High-Resolution Site Characterization of a Glacial Aquifer System Using Environmental Sequence Stratigraphy (ESS) and Geophysical Logging of Existing Monitoring Well Network

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Background/Objectives. Glacial aquifer systems are widely regarded as among the most heterogeneous, making high resolution site characterization an almost essential component of site investigation. However, direct push technologies are not always feasible or cost-effective in glacial substrates due to highly compacted and/or gravel-rich tills and outwash. To efficiently create a site-wide subsurface conceptual site model for groundwater and better understand preferential pathways within a buried valley train and till aquifer system in southwestern Ohio we utilized the existing monitoring well network to collect continuous high resolution lithologic and hydrologic data.

Approach/Activities. We revisited over 40 cased monitoring well locations and logged them using natural gamma emissions. Gamma logging rates were reduced to under 10 ft/min to produce a robust signal in glacial terrain. In addition, we deployed a colloidal borescope at a subset of locations to determine flow velocity and direction within specific screened intervals. We applied Environmental Sequence Stratigraphy (ESS) techniques to create a detailed hydrostratigraphic framework for the site using lithologic data reformatted to reflect vertical grain size trends. Flow vectors from the borescope data were compared to potentiometric maps generated from two (spring and fall) synoptic rounds of water level measurements from over 160 wells.

Results/Lessons Learned. The ~60 to 80 ft thick permeable zones within the buried valley aquifer system is comprised of stacked 5 to 15 ft. thick fining upward successions of gravel and sand deposited as glacio-fluvial bars and channel fills. Flow within these units is generally parallel to the valley axis, though local variations in speed and direction potentially attributable to lithology were observed. Significant localized variation in flow direction and speed was observed in wells screened in outwash near the till uplands at margins of the valley train aquifer. This was also the case in shallow wells near modern river courses.

Most complex sites have a comprehensive network of active and inactive monitoring wells constructed over years of site investigation. Combining analysis of archived lithologic logs from these points with newly acquired down hole geophysical data provides an efficient means to vastly improve the vertical resolution of site data at a very low cost.