DETERMINING AND MONITORING MOVMENT OF THE SALT/FRESH WATER INTERFACE ON SHELTER ISLAND WITH THE USE OF INDUCTION LOGGING

Geralynn Fitzpatrick
Suffolk County Health Services - Bureau of Water Resources
225 Rabro Drive, Hauppauge, NY 11788

Ronald J. Paulsen
Suffolk County Health Services - Bureau of Water Resources
225 Rabro Drive, Hauppauge, NY 11788

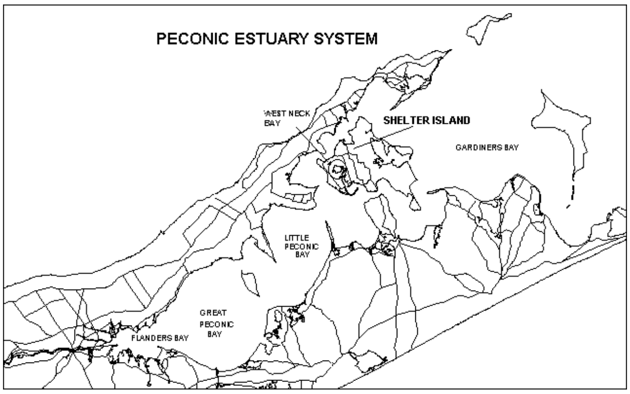


Figure 1 Click right mouse button on image to view image.

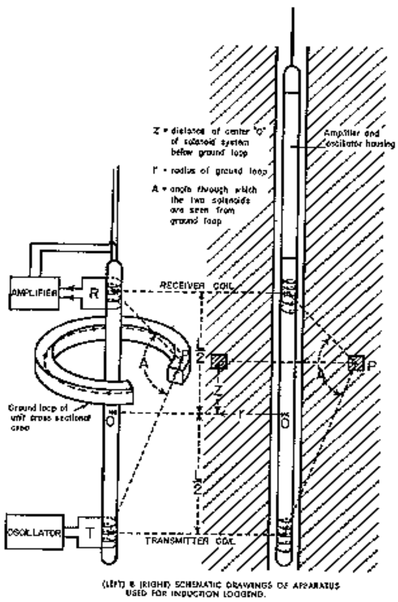
Shelter Island, located in Suffolk County (Figure-1) between the north and south forks, has a unique and limited aquifer system. Their sole source freshwater supply is the upper glacial aquifer which is recharged solely by precipitation (Soren 1974). Being an island, the freshwater lens grades into saltwater creating a zone of mixed water between the two which is often approximated as a sharp interface. This interface moves in response to many factors such an increased freshwater consumption and decreased precipitation. If more freshwater is pumped from the aquifer in these areas then is being recharged, then the interface can move inland and threaten the supply of freshwater. Therefore, it is important that this interface be determined and monitored to establish appropriate water management strategies.

Borehole geophysics is one way to determine the freshwater/ saltwater interface. This technology allows the acquisition of continuous or point measurement as a function of depth by lowering a probe down the hole and electrically transmitting a signal in digital or analog format to an integrally mounted electronics console at the surface. Many different kinds of data can be obtained depending on the probe type. For the purpose of determining the interface, an induction probe was utilized to measure conductivity of the material surrounding the borehole. Electrical conductivity is a function of the soil type, porosity, degree of saturation and electrochemistry of the pore fluids (Keys,1990). The conductivity of the pore fluids is by far the most dominate factor influencing the measurement and the fact that salt water is much more conductive than fresh water makes it very conducive to determining the salinity of the pore fluids.

The conductivity measurements are made by generating an electromagnetic field that induces an electric field which produces an electrical current that is proportional to the conductivity of the surrounding material (Figure 2). The probe design is such that it is not sensitive to material at a radial distance less than about 10 cm, and is most sensitive to material located at about 30 cm with appreciable sensitivity out to about 100cm. This is done so that contribution from borehole fluids to the instrument measurement is negligible yet can achieve a relatively large lateral range of exploration. The vertical resolution of the probe used in this study was approximately 65 cm (Golberg 1996).

The results of the Shorewood peninsula, one (1) of four (4) areas studied, are presented here. Permanent well locations were selected based on the desire to construct a longitudinal cross-section through the peninsula from the tip at the shoreline inland toward the center of the island. In addition to targeting problem areas and providing good coverage. To determine the movement of the interface, each well was logged three times in the course of 18 months (fall of 1996 and spring and fall of 1997) to account for seasonal and yearly fluctuations. The wells were drilled using a hollow stem auger cased with 2 inch schedule 40 PVC with ten (10) foot PVC, slot 10 screens. The instrument used in this study was the Geonics EM-39 borehole induction probe.

The probe was allowed to warm up a minimum of 10 minutes, as recommended by the manufacturer, then calibrated. The probe was then placed into the well so that the top of the assembly was at the top of the casing. The electrical conductivity was measured in milliSiemens per meter (mS/m). Measurement exceeding 100 mS/m were considered salt.



(LEFT) & (RIGHT) SCHEMATIC DRAWINGS OF APPARATUS USED FOR INDUCTION LOGGING.

Figure 2 Click right mouse button on image to view image

The log from the well closest to the tip of the peninsula (SW7A) located 20 feet from the shoreline, shows a relatively sharp increase in conductivity (exceeding 100 mS/m) at approximately 20 feet below ground surface. With the static water table located approximately 1 foot below grade, this translates to about 18 feet of freshwater. The logs from the next two wells (SW7B and SW7C), located 170 feet and 325 feet from the shoreline on the transact, indicate an increasing amount of freshwater as you go inland

(approximately 22 feet and 30 feet of freshwater, respectively). The log from the well positioned approximately 1,600 feet inland (SW9), located in the middle of the peninsula, shows about 63 feet of freshwater.

The movement of the interface can be best seen in the well located 190 feet from the shoreline (SW7B). This well is minimally influenced by tidal fluctuations yet sensitive to movement due to variations in precipitation and groundwater usage. As can be seen in the log profiles, the interface is deeper in the spring of 1997 after a period of high precipitation, creating a greater freshwater lens (approximately 25 feet of freshwater as compared to 22 feet) then seen during the fall of 1996 when the interface was at its highest. Shelter Islands limited aquifer system is very sensitive to variations in precipitation and groundwater usage, as can be seen in the Figure-2 movement of the freshwater/saltwater interface in the study area. Induction logging has proved to be an easy and accurate way of measuring pore water conductivity and an useful tool for determining and monitoring the location of the interface.

SELECTED REFERENCES

Golberg D., The role of downhole measurements in marine geology and geophysics, Reviews of Geophysics, 35 (3) 315-342,1997

Keys, W.S., 1990, Borehole geophysics applied to water-resources investigations: *U.S. Geological Survey Techniques of Water-Resources Investigations*, book 2, chap. E2, 150p.

Soren, J., Hydrogeologic conditions in the town of Shelter Island, Suffolk County, Long Island, New York, *U.S. Geological Survey Water Resources Investigation* 77-77, 22 pp, 1978.