

**Hydrologic Forecast Centre
Manitoba Infrastructure and Transportation
Winnipeg, Manitoba**

**FIRST SPRING FLOOD OUTLOOK FOR MANITOBA
February 29, 2016**

Overview

The first 2016 spring flood outlook prepared by the Hydrologic Forecast Centre of Manitoba Infrastructure and Transportation reports normal to below normal runoff potential across the province. The risk of overland flooding is generally minor to moderate across the province.

This first outlook estimates the potential for overland flooding as moderate in the northwestern areas of the province and minor to moderate in the rest of the province. This could change depending on weather conditions between now and the spring melt. The second outlook at the end of March will further define the flood potential.

Most of the major lakes are near normal levels for this time of the year, and the risk for potential flooding is minor under normal weather conditions. Flows and levels in most rivers are near normal for this time of the year.

Frost in Soil:

Due to the mild weather and below-average snow cover on most areas across the province, frost depth is near-normal to slightly less than normal throughout most of Manitoba. Generally, below normal frost depth means that the soil can absorb more melting water and potentially decrease the amount of overland flooding whereas above normal frost depth can contribute to increased runoff.

Soil Moisture Conditions at Freeze up:

- Southern Manitoba including the Red River Valley: near-normal to below normal
- Western Manitoba: near-normal
- Saskatchewan: above-normal
- Northern Manitoba, including The Pas region: above-normal
- Interlake: near-normal to above normal
- Eastern Manitoba: near normal to above normal

Winter Precipitation:

Winter precipitation is below-normal to well below-normal throughout the central and southern portions of Manitoba and Saskatchewan including the Red River, the Interlake, the Souris River, the Qu'Appelle River and the Assiniboine River basins.

Winter precipitation has been near-normal for Eastern Manitoba (Whiteshell area), the Saskatchewan River watershed in Saskatchewan and the northern part of the Lake Winnipegosis basin. Localized above-normal winter precipitation has occurred near The Pas.

Ice Jams:

When warmer temperatures arrive and runoff starts, there is a chance of localized flooding due to ice jams or snow blockages in drains, ditches and small streams. Major ice jams are difficult to predict as to location and magnitude and cannot be ruled out. On most major rivers, ice thickness is normal to below-normal for this time of the year due to below-normal temperatures and lower than normal snow cover to provide insulation and inhibit freezing.

Ice Jam Mitigation Program with the Ice Cutters and Amphibex Fleet:

The North Red Community Water Maintenance Corporation will be focusing this year's ice jam mitigation program on the north Red, Assiniboine, Icelandic, Brokenhead and Fisher Rivers as well as the Portage Diversion to reduce the potential of ice jams. On the Red River, the Amphibex fleet has already broken a 4-5 km channel down the centre and work is ongoing.

The chances of minor localized flooding due to snow blockages in drains, ditches and small streams during the early part of the run-off period will depend on the nature of the spring breakup and rate of melt.

Runoff:

The potential for spring runoff is near-normal in the upper Assiniboine River basin, below normal in the lower Assiniboine basin, the Qu'Appelle River and the Souris River basins. The potential for spring runoff is normal to below-normal in the Red River, Roseau River basins as well as the Interlake region. The runoff potential is below normal for the Pembina River. The runoff potential is normal to above-normal in the Saskatchewan River basin and is near-normal throughout the rest of the province, including the Winnipeg River basin.

The potential for normal to above-normal runoff in the Saskatchewan River basin (including the Carrot River) is a result of above-normal soil moisture content at freeze-up and normal to above-normal snowpack water content.

The Red River valley has experienced normal to below-normal soil moisture conditions south of the border and above-normal soil moisture on the Manitoba portion of the basin. Combined with below-normal winter precipitation the risk of major flooding is low for the Red River.

Flood Outlook:

The magnitude of spring flood potential is still very dependent on weather until the spring melt. Flood potential is significantly affected by:

- the amount of additional snow and rain;
- frost depth at the time of runoff;
- the timing and rate of the spring thaw; and
- the timing of peak flows in Manitoba, the U.S. and other provinces.

Delayed thaw and spring rainstorms could result in rapid snow melt aggravating overland flooding and increasing tributary flows. A single precipitation event similar to the rainstorm that occurred in the summer of 2014 could change the flood outlook significantly.

The province's practice is to plan and prepare for unfavourable weather conditions, the scenario of highest flood risk. The outlook shows the risk of overland flooding for the unfavourable weather scenario in the following watersheds:

- Red River: minor risk;
- Pembina River: minor risk;
- Roseau River: moderate risk;
- Assiniboine River: moderate risk;
- South West Region: minor risk;
- Interlake Region and the Fisher River: moderate risk;
- Eastern Region and the Winnipeg River: moderate; and
- Northern Manitoba/The Pas Regions and the Saskatchewan, Carrot and Swan Rivers: moderate risk.

Preparations:

The Manitoba government and municipalities are continuing to prepare for spring flooding. This includes working with municipal emergency management teams to review existing emergency response plans and sharing information through conference calls and flood information seminars in Morris, Brandon and Selkirk.

Provincial flood-fighting equipment includes:

- six sandbag-making machines;
- 19,900 super sandbags;
- 2.2 million regular sandbags
- 32.5 km of Hesco cage barriers, into which sand or other heavy material is placed;
- 69 km of water-filled barriers, of which 35.3 km are in rapid-response trailers;
- a total of 34 pumps;
 - 17 of which are heavy duty pumps used to move large volumes of flood water;
 - the remainder are part of mobile trailers kits used to fill water barriers, and
- 61 heavy-duty steamers.

Manitoba continues to work with stakeholders across the Assiniboine River basin through the newly formed Assiniboine River Basin Initiative. Representatives from the Manitoba government, Keystone Agricultural Producers, the Association of Manitoba Municipalities and Manitoba Conservation Districts Association will join other stakeholders for a meeting next month in Minot, North Dakota. The goal is to discuss options and solutions to common concerns such as drainage, flooding, water quality and drought.

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Soil Moisture Conditions

As previously outlined in the 2015 Fall Conditions Report, the soil moisture analysis based on weighted summer and fall precipitation indicates normal to above normal for most of Manitoba and above normal throughout most of Saskatchewan. The soil moisture is below normal for the US portion of the Red River basin (Figure 1 and Figure 2). The Assiniboine, Qu’Appelle and Souris River basins have observed similar soil moisture as that recorded in the fall of 2014. The increased soil moisture was a factor in contributing to above average runoff in the spring of 2015 in those basins.

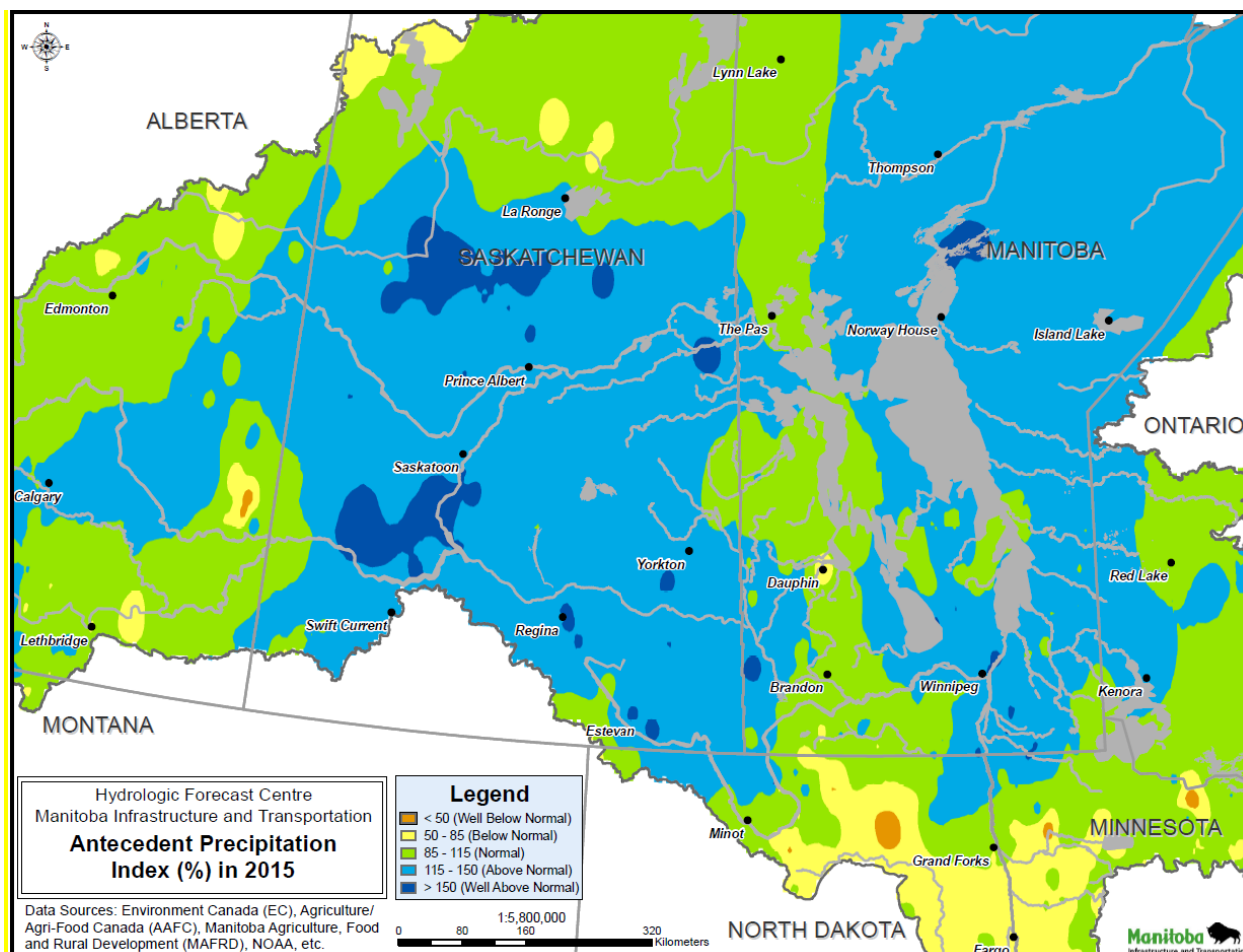


Figure 1 - Antecedent Precipitation Index (API) for the Fall of 2015.

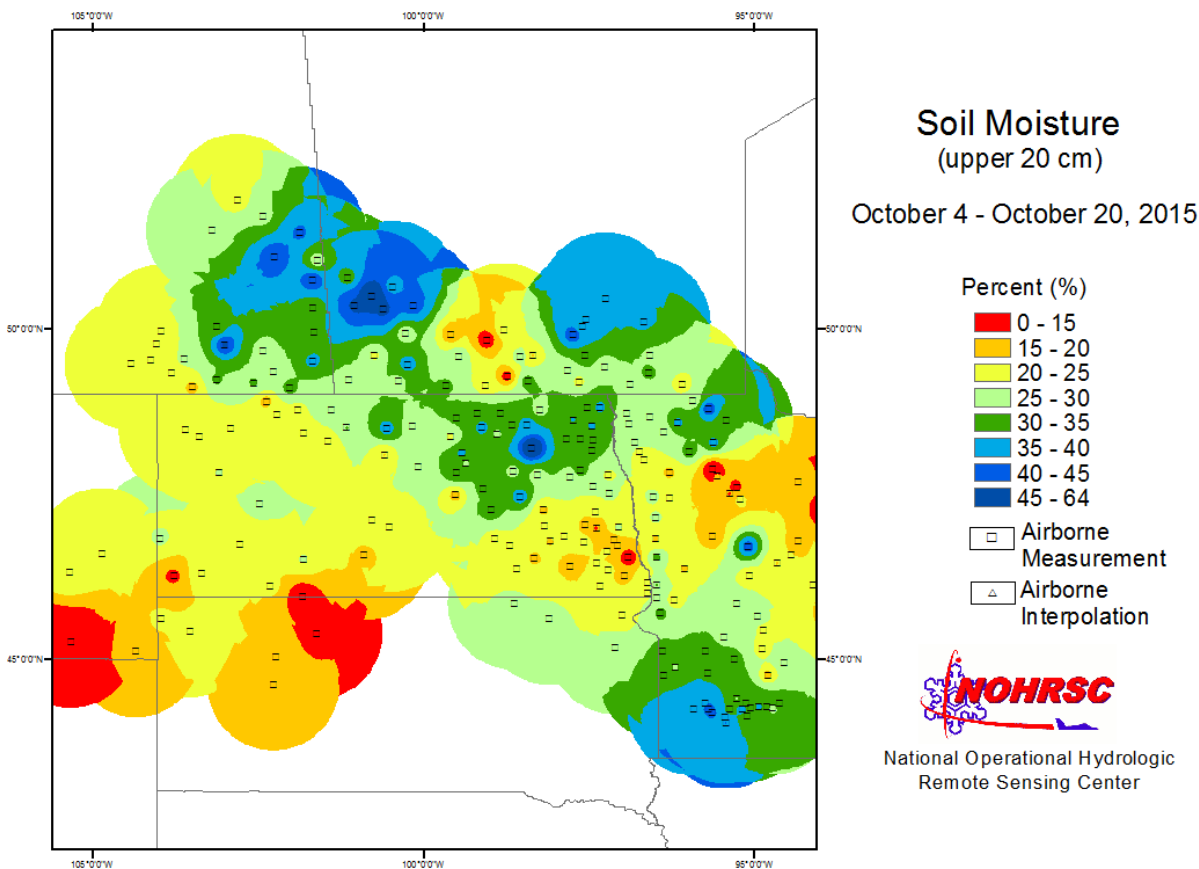


Figure 2 - Gamma Survey derived soil moisture (in the upper 20 cm of soil) from October 4 - October 20, 2015.

Frost Depth

Frost depth information is sparse and variable across watersheds based on winter temperatures and amount of snow cover insulation. Frost depth is considered to be near-normal to below normal throughout most of the province due to above-average winter temperatures and below-average snow cover.

Snowpack Conditions & Snow Water Content

November to February snowfall has been below normal in most areas of Manitoba as well as the U.S. portion of the Red River and Souris River basins. In southwest Manitoba and southeast Saskatchewan snowfall has been well below normal. Conversely, central Saskatchewan and The Pas region have experienced normal to above normal snowfall and southeast Manitoba has received near-normal snowfall. Alberta displays accumulated snowfall ranging from well below normal to normal throughout the center and southern portions of the province (Figure 3 and Figure 4).

Based on mid-February field observations (Figure 5), the average water content in the snowpack in the upper Assiniboine is 40 mm (1.6 inches) (observations range between from 30 mm to 60 mm), 70 mm (2.8 inches) in northwestern parts of Manitoba (including The Pas region) and into northeast Saskatchewan (observations range between 50 mm to 90 mm), 55 mm (2.2 inches) in the Interlake region (observations range from 40 mm to 70 mm), 35 mm (1.4 inches) in the Red River basin (observations range from 20 mm to 50 mm) and 70 mm in southeast Manitoba and Whiteshell area (observations range from 55 mm to 80 mm).

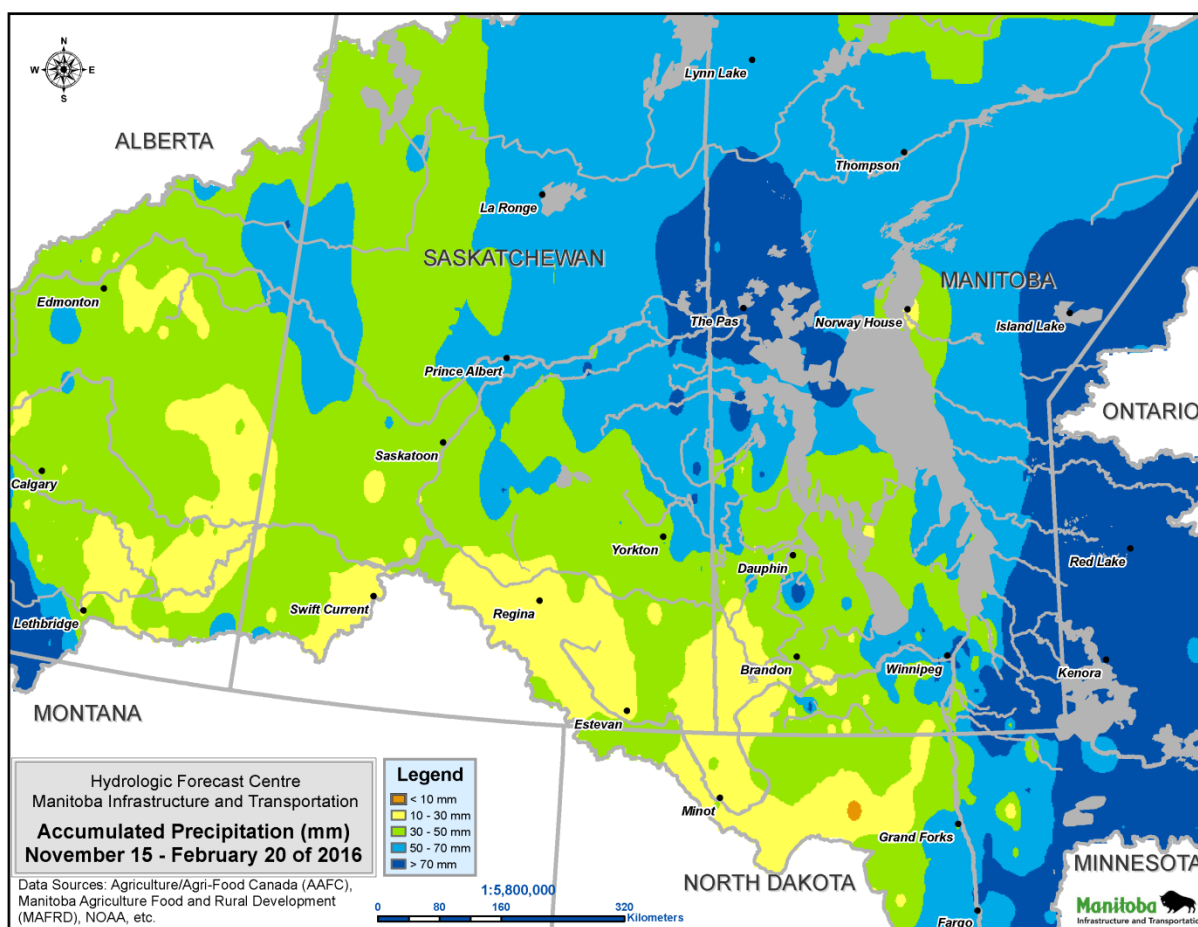


Figure 3 - Accumulated precipitation between November, 2015 to February, 2016.

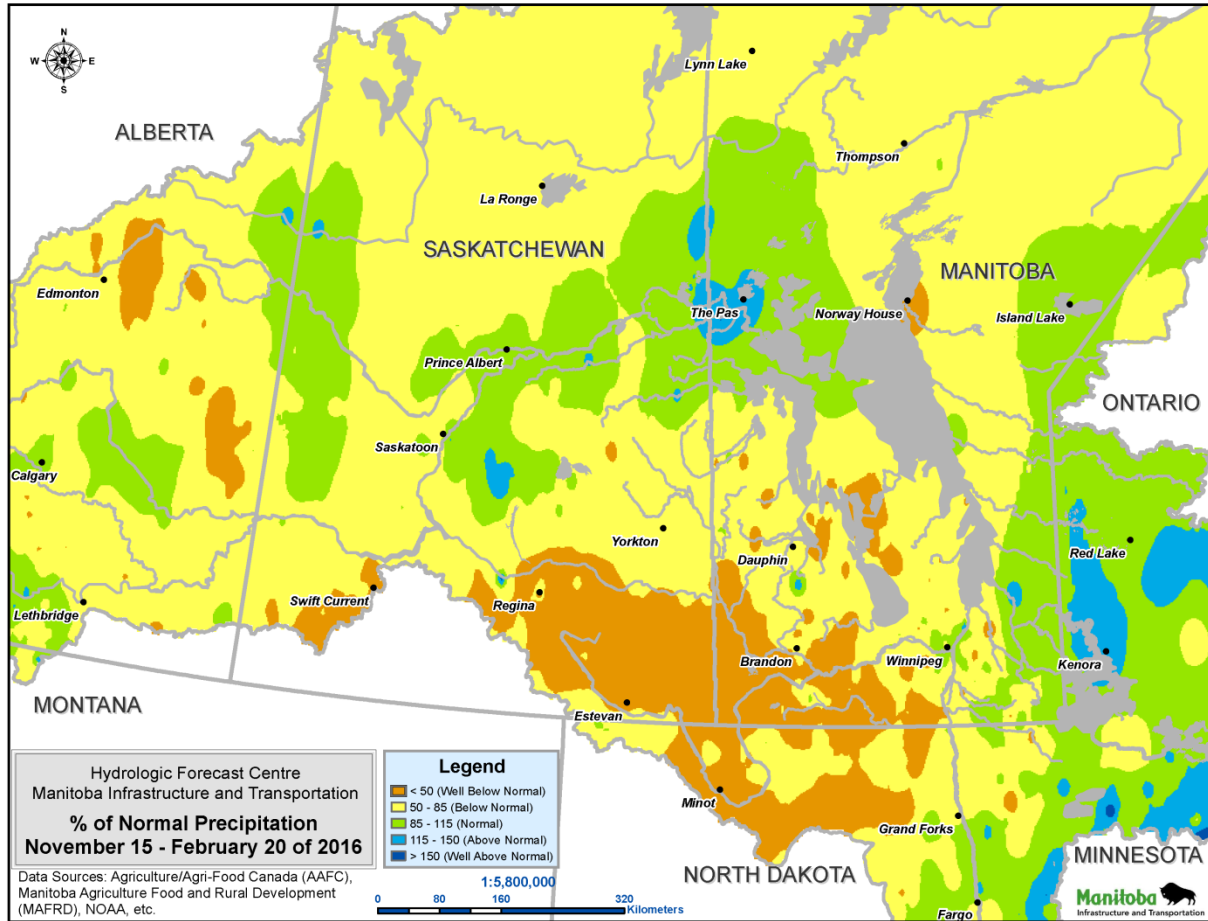


Figure 4 - Percent of Normal Precipitation from November, 2015 to February, 2016.

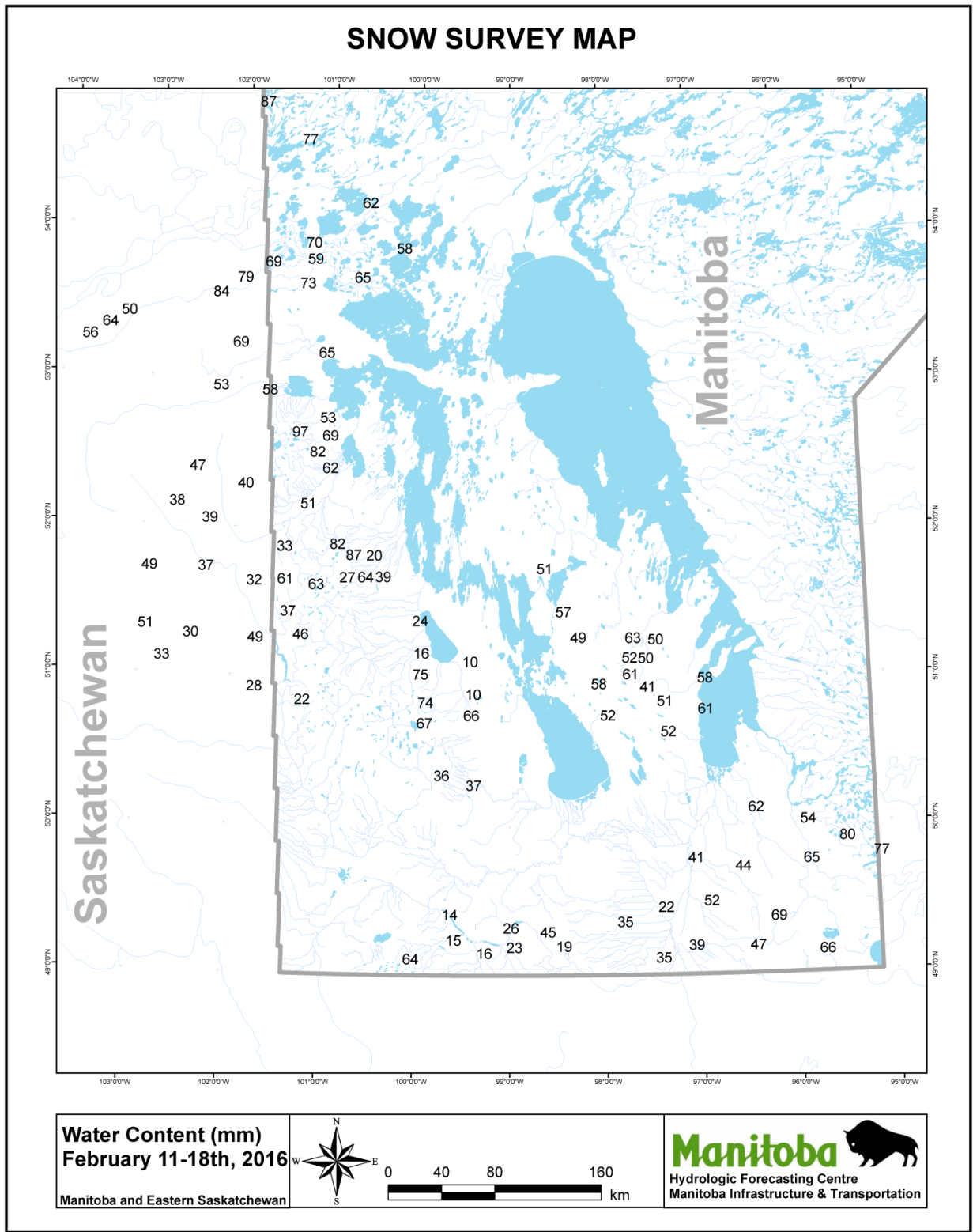


Figure 5 - February 11th – 18th, 2016 snow survey results in millimetres of water content.

Lake Level and River Flow Conditions

Water levels/flows at freeze-up:

- Saskatchewan, Assiniboine, Souris, and Qu'Appelle Rivers: well above normal;
- Red River: near normal; and,
- Major lakes, such as Dauphin, St. Martin, Winnipegosis, Manitoba, and Winnipeg: near-normal levels.

Current river flow conditions:

- Red River, Roseau River, Pembina River: generally flows are near-normal for this time of year;
- Northern Rivers (including Red Deer, Saskatchewan, and Carrot Rivers): flows are above normal for this time of year;
- Assiniboine River, Souris River, Qu'Appelle River: flows are above normal for this time of year; and,
- Interlake rivers (including the Waterhen, Fisher, and Fairford Rivers): flows are normal to above-normal for this time of year.

River Ice Conditions and Ice Jamming¹

The Red River has near-normal ice cover due to above-normal temperatures and below-normal snow cover. A lack of snow cover results in a lack of insulation for the ice, and therefore enhanced ice thickening. Based on late-February measurements this year, ice thickness ranged between 36 cm (14 inches) and 61 cm (24 inches). Normal ice thickness varies according to the size and the location of the river and typically ranges between 30 cm (12 inches) and 61 cm (24 inches). The ice thickness on most of the major rivers is normal to below-normal.

Spring weather affects deterioration of ice and will be a significant factor in determining ice strength at break-up. It is difficult to predict the time of occurrence and extent of ice jamming. However with the ice cutting and the Amphibex ice breaking activities ice jamming and related flooding on the lower Red River will be reduced.

Localized brief flooding can occur when and where ice jams develop, even with below average river flows.

¹ See Appendix A for 'Ice Jam' definition

Runoff Potential²

The expected 2016 spring runoff potential (Figure 6) is based on:

- 2015 measurements of soil moisture at freeze up;
- Snowpack conditions as of mid-February 2016; and,
- The average future weather conditions.

The runoff potential ranges from below-normal to normal for most of Manitoba and the U.S. while the runoff potential in Saskatchewan is slightly higher. The runoff potential is described for the following areas:

- Red River Basin: below-normal to normal;
- Pembina River: below-normal;
- Southeastern Manitoba: near-normal;
- Upper Assiniboine River basin: near-normal conditions upstream of Shellmouth Reservoir;
- Qu'Appelle River basin: near-normal;
- Saskatchewan River basin; normal to above-normal
- Souris River basin: below-normal to normal;
- Interlake Region: below-normal to normal;
- Northern Manitoba: near-normal;
- Dauphin Lake/Riding Mountain area: below-normal to normal
- Northwest Manitoba (including the northern areas of Lake Winnipegosis, The Pas): normal to above-normal; and,
- Regions to the east of Lake Winnipeg (including Berens River) and Island Lake area: near-normal.

² See Appendix A for 'Runoff Potential' definition

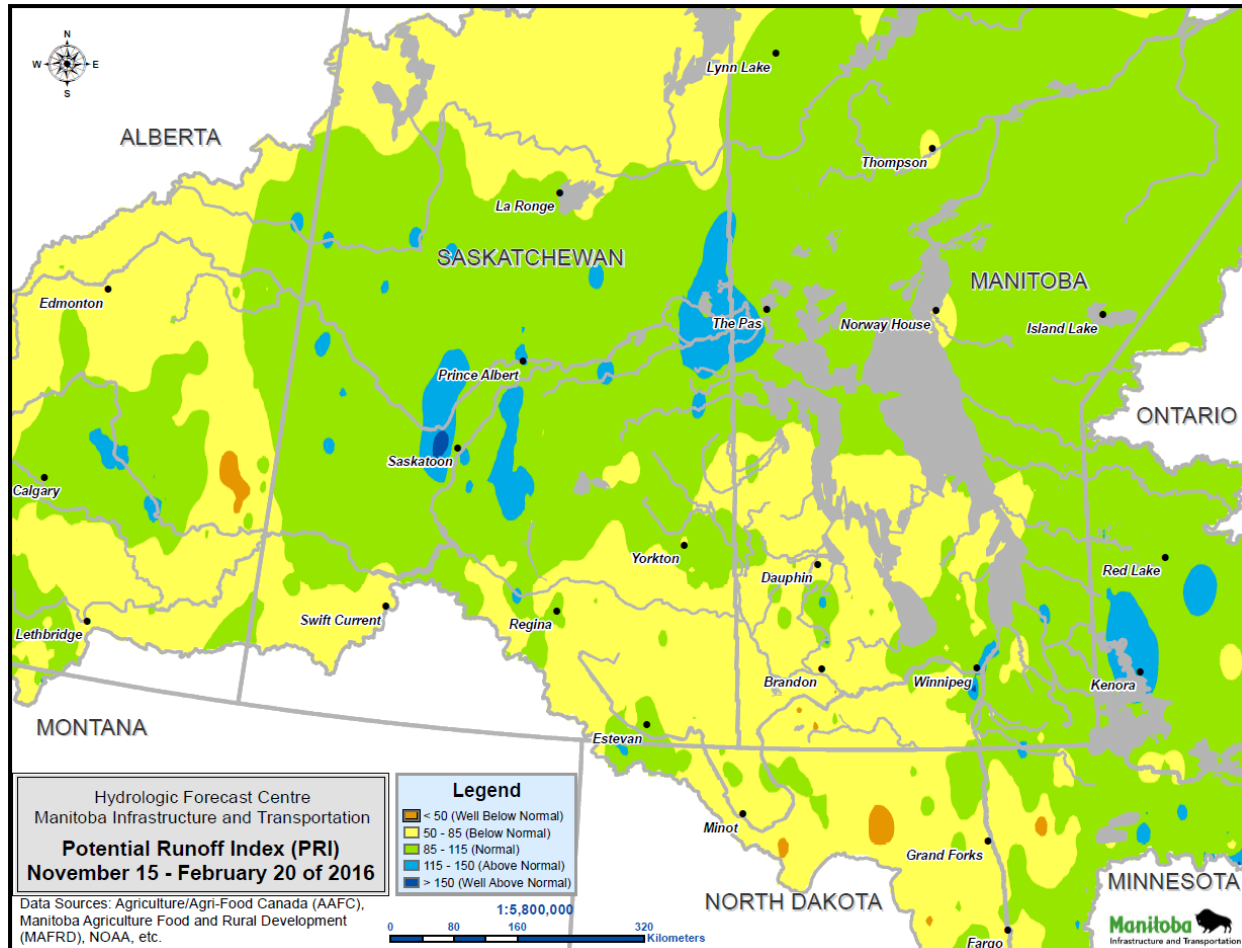


Figure 6 – Runoff Potential as of February 20th, 2016.

Flood Outlook³

Spring flood outlooks are estimated peak water levels and flows that are based on diverse information. They are provided for three weather scenarios (favourable, normal, unfavourable) which correspond to three different probabilities of occurrence (lower decile, median, upper decile). The Province's practice is to plan and prepare for the upper decile condition. For further information see Appendix A: Definitions.

The risk of potential flooding is described by four categories: minor, moderate, major and severe.

A number of uncertainties exist with respect to this preliminary flood outlook. These include, but are not limited to the following:

- Future weather uncertainties (snowfall and spring rainfall);

³ See Appendix A for 'Flood Outlook', 'Weather Scenarios', 'Favourable Weather', 'Normal Weather', and 'Unfavourable Weather' definitions

- 2016 winter snowpack, onset of melt, and melt rate (i.e. timing and speed of snow melt);
- Water regulation in the USA and Saskatchewan;
- Uncertainty in meteorological and hydrometric data; and,
- Model prediction uncertainty.

Red River

- The risk for major spring flooding on the Red River main stem remains minor. The current soil moisture condition varies from below-normal on the U.S. portion of the basin to above-normal on the Canadian side of the border. Winter precipitation has been below normal this year throughout most of the basin.
- Favourable weather: minor risk of flooding
 - Levels would be slightly higher than spring melt levels observed in 2012 from Emerson to Ste. Agathe.
- Normal weather: minor risk of flooding
 - Levels would be slightly lower than spring melt levels observed in 2014 from Emerson to Ste. Agathe.
- Unfavourable weather: minor risk of flooding
 - Levels on the Red River main stem would be similar to 2013 from Emerson to Ste. Agathe.
- There is a minor flood risk for the small tributaries such as the La Salle, Rat and Morris Rivers.
- There is sufficient community protection within the Red River basin as community dike elevations are higher than the predicted levels.

Red River Floodway

- The Red River Floodway has been operated for 31 out of the 47 years since it has been constructed for the purpose of providing flood protection to the City of Winnipeg. However due to well below normal conditions throughout the basin, there is a very low chance that the Floodway will be operated during the 2016 spring melt.
- The ice-induced peak at James Avenue is estimated between 3.0 m (9.8 feet) to 5.8 m (19.0 feet).
- Open water estimated levels at James Avenue are:
 - Favourable weather: 2.5 m (8.3 feet)
 - Unfavourable weather: 5.3 m (17.5 feet)

Pembina River and Roseau River

- The potential for spring flooding ranges from minor on the Pembina River to moderate on the Roseau River. The Pembina River basin has received well below-normal snowfall on top of below-normal to normal soil moisture while the Roseau River has experienced below-normal to normal snowfall with soil moisture that is normal to above-normal.
- Favourable to normal weather: minor risk of flooding.
 - Levels will be less than those experienced in 2008.
- Unfavourable weather: minor risk of flooding.
 - Levels will be less than those experienced in 1999.

Assiniboine River

- Flood risk ranges from minor to moderate due to above normal soil moisture in the upper portions of the watershed and near-normal snow water equivalent in the snowpack.
 - Favourable weather: minor risk of flooding
 - Levels will be lower than 2008 from Shellmouth downstream to Holland.
 - Normal weather: minor risk of flooding
 - Levels will be slightly less than 2004 from Shellmouth downstream to Holland.
 - Unfavourable weather: moderate risk of flooding
 - Levels will be similar to 2003 from Shellmouth to downstream to Holland.
 - Brandon flood protection levels⁶ are adequate for this scenario.
- The flood outlook for the Qu'Appelle River at St. Lazare:
 - Favourable to unfavourable weather: minor risk of flooding
 - St Lazare flood protection⁶ levels are adequate.

Portage Diversion

- The Portage Diversion has been operated 34 out of the 46 years since it has been constructed for the purpose of preventing ice jamming on the Assiniboine River east of Portage and to provide flood protection to the City of Winnipeg in accordance with the operating guidelines. The possibility of operating the Portage Diversion cannot be ruled out at this time.

Shellmouth Dam

- The forecasted inflow volume into the Shellmouth reservoir for favourable, normal and unfavourable conditions are 200,000 ac-ft, 320,000 ac-ft and 450,000 ac-ft, respectively.
- The Shellmouth Dam is being operated to draw down the reservoir to provide storage capacity for reservoir inflows to reduce flooding downstream. The current reservoir level is 423.40 m (1389.1

ft). The Shellmouth Liason Committee is continuing to manage operations to meet the target level of 427.33 m to 427.94 m (1402 ft to 1404 ft) after the spring runoff. The current outflow from the reservoir is 670 cfs (cubic feet per second).

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South West Region

- Although snow accumulation within the Souris River basin is below normal, soil moisture within most of the basin is considered to be normal to above-normal conditions. Estimated flooding for the Souris River and its tributaries is as follows:
 - Favourable weather: minor risk of flooding downstream of Minot along the main stem.
 - Levels are expected to be similar to 2012 levels at Wawanesa.
 - Normal weather: minor flood risk downstream of Minot along the main stem.
 - Levels are generally expected to be similar to 2010 levels at Wawanesa.
 - Unfavourable weather: moderate flood risk downstream of Minot along the main stem.
 - Levels are expected to be lower than 2015 levels at Wawanesa.
 - The existing dikes in the towns of Melita, Souris and Wawanesa have sufficient elevation to protect against these levels.

Interlake Region

- Soil moisture is normal to above-normal throughout the Interlake region with below-normal snow accumulation. Estimated flooding potential is as follows:
 - Favourable to normal weather: minor risk of flooding.
 - Unfavourable weather: moderate risk of flooding.
- As in most years the risk of ice jamming is high for the Icelandic, Fisher and Whitemud Rivers.

Fairford Control Structure

- Fairford Control Structure flows were reduced from maximum outflow in fall of 2015 as the lake level approaches the median condition. Outflows are currently approximately 80% of maximum capacity and will remain this way until ice break up on the Fairford and Dauphin rivers. Future operations of the Fairford control structure will be subject to basin conditions after ice break up.

Eastern Region

- Both the soil moisture and the accumulated snowpack are near normal for the Eastern Region, including Winnipeg River. Estimated flooding potential:
 - Favourable to normal weather: minor risk flooding.

- Unfavourable weather: minor to moderate risk of flooding.

Manitoba Lakes

- Current lake levels are provided with indication of how levels are trending with long-term average levels. Further forecast information for lake levels will be provided in the March Flood Outlook. Currently, all major lakes are near-normal levels.

Lake Manitoba

- Lake Manitoba's current level is 247.39 m (811.64 ft).
- The current level is normal for this time of year, and is inside the interim operating range of 247.0 m (810 ft) to 247.7 m (812 ft).

Lake St. Martin

- Lake St. Martin is currently at 244.06 m (800.72 ft).
- The current level is 0.45 m (1.48 ft) above normal for this time of year.

Lake Winnipeg

- Lake Winnipeg's current level is 217.70 m (714.24 ft).
- The current level is 0.35 m (1.15 ft) above normal for this time of year, however is still within the operating range of 216.71 m (711 feet) to 217.93 m (715 feet).

Lake Winnipegosis

- Lake Winnipegosis is currently at 253.45 m (831.53 ft).
- The current level is 0.29 m (0.95 ft) above normal for this time of year.

Dauphin Lake

- Dauphin Lake's current level is 260.37 m (854.24 ft).
- The current level is 0.12 m (0.40 ft) above normal for this time of year, but within the upper operating range of 260.5 m (854.8 feet).

Northern Manitoba and The Pas Regions

- Soil moisture is generally above-normal throughout the Saskatchewan River Basin, with regions of normal condition in Alberta. The accumulated snowpack ranges from below-normal to normal with pockets of above-normal snowpack near the Manitoba-Saskatchewan border. The ice eliminated level on the main stem of the Saskatchewan River at The Pas is expected to be below bank full level in the unfavourable weather scenario, although much will depend on future weather and the regulation of Saskatchewan's Tobin Lake outflows.

- Saskatchewan River potential flooding ranges from minor to moderate when considering all potential weather scenarios.
 - Favourable to normal weather: minor risk of flooding.
 - Levels will be similar to 2001 levels.
 - Favourable to normal weather: minor risk of flooding.
 - Levels will be similar to 2009 levels
 - Unfavourable weather: moderate risk of flooding
 - Levels will be similar to 2015 levels
- The Carrot River near Turnberry and the Red Deer River near Erwood are both tracking near-normal streamflow conditions and under unfavourable weather may have a moderate risk of flooding.
- Swan River estimated flows and flooding:
 - Unfavourable weather: minor risk of flooding.

Flood Preparations

- The Manitoba government and municipalities are continuing to prepare for spring flooding. This includes work with municipal emergency management teams to review existing emergency response plans and sharing information through conference calls and flood-preparedness meetings.
- The ice-jam mitigation program north of Winnipeg has begun with ice cutters and Amphibex machines working along the Red River to weaken the ice. Approximately 4-5 km of river ice-cutting is complete at this time.

Future Forecast Information

- A second flood outlook will be published with updated information in late March when further precipitation and other weather details are available.

Appendix A: Definitions

¹ Ice Jam:

- A blockage of ice on a river/stream which restricts flow, resulting in increased water levels upstream.
- Jams may occur due to changing river channel geometry, bends in the river channel, depth of ice, rate of water level rise, or a solid section of ice downstream.

² Runoff Potential:

- Indication of how much water is expected to flow overland as opposed to being absorbed into the ground
- Is based on soil moisture measurements at freeze up, most recent snowpack conditions, and normal future weather conditions
- Is a contributing factor into flood outlook determinations
- Described in comparison to normal historical conditions (i.e. normal, near normal, slightly above normal, etc.)
- Can change significantly if future precipitation and melt rates differ from the average

³ Flood Outlook:

- Estimated spring peak water levels and flows provided before spring water flow begins
- Estimates are based on diverse information, such as soil moisture, winter precipitation, snowpack, topography, current water level, channel capacity, and future weather condition scenarios (precipitation, temperatures, etc.)
- Estimates are provided for three weather scenarios (favourable, normal, unfavourable) which correspond to three different probabilities of occurrence (lower decile, median and upper decile)

³ Weather Scenarios:

- Used to account for future weather such as additional snow, melt rates and spring rainfall, determined by statistical analysis of the past 30-40 years of climate data
- Three scenarios used:
 - Lower decile
 - There is a 10% chance of the weather being that 'favourable' or better. 90% of the time the weather will be worse than this 'favourable' condition.
 - Median
 - There is a 50% chance of the weather being 'normal' or better.
 - Upper decile
 - There is a 10% chance of the weather being that 'unfavourable' or worse. 90% of the time the weather will be better than this 'unfavourable' condition.
- Province's practice is to plan/prepare to the upper decile condition.

³ Favourable Weather:

- Characterized by little additional precipitation and a gradual snow melt

³ Normal Weather:

- Characterized by normal rainfall and temperature
- Typically used to describe historic climate trends

³ Unfavourable Weather:

- Significant wide spread precipitation with a rapid snowmelt

⁵ Flow/Discharge [expressed in cubic feet per second (cfs) or cubic metres per second (cms)]:

- The volume of water that passes a given location within a given period of time.

⁶ FPL – Flood Protection Level:

- The greater of the flood of record or the 1-in-100-yr flood, plus a freeboard allowance for a particular waterway (typically 2 feet) or water body (site specific).
- It is provided by the HFWM branch of MIT on a site specific and structure specific basis.
- This is formally set by the Water Resources Administration Act for the Red River designated flood areas.
- In non Designated Flood Areas, the FPL is recommended by the Province, but ultimately regulated by the local planning districts and/or municipalities.

Additional terminology:

Operational Forecasts:

- Estimated future crest water level, flow and date of occurrence provided once active melt and river flow has begun.
- Estimates are modelled based on observed flow, existing conditions (including channel capacity, topography, and remaining snowpack) and normal future weather.
- Observed conditions are monitored throughout the flood and compared against the historic climate data used to generate the forecast.
- Forecasts are updated when weather conditions are outside the range of historical climate data used to generate the forecast.
- A range of forecasted values is provided further in advance of an upcoming forecasted crest because of unknowns in the basin conditions and river flows, and limitations in the modelling procedures.