Effect of Liquid Conductivity on Time Domain Reflectometry based Water Level Measurement in Porous Media

Jessica Pippard

Mercer University

EXTENDED ABSTRACT

Time domain reflectometry (TDR) is a measurement technique that makes use of the time it takes for an electrical impulse to reflect back to a source. The reflected signal (waveform) may be correlated to a variety of soil properties, including moisture content and conductivity. This project studied the potential for the application of TDR technology to the measurement of landfill leachate levels. There are a number of factors that could impact the use of TDR for leachate level measurement, including the media surrounding the probe, the conductivity of the liquid, and the probe configuration. This project evaluated the impact of the conductivity of the liquid and size of the media on the generated waveform. The TDR probe used in this study consisted of a 30.5-cm long, 5.08-cm diameter PVC well screen with 0.51-cm slots surrounded by a stainless steel mesh with a stainless steel rod running through the center. The outer stainless steel mesh was soldered to the outer braid (shield) of a co-axial cable while the center rod was soldered to the conductor of the co-axial cable. The TDR measurement was taken via a Campbell Scientific TDR 100.

Experiments were conducted by placing the probe in a large cylinder with tubes attached for draining of the cylinder and reading of the water level within the cylinder. The cylinder was filled with water at ~2cm intervals to a depth of 21cm and then completely drained at intervals of ~2cm. TDR waveforms were taken for each water level. The data was then manipulated to identify the correlation between the waveforms and the water depths. These experiments were conducted with the probe standing in open water and then standing in five conductivities ranging between approximately 2500 and 30000µS/cm. These experiments were then repeated with the same five conductivities and small, medium, and large rock media surrounding the probe.

The evaluation of the data consisted of identifying a distinct change in the TDR waveform which could be correlated to the air-water interface. This point on the TDR waveform was then plotted against the water depth in the column. The relationship was found to be linear with a correlation coefficient of 0.9982 for the experiment with only water, 0.9990 for the lowest conductivity, 0.9930 for the second conductivity, 0.9964 for the third conductivity, 0.9972 for the fourth conductivity, and 0.9936 for the highest conductivity. The correlation coefficients for the small, medium, and large rock media when tested in conjunction with the five respective conductivities will also be included on the poster. These results indicate that the TDR waveforms can be used to accurately measure water depth in a variety of conductive liquids and rock media. The next phase of this project will be to evaluate the impact of probe configuration on the waveform measurement.