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Hydrogeologic and Geomorphic Processes in a Wastewater Spray Irrigated Agricultural System Located in a Karstic Seasonably-Cold Climate

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Pennsylvania State University has been operating a wastewater irrigation site known as the “Living Filter” continuously since 1962, making it one of the oldest wastewater irrigation sites in operation with an unparalleled wealth of data accumulated over decades. The geology of central Pennsylvania, specifically the Nittany Valley, is comprised of carbonate-derived geologic formations with regionally orientated fracture traces in a SW-NE trend. The presence of fracture traces can produce concentrated areas of high permeability which can result in dolines in areas of easily dissolved rocks such as carbonates. The addition of roughly 1.5 MGD of secondary treated wastewater over cropped and forested lands has resulted in the formation of several suspected subsidence dolines in the area with the same general lineation as the fracture traces. Digital Elevation Models (DEMs) over the past decade indicate a rate of change for the areal extent of the dolines on cumulative order of several thousand square feet. By tracking the dolines over time we can determine whether or not irrigation using secondary treated wastewater has a significant impact on the regression of dolines. The transmissivity of wells drilled within the bedrock fractures in the unconfined aquifer are 40 to 100 times higher than the values of wells drilled outside of the fractures suggesting that the bedrock fractures can act as preferential flow pathways. Wastewater is rich in organic matter, nitrate, phosphate, and several other compounds that can seriously effect groundwater quality. Since 1982 nitrate, phosphate, and fecal coliform levels have been monitored in wells in and around the site. By creating a groundwater model that matches previous concentrations we can predict what the contaminant profiles might look like in several different scenarios as the rate of wastewater application to the Living Filter is expected to decrease beginning in the year 2020. By determining the long term impacts of changes to the irrigation rates to the Living Filter we can better understand the effects that might take place on the groundwater quality.