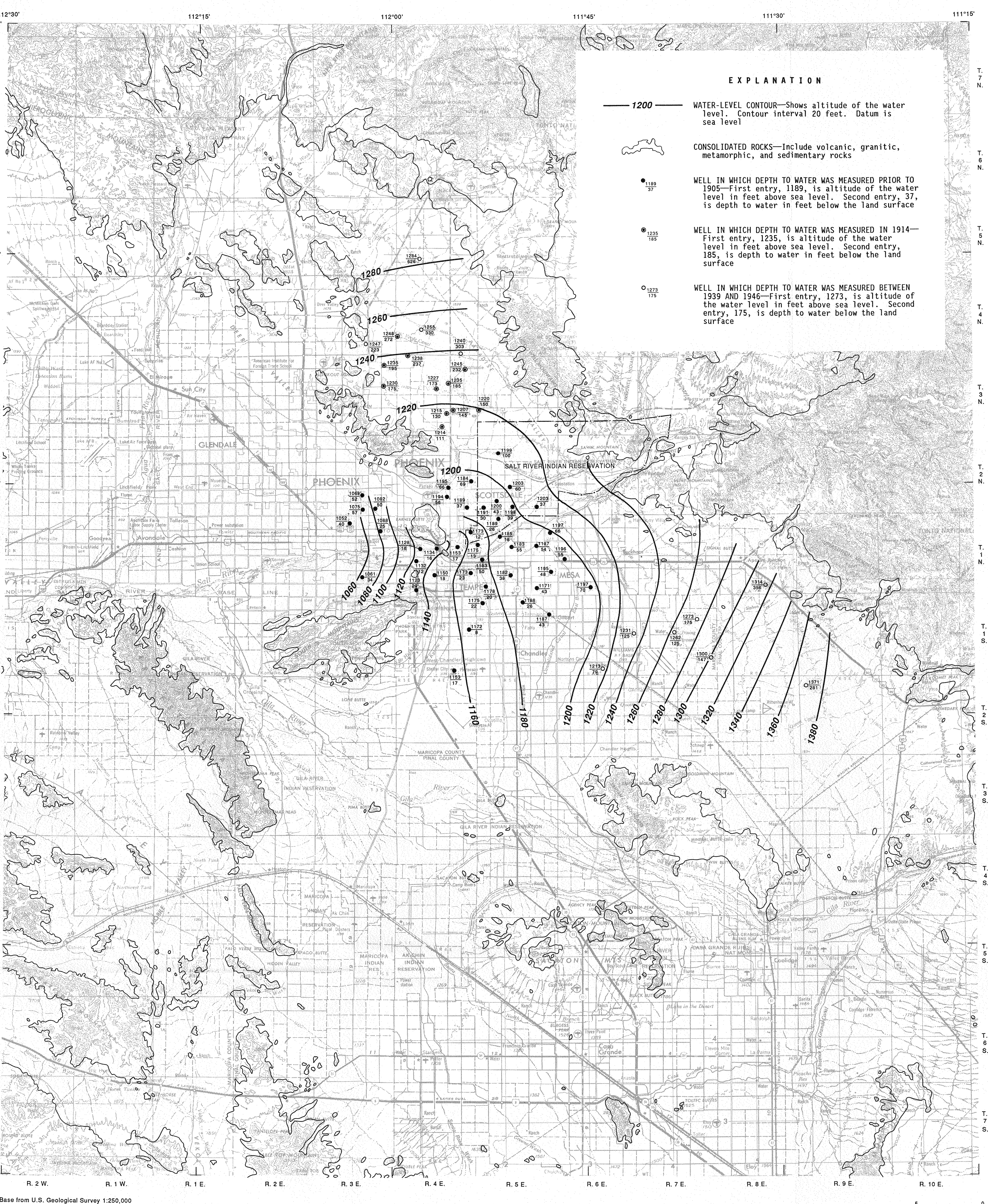
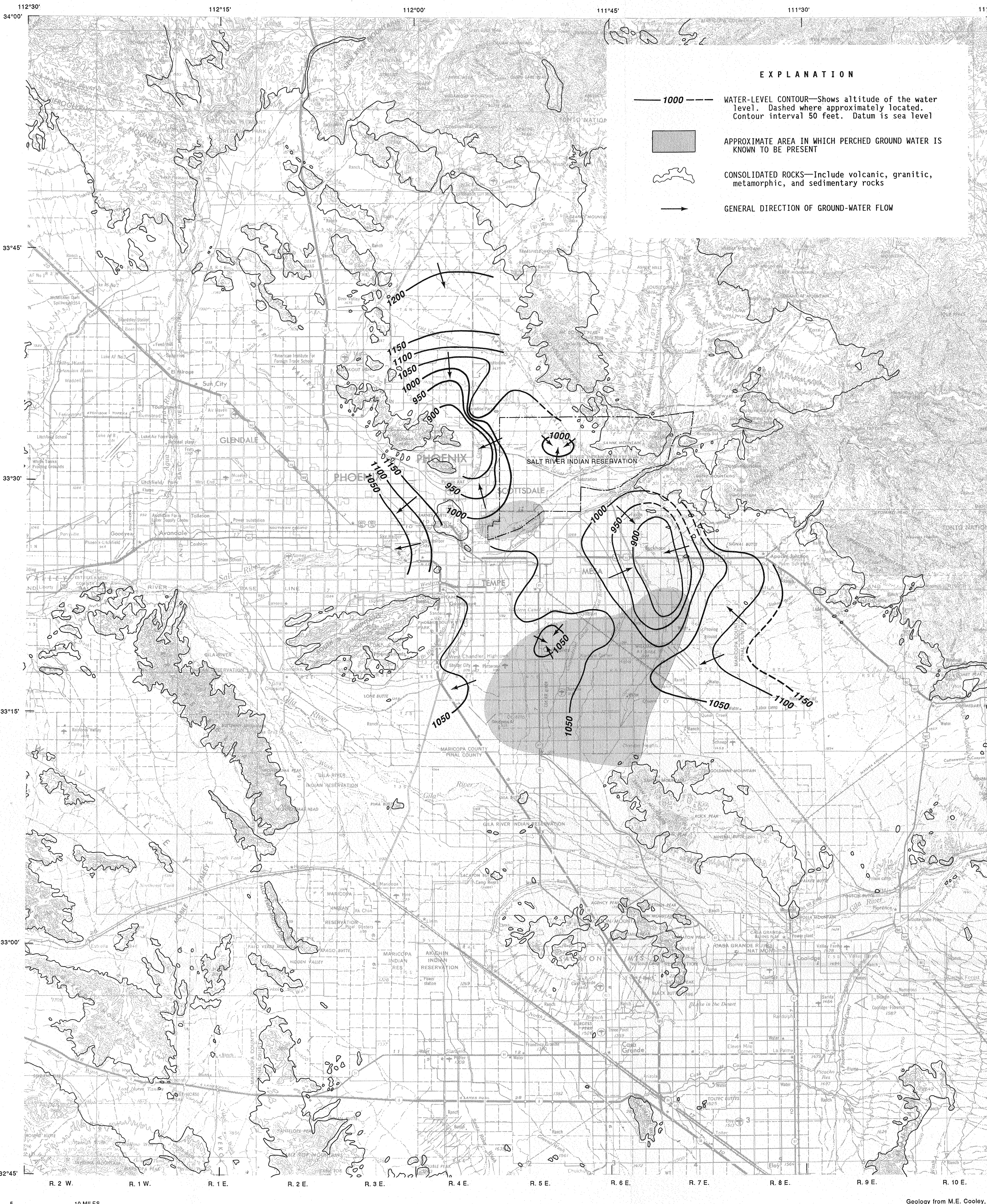



ALTITUDE OF THE WATER LEVEL, ABOUT 1900

TOPOGRAPHIC CONTOUR INTERVAL 200 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929




ALTITUDE OF THE WATER LEVEL, 1986

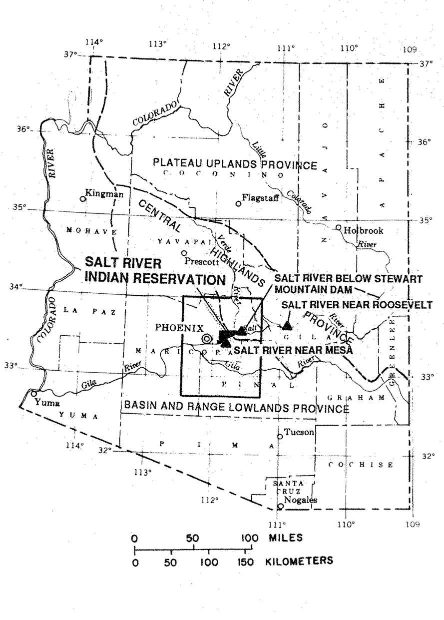



Figure 1.--Location of study area (shaded).

## INTRODUCTION

The Salt River Indian Reservation covers about 77 mi² in the eastern part of Salt River Valley in south-central Arizona, which is one of the major agricultural areas in the State. Increased water use since 1900 has resulted in major changes in the ground-water system in and near the reservation. The purpose of this study was to evaluate those changes. About 800 mi² of the regional ground-water area was included in the study in order to evaluate the ground-water resources of the reservation (fig. 1).

The study area is in the Basin and Range physiographic province (Fenneman, 1931) and consists of broad alluvial valleys surrounded by mountain ranges that rise abruptly above the generally flat valley floors. The mountains are composed of consolidated rocks, which include crystalline, extrusive, and sedimentary rocks. The crystalline and extrusive rocks are virtually impermeable and form physical boundaries for surface-water and ground-water flow. The valleys are underlain by thousands of feet of permeable sediments that contain large quantities of ground water. The oldest sediments were deposited before high-angle block faulting occurred. These sediments consist mostly of reddish-colored, well-cemented breccia, conglomerate, sandstone, and siltstone and are exposed mainly north of the Salt River along the east and west boundaries of the study area (Laney and Hahn, 1986). Other sediments were deposited during and after block faulting and consist of unconsolidated clay, silt, sand, and gravel and variably consolidated caliche, mudstone, siltstone, sandstone, conglomerate, and evaporites. The degree of sorting and cementation and the distribution of the materials differ areally and with depth. Interbedding and lensing are common, and lateral discontinuities caused by high-angle faults may be present in some lower units (Laney and Hahn, 1986).

The valley floor ranges in altitude from about 1,100 ft above sea level in the southwest to about 2,000 ft in the north. The Phoenix and South Mountains have peaks as high as 2,500 ft above sea level. The McDowell and Superstition Mountains are about 4,000 and 5,000 ft in altitude, respectively. The western two-thirds of the Salt River Indian Reservation is in the valley and the eastern one-third is in the McDowell Mountains. The principal water resources of the area include streamflow of the Salt River and ground water stored in the underlying sediments. The average annual precipitation ranges from about 8 in. on the valley floor to about 16 in. in the Superstition Mountains, and the average annual lake evaporation is about 75 in. (Sellers and Hill, 1974). The flow of the Salt River is controlled, except during extremely wet years, by reservoirs that were constructed to store excess runoff and regulate the flow of the river. The first structure, Theodore Roosevelt Dam, on the Salt River was completed in 1911, followed by Mormon Flat Dam in 1925, Horse Mesa Dam in 1927, and Stewart Mountain Dam in 1930. On the Verde River, Bartlett Dam was completed in 1939 and Horseshoe Dam in 1946. The six reservoirs have a combined storage capacity of more than 2 million acre-ft of water. Irrigated agriculture, which became a prominent industry in the 1940's, together with other industries and municipalities, uses the available surface water from the reservoirs and about 1 million acre-ft of ground water each year in the Salt River Valley (U.S. Geological Survey, 1986).

The hydrologic data on which these maps are based are available, for the most part, in computer-printout form for consultation at the Arizona Department of Water Resources, 99 East Virginia, Phoenix, and at U.S. Geological Survey offices in: 375 South Euclid Avenue, Tucson, and 1545 West University, Tempe. Material from which copies can be made at private expense is available at the Tucson and Tempe offices of the U.S. Geological Survey.

This investigation was done in cooperation with the U.S. Bureau of Indian Affairs. The authors gratefully acknowledge the cooperation and assistance of the personnel of the Salt River Pima-Maricopa Indian Community, City of Scottsdale Water Department, City of Mesa Utility Operations Division, and Salt River Project. The authors particularly wish to thank Arnold Makil of the U.S. Bureau of Indian Affairs for his help with the data collection.

## AQUIFER CHARACTERISTICS

The main water-bearing unit consists of sediments that are several thousand feet thick in places. The sediments have been divided into four units—upper, middle, lower, and red (Laney and Hahn, 1986) on the basis of geologic and hydrologic properties. The upper unit consists of gravel, sand, and silt and is as much as 300 ft thick south and southwest of Mesa and 200 ft thick in Paradise Valley. The unit has excellent water-bearing characteristics and, where saturated, may yield as much as 4,500 gal/min of water to wells (Laney and Hahn, 1986). Ground water is perched in the upper unit in the south-central part of the area where most of the deposits are silt. Near Scottsdale, where most of the deposits are sand and gravel, perched water also occurs and may be caused by buried caliche-cemented terraces (Péwé, 1978). The middle unit consists mostly of silt, siltstone, and silty sand and gravel. The unit is as much as 1,000 ft thick and generally will yield about 1,000 gal/min of water to wells. North of Mesa, the unit yields about 4,000 gal/min of water locally to wells (Laney and Hahn, 1986). The lower unit consists mainly of mudstone, clay, silt, and evaporites with locally interbedded sand and gravel, conglomerate, and basalt and may be as much as 10,000 ft thick. In many areas, the lower unit yields 50 gal/min or less of water to wells; however, the conglomerate and the sand and gravel units may yield as much as 3,500 gal/min to wells (Laney and Hahn, 1986). The red unit, which consists of well-cemented coarse-grained materials, has been subjected to faulting. Although the thickness of the red unit is not known, it is as much as 500 ft thick near Scottsdale and yields about 1,000 gal/min of water to wells (Laney and Hahn, 1986). The crystalline rocks that are exposed along the margins of the study area may yield as much as 10 gal/min of water to wells from fractures.

The hydraulic characteristics of the water-bearing units have a wide range of values because of the extreme heterogeneity of the units. The hydraulic conductivity of the upper unit, which has been dewatered in much of the area, ranges from about 50 to 500 ft/d (Laney and Hahn, 1986); specific yield ranges from 15 to 25 percent (Freethey and others, 1986). The middle unit contains the most recoverable ground water and is the major source of ground water in the study area. Aquifer-test data show that the hydraulic conductivity of the middle unit ranges from about 20 to 100 ft/d (Niccoli and Long, 1981); specific yield is estimated to range from 5 to 20 percent. Ross (1980) used a uniform specific-yield value of 12 percent in his model. Little is known about the hydraulic characteristics of the lower units because of the lack of data from wells perforated only in the individual units. Laney and Hahn (1986) estimated that hydraulic conductivity of the lower and red units may range from 0.001 to 100 ft/d.

## GROUND-WATER CONDITIONS, ABOUT 1900

An arbitrary date of about 1900 was used for the water-level contours because the first records on wells and depths to water were compiled between 1897 and 1905. Water-level data for about 1900 for the Phoenix-Mesa area were compiled by Lee (1905). The earliest available water-level data for Paradise Valley were compiled by Meinzer and Ellis (1916). Water-level contours are substantiated by water-level data collected before large quantities of ground water were withdrawn in the area southeast of Mesa (Babcock and Halpenny, 1942) and in the north end of Paradise Valley (McDonald and others, 1947).

Records indicate that non-Indian settlers started diverting water from the Salt River for irrigation in 1868. By 1889, water was diverted for the irrigation of more than 35,000 acres (Davis, 1897). The Arizona Canal was constructed in 1883 and 1884 and first used in 1885. Pumping of ground water for irrigation began in the late 1890's (Davis, 1897); however, only small quantities of ground water were withdrawn until the 1940's (Anderson, 1968). When the non-Indian settlers arrived, water levels were shallow—less than 10 ft to about 70 ft below the land surface in the Phoenix-Mesa-Chandler area. The gradient of the ground water sloped generally with the gradient of the Salt River (Lee, 1905). Water-level contours indicate that the hydraulic gradient averaged about 0.001 and ranged from 0.0006 to 0.004. Near the Arizona Canal, water levels were about 60 to 70 ft below the land surface. In Paradise Valley, 10 mi northwest of the Arizona Canal, water levels were about 270 ft below the land surface (Meinzer and Ellis, 1916). Along the Salt River and in the area south of the river, the direction of ground-water movement was from east to west. In Paradise Valley, the ground water moved from north to south. Water-level contours indicate that water moved from the Salt River to the aquifer in the first 10 mi downstream from Granite Reef Dam; however, about 3 mi farther downstream, in the area north of Tempe, water moved from the aquifer to the Salt River. The diversion of surface water for irrigation reduced recharge along the river, created new areas of recharge along unlined irrigation canals and under irrigated fields, and caused minor changes in ground-water flow patterns. For example, in Paradise Valley, water-level measurements indicated the development of a ground-water ridge under the Arizona Canal (Meinzer and Ellis, 1916). Water levels were more than 20 ft above the natural water table near the Arizona Canal. Effects of the ridge extended 2 mi or more northward from the canal. In general, however, the areas and amounts of artificial recharge were small and probably had little impact on the hydrologic system as a whole. Before 1923, the hydrologic system in central Arizona was considered to be in equilibrium; that is, inflow was equal to outflow (Anderson, 1968).

The volume of recoverable ground water in storage beneath the Salt River Indian Reservation to a depth of 1,200 ft below the land surface was about 4 million acre-ft in 1900. This volume was estimated using specific-yield values ranging from 0.10 to 0.20 and estimated aquifer volumes.

## GROUND-WATER CONDITIONS, 1986

Between 1900 and 1986, water levels declined and the direction of ground-water movement changed significantly because millions of acre-feet of water were pumped from the ground-water reservoir (U.S. Geological Survey, 1986) and because recharge decreased. In 1900, the general direction of ground-water flow was from north to south in Paradise Valley and east to west along and south of the river. By 1986, ground water flowed toward the center of cones of depression east of Mesa and west of the reservation. In most of the area, water-level contours indicate that the hydraulic gradient ranges from about 0.002 to 0.03.

In 1986, depth to water below the land surface was less than 100 ft near the Salt River, more than 500 ft east of Mesa, and 400 ft west of the Salt River Indian Reservation. As water levels declined, areas of perched ground water that are apparently supported by fine-grained or cemented material within the upper unit remained. Perched ground water may result, in part, from irrigation-return flow. Water levels were measured in winter when pumping for irrigation was minimal. Agricultural pumping seldom ceases, however, and continuous pumping occurs at many public-supply wells. Hence, static water levels are uncommon. Water-level contours represent the regional water table as interpreted from a complex water-level data set. Withdrawal of ground water and resulting water-level declines caused land subsidence in Paradise Valley and the Mesa-Chandler areas (Schumann, 1974). About 3 million acre-ft of recoverable ground water is in storage to a depth of 1,200 ft beneath the Salt River Indian Reservation.

## CONVERSION FACTORS

For readers who prefer to use the metric (International System) units, the conversion factors for the inch-pound units used in this report are listed below:

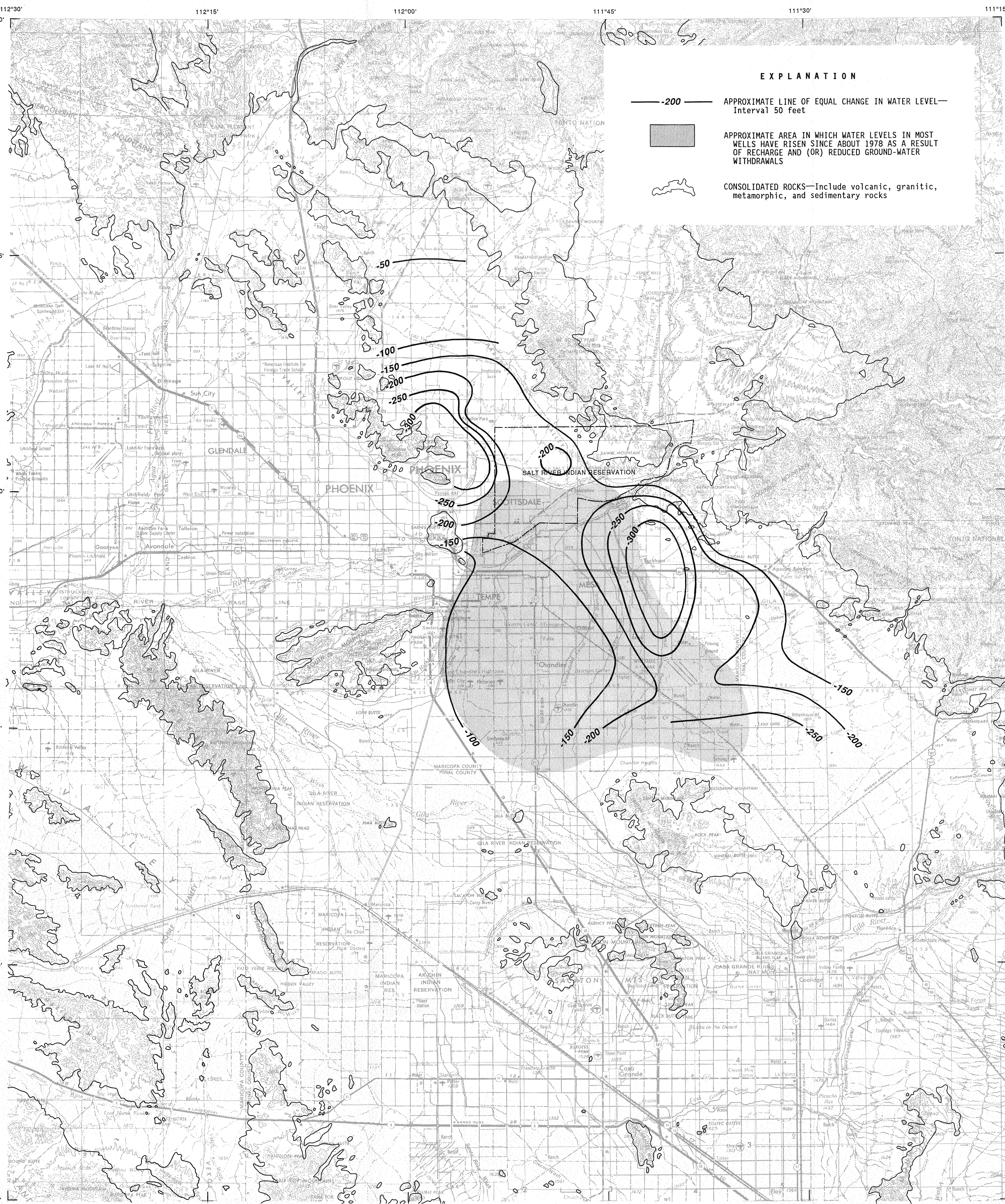
| Multiply inch-pound unit | By | To obtain metric unit |
|---|---|---|
| inch (in.) | 25.40 | millimeter (mm) |
| foot (ft) | 0.3048 | meter (m) |
| square mile (mi²) | 2.590 | square kilometer (km²) |
| acre-foot (acre-ft) | 0.001233 | cubic hectometer (hm³) |
| gallon per minute (gal/min) | 0.06309 | liter per second (L/s) |
| degree Fahrenheit (°F) | °C = 5/9(°F-32) | degree Celsius (°C) |

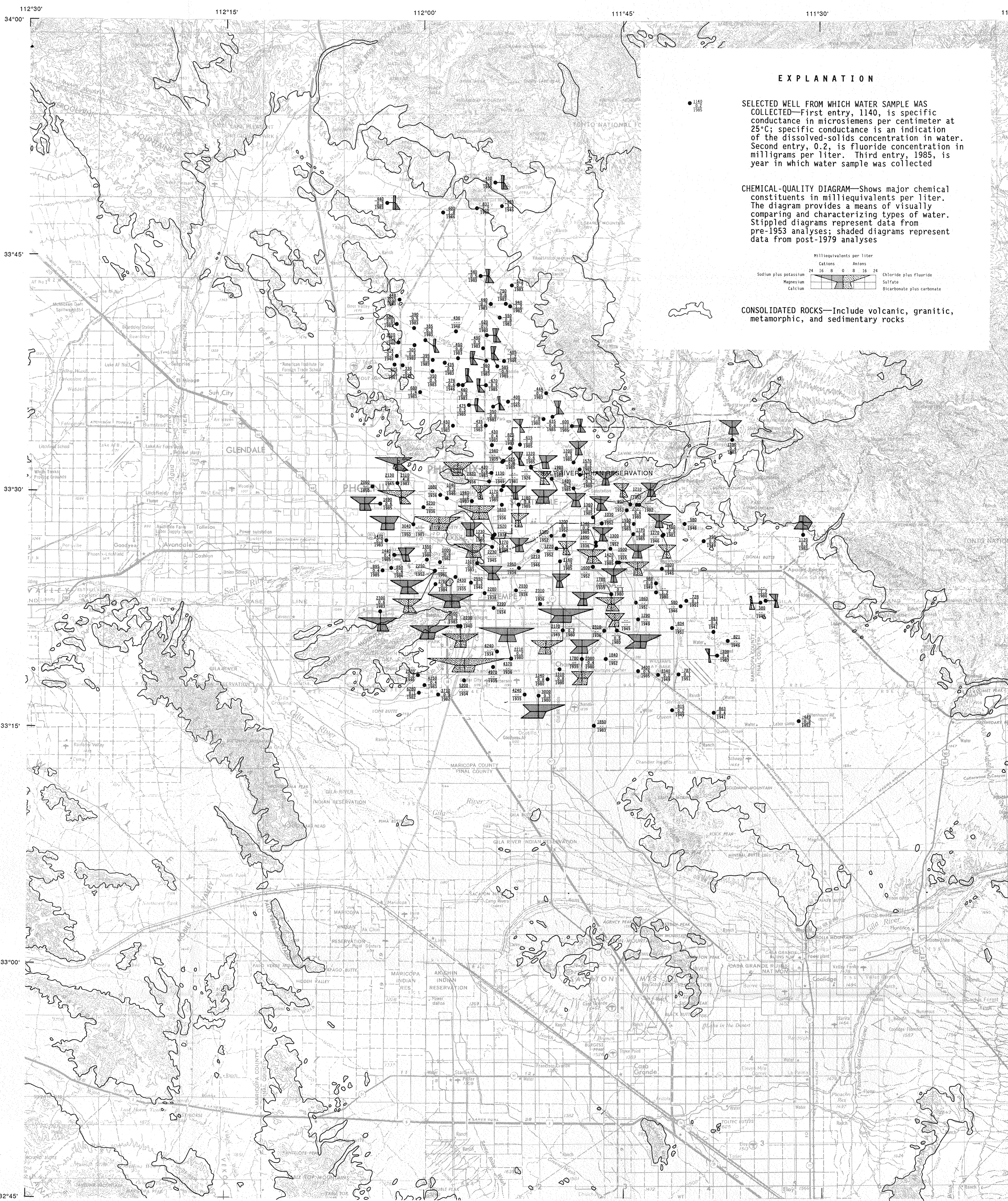
Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Sea Level Datum of 1929."

# GROUND-WATER CONDITIONS IN AND NEAR THE SALT RIVER INDIAN RESERVATION, SOUTH-CENTRAL ARIZONA

By
B.W. Thomsen and B.H. Miller

1991




Base from U.S. Geological Survey 1:250,000
Mesa, 1954-69 and Poenix, 1954-69

TOPOGRAPHIC CONTOUR INTERVAL 200 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology from M.E. Cooley, 1973

# CHANGE IN WATER LEVEL, ABOUT 1900 TO 1986

# CHEMICAL QUALITY OF THE GROUND WATER

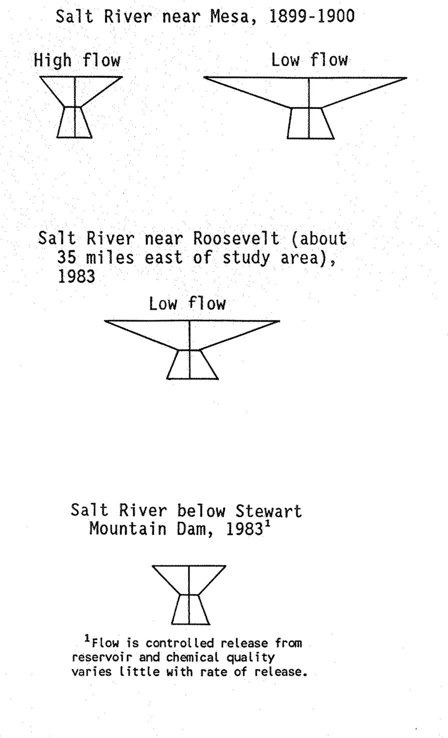



Figure 2.--Chemical quality of the surface water.

## CHANGE IN WATER LEVEL FROM ABOUT 1900 TO 1986

The change in water level as shown on the map represents differences between water-level altitudes in about 1900 and 1986 (sheet 1). Water levels in wells declined more than 300 ft east of Mesa and west of the reservation, 100 to 250 ft on the reservation, 100 to 150 ft in the Tempe-Chandler area, and less than 50 ft near the north end of Paradise Valley. Changes in the ground-water system are the result of decrease of natural recharge and withdrawal of ground water. Recharge to the ground-water reservoir decreased because flow in the river was virtually eliminated as a result of the retention of water in the reservoirs on the Salt and Verde Rivers. Water infiltrating from canals and irrigated fields provides some recharge, but the quantity has diminished with time because many canals have been lined and irrigation practices have been changed to conserve water. Since ground-water pumping began, more than 80 million acre-ft has been pumped from the Salt River Valley (U.S. Geological Survey, 1986). The part of the Salt River Valley included in this report contains about half the irrigated land in the valley, but distribution of ground-water pumping has not been determined. Most of the ground water pumped in the study area has been used for irrigation. Although surface water is used for irrigation in much of the area, ground water has been withdrawn in nearly all areas to supplement or replace surface-water supplies in dry years. Surface water is not available in the Queen Creek area or in Paradise Valley north of the Arizona Canal. Long-term ground-water withdrawal together with the depletion of natural recharge has resulted in a general decline in water levels in wells throughout the area. The largest declines are in areas of large ground-water withdrawals or low aquifer yield. Most of the decline has occurred since the 1940's when intense development of ground-water resources began.

The release of large quantities of floodwater into the normally dry channel of the Salt River between February 1978 and June 1980 resulted in recharge to the ground-water system. Water levels in wells rose more than 50 ft along the Salt River and as much as 20 ft in most of the area between the Arizona Canal on the north and Chandler on the south (Mann and Rohne, 1983). Between the Arizona Canal and Chandler, water levels were lowest in 1978 and continued to rise slightly either as a result of additional recharge of floodwater or decreases in ground-water pumping. The area affected by rising water levels was determined by comparing altitudes of ground-water levels in 1986 with altitudes of ground-water levels in 1976 (Laney and others, 1978).

## CHEMICAL QUALITY

Chemical quality of ground water in and near the Salt River Indian Reservation varies areally but is generally of good chemical quality for public supply (U.S. Environmental Protection Agency, 1976). In the area north of the Arizona Canal, specific conductance of the ground water ranged from about 300 to 600 µS/cm (microsiemens per centimeter at 25 °C). Specific conductance is a measure of the ability of the ions in solution to conduct electrical current and is an indication of the amount of dissolved solids in water. The dissolved-solids content, in milligrams per liter, is about 0.6 of the specific conductance. From the Arizona Canal to the south boundary of the study area, specific conductance of the ground water ranged from about 1,200 to 2,000 µS/cm. Near the southwestern part of the area, specific conductance of the ground water in some wells was greater than 6,000 µS/cm. Ground water in the southwestern part of the area generally is not used for public supply because of large dissolved-solids concentrations but is acceptable for irrigation and industrial uses.

Chemical data on ground water and surface water were collected from 1896 to 1903 (Lee, 1905). Because the location of the ground-water sampling sites and the methods used to collect and analyze the samples are uncertain, comparison of these data with more recent water-quality data is questionable, but some general observations are possible. For example, the dissolved-solids concentration (residue on evaporation at 110 °C) for a ground-water sample collected in Paradise Valley in 1902 was 256 mg/L (milligrams per liter), which is comparable to 1985 data in that area. Dissolved-solids concentrations for ground water in the Scottsdale-Tempe-Mesa area ranged from 520 to 3,810 mg/L for samples collected from 1896 to 1903 and from 500 to about 3,000 mg/L for samples collected from 1926 to 1986. The large concentrations of dissolved solids recorded by Lee (1905) may reflect the natural quality of the shallow ground water at that time or may have been the result of the leaching of salts from the soil and percolation of irrigation water to the shallow ground-water reservoir. Much of the area had been irrigated for many years before samples of the ground water were analyzed.

Chemical-quality data collected from 1980 to 1985 were compared with data collected from 1926 to 1952 before intense ground-water pumping began. In general, the data show little evidence of change in chemical quality of the ground water in most of the area. Eight wells in the study area were sampled before 1953 and after 1979, and chemical-quality diagrams for each pair of analyses are shown for comparison. Chemical-quality diagrams for the predevelopment and postdevelopment samples for three wells in sec. 19, T. 1 N, R. 4 E.; sec. 22, T. 2 N., R. 3 E.; and sec. 24, T. 2 N., R. 4 E., are similar. Chemical-quality diagrams show that concentrations of dissolved solids, especially sodium, calcium, and chloride, increased in three wells in sec. 10, T. 1 S, R. 5 E.; sec. 24, T. 1 S., R. 5 E.; and sec. 8, T. 1 S., R. 6 E., and decreased in two wells in sec. 2, T. 1 N., R. 3 E., and sec. 19, T. 1 S., R. 4 E. The apparent changes in the chemical quality of ground water probably resulted from the dewatering of sediments, deepening of wells, and changes in recharge patterns. One of the wells in sec. 24, T. 2 N, R. 4 E., for which two chemical analyses are available was deepened between sampling dates; however, the chemical-quality diagrams for the two samples are similar.

Ground water in Paradise Valley was a mixed sodium magnesium bicarbonate type, whereas ground water in most of the Salt River Indian Reservation and to the south was a sodium chloride type. Concentrations of fluoride ions in ground water generally were less than 1.4 mg/L, which is the maximum contaminant level set by the Bureau of Water Quality Control (1978) for fluoride levels in areas where the annual average maximum daily air temperature is greater than 79.3 °F. In one area south of the reservation, fluoride concentrations ranged from 1.5 to 2.6 mg/L. Water samples from a few wells near the consolidated-rock outcrops on the west side of Paradise Valley and near Carefree contained fluoride concentrations that ranged from 2.2 to 4.5 mg/L. North of the reservation, water from a 2,830-foot-deep well contained fluoride concentrations of 7.0 mg/L.

Nitrate concentrations exceeded the maximum contaminant level of 10 mg/L as nitrogen (U.S. Environmental Protection Agency, 1976) in water from a few wells scattered throughout the southern part of the study area. In the Salt River Indian Reservation, water samples from two wells in secs. 16 and 23, T. 2 N., R. 5 E., contained concentrations of nitrate as nitrogen of 22 and 11 mg/L, respectively.

Concentrations of hexavalent chromium exceeded the maximum contaminant level of 0.050 mg/L (U.S. Environmental Protection Agency, 1976) in water samples taken in 1983 from a well in sec. 23, T. 3 N., R. 4 E., and one in sec. 25, T. 4 N., R. 3 E. Concentrations of hexavalent chromium were 0.190 and 0.056, respectively, and correlate with data from a study on hexavalent chromium in Paradise Valley by Robertson (1975), which stated that the occurrence has a natural geologic origin.

Water in the Salt River near Mesa was sampled for chemical analysis during seven periods in 1899 and 1900 (Lee, 1905). Dissolved-solids concentrations ranged from 724 to 1,391 mg/L, which is approximately equivalent to specific conductance of about 1,200 to 2,300 µS/cm. The largest dissolved-solids concentrations occurred during low flows and the smallest during high flows. The chemical-quality diagram for the low-flow conditions of 1900 is similar to the diagram for a typical low-flow sample taken in 1983 from the Salt River near Roosevelt (fig. 2). The chemical-quality diagram for the high-flow conditions of 1899 is similar to the diagram for a sample of the water released from Stewart Mountain Dam in 1983. Since the reservoirs were completed, recharge has consisted mainly of water released from storage. This water includes large volumes of surface runoff that typically contain small concentrations of dissolved solids. Most of the surface runoff occurs on a few days each year, and the water would pass quickly from the watershed if the reservoirs were not present. Water that was available for recharge most of the time under natural conditions, therefore, was base flow. Most of the surface runoff now is stored in the reservoirs where the base flow of the river is diluted. In 1983, the specific conductance of water from the Salt River near Roosevelt, which is upstream from the reservoir, averaged 1,965 µS/cm for base flow and 455 µS/cm for high flow. Specific conductance of water from the Verde River below Tangle Creek, above Horseshoe Dam, averaged 619 µS/cm for base flow and 270 µS/cm for high flow. In 1983, releases from the downstream reservoirs had an average specific conductance of 900 µS/cm on the Salt River and 362 µS/cm on the Verde River (White and Garrett, 1986).

## SELECTED REFERENCES

Anderson, T.W., 1968, Electrical-analog analysis of ground-water depletion in central Arizona: U.S. Geological Survey Water-Supply Paper 1860, 21 p.

Arteaga, F.E., White, N.D., Cooley, M.E., and Sutheimer, A.F., 1968, Ground water in Paradise Valley, Maricopa County, Arizona: Arizona State Land Department Water-Resources Report 35, 76 p.

Babcock, H.M., and Halpenny, L.C., 1942, Records of wells, well logs, water analyses, and map showing locations of wells, Queen Creek area, Maricopa and Pinal Counties, Arizona: U.S. Geological Survey Open-file report, 39 p.

Bureau of Water Quality Control, 1978, Drinking water regulations for the State of Arizona: Arizona Department of Health Services duplicated report, 39 p.

Davis, A.P., 1897, Irrigation near Phoenix, Arizona: U.S. Geological Survey Water-Supply and Irrigation Paper 2, 98 p.

Cooley, M.E., 1973, Map showing distribution and estimated thickness of alluvial deposits in the Phoenix area, Arizona: U.S. Geological Survey Miscellaneous Investigations Series Map I-845-C, 1 sheet.

Fenneman, N.M., 1931, Physiography of western United States: New York, McGraw-Hill, 534 p.

Freethey, G.W., Pool, D.R., Anderson, T.W., and Tucci, Patrick, 1986, Description and generalized distribution of aquifer materials in the alluvial basins of Arizona and adjacent parts of California and New Mexico: U.S. Geological Survey Hydrologic Atlas HA-663, 4 sheets.

Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water (3d ed.): U.S. Geological Survey Water-Supply Paper 2254, 263 p.

Laney, R.L., and Hahn, M.E., 1986, Hydrogeology of the eastern part of the Salt River valley area, Maricopa and Pinal Counties, Arizona: U.S. Geological Survey Water-Resources Investigations Report 86-4147, 4 sheets.

Laney, R.L., Ross, P.P., and Littin, G.R., 1978, Maps showing ground-water conditions in the eastern part of the Salt River Valley area, Maricopa and Pinal Counties, Arizona—1976: U.S. Geological Survey Water-Resources Investigations Report 78-61, 2 sheets.

Lee, W.T., 1905, Underground waters of Salt River Valley, Arizona: U.S. Geological Survey Water-Supply and Irrigation Paper 136, 196 p.

Mann, L.J., and Rohne, P.B., Jr., 1983, Streamflow losses and changes in ground-water levels along the Salt and Gila Rivers near Phoenix, Arizona—February 1978 to June 1980: U.S. Geological Survey Water-Resources Investigations Report 83-4043, 11 p.

McDonald, H.R., Wolcott, H.N., and Bluhm, F.I., 1947, Geology and ground-water resources of Paradise Valley, Maricopa County, Arizona, *with a section on* Quality of water, by J.D. Hem: U.S. Geological Survey open-file report, 34 p.

Meinzer, O.E., and Ellis, A.J., 1916, Ground water in Paradise Valley, Arizona, *in* Contributions to the hydrology of the United States, 1915: U.S. Geological Survey Water-Supply Paper 375, p. 51-75.

Niccoli, M.A., and Long, M.R., 1981, Determination of transmissivity values in the Salt River Valley using recovery tests, specific capacity data and DWR driller log program: Hydrology and Water Resources in Arizona and the Southwest, v. 11, p. 117-124.

Péwé, T.L., 1978, Terraces of the lower Salt River Valley in relation to late Cenozoic history of the Phoenix basin, Arizona, *in* Burt, D.M., and Péwé, T.L., eds., Guidebook to the geology of central Arizona: Arizona Bureau of Geology and Mineral Technology Special Paper 2, p. 1-45.

Reeter, R.W., and Remick, W.H., 1986, Maps showing groundwater conditions in the west Salt River, east Salt River, Lake Pleasant, Carefree and Fountain Hills sub-basins of the Phoenix active management area, Maricopa, Pinal and Yavapai Counties, Arizona—1983: Arizona Department of Water Resources Hydrologic Map Series Report 12, 3 sheets.

Robertson, F.N., 1975, Hexavalent chromium in the ground water in Paradise Valley, Arizona: Ground Water, v. 13, no. 6, 11 p.

Ross, P.P., 1980, Simulated effects of a proposed well field on the ground-water system in the Salt River Indian Reservation, Maricopa County, Arizona: U.S. Geological Survey Open-File Report 80-503W, 22 p.

Schumann, H.H., 1974, Land subsidence and earth fissures in alluvial deposits in the Phoenix area, Arizona: U.S. Geological Survey Miscellaneous Investigations Series Map I-845-H, 1 sheet.

Sellers, W.D., and Hill, R.H., eds., 1974, Arizona climate 1931-1972: Tucson, University of Arizona Press, 616 p.

Thomsen, B.W., and Baldys, S., 1985, Ground-water conditions in and near the Gila River Indian Reservation, south-central Arizona: U.S. Geological Survey Water-Resources Investigations Report 85-4073, 2 sheets.

U.S. Environmental Protection Agency, 1976 [1978], Quality criteria for water: U.S. Environmental Protection Agency publication, 256 p.

U.S. Geological Survey, 1986, Annual summary of ground-water conditions in Arizona, spring 1984 to spring 1985: U.S. Geological Survey Open-File Report 86-422W, 2 sheets.

U.S. Public Health Service, 1962, Drinking water standards, 1962: U.S. Public Health Service publication 956, 61 p.

White, N.D., and Garrett, W.B., 1986, Water resources data, Arizona, water year 1983: U.S. Geological Survey Water-Data Report AZ-83-1, 387 p.

# GROUND-WATER CONDITIONS IN AND NEAR THE SALT RIVER INDIAN RESERVATION, SOUTH-CENTRAL ARIZONA

By
B.W. Thomsen and B.H. Miller

1991