2022 COLD BROOK CONDUCTIVITY STUDY | MEMORANDUM

TO: Steve Lewis & Heinrich Wurm, Kezar Lake Watershed Association

FROM: Laura Diemer & Luke Frankel, FB Environmental Associates

SUBJECT: **2022 Cold Brook Conductivity Study**

DATE: February 1, 2022

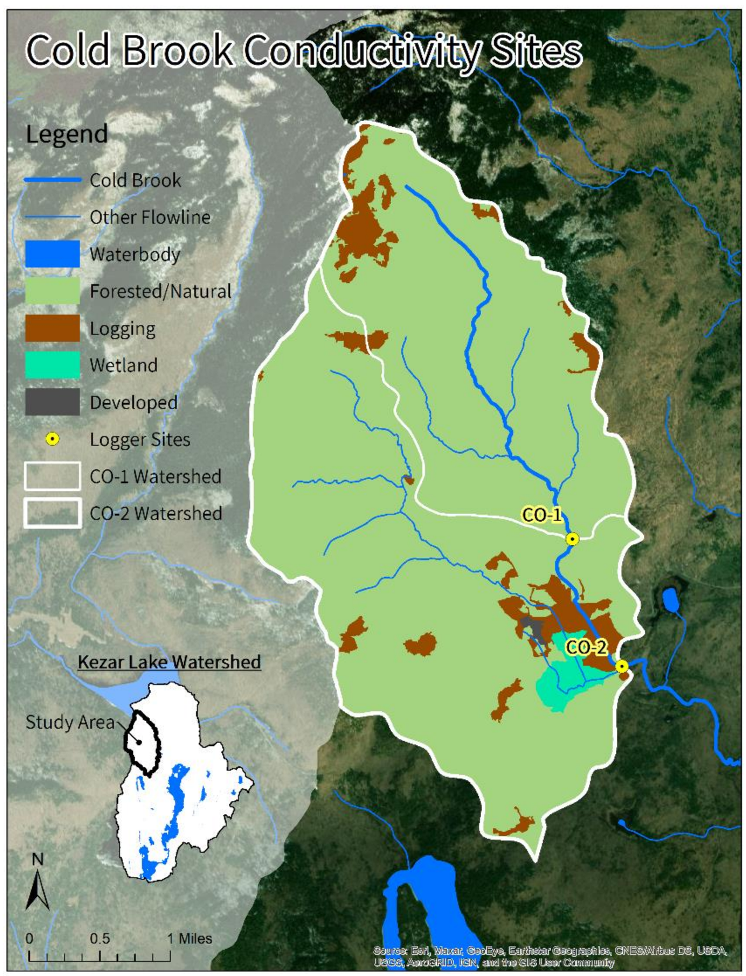
CC: Forrest Bell, FB Environmental Associates

BACKGROUND

In 2021, the Kezar Lake Watershed Association (KLWA) hired FB Environmental Associates (FBE) to investigate the potential water quality impacts of a malfunctioning septic system in the watershed by deploying continuous conductivity data loggers at two locations along Cold Brook, positioned upstream and downstream of the septic system in question. The results from 2021 showed that during dry conditions the site downstream from the septic system (CO-2) had elevated specific conductivity compared to the upstream site (CO-1), suggesting that the septic system may have been negatively impacting the brook's water quality. After the 2021 monitoring season, the septic system in question was upgraded to reduce water quality impacts. If the upgrade was successful and the leachate signal was in fact captured in the 2021 specific conductivity data at CO-2, then 2022 monitoring results should reflect improved water quality (i.e., lower specific conductivity at CO-2) compared to 2021.

METHODS

On April 22, 2022, two Onset HOBO® conductivity-temperature data loggers were deployed at an upstream control site (CO-1) and a downstream impacted site (CO-2) in Cold Brook to bracket the malfunctioning septic system (Map 1). These loggers collected continuous measurements of temperature and conductivity at 30-minute intervals until they were retrieved on November 1, 2022. At each site, the loggers were deployed within PVC pipes attached to cement blocks that were secured to trees on the bank using metal cables. Maintenance was performed on the loggers during monthly site visits in June, August, and September, during which the loggers were cleaned, downloaded, and repositioned if needed. Additionally, measurements of water temperature and specific conductivity were taken using a YSI ProSolo field meter during all maintenance events and during deployment and retrieval.



MAP 1. Cold Brook conductivity sites shown along with the land use associated with their watersheds.

Quality assurance and quality control of the data followed the USGS Guidelines and Standard Procedures for Continuous Water-Quality Monitors (Wagner et al., 2006), as well as the HOBO® logger user manuals and best professional judgement. Conductivity data were converted to specific conductivity and calibrated, if necessary, through the HOBOware® Pro Conductivity Assistant using YSI

ProSolo field measurements or post-cleaning logger values. At site CO-1, values from August 23 to September 21 and from October 14 to November 1 were removed due to the logger being out of the water (presumably pushed onto the bank during a high-flow event). Air temperature and daily precipitation values were taken from a NOAA weather station in Fryeburg, ME (National Centers for Environmental Information, 2022).

RESULTS

Similar to 2021, temperature and specific conductivity values were higher at CO-2 compared to CO-1 in 2022 (Figure 1). Water temperatures were strongly influenced by atmospheric weather conditions, as indicated by the similar temporal pattern observed between the two sites and air temperature (Figure 1a). Specific conductivity had a weaker response to weather conditions at both sites, with values generally remaining constant before and after precipitation events (Figure 1b). An exception to this is large precipitation events like those on August 22, September 5, September 18, and October 13 when pulses of freshwater caused a subsequent decrease in specific conductivity at CO-2. Similar to 2021, extended periods with minimal rainfall like that observed from June 10 to August 21 in 2022 resulted in elevated specific conductivity values at CO-2 while values at CO-1 remained constant. During this period, the average specific conductivity was 15 µS/cm at CO-1 and 34 µS/cm at CO-2. During all times outside of this period (e.g., April 22 to June 9 and August 22 to November 1), specific conductivity values were more similar at the two sites, averaging 13 µS/cm at CO-1 and 16 µS/cm at CO-2. Due to the locations of CO-1 and CO-2 along Cold Brook, it is possible that the elevated specific conductivity at CO-2 during dry weather is the result of the concentration of discharge from the septic system in the watershed (see Discussion).

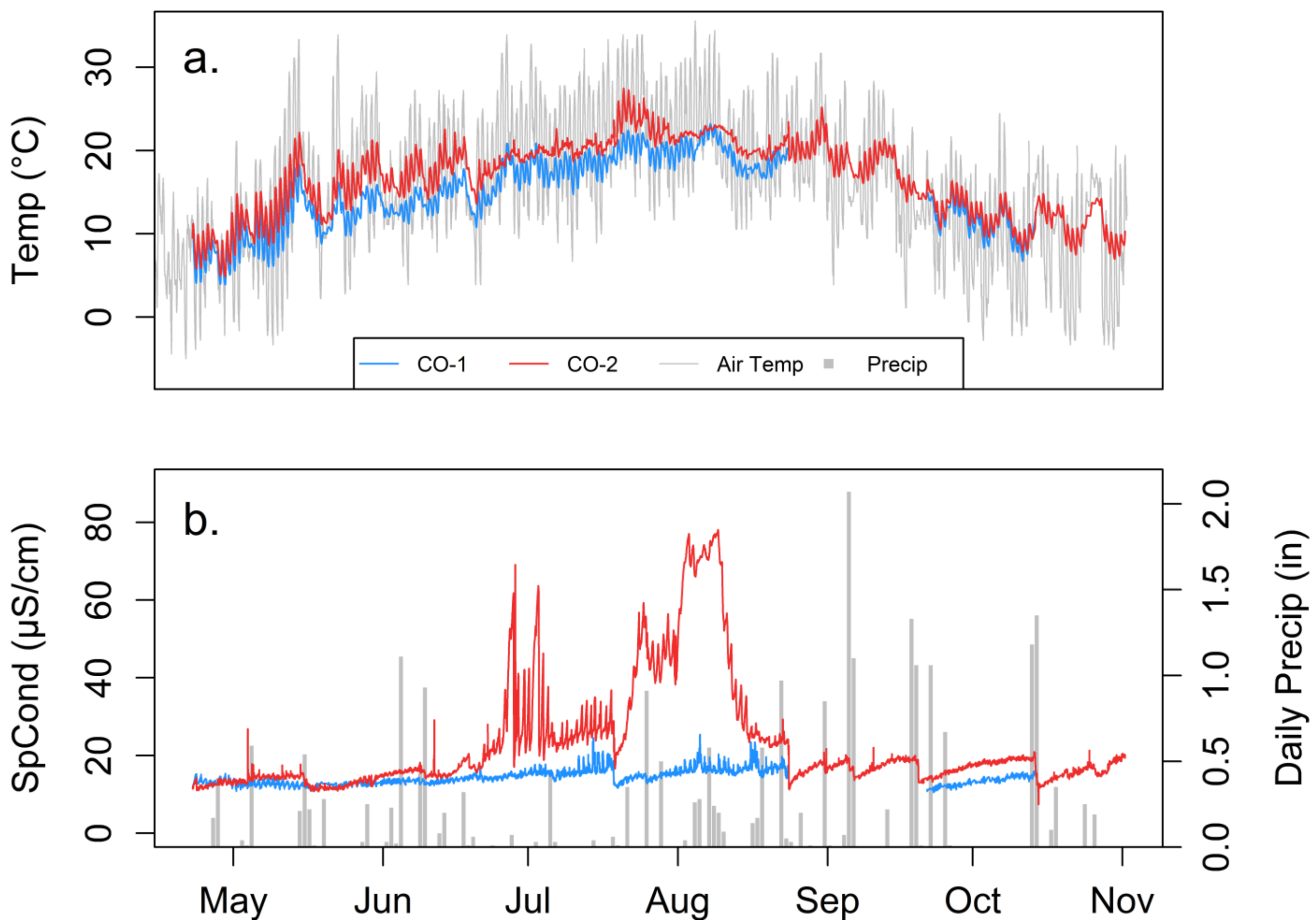


FIGURE 1. 2022 continuous monitoring data for Cold Brook at sites CO-1 and CO-2 for (a) water temperature and (b) specific conductivity. Time series of weather conditions (air temperature and daily precipitation) are shown in gray.

DISCUSSION

Other Factors

Although the specific conductivity results from both 2021 and 2022 suggest that the septic system may have been impacting water quality in Cold Brook during baseflow, other factors may also have been influencing the difference in specific conductivity between the two sites. As was discussed in the 2021 memo, differences in land use and stream geomorphology could also be contributing to the higher specific conductivity at CO-2. Even if the septic system were absent, it is possible that the conductivity at CO-2 would still be higher than CO-1 due to the localized logging activity and more erodible floodplain channel at CO-2 likely contributing more dissolved constituents than the forested, rock-stabilized banks at CO-1. Further complicating the matter, a beaver dam was discovered roughly 500 feet upstream of CO-2 during the September 21, 2022 maintenance event. This dam was likely in place for most of the 2022 logger deployment period and therefore would have impacted conductivity values at CO-2. Since beaver dams are typically hotspots of microbial decomposition due to their ability to trap organic debris within the upstream impoundment, they can cause an increase in the concentrations of dissolved constituents downstream (Grudzinski, et al. 2022). In addition to differences in land use and geomorphology, this potential increase in dissolved constituents from the beaver dam could be contributing to the elevated specific conductivity values at CO-2.

Beaver dam upstream of site CO-2 on September 21, 2022. © FBE.

Logger out of the water at site CO-1 on September 21, 2022. © FBE.

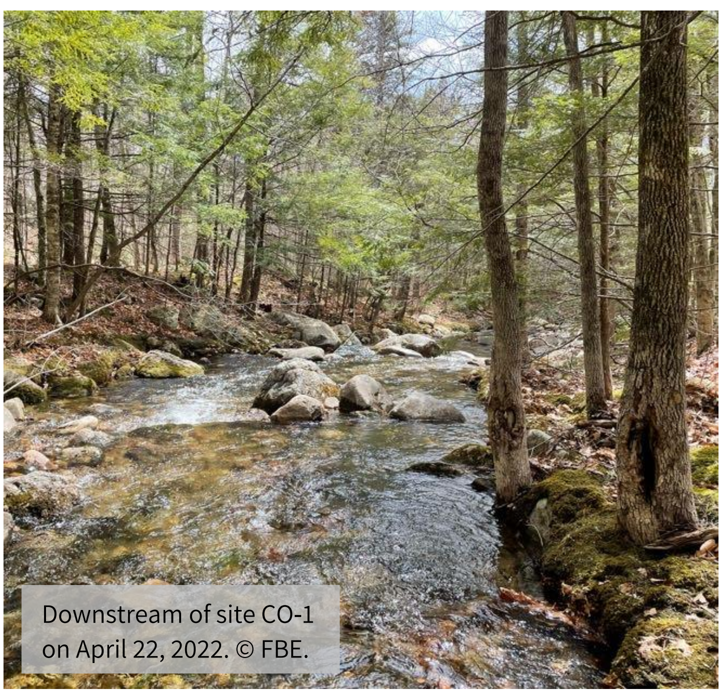
Dam impoundment upstream of site CO-2 on September 21, 2022. © FBE.

Comparison Between 2021 and 2022

One of the factors controlling interannual variability in specific conductivity is precipitation. Depending on the conditions in the watershed, precipitation can either increase specific conductivity by flushing more dissolved constituents into a waterbody or decrease specific conductivity by diluting concentrations in the water. In the case of Cold Brook, precipitation tends to decrease specific conductivity as large events cause a subsequent decline in values at both sites, with the decline being more pronounced at CO-2.

Total precipitation was similar in the region during the growing seasons of 2021 and 2022, causing specific conductivity to also be similar between the two years (Figure 2). From May through October, total precipitation in Fryeburg, ME was 18.6 inches in 2021 and 23.8 inches in 2022. The corresponding average specific conductivity values over that interval for CO-2 were 25 µS/cm in 2021 and 23 µS/cm in 2022. For CO-1, average specific conductivity over that interval was 16 µS/cm in 2021 and 14 µS/cm in 2022. Although average levels were similar between the two years, the timing and magnitude of the spikes in specific conductivity varied depending on the pattern of precipitation during both years. In 2021, specific conductivity at CO-2 spiked twice at the beginning and end of June to values over 60 µS/cm and 100 µS/cm, respectively, as the conditions during that time were abnormally dry (concentrating dissolved constituents). In 2022, the peaks in specific conductivity at CO-2 occurred later in the year and over a longer period but were lower in magnitude, remaining below 80 µS/cm throughout the summer. This difference was because the lack of rain in 2022 was not as severe as 2021 but rather consisted of moderate rainfall for the end of June through the beginning of August.

Despite the septic system upgrade, specific conductivity was similarly high at CO-2 in 2022 compared to 2021, suggesting that either leachate in soils and groundwater were still flushing out or the leachate signal was negligible in the specific conductivity data for 2021. The small decline in average specific conductivity at CO-2 in 2022 is better explained by an increase in precipitation that year than any upgrade to the septic system as the control site CO-1 also experienced a similar average decline in specific conductivity. To better understand the cause of the elevated specific conductivity at CO-2, other parameters should be investigated at the two sites.



Downstream of site CO-1 on April 22, 2022. © FBE.

Downstream of site CO-2 on April 22, 2022. © FBE.

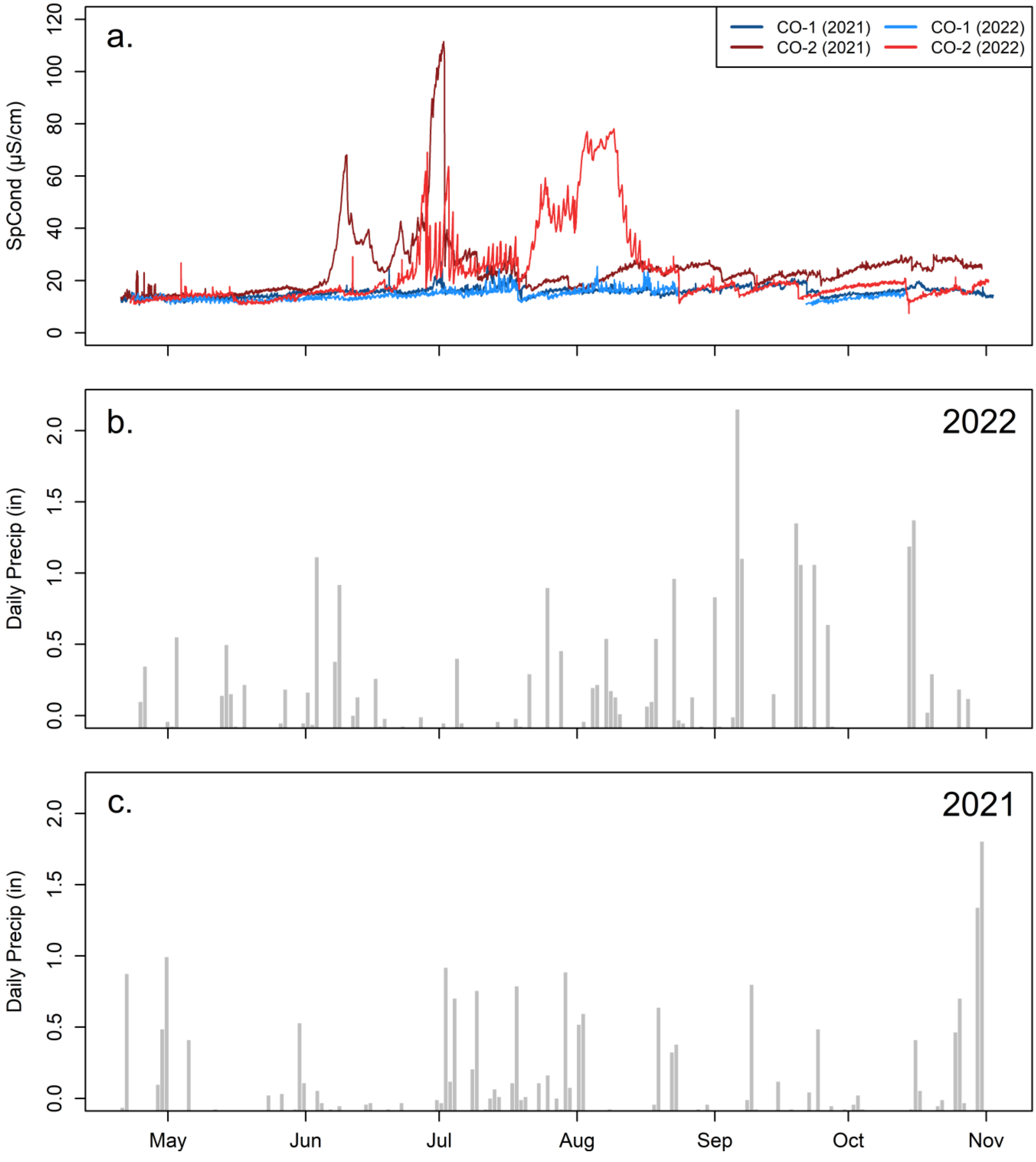


FIGURE 2. Time series plots of (a) specific conductivity at sites CO-1 and CO-2 in 2021 and 2022, (b) daily precipitation in 2022, and (c) daily precipitation in 2021.

CONCLUSIONS

- CO-2 experienced elevated specific conductivity during dry periods in 2022 (similar to 2021), suggesting that either leachate in soils and groundwater were still flushing out despite the septic system upgrade or the leachate signal was negligible in the specific conductivity data for 2021 and the elevated specific conductivity at CO-2 is due to logging or other activities.
- In addition to differences in land use and stream geomorphology, a beaver dam located just upstream of CO-2 could also be contributing to the difference in specific conductivity observed between CO-1 and CO-2.
- Total precipitation was similar in 2021 and 2022, causing the average specific conductivity during the growing season at CO-2 and CO-1 to be similar between the two years.
- Differences in specific conductivity between 2021 and 2022 are better explained by precipitation than any upgrades to the failing septic system.
- To further investigate the cause of elevated specific conductivity at CO-2, additional parameters such as nutrient and bacteria concentrations should be collected at both sites.

REFERENCES

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