

Concept plan for USGS study on establishing potential groundwater ages in springs in the Black Earth Creek watershed

Hydrologic studies in the Black Earth Creek (BEC) watershed over the last 20 years have made many advancements in understanding the overall groundwater and surface-water flow system in the basin. Groundwater flow models by the USGS (Hunt and others, 2016) and the Wisconsin State Geologic and Natural History Survey (Parsen and others, 2016) have established general groundwater flow paths and contributing areas to BEC and its tributaries, but these models were not sufficiently detailed to establish specific source areas or time-of-travel to individual spring complexes throughout the watershed. Recent and planned changes in land use in the Cross Plains area have raised questions about potential impacts on the spring complex east of the Brewery Creek tributary (Festge Spring Complex). Developing an understanding of the age and source of groundwater feeding the Feste Spring Complex and other spring complexes will help determine the impact land use changes may have on spring discharge east of Cross Plains and throughout the watershed.

Evidence suggests Festge Springs are fed by water from a high-transmissivity fracture zone in the Tunnel City Group which is part of the upper bedrock aquifer in Dane County (Hunt and others, 2016; Swanson and others, 2006). The Wisconsin Springs Inventory identifies other springs in the Black Earth Creek watershed, such as the headwaters of Garfoot Creek, (Swanson and others, 2019) that appear to stratigraphically intercept the Tunnel City Group. The high-discharge zone in upper Black Earth Creek falls right within the Tunnel City zone of the Dane County bedrock geologic map (Brown and others, 2013).

Groundwater age dating in the upper bedrock aquifer in locations across Dane County have found waters up to 1,000 years old (K. Hood, USGS, written com, 2026) and WGNHS studies have found upper bedrock groundwater with no modern component in several areas of Dane County (Bradbury and others, 1999), including sites in the Black Earth Creek watershed. Shallow glacial aquifer water in the county has been found to be on the order of 5-35 years old (Hood; Bradbury and others).

To determine spring water age and potential sources, we propose a study that would collect groundwater samples from spring complexes, shallow groundwater from the unconsolidated aquifer and groundwater from the bedrock aquifer within the BEC watershed. Age dating techniques and testing for modern water tracers will be used to help determine the relative age of groundwater feeding various springs. This information would be highly relevant to understanding the sensitivity of Festge springs and other spring complexes throughout the watershed to recent and future changes in land use and would help future efforts to update or refine groundwater models for the area. Though age dating will not reveal direct contributing areas, it does indicate the likely depth of groundwater source which can be used to infer sensitivity to land use changes. Young water, for example, would indicate a shallow, local contributing area, while old water would indicate a deeper bedrock source with a more distant contributing area.

Scope and Timeline

This project is expected to last three years. We propose selecting about 12 individual sampling locations, including several discharge zones within the spring complexes around the watershed and other groundwater sites to use for comparison. Years one and two would focus on the field effort of planning and collecting samples. The first year would include selecting field sampling sites, testing sampling equipment, and collecting samples for tritium, nutrients, major ions, and possibly one or more anthropogenic contaminants such as pharmaceuticals. Sites with no detectable tritium would be re-sampled the following year for additional age-dating tracers, including noble gases, carbon-14, and Helium-3/helium-4. The third year would include chemical age interpretation analysis and report production.

Estimated Budget:

Breakdown:	Year 1	Year 2	Year 3	total
Staff: fieldwork and planning; project management; analysis and writing	\$ 52,000	\$ 42,000	\$ 100,000	
Sample analysis and publication costs	\$22,500	\$ 37,600	\$17,000	
Total estimated costs	\$ 74,500	\$ 79,600	\$ 116,000	\$ 271,100
Possible USGS Matching Funds	\$ 14,500	\$ 15,520	\$ 23,400	\$ 53,420
Cooperator Funding	\$60,000	\$64,080	\$93,600	\$ 217,680

References:

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Hunt, R.J., Westenbroek, S.M., Walker, J.F., Selbig, W.R., Regan, R.S., Leaf, A.T., and Saad, D.A., 2016, Simulation of climate change effects on streamflow, groundwater, and stream temperature using GSFLOW and SNTMP in the Black Earth Creek Watershed, Wisconsin: U.S. Geological Survey Scientific Investigations Report 2016–5091, 117 p., <http://dx.doi.org/10.3133/sir20165091>

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