CHAPTER 7: OVERVIEW OF THE WATERSHED

Lundbreck Falls on Crowsnest River – J. Charest

Chapter 7: Overview of the Watershed

The Oldman watershed (Figure 7.1) is a large diverse land and water system that varies greatly, both in term of the status of the land and water resources and impacts from human activities. In headwater Sub-basins, water quantity is adequate, quality is fair to good and riparian ecosystems are generally healthy. However, as the Oldman River flows east the water quality deteriorates, available supplies diminish, and there are several issues of concern. Chapters 7, 8, 9 and 10 provide an overall assessment of the state of the Oldman watershed, using information from each of the Sub-basins and mainstem of the Oldman River. These chapters summarize human impacts on the watershed, identify knowledge gaps, issues and emerging trends, and provide recommendations for future management actions.

7.1 Synthesis and Assessment of Indicators

7.1.1 Terrestrial and Riparian Ecology

Land Cover

The Oldman watershed covers approximately 3 million ha in southern Alberta, extending eastward from the forested slopes of the Rocky Mountains, through rangelands in the foothills, dryland and irrigated agricultural plains, to the prairie grasslands (Figure 7.2). The prairie region of the province is classified as semi-arid, with total precipitation ranging from 300 to 450 mm per year. Less than half the precipitation falls during the growing season, May through August.

Moving from west to east, progressively more land is in grasslands and agricultural land uses and less in forests (Figure 7.1). Forests dominate the Mountain Sub-basins; native grasslands are present in all Sub-basins and are the dominant cover in the Foothills Sub-basins. Cultivated agriculture is the main land use in 60% of the watershed and covers half or more of the Southern Tributaries and Prairie sub-basins. Approximately 20% of the cultivated land is irrigated. Cereals and forage crops dominate both dryland and irrigated areas.

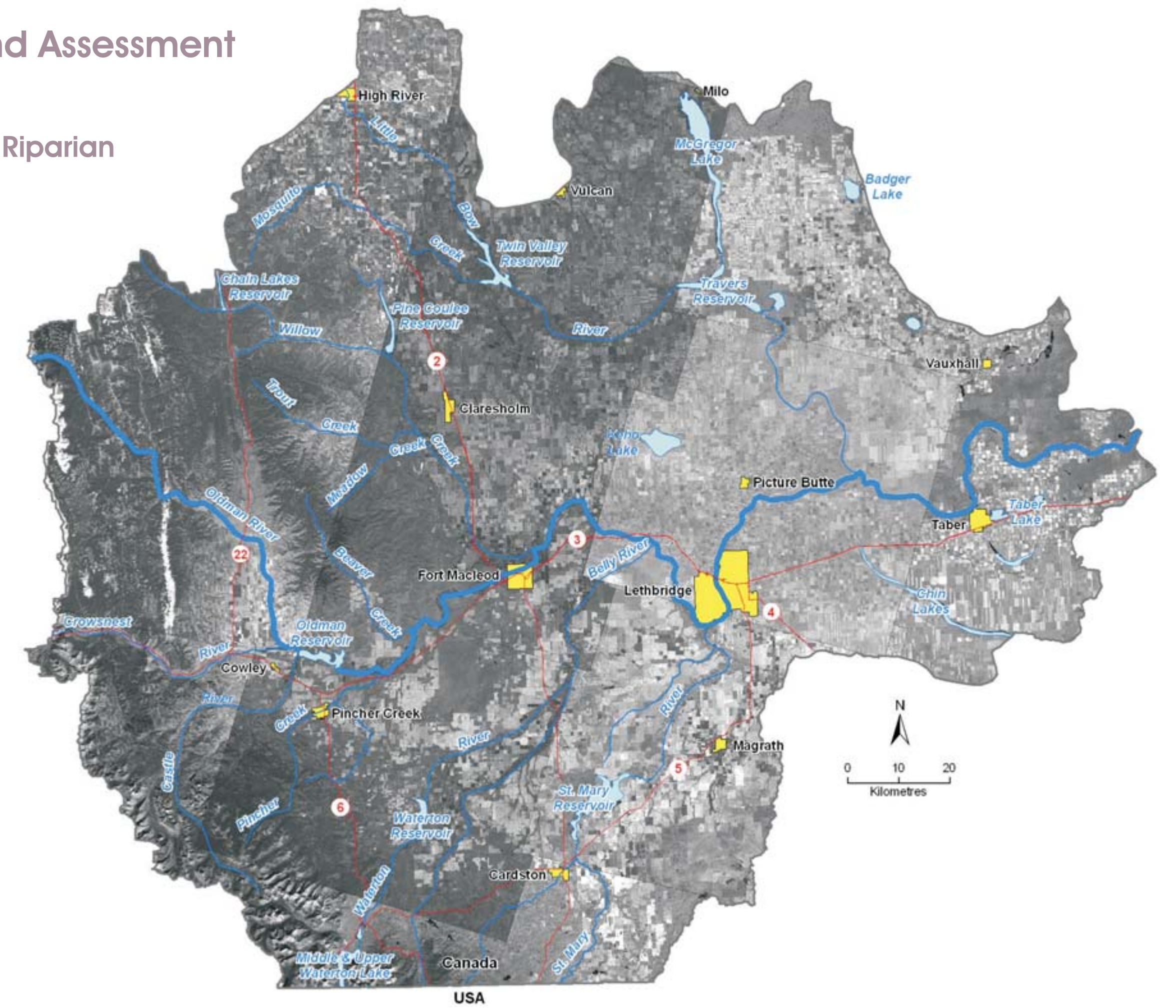


Figure 7.1: Oldman Watershed

Soil Erosion

Approximately, 30% of the watershed has a soil erosion risk of moderate or more, most of which occurs in the Prairie Sub-basins. Common soil erosion control techniques used throughout the watershed include crop rotation, rotational grazing, soil conservation tillage, windbreaks or shelter belts and buffer zones around water bodies.

The effect of long term climate change may increase drought magnitudes and frequencies, and the proportion of precipitation in the form of rain (Sauchyn and Kulshreshtha 2008). These changes will increase the likelihood of wind and water erosion (Soil and Water Conservation Society 2003, Sauchyn and Kulshreshtha 2008). Research and technology development will be required to provide the necessary understanding and tools to make a risk-based approach to soil conservation as impacted by climate change.

With increasing population, expanding land use activities and potential change to more arid climatic conditions, more attention to erosion control and conservation measures is necessary.

Riparian Health

Overall the riparian health of the watershed, based on over 400 sites, is rated as 15% healthy, 55% healthy but with problems and 30% unhealthy. The riparian areas of the watershed are less healthy than riparian areas in Alberta as a whole, where 21% are healthy, 51% are healthy with problems and 28% are unhealthy (Fitch and Ambrose 2003). The least healthy areas in the watershed are in the Prairie Sub-basins and the Oldman River mainstem.

The goal of the Cows and Fish Program is to progressively increase the health of Alberta's riparian areas by 2030 so that 60% are healthy, 25% are healthy with problems and only 15% remain unhealthy. Measures to improve riparian health include adoption of better land use and water management practices, phasing out some land uses and restoring function to riparian landscapes. With good management and integration of a variety of uses, riparian areas will provide habitats for sustaining fish and wildlife species, functioning watersheds, good water quality and supply, forage for livestock, and recreational opportunities.

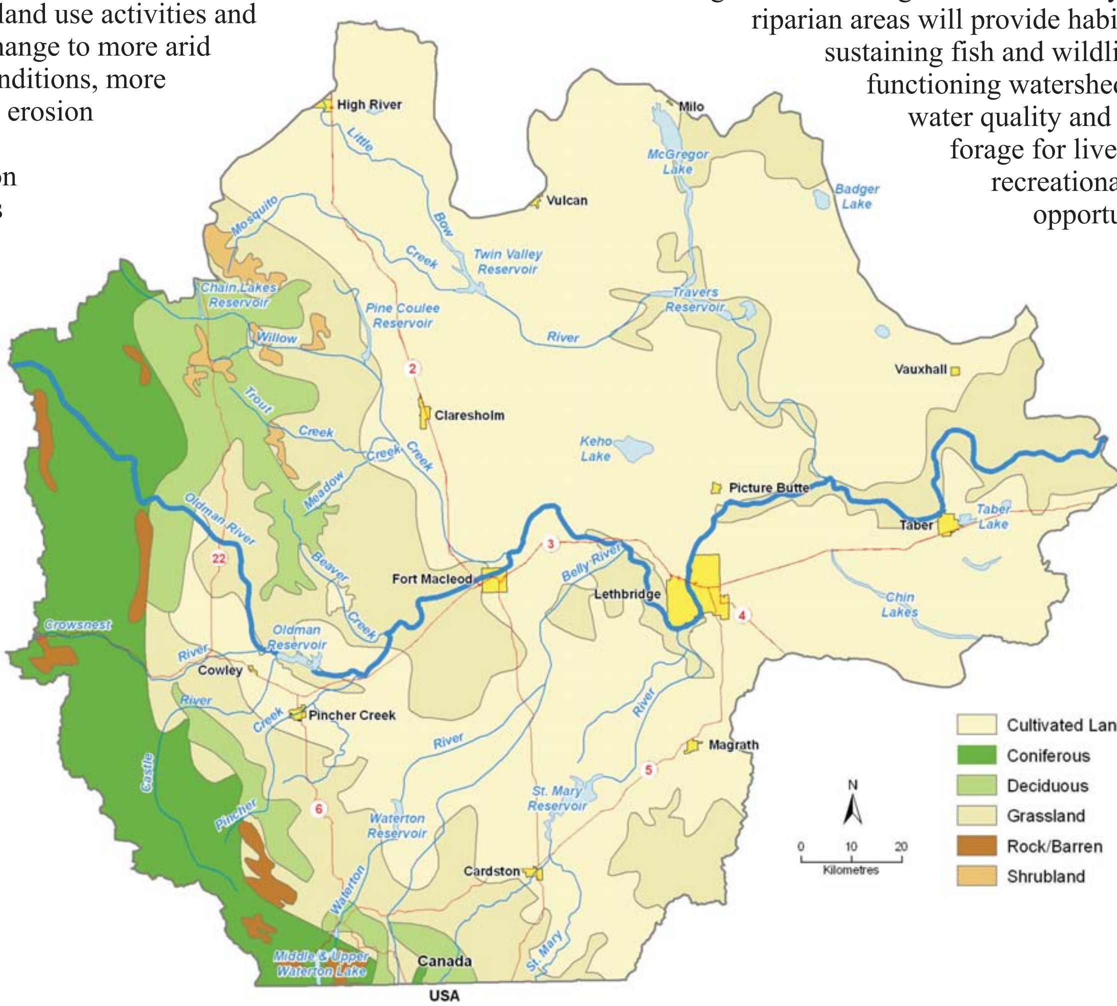


Figure 7.2: Land Cover in the Oldman Watershed

Land Use

Land use activities in the watershed include agriculture, forestry, mining, recreation, and oil and gas extraction. Total disturbance from land use activities covers approximately 60% of the watershed. Agricultural activities dominate while the remainder is made up of well sites and linear disturbances from roads, pipelines and cutlines (Figure 7.3). The Prairie and Southern Tributaries sub-basins are the most disturbed, where in addition to agriculture and linear features, other minor disturbances include urban areas, oil and gas wells, and reservoirs.

Linear developments through the forested areas result in the progressive loss of mature forest, alteration of forest structure, and fragmentation of wildlife habitat. Wildlife corridors can be altered by roads and other linear developments. Drainage patterns and water quality within watersheds can be altered by increases in the area of compacted surface. Seismic cutlines are of particular concern because regeneration is difficult due to soil and root disturbance, grass competition, and continued use for vehicle access.

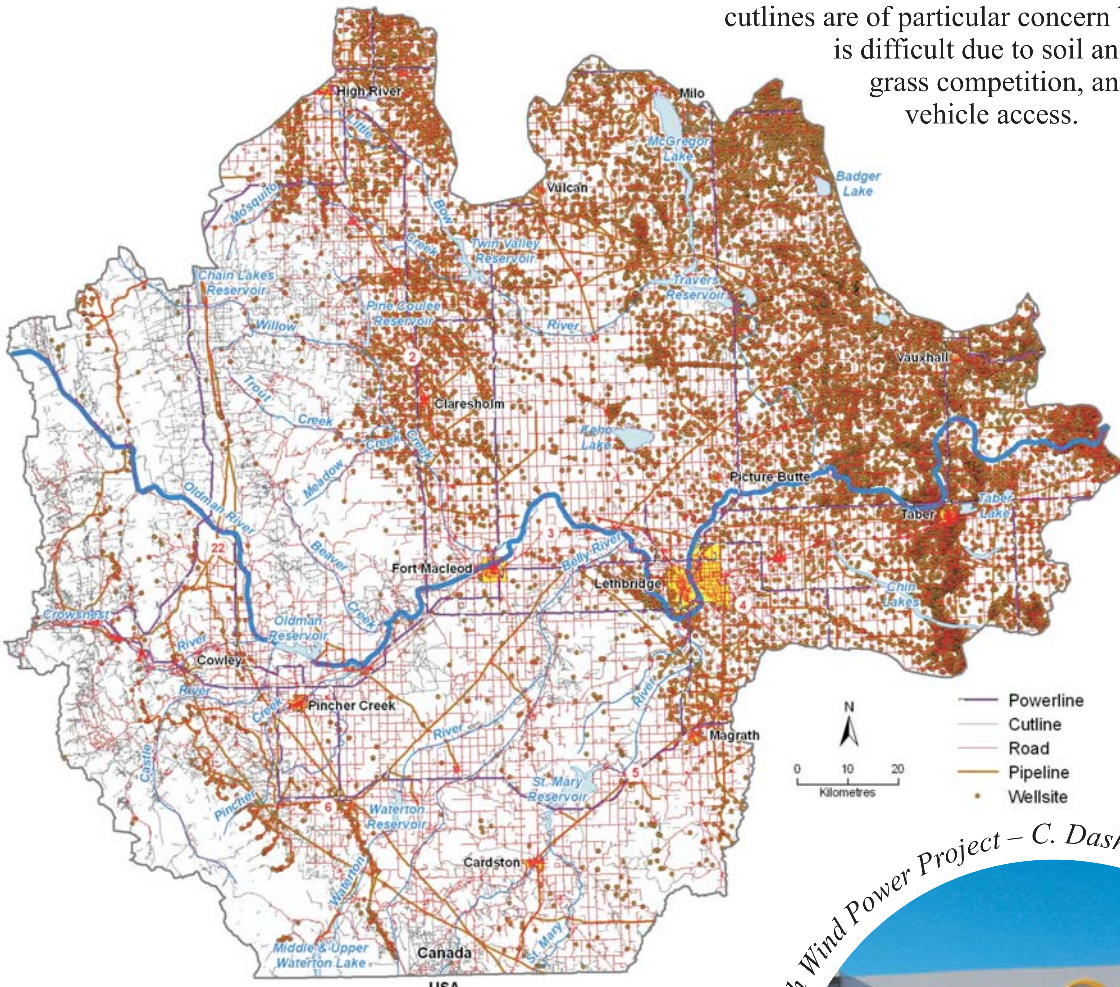
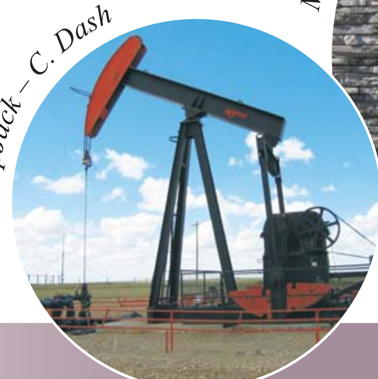


Figure 7.3: Land Use in the Oldman Watershed

Magrath Wind Power Project – C. Dash



PumpJack – C. Dash

Over 500 intensive livestock operations or confined feeding operations (CFOs) occur in the watershed. The majority are located in the Prairie Sub-basins in the vicinity of Lethbridge with smaller numbers in the Foothills and Southern Tributaries (Figure 7.4). Other livestock operations, such as cow-calf facilities and range cattle, are widely dispersed over the area. Concerns with increasing numbers of CFOs and other livestock operations are downstream effects of higher concentrations of nutrients, TSS, fecal bacteria and mass loading. CFOs are regulated by the Natural Resources Conservation Board (NRCB). The effects of other operations that are located along stream and river valleys have been assessed indirectly, in this report, in the riparian health program.

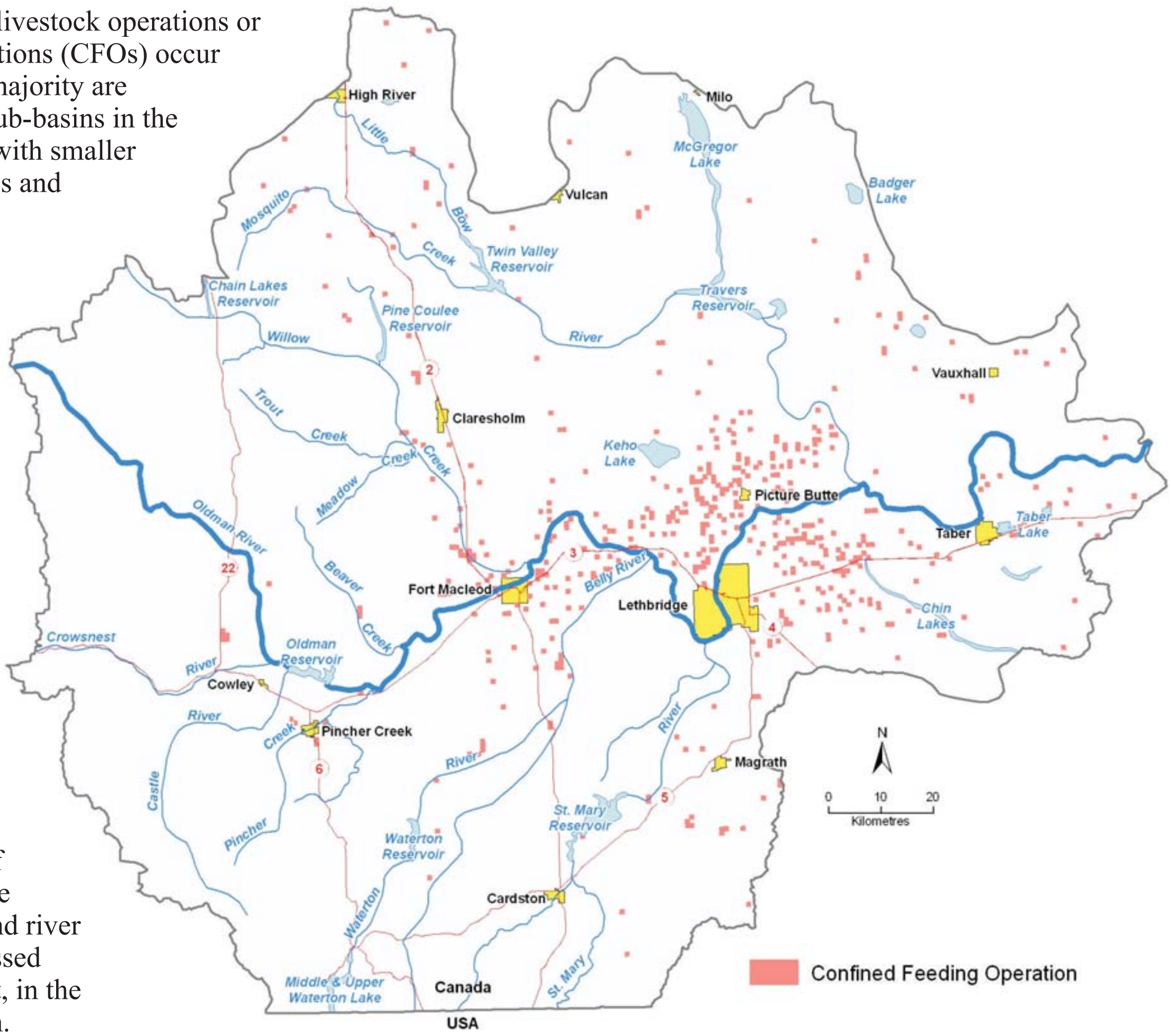
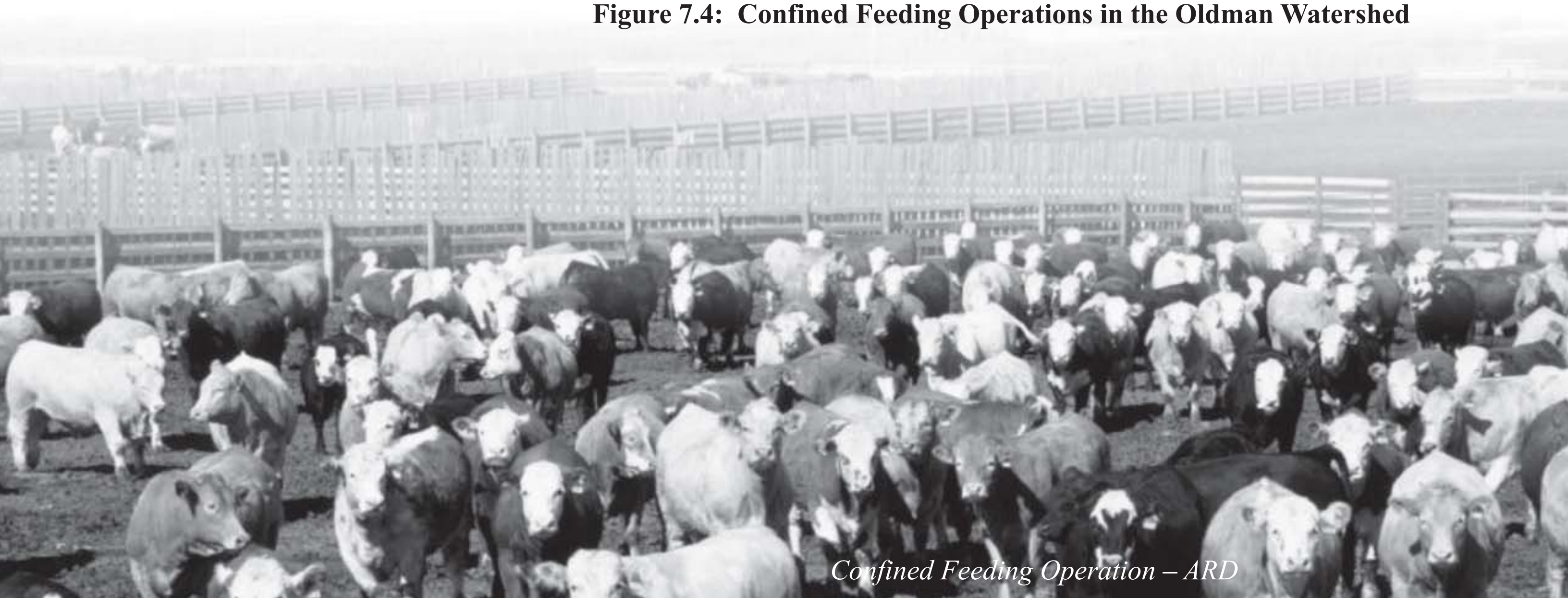


Figure 7.4: Confined Feeding Operations in the Oldman Watershed



Confined Feeding Operation – ARD

In 2006, the Oldman watershed was home to more than 210 000 people, almost half of whom live in Lethbridge and other communities within the boundaries of County of Lethbridge (Figure 7.5). Population growth between 1996 and 2006 has been approximately 13%, a reflection of the growth in agricultural activities, including CFOs and food processing industries. Note that the population data is from StatsCan for each municipality or county. For the rural municipalities only partially in the watershed, the assumption is that the population is uniformly distributed. In the municipal district (MD) of Foothills, the majority of the population is likely outside the watershed and located much closer to Calgary, hence the growth may be somewhat over estimated. The stress placed on water quality and quantity in the watershed as a consequence of the expanding activities of a growing population is not unique. However, the intensity of the development, coupled with the semi-arid nature of this region, presents a particular challenge to the protection of aquatic resources (OWC 2005).

Overall Ranking for Terrestrial Indicators

Integrating results of terrestrial analysis for land cover, soil erosion, riparian health and land use results in an overall ranking of **"Fair"** for the Oldman watershed. Rankings for each of the Sub-basins are shown in Table 7.1

Table 7.1: Overall State of the Watershed Ranking for Terrestrial Indicators

Sub-basins	Ranking
Mountains	Good
Foothills	Good
Southern Tributaries	Fair
Prairie	Poor
Mainstem	Good
Oldman Watershed	Fair

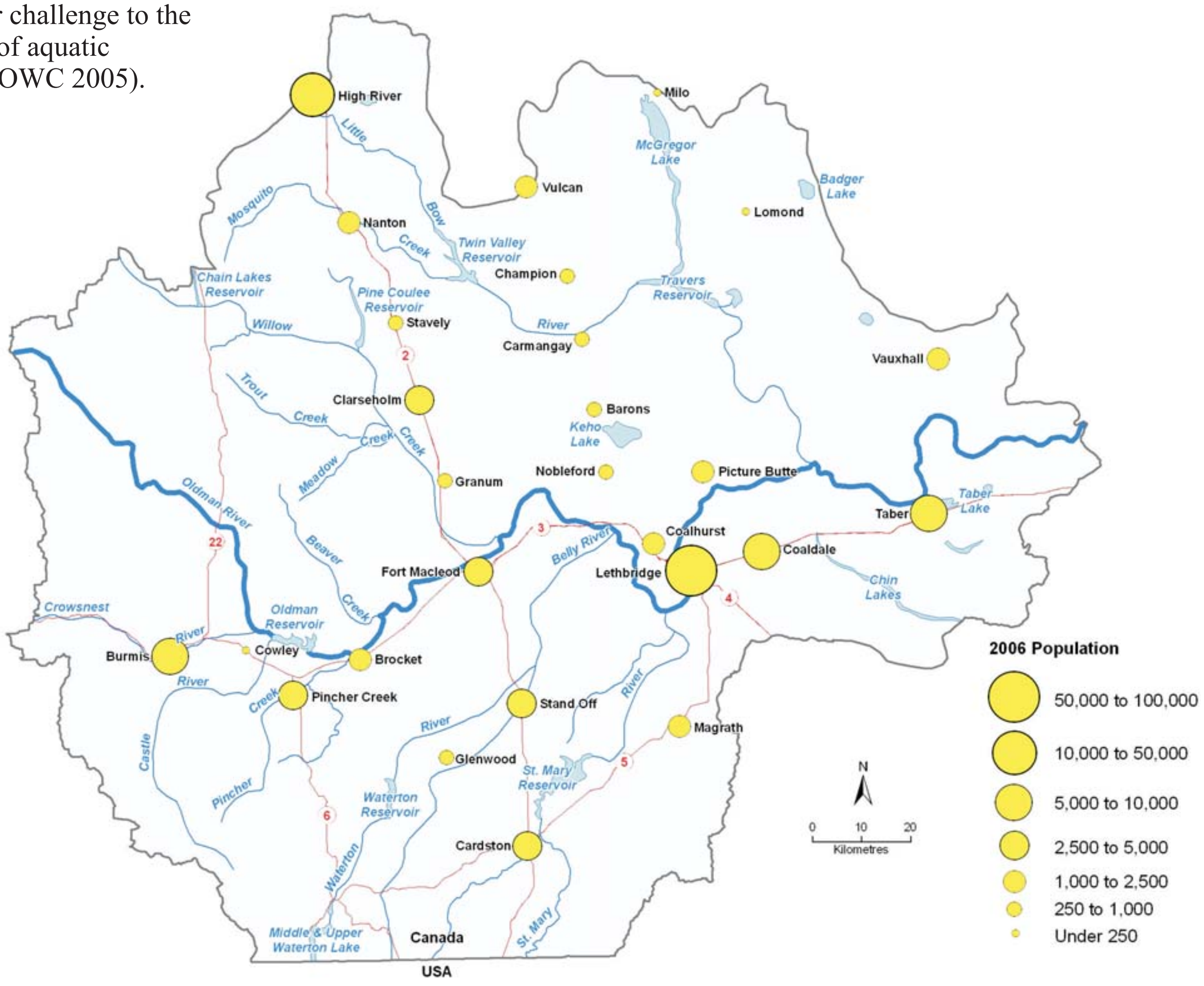


Figure 7.5: Population in the Oldman Watershed

7.1.2 Water Quantity

Flow Variability

Water management in the Oldman watershed must consider the impacts of both droughts and floods. Natural flows in the Oldman watershed are highly variable both geographically and temporally. Median annual unit runoff yields are very high in the western and southern mountainous headwaters, reaching over 900 dam^3/km^2 in upper reaches of the Waterton and Belly rivers. By contrast, median annual yields in the Prairie Sub-basins are less than 10 dam^3/km^2 (Little Bow River). Flows are also highly variable from year to year. For instance, the annual natural discharge of the Oldman River near the Mouth varies from a low of 1.41 million dam^3 to a high of 7.10 million dam^3, a five-fold range in flows. Annual peak flows in the watershed are also highly variable. During the past 45 years, mean daily peak flows ranged from 74.5 m^3/s (2001) to 3990 m^3/s (1995). The floods of 1995 and 2005 are vivid in the memories of current residents.

Trend analyses of natural flows (recorded natural flows at some hydrometric stations and reconstructed at others) show signs of decreasing flows, but trends are not considered to be scientifically significant at any stations except those on Beaver Creek in the Foothills Sub-basins and the Little Bow River in the Prairie Sub-basins. These are two of the smaller tributaries in the study area that may be impacted by land use changes and, in the case of the Little Bow River, errors in the particularly difficult reconstruction of natural flows. Table 7.2 shows the probability of a decreasing trend at all locations analysed. Periodic analyses are required to determine if a more general decline in flows that could be attributed to climate change becomes evident.

Licensed Allocation and Actual Use

The waters of the Oldman watershed are highly regulated and extensively used. There are three major onstream storage reservoirs, Oldman River, Waterton and St. Mary reservoirs, with a total storage capacity of about 970 000 dam^3. In addition, there are over 660 000 dam^3 of offstream storage, some of which is located outside of the Oldman watershed.

These storage reservoirs are used primarily to better match temporal and geographic variations in water supply and demand (primarily irrigation demand) through flow regulation, and to maintain instream flow targets. Other uses include reservoir recreation, flood control and meeting inter-provincial apportionment commitments. An overview of the benefits and impacts of dams and reservoirs is presented in Appendix E.

Water demands are generally low in the upper reaches of streams in the watershed, but increase to high levels in lower reaches of most streams. Table 7.2 shows the extent of water allocations and estimated actual uses, expressed as percentages of the median natural flow (it is important to read the notes at the bottom of the table to assist in interpreting the data and the rankings). Generally, the higher the actual use is, expressed as a percentage of natural flow, the greater the potential for water supply deficits. However, several other factors come into play in a complex water resource system. For instance, storage and flow regulation can help to reduce deficits. Simulation modeling is required to determine performance in meeting consumptive and instream requirements in highly regulated streams.

Actual water use is almost always less than total allocations. Where there is a large difference between allocation and use, there is potential for expansion of use within existing allocations. The data for the Waterton, Belly and St. Mary rivers below the Belly-St. Mary Headworks and for the Oldman River at the Mouth indicate that there is considerable potential for expansion in the Southern Tributaries Sub-basins and along the Oldman River mainstem without the requirement of additional allocations. However, the available water supply may not support additional expansion without increased deficits to instream needs and existing consumptive use projects with junior licence priorities. In contrast, the Little Bow River has high allocations, but the potential for expansion within existing allocations is low because there is little difference between the use and allocations.

Table 7.2: Licence Allocations, Estimated Actual Uses and Performance in Meeting Instream Requirements

Location	Probability of Annual Trend [7] (%)	% of Median Natural Flow		% of Months of Instream Deficits (1992-2001)	
		Allocation	Actual Use	IO	WCO
Mountain Sub-basins					
Crowsnest River near Frank	31	0.1	0.1	1.3	2.5
Crowsnest River near Lundbreck	41	3.2	0.5	2.5	2.5
Castle River near Beaver Mines	25	0.4	0.4	49.3 [6]	54.5 [6]
Castle River near Cowley	7	0.9	0.6	39.2 [6]	44.2 [6]
Foothills Sub-basins					
Willow Creek near Claresholm	65	11.0	9.5	10.8	17.5
Willow Creek near Nolan	83	25.4	21.1	5.0	18.3
Beaver Creek near Brocket	98	11.9	9.6	38.3 [6]	40.0 [6]
Pincher Creek at Pincher Creek	80	7.0	5.4	4.4	42.3
Southern Tributaries Sub-basins					
Waterton River near Waterton Park	59	0.2	0.1	5.8	9.2 [6]
Waterton River near Stand Off	55	NA [1]	NA [1]	1.7	37.5
Belly River near Mountain View	16	12.6	2.0	1.7	3.3
Belly River near Glenwood	33	NA [1]	NA [1]	0.8	35.0
Belly River near Mouth	6	NA [1]	NA [1]	NA [2]	NA [2]
Lee Creek at Cardston	21	5.8	2.8	52.8 [6]	56.0 [6]
St. Mary River at International Body	17	43.6 [3]	27.1 [3]	5.8	10.8
St. Mary River near Lethbridge	55	NA[1]	NA[1]	4.2	40.0
Waterton, Belly, St. Mary Rivers below Belly-St. Mary Headworks [4]		74.7	37.9		
Prairie Sub-basins					
Little Bow River at Carmangay [5]	97	66.8	58.2	NA	0.0
Little Bow River near the Mouth [5]	97	68.7	60.1	NA	3.3
Mainstem Oldman River					
Oldman River near Waldren's Corner	5	0.1	0.1	1.3	2.5
Oldman River near Brocket	66	2.1	1.4	9.3	18.0
Oldman River near Fort Macleod	66	37.1	17.4	NA [2]	NA [2]
Oldman River near Lethbridge	30	56.7	31.8	2.6	20.4
Oldman River near the Mouth	36	59.6	39.0	1.6	16.4

Notes:

1 Some allocations are to the combined flow of Waterton, Belly and St. Mary Rivers.

2 Recorded flow unavailable.

3 Allocation and use is United States entitlement and actual use under Boundary Waters Treaty.

4 Combined flow and allocations to Waterton, Belly and St. Mary rivers.

5 Median annual flow includes diversions from the Highwood River.

6 Most deficits occur due to the Instream Objectives (IO) or Water Conservation Objectives (WCO) being higher than natural flow. In these cases, frequent deficits do not affect the ranking.
Most deficits occur due to the Instream Objectives (IO) or Water Conservation Objectives (WCO) being higher than natural flow. In these cases, frequent deficits do not affect the ranking.

7 The probability of an annual trend equals 1.0 minus the p-value determined in a Mann-Kendall analysis. It is an indication of the likelihood of declining flows.

Colour Index: Good; Fair; Poor

Figures 7.6 and 7.7 show the relationship between allocations, estimated actual uses, instream needs and natural flow for the Southern Tributaries Sub-basins and the Oldman River near the Mouth. In the Southern Tributaries Sub-basins, the current actual use plus the WCO would be approximately equal to 25% of the natural flow volume. If the actual use increased by, say, 50% (still well within the allocation), the use plus the WCO would exceed the median natural flow. The Oldman River is in a similar condition. As noted earlier, simulation modeling of water supply and demand would have to be carried out to determine the feasibility and implications of water demand increases.

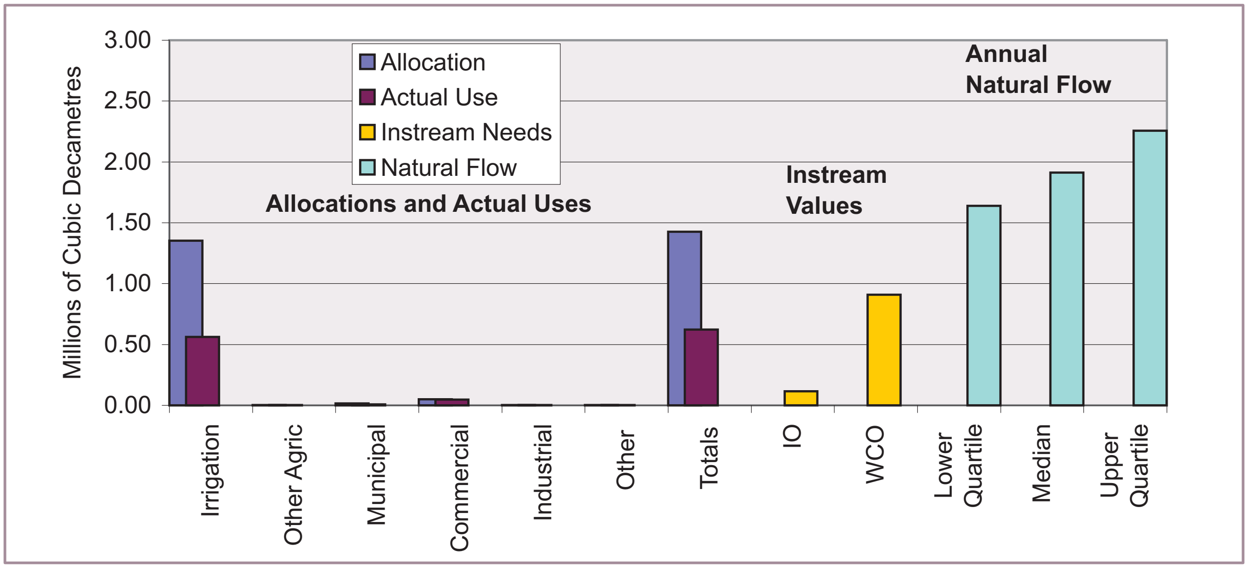


Figure 7.6: Water Demands and Supplies – Southern Tributaries Sub-basins

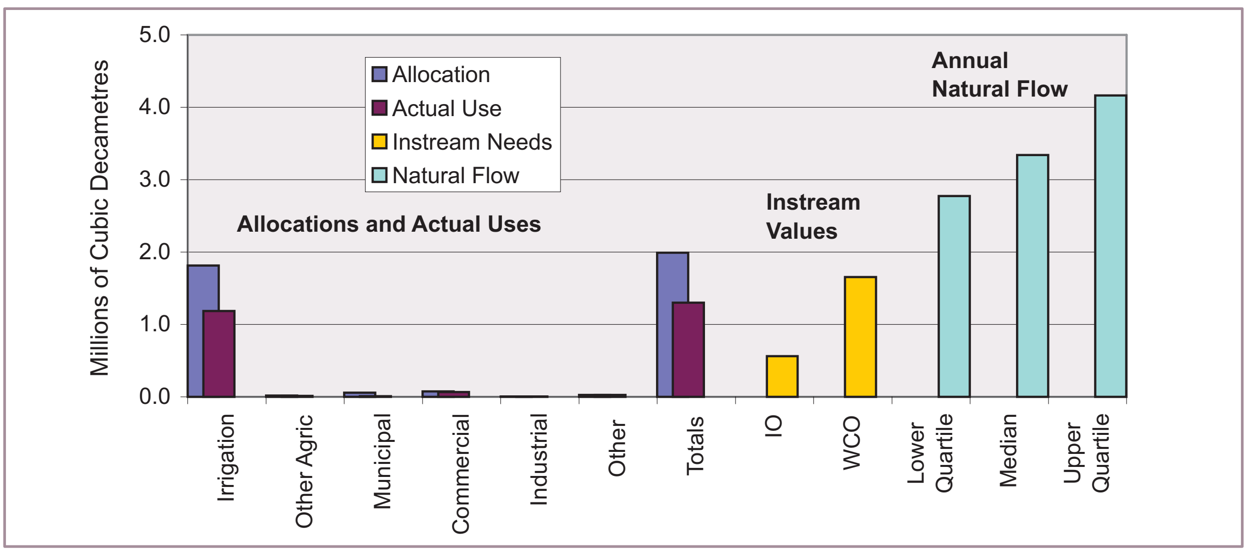


Figure 7.7: Water Demands and Supplies – Oldman River Near the Mouth

Irrigation District Water Use Efficiency

Nine of Alberta's 13 irrigation districts are sourced from waters of the Oldman watershed (Figure 7.8). Some of the irrigated lands extend beyond the Oldman watershed. The districts range in size from 1442 assessed ha (Mountain View Irrigation District) to 150 857 assessed ha (St. Mary River Irrigation District, Canada's largest district).

The irrigation districts in the Oldman watershed (as well as in the Bow River watershed) have made significant gains in water-use efficiency over the past several decades. The unit gross diversion (withdrawal from the source stream per hectare of irrigated land) has been declining steadily since 1976 when systematic collection of data began (Figure 7.9). A Mann-Kendall trend analysis indicates that the trend is significant at a 95% level of confidence. The trend line indicates an average annual reduction in withdrawal of 0.6% or about 2.4 mm/y.

Efficiency improvements during the past three decades have been realized from the combined impacts of on-farm application efficiencies, district conveyance improvements, and reduced return flows.

On-Farm Application Efficiencies

The on-farm component represents about 70 to 75% of the gross diversion. During the past four decades, changes in the mix of irrigation methods and equipment have been the primary influence on on-farm efficiency. The change in irrigation methods and equipment from gravity flood irrigation, to wheel-move sprinklers, and to centre-pivot sprinklers has improved on-farm control of water and irrigation efficiency, but also has reduced labour costs and enabled irrigation of additional areas "above the ditch".

Assessed Area – The area of land within irrigation districts for which a water rate has been assessed. It is always larger than the area actually irrigated for several reasons, such as crop rotations, weather conditions, and social or economic circumstances. Also, in some districts, permanent water rights were given for irrigation of small parcels that are not practical to irrigate to-day. Owners of such parcels may use water for livestock or domestic purposes and continue to pay their water rates to ensure deliveries (Irrigation Water Management Study Committee 2002).

Figure 7.8: Diversions in the Oldman Watershed

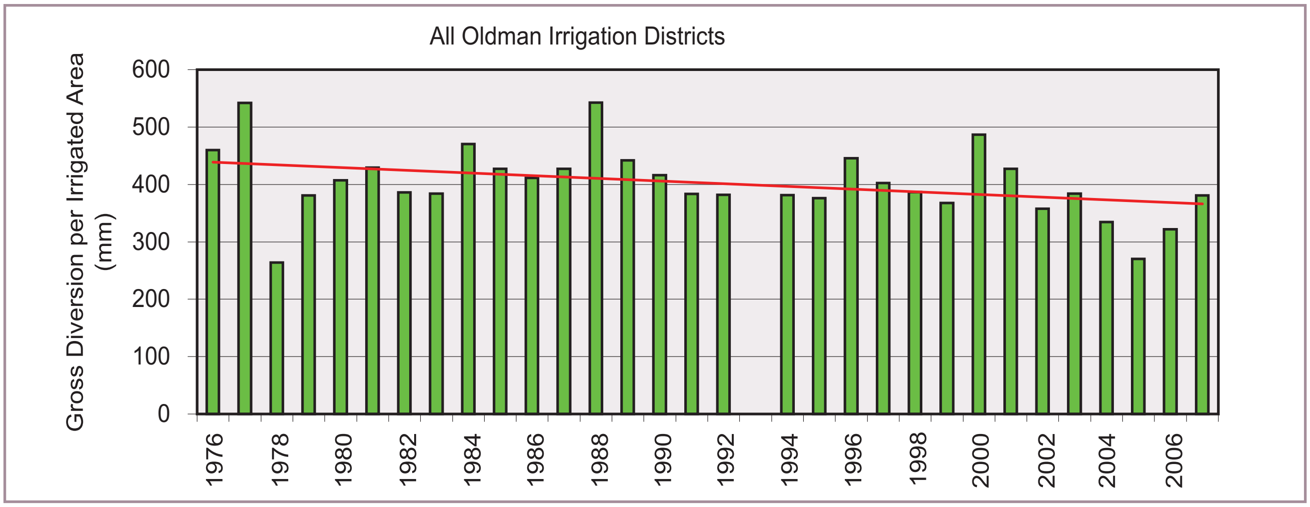


Figure 7.9: Unit Gross Diversion to Irrigation Districts within the Oldman Watershed Expressed as Depth over the Irrigated Area

Low pressure centre pivots, with efficiencies of 80% or higher, are currently the equipment of choice in southern Alberta and are leading the way in on-farm efficiency improvements. These centre pivots occupied almost half of the irrigated land within districts in 2007.

Irrigation District Conveyance Efficiency

Conveyance losses are primarily seepage and evaporation from canals and reservoirs. Prior to 1970 seepage caused considerable water logging and soil salinity problems downslope from canals and reduced water use efficiencies. In 1969, the provincial government and irrigation districts initiated a cost-sharing program to rehabilitate district-owned infrastructure and reclaim seepage-impacted lands. Also, in the early 1970s, the province initiated a program to rehabilitate their headworks (owned by the province). Both these programs are continuing today. The cost-share Irrigation Rehabilitation Program has improved about 70% of district conveyance works. Canals were upgraded and impervious liners were installed where necessary to prevent seepage, structures were replaced and automated, and many canals were replaced by pipelines.

Pipelines now comprise almost 40% of the total length of conveyance works within the districts. Replacement of canals with pipelines is continuing. This further reduces seepage and evaporation losses, and in many cases reduces return flows. Reservoir evaporation is not likely to reduce in the future. In fact, with warmer summer temperatures as a result of a changing climate, reservoir evaporation may increase by a small amount.

In Alberta, **on-farm application efficiency** is defined as the amount of irrigation water applied and retained within the active root zone as a percentage of the total amount of irrigation water delivered to the on-farm system (Irrigation Water Management Study Committee 2002.)

Return Flows

Return flows are the consequence of the inability to perfectly match *variable water supplies* with *variable water demands* in a canal distribution system. Surplus deliveries are returned to flowing surface waters through drainage channels. Return flows are not always returned to the source stream. Some of the return flow from Sub-basins in the Oldman watershed is returned far downstream from the point of withdrawal. Some is returned to the South Saskatchewan River, and a small amount is returned to

Net evaporation = Gross evaporation minus precipitation directly on the open water surface.

the closed Pakowki Lake Basin. Also, return flow quality may be less desirable than natural flow in the receiving stream. Nevertheless, return flows are available for uses other than the purpose for which they were withdrawn.

Prior to 1995, monitoring of return flows was minimal. Since the mid-1990s, most irrigation districts have made concerted efforts to monitor return flows from their districts. Since monitoring began, there has been a steady but modest decrease in the volume of return flow and a more pronounced decrease in the gross diversion, probably due to several factors including better control of water and the installation of pipelines.

Irrigation District Efficiency Indicators

Unit gross diversions (expressed in mm) vary from year to year depending primarily on weather conditions. The average unit gross diversions for the period 2003 to 2007 are taken as an indicator of current irrigation district efficiencies (Table 7.3). Unit gross diversion varies markedly from district to district. Comparisons among the districts are not necessarily a reflection of district management. There are numerous factors involved, including:

- layout and design of distribution system;
- agro-climatic conditions;
- crop mix;
- district size and density, usually expressed as irrigated area divided by conveyance length;
- extent of district rehabilitation;
- volume and distribution of internal storage; and
- communication and management.

The early layout and design of the original gravity flood irrigation distribution systems established patterns of land use and water dependencies that were inherited by today's districts. In some cases, this inheritance came with inefficient, high maintenance systems by to-day's standards that are difficult to change without major impacts on landowners and communities dependant on the distribution system for their water supplies. For these reasons, comparison of efficiencies among the districts is not necessarily an indication of district management. More important for subsequent state of the watershed assessments is continued improvement in efficiency for each individual district.

Considering all irrigation districts in the Oldman watershed, the unit gross diversions (dam^3 per irrigated

Table 7.3: Summary of Average Unit Gross Diversion for Irrigation Districts in the Oldman Watershed, 2003 to 2007[5]

Irrigation District	2007 Unit Gross Div[1] (mm)	Historical Trends					
		Trend Direction	Rate[2] (mm/year)	Significance Confidence Level[3]			
				<90%	90%	95%	99%
Aetna	487	Decreasing	2.4	X			
Leavitt	401	Decreasing	4.6	X			
Lethbridge Northern	316	Decreasing	4.5				X
Magrath	289	Decreasing	1.3	X			
Mountain View	316	Decreasing	3.1	X			
Raymond	266	Decreasing	1.1	X			
St. Mary River	361	Decreasing	2.1		X		
Taber	322	Decreasing	3.5				X
United	331	Decreasing	5.7				X
All Irrigation Districts[4]	338	Decreasing	2.4			X	

Notes:

1 Unit gross diversion is based on average for period 2003 to 2007.

2 Rate of increasing or decreasing trend is based on trendline slope.

3 Trend significance is based on Mann-Kendall non-parametric trend analysis. Trends with >95% confidence level are usually considered to be significant in scientific literature. Trends with 90% to 95% confidence level are considered to be probably significant in this study.

4 Includes all Oldman districts weighted by irrigated areas.

5 All data have been taken from ARD's Ropin' the Web. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/irr7401

hectare or mm) have decreased substantially (Table 7.3). Some of the conserved water has been used to expand the irrigated area. Since about 1985, the gross diversions (dam^3) have decreased by a small amount in spite of a significant increase in the irrigated areas, resulting in a small net benefit to instream flows.

Municipal Water Use Efficiency

Use of water for municipal purposes refers to withdrawing water from a surface or groundwater source, treating the water to comply with Health Canada's Guidelines for Drinking Water Quality, distributing it to homes, commercial and institutional establishments, and industrial users in cities, towns and villages. It does not include water use in hamlets, rural subdivisions or industrial complexes in rural area. Municipal water use often involves irrigation of parks and golf courses, and uses for other recreational and aesthetic amenities. Water use records indicate that municipal use is usually highest in the summer months, primarily due to outside watering of lawns, gardens and parks. Not all water withdrawn from the source is consumed. The portion not consumed is usually treated to remove impurities and released to the source stream or other receiving body as wastewater effluent, commonly referred to as return flow. The proportion of diverted flow that is returned is variable, depending on site specific factors. For communities with continuous return flow, 80% is commonly used for planning purposes. For communities with lagoon treatment and intermittent releases, return flow can vary from zero to 75%. Good quality return flow can be used to supply downstream water demands. Poor quality return flow sometimes contributes to water quality problems in the receiving stream.

Population is a key factor in determining municipal water requirements. However, per capita consumptive use computed from records of withdrawals and population often vary because of factors such as infrastructure design, unrecorded amounts of water provided for domestic and other uses outside the urban center, and varying amounts of commercial, industrial and institutional water uses within urban areas (Hydroconsult 2001).

Annual water use, population and daily per capita use were determined for each urban community within the Oldman watershed (Figure 7.10) and for communities outside the watershed that are supplied by surface waters of the Oldman watershed. Data were determined for the two most recent federal census years, 2001 and 2006 (Stats Canada 2006).

Water withdrawals for 2001 and 2006 for communities in the watershed were obtained primarily from AENV's Water Use Reporting System database. Where the information was unclear, or where water use differed substantial between 2001 and 2006, the information was verified by direct contact with the communities. Extenuating circumstances were noted. The data include all domestic, commercial, institutional and industrial uses within the communities (Table 7.4). The total estimated surface and groundwater withdrawals for cities, towns and villages are summarized in Table 7.5 and compared with Alberta and Canada averages.

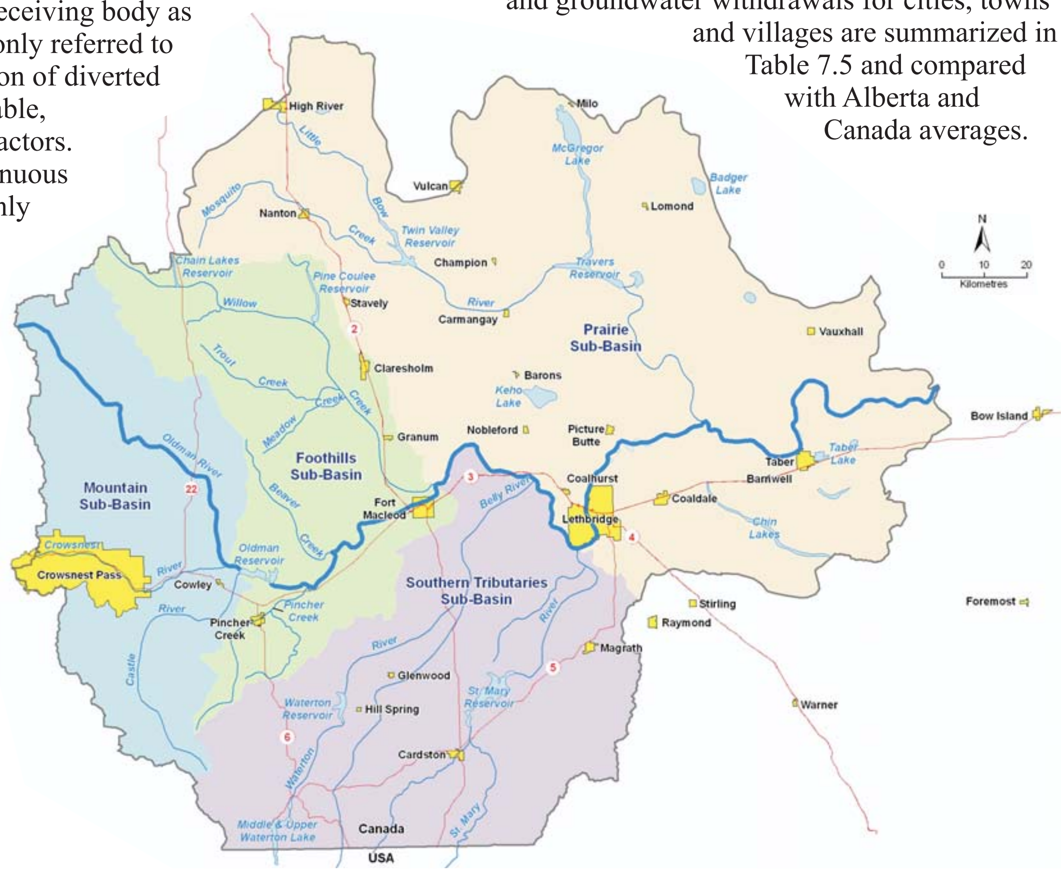


Figure 7.10 Communities that Use Water from the Oldman Watershed

Table 7.4 Municipal Water Use for Communities in the Oldman Watershed for 2001 and 2006.

Municipality	Population		Water Source	Historic Use (2001)		Current Use (2006)		Comments
	2001	2006		m^3	L/c-d	m^3	L/c-d	
Mountain Sub-basins								
Municipality of Crowsnest Pass (includes Bellevue, Blairmore, Frank and Coleman)	5 749	6 262	Groundwater and Crowsnest River	2 826 298	1 347	3 179 527	1 391	Blairmore provides water to a gold course for irrigation in the summer and a ski hill for now making in the winter. Blairmore per capita water use on 15 April 2009 was 3540 itres. Extent of surface water use unknown.
Village of Cowley	225	219	Castle River	44 960	547	44 960	562	
Foothills Sub-basins								
Town of Claresholm	3 622	3 700	Pine Coulee Reservoir, Willow Creek	1 085 382	821	1 226 502	908	Source, Willow Creek through the works of AENV.
Town of Granum	392	415	Willow Creek	105 038	734	105 038	693	Winter flow supplemented by releases from Pine Coulee Reservoir.
Town of Pincher Creek	3 666	3 625	Pincher Creek, Castle River	1 040 444	778	971 239	734	Approximately 65% of the Town's water comes from Pincher Creek.
Southern Tributaries Sub-basins								
Town of Bow Island	1 704	1 790	SMRID canal			435 131	666	Source, St. Mary River through works of AENV and SMRID. Bow Island has winter storage.
Town of Cardston	3 475	3 452	St. Mary River and Lee Creek	1 097 930	866	1 045 957	830	Approximately 70% from st. Mary River and 30% from Lee Creek.
Town of Magrath	1 993	2 081	Jensen Reservoir	426 220	586	482 087	635	Source, St. Mary River through the works of AENV.
Town of Raymond	3 200	3 205	Ridge Reservoir	744 464	637	841 000	719	Source, St. Mary River through the works of AENV.
Village of Foremost	531	524	Wells. St. Mary River for non-potable purposes.					Surface water source, St. Mary River through the works of AENV and SMRID for outside watering and fire fighting. Volume unquantified.
Village of Glenwood	258	280	Groundwater for household use. Belly River for non-potable uses.	256 264	2 721	85 775	839	Local cheese plant uses village water and changed process in 2006 resulting in substantially reduced water use. Surface water provided through works of UID.
Village of Hill Spring	218	192	Groundwater for household use. Belly River for non-potable uses.					Surface water provided through works of UID.
Village of Stirling	877	921	Ridge Reservoir	289 913	906	374 400	1 114	Source, St. Mary River through the works of AENV.
Village of Warner	379	307	Ridge Reservoir			38 500	344	Source, St. Mary River through the works of AENV.

Municipality	Population		Water Source	Historic Use (2001)		Current Use (2006)		Comments
	2001	2006		m^3	L/c-d	m^3	L/c-d	
Prairie Sub-basins								
Town of Taber	7 671	7 591	Chin Lake	2 742 410	979	2 555 570	922	Source, St. Mary River via works of AENV and SMP.
Town of Nanton	1 841	2 055	Mosquito Creek, spring, well	277 613	413	299 330	399	Mosquito Creek (67%); well (0%), spring (33%) in 2006.
Town of Picture Butte	1 701	1 592	Picture Butte Lake Reservoir	246 453	397	418 269	720	Upgrade to treatment plant in 2001 required increasingly more backwashing of filtration system until about 2007, after which aeration and other systems have reduced that requirement substantially. Each backwash takes 64 000 litres and was being done almost daily by 2006. Also, since 2006 a low flow fixtures bylaw has been implemented for all new construction and renovations as well as summer watering restrictions.
Town of Vauxhall	1 112	1 069	BRID canal	304 076	749	304 076	779	Source, Bow River through works of AENV and BRID. Vauxhall has reservoirs for winter storage.
Town of Vulcan	1 762	1 940	Twin Valley Reservoir, Little Bow River	337 614	525	397 788	562	Little Bow River flows supplemented by diversions from Highwood River.
Town of Stavely	442	435	Groundwater	71 813	445	69 772	439	
Village of Barnwell	584	613	Chin Lake	122 172	611	98 886	442	Source, St. Mary River via works of AENV and SMP.
Village of Champion	355	364	Travers Resevoir	75 557	583	82 465	621	Source, Bow River through works of AENV.
Village of Carmangay	255	336	Little Bow River	50 305	540	52 570	429	Little Bow River flows supplemented by diversions from Highwood River.
Village of Milo	115	100	Lake McGregor					Source, Bow River through works of AENV.
Village of Lomond	171	175	BRID (Little Bow)	47 571	762	45 571	745	Bow River water supplied through works of AENV and BRID. winter storage available.
Mainstem Oldman River								
City of Lethbridge	67 374	74 637	Oldman River	17 373 685	706	19 411 525	713	Provides water to County of Lethbridge and McCains plant.
Town of Fort Macleod	2 990	3 072	Oldman River	1 232 469	1 129	1 108 943	898	
Town of Coaldale	6 008	6 177	Oldman River	1 116 715	509	839 893	373	Supplied through works of Lethbridge Regional Water Services Commission.
Town of Coalhurst	1 476	1 523	Oldman River	249 761	464	261 263	470	Supplied through works of City of Lethbridge.
Village of Barons	284	276	LNID canal	89 776	866	70 832	703	Source: Oldman Reservoir through works of AENV and LNID and Village of Nobleford. Winter storage provided at Nobleford.
Village of Nobleford	615	689	LNID canal	166 439	741	168 709	671	Source: Oldman River, AENV and LNID. Nobleford has its won reservoirs for winter water supply. Nobleford provides water to Barons. Each community has its own licence and reports water use separately.

Table 7.5: Weighted Average Municipal Per Capita Water Use in the Oldman Watershed Compared with the Alberta and Canadian Average

	Average Withdrawal (L/c-d)		Residential (%)	Commercial and Industrial (%)	System Losses (%)
	2001	2006			
Oldman Watershed	742	747			
Alberta (2001)[1]	519		56	35	9
Canada (2001)[1]	622		56	31	13

The variations in per capita use among communities is not necessarily an accurate measure of water use efficiency because of the differences among communities in the non-household uses such as industrial, commercial, institutional and recreational uses, as well as unrecorded amounts provided for domestic use outside the urban area. A more important statistical observation is the difference in efficiency within each individual community with the passage of time.

The 2001 and 2006 average per capita withdrawals were computed based on the withdrawal volumes and 2006 population. The average withdrawal for all communities was computed to be 742 litres per capita-day (L/c-d) for 2001 and 747 L/c-d for 2006, indicating a slight increase in per capita use over the five-year period. The 2001 average per capita withdrawal for the Oldman watershed is considerably higher than the 2001 averages for Alberta and Canada published by Environment Canada (2004).

Five communities had per capita water use reductions greater than 10% between the years 2001 and 2006. The communities were contacted to determine the measures taken to reduce their per capita consumption. Reductions in some communities were circumstantial; others were a result of deliberate efforts to conserve water.

- *Village of Glenwood* – A local cheese plant that uses village water adopted a new process in 2006 which resulted in substantial water use reductions.
- *Village of Barnwell* – The village's aging water treatment plant could not keep up with demand. Outside watering was strictly rationed in recent years. The water treatment plant has now been updated.
- *Village of Carmangay* – The village has been trying to instil a conservation ethic within the community through an education and awareness program and increased water metering. Regular plant maintenance is being carried out. Summer water restrictions are common.
- *Town of Fort Macleod* – A leak detection program is thought to be the primary reason for the reduction in per capita use.
- *Town of Coaldale* – Several water saving programs were implemented during the five year period, such as leak detection, replacement of valves and hydrants, upgrading residential water meters and metering of non-potable uses.

Overall Ranking for Water Quantity Indicators

Overall, the water quantity of the Oldman watershed is **"Fair"** based on the results of analysis of flow variability, licensed allocation and actual use, as well as water use efficiencies within irrigation districts and municipalities. The ranking for each of the Sub-basins is shown in Table 7.6

Table 7.6: Overall State of the Watershed Ranking for Water Quantity

Sub-basins	Ranking
Mountains	Good
Foothills	Fair
Southern Tributaries	Poor
Prairie	Fair / Poor
Mainstem	Poor
Oldman Watershed	Fair

7.1.3 Water Quality

Water quality in the Oldman watershed originates in the headwaters changing with downstream drainage and associated land-use patterns. A combination of effects from non-point sources (e.g., runoff from agricultural lands, pastures, etc.) and point sources (that are mainly related to industry and other discharges) creates additional loadings to streams in the watershed. All of these factors affect changes in concentrations of indicators, their temporal trends and loadings in different streams and their reaches.

The overall temporal trend pattern for all indicators (Figure 7.11) in the Oldman watershed shows neutral and/or decreasing trends within upstream reaches except in the Foothills and Prairie sub-basins. These two Sub-basins show increasing trends for almost all indicators. The upstream reach of the Oldman River shows no trend, with variable trends downstream. Increasing trends in the Oldman River mainstem are caused by higher loading from tributaries and/or effects from urban centres. Decreasing trends in the Mainstem are maintained when lower loadings from the tributaries occur.

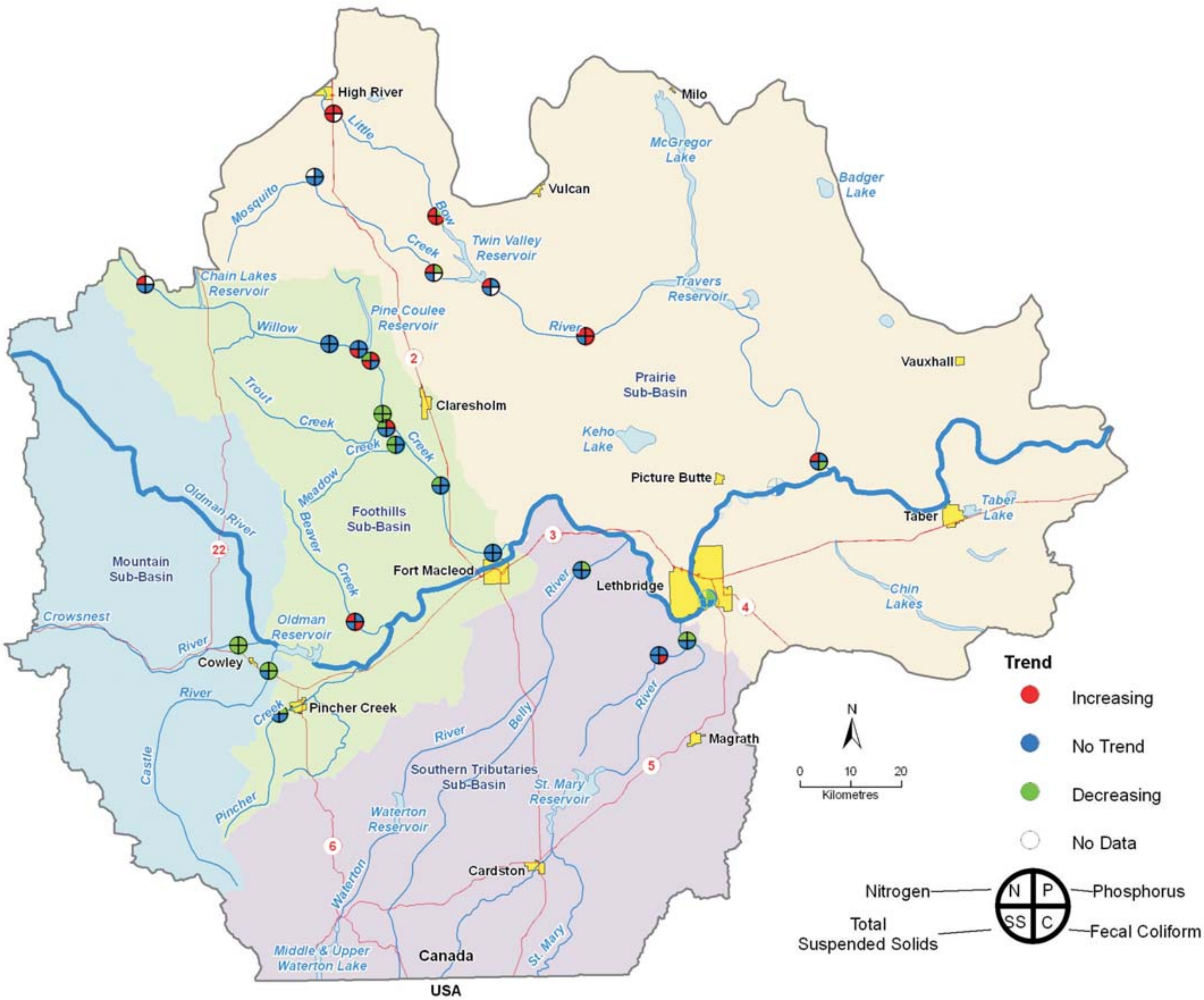


Figure 7.11: Water Quality Trends in the Oldman Watershed

Nitrogen

Total nitrogen concentrations within the Oldman watershed, during the 25 to 30 years of monitoring, were within the surface water quality guidelines for the protection of aquatic life. Concentrations below the guidelines were observed sporadically and no clear tendency in the trend pattern could be interpreted. The only consistent increases and exceedances were observed during the 2005 flood event but even that did not occur everywhere in the watershed.

Overall number of exceedances above the guidelines within available data set is very low and thus this indicator shows water quality to be in good condition.

Phosphorus

Total phosphorus content in the Oldman watershed and its temporal variations and changes between Sub-basins as well as within the Oldman River mainstem has changed over the last 30 years. The available data show that guidelines exceedances were generally not observed in the Mountains Sub-basins and were even less often seen in the Foothills Sub-basins, where only small tributaries were prone to higher phosphorus concentrations. Very rare exceedances were recorded in Southern Tributaries Sub-basins, where data were not so readily available. Exceedances were most often observed in Prairie Sub-basins, and these occurred broadly and relatively clearly in the last years. Guidelines used for the assessment were for the protection of aquatic life.

Collectively, water from all Sub-basins ends up in the Oldman River mainstem and thus, these data show effects from the watershed as whole. Phosphorus concentrations in earlier decades (1970s through mid 1990s) in the Oldman River mainstem often exceeded water quality guidelines. Since then, no guideline exceedances were observed except during the extreme flood event in 2005.

Overall the number of exceedances above the guidelines within available data set is more pronounced in Prairie Sub-basins and the Oldman River mainstem. In recent years, the exceedances occurred more often in Prairie Sub-basins compared to other upstream tributaries and upper reaches of the Oldman River. As such, it is concluded that phosphorus shows a relative deterioration in values in Prairie Sub-basins. Thus, concentration levels in the watershed show certain improvements upstream, with potential deterioration in phosphorus levels within the Prairie Sub-basins.

Total Suspended Solids

In the Oldman watershed, total suspended solids (TSS) concentrations reflect landuse conditions contributing non-point source inputs associated with land-use effects (e.g., erosion) as well as point sources (e.g., municipal wastewater treatment discharges, industrial discharges). The guidelines for TSS are established based on background concentrations and are not a fixed number as for other indicators (e.g., nitrogen, phosphorus and fecal coliforms). For this report, changes and exceedances were assessed using median TSS concentrations over the period of monitoring at each site. The medians represent the “observed background”. The exceedances above these backgrounds thus represents actual variation, and assessed values were established at less than 100% and more than 100% of observed background values. The TSS concentrations in the Oldman watershed exceeded long-term observed backgrounds fairly often but no specific pattern was identified. The only dependence that was clearly marked related to high flows, e.g., in 2005. Overall within the watershed, TSS concentrations were less than 100% of the observed background (i.e., median) in approximately half of the observations. This exceedance is relatively low. For approximately 10 to 15% of the observations, TSS concentrations were greater than 100% of the observed background (i.e., median).

In cases where exceedances occurred several years in a row this reflects a potential deterioration in water quality. This pattern was observed in some streams within the Foothills and Prairie sub-basins. Overall the number of exceedances above the observed background is more pronounced in the Prairie Sub-basins and the mainstem of the Oldman River. However, the value in most exceedances was less than 100% of background and these exceedances happened randomly with no clear pattern that could be attributed to water quality deterioration. It is concluded that the noted exceedances in TSS concentrations above the long-term backgrounds represent inter-annual fluctuations for this indicator.

Fecal Coliforms

Fecal coliforms counts represent a bacteriological water quality indicator and their numbers and variations within the watershed are of particular interest. In the Oldman watershed exceedances above guidelines can be found particularly in Prairie, Southern Tributaries, and Foothills sub-basins. Over the long-term, the situation improves. The peak exceedances that happened in 2005 were associated with a high flow year which caused extensive runoff and wash off in the drainage areas.

The overall pattern in fecal coliform levels in the watershed demonstrated a tendency to improvement rather than deterioration. The occasional exceedances that occur appear to be due to extreme flow events.

Overall Ranking for Water Quality Indicators

Integrating results of water quality analysis for nitrogen, phosphorus, TSS and fecal coliforms gives an overall rank of **"Good"** to **"Fair"** for the Oldman watershed. Rankings for each of the Sub-basins are shown in Table 7.7

7.2 Watershed Assessment

Based on an evaluation of the combined ranking, the health of each of the Sub-basins is shown in Table 7.8.

Overall, the health of the Oldman watershed is rated as "fair". The Mountain Sub-basins is good, three Sub-basins are ranked fair and the Prairie Sub-basins is ranked fair to poor. Sub-basins with a fair ranking are Foothills, Southern Tributaries and Mainstem with land cover, riparian health, land use, water allocations, surface water nutrient levels being the indicators of most concern. In the Prairie Sub-basins indicators of most concern are land cover, riparian health, land use, water allocations and surface water nutrient levels.

Storage, flow regulation, and water diversions are the keys to meeting current water use levels within the Oldman watershed. In one instance (Little Bow River sub-basin), diversion from outside the watershed is used to meet current demand. Overall, management actions are required to maintain sustainability in light of potential expansion of demand (within current allocations) and potentially lower streamflow as a result of climate change.

Table 7.7: Overall State of the Watershed Ranking for Water Quality

<table>
<tr><th>Sub-basins</th><th colspan="2">Ranking</th></tr>
<tr><td>Mountains</td><td colspan="2">Good</td></tr>
<tr><td>Foothills</td><td colspan="2">Fair</td></tr>
<tr><td>Southern Tributaries</td><td colspan="2">Fair</td></tr>
<tr><td>Prairie</td><td>Fair</td><td>Poor</td></tr>
<tr><td>Mainstem</td><td>Good</td><td>Fair</td></tr>
<tr><td>Oldman Watershed</td><td>Good</td><td>Fair</td></tr>
</table>

Table 7.8: Overall State of the Watershed Ranking for all Indicators by Sub-basins

<table>
<tr><th rowspan="2">Indicator</th><th colspan="9">Sub-Basins</th></tr>
<tr><th>Mountain</th><th>Foothills</th><th>Southern Tributaries</th><th colspan="2">Prairie</th><th colspan="2">Mainstem</th><th colspan="2">Oldman Watershed</th></tr>
<tr><td>Terrestrial and Riparian</td><td>Good</td><td>Good</td><td>Fair</td><td colspan="2">Poor</td><td colspan="2">Good</td><td colspan="2">Fair</td></tr>
<tr><td>Water Quantity</td><td>Good</td><td>Fair</td><td>Poor</td><td>Fair</td><td>Poor</td><td colspan="2">Poor</td><td colspan="2">Fair</td></tr>
<tr><td>Water Quality</td><td>Good</td><td>Fair</td><td>Fair</td><td>Fair</td><td>Poor</td><td>Good</td><td>Fair</td><td>Good</td><td>Fair</td></tr>
<tr><td>Overall</td><td>Good</td><td>Fair</td><td>Fair</td><td>Fair</td><td>Poor</td><td colspan="2">Fair</td><td colspan="2">Fair</td></tr>
</table>

Water quality monitoring has been sporadic, both spatially and temporally, and is not currently designed to support watershed-wide assessments. A watershed-wide monitoring approach should be developed for the water quality indicators used in this report.

Several potential indicators were considered in the selection process (Appendix B) but were rejected because not all the criteria were met, primarily due to lack of data or application across all the Sub-basins in the watershed. These areas and indicators should be the first issues addressed in the future watershed management plan.

The following indicators should be considered in all Sub-basins in future reports:

- invertebrates or fish as an indicator of aquatic health;
- pesticides as an indicator for water quality; and
- groundwater resources and quality because the closure of the Oldman watershed to new surface licences heightens the demand for groundwater use within the watershed.

In future reports, cottonwoods should be considered as an additional indicator of riparian health for the Southern Tributaries, Prairie, and Mainstem sub-basins.

Livestock Fencing Along Waterways – ARD

Water Sampling – ARD