Heavy Metal Water Pollution within the Boulder Creek Watershed and a Review of At-Home Drinking Water Test Kits

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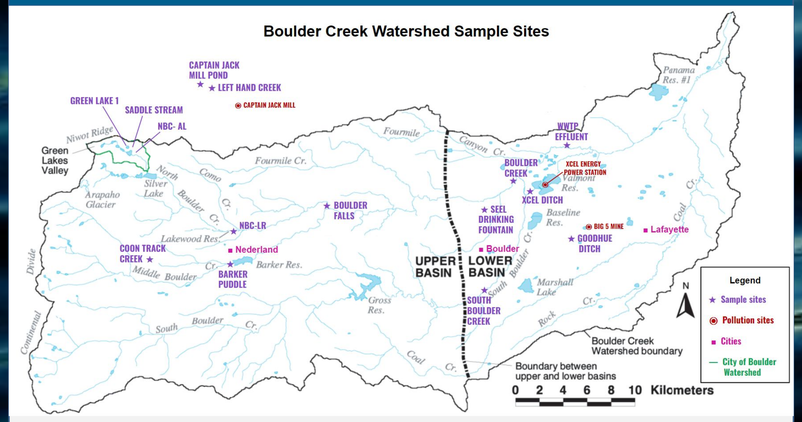
Introduction

- Contaminated drinking water is a pathway of chronic exposure to toxic pollutants. Prolonged exposure to pollutants such as heavy metals can negatively impact human health.
- These pollutants are abundant in the environment and exposure is common near industrial and urban areas.
- The average person should have access to a reliable and affordable method to assess their own drinking water quality. There are many commercially available brands of at-home drinking water test kits that vary greatly in their accuracy.
- **The objective of this research is to identify and quantify water pollutants across the Boulder Creek Watershed and analyze the performance of different brands of at-home drinking water test kits.**

Methods



Water samples were collected from locations determined by previous water pollution data and elevational position in the watershed.

Results from the kits were compared to results reported by a YSI Multiparameter Water Quality Meter

Samples were analyzed by following procedures outlined in each kit. 4 different brands of kits were used in analysis.

Figure 1: Describes sampling sites and methodology

Results

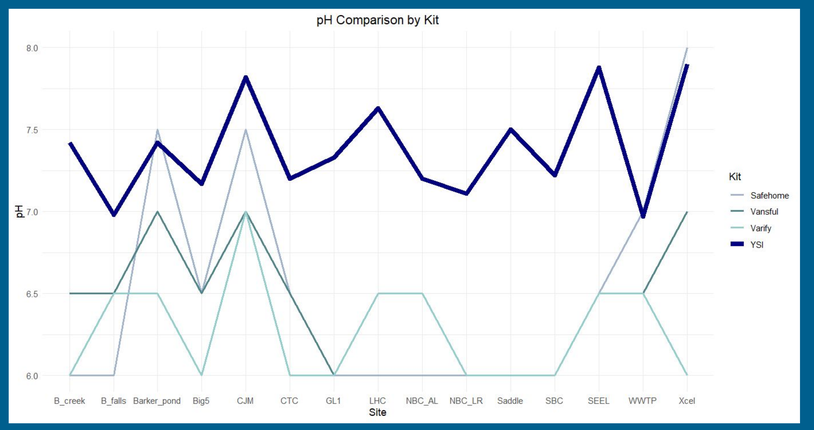


Figure 2: Compares pH measurements across sites collected with kits and YSI probe. The YSI probe pH measurements (thicker line) are significantly different than each kits' pH measurement according to a generalized linear model (p-value= 0.0153). The Safehome kit measurements are significantly different than the Vansful kit (p-value= 0.0019) and marginally different than the Varify kit (p-value= 0.0605).

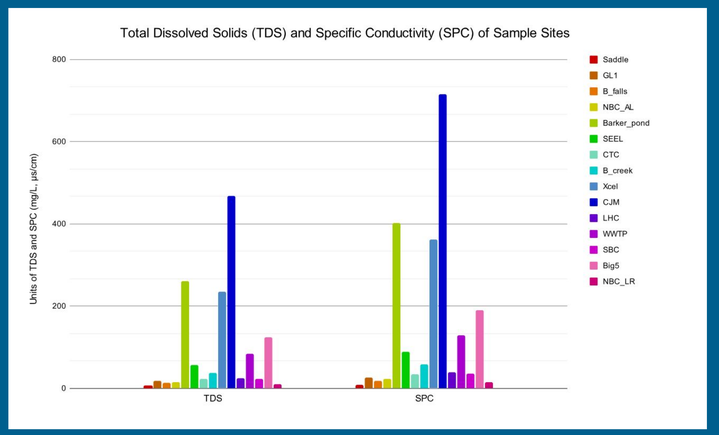


Figure 3: Depicts TDS and SPC at all sampling sites. With only a single sampling event occurring, there is a lack of statistical power to show difference among sites. However, contaminated sites show elevated levels of SPC and TDS which is often associated with heavy metals.

Review of Kit Performance

	Accuracy	Ease of use	Price
Safehome	★★★☆☆	★★★★☆	★★★☆☆
Varify	★★☆☆☆	★★★★☆	★★★★☆
Vansful	★★☆☆☆	★★★★☆	★★★★★
JNW	★☆☆☆☆	★★★★★	★★★★☆

Figure 4: Depicts a rating out of 5 stars of the performance of each kit. Accuracy is determined by analyzing how the test results compare to a more precise method of testing such as the YSI. Ease of use refers to the clarity of the instructions included in the kit and if the results are easy to interpret. Price is determined by comparing the overall performance of the kit to what is included in the kit. Overall, Safehome is the best kit.

Discussion

- **All four kits failed to detect the presence of heavy metals** although there are elevated levels of SPC and TDS at contaminated sites (Figure 3). While SPC and TDS are not direct indicators of heavy metal presence, these parameters indicate a strong ionic charge often associated with heavy metals. Further evidence of heavy metal presence is seen in extreme color change of a contaminated water sample as suspended solids settled.
- **Kit results were difficult to interpret** resulting in a misleading analysis of water quality. Color charts provided in the kits are difficult to interpret because the colors are very similar and the dip strips often displayed color variations not included on the chart. Color pads on the dip strip test also frequently bled onto one another further interfering with the results. Statistical analysis shows a significant difference (p-value < 0.02) among kits for certain parameters (Zn, SO_4, NaCl) at the same sample site. This difference can be attributed to the difficultly of interpreting dip-strip colors rather than differing levels of contaminants.
- **Safehome is the top performing kit** out of all four kits tested (Figure 4). Overall, Safehome had the lowest frequency of bleeding color pads and unrecognizable color results. According to Figure 2, the generalized linear model comparing pH measurements of all kits to pH of the YSI reports that Safehome has the most accurate measurements. The kit with the worst performance was the JNW as there was not a single detection of any parameter across all of the samples (Figure 4).
- **These drinking water test kits are unsuitable for measuring drinking water quality.** According to the kits, the obviously contaminated samples are safe for human consumption in regards to the amount of heavy metals present. Results provided by a chi squared test indicate that site was not significant among kits (p-value > 0.05). All the kits reported the same results, no matter the site, meaning that the polluted water samples are just as safe to drink as the clean alpine water samples.

Conclusion

- **These currently commercially available kits are unsuitable for the analysis of drinking water quality.** The kits falsely reported that all the samples were safe to drink despite the high likely presence of heavy metals.
- **The performance of these kits is concerning for human health.** These kits are one of the only accessible and affordable ways to assess water quality, but they are inadequate and put people at risk for consuming dangerous polluted water.

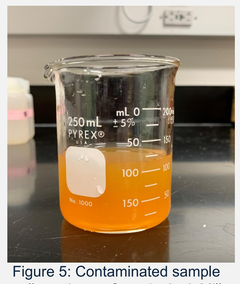


Figure 5: Contaminated sample collected near Captain Jack Mill.

Future Work

- **Collect samples from more sites** so that there is more balance in polluted and non-polluted sites.
- **Use specialized equipment** to detect the actual levels of heavy metals in each sample and compare those measurements to kit data.
- **Test a wider variety of kit types** for a more encompassing consumer review.

References

More info

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