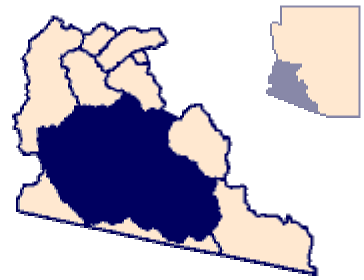
LOWER GILA BASIN



The Lower Gila basin is in southwestern Arizona and contains about 7,310 square miles (Figure 15). The basin contains numerous elongated fault-block mountain chains with intervening alluvial valleys. In the north and central parts of the basin the mountain chains are widely separated and the alluvial valleys form broad plains. Along the southern and southeastern edges of the basin, the mountain chains are much closer to each other and the alluvial valleys are smaller and narrower than in the rest of the basin. The basin is bounded on the west by the Colorado River and the Gila, Tinajas Alta , and Chocolate Mountains. The Kofa, Little Horn, and Gila Bend Mountains and their intervening highlands form the basin's northern boundary. The Saucedo and Ajo Mountain ranges form the eastern boundary, and the Puerto Blanco and Cabeza Prieta Mountains form the basin's southern boundary.

Elevations in the basin range from less than 200 feet above mean sea level to more than 4,000 feet above mean sea level in some of the higher mountain chains. The highest mountain ranges generally occur around the periphery of the basin.

The Gila River and its many tributaries constitute the main drainage in the Lower Gila basin. The Gila is an ephemeral river that flows to the southwest from Painted Rock Dam to just west of Dome, Arizona, where it exits the basin. Most of the time the riverbed is dry except for local ponds and agricultural drainage siphoned into the riverbed; however, water released from Painted Rock Dam for flood control purposes and heavy, localized rainfall cause occasional flows in the river.

Groundwater in the Lower Gila basin occurs in both the floodplain alluvium and the basin-fill. Streambed deposits of sand, gravel, and scattered boulders occupy the larger washes and the floodplain of the Gila River. The streambed alluvium ranges from 10 feet thick in the smaller washes to as much as 110-feet thick in the Gila River floodplain (Babcock and others, 1947).

The basin-fill can be divided into three separate units: an upper sandy unit, a middle fine-grained unit, and a lower coarse-grained unit (Weist, 1965). The upper sandy unit is usually 200 feet to 380 feet thick and composed mostly of sand and gravel with some silt and clay layers. The middle fine-grained unit is 250 feet to 750 feet thick and contains mostly silts and clays with occasional thin sand and gravel beds. The lower unit which has some well-cemented zones is composed of coarse sand and gravel. The thickness of the lower unit is extremely variable and it does extend to the bedrock (Weist, 1965).

The Lower Gila basin can be divided into two sections, eastern and western, based on how and where groundwater resources have been developed. The eastern section includes the Gila River floodplain and the surrounding alluvial plains from Painted Rock Dam to near Dateland. The western section encompasses the Gila River floodplain from Dateland to Dome, about 20 miles east of Yuma.

Eastern Section

In the eastern section of the Lower Gila basin most groundwater development has occurred in the broad alluvial plains that border the Gila River. The main aquifer in these alluvial plains are sand and gravel lenses in the basin-fill sediments. The lenses are discontinuous but are probably hydrologically connected because the water table forms a nearly uniform plain (Armstrong and Yost, 1958). The groundwater is generally unconfined, but thick clay layers and interbedded lava flows cause localized confining conditions (Weist, 1965). The middle fine-grained basin-fill unit usually doesn't yield enough water to wells to be considered a reliable aquifer. However, some low-yield stock and domestic wells have been completed in the middle unit (Weist, 1965).

Groundwater in the eastern part of the basin is used primarily for crop irrigation. Main areas of agricultural development are in the Hyder Valley north of Hyder, Arizona, Dendora Valley, the Palomas Plain north of Horn, Arizona, and in the Sentinel Plain east of Dateland, Arizona. Groundwater development began first in the Dendora Valley area in the 1930's. By the 1950's, groundwater use in the Dendora Valley area averaged between 5,000 and 7,000 acre-feet per year (Armstrong and Yost, 1958). Groundwater development did not begin in the Palomas Plain-Hyder Valley area until the early 1950's. Between 1951 and 1954, over 25 irrigation wells were drilled and groundwater pumpage increased from 15,000 acre-feet in 1951 to 30,000 acre-feet in 1954 (Armstrong and Yost, 1958). Groundwater pumpage peaked in 1981 when 315,000 acre-feet were withdrawn (U.S. Geological Survey, 1986). Groundwater pumpage in the eastern part of the basin from 1940 to 1984 totaled 3,837,000 acre-feet of water (U.S. Geological Survey, 1986). Freethey and Anderson (1986) estimated recoverable predevelopment groundwater in the eastern part to be 17,000,000 acre-feet.

Weist (1965) reported the average yield of irrigation wells near Dateland and Hyder to be 1,500 gallons per minute, while Armstrong and Yost (1958) reported irrigation well yields of 500 to 2,500 gallons per minute in Dendora Valley and Palomas Plain.

Predevelopment water levels were reported to be 8 to 10 feet below land surface in the Gila River floodplain and 100 to 250 feet below land surface in the alluvial plains (Armstrong and Yost, 1958). Since agricultural development began, water levels have generally declined in the irrigated areas away from the Gila River (Armstrong and Yost, 1958; Weist, 1965). Water levels measured in 1978 ranged from 19 to 50 feet below land surface in the Gila River floodplain to as deep as 415 feet below land surface in the alluvial plains (White and others, 1979). White and others (1979) reported that during the periods 1965-1977 and 1973-1977, groundwater withdrawals resulted in water-level declines in the developed area; however wells near the Gila River did not have large water level declines, and that some actually had rising water levels. Since wells in or near the Gila River are influenced by infiltration from floodflows, White and others (1979) attributed the steady or rising water levels in wells near the river to greater-than-normal flows in the Gila River in 1966, 1973, and 1975.

Water-level contours (White and others, 1979) indicate three cones of depression had formed in the irrigated areas: one cone is in the Hyder Valley north of Hyder, Arizona; a second cone is in the Palomas Plain north of Horn, Arizona; and the third cone is east of Dateland, Arizona, and just north of the Aztec Hills. From 1965 to 1978, one well in the Aztec Hills cone declined 96 feet, an average of seven feet per year (White and others, 1979). Water levels declined even faster in wells in the other two cones of depression. From 1973 to 1978, a well in the cone north of Horn, Arizona, declined at an average rate of 12.8 feet per year, and in the cone north of Hyder, Arizona another well recorded an average decline of 15 feet per year (White and others, 1979).

Predevelopment groundwater movement was from the north and southeast toward the Gila River and then downstream to the southwest. The extensive groundwater pumpage that formed the cones of depression has also changed the general movement of groundwater in the irrigated areas. The Hyder Valley cone is centered just south of Turtleback Mountain and pulls water from the Hyder area north towards Turtleback Mountain. The Palomas Plain cone, located north of Horn, Arizona, also pulls water to the north from the Gila River and Horn areas. The Aztec Hills cone pulls water to the south from the Gila River and to the west from the Sentinel Plain (White and others, 1979).

Groundwater recharge in the eastern part of the Lower Gila basin comes from four sources: runoff, underflow, irrigation water, and precipitation (Armstrong and Yost, 1958). Runoff in the washes and the Gila River floodplain is the main source of recharge in the eastern part of the basin. Current runoff recharge is less than predevelopment recharge because floodflows in the Gila River, the main source of runoff recharge, have been reduced by upstream water use and storage facilities. Underflow from the Painted Rock Dam area probably contributes the next greatest amount of natural recharge; Armstrong and Yost (1958) estimated underflow at Painted Rock Dam to be less than 300 acre-feet per year. As much as 20% of irrigation water may return to the regional aquifer (Armstrong and Yost, 1958); however, irrigation recharge is probably only effective where water levels are shallow. Areas with deeper water levels probably don't receive appreciable recharge from irrigation waters (Weist, 1965). Direct precipitation provides negligible recharge due to low rainfall and high evapotranspiration rates. The current amount of recharge in the eastern part of the Lower Gila basin is not known; however, total recharge is assumed to be less than withdrawals because water levels generally are declining.

The chemical quality of the groundwater is extremely variable. Most of the groundwater is rated as marginal for use on salt-sensitive crops, but is suitable for domestic and stock use (Weist, 1965). Water in wells near the Gila River has a salty taste due to high total dissolved solids concentrations and needs treatment for domestic use (Weist, 1965). Total dissolved solids values are highest near the Gila River and decrease away from the river (Weist, 1965; White and others, 1979). Total dissolved solids values ranged from 300 milligrams per liter (mg/l) to over 9,000 mg/l (White and others, 1979; Weist, 1965). The secondary maximum contaminant level recommended by the EPA for total dissolved solids in drinking water is 500 mg/l.

Fluoride values show just the opposite relationship: lowest near the Gila River and highest in the alluvial plains away from the river (White and others, 1979; Weist, 1965). Fluoride values generally are also above the recommended maximum contaminant level of 4.0 mg/l in drinking water. Fluoride values ranged from 0.3 mg/l to 9.1 mg/l (White and others, 1979).

Western Section

In the western part of the Lower Gila basin, most groundwater development has occurred in the Gila River floodplain. The main aquifer is the streambed alluvium in the Gila River floodplain. The aquifer has two units: an upper sandy unit, 20 to 80 feet thick, consisting of alternating silt, sand, and gravel beds, and a lower gravel unit, 10 to 70 feet thick (Leake and Clay, 1979). The streambed alluvium overlies a thick, fine-grained unit composed of clay, silt, and fine-sand lenses. The fine-grained unit doesn't provide sufficient water for irrigation wells (Babcock and others, 1947). Groundwater in the floodplain aquifer is at a shallow depth and is unconfined. Little groundwater development has occurred in the valleys and plains of the western part of the basin. Due to the lack of wells, little is known of the potential groundwater resources of these areas.

Agricultural development began in the late 1800's and generally was confined to the Gila River floodplain (U.S. Bureau of Reclamation, 1974). In the early 1900's, upstream water diversions left little surface water available for irrigation. To supply a steady source of irrigation water, the first irrigation well was drilled and put into operation in 1915 (U.S. Bureau of Reclamation, 1974). In the late 1940's, the U.S. Bureau of Reclamation began the Gila Project to bring Colorado River water into the area for irrigation because reuse of local groundwater had increased the salinity in the groundwater, making it unsuitable for irrigation. In 1952, the first Colorado River water was delivered and in 1957, the canal system was completed and turned over to the Wellton-Mohawk Irrigation and Drainage District for administration (U.S. Bureau of Reclamation, 1974). Until 1952, most groundwater pumped from the western part of the basin was used for irrigation; pumping of groundwater for irrigation ceased by 1957 (Leake and Clay, 1979). Water deliveries for the period 1976-1988 averaged 398,207 acre-feet per year (Earthinfo. 1989).

Excessive recharge that resulted from the application of imported Colorado River water raised water levels and caused waterlogged conditions that threatened crop production in much of the irrigated area. In 1961, a network of wells began pumping excess groundwater into drainage canals to lower water levels and relieve waterlogging (Leake and Clay, 1979). Since 1961, groundwater pumpage in the western part of the basin has been primarily for drainage of excess irrigation water. Groundwater development outside the Gila River floodplain is minimal; most wells outside the floodplain are low-yield stock or domestic wells (Leake and Clay, 1979).

Predevelopment water levels in the Gila River floodplain ranged from 10 to 20 feet below land surface (Leake and Clay, 1979). By the late 1930's, some shallow irrigation wells began to go dry and increasing salinity made local groundwater unsuitable for irrigation. The importation of Colorado River water that began in 1952, brought water levels to within six feet of the land surface and threatened to drown crops in the irrigated areas (U.S. Bureau of Reclamation, 1974). Since 1960, the Wellton-Mohawk Irrigation District has attempted to maintain water levels by pumping excess groundwater from the floodplain aquifer into drainage canals. In 1976, the Bureau of Reclamation reported water levels in the floodplain ranging from 4.5 feet below land surface to 26 feet below land surface (Leake and Clay, 1979).

Groundwater movement in the western part of the Lower Gila basin is from the adjoining valleys and plains towards the

Gila River. In the Gila River floodplain, groundwater moves uniformly downstream through the floodplain aquifer. Recharge of irrigation water has created several groundwater mounds in the floodplain aquifer (Leake and Clay, 1979).

There are four sources of recharge in the western part of the basin: infiltration of irrigation water, underflow from upstream and side valleys, Gila River flow infiltration, and rainfall (Babcock and others, 1947). Infiltration of irrigation water is the largest source of recharge in the lower section. As previously mentioned, recharge of applied irrigation water is so great that excess groundwater must be pumped into drainage canals for removal from the basin. From 1970 through 1975, the U.S. Bureau of Reclamation (1976b) estimated annual recharge into the local aquifer from the application of Colorado River water at 213,362 acre-feet per year.

Underflow into the western part of the basin is probably the next most consistent source of recharge. Underflow comes into the western section from the eastern section of the basin through the Gila River floodplain and from the side washes that drain the valleys and plains that border the Gila River. Underflow into the western section is estimated by the U.S. Bureau of Reclamation (1976b) to be 4,670 acre-feet of water per year.

Inconsistent flow in the Gila River causes recharge from the river usually to be negligible. However, floodflows in the river can contribute significant recharge to the floodplain aquifer. Water releases from Painted Rock Dam in 1975 caused the Gila River to flow for much of 1975 and resulted in an estimated 59,500 acre-feet of recharge into the floodplain aquifer (U.S. Bureau of Reclamation, 1976b).

Recharge from rainfall is small because of the arid climate and high evaporation rates. Some rainfall infiltrates into the sand and gravel in the desert washes and then enters the aquifer as underflow from the side washes. Total recharge into the western part varies depending on the amount of water used for irrigation, and to a lesser extent, the amount of water released into the Gila River. The U.S. Bureau of Reclamation (1976b) estimated average aquifer recharge in the western part for 1970 to 1975 as 286,047 acre-feet per year.

Groundwater is discharged from the western part as: evapotranspiration by crops and phreatophytes, drainage pumped into canals, and underflow. The largest source of discharge from the lower section is evapotranspiration from crops and phreatophytes. Evapotranspiration averaged 320,498 acre-feet of water for the period 1970 to 1975 (U.S. Bureau of Reclamation, 1976b). Drainage pumped to relieve excess recharge is the next largest source of groundwater discharge in the western part. The U.S. Bureau of Reclamation (1976b) estimated an average of 211,306 acre-feet of drainage water were pumped from the Gila River floodplain aquifer from 1970 to 1975. Underflow through the Gila River floodplain and south towards Mexico averages 13,670 acre-feet of water annually (U.S. Bureau of Reclamation, 1976b). The annual average discharge from the Gila River floodplain aquifer for 1970 to 1975 was estimated to be 286,397 acre-feet (U.S. Bureau of Reclamation, 1976b).

The quality of water in the western part of the Lower Gila basin generally is unsuitable for most uses. Water quality in the valleys and plains away from the Gila River floodplain is marginal to suitable, but water quality in the Gila River floodplain is unfit for irrigation and human consumption (Leake and Clay, 1979). Prior to groundwater development for irrigation, water quality in the Gila River floodplain was poor. The recycling of irrigation water in the floodplain gradually increased the salinity of the local groundwater. By the late 1940's, local groundwater was no longer suitable for irrigation or domestic use.

In 1976, total dissolved solids concentrations for groundwater in the western part ranged from 270 milligrams per liter (mg/l) in areas away from the Gila River to 12,490 mg/l in the Gila River floodplain (Leake and Clay, 1979). The highest total dissolved solids concentrations, usually over 7,000 mg/l, are found in the Gila River floodplain. Fluoride concentrations ranged from 1.0 mg/l to 10.0 mg/l (Leake and Clay, 1979).