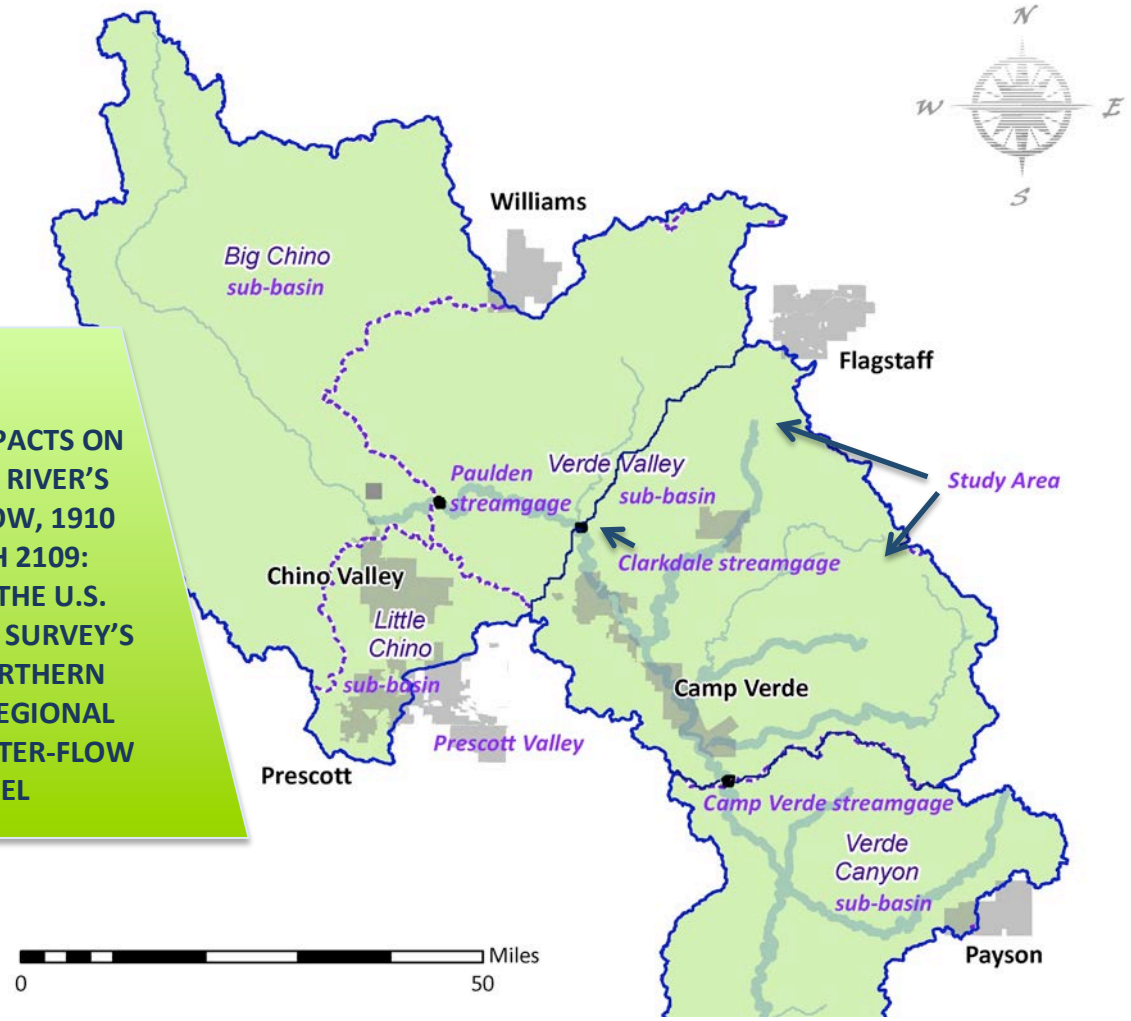
Verde River Basin PARTNERSHIP

Informing the Community About Our Water

HUMAN IMPACTS ON THE VERDE RIVER'S STREAMFLOW, 1910 THROUGH 2109: APPLYING THE U.S. GEOLOGICAL SURVEY'S (USGS) NORTHERN ARIZONA REGIONAL GROUNDWATER-FLOW MODEL



Groundwater pumping, both above the Clarkdale streamgage and in the Verde Valley, that became substantial in the 20th century, began to decrease the base flow **(groundwater-supplied component of streamflow)** of the Verde River in the same years in which pumping began and will continue to affect base flow well into the future. Clearly the Verde River's year-round flow is at risk, and groundwater to support future populations will become ever more difficult and more expensive to acquire. The time to plan is now.

Pumping of groundwater from these aquifers reduces the river's base flow because the wells eventually draw most of their water from features that are connected to groundwater, such as streams, springs, wetlands. The resulting progressive depletion of base flow means that parts of the Verde River eventually will no longer flow year-round. Pumpage can also reduce the amount of water used by plants whose roots tap into groundwater.

Photo Courtesy: Derek von Briesen

The Verde River: One of Arizona's Most Critical Resources

The Verde Valley in north-central Arizona is often praised as one of the most beautiful areas in the country. Part of its stunning scenery is the Verde River—one of the last free-flowing rivers in the desert Southwest. But the river is worth far more than its scenic value.

Streamflow of the Verde and its tributaries irrigates crops in the Verde Valley and provides both drinking water and irrigation far to the south in Maricopa County. The river and its perennial tributaries provide critical wildlife habitat and support an active recreation industry.

The river also gets a large amount of its water from groundwater—water that seeps into the ground and is stored beneath the ground surface in aquifers. Where an aquifer intersects the ground surface, its groundwater discharges (exits) to springs, wetlands, or streams. The portion of streamflow provided by groundwater discharge is called its base flow.

About 30 to 50 percent of the Verde River's annual flow within and above the Verde Valley is provided by base flow. Without that contribution of groundwater, the river would flow only when storms or snowmelt provide sufficient runoff.

HUMAN IMPACTS ON THE VERDE RIVER'S STREAMFLOW, 1910 THROUGH 2109 APPLYING THE USGS NORTHERN ARIZONA REGIONAL GROUNDWATER-FLOW MODEL.*

MAJOR RESULTS

Modeled Reduction of Base Flow for 1910 through 2005. Applies historical groundwater pumpage, incidental recharge, and artificial recharge.

- Human–induced **base-flow reduction** by the end of 2005 is approximately 4800, 4,900 and 10,200 acre–feet per year respectively, at the Paulden, Clarkdale and Camp Verde streamgages. An acre–foot, 325,851 gallons, is sufficient water to supply between two and four families a year.

- Human-induced **base-flow reduction** within the Verde Valley between the Clarkdale and Camp Verde streamgages is approximately 5,300 acre–feet per year.

The nearly identical model-predicted base-flow reduction at the Paulden and Clarkdale streamgages through time indicates that loss of base flow at the Paulden gage, near the Verde River headwaters is transmitted virtually intact to the Clarkdale gage. This reflects the low use of groundwater pumping between the two streamgages as the river travels mostly through Forest Service lands.

Forward Looking Model Runs:

1. **Modeled Reduction of Base Flow for 1910 through 2109. Net groundwater withdrawal for 2005 held unchanged from 2005 through 2109. Amount of groundwater withdrawal is the same in 2109 as in 2005.**

- Human–induced **base–flow reduction** by the end of 2109 is approximately 7,800, 8,200 and 17,400 acre-feet per year respectively, at the Paulden, Clarkdale and Camp Verde streamgages.

- Human–induced **base-flow reduction** within the Verde Valley (between the Clarkdale and Camp Verde streamgages) is approximately 9,200 acre-feet per year.

- **Groundwater declines of more than 100 feet would occur** in the vicinity of Cottonwood, near Sedona, along Dry Beaver Creek near the Village of Oak Creek, in the Woody Ridge area southwest of Flagstaff, and in the Lake Mary area southeast of Flagstaff.

2. Modeled Reduction of Base Flow for 1910 through 2109. Net groundwater withdrawal increased by 3 percent per decade from 2005 value for five decades (2010 through 2059), then unchanged through 2109.

- Human–induced **base-flow reduction** by the end of 2109 is approximately 8,200, 8,700 and 18,800 acre–feet per year respectively, at Paulden, Clarkdale and Camp Verde streamgages.

3. Modeled Reduction of Base Flow for 1910 through 2109. Net groundwater withdrawal decreased by 3 percent per decade from 2005 value for five decades (2010 through 2059), then unchanged through 2109.

- Human–induced **base–flow reduction** by the end of 2109 is approximately 7,300, 7,600, and 15,600 acre-feet per year respectively, at Paulden, Clarkdale, and Camp Verde streamgages.

The USGS study findings outlined above demonstrate that pumping above the Clarkdale streamgage and in the Verde Valley—a practice that grew rapidly during the 20th century—had an immediate impact on streamflow and will continue to affect the river's flow well into the future.

Photo Courtesy: Gary Beverly

THESE MODEL RUN ESTIMATES ARE CONSERVATIVE

Fifteen percent by 2060 is a conservative estimate of future water demand. It represents approximately half of the unmet water demand estimated for the Verde Valley in 2050 by the Central Yavapai Highlands Water Resources Management Study.** Further, the predicted reductions in base flow reflect the inability of some of the existing wells in all three of the forward-looking model runs to provide the full amount of intended pumpage.

THE USGS NORTHERN ARIZONA REGIONAL GROUNDWATER-FLOW MODEL:***A POWERFUL WATER MANAGEMENT TOOL

The USGS has indicated that this model can be used by resource managers to examine the hydrologic consequences of various groundwater development and climate change scenarios. The USGS is recognized as the gold standard in groundwater-flow model development. Don Pool, the model's developer, also developed the successful groundwater-flow model for the San Pedro River Basin.

It is widely accepted that numerical groundwater-flow models are the best tools available to help us evaluate human-induced changes to the movement and storage of groundwater.

For more information please visit: www.vrbp.org.

Prior to its release this model went through the highest level of peer review that the USGS conducts. This review included modeling sources within and outside the agency.

*New USGS report analyzed in this Water-Resource Note (see http://pubs.usgs.gov/sir/2013/5029/)
**Central Yavapai Highlands Water Resources Management Study; see Phase 1 Results at http:// www.yavapai.us/bc-wac/cyhwrms/
***USGS Northern Arizona Regional Groundwater-Flow Model (see http://pubs.usgs.gov/sir/2010/5180