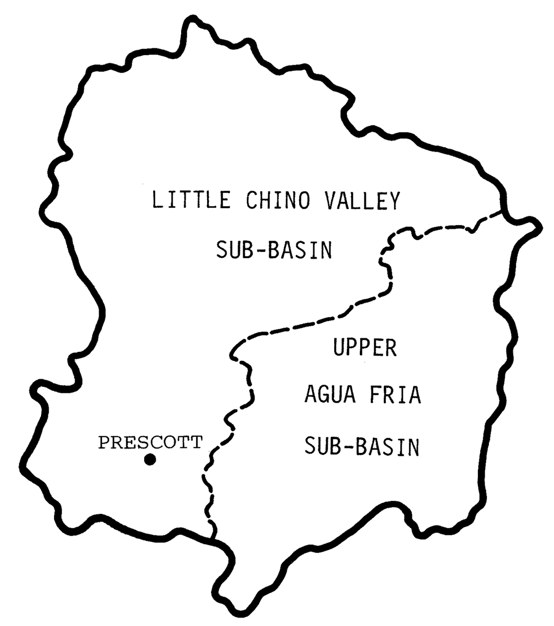
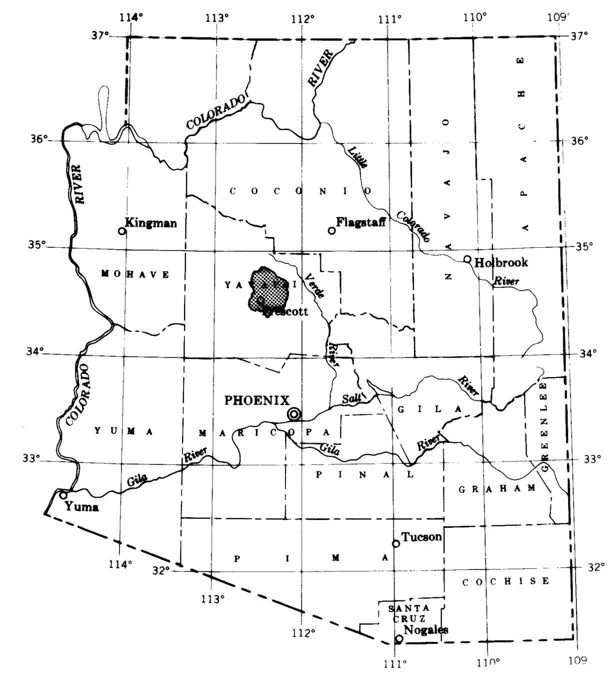
5 0 5 MILES

5 0 5 10 KILOMETERS

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100-FOOT INTERVALS
DATUM IS MEAN SEA LEVEL
SCALE 1:125,000



(INSET)
PRESCOTT ACTIVE MANAGEMENT AREA
NO SCALE



INDEX MAP SHOWING AREA
OF REPORT (SHADED)

EXPLANATION

507 / 4556 — WELL IN WHICH WATER LEVEL WAS MEASURED IN 1982--First number, 507, is depth to water in feet below land surface. Plus sign before number indicates height of water above land surface. Second number, 4556, is the altitude of the water level in feet above mean sea level.

5835 — SPRING FIELD CHECKED IN 1982--Number, 5835, is the altitude of the spring in feet above mean sea level

BEDROCK (VOLCANIC, GRANITIC, METAMORPHIC, OR CRYSTALLINE SEDIMENTARY ROCK)--Water may occur in weathered or fractured zones, joint systems, or thin veneers of alluvial or fluvial sediment overlying consolidated rocks

WATER-BEARING UNITS (CONGLOMERATE, CLAY, SILT, SAND, GRAVEL, BASALT)

2500 — WATER-LEVEL CONTOUR--Shows altitude of the water level. Contour interval 50 and 100 feet. Datum is mean sea level

ARTESIAN ZONE--Dashed line bounds approximate area in which groundwater occurs under artesian conditions

PRESCOTT ACTIVE MANAGEMENT AREA BOUNDARY

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
inches	25.4	millimeters
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
cubic feet per second	35.319	cubic meters per second

CLIMATE AND PHYSIOGRAPHY

The Prescott Active Management Area (AMA), created by the Arizona Groundwater Management Act of 1980, is located in central Arizona about 80 miles north of Phoenix. The AMA includes about 470 square miles of rounded grass covered hills and stark granite outcrops flanked by mountains, and is divided into two sub-basins: Little Chino Valley and Upper Agua Fria. The Little Chino Valley portion of the AMA is bounded by the Black Hills on the east and north, the Bradshaw Mountains on the south, and by Sullivan Buttes, and Granite Mountain on the west. The sub-basin is drained principally by Granite Creek, which rises in the Bradshaw Mountains, and exits the sub-basin through the northern extension of the Black Hills east of Del Rio Springs. The Upper Agua Fria portion of the AMA is bounded by the Bradshaw Mountains on the south and west and by the Black Hills on the east. The sub-basin is drained by the Agua Fria River which rises in Granite Dells and exits the sub-basin south of Humboldt. An inconspicuous surface-water divide separates the two sub-basins roughly along US 89A east of Granite Dells (see inset).

Precipitation in the Prescott AMA ranges from about 12 inches per year in the valley areas, to more than 18 inches per year in the City of Prescott. The difference is attributable to the orographic nature of summer thunderstorms in the area and Prescott's proximity to the mountains. Precipitation probably is significantly greater at higher elevations in the mountains surrounding the basin. Average daily maximum temperatures for the AMA are 89°F in July and 50°F in January, and average daily minimum temperatures are 57°F in July and 22°F in January. Extremes of 103°F in July and -21°F in January have been recorded. Sellers and Hill (1974, p. 154, 400, 403) give detailed climatic data for the area.

GROUNDWATER OCCURRENCE AND MOVEMENT

Little Chino Valley

Groundwater in Little Chino Valley occurs under artesian (confined), water table (unconfined), and perched conditions. (See Sheet 2 for discussion of perched aquifer.) Confined aquifers, as the name suggests, contain groundwater that is confined under pressure between relatively impermeable or significantly less permeable material and that will rise above the top of the aquifer. If the water rises above the land surface it will flow naturally. A well drilled into such a confined aquifer is an artesian well, and if the water rises above the land surface, it may be termed a flowing artesian well (Lohman, 1972, p. 7). Artesian conditions in Little Chino Valley were first described by Schwalen (1967, p. 33, 37), and the approximate boundary of the known artesian zone of the aquifer system is depicted on the map by a fine dashed line. The aquifer consists of bedded flows of basalt interbedded with clay, sand and gravel. The basalts are described as vesicular, scoriaceous, and amygduloidal in texture, i.e., porous or full of holes (Schwalen, 1967, p. 23). Some well drillers' reports also indicate: sections in wells from which no cuttings were recovered, circulation losses, and instances where drill tools dropped several feet in the hole during drilling. All of these data indicate that open cavities exist in the basalts, a condition that is consistent with the deposition of basaltic volcanics. Additionally, fractures and joint systems have most likely created pathways for the movement of groundwater and thus, basalts may act as an aquifer. In most places the basalts are overlain by a clay layer that, together with layers of massive nonporous basalt, form the confining layer for the artesian zone. The total thickness of the aquifer is unknown, but wells have penetrated as much as 200 feet of basalt and alluvium after encountering first water.

Schwalen (1967, p. 34, plate IV, V) suggests that a barrier to groundwater flow exists in the northern part of the artesian zone. Evidence of the barrier includes differences in Hydrographs A and C (see sheet 2), which are from wells on either side of the barrier, and differences in subsurface geology across the barrier, as noted in drillers' logs. Except to the north, the boundaries of the artesian zone are not easily defined, and existing data suggest the artesian zone grades into a water-table condition, which exists throughout the rest of the alluvial portion of the sub-basin. The piezometric surface, or the level to which water will rise in a properly constructed, tightly cased well, in the artesian zone ranges from about 220 feet below land surface at its southern extent to about one foot above land surface near the groundwater barrier in the north. Irrigation wells penetrating the artesian zone yield between 500 and 1,500 gallons per minute. Some wells in the northern part of the artesian zone flowed year round until 1962 and individual discharges were as much as 2,800 gallons per minute at land surface (Schwalen, 1967, p. 36). Since that time, wells flow only in the winter months during the non-irrigation season, when pumping stress on the aquifer is reduced. In the winter of 1981-82, seven flowing wells remained. The estimated combined discharge of these wells was 1,000 gallons per minute.

Del Rio Springs, at the north end of the sub-basin, near the groundwater flow barrier, may be a discharge point for the artesian zone. Some incomplete records of discharge exist for Del Rio Springs for the period 1939-46 that indicate the average discharge was about 1,800 gallons per minute (Schwalen, 1967, p. 47). Turner (1962, p. 3) estimated the springs were discharging about 1,000 gallons per minute in March 1962. Currently, it is difficult to estimate the discharge of the springs because a dense growth of reeds covers the area of discharge, and runoff from Little Chino Creek mingles with the spring water. However, the discharge probably is less than 1,000 gallons per minute. The drop in discharge rate over the period 1939 to present parallels the drop of the piezometric surface of water in the artesian zone (see Hydrograph C and disscusion of change in water level, Sheet 2), which suggests hydraulic connection between the springs and the artesian zone. The chemical quality of water from Del Rio Springs is virtually identical to the quality of water from wells completed in the artesian zone (see map, sheet 3) and thus, Del Rio Springs probably represents a natural discharge point for groundwater in the artesian zone.

The water-table zone in Little Chino Valley consists of alluvium composed of clay, sand, gravel, conglomerate, and locally interbedded basalt. In the area south and west of Granite Dells basalt crops out on the ground surface, and successful wells have been completed by drilling through the basalt into the saturated alluvium. Depth to water in this area ranges from less than 10 to about 220 feet below land surface. In the western and southern part of Township 16 North, Range 2 West, depth to water ranges from about 60 to about 350 feet below land surface. In Lonesome Valley depth to water ranges from about 160 feet below land surface near the northern end of the valley, to more than 580 feet below land surface northeast of Granite Dells. Depth to water in the area northwest of Granite Dells ranges from about 100 to about 460 feet below land surface. Most wells completed in the water-table zone are used for domestic and stock purposes and are equipped to yield only a few tens of gallons per minute. As a result, maximum potential yields of wells in the water-table zone are unknown.

The bedrock areas that surround the Little Chino Valley sub-basin consist of granite, schist, basaltic and andesitic volcanics, crystalline sedimentary rocks (mostly limestone), and in places, are covered by thin patches of unconsolidated alluvium. Many successful wells have been completed in areas where the bedrock is sufficiently weathered or fractured. In addition, numerous springs issue from joints, fractures and weathered zones in the bedrock that forms the mountains west of Prescott. Most of these springs yield 1 to 4 gallons per minute and some are used for domestic purposes.

In the northern part of Township 15 North, Range 2 West, another barrier to groundwater flow restricts the northward movement of groundwater into Township 16 North, Range 2 West. South of this barrier groundwater flows northeastward into Lonesome Valley. The general flow direction of groundwater in the rest of the sub-basin is north-northwest to the natural discharge point at Del Rio Springs.

Upper Agua Fria

Groundwater in the Upper Agua Fria occurs under water table conditions, although some local artesian conditions may exist in the sub-basin. Drillers' logs indicate wells penetrate alluvium and basalt interbedded with clay and conglomerate, and the basalts may act as confining layers. Depth to water in the alluvium varies from about 25 feet below land surface near Humboldt, to about 530 feet below land surface in Prescott Valley. Yields from wells in the sub-basin range from a few gallons per minute from wells completed in the bedrock, to 1,750 gallons per minute in a public supply well completed in the alluvium. Most large-diameter wells completed in the alluvium are capable of producing at least 100 gallons per minute. The direction of groundwater flow is generally southward, roughly paralleling the surface-water drainage of the Agua Fria River and its tributaries. The Agua Fria River is perennial through a small reach near Humboldt, where it flows out of the sub-basin. The base flow of the river in this reach probably represents discharge of groundwater. The groundwater is forced to surface by volcanic flows, which restrict or prevent the movement of groundwater from the sub-basin. The base flow of the river in this reach was measured seven times intermittently between August 1981 and August 1982. It varied between 0.94 cubic feet per second (420 gallons per minute) and 1.38 cubic feet per second (620 gallons per minute). The average base flow was 1.13 cubic feet per second (510 gallons per minute), or about 820 acre-feet per year.

BASE FROM U.S. GEOLOGICAL SURVEY
PRESCOTT, AZ., 1954, REV. 1970, 1:250,000

DEPTH TO WATER AND ALTITUDE OF THE WATER LEVEL, 1982

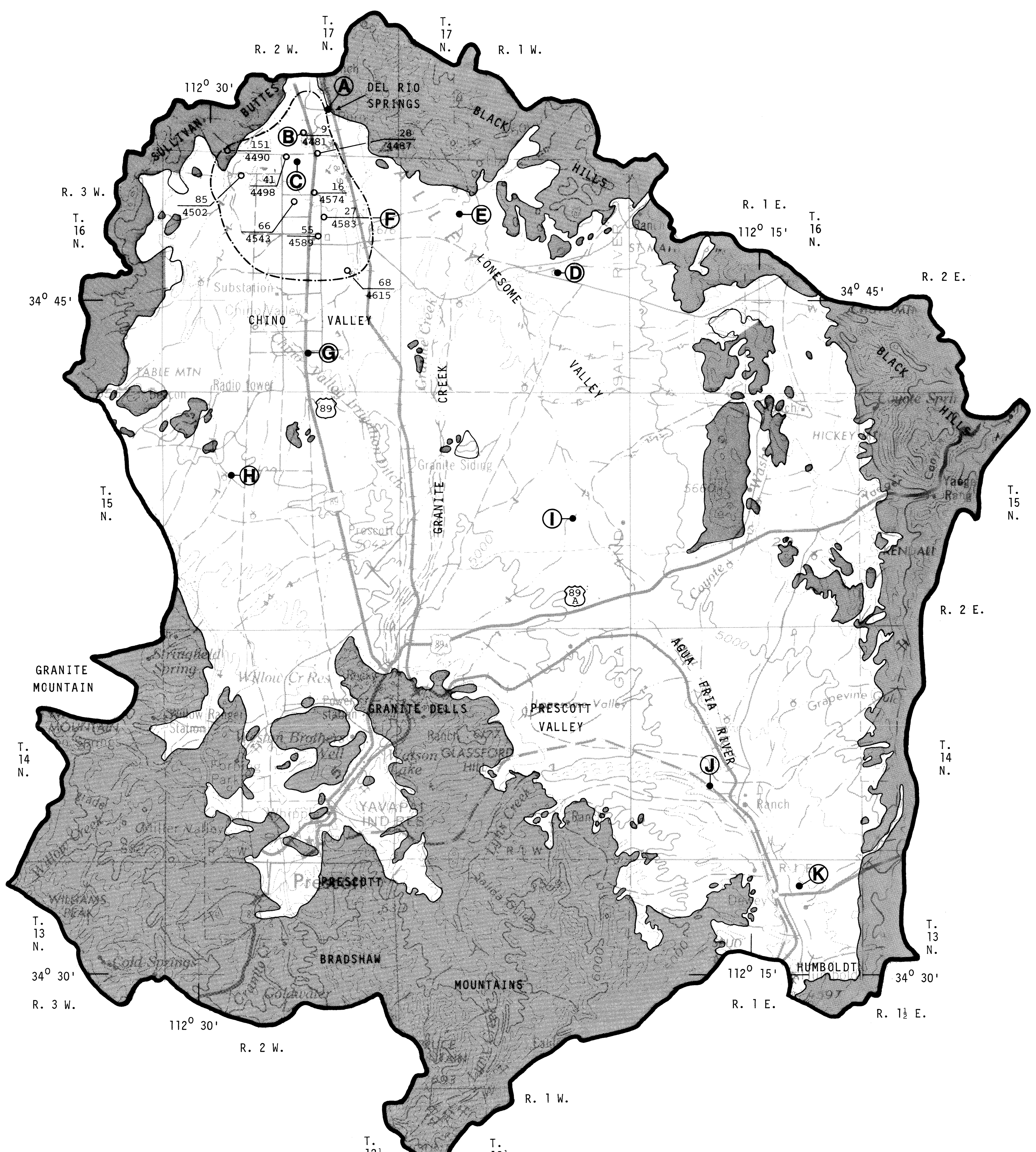
MAPS SHOWING GROUNDWATER CONDITIONS IN THE PRESCOTT ACTIVE MANAGEMENT AREA, YAVAPAI COUNTY, ARIZONA--1982

BY

W. H. REMICK

These hydrologic maps are available upon request from the Department of Water Resources, Basic Data Unit, 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: Federal Building, 301 West Congress Street, Tucson, and Valley Center, 241 North Central Avenue, Suite 1880, Phoenix, Arizona.

PREPARED IN COOPERATION WITH THE UNITED STATES GEOLOGICAL SURVEY

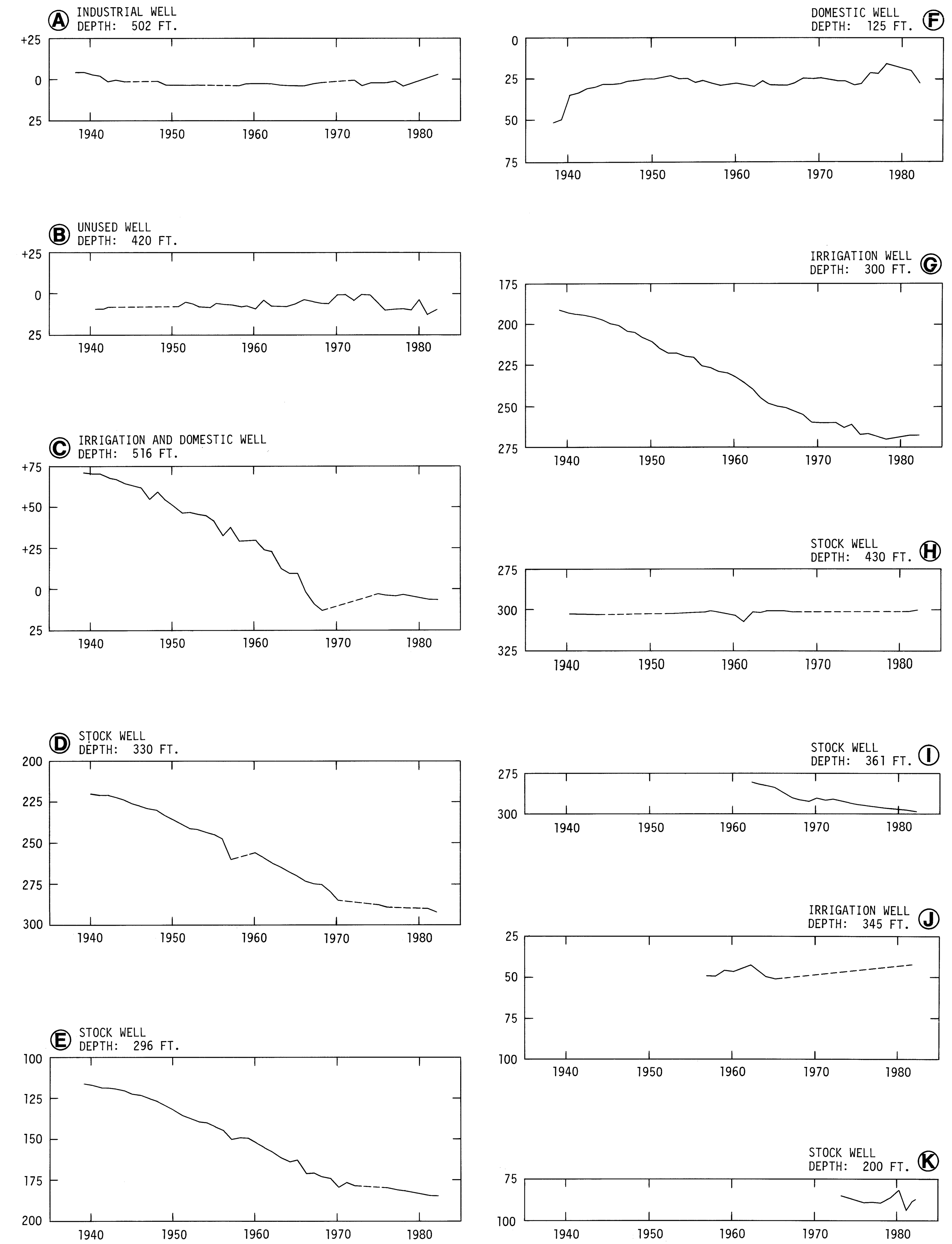


5 0 5 MILES

5 0 5 10 KILOMETERS

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100-FOOT INTERVALS
DATUM IS MEAN SEA LEVEL
SCALE 1:125,000

HYDROGRAPHS OF THE WATER LEVEL IN SELECTED WELLS SHOWN ON THE MAP
(Dashed line indicates inferred water level.)



Perched Aquifer

In the northern part of the Little Chino Valley sub-basin, an extensive perched aquifer underlies about 12 square miles. The areal extent of the perched aquifer approximates that of the artesian zone, probably because the confining layer of the artesian zone also forms the perching layer for the perched aquifer. The perched aquifer consists of alluvium composed of clay, silt, sand, gravel, and conglomerate. Depth to water ranges from less than 10 to more than 150 feet below land surface. Seasonal fluctuations of water levels in the perched aquifer were first noted in the late 1930's when Schwalen (1967, p. 35, Plt. IV) noted fluctuations of the water level were opposite those of the artesian zone. Schwalen theorized that the fluctuations were the result of applied irrigation water from the artesian zone percolating to the perched aquifer, thus causing a rise in water levels during the irrigation season. Subsequent investigation has indicated that this situation does not occur over the entire perched aquifer. The irrigated area in the Little Chino Valley sub-basin lies mostly in Township 16 North, Range 2 West, along U.S. Highway 89. In this intermediate area seasonal fluctuations of water level in the perched aquifer follow the pattern described by Schwalen. In the southern part of Section 34, Township 17 North, Range 2 West, seasonal fluctuations in water level parallel fluctuations in the artesian zone probably as a result of water from unregulated flowing artesian wells percolating to the perched aquifer during the winter months. The amount of water applied in the winter may equal or exceed the amount applied to crops during the growing season. Because little or no corresponding consumptive use of this water occurs in the winter, much of it percolates to the perched zone and results in a rise in water level during the winter, or non-irrigation season. On the western and eastern fringes of the perched aquifer little if any seasonal change in water level is observed, probably because there is neither irrigated land nor flowing wells in the immediate area.

No annual change in water level in the perched zone has been observed, except as indicated by measurements made between the late 1930's and mid 1940's, which showed a rise in water level (Schwalen, 1967, plate IV). The water level rose in a well in an irrigated area (see Hydrograph F), and continued to rise until the water surface intercepted a highly permeable stratum (Schwalen, 1967, p. 35) through which the water probably began seeping into a nearby creek. Measurements made in 1981 and 1982 suggest the water level in the perched zone may be declining. However, the measurements are not conclusive, as they have not been made over a sufficient period of time to determine any trend.

Most of the wells completed in the perched aquifer are domestic wells, and yields are governed more by pump size than the aquifer's ability to produce water. Most of these wells yield about 10 to 30 gallons per minute.

CHANGE IN WATER LEVEL

Under long-term natural conditions, the amount of water entering a groundwater aquifer (recharge) is equal to the amount of water leaving the aquifer (discharge), and no changes in water level occur. When withdrawals from a groundwater aquifer exceed the amount of recharge, water is removed from storage and a lowering of the water level will occur. Near the town of Chino Valley water levels declined as much as 75 feet between 1940 to 1982 primarily as a result of pumpage of water for irrigation (see Hydrographs C, D, E, and G). Northwest of Granite Dells water levels have not changed since 1940 (see Hydrograph H). Sub-surface units of low permeability (silt and clay) may retard the flow of water out of the area from west to east, and the barrier in the northern part of Township 15 North, Range 2 West, may restrict the movement of groundwater northward out of the area. The area may also have a major source of recharge, and the amount of water entering this portion of the aquifer may equal the amount being removed.

In the Upper Agua Fria sub-basin few water levels have been observed long enough to establish a trend. Water-level measure ments for one well (see Hydrograph J) are available from the late 1950's and early 1960's but none are available between 1965 and 1982. In 1978 the first comprehensive set of water-level data was collected (Littin, 1981) and since that time several wells are measured on a regular basis. The available data indicate that water levels in the Upper Agua Fria sub-basin are changing little or not at all, except in a well field in Prescott Valley where water levels may have declined as much as 73 feet between 1972 and 1982. The actual change in water level in this area is difficult to determine because the well in which the 73 foot water-level decline occurred reportedly experienced a structural failure that adversely affected its production capability. The well is no longer used, and water levels obtained from it may not be representative of the aquifer as a whole.

EXPLANATION

85/4502 — WELL IN WHICH DEPTH TO WATER WAS MEASURED IN PERCHED AQUIFER IN 1982--First number, 85, is depth to water in feet measured below land surface. Second number, 4502, is the altitude of the water level in feet above mean sea level

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

B — WELL FOR WHICH A HYDROGRAPH DEPICTING CHANGES IN DEPTH TO WATER IN PERCHED ZONE IS SHOWN

BEDROCK (VOLCANIC, GRANITIC, METAMORPHIC OR CRYSTALLINE SEDIMENTARY ROCK)--Water may occur in weathered or fractured zones, joint systems, or thin veneers of alluvial or fluvial sediment overlying consolidated rocks

WATER-BEARING UNITS (CONGLOMERATE, CLAY, SILT, SAND, GRAVEL, BASALT)

PERCHED-WATER AQUIFER--Line bounds approximate area in which perched groundwater is known to exist

PRESCOTT ACTIVE MANAGEMENT AREA BOUNDARY

BASE FROM U.S. GEOLOGICAL SURVEY
PRESCOTT, AZ., 1954, REV. 1970, 1:250,000

HYDROGRAPHS OF SELECTED WELLS; DEPTH TO WATER AND WATER LEVEL ALTITUDES IN THE PERCHED ZONE

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BY
W. H. REMICK

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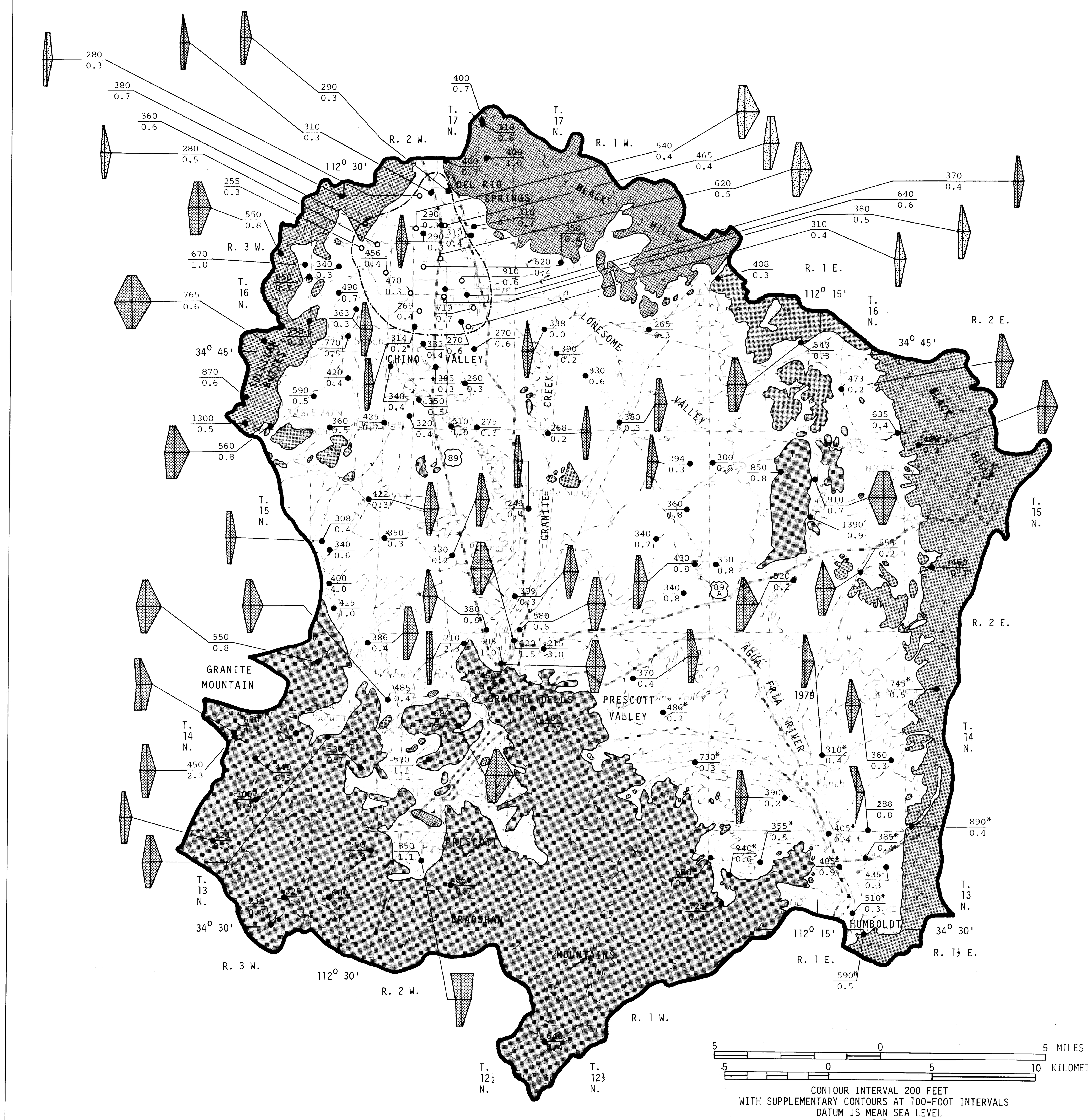


5 0 5 MILES
5 0 5 10 KILOMETERS

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100-FOOT INTERVALS
DATUM IS MEAN SEA LEVEL
SCALE 1:125,000

EXPLANATION

590/0.5 ● WELL FOR WHICH A WATER SAMPLE WAS COLLECTED IN 1981-82--First number, 590, is specific conductance in micromhos per centimeter at 25°C (specific conductance is an indication of the dissolved-solids concentration in water). Asterisk after number indicates water sample collected in year other than 1981-82. Second number, 0.5, is the fluoride concentration in milligrams per liter

910/0.6 ○ WELL FOR WHICH A WATER SAMPLE WAS COLLECTED IN PERCHED ZONE IN 1981-82--First number, 910, is the specific conductance in micromhos per centimeter at 25°C (specific conductance is an indication of the dissolved-solids concentration in water). Second number, 0.6, is the fluoride concentration in milligrams per liter

480/0.2 SPRING FOR WHICH A WATER SAMPLE WAS COLLECTED IN 1981-82--First number, 480, is specific conductance in micromhos per centimeter at 25°C (specific conductance is an indication of the dissolved-solids concentration in water). Second number, 0.2, is the fluoride concentration in milligrams per liter

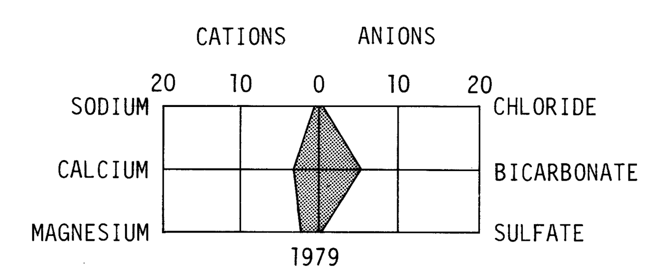
BEDROCK (VOLCANIC, GRANITIC, METAMORPHIC, OR CRYSTALLINE SEDIMENTARY ROCK)--Water may occur in weathered or fractured zones, joint systems, or thin veneers of alluvial or fluvial sediment overlying consolidated rocks

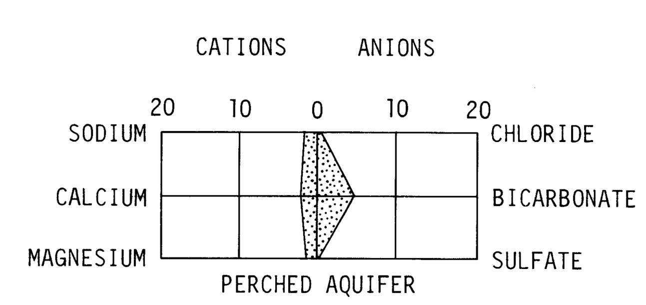
WATER-BEARING UNITS (CONGLOMERATE, CLAY, SILT, SAND, GRAVEL, BASALT)

PERCHED AQUIFER--Line bounds approximate area in which perched groundwater is known to exist

PRESCOTT ACTIVE MANAGEMENT AREA BOUNDARY

CHEMICAL QUALITY DIAGRAM--Shows major constituents in milliequivalents 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. Year, 1979, below diagram indicates sample collected in year other than 1981-82





WATER QUALITY

In the Prescott AMA, groundwater is generally of good quality for most uses. In the Little Chino Valley sub-basin, specific conductance values determined from chemical analyses of water from wells and springs in the artesian and water table zones range from 210 to 1,300 micromhos per centimeter. Dissolved-solids concentrations may be approximated by multiplying the specific conductance by 0.6, which is the approximate ratio of dissolved solids (in mg/L) to specific conductance (in micromhos per centimeter). The maximum concentration level for dissolved solids is 500 mg/L (specific conductance equals 833 micromhos per centimeter), as proposed in the secondary drinking-water standards of the U.S. Environmental Protection Agency (1977b, p. 17146) in accordance with the provisions of the Safe Drinking Water Act (Public Law 93-523). Seven of the 80 samples tested exceeded this limit; all were from wells completed in bedrock in the mountains on the fringes of the sub-basin. In the perched aquifer specific conductance values determined from chemical analyses of water from wells range from 235 to 1,060 micromhos per centimeter. Only 2 of 83 samples collected exceed the maximum concentration level of 833 micromhos per centimeter.

In the Upper Agua Fria sub-basin, specific conductance values determined from chemical analyses of water from wells tested range from 290 to 1,390 micromhos per centimeter, and 12 of 62 samples exceed the maximum concentration level of 833 micromhos per centimeter. All of the samples which had levels in excess of the maximum concentration were collected from wells completed in bedrock in the mountains west of Humboldt.

Fluoride concentrations in water samples from wells in the Prescott AMA range from 0 to 4.0 mg/L. The maximum concentration level for fluoride in public water supplies differs according to the annual maximum daily air temperature (Bureau of Water Quality Control, 1978, p. 6). The annual average maximum daily air temperature for the lower elevations (below 5,000 feet) in the Prescott AMA is about 72°F. The annual average daily maximum air temperature for the higher elevations (above 5,000 feet) is about 69°F. Therefore, the maximum concentration level for fluoride is 1.6 and 1.8 mg/L for the lower and higher elevations, respectively. Only 8 of 364 samples collected contained fluoride in excess of the maximum concentration level, and all 8 were from wells completed in bedrock in the mountains of the Little Chino Valley sub-basin.

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BASE FROM U.S. GEOLOGICAL SURVEY
PRESCOTT, AZ., 1954, REV. 1970, 1:250,000

CHEMICAL QUALITY OF WATER
MAPS SHOWING GROUNDWATER CONDITIONS IN THE PRESCOTT ACTIVE MANAGEMENT AREA, YAVAPAI COUNTY, ARIZONA--1982
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