# Physical and biological removal of nitrate along a Colorado montane headwater stream: Understanding the role of bidirectional hydrologic exchange at various spatial and temporal scales

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**Abstract.** Along Colorado Front Range stream networks, agriculture and industry have increased the amount of biologically available nitrogen in stream networks. This can shift ecosystems from N limited to N saturated, typically resulting in eutrophication. The removal of nitrate is thus important to understand for water quality concerns. Nitrate in a stream can be removed biologically through denitrification or assimilation, or physically, through a hydrologic flowpath leaving the main channel. Various mass balance approaches are used to understand removal rates of nitrate, yet rarely are used in conjunction with the hydrologic mass balance of the system. Therefore, the models do not include the bidirectional exchange of surface water and groundwater along the channel. We seek to determine the current biological nitrate removal rates in a forested headwater stream catchment through resolving the hydrologic mass balance and the nitrate mass balance. The combined mass balance approach will include lateral inflows and outflows along 100 meter increments of a 1000 meter reach of Lower Gordon Gulch Creek, Colorado. The creek runs west to east with north-facing and south-facing hillslopes, and drains a 2.5 $km^2$ catchment of the Boulder Creek Watershed, a drinking water supply for the city of Boulder, Colorado. Preliminary results suggest that upstream locations may act as biological nitrate sources, whereas downstream locations may act as biological nitrate sinks. Moreover, increased hydrologic fluxes of nitrate to the stream correlate with increased biological nitrate removal, much like Michaelis-Menten kinetics. Such findings are important for management considerations involving preservation and/or restoration of Front Range headwater streams to maintain or improve downstream water quality.