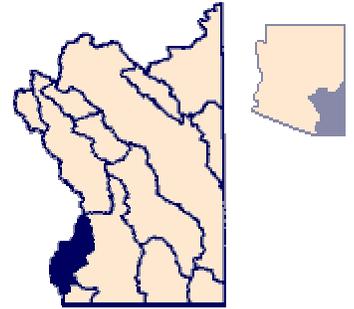


## CIENEGA CREEK BASIN

The Cienega Creek basin occupies approximately 605 square miles in southeastern Arizona (Figure 17). The basin is in the Basin and Range physiographic province and consists of a narrow northeast trending alluvial valley surrounded by fault-block mountains. The basin's central valley, Empire Valley, narrows to the north and southwest where surface water drainages exit the basin. The basin is bounded by the Santa Rita and Empire Mountains on the west, the Rincon Mountains on the north, the Whetstone and Mustang Mountains on the east, and the Canelo Hills and Patagonia Mountains on the south.



Cienega and Sonoita Creek are the main surface water drainages in the basin. Cienega Creek is primarily an ephemeral stream that drains towards the north into the Tucson Active Management Area. The creek can be divided into two sections: an upper section that drains the central valley, and a lower section that flows through a narrow valley and empties into Pantano Wash. The central valley narrows near the northern end and impermeable bedrock forms what locals call "the Narrows", separating Cienega Creek into the upper and lower sections. Impermeable bedrock at "the Narrows", and in several other places downstream, forces groundwater into Cienega Creek's streambed creating small perennial reaches. Other than the perennial stretches in the lower reaches, most flow in Cienega Creek is runoff from local storm events. Average annual surface discharge in the lower section is 1,900 acre-feet per year (Montgomery & Associates, 1985).

A surface-water divide southwest of Sonoita, Arizona, separates the Sonoita Creek and Cienega Creek watersheds. Sonoita Creek, a perennial stream that flows to the southwest through a narrow valley surrounded by mountains, empties into the Santa Cruz River north of Nogales, Arizona. Sonoita Creek's mean annual surface flow is approximately 5,850 acre-feet per year (Kennard and others, 1988).

The central valley of Cienega Creek basin is a high, semi-arid desert grassland with elevations of 3,000 to 5,000 feet above mean sea level. The mountains surrounding the valley have elevations of 6,000 to 8,000 feet above mean sea level.

The two principal aquifers in the Cienega Creek basin are the streambed alluvium and the basin-fill alluvium. The Pantano Formation and the bedrock complex of the surrounding fault-block mountains yield small amounts of water to wells and are considered only minor aquifers. The basin can be divided into three groundwater sections based on the presence of a distinctive aquifer or set of aquifers: upper Cienega Creek, lower Cienega Creek, and Sonoita Creek.

### Upper Cienega Creek Section

The upper Cienega Creek section includes most of Cienega Creek basin's central valley. There are two aquifers in the sub-basin: the streambed alluvium and the basin-fill alluvium. Because of limited areal extent, the streambed alluvium is a minor aquifer in upper Cienega Creek. The streambed alluvium is composed of sand and gravel deposited along Cienega Creek and its' tributary washes. Boggs (1980) estimated the younger alluvium to be a maximum thickness of 200 feet. Only a few stock and domestic wells have been completed in the streambed alluvium; as a result, very little detailed information is available on the streambed alluvium in the area.

The main aquifer in upper Cienega Creek is the basin-fill alluvium. The basin-fill alluvium, composed of interbedded clay, silt, sand, and gravel layers, is deepest in the southern part of the area between Sonoita and Elgin, Arizona.

Most water levels in the basin-fill reflect an unconfined regional water table. However, confining conditions occur in Township 19 South, Range 17 East, where several deep exploration wells flow under artesian pressure (Geraghty and Miller, 1970). In this area clay layers in the upper fine-grained portion of the alluvium separate the unconfined (water-table) aquifer from a lower leaky, confined (artesian) aquifer. The areal extent of the confined (artesian) aquifer is

unknown. Water levels recorded in the area during 1987 ranged from 31 feet above land surface in one of the flowing wells to 406 feet below land surface near the Santa Rita Mountains (Arizona Department of Water Resources, 1992).

### **Lower Cienega Creek Section**

Lower Cienega Creek section runs from "the Narrows" (which coincides with the surface-water divide) northward to the northern boundary of the basin. The three aquifers in the area, in descending order, are the streambed alluvium, the basin-fill alluvium, and the Pantano Formation.

The main aquifer in the lower Cienega Creek section is the streambed alluvium. The streambed alluvium occupies a narrow stream valley and consists of unconsolidated silt, sand, and gravel deposits. Water levels in the streambed alluvium range from 4 to 51 feet below land surface and indicate that the alluvium acts as an unconfined aquifer. Aquifer tests of the alluvium indicated that large-capacity production wells could yield 700 to 1,500 gallons per minute. Currently, stock and domestic wells completed in the alluvium yield 10 to 400 gallons per minute (Montgomery & Associates, 1985).

The basin-fill alluvium is a poor aquifer in the lower section. The basin-fill alluvium, which underlies the streambed alluvium, is composed of loosely-to-moderately lithified clay, silt, sand, and gravel to boulder-sized particles. The basin-fill ranging from 25 to over 525 feet thick contains interbedded clay layers, creating a leaky, confined aquifer. Water levels range from above land surface to 340 feet below land surface. The presence of flowing artesian wells

indicates an upward hydraulic gradient from the basin-fill into the streambed alluvium. Stock and domestic wells finished in the basin-fill commonly yield 2 to 75 gallons per minute and average 25 gallons per minute (Montgomery & Associates, 1985).

The Pantano Formation underlies the basin-fill in much of the lower Cienega Creek area. The Pantano Formation consists of moderately-to-well lithified conglomerates, breccias, and fanglomerates. Approximately 20 wells have been completed in the Pantano Formation and depths to water range from 35 to 200 feet below land surface. Yields from wells completed solely in the Pantano Formation range from 2.5 to 30 gallons per minute (Montgomery & Associates, 1985).

### **Sonoita Creek Section**

The Sonoita Creek section is the southwestern extension of the Cienega Creek groundwater basin. Sonoita Creek is a perennial stream that flows to the southwest through a narrow valley surrounded by mountains. The main aquifer in the area is the streambed alluvium that forms the floodplain of Sonoita Creek and its major tributaries. The streambed alluvium, composed of unconsolidated silt, sand, and gravel deposits, may be up to 90-feet thick. Most wells in the area are completed in the streambed alluvium. Yields from wells completed in the streambed alluvium generally range from 3 to 10 gallons per minute; however, one stock well was reported to yield 150 gallons per minute (Feth, 1954).

The basin-fill alluvium and the igneous rocks of the surrounding mountains are minor aquifers in the Sonoita Creek area; very few wells have been completed in either aquifer. The basin-fill forms terrace deposits consisting of silt, sand, gravel, and boulders. As many as five terraces can be identified on the area's west side adjacent to the Santa Rita Mountains. The numerous washes which dissect the basin-fill terraces, dewater the terraces, making the basin-fill dry except where it extends below the level of Sonoita Creek. The few wells completed in the basin-fill are low yielding stock and domestic wells (Feth, 1954).

Groundwater in the Cienega Creek basin is used for irrigation, domestic and stock purposes. The total amount of groundwater pumped to support irrigation is about 650 acre-feet: about 315 acre-feet per year are pumped in the lower Cienega Creek area, with the remaining irrigation water pumped in the Sonoita Creek area (Montgomery & Associates, 1985). There is only one irrigation well in the upper Cienega Creek area. Total annual groundwater pumpage in the basin is estimated by Arizona Department of Water Resources (1988) to be 1,200 acre-feet. The total amount of recoverable groundwater in storage to 1,200 feet below land surface in the basin is estimated to be 5.1 million acre-feet (Arizona Department of Water Resources, 1988; Anderson and Freethey, 1986).

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The long-term trend of water levels in Cienega Creek basin shows no change, indicating the balance between groundwater discharge and groundwater recharge. Water-level contours in the basin indicate that groundwater movement is from the higher elevations to the lowland area. Groundwater movement is then out of the basin by one of the two outlets: in the north along lower Cienega Creek or in the south along Sonoita Creek.

Groundwater recharge in Cienega Creek basin comes from two main sources: mountain-front recharge, and streambed infiltration of runoff along Cienega Creek, Sonoita Creek, and their major tributaries. Direct recharge from precipitation in the basin's lowlands is probably negligible because of low precipitation rates and high evapotranspiration.

Recharge estimates, which averaged 12,700 acre-feet per year, ranged from a low of 6,900 acre-feet per year to a high of 19,500 acre-feet per year. However, several points should be noted: only one investigator, Freethy and Anderson, included the Sonoita Creek area in their estimates (all the other investigators studied only the upper and lower Cienega Creek portions of the basin), and none include streambed infiltration in their recharge figures.

Streambed infiltration is a source of recharge along the stretches and tributaries of Cienega Creek, and along tributaries of Sonoita Creek. Montgomery & Associates (1985) estimated streambed infiltration along Cienega Creek to be between 1,600 and 6,000 acre-feet per year. Adding the mountain-front and streambed infiltration numbers together, total recharge along Cienega Creek could range from 8,500 to 25,500 acre-feet per year and average 16,600 acre-feet per year. No recharge estimates are available for the Sonoita Creek area.

The chemical quality of water found in Cienega Creek basin is suitable for most uses. The majority of producing wells in the basin draw water from the streambed alluvium and the basin-fill alluvium. Water from wells completed in the basin-fill in the upper Cienega Creek area was slightly better in quality than water from either lower Cienega Creek area or Sonoita Creek area wells. Overall, total dissolved solid values which averaged 540 milligrams per liter (mg/l), ranged from a low of 115 mg/l to a high of 1,100 mg/l. Fluoride concentrations which ranged from 0.1 to 2.9 mg/l, averaged 0.4 mg/l (Murphy and Hedley, 1984).