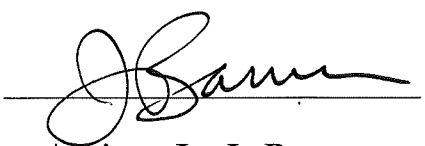
SOURCES AND PROCESSES OF IMPACTS ON STREAM WATER EVOLUTION IN A RAPIDLY URBANIZING WATERSHED IN AUSTIN, TX

Lakin K. Beal

ABSTRACT

Conservation of fresh water resources in urban systems is critical for ensuring fresh water resiliency, yet the associated urbanization of watersheds will increasingly impact the quality and quantity of these resources. We investigate geochemical sources and processes through which municipal (supply and waste) water impacts stream and spring water composition in the Bull Creek watershed (Austin, Texas), which exhibits a pronounced spatial gradient in its rapid urban development. Isotopic ($^{87}Sr/^{86}Sr$) and elemental variations in stream and spring water are assessed for both urban and rural sites. Stream and spring water compositions reflect increasing urban impact, wherein $^{87}Sr/^{86}Sr$ values and ion concentrations are used to quantify the relative influence of municipal versus natural water contribution to stream and spring water compositions. A strong correlation between increased urbanization and $^{87}Sr/^{86}Sr$ values of stream water can be accounted for by two different models: (1) municipal water leakage from failing urban infrastructure and/or irrigation, or (2) ion exchange as precipitation infiltrates through naturally varying $^{87}Sr/^{86}Sr$ in soils. Significant increases in irrigated soil $^{87}Sr/^{86}Sr$ values relative to unirrigated soils indicate that municipal water resets soil compositions with extensive irrigation, and that process (1) is thus a dominant driver of stream and spring water evolution at urban sites. Elevated Na and Cl concentrations in the urban stream and spring waters, relative to endmember concentrations (rural water, and municipal supply water), are indicative of municipal waste water influence. Fluid mixing models between these endmember compositions show that urban stream and spring water is influenced by up to 95% municipal supply water composition. Water-rock interaction modeling supports a new geochemical evolution pathway, whereby municipal water infiltrates through and interacts with limestone bedrock as groundwater prior to stream discharge. This geochemical modeling of urban stream and spring compositions yield varying groundwater residence times, and provides evidence that municipal water may take both phreatic (i.e., long groundwater residence time) and vadose (i.e., short groundwater residence time) zone flow pathways. This study documents the significance of municipal water influence on stream and spring water compositions in a semi-urbanized watershed, and uniquely identifies the flow pathways and geochemical evolution of municipal water once it leaves the urban infrastructure network. We advocate that municipal water evolved by these processes should be considered as a significant component of watersheds and aquifers.



Advisor: Jay L. Banner