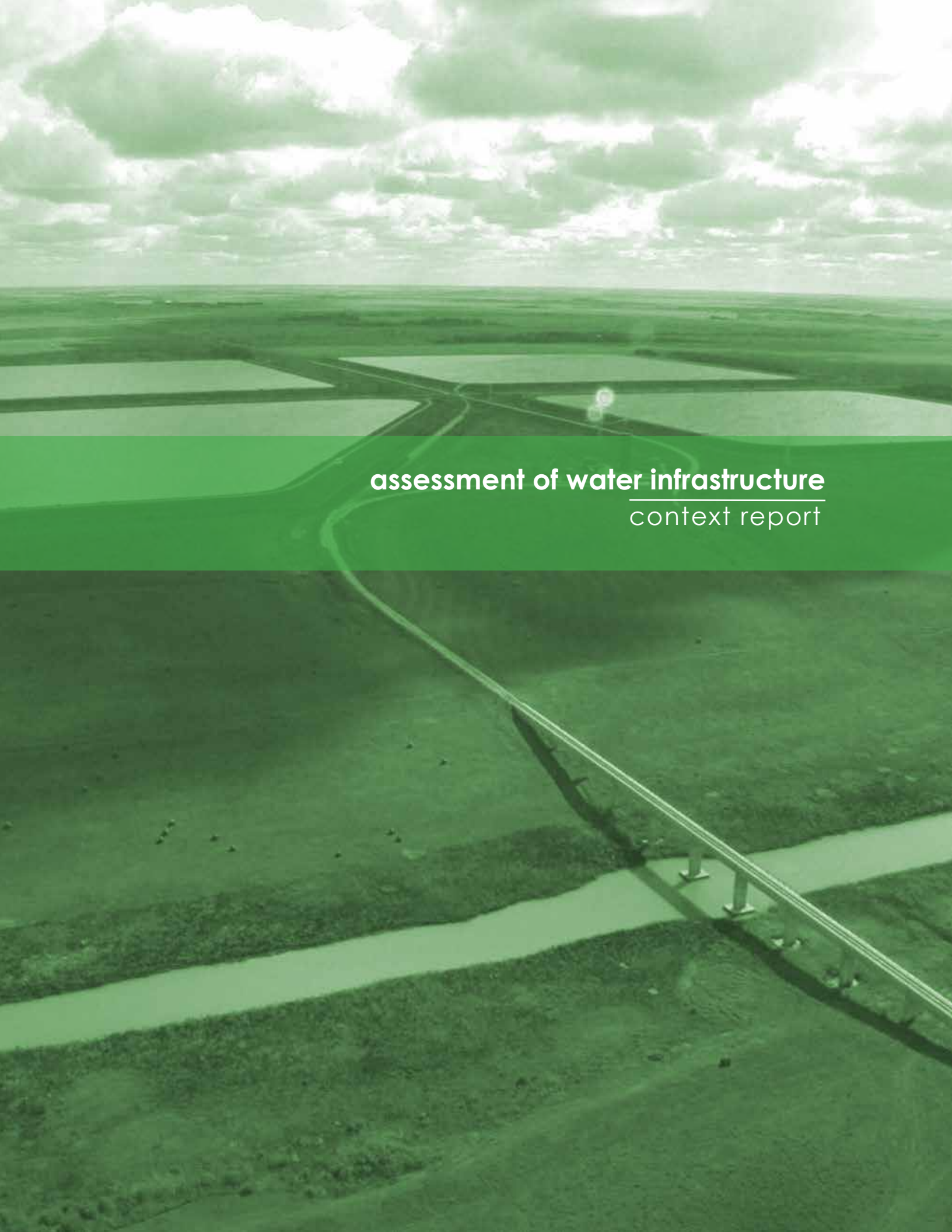

assessment of water infrastructure

context report

Partnership of the Manitoba Capital Region Assessment of Regional Water Infrastructure

Prepared for:
Partnership of the Manitoba Capital Region

Prepared by:
Stantec Consulting Ltd.
500 -311 Portage Avenue
Winnipeg, MB R3B 2B9

Project No. 111215850

April 8, 2016

Sign-off Sheet

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Prepared by _____

(signature)

Len Chambers, C.E.T., P.Eng., FEC

Reviewed by _____

(signature)

Warren Thompson, CMB, MBA, B.Sc., AAE

Stantec

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1.0 INTRODUCTION

Within the Capital Region, the City of Winnipeg has the largest population concentration. According to the 2011 Census, 663,615 people (87% of the capital region) reside in Winnipeg. The remaining "rural" population consists of 103,763 people (2011 Census). It is projected that both urban and rural centres will grow approximately 27 and 40% respectively by 2033. This will result in 177,340 new resident (2011 – 2033) in Winnipeg and 41,357 residents in the capital region outside of the City of Winnipeg.

With water conservation strategies, the City of Winnipeg can easily accommodate future growth within its boundaries from a water consumption perspective. However, in a recent International Joint Commission ruling, the City of Winnipeg cannot sell water outside the City limits. Therefore, the rural community will need to provide its own domestic water. Excluding urban centres like the City of Selkirk, Headingley, Sanford, La Salle, Oakbank and Lorette, most rural populations will continue to depend on individual wells for domestic water.

The Capital Region is very fortunate to have a large major regional aquifer system which serves as a water supply for municipal, industrial and residential use in the capital region.

For regional development, a Regional Water Strategy should include:

- Clean safe drinking water
- Water conservation
- Groundwater protection
- Lake friendly development practices
- Reduction in nutrient flow into regional rivers and lakes
- Watershed management

The Partnership of the Manitoba Capital Region (PMCR) is serviced by a good supply of domestic potable water but the critical strategic nature of this vital resource requires improved levels of conservation and efficiency in delivering safe and essential water supplies.

1.1 THE CITY OF WINNIPEG

Winnipeg's drinking water comes from Shoal Lake, which is part of the Lake of the Woods. It is a large isolated lake in the southeast corner of Manitoba, at the Manitoba-Ontario border.

Construction of the Winnipeg Aqueduct began in 1915 and was completed in 1919.

The City of Winnipeg withdraws water from Shoal Lake (Figure 1) based on the authority granted by Provincial Acts from both Manitoba and Ontario, as well as a federal government bill from the Senate of Canada. This authority was reviewed and approved by the International Joint Commission in 1914. Since Shoal Lake is higher than Winnipeg, water flows downhill through the aqueduct. The aqueduct is a large concrete pipe that was built to carry the water. The aqueduct can carry 386 million litres, or 85 million gallons of water per day.

Figure 1 – Aerial view of Shoal Lake

Before it is treated, water from Shoal Lake is stored in Deacon Reservoir (Figure 2). The reservoir is on the east side of the Winnipeg floodway, a few kilometres south of PTH 15. Water is stored at Deacon Reservoir to handle peak summer demands for water and to allow brief shutdowns of the aqueduct for maintenance. The four large outdoor reservoirs hold up to 8.8 billion litres (1.9 billion gallons) of water – enough to supply Winnipeg for about 30 days. Powerful pumps move the water from the reservoirs into the plant for treatment.

Figure 2 – Aerial view of Deacon Reservoir

1.1.1 Water Treatment

The City of Winnipeg water treatment plant at Deacon's Corner is a state-of-the-art, modern facility designed for performance, safety, and environmental sustainability. The water treatment plant was completed in 2009.

Located at Deacon Reservoir, the water treatment plant:

- is expected to last about 75 years with normal upkeep and maintenance
- can treat 400 million litres of water per day (capacity of the Winnipeg Aqueduct)

The water passes through the following treatment steps for treatment:

- Coagulation / Flocculation

- Dissolved air flotation
- Ozonation
- Filtration
- Chlorine disinfection
- Ultraviolet light disinfection

Treatment plant prevents waterborne pathogens the *Giardia* and *Cryptosporidium* from entering the distribution system. Current consumption is around 250 ML/d, well below 385 ML/d Aqueduct capacity and the treatment plant capacity. In 2014 water consumption was 241.8 ML/d.

1.1.2 Distribution System

The City of Winnipeg maintains a treated water distribution system which consists of the Branch I and Branch II Aqueduct, reservoirs, pumping stations, feedermains and distribution mains to provide potable water and fire protection to the residents and businesses of the City of Winnipeg. The major reservoirs include:

- Deacon Reservoir and Pump Station
- McLean Reservoir and Pump Station
- Tache Booster Pumping Station
- McPhillips Reservoir and Pumping Station
- Wilkes Reservoir and Hurst Pumping Station

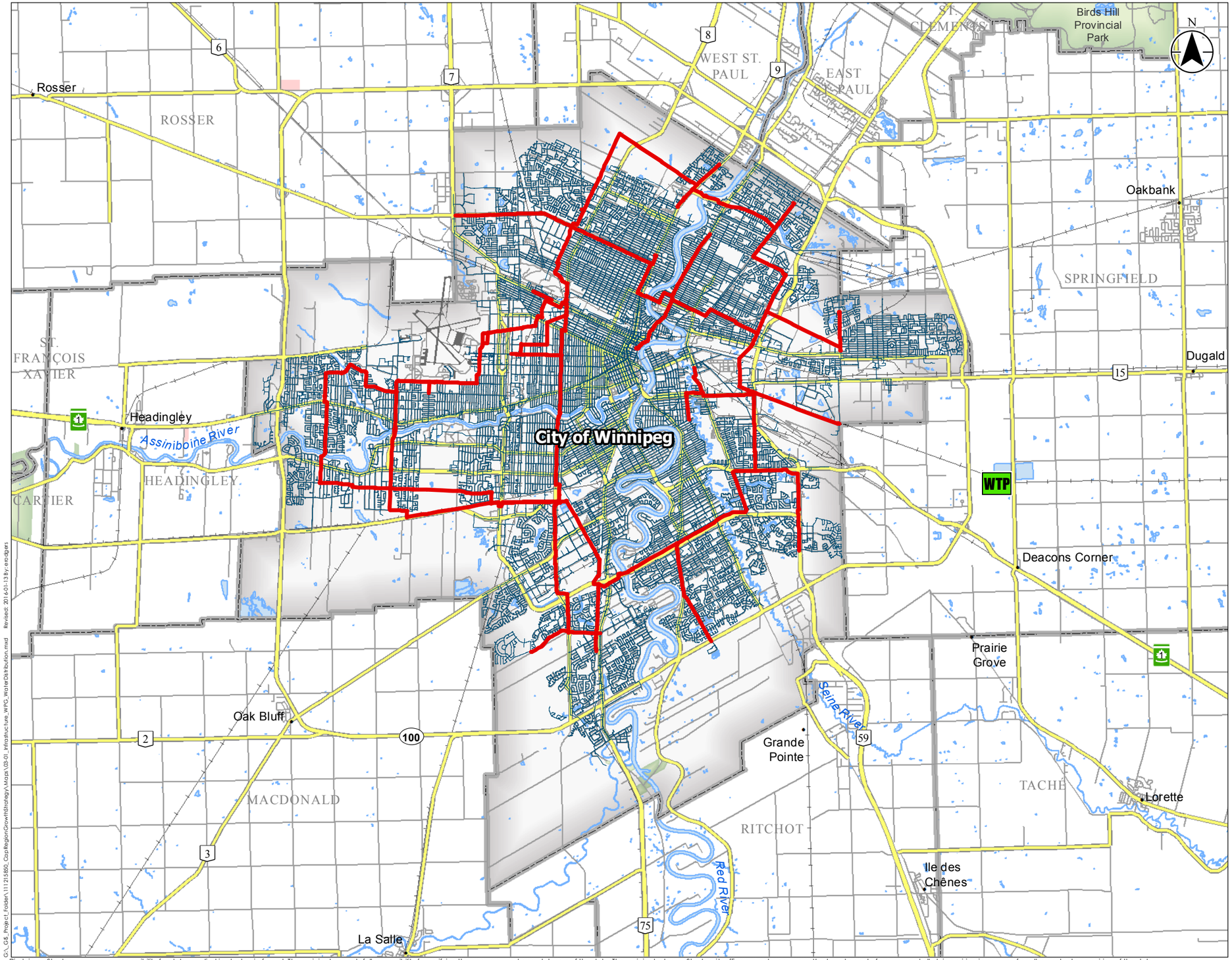
In Winnipeg 60% of water is used for residential purposes, 19% for commercial, 9% industrial and 12% is unaccounted for water (fire, main cleaning, etc.). Water consumption in 2004 was 217 L/c/d down from 228L/c/d in 1992. Projected water consumption may be around 196 L/c/d in 2019.

The major concern for the PMCR is that the City of Winnipeg cannot sell water outside its boundaries, and therefore, cannot sell water to the Manitoba Capital Region municipalities. This was a ruling by the International Joint Commission. However, the City's water treatment plant has capacity of meet the City's future domestic water needs.

See Figure 3 – City of Winnipeg Water Distribution.

1.2 CARTIER REGION WATER COOPERATIVE (CRWC)

Over time, other water utilities have been established and are actively producing potable water for domestic consumption. One such utility is the Cartier Regional Water Cooperative.



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PARTNERSHIP OF THE MANITOBA CAPITAL REGION

Water Distribution

- WTP Water Treatment Plant
- Water Feeder Main
- Water Main

Landbase

- Community
- Trans-Canada Highway
- Highway
- Major Road
- Railway
- Watercourse
- Waterbody
- First Nation Lands
- Provincial Park
- City
- Rural Municipality

0 2.5 5 Kilometers

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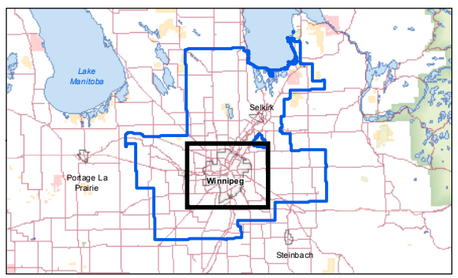
Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base features produced by Natural Resources Canada, Province of Manitoba and City of Winnipeg



Project Location
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Province of Manitoba

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Client/Project
Project: Regional Growth Strategy
Client: Partnership of the Manitoba Capital Region

Figure No.
3

Title
City of Winnipeg Water Distribution

The CRWC supplies potable water to rural residents and communities located in the municipalities of Cartier, Grey, Headingley, Portage la Prairie, Rockwood, Rosser, St. Francois Xavier and Woodlands. The CRWC provides water to over 10,000 people. The CRWC system consists of a central WTP located in St. Eustache, a regional distribution system and satellite reservoirs with local distribution mains. Satellite reservoirs are located at Elie, Grosse Isle, Headingley, Headingley Correctional Institute (HCI), Oakville, Fannystelle and St. Francois Xavier. A new water storage reservoir will be operational in the RM of Rosser (for CentrePort area) in early 2016 followed by a new water storage reservoir constructed in the RM of West St. Paul.

The CRWC water distribution network contains over 680 km of distribution pipeline with annual consumption of 756,161 m3 (2013) servicing a population of 9,952 people (2013).

The recent construction of a new water treatment plant (WTP) in the RM of Headingley will allow the CRWC to meet the increasing water demands due to residential and commercial growth in the capital region municipalities and supply treated water for future industrial development at CentrePort Canada in the RM of Rosser.

The new water treatment plant in Headingley has capacity of 150 L/s using the Assiniboine River as a surface water supply. The treatment process will consist of an integrated membrane system including ultrafiltration (UF) and low energy reverse osmosis (LERO) membranes. Reject water from the membrane process will be discharged back to the Assiniboine River via an existing outfall used by the Headingley wastewater treatment plant (WWTP). With the proposed expansion, the operating capacity of the CRWC will increase from 60 L/s to 210 L/s.

The CRWC distribution system will be expanded with the installation of approximately 22 kms of 450 mm diameter treated water supply main to extend into the RM of Rosser (CentrePort Canada). A pumphouse and 7.5 ML below-grade concrete reservoir is currently under construction to store treated water and where it will be re-chlorinated prior to distribution. Reservoir capacity will provide equalization and emergency storage and supply a minimum fire flow of 285 L/s for 4 hours to meet the fire flow requirements of the CentrePort industrial development in the early stages of development.

Headingley's WTP, combined with the 60 L/s capacity of the St. Eustache WTP will provide a total treatment capacity of 210 L/s for the CRWC. 90 L/s will be sent to the RM of Rosser for the CentrePort Industrial Development.

Table 1 below is from CRWC Projected Water Demands[1].

Table 1 – CRWC Projected Water Demands

Projected Water Demands CRWC 20-Year	Population 15,434
Consumption Rate	255 Average L/c/d

[1] page 5, Manitoba Environment Act Proposal, Cartier Regional Water Cooperative, July 2013, by Dee Genaille, P.Eng.

Day Demand	3,935,670 L/day
Peak Day Factor	1.6
Peak Day Demand	6,297,072 L/day
Average Day Flow (20 hr)	54.7 L/s
Treatment Capacity	87.5 L/s
CentrePort	
Low Demand Users	320,000 L /day
High Demand Users	3,736,500 L/day
Total Average Day Demand	4,056,500 L/day
Peak Day Factor	1.6
Peak Day Demand	90.1 L/s
Combined Treatment Capacity	177.6 L/s

The Headingley WTP will divert raw water from the Assiniboine River. A 2012 study conducted by Genivar in 2012 assessed the current water demand on the Assiniboine River and projected municipal, industrial, irrigation and recreational water usage. This Study was intended to be used as a planning document when considering water demand allocation along the designated reaches of the Assiniboine River and what the potential effects of climate change may have on water demand. Climate change effects are not known at this time and the impacts are speculative. Factoring in presumed climate change effects, water demand would increase by 32% for municipal use and remain relatively constant for recreational and industrial use with a substantial increase in irrigation needs. Municipal and industrial water demands are protected under The Water Rights Act as a "first come, first serve" basis.

Many municipalities have implemented water conservation methods such as low flow fixtures, water rate utility costing which all contribute to significant reductions in water demand. A total of 3,805 dam^3 of water is projected to be diverted from the Assiniboine River annually with the expansion of the CRWC system which includes the construction of the 210 L/s Headingley WTP. This amount is less than the current volume of 5,982 dam^3 allocated by the CRWC Water Rights Act License and well below the 26,500 dam^3 available in the Assiniboine River for new allocation.

The following information from the various rural municipalities has been summarize from Drinking Water Management Plans submitted to the Province of Manitoba and are referenced at the end of this document.

See Figure 4 – Manitoba Capital Region Water Distribution.

1.3 RM OF CARTIER

The Local Urban District (LUD) of Elie is the largest population centre in the RM of Cartier. Other population centres are St. Eustache and Springstein. Municipal water is present in Elie, St. Eustache and Springstein through the CRWC. Regional water provides potable water to most rural residents in Cartier. Fresh groundwater resources within Cartier are limited.

The 2011 population was 3,153. Water consumption is assumed to be 230 L/day.

There is a reservoir in Elie with 230 m^3 of storage, which is basically one day's water consumption storage. However, the reservoir empties 4 or 5 times per day, indicating that the capacity of the reservoir needs to be increased.

St. Eustache has a reservoir (76 m^3 capacity) with 1.5 days of storage.

Springstein has a 100 mm diameter water supply line. However, the residents experience low water pressure issues when the nearby Hutterite colonies and municipalities are drawing water.

Other areas such as Dacotah, Lido Plage, the Whitehorse Trailer Park, Camp Assiniboia and the residential development north of the Trans-Canada Highway are all connected to the CRWC system.

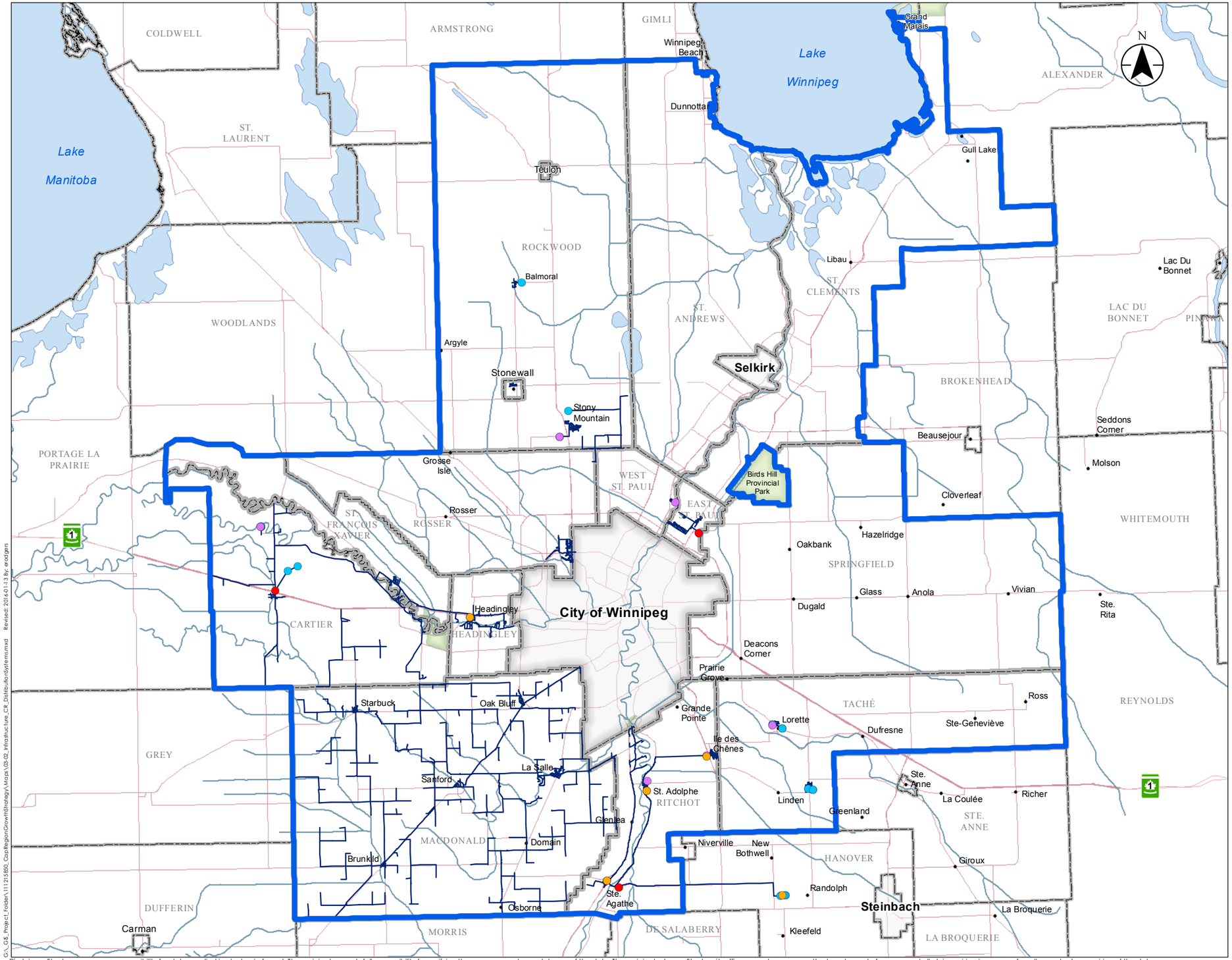
1.4 RM OF HEADINGLEY

The RM of Headingley is part of the Cartier Regional Water Cooperative and has a new water treatment plant which processes raw water from the Assiniboine River. This water is used in the RM of Headingley, and then sent to the CRWC reservoir in the RM of Rosser. From this reservoir chlorine is added and will be re-pumped to Stoney Mountain Penitentiary (in the RM of Rockwood) as well as to a new proposed reservoir in the RM of West St. Paul.

Water from the Assiniboine River can be taken directly to the water treatment plant or stored in a 135,000 m^3 pond east of the water treatment plant. The storage ponds allow for pre-treatment and for use when river water quality deteriorates, typically in mid-spring or late summer.

The treatment process consists of:

- Potassium premaganate to break down organic substances which contribute to taste and odour
- A coagulant may be added to assist in removing suspended sediments
- Activated carbon is added to adsorb organics
- Water transferred to the clarifier



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PARTNERSHIP OF THE MANITOBA CAPITAL REGION

Distribution System

- Pump House
- Reservoir
- Pipeline
- Water Treatment Plant
- Well

Landbase

- Community
- Trans Canada
- Provincial Highway
- Watercourse
- Waterbody
- Provincial Park
- City
- Rural Municipality
- Capital Region

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Notes

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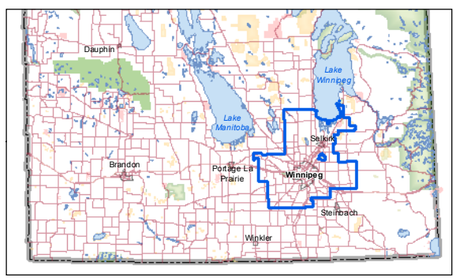

Project Location
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Reviewed by George Kroupa on 2015-10-21

Client/Project
Project: Regional Growth Strategy
Client: Partnership of the Manitoba Capital Region

Figure No.
4

Title
Manitoba Capital Region Water Distribution Systems

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- Lime is added to increase pH which precipitates out carbonate materials and many other dissolved substances
- Caustic soda is added occasionally for non-carbonate hardness removal
- Coagulant and polymer is added to bind precipitates and sediment together into a settleable "floc"
- Powdered activated carbon is added again for taste and odour control
- Clear effluent is conveyed into a re-carbonation tank where carbon dioxide is bubbled through to neutralize the high pH
- Water is passed through coal and sand filters and a small dosage of chlorine is added to kill pathogenic organisms (bacteria, viruses, etc.)
- Fluoride is added for dental health purposes

Reservoir and Pumping Station

Water from the treatment plant is pumped to a reservoir and pumping station in Headingley. The reservoir has storage capacity of 1,100 m^3. The pumping station delivers domestic water as well as high capacity pumping to the fire hydrants in Headingley in the event of a fire. There is also a standpipe for truck fill.

Headingley owns and manages the distribution system within the RM. Of the 936 identified dwellings in the RM, 889 are connected to the water system. The remaining dwellings generally get their water delivered to holding tanks from the truck fill. The groundwater has high saline content. There are no private water systems within the RM.

The water plant delivers domestic and fire water to CentrePort. This plant can be expanded as required. The current plant capacity is 210 L/s.

1.5 RM OF MACDONALD

The RM of MacDonald has a water treatment plant (membrane filtration treatment) located in Sanford, Manitoba, with raw water from the La Salle River. Raw water is stored in 270,000 m^3 retention ponds.

There are six water reservoirs in the RM. They are listed below with their respective storage capacity.

- Sanford 1912 m^3
- Domain 150 m^3
- La Salle 1265 m^3
- Oak Bluff 670 m^3
- Starbuck 280 m^3

- Brunkild 200 m³

There has been consistent growth within the communities of LaSalle and Oak Bluff in 2014. The following graph (Figure 5) shows a breakdown of annual water consumption by community.

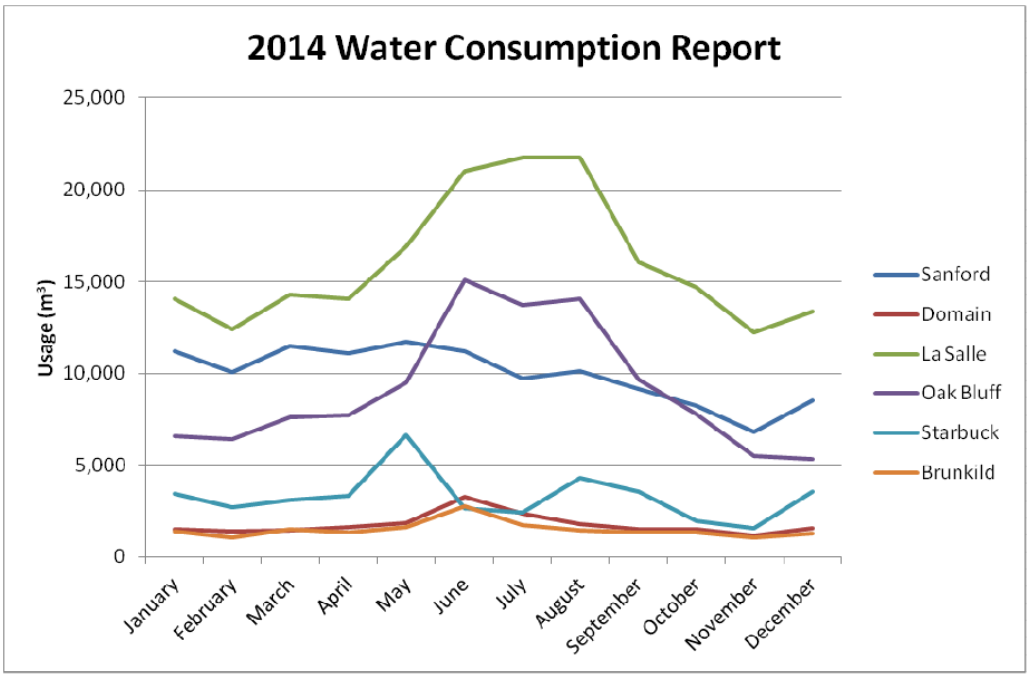


Figure 5 – 2014 Water Consumption Report Graph

1.6 RM OF RITCHOT

There are four centres of population in the RM of Richot. Three are the villages of Ste-Agathe, St. Adolphe and Ile-des-Chenes and are serviced by municipal water. Raw water is sourced from three artesian wells in Hanover and one well inside Ritchot near the Hanover border. There is a central WTP east of Ste. Agathe, with transmission lines to reservoirs in each village. The current system (2012) provides service to 1158 properties, of which 178 are rural (outside of the three villages). The fourth community is Grande Pointe, which is on individual wells (280 single family residents plus light industrial of about 12 businesses).

Ile des Chenes is serviced by the Ritchot Regional Water System, which also serves Ste. Agathe, the Reil Industrial Park, St. Adolphe and a number of rural residential and agriculture districts west of the Red River. The existing drinking water supply and treatment system serves a population of about 4,100 people. The system can be upgraded to serve 15,000 people by adding two additional wells, constructing a second supply pipeline, expanding the WTP and its treated water storage reservoir.

Red River Planning District six member municipalities include the City of Selkirk and village of Dunottar as well as the RM's of:

- St. Clements
- East St. Paul
- West St. Paul
- St. Andrews

Excluding the City of Selkirk, 92% of the Red River Planning Districts population use private wells.

1.7 CITY OF SELKIRK

Raw water is supplied from four (4) wells (three deep wells and one shallow well) and has annual withdrawal volumes of 2,160,000 m^3. The City of Selkirk is scheduled to construct a new raw water supply line in 2016. Selkirk has recently upgraded the water treatment plant.

The 2011 census determined the population of Selkirk to be 9,834 people. 98% of the City of Selkirk is connected to the municipal water distribution system. Selkirk has capacity to accommodate future growth, from a water supply prospective when the new raw water service line is operational.

Selkirk has shared service agreements with the RM of St. Andrews to provide water to Mapleton Lanes condominium and has capacity to provide further water service extensions.

1.8 DUNNOTTAR

Dunnottar has no public water system. Water is supplied by private wells, seasonal surface water sources and one semi-public system (Dunnottar Artesian Wells). The 2013 census determined the population to be 696 people. Estimated annual domestic water demand in 2011 was 68,590 m^3/year. The community is fully built-out so there will be very little to no future growth.

1.9 RM OF ST. CLEMENTS

The residents and businesses in the RM use private wells. East Selkirk has a water distribution system and treatment plant which was built fairly recently and can accommodate 260 dwellings. There are 13 semi-public water systems within the RM (restaurants, Hutterite Colony, golf course, hotel, and school).

The 2011 census population of 10,505 people yields 1,150,297 m^3/year of water usage, based on 300 l/c/d.

1.10 RM OF EAST ST. PAUL

Raw water is supplied from a well water supply and has a water treatment plant and municipal distribution system. There are 929 connections to the public municipal system. The 2011 census population was 9,046 people. Annual domestic residential water demand is estimated at 891,403 m^3 annually.

1.11 RM OF WEST ST. PAUL

Currently, there is one municipal water system in the RM servicing 65 properties (Rivercrest subdivision). There are six (6) semi-public systems (motel, restaurants, school, daycare). All other properties are on individual wells. The 2011 census population was 4,932 people. Annual domestic water demand is estimated to be 456,483 m^3/year and a new water supply main and reservoir/pump house will be constructed in 2016. The RM currently has an agreement to get treated water from the CRWC and will be construction a new water supply main and reservoir/pumphouse in 2016.

1.12 RM OF ST. ANDREWS

Residents and business in the RM are on their own well system (no public drinking water systems). There are 14 semi-public water systems in the RM (schools, day care, golf course, service station and restaurants). The 2011 census population was 11,875. Based on 300 l/c/p, the estimated annual domestic water demand is 1,300,312 m^3/year.

1.13 RM OF SPRINGFIELD

The RM has a water treatment plant in Oakbank with water distribution in Oakbank and Dugald. Raw water is extracted from the Moosenose Aquifer through two wells. The Dugald pumphouse re-chlorinates treated water from the Oakbank water treatment plant and pumphouse. In 2012, there were 519 and 191 REU's connected to the municipal water system in Oakbank and Duglald respectfully.

Anola gets raw water from a well through a treatment plant, reservoir and pumphouse with municipal distribution system. There are 36 building connected to the distribution system.

The 2011 Census population was 14,069 people in 5,061 dwellings.

1.14 RM OF ST. FRANCOIS XAVIER

The RM is part of the Cartier Regional Water Cooperative. There is a regional water treatment plant at St. Eustache and a CRWC reservoir and pump house in the Village of St. Francois Xavier. The water treatment plant draws raw water from the Assiniboine River via an intake located close to the Baie St. Paul Bridge on PR 248.

The 2014 population was 1,316 people.

There are 921 people or 334 households receiving potable water from the St. Francois reservoir or the CRWC rural pipeline. All water consumed in the RM is produced by CRWC. Of the 460 total dwelling units, approximately 75% are connected to municipal water system or to the CRWC water line. The remaining dwelling units use truck-hauled water (115 units). Estimated water consumption is about 178 l/day/capita in 2013.

1.15 RM OF TACHE

The 2011 Census states 10,284 people living in 3,285 residents. Rural residents rely on private wells. There are two urban centres in the RM that have public water systems.

In 2012, there were approximately 2,490 residents in Lorette connected to the public water system through 929 residential connections and 86 commercial buildings. Average consumption was 226 l/p/d. A new water treatment plant was constructed in Lorette in 2009.

In 2012, there were approximately 1,239 residents in Landmark connected to the water system through 398 residential connections plus 22 commercial connections. Average consumption was 227 l/p/d in 2012.

Raw water is from groundwater aquifers for both private wells and public water systems.

At the time of writing this report, no information has been received on the following locations:

- RM of Rockwood
- Town of Stonewall
- RM of Rosser
- Niverville
- Teulon

1.16 SUMMARY OF WATER CONSUMPTION BY COMMUNITY

Community	Year	Population	Residential Demand (m^3/year)	Per Capita Consumption (l/c/d)
City of Winnipeg	2011	663,615		217 (2004)
RM of Cartier	2011	3,153		230
RM of Headingley				
RM of Macdonald				
RM of Ritchot		4,100		

Community	Year	Population	Residential Demand (m^3/year)	Per Capita Consumption (l/c/d)
City of Selkirk	2011	9,834		
Dunnotar	2013	696	68,590	270
St. Clements	2011	10,505		300 (assumed)
RM of East St. Paul	2011	9,046	891,403	270 (assumed)
RM of West St. Paul	2011	4,932	456,483	254 (assumed)
RM of St. Andrews	2011	11,875	1,300,312	300 (assumed)
RM of Springfield	2011	14,069		
RM of St. Francois	2014	1,316		176
RM of Tache	2011	10,284		227

Data from some Municipalities has not been received; therefore, some of the information is left blank.

2.0 GROUNDWATER RESOURCES IN THE MANITOBA CAPITAL REGION

The Manitoba capital region is very fortunate to have a large major regional aquifer system in the area. This aquifer, known locally as the carbonate aquifer system, serves as a water supply for municipal, industrial, and residential use in the capital region.

2.1 AQUIFER OVERVIEW

The carbonate aquifer system is a large aquifer in Manitoba, which extends from the US/Manitoba border, through the Manitoba Interlake, to the area north of The Pas. The aquifer is composed of bedded limestone/dolostone, with the main permeability coming from bedding planes, joint sets, and karstic features. Due to this condition, aquifer transmissivity and well yield can vary substantially from location to location. In some cases, extremely high aquifer transmissivities are possible in the carbonate aquifer system in the capital region.

The aquifer is recharged predominantly from a set of large glacial and post glacial moraines lying to the east of the capital region, in an area known as the Sandilands. Snow melt infiltrates through to the aquifers lying in subcrop. A major source of recharge is located within the capital region near the Birds Hill Glacio-Fluvial Complex. In this area, glacial and post glacial sand and gravel has been deposited directly onto the carbonate bedrock surface. Another large recharge area occurs near the Town of Stonewall, in an area where hard bedrock has very shallow burial.

The majority of the aquifer is covered by a thick blanket of lacustrine clays. This acts a confining material, and much of the aquifer is under confined pressure in the capital region. Some areas, where the confining material is thin or has been removed, the aquifer is still present in an unconfined condition.

Groundwater quality is complex, due to the recharge and discharge dynamics. The Red River was traditionally thought to be a major source of groundwater discharge in the area. Further discharge now occurs through the low flow channel in the Red River Floodway. Groundwater quality east of the Red River and south of the Assiniboine River extending through the city and extending towards Lake Manitoba is brackish to saline. This is the result of deeper basinal waters pushing upwards from the center of the Williston basin. The other areas are fresh, although within this area, the quality can also vary substantially, depending on the proximity of recharge/discharge areas. Near the fresh/saline boundary, groundwater quality is highly variable both laterally and vertically. The boundary is a complex intermixing zone in the aquifer.

Static groundwater levels in the area are highly variable. Within the capital region, there are no known areas where long term progressive drawdown has been noted. The largest long term progressive drawdown occurred resulting from the construction of the Red River floodway. The aquifer typically responds very quickly to seasonal and climatic changes. The aquifer typically is

relatively stable throughout the winter season, with a sharp rise during the spring snow melt. The aquifer static water levels are highly dynamic.

2.2 HISTORICAL USE

The carbonate aquifer system has played a major role in the development of the area, and this continues to this day. The use of the aquifer was started by the early settlers in the area. The City of Winnipeg developed a water supply derived from wells completed into the aquifer extending to the north. These wells were in service in the late 1890's and their use continued until 1919 when the Shoal Lake Aqueduct was built. The wells were terminated due to the lack of proper water treatment options, and the difficulty in securing a long term assessment of the water supply.

Starting in 1919, the William Davies Company developed a meat packing plant in St. Boniface. This company eventually developed into Canada Packers Limited. By the late 1930's they were joined by Swifts Foods, and the Union Stock Yards. The two meat packing plants utilized over a million gallons per day each for mechanical refrigeration and washing. Union Stockyards utilized groundwater for livestock watering. The use of groundwater in the area resulted in a significant drawdown in the carbonate aquifer system. The final shutdown of these plants occurred in the early 1990's and the recovery effects are still being seen to this day.

Groundwater levels in Winnipeg were also affected by the construction of the Red River Floodway, which encountered the aquifer near the eastern side of the city. Static water levels in the downtown Winnipeg area are recovering, and this having an effect on construction and deep foundations in the city.

In the outlying areas, there is little use of the aquifer, and static water levels are generally stable.

A major drawdown cone is also present in the aquifer near the City of Selkirk. This has resulted in nearly 100 years of major groundwater use in the area.

North of the City of Winnipeg, a large area of the aquifer has been effectively placed in quarantine due to a large industrial spill of organic contaminants. This quarantined area is the largest contaminated site in Manitoba and is currently being maintained through a pump and treat system.

2.3 FUTURE USES OF THE AQUIFER

The carbonate aquifer system in the capital region is a major source of water supplies for the area. Although the groundwater quality is highly variable, it can be used for water supply and for well to well heating and cooling applications. Fire protection is another major use of the aquifer, due to the high capacities that are frequently possible. Major groundwater supplies are

located quite regularly through the aquifer. Outside of the City of Winnipeg, virtually all of the major towns and municipalities utilize the carbonate aquifer system for water supply.

Land use planning in the area should include detailed reviews of the geology and hydrogeology in the area (Figure 6). Due to the highly changing geology and hydrogeology, this review is critical. Some areas of the aquifer are highly susceptible to impact due to the unconfined conditions that may be present. Shallow nitrate contamination is a common problem in area. Further, public awareness of the aquifer is not always common, and many development decisions don't include a hydrogeological component.

Grand Marais

Teulon

Warren

Stonewall

Selkirk

Beausejour

Anola

Winnipeg

SALINE FRESH

Ile des Chenes

La Salle

Sanford

Ste. Anne

Niverville

SALINE FRESH

Steinbach

Grunthal

Morris

Legend

Recharge Zone
(Render, 1986)

NORTH

Rockwood Sensitive Area
(MCWS, 2014)

Saline-Fresh Water Boundary

Sandstone
(Betcher, 1993)

Carbonate
(Render, 1986)

Winnipeg Formation Subcrop
(Manitoba Mineral Resources, 2013)

10 km

Figure 6

3.0 LAND DRAINAGE IN THE MANITOBA CAPITAL REGION

3.1 OVERVIEW

The Manitoba Capital Region is centered around the confluence of The Red River and the Assiniboine River, and overlies 8 sub-watershed areas as identified in Figure 9. The Region is subject to seasonal flooding, with a portion of the Region identified by the Red River Designated Flood Area (RRDFA) and the Lower Red River Designated Flood Area (LRRDFA), see Figure 7 and 8. To manage seasonal flooding, the Capital Region is protected by two flood control structures. The Portage Diversion manages flows in the Assiniboine River downstream of Portage la Prairie. The Red River Floodway manages flows in the Red River through and downstream of the City of Winnipeg. Artificial flooding resulting from the operation of the Red River Floodway is localized within the RRDFA.

Management of development and land drainage in the Region is under the jurisdiction of several regulatory agencies, including:

- The Province of Manitoba
- The City of Winnipeg
- The Red River Planning District
- Individual Regional Municipalities

3.2 HISTORY

The Capital Region has been built up from primarily agricultural land with a history of flooding. Original drainage works were constructed to drain land as quickly as possible following the spring melt, extending the growing season. These included construction of large regional open channel drainage networks and field drains. Land drainage within the City of Winnipeg and other urbanized areas, likewise sought to move stormwater as quickly as possible to natural watercourses. The original drainage systems in the City of Winnipeg utilized combined sewers, which were designed to overflow untreated sewage to the rivers during wet weather events. These drainage works increased flood potential of lands predisposed to flooding and increased nutrient loading on receiving bodies.

Following disastrous flooding in 1950 the Red River Floodway was proposed, and construction was completed in 1968. The floodway was expanded in 2010 to provide an increased level of protection for the City of Winnipeg. The Portage Diversion was constructed in 1970, and provides flood protection for the City of Winnipeg, Elie, Brunkild and La Salle. The Portage diversion directs high flows in the Assiniboine River north to Lake Manitoba.

3.3 CURRENT STATE OF DRAINAGE

The regional open channel drainage system is reported to be at or over capacity in many parts of the Capital Region, and increased runoff due to development must be restricted. Land drainage systems within the City of Winnipeg follow a drainage master plan that requires the construction of new ponds to attenuate runoff. Some municipalities, notably Springfield and West St. Paul, have commissioned Drainage Master Plans in order to establish guidelines for development and to plan regional drainage works.

Design standards within the Capital Region typically follow accepted City of Winnipeg guidelines. Many of the municipalities within the Capital Region have issued drainage criteria manuals to codify the design of land drainage infrastructure. However, the City of Winnipeg has not issued a current design manual, and so drainage design within the City of Winnipeg is inconsistent. Accepted design practice for new developments within the city of Winnipeg is to provide piped Land Drainage Sewer (LDS) capable of providing a 5 year level of service, with pipes surcharged to 150 mm below gutter elevation. Ditch drainage is permitted on rural cross section roadways, but is not common. Stormwater Retention Basins (SRB) are required for large residential developments, and must be capable of storing a 100 year design event with 600 mm of freeboard (see Figure 10). SRBs typically occupy 3.5% to 5.0% of developable area. Smaller developments, including commercial sites and single lot developments, are typically required to store the 25 year post development runoff and release it at a 5 year predevelopment rate. The requirement to restrict post-development flows to 5 year pre-development rates has been adopted by most municipalities. The most commonly accepted design methodology for drainage works is the Rational Method. The City of Winnipeg accepts this for LDS design, but requires hydrologic modeling of pond interaction and backwater effects. The Province accepts Rational method analysis as well as Unit Area runoff rates for agricultural land. Agricultural runoff rates remain generally unregulated, and drainage improvements to cropland are often undertaken without approval or oversight.

Analysis and design of regional open channel drainage generally follows Province of Manitoba guidelines. Governing design criteria are presented in the Water Control & Structures Design Manual, issued by Manitoba Infrastructure and Transportation (MIT).

The City of Winnipeg is currently working to separate their combined sewer systems to minimize sewer overflows and basement flooding. There are regulations in place to restrict the application of fertilizers within the Red River Special Management Area. There are no stormwater quality or quantity regulations in place within the Capital Region.

3.4 FUTURE DRAINAGE

In 2014, the Province rolled out its Surface Water Management Strategy, which calls for improvement and protection of water quality, and preparation for extreme events. Water quality improvements are focused on nutrient removal and include preservation of existing

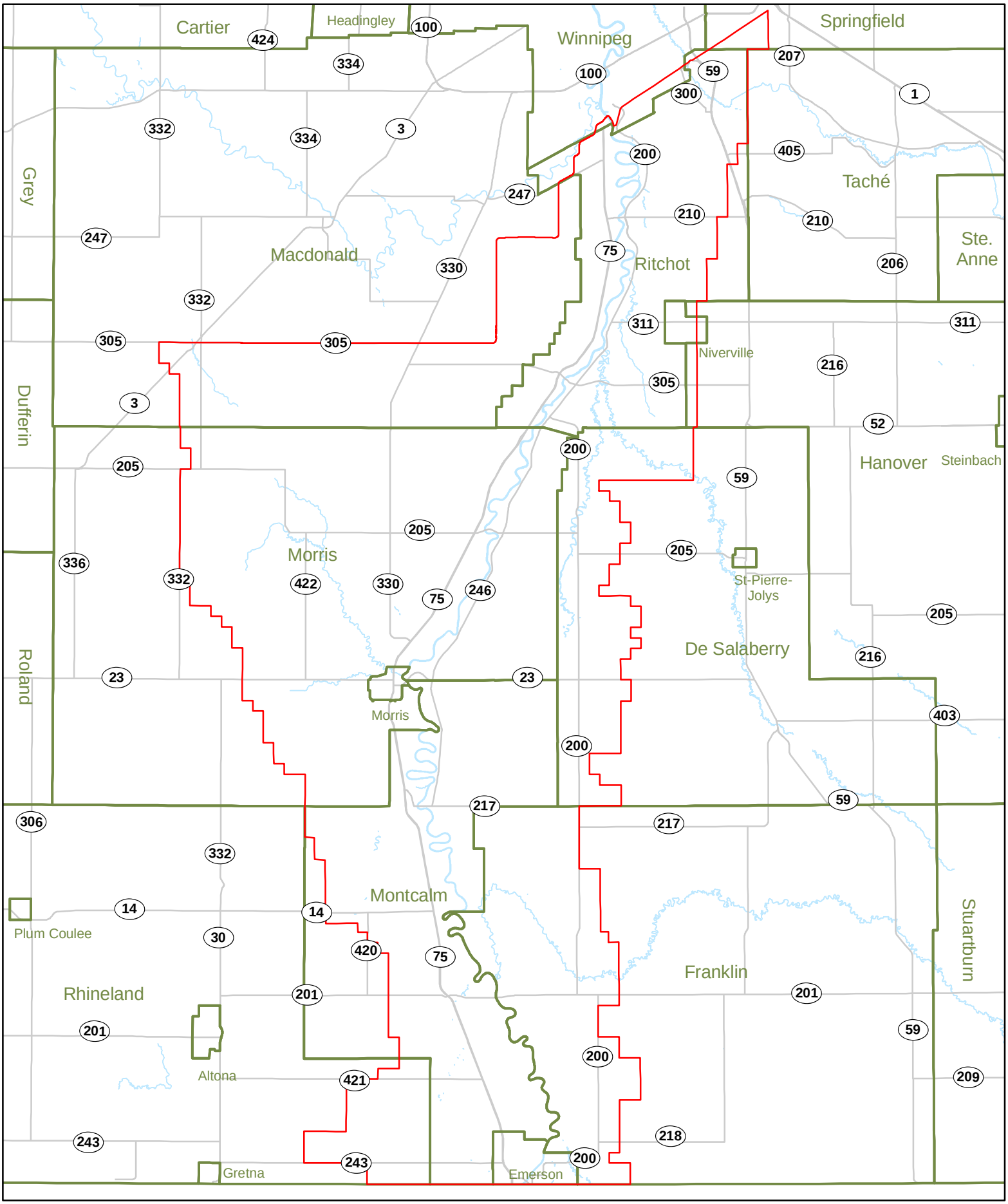


Figure 7

Red River Designated Flood Area

Municipal Boundaries
Provincial Roadways
Designated Flood Area

Manitoba
Dept. of Local Government

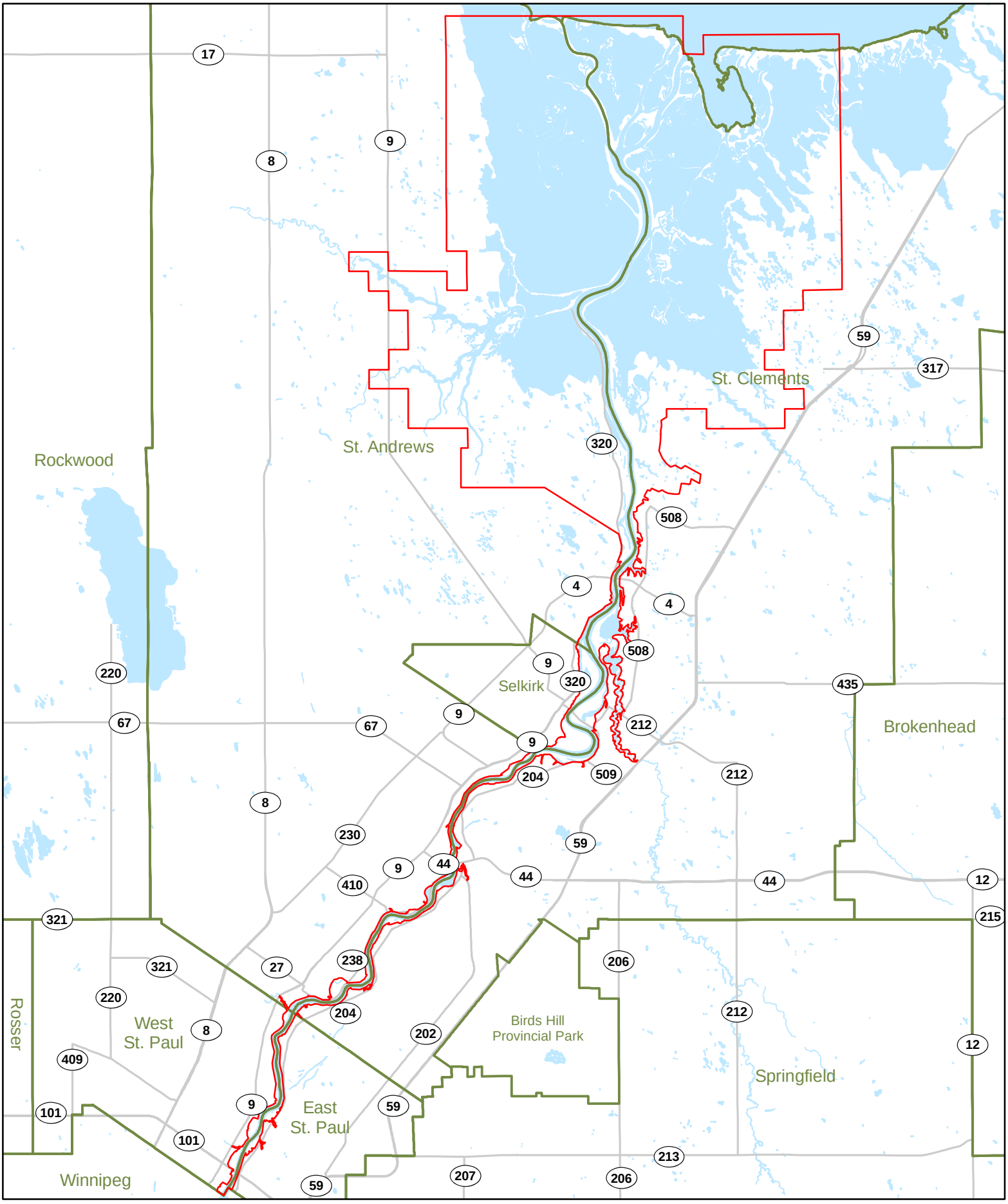


Figure 8

Lower Red River Designated Flood Area

Stantec

PARTNERSHIP OF THE MANITOBA CAPITAL REGION

Lake Winnipeg

Lake Manitoba

N

Cooks Creek/ Devils Creek Sub-Watershed 05OJ

Lower Assiniboine River Sub-Watershed 05MJ

Red River Sub-Watershed 05OC

La Salle River Sub-Watershed 05OG

Boyne-Morris Sub-Watershed 05OF

Rat River Sub-Watershed 05OE

Seine River Sub-Watershed 05OH

Land Drainage

DFO Streams and Constructed Drains

Source: Department of Fisheries Milani Classification System

Sub Watersheds

- Boyne-Morris Sub-Watershed
- Cooks Creek/Devils Creek Sub-Watershed
- La Salle River Sub-Watershed
- Lower Assiniboine River Sub-Watershed
- Rat River Sub-Watershed
- Red River Sub-Watershed
- Roseau River Sub-Watershed
- Seine River Sub-Watershed

Landbase

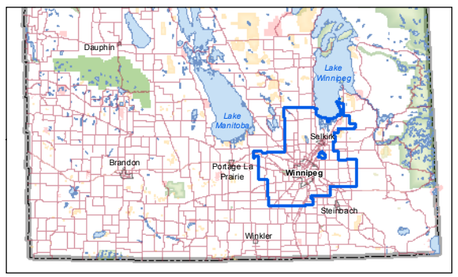
- Waterbody
- City
- Rural Municipality

0 10 20 Kilometers

1:500,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base features produced by Natural Resources Canada, Manitoba Municipal Governments and Manitoba Conservation and Water Stewardship



Project Location
Manitoba Capital Region
Province of Manitoba

111215850
Prepared by Evan Rodgers on 2015-10-21
Reviewed by George Kroupa on 2015-10-21

Client/Project
Project: Regional Growth Strategy
Client: Partnership of the Manitoba Capital Region

Figure No.
9

Title
Manitoba Capital Region Land Drainage

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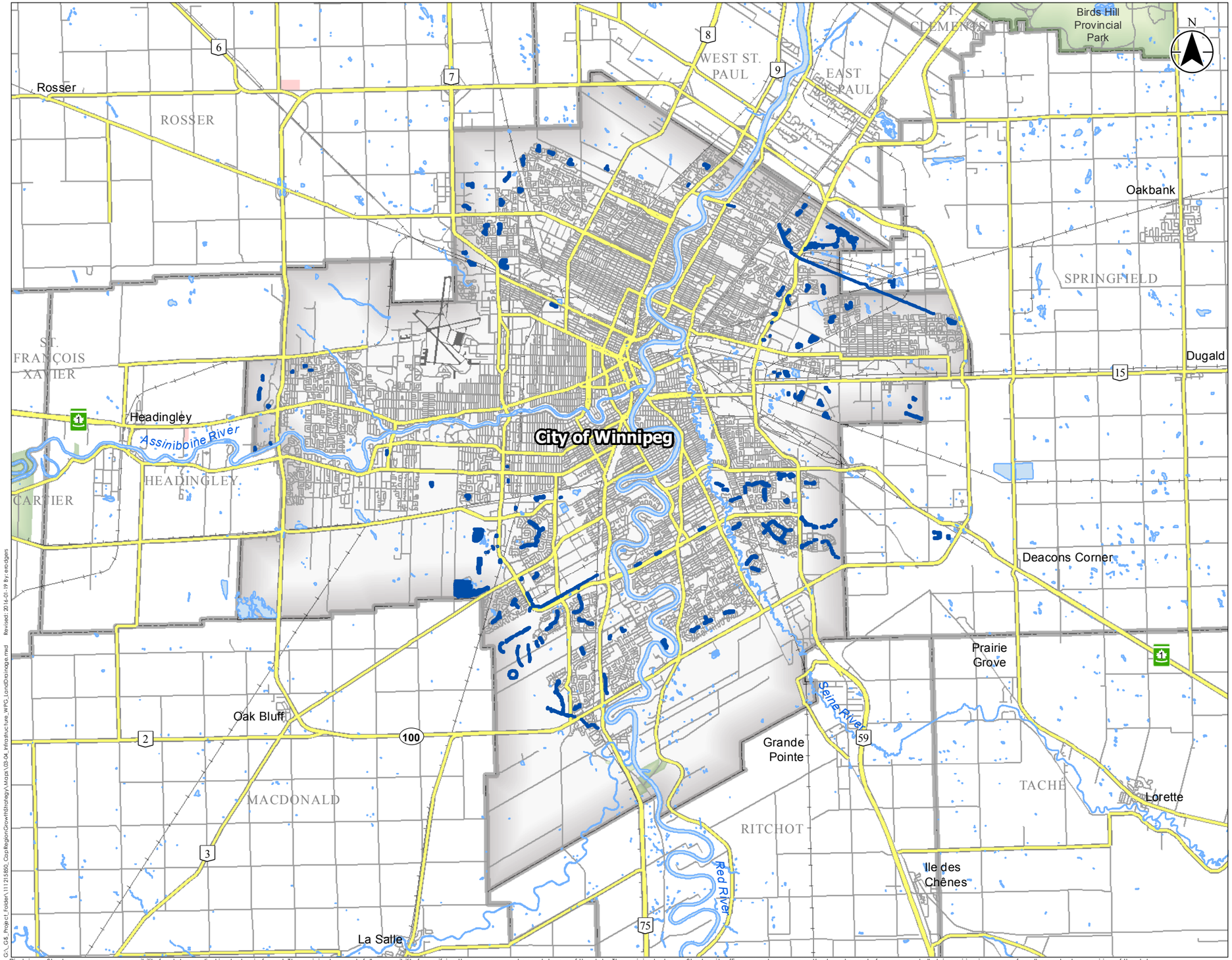
wetlands, develop a new approach to regulation of agricultural runoff, and promote urban stormwater management. Preparation for extreme events involves a recommendation to improve stormwater storage and retention at the lot level, on small scale projects, and as part of a basin level management approach, as well as restricting development on flood prone lands, and improvement to flood protection works.



Stantec

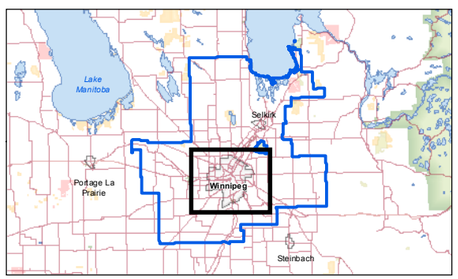
PARTNERSHIP OF THE MANITOBA CAPITAL REGION

Land Drainage
- Stormwater Retention Basin

Landbase
- Community
- Trans-Canada Highway
- Highway
- Major Road
- Railway
- Watercourse
- Provincial Park
- First Nation Lands
- Water
- City
- Municipality

0 2.5 5 Kilometers
1:150,000 (At original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base features produced by Natural Resources Canada, Province of Manitoba and City of Winnipeg



Project Location
Manitoba Capital Region
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111215850
Prepared by Evan Rodgers on 2015-10-21
Reviewed by George Kroupa on 2015-10-21

Client/Project
Project: Regional Growth Strategy
Client: Partnership of the Manitoba Capital Region

Figure No.
10

Title
City of Winnipeg Land Drainage

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