

# **Anthropogenic Compounds Associated with Groundwater Near an Abandoned Copper and Uranium Mine, Grand Canyon, AZ, USA**

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Previous studies along the south rim of Grand Canyon have suggested different flowpaths (towards Indian Garden Spring or Monument Spring) for the treated wastewater effluent discharged since the 1980s on the rim of the Grand Canyon along Bright Angel Wash. In 2021, effluent at the source along Bright Angel Wash and 6 springs discharging around 3,000 vertical feet below the south rim were analyzed for anthropogenic compounds for the first time. Two springs (Monument and Upper Horn Bedrock) showed the presence of anthropogenic PFAS compounds and elevated nitrate, but not at Indian Garden Spring. Monument Spring had higher nitrate and PFAS concentrations suggesting a higher proportion of water with recent anthropogenic compounds compared with Upper Horn Bedrock Spring. Groundwater discharging to Horn Creek, located near the Orphan Mine (a former copper and uranium breccia pipe mine), first emerges from the base of a bedrock cliff at Upper Horn Bedrock Spring which has elevated and variable uranium concentration (151 to 290 µg/L). The water discharging from the Upper Horn Bedrock Spring had slightly elevated nitrate compared with surrounding springs and low-level concentrations of two PFAS compounds. The presence of water with modern anthropogenic compounds in proximity to a uranium mine has implications for mobility of trace elements associated with the ore deposit that introduce additional complexities for remediation. Additionally, the southwestern United States is experiencing a prolonged drought and contributions from artificially recharged water may comprise a larger component of the water system going forward. Further time series sampling at Horn and Monument Springs is needed to understand geochemical variability related to variable contributions of water with anthropogenic compounds to the groundwater system of the south rim of the Grand Canyon.