Abstract 2004-5130

The Cedar River alluvial aquifer is the primary source of municipal water in the Cedar Rapids, Iowa, area. Since 1992, the U.S. Geological Survey, in cooperation with the City of Cedar Rapids, has investigated the hydrogeology and water quality of the Cedar River alluvial aquifer. This report describes a detailed analysis of the ground-water flow system in the alluvial aquifer, particularly near well field areas.

The ground-water flow system in the Cedar Rapids area consists of two main components, the unconsolidated Quaternary deposits and the underlying carbonate bedrock that has a variable fracture density. Quaternary deposits consist of eolian sand, loess, alluvium, and glacial till. Devonian and Silurian bedrock aquifers overlie the Maquoketa Shale (Formation) of Ordovician age, a regional confining unit.

Ground-water and surface-water data were collected during the study to better define the hydrogeology of the Cedar River alluvial aquifer and Devonian and Silurian aquifers. Stream stage and discharge, ground-water levels, and estimates of aquifer hydraulic properties were used to develop a conceptual ground-water flow model and to construct and calibrate a model of the flow system. This model was used to quantify the movement of water between the various components of the alluvial aquifer flow system and provide an improved understanding of the hydrology of the alluvial aquifer.

Ground-water flow was simulated for the Cedar River alluvial aquifer and the Devonian and Silurian aquifers using the three-dimensional finite-difference ground-water flow model MODFLOW. The model was discretized into 223 rows and 354 columns of cells. Areal cell sizes range from about 50 feet on a side near the Cedar River and the Cedar Rapids municipal wells to 1,500 feet on a side near the model boundaries and farthest away from the Cedar Rapids municipal well fields. The model is separated into five layers to account for the various hydrogeologic units in the model area.

Model results indicate that the primary sources of inflow to the modeled area are infiltration from the Cedar River (53.0 percent) and regional flow in the glacial and bedrock materials (34.1 percent). The primary sources of outflow from the modeled area are discharge to the Cedar River (45.4 percent) and pumpage (44.8 percent). Current steady-state pumping rates have increased the flow of water from the Cedar River to the alluvial aquifer by 43.8 cubic feet per second. Steady-state and transient hypothetical pumpage scenarios were used to show the relation between changes in pumpage and changes in infiltration of water from the Cedar River. Results indicate that more than 99 percent of the water discharging from municipal wells infiltrates from the Cedar River, that the time required for induced river recharge to equilibrate with municipal pumpage may be 150 days or more, and that ground-water availability in the Cedar Rapids area will not be significantly affected by doubling current pumpage as long as there is sufficient flow in the Cedar River to provide recharge.