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Well responses to barometric-pressure fluctuations in confined and semi-confined aquifers

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Modern data logger and sensor technology enable well responses to barometric pressure changes to be monitored at a high frequency and precision. In this presentation, we demonstrate that such monitoring data can be utilized not just for the conventional calculation of a well's barometric efficiency but also to provide valuable information for site characterization applications. We investigate the water-level responses of wells in confined and semi-confined aquifers to changes in barometric pressure and show how simple analytical solutions can be fit to experimentally determined barometric response functions to place bounds on the properties of the confining bed. We demonstrate our approach at the Larned Research Site, located along the Arkansas River in south-central Kansas in the Great Plains region of the United States. The site contains monitoring wells tapping an unconsolidated, semi-confined aquifer (High Plains Aquifer) overlain by a clay unit and a shallow, unconfined aquifer. Water levels and atmospheric pressure have been monitored in the wells at 15-minute intervals for up to seven years. The spatial and temporal changes in the barometric response functions provide important insights on the degree of confinement and its change in space and time. Short term (hour or less) response functions indicate a classical confined aquifer, whereas long term responses (day) show semi-confined behavior, an indication that the air pressure exerted on the water table is being transmitted downward through the confining bed. The barometric response functions vary little in space, indicating the homogeneity of the confining bed, but do vary temporally as a function of the water table elevation and the pneumatic diffusivity of the vadose zone.