98|16

Operation of Flood Control Works
in the
1997 Red River Flood

A Review of Material Presented
to the
Manitoba Water Commission

by the
Department of Natural Resources

June 30, 1998

Operation of Flood Control Works
in the
1997 Red River Flood

- Overview of flood control works - Steve Topping
- Shellmouth Reservoir - Jim Smithson
  - Description & operating rules
  - 1997 operation
- Portage Diversion - Eugene Kozera
  - Description & operating rules
  - 1997 operation
- Lake Manitoba Impacts - Steve Topping
- Red River Floodway - Eugene Kozera
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- Flood Forecasting - Alf Warkentin
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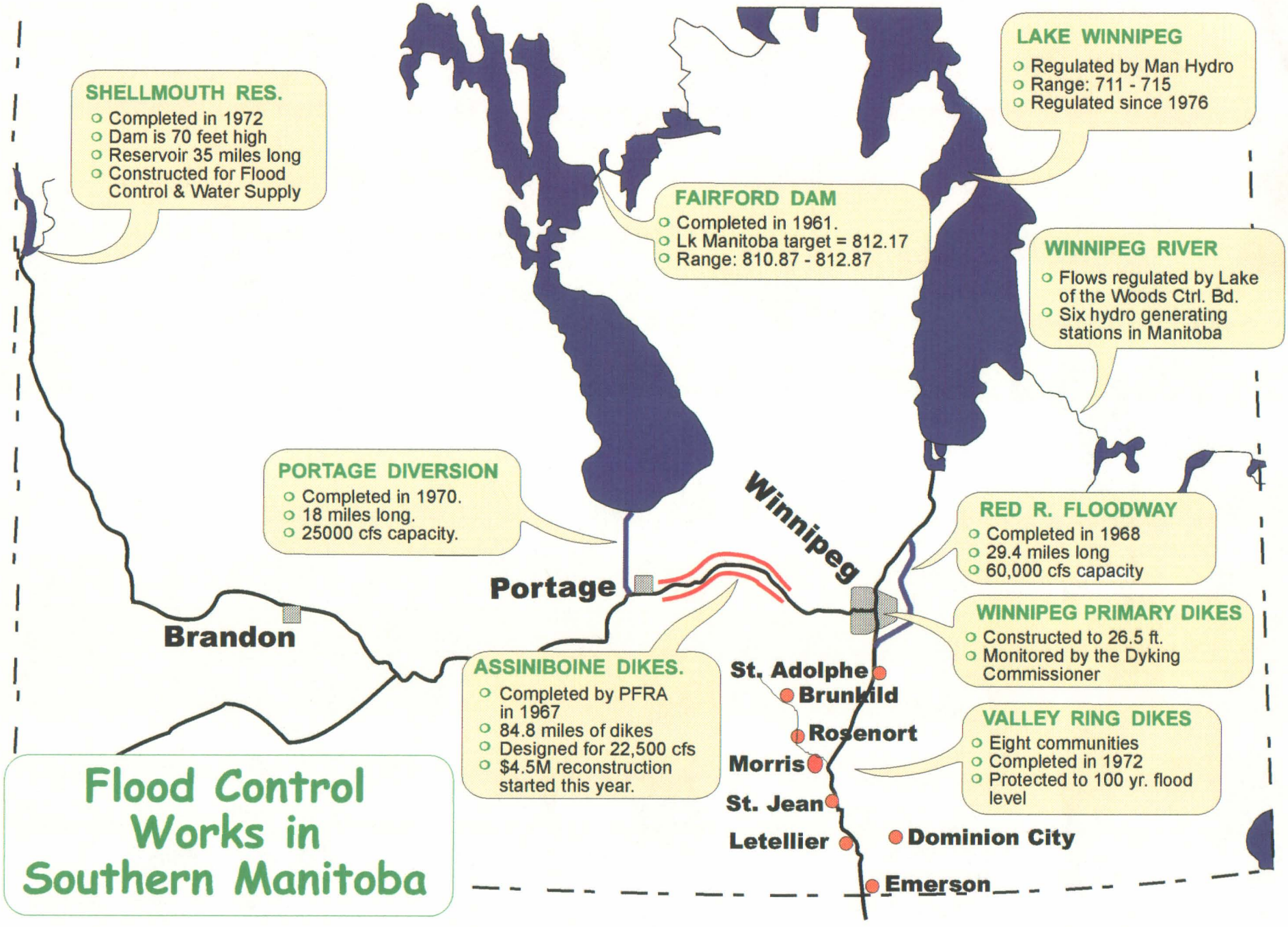
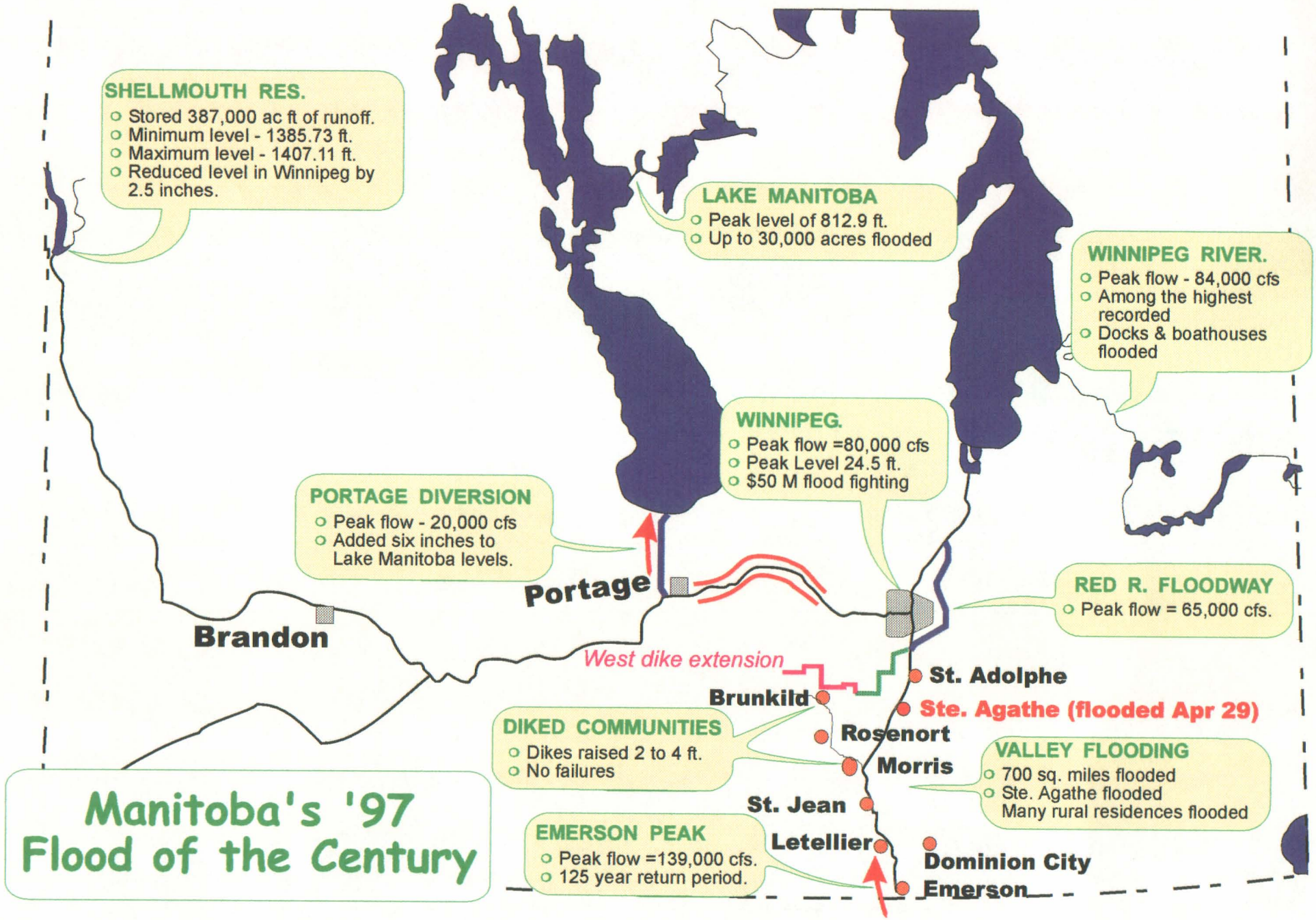
- 1997 operational considerations - Rick Bowering
  - West dike extension
  - impact on Grande Pointe & Ste. Agathe
- Red River Valley Designated Flooded Area - Ron Bryer
- Wrap up/ further actions

- Overview of flood control works - Rick Bowering


SHELLMOUTH RES.
Completed in 1972
Dam is 70 feet high
Reservoir 35 miles long
Constructed for Flood Control & Water Supply
LAKE WINNIPEG
Regulated by Man Hydro
Range: 711 - 715
Regulated since 1976
FAIRFORD DAM
Completed in 1961.
Lk Manitoba target = 812.17
Range: 810.87 - 812.87
WINNIPEG RIVER
Flows regulated by Lake of the Woods Ctrl. Bd.
Six hydro generating stations in Manitoba
PORTAGE DIVERSION
Completed in 1970.
18 miles long.
25000 cfs capacity.
Winnipeg
RED R. FLOODWAY
Completed in 1968
29.4 miles long
60,000 cfs capacity
Portage
Brandon
WINNIPEG PRIMARY DIKES
Constructed to 26.5 ft.
Monitored by the Dyking Commissioner
ASSINIBOINE DIKES.
Completed by PFRA in 1967
84.8 miles of dikes
Designed for 22,500 cfs
$4.5M reconstruction started this year.
St. Adolphe
Brunkild
Rosenort
Morris
St. Jean
Letellier
Dominion City
Emerson
VALLEY RING DIKES
Eight communities
Completed in 1972
Protected to 100 yr. flood level
Flood Control Works in Southern Manitoba


SHELLMOUTH RES.
Stored 387,000 ac ft of runoff.
Minimum level - 1385.73 ft.
Maximum level - 1407.11 ft.
Reduced level in Winnipeg by 2.5 inches.
LAKE MANITOBA
Peak level of 812.9 ft.
Up to 30,000 acres flooded
WINNIPEG RIVER.
Peak flow - 84,000 cfs
Among the highest recorded
Docks & boathouses flooded
WINNIPEG.
Peak flow =80,000 cfs
Peak Level 24.5 ft.
$50 M flood fighting
PORTAGE DIVERSION
Peak flow - 20,000 cfs
Added six inches to Lake Manitoba levels.
Portage
Brandon
RED R. FLOODWAY
Peak flow = 65,000 cfs.
West dike extension
St. Adolphe
Brunkild
Ste. Agathe (flooded Apr 29)
DIKED COMMUNITIES
Dikes raised 2 to 4 ft.
No failures
Rosenort
Morris
VALLEY FLOODING
700 sq. miles flooded
Ste. Agathe flooded
Many rural residences flooded
St. Jean
EMERSON PEAK
Peak flow =139,000 cfs.
125 year return period.
Letellier
Dominion City
Emerson
Manitoba's '97
Flood of the Century

- Shellmouth Reservoir - Jim Smithson
  - Description & operating rules
  - 1997 operation

FACTS ABOUT SHELLMOUTH DAM AND RESERVOIR

- Located on Assiniboine River near Russell, several miles from Manitoba-Saskatchewan Boundary (Fig. 1).
- Construction between 1965 and 1969 at cost of $10.8 m.
- Operational since 1970.
- Reservoir is 35 miles long with a maximum depth of 40 feet.
- Top of dam elevation 1427.5 feet.
- Spillway crest elevation = 1408.5 feet.
- Storage at spillway crest = 387,000 acre-feet.
- Conduit maximum discharge capacity 7000 cfs.

MAIN PURPOSES AND BENEFITS OF DAM AND RESERVOIR

The Shellmouth Dam and Reservoir was developed as a multi-purpose facility. The project was developed primarily for flood control benefits to Brandon and Winnipeg, and for water supply for a number of uses from the Assiniboine River. Supplementary benefits of the project include flood control to agricultural land and residential property in the Assiniboine River Valley from the Shellmouth Dam to Winnipeg, a substantial fisheries value on the reservoir, and recreational uses associated with the reservoir.

1997 SPRING SHELLMOUTH RESERVOIR OPERATION

- Runoff commenced in mid April.

- The inflow sources were:
  - Assiniboine River at Kamsack 70%
  - Shell River 19%
  - Local runoff 11%

- Shellmouth Reservoir at 1385.73 feet at the start of runoff (historic low).

- Shellmouth Reservoir reached a peak level of 1407.10 feet (21.4 foot increase in water level).

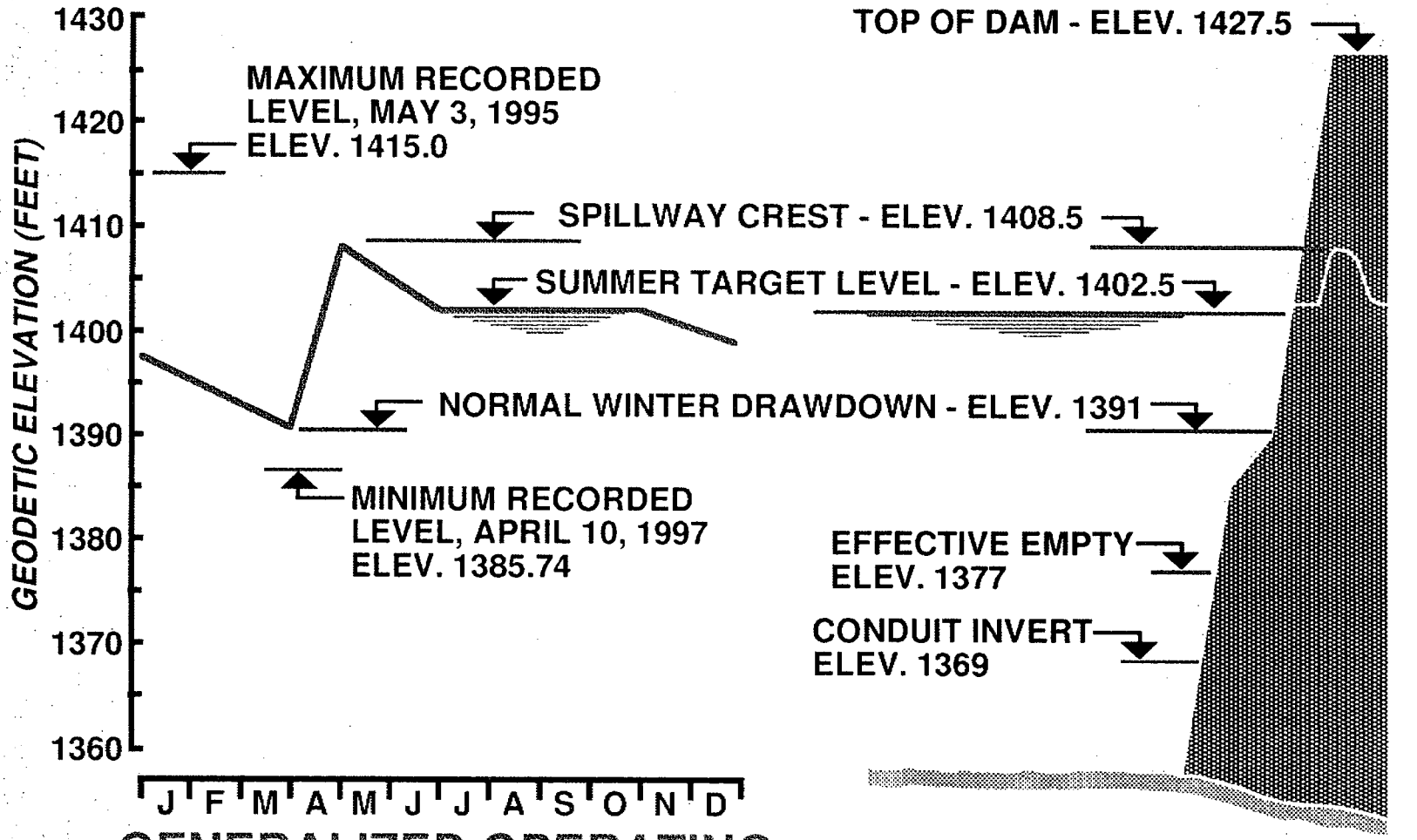
- The total inflow into Shellmouth Reservoir was 360,000 acre-feet.

- Shellmouth Reservoir stored 254,000 acre-feet of water (70% of the total spring inflow). Peak flow on the river at the Reservoir was reduced from 10,600 cfs to 1,650 cfs.

- At Russell, the peak flow was reduced by 8,300 cfs (from 10,200 to 1,870 cfs) a reduction of about 10 feet in stage.

- At St. Lazare, the peak flow was reduced by 7,000 cfs (from 12,000 to 5,000 cfs) as reduction of about 4 feet in stage.

Manitoba
Natural Resources



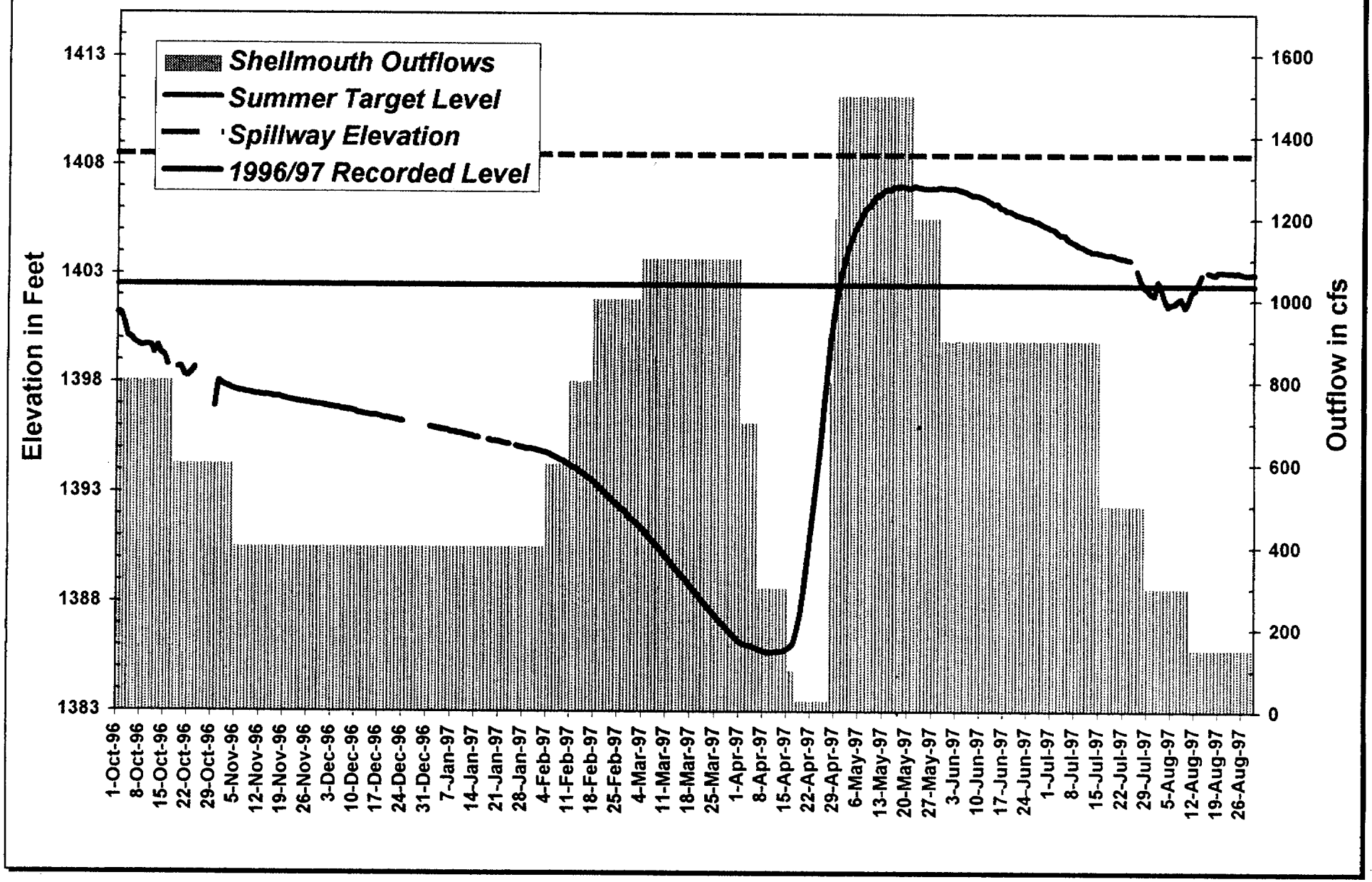
GENERALIZED OPERATING LEVELS

DAM CROSS-SECTION

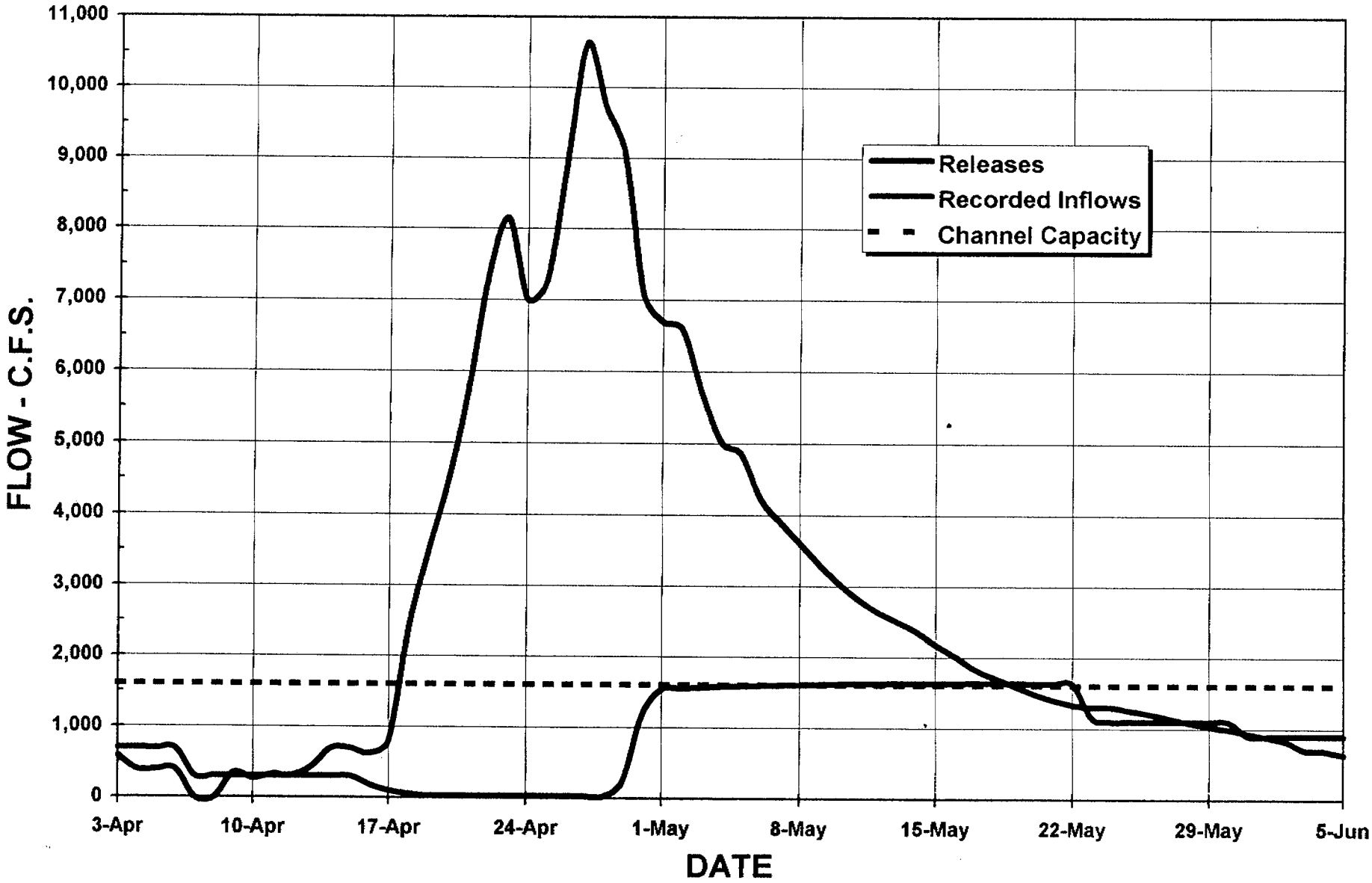
DECISION-MAKING PROCESS

- Prepare inflow forecast (10%, 50%, 90%)
- Reservoir Routings (various outflow scenarios)
- Internal Consultations (river conditions, flooding, water supply)
- Input from Shellmouth Reservoir Regulation Liaison Committee re operating options
- WRB makes final decision

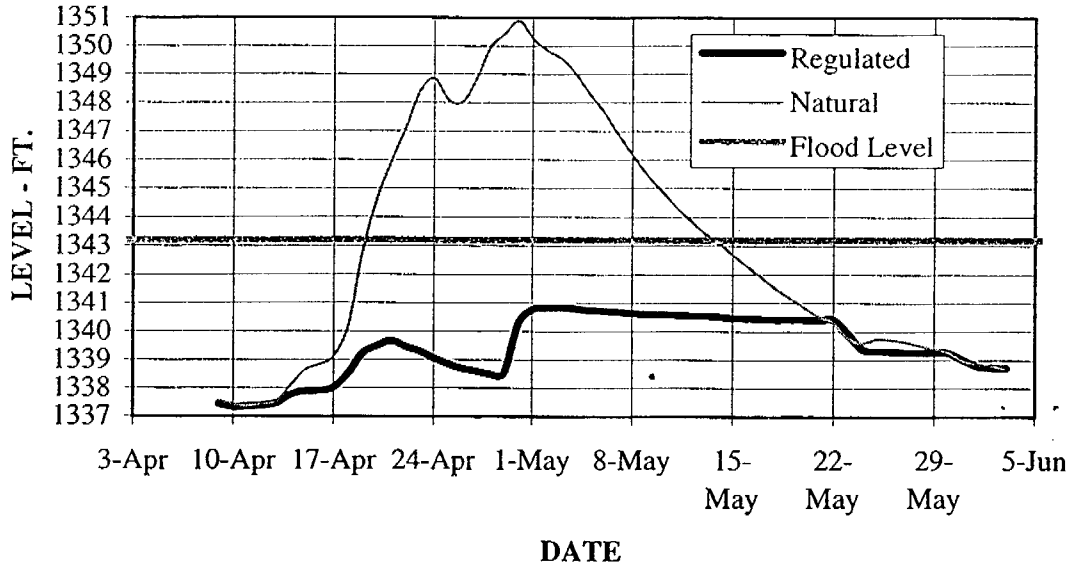
1996/1997 Shellmouth Operation



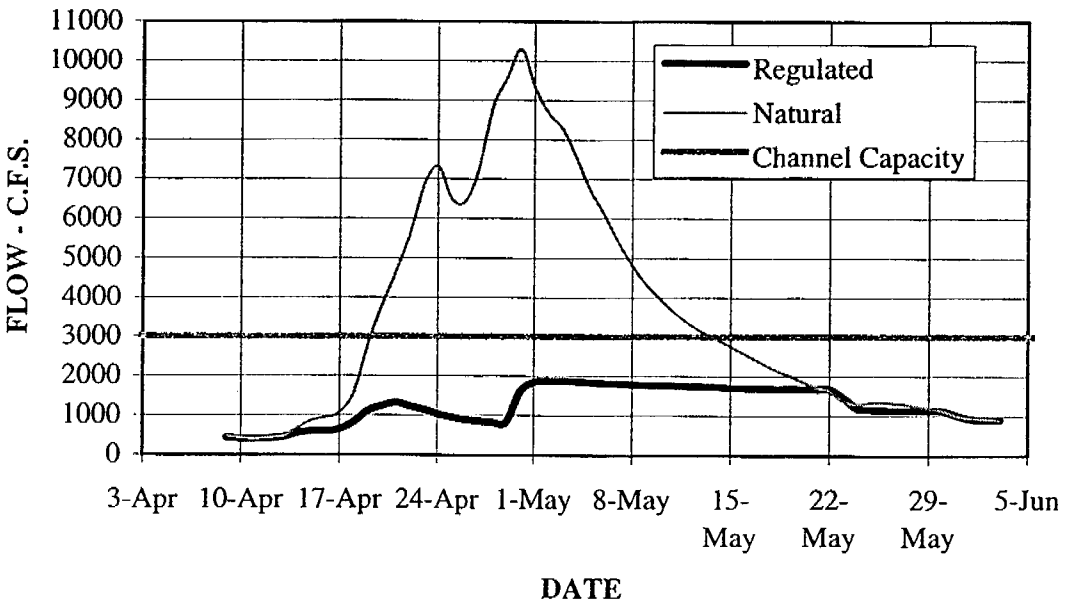
ASSINIBOINE RIVER AT SHELLMOUTH DAMSITE
DAM RELEASES AND RECORDED INFLOWS
1997



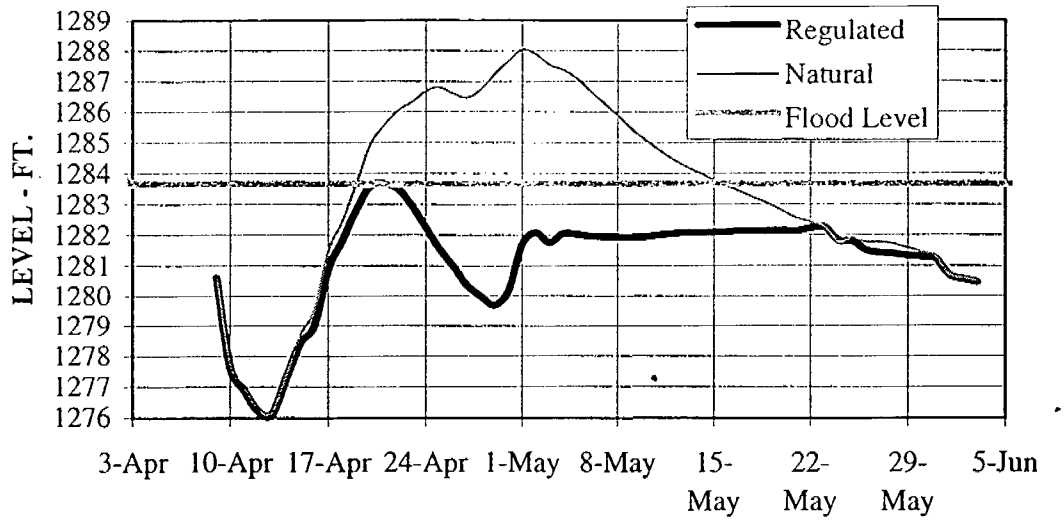
ASSINIBOINE RIVER NEAR RUSSELL REGULATED AND NATURAL LEVELS 1997



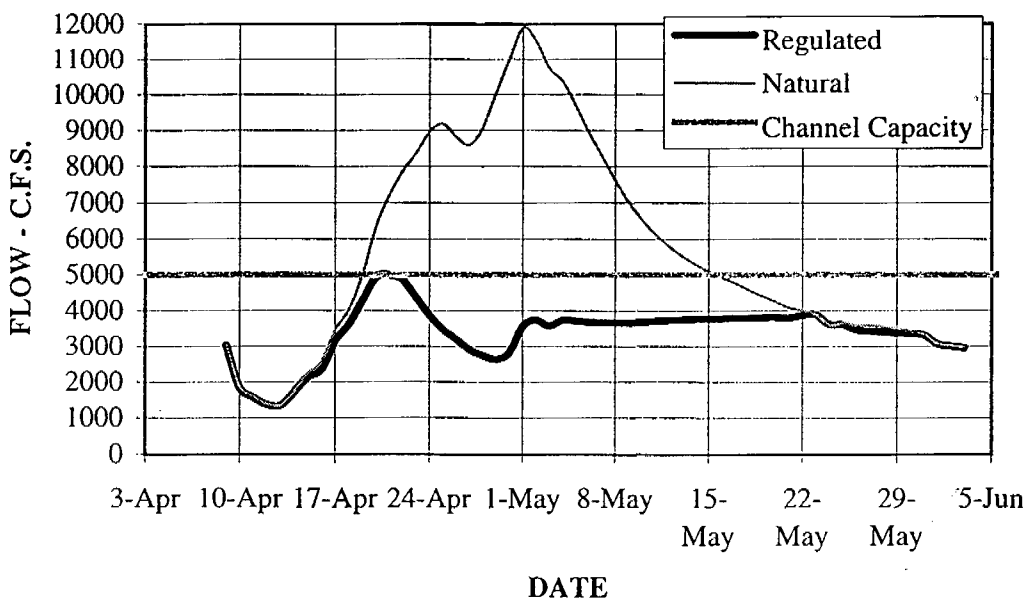
ASSINIBOINE RIVER NEAR RUSSELL REGULATED AND NATURAL FLOWS 1997



ASSINIBOINE RIVER AT ST. LAZARE REGULATED AND NATURAL LEVELS 1997



ASSINIBOINE RIVER AT ST. LAZARE REGULATED AND NATURAL FLOWS 1997



SHELLMOUTH DAM AND RESERVOIR

OPERATING GUIDELINES

Mission Statement:

To operate the Shellmouth Dam and Reservoir as a multi-purpose facility to optimize the long-term social and economic benefits for all Manitobans.

Purpose:

The Shellmouth Dam and Reservoir was developed to relieve the flood threat and to ensure a sufficient water supply along the Assiniboine River in Manitoba. At the same time, other uses are made of the water controlled by the dam which result in a number of constraints that affect operating decisions. These uses include provision of municipal water supplies for the cities of Brandon and Portage la Prairie, cooling for thermal electric generation, irrigation, stockwatering, sewage effluent dilution and enhancement of recreation and fisheries both on the Shellmouth Reservoir and along the river between the reservoir and Winnipeg. Within the current operating regime, some discretionary variation is possible to meet the various interests at specific times. Since some of the operational demands are conflicting and some are compatible, the operation of the reservoir must be carried out in such a manner as to optimize the benefits and minimize conflicts to all those affected.

Operating Guidelines:

The generalized operating guidelines which have been developed to ensure that the reservoir can provide reasonable levels of both flood protection and water supply capability are indicated on Figure 1:

1. The reservoir is gradually lowered over the fall and winter period to provide flood storage capacity for the spring runoff which usually begins around the end of March. The winter drawdown target level is somewhat variable, dependent upon the spring inflow forecast. The original operating rule was to draw the reservoir down to a fixed winter target level of about 1391.0 feet. However, with improved probabilistic forecasting techniques the reservoir may now be lowered well below this point to increase flood storage capacity, or held well above this point to increase the likelihood that the available runoff will provide sufficient storage for water supply and recreational use during the summer period.

2. During spring runoff, primary consideration is to control reservoir outflows to minimize downstream flooding. Excess inflows are stored in the reservoir until the water level nears the spillway crest elevation of 1408.5 feet. If inflow forecasts indicate that the spillway will be overtopped, outflows will be increased sooner, so as to minimize the eventual peak outflow. The intent is to minimize overbank flooding along the river below the dam and during flood periods to keep outflows to a value no greater than what the river flow would have been without

the dam in place. At present, an attempt is made to maintain outflows to a maximum of about 1600 cfs to prevent localized flooding and facilitate land drainage.

3. After spring runoff, reservoir levels are gradually lowered by conduit releases to a summer target level of about 1402.5 feet to optimize recreational and fishery conditions. The reservoir level may be held a few feet above this point to reduce the chances of water supply shortages when summer drought conditions are anticipated.

4. In the event of summer rainfall floods the available reservoir storage above the target summer level of 1402.5 feet is used to reduce downstream flow rates and minimize flooding. Outflows are increased if the level exceeds 1405 feet in order to reduce flooding of recreation facilities and to minimize the chance of overtopping the spillway.

5. During normal summer operation, primary consideration is to make reservoir releases to meet water allocation commitments to downstream licensed users and domestic users and to meet instream flow needs. Reservoir release rates are dependent upon the prevailing inflow rates, long-term inflow forecasts, and downstream tributary flows and water demands. Reservoir release rates are varied throughout the year to meet a minimum target instream flow for 25 cfs immediately below the dam and 200 cfs at Headingley. Consideration must also be given to other factors such as travel time of Shellmouth Reservoir releases and maintaining an adequate reservoir level for recreational and fishery purposes.

Procedures:

General seasonal operation strategies for the reservoir are planned about three times per year - once in late fall for the winter drawdown period, once in late winter in preparation for the impending spring runoff, and once in late spring for summer water supplies after the spring runoff period is over. These seasonal strategies are based largely on runoff forecasts and past experience, acknowledging the risks associated with the possibility that extreme conditions may rapidly develop.

While operation strategies set out the ideal operation scenario, the actual operations follow regular updates on hydrologic conditions and forecasts. These updates are done monthly from November to March, weekly or daily during spring runoff, and following major rainstorms during the summer.

- Portage Diversion - Eugene Kozera
  - Description & operating rules
  - 1997 operation

Note: Also included are Mr. Kozera's speaking notes

Portage Diversion

➢ **Map of major flood control works**

- The Portage Diversion is one of three major flood control works protecting the City of Winnipeg.

➢ **Map of Portage Diversion**

- The Portage Diversion consists of three components.

➢ **Channel (aerial)**

- The first component is the Diversion channel, which carries a portion of the Assiniboine River flood waters to Lake Manitoba.
- The channel consists of an excavated channel with dykes on both sides
- The channel is 18 miles long. Its width varies from 175 feet to 1,200 feet, with an average width of 600 ft.
- The channel's capacity is near 25,000 cfs.

➢ **Failsafe (aerial)**

  - However, at its north end, at Delta Marsh, the west dyke has a low section that acts a spill section at higher flows; this section is called a failsafe. At about 15,000 cfs water flows over this spill section into Delta Marsh.
  - When water flows over this spill section, the Marsh as well as some adjacent farmland is negatively affected.

➢ **Drop #1 (aerial)**

- There is a drop of over 55 ft. in the 18 miles of the channel. To keep the water velocities down to acceptable levels, three concrete drop structures were constructed along the length of the channel.

➢ **Drop#1 (ground level)**

➢ **Outlet (aerial)**

- One of the drops is at the outlet of the diversion channel into Lake Manitoba.

➢ **Dam and reservoir area, with much flow in diversion (aerial, looking north)**

- The second component is the diversion dam.
- It is located at the upstream end of the diversion channel.

➢ **Diversion Dam, side view (aerial)**

- It holds the gates that control how much water flows into the diversion channel.
- This control function is done by 4 vertical lift gates, 40 ft. wide and 14.5 ft. high. As the gates are raised, the flow down the diversion increases.

➢ **Dam and reservoir area, with little flow in diversion (aerial)**

- The third component is the spillway dam located on the Assiniboine River, just east (ie. downstream) of the entrance of the diversion channel.

➢ **Spillway dam, looking upstream (aerial)**

- This dam creates a reservoir covering about 1,600 acres.
- During the summer and fall, the reservoir is kept at elevation 869 ft.; its maximum depth is over 20 ft.. Over winter, it's kept at 855 ft.

➢ **Gates, no flow over (close-up)**

- Within this dam is a concrete control structure with 2 Bascule fish-belly type gates 13 ft. high by 75 ft. wide.

➢ **Spring flow over gates (ground level)**

- During the spring they are raised and lowered to control the amount of water flowing down the Assiniboine River. During the summer, they are usually left alone in their full-raised position, and no water flows over them.

➢ **Flow thru centre pipe**

- In the centre pier of the control structure is a gated pipe which allows for summer-time releases when the Bascule gate is fully raised.
- In the structure there are two pipes for Portage la Prairie's water supply.

➢ **Meanders upstream (b&w aerial photo)**

- Operation of the Portage Diversion structures during the early part of spring is, in some years, greatly complicated by ice jams on the Assiniboine River west of the structures.
  - Large ice jams occur at several locations; large quantities of water and ice pile up, and when the jam breaks, a slug of water and ice flows downstream, into the Portage reservoir.

➢ **Ice in reservoir, in front of Spillway Dam**

- When this slug of ice and water enters the Portage reservoir, some of the water is stored but usually the volume of water is large and much flows down the Diversion channel and/or over the Spillway gates.

➢ Ice in reservoir, in front of Diversion Dam

- Regarding the ice flowing in from upstream, the sheet of ice in the reservoir does act as a barrier to the upstream ice. Depending on the year, this barrier keeps most of the upstream ice from flowing further downstream on the river, or down the Diversion channel. In other years, signficant quantities of ice do flow down the river and/or channel. Then, ice jamming in the river or in the channel or where the channel enters Lake Manitoba can happen. Ice jamming on the river can cause flooding of adjacent property. Ice jamming on the diversion or on the Lake can reduce the diversion channel's capacity.

❖ "Portage Diversion Operation Rules and Objectives"

- There is only one rule: the maximum flow on the diversion channel is 25,000 cfs.
- There are a number of objectives. The main objective is to keep water levels in Winnipeg at James Avenue below 17 ft. or 18 ft.
- Secondary objectives are:
  - Keep flows on the diversion channel below 15,000 cfs, so that the failsafe is not overtopped.
  - When there is ice on the Assiniboine River east of the Spillway Dam, keep flows in the river below 5,000 cfs. This is to reduce the chance of ice jams east of Portage.
  - When there is no longer ice on the Assiniboine River east of the Spillway Dam, keep flows in the river below 10,000 cfs, to minimize agricultural damages and damage to the dykes along the river.
  - Keep water levels on Lake Manitoba below 812.87 ft.
  - Keep the daily water level changes in the Assiniboine River east of Portage below 0.5 ft., to minimize bank and dyke slumping.

1997 Operation

❖ **Hydrograph**

- The large ice jams that had developed on the Assiniboine River west of Portage broke on April 19 and 20. Large volumes of water along with large quantities of ice flowed into the Portage Reservoir.

- The structures were operated to minimize the amount of ice and water released down the Assiniboine River, to minimize the chances of ice jams and flooding along the river east of Portage.

- A fairly significant amount of ice was released down the Diversion channel The ice could not be contained/stored in the Reservoir area; allowing it to flow down the channel was the lesser of the two evils.

- Virtually no ice jamming occured in the Diversion channel. A relatively large jam occurred on the Lake Manitoba ice, where the channel outlets into the lake. Holes had been drilled in the lake ice, for the first time ever, but the area of drilling was too small. This ice jam on the Lake caused a backwater up the channel, reducing its capacity. The large flows down the channel, in combination with this reduction in channel capacity, resulted in the failsafe being breached for nearly 2 days. The failsafe area was eroded away, as it always is when water flows over it. The ice jam on the Lake ice was blasted, and it broke up on April 21.

- For the next 7 days the flows in the Diversions channel were kept low enough so that repairs could be done on the failsafe area. We knew, from the forecasts, that we'd want to put well over 10,000 cfs into the channel in a few days, to minimize the amount of Assiniboine River water flowing into Winnipeg when the peak on the Red River occurred. If the repairs could be done in time, the failsafe would not have to be breached again, reducing the flood damages there.

- To enable the diversion channel to be repaired, the flows over the Spillway gates were kept over 5,000 cfs (which is the desirable maximum when there is ice on the river downstream) for a number of days. Considering the local inflows, flows were quite high for a number of days. Ice jams, with the resulting higher water levels, occurred on the Assiniboine River between Baie St. Paul and Winnipeg on April 24 to 26. The actual damages caused by these high water levels was quite small, although the high levels did cause, understandably, a lot of concern on the part of affected citizens. We speculate that these jams occurred because of the high flows on the Assiniboine River. A good portion of these flows was due to local runoff. It is entirely speculative if the jams would have occurred if the flows over the Portage Spillway had been cut back to zero. Of course, if that had been

done, water would have been flowing over the Portage Diversion channel failsafe for around 2 weeks, causing damage there.

- In the next phase, flows over the Spillway gates were reduced to near zero as the peak on the Red River hit Winnipeg.

- Then, as the water level in Winnipeg decreased, flows over the Spillway gates were increased, partly to keep water levels in Winnipeg from dropping too fast (the City geotechnical experts had expressed the fear that too fast of a drop would result in major bank and dyke failures) and partly in recognition of increasing Lake Manitoba levels.

- Roughly when the James Avenue water level hit 17 ft., the flows over the Spillway gates was increased and diversion flows were decreased, taking into account the Lake Manitoba objective.

PORTAGE DIVERSION OPERATION RULES AND OBJECTIVES

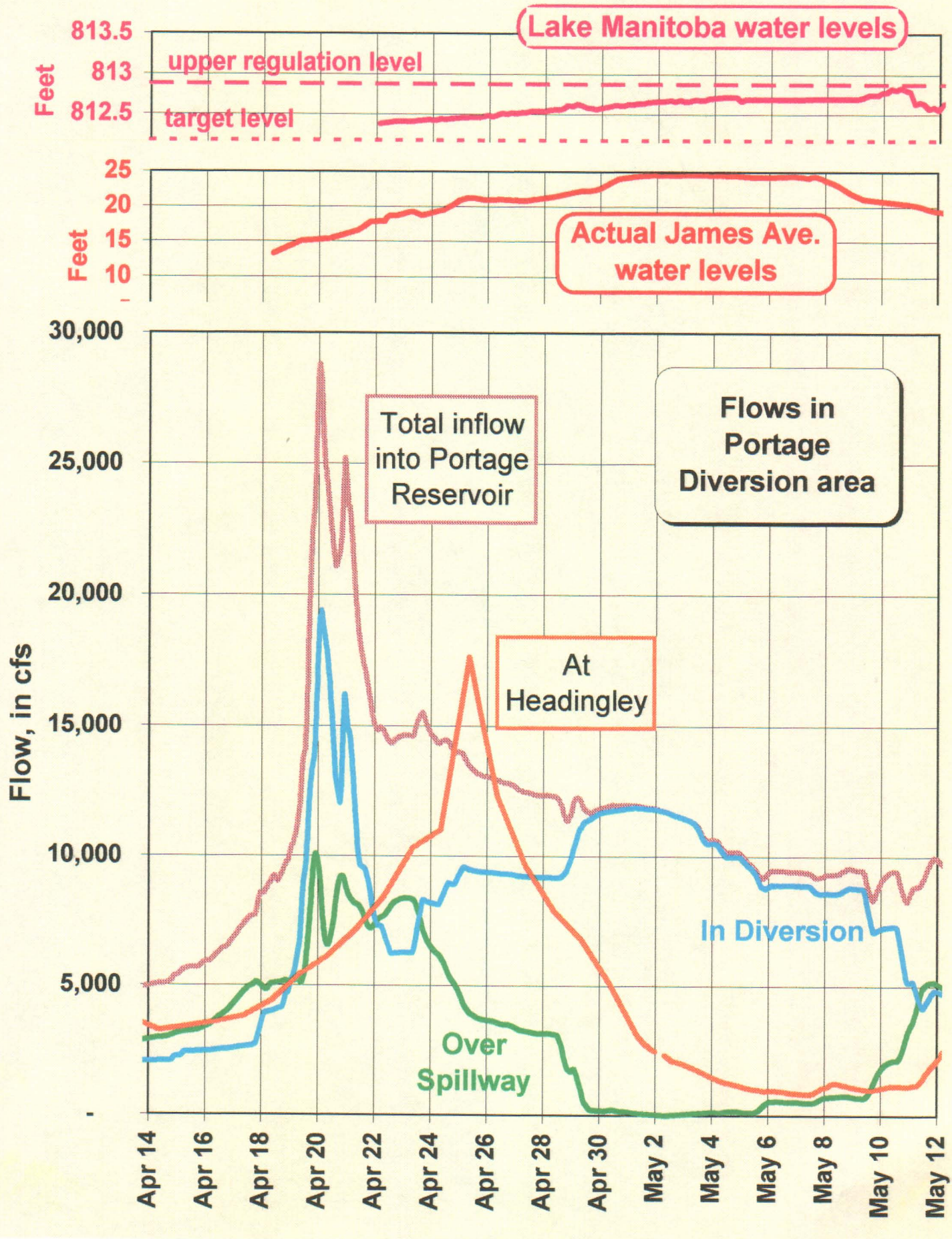
Rule:

- **maximum flow on the Diversion channel is 25,000 cfs**

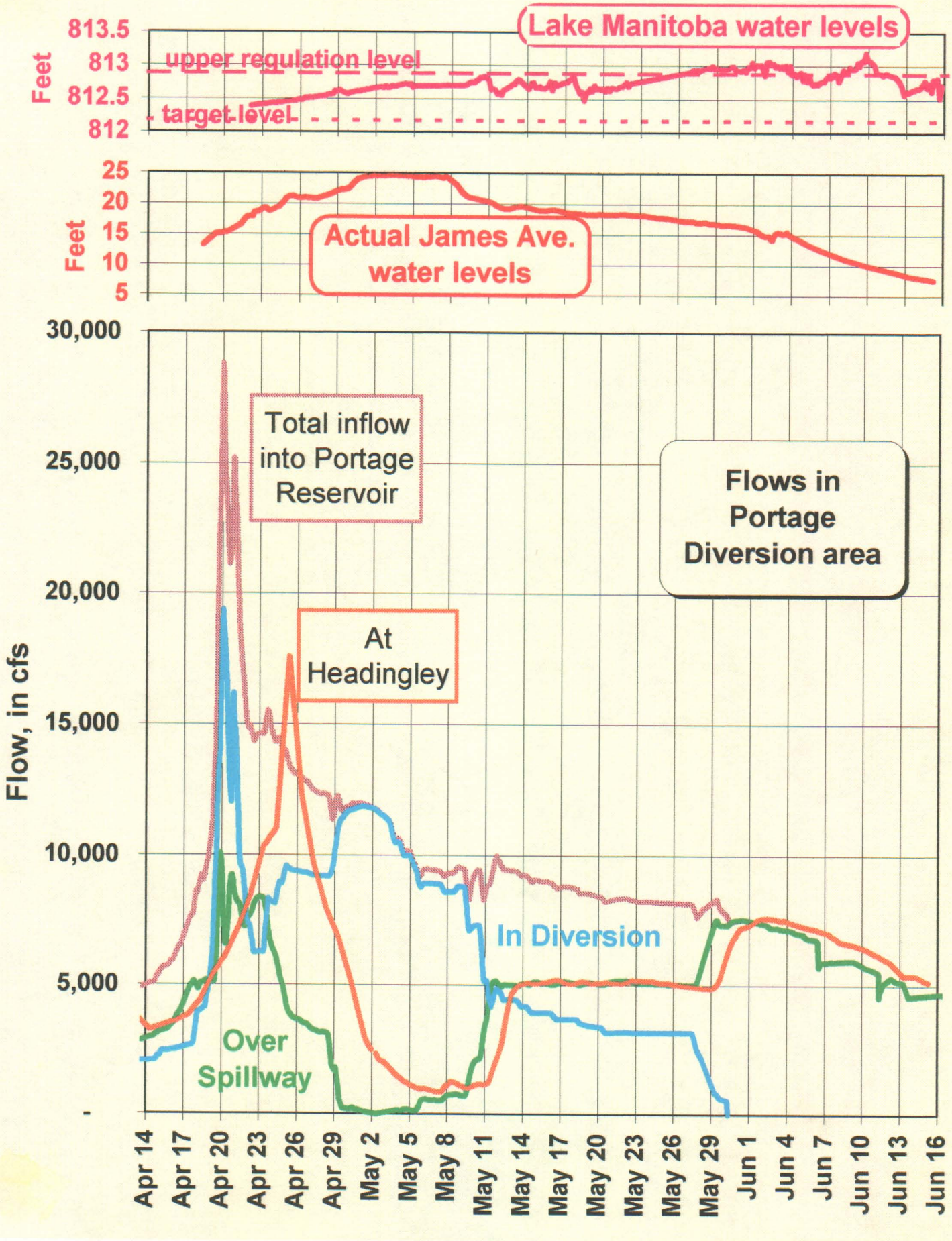
Objectives:

- **keep James Ave. levels below 17 or 18 ft.**
- ❖ **keep Div. channel Q below 15,000 cfs**
- ❖ **when there is ice on the Assiniboine R. e. of Portage, keep river Q's < 5,000 cfs**
- ❖ **when no ice, keep river Q's < 10,000 cfs**
- ❖ **keep L. Manitoba level below 812.87 ft.**
- ❖ **keep daily drops in Assiniboine R. levels east of Portage to 0.5 ft. or less**

1997 Flood: Portage Diversion



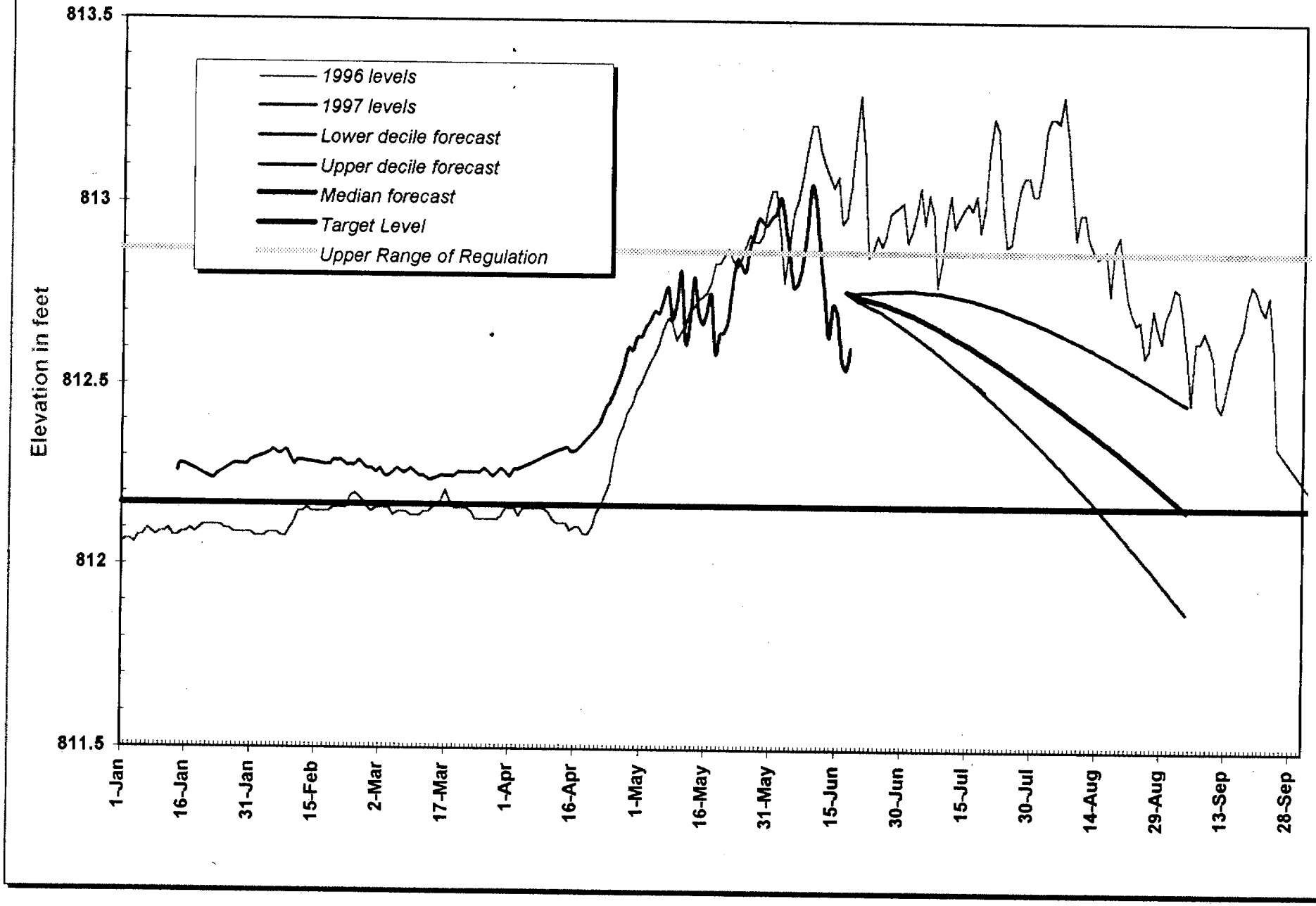
1997 Flood: Portage Diversion



- Lake Manitoba Impacts - Steve Topping

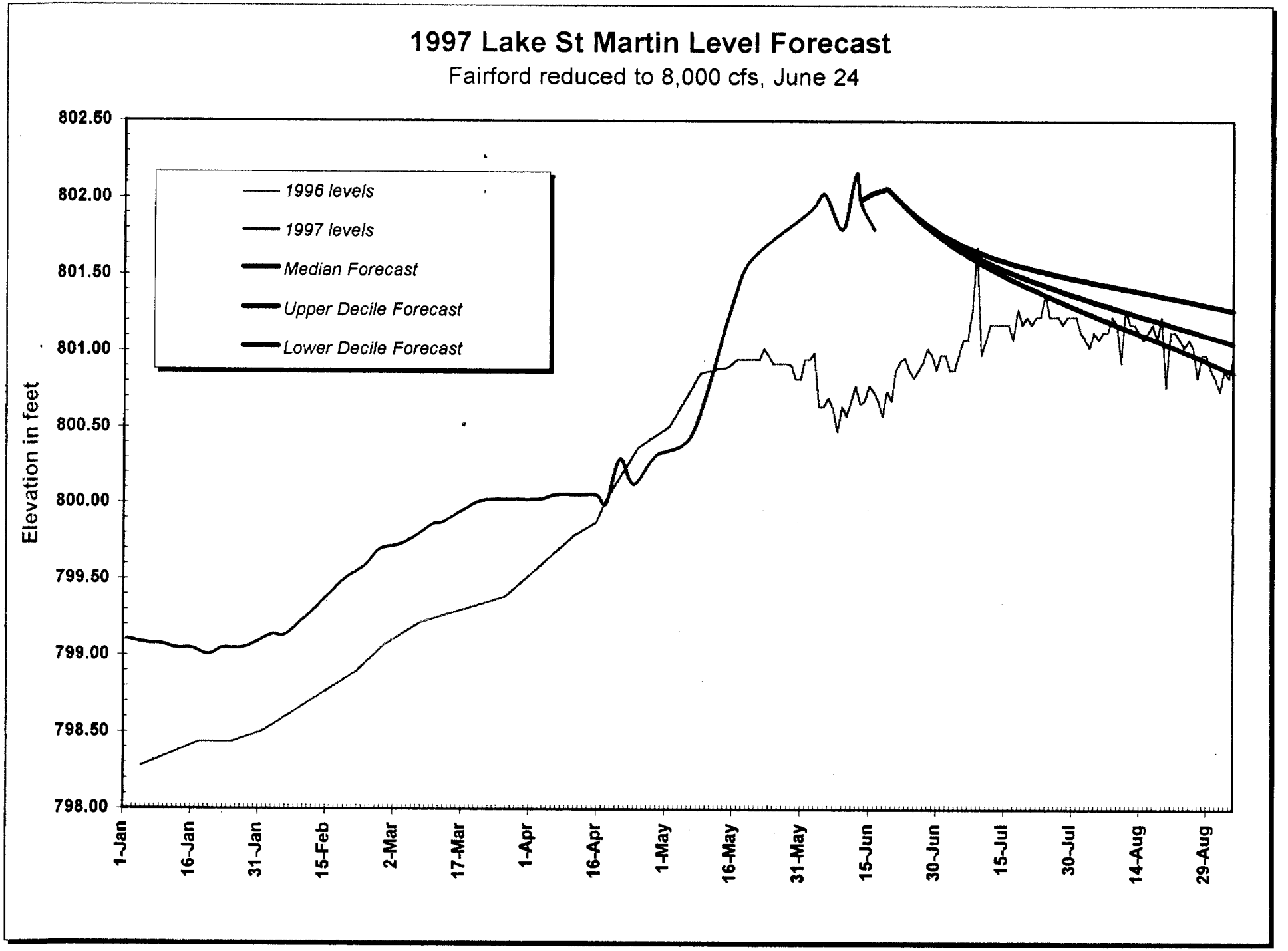
1997 Lake Manitoba Level Forecast

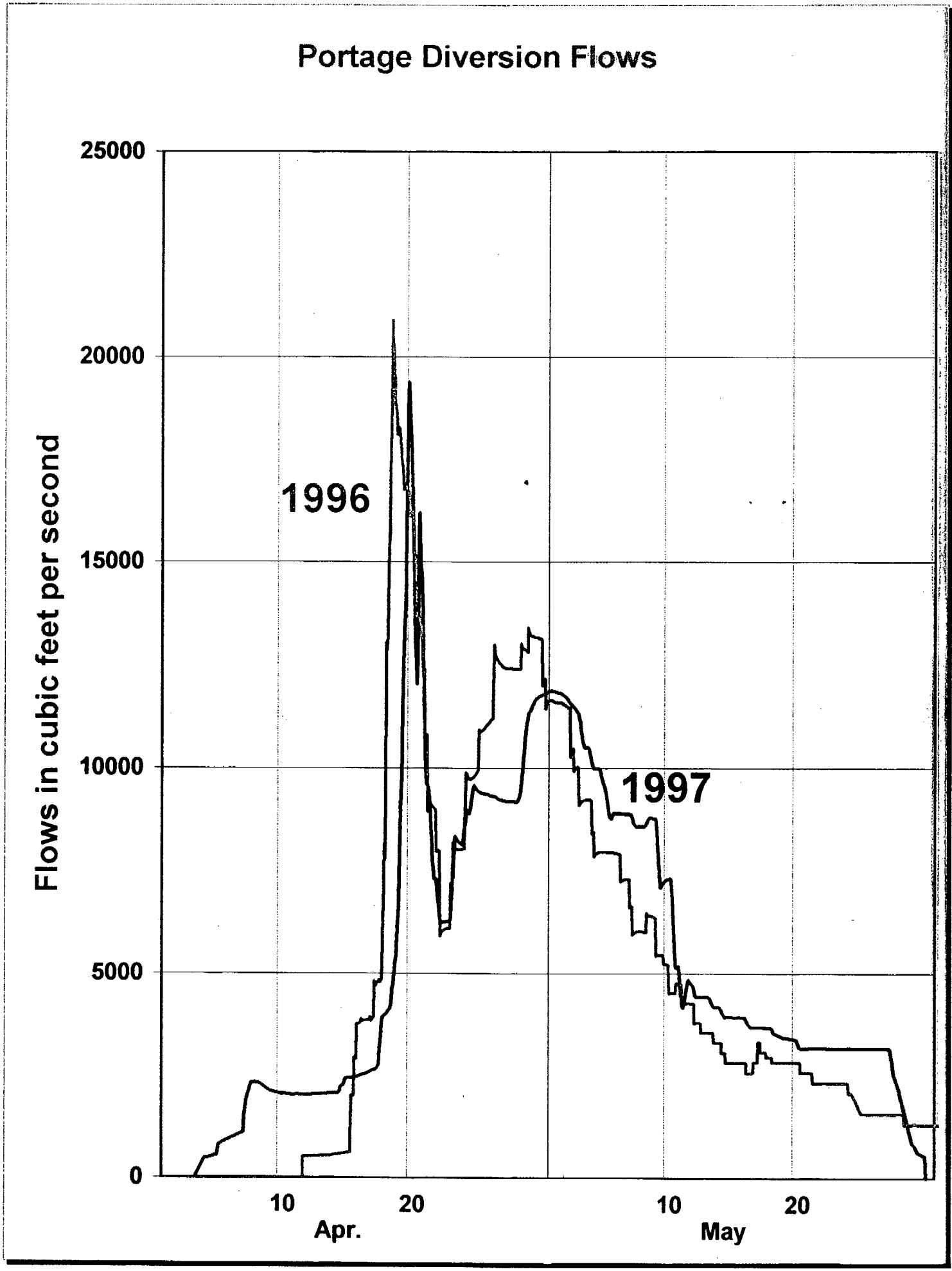
Fairford reduced to 8,000 cfs, June 24



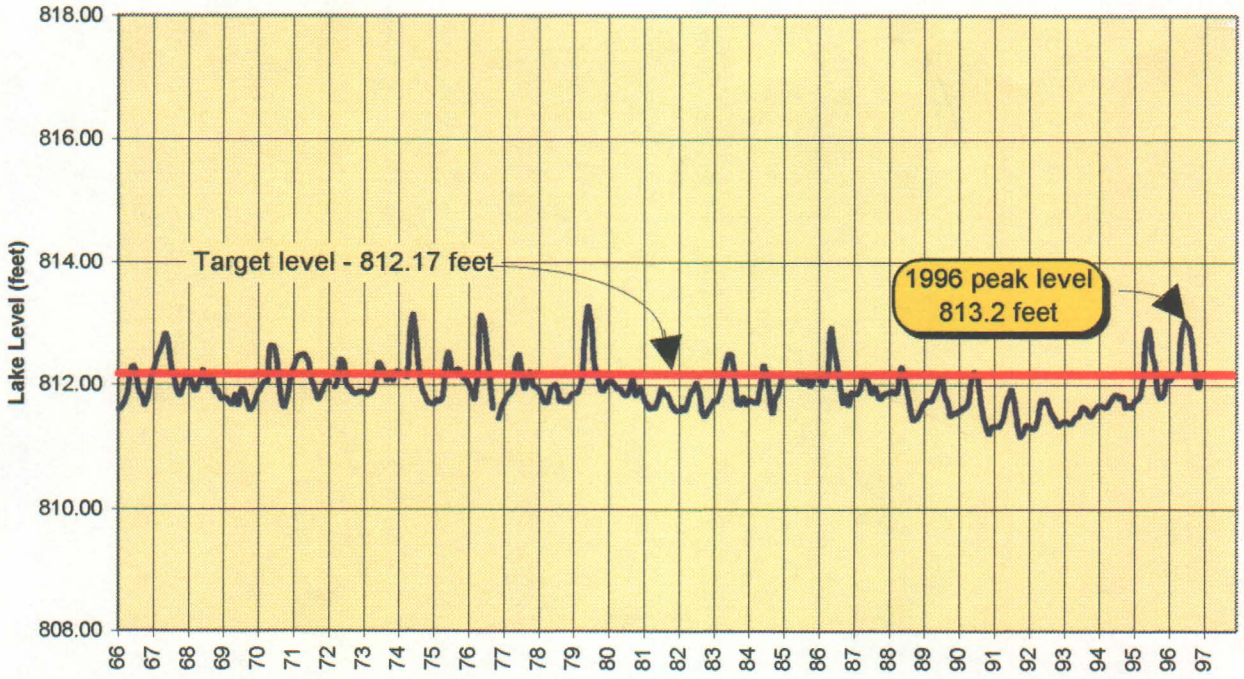
1997 Lake St Martin Level Forecast

Fairford reduced to 8,000 cfs, June 24

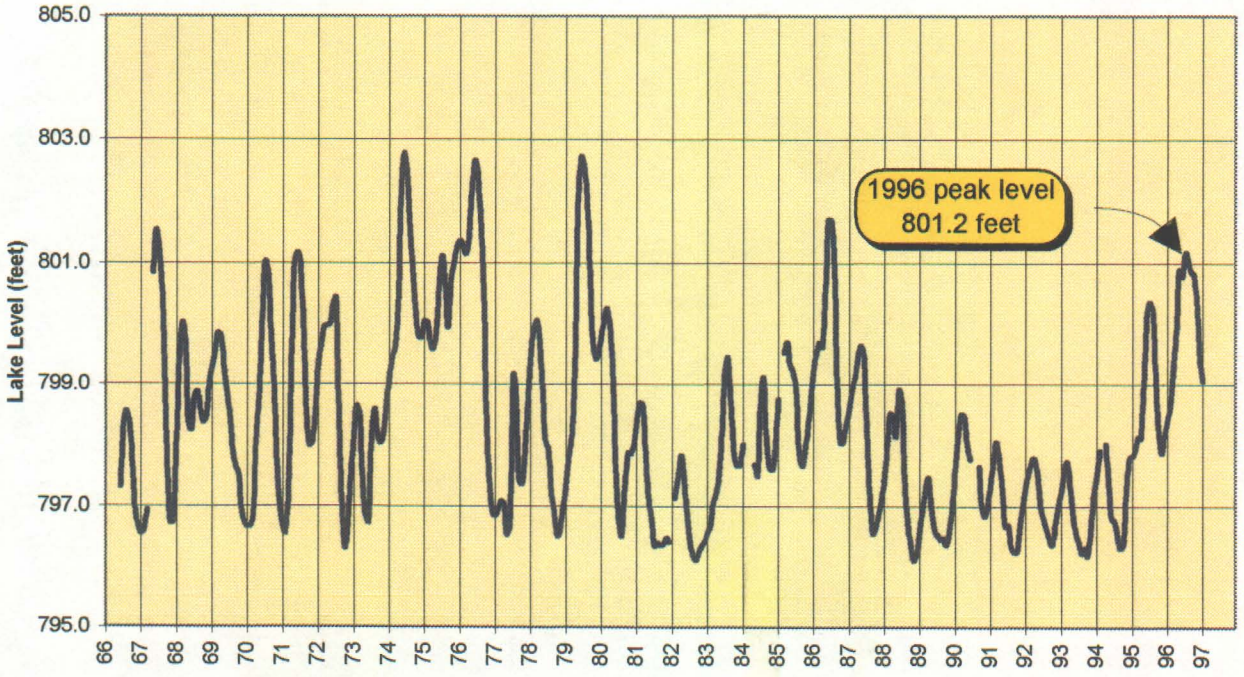



Portage Diversion Flows
Flows in cubic feet per second
25000
20000
15000
10000
5000
0
1996
1997
10
20
Apr.
10
20
May

Lake Manitoba Recorded Levels



Lake St. Martin Recorded Levels



- Red River Floodway - Eugene Kozera
  - Description & operating rules
  - 1997 operation

Note: Also included are Mr. Kozera's speaking notes

Red River Floodway

Channel

➢ **Map showing channel location**

- It runs for 29 miles from just south of St. Norbert to just north of Lockport.

➢ **Channel (aerial)**

- It is essentially a huge ditch, excavated out of the prairie east of Winnipeg; the bottom of this ditch is about 20 ft. above the bottom of the Red River.
- The average depth of the channel is 30 ft., but it gets up to 66 ft. deep going through the Birds Hill ridge.
- Its bottom width ranges from 380 ft. to 540 ft.; the topwidth ranges from 700 ft. to 1000 ft.
- At its northern end, not only soil but also some bedrock had to be excavated to create the channel.
- Well over half of the cost of the Red River Floodway was for excavating the channel.

➢ **Bridge (ground level)**

- 12 bridges (for highways and railways) were built to cross the floodway channel.

➢ **Lip: drawing (profile)**

- At the start, or southern end, of the floodway channel is a 7 foot high chunk of earth that is called a lip.
- This earth lip prevents river ice from entering the channel; ice in the channel could get jammed in the piers of the bridges, and significantly reduce the carrying capacity of the channel.

➢ **Outlet (ground view)**

- Where the floodway channel re-enters the Red River, just north of Lockport, is a concrete structure called the outlet structure.
- Its function is to ensure that the floodway water re-enter the Red River in such a way that does not cause erosion of the river bed and banks.
- Because the bottom of the floodway is about 20 ft. higher than the bottom of the river, without an outlet structure the floodway waters would plunge down into the river, causing much erosion.

➢ **Outlet (aerial)**

- But with the outlet structure in place, the floodway waters flow over the concrete rollway, into a stilling basin.
- The stilling basin absorbs the energy of this falling water, and the floodway waters can peacefully flow into the Red River.

West Dyke

➢ **West Dyke (aerial)**

- The second component of the Red River Floodway is the West Dyke.
- Its function is to keep flood waters on the west side of the Red River from entering Winnipeg.
- This dyke starts on the west bank of the Red River and runs west and south.
- When constructed in the 1960's, it ran 20 miles in length, ending about 11 miles west of Ste. Agathe.
- In 1997, because of the high river levels and the possibility of Red River water flowing into Wpg. around the West Dyke's western end, an additional 20 miles or so were added and the existing West Dyke was raised.

Inlet Control Structure

➢ **ICS (aerial, looking south)**

- The third component of the Red River Floodway is the Inlet Control Structure.
- It is located on the Red River just south of St. Norbert.
- Its function is to regulate the flood water levels on the Red River at the entrance of the floodway channel.

➢ **Gates down (drawing)**

- It does this via two gates.
- During low flows the gates sit at the bottom of the river, under 6 ft. of water.

➢ **Gates up (drawing)**

- But during flood flows, they are raised to regulate the upstream water levels.

➢ **Gates up during construction (north side)**

- The gates are each 112.5 feet long and 34.8 ft. high when fully raised.
- These heavy, large gates are housed in a huge concrete structure that exists for one reason and one reason only --- to hold the gates.

➢ **Gates up during construction (south side)**

- It is made up of over 100,000 yd3 of concrete, 85% of which is below the bottom of the river.
- It sits on bedrock.

➢ **ICS looking south (aerial)**

- Just downstream of the gates is a concrete flip bucket, which absorbs the energy of the flood waters as they pour over the gates.

- But why is it necessary to have the Inlet Control Structure, with gates that raise the upstream water level?
- This series of slides will illustrate the reason.

➢ "Why need gates?" : before flood works built

- In the first slide you see what a moderate flood on the Red River would look like.
- You can see that the water surface is near the top of the bank.
- This is the natural water surface for this flood.

➢ "Why need gates?" : with Floodway channel only

- In this next slide, a floodway channel has been constructed.
- You can see that the bottom of the entrance to the floodway channel is quite a bit higher than the river bottom, but it is low enough that quite a bit of water would flow into that channel.
- Since some water flows into that channel, less water flows down the Red River into Winnipeg.
- Therefore, the water level north of the floodway entrance is lower now.
- Immediately south of the floodway channel, the water level is much lower than it was under natural conditions, even though at this point the same amount of water is flowing as before the floodway channel was built.
- At this point just south of the floodway channel, the velocity of the river waters is now much higher than before the floodway channel was built.
- With these higher velocities, significant erosion of the river bed and banks would occur.
- This eroded material would be depositted somewhere downstream, where the water velocities are too low to carry the eroded material.
- This erosion and deposition, which would be very very significant in times of flooding, is the main reason why the floodway gates exist.
- Before we go the next slide, I'd just like to point out that, as you go further south, the water surface gets closer and closer to what it was under natural conditions.

➢ "Why need gates?" : with Floodway channel and gates

- On this next slide we see what happens when floodway control gates are installed and raised so that the water surface south of them is equal to the water surface under natural conditions.
- Two significant things happen.
- Firstly, with the water levels higher, the water velocity drops back down to what it was under natural conditions; erosion and deposition are no longer a problem.
- Secondly, since the water level at the floodway channel entrance is now much higher than without the gates, much more water can flow into the floodway channel; of course, this would result in much less water flowing into Winnipeg.

- Thus, installing and operating the floodway control gates does two things: it eliminates the erosion and deposition problem, and it provides much greater protection for Winnipeg; and it does this without increasing the water levels above natural conditions in the area south of the floodway.

➢ **"Why need gates?" : with water level lower because of Portage Diversion**

- This next slide shows the affect of diverting some water down the Portage Diversion.
- With this diversion, less Assiniboine River water enters the Red River in Winnipeg, so the water level on the Red River drops.
- You can see that with this gate setting, the water level on the Red River south of the control gates is below the natural water level.

➢ **"Why need gates?" : gates raised to compensate for Portage Diversion's affect**

- Thus, the control gates are raised a bit to make this water level at the natural level.

➢ **Floodway & Portage Diversion peak flows since 1968: chart**

- In the 30 years since the floodway was completed in early 1968, it has been used in 18 springs.
- It has never been used in the summer because water levels have never been high enough in the summer; in the summer of 1993 the water level on the Red River at James Avenue hit a record high for summer of about 16.5, but only a small amount of water trickled into the Floodway channel.

- **Red R. (at James Ave.) natural and actual water levels: chart**

- The flood control works for Winnipeg have had quite an affect on water levels on the Red River in a number of spring floods.
- For example, in the spring of 1979 the water level in Winnipeg without the flood control works would have been around 30 ft. (the same as in 1950); with the control works, the actual peak elevation was only 19.2.

- **Flood damages in Winnipeg, with and without flood control works: chart**

- This next slide shows this more concretely in terms of damages that actually did occur and what would have occurred if the flood control works did not exist.
- For example, in the 1997 flood, the damages without the flood control works would have been over $3 billion; in actual fact, it was under $100 million.

How Floodway Is Operated

❖ **Quote from 1958 report**

- Following the disastrous 1950 flood, detailed studies were undertaken examining various alternatives for flood protection of Winnipeg. The last major study was done in 1958 by a Royal Commission; in its report, the Commissioners stated that construction of the Floodway, Portage Diversion and an Assiniboine River dam "will ensure virtually complete flood protection to all parts of Greater Winnipeg behind the main dyking system for all floods up to 169,000 cfs".
-
- Following the construction of the Floodway, the rules of operation to provide this flood protection were finalized.

❖ **Ice rule, old**

- If the water level at James Avenue is under 15.0 ft., and if the water level at the Inlet is under 750.0 ft., and if heavy ice floes are occuring on the Red River, raising the Floodway gates is postponed to prevent ice floes from entering the Floodway channel. This was to limit the amount of erosion that the ice could cause in the inlet portion of the floodway channel.

❖ **Ice rule, new**

- Since that time, experience has demonstrated that ice entering the floodway channel can hang up on the lip, or jam up against the bridge piers, and so reduce the capacity of the channel. Therefore, raising of the floodway gates is now delayed until ice is flowing in relatively small pans, regardless of what the water level is at James Avenue or at the Inlet.

❖ **Initial depth rule, old**

- To reduce the amount of erosion damage on the lip, delay raising of the Floodway gates until such time as at least one foot of depth of flow occurs over the lip; that is, when raising the gates would result in a water level of 751 ft. at the Inlet.

❖ **Initial depth rule, new**

- Since that time, experience has shown that 752 ft. is a better initial water level at the Inlet for preventing erosion.

❖ **Final drop rule, old**

- To reduce the amount of erosion damage on the lip near the end of the flood, when water levels are fallling, the gates should be fully lowered when the water level at the Inlet approaches 751 ft.

❖ **Final drop rule, new**

- Since that time, experience has shown that the City's pumping costs increase dramatically when water levels are above 15 ft., and that lowering the gates in one 'shot' results in a fairly significant wave travelling down the river. Therefore, the water level at the Inlet is kept at 752 ft. or so until the James Avenue level drops well below 15 ft., and the gate is lowered in two 'shots' to minimize the size of the wave.

⊙ There were a set of rules developed for that period when ice was no longer a problem, but prior to the late part of the falling stages; this period could be called the period of 'high stages' These rules dictated what water levels were to be maintained at the Inlet and within Winnipeg. This set of rules use two values that require explanation: this first is "natural flows on the Red River north of the Assiniboine River", and the second is "natural water levels on the Red River at the Floodway Inlet".

- Natural flows on the Red River north of the Assiniboine River:

❖ **River system before flood control works**

- Prior to the construction of flood control works, all Red River flows went through Winnipeg, and all Assiniboine River flows went through Winnipeg, except for that portion that spilled out east of Portage la Prairie.

❖ **River system after flood control works**

- After the construction of the flood control works, some Red River flow is diverted around Winnipeg, and some Assiniboine River flow is diverted to Lake Manitoba. As well, the flows that spilled out of the Assiniboine east of Portage la Prairie now remain in the river.
- Therefore, today, the natural flow on the Red River north of the Assinibione River is calculated thusly:

"actual flow at James Avenue" + "flow in Floodway channel" + "flow in Portage Diversion Channel" - "Assiniboine River flow that would have been lost in natural conditions that now is part of the river flow"

- Natural water levels on the Red River at the Floodway Inlet:

- ❖ **"Natural water level at Floodway Inlet with zero flow on the Red River"**

- The natural water level at the Inlet is a function of the flow on the Red River and on the Assiniboine River. In the case where the flow on the Assiniboine River is "x", and there is no flow on the Red River, the water level at the Inlet is quite low.
  - ❖ **"Natural water level at Floodway Inlet with zero flow on the Assiniboine River"**
- In the case where the flow on the Red River is "x", and there is no flow on the Assiniboine River, the water level at the Inlet is relatively high.
  - ❖ **"Natural water level at Floodway Inlet with some flow on the Red River and some flow on the Assiniboine River"**
- In the case where there is flow on both rivers, and the flows add up to "x", the water level at the Inlet is somewhere between the water levels of the above two cases.
  - ❖ **Chart: "Natural water level on Red R. at Floodway Inlet"**
- The natural water levels at the Inlet were determined by the Floodway designers for a large number of combinations of Red and Assiniboine flows. This was plotted up for three principle conditions ---- low, average and high Assiniboine River flows.
  - ❖ **Chart: "Natural water level on Red R. at Floodway Inlet", with dashed lines**
- If the natural flow on the Red River north of the Assiniboine River is 120,000 cfs, the chart yields three water levels at the Inlet.
  - ❖ **Chart: "Natural water level on Red R. at Floodway Inlet", with dashed lines (blow-up of the previous chart)**
- The three levels are for low, average and high Assiniboine River flows.

❖ **High stages: rule #1**

- For natural flows on the Red River north of the Assiniboine River up to 169,000 cfs
  - ⇒ maintain natural water levels on the Red River at the Floodway Inlet
  - This is the rule that has been applied in every flood year prior to 1997. In 1974 and 1976 this rule was inadvertently broken because one of the curves used in operating the gate was faulty; this was examined by the Water Commission following the 1979 flood.
  - The natural peak flow in 1997 was estimated to be 161,000 cfs, but this rule was not used during parts of the Red's high stages for a number of reasons, which I will discuss later.

❖ **High stages: rule #2**

- For natural flows on the Red River north of the Assiniboine River from 169,000 cfs to 189,000 cfs:
  - ⇒ maintain a water elevation of 751.5 ft. at the Redwood Bridge (which is equal to 25.5 ft. at James Avenue)
  - ⇒ raise water levels at the Inlet above natural to a maximum of 775.8 ft.
  - In 1997, during the peak, this rule was used, except with one modification: a water level of 24.5 ft. was maintained at James Avenue. This was so for these reasons:
    - □ A large number of surface drains in the newer parts of Winnipeg that are designed to carry rainfall runoff directly into the Red or Assiniboine Rivers enter the river roughly at a James Avenue elevation of 24.5 ft. With a James Avenue elevation of 25.5 ft., significant amounts of back flow would occur; some of this would get into the sewer system, resulting in significant amounts of basement flooding.
    - □ With a James Avenue elevation of 25.5 ft., the freeboard on the primary dykes would be only 1 ft.. With waves during windy spring days, the uncertainty in calculating the design elevations for the dyke for such an elevation at James Avenue, the uncertainties in dyke elevations given dyke erosion and dyke settling, and given limitations in surveying accuracies, such a freeboard might be too small at certain places, resulting in overtopping.
    - □ The secondary dykes in certain parts of the City, especially those at the south end, would have been overtopped. Under the rule used in 1997, in which James Avenue was allowed to go only up to 24.5 ft., the

secondary dykes in the St. Norbert area were within inches of being overtopped.

- The City Government had grave concerns about the impact of a James Avenue water level of 25.5 ft.; it explicitly asked that the James Avenue elevation not be allowed to go above 24.5 ft. The City simply would not have been able to cope with upgrading secondary dykes, blocking the surface drains, and upgrading the primary dyke where necessary, even with the help of the Canadian Army. Therefore, with James Avenue at 25.5 ft., Winnipeg would have experienced a major increase in damages.

❖ **High stages: rule #3**

- For natural flows on the Red River north of the Assiniboine River from 189,000 cfs to 199,000 cfs:
  - ⇒ when flows reach 190,000 cfs, the City's primary dykes will be raised to level 30.5 ft.
  - ⇒ the water elevation at the Redwood Bridge will be allowed to reach 755.5 ft. (29.5 ft. at James Avenue), with the water elevation at the Inlet being 775.8 ft.
  - ⇒ if there are construction delays in raising the primary dykes:
    - ⇒ water elevation at the Redwood Bridge will be kept at 751.5 ft. (25.5 ft. at James Avenue)
    - ⇒ the water elevation at the Inlet cannot exceed 778.0 ft.

❖ **High stages: rule #4**

- For natural flows on the Red River north of the Assiniboine River from 199,000 cfs to 217,000 cfs:
  - ⇒ the water elevation at the Redwood Bridge will be maintained at 755.5 ft. (29.5 ft. at James Avenue)
  - ⇒ water levels at the Inlet will be raised, as required, to a maximum of 778.0 ft.

❖ **High stages: rule #5**

- For natural flows on the Red River north of the Assiniboine River above 217,000 cfs:
  - ⇒ water levels at the Inlet will not be allowed to exceed 778.0 ft.

❖ **Applicable "high stage" rule: 1826-1997**

1997 Operation

❖ **Hydrographs of 1997 flood on Red River**

✶ The revised operating rules state that the Floodway gates shouldn't be raised until the Red River ice is broken up into relatively small floes, and these floes are moving down the river. This is to keep ice out of the Floodway channel; ice there could hang up on the lip at the channel's entrance, and jam up against the piers of the bridges over the channel.

- However, this past spring, the ice on the Red River at the Floodway Inlet remained in large, stationary pans longer than usual. By the evening of April 21, the water level at James Avenue had climbed to near 18 ft.; the Red R. at the Floodway Inlet was over 4 ft. higher than the lip of the Floodway channel. Nearly 7,000 cfs was flowing into the Floodway channel.
- Based on the Red R. flow forecast, the James Avenue water level would exceed 19 ft. by morning if the gates weren't operated.
- Given the depth of flow over the channel lip, ice hanging up on the lip seemed very unlikely. As well, the ice blasting experts from the Department of Highways felt that, if ice did jam at the piers of bridges over the channel, the ice was sufficiently rotten to be fairly easily blasted.

🖂 **Point #1 on hydrograph**

- So the gates were raised at 10 pm.
- Ice did jam on the piers of the St. Mary's Road bridge in the night of April 21/22. Initial attempts at breaking the jam by blasting were unsuccessful; the jam broke up by itself around 6 am of the 22nd.
- Large pans of stationary ice were in place in the river upstream of the Inlet Control Structure till the late afternoon of the 22nd --- the gates were operated less than normally to keep upstream water levels as low as practicable; it was felt that the higher the water levels at the Floodway channel inlet the greater the chance that upstream ice would flow into the floodway channel.
- The pans of ice broke up and started flowing freely in the late afternoon of the 22nd. The gates were then raised in a series of steps to bring the upstream water level back up to natural.

🖂 **Point #2 on hydrograph**

✶ The water level at the Inlet remained near, or below, natural until the middle of the 25th.

- Late on the 24th, it was observed that the riprap at the downstream toe of the Inlet Control Structure was eroding. To facilitate placement of new rip rap, the gates were raised to keep the downstream water level from rising too much.

- As you can see, raising of the gates to accomplish this resulted in the water level at the Inlet going only a little above natural.

Point #3 on hydrograph

✶ At this point, the floodway gates, instead of being raised as flows on the Red R. increase, actually need to be dropped in order to maintain natural water levels at the Inlet.

- An engineering consulting firm had been hired in 1996 to assess the condition of the Inlet Control Structure. The firm had identified the anchor bolts on the servo-motor support beams as possibly being under-designed for the condition when the gates are lowered when upstream water levels are especially high. This observation had not been acted on as of May 1997. However, now that we were in that kind of situation, the decision was made to "play it safe" and have those anchor bolts replaced.
- During the examination of the anchors it was discovered that the west gate was somewhat higher than the east gate. To that point in time, we thought that both gates were at the same elevation. Going back over the operation records, we concluded that the manometer malfunctioned sometime during the last gate raises on April 24 and 25.

Point #4 on hydrograph

- Installation of the new anchors for the west gate was completed late on April 27. The west gate was lowered in a series of steps on April 28 to make it equal in height to the east gate.

Point #5 on hydrograph

- Installation of the new anchor bolts for the east gate was completed in the morning of April 29. From then to early on April 30 the gates were lowered incrementally to bring the water level at the Inlet back down to natural; this would have brought the water level at James Avenue back up to where it should have been.
- During this series of gate dropss, it was observed that the water level just south of the Inlet Control Structure rose faster than expected, given the flows on the river and the gate elevations. It was suspected that this was so because the equations used in determining the water level at different gate settings were developed, back in the 1950's and 60's, using natural water levels at the Inlet that were too low. That is, the estimated natural water levels for this range of flows is higher than estimated in the 1950's and 60's.

Point #6 on hydrograph

✶ At this point, a new forecast indicated that, in a day or two, the gates would have to be raised to keep water levels in Winnipeg from rising above 24.5 ft. (at James Avenue). Therefore, no further gate drops

took place --- the water level at the Inlet was allowed to rise above natural.

Point #7 on hydrograph

- On May 1st (8 p.m.) the gates were raised 1/2 ft. to keep the James Avenue water level from exceding 24.5 ft. This resulted in the water elevation at the Inlet reaching 771.3 for most of May 3rd and 4th.
- Using the natural water level curves developed in the 1950's and 60's, this peak water level at the Inlet was a bit over 1 ft. above natural. If our estimate of the true natural water level being around 1/2 ft. higher is correct, the actual peak was a bit over 1/2 ft. above natural.

* As I mentioned earlier, for the high flows experienced in the 1997 flood, the floodway gates are actually lowered, instead of raised. Accordingly, the gates were lowered during May 5 and 6; this kept James Avenue around 24.5 ft. and saw the water level at the Inlet drop until it reached natural levels (as calculated in the 1950's and 60's).

Point #8 on hydrograph

- Flows on the Red River began to drop quite quickly at this point. The geotechnical experts in the City were very concerned that at sharp drop in water levels would result in major dyke failures. To help reduce the rate of drop in the water levels in the City, the gates were operated in such a way on May 7th and 8th so as to lower the Inlet elevation a bit below natural, and so reduce the rate of drop in the City.

Point #9 on hydrograph

- From May 9th to 30th the gates were operated to keep the Inlet elevation at natural.

Point #10 on hydrograph

- From May 31st to June 2nd the gates were operated to minimize erosion on the lip, and to minimize the size of the wave travelling down the river once the gate was dropped. Since it was not raining at the time, and there was no forecast of rain, keeping the water level at James Avenue below 15 ft. was not a concern.

1958 ROYAL COMMISSION REPORT

Construction of the Red River Floodway,

the Portage Diversion

and a dam and reservoir on the

Assiniboine River

"... will ensure virtually complete

flood protection

to all parts of Greater Winnipeg

behind the main dyking system

for all floods up to 169,000 cfs"

RULES: initial gate operation, with ice

If James Ave. water level is under 15 ft., and the water level at the Inlet is under 750.0 ft., and heavy ice floes are occurring on the Red,

postpone raising gates to avoid ice floes entering the Floodway channel.

RULES: initial gate operation, with ice

1970 rule:

If James Ave. water level is under 15 ft., and the water level at the Inlet is under 750.0 ft., and heavy ice floes are occurring on the Red, postpone raising gates to avoid ice floes entering the Floodway channel.

New rule:

Delay raising gates until ice on river is flowing in small pans, regardless of the river level at James Ave.

1997 experience:: add following:

If significant flood damages in Winnipeg are imminent, raise gates.

RULES: initial depth of flow over lip

To reduce the amount of erosion on the lip that occurs when water first starts flowing into the Floodway channel,

the initial gate raise should result in a water level at the Inlet of 751 ft.

RULES: initial depth of flow over lip

To reduce the amount of erosion on the lip that occurs when water first starts flowing into the Floodway channel,

1970 rule:

the initial gate raise should result in a water level at the Inlet of 751 ft.

New rule:

the initial gate raise should result in a water level at the Inlet of 752 ft.

RULES: final drop of gate

To reduce the amount of erosion on the lip at the end of the flood,

the gates should be lowered completely when the water level at the Inlet reaches reaches 751 ft.

RULES: final drop of gate

To reduce the amount of erosion on the lip at the end of the flood,

1970 rule:

the gates should be lowered completely when the water level at the Inlet reaches reaches 751 ft.

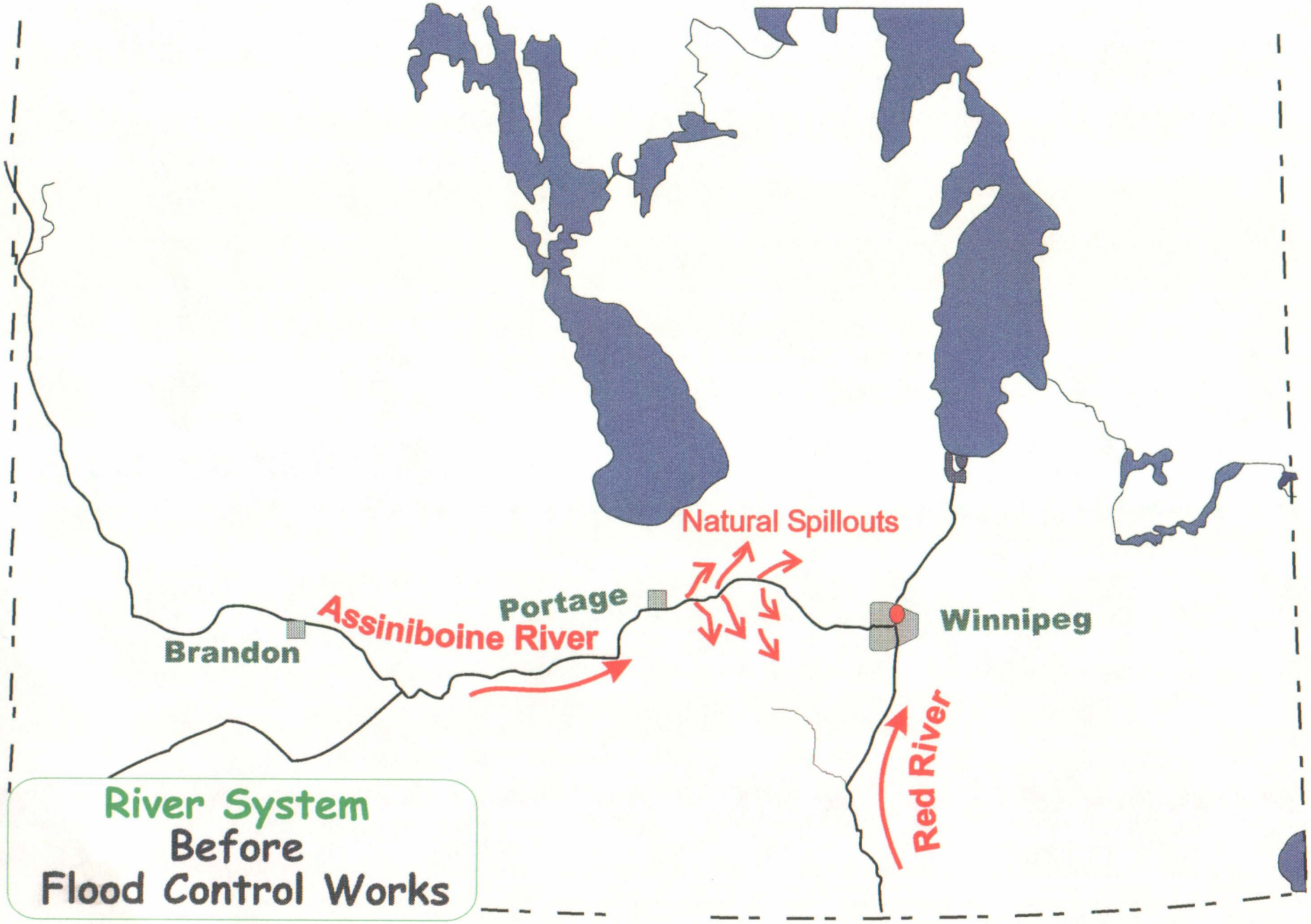
New rule:

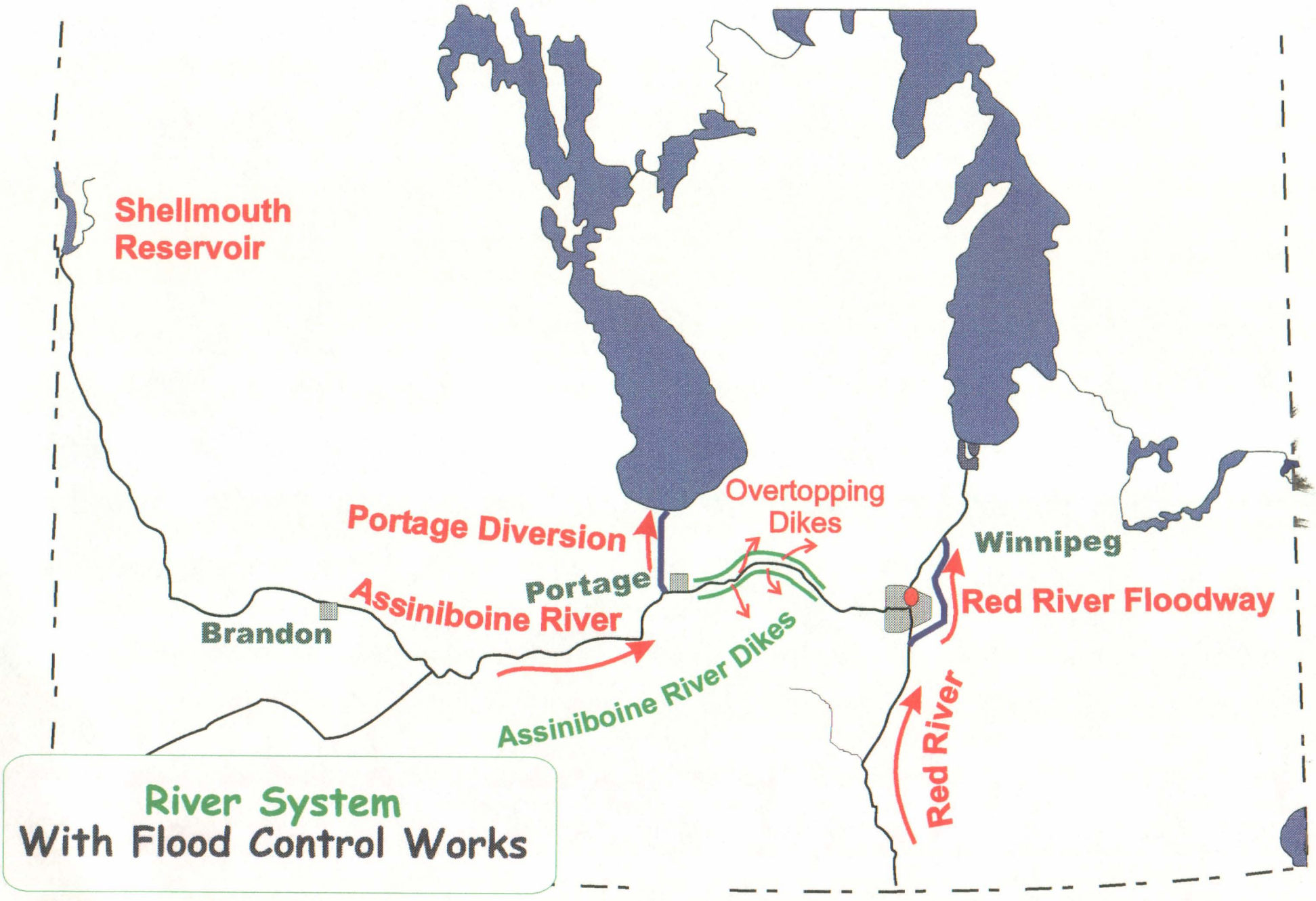
and to minimize flood pumping costs within the City should it rain,

keep the Inlet water level at 752 ft. until James Ave. water levels are well below 15 ft., then drop the gates in two 'shots' :

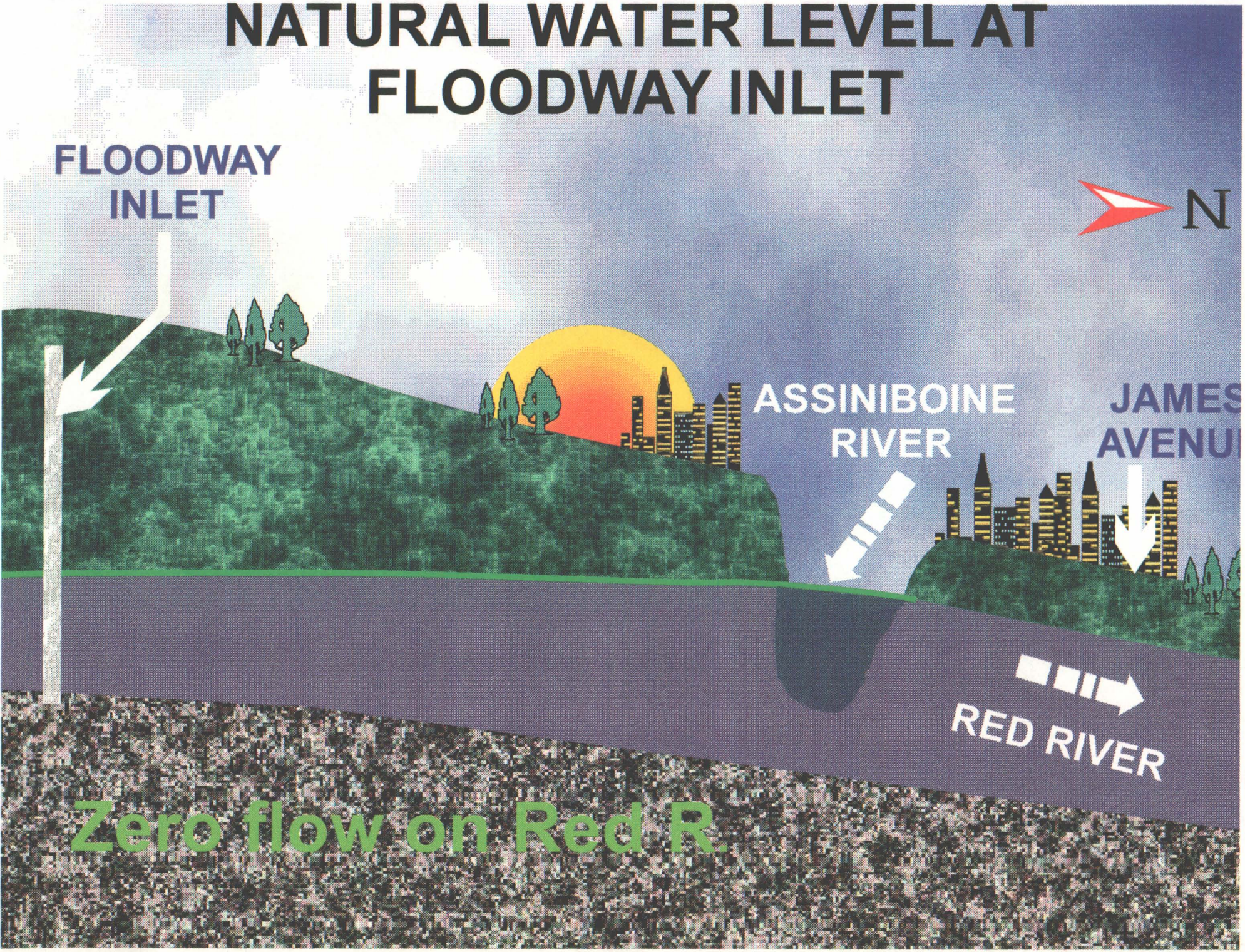
first one to drop Inlet level below lip,

second one (after some time) is final


Natural Spillouts
Portage
Assiniboine River
Brandon
Winnipeg
Red River
River System
Before
Flood Control Works



River System
With Flood Control Works


NATURAL WATER LEVEL AT FLOODWAY INLET
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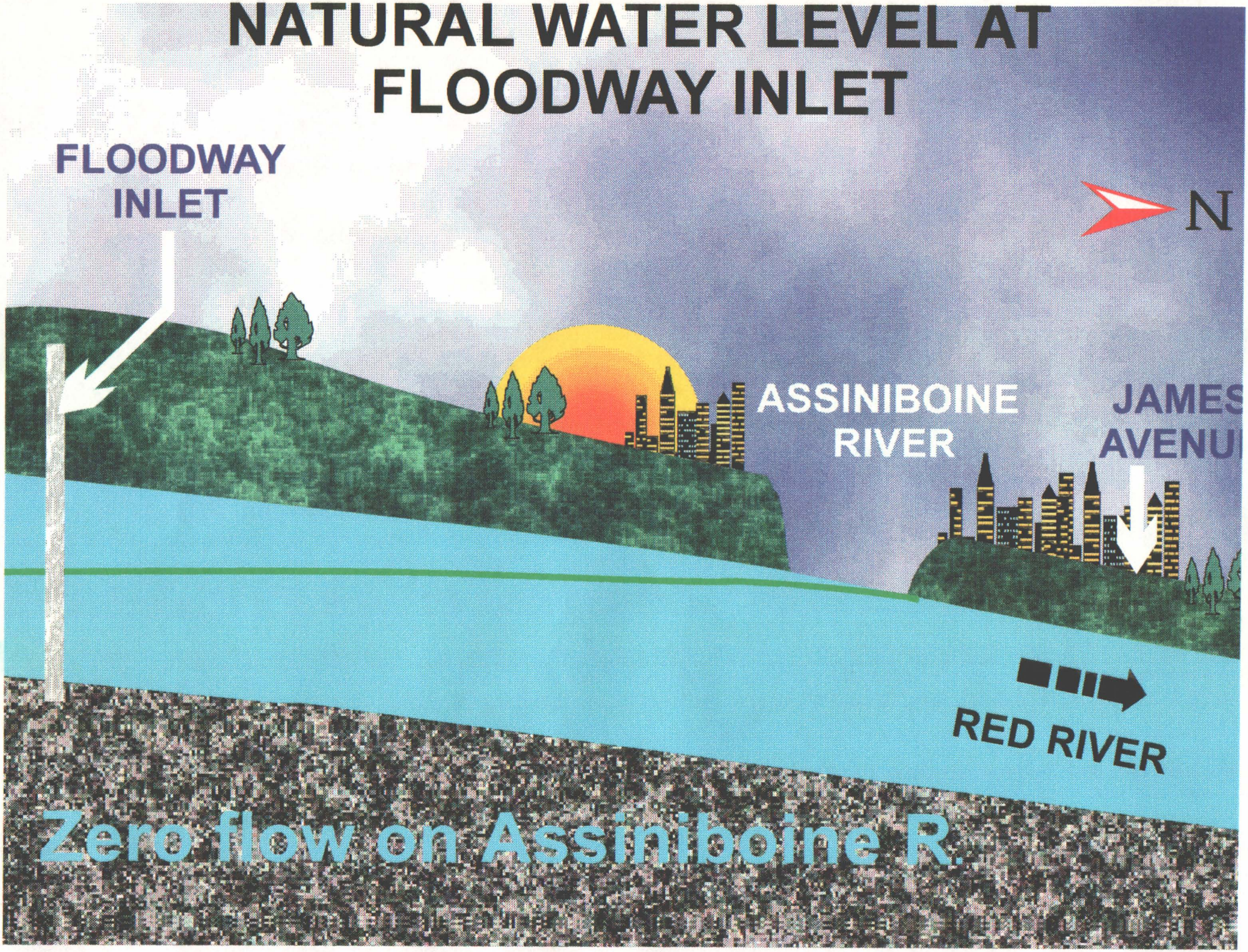
JAMES AVENU
RED RIVER
Zero flow on Red R


NATURAL WATER LEVEL AT FLOODWAY INLET
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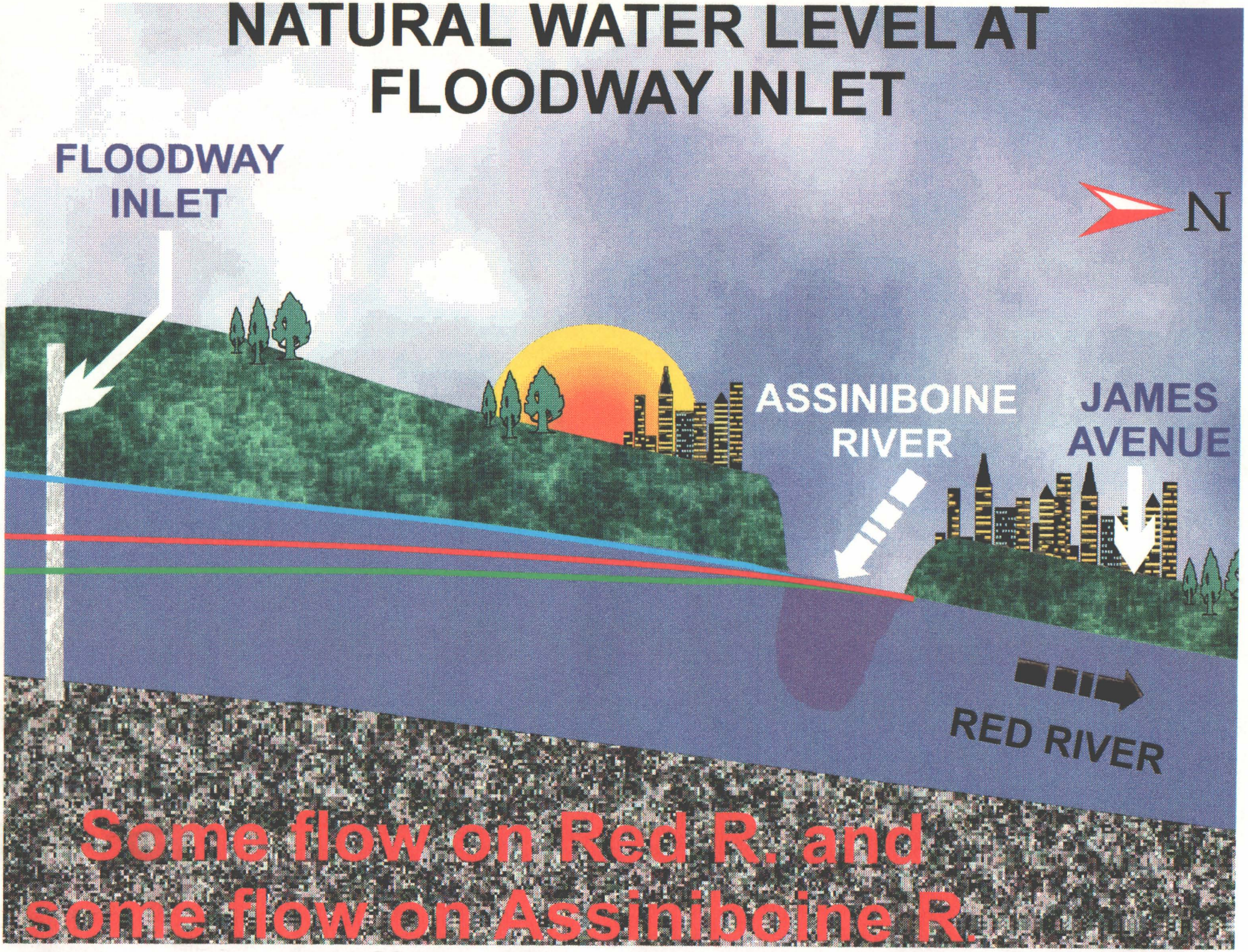
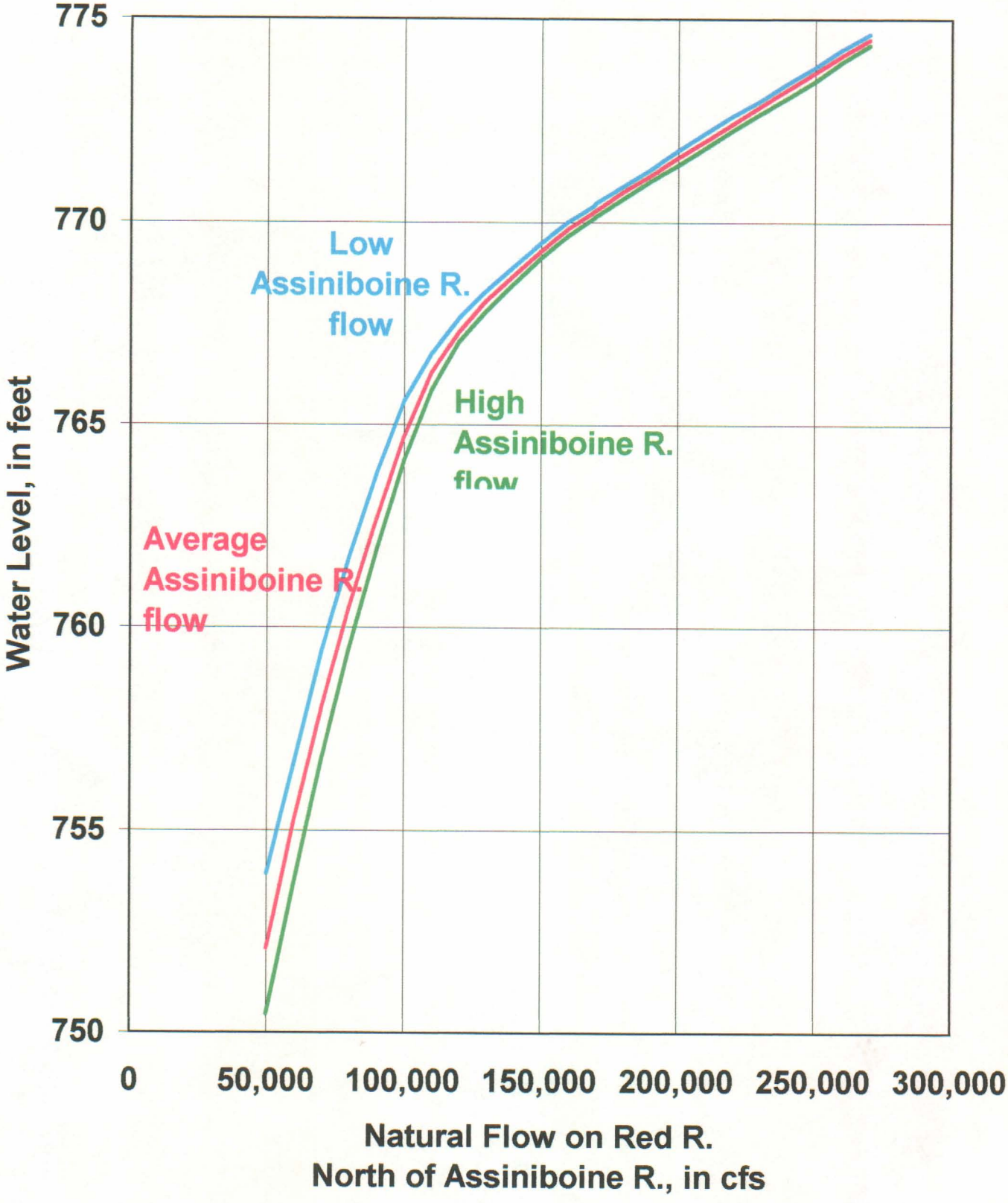
JAMES AVENU
RED RIVER
Zero flow on Assiniboine R.

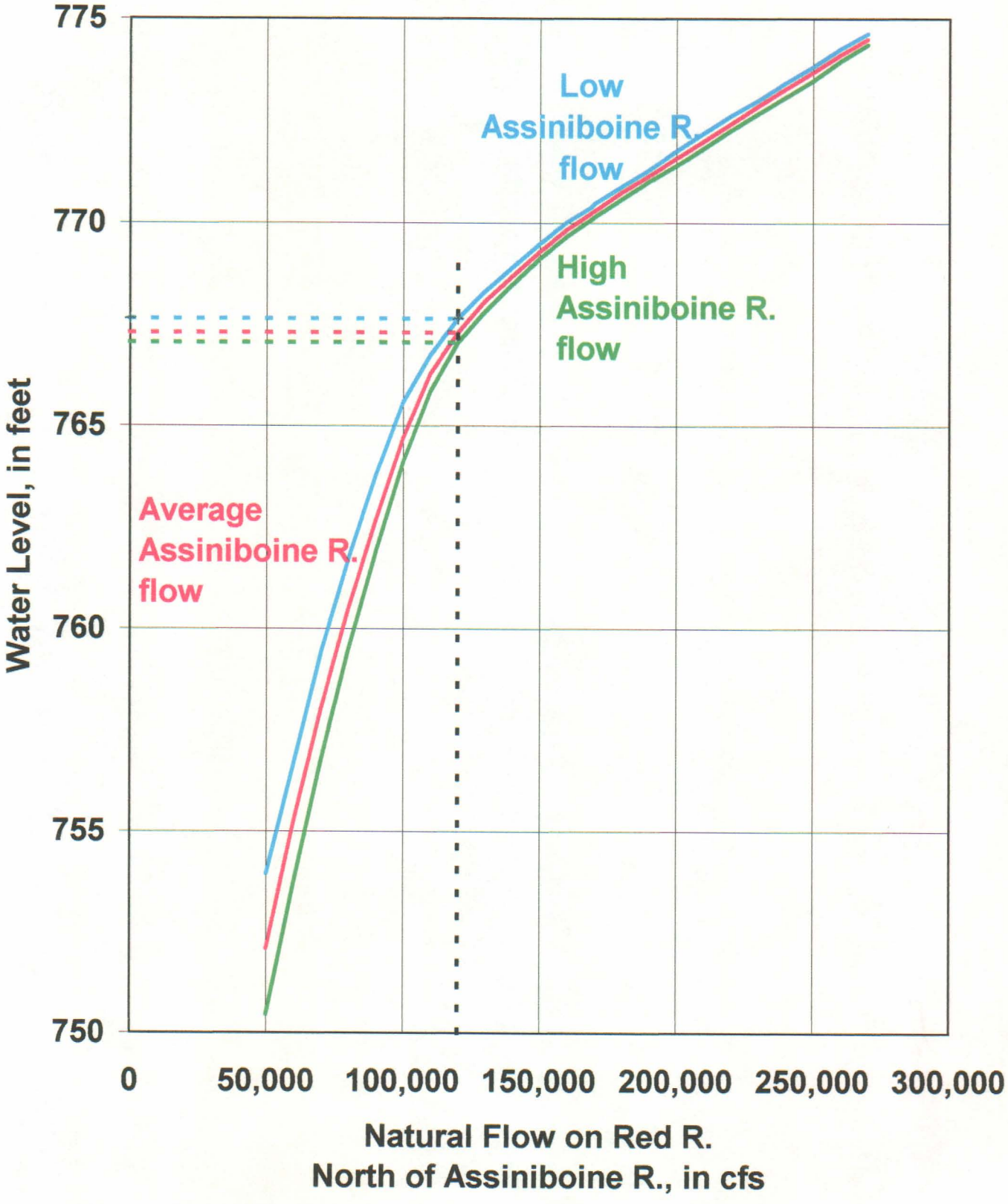
NATURAL WATER LEVEL AT FLOODWAY INLET



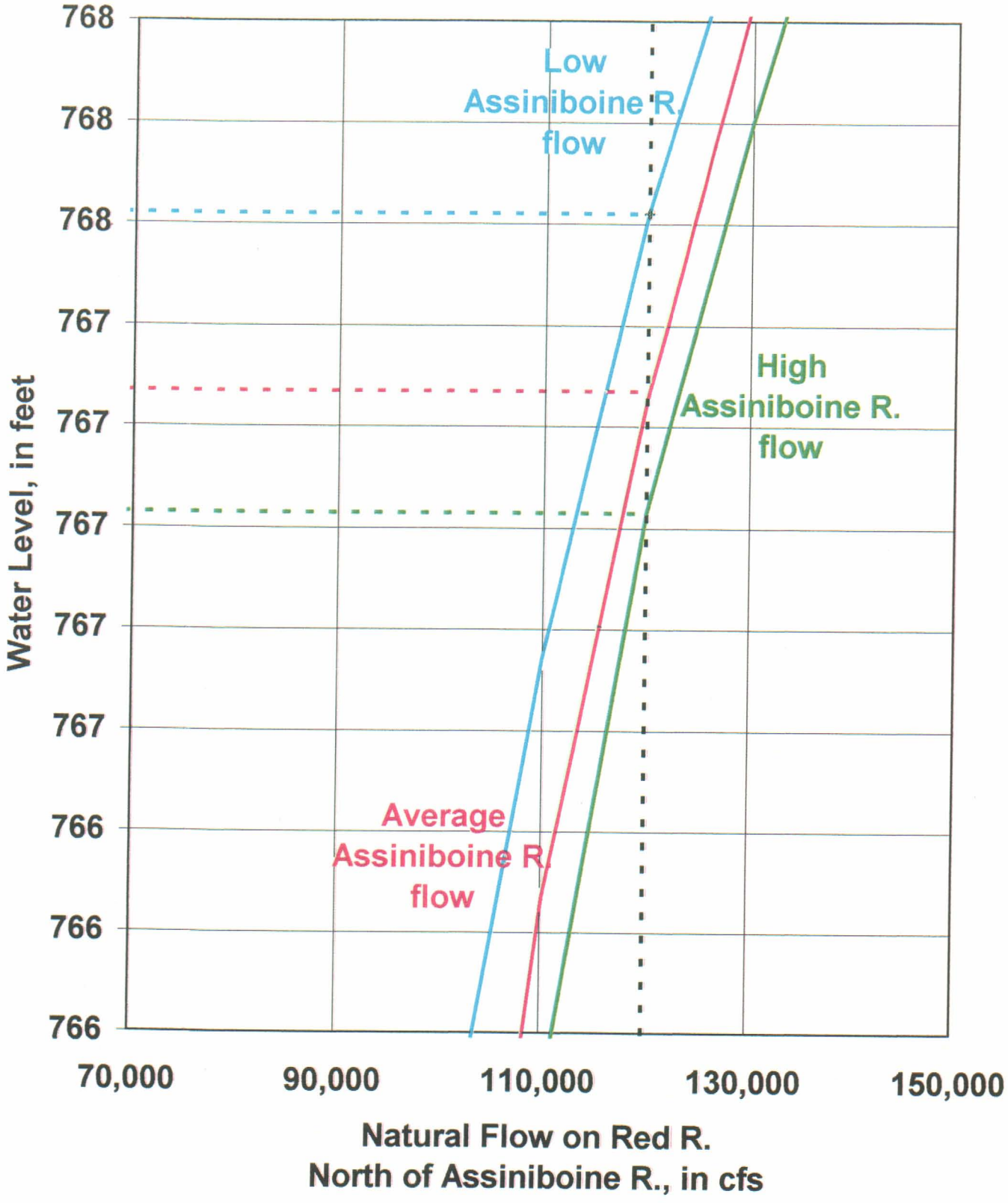
Natural Water Level on Red R. at Floodway Inlet



Natural Water Level on Red R. at Floodway Inlet



Natural Water Level on Red R. at Floodway Inlet



RULE # 1 for high stages:

natural flow at James Ave. <= 169,000 cfs

- maintain natural water levels at the Inlet

- ☐ this rule for high stages applied in every flood year up to 1997
- ☐ rule was inadvertently broken in 1974 and 1976 due to use of faulty gate curve
- ☐ although 1997 peak natural flow at James Ave. was only 161,000 cfs, this rule was not used for highest 6 days in 1997

RULE # 2 for high stages:

natural flow at James Ave.

between 169,000 cfs and 189,000 cfs

- **maintain a water elevation of 751.5 ft. at Redwood Bridge (25.5 ft. at James Ave.)**
- **raise water levels at the Inlet above natural to a maximum of 775.8 ft.**

☐ **In the later 1980's, " 25.5 " was changed to " 24.5 ", because it was recognized that Winnipeg would experience very large flood damages at 25.5. This rule change was not documented in Floodway manual.**

Why " 25.5 ft . " at James Ave. changed to " 24.5 ft. "

- the freeboard on the primary dikes would be under 1 ft., due to:
  - ☐ waves, due to wind
  - ☐ uncertainties in calculating the design water surface profile
  - ☐ dyke settling, erosion, etc.
  - ☐ with low Assiniboine R. flows, slope of Red R. water surface is greater
- large numbers of surface drains in newer parts of Winnipeg enter rivers at 24.5 ft.: at 25.5 ft., significant backflows would cause major surface flooding and basement flooding
- some secondary dikes (especially in southern Winnipeg) would have been overtopped

RULE # 3 for high stages:

natural flow at James Ave.

between 189,000 cfs and 199,000 cfs

- **when flows reach 190,000 cfs, the Primary dikes are raised 5 ft. to 31.5 ft.**
- **the water elevation at Redwood Bridge will be allowed to reach 755.5 ft (29.5 ft.at James Ave.), with the level at the Inlet being 775.8 ft.**
- **if there are delays in raising the dikes:**
  - ❖ **water elevation at Redwood Bridge will be kept below the top of dikes**
  - ❖ **water level at Inlet not to exceed 778 ft.**

RULE # 4 for high stages:

natural flow at James Ave.

between 199,000 cfs and 217,000 cfs

- the water elevation at Redwood Bridge will be maintained at 755.5 ft. (29.5 ft. at James Ave.)
- water levels at the Inlet will be raised, as required, to a maximum of 778 ft.

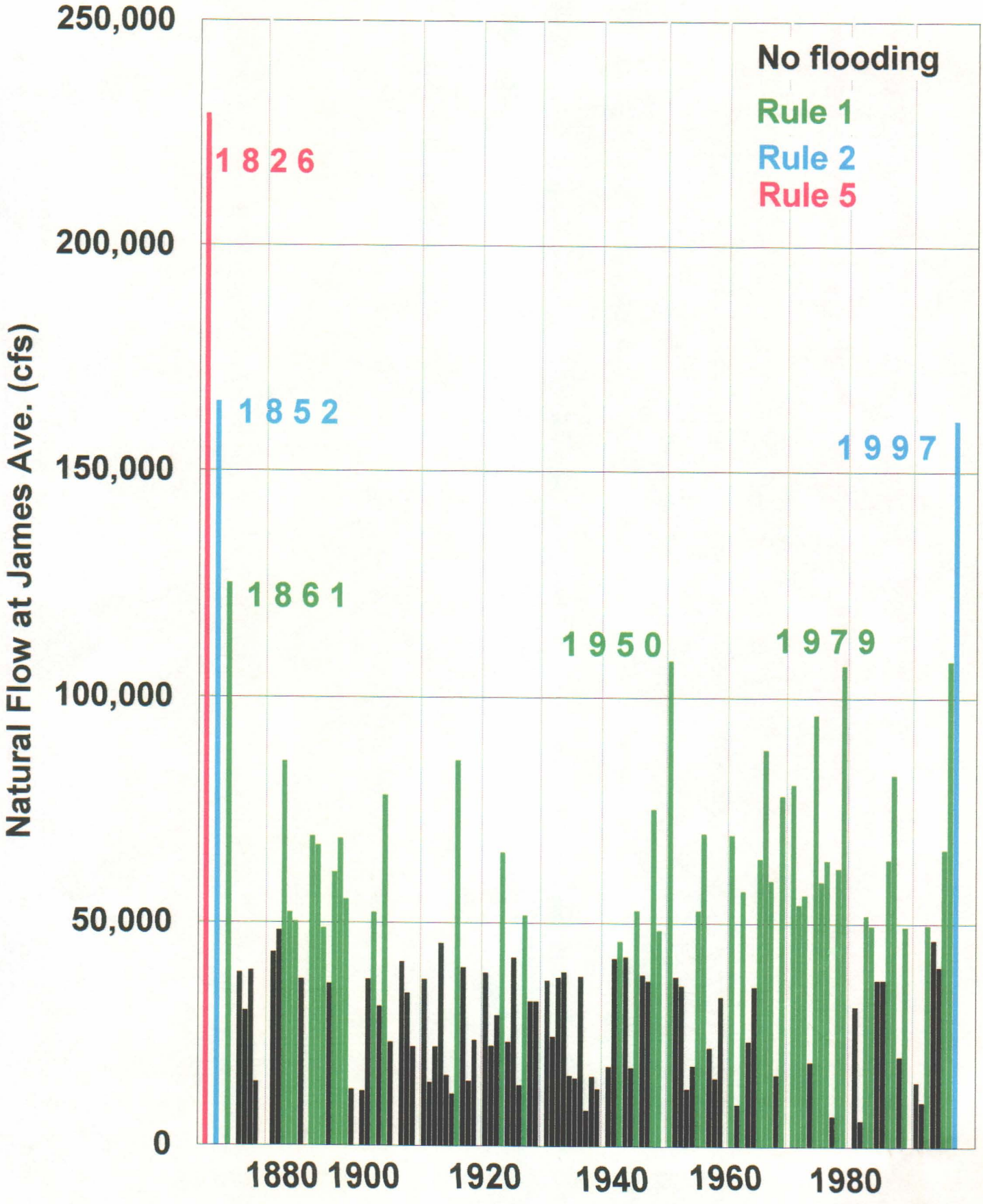
RULE # 5 for high stages:

natural flow at James Ave.

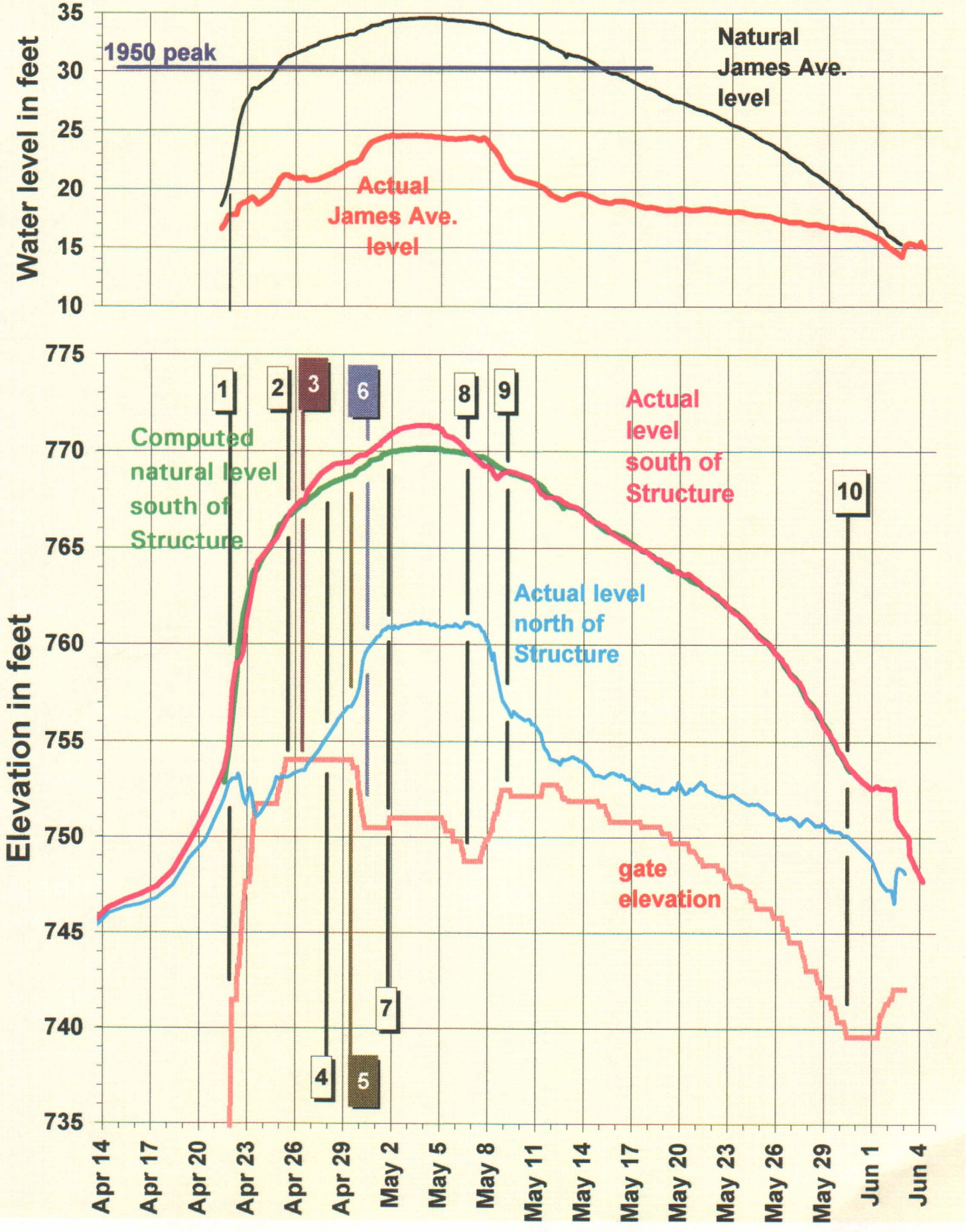
above 217,000 cfs

- water levels at the Inlet will not be alllowed to exceed 778 ft. (water levels within Winnipeg will be allowed to rise above 29.5 ft.)

Applicable "High Stage" Rule



1997 Flood: Red River



- Flood Forecasting - Alf Warkentin
  - Proceduresl
  - 1997 forecasts

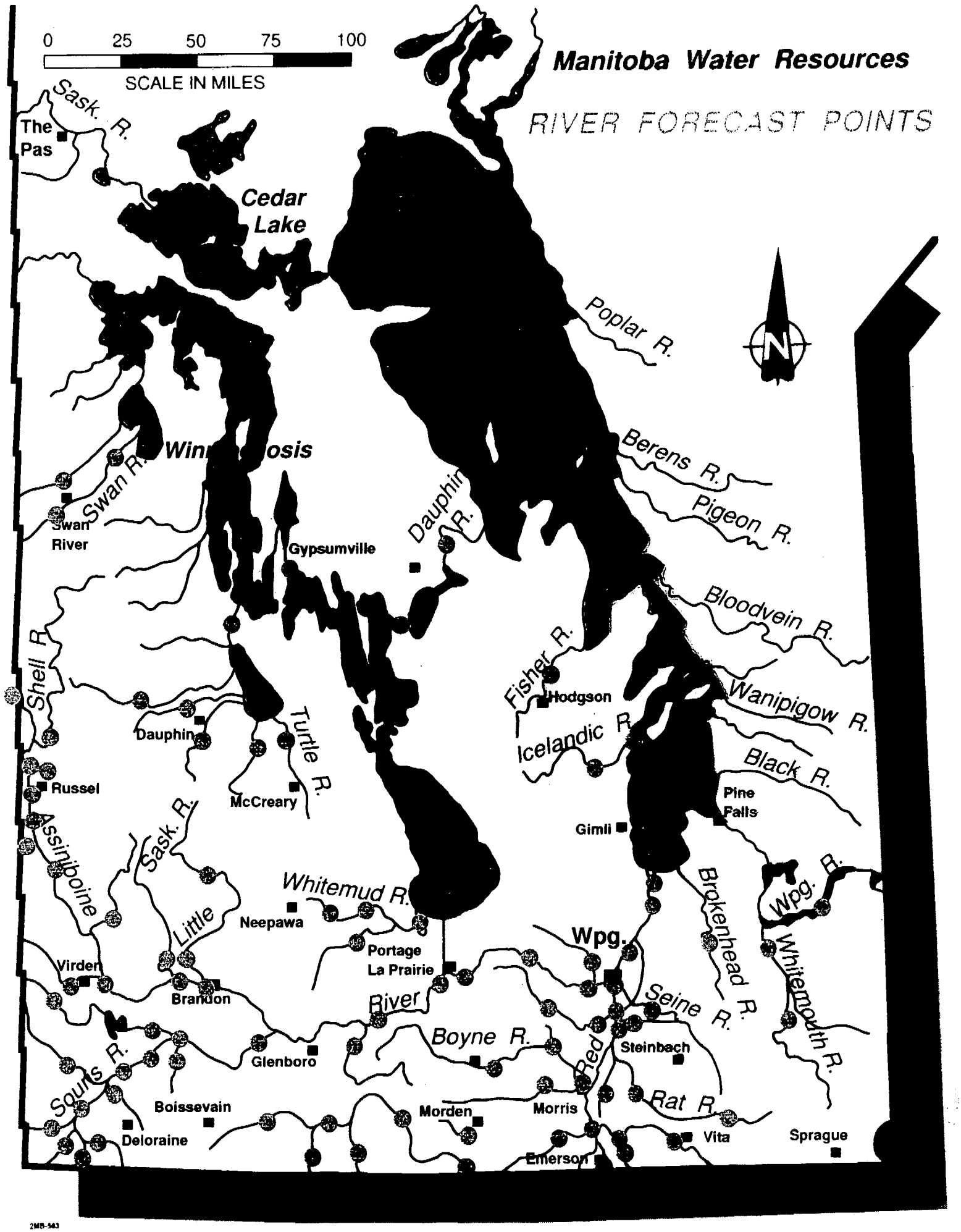
MANITOBA RIVER FORECAST CENTRE

A. FLOOD FORECASTING

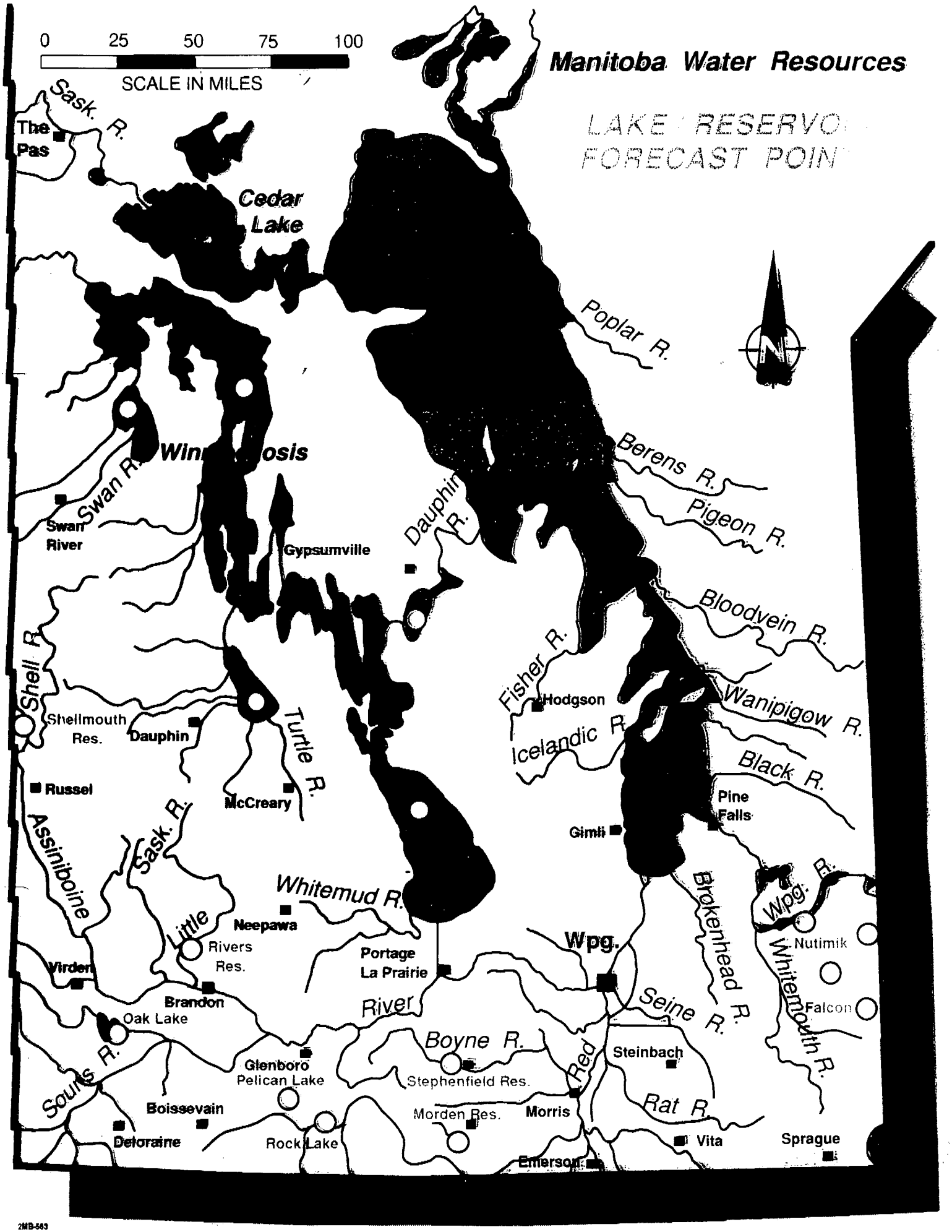
1. PEAK STAGES FROM SNOWMELT, SPRING RAIN
2. FLASH FLOODS (CONVECTIVE OR CYLONIC RAINSTORMS)

B. WATER SUPPLY FORECASTING

1. RESERVOIR/LAKE INFLOWS, LEVELS
2. MINIMUM RIVER LEVELS


0 25 50 75 100
SCALE IN MILES
Manitoba Water Resources
RIVER FORECAST POINTS
Sask. R.
The Pas
Cedar Lake
Poplar R.
N
Swan R.
Swan River
Gypsumville
Dauphin R.
Berens R.
Pigeon R.
Bloodvein R.
Shell R.
Fisher R.
Hodgson
Wanipigow R.
Dauphin
Turtle R.
Icelandic R.
Black R.
Russel
McCreary
Pine Falls
Gimli
Assiniboine
Sask. R.
Whitemud R.
Brokenhead R.
Wpg. R.
Neepawa
Little
Wpg.
Portage La Prairie
Whitemouth R.
Virden
Brandon
River
Seine R.
Boyne R.
Steinbach
Souris R.
Glenboro
Red
Rat R.
Boissevain
Morden
Morris
Deloraine
Vita
Sprague
Emerson

2MB-543


0 25 50 75 100
SCALE IN MILES
Manitoba Water Resources
LAKE / RESERVO
FORECAST POIN
N
Sask. R.
The Pas
Cedar Lake
Poplar R.
Swan R.
Swan River
Gypsumville
Dauphin R.
Berens R.
Pigeon R.
Bloodvein R.
Shell R.
Shellmouth Res.
Dauphin
Turtle R.
Fisher R.
Hodgson
Icelandic R.
Wanipigow R.
Black R.
Russel
McCreary
Pine Falls
Gimli
Assiniboine
Sask. R.
Whitemud R.
Little
Rivers Res.
Neepawa
Portage La Prairie
Wpg.
Brokenhead R.
Wpg. R.
Nutimik
Whitemouth R.
Falcon
Virden
Brandon
Oak Lake
River
Seine R.
Boyne R.
Steinbach
Red
Souris R.
Glenboro
Pelican Lake
Stephenfield Res.
Rat R.
Boissevain
Morden Res.
Morris
Deloraine
Rock Lake
Vita
Sprague
Emerson

2MB-563

Manitoba Water Resources
HYDROLOGIC FORECAST CENTRE

MAJOR LIAISON
AND CLIENT RELATIONSHIPS

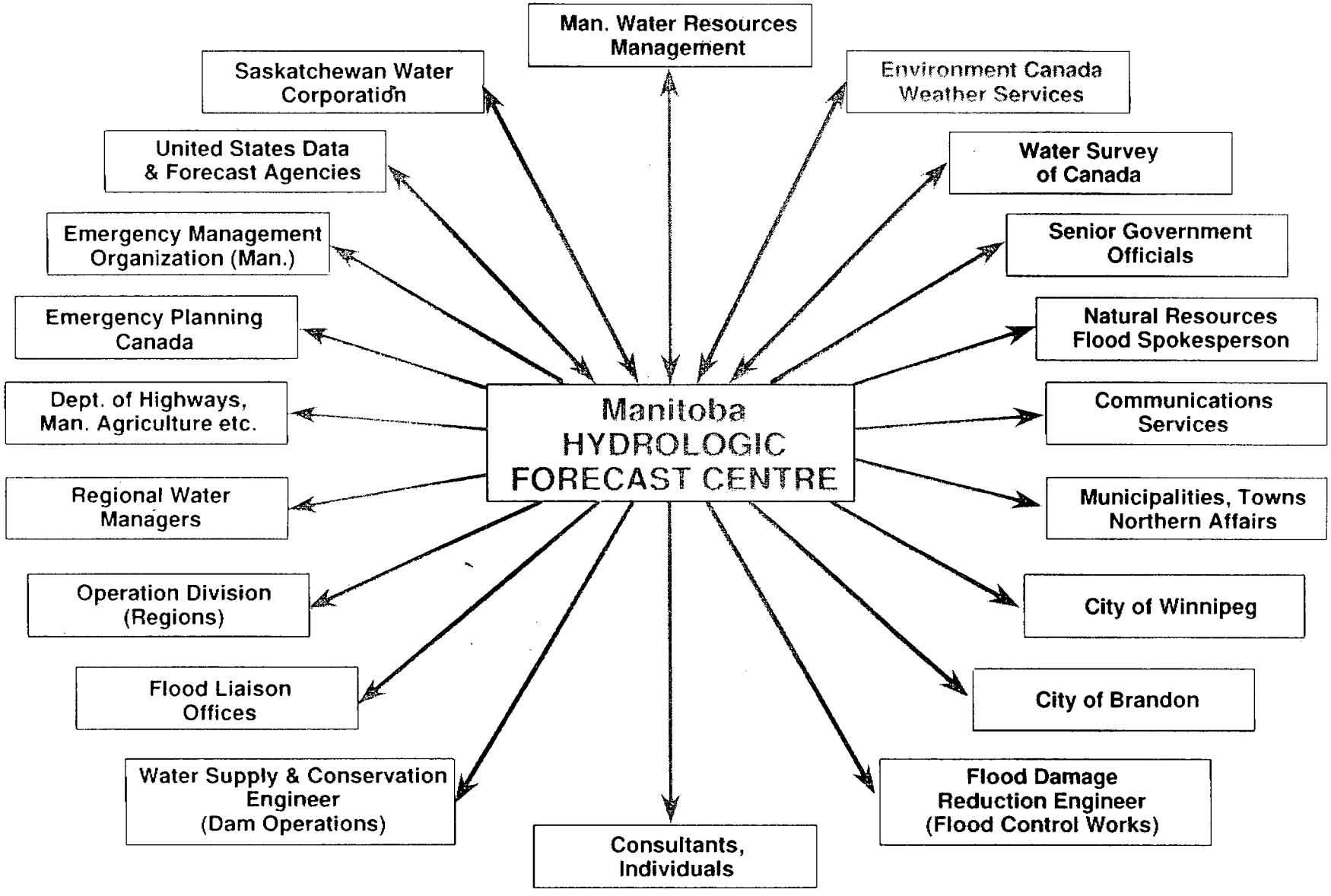


Figure 1.

MAJOR COMPONENTS OF RIVER FORECASTING SYSTEMS

1. DATA NETWORKS (meteorologic, hydrometric)
   - historical
   - real time
2. A MEANS OF PREDICTING RUNOFF COEFFICIENTS
3. A MEANS OF CONVERTING RUNOFF DEPTHS TO STREAMFLOW HYDROGRAPHS
4. A MEANS OF CONVERTING PREDICTED RIVER FLOWS TO STAGES
5. A MEANS OF EFFECTIVELY CONVEYING RIVER FORECASTS TO FLOOD FIGHTERS AND CONCERNED CITIZENS

MAJOR FACTORS DETERMINING SPRING RUNOFF

- **WATER CONTENT OF SNOWCOVER PLUS EFFECTIVE SPRING RAIN (TOT PRECIP)**
- **SOIL MOISTURE (API)**
- **RATE OF SNOWMELT (MELT INDEX)**

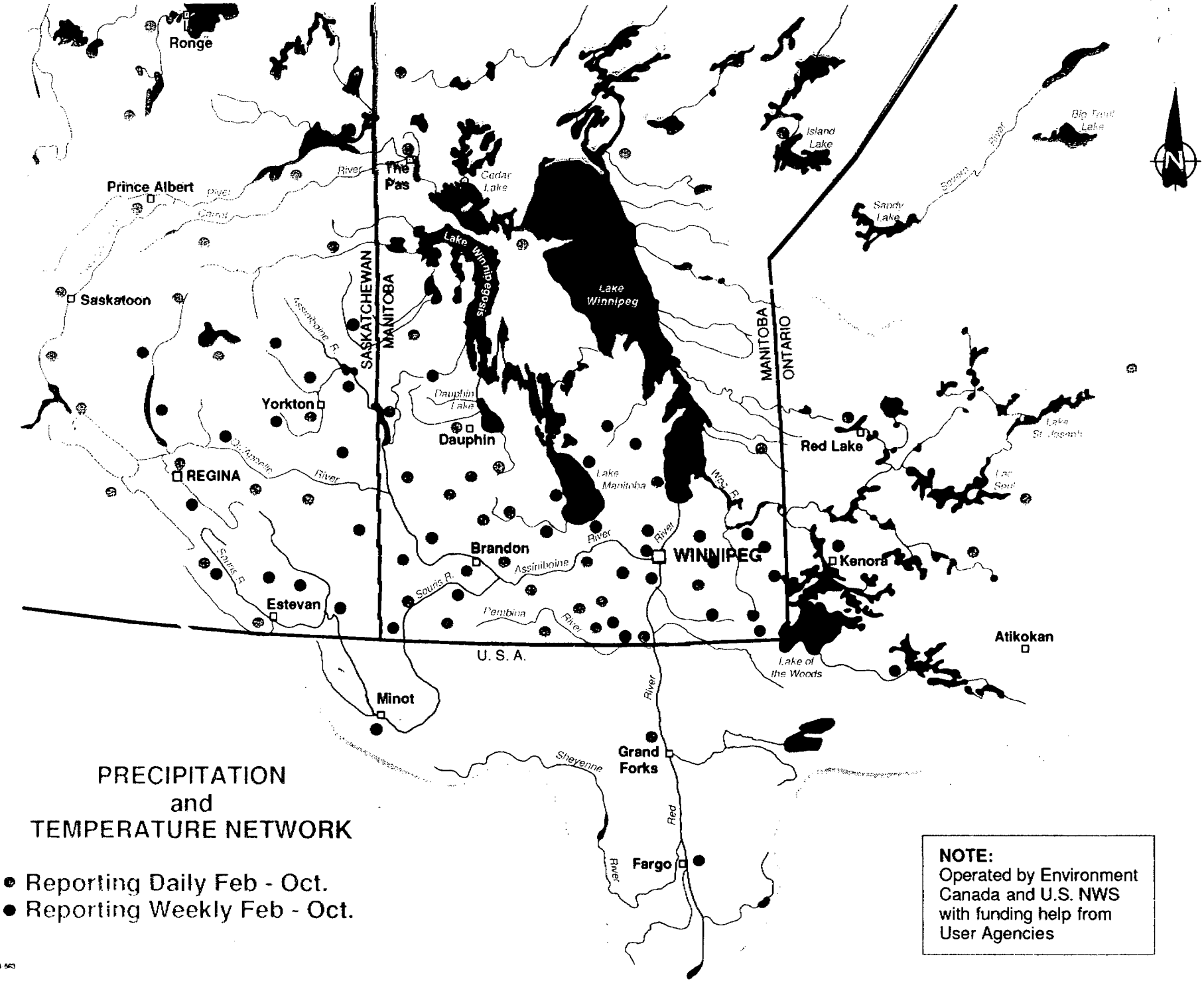
OTHER FACTORS

DEPTH OF SOIL FROST

WATER CHANGES IN SOIL MOISTURE

EXTENT OF SNOW DRIFTING

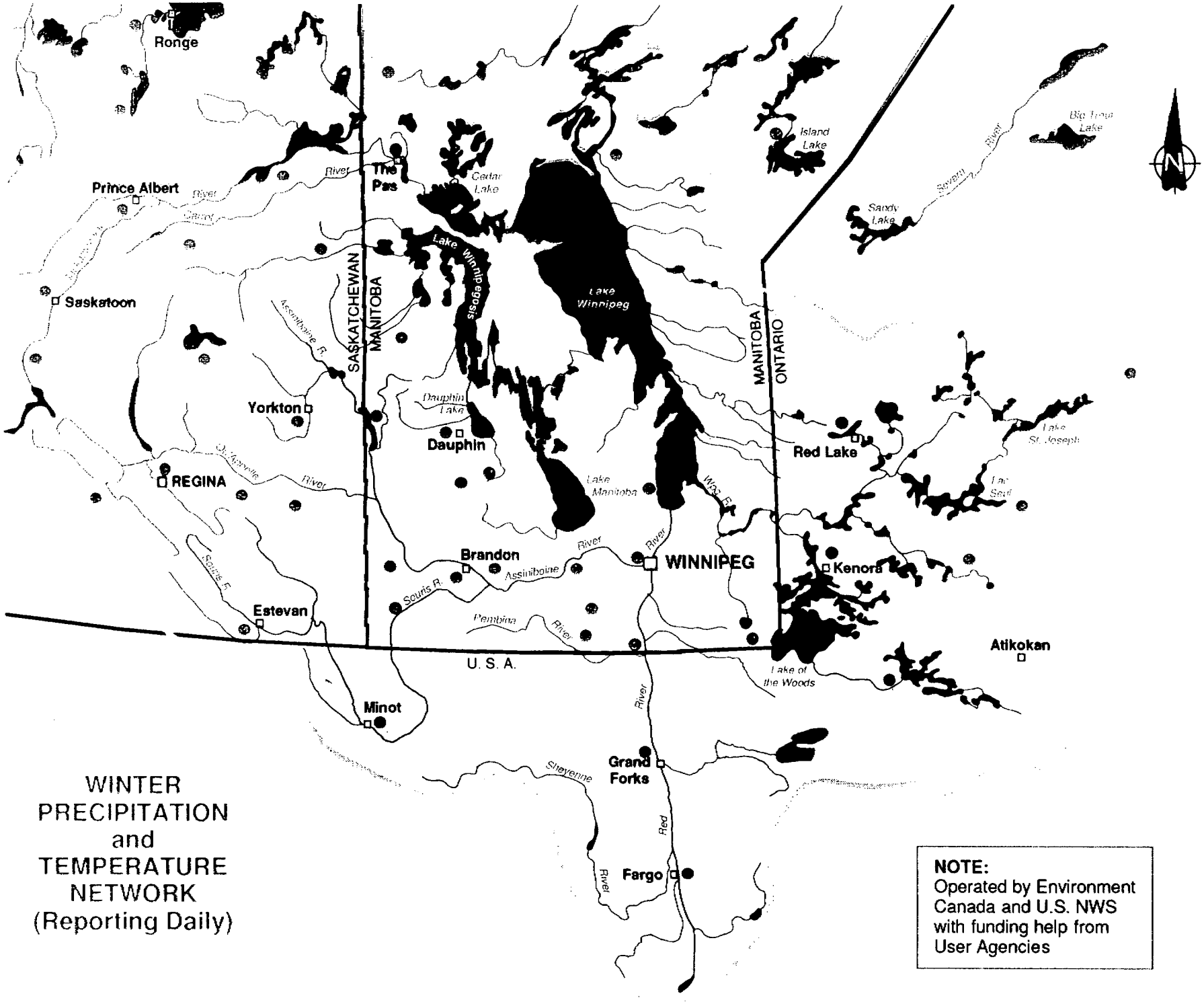
SURFACE DEPRESSION STORAGE



PRECIPITATION and TEMPERATURE NETWORK

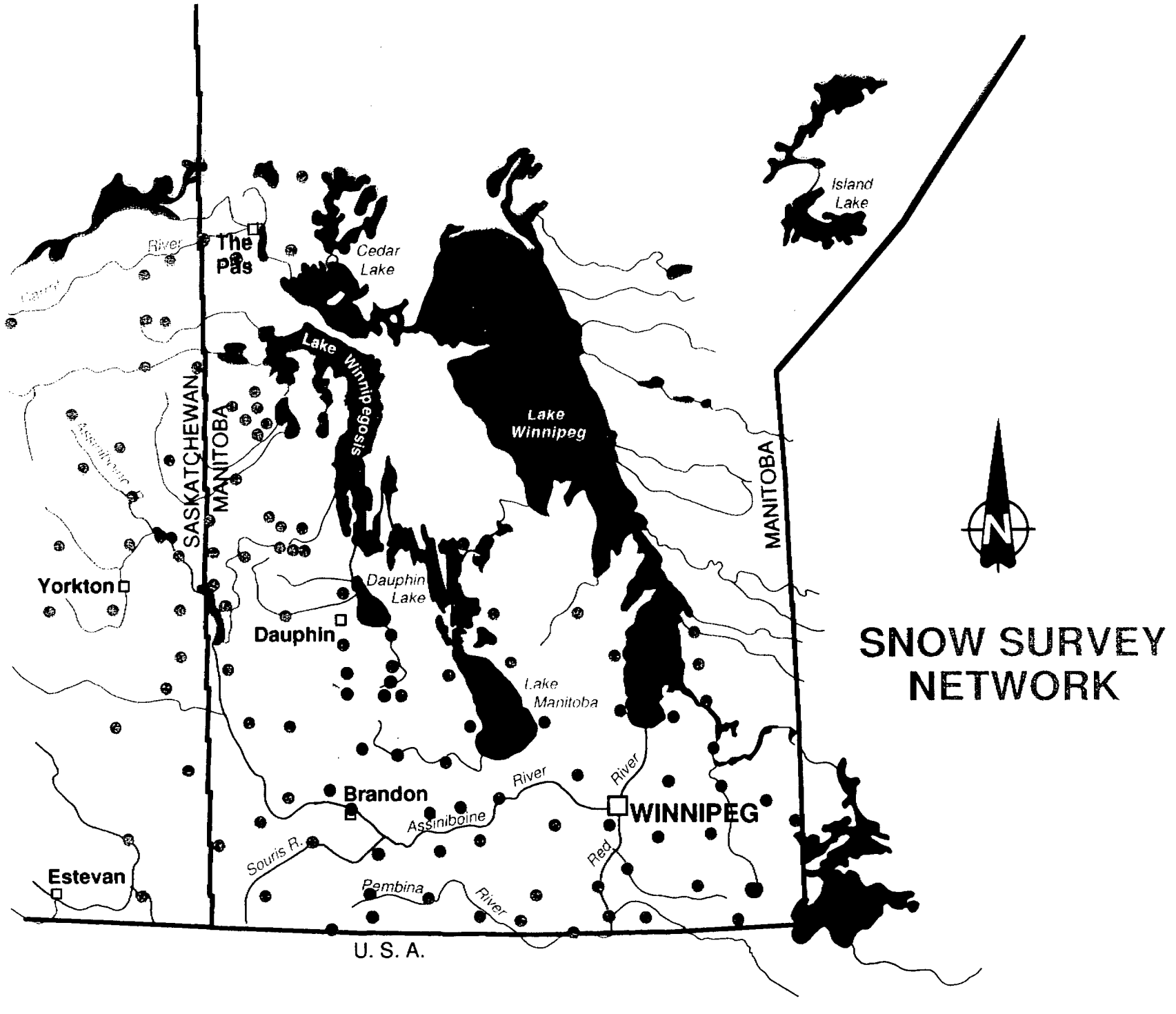
- Reporting Daily Feb - Oct.
- Reporting Weekly Feb - Oct.

NOTE:
Operated by Environment Canada and U.S. NWS with funding help from User Agencies



WINTER PRECIPITATION and TEMPERATURE NETWORK (Reporting Daily)

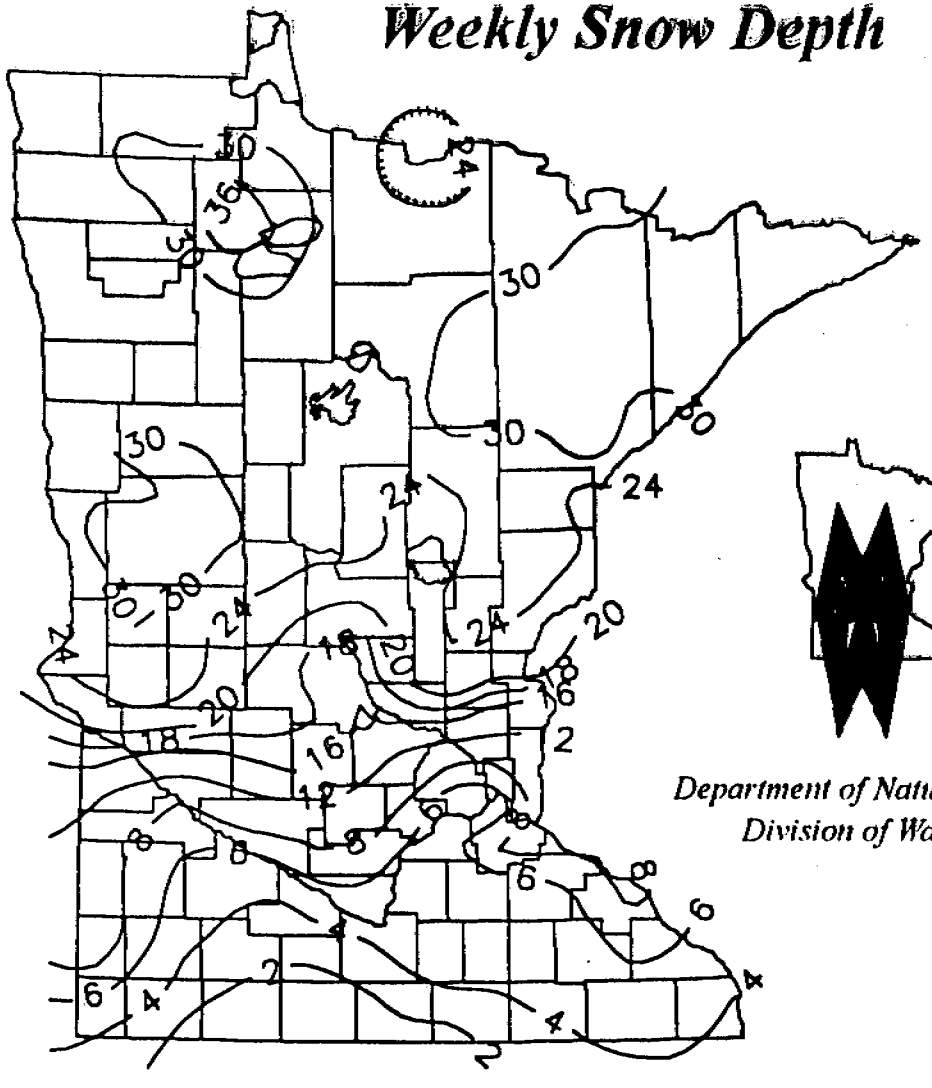
NOTE:
Operated by Environment Canada and U.S. NWS with funding help from User Agencies


Island Lake
The Pas
Cedar Lake
Lake Winnipegosis
Lake Winnipeg
SASKATCHEWAN
MANITOBA
MANITOBA
Yorkton
Dauphin Lake
Dauphin
Lake Manitoba
Brandon
Assiniboine River
Red River
WINNIPEG
Souris R.
Pembina River
Estevan
U. S. A.
N
SNOW SURVEY NETWORK

2MB-563

For 8 am, March 13, 1997

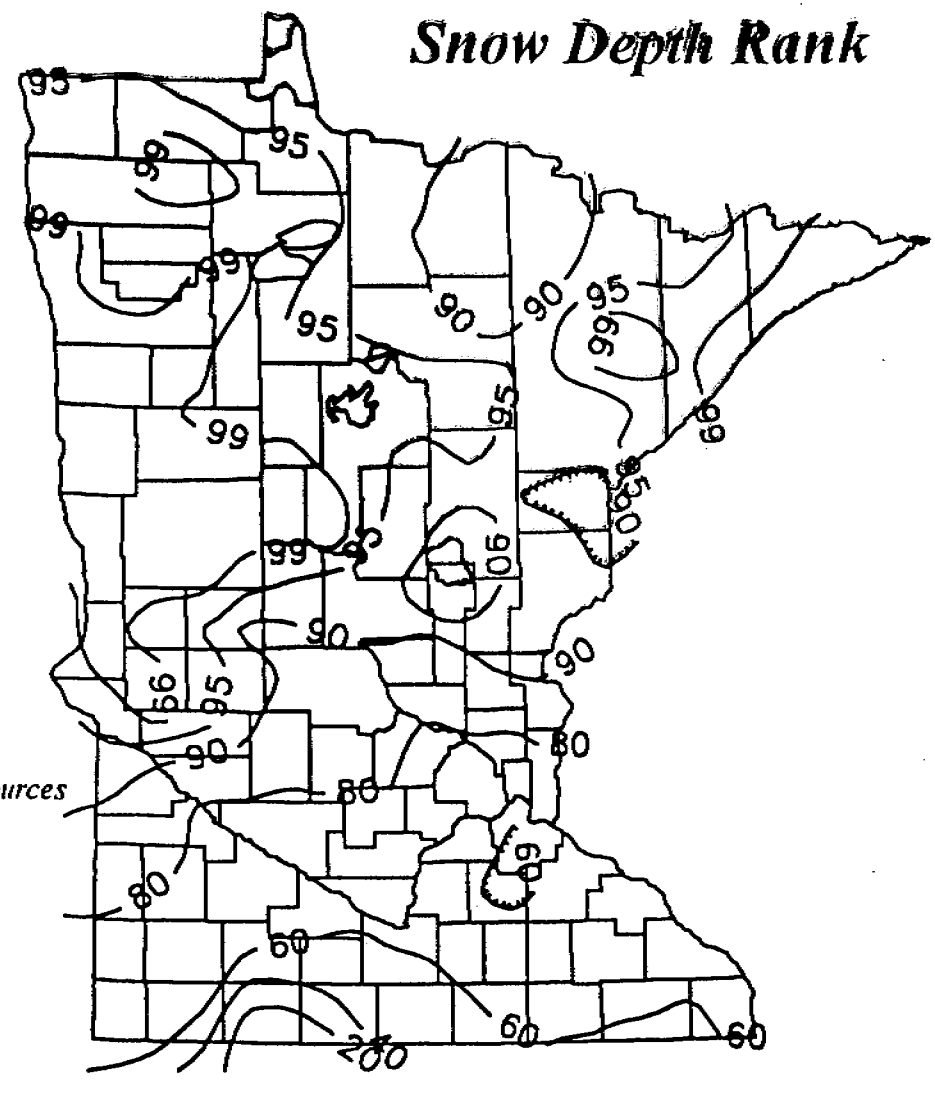
Weekly Snow Depth



Department of Natural Resources
Division of Waters

Values are in inches
Snow depths are generally measured on grassy, protected areas

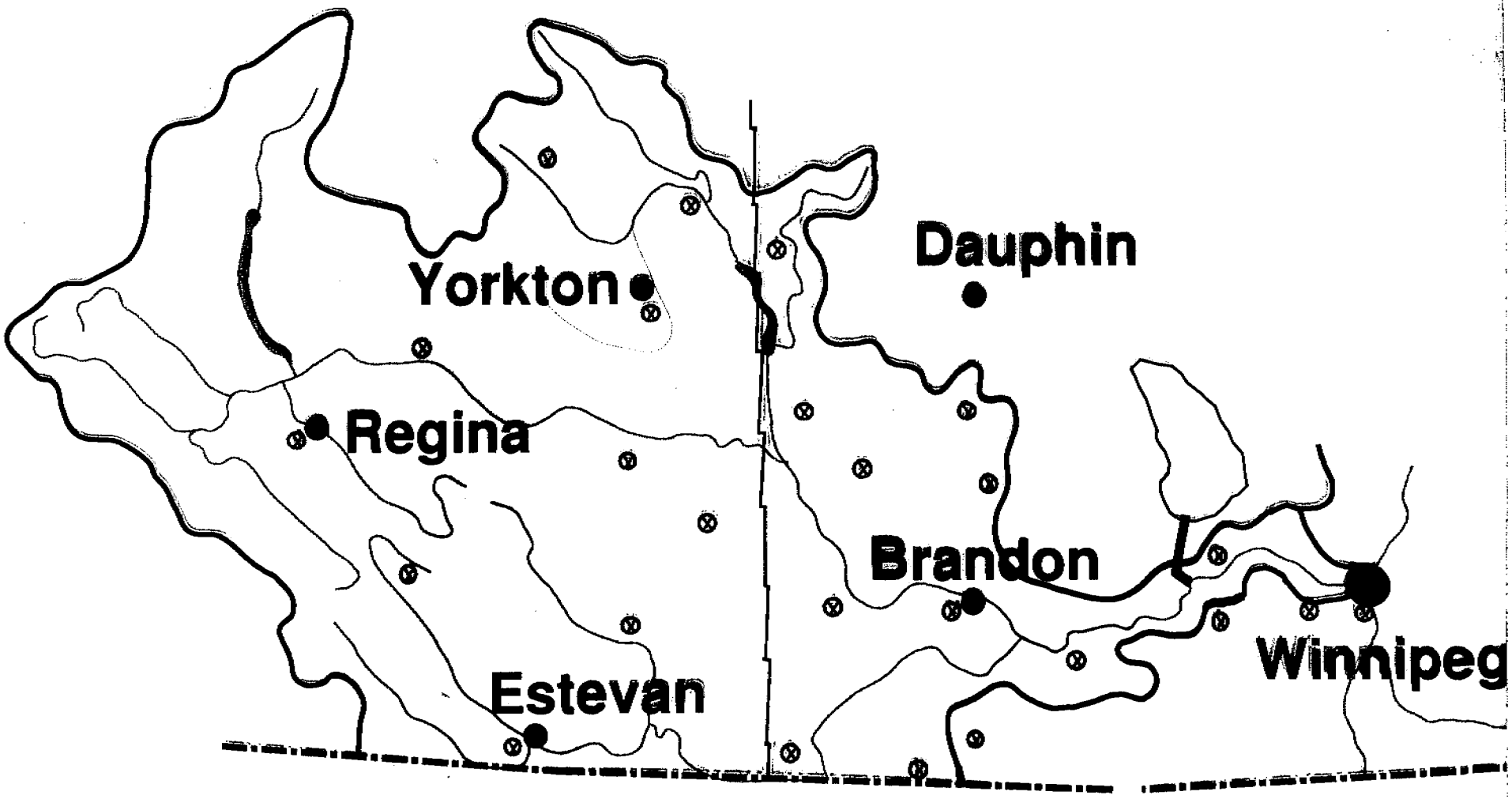
Snow Depth Rank



Values are a ranking relative to historical record
for this date: 0 = lowest, 100 = highest

Data: National Weather Service, Department of Natural Resources
Prepared by: State Climatology Office, DNR - Division of Waters

URL: http://www.soils.agri.umn.edu/research/climatology



SOIL MOISTURE NETWORK (1955 - 1993)

ANTECEDENT PRECIPITATION INDEX (API)

WEIGHTED MONTHLY PRECIPITATION (May - October)

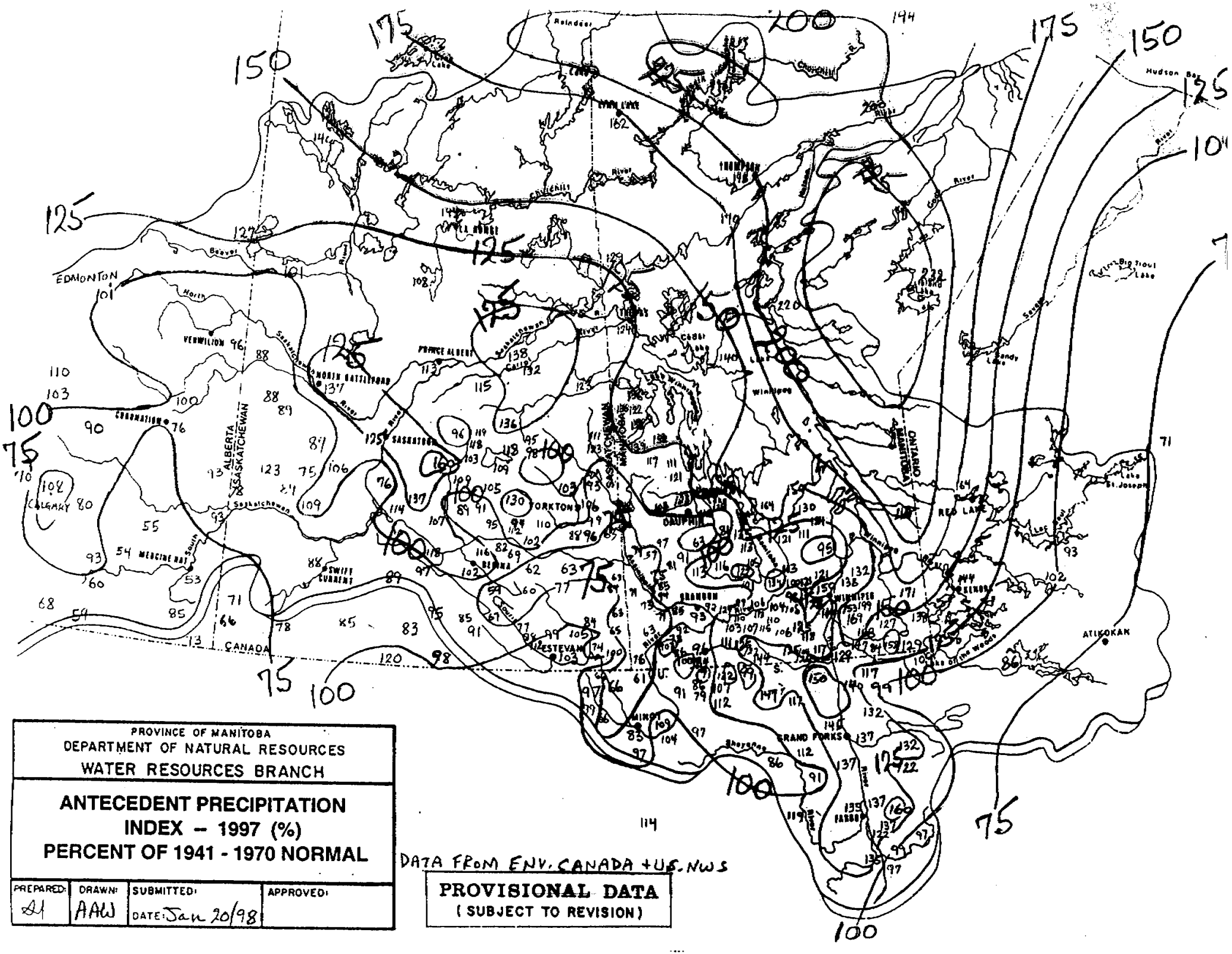
	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
Weight	0.07	0.08	0.12	0.18	0.25	0.30

$$API = \frac{\text{Observed May}}{\text{Normal May}} \times 0.07$$

$$+ \frac{\text{Observed June}}{\text{Normal June}} \times 0.08$$

$$\vdots$$

$$+ \frac{\text{Observed October}}{\text{Normal October}} \times 0.30$$



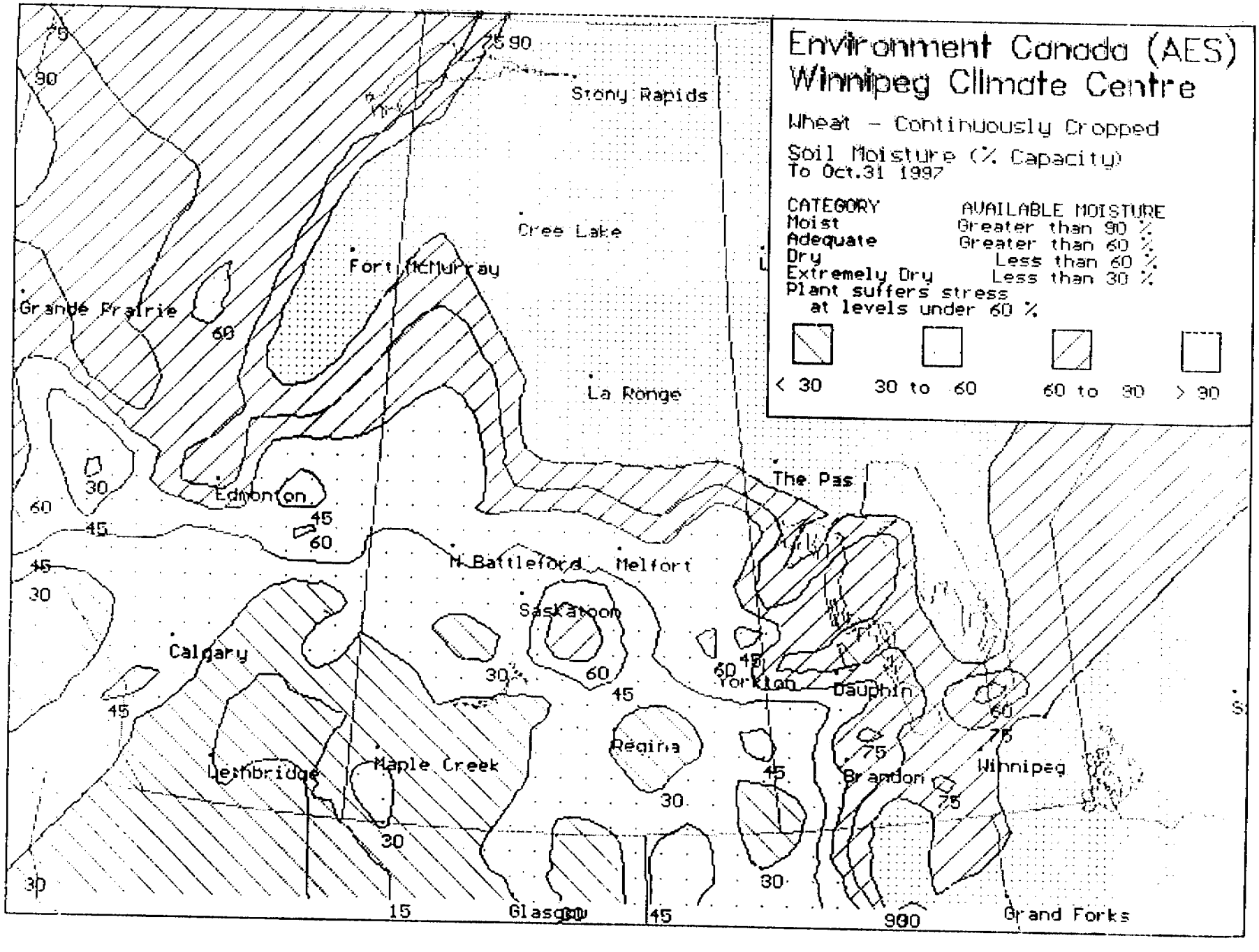
PROVINCE OF MANITOBA
DEPARTMENT OF NATURAL RESOURCES
WATER RESOURCES BRANCH

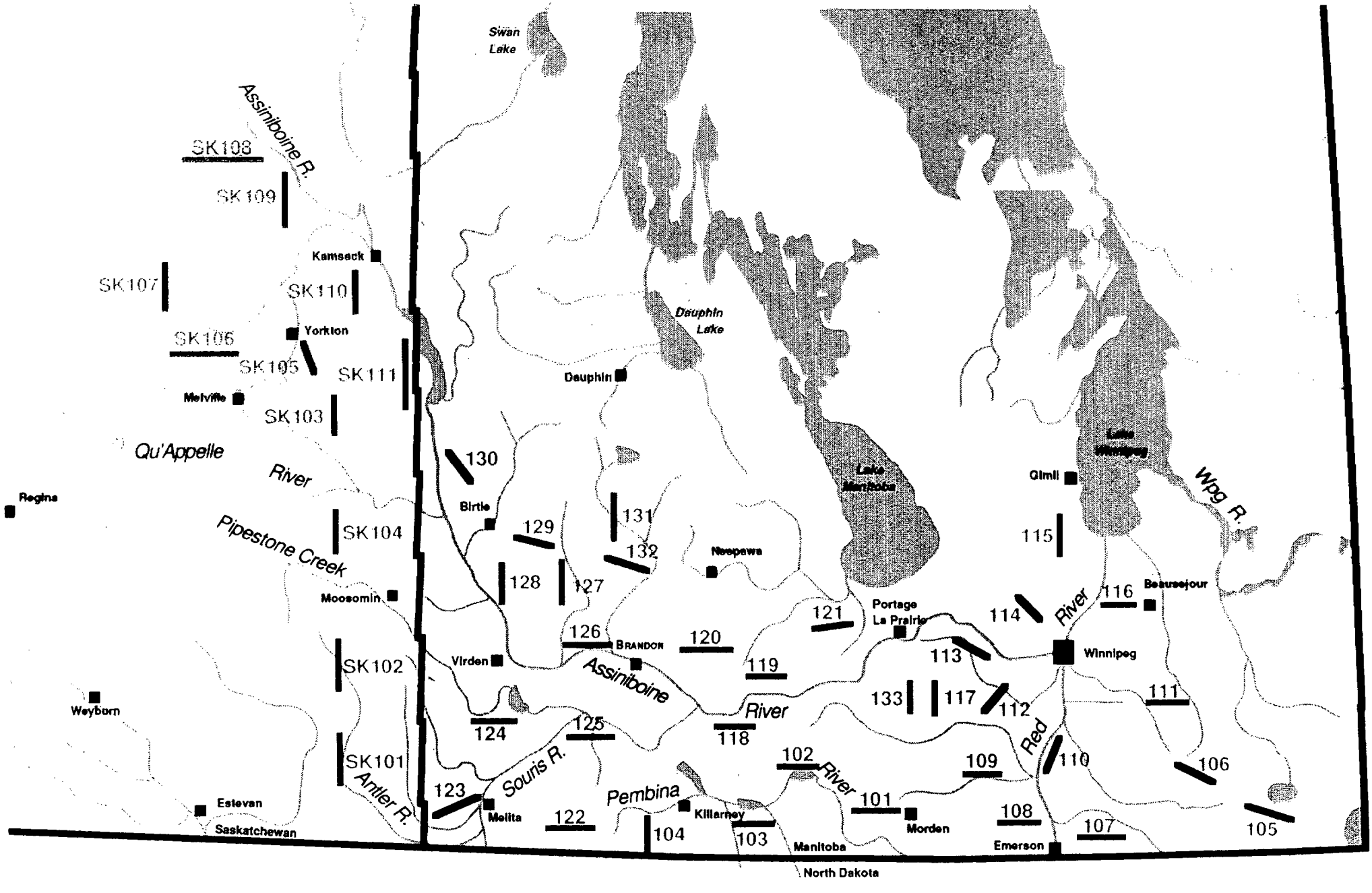
ANTECEDENT PRECIPITATION INDEX -- 1997 (%)
PERCENT OF 1941 - 1970 NORMAL

PREPARED:	DRAWN:	SUBMITTED:	APPROVED:
AA	AAW	DATE: Jan 20/98	

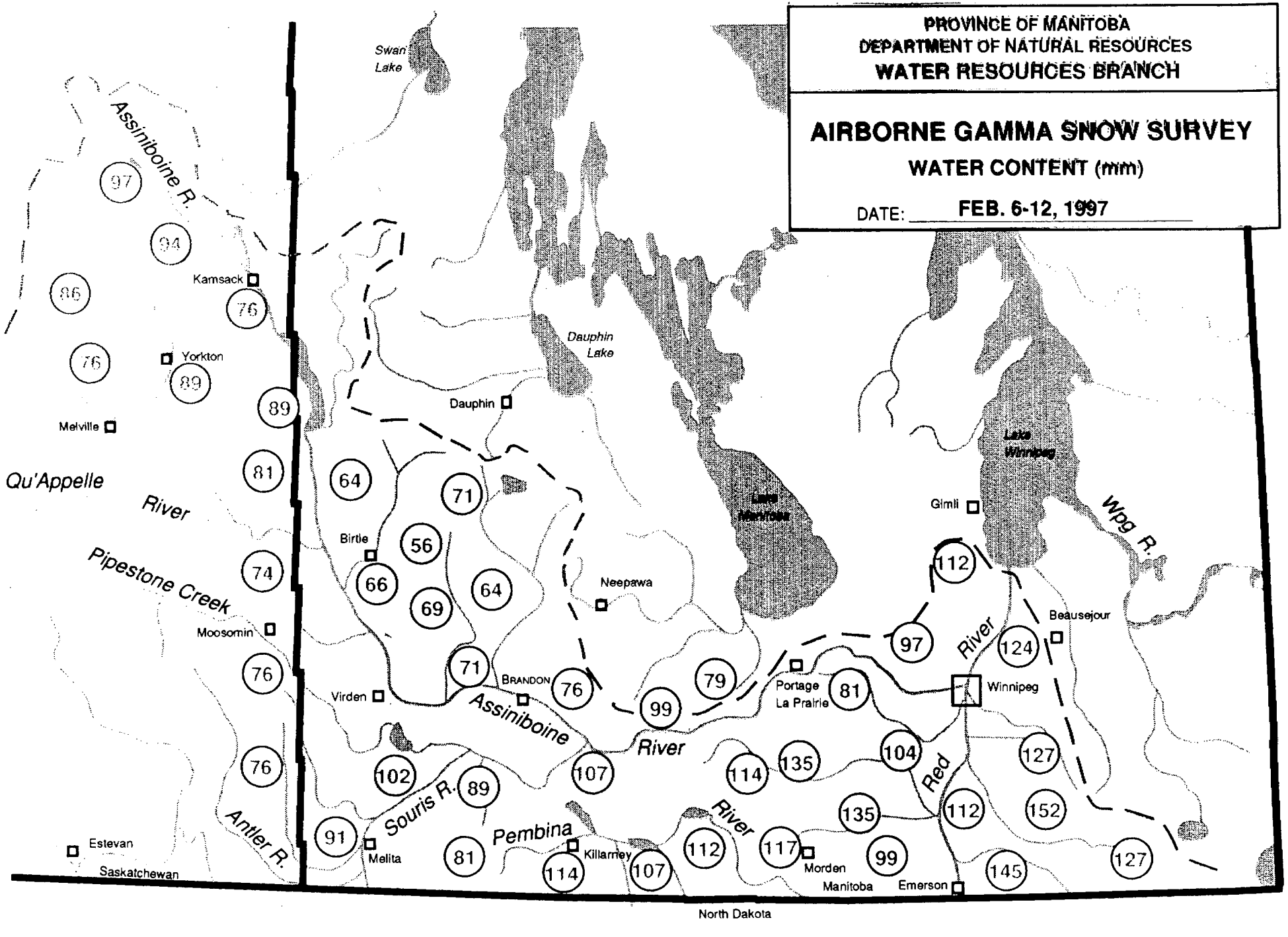
DATA FROM ENV. CANADA + U.S. NWS

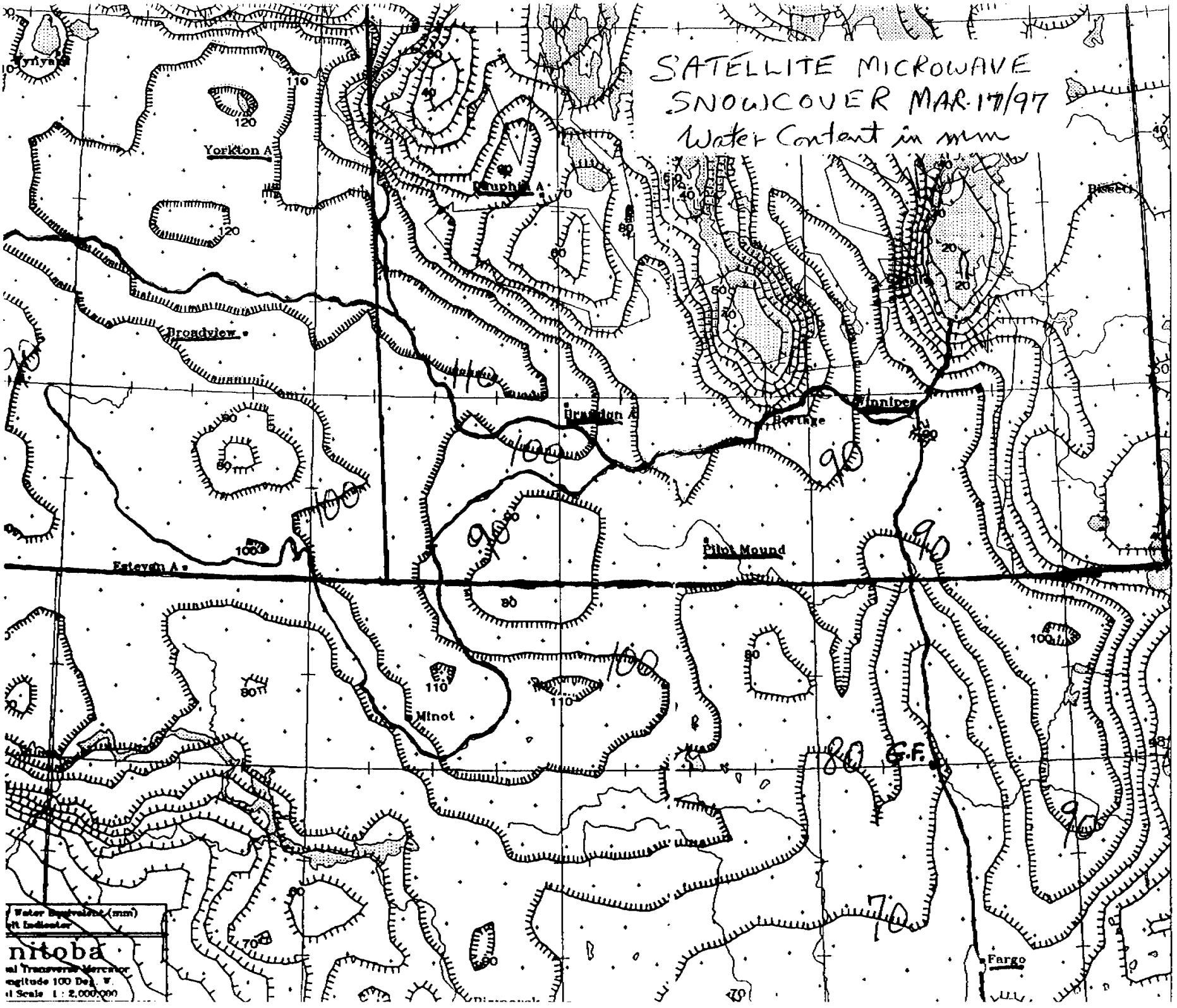
PROVISIONAL DATA
(SUBJECT TO REVISION)

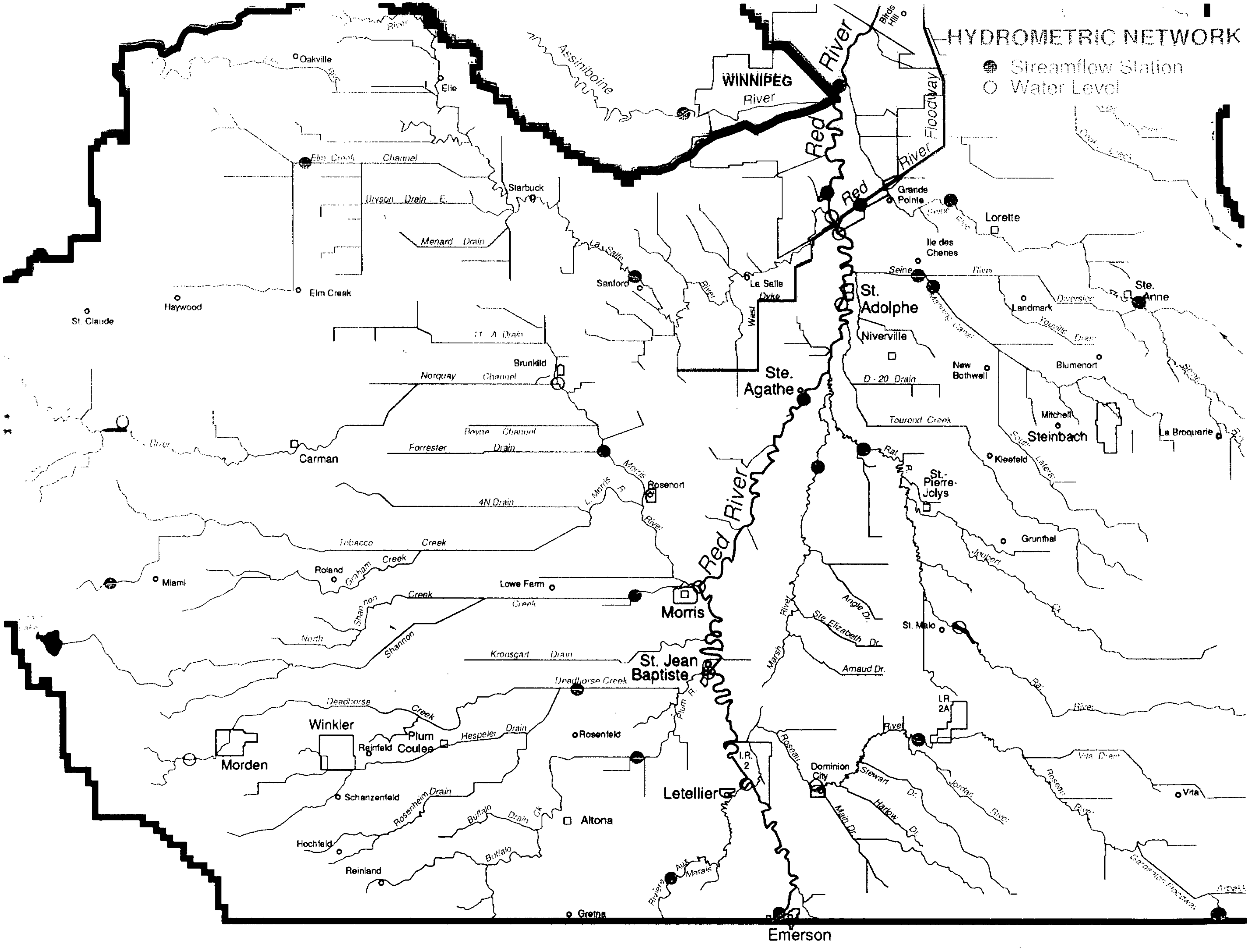

Environment Canada (AES)
Winnipeg Climate Centre
Wheat - Continuously Cropped
Soil Moisture (% Capacity)
To Oct.31 1997
CATEGORY AVAILABLE MOISTURE
Moist Greater than 90 %
Adequate Greater than 60 %
Dry Less than 60 %
Extremely Dry Less than 30 %
Plant suffers stress at levels under 60 %
< 30
30 to 60
60 to 90
> 90
Stony Rapids
Cree Lake
Fort McMurray
Grande Prairie
La Ronge
The Pas
Edmonton
N.Battleford
Melfort
Saskatoon
Calgary
Yorkton
Dauphin
Regina
Lethbridge
Maple Creek
Brandon
Winnipeg
Glasgow
Grand Forks

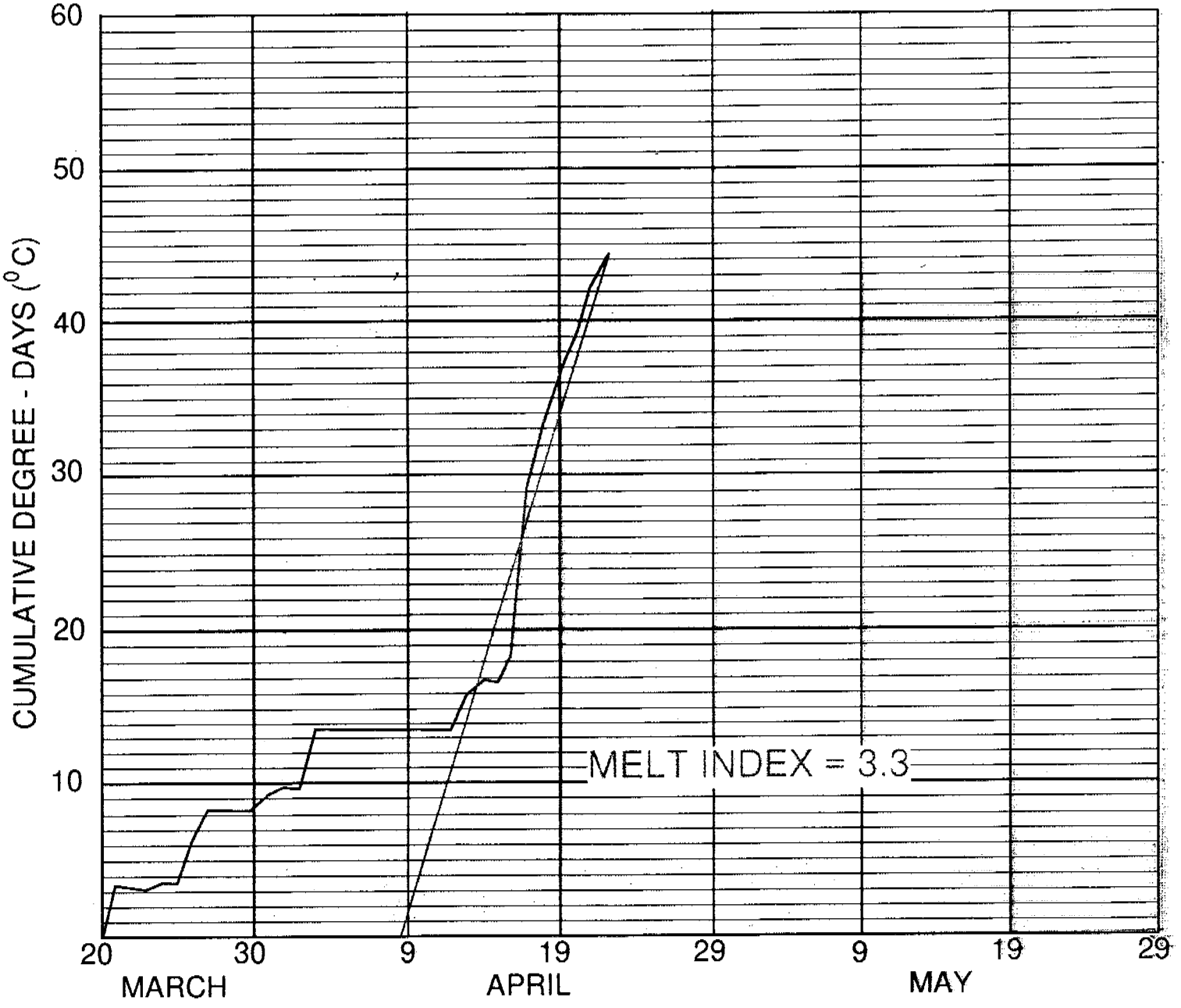


GAMMA SURVEY FLIGHT LINES


PROVINCE OF MANITOBA
DEPARTMENT OF NATURAL RESOURCES
WATER RESOURCES BRANCH
AIRBORNE GAMMA SNOW SURVEY
WATER CONTENT (mm)
DATE: FEB. 6-12, 1997
Swan Lake
Assiniboine R.
Kamsack
Yorkton
Melville
Dauphin Lake
Dauphin
Lake Winnipeg
Lake Manitoba
Gimli
Wpg R.
Qu'Appelle River
Pipestone Creek
Moosomin
Birtle
Neepawa
Beausejour
Virden
BRANDON
Assiniboine River
Portage La Prairie
Winnipeg
Red River
Souris R.
Pembina River
Antler R.
Estevan
Saskatchewan
Melita
Killarney
Morden
Manitoba
Emerson
North Dakota
97
94
86
76
89
81
64
71
56
66
69
74
99
79
102
107
114
135
104
127
112
152
91
117
145
2MB-563


SATELLITE MICROWAVE
SNOWCOVER MAR. 17/97
Water Content in mm
Yorkton A
Broadview
Estevan A
Pilot Mound
Minot
Fargo
Winnipeg
Portage
Brandon A
Water Equivalent (mm)
nitoba


HYDROMETRIC NETWORK
Streamflow Station
Water Level
WINNIPEG
Red River
Assiniboine
Floodway
Birds Hill
Oakville
Elie
Elm Creek Channel
Dryson Drain E.
Starbuck
Menard Drain
La Salle River
Sanford
La Salle
West Dyke
Elm Creek
Haywood
St. Claude
Grande Pointe
Lorette
Ile des Chenes
Seine River
St. Adolphe
Ste. Anne
Landmark
Diversion
Niverville
Blumenort
New Bothwell
D - 20 Drain
11 A Drain
Brunkild
Norquay Channel
Ste. Agathe
Carman
Boyne Channel
Forrester Drain
Tourond Creek
Mitchell
Steinbach
La Broquerie
Kleefeld
Rat R.
St.-Pierre-Jolys
Morris
Rosenort
4N Drain
L. Morris R.
River
Grunthal
Joubert
Tobacco Creek
Graham Creek
Roland
Miami
Lowe Farm
Shannon Creek
North
Shannon
Morris
Angle Dr.
Ste. Elizabeth Dr.
St. Malo
Krongsart Drain
St. Jean Baptiste
Marsh River
Amaud Dr.
Deadhorse Creek
Deadhorse Creek
Winkler
Plum Coulee
Hespeler Drain
Reinfeld
Rosenfeld
Plum R.
I.R. 2A
Vita Drain
Morden
I.R. 2
Roseau
Dominion City
Stewart Dr.
Jordan River
Vita
Letellier
Schanzenfeld
Rosenheim Drain
Buffalo Drain Ck
Altona
Main Dr.
Harlow Dr.
Hochfeld
Reinland
Buffalo
Riviere Aux Marais
Gretna
Emerson



MELT INDEX CALCULATION
YORKTON

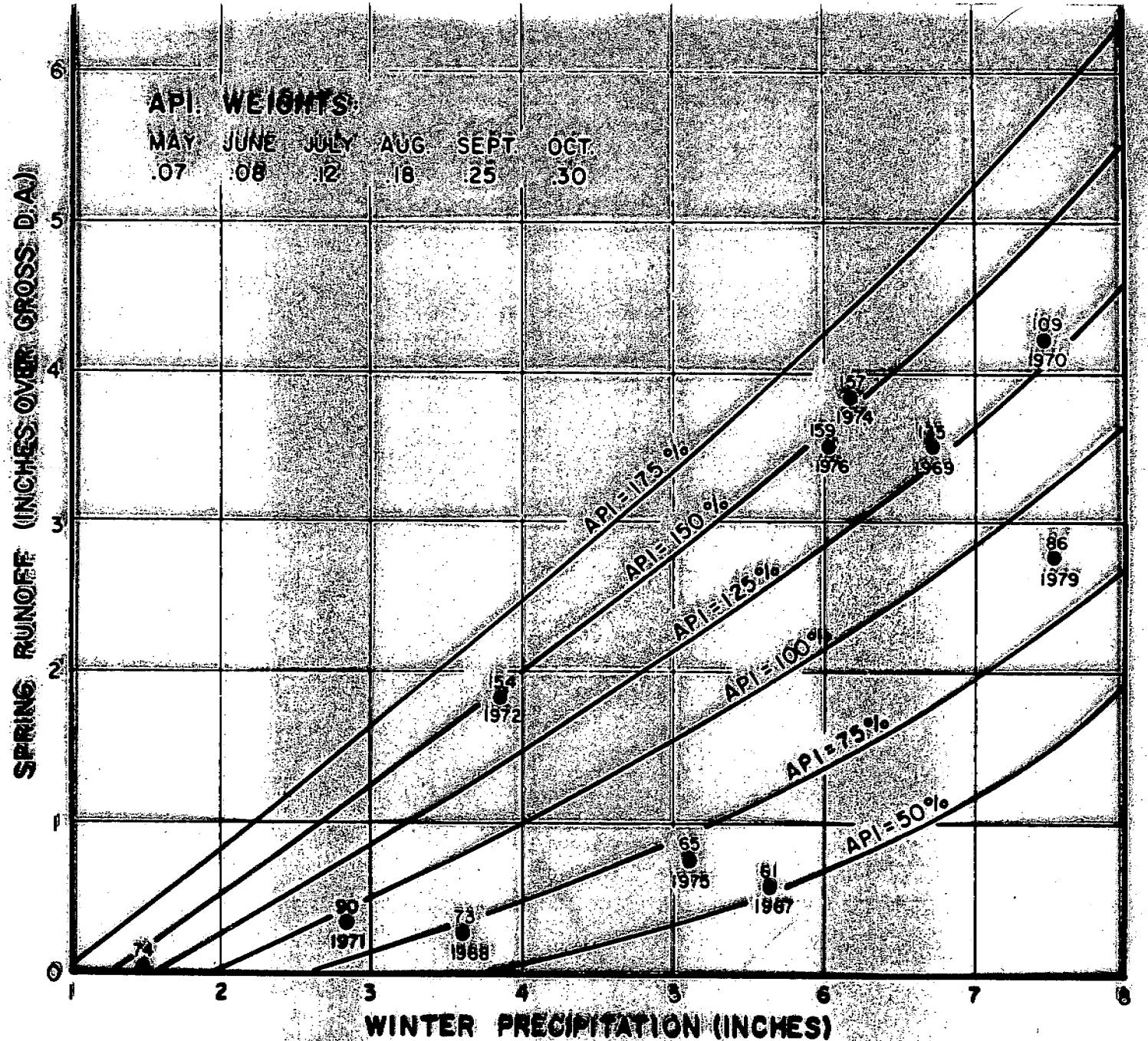
FLOOD FORECAST METHODOLOGIES

1. RUNOFF FORECASTING

- EMPIRICAL EVENT MODEL
  - STATISTICAL
  - GRAPHICAL
- PARAMETERS IDENTIFIED USING:
  - HYDROLOGIC CONSIDERATIONS
  - INFORMATION FROM PAST EVENTS
  - TRIAL & ERROR

2. RIVER FLOW & STAGE FORECASTING

- TRIBUTARY HYDROGRAPHS EXTENDED USING UPSTREAM HYDROMETRIC DATA, UNIT HYDROGRAPHS ETC.
- STREAMFLOW ROUTING USED FOR BOTH OUTLOOKS & OP. FORECASTING OF LARGE RIVERS



MANAPI GRAPHICAL MODEL FOR WILLOW CREEK WATERSHED

FIGURE

FIGURE

SPRING RUNOFF FORECASTING

STATISTICAL APPROACH

$$\text{RUNOFF} = C\, X_1^{k}\, X_2^{l}\, X_3^{m}$$

WHERE:

C = CONSTANT

X_1, X_2, X_3 = THE INDEPENDENT VARIABLES

k, l, m = THE EXPONENTS OBTAINED BY FLETCHER OPTIMIZATION

SPRING RUNOFF FORECASTING - KAMSACK BASIN

1. $RO = 2.65 \times 10^{-8} (P)^{2.65} (MI)^{0.38} (API)^{1.30}$

2. $RO = 3.04 \times 10^{-7} (P)^{2.73} (MI)^{0.47} (SMW)^{0.72}$

3. $RO = 7.66 \times 10^{-8} (P)^{2.52} (MI)^{0.38} (API)^{1.17} (PSR)^{0.09}$

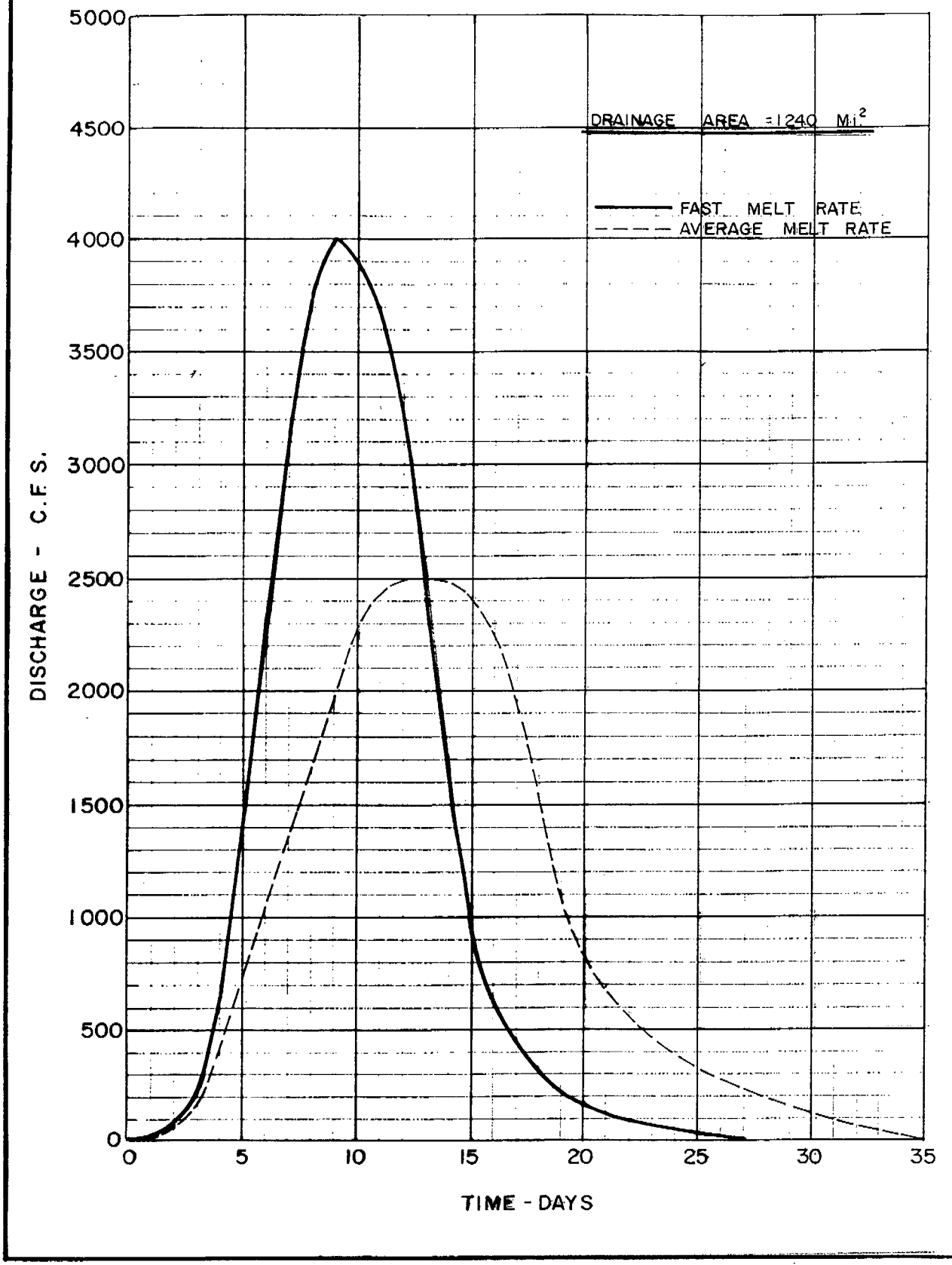
4. $RO = 7.36 \times 10^{-7} (P)^{2.63} (MI)^{0.51} (SMW)^{0.57} (PSR)^{0.10}$

5. $RO = 3.57 \times 10^{-10} (P)^{2.78} (MI)^{0.33} (API)^{1.21} (LUI)^{0.95} (PSR)^{0.09}$

6. $RO = 3.56 \times 10^{-11} (P)^{3.11} (MI)^{0.39} (SMW)^{0.83} (LUI)^{1.61} (PSR)^{0.07}$

RO:	SPRING RUNOFF VOLUME (MM OVER WATERSHED)
P:	WINTER & EFFECTIVE SPRING PRECIPITATION (MM)
MI:	MELT INDEX (AVERAGE DEGREE - DAYS/DAY)
API:	ANTECEDENT PRECIPITATION INDEX
SMW:	E.C. MODELLED SOIL MOISTURE - OCT. 31 - WHEAT (% CAPACITY)
PSR:	PREVIOUS SPRING RUNOFF (MM)
LUI:	LAND USE INDEX (50 IN 1948, 75 IN 1997)

EQUATIONS BASED ON data for 1948-1997



PROVINCE OF MANITOBA

DEPARTMENT OF MINES, NATURAL RESOURCES AND ENVIRONMENT

WATER RESOURCES DIVISION

MUSKINGUM FLOOD ROUTING PROCEDURES FOR RED, ASSINIBOINE, SOURIS

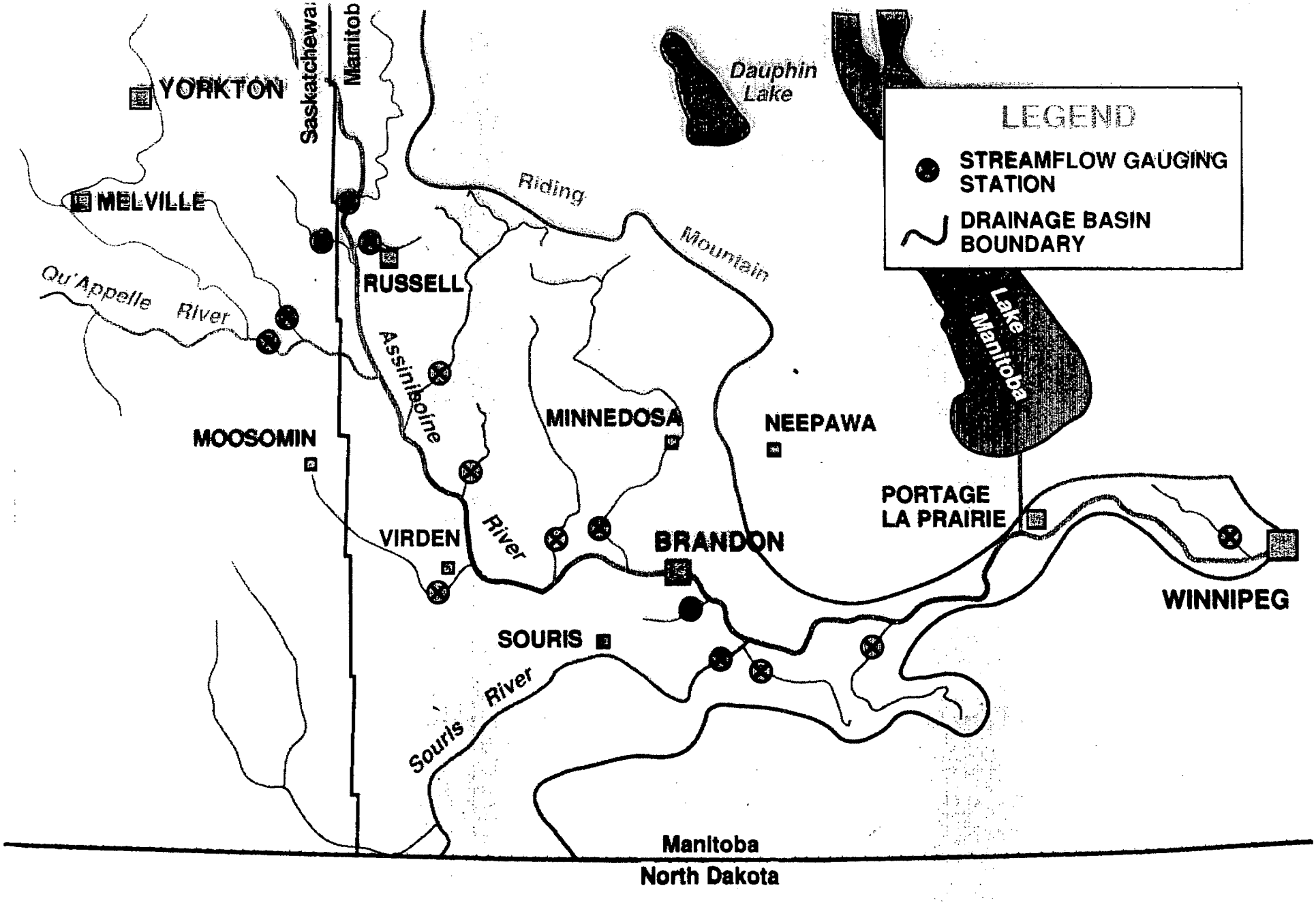
UNIT HYDROGRAPHS OF SNOWMELT

FOR

ANTLER RIVER NEAR MELITA

PREPARED	DRAWN	SUBMITTED	APPROVED
A WARKENTIN	A.W.		

SCALE	DATE	SHEET	FILE NO.



TRIBUTARY FORECAST POINTS FOR FLOOD ROUTING

MUSKINGUM FLOOD ROUTING

FOR RED, ASSINIBOINE, SOURIS

BASED ON EQUATION OF CONTINUITY

AVE. INFLOW - AVE. OUTFLOW = CHANGE IN STORAGE

$$\frac{I_2 + I_2}{2} - \frac{O_1 + O_2}{2} = \frac{S_2 - S_1}{t_2 - t_1}$$

$$S = K [XI + (1 - X) O]$$

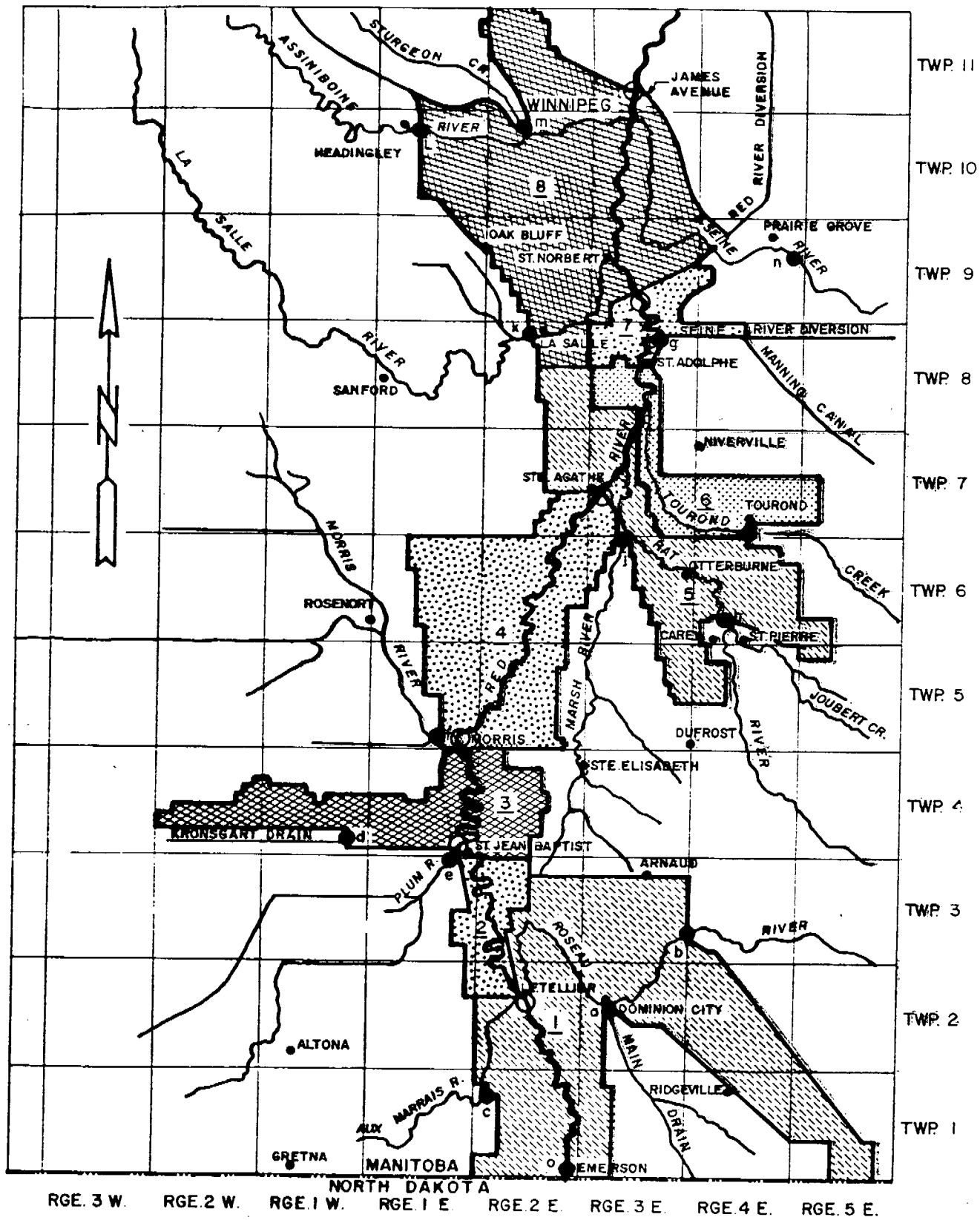
X - - - A MEASURE OF WEDGE STORAGE DUE TO SLOPE OF FLOOD WAVE

K - - - INDICATOR OF BULK OF STORAGE OTHER THAN WEDGE STORAGE

ROUTING FORMULA

$$O_2 = C_1 I_2 + C_2 I_1 + C_3 O_1$$

VALUES OF "C" VARY WITH CHOSEN K AND X VALUES FOR EACH RIVER REACH



LEGEND:

- ● – LOCATION OF HYDROMETRIC STATION REQUIRED FOR INPUT (SEE TABLE 1.)
- 1 TO 8 UNGAUGED AREAS (SHADED)
- ○ – END-OF-REACH LOCATION

PROVINCE OF MANITOBA
DEPARTMENT OF MINES, NATURAL RESOURCES AND ENVIRONMENT
WATER RESOURCES DIVISION

PREPARED	DRAWN	SUBMITTED	APPROVED
A.WARKENTIN	A.W.		DIRECTOR OF PLANNING
	CHECKED		

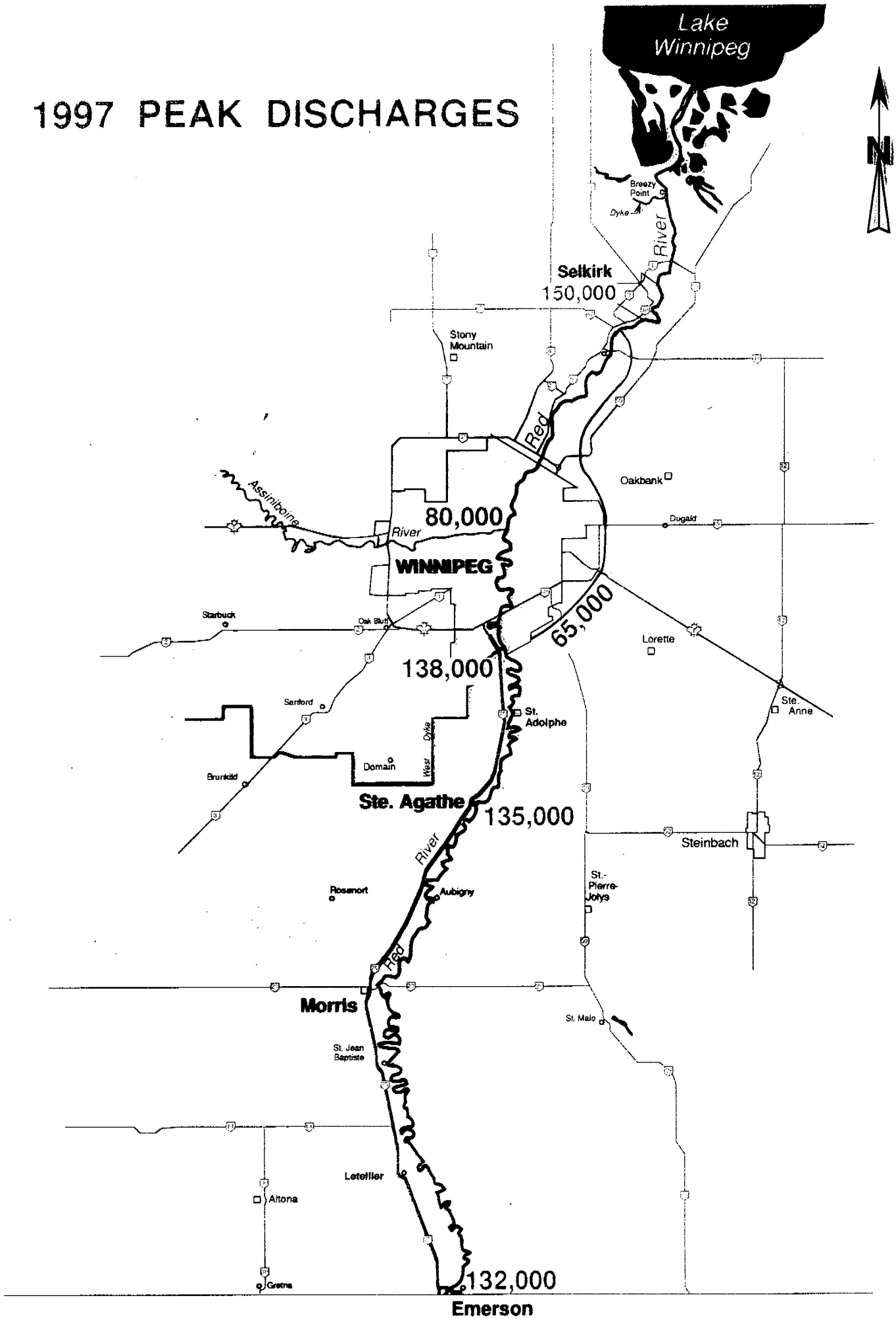
MUSKINGUM FLOOD ROUTING PROCEDURES FOR RED, ASSINIBOINE, SOURIS

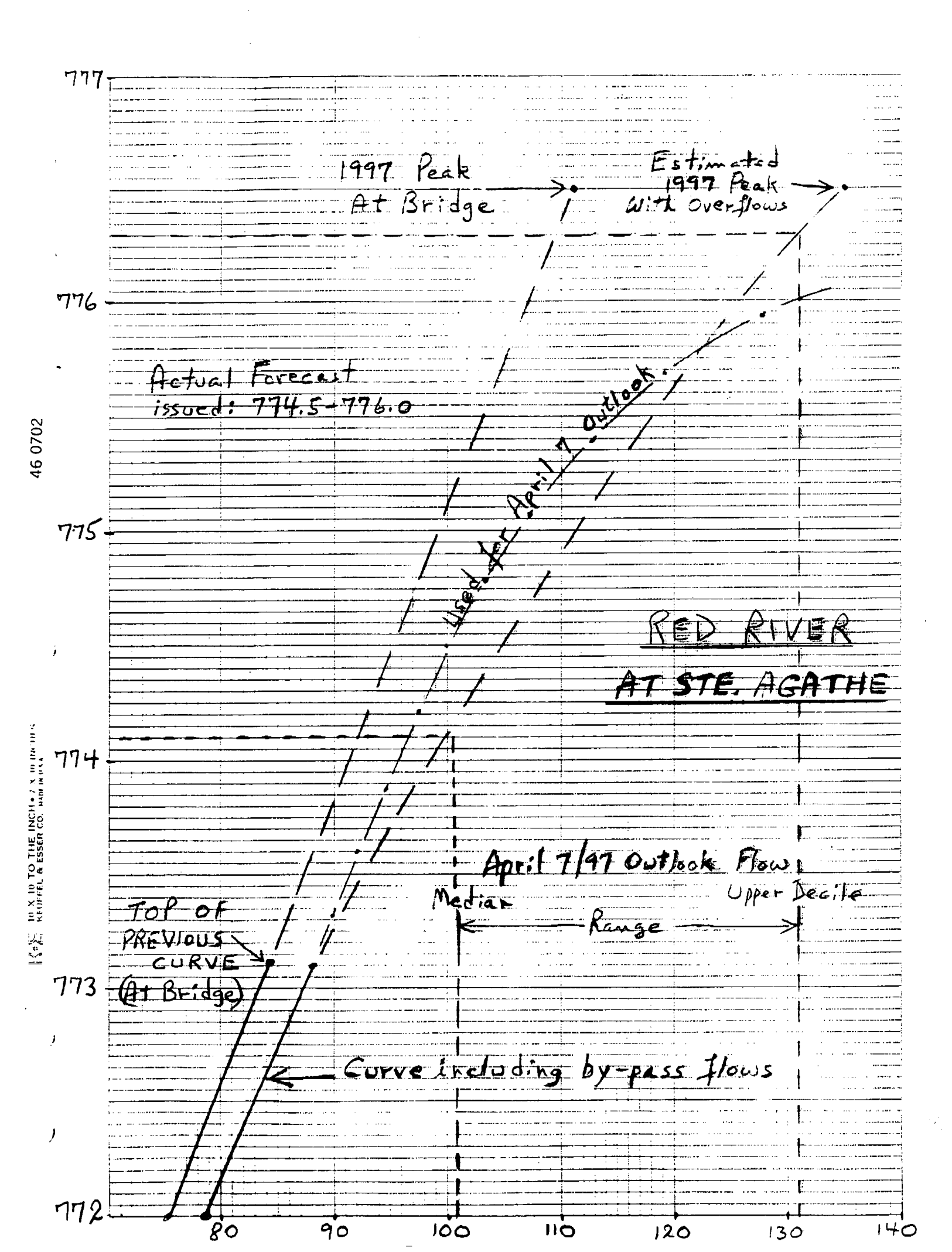
RED RIVER - UNGAUGED AREA AND INPUT HYDROMETRIC STATION LOCATIONS

SCALE	DATE	SHEET	FILE NO.
AS SHOWN		OF	

FIG. 1

1997 PEAK DISCHARGES




777
776
775
774
773
772
1997 Peak
At Bridge
Estimated
1997 Peak
With Overflows
Actual Forecast
issued: 774.5-776.0
Used for April 7 Outlook
RED RIVER
AT STE. AGATHE
April 7/97 Outlook Flow
Median
Range
Upper Decile
TOP OF
PREVIOUS
CURVE
(At Bridge)
Curve including by-pass flows
80
90
100
110
120
130
140
46 0702
10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

UNKNOWNS
FOR SPRING RUNOFF OUTLOOKS

- **ADDITIONAL SNOW (OR LOSSES)**
- **DATE OF BREAKUP**
- **AMOUNT OF SPRING RAIN**
- **MELT RATE**

STATISTICAL TERMINOLOGY

LOWER DECILE

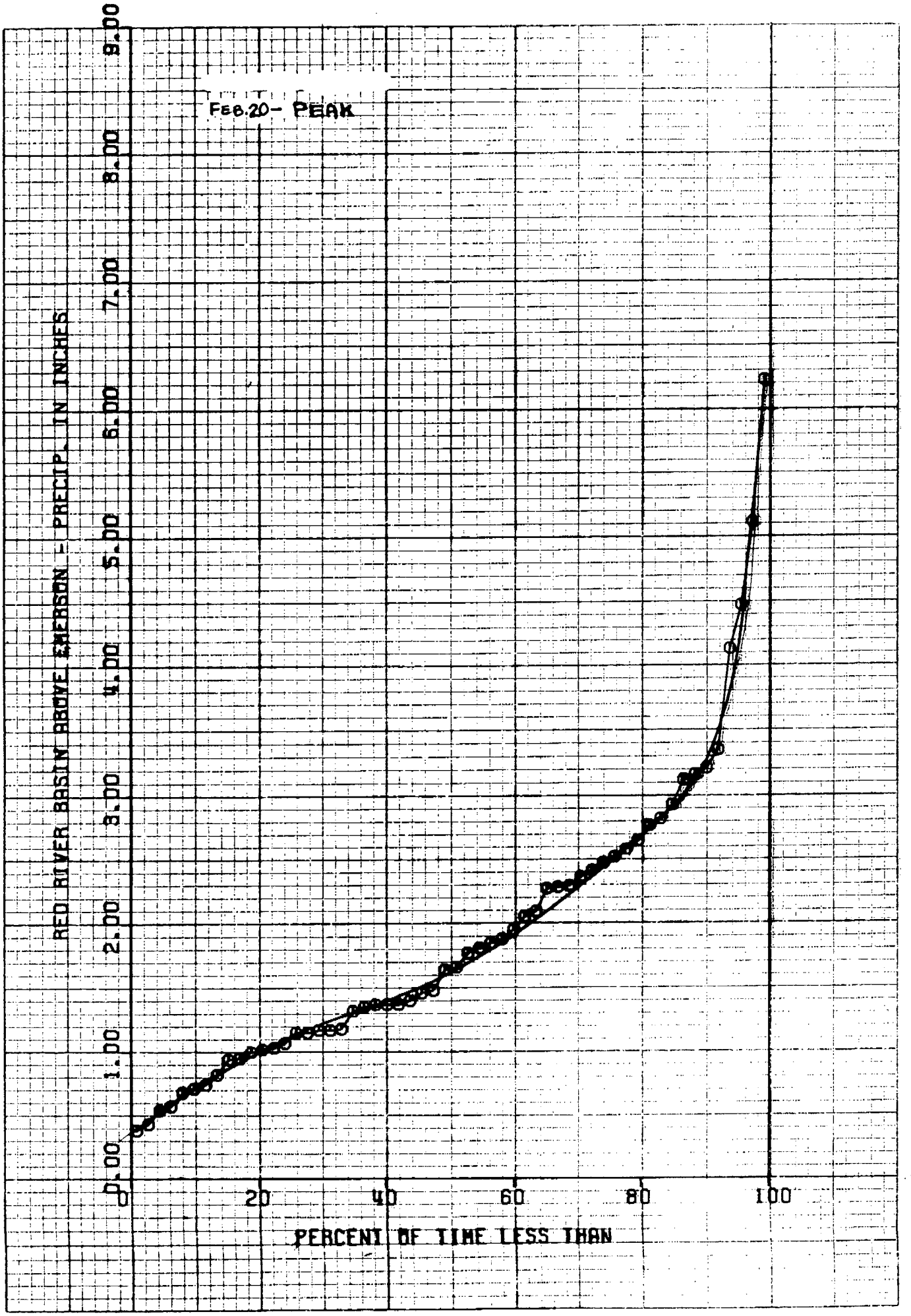
THAT VALUE OF A LONG DATA SET WHICH HAS BEEN EXCEEDED 90% OF THE TIME

MEDIAN

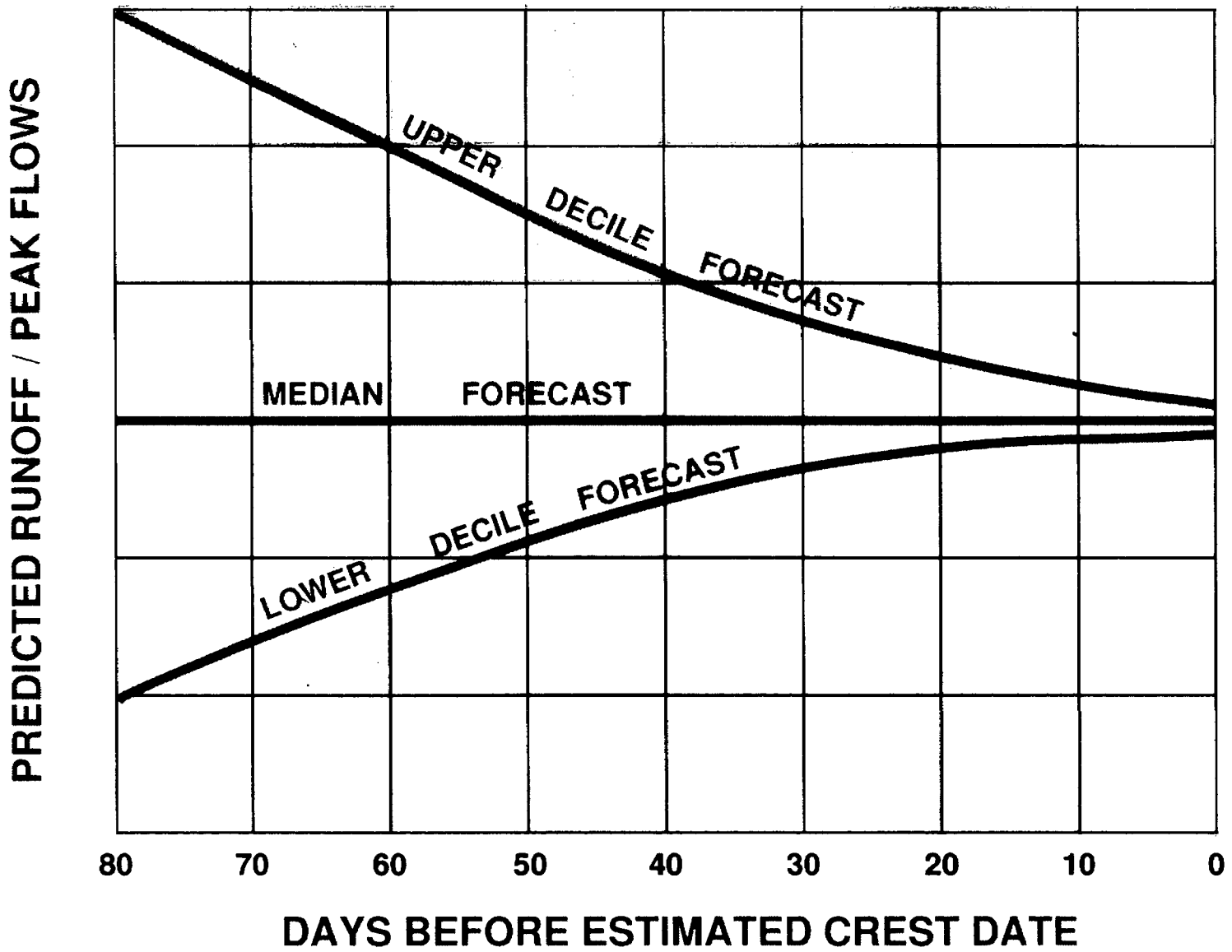
THAT VALUE OF A LONG DATA SET WHICH HAS BEEN EXCEEDED 50% OF THE TIME

UPPER DECILE

THAT VALUE OF A LONG DATA SET WHICH HAS BEEN EXCEEDED 10% OF THE TIME


FEB.20- PEAK
RED RIVER BASIN ABOVE EMERSON - PRECIP. IN INCHES
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0
20
40
60
80
100
PERCENT OF TIME LESS THAN

PROBABILISTIC FORECASTING FOR NORMAL WEATHER SCENARIO



SPRING FLOOD FORECAST TYPES AND TIMETABLES

1. FLOOD OUTLOOKS - ISSUED FEBRUARY & MARCH

- **BASED ON EXISTING SOIL MOISTURE, SNOWCOVER**

- **FUTURE WEATHER AT:**

  LOWER DECILE

  MEDIAN

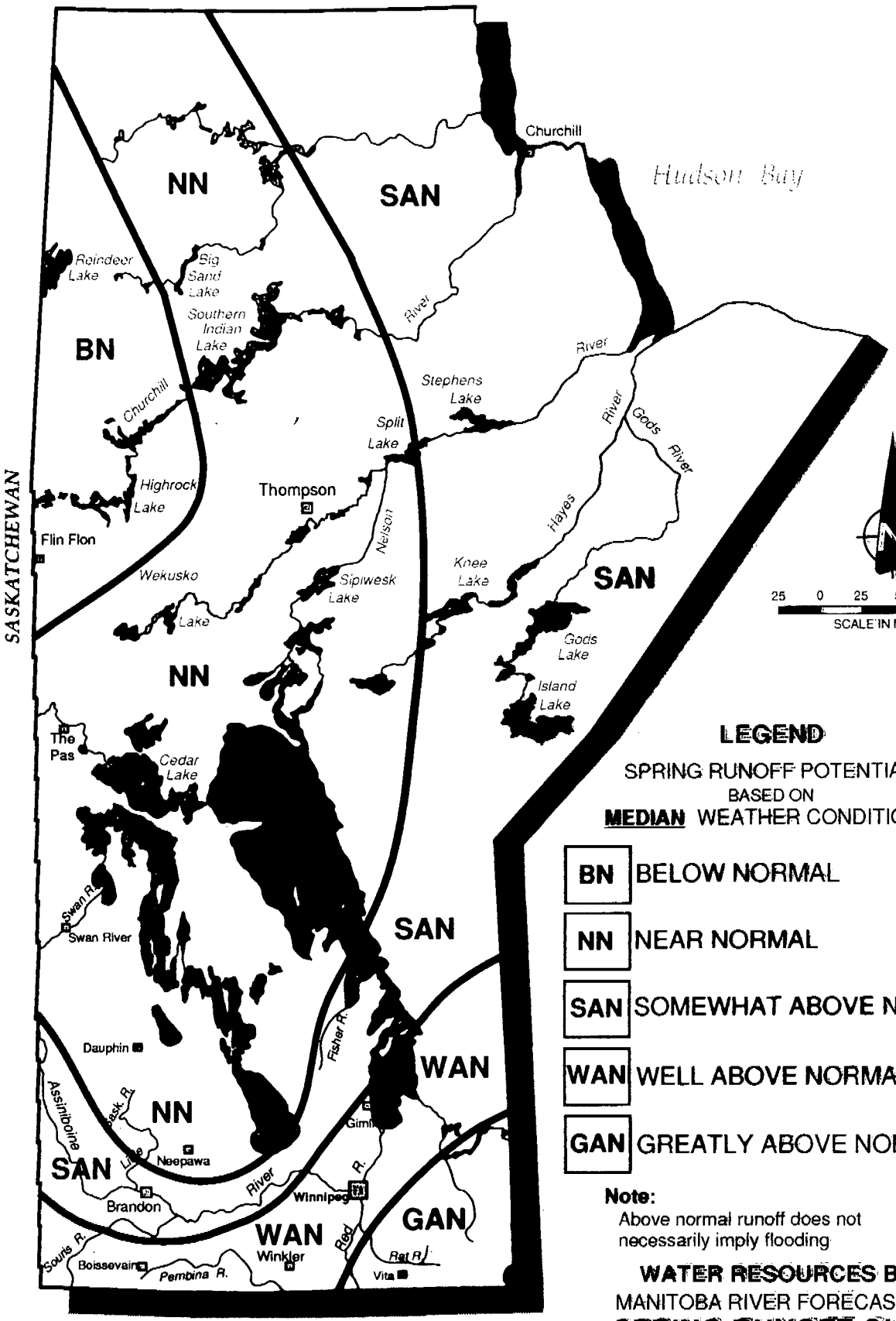
  UPPER DECILE

2. OPERATIONAL FORECASTS - ISSUED DAILY DURING SPRING RUNOFF

- **BASED ON OBSERVED AS WELL AS PREDICTED RUNOFF & STREAMFLOW**

- **AVERAGE WEATHER CONDITIONS USED**

- **FORECAST RANGE USED**



LEGEND

SPRING RUNOFF POTENTIAL
BASED ON
MEDIAN WEATHER CONDITIONS

BN	BELOW NORMAL
NN	NEAR NORMAL
SAN	SOMEWHAT ABOVE NORMAL
WAN	WELL ABOVE NORMAL
GAN	GREATLY ABOVE NORMAL

Note:
Above normal runoff does not necessarily imply flooding

WATER RESOURCES BRANCH
MANITOBA RIVER FORECAST CENTRE

SPRING RUNOFF OUTLOOK

FORECAST DATE: **MAR 20, 1997**
PREPARED BY A.A.W.

Manitoba
Natural Resources
Hon. J. Glen Cummings
Minister

2MB-563

Manitoba Water Resources Branch
Hydrologic Forecast Centre

Spring Flood Outlook for Tributary and Other Watersheds Based on Normal Future Weather Conditions

February 20, 1998

	Snowcover	Soil Moisture	**Spring Flood Outlook
RED RIVER Tributaries			
Roseau River, Rat River, Seine River, Cooks Creek Deadhorse Creek	Near Normal	Well Above Normal	Minor Flooding Possible
Plum River, Morris River, La Salle River, Netley Creek	Below Normal	Above Normal	Flooding Unlikely
ASSINIBOINE RIVER Tributaries			
Shell River, Conjuring Creek, Birdtail Creek, Qu'Appelle River, Gopher Creek, Oak River, Little Saskatchewan River	Below Normal	Below Normal	Flooding Unlikely
Cypress River	Near Normal	Near Normal	Flooding Unlikely
Sturgeon Creek, Omands Creek	Below Normal	Above Normal	Flooding Unlikely
SOURIS RIVER Tributaries			
Antler River, Gainsborough Creek, Graham Creek, Pipestone Creek	Much Below Normal	Below Normal	No Flooding
Waskada Creek, Medora Creek Elgin Creek, Oak Creek	Below Normal	Near Normal	Flooding Unlikely
INTERLAKE			
Fairford River, Dauphin River	Below Normal	Near Normal	Flooding Unlikely
Fisher River, Lundar Drain	Near Normal	Somewhat Above Normal	Minor Flooding Possible
SOUTHEASTERN MANITOBA			
Brokenhead River, Whitemouth River Whiteshell River, Bloodvein River, Berens River	Below Normal	Well Above Normal	Minor Flooding Possible
Winnipeg River	Below Normal	Near Normal	Flooding Unlikely
WESTLAKE AREA			
Whitemud River, Big Grass River	Near Normal	Near Normal	Flooding Unlikely
Turtle River, Ochre River, Vermilion River, Wilson River, Valley River, Swan River	Below Normal	Near Normal	Flooding Unlikely
NORTHWEST			
Carrot River, Red Deer River, Saskatchewan River, Grass River	Below Normal	Somewhat Above Normal	Flooding Unlikely
Lynn Lake - Brochet area	Near Normal	Well Above Normal	Localized Flooding Likely
NORTHEAST			
Norway House, Thompson, Island Lake area	Below Normal	Well Above Normal	Flooding Unlikely
Gillam to Churchill area	Near Normal	Well Above Normal	Localized Flooding Likely

**The occurrence and extent of flooding will depend greatly on weather conditions from now through the end of April, 1998. This outlook is bas on normal additional precipitation with the main snowmelt occurring in late March or early April. An earlier melt with below average precipitati would greatly reduce runoff and minimize the chance of flooding. A late breakup and/or heavy additional precipitation would increase the flo potential.

Manitoba Water Resources---River Forecast Centre March 20,1997

DETAILED SPRING FLOOD OUTLOOK FOR SMALLER WATERSHEDS

(All flows in Cubic Feet per Second)

Stream Location	**Predicted Peak Flow Low	Median	High	Bankfull (no Ice)	Previous Spring Peaks 1979	1995	1996	Max. Recorded Flow	Year
Red River Watershed:									
Aux Marais - Christie	500	1,200	1,700	500	1,300	470	1,200	2,650	1974
Boyne-Carman (downstream Div.)	1,000	1,500	2,000	2,500	4,600	1,040	1,440	4,700	1974
Buffalo Creek - Rosenfeld	3,000	4,500	6,000	3,000	7,600	1,500	4,600	7,600	1979
Deadhorse Creek - Morden	600	1,000	2,000	2,000	4,000	900	1,000	4,200	1971
Deadhorse Creek - Rosenfeld	3,500	5,000	7,000	5,000	10,000	2,400	5,600	10,000	1979
Elm Creek Channel - NW5-10-4W	1,200	1,600	2,000	1,500	2,400	550	1,700	2,400	1979
Grassmere Drain - Middlechurch	1,200	1,500	1,800	1,500	1,800	530	1,600	1,700	1974
LaSalle River - Elie	200	350	500	400	600	200	400	600	1979
LaSalle River - Sanford	2,500	3,500	4,500	3,500	4,200	2,200	4,000	4,400	1970
LaSalle River - LaSalle	3,500	4,800	6,000	*4,000	6,800	3,500	5,200	7,000	1974
Main Drain - Dominion City	1,000	1,500	2,000	800	1,800	550	1,100	1,800	1979
Marsh River - Otterburne	2,500	3,300	4,500	2,000	3,300	1,200	2,500	3,300	1979
Morris River - Rosenort	3,500	4,500	5,500	* 5,000	-	3,300	4,400	6,000	1974
Netley Creek - Petersfield	1,000	1,700	2,300	1,500	2,300	1,000	2,000	2,600	1974
Rat River - Zhoda	500	1,000	1,500	400	680	220	350	1,300	1960
Rat River - Otterburne	1,700	2,700	3,800	2,500	1,550	1,000	1,500	5,900	1950
Roseau River - Dominion City	3,500	5,000	6,500	*4,500	3,700	3,600	5,000	8,100	1950
Seine River - Ste. Anne (u/s Div.)	1,000	1,500	2,000	700	1,200	440	900	3,500	1967
Seine River - Prairie Grove	600	1,200	2,000	1,500	2,100	650	1,100	2,260	1974
Seine River Diversion - PTH 59	3,000	4,000	5,500	4,000	4,300	1,700	3,800	4,660	1967
Shannon Creek - Morris	2,000	3,000	4,000	2,000	-	2,000	3,600	4,500	1974
Cook's Creek u/s Diversion	1,500	2,200	3,200	1,100	2,600	600	1,000	2,760	1974
Assiniboine River Watershed:									
Arrow River - Arrow R.	200	400	700	600	750	750	250	1,150	1969
Birdtail Creek - Birtle	400	700	1,100	1,500	1,800	2,300	850	1,800	1979
Conjuring Creek - Russell	200	300	400	300	310	420	350	560	1974
Cypress River - Bruxelles	900	1,200	1,500	1,000	2,400	1,600	1,400	2,700	1974
Gopher Creek - Virden	200	350	500	800	420	500	320	1,660	1976
Little Sask. River - Minnedosa	500	1,000	1,500	3,000	1,800	2,200	880	3,200	1970
Oak River - Rivers	400	800	1,200	1,400	1,400	700	460	1,500	1969
Omand's Creek - Winnipeg	300	400	500	500	600	300	450	600	1979
Qu'Appelle River - St. Lazare	300	400	6,500	*5,000	2,900	4,600	3,900	8,900	1955
Shell River - Inglis	400	700	1,200	1,600	1,600	2,100	880	2,500	1968
Sturgeon Creek - Winnipeg	1,400	1,900	2,400	1,700	2,400	1,700	2,200	2,900	1974
Souris River Watershed:									
Antler River - PTH 83	1,000	1,500	2,200	1,500	1,500	900	2,200	4,200	1976
Elgin Creek - Souris	500	1,000	1,500	1,000	1,900	570	1,500	1,900	1976
Gainsborough Creek - Lyleton	400	600	900	1,000	540	380	460	3,300	1976
Graham Creek - Melita	150	250	370	500	150		170	1,300	1976
Medora Creek - Napinka	400	700	1,000	500	500	370	1,200	1,500	1976
Oak Creek - Stockton	300	450	700	1,000	1,505	750	530	1,600	1974
Pipestone Creek - PTH 83	1,700	2,500	3,500	2,000	1,800	1,500	3,800	5,500	1976
Plum Creek - Souris	500	1,000	1,500	2,500	190	500	1,500	5,500	1976
Waskada Creek - Cranmer	200	300	400	300	400	190	370	700	1976

* Flooding could occur with lesser flows at these stations due to possible backwater from other nearby rivers.

Note:Peak flow on any stream could be briefly higher than predicted if channel becomes blocked by ice or debris.

Manitoba Water Resources--- Hydrologic Forecast Centre

FORECAST SPRING PEAK STAGES FOR MAJOR RIVERS

All Water Levels in Feet Above Sea Level Unless Noted

FEBRUARY 20,1998

	Forecast *Lower Decile	Forecast **Median	Forecast ***Upper Decile	Flood Stage (Rural)	Dyke Elevation (Towns)	Comparative Peak Water Levels		
						1995	1996	1997
RED RIVER (Flood Control Works in Operation)								
Emerson	770.5	783.5	788.5	783.2	794.5	784.8	789.6	792.5
Letellier	767.0	779.5	783.5	780.1	789.7	781.3	784.5	787.7
St.Jean	763.5	774.0	780.0	771.6	786.3	776.1	781.3	784.3
Morris	760.0	770.0	777.5	769.4	785.3	772.3	779.6	783.3
Ste. Agathe	750.5	761.5	770.0	771.8	No Dyke	764.9	771.9	776.5
St. Adolphe	747.0	756.5	764.5	757.5	774.5	760.7	767.4	772.5
Above Floodway Inlet	744.0	752.0	760.5	760.0	No Dyke	757.4	764.6	771.5
Below Floodway Inlet	744.0	749.6	751.5	752.0	No Dyke	751.9	753.5	761.1
Winnipeg-James Ave.	739.1	743.7	745.1	745.6	754.1	745.5	746.9	752.1
" (Above Datum)	12.0	16.1	17.5	18.0	26.5	17.9	19.4	24.5
N. Selkirk (at PTH #4)	717.0	720.0	723.5	723.5		724.5	727.5	726.2
ASSINIBOINE RIVER (Control Works in Operation)						1995	1996	1997
Shellmouth	1349.0	1350.0	1351.5	1354.2		1360.8		1353.4
Russell	1338.5	1339.5	1341.0	1343.2		1352.0	1341.1	1341.6
Millwood	1318.5	1319.5	1321.0	1321.6		1332.1		
St. Lazare	1277.0	1280.0	1282.5	1283.7		1288.8	1285.8	1283.4
Miniota	1228.0	1231.4	1235.7	1236.8		1245.0	1242.7	1238.3
Virden	1203.0	1207.0	1212.5	1213.5		1218.4	1216.5	1214.3
Griswold	1187.0	1191.5	1196.0	1196.4		1201.0	1199.3	1197.4
Brandon (Ist St.)	1166.0	1168.0	1170.5	1172.0		1178.8	1174.1	1171.5
Portage u/s Div. Flow	2000	5000	10000			25000	26000	29500
Portage la P.(Southpo	841.5	844.0	845.5	848.0		847.9		
Baie St. Paul	788.0	790.7	792.5	796.0		795.9	796.6	800.4
Headingley	761.5	763.6	765.0	767.5		766.0	767.1	769.4
SOURIS RIVER						1976	1996	1997
Coulter	1404.5	1406.3	1409.5	1406.5				
Melita (PTH #3)	1395.0	1398.7	1403.5	1401.6		1411.8	1408.7	1407.6
Napinka (u/s Dam)	1391.5	1394.7	1398.0	1394.1			1401.0	1400.0
Hartney (u/s Dam)	1375.5	1378.5	1380.5	1379.0		1394.6	1386.0	1384.2
Souris (u/s Dam)	1347.5	1349.5	1350.5	1354.0		1364.3	1352.4	1351.1
Wawanesa	1143.5	1146.5	1148.5	1155.0		1163.2	1153.0	1151.1

Notes:

* Lower Decile-- refers to a combination of future weather conditions whose severity has been exceeded 90% of the time during the past 50 years.

** Median-- same as above except has been exceeded 50% of the time.

*** Upper Decile-- same as above except has been exceeded 10% of the time.

Effects of possible ice jams on peak stages are not included in the forecast.

Manitoba Water Resources---River Forecast

SPRING PEAK STAGE FORECASTS ---OTHER DYKED COMMUNITIES

APRIL 9,1997 (All levels in feet above sea level)

COMMUNITY	Forecast Lower Decile	Forecast Median	Forecast Upper Decile	Flood Stage	Dyke Elevation	Comparative Peak Water Levels 1979	1995	1996
Brunkild	782.5	783.5	785.0	782.0	785.7	781.9		783.0
Dominion City	784.0	786.0	787.5	784.0	786.0	784.1		783.8
Rosenort	779.5	782.5	784.5	778.7	786.5	781.3		779.6
Ste. Rose du Lac	864.5	866.5	868.5	870.8	874.3			869.3

Manitoba Water Resources---Hydrologic Forecast Centre

FORECAST PEAK LEVELS FOR LAKES--- SPRING OF 1998

February 20, 1998 Forecast

(All Levels are Wind Eliminated and in Feet Above Sea Level)

	RECENT LEVEL	SUMMER TARGET LEVEL	FORECASTED PEAK LEVEL LOWER DECILE	MEDIAN	UPPER DECILE	Previous Peak Levels (feet) 1995	1996	1997
Big Whiteshell	1017.7	1019.0	1018.0	1018.5	1019.5	1018.8	1020.4	1018.5
Brereton Lake	1036.4	1036.8	1037.0	1037.5	1038.5	1037.1	1038.0	1038.4
Cedar Lake	836.7		839.5	841.7	842.0	841.5	841.6	841.6
Dauphin Lake	854.1	854.8	854.2	854.5	855.5	858.5	855.8	855.4
Falcon Lake	1065.7	1065.2	1066.0	1066.5	1067.5	1066.0	1067.1	1067.5
Jessica Lake	1017.1	1017.5	1017.5	1018.0	1018.5	1017.8	1018.7	1018.5
Lake Winnipeg	713.9	714.0	714.1	714.5	715.0	714.3	715.0	715.7
Lake Manitoba	812.1	812.2	812.3	812.4	812.6	813.2	813.3	812.9
Lake Winnipegosis	831.8	831.5	831.8	832.2	832.6	831.4	832.6	832.8
Lake St. Martin	799.3	800.0	799.5	800.5	801.5	800.4	801.3	802.1
Lake Of The Woods	1058.0	1060.0	1059.0	1060.0	1060.5	1059.1	1061.1	1059.7
Lake Of The Prairies	1399.5	1402.5	1401.4	1406.0	1409.0	1415.0	1408.0	1407.1
Nutimik Lake	901.3	901.5	902.0	903.5	905.0	902.1	905.1	907.1
Oak Lake	1408.9	1410.0	1409.0	1409.3	1409.8	1410.6	1411.6	1410.3
Pelican Lake	1350.3	1351.0	1350.5	1351.5	1352.5	1352.5	1352.1	1353.4
Rock Lake	1329.5	1331.0	1332.5	1335.0	1337.5	1338.1	1337.6	1338.3
West Hawk Lake	1091.0	1091.0	1091.5	1092.0	1092.8	1091.6	1092.8	1092.8

Note: levels may be temporarily higher than predicted if strong winds occur.

Manitoba Water Resources Branch

Daily Water Levels and Forecasts

April 20, 1997

Red River

LOCATION	Conditions this Morning		Change From April 19 (ft.)	Total Rise to Date (ft.)	Forecasted Peak		Flood Stage (ft.)	Dike Design Elev. (ft.)	Previous Peak Stages and Flows 1979		1996	
	FLOW (cfs)	STAGE (ft.)			STAGE (ft.)	DATE			FLOW (cfs)	STAGE (ft.)	FLOW (cfs)	STAGE (ft.)
Breezy Point		717.78	+0.65		724.0-726.5	Apr 22-25		No Dike				726.50
Selkirk--PTH #4		720.31	+0.92		726.0-727.5	Apr 22-25		No Dike				727.50
Winnipeg-James A	40,000	15.3	+0.3	13.4	23.5-24.5	May 2	18.0	26.5	55,200	19.17	58,500	19.35
Below Floodway	33,000	749.80	+0.95		759.3-760.3	May 1	752.0	No Dike	44,800	752.92	39,800	753.51
Above Floodway	33,000	751.25	+1.60	18.28	769.0-770.0	May 1	760.0	No Dike	90,000	764.99	78,000	764.59
St. Adolphe		755.68	+2.19	21.37	772.5-773.5	May 1	757.5	772.0	91,000	768.31	75,000	767.35
Ste. Agathe	35,000	760.68	+2.50	21.95	776.5-777.5	April 30	771.8	No Dike	88,000	773.10	72,000	771.92
Morris		769.48	+2.96	25.36	784.5-785.5	April 29	769.4	786.0	90,000	781.26	72,500	779.55
St. Jean		774.48	+2.90	28.27	785.0-786.0	April 26	771.6	786.4	90,000	782.36	71,500	781.26
Letellier		780.61	+2.39	30.46	788.0-789.0	April 26	780.1	788.5	94,000	785.50	74,500	784.54
Emerson	44,000	785.80	+3.11	33.68	794.0-795.0	April 25	783.2	794.6	92,000	791.27	72,000	789.60
Drayton		42.95	+1.45	31.73	Under Rev.	Apr. 23	32	N/A	92,900	43.66	66,000	42.29
Grand Forks	107,000	53.7	+0.8	33.0	54.0	Apr. 20	28	N/A	82,000	48.81	56,000	45.85
Halstad	52,000	40.68	+0.05	29.99	At	Peak	24	N/A	42,000	39.00	24,000	35.60
Fargo	28,400	39.08	-0.34		**39.8	Apr. 18	17	N/A	17,300	34.93	9,500	28.70
Wahpeton	12,500	18.66	-0.18		**19.1	Apr. 16					5,000	

** Recorded Peak

Note: Forecast is based on predicted favourable weather for the next 10 days.

Manitoba Water Resources Branch

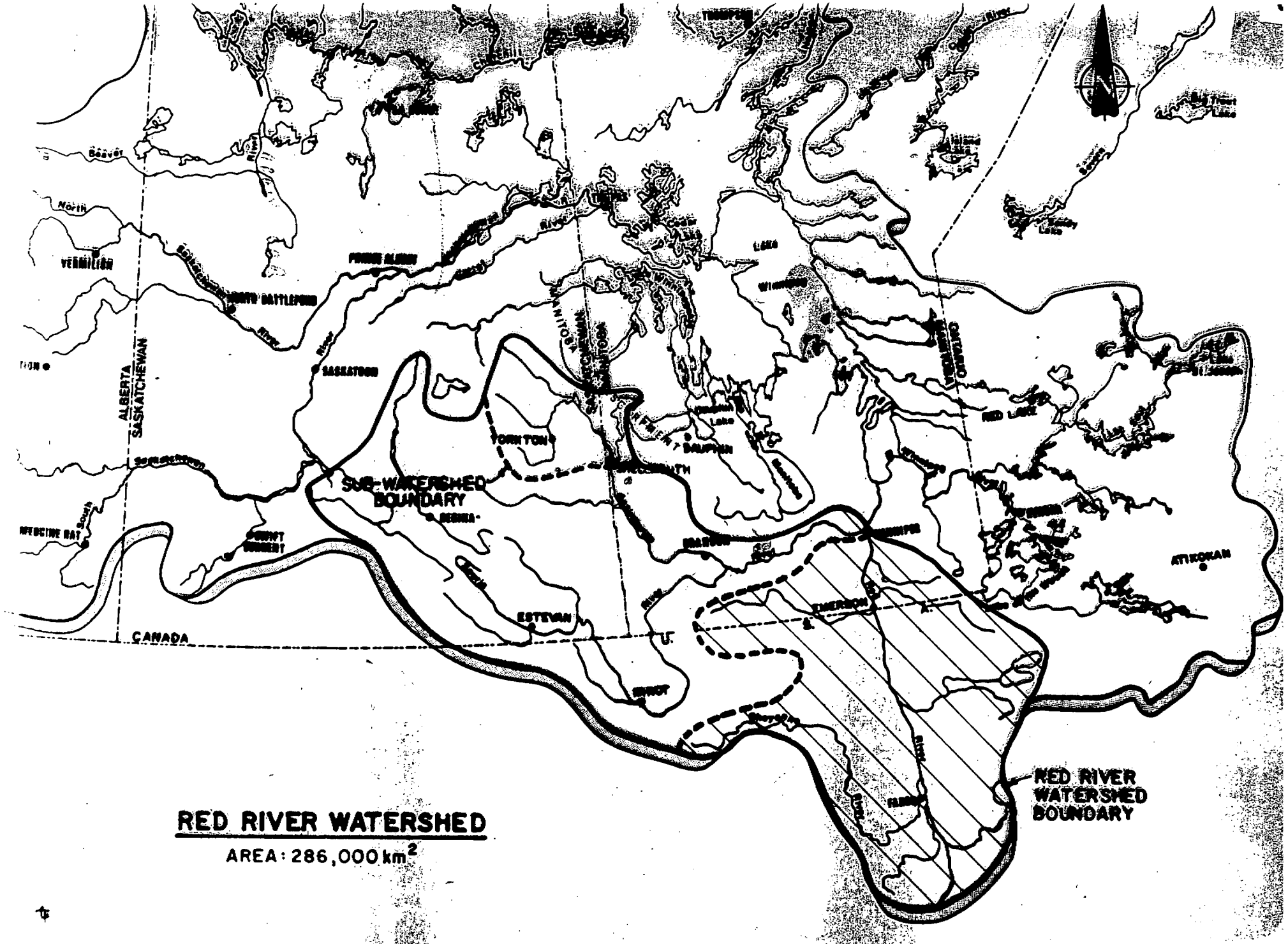
Daily Water Levels and Forecasts

APRIL 8, 1998 City of Winnipeg

LOCATION	Today's Conditions			Three Day Forecast of STAGE or FLOW			Predicted Peak Flow or Level and Date		Previous Peak Stages and Flows 1996		1997	
	FLOW (cfs)	STAGE (ft.)	Change from Apr 7	Apr 9	Apr 10	Apr 11	Q or WL	Date	FLOW (cfs)	STAGE (ft.)	FLOW (cfs)	STAGE (ft.)
Red River												
Above Floodway	34,100	749.15	-0.31	748.9	748.7	748.3	**754.6	Apr 1	78,000	764.59	139,000	771.50
Below Floodway	34,100	748.59	-0.29	748.4	748.2	747.8	**	Mar 31	39,800	753.51	73,000	761.10
S. Perimeter												
Bishop Grandin	35,200	18.5	-0.3	18.3	18.2	17.9	**21.1	Mar 31	42,500	22.10		29.70
Elm Park Bridge												
James Avenue	43,500	15.6	-0.2	15.5	15.7	15.5	**17.2	Mar 31	58,500	19.35	80,000	24.50
Kildonan Bridge	43,500	13.1	-0.3	13.0	13.2	13.0	**14.9	Mar 31	59,000	16.80		21.80
Assiniboine River												
Headingley	7,700	763.81	+0.41	764.2	765.0	765.0	765.0	Apr 10-13	11,500	767.10	18,000	769.40
W. Perimeter												
St. James Bridge												
Sturgeon @ Ness							**1700 cfs	Mar 30	2,200		2,500	
Omands @ Dublin							**380 cfs	Mar 29	450		400	
La Salle- La Salle	1,100		-300	800	600	400	**3600 cfs	Mar 30	5,200		5,500	

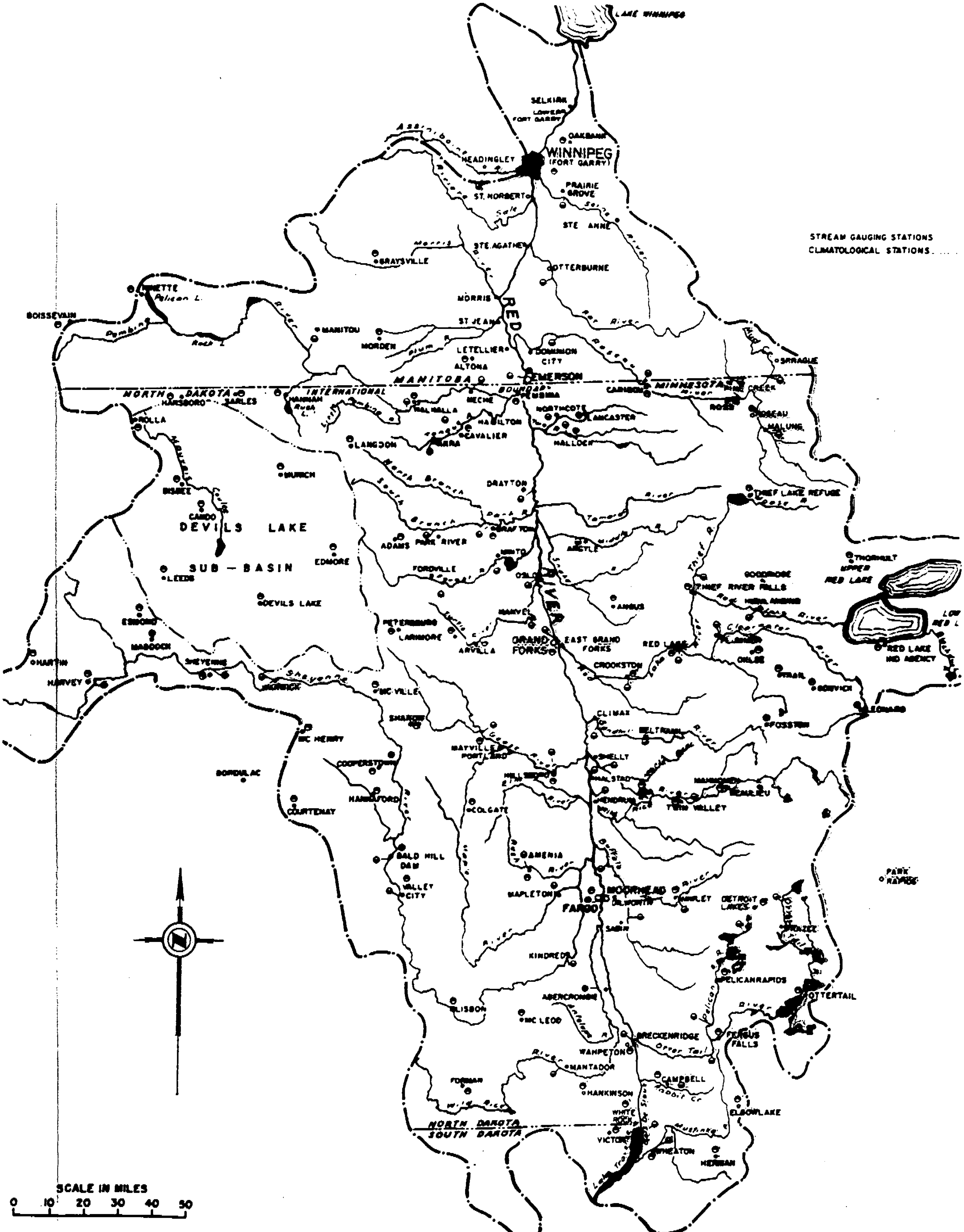
Note: Forecast based on normal weather conditions.

** Recorded Peak

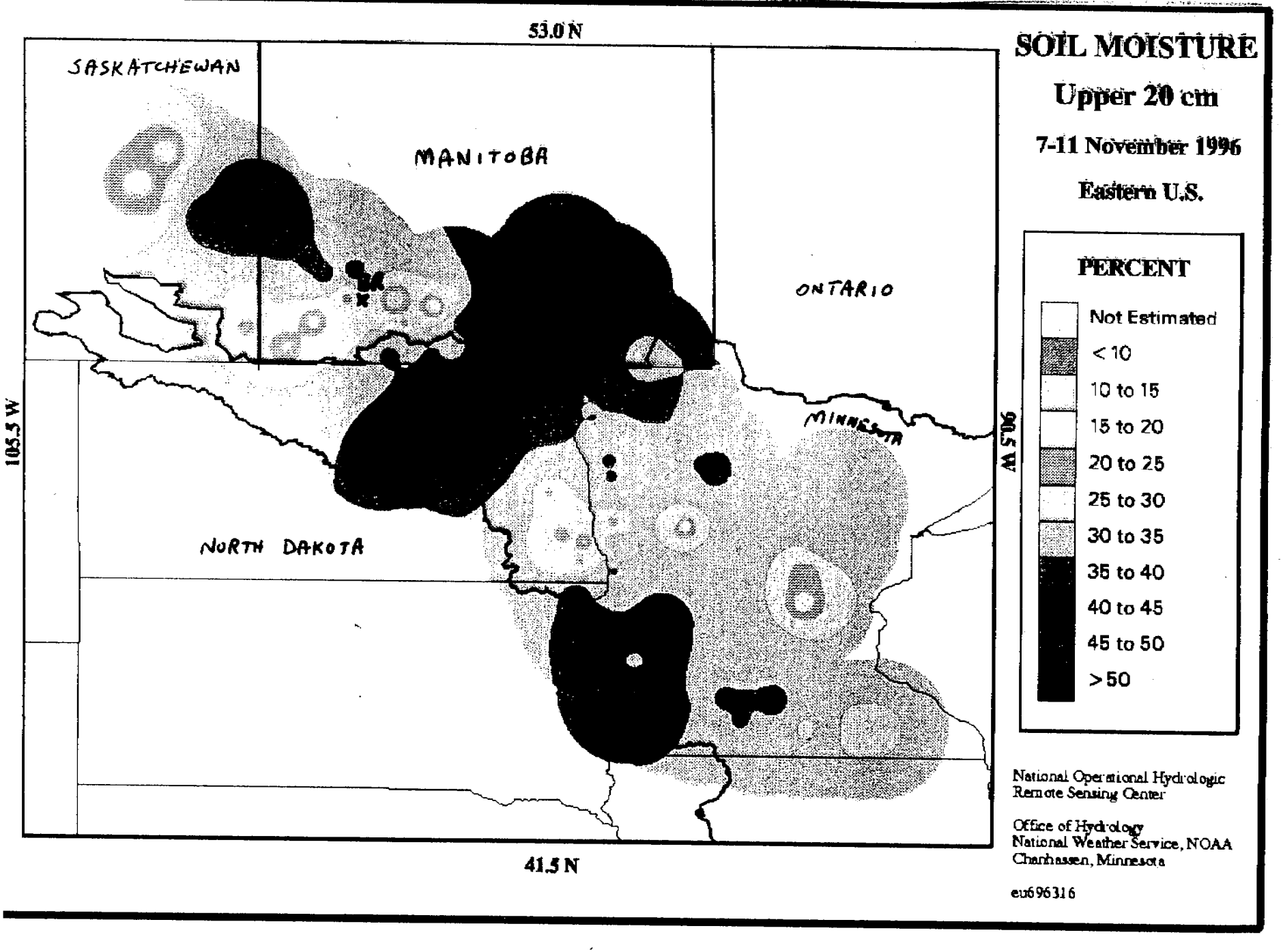


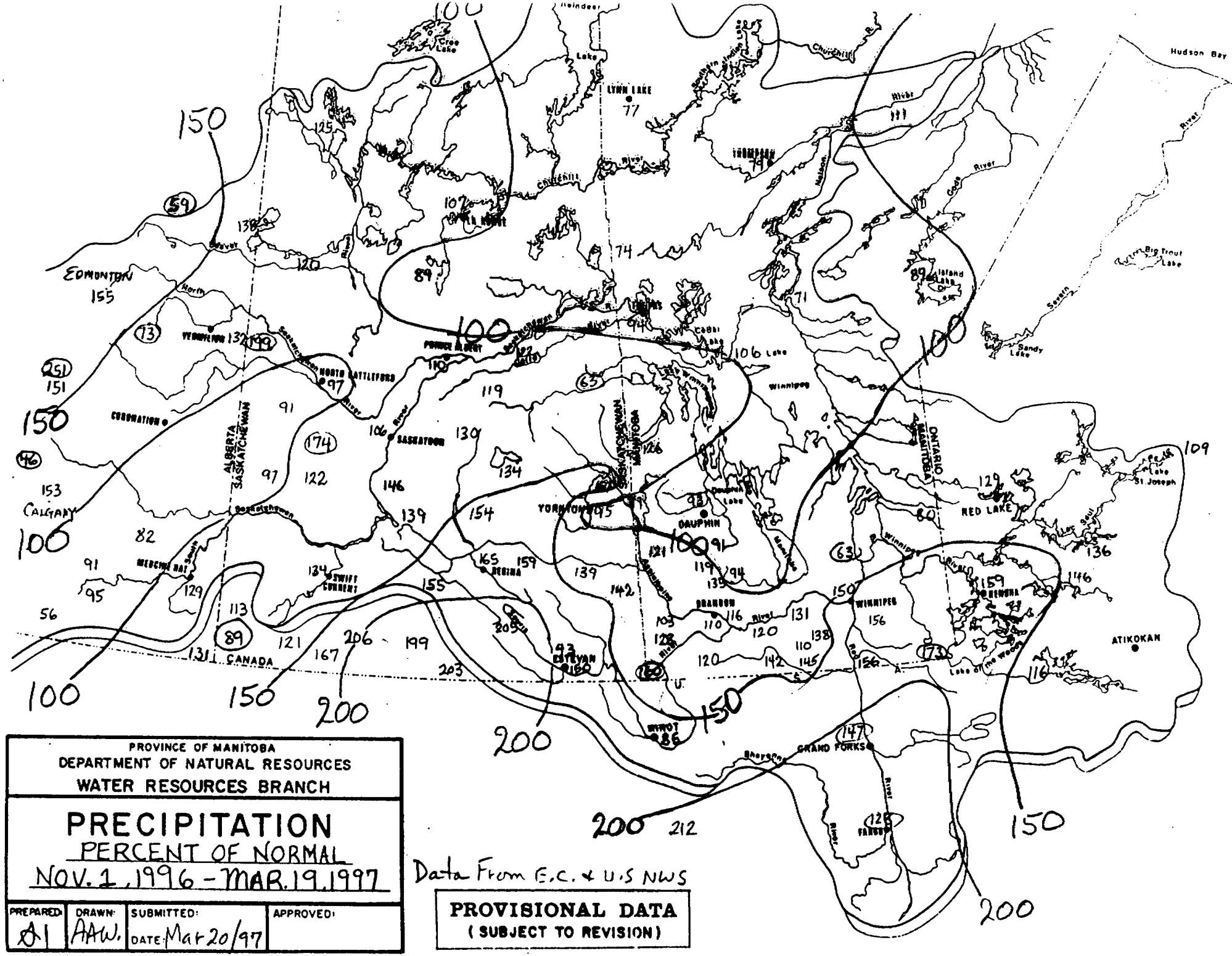
RED RIVER WATERSHED

AREA: 286,000 km^2



LAKE WINNIPEG
SELKIRK
LOWER FORT GARRY
OAKBANK
WINNIPEG (FORT GARRY)
HEADINGLEY
ST. NORBERT
PRAIRIE GROVE
STE ANNE
STE. AGATHE
OTTERBURNE
BRAYSVILLE
MORRIS
ST JEANS
RED
MANITOU
MORDEN
LETELLIER
ALTONA
DOMINION CITY
EMERSON
SPRAGUE
BOISSEVAIN
Pelican L.
Rock L.
MANITOBA
NORTH DAKOTA
INTERNATIONAL
BOUNDARY
MINNESOTA
SARLES
HANNAH
PEMBINA
WALHALLA
NECHE
HAMILTON
NORTHCOTE
LANCASTER
CARIBOU
PINE CREEK
ROSEAU
MALUNG
ROLLA
CAVALIER
LANGDON
HALLOCK
MUNICH
BISBEE
CANDO
DRAYTON
DEVILS LAKE
SUB-BASIN
EDMORE
LEEDS
DEVILS LAKE
ADAMS
PARK RIVER
GRAFTON
MINTO
ARGYLE
FORDVILLE
OSLO
THIEF LAKE REFUGE
THORHULT
UPPER RED LAKE
GOODRIDGE
THIEF RIVER FALLS
ANGUS
RIVER
PETERSBURG
LARIMORE
MANVEL
ARVILLA
GRAND FORKS
EAST GRAND FORKS
CROOKSTON
RED LAKE
OKLEE
RED LAKE IND AGENCY
HARVEY
SHEYENNE
WARWICK
MC VILLE
SHARON
CLIMAX
BELTRAMI
FOSSTON
LEONARD
MC HENRY
MAYVILLE
PORTLAND
SHELLY
HALSTAD
COOPERSTOWN
HILLSBORO
BORDULAC
HANNAFORD
HENDRUM
TWIN VALLEY
COURTENAY
COLGATE
BALD HILL DAM
AMENIA
VALLEY CITY
MAPLETON
MOORHEAD
FARGO
DILWORTH
HAWLEY
DETROIT LAKES
PARK RAPIDS
SABIN
KINDRED
PELICAN RAPIDS
ABERCROMBIE
OTTERTAIL
LISBON
MC LEOD
BRECKENRIDGE
FERGUS FALLS
WAHPETON
MANTADOR
CAMPBELL
FORMAN
HANKINSON
ELBOW LAKE
WHITE ROCK
NORTH DAKOTA
SOUTH DAKOTA
VICTOR
WHEATON
HERMAN
STREAM GAUGING STATIONS
CLIMATOLOGICAL STATIONS
SCALE IN MILES
0 10 20 30 40 50


53.0 N
SASKATCHEWAN
MANITOBA
ONTARIO
MINNESOTA
NORTH DAKOTA
105.5 W
90.5 W
41.5 N
SOIL MOISTURE
Upper 20 cm
7-11 November 1996
Eastern U.S.
PERCENT
Not Estimated
< 10
10 to 15
15 to 20
20 to 25
25 to 30
30 to 35
35 to 40
40 to 45
45 to 50
> 50
National Operational Hydrologic
Remote Sensing Center
Office of Hydrology
National Weather Service, NOAA
Chanhassen, Minnesota
eu696316

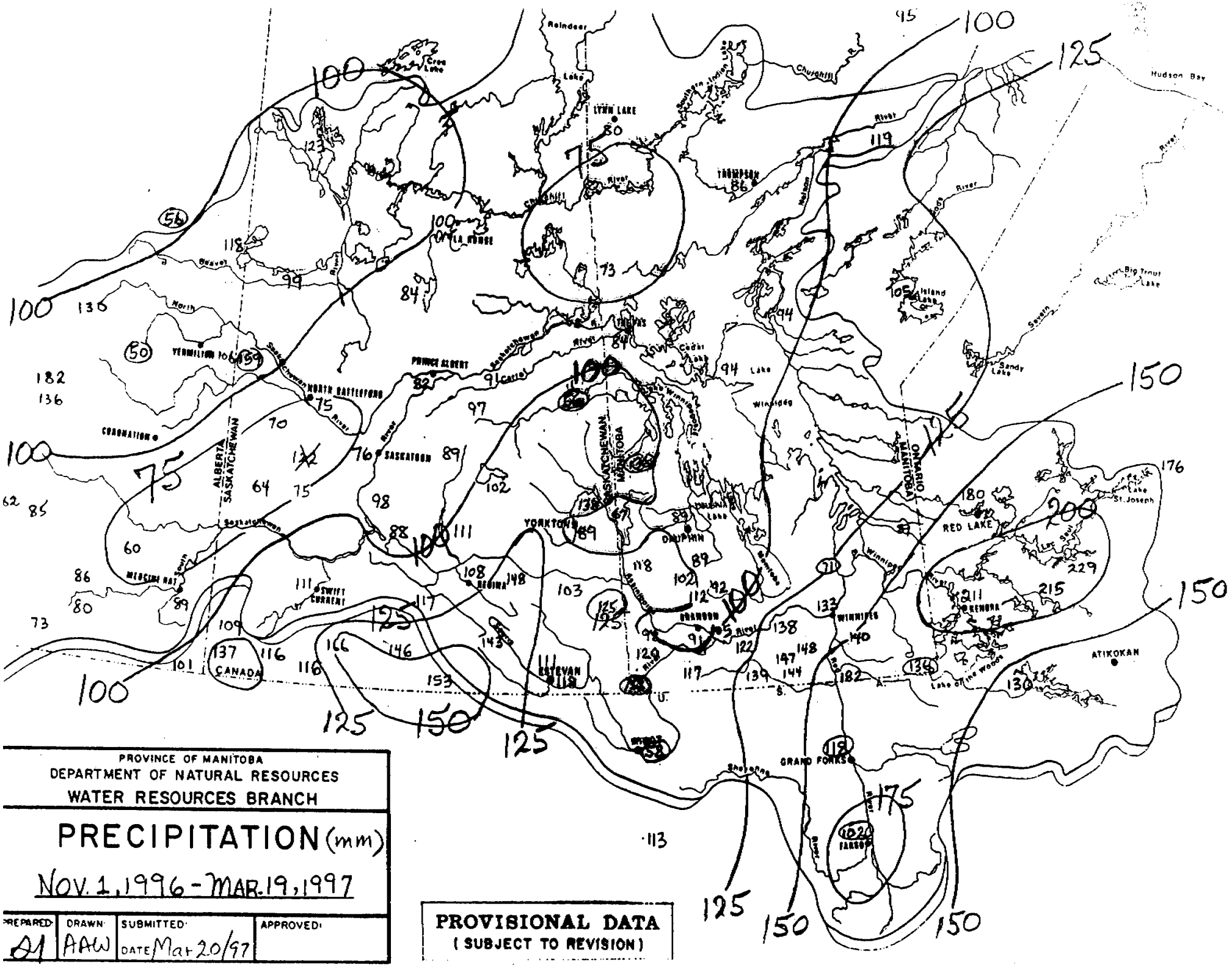


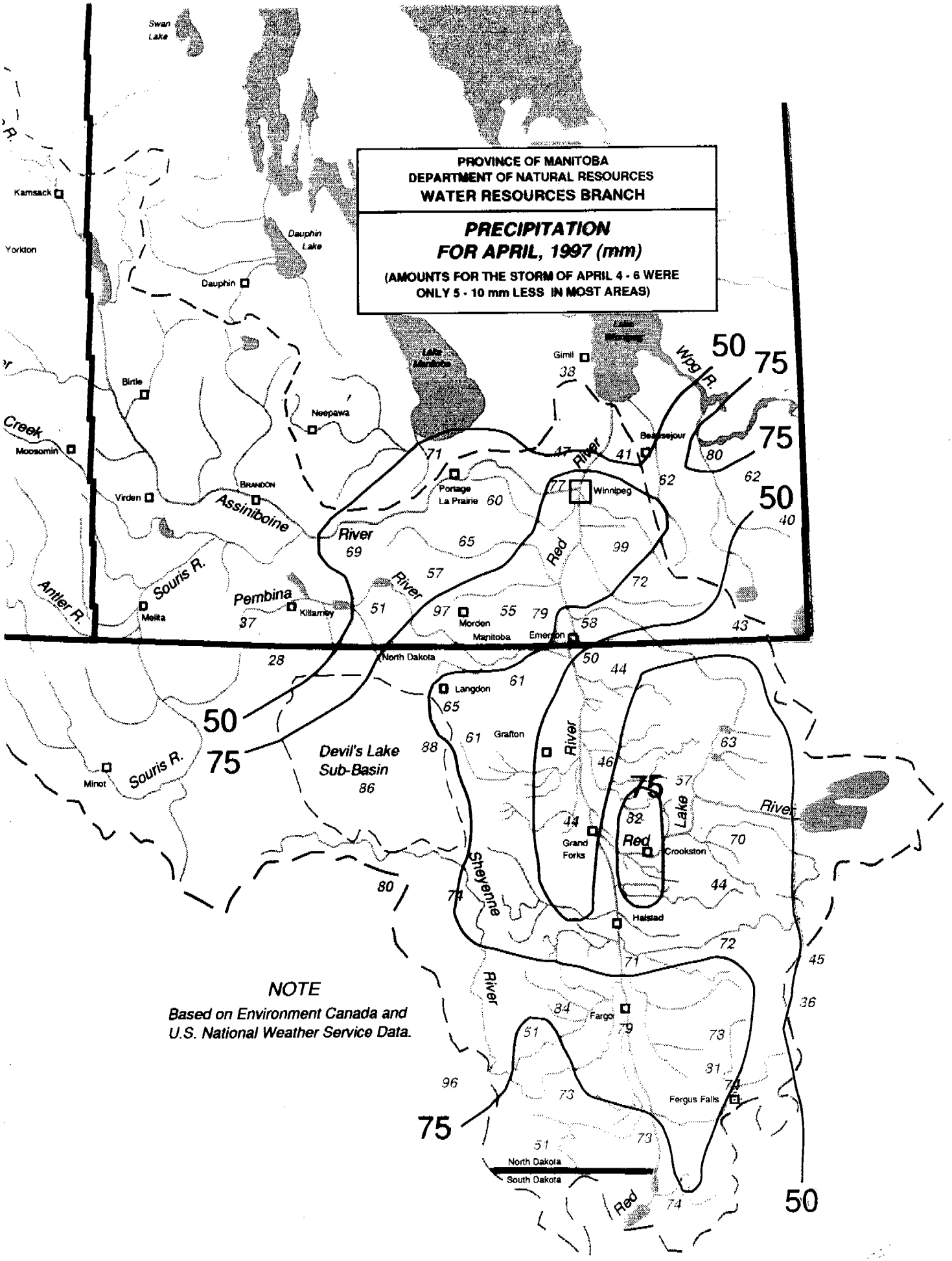
PROVINCE OF MANITOBA
DEPARTMENT OF NATURAL RESOURCES
WATER RESOURCES BRANCH

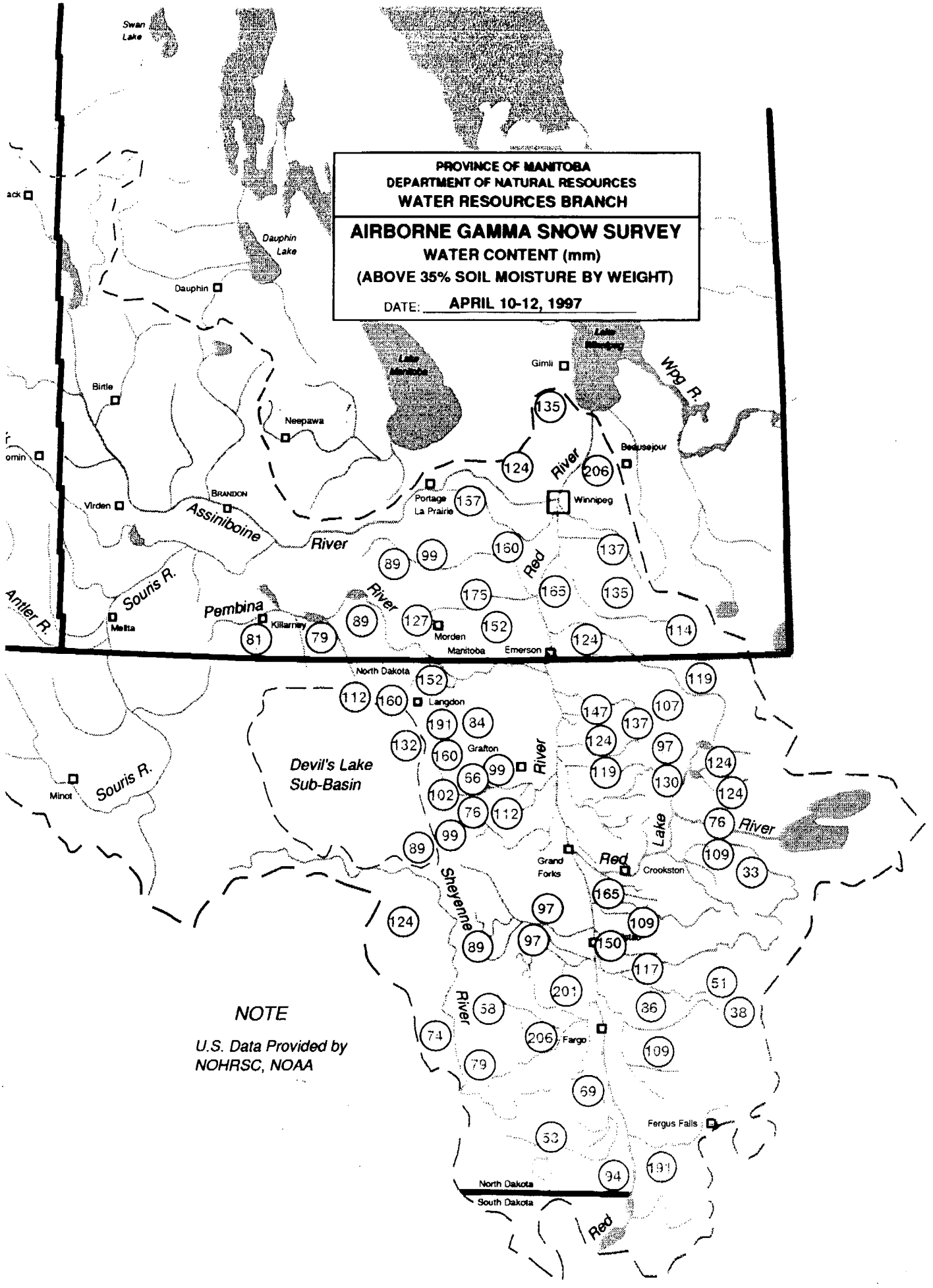
PRECIPITATION
PERCENT OF NORMAL
NOV. 1, 1996 - MAR. 19, 1997

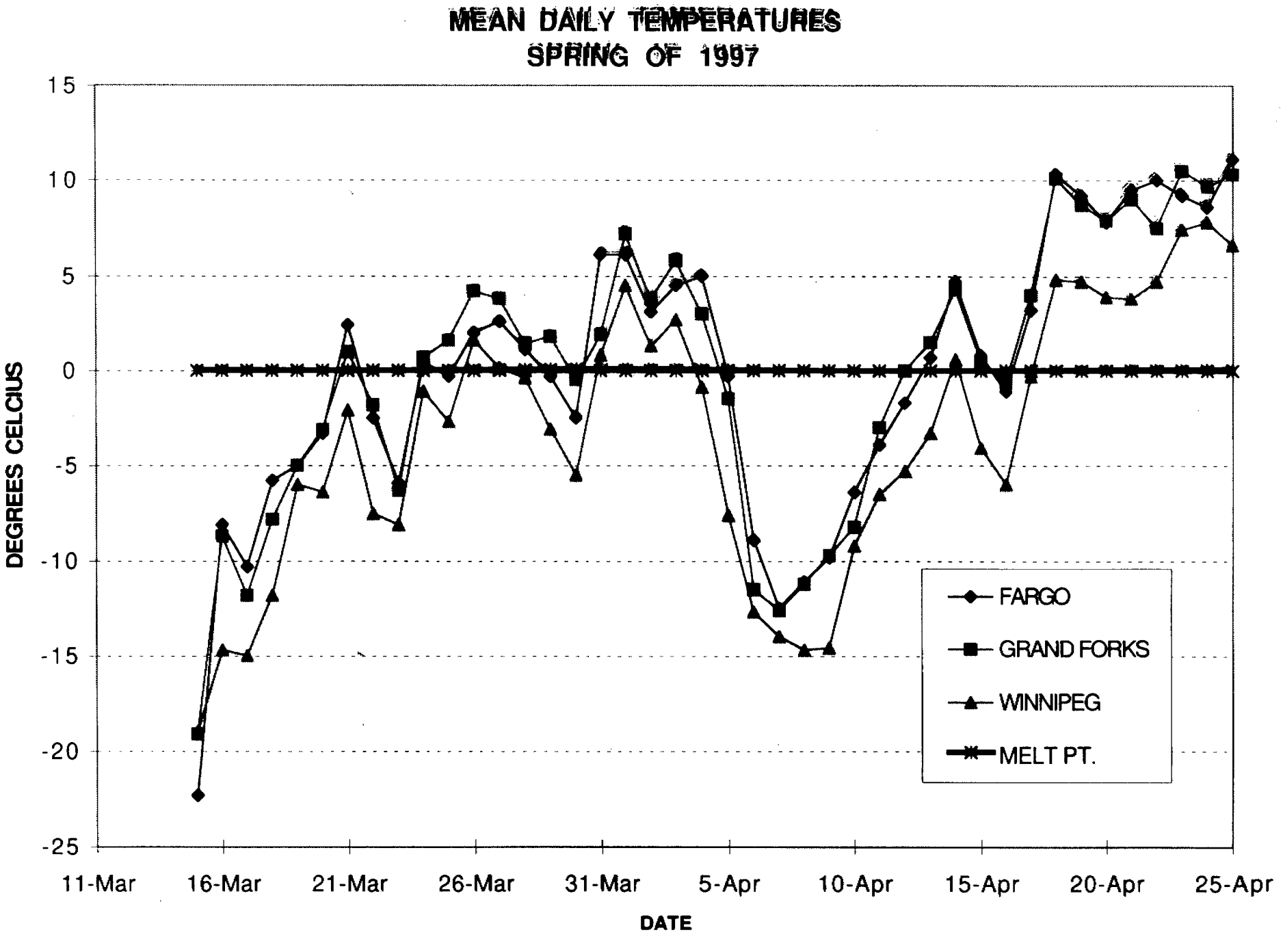
PREPARED:	DRAWN:	SUBMITTED:	APPROVED:
AI	AAW.	DATE: Mar 20/97	

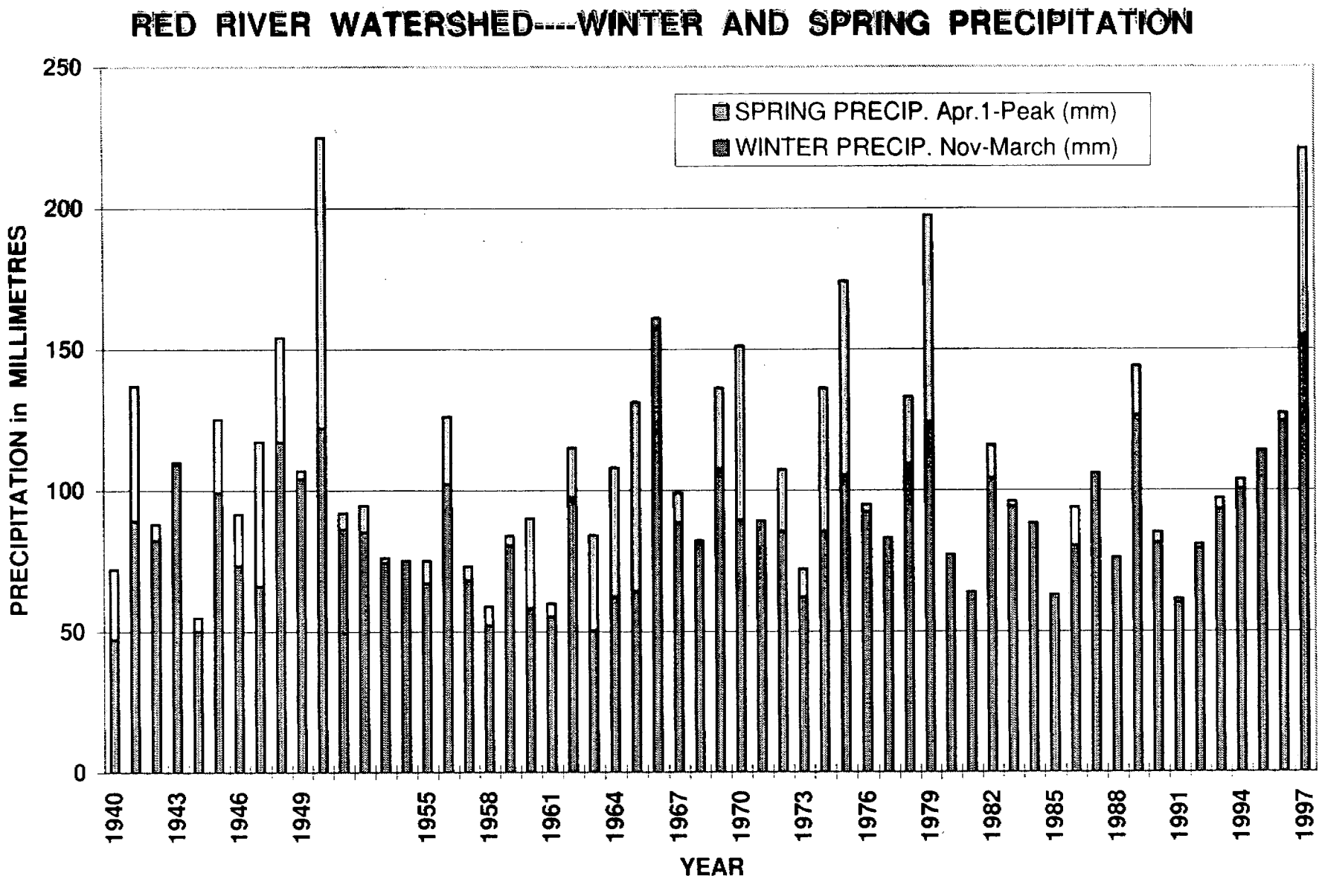
PROVISIONAL DATA
(SUBJECT TO REVISION)


PROVINCE OF MANITOBA
DEPARTMENT OF NATURAL RESOURCES
WATER RESOURCES BRANCH
PRECIPITATION (mm)
NOV. 1, 1996 - MAR. 19, 1997
PREPARED
DRAWN
AAW
SUBMITTED
DATE Mar 20/97
APPROVED
PROVISIONAL DATA
(SUBJECT TO REVISION)
Reindeer Lake
Cree Lake
LYNN LAKE
Churchill
Hudson Bay
THOMPSON
LA RONGE
Beaver River
North Saskatchewan River
YORKTON
PRINCE ALBERT
NORTH BATTLEFORD
SASKATOON
CRAIGNOOK
MEDICINE HAT
SWIFT CURRENT
REGINA
DAUPHIN
Winnipeg River
RED LAKE
WINNIPEG
KENORA
ATIKOKAN
Lake of the Woods
GRAND FORKS
FARGO
CANADA
U.S.
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO


PROVINCE OF MANITOBA
DEPARTMENT OF NATURAL RESOURCES
WATER RESOURCES BRANCH
PRECIPITATION
FOR APRIL, 1997 (mm)
(AMOUNTS FOR THE STORM OF APRIL 4 - 6 WERE ONLY 5 - 10 mm LESS IN MOST AREAS)
Swan Lake
Kamsack
Yorkton
Dauphin Lake
Dauphin
Birtle
Neepawa
Gimli
Lake Winnipeg
Lake Manitoba
Wpg R.
Creek
Moosomin
Virden
BRANDON
Assiniboine
River
Portage La Prairie
Winnipeg
Red
Souris R.
Antler R.
Pembina
Killarney
Morden
Manitoba
Emerson
North Dakota
Langdon
Grafton
Devil's Lake Sub-Basin
Minot
Souris R.
Grand Forks
Crookston
Lake
Red River
Halstad
Sheyenne River
Fargo
Fergus Falls
North Dakota
South Dakota
Red River
50
75
NOTE
Based on Environment Canada and U.S. National Weather Service Data.


PROVINCE OF MANITOBA
DEPARTMENT OF NATURAL RESOURCES
WATER RESOURCES BRANCH
AIRBORNE GAMMA SNOW SURVEY
WATER CONTENT (mm)
(ABOVE 35% SOIL MOISTURE BY WEIGHT)
DATE: APRIL 10-12, 1997
Swan Lake
Dauphin Lake
Dauphin
Birtle
Neepawa
Gimli
Lake Winnipeg
Lake Manitoba
Winnipeg River
Red River
Assiniboine River
Souris R.
Antler R.
Pembina River
Portage La Prairie
Virden
Brandon
Melita
Killarney
Morden
Manitoba
Emerson
Beausejour
Winnipeg
North Dakota
Langdon
Grafton
Devil's Lake Sub-Basin
Minot
Grand Forks
Crookston
Lake Sheyenne
Fargo
Fergus Falls
South Dakota
NOTE
U.S. Data Provided by NOHRSC, NOAA

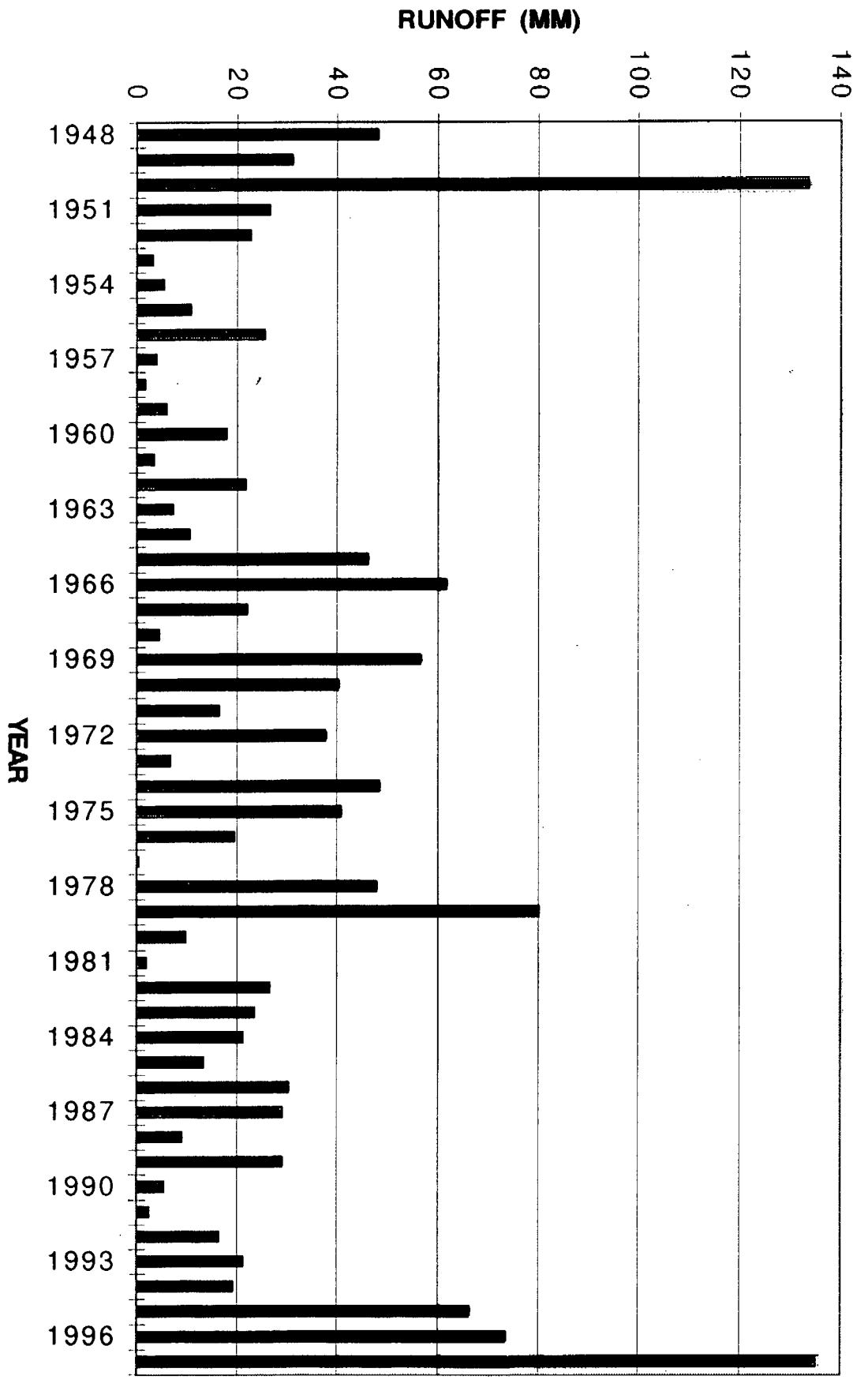

MEAN DAILY TEMPERATURES
SPRING OF 1997
15
10
5
0
-5
-10
-15
-20
-25
DEGREES CELCIUS
11-Mar
16-Mar
21-Mar
26-Mar
31-Mar
5-Apr
10-Apr
15-Apr
20-Apr
25-Apr
DATE
FARGO
GRAND FORKS
WINNIPEG
MELT PT.


RED RIVER WATERSHED----WINTER AND SPRING PRECIPITATION
SPRING PRECIP. Apr.1-Peak (mm)
WINTER PRECIP. Nov-March (mm)
PRECIPITATION in MILLIMETRES
250
200
150
100
50
0
1940
1943
1946
1949
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
YEAR

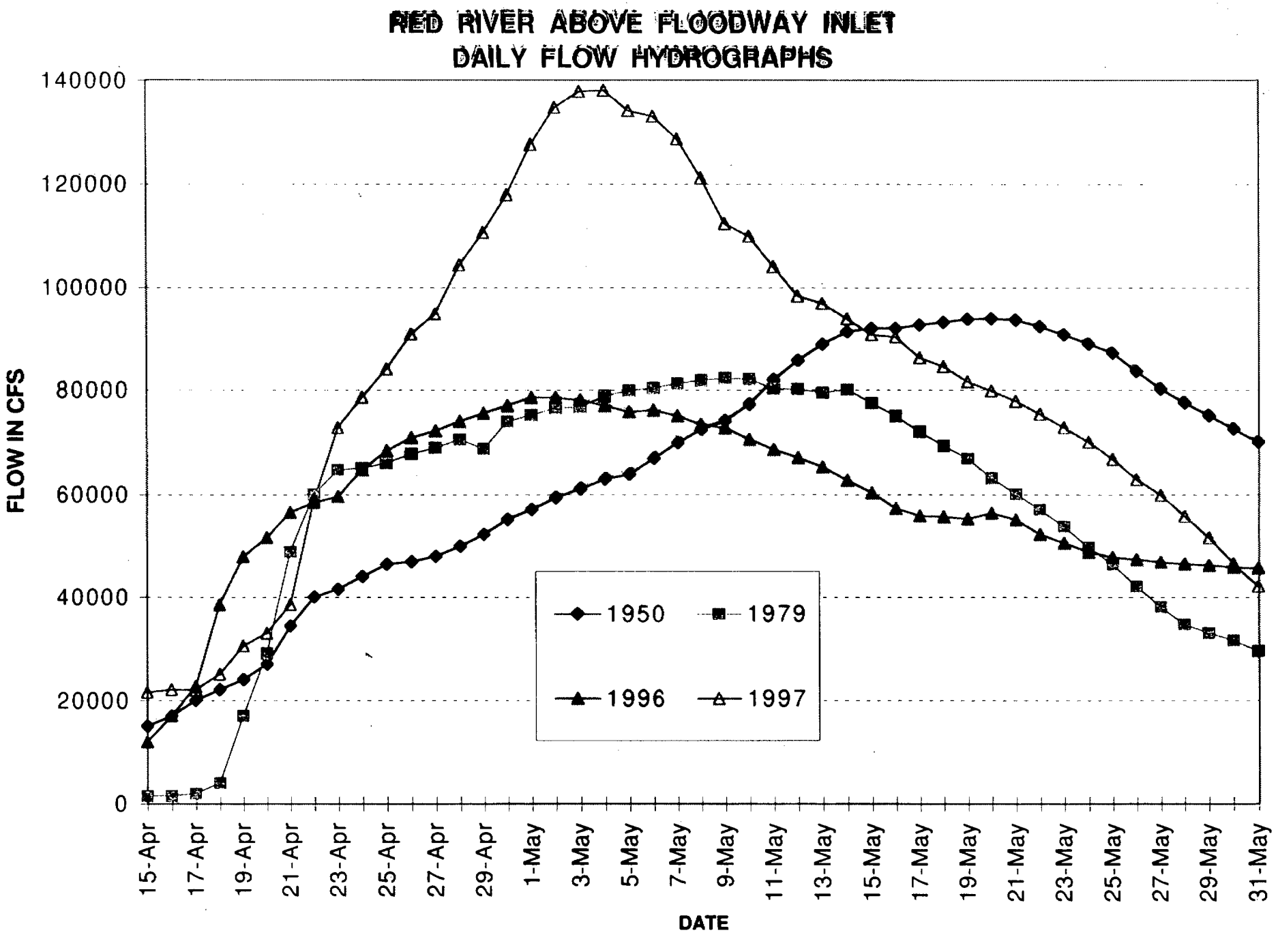
RED RIVER 1997 FLOOD CAUSES

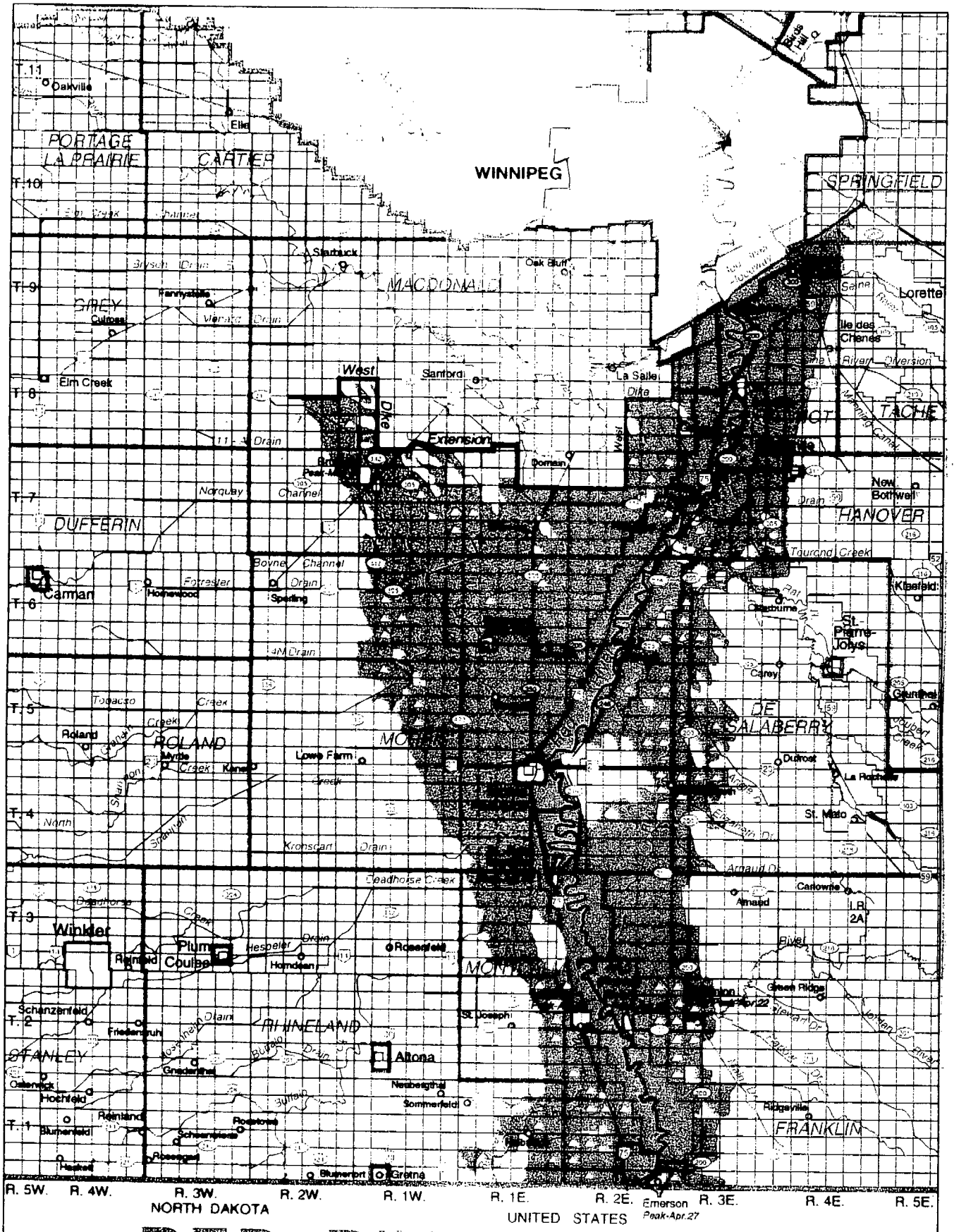
RELATIVE LEVEL OF SEVERITY BASED ON 1940 - 1997

	MAGNITUDE	PERCENTILE
1. WINTER & SPRING PRECIPITATION (up to April 6)	220 mm	98
2. AIRBORNE GAMMA SNOWCOVER (Apr. 10-12/97)	140 mm	highest on record
3. MELT RATE	3.3 Deg. C./day	50
4. ANTECEDENT SOIL MOISTURE API GAMMA SURVEY (Nov. 8-11/96)	 2.5 29% by weight	 60 third highest since 1979
5. GROUND FROST DEPTH (mean)	0.5 m	below average
6. NORTH - SOUTH RUNOFF TIMING		unfavourable
7. WEATHER DURING SPRING RUNOFF (Apr. 7-May 31)	60 mm	25



SPRING RUNOFF DEPTHS--RED RIVER BASIN (MM)


RED RIVER ABOVE FLOODWAY INLET
DAILY FLOW HYDROGRAPHS
FLOW IN CFS
140000
120000
100000
80000
60000
40000
20000
0
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
DATE
1950
1979
1996
1997



RED RIVER VALLEY

RED RIVER MAXIMUM FLOODED AREA FOR 1997

Based on Radarsat Imagery from April 27, May 1, May 4 & May 8 1997, and on aerial photography from April 29, May 1 and May 2, 1997.

Islands one or more this section (2 Ac.- 30 Ac.).

Road — **Road Flooded**

June 9, 1997

Manitoba Natural Resources

EXCERPTS FROM 1997 FLOOD OUTLOOKS FOR THE RED RIVER IN MANITOBA

JANUARY 15, 1997

"THE UPPER DECILE FUTURE WEATHER CONDITION POINTS TO A FLOOD SIMILAR TO THAT OF 1979 AND QUITE POSSIBLY BEYOND"

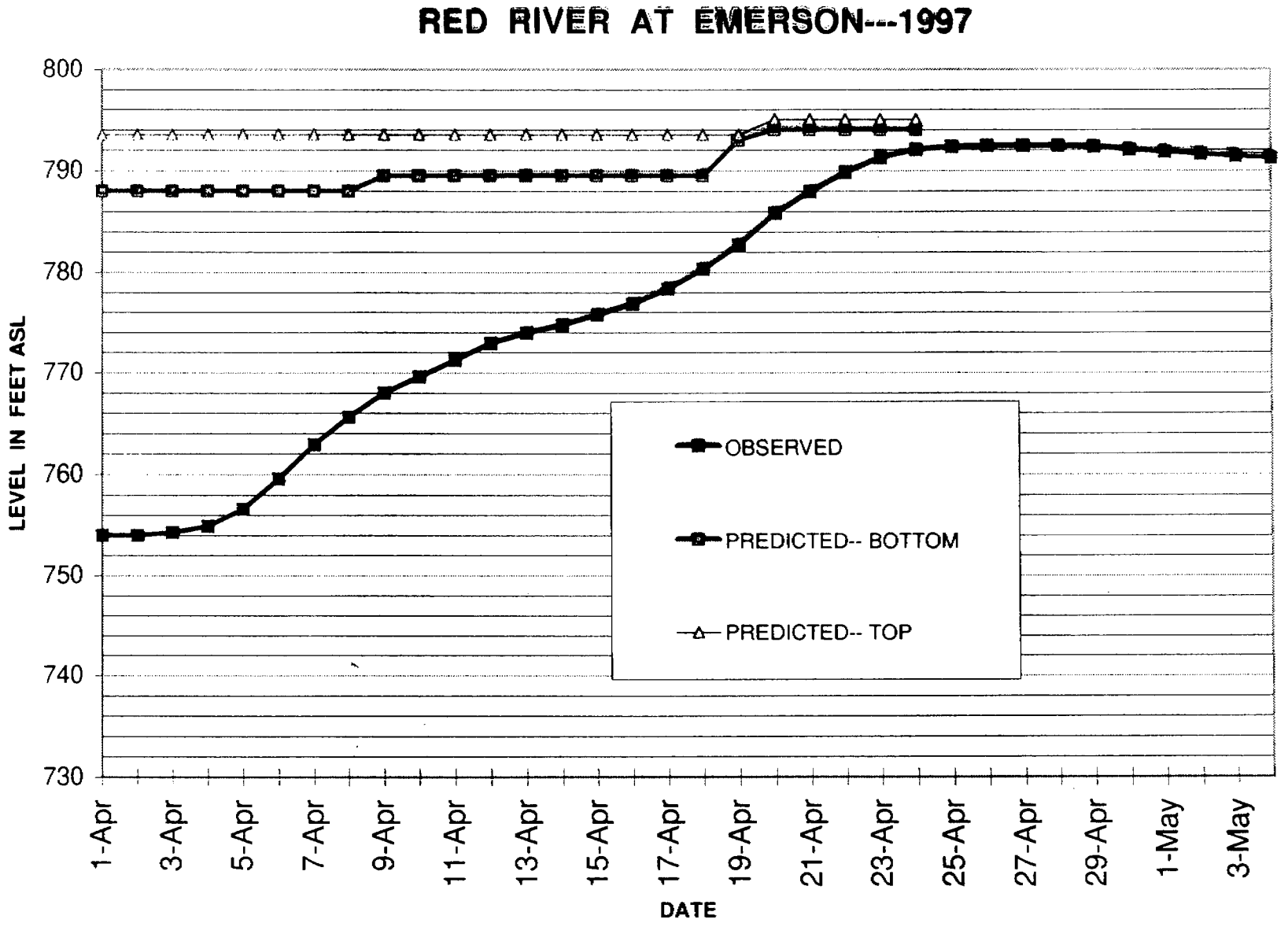
FEBRUARY 24, 1997

"UNDER AN ADVERSE WEATHER SCENARIO (ONE IN TEN CHANCES), FLOOD LEVELS FROM EMERSON TO SELKIRK COULD SURPASS ALL PREVIOUS FLOODS THIS CENTURY"

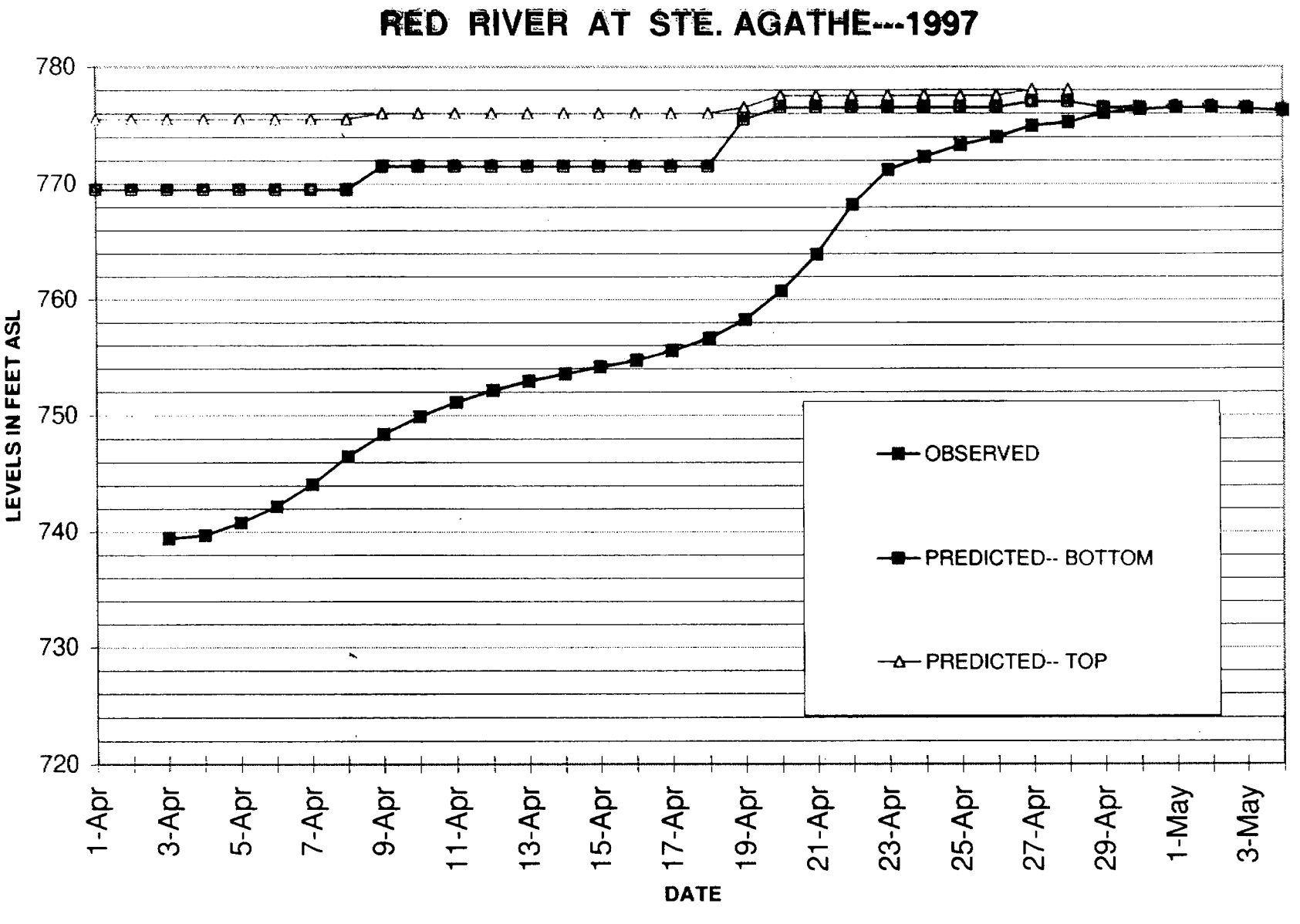
MARCH 21, 1997

"UNDER AN ADVERSE WEATHER SCENARIO LEVELS COULD BE TWO TO FOUR FEET HIGHER THAN THOSE OF 1979, DEPENDING ON LOCATION ALONG THE RIVER"

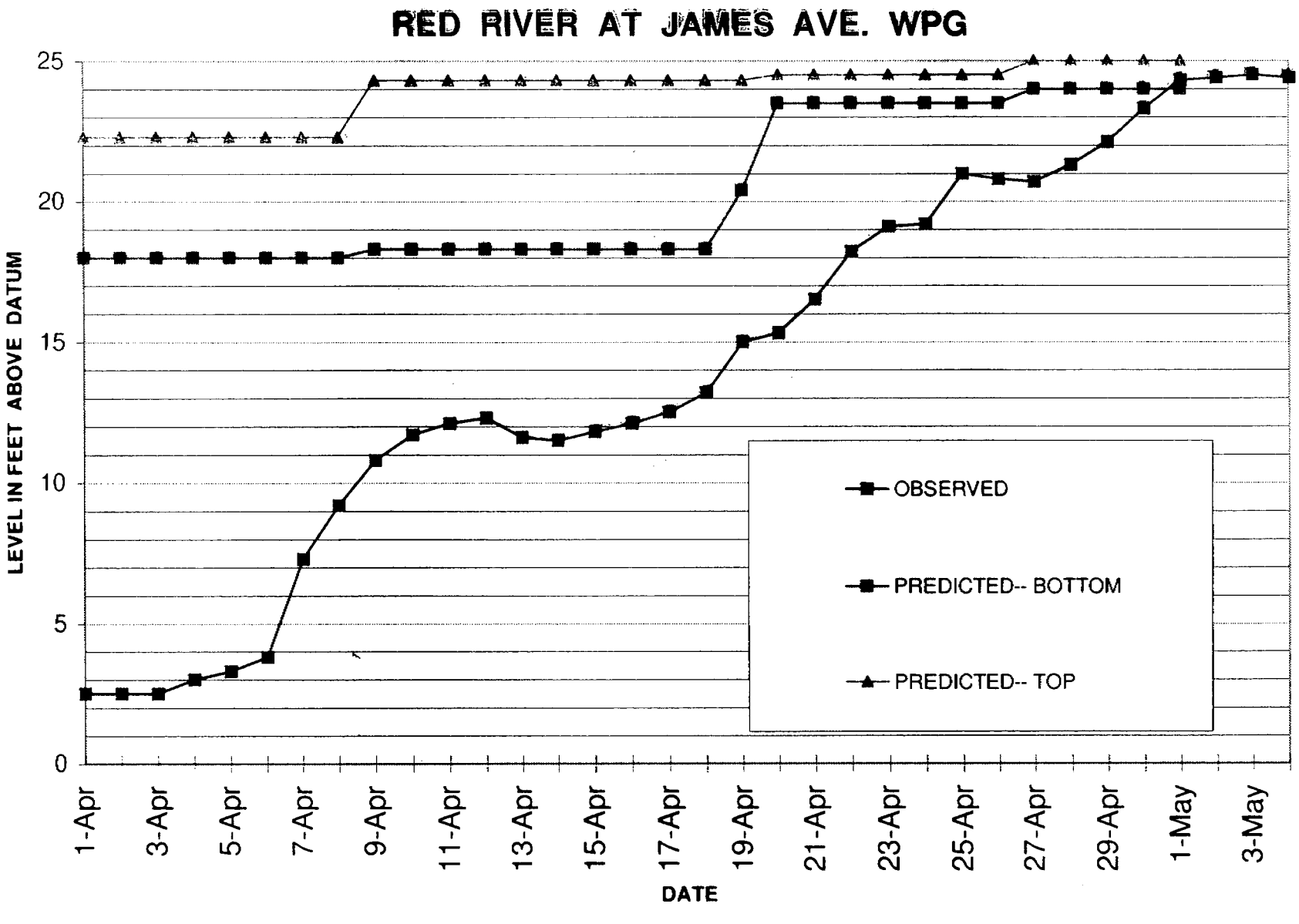
MANITOBA RIVER FORECAST CENTRE



MANITOBA RIVER FORECAST CENTRE



MANITOBA RIVER FORECAST CENTRE



River Forecast Centre

REVIEW OF RED RIVER CREST FORECASTING
SPRING OF 1997

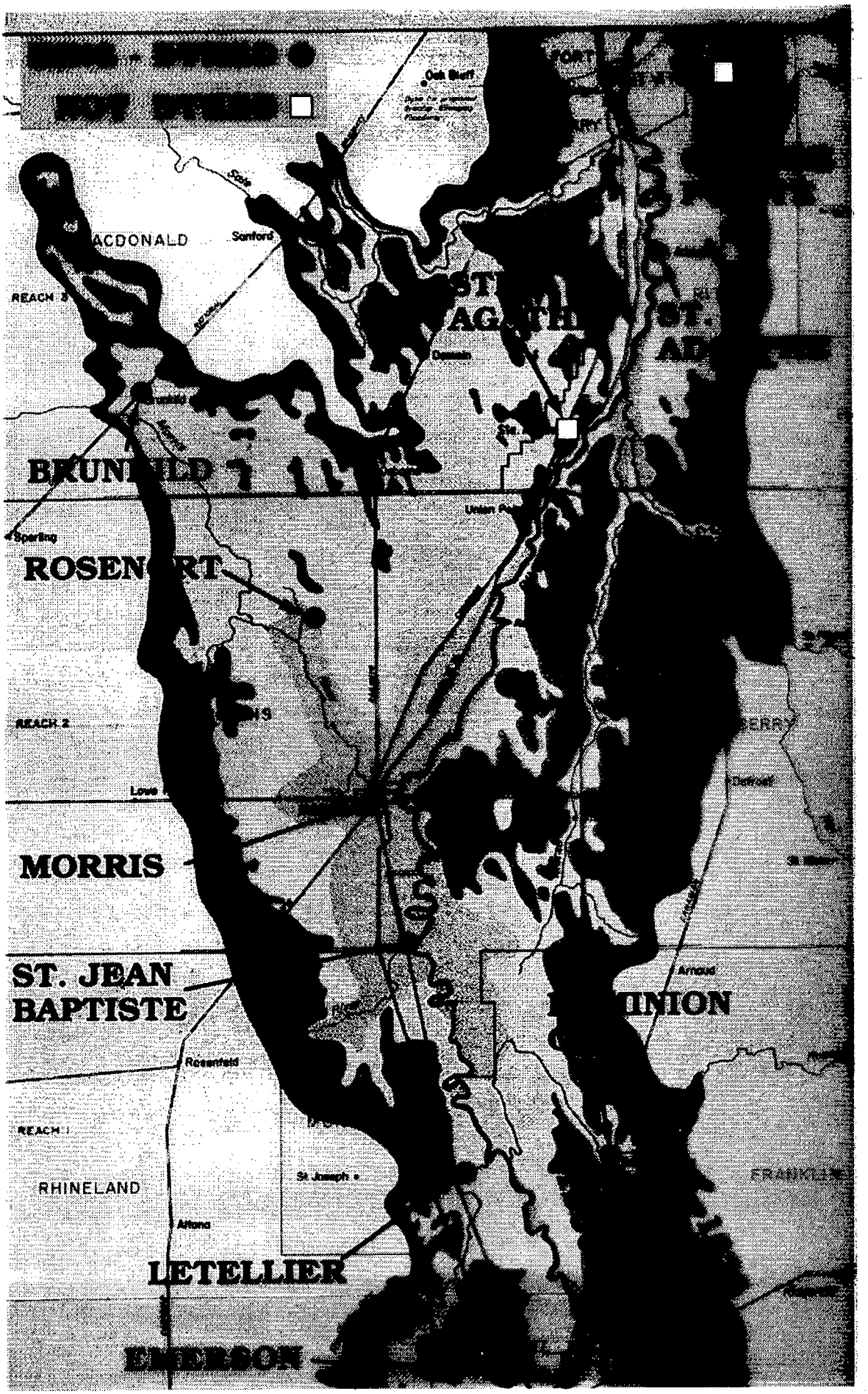
Predicted Crest Elevations in Feet						
Forecast Date	Emerson	Morris	Ste. Agathe	Floodway Inlet	Winnipeg (James Ave.)	Selkirk (PTH #4)
February 24	790.5-793.0	780.5-783.5	773.0-775.5	765.8-769.2	19.3-22.5	
March 21	791.0-793.0	781.0-783.5	773.0-775.5	765.2-769.0	19.3-22.3	
Favourable Melt Followed by April 4-6 Blizzard						
April 10	792.0-793.5	782.0--784.0	774.5-776.0	767.3-769.6	19.7-24.3	725.0-727.5
	River Levels at Grand Forks rise much higher than predicted					
April 18	793.0-793.5	783.0-784.0	775.5-776.5	768.3-769.5	20.4-24.3	725.0
Crest Levels at Grand Forks revised upward significantly						
April 20	794.0-795.0	784.5-785.5	776.5-777.5	769.0-770.0	23.5-24.5	726.5-727.5
Manitoba Tributaries crests coincident with Emerson Crest						
April 27	Near Peak	784.5-785.5	777.0-778.0	769.5-770.5	24.0-25.0	727.0-728.0
Update Based On Flow Measurements at Ste. Agathe						
April 29	Crested	Near Peak	776.5	770.0-770.5	24.0-25.0	727.0-728.0
Actual Crest	792.5	783.0	776.5	771.3	24.5	726.2
Crest Date	April 27	April 30	May 2	May 4	May 2-4	May 4-5

RED RIVER FORECASTS FOR 1997 FLOOD

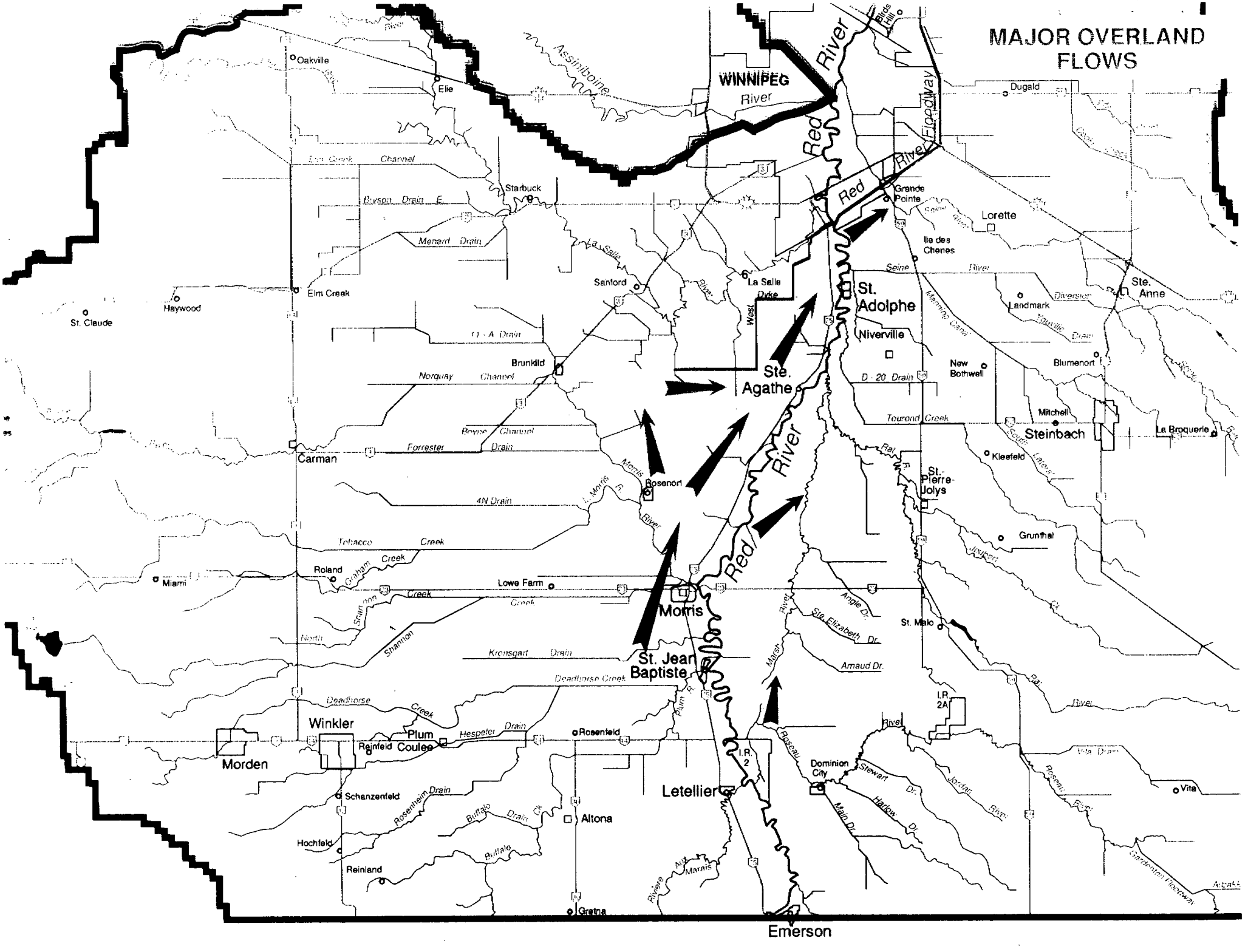
As Issued by Manitoba Water Resources

(All Levels in Feet)

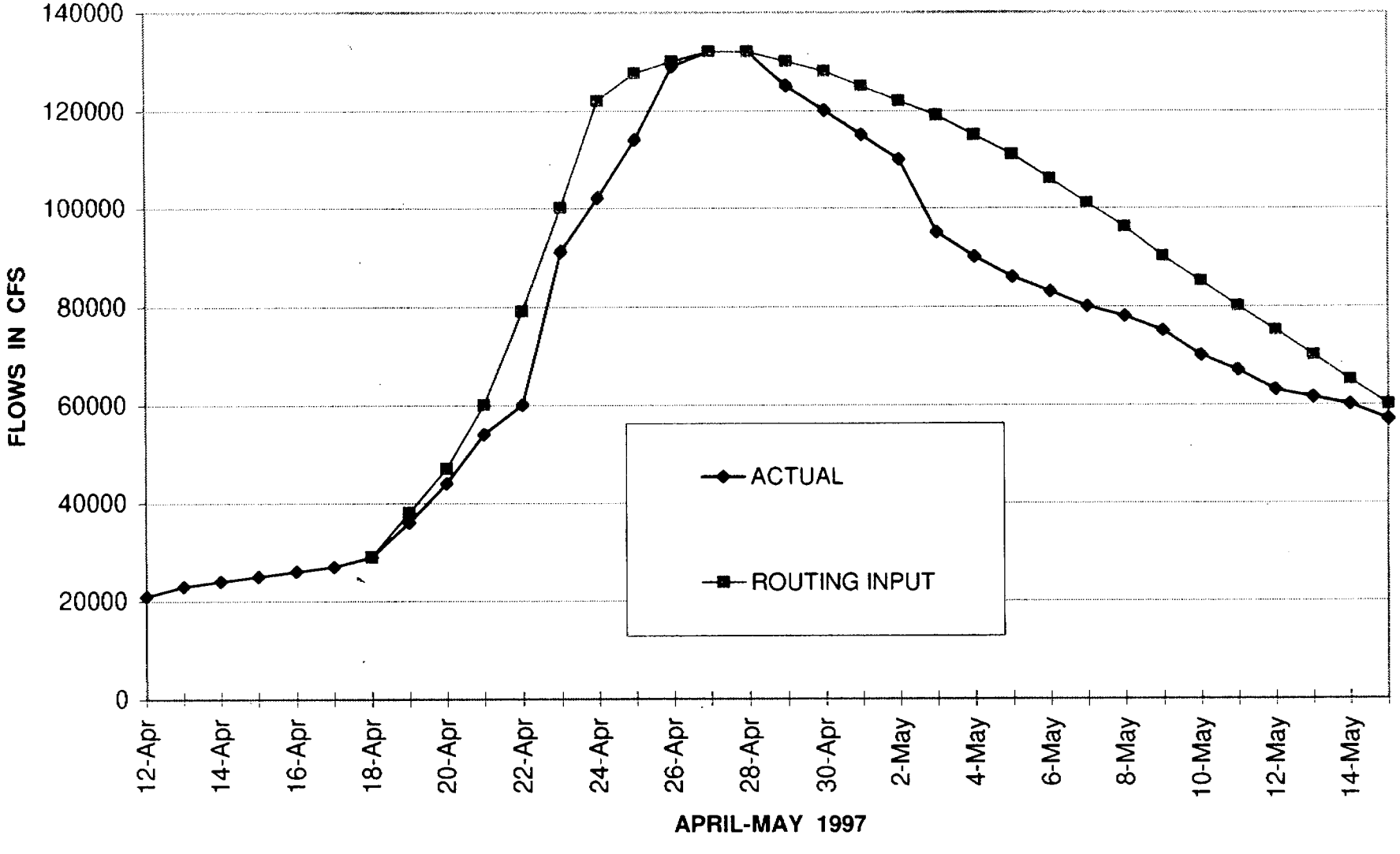
	March 21/97 Outlook Med.	Upp..	April 10/97 Outlooks Med.	Upp..	April 20/97 Forecast (Good Weather)	Total Spring Rise	Recorded 1997 Peak	Deviation From April 20 Forecast
Emerson	791.0	793.0	792.0	793.5	794.0 - 795.0	40.3	792.5	-1.5
Letellier	785.5	787.5	786.0	788.0	788.0 - 789.0	39.0	787.7	-0.3
St. Jean	782.2	784.5	783.0	785.0	785.0 - 786.0	37.9	784.3	-0.7
Morris	781.0	783.5	782.0	784.0	784.5 - 785.5	39.2	783.3	-1.2
Ste. Agathe	773.0	775.5	774.5	776.0	776.5 - 777.5	37.0	776.5	0.0
St. Adolphe	768.4	772.2	770.0	772.7	772.5 - 773.5	38.4	772.5	0.0
U/S/ Floodway	765.2	769.0	767.3	769.8	769.0 - 770.0	38.5	771.5	+1.5
D/S Floodway	753.6	758.1	754.6	759.8	759.3 - 760.3	29.4	761.1	+0.8
Bishop Grandin			23.0		27.5 - 28.5	26.4	29.7	+1.2
James Avenue	19.3	22.3	19.7	24.3	23.5 - 24.5	24.0	24.5	0.0
Kildonan Bridge			17.1		21.0 - 22.0	20.8	21.8	0.0
Selkirk PTH 4	724.0	727.5	725.0	727.5	726.0 - 727.5	---	726.2	0.0

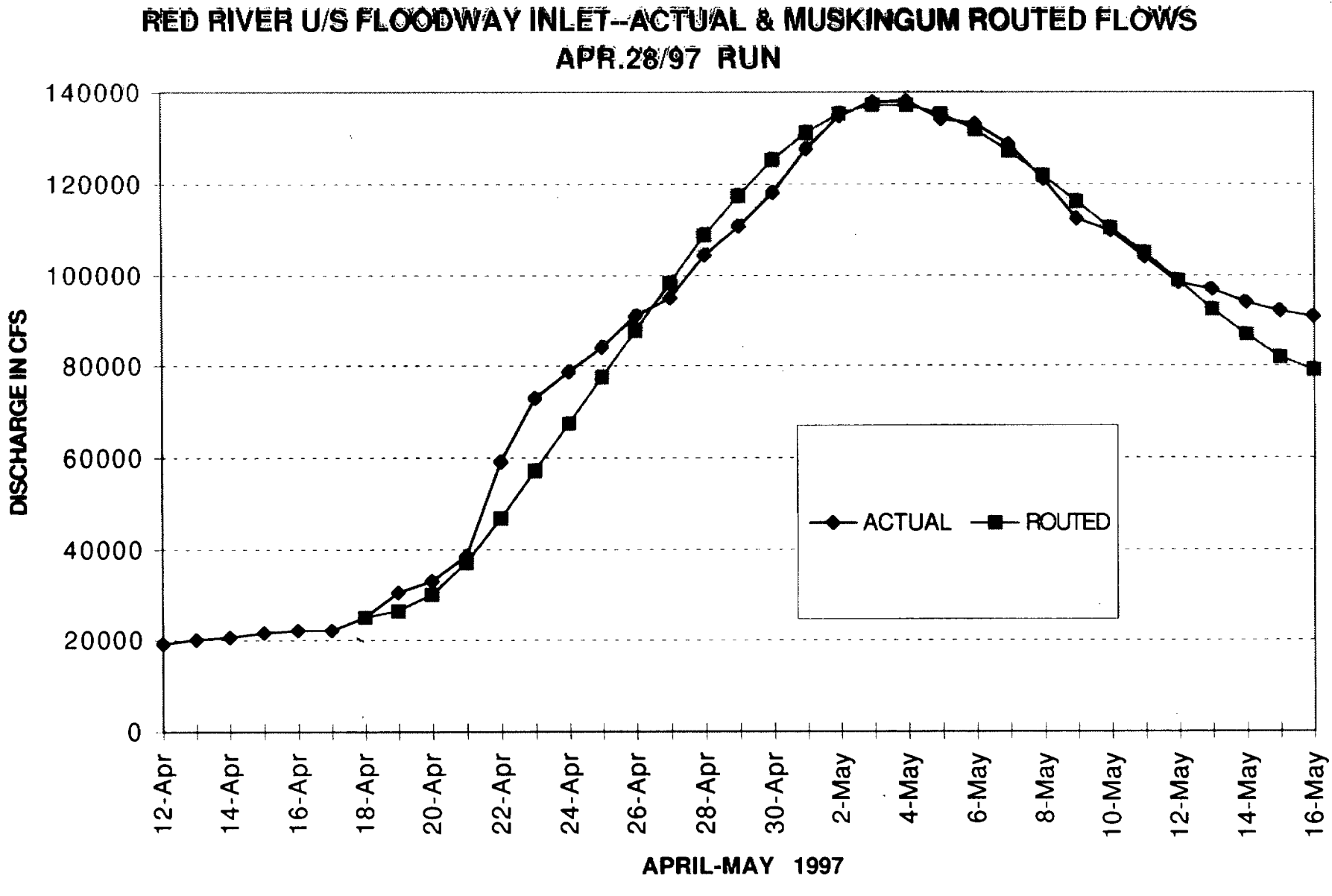


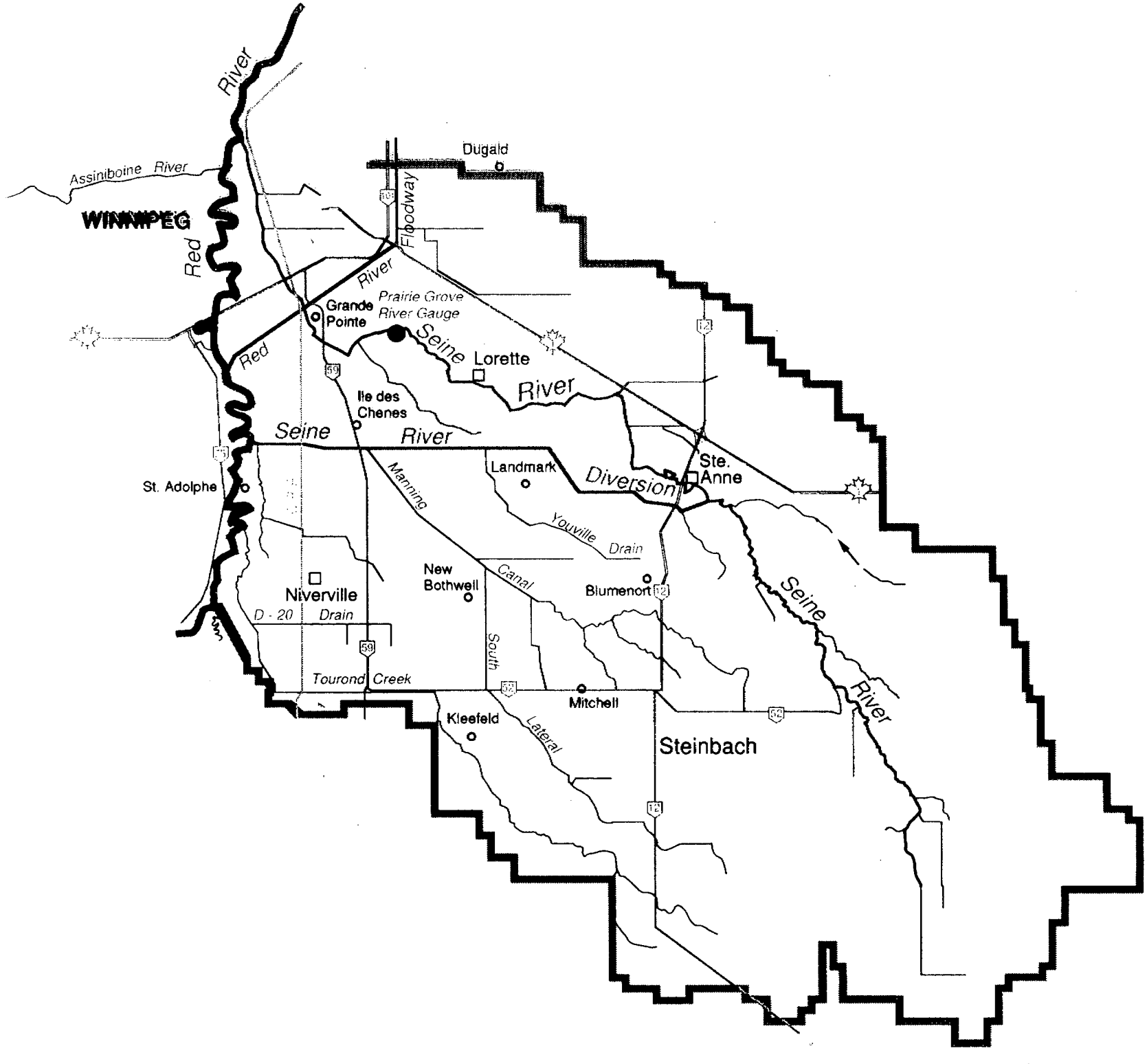
RED RIVER VALLEY COMMUNITIES


MAJOR OVERLAND FLOWS
WINNIPEG
Red River
Red River Floodway
Assiniboine River
Oakville
Elie
Dugald
Starbuck
Grande Pointe
Lorette
Ile des Chenes
Seine River
Ste. Anne
Landmark
Elm Creek
Haywood
St. Claude
Sanford
La Salle River
La Salle Dyke
West
St. Adolphe
Niverville
New Bothwell
Blumenort
Steinbach
Mitchell
La Broquerie
Kleefeld
St. Pierre-Jolys
Grunthal
Brunkild
Ste. Agathe
Carman
Roseau River
Rosenort
Morris
Miami
Roland
Lowe Farm
Tobacco Creek
Graham Creek
Shannon
Kronsgart Drain
St. Jean Baptiste
St. Malo
Ste Elizabeth Dr.
Amaud Dr.
Marsh River
Angle Dr.
Deadhorse Creek
Winkler
Plum Coulee
Reinfeld
Rosenfeld
Morden
Hespeler Drain
Schanzenfeld
Rosenheim Drain
Buffalo Drain
Altona
Hochfeld
Reinland
Gretna
Letellier
I.R. 2
I.R. 2A
Dominion City
Stewart Dr.
Hallow Dr.
Main Dr.
Vita
Emerson

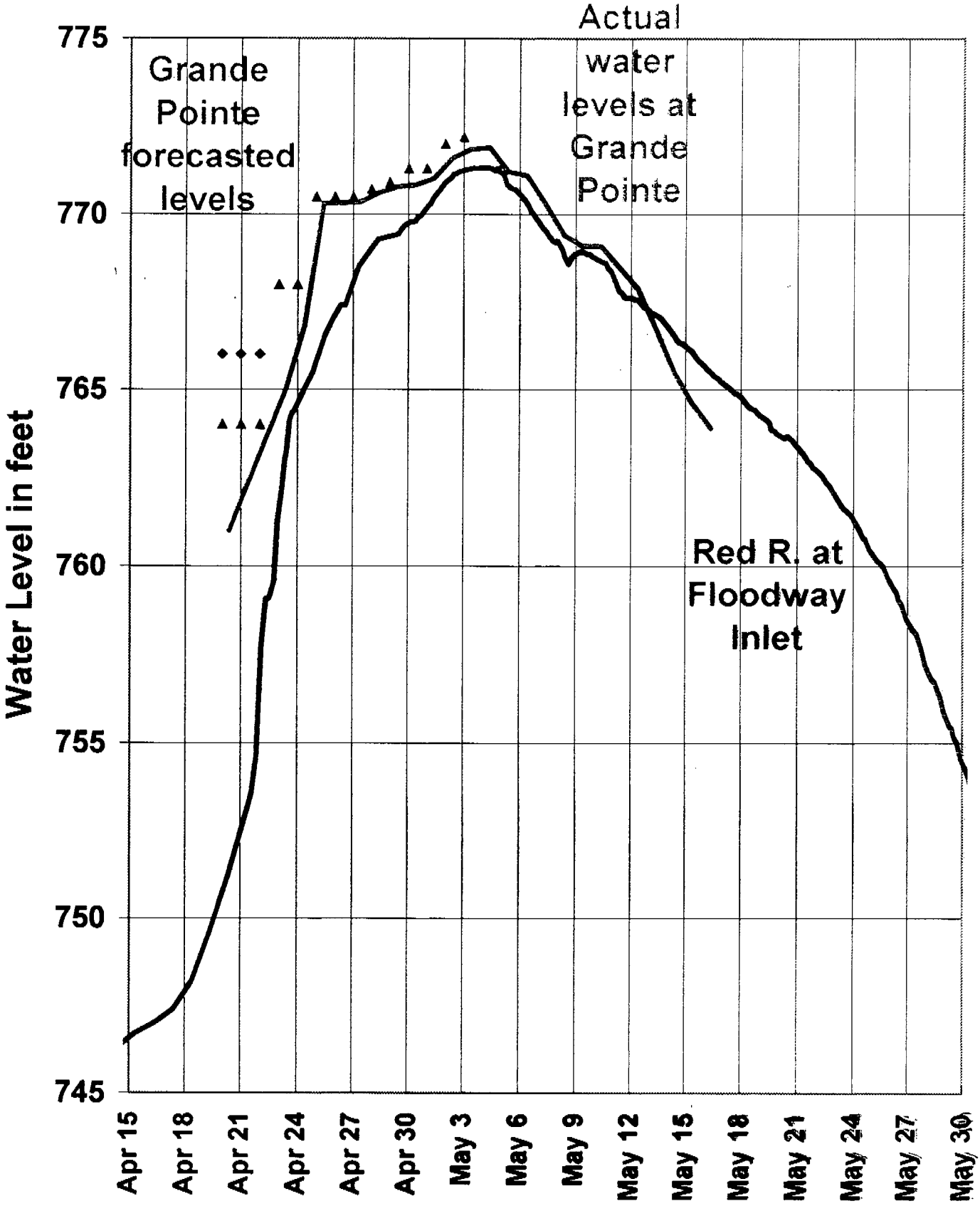
RED RIVER FLOWS--EMERSON--ACTUAL & APR.28 ROUTING INPUT



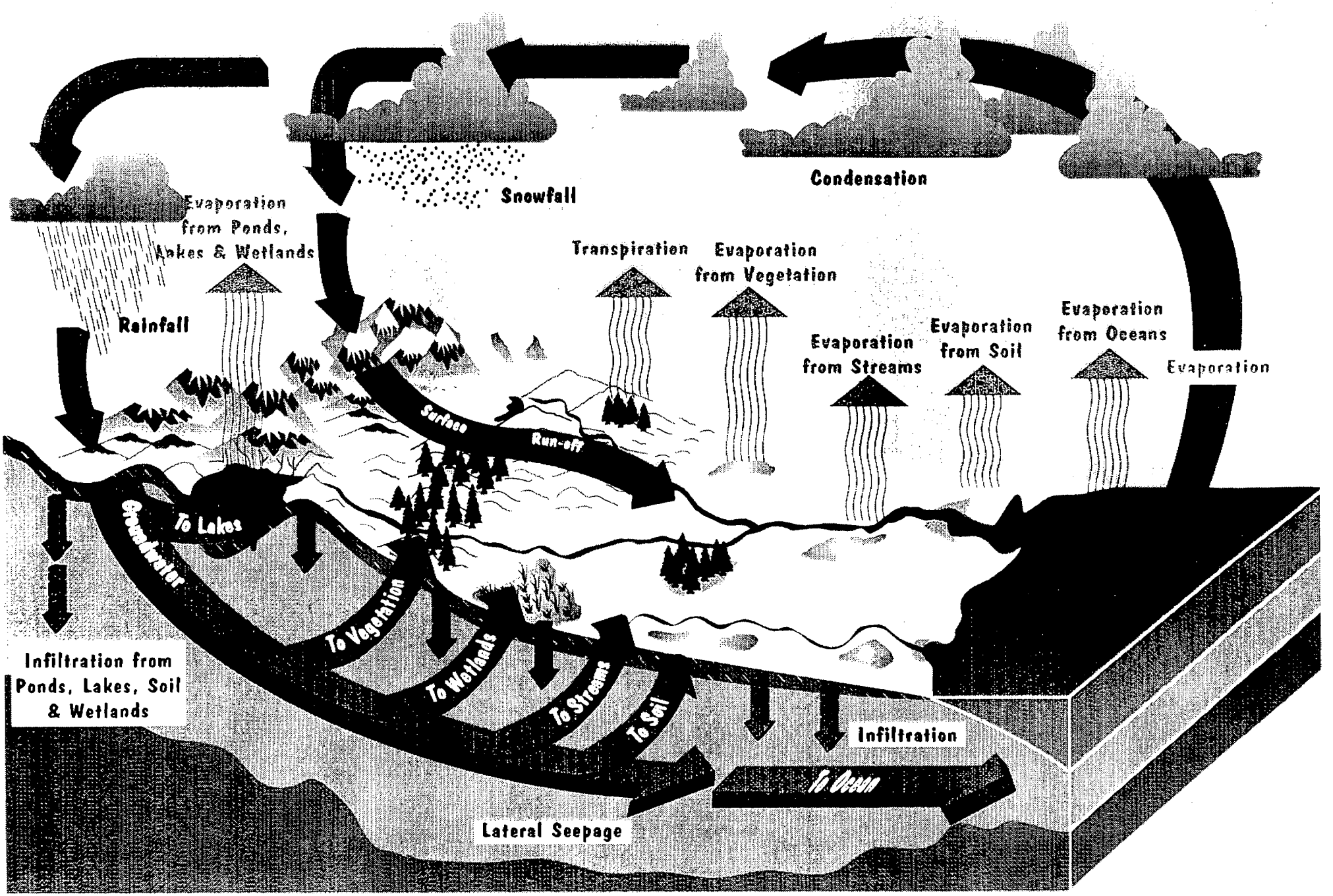

RED RIVER U/S FLOODWAY INLET--ACTUAL & MUSKINGUM ROUTED FLOWS
APR.28/97 RUN
DISCHARGE IN CFS
140000
120000
100000
80000
60000
40000
20000
0
ACTUAL
ROUTED
12-Apr
14-Apr
16-Apr
18-Apr
20-Apr
22-Apr
24-Apr
26-Apr
28-Apr
30-Apr
2-May
4-May
6-May
8-May
10-May
12-May
14-May
16-May
APRIL-MAY 1997


Red River
Assiniboine River
WINNIPEG
Red River
Floodway
Dugald
Grande Pointe
Prairie Grove River Gauge
Seine River
Lorette
Red
Ile des Chenes
Seine River
Landmark
Ste. Anne
Divertion
St. Adolphe
Manning
Youville Drain
New Bothwell
Canal
Niverville
D - 20 Drain
Blumenort
Seine River
South
Tourond Creek
Mitchell
Kleefeld
Lateral
Steinbach

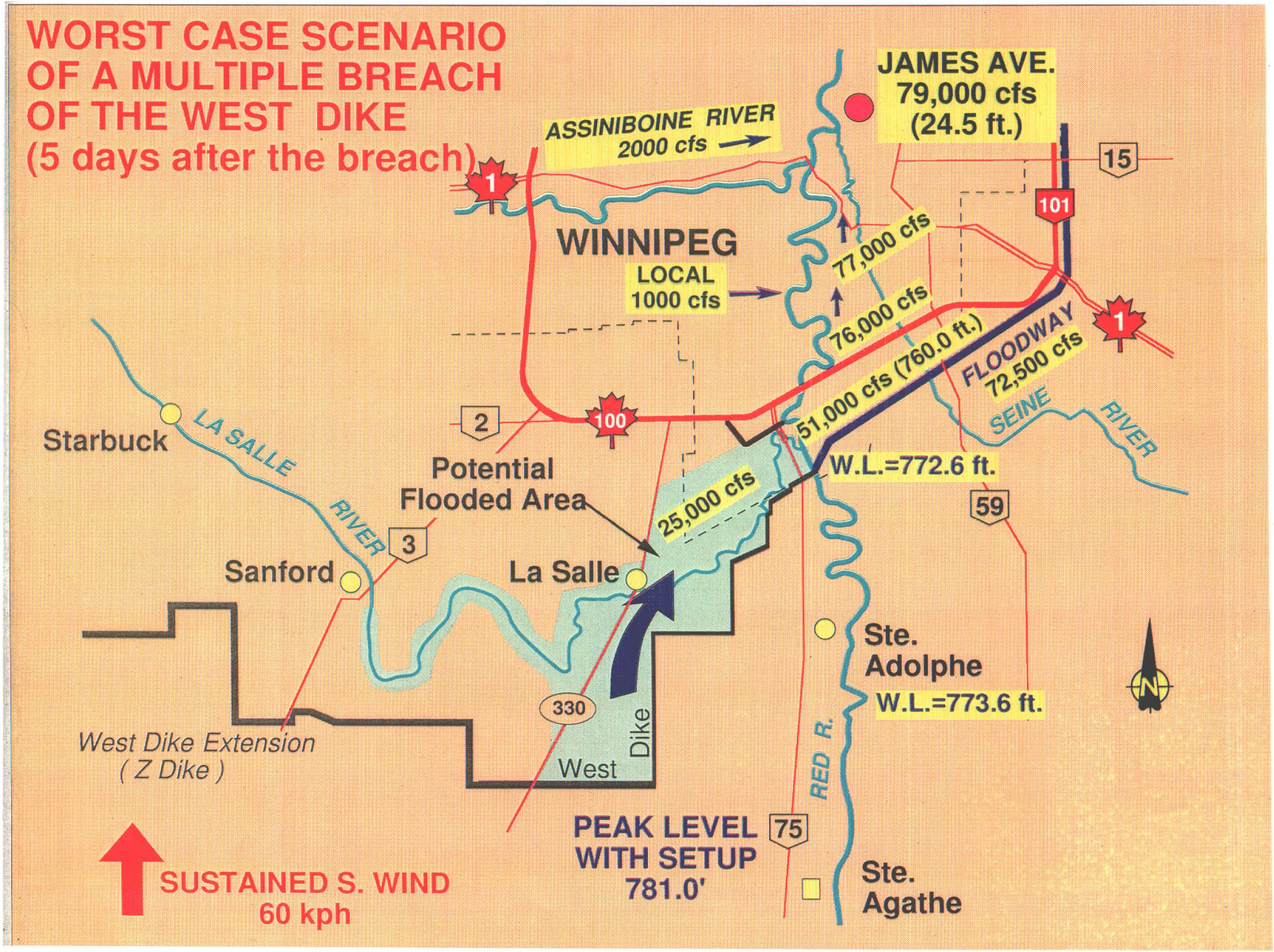
1997 Flood: Water Levels

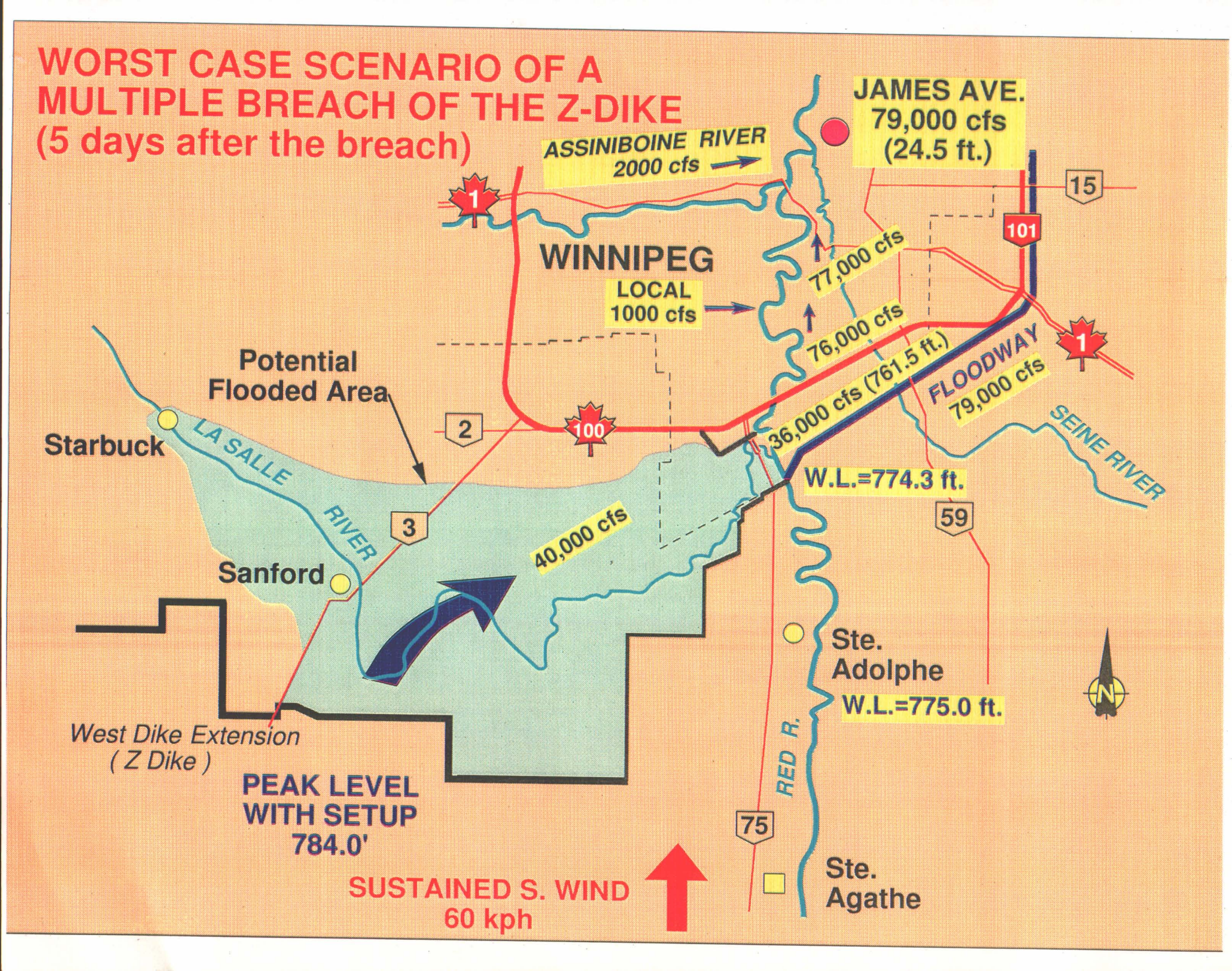


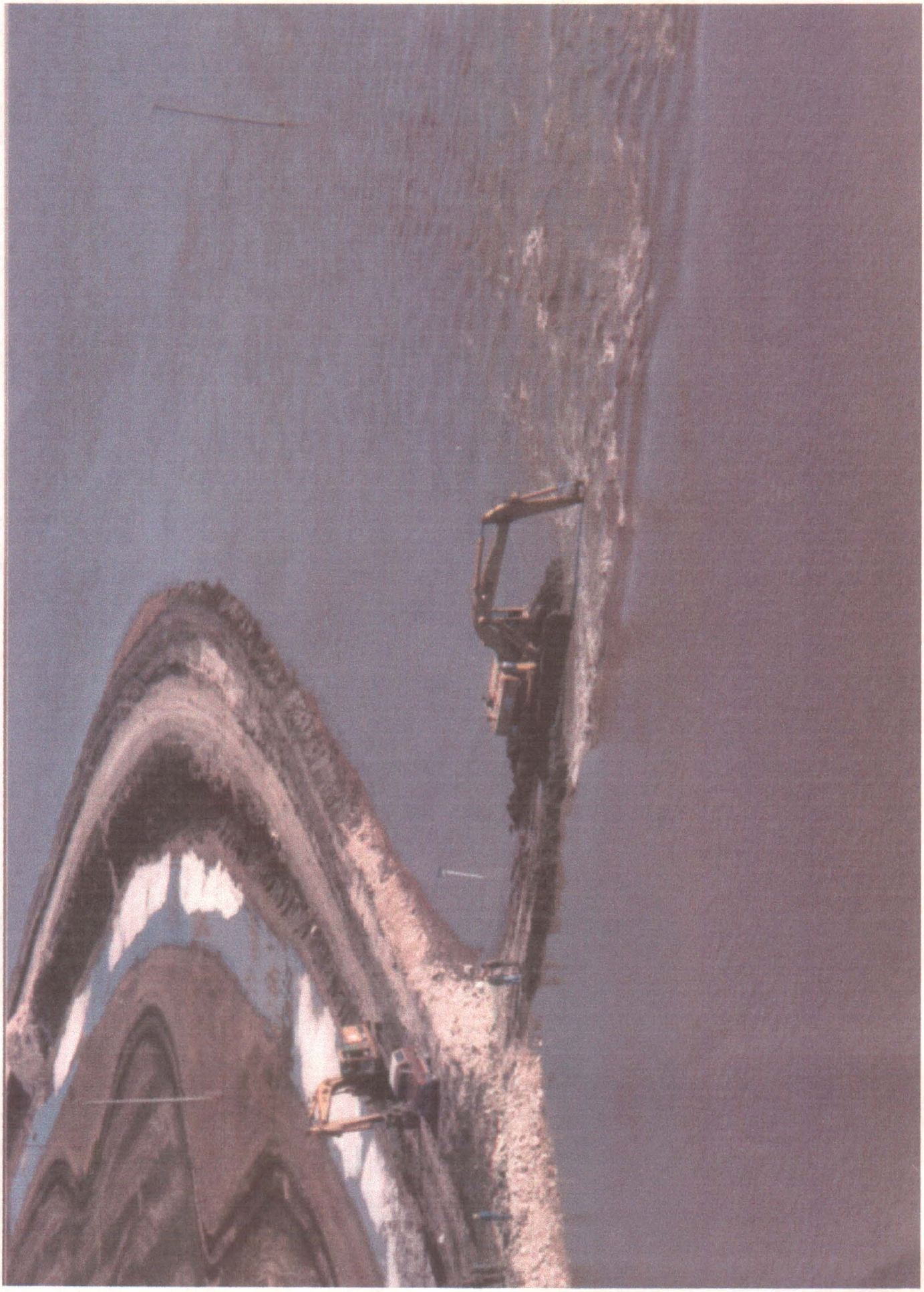
THE HYDROLOGIC CYCLE



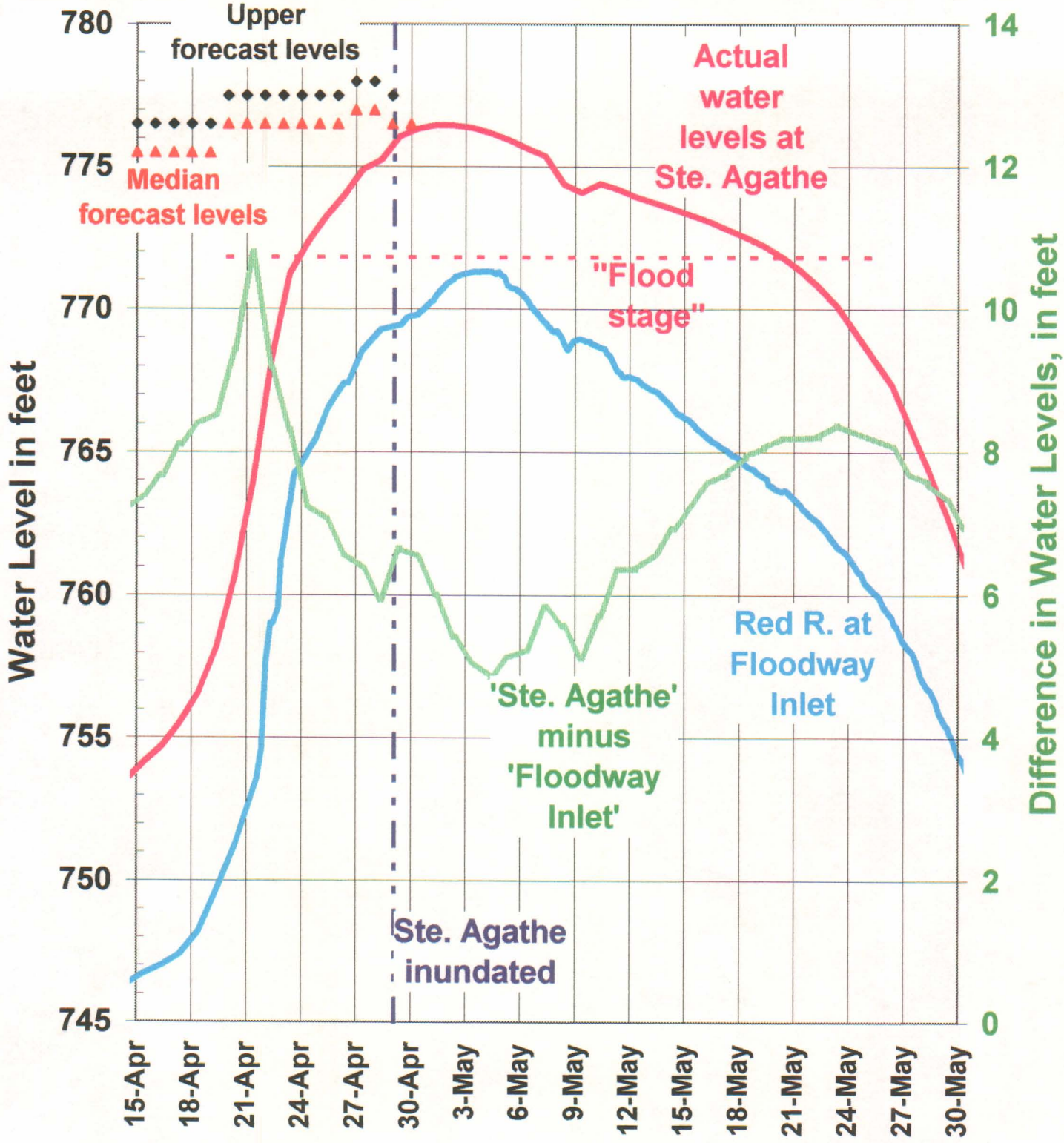
- 1997 operational considerations - Rick Bowering
  - West dike extension
  - impact on Grande Pointe & Ste. Agathe

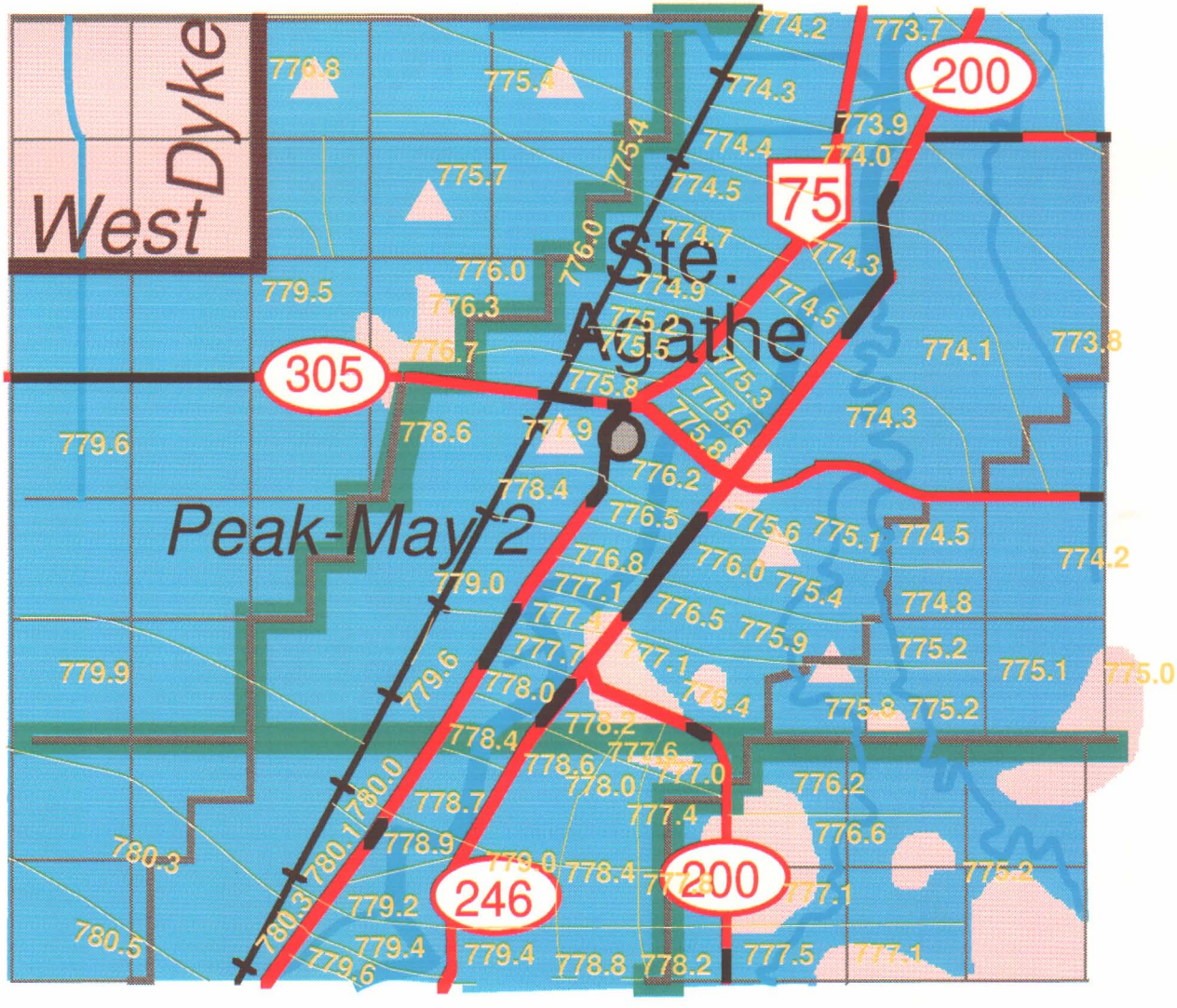

WORST CASE SCENARIO
OF A MULTIPLE BREACH
OF THE WEST DIKE
(5 days after the breach)
JAMES AVE.
79,000 cfs
(24.5 ft.)
ASSINIBOINE RIVER
2000 cfs
WINNIPEG
LOCAL
1000 cfs
77,000 cfs
76,000 cfs
51,000 cfs (760.0 ft.)
FLOODWAY
72,500 cfs
SEINE
RIVER
W.L.=772.6 ft.
Starbuck
LA SALLE
RIVER
Potential
Flooded Area
25,000 cfs
Sanford
La Salle
West Dike Extension
(Z Dike)
West Dike
Ste.
Adolphe
W.L.=773.6 ft.
RED R.
PEAK LEVEL
WITH SETUP
781.0'
Ste.
Agathe
SUSTAINED S. WIND
60 kph
1
15
101
2
100
3
59
75
330


WORST CASE SCENARIO OF A
MULTIPLE BREACH OF THE Z-DIKE
(5 days after the breach)
ASSINIBOINE RIVER
2000 cfs
JAMES AVE.
79,000 cfs
(24.5 ft.)
WINNIPEG
LOCAL
1000 cfs
77,000 cfs
76,000 cfs
36,000 cfs (761.5 ft.)
FLOODWAY
79,000 cfs
Potential
Flooded Area
Starbuck
LA SALLE
RIVER
Sanford
40,000 cfs
W.L.=774.3 ft.
SEINE RIVER
Ste.
Adolphe
W.L.=775.0 ft.
RED R.
Ste.
Agathe
West Dike Extension
(Z Dike)
PEAK LEVEL
WITH SETUP
784.0'
SUSTAINED S. WIND
60 kph
1
15
101
100
2
3
59
75
N



1997 Flood: Water Levels





RED RIVER 1997 FLOODING

MAXIMUM LEVELS NEAR STE.AGATHE

Based on Radarsat Imagery from April 27, May 1, May 4 & May 8 1997, and on aerial photography from April 29, May 1 and May 2, 1997.

Islands one or more this section (2 Ac.- 30 Ac.).

Road Road Flooded

Manitoba
Natural Resources
Water Resources

- Red River Valley Designated Flooded Area
  - Ron Bryer

RED RIVER VALLEY DESIGNATED FLOOD AREA

- Established in 1979 under Section 17 of The Water Resources Administration Act.
- A permit is required for the construction or reconstruction of any structure within the Designated Flood Area.
- Grades are set by Natural Resources Surveyors.
- Development is inspected for compliance to elevation criteria following completion of construction.
- Notice of compliance/non compliance to be sent to the permit holder and municipality.
- The Minister may order the removal of non-compliant structures.
- Amendments introduced in 1990 allow the Minister to vary flood proofing criteria and register notices in the Land Titles Office.

COMPLIANCE

- 881 permits issued prior to the 1997 flood.
- 535 were for residences.
- 362 residences have been completed and inspected.
- 206 complied with the flood proofing requirements.
- 156 did not meet requirements.
- 125 of those that did not comply had main floor elevations above the 100 year flood level.

CHANGES BEING CONSIDERED

- Develop improved means of enforcing the flood protection requirements specified under the program.

- Ensure that future purchasers of property in the valley will be advised if a property does not meet provincial floodproofing criteria.

- Reduce future compensation payments by all levels of government.

- Change the boundary of the designated flood area.

- Amend the Accessory Structures section of the regulation.

MANITOBA NATURAL RESOURCES
THE WATER RESOURCES ADMINISTRATION ACT

Application for Permit in the Red River Valley Designated Flood Area

I, _____ of the _____
(Applicant's Name) (R.M./Town/Village)

_____, in the Province of Manitoba, apply for a permit to build

_____
(describe nature, purpose and size of building or structure)

_____

situated on _____
(give legal description and if the land is not subdivided give accurate location within section)

_____

In making this application I am fully aware that neither the Government of Manitoba nor any department, branch, or agency thereof can forecast or guarantee that the flood protection level would not be equalled or exceeded in the future; that I agree to comply with the conditions stipulated in the permit.

Address:	Signature of Applicant:
	Date:
Postal Code:	Telephone:

CERTIFICATION:

I, _____, Secretary-Treasurer of the

_____ hereby certify that the Applicant is the registered

owner of the land described herein.

DATED at _____, in the Province of Manitoba this

_____ day of _____, A.D. 19___.

_____
Secretary-Treasurer

MANITOBA
DEPARTMENT
OF NATURAL RESOURCES

Water Resources Branch
1577 Dublin Avenue
Winnipeg MB R3E 3J5

PERMIT

No./97

Issued pursuant to The Water Resources Administration Act

Red River Valley Designated Flood Area

_____ *of the Rural Municipality of* _____ in the Province of Manitoba is hereby permitted to build or place *a* _____ within the Red River Valley Designated Flood Area on , subject to the following conditions:

(a) The flood protection level shall not be less than elevation **XXX feet**, G.S. of C. Datum.

(b) Finished floor level shall not be less than elevation **XXX feet**, G.S. of C. Datum.

(c) The level of the surrounding fill at the building line shall not be less than elevation **XXX feet**, G.S. of C. Datum, and shall not slope more than 6 inches for a horizontal distance of 15 feet from the building line and not more than 1 foot vertically to 4 feet horizontally thereafter. The fill shall be constructed of suitable compacted clay.

_____
Minister of Natural Resources

Date Issued: _____

Inspected for Compliance by: _____ Date: _____

Approved by: _____ Date: _____

Comparative Stages - Red River 1997

Location	Observed Peak	Observed 1979	Observed 1996	DFA -100 Year	Comparison With this Year		
					1979	1996	100 Year
Grande Pointe	771.9	764.99	764.6	769.4	6.9	7.3	2.5
Above Floodway	771.3	764.99	764.59	769.20	6.3	6.7	2.1
St. Adolphe	772.8	768.31	767.35	770.80	4.2	5.1	1.7
Ste. Agathe	776.5	773.10	771.92	775.00	3.4	4.6	1.5
Morris	783.3	781.26	779.55	783.00	2.1	3.8	0.3
St. Jean	784.2	782.36	781.26	784.00	1.8	2.9	0.2
Letellier	787.6	785.50	784.54	786.50	2.1	3.1	1.1
Emerson	792.5	791.27	789.60	792.50	1.2	2.9	0.0

Note: Elevations in Feet, Letellier peak subject to revision

Prohibitions within designated flood areas
17(1) No person shall

(a) build, construct, erect, or bring any building, structure, or erection other than a fence on or within a designated flood area; or

(b) make any addition to or reconstruct any building, structure, or erection other than a fence within a designated flood area;

unless he has a valid and subsisting permit therefor issued under subsection (3).

Further prohibitions
17(2) No person shall occupy or maintain any building, structure, or erection that was built, constructed, erected or reconstructed, or to which an addition was made contrary to subsection (1) or that does not comply with the terms and conditions of a permit issued under subsection (3).

Permit
17(3) The minister may issue a permit

(a) for the building, erection, construction, or bringing a building, structure or erection on or within a designated flood area;

(b) for the addition to or reconstruction of any building, structure or erection within a designated flood area; or

(c) for both the purposes mentioned in clause (a) and the purposes mentioned in clause (b);

and the minister may make the permit subject to such terms and conditions, not inconsistent with the regulations, as the minister may deem advisable.

R.S.M. 1987 Supp., c. 33, s. 4.

Cancellation of permit
17(4) The minister may cancel a permit issued under subsection (3) where he has reason to believe that the work being carried out under the permit does not comply with the terms and conditions thereof or with such floodproofing criteria as may be prescribed in the regulations.

R.S.M. 1987 Supp., c. 33, s. 5.

Application for variation.
17(5) The holder of a permit issued under subsection (3) may apply to the minister for

(a) a variation of any of the terms and conditions subject to which the permit was issued; or

Interdiction dans les zones inondables reconnues
17(1) À moins d'être titulaire d'un permis valide et en vigueur délivré à cette fin aux termes du paragraphe (3), nul ne peut :

a) construire, ériger ou amener un bâtiment ou une structure autre qu'une clôture dans la zone inondable reconnue;

b) agrandir ou reconstruire un bâtiment ou une structure autre qu'une clôture dans une zone inondable reconnue.

Autres interdictions
17(2) Il est interdit d'occuper ou d'entretenir un bâtiment ou une structure qui a été construit, érigé ou agrandi contrairement au paragraphe (1) ou qui n'est pas conforme aux modalités et conditions d'un permis délivré en vertu du paragraphe (3).

Permis
17(3) Le ministre peut délivrer un permis pour :

a) la construction, l'érection ou l'apport d'une structure ou d'un bâtiment dans la zone inondable reconnue;

b) l'agrandissement ou la reconstruction d'un bâtiment ou d'une structure dans la zone inondable reconnue.

c) les fins visées aux alinéas a) et b).

Le ministre peut assortir le permis des modalités et conditions qu'il juge opportunes, dand la mesure où elles sont compatibles avec les règlements.

Suppl. L.R.M. 1987, c. 33, art. 4.

Annulation du permis
17(4) Le ministre peut annuler un permis délivré en vertu du paragraphe (3) lorsqu'il a des raisons de croire que les travaux exécutés aux termes du permis ne sont pas conformes aux modalités et conditions de celui-ci ni aux critères de prévention des inondations prévus aux règlements.

Suppl. L.R.M. 1987, c. 33, art. 5.

Demande de modification et de dérogation
17(5) Le titulaire d'un permis délivré en vertu du paragraphe (3) peut demander au ministre :

a) une modification des modalités et conditions aux termes desquelles le permis a été délivré;

(b) a variation of any provision of the applicable floodproofing criteria prescribed in the regulations; or

(c) a variation under both clause (a) and clause (b).

R.S.M. 1987 Supp., c. 33, s. 5.

Order for variation

17(6) The minister may by order grant, in whole or in part, any variation of a term or condition of a permit or a provision of floodproofing criteria for which application is made under subsection (5),

(a) where the minister is satisfied that compliance with the term or condition or the provision, without variation, would have an adverse effect on developed neighboring land; or

(b) where the application relates to a permit for the reconstruction of, or the construction of an addition to, or the construction of a building or other structure appurtenant to, an existing building lawfully constructed and lawfully maintained, and the minister is satisfied that compliance with the term or condition or the provision, without variation, would be impossible or impractical; or

(c) where the application relates to a permit for the replacement of an existing building or structure, lawfully constructed and lawfully maintained, that has been destroyed by fire or flood or other peril, and the minister is satisfied that compliance with the term or condition or the provision, without variation, would be impossible or impractical;

as the case may be, and the minister may make the order subject to terms and conditions including a term or condition prohibiting the applicant from receiving any flood protection assistance or flood damage assistance for which the applicant might otherwise be eligible.

R.S.M. 1987 Supp., c. 33, s. 5.

Appeal to Municipal Board.

17(7) Where the minister

(a) refuses to issue a permit under subsection (3); or

(b) cancels a permit under subsection (4); or

(c) refuses to make an order for a variation under subsection (6); or

b) une dérogation aux critères de prévention des inondations applicables prévus aux règlements;

c) la modification visée à l'alinéa a) et la dérogation visée à l'alinéa b).

Suppl. L.R.M. 1987, c. 33, art. 5.

Arrêté visant une modification ou une dérogation

17(6) Le ministre peut, par arrêté, apporter la modification ou accorder la dérogation visée au paragraphe (5), en tout ou en partie, et assortir l'arrêté de modalités et conditions, y compris une modalité ou condition interdisant au requérant de recevoir l'aide à laquelle il aurait normalement droit pour la protection contre les inondations ou pour les dommages causés par celles-ci :

a) s'il est convaincu que l'observation de la modalité ou de la condition ou des critères de prévention des inondations, sans modification ni dérogation, aurait une incidence négative sur les biens-fonds voisins mis en valeur;

b) si la demande vise un permis de reconstruction d'un bâtiment existant construit et entretenu légalement, la construction d'un rajout à un tel bâtiment ou la construction d'un bâtiment ou autre structure s'y rattachant, et si le ministre est convaincu que l'observation de la modalité ou condition ou des critères de prévention des inondations, sans modification ni dérogation, serait impossible ou impraticable;

c) si la demande vise un permis de remplacement d'une structure ou d'un bâtiment existant, construit et entretenu légalement, qui a été détruit lors d'un incendie, d'une inondation ou d'un autre désastre, et si le ministre est convaincu que l'observation de la modalité ou condition ou des critères de prévention des inondations, sans modification ni dérogation, serait impossible ou impraticable.

Suppl. L.R.M. 1987, c. 33, art. 5.

Appel à la Commission municipale

17(7) Si le ministre :

a) refuse de délivrer un permis en vertu du paragraphe (3);

b) annule un permis en vertu du paragraphe (4);

c) refuse de prendre un arrêté apportant la modification ou accordant la dérogation visée au paragraphe (6);

(d) makes an order under subsection (6) for a partial variation only, but refuses to make an order for the whole variation applied for under subsection (5);

the person affected by the refusal or cancellation may in writing appeal therefrom to The Municipal Board.

R.S.M. 1987 Supp., c. 33, s. 5.

Trial de novo

17(8) An appeal to the Municipal Board under subsection (7) shall be by way of trial de novo, and after hearing the appeal The Municipal Board may direct the minister

(a) to issue or re-issue the permit; or

(b) to make an order granting the variation applied for, in whole or in part; or

(c) to make an order revoking the order appealed from and to make such further order as The Municipal Board may direct;

as the case may be, or may dismiss the appeal, and the minister shall carry out any direction of The Municipal Board.

R.S.M. 1987 Supp., c. 33, s. 5.

Filing of order in land titles office

17(9) The minister may file in the proper land titles office or registry office, as the case may require, a copy of any order made by the minister under this section.

R.S.M. 1987 Supp., c. 33, s. 5.

Filing of notice in land titles office

17(10) Where a building, structure or erection is built, constructed or erected within or brought onto a designated flood area, or is occupied or maintained within a designated flood area, in contravention of any provision of this section or in contravention of any applicable flood proofing criteria, the minister may file a notice to that effect in the proper land titles office or registry office, as the case may require.

R.S.M. 1987 Supp., c. 33, s. 5.

Cancellation of notice

17(11) The minister may at any time cancel a notice filed under subsection (10), and in that event shall file a cancellation of the notice in the proper land titles office or registry office.

R.S.M. 1987 Supp., c. 33, s. 5.

d) prend un arrêté en vertu du paragraphe (6) apportant la modification ou accordant la dérogation visée au paragraphe (5), en partie seulement,

la personne lésée par le refus ou l'annulation peut, par écrit, en appeler auprès de la Commission municipale.

Suppl. L.R.M. 1987, c. 33, art. 5.

Procès de novo

17(8) L'appel interjeté conformément au paragraphe (7) est entendu par voie de procès de novo. Après l'audition de l'appel, la Commission peut ordonner au ministre :

a) de délivrer le permis ou de le rétablir;

b) de prendre un arrêté apportant la modification ou accordant la dérogation faisant l'objet de la demande, en tout ou en partie;

c) de prendre un arrêté révoquant l'arrêté faisant l'objet de l'appel et de prendre tout autre arrêté qu'elle exige.

La Commission peut aussi rejeter l'appel. Le ministre doit se conformer à l'ordonnance de la Commission.

Suppl. L.R.M. 1987, c. 33, art. 5.

Dépôt de l'arrêté

17(9) Le ministre peut déposer au bureau des titres fonciers ou au bureau du registre foncier approprié, selon le cas, une copie de l'arrêté pris par le ministre en vertu du présent article.

Suppl. L.R.M. 1987, c. 33, art. 5.

Dépôt d'un avis au bureau des titres fonciers

17(10) Lorsqu'une structure ou un bâtiment est construit, érigé, transporté, occupé ou entretenu dans une zone inondable reconnue en contravention des dispositions du présent article ou des critères de prévention des inondations applicables, le ministre peut déposer un avis faisant état de cette contravention au bureau des titres fonciers ou au bureau du registre foncier approprié, selon les exigences du cas.

Suppl. L.R.M. 1987, c. 33, art. 5.

Annulation de l'avis

17(11) Le ministre peut en tout temps annuler un avis déposé conformément au paragraphe (10), auquel cas il dépose une annulation de l'avis au bureau des titres fonciers ou au bureau du registre foncier approprié.

Suppl. L.R.M. 1987, c. 33, art. 5.

Memorials on Certificates of Title

17(12) Upon the filing under this section of any order, notice or cancellation of a notice, or a copy of any of them, in a land titles office in respect of new system land, the district registrar shall endorse a memorial thereof on the certificate of title containing the land without production of the duplicate certificate of title.

R.S.M. 1987 Supp., c. 33, s. 5.

Removal of buildings, etc.

17(13) Where a building, structure or erection is built, constructed or erected within or brought onto a designated flood area, or is occupied or maintained within a designated flood area, in contravention of any provision of this section or in contravention of any applicable flood proofing criteria, the minister may order the building, structure or erection to be removed from the designated flood area within a period of time stated in the order, and if the owner thereof fails to comply with the order the minister may cause the building, structure or erection to be removed and the cost of the removal may be charged against and collected from the owner.

R.S.M. 1987 Supp., c. 33, s. 5.

Evacuation order

18(1) Where

(a) a dyked area is flooded;

(b) in the opinion of the minister, a dyked area is in imminent danger of being flooded because of a weakness in a designated dyking system or the danger of a flood exceeding the level against which a designated dyking system can protect the dyked area;

(c) the means of access by road to and from a dyked area are flooded, or, in the opinion of the minister, in imminent danger of being flooded;

(d) the water supply in the dyked area is polluted or, in the opinion of the minister, in danger of becoming polluted because of flooding in the dyked area or the territory immediately surrounding it; or

(e) in the opinion of the minister, the health or safety of persons within a dyked area is or may be threatened because of flooding or imminent danger of flooding in the dyked area or the territory immediately surrounding it;

the minister may in writing order that the dyked area be evacuated to protect the health and safety of persons in the dyked area and to prevent loss of life.

Extrait au certificat de titre

17(12) Lors du dépôt, conformément au présent article, d'un arrêté, d'une ordonnance, d'un avis, de l'annulation d'un avis ou d'une copie de ceux-ci au bureau des titres fonciers à l'égard d'un bien-fonds assujetti au nouveau système, le registraire de district en porte un extrait au certificat de titre visant le bien-fonds sans qu'il soit nécessaire de produire l'ampliation du certificat de titre.

Suppl. L.R.M. 1987, c. 33, art. 5.

Enlèvement de la structure ou du bâtiment

17(13) Lorsqu'une structure ou un bâtiment est construit, érigé, transporté, occupé ou entretenu dans une zone inondable reconnue en contravention des dispositions du présent article ou des critères de prévention des inondations applicables, le ministre peut arrêter qu'il soit enlevé de la zone inondable reconnue dans le délai prévu à l'arrêté. Si le propriétaire ne se conforme pas à l'arrêté, le ministre peut faire enlever la structure ou le bâtiment. Les coûts de cet enlèvement peuvent être imputés au propriétaire et recouvrés auprès de lui.

Suppl. L.R.M. 1987, c. 33, art. 5.

Arrêté d'évacuation

18(1) Le ministre peut ordonner par écrit qu'une zone endiguée soit évacuée afin de protéger la santé et la sécurité des personnes dans cette zone et afin d'éviter des pertes de vies, dans l'un ou l'autre des cas suivants :

a) une zone endiguée est inondée;

b) de l'avis du ministre, une zone endiguée est sur le point d'être inondée en raison d'une déficience d'un réseau de digues reconnu ou encore, il y a danger que l'eau dépasse le niveau au-delà duquel un réseau de digues reconnu ne peut protéger la zone endiguée;

c) les routes menant à la zone endiguée sont inondées ou, de l'avis du ministre, sur le point de l'être;

d) l'eau potable de la zone endiguée est polluée ou, de l'avis du ministre, sur le point de l'être en raison de l'inondation de la zone endiguée ou des territoires immédiatement adjacents;

e) de l'avis du ministre, la santé ou la sécurité des personnes de la zone endiguée est ou pourrait être menacée du fait de l'inondation ou du danger imminent d'inondation dans cette zone ou dans les territoires immédiatement adjacents.

THE WATER RESOURCES ADMINISTRATION ACT
(C.C.S.M. c. W70)

Designated Flood Areas Regulation

Regulation 266/90
Registered December 11, 1990

CONTENTS

Definitions

1 In this regulation,

"accessory structure" means a structure described in section 11; («construction annexe»)

"Act" means The Water Resources Administration Act; («loi»)

"flood protection level" means the flood protection level determined by the minister under section 4; («niveau de protection contre les inondations»)

"hazardous material" includes material that is inflammable, explosive or toxic; («matériaux dangereux»)

"highway" means a highway as defined in The Highway Traffic Act; («route»)

"inspector" means an inspector appointed by the minister under section 5; («inspecteur»)

"permit" means a permit issued under subsection 17(3) of the Act; («permis»)

LOI SUR L'AMÉNAGEMENT HYDRAULIQUE
(C.P.L.M., c. W70)

Règlement sur les zones inondables reconnues

Règlement 266/90
Date d'enregistrement : le 11 décembre 1990

TABLE DES MATIÈRES

Définitions

1 Les définitions qui suivent s'appliquent au présent règlement.

«construction annexe» Construction visées à l'article 11. ("accessory structure")

«construction» Bâtiments, réservoirs de stockage, puits forés et leurs rajouts, à l'exception :

a) des bâtiments nécessaires qui sont normalement accessoires à des constructions en plein air à usage récréatif, comme les vestiaires et les toilettes;

b) des remises de moins de 10 m^2;

c) des abris à bestiaux et des constructions ouvertes semblables à usage agricole. ("structure")

«inspecteur» Fonctionnaire nommé par le ministre en application de l'article 5. ("inspector")

«Loi» Loi sur l'aménagement hydraulique. ("Act")

"structure" means a building, storage tank or drilled well, and includes an addition to any of those things, but does not include

(a) necessary buildings that are normally incidental or subordinate to open-air structures used for recreational purposes, such as change rooms and washrooms;

(b) storage sheds under $10m^2$; or

(c) cattle sheds and similar open-air buildings used for agricultural purposes. («construction»)

Application

2 This regulation does not apply to a structure that is located

(a) within a designated dyking sytem; or

(b) on a site the elevation of which is above the flood protection level.

Designated flood areas

3 The area described in Schedule A is a designated flood area.

Flood protection level

4 The minister shall determine a flood protection level for designated flood areas which shall be the maximum static water level determined to occur during flooding conditions of a certain frequency, plus a specific minimum freeboard allowance.

Inspectors

5 The minister may appoint one or more employees of the Department of Natural Resources as inspectors for the purposes of this regulation.

Application to build

6 An application for a permit to build, construct or erect a structure within a designated flood area shall be made in a form determined by the minister and shall be accompanied by

(a) plans and specifications of the structure;

(b) a plan or description indicating the location of the structure on its site; and

(c) a copy of the certificate of title covering the site.

Permit subject to condition

7 Every permit shall be issued subject to the condition that any structure to which the permit applies meets the requirements set out in sections 9, 10 and 11.

Establishment of reference mark

8(1) Upon a permit being issued, and within 15 days following the receipt of a written request of the permit holder requesting the establishment of a reference mark, an inspector shall, at no cost to the permit holder, establish a reference mark at or near the site of the structure or proposed structure indicating the flood protection level applicable to that site and structure.

«matériaux dangereux» Matériaux inflammables, explosifs ou toxiques. ("hazardous material")

«niveau de protection contre les inondations» Niveau sécuritaire en cas d'inondations déterminé par le ministre en application de l'article 4. ("flood protection level")

«permis» Permis délivré en application du paragraphe 17(3) de la Loi. ("permit")

«route» S'entend au sens du Code de la route. ("highway")

Application

2 Le présent règlement ne vise pas les constructions :

a) situées dans les limites d'un réseau de digues reconnu;

b) situées sur des terrains dont l'élévation est supérieure au niveau de protection contre les inondations.

Zones inondables reconnues

3 La zone décrite à l'annexe A est une zone inondable reconnue.

Niveau de protection contre les inondations

4 Le ministre détermine le niveau de protection contre les inondations s'appliquant aux zones inondables reconnues. Il s'agit du niveau statique maximum de l'eau prévu en cas d'inondations survenant à une fréquence reconnue, en plus d'une marge minimale déterminée de revanche.

Inspecteurs

5 Le ministre peut nommer des employés du ministère des Ressources naturelles à titre d'inspecteurs aux fins du présent règlement.

Demandes de permis de construction

6 Les demandes de permis de construction ou d'érection d'un ouvrage dans une zone inondable reconnue doivent être présentées au moyen de la formule déterminée par le ministre et être accompagnées des documents suivants :

a) les plans et les devis de construction;

b) des plans ou une description indiquant l'emplacement de la construction;

c) une copie du titre de propriété du bien-fonds.

Conditions attachées aux permis

7 Les permis ne sont délivrés que pour les constructions qui sont conformes aux exigences énoncées aux articles 9, 10 et 11.

Établissement d'une marque de référence

8(1) Sur délivrance d'un permis et dans les 15 jours qui suivent la réception d'une demande écrite du titulaire du permis en vue de l'établissement d'une marque de référence, l'inspecteur établit, sans frais pour le titulaire du permis, à l'emplacement de la construction proposée ou à proximité de celle-ci, une marque de référence indiquant le niveau de protection contre les inondations.

8(2) Upon the written request of the permit holder, an inspector shall re-establish any reference mark established under subsection (1), but the cost of the re-establishment shall be borne by the permit holder.

Floodproofing criteria

9(1) Every structure that is located within a designated flood area, other than an accessory structure referred to in section 11, shall be
(a) constructed on a site raised by fill; or
(b) supported by piles.

9(2) If a structure that is constructed on a site raised by fill has a basement or cellar,
(a) the site shall be raised by impervious fill in accordance with the requirements illustrated in Schedule B;
(b) the elevation of the main floor shall be at least 30 cm above the applicable flood protection level; and
(c) if the in situ material is pervious, the design of the structure shall be certified by a Professional Engineer as being capable of withstanding hydrostatic and uplift pressures by a static water level at the flood protection level.

9(3) If a structure that is constructed on a site raised by fill has no basement or cellar,
(a) the site shall be raised by fill in accordance with the requirements illustrated in Schedule C;
(b) the elevation of the main floor shall not be less than the applicable flood protection level; and
(c) the top of the fill shall not be more than 30 cm below the applicable flood protection level.

9(4) If a structure is supported by piles,
(a) the structure shall be supported in accordance with the requirements illustrated in Schedule D or another equivalent support system;
(b) the structure shall be so constructed that it will not be buoyant when the water surface of any flood that may occur is higher than the bottom of the horizontal members supporting the structure; and
(c) the elevation of any floor containing finished space shall be at least 1.0 m above the applicable flood protection level.

Additional requirements

10 In addition to the flood proofing criteria set out in section 9, every structure described in section 9 shall meet the following requirements:
(a) all windows, exterior doors or other exterior openings shall be located above the applicable flood protection level;

8(2) L'inspecteur rétablit, sur réception d'une demande écrite de la part du titulaire de permis et aux frais de celui-ci, la marque de référence visée au paragraphe (1).

Critères de prévention des inondations

9(1) Les constructions, à l'exclusion des constructions annexes visées à l'article 11, situées dans une zone inondable reconnue sont :
a) érigées sur un emplacement remblayé;
b) supportées par des pilotis.

9(2) Les constructions comportant un sous-sol ou une cave et qui sont érigées sur des matériaux de remblayage doivent remplir les conditions suivantes :
a) les matériaux de remblayage sur lesquels sont érigés les constructions en question sont imperméables et conformes aux exigences illustrées à l'annexe B;
b) le plancher du rez-de-chaussée est à au moins 30 cm au-dessus du niveau de protection contre les inondations;
c) si les matériaux en place sont perméables, les plans des constructions sont certifiés par un ingénieur professionnel, attestant que les constructions peuvent résister aux pressions hydrostatiques et aux poussées ascendantes exercées par le niveau d'eau statique correspondant au niveau de protection contre les inondations.

9(3) Les constructions ne comportant pas de sous-sol ou de cave et qui sont érigées sur des matériaux de remblayage doivent remplir les conditions suivantes :
a) les matériaux de remblayage sur lesquels sont érigés les constructions en question sont conformes aux exigences illustrées à l'annexe B;
b) le plancher du rez-de-chaussée ne se trouve pas au-dessous du niveau de protection contre les inondations;
c) le dessus du remblai ne se trouve pas à plus de 30 cm au-dessous du niveau de protection contre les inondations.

9(4) Les constructions supportées par des pilotis :
a) sont conformes aux exigences illustrées à l'annexe D ou à un autre système de support équivalent;
b) sont érigées de telle sorte qu'elles ne puissent flotter lorsque les eaux, pendant une inondation, atteignent un niveau supérieur à la face inférieure des raidisseurs horizontaux;
c) ont des planchers qui, s'ils sont finis, sont situés à au moins 1 m au-dessus du niveau de protection contre les inondations.

Autres exigences

10 En plus des critères visés à l'article 9, toutes les constructions visées au même article doivent satisfaire aux exigences suivantes :
a) les fenêtres, les portes extérieures ou autres ouvertures extérieures sont situées au-dessus du niveau de protection contre les inondations;

(b) the electrical distribution panel in the structure shall be located above the main floor unless an existing panel located below the main floor is being replaced or added to in the same location;
(c) the potable water shut-off valve shall be located on the main floor;
(d) if the structure has floor space below the applicable flood protection level, the drain between the structure and any septic or holding tank or a common sanitary sewer line shall have a backwater valve;
(e) the weeping tiles shall drain to a covered sump pit equipped with a submersible pump and discharge piping to grade; and
(f) the piping from the floor drain trap shall extend to the finished basement floor level.

b) le tableau de distribution de l'électricité dans la construction principale est situé au-dessus du rez-de-chaussée, à moins que le tableau situé au-dessous du rez-de-chaussé ne soit remplacé, au même endroit, ou qu'il y soit porté un ajout;
c) le robinet d'arrêt de l'eau potable est situé au rez-de-chaussée;
d) si les constructions ont une surface habitable au-dessous du niveau de protection contre les inondations, le branchement d'égout entre les constructions et la fosse septique, le réservoir ou la canalisation d'égout public est muni d'un clapet anti-retour;
e) les tuiles de drainage s'écoulent vers un puisard couvert muni d'une pompe submersible et d'un tuyau d'évacuation au niveau du sol;
f) le tuyau partant du siphon de plancher se rend jusqu'au niveau du plancher du sous-sol fini.

Accessory structures
11(1) Every structure described in this section that is located in a designated flood area shall comply with the floodproofing criteria set out in this section.

Constructions annexes
11(1) Les constructions visées au présent article doivent être conformes aux critères de prévention des inondations y énoncés.

11(2) If a structure is an attached garage, a livestock barn, granary, farm machinery shed or other building used for the storage of agricultural produce, or a workshop or shed used for the storage of immovable equipment or material or hazardous material,
(a) the floor elevation of the structure shall not be more than 30 cm below the applicable flood protection level; and
(b) the top of the fill shall not be more than 60 cm below the applicable flood protection level.*

11(2) Les garages contigus, les étables, les silos à grains, les hangars à machines agricoles, les bâtiments servant au stockage de produits agricoles, les ateliers et les remises servant à abriter des installations ou du matériel agricoles fixes ou des matériaux dangereux doivent satisfaire aux exigences suivantes :
a) le plancher de la construction est à un maximum de 30 cm au-dessous du niveau de protection contre les inondations;
b) le dessus du remblai est à un maximum de 60 cm au-dessous du niveau de protection contre les inondations.*

11(3) If a structure is a detached garage,
(a) the floor elevation of the structure shall not be more than 1.5 m below the applicable flood protection level;
(b) if constructed of wood, wood by-products or any other material susceptible to water damage, the structure shall be supported by a foundation constructed of water resistant material, and the top of the foundation shall not be more than 50 cm below the flood protection level applicable to the site; and
(c) any immovable equipment or material or hazardous material stored in the structure shall be stored 1.0 m above the floor level.

11(3) Les garages autonomes doivent satisfaire aux exigences suivantes :
a) le plancher est à un maximum de 1,5 m au-dessous du niveau de protection contre les inondations;
b) les garages construits en bois, avec des dérivés du bois ou tout autre matériau susceptible d'être endommagé par l'eau sont supportés par des fondations faites de matériaux imperméables et dont la partie supérieure est à un maximum de 50 cm au-dessous du niveau de protection contre les inondations;
c) l'équipement et les installations fixes ainsi que les matériaux dangereux sont entreposés à 1 m au-dessus de la surface du plancher.

* This criterion assumes that these are slab-on-grade constructions.

* Ce critère suppose des constructions érigées sur des dalles en béton au sol.

11(4) If a structure is a storage tank for fuel oil, gasoline or any other liquid or solid, the structure shall
(a) be situated above the applicable flood protection level or be buried underground;
(b) be anchored to prevent flotation; and
(c) have the vent and filler pipes extend above the applicable flood protection level.

11(5) If a structure is a drilled well, the well casing shall
(a) extend upward at least to the applicable flood protection level; or
(b) be sealed at the top.

Private dykes
12 No person shall construct a dyke for flood protection of an existing structure unless it is constructed in accordance with the requirements illustrated in Schedule E.

Inspection
13(1) An inspector shall make a final inspection to ascertain compliance with the floodproofing criteria applicable to any permit within 10 days of the receipt of a written request from the permit holder.

13(2) An inspector may at any stage of, or following the completion of, the construction of a structure make an inspection to ascertain compliance with the floodproofing criteria applicable to any permit.

Notice of compliance
14 An inspector who has carried out an inspection under subsection 13(1) shall issue a written notice, in a form determined by the minister, to the permit holder and the appropriate municipal authority indicating whether or not the structure inspected complies with this regulation.

Repeal
15 Manitoba Regulation 23/88 R is repealed.

11(4) Les réservoirs de stockage pour les solides ou les liquides, notamment le mazout et l'essence :
a) sont situés au-dessus du niveau de protection contre les inondations ou sont enterrés;
b) sont fixés de façon à ne pas pouvoir flotter;
c) ont des tuyaux de remplissage et d'aération dont l'extrémité supérieure est située au-dessus du niveau de protection contre les inondations.

11(5) L'extrémité supérieure du tubage des puits forés est, selon le cas :
a) située au-dessus du niveau de protection contre les inondations;
b) scellée.

Digues privées
12 Il est interdit d'ériger une digue dans le but de protéger une construction existante contre les inondations à moins que la digue ne soit conforme aux exigences illustrées à l'annexe E.

Inspection
13(1) Un inspecteur fait, dans les 10 jours qui suivent la réception d'une demande écrite du titulaire de permis, l'inspection définitive afin de s'assurer que les travaux ont été exécutés conformément aux critères de prévention des inondations.

13(2) Un inspecteur peut, en tout temps après le début des travaux et à sa discrétion, faire une inspection afin de s'assurer que les travaux sont exécutés conformément aux critères de prévention des inondations.

Avis de conformité
14 L'inspecteur qui a procédé à une inspection en application du paragraphe 13(1) délivre un avis écrit, en la forme déterminée par le ministre, au titulaire du permis et à l'administration municipale appropriée indiquant si la construction inspectée est conforme au présent règlement.

Abrogation
15 Le règlement du Manitoba n° 23/88 R est abrogé.

SCHEDULE A
DESIGNATED FLOOD AREAS

Designated flood areas

1(1) The "Red River Valley Designated Flood Area" comprises all the lands shown on Plan No. 11-1-1554, excepting thereout that area within the Village of Niverville limits that is east of the Canadian Pacific Railway right-of-way as indicated on Plan 11-1-1582.

1(2) The plans referred to in subsection (1) are filed at the head office of the Water Resources Branch of the Department of Natural Resources in Winnipeg.

ANNEXE A
ZONES INONDABLES RECONNUES

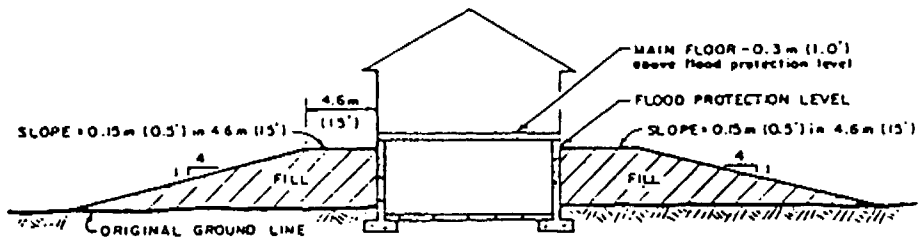
Zones inondables reconnues

1(1) La zone inondable reconnue de la vallée de la rivière Rouge comprend les biens-fonds indiqués sur le plan n° 11-1-1554, à l'exception de la zone située à l'intérieur des limites du village de Niverville, à l'est de l'emprise du Canadien Pacifique, ainsi que l'indique le plan n° 11-1-1582.

1(2) Les plans mentionnés au paragraphe (1) ont été déposés au bureau central de la Direction des ressources hydrauliques du ministère des Ressources naturelles à Winnipeg.

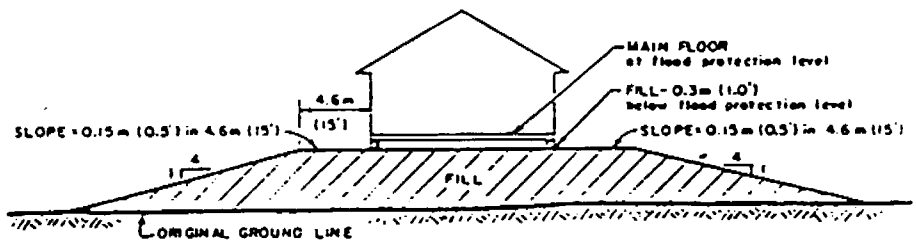
SCHEDULE B

STRUCTURE WITH A BASEMENT OR CELLAR



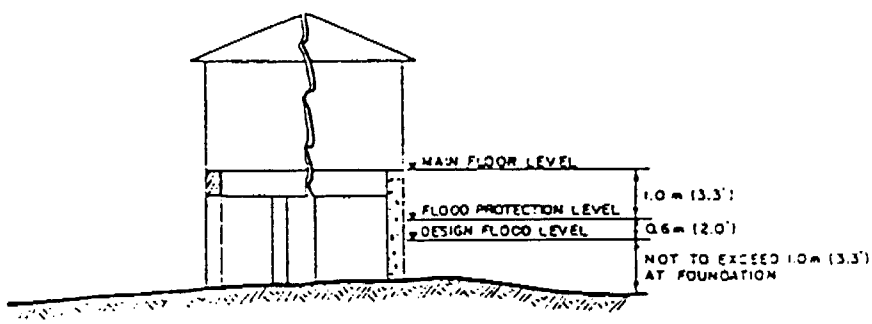
SCHEDULE C

STRUCTURE WITH NO BASEMENT OR CELLAR



SCHEDULE D

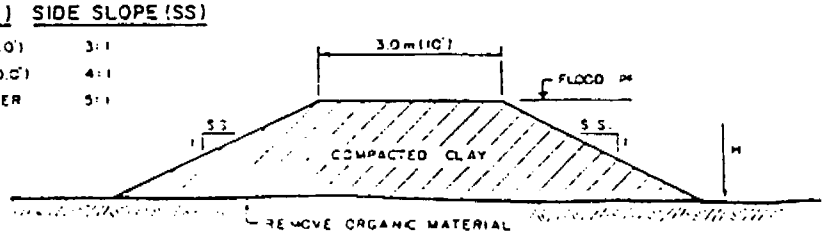
ELEVATED STRUCTURE



SCHEDULE E

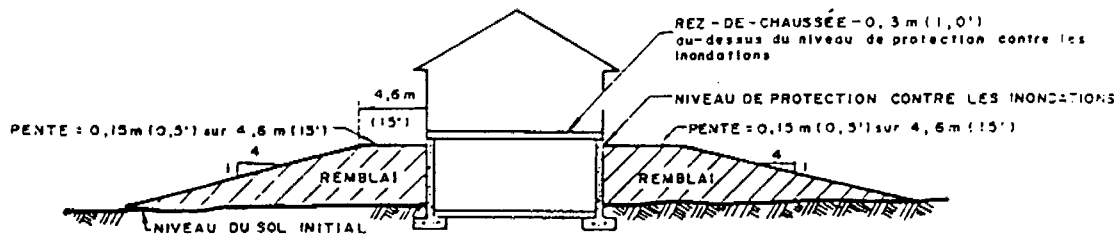
DYKE CROSS-SECTION

DYKE HEIGHT (H)	SIDE SLOPE (SS)
0.3 m (1.0') TO 1.5 m (5.0')	3:1
1.5 m (5.0') TO 3.0m (10.0')	4:1
3.0m (10.0') OR GREATER	5:1



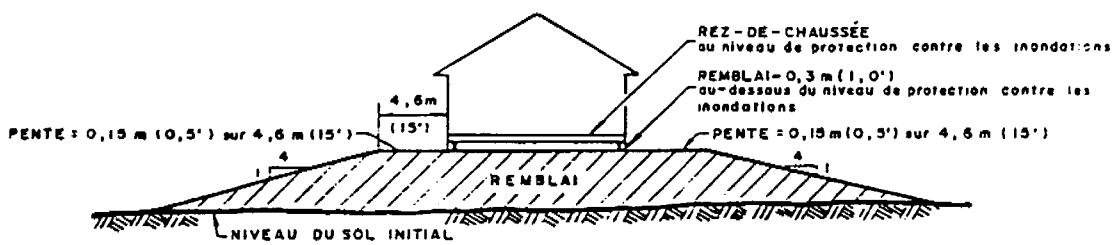
ANNEXE B

CONSTRUCTION AYANT UN SOUS-SOL OU UNE CAVE



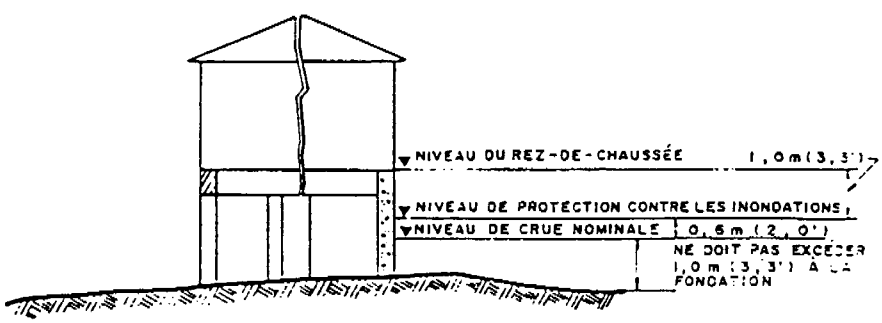
ANNEXE C

CONSTRUCTION SANS SOUS-SOL NI CAVE



ANNEXE D

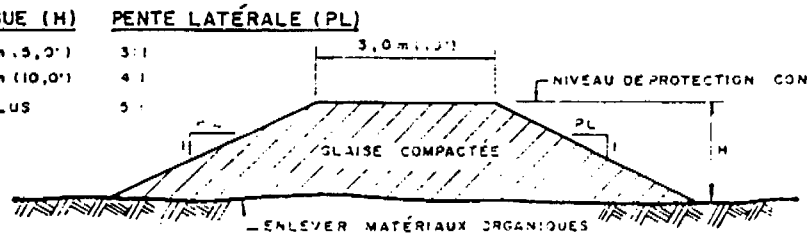
CONSTRUCTION SURÉLEVÉE



ANNEXE E

COUPE TRANSVERSALE D'UNE DIGUE

HAUTUR DE LA DIGUE (H)	PENTE LATÉRALE (PL)
0,3 m (1,0') À 1,5 m (5,0')	3:1
1,5 m (5,0') À 3,0 m (10,0')	4:1
3,0 m (10,0') OU PLUS	5:1



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