In June of 2016, the US Geological Survey used waterborne-resistivity profiling to map the shallow (<10m) subsurface distribution of electrical properties as a proxy for streamed hydraulic conductivity. Two-dimensional vertical profiles of resistivity were used to identify differences in geophysical structure of the streambed for reaches of the Tallahatchie (10 km), Quiver (50 km), and Sunflower (70 km) Rivers in the Mississippi River Valley. Inverse modeling was used to develop two-dimensional (2D) vertical profiles of resistivity for each stream. Model results showed that Quiver River was 51 cm/m higher than the Sunflower River, and 38 cm/m higher than the Tallahatchie River. Differences in streamed lithology can be interpreted from the variation and distribution of resistivity values. Along the Sunflower, resistivity is highly variable, with a standard deviation of 50 cm/m, whereas the Tallahatchie has a standard deviation of 25 cm/m, and the Quiver River has a standard deviation of 20 cm/m, illustrating a decrease in variability of resistivity of the Tallahatchie, with a standard deviation of 25 cm/m, and 20% greater than the Quiver at 40 cm/m. In regional groundwater flow models, the hydraulic conductivity of unconsolidated materials is typically an estimated parameter because of difficulty in obtaining a data-supported value in real-world conditions. Modeled resistivities from this study will be used to scale streamed hydraulic conductivity within a regional groundwater-flow model to assess water-management scenarios. Future studies will continue the application of geophysical models to improve this approach.

**Methods**

- Waterborne-resistivity profiling was done using a 10-channel Tri Instruments ProSonic resistivity meter. A 40-meter long floating reciprocal Schleicher hammer with a 5-meter electronic cable was used to conduct the surveys (Figs 2-8.5).
- Geophysical positioning and water depth were collected using a Garmin GPSmap 88S handheld. Stream temperature, conductivity, and specific conductivity were measured using a YSI Pro Plus water quality meter.
- Data processing and visualization was done using Geosoft’s Oasis Montaj geophysical software. The raw and processed data are available in Miller (2016).

- Apparent resistivity data were modeled using k1D version 3.52 developed by Interpex Limited (2016).
- Occam’s inversion (Constable et al., 1986) was used to create a smooth-model for each sounding.
- The water column was represented in the model as layer 1. Layers 2-4 were used to evaluate the near-surface geotechnical properties of the streambed near the streamed controlling water surface and groundwater exchange.

**Results & Discussion**

Overall, resistivity values from waterborne surveys for the Sunflower, Quiver, and Tallahatchie Rivers show different resistivities that correlate to large-scale lithology changes in each geotechnical unit (Figs 5-6, Table 2.8.5). The Sunflower River (Figure 4): Resistivities were highly varied longitudinally along the main channel. The Sunflower meanders through a mix of backswab, point bar, and abandoned channel areas, each with their own geophysical signature (Table 2).

- As the river meandered into the abandoned channel deposits the resistivity values decreased substantially, indicating an increase in clay content found within the abandoned channel.
- As the river meandered out of the abandoned channel deposits, into the increasingly sandier point bar deposits, the resistivity increased rapidly, reaching 20-40 m as the channel meandered towards the point bar.
- Subsurface lithology data collected from the installation of three wells were used to evaluate the geotechnical properties of the streambed. The 3D resistivity surveys in combination with the geotechnical surveys. Along the western bank of the Sunflower River there are wells with documented borehole lithology (Figs 4.6-6). The resistivity values are approximately 15 m of clay which correlates with the low resistivity feature in the resistivity model.

**Conclusion**

Waterborne-resistivity profiling is a relatively quick, non-invasive method to map shallow subsurface geotechnical properties of rivers in the Mississippi River Alluvial Plain. The resistivity data in the study area has good correlation with mapped geotechnical and geomorphological features and can be used qualitatively, streamed hydraulic conductivity. For example point bar and abandoned channel deposits which contain substantially more clay have lower resistivity values. Lithological data from nearby boreholes confirmed the relation between resistivity and lithology at depth. The mapped geotechnical and resistivity data can be used collectively to design a targeted drilling program to develop a quantitative estimate of streamed hydraulic conductivity from the resistivity data.

**References**


**Map Citations**


