

Characterizing ground water contributions to stream flow in the Mill Run, PA watershed.

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Introduction and Goals

The Mill Run watershed is located within West Mead Township, Crawford County, PA. Mill Run flows through the city of Meadville and drains into French Creek. The Mill Run watershed is 2,295 hectares (6,500 acres); the headwaters start in the valley where Tamarack Lake occurs. Historically, the headwaters consisted of a swampy valley; the Lake was built in 19 for recreational purposes.



Figure 1. Aerial photograph of the Mill Run watershed.

The goal of our work was to answer two questions:

- 1) What are the ground water contributions to surface flow in Mill Run?
- 2) How much groundwater recharge is likely to occur in the watershed and where does it occur?

The area is underlain by Paleozoic sedimentary rocks and Quaternary glacial deposits (Fig. 5). The stream bottom consists of glacial deposits along some reaches and Devonian bedrock along others; the downstream portion of Mill Run has been cemented into a fixed channel. Four intermittent streams, the outlet from Tamarack Lake, and groundwater discharge represent the contributions to flow in Mill Run. Groundwater recharge should occur since less than 11% of the land surface has impermeable cover (Table 1).

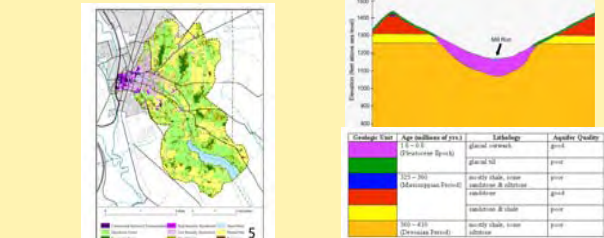


Figure 4 (and Table 1 below). Land use/land cover map and data.

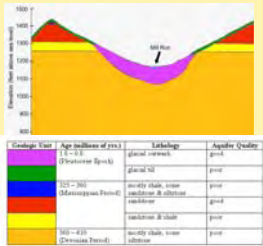


Figure 5. A schematic cross-section of the bedrock and surficial geology in the watershed.

Stream sampling

On October 14, 2004 we sampled from the headwaters of Mill Run to where it drains into French Creek. Four sampling locations were chosen to measure stream discharge (Q) and collect water samples for dissolved silica analysis. In addition, a perennial groundwater spring in the watershed was sampled for comparison.

Figure 5. Sampling locations along Mill Run. Photographs of (a) Tamarack Lake and (b) the outlet from the dam.

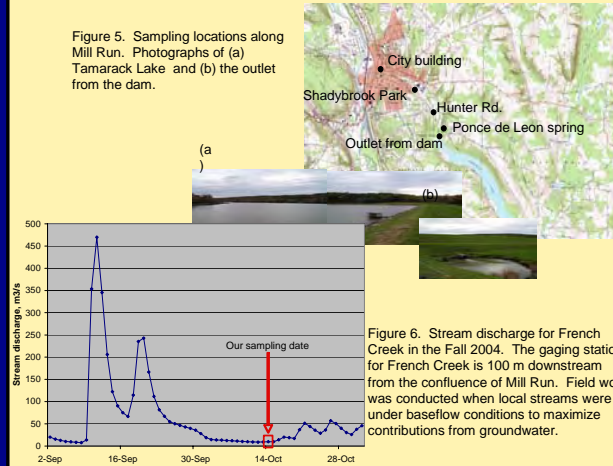
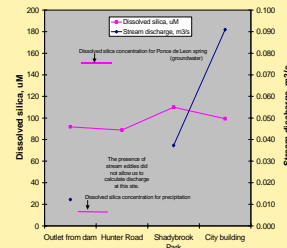


Figure 6. Stream discharge for French Creek in the Fall 2004. The gaging station for French Creek is 100 m downstream from the confluence of Mill Run. Field work was conducted when local streams were under baseflow conditions to maximize contributions from groundwater.

Figure 7. Changes in stream Q and dissolved silica along the stretch of Mill Run. Discharge increases from 1.2×10^{-2} to $9.1 \times 10^{-2} \text{ m}^3/\text{s}$ in the downstream direction. Dissolved silica concentrations also increase downstream, suggesting that groundwater contributions occur along the entire stretch of Mill run.



Our stream sampling results indicate:

Under baseflow conditions, groundwater contributions to Mill Run occur along the entire stretch. Mill Run is a gaining stream.

Water budget & recharge estimates

A budget can be written for the inputs and outputs of water to the Mill Run watershed. In a simple mathematical format, this budget is expressed as:

$$P - (ET + Q) = \text{Changes in groundwater}$$

Where P = Precipitation into the watershed

Q = Stream discharge from the watershed

ET = Evapotranspiration from the watershed

If the outputs (ET + Q) do not equal the inputs (P), then water is either gained from or lost to the groundwater system.

Under baseflow conditions, an annual water budget is:

6.5 billion gallons - (4.2 billion gallons + 0.77 billion gallons) =

1.5 billion gallons of water recharges the groundwater system

(Note: This is a maximum estimate because the stream discharge value (Q) is likely to be much larger most years.)

Where is recharge likely to occur within the watershed?

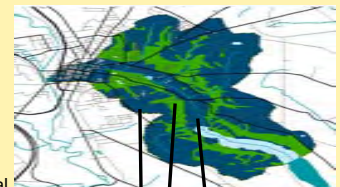
We used a geographic information system (GIS)

to combine spatial datasets:

- Soil type
- Slope of land
- Land use/land cover

Based on these characteristics,

we created a map of the potential for groundwater recharge (Fig. 8).



Our recharge results indicate:

Under baseflow conditions, groundwater recharge occurs on hilltops and in the valleys of the watershed.

Figure 8. GIS map of groundwater recharge potential. Blue areas are zones likely to receive recharge; green zones are areas less likely to have recharge. Black lines identify topographic settings for each zone--recharge occurs on hilltops and in valleys; the walls of the valley are not conducive to recharge..