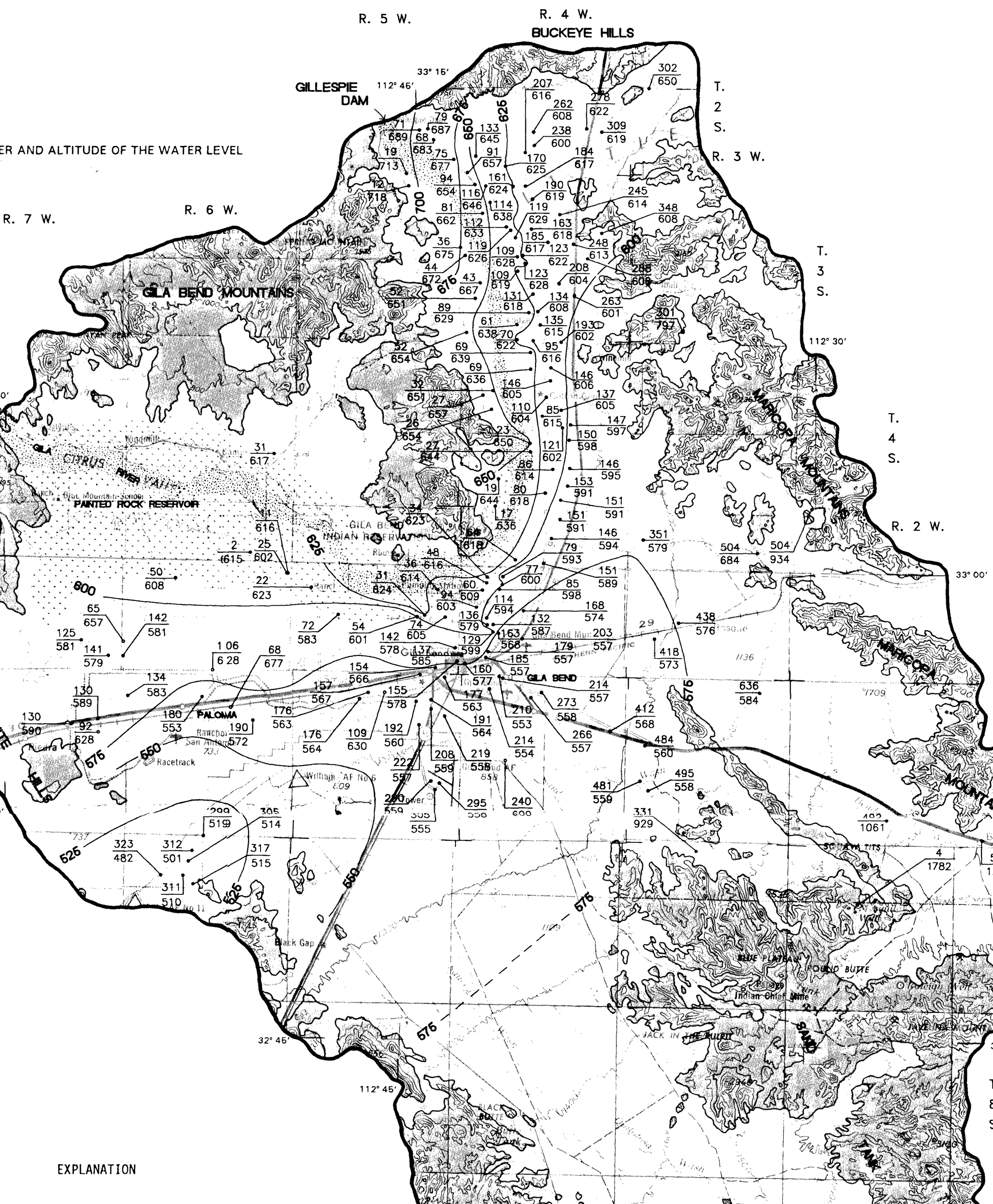


EXPLANATION

WELL IN WHICH DEPTH TO WATER WAS MEASURED IN FALL 1993--Upper number, 333, is depth to water, in feet, below land surface. Lower number, 645, is the altitude of the water level, in feet, above mean sea level

WELL IN AN ANOMALOUS DEPTH TO WATER WAS MEASURED IN FALL 1993--Upper number, 240, is depth to water, in feet, below land surface. Lower number, 600, is the altitude of the water level in feet

APPROXIMATE STREAM CHANNEL OF THE GILA RIVER

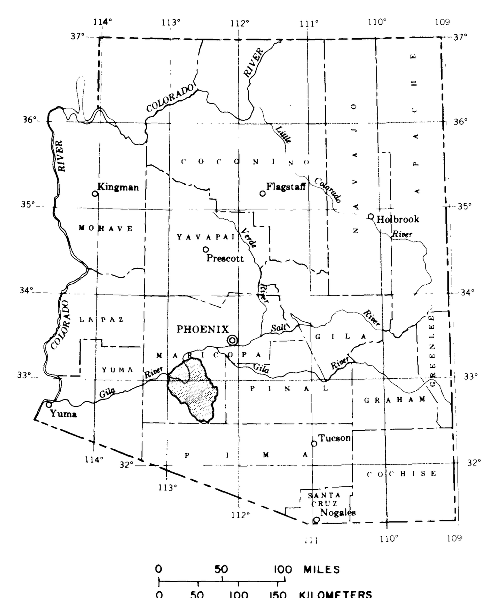
APPROXIMATE AREA SUBJECT TO PERIODIC INUNDATION BY PAINTED ROCK RESERVOIR

ALLUVIUM--Consists of semi-consolidated to poorly consolidated sand, silt, clay, and gravel and conglomerate

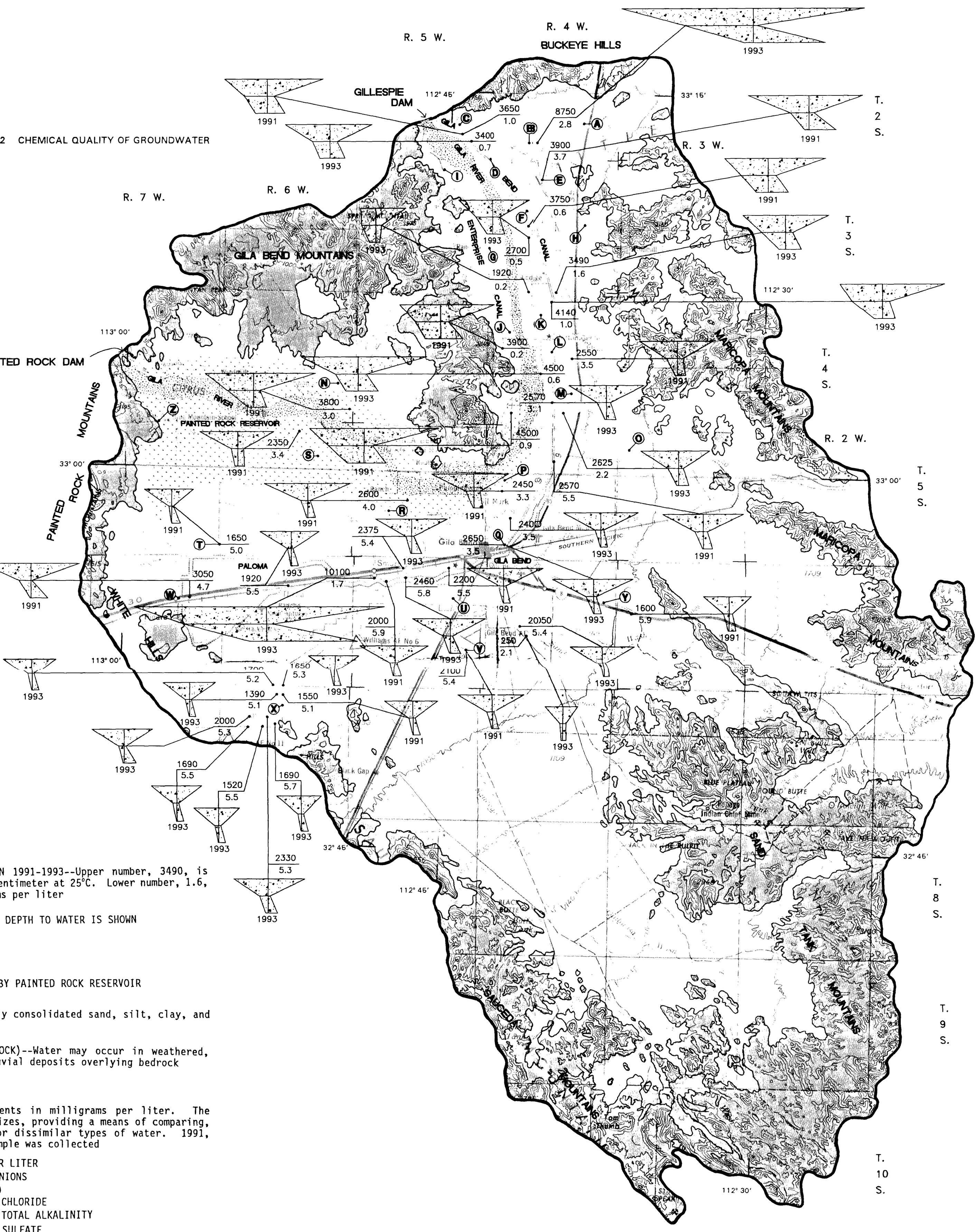
HARDROCK (GRANITIC, METAMORPHIC, OR VOLCANIC ROCK)--Water may occur in weathered, fractured or faulted joint systems, or fluvial deposits overlying bedrock

WATER-LEVEL CONTOUR--Shows the approximate altitude of the water level. Contour interval 25 feet. Datum is mean sea level, dashed where inferred

BOUNDARY OF GILA BEND BASIN



INDEX MAP SHOWING AREA OF REPORT (SHADED)



EXPLANATION

WELL FOR WHICH A WATER SAMPLE WAS COLLECTED IN 1991-1993--Upper number, 3490, is specific conductance in microsiemens per centimeter at 25°C. Lower number, 1.6, is the fluoride concentration in milligrams per liter

WELL FOR WHICH A HYDROGRAPH DEPICTING CHANGES IN DEPTH TO WATER IS SHOWN

APPROXIMATE STREAM CHANNEL OF THE GILA RIVER

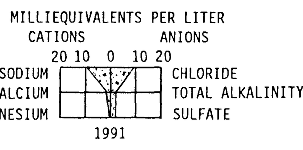
APPROXIMATE AREA SUBJECT TO PERIODIC INUNDATION BY PAINTED ROCK RESERVOIR

ALLUVIUM--Consists of semi-consolidated to poorly consolidated sand, silt, clay, and gravel and conglomerate

HARDROCK (GRANITIC, METAMORPHIC, OR VOLCANIC ROCK)--Water may occur in weathered, fractured or faulted joint systems, or fluvial deposits overlying bedrock

BOUNDARY OF GILA BEND BASIN

CHEMICAL QUALITY DIAGRAM--Shows major constituents in milligrams per liter. The diagrams are in a variety of shapes and sizes, providing a means of comparing, correlating, and characterizing similar or dissimilar types of water. 1991, below diagram, indicates year in which sample was collected



INTRODUCTION

The Gila Bend basin is located in western Maricopa County in the Sonoran Desert section of the Basin and Range physiographic province in Arizona (Fenneman, 1931, p. 367-77). The basin is bounded by the Buckeye Hills and the Gila Bend Mountains on the north, the Maricopa Mountains on the east, the Sand Tank Mountains on the southeast, the Sauceda Mountains on the south, the White Hills on the southwest and the Painted Rock Mountains on the west. The basin is comprised of parts of two northwest-trending structural troughs separated by the Gila Bend and Sand Tank Mountains (Johnson and Cahill, 1955, p. 7), and encompasses approximately 1,284 square miles. Land-surface altitudes range from 4,084 feet at Maricopa Peak in the Sand Tank Mountains to 524 feet in the bed of the Gila River at Painted Rock Dam.

Paloma Ranch, located west of the Town of Gila Bend, is the largest agricultural operation in the basin. This farm accounts for approximately three-quarters of all acres under cultivation in the Gila Bend basin. The total area currently under irrigation in the basin is about 45,000 acres and the primary crop grown is cotton (Steve Smarick, Natural Resources Conservation Service and Jake Stephens, Paloma Ranch, personal commun., 1995).

Precipitation in the Gila Bend basin averages about 6 inches annually as recorded at Gila Bend, which is located near the center of the basin. The maximum recorded temperature at Gila Bend is 122 °F and the minimum is 10 °F. The average daily mean temperature is 72.4 °F (National Weather Service, personal commun., 1995).

The major natural surface-water feature in the Gila Bend basin is the Gila River. Associated manmade features include Gillespie Dam, the Gila Bend Canal, the Enterprise Canal, Painted Rock Dam and Painted Rock Reservoir. The Gila River, which traverses the basin, enters from the north at the site of Gillespie Dam, bends around the Gila Bend Mountains and exits at Painted Rock Dam in the Painted Rock Mountains. The flow of Gila River at Gillespie Dam is perennial, predominately due to a combination of effluent discharged upstream at the City of Phoenix's 91st Avenue Water Treatment Facility, return flow of agricultural irrigation water and groundwater pumped into the river for drainage purposes by the Buckeye Irrigation District. Gillespie Dam was constructed in 1921 to divert all non-flood flows of the Gila River entering the basin to the Gila Bend and Enterprise Canals. These canals supply water to most of the farmland in the Gila Bend basin (U.S. Army Corps of Engineers, 1994, p. 93). Along its 35-mile length, wells pump groundwater into the Gila Bend Canal for use on Paloma Ranch. Painted Rock Dam was completed in 1960 to control all upstream floods up to approximately 300,000 ft^3/sec peak flow, and has a maximum controllable discharge of 22,500 ft^3/sec (U.S. Army Corps of Engineers, 1962, p. 3). Painted Rock Reservoir, created by the dam, inundates approximately 53,200 acres and has a capacity of approximately 2,476,300 acre-feet at the dam spillway crest, which is 661 feet above mean sea level (U.S. Army Corps of Engineers, 1994, p. 67). The operational maximum flood release was exceeded for the first time in February 1993 at a peak outflow of 25,600 ft^3/sec (U.S Army Corps of Engineers, 1994, p. 61).

Most of the previous groundwater studies of the Gila Bend basin were based on data collected following a major flood. This study is no exception. Heavy rains from December 1992 to February 1993 throughout Arizona caused major flooding in much of the state, and record to near record flows occurred along the Gila River. The total annual flow of the Gila River below Gillespie Dam in 1993 (as measured at USGS surface-water station no. 09519500) was over 5 1/2 million acre-feet (Smith and others, 1995 p. 247). This was the highest discharge recorded for a single calendar year at this location. As a result of this flooding, Gillespie Dam was breached in January 1993, effectively eliminating surface-water diversions to the Gila Bend Canal. Pumps have subsequently been installed just below the breach to pump surface water from behind a diversion dike into the Gila Bend Canal. These pumps have a combined capacity of approximately 200 ft^3/sec (Jake Stephens, Paloma Ranch, personal commun., 1995).

GEOLOGY

The fault-block mountain ranges of the Gila Bend basin are the result of tilting and faulting of the existing rocks which probably occurred during the Tertiary Period (Babcock and Kendall, 1948, p. 4). The geologic history of the Gila Bend basin since the Tertiary includes intervals of alluvial deposition and volcanic activity. Periodic volcanic eruptions produced lava flows and cones that temporarily dammed the Gila River. One volcanic cone in the northern part of the Painted Rock Mountains diverted the river around the southern part of these mountains (Babcock and Kendall, 1948, p. 4). The river was also dammed by a Quaternary Period lava flow at the present site of Gillespie Dam, which may have diverted the river through the Gila Bend Mountains (Babcock and Kendall, 1948, p. 5).

Hardrock

The Gila Bend basin is enclosed by hardrock except for an area on the southwest between the Painted Rock and Sauceda Mountains (U.S. Bureau of Reclamation, 1977a, p. 69). Volcanic outcrops between the Sauceda and Painted Rock Mountains are probably remnants of the Sentinel lava flow. The Sentinel lava flow consists of Quaternary basalt and occupies about 225 square miles of southwestern Maricopa County to the west of the Gila Bend basin (Oxford and Bender, 1976, p. 3). Basalt, probably from this flow, also occurs along the western edge of the basin at shallow depths between 80 and 150 feet below land surface.

Other igneous rocks are found in the mountains surrounding the basin. These include Precambrian granites of varying ages found in all the mountains except the Sauceda and Painted Rock Mountains. Younger granites formed during the Laramide Orogeny crop out in the Buckeye Hills and the Painted Rock Mountains. Quaternary basalt and Cretaceous andesite occur in the Gila Bend, Sand Tank, Sauceda and Painted Rock Mountains. Metamorphic rocks include older Precambrian granite gneiss found in the southeastern tip of the Gila Bend Mountains and older Precambrian schist in the Sand Tank Mountains, Maricopa Mountains and the White Hills. Sedimentary rocks composed of Tertiary sand, gravel and conglomerates are found mainly in the Sand Tank Mountains. A 200-foot cliff of steeply tilted sandstone beds occurs in the extreme southwestern part of the Gila Bend Mountains (Johnson and Cahill, 1955, p. 11).

Alluvium

The U.S. Bureau of Reclamation divided the alluvium of the Gila Bend basin into three units identified as the upper alluvial unit, the middle fine-grained unit and the lower conglomerate. The composition of the upper alluvial unit is not defined by the U.S. Bureau of Reclamation, but is reported to range in thickness from 0 to 1,000 feet (U.S. Bureau of Reclamation, 1977a, p. 69-70). Approximately 300 to 500 feet of coarse- to fine-grained deposits overlie the locally named Sil Murk Formation in the upper alluvial unit south of the Gila Bend Mountains (Heindl and Armstrong, 1963, p. A31). These deposits were laid down from the late Tertiary to the early Quaternary Period when the main surface-water drainage from the basin was probably around the south end of the Painted Rock Mountains (Heindl and Armstrong, 1963, p. A30-31). The middle fine-grained unit includes the Sil Murk Formation. The middle fine-grained unit ranges in thickness from 0 to 700 feet and is found primarily in that part of basin west of Gila Bend but may extend further east (U.S. Bureau of Reclamation, 1977a, p. 69-70). The Sil Murk Formation is comprised mainly of pebble- to boulder-sized conglomerates with thin interbedded volcanics near the top (U.S. Bureau of Reclamation, 1977a, p. 70), and is probably late middle Tertiary in age (Heindl and Armstrong, 1963, p. A20). The top of Sil Murk Formation marks an old erosional surface upon which the upper alluvial unit is deposited. This surface dips gently to the west and south and more steeply to the east away from the Gila Bend Mountains (Heindl and Armstrong, 1963, p. A27). The surface of the lower conglomerate unit ranges from about 600 feet above sea level in the northern part of the basin to over 600 feet below sea level near Paloma Ranch. The age of the lower conglomerate is unknown. Locally, it may exceed 1,000 feet in thickness (U.S. Bureau of Reclamation, 1977a, p. 69-70).

For this study, terms proposed by Anderson, Freethey and Tucci (1990, p. 20-26) to describe the basin fill of alluvial basins in south-central Arizona are used. Stream alluvium refers to the unconsolidated deposits along the Gila River and its tributaries. It ranges in age from late Pliocene to Holocene. Upper basin fill refers to those alluvial deposits that are unconsolidated to moderately consolidated and includes most of the upper alluvial unit identified by the U.S. Bureau of Reclamation. Lower basin fill refers primarily to weakly to highly consolidated gravel, sand, silt and clay which includes most of the middle fine-grained unit, the Sil Murk Formation and lower conglomerate unit identified by the U.S. Bureau of Reclamation. In general, lower basin fill represents deposition in topographically closed basins with interior drainage and upper basin fill represents deposition during a transition period from a closed- to integrated-drainage basin.

The basin fill north of Gila Bend is relatively thin due to the presence of pediments, and locally contains interbedded volcanics (Wolcott, 1953, p. 2). Driller's logs show extensive pediments on the eastern part of the basin north of Gila Bend but virtually none on the west where the basin fill is up to 1,480 feet thick. On the east side of the Gila River the basin fill is generally not much thicker than 1,000 feet and decreases in thickness to the east as the pediments are encountered. Driller's logs show the upper basin fill near Gila Bend is at least 1,622 feet thick. The lower basin fill is at least 160 feet thick near Gila Bend. East of Gila Bend the upper basin fill is at least 2,158 feet thick. The thickness of the lower basin fill in this area is unknown.

GROUNDWATER

The upper and lower basin-fill units comprise the principal aquifer of the Gila Bend basin. Groundwater in the upper basin fill is generally unconfined to semi-confined. Perched, semiperched, or confined conditions occur locally (U.S. Bureau of Reclamation, 1977a, p. 69). Groundwater in the Gila Bend basin is primarily recharged by infiltration of surface flows of the Gila River and its tributaries. Other sources of recharge include infiltration of surface water applied to agricultural land and underflow from the Hassayampa sub-basin of the Phoenix Active Management Area north of Gillespie Dam. Changes in water levels throughout the Gila Bend basin are governed by complex interactions of groundwater and surface water. Water-level declines occur primarily in response to the pumping of wells during periods of low flow of the Gila River. During periods of high flows, water levels may rise despite large withdrawals of groundwater from wells.

Occurrence

[illegible]

Well Yields

Historical records and recent data provided by Paloma Ranch show most agricultural well yields in the Gila Bend basin range from 1,000 to 5,000 gal/min. Well yields north of Gila Bend average 2,200 gal/min. West of Gila Bend, well yields average more than 2,400 gal/min.

Recharge and Movement

[illegible]

Cahill and Wolcott (1955, p. 4, pl. 2) were the first to suggest groundwater principally flowed out of the Gila Bend basin south of the Painted Rock Mountains. No estimate of outflow was made at that time. There is also evidence that the Gila River once flowed out of the basin through this area after a lava flow dammed its path through the Painted Rock Narrows (Turner, 1956, p. 3-4). Contours of groundwater-surface altitude suggest that most of the groundwater in the western part of the Gila Bend basin presently moves south away from the Painted Rock Reservoir area and exits the basin south of the Painted Rock Mountains. Lava flows associated with the Sentinel Plain lava flow in this area lay on alluvium, and are too thin and occur at depths too shallow to act as barriers to groundwater flow.

WATER QUALITY

The earliest comprehensive sampling of groundwater in the Gila Bend basin was done by the U.S. Geological Survey in 1946. Results of analyses from that time showed the quality of groundwater throughout the basin was poor and would be classified as unsatisfactory for most agricultural uses. Groundwater throughout the basin was found to have a high dissolved-solids concentration consisting mostly of large amounts of sodium and chloride. Groundwater to the north of Gila Bend had even higher concentrations of dissolved solids. There were higher amounts of calcium and magnesium and lower amounts of fluoride than in groundwater to the south and west (Hem, in Babcock and Kendall, 1948, p. 15). Groundwater samples for this study were collected from 1991 to 1993 (map 2) and, with few exceptions, analyses show that water quality conditions have not changed since 1946.

Fluoride concentrations in groundwater from wells sampled for this study ranges from 0.2 to 5.9 mg/L. Fluoride from wells to the north of Gila Bend average 2.1 mg/L. Samples from wells to the south and west average 4.9 mg/L of fluoride. The dividing line between the north, and south and west parts of the basin is arbitrarily drawn diagonally from the northwest corner of T. 5 N., R. 4 W. to the center of T. 6 S., R. 3 W. Although Gila Bend is located south of this line, Gila Bend is used synonymously with the line. The maximum contaminant level (MCL) for fluoride is either 4.0 or 6.0 mg/L. The MCL is an enforceable standard set by the U.S. Environmental Protection Agency for drinking water. The fluoride level allowed is dependent on the number of year-round residents a water system serves (Arizona Department of Environmental Quality, 1991, p. 26). Private domestic wells and wells used for agriculture are exempt from state and federal regulations of water quality. Analyses of samples collected between 1991 and 1993 show sulfate, alkalinity and specific-conductance values are higher north of Gila Bend than elsewhere in the basin.

Groundwater samples from four wells sampled for this study exceed the MCL for nitrates ($NO_2 + NO_3$, dissolved) of 10 mg/L as N. Samples from two of these wells also exceed the MCL of 10 $\mu g/L$ for selenium. The concentration of nitrates in the surface flows of the Gila River above diversions at Gillespie Dam averaged 8.8 mg/L from October 1990 to September 1991 and the concentration of selenium averaged 3.4 $\mu g/L$ (Boner and others, 1992, p. 301, 303).

Boron in groundwater throughout the Gila Bend basin was previously reported to be higher than limits suggested by the U.S. Department of Agriculture for boron-sensitive crops such as citrus (Johnson and Cahill, 1955, p. 32). Boron is also present in high concentrations in surface flows of the Gila River. Boron ranged from 1,300 to 2,500 $\mu g/L$ from October 1990 to September 1991 in samples collected from the Gila River above diversions at Gillespie Dam (Boner and others, 1992, p. 302). Maximum boron concentration from groundwater samples was 6,600 $\mu g/L$. Although water containing 2,000 $\mu g/L$ may be used without injury, an upper limit of 750 $\mu g/L$ is thought to protect most sensitive crops from boron toxicity (U.S. Environmental Protection Agency, 1976). Of 32 wells sampled for boron, 20 exceed 750 $\mu g/L$. Wells sampled north of Gila Bend average 1,120 $\mu g/L$ of boron. Wells sampled in the south and west average 1,430 $\mu g/l$.

Surface flows of the Gila River throughout the basin are usually highly mineralized with calcium and sodium (Hem, in Babcock and Kendall, 1948, p. 15). As groundwater was withdrawn by the pumping of wells it was expected that groundwater would be replaced with the more highly mineralized water of the Gila River resulting in a continual increase of the dissolved-solids content of the groundwater (Hem, in Babcock and Kendall, 1948, p. 16). However, Johnson and Cahill (1955, p. 36-37) reported that high flows during floods were considerably less mineralized and recharge from this water tended to reduce the concentration of dissolved solids in the groundwater reservoir. Figure 4 shows the total annual flow of the Gila River below Gillespie Dam in thousands of acre-feet per calendar year. Figure 5 shows the yearly average specific conductance of the Gila River measured at Gillespie Dam. These graphs illustrate the relationship between higher flows and lower mineralization. Dissolved-solids content decreased in 19 of 23 wells sampled in 1953-55 and 1964-66. From 1953 to 1966 water levels declined throughout the basin and flows of the Gila River were low. The low flows of the Gila River were highly mineralized from 1953 to 1966, but they were apparently insufficient in volume to replenish the groundwater reservoir.

From 1966 to 1976 specific conductance of the Gila River remained relatively unchanged while pumpage throughout the basin increased substantially. Recharge from minor floods in 1966 and 1973 caused water levels to rise in the northern part of the basin despite the increased pumpage. The average specific conductance of groundwater in the northern part of the basin increased over this time. Specific conductance also increased in groundwater in the western part of the basin even though most static water levels declined from 1966 to 1976. A possible explanation for this situation is that although recharge occurred throughout the basin, it was not enough to replenish groundwater withdrawn in the central and western parts of the basin. However, the volume and dissolved-solids concentration were sufficient to cause the increase in specific conductance.

The average specific conductance of groundwater throughout the basin has not changed significantly since the late 1970's (fig. 3). The average annual specific conductance of the Gila River measured at Gillespie Dam above diversions declined sharply in the late 1970's but has since remained relatively unchanged (fig. 5). Dissolved-solids content may be approximated by multiplying the specific-conductance values used in this report by 0.6. (See conversion table.) Of 16 wells sampled in 1976-79 and again in 1991-93, six show slight-to-moderate increases of dissolved-solids content, nine remain relatively unchanged and one shows a significant decrease. Of the six wells that show increases of dissolved solids, all but one are north of Gila Bend. The single well that shows a decrease in total dissolved solids is also north of Gila Bend.

The average specific conductance of groundwater south and west of Gila Bend has consistently been lower than that of groundwater to the north. (See fig. 3.) Specific-conductance values of 43 wells sampled throughout the Gila Bend basin for this study range from 1,250 to over 10,000 $\mu S/cm$ at 25°C. The specific conductance of groundwater from wells north of Gila Bend average 3,500 $\mu S/cm$ while those to the south and west average 2,300 $\mu S/cm$. Wells throughout the basin that are perforated exclusively below 1,000 feet below land surface consistently show lower specific-conductance values than those with perforations above 1,000 feet. Most wells west of Gila Bend are over 1,000 feet deep, while few to the north exceed 1,000 feet in depth.

According to Smith and others (1964, p. 4), water with specific-conductance values of less than 750 $\mu S/cm$ is considered satisfactory for the irrigation of most crops. Values that range from 750 to 2,250 $\mu S/cm$ may be used for irrigation purposes with satisfactory results provided drainage is sufficient and salt-sensitive crops are avoided. Water with specific-conductance values greater than 2,250 $\mu s/cm$ may be used occasionally, but without exceptional drainage and sufficient leaching, crop yields may be adversely affected. However, Hem (1985, p. 217) stated water with a specific conductance greater than 5,000 $\mu S/cm$ is used to successfully raise crops. He further stated that the usability of water depends not only on the water quality but also on soil conditions, crops grown, irrigation techniques and local experience of farmers. For example, during peak flood flows, surface water is not diverted for irrigation use due to high sediment content (Jake Stephens, Paloma Ranch, personal commun., 1995).

The dissolved-solids content of the groundwater is not expected to rise unless significant recharge occurs during flows which are highly mineralized. This situation is not likely to occur since most of the recharge occurs during periods of high flows in which the dissolved-solids content is low. The dissolved-solids content of groundwater has been shown to decrease during periods of high pumpage and low flows in the Gila River. A possible explanation of this observation could be that the groundwater is stratified so that highly mineralized water occurs only in the upper part of the groundwater reservoir. As the upper zone is dewatered and water levels drop, less water of poor quality is yielded to wells. As long as water levels remain high or continue to rise, water quality is not expected to improve. Only when water levels were at their lowest did a marked improvement in water quality occur.

For readers who prefer to use metric units rather than inch-pound units, the conversion factors for the terms used in this report are listed below:

Multiply inch-pound unit	By	To obtain metric unit
inch	25.4	millimeter
foot	0.3048	meter
mile	1.609	kilometer
square mile	2.590	square kilometer
acre	0.4047	square hectometer
acre-foot	0.001233	cubic hectometer
gallons per minute	0.06309	liters per second

SELECTED REFERENCES

Anderson, T. W., Freethey, G. W., and Tucci, Patrick, 1990, Geohydrology and water resources of alluvial basins in south-central Arizona and parts of adjacent states: U. S. Geological Survey Open-File Report 89-378, 99 p., 28 figs., 2 tables, 3 plates.

Anning, D. W. and Duet, N. R., 1994, Summary of ground-water conditions in Arizona, 1987-90: U. S. Geological Survey Open-File Report 94-476, 2 sheets.

Arizona Department of Environmental Quality, 1991, Public and semi-public water supply system rules, State of Arizona: Department of Environmental Quality, Phoenix, Arizona, 56 p.

Babcock, H. M., and Kendall, K. K. 1948, Geology and ground-water resources of the Gila Bend basin, Maricopa County, Arizona, with a section on quality of water by J. D. Hem: U. S. Geological Survey open-file report, 26 p.

Boner, F. C., Davis, R. G., and Duet, N. R., 1992, Water resources data, Arizona, water year 1991: U. S. Geological Survey Water-Data Report AZ-91-1, 411 p., 8 figs.

Cahill, J. M. and Wolcott, H. N., 1955, Further investigations of the ground-water resources of the Gila Bend and Dendora areas, Maricopa County, Arizona: U. S. Geological Survey open-file report (unnumbered), 9 p., 4 figs., 2 tables, 2 plates.

Dugan, J. T. and Peckenpaugh, J. M., 1985, Effects of climate, vegetation, and soils on consumptive water use and ground-water recharge to the Central Midwest Regional Aquifer System, Mid-Continent United States: U. S. Geological Survey Water-Resources Investigations Report 85-4236, 78 p., 25 figures.

Fenneman, N. M. 1931, Physiography of the western United States: Mcgraw Hill Book Co., Inc., New York and London, 534 p.

Heindl, L. A. and Armstrong, C. A., 1963, Geology and ground-water conditions in the Gila Bend Indian Reservation, Maricopa County, Arizona: U. S. Geological Survey Water-Supply Paper 1647-A, 48 p.

Hem, John D., 1985, Study and Interpretation of the chemical characteristics of natural water: U. S. Geological Survey Water-Supply Paper 2254, 263 p., 51 figs., 33 tables, 3 plates.

Johnson, P. W. and Cahill, J. M., 1955, Ground-water resources and geology of the Gila Bend and Dendora areas, Maricopa County, Arizona: U.S. Geological Survey open-file report, 53 p.

Oxford, R. B. and Bender, G. L., 1973, Proposed natural areas, Sentinel Plain lava flow: Arizona Academy of Sciences for Planning Division, State Department of Economic Planning and Development, Office of the Governor, State of Arizona, Report No. 37, 6 p., unnumbered.

Sebenik, P. G., 1981, Maps showing ground-water conditions in the Gila Bend basin area, Maricopa County, Arizona--1979: Arizona Department of Water Resources Hydrologic Map Series Report No.3, 2 sheets.

Smith, C. F., and others, 1995, Water resources data, Arizona, water year 1994: U.S. Geological Survey Water Data Report AZ-94-1, 320 p., 8 figs.

Smith, H. V., Draper, G. E., and Fuller, W. H., 1964, The quality of Arizona irrigation waters: Agricultural Experiment Station, The University of Arizona, Tucson, Arizona, 96 p., 6 figs., 6, tables.

Todd, David Keith, 1980, Groundwater Hydrology: John Wiley and Sons, Inc, New York, 535 p.

Turner, S. F., 1956, Water resources available for use on Gillespie Property in Gila Bend area, Arizona: Samuel F. Turner and Associates, Phoenix, Arizona, 37 p.

United Nations, 1975, Ground-water storage and artificial recharge: United Nations Department of Economic and Social Affairs Natural Resources/Water Series No. 2, 270 p., 43 figures.

U. S. Army Corps of Engineers, 1962, Gila River and tributaries downstream from Painted Rock reservoir, Letter from the Secretary of the Army: U. S. Senate document no. 116, 87th Congress, 2nd session, 97 p., 3 plates.

U. S. Army Corps of Engineers, 1994, Flood Damage Report, State of Arizona, Floods of 1993: U. S. Army Corps of Engineers publication, Los Angeles District, South Pacific Division, 108 p., 40 figs., 11 tables, 4 appendicies.

U. S. Bureau of Reclamation, 1976a, Central Arizona Project geology and ground-water resources report, Maricopa and Pinal Counties, Arizona: U. S. Bureau of Reclamation publication, V. 1, 105 p., 73 figs., 1 appendix.

U. S. Environmental Protection Agency, 1986, Quality criteria for water 1986: U.S. Environmental Protection Agency Report EPA 440/5-86-001, Office of Water Regulations and Standards, Washington, D.C., unnumbered.

White, N. D., 1963, Ground-water conditions in the Rainbow Valley and Waterman Wash areas, Maricopa and Pinal Counties, Arizona: U. S. Geological Survey Water-Supply Paper 1669-F, 50 p., 6 figs., 8 tables, 4 plates.

Wilson, E. D., Moore, R. T. and Pierce, H. W., 1957, Geologic Map of Maricopa County, Arizona: Arizona Bureau of Mines, University of Arizona, 1 map.

Wolcott, H. N., 1953, Memorandum on ground-water and geology of Rainbow Valley-Waterman Wash area, Maricopa County, Arizona, U. S. Geological Survey, 13 p., 3 tables, 1 plate.

BASE FROM U.S. GEOLOGICAL SURVEY
PHOENIX, ARIZONA, 1954, REV. 1969, 1:250,000
AJO, ARIZONA, 1953, REV. 1969, 1:250,000

MAPS SHOWING GROUNDWATER CONDITIONS
GILA BEND BASIN, MARICOPA COUNTY, ARIZONA--1993

BY

S. J. RASCONA

These hydrologic maps are available upon request from the Department of Water Resources, Basic Data Section, 2810 South 24th Street, Suite 122, Phoenix, Arizona, 85034. The hydrologic data on which these maps are based are available, for the most part, in computer-printout form and may be consulted at the Department of Water Resources and at the U.S. Geological Survey offices located at: 375 S. Euclid, Tucson, Arizona, 85719, and 1545 West University, Tempe, Arizona, 85281.

HYDROGRAPHS OF THE WATER LEVEL IN SELECTED WELLS

(Dashed lines indicates inferred water level)

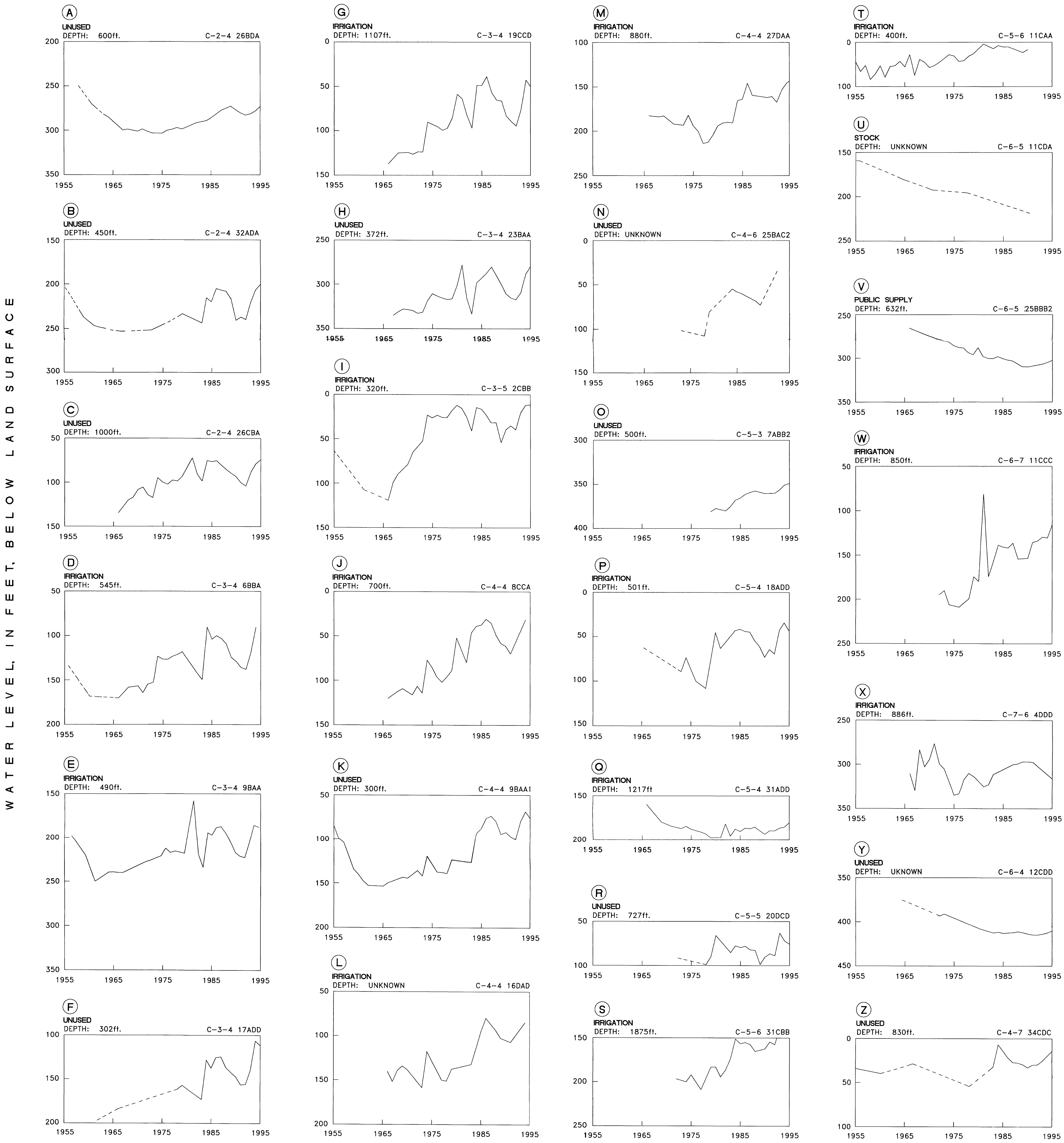


FIGURE 1

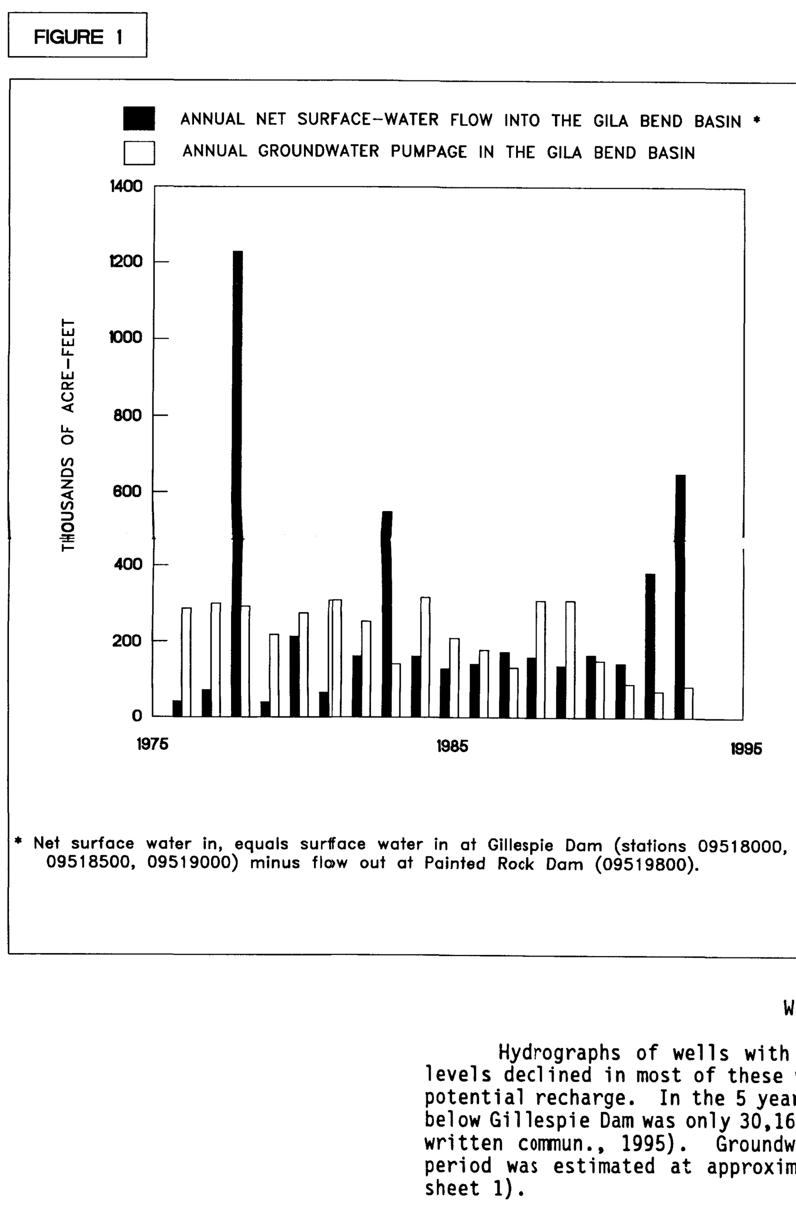


FIGURE 2

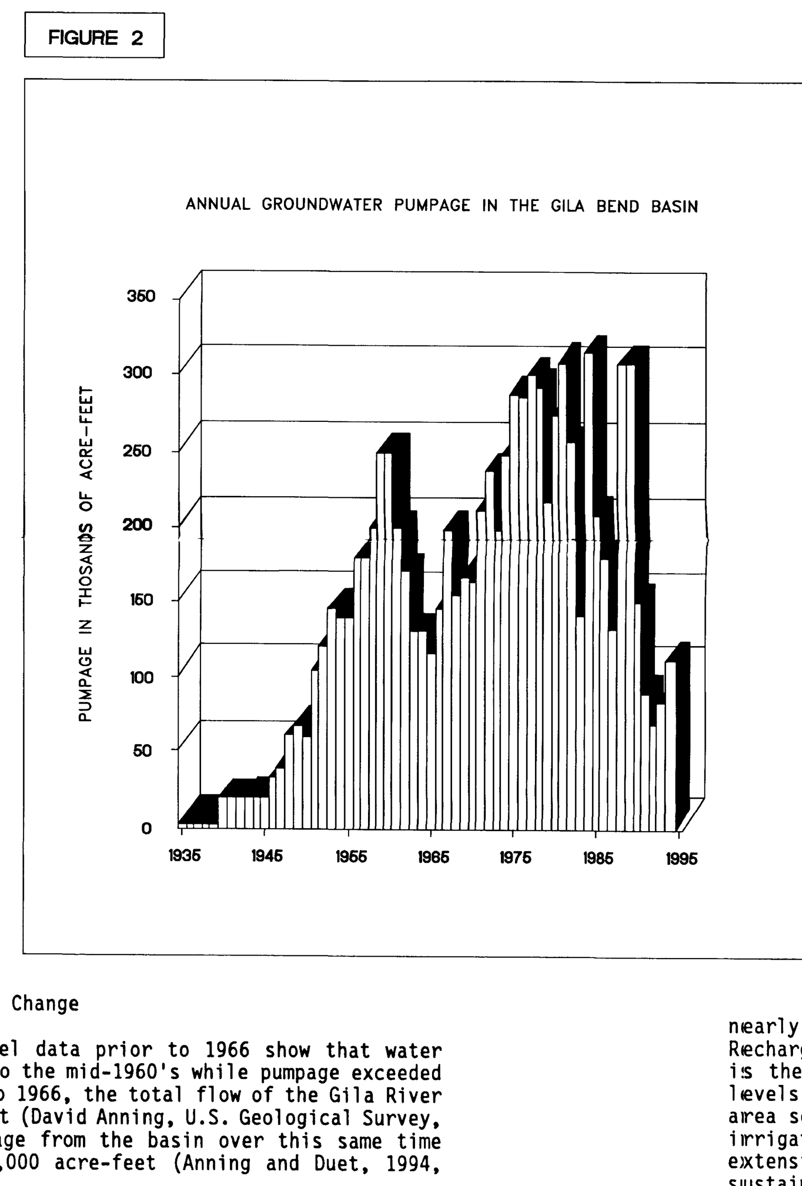


FIGURE 3

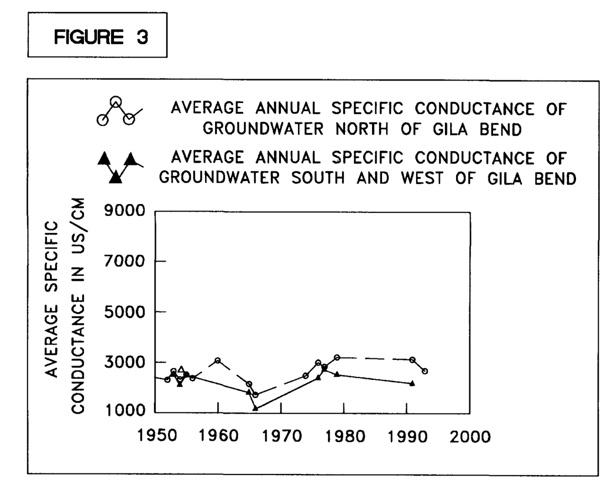


FIGURE 4

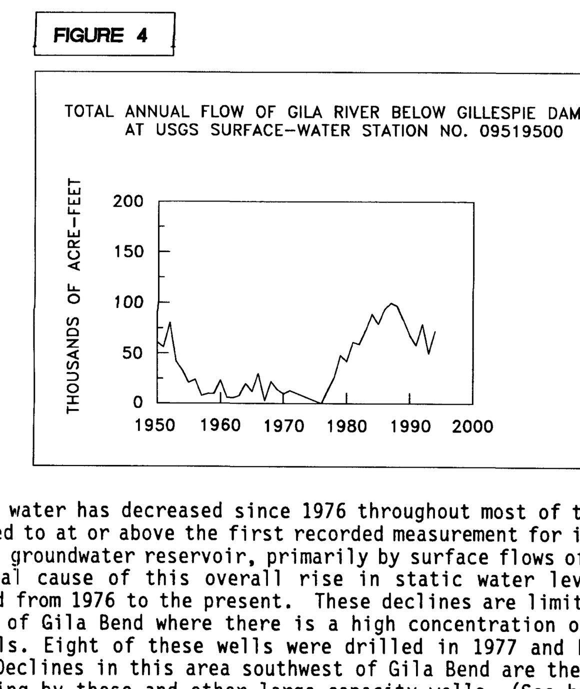
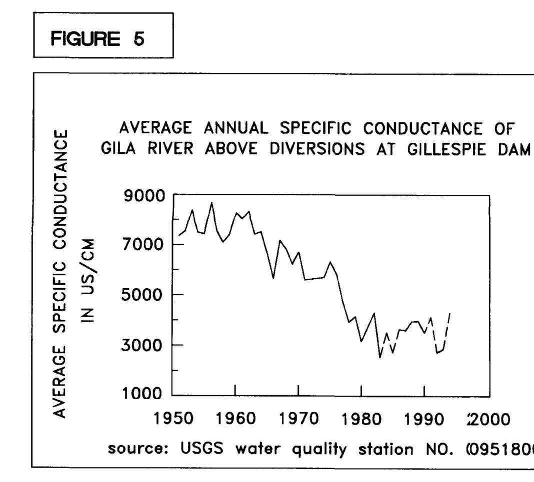


FIGURE 6



Water-Level Change

Hydrographs of wells with water-level data prior to 1966 show that water levels declined in most of these wells up to the mid-1960's while pumpage exceeded potential recharge. In the 5 years prior to 1966, the total flow of the Gila River below Gillespie Dam was only 30,168 acre-feet (David Anning, U.S. Geological Survey, written commun., 1995). Groundwater pumpage from the basin over this same time period was estimated at approximately 745,000 acre-feet (Anning and Duet, 1994, sheet 1).

From 1966 to 1976, significant recharge was limited to the northern part of the basin. Depth to water in the northern part of the basin decreased during this period, primarily due to high flows in 1966 and 1973. However, depth to water increased in the central part of the basin during this same time period as pumpage throughout the basin increased dramatically. (See fig. 2.)

Depth to water has decreased since 1976 throughout most of the basin and has nearly recovered to at or above the first recorded measurement for individual wells. Recharge to the groundwater reservoir, primarily by surface flows of the Gila River, is the principal cause of this overall rise in static water levels. Few water levels declined from 1976 to the present. These declines are limited mainly to the area southwest of Gila Bend where there is a high concentration of large-capacity irrigation wells. Eight of these wells were drilled in 1977 and have been pumped extensively. Declines in this area southwest of Gila Bend are the result of heavy sustained pumping by these and other large-capacity wells. (See hydrographs U and V, sheet 3.)

No significant coalescing cones of depression or groundwater mounds discussed in previous reports were observed during this study. A slight depression in the groundwater surface south of Gila Bend may become more pronounced during prolonged dry periods.

BASE FROM U.S. GEOLOGICAL SURVEY
PHOENIX, ARIZONA, 1954, REV. 1969, 1:250,000
AJO, ARIZONA, 1953, REV. 1969, 1:250,000

MAPS SHOWING GROUNDWATER CONDITIONS
GILA BEND BASIN, MARICOPA COUNTY, ARIZONA--1993

BY

S. J. RASCONA

These hydrologic maps are available upon request from the Department of Water Resources, Basic Data Section, 2810 South 24th Street, Suite 122, Phoenix, Arizona, 85034. The hydrologic data on which these maps are based are available, for the most part, in computer-printout form and may be consulted at the Department of Water Resources and at the U.S. Geological Survey offices located at: 375 S. Euclid, Tucson, Arizona, 85719, and 1545 West University, Tempe, Arizona, 85281.