# MICROBIAL WATER QUALITY IN SURFACE WATER OF THE SOUTH SASKATCHEWAN RIVER SUB-BASIN

## SEAWA Watershed Report 2009-3

## SEAWA Web-based State of the Watershed Report

South East Alberta Watershed Alliance
721 97 Carry Drive SE
Medicine Hat, Alberta, Canada T1B 3M6

www.seawa.ca 403.488.8110

# Microbial Water Quality in Surface Water of the South Saskatchewan River Sub-Basin


## Summary

Surface water quality affects human and animal health and microbial water quality is especially important. Direct contact with contaminated water poses health risks to swimmers, livestock and anyone who consumes untreated water. The quality of crops can be compromised if they are irrigated with water containing pathogenic microorganisms. Both surface and ground water can become contaminated through direct land application of sewage effluent, septic systems and improper manure storage and handling. Health risks associated with microorganisms include respiratory, gastrointestinal, eye, ear, skin and allergy illnesses and can be potentially fatal to immunocompromised patients such as victims of cancer or autoimmune deficiency syndrome (AIDS).[4] Bacterial water quality is an indication of the potential presence of various organisms such as *Escherichia coli*, *Giardia,* and *Cryptosporidium*. Faecal contamination by *E. coli* is widely used as an indicator of related pathogenic organisms such as *Salmonella, Shigella*, *Campylobacter*, and *Yersinia*.[39]*E. coli* occurs naturally in human and animal bodies but some strains contain toxic cell wall components, some of which can be fatal as shown by the Walkerton tragedy. Some algae which are really photosynthetic bacteria can produce toxins such as geosmin and microcystin which affect the palatability and safety of water during seasonal algae blooms.

The evaluation of water quality for a specific water body is typically based on the major uses for that source. The acceptable amount of faecal coliform bacteria in water used for irrigating vegetable crops is therefore different from the guideline that is applied to waters used for swimming or drinking. Regions of extensive agriculture and sewage outfalls have the potential to introduce pathogens into surface waters which must be removed by water treatment before direct consumption. The guidelines for water quality stipulated by Alberta Environment indicate acceptable levels of indicator organisms that can be present to minimize the possibility of waterborne disease. Livestock (especially beef cattle) can be important sources of these microorganisms, especially during periods of high runoff. Agricultural inputs are generally considered to be non-point sources because of their wide geographic distribution and are difficult to control. Point sources such as sewage outfalls are much easier to regulate and treat.


## Introduction

Water quality is essential for aquatic life and for human and animal health and enjoyment. Water quality, including microbial water quality, is regularly monitored and used to identify changes in a watershed that are useful for regulatory compliance and future watershed planning. Monitoring can also identify locations where there are problems related to land use practices.

Microbial water quality describes the levels of microscopic organisms: bacteria, protozoa, and viruses in water. Most of these are naturally occurring and are important parts of the decomposer food chain in an aquatic ecosystem. Some organisms are directly responsible for waterborne disease and others are used as indicators of faecal contamination. [34] It is not practical to monitor the occurrence of all of potential waterborne pathogens so the assumption is made that the risk of waterborne disease is higher if sewage contamination is present. The levels of all microorganisms found in water are affected by natural environmental factors such as river flow, local geology, climate, and discharge into rivers from agricultural and human activity.[17]

## Background

Before the arrival of European settlers, aboriginal people occupied the area that is now the South Saskatchewan River Sub-basin. As a convenient means of transportation and a source of drinking water, the river played a significant role in aboriginal displacement westward, the western expansion of the fur trade, early missionary efforts in the West, major exploration, scientific survey, and military expeditions as well as in the early European settlement of the West. [35]

During European settlement on the South Saskatchewan, water use for human, animal, agricultural, and industrial consumption was continual and largely unregulated. The first users were fur trade communities, missions, and the small river communities of Métis that grew up throughout the West. From the end of the 19th century to the beginning of the 20th century, settlements along the river created a greater need for water and river ice. [20] The introduction of European settlement has impacted the natural water quality of the South Saskatchewan. Today, the water quality index (WQI), designed by the Alberta Government, is used to rate water quality, based on estimations of the natural conditions.[20] As we gain more scientific knowledge, the water quality index has been expanded and refined to better define our water quality. A brief history of the water quality index is given at[11]: http://environment.gov.ab.ca/info/library/7792.pdf. Additional information on irrigation: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex2, ranching: http://www.ucalgary.ca/applied_history/tutor/calgary/FRAMEranch.html, and human activity: http://environment.gov.ab.ca/info/library/7771.pdf .

During the 1950s and 1960s, problems caused by excessive nutrients and oxygen-demanding substances entering aquatic environments, primarily from municipal and industrial sources, were of great concern.[20] The mountain-fed streams of the South Saskatchewan river are naturally nutrient poor, but treated sewage effluents, storm water runoff, and agricultural runoff significantly increase levels to concentrations greater than natural levels, leading to algae blooms. Some of these algae species, particularly those in the blue-green algae group (Cyanobacteria, a group of photosynthetic bacteria), produce objectional compounds which accumulate when they die. Some are toxins such as microcystin which can cause liver damage. Others such as geosmin (literally, earth-smelling) add objectionable tastes and odours to water at low concentrations. Higher levels of some of these algal products can affect human and animal health. [20]

The biological quality of water can be degraded by introduction of bacteria normally found in the intestinal tract of humans or animals or by waterborne protozoan pathogens such as *Giardia* ('Beaver Fever') and *Cryptosporidium*. In addition, human activities such as urban development, irrigation and other farm activities, industrial development, and resource developments may degrade the quality of natural waters by adding nutrients, herbicides and pesticides. Land-use change by itself may also affect water quality by increasing the amount of run-off.[42] In order to counteract this; more systematic data collection programs were implemented, beginning in the late 1960s which are ongoing. Long-term monitoring is essential to understand aquatic ecosystems and to determine trends over time. [20]

Following the creation of Alberta Environment and the development of provincial legislation for regulating point-source discharges in the 1970s, field studies expanded to include non-point source issues associated with agriculture, urban runoff, and atmospheric deposits. In the 1980s and 1990s, water quality concerns expanded to the general health of aquatic ecosystems, reflected in the presence of small quantities of toxic substances found in various ecosystem components (water, sediments, plants and animals). The tendency for some contaminants (e.g., pesticides, and metals) to build up in fish and wildlife and pose a risk to human and environmental health was recognized. Recently, issues have arisen regarding the presence of human pharmaceuticals, flame retardants, pathogens and new agricultural

chemicals in aquatic ecosystems. Potential sources of these contaminants and toxins include large urban areas and intensive agricultural operations. Climate change is a serious concern, and seasonal shifts in flow regimes, caused by earlier snow melt and more rain in the winter rather than snow could result in increased water contamination by washing contaminants into water bodies.[43]

## Water Quality Guidelines

Depending on the use of water, specific guidelines must be followed, such as that for recreational use, drinking water, and agricultural purposes. Two sites along the South Saskatchewan are used to assess overall water quality, including microbial parameters: a provincial site above Medicine Hat, and an Environment Canada site managed by the Prairie Provinces Water Board at Highway 41.[17]

The *Surface Water Quality Guidelines for Use in Alberta 1999* provids guidelines for surface water quality for drinking, recreation, and agricultural uses. [19] http://environment.gov.ab.ca/info/library/5713.pdf. It uses the River Bacterial Index formula that incorporates two factors representing key aspects of water quality. This includes the number of times bacterial density in these samples exceeds a guideline (frequency) and the extent to which the guideline is exceeded (amplitude). The result is a number between 0 and 100, where 100 represents the best water quality and the numbers are further divided into 5 categories (Table 1.1).[12] If these pathogens exceed the Canadian Water Quality Guidelines, a threat is posed to the public; causing illness which can be serious.

Table 1.1 Categories of Water Quality based on the River Bacterial Index formula[12]

| | |
|---|---|
| 96 - 100 | **Excellent -** Guidelines almost always met; best quality |
| 81 - 95 | **Good -** Guidelines occasionally exceeded, but usually by small amounts; threat to quality is minimal |
| 66 - 80 | **Fair -** Guidelines sometimes exceeded by moderate amounts; quality occasionally departs from desirable levels |
| 46 - 65 | **Marginal -** Guidelines often exceeded, sometimes by large amounts; quality is threatened, often departing from desirable levels |
| 0 - 45 | **Poor -** Guidelines almost always exceeded by large amounts; quality is impaired and well below desirable levels; worst quality |

Water quality guidelines for drinking are designed by Health Canada. Health Canada Guidelines for *Drinking Water Microbial Parameters* can be found at http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/sum_guide-res_recom/micro-eng.php.[34]

Water for recreational use is sampled for faecal coliforms, and the averages of at least five samples taken should not exceed 100 *E.coli*/100mL. Total coliforms in water should have a count of less than 5000 organisms per 100mL in 90 percent of samples. Waterborne pathogens, which usually are responsible for diseases, should not be present.[19] Additional information on the *Recreational Water Quality Guidelines* for microbial pathogens can be found at[33]:

http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/guide_water-1992-guide_eau/section3-eng.php#sec3.

To monitor agricultural water quality, Drain S-6 located near Bow Island is used as a sentinel site. Here, the Alberta Environmentally Sustainable Agriculture program (AESA) monitors the water quality. Methods of fecal bacterial monitoring as recommended by the AESA can be found at[7]:
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/aesa5825?opendocument.

Many farms contain man-made dugouts to collect water which is consumed by both humans and animals in rural areas through the South Saskatchewan River Sub-basin (SSRSB). In order to prevent waterborne disease, proper treatment must occur. Water Quality Guideline for Dugouts can be found at:
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/eng10362 and
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/eng1036. A summary of the various pathogens that can occur and their effects are found at:
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/eng10479. [8]

## Waterborne Pathogens

Harmful microorganisms that may be found in water are categorized into current bacterial pathogens, emerging bacterial pathogens, protozoa, viruses, and algae. Each of these organisms has the potential to cause waterborne disease so they are monitored. The presence of indicator bacteria such as *Escherichia coli* in a water supply suggests that the water may have been recently contaminated with the faecal material of humans or animals. *E. coli* is a good indicator because it does not occur naturally in water and some strains contain endotoxins (toxic proteins built into the cell wall). The presence of indicator microorganisms indicates a potential health risk and additional contamination with other waterborne pollutants such as nutrients. Chlorination can kill most bacteria and viruses but is only partially effective against algae and *Giardia*. *Cryptosporidium* is highly resistant to chlorination and can only be effectively removed by filtration and advanced water treatment such as ozonation or UV light.

Current bacterial pathogens of concern include *E. coli*, *Salmonella*, *Shigella*, *Campylobacter*, and *Yersinia*, all of which may be found in human and animal faecal material. Health Canada describes these organisms, their health effects, how to assess their presence, and the sanitization treatment that is used to treat them at[30]: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/pathogens-pathogenes/pathogens-pathogenes-eng.php#a5. Deadly pathogens such as cholera or typhoid can also be waterborne but there have been no waterborne outbreaks of these diseases in Canada for a long time. Monitoring data for faecal coliforms and *E. coli* upstream of Medicine Hat are shown in Figure 1.

Emerging pathogens include *Legionella*, *Mycobacterium avium* complex (MAC), *Aeromonas hydrophila*, and *Helicobacter pylori*, as described by Health Canada[30]: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/pathogens-pathogenes/legionella-eng.php#a6. These organisms are capable of causing disease but the importance of waterborne transmission is not well understood.

Protozoans such as *Giardia* and *Cryptosporidium* can also be found in waters throughout the South Saskatchewan River sub-basin. These particular organisms are very resistant to even harsh environmental conditions. Health Canada provides information on their description, symptoms, treatment, prevention, and testing methods[32]: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/*Giardia*_cryptosporidium-eng.php. The effects of these pathogens can be found at[29]: http://www.ec.gc.ca/soer-ree/English/soer/MWWE2.cfm, Box 5. In order to counteract the high potential for contamination and the resistance of protozoans to chlorination, some water treatment plants (including Medicine Hat) now treat finished water with UV radiation.[14] With the notable exception of the Walkerton *E. coli* outbreak, *Cryptosporidium* and

*Giardia* have been responsible for most of the waterborne disease outbreaks recorded in the last 30 years.

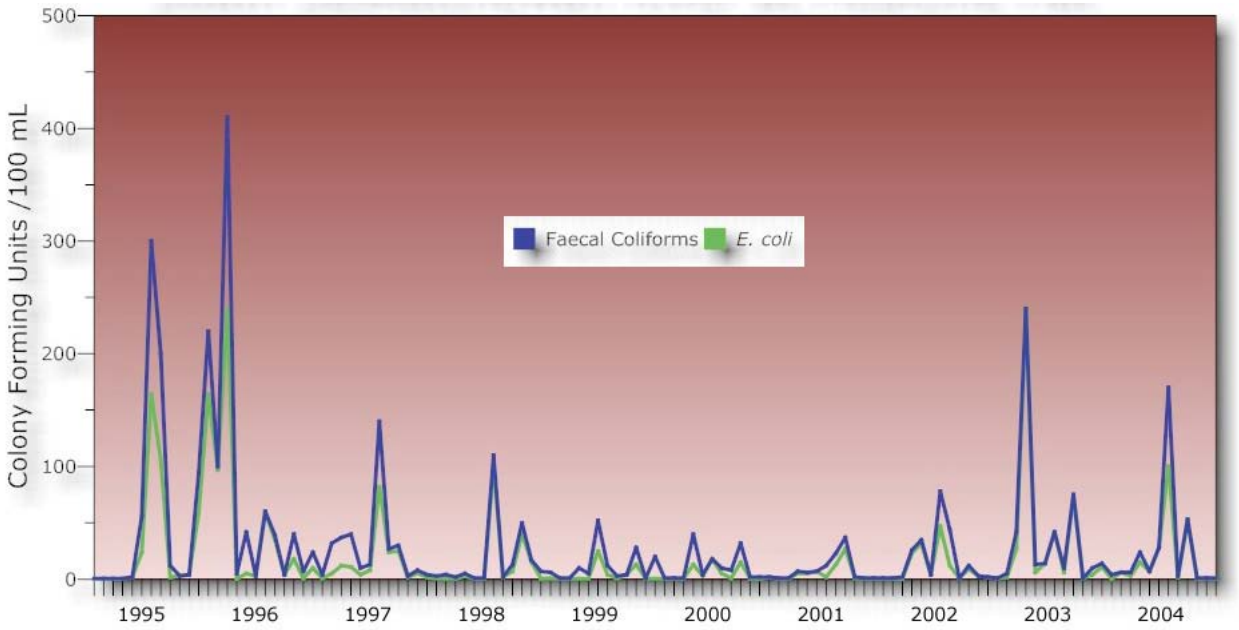


**Figure 1.** Faecal coliform and *Escherichia coli* occurrence in the South Saskatchewan River upstream of Medicine Hat.

There are a variety of viruses that can be transmitted by water and generally cause diarrhea. Rotaviruses, reoviruses, and even polio viruses can all be introduced from faecal contamination and cause disease, most seriously in young children and infants. Chlorination is effective in killing these pathogens.

Excessive nutrients, especially phosphates and nitrates, can cause algae blooms in surface waters. The most serious threat from algal growth comes from certain species of blue-green algae – Cyanobacteria - that produce potent toxins that can damage the human liver or nervous system. Large amounts of algae and cyanobacteria can also clog pipes and filter lines. Algae bacteria can also interfere with recreational uses and reduce the visual appeal of the shoreline. Algal blooms can cause increased water cloudiness and discoloration, unpleasant odours, excessive fouling of fishing gear, and foaming. Although the foul appearance and odour of the water deter people from drinking it, contact can occur through swimming, canoeing, or other recreational activities. Basic information on algae and cyanobacteria, and its affect on water quality can be found at[1]: http://www4.agr.gc.ca/AAFC-AAC/displayafficher.do?id=1189714026543&lang=eng.

Additional information on these pathogens: Information on *Cryptosporidium*, *E.coli*, *Campylobacter*, algae, *Giardia*, *Heliocobacter pylori*, *Legionella*, *Shigella*, viruses, and multiple other water quality components can be found at[38]: http://www.safewater.org/resources/fact-sheets.html.

## Microbial Water Quality in the South Saskatchewan River Basin

There are only two monitoring stations in the Alberta portion of the South Saskatchewan River. One is located just upstream of Medicine Hat (Station #AB05AK0020) and there is a downstream site where Highway 41 crosses the river just west of the Alberta-Saskatchewan border (Station #05AK001). The former is monitored by Alberta Environment and the latter by

the Prairie Provinces Water Board (PPWB), an arm of Environment Canada. The data from the Environment Canada site are more limited and not all of the same parameters are monitored. These two sampling sites (Figure 2) help to define the two reaches of the South Saskatchewan River defined by Alberta Environment.[14]

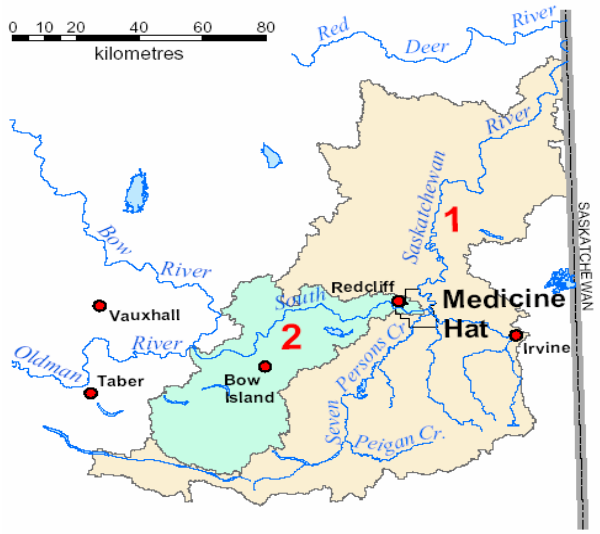


**Figure 2.** Reaches of the South Saskatchewan River Sub-basin.[14]

As summarized in Figure 3, bacterial water quality in the South Saskatchewan River upstream from Medicine Hat was rated good in 2005-06. Conditions improved in the subsequent year to excellent (Figure 3). Municipal effluent from Medicine Hat has had a relatively small impact on the South Saskatchewan River, as the flow discharged is relatively small and there is a high rate of dilution.[14] Although it is not regularly monitored, in 2003 water quality met all the objectives of the PPWB at this site and there were few exceptions in previous years.[14] However, algae growth has been occasionally reported in downtown Medicine Hat during low flows in early spring, due to thermal impacts of discharge from a thermal generating station, upstream of the gauging station.[14] Recent data for bacterial water quality can be found at: 2005-2006[18] http://www3.gov.ab.ca/env/soe/water_indicators/22_bacterial_index.html and 2006-2007[13] and http://environment.gov. ab.ca/info/library/7716.pdf.

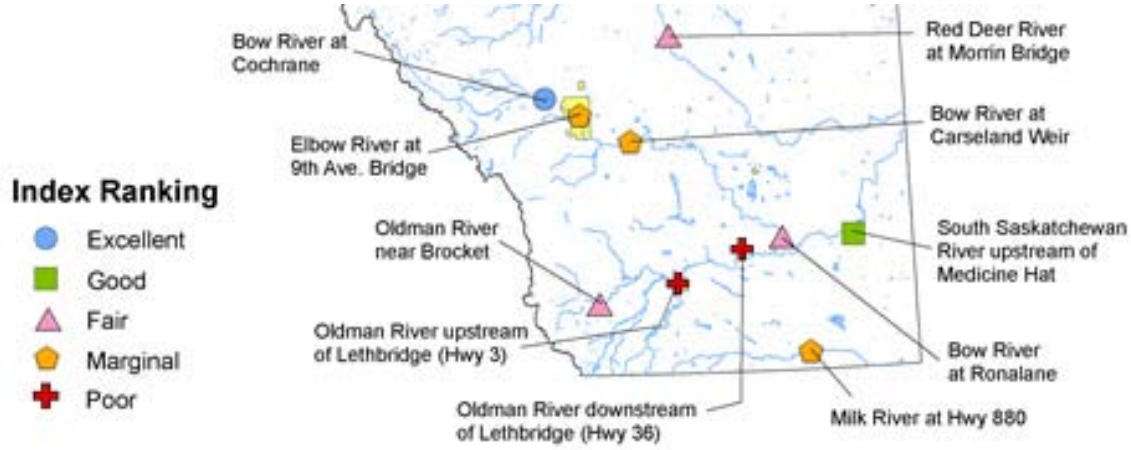


**Figure 3.** Bacterial water quality in the South Saskatchewan River Basin from 2005-2006.[18]

The reaches of the South Saskatchewan River were in better condition than the lower reaches of either the Bow or the Oldman rivers, at least during 2005-07. This is due to the increased flow of the two rivers combined and the ability of one of the sub-basins to provide water when the other might be in a period of low discharge.[53] The water quality in the South Saskatchewan River also ranks higher than the Red Deer Sub-basin, although there is a small amount of effluent from the city of Red Deer.[21 18 12] Significant sources of pathogens to water

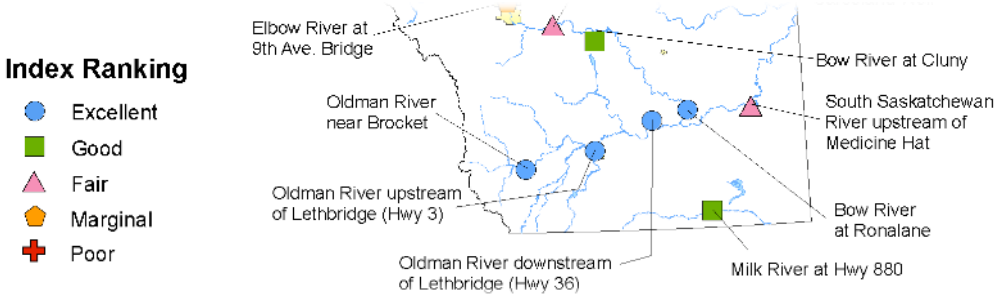


**Figure 4.** Bacteria water quality in the South Saskatchewan River Basin in 2006-2007.[12]

bodies can include: sediment and nutrient inputs from runoff, manure applied to crops or accumulating around areas where livestock are confined, livestock accessing water bodies to drink, waste from domestic pets in city parks, flocks of waterfowl, and wastewater treatment plant lagoons.

The number of microorganisms found in surface water can be influenced by climate. Climatic events such as thunderstorms may cause significant overland flow, raising the overall contribution of runoff to rivers and other surface waters. As it travels, the runoff may collect bacteria, as well as other contaminants, which are then integrated to the receiving river. This was evident in 2005, when excessive run-off due to rainfall decreased water quality in the South Saskatchewan River (Figure 3).[18] As a result of this, water quality improved through 2006-2007 (Figure 4).[12]

Direct release of human sewage from leaking septic systems, overflowing lagoons during floods, and cross-connections between the storm water and sanitary sewage systems can also lead to localized wastewater-related problems[15]. Due to the improper treatment of wastewater in this manner, and the presence of pathogens can be an indicator of the overall health of a watershed habitat.[16]

Recent data for *Giardia* and *Cryptosporidium* in Medicine Hat indicate that occasional spikes may occur during the summer months which correspond to periods of increased animal and human activity as well as seasonal runoff (Figures 5 and 6).[40] The concentrations of these parasites are within the normal range for large river systems in Canada and not all of them are pathogenic to humans. *Giardia* infections are usually cleared without treatment from healthy people within a month. Anti-parasitic drugs (the most common in Canada is metronidazole) are available and are particularly helpful to immunocompromised people in whom the illness could otherwise develop into a persistent state. *Cryptosporidium* is similar; it will usually disappear from healthy people within a month but there is no specific drug treatment. Anti-diarrheal drugs and rehydration therapy may be used if diarrhea becomes severe.[27]

## Agricultural Runoff

Agricultural runoff is a significant source of pathogens to surface water and, together with loadings from other non-human sources, can exceed loadings from wastewater treatment plants, especially when enhanced treatment has drastically reduced loadings from these facilities. The report *Watershed Selection for the AESA Stream Water Quality Monitoring Program*, presents the agricultural intensity of the South Saskatchewan River Sub-basin, as well as throughout Alberta[23]. The Agricultural Intensity Index (AII) is the relative ranking of watersheds based on manure production, fertilizer use and agrochemical use, per unit area, based on 2001 Census of Agriculture. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/aesa5832/$FILE/watershedselection.pdf. Livestock, especially beef cattle have been pinpointed as a large source of microorganisms, such as *E.coli* and *Salmonella*.[25] Run-off from these areas may contaminate additional sources of water, including groundwater.[25] The surface water quality risk for agricultural practices in Alberta can be found at[6]: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex10338. It is also suggested that

leaving cattle in fields over winter (overwintering) in livestock operations can also have an effect on water quality, causing the accumulation of microorganisms[5]: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/wat3349.

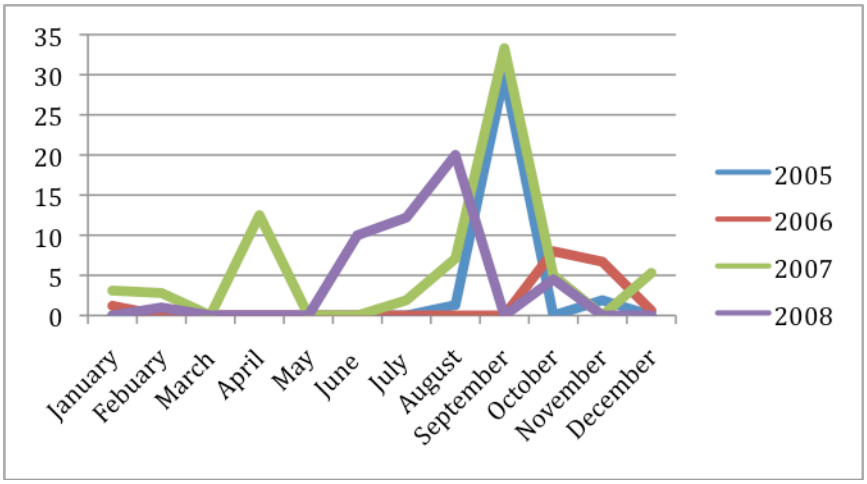


**Figure 5.** *Giardia* cysts in the South Saskatchewan River at Medicine Hat (#s/100L).[40]

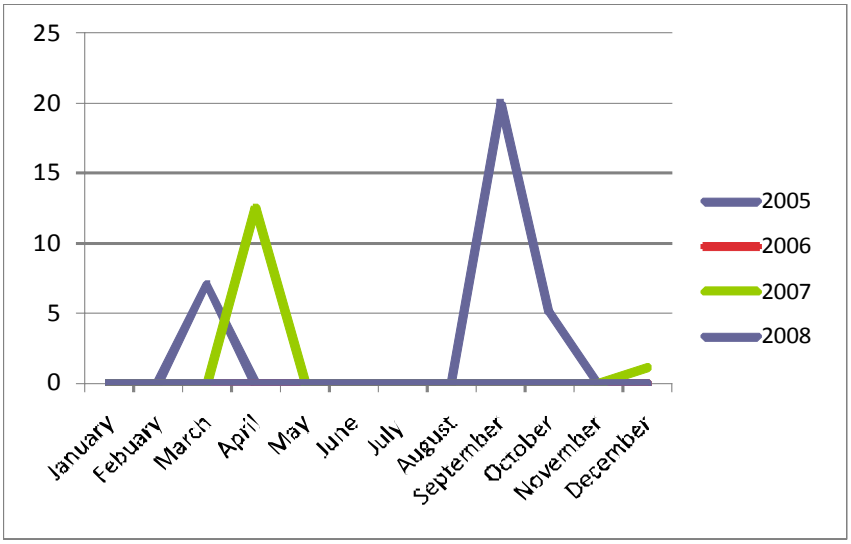


**Figure 6.** *Cryptosporidium* oocysts in the South Saskatchewan River at Medicine Hat (#s/100 L).

## Water Treatment

Water is treated to Alberta Government standards in order to protect the health of the public. There are specific treatments for pathogens, bacteria, viruses, and various activities. In the SSRSB, there are two locations for raw water quality sampling, including nutrients, pesticides, chemicals, as well as microorganisms. Station #AB05AK0020, upstream of Medicine Hat, is monitored by Alberta Environment, and #05AK001, at Highway 41, along the Alberta-Saskatchewan Border, monitored by the PPWB under Environment Canada[17]. Reach #1 of the SSRSB is monitored by the PPWB, while Alberta Environment, under the Long-Term River Network (LTRN) (Appendix, Figure 1.5), monitors #2. [14]

Various treatment methods can be used to prepare raw surface water for drinking. These methods include boiling, chlorination, iodination, and filtration. A description of these methods and their effectiveness can be found at[31]: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/outdoor-plein_air-eng.php. Water must also be properly treated for agricultural practices http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1187637343829&lang=eng and http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1195479971027&lang=eng.[2] The amount of treatment occurring in rural areas varies. It is estimated that 53% of dugouts in Alberta do not meet water quality guidelines, compared with 7% of wells. In Saskatchewan, about 25% of farms use carbon filtration for domestic water, 25% used carbon filtration with chlorination (for bacteria and parasites) and 50% use no treatment.[26] Additional information on this can be found at: http://www.ec.gc.ca/soer-ree/English/SOER/1996report/Doc/1-6-4-4-2-3-1.cfm.

Waterborne diseases caused by bacteria, viruses, and protozoa are the most common health hazards associated with drinking water (and recreational waters) in Canada, resulting in illnesses and economic impacts on local communities. [27] Threats to water quality as detailed by Environment Canada can be found at http://www.ec.gc.ca/INRE-NWRI/default.asp?lang=En&n=235D11EB-1&offset=2&toc=show#tre. [28] Municipalities treat and disinfect water used for drinking; thus, widespread outbreaks of waterborne infections are rare. Even so, isolated incidents of microbial contamination of drinking water in Canada from Combined Sewer Outflows, storm water, and inadequately treated sewage have been reported.[29] These are usually associated with either poorly functioning water treatment facilities, or, the complete lack of such facilities from a dependence on good-quality raw water.

Waters in the great Canadian outdoors are generally of good quality, but to ensure an enjoyable experience, users should be prepared to boil or disinfect all drinking water. Filtration prior to disinfection will provide additional protection. No surface water can be considered safe for human consumption without treatment. Even the cleanest looking spring water could be polluted. Untreated water may be contaminated with bacteria, viruses and protozoa. Well water, fast-moving rivers and the deepest parts of lakes are the best locations to obtain water. Users should avoid stagnant water, shoreline water, and water close to human habitations and campsites. Even in winter, all water should be purified. During the winter, it is best to use an open water source or obtain water through a hole in the ice. Eating snow or ice directly can lead to stomach cramps and headaches. Coloured snow may indicate the presence of algae that could cause diarrhea if ingested.[31] Health Canada has indicated that the true incidence of waterborne diseases is likely much higher than reported, as the majority of cases involve mild, flu-like symptoms that do not require medical treatment.[27] http://www.ec.gc.ca/soer-ree/English/soer/MWWE1.cfm.

**Recreational Water**

Current federal guidelines for recreational water quality suggest that only between 1 and 2% of recreational water users would be at risk of gastrointestinal illness by bacterial pathogens. Nevertheless, outbreaks of illness linked to these parasites in drinking water can occur.[32] The risk associated with common pathogens can be found at http://www.health.alberta.ca/documents/ND-Enteric-Transmission.pdf.[67] Enteric disease rates for 2007 can be found at: http://www.health.alberta.ca/documents/Trends-2007-communicable.pdf, and throughout Canada incidence of pathogenic disease by province: http://dsol-smed.phac-aspc.gc.ca/dsol-smed/ndis/index_e.html.[65]Accidental exposures to cyanobacteria may also occur during recreational activities, such as swimming, canoeing, and sailing. More information is available at http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/outdoor-plein_air-eng.php. [31] Beaches may be closed by local authorities when

contaminant levels exceed guideline thresholds and remain closed, often for several days, until contaminant levels have returned to safer values. http://www.ec.gc.ca/soer-ree/English/soer/MWWE2.cfm.[27]

## Examples of Waterborne Disease Outbreaks

During May 2000, a serious threat was osed to the community of Walkerton, Ontario as the water supply became contaminated with *E. coli* 0157:H7. The water supply became contaminated by farm run-off to an adjacent well that was known to be vulnerable to contamination. Many residents of the town of approximately 5,000 began to simultaneously experience bloody diarrhea, gastrointestinal infections, and other symptoms of *E. coli* infection. At least seven people died directly from drinking the E*. coli* contaminated water, and about 2,500 became ill. Further information is available at http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/00vol26/dr2620eb.html.

Similarly, in April 2001, *Cryptosporidium parvum* was suspected of being the causative organism in the outbreak after several laboratory-confirmed cases were identified in North Battleford, Saskatchewan. An estimated 5,800 to 7,100 people from the North Battleford area were affected, along with hundreds of visitors from other parts of Saskatchewan, Alberta, Manitoba, and British Columbia. Two weeks before the outbreak, the sludge blanket in the Water Treatment Plant clarifier was replaced and difficulties were experienced in re-establishing effective treatment. The sewage treatment plant outfall for the North Battleford is located 2 km upstream of the raw water intake on the North Saskatchewan River. Analysis of treated drinking water revealed the presence of both *Giardia* and *Cryptosporidium*. 'Treated" sewage entering the river contained up to 12,000 cyts/L during early May but the concentration declined to low levels by the middle of the month. A maximum concentration of 25,000 *Giardia* cysts/L was observed in the third week of May. *Giardia* continued to be detected in raw water long after *Cryptosporidium* could no longer be detected. DNA analysis showed that the *Cryptosporidium* and *Giardia* cysts present in raw sewage were of human, not animal origin. The original source of parasites could not be identified but raw water was certainly contaminated by the sewage treatment plant discharge upstream of the drinking water intake during the outbreak. [24 37 41]

## Conclusion

Continual water monitoring in the sub-basin is used to maintain the quality of water present. In addition, influential agricultural and industrial practices are closely monitored. These practices can contribute immensely not only to the bacterial water quality index, but the overall surface water quality index.[18] Several government, industry, and stakeholder groups monitor surface water quality in the South Saskatchewan River Sub-Basin. Alberta Environment programs conduct extensive water quality testing through the Long-Term River Network, the River Quality Index, and the monitoring of lakes. Alberta Environment works along with the South East Alberta Watershed Alliance (SEAWA), the County of Forty Mile, and Cypress County to maintain a high level of water quality. [14] Future water quality in these reaches of the South Saskatchewan River will likely depend on the monitoring of water quality, dilution rates, and the influence of the Oldman and Bow Rivers. [25 18]

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## GLOSSARY

Algae - aquatic, photosynthetic organisms, ranging in size from single-celled forms to the giant kelp. Algae were once considered to be plants but are now classified separately because they lack true roots, stems, leaves, and embryos. Algae are not a proper taxonomic group but include members from the Kingdoms Plantae, Protozoa and Monera (bacteria).

Carbon filtration- a method of filtering that uses a piece of carbon to remove contaminants and impurities, using chemical adsorption. Each piece of carbon is designed to provide a large section of surface area, in order to allow contaminants the most possible exposure to the filter media. Carbon filtration is widely used to remove objectionable tastes and odours from water.

Combined Sewer Overflow - A combined sewer outflow is a type of sewer system that provides partially separated channels for sanitary sewage and storm water runoff. This allows the sanitary sewer system to provide backup capacity for the runoff sewer when runoff volumes are unusually high, but is vulnerable to combined sewer outflow discharges during peak rainfall events

*Cryptosporidium* – a single celled protozoan that infects and inhabits the digestive tract of animal species and humans. In humans, it can cause a diarrhoaeal illness called cryptosporidiosis. It is passed via the faecal-oral route by contaminated hands, food or water, human-human contact and human-animal contact. Filtration, ultraviolent light and ozonation are the most effective methods of water treatment; *Cryptosporidium* oocysts are highly resistant to chlorination.

Cyst - A small capsule like sac that encloses certain organisms in their dormant or larval stage. Cysts produced by infectious agents such as *Giardia* can be highly resistant to environmental stress and chemical disinfectants. They are produced asexually in contrast to eggs which require the fusion of sperm and egg.

Gastrointestinal – the digestive tract, which uses a system of organs to digest food

*Giardia* – Single- celled protozoa that infect and inhabit the digestive tract of humans and animal species.

Immunocompromised - having no or a poor immune response, to certain diseases

Protozoan - a group of single-celled microscopic organisms. Protozoa are passed by ingestion of food contaminated with infected feces; this can be prevented by hand washing and stool precautions.

Oocyst – Like a cyst but the product of a partially sexual life cycle. *Cryptosporidium* produces highly resistant oocysts.

Viruses – a microscopic infectious agent that can only reproduce inside a host cell.

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South East Alberta Watershed Alliance
721 97 Carry Drive SE
Medicine Hat, Alberta, Canada T1B 3M6

**www.seawa.ca** **403.488.8110**

The **South East Alberta Watershed Alliance (SEAWA)** was formed in 2007 and incorporated as a non-profit society in 2008. SEAWA is the designated WPAC (Watershed Policy and Advisory Council) for South East Alberta. SEAWA Members include interested individuals throughout the watershed along with our communities, ranchers, farmers, industries, companies, governments, conservation groups and educational institutions.

**SEAWA Vision:** *A healthy watershed that provides balance between social, environmental and economic benefits.*

**SEAWA Mission:** *South East Alberta Watershed Alliance brings together diverse partners to plan and facilitate the sustainable use of the South Saskatchewan River Watershed for present and future needs.*

SEAWA has over two hundred members and encourages new individual and community sector members. We are proud to include the following among our founding members:

*Government Sector:* Alberta Government, City of Medicine Hat, Government of Canada, Cypress County, Palliser Health Region, Town of Redcliff, Town of Bow Island, and Special Areas Board.

*Land Resource - Industry and Agriculture Sectors:* St Mary River Irrigation District, Murray Lake Ranching, GG Bruins Farms, Short Grass Ranches, Canadian Fertilizers Limited, Redcliff Technology Enterprise Centre, Box Springs Business Park, and Canadian Centre for Unmanned Vehicles.

*Academic, Research and Non-Governmental Organizations Sectors:* Medicine Hat College, Alberta Research Institute, Red Deer Watershed Alliance, and Hyperion Research.

*Tourism and Conservation Sectors:* Grasslands Naturalists, Canadian Badlands, and Medicine Hat Interpretive Program.

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