Streamflow and Water Chemistry of the Springs in the Cannon Valley Wilderness Park

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ABSTRACT

An investigation was performed to determine flow rates, ion discharge, and lead concentrations of two springs and their tributary streams in the Cannon River Wilderness Park. The total water flow per second was measured and combined with historical data to arrive at ion concentrations. Water samples were analyzed for the presence and amount of lead. Flow ranged from 1300 cc/s at the smaller spring to 11, 000 cc/s near Fiske Bridge. Lead content was found to be about 10 times the EPA drinking water standards at the smaller spring and 5 times at the larger.

INTRODUCTION

The Cannon River Wilderness Park is located near Northfield, Minnesota along the Cannon River (*see Figure 1, below*). The park contains several springs that flow from the Shakopee Aquifer and feed into the Cannon River. For many years, Carleton students have conducted research dealing with the water chemistry of this region. Most studies have focused on lakes and wells, rather than the springs. However, two studies have been performed on the springs within the park. One group conducted a detailed study of anion concentrations in the CRWP. Another group dated water around the area (including one of the springs) using chlorofluorocarbons and measured cation concentrations.

Though the water of the springs has undergone extensive chemical analysis, no measurements of flow rates have been taken to date. The purpose of this study is to record accurate flow rates from the springs and, using this data and data from previous studies, determine the rate at which the springs discharge ions into the Cannon River.

We went to the field and took flow measurements at the springs and at a few sites downstream. Using meter sticks, we made a stream cross-section at each site in order to calculate the volume. Combining this data and the historical ion concentrations, we were able to determine the rate of discharge for each ion. In addition, we took water samples from each of the springs and analyzed them for lead content to determine whether the springs were a source of lead contamination. To create context for this measurement, we compared the concentrations to the Environmental Protection Agency's safe drinking water standards.

Figure 1: Location of the Cannon River Wilderness Park in relation to Northfield, MN

Image courtesy of www.mapquest.com

METHOD

Our group took measurements on 24 October, 1 November, and 3 November at 6 sites in the CWRP: two springs and four stream locations (two along each stream—*see Figure 2, below*). The materials used included plastic water sample cups, a meter stick, a Secchi turbidity tube, one YSI 85 meter, and one water flow meter. On 24 October and 1 November, we used the YSI meter to obtain temperature and conductivity readings from the two springs and took water samples. On 3 November, we measured the flow rate with the flow meter and recorded the dimensions of the streambed at each location by measuring distances with a meter stick. To find the lead content of the sample, on November 8 we used an atomic absorption apparatus. We calibrated the machine using samples of known concentrations and then found the unknown concentrations using the absorption results and the formula for the calibration curve we had produced.

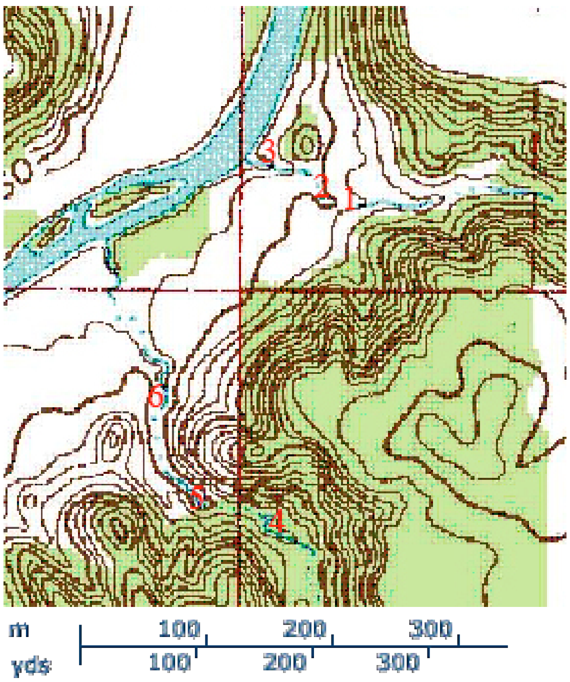

Figure 2: Site locations (as denoted by number) within the Cannon Valley Wilderness Park

Image courtesy of United States Geological Survey

RESULTS

Field Observations:

Table 1: Flow Rates

Location	Flow (cm^3/s)
Site I	1,300
Site II	3,500
Site III	4,200
Site IV	8,900
Site V	10,000
Site VI	11,000

Flow at the different sites varied from 1,300 cm^3/s to 10,000 cm^3/s. Flow at Site I was 1300 cm^3/s. Farther down the stream, at Site II, flow was 3,500 cm^3/s. At Site III, the mouth of the Cannon River, it was measured as 4,200 cm^3/s. This stream had the smaller volume of the two that we studied. Site IV, the spring of the second stream, had a flow of 4,800 cm^3/s. The flow at Site V was 8,900 cm^3/s. At Site VI, the flow was 10,000 cm^3/s.

Historical Data

Table 2: Ion discharge rates (mg/s)

Ion	Discharge Rate (Site I)	Discharge Rate (Site II)
Chloride	4.75072	46.36
Fluoride	0.1053	0.51264
Nitrate	0.06887	0.77341
Phosphate	0	0
Sulfate	75.764	475.26
Sodium`	6.5	No data
Potassium	3.9	No data
Magnesium	54.6	No data

Note: The cation (Sodium, Potassium, Magnesium, and Calcium) concentrations are approximate because they are derived from a bar graph with low precision.

Table 3: Lead Concentrations (*see Appendix A for graph*)

Source	Concentration(ppm)	Absorbency Reading
Cannon River Stream	0.07353	0.002
Fiske Creek Spring	0.14706	0.001
EPA Drinking Water Standard	0.015	N/A

DISCUSSION

The flow of the two streams varied considerably, depending on the stream and on the place where the measurement was taken. The spring feeding Fiske Creek produces nearly 8 times the flow of the other spring. Measurements further along each creek increased as more sources of runoff met with the water from the original spring. The flow of the unnamed creek increased more drastically (1300 cc/s to 4200 cc/s) than that of Fiske Creek (8900 cc/s to 11,000 cc/s). The difference in increase is primarily due to the fact that the unnamed creek has a greater number of sources than Fiske Creek, which is fed primarily by the single spring.

Using the historical ion data, we found that the anion most rapidly deposited into the Cannon River is sulfate, due to the sulfurous nature of the springs. The most rapidly deposited cation is calcium, which is present in the groundwater because of the location of the aquifer within the sedimentary layers.

Both springs were found to contain lead. When compared with the EPA standards, the concentration of Fiske Spring was about five times the "action level" (the maximum amount of lead acceptable in drinking water). The Cannon River Spring was nearly ten times the prescribed drinking water concentration. Though this shows the extent of lead content, it is slightly misleading: the unfiltered springs are clearly not a source of drinking water.

Our sources of error were primarily systematic. For example, the current in the stream varies depending on depth differentials and recent weather patterns. This could have affected our flow measurement. In addition, the apparatus used to measure the depth of the streams (a meter stick) is not very precise. Further, the water level did not remain precisely constant during measurement and the meter stick sometimes plunged into the streambed, leading to a lower level of accuracy. Contaminants in the sample cups would affect the lead concentration results. Also, the calibration curve was difficult to plot, primarily because one of our standards did not yield a reasonable result. Therefore, we only had three points to create our line. Further, the readings only went to three decimal places, leaving considerable room for discrepancy between the actual reading and that used in calculation.

CONCLUSION

In this study, we have built upon previous work done by earlier Carleton College geology research groups by addressing a new dimension of groundwater analysis in the Cannon River Wilderness Park. We measured flow at two of the park's springs and at two other selected sites along each stream. We found that together, the springs contribute 10,200 cc/s to the flow of the Cannon River.

Our study could be improved in several ways. First, had we been able to take flow measurements on multiple days, and then use the average of these measurements, the effect of changing currents on our measurements would have been minimized. Also, more precise distance measuring equipment would have provided more accurate measurements of stream dimensions at the various sites. Lastly, a more thorough and precise analysis of lead content would yield more accurate and credible results.

Further studies on the groundwater of the CRWP could focus on suspended sediment loads, cation concentrations, the presence of heavy metal pollutants, and the erosional effects of the two streams.

The knowledge of the amount of flow from the two springs is useful in research dealing with sediments and contaminants provides valuable data regarding the physical properties of the springs and the streams that they feed.

REFERENCES

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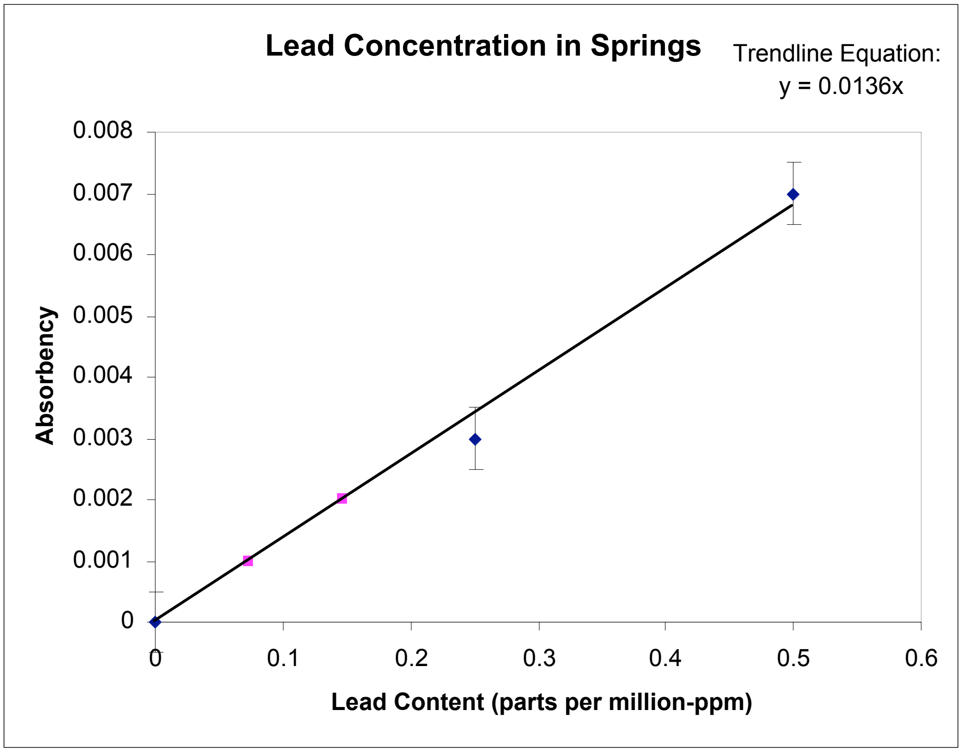
APPENDIX A

Figure 2: Calibration curve



The blue points are the standards used to arrive at the curve. The pink points are the unknown samples from the springs.