

Geology and ground-water resources of Townsend Valley, Montana

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Groundwater-Surface Water Interaction

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ABSTRACT
Groundwater-surface water interaction has received increasing recognition as a key area of research that will improve our understanding of the global water cycle. Rather than treating these resources separately, understanding their interaction provides insight into responses to both natural changes and global change. Research into groundwater-surface water interaction has also revealed heterogeneity that challenges our ability to make measurements at the appropriate scale. Despite these challenges, advances in monitoring methods using geophysics, remote sensing, and direct monitoring have provided new insight into spatial and temporal variation in groundwater-surface water interactions.

KEY WORDS: Hydrogeophysics, seepage, barometric, seepage, seepage, seepage.

1. INTRODUCTION

Understanding the hydrologic cycle requires not only studying the resources such as groundwater, surface water, and the atmosphere, but also the transitions from one resource to another. Groundwater is a natural part of water cycles, natural processes in the subsurface. As such, the flux of water between groundwater and surface water is governed by the equation for saturated flow in porous media (Darcy's Law) (Equation 1):

$$Q = -K \frac{dh}{dx} \quad (1)$$

where K is the hydraulic conductivity of materials on the top of a lake, stream, or other surface water feature and is the head gradient across the interface. Although this equation shows the potential for quantifying transitions, the fluxes between groundwater and surface water are not well understood (1). The boundary is difficult to understand, which makes measurement difficult. Recharge is and discharge from groundwater is heterogeneous, so point measurements do not sufficiently measure the nature of these fluxes.

The interface between groundwater and surface water occurs where the water table (top of the saturated zone) intersects land surface. In other words, the groundwater-surface water interface occurs in streams and rivers, lakes, wetlands, and the ocean. Other than pore discharge or recharge, the discharge is occurring below the surface of the water. Simply stated, for no water to discharge is occurring because surface water is a manifestation of groundwater.

discharge. Many streams would go dry between rain events if they did not receive groundwater discharge (often that means the water discharge from streams is not a discharge of water). When the water table drops, wetlands and lakes can go dry. Perched lakes or low permeability sediments can persist above the water table, but most lakes receive groundwater discharge or have a combination of groundwater discharge and recharge. Even for a water body or wet at the same, groundwater discharge has been recognized as an important component of the hydrologic cycle (2). Thus, groundwater discharge is a manifestation of all surface water resources (3).

The interface can involve flows in both directions (Figure 1). Lakes and wetlands are known to both gain and lose water to groundwater. Perched lakes can lose groundwater through low permeability lake beds. Groundwater discharge is also typically occurs along the three basic flow system concepts (4, 5), but can be gaining streams (from groundwater) or one losing and losing (losing flux to groundwater) in another. Streams can be gaining or

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