Rainbow Creek Water Supply:
Source Water Characteristics

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Introduction

In British Columbia, drinking water quality is becoming a significant public issue. We all want to have confidence in the quality of the water we consume. Its protection is also important to local purveyors, who act as our water suppliers, and to provincial government ministries responsible for water management. Within the Omineca-Peace region of B.C., our most common potable source per capita is ground water, although many communities do make use of rivers, streams or lakes. Our basic drinking water quality is determined by a number of factors including local geology, climate and hydrology. In addition to these, human land use activities such as urbanization, agriculture and forestry, and the pollution they may cause, are becoming increasingly important influences. Environmental managers have a responsibility to control land use development so as to minimise the effects of these activities on source water quality.

The province's Drinking Water Protection Act, enacted in October, 2002, places the responsibility for drinking water quality protection with the B.C. Ministry of Health and local water purveyors. However, through the B.C. Environmental Management Act, the British Columbia Ministry of Environment (MOE) is responsible for managing and regulating activities in watersheds that have a potential to affect water quality. Accordingly, the Ministry plans to take an active role in protecting drinking water quality at its source.

MOE implemented a raw water quality and stream sediment monitoring program at selected communities in the Omineca-Peace region in 2002. Community sites were selected using a risk assessment process that considered:

- whether the source supply was surface water or ground water,
- the level of water treatment used,
- the population size served,
- the potential for upstream diffuse and point-source pollution,
- the availability of current, high-quality and representative data on each raw water source,
- whether past outbreaks of waterborne illness had been reported,
- the ability/willingness of local purveyors to assist with sampling.

Through this process and with available funding, 18 community water supplies in the Omineca-Peace region were selected for monitoring during 2002/03, with four or more sites being selected each subsequent year.

This brief report will summarise water quality data collected from Rainbow Creek. There are 23 domestic water licenses on Rainbow Creek, as well as one trailer park (Figure 1). The data are compared to current Canadian drinking water quality guidelines meant to protect finished water. This comparison should identify parameters with concentrations that represent a risk to human health. It is intended that this process will lead to the identification of human activities responsible for unacceptable source water quality, and that it will assist water managers to develop measures to improve raw water quality, where needed.

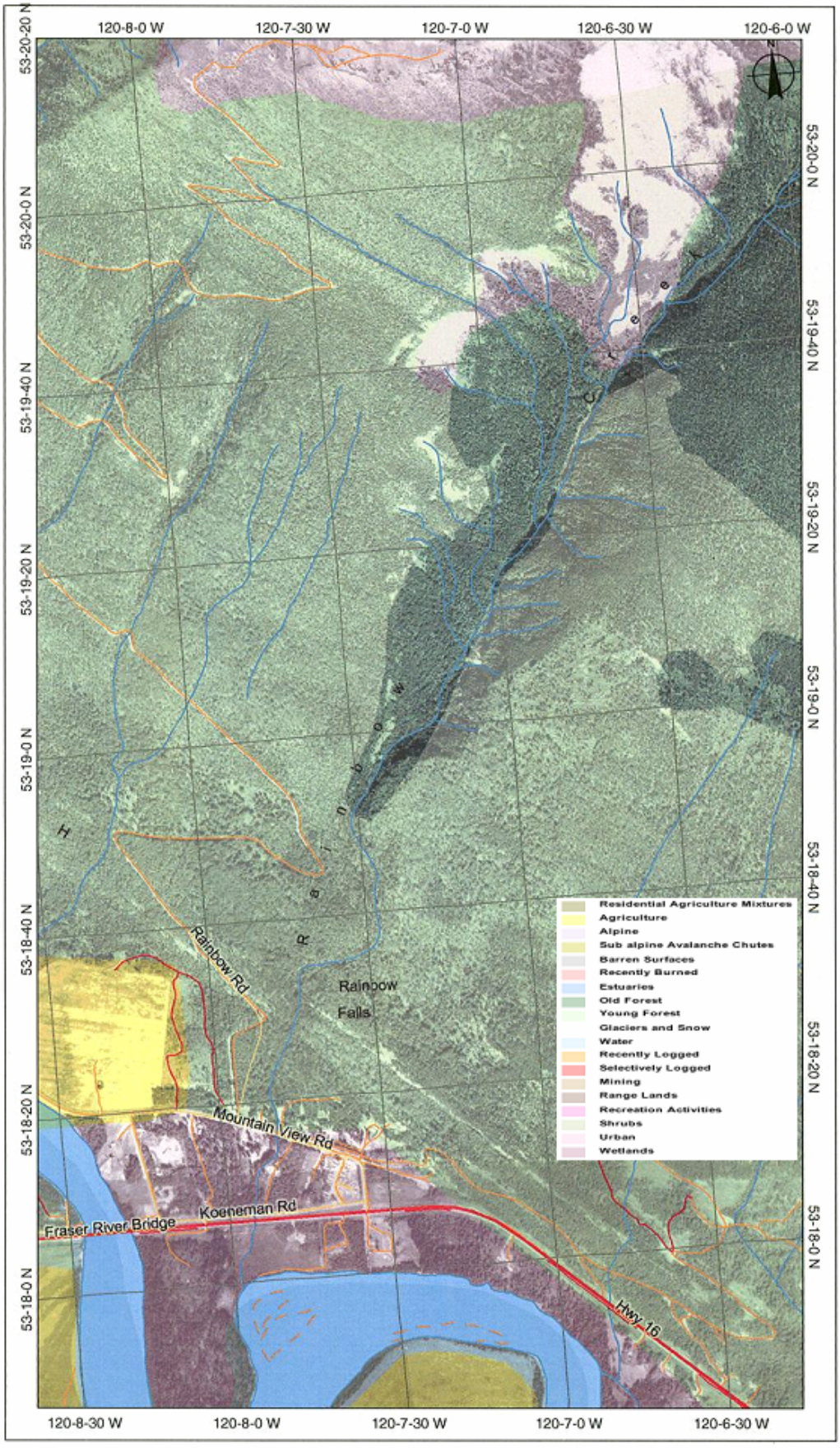

Figure 1. Rainbow Creek Watershed. Samples were collected at the Koeneman Road crossing. The map scale is 1:20,000.

Site Description

Watershed Overview

Rainbow Creek is located less than 2km east of McBride. It is a small 4th order stream that drains a southwestern slope of the Rocky Mountain Trench. Rainbow Creek lies within three biogeoclimatic zones, including the Engleman Spruce-Subalpine Fir, the Interior Cedar Hemlock and the Sub-Boreal Spruce. The Engleman Spruce-Subalpine Fir zone has hilly, mountainous terrain, cold and snowy conditions (a snowpack of 2-3 m is common) for 5-7 months of the year, and short cool summers. The Interior Cedar Hemlock zone generally has long warm summers, cool wet winters and productive coniferous forests. The Sub-Boreal Spruce zone is characterized by gently rolling terrain, dense coniferous forests, and extremes in the annual temperature range of -40°C to 30°C (B.C. Ministry of Forests, 1998).

There is very little land use activity in the Rainbow Creek watershed. The activity that is present includes residential development and some agriculture. These activities are concentrated in the bottom of the watershed, so are not likely to affect most of the users.

The Rainbow Creek watershed, which is 5km^2, drains southeast from Mt. Teare into the Fraser River. The stream is 1.5-2m wide and is dominated by a cobble and gravel bed. The riparian vegetation changes throughout the watershed; however, it was dominated by deciduous trees and shrubs at the sample site.

According to Ministry water licensing information, there are 23 active domestic water licenses and one trailer park diverting water from Rainbow Creek. The total combined daily withdrawal is approximately 18,500 gallons/day.

Materials & Methods

Sample Collection & Analyses for the 2005/06 Water Monitoring Program

An experienced MOE staff member collected water samples in laboratory certified polyethylene bottles for a variety of chemical and bacterial analyses. Representative grab samples were collected directly from Rainbow Creek, upstream of the Koeneman Road crossing. Samples were collected on five dates during various flow conditions. This included a winter low, spring runoff, a summer rain and a fall low. An additional sample was added during March of 2006 due to warm weather which resulted in melting snow packs and an early runoff.

Bottles used for general ion analyses were rinsed three times with source water prior to sample collection. Metal and bacterial bottles were not rinsed and metal samples were lab preserved. Water samples were shipped by overnight courier in coolers with ice packs to Cantest Laboratories Inc. for bacteria and Maxxam Analytical Services for chemistry analysis. Bacterial samples were analysed using membrane filtration. Metals analysis made use of ICPMS technology.

Figure 2. An upstream view of Rainbow Creek taken from Koeneman Road. Samples were collected from mid-channel.

Quality Assessment (QA)

To ensure accuracy and precision of data, quality assurance and control (QA/QC) procedures were incorporated into the monitoring program. This included use of rigorous sampling protocols, proper training of field staff, setting of data quality objectives (DQO) and the submission of QA samples to the lab. Field QA included duplicate and blind blank samples.

Blank samples detect contamination introduced in the field and/or in the lab. A comparison of duplicate results measures the effect of combined field error, laboratory error and real between-sample variability. The blind blank and duplicate program accounted for roughly 10% of the overall chemistry and bacterial sample numbers.

Results

Water Monitoring Program (2005/06)

Quality Assessment (QA)

The field blank and duplicate results indicate that minimal field or lab contamination of samples with bacteria occurred and that acceptable precision in bacterial sampling and analysis was observed. Bacterial samples collected on October 7th, 2005, were not included in this report because they exceeded our required maximum holding time of 48hrs.

The water chemistry field blank and replicate samples were considered to be of good quality, except for one replicate DQO exceedance. The total manganese replicate sample collected on January 10th, 2006 had a relative percent difference of 29%, exceeding our DQO of 25%. However, the values detected were still an order of magnitude below the recommended guideline, suggesting the DQO exceedance will not have a large impact on the results in this study. Because of the exceedance, the values were removed from the summary statistics. There were no blanks that exceeded the lab acceptance criteria of 5 times the method detection limit (MDL).

All data, with the above exceptions, are considered to be of good quality, and are considered suitable for review.

Bacteriology

The 2005/06 bacterial data are summarised in Table 1. As displayed both total coliforms and Enterococci were detected during sample collection. Although total coliforms can originate naturally in the environment, Enterococci generally suggests contamination by human or warm-blooded animals. The presence of these indicator bacteria tend to suggest that human illness may result if users are not currently treating their water supply.

Table 1. Results of bacterial analysis for Rainbow Creek. Results are in CFU/100mL.

Date	Total Coliforms	*E.coli*	Enterococci	Fecal Coliforms
Provincial Guideline	0 CFU/100mL	0 CFU/100mL	0 CFU/100mL	0 CFU/100mL
10/07/05	N/A	N/A	N/A	N/A
01/10/06	<1	<1	<1	<1
03/22/06	<1	<1	<1	<1
05/15/06	**4**	<1	1	1
08/01/06	**22**	1	**40**	1

Water Chemistry

In 2005/06, stream water samples were collected on five dates. The water samples were analysed for general parameters as well as for the ICPMS low level metals package that includes metals in the total and dissolved form (Table 2).

Of the chemical and physical parameters tested through the duration of this study, only one slightly exceeded recommended drinking water guidelines.

Turbidity (NTU) - The maximum detected turbidity was 0.3 NTU, with a mean of 0.2 NTU, both exceeding the recommended provincial DW guideline of <0.1 NTU (it is of note that these values are very close to the MDL and therefore uncertainty is high). Turbidity is a measure of the suspended particulate matter in the water, including silt, organic material and/or micro-organisms, that interfere with the passage of light. Turbidity can increase the available surface area of solids upon which bacteria grow, can interfere with disinfection and can be aesthetically unpleasant. Possible sources of elevated turbidity include riparian clearing, poorly constructed road crossings and unstable stream banks. Although these concentrations exceed the new drinking water guideline, the concentrations are still very low and are likely of natural origin.

The data from 2005/06 suggests that most chemical and physical parameters in Rainbow Creek have low concentrations compared to drinking water guidelines.

Table 2. Results of chemical analysis for Rainbow Creek. MDL = Method Detection Limit.

	Unit	MDL	Sample Date 10/07/05	Sample Date 1/10/06	Sample Date 03/22/06	Sample Date 05/15/06	Sample Date 8/01/06	DW Guideline
Bacteria								
Total Coliforms	CFU/100mL	<1		<1	<1	4	22	<1
Fecal Coliforms	CFU/100mL	<1		<1	<1	<1	1	<1
E.Coli	CFU/100mL	<1		<1	<1	1	1	<1
Enterococci	CFU/100mL	<1		<1	<1	1	40	<1
Misc. Inorganics								
Bromide (Br)	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Fluoride (F)	mg/L	0.01	0.05	0.04	0.04	0.04	0.05	1.5
Preparation								
Filter and HNO3 Preservation	N/A	N/A	YES	YES	YES	YES	Yes	
Calculated Parameters								
Total Hardness (CaCO3)	mg/L	0.5	160	180	180	150	160	
Misc. Inorganics								
Dissolved Hardness (CaCO3)	mg/L	0.5	160	180	180	150	160	500
Alkalinity (Total as CaCO3)	mg/L	0.5	125	130	136	115	114	
Total Organic Carbon (C)	mg/L	0.5	<0.5	<0.5	0.7	<0.5	<0.5	4
Anions								
Dissolved Sulphate (SO4)	mg/L	0.5	31.6	34.6	37.1	24.7	33.8	500
Dissolved Chloride (Cl)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	250
Dissolved Metals by ICPMS								
Dissolved Aluminum (Al)	ug/L	0.3	0.5	0.6	0.3	1	1.7	200
Dissolved Antimony (Sb)	ug/L	0.005	<0.005	0.008	0.008	<0.005	0.007	
Dissolved Arsenic (As)	ug/L	0.1	<0.1	<0.1	0.1	<0.1	<0.1	
Dissolved Barium (Ba)	ug/L	0.02	3.4	3.23	3.66	2.51	3.11	
Dissolved Beryllium (Be)	ug/L	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Dissolved Bismuth (Bi)	ug/L	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Dissolved Cadmium (Cd)	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Dissolved Chromium (Cr)	ug/L	0.2	0.4	0.6	<0.2	<0.2	<0.2	
Dissolved Cobalt (Co)	ug/L	0.005	0.006	<0.005	<0.005	<0.005	<0.005	
Dissolved Copper (Cu)	ug/L	0.05	0.11	0.10	0.06	0.13	<0.05	
Dissolved Lead (Pb)	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	0.01	
Dissolved Lithium (Li)	ug/L	0.05	4.99	6.50	5.88	4.47	5.47	
Dissolved Manganese (Mn)	ug/L	0.008	0.372	0.012	0.039	0.1	0.009	
Dissolved Molybdenum (Mo)	ug/L	0.05	0.16	0.18	0.19	0.13	0.16	
Dissolved Nickel (Ni)	ug/L	0.05	0.05	<0.05	<0.05	0.07	<0.05	
Dissolved Selenium (Se)	ug/L	0.2	<0.2	<0.2	0.3	<0.2	<0.2	
Dissolved Silver (Ag)	ug/L	0.02	<0.02	<0.02	<0.02	<0.02	0.04	
Dissolved Strontium (Sr)	ug/L	0.005	533	533	564	402	432	
Dissolved Thallium (Tl)	ug/L	0.002	<0.002	<0.002	<0.002	<0.002	0.004	
Dissolved Tin (Sn)	ug/L	0.01	<0.01		<0.01	<0.01	0.01	
Dissolved Uranium (U)	ug/L	0.002	1.65	2.13	2.09	1.47	1.42	
Dissolved Vanadium (V)	ug/L	0.06	<0.06	<0.06	<0.06	<0.06	<0.06	
Dissolved Zinc (Zn)	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Leachable Metals								
Total Aluminum (Al)	ug/L	0.3	0.8	1.5	0.4	2	1.7	
Total Antimony (Sb)	ug/L	0.005	<0.005	0.005	0.007	0.006	0.005	6
Total Arsenic (As)	ug/L	0.1	<0.1	<0.1	0.1	<0.1	0.1	10
Total Barium (Ba)	ug/L	0.02	3.44	3.30	3.56	2.64	2.79	1000
Total Beryllium (Be)	ug/L	0.02	<0.02	<0.02	<0.02	<0.02	0.02	4
Total Bismuth (Bi)	ug/L	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Total Cadmium (Cd)	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	5
Total Chromium (Cr)	ug/L	0.2	0.7	0.4	<0.2	<0.2	<0.2	50
Total Cobalt (Co)	ug/L	0.005	0.005	<0.005	<0.005	<0.005	<0.005	
Total Copper (Cu)	ug/L	0.05	0.17	0.05	0.07	0.13	0.11	1000
Total Lead (Pb)	ug/L	0.01	<0.01	0.02	<0.01	<0.01	<0.01	10
Total Lithium (Li)	ug/L	0.05	5.28	6.75	5.42	4.74	5.09	
Total Manganese (Mn)	ug/L	0.008	0.439	0.286	0.081	0.162	0.17	50
Total Molybdenum (Mo)	ug/L	0.05	0.17	0.18	0.18	0.16	0.22	250
Total Nickel (Ni)	ug/L	0.05	0.11	<0.05	0.05	0.11	<0.05	
Total Selenium (Se)	ug/L	0.2	<0.2	<0.2	0.3	<0.2	0.2	10
Total Silver (Ag)	ug/L	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Total Strontium (Sr)	ug/L	0.005	528	538	551	445	387	
Total Thallium (Tl)	ug/L	0.002	<0.002	<0.002	<0.002	<0.002	0.002	2
Total Tin (Sn)	ug/L	0.01	0.01	0.01	0.01	<0.01	0.01	
Total Uranium (U)	ug/L	0.002	1.63	2.06	2.01	1.64	1.43	100
Total Vanadium (V)	ug/L	0.06	<0.06	<0.06	<0.06	<0.06	<0.06	
Total Zinc (Zn)	ug/L	0.1	<0.1	1.0	<0.1	<0.1	<0.1	5000
MISCELLANEOUS								
True Colour	Col. Unit	5	<5	<5	<5	<5	<5	15
Nutrients								
Total Kjeldahl Nitrogen (Calc)	mg/L	0.02	0.03	<0.02	<0.02	0.09	0.05	
Total Organic Nitrogen (N)	mg/L	0.02	0.03	<0.02	<0.02	0.09	0.05	
Dissolved Phosphorus (P)	mg/L	0.002	<0.002	<0.002	<0.002	0.003	<0.002	
Ammonia (N)	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	Refer to tables
Total Inorganic Carbon (C)	mg/L	0.5	30.6	30.2	34.1	28.3	28.4	
Nitrate plus Nitrite (N)	mg/L	0.002	0.029	0.085	0.076	0.175	0.041	10
Total Nitrogen (N)	mg/L	0.02	0.06	0.10	0.08	0.27	0.09	
Total Phosphorus (P)	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	
Physical Properties								
Conductivity	uS/cm	1	303	315	333	270	290	700
pH	pH Units	0.1	8.2	8.2	8.3	7.8	8.1	6.5-8.5
Physical Properties								
Total Suspended Solids	mg/L	4	<4	<4	<4	<4	<4	Refer to tables
Turbidity	NTU	0.1	0.2	0.3	0.1	0.2	0.2	0.1
Dissolved Metals by ICP								
Dissolved Boron (B)	mg/L	0.008		<0.008				
Dissolved Calcium (Ca)	mg/L	0.05	49.3	52.1	52.3	46.2	49.9	
Dissolved Iron (Fe)	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.3
Dissolved Magnesium (Mg)	mg/L	0.05	9.98	10.9	11.2	8.55	9.23	100
Dissolved Phosphorus (P)	mg/L	0.1		<0.1				
Dissolved Potassium (K)	mg/L	1		<1			42.6	
Dissolved Sodium (Na)	mg/L	0.05		2.57			<0.005	
Dissolved Sulphur (S)	mg/L	0.1		12.5			8.05	
Dissolved Titanium (Ti)	mg/L	0.003		<0.003			2	
Dissolved Zirconium (Zr)	mg/L	0.005		<0.005				
Total Metals by ICP								
Total Boron (B)	mg/L	<0.008		<0.008				
Total Calium (Ca)	mg/L	0.05	48.9	49.6	48	45.8	42.6	
Total Iron (Fe)	mg/L	0.005	<0.005	0.007	<0.005	<0.005	<0.005	
Total Magnesium (Mg)	mg/L	0.05	9.88	10.5	10.2	8.54	8.05	
Total Phosphorus (P)	mg/L	1		<0.1				
Total Potassium (K)	mg/L	1		<1				
Total Sodium (Na)	mg/L	0.05	2.21	2.48	2.52	2.06	2	200 (20 for sensitive)
Total Sulphur (S)	mg/L	0.1		11.7				
Total Titanium (Ti)	mg/L	0.003		<0.003				
Total Zirconium (Zr)	mg/L	0.005		<0.003				
Extra								
Ultra Violet Transmittance	% or AU/cm	2	96	98		0.07		
	Exceeding DQO							
	Exceeding WQ Guideline							

Conclusions & Recommendations

Review of Rainbow Creek water quality data suggests excellent source water. Most water quality parameters were well under Canadian drinking water guidelines, except for slightly elevated turbidity. However, these turbidity values were less than five times their MDL, and therefore considered too unreliable to make strong conclusions. Furthermore, the low values detected, 0.1-0.3NTU, are well within naturally occurring surface water concentrations.

One concern regarding the water supply is the detected Enterococci and total coliform indicators. The levels detected were high enough to cause human illness should water treatment systems become ineffective. The elevated levels were found in August of 2006, following a precipitation event of approximately 15mm. This suggests that the feces of warm blooded animals may have been transported to the stream via overland flow. Regardless, surface waters such as streams and lakes are more likely to contain disease-causing organisms than groundwater (B.C. Healthfile #49b, 2000). Because of this, water treatment is recommended for any resident of British Columbia who receives their drinking water directly from a surface source (B.C. Healthfile #49a, 2000).

It is recommended that Rainbow Creek water users discuss water treatment options with Northern Health. More specifically, the water should be treated for pathogens, including bacteria and parasites. It is also recommended that any future development in the upper sectors of the watershed have adequate sediment control measures to prevent any degradation of the stream water quality for the downstream users. Given the steep slope of the terrain, increased activity in the riparian area will likely increase the amount of suspended solids and turbidity, which in turn will impair the quality of the resource.

This study is one part of a broader water quality management program being carried out by the Environmental Quality Section in MOE's Omineca-Peace Region. The overall objectives of this program are to monitor water quality to identify problems, to determine causes, and to work with local governments, landowners and other interested parties to improve or otherwise protect water quality and aquatic life. Information sharing between governments, specifically MOE, Northern Health and various Regional and Municipal governments, is an ongoing practice.

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Contact Information

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