# MANITOBA FLOODWAY AUTHORITY

**RED RIVER FLOODWAY EXPANSION PROJECT**

**2006 GROUNDWATER MONITORING ACTIVITY REPORT**

**FINAL REPORT**
**MARCH, 2007**

KGS Group Project: 05-1100-01.19.12.06
Reference Number: .9905212 HM29


**KGS Group**
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KONTZAMANIS ▪ GRAUMANN ▪ SMITH ▪ MACMILLAN INC.
*CONSULTING ENGINEERS & PROJECT MANAGERS*

March 28, 2007

File No: 05-1100-01.19.12.06

Manitoba Floodway Authority
200 – 155 Carlton Street
Winnipeg, MB
R3C 3H8

ATTENTION: Mr. Doug Peterson
Manager of Environmental Services

RE: Red River Floodway Expansion Project
2006 Groundwater Monitoring Activity Report
Reference Number: .9905212 HM29

Dear Mr. McNeil:

Please find enclosed twenty (20) final copies of the 2006 Groundwater Monitoring Activity Report for your review and comments. The report combines requirements for baseline monitoring and annual monitoring in Environmental Licence 2691 (including construction monitoring) for the 2005 and 2006 period. Because of privacy issues and the volume of data, detailed information is not presented here, but may be made available to the Manitoba Floodway Authority if required.

We appreciate the opportunity to provide on-going services to Manitoba Floodway Authority on this project.

Sincerely,

J. Bert Smith, P.Eng.
Channel Design Manager

JBS/mfh/mlb
Enclosure

CC: Mr. Dave MacMillan, P. Eng., Project Manager – KGS Group

# TABLE OF CONTENTS

**PAGE**

# 1.0 INTRODUCTION

This report combines requirements for both baseline and annual (construction) monitoring for 2005 and 2006 in accordance with Clause 27 and Clause 30 of Environmental Licence No. 2691 dated July 8, 2005.

1. 2005 Baseline monitoring programs have been completed in accordance with Clause 30 of Environmental Licence No. 2691 dated July 8, 2005 as summarized in this report.

2. The 2005 water quality monitoring report has been completed in accordance with Clause 27 of the Environmental Licence as summarized in this report.

3. The 2006 water quality monitoring report has been completed in accordance with Clause 27 of the Environmental Licence as summarized in this report.

This report contains a summary of all of the material in the Baseline and 2005 Groundwater Monitoring Report issued March 2006 and reports on the 2006 monitoring activities and data. Data gathered during the monitoring programs has been analyzed and interpreted to address environmental issues. The interpretations given in this report are preliminary and further study is required to confirm them.

## 2.0 AQUIFER CHARACTERIZATION

The confined carbonate aquifer is found along most of the Floodway Channel. It is part of a regional flow system from eastern Manitoba and has moderate to high conductivity. The confined carbonate bedrock aquifer has natural variations in water quality with the specific conductance ranging from 1,000 to 2,000 µS/cm. Locally near the Floodway Inlet, mixing with saline groundwater from southwest Manitoba results in higher conductivity (> 3,000 µS/cm) groundwater with increased chloride and sodium. Conductivity is a measure of dissolved solids, such as calcium, magnesium, chloride, sodium and sulphate.

Lower conductivity values are found in the bedrock aquifer where it is influenced by the Birds Hill surficial granular aquifer from CPR Keewatin to Church Road. The Birds Hill sand and gravel is a local unconfined aquifer near PTH 59N. Bedrock beneath and surrounding the Birds Hill deposit has lower groundwater conductivity due to the freshwater recharge through the sand and gravel. Natural variations in groundwater quality with area and with the seasons must be considered when the baseline and ongoing water quality results are evaluated during construction activities and Floodway operation events. In the vicinity of the Bird's Hill sand and gravel surficial aquifer, recharge from precipitation forms groundwater with lower conductivity (500 µS/cm to 1,000 µS/cm) than other areas of the carbonate aquifer.

The intrusion of any surface water into the groundwater is easiest to detect when the chemical contrast between the two is greatest. Most groundwater conductivity values were greater than surface water conductivity measured during spring Floodway operation, when river conductivity values were lowest. In this situation, most parameters would be expected to decrease if surface water intruded. During summer Floodway operation in 2005, river conductivity values were higher than in the spring and higher than the natural groundwater in some areas near the CPR Keewatin Bridge, PTH 59N and Church Road. An increase in some parameters would be expected, if the groundwater intruded at that time.

# 3.0 DOMESTIC WELLS

## 3.1 INTRODUCTION

Domestic well inventories were conducted in 2005 at 541 locations of the 612 well sites located. Limited domestic well sampling was conducted in 2003 (25 locations). Extensive sampling was conducted in 2005 with 1048 samples collected during four sampling events. Sampling events in 2005 included pre-spring runoff, spring Floodway operation, summer emergency Floodway operation and fall. Of the wells sampled in 2005, 242 wells were sampled once, 222 wells were sampled three times and 147 wells were sampled 4 times. Approximately 160 wells were sampled during each of the four sampling periods in 2006. Domestic well locations are shown on Figure HM29-1. In total, approximately 500 individual wells have been sampled at least once to the end of 2006. Individual well owners receive copies of their laboratory analysis after each sampling event.

The electronic well inventory database was expanded and updated in 2006. It contains all homeowner interview information, field sampling results and links to water chemistry results. The inventory is being used with the Floodway GIS database on an on-going basis as a resource when investigating public inquiries and during temporary groundwater depressurization activities at construction sites such as bridges and the aqueduct.

Changes in domestic well water quality consist of increases or decreases in various parameters. An increase could also be caused by local infiltration or well installation conditions. Increases in parameters would be expected from an influx of contaminants from septic fields, changes in well water quality due to a change in water elevation in the well and changes in the bedrock aquifer flow system. These changes could occur without direct infiltration of Floodway surface water into the groundwater. Increases in nitrate + nitrite or bacteria could be associated with Floodway surface water infiltration, since these parameters are higher in Floodway water than in the aquifer.

### 3.2 BACTERIA

Levels of Total Coliform bacteria in domestic wells are low and do not correlate with periods of Floodway operation or construction activities. Positive detection of Total Coliform during each period ranged from 3% to 12% of wells sampled to date, except during the period of very high rainfall in July 2005 when 33% of wells tested positive. In 2005, there were only a few domestic well groundwater samples that tested positive for bacteria before the spring melt and immediately after Floodway Operation (Total Coliform 3% and 8% of wells respectively and no *E. Coli* detections). Most of the wells which tested positive for bacteria in 2005 did so in July 2005, during a period of extremely high precipitation, coinciding with the emergency summer operation of the Floodway (Total Coliform 33% and 5% detections of *E. Coli*). Manitoba Water Stewardship reported a widespread increase in bacterial contamination of wells throughout the province and the region during this period based on homeowner submission of samples to the laboratory. The increase was attributed to a combination of high groundwater level conditions, heavy rainfall, standing water and local flooding. By October 2005, conditions were only slightly higher than before the summer flood (Total Coliform 12%, *E. Coli* less than 1 %). These detection numbers are not indicative of the overall groundwater conditions along the Floodway, since the well sample locations have been concentrated in higher sensitivity areas. In addition, wells with previous bacteria presence were prioritized for the ongoing sampling program, whereas the total number of wells sampled were reduced.

During the 4 sampling periods in 2006, from 8 to 11% of domestic well groundwater samples tested positive for Total Coliform, with little correlation to Floodway operation in April 2006. *E. Coli* was detected only before the spring melt and in only 4% of samples. The spring 2006 flood was larger than the summer 2005 flood, but bacteria was detected in fewer samples (11%) in the Spring 2006 flood. This is consistent with the interpretation that the surge of bacteria seen in the groundwater in July 2005 was largely related to the high precipitation, rather than the summer Floodway Operation.

For the entire 2005 to 2006 period, most positive detections of coliform bacteria have occurred north of the TransCanada Highway. There was no association established between the location of the well and the percentage of time bacteria was detected in that well, especially when the high rainfall July 2005 period was excluded, although clusters of wells with positive bacteria can be seen in higher density developments. Of the 502 domestic wells sampled for bacteria in 2005 and 2006, 75 wells or 15% tested positive for Total Coliform during at least 1 sampling event. If the unusual July 2005 period is excluded, fewer wells (51 wells or 10%) tested positive for coliform. The data was analyzed to determine if there were wells where bacteria was detected only during periods when the Floodway was in operation. Bacteria was detected in a small number of wells only during floodway operation. A group of these wells occurs at the north end of the Floodway. All wells are assumed to be developed in the bedrock aquifer based on drilling records examined in selected areas.

Total Coliform was present in only four of these 37 wells during flood events, excluding the 2005 summer flood. Only 1% of all water samples (18 out of 502 wells sampled) tested positive for *E. Coli* bacteria in 2005 to 2006, with no correlation to flood events or location. *E. Coli* has been detected in few (4%) of the wells sampled and it has been detected more than once in only one well. All homeowners were notified of positive bacteria results immediately. Further investigation is required before conclusions can be made.

### 3.3 NITRATE-NITRITE

Most nitrate + nitrite (as N) values throughout the study area are well below the Canadian Drinking Water Quality Guideline (CDWQG) value of 10 mg/L nitrate + nitrite (as N) with 60% to 85% of samples less than detection (0.01 mg/L) and most values less than 1 mg/L. Values greater than 1 mg/L and up to 5 mg/L were found in 4% to 8% of domestic wells north of Highway 59 N bridge to the Outlet. Three of these well locations had a nitrate + nitrate (as N) value over 10 mg/L. No increase in these broad ranges was seen during Floodway operation, although there were individual wells that showed slight increases (in the 0.01 to 1 mg/L range) during Floodway operation.

### 3.4 PESTICIDES

Pesticides analyzed, which are used in local agricultural practice and for Floodway construction, were not detected in the 10 domestic wells and 9 monitoring wells sampled in 2005 and 2006.

## 3.5 SPECIFIC CONDUCTIVITY

If Floodway surface water intrudes into the carbonate aquifer, the mixing would result in a concentration decrease of most groundwater quality parameters. The change could be seen most readily in areas of more mineralized groundwater with higher conductivity levels. Summer 2005 flood surface water conductivity and inorganic parameter values in the channel were higher than surface water concentrations in the Spring in 2005. In areas from CPR Keewatin to Church Road any influence on conductivity, hardness, sulphate, chloride and sodium would be difficult to detect where groundwater concentrations were similar to the summer flood quality.

For the 2005 and 2006 spring Floodway operation and the 2005 summer Floodway operation, no obvious change in groundwater quality is seen in 189 (84%) of the 226 domestic wells sampled during flood events. Only 37 wells (16%) showed possible slight to minor decreases in parameter concentrations, (or increases in certain areas during the summer flood). The wells selected for sampling were in areas of higher sensitivity with potential for interconnection where changes may be more likely to occur.

The decreases in parameter concentrations were rated as slight to minor for all but two locations. For the two locations that were rated as moderate, one is distant from the Floodway, and the other is close to a gravel pit. All domestic wells monitored with water quality decreases are located from north of PTH 15 to the Floodway outlet. The cause of the water quality changes noted above has not been determined and will require additional follow-up work.

Frequent monitoring (up to weekly) was done at 5 wells during flood events. Even in cases where changes associated with Floodway operation occurred, the changes lasted only until the end of the Floodway operation. Water quality returned quickly to typical pre-flood groundwater concentrations as soon as the Floodway Channel drained.

# 4.0 MONITORING WELLS

## 4.1 INTRODUCTION

Monitoring well samples have been collected from approximately 38 bedrock wells, 20 till wells, and 6 sand and gravel wells (Oasis Road area only), adjacent to the Floodway. Monitoring well locations are shown in Figure HM29-2. Conductivity in the monitoring wells generally shows the same distribution along the Floodway as for the domestic wells.

## 4.2 BACTERIA

Sampling of disinfected monitoring wells in 2005 showed that bacteria results from the monitoring wells were variable and that it was not feasible to disinfect the 2-inch standpipes sufficiently to eliminate sediment, which can naturally carry Total Coliform. Larger diameter provincial wells were installed in the past for water level monitoring and did not have the sanitary protection needed for reliable bacteria monitoring. Bacteria sampling in monitoring wells has been discontinued for these reasons, and was not sampled in 2006.

## 4.3 NITRATE-NITRITE

Nitrate + nitrite (as N) concentrations in monitoring wells were generally very low, below 0.3 mg/L, with a few up to 0.7 mg/L. Elevated nitrate + nitrite (as N) up to 2 mg/L was found during and after Flood events in only one bedrock monitoring well on the west side of PTH 59N. Wells were installed for monitoring in 2007.

## 4.4 PESTICIDES

The pesticides analyzed represented products used in the area for agriculture plus those intended for Floodway construction use. There were no pesticides detected in the 9 monitoring wells sampled in 2005 to 2006.

## 4.5 SPECIFIC CONDUCTIVITY

Of the 37 bedrock wells monitored during the flood events, 11 wells (30%) showed possible decreases in specific conductivity and other parameter concentrations, (or increases in certain areas during the summer flood). The decreases were rated as slight (less than 10%) to minor (10% to 25% changes) for all but four locations. Four wells with moderate changes (greater than 25%) were found. They are located at the Floodway Inlet (where the Red River is connected to the carbonate aquifer), at the west side of PTH 59N (where the Floodway channel is in sand and gravel over bedrock), and at Dunning Road (where the Floodway low flow channel is in till). Many of the monitoring wells are located on the shoulder of the channel, or in the spoil pile and would be expected to experience any changes more quickly than domestic wells located beyond the Floodway right of way. Further work is required to determine the cause of these water quality changes.

A consistent correlation between Floodway operation and specific conductivity trends was not found at 8 of the 10 bedrock wells where continuous monitoring transducers were installed. A possible correlation with moderate change was found at one location at Dunning Road. Consistent conductivity and temperature changes associated with Floodway operation were found at the bedrock monitoring well on the west side of the Floodway south of PTH 59N. Water quality and temperature changes occurred very quickly in response to Floodway surface water level changes at this location, with very little time lag in the response. Water quality returns to a groundwater type by the time Floodway operation has finished.

A detailed review was completed of Provincial Water Quality Data for the 1974 Flood, which was a large flood of over 4 weeks duration with frequent sampling results. At 10 of the 11 wells, groundwater parameters either remained at typical levels, or the changes could not be correlated with flood events. Some moderate decrease in water quality parameters was seen at one monitoring well near Hay Road.

## 4.6 MICROSCOPIC PARTICULATE ANALYSIS

Microscopic Particulate Analysis (MPA) Testing was conducted on 2 wells on the west side of the Floodway in 2005. These wells showed a low risk of surface water contamination and tested negative for Giardia and Cryptosporidium Protozoa. The lack of particulate matter is one indication that the wells are not likely to be classified as Groundwater Under the Direct Influence of Surface Water (GUDI).

## 4.7 WATER LEVELS

Water level measurements taken from 2003 through 2006 have established baseline, non-flood seasonal variations, as well as changes throughout Floodway operation periods.

## 4.8 TRANSDUCER MEASUREMENTS

Data from the transducers taking continuous conductivity measurements at monitoring wells did not identify potential surface water intrusion events based on conductivity decreases, during the spring and summer flood, except at PTH 59N west side. Subtle influences on transducers were seen at CPR Keewatin, Hay Road and Dunning Road, consistent with water quality results.

Infiltration of Floodway surface water into the bedrock aquifer was documented at PTH 59N West Side at a well located within 40 m of the west Channel slope within the Floodway Right of Way. A short-term moderate decrease in conductivity was measured during all three flood events in 2005 and 2006. A slight, but definitive temperature decrease was measured during both spring floods (colder surface water than groundwater) and a temperature increase was recorded during the summer flood (warmer surface water than groundwater) of 2005. Water quality and temperature changes occurred concurrently with water level changes at this location, with little time lag. Water quality returned to groundwater type by the time the Floodway Channel had drained. Subtle influences on transducers were seen north of PTH 59 North Bridge, consistent with water quality results.

# 5.0 GROUNDWATER DISCHARGE AND BASEFLOW

A Low Flow Channel baseflow program was conducted in February 2005 using temporary weirs constructed across the Low Flow Channel. A winter survey of seepage sites was also conducted. Most groundwater seepage sites previously identified along the Channel during the 1960's and early 1970's were also observed in February 2005 as either open water or zones of thin ice. Additional seepage sites north of PTH 59N also were identified. Cumulative increases in baseflow were measured at temporary weirs constructed along the Channel in 2005, from north of the CPR Keewatin Bridge to the Outlet Structure. The maximum total baseflow discharge measured at the Outlet Structure was estimated to be 4 cfs or approximately 1500 Igpm in February 2005. Water quality samples taken from the Low Flow Channel in February 2005 (and subsequent monitoring during the surface water monitoring programs) were comparable to the area bedrock groundwater quality, which indicates local groundwater discharge into the Channel.

Groundwater discharge into the Channel base (as springs) was identified at 15 locations in 2005. These discharge points were photographed, geo-referenced and sampled during the late spring/summer baseflow 2005 discharge program. Four of the discharge locations were sampled daily immediately following the spring 2006 flood. The water chemistry was typical of groundwater at all locations sampled, indicating that discharge conditions are established within days (or sooner) of the Floodway draining.

# 6.0 CONSTRUCTION DEPRESSURIZATION MONITORING

Construction groundwater monitoring was conducted at PTH 59S bridge, TransCanada Highway bridge and the City of Winnipeg Aqueduct during aquifer depressurization programs in 2006. Groundwater levels returned to normal immediately after pumping programs stopped. Additional monitoring was conducted at the Kildare Land Drainage Pump Station in advance of pumping beginning in January 2007 and at Spring Hill/Oasis Road in advance of construction in 2007.

The Groundwater Action Response Plan has been used effectively during construction. Public complaints during groundwater depressurization projects were minimal, with most being unrelated to operations. Complaints at four wells near the Aqueduct were resolved including one well replacement due to a collapsed casing, one pump replacement, one pump lowering and one case of temporary turbidity during aquifer recovery. Manitoba Floodway Authority also has responded to several public complaints in other areas in 2005 to 2006, which were established to be unrelated to Floodway operations.

**FIGURES**

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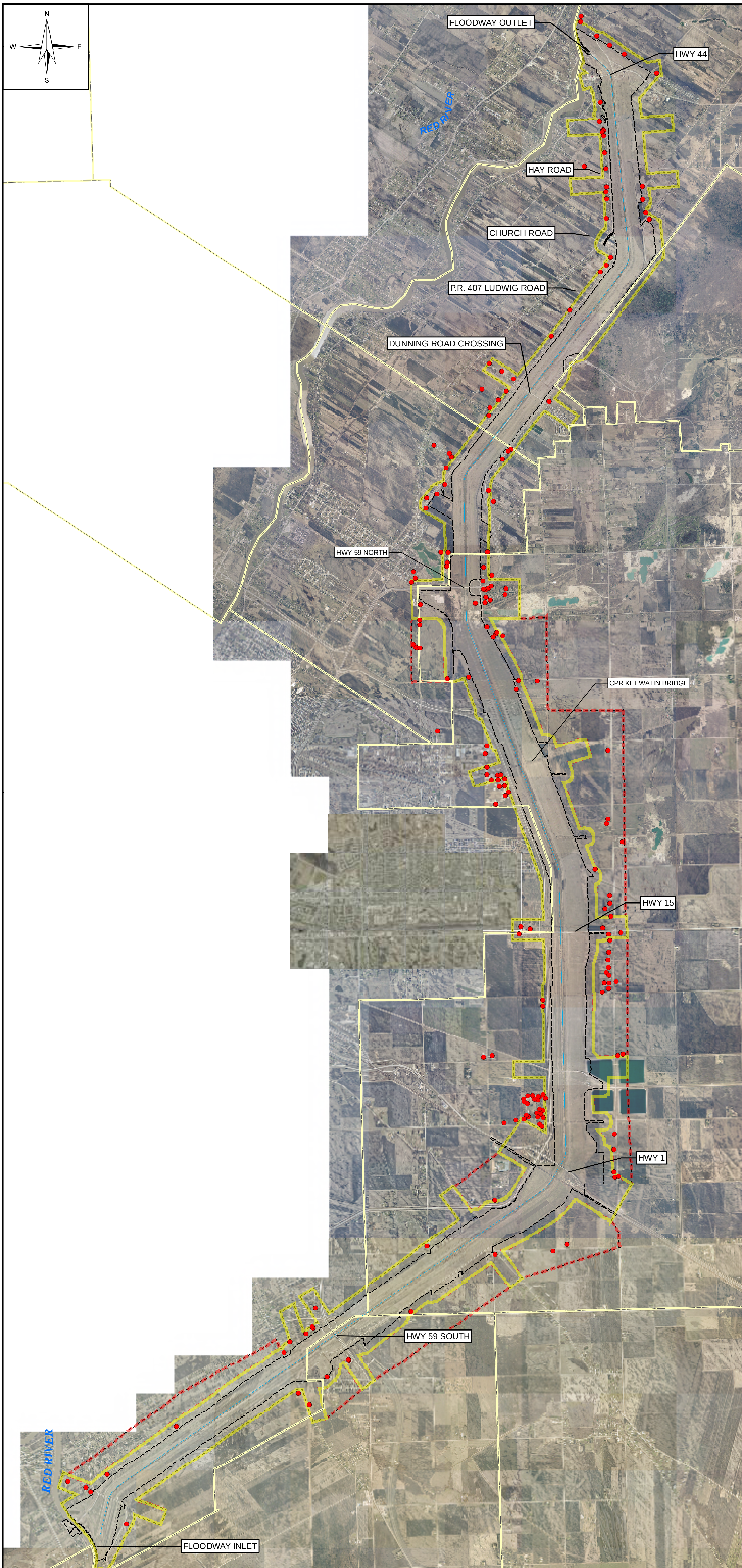


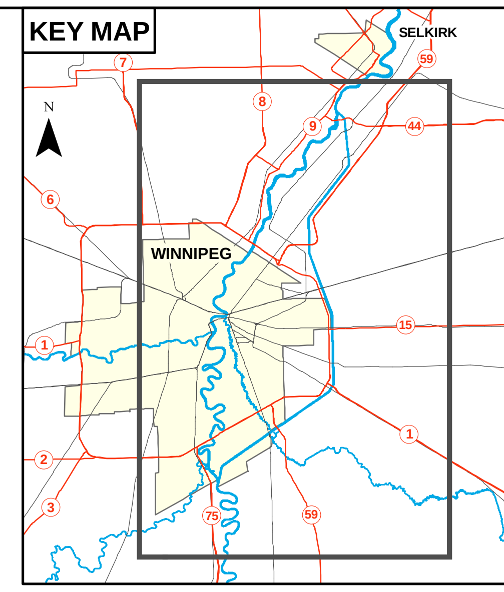


Floodway Right of Way Limits

Domestic Well Monitoring Area Within
- 200m of Floodway Right of Way
- 1km of Bridge Crossings
- 1km of Detailed Sections

Additional Monitoring Area Boundary

Domestic Wells Sampled 2006

1:100,000

0 1 2 3 4 5

Kilometres

All units are metric and in metres unless otherwise specified.
Universal Transverse Mercator Projection, NAD 1983, Zone 14
Elevations are in metres above sea level (MSL)

MEMO REFERENCE 05-1100-01.9905212-HM29

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MANITOBA FLOODWAY AUTHORITY

RED RIVER FLOODWAY EXPANSION

2006 GROUNDWATER MONITORING SUMMARY REPORT

DOMESTIC WELL MONITORING
LOCATIONS 2006

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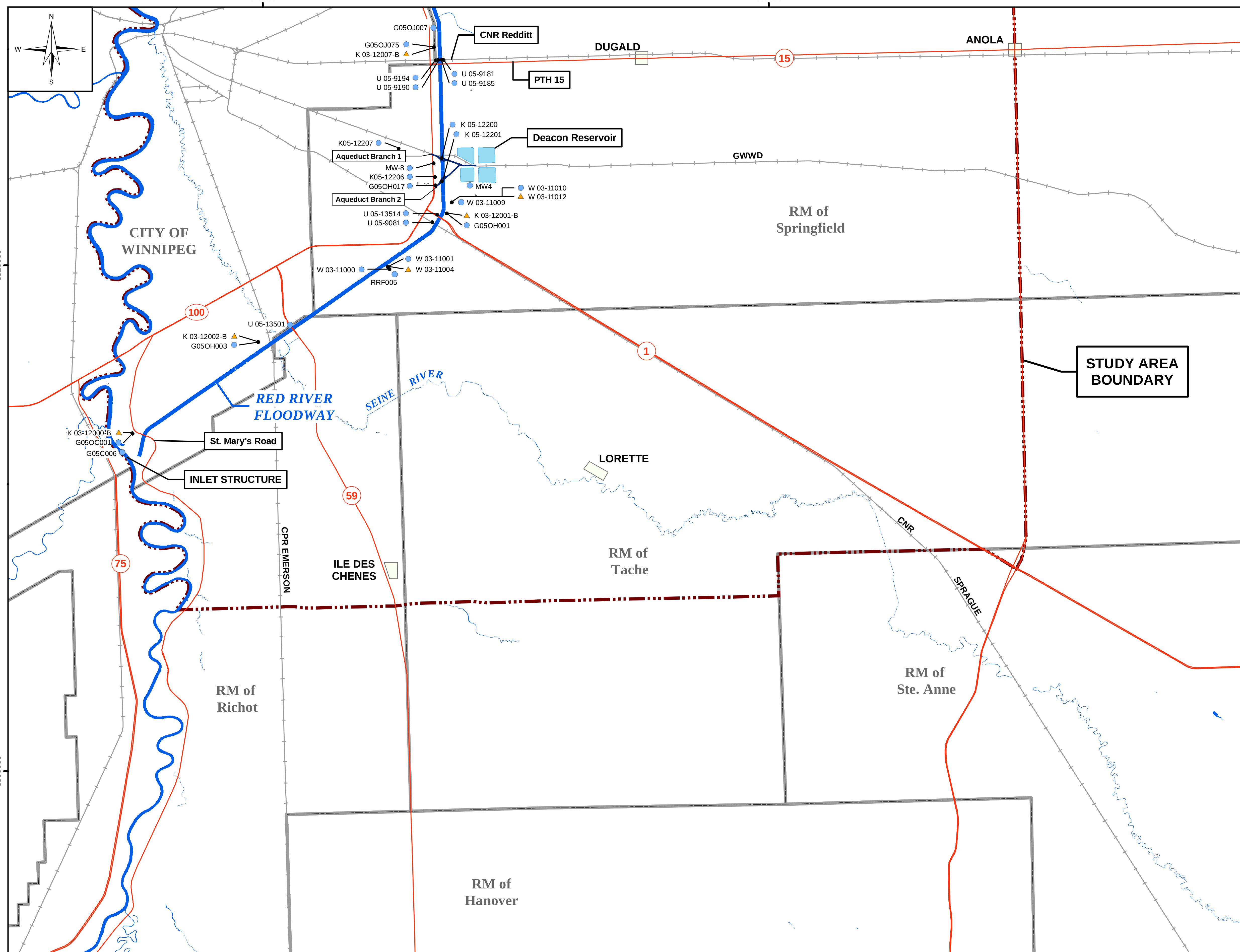
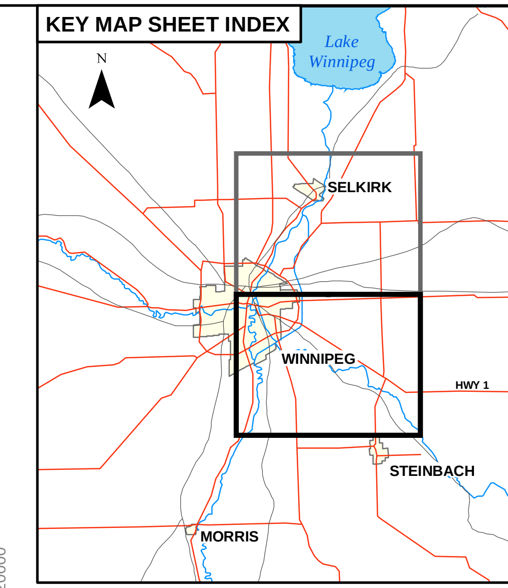
| MARCH 2007 | HM29-1 | REV: 0 |




Monitoring Wells

- Bedrock Well
- Till Well
- Sand and Gravel Well

Topographic Features

- Primary Highways
- Railway
- Major Rivers
- RM Boundaries
- Study Area Boundary

1:150,000

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Kilometres

All units are metric and in metres unless otherwise specified.
Universal Transverse Mercator Projection, NAD 1983, Zone 14
Elevations are in metres above sea level (MSL)

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MANITOBA FLOODWAY AUTHORITY

RED RIVER FLOODWAY EXPANSION

2006 GROUNDWATER MONITORING SUMMARY REPORT

MONITORING PROGRAM
MONITORING WELL LOCATIONS
(SOUTH, SHEET 1of 2)

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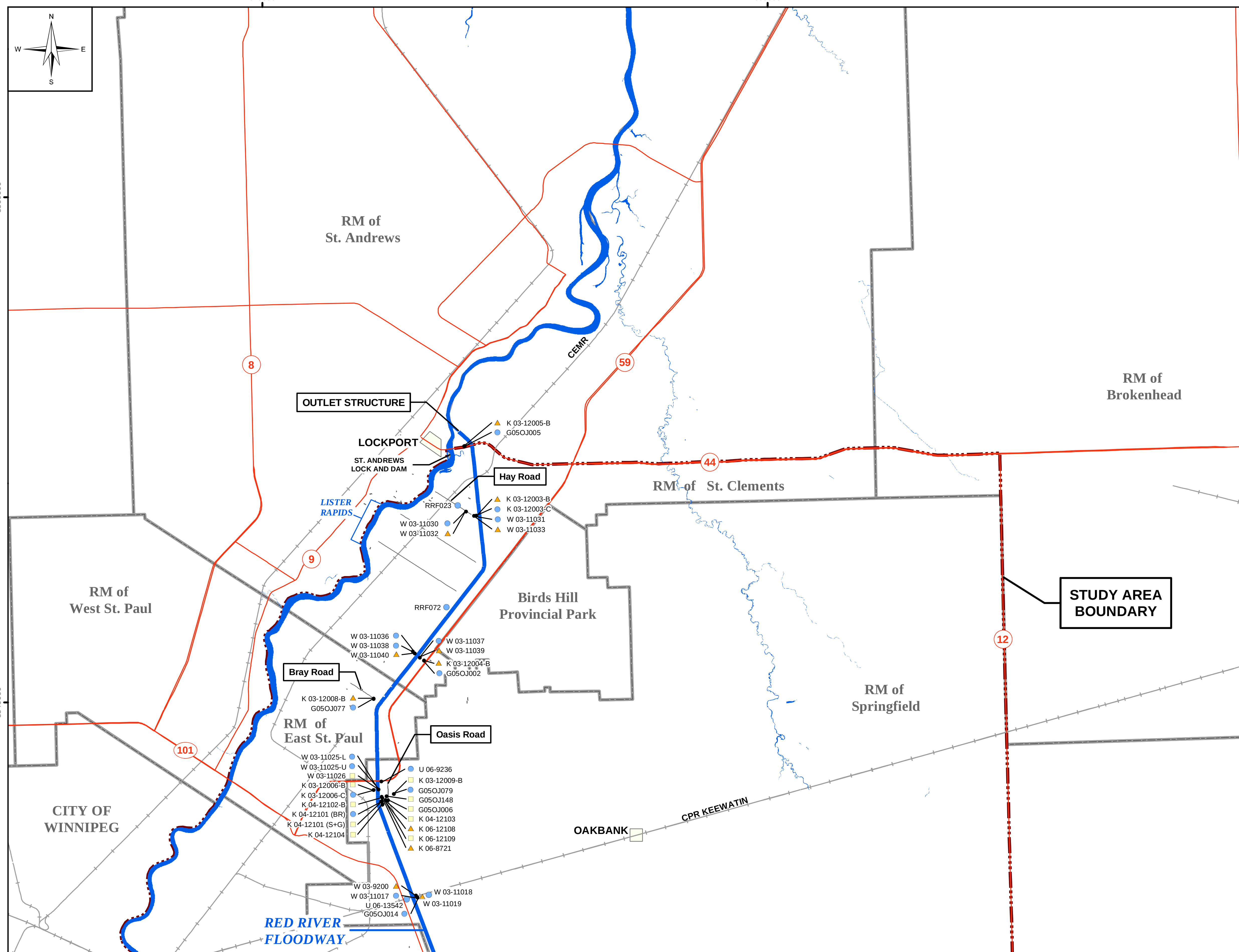
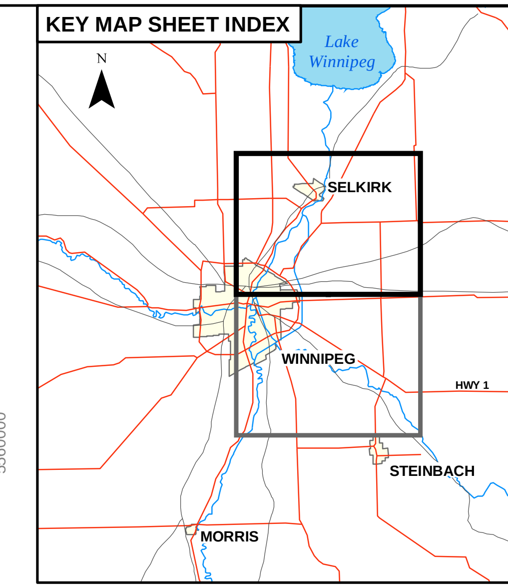



## KEY MAP SHEET INDEX




**Monitoring Wells**

- Bedrock Well
- Till Well
- Sand and Gravel Well

**Topographic Features**

- Primary Highways
- Railway
- Major Rivers
- RM Boundaries
- Study Area Boundary

1:150,000

0 1 2 4 6 8

Kilometres

All units are metric and in metres unless otherwise specified.
Universal Transverse Mercator Projection, NAD 1983, Zone 14
Elevations are in metres above sea level (MSL)

MEMO REFERENCE ........05-1100-01.9905212-HM29..........

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MANITOBA FLOODWAY AUTHORITY

RED RIVER FLOODWAY EXPANSION

2006 GROUNDWATER MONITORING SUMMARY REPORT

MONITORING PROGRAM
MONITORING WELL LOCATIONS
(NORTH, SHEET 2 of 2)

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