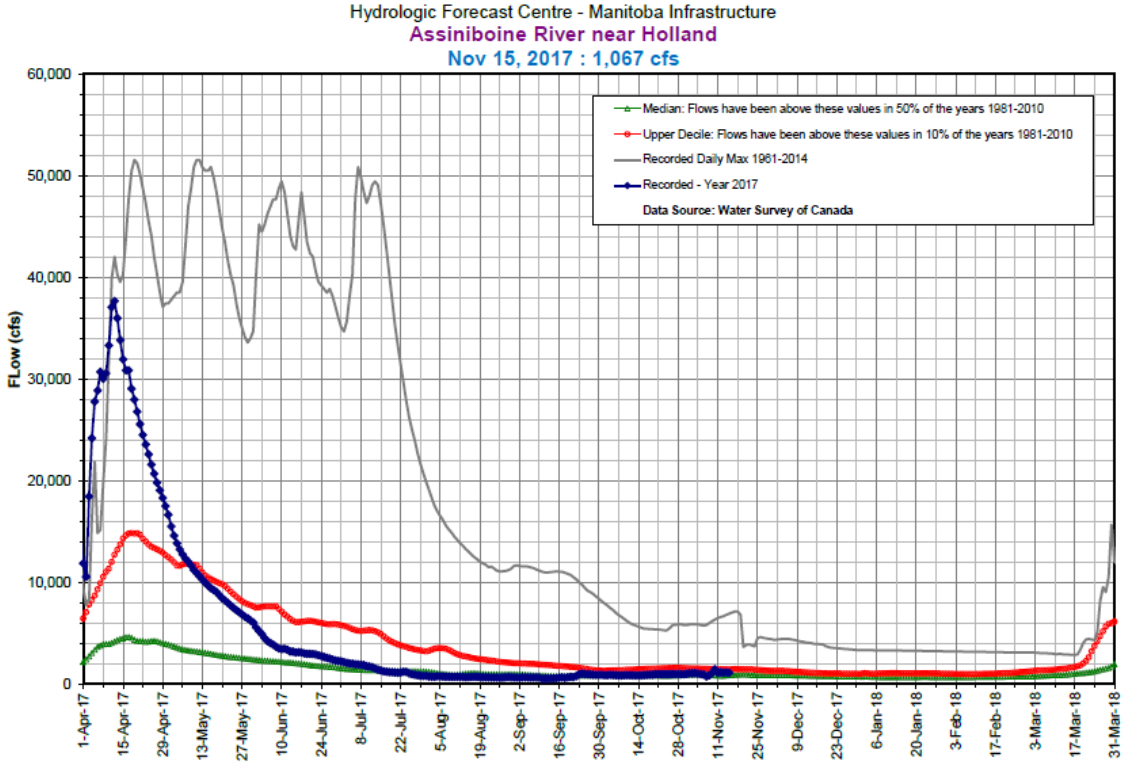

Figure 13. Assiniboine River Flows near Holland.

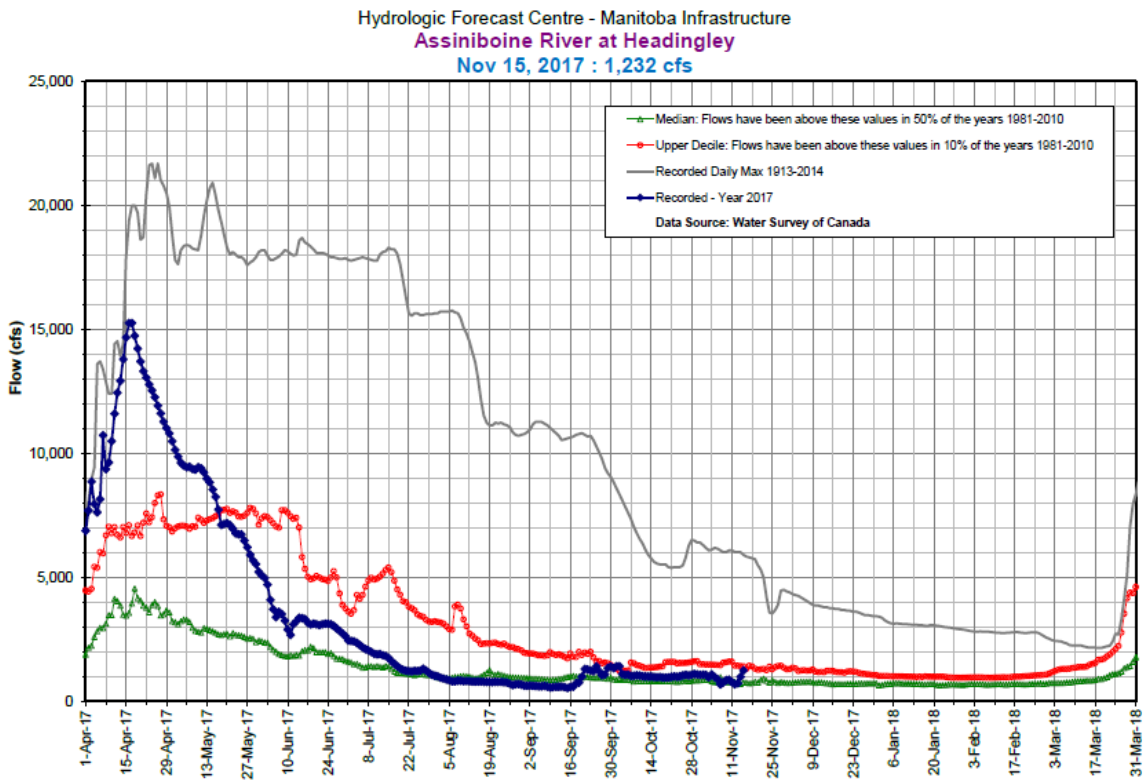

Figure 14. Assiniboine River Flows at Headingley.

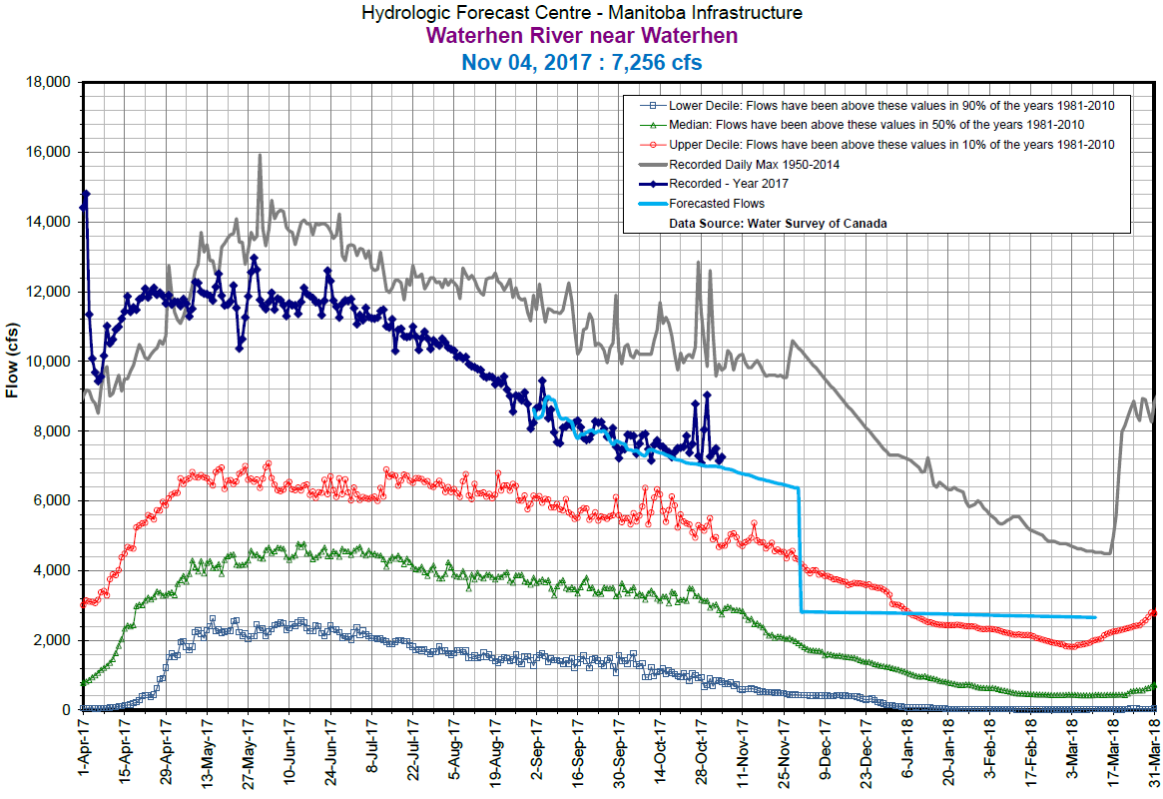

Figure 15. Waterhen River Flows near Waterhen.

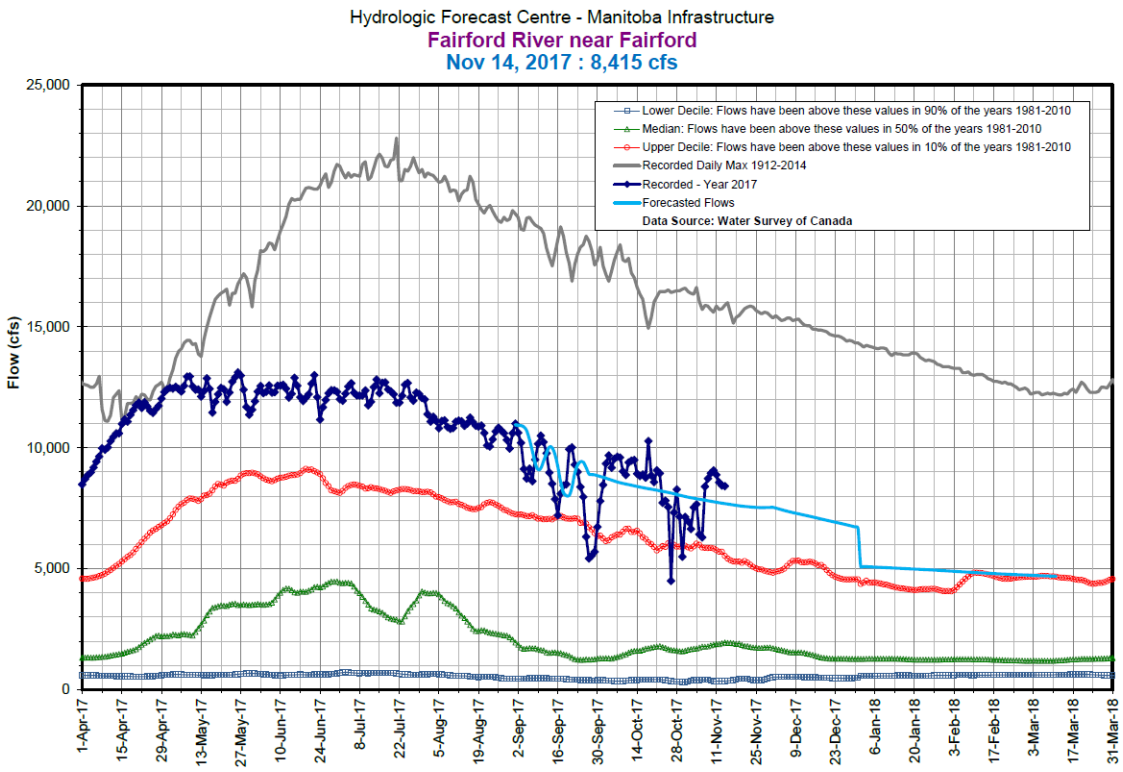

Figure 16. Fairford River Flows near Fairford.

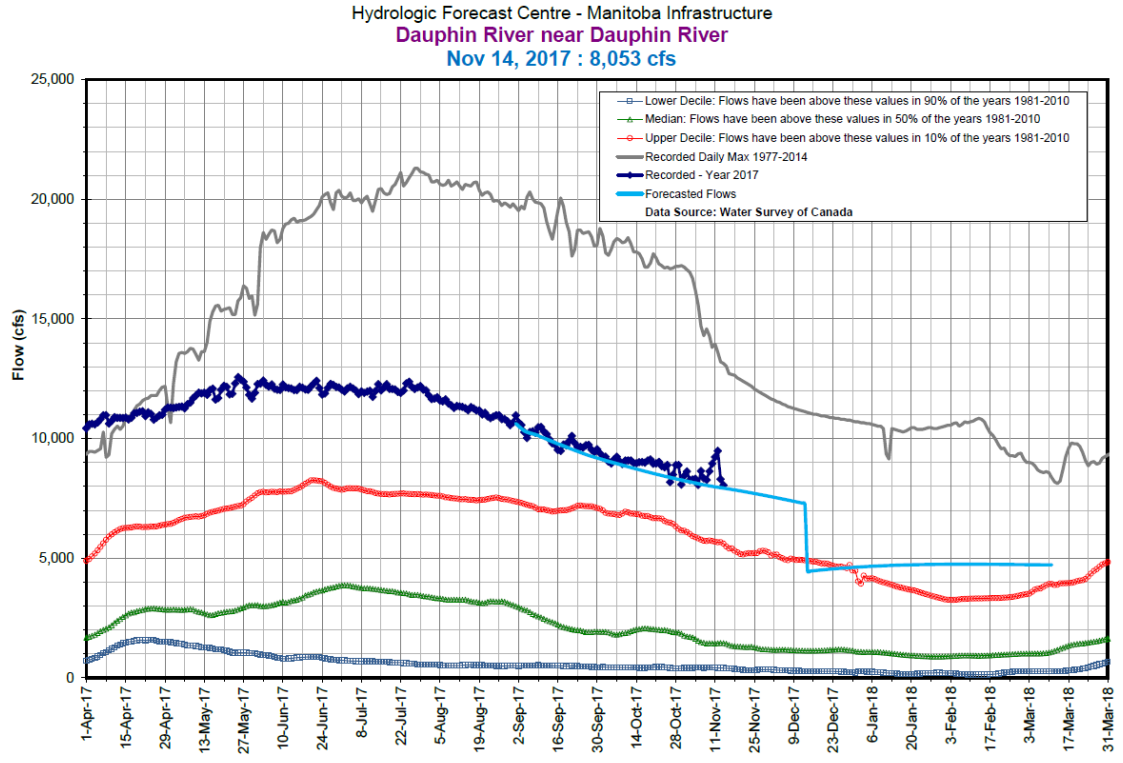

Figure 17. Dauphin River Flows near Dauphin River.

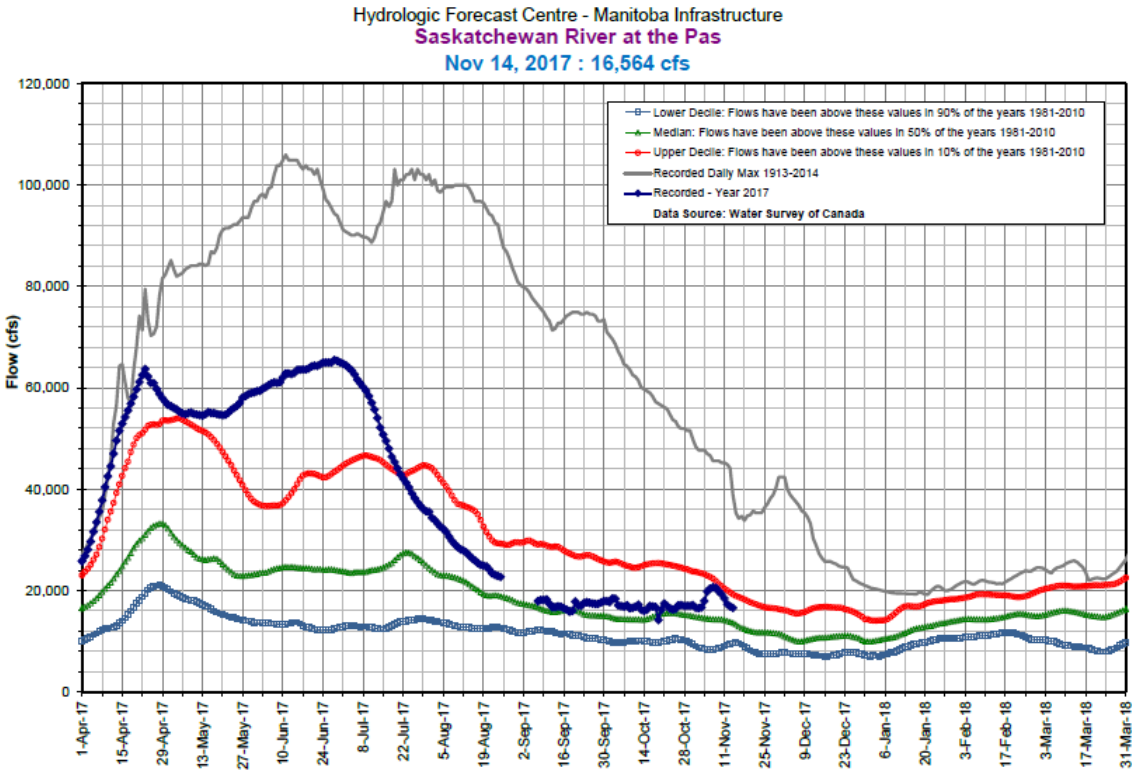

Figure 18: Saskatchewan River Flows at The Pas.

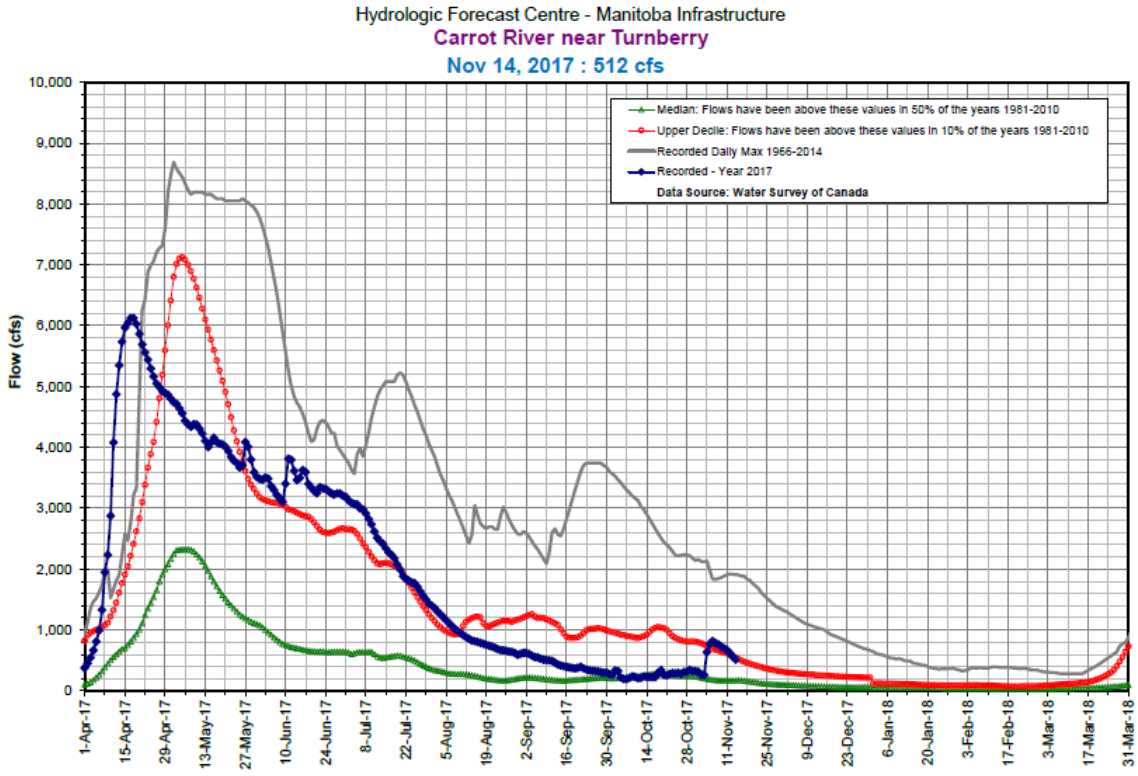

Figure 19. Carrot River Flows near Turnberry.

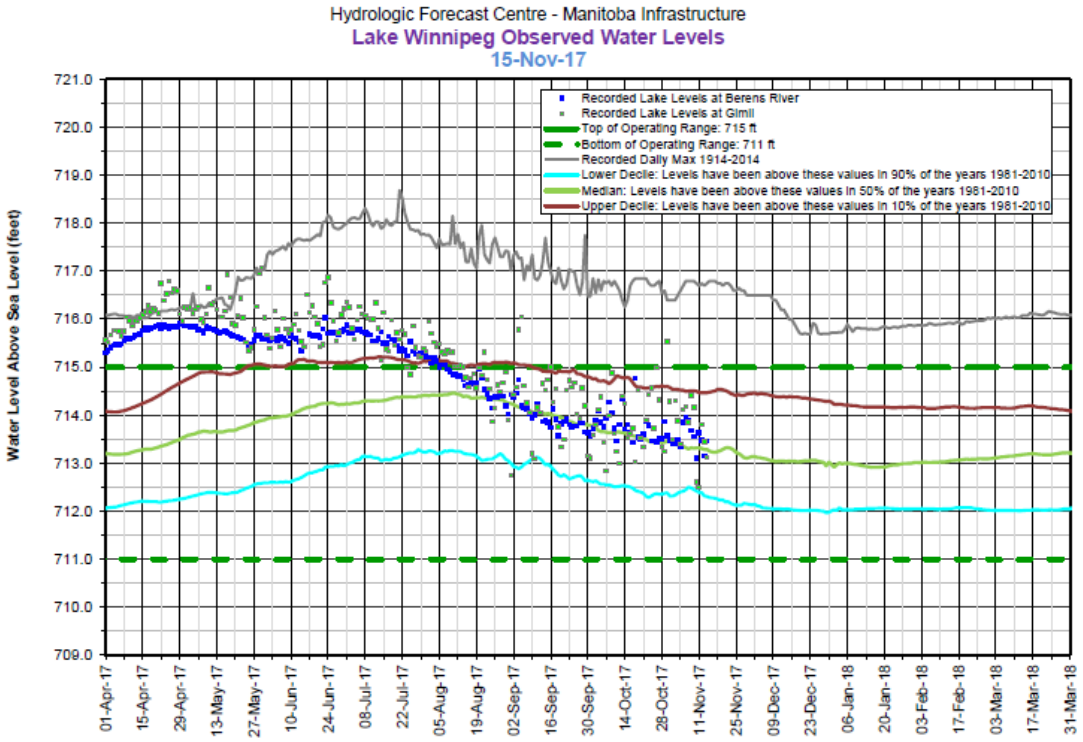

Figure 20. Lake Winnipeg Water Levels.

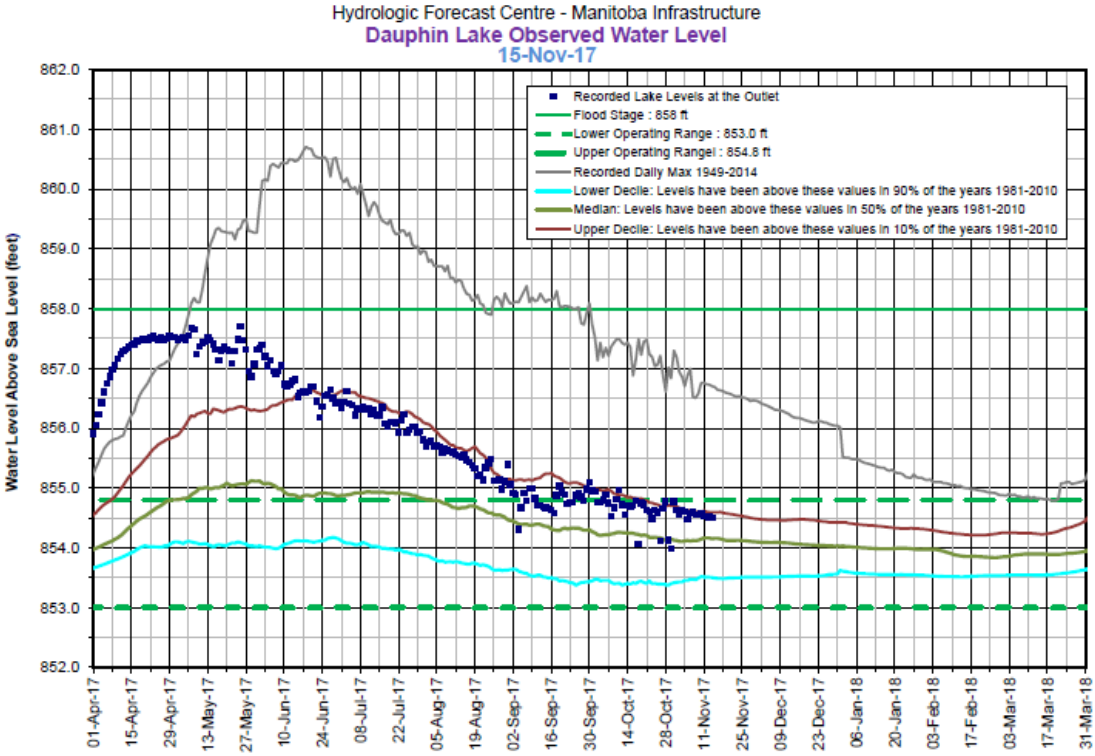

Figure 21. Dauphin Lake Water Levels.

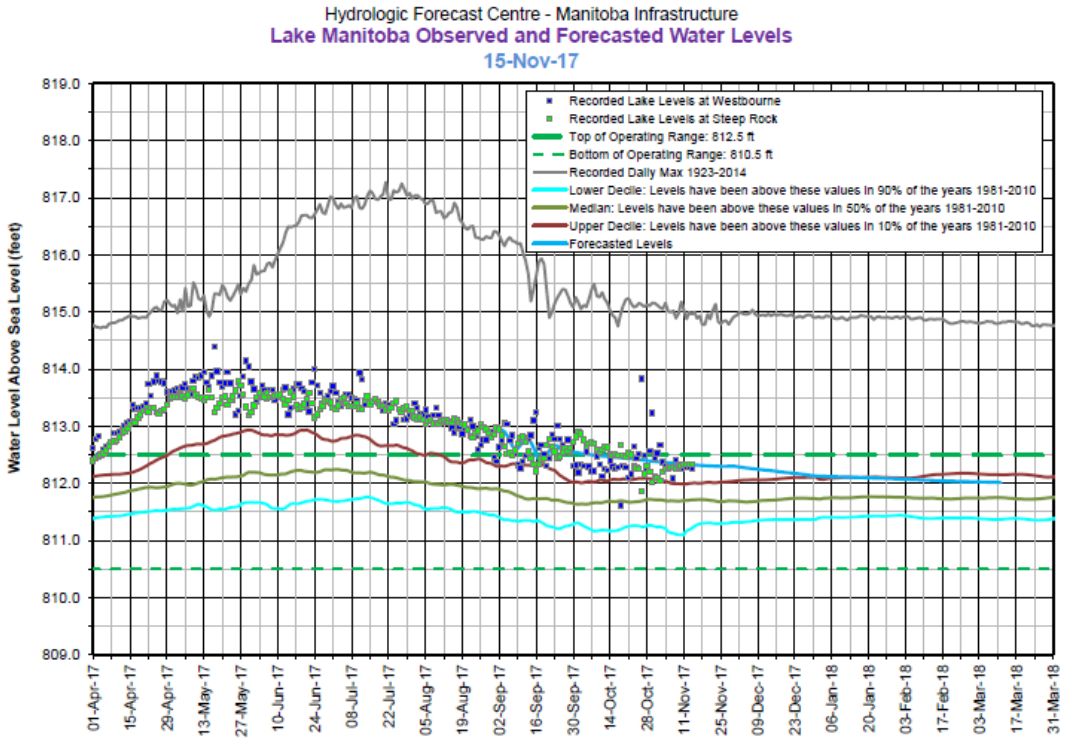

Figure 22. Lake Manitoba Water Levels.

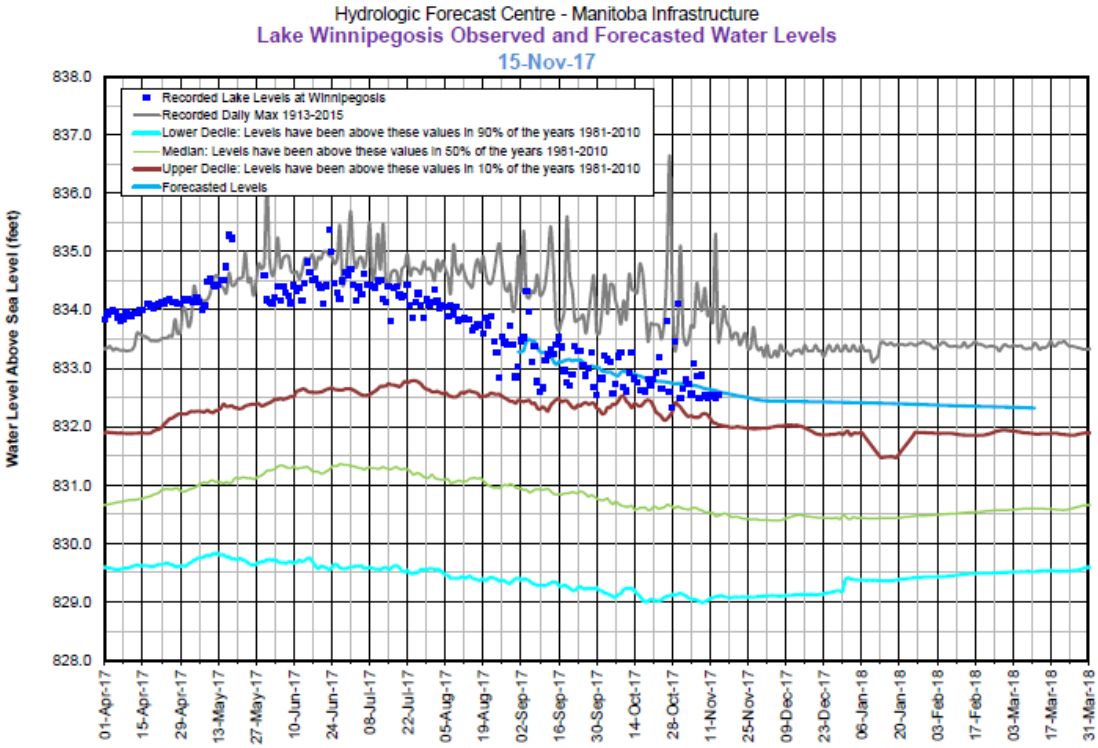

Figure 23. Lake Winnipegosis Water Levels.

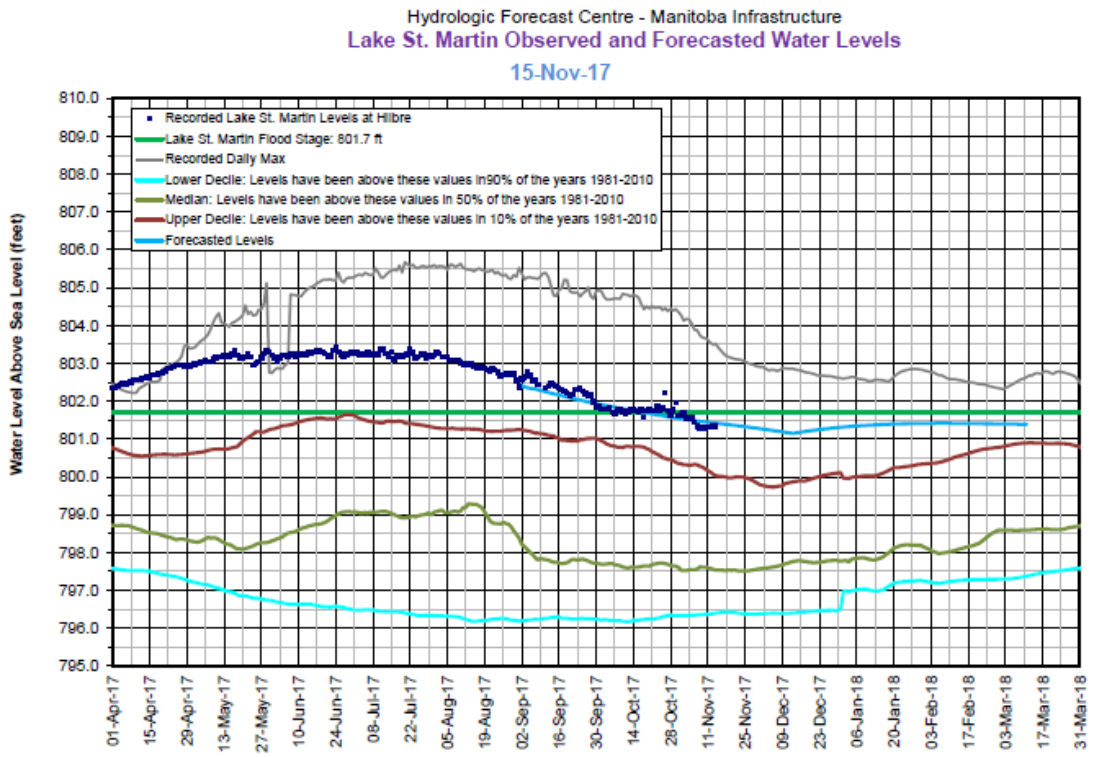

Figure 24. Lake St. Martin Water Levels.

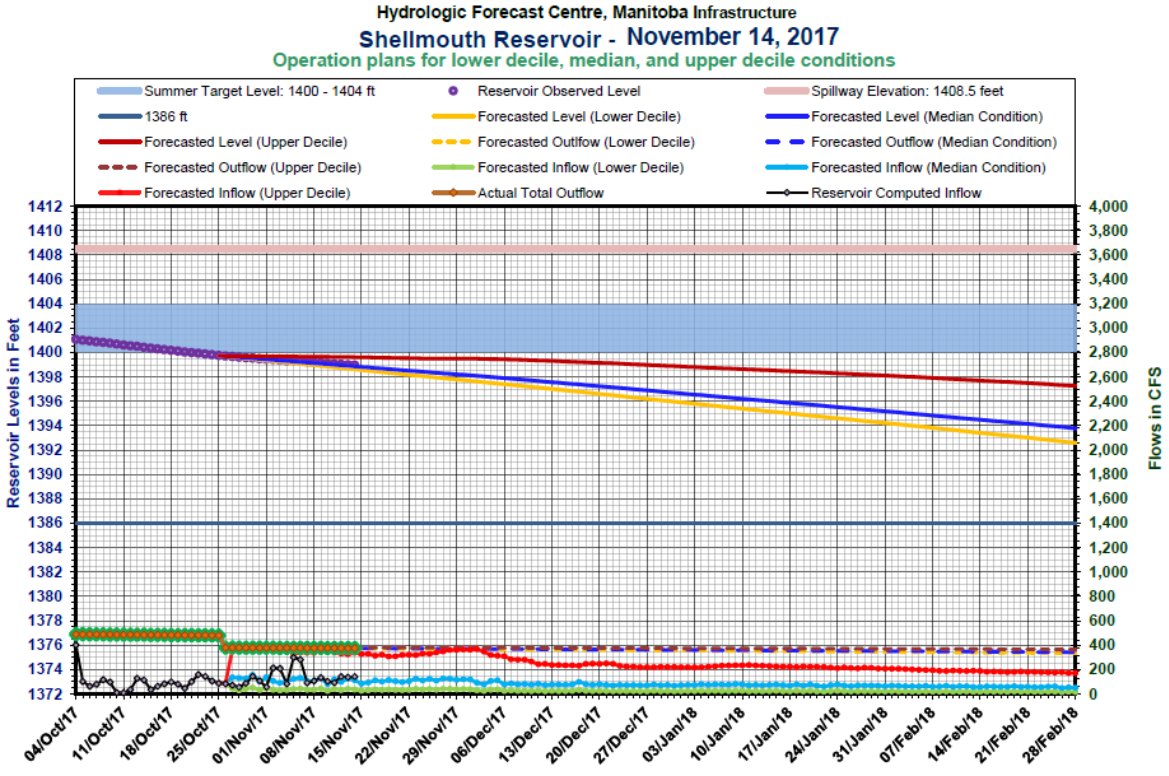

Figure 25. Lake of the Prairies (Shellmouth Reservoir) Water Levels and Flows.

WINTER PRECIPITATION (LONG TERM PRECIPITATION OUTLOOK)

Environment Canada issued a long term precipitation outlook in early November for the winter and spring periods (Figures 26 to 29). Based on the outlook it is expected that precipitation will be above normal from November 2017 to January 2018 for most parts of Manitoba and Saskatchewan. Precipitation forecast trends are very weak after January, which could favour near normal conditions. The NWS Climate Prediction Center's outlook indicates above normal precipitation within the USA portion of the Red River and the Souris River basins for December, January and February (Figure 30). The NWS Climate Prediction Center also forecasts above normal precipitation within the USA portion of the Red River basin and the Souris River basin for January, February and March (Figure 31). This is in contrast to Environment Canada's outlook, which does not indicate a clear model trend for these months.

Experience indicates that long term precipitation outlooks are more accurate for the first month of the forecast time frame and forecast modelling results start to deviate significantly further into the future. Generally, long term weather forecasts are not as reliable as short term forecasts, and this is partly why the long term precipitation forecasts are not consistent at this time.

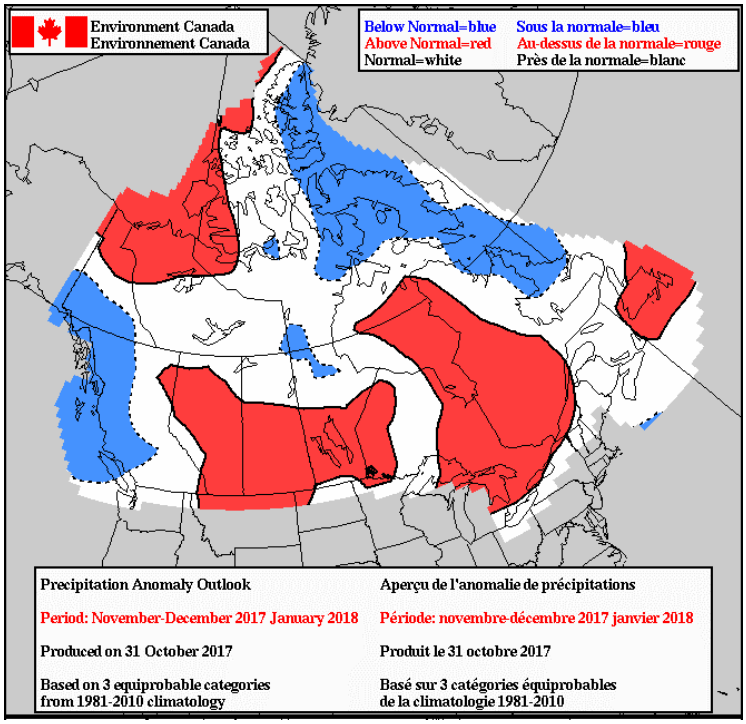

Figure 26. Environment Canada's Deterministic Precipitation Outlook (November-December-January).

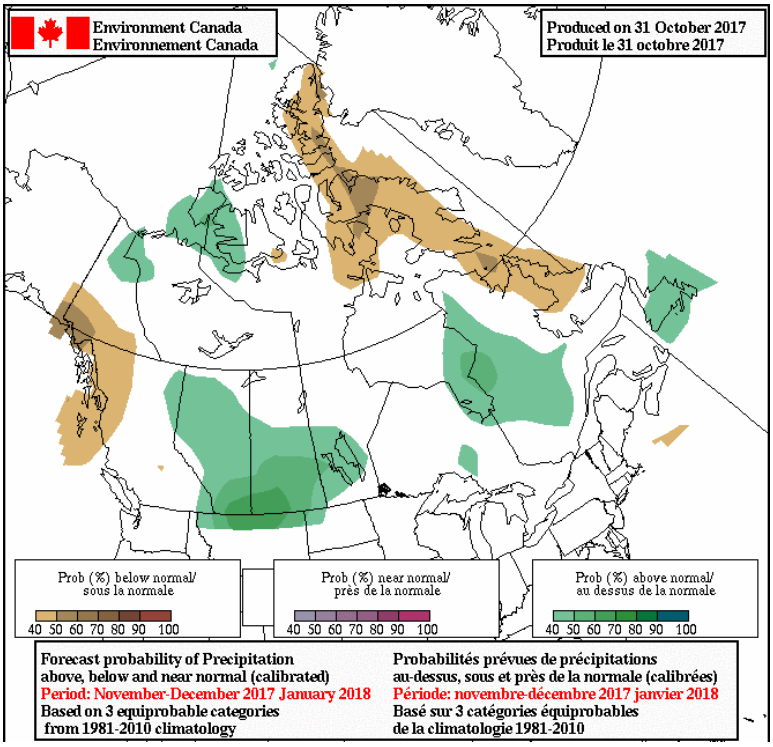

Figure 27 Environment Canada's Probabilistic Precipitation Outlook (November-December-January).

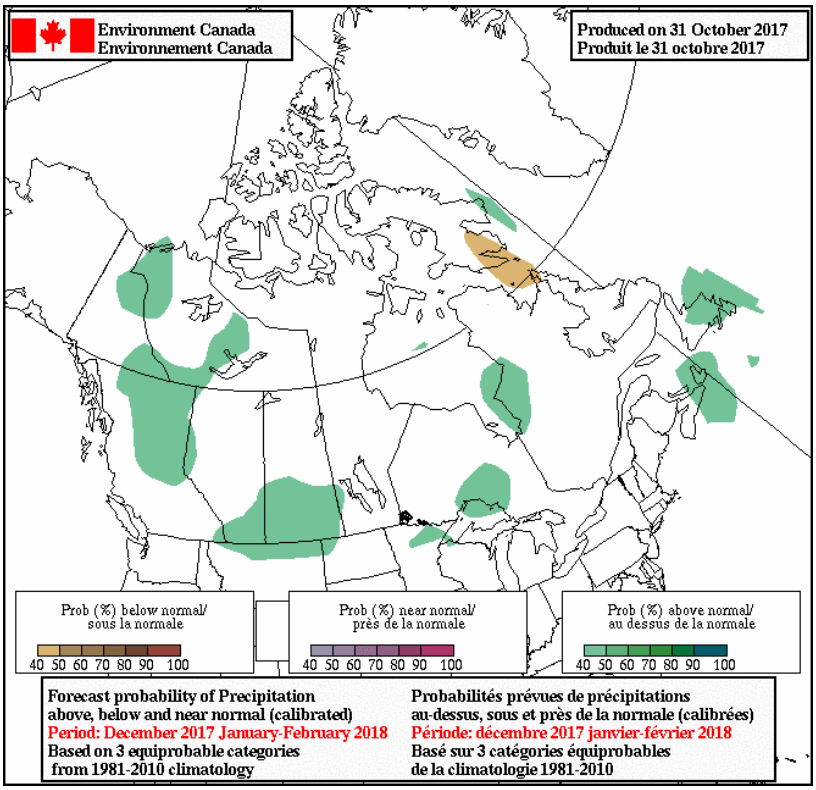

Figure 28 Environment Canada's Probabilistic Precipitation Outlook (December-January-February).

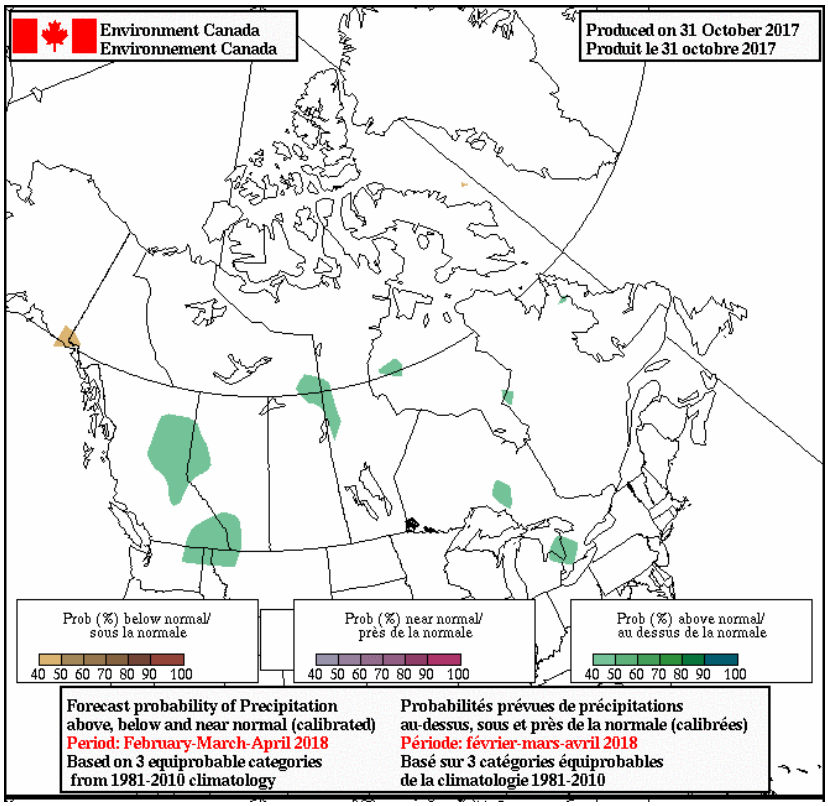

Figure 29 Environment Canada's Probabilistic Precipitation Outlook (February-March-April).

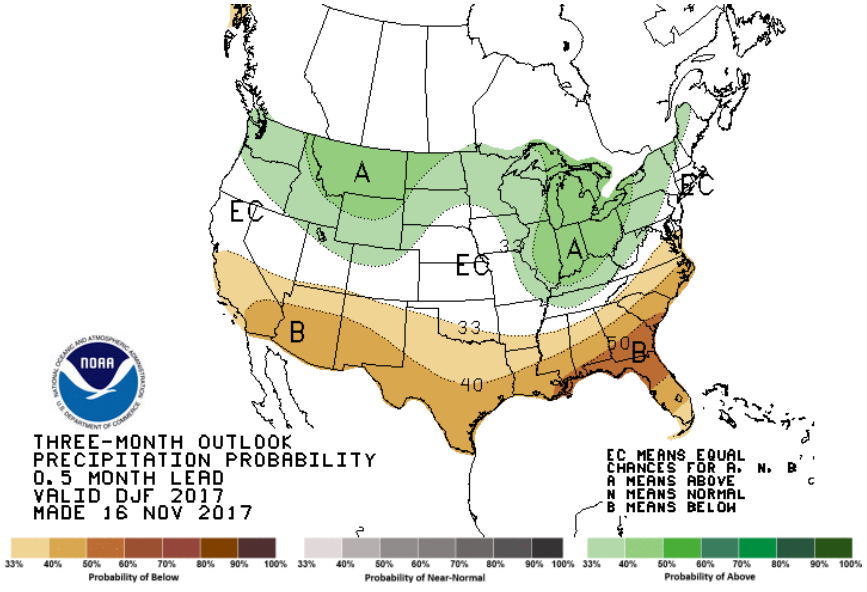

Figure 30. National Weather Services' Precipitation Outlook (December, January & February).

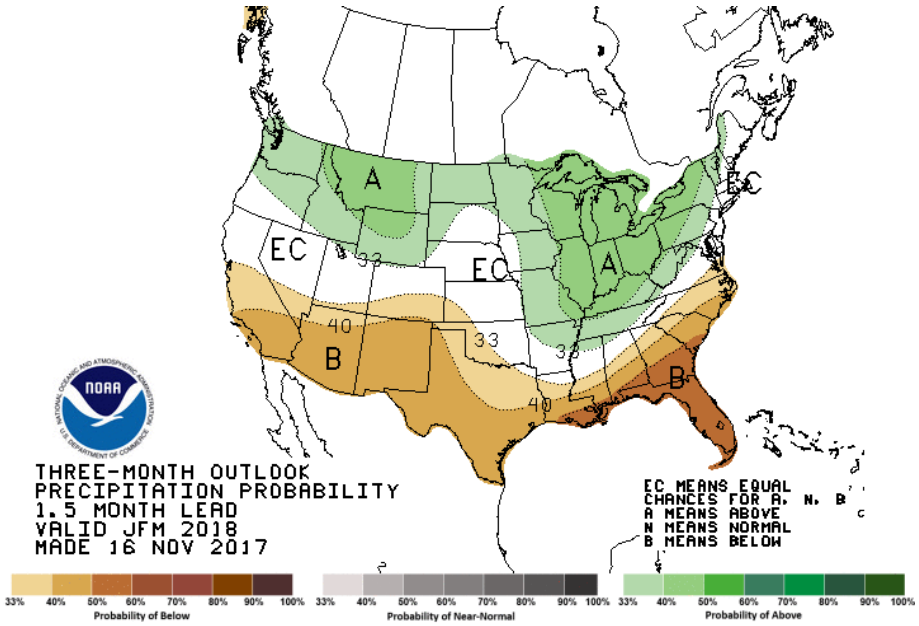

Figure 31. National Weather Services' Precipitation Outlook (January, February, & March).