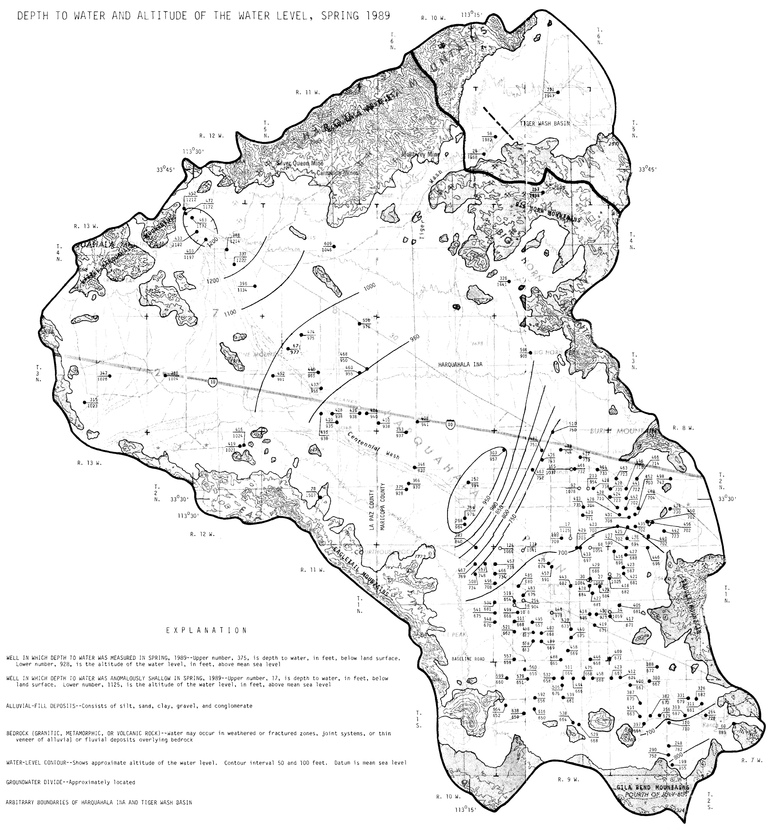
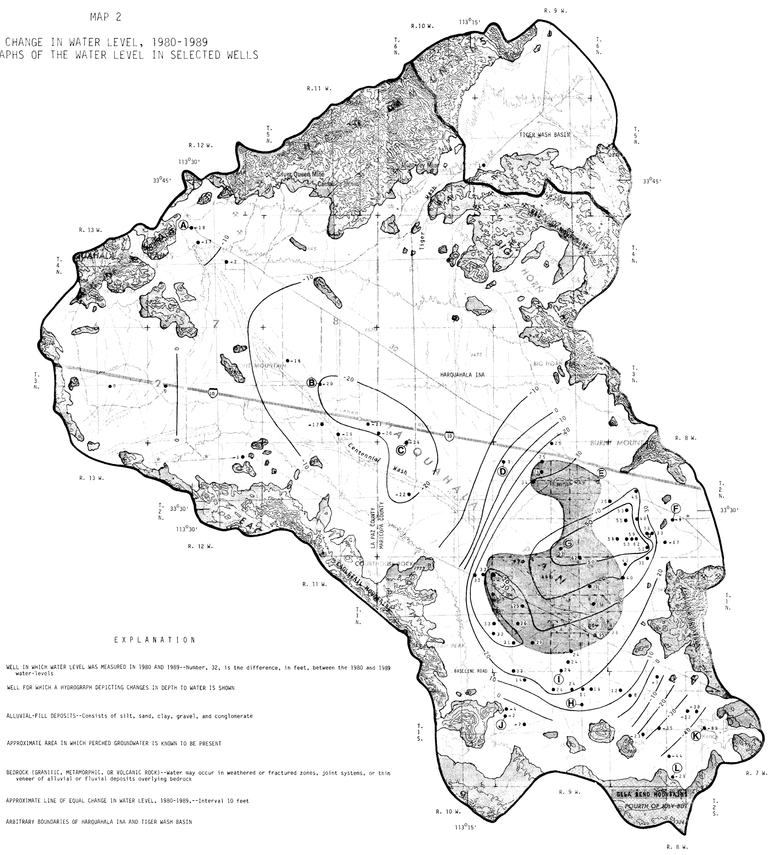
MAP 1

DEPTH TO WATER AND ALTITUDE OF THE WATER LEVEL, SPRING 1989



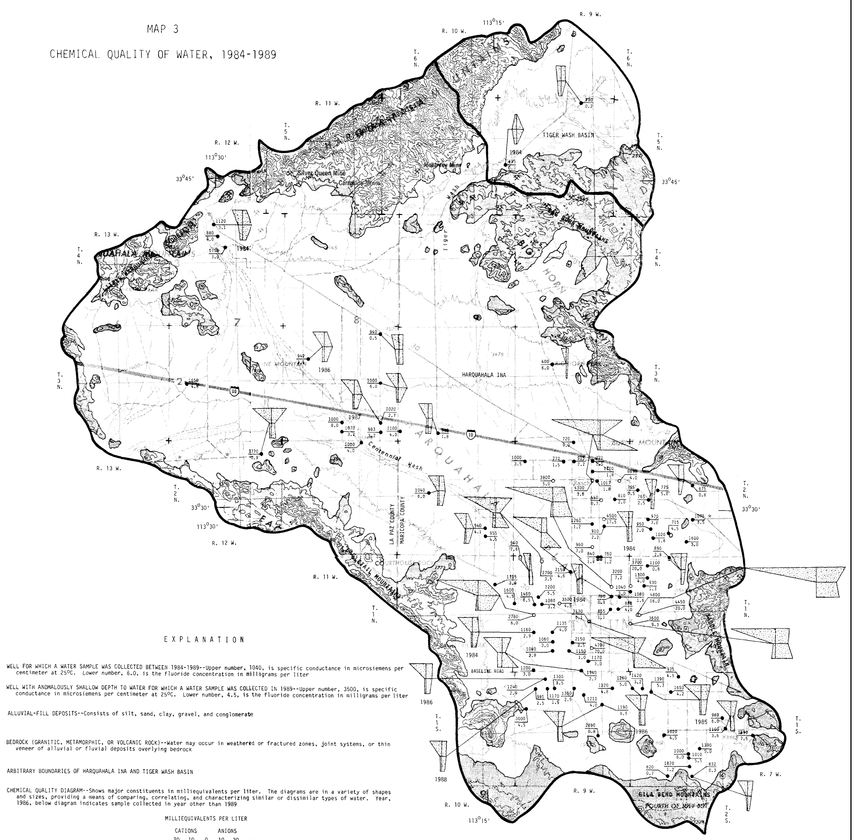
MAP 2

CHANGE IN WATER LEVEL, 1980-1989
HYDROGRAPHS OF THE WATER LEVEL IN SELECTED WELLS



MAP 3

CHEMICAL QUALITY OF WATER, 1984-1989



INTRODUCTION

The Harquahala Irrigation Non-Expansion Area (INA) and Tiger Wash basin together comprise approximately 850 square miles of arid land about 60 miles west of Phoenix. The Harquahala INA includes about 90 percent of this area and is bounded on the north by the Harquahala Mountains, on the west by the Little Harquahala Mountains, on the southwest by the Eagletail Mountains, on the south by the Gila Bend Mountains, on the east by Saddle Mountain, and on the northeast by the Big Horn Mountains. Tiger Wash basin covers about 70 square miles and is bounded on the west by the Harquahala Mountains, on the south by the Big Horn Mountains, and on the northeast by a low-relief alluvial surface-water divide, which is also the boundary for the Hassayampa sub-basin of the Phoenix Active Management Area (AMA).

Centennial Wash is the principal surface-water drainage for the Harquahala INA. Centennial Wash enters the INA in the northwest through the narrows between the Harquahala Mountains and the Little Harquahala Mountains, and exits the INA in the southeast. Tiger Wash drains Tiger Wash basin and flows southward into Centennial Wash. Both Centennial Wash and Tiger Wash are intermittent streams that flow only in response to rainfall. The only part of the Harquahala INA that does not drain into Centennial Wash is an area west of a surface water divide that is oriented north and south across the middle of T.3N., R.12W. Surface water west of the divide is part of the Bouse Wash drainage and exits the Harquahala INA towards the southwest into the adjacent Ranegras Plain basin.

The climate in the Harquahala INA and Tiger Wash basin is hot and dry. The average annual precipitation is about 6 inches; about one-third occurs in August and September. The average daily maximum temperature is 65°F in January and 106°F in July. The highest recorded temperature was 124°F in July, 1971. The average daily minimum temperature is 31°F in January and 72°F in July. The lowest recorded temperature was 9°F in January, 1971 (Sellers and others, 1985, p. 89, 92, 101, 104, 113).

HARQUAHALA INA
Groundwater Occurrence

The Harquahala INA is a broad elongated alluvium-filled structural basin that is typical of the Sonoran Desert Section of the Basin and Range Physiographic Province (Fenneman, 1931, p. 367-377). The basin is surrounded by mountain ranges that are composed of Precambrian granitic and metamorphic rocks, Tertiary volcanic rocks and Quaternary volcanic rocks (Metzger, 1957, p. 13). The alluvium is composed of heterogeneous deposits of clay, silt, sand, and gravel. The thickness of the alluvium varies from 0 feet at the mountain fronts to perhaps as much as 5,000 feet in the deepest part of the basin near the northwest corner of T.2N., R.9W. (U.S. Bureau of Reclamation, 1976, p. 76). In the southeastern part of the basin the alluvium consists of coarse deposits of sand and gravel. However, north of Baseline Road, the coarse deposits are overlain by fine-grained beds which are principally composed of clay. The fine-grained beds increase in thickness towards the northwest and are more than 1,000 feet thick in the western part of T.2N., R.9W. Farther west, near sections 34-36, T.3N., R.11W., the fine-grained beds appear to grade into an alternating sequence of fine-grained and coarse-grained layers that overlie a conglomerate beginning at a depth of about 800-850 feet (Graf, 1980a). In the northwestern part of the basin in T.4N., R.12W. drillers logs show that the area consists of alternating layers of moderately coarse to coarse materials underlain by conglomerate. The rest of the basin has very little information available which details the lithology of the alluvium.

Groundwater in the Harquahala INA occurs in a regional aquifer within the alluvium in an unconfined condition, although local lithology may cause semiconfined or confined conditions to occur. In the spring of 1989, depth to water in the regional aquifer ranged from 199 feet to 654 feet below land surface. Also, perched groundwater occurs in a rather extensive area in T. 2N., R.9W., T.1N., R.9W., and the western part of T.1N., R.8W. (map 2). The perched groundwater has formed on top of the fine-grained beds from the downward percolation of irrigation water (Graf, 1980a). In several wells, perched groundwater enters the wellbore and "cascades" down the well to the lower regional aquifer. This results in depths to water in these wells that are intermediate between the depths to water in the perched and regional aquifers. These water levels are "anomalously shallow" with respect to the regional aquifer (map 1). Anomalously shallow depths to water observed in the spring of 1989 ranged from 17 feet to 254 feet below land surface. Groundwater also occurs in the surrounding mountains in weathered and fractured zones, joint systems, or thin veneers of alluvial or fluvial deposits overlying bedrock.

Discharge measurements on irrigation wells were performed by the U.S. Geological Survey in 1984 and the Arizona Department of Water Resources in 1989. The discharge measurements ranged from 350 to 3,000 gallons per minute. Generally, the best well yields were found in the alternating sequence of fine-grained and coarse-grained layers in T.3N., R.11W.

Water-Level Changes

Historically, the most significant water-level changes have been in the southeast part of the Harquahala INA. Large-scale development of cultivated acreage that began in the 1950's reached a peak in the mid-1960's when 39,500 acres of land was in cultivation (Denis, 1971, p. 3) and groundwater pumpage was 200,000 acre-feet per year (U.S. Geological Survey, 1986). Water-level declines of as much as 27 feet per year that occurred from overdraft of the groundwater resource eventually caused economically marginal farms to go out of business, and by the 1970's abandoned farmland became common. By 1980, water levels in some wells drilled in the early 1950's had declined a total of 325 feet (see Hydrograph I). During the early 1980's groundwater pumpage began to fall below 100,000 acre-feet per year and the rate of water-level decline slowed. In August, 1985, Colorado River water from the Central Arizona Project (CAP) Canal became available and has now replaced groundwater as the major source of irrigation water. During 1987, about 85,000 acre-feet of surface water from the CAP Canal was delivered to the Harquahala INA (Jody Gould, Central Arizona Water Conservation District, oral commun., 1989), groundwater pumpage totaled only about 10,000 acre-feet, and about 18,000 acres of land was in cultivation (Diane Lovell, Harquahala Valley Irrigation District, oral commun., 1989). As a result of the reduced groundwater pumpage, the previous trend of water-level declines in most of the southeast part of the Harquahala INA has been reversed. Water levels are presently rising in wells that have experienced the greatest declines. Near section 34, T.2N., R.9W., water levels have risen as much as 70 feet since 1985. The reduced groundwater pumpage in the southeast area of the Harquahala INA is allowing the groundwater to fill the cones of depression that developed from the historic large-scale withdrawal of groundwater. It should be emphasized that the water-level rises do not represent net groundwater recharge to the basin. The outer portions of the southeast area continue to decline as groundwater moves into the central portions of this area.

The rest of the Harquahala INA has experienced moderate water-level changes. Near sections 34-36, T.3N., R.11W., water levels have declined about 20 feet since 1980. The western area of the INA near T.3N., R.13W. has shown no water-level changes, while the northwest area near T.4N., R.12W. has shown water-level declines of 7 to 18 feet.

Water Quality

The quality of groundwater in samples collected from the regional aquifer within the Harquahala INA is generally suitable for irrigation purposes. Due to moderately high concentrations of dissolved fluoride and high concentrations of dissolved solids, the groundwater is not suitable for drinking-water purposes without proper treatment. Samples of groundwater collected from wells affected by the perched groundwater, e.g., wells with anomalously shallow depths to water, are generally higher in concentrations of dissolved fluoride and dissolved solids.

The maximum contaminant level for fluoride in public drinking-water supplies, as recommended by the U.S. Environmental Protection Agency and the Arizona Department of Environmental Quality, is 4.0 milligrams per liter (mg/L). During the period 1984 to 1989, 115 samples of groundwater were analyzed for fluoride and 49 of the samples exceeded the maximum contaminant level. The range for fluoride for samples collected from the regional aquifer was 0.3 to 9.0 mg/L. The range for fluoride for samples collected from wells with anomalously shallow depths to water was 0.7 to 20.0 mg/L.

Dissolved-solids concentration may be approximated by multiplying specific-conductance values by 0.6, which is the approximate ratio of dissolved solids (in mg/L) to specific conductance in microsiemens per centimeter (uS/cm). The maximum contaminant level for dissolved solids, as recommended by the U.S. Environmental Protection Agency and the Arizona Department of Environmental Quality, is 500 mg/L (833 uS/cm). During the period 1984 to 1989, 118 samples of groundwater were analyzed for specific conductance and 102 of the samples exceeded the maximum contaminant level. The range for specific conductance for samples collected from the regional aquifer was 400 to 3,000 uS/cm. The range for specific conductance for samples collected from wells with anomalously shallow depth to water was 440 to 6,990 uS/cm.

TIGER WASH BASIN

The Tiger Wash basin is a small, shallow, alluvium-filled structural basin. The alluvium is composed of heterogeneous deposits of clay, silt, sand and gravel that are probably less than 1,000 feet thick. There are very few wells in Tiger Wash basin and only three were measured for depth to water in the spring of 1989. The depths to water were 28, 58, and 221 feet below land surface. These measurements and depth-to-water measurements in the adjacent Hassayampa sub-basin of the Phoenix AMA indicate the possibility of a groundwater divide in the northwest corner of T.5N., R.9W. From this divide it appears that groundwater flows to the southwest along the Tiger Wash drainage and to the northeast into the Hassayampa sub-basin. The wells in Tiger Wash basin are used for domestic and stock purposes and are equipped to yield less than 25 gallons per minute, thus the potential yield of a large diameter, properly constructed well is unknown. Water-level changes in Tiger Wash basin since 1980 have been small rises. Only two groundwater samples were collected in the Tiger Wash basin. The values for fluoride and specific conductance were below the recommended maximum contaminant levels. This suggests that the quality of the groundwater appears to be suitable for most purposes.

SELECTED REFERENCES

Arizona Department of Environmental Quality, 1989, Public and semi-public water supply system rules: Arizona Department of Environmental Quality Report, 44 p.

Denis, E.E., 1971, Ground-water conditions in the Harquahala Plains, Maricopa and Yuma Counties, Arizona: Arizona State Land Department Water-Resources Report 45, 44 p., 2 pls., 7 figs., 4 tables.

_____1976, Maps showing ground-water conditions in the Harquahala Plains area, Maricopa and Yuma Counties, Arizona--1975: U.S. Geological Survey Water-Resources Investigations 76-33, 3 sheets.

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

Graf, C.G., 1980a, Maps showing ground-water conditions in the Harquahala Plains area, Maricopa and Yuma Counties, Arizona--1980: Arizona Department of Water Resources Hydrologic Map Series Report Number 1, 3 sheets.

_____1980b, Origin, development, and chemical character of a perched water zone, Harquahala Valley, Arizona: Hydrology and Water Resources in Arizona and the Southwest, v. 10, 6 p.

Metzger, D.G., 1957, Geology and ground-water resources of the Harquahala Plains area, Maricopa and Yuma Counties, Arizona: Arizona State Land Department Water-Resources Report 3, 40 p., 2 pls., 7 figs., 4 tables.

Ross, C.P., 1923, The lower Gila region, Arizona--a geographic, geologic, and hydrologic reconnaisance, with a guide to desert watering places: U.S. Geological Survey Water-Supply Paper 498, 237 p., 23 pls., 16 figs.

Sellers, W.D., Hill, R.H., Sanderson-Rae, Margaret, 1985, Arizona climate, the first hundred years, 1885-1985: Institute of Atmospheric Physics, University of Arizona, 143 p., 3 figs., 18 tables.

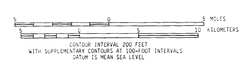
Stulik, R.S., 1964, Effects of ground-water withdrawal, 1954-63, in the lower Harquahala Plains, Maricopa County, Arizona: Arizona State Land Department Water-Resources Report 17, 8 p., 5 figs.

U.S. Bureau of Reclamation, 1976, Central Arizona Project--geology and ground-water resourcs report, Maricopa and Pinal Counties, Arizona: U.S. Bureau of Reclamation publication, v. 1, 105 p.

U.S. Environmental Protection Agency, 1986, Quality criteria for water-1986: EPA-440/5-86-001, 501 p.

_____1986, National primary and secondary drinking water regulations; fluoride; final rule: Washington, Federal Register, v. 51, no. 63, p.11396-11397.

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.



ESTIMATED GROUNDWATER PUMPAGE IN THE HARQUAHALA INA AND TIGER WASH BASIN

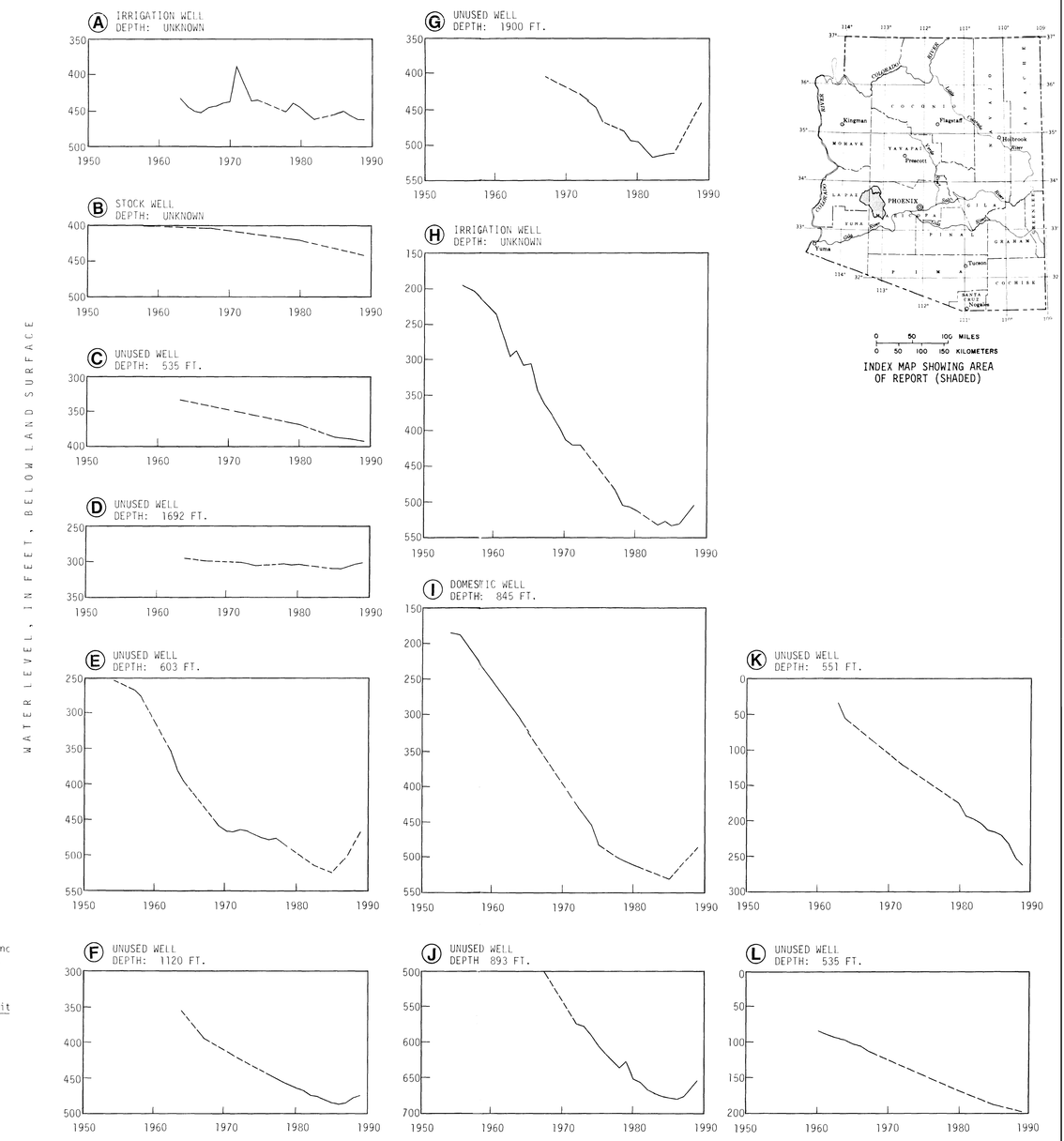
Year	Pumpage, in thousands of acre-feet
1940	1
1941	1
1942	1
1943	1
1944	1
1945	1
1946	1
1947	1
1948	1
1949	1
1950	5
1951	7
1952	10
1953	20
1954	33
1955	30
1956	40
1957	50
1958	60
1959	95
1960	125
1961	100
1962	200
1963	200
1964	200
1965	200
1966	160
1967	170
1968	165
1969	145
1970	111
1971	99
1972	108
1973	109
1974	137
1975	130
1976	129
1977	123
1978	100
1979	93
1980	108
1981	129
1982	79
1983	56
1984	72
1985	59
1986	13
1987	10
1988	10
TOTAL:	3700

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

HYDROGRAPHS OF THE WATER LEVEL IN SELECTED WELLS SHOWN ON MAP 2

(Dashed line indicates inferred water level)



INDEX MAP SHOWING AREA OF REPORT (SHADED)

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

DEPTH TO WATER AND ALTITUDE OF THE WATER LEVEL, SPRING 1989, CHANGE IN WATER LEVEL, 1980-1989, HYDROGRAPHS OF THE WATER LEVEL IN SELECTED WELLS, AND CHEMICAL QUALITY OF WATER, 1984-1989
MAPS SHOWING GROUNDWATER CONDITIONS IN THE HARQUAHALA IRRIGATION NON-EXPANSION AREA AND TIGER WASH BASIN, MARICOPA AND LA PAZ COUNTIES, ARIZONA -- 1989

BY
J.D. HEDLEY

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: Federal Building, 301 West Congress Street, Tucson, Arizona, and 3738 North 16th Street, Suite E, Phoenix, Arizona.