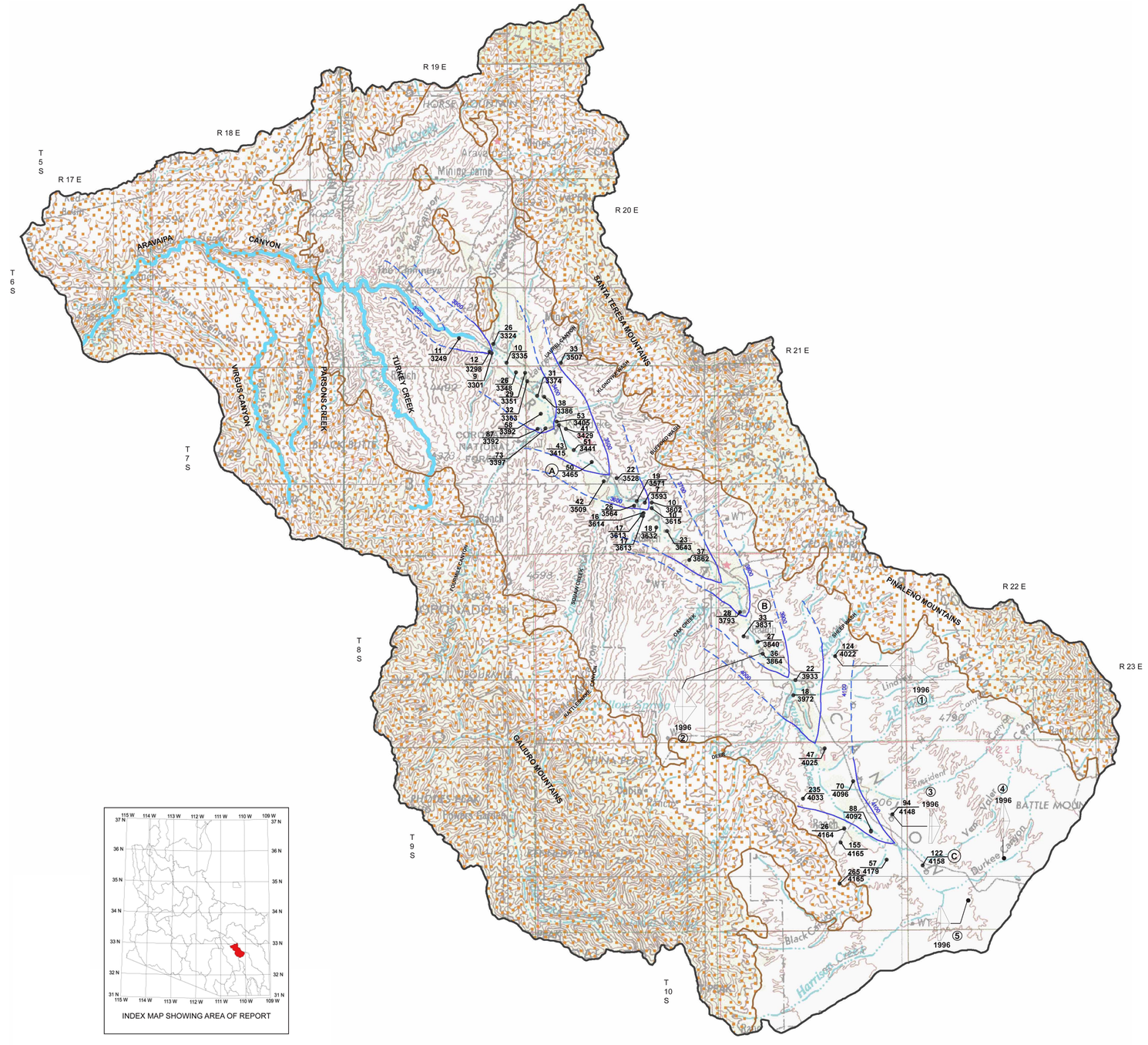
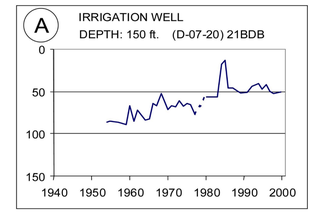


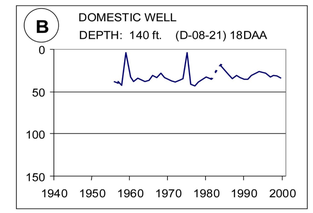
INDEX MAP SHOWING AREA OF REPORT

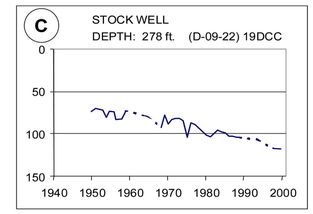
HYDROGRAPHS OF THE WATER LEVEL IN SELECTED WELLS

Dashed lines indicate inferred water level

WATER LEVEL, IN FEET, BELOW LAND SURFACE







LEGEND - EXPLANATION

WELL IN WHICH DEPTH TO WATER WAS MEASURED IN 1996 - UPPER NUMBER, 124, IS DEPTH TO WATER IN FEET BELOW LAND SURFACE. LOWER NUMBER, 4022, IS THE ALTITUDE OF THE WATER LEVEL IN FEET ABOVE MEAN SEA LEVEL. DATUM IS REFERENCED TO THE NATIONAL VERTICAL GEODETIC DATUM OF 1929.

HARDROCK GRANITIC, METAMORPHIC, VOLCANIC OR CONSOLIDATED SEDIMENTARY ROCK - WATER MAY OCCUR IN WEATHERED OR FRACTURED ZONES, JOINT SYSTEMS, OR FLUVIAL DEPOSITS OVERLYING BEDROCK.

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

WATER QUALITY WELL WELL FOR WHICH A WATER QUALITY ANALYSIS WAS PERFORMED

PERRENIAL WATERCOURSE ONE WHICH FLOWS CONTINUOUSLY FROM SOURCE TO MOUTH THROUGHOUT THE YEAR. SOURCE LOCATION MAY VARY OR MIGRATE DUE TO SEASONAL WEATHER EFFECTS.

BOUNDARY BETWEEN HARDROCK AND ALLUVIUM

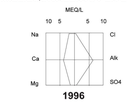
BOUNDARY OF ARAVAIPA CANYON BASIN

WATER LEVEL CONTOURS - SHOWS THE APPROXIMATE ALTITUDE OF THE WATER-LEVEL. THE NUMBER 4000 REPRESENTS 4000 FEET ABOVE MEAN SEA LEVEL. DASHED WHERE INFERRED.

STIFF DIAGRAM

STIFF DIAGRAM - SHOWS MAJOR CHEMICAL 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. 1996, BELOW DIAGRAM, INDICATES YEAR IN WHICH SAMPLE WAS COLLECTED.

MILLIEQUIVALENTS PER LITER



SCALE BARS

5 0 5 10 STATUTE MILES

5 0 5 10 KILOMETERS

1 0 5 NAUTICAL MILES

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS

TRANSVERSE MERCATOR PROJECTION

BLACK NUMBERED TICK MARKS, IF VISIBLE, INDICATE THE 10,000 METER UNIVERSAL TRANSVERSE MERCATOR GRID, ZONE 12

BLACK LINES INDICATE TOWNSHIP AND RANGE SELECTED FENCE LINES

1977 MAGNETIC DECLINATION FROM TRUE NORTH VARIES FROM 13 DEGREES (230 MILS) EASTERLY FOR THE CENTER OF THE WEST EDGE TO 12½2 (220 MILS) EASTERLY FOR THE CENTER OF THE EAST EDGE

N
W E
S

FOR READERS WHO PREFER TO USE METRIC UNITS RATHER THAN INCH-FEET UNITS, THE CONVERSION FACTORS FOR THE TERMS USED IN THIS REPORT ARE LISTED BELOW:

ENGLISH UNITS		METRIC UNITS	
1	INCH	25.4	MILLIMETERS
1	FOOT	0.3048	METERS
1	MILE	1.609	KILOMETERS
1	SQUARE MILE	2.59	SQUARE KILOMETERS

BASE MAP FROM U.S. GEOLOGICAL SURVEY 1:250,000 TUCSON (1977) AND MESA (1978)

ARIZONA DEPARTMENT OF WATER RESOURCES
SECURING ARIZONA'S WATER FUTURE

MAPS SHOWING GROUNDWATER CONDITIONS IN THE ARAVAIPA CANYON BASIN PINAL AND GRAHAM COUNTIES, ARIZONA - 1996

BY
MARK A. HOLMES

THESE HYDROLOGIC MAPS ARE AVAILABLE UPON REQUEST FROM THE ARIZONA DEPARTMENT OF WATER RESOURCES, INFORMATION CENTRAL, 500 NORTH THIRD STREET, PHOENIX, ARIZONA, 85004. THE HYDROLOGIC DATA ON WHICH THESE MAPS ARE BASED ARE AVAILABLE AT THE ADWR INFORMATION CENTRAL AND FROM THE U.S. GEOLOGICAL SURVEY OFFICE, USGS MAP SALES, BOX 25286, FEDERAL CENTER, BUILDING 810, DENVER, COLORADO 80225.

INTRODUCTION

Aravaipa basin is an intermontaine valley which encompasses 537 square miles and is located 55 miles northeast of Tucson in southeast-central Arizona (See Sheet 1). The basin is bounded on the west by the Galiuro Mountains (7,540 feet above m.s.l.), on the east by the Santa Teresa and Pinaleno Mountains (7,489 feet above m.s.l.), and the north by the Horse Mountain Complex (6,174 feet above m.s.l.). A topographic high provides the southern boundary of the basin and separates it from the Willcox basin. The basin extends approximately 40 miles along Aravaipa Creek. The southern boundary resides approximately 27 miles north of Willcox as a groundwater divide and the northern boundary resides at the San Carlos Indian Reservation. The basin is northwest-trending and sloping, and the valley ranges from 10 to 17 miles wide. The basin topography varies greatly due to a number of physiographic features. The southern half of the basin has a central valley floor that is narrow, low, and flat. The northern half of the basin, referred to as Aravaipa Canyon, is an incised valley cut through the Galiuro Mountains with some vertical canyon walls up to 700 feet high (Ellingson, 1980).

The basin is drained by Aravaipa Creek and its main tributaries to include Sheep Wash, Buford Wash, Klondyke Wash, and Laurel Canyon in the east, and Deer Creek, Oak Creek, Rattlesnake Canyon, Squaw Creek, and Fourmile Canyon in the west (Neuman & Adar, 1983). Aravaipa Creek flows to the northwest from the headwater area, which is a surface-water and groundwater divide between the Willcox and Aravaipa basins. The headwaters of Aravaipa Creek form north of the surface-water divide at an elevation of 4,300 feet. Aravaipa Creek is ephemeral from the headwater area to Aravaipa Spring. Aravaipa Spring is located three miles northwest from the community of Klondyke at the head of the Aravaipa Canyon at an elevation of 3,320 feet. Stowe Gulch, which drains the Horse Mountain complex, has its confluence with Aravaipa Creek at the seepage zone of Aravaipa Spring (Ellingson, 1980). Aravaipa Creek perennially flows 25 miles from Aravaipa Spring through Aravaipa Canyon and discharges into the San Pedro River at an elevation of 2,450 feet above m.s.l. (Neuman & Adar, 1983). The mean stream-channel gradient of Aravaipa Creek within the valley is approximately 0.8 percent (45 feet per mile), however, through the canyon itself the mean stream gradient is 1.8 percent (97 feet per mile), (Ellingson, 1980; Hadley, 1991).

The climate within the basin region varies greatly over short distances as lowlands alternate with mountains to create abrupt changes. Higher elevations have cooler average annual temperatures and more precipitation while the valley has hot summers and mild winters, (Brazel et al, 1981). The climate of the Aravaipa Basin area has two rainy seasons separated by two dry periods (Hadley et al, 1991). Average precipitation ranges from 20 inches per year in the Galiuro and Santa Teresa Mountains to 14 inches at the Klondyke rain gauge, (Ellingson, 1980; Brazel et al, 1981). Rain events during the months of December, January, February, & March are mainly non-intensive and occasionally long lasting. Intense rain events during July and August, due to monsoon thunder storms, make these months the wettest of the year. April and May are the driest months of the year providing little precipitation, (Sellers et al, 1985). With an annual mean snowfall of 1.6 inches recorded at Klondyke, snowfall provides additional precipitation within the basin. Winter snow is found at elevations exceeding 5,500 feet along the northern sides of the Santa Teresa and Horse Mountains, and above 6000 feet along the northeastern side of the Galiuro Mountains. June and July are the hottest months of the year with average daytime high temperatures ranging from 90° to 95° F at Klondyke. The coldest months of the year are January and February with average daytime high temperatures ranging from 60° to 65° F at Klondyke (Neuman & Adar, 1983).

SETTLEMENT

In 1867, William A. Bell, an English geographer, recorded the earliest detailed description of Aravaipa Valley while working with the survey crew of the Kansas Pacific Railroad's projected southern route. From 1870 to 1920 Aravaipa Valley supported five mining camps with a population of more than 100 people, two rural villages on the east and west ends of the canyon, dozens of isolated ranches, and a market central called Klondyke, (Hadley et al, 1991). The Taylor Grazing Act of 1934 reorganized grazing on public lands and ended the possibility that a plot of free land could be converted into a substantial holding. During the 1930's, second and third generation children left Aravaipa due to depressed economic conditions, (Hadley et al, 1991).

Aravaipa Valley experienced three phases of mining activity. The first took place between the late 1880's and the 1920's at the town-site of Aravaipa and the Table Mountains (west of the basin boundary). This mining phase focused on lead, silver, and copper ores. The second phase began during WWI and continued until the great depression and was located in the Klondyke and Grand Reef area. The third phase, initiated by the economic recovery of the Second World War, was centered at Copper Creek. This third phase mining extracted molybdenum and lead ore. This last phase continued into the 1950's at which time all mining activity ceased and the local population decreased radically (Ellingson, 1980; Hadley et al, 1991).

The cattle history of Aravaipa can be viewed as a 120 year attempt to reduce drought risks and increase financial returns. In arid lands like Aravaipa, the overriding ecological risk to the cattle and the range is both long term drought and seasonal dry periods. Also, from the 1900's to the 1940's goat ranching was exploited as goats thrived within this area. However, they exerted a significant stress on the plant composition, distribution, and abundance of the range. Beginning in the 1960's, and continuing to present, a conservation and multiple-use philosophy started which attempts to restore grasslands and riparian plant communities with limitation or elimination of livestock as a strategy, (Hadley, 1991).

Farming has endured primarily where the flood plain is wide and the water diversion techniques are employed. In the 1940's, with the advent of tractors, more land could be cleared and cultivated. During the 1950's, farmers were drilling large wells along the creek for irrigation (Hadley, 1991; Ellingson, 1980; Neuman & Adar, 1983). These farms with large capacity wells are what remain of economic farming today.

GEOLOGY

Aravaipa basin is a narrow graben structure with deep normal faults residing on both sides of the valley (Robinson, 1976; Ellingson, 1980; Neuman & Adar, 1983). Aravaipa basin was part of a massive high relief granodioritic pluton erosional surface during the late Cretaceous (Neuman & Adar, 1983; Simons, 1964). The Galiuro Mountains, which formed in the late to mid Tertiary, are composed of varying formations of basalt, andesite, and rhyolite (Moore, 1962; Robinson, 1976). The Santa Teresa Mountains, which formed in the early Tertiary, are composed almost entirely of the Santa Teresa granitic pluton and is one of the largest outcrops of this formation exposed in Arizona. The Horse Mountains, which formed in the late Cretaceous, are a volcanic group consisting of lavas, tuffs, and agglomerates. Rock units within Aravaipa Valley range in age from Precambrian to Holocene.

The formation of the present Aravaipa Valley started in the late Tertiary due to relative uplift of the adjacent mountain blocks (Neuman & Adar, 1983). This uplift was part of a regional tectonic event known as the Basin and Range orogenic effect. The surrounding mountains uplifted and began to erode and fill the basin. This fill created elongated pediments along the mountain fronts. The basin fill consists of three primary lithostratigraphic units with some commonality and some discontinuous lucustrine sediments. These three lithostratigraphic units, from oldest to youngest, are the Hell Hole conglomerate, older alluvium, and younger alluvium. The estimated maximum depth to bedrock along the axis of the basin may exceed 2,300 feet (Simons, 1964).

The Hell Hole conglomerate, which is late Tertiary in age, rests unconformably on the Galiuro volcanics and to some extent on the Horse Mountain volcanics and is the lowest known bedrock unit in the basin. This conglomerate is generally a light-colored cream, buff, orange, pink, or brown moderately to well indurated rock and has angular to rounded pebbles, cobbles, and occasionally boulders in a sand or grit matrix held together by calcite. The source of rock fragments is the Galiuro Mountains. The conglomerate attains a thickness of at least 600 feet in the canyon between Turkey Creek and Hell Hole. A maximum thickness of 2,000 feet resides on a northeast trending section between Wire Coral Draw to the southwest and Maroga Canyon to the northeast (Ellingson, 1980; Moore, 1962; Neuman & Adar, 1983; Robinson, 1976; Simons, 1964).

The older alluvium, which is Quaternary in age, unconformably overlies rocks that range in age from Precambrian to Tertiary. Predominantly the older alluvium overlies Horse Mountain volcanics, Pinal schist, Galiuro volcanics, and Hell Hole conglomerate. The older alluvium consists primarily of poorly bedded unconsolidated to slightly consolidated sand and gravel. Rock fragments range in shape from angular to rounded and sand to boulder in size (Ellingson, 1980; Robinson, 1976; Simons, 1964). The old alluvium basin fill is predominantly post Basin and Range development and nothing in the general character of the older alluvium during deposition suggests the terrain or climate differed greatly from the present (Simons, 1964). This unit ranges from 350 to 500 feet thick west of Stowe Gulch, but is more than 600 feet thick in Old Deer Creek. Small remnants of stream channels are preserved along the axis of the creek on both sides. Small outcrops of brown sand and silt are exposed at several places along Stowe Gulch, Klondyke Wash, and the southwest side of Aravaipa Valley. These deposits have been interpreted as lake deposits and are more widespread along the northeast side of Aravaipa Valley between Stowe Gulch and Buford Canyon. The deposits consist of unconsolidated brown, very poorly bedded fine sand and silt and are overlain by 25 feet of brown to gray fairly well bedded coarse sand and pebble gravel (Simons, 1964).

Younger alluvium, interpreted as Holocene in age, rests unconformably on sedimentary and volcanic rocks of Tertiary or Quaternary age (Simons, 1964). The younger alluvium consists of unconsolidated poorly sorted fluvial sand and gravel along the present stream courses. The thickness of this unit everywhere is uncertain, but cut-banks along the northern section of Aravaipa Creek are several feet thick and in the wider parts of the creek it is tens of feet thick. The younger alluvium reaches a maximum width of almost a mile at the confluence with major tributaries. Small-scattered patches of younger alluvium rest on rocks of Precambrian, Paleozoic, and Mesozoic in age throughout the basin (Simons, 1964; Neuman & Adar, 1983; Robinson, 1976; Ellingson, 1980).

GROUNDWATER OCCURENCE

The commonly used aquifers of the Aravaipa basin are the younger alluvium (upper water table aquifer) and the older alluvium (deep aquifer); (Neuman & Adar 1983; ADWR 1994). The upper unconfined aquifer consists of the younger alluvium and is the major source of groundwater for use within the basin. However, this aquifer is limited to the course of the creek and the alluvial fans from Aravaipa's major tributaries. The deep aquifer consists of the older alluvium and provides water within several thin permeable layers of sand and gravel.

BASIN FILL DEPOSITS

The basin fill deposits, consisting of the Hell Hole conglomerate, older alluvium, and younger alluvium, are considered the principal aquifer system for the basin. Although unconformities exist between stratigraphic units and complexities exist within the basin fill deposits, the Hell Hole conglomerate cannot be distinguished from the older alluvium in various areas. In other areas, truncated and indurated terraces and lake deposits exist within the older alluvium sediments, and the Hell Hole conglomerate and older alluvium units may not even be in contact with each other (Simons, 1964).

CONFINED AQUIFER (Older Alluvium)

Based on water level records in Neuman & Adar (1983) the confined aquifer potentiometric head is higher in elevation than the water table elevation in many areas up-gradient from Aravaipa Spring. The confined aquifer potentiometric head is higher than the unconfined aquifer head during winter and summer and the head difference is greater during the summer (Neuman & Adar, 1983). This suggests that water is leaking from the confined aquifer into the unconfined aquifer. Well logs suggest that the most permeable units within the older alluvium are 10 to 35 feet thick sand layers within cemented low-permeability layers ranging from 35 to 100 feet thick. The bottom of the upper confining unit is 230 to 350 feet below the surface at the uplands near the drainage divide (Neuman & Adar, 1983) . Depth to water within the older alluvium varies from 25 feet below the land surface where the younger alluvium is stratigraphically thin to over 500 feet below land surface in the uplands near the drainage divide. Driller's logs from the southern extent of the basin indicate the existence of a very thin water bearing unit on top of the older alluvium confining unit. However, within this area most of the wells extract water from the older alluvium suggesting that the thickness of the younger alluvium decreases to the south and the aquifer apparently thins out near Peyote Church. South of this location only a temporary water table aquifer exists during rainy times (Neuman & Adar, 1983; 1987).

HARDROCK AQUIFERS

Hard rock formations within the basin appear to have very low primary porosity, however secondary porosity has some influence on springs and alluvial aquifer recharge. The largest spring emerging from volcanic rocks is located 0.3 miles downstream from Virgus Canyon and discharges at the stream elevation. This spring is estimated to have an average discharge of 100 gpm. Another spring, contributing water to Right Prong Fourmile Creek in T7S, R19E, S27, can be attributed to groundwater storage and secondary porosity along an adjacent fault on the contact between the volcanics and the Hell Hole conglomerate. The only well drilled into the Galiuro volcanics within the basin is located at T6S, R18E, S32 and has a depth of 500 feet and only provides water for stock purposes (Ellingson, 1980). There is one known seep developed for human use within the Hell Hole conglomerate, and it is located at the confluence of Arizona Gulch and Old Deer Creek. Horizontal drilling into the seep resulted in a continuous supply of water through a 0.5 inch pipe. It is not expected that groundwater development within this conglomerate would produce water unless development occurs within fracture zones (Ellingson, 1980). Two deep well records from the south end of the basin indicate the presence of two thin confined water bearing layers within lava flows at depths below 1,000 feet (Neuman & Adar, 1983).

SPRINGS

It has been observed that mountain springs drain small local aquifers within fracture zones or faults. Some springs provide perennial discharge while others decrease or stop during drier times (Neuman & Adar, 1983). The majority of springs occur within the north side of Aravaipa Canyon in both the conglomerate and the Galiuro volcanics. Springs contribute water to valley sediments on both the eastern and western pediments and generally at contacts of mountain block rocks, basin fill, or fault zones in mountain blocks. The discharging water is stored within faults or fault zones and may discharge a few gallons per minute to over 100 gpm (Ellingson, 1980; Neuman & Adar, 1983). Aravaipa Basin has some noted springs that emerge both near stream level and high in the canyon walls (Ellingson, 1980). Most mountain springs have low discharge rates with the exception of those near Stowe Gulch, Fourmile Canyon, and Deer Creek. The aforementioned springs have high perennial discharge rates and discharge from the contact between the older alluvium and igneous bedrock. Varied spring discharge elevations suggest a non-regional draining of water that travels in fault zones or as perched water above confining layers (Ellingson, 1980).

RECHARGE

Recharge from infiltrating precipitation and runoff is the sole source of recharge to the basin (Freethey & Anderson, 1986). Recharge mechanisms within the basin include: direct infiltration of precipitation, stream infiltration, mountain front recharge, alluvial fan storage and recharge, lateral inflows through the upper layers of the older alluvium, upward leakage from the older alluvium, and seepage from applied irrigation (ADWR, 1994; Ellingson, 1980; Neuman & Adar, 1983). The amount of recharge by direct precipitation to the younger alluvium aquifer is negligible due to high evapotranspiration rates and the limited surface area of the younger alluvium. The amount of recharge by stream infiltration is related to the area of the basin having precipitation and the intensity and duration of the event. Stream infiltration is important for Oak Creek, Rattlesnake and Fourmile Canyon areas. Mountain front pediments initiate deep percolation through the older alluvium and provide lateral flow into the younger alluvium. Thus, mountain front recharge is significant for most regions of the basin. Alluvial fans are recharged by floods and annual snow melt, and due to the high topographic relief produce steep hydraulic gradients. This water infiltrates the alluvial fans, and in turn recharges the younger alluvium, and Aravaipa Creek. This form of recharge is found to be significant for Sharizona, Rattlesnake, Fourmile, Klondyke, Laurel, and Stowe Gulch Fans. Lateral inflows from the upper portion of older alluvium to the younger alluvium occur in most areas of the basin, and are a significant recharge mechanism throughout the basin. Upward leakage from the confined (older alluvium) aquifer occurs throughout most of the basin under the younger alluvium. The amounts of leakage and locations vary throughout the basin but probably have a substantial role in younger alluvium recharge. The development of groundwater resources is small and limited within the basin, and was estimated at 3,000 acre-feet/year in 1976 and 3,100 acre-feet/year in 1983. Since mining activities ceased in 1957 and the amount of agriculture has remained approximately the same, the amount of pumping is unchanged. The amount of infiltration recharge produced by pumping and irrigating is negligible (Ellingson, 1980; Neuman & Adar, 1983; Gould & Wilson, 1976).

DISCHARGE

Groundwater is discharged primarily by natural means to Aravaipa Creek, with some small discharge to wells. Of the total water that discharges through the basin, 61% is discharged as evapotranspiration, 31% is discharged as stream base flow, and 8% is discharged as underflow, (Freethey & Anderson, 1986; Buol, 1964). The US Geological Survey has a gaging station at the west-end of Aravaipa Canyon that has been collecting stream discharge data since 1966. The mean annual discharge of Aravaipa Creek is 37.8 cfs (27,387 acre-feet/year) based on the 33-year record (USGS, 1999; www.waterdata.usgs.gov; Hardy, 1990). Contributing to discharge is the evaporation of perennial/ephemeral springs and the perennial streams that flow within the basin. The total number of flowing springs is relatively small, and the majority of them have low perennial or ephemeral discharges. Pumping wells are a minor discharge mechanism accounting for approximately 3,100 acre-feet/year (Ellingson, 1980; Neuman & Adar, 1983). Irrigation accounts for approximately 3,000 acre-feet/year, domestic use accounts for 13 acre-feet/year, and water used for stock accounts for 45 acre-feet/year. The population within the basin has not increased substantially since 1985, and therefore pumped water has not significantly increased. Direct stream diversions for irrigation account for 100 acre-feet/year (Ellingson, 1980).

MOVEMENT AND STORAGE

The general groundwater flow pattern is similar to the surface runoff pattern. Groundwater moves from high mountain elevations to mountain fronts and pediments towards the center of the basin. Groundwater flows northwest along the central axis of the valley (Ellingson, 1980; Neuman & Adar, 1983; Anderson et al, 1992; ADWR, 1994). At higher elevations the water-bearing and transmitting properties of volcanic and plutonic rocks vary widely. Observed springs show that groundwater exists and flows within these units, however, flow directions and velocities vary greatly with each spring, as the springs are due to tectonic driven mechanisms of secondary porosity rather than primary porosity. As groundwater from all parts of the valley moves towards the head of Aravaipa Canyon, the cross-sectional area of the alluvial sediments is greatly reduced creating a ponding effect due to a more restricted flow path (Ellingson, 1980). The perennial portion of Aravaipa Creek emerges at this location. A groundwater divide at the southern portion of the basin is suggested by a topographic high that has been verified with gravity data indicating a shallow bedrock structure at this location (Robinson, 1976; Ellingson, 1980; Neuman & Adar, 1983). This bedrock structure has been suggested to separate a higher water table elevation within the Willcox Basin to the south. However, there is probably some leakage across this bedrock structure into the lower and naturally drained Aravaipa Basin (Ellingson, 1980). Groundwater within the confined aquifer flows from the pediments towards the basin axis while maintaining a high potentiometric head compared to the water table head elevation. The difference in the two head values causes groundwater to flow across the confining layer into the unconfined aquifer (Ellingson, 1980; Neuman, 1983; Anderson et al, 1992).

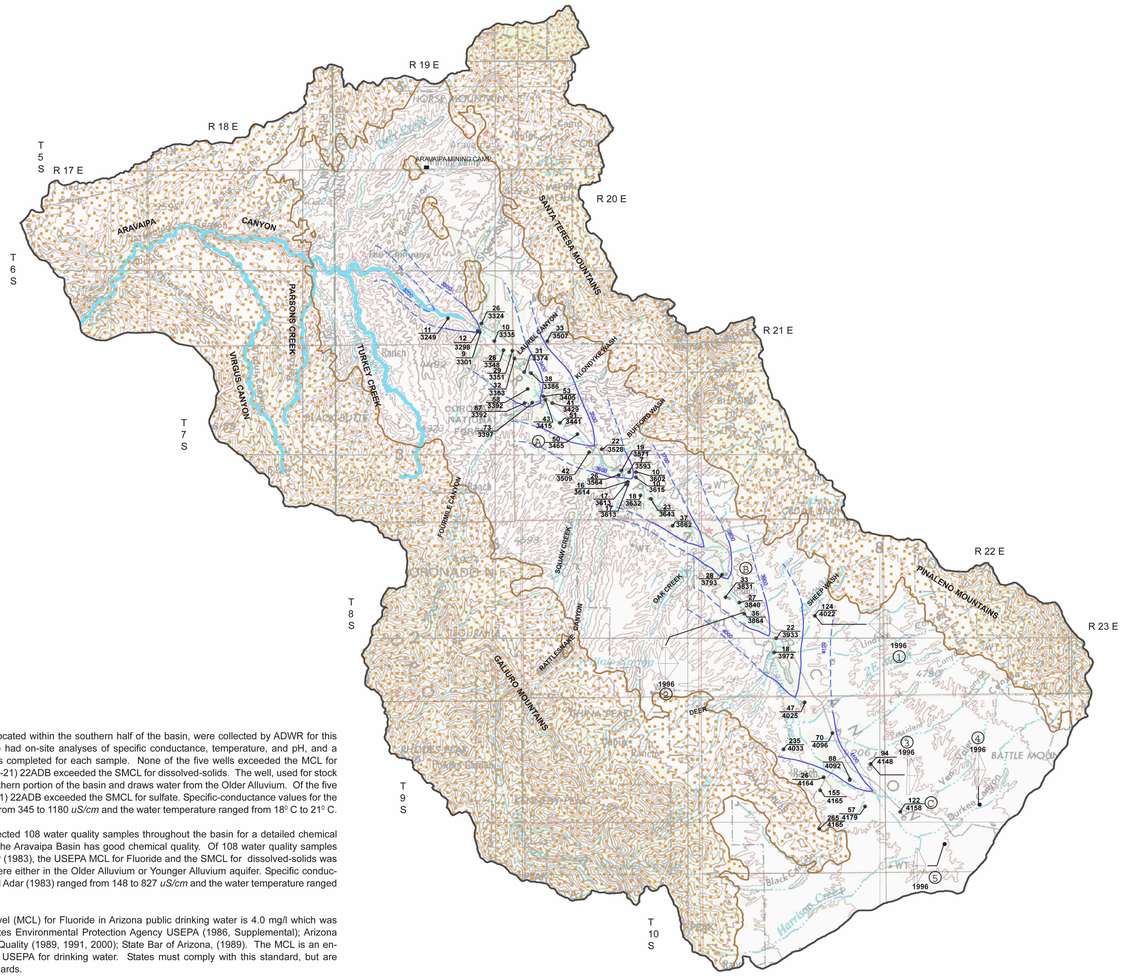
Freethey & Anderson (1986) estimates 5 million acre-feet of stored water in the basin fill aquifer to a depth of 1,200 feet below the land surface. This amount has probably changed very little with no new growth or agriculture within the basin. There are probably some groundwater influences caused by pumping, however, total pumping is relatively insignificant and probably creates small local groundwater depressions.

WATER-LEVEL CHANGES

Water level changes within Aravaipa basin are significant. Water levels are affected by pumping and variations in seasonal aquifer recharge. The small alluvial aquifer (younger alluvium) along Aravaipa Creek, is more sensitive to seasonal variations and pumping. Water levels within the vicinity of Hydrograph well C (D-09-22 19DCC) have decreased. These decreases may be attributed to well position and depth within the older alluvium aquifer and increased pumping. Also, just south of the groundwater divide (basin boundary) within the Willcox basin, water levels have declined 200 feet from 1954 to 1975 (Mann et al, 1978) and 25 feet from 1975 to 1990 (Oram, 1992). There is a possibility that water table decreases have changed the groundwater divide location and elevation, which would affect the water table gradient at the groundwater divide. Water levels have declined 13 to 47 feet within the Aravaipa Basin at the southern boundary (See Sheet I, Well C Hydrograph). Well D-09-22 19DCC (Well C), located closest to the groundwater divide, had water level declines of 47 feet from 1950 to 1996.

The average increase in the water level for wells that have records dating back to 1950 (A & B Hydrographs) is 20 feet which averages 0.38 feet per year. The average decrease in the water level for wells that have records dating back to 1950 (Well C) is 47 feet and averages 0.75 feet per year.

South of the Aravaipa-Willcox basin divide the amount of cultivated land and the number of wells in the Willcox basin increased from the 1950's to the 1970's. Annual groundwater withdrawals increased, reaching a peak of 339,000 acre-feet per year. Water levels in at least nine wells in the north section of Willcox basin had water levels decline more than 200 feet during peak water production periods. Due to economic conditions, many marginally successful farms went out of production in the 1970's. Groundwater usage within the northern Willcox basin has decreased since the 1970's causing groundwater levels to start recovering (Oram, 1990). It is possible that recovery of the water table south of the groundwater divide between Aravaipa and Willcox basins caused a shift in the location of the divide and an increase in water levels for parts of the younger alluvium aquifer after the 1970's within Aravaipa Basin. Various wells, such as (Wells A & B) may suggest this increase in the water levels after the 1970's. Also, the average discharge from Aravaipa Creek increased approximately 362 acre-feet/year or 0.5 cfs from mid 1970 to the present. This increase may also reflect precipitation changes, evapotranspiration changes, measurement error, or other unknown factors.



WATER QUALITY

Water samples from 5 wells, located within the southern half of the basin, were collected by ADWR for this study (Sheet I). Each sample had on-site analyses of specific conductance, temperature, and pH, and a detailed chemical analysis was completed for each sample. None of the five wells exceeded the MCL for fluoride, however well 1 (D-08-21) 22ADB exceeded the SMCL for dissolved-solids. The well, used for stock purposes, is located in the southern portion of the basin and draws water from the Older Alluvium. Of the five wells sampled, well 1 (D-08-21) 22ADB exceeded the SMCL for sulfate. Specific-conductance values for the five wells of this study ranged from 345 to 1180 *uS/cm* and the water temperature ranged from 18° C to 21° C.

Neuman and Adar (1983) collected 108 water quality samples throughout the basin for a detailed chemical analysis. The groundwater of the Aravaipa Basin has good chemical quality. Of 108 water quality samples analyzed by Neuman and Adar (1983), the USEPA MCL for Fluoride and the SMCL for dissolved-solids was not exceeded. These wells were either in the Older Alluvium or Younger Alluvium aquifer. Specific conductance values from Neuman and Adar (1983) ranged from 148 to 827 *uS/cm* and the water temperature ranged from 14.5° C to 26.5° C.

The maximum contaminant level (MCL) for Fluoride in Arizona public drinking water is 4.0 mg/l which was established by the United States Environmental Protection Agency USEPA (1986, Supplemental); Arizona Department of Environmental Quality (1989, 1991, 2000); State Bar of Arizona, (1989). The MCL is an enforceable standard set by the USEPA for drinking water. States must comply with this standard, but are allowed to set more rigid standards.

The relationship between ionic concentration and specific conductance has a reasonably well defined straight-line regression. The concentration of dissolved solids (mg/l) may be approximated by multiplying the specific conductance (micromhos or *uS /cm at 25°C*) value by 0.6 (Hem, 1992). The USEPA has established a Secondary MCL for dissolved solids at 500 mg/l, which is approximately equivalent to 833 *uS /cm*. The USEPA has also set the SMCL for Sulfate at 250 mg/l. Secondary MCL are guidelines only based on aesthetic qualities such as taste, odor, or color, and are not enforceable standards (USEPA, 1988; ADEQ, 1989, 1991, 2000). Water exceeding the Secondary MCL standards may not pose a health risk.

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SCALE BARS

0 5 10 STATUTE MILES

0 5 10 KILOMETERS

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS

TRANSVERSE MERCATOR PROJECTION

BLACK NUMBERED TICK MARKS, IF VISIBLE, INDICATE THE 10,000 METER UNIVERSAL TRANSVERSE MERCATOR GRID, ZONE 12
BLACK LINES INDICATE TOWNSHIP AND RANGE SELECTED FENCE LINES

1977 MAGNETIC DECLINATION FROM TRUE NORTH VARIES FROM 13 DEGREES (230 MILS) EASTERLY FOR THE CENTER OF THE WEST EDGE TO 12°10' (220 MILS) EASTERLY FOR THE CENTER OF THE EAST EDGE

N W E S

LEGEND - EXPLANATION

124 / 4022 — **WELL IN WHICH DEPTH TO WATER WAS MEASURED IN 1996 -** UPPER NUMBER, 124, IS DEPTH TO WATER IN FEET BELOW LAND SURFACE. LOWER NUMBER, 4022, IS THE ALTITUDE OF THE WATER LEVEL IN FEET ABOVE MEAN SEA LEVEL. DATUM IS REFERENCED TO THE NATIONAL VERTICAL GEODETIC DATUM OF 1929.

HARDROCK GRANITIC, METAMORPHIC, VOLCANIC OR CONSOLIDATED SEDIMENTARY ROCK - WATER MAY OCCUR IN WEATHERED OR FRACTURED ZONES, JOINT SYSTEMS, OR FLUVIAL DEPOSITS OVERLYING BEDROCK.

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

S — **WATER QUALITY WELL** WELL FOR WHICH A WATER QUALITY ANALYSIS WAS PERFORMED

PERRENIAL WATERCOURSE ONE WHICH FLOWS CONTINUOUSLY FROM SOURCE TO MOUTH THROUGHOUT THE YEAR. SOURCE LOCATION MAY VARY OR MIGRATE DUE TO SEASONAL WEATHER

BOUNDARY BETWEEN HARDROCK AND ALLUVIUM

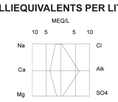
BOUNDARY OF ARAVAIPA CANYON BASIN

4000 — **WATER LEVEL CONTOURS -** SHOWS THE APPROXIMATE ALTITUDE OF THE WATER-LEVEL. THE NUMBER 4000 REPRESENTS 4000 FEET ABOVE MEAN SEA LEVEL. DASHED WHERE INFERRED.

STIFF DIAGRAM

STIFF DIAGRAM - SHOWS MAJOR CHEMICAL 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. 1996, BELOW DIAGRAM, INDICATES YEAR IN WHICH SAMPLE WAS COLLECTED.

MILLIEQUIVALENTS PER LITER



1996

BASE MAP FROM U.S. GEOLOGICAL SURVEY
1:250,000 TUCSON (1977) AND MESA (1978)

ARIZONA DEPARTMENT OF WATER RESOURCES
SECURING ARIZONA'S WATER FUTURE

MAPS SHOWING GROUNDWATER CONDITIONS IN THE ARAVAIPA CANYON BASIN
PINAL AND GRAHAM COUNTIES, ARIZONA - 1996

BY
MARK A. HOLMES

THESE HYDROLOGIC MAPS ARE AVAILABLE UPON REQUEST FROM THE ARIZONA DEPARTMENT OF WATER RESOURCES, INFORMATION CENTRAL, 500 NORTH THIRD STREET, PHOENIX, ARIZONA, 85004. THE HYDROLOGIC DATA ON WHICH THESE MAPS ARE BASED ARE AVAILABLE AT THE ADWR INFORMATION CENTRAL AND FROM THE U.S. GEOLOGICAL SURVEY OFFICE, USGS MAPS SALES, BOX 25286, FEDERAL CENTER, BUILDING 810, DENVER, COLORADO 80225.