Winnipeg Carbonate Aquifer
Water Elevations

By Frank Render, P.Eng

BACKGROUND

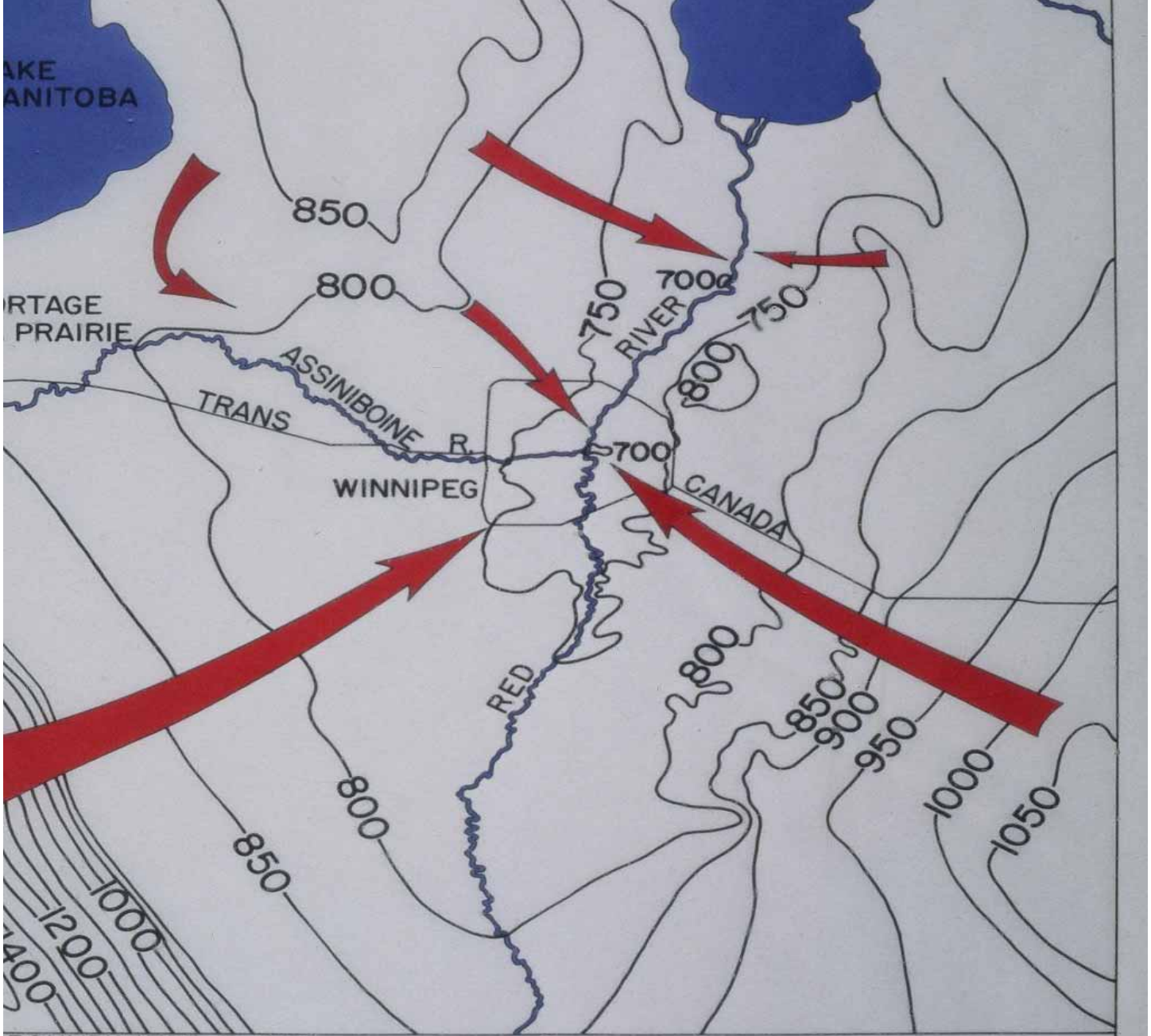
The main aquifer under Winnipeg occurs in the upper fifty feet of the thick limestone rock sequence that underlies the City and the surrounding area. The permeability of the aquifer varies dramatically from place to place. The water levels in various parts of the city have fluctuated with the various groundwater usage and precipitation variations. In central Winnipeg, where there has been some concern expressed about increased pressures in the aquifer; the well water levels have risen some 10 feet in the last 3 decades mainly due to decreases in private well pumping in various parts of the city. Of this rise it is estimated that 3 feet during the last few years is due to increased recharge.

BACKGROUND

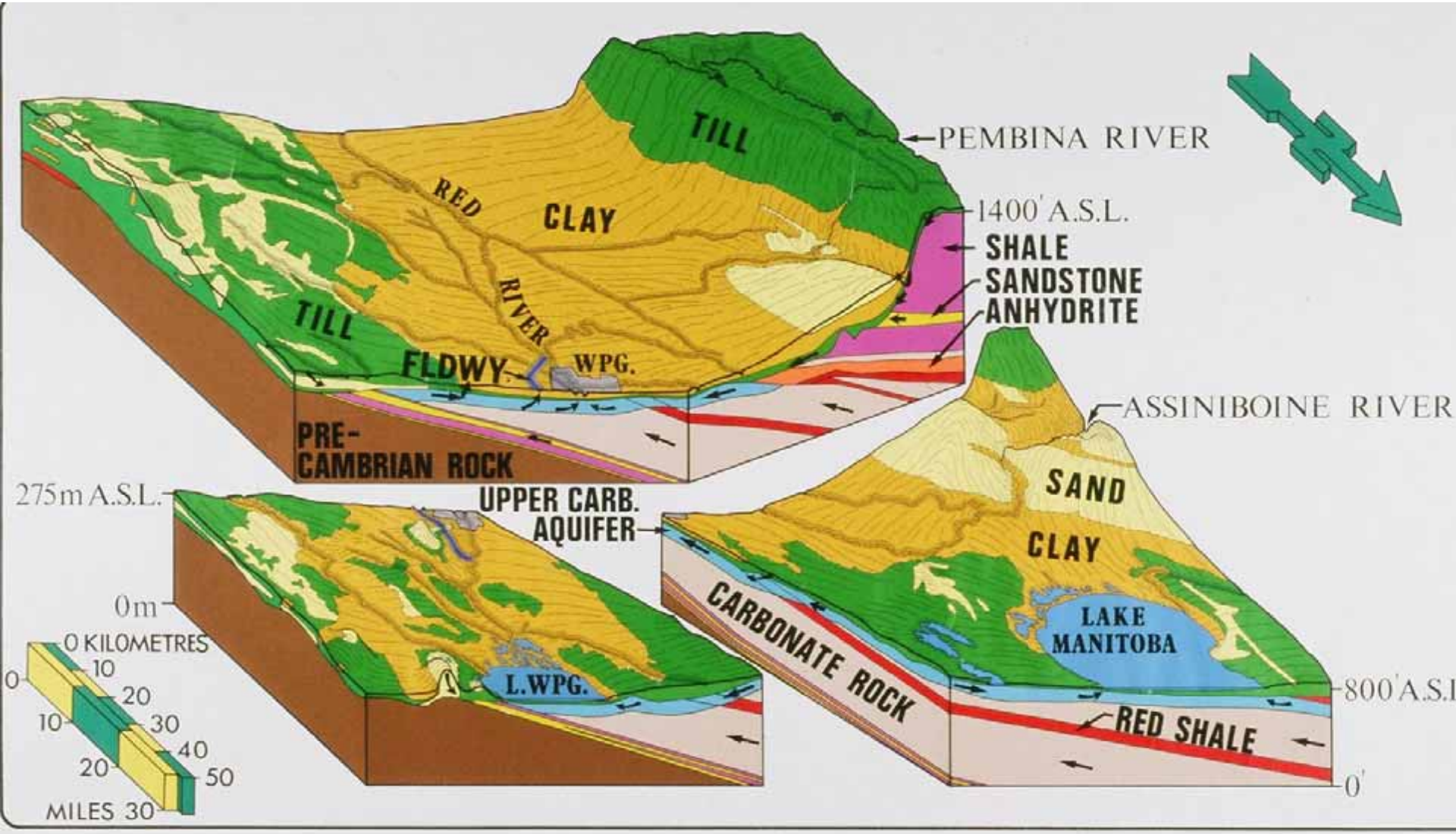
Upward aquifer pressures in the central city area have increased by some 4 pounds per square inch. Fortunately for construction problems the permeability of the aquifer in this area is at some of the lowest values anywhere in the City. Thus most construction groundwater problems are easily manageable. A phenomena that is notable from the viewpoint of construction is that aquifer water levels in the city tend to peak during spring flood periods and are lowest during the summer heavy pumpage intervals. In the City center area the average variation is 9 feet; with a maximum change of 14 feet. Rational for these fluctuation with an overview of regional groundwater flow balance will be discussed at this meeting.

Forward

- Review geology and hydrogeology
- Show piezometric variations in the carbonate aquifer in the Winnipeg area
- Illustrate the effects of interaction with the rivers and the Red River Floodway on piezometric levels
- Discuss the effects on construction and river bank stability of piezometric increases that have occurred over the last 25 years.

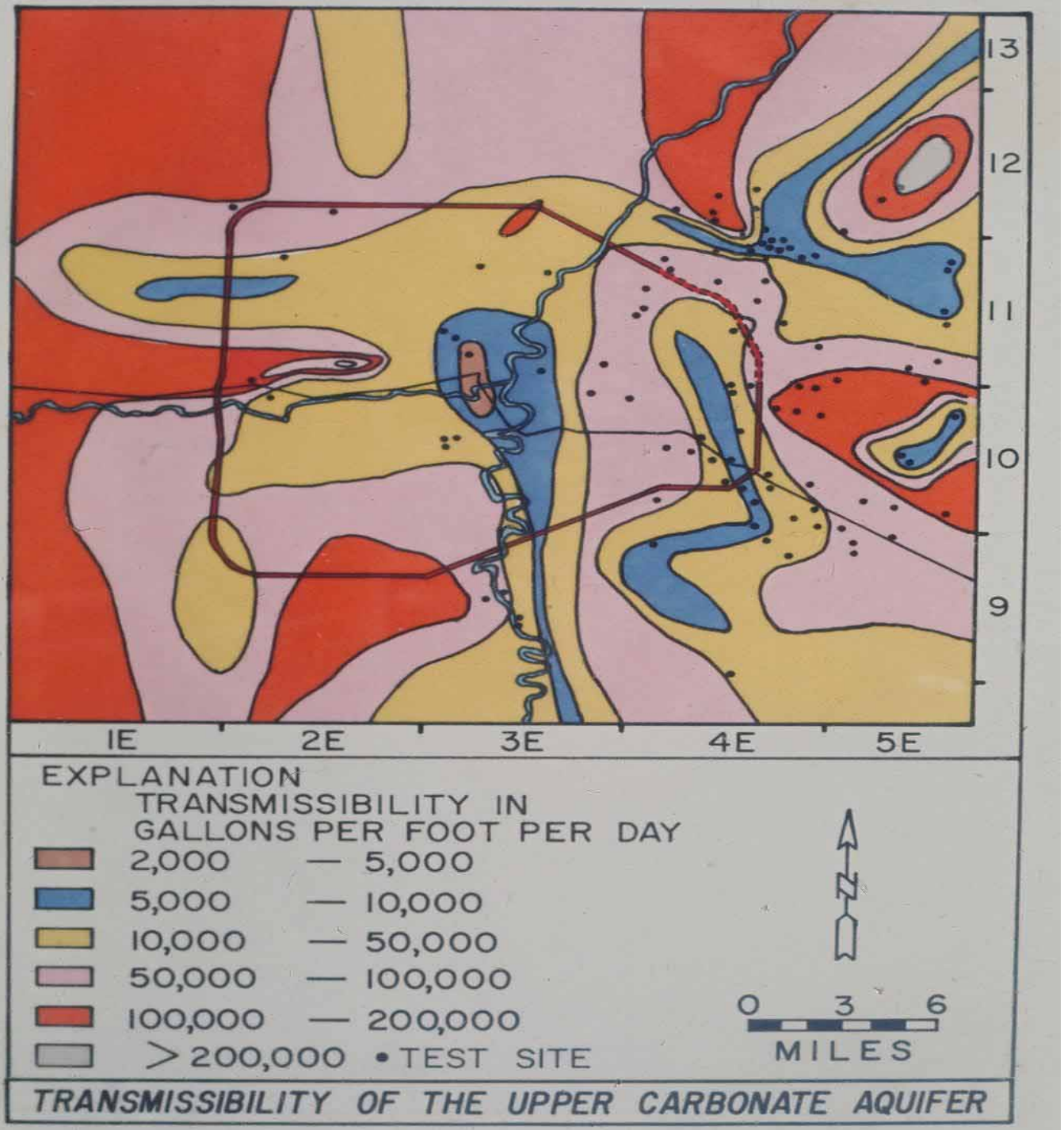


POTENTIOMETRIC SURFACE UPPER BEDROCK AQUIFER

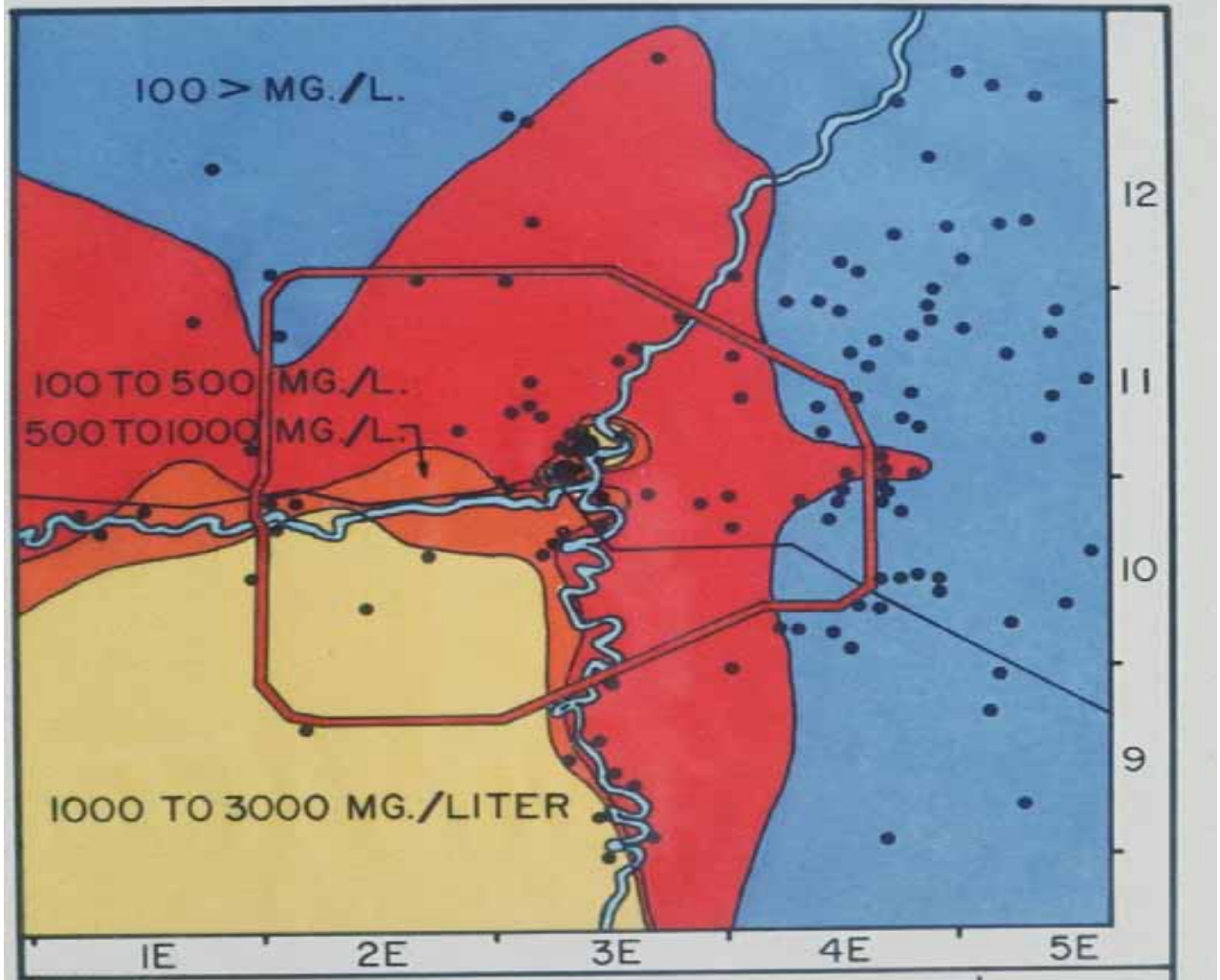


WINNIPEG HYDROGEOLOGY


RED RIVER FLOODWAY
LOC. RED RIVER JOB STA 753
DIR. E
D: 10' 30'
DESC. TAN COLOURED CLAY PATCHES
DATE. 23/5/64



TRANSMISSIBILITY OF THE UPPER CARBONATE AQUIFER



EXPLANATION

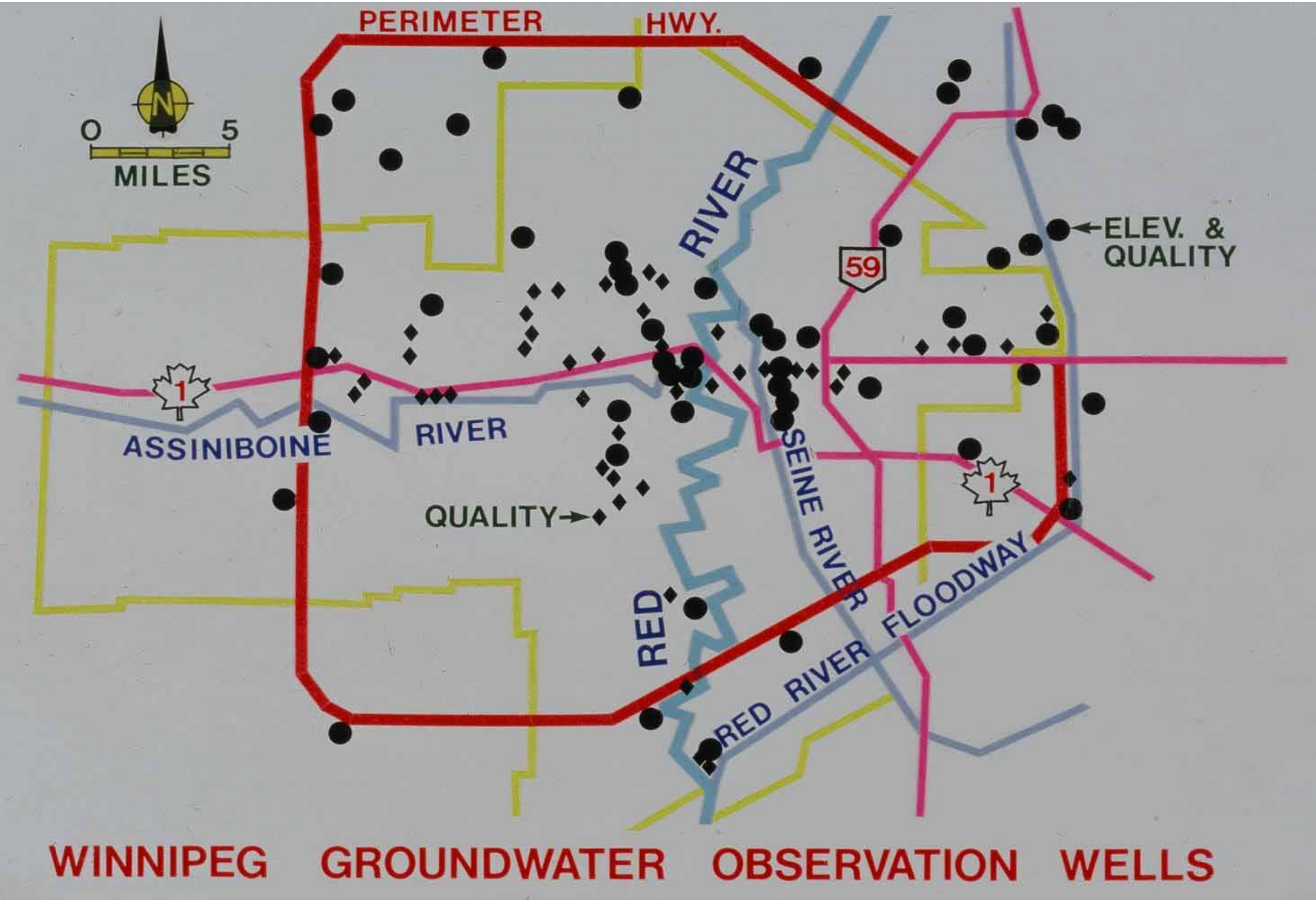
- SELECTED SAMPLING SITE
- 10,000 MILLIGRAMS PER LITER

N

0 3 6

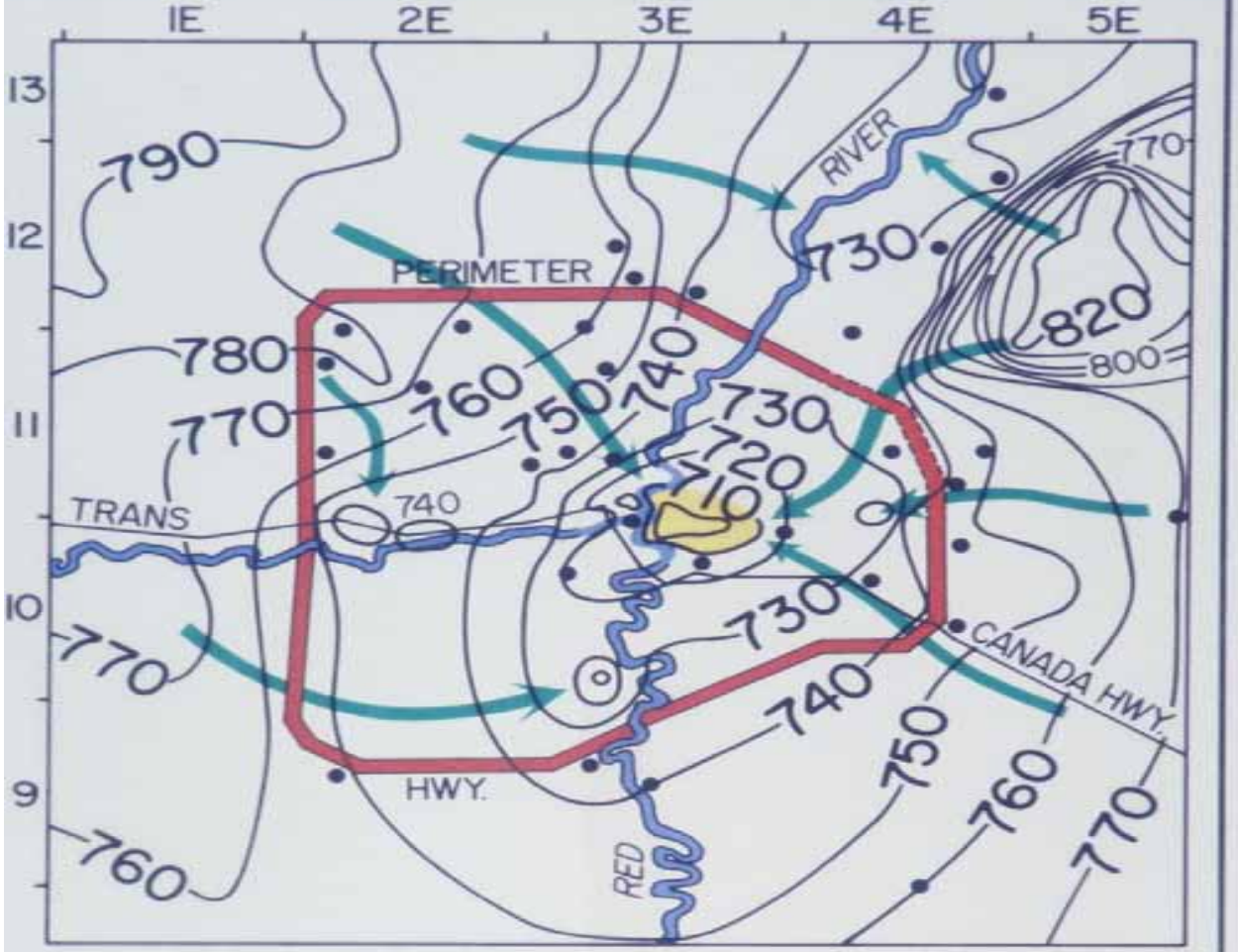
MILES

UPPER CARBONATE AQUIFER CHLORIDE ION CONCENTRATIONS



WINNIPEG GROUNDWATER OBSERVATION WELLS


K2-6



• CONTROL WELL

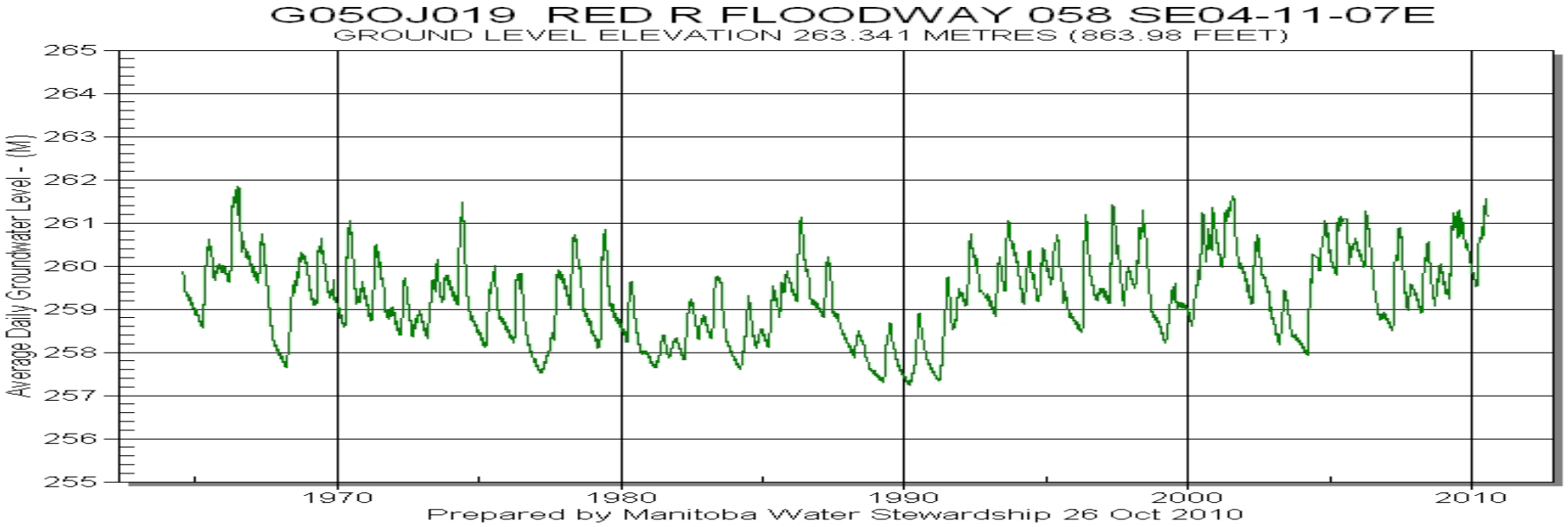
720 UPPER CARBONATE AQUIFER PIEZOMETRIC CONTOUR (FT.)

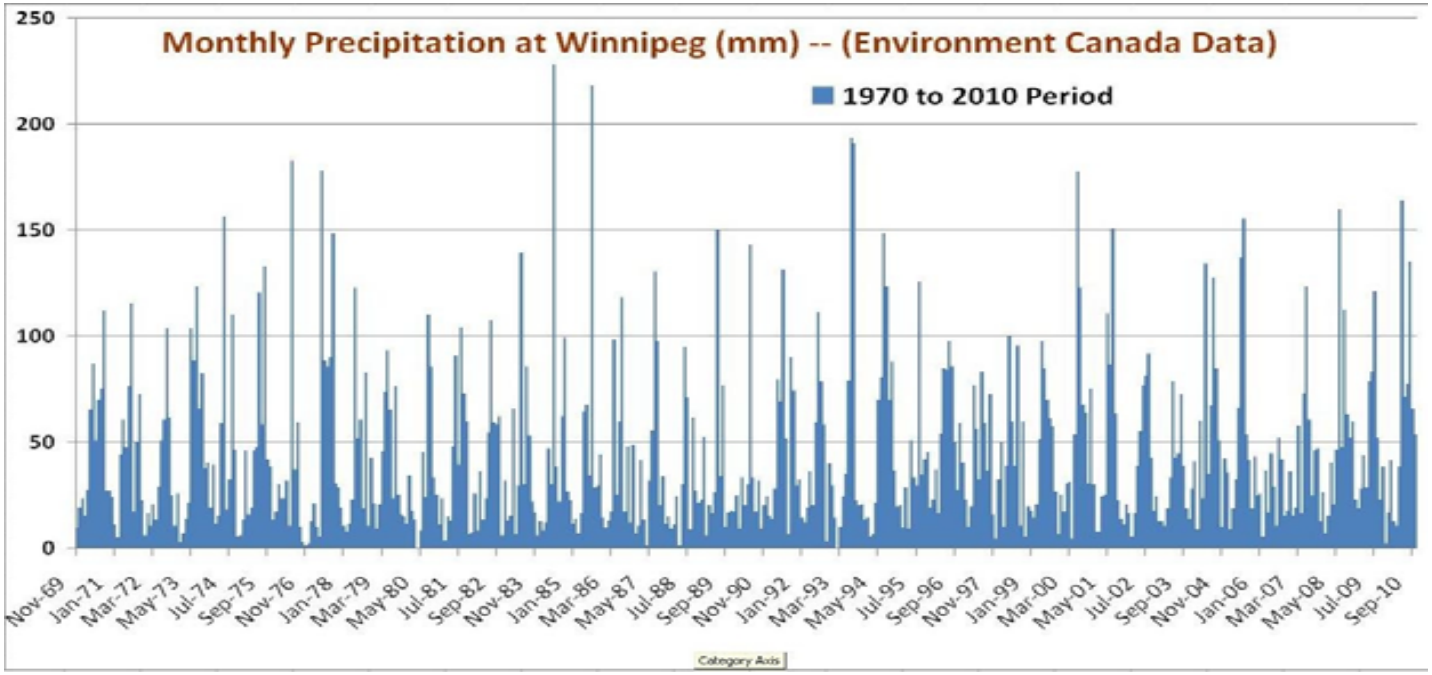
0 3 6 MILES

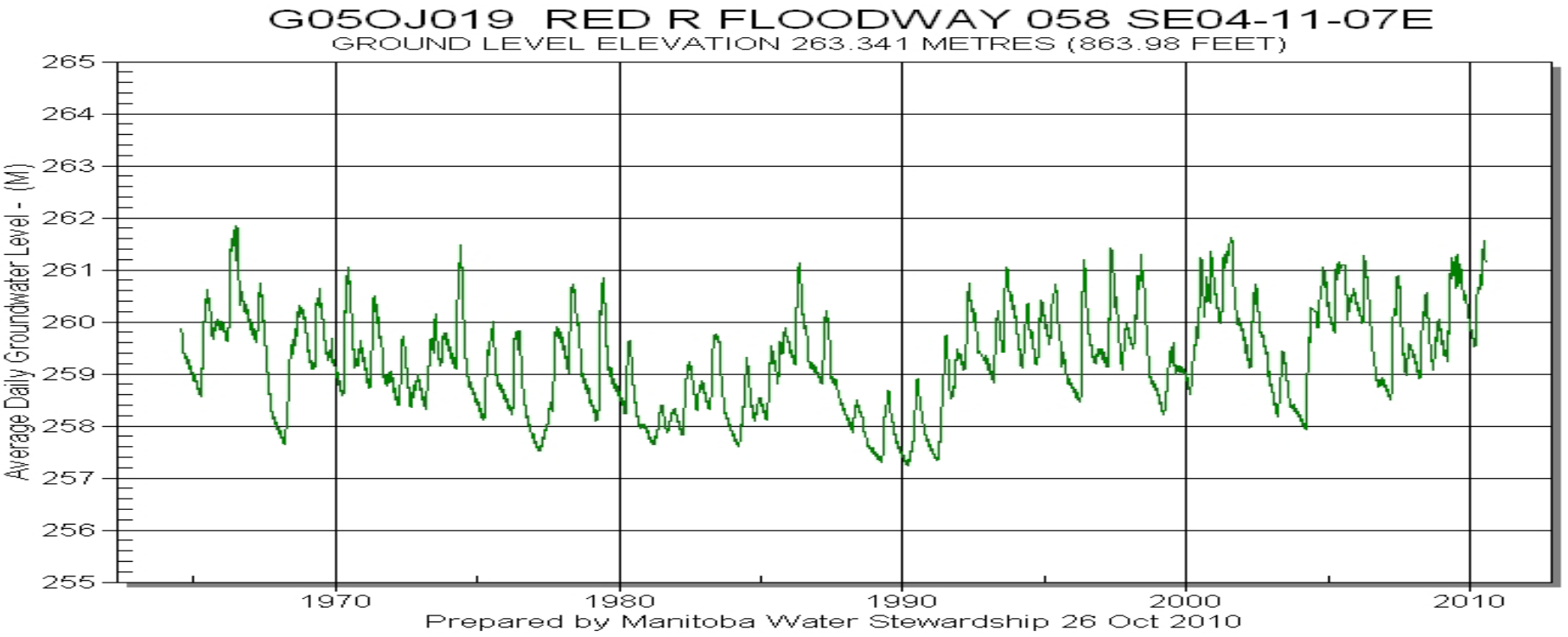
0 5 10 KM.

N

PIEZOMETRIC SURFACE, SEPT. 1969


G05OJ019 RED R FLOODWAY 058 SE04-11-07E
GROUND LEVEL ELEVATION 263.341 METRES (863.98 FEET)
Average Daily Groundwater Level - (M)
265
264
263
262
261
260
259
258
257
256
255
1970
1980
1990
2000
2010
Prepared by Manitoba Water Stewardship 26 Oct 2010


Monthly Precipitation at Winnipeg (mm) -- (Environment Canada Data)
1970 to 2010 Period
250
200
150
100
50
0
Nov-69
Jan-71
Mar-72
May-73
Jul-74
Sep-75
Nov-76
Jan-78
Mar-79
May-80
Jul-81
Sep-82
Nov-83
Jan-85
Mar-86
May-87
Jul-88
Sep-89
Nov-90
Jan-92
Mar-93
May-94
Jul-95
Sep-96
Nov-97
Jan-99
Mar-00
May-01
Jul-02
Sep-03
Nov-04
Jan-06
Mar-07
May-08
Jul-09
Sep-10
Category Axis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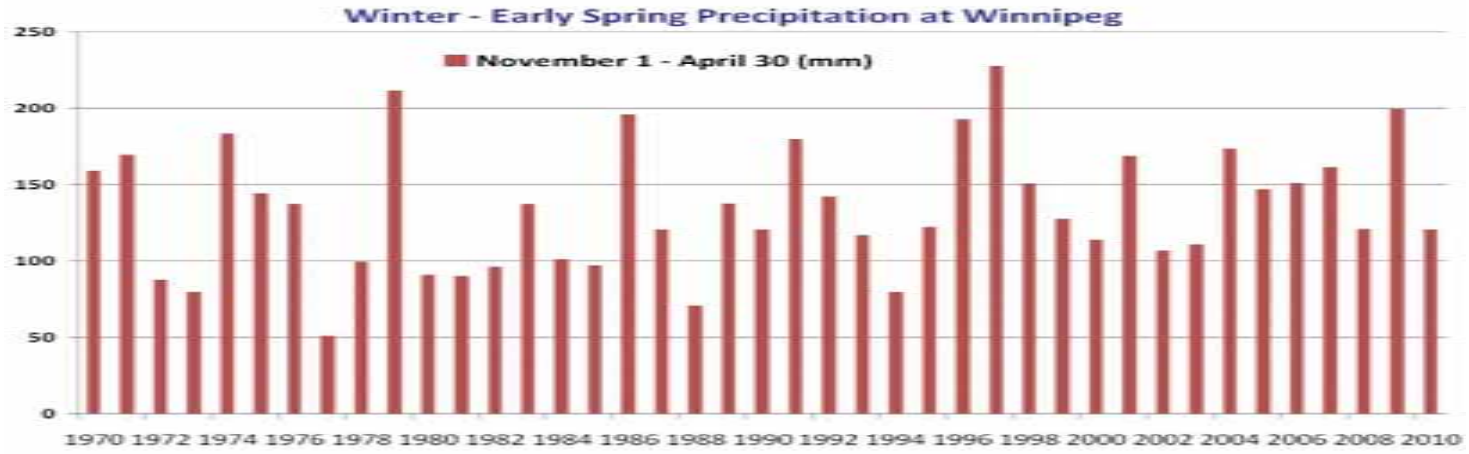
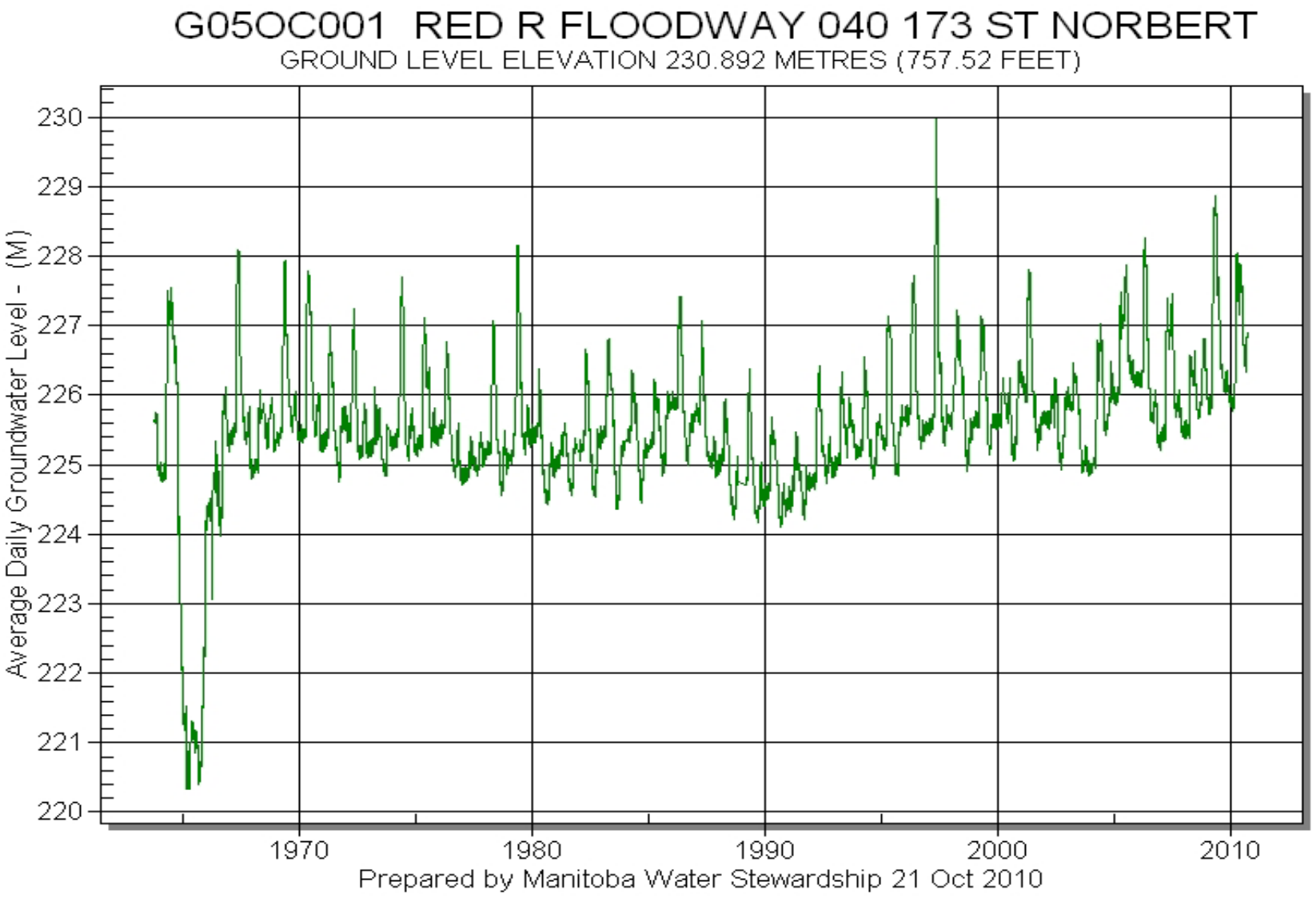
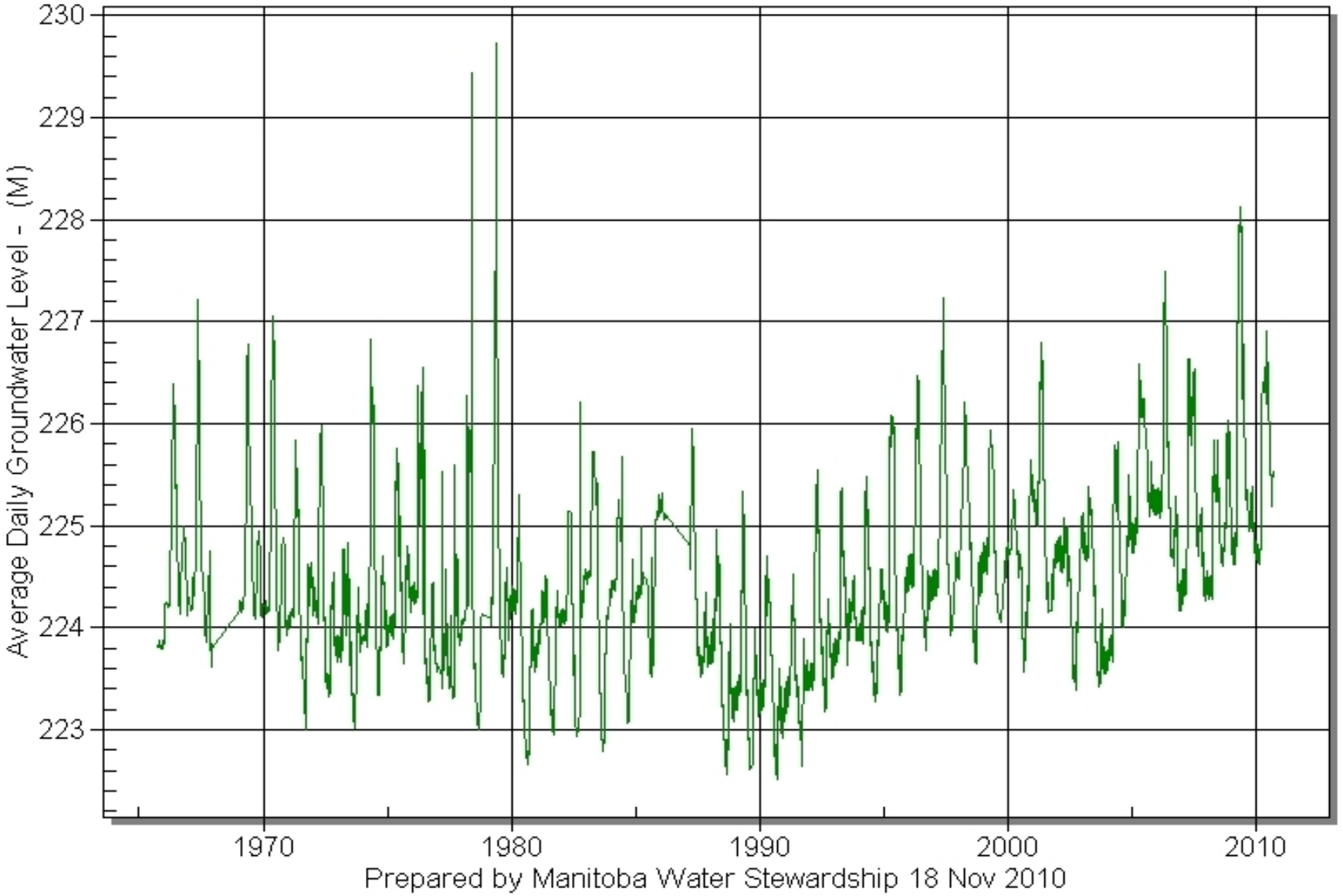
1990
2000
2010
Prepared by Manitoba Water Stewardship 26 Oct 2010


Winter - Early Spring Precipitation at Winnipeg
November 1 - April 30 (mm)
250
200
150
100
50
0
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010

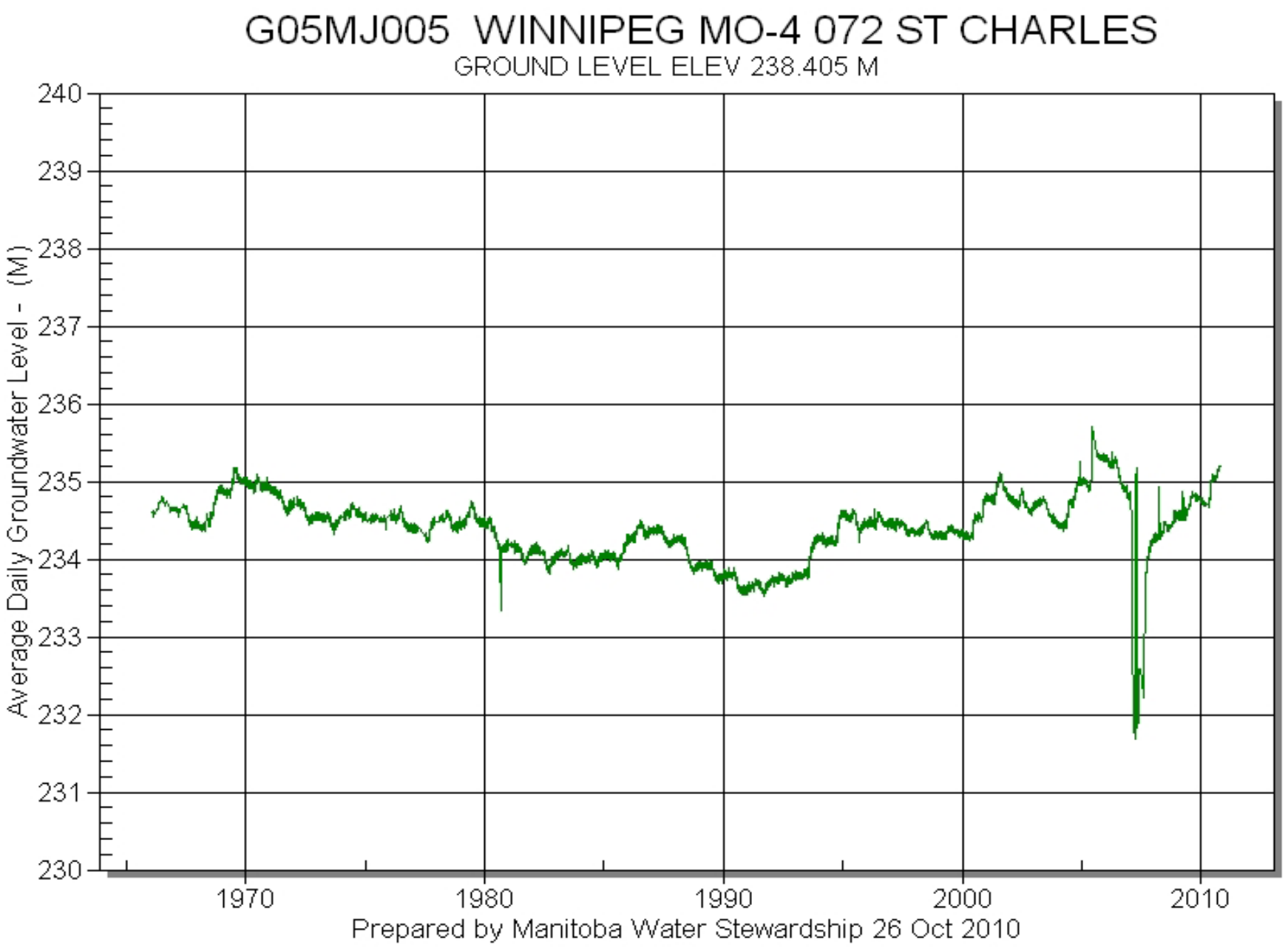

G05OC001 RED R FLOODWAY 040 173 ST NORBERT
GROUND LEVEL ELEVATION 230.892 METRES (757.52 FEET)
Average Daily Groundwater Level - (M)
230
229
228
227
226
225
224
223
222
221
220
1970
1980
1990
2000
2010
Prepared by Manitoba Water Stewardship 21 Oct 2010

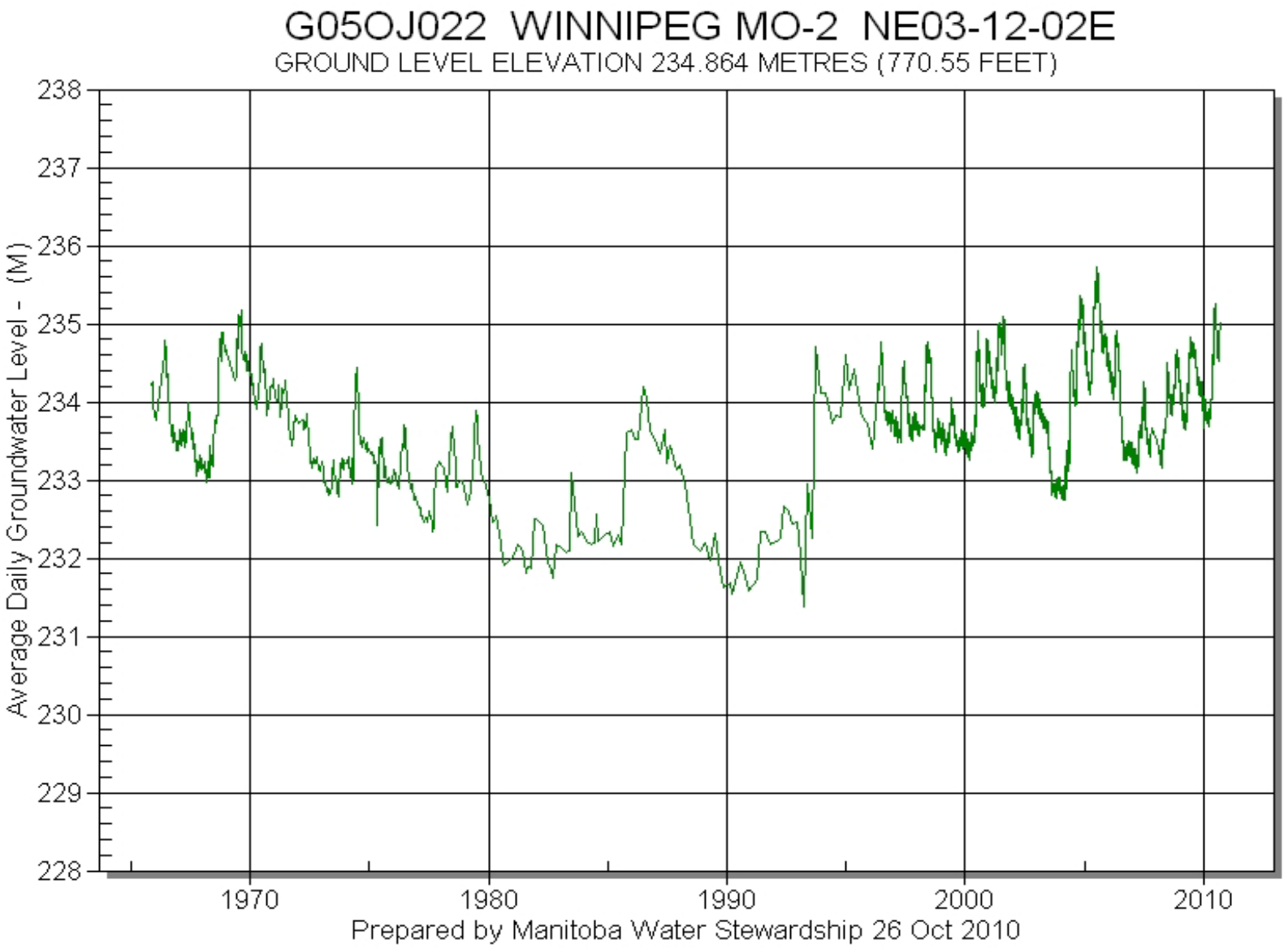
G05OC018 M-189 PERIMETER & HWY 75 93 ST NORBERT

GROUND LEVEL ELEVATION 231.237 METRES (758.65 FEET)

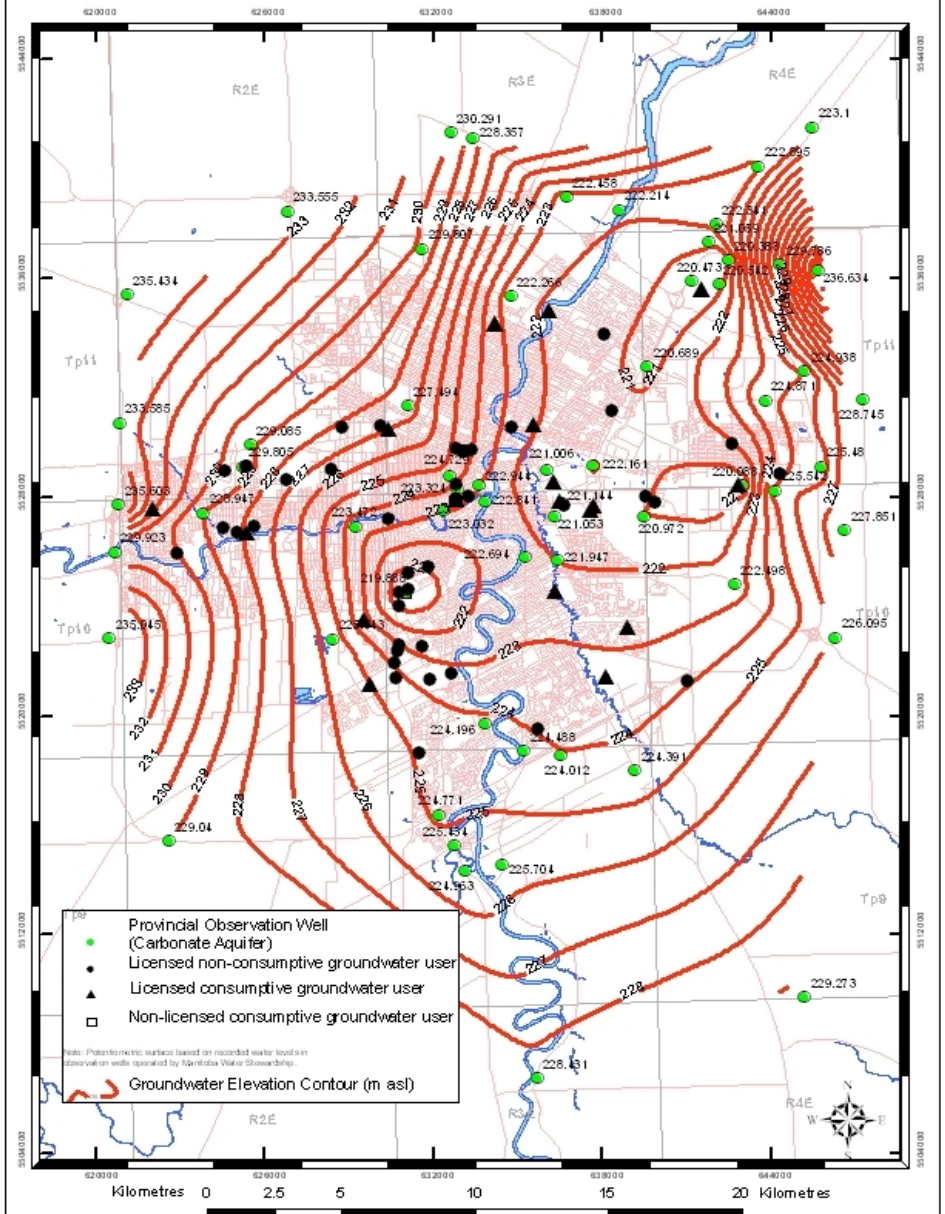


Prepared by Manitoba Water Stewardship 18 Nov 2010


G05MJ005 WINNIPEG MO-4 072 ST CHARLES
GROUND LEVEL ELEV 238.405 M
Average Daily Groundwater Level - (M)
240
239
238
237
236
235
234
233
232
231
230
1970
1980
1990
2000
2010
Prepared by Manitoba Water Stewardship 26 Oct 2010

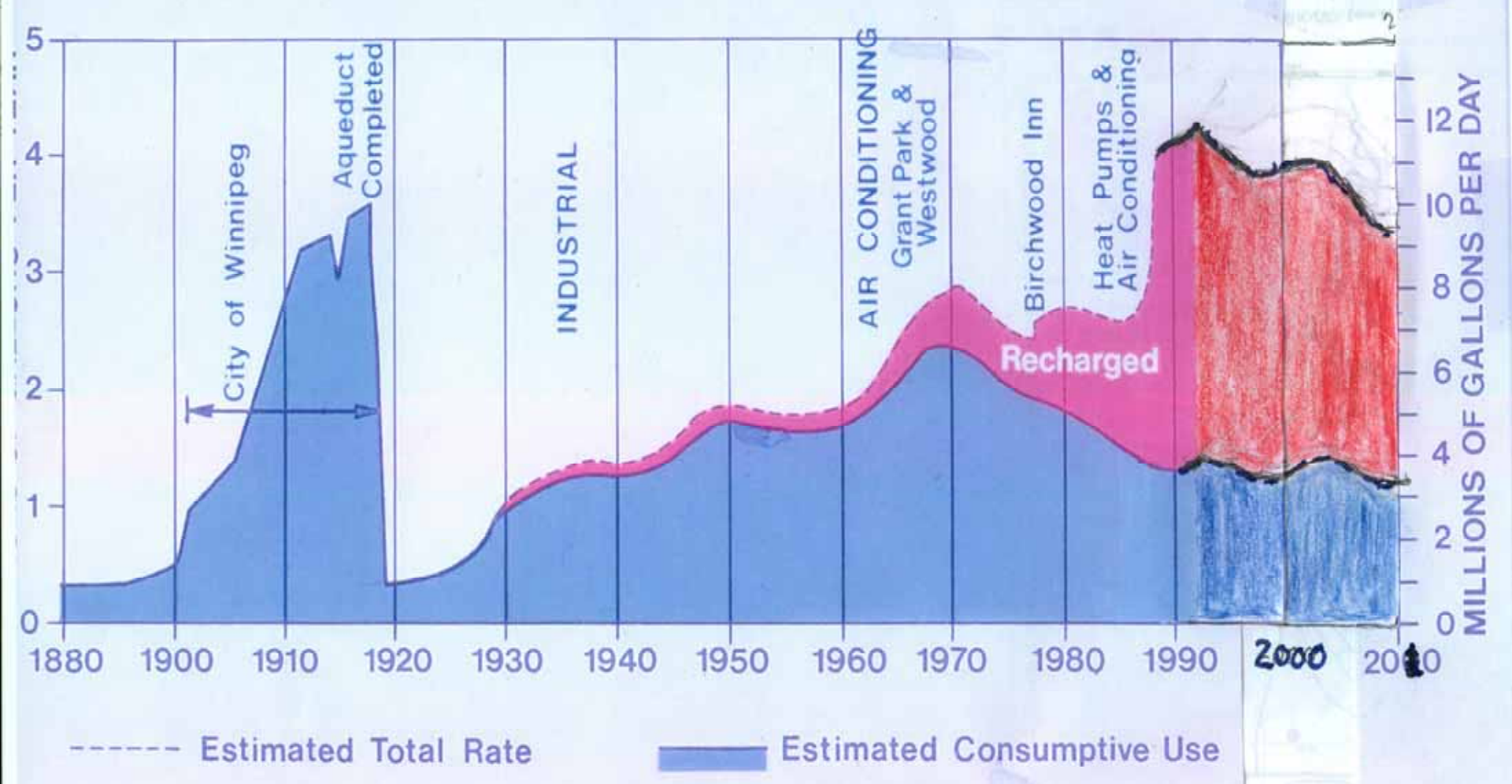

G05OJ022 WINNIPEG MO-2 NE03-12-02E
GROUND LEVEL ELEVATION 234.864 METRES (770.55 FEET)
Average Daily Groundwater Level - (M)
238
237
236
235
234
233
232
231
230
229
228
1970
1980
1990
2000
2010
Prepared by Manitoba Water Stewardship 26 Oct 2010

Carbonate Aquifer Potentiometric Surface
Winnipeg Area
August 1, 2006

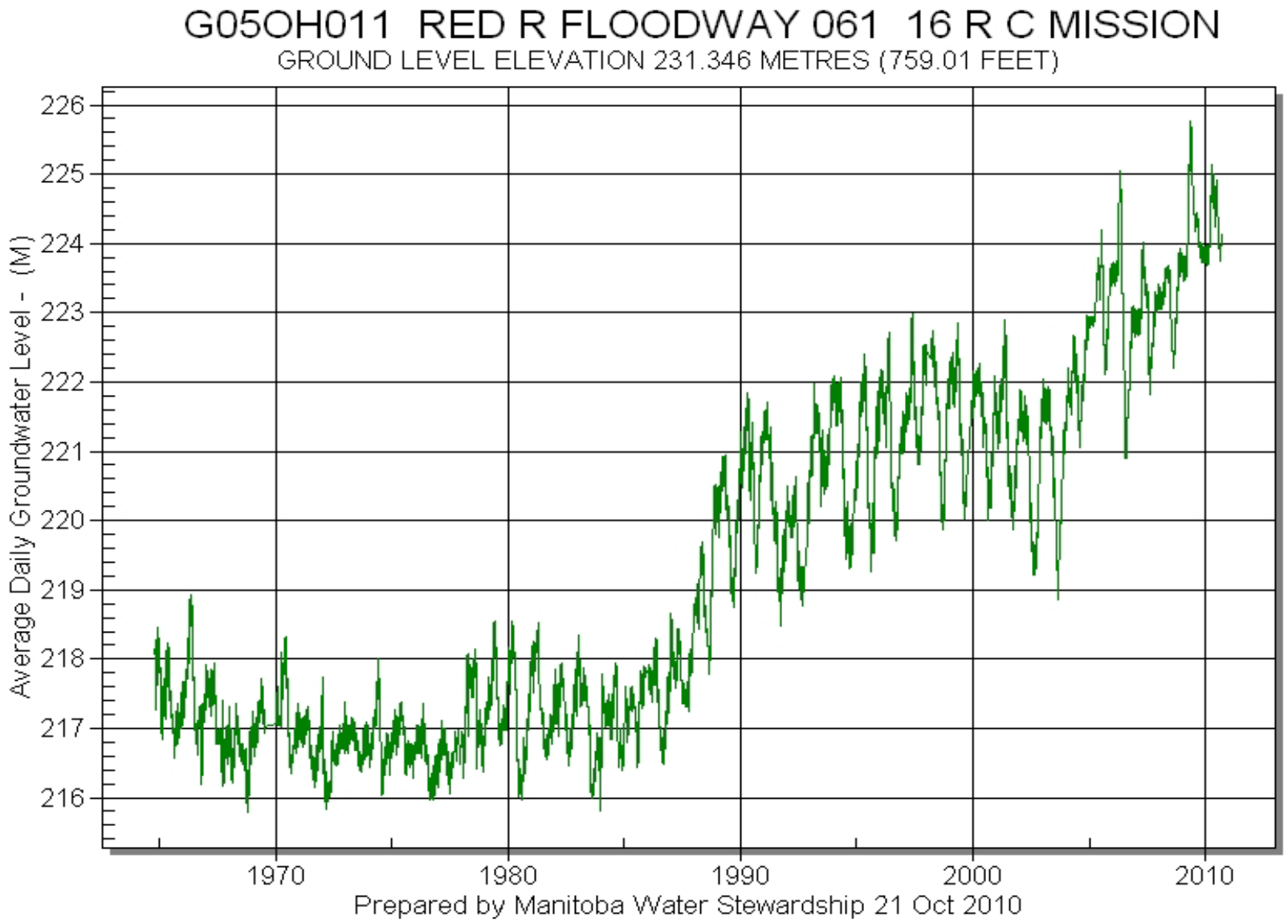


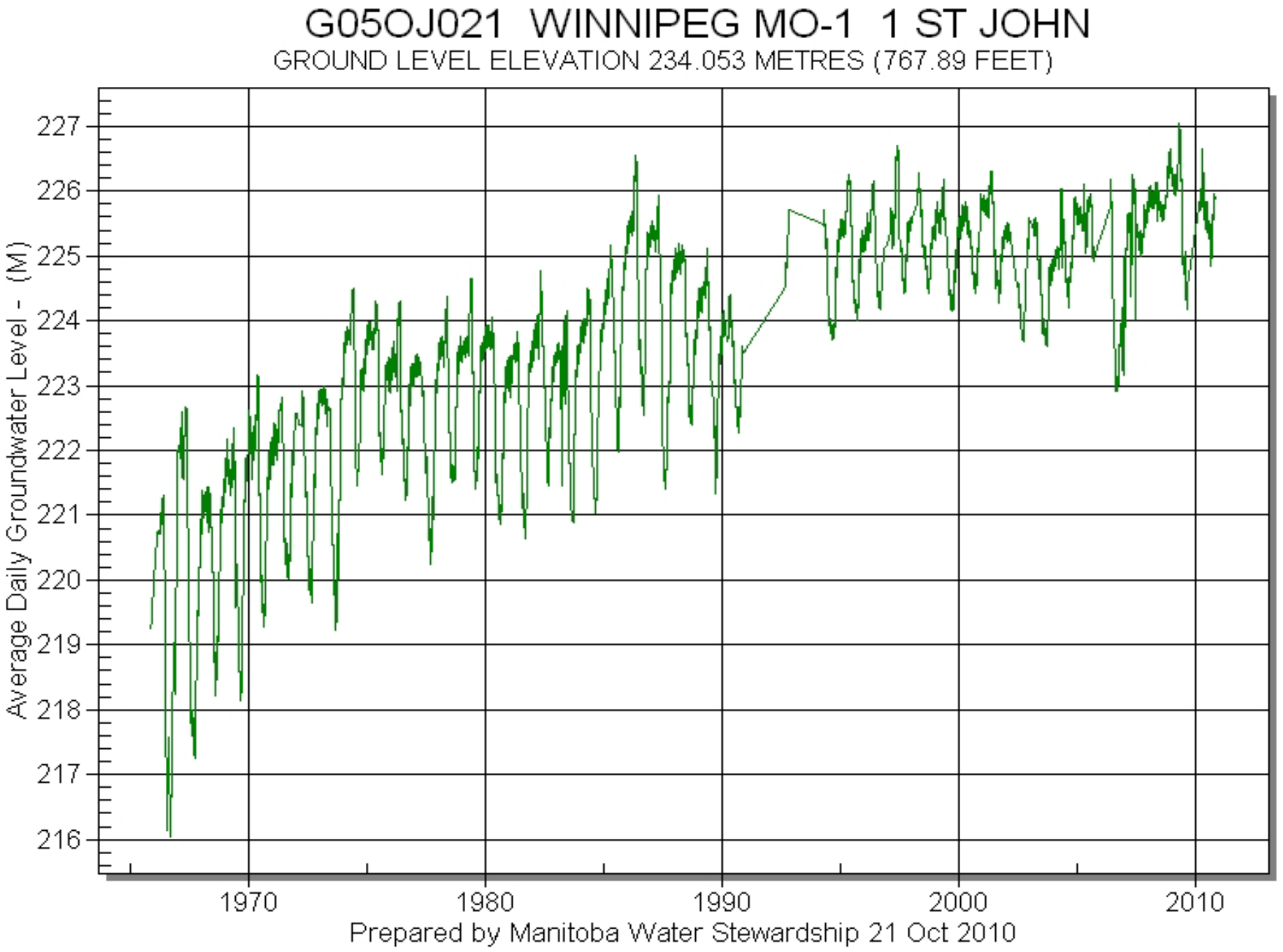
UTM NAD83, Zone 14

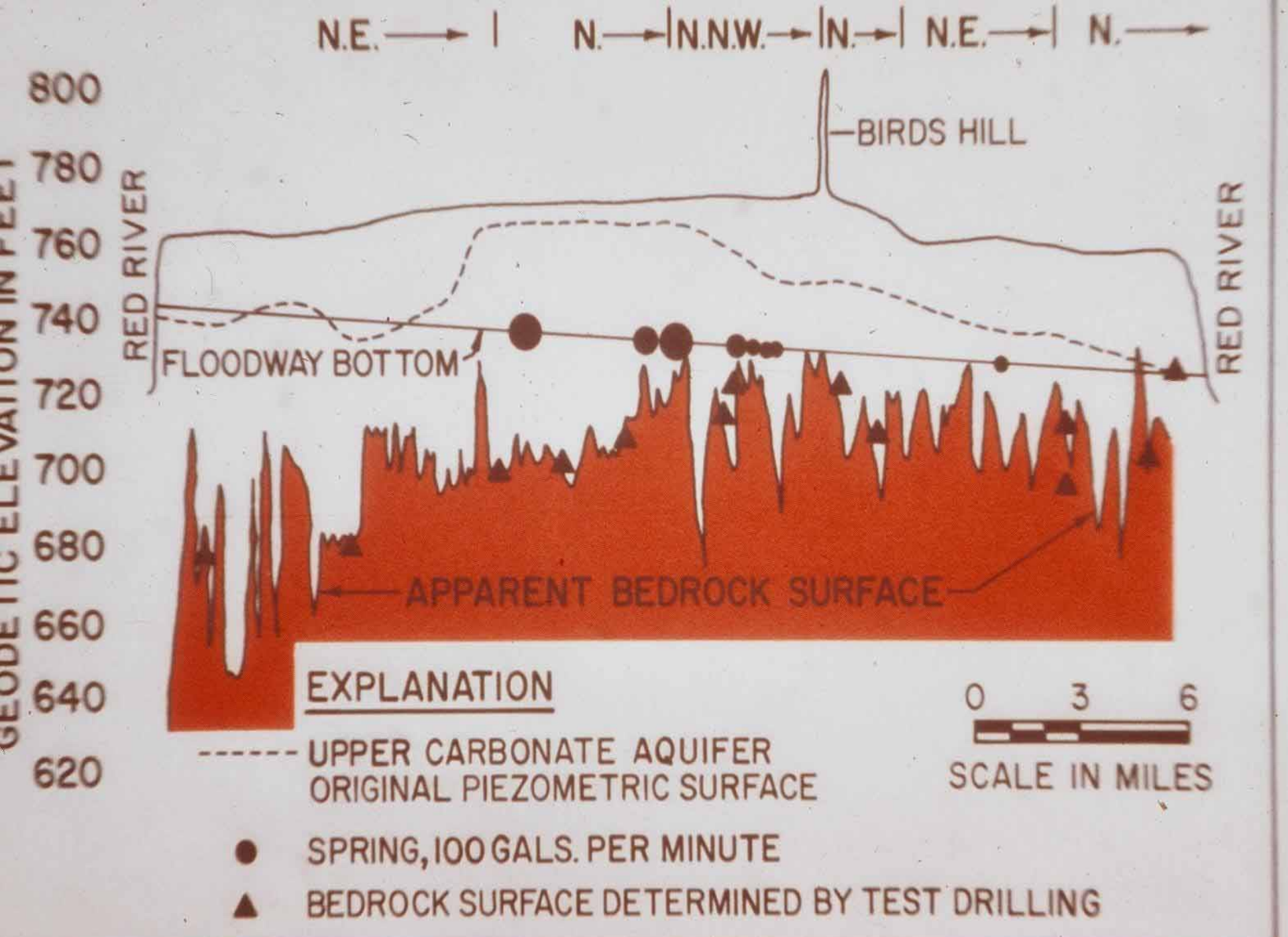
Groundwater Management Section
June 2007

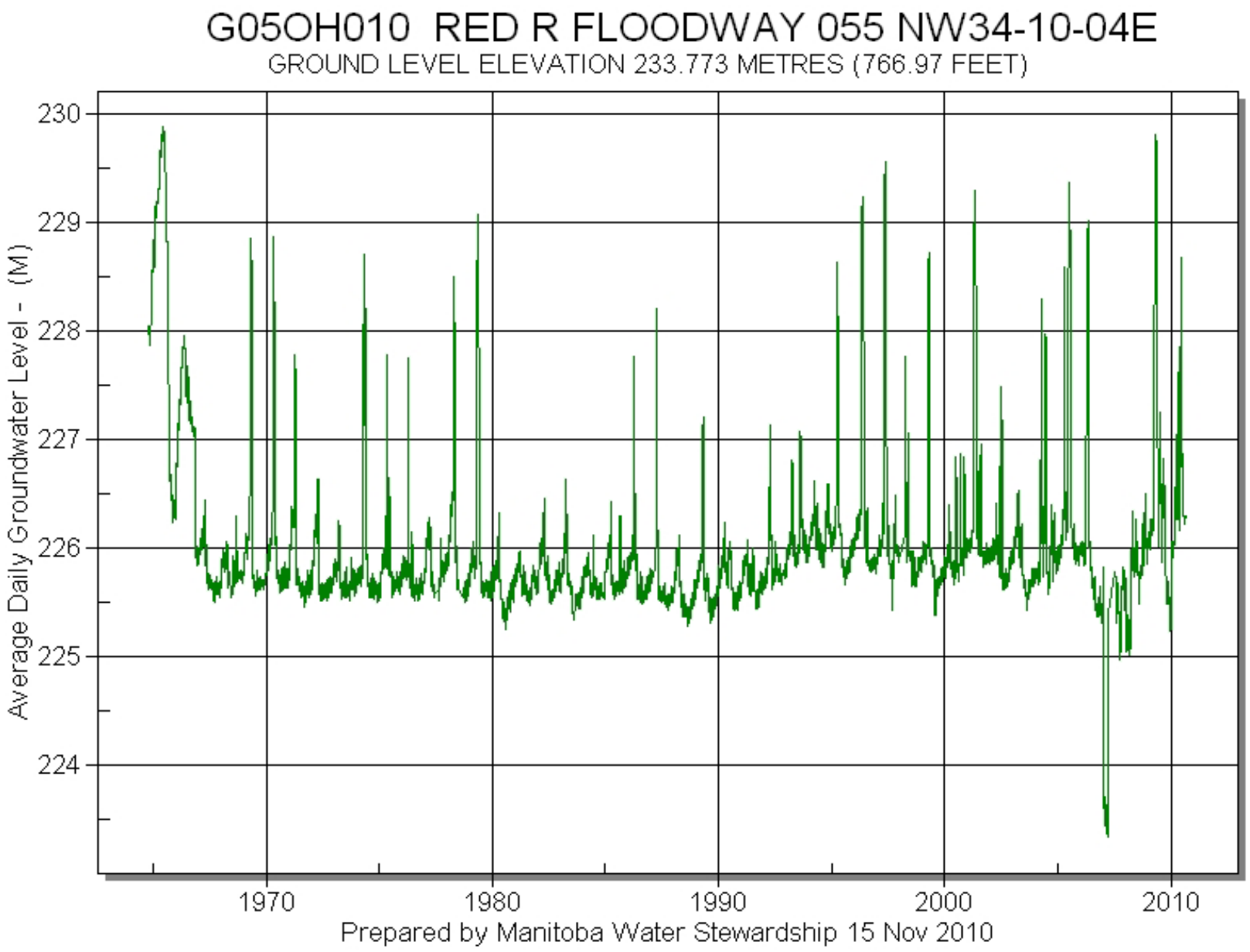


PUMPING RATES

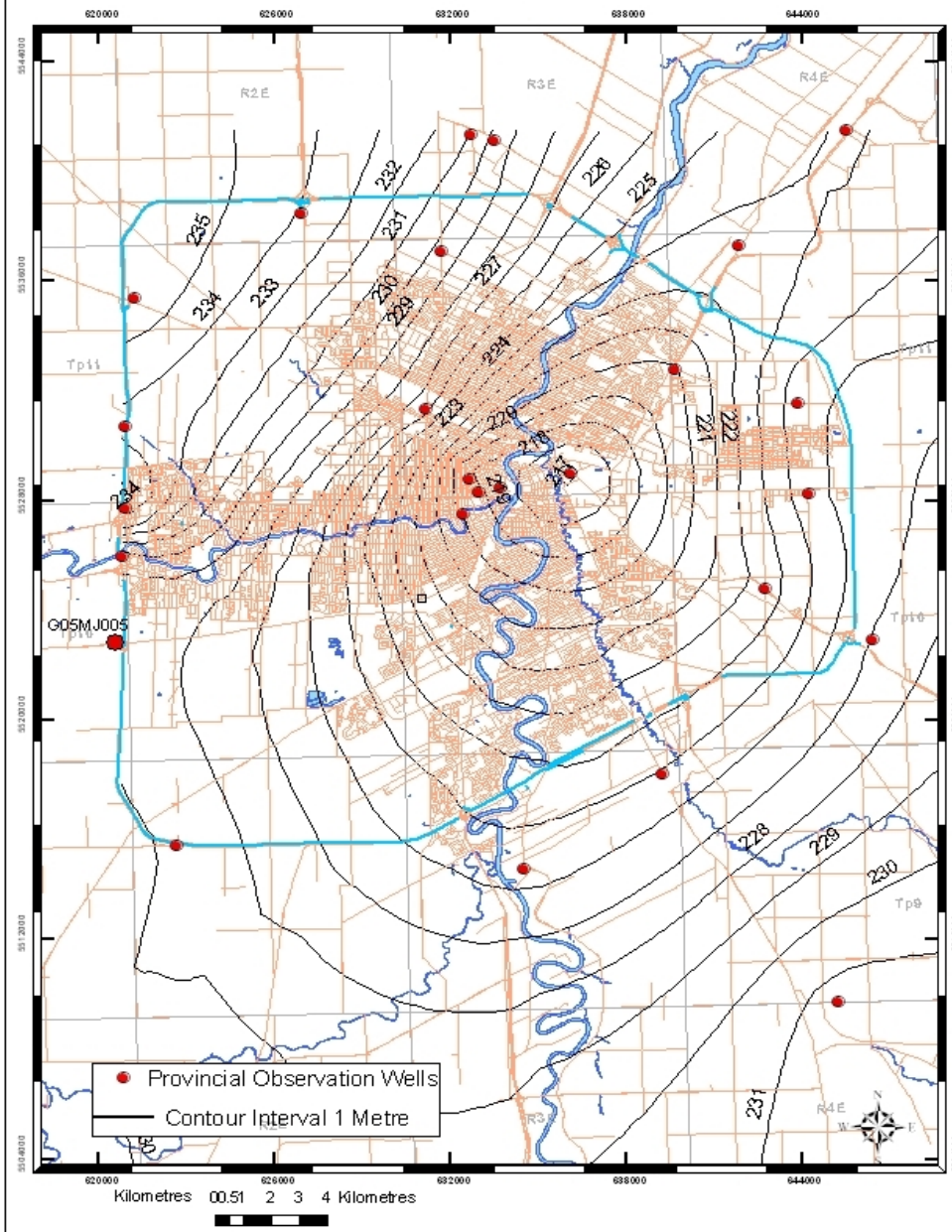

G05OH011 RED R FLOODWAY 061 16 R C MISSION
GROUND LEVEL ELEVATION 231.346 METRES (759.01 FEET)
Average Daily Groundwater Level - (M)
226
225
224
223
222
221
220
219
218
217
216
1970
1980
1990
2000
2010
Prepared by Manitoba Water Stewardship 21 Oct 2010


G05OJ021 WINNIPEG MO-1 1 ST JOHN
GROUND LEVEL ELEVATION 234.053 METRES (767.89 FEET)
Average Daily Groundwater Level - (M)
227
226
225
224
223
222
221
220
219
218
217
216
1970
1980
1990
2000
2010
Prepared by Manitoba Water Stewardship 21 Oct 2010


N.E.
N.
N.N.W.
N.
N.E.
N.
800
780
760
740
720
700
680
660
640
620
GEODETIC ELEVATION IN FEET
BIRDS HILL
RED RIVER
RED RIVER
FLOODWAY BOTTOM
APPARENT BEDROCK SURFACE
EXPLANATION
UPPER CARBONATE AQUIFER
ORIGINAL PIEZOMETRIC SURFACE
SPRING, 100 GALS. PER MINUTE
BEDROCK SURFACE DETERMINED BY TEST DRILLING
0 3 6
SCALE IN MILES


G05OH010 RED R FLOODWAY 055 NW34-10-04E
GROUND LEVEL ELEVATION 233.773 METRES (766.97 FEET)
Average Daily Groundwater Level - (M)
230
229
228
227
226
225
224
1970
1980
1990
2000
2010
Prepared by Manitoba Water Stewardship 15 Nov 2010

Carbonate Aquifer Potentiometric Surface
Winnipeg Area
August 15, 1970



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November, 2010

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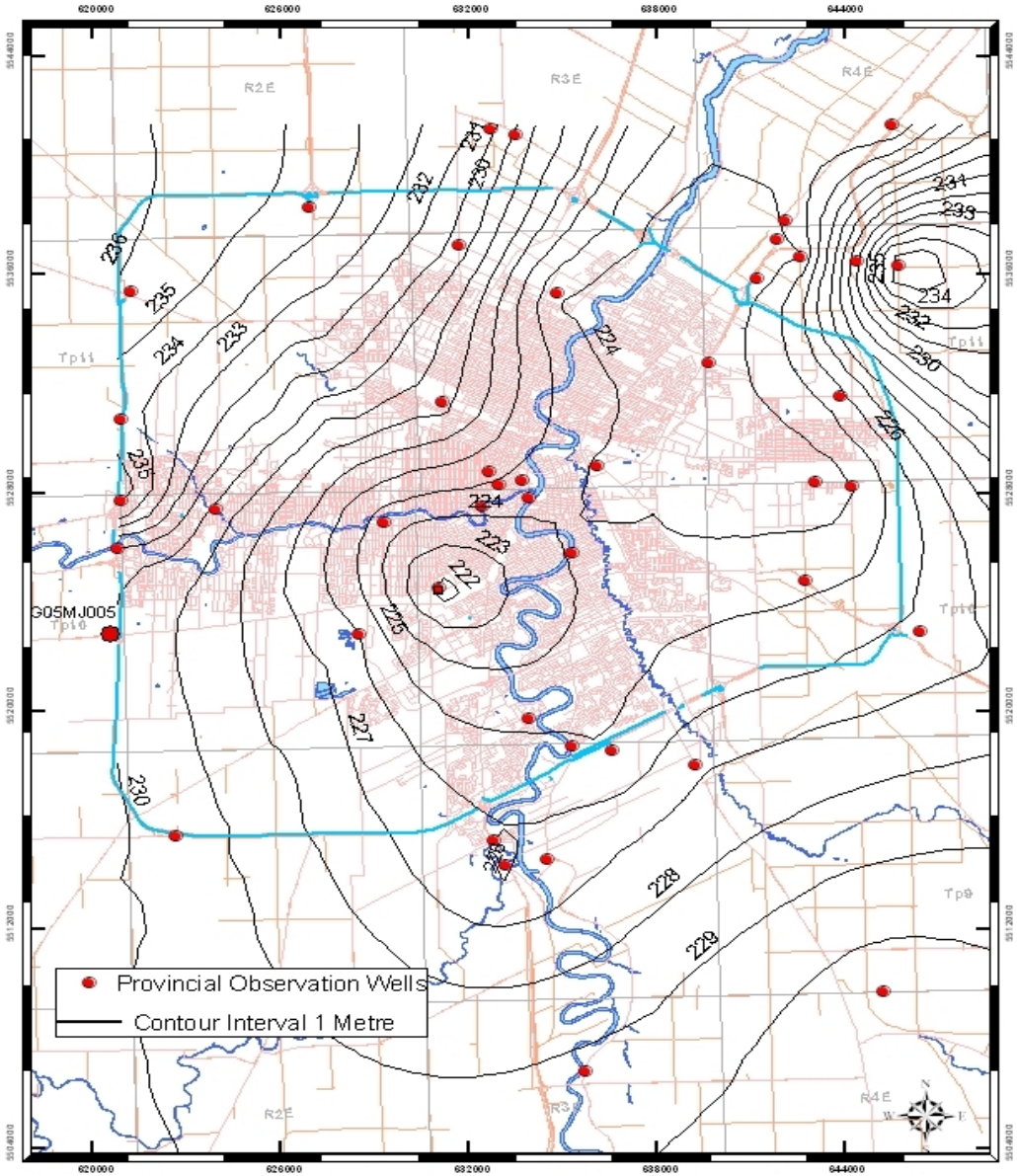
Carbonate Aquifer Potentiometric Surface
Winnipeg Area
August 15, 2010



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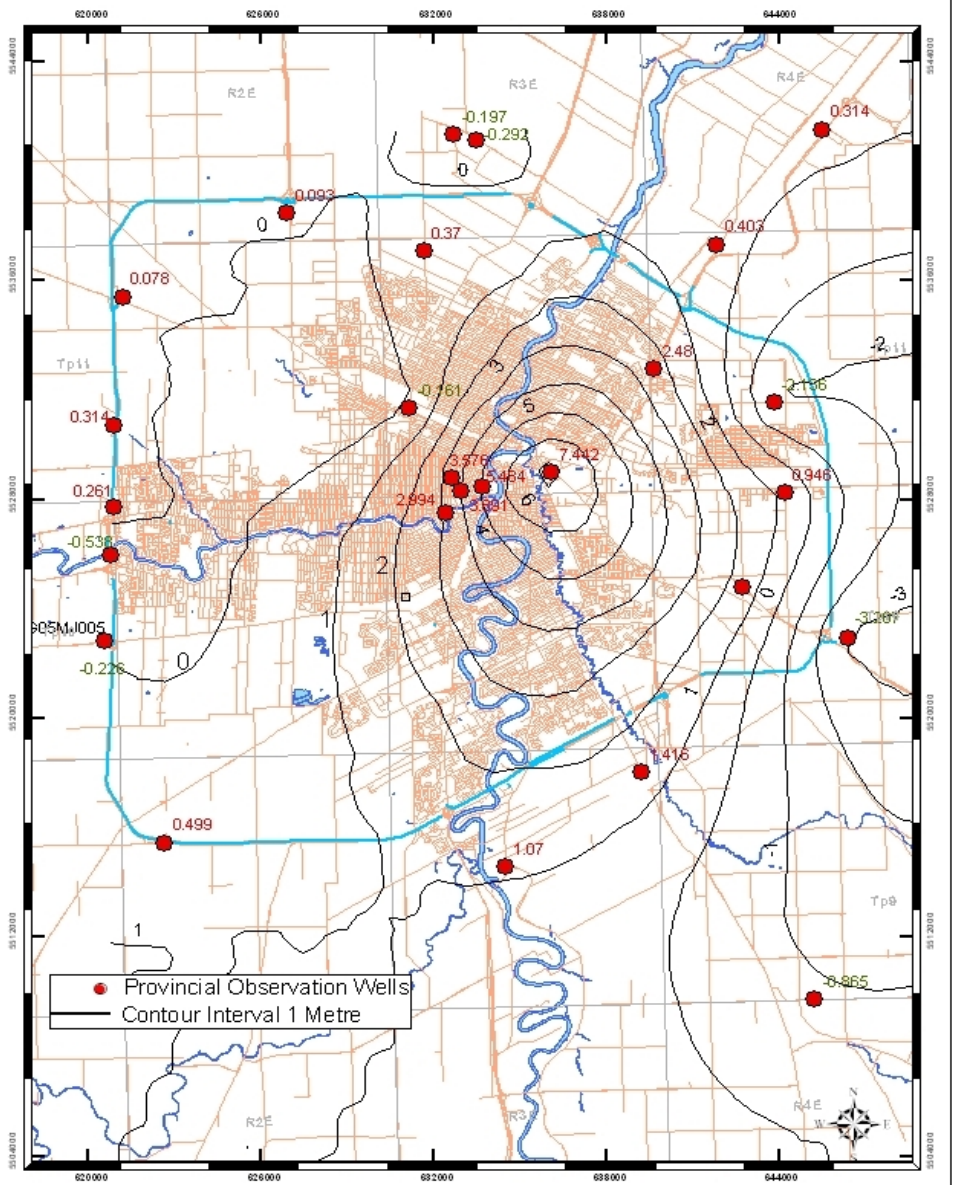
Carbonate Aquifer Potentiometric Surface Difference

Winnipeg Area
Between Spring 1970 to Spring 2009



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CONCLUSIONS

- Since late 1980's 1 to 7 metre piezometric increases have occurred in the central City caused by the stoppage of 2.5 mgd of pumping and wet weather
- Due to low transmissivity this is not a major problem under the core area of the city
- The increased piezometric pressure is negative from the viewpoint of river bank stability
- Even with continued wet weather only small further increases in piezometric pressure are anticipated.

Author's Biography:

Mr. Frank Render, B.Sc.(Geo) and M.Sc. (Hydrogeology), P. Eng. is a geological engineer. He worked on the Red River Floodway Project during 1962-68. During the period 1996 to 2004 he was Manager of the Manitoba Government's Groundwater Section. One of his major studies during his work career was the study of Carbonate aquifer that underlies Winnipeg and most of the Manitoba section of the Red River basin. Since retirement he has maintained continued interest in groundwater aquifers in Manitoba.