Wasa Lake Ground Water Quality Assessment

BC Ministry of Water, Land and Air Protection
Kootenay Health Protection – Interior Health

Introduction

Ground water is an essential and vital resource for many residents of British Columbia and provides numerous households with water for drinking and washing. However, as ground water is not readily visible, it remains a hidden resource whose value is not well understood or appreciated. In recent years, events affecting ground water quality have heightened public awareness and concern about the importance and vulnerability of the resource.

Ground water exists almost everywhere within the ground, but some areas contain more water than others. The water table is the level below which all spaces in the soil are filled with water. The region below the water table is called the saturated zone. An aquifer is ground water that produces useful quantities of water when tapped by a well *(Figure 1)*.

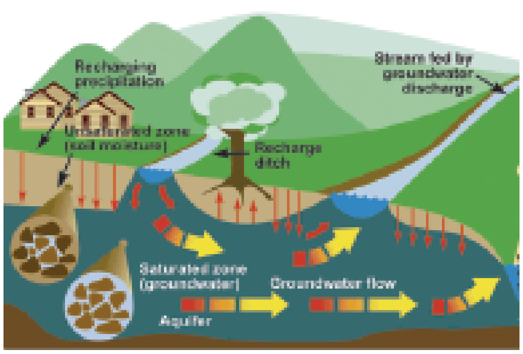

Figure 1. Example of typical ground water flow[1].

Ground water quality is influenced by natural factors such as local geology, climate, and hydrology. Ground water quality can also be affected by human activities. Any addition of undesirable substances to ground water caused by human activities is considered to be contamination.

Some sources of potential contamination are:

- Fertilizers and pesticides on agricultural land
- Livestock wastes
- Leaking septic systems
- Fuel storage tanks
- Runoff of salt and chemicals from roads and highways

Soil particles slow and reduce transport of most of these contaminants, which is why ground water is generally considered a safer drinking water source than surface water.

What is being done in BC to protect ground water quality?

In 1994, the BC government established an aquifer classification system to inventory and prioritize aquifers for planning, management and protection of the Province's ground water resource. This system classifies aquifers based on development, vulnerability to contamination, and importance of the aquifer. The highest designation of IA means the aquifer is vulnerable to contamination from surface sources and has a high water demand relative to availability. Within the Kootenay Region, two aquifers received the IA designation **(Jaffray and Wasa)**.

The provincial ambient ground water monitoring network was expanded in 2003 to monitor more IA aquifers in BC. As a result, a comprehensive ground water quality monitoring program of both the Jaffray and Wasa aquifers was undertaken in 2003/2004.

The Wasa IA Aquifer

Wasa is a quiet cottage community in the Kootenay River Valley on Highway 93/95, approximately 35 km north of Cranbrook. The community is comprised of summer cottages, permanent homes, small businesses, a provincial park, and campgrounds.

1 Adapted from Environment Canada. 2004. Freshwater Website. Updated June 8, 2004. http://www.ec.gc.ca/water/en/nature/grdwtr/e_gdwtr.htm

The community relies on ground water from the Wasa aquifer to supply domestic water. The ground water in Wasa is partially influenced by upland drainage. However during periods of increased stream flow caused by runoff from rain or snowmelt, known as freshet, the major contributing factor to water quality and ground water levels appears to be the Kootenay River.[2]

Wasa is located in the South Rocky Mountain trench, which is filled to varying depths with permeable glacial sediments that are comprised predominantly of loose sand and gravel.[3] Because the Wasa aquifer is made up of these permeable materials, the ground water is able to move freely through the openings between the individual soil particles. This may make the aquifer vulnerable to contaminants from septic systems or introduced through surface infiltration of rainfall and snowmelt, as water percolating into the ground to recharge the ground water can dissolve and transport different substances *(Figure 2)*.

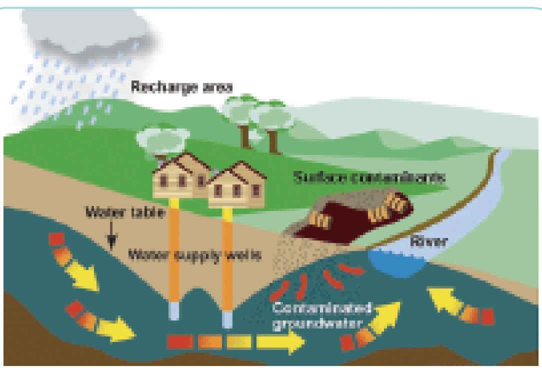

Figure 2. Example of contaminants infiltrating surface soils to ground water[1].

Study Overview

The Wasa ground water quality study was developed by the Environmental Quality Section of the Ministry of Water, Land and Air Protection (WLAP). During the study design, specific risks to water quality within the community of Wasa were evaluated to determine which variables should be analyzed in each ground water sample and which wells should be included in the study.

How were sites selected?

Five residences were selected around Wasa Lake. The study area is shown in *Figure 3*. Wells were selected based on:

- availability of "raw" untreated water
- proximity to likely contamination sources
- spacing to provide reasonable coverage of the study area
- ability to access the well when no one is home (e.g., outdoor taps)

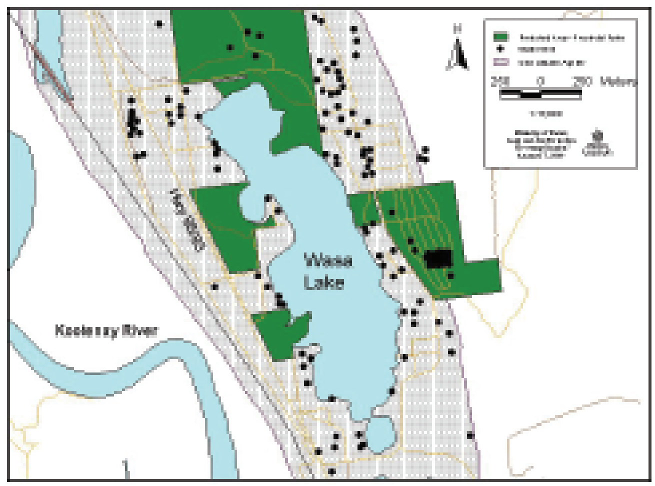

Figure 3. Wasa Lake and the Wasa 1A aquifer.

How were water samples collected?

Water samples were collected in plastic bottles at outside faucets and/or indoor taps that had no water treatment. Taps were flushed for several minutes prior to collecting samples to ensure the samples did not contain substances that may leach from plumbing systems. Samples were then placed in coolers with ice and were shipped the same day to specialized water testing laboratories (PSC Analytical Laboratories, Cantest Ltd., and JR Laboratories).

2 BC Ministry of Environment. 1987. Wasa Lake. Water Management Branch, Nelson, BC.
3 BC Hydro. 1977. Kootenay River Diversion Project Preliminary Engineering Assessment. Hydroelectric Design Division, Report No 813.

When were water samples collected?

Water sampling was done over a seven month period. Samples were collected on:

- September 10, 2003
- October 15, 2003
- November 18, 2003
- December 22, 2003
- February 11, 2004
- March 8, 2004

What are safe levels?

WLAP and Health Canada publish drinking water quality guidelines[4,5] which identify substances that have been found in drinking water and are known or suspected to be harmful. The guidelines help to protect the health of Canadians by establishing maximum acceptable concentrations that can be permitted in water used for drinking. The guidelines also provide several aesthetic objectives for drinking water, which may give an unpleasant appearance, taste and odour if the substance is found at concentrations above the guideline.

What were the samples tested for and what were the results?

The results for the entire study are summarized in *Table 1.*

General Parameters: Water samples were tested for parameters that are useful to characterize general properties, including alkalinity, pH, turbidity, conductivity, chloride and fluoride. All general parameters were within available drinking water quality guidelines.

Nitrogen: Samples were tested for different chemical forms of nitrogen, including ammonia, nitrate, and nitrite, which can be introduced into ground water from septic disposal or agriculture (chemical fertilizers, animal wastes). Nitrate is the most common form of nitrogen found in ground water. All levels of nitrogen were below available drinking water quality guidelines.

Total metals: Samples were tested for total metals. Metals occur naturally in ground water at different concentrations based on the geologic properties of the surrounding rocks and soils. Higher concentrations of metals in ground water may occur due to human activities such as mining or industry. In addition, lead and copper are sometimes found in drinking water. These metals are not usually elevated within the ground water, but get into the water by leaching out of pipes and soldered joints. All metals were below available drinking water quality guidelines.

Hydrocarbons: Samples were also tested for hydrocarbon contamination on November 18, 2003 only. The analyses included benzene, toluene, ethylbenzene and xylenes (known as BTEX), methyl tertiary-butyl ether (known as MTBE), and aromatic and volatile petroleum hydrocarbons. Common sources of these compounds include leaking underground storage tanks, spills from gasoline storage sites, and stormwater runoff from roads. All samples had undetectable levels of hydrocarbons and were below available drinking water quality guidelines.

Bacteria: Samples were tested for indicators of fecal contamination, including total and fecal coliforms, *Escherichia coli (E. coli)*, and *Enterococcus.* These micro-organisms exist in the intestines of warm blooded animals and are found in wastes. They are used as indicators to verify the safety of drinking water as their presence suggests that other enteric pathogenic microorganisms could also be present. Note that total coliform bacteria may occur naturally in soil, vegetation and water, in addition to feces. This means total coliforms are less reliable indicators of fecal pollution than specific fecal coliform bacteria, such as *E. coli* or *Enterococcus.*[6]

Of these bacteria, *E. coli* often receive the most attention, particularly in light of the Walkerton tragedy. *E. coli* is the predominant species within the fecal coliform group of bacteria. It is generally the most sensitive to environmental stresses and only occurs in the digestive tract of humans and warm-blooded animals[6]. Therefore, *E. coli* is a definitive indicator of recent fecal contamination of water.

4 BC WLAP. 2001. British Columbia Approved Water Quality Guidelines (Criteria) 1998 Edition. Updated: August 24, 2001. *http://wlapwww.gov.bc.ca/wat/wq/BCguidelines/approved.html#1*
5 Health Canada. 2003. Summary of Guidelines for Canadian Drinking Water Quality. *http://www.hc-sc.gc.ca/hecs-sesc/water/pdf/summary.pdf*
6 Health Canada. 1988. Bacteriological Quality. Updated January 2002. *http://www.hc-sc.gc.ca/hecs-sesc/water/publications/bacteriological_quality/toc.htm*

Drinking water quality guidelines state that no sample should contain coliform bacteria. None of the Wasa samples had positive results for *E. coli*, *enterococcus*, or fecal coliforms which, if present, indicate recent fecal contamination. However, 5 of 29 samples contained low levels of total coliform, ranging from 1 to 18 Colony Forming Units (CFU) per 100 ml. While the origin of total coliforms in these samples is unknown, some members of the group may be of fecal origin. The presence of total coliforms in well water samples in the absence of other fecal bacteria may indicate that the Wasa aquifer is prone to surface water infiltration and may therefore be at risk of fecal contamination.

Consequently, it is recommended that residents of Wasa consider using some type of water disinfection system to treat their drinking water.

It should be noted that contamination is often intermittent and may not be revealed by the examination of a single sample. A bacteriological water analysis shows only that at the time of examination, bacteria indicating fecal pollution did or did not grow under laboratory conditions from the sample of water tested.

How do we know the data is valid?

As part of the Wasa ground water study, quality control (QC) samples were collected to check for external contamination of water samples and confirm the accuracy of the data. Two samples containing only deionized water *(field blanks)* were submitted to the laboratory to ensure that samples were not contaminated in the field or at the laboratory. In addition, two samples were collected from some residences and submitted to the laboratory as separate samples to examine the variability of water quality and the accuracy of the lab *(field replicates)*. The QC results found sample contamination and variability among the field replicates did not affect study conclusions.

Are there any risks to health?

The results of this study suggest that the Wasa aquifer may be vulnerable to contamination from surface sources. The risk of contamination is probably greatest during spring thaw or heavy rainfall events.

What can be done to ensure drinking water is safe?

Just because you are not getting sick does not mean that your well water is safe. Residents using the aquifer as a drinking water source can contact the local Health Protection Office of Interior Health for advice on disinfecting their drinking water. In general, water from wells that are vulnerable to contamination should be disinfected for drinking purposes. Some options are:

- boil water for drinking
- use bottled water
- install disinfection equipment such as ultra violet filter units

Are there laws to protect drinking water?

The *Drinking Water Protection Act* came into force in May 2003. This legislation provides a detailed and comprehensive framework for drinking water protection. Most of the legislation will be administered by the BC Ministry of Health Services and the Regional Health Authorities (Interior Health). However, WLAP shares some responsibility for protecting water quality through the management and regulation of some activities in watersheds that have the potential to affect water quality.

Ground Water Protection Regulations were passed under the provincial *Water Act* in July 2004. The regulations are an integral part of the Province's Action Plan for Safe Drinking Water, which attempts to protect water from the source to the tap. The new regulations address the risk of ground water contamination by establishing standards to ensure wells are properly drilled, sealed, maintained and closed. The regulations also require larger drinking water supply wells to be flood-proofed so run-off contamination cannot occur during flooding or heavy rains.

Table 1. Summary of water quality from five wells supplied by the Wasa aquifer sampled September 2003 - March 2004

PARAMETER	UNITS	DWG	TOTAL # SAMPLES	MINIMUM	MAXIMUM	AVERAGE	90th PERCENTILE
Bacteriology							
Fecal coliform	CFU/100mL	0	19	< 1	< 1	< 1	< 1
Total coliform	CFU/100mL	0*	29	< 1	**18**	**2**	**4**
E. coli	CFU/100mL	0	29	< 1	< 1	< 1	< 1
Enterococci	CFU/100mL	0	19	< 1	< 2	< 2	< 1
General							
pH	pH units	6.5 to 8.5§	29	8.1	8.3	8.2	8.3
Specific Conductance	µS/cm	700	29	312	572	483	565
Turbidity	NTU	1	29	< 0.10	0.48	0.16	0.25
Alkalinity **(total)**	mg/L	-	29	203	250	228	245
Dissolved Anions							
Chloride	mg/L	250§	29	2.7	8.9	5.8	7.8
Fluoride	mg/L	1.5	29	0.05	0.14	0.08	0.12
Dissolved Nitrogen							
Ammonia	mg/L	-	29	< 0.005	0.034	0.007	< 0.005
Nitrate	mg/L	10	29	0.14	0.72	0.33	0.70
Nitrate + Nitrite	mg/L	-	29	0.136	0.722	0.335	0.707
Nitrite	mg/L	3.2*	29	< 0.002	0.006	0.003	0.004
Total Metals							
Aluminum **(Al)**	µg/L	100	29	0.5	3.4	1.3	2.0
Antimony **(Sb)**	µg/L	6	29	0.021	0.057	0.032	0.042
Arsenic **(As)**	µg/L	25	29	0.1	0.8	0.3	0.5
Barium **(Ba)**	µg/L	1000	29	60.2	90.1	75.8	86.4
Beryllium **(Be)**	µg/L	-	29	< 0.02	0.04	0.02	< 0.02
Bismuth **(Bi)**	µg/L	-	29	< 0.02	< 0.02	< 0.02	< 0.02
Cadmium **(Cd)**	µg/L	5	29	< 0.01	0.03	0.01	< 0.02
Chromium **(Cr)**	µg/L	50	29	< 0.2	10.4	3.2	7.9
Cobalt **(Co)**	µg/L	-	29	< 0.005	0.219	0.042	0.213
Copper **(Cu)**	µg/L	1000§	29	1.15	47.2	12.1	35.4
Lead **(Pb)**	µg/L	10	29	0.03	7.60	0.79	2.10
Lithium **(Li)**	µg/L	-	29	4.53	10.70	6.30	7.83
Manganese **(Mn)**	µg/L	50§	29	0.016	1.170	0.364	0.789
Molybdenum **(Mo)**	µg/L	250	29	0.70	1.47	0.94	1.12
Nickel **(Ni)**	µg/L	-	29	< 0.05	1.46	0.34	1.08
Selenium **(Se)**	µg/L	10	29	< 0.2	0.4	0.2	0.3
Silver **(Ag)**	µg/L	-	29	< 0.02	0.44	0.03	< 0.02
Strontium **(Sr)**	µg/L	-	29	235	350	301	335
Thallium **(Tl)**	µg/L	2	29	< 0.002	0.039	0.006	0.011
Tin **(Sn)**	µg/L	-	29	< 0.01	3.14	0.21	0.36
Uranium **(U)**	µg/L	100	29	2.74	3.81	3.19	3.49
Vanadium **(V)**	µg/L	-	29	< 0.06	3.06	0.96	2.34
Zinc **(Zn)**	µg/L	5000§	29	2.8	64.2	13.2	33.2

NOTES

1. Drinking Water Quality Guidelines (DWG) maximum acceptable concentration from BC WLAP (2001)[4] for raw untreated water, unless otherwise noted. (*) = Health Canada DWG[5], (§) = aesthetic objective.
2. Bold values exceeded DWG.
3. 90th Percentile = 90% of all samples less than this value.

Study Conclusions

This study found water quality in the Wasa aquifer is generally within the normal and accepted range of ground water and available drinking water quality guidelines. However, the presence of total coliform bacteria in some samples may indicate that the aquifer is vulnerable to contamination from surface sources. Residents using the aquifer as a drinking water source should seek advice from the Kootenay Health Protection office of Interior Health for water treatment options.

Contacts

For further information on this study, please contact:

Jolene Raggett, Impact Assessment Biologist
Environmental Quality Section
Environmental Protection Division
Ministry of Water, Land and Air Protection
Phone: (250) 354-6355

If you would like specific information regarding health issues and/or options for treating drinking water, please contact:

Dan Byron, Drinking Water Officer
Kootenay Health Protection, Interior Health
Phone: (250) 420-2220

Further Information

General information on ground water in BC
http://wlapwww.gov.bc.ca/wat/gws/gwis.html
http://www.healthservices.gov.bc.ca/protect/water.html

Health Canada's drinking water guidelines
http://www.hc-sc.gc.ca/hecs-sesc/water/pdf/summary.pdf

Well Protection Toolkit
http://wlapwww.gov.bc.ca/wat/gws/well_protection/acrobat.html
or contact the Water Protection Section
at (250) 387-9932

Canadian Ground Water Association
www.bcgwa.org

BC Ground Water Protection Regulation
http://wlapwww.gov.bc.ca/wat/gws/gws_reg_back/back.html

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