Executive Summary

The Water Quality Committee assumed the responsibility of meeting the Study objectives of assessing the quality of the Upper Assiniboine River Basin’s water resources and identifying the effects of various activities on water quality. With input from Basin residents, the Committee identified water quality concerns. It then reviewed existing information for those issues. They were:

- The effects of agricultural drainage on water quality;
- Nutrient enrichment of water bodies from municipal effluent;
- Nutrient enrichment from livestock access to watercourses;
- Trends in water quality for the Basin; and
- The protection of groundwater from contamination.

Some of the impacts of agricultural land drainage on water quality include nutrient loading, pesticide contamination, heavy metal contamination, erosion and sedimentation. As well, water quality benefits accrued by wetland retention are lost when wetlands are drained. Ammonia nitrogen, nitrates and nitrites can negatively impact water quality of receiving water bodies when transported by a drainage system. Particulate phosphorous may be transported downstream to receiving water bodies via agricultural drainage when soil particles erode and are carried with the water flow.

Effective wastewater treatment involves proper planning, design, construction, operation, monitoring. The Town of Roblin in Manitoba has designed a comprehensive program for the treatment and management of its effluent and reduction of nutrients being discharged into the local watershed. The project consists of constructed wetlands and a hybrid poplar wood lot in addition to the existing irrigation system. Other towns are observing the Roblin experience and considering the possibilities open to them through the proper management of their treated effluent.

Various demonstration projects conducted in the Study area showed that improvement to riparian areas through alternative pasturing, livestock watering systems, and properly located and managed winter feeding sites are effective in maintaining water quality. There can be a benefit in increased awareness of the value of manure as a resource rather than a waste. In addition, manure management practices should be improved.

There are other key points that should be targeted by and for the agricultural industry in general with respect to improving water quality. These include the proper handling and application of farm chemicals and pesticides; appropriate methods and locations for cleaning sprayers and empty containers; use of container disposal sites; testing for the effects from hazardous substances in landfills, container collection sites, and discontinued bulk fuel depots and gas stations; and, development of Best Management Practices for annual cropping.
Groundwater plays an important part in the everyday life of the majority of the population in the Basin. Many of the major aquifers in this area are vulnerable to contamination by surface activities. Even deeper formations, that are normally considered safe, are susceptible to contamination if precautions are not taken. Old wells are a major concern if they are not properly abandoned, as they can be a major factor in allowing contaminants to enter the water bearing formation. Proper decommissioning of abandoned wells; proper maintenance of existing wells; and proper siting and construction of new wells are all factors to be considered in protecting water quality.

The management of groundwater throughout the area is the responsibility of the provincial governments and is generally shared between a number of agencies within each province. While each agency compiles large amounts of data regarding the different aspects of groundwater quality and quantity each year, there is little integrated database management. As a result, much of the information regarding ground water availability and quality is lacking continuity and can be difficult to obtain.

Although some regulations are in place for protection of groundwater, more work must be carried out to limit the occurrences of contamination and their effects. Monitoring of groundwater, particularly in the most sensitive areas, must be implemented and carried out in order to track the changes occurring to the water formations. Without long-term monitoring, it will be impossible to adequately protect the Basin's groundwater in the future since changes will not be detected until contamination is widespread.

A review of the available data for several water bodies in the Upper Assiniboine River Basin indicates that in general the water quality is suitable for its expected uses. There are areas where limitations to such uses as irrigation are evident. It is important to note that in some cases the assessment is based on a limited quantity of data. Additional monitoring would be required to update the water quality conditions at those locations. The Prairie Provinces Water Board (PPWB) sampling site on the Assiniboine River near Kamsack provides an ongoing measure of water quality trends in the upper reaches of the Basin and provides the only current data source. Trend analysis results for the Assiniboine River were encouraging. There were no constituents that showed a significant, long-term increasing trend. However, dissolved oxygen, total phosphorus and dissolved manganese did show exceedances to the PPWB water quality objectives and may affect downstream uses.

Recommendations provided in this report relate to monitoring requirements, agricultural practices, water resource protection and information and education. Surface and groundwater monitoring should be improved to determine current conditions. Increased testing will highlight areas of concern and long-term trends. Best management practices for agriculture and other industries throughout the Basin need to be developed emphasizing improved riparian areas and surface and groundwater protection. Water quality impacts should be considered in evaluation of drainage projects. Maintenance of existing wetlands should be encouraged to reduce nutrient loading and sediments in receiving waters. Groundwater protection measures include proper disposal of chemical containers, proper well design, maintenance and abandonment. The long-term impacts of municipal wastewater releases need to be assessed.
Acknowledgements

The Water Quality Committee would like to thank Dillon Consulting Limited for their work on the literature review and the preparation of the document “Upper Assiniboine River Basin Water Quality”. In particular the committee would like to thank Nicholas Barnes, the project manager.

The Water Quality Committee wishes to acknowledge the following for their technical assistance and commitment of time and effort to ensure that the off-stream livestock watering demonstration project would proceed: PK Herefords, Ducks Unlimited, District 19 ADD Board, Saskatchewan Agriculture and Food, and Saskatchewan Environment and Resource Management.

The Committee would like to acknowledge the partners of the Whitesand River Watershed Enhancement Project which included co-operators PK Herefords, Tom Lamont, Carey Weinbender, Ward Manahan, Ivan Olynyk, Brian Berrns, James Sharpe, Al Claiter and Duane Thompson; Prairie Farm Rehabilitation Administration; Saskatchewan Wetland Conservation Corporation; and Saskatchewan Agriculture and Food.

The Water Quality Committee would like to thank the Town of Roblin for agreeing to use its alternative effluent management system as a demonstration project for the Upper Assiniboine River Basin Study.

The Committee gratefully acknowledges and thanks the following people for their contributions to this report: Trent Catley, Saskatchewan Agriculture and Food; Rhonda Kurtz, Manitoba Agriculture and Food; Rollie Fortin, Manitoba Conservation; and Richard Zitta, Saskatchewan Environment and Resource Management.

Many thanks are also extended to the GIS Committee for the development and generation of the maps for the Dillon Consulting Limited report and Water Quality Committee’s report.
Contributors

Participating Agencies

The Water Quality Committee was comprised of representatives from a number of federal and provincial government agencies, including:

- Environment Canada
- Manitoba Conservation
- Manitoba Intergovernmental Affairs
- Prairie Farm Rehabilitation Administration
- Sask Water
- Saskatchewan Environment and Resource Management
- Saskatchewan Agriculture and Food

Upper Assiniboine River Basin Study - Water Quality Committee Members

Brian Campbell, Saskatchewan Agriculture and Food, 38-5th Avenue North, Yorkton, SK S3N 0Y8
Gary Dunn, Ecological Research Division, Environmental Conservation Branch, Environment Canada, 2365 Albert Street, Room 300 Park Plaza, Regina, SK S4P 4K1
Brad Fairley, Prairie Farm Rehabilitation Administration, 1800 Hamilton Street, Suite 603, Regina, SK S4P 4L2
Richard Pasquill, Manitoba Water Services Board, Manitoba Intergovernmental Affairs, P.O. Box 22080, 2022 Currie Boulevard, Brandon, MB R7A 6Y9
Joanne Sketchell, Rural Water Quality Services, Sask Water, #330-350 Third Avenue North, Saskatoon, SK S7K 2H6
Perry Stonehouse, Manitoba Conservation, Western Region, 1129 Queens Avenue, Brandon, MB R7A 1L9
Candace Vanin, Prairie Farm Rehabilitation Administration, Box 130, 109-290 Prince William Drive, Melville, SK S0A 2P0
Dwight Williamson, Manitoba Conservation, 123 Main Street, Suite 160, Winnipeg, MB R3C 1A5
Joe Zarowny, Saskatchewan Environment Resource Management, Environmental Protection, 120 Smith Street, Yorkton, SK S3N 3V3

Study Directors

Bob Harrison, Water Resources Branch, Manitoba Conservation, Box 14, 200 Saulteaux Crescent, Winnipeg, MB R3J 3W3
Doug Kozusko, Sask Water, 111 Fairford Street East, Moose Jaw, SK S6H 7X9
# Table of Contents

Executive Summary ................................................................................. i

Acknowledgments .................................................................................. iii

List of Figures ............................................................................................... xi

List of Tables ................................................................................................. xii

1 Introduction ............................................................................................. 1

1.1 Objectives ........................................................................................... 1

1.2 Scope of Work ....................................................................................... 3

2 Surface Water Quality ........................................................................... 5

2.1 Introduction ........................................................................................... 5

2.2 Legislation ............................................................................................ 5

2.2.1 Saskatchewan .................................................................................. 5

2.2.1.1 Surface Water Quality Objectives .......................................... 7

2.2.1.2 Water Pollution Control and Waterworks Regulations .............. 7

2.2.1.3 Other Regulations/Guidelines ............................................... 7

2.2.2 Manitoba ........................................................................................ 7

2.3 Water Quality in Saskatchewan ......................................................... 8

2.3.1 Assiniboine River ............................................................................ 8

2.3.1.1 Microbiological Water Quality .............................................. 11

2.3.1.2 Nutrients ................................................................................ 11

2.3.1.3 Water Chemistry .................................................................... 12

2.3.2 Whitesand River ........................................................................... 12

2.3.2.1 Microbiological Water Quality .............................................. 12

2.3.2.2 Nutrients ................................................................................ 14

2.3.2.3 Water Chemistry .................................................................... 14

2.3.3 Good Spirit Lake ........................................................................... 14

2.3.3.1 Bacteriological Water Quality .............................................. 16

2.3.3.2 Nutrients ................................................................................ 16

2.3.3.3 Water Chemistry .................................................................... 16

2.3.4 Fishing Lake .................................................................................. 16

2.3.4.1 Microbiological Water Quality .............................................. 16

2.3.4.2 Nutrients ................................................................................ 17

2.3.4.3 Water Chemistry .................................................................... 18

2.4 Current Water Quality in Manitoba .................................................. 18

2.4.1 Lake of the Prairies ....................................................................... 19

2.4.1.1 Fecal Coliform ....................................................................... 19
### 4.3.3 Wells ...................................................... 43
### 4.3.4 Well Abandonment ........................................... 43
### 4.3.5 Animal Diseases Associated with Water ...................... 44

#### 4.4 Prairie Provinces Committee on Livestock Development and Manure Management ........................................ 45

#### 4.5 Demonstration Projects ............................................... 46

##### 4.5.1 Off-Stream Livestock Watering Demonstration ..................... 46

- 4.5.1.1 1998 ............................................... 46
- 4.5.1.2 1999 ............................................... 47

##### 4.5.2 Whitesand River Watershed Enhancement Project .................. 48

- 4.5.2.1 PK Herefords (Clint, Jim, and Richard Kopelchuk) ................. 49
- 4.5.2.2 Lucky “C” Ranches (Al Claiter) ........................................ 50
- 4.5.2.3 Weimbender, Carey and Leanne .......................................... 50
- 4.5.2.4 Lamont, Tom and Betty .................................................. 51
- 4.5.2.5 Manahan, Ward and family ............................................. 52
- 4.5.2.6 Pretty View Stock Farm, (Ivan and Phyllis Olynyk) .................. 52

#### 4.6 Summary/Recommendations ........................................... 53

##### 4.6.1 Key Target Areas for Livestock Industry .......................... 53

##### 4.6.2 Public Information ........................................... 54

### 5 Cropping and Water Quality ................................................. 55

#### 5.1 Introduction ........................................................ 55

#### 5.2 Pesticides .......................................................... 55

##### 5.2.1 Pesticide ................................................... 55

- 5.2.1.1 Pesticide Classification by Purpose/Mode of Action ............... 55
- 5.2.1.2 Pesticide Classification by Formulation ................................. 60
- 5.2.1.3 Pesticide Classification by Chemical Composition ................. 60
- 5.2.1.4 Toxicity of Pesticides .................................................. 61
- 5.2.1.5 Pesticides Toxic to Fish .............................................. 61

#### 5.3 Pesticides discussed in the Dillon Consulting Limited, Literature Review .................. 62

##### 5.3.1 DDT ...................................................... 62
##### 5.3.2 2, 4, 5-T .................................................... 62
##### 5.3.3 Atrazine .................................................... 62
##### 5.3.4 Endosulfan .................................................... 63
##### 5.3.5 Metolachlor .................................................... 63
##### 5.3.6 Phorate .................................................... 63

#### 5.4 Water Sources for Pesticide Application .................................. 63

#### 5.5 Legislation .......................................................... 64

##### 5.5.1 Federal ..................................................... 64
##### 5.5.2 Saskatchewan ..................................................... 64
##### 5.5.3 Manitoba ....................................................... 65

#### 5.6 AgriculturalChemical Container Disposal .................................. 65

##### 5.6.1 Saskatchewan ..................................................... 65
##### 5.6.2 Manitoba ....................................................... 66
5.6.3 Agricultural Chemical Container Collection Depots .......................... 67
5.6.4 Agricultural Pesticide Collection Sites ........................................ 67
5.7 Tillage and Seeding Activity .......................................................... 67
5.8 Fertilizer ......................................................................................... 71
5.9 Summary/Recommendations ............................................................... 72

6 Municipal Lagoons and Water Quality .................................................. 73

6.1 Introduction ....................................................................................... 73
6.1.1 Municipal Wastewater .................................................................... 73
6.1.2 Wastewater Treatment/Lagoons .................................................. 74
6.1.3 Treatment ..................................................................................... 74
6.2 Legislation ......................................................................................... 75
6.2.1 Saskatchewan ............................................................................... 75
6.2.2 Manitoba .................................................................................... 76
6.3 Factors Affecting Wastewater Treatment in Lagoons ............................ 76
6.4 Facility Operation, Maintenance, and Monitoring ............................... 77
6.4.1 Release of Wastewater .................................................................... 77
   6.4.1.1 Wastewater as a Resource ..................................................... 77
   6.4.1.2 Solids .................................................................................. 78
   6.4.1.3 Odour ................................................................................ 78
   6.4.2 Permits/Licenses ......................................................................... 78
   6.4.2.1 Saskatchewan ..................................................................... 78
   6.4.2.2 Manitoba .......................................................................... 79
6.5 Environmental Impacts ...................................................................... 80
6.6 Mechanical Wastewater Treatment Plants ......................................... 80
6.7 Current Municipal Lagoons in the Basin ............................................ 83
   6.7.1 Saskatchewan ........................................................................... 83
   6.7.2 Manitoba ................................................................................. 84
6.8 Summary ............................................................................................ 86
6.9 Recommendations ............................................................................. 86
6.10 Municipal Alternatives...a Case Study .............................................. 87
    6.10.1 Wetlands Design and Operation ............................................. 88
    6.10.2 Hybrid Poplar Trees ............................................................... 90
    6.10.3 Effluent Production Management ......................................... 91
       6.10.3.1 High Water Usage ........................................................ 91
       6.10.3.2 Groundwater Infiltration ................................................. 91
       6.10.3.3 Effluent Quality ............................................................ 91
    6.10.4 Summary ............................................................................... 92
    6.10.5 Conclusion............................................................................. 92

7 Groundwater Protection ......................................................................... 93

7.1 Introduction ....................................................................................... 93
7.2 Legislation ........................................................................................ 94
7.2.1 Saskatchewan ............................................................... 94
    7.2.1.1 The Water Corporation Act .................................. 94
    7.2.1.2 The Groundwater Conservation Act ..................... 94
    7.2.1.3 The Environmental Management and Protection Act (EMPA) . 94
    7.2.1.4 The Public Health Act ...................................... 94
    7.2.1.5 The Agricultural Operations Act ......................... 95
    7.2.1.6 Other Guidelines/Regulations ............................. 95

7.2.2 Manitoba ..................................................................... 95
    7.2.2.1 The Groundwater and Well Water Act .................. 95
    7.2.2.2 The Water Rights Act ...................................... 95
    7.2.2.3 The Environmental Act .................................... 95
    7.2.2.4 The Public Health Act ...................................... 95
    7.2.2.5 Other Guidelines/Regulations ............................. 96

7.3 Aquifer Vulnerability .................................................... 96
7.4 Well Abandonment ....................................................... 97
7.5 Contaminants .................................................................. 97
7.6 Groundwater Management ............................................. 98
7.7 Groundwater Protection ................................................ 99
7.8 Monitoring ..................................................................... 100
7.9 Summary ....................................................................... 101
7.10 Recommendations ........................................................ 101

8 Conclusions and Recommendations ...................................... 103

8.1 Groundwater Monitoring ............................................... 103
8.2 Surface Water Monitoring .............................................. 104
8.3 Agricultural Practices .................................................... 105
8.4 Effluent Management ..................................................... 107
8.5 Groundwater Protection ................................................ 108
8.6 Information and Education ............................................. 109

References ......................................................................... 110

Glossary ............................................................................. 114

Appendices:
I. Terms of Reference
II. Upper Assiniboine River Basin Water Quality Study Final Report, November 1998
III. Water Quality Trends in the Upper Assiniboine River at the Interprovincial Boundary
IV. Saskatchewan’s Pesticide Container Management Program
V. Kopelchuk Project: Off-Stream Cattle Watering Demonstration Site
   Town of Roblin Alternate Effluent Management
   Water Quality in the Upper Assiniboine River Basin
List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Upper Assiniboine River Basin Study Location Plan</td>
<td>2</td>
</tr>
<tr>
<td>2.1</td>
<td>Historical Locations of Provincial Water Quality Stations</td>
<td>6</td>
</tr>
<tr>
<td>4.1</td>
<td>Percentage of Farms That Have Livestock in the Upper Assiniboine River Basin</td>
<td>32</td>
</tr>
<tr>
<td>4.2</td>
<td>Total Cattle and Calves in the Upper Assiniboine River Basin</td>
<td>33</td>
</tr>
<tr>
<td>4.3</td>
<td>Total Pigs in the Upper Assiniboine River Basin</td>
<td>34</td>
</tr>
<tr>
<td>4.4</td>
<td>Total Poultry in the Upper Assiniboine River Basin</td>
<td>35</td>
</tr>
<tr>
<td>4.5</td>
<td>Total Sheep and Lambs in the Upper Assiniboine River Basin</td>
<td>36</td>
</tr>
<tr>
<td>4.6</td>
<td>Total Horses and Ponies in the Upper Assiniboine River Basin</td>
<td>37</td>
</tr>
<tr>
<td>5.1</td>
<td>Tillage Practices Used to Prepare Land for Seeding in the Upper Assiniboine River Basin</td>
<td>56</td>
</tr>
<tr>
<td>5.2</td>
<td>Fertilizer Usage in the Upper Assiniboine River Basin</td>
<td>57</td>
</tr>
<tr>
<td>5.3</td>
<td>Herbicide Usage in the Upper Assiniboine River Basin</td>
<td>58</td>
</tr>
<tr>
<td>5.4</td>
<td>Insecticide Usage in the Upper Assiniboine River Basin</td>
<td>59</td>
</tr>
<tr>
<td>5.5</td>
<td>Location of Municipal Agricultural Collection Depots in the Basin</td>
<td>69</td>
</tr>
<tr>
<td>6.1</td>
<td>Photograph of the Signage for the Town of Roblin’s Alternative Management System</td>
<td>89</td>
</tr>
<tr>
<td>6.2</td>
<td>Photograph of the Roblin Lagoon, Showing Cells 1 and 2</td>
<td>89</td>
</tr>
<tr>
<td>7.1</td>
<td>Major Aquifers Located in the Yorkton Area</td>
<td>93</td>
</tr>
</tbody>
</table>
## List of Tables

| Table 2.1 | Suitability of Some Water Bodies in the Upper Assiniboine River Basin, For Various Uses | 8 |
| Table 2.2 | Location of Water Quality Sampling Stations | 9 |
| Table 2.3 | Water Quality Results for the Assiniboine River Versus Saskatchewan Surface Water Quality Objectives for Irrigation, Livestock Watering, And Non-contact Recreation 1980 to 1998 | 10 |
| Table 2.4 | Water Quality Results for the Whitesand River Versus Saskatchewan Surface Water Quality Objectives for Irrigation, Livestock Watering, and Non-contact Recreation 1980 to 1998 | 13 |
| Table 2.5 | Water Quality Results for Good Spirit Lake Versus Saskatchewan Surface Water Quality Objectives Set for Irrigation, Livestock Watering, And Recreation (Contact and Non-contact), 1993 to 1998 | 15 |
| Table 2.6 | Water Quality Results For Fishing Lake Versus Saskatchewan Surface Water Quality Objectives For Irrigation, Livestock Watering, And Recreation (Contact And Non-contact), 1993 to 1998 | 17 |
| Table 2.7 | Location of Water Quality Sampling Stations | 18 |
| Table 2.8 | Water Quality Data for Five Stations Along the Lake of the Prairies, Ranging from the Dam (LP-1) to the Most Upstream Station (LP-5) at the Manitoba Border For the Period 1991 to 1993 | 20 |
| Table 2.9 | Historic Water Quality Data for the Shell River From the Most Downstream Station Before the River Flows into the Lake Dating from Three Decades Between the Early 1970s to the 1990s | 22 |
| Table 5.1 | Municipal Agricultural Chemical Container Collection Depots in Saskatchewan | 68 |
| Table 6.1 | Sewage Treatment Processes - Typical Effluent Quality | 79 |
| Table 6.2 | Water Quality Results from 1992 to 1999 Presented as a Seasonal Average for Effluent of the Yorkton Sewage Treatment Plant | 81 |
Table 6.3 Water Quality Results from 1992 to 1999 Presented as a Seasonal Average for Yorkton Creek Upstream and Downstream of the Yorkton Sewage Treatment Plant ........................................................... 82

Table 6.4 Average Nutrient Reduction in Wetlands ................................................. 90
1 Introduction

The governments of Saskatchewan, Manitoba and Canada agreed to undertake a comprehensive water management study of the Upper Assiniboine River Basin in eastern Saskatchewan and western Manitoba. The Study area includes the entire Basin in Saskatchewan and Manitoba north of the Qu'Appelle River. This portion of the Basin has a drainage area of 21,000 km$^2$ of which 79 percent is in Saskatchewan (Figure 1.1). The Study was a response to public demand for the resolution of the diverse and persistent water management issues in the Basin. Water related issues include: conflict between agricultural drainage interests and downstream flooding, uncertainty over water supplies, concerns over the disappearance of wetland and wildlife habitat, and complaints linked to the quality of the Basin’s water bodies and aquifers. The purpose of the Study was to develop a water management framework to guide future water management in the Basin to resolve these issues. A complete overview of the Study is contained in the main Study report.

The Study was initiated by an Agreement among the governments of Saskatchewan (represented by the Saskatchewan Water Corporation (Sask Water)), Manitoba (represented by Manitoba Conservation) and Canada (represented by Environment Canada) in October 1996. Many other private citizens, consultants, and agencies (including the Prairie Farm Rehabilitation Administration, Ducks Unlimited Canada, Manitoba Agriculture and Food, Manitoba Industry and Trade, Manitoba Intergovernmental Affairs, Saskatchewan Agriculture and Food, Saskatchewan Environment and Resource Management, Saskatchewan Wetlands Conservation Corporation, and Saskatchewan Municipal Affairs, Culture and Housing) contributed to this Study. Study work was undertaken by five technical committees, a strategy committee and supported by a communications committee. Public involvement was a vital component of the Study and was facilitated through six local watershed committees.

This committee report discusses the water quality knowledge gained over the course of the Upper Assiniboine River Basin Study.

1.1 Water Quality Committee

The Water Quality Committee was comprised of personnel with a background in water quality representing Saskatchewan, Manitoba and Canada. The committee identified water quality concerns within the Basin, reviewed existing information for those identified issues, formed an information program, and advanced recommendations to be used in the development of a water management framework.

1.2 Objectives

The objectives of the Water Quality Committee were to assess the quality of the Basin’s water resources by gathering and reviewing the existing water quality information. The committee also identified and reviewed the effects of various activities within the Basin on water quality.
Water Quality concerns raised at a series of open houses in November 1996 by local residents provided the primary focus for the Water Quality Committee’s activities. The issues raised were compiled and prioritized and provided the basis of the committee’s terms of reference (Appendix I). The water quality issues identified and addressed by the committee were:

- The effects of agricultural drainage on water quality;
- Nutrient enrichment of water bodies from municipal effluent;
- Nutrient enrichment from livestock access to watercourses;
- Trends in water quality for the Basin; and
- The protection of groundwater from contamination.
1.3 Scope of Work

To address the identified issues the Water Quality Committee commissioned Dillon Consulting Limited of Winnipeg to conduct a literature review on the effect of these activities within the Basin on water quality. The specific objectives of the Study were to review the effects of agricultural drainage, livestock and range management practices, and municipal lagoon releases on surface and ground water quality. In addition, groundwater protection information and related education materials were to be compiled. The literature review was based primarily on existing information directly related to the Upper Assiniboine River Basin, or where information was not available, the Canadian Prairies or other specific regions. The consultant’s report was completed in November 1998 and is contained in Appendix II. The information compiled in the literature review was then used by the Water Quality Committee as the basis for the development of a public information brochure.

Surface water quality monitoring of the main water bodies in the Basin has been conducted but only to a limited extent. Samples have been collected and analyzed from the Assiniboine River, the Whitesand River, Fishing Lake, Good Spirit Lake, Lake of the Prairies, Shell River and Big Boggy Creek. The Committee reviewed the existing water quality data collected from these water bodies to examine whether the water is suitable for most expected uses when compared to the current Water Quality Objectives.

The most comprehensive water quality information for the Basin is from the Prairie Provinces Water Board monitoring station near Kamsack. Monitoring at this station has been conducted on a monthly basis since 1974. Water quality data collected by the Prairie Provinces Water Board for the period 1981 to 1997 were examined to assess the long-term trends in water quality.

Livestock are an integral part of the agricultural activity within the Upper Assiniboine River Basin. Management practices associated with all types of livestock activities do have an impact on groundwater and surface water quality. Livestock watering in streams and rivers has the potential to degrade riparian areas, and increase nutrients and pathogens. During the course of this study, the Water Quality Committee participated in several livestock demonstration projects within the Basin. In the summer of 1998 and 1999, an off stream watering demonstration project was conducted on the Whitesand River south of Canora.

In 1999, the Whitesand River watershed enhancement projects were also undertaken with six co-operators with cattle near the Whitesand River or a tributary of the river. Numerous activities were undertaken by the project co-operators throughout the spring, summer, and fall of 1999. These activities included establishment of vegetative buffer strips, conversion of crop land to forages, fence construction, off stream watering site development, berm construction, improvement of low-level crossings, rotational grazing management planning, and the relocation of winter feeding sites.

Cropping, field runoff, and drainage activities can all impact water quality. The movement of water across cultivated fields can transport nutrients, sediment, and pesticides to surface and
ground water supplies. The committee examined the roles of best management practices and the ability of riparian buffer areas to minimize the impacts on water quality.

Throughout the Basin there are 32 towns that operate multi-celled lagoons as part of their wastewater treatment system. Each province has discharge objectives and regulations that control the construction, operation, and pollution control mechanisms for lagoons. Despite these objectives and regulations, lagoon systems do have the potential to impact receiving waters with the susceptibility being dependant on the location, soil type, and timing of the release. The committee reviewed the impact of the release of effluent from lagoons on receiving water bodies. It also examined alternative management systems for the disposal of treated wastewater effluent such as the combined use of a traditional lagoon system and constructed wetlands implemented by one town within the Basin.

Groundwater is an important water resource within the Basin and used as the major source of potable water for numerous cities, towns, villages, and individuals throughout the region. The committee examined the various sources of groundwater contamination and the methods for protecting groundwater supplies including proper well siting and construction, protection from potential contaminants in the recharge area, adopting beneficial management practices to reduce non-point contamination from agricultural sources, monitoring, and the need to properly decommission and seal unused or abandoned wells.
2 Surface Water Quality

2.1 Introduction

Surface water is one of the most important resources in the Upper Assiniboine River Basin. Major uses of surface water in this area include recreation, potable water supplies, use by aquatic life, and agricultural uses such as irrigation, and livestock watering.

Agriculture is the primary economic activity within the Upper Assiniboine River Basin. Activities such as increased drainage of sloughs, runoff from intensive livestock operations, and increased use of fertilizer and chemicals all have the potential to affect water quality in the area. Other activities that may alter surface water quality within the Basin include: discharges from municipal sewage lagoons; runoff from landfills and hazardous substance storage sites, such as chemical collection depots; and indiscriminate disposal of wastes such as used oil.

In general, any substance that may enter a body of water is deemed to be a potential pollutant if it adversely affects water quality for any specific use. The primary factors that influence water quality are the nature and total volume of the polluting effluent. However, the resulting quality of water also depends upon the quality of the receiving water, its assimilative capacity, the rate of water flow, and the rate of chemical and biological changes within the system.

Water quality is periodically monitored by taking samples which are analysed to identify specific dissolved and suspended substances. Figure 2.1 identifies where provincial water quality sampling stations have been located in the Basin.

2.2 Legislation

2.2.1 Saskatchewan

The Province of Saskatchewan has various acts, policies, regulations, and guidelines to conserve water and to protect, maintain, and improve its quality for the protection of public health, as well as for the following purposes:

- Preservation and protection of water supplies;
- Sustainable development of agriculture and other economic activities;
- Preservation of aesthetic values;
- Preservation of fish and wildlife; and
- Municipal and domestic water supplies.
Figure 2.1
Locations of Water Quality Monitoring Stations
2.2.1.1 Surface Water Quality Objectives

Saskatchewan has established specific *Surface Water Quality Objectives* (Saskatchewan Environment and Resource Management, 1997) which are used to assess surface waters and evaluate their suitability for various uses. Major parameters for assessing the suitability of water for its various uses in the Basin include: bacteria (total and fecal coliforms), total dissolved solids, major ions, nutrients (nitrogen and phosphorous), dissolved oxygen, pesticides, pH, mercury, etc. For example, fecal coliform counts in excess of 200 per 100 millilitres (mL) of sample would indicate that the water is not acceptable for non-contact recreation (e.g., boating, fishing). Total dissolved solids greater than 1000 milligrams per litre (mg/L) may not be tolerated by all types of livestock. Similarly, levels of sodium and total dissolved solids greater than 100 and 700 mg/L respectively, may make the water unsuitable for irrigation depending on the soil irrigated and crop grown.

In terms of water quality, Table 2.1 provides a brief analysis of the suitability (by water use) of the major water bodies within the Basin.

2.2.1.2 Water Pollution Control and Waterworks Regulations

Saskatchewan’s *Water Pollution Control and Waterworks Regulations* regulate all the municipal waterworks exceeding a capacity of 18 cubic metres per day. Waterworks of less than 18 cubic metres per day (e.g., private wells, municipal wells) are regulated by Saskatchewan Health. Regulated waterworks are permitted by Saskatchewan Environment and Resource Management (SERM), and some permit requirements include:

- daily testing for total and free chlorine; and
- sample submissions to the provincial lab for testing of bacteria, nitrates, sulphates, arsenic, iron, selenium, pesticides, trihalomethanes, cyanide, mercury, benzene, etc.

2.2.1.3 Other Regulations/Guidelines

In addition to the provincial *Surface Water Quality Objectives* and *Water Pollution Control and Waterworks Regulations*, some other acts, regulations, and guidelines that are currently in place in Saskatchewan to help protect water quality, include:

- *The Environmental Management and Protection Act*;
- *The Hazardous Substances and Waste Dangerous Goods Regulations*;
- *The Drainage Control Regulations*; and
- *The Agricultural Operations Act*.

2.2.2 Manitoba

The following acts, regulations and objectives govern water quality in Manitoba:
The Manitoba Environment Act;
The Livestock Manure and Mortalities Management Regulation;
The Manitoba Dangerous Goods Handling and Transportation Act;
The Manitoba Surface Water Quality Objectives;
The Protection of Water Sources Regulations under The Public Health Act; and
The fish consumption guidelines for Lake of the Prairies based upon mercury concentrations.

Table 2.1
Suitability of Some Water Bodies in the Upper Assiniboine River Basin, for Various Uses*

<table>
<thead>
<tr>
<th>Water Bodies</th>
<th>Recreation</th>
<th>Irrigation</th>
<th>Aquatic Life</th>
<th>Livestock Watering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good Spirit Lake (1993 - 1998)</td>
<td>✔</td>
<td>(✔)</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Fishing Lake (1993 - 1998)</td>
<td>✔</td>
<td>✗</td>
<td>✔</td>
<td>✗</td>
</tr>
<tr>
<td>Whitesand River (1980 - 1998)</td>
<td>✔</td>
<td>(✔)</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Assiniboine River (1980 - 1998)</td>
<td>✔</td>
<td>(✔)</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Big Boggy Creek (1991-1993)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Lake of the Prairies (1991-1993)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

* Using data from water quality monitoring stations upstream of known waste water discharges to represent ambient conditions.

✔ Suitable
(✔) Suitable with some limitations based on soil irrigated and crop grown.
✗ Not Suitable

2.3 Water Quality in Saskatchewan

Saskatchewan Environment and Resource Management (SERM) has conducted some water quality monitoring on major water bodies in the Basin such as the Assiniboine River, Whitesand River, Good Spirit Lake, and Fishing Lake. The location of sampling stations where SERM monitored water quality is shown on Table 2.2 and Figure 2.1. The following section provides a brief overview of the water quality for these water bodies based on available data. The water quality will also be compared to Saskatchewan’s Surface Water Quality Objectives (SERM, 1997) where applicable. All water quality data are reported in milligrams per litre (mg/L) except for fecal coliform bacteria which are measured in organisms per 100 millilitres of water (organisms /100 mL).

2.3.1 Assiniboine River

The Assiniboine River originates northwest of the Town of Preeceville, Saskatchewan, and flows in a southeasterly direction before entering Manitoba at Lake of the Prairies (also known as Shellmouth Reservoir). The Saskatchewan portion of the Assiniboine River is classified as an intermittent stream (Lane and Sykes, 1982), since annual peak flows are highly variable and flow decreases very rapidly after spring runoff. In dry years, the flow may decrease to zero during late summer and autumn.
Table 2.2
Location of Water Quality Sampling Stations

<table>
<thead>
<tr>
<th>Upper Assiniboine River Basin</th>
<th>Major Waterbodies and Location of Sampling Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waterbody</td>
<td>Sampling Station</td>
</tr>
<tr>
<td>------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Assiniboine River</td>
<td>Nr. Kamsack WTP</td>
</tr>
<tr>
<td></td>
<td>No. 5 Hwy.</td>
</tr>
<tr>
<td></td>
<td>No. 8 Hwy.</td>
</tr>
<tr>
<td></td>
<td>No. 357 Hwy.</td>
</tr>
<tr>
<td></td>
<td>No.47 Hwy.</td>
</tr>
<tr>
<td></td>
<td>Sturgis Weir</td>
</tr>
<tr>
<td></td>
<td>No. 9 Hwy.</td>
</tr>
<tr>
<td>Whitesand River</td>
<td>Opp. Canora WTP</td>
</tr>
<tr>
<td></td>
<td>1 mile E. of Canora</td>
</tr>
<tr>
<td></td>
<td>6 miles E. of Canora</td>
</tr>
<tr>
<td>Good Spirit Lake</td>
<td>North End</td>
</tr>
<tr>
<td></td>
<td>Canora Beach</td>
</tr>
<tr>
<td></td>
<td>Mid Lake</td>
</tr>
<tr>
<td></td>
<td>Burgis Beach</td>
</tr>
<tr>
<td></td>
<td>South End</td>
</tr>
<tr>
<td></td>
<td>Prov. Park Beach</td>
</tr>
<tr>
<td>Fishing Lake</td>
<td>Buckhorn Bay</td>
</tr>
<tr>
<td></td>
<td>Saskin Beach</td>
</tr>
<tr>
<td></td>
<td>Southwest Bay</td>
</tr>
<tr>
<td></td>
<td>Leslie Beach</td>
</tr>
<tr>
<td></td>
<td>Southeast Bay</td>
</tr>
</tbody>
</table>

Water quality monitoring on the Assiniboine River has been carried out sporadically over the years. Table 2.3 (A to D) shows minimum, maximum and mean (average) values for the most significant water quality parameters as measured at seven sites along the river during the period 1980 to 1998. The sampling frequency varied considerably from one station to another, with the station at No. 9 Highway sampled once, while the site at No. 5 Highway was sampled up to 40 times. This confirms that data for certain sites may be limited, and in cases where monitoring has been discontinued for some time the results may be dated. Therefore, it is important that these data be interpreted with caution and especially with reference to the water flows present at the time of sampling. Also, some stations are located in the municipal wastewater discharge mixing zones which may not represent ambient conditions in the river. Water quality at these stations is generally affected during the periods of municipal discharge.
Table 2.3
Water Quality Results for the Assiniboine River Versus Saskatchewan Surface Water Quality Objectives* for Irrigation, Livestock Watering, and Non-contact Recreation 1980 to 1998

(A) Fecal Coliform Counts

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sturgis Weir</td>
<td>11</td>
<td>2</td>
<td>600</td>
<td>90</td>
</tr>
<tr>
<td>No. 47 Hwy</td>
<td>8</td>
<td>1</td>
<td>40</td>
<td>23</td>
</tr>
<tr>
<td>No. 9 Hwy</td>
<td>5</td>
<td>4</td>
<td>40</td>
<td>23</td>
</tr>
<tr>
<td>Nr. Kamsack WTP</td>
<td>7</td>
<td>10</td>
<td>23</td>
<td>12</td>
</tr>
<tr>
<td>No. 5 Hwy</td>
<td>37</td>
<td>2</td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td>No. 8 Hwy</td>
<td>12</td>
<td>6</td>
<td>590</td>
<td>79</td>
</tr>
<tr>
<td>No. 357 Hwy</td>
<td>8</td>
<td>2</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>

* Irrigation=100/100 mL; Non-Contact Recreation=1000/100 mL

(B) Nutrients: Total Kjeldahl Nitrogen* Phosphorous*

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sturgis Weir</td>
<td>13</td>
<td>1.0</td>
<td>6.6</td>
<td>2.5</td>
<td>13</td>
<td>0.06</td>
<td>0.50</td>
<td>0.21</td>
</tr>
<tr>
<td>No. 47 Hwy</td>
<td>10</td>
<td>1.1</td>
<td>6.9</td>
<td>2.2</td>
<td>10</td>
<td>0.06</td>
<td>1.17</td>
<td>0.32</td>
</tr>
<tr>
<td>No. 9 Hwy</td>
<td>5</td>
<td>0.7</td>
<td>1.7</td>
<td>1.0</td>
<td>5</td>
<td>0.05</td>
<td>0.14</td>
<td>0.09</td>
</tr>
<tr>
<td>Nr. Kamsack WTP</td>
<td>7</td>
<td>0.4</td>
<td>2.8</td>
<td>1.3</td>
<td>10</td>
<td>0.07</td>
<td>0.52</td>
<td>0.15</td>
</tr>
<tr>
<td>No. 5 Hwy</td>
<td>40</td>
<td>0.1</td>
<td>15.0</td>
<td>2.8</td>
<td>40</td>
<td>0.02</td>
<td>1.25</td>
<td>0.29</td>
</tr>
<tr>
<td>No. 8 Hwy</td>
<td>14</td>
<td>0.2</td>
<td>4.7</td>
<td>2.2</td>
<td>14</td>
<td>0.08</td>
<td>0.75</td>
<td>0.32</td>
</tr>
<tr>
<td>No. 357 Hwy</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>11</td>
<td>0.05</td>
<td>0.85</td>
<td>0.32</td>
</tr>
</tbody>
</table>

* no set objectives

(C) Sulphate Total Dissolved Solids (calculated)

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sturgis Weir</td>
<td>10</td>
<td>51.0</td>
<td>170.0</td>
<td>98.3</td>
<td>10</td>
<td>241</td>
<td>851</td>
<td>597</td>
</tr>
<tr>
<td>No. 47 Hwy</td>
<td>8</td>
<td>48.0</td>
<td>112.0</td>
<td>81.1</td>
<td>8</td>
<td>218</td>
<td>782</td>
<td>532</td>
</tr>
<tr>
<td>No. 9 Hwy</td>
<td>1</td>
<td>96.0</td>
<td>96.0</td>
<td>96.0</td>
<td>1</td>
<td>749</td>
<td>749</td>
<td>749</td>
</tr>
<tr>
<td>Nr. Kamsack WTP</td>
<td>11</td>
<td>64.0</td>
<td>208.0</td>
<td>148.0</td>
<td>11</td>
<td>299</td>
<td>1371</td>
<td>759</td>
</tr>
<tr>
<td>No. 5 Hwy</td>
<td>34</td>
<td>59.0</td>
<td>268.0</td>
<td>155.0</td>
<td>33</td>
<td>261</td>
<td>996</td>
<td>655</td>
</tr>
<tr>
<td>No. 8 Hwy</td>
<td>11</td>
<td>112.0</td>
<td>395.0</td>
<td>174.0</td>
<td>11</td>
<td>453</td>
<td>1362</td>
<td>747</td>
</tr>
<tr>
<td>No. 357 Hwy</td>
<td>11</td>
<td>108.0</td>
<td>173.0</td>
<td>147.0</td>
<td>11</td>
<td>413</td>
<td>807</td>
<td>591</td>
</tr>
</tbody>
</table>

* Livestock=1000 mg/L

(D) Chloride Sodium, dissolved

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sturgis Weir</td>
<td>13</td>
<td>2.0</td>
<td>75.0</td>
<td>13.5</td>
<td>10</td>
<td>1.0</td>
<td>32.0</td>
<td>19.2</td>
</tr>
<tr>
<td>No. 47 Hwy</td>
<td>10</td>
<td>2.0</td>
<td>26.0</td>
<td>6.3</td>
<td>8</td>
<td>1.0</td>
<td>36.0</td>
<td>16.8</td>
</tr>
<tr>
<td>No. 9 Hwy</td>
<td>5</td>
<td>4.0</td>
<td>14.0</td>
<td>8.0</td>
<td>1</td>
<td>22.0</td>
<td>22.0</td>
<td>22.0</td>
</tr>
<tr>
<td>Nr. Kamsack WTP</td>
<td>11</td>
<td>4.0</td>
<td>26.0</td>
<td>8.8</td>
<td>11</td>
<td>6.0</td>
<td>54.0</td>
<td>27.1</td>
</tr>
<tr>
<td>No. 5 Hwy</td>
<td>40</td>
<td>2.0</td>
<td>350.0</td>
<td>30.3</td>
<td>34</td>
<td>16.0</td>
<td>96.0</td>
<td>41.1</td>
</tr>
<tr>
<td>No. 8 Hwy</td>
<td>14</td>
<td>14.0</td>
<td>110.0</td>
<td>37.0</td>
<td>11</td>
<td>36.0</td>
<td>147.0</td>
<td>55.7</td>
</tr>
<tr>
<td>No. 357 Hwy</td>
<td>10</td>
<td>15.0</td>
<td>37.0</td>
<td>22.6</td>
<td>11</td>
<td>27.0</td>
<td>47.0</td>
<td>37.7</td>
</tr>
</tbody>
</table>

* Irrigation=100 mg/L
2.3.1.1 Microbiological Water Quality

The provincial microbiological water quality objectives are based on counts of total and fecal coliform bacteria. Since fecal coliforms are naturally abundant in the lower intestine of humans and other warm-blooded animals, and are rare or absent in unpolluted waters, their presence serves as a reliable indication of sewage or fecal contamination in water.

Table 2.3 (A) shows the fecal coliform bacteria counts for the Assiniboine River compared to the provincial surface water quality objectives for irrigation and non-contact recreation. It is generally recognized that very little, if any, contact recreation (swimming, water skiing) occurs in the river. Based on the mean fecal coliform counts, the Assiniboine River met the surface water quality objectives for irrigation and non-contact recreation during the sampling period. The maximum one-time count at the Sturgis Weir site of 600 organisms per 100mL occurred in April, 1985 during a municipal wastewater discharge from the Town of Preeceville. Similarly, the maximum count at No. 8 Highway (590 organisms/100mL) occurred during a discharge from the Town of Kamsack in April, 1991. A 1991 study on the impacts of the Kamsack discharge confirmed elevated levels of bacteria below the discharge point, but the values quickly returned to ambient (background) levels within a short distance downstream (as shown by the data for No. 357 Highway), and the overall impact of the effluent on the river water quality was minimal. Although the surface water quality objective for irrigation was exceeded on these two occasions, there is little likelihood that the water would be used for irrigation at that time of year.

2.3.1.2 Nutrients

Table 2.3 (B) shows the concentration of total nitrogen and total phosphorus in the Assiniboine River for the period 1980 to 1998. Mean total nitrogen concentrations ranged from 1.0 to 2.8 mg/L with a maximum one-time value of 15.0 mg/L at No. 5 Highway. Mean total phosphorus ranged from 0.09 to 0.32 mg/L with a maximum of 1.24 mg/L. Elevated nutrient levels occur naturally throughout the Basin but this situation may be exacerbated by municipal wastewater discharges. The levels normally returned to background concentrations within a short distance downstream of the discharge points.

In Saskatchewan, nutrient levels in surface waterbodies are naturally high due to the nutrient-rich soils found throughout the province. As such, there are no specific water quality objectives for these parameters. The Canadian Council of Ministers of the Environment (CCME) and various provinces, including Saskatchewan and Manitoba, are presently in the process of developing water quality objectives for nutrients. In the meantime, the provinces continues to use general objectives that state nutrient concentrations should not be increased from natural levels such that nuisance growths of algae or aquatic weeds result.
2.3.1.3 Water Chemistry

The sum of the dissolved ions (mineral salts) in water is closely related to water salinity and is usually expressed as total dissolved solids (TDS). Salinity of the water is most important with respect to various agricultural uses such as irrigation or livestock watering, and is determined by the types of rock or soil in the watershed and by the amount of evaporation relative to precipitation. The Saskatchewan surface water quality objectives specify that the level of TDS in water should be less than 700 mg/L when used for irrigation, and less than 1000 mg/L for livestock watering.

Table 2.3 (C) provides the TDS results for the Assiniboine River, along with the results for the specific ion, sulphate. Mean TDS values for the Assiniboine River ranged from 532 to 759 mg/L, indicating that the river is moderately saline. Based on the maximum values, the surface water quality objective for irrigation was exceeded at several locations, due either to the effects of municipal wastewater discharges (at No.8 Highway) or low flow conditions during the winter months (near the Kamsack water treatment plant). Based on the concentration of sulphate (also from Table 2.3 (C)), the water would be considered suitable for livestock watering.

Sodium and chloride (Table 2.3 (D)) are the most significant cations in terms of irrigation use. In the Assiniboine River these constituents exhibited a similar pattern to that of TDS, with the highest values observed downstream during municipal effluent discharges. The water at the upstream sites would be considered suitable for irrigation.

2.3.2 Whitesand River

The Whitesand River is a major tributary of the Assiniboine River in Saskatchewan. It originates at Whitesand Lake, just south of Margo, and flows primarily in an easterly direction before entering the Assiniboine River near Kamsack. The Whitesand River is an intermittent stream that may have no flow for part of the year, but experiences rapid variations in flow because of its direct response to rainfall or snowmelt events.

Water quality monitoring on the Whitesand River has also been sporadic over the years. Monitoring in the upper reaches of the river was largely discontinued in the late 1970s. Table 2.4 (A to D) shows minimum, maximum and mean values for the most significant water quality parameters as measured at nine sites along the river during the period 1980 to 1998. Again, there is a significant variation in the sampling frequency between stations.

2.3.2.1 Microbiological Water Quality

Table 2.4 (A) shows the fecal coliform bacteria counts for the Whitesand River for the period 1980 to 1998, compared to the provincial surface water quality objectives for irrigation and non-contact recreation. As was the case with the Assiniboine, there would not likely be any contact recreation (swimming, water skiing) taking place along the Whitesand River.
# Table 2.4

## Water Quality Results for the Whitesand River Versus Saskatchewan Surface Water Quality Objectives* for Irrigation, Livestock Watering, and Non-contact Recreation 1980 to 1998

### A. Fecal Coliform Counts

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>North of Springside</td>
<td>5</td>
<td>10</td>
<td>1180</td>
<td>478</td>
</tr>
<tr>
<td>No. 9 Hwy</td>
<td>4</td>
<td>10</td>
<td>40</td>
<td>19</td>
</tr>
<tr>
<td>No. 5 Hwy - E. of Canora</td>
<td>4</td>
<td>8</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>Opp. Canora WTP</td>
<td>8</td>
<td>8</td>
<td>90</td>
<td>27</td>
</tr>
<tr>
<td>Below PFRA Dam</td>
<td>3</td>
<td>23</td>
<td>40</td>
<td>29</td>
</tr>
<tr>
<td>1 mile E. of Canora WTP</td>
<td>16</td>
<td>30</td>
<td>230</td>
<td>61</td>
</tr>
<tr>
<td>6 miles E. of Canora</td>
<td>19</td>
<td>30</td>
<td>200</td>
<td>49</td>
</tr>
<tr>
<td>North of Mikado</td>
<td>2</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>No. 5 Hwy nr. Kamsack</td>
<td>2</td>
<td>24</td>
<td>66</td>
<td>45</td>
</tr>
</tbody>
</table>

* Irrigation=100/100 mL; Non-Contact Recreation=1000/100 mL

### B. Nutrients: Total Kjeldahl Nitrogen* Phosphorous*

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>North of Springside</td>
<td>5</td>
<td>0.8</td>
<td>1.8</td>
<td>1.3</td>
<td>5</td>
<td>0.10</td>
<td>0.27</td>
<td>0.17</td>
</tr>
<tr>
<td>No. 9 Hwy</td>
<td>4</td>
<td>1.8</td>
<td>14.0</td>
<td>5.3</td>
<td>4</td>
<td>0.31</td>
<td>3.30</td>
<td>1.42</td>
</tr>
<tr>
<td>No. 5 Hwy - E. of Canora</td>
<td>4</td>
<td>4.2</td>
<td>14.0</td>
<td>7.0</td>
<td>4</td>
<td>0.70</td>
<td>3.10</td>
<td>1.43</td>
</tr>
<tr>
<td>Opp. Canora WTP</td>
<td>8</td>
<td>1.6</td>
<td>16.0</td>
<td>4.2</td>
<td>8</td>
<td>0.37</td>
<td>3.10</td>
<td>1.14</td>
</tr>
<tr>
<td>Below PFRA Dam</td>
<td>3</td>
<td>1.8</td>
<td>6.5</td>
<td>3.8</td>
<td>3</td>
<td>0.46</td>
<td>1.45</td>
<td>0.87</td>
</tr>
<tr>
<td>1 mile E. of Canora WTP</td>
<td>17</td>
<td>1.3</td>
<td>16.5</td>
<td>7.4</td>
<td>17</td>
<td>0.05</td>
<td>2.88</td>
<td>1.12</td>
</tr>
<tr>
<td>6 miles E. of Canora</td>
<td>18</td>
<td>0.6</td>
<td>17.8</td>
<td>4.5</td>
<td>19</td>
<td>0.13</td>
<td>2.10</td>
<td>0.67</td>
</tr>
<tr>
<td>North of Mikado</td>
<td>2</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>2</td>
<td>0.21</td>
<td>0.70</td>
<td>0.50</td>
</tr>
<tr>
<td>No. 5 Hwy nr. Kamsack</td>
<td>2</td>
<td>1.4</td>
<td>2.1</td>
<td>1.8</td>
<td>2</td>
<td>0.15</td>
<td>0.23</td>
<td>0.19</td>
</tr>
</tbody>
</table>

* no set objectives

### C. Sulphate Total Dissolved Solids

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>North of Springside</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>No. 9 Hwy</td>
<td>1</td>
<td>385.0</td>
<td>385.0</td>
<td>385.0</td>
<td>1</td>
<td>1515</td>
<td>1515</td>
<td>1515</td>
</tr>
<tr>
<td>No. 5 Hwy - E. of Canora</td>
<td>1</td>
<td>500.0</td>
<td>500.0</td>
<td>500.0</td>
<td>1</td>
<td>1953</td>
<td>1953</td>
<td>1953</td>
</tr>
<tr>
<td>Opp. Canora WTP</td>
<td>12</td>
<td>100.0</td>
<td>594.0</td>
<td>348.2</td>
<td>11</td>
<td>373</td>
<td>2659</td>
<td>1402</td>
</tr>
<tr>
<td>Below PFRA Dam</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1 mile E. of Canora WTP</td>
<td>17</td>
<td>143.0</td>
<td>700.0</td>
<td>364.5</td>
<td>16</td>
<td>566</td>
<td>2239</td>
<td>1274</td>
</tr>
<tr>
<td>6 miles E. of Canora</td>
<td>19</td>
<td>139.0</td>
<td>630.0</td>
<td>318.8</td>
<td>19</td>
<td>550</td>
<td>2824</td>
<td>1134</td>
</tr>
<tr>
<td>North of Mikado</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>No. 5 Hwy nr. Kamsack</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

* Livestock=1000 mg/L

Note: “--” means no data available

### D. Chloride Sodium, dissolved

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>North of Springside</td>
<td>5</td>
<td>10.0</td>
<td>22.0</td>
<td>18.0</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>No. 9 Hwy</td>
<td>4</td>
<td>22.0</td>
<td>176.0</td>
<td>89.0</td>
<td>1</td>
<td>157.0</td>
<td>157.0</td>
<td>157.0</td>
</tr>
<tr>
<td>No. 5 Hwy - E. of Canora</td>
<td>4</td>
<td>14.0</td>
<td>310.0</td>
<td>137.5</td>
<td>1</td>
<td>203.0</td>
<td>203.0</td>
<td>203.0</td>
</tr>
<tr>
<td>Opp. Canora WTP</td>
<td>13</td>
<td>18.0</td>
<td>505.0</td>
<td>134.4</td>
<td>12</td>
<td>22.0</td>
<td>405.0</td>
<td>141.66</td>
</tr>
<tr>
<td>Below PFRA Dam</td>
<td>3</td>
<td>40.0</td>
<td>256.0</td>
<td>145.3</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1 mile E. of Canora WTP</td>
<td>16</td>
<td>11.0</td>
<td>502.0</td>
<td>148.0</td>
<td>17</td>
<td>23.0</td>
<td>384.0</td>
<td>137.5</td>
</tr>
<tr>
<td>6 miles E. of Canora</td>
<td>17</td>
<td>14.0</td>
<td>356.0</td>
<td>97.7</td>
<td>19</td>
<td>36.0</td>
<td>465.0</td>
<td>114.0</td>
</tr>
<tr>
<td>North of Mikado</td>
<td>2</td>
<td>30.0</td>
<td>84.0</td>
<td>57.0</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>No. 5 Hwy nr. Kamsack</td>
<td>2</td>
<td>24.0</td>
<td>66.0</td>
<td>45.0</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

* Irrigation=100 mg/L
Overall, the bacteriological quality of the Whitesand at most of the monitoring stations was fairly good. Mean fecal coliform counts from No. 9 Highway all the way downstream to No. 5 Highway near Kamsack ranged from only 10 to 61 organisms per 100 millilitres of water (organisms/100mL), easily meeting the surface water quality objectives. The exception to this was the most upstream site (North of Springside) where mean counts were 478 organisms/100mL with a one-time maximum of 1180 organisms/100mL. However, it should be noted that this value is quite old and the reason for this high value is not known at this time. Additional sampling would help to determine the current microbiological water quality at this station. Two other high counts of 230 and 200 organisms/100mL were recorded downstream of Canora during wastewater discharges from that community. There are no known irrigation or recreational uses of the river in those locations.

2.3.2.2 Nutrients

Table 2.4 (B) shows the concentration of total nitrogen and total phosphorus in the Whitesand River. Mean nitrogen concentrations ranged from 1.3 to 7.4 mg/L, while mean phosphorus ranged from 0.17 to 2.71 mg/L. This confirms that nutrient levels in the Whitesand have been highly variable over the years. Again, the river flows through an area of nutrient-rich farmland and it is expected that runoff from the adjacent land would affect nutrient levels in the river. In addition, there are localized impacts from municipal wastewater discharges at several locations along this river reach. The variation in nutrient concentration can also be attributed to the large fluctuations in water flows.

2.3.2.3 Water Chemistry

Total dissolved solids (TDS) and sulphate concentrations for the Whitesand River are shown in Table 2.4 (C). Mean TDS levels ranged from 1134 to 1953 mg/L, indicating that the water is quite saline. Based on the mean concentrations of sulphate (at those stations where data were available) the water would be considered suitable for livestock watering.

Sodium and chloride concentrations (Table 2.4 (D)) exceeded the provincial surface water quality objective for irrigation at a number of stations, indicating that there would be some limitations to using the water for irrigation depending on the soil and crop type.

2.3.3 Good Spirit Lake

Good Spirit Lake is a relatively shallow recreational lake in east-central Saskatchewan located about 15 kilometres southwest of Canora. During the summer months, the lake occasionally experiences nuisance growths of algae. The water quality monitoring of Good Spirit Lake has also been sporadic over the years. Data for the period 1993 to 1998 shown in Table 2.5 (A to D) indicates that the water quality has been quite good overall, and is typical of shallow lakes in this region.
### Table 2.5
Water Quality Results for Good Spirit Lake Versus Saskatchewan Surface Water Quality Objectives* Set for Irrigation, Livestock Watering, and Recreation (Contact and Non-contact), 1993 to 1998

<table>
<thead>
<tr>
<th>Fecal Coliform Counts</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Station</strong></td>
<td><strong>No. of Samples</strong></td>
<td><strong>Min</strong></td>
<td><strong>Max</strong></td>
</tr>
<tr>
<td>North End</td>
<td>1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Canora Beach</td>
<td>4</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Mid Lake</td>
<td>3</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Burgis Beach</td>
<td>4</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>South End</td>
<td>1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Provincial Park Beach</td>
<td>5</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

* Irrigation=100/100 mL; Contact Recreation=200/100 mL; Non-Contact Recreation=1000/100 mL

<table>
<thead>
<tr>
<th>Nutrients: Total Kjeldahl Nitrogen*</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Station</strong></td>
<td><strong>No. of Samples</strong></td>
<td><strong>Min</strong></td>
<td><strong>Max</strong></td>
<td><strong>Avg</strong></td>
<td><strong>No. of Samples</strong></td>
<td><strong>Min</strong></td>
<td><strong>Max</strong></td>
</tr>
<tr>
<td>North End</td>
<td>1</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>1</td>
<td>0.09</td>
<td>0.09</td>
</tr>
<tr>
<td>Canora Beach</td>
<td>1</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>6</td>
<td>0.07</td>
<td>0.15</td>
</tr>
<tr>
<td>Mid Lake</td>
<td>3</td>
<td>1.7</td>
<td>2.5</td>
<td>2.1</td>
<td>3</td>
<td>0.05</td>
<td>0.08</td>
</tr>
<tr>
<td>Burgis Beach</td>
<td>1</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>6</td>
<td>0.08</td>
<td>0.16</td>
</tr>
<tr>
<td>South End</td>
<td>1</td>
<td>1.4</td>
<td>1.4</td>
<td>1.4</td>
<td>1</td>
<td>0.23</td>
<td>0.23</td>
</tr>
<tr>
<td>Provincial Park Beach</td>
<td>2</td>
<td>1.5</td>
<td>1.6</td>
<td>1.55</td>
<td>7</td>
<td>0.07</td>
<td>0.16</td>
</tr>
</tbody>
</table>

* no set objectives

<table>
<thead>
<tr>
<th>Sulphate Total Dissolved Solids (calculated)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Station</strong></td>
<td><strong>No. of Samples</strong></td>
<td><strong>Min</strong></td>
<td><strong>Max</strong></td>
<td><strong>Avg</strong></td>
<td><strong>No. of Samples</strong></td>
<td><strong>Min</strong></td>
<td><strong>Max</strong></td>
<td><strong>Avg</strong></td>
<td></td>
</tr>
<tr>
<td>North End</td>
<td>1</td>
<td>397.0</td>
<td>397.0</td>
<td>397.0</td>
<td>1</td>
<td>907</td>
<td>907</td>
<td>907</td>
<td></td>
</tr>
<tr>
<td>Canora Beach</td>
<td>1</td>
<td>303.0</td>
<td>303.0</td>
<td>303.0</td>
<td>1</td>
<td>752</td>
<td>752</td>
<td>752</td>
<td></td>
</tr>
<tr>
<td>Mid Lake</td>
<td>3</td>
<td>290.0</td>
<td>386.0</td>
<td>325.7</td>
<td>3</td>
<td>748</td>
<td>894</td>
<td>798</td>
<td></td>
</tr>
<tr>
<td>Burgis Beach</td>
<td>1</td>
<td>309.0</td>
<td>309.0</td>
<td>309.0</td>
<td>1</td>
<td>759</td>
<td>759</td>
<td>759</td>
<td></td>
</tr>
<tr>
<td>South End</td>
<td>1</td>
<td>386.0</td>
<td>386.0</td>
<td>386.0</td>
<td>1</td>
<td>899</td>
<td>899</td>
<td>899</td>
<td></td>
</tr>
<tr>
<td>Provincial Park Beach</td>
<td>2</td>
<td>304.0</td>
<td>386.0</td>
<td>345.0</td>
<td>2</td>
<td>748</td>
<td>891</td>
<td>820</td>
<td></td>
</tr>
</tbody>
</table>

* Livestock=1000 mg/L

<table>
<thead>
<tr>
<th>Chloride Sodium, dissolved</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Station</strong></td>
<td><strong>No. of Samples</strong></td>
<td><strong>Min</strong></td>
<td><strong>Max</strong></td>
<td><strong>Avg</strong></td>
<td><strong>No. of Samples</strong></td>
<td><strong>Min</strong></td>
<td><strong>Max</strong></td>
<td><strong>Avg</strong></td>
<td></td>
</tr>
<tr>
<td>North End</td>
<td>1</td>
<td>9.0</td>
<td>9.0</td>
<td>9.0</td>
<td>1</td>
<td>26.0</td>
<td>26.0</td>
<td>26.0</td>
<td></td>
</tr>
<tr>
<td>Canora Beach</td>
<td>1</td>
<td>7.0</td>
<td>7.0</td>
<td>7.0</td>
<td>1</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td>Mid Lake</td>
<td>3</td>
<td>6.0</td>
<td>9.0</td>
<td>7.0</td>
<td>3</td>
<td>20.0</td>
<td>25.0</td>
<td>21.7</td>
<td></td>
</tr>
<tr>
<td>Burgis Beach</td>
<td>1</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>1</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td>South End</td>
<td>1</td>
<td>9.0</td>
<td>9.0</td>
<td>9.0</td>
<td>1</td>
<td>25.0</td>
<td>25.0</td>
<td>25.0</td>
<td></td>
</tr>
<tr>
<td>Provincial Park Beach</td>
<td>2</td>
<td>6.0</td>
<td>8.0</td>
<td>7.0</td>
<td>2</td>
<td>19.0</td>
<td>26.0</td>
<td>22.5</td>
<td></td>
</tr>
</tbody>
</table>

* Irrigation=100 mg/L
2.3.3.1 Bacteriological Water Quality

As shown in Table 2.5 (A), fecal coliform bacteria counts were very low over the period of record, easily meeting the surface water quality objectives for all expected uses, including contact and non-contact recreation.

2.3.3.2 Nutrients

Table 2.5 (B) provides the concentration of major plant nutrients (nitrogen and phosphorus). Although the levels of these parameters were not excessive in Good Spirit Lake, they were in adequate supply to sustain abundant growth of algae and other aquatic plants under the right conditions. Naturally available nutrients in the lake, together with warm, sunny weather during spring and summer are the primary causes of nuisance algal growths in many prairie lakes. This is a natural situation and does not indicate a water pollution concern.

2.3.3.3 Water Chemistry

Table 2.5 (C) shows that the water in Good Spirit Lake was quite mineralized. Mean TDS levels ranged from 752 to 907 mg/L, slightly exceeding the surface water quality objective for irrigation. Nevertheless, the water would likely be suitable for irrigation of most crops depending on the species and soil type in the area. Based on the mean sulphate levels of 303 to 397 mg/L, the water would be suitable for livestock watering.

With respect to irrigation use, sodium and chloride were found in concentrations well below the provincial surface water quality objectives for these parameters (see Table 2.5 (D)).

2.3.4 Fishing Lake

Fishing Lake is a medium-sized recreational lake situated in east-central Saskatchewan about 30 kilometres southeast of Wadena. The water quality of Fishing Lake has typically been rated quite high due to its clarity and lack of algal growth.

A recreational lake assessment was carried out on Fishing Lake by SERM in 1994/95, and occasional monitoring has been done since that time. Table 2.6 (A to D) provides the minimum, maximum and mean data for the monitoring done on Fishing Lake to date.

2.3.4.1 Microbiological Water Quality

As shown in Table 2.6 (A), the bacteriological quality of Fishing Lake was excellent during the sampling period. Mean fecal coliform counts were only 5 organisms per 100mL of water at all stations, with maximum counts of only 10 organisms/100mL. These results indicate good quality for contact and non-contact recreation.
Table 2.6
Water Quality Results for Fishing Lake Versus Saskatchewan Surface Water Quality Objectives* for Irrigation, Livestock Watering, and Recreation (Contact and Non-contact), 1993 to 1998

(A) Fecal Coliform Counts

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buckhorn Bay</td>
<td>15</td>
<td>2</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Saskin Beach</td>
<td>16</td>
<td>2</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Southwest Bay</td>
<td>15</td>
<td>2</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Leslie Beach</td>
<td>16</td>
<td>2</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Southeast Bay</td>
<td>15</td>
<td>2</td>
<td>10</td>
<td>4</td>
</tr>
</tbody>
</table>

* Irrigation=100/100 mL; Contact Recreation=200/100 mL; Non-Contact Recreation=1000/100 mL

(B) Nutrients: Total Kjeldahl Nitrogen* Phosphorous*

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buckhorn Bay</td>
<td>10</td>
<td>0.7</td>
<td>1.7</td>
<td>1.2</td>
<td>10</td>
<td>0.02</td>
<td>0.06</td>
<td>0.04</td>
</tr>
<tr>
<td>Saskin Beach</td>
<td>10</td>
<td>0.5</td>
<td>1.6</td>
<td>1.2</td>
<td>10</td>
<td>0.02</td>
<td>0.07</td>
<td>0.04</td>
</tr>
<tr>
<td>Southwest Bay</td>
<td>10</td>
<td>0.5</td>
<td>1.6</td>
<td>1.2</td>
<td>10</td>
<td>0.02</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Leslie Beach</td>
<td>10</td>
<td>0.7</td>
<td>2.0</td>
<td>1.4</td>
<td>10</td>
<td>0.02</td>
<td>0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>Southeast Bay</td>
<td>11</td>
<td>0.5</td>
<td>1.8</td>
<td>1.3</td>
<td>11</td>
<td>0.02</td>
<td>0.22</td>
<td>0.06</td>
</tr>
</tbody>
</table>

* no set objectives

(C) Sulphate Total Dissolved Solids (calculated)

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buckhorn Bay</td>
<td>10</td>
<td>1914</td>
<td>2794</td>
<td>2378</td>
<td>10</td>
<td>3088</td>
<td>4368</td>
<td>3746</td>
</tr>
<tr>
<td>Saskin Beach</td>
<td>10</td>
<td>1905</td>
<td>2832</td>
<td>2376</td>
<td>10</td>
<td>3074</td>
<td>4417</td>
<td>3746</td>
</tr>
<tr>
<td>Southwest Bay</td>
<td>10</td>
<td>1897</td>
<td>2832</td>
<td>2376</td>
<td>10</td>
<td>3065</td>
<td>4339</td>
<td>3759</td>
</tr>
<tr>
<td>Leslie Beach</td>
<td>10</td>
<td>1931</td>
<td>2792</td>
<td>2395</td>
<td>10</td>
<td>3106</td>
<td>4366</td>
<td>3772</td>
</tr>
<tr>
<td>Southeast Bay</td>
<td>11</td>
<td>512</td>
<td>2743</td>
<td>2200</td>
<td>11</td>
<td>1369</td>
<td>4308</td>
<td>3523</td>
</tr>
</tbody>
</table>

* Livestock=1000 mg/L

(D) Chloride Sodium, dissolved

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
<th>No. of Samples</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buckhorn Bay</td>
<td>10</td>
<td>50.0</td>
<td>78.0</td>
<td>68.4</td>
<td>10</td>
<td>277.0</td>
<td>410.0</td>
<td>343.8</td>
</tr>
<tr>
<td>Saskin Beach</td>
<td>10</td>
<td>50.0</td>
<td>74.0</td>
<td>65.6</td>
<td>10</td>
<td>276.0</td>
<td>414.0</td>
<td>344.2</td>
</tr>
<tr>
<td>Southwest Bay</td>
<td>10</td>
<td>52.0</td>
<td>76.0</td>
<td>66.1</td>
<td>10</td>
<td>278.0</td>
<td>412.0</td>
<td>343.3</td>
</tr>
<tr>
<td>Leslie Beach</td>
<td>10</td>
<td>53.0</td>
<td>78.0</td>
<td>65.8</td>
<td>10</td>
<td>280.0</td>
<td>418.0</td>
<td>345.1</td>
</tr>
<tr>
<td>Southeast Bay</td>
<td>11</td>
<td>8.0</td>
<td>75.0</td>
<td>60.3</td>
<td>11</td>
<td>86.0</td>
<td>414.0</td>
<td>320.5</td>
</tr>
</tbody>
</table>

* Irrigation=100 mg/L

2.3.4.2 Nutrients

Table 2.6 (B) shows that nutrient concentrations were quite low during the sampling period, with mean total nitrogen ranging from 1.2 to 1.4 mg/L, while mean total phosphorus fell in the range of 0.03 to 0.06 mg/L. These values would be considered as ‘natural’ levels for a lake in this region. Nuisance growths of algae and aquatic plants that limit recreational or other uses would not generally be expected to occur.
2.3.4.3 Water Chemistry

Table 2.6 (C) shows that mean total dissolved solids (TDS) ranged from 3523 to 3772 mg/L, exceeding the surface water quality objectives of 700 mg/L for irrigation use and 1000 mg/L for livestock use. With such high TDS levels, and with mean sodium concentrations ranging from 320.5 to 345.1 mg/L (Table 2.6 (D)), the water in Fishing Lake would be considered unsuitable for irrigation of most crops, except for those that are very tolerant to sodium and other salts.

Based on the levels of sulphate shown in the Table 2.6 (C), the water in Fishing Lake would be considered unsuitable for livestock watering.

2.4 Water Quality in Manitoba

Most of the available water quality data for the Manitoba portion of the Upper Assiniboine River Basin focuses on the main water bodies of the region. The location of sampling stations where Manitoba Conservation monitors water quality is shown on Table 2.7. Lake of the Prairies was formed by a dam located at the confluence of the Shell River and the Assiniboine River and extends northwesterly across the Manitoba border into Saskatchewan. The Shell River originates in the Duck Mountains on the northeastern edge of the Basin boundary and has a gross drainage area of 1999 km². Boggy Creek empties into the Lake of the Prairies at the Manitoba border and has a gross drainage area of 435 km². Other streams in the area would include Cupar, Blackbird, Conjuring, Smith, and Thunder creeks. However, water quality data for these smaller streams is limited and they have not been included in any water quality synopsis.

<table>
<thead>
<tr>
<th>Name</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Boggy Creek at PR. No.484</td>
<td>51 16.65</td>
<td>101 29.03</td>
</tr>
<tr>
<td>Shell River at PR.No. 594, South of Boggy Creek</td>
<td>51 27 00</td>
<td>101 20 00</td>
</tr>
<tr>
<td>Shell River at PR. No. 583, South of Roblin</td>
<td>51 10 00</td>
<td>101 20 00</td>
</tr>
<tr>
<td>Shell River at PTH No. 83</td>
<td>50 57 00</td>
<td>101 21 00</td>
</tr>
<tr>
<td>Shell River at PR No. 367, North East of San Clara</td>
<td>51 31 00</td>
<td>101 23 00</td>
</tr>
<tr>
<td>Shell River at PR No. 483, North West of Merridale</td>
<td>51 21 00</td>
<td>101 15 00</td>
</tr>
<tr>
<td>Shell River at PR No. 591, North East of Roblin</td>
<td>51 15 00</td>
<td>101 15 00</td>
</tr>
<tr>
<td>Shell River at PTH No 5, East of Roblin</td>
<td>51 13 00</td>
<td>101 13 00</td>
</tr>
<tr>
<td>Shell River at PR No. 589, South East of Roblin</td>
<td>51 00 00</td>
<td>101 18 00</td>
</tr>
<tr>
<td>Shell River at PR No. 583 at Shevlin</td>
<td>51 12 00</td>
<td>101 13 00</td>
</tr>
<tr>
<td>Lake of the Prairies above Dam</td>
<td>50 58 00</td>
<td>101 25 00</td>
</tr>
<tr>
<td>Lake of the Prairies Shell River Mouth</td>
<td>50 58 00</td>
<td>101 23 00</td>
</tr>
<tr>
<td>Lake of the Prairies, South of PTH No. 5</td>
<td>51 13 00</td>
<td>101 31 00</td>
</tr>
</tbody>
</table>
In Manitoba, surface water quality objectives have been derived for the protection of beneficial water uses (Williamson, 1988). The major water uses of Lake of the Prairies and its tributaries are recreation, habitat for aquatic life and wildlife, and livestock watering. The following section provides a brief overview of the water quality for the three main streams.

2.4.1 Lake of the Prairies

The Lake of the Prairies (Shellmouth Reservoir) has a mean depth of 7 metres and a surface area of 52 km\(^2\). The Lake of the Prairies was created to provide downstream flood control protection and to provide a consistent water supply to downstream users as far away as Portage la Prairie. The lake is a heavily utilized recreational area and supports an excellent walleye sport fishery worth close to $2,000,000 to the local economy.

2.4.1.1 Fecal Coliform

Table 2.8-A shows the mean fecal coliform data for five stations along Lake of the Prairies, ranging from the dam (LP-1) to the most upstream station (LP-5) at the Manitoba border for the period 1991 to 1993. Fecal coliform bacteria originate in the digestive tracts of warm-blooded animals. They are used as indicator organisms and their presence usually suggests contamination by human or animal faeces. When found in large numbers they are often associated with disease causing organisms. As in Saskatchewan, Manitoba’s fecal coliform objective is set at 200 organisms per 100 mL for the protection of primary recreation activities, such as swimming or water skiing. Fecal coliform concentrations ranged from 10 to 70 organisms per 100 mL and were well below this objective, indicating that primary recreation is adequately protected in Lake of the Prairies.

2.4.1.2 Phosphorous

Manitoba’s surface water objective for total phosphorous was established at 0.025 mg/L in order to limit the growth and development of nuisance algal blooms in lakes and reservoirs. Table 2.6-B indicates that mean phosphorous concentrations increase toward the shallower portion of the lake at the Manitoba-Saskatchewan border. It is also clear that the objective is exceeded throughout the lake. Consequently, the potential for widespread algal blooms is high, particularly during the open water season. Reduction in loading from external phosphorous sources is needed before a reduction in algal blooms is likely to occur. However, internal loading of phosphorous within the lake is a major contributor to the annual phosphorous loading (Fortin and Gurney, 1998). This recycling source of phosphorous will buffer the benefits of reduced external loading and create a lag time before any observed decrease in the extent of algal blooms can be observed.
Table 2.8
Water Quality Data for Five Stations Along the Lake of the Prairies, Ranging From the Dam (LP-1) to the Most Upstream Station (LP-5) At the Manitoba Border for the Period 1991 to 1993

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of Samples</th>
<th>Mean</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Water Quality Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LP 1</td>
<td>38</td>
<td>10.0</td>
<td>10.0</td>
<td>0.0</td>
<td>10.0</td>
<td>200</td>
</tr>
<tr>
<td>LP 2</td>
<td>37</td>
<td>10.0</td>
<td>10.0</td>
<td>0.0</td>
<td>10.0</td>
<td>200</td>
</tr>
<tr>
<td>LP 3</td>
<td>38</td>
<td>10.0</td>
<td>10.0</td>
<td>0.0</td>
<td>10.0</td>
<td>200</td>
</tr>
<tr>
<td>LP 4</td>
<td>37</td>
<td>10.0</td>
<td>10.0</td>
<td>0.0</td>
<td>10.0</td>
<td>200</td>
</tr>
<tr>
<td>LP 5</td>
<td>37</td>
<td>11.0</td>
<td>10.0</td>
<td>1.0</td>
<td>70.0</td>
<td>200</td>
</tr>
<tr>
<td>B.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LP 1</td>
<td>43</td>
<td>0.100</td>
<td>0.089</td>
<td>0.025</td>
<td>0.292</td>
<td>0.025</td>
</tr>
<tr>
<td>LP 2</td>
<td>42</td>
<td>0.099</td>
<td>0.082</td>
<td>0.027</td>
<td>0.291</td>
<td>0.025</td>
</tr>
<tr>
<td>LP 3</td>
<td>42</td>
<td>0.118</td>
<td>0.101</td>
<td>0.033</td>
<td>0.286</td>
<td>0.025</td>
</tr>
<tr>
<td>LP 4</td>
<td>44</td>
<td>0.161</td>
<td>0.108</td>
<td>0.042</td>
<td>0.446</td>
<td>0.025</td>
</tr>
<tr>
<td>LP 5</td>
<td>44</td>
<td>0.205</td>
<td>0.152</td>
<td>0.055</td>
<td>0.705</td>
<td>0.025</td>
</tr>
<tr>
<td>C.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LP 1</td>
<td>41</td>
<td>9.40</td>
<td>9.00</td>
<td>6.10</td>
<td>13.60</td>
<td>47% saturation</td>
</tr>
<tr>
<td>LP 2</td>
<td>42</td>
<td>10.00</td>
<td>9.40</td>
<td>5.20</td>
<td>18.50</td>
<td>47% saturation</td>
</tr>
<tr>
<td>LP 3</td>
<td>40</td>
<td>10.00</td>
<td>10.15</td>
<td>5.10</td>
<td>14.60</td>
<td>47% saturation</td>
</tr>
<tr>
<td>LP 4</td>
<td>41</td>
<td>10.10</td>
<td>10.00</td>
<td>6.40</td>
<td>18.10</td>
<td>47% saturation</td>
</tr>
<tr>
<td>LP 5</td>
<td>44</td>
<td>10.00</td>
<td>9.80</td>
<td>0.50</td>
<td>21.00</td>
<td>47% saturation</td>
</tr>
</tbody>
</table>

2.4.1.3 Dissolved Oxygen

Manitoba’s dissolved oxygen objective of 47 percent saturation has been set for the protection of aquatic life commonly found in cool water habitat. In order to achieve this objective, the dissolved oxygen concentrations need to be greater than or equal to 5 mg/L throughout most of the year. Fish kills will likely occur at dissolved oxygen concentrations of less than 1 mg/L, while some fish species may be under stress at concentrations of less than 3 mg/L. Data for the period 1991 to 1993 indicate an average concentration of close to 10 mg/L across the lake (Table 2.8-C). Wind action on the lake maintains a well mixed water column, recirculating oxygen throughout the lake. Oxygen profiles in the lake have shown oxygen levels below the objective at the bottom depths of the lake, but never for prolonged periods. Overall, the dissolved oxygen levels observed in the lake support the protection of aquatic life.
2.4.1.4 Total Dissolved Solids/Sulphate

Sulphate concentrations ranged from 20 to 254 mg/L along the length of the lake only slightly exceeding the irrigation objective of 250 mg/L two percent of the time. Overall, the water is suitable for irrigation, however irrigation is not prevalent along the lake and is not an important use. Maximum TDS values ranged from 530 to 650 mg/L and maximum sulphate concentrations of 254 mg/L were well below the guidelines for livestock watering of 3000 mg/L and 600 mg/L, respectively.

2.4.2 Shell River

Lake of the Prairies is a mainstream lake with most of the inflow into the lake coming from the Assiniboine River and its upstream tributaries in Saskatchewan. The Shell River is the main Manitoba source of inflow into the lake and comprises approximately 11 percent of the gross drainage area to the lake. Most of the historic water quality data for the Shell River comes from WQ 172, the most downstream station before the river flows into the lake, with information dating back three decades from the early 1970s to the 1990s. Mean concentrations over each decade, of approximately equal sample sizes, have been calculated for comparison.

2.4.2.1 Fecal Coliform

The mean fecal concentrations for the Shell River, as shown in Table 2.9-A, are all well below the Manitoba water quality objective of 200 organisms per 100 mL. It appears that the water quality has shown some improvement over time, with mean concentrations decreasing from the beginning period of data collection. Over the period of the 1970s to 1980s, individual samples have exceeded the objective eight percent of the time, ranging in values from 0 to 750 organisms per 100 mL. No exceedances were observed during the 1990s. Overall, the objective is currently being met in the Shell River.

2.4.2.2 Phosphorous

The Manitoba objective for phosphorous in streams has been set at 0.05 mg/L in order to prevent excess macrophyte or algal blooms. This objective has been exceeded 57 percent to 70 percent of the time for the period of record. Table 2.9-B shows that the mean concentration of total phosphorous has remained relatively consistent in the 0.06 to 0.07 mg/L range, possibly indicating that natural and anthropogenic sources of phosphorous input to the Shell River have been comparatively stable.

2.4.2.3 Dissolved Oxygen

Historically, dissolved oxygen concentrations are high with mean concentrations ranging between 10 to 11 mg/L, well within the dissolved oxygen objective (Table 2.9-C). Minimum concentrations as low as 3.0 mg/L were occasionally observed during the low flow and ice
covered months of January and February. Concentrations less than 5 mg/L were only observed four percent of the time during the period of record. The dissolved oxygen levels observed in the Shell River are presently sufficient to support the protection of aquatic life.

**Table 2.9**

*Historic Water Quality Data for the Shell River*

*From the Most Downstream Station Before the River Flows into the Lake*

*Dating from Three Decades Between the Early 1970s to the 1990s*

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of Samples</th>
<th>Mean</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Water Quality Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>1970s</td>
<td>41</td>
<td>79.0</td>
<td>9.0</td>
<td>0.0</td>
<td>750.0</td>
</tr>
<tr>
<td></td>
<td>1980s</td>
<td>46</td>
<td>45.0</td>
<td>4.0</td>
<td>0.0</td>
<td>460.0</td>
</tr>
<tr>
<td></td>
<td>1990s</td>
<td>37</td>
<td>19.0</td>
<td>10.0</td>
<td>1.0</td>
<td>80.0</td>
</tr>
<tr>
<td>B.</td>
<td>1970s</td>
<td>50</td>
<td>0.062</td>
<td>0.030</td>
<td>0.010</td>
<td>0.600</td>
</tr>
<tr>
<td></td>
<td>1980s</td>
<td>42</td>
<td>0.067</td>
<td>0.030</td>
<td>0.012</td>
<td>0.600</td>
</tr>
<tr>
<td></td>
<td>1990s</td>
<td>47</td>
<td>0.060</td>
<td>0.044</td>
<td>0.014</td>
<td>0.253</td>
</tr>
<tr>
<td>C.</td>
<td>1970s</td>
<td>48</td>
<td>10.20</td>
<td>10.20</td>
<td>6.80</td>
<td>14.20</td>
</tr>
<tr>
<td></td>
<td>1980s</td>
<td>47</td>
<td>9.70</td>
<td>9.50</td>
<td>3.00</td>
<td>13.40</td>
</tr>
<tr>
<td></td>
<td>1990s</td>
<td>47</td>
<td>10.10</td>
<td>9.80</td>
<td>6.30</td>
<td>13.50</td>
</tr>
</tbody>
</table>

**2.4.2.4 Total Dissolved Solids/Sulphate**

The maximum sulphate concentrations were derived from the 1970s and 1990s data only and range between 327 and 385 mg/L. These values are well below the livestock watering objective of 600 mg/L but do exceed the irrigation objective of 250 mg/L, 27 percent and 50 percent of the time respectively during the two sampling periods. The exceedences of sulphate do not support irrigation as a water use however, like the Lake of the Prairies, irrigation is not an important use of the Shell River. Maximum TDS concentrations are well below the livestock watering objective of 3000 mg/L, ranging in values between 850 and 900 mg/L.

**2.4.3 Boggy Creek**

Boggy Creek is a shallow stream that derives most of its flow during the spring snowmelt and after significant rainfall events. Water quality data for Boggy Creek are available from a water quality station located just upstream of the creek’s outlet to Lake of the Prairies. Information is available from 1991 to 1993.
2.4.3.1 Fecal Coliform

The mean fecal coliform concentration of 32 organisms per 100 mg/L is well below the recreation objective of 200 organisms per 100 mg/L. Fecal coliform concentrations as high as 410 per 100 mg/L were observed during the summer, but never for extended periods. Livestock were pastured upstream of the site and there was abundant beaver activity in the area, which may have contributed to the higher values.

2.4.3.2 Phosphorous

The mean total phosphorous concentration of 0.126 mg/L is well above the Manitoba guideline for streams of 0.05 mg/L. Bank erosion and weathering have an important role in the concentration of total phosphorous found in Boggy Creek. The highest values of total phosphorous (0.705 mg/L) were associated with the high spring runoff when particulate phosphorous made up over 70 percent of the total concentration.

2.4.3.3 Dissolved Oxygen

Mean dissolved oxygen concentrations of 10.3 mg/L were well above the oxygen objective for the protection of aquatic life. Minimum values observed were also well above the guideline, so that oxygen levels are quite sufficient to sustain aquatic life in Boggy Creek.

2.4.3.4 Total Dissolved Solids

Mean TDS concentrations of 956 mg/L and mean sulphate concentrations of 367 mg/L are both well below the livestock watering objective. However, the sulphate objective for irrigation of 250 mg/L is exceeded by the concentrations found in Boggy Creek, rendering it unsuitable for irrigation.

In conclusion, all the beneficial uses are supported on the Manitoba side of the Upper Assiniboine River Basin. Total phosphorous concentrations exceed the objective in both the streams and lake. The greatest impact of this exceedence is on Lake of the Prairies where the rapid development of algal blooms can diminish the aesthetic appeal of the lake. Exceedences of the sulphate guideline in both Boggy Creek and Shell River make it unsuitable for irrigation although this is not one of the primary uses of either stream.

2.5 Trends in Water Quality at the Kamsack Prairie Provinces Water Board (PPWB) Station

To determine long-term trends in water quality, the Assiniboine River at Kamsack data for the period 1981 to 1997 were reviewed by Environment Canada. Time series graphs were produced and non-parametric trend tests were conducted to identify trends in water quality parameters in the
Assiniboine River at the Kamsack site. The results were encouraging, as no parameters showed a long-term increasing trend in concentration and a few (total nickel, total coliform, and alpha BHC) displayed long-term decreasing trends in concentration.

The water quality results at Kamsack were compared to the PPWB Water Quality Objectives to identify possible variables of concern in the river. The dissolved oxygen objective was exceeded periodically, mainly under winter ice conditions, which is often typical of intermittent prairie streams. The dissolved manganese objective was also exceeded but mainly during the winter months. The total phosphorus objective, established in 1990, was occasionally exceeded but this objective is out dated and under review. The report entitled, *Water Quality Trends in the Assiniboine River at the Interprovincial Boundary* reviews water quality conditions in the Assiniboine River in more detail and is included as Appendix III of this report.

### 2.6 Summary

In summary, a review of the available data for several water bodies in the Upper Assiniboine River Basin indicates that in general the water quality is suitable for its expected uses. There are several areas where limitations to uses such as irrigation are evident. It is important to note that in some cases the assessment is based on a limited quantity of data. Additional monitoring would be required to update the water quality conditions at those locations. The PPWB sampling site on the Assiniboine River near Kamsack provides an ongoing measure of water quality trends in the upper reaches of the Basin and provides the only up-to-date data. However, Saskatchewan has expressed a concern that the sampling station is too close to the point of wastewater discharge from Kamsack.

### 2.7 Recommendations

1) Monitoring for dissolved oxygen, total phosphorous and dissolved manganese should continue at a frequency that is capable of detecting long-term trends in water quality. This is recommended since levels of these variables already exceed the PPWB Water Quality Objective for the Assiniboine River and could potentially have a detrimental effect on downstream users in the Basin.

2) Methods of operational effluent release procedures in coordination with Assiniboine River stream flows should be reviewed. A reduction of nutrients in the Assiniboine River may have the potential to reduce accelerated aquatic weed growth in the river.

3) A monitoring program should be carried out to collect additional data in order to confirm the current status of water quality conditions in the Basin. Water quality monitoring carried out on the major waterbodies in the Saskatchewan portion of the Upper Assiniboine River Basin has provided some baseline data for the period 1980 to 1998. However, the sampling frequency has been highly variable and some of the results are quite dated.
2.7.1 Brochures

Appendix V of this report is an 18-page booklet entitled, “Water Quality in the Upper Assiniboine River Basin” that was published in January 2000. This document was jointly produced as an initiative of the Governments of Saskatchewan, Manitoba, and Canada. Two sections within this booklet provide a brief overview of water quality and trends within the Basin. They are “Water Quality in the Basin, pages 3 to 6”, and “Trends in Water Quality, pages 6 to 9”.

3 Drainage and Water Quality

3.1 Introduction

Drainage was an important part of settlement of the Prairies and, until recently, governments have supported drainage activities directly and indirectly. Increased mechanization in farming practices, along with a trend to larger land holdings has led to increased drainage activity. Because commodity prices have not increased at the same rate as input costs, farmers have increased their land base in an effort to make a living by conventional farming methods. Larger land holdings mean that more work must be completed in the same amount of time, so larger implements are often used to complete fieldwork quicker. Larger implements make navigation around wetlands more difficult and time consuming. The resulting economic inefficiency and inconvenience are often cited as reasons for removal of wetlands from cultivated lands. Some producers may view any form of wildlife habitat as competition detrimental to their farming operation.

3.2 Legislation Governing Water Quality as it Pertains to Drainage

The Water Corporation Act in Saskatchewan and The Water Rights Act in Manitoba legislate drainage in their respective provinces. Neither act governs the effects of drainage on water quality.

3.2.1 Federal

In the past, the Western Grain Transportation Act (WGTA) and the Canadian Wheat Board's (CWB's) acreage based quota allocation influenced drainage activities. The WGTA lowered the farmers' cost of transporting grains and oilseeds to export position making their production more profitable. With relatively higher profits from growing grains and oilseeds compared to other land uses, farmers had an incentive to increase their acreage seeded to grains and oilseeds. The CWB's acreage based quota allocation was set up to give every farmer fair access to market grain. By using acreages to calculate a farmer's allocation, farmers could increase their allocation by increasing their cultivated acreage. The incentive to increase their allocation may have encouraged farmers to drain wetlands, break native grassland, and clear trees.

3.2.2 Saskatchewan

The Government of Saskatchewan’s wetland policy supports the sustainable management of wetlands to maintain the multiple benefits they provide, now and into the future. Provincial government departments and agencies that participated in policy development and deliver land/water use programs and policies have been directed to guide policy implementation. These include Saskatchewan Wetland Conservation Corporation (lead in policy implementation), Saskatchewan Environment and Resource Management, Sask Water, Saskatchewan Agriculture and Food, and Saskatchewan Municipal Affairs, Culture and Housing. One of the objectives is to encourage sustainable management of wetlands on public and private lands to maintain their
functions and benefits. Another is to restore or rehabilitate degraded wetland ecosystems where previous destruction or alteration has resulted in a significant loss of wetland functions or benefits. One of the principles underlying these objectives is that the rights of landowners and their role in the stewardship of land are recognized and their ongoing involvement is assured. However, there is no program that involves the landowner, agricultural land drainage and wetlands in a way that effects maintaining or improving water quality. This might take place through integrated planning of land use and drainage activities with local landowner cooperation. The *Water Corporation Act* may be able to accommodate this approach through administration of a modified drainage approval process that recognizes water quality with local landowner cooperation. In order to achieve this there would need to be a high level of compliance with the legislation.

*The Conservation Easements Act* (1996) introduced conservation easements and programs providing tax incentives for wetland retention. These programs offer options to landowners faced with land use decisions. The concept of conservation easements or development easements is the manner in which landowners can receive the monetary benefit from changing the land use. This may, indirectly, contribute to improving water quality.

Improving the administration of *The Water Corporation Act* in harmony with the wetland policy and encouraging sustainable management of wetlands on public and private lands to maintain their functions and benefits can lead to water quality improvements that will benefit both the landowner and the environment.

### 3.2.3 Manitoba

Manitoba has wetland conservation policies similar to Saskatchewan that suggest, “wetlands shall, where possible, be conserved.” Manitoba’s Water Policy 2.2 suggests that, “wetland retention shall be promoted primarily by the provision of incentives, but with regulation where required, not only as essential elements of water conservation and protection, but also as key measures to reduce siltation impacts, downstream flooding, and non-point source pollution.” This policy suggests that the Government of Manitoba will “regulate activities and enforce compliance, where necessary, to ensure that the public’s general conservation interests are not undermined” and “review and modify government legislation and policy to ensure that they support conservation”. *The Water Rights Act*, which has been used to regulate drainage in Manitoba, does not presently support this policy.

### 3.2.4 Drainage

Saskatchewan and Manitoba landowners are required, by law, to apply for and receive a license to construct drainage works prior to construction. There are many unlicensed works in both provinces, the impact of which has not been quantified. Impacts to water quality are not presently a consideration in the provinces’ drainage licensing processes.
Removal of wetland surface storage areas through drainage may allow nutrients, contaminants, and sediments to flow into rivers and streams, which has an effect on water quality in these receiving waterways.

Wetlands significantly reduce levels of phosphorous, nitrogen, biochemical oxygen demand (BOD), and coliforms while providing valuable habitat for a variety of wildlife. Wetlands are said to be one of the most productive ecosystems. Wetlands may be closely linked with groundwater in that they may be recharge or discharge sites for groundwater.

Drainage ditches can carry water contaminated by high concentrations of salts and other chemicals from the catchment area. Evaporation of these waters can further concentrate the mineral content. Straight, non-vegetated drainage channels increase the speed of runoff events. This increases the likelihood of erosion and subsequent sedimentation. Increased turbidity of the runoff water is likely to impact fish and other aquatic life. Given an increase in water flow speeds, drainage may also contribute to the duration and/or severity of the flood peak in small to moderate flood events.

Larger flood events lead to damage from erosion and nutrient/contaminant loading, increasing the area of affected flood plains. Larger floods may increase sediment loading to reservoirs, lakes, and streams, but may improve instream water quality due to dilution.

### 3.3 Literature Review

#### 3.3.1 Dillon Consulting Limited: *Upper Assiniboine River Basin Water Quality Study - Final Report, November 1998*

The literature review completed by Dillon Consulting Limited is an examination of drainage of cultivated lands. At present, drainage activities continue despite the lack of government financial assistance because many landowners perceive drainage as a cost beneficial land improvement activity, without considering the societal costs of drainage. Greater effort has been made to reduce impacts of wetland drainage on private and public lands in recent years. There is a heavy reliance on legislation to provide this protection. The following are water quality concerns related to drainage:

- Nutrients entering surface and groundwater supplies from external sources such as agricultural fertilizer can impact water quality, creating negative consequences for wildlife, livestock, human and aquatic biota. Nutrient loading of surface water may result in algal growth. This may cause reductions or changes in aquatic biota due to the shading effect of algae in the water column, the reduction of water flow in the water body or lowering of dissolved oxygen levels that result during decomposition of algae. Species of algae may develop which are highly toxic to humans, livestock and wildlife. Algae may negatively impact drinking water quality by imparting odour and taste (Tones, 1987). Some of the chemical treatment methods for controlling algal growth in drinking water supplies, such as copper sulphate, may also negatively impact water quality.
High concentrations of ammonia nitrogen may occur in water sources as a result of fertilizer runoff facilitated by drainage. Increased concentrations of ammonia nitrogen in surface water can stimulate the growth of algae and aquatic plants. Ammonia readily converts to nitrate and nitrite through a chemical reaction which uses dissolved oxygen. Reduction of dissolved oxygen can negatively impact aquatic biota. High levels of nitrogen in groundwater may also create a health problem called blue-baby syndrome in infants, which can lead to respiratory failure. High levels of nitrogen in water supplied to livestock can result in weight loss and poor feed conversion (USCATST, 1992; CCME, 1987).

Phosphorous laden soil particles may be added to a water body by erosional surface runoff facilitated by drainage. Particulate phosphorous is released in solution with water and may result in impacts to water quality. In its dissolved form, phosphorous is readily taken up by plants and algae (Beck, 1996). Phosphorus is often a greater concern for aquatic systems than nitrogen because it is generally considered the limiting factor for the growth of freshwater phytoplankton such as algae (CCME, 1987).

Pesticides may contaminate surface and ground water. Drainage of lands on which these chemicals are used may facilitate their movement to water bodies. Pesticides can be toxic to humans, livestock and wildlife depending on a number of factors including the type of pesticide and dilution rate.

Agricultural land drainage may facilitate the accumulation of heavy metals in receiving water bodies.

Agricultural land drainage may aggravate soil erosion and deposition impacts on the receiving water body by increasing water flow rates along disturbed soils. Increased silt loading and turbidity can present problems for recreation use of water bodies because of decreased visibility (Fisheries and Oceans, 1992). Sediments are also known to cover fish spawning areas. Sedimentation, the settling out of suspended sediments, can also affect the storage capacity and life span of reservoirs (Kuiper, 1962).

Agricultural land drainage which includes the removal of wetlands may cause impacts to surface and ground water. Wetlands significantly reduce phosphorous, nitrogen, BOD and coliforms. Removal of wetlands reduces this function. Drainage of marshlands may impact the recharge and discharge of the aquifer and result in groundwater quality changes (van der Kamp, 1989).

Gobert (1983) outlined the potential impact of large scale drainage projects on flood conditions in the Basin. With the addition of drainage waters, the duration and peak flows of small floods (1:2 year flood) increase, creating flooding that will last as much as a week longer than under natural conditions.

A complete copy of the Dillon Consulting Limited report forms Appendix II of this report.
3.4 Summary

Drainage may reduce water quality of the receiving water body. Some of the impacts of agricultural land drainage on water quality include nutrient loading, pesticide contamination, heavy metal contamination, erosion and sedimentation and removal of the natural buffering capabilities of wetlands through their drainage. Ammonia nitrogen, nitrates and nitrites can negatively impact water quality of receiving water bodies when transported by a drainage system. Particulate phosphorous may be transported downstream to receiving water bodies via agricultural drainage when soil particles erode and are carried with the water flow.

Concentration of pesticides in the receiving water body may occur as a result of runoff from cultivated lands due to drainage. Heavy metals may accumulate in the receiving water body if agricultural fields are drained. Erosion and sedimentation resulting from agricultural land drainage may contribute to infilling of reservoirs, nutrient and heavy metal loading and accumulation of pesticides. Furthermore, water quality benefits accrued by wetland retention are lost when those wetlands are drained. Lastly, duration of flooding and peak flow rates are increased during small flood events with addition of drainage waters.

3.5 Recommendations

The Water Quality Committee makes the following recommendations:

1) Water quality should be taken into consideration when evaluating drainage projects. Drainage project approvals should be coordinated so that more efficient monitoring of water quality is possible. Criteria for rating or evaluating drainage projects should be established and used since no such evaluation currently is applicable. The evaluation process would include such items as soil texture, slope, seeding system, extent of residue cover, significant rainfall and runoff events, average annual precipitation and impact on wetlands. A code of practise should be developed for construction of drainage projects to reduce project caused impacts to water quality.

2) Watershed-based planning should be undertaken to account for the cumulative impacts of drainage on water quality. Maintenance of existing wetlands should be regulated and encouraged to ensure some surface water storage within the Basin. This would reduce impacts of drainage on small flood events and would improve water quality by utilizing the wetlands' ability to filter out nutrients and sediments.

3) Maintenance of riparian areas around water courses and water bodies should be encouraged. Preference should be given for licensing of drainage works that include establishment of vegetation cover such as grasses to protect the ditch from erosion. Buffer strips or bush adjacent to water courses or water bodies should be protected to reduce the potential for erosion or contamination of the receiving water body.
4 Livestock and Water Quality

4.1 Introduction

Agriculture is the dominant landscape activity in the Upper Assiniboine River Basin, with livestock being an integral part of this activity. This chapter discusses the current livestock inventory within the Basin; the regulatory control of livestock production; and provides clarification of some sections of the literature review conducted by Dillon Consulting Limited. This chapter also reports on the demonstration/special projects that were conducted in the Basin and involved the Water Quality Committee.

Approximately 56.2 percent of the farms within the boundary of the Basin raise some type of livestock (Statistics Canada, 1998). Figure 3.1 (map) shows the percentage of farms by rural municipality within the Basin that have livestock on site. Figures 3.2 to 3.6 indicate the respective numbers of animals by species per rural municipality.

The current hog numbers per rural municipality are in some cases significantly different from those shown on the 1996 census map, due to recent developments (Figure 3.3). A 2400 sow farrow to finish hog unit was constructed in RM #334 during 1998 and initially stocked with animals in January 1999. The total pig numbers (sows, boars, gilts, weanlings and feeders) in the rural municipality will increase by 35,500 animals before 2001.

Similarly, a 5000 sow farrow to finish unit is planned in the general vicinity of RMs #304 and 305. All necessary approvals have been granted for part of the operation which will result in an additional 36,500 pigs in RM #305. Applications are pending (although no specific sites have been chosen at this time) for three remaining feeder barns (tentatively planned for somewhere within the Basin) to complete the project for an additional 34,500 pigs. Other local groups within the Basin have initiated discussions to locate large hog operations within the next several years in their own rural municipalities in the Basin.

In Saskatchewan, as of January 1, 2000, cattle numbers are down 4 percent, hog numbers are up 4 percent, and sheep numbers are up 4 percent from 1999 levels. In Manitoba, as of January 1, 2000 cattle numbers are down 4 percent, hog numbers are down 7 percent, and sheep numbers are up 15 percent from 1999 (Statistics Canada, Livestock Statistics, 1999).

Saskatchewan and Manitoba expect small increases in the cattle inventory over the upcoming years. This increase will not only be in the cow herd, but also in animals kept on feed for market. Both provinces anticipate increases in the hog inventory. Manitoba suggests the hog marketings in the Province may increase by 6 percent in 2000. Saskatchewan anticipates hog marketing to increase by 15 percent in 2000. Broiler chicken production is expected to expand by about 7 percent in Saskatchewan for 1999 (Saskatchewan Agriculture and Food, Annual Report 1998); trends in Manitoba also indicate expansion.
Figure 4.1
Percentage of Farms that have Livestock in the Upper Assiniboine River Basin

56.2% of farms in the Upper Assiniboine Basin have livestock.
Figure 4.2
Total Cattle and Calves in the Upper Assiniboine River Basin
Figure 4.3
Total Pigs in the Upper Assiniboine River Basin

56.2% of farms in the Upper Assiniboine Basin have livestock.

Prepared by: Geomatics Unit, Statistics Branch (RC)
Source: 1996 Census of Agriculture, Statistics Canada (Table 15)
Date: March 9, 2003
Figure 4.4
Total Poultry in the Upper Assiniboine River Basin

56.2% of farms in the Upper Assiniboine Basin have livestock.
Figure 4.5
Total Sheep and Lambs in the Upper Assiniboine River Basin

56.2% of farms in the Upper Assiniboine Basin have livestock.
Figure 4.6
Total Horses and Ponies in the Upper Assiniboine River Basin
Under supply management, the production of milk for domestic use and traditional export markets is controlled by quota allocations. No increase is anticipated in either province. In Saskatchewan, there was a decline in the number of dairies from 700 in 1980 to 400 in 1999, while total quota remained unchanged (pers. comm. Deb Haupstein, Provincial Dairy Specialist, Inspection and Regulatory Management, SAF; March 29, 2000). The trend is to fewer but larger dairy farms.

4.2 Legislation for the Establishment and Operation of Livestock Facilities

Livestock development is regulated in both Saskatchewan and Manitoba, although each province has a somewhat different approach to this regulation.

4.2.1 Saskatchewan

4.2.1.1 The Agricultural Operations Act

The Agricultural Operations Act was proclaimed November 27, 1996. In Saskatchewan this Act is the primary legislation that deals with the establishment, expansion, and operation of livestock facilities within the Province.

The main provisions of The Agricultural Operations Act include:

- The protection of farmers from unwarranted nuisance lawsuits;
- A mechanism for resolving nuisance disputes between agricultural producers and their immediate neighbors; and
- The protection of groundwater and surface water by proper management of manure and animal waste.


- Part II - Agricultural Nuisance Provisions: deals with complaints of nuisance resulting from all agricultural operations, including livestock. More detailed information on the nuisance complaint process and the Agricultural Operations Review Board is available by acquiring a copy of The Agriculture Operations Act, the “Guidelines for Establishing and Managing Livestock Operations” publication, or by contacting Saskatchewan Agriculture and Food.

- Part III - Intensive Livestock Provisions: requires operators of certain intensive livestock operations to obtain approved waste storage and waste management plans. Prior to a decision, applications submitted to Saskatchewan Agriculture and Food (SAF) are sent to other departments and agencies for comment. A decision on issuance of an approval is based on information within the
application, SAF’s own investigation, comments from the referral agencies, and concerns expressed by area citizens. Applications for large intensive livestock operations (ILOs) are routinely sent for comment to Saskatchewan Environment and Resource Management (SERM), Sask Water, Saskatchewan Highways and Transportation, Saskatchewan Municipal Affairs, Culture and Housing, and Saskatchewan Health. Other agencies and organizations may be included at SAF’s discretion. The local rural municipality is requested to comment on all ILO application.

4.2.1.2 Approval from Other Authorities

Other agencies may have conditions of approval within their own jurisdiction that can affect the development of livestock facilities. Although these agencies will usually become aware of the proposal through the referral process for application under The Agricultural Operations Act, it is always prudent for the livestock developer to contact these groups prior to SAF’s referral process to determine what requirements they may have.

1) Local Municipalities may require:
   - Development or discretionary use permits for establishing or expanding livestock operations;
   - Advertising and approval of zoning changes;
   - Input to subdivision approvals (if required) and subdivision servicing agreements;
   - Road maintenance cost agreements for heavy traffic on municipal roads;
   - Building setback distances from roads; and
   - If within a planning district, the recommendation of the planning district.

2) Sask Water may require:
   - A groundwater investigation permit for drilling test wells;
   - Approval to construct and operate wells and use groundwater;
   - Approval to construct and operate earth works and use surface water;
   - Approval to construct within reservoir development areas; and
   - Approval to alter drainage.

3) Saskatchewan Environment and Resource Management may require:
   - Approval if an incinerator is to be used; and
   - Pre-screening under The Environmental Assessment Act.

4) Saskatchewan Highways and Transportation may require:
   - Specific setback distances to highways if adjacent to the proposed site.
5) Saskatchewan Health may require:
   ▶ Acknowledgement from the local health district (public health inspector) that the
     project does not contravene bylaws of the health district.

6) Other agencies may:
   ▶ Be included in the SAF referral process. Typical project specific referral agencies
     would include railroads, wildlife organizations, regional parks, resorts, towns or
     villages, community associations, and organized citizen groups.

4.2.2 Manitoba

Several acts share the responsibility for the establishment, expansion, and/or management of
livestock facilities in Manitoba (The Agricultural Development Committee, 1998). Livestock
operators should be aware of a number of provincial acts and regulations and local municipal
bylaws that could affect the establishment, expansion, and/or management of their facilities.
Siting and other land use considerations are dealt with through The Municipal Act. The
Planning Act and consequent bylaws, permitting and planning authorities are delegated to local
municipalities. Water supply may be regulated by The Water Rights Act.

Livestock manure and mortalities management are regulated under The Environment Act, while
odour and other nuisance issues are addressed by The Farm Practices Protection Act, and
municipal bylaws.

4.2.2.1 The Environment Act

Under The Environment Act, the Livestock Manure and Mortalities Management Regulation MR
42/98 strengthens the protection of the environment, enhances enforcement capabilities, and
helps to ensure that livestock production will be sustainable in the long-term in Manitoba.

Following are some important areas addressed under the Regulation:

1) Spreading of manure - land application on fields by large-scale livestock operations,
defined as having more than 400 animal units of a given livestock type, is now prohibited
from November 10 until April 15. Livestock operations with fewer than 400 animal units
of any one type of livestock are exempt, unless their manure management practices are
causing an environmental concern. Existing producers have until November 10, 2003 to
comply with the new measures concerning winter application of manure, whereas new
large-scale producers must comply as soon as their operation is established. Emergency
situations may warrant exceptions to the prohibition of winter application, upon approval
by Manitoba Conservation. Livestock operations that are otherwise exempt from the
prohibition of winter application will still have to meet minimum setback distance
requirements from sensitive areas such as watercourses, wells, sinkholes, and springs.

2) Application rate - the Regulation sets enforceable limits on the amount of soil nitrates
that can be present in the soil at any point in time. The rate of manure application is to be
determined on the basis of nitrogen content in the manure, residual nitrogen concentrations in the soil, soil texture, and annual nitrogen requirements for the particular crop on that land.

3) Manure management plans - large intensive livestock operations have to prepare and register an annual manure management plan. The manure management plan ensures optimal use of the nutrients in manure and that environmentally sensitive areas can be identified and protected. The manure management plan describes the volume, type (i.e., liquid or solid), and nitrogen content of the manure produced. It also reports how, when, and where the manure will be applied. This new requirement for registration of the annual manure management plan will be in effect starting January 1, 1999 for new operations and November 10, 1999 for existing operations.

4) Manure storage structures - manure has to be stored in appropriate structures. In the case of solid manure, field storage is also acceptable. All structures require a permit from Manitoba Conservation prior to construction. In addition, the structures must be certified by an engineer, before their use or operation, as being constructed according to engineering design standards.

5) Allowance for innovative practices - considerable research and innovation is occurring in the field of livestock production and technological advancements are occurring at a rapid rate. Hence, the requirements of the regulation may be varied where innovative and environmentally sound practices or procedures are proposed.

6) Mortalities - the Regulation provides for proper disposal of mortalities by rendering, composting, incineration, or burial where environmental conditions are suitable. Mortalities shall be stored in a secure manner and kept either refrigerated or frozen if retained more than 48 hours after death.

7) Manure spills - persons transporting livestock manure are required to immediately report the occurrence of a spill or other discharge of livestock manure, as defined in Section 9 of the Regulation, where the location or quantities involved may cause an adverse effect on the environment. Minor spills or spills in locations that do not pose a significant threat or risk to the environment do not need to be reported.

8) Setbacks - siting requirements which establish the minimum distances (100 metres) for which manure storage facilities and composting sites must be set back from surface water courses, sinkholes, wells, and springs, continue to offer strong protection of water resources.

9) Pollution issues - other sections of the Regulation continue to prohibit the direct contamination of surface water and groundwater by livestock manure. Similarly, livestock manure must not be permitted to escape the property boundaries of land where it is either stored or applied as a fertilizer.
4.2.2.2  *The Water Rights Act*

Under *The Water Rights Act*, a license may be required to withdraw water from a surface or below ground source. For agricultural operations, this license is required when water usage exceeds 25,000 litres per day. At lesser rates of usage, no license is required.

4.3  **Literature Review- Dillon Consulting Limited:** *Upper Assiniboine River Basin Water Quality Study - Final Report, November 1998*

A literature review completed by Dillon Consulting Limited finds that all landscape activities have the potential to impact both groundwater and surface water quality. All land management practices and related farming activities can have a cumulative effect on water quality. Measured degradation or improvements in water quality cannot be easily attributed to any individual practice or activity.

4.3.1 Riparian Areas

Section 3.3 of the literature review completed by Dillon Consulting Limited deals with livestock issues. The report accurately outlines the degradation of riparian areas that can occur when cattle are allowed uncontrolled access to rivers, lakes, sloughs, and streams. However, it is important to note the relative impact of livestock numbers, stocking densities and/or holding concentrations when examining the impacts of livestock on watercourses and riparian areas. Negative effects on water quality and riparian areas can occur with cattle, if animals are not properly managed and distributed (Harker et al., 1997).

- **Grazing** - increased awareness and adoption of rotational grazing systems, such as time controlled grazing, deferred grazing, and rest rotation grazing systems aids in the distribution of livestock by modifying the placement of animals, varying the duration of grazing in accordance with the landscape’s vegetation, topography, and elevation. As well, there is an increasing awareness and participation by more and more livestock producers in adopting effective riparian area management on lands and stream banks within their control.

- **Herd Health** - improvements to herd health are directly related to improvements in water quality and increased rates of weight gain greatly benefit livestock producers’ bottom line. The Whitesand River Watershed Enhancement Project (see Section 4.5.2) is a case in point. Nevertheless, awareness of protection and enhancement of riparian areas needs to be a long-term coordinated effort within the Basin. Individual land managers and livestock operators must be recognized for their efforts in adopting management practices that improve riparian areas.
4.3.2 Field Spreading Manure

On manure utilization, the literature review by Dillon Consulting Limited stresses that manure must be managed as a soil amendment that is applied based on good agronomic practices of testing the soil and the manure and matching nutrient application to the crop being grown. This approach is valid regardless of the size of the livestock operation or species being raised. This approach forms the basis for the manure management strategy within the regulatory framework of each province.

4.3.3 Wells

The literature review makes note that wells with the highest concentrations of nitrates had cattle operations nearby. While the presence of elevated nitrates in groundwater is usually an indication of human activities resulting from animal or human waste, it must be understood that the excess nitrate concentrations may be attributable more to the siting and maintenance of the well than to the cattle. When yard sites were initially developed by the original settlers, one criterion for site selection was the availability of groundwater accessible with a hand dug well. Since pressurized water systems were not available, the cattle were penned very close to the well for convenience. The soil conditions of the cattle pens is then suspect, given the fact such a shallow well could be developed. The accumulation of nutrients from the manure in the pens can be a source of contamination for shallow wells. Hand dug wells are large in diameter, which makes proper sealing of the cribbing against surface water contamination more difficult. The result is that many cattle facilities have been developed more closely to the well (shallow aquifers) than is advisable and on soils that may be questionable by today's standards. The proximity of the household septic system to the well is also a consideration for nitrate contamination.

4.3.4 Well Abandonment

Perhaps the most important point to consider in the literature review by Dillon Consulting Limited, is the discussion on abandoned wells. Any type of excavation that extends into the subsoil increases the potential for groundwater contamination. Improperly abandoned wells are particularly susceptible to providing a direct path for contaminants to reach the groundwater. They can also be a very real safety hazard to animals and people. Existing wells that are improperly capped are equally prone to subsoil contamination. As the report suggests, emphasis on properly decommissioning abandoned wells, in conjunction with assuring operative wells are properly maintained, is of prime consideration for the protection of groundwater in the Basin.
4.3.5 Animal Diseases Associated with Water

The literature review by Dillon Consulting Limited also mentions the transmission of disease when cattle have direct access to open water and flowing water in particular. While several diseases are mentioned in the report, there was no discussion on them. The following information is cited primarily from The Merck Veterinary Manual, 8th Edition (Merck and Co. 1998), with excerpts from other references noted;

- **Leptospirosis** - is a contagious disease of animals, including man and wildlife. Because the organisms survive in surface waters for extended periods, the disease is often water-borne. The disease in man is often occupationally related to those working frequently with animals. Management methods to reduce transmission include rat control, fencing cattle from potentially contaminated streams and ponds, separation of cattle from pigs and wildlife, careful selection of replacement stock, and vaccination of replacement stock.

- **Bovine Viral Diarrhea Virus (BVDV)** - is well known to cattle operators. The natural reservoir for BVDV is persistently infected cattle. BVDV is transmitted transplacentally (in the womb) during the first four months of fetal development; therefore, infection is present at birth and lasts for life. Large numbers of BVDV are shed in the secretions and excretions of persistently infected cattle.

- **Giardiasis** - commonly known as “Beaver Fever” is a parasitic disease that occurs worldwide in most domestic and wild animals, many birds, and people. *Giardia* cysts survive in the environment and thus are a source of infection and reinfection for animals, particularly those in crowded conditions. Cysts are susceptible to desiccation, and areas should be allowed to dry thoroughly after cleaning. Principal animals involved are beaver, porcupines, dogs, and other animals. To prevent the infection in humans, avoid drinking or swallowing any untreated surface water and wash hands after contact with surface water. *Giardia* is now recognized as the most common intestinal parasite in humans world wide and it appears that a similar situation exists in animals (Olson *et al.*, n.d.). It is now established that giardiasis is an important disease of both animals and humans, yet there is limited knowledge of this disease.

- **Cryptosporidiosis** - is a parasitic disease that occurs worldwide. It is not host-specific and is common in young ruminants, particularly calves. It is also found in man and pigs and is rare in dogs, cats, and horses. Unless the immune system is compromised, it is self-limiting. Principal animals involved are cattle and other animals. To prevent the infection in humans, avoid drinking or swallowing any untreated surface water and wash hands after contact with surface water or direct exposure to cattle and other farm animals.
4.4 Prairie Provinces Committee on Livestock Development and Manure Management

A tri-provincial committee among Alberta, Saskatchewan, and Manitoba was established to develop a common environmental approach for livestock development on the Prairies. The Committee’s theme is “Sustainable Livestock Development Through Science Based Standards”. The committee realized that each province was dealing with similar concerns regarding livestock issues and that the three provinces were dealing with these livestock issues under similar weather and soil conditions.

The Committee is co-chaired by representatives of Alberta Agriculture Food and Rural Development, Saskatchewan Agriculture and Food, and Manitoba Agriculture and Food. Membership on the Committee includes both regulatory and development based agencies from each province (Alberta Agriculture Food and Rural Development, Saskatchewan Agriculture and Food, Manitoba Agriculture and Food, and Manitoba Conservation). The Prairie Farm Rehabilitation Administration (PFRA) under Agriculture and Agri-Food Canada, represents Canada.

The Committee is responsible for the mandate, direction, selection, and prioritization of specific topics for the development of standards. This is accomplished through regular meetings, consultation with researchers and industry, and detailed priority setting sessions. Topics targeted for standards development are those expected to provide benefit to industry regulators and stakeholders, and which have sufficient scientific basis for development. Topics lacking in sufficient science for the development of standards are identified as priority research topics.

For the 1999-2000 period, the Committee has formed four working groups to draft standards for:

- Site characterization for livestock development;
- Manure storage construction;
- Manure use and application; and
- Defining animal units.

Completion dates of the tasks will vary between topics. Most tasks are targeted for completion in the year 2000. Communication of committee activities is accomplished through stakeholder consultation and through an annual manure management conference. The conference highlights advanced and applied research relating to manure management with a prairie theme, and is hosted on a rotational basis by the three prairie Provinces. The first manure management conference was held on June 23 and 24, 1999 in Saskatoon, Saskatchewan. The year 2000 conference is scheduled for June 26 to 28 in Calgary, Alberta.
4.5 Demonstration Projects

4.5.1 Off-Stream Livestock Watering Demonstration

The Water Quality Committee of the Upper Assiniboine River Basin Study assisted in developing an off-stream watering demonstration at the PK Hereford farm on the Whitesand River south of Canora on Hwy. No. 9. Research in Alberta and Saskatchewan has shown that livestock performance has benefitted from clean drinking water (Willms et al., n.d.). Given a choice, the research showed that cattle preferred to drink from a trough rather than from a dugout. The daily rate of gain can be significantly greater for cattle using a trough as compared to those accessing surface water directly. Similar research is continuing in the Prairie provinces and British Columbia.

Based on the economic benefits and increasing environmental concerns of the public, herd and range management practices now focus on techniques that protect or enhance water quality by restricting livestock access to surface water supplies. These techniques tend to encourage vegetative growth in riparian areas. An increase in the numbers of woody plants improves stream bank stability and eventually offers better shelter for the cattle. The increased plant growth and stability of the stream bank leads to healthier and more diverse aquatic life in the stream or river.

4.5.1.1 1998 Activities

In the spring of 1998, PK Herefords approached Saskatchewan Agriculture and Food to discuss alternatives to the pasturing and overwintering system they currently practice. The Whitesand River flows in a northerly direction through the east portion of their pasture. From the west, the Good Spirit Lake drainage channel dissects the section and joins the Whitesand River. PK Herefords wanted to move the wintering site from the river's edge to an upland area north and west of the main yard. The Upper Assiniboine River Basin Study, Water Quality Committee, became involved and supported their plans. The Committee suggested that an off-stream watering system be used over the summers of 1998 and 1999 as a trial to determine the practicability of fencing along the banks of the Whitesand River. With the local support of the District 19 Agriculture, Development, and Diversification Board (ADD Board), the operator agreed to the plan and the project was initiated. A solar powered 24-volt pumping unit was installed to deliver water from the Whitesand River to a trough on the edge of the river bank. Two 12-volt marine batteries powered both the pump and electric fence. About 2.5 kilometres of electric fence was installed along both sides of the river to restrict the cattle from watering in the river. River crossings for the cattle were established by placing gates in the electric fence on either side of the river at several locations. It took two days to place the electric fence along both sides of the Whitesand River. The fence was energized as each section was completed and marked with ribbon. By the time fence construction was finished, the cattle had been trained to the fence and were remaining out of the area between the fence and the river. The fence was in place and operational before the solar pumping system was installed. The solar powered
watering system was not received and installed until September. The cattle never used the trough for their water supply. Lack of use of the trough by the cattle was attributed to several factors:

- The solar pump/trough system was not in place long enough for the cattle to adapt;
- The river should have been completely isolated for a period of time to force the cattle to drink from the trough; and
- Although placed in the near vicinity of the mineral/salt blocks and back rub, the trough should have been placed immediately adjacent to these items.

Fencing of a water course is not always the practical answer to riparian area protection. In this pasture the Whitesand River’s flood plain is relatively wide and shallow. It is prone to flooding in the spring and has variable water depth throughout the summer and fall due to rainfall occurrences and upstream water management. A heavy rain in June 1998 raised the water level of the river sufficiently to flood sections of the electric fence. Although the fence withstood the onslaught of water and debris very well with only minor repair necessary after the water went down, it demonstrated that corridor fencing for this site was not a long-term solution.

A more practical approach is required on a river with such a wide and low flood plain. Adopting a rotational grazing system, whereby the cattle are allowed to intensively graze the area for a very short time period and are then moved off to another pasture may be the solution. This type of system works well for grazing in the fall when water levels are usually at the lowest and forage supplies elsewhere in the pastures are declining. In October 1998 the fence and watering system were removed from the river area.

4.5.1.2 1999 Activities

The solar powered pump and watering system were re-installed in the pasture in the spring of 1999. No additional fencing was installed. The cattle were given free choice to water from either the river or a trough. As stated earlier, research has shown that cattle prefer to water from a clean trough rather than a static water source which they must enter to drink (i.e., a dugout or slough). The demonstration was intended to confirm whether cattle also exhibit this preference with flowing water. Flowing water tends to experience less quality degradation than standing water. Over the years the cattle herd had become very accustomed to drinking from the river. To help offset this habit, the watering trough was located adjacent to the mineral/salt blocks and back rub as an added incentive to use the trough.

The cattle did exhibit some tendency to drink from the trough instead of from the river. Not all animals used the trough. This was expected given the animals’ past history of always having had the river as the only source of water. The pumping system was removed in the fall of 1999 and the project was terminated.
4.5.2 Whitesand River Watershed Enhancement Project

In addition to PK Herefords, five other cattle operators on or near the Whitesand River were approached to determine if they wished to improve their riparian area management along the river and its tributaries. Several meetings were held with all interested co-operators. It was explained that in conjunction with improvements to the riparian areas, application would be initiated under *The Agricultural Operations Act* to have the confinement portion of each of their livestock operations renovated sufficiently to receive approval under the Act. All agreed to participate and riparian area/pasture management plans were developed.

Application was made to the National Soil and Water Conservation Program (NSWCP) for support funding. All management plans were developed to target two primary purposes:

- Voluntary adoption and demonstration of alternative livestock and cropping management practices to protect or enhance water quality in riparian areas; and
- Cattle confinement area renovations necessary to receive approval under *The Agricultural Operations Act*.

The Whitesand River Watershed Enhancement Project was patterned after a similar and relatively successful riparian management project near Melville called the Crescent Creek Watershed Enhancement Project. In 1997, plans were made to enhance landowners’ awareness of riparian management practices and water quality issues on Crescent Creek upstream of the City of Melville Reservoir. The reservoir, in addition to supplying a portion of the City of Melville’s municipal water supply, is a recognized sport fishery, one of the few sites in eastern Saskatchewan annually stocked with pickerel from the provincial fish hatchery.

Approximately 70 landowners within the targeted watershed area were contacted, provided information about riparian area management and surveyed as to their interest in participating in the project. Site visits were conducted with interested landowners and riparian management plans were developed and voluntary agreements to undertake enhancement activities were completed. To date, 12 co-operators have undertaken various enhancement activities and 2,880 acres of land have been impacted upstream of the reservoir.

The adoption of riparian enhancement activities was found to be greater in the second year of the project than the first and this was attributed to three factors:

- Time required to “plant the seed” or idea of change;
- Neighbor watching neighbor and learning from their peers; and
- Overcoming a watershed project’s negative connotation of land control.

It is anticipated that future participation by landowners will be limited only by budget, as most producers are environmentally conscientious and want to adopt enhancement activities, but cannot due to currently depressed economics in the primary agricultural production sector.
In addition to working with landowners, a group of local volunteers from the Melville Comprehensive Institute and wildlife conservation groups were trained to assist with volunteer ecological monitoring of Crescent Creek. This has involved educational workshops (three held to date), and monthly monitoring of water quality, riparian health assessment of various reaches of stream banks along Crescent Creek, and surveys of macro-invertebrates. Water samples are collected at three sites each month and analyzed for temperature, pH, dissolved oxygen, electrical conductivity, total dissolved solids (TDS), nitrates, phosphates, and coliform bacteria. The riparian health assessment criteria used were developed by Dr. Paul Hansen, Riparian and Wetland Research Program, Montana State University. The Crescent Creek project was made possible by in-kind contributions from participating landowners and funding from Environment Canada’s Action 21 Program (1998-2000), the Canadian Adaptation in Rural Development in Saskatchewan Program (CARDS, 2000-2001), and the efforts of partnering agencies of PFRA, SWCC, and SERM.

In the spring of 1999, funding support was confirmed for the Whitesand River Watershed Enhancement Project for activities related to landowner contact, riparian area enhancement, and volunteer ecological monitoring. Initially, over 127 landowners were contacted along a 56.3 kilometre target section of the Whitesand River, within rural municipalities #273, #274, and #244. The project was intended to educate and increase awareness of riparian management practices and explain the benefits of stream bank stewardship. By August 1999 riparian management plans were developed for a total of eight co-operators, involving 3,840 acres. All six co-operators have cattle near the Whitesand River or a tributary of the Whitesand River.

Numerous activities were undertaken by the project co-operators throughout the spring, summer, and fall of 1999. These activities included establishment of vegetative buffer strips, conversion of crop land to forages, fence construction, off-stream watering site development, berm construction (to control runoff), improvement of low-level crossings, rotational grazing management planning, and the relocation of winter feeding sites. Enhancement activities were cost-shared with the landowners to a maximum of 50 percent as described below.

4.5.2.1 PK Herefords (Clint, Jim, and Richard Kopelchuk)

The Kopelchuks currently operate a mixed farming operation involving over 1000 acres of grains and oilseed production, and a 60-head purebred Horned Hereford operation along the banks of the Whitesand River on NE-23-29-04-W2 in the RM of Good Lake #274. Their farm is situated adjacent to Hwy No. 9 where the highway crosses the Whitesand River south of Canora, Saskatchewan. Upland soils are dominantly sandy fluvial (Perley-Meota) and the lower flood plain areas are weakly developed runway soils associated with shallow, poorly drained areas. Their existing wintering facilities and holding pasture are located beside the Whitesand River within the flood plain.

The Kopelchuks’ riparian management plan was to relocate the winter feeding site to an upland area west of the yard and away from the Whitesand River. A multi-row shelter belt was established in 1994 around the perimeter of the new winter feeding site to provide additional
shelter. Relocation in 1999 involved constructing 152 m of corral fence, 152 m of porosity fence, barbed wire fence, relocating the cattle shelter, trenching 122 m of water and power lines, and installing two watering bowls west of their existing farm yard. Decommissioning of the old winter feeding site and additional tree planting on the south perimeter of the quarter section are planned in 2000. Approval under The Agricultural Operations Act was received in fall 1999.

Project Cost: $28,542.00

4.5.2.2 Lucky “C” Ranches (Al Claiter)

Al Claiter operates a 100-head purebred cattle operation west of Ebenezer in the RM of Good Lake #274. Five out of six quarters of land (E1/2-32-27-04-W2, S1/2-33-27-04-W2 and SW-27-27-04-W2) are bisected by Yorkton Creek, a tributary of the Whitesand River, and are located just south of the convergence of the Yorkton and Cussed creeks. The Town of Ebenezer well is located on his home quarter (SE-32-27-04-W2).

Claiter’s riparian management plan was to construct 8 km of fence (permanent and electric) to restrict access of livestock to the creek and other surface water bodies. Vegetative buffer strips were established along 3.2 km of stream bank, an additional 60 acres of crop land was converted to forages, and two of three off-stream watering sites were established. Mr. Claiter received approval under The Agriculture Operations Act in the fall of 1999.

Project Cost: $12,911.00

4.5.2.3 Weinbender, Carey and Leanne

The Weinbenders operate a mixed grain and 80-head purebred Charolais operation on six quarters of land in the RM of Sliding Hills #273. Five of the six quarters are bisected by the Whitesand River and land use is predominantly forage production (hay and pasture). In the past, the Weinbenders’ rotational grazing system utilized the riparian areas and stream banks extensively, and the cattle watered directly from the river. The Weinbenders enhanced their present rotational grazing system and converted an additional 100 acres of crop land on an adjacent upland site to forage to reduce the grazing pressures on the riparian areas. This was accomplished by seeding additional acres of crested wheatgrass and meadow bromegrass on two parcels (NW-30-29-03-W2 and SE 31-29-03 W2), constructing a barbed wire fence, and establishing an off-stream watering site.

Their winter feeding site built on the south facing slope of a shallow coulee on SW-31-29-03-W2, is less than 200 metres from the Whitesand River. It consists of five holding pens, a 12 by 24 metre cattle shelter, calf shelters, lights and watering bowls. The coulee bottom or draw area has extensive woody vegetation running approximately 350 m in length, and flows intermittently (for 2-10 days each spring) into the Whitesand River. Peak surface runoff through the coulee is largely attributed to spring snow melt entering the ditches of the grid roads that run west and north of, and from beyond their farmyard. This ditch runoff then drains easterly through a ditch
culvert and into the coulee. The south-facing orientation of the winter feeding site provides for high rates of sublimation, and surface runoff directly from the winter feeding site in spring is minimal. Significant rainfall events in spring/summer are the greatest potential source of surface runoff from the winter feeding site but by then the cows and calves have already been turned out onto pasture. Each year the cattle are normally turned out to crested wheatgrass (CWG) pastures in early spring (May) and do not return to the winter feeding site until November/December.

The Weinbenders originally planned to relocate their wintering facilities to an upland area on NE-25-29-04-W2, 300 metres west of the existing yard site, approximately 366 m away from the river. Despite receiving NSWCP approval to fund 50 percent of their original proposal, the economic feasibility of relocation, combined with current economic constraints, eliminated the possibility of relocation. The Weinbenders strived to become compliant with The Agricultural Operations Act and a revised riparian management plan was proposed, involving PFRA engineered options such as culvert and drop structures and holding ponds. Again, cost estimates for the engineered works were excessive (over $40,000) and prohibitive. Also of note, the loss of native woody vegetation due to proposed construction activities and earth moving equipment would have been extensive and required considerable time for rejuvenation. Finally, site assessment of the coulee in August 1999 revealed extensive natural re-vegetation (i.e., grassed in) of the coulee bottom, after an electric fence was installed running parallel to the bottom of the coulee. This left the cattle to the higher side slopes and upland areas of the winter feeding site and away from the bottom of the draw area. Additional measures of manure management and corral cleaning were imposed and the site was finally granted approval under The Agricultural Operations Act in February 2000.

Project Cost: $12,911.00

4.5.2.4 Lamont, Tom and Betty

The Laments operate a 25-head livestock operation on 62 acres on Pt-SW-28-30-03-W2, which is bisected by the Whitesand River, in a highly visible location immediately adjacent to Hwy No. 5 east of Canora. Soils are dominantly silty clay loam (Naicam-Yorkton) with some sandy loam (Bredenbury-Meota) occurring. The parcel is separated into five grazing paddocks of native and tame forage, of which three paddocks include riparian areas. The river banks of the Whitesand River are deeply incised at this location. In the past the cattle grazed on the steep slopes down to the water's edge and watered from the river. The Laments wanted to mitigate the stream bank erosion that was evident from this practice.

The Laments’ riparian management plan focused on enhancing the riparian condition by deferring and limiting the duration of grazing on the river banks. This was accomplished by the establishment of an off-stream watering site, rejuvenating the upland forage stand, and construction of approximately 800 metres of barbed wire fence. As well, an old domestic garbage dump site which was situated within the riparian area, and visible from Hwy No.5, was
removed and the site reclaimed. The Laments received approval under *The Agricultural Operations Act* in the fall of 1999.

Project Cost: $3,583.00

### 4.5.2.5 Manahan, Ward and family

Ward Manahan and his family operate a mixed farm along Hwy No. 9 south of Canora on the N1/2-24-29-04 W2. Approximately 1.4 km of Whitesand River bisects the NW quarter. The soils are dominantly sandy fluvial (Perley and Perley-Meota). Current land use on the 320 acres includes:

- pasture along a narrow strip of river bank;
- 30 acre paddock seeded to smooth brome/alfalfa in 1997 and 1998 (some re-seeding was required due to dry conditions and poor establishment);
- 30 acres seeded to alfalfa for hay;
- approximately 170 acres cultivated; and
- 90 acres of yard, gravel pits and river bank.

Manahans’ riparian management plan was to implement a rotational grazing system that deferred grazing of his 30 head of cow-calf pairs on the river banks. To accomplish this, vegetative buffer strips were seeded along the river, 80 acres of crop land was converted to pasture, 4 km of barbed wire fence were constructed to restrict access of cattle to the river, and an off-stream watering site was established. The Manahans received approval under *The Agricultural Operations Act* in the fall of 1999.

Project Cost: $14,884.00

### 4.5.2.6 Pretty View Stock Farm, (Ivan and Phyllis Olynyk)

Ivan and Phyllis Olynyk run a 100-head purebred Red Angus operation in a highly visible location along Hwy No. 9 within 300 metres of the Whitesand River. The soils are dominantly sandy fluvial (Perley and Perley-Meota soils). Their existing winter feeding site on Pt. SE-13-29-04-W2 is situated on (and bisected by) an intermittent creek (tributary of the Whitesand River).

Their riparian management plan involved relocating the winter feeding site to an upland area away from the creek and relocating corrals and porosity fence, calving sheds and watering bowl. The management plan also included the construction of a 800 metre berm, improving a low level crossing and culvert installation, grassing a buffer strip and the berm, and constructing approximately 1.6 km of barbed wire fence along the perimeter of the creek to restrict access of the cattle to that area. On W1/2-12-29-04-W2, the Olynyks were also interested in improving a 30-acre riparian pasture dissected by Wallace Creek. Wallace Creek is a tributary of the
Whitesand River which crosses the Hwy No. 9. Cattle currently water directly from the creek. Time constraints did not allow the work on the riparian pasture to be completed in 1999.

Project Cost: $16,792.59

Local groups and educational institutions were approached to determine interest in assisting with water quality monitoring, riparian health assessment, and macro invertebrate surveys. At six sites along the Whitesand River and its tributaries, water samples were collected and analyzed, macro invertebrates were surveyed and specimens were collected. Song bird and waterfowl surveys were conducted.

Funding under the NSWCP was also approved for production of a 22-minute video featuring riparian projects within the Basin and across Saskatchewan. The video is being prepared by the project partners for general distribution to explain the merits of good riparian area management from producers’ standpoints. Entitled “Riparian Areas: Caring for a Prairie Treasure”, this video will be available for general distribution in April 2000 and will provide an excellent educational tool for schools, producer groups and public extension events and promote the efforts of the land owners involved in stream bank stewardship.

A full size display featuring the Whitesand River and Crescent Creek Watershed Enhancement Projects was developed in the fall of 1999. The display helped promote project accomplishments at the “Where Land Meets Water” Riparian Conference in Red Deer, Alberta during October 19-21, 1999. The display was also used at the Forage and Grazing Management Conference in Saskatoon, Saskatchewan in December 8-10, 1999 and at the Farm and Leisure Trade Show in Yorkton, Saskatchewan April 27 - 29, 2000.

Other livestock producers along the Whitesand River and tributaries have expressed interest in improving the riparian areas in 2000. Funding from Canadian Adaptation in Rural Development in Saskatchewan Program CARDS (2000/2001) will assist in this endeavour.

### 4.6 Summary and Recommendations

Based on the observations in the Dillon Consulting Limited report “Upper Assiniboine River Basin Water Quality Study - Final Report, November 1998” and the UARBS’s research of the Basin, several key points that should be targeted by and for the livestock industry with respect to improving water quality were noted.

#### 4.6.1 Key Target Areas for Livestock Industry

1) Proper decommissioning of abandoned wells; proper maintenance of existing wells and; proper siting and construction of new wells.

2) Improvement to riparian areas through alternative pasturing, livestock watering systems, and properly located and managed winter feeding sites.
3) Increased awareness of the value of manure as a resource rather than a waste, and the related manure management practices associated with storage, removal and land application.

4) Education to the public that proximity of animals, confined or pastured, near surface water does not automatically mean pollution is occurring.

5) Long-term monitoring of water quality and riparian health on a watershed basis; utilizing well defined parameters and protocols along with efficient implementation, for establishing baseline information, analyzing emerging trends or issues, and planning/developing practical, targeted solutions and recommendations.

6) Education and awareness of issues affecting landscape management (i.e., land and water) involves an integrated interagency approach to strive for the provision of accurate, unbiased, and effective communication of information/results to the general public and stakeholders.

4.6.2 Public Information

A brochure and fact sheet were prepared as part of a public information program and are in Appendix V of this report. In the 18 page booklet entitled “Water Quality in the Upper Assiniboine River Basin”, an overview of livestock and water quality was provided on pages 9 to 11. In addition, a fact sheet was developed on the Kopelchuk Project; “Off-Stream Cattle Watering Demonstration Site”.
5 Cropping and Water Quality

5.1 Introduction

Annual cropping is practiced by virtually every farm in the Basin. This chapter offers discussion on tillage practices, fertilizer use, and associated regulatory controls.

Figures 5.1 to 5.4 are maps of the Basin that were developed based on data from the 1996 Census of Agriculture. Figure 5.1 shows the tillage practices used to prepare land for seeding, while Figures 5.2, 5.3, and 5.4, respectively, show fertilizer, herbicide, and insecticide usage in the Basin. The figures show that commercial fertilizers and herbicides are used extensively throughout the Basin. Insecticides are less commonly used. The need for insecticides is dependent upon whether weather conditions support above normal proliferation of harmful insect pest outbreaks.

The maps only show the agricultural use of herbicides, insecticides, and fertilizers. The maps do not include the products used in non-agricultural sectors such as residential lawns and gardens, parks, golf courses, or forestry.

5.2 Pesticides

5.2.1 Pesticide

A pesticide is any chemical used to control pests such as weeds (herbicides), insects (insecticides), crop diseases (fungicides), or rodents (rodenticides). In general, insecticides are more toxic than herbicides. Organophosphorous insecticides are more toxic than carbamates and organochlorine insecticides. Pesticides are classified in three ways:

5.2.1.1 Pesticide Classification by Purpose/Mode of Action

(1) Insecticides
   (a) contact insecticides - direct external contact with insect provides control
   (b) stomach poisons - insect must ingest to provide control
   (c) systemic insecticides - applied to and absorbed by plant/animal for insect control
   (d) fumigants - contact and control insect through vaporized form; this type can be further classified by the stage of life cycle that the insect is currently in during control: adulticides, larvicides, oxicides
Figure 5.1
Tillage Practices Used to Prepare Land for Seeding in the Upper Assiniboine River Basin
Figure 5.2
Fertilizer Usage in the Upper Assiniboine River Basin
Figure 5.3
Herbicide Usage in the Upper Assiniboine River Basin
Figure 5.4
Insecticide Usage in the Upper Assiniboine River Basin
(2) Herbicides
(a) contact herbicides - direct contact with plant tissue provides control
(b) systemic or translocated herbicides - control by being absorbed by the plant
(c) growth regulators - control by regulating growth characteristics of the plant
(d) selectivity - non-selective: kills or suppresses all vegetation; selective: kills or suppresses target vegetation
(e) time of application - pre-plant: soil applied or soil incorporated; pre-emergent: applied prior to crop emergence; post-emergent: applied after crop emergence

(3) Fungicides
(a) protectant fungicides - applied before infection occurs, coverage important
(b) systemic fungicides - absorbed by the plant for somewhat longer term protection

5.2.1.2 Pesticide Classification by Formulation

1. solution (SN)
2. emulsifiable
3. concentrate (EC)
4. wettable powder (WP)
5. flowable (F)
6. dry flowable (DF)
7. granule (G)
8. water dispensable granule (DG)
9. water soluble powder (WSP)
10. amine (A)
11. ester (E)

5.2.1.3 Pesticide Classification by Chemical Composition

(Guide to Crop Protection, 2000)

1. Biological Pesticides - are living organisms (or their spores) used to control pests, e.g., Bacillus thuringiensis (Bt)
2. Inorganic Compounds - do not contain carbon, e.g., copper sulphate (blue-stone), aluminum phosphate (Gastoxin, an insecticide used to control insects in stored grain)
3. Organic Compounds - contain carbon, make up over 22 groups or families of chemicals. The major organic chemical groups are:

(a) Organochlorine compounds: most are insecticides with a high toxicity, e.g., lindane (Vitavax, DB Green L Dual Purpose, NM Dual Purpose, Agrox. Foundation, and Premiere Plus), endosulfan (Thiodan, Thionex, and Endosulfan). They are generally persistent in the soil and can accumulate in fatty tissues.
(b) Organophosphorous compounds: most are insecticides, with high toxicity to mammals. They act as cholinesterase depressants affecting the central nervous system, e.g., malathion (Malathion and Fyfanon), dimethoate (Cygon, Lagon, and Hopper Stopper), chlorpyrifos (Lorsban and Pyrinex).
(c) Carbamate and thiocarbamate compounds - occur as:
   ▶ insecticides that are highly toxic, e.g., carbaryl (Sevin), methomyl (Lannate) and carbofuran (Furadan)
herbicides that are low toxicity to mammals e.g., triallate (Avedex)
fungicides that are very low toxicity e.g., mane (DB Green L)

(d) Chlorophenoxy compounds: most are herbicides with low to very low toxicity to mammals and include 2,4-D, MCPA, and Mecoprop.
(e) Substituted ureas: most are herbicides with moderate toxicity e.g., linuron (Linuron 480, Afolan F, and Lorox Toss-N-Go)
(f) Triazines and triazoles: most are herbicides with moderate toxicity. They tend to persist in the soil e.g., atrazine (Atrazine), cyanazine (Bladex), metribuzine (Sencor), simazine (Simazine and Princep), and amitrole (Amitrol)
(g) Botanicals and pyrethroids: derived from plant materials and include pyrethrin, nicotine, and rotenone. Pyrethroids are synthetic compounds similar to pyrethrin, but modified to improve stability.
(h) Nitrophenolic compounds - have a strong staining, yellow colour and are highly toxic to humans and animals. They are insecticides, fungicides, and herbicides including crop desiccants.
(i) Dinotrolototulidine compounds: these are herbicides that are yellow in colour, and have a low toxicity to mammals e.g., trifluralin (Trifluralin).
(j) Phthalimides: these fungicides are moderately toxic to humans e.g., captan (Captan).
(k) Other chlorinated organic acids: this group has relatively low toxicity to humans, but residues may persist in the soil e.g., picloram (Tordon)
(l) Pyridyllium compounds: are herbicides capable of rapid dessication of foliage (e.g., diquat and paraquat). These chemicals are highly toxic to humans, especially if inhaled.
(m) Other: included alcohols, aldehydes, acetamides, pyridines, nitriles and more.

5.2.1.4 Toxicity of Pesticides

It is important to understand the relative toxicity of the pesticide in question. Toxicity varies with the type of formulation used, the route of absorption into the body, and body weight. Susceptibility of humans to pesticide poisoning also varies with age, sex, nutritional state, and health status. Relative toxicity is measured as the lethal dose 50 percent (LD50) value of the active ingredient of each pesticide (Saskatchewan Agriculture and Food and Saskatchewan Labour, 1998). The smaller the LD50 value, the more toxic the compound. Knowing the relative toxicity of a compound allows applicators the ability to choose less hazardous pesticides to control pests.

5.2.1.5 Pesticides Toxic to Fish

(1) Herbicides
(a) acrolein (Magnacide)
(b) copper sulphate
(c) bromoxynil (Pardner, Laser, Torch)
(d) metolachlor (Dual II)
(2) **Insecticides**

(a) azinphos-methyl (Guthion)  
(b) bendiocarb (Ficam, Trumpet)  
(c) fenthion (Spotton)  
(d) carbofuran (Furadan - banned in 1996)  
(e) malathion (Malathion)  
(f) chlorpyrifos (Lorsban, Dursban)  
(g) methamidophos (Monitor)  
(h) cypermethrin (Ripcord, Cymbush, Stockaid)  
(i) deltamethrin (Decis)  
(j) parathion (Guardsman)  
(k) dicofol (Kelthane)  
(l) permethrin (Ambush, Ectiban)  
(m) disulfoton (Di-syston)  
(n) rotenone (Deritox)  
(o) endosulfan (Endosulfan)  
(p) terbufos (Counter)  
(q) oxydemeton-methyl (Metasystox-R)

(3) **Fungicides**

(a) captan (Captan)  
(b) maneb (DB-Green L, N-M Drill Box)  
(c) dodemorph (Meltatox)  
(d) pentachlorophenol (Wood Preserver)  
(e) folpet (Phalaton, Folpan)

### 5.3 Pesticides Discussed in the Dillon Consulting Limited, Literature Review

Clarification for some of the pesticides discussed in the literature review conducted by Dillon Consulting Limited is warranted.

#### 5.3.1 DDT

This insecticide was banned for agricultural use in Canada in 1970. Use of DDT after that date was subject to strict control and only allowed if no other option existed. In 1985 all remaining DDT uses were withdrawn from Canada under any circumstances. The USA banned DDT for all uses in 1973. DDT is still used extensively in some countries to control malaria.

#### 5.3.2 2,4,5-T

Canadian registration for this herbicide was discontinued January 1, 1986. A member of the chemical group of chlorophenoxy compounds, these herbicides have a very low toxicity to humans.

#### 5.3.3 Atrazine

This herbicide is registered for use on corn only. There is very limited cropping of corn in the Basin. The limited amount of corn that is grown in the Basin is usually harvested as silage. Common practice is to use no herbicides on the silage corn unless weed conditions get ahead of
the corn crop in the spring. There may also be some limited use of atrazine on sweet corn grown for local use.

5.3.4 Endosulfan

Endosulfan includes Thiodan and Thionex. Endosulfan is registered for insect control on potato, sunflower, and bean crops. The acreage committed to these crops is very limited in the Basin.

5.3.5 Metolachlor

Metolachlor is the active ingredient in Dual II. The herbicide is registered for use on corn, soybeans, potatoes, dry beans, sweet white lupins, and processing peas. Based on the limited acres of these crops in the Basin, use of metolachlor is negligible.

5.3.6 Phorate

Phorate is the active ingredient in Thimet. The insecticide is registered for use on potatoes. Based on the limited acres of potatoes grown in the Basin, use of phorate is negligible.

5.4 Water Sources for Pesticide Application

Virtually all pesticides must be mixed with water for application. There are two primary reasons why a clean water supply is important for effective pesticide control:

1) clean water enables the pesticide to perform as expected; and
2) clean water reduces the frequency of plugged nozzles.

Extreme caution is imperative when filling the sprayer to ensure that no pesticide is allowed to enter the water supply. Many community wells forbid filling a sprayer directly from the well. Only nurse tanks can be used. This is also a very good practice to follow for private wells.

When pumping directly from wells and surface water, the end of the delivery hose should never be extend into the tank and the pumping system should be equipped with an anti-siphoning device. The sprayer tank should not be allowed to overflow during filling and chemicals should not be handled in the vicinity of the water supply in case of accidental spills.

Improperly sealed abandoned wells in the spray path of pesticides or in the vicinity of handling the chemicals can offer an immediate pathway for the pesticides to reach groundwater. All abandoned wells should be decommissioned properly. Existing wells should have the cribbing/ground surface area sealed and contoured properly. Surface water supplies should be afforded sufficient protection from accidental spills.
5.5 Legislation

Pesticide use is regulated in both Saskatchewan and Manitoba.

5.5.1 Federal

Federal control over pesticides is through the Pest Control Products (Canada) Act. The Act deals primarily with the registration of pesticides but it does have a section which deals directly with pesticide application. It states that pesticides must be applied in accordance with label directions. This means that a pesticide can only be used for the purpose for which it was created.

5.5.2 Saskatchewan

The Pest Control Products (Saskatchewan) Act regulates the use, handling and distribution of pesticides in Saskatchewan. It requires that all commercial or custom pesticide applicators be trained and licensed. Pesticide applicator training is offered by the Saskatchewan Institute of Applied Science and Technology (SIAST) either as classroom or home study courses. Upon successful completion, a pesticide applicator licence can be applied for annually. Pesticide recertification/training is required every five years. Some of the Saskatchewan pesticide regulations are:

1) Any person who applies pesticides for other than their own use must have a valid pesticide applicators licence.
2) Any person who conducts a business of applying pesticides must have a valid pesticide service licence.
3) Any person who sells pesticides must have a valid pesticide vendor licence.
4) All licensed applicators must keep a record of every pesticide application and keep these records for three years.
5) All licensed aerial applicators must have $25,000 drift insurance.
6) No person shall apply pesticides to open bodies of water without a permit.
7) No person shall use pesticides in a manner other than what is described on the pesticide label.

Regulations regarding distance restrictions, wind speed restrictions, application method (air vs. ground), etc., vary from product to product. These specific restrictions are outlined on the pesticide label for each individual product. The label is considered a legal document and the application methods listed on the label must be followed. This applies to all pesticide applicators.

Some examples of these restrictions are: do not apply this product within 15 m of an environmentally sensitive area; do not apply when bees are actively foraging; and you must be a certified applicator to apply this product.
5.5.3 Manitoba

The purpose of *The Manitoba Pesticides and Fertilizers Control Act* (PFCA) is to ensure safe pesticide use by making pesticide dealers and applicators more knowledgeable about pesticide use and safety. The PFCA outlines training, examination and licensing requirements to meet this goal. Under the PFCA, all commercial pesticide applicators and retail pesticide dealers are required to have a license.

Pesticide dealer/applicator training material and examinations are available from Assiniboine Community College, 1430 Victoria Avenue E., Brandon MB, R7A 2A9. Courses are offered in specific licensing categories depending on the type of pesticide application being done or type of pesticides being sold. Course re-certification is required every five years.

A dealer/applicator can apply for a license once training is complete. Pesticide licenses are issued by Manitoba Agriculture and Food, 201-545 University Crescent, Winnipeg MB, R3T 5S6. Licenses are renewable yearly for a fee of $50.00. Commercial applicators must provide evidence of liability insurance as a licensing requirement.

The PFCA requires a minimum of $250,000 general liability and $25,000 spray drift or chemical misuse coverage. The PFCA requires pesticide dealers to keep a record of all commercial and restricted pesticides sold and requires a record of pesticide application be kept by all pesticide applicators.

Exemptions under the PFCA include:

1) Fertilizers, domestic label pesticides, wood preservatives, antimicrobials, animal repellants, feed preservatives, bactericides;
2) Farmers who apply pesticides to their own land and for not more than 3 individuals per year on less that 500 ha off their own farm in any year; and
3) Wholesale pesticide vendors or distributors.

The Pesticide Advisory Committee advises the Manitoba Agriculture and Food Minister on issues relating to the PFCA. The committee consists of seven members representing the Manitoba and municipal governments, dealers/applicators and producer groups. Penalties under the PFCA include fines ($100 to $1000), and imprisonment (60 days to six months) or both.

5.6 Agricultural Chemical Container Disposal

5.6.1 Saskatchewan

In Saskatchewan, there are two programs presently in place that deal with the collection of empty agricultural chemical containers. Many pesticide collection sites are operated by local rural municipalities. Some of these sites have been closed and new sites established that are operated by suppliers of the pesticides. Prior to returning empty agricultural chemical containers farmers
are required to clean, triple rinse, and properly drain the containers. The empty containers are collected from the sites by the end of each crop year.

The first program began in 1982, and was referred to as the “Pesticide Container Management Program.” Saskatchewan Environment and Resource Management (SERM) provided funding for initial start-up of the sites, developed extensive siting criteria, and conducted site inspections. However, the day-to-day operations and maintenance of the program was the responsibility of the local municipality (Appendix IV).

The second program, “Voluntary Container Collection Program,” began operation at the start of the 1999 crop season. It is co-ordinated by the Saskatchewan Pesticide Container Management Association Inc. in conjunction with the Crop Protection Institute. Crop protection distribution companies and their participating retail dealers are voluntary participants in the program. Once collected, the empty, clean containers are transported to a central location for shredding. The shredded plastic is shipped to recycling plants for the manufacture of products such as curb stops and fence posts.

These two programs do not deal with unwanted and unused chemical product. Within Saskatchewan, The Pest Control Products (Saskatchewan) Act regulates the improper use, storage, disposal, or abandonment of agricultural chemicals and containers. Local environment offices should be notified if chemicals/chemical containers are improperly used or discarded.

5.6.2 Manitoba

In Manitoba, the pesticide container collection sites are regulated under The Dangerous Goods Handling and Transportation Act which ensures each site is permitted. The permit ensures that surface and groundwater are protected and that each site is lined, bermmed and suitable for receiving the containers. Sites were originally established and maintained within Manitoba municipalities and weed districts with monies supplied by the Association for Clean Rural Environment (ACRE). ACRE received funding from the Crop Protection Institute (CPI) from a levy associated with the sale of pesticide product. Since 1995, the CPI has reduced direct funding to ACRE and instead has funded a private contractor with a mobile operation to shred/crush and dispose of containers at each site. Available funds from ACRE to pay the municipalities for their continued participation in the collection program have been used up. One of the proposed solutions under consideration is to have depots established at retail outlets instead of the current sites. The municipalities have asked Manitoba Conservation to regulate and impose a pesticide container sales levy under The Wrap Act to fund the on-going program. Manitoba is currently reviewing the program to ensure that the problems are resolved and that the handling and disposal of pesticide containers continues to operate in an efficient manner.
5.6.3 Agricultural Chemical Container Collection Depots

Table 5.1 (Saskatchewan only) and Figure 5.5 (map) identify the agricultural chemical container collection depots in the Basin. Excluded from the table, are the container collection sites established through dealer participation within the Upper Assiniboine River Basin (Saskatchewan only). These dealer sites were only established over the last two years and include the following locations: Kamsack (Pioneer Grain Co.), Rama (Rama Co-op Association Ltd.), Rhein (Imperial Oil), Yorkton (Cropmate - UAP, Imperial Oil, Parrish and Heinbecker Ltd.). The municipal sites are being gradually closed in preference to the dealer sites.

5.6.4 Agricultural Pesticide Collection Sites

In early spring 1999, the “Saskatchewan Pesticide Return Program” was initiated for the collection and disposal of unwanted, and obsolete agricultural pesticides. In 1999, only the southern part of the Province participated. In 2000, central Saskatchewan is being targeted and Basin residents south of Hwy No. 16 can participate. In 2001, the program will cover areas north of Hwy No. 16. The program focuses on the collection of pesticides only. Products such as antifreeze, solvents, paints, and other hazardous wastes will not be accepted. Although, a similar program does not exist in Manitoba, negotiations are currently underway to get a similar program organized (personal communication, Cam Davreux, Crop Protection Institute 416-622-9771).

5.7 Tillage and Seeding Activity

Approximately 13 percent of soils within the Basin are coarse textured (sands and sandy loams) and are located around Good Spirit Lake, Sturgis, and Spy Hill. Permanent cover should be the appropriate land use for these soils with the associated forage and livestock production. Over 83 percent of the Basin soils are a moderate texture (loams and clay loams). Combined with normally abundant precipitation, these high quality, fertile soils are conducive to intensive crop production.

There are countless definitions used to report on types of tillage, seeding, and cropping systems. Although usually understood by everyone involved with the industry, the terms defining the various seeding systems tend to have different implications and need to be defined for clearer understanding. Generally, all tillage, seeding, and cropping practices fall into two broad categories: conventional tillage and conservation tillage.

When conservation systems are chosen, emphasis on the importance of field machinery shifts from tillage units to the seeding and harvesting equipment. Managing increased amounts of crop residue becomes more of a challenge in putting the seed in the ground. High amounts of residue on the soil surface can increase plugging and hair pinning during seeding. Ensuring effective spread of crop residues at harvest can be a challenge. Seeding directly into standing stubble (direct seeding) is the ultimate goal of conservation systems.
### Table 5.1
Municipal Agricultural Chemical Container Collection Depots in Saskatchewan

<table>
<thead>
<tr>
<th>Rural Municipality</th>
<th>Land Location (portion, Section, Township, Range, Meridian)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spy Hill, No. 152</td>
<td>SW 16-18-32 W1</td>
</tr>
<tr>
<td>Spy Hill, No. 152 - discontinued site</td>
<td>NW 30-19-31 W1</td>
</tr>
<tr>
<td>Spy Hill, No. 152 - discontinued site</td>
<td>SE 22-19-31 W1</td>
</tr>
<tr>
<td>Langenburg, No. 181</td>
<td>SE 04-21-31 W1</td>
</tr>
<tr>
<td>Langenburg, No. 181 - discontinued site</td>
<td>SW 04-21-31 W1</td>
</tr>
<tr>
<td>Langenburg, No. 181 - discontinued site</td>
<td>SE 25-21-31 W1</td>
</tr>
<tr>
<td>Fertile Belt, No.183</td>
<td>SW 35-19-01 W2</td>
</tr>
<tr>
<td>Churchbridge, No. 211</td>
<td>SE 29-22-32 W1</td>
</tr>
<tr>
<td>Saltcoats, No. 213</td>
<td>SW 04-23-02 W2</td>
</tr>
<tr>
<td>Cana, No. 214</td>
<td>SW 15-23-05 W2</td>
</tr>
<tr>
<td>Stanley, No. 215</td>
<td>SE 27-23-08 W2</td>
</tr>
<tr>
<td>Calder, No. 241</td>
<td>NW 17-25-31 W1</td>
</tr>
<tr>
<td>Calder, No. 241</td>
<td>SE 31-26-32 W1</td>
</tr>
<tr>
<td>Wallace, No. 243</td>
<td>SW 20-27-02 W2</td>
</tr>
<tr>
<td>Wallace, No. 243 - discontinued site</td>
<td>NE 32-25-02 W2</td>
</tr>
<tr>
<td>Orkney, No. 244</td>
<td>SE 26-27-02 W2</td>
</tr>
<tr>
<td>Garry, No. 245</td>
<td>NE 02-27-08 W2</td>
</tr>
<tr>
<td>Ituna Bon Accord, No. 246</td>
<td>NW 03-26-12 W2</td>
</tr>
<tr>
<td>Cote, No. 271</td>
<td>NW 27-29-32 W1</td>
</tr>
<tr>
<td>Sliding Hills, No. 273</td>
<td>SE 10-30-01 W2</td>
</tr>
<tr>
<td>Sliding Hills, No. 273 - discontinued site</td>
<td>SW 05-30-02 W2</td>
</tr>
<tr>
<td>Good Lake, No. 274</td>
<td>SW 19-28-05 W2</td>
</tr>
<tr>
<td>Good Lake, No. 274 - discontinued site</td>
<td>NW 24-28-05 W2</td>
</tr>
<tr>
<td>Good Lake, No. 274</td>
<td>SE 15-30-04 W2</td>
</tr>
<tr>
<td>Good Lake, No. 274 - discontinued site</td>
<td>NW 04-28-05 W2</td>
</tr>
<tr>
<td>Insinger, No. 275</td>
<td>NE 20-29-08 W2</td>
</tr>
<tr>
<td>Foam Lake, No. 276</td>
<td>SE 30-30-11 W2</td>
</tr>
<tr>
<td>Keys, No. 303</td>
<td>NW 16-32-02 W2</td>
</tr>
<tr>
<td>Buchanan, No. 304</td>
<td>SW 35-31-06 W2</td>
</tr>
<tr>
<td>Invermay, No. 305</td>
<td>SW 11-33-09 W2</td>
</tr>
<tr>
<td>Clayton, No. 333</td>
<td>NW 20-36-01 W2</td>
</tr>
<tr>
<td>Preeceville, No. 334</td>
<td>SE 03-35-05 W2</td>
</tr>
<tr>
<td>Hazel Dell, No. 335</td>
<td>SE 15-35-08 W2</td>
</tr>
<tr>
<td>Hazel Dell, No. 335 - discontinued site</td>
<td>NE 33-35-08 W2</td>
</tr>
<tr>
<td>Sasman, No. 336</td>
<td>NW 11-35-10 W2</td>
</tr>
<tr>
<td>Sasman, No. 336</td>
<td>NE 22-34-11 W2</td>
</tr>
<tr>
<td>Sasman, No. 336</td>
<td>SW 02-36-12 W2</td>
</tr>
</tbody>
</table>
Figure 5.5
Location of Municipal Agricultural Collection Depots in the Basin
The Saskatchewan Soil Conservation Association focuses on direct seeding systems (seeding into standing stubble) and measures the level of soil disturbance associated with the seeding operation as low disturbance or high disturbance. The amount of disturbance is a factor of opener type (knife, disc and coulter, spoon or sweep), row spacing, and speed.

The Prairie Farm Rehabilitation Administration (PFRA) has conducted an annual survey of crop residue and seeding systems on over 500 sites in east-central Saskatchewan since 1997. Fields at the corners of townships (Sections 1, 6, 31, and 36) are monitored annually and parameters such as the type of crop grown, amount of stubble, orientation of the stubble (standing, flat, or mixed), most recent field operation, type of packing system, row spacing, seed spread (type of opener), and type of seeding system (conventional, minimum till, or zero till) are measured. The goal of the survey is to determine the percentage of cultivated lands at risk to soil erosion and, for the long-term, to gather and analyze sufficient data to be able to establish trends in seeding and cropping systems. Three years of data reveal that conventional tillage systems are practiced on 85 percent of the annually cropped lands in east-central Saskatchewan. The remaining 15 percent of lands involve some type of conservation tillage (13 percent are minimum tillage and 2 percent are zero tillage).

Susceptibility to erosion is dependent upon soil type, soil texture, slope, field implements, climate and crop rotations (high residue crops vs. low residue crops). On all but steeply sloping fields, an estimated 1.12 tonnes of residue per hectare (1000 lbs/ acres; 50 percent cover) is adequate to fully protect the soil from erosion. The survey revealed that, of the 85 percent of lands under conventional tillage in east central Saskatchewan, 94 percent of the fields had insufficient amounts of crop residue present to protect from the threat of erosion. Comparatively, 50 percent of minimum tillage fields and 28 percent of zero tillage fields had insufficient crop residue cover to protect the soil from erosion risk.

Prairie Farm Rehabilitation Administration is currently conducting an analysis called the “Prairie Agricultural Landscapes” (PAL) project in which land use (as determined by Ag Census data) is being correlated to soil landscapes of Canada. Land use categories are broadly defined as being high pasture, medium pasture and low pasture. Low pasture is split into three additional categories of low, medium and high summer fallow. Agricultural Census data from 1996 provide information on average size of farm, number of cattle per farm, percentage of summer fallow, and percentages of crops grown.

According to PAL, the vast majority of farms within the Basin fall into a category defined as low pasture and medium summer fallow. Approximately 28 percent of land is in pasture and hay, with an average of 52 cattle per farm. The annually cropped area is 62 percent cereal, 19 percent summer fallow, 10 percent oilseed, 4.5 percent pulse, and 2 percent flax.

This compares roughly to the 1996 Canadian Wheat Board data for east central Saskatchewan which shows, on average, that 25 percent of land is pasture or tame hay. Of the annually cropped area, 46 percent is cereal, 24 percent is summer fallow, 20 percent is oilseed, 5 percent is flax, and 4 percent is pulse.
5.8 Fertilizer

Soil fertility is an important factor in annual crop and forage production. Plants require at least 16 different nutrients for growth. The major (macro) nutrients required for optimal field crop production on the Prairies are nitrogen (N), phosphorous (P), potassium (K), and sulphur (S). The fertilizer form of P is phosphate (P₂O₅) and of K is potash (K₂O). In addition to nutrient levels, soil pH and electrical conductivity (indication of salinity) are key characteristics that influence soil fertility.

Agricultural producers enhance soil fertility by augmenting soil nutrient levels with either commercial fertilizer blends (inorganic fertilizer), manure (organic fertilizer), or a combination of both. It has been long established that farmers should annually soil test individual fields to compare plant-available nutrient levels of the soil to fertilizer requirements for the anticipated yield and nutrient uptake of the selected crop. Crop uptake of nutrients varies not only with yield, but is also affected by soil and climatic conditions. Nutrient balancing (i.e., matching the estimated nutrient uptake of the crop with the nutrient availability of the particular soil in each field) is the underlying premise for all fertilizer applications in order to economically achieve optimal yields and prevent nutrient surpluses.

Nitrogen content of a soil varies with soil zone, soil moisture, soil texture, and soil organic matter content. Nitrogen is critical for plant growth, yield, and protein content of the seed. Phosphorous is important for rooting, flowering and seed production. Potassium is necessary for photosynthesis, osmotic regulation and activation of enzyme systems. Sulphur is important in S-sensitive crops such as canola. Nitrogen and sulphur are both very mobile in the soil and as a result, soil sampling depths to 60 cm are recommended. Most phosphorous is readily adsorbed (or fixed) to soil particles and generally is not mobile. However, phosphorous can be transported in surface run-off by either being attached to soil particles suspended in run-off (i.e., P attached to suspended solids or sediment) or, to a lesser extent, a fraction of soil phosphorous can become dissolved in soil solution.

Good business planning dictates that in order to maximize profits agricultural producers must be careful to keep input costs down and not over fertilize. Nutrient balancing is essential in managing the amount of nutrients produced and utilized on the farm. Over application of any fertilizer, either manure or commercial fertilizer, can be detrimental and is not recommended. Over application of nitrogen can soon become evident in the crop through lodging, delayed crop maturity, elevated nitrate levels in forages and unrealized profit. Over application of phosphorous can potentially occur in lands where excessive amounts of fertilizer (inorganic or organic) have been applied, and also where fertilizer application rates have focused on balancing for nitrogen only. As N and P are major plant nutrients, N and P loading of surface water sources can lead to increased eutrophication and excessive algae growth.

In addition to nutrient balancing, vegetative buffers and filter strips are highly effective at trapping and filtering nutrients and sediments in run-off from arable lands. Depending upon steepness of slope and soil texture, vegetative buffers established adjacent to riparian areas
should be a minimum 30 m wide and are recognized as a best management practice on all agricultural lands draining into surface water bodies.

The threat of non-point source pollution to surface water and groundwater quality by agricultural fertilizers within the Basin is considered minimal. Increased awareness of nutrient management, prevention of nutrient loading, and possible adoption of farm mineral accounting systems will lead to preventing surplus nutrient levels and reduce the risk of water quality problems in the future.

Best management practices (BMPs) have been developed for the application of manure as a fertilizer. It is advisable that BMPs be developed for commercial fertilizers as well and, further to that, annual cropping practices in general.

5.9 Summary and Recommendations

Based on the observations in the literature review by Dillon Consulting Limited, “Upper Assiniboine River Basin Water Quality Study - Final Report, November 1998” and general knowledge of the Basin, there are several key points that should be targeted by and for the agricultural industry with respect to improving water quality.

1) Proper decommissioning of abandoned wells and maintenance of existing wells.

2) Continued use of pesticide container disposal sites along with proper on-farm preparation of the containers for disposal - triple rinsing, punctured containers.

3) Without extensive testing, the effect from hazardous substances and storage sites (i.e., chemical collection depots, landfills, discontinued bulk fuel depots, and gas stations) and the full extent of potential contamination is difficult to determine.

4) Construction of new storage facilities must comply with more stringent regulations that protect the environment from spills and leaching of hazardous substances.

5) Education to caution the pesticide user to avoid cleaning sprayers and chemical containers near open water.

6) Education to inform the pesticide user about applying product at the proper rates and to adhere to label restrictions and recommended practices.

7) Joint effort among all agencies to develop a ‘Glossary of Terms’ that are representative and consistent within the agricultural industry for seeding/tillage/rotation systems.

8) Best management practices should be developed for annual cropping practices.
6 Municipal Lagoons and Water Quality

6.1 Introduction

Throughout the various watershed drainage regions that make up the Upper Assiniboine River Basin there are 32 towns that operate licensed multi-celled lagoons as part of their wastewater treatment system (Dillon Consulting Limited, 1998). These systems utilize the forces of nature to treat the effluent and are designed to provide the minimal amount of treatment required by both the provinces of Saskatchewan and Manitoba for towns and small villages. The various licenses for these systems allow for the discharge of the lagoons once or twice yearly into the local watercourse. While many of the towns do not discharge their treated effluent directly into the Assiniboine River, all drainage from this area eventually drains into the river. The Town of Roblin is the only community utilizing lagoons within the Basin that provides alternate disposal methods for their treated effluent. The City of Yorkton has a more advanced mechanical wastewater treatment system, which treats the effluent on a continuous basis allowing for continuous discharge to the river (Dillon Consulting Limited, 1998).

Each province has discharge objectives and regulations that control the construction, operation, and pollution control mechanisms for lagoons. Operating licence/permits for each individual project are designed to protect the receiving water bodies from contamination or pollution. While the requirements of each licence/permit varies, each requirement is specific to the local situation and takes into account the mixing zone of the receiving body of water, flows present, and the time of year.

Since there are a number of sewage treatment facilities within this drainage area, river water quality could be a major concern to the Basin and downstream water bodies due to accumulation of nutrients such as nitrogen and phosphorous. It is these nutrients that accumulate in the water bodies and act as fertilizers and encourage algal growth. The accumulation of nutrients in the various water bodies is of concern as it can lead to a decrease in water quality and eutrophication of the lakes over the long-term.

Sludge and liquid effluent from municipal and agricultural waste contain trace metals. Land applications can redistribute these in the aquatic environment where they can be transferred through the food chain. Some are highly mobile and can leach into groundwater or runoff (EPA, 1976). Others accumulate in surface soils where runoff can transfer trace metals to surface water bodies via eroded soils (USCATST, 1992; EPA, 1976).

6.1.1 Municipal Wastewater

Municipal wastewater comes from our homes, businesses, and industries. It carries the wastes of daily living, such as water from showers, toilets, laundry, dishwashers, and business operations. Municipal wastewater is usually gray in colour and most often has a musty odour. Wastewater is approximately 99.9 percent water, with the remaining 0.1 percent being solids. Almost half (40
percent) of these solids are dissolved solids - they are dissolved in the wastewater much like salt is dissolved in sea water. The rest of the solids are suspended solids.

Lagoons are shallow ponds that utilize components of nature such as sunlight, algae, microorganisms, and oxygen to interact and treat or stabilize the wastewater. They are designed to provide secondary treatment, the minimal amount of treatment required by both the provinces of Saskatchewan and Manitoba for towns and small villages. Although lagoon construction can cost in excess of $100,000 they are relatively inexpensive compared to more advanced systems, have minimal operating costs, and are simpler to operate.

6.1.2 Wastewater Treatment/Lagoons

Within the Upper Assiniboine River Basin, two processes for wastewater treatment are found, utilizing a system of at least two ponds or cells, referred to as lagoons. Many larger lagoon systems may contain several treatment and storage cells. When wastewater is treated properly, many suspended and dissolved pollutants are removed and the effluent can be released safely to the environment. There are three types of lagoon treatment cells used in Saskatchewan: facultative lagoons, aerated lagoons, and anaerobic lagoons.

1) **Facultative Lagoons** have an aerobic (containing oxygen) surface layer and an anaerobic (without oxygen) bottom layer. Facultative lagoons are the most common type with approximately 500 in Saskatchewan. All the lagoons located within the Saskatchewan portion of the Basin are a facultative treatment cell design.

2) **Aerated Lagoons** add oxygen artificially to the wastewater with various types of aeration devices, and they can treat wastewater in a smaller treatment cell. However, they do require a power input. Aerated lagoons tend to be smaller and deeper than facultative lagoons.

3) **Anaerobic Lagoons** operate without any dissolved oxygen. Wastewater treatment is provided by anaerobic microorganisms that can thrive without dissolved oxygen. These lagoons are smaller but deeper than the facultative type.

6.1.3 Treatment

1) **Primary Treatment** involves the physical removal of the solid materials in the wastewater that readily settle out by gravity, and takes place in the first cell, called the treatment or primary cell.

2) **Secondary Treatment** - purifies wastewater by removing organic materials through biological processes, and takes place in the secondary cell. It is also referred to as the storage cell because it stores the wastewater between releases into the environment. Processes within the secondary cell utilize microorganisms (bacteria and other small organisms) to consume organics such as fats, carbohydrates, and proteins that are
dissolved in the wastewater. Aerobic microorganisms use oxygen and give off carbon
dioxide as they consume the organic “food” during secondary treatment. Anaerobic
microorganisms also use this food source, but they do not use oxygen, and they give off
gases such as methane and hydrogen sulphide.

6.2 Legislation

6.2.1 Saskatchewan

Within Saskatchewan, lagoon construction and operation are subject to The Water Pollution
Control and Water Works Regulations (WPC and WWRs) of The Environmental Management
and Protection Act (EMPA), as well as The Water Corporation Act (WCA). The highlights of
the legislation include:

- Construction or alteration of a lagoon requires approval by Sask Water (WCA).
- A permit is required for wastewater disposal from Saskatchewan Environment and
  Resource Management (EMPA).
- Treated wastewater must meet requirements set by the Minister of Environment
  and Resource Management (EMPA).
- A minimum of secondary wastewater treatment or use of facultative lagoons is
  required in Saskatchewan (WPC and WWRs).
- Facultative lagoons must have a minimum of two cells operating in series - one
  after the other (WPC and WWRs).
- A minimum size for primary cells is specified (WPC and WWRs).
- Lagoons cannot be discharged between November 1 and spring runoff (WPC and
  WWRs).
- Tests must be done and records maintained as required by the Minister of
  Environment and Resource Management (WPC and WWRs).

Sask Water approves wastewater treatment facility construction applications and issues a permit
to operate. Applications are then sent to Saskatchewan Environment and Resource Management
for approval of health and environmental elements, and to issue a permit for the sewage works.
This permit sets out the required testing and record keeping, and identifies any limits that the
treatment facility may be required to meet.

Private wastewater treatment and disposal, which occurs where there is no municipal collection
system, is subject to regulations and permitting administered by Saskatchewan Health. In the
case of small commercial developments, (i.e., small motels, trailer courts and small restaurants,
etc.), where the wastewater flow rate is less than 18 cubic metres (4,000 gallons) per day, the
construction of wastewater treatment and disposal facilities requires approval from Sask Water,
and is subject to regulations and permitting administered by Saskatchewan Health.
During an emergency situation a permit may be amended to reflect actual operating circumstances. For example, recent years of excessive rainfall have resulted in emergency discharge of effluent from some systems which incorporate evaporation cells. In such an event, samples are taken prior to discharge and have shown to be suitable for release to the environment because the effluent primarily consists of rainwater. There are also some communities, although allowed to discharge twice a year, that do not discharge at all. This may be due to decreasing population, minimal snow and rain moisture or drought like conditions causing excessive evaporation.

6.2.2 Manitoba

All lagoon operations and discharges fall under The Manitoba Environment Act and must be licenced to operate. A license is issued once an environmental impact assessment and mitigation plan has been completed by the proponent. Specifications for discharge limits, lagoon construction details, operation and design loadings are normally a part of the license. Each license may be similar or unique depending upon the environmental conditions associated with its location.

Lagoon operations also fall under the Water Works, Sewage and Sewerage Disposal Regulation of The Public Health Act. One primary focus of this Act is to evaluate the additional hydraulic and organic loading from the new sub division proposal and expansions on the acceptable capacity sewerage works to receive it.

6.3 Factors Affecting Wastewater Treatment in Lagoons

Many natural factors affect how well lagoons work in treating wastewater. Ideal conditions for lagoon treatment occur during the long, warm, sunny days of summer, when a moderate breeze is blowing.

1) **Wind Action** - wind mixes the wastewater and adds the oxygen necessary for aerobic microorganisms to do their work.

2) **Temperature** - affects how much oxygen the wastewater can hold and determines how quickly the microorganisms will act to break down the organic materials in the wastewater. Treatment occurs most quickly when temperatures are high.

3) **Sunlight** - causes algae to grow in the lagoon. Algae, like other plants, give off oxygen as they grow. Aerobic microorganisms use this oxygen as they break down dissolved materials in the wastewater. These processes also help to destroy disease-causing bacteria.

4) **Winter** - treatment also occurs during the winter months when solids settle out in the treatment cell and anaerobic bacteria break down organic pollutants. Due to colder
temperatures and lack of natural aeration and sunlight, winter treatment is not as effective as treatment during the other seasons.

5) **Unwanted Waste** - although lagoon treatment systems can cope with most normal waste products, consumers are discouraged from disposing of wastes such as battery acid, solvents, paints, waste oil products, and other toxic or hazardous wastes into their municipal sewer systems.

### 6.4 Facility Operation, Maintenance, and Monitoring

#### 6.4.1 Release of Wastewater

Adequately sized and properly operated lagoon systems provide treatment that meets provincial objectives. Treated wastewater from the lagoon storage cells may be released according to their licence specifications but generally occurs twice a year. The first release typically occurs during the spring runoff, the second during the fall - usually in late October. Within the Upper Assiniboine River Basin, 17 communities discharge treated wastewater directly into watercourses such as the Assiniboine River; nine communities discharge treated wastewater into localized water bodies, such as sloughs or small lakes; three communities utilize alternative disposal methods, such as effluent irrigation; and, three communities do not discharge wastewater as there is enough evaporation during the summer (see section 6.7).

During the spring release, wastewater treated in the lagoon and stored over the winter is discharged and mixes with the runoff from melting snow. In the fall release, wastewater treated and stored over the summer is discharged from the lagoon. After each release, the discharge valve from the storage cell is closed, and a valve between the treatment storage cells is opened briefly to “equalize” the cells. This prevents drying out of the cells after the spring release and freezing of the piping after the fall release.

Lagoons may be discharged into dry or flowing creek beds, rivers, sloughs, ditches, fields, pastures, and sometimes lakes. Communities must have agreements with landowners to allow for disposal of treated wastewater to private land.

#### 6.4.1.1 Wastewater as a Resource

Saskatchewan Environment and Resource Management encourages the use of treated wastewater as a resource. For example, it can be used for irrigating crop land, a process known as effluent irrigation. Treated wastewater is often suitable for use in wetlands projects for rearing waterfowl.
6.4.1.2 Solids

The solid material that settles to the bottom of the lagoon is called sludge or bio-solids. Most of the bio-solids are decomposed by microorganisms in the lagoon. It is seldom necessary to remove the few bio-solids that remain. When removal does become necessary, these solids may be spread on nearby farmland, where they serve as a source of nutrients for crop growth. Communities should contact their local environment department representatives for guidelines prior to bio-solid disposal.

6.4.1.3 Odour

Odour is not normally a significant problem around lagoons. However, lagoons that are too small to serve a community’s population sometimes have odour problems. Also, for a short period of time in the spring immediately after the ice melts, it is normal for lagoon systems to experience temporary odorous conditions. Gases such as hydrogen sulphide given off by anaerobic bacteria as they treat the wastewater under the ice will cause odours in the spring.

6.4.2 Permits/Licenses

6.4.2.1 Saskatchewan

In Saskatchewan, each community’s wastewater treatment system is issued a permit that outlines how many samples must be collected by the community, where the samples must be taken from, how the samples must be analyzed, and which operating records must be kept.

Usually three samples are required. The first sample is taken upstream from the point of discharge, the second sample at the point of discharge, and the third sample is taken downstream from the point of discharge. The second and third samples are taken halfway through the discharge process. Samples are analyzed for the following parameters: total kjeldahl nitrogen; nitrate nitrogen; total phosphorous; total suspended solids; volatile suspended solids; dissolved organic carbon; 5-day 20°Celsius biochemical oxygen demand; total coliform bacteria; fecal coliform bacteria; conductivity at 25°Celsius; pH; alkalinity; calcium; magnesium; potassium; sodium; bicarbonate; carbonate; chloride; and sulphate.

Communities take samples to find out how well the lagoon treatment system is working and what effects the discharges are having on water quality in the receiving environment. The data obtained from sampling are primarily used as an indication of how well a system is working. Operating records would include dates of effluent discharges and the quantity of effluent discharged. Table 6.1 lists expected effluent quality produced by well operated treatment facilities that treat typical municipal sanitary sewage.
Table 6.1
Sewage Treatment Processes - Typical Effluent Quality

<table>
<thead>
<tr>
<th>Process</th>
<th>BOD₅ mg/L</th>
<th>TSS mg/L</th>
<th>Total-P mg/L</th>
<th>Total-N mg/L</th>
<th>Total Coliforms /100 mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- incl. anaerobic lagoons</td>
<td>75-150</td>
<td>50-110</td>
<td>5-7</td>
<td>25-45</td>
<td>&gt;2x10⁶</td>
</tr>
<tr>
<td>- with phosphorous removal</td>
<td>45-85</td>
<td>25-50</td>
<td>1-2</td>
<td>20-40</td>
<td>&gt;2x10⁵</td>
</tr>
<tr>
<td>Secondary:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- biological (Mech.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- aerated Lagoons</td>
<td>10-25</td>
<td>10-25</td>
<td>3.5-6.5</td>
<td>15-35</td>
<td>2x10⁴-2x10⁵</td>
</tr>
<tr>
<td>- aerobic Lagoons</td>
<td>15-30</td>
<td>20-35</td>
<td>4-7</td>
<td>20-40</td>
<td>2x10³-2x10⁵</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;2x10³-2x10⁵</td>
</tr>
<tr>
<td>(Spring)</td>
<td>25-70</td>
<td>20-60</td>
<td>3.5-7</td>
<td>20-35</td>
<td>2x10²-2x10⁴</td>
</tr>
<tr>
<td>(Late Fall)</td>
<td>10-30</td>
<td>10-40</td>
<td>2-5</td>
<td>5-20</td>
<td></td>
</tr>
<tr>
<td>Advanced:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- secondary with chemical treatment (phosphorous control)</td>
<td>36660</td>
<td>36828</td>
<td>0.5-1.5</td>
<td>15-35</td>
<td>2x10²-2x10⁴</td>
</tr>
</tbody>
</table>

* levels required by SERM for communities within the Saskatchewan portion of the Basin.

6.4.2.2 Manitoba

All lagoon operations and discharges fall under the *The Manitoba Environment Act* and must be licensed to operate. Lagoon operators usually follow a similar procedure in order to comply with their license requirements for discharge (generally these deal with BOD and coliform limits but are specific for each license). Prior to any lagoon discharge, the primary and secondary cells are isolated by closing the interconnecting valve between the two cells. Typically, the secondary cell remains isolated for a period of two to three weeks to allow for natural breakdown of organics and coliforms without the introduction of any new wastewater from the primary cell.

After this period, the secondary cell is sampled and will only be discharged if the laboratory results indicate that the effluent is within the license discharge limits. Otherwise the secondary cell will be re-sampled. Further treatment would have been on-going as turnaround time for results from the lab is usually between seven to ten days. Once the effluent meets license limits, the secondary cell will be discharged. After the release has been completed, the interconnecting valve between the primary and secondary cell is re-opened to provide storage capacity for the incoming wastewater. This cycle would be repeated for each discharge event. During discharge, department staff from Manitoba Conservation may monitor the effluent quality. The frequency of monitoring is variable from region to region and is dependent upon individual lagoon circumstances and history. Specific details for the lagoon operations in the Manitoba portion of the Basin have been summarized in section 6.7.2.
6.5 Environmental Impacts

Although properly constructed and operated lagoons generally provide high quality wastewater treatment, environmental impacts can occur when treated wastewater is released. For example:

- Bacteria may render downstream water unfit for drinking water supply, irrigation, or recreation uses.
- Minerals in the wastewater can affect the use of the receiving water for irrigation or livestock watering.
- Available nutrients such as phosphorous from a lagoon discharge may promote excessive growth of algae and weeds in waterways.
- Discharges of ammonia from a lagoon may be harmful to aquatic life, including fish because of the toxicity of the unionized ammonia form.
- Increased colour and turbidity (cloudy water) can impair the physical appearance of downstream water for some uses.
- Seepage (leakage) from lagoons can result in damage to land or groundwater.

6.6 Mechanical Wastewater Treatment Plants

Mechanical wastewater treatment plants consist of arrangements of mechanical devices and structures that treat wastewater within a matter of hours. They can be fairly compact and are thus suitable for larger centres. Although mechanical treatment systems require less space than lagoons, they are expensive to build and operate.

The H.M. Bailey Water Pollution Control Plant in Yorkton, commissioned in 1991, is the only mechanical treatment plant in the Saskatchewan portion of the Basin. The plant discharges treated wastewater on a daily basis, therefore, more diligent monitoring of the effluent and the receiving stream is required (see Table 6.2). Table 6.3 provides the mean seasonal water quality results for three monitoring stations on Yorkton Creek; Station 1: 1 mile upstream of the discharge; Station 2: 1 mile downstream of the discharge; and, Station 3: 10 miles downstream. The monitoring was done by the City of Yorkton during the period 1992 to 1999 as a requirement of the City’s permit to operate sewage works. The parameters used in Table 6.1 are significant when assessing the impacts of a municipal wastewater discharge. Overall, the H.M. Bailey Plant met the requirements as specified by the province (Table 6.1) for secondary sewage treatment at a mechanical treatment plant.

As shown in Table 6.3, total coliform and fecal coliform counts at Station 1 ranged from 840 to 25,432 organisms per 100mL, and 64 to 458 organisms per 100 mL, respectively. The relatively high counts during summer at this station may be due to contamination from livestock operations or other sources. The total and fecal coliform counts increased dramatically at Station 2, as would be expected just below a wastewater discharge. However, by the time the effluent reached Station 3 there was a significant die-off of these bacteria to levels at least 90 percent less than measured at Station 2. Data presented in Table 2.4 for the Whitesand River indicate that this die-off continued downstream to where coliform counts ranged from only 10 to 40 organisms per
100 mL at Highway No. 9. These counts were well below the surface water quality objectives for both contact and non-contact recreation.

The data for nutrient loadings from Table 6.3 indicate that the concentration of total nitrogen, total phosphorus, ammonia-nitrogen and nitrate-nitrogen downstream of the discharge are lowest in spring and highest in winter. Again, this is expected since nutrient concentrations are typically affected by the quantity of water flow in the system, with lower concentrations in spring and higher concentrations in winter under ice. The data also indicate that lower concentrations of nitrate-nitrogen and higher concentrations of ammonia-nitrogen during winter may be due to anaerobic conditions and conversion of nitrate to ammonia.

### Table 6.2
Water Quality Results from 1992 to 1999 Presented as a Seasonal Average for Effluent of the Yorkton Sewage Treatment Plant

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fecal Coliforms</td>
<td>24268</td>
<td>57029</td>
<td>159994</td>
<td>119912</td>
</tr>
<tr>
<td>Total Coliforms</td>
<td>118533</td>
<td>334830</td>
<td>255361</td>
<td>422870</td>
</tr>
<tr>
<td>NO₃NO₂</td>
<td>2.82</td>
<td>7.5</td>
<td>8.75</td>
<td>3.02</td>
</tr>
<tr>
<td>Ammonia</td>
<td>23.2</td>
<td>12.98</td>
<td>14.16</td>
<td>24.88</td>
</tr>
<tr>
<td>TKN</td>
<td>28.8</td>
<td>14.5</td>
<td>16.5</td>
<td>31.6</td>
</tr>
<tr>
<td>BOD</td>
<td>16.4</td>
<td>25.2</td>
<td>23.0</td>
<td>23.75</td>
</tr>
<tr>
<td>Total P</td>
<td>4.53</td>
<td>3.99</td>
<td>5.77</td>
<td>6.25</td>
</tr>
<tr>
<td>Ortho-P</td>
<td>3.69</td>
<td>2.93</td>
<td>4.87</td>
<td>4.99</td>
</tr>
<tr>
<td>Sodium</td>
<td>344.8</td>
<td>307.6</td>
<td>350.5</td>
<td>386.9</td>
</tr>
<tr>
<td>Sulphate</td>
<td>445.1</td>
<td>563.8</td>
<td>511.3</td>
<td>426.5</td>
</tr>
<tr>
<td>TDS</td>
<td>2108</td>
<td>2204</td>
<td>2159</td>
<td>2195</td>
</tr>
<tr>
<td>TSS</td>
<td>11.9</td>
<td>13.8</td>
<td>11.6</td>
<td>13.7</td>
</tr>
</tbody>
</table>

Expressed in mg/L
Table 6.3
Water Quality Results from 1992 to 1999 Presented as a Seasonal Average for Yorkton Creek Upstream and Downstream of the Yorkton Sewage Treatment Plant

<table>
<thead>
<tr>
<th>Parameters</th>
<th>1.6 km upstream STP</th>
<th>1.6 km downstream STP</th>
<th>West of Ebenezer (16.1 km north of Yorkton)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spring</td>
<td>Summer</td>
<td>Fall</td>
</tr>
<tr>
<td>Fecal Coliforms</td>
<td>64</td>
<td>458</td>
<td>80</td>
</tr>
<tr>
<td>Total Coliforms</td>
<td>11250</td>
<td>25432</td>
<td>840</td>
</tr>
<tr>
<td>NO$_3$NO$_2$</td>
<td>0.536</td>
<td>0.048</td>
<td>0.13</td>
</tr>
<tr>
<td>Ammonia</td>
<td>0.82</td>
<td>0.06</td>
<td>0.19</td>
</tr>
<tr>
<td>TKN</td>
<td>3.16</td>
<td>2</td>
<td>2.41</td>
</tr>
<tr>
<td>BOD</td>
<td>7.01</td>
<td>3.1</td>
<td>2.48</td>
</tr>
<tr>
<td>Total P</td>
<td>0.6</td>
<td>0.2</td>
<td>0.19</td>
</tr>
<tr>
<td>Ortho-P</td>
<td>0.38</td>
<td>0.11</td>
<td>0.09</td>
</tr>
<tr>
<td>Sodium</td>
<td>55</td>
<td>76</td>
<td>94</td>
</tr>
<tr>
<td>Sulphate</td>
<td>133.5</td>
<td>302</td>
<td>387</td>
</tr>
<tr>
<td>TDS</td>
<td>514</td>
<td>925</td>
<td>107</td>
</tr>
<tr>
<td>TSS</td>
<td>20.7</td>
<td>7.6</td>
<td>10.3</td>
</tr>
</tbody>
</table>

Expressed in mg/L
6.7 Current Municipal Lagoons in the Basin

6.7.1 Saskatchewan

All population figures are taken from the Saskatchewan Municipal Affairs, Culture and Housing 1999 Municipal Directory.

1) Buchanan - Population 279, located at SE 4-31-06-W2, 2 cell system, allowed to discharge twice a year into Good Spirit Creek.
2) Calder - Population 106, located at NE 15-25-31-W1, 2 cell system, allowed to discharge twice a year into Calder Lake.
3) Canora - Population 2,208, located at NE 31-30-03-W2, 2 cell system, allowed to discharge twice a year into Whitesand River.
4) Churchbridge - Population 815, located at SE 18-22-32-W1 and NW 08-22-32-W1, 2 cell system, allowed to discharge twice a year into Deerhorn Creek.
5) Duck Mountain Provincial Park - Population unknown (seasonal), located at N ½ 21-30-30-W1 (Ministik/Core area), 2 cell system, allowed to discharge twice a year into marsh area located at NE 21-30-30-W1. Another lagoon is located at NW 13-31-30-W1 (Pickeral Point), 2 cell system, allowed to discharge into a surface drainage in the NW 13-31-30-W1.
6) Ebenezer - Population 166, located SW 25-27-04-W2, 2 cell system. Strictly an evaporation system which does not discharge unless in an emergency.
7) Good Spirit Provincial Park - Population unknown (seasonal), located at E 1/28-29-5-W2, 2 cell system. Primarily an evaporation system, however, also allowed to utilize effluent irrigation as a method of disposal if needed.
8) Hyas - Population 119, located at NE 06-34-02-W2, 2 cell system, allowed to discharge twice a year into a nearby slough.
9) Invermay - Population 295, located at NW 01-33-09-W2, 2 cell system, allowed to discharge twice a year into Saline Lake.
10) Jedburgh - Population 13, located at NE 36-26-08-W2, 2 cell system that doesn’t discharge.
11) Kamsack - Population 2,264, located at NE 27-29-32-W1, 2 cell system, allowed to discharge twice a year into Assiniboine River.
12) Langenburg - Population 1,119, located at NE 26-21-31-W1, 2 cell system, allowed to discharge twice a year into Smith Creek.
13) MacNutt - Population 95, located at SE 22-24-31-W1, 2 cell system, intermittent discharge.
14) Margo - Population 127, located at NW 10-33-10-W2, 2 cell system, discharges into Margo Lake.
15) Melville - Population 4,646, located at NE 04-23-06-W2, a 4 cell system, allowed to discharge twice a year into Crescent Creek. Also allowed to utilize effluent irrigation to the golf course.
16) Preeceville - Population 1,148, located at SE 27-34-05-W2, 2 cell system, allowed to discharge twice a year into the Assiniboine River.
17) Rama - Population 99, located at SW 24-32-08-W2, 1 cell system, discharges into slough on village property.
18) Rhein - Population 197, located at SW 26-27-2-W2, 2 cell system, allowed to discharge twice a year into slough on same location.

19) Saltcoats - Population 531, located at NW 36-23-02-W2, 2 cell system, allowed to discharge twice a year into natural drainage course.

20) Sheho - Population 181, located at NW 10-30-09-W2, 2 cell system, allowed to discharge twice a year into Elbow Creek.

21) Spy Hill - Population 264, located at NE 02-19-31-W1, 2 cell system, allowed to discharge twice a year into Deerhorn Creek.

22) Stenen - Population 100, located at SE 09-34-03-W1, anerobic 2 small treatment cells, allowed to discharge twice a year.

23) Sturgis - Population 684, located at NW 21-34-04-W2, 2 cell system, allowed to discharge twice a year into the Assiniboine River.

24) Theodore - Population 434, located at SW 15-28-07-W2, 2 cell system, allowed to discharge twice a year into Theodore Lake (slough).

25) Togo - Population 138, located at NE 02-28-30-W1, 2 cell system which doesn’t discharge.

26) Veregin - Population 90, located at SW 10-30-01-W2, 2 cell system, doesn’t discharge.

27) Wroxton - Population 50, located at NW 03-26-32-W1, 2 cell system, doesn’t discharge.

28) Yorkton - Population 15,154, Mechanical treatment system, constant discharge into Yorkton Creek.

6.7.2 Manitoba

There are five municipal lagoons currently operating within the Manitoba portion of the Upper Assiniboine River Basin. A brief synopsis of each lagoon is provided outlining background, monitoring, and enforcement issues.

1) Binscarth - the Town of Binscarth currently operates a lagoon located in the NW 10-19-28 W3. This lagoon was established 35 years ago and issued a license in 1965 by the Provincial Sanitary Control Commission (PSCC). Conditions of the license are very general. Periods of discharge to Silver Creek are restricted to occur between May 15 to November 1. There are no specific discharge restrictions with respect to coliform bacteria or biological oxygen demand. Instead, it broadly states that effluent discharge should not create a nuisance either in Silver Creek or adjacent drainage course.

PSCC licenses were not validated in the revised Environment Act of 1988. This change within the Act essentially required all new and existing lagoons to submit an environmental impact assessment proposal prior to being issued a new license. The Town of Binscarth has only recently applied for a new license as part of their proposal to remedy seepage losses from their secondary cell. Historically, rates of seepage loss through the bottom of the secondary cell have been of sufficient magnitude that it was often unnecessary to discharge effluent to Silver Creek.
2) **Inglis** - the lagoon currently servicing the Town of Inglis is located in SW 6-23-27 W3. This lagoon was built 34 years ago and issued a license in 1966 by the PSCC. The effluent discharge route is via Bear Creek, which flows into the Shell River. Again, conditions of the discharge are very general. The license requires that effluent discharge can only occur from the period between May 15 to June 15 and within the period from September 15 to November 1. The clause that “effluent discharge should not create a nuisance either in Bear Creek or adjacent drainage course” is also present.

Similar to Binscarth, this lagoon has officially operated without a license since 1988, and has been following the conditions of the original license. Currently, the Town of Inglis is in the final process of receiving a new license after submitting a proposal to expand the capacity of the lagoon’s secondary cell.

3) **Angusville** - the Angusville lagoon is located in NE 21-20-26 W3. The lagoon was established 28 years ago and is still operating under the license issued by the Clean Environment Commission in 1972. License specifications only allow effluent discharged to a slough south of the lagoons to occur between May 15 to November 1. License requirements also stipulate that prior to discharge, the effluent quality must not have a BOD concentration of greater than 30 mg/L or a level of total coliform bacteria greater than 1500 organisms per 100 mL.

4) **Russell** - the municipal lagoon servicing the Town of Russell is located in the SE 4-21 28 W3. Discharge from the lagoon is directed south along an intermittent drainage channel to Silver Creek, approximately 24 km south. Silver Creek flows south and empties into the Assiniboine River southwest of Binscarth.

The lagoon was established 35 years ago and operated under PSCC license until 1978. The new license developed under an order from the Clean Environment Commission is still in effect today. Conditions of the license allow effluent discharge to occur during the year from May 15 to November 1. The license also specifies that before discharging effluent, the quality of the BOD concentration must be no greater than 30 mg/L and the total coliform bacteria content must be no greater than 1500 organisms per 100 mL.

Past enforcement issues have been related with the failure of the lagoon operator to ensure sampling was conducted for total coliform prior to release and with the effluent failing to meet the total coliform limits. BOD results have met the license limits. Currently the Town is dealing with a berm failure along the north cell that occurred in the spring of 1999, although this has been temporarily repaired. The Town is in the process of reviewing and providing a more permanent solution to the problem.

5) **Roblin** - the original lagoon site was located close to Roblin in NW 5-26-28 W3. This lagoon operated from 1959 to 1981 with effluent discharge directed to West Goose Lake. The current Roblin lagoon was established 19 years ago and is located in SW 28-25-28 W3. It was licensed under an order by the Clean Environment Commission and specified conditions that allowed for discharge of effluent via land irrigation application.
license specified conditions that allowed for emergency discharge to the Shell River in the event that effluent discharge could not occur to the irrigated land.

The current active license, developed in 1998, stipulates conditions that permit effluent discharge either to a land application or a constructed wetland. The constructed wetland was added to the system because of the diminishing capacity of the irrigated land to receive effluent, particularly during wet years. Once the wetland is fully operable, any flow-through discharge to the Shell River will be of high quality, with reduced nutrients and organic loading.

License requirements for discharge from the wetlands into the Shell River specify concentration limits for un-ionized ammonia not to exceed 0.05 mg/L and for total phosphorous not to exceed 0.15 mg/L. A standard clause dealing with fecal coliform (200 organisms per 100 mL), total coliform (1500 organisms per 100 mL), and BOD (30 mg/L) concentrations are also included. Other clauses limit the amount of mineral concentration that must be met for discharge. These include Al, As, Be, Bo, Cd Co, Cr, Cu, F, Fe, Li Mn, Mo, Hg, Ni, Pb, Se, V, Zn.

License conditions also specify that effluent discharge from the lagoons to either the land application or wetlands can only occur from May 1 to November 1. At the present time, while the wetland plants are developing, suspensions of the license requirement for discharge to the Shell River have been granted to the Town when requested. Requests have only been granted when the effluent quality met BOD concentrations of 30 mg/L or less, fecal coliform concentrations of 200 organisms or less, total coliform concentrations of 1500 organisms or less, and chlorine residuals of 11 micrograms or less.

6.8 Summary

In summary, effective wastewater treatment involves proper planning, design, construction, operation, monitoring, and an investment of hundreds of thousands of dollars by each community. Whether treatment is provided by lagoons or mechanical wastewater treatment plants, a coordinated effort of community officials, operators, engineers, and the provincial government ensures that systems work efficiently and minimize impacts on the health and safety of the residents and on the environment.

6.9 Recommendations

There is no present evidence to suggest that wastewater release or seepage is a major concern in the Basin. More extensive studies and monitoring are required to determine any long-term effects.
6.10 Municipal Alternatives...a Case Study
The Town of Roblin’s Alternate Effluent Management System

The Town of Roblin, a small community of 2100 people located in the northeast corner of the Basin, has taken a different approach to sewage disposal than most urban centres in the Upper Assiniboine River Basin. While the Town still relies on a typical lagoon system to treat the effluent to provincial discharge standards, they have chosen alternative methods of managing the treated effluent and have developed a system unlike any other in the Basin.

During the redevelopment of their lagoon system during the late 1970s, the Town decided rather than discharging the lagoon cells into the Shell River, which empties into Lake of the Prairies, they would utilize all of the liquid produced to irrigate crop land. During the 1980s, when dry weather was prevalent, the liquid was put to good use in the irrigation of alfalfa crops. The additional liquid, with its natural nutrient loading, drastically increased the amount of crop produced and harvested. However, with the wet weather in the 1990s, problems were encountered properly utilizing all the effluent from the Town. During this time the crops needed much less liquid for growth, while the amount of liquid being produced increased by more than 30 percent. In order to properly manage the total amount of effluent produced during the wetter years, additional alternatives were required. As a result, an investigation into various options available was initiated. Throughout the research process, a large number of different options were examined:

1) Snowfluent - a process in which effluent is turned into snow with the use of snow making equipment. As the effluent is sprayed into the air and freezes, all bacteria are killed and the minerals precipitate out during the process. Concern: a salinity problem may occur on the land used for the processing of the effluent due to the minerals left behind following the spring melt and concerns existed regarding the runoff liquid.

2) Increase Irrigation Land Base - during wet years, the additional land base should be sufficient to properly utilize all the effluent. Concern: during dry cycles, insufficient effluent would be available to maximize production on the total land base served.

3) Provide Carryover Storage Capacity - installation of additional holding cell(s) to carry over excess liquid from one year to the next when wet weather is encountered. Concern: this would only provide one year of grace as the held liquid would still have to be utilized the following year for irrigation. Examination of the weather cycles in the area indicated these wet/dry cycles usually last for a much longer periods of time.

4) Split disposal - utilize as much effluent as possible through the irrigation process with the remaining effluent discharging to the local river. Concern: this would create some impact on the local water bodies and be of concern to the local population.

5) Reduce Effluent Production - reducing or eliminating the invasion of groundwater into the sewer system would reduce the amount of effluent being produced and, therefore, the
amount of effluent to be disposed of in the irrigation process. Concern: while this could be part of an overall management process of the effluent system, reduction of infiltration water alone would not be sufficient to meet the needs of the Town.

6) Constructed Wetlands - construction of a wetland system could be used to provide additional treatment to a large portion of the effluent with little or no discharges required while still utilizing the major portion for crop production. Concern: cost of construction and complexity of establishing and maintaining proper plant growth.

Each option examined had its own advantages and disadvantages. In the end, constructed wetlands appeared to have the most advantages of the various alternatives investigated. During dry years, liquid could easily be diverted to the irrigation site as required for plant growth. During years with above normal precipitation, excess liquid could be handled through the wetlands. In the extreme case, if the amount of precipitation is excessive, and too much liquid is produced to be properly processed, a discharge to the river would be required. If this situation should occur, the quality of liquid from the wetlands would be much superior and would not create undue nutrient loading to the Shell River or to Lake of the Prairies. Due to the versatility of the system, it was decided to install an 18-hectare (40 acre) constructed wetland, along with other alternatives, and integrate them into the existing lagoon-irrigation system.

6.10.1 Wetlands Design and Operation

A constructed wetland is basically a marsh that has been designed, built and operated for a particular purpose. In most instances, the site utilized was not previously a wetland and some earth work is required to build the required berms and cells. In Roblin's case, the wetlands are composed of four different cells located on a portion of the 36-hectare (80 acre) parcel of land located adjacent to the existing lagoons. Each cell is seeded down to a variety of reed, sedge, rush, and other marsh type plants such as cattails and bulrushes.

As the pre-treated liquid slowly passes through the various cells, the natural purification process continues as bacteria further break down any remaining organic matter. In addition, the floating and rooted plants remove much of the nutrient loading from the liquid, further processing it and greatly improving the water quality.

In order to properly optimize plant growth and insure longevity, the liquid levels within the cells are maintained at an optimum level of 30 cm. Due to the shallow nature of the liquid, the area covered, and the large mass of plants present, most of the liquid is lost to evaporation and plant evapo-transpiration. The Roblin wetlands system is designed to process 13,600 m³ (30 million gallons) of pre-treated effluent each year, which is approximately 50 percent of the Town's total effluent production. It is anticipated that in an average to slightly wet year, no discharges from the wetlands will be required.
Figure 6.1
Photograph of the Signage for the Town of Roblin’s Alternative Management System

Figure 6.2
Photograph of the Roblin Lagoon, Showing Cells 1 and 2
Table 6.4 shows the average nutrient reduction achieved by wetlands of this nature. The Roblin treated effluent quality is much better than the stated averages, with levels of: BOD$_5$ at 10-15; TN at 0.01-9.0; and TP at 2.8-3.5.

**Table 6.4**  
**Average Nutrient Reduction in Wetlands**  
*(North American Wetlands Conservation Council of Canada 1994)*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>In (mg/L)</th>
<th>Out (mg/L)</th>
<th>Removal Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-day Bio-chemical oxygen demand (BOD$_5$)</td>
<td>38.8</td>
<td>10.5</td>
<td>73</td>
</tr>
<tr>
<td>Total Suspended Solids (TSS)</td>
<td>49.1</td>
<td>15.3</td>
<td>69</td>
</tr>
<tr>
<td>Ammonia Nitrogen (NH$_3$-N)</td>
<td>7.5</td>
<td>4.2</td>
<td>44</td>
</tr>
<tr>
<td>Total Nitrogen (TN)</td>
<td>14</td>
<td>5</td>
<td>64</td>
</tr>
<tr>
<td>Total Phosphorous (TP)</td>
<td>4.2</td>
<td>1.9</td>
<td>55</td>
</tr>
</tbody>
</table>

The main disadvantage to wetlands is that unlike many other projects or sewage works installed, newly constructed wetlands can take several years and a great deal of work before the proper amount and variety of vegetation is established for the wetland to operate properly. Once the cells have been in operation for a number of years, the salinity of the remaining effluent must be monitored very carefully due to the amount of evaporation that takes place. In addition, great care must be taken to insure natural predators, such as muskrats, are controlled and the site must be properly managed to prevent permanent damage from occurring to the plant growth and dike wall structures.

**6.10.2 Hybrid Poplar Trees**

In addition to the wetlands project, a total of 5,000 hybrid poplar trees were planted on 7 to 9 hectares (15 to 20 acres) of land around the wetland cells to form a type of plantation. Additional trees will be planted in upcoming years on the rest of the land bordering the wetlands. These hybrid poplar trees will not only provide seepage control, but will also provide an additional use for the effluent. Since these trees are very fast growing and require a great deal of liquid for growth, large amounts of effluent can be used from the wetlands for irrigating the trees. Once established, the liquid requirements will increase even more due to the amount of evapotranspiration from the vegetative canopy. In addition to the uptake of additional liquid, the trees will provide excellent wildlife habitat and help stabilize the soil. Hybrid poplar trees are extremely rapid growing and will reach a height of 9 metres and mature within 10 years. The trees may then be harvested and sold for further processing into a variety of wood products.
6.10.3 Effluent Production Management

6.10.3.1 High Water Usage

A water and sewer audit carried out indicated the per-capita usage of water within the Town was much higher than normal. Given the size and population of Roblin, the amount of effluent produced yearly is approximately 250 percent of that produced by towns of similar size. As a result, the Town has embarked on a public education and water conservation program in an attempt to reduce the average water consumption. Part of this involved the supply and installation of toilet dams and flow restrictions in many of the homes. After the first phase of the "water use reduction" program, approximately 50 percent of the homes had installed the water saving devices. Further promotions are planned to increase participation among the Town residents and further reduce water consumption. The Town has also initiated the replacement of some water lines in an attempt to improve the quality of water and reduce the need for unnecessary conditioning equipment in each house.

6.10.3.2 Groundwater Infiltration

While the wetter weather created more processed effluent for disposal, the amount of increase was not proportional to the increase in yearly rainfall. During a two-year period, the amount of effluent produced rose from less than 50,000,000 gallons to more than 65,000,000 gallons yearly. Further investigation revealed that a surficial gravel formation in one portion of the Town, was a major cause for the large increase in effluent being produced. Due to local topography, most of the drainage around this area flows into this formation and becomes trapped. During wet years, the water table in this area can rise to nearly ground level. While the Town of Roblin had replaced many of the sewer lines in this area to eliminate any groundwater invading the lines, the problem was only postponed. The water level continued to rise until it reached the level of the weeping tiles in the nearby homes. At this point, a great deal of the groundwater drains off through the home weeping tiles and into the sewer collection system placing a large strain on the lagoon and disposal system. The Town is presently investigating and collecting data to better understand the situation and will be considering various options for controlling this groundwater invasion. By controlling the excess infiltration of groundwater into the sewer system, the present demand on the lagoon and effluent management system will be greatly reduced.

6.10.3.3 Effluent Quality

The major drawback to any action taken to reduce the level of groundwater infiltration into the sewer system will be the deterioration of the quality of effluent being produced. Without the additional liquid, acting to dilute the treated effluent, the mineral content of the effluent will increase. This can create problems with increased soil salinity of the irrigation and wetland sites. In an attempt to reduce the mineral content (chloride levels) the Town is embarking on a program of voluntary controls for in-house water softeners. Previous experience in other centres in the province has shown that most domestic softeners are not set for the most economical use of salt. By simply resetting the softeners, the amount of salt ending up in the sewer system can be
reduced by approximately 30 percent without affecting the performance of the softeners. This will not only save the homeowner money, but will also have a positive affect on maintaining the quality of the effluent being produced and extend the useful lifetime of the irrigation and wetland sites.

6.10.4 Summary

Overall, the inclusion of a wetland and woodlot to the already existing irrigation system, along with the future actions to reduce effluent production, will have many positive benefits for the Town of Roblin. Not only will these efforts greatly assist in the Town's ability to properly manage the effluent during the different weather cycles, but will continue to limit the amount of nutrients being discharged into the local watershed and eventually into Lake of the Prairies. This will assist in maintaining the water quality in the lake for not only fish and wildlife, but also the local population and tourists.

The constructed wetlands and hybrid poplar plantation will also provide not only renewable and saleable wood products in the future, but will also provide a large area of ideal habitat for wildlife and birds. The Town is hoping to establish a nature and educational walk through the wetlands/plantation area for tourists and students. The local school has already expressed interest in utilizing the area for classroom education and participation. As a result of the Town’s commitment and efforts over the years, other towns are presently looking at Roblin's example and are seriously considering the various possibilities open to them in the proper management of their treated effluent.

6.10.5 Conclusion

With a little thought and ingenuity, many towns can begin to utilize their effluent for production of goods, while reducing the impact on our country’s water bodies from lagoon discharges. This will extend the useful lifetime of the rivers and lakes and prolong their enjoyment for our citizens and tourists, while ensuring that the purity of the water supplies remains high.
7 Groundwater Protection

7.1 Introduction

Throughout the Upper Assiniboine River Basin, groundwater plays an integral part in everyone’s daily life. Due to existing geology in the area, groundwater is utilized as the major source of potable water for numerous cities, towns, villages, and individuals scattered throughout the region. While some of these groundwater sources are very shallow, others are fairly deep. The susceptibility of each aquifer (water bearing formation) to contamination varies greatly and is dependant on the type and amount of deposits or overburden covering the water table.

Figure 7.1
Major Aquifers Located in the Yorkton Area

![Diagram of Major Aquifers Located in the Yorkton Area]
7.2 Legislation

The provinces of Saskatchewan and Manitoba both have various acts, policies, regulations, and guidelines to develop, maintain and protect groundwater in the province for the protection of public health, as well as the following purposes:

- Preservation and protection of groundwater supplies;
- Sustainable development of groundwater for domestic, agricultural, industrial, and other economic activities;
- Preservation of water quality;
- Protection of public health; and
- Municipal and domestic water supplies.

7.2.1 Saskatchewan

7.2.1.1 The Water Corporation Act

The Act empowers and mandates the corporation to undertake numerous responsibilities to manage, protect, and develop the provincial water resource including the licensing required to divert water from a groundwater source.

7.2.1.2 The Groundwater Conservation Act

The purpose of this Act is to obtain logs of wells drilled and information on formation and materials during the drilling operations. This information is utilized in various geological studies and to provide for the conservation, development, and utilization of groundwater resources and prevent pollution and contamination of groundwater.

7.2.1.3 The Environmental Management and Protection Act (EMPA)

The EMPA governs pollution control in the province of Saskatchewan dealing specifically with water pollution, industrial effluent works, sewage works, and regulation of all matters concerning water quality. The Act establishes permit requirements, and procedures of permit acquisition for discharge of contaminants that might cause a change in water quality or water pollution.

7.2.1.4 The Public Health Act

The Public Health Act governs the operation of all water systems used for human consumption and controls all aspects of the water source, treatment, distribution system, sampling requirements, and operation.
7.2.1.5 The Agricultural Operations Act

*The Agricultural Operations Act* balances environmental responsibilities with the realities of agriculture protection. A major provision of the Act is the protection of groundwater and surface water by proper management of manure and animal waste.

7.2.1.6 Other Guidelines/Regulations

- *The Irrigation Act*
- The Water Pollution Control and Water Works Regulations
- The Environmental Spills Regulations

7.2.2 Manitoba

7.2.2.1 The Groundwater and Well Water Act

Manitoba *Groundwater and Well Water Act* was established to insure all well drillers operating in the province are licensed and the installation of all water wells meet certain development criteria, well information is recorded, flowing wells are sealed, precautions are taken to insure pollution of aquifers does not take place, and dry or abandoned wells are properly sealed.

7.2.2.2 The Water Rights Act

*The Manitoba Water Rights Act* requires that all wells diverting more than 25,000 liters per day be licensed to insure proper allocation and distribution of available aquifer capacities and to limit any inter-well interference or aquifer dewatering by various water users of an aquifer. Water is allocated on a "first in time, first in right" principal.

7.2.2.3 The Environmental Act

The Manitoba *Environmental Act* requires all classes of development to undergo an environmental assessment and licensing process. This would include operations such as landfills, lagoons, large livestock operations, industrial sites etc. Construction plans, operational guidelines, and sampling requirements would all be specified in the license in order to mitigate any potential impacts to groundwater quality and the environment.

7.2.2.4 The Public Health Act

*The Public Health Act* provides regulations and orders respecting; sewer treatment systems; construction, maintenance and purification of water systems and supplies; and preventing pollution of wells, underground waters and springs.
7.2.2.5 Other Guidelines/Regulations

- The Designated Flood Area Regulation
- The Water Supply Commission Act
- The Manitoba Water Services Board Act
- The Conservation Districts Act

7.3 Aquifer Vulnerability

With shallow groundwater formations, such as the Collacott and Logan aquifer systems near Yorkton, the water table is quite close to the surface and open to a variety of possible contaminants. The Sturdee aquifer system is also sensitive to contaminants due to the permeability of the overlying material. These types of aquifers are referred to as ‘unconfined’ or ‘vulnerable’ aquifers since they do not have a good protective layer of clay or till (bolder clay) between the water table and the surface of the ground. In some cases, the water level can come so close to the surface that groundwater can form sloughs or lakes as the ground elevation drops below the surface of the water table. Depending on how much the ground elevation fluctuates, these areas may be permanently inundated with water or may only become evident during periods of high water table.

With this type of aquifer, any surface activity has the potential to impact on the quality of the groundwater. Since these formations do not have sufficient protective covering of clay or other impermeable material, there is little to stop the downward migration of any pollutant once it is past the upper root zone of soil. These types of aquifers are often most at risk for contamination with the accumulation of nitrates, fuels, pesticides (herbicides, insecticides, fungicides, or rodenticides) or a multitude of other contaminants.

Of additional concern is the interaction of surface watercourses and groundwater and their effects on the aquifers. For example, during the mid-1990s, the Logan east aquifer developed a colour problem that was the result of naturally induced recharge from Yorkton Creek. The Sturdee aquifer system may be connected to the overlaying watercourses and, therefore, is very susceptible to contamination from pollutants being carried in the surface creeks or streams.

The alluvial fill type aquifers, commonly found along river channels, are also extremely susceptible to contamination as they recharge directly from the river and are susceptible to all the various contaminants carried by the river. This not only includes fertilizers, pesticides, fuels, and other contaminants washed off fields and urban residential areas, but also sewage and lagoon discharges or any land development that occurs upstream.

In other areas of the Basin, aquifers are deeper in nature and are often protected with a thick layer of impervious materials such as clay or till. In some instances, the water in the aquifer is under some pressure and will tend to rise up the well casing once this layer is penetrated during the drilling operation. Since these confined aquifers are not as open to contamination, they are generally assumed to be less vulnerable to surface activity.
Despite having this natural protection, many of these wells are found to be contaminated to some extent each year. This contamination generally occurs through the well itself, around the casing or through an old or improperly abandoned well, and is often a direct result of the lack of knowledge and poor management practices by the owner.

### 7.4 Well Abandonment

One of the greatest threats to the integrity of our groundwater, regardless of whether it is from a confined or unconfined aquifer, is through the well itself. While the chances of contamination around or through the existing well can be easily prevented, many wells become contaminated each year due to owner error or lack of knowledge.

Even more of a concern, is the number of old and abandoned wells existing throughout the country today. Given that wells have an average useful lifetime of 15 to 30 years, and wells have been drilled in this country since the late 1800s, a great number of wells have been drilled and subsequently replaced over the years. In Manitoba alone, it is estimated there are 10,000 wells that have not been properly abandoned and sealed to prevent contamination.

The necessity to properly seal old abandoned wells became evident during the “Flood of the Century” around Winnipeg in 1998 when a great number of abandoned wells were found to be open and were allowing huge amounts of contaminated flood water to invade the local aquifer. As a result, many months of work were needed to clean up the problem created by these old wells. The amount of permanent damage sustained to the aquifer is unknown. While this is the extreme case, the majority of well contamination occurring in confined aquifers is a result of poorly sealed or abandoned wells.

Both Saskatchewan and Manitoba have guidelines for the proper abandonment and sealing of wells, but the lack of enforcement has resulted in the existence of a great number of abandoned wells that provide a direct path for contaminants to enter and greatly impact an aquifer.

### 7.5 Contaminants

There are a great number of elements and compounds that can contaminate a groundwater source. In the farming community, the most common sign of contamination is a build up of nitrates in the water supply. The nitrates are commonly a result of excess nitrogen from fertilizers or manure leaching down past the plant root zone. Once past the root zone, they continue their downward movement with water until an impervious layer of soil or a water table is encountered.

This problem is very common on sandy or course-textured soils overlaying a shallow unconfined aquifer. Unfortunately, because these soils are not well suited to crop production, many livestock operations were developed in these areas compounding the nitrate contamination problem. In addition to nitrates, pesticides are an ever increasing concern to groundwater contamination.
These chemicals are normally very water soluble and can easily wash down through the soil and accumulate in the water table.

The farming community is not the only area of concern. Urban centres can also add to the groundwater contamination problem due to the larger concentration of people, vehicles, and industries in one location. The large amount of fertilizers and pesticides used on lawns, salt on streets, and chemicals, fuels, and waste from businesses and industries have the potential to impact groundwater and surface water supplies through runoff or infiltration.

Due to the services provided, the urban centres must also deal with a large sewer collection and treatment system. While these sewage treatment systems have a major potential to cause contamination, their design, construction and operation are carefully monitored and regulated by provincial agencies.

7.6 Groundwater Management

The management of groundwater resources is the responsibility of the provinces and is commonly shared between several different agencies within each province. The assessment, management, and allocation of groundwater resources are the sole responsibility of one agency in each province, while water quality and potability are the responsibility of various agencies in each province.

Aquifer investigation, mapping, and identification have been carried out in both provinces by Sask Water and Manitoba Conservation. The aquifer boundaries and numerous small surficial deposits are not well defined. While well drill logs and other information are constantly being amassed and recorded to increase the aquifer database in each province, present funding limitations and higher priorities limit the more intense investigation needed for more exact mapping of many of the aquifers throughout the area. While some data are gathered on general water quality by this sector of the government, specific tests for pesticides and other potential contaminants are not generally carried out.

Some work has been carried out to map the potential for groundwater pollution of aquifers in one portion of the Basin. Since the potential for contamination is directly related to the amount and type of overburden above a fresh water aquifer, anything with less than 5 to 6 metres of clay, till, or other low-permeable materials is normally considered a "Pollution Hazard Zone".

It is the responsibility of the health and environmental agencies to monitor problems with water quality as it pertains to human health concerns. If a problem occurs that indicates a contamination concern, it is the responsibility of these agencies to take corrective steps and possibly enact the necessary regulations to prevent further contamination. While various agencies collect water quality information, there seems to be little integrated database management.
7.7 Groundwater Protection

Regulation and enforcement, coupled with public education, are generally used to protect groundwater from contamination. The regulations protecting the aquifers usually come about as a response to a problem rather than a forward-looking policy that prevents contamination in the first place.

At present, regulations are generally in place to prevent contamination from major “point source” potential contaminants. As an example, regulations exist regarding the placement, construction, and operation for projects such as waste disposal sites, municipal lagoons, fuel stations, farm manure storage sites, and a multitude of other collection and disposal systems.

Until groundwater contamination in the Basin is better understood, it is difficult to develop and justify a regulatory and enforcement system beyond the existing legal structure. Unfortunately, waiting until there has been sufficient groundwater contamination to justify regulations and enforcement does not adequately protect the current status of our groundwater.

Rather than relying only on regulations to protect the groundwater, public awareness, education programs, and incentives are methods that must be utilized if groundwater quality is to be maintained. As the public learns of the susceptibility of aquifers to contamination and how easily it can occur, they begin to understand the consequences of their everyday actions.

In order to be successful, public education approaches for a specific audience, such as agricultural producers, should be comprehensive, straightforward and related to existing farm management practices. As an example, Best Management Practices (BMPs) is a method of communicating environmentally favourable choices to producers. BMPs are those practices developed for a particular industry, such as agriculture, to protect the environment and long-term sustainability of the industry. For best results, BMPs should be developed with co-operation from all parties involved in a particular industry. Some of the recommendations included to prevent leaching of nitrogen into the water table include matching the nitrogen inputs to the cropping needs, not applying nitrogen to coarse textured soils in the fall, and analysing soil for nutrient content prior to fertilizer and manure applications.

Groundwater protection recognizes that prevention is the only effective approach to dealing with the potential for groundwater contamination. Once groundwater supplies are contaminated, remediation is often difficult, time consuming and expensive. Contamination that has occurred through leaching may not only require the source of contamination to be removed, but also the removal of the overlying soils through which the contaminant percolated. Methods for protecting groundwater supplies include proper well siting and construction, protection from potential contaminants in the recharge area, adopting beneficial management practices to reduce non-point contamination from agricultural sources, monitoring, and the need to properly decommission and seal unused or abandoned wells.
7.8 Monitoring

Monitoring and analysis of water quality throughout all the aquifers in the Basin is an expensive and time-consuming activity that is difficult to undertake given the current fiscal restraints being encountered. Any extensive monitoring that is undertaken should be concentrated in those areas most susceptible to contamination.

One important component of monitoring is the data analysis to identify water quality changes. Once sufficient data has been collected at regular intervals, trend analysis of variables can be carried out. This information, combined with modeling of the baseline conditions, can provide sufficient information to change the regulatory systems or implement appropriate public education before significant negative water quality changes occur. At the very least, samples should be obtained in areas of concern for chemical changes such as pesticides to establish a baseline for future comparisons.

Monitoring of groundwater supplies and some groundwater mapping have been undertaken to a limited extent in the Basin. In 1996, a small survey of 23 shallow wells was conducted for ADD Districts 12 and 13 by Clifton Associates Ltd., SERM, and PFRA with funding from the Canada-Saskatchewan Agriculture Green Plan Agreement. ADD Districts 12 and 13 are centered around Yorkton and Melville respectively. Groundwater quality within the area was very good, despite being quite variable. In early September 1996, 23 “worst case scenario” wells were sampled. The parameters most commonly found that exceeded applicable guidelines were: nitrates (as NO₃⁻), sulphate, and total hardness (detected in 9 out of 23 wells). Nitrates are typically a result of human activities related to point source contamination from animal or human wastes and direct entry of nitrogen based fertilizers into the well, whereas sulphates and total hardness occur naturally. The study reported that non-point contamination of aquifers with nitrate from nitrogen-based fertilizers is unlikely, except in areas where intensive agricultural production under irrigation is practiced. Nitrates are very mobile in groundwater and are known to dissipate with depth in an aquifer, although rates of dissipation vary widely depending upon temperature and other factors. The study also noted that because these wells were “worst case scenario” (i.e., wells with an extremely high contamination potential), random sampling would likely produce results with significantly less nitrate concentrations. Nitrate levels exceeding 45 mg/L pose a risk to the health of infants by causing the condition known as “blue baby syndrome”.

Pesticides were detected in two of the 23 wells. However, the detection levels were 1,000 times lower than the Maximum Acceptable Concentration (MAC) specified by SERM’s Municipal Drinking Water Quality Objectives. The pesticides detected were Dicamba (Banvel), MCPA and Atrazine. The “Shallow Groundwater Quality Survey for ADD Districts #12 and #13” was part of a larger province-wide study involving seven ADD Districts, in which a total of 184 shallow wells were screened from July to September in 1996, for 13 pesticides, major ions, and physical properties. Of all of the participating ADD Districts, ADD Districts #12 and #13 had the lowest percentage of wells with detections.
7.9 Summary

While groundwater plays an important part in the everyday life of the majority of the population throughout the Basin, many of the major aquifers in this area are vulnerable to contamination by surface activities. Even deeper formations, that are normally considered safe, are susceptible to contamination if precautions are not taken. Old wells are a major concern if they are not properly abandoned, as they can be a major factor in allowing contaminants to enter the water bearing formation.

The management of groundwater throughout the area is the responsibility of the provincial governments and is generally split between a number of agencies within each province. While each agency compiles large amounts of data regarding the different aspects of groundwater quality and quantity each year, there is little integrated database management. As a result, much of the information regarding availability and water quality is lacking continuity and can be difficult to obtain.

While it is known that pollution is occurring, even though some regulations are in place for protection of this vital resource, more work must be carried out to limit the occurrences of contamination and their effects. Monitoring of groundwater, particularly in the most sensitive areas, must be implemented and carried out in order to track the changes occurring to the water formations. Without long-term monitoring, it will be impossible to adequately protect our groundwater in the future since changes will not be detected until contamination is widespread.

The long-term potential for groundwater quality in the Upper Assiniboine River Basin, as with the rest of the Prairies, is that it may degrade from its current level as a result of human activity. To what extent and how soon this may occur is impossible to predict given the large number of variables present. The future of our groundwater quality is not only the responsibility of the various government departments, but also of every person living in the Basin.

A brochure entitled “Water Quality in the Upper Assiniboine River Basin” was developed as part of this study. It incorporates information on groundwater protection and is included in Appendix V of this report.

7.10 Recommendations

1) Initiate a public education program on proper well and aquifer management to protect our groundwater formations from contamination.

2) Implement and enforce proper well abandonment policies when new wells are installed and actively seal existing abandoned wells to reduce the chances of contamination.

3) Better define the outer limits of the various aquifers in the region, with emphasis on unconfined or vulnerable aquifers.
4) Develop "Pollution Hazardous Zone" maps of the various aquifers in the region. These maps could then be utilized by local governments and planners as a guide in the future development of the area.

5) Develop and promote Best Management Practices (BMPs) for agriculture and other industries throughout the area with emphasis on groundwater protection.

6) Encourage the various agencies responsible for groundwater information and water quality to share information and jointly develop a database of the present status of our groundwater and its quality. This will require extensive cooperation and sharing of information between the various agencies and a long-term commitment from government to support the pooling of information.

7) Encourage the testing of groundwater supplies on an annual or biannual basis by providing water analysis at a reduced cost. This information can then be used in the development of the overall groundwater availability/water quality database and will assist in the determination of where and when further monitoring is required.

8) Initiate a regular monitoring program of the various aquifers for possible contaminants such as pesticides to identify areas of concern. Once these areas of concern are identified, long-term monitoring and possible corrective actions can be implemented. Without good water quality information indicating our present situation it will be very difficult, if not impossible, to determine what is happening to our resources in the future.
8 Conclusions and Recommendations

Water is one of the most important resources in the Upper Assiniboine River Basin. Water is used for domestic use, economic development, agricultural purposes, livestock watering, fishing and recreation.

In general, any substance that may enter a water body can be a potential source of pollution. The type of pollutant and the volume which is introduced to the water supply are the primary factors that influence water quality. The resulting water quality depends on the original quality of the receiving water, its assimilative capacity, level of mixing, rate of water flows, and the rate of chemical and biological changes. Effluents from sewage treatment facilities, suspended sediments, and nutrients and pesticides in runoff from agriculture and livestock operations are the major sources of pollutants.

8.1 Groundwater Monitoring

Groundwater is often the sole water source for municipal, domestic, agricultural and industrial needs. Groundwater can be contaminated from a number of sources, including fertilizer and pesticide applications, manure storage and spreading, livestock operations, effluent irrigation, landfills, leaking septic and fuel storage tanks and lagoon seepage.

Once an aquifer is contaminated, it is difficult, expensive and time consuming to clean up. Because a contaminant cannot be easily removed from groundwater supplies, prevention is the only effective approach to maintain a safe and clean supply.

The long-term potential for groundwater quality in the Upper Assiniboine River Basin may degrade from its current level as a result of human activity. Predictions concerning such degradation are difficult given the large number of unknowns present. It is certain, however, that the future of our groundwater quality is not only the responsibility of governments and concerned agencies, but also of every person living in the Basin.

Recommendation 1.

Aquifers should be monitored regularly for possible contaminants.

Once these areas of concern are identified corrective actions can be implemented. Without good water quality information indicating our present situation it will be very difficult, if not impossible, to determine water quality trends.
Recommendation 2.

Aquifer maps should be developed to define various aquifers in the region with an emphasis on unconfined or vulnerable aquifers.

Aquifer maps would be utilized by local governments and planners as a guide in the future development of the area.

Recommendation 3.

Testing of private groundwater wells should be encouraged on an annual or biannual basis through water quality testing services at a reduced cost.

This information can also be used to develop an overall groundwater availability/water quality database and assist in determining future monitoring needs.

Recommendation 4.

Groundwater monitoring should be done in the vicinity of hazardous storage facilities (e.g., chemical collection depots, landfills, discontinued bulk fuel depots, and gas stations) to determine whether contamination is occurring.

8.2 Surface Water Monitoring

Nutrients entering surface and groundwater supplies from external sources such as agricultural fertilizer can impact water quality, creating negative consequences for wildlife, livestock, human and aquatic biota. Nutrient loading of surface water may result in algal growth. This may cause reductions or changes in aquatic biota due to the shading effect of algae in the water column or lowering of dissolved oxygen levels that result during decomposition of algae. Species of algae may develop which are highly toxic to humans, livestock and wildlife. Algae may negatively impact drinking water quality by imparting odour and taste.

Recommendation 5.

Long-term monitoring of surface water quality and riparian health on a watershed basis should be implemented. Monitoring should be carried out to collect information to confirm the current status of water quality and identify potential problems in the Basin.

This should utilize well defined constituents and protocols along with efficient implementation to establish baseline information, analyze emerging trends or issues, and plan/develop practical, targeted solutions and recommendations.
Recommendation 6.

Monitoring should continue on the Assiniboine River at the PPWB station near Kamsack at a frequency that is capable of detecting long-term trends in water quality.

The levels of dissolved oxygen, total phosphorous and dissolved manganese already exceed the Prairie Provinces Water Board (PPWB) Water Quality Objective for the Assiniboine River and could potentially have a detrimental effect on downstream users in the Basin.

8.3 Agricultural Practices

Agriculture and livestock production are dominant activities in the Basin. Surface runoff may reduce water quality of the receiving water body. Some of the impacts of agricultural land runoff on water quality include nutrient loading, pesticide and heavy metal contamination, erosion and sedimentation, and removal of the natural buffering capabilities of wetlands through their drainage.

Management practices associated with all types of livestock activities will have an impact on groundwater and surface water quality. Impaired water quality can result from soil erosion due to overgrazing of pasture; nutrient overloading of streams, water bodies and groundwater through improperly controlled runoff from livestock pens or improper application of manure; and, degradation of shorelines due to overstocking of cattle near streams, lakes and sloughs. With the increase in both the number and size of livestock operations within the Basin, sustainable livestock management practices become more critical.

Agricultural land drainage including the removal of wetlands may cause impacts to surface and groundwater. Wetlands significantly reduce phosphorous, nitrogen, BOD and coliforms. Removal of wetlands reduces this function. Agricultural land drainage may aggravate soil erosion resulting in increased sedimentation in the receiving water body. Increased silt loading and turbidity can present problems for recreation use of water bodies because of decreased visibility. Sediments are also known to cover fish spawning areas and can also affect the storage capacity and life span of reservoirs.

High concentrations of ammonia nitrogen may occur in water sources as a result of fertilizer runoff facilitated by drainage. Increased concentrations of ammonia nitrogen in surface water can stimulate the growth of algae and aquatic plants. Ammonia readily converts to nitrate and nitrite through a chemical reaction which uses dissolved oxygen. Reduction of dissolved oxygen can negatively impact aquatic biota. High levels of nitrogen in groundwater may also create a health problem called blue-baby syndrome in infants, which can lead to respiratory failure. High levels of nitrogen in water supplied to livestock can result in weight loss and poor feed conversion.

Phosphorous laden soil particles may be added to a water body by erosional surface runoff facilitated by drainage. Phosphorous adhering to soil particles can be released into the water
column. In its dissolved form, phosphorous is readily taken up by plants and algae. Phosphorus is often a greater concern for aquatic systems than nitrogen because it is generally considered the limiting factor for the growth of freshwater phytoplankton such as algae.

Pesticides may contaminate surface and groundwater. Drainage of lands on which these chemicals are used may facilitate their movement to water bodies. Pesticides can be toxic to humans, livestock and wildlife depending on a number of factors including the type of pesticide and dilution rate.

**Recommendation 7.**

*Best Management Practices for agriculture and other industries in the Basin should be developed and promoted with emphasis on surface and groundwater protection. A glossary of terms for seeding, tillage and rotational systems should be developed that is consistent with the agricultural industry.*

Best management practices have been advocated as a means to reduce non-point contamination of water resources from agriculture. Such practices include avoiding chemical contamination by maintaining a suitable distance from wells during application, practising proper chemical storage, managing fertilizer applications to reduce nitrate leaching, and minimizing surface runoff.

**Recommendation 8.**

*The livestock industry should be encouraged to improve riparian areas through alternative pasturing, livestock watering systems, and properly located and managed winter feeding sites.*

**Recommendation 9.**

*Information should be provided on the value of manure as a nutrient-rich fertilizer.*

Manure is a nutrient-rich fertilizer product very suitable for application to crop lands. As with any fertilizer product, the manure should be applied to the land to match the nutrient requirements of the crop being grown. Over-application of the manure not only compromises the environment through a potential increase in runoff and leaching, but also can result in economic loss to the farmer by extending crop maturation time.

**Recommendation 10.**

*Water quality should be taken into consideration when evaluating drainage projects. Criteria should be established for rating or evaluating drainage projects. A code of practise should be developed for construction of drainage projects to reduce impacts on water quality.*
The evaluation process would include such items as soil texture, slope, seeding system, extent of residue cover, significant rainfall and runoff events, average annual precipitation and impact on wetlands.

**Recommendation 11.**

*Watershed-based planning should be undertaken to account for the cumulative impacts of drainage on water quality. Maintenance of existing wetlands should be encouraged to ensure some surface water storage within the Basin.*

**Recommendation 12.**

*Maintenance of natural vegetation cover around water bodies should be encouraged. Licensing preference should be given to drainage works that include establishment of vegetation cover such as grasses to protect the ditch from erosion. Buffer strips or bush adjacent to water courses or water bodies should be protected to reduce the potential for erosion or contamination of the receiving water body.*

**Recommendation 13.**

*Pesticide container disposal sites should continue to be used along with proper on-farm preparation of the containers for disposal (e.g., triple rinse puncture containers).*

**Recommendation 14.**

*Education activities should be implemented to caution pesticide users to avoid cleaning sprayers and chemical containers near open water and to apply product at the proper rates and follow label restrictions and recommended practices.*

### 8.4 Effluent Management

Effective wastewater treatment involves proper planning, design, construction, operation, monitoring, and an investment of hundreds of thousands of dollars by each community. Treatment is provided by lagoons or mechanical wastewater treatment plants.

The approach to effluent treatment employed by the Town of Roblin shows that many towns may be able to use their effluent for economic activity, while reducing the impact on water bodies from lagoon discharges. This will protect the rivers and lakes and provide continued enjoyment by residents and tourists, while ensuring that water quality is maintained.
Recommendation 15.

More extensive studies and monitoring are required to determine any long-term effects of lagoons on receiving water bodies.

At present there is no evidence to suggest that wastewater release or seepage is a major concern in the Basin, but it may be a contributing factor to water quality deterioration.

Recommendation 16.

The required quality of wastewater effluent and the procedures for its release to the Assiniboine River should be reviewed.

A reduction of nutrients in the Assiniboine River may have the potential to reduce accelerated aquatic weed growth in the river. The release of effluent should be coordinated with stream flows to dilute nutrient levels.

8.5 Groundwater Protection

One of the greatest threats to the integrity of groundwater, regardless of whether it is from a confined or unconfined aquifer, is the well itself. The chances of contamination around or through the existing well can be easily prevented. Many wells become contaminated due to owner error or lack of knowledge.

Even more of a concern, is the number of old and abandoned wells. Given that wells have an average life of 15 to 30 years, many wells have been drilled and subsequently replaced over the years. Wells can provide a direct connection for easy introduction of contaminants from the surface to an aquifer. Groundwater protection recognizes that prevention is the only effective approach to deal with the potential for groundwater contamination.

Recommendation 17.

Abandoned wells should be properly decommissioned.

Recommendation 18.

Wells should be properly sited, constructed, and maintained to protect groundwater from contamination.

Recommendation 19.

A public education program on proper well and aquifer management should be initiated to protect our groundwater formations from contamination.
Recommendation 20.

More stringent regulations should be applied to the construction and monitoring of new facilities such as landfills, lagoons, chemical storage and pesticide container disposal sites.

8.6 Information and Education

Recommendation 21.

Agencies responsible for surface and groundwater management and protection should be encouraged to share information and develop a joint database of the current status of water quality.

Recommendation 22.

Agencies should provide coordinated and effective communication to the public and stakeholders on issues related to landscape management that affect surface and groundwater.
References

Agriculture and Agri-Food Canada. 1999. Saskatchewan Pesticide Return. *A program for the collection and disposal of unwanted, obsolete agricultural pesticides.* Agriculture and Agri-Food Canada and Crop Protection Institute of Canada (brochure).


Buchanan B, Nga De La Cruz, J. Macpherson, and K. Williamson. 1996. Water Wells… that last for generations. Agriculture and Agri-Food Canada, Alberta Environmental Protection, and Alberta Agriculture Food and Rural Development. 91 p.


Kuiper, E. 1962. Sedimentation of the South Saskatchewan Reservoir. Prairie Farm Rehabilitation Administration, Winnipeg, Manitoba.


Olson, M. E., D. W. Morck, and L. Desselliers. n.d. *Giardiasis in Animals and Humans*. Department of Microbiology and Infectious Diseases and Biological Sciences, University of Calgary University of Calgary. 18 p.


Statistics Canada. 1999. Livestock Statistics, Cattle and calves on farms semi-annually by province, pigs on farms quarterly by province, sheep and lambs on farms semi-annually by province. Catalogue #23603E.


Glossary

**Conservation Tillage** - any tillage sequence in which the object is to minimize or reduce loss of soil and water. Operationally, it is any tillage and seeding sequence which leaves more than 30% of crop residue on the soil surface.

**Conventional Tillage** - primary and secondary tillage operations normally performed in preparing a seedbed and/or cultivating for a given crop grown in a given geographical area; usually results in less than 30% of crop residues remaining on the surface of the soil after completion of the tillage sequence.

**Cultivated Land** - For the purposes of this report, cultivated land is land that is tilled and used for annual cropping.

**Drainage** - Movement of water off of land. Drainage may be natural or man-made. For the purpose of this report, drainage refers to movement of surface water by man-made works.

**Ecosystem** - “a community of organisms interacting with one another and with the chemical and physical factors making up their environment.” The chemical and physical factors include sunlight, rainfall, soil nutrients, climate, salinity, etc. An ecosystem is inherently leaky: that is, at a minimum, energy and nutrients move in and out. Just as likely, individual organisms (such as seeds, spiders, and sparrows) move in and out as well. Some considerations based on this definition are:

- All parts of the planet, from a microbe drifting in the upper atmosphere, to the wheat midge egg in the soil and the tadpole in the slough, are within an ecosystem. An ecosystem has no defined size.
- Ecosystems are not necessarily stable, nor are all their component species necessarily native to the area. Purple loosestrife is an example on an intruder that now can be a member of a given ecosystem.
- Ecosystems are difficult to separate from each other. Boundaries may be drawn to study a specific species, but the boundary is arbitrary.
- Based on the definition now used by ecologists, an ecosystem can be large or small and can include both pristine and highly developed areas.

**Holding Pond** - associated with the collection of runoff from outdoor livestock pens, primarily those of cattle. Holding ponds are usually less than 1.2 metres deep. A holding pond confines runoff water which has been exposed to manure and livestock. The holding pond is rarely at design capacity since it is dependant on precipitation events, the spring melt, and evaporation. Very few solids accumulate in a holding pond. Most of the solids normally remain within the manure pack in the pens until field spread or are stockpiled for future field spreading. If a high concentration of solids is anticipated in the runoff, a settling basin is used before the holding pond.
Intensive Livestock Operation (ILO) - means the confining of any of the following animals, where the space per animal unit is less than 370 m²: poultry, hogs, sheep, goats, cattle, horses, elk, mule deer, white-tail deer, fallow deer, bison, or any other prescribed animals. The number of animals of each species required to make one animal unit is shown in Table 1 of The Agricultural Operations Act or Appendix B of the Guidelines for Establishing and Managing Livestock Operations. Approval is required for any intensive livestock operation that:
- contains an earthen manure storage area or lagoon;
- involves the rearing, confining, or feeding of 300 or more animal units; or
- confines more than 20 animal units, but less than 300 animal units for more than 10 days in any 30-day period, within 300 metres of surface water or 30 metres of a domestic water well not controlled by the operator.

No-Till or Zero Till - a procedure whereby a crop is planted directly into the soil with no primary or secondary tillage since the harvest of the last crop; usually a special seeding machine is required to prepare a narrow, shallow seedbed immediately around the seed.

Manure Storage - there may be some confusion in the terminology of manure containment practices. An earthen manure storage (EMS) is the term associated with the storage of liquid manure in an earthen structure. An EMS is strictly a storage unit and is not designed for “treatment” of the waste as is expected of municipal lagoons. As a rule, an EMS is 3 to 5 metres deep. Within the Basin, EMSs are used primarily for the storage of liquid hog manure. There is limited use of EMSs for storage of liquid dairy and poultry manure. Manitoba suggests that an EMS should have a minimum 200 days of storage; Saskatchewan requests 400 days of storage for all new EMS structures. Both provinces require the involvement of professional engineers in the design of an EMS.

Minimum Tillage - the minimum use of primary and/or secondary tillage necessary for meeting crop production requirements under the existing soil and climatic conditions, usually resulting in fewer tillage operations than normally used in conventional tillage.

Pesticide - is defined as any chemical used to control pests such as weeds (herbicides), insects (insecticides), crop diseases (fungicides), and rodents (rodenticides). In general, insecticides are more toxic than herbicides. Organophosphorous insecticides are more toxic than carbamates and organochlorine insecticides.

Riparian Area - the transition zones between land and water environments. They are the narrow strips of land located along streams, lakes, potholes, springs, coulees, and wooded draws - anywhere that water is plentiful. Riparian area boundaries can normally be identified from the surrounding uplands by an increased abundance of water and by plant communities that are different from those of the drier uplands.

Reduced Tillage - a tillage system in which the total number of tillage operations used for seedbed preparation is reduced from that normally used on that particular field or soil.
Stockpiling of Manure - The piling of manure prior to spreading on fields is considered an acceptable practice provided the location of the pile(s) ensures protection of ground and surface water.

Waste Storage Plan - describes the type of storage, duration of storage, capacity, drawings showing dimensions, setback distances, groundwater conditions, construction techniques, freeboard, description of soils investigation, and details of monitoring programs.

Waste Management Plan - outlines the method of handling, utilizing, and disposing of waste by-products originating from the intensive livestock operation.

Watershed - the "Entire region drained by a waterway that drains into a lake or reservoir; total area above a given point on a stream that contributes to the flow at that point (the definition used for defining the UARB Study boundary); the topographic dividing line from which surface streams flow in two different directions." Except where two watersheds are separated by very flat areas, it is relatively easy to define watershed boundaries. A watershed can be any size ranging from the smallest of streams to everything upstream of a river's discharge point at the ocean shore.