

Manitoba 2009 Spring Flood Report

Report on the Spring Flood of 2009 in Southern Manitoba

Introduction

The 2009 spring flood produced serious flooding in much of southern Manitoba due to a combination of high river levels and unusual ice conditions. The most significant flooding occurred in the Red River Valley and the southern Interlake region. There was relatively little flooding in the Westman area, from Riding Mountain north to The Pas. Unusual weather conditions in March and April caused unprecedented ice conditions which increased river flooding and caused extensive overland flooding.

Red River Flooding

Magnitude of 2009 flood:

The 2009 Red River spring flood was the second highest in much of the Manitoba portion of the river since the start of official records in 1912. The unregulated crest of 9.9 metres (32.5 feet) at James Avenue in Winnipeg was exceeded only by the floods of 1997, 1776, 1826 and 1852. See page 20 for charts (Figures 1 and 2) showing the top 10 floods since 1800 and the top floods of the last century for the Red River as measured at James Avenue.

The crest at Emerson was only the fourth highest since 1950 and was lower than in 1997 and slightly lower than in 1950 and 1979. The crest at Morris on April 19, 2009 exceeded the 1950 and 1979 crest levels by about 0.15 m (0.5 ft) but was 0.43 m (1.4 ft) lower than in 1997. The crest at the floodway inlet was 233.7 m (766.75 ft), 1.4 m (4.75 ft) lower than in 1997. The crest of 6.9 m (22.5 ft) at James Avenue in Winnipeg on April 16 was only 0.6 m (two ft) lower than in 1997. It was the second-highest observed crest since the use of major flood control works began in 1969. The ice-affected crest at Selkirk was the fourth highest on record. It was 0.55 m (1.8 ft) lower than the record ice jam crest of 2007 and 0.18 m (0.6 ft) lower than the ice jam crest of 1996 and slightly lower than the ice jam crest of 2004. On April 12, record high levels occurred where Netley Creek meets the Red River, due to a major ice jam. See page 21 for a table (Figure 3) showing Red River peaks for flood years since 1950.

The unregulated flood volume of 11.9 million acre-feet for the Red River at Selkirk was the highest on record since 1852 and significantly greater than the 10.7 million acre-foot volume of 1997. The 2009 volume in the Red River Floodway at St. Norbert was 2.67 million acre-feet, considerably less than the 3.32 million acre-feet in 1997. See page 22 for a chart (Figure 4) showing annual floodway volumes at St. Norbert since 1969. The use of major flood controls lowered the crest in downtown Winnipeg from 9.9 m (32.5 ft) to 6.9 m (22.5 ft.)

Flood causes

The high run-off and peak flow were mainly caused by record high soil moisture levels at freeze-up in 2008. A heavy rainstorm in the first week of November, 2008 was a very significant factor. See page 22 for a plot (Figure 5) showing a soil moisture index for the Red River watershed upstream of Emerson at freeze-up each year since 1948.

The high soil moisture was followed by an above-average snowpack in the United States portion of the watershed. See page 23 for a map (Figure 6) showing the snow-water equivalent on March 12 to 14, 2009 based on an airborne gamma snow survey. Soil moisture was also high in the Manitoba portion, but the snowpack in Manitoba was close to average. Spring precipitation was close to average. Significant ground frost due to a cold winter added to spring run-off. The snow-melt rate was not unusually high and came in two melt events. An early melt between March 20 and 23 melted most of the snow in the United States portion. It was followed by two weeks of sub-zero temperatures which delayed run-off in the Manitoba portion. The final snow melt occurred between April 10 and 13. See page 23 (Figure 7) for daily mean temperatures for Grand Forks and Winnipeg.

The 2009 flooding in the Red River watershed was made significantly worse by unusual ice conditions which caused blockages in the drainage system and raised river levels beyond what would have occurred under normal conditions. River levels from St. Adolphe to Breezy Point were particularly affected by ice. River ice was generally of average thickness, based on an early March survey, but was unusually strong due to a cold winter and a two-week cold spell from late March to early April which kept river ice from deteriorating before spring run-off. Ice jams developed on the Red River when high flows resulting from the March snow-melt in the United States portion encountered strong, solid ice in the Manitoba portion. Serious ice jams first developed from Lockport to Lower Fort Garry in the last week of March raising levels in the area to within 0.3 m (one ft) of the 1997 crest. Ice jams in Winnipeg, Selkirk and Breezy Point between April 9 and 11 raised levels much above open water conditions.



Flooding at the St. Andrews Dam at Lockport.

City of Winnipeg crests with ice and open water:

Ice was particularly stubborn in moving out of the Winnipeg area. Since floodway operations began in 1969, ice has always moved before levels at James Avenue in Winnipeg exceeded 5.6 m (18.5 ft.) In 2009, ice did not move until the level at James Avenue had reached 6.1 m (20 ft) on April 11. Southern parts of the city had particularly high water levels due to ice conditions.

Flooding was generally averted by emergency dikes, but a few low-lying buildings and roads were temporarily flooded.

Ice finally cleared out of southern parts of the city on April 10 and out of central and northern parts of the city on April 11 following a series of ice jams, the last of which broke at Redwood Bridge on April 11.



The Amphibex ice breaker was used to break up an ice jam at the south perimeter bridge.

The city had an open water (without stationary ice) crest of 6.85 m (22.5 ft) on April 16 when an ice run on the Assiniboine River coincided with crests on local streams in the Winnipeg area and high flows on the Red River at St. Norbert. A crest of 5.3 m (17.3 ft) also occurred on May 13, primarily in response to a 50 mm rainstorm over the city. Sewer back-up and basement flooding were minimal because the rainfall did not exceed the capacity of the pumping system for most of the storm.



Ice jam on Scotia Street.



Ice jam on Lyndale Drive.

Operation of major flood control works

Operation of the Red River Floodway was difficult because ice at the floodway inlet did not move freely until April 10, several days after levels in the city had exceeded flood stage. A limited operation of the floodway began on April 8, despite the presence of ice at the inlet. This operation posed a risk of river ice going into the floodway channel and forming an ice jam; however, it was necessary because of excessive river levels in southern parts of the city. Ten tracked excavators with extended reaches were used to remove ice and help it move between the St. Mary's Road bridge and the floodway inlet.

Minor ice jamming did develop in the floodway channel near St. Mary's Road bridge but serious jams were avoided when the ice run from St. Adolphe was able to break through the bridge ice on April 10.



Minor ice jamming in the floodway channel near the St. Mary's Road bridge.

Ice conditions made it difficult to determine river flows required to compute natural levels of the Red River at the floodway inlet, making operation of the floodway difficult. The peak water flow diverted in 2009 was 43,600 cfs. The operation of flood controls on the Assiniboine River was vital in reducing river levels from Winnipeg to Breezy Point. (See page 12 for details.)

Flood characteristics

A record high crest occurred in the Fargo area on March 28 after heavy melting in the headwater area between March 20 and 23. This melt started run-off from Grand Forks to Winnipeg but run-off was interrupted by cold weather and did not start again until just before mid-April. As a result, crests in the Manitoba portion did not occur until after mid-April. See page 24 (Figure 8) for the chart showing hydrographs of daily water levels at Fargo, Emerson, Morris, the floodway inlet, downstream of the floodway, James Avenue in Winnipeg, Lockport and Selkirk.

The peak flow at Emerson was the fourth highest on record since 1948, see 32 (Figure 24). The crest flow increased from 85,000 cfs at Emerson to 97,900 cfs at the floodway inlet, an unusually large increase. The 1997 and 2006 crests only increased by about 5,000 cfs and the 1979 crest actually decreased by 10,000 cfs. This demonstrates the unusual nature of the 2009 flood in terms of north-south timing of the run-off.

The 2009 flood inundated 1,000 km² (386 square miles) of agricultural land between Emerson and the floodway inlet compared to 1,840 km² (710.3 square miles) for the 1997 flood. See page 25 (Figure 10) for a radarsat map of the flooded area near the time of maximum flooding on April 19. The flood had a long duration with overbank flows at Morris from April 3 to May 18. Provincial Trunk Highway #75 at Morris was closed to traffic for 37 days from April 7 to May 13, compared to a 45 day closure in 1997. PR 200 between Morris and the floodway inlet was closed to traffic from April 9 to May 12. Many homes in the Red River Valley were accessible only by boat for more than a month.

While disruptions to transportation were extensive, there were only a few homes evacuated or flooded. The 95 per cent of buildings that were flood-proofed after the 1997 flood remained dry, with the exception of one property where the ring dike closure was breached. Flood claims under the Disaster Financial Assistance (DFA) program are not yet final but are expected to be in the \$40 million range. This includes provincial government costs of \$16.2 million and First Nations costs of \$4 million. This is much less than the \$240 million DFA eligible costs for the 1997 flood.

Flood forecasts

Flood forecasts in February and March indicated the likelihood of a spring flood between 2006 and 1979 levels and less than a 10 per cent chance of a flood as large as 1997. Actual flood crests from St. Jean northward exceeded 1979 crests by a small margin. Actual crests exceeded forecasts, but from Emerson to the floodway inlet it was within two feet of recorded crests, which is a relatively small deviation given the total spring rise of 9.4 m (31 ft) to 11.3 m (37 ft.)

Peak stages from Winnipeg to Breezy Point were significantly higher than predicted due to the effect of adverse ice conditions and the coincidence of the crests on the Red River, Assiniboine River and local streams in the Winnipeg area.

Following the second melt period, near mid-April, it became apparent that run-off from Manitoba tributaries would be somewhat greater than had been anticipated, especially from the western tributaries, and that the timing of these tributary crests would be unfavourable. Flow measurements in tributaries were finally possible once ice cleared out. An April 14th flood analysis (flood routing) showed that a long flat crest at Emerson would not allow for significant reduction of the U.S. crest as it moved through the large Manitoba flood plain, which usually occurs in most large floods. This extended crest combined with the relatively high second crest on the Manitoba tributaries would result in higher peak flows on the Red River in Manitoba. Based on this information, forecasts were raised in several increments based on updated tributary flows. While the forecast changed from a range between 2006 and 1979 to the second highest on record, this is not a large change as there is not much elevation difference between the peak stages of 1979 and 2009. See the table (Figure 11) on page 25.

Daily forecasts for the City of Winnipeg issued between March 24 and April 8, indicated a crest as high as 6.25 m (20.5 ft). This was raised to 6.7 m (22 ft) on April 9, including a 0.45 m (1.5 ft) allowance for ice jams. The city raised the freeboard on its dikes from the usual 0.6 m (two ft) to 0.9 m (three ft) on March 27, in response to these forecasts. Freeboard was further raised to 1.2 m (4 ft) in a few vulnerable areas on March 30. This was sufficient to withstand ice jam crests and the eventual open water crest of 6.85 m (22.5 ft) at James Avenue on April 16. Four buildings in Winnipeg were partially flooded.

Forecasts for the Red River from Selkirk to Breezy Point indicated that flooding due to ice jams was possible, but that peaks were unlikely to reach record levels due to ice mitigation activities. The crest at Selkirk was 0.55 m (1.8 ft) below that of the record ice jam crest of 2007.

Assiniboine River

The Assiniboine River had minor to moderate spring flooding in the portion from St. Lazare to Brandon during 2009, as predicted. See page 26 (Figure 12) for peak flows at Brandon since 1971. Peak stages from Virden through Brandon were about 0.3 m (one ft) higher than predicted in March, based on normal spring weather. The Assiniboine Valley at Virden was flooded from April 9 to April 22, a relatively short period due to minimal spring flows from Shellmouth Reservoir. Flows into the Portage Reservoir were unusually high due to above average flows on both the Souris River and the Assiniboine River at Brandon until mid-May. A relatively high crest occurred at Headingley and west Winnipeg on April 16 because of an ice run initiated by high flows at Portage la Prairie a few days earlier.

The Portage Diversion was in operation from March 28 to May 23. The long period of operation was needed to reduce flood levels in the City of Winnipeg during April. It also reduced the risk of sewer back-ups in May. The total amount diverted was the same as the 1995 diversion volume, which was the second highest on record. It was equivalent to 0.29 m (0.95 ft) on Lake Manitoba. See page 26 (Figure 13) for annual Portage Diversion volumes from 1970 to 2009. Diversion flows were as high as 20,000 cfs on April 15 causing a washout of the failsafe on the diversion. The high diversion flows were required to prevent serious flooding on the lower Assiniboine River because Portage Reservoir inflows were as high as 27,600 cfs and the downstream bankfull capacity is only 12,000 cfs. Operation of the diversion prevented potentially serious flooding along the lower Assiniboine River from Portage La Prairie to Headingley and reduced the crest in the City of Winnipeg by 0.6 m (two ft.)

The Shellmouth Reservoir was successfully operated to prevent spring flooding from the Shellmouth Dam to St. Lazare and to reduce flooding further downstream to Brandon. The reservoir rose to an optimum level during the spring while outflows remained well below the downstream channel's capacity. Operation of the reservoir had little effect on the crest at Winnipeg, but produced a somewhat faster decline in levels after the crest.

Souris River

The 2009 flood on the Souris River at Melita was the highest since 1999. It was similar to 1995 levels for the sixth highest peak on record since 1973. It followed a significant drought in 2008. Extensive flooding of agricultural land occurred from the United States boundary to just south of Melita from late April through most of May. Some overbank flows also took place between Melita and Souris from late April to early May.

The flood was caused by heavy autumn rains and more than twice the normal snowcover in the North Dakota portions of the watershed. Run-off from the Saskatchewan and Manitoba portions was only somewhat above average.

Peak flows and levels in Manitoba in early May were 0.6 to 0.9 m (two to three ft) lower than predicted because run-off from the Saskatchewan and North Dakota portions was much lower than expected. A slow melt and dry weather during most of the spring run-off period reduced levels. Also, run-off from the Manitoba portion had nearly finished by the time flood water arrived from the United States. It is also possible that the 2008 drought may have had a greater effect on run-off than anticipated.

Pembina River

The Pembina River flood of 2009 was the greatest on record for the portion from Rock Lake to Windygates in Manitoba and somewhat exceeded the previous large floods of 1974 and 2006.

Most of the Pembina River Valley was flooded from the second week of April to early May. Flooding from Rock Lake to Swan Lake continued until late May. More than a dozen cottages on Rock Lake were flooded and some precautionary dikes were built at the Holiday Mountain Resort at La Riviere. A partial dike closure was made at Gretna based on river forecasts. High levels in North Dakota threatened to flood the road along the International Boundary but the absence of strong south winds at the time of the crest prevented this. Peak stages from the Gretna/Neché area to the Red River were about 0.09 m (0.3 ft) higher than in 2006.

The flood was caused by high autumn soil moisture and above-average snowcover which was particularly high in the United States portion of the watershed. Despite poor data available in parts of the watershed, the March flood outlook, and subsequent updates in April, indicated that a significant flood would occur. However, the forecast indicated that the flood would likely be somewhat less severe than that of 2006 when in fact, it turned out to be somewhat greater. An accurate forecast for Windygates was provided to United States flood managers several days before the crest, based on an evaluation of upstream river conditions.

Interlake area

Spring run-off in the Interlake was above average but not as great as in many past floods. The main cause of the above-average run-off was the high levels of soil moisture and water remaining in depression storages in swamps, hollows and other low areas from the very wet summer of 2008.

Snowcover appeared to be close to average, based on conventional snow surveys. Significant flooding occurred on the Fisher River at the Peguis First Nation where many homes are located at low elevations near the river. See page 27 (Figure 15) for spring peak stages for the Fisher River near the high school bridge at Peguis for significant flood years.

Peaks on the Fisher River were higher than expected and as a result there was insufficient time for diking at Peguis. Peak stages on the Fisher River are difficult to predict due to chronic ice conditions which make it difficult to estimate and forecast river flows and predict levels. A rapid melt and some rain on the weekend of April 10th contributed to the higher crest.

The Interlake had serious overland flooding. There was also flooding along the shorelines of interior lakes such as the Shoal Lakes, Dog Lake and Fish Lake as spring run-off flowed into lakes that were still high from the 2008 summer rainstorms.

Winnipeg River

The Winnipeg River level rose steadily from early April onward and reached 276.3 m (906.5 ft) by early June. It rose further to 276.5 m (907.2 ft) at the end of June after a major rainstorm on June 27. This peak level is 1.8 m (six ft) above average and produced significant flooding on recreational properties such as parks, boat houses and docks.

Overland flooding

Water collecting in low lying areas of the landscape because of excess snowmelt and/or rain is referred to as overland flooding. The spring of 2009 produced severe overland flooding in the Red River Valley, southern Interlake and eastern Manitoba due to drainages blocked by ice. The early snowmelt from March 20 to 23 caused water to collect in fields and ditches. However the run-off was interrupted by two weeks of sub-zero temperatures which froze water in fields, ditches and streams.

Blockages of the drainage system due to ice were extensive and impeded flows from the second snowmelt near mid-April, which aggravated overland flooding. Manitoba Infrastructure and Transportation did extensive work to unclog frozen culverts and small bridges which would have severely blocked run-off. This was done by crews equipped with steamers, who did most of their work during the two-week cold snap. While overland flooding was still extensive, it was significantly reduced by the steaming process.

A 75 millimetre to 100 millimetre rainfall over the Red River Valley, the eastern Interlake and eastern Manitoba between June 26 and 28 produced extensive overland flooding. It raised most streams to their bankfull capacity with minor flooding in some areas. Some rural homes were surrounded by water and others, including some in Winnipeg, had basement flooding. Most small streams crested by the end of June, but the Red River did not crest until early July. The storm also brought northerly winds of up to 100 km/hour over eastern Manitoba and on the southern shores of Lake Winnipeg, causing near record high levels of 219 m (718.5 ft), not including waves. Serious shoreline erosion and some flooding occurred in some areas. This was one of the worst summer storms on record in terms of heavy rain and strong winds over a very large area.

Lake levels

Unusually high flows on the Red River and the Winnipeg River raised Lake Winnipeg to 218 m (715.3 ft) by mid-June. This is well above average and 0.09 m (0.3 ft) above the top of the target of 216.7 to 217.9 m (711-715 ft) for the lake. This occurred despite maximum outflows being discharged from the lake since November, 2008. The natural level of the lake would have been significantly higher since the outlet was much smaller capacity before regulation.

Lake Manitoba rose to 247.8 m (812.9 ft) by mid-June, partly because of high flows from the Portage Diversion, which was operated extensively to reduce levels on the lower Assiniboine River and in the City of Winnipeg. The lake would have risen significantly higher if the improved outlet's capacity at Fairford Dam had not been expanded in 1960. Outflows from the lake were maintained at the maximum possible level, without causing serious flooding on Lake St. Martin downstream. Lake St. Martin rose to 244.5 m (801.5 ft), which is close to flood stage. Dikes at Lake St. Martin First Nation were improved to prevent flooding during wind storms.

Many lakes in the Interlake region rose to record high levels during the spring of 2009 and some continued to record high levels going into the summer. Many lakes in the Interlake do not have outlets and are slow to decline. See page 28 (Figure 16) for levels for North Shoal Lake since 1976.

Lake of the Woods rose to an upper level of 323.3 m (1060.6 ft), more than 0.3 m (one ft) above its summer target level. This occurred by the third week of June, despite above average outflows.

Rock Lake on the Pembina River rose to a record high level of 408.25 m (1339.4 ft) in mid-April. Pelican Lake rose above its desirable level, but operation of the outlet control reduced the peak level and duration of high water. Most lakes in western Manitoba remained in the desirable range, although Sandy Lake and North Thomas Lake southwest of Riding Mountain were unusually high.

Flood preparedness

Preparation for a possible flood began early in 2009, with a special assessment by the Hydrologic Forecast Centre in mid-January, followed by the spring flood outlooks issued in February and March.

The flood outlooks were widely distributed via e-mail and various government websites. A flood workshop by Emergency Measures Organization and Manitoba Water Stewardship in Morris on March 10 was well attended by municipal officials and emergency responders in the Red River Valley. Attendees were advised that the spring flood potential was high, due to record high soil moisture conditions. Municipal, town and city officials, emergency co-ordinators and provincial senior staff then reviewed their emergency plans and procedures and ensured that staff and equipment would be available in a flood emergency. Utilities, private industry and individual landowners reviewed their vulnerabilities and made plans for relocation of flood-prone property including animals where this was possible.

Much preparation was done to minimize the risk of ice jams along the Red River, from Selkirk to Breezy Point. This included ice breaking with two Amphibexes and ice cutting from early March to the second week of April. Arrangements to obtain equipment required for this work were made well in advance of the flood. Most of the work was concentrated in the area near the City of Selkirk where record ice jams occurred in 2007.

On the Assiniboine River, flood preparedness included forecasting spring inflows to Shellmouth Reservoir and drawing the reservoir down to a level appropriate to meet both flood control and water supply objectives.

Innovations and improvements in flood mitigation

Many innovative activities were implemented during the 2009 flood. These included ice cutting, use of long-reach backhoes to move river ice, use of flood tubes and aquadams for dikes, use of steamers for ice removal, use of LiDAR data for determining property elevations and use of satellite river-ice tracking.

There has been a great improvement over the decades in the ability of all three levels of government to cope with major floods. Protective infrastructure and methods of flood warning and flood fighting are vastly improved from the 1950 era and significantly improved even since the 1997 flood. The construction of major flood controls, such as the Red River Floodway, Portage Diversion and Shellmouth Reservoir, ring dikes around towns and villages and extensive flood proofing of individual homes and farms in the Red River Valley, have vastly reduced flood damage. There was little or no protection in 1950. Damage for a 2009 flood, under 1950 conditions, would be prohibitive. Additional improvements after the 1997 flood include protection of 95 per cent of individual homes and farms by raising or diking and construction of additional ring dikes around towns and villages.

In addition to flood proofing, better preparation for floods is enabled by better advance warning of floods. Improved probability forecasting for the United States portion (by the U.S. National Weather Service) is very beneficial to Manitoba. Improved flood routing and availability of LiDAR land elevation data in Manitoba is also helpful. Improvements in the river level and flow network and availability of airborne and satellite, snow-survey data are an asset to flood warning.

Emergency flood management has improved over the decades due to:

- new innovative technology
- better equipment
- better planning
- co-ordination of flood fighting efforts

Improved communication via e-mail, websites, cell phones, Blackberries, etc. has led to faster co-ordinated responses to planning and flooding issues. Improved command structures, a more specialized and knowledgeable workforce and a greater dedication by government to provide resources for solution of flooding problems, have all led to improved flood fighting and damage reduction.

Improved co-ordination between provincial and municipal governments has also contributed to better flood mitigation and response. Manitoba Water Stewardship and EMO interaction with emergency co-ordinators at the municipal level and with Manitoba Native Firefighters and Indian and Northern Affairs Canada (INAC), have improved awareness and response to flooding concerns.

Summary of flood fighting activities and successes

Following is a list of key flood fighting activities that were instrumental in reducing damages from the 2009 spring flood.

- An incident command structure successfully co-ordinated the provincial flood fighting effort with 250 government staff members working on flood management.
- The greatest success of the 2009 flood was the large reduction in flood damages, due to operation of major flood controls. Operation of the Red River Floodway, Portage Diversion and Shellmouth Reservoir reduced the crest in Winnipeg by 10 feet, preventing in the order of \$10 billion in flood damages.
- To protect towns, 15 community ring dikes were activated in the Red River Valley. Of these, 13 were partially closed and two were fully closed. Closure of ring dikes protected homes and businesses and enabled business continuity. Dike closures were carefully made in stages, based on river forecasts, to minimize disruption to business while ensuring necessary protection. The value of ring dikes was once again demonstrated through total savings of approximately \$700 million.
- There were 1,730 individual homes and businesses protected by infrastructure constructed after the 1997 flood. This saved close to \$100 million in potential damages. However, there was a loss of access and people had to commute longer distances.
- Provincial Trunk Highway #75 was rerouted, minimizing disruption to trade.
- Ice breaking and sawing prevented serious flooding in the City of Selkirk and vicinity. An additional Amphibex ice breaker and three ice cutters were acquired, making Manitoba a leader in ice mitigation technology.
- An Amphibex released an ice jam at the south perimeter bridge. Ice cutting alleviated flooding on the Icelandic River at Riverton and on the Whitemud River at Westbourne. Ice cutting on the Portage Diversion likely prevented ice jams.
- Use of long-reach backhoes helped prevent ice jams in the floodway channel.
- The province purchased 25.1 kilometres (15.6 miles) of Tiger Dam flood tubes and 7.6 km (4.7 miles) of Aquadams, all of which were deployed to the field.

- Steaming of culverts and small bridges blocked by ice helped improve drainage and reduce overland flooding and flooding on small streams. There were 37 steamer crews used by the province in municipalities.
- Flood liaison offices were established in Winnipeg, Morris and Brandon providing essential flood fighting information and current flood forecasts, mainly to individuals. The Morris office provided detailed information on elevations of properties and dikes in the Red River Valley, based on LiDAR data.
- The Hydrologic Forecast Centre provided daily flood reports to flood fighters, emergency managers, officials at all three levels of government and the flood liaison offices. Flood forecasting assisted optimum operation of flood controls, facilitated additions to freeboard of dikes in Winnipeg and timely actions on closures at ring dikes. It also enabled planning and preparatory actions such as moving materials and animals to higher ground.
- Media briefings were held daily during the height of the flood to inform the public and a website with flood information was maintained.
- Five-day forecasts and crest forecasts with and without ice jams, were regularly provided to the City of Winnipeg to help with planning and emergency operations. The decision by the city to add to the freeboard of their dikes, in response to these forecasts, saved hundreds of homes from being flooded.
- Arrangements were made with the Canada Centre for Remote Sensing to provide satellite imagery on flooded areas in the Red River and Souris River valleys. This was applied to a Google earth background to produce flood inundation maps every three to four days.
- Permanent flood protection was installed at Melita (\$380,000) and at the Kiwanis Seniors Complex in Selkirk (\$150,000).
- Four hydrometric crews obtained flow measurements and water levels of rivers and lakes. The province purchased two acoustic Doppler-flow meters at a cost of \$20,000 each. This enabled quick river-flow measurements under difficult conditions. Cross training of Manitoba Water Stewardship and Manitoba Infrastructure and Transportation staff as hydrometric technicians was conducted.

Emergency Management

Pre-flood preparation

Early analysis, provided by Manitoba Water Stewardship, indicated that southern Manitoba might experience significant flooding, equal to or exceeding 1979, but less than 1997. Because of flood proofing strategies implemented after the 1997 flood, all communities in the Red River Valley, south of Winnipeg, were well prepared to deal with anticipated water levels.

Most homes and buildings outside of the protection of the floodway and community ring dikes were also protected by flood mitigation strategies. Some of the roads in the Red River Valley south of Winnipeg are below 1979 elevations. While road access to ring dike communities was likely to continue, some individual homes and farm properties would be cut off, which meant evacuating residents.

In co-operation with the city and non-government organizations – including the Red Cross, Salvation Army, St. John Ambulance and Mennonite Disaster Services – preparations were made to register evacuees and provide assistance and accommodations for them.

Before the flood, all of the potentially affected municipalities continued to prepare, using their emergency plans. This included co-ordinating the first responders under their authority. Ongoing training was provided to local officials and responders by EMO. Municipal emergency plans had been prepared, reviewed by EMO and tested.

Council resolutions in 18 municipalities were passed for Emergency Prevention Orders, under *The Emergency Measures Act*. These allowed the municipalities to exercise preventive or preparation powers.

Although emergency preparedness is primarily a municipal responsibility, the provincial government took steps to co-ordinate and deliver any required support, including:

- Flood-fighting efforts of all government departments were merged into an incident command structure led by Water Stewardship and EMO.
- EMO also led Incident Command with all other agencies involved. This formed a unified command by working closely with Water Stewardship.
- River ice was broken up using the Amphibex and other equipment.
- Steamers were loaned to municipalities and First Nations communities and provincial crews also worked to thaw blocked culverts and drains.

EMO's regional emergency managers kept in contact with the municipal emergency co-ordinators and provided advice and assistance, including co-ordination of provincial support. Provincial departments ensured appropriate services were available in flood affected areas, including:

- Manitoba Health and Healthy Living worked with the Medical Transportation Co-ordination Centre to provide Emergency Medical Services helicopter service out of Alberta.
- The Office of the Fire Commissioner assigned a mobile command centre and appropriate staff to help local fire departments with water rescue services.
- Manitoba Conservation placed staff and equipment on standby in case local authorities needed boats or additional staff.

As well, Manitoba Emergency Measures Organization, in co-operation with other provincial departments, provided a significant numbers of Tiger Dams and trailers, and other types of portable dike equipment for affected communities. EMO also partnered with Manitoba Science Technology Energy and Mines to buy and install an electronic, emergency-management software suite for the Emergency Co-ordination Centre. It allowed better internal communication and co-ordination with provincial departments.

Manitoba Family Services and Housing co-ordinated several agencies to register and support evacuees. Communications Services Manitoba continued to co-ordinate all public media information and updates on the anticipated flood.

Flood response


Local emergency plans were adapted to the existing circumstances. One of the most serious challenges was ice jams on the river. These had a profound effect on some of the communities north of Winnipeg, particularly East St. Paul and St. Clements. Frozen culverts and drains prevented the free flow of water overland and provincial crews worked tirelessly to thaw the ice blocks.

Municipalities, with provincial assistance, managed their community efforts, including:

- sandbagging and installing temporary flood protection
- installing Tiger Dams and similar flood protection
- declaring states of local emergency (in 16 communities) so that they could use the powers available under *The Emergency Measures Act*.

Municipalities ensured local emergency centres stayed in contact with the province's Emergency Co-ordination Centre.

The province's Emergency Co-ordination Centre (ECC) was activated by EMO. Staff from provincial departments and agencies who worked in the ECC represented: Emergency Management Organization, Water Stewardship, Infrastructure and Transportation, Family Services and Housing, Conservation, Public Safety Canada, Agriculture, Food and Rural Initiatives, Partners in Disaster (non-government responding or support agencies) and Communications Services Manitoba.



Manitoba's Amateur Radio Emergency Service provided telecommunication links between local emergency operations centres in high risk communities and the provincial ECC. Communications Services Manitoba co-ordinated daily media conferences, news releases and website information updates. Municipalities were updated with daily flood forecasts on conference calls with municipal leaders and provincial departments. EMO's regional emergency managers worked in the municipalities throughout the flood.

Evacuations

An evacuation registration centre was set up in Winnipeg at Century Arena. It was operated by city and provincial staff and non-governmental agencies.

At the height of the flood approximately 2,800 people had been evacuated from affected areas. This included First Nations communities, such as Peguis where a very large evacuation was required. Most residents registered with either the Manitoba Association of Native Firefighters (MANFF) or the Red Cross.

Unlike the situation in 1997, only two communities protected by ring dikes were evacuated, Roseau River First Nation and the village of Riverside. However, there were evacuations from some at-risk communities, including the personal care home in St. Adolphe, and people in homes that had lost road access outside of a ring dike.

Disaster Financial Assistance (DFA)

DFA is generally available for evacuation costs, costs to prevent or limit imminent damage and for non-insurable damage to basic and essential property such as a principal residence, or buildings and other non-insurable losses essential to the operation of eligible farms and small businesses.

This year, the province increased the maximum amount a private citizen may claim to \$200,000. This is up from the previous maximum of \$100,000 for eligible homes, farms or businesses. Municipal cost sharing was also amended to limit the amount a municipality must pay, to \$5 per capita, after which, the province pays 100 per cent of the cost.

This may be subject to further cost sharing with the Government of Canada. Discussions have been initiated with the federal government on cost sharing for this disaster. As of June 30, 2009, more than 1,000 applications for DFA have been made for approximately \$40 million in damages.

DFA claims are managed through EMO. Extra temporary staff have been hired to improve the processing time for these claims.

Lessons learned and recommended improvements

The 2009 flood demonstrated the range of extreme flood conditions which can result from unusual spring weather such as an early March melt, followed by an extended period of cold weather. The experience has been particularly valuable in the areas of flood forecasting, operation of flood control structures, managing river ice and overland flooding with river ice. This information will help in the management of future floods and the following work is underway or planned:

- Design work and benefit-cost analysis will begin shortly on improvements to the floodway inlet to allow greater flows into the floodway channel. This is expected to reduce river levels in Winnipeg during floods of lesser magnitude than that of 1997 (such as those of 2009 and 2006), and reduce flooding south of the floodway inlet in major floods.
- Buy-out programs have been established for residents of the Breezy Point (St. Andrews) and St. Peters Road (St. Clements) areas, to eliminate the future risk to residents and emergency responders from the sudden rise of the Red River due to unpredictable ice jams.
- A detailed proposal for a cost-shared flood mitigation program has been proposed to the federal government that identifies the following initial provincial priorities:
 - flood protection for communities and homes on Peguis and Fisher River First Nations, the Red River north of Winnipeg and other at-risk areas;
 - enhanced ice jam mitigation;
 - improvements to the City of Winnipeg's secondary dike system, and to Winnipeg's sewer system to mitigate the risk of basement flooding due to sewer back-up; and
 - raising provincial roads to improve community access during a flood event, such as PTH 3 in the vicinity of Melita, sections of PTH 75 north and south of Morris, and, subject to thorough hydraulic impact assessments, other sections of PTH 75 (including at Morris), and sections of PTH 23, PR 201, PR 200 and PR 205.
- Ice mitigation methodologies will be further reviewed in light of the 2009 experience. Acquisition of additional ice mitigation equipment, including additional ice cutters, is proposed and the need for an additional Amphibex will be assessed.
- Discussions have been initiated with Indian and Northern Affairs Canada and First Nation leadership aimed at improving the emergency management capacity in First Nations, including hazard assessment, risk analysis, planning, preparedness, response and recovery.
- Improvements in training, facilities and equipment will be advanced to enhance the capacity to assist municipalities and further improve the effectiveness of flood emergency management.
- The floodway operation rules will undergo a public review as required under the terms of the floodway expansion project's *Environment Act* licence. The review will be completed by July 2010 and will provide an opportunity for public input on how the rules can be improved.

- Improvements are planned to the floodway operations computer model to account for the influence of ice cover based on the 2009 experience, and to real time monitoring of the Red River flows in the area of the floodway inlet control structure and on local streams (such as La Salle River, Omands Creek, Truro Creek), that will enable more precise floodway operations.
- Improvements in flood forecasting tools and procedures are also planned, including improvements to hydrometric and climatological data networks.
- The Designated Flood Area regulation (under *The Water Resources Administration Act*) will be extended to points from Winnipeg to beyond Breezy Point in order to regulate and appropriately limit development in areas that are below the highest recorded flood level plus one foot.

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Figure 1

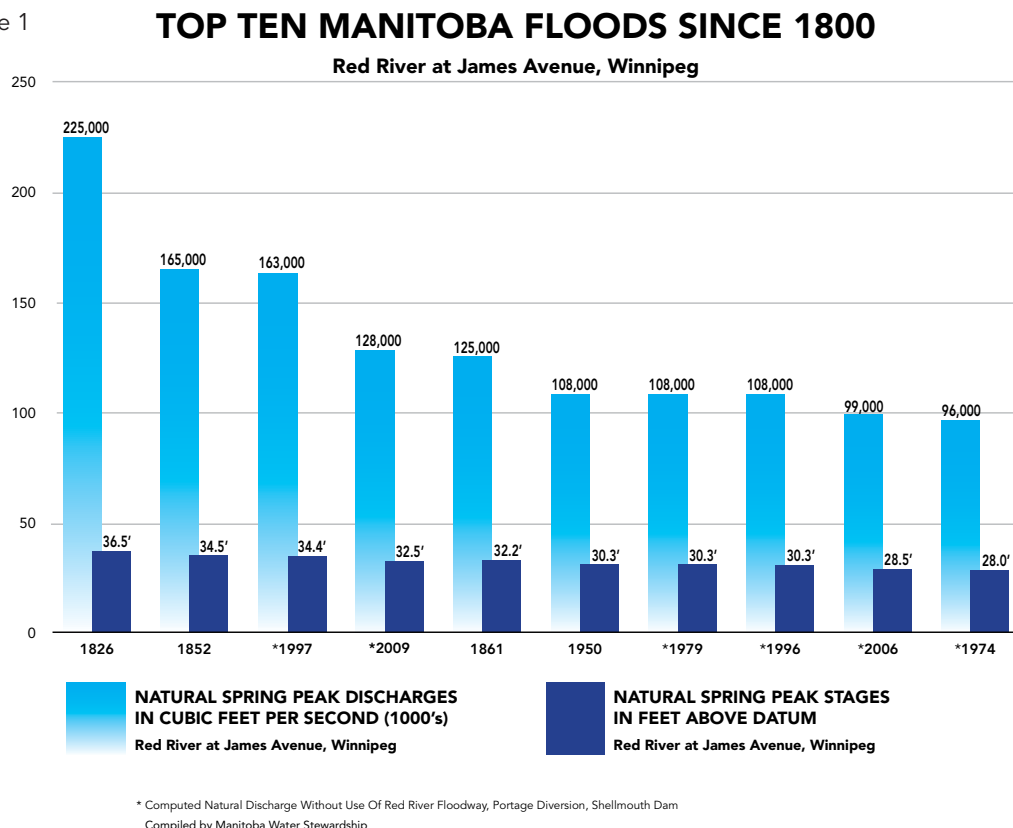


Figure 2

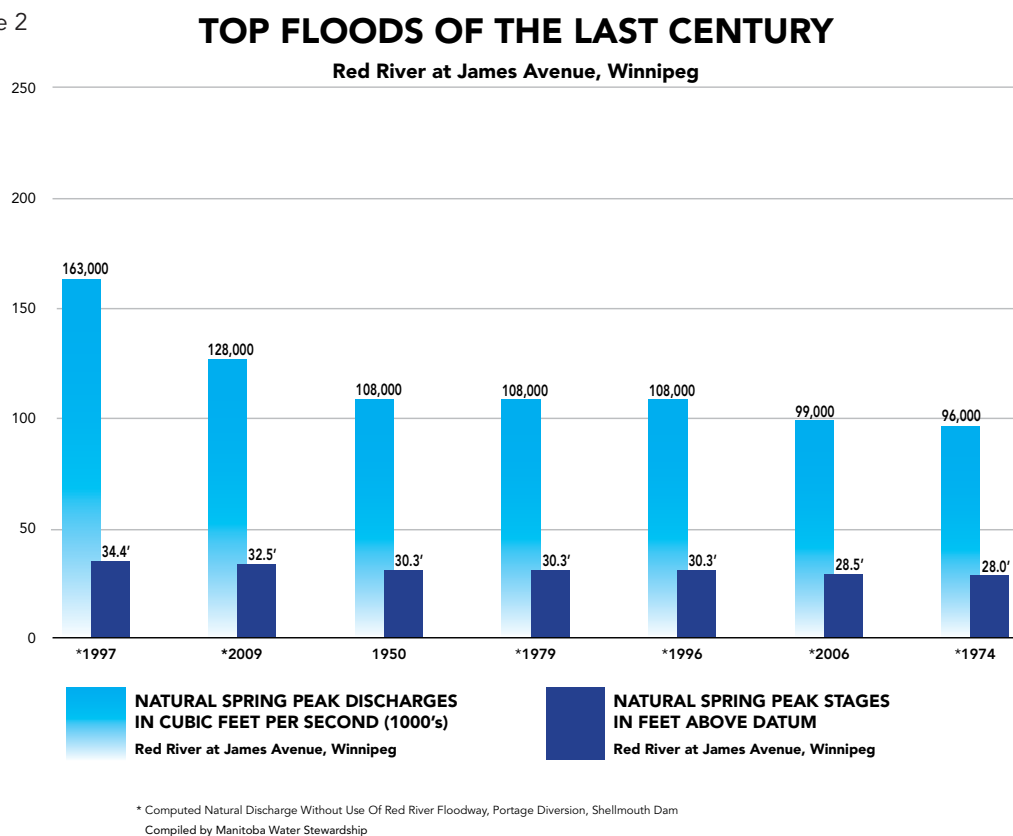


Figure 3

Red River Spring Flood Peaks from 1950 to 2009

Peak Stages in Feet Above Sea Level

	1950	1966	1979	1996	1997	2006	2007	2009
Emerson	790.9	789.3	791.3	789.6	792.5	789.5	782.2	790.8
Letellier	785.3	784.4	785.2	784.5	787.7	783.8		785.2
St. Jean	782.3	780.6	782.4	781.3	784.3	781.0		782.9
Morris	781.7	778.9	781.3	779.6	783.3	779.3	770.6	781.9
Ste. Agathe	773.2	770.9	773.1	771.9	776.5	771.0		773.7
St. Adolphe	769.0		768.3	767.4	772.5	766.6		769.2
Floodway Inlet	766.0	763.0	765.5	764.6	771.5	763.4	753.8	766.8
St. Norbert	765.7	762.3	752.9	753.5	761.1	754.8		756.6
Winnipeg	30.3	26.3	19.2	19.2	24.5	20.4	18.0	22.5
(James Ave)								
U/S Lockport	734.9	732.35			738.9	730.8	733.1	738.5
Selkirk	726.0	729.3		730.0	728.5	723.6	731.2	729.4
Breezy Point					720.3	719.2	719.3	721.9

Note: Red figures denote highest stage recorded since operation of major flood control works in 1969.
Blue figures denote second highest since operation of major flood control works.
The year 2007 was not a flood year except for record ice jam flooding in the Selkirk area.
Stages from St. Norbert to Lockport for 1950 and 1966 are as recorded without flood control works.

Figure 4

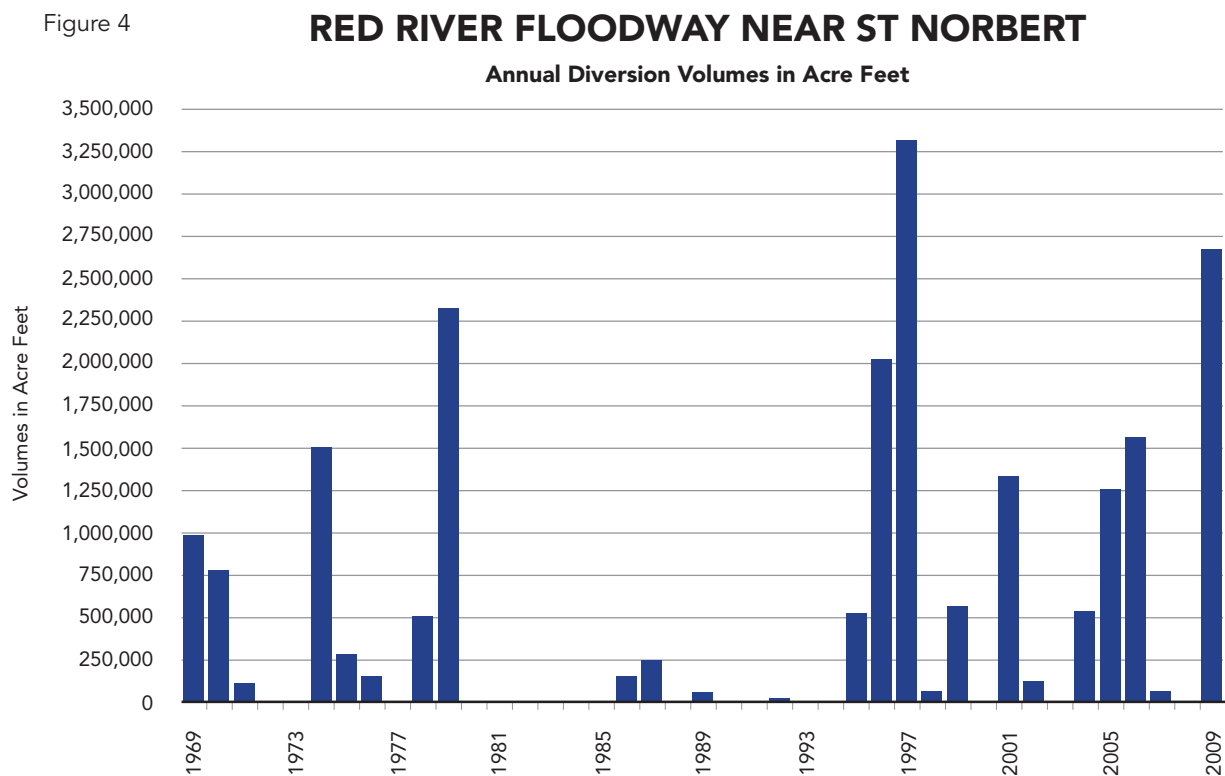


Figure 5

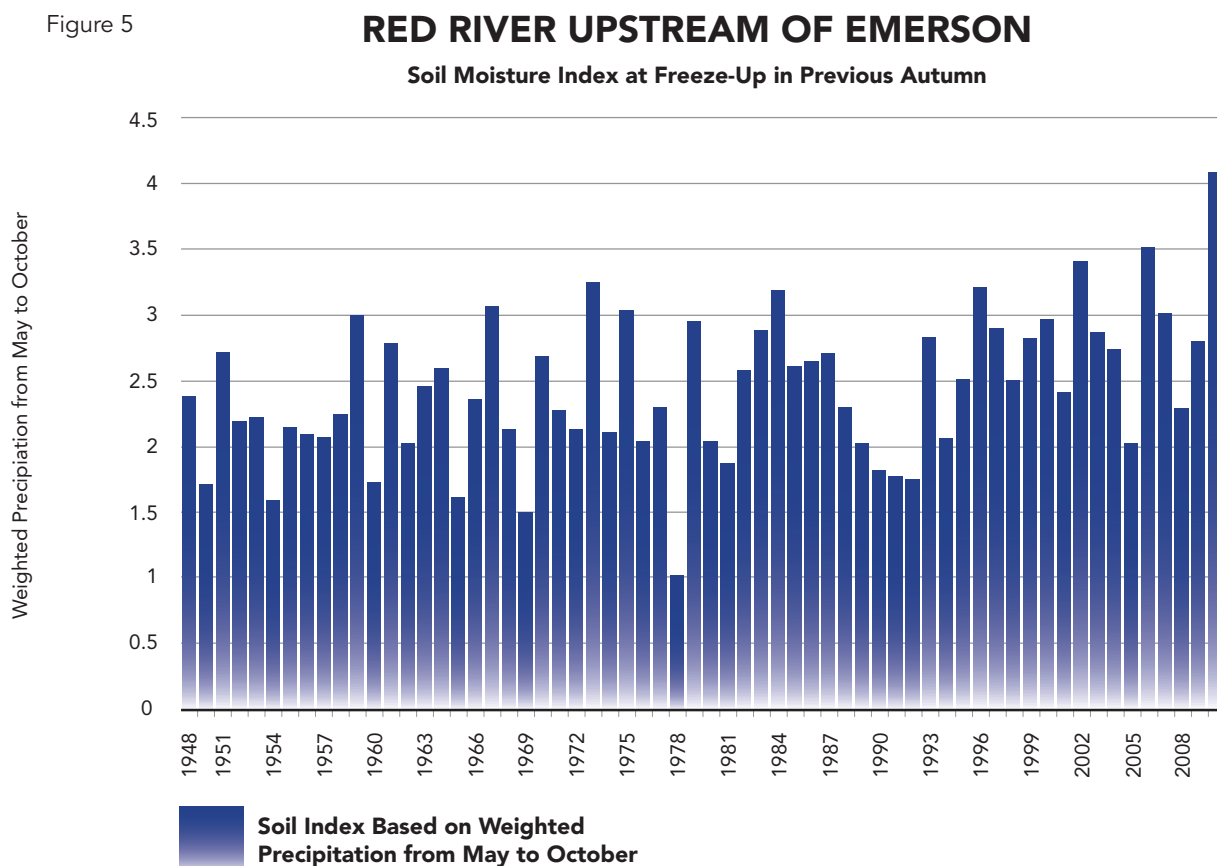


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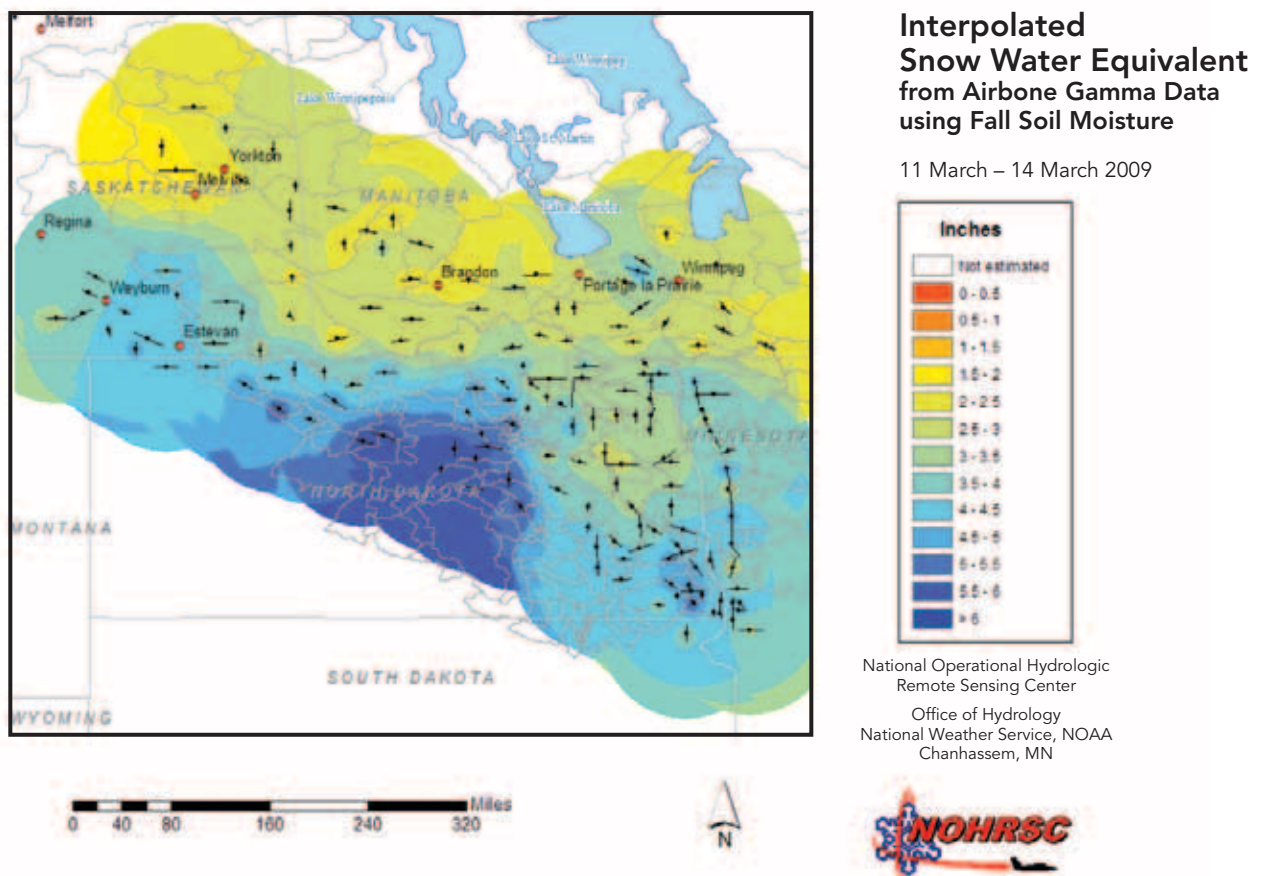


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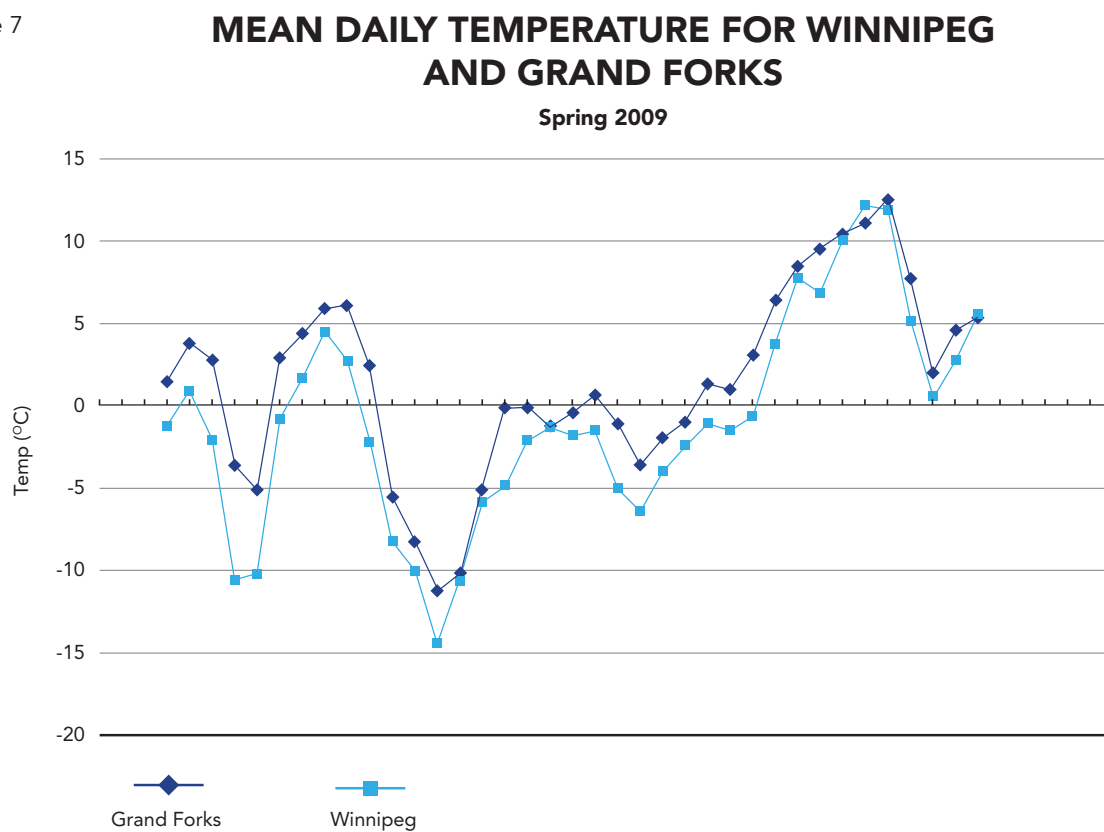


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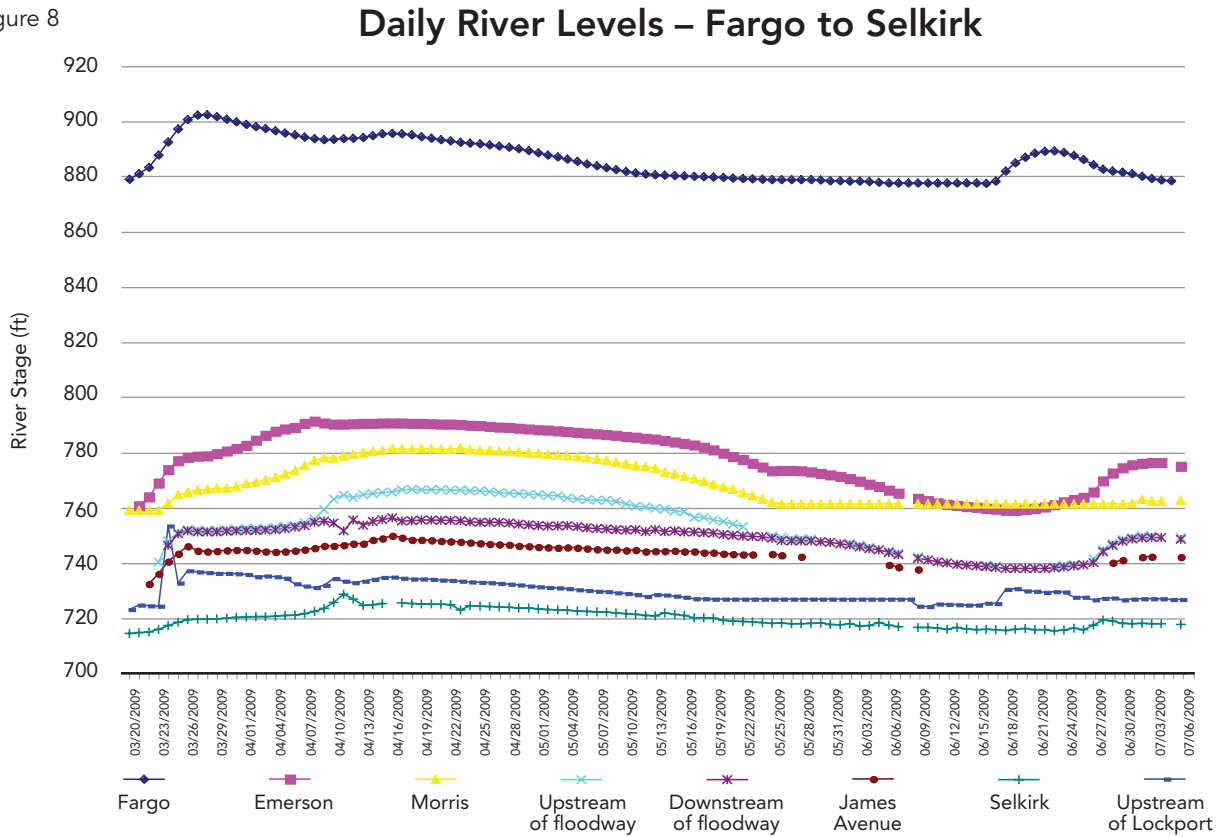


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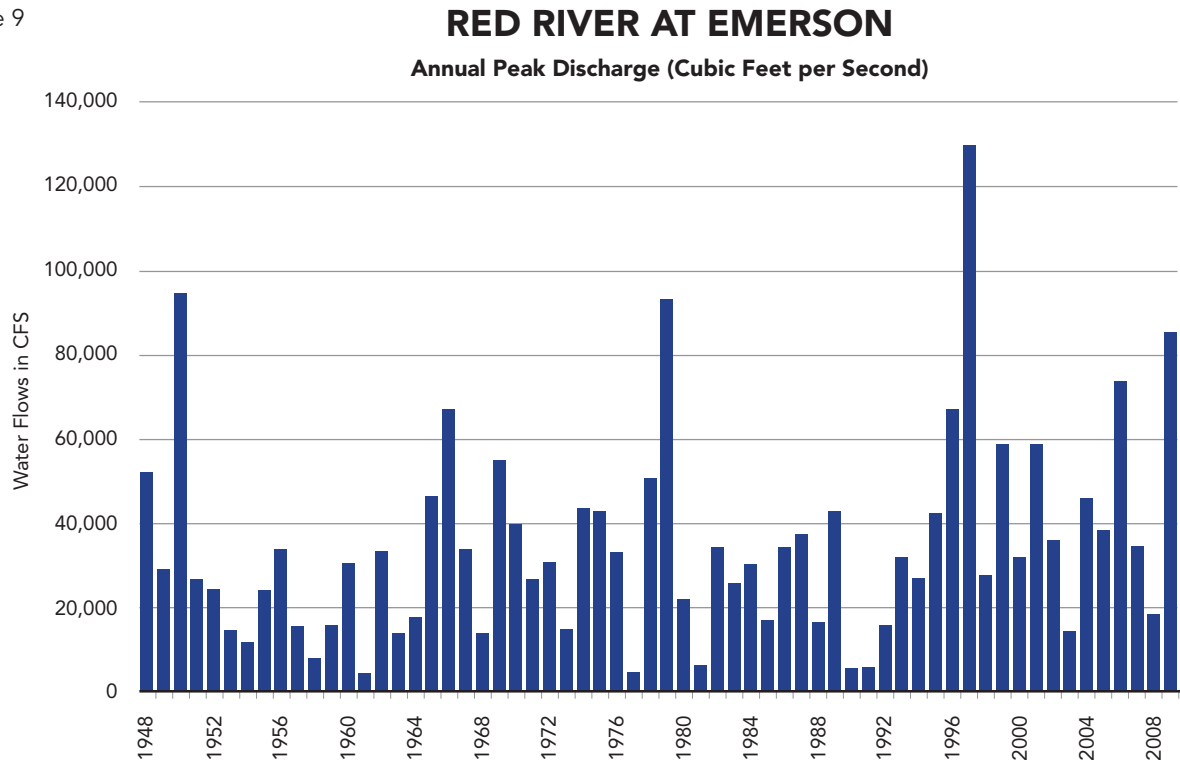


Figure 10

Red River Valley Flooded Area Map - April 20, 2009

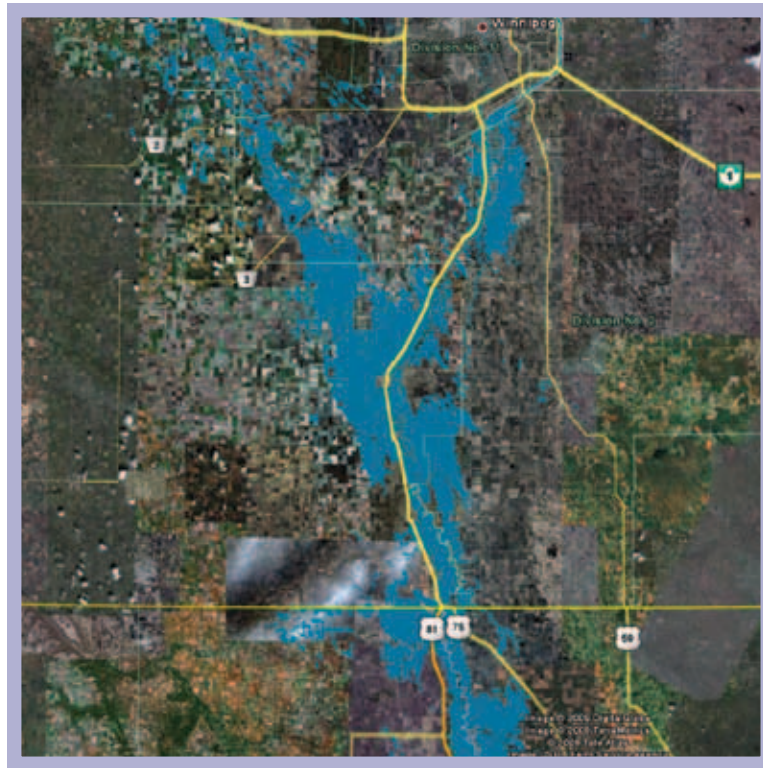


Figure 11

Red River Forecast Accuracy Evaluation 2009 Spring Flood

All values are in feet

	Observed Crest and Date		Total Spring Rise	Error on March 20th Forecast	Error on April 5th Forecast	Error on April 12/09 Forecast
Emerson	16-Apr	790.8	36.8	0	0	0.2
Letellier	18-Apr	785.2	36.2	0.2	0.7	0.5
St. Jean	19-Apr	782.8	31.2	0.75	1.36	0.8
Morris	20-Apr	781.9	34.2	0.89	1.39	1.6
Ste. Agathe	20-Apr	773.6		0.75	1.15	0.9
St. Adolphe	19-Apr	769.2	33.1	0.9	1.7	1.0
Floodway Inlet	17-Apr	766.7	34.0	1.15	1.75	1.2
St. Norbert	16-Apr	756.6		3.6	1.1	0.4
James Ave.	16-Apr	22.5	19.3	3.0	2.0	1.9
Selkirk	12-Apr	729.4		4.4	2.4	Had Occurred
Breezy Point	12-Apr	721.9			1.43	-0.6

Note: A positive error means that the actual crest exceeded the forecast crest

Figure 12

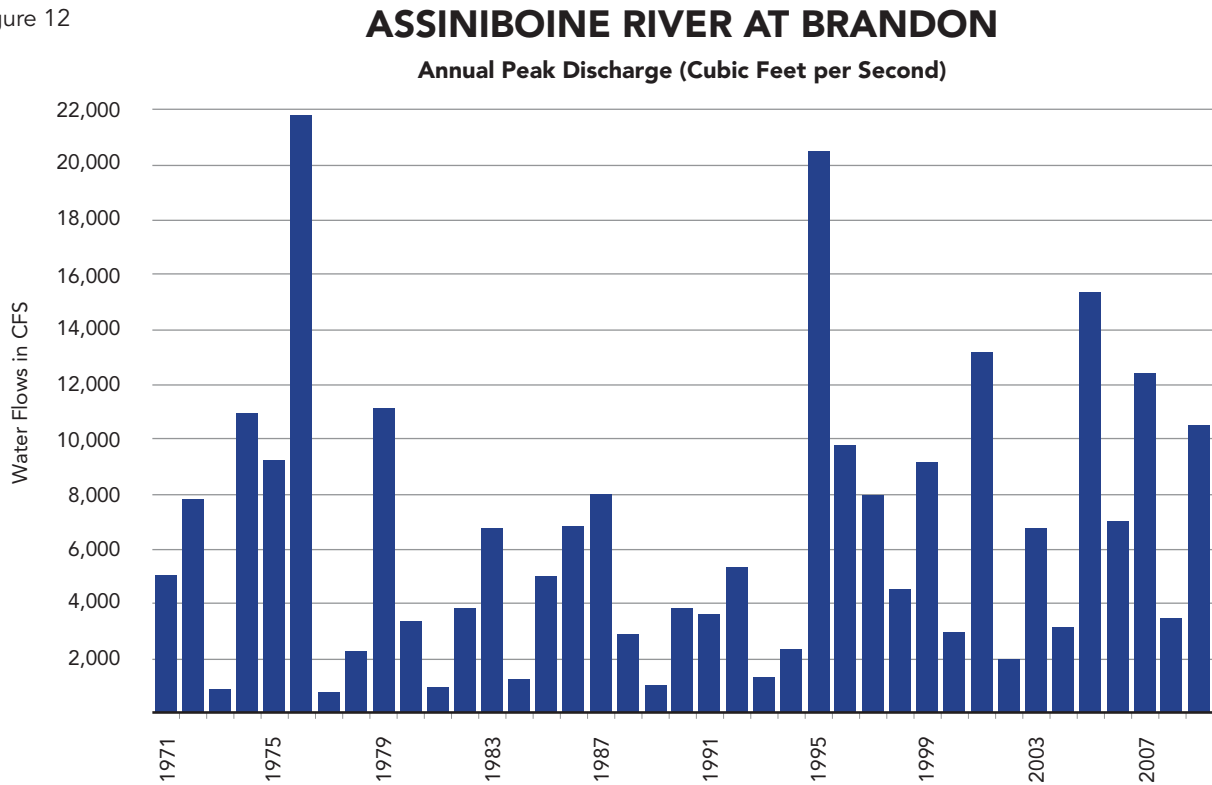


Figure 13

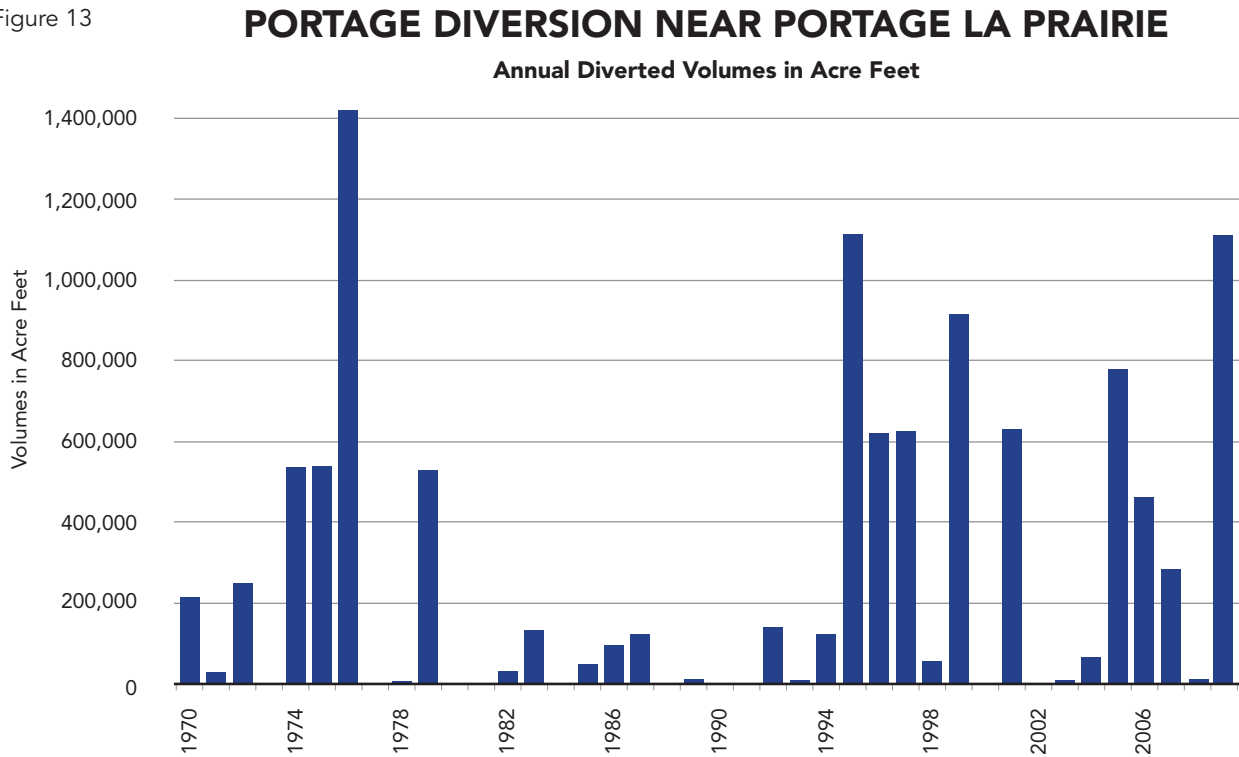


Figure 14

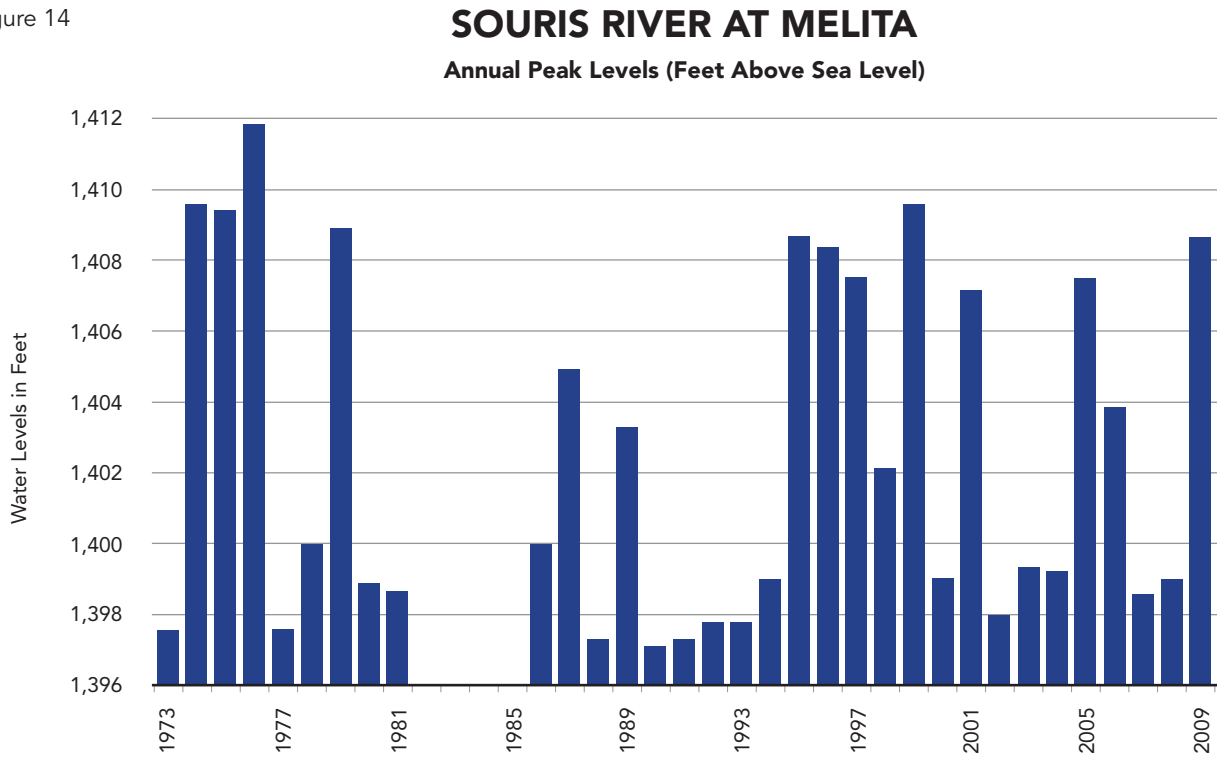


Figure 15

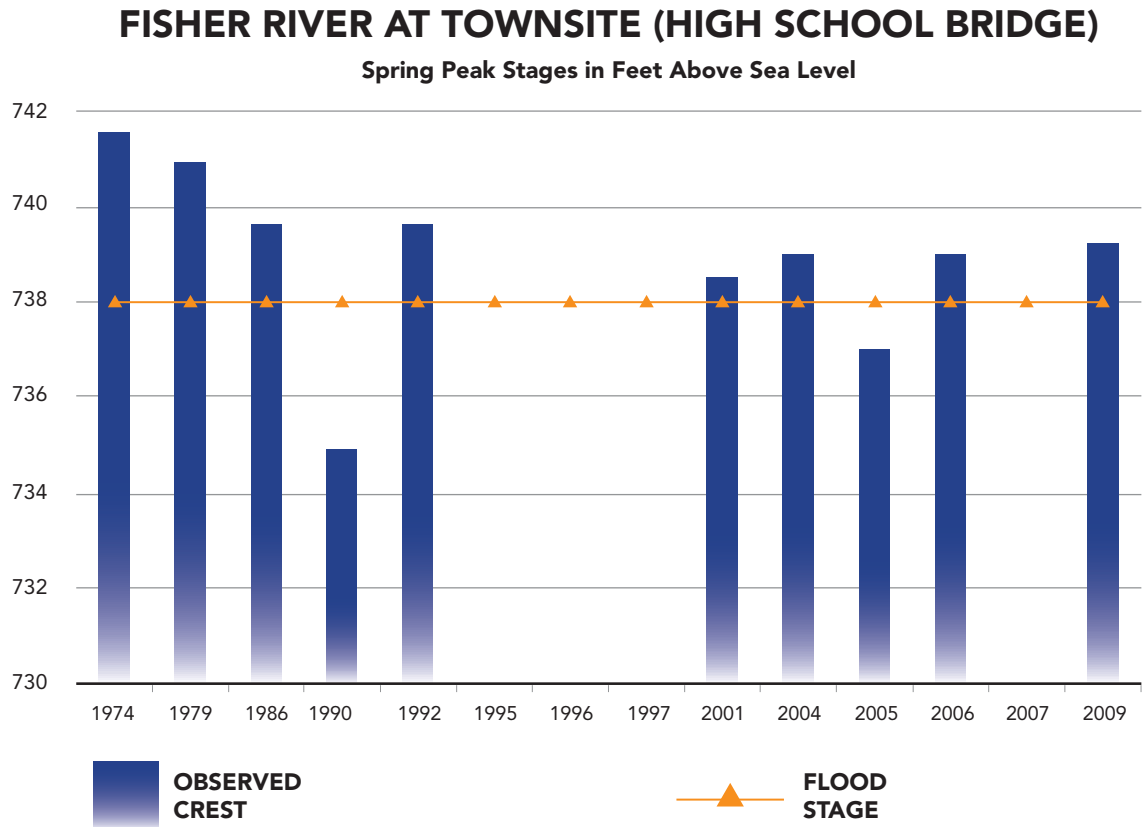


Figure 16

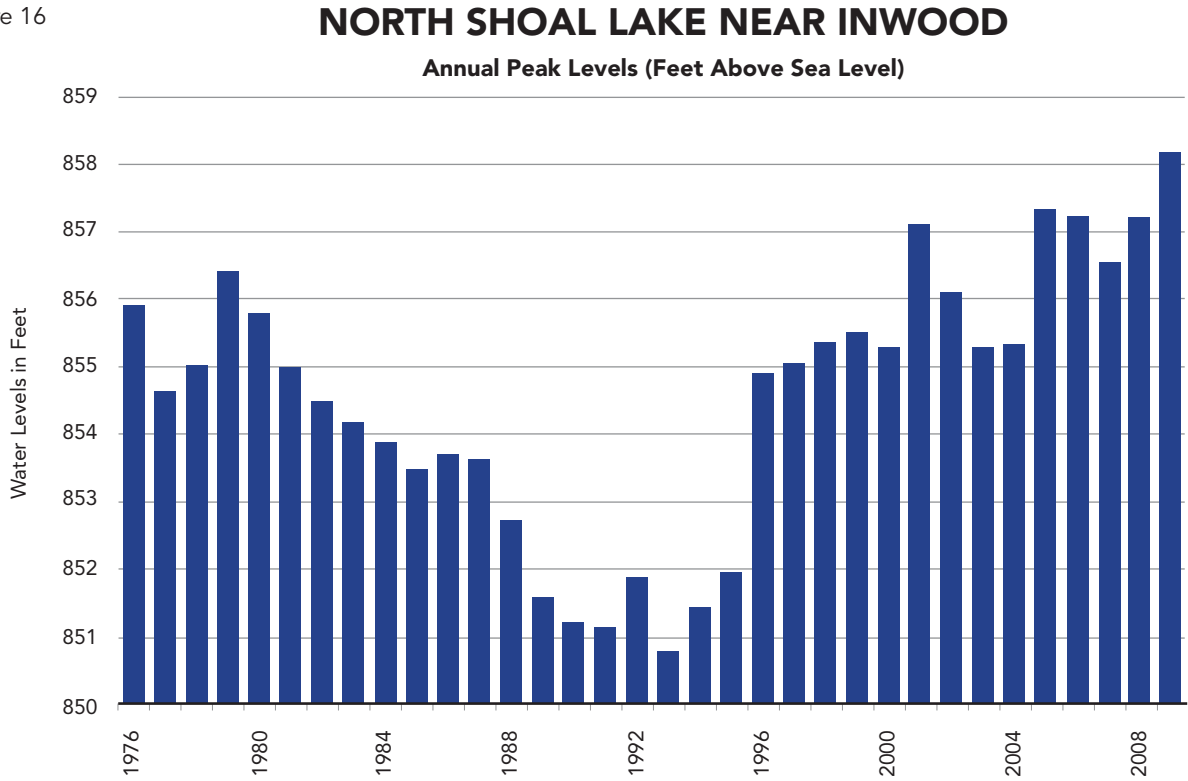


Figure 17

