

# **HOW WE KNOW THAT GROUND WATER IN THE BIG CHINO VALLEY FLOWS INTO THE VERDE RIVER**

by

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Although not apparent to the observer on the ground, water contained within an aquifer is in constant motion. Just as gravity acts above the land surface to cause water in a stream or river to flow down hill, gravity also acts below land surface to cause ground water to flow from higher elevation to lower elevation, or “down hill.”

A recent U. S. Geological Survey (USGS) report by the Blasch and others (USGS Scientific Investigations Report 2005-5198) states that ground-water in Big Chino valley flows southeastward toward Paulden to eventually discharge to the Verde River. This description is based primarily on water-level data from 2004 collected by the Arizona Department of Water Resources. Water level refers to the elevation above sea level of water standing in a well. A contour map of water levels in the Big Chino Valley for 2004 is provided as plate 3, and the actual water-level data are provided in Appendix 5 of the USGS report.

The use of water levels to determine the direction of ground-water movement is derived from a basic principle in ground-water hydrology. The principle is founded on Darcy’s Law, which describes the rate and direction of ground-water movement through a porous medium (an aquifer) and was first stated by Henry Darcy in 1856. Among other things, the law states that ground-water flow is in the direction of decreasing water levels. The direction of movement is, of course, a reflection of the fact that gravity causes movement in a “down hill” direction. Actually, the general movement of ground water is at right angles to contours of ground-water levels such as shown on plate 3. As depicted in the plate, the decline in water levels from the upper Big Chino Valley to the area of the springs east of Paulden where perennial flow of the Verde River begins is about 300 feet, and the contours indicate a general movement down the valley toward Paulden and the Verde River. The map further shows that water levels in Williamson Valley decline toward the Big Chino Valley, and the contours indicate that ground water in Williamson Valley moves toward the Big Chino Valley to combine with the movement of water in the latter valley toward the Verde River.

In 1963, the USGS located a streamgage about 8 miles below the approximate location where flow in the Verde River becomes perennial due to inflow of ground water. Measurements of flow at this streamgage have been used since that time

to calculate ground-water discharge to the river above the gage. The source of this water has been debated by some. However, given the direction of ground-water movement in Big Chino Valley discussed above, some of this water must be derived from the valley. Another recent USGS report by Wirt and others (USGS Open File Report 2004-1411) leaves little doubt that somewhere between 80 to 86 percent of ground-water discharge to the Verde River above the streamgage is derived from the Big Chino Valley.

The streamgage is located at a point where, for all practical purposes, ground water from the Big Chino Valley has been forced to enter the river above the gage. This results from the fact that the hard crystalline rock that forms the basement of the Big Chino Valley aquifer system crops out not far below the gage. Blasch (fig.13, p.26) shows a general decline in the ground-water contribution to the river (known as baseflow) from the streamgage downstream to the Mormon Pocket area (a distance of about 14 miles); he states that baseflow abruptly increases there owing to ground-water inflow from more permeable rocks.

The springs at the head of the Verde River just east of Paulden occur where the ground water moving downhill through the Big Chino aquifer intersects the ground surface. A corollary of our knowledge that the ground water in the Big Chino aquifer flows "down hill" to the springs at the head of the Verde River is that interception and removal of the flowing ground water by wells in Big Chino Valley will eventually reduce the discharge from the springs at the head of the Verde River.