THE CONNECTICUT VALLEY SEISMIC AND RESISTIVITY STUDY

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INTRODUCTION

The Connecticut Valley of Western Massachusettes was the site of a seismic and electrical resistivity study conducted to determine the most effective methods for determining depth to the water table, bedrock and major interfaces within the sediment column above bedrock. Four study sites were chosen on the basis of their estimated depth to bedrock, the availability of well logs, and isolation from heavy traffic and excessive noise.

The methods employed in this study are most commonly used in the determination of shallow aquifer geometries. Seismic refraction analysis involves the timing of specific wavefronts of refracted rays produced by a near-surface seismic source and the plotting of these arrival times against their distances from the original energy source. By examining changes in velocity as seen in changes in slope, the depth and velocity of subsurface materials are determined. Seismic reflection analysis uses the measurement of reflected waves to determine layer thickness and velocities. These arival times are reflections of acoustic impedence which result from variations between the material interfaces. Electrical resistivity exploration used both the Wenner array with the Lee modification and the Schlumberger method. Each array uses slightly different spacing of the electrodes.

Each of the four sites was located on the floodplain of the Connecticut River. The dominant materials present were silty sands, lake clays and glacial tills. The bedrock is the Jurassic New Haven Formation which is predominantly an arkosic sandstone. The unconsolidated materials are predominantly Pleistocene deposits.

SITE INTERPRETATIONS

Aqua Vitae Road, Hadley

The most conclusive results fot this site are based on data from seismic reflection and elevtrical resistivity readings. Seismic reflection clearly indicate bedrock depth, whereas the study area is too restricted for seismic refractions to provide this information. Resistivity readings showed strong agreement between electrode configurations. Models correlated well with well logs.

The refraction data did locate the depth of the water table, as did the resistivity data which agreed with the refraction results. Information supplied by all methods was essentially in agreement.

Great Pond, Hatfield

The greatest agreement among methods for this site was found between the refraction data and the Schlumberger data. Both the Schlumberger and the refraction data were in agreement for the location of the water table, placing it at 3.0m below the surface. The Lee modification proved useful by indicating a lateral discontinuity in the sediment column.

Straits Road, Hatfield

Based on models derived from Schlumberger readings, the depth to the water table was determined to be 4.75m, which agrees with the figure of 4.8m obtained form seismic refraction analysis. The reflection data agreed with neither the resistivity data nor the refraction data as the offset was not great enough to receive bedrock reflections. No well logs were available for this site so no further comparison could be made. The refraction data and Shclumberger data also identified a second interface at a depth of 62m.

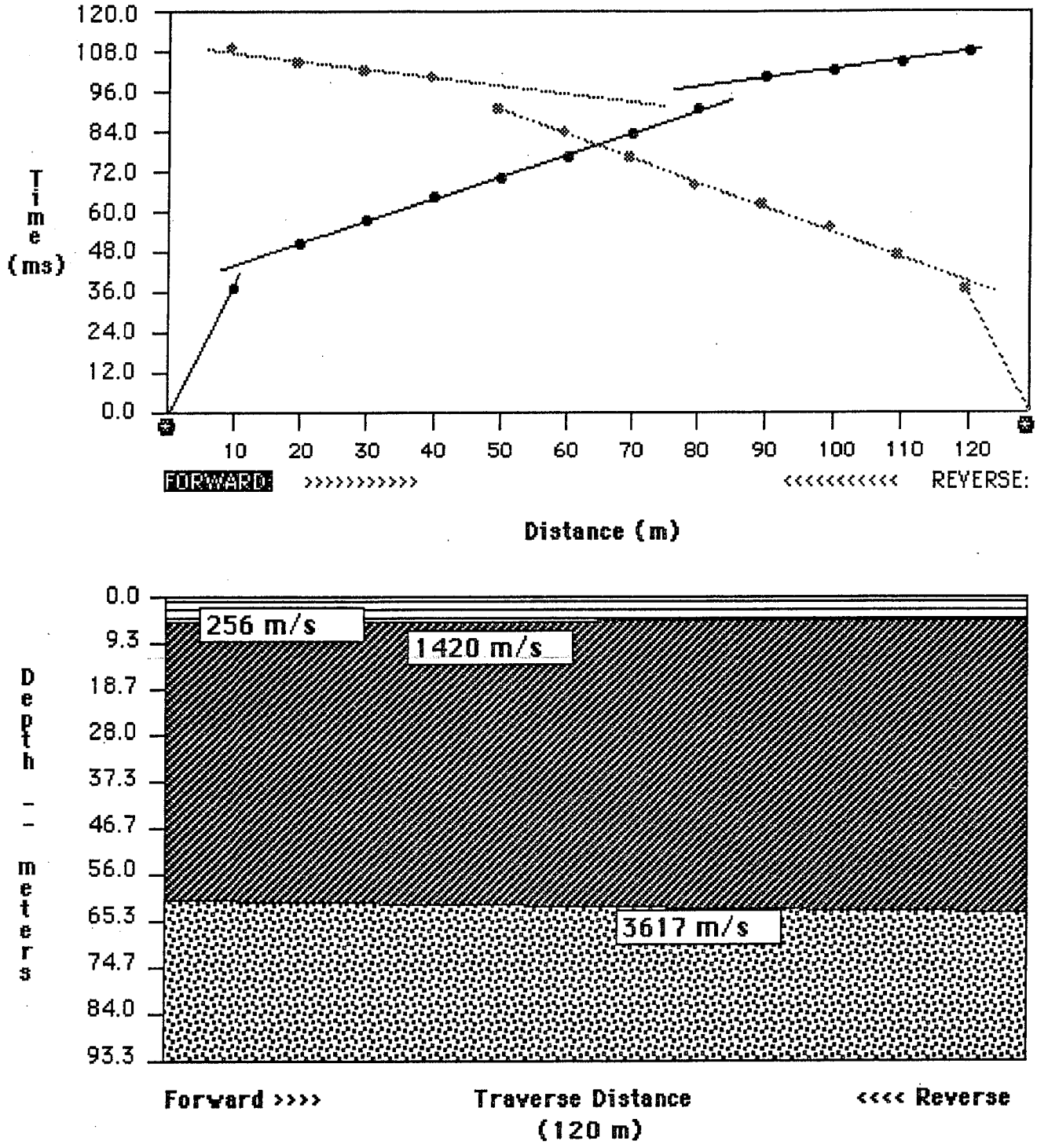

Figure 1. Refraction data and interpretation for Great Pond site. Both depth to water table and depth to the bedrock surface agreee reasonably well with resistivity data interpretations.

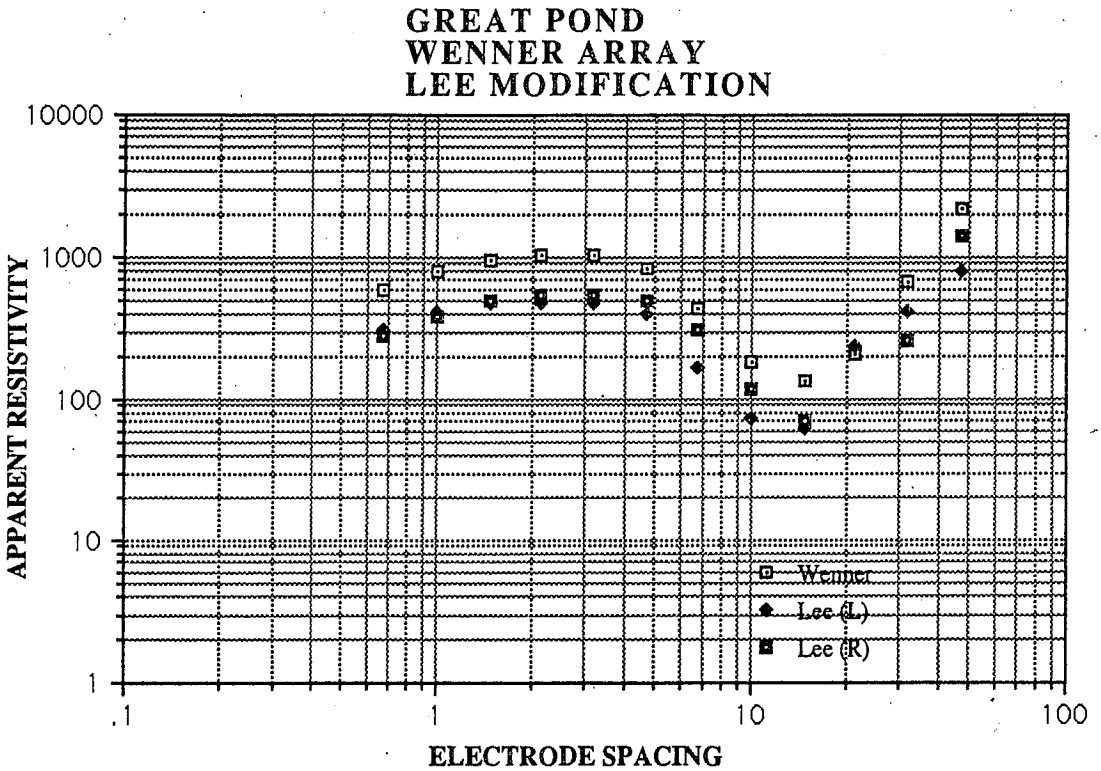

Figure 2. Electrical resistivity data for Great Pond using the Wenner electrode configuration with the Lee modification. Models place the water table at the same depth as refractions data, but lateral variations at depth (illustrated by the Lee measurements) preclude determining depth to bedrock with the Wenner data.

North Street/Roaring Brook, Whately

The well data for this site establishes the depth to the water table as 4m. There was agreement between the well data and the two resistivity methods pertaining to the depth of the water table and bedrock. The seismic reflection data places the depth to the bedrock interface at a lower value than the resisitivity, the refraction and the well log elevation.

CONCLUSIONS

The most effective means of determining depths to the water table and bedrock is acheived by a combination of geophysical techniques. The utilization of different methods enables the operator to supplement data with values from the approaches which provide superior data for a given area. Dependence upon a specific method may lead to biased interpretations and models which would reflect only a portion of the sub-surface geology. The most complete analysis requires the utilization of seismic refraction, seismic reflection, and electrical resistivity.