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Implications of Refining Vertical Resolution of Hydraulic Conductivity in the Numerical Modeling of Groundwater Flow to Surface Water, NAS Whiting Field, Florida

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Background/Objectives. Naval Air Station Whiting Field is located near Milton, Florida and is one of the Navy's two primary pilot training bases. Commissioned in 1943, historic operations at Whiting Field generated industrial wastes that contaminated soil and the water-table aquifer. The Environmental Protection Agency placed Whiting Field on the Superfund program's National Priorities List of contaminated sites in 1994. The U.S. Geological Survey was tasked with studying the contaminant migration and remediation processes at this site. A numerical model is under development to better define groundwater flow patterns, discharge to surface water, and the potential fate of contaminants. An initial model discretized the water-table aquifer into five layers, with the top layer between land surface and elevation -50 feet National Geodetic Vertical Datum of 1929 (NGVD29). However, with land surface ranging from 3.3 to 206.6 feet NGVD29, the top layer thickness is over 250 feet at highest land elevations. To more accurately simulate contaminant transport, refining the resolution in this top model layer is necessary.

Approach/Activities. Spatial variability in aquifer composition has been defined in aquifer cores at 6,296 different locations in the Whiting Field area and characterized by definitions in the Unified Soil Classification System.
The initial, lower-resolution groundwater model was developed with MODFLOW-NWT and calibrated to known groundwater levels with the PEST parameter-estimation code. The field-observed aquifer compositions were correlated to the calibrated hydraulic conductivity values in the model. This was used to develop a representative hydraulic conductivity for each composition to guide the development of the refined grid.

Each field-observed aquifer composition corresponded to a range of model hydraulic conductivity values. Despite these uncertainties, however, distinct trends are observed. The lowest median hydraulic conductivities are at locations with aquifer compositions specified as low-plasticity clay, with silt, poorly-graded clayey sand, and high-plasticity clay ranked next lowest. The highest median hydraulic conductivities correspond to well-graded sand and silty sand. This level of consistency indicates that the calibrated hydraulic conductivities reflect actual variations in aquifer properties.

The median hydraulic conductivities for each field location were used to specify initial values of parameters for a refined layering scheme in the numerical model. The original top layer is divided into five layers with bottom elevations of 150, 100, 50, 0, and -50 feet NGVD29, respectively. The top three layers are absent at locations with the lowest elevations, and the uppermost layer is, at most, 53 feet thick at the highest elevations.

Results/Lessons Learned. The vertically-refined model was used to simulate steady-state conditions. Comparisons with known groundwater level measurements indicated slight improvement over the pre-refinement model, with a reduction of sum of squared differences from 0.043 to 0.039 ft^2 for 59 well measurements. Further application of the numerical model may reveal geologically defined areas of preferential flow and accelerated contaminant transport from source areas to a surface-water body at lower altitudes.