THE HYDROGEOLOGY AND HYDROGEOCHEMISTRY OF A LARGE MINE SPOIL AREA: STAR FIRE TRACT, EASTERN KENTUCKY

David R. Wunsch, Ph.D.
James S. Dinger, Ph.D.
Page B. Taylor
Daniel I. Carey, Ph.D.

Kentucky Geological Survey
University of Kentucky
Lexington, Kentucky 40506-0107
606/257-5500

ABSTRACT

Cyprus Mountain Coals, a subsidiary of Cyprus Minerals, Inc., owns, fee simple, 17,000 acres of land in eastern Kentucky containing significant coal reserves. It is estimated that 10,000 acres of relatively flat land will be created by the year 2010 by mountaintop removal techniques at the Star Fire Mine, thus providing a site for new land uses and future economic development. As a result, the company has a considerable interest in post-mine development of the property.

The Kentucky Geological Survey is directing an applied research program aimed at developing a cost-effective and reliable water supply for future property development at the Star Fire site. It is anticipated that an aquifer constructed in mine spoil will act as a unique water supply and maybe engineered to provide base flow to the small streams that could feed moderate water supply reservoirs on site during drought conditions.

Areas of ground-water recharge and discharge have been identified at the site. Major recharge enters the spoil by way of disappearing streams, ground-water flow from bedrock that is in contact with the mine spoil, and a specially designed infiltration basin. Ground water discharges predominantly from springs and seeps along the western outslope of the spoil.

Chemical analyses of water samples taken from wells and springs at the site indicate that all of the waters are a calcium-magnesium- sulfate type, differing mainly in the total concentration of these constituents. Saturation indices calculated using the geochemical model PHREEQE indicate that the ground water at the site is near equilibrium with gypsum. All but one of the samples had a pH measurement between 6.0 and 7.0, indicating that the spoil at the site does not produce highly acidic water.

Visual inspection of the monitoring-well surface casings indicates that differential settlement is occurring within the mine spoil. The most significant spoil settlement occurs in the most recently placed spoil near the active mining pit.

A conceptual model showing ground-waterflow at the site based on data from 14 monitoring wells, springs, and ponds indicates that two distinct but interconnected water tables have been established: one in the spoils interior, and the second in the hollow f ills that surround the main spoil body at lower elevations (Fig. 1). The average saturated thickness of the hollow fill areas (30.1 ft.) is approximately twice the saturated thickness found in the spoil's interior (15.4 ft.). Based on an average saturated thickness of 21 feet for the entire site, the spoil stores an estimated 4,200 acre- feet (1.37 billion gallons) of water. Dye-tracing data, hydraulic gradients, and chemical data indicate that ground water moves more slowly in the spoil's interior. Ground water that accumulates in this area flows down into the hollow fills or discharges as surface-water overflow from two perched ponds during periods of high precipitation.

Hydraulic conductivity (K) values derived from slug tests range from 2.0 x E-6 to > 2.9 x E-5 ft./sec. A conceptual model showing ground-water flow at the site has been proposed based on data interpretations and observations from the site.

Hydraulic conductivity (K) values derived from slug tests range from 2.0 x E–6 to > 2.9 x E–5 ft./sec. A conceptual model showing ground-water flow at the site has been proposed based on data interpretations and observations from the site.

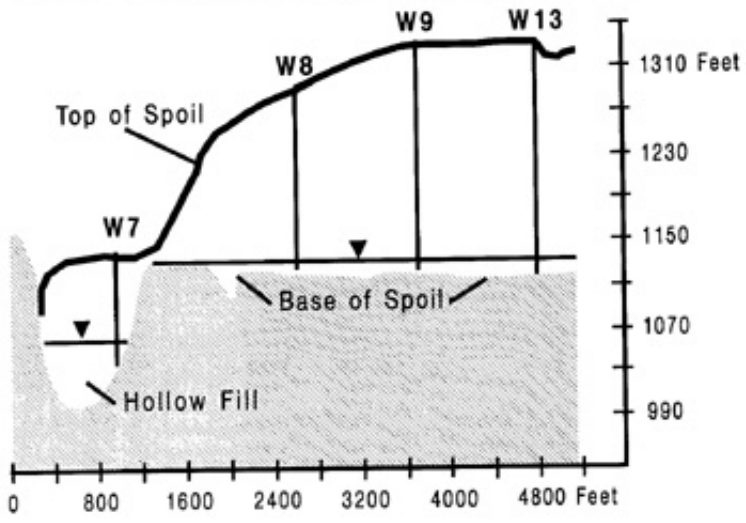

Figure 1.