

**INVESTIGATION OF SURFACE WATER - GROUNDWATER INTERACTIONS AS A BASIS TO ADJUST MUNICIPAL LAND USE POLICY IN PENNSYLVANIA: STEWARDSHIP IMPLICATIONS FOR DEEP AQUIFER WATER SUPPLY AND STREAM-BREEDING SALAMANDERS**

James Shallenberger, Paul Cooper, Scott McBurney, Robert Stanfield  
Princeton Hydro, LLC  
1108 Old York Road  
Ringoes, NJ 08551

**ABSTRACT**

Two years of hydrological investigation are complete in a rural, forested catchment setting in Bucks County, Pennsylvania's diabase bedrock region. The diabase forms a topographic high area with clay- (i.e., montmorillonite) dominated soil types that present slight opportunity for groundwater recharge. Groundwater movements occur at/near the soil – bedrock interface and in the bedrock via interconnected fractures. Most groundwater flow systems are inferred to exhibit short flowpaths that discharge to a network of streams including some that are state-designated exceptional value. Moreover, the diabase lacks primary porosity; interconnected fracture zones predominate in the uppermost 100-foot thickness of the diabase, that in places, exceeds 400 feet thickness.

The investigation includes manual and automated water level measurements in low-order streams as well as a network of well points installed in riparian wetland and upland portions of the study area. In addition to water level monitoring, a water budget was prepared based on stream stage – discharge relationships determined using two V-notch weirs as well as instantaneous stream velocity measurements in the study area, and rainfall records. Salamander occurrence is surveyed at least monthly in settings that satisfy categorization along a hydrology gradient as: (i) persistent/perennial flow, (ii) groundwater discharge (i.e., spring/seep), and (iii) intermittent flow. The salamander survey method consists of both within-bank and above-bank searches with fixed effort targeted to a discrete number of natural cover pieces.

The primary objective of our investigation is to estimate a water budget in a forested headwaters catchment in order to infer the annual proportion of precipitation available for deep aquifer recharge. Deep aquifer recharge capacity is considered an important factor for municipal land use rules to ensure adequate potable water supply exists for residents in the area. The investigation also is being used to correlate potentially sensitive biota (specifically salamanders; Order Caudata) to physical hydrology and water chemistry variables. The relationship between salamander use/abundance and hydrology gradients is expected to furnish additional context to adjust municipal land use policies/ordinances with the aim of preserving the area's extraordinary natural resource features and rural character in the face of increasing land development pressures.

**KEYWORDS**

Hydrology study, diabase aquifer recharge, salamander/Caudata, linking salamanders to hydrology variables