RESEARCH AT THE GEOHYDROLOGIC EXPERIMENTAL AND MONITORING SITE (GEMS)

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In recent years, hydrogeologists have been called upon at an increasing frequency to evaluate the threat posed by a waste site to the waters of underlying aquifers. A key element of such an evaluation is the prediction of how a contaminant might move in the subsurface. Since contaminant movement in the subsurface is controlled by physical, chemical, and biological processes, the complexity of the problem makes accurate prediction difficult. Often the assumption that fluid constituents do not react with the formation matrix is resorted to as a perceived worst-case analysis. Even with this simplistic assumption, however, current methodology is often incapable of providing information of the detail and reliability required for evaluation efforts. A primary source of this inadequacy is that many of the methods currently used for the measurement of the properties controlling the flow of ground water in the subsurface are based on the assumption that alluvial aquifers are homogeneous (i.e. have the same properties everywhere in the aquifer). In actuality, these deposits tend to be a complex intermingling of lenses of gravel- through clay-sized materials. This heterogeneity can wreak havoc with efforts to characterize aquifer properties, as major pathways in the subsurface along which contaminants may preferentially move can be completely missed. There is a need to employ techniques that will allow the actual complexity of the geologic system to be assessed. The theoretical and field testing of such techniques is the purpose of a multiyear project of the Kansas Geological Survey (KGS).

In order to assess the potential for a technique to provide information concerning the actual complexity of a geologic system, field testing must be done in a setting with a high degree of subsurface control. The KGS Geohydrologic Experimental and Monitoring Site (GEMS) has been designed for just this purpose. GEMS was established in April of 1988 on the Robinson Tract of the Kansas Ecological Reserve. This land is managed by the Experimental and Applied Ecology Program of the University of Kansas. This particular site was selected due to the underlying geology, the existence of a high-capacity pumping well at the site, and the accessibility of the site to researchers and students from the University of Kansas. Work at the site is currently being directed by Jim Butler and Carl McElwee of the Geohydrology and Mathematical Geology Sections, respectively, of the KGS.

Since its inception in the spring of 1988, GEMS has been the site of two major research projects. The first research effort at this site was directed at increasing knowledge concerning the detailed structure of the alluvial deposits underlying this site. Towards that goal, several groups (nests) of wells have been drilled. Figure II-1 depicts an areal view of the well nests that have been established to this point. Each nest consists of wells drilled to different depths in the underlying alluvium. Figure II-2 is a cross-section through one of the nests at which an additional well was drilled into the bedrock beneath the alluvium. As shown in Figure II-2, the alluvial deposits essentially consist of approximately 35 feet of clay and silt overlying 35 feet of sand and gravel. Although the geology of the near-surface deposits at GEMS is easy to describe in general terms, a detailed description of the deposits is very difficult. A device for taking relatively undisturbed cores of saturated sands and gravels while drilling has been developed by the KGS in order to allow a detailed description of the subsurface at this and similar sites. Over two hundred feet of core have been recovered and have been or are currently being analyzed in a KGS laboratory for permeability, porosity, and the distribution of grain sizes in a core. Over the next two years, an additional 300 feet of core will be recovered and taken to the laboratory for similar analyses. The results of the laboratory analyses will

enable the aquifer underlying GEMS to be described in more detail than has ever been done at a site of this type.

The second major research effort being carried out at GEMS is focussed on well tests. Well tests are a class of techniques that are based on the introduction of a pressure disturbance (e.g., turning on a pump) into a well drilled into the aquifer and the subsequent measurement of how this disturbance evolves with time at the source and neighboring observation wells. The data describing this temporal evolution can be used to obtain estimates of the transmissive and storage properties of an aquifer. Three issues are currently being examined at GEMS: 1) the nature of the pressure disturbance required for obtaining information of different types; 2) where to place the source and observation wells in order to maximize the information that can be obtained from a test; and 3) how to analyze the collected data. If this work is successful, well tests can be used to supplement core data by providing information on the aquifer in areas between wells.

The majority of the work done to date at GEMS has been of an experimental nature. However, as can be deduced from the name of the site, there is also a monitoring component to work at GEMS. Although this component is still in its initial stages, the goal is to use GEMS as a long-term monitoring site to study hydrologic processes in the Kansas River floodplain. In the next several years, we are planning to install a fully equipped weather station as well as equipment to monitor water movement in the unsaturated zone above the water table.

In addition to the extensive KGS research that is currently being carried out at this site, GEMS is also being used in academic activities at the University of Kansas. GEMS serves as the primary field area for the class in hydrogeological field methods taught through the Department of Geology by KGS staff. Five graduate students at the University of Kansas have also worked at GEMS on either M.S. or Ph.D. projects.

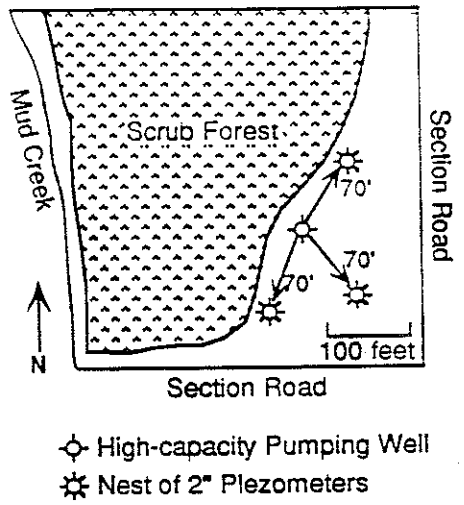

Figure II-1. Areal view of the Geohydrologic Experimental and Monitoring Site (GEMS).

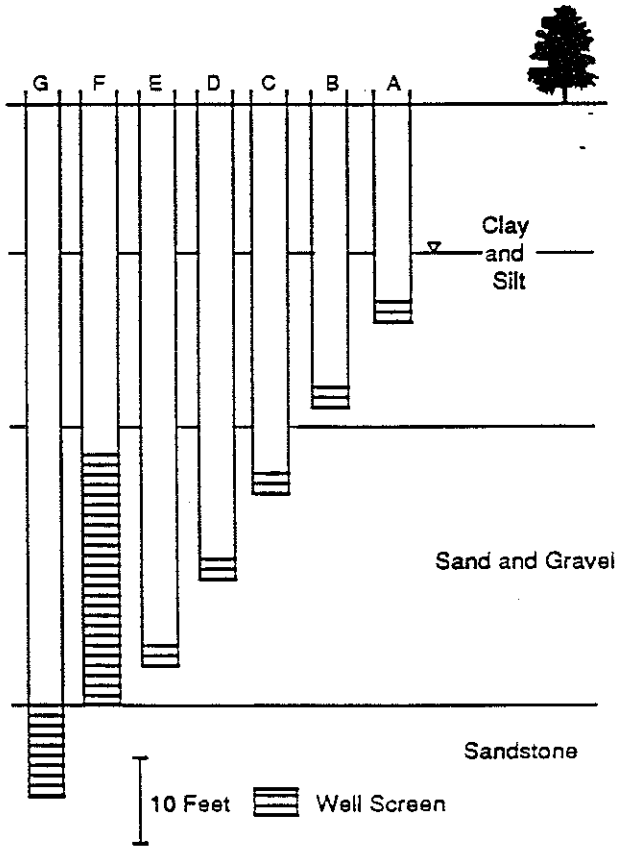

Figure II-2. Cross-sectional view of a well nest at GEMS.