

CANADA – BRITISH COLUMBIA WATER QUALITY MONITORING AGREEMENT

WATER QUALITY ASSESSMENT OF MOYIE RIVER AT KINGSGATE (1980 – 2004)

Pommen Water Quality Consulting

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Executive Summary

The Moyie River watershed is located in the southeast corner of British Columbia. Its headwaters are in the Purcell Mountains southwest from Cranbrook, and the river flows south through Moyie Lake into Idaho to join the Kootenai River near Bonners Ferry, Idaho. The water quality sampling station is located at the Canada-US border at Kingsgate. This assessment is based on up to 18 years of water quality data during 1980-2004. The main human influences on water quality in the Moyie River watershed were forestry, highway transportation, and a small amount of agriculture. The water quality trends identified below have not been confirmed by statistical analysis.

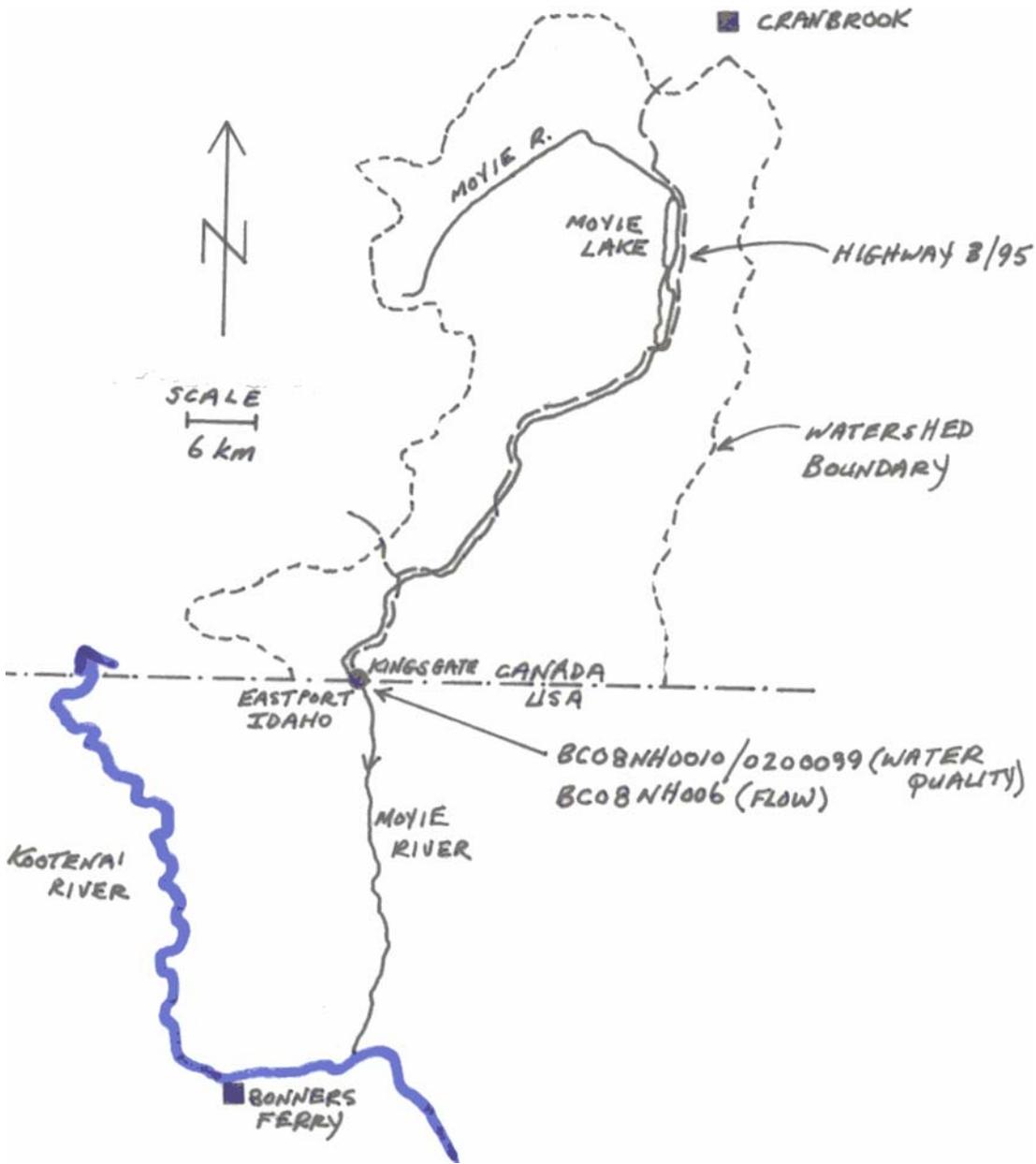
Conclusions

- The water was very soft and had a moderate to low (alkalinity) or moderate to high (calcium) sensitivity to acids. There was a slight increasing (improving) trend in alkalinity between 1980-95 and 2003-04, which made the water less sensitive to acids, but the calcium indicator of acid sensitivity did not change over time.
- Chloride and sodium had slight increasing trends over time, possibly due to the use of highway road salt, but the levels were well below all water quality guidelines, and thus the trends were not environmentally significant.
- Numerous water quality indicators had apparent declining trends from 1980-95 to 2003-04, but they were not real, being attributable to declining minimum detectable limits, artificial contamination, or lower flows and turbidity in 2003-04.
- Cadmium (2003-04) and zinc (1982-2004) levels exceeded aquatic life guidelines during low flows, but this is believed to be due to the natural mineralization of the watershed, although there is evidence of past mining at Moyie Lake.
- Water temperature exceeded the aquatic life guideline on two occasions in August of 1981 and 2004.
- Turbidity was relatively low, probably due to the influence of Moyie Lake, but drinking water would still need partial treatment, such as filtration, plus disinfection before consumption.
- Fecal contamination was low in 2003-04, and the water met the drinking water guideline for water receiving partial treatment plus disinfection.

Recommendations

- The water quality of the Moyie River at Kingsgate was good with the exception of cadmium and zinc (see recommendation below), there were no apparent environmentally significant deteriorating trends during 1980-2004, and there are no proposed developments that could affect water quality. Consequently, it is recommended that routine monitoring be suspended for another 5-10 years, or until reactivation is warranted by proposed developments.
- Consider investigating the sources of cadmium and zinc in the Moyie River during low flows since this is a transboundary river, and it would be prudent to confirm whether the sources are natural or human-induced. (The US water quality criteria for cadmium and zinc are an order of magnitude higher than the B.C. and Canadian guidelines and were not exceeded.) Zinc levels appeared to stay the same during 1980-2004, while cadmium measurements sensitive enough to measure the levels in the Moyie River only began in 2003-04, precluding the identification of long-term trends.
- Correct the errors in the EMS database.

Figure 1 Map of the Moyie River Basin



Authors

Pommen, L.W. Pommen Water Quality Consulting, Victoria, B.C.

Contributors

McDonald, L.E. Environmental Protection, Ministry of Environment, Cranbrook,
B.C.

Ryan, A. Aquatic Sciences Section, Environmental Conservation Branch,
Environment Canada, Vancouver, B.C.

Beatty, J. Environmental Protection, Ministry of Environment, Nelson, B.C.

Raggett, J. Environmental Protection, Ministry of Environment, Nelson, B.C.

Swain, L.G. Water and Air Monitoring and Reporting Section, Water, Air and
Climate Change Branch, Ministry of Environment, Victoria, B.C.

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1. Introduction

The Moyie River watershed is located in the southeast corner of British Columbia. Its headwaters are in the Purcell Mountains southwest from Cranbrook, and the river flows south through Moyie Lake into Idaho to join the Kootenai River near Bonners Ferry, Idaho.

The Moyie River at Kingsgate water quality monitoring station is located at the Highway 95 Bridge, 0.5 km upstream from the Canada-US border (Figure 1). The drainage area of the river at the water quality station is 1480 km². The river is used for fishing, recreation, and irrigation. Forestry and a little agriculture were cited as the main influences on water quality¹. Highway 3/95 follows the river through the Canadian portion of the basin, and might affect water quality through the use of road salt for de-icing and spills of petroleum or other hazardous cargoes.

Flow was monitored on the Moyie River at Eastport on the Canada-US border (Water Survey of Canada station BC08NH006) during 1980-2004, and these data are plotted in Figures 2a and 2b. Environment Canada collected water quality data at Kingsgate about once every two months during 1980-95 and the data are stored on ENVIRODAT (BC08NH0010), and were copied to the B.C. Environmental Monitoring System (EMS, site number 0200099). Water quality monitoring at the station was suspended in 1995, and then reactivated in 2003-04 as a federal-provincial water quality monitoring station with joint operation by Canada and B.C. Water quality data were collected monthly during a 16-month period from September 2003 to December 2004. Up to 18 years of water quality data during 1980-2004 were used in this report. The data are plotted in Figures 3 to 35.

1. Water Quality Assessment

The status and trends of water quality were assessed by plotting the water quality indicators over time and comparing the values to the Province's approved² and working³ water quality guidelines or the Canadian water quality guidelines⁴. There are no site-specific water quality objectives for the Moyie River. Any levels or changes of the indicators over time that may have been harmful to sensitive water uses, such as drinking water, aquatic life, wildlife, recreation, irrigation and livestock, are described below in alphabetical order.

The data for 1980-95 were reviewed previously, and no environmentally significant changes over time were found^{1,5}. Sixteen months of data during 2003-04 were available for comparison to the 1980-95 data to look for any recent changes over time.

Before the data were assessed, the data were reviewed and the errors found on EMS were compiled in Tables 1-3, and it is recommended that these corrections be made to the EMS database.

Water quality indicators that were reviewed but not discussed because they were below all water quality guidelines and showed no harmful trends were: antimony, arsenic, barium, bismuth, boron, carbon-dissolved organic, colour-true, conductance-specific, gallium, lanthanum, lithium, molybdenum, nickel, rubidium, silver, strontium, sulphate, tin, thallium, uranium, and vanadium.

Alkalinity, total (Figure 3) had a moderate to low sensitivity to acids, which appeared to increase slightly over time. This could be due to the lower stream flows in 2003-04 (Figure 2a) and thus a greater

proportion of mineralized ground water. This is viewed as an improving trend because it made the river better able to neutralize acidic inputs, but the cause of the apparent trend is unknown.

Aluminum (Al) (Figure 4) had values above the drinking water and aquatic life guidelines during 1990-95, but not during 2003-04. The apparent decline over time was probably due to the lower flows during 2003-04, resulting in lower levels of turbidity (aluminum is highly correlated with turbidity).

Beryllium (Be) (Figure 7) had levels well below all water quality guidelines. The apparent decline over time was due to declining minimum detectable limits (MDL).

Cadmium (Cd) (Figure 8a) had MDL that were above the aquatic life guidelines during 1980-95, and thus these data are unreliable for comparison to the guidelines. The apparent decline over time was due to declining MDL. **Figure 8b** shows that low-level cadmium in 2003-04 often exceeded the aquatic life guideline. This is believed to be a natural condition due to the mineralization of the watershed, although there is evidence of past mining at Moyie Lake, which might increase cadmium mobilization.

Calcium (Ca), Hardness, and Magnesium (Mg) (Figure 9) showed that the water had a moderate to high sensitivity to acids (calcium), and was very soft with respect to hardness. There was no apparent change over time, in contrast to the increasing trend for alkalinity.

Chloride (Cl) (Figure 11) had levels that were well below all water quality guidelines. There was a slight increasing trend over time, possibly due to the increased use of road salt for de-icing on Highway 3/95, but the trend is not environmentally significant because the highest value is 89 times below the lowest water quality guideline.

Chromium (Cr) (Figure 12) had all but one value (in 1990) below the aquatic life guideline (1 µg/L). There was an apparent declining trend over time due to declining MDL.

Cobalt (Co) (Figure 13) had levels that were well below all water quality guidelines. There was a declining trend over time due to declining MDL.

Coliforms, fecal, Enterococci, and E. coli (Figure 14) were measured only in 2003-04, and met all water quality guidelines for all uses with the exception of those for drinking water that receives only disinfection (3/100 ml for enterococci and 10/100 mL for fecal coliforms and E. Coli). (The value of 270/100 mL for enterococci on July 20, 2004 came from the Environment Canada database, ENVIRODAT, and is judged to be a probable error as it is seven times the fecal coliform and E. coli values.) These guidelines were exceeded on two to five dates, depending on the indicator. The turbidity of the Moyie River was low, but partial treatment (e.g., filtration) plus disinfection would probably be needed before drinking water consumption, and the guidelines for this water use (25 and 100/100 mL) were met in 2003-04.

Copper (Cu) (Figure 17) often exceeded the aquatic life guideline during 1980-90, but the data are suspect due to high MDL and artificial contamination during 1986-90 (the most obvious contaminated values were removed from the Figure). The 2003-04 results obtained with low-level methods were well below the guideline. The apparent declining trend over time was due to declining MDL and the unreliable 1986-90 results. The contaminated 1986-90 values should be removed from the EMS database.

Fluoride (F) (Figure 18) showed no change over time and that the aquatic life guideline was exceeded on only three occasions (in 1981-82), which may be errors.

Iron (Fe) (Figure 19) shows that the aquatic life and aesthetic drinking water guidelines (0.3 mg/L) were exceeded on only three occasions (in 1984-86 during spring freshet). There was an apparent declining trend over time, but this was probably due to the lower turbidity during 2003-04 due to lower flows.

Lead (Pb) (Figure 20) shows that levels occasionally exceeded the aquatic life guidelines during 1980-88, possibly due to higher MDLs and likely sample contamination during 1986-90. The 2003-04 results obtained with low-level methods were well below the guideline. The apparent declining trend over time is possibly due to declining MDL and the contaminated 1986-90 results, as well as lower turbidity in 2003-04. The contaminated 1986-90 values should be removed from the EMS database.

Manganese (Mn) (Figure 22) shows that all values were below the aesthetic drinking water guideline (0.05 mg/L). The apparent declining trend was due to declining MDL and lower turbidity in 2003-04.

Nitrogen (N) (Figure 25) shows a declining (improving) trend in all nitrogen forms (nitrate, nitrite, Kjeldahl, and total dissolved) during 1982-95, but levels increased again in 2003-04. No explanation can be offered for these changes, but they are not environmentally significant with respect to water quality guidelines.

pH (Figure 26) shows that most values were within the aquatic life and drinking water guidelines. Exceptions are one high field pH value in 1981, which was 1.4 units above laboratory pH replicates, and thus may be an error, and low values in 1985-88, which are related to the loss of laboratory control that occurred in 1986-89. There was one value in 2004 below the drinking water and aquatic life guidelines, which is suspiciously low, but it occurred during a conductance minimum in freshet and thus may be genuine. There was no apparent change over time.

Phosphorus (P) (Figure 27) shows an apparent decreasing (improving) trend over time, but 2003-04 had lower flows and turbidity, which probably resulted in lower total phosphorus levels.

Selenium (Se) (Figure 28) shows that all values were well below water quality guidelines. The apparent minor declining trend is due to declining MDL.

Sodium (Na) (Figure 29) levels were well below all water quality guidelines. There was a slight increasing trend over time, possibly due to the increased use of road salt for de-icing on Highway 3/95 or due to lower flows in 2003-04 and thus a greater proportion of mineralized ground water in the river, but the trend is not environmentally significant because the highest level is seven times below the lowest water quality guideline, which is the alert level for people on sodium-restricted diets, and 68 times below the aesthetic drinking water objective.

Temperature, water (T) (Figure 32) had only two dates with results above the aquatic life guideline of 19 degrees C, while the drinking water aesthetic guideline of 15 degrees C was often exceeded in summer, when the water would be warm enough for water-contact recreation. There was no apparent change over time.

Turbidity (Figure 33) levels were relatively low, probably due to settling and the attenuation of extreme flows in Moyie Lake, but the drinking water guideline of 1 NTU was often exceeded, indicating that partial treatment (e.g., filtration) plus disinfection was needed before consumption. There was an apparent decline over time, but this was probably due to the lower flows during 2003-04.

Zinc (Zn) (Figure 35) shows that the 7.5 µg/L aquatic life guideline at hardness ≤ 90 mg/L was often exceeded, mainly during winter low flows. This is believed to be a natural condition due to the mineralization of the watershed, although there is evidence of past mining at Moyie Lake, which might increase zinc mobilization. There was no change over time. The most obvious outliers were removed from the Figure, one value in 1981 and seven values during the 1986-90 period of artificial contamination due to the failure of preservative vials. These outliers should be crosschecked with ENVIRODAT and removed from EMS if they are believed to be errors.

References

1. B.C. Ministry of Environment, Lands and Parks and Environment Canada. 2000. Water Quality Trends in Selected British Columbia Waterbodies.
2. Ministry of Water, Land and Air Protection. 2001a. British Columbia Approved Water Quality Guidelines (Criteria). 1998 Edition updated August 24, 2001.
3. Ministry of Water, Land and Air Protection. 2001b. A Compendium of Working Water Quality Guidelines for British Columbia. 1998 Edition updated August 23, 2001.
4. Canadian Council of Ministers of the Environment (CCME). 2003. Canadian Environmental Quality Guidelines.
5. Webber, T.N. and B. Wipperman. 1996. State of Water Quality of Moyie River at Kingsgate. Canada-British Columbia Water Quality Monitoring Agreement. B.C. Ministry of Environment, Lands and Parks and Environment Canada.