

# Red Deer River State of the Watershed Report



April 01, 2009

This report was written by *Aquality* Environmental Consulting Ltd., Edmonton, AB, for the Red Deer River Watershed Alliance, Red Deer, Alberta, Canada.



Copyright © 2009 by the Red Deer River Watershed Alliance

Copies of this report are not certified unless stamped with an original Alberta Society of Professional Biologists (ASPB) stamp and initialed and dated by an ASPB member in good standing.

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the publisher.

Published in 2009  
by  
Red Deer River Watershed Alliance, 4918 – 59 Street, Red Deer, Alberta, T4N 2N1, Canada.

Please reference this report as:

*Aquality* Environmental Consulting Ltd. 2009. Red Deer River State of the Watershed Report. Report prepared for the Red Deer River Watershed Alliance, Red Deer, Alberta, Canada.

ISBN 978-0-9812391-0-1

Cover image – “*The Lay of the Land*”, 40” x 60”, oil on canvas.

Dean Francis and Fran Hartsook reside east of Empress, Alberta, near the South Saskatchewan River. Here, they have developed “Sagebrush Studios”, home, studio, galleries and gardens, where one can enjoy a unique blend of art and nature. Painting full-time since 1978, Dean captures the Canadian Prairies in a rich array of colour, form and texture. His oil paintings can be found in private and corporate collections throughout Canada and the U.S. Dean Francis paintings are available at Sagebrush Studios gallery and through [www.deanfrancis.ca](http://www.deanfrancis.ca).

## Acknowledgements

A State of the Watershed report summarizes the current knowledge of a watershed with respect to land-use, water quality, water quantity, fisheries and selected biological indicators. The information required to complete a state of the watershed report is scattered throughout the scientific literature, reports from federal, provincial and municipal governments, non-governmental agencies, industry, consultants and various other stakeholders in a region. Composing such a report requires the combined efforts of many individuals, committees and agencies over an extended period of time.

First and foremost, we acknowledge the invaluable contributions of members of the Steering Committee and the Technical Advisory Committee.

### State of the Watershed Steering Committee

Tracy Scott – Ducks Unlimited Canada (Chair)  
Richard Bennett – Red Deer River Watershed Alliance  
Glen Brandt – Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration  
David Brown/Quentin Schatz – Alberta Health Services  
Barry Cole – Alberta Sustainable Resource Development  
Tom Daniels – Sundre Forest Products  
Margaret Glasford – Alberta Stewardship Network  
Darren Kuz – Tourism Red Deer  
Dug Major – Special Areas Board  
Tom Marstaller/Pam Vust – City of Red Deer  
Chris Morrison/Lee Taylor – Quicksilver Resource Ltd.  
Wes Olstad – Mountain View Regional Water Services Commission  
Richard Orr – Department of Fisheries and Oceans  
Rob Schwartz – Member-at-large  
Bill Shaw – Red Deer River Watershed Alliance  
Doug Thrussell/Greg Nelson – Alberta Environment  
Chad Willms/Rob Deverell – MD of Rocky View  
Larry Wright – Town of Olds  
Jamie Wuite – Alberta Agriculture and Rural Development

### Technical Advisory Committee

Beverly Anderson – Red Deer River Watershed Alliance (Chair)  
David Brown – Alberta Health Services  
Vance Buchwald – Alberta Sustainable Resource Development  
Terry Chamulak – Alberta Environment  
Tim Chau – Alberta Environment  
Craig Emmerton – Alberta Environment  
Bill Franz – Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration  
Myron Hawryliw – Alberta Agriculture and Rural Development  
Terry Krause – Alberta Tourism, Parks and Recreation  
Kelsey Kure – Sundre Forest Products  
Brandon Leask – Alberta Agriculture and Rural Development  
Maggie Romuld – University of Lethbridge  
Jonathan Thompson – Ducks Unlimited Canada  
Ken Williamson – Alberta Agriculture and Rural Development  
Joe Windle – City of Red Deer

## Red Deer River State of the Watershed Report

---

We also thank the Board of Directors of the Red Deer River Watershed Alliance (RDRWA) for their contributions to this endeavor.

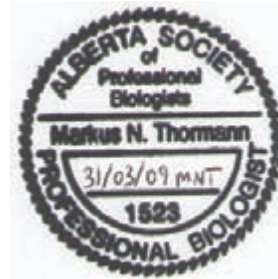
Earl Graham – Chair, Clearwater County & Rocky Riparian Group  
Dale Christian – Butte Action Committee  
Tom Daniels – Sundre Forest Products  
Craig DeCoursey – Apache Canada Ltd.  
Paul Goranson – City of Red Deer  
David Johnson/Dr. Abimbola Abiola – Olds College  
Dug Major – Municipal Affairs  
Jim Martin – Dickson Fish and Game  
Norrine Samson/Philip Simpson – Samson Cree Nation  
Doug Sawyer – Alberta Beef Producers  
Tracy Scott – Ducks Unlimited Canada  
Bill Shaw – Member-at-Large  
Jack Swainson – Alberta Conservation Tillage Society  
Greg Nelson/Doug Thrussell – Alberta Environment  
Vic Walls/Richard Bennett – Member-at-Large  
Jamie Wuite – Alberta Agriculture and Rural Development

Thanks are also extended to Donna Trottier (Program Coordinator) for her time and effort since the inception of this project.

A special thanks goes to Craig Wright, Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration, for the tremendous GIS support he provided to this report. Your enthusiasm and impeccable work are greatly appreciated.

In addition, we appreciate the contributions of Susan May, Intrinsic Design, Edmonton, for her tireless work creating the State of the Watershed logo, open house posters, postcards and videos. Wendy Proudfoot, Alberta Natural Heritage Information Centre, Alberta Tourism, Parks and Recreation, Edmonton, and Jim Herbers, Alberta Biodiversity Monitoring Institute, provided invaluable information on rare organisms in the Red Deer River watershed. Water quality data was provided by NOVA Chemicals Corporation, Red Deer, and the Medicine River Watershed Society. Kerri O’Shaughnessy, Alberta Riparian Habitat Management Society - Cows and Fish, Edmonton, provided numerous riparian health assessment reports (Medicine River Watershed Society, Friends of the Little Red Deer River Society, Rosebud River Watershed Partners), and Diana Rung, Alberta Conservation Association, Red Deer, provided riparian health assessment videography of Gull and Sylvan Lakes. We are thankful to all of them for their time and effort.

Last but not least, everyone at *Aquality* Environmental Consulting Ltd., Edmonton, contributed to this report, and we thank Dr. Markus Thormann, Melissa Logan, Joshua Haag, Jay White, Michelle Gray and Amanda Parsons for data compilation and report composition and Jon Fuller and Fran Thompson for technical and administrative support.





### **FINANCIAL CONTRIBUTORS**

The Red Deer River Watershed Alliance would like to thank the following organizations who have very graciously provided financial support for the preparation of this report. Without this support, the project would not have been possible. Our very sincere gratitude is extended to:

#### **Platinum sponsors**



Agriculture and  
Agri-Food Canada

Agriculture et  
Agroalimentaire Canada



#### **Gold Sponsor**



#### **Silver Sponsors**



#### **Bronze Sponsors**

Atco Power Sheerness Generating Station  
Ducks Unlimited Canada  
Eastern Irrigation District

#### **Business Sponsors**

KutApoz  
Pembina Pipeline Corporation  
Quicksilver Resources Inc.  
Shell Canada Limited

## Executive Summary

The Red Deer River watershed forms the largest sub-basin of the South Saskatchewan River basin. The Red Deer River originates in the Canadian Rocky Mountains in Banff National Park and flows over and through mountains, foothills, rangeland, residential land, industrial land, oil and coal deposits, cities, towns, parks, reserves, forests and croplands across southern Alberta, joining up with the South Saskatchewan River 8 km past the Saskatchewan border. The Red Deer River has a length of 724 km and a drainage area of 49,650 km<sup>2</sup>. The river is fed by meltwater, glacial streams from Mount Drummond and Cyclone Mountain in the Rocky Mountains and numerous freshwater springs and tributaries. Its watershed includes 55 urban centres and 18 rural or regional municipalities.

The major urban centres in the Red Deer River watershed include the Cities of Red Deer and Brooks and the Towns of Strathmore and Sylvan Lake. The largest rural populations are found in Red Deer County, the Municipal District of Rocky View No. 44 and Mountain View County. There are about 13,000 farms in the Red Deer River watershed that cover an area of nearly 4.87 million ha, which is equivalent to about 48,700 km<sup>2</sup> of the watershed. About 43% of the land in the watershed is used to raise crops, principally barley, alfalfa, canola and spring wheat. In addition to municipal and agricultural developments, the Red Deer River watershed is characterized by a diverse commercial and industrial mosaic, including golf courses, bottling and food processing plants, gardening and landscaping establishments, aggregate washing facilities for the construction industry, parks and recreation facilities, fertilizer plants, manufacturing facilities, mines and forestry-related facilities.

In response to a growing population base and economy over the past decade, the Red Deer River Watershed Alliance (RDRWA) was formed in June 2005 to promote watershed health and the good use and proper management of water within the Red Deer River watershed. Its vision is for a healthy, dynamic and sustainable watershed through the efforts of the entire community by (1) providing a forum for information exchange and dialogue, (2) raising awareness on watershed issues, (3) promoting the use of best practices and integrated management of land and water resources, (4) fostering the preservation and enhancement of water quality management, and (5) championing the wise management of water quantity and supply. It was designated the Watershed Planning and Advisory Council for the Red Deer River watershed under the Government of Alberta's *Water for Life Strategy* in September 2005.

In January 2008, *Aquality* Environmental Consulting Ltd., Edmonton, was contracted by the RDRWA to develop this State of the Watershed report for the Red Deer River watershed. The purpose of this report is to summarize the current knowledge, comment on the environmental integrity of the Red Deer River watershed and provide the basis for a future Integrated Watershed Management Plan. This report focuses on 20 indicators that fall into four major indicator groups (land use, water quality, water quantity and biological indicators) and provides the background information that is required for improved watershed management decisions by regulators, policy makers, landowners and industrial users. Each of the indicators is treated individually for the Red Deer River mainstem and the 15 subwatersheds that form the Red Deer River watershed (Panther, James, Raven, Little Red



Deer, Medicine, Blindman, Waskasoo, Buffalo, Threehills, Kneehills, Michichi, Rosebud, Berry, Matzhiwin and Alkali). Of these 20 indicators, three are indicators of risk and nine are indicators of condition. The remaining eight indicators provide additional background information only. Each subwatershed section concludes with an overall rating that resulted from the combined evaluation of the risk and condition indicators. The state of the watershed report concludes by identifying knowledge gaps and providing recommendations to maintain or strive towards healthy ecosystems and the sustainable use of aquatic resources in the Red Deer River watershed.

Based on the chosen risk and condition indicators, it was determined that 11 out of the 15 subwatersheds have a medium level of risk to their ecological integrity, while four have a low level of risk (Panther, James, Raven and Little Red Deer subwatersheds). The parameters of most concern with regard to risk are oil and gas activity and urban, rural, agricultural, and recreational developments. Manure is problematic in the Blindman, Waskasoo and Kneehills subwatersheds and is close to becoming problematic in other subwatersheds with high feedlot density.

Five subwatersheds in the central portion of the watershed are currently ranked as being in poor condition (Medicine, Blindman, Waskasoo, Kneehills and Michichi). The condition indicators of concern in these subwatersheds are linear development, surface water nutrient levels and land cover. Eight subwatersheds are in fair condition, and only two are in good condition (Panther and Alkali).

Overall, by combining the risk and condition ratings to obtain an overall ranking system, five subwatersheds received a poor grade (C- to C+), eight received a fair grade (B- to B+) and two received a good grade (A- to A+). The subwatersheds receiving a poor ranking are the Medicine, Blindman, Buffalo, Michichi and Kneehills, with land cover, surface water nutrient levels, linear development and oil and gas activity being the indicators of most concern. These areas and indicators should be the first issues addressed in the future Red Deer River Integrated Watershed Management Plan (IWMP). The subwatersheds receiving the best overall ranking were the Panther and the Alkali. It is important to consider preserving this good ranking using appropriate management planning activities.

It should be noted that many knowledge gaps exist, including detailed subwatershed level wetland loss, riparian health assessments, water quality data (particularly bacteria, parasites, pesticide and pharmaceutical data), groundwater quality and quantity, instream flow needs and wildlife diversity. This information will be instrumental in accurately assessing the overall health of the subwatersheds and the Red Deer River watershed as a whole, and should be considered in the IWMP stage as the information becomes available.

## Table of Contents

<b>Acknowledgements .....</b>	<b>3</b>
<b>Executive Summary .....</b>	<b>6</b>
List of Tables .....	12
List of Figures .....	16
<b>Acronyms, Abbreviations, and Standardized Shorthand Notations.....</b>	<b>26</b>
<b>1.0 Introduction .....</b>	<b>29</b>
1.1 Purpose of Report.....	29
1.2 Scope of Report .....	29
1.3 RDRWA Background .....	31
1.4 Institutional and Regulatory Authorities .....	31
1.4.1 Federal Government.....	31
1.4.2 Provincial Government.....	32
1.4.3 Municipal Governments .....	32
<b>2.0 Methods.....</b>	<b>35</b>
2.1 Indicators of Ecological Integrity .....	35
2.2 Assessing Watershed Condition .....	35
2.3 Data Collection .....	38
<b>3.0 The Red Deer River Watershed .....</b>	<b>39</b>
3.1 Watershed Overview .....	40
3.1.1 Land Use .....	44
3.1.2 Water Quality.....	55
3.1.3 Biologicals .....	91
3.1.4 Water Quantity .....	115
3.2 Natural Regions in the Red Deer River Watershed .....	136
3.2.1 Rocky Mountain Natural Region .....	137
3.2.2 Foothills Natural Region.....	139
3.2.3 Boreal Forest Natural Region .....	139
3.2.4 Parkland Natural Region .....	140
3.2.5 Grassland Natural Region .....	141
<b>4.0 State of the Red Deer River Subwatersheds .....</b>	<b>144</b>
4.1 Panther River Subwatershed .....	144
4.1.1 Watershed Characteristics .....	144
4.1.2 Land Use Indicators.....	147
4.1.3 Water Quality Indicators.....	159
4.1.4 Water Quantity Indicators .....	161
4.1.5 Biological Indicators .....	169
4.1.6 Subwatershed Assessment .....	172
4.2 James River Subwatershed .....	174
4.2.1 Watershed Characteristics .....	174
4.2.2 Land Use Indicators.....	177
4.2.3 Water Quality Indicators.....	191
4.2.4 Water Quantity Indicators .....	194
4.2.5 Biological Indicators .....	205
4.2.6 Subwatershed Assessment .....	210
4.3 Raven River Subwatershed .....	213
4.3.1 Watershed Characteristics .....	213
4.3.2 Land Use Indicators.....	216



4.3.3	<i>Water Quality Indicators</i> .....	229
4.3.4	<i>Water Quantity Indicators</i> .....	231
4.3.5	<i>Biological Indicators</i> .....	242
4.3.6	<i>Subwatershed Assessment</i> .....	248
4.4	Little Red Deer River Subwatershed .....	251
4.4.1	<i>Watershed Characteristics</i> .....	251
4.4.2	<i>Land Use Indicators</i> .....	254
4.4.3	<i>Water Quality Indicators</i> .....	270
4.4.4	<i>Water Quantity Indicators</i> .....	275
4.4.5	<i>Biological Indicators</i> .....	288
4.4.6	<i>Subwatershed Assessment</i> .....	298
4.5	Medicine River Subwatershed .....	301
4.5.1	<i>Watershed Characteristics</i> .....	301
4.5.2	<i>Land Use Indicators</i> .....	304
4.5.3	<i>Water Quality Indicators</i> .....	319
4.5.4	<i>Water Quantity Indicators</i> .....	323
4.5.5	<i>Biological Indicators</i> .....	333
4.5.6	<i>Subwatershed Assessment</i> .....	338
4.6	Blindman River Subwatershed .....	341
4.6.1	<i>Watershed Characteristics</i> .....	341
4.6.2	<i>Land Use Indicators</i> .....	344
4.6.3	<i>Water Quality Indicators</i> .....	359
4.6.4	<i>Water Quantity Indicators</i> .....	378
4.6.5	<i>Biological Indicators</i> .....	388
4.6.6	<i>Subwatershed Assessment</i> .....	397
4.7	Waskasoo Creek Subwatershed .....	400
4.7.1	<i>Watershed Characteristics</i> .....	400
4.7.2	<i>Land Use Indicators</i> .....	403
4.7.3	<i>Water Quality Indicators</i> .....	415
4.7.4	<i>Water Quantity Indicators</i> .....	417
4.7.5	<i>Biological Indicators</i> .....	426
4.7.6	<i>Subwatershed Assessment</i> .....	429
4.8	Buffalo Subwatershed .....	432
4.8.1	<i>Watershed Characteristics</i> .....	432
4.8.2	<i>Land Use Indicators</i> .....	435
4.8.3	<i>Water Quality Indicators</i> .....	449
4.8.4	<i>Water Quantity Indicators</i> .....	462
4.8.5	<i>Biological Indicators</i> .....	473
4.8.6	<i>Subwatershed Assessment</i> .....	478
4.9	Threehills Creek Subwatershed .....	481
4.9.1	<i>Watershed Characteristics</i> .....	481
4.9.2	<i>Land Use Indicators</i> .....	484
4.9.3	<i>Water Quality Indicators</i> .....	497
4.9.4	<i>Water Quantity Indicators</i> .....	506
4.9.5	<i>Biological Indicators</i> .....	519
4.9.6	<i>Subwatershed Assessment</i> .....	525
4.10	Kneehills Creek Subwatershed .....	528
4.10.1	<i>Watershed Characteristics</i> .....	528
4.10.2	<i>Land Use Indicators</i> .....	531

4.10.3	<i>Water Quality Indicators</i> .....	543
4.10.4	<i>Water Quantity Indicators</i> .....	545
4.10.5	<i>Biological Indicators</i> .....	556
4.10.6	<i>Subwatershed Assessment</i> .....	560
4.12	Michichi Creek Subwatershed .....	562
4.11.1	<i>Watershed Characteristics</i> .....	562
4.11.2	<i>Land Use Indicators</i> .....	565
4.11.3	<i>Water Quality Indicators</i> .....	578
4.11.4	<i>Water Quantity Indicators</i> .....	580
4.11.5	<i>Biological Indicators</i> .....	591
4.11.6	<i>Subwatershed Assessment</i> .....	598
4.12	Rosebud River Subwatershed .....	600
4.12.1	<i>Watershed Characteristics</i> .....	600
4.12.2	<i>Land Use Indicators</i> .....	603
4.12.3	<i>Water Quality Indicators</i> .....	616
4.12.4	<i>Water Quantity Indicators</i> .....	619
4.12.5	<i>Biological Indicators</i> .....	629
4.12.6	<i>Subwatershed Assessment</i> .....	633
4.13	Berry Creek Subwatershed .....	636
4.13.1	<i>Watershed Characteristics</i> .....	636
4.13.2	<i>Land Use Indicators</i> .....	639
4.13.3	<i>Water Quality Indicators</i> .....	652
4.13.4	<i>Water Quantity Indicators</i> .....	654
4.13.5	<i>Biological Indicators</i> .....	665
4.13.6	<i>Subwatershed Assessment</i> .....	673
4.14	Matzhiwin Creek Subwatershed .....	676
4.14.1	<i>Watershed Characteristics</i> .....	676
4.14.2	<i>Land Use Indicators</i> .....	679
4.14.3	<i>Water Quality Indicators</i> .....	693
4.14.4	<i>Water Quantity Indicators</i> .....	700
4.14.5	<i>Biological Indicators</i> .....	712
4.14.6	<i>Subwatershed Assessment</i> .....	719
4.15	Alkali Creek Subwatershed .....	722
4.15.1	<i>Watershed Characteristics</i> .....	722
4.15.2	<i>Land Use Indicators</i> .....	725
4.15.3	<i>Water Quality Indicators</i> .....	737
4.15.4	<i>Water Quantity Indicators</i> .....	739
4.15.5	<i>Biological Indicators</i> .....	750
4.15.6	<i>Subwatershed Assessment</i> .....	757
<b>5.0</b>	<b>Data Gaps</b> .....	<b>759</b>
5.1	Land Use Indicators .....	759
5.2	Water Quality Indicators .....	761
5.3	Water Quantity Indicators .....	762
5.4	Biological Indicators .....	764
<b>6.0</b>	<b>Discussion and Conclusions</b> .....	<b>766</b>
6.1	Land Use .....	766
6.1.1	<i>Wetland Loss</i> .....	766
6.1.2	<i>Riparian Health</i> .....	767
6.1.3	<i>Livestock Manure Production</i> .....	767

6.1.4	<i>Urban, Rural, Agricultural and Recreational Developments</i> .....	768
6.1.5	<i>Linear Developments</i> .....	768
6.1.6	<i>Oil and Gas Activities</i> .....	769
6.2	Water Quality .....	769
6.2.1	<i>Nutrients</i> .....	769
6.2.2	<i>Bacteria</i> .....	771
6.2.3	<i>Parasites</i> .....	772
6.2.4	<i>Pesticides</i> .....	772
6.3	Water Quantity.....	773
6.3.1	<i>Minimum Flows to Maintain Ecological Integrity</i> .....	773
6.4	Biologicals .....	773
6.4.1	<i>Wildlife Biodiversity</i> .....	773
6.4.2	<i>Land Cover</i> .....	774
6.5	Cultural and Historical Considerations .....	776
6.6	Red Deer River Watershed Health Assessment .....	777
<b>7.0</b>	<b>Recommendations</b> .....	<b>787</b>
7.1	Stewardship Opportunities.....	793
7.2	Future Strategies .....	794
	<b>Bibliography</b> .....	<b>795</b>
	<b>Glossary</b> .....	<b>806</b>
	<b>Appendix A – Indicator Report</b> .....	<b>812</b>
	<b>Appendix B – Summary Results from October 2008 Open Houses</b> .....	<b>831</b>

## List of Tables

Table 1. Legislation and policy involving water and watershed management in Alberta. ....	33
Table 2. Data sources for maps generated by the Prairie Farm Rehabilitation Administration.....	38
Table 3. Historical resources in the Red Deer River valley.....	42
Table 4. Population distribution and growth in the Red Deer River watershed from 1996-2006.....	44
Table 5. Urban population and change in the Red Deer River watershed in 2001 and 2006.....	45
Table 6. Rural population and change in the Red Deer River watershed in 2001 and 2006. ....	46
Table 7. Agricultural land use in the Red Deer River watershed in 2001. ....	47
Table 8. Classifications of farms in the Red Deer River watershed compared to Alberta in 2001. ....	48
Table 9. Estimated livestock populations in the Red Deer River watershed compared to Alberta in 2001. ....	48
Table 10. Summary statistics for selected water quality parameters (1997) in the Red Deer River at Sundre.....	59
Table 11. Summary statistics for selected water quality parameters and total metals/metalloids (1999-2003) in the Red Deer River at Queen Elizabeth II Highway upstream of Red Deer.....	66
Table 12. Summary statistics for selected water quality parameters in the Red Deer River at Joffre in 2007 .....	68
Table 13. Summary statistics for selected water quality parameters and total metals/metalloids (1999-2003) in the Red Deer River at Nevis downstream of Red Deer .....	77
Table 14. Summary statistics for selected water quality parameters and total metals/metalloids (1999-2003) in the Red Deer River at Morrin upstream of Drumheller .....	78
Table 15. Summary statistics for selected water quality parameters and total metals/metalloids (1999-2003) in the Red Deer River at Bindloss near the Alberta-Saskatchewan border .....	81
Table 16. Comparison of means of selected water quality parameters and total metals/metalloids (1999-2003) in the Red Deer River at five sampling sites along the Red Deer River ...	84
Table 17. Assessment of different water quality components at three locations in the Red Deer River .....	85
Table 18. Assessment of aquatic ecosystem health in the Red Deer River .....	85
Table 19. Comparison of selected water quality parameters in 1973-1984 and 1999-2003 for the Red Deer River reaches.....	86
Table 20. Land cover in the Red Deer River watershed.....	92
Table 21. Riparian health rating system .....	95
Table 22. Riparian health assessments of the Red Deer River.....	96
Table 23. Fish species in the Red Deer River.....	99
Table 24. Minimum inflow needs to maintain adequate water quality for local fisheries in the Red Deer River .....	101
Table 25. Endangered, threatened and species of special concern in the 15 subwatersheds of the Red Deer River watershed .....	110
Table 26. Advisories and warnings in the Red Deer River since 2001 .....	118
Table 27. Active licenses and surface water diversions from the Red Deer River.....	119
Table 28. Recreational facilities in the Panther River subwatershed .....	151
Table 29. Linear developments in the Panther River subwatershed.....	153
Table 30. Number of known active and abandoned oil, gas, water and other wells in the Panther River subwatershed .....	157
Table 31. Water quality in Douglas Creek.....	160
Table 32. Land cover in the Panther River subwatershed .....	170
Table 33. Condition and risk indicator summary for the Panther River subwatershed .....	173
Table 34. Condition and risk assessments of the Panther River subwatershed.....	173

Table 35. Riparian health assessment of waterbodies in the James River subwatershed. ....	178
Table 36. Recreational facilities in the James River subwatershed. ....	184
Table 37. Linear developments in the James River subwatershed.....	185
Table 38. Number of known active and abandoned oil, gas, water and other wells in the James River subwatershed .....	186
Table 39. Water quality in the James River subwatershed.....	193
Table 40. Advisories and warnings in the James River subwatershed since 2001.....	199
Table 41. Surface and groundwater diversions in the James River subwatershed .....	200
Table 42. Land cover in the James River subwatershed .....	208
Table 43. Condition and risk indicator summary for the James River subwatershed .....	212
Table 44. Condition and risk assessments of the James River subwatershed .....	212
Table 45. Recreational facilities in the Raven River subwatershed .....	222
Table 46. Linear developments in the Raven River subwatershed.....	224
Table 47. Number of known active and abandoned oil, gas, water and other wells in the Raven River subwatershed .....	224
Table 48. Water quality in the North Raven River .....	230
Table 49. Advisories and warnings in the Raven River subwatershed since 2001 .....	236
Table 50. Surface and groundwater diversions in the Raven River subwatershed. ....	239
Table 51. Land cover in the Raven River subwatershed .....	244
Table 52. Condition and risk indicator summary for the Raven River subwatershed .....	250
Table 53. Condition and risk assessments of the Raven River subwatershed.....	250
Table 54. Riparian health assessment of waterbodies in the Little Red Deer River subwatershed. ...	255
Table 55. Recreational facilities in the Little Red Deer River subwatershed. ....	262
Table 56. Linear developments in the Little Red Deer River subwatershed.....	264
Table 57. Number of known active and abandoned oil, gas, water and other wells in the Little Red Deer River subwatershed .....	268
Table 58. Water quality in creeks and rivers in the Little Red Deer subwatershed.....	272
Table 59. Pesticide concentrations in the Little Red River and Dogpound Creek.....	274
Table 60. Advisories and warnings in the Little Red Deer River subwatershed since 2001 .....	282
Table 61. Surface and groundwater diversions in the Little Red Deer River subwatershed .....	285
Table 62. Land cover in the Little Red Deer River subwatershed .....	296
Table 63. Condition and risk indicator summary for the Little Red Deer River subwatershed .....	300
Table 64. Condition and risk assessments of the Little Red Deer River subwatershed.....	300
Table 65. Riparian health assessment of waterbodies in the Medicine River subwatershed. ....	305
Table 66. Recreational facilities in the Medicine River subwatershed .....	311
Table 67. Linear developments in the Medicine River subwatershed.....	313
Table 68. Number of known active and abandoned oil, gas, water and other wells in the Medicine River subwatershed .....	317
Table 69. Water quality in Black Creek and Horseguard Creek .....	320
Table 70. Mean concentrations of <i>Cryptosporidium</i> and <i>Giardia</i> spp. cysts in the Medicine River...	321
Table 71. Pesticide concentrations in Medicine River and Black Creek .....	322
Table 72. Advisories and warnings in the Medicine River subwatershed since 2001 .....	327
Table 73. Surface and groundwater diversions in the Medicine River subwatershed .....	330
Table 74. Land cover in the Medicine River subwatershed .....	335
Table 75. Condition and risk indicator summary for the Medicine River subwatershed .....	339
Table 76. Condition and risk assessments of the Medicine River subwatershed.....	340
Table 77. Recreational facilities in the Blindman River subwatershed.....	351
Table 78. Linear developments in the Blindman River subwatershed .....	353

Table 79. Number of known active and abandoned oil, gas, water and other wells in the Blindman River subwatershed .....	357
Table 80. Water quality in creeks in the Blindman River subwatershed .....	368
Table 81. Pesticide concentrations in waterbodies in the Blindman River subwatershed.....	376
Table 82. Surface and groundwater diversions in the Blindman River subwatershed .....	385
Table 83. Land cover in the Blindman River subwatershed	394
Table 84. Condition and risk indicator summary for the Blindman River subwatershed .....	398
Table 85. Condition and risk assessments of the Blindman River subwatershed .....	399
Table 86. Linear developments in the Waskasoo Creek subwatershed .....	409
Table 87. Number of known active and abandoned oil, gas, water and other wells in the Waskasoo Creek subwatershed .....	413
Table 88. Surface and groundwater diversions in the Waskasoo Creek subwatershed.....	423
Table 89. Land cover in the Waskasoo Creek subwatershed.....	427
Table 90. Condition and risk indicator summary for the Waskasoo Creek subwatershed.....	430
Table 91. Condition and risk assessments of the Waskasoo Creek subwatershed .....	431
Table 92. Recreational facilities in the Buffalo subwatershed.....	441
Table 93. Linear developments in the Buffalo subwatershed .....	443
Table 94. Number of known active and abandoned oil, gas, water and other wells in the Buffalo subwatershed.....	447
Table 95. Water quality in Little Buffalo Creek .....	457
Table 96. Water quality in Haynes Creek.....	458
Table 97. Pesticide concentrations in waterbodies in the Buffalo subwatershed. ....	461
Table 98. Surface and groundwater diversions in the Buffalo subwatershed .....	470
Table 99. Land cover in the Buffalo subwatershed.....	475
Table 100. Ecologically Significant Areas in the Buffalo subwatershed.....	477
Table 101. Condition and risk indicator summary for the Buffalo subwatershed .....	479
Table 102. Condition and risk assessments of the Buffalo subwatershed .....	480
Table 103. Recreational facilities in the Threehills Creek subwatershed .....	490
Table 104. Linear developments in the Threehills Creek subwatershed .....	495
Table 105. Number of known active and abandoned oil, gas, water and other wells in the Threehills Creek subwatershed.....	495
Table 106. Water quality in the Pine Lake siphon outflow .....	503
Table 107. Pesticide concentrations in waterbodies in the Threehills Creek subwatershed .....	505
Table 108. Surface and groundwater diversions in the Threehills Creek subwatershed .....	516
Table 109. Land cover in the Threehills Creek subwatershed .....	522
Table 110. Ecologically Significant Areas in the Threehills Creek subwatershed .....	524
Table 111. Condition and risk indicator summary for the Threehills Creek subwatershed .....	526
Table 112. Condition and risk assessments of the Threehills Creek subwatershed .....	527
Table 113. Linear developments in the Kneehills Creek subwatershed .....	537
Table 114. Number of known active and abandoned oil, gas, water and other wells in the Kneehills Creek subwatershed.....	541
Table 115. Water quality in the Kneehills Creek subwatershed .....	544
Table 116. Surface and groundwater diversions in the Kneehills Creek subwatershed.....	553
Table 117. Land cover in the Kneehills Creek subwatershed .....	557
Table 118. Condition and risk indicator summary for the Kneehills Creek subwatershed.....	561
Table 119. Condition and risk assessments of the Kneehills Creek subwatershed .....	561
Table 120. Recreational facilities in the Michichi Creek subwatershed .....	571
Table 121. Linear developments in the Michichi Creek subwatershed .....	572

Table 122. Number of known active and abandoned oil, gas, water and other wells in the Michichi Creek subwatershed.....	576
Table 123. Water quality in Wolf Creek .....	579
Table 124. Pesticide concentrations in Foxall Lake.....	580
Table 125. Surface and groundwater diversions in the Michichi Creek subwatershed.....	588
Table 126. Land cover in the Michichi Creek subwatershed .....	592
Table 127. Ecologically Significant Areas in the Michichi Creek subwatershed .....	595
Table 128. Condition and risk indicator summary for the Michichi Creek subwatershed.....	599
Table 129. Condition and risk assessments of the Michichi Creek subwatershed .....	599
Table 130. Riparian health assessment of waterbodies in the Rosebud River subwatershed. ....	604
Table 131. Linear developments in the Rosebud River subwatershed.....	610
Table 132. Number of known active and abandoned oil, gas, water and other wells in the Rosebud River subwatershed .....	614
Table 133. Water quality in Serviceberry Creek .....	617
Table 134. Pesticide concentrations in the Rosebud River.....	618
Table 135. Surface and groundwater diversions in the Rosebud River subwatershed .....	626
Table 136. Land cover in the Rosebud River subwatershed .....	631
Table 137. Condition and risk indicator summary for the Rosebud River subwatershed .....	634
Table 138. Condition and risk assessments of the Rosebud River subwatershed.....	635
Table 139. Recreational facilities in the Berry Creek subwatershed .....	645
Table 140. Linear developments in the Berry Creek subwatershed .....	646
Table 141. Number of known active and abandoned oil, gas, water and other wells in the Berry Creek subwatershed .....	650
Table 142. Water quality in the Berry Creek subwatershed.....	653
Table 143. Surface and groundwater diversions in the Berry Creek subwatershed.....	662
Table 144. Land cover in the Berry Creek subwatershed. ....	668
Table 145. Ecologically Significant Areas in the Berry Creek subwatershed .....	670
Table 146. Condition and risk indicator summary for the Berry Creek subwatershed.....	674
Table 147. Condition and risk assessments of the Berry Creek subwatershed .....	675
Table 148. Recreational facilities in the Matzhiwin Creek subwatershed .....	685
Table 149. Linear developments in the Matzhiwin Creek subwatershed.....	690
Table 150. Number of known active and abandoned oil, gas, water and other wells in the Matzhiwin Creek subwatershed .....	691
Table 151. Water quality in waterbodies in the Matzhiwin subwatershed.....	698
Table 152. Surface and groundwater diversions in the Matzhiwin Creek subwatershed .....	709
Table 153. Land cover in the Matzhiwin Creek subwatershed .....	715
Table 154. Ecologically Significant Areas in the Matzhiwin Creek subwatershed .....	717
Table 155. Condition and risk indicator summary for the Matzhiwin Creek subwatershed .....	720
Table 156. Condition and risk assessments of the Matzhiwin Creek subwatershed.....	721
Table 157. Linear developments in the Alkali Creek subwatershed .....	731
Table 158. Number of known active and abandoned oil, gas, water and other wells in the Alkali Creek subwatershed .....	735
Table 159. Water quality in the Alkali Creek subwatershed.....	738
Table 160. Surface and groundwater diversions in the Alkali Creek subwatershed .....	747
Table 161. Land cover in the Alkali Creek subwatershed. ....	752
Table 162. Ecologically Significant Areas in the Alkali Creek subwatershed .....	754
Table 163. Condition and risk indicator summary for the Alkali Creek subwatershed .....	758
Table 164. Condition and risk assessments of the Alkali Creek subwatershed. ....	758
Table 165. Indicator rating summary.....	782



## List of Figures

Figure 1. The 15 subwatersheds that comprise the Red Deer River watershed in Alberta.....	30
Figure 2. Major urban centres in the Red Deer River watershed .....	49
Figure 3. Cattle density (cattle/ha) in the Red Deer River watershed in 2006 .....	50
Figure 4. Manure production (tonnes/ha) in the Red Deer River watershed in 2001.....	51
Figure 5. Feedlots and intensive livestock operations in the Red Deer River watershed in 2006.....	52
Figure 6. Oil and gas well density in the Red Deer River watershed in 2006 .....	54
Figure 7. Federal hydrometric stations in the Red Deer River watershed.....	57
Figure 8. Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations in the Red Deer River near Bowden .....	60
Figure 9. Ammonia concentrations in the Red Deer River near Bowden .....	61
Figure 10. Nitrate-nitrite concentrations in the Red Deer River near Bowden .....	61
Figure 11. Dissolved oxygen (DO) concentrations in the Red Deer River at the Queen Elizabeth II Highway bridge .....	62
Figure 12. Ammonia concentrations in the Red Deer River at the Queen Elizabeth II Highway bridge .....	63
Figure 13. Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations in the Red Deer River at the Queen Elizabeth II Highway bridge.....	64
Figure 14. Total nitrogen (TN) concentrations in the Red Deer River at the Queen Elizabeth II Highway bridge .....	65
Figure 15. Nitrate-nitrite concentrations in the Red Deer River at the Queen Elizabeth II Highway bridge .....	66
Figure 16. Total phosphorus (TP) concentrations in the Red Deer River at Joffre .....	68
Figure 17. Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations in the Red Deer River at Nevis.....	69
Figure 18. Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations in the Red Deer River at the Morrin bridge.....	70
Figure 19. Total nitrogen (TN) concentrations in the Red Deer River at Nevis.....	71
Figure 20. Total nitrogen (TN) concentrations in the Red Deer River at the Morrin bridge.....	72
Figure 21. Ammonia concentrations in the Red Deer River at Nevis.....	73
Figure 22. Ammonia concentrations in the Red Deer River at the Morrin bridge.....	74
Figure 23. Nitrate-nitrite concentrations in the Red Deer River at Nevis.....	75
Figure 24. Nitrate-nitrite concentrations in the Red Deer River at the Morrin bridge.....	76
Figure 25. Annual Alberta River Water Quality Index (ARWQI) Values and sub-index values from 1996-2004 for three Red Deer River LTRN sites .....	80
Figure 26. Adherence to water quality standards of the Prairie Province Water Board (PPWB) objectives in various water courses in Alberta and Saskatchewan .....	83
Figure 27. Overall water quality index comparison at the Alberta Environment water quality monitoring stations at Queen Elizabeth II Highway (Reach 2) and Morrin bridge (Reach 3) from 1996-2007 .....	87
Figure 28. Pharmaceutical compounds in the Red Deer River from fall 2004 to spring 2007 upstream and downstream of the city of Red Deer .....	91
Figure 29. Land cover of the Red Deer River watershed .....	93
Figure 30. Land cover changes in the 15 subwatersheds of the Red Deer River watershed.....	94
Figure 31. Prairie Habitat Joint Venture Monitoring transects in the Red Deer River watershed .....	98
Figure 32. Wetland cover types in the Red Deer River watershed .....	99
Figure 33. Fish populations in the Red Deer River from 1991-2006.....	102

Figure 34. Mean of periphyton chl. <i>a</i> densities measured at three sites on the Red Deer River in 1999-2003 .....	104
Figure 35. Fecal coliform concentrations in the Red Deer River west of Bowden .....	106
Figure 36. <i>E. coli</i> concentrations in the Red Deer River at the Queen Elizabeth II Highway bridge ...	107
Figure 37. <i>E. coli</i> concentrations in the Red Deer River at Nevis .....	108
Figure 38. <i>E. coli</i> concentrations in the Red Deer River at the Morrin bridge .....	109
Figure 39. Red Deer River flow at various stations from 1961-2007. ....	118
Figure 40. Active surface water licenses that permit water diversions from the Red Deer River. ....	120
Figure 41. Distribution of active water allocations in the Red Deer River watershed. ....	121
Figure 42. Red Deer River watershed historical water allocations for municipal purposes .....	122
Figure 43. Water allocation for agricultural activities in the Red Deer River watershed .....	124
Figure 44. Historical trends in water allocation for livestock in the Red Deer River watershed .....	125
Figure 45. Historical trends in surface water allocation for irrigation in the Red Deer River watershed .....	126
Figure 46. Water allocation for commercial activities in the Red Deer River watershed. ....	127
Figure 47. Historical trend in commercial sector water allocation in the Red Deer River watershed	128
Figure 48. Petroleum water allocation by use in the Red Deer River watershed .....	129
Figure 49. Historical trends in water allocations for injection .....	130
Figure 50. Historical trends in water allocations for gas and petrochemical plants. ....	130
Figure 51. Water allocations for the industrial sector in the Red Deer River watershed .....	132
Figure 52. Historical trends in water allocations for cooling in the Red Deer River watershed .....	133
Figure 53. Other sector water allocations by use in the Red Deer River watershed .....	135
Figure 54. Historical trends in water allocations for water management in the Red Deer River watershed. ....	135
Figure 55. The Natural Regions and Subregions of the Red Deer River watershed .....	138
Figure 56. Location of the Panther River subwatershed .....	145
Figure 57. Natural subregions of the Panther River subwatershed. ....	146
Figure 58. Cattle density (cattle/ha) in the Panther River subwatershed. ....	149
Figure 59. Agricultural intensity (% cropland) in the Panther River subwatershed. ....	150
Figure 60. Visitation statistics for four recreation facilities in the Panther River subwatershed .....	152
Figure 61. Linear developments in the Panther River subwatershed. ....	154
Figure 62. Waterbody crossings in the Panther River subwatershed. ....	155
Figure 63. Pipeline crossings over waterbodies in the Panther River subwatershed. ....	156
Figure 64. Known active and abandoned oil, gas, water and other wells in the Panther River subwatershed. ....	158
Figure 65. Waterbodies in the Panther River subwatershed. ....	163
Figure 66. Discharge rates of the Red Deer River above the confluence with the Panther River .....	164
Figure 67. Discharge rates of the Red Deer River below the confluence with Burnt Timber Creek...	165
Figure 68. Topography (10-m contour intervals) of the Panther River subwatershed. ....	167
Figure 69. Surface water licenses in the Panther River subwatershed. ....	168
Figure 70. Land cover in the Panther River subwatershed. ....	171
Figure 71. Location of the James River subwatershed. ....	175
Figure 72. Natural subregions in the James River subwatershed .....	176
Figure 73. Feedlots and intensive livestock operations in the James River subwatershed .....	180
Figure 74. Cattle density (cattle/ha) in the James River subwatershed. ....	181
Figure 75. Manure production (tonnes/ha) in the James River subwatershed .....	182
Figure 76. Agricultural intensity (% cropland) in the James River subwatershed .....	183
Figure 77. Visitation statistics for two recreation facilities in the James River subwatershed. ....	185
Figure 78. Linear developments in the James River subwatershed. ....	187

Figure 79. Waterbody crossings in the James River subwatershed.....	188
Figure 80. Pipeline crossings over waterbodies in the James River subwatershed.....	189
Figure 81. Known active and abandoned oil, gas, water and other wells in the James River subwatershed.....	190
Figure 82. Waterbodies in the James River subwatershed.....	196
Figure 83. Discharge rates in James River in the James River subwatershed.....	197
Figure 84. Discharge rates of Bearberry Creek near Sundre in the James River subwatershed.....	198
Figure 85. Non-contributing drainage area in the James River subwatershed. ....	201
Figure 86. Topography (10-m contour intervals) of the James River subwatershed.....	202
Figure 87. Surface water licenses in the James River subwatershed .....	203
Figure 88. Groundwater licenses in the James River subwatershed .....	204
Figure 89. Fish populations in Bearberry Creek in 1986, 1997, 2002 and 2004-2005.....	207
Figure 90. Land cover in the James River subwatershed .....	209
Figure 91. Location of the Raven River subwatershed .....	214
Figure 92. Natural subregions of the Raven River subwatershed.....	215
Figure 93. Feedlots and intensive livestock operations in the Raven River subwatershed.....	218
Figure 94. Cattle density (cattle/ha) in the Raven River subwatershed .....	219
Figure 95. Manure production (tonnes/ha) in the Raven River subwatershed.....	220
Figure 96. Agricultural intensity (% cropland) in the Raven River subwatershed .....	221
Figure 97. Visitation statistics for two recreation facilities in the Raven River subwatershed .....	223
Figure 98. Linear developments in the Raven River subwatershed.....	225
Figure 99. Waterbody crossings in the Raven River subwatershed.....	226
Figure 100. Pipeline crossings over waterbodies in the Raven River subwatershed.....	227
Figure 101. Known active and abandoned oil, gas, water and other wells in the Raven River subwatershed.....	228
Figure 102. Waterbodies in the Raven River subwatershed.....	233
Figure 103. Discharge rates of the Raven River near Raven .....	234
Figure 104. Major dams in the Raven River subwatershed .....	235
Figure 105. Non-contributing drainage area in the Raven River subwatershed .....	237
Figure 106. Topography (10-m contour intervals) of the Raven River subwatershed.....	238
Figure 107. Surface water licenses in the Raven River subwatershed .....	240
Figure 108. Groundwater licenses in the Panther River subwatershed .....	241
Figure 109. Fish populations in the North Raven River (a.k.a. Stauffer Creek) in 1972-1973, 1985, 1995-1996, 2000-2002 and 2005.....	245
Figure 110. Fish populations in Beaver Creek in 1977, 1989, 1996-1997 and 2005.....	246
Figure 111. Land cover in the Raven River subwatershed .....	247
Figure 112. Location of the Little Red Deer River subwatershed .....	252
Figure 113. Natural subregions of the Little Red Deer River subwatershed .....	253
Figure 114. Feedlots and intensive livestock operations in the Little Red Deer River subwatershed .....	258
Figure 115. Cattle density (cattle/ha) in the Little Red Deer River subwatershed .....	259
Figure 116. Manure production (tonnes/ha) in the Little Red Deer River subwatershed.....	260
Figure 117. Agricultural intensity (% cropland) in the Little Red Deer River subwatershed .....	261
Figure 118. Visitation statistics for two recreation facilities in the Little Red Deer River subwatershed.....	263
Figure 119. Linear developments in the Little Red Deer River subwatershed .....	265
Figure 120. Waterbody crossings in the Little Red Deer River subwatershed.....	266
Figure 121. Pipeline crossings over waterbodies in the Little Red Deer River subwatershed.....	267
Figure 122. Known active and abandoned oil, gas, water and other wells in the Little Red Deer River subwatershed .....	269

Figure 123. Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations in Fallentimber Creek..... 271

Figure 124. Fecal coliform concentrations in Fallentimber Creek ..... 273

Figure 125. Waterbodies in the Little Red Deer River subwatershed..... 277

Figure 126. Discharge rates of the Little Red Deer River near the confluence with the Red Deer River ..... 278

Figure 127. Discharge rates of Fallentimber Creek near Sundre ..... 279

Figure 128. Discharge rates of the Little Red Deer River near Water Valley ..... 280

Figure 129. Major dams in the Little Red Deer River subwatershed ..... 281

Figure 130. Non-contributing drainage area in the Little Red Deer River subwatershed ..... 283

Figure 131. Topography (10-m contour intervals) of the Little Red Deer River subwatershed ..... 284

Figure 132. Surface water licenses in the Little Red Deer River subwatershed. .... 286

Figure 133. Groundwater licenses in the Little Red Deer River subwatershed ..... 287

Figure 134. Fish populations in the Little Red Deer River from 1978-2006..... 290

Figure 135. Fish populations in Dogpound Creek from 1963-2006 ..... 291

Figure 136. Fish populations in Fallentimber Creek in 1973-1974, 1987-1988, 1993, 1995, 1998, 2000 and 2006 ..... 292

Figure 137. Fish populations in Beaverdam Creek..... 293

Figure 138. Fish populations in Big Prairie Creek in 1986, 2003 and 2005..... 294

Figure 139. Land cover of the Little Red Deer River subwatershed ..... 297

Figure 140. Location of the Medicine River subwatershed ..... 302

Figure 141. Natural subregions of the Medicine River subwatershed ..... 303

Figure 142. Feedlots and intensive livestock operations in the Medicine River subwatershed..... 307

Figure 143. Cattle density (cattle/ha) in the Medicine River subwatershed. .... 308

Figure 144. Manure production (tonnes/ha) in the Medicine River subwatershed..... 309

Figure 145. Agricultural intensity (% cropland) in the Medicine River subwatershed ..... 310

Figure 146. Visitation statistics for two recreation facilities in the Medicine River subwatershed. .. 312

Figure 147. Linear developments in the Medicine River subwatershed. .... 314

Figure 148. Waterbody crossings in the Medicine River subwatershed. .... 315

Figure 149. Pipeline crossings over waterbodies in the Medicine River subwatershed ..... 316

Figure 150. Known active and abandoned oil, gas, water and other wells in the Medicine River subwatershed..... 318

Figure 151. Waterbodies in the Medicine River subwatershed. .... 324

Figure 152. Discharge rates of the Medicine River near Eckville ..... 325

Figure 153. Major dams in the Medicine River subwatershed ..... 326

Figure 154. Non-contributing drainage area in the Medicine River subwatershed ..... 328

Figure 155. Topography (10-m contour intervals) of the Medicine River subwatershed ..... 329

Figure 156. Surface water licenses in the Medicine River subwatershed ..... 331

Figure 157. Groundwater licenses in the Medicine River subwatershed ..... 332

Figure 158. Fish populations in Medicine River in the Medicine River subwatershed, 1991-1993, 1999, 2001 and 2005 ..... 336

Figure 159. Land cover of the Medicine River subwatershed ..... 337

Figure 160. Location of the Blindman River subwatershed ..... 342

Figure 161. Natural subregions of the Blindman River subwatershed ..... 343

Figure 162. Feedlots and intensive livestock operations in the Blindman River subwatershed ..... 347

Figure 163. Cattle density (cattle/ha) in the Blindman River subwatershed..... 348

Figure 164. Manure production (tonnes/ha) in the Blindman River subwatershed ..... 349

Figure 165. Agricultural intensity (% cropland) in the Blindman River subwatershed ..... 350

Figure 166. Visitation statistics for three recreation facilities in the Blindman River subwatershed. 352

Figure 167. Linear developments in the Blindman River subwatershed ..... 354

Figure 168. Waterbody crossings in the Blindman River subwatershed. .... 355

Figure 169. Pipeline crossings over waterbodies in the Blindman River subwatershed ..... 356

Figure 170. Known active and abandoned oil, gas, water and other wells in the Blindman River subwatershed..... 358

Figure 171. Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations in Gull Lake ..... 360

Figure 172. Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations in Sylvan Lake ..... 360

Figure 173. Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations in the Blindman River ..... 361

Figure 174. Total nitrogen (TN) concentration in Gull Lake..... 362

Figure 175. Total nitrogen (TN) concentration in Sylvan Lake ..... 362

Figure 176. Total nitrogen (TN) concentrations in the Blindman River ..... 363

Figure 177. Total ammonia and total dissolved ammonia concentrations in Gull Lake..... 364

Figure 178. Total and total dissolved ammonia concentrations in Sylvan Lake ..... 364

Figure 179. Nitrate-nitrite concentrations in Gull Lake ..... 365

Figure 180. Nitrate-nitrite concentrations in Sylvan Lake. .... 365

Figure 181. Dissolved oxygen (DO) concentrations in Gull Lake..... 366

Figure 182. Dissolved oxygen (DO) concentrations in Sylvan Lake..... 367

Figure 183. Total coliform and fecal coliform concentrations in Gull Lake ..... 372

Figure 184. Total coliform and fecal coliform concentrations in Sylvan Lake ..... 373

Figure 185. Fecal coliform concentrations in the Blindman River ..... 374

Figure 186. Total coliform concentrations in the Blindman River ..... 374

Figure 187. Waterbodies in the Blindman River subwatershed ..... 379

Figure 188. Discharge rates of the Blindman River near Bluffton ..... 380

Figure 189. Discharge rates of the Blindman River near Blackfalds ..... 381

Figure 190. Non-contributing drainage area in the Blindman River subwatershed ..... 383

Figure 191. Topography (10-m contour intervals) of the Blindman River subwatershed ..... 384

Figure 192. Surface water licenses in the Blindman River subwatershed. .... 386

Figure 193. Groundwater licenses in the Blindman River subwatershed..... 387

Figure 194. Fish populations in the Blindman River from 1991-2007 ..... 391

Figure 195. Fish populations in Gull Lake in 1995-1999, 2001-2003, 2005 and 2007 ..... 392

Figure 196. Fish populations in Sylvan Lake in 1993-1998 and 2005. .... 393

Figure 197. Land cover of the Blindman River subwatershed ..... 395

Figure 198. Location of the Waskasoo Creek subwatershed..... 401

Figure 199. Natural subregions of the Waskasoo Creek subwatershed ..... 402

Figure 200. Feedlots and intensive livestock operations in the Waskasoo Creek subwatershed ..... 405

Figure 201. Cattle density (cattle/ha) in the Waskasoo Creek subwatershed..... 406

Figure 202. Manure production (tonnes/ha) in the Waskasoo Creek subwatershed ..... 407

Figure 203. Agricultural intensity (% cropland) in the Waskasoo Creek subwatershed..... 408

Figure 204. Linear Developments in the Waskasoo Creek subwatershed..... 410

Figure 205. Waterbody crossings in the Waskasoo Creek subwatershed. .... 411

Figure 206. Pipeline crossings over waterbodies in the Waskasoo Creek subwatershed ..... 412

Figure 207. Known active and abandoned oil, gas, water and other wells in the Waskasoo Creek subwatershed..... 414

Figure 208. Waterbodies in the Waskasoo Creek subwatershed ..... 418

Figure 209. Discharge rates in Waskasoo Creek at Red Deer. .... 419

Figure 210. Non-contributing drainage area in the Waskasoo Creek subwatershed ..... 421

Figure 211. Topography (10-m contour intervals) of the Waskasoo Creek subwatershed .....	422
Figure 212. Surface water licenses in the Waskasoo Creek subwatershed.....	424
Figure 213. Groundwater licenses in the Waskasoo Creek subwatershed.....	425
Figure 214. Land cover of the Waskasoo Creek subwatershed .....	428
Figure 215. Location of the Buffalo subwatershed .....	433
Figure 216. Natural Subregions of the Buffalo subwatershed.....	434
Figure 217. Feedlots and intensive livestock operations in the Buffalo subwatershed .....	437
Figure 218. Cattle density (cattle/ha) in the Buffalo subwatershed.....	438
Figure 219. Manure production (tonnes/ha) in the Buffalo subwatershed .....	439
Figure 220. Agricultural intensity (% cropland) in the Buffalo subwatershed .....	440
Figure 221. Visitation statistics for two recreation facilities in the Buffalo subwatershed .....	442
Figure 222. Linear developments in the Buffalo subwatershed .....	444
Figure 223. Waterbody crossings in the Buffalo subwatershed .....	445
Figure 224. Pipeline crossings over waterbodies in the Buffalo subwatershed.....	446
Figure 225. Known active and abandoned oil, gas, water and other wells in the Buffalo subwatershed.....	448
Figure 226. Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations in Buffalo Lake.....	450
Figure 227. Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations in Alix Lake .....	451
Figure 228. Total nitrogen (TN) concentration in Buffalo Lake.....	452
Figure 229. Total nitrogen (TN) concentrations in Alix Lake.....	453
Figure 230. Total ammonia and total dissolved ammonia concentrations in Buffalo Lake.....	454
Figure 231. Total ammonia concentrations in Alix Lake .....	454
Figure 232. Nitrate-nitrite concentrations in Buffalo Lake .....	455
Figure 233. Nitrate-nitrite concentrations in Alix Lake.....	455
Figure 234. Dissolved oxygen (DO) concentrations in Buffalo Lake .....	456
Figure 235. Dissolved oxygen (DO) concentrations in Alix Lake.....	457
Figure 236. Total coliform and fecal coliform concentrations in Buffalo Lake .....	459
Figure 237. Total coliform and fecal coliform concentrations in Alix Lake.....	460
Figure 238. Waterbodies in the Buffalo subwatershed .....	463
Figure 239. Discharge rates in Parlby Creek near Mirror.....	464
Figure 240. Discharge rates in Parlby Creek at Alix.....	465
Figure 241. Discharge rates in Haynes Creek near Haynes.....	466
Figure 242. Non-contributing drainage area in the Buffalo subwatershed .....	468
Figure 243. Topography (10-m contour intervals) of the Buffalo subwatershed .....	469
Figure 244. Surface water licenses in the Buffalo subwatershed .....	471
Figure 245. Groundwater licenses in the Buffalo subwatershed.....	472
Figure 246. Northern pike populations in Buffalo Lake from 1995-1998 .....	474
Figure 247. Land cover of the Buffalo subwatershed .....	476
Figure 248. Location of the Threehills Creek subwatershed.....	482
Figure 249. Natural subregions of the Threehills Creek subwatershed.....	483
Figure 250. Feedlots and intensive livestock operations in the Threehills Creek subwatershed .....	486
Figure 251. Cattle density (cattle/ha) in the Threehills Creek subwatershed .....	487
Figure 252. Manure production (tonnes/ha) in the Threehills Creek subwatershed .....	488
Figure 253. Agricultural intensity (% cropland) in the Threehills Creek subwatershed.....	489
Figure 254. Visitation statistics for two recreation facilities in the Threehills Creek subwatershed..	491
Figure 255. Linear developments in the Threehills Creek subwatershed.....	492
Figure 256. Waterbody crossings in the Threehills Creek subwatershed.....	493

Figure 257. Pipeline crossings over waterbodies in the Threehills Creek subwatershed.....	494
Figure 258. Known active and abandoned oil, gas, water and other wells in the Threehills Creek subwatershed.....	496
Figure 259. Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations in Pine Lake .....	498
Figure 260. Total nitrogen (TN) concentrations in Pine Lake.....	499
Figure 261. Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations in Ghostpine Creek.....	499
Figure 262. Total nitrogen (TN) concentrations in Ghostpine Creek.....	500
Figure 263. Total ammonia and total dissolved ammonia concentrations in Pine Lake .....	501
Figure 264. Nitrate-nitrite concentrations in Pine Lake.....	501
Figure 265. Dissolved oxygen (DO) concentrations in Pine Lake .....	502
Figure 266. Total coliform and fecal coliform concentrations in Pine Lake.....	504
Figure 267. Waterbodies in the Threehills Creek subwatershed.....	508
Figure 268. Discharge rates in Threehills Creek below Ray Creek .....	509
Figure 269. Discharge rates in Renwick Creek near Three Hills .....	510
Figure 270. Discharge rates in Ray Creek near Innisfail.....	511
Figure 271. Major dams in the Threehills Creek subwatershed. ....	512
Figure 272. Non-contributing drainage area in the Threehills Creek subwatershed.....	514
Figure 273. Topography (10-m intervals) of the Threehills Creek subwatershed .....	515
Figure 274. Surface water licenses in the Threehills Creek subwatershed.....	517
Figure 275. Groundwater licenses in the Threehills creek subwatershed.....	518
Figure 276. Fish populations in Pine Lake from 1995-1999.....	521
Figure 277. Land cover of the Threehills Creek subwatershed.....	523
Figure 278. Location of the Kneehills Creek subwatershed.....	529
Figure 279. Natural subregions of the Kneehills Creek subwatershed .....	530
Figure 280. Feedlots and intensive livestock operations in the Kneehills Creek subwatershed .....	533
Figure 281. Cattle density (cattle/ha) in the Kneehills Creek subwatershed.....	534
Figure 282. Manure production (tonnes/ha) in the Kneehills Creek subwatershed .....	535
Figure 283. Agricultural intensity (% cropland) in the Kneehills Creek subwatershed.....	536
Figure 284. Linear developments in the Kneehills Creek subwatershed .....	538
Figure 285. Waterbody crossings in the Kneehills Creek subwatershed .....	539
Figure 286. Pipeline crossings over waterbodies in the Kneehills Creek subwatershed .....	540
Figure 287. Known active and abandoned oil, gas, water and other wells in the Kneehills Creek subwatershed.....	542
Figure 288. Waterbodies in the Kneehills Creek subwatershed .....	547
Figure 289. Discharge rates in Kneehills Creek near Drumheller.....	548
Figure 290. Major dams in the Kneehills Creek subwatershed .....	549
Figure 291. Non-contributing drainage area in the Kneehills Creek subwatershed.....	551
Figure 292. Topography (10-m contour intervals) of the Kneehills Creek subwatershed .....	552
Figure 293. Surface water licenses in the Kneehills Creek subwatershed .....	554
Figure 294. Groundwater licenses in the Kneehills Creek subwatershed.....	555
Figure 295. Land cover of the Kneehills Creek subwatershed .....	559
Figure 296. Location of the Michichi Creek subwatershed.....	563
Figure 297. Natural subregions of the Michichi Creek subwatershed.....	564
Figure 298. Feedlots and intensive livestock operations in the Michichi Creek subwatershed .....	567
Figure 299. Cattle density (cattle/ha) in the Michichi Creek subwatershed .....	568
Figure 300. Manure production (tonnes/ha) in the Michichi Creek subwatershed .....	569
Figure 301. Agricultural intensity (% cropland) in the Michichi Creek subwatershed.....	570



Figure 302. Visitation statistics for Midland Provincial Park in the Michichi Creek subwatershed....	571
Figure 303. Linear developments in the Michichi Creek subwatershed.....	573
Figure 304. Waterbody crossings in the Michichi Creek subwatershed.....	574
Figure 305. Pipeline crossings over waterbodies in the Michichi Creek subwatershed.....	575
Figure 306. Known active and abandoned oil, gas, water and other wells in the Michichi Creek subwatershed.....	577
Figure 307. Waterbodies in the Michichi Creek subwatershed.....	582
Figure 308. Discharge rates in Michichi Creek near Drumheller.....	583
Figure 309. Major dams in the Michichi Creek subwatershed.....	584
Figure 310. Non-contributing drainage area in the Michichi Creek subwatershed.....	586
Figure 311. Topography (10-m contour intervals) of the Michichi Creek subwatershed.....	587
Figure 312. Surface water licenses in the Michichi Creek subwatershed.....	589
Figure 313. Groundwater licenses in the Michichi Creek subwatershed.....	590
Figure 314. Land cover of the Michichi Creek subwatershed.....	594
Figure 315. Location of the Rosebud River subwatershed.....	601
Figure 316. Natural subregions of the Rosebud River subwatershed.....	602
Figure 317. Feedlots and intensive livestock operations in the Rosebud River subwatershed.....	606
Figure 318. Cattle density (cattle/ha) in the Rosebud River subwatershed.....	607
Figure 319. Manure production (tonnes/ha) in the Rosebud River subwatershed.....	608
Figure 320. Agricultural intensity (% cropland) in the Rosebud River subwatershed.....	609
Figure 321. Linear developments in the Rosebud River subwatershed.....	611
Figure 322. Waterbody crossings in the Rosebud River subwatershed.....	612
Figure 323. Pipeline crossings over waterbodies in the Rosebud River subwatershed.....	613
Figure 324. Known active and abandoned oil, gas, water and other wells in the Rosebud River subwatershed.....	615
Figure 325. Waterbodies in the Rosebud River subwatershed.....	620
Figure 326. Discharge rates in Rosebud River at Redland.....	621
Figure 327. Major dams in the Rosebud River subwatershed.....	622
Figure 328. Non-contributing drainage area in the Rosebud River subwatershed.....	624
Figure 329. Topography (10-m contour intervals) of the Rosebud River subwatershed.....	625
Figure 330. Surface water licenses in the Rosebud River subwatershed.....	627
Figure 331. Groundwater licenses in the Rosebud River subwatershed.....	628
Figure 332. Land cover of the Rosebud River subwatershed.....	632
Figure 333. Location of the Berry Creek subwatershed.....	637
Figure 334. Natural subregions of the Berry Creek subwatershed.....	638
Figure 335. Feedlots and intensive livestock operations in the Berry Creek subwatershed.....	641
Figure 336. Cattle density (cattle/ha) in the Berry Creek subwatershed.....	642
Figure 337. Manure production (tonnes/ha) in the Berry Creek subwatershed.....	643
Figure 338. Agricultural intensity (% cropland) in the Berry Creek subwatershed.....	644
Figure 339. Visitation statistics for Little Fish Lake Provincial Park in the Berry Creek subwatershed.....	645
Figure 340. Linear developments in the Berry Creek subwatershed.....	647
Figure 341. Waterbody crossings in the Berry Creek subwatershed.....	648
Figure 342. Pipeline crossings over waterbodies in the Berry Creek subwatershed.....	649
Figure 343. Known active and abandoned oil, gas, water and other wells in the Berry Creek subwatershed.....	651
Figure 344. Waterbodies in the Berry Creek subwatershed.....	656
Figure 345. Discharge rates in Berry Creek near Rose Lynn.....	657
Figure 346. Major dams in the Berry Creek subwatershed.....	658

Figure 347. Non-contributing drainage areas in the Berry Creek subwatershed .....	660
Figure 348. Topography (10-m contour intervals) of the Berry Creek subwatershed.....	661
Figure 349. Surface water licenses in the Berry Creek subwatershed.....	663
Figure 350. Groundwater licenses in the Berry Creek subwatershed .....	664
Figure 351. Fish populations in the Berry Creek from 1996-2007 .....	667
Figure 352. Land cover of the Berry Creek subwatershed.....	669
Figure 353. Location of the Matzhiwin Creek subwatershed .....	677
Figure 354. Natural subregions of the Matzhiwin Creek subwatershed. ....	678
Figure 355. Feedlots and intensive livestock operations in the Matzhiwin Creek subwatershed.....	681
Figure 356. Cattle density (cattle/ha) in the Matzhiwin Creek subwatershed .....	682
Figure 357. Manure production (tonnes/ha) in the Matzhiwin Creek subwatershed.....	683
Figure 358. Agricultural intensity (% cropland) in the Matzhiwin Creek subwatershed .....	684
Figure 359. Visitation statistics for two recreation facilities in the Matzhiwin Creek subwatershed	686
Figure 360. Linear developments in the Matzhiwin Creek subwatershed .....	687
Figure 361. Waterbody crossings in the Matzhiwin Creek subwatershed .....	688
Figure 362. Pipeline crossings over waterbodies in the Matzhiwin Creek subwatershed .....	689
Figure 363. Known active and abandoned oil, gas, water and other wells in the Matzhiwin Creek subwatershed.....	692
Figure 364. Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations in Crawling Valley Reservoir .....	694
Figure 365. Total nitrogen (TN) concentrations in the Crawling Valley Reservoir.....	695
Figure 366. Total ammonia and total dissolved ammonia concentrations in the Crawling Valley Reservoir .....	695
Figure 367. Nitrate-nitrite concentrations in the Crawling Valley Reservoir.....	696
Figure 368. Dissolved oxygen (DO) concentrations in the Crawling Valley Reservoir .....	697
Figure 369. Waterbodies in the Matzhiwin Creek subwatershed .....	702
Figure 370. Discharge rates in Matzhiwin Creek below Ware Coulee.....	703
Figure 371. Discharge rates in Onetree Creek near Patricia.....	704
Figure 372. Major dams in the Matzhiwin Creek subwatershed .....	705
Figure 373. Non-contributing drainage area in the Matzhiwin Creek subwatershed .....	707
Figure 374. Topography (10-m contour intervals) of the Matzhiwin Creek subwatershed .....	708
Figure 375. Surface water licenses in the Matzhiwin Creek subwatershed .....	710
Figure 376. Groundwater licenses in the Matzhiwin Creek subwatershed. ....	711
Figure 377. Fish populations in the Crawling Valley Reservoir from 1989-2004 .....	714
Figure 378. Land cover of the Matzhiwin Creek subwatershed. ....	716
Figure 379. Location of the Alkali Creek subwatershed.....	723
Figure 380. Natural subregions of the Alkali Creek subwatershed.....	724
Figure 381. Feedlots and intensive livestock operations in the Alkali Creek subwatershed .....	727
Figure 382. Cattle density (cattle/ha) in the Alkali Creek subwatershed. ....	728
Figure 383. Manure production (tonnes/ha) in the Alkali Creek subwatershed.....	729
Figure 384. Agricultural intensity (% cropland) in the Alkali Creek subwatershed.....	730
Figure 385. Linear developments in the Alkali Creek subwatershed.....	732
Figure 386. Waterbody crossings in the Alkali Creek subwatershed.....	733
Figure 387. Pipeline crossings over waterbodies in the Alkali Creek subwatershed.....	734
Figure 388. Known active and abandoned oil, gas, water and other wells in the Alkali Creek subwatershed.....	736
Figure 389. Waterbodies in the Alkali Creek subwatershed.....	741
Figure 390. Discharge rates of Alkali Creek.....	742
Figure 391. Major dams in the Alkali Creek subwatershed .....	743

Figure 392. Non-contributing drainage area in the Alkali Creek subwatershed.....	745
Figure 393. Topography (10-m contour intervals) of the Alkali Creek subwatershed.....	746
Figure 394. Surface water licenses in the Alkali Creek subwatershed.....	748
Figure 395. Groundwater licenses in the Alkali Creek subwatershed .....	749
Figure 396. Land cover of the Alkali Creek subwatershed.....	753
Figure 397. Ducks Unlimited Canada projects in the Red Deer River watershed.....	767
Figure 398. Water erosion risk in the Red Deer River watershed. ....	769
Figure 399. Surface water quality risk in the Red Deer River watershed .....	770
Figure 400. Groundwater quality risk in the Red Deer River watershed .....	771
Figure 401. Aquifer vulnerability index for the Red Deer River watershed.....	772
Figure 402. Biodiversity risk in the Red Deer River watershed.....	773
Figure 403. Number of species at risk in the Red Deer River watershed .....	774
Figure 404. Aerial extent of wetlands in the Red Deer River watershed.....	775
Figure 405. Percent organic soils in the Red Deer River watershed.....	776
Figure 406. Historic resource densities in the Red Deer River watershed .....	777
Figure 407. Risk indicator ranking summary of the 15 subwatersheds that comprise the Red Deer River watershed .....	779
Figure 408. Condition indicator ranking summary of the 15 subwatersheds that comprise the Red Deer River watershed. ....	780
Figure 409. Overall rankings of the Red Deer River watershed, based on the combined rating of risk and condition indicators.....	781

## Acronyms, Abbreviations, and Standardized Shorthand Notations

### A

a.s.l. – Above sea level  
AAFC-PFRA – Agriculture and Agri-Food  
Canada-Prairie Farm  
Rehabilitation Administration  
AARD – Alberta Agriculture and Rural  
Development  
ABMI – Alberta Biodiversity Monitoring  
Institute  
ACA – Alberta Conservation Association  
AENV – Alberta Environment  
Ag – Silver  
Al – Aluminum  
ALMS – Alberta Lake Management  
Society  
AOPA – Agricultural Operations Practices  
Act  
ARWQI – Alberta River Water Quality  
index  
As – Arsenic  
ASRD – Alberta Sustainable Resource  
Development  
ASWQG – Alberta Surface Water Quality  
Guideline  
ATPR – Alberta Tourism, Parks, and  
Recreation  
ATV – All-terrain vehicle  
AVI – Alberta Vegetation Inventory

### B

BMP – Best management practices  
BDL – Below detection limits  
BOD – Biological oxygen demand  
BRBC – Bow River basin Council  
BTBC – Blackfoot Tribal Business Council

### C

CAESAA – Canada-Alberta Environment  
Sustainable Agriculture  
Agreement  
CBM – Coal-bed methane  
CCME – Canadian Council of Ministers of  
the Environment  
CCME – Canadian Council of Ministers of  
the Environment  
Cd – Cadmium

CEAA – Canadian Environmental  
Assessment Act  
CEPA – Canadian Environmental  
Protection Act  
CFO – Confined feedlot operation  
CFU – Colony-forming unit  
Chl. *a* – Chlorophyll *a*  
CO – Carbon Monoxide  
Co – Cobalt  
COD – Chemical oxygen demand  
COSEWIC – Committee on the Status of  
Endangered Wildlife in Canada  
Cr – Chromium  
Cu – Copper  
CWS – Canadian Wildlife Service

### D

dam<sup>3</sup> – Deca metre  
dam<sup>3</sup>/yr – Deca metre per year  
DFO – Department of Fisheries and  
Oceans  
DO – Dissolved oxygen  
DUC – Ducks Unlimited Canada

### E

EC – Environment Canada  
EIA – Environmental Impact Assessment  
ENGO – Environmental Non-Government  
Organization  
EPEA – Environmental Protection and  
Enhancement Act  
ER – Environmental Reserve  
ERCB – Energy Resources Conservation  
Board  
ESA – Ecologically Significant Area

### F

Fe – Iron  
FMA – Forest Management Area  
FMU – Forest Management Unit

### H

H<sub>2</sub>SO<sub>4</sub> – Sulphuric acid  
ha – Hectare  
HADD – Harmful alteration, disruption or  
destruction

Hg – Mercury

**I**

IMP – Integrated Management Plan  
IRM – Integrated resource management  
IWMP – Integrated Watershed  
Management Plan

**L**

LTRN – Long-Term River Network  
LUZ – Land-Use Zone

**M**

MGA – Municipal Government Act  
Mn – Manganese  
Mo – Molybdenum  
MUD – Municipal Use Database

**N**

N – Nitrogen  
N<sub>2</sub>O – Nitrous oxide  
NH<sub>3</sub> – Ammonia  
Ni – Nickel  
NO<sub>2</sub><sup>-</sup> – Nitrite  
NO<sub>2</sub><sup>-</sup>-NO<sub>3</sub><sup>-</sup> – Nitrite and nitrate, combined  
NO<sub>3</sub><sup>-</sup> – Nitrate  
NPRI – National Pollution Release  
Inventory  
NRCB – Natural Resources Conservation  
Board  
NSAID – Non-steroidal anti-inflammatory  
drug  
NSWA – North Saskatchewan Watershed  
Alliance  
NVI – Native vegetation inventory  
NWA – Natural Wildlife Area

**O**

OHV – Off-highway vehicle  
OWC – Organic Wastewater  
Contaminants

**P**

P – Phosphorus  
p or p-value – Probability value  
(statistics)  
PAL – Protection of aquatic life (with  
reference to guidelines)

Pb – Lead

PFRA – Provincial Forest Recreation Area  
PGR – Provincial Grazing Reserve  
PHJV – Prairie Habitat Joint Venture  
PNA – Provincial Natural Area  
PP – Provincial Park  
PPWB – Prairie Provinces Water Board  
PRA – Provincial Recreation Area

**R**

RDRWA – Red Deer River Watershed  
Alliance  
RHA – Regional Health Authorities

**S**

SARA – Species at Risk Act  
SC – Steering Committee  
Se – Selenium  
SO<sub>2</sub> – Sulphate  
SRD – Sustainable Resource Development  
(Alberta)

**T**

TAC – Technical advisory committee  
TDP – Total dissolved phosphorus  
TDS – Total dissolved solids  
TKN – Total Kjeldahl nitrogen  
TN – Total nitrogen  
TP – Total phosphorus  
TR – Total residue  
TSS – Total suspended solids

**U**

UC – Union Carbide  
UNESCO – United Nations Educational,  
Scientific and Cultural  
Organization

**V**

Va – Vanadium  
VOC – Volatile organic compounds

**W**

WAC – Watershed Advisory Council  
WP – Wildlife Park  
WPAC – Watershed Planning and  
Advisory Council  
WQG – Water quality guideline(s)

WS – Wildlife Sanctuary  
WURS – Water Use Reporting System  
WWTP – Waste-water treatment plant

µg/L – Micro gram per litre  
µm – Micro metre

**Z**  
Zn – Zinc

**Y**