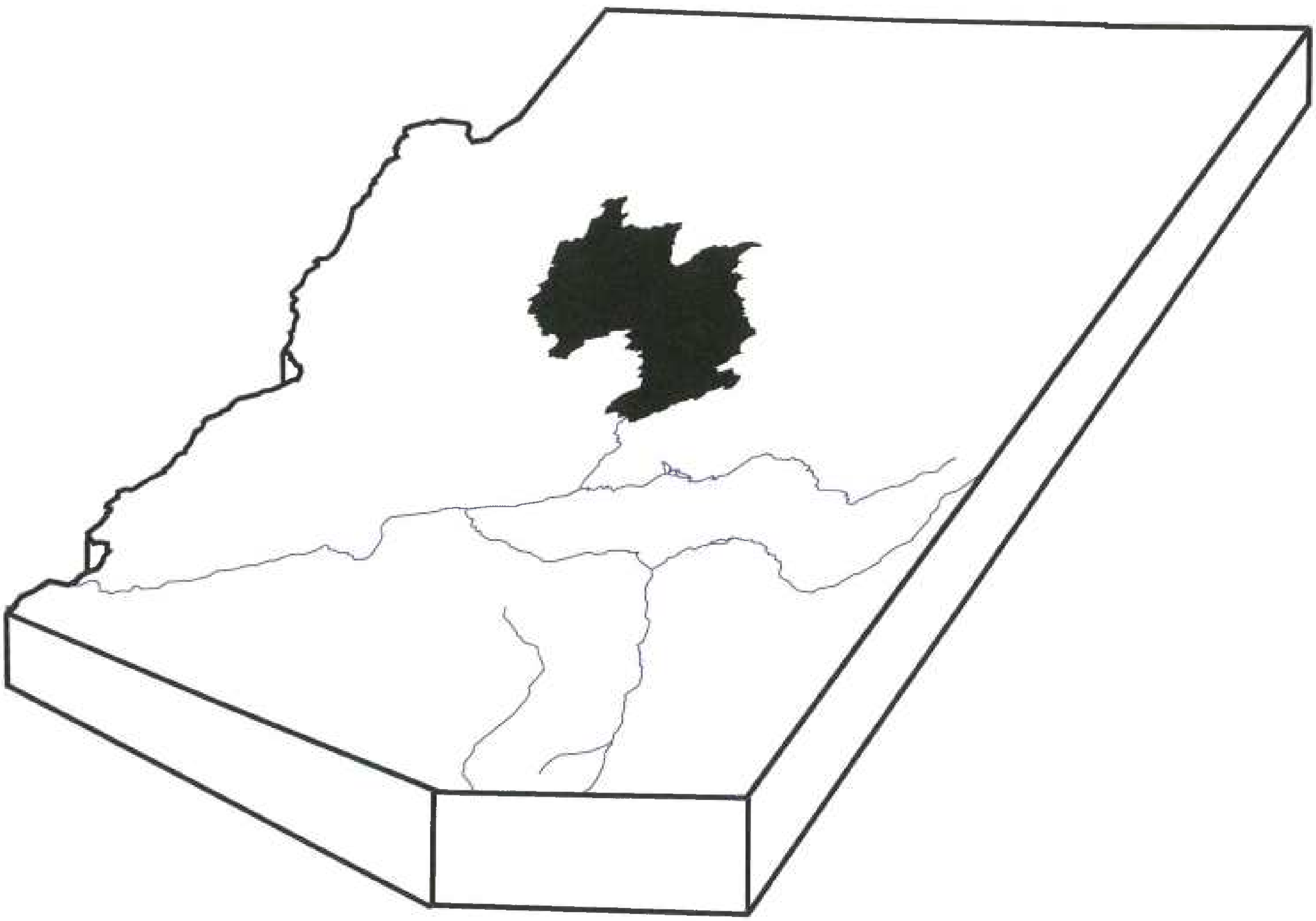
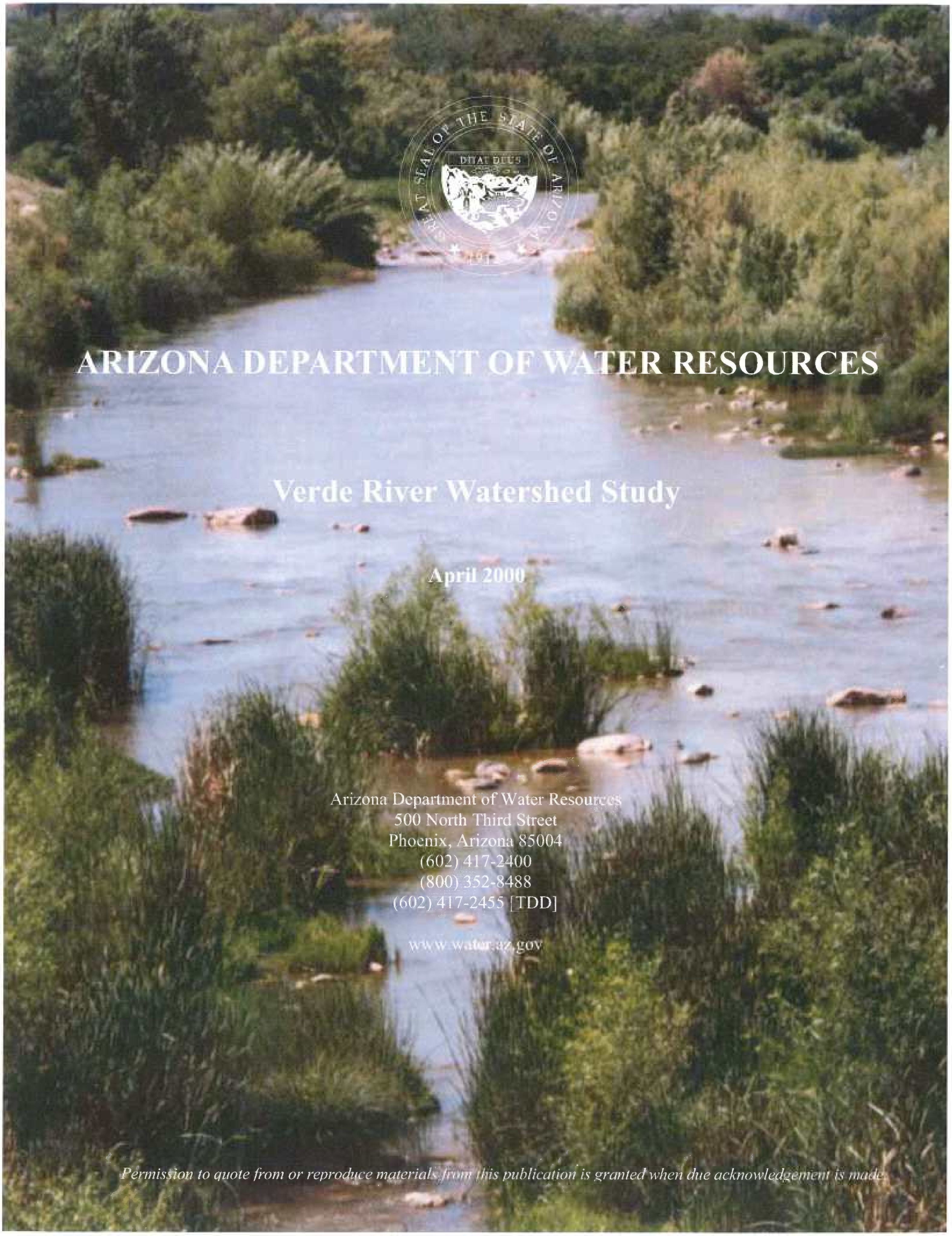
VERDE RIVER WATERSHED STUDY



ARIZONA DEPARTMENT OF WATER RESOURCES

2000



ARIZONA DEPARTMENT OF WATER RESOURCES

Verde River Watershed Study

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Arizona Department of Water Resources
500 North Third Street
Phoenix, Arizona 85004
(602) 417-2400
(800) 352-8488
(602) 417-2455 [TDD]

www.water.az.gov

Acknowledgements

Rita P. Pearson

Director, Arizona Department of Water Resources

J. Darrell Jordan

Assistant Director, Surface Water Management

Study Team

Craig A. Brown

Siegfried Eichberg

David A. Keadle

William D. Musielak

Thomas G. Whitmer

Contributing Staff

Frank E. Corkhill

Ana M. Marquez

Jack McCormack

Mark R. Preszler

Frank G. Putman

Kathy L. Rall

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***Picture Acknowledgement**: View toward the northwest of the Verde River near Tuzigoot National Monument, between Clarkdale and Cottonwood. Photo taken by D. A. Keadle, 1999.*

TABLE OF CONTENTS

PAGE

PAGE

LIST OF TABLES

LIST OF FIGURES

PAGE

PAGE

LIST OF ABBREVIATIONS AND ACRONYMS

ACC	Arizona Corporation Commission
ADEQ	Arizona Department of Environmental Quality
ADES	Arizona Department of Economic Security
ADOC	Arizona Department of Commerce
ADWR	Arizona Department of Water Resources
AMA	Active Management Area
AWQS	Arizona Water Quality Standards
BLM	Bureau of Land Management
CVID	Chino Valley Irrigation District
EPA	Environmental Protection Agency
GPCD	Gallons Per Capita Per Day
ITC	Inter-tropical Convergence Zone
MCL	Maximum Contaminant Level
NRCS	Natural Resource Conservation Service
SCS	Soil Conservation Service
SMCL	Secondary Maximum Contaminant Level
SRP	Salt River Project

USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Survey
VVWUA	Verde Valley Water Users Association
WWTP	Wastewater Treatment Plant

GLOSSARY OF TERMS

Acre-foot: The amount of water required to cover one acre to a depth of one foot. It is equal to 325,851 gallons.

Active Management Area: A geographical area that has been designated by the Legislature as requiring active management of groundwater withdrawals from pumping.

Alluvium: Sediments of varying sizes deposited by flowing water as in a riverbed or floodplain.

Aquifer: A geologic formation, group of formations, or part of a formation that contains sufficient saturated material capable of transmitting significant quantities of water to wells and springs.

Artesian Aquifer: Also referred to as a confined aquifer. An aquifer in which groundwater is confined under pressure significantly greater than atmospheric. Groundwater contained in the confined aquifer is under sufficient hydrostatic pressure to rise above the top of the aquifer.

Bank Storage: Water absorbed into the banks of a stream channel when the stage in the stream rises above the adjacent water table in the streambank. Water contained as bank storage returns to the channel as seepage when the stage in the stream falls below the water table in the adjacent streambank.

Baseflow: Groundwater that has been discharged into a stream channel as spring or seepage water.

Confined Aquifer: See Artesian Aquifer.

Consumptive Use: The amount of water absorbed by crops, which includes transpiration and evaporation from the soil surfaces surrounding the plants.

Contaminant: Any physical, chemical, biological, or radiological substance or matter in water.

CFS: A unit of measure of flowing water. One cfs means that one cubic foot of water, or 7.48 gallons, passes a given point during an interval of one second or 449 gallons per minute.

Direct Runoff: Water entering stream channels promptly after rainfall or snowmelt.

Discharge: The volume of water flowing in a stream or through an aquifer past a specific point in a given period of time.

Discharge of Groundwater: The process by which water leaves an aquifer.

Diversion: A structure or facility built for the purpose of taking water from its source.

Drainage Basin: The land area from which surface runoff drains into a stream system.

Effluent: Treated wastewater which may be used for various purposes.

Ephemeral Stream: A stream that flows only in direct response to precipitation.

Floodplain: Lowland area adjacent to the active stream channel that is periodically inundated by flood water; the land outside of a steam channel formed by sediments deposited by the stream.

Floodplain Alluvium: Unconsolidated gravel, sand, and/or silt found beneath or on either side of a floodplain.

Gaging Station: A location along a watercourse where streamflow is regularly measured by permanently installed equipment.

Gaining Stream: A stream or reach of a stream, the flow of which is being increased by the inflow of groundwater.

Groundwater: The water contained in interconnected pores located below the water table in an unconfined aquifer or located in a confined aquifer.

Groundwater Flow: The movement of water through openings in sediment and rock; occurs in the zone of saturation.

Groundwater Recharge: The natural or artificial replacement of groundwater, or addition of water to a groundwater aquifer.

Hydrogeology: The study of the interrelationships of geologic materials and processes with water, especially groundwater.

Industrial Use: Water used by a commercial operation or business, such as dairies, sand and gravel operation, fish farming, etc.

Infiltration: The flow of water downward from the land surface into and through the upper soil layers.

Intermittent Stream: A stream that flows only at certain times of the year or flows seasonally. Streamflow is supported by baseflow during part of the year when the elevation of the water table in an adjacent aquifer rises above the streambed elevation.

Losing Stream: A stream or reach of a stream that is loosing water by seepage into the ground.

Monitoring well: A well drilled with the specific purpose of measuring groundwater elevation or quality.

Perched Aquifer: An aquifer separated from the underlying regional groundwater system by a geologic unit having a lower hydraulic conductivity.

Perennial Stream: A stream that flows continuously year round.

Phreatophyte: A term literally meaning "well-plant" that refers to plants that use groundwater. It is often used as a synonym for "riparian plant".

Porosity: The ratio of the volume of the pores or interstices in a rock or sediment to the total volume of the rock or sediment.

Reach: A specified length of a river, stream, or channel.

Recharge: The process of addition of water back to an aquifer.

Riparian Area: A geographically delineated area with a distinct resource value. It is characterized by deep-rooted plant species that depend on having roots in the water table or its capillary zone and that occurs within or adjacent to a natural perennial or intermittent stream channel or within or adjacent to a lake, pond, or marsh bed maintained primarily by natural water sources.

Runoff: The total amount of water flowing in a stream. It includes overland flow, return flow, interflow, and baseflow.

Safe Yield: The amount of naturally occurring groundwater that can be economically and legally withdrawn from an aquifer on a sustained basis without impairing the native groundwater quality or creating an undesirable effect such as environmental damage. It cannot exceed the increase in recharge or leakage from adjacent strata plus the reduction in discharge, which is due to the decline in head caused by pumping.

Specific Yield: The ratio of the volume of water rock or soil will yield by gravity drainage to the volume of the rock or soil. Gravity drainage may take many months to occur.

Static Water Level: The water level measured in a well that represents the undisturbed elevation of the water table surface.

Storage: The volume of water naturally detained in an aquifer.

Sub-basin: An area which encloses a relatively hydrological distinct body of groundwater within a groundwater basin, and which is described horizontally by surface description.

Subflow: Subsurface water found in alluvial deposits that are hydraulically connected to a perennial or intermittent stream such that withdrawal of this subsurface water would diminish the flow of the stream. It is the downstream flow of water through the permeable deposits that underlie a stream and are vertically and laterally bounded by rocks or sediments of lower hydraulic conductivity.

Subwatershed: A part of a watershed defined by the intervening drainage area between streamflow gaging stations or the watershed outlet.

Surface Water: Water that occurs on the land surface including ponds, lakes, streams, and rivers.

Water Budget: An evaluation of all the sources of supply and the corresponding discharges with respect to an aquifer or a drainage basin.

Water Duty: The water duty is the amount of water determined to be the reasonable annual application requirement for an acre of irrigated land.

Water Providers: City, town, private water company, or cooperative that provides water to a distinct geographical area.

Watershed: The drainage area of a designated principal stream tributary to the Verde River system.

Water Table: The surface in an unconfined aquifer at which the pore water pressure is atmospheric. The water level can be measured in wells that penetrate the zone of saturation.

Wetland: General term applied to shallow open-water habitats and seasonally or permanently saturated land areas, including lake edges, river margins, estuaries, and freshwater marshes.

Withdrawal: The process of capturing or acquiring water by diversion from a surface source or pumping from a groundwater aquifer.

CHAPTER 1

Introduction

CHAPTER 1: INTRODUCTION

The Verde River Watershed, and in particular areas along the Verde River, with its pleasing climate, year-round water, beautiful and diverse landscapes, and close proximity to nearby desert and mountain resources are attracting people in ever increasing numbers. Without proper planning, Arizona is in danger of losing enormous economic, aesthetic, and environmental benefits associated with the Verde River and its tributaries and the riparian areas associated with each.

The population of the major cities and towns within the Verde Watershed has more than doubled in the last 20 years and is projected to more than double again within the next 50 years. Municipal water usage has increased by more than 39 percent over the last eight years and at the present rate of growth will increase by more than 400 percent over the next 50 years.

Land uses are changing as more farms and ranches are subdivided and commercially developed directly affecting water usage. The number of wells is increasing proportionally with the rapid increase in urbanization, which will affect the volume of water available in the regional aquifer.

1.1 BACKGROUND

Many of Arizona's rivers have been taken for granted lately by communities that have been developed next to the rivers. People have diverted and pumped water, built dams and channelized rivers, cut down trees for homes, fuel, and cropland, mined sand and gravel, poured chemicals and waste into the rivers, and recreated for more than a hundred years on the Verde River and its tributaries. These types of land and water uses without long-range planning may eventually result in dry riverbeds with no green vegetation, no fish or wildlife, no recreation attraction, and reduced economic potential.

It is unclear whether the current demands for surface water and groundwater within the Verde River Watershed have caused any significant impacts on baseflow levels of the Verde River itself. Increasing water demands at the current rate of population growth without long-term water resource planning, however, will eventually impact the availability of both surface water and groundwater. The Little Chino sub-basin of the Prescott AMA has experienced significant groundwater declines in some areas and these declines have reduced flow in Del Rio Springs. Similar effects on other springs could be seen in the future with unplanned continued development.

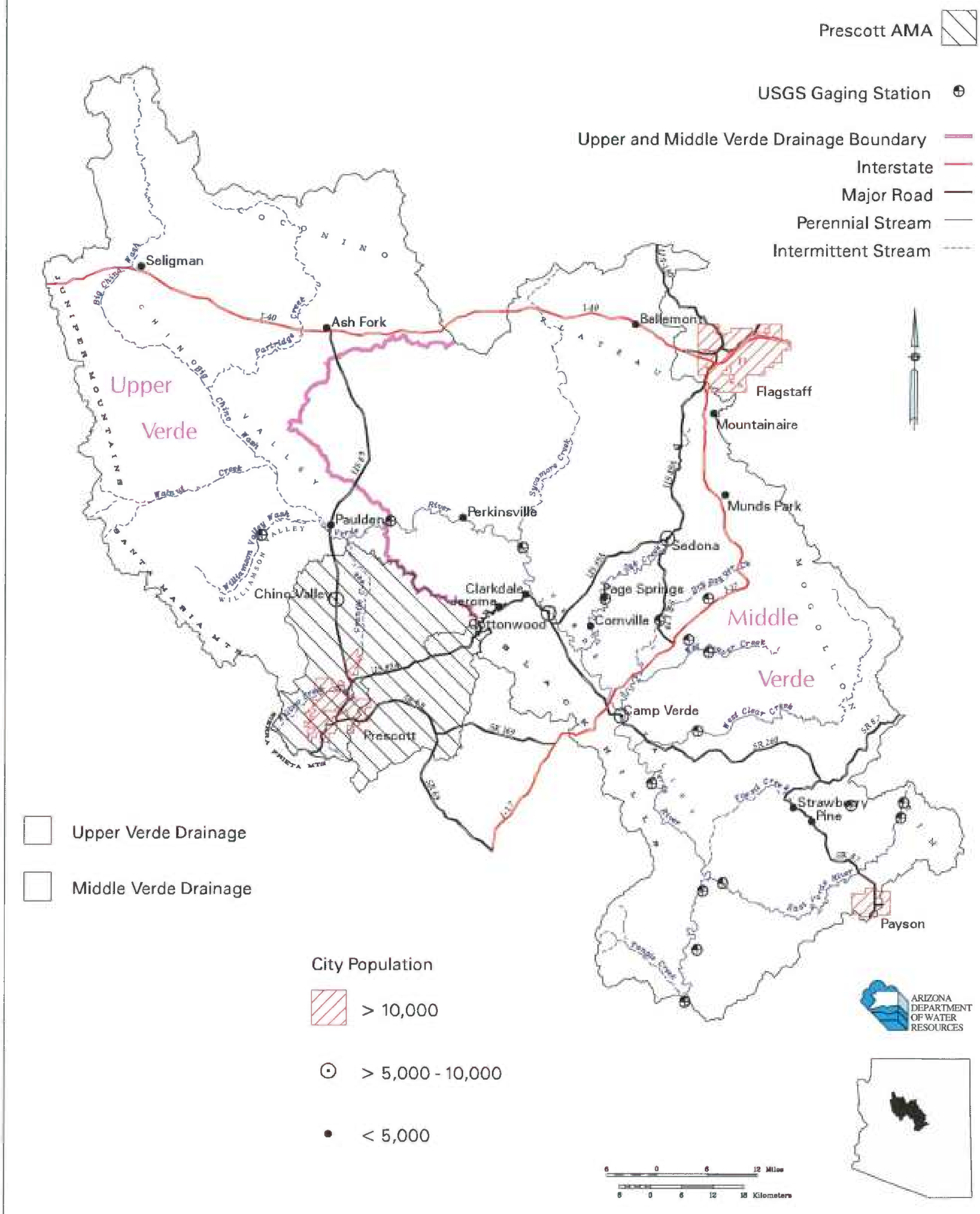
Little is known about how much groundwater is actually in storage in many areas of the Verde Watershed or about how water use in the Upper Verde may affect the continued availability of water for the Verde Valley, which depends on Verde River flows. These issues have caused a great deal of concern, expressed by water users within the Upper and Middle Verde areas as well as by downstream users of Verde River water, about the future availability and reliability of surface water and groundwater within the Verde Watershed.

1.2 STUDY AREA

The study area is located in Central Arizona and covers parts of Yavapai, Coconino, and Gila Counties. Included within the study area are the headwaters of the Verde River, Chino, Williamson, and Verde Valleys, the East Verde River, the incorporated areas of Prescott, and portions of the Cities of Payson and Flagstaff. See Figure 1.1.

The Verde River basin covers approximately 5,500 square miles and is divided into the Big Chino, Verde Valley, and Verde Canyon sub-basins. For purposes of this study, the Verde Watershed is divided into the Upper and Middle Verde regions, with the division occurring at the U. S. Geological Survey (USGS) gaging station on the Verde River near Paulden. The Upper Verde region encompasses the Williamson, Big, and Little Chino Valleys. The Middle Verde region encompasses everything downstream of the USGS gaging station on the Verde River near Paulden to the USGS gaging station on the Verde River below Tangle Creek.

Figure 1.1 - Verde River Watershed Study Area



Source: Arizona Department of Water Resources.

1.3 OBJECTIVE

In an effort to assist the rural communities of Arizona with their increasing problems associated with water resource management and development, the Arizona Department of Water Resources (ADWR) initiated a comprehensive study of the current water resources within the Verde Watershed area in 1998. The objective of the study was twofold: 1) identify and present a comprehensive overview of the current state of water resources for the Verde River Watershed study area; and 2) identify areas where further studies are needed in order to fully understand the impacts of current and future uses of water resources within the Verde River Watershed study area.

This report is the result of that effort and presents a comprehensive look at the current and historical water resources for the Verde River Watershed including surface water and groundwater supplies, municipal, industrial, agricultural, and other water demands, natural and artificial recharge, and effluent supplies and demands. Other factors identified and presented in this study are demographics, climate, soils and geology.

As part of the comprehensive overview of the water resources, water budgets were developed for five specific geographic regions within the study area to evaluate the hydrologic components of the watershed and to determine the current status of the groundwater system. Two regions were located in the Upper Verde and three were located within the Middle Verde. Annual water budgets were developed for the two regions located within the Upper Verde, while seasonal and annual water budgets were developed for the three regions within the Middle Verde. Included within the water budgets are inflows, outflows, and changes in water storage.

The information presented in this report is based upon the best available data to ADWR. Minimal or no data in some areas limits the ability to fully understand or define the actual status of the current water resources in the Verde River Watershed area. A series of conclusions and recommendations based upon the identification and analysis of the data related to the water resources of the Verde River Watershed study area are also presented in this report. The recommendations highlight those areas where further studies are needed to fully understand the current status of the water resources within the Verde River Watershed study area. It is hoped that this study will be used by the water managers and planners of the Upper and Middle Verde regions as a building block for future studies and advanced planning on behalf of the water users of the Verde River system. This study will also aid ADWR with any future adjudication activities encompassing the Verde River and its tributaries.

CHAPTER 2

Study Area Description

CHAPTER 2: STUDY AREA DESCRIPTION

2.1 PHYSIOGRAPHIC FEATURES

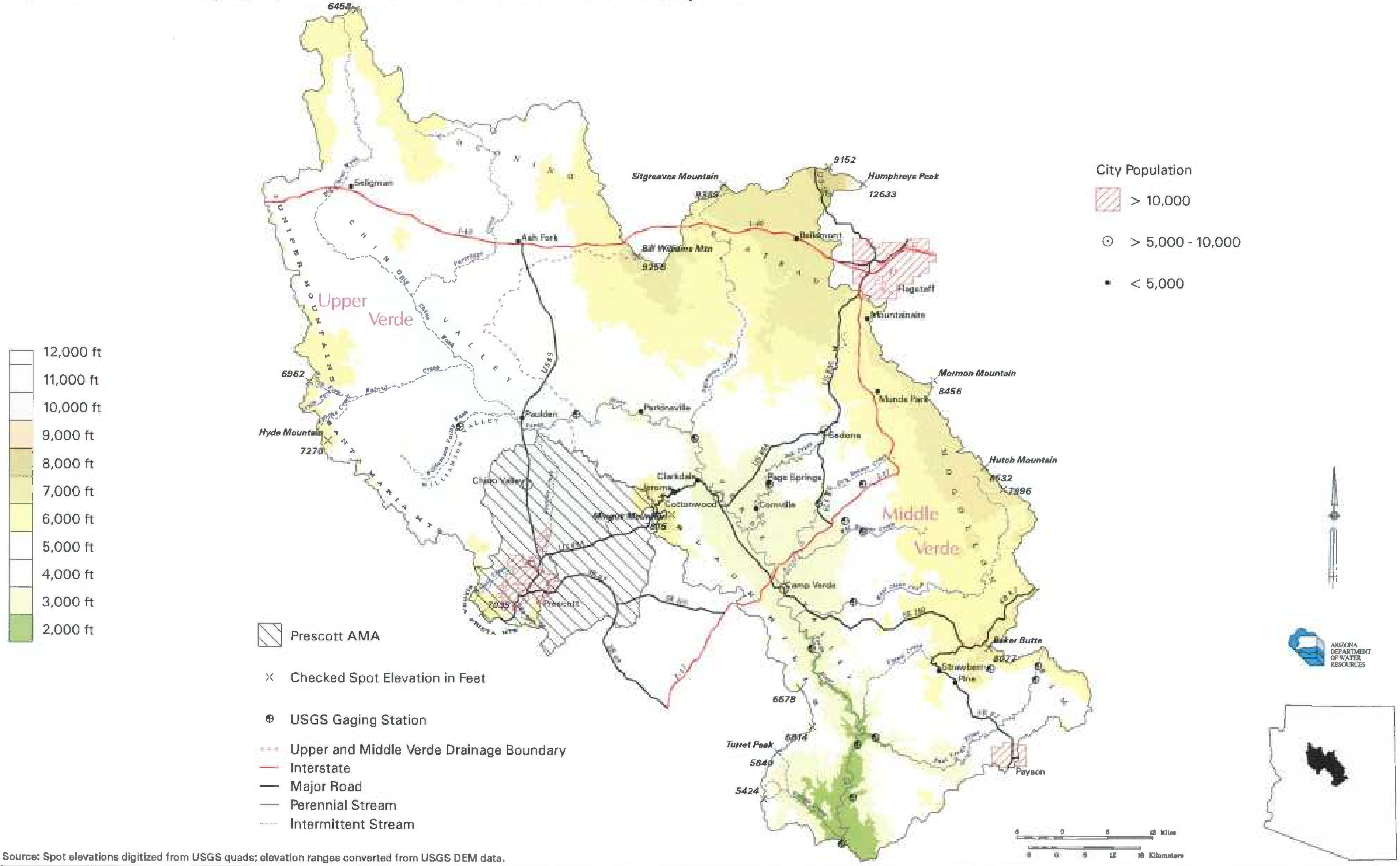
The Verde River Watershed Study encompasses an area that extends from the Coconino Plateau in the north to the USGS gaging station on the Verde River below Tangle Creek in the south, and from the Juniper and Santa Maria Mountains in the west to the Mogollon Rim in the east. Within the study area are the headwaters of the Verde River, Chino, Williamson, and Verde Valleys, the East Verde River, and portions of the Cities of Prescott, Payson, and Flagstaff. The Verde River is a tributary to the Salt River and is part of the Colorado River System.

The total length of the Verde River in the study area, including the Big Chino Wash and its tributaries from north of Interstate 40 near Seligman to the USGS gaging station below the confluence with Tangle Creek is approximately 235 miles. The total drainage of the study area is 5,501square miles. The elevation of the study area ranges from 2,029 feet above sea level at the Verde River gaging station 1.3 miles downstream from Tangle Creek and nine miles upstream from Horseshoe Dam to 12,633 feet above sea level at Humphreys Peak in the San Francisco Mountains.

For purposes of this study, the Verde Watershed is divided into the Upper and Middle Verde regions, with the division occurring at the USGS gaging station on the Verde River near Paulden. The Upper Verde region encompasses the Williamson, Big, and Little Chino Valleys. The Middle Verde region encompasses everything downstream of the USGS gaging station on the Verde River near Paulden to the USGS gaging station on the Verde River below Tangle Creek. The primary area of concern in the Middle Verde region is the Verde Valley. Figure 2.1 presents the study area and identifies the dividing line between the Upper and Middle Verde regions.

The Big Chino Wash meanders through Chino Valley, which extends from Interstate 40 near Seligman in the north to very near Prescott in the southeast. The elevation of Chino Valley ranges from approximately 5,200 feet near Prescott and Seligman to about 4,300 feet at Sullivan Lake. The portion of Chino Valley within the Prescott AMA is known as the Little Chino Valley.

Figure 2.1 - Physiography of the Verde River Watershed Study Area



Source: Spot elevations digitized from USGS quads; elevation ranges converted from USGS DEM data.

Chino Valley is bordered by the Juniper Mountains on the west, Santa Maria Mountains on the southwest, Sierra Prieta Mountains and portions of the Bradshaw Mountain Range on the south, and on the northeast by the Black Mesa. These mountain ranges typically reach elevations of 7,000 feet or more above sea level.

Two of the three primary tributaries feeding the Big Chino Wash originate in the Juniper and Santa Maria Mountains. They are Walnut Creek and its tributary Apache Creek and Williamson Valley Wash, which flows through Williamson Valley. The other tributary to Big Chino Wash originates on the Coconino Plateau and is known as Partridge Creek.

Big Chino Wash is dammed just south of Paulden to form Sullivan Lake. The watercourse below Sullivan Lake is considered to be the headwaters of the Verde River. The Verde River is perennial from just below Sullivan Lake to the end of the study area (143 miles).

From the headwaters below Sullivan Lake to Clarkdale, the Verde River flows through some very rugged and scenic country. Two major tributaries join the Verde in this stretch of the river. They are the Granite and Sycamore Creeks. Granite Creek and its two tributaries, Willow and Bannon Creeks, originate in the mountainous areas south of Prescott. Dams have been constructed on all three of these waterways to provide water to the City of Prescott and the Chino Valley Irrigation District (CVID). The construction of these dams created Willow Creek Reservoir, Upper and Lower Goldwater Lakes, and Watson Lake. Granite Creek flows north through Chino Valley and joins the Verde River about three miles below Sullivan Lake. Sycamore Creek originates on the Coconino Plateau and joins the Verde River downstream from Perkinsville. Sycamore Creek runs through some scenic canyons and is protected mostly by the Sycamore Canyon Wilderness Area.

The area from Clarkdale to below Camp Verde is known as the Verde Valley. This Valley ranges in elevation from approximately 3,542 feet at Clarkdale to 3,133 feet at Camp Verde. Historically, this area has been more densely populated than other areas on the Verde River. The Black Hills bound the Verde Valley to the south and west, which reach an elevation of 7,815 feet at Mingus Mountain, and on the north and east by the Coconino Plateau and the Mogollon Rim. The major tributaries that contribute to the Verde River in this region are the Oak, Dry, Wet Beaver, and West Clear Creeks. All these waterways originate either on the Coconino Plateau or the Mogollon Rim.

The mountains of the Coconino Plateau and the Mogollon Rim are generally higher in elevation than other mountain ranges previously mentioned. The average elevation of these mountains is between 7,000 and 8,000 feet with Humphreys Peak in the San Francisco Mountains and Baker Butte on the Mogollon Rim reaching elevations of 12,633 and 8,074 feet respectively. Because the Coconino Plateau and Mogollon Rim are higher in elevation than other mountains, precipitation is generally greater on the slopes of these areas. As a result, all tributaries that originate on these slopes tend to carry more water for longer periods throughout the year.

Downstream from Camp Verde, the Verde River again flows through some very rugged country. Three primary tributaries flow into the Verde River in the stretch below Camp Verde to below the mouth of Tangle Creek. The three tributaries are Fossil Creek, East Verde River, and Tangle Creek. Fossil Creek and the East Verde River originate from the Mogollon Rim. Tangle Creek originates in the Black Hills.

Oak Creek and the East Verde River are both perennial throughout their entire lengths. Wet Beaver, West Clear, and Fossil Creeks are perennial for most of their lengths and only become intermittent or ephemeral at their lower reaches. Some of the other washes and creeks such as Sycamore, Dry Beaver, Walnut, and Apache Creeks are perennial for specific reaches of their course. See Figure 2.1 for perennial streams.

2.2 CLIMATE

Precipitation

Arizona has two seasons of the year when precipitation is especially common. A wet season in winter usually between December and March and a wet season in summer usually between July and September. In winter, large cyclonic storms originate in the northern Pacific Ocean that may spread precipitation statewide. This precipitation is normally gentle. In the Verde River watershed, much of it may occur in the form of snow, especially at the higher elevations. These storms can last a few days depositing a foot or more of snow over large portions of the watershed. Orographic uplifting caused by the forced uplifting of air masses by mountain ranges accounts for the increased amounts of precipitation along mountain ranges. Winter storms produce most of the usable surface water supply.

Summer precipitation occurs as a result of the seasonal shifting of the Intertropical Convergence Zone (ITC); the area where trade winds converge. This shift of the ITC brings Arizona under the influence of subtropical air masses. The influx of warm, moist air usually from July through September is called monsoon. The sources of this warm, moist air are primarily the Gulf of Mexico and the Sea of Cortez. The percentage of annual precipitation resulting from monsoon rains is normally highest in southeastern Arizona and decreases toward the northwestern part of the State. In the central region of the State including the Verde River watershed, the summer monsoon accounts for an increase in precipitation primarily during July and August.

Summer precipitation is the result of convection; the rising of heated, less dense, moisture-laden air that forms thunderstorms. These thunderstorms usually form over mountains and result in isolated, often violent downpours. Water from these downpours may cause short, sometimes hazardous runoff better known as flash flooding.

Mean annual precipitation in the Verde River watershed ranges from 10 to 20 inches in the valleys and plateaus to more than 25 inches in the higher mountains. On the windward (southern and western) side of the highest mountains such as the San Francisco Peaks, precipitation exceeds 30 inches and in some years may exceed 40 inches. Table 2-1 presents the temperature and precipitation data for selected cities within the Verde Watershed study area.

TABLE 2-1

TEMPERATURES AND PPT DATA FOR SELECTED CITIES IN THE VERDE WATERSHED

CITY OR TOWN	ELEVATION (FEET)	TEMPERATURES (ANNUAL AVG F)		AVERAGE ANNUAL PRECIPITATION (INCHES)	
		MAXIMUM	MINIMUM	TOTAL ANNUAL	SNOW, HAIL, SLEET
Ashfork	5,142	71.9	36.6	12.38	15.10
Camp Verde	3,133	80.1	43.7	13.03	5.00
Chino Valley	4,750	72.2	36.9	12.50	10.60
Clarkdale	3,542	78.8	45.4	12.21	5.00
Cottonwood	3,300	78.8	45.4	12.21	5.00
Flagstaff	7,000	60.8	30	19.80	84.40
Jerome	5,248	69.2	48.6	17.90	24.90
Payson	5,000	72.5	38.6	20.77	25.10
Prescott	5,400	69.1	36.8	18.10	23.70
Sedona	4,500	74.7	45.7	17.15	8.80
Seligman	5,242	71.9	36.5	10.28	14.30

Source: Arizona Department of Commerce, 1996, 30 year average.

Temperature

Temperatures in Arizona vary greatly from season to season and from one area of the State to another. These large variations in temperature result mainly from differences in elevation. In summer, average temperatures change with elevation uniformly throughout the state from the mid 90s at altitudes below 500 feet, to the high 50s at altitudes above 8,000 feet. Latitude is also a factor in temperature differences, especially in winter when stations in the northeastern part of the state are often ten degrees cooler than those at a similar elevation in the southeastern part of the state. The most pleasant months in Arizona are in fall and spring. Clear skies, little precipitation, and large daily temperature changes characterize these months. These large daily changes in temperature are caused by intense surface heating during the day and radiational cooling at night. In late winter and spring it is not unusual for a diurnal temperature range of 30ºF to 40ºF and sometimes exceeding 50ºF.

In the Verde River Study area, most communities are located at elevations between 3,000 and 5,200 feet in a climate that is generally quite pleasant during the summer months. This is especially true for those communities located above 5,000 feet in elevation. Daytime temperatures during the summer normally range from the upper 80s to low 90s with occasional periods of low 100s occurring during periods of clear skies and low humidity. Mean daily minimum and maximum temperatures in winter generally range from the low 20s to mid 30s and the low 50s to low 60s respectively.

Evapotranspiration

Moisture leaves the surface of the earth and bodies of water through the processes of evaporation and transpiration. Direct evaporation from the Verde Watershed study area ranges from 85 to 110 inches annually from a Class A pan (Laboratory of Climatology, 1975). Ordinarily only the upper 30 cm (1 foot) of soil is dried by evaporation in a single dry season. Plants draw the soil water into their systems through vast networks of tiny roots. This soil water, after being carried upward through the trunk and branches into the leaves, is discharged through leaf pores into the atmosphere in the form of water vapor. This process is known as transpiration. The combined loss by both processes is known as evapotranspiration. Factors such as time of year, temperature, length of day, amount of sunlight received, humidity, and wind velocity are all contributing factors to the evaporation process. The amount and extent of vegetation cover and vegetation type, such as deciduous or coniferous trees and phreatophytic or xerophytic plants, are factors that contribute to the amount of transpiration.

In the Verde Valley Study area, the average annual potential evapotranspiration rate for the frost-free period varies from 15 inches along the Mogollon Rim in the northeastern part of the study area to 25 inches in the Verde Valley. The estimated annual evapotranspiration for the Verde Valley from the USGS gaging station on the Verde River near Paulden to below the USGS gaging station on the East Verde River near Childs is approximately 35,000 acre-feet (Anderson, 1976).

2.3 DEMOGRAPHIC CHARACTERISTICS

Population - Historic and Future Projections

Numerous towns exist within the Verde Watershed Study Area with the majority of population residing in Yavapai County. Two of the three primary population centers, the City of Prescott and Verde Valley, are located in Yavapai County. The Town of Payson, located in Gila County, is the third largest population center and is actually located in both the Verde and Salt River Watersheds. It should be noted that the southwestern portion of the City of Flagstaff also borders the Verde Watershed, but is not addressed in this report because of the fact that the majority of municipal wells serving the City of Flagstaff are located in the Little Colorado River watershed. With more than 90 percent of the population of the study area residing in Yavapai County, the primary focus of the demographics will be on this county.

In recent years the Town of Payson, City of Prescott, and several other towns within the Verde Valley have experienced rapid increases in their populations. The population of the Verde River basin doubled between 1980 and 1994. During that same time period, the Towns of Camp Verde, Payson, and Clarkdale and the Cities of Prescott and Cottonwood experienced population increases of 89, 88, 63, 47, and 38 percent respectively (Arizona Department of Economic Security [ADES], 1991). This trend in rapid growth is projected to continue with some forecasts estimating a 128 percent increase in population between 1994 and 2040 for the Verde Valley.

Yavapai County as a whole has also experienced tremendous growth in recent years. Between 1980 and 1990, Yavapai County's population increased 58 percent from 68,145 to 107,714. By July 1997, Yavapai County's population had increased from 107,714 to 142,075; a 32 percent increase (Arizona Department of Commerce [DOC], 1997). In 1997, Yavapai County was one of three counties in the State that experienced an increase in population greater than 24.6 percent (ADES, 1997). The populations of the major communities within the Verde River Watershed study area since 1970 and the most recent estimates published in July 1997 are listed in Table 2-2.

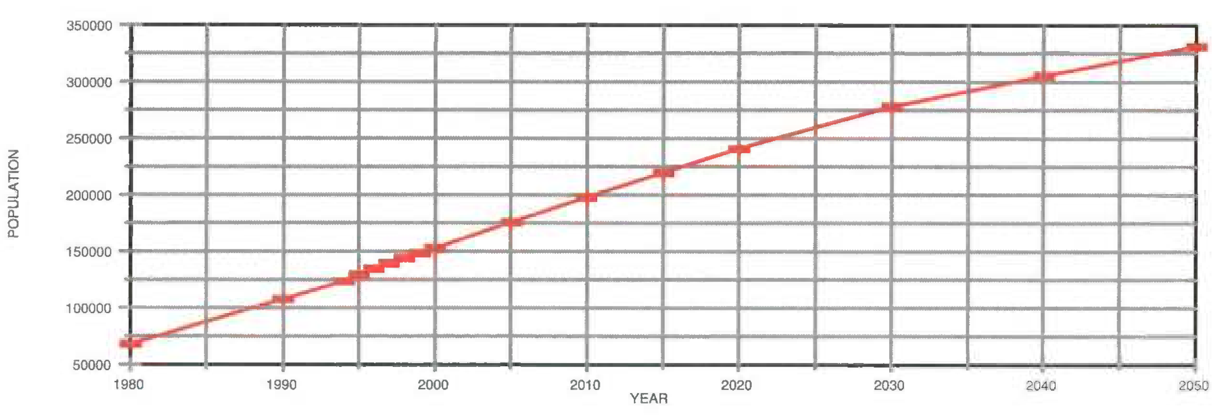
TABLE 2-2
POPULATION TRENDS WITHIN THE VERDE WATERSHED STUDY AREA

CITY/TOWN/COUNTY	1970	1980	1990	1994	1997
Total in Yavapai County	NA	68,145	107,714	123,500	142,075
Camp Verde	NA	3,824	6,243	7,210	7,805
Chino Valley	NA	2,858	4,837	5,645	6,970
Clarkdale	892	1,512	2,144	2,460	2,815
Cottonwood	2,715	4,550	5,918	6,300	7,300
Verde Village	NA	1,040	7,000	8,205*	8,500 **
Prescott	13,030	19,865	26,952	29.155	33,695
Sedona	2,022	5,319	7,720	8,480	9,760
Payson (Gila County)	1,790	5,068	8,377	9,505	12,125

Source: ADES, 1997.
*Northern Arizona Council of Government estimates.
**Local estimate.
NA = not available.

Census data indicates a steady growth for major populated centers within the watershed. The population in Yavapai County is estimated to exceed 325,000 people by the year 2050 (ADES, 1997). Figure 2.2 presents the projected trend in population growth for Yavapai County through the year 2050.

Figure 2.2 - YAVAPAI COUNTY POPULATION PROJECTIONS 1980 - 2050



Employment by Sector

Labor force and employment statistics are presented in Table 2-3. Table 2-3 displays the actual trend of increasing labor force numbers and increasing employment by sector for the past 17 years. Yavapai County's 1997 civilian labor force was estimated to be 63,300. From this number, approximately 43,600 people were employed by all industries excluding agriculture. The Verde Valley's labor force is also expected to increase as a direct result of Yavapai County's continuously increasing population. By the year 2000, the civilian labor force in Yavapai County is estimated to triple the labor force of 1980. Recent trends indicate that labor force numbers in the agriculture industry have been declining as farming activity gives way to expanding commercial developments.

Agricultural

Farming played a significant role in the early development of the Verde Watershed, especially in development of the Verde and Chino Valleys. Today, however, agriculture employs less than one percent of the labor force in Yavapai County. Agriculture, forestry, and fishing related occupations combined employed 1.1 percent of the total labor force in Yavapai County between 1996 and 1997 (ADES, 1996 and 1997). The latest average monthly employment number in the agriculture industry is estimated to be 647 people.

Non-agricultural

Like agriculture, copper mining played a significant role in the early years in Yavapai County and Verde Valley and was at some point in time one of the largest employers. Today, however, mining employs less than 2 percent of the labor force. Presently, the primary industries are tourism, recreation, manufacturing, and government (ADES, 1996). Government industry is currently the largest employer in the study area, employing approximately 7,400 people in 1995. The Ruger Corporation, a manufacturing company located in the City of Prescott, is the second largest employer in Yavapai County, employing approximately 1,400 at the Prescott facility (Burkhart, 1998).

TABLE 2-3

YAVAPAI COUNTY LABOR FORCE AND EMPLOYMENT (ANNUAL AVERAGES)

YAVAPAI COUNTY	1980	1990	1994	1997
Total Civilian Labor Force	29,400	45,250	57,925	63,256
Total Unemployment	1,850	2,075	3,125	2,530
Percent Unemployment	6.30%	4.60%	5.40%	4.00%
Total Employment	27,550	43,175	54,800	60,726
Non-Agricultural Employment by Sector				
Manufacturing	1,850	2,325	2,800	3,600
Mining & Quarrying	1,025	925	800	700
Construction	1,250	2,325	3,500	4,000
Transportation, Communication, and Public Utilities	825	1.075	1,200	1,100
Trade	4,250	7,625	10,400	112,100
Finance, Insurance, & Real Estate	700	1,050	1,500	1,600
Services & Miscellaneous	3,175	6,625	10,000	11,900
Government	4,075	5,875	7,000	8,000
Agricultural Employment (Average Monthly Estimate)	NA	NA	NA	647

Source: ADES, 1997.

Land Ownership

Yavapai County originally encompassed more than 65,000 square miles and is one of the original four counties that were created when Arizona was still a territory. Today Yavapai County covers 8,125 square miles. Percent ownership of Yavapai County is presented in the following Table 2-4 and Figure 2.3. Figure 2.4 is a map showing land ownership throughout the study area.

TABLE 2-4

YAVAPAI COUNTY LAND OWNERSHIP

ENTITY	PERCENT LAND OWNED
U. S. Forest Service (Portions of Prescott, Tonto, Kaibab and Coconino National Forests)	38 %
State of Arizona	24.60%
Privately Owned	25.00%
Bureau of Land Management	11.60%
Yavapai Indian Reservation	<0.5%
Public Lands	<0.5%

Source: Arizona Department of Commerce 1997.

Figure 2.3

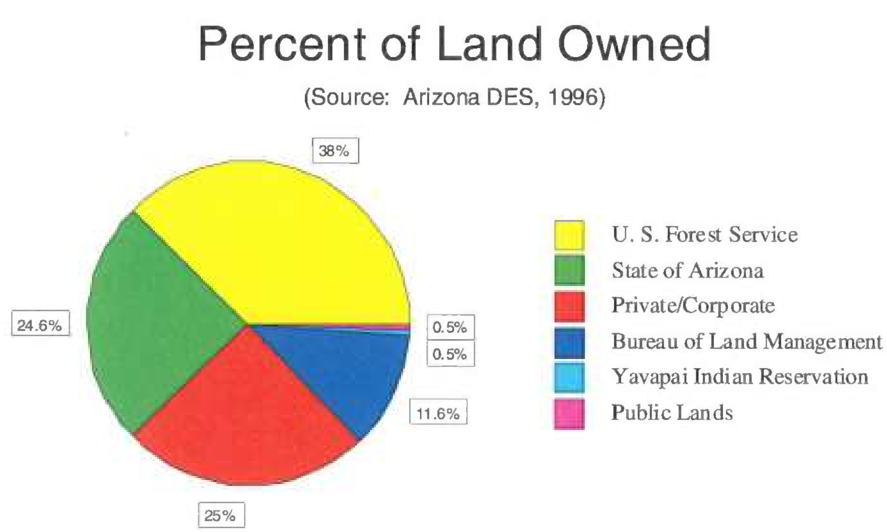
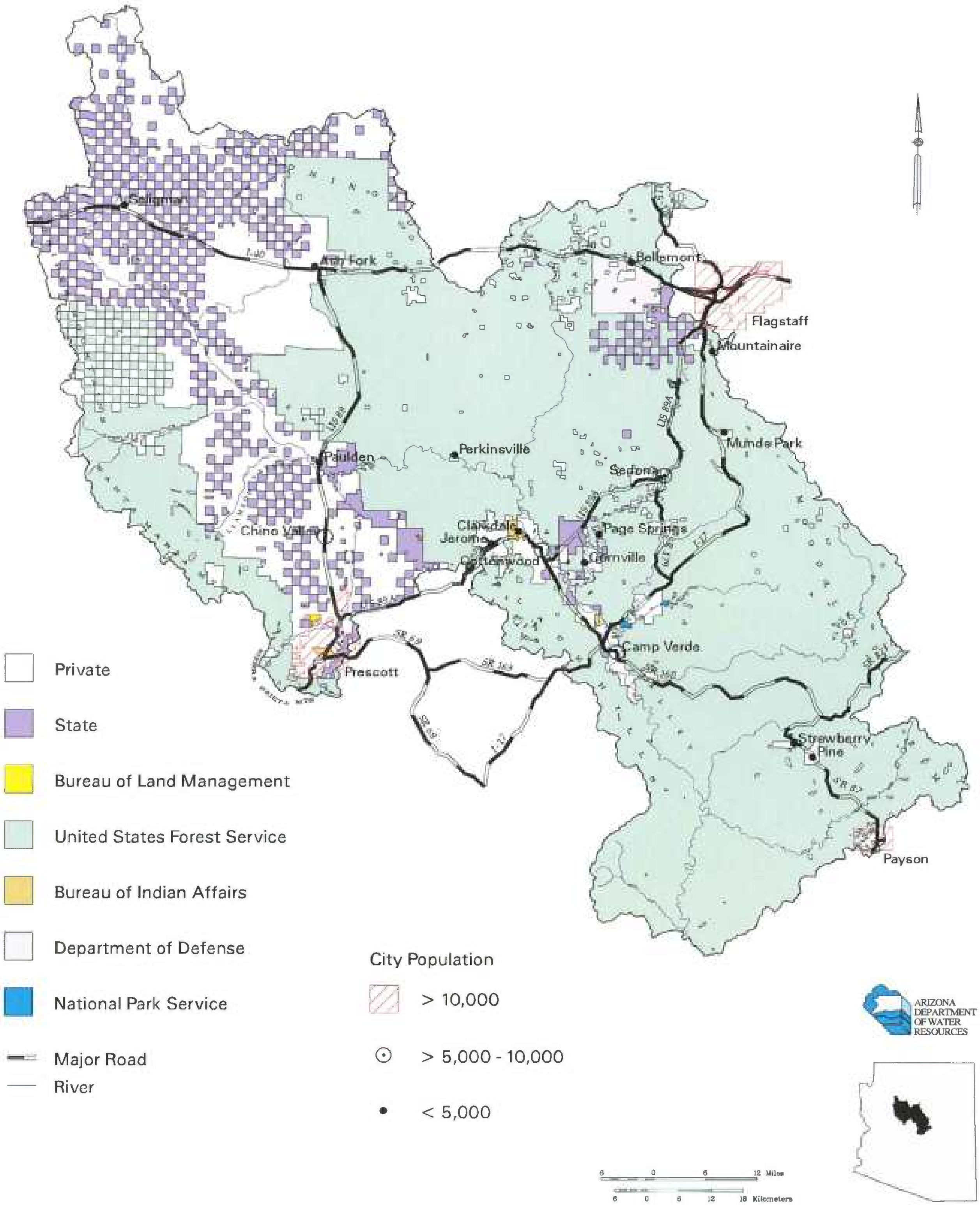


Figure 2.4 - Land Ownership in the Verde River Watershed Study Area



Source: Arizona State Land Department.

2.4 SOILS

The soil map contained in this report shows general soil associations in the Verde study area (Figure 2.5). The soil classifications from the map represent landscapes with distinctive proportional patterns of soils. The associations usually consist of one or more major soils and at least one minor soil, and are named after the major soils. Different soil associations may include a similar soil type but not in the same pattern. Most of the soil associations in the watershed are used mainly for rangelands, irrigated farming, urban development, wildlife, and mining. Where the soils are cultivated, crops such as alfalfa, small grains, and corn are grown on a yearly basis. Soil features restricting farm and irrigation development are poor topsoil characteristics, moderately low available water capacity, and slow permeability. In several areas of the watershed, forage production, wildlife habitat, and mining are limited due to the limited rainfall, high evaporation, and rapid water runoff.

Generally, most soils in the Verde watershed occur on gently sloping, undulating mesas, plains, and floodplains. They also occur on moderately steep and gentle side slopes of mountains and hills, and on alluvial fans. Many of the soils found on mountains and hills in the watershed are well-drained, stony, cobbly, and gravelly loams and were formed on steep slopes from erosional deposits. The soils found in river floodplains and valley fans, terraces, and plains are also well drained. They consist mostly of coarse to fine textured soils with slopes that are nearly level to steep. Many of the soils along the Verde River are primarily alluvial in nature.

The Big Chino, Little Chino, Walnut Creek, Williamson Valley, and Prescott areas contain several different kinds of soils. Soil associations, where a majority of agricultural and urban development has occurred, include the *Springerville-Cabezon, Cabezon-Thunderbird-Venezia, Pastura-Poley-Patri, Pastura-Abra-Lynx, and Lonti-Balon-Lynx* associations. These soils are normally well drained, coarse textured to fine textured, and nearly level to very steep. They occur on valley fans, terraces, and plains of the Upper Verde subwatershed and were formed from alluvium and residual erosional deposits. Many of the Upper Verde soils were formed from material weathered from granite and basalt source rocks. The Upper Verde soils normally have poor to fair topsoil characteristics, moderately low to high water capacity, and slow to moderate permeability.

Several different kinds of soils are also found in areas near and around Clarkdale, Cottonwood, Cornville, Page Springs, Camp Verde, and Sedona in Verde Valley. These include the *Tortugas-Purner-Jacks, Lithic Torriothents-Lithic Haplustolls-Rock Outcrop, and*

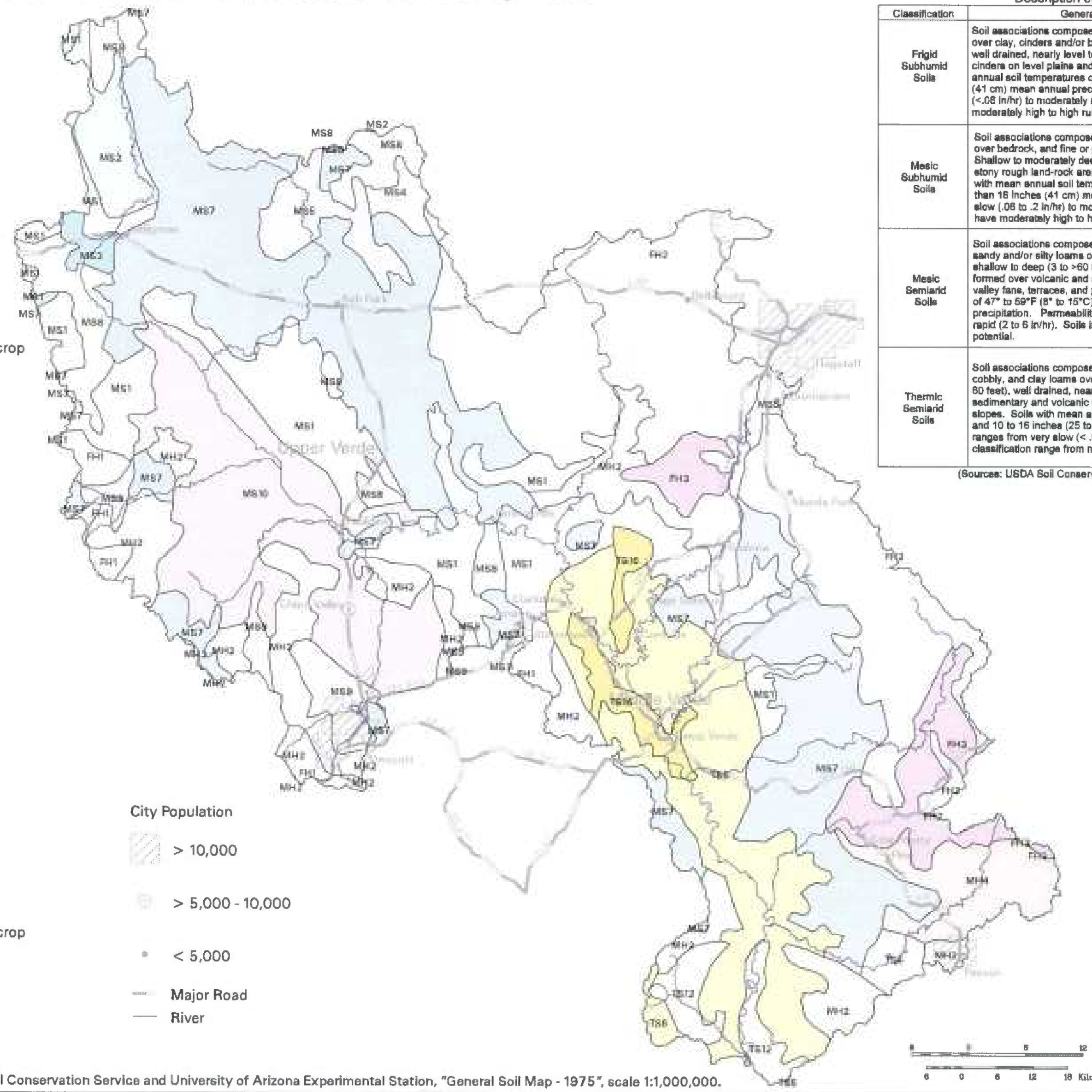
Figure 2.5 - Soil Associations in the Verde River Watershed Study Area

Frigid Subhumid
- FH1 - Mirabal-Dandrea-Brolliar
- FH2 - Sponseller-Ess-Gordo
- FH3 - Soldier-Hogg-McVickers

Mesic Subhumid
- MH2 - Lithic-Haplustolls-Lithic Argiustolls-Rock Outcrop
- MH4 - Roundtop-Tortugas-Jacks

Mesic Semiarid
- MS1 - Tortugas-Purner-Jacks
- MS2 - Winona-Boysag-Rock Outcrop
- MS3 - Palma-Clovis-Trail
- MS4 - Rudd-Bandera-Cabezon
- MS5 - Roundtop-Boysag
- MS7 - Cabezon-Thunderbird-Springerville
- MS8 - Pastura-Poley-Partri
- MS9 - Lonti-Balon-Lynx
- MS10 - Pastura-Abra-Lynx

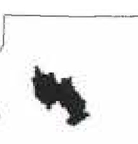
Thermic Semiarid
- TS4 - White House-Bernardino-Hathaway
- TS6 - Lithic Torriothents-Lithic Haplustolls-Rock Outcrop
- TS12 - Continental-Latene-Pinaleno
- TS16 - Penthouse-Latene-Pinaleno



Description of Soil Classifications

Classification	General Soil Features and Interpretations
Frigid Subhumid Soils	Soil associations composed of cobbly, gravelly, stony, sandy, and silt loams over clay, cinders and/or bedrock. Moderately deep to deep (20 to >60 feet), well drained, nearly level to steep soils generally formed over basalt and cinders on level plains and mesas and on steep side slopes. Soils with mean annual soil temperatures of less than 47°F (8°C) and more than 16 inches (41 cm) mean annual precipitation. Permeability ranges from very slow (<.06 in/hr) to moderately rapid (2 to 6 in/hr). Soils in this classification have moderately high to high runoff potential.
Mesic Subhumid Soils	Soil associations composed of very gravelly, gravelly, cobbly loams and clays over bedrock, and fine or gravelly sandy loams over clay and bedrock. Shallow to moderately deep (6 to >40 feet), well drained, soils formed over stony rough land-rock areas on strongly sloping and steep side slopes. Soils with mean annual soil temperatures of 47° to 59°F (8° to 15°C) and more than 16 inches (41 cm) mean annual precipitation. Permeability ranges from slow (.06 to .2 in/hr) to moderate (.6 to 2.0 in/hr). Soils in this classification have moderately high to high runoff potential.
Mesic Semiarid Soils	Soil associations composed of loam and very cobbly, cobbly, gravelly, fine sandy and/or silty loams over clay, cinders, hardpan, and/or bedrock. Very shallow to deep (3 to >60 feet), well drained, very steep to nearly level soils formed over volcanic and sedimentary rocks on mountains and hills and on valley fans, terraces, and plains. Soils with mean annual soil temperatures of 47° to 59°F (8° to 15°C) and 10 to 16 inches (25 to 41 cm) mean annual precipitation. Permeability ranges from slow (.06 to .2 in/hr) to moderately rapid (2 to 6 in/hr). Soils in this classification range from low to high runoff potential.
Thermic Semiarid Soils	Soil associations composed of loam and gravelly, gravelly sandy, fine sandy, cobbly, and clay loams over clay and/or bedrock. Shallow to deep (4 to > 60 feet), well drained, nearly level to gently sloping soils formed over sedimentary and volcanic rocks; on flood plains, low terraces and valley side slopes. Soils with mean annual soil temperatures of 59° to 72°F (15° to 22°C) and 10 to 16 inches (25 to 41 cm) mean annual precipitation. Permeability ranges from very slow (< .06 in/hr) to moderate (.6 to 2.0 in/hr). Soils in this classification range from moderately low to high runoff potential.

(Sources: USDA Soil Conservation Service, 1974; 1975; 1976; 1983; NRCS, 1995.)



ARIZONA DEPARTMENT OF WATER RESOURCES

Source: Modified from United States Department of Agriculture, Soil Conservation Service and University of Arizona Experimental Station, "General Soil Map - 1975", scale 1:1,000,000.

Penthouse-Latene-Cornville soil associations, which are well drained, coarse to fine textured, and nearly level to very steep. They also formed from alluvium and erosional material. The associations generally have slow permeability and low to moderate water capacity. The floodplains of the Verde River and major tributaries in the watershed contain riverwash and terrace deposits consisting of poorly sorted, fine to coarse gravel and small boulders. Terrace deposits occur along the wide channel of the Verde River as well as the small channels along tributary creeks. They consist primarily of a mixture of silt, sand, gravel, and unconsolidated but finely stratified clays. The channel deposits are permeable and may form good water table aquifers.

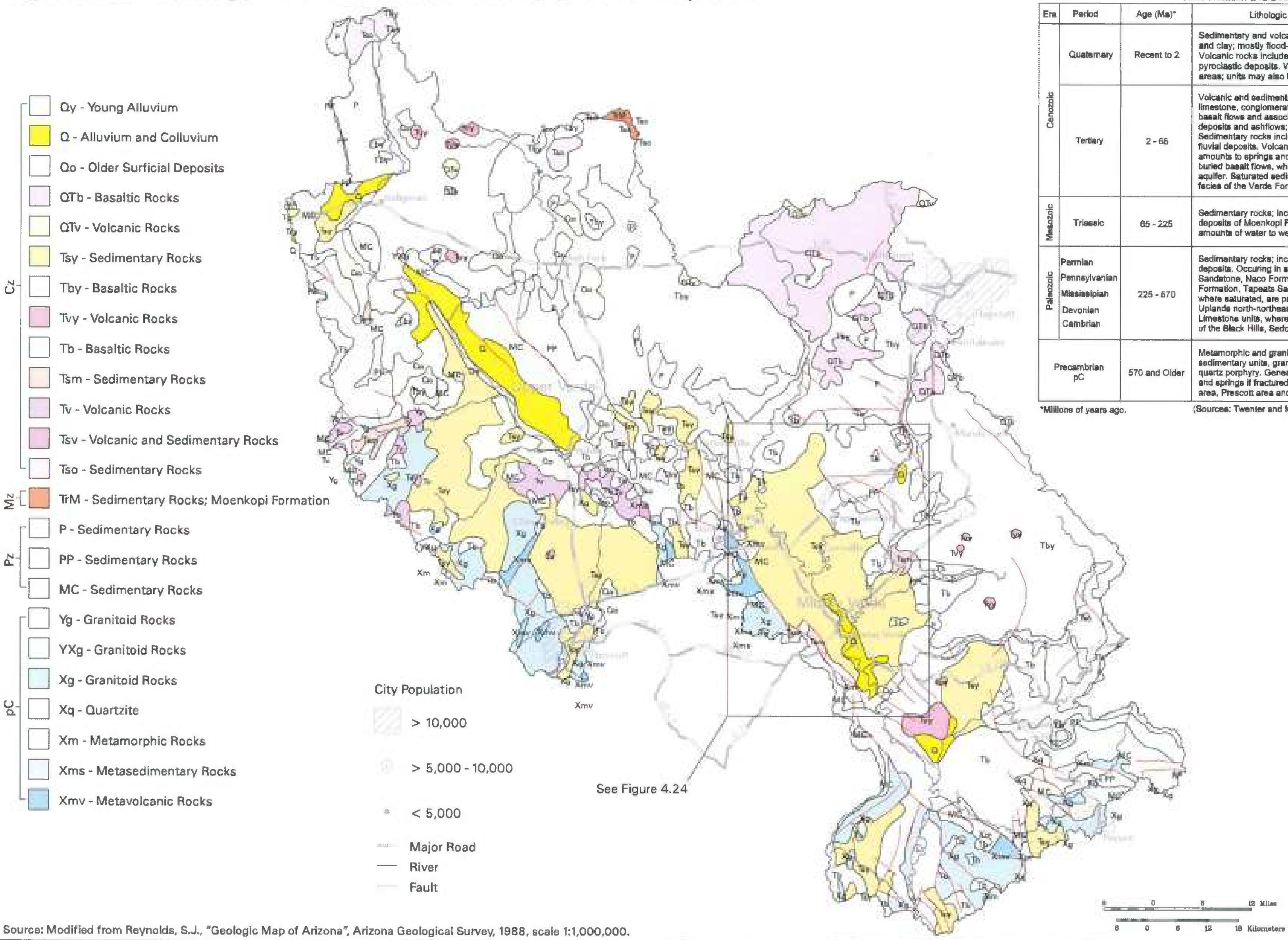
In the areas around Payson, Strawberry, and Pine, many of the soils found along creek bottoms and drainages are poorly sorted, medium to fine textured gravel, sand, silt, and clays. Soils that formed in the smaller valleys and plains in this part of the watershed such as the *Soldier-Hock-McVickers, Roundtop-Tortugas-Jacks, and Lithic Haplustolls-Lithic Argiustolls-Rock Outcro,* are predominantly material weathered from granite, sedimentary, and volcanic source rocks. These soils usually have poor topsoil characteristics, a shallow depth to bedrock, moderately slow permeability, low available water capacity, and are subject to runoff along washes and creeks.

2.5 GEOLOGY

The geology map contained in this report shows general geological formations in the Verde study area (Figure 2.6). The State of Arizona is divided into three physiographic regions or provinces: the basin and range deserts of southern and western Arizona, the mountainous Central Highlands, and the Colorado Plateau occupying the northern portion of Arizona. The Verde watershed occurs mainly in the Central Highlands region. This distinct region has also been called the Transition Zone between the northern and southern halves of the State. It is characterized by a chain of narrow valleys separated by steep mountain ranges dividing the Central Highlands from the Colorado Plateau to the north. The Verde and Chino Valleys are part of that chain forming the transition zone.

The geology of the Verde watershed is complex, varying widely in age, lithology, and structure. Igneous, metamorphic, and sedimentary rocks are all represented in the study area and range in age from Precambrian to Quaternary. Rock units within the Verde watershed are

Figure 2.6 - Geology in the Verde River Watershed Study Area



Time Relation and Description of Map Units

Era	Period	Age (Ma)*	Lithologic Description and Water-bearing Characteristics
Cenozoic	Quaternary	Recent to 2	Sedimentary and volcanic rocks; includes unconsolidated gravel, sand, silt and clay; mostly flood-plain and terrace deposits near streams and washes. Volcanic rocks include recent basalt flows and related ashflow tuff and pyroclastic deposits. Where saturated units will yield groundwater in localized areas; units may also be influenced by the stage of nearby streams.
	Tertiary	2 - 65	Volcanic and sedimentary rocks; includes basalt flows, claystone, sandstone, limestone, conglomerate and mudstone deposits. Volcanic rocks mainly olivine basalt flows and associated andesite flows, dacite porphyry, dikes, pyroclastic deposits and ashflows; includes Perkinsville and Hickey Formations. Sedimentary rocks include consolidated and semi-consolidated lacustrine and fluvial deposits. Volcanics generally above water table yielding small amounts to springs and wells in areas of Middle Verde. In Upper Verde buried basalt flows, where saturated, are a principal unit of the regional aquifer. Saturated sedimentary rocks such as the limestone and sandstone facies of the Verde Formation yield water to wells in Verde Valley.
Mesozoic	Triassic	65 - 225	Sedimentary rocks; includes limestone, sandstone, siltstone, mudstone deposits of Moenkopi Formation. Generally above water table yielding small amounts of water to wells in the northern portion of study area.
Paleozoic	Permian Pennsylvanian Mississipian Devonian Cambrian	225 - 570	Sedimentary rocks; includes limestone, sandstone, siltstone and mudstone deposits. Occuring in study area are the Toroweap Formation, Coconino Sandstone, Naco Formation, Supai Formation, Redwall Limestone, Martin Formation, Tapeats Sandstone, undifferentiated. Sandstone and siltstone, where saturated, are principal units of regional aquifer in the Plateau Uplands north-northeast of the Mogollon Rim and in the Sedona area as well. Limestone units, where saturated, yield water to wells in northern part of the Black Hills, Sedona area and Ash Fork vicinity.
	Precambrian pC	570 and Older	Metamorphic and granitic rocks; includes metamorphosed volcanic and sedimentary units, granite, quartzite, schist, igneous intrusive diorite and quartz porphyry. Generally units may yield small amounts of water to wells and springs if fractured, jointed or weathered in south-central portions of study area, Prescott area and Payson vicinity.

*Millions of years ago.

(Sources: Twenter and Metzger, 1963; Levings, 1980; Owen-Joyce and Bell, 1983.)

ARIZONA DEPARTMENT OF WATER RESOURCES

Source: Modified from Reynolds, S.J., "Geologic Map of Arizona", Arizona Geological Survey, 1988, scale 1:1,000,000.

grouped by age into four broad categories: Precambrian rocks, Paleozoic rocks, Tertiary and Quaternary volcanic rocks, and Tertiary and Quaternary basin fill alluvium.

Precambrian age rocks occur widely in several areas within the study area. These rocks consist primarily of metamorphic rocks and large intrusive igneous bodies, which are exposed in the mountain ranges. They form the basement complex, which extends to great depth and underlies the majority of the southern portion of the watershed. These rocks are predominant in the Bradshaw Mountains, Black Hills, Santa Maria Mountains, and Sierra Prieta Mountains near Prescott and along the southern margin of the Mogollon Rim. They also underlie the sedimentary and metamorphic rocks and alluvial units in the center of the basins of the Verde Watershed. The majority of local copper mining has taken place in the Precambrian metamorphic and intrusive igneous rocks of the Black Hills just north of Mingus Mountain.

Precambrian age rocks are nearly impermeable except where fractured or faulted. Generally, these units do not contain large quantities of water, but locally may yield small amounts to seeps and springs. These rocks usually act as a barrier to groundwater flow and where exposed on the surface are not conducive to infiltration but instead cause runoff.

Rocks of Paleozoic age generally lie just above the Precambrian rocks. These rock units are best exposed along the Mogollon Rim, which extends along most of the northern portions of the watershed. Approximately 1,900 feet of Paleozoic sandstone, limestone, and shale are exposed along the steep Mogollon Rim escarpment. The Supai Formation, Coconino Sandstone, Toroweap Formation, and Kaibab Limestone overlay Redwall Limestone, which is perhaps the oldest Paleozoic rock unit exposed in this part of the study area. Several of these units contain groundwater and form a regional aquifer. The Martin Formation, Tapeats Sandstone, and Precambrian granitic rocks underlie the Redwall Limestone. These older rock groups come into contact with thick accumulations of Tertiary and Quaternary sedimentary and volcanic rocks in the central portions of the watershed.

Tertiary and Quaternary age volcanic rocks are the upper most units and are commonly exposed on land surface. They consist primarily of basalt and are predominant in the northern portions of the watershed in the Coconino Plateau and cap the Mogollon Rim. Tertiary rocks include the Hickey Formation and Perkinsville Formation. Volcanic rocks occur widely in the central and southern portions of the watershed. Exposures occur on Mingus Mountain, Verde Canyon, and in small buttes near Perkinsville and Sycamore Creek where lava flows cap the Paleozoic sedimentary sequences (USGS, 1984).

Tertiary and Quaternary age basin fill alluvium overlies much of the Precambrian to Tertiary age consolidated bedrock in the north central portions of the watershed. Extensive deposits of basin fill alluvium occur in the Big Chino and Verde Valleys. Much of the younger Quaternary stream alluvium consists of unconsolidated sand, gravel, and silt deposited within present stream channels as floodplain alluvium and channel fill. Sand and gravel mines located within the watershed generally occur in these younger stream alluvium deposits. The Verde River and its perennial and intermittent tributary streams deposited the Quaternary alluvium. Areas containing older surficial deposits occurring in the western and central portions of the watershed are just north of Prescott in the vicinity of Williamson, Little Chino, and Verde Valleys (USGS, 1984).

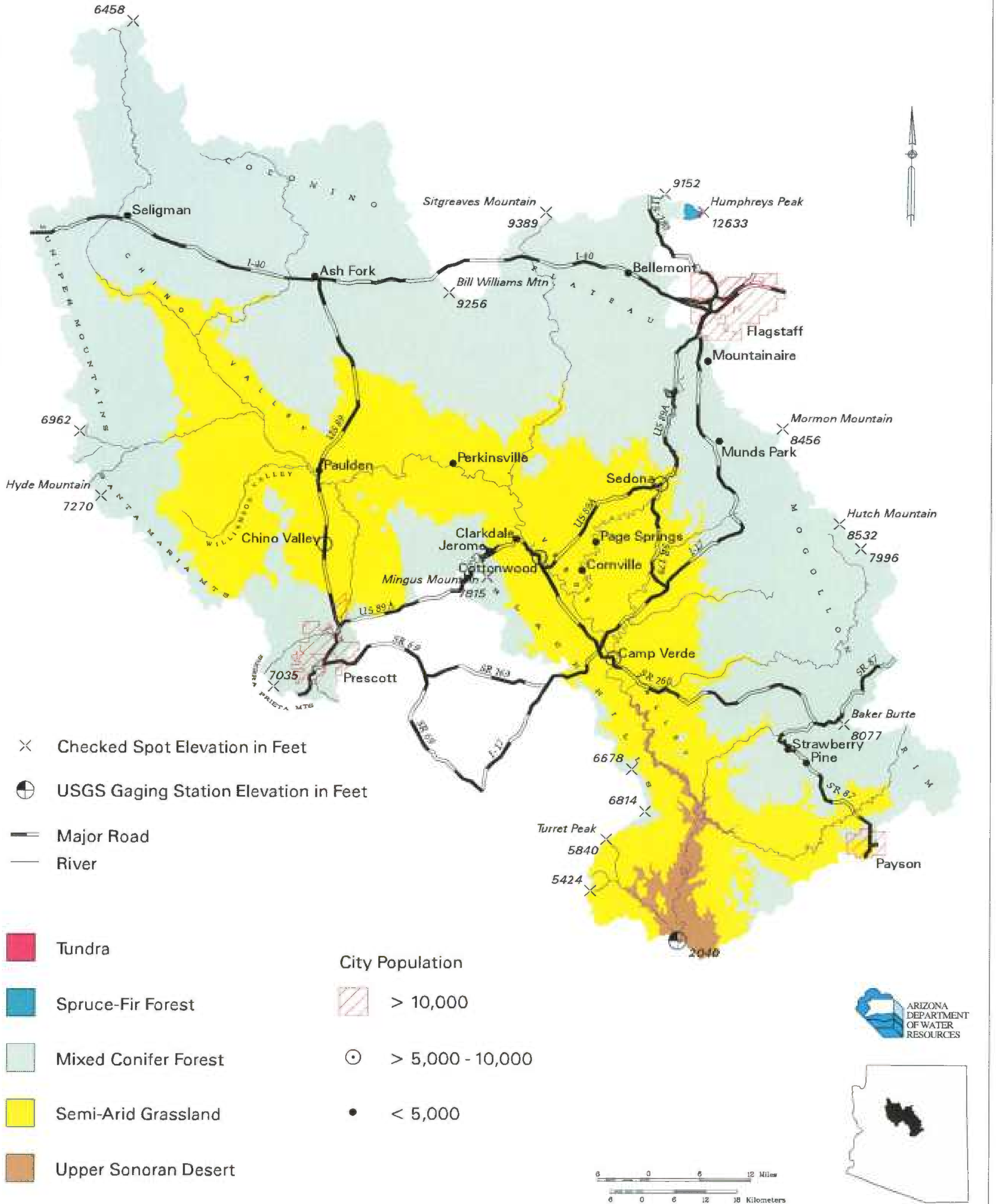
Around the Camp Verde area, channel deposits are coarse grained and range from approximately 60 feet to 100 feet thick. Terrace and floodplain deposits in the Camp Verde area consist of unconsolidated gravel, sand, silt, and clay. In some areas the terrace deposits contain reworked Verde Formation (Owen-Joyce, 1984). The Verde Formation in the center of the Verde Valley is composed of chalky lake limestone and siltstone deposits. An example of this chalky lake limestone deposit can be observed at Montezuma's Well. The Verde Formation is believed to have been deposited between three and six million years ago in freshwater lakes created when volcanic flows dammed streams in the ancestral Verde Valley. Units of Tertiary lava also occur in this formation. The water bearing Verde Formation covers as much as 325 square miles and supplies most of the groundwater to growing communities in the Verde Valley (Owen-Joyce and Bell, 1983).

More information about the geology of the Verde River Watershed can be obtained from studies by Twenter and Metzger (1963), Krieger (1965), Levings (1980), Owen-Joyce and Bell (1983), and Owen-Joyce (1984). Information can also be obtained from the Internet by contacting http://www.verde.org or by contacting the Department of Interior, U. S. Geological Survey Field Office, Public Assistance 1-520-556-7000.

2.6 VEGETATION

The vegetation map contained in this report shows primary biotic community locations within in the Verde study area (Figure 2.7). The natural vegetation coverage that occurs in the Verde River Watershed Study Area is determined by many factors, such as elevation,

Figure 2.7 - Primary Biotic Communities of the Verde River Watershed Study Area



Source: Spot elevations digitized from USGS quads; vegetation ranges converted from USGS DEM data.

temperature, and precipitation. Other factors that may influence the occurrence of certain biotic communities in the study area may be physiographic features, such as soils and topography. A mountain slope at an elevation of 5,000 feet, for instance, may support a different biotic community than a canyon, valley, or mesa at the same elevation. A northfacing slope on a mountain supports a different community of plants than a southfacing slope at the same elevation and same mountain. The direction of the slope of the mountain may also be a factor. If a mountain slope faces seasonally prevailing, moisture laden winds (in the Verde River watershed usually west or southwest-facing slopes) precipitation may be much higher on the windward side of the mountain than on the leeward side. All these conditions are contributing factors and the various ranges of biotic communities often overlap.

Upper Sonoran Desert vegetation occurs primarily from the lowest elevation (2,029 feet) of the study area at the USGS gaging station on the Verde River below the confluence with Tangle Creek, to an elevation of about 3,500 feet. This type includes many species of cacti, including Prickly Pear, Cholla, and Saguaro and various trees such as Palo Verde and Mesquite. The natural vegetation in the Verde Valley, which lies roughly between 3,000 feet to 3,500 feet, is primarily semi-arid grassland. This type of biotic community supports grasses such as grama species, cacti, plants such as Jojoba, and trees such as Palo Verde and Mesquite. Big Chino, Little Chino, and Williamson Valleys range in elevation from about 4,500 feet to about 5,500 feet. These elevations support primarily plains, grasslands, grama-dominated short grasses, which are occasionally interspersed with chaparral, and stands of Pinon and Juniper woodlands at the higher parts of these valleys.

The various mountain ranges and plateaus that surround these valleys support chaparral and Pinon and Juniper woodlands at the lower elevations. Ponderosa Pine is dominant within a mixed conifer forest, with Douglas Fir dominating canyons and north-facing slopes from approximately 5,000 feet to about 9,500 feet. Starting at elevations of 8,500 feet to 9,000 feet to a maximum elevation of about 11,500 feet on the west-facing slope of Humphreys Peak, stands of spruce, firs, and other needle-leaf trees occur. These stands are occasionally intermingled with some broad-leafed winter deciduous species. Above the timberline, at about 11,500 feet to the summit of Humphreys Peak (elevation 12,633 feet), alpine tundra may exist. Precipitation here is about 35 to 40 inches annually and may exceed 50 inches in any given year. Only a few areas of the peak are actually covered with alpine tundra vegetation due largely to the steepness of slopes, looseness of soil, and the presence of rocky outcrops.

The upper elevations of the watershed contain extensive forests of pines, firs, and other deciduous species. Located within these forests are springs, washes, and creeks that contribute to the Verde River watershed. Riparian deciduous forests, consisting primarily of sycamore and cottonwood, exist throughout the watershed at medium and lower elevations along reaches of perennial and intermittent washes, creeks, and rivers. They are usually of limited areal extent and often just occur along the stream banks.

CHAPTER 3

Water Uses and Demands of the Upper and Middle Verde River Watersheds

CHAPTER 3: WATER USES AND DEMANDS OF THE UPPER AND MIDDLE VERDE RIVER WATERSHEDS

3.1 INTRODUCTION

This chapter addresses each the following categories of water demand that is occurring in the Upper and Middle Verde Watershed areas. The primary categories are: municipal/domestic, irrigation, industrial, livestock, and natural uses. The total water use and demand for each category is presented along with a detailed description of the water use and demand for each specific area (i.e., Big Chino, Little Chino, Verde Valley, etc.) and how each component was determined. Non-municipally supplied industrial and commercial uses are discussed separately. Historical trends in water use are also presented when applicable.

3.2 MUNICIPAL USES

Private and Municipal Water Providers

The population of Yavapai County is projected to exceed 305,000 people by the year 2040 (ADWR, Statewide Water Planning, 1997). In order to meet the water demand from this growth, long-term planning and cooperation between the current and future water providers will have to occur. For purposes of this report, water provider implies any organization that supplies potable water for residential, commercial, or industrial use. Water providers for solely irrigation use are addressed in the irrigation section of this report.

The water use data for calendar years 1990 through 1997 was collected from Arizona Corporation Commission (ACC) annual filings and from two surveys conducted by Arizona Department of Water Resources (ADWR) in 1995 and 1998. A total of 79 private and municipal water providers were initially identified within the study area, which includes the Williamson Valley, Big and Little Chino Valleys, Verde Valley, and the Payson area. Twenty-three surveys were sent to water providers in the Williamson Valley and Big and Little Chino Valleys, 49 were sent to water providers in the Verde Valley, and seven surveys were sent to water providers in the Payson area. Of the 79 water providers initially identified, 20 had either moved without leaving a forwarding address, gone out of business, or were actually located outside the study area. Figures 3.1 and 3.2 demonstrate the change in demand for municipally supplied water from 1990-1997 for the Upper and Middle Verde areas respectively.

Of the remaining 59 private and municipal water providers in the study area, 42 (70%) completed and returned their survey questionnaire. These water providers range in size from small private homeowner associations with only a few connections to large water providers such as the City of Prescott and the Arizona Water Company, which currently own and operates three different systems located within the study area. See Exhibit 1 in Appendix A for a copy of the 1998 survey.

A short profile including service area maps, total water use, gallons per capita per day (GPCD) usage, water use by use category (residential, commercial, industrial, other), and seasonal uses for water providers that delivered in excess of 20 acre-feet annually, was developed and are presented for years 1990 through 1997 in Appendix A. Profiles, service area maps, and tables were also developed for two water providers in the Payson and Strawberry areas that delivered less than 20 acre-feet per year. These two water providers were included because of the history of water resource problems in the Payson, Pine, and Strawberry areas. Tables 3-1 and 3-2 present the water providers in both the Upper and Middle Verde areas that deliver more than 20 acre-feet annually.

TABLE 3-1

UPPER VERDE WATER PROVIDERS
DELIVERING MORE THAN 20 ACRE-FEET PER YEAR

UPPER VERDE WATER PROVIDERS	LOCATION
Abra Water Company	Paulden, AZ
Ashfork Water Service	Ashfork, AZ
Chino Meadows II	Chino Valley, AZ
Granite Oaks Water	Prescott, AZ
City of Prescott	Prescott, AZ

Figure 3.1 Upper Verde 1992-1997
Municipally Supplied Water Demand

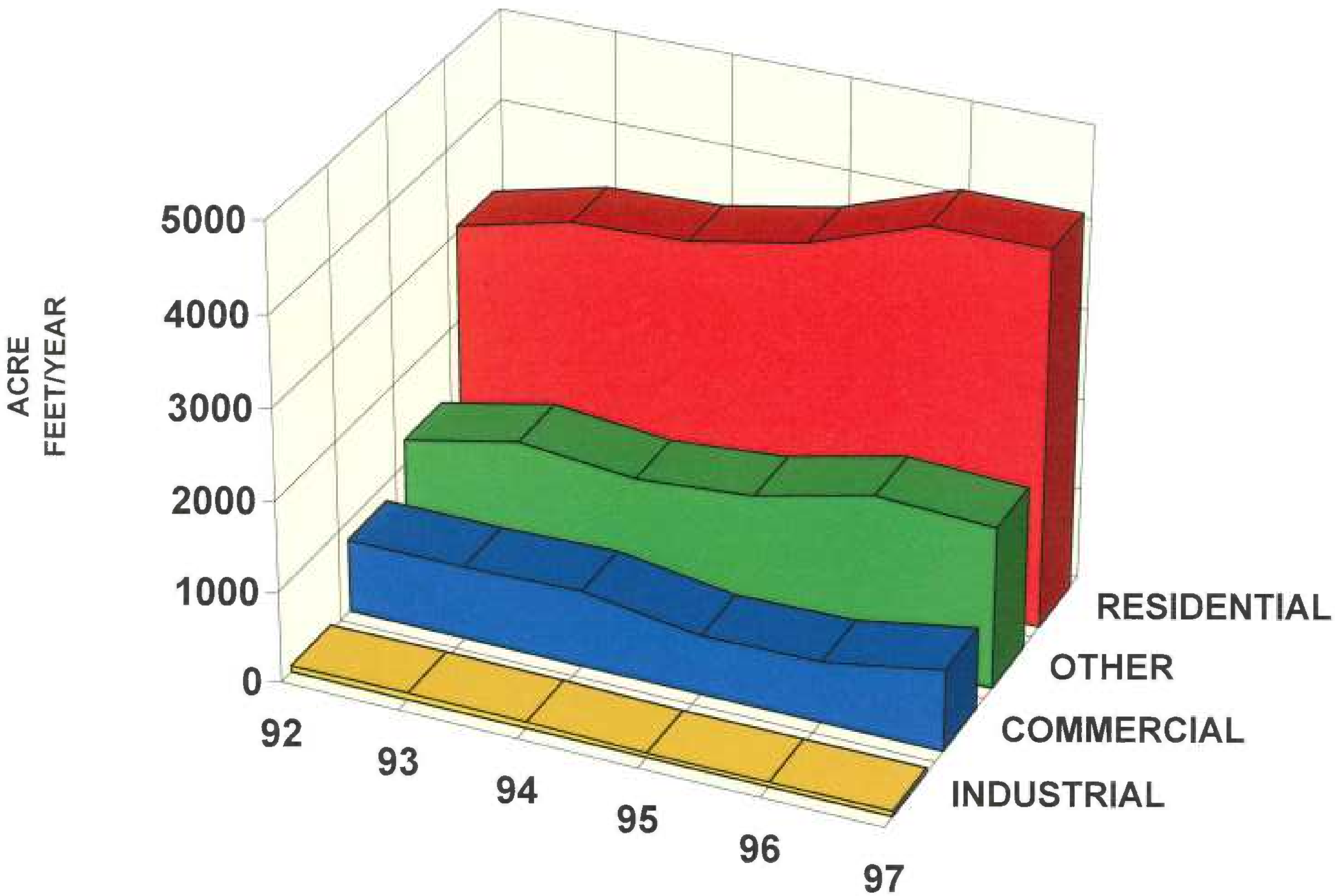


Figure 3.2 Middle Verde Municipal Water Use 1990-1997 In Acre-Feet/ Year

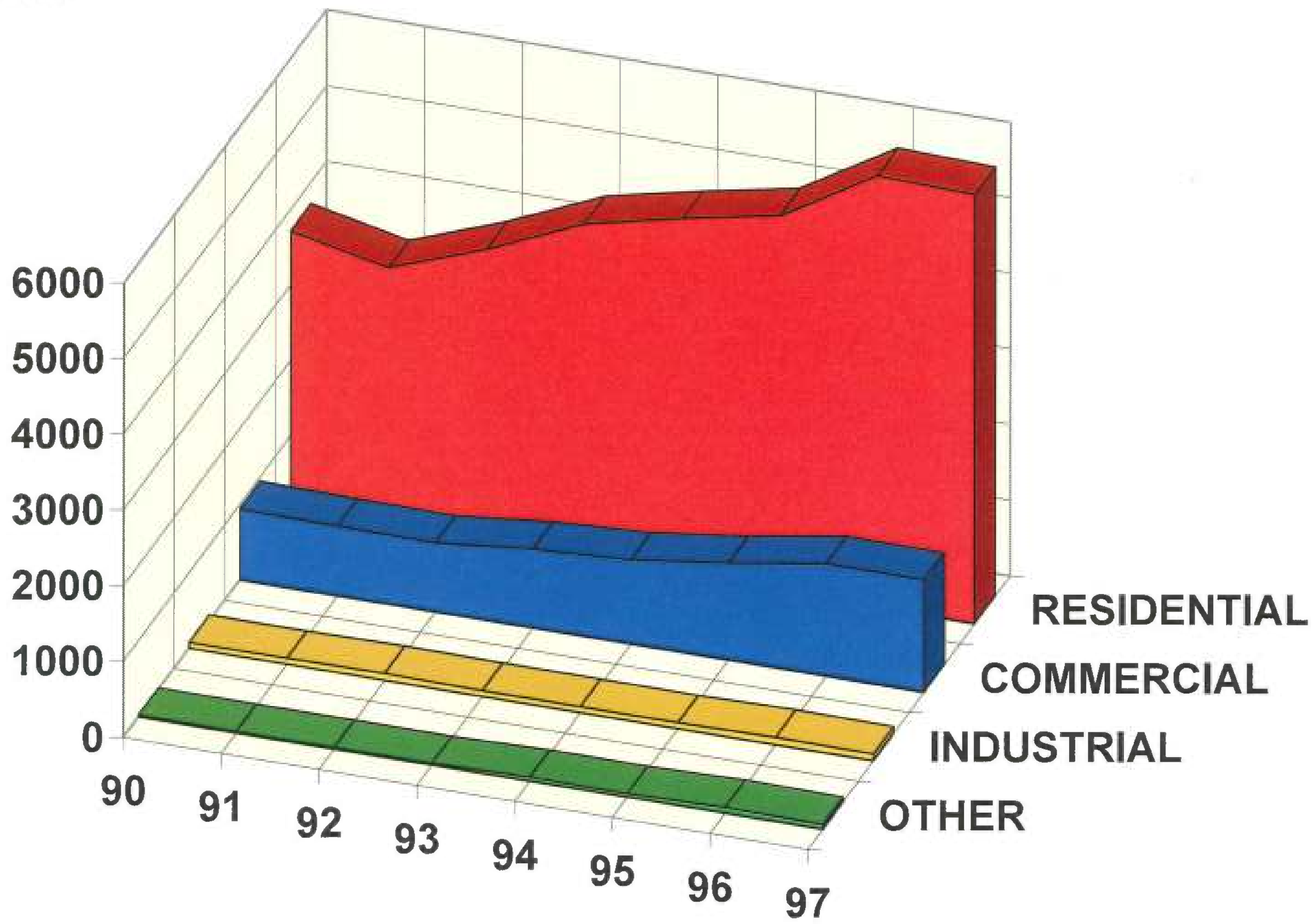


TABLE 3-2

**MIDDLE VERDE WATER PROVIDERS
DELIVERING MORE THAN 20 ACRE-FEET PER YEAR**

MIDDLE VERDE WATER PROVIDERS	LOCATION
Arizona Water Company – Pinewood	Pinewood/Munds Park, AZ
Arizona Water Company – Rimrock	Rimrock, AZ
Arizona Water Company – Sedona	Sedona, AZ
Big Park Water Company	Sedona, AZ
Boynton Canyon Ench. HOA	Sedona, AZ
Camp Verde Water System	Camp Verde, AZ
Clemenceau Water Company	Cottonwood, AZ
Cordes Lakes Water Company	Cottonwood/Verde Village, AZ
Cottonwood Water Works	Cottonwood, AZ
Oak Creek Valley Property Owners Association	Cornville, AZ
Oak Creek Water Company #1	Sedona, AZ
Payson, Town of	Payson, AZ
Pine Valley Water Company	Sedona, AZ
Sedona Shadows	Sedona, AZ
Verde Lakes Water Company	Camp Verde, AZ

Tables 3-3 and 3-4 present the Upper and Middle Verde water providers that delivered less than 20 acre-feet annually:

TABLE 3-3

**UPPER VERDE WATER PROVIDERS
DELIVERING LESS THAN 20 ACRE-FEET PER YEAR**

UPPER VERDE WATER PROVIDER	LOCATION
Antelope Lakes Water Company	Chino Valley, AZ
Granite Dells Water Company	Prescott, AZ
Granite Mountain Water Company	Chino Valley, AZ
Inscription Canyon Ranch	Prescott, AZ
Jackson Acres DWI District	Prescott, AZ

TABLE 3-4

MIDDLE VERDE WATER PROVIDERS DELIVERING LESS THAN 20 ACRE-FEET PER YEAR

MIDDLE VERDE WATER PROVIDER	LOCATION
Bonita Creek Land and HOA	Payson, AZ
Lake Verde Water Company	Camp Verde, AZ
Little Park Water Company	Sedona, AZ
Montezuma Heights Water and Airport	Camp Verde, AZ
Red Rock Water Co-op	Sedona, AZ
Verde Heights Water Co-op	Cottonwood, AZ

The combined total annual water demand for private and municipal water providers in the Upper and Middle Verde in 1997 was approximately 14,210 acre-feet. This total includes 8 of the 11 total water providers that delivered less than 20 acre-feet per year, and does not include the Town of Payson, which delivered 1,414 acre-feet in 1997. Payson was not included in this total because the town is situated between the Salt and the Verde watersheds and it was not possible to separate out the water totals for each watershed. Approximately 69 percent of the water was delivered to residential customers, 17 percent was delivered to commercial customers, and 14 percent was divided equally among industrial and other customers within the Middle Verde. Between 1990 and 1997, the total water demand for all water providers in the study increased by 44 percent. There was a 34 percent increase for water providers in the Upper Verde and a 54 percent increase for water providers in the Middle Verde. See Figures 3.1 and 3.2 for municipally supplied water demand between 1990 and 1997 for the Upper and Middle Verde respectively. In 1997, the annual water demands for water providers ranged from less than one acre-foot for the Antelope Lakes Water Company to a high of 6,510 acre-feet for the City of Prescott. See Tables 2a and 2b in Appendix A for more information regarding total water use by water providers

The average use per person was calculated for each water provider for the purpose of comparison and as an indication of how providers compare with cities within active management areas (AMAs). The GPCD values were developed by dividing the total water use for each provider (including residential, commercial, municipal, and industrial) by the local area population served. This value was then divided by the number of days in one-year (365) to determine the GPCD. Water provided for irrigation use only was not included in the GPCD calculations.

GPCD = (Total Water Delivered / local area population served) / 365 days.

Many areas within the watershed are served by more than one provider. The population served within each service area was determined by multiplying the number of residential hookups provided by each water provider by the average number of people per household for the community as determined and presented in the Arizona Department of Economic Security's (ADES) 1990 census report. For those water provider areas where an average number of people per household was not available for the specific community, the average number of people per household for Yavapai County (2.35) was used to estimate the population of the service area. The population was not determined for some water providers in cases where there is a large seasonal population and the actual number of hookups was not available.

GPCDs for the study area ranged from a low 56 for the Chino Meadows II Water Company to a high 645 for the Clemenceau Water Company. The extremely high GPCD of the Clemenceau Water Company is due to the low population and very high commercial and industrial water demand in their service area. Approximately 65 percent of the water delivered by the Clemenceau Water Company is for commercial and industrial users.

The average GPCD for the entire study area in 1997 was 166, which was based on the total water delivered by the 16 water providers that same year. The average was determined by dividing the total water delivered by the total population within the water providers' service areas. This number was then dividing by 365 (days in the year). All water providers that delivered less than 20 acre-feet per year were not included in this determination.

Average GPCD for Study Area in 1997 (166) = (Total Water Delivered in 1997 [4.51 billion gallons] / Total Population of Study Area [74,223]) / 365 (days)

The average residential GPCD for the Upper Verde and Middle Verde water providers that delivered in excess of 20 acre-feet of water in 1997 is 97 and 133 respectively. Residential GPCDs are based on residential water consumption only and do not include commercial and industrial water use. The residential GPCDs are also used to calculate the annual volume of water pumped by the active domestic wells in both the Upper Verde and Middle Verde regions and are presented in Chapter IV-Water Resources. Tables 3-5 and 3-6 present the total water delivered in acre-feet by the Upper Verde and Middle Verde water providers that pumped 20 acre-feet or more annually:

TABLE 3-5

UPPER VERDE WATER PROVIDERS
TOTAL WATER DELIVERED FOR YEARS 1990-1997
(ACRE-FEET)

WATER PROVIDER	1990	1991	1992	1993	1994	1995	1996	1997
Abra Water Company	NA	NA	NA	NA	NA	NA	52	56
Ashfork Water Service	79	78	71	72	NA	85	80	81
Chino Meadows II	38	43	47	59	74	86	102	112
Granite Dells	2	2	3	2	2	2	3	4
Granite Mountain	2	2	2	2	3	7	8	9
Granite Oaks	6	13	23	34	52	51	104	111
Inscription Ranch	0	0	0	0	0	0	0	6
Jackson Acres	0	0	0	6	6	6	5	5
City of Prescott	5,014	5,240	5,075	5,633	5,637	5,685	6,352	6,509
Totals (acre-feet)	**5,141**	**5,378**	**5,221**	**5,809**	**5,774**	**5,922**	**6,706**	**6,893**

Source: ADWR water provider surveys.

TABLE 3-6

MIDDLE VERDE WATER PROVIDERS
TOTAL WATER DELIVERED FOR YEARS 1990-1997
(ACRE-FEET)

WATER PROVIDER	1990	1991	1992	1993	1994	1995	1996	1997
Arizona Water Company-Sedona	1,514	1,608	1,539	1,763	1,914	2,070	2,379	2,442
Az Water Company-Rimrock	131	159	157	183	195	205	230	233
Az Water Company-Pinewood	175	189	192	220	223	223	250	243
Big Park Water Company	441	499	470	499	550	574	616	642
Boynton Canyon	25	24	28	40	NA	49	48	49
Camp Verde Water System	206	225	225	255	262	288	304	321
Clemenceau Water Company	159	161	171	185	NA	184	214	208
Cordes Lakes Water Company	555	NA	623	724	758	841	908	872
Cottonwood Water Works	1,198	1,201	1,118	1,268	1,388	1,438	1,667	1,685
Lake Verde Water Company	8	8	9	10	11	11	12	12
Little Park Water Company	10	12	11	NA	NA	14	17	17
Montezuma Heights	NA	NA	NA	NA	NA	12	16	18
Oak Creek Valley	NA	22	21	25	27	34	35	36
Oak Creek Water Company	163	170	172	186	211	225	262	245
Pine Valley Water Company	19	22	23	25	28	NA	34	32
Sedona Shadows	65	62	67	82	81	NA	88	NA
Verde Heights	NA	NA	NA	NA	NA	5	6	6
Verde Lakes Water Company	82	92	95	110	124	199	284	250
Totals (acre-feet)	**4,751**	**4,454**	**4,921**	**5,575**	**5,960**	**6,372**	**7,370**	**7,311**

Source: ADWR water provider surveys, not including Payson water providers.

Seasonal uses for each water provider were based on survey responses. Each water provider was asked to indicate the percentage of total water delivered during three periods of the year: January through April, May through August, and September through December. The percentage of total water delivered during these three time periods is as follows:

- January through April 25%
- May through August 46%
- September through December 29%

The survey also determined that at least 11 water providers do not meter the flow of water to their users.

The majority of water providers rely exclusively on the use of groundwater to meet their demands. The percentage of water providers that utilize groundwater versus surface water or a combination of surface water and groundwater and the corresponding volume of water associated with each percentage are as follows:

Source of Water and Percentage of Use		Volume of Water (Acre-feet)
Groundwater	84%	11,587
Surface Water	5%	724
Both	11%	1,448
Total	100%	13,759

These percentages and volume totals are from the year 1997 and are based on the information provided by the water providers within the study area. Water deliveries in Payson are not included in these totals. Water pumped from a well is considered to be groundwater in this report.

As mentioned previously, the Town of Jerome, Rocky Springs, and Bonita Creek are the only providers that receive their supply of water exclusively from surface water or springs.

Effluent Recharge

The results of a 1995 ADWR survey revealed that 70 percent of municipal users had septic systems, 8 percent were connected to a wastewater treatment plant (WWTP), and 22 percent utilized both. Although numerous wastewater treatment facilities were identified in the study area, the majority of these are small, individually maintained facilities that treat only several hundred gallons per day (GPD). Seven primary WWTPs exist in the Upper Verde and Middle Verde study area that treat up to several hundred thousand gallons per day.

In the Upper Verde region, the City of Prescott operates two wastewater treatment plants; the Sun Dog facility near Prescott and a facility at the Prescott Airport. Approximately 3,100 acre-feet of effluent is treated and discharged annually by the City of Prescott. An estimated 1,000 acre-feet of the total effluent is generated by the Sun Dog facility alone and is used for turf irrigation at Antelope Hills Golf Course. The City of Prescott is estimated to recharge about 1,800 acre-feet of treated effluent at its own facility (ADWR, Prescott AMA, 1996).

The Chino Valley Irrigation District (CVID) received approximately 100 to 310 acre-feet of treated effluent annually from the City of Prescott between the years 1993 and 1997. The average volume of treated effluent received by CVID during this same time period was estimated to be 170 acre-feet per year. Approximately 50 percent of the effluent that is discharged into the CVID transmission system is lost to seepage and evaporation.

In the Middle Verde region, the WWTP in Clarkdale currently lists about 650 hookups. Clarkdale WWTP estimates 168 acre-feet of treated effluent is applied annually to leaching fields for recharge. The Pinewood Sanitary District in Munds Park maintained 2,600 residential hookups in 1996. During the winter about 9 acre-feet of effluent is treated per month and that number increases in the summer to almost one acre-foot per day on weekends. This is primarily due to a large seasonal population. Virtually all of the treated effluent is utilized by an 18 hole golf course (Pinewood Golf Course). Any effluent not used by the golf course is released into Munds Canyon, which flows into Oak Creek.

The WWTP in Camp Verde listed 477 residential customers in 1996 and treated nearly 150 acre-feet that year. The City of Sedona's WWTP treated approximately 670 acre-feet from an estimated 1,300 residential hookups on its system in 1996. The Sedona WWTP's treated effluent is primarily used for recharge in either a wetlands or marsh area along with nine infiltration basins. These recharge sites cover a total of 265 acres.

The City of Cottonwood's WWTP listed 1,173 hookups in 1996 and treated approximately 540 acre-feet of effluent that year. The wastewater treatment plant in Jerome estimated 200 residential hookups with about 56 acre-feet being treated in 1996. The majority of effluent from the WWTPs is used for irrigation purposes on golf courses and for recharge. No estimate of the total amount of recharge that is occurring from treated effluent has been determined.

Another source of recharge from effluent is due to private septic systems. As previously stated, approximately 70 percent of residential water users utilize septic systems. The exact number of septic systems within the study area is unknown. For this report, an estimate of total recharge from septic was determined by multiplying the estimated number of septic systems by the average number of people per household. This number was then multiplied by the estimated daily indoor water use per person. The product of these two numbers was then multiplied by the number of days in a year. To convert this number to acre-feet, the product was divided by the number of gallons in one acre-foot of water. This method of determination assumes that all residences served by a private domestic well are on a septic system, all indoor water use is discharged to the septic system, and 100 percent of water is recharged to the aquifer. In reality, the actual percentage of the discharge from the septic system that is being recharged to the aquifer is unknown. In locations where the depth to the aquifer is rather shallow the percentage may be as high as 100 percent. In other locations the percentage may be zero because the depth to water and decline in water table prevents the septic discharge from ever reaching the aquifer.

Estimated Annual Recharge from Septic System (acre-feet):
(Total number of septic systems)(Average number of people per household)(Estimated daily indoor use per person [gallons])(365 [days in year]) / 325,851.

The total number of septic systems is based on two assumptions: 1) all households that receive water from a municipal/private provider and are not connected to a municipal wastewater treatment plant are assumed to be utilizing a septic system; and 2) all households that receive water from a private well are assumed to be on a private septic system. Based on these assumptions, the total number of septic systems is equal to the following:

The total number of septic systems = (total number of residential water hookups - total number of WWTP hookups) + total number of domestic wells.

Average number of people per household = 2.35 for Yavapai County and 2.99 for Coconino County (DES, 1990).

Estimated daily indoor water use per person = 69 gallons per capita per day (Arizona Municipal Water Users Association (AMWUA), 1999).

Number of days in one year = 365 days.

Number of gallons in one acre-foot = 325,851 gallons.

For the Upper Verde, the estimate of recharge resulting from private septic systems was calculated for Big Chino and Little Chino Valleys separately as follows. The estimated recharge from septic in the Big Chino Valley is as follows:

Big Chino Estimate of Annual Recharge due to Septic Systems in 1996:
([896-0] + 992)(2.35)(69)(365) / 325,851 **= 343 acre-feet of recharge.**

0	=	The number of WWTP hookups in the Big Chino.
896	=	Total residential water provider hookups in the Big Chino Valley.
992	=	The estimated number of private domestic wells in the Big Chino Valley.
2.35	=	Average number of people per household in Yavapai County (ADES, 1990).
69	=	Estimated average indoor water use per capita (AMWUA, 1999).
365	=	Number of days per year.
325,851	=	Number of gallons per acre-foot of water.

Little Chino Estimate of Annual Recharge due to Septic Systems in 1996:
([15,931 – 10,639] + 3,551)(2.35)(69)(365) / 325,851= **1,606 acre-feet of recharge.**

15,931	=	Total number of residential water provider hookups in Little ChinoValley.
10,639	=	Total residential wastewater provider hookups in the Little Chino Valley.
3,551	=	The estimated number of private domestic wells in the Little Chino Valley.
2.35	=	Average number of people per household in Yavapai County (ADES, 1990).
69	=	Estimated average indoor water use per capita (AMWUA, 1999).
365	=	Number of days per year.
325,851	=	Number of gallons per acre-foot of water.

Table 3-7 shows the determination of private septic systems in the Little Chino Valley.

TABLE 3-7

ESTIMATED NUMBER OF PRIVATE SEPTIC SYSTEMS IN THE UPPER VERDE

PRESCOTT	TOTAL
Residential Water Hookups	15,931
Residential Wastewater Hookups	10,639*
Estimated Residential Septic Systems	5,292

Source: ADWR 1995 and 1998 surveys.
*City of Prescott, Water Billing Department.

Total Estimated Recharge due to Septic Systems in 1996 for the Upper Verde:
343 + 1,606 = 1,949 acre-feet.

The estimated annual recharge from septic systems in the Middle Verde is calculated in the same way. One difference is in the number of people per household. A small portion of the Middle Verde is located within Coconino County and as a result the average number of people per household for Coconino County was used for that section only.

Middle Verde (Yavapai County) Estimate of Annual Recharge due to Septic Systems in 1996:
([13,898 – 5,750] + 3,478)(2.35)(69)(365) / 325,851 = **2,112 acre-feet of recharge**.

13,898 = Total residential water provider hookups in Middle Verde.
5,750 = Total residential WWTP hookups in the Middle Verde.
3,478 = Total number of private domestic wells in the Middle Verde.
2.35 = Average number of people per household in Yavapai County ADES, 1990).
69 = Estimated average indoor water use per capita (AMWUA, 1999).
365 = Number of days per year.
325,851 = Number of gallons per acre-foot of water.

Middle Verde (Coconino County) Estimate of Annual Recharge due to Septic Systems in 1996:
([2,643 – 2,600] + 0)(2.99)(69)(365) / 325,851 **= 10 acre-feet of recharge.**

The number of wells in this formula is zero because it was not possible to break down the number of wells by county and it is believed the majority of wells are located in Yavapai County. See Table 3-8 for the determination of private septic systems in the Middle Verde.

TABLE 3-8

ESTIMATED NUMBER OF PRIVATE SEPTIC SYSTEMS IN THE MIDDLE VERDE

RESIDENTIAL WATER HOOKUPS							
Sedona	Camp Verde	Cottonwood	Jerome	Munds Park	Total Hookups	Total Hookups Yavapai County	Total Hookups Coconino County
7,095	778	3,142	240	2,643	13,898	11,255	2,643
RESIDENTIAL WASTEWATER HOOKUPS							
1,300	477	1,173	200	2,600	5,750	3,150	2,600
ESTIMATED RESIDENTIAL SEPTIC SYSTEMS FOR THE MIDDLE VERDE							
5,795	301	1,969	40	43	8,148	8,105	43

Total Estimated Recharge due to Septic Systems in 1996 for the Middle Verde:
2,112 + 10 = 2,122 acre-feet.

Total Estimated Recharge due to Septic Systems in 1996 for the Verde Watershed:
1,949 + 2,122 = 4,071 acre-feet.

Projected Water Use for Yavapai County

The projected population of Yavapai County in the year 2040 is estimated to be more than 305,000 people (ADWR Statewide Water Planning Study, 1997). This projected increase in population will cause a proportionate increase in water usage. Based on the projected population in 2040, the projected annual water use for the Upper and Middle Verde areas are 13,717 and 15,278 acre-feet respectively. These projections are based on 1997 totals among Verde Watershed water suppliers and population projections for the year 2040.

Municipal Summary

In 1998, ADWR conducted a survey of the 59 municipal/private water providers located within the Verde Watershed study area. Forty-two of the water providers, which included the largest water providers, completed and returned their survey. Of the 42 water providers that completed the survey, 20 delivered in excess of 20 acre-feet per year, 11 delivered less than 20 acre-feet per year, and 11 water providers did not meter their deliveries. Five of the 20 largest water providers were located in the Upper Verde area and 15 were located in the Middle Verde area. In 1997, the annual water demands for water providers ranged from a low of less than one acre-foot to a high of 6,510 acre-feet for the Antelope Lakes Water Company and the City of Prescott respectively.

Approximately 9,890 acre-feet of water was delivered in 1990 by all of the municipal/private water providers in the Upper and Middle Verde except the Town of Payson. In 1997, the total water delivered by the same group of municipal/private water providers had increased by 44 percent to an estimated 14,210 acre-feet. The projected water uses in the year 2040 for the Upper and Middle Verde areas are 13,720 and 15,280 acre-feet per year respectively. Figures 3.3 and 3.4 present the 1997 demands for municipally supplied water expressed as a percentage for the Upper and Middle Verde areas, respectively. Figure 3.5 shows the total water use for the Upper and Middle Verde study areas.

Figure 3.3 1997 Upper Verde Municipally Supplied Water Demand

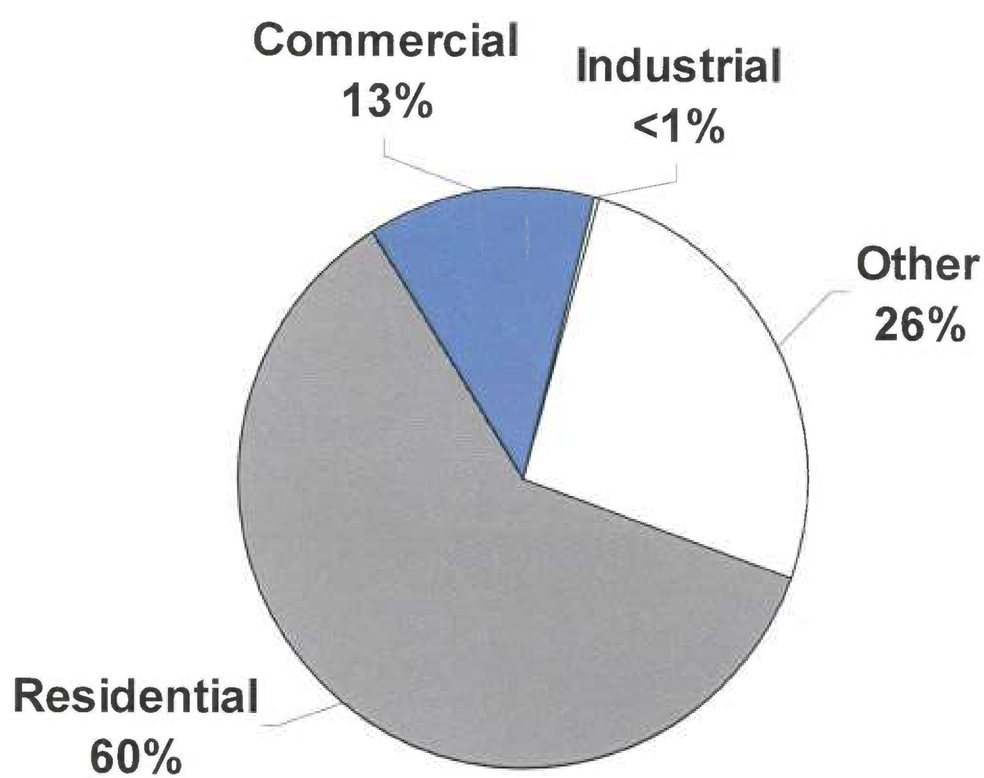


Figure 3.4 1997 Middle Verde Municipally Supplied Water Demand

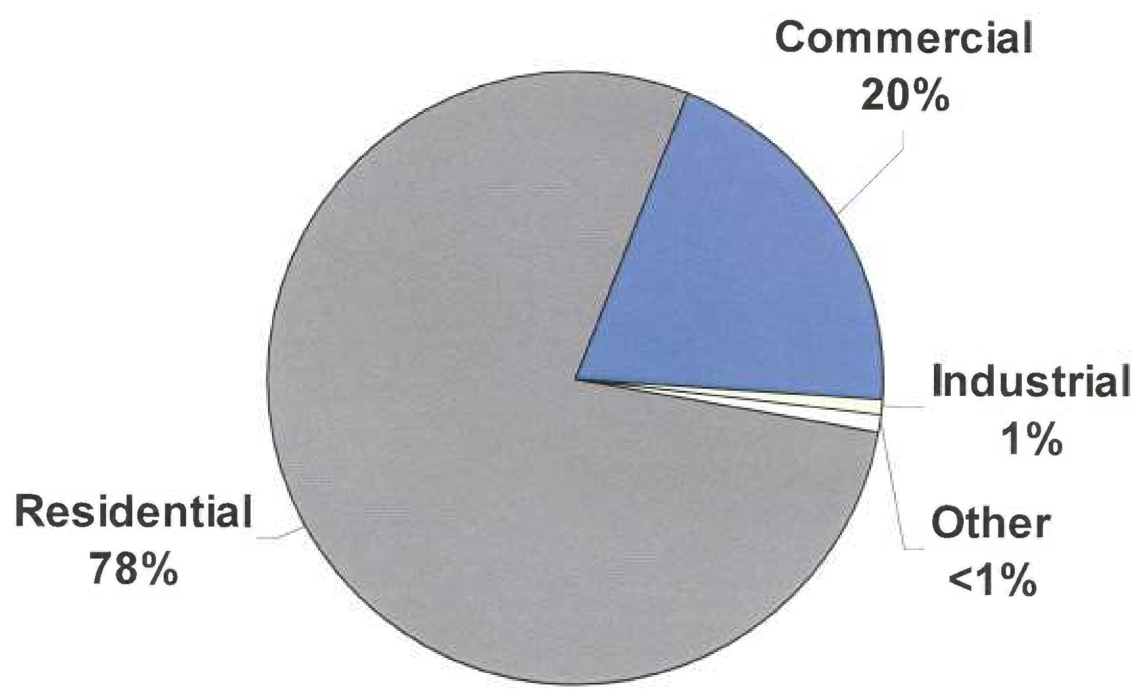
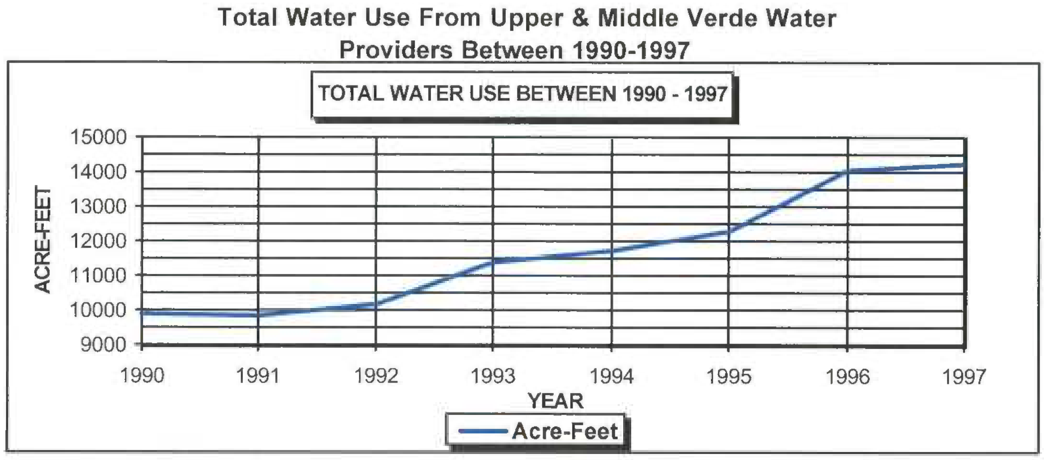
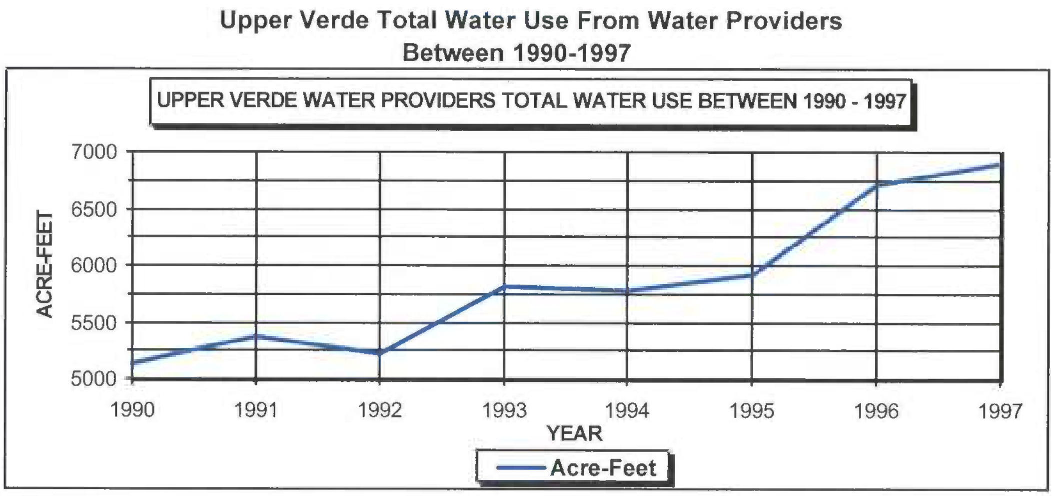
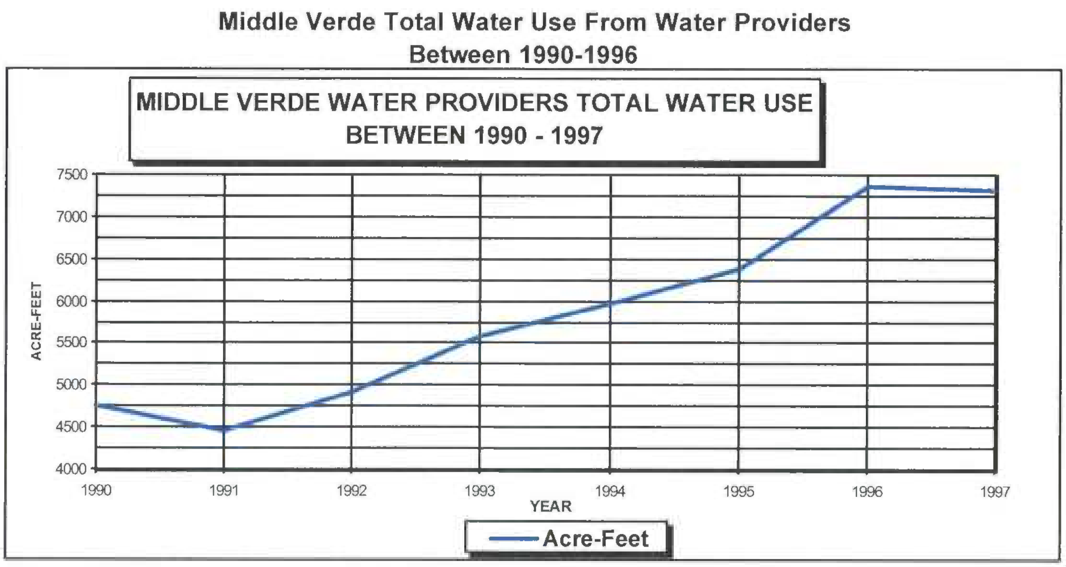


Figure 3.5 Total Water Use Graphs







Approximately 69 percent of the water was delivered to residential customers, 17 percent was delivered to commercial customers, and 14 percent was divided equally among industrial and other customers. Approximately 25 percent of the water was delivered between January and April, 46 percent was delivered between May and August, and the remaining 29 percent was delivered between September and December. The sources of water delivered by the municipal/private water companies were as follows: 84 percent of the total water delivered was exclusively groundwater, 11 percent was a combination of surface and groundwater, and the remaining 5 percent was exclusively surface water.

The GPCD was calculated for each water provider for the purpose of comparison and as an indication of how providers compare with cities within active management areas. The average total GPCD for the combined Upper and Middle Verde area in 1997 was estimated to be 166, which includes residential, industrial, and other water uses. The average GPCD for residential water use only in 1997 for the Upper and Middle Verde areas were about 97 and 133, respectively.

Based on a survey conducted by ADWR in 1995, 70 percent of all municipally supplied water customers in the Upper and Middle Verde area were connected to privately owned septic systems, 8 percent were connected to wastewater treatment plants, and 22 percent were connected to both. The estimated volume of recharge resulting from effluent in 1996 for the Upper and Middle Verde areas was 1,950 and 2,110 acre-feet respectively.

In the Upper Verde area, 1,610 acre-feet of effluent recharge were estimated to occur in the Big Chino, while the remaining 340 acre-feet were estimated to occur in the Little Chino.

3.3 DOMESTIC USES

Based on ADWR's Wells Registry database, an estimated 9,400 wells currently exist in the Upper Verde Subwatershed. Around 4,540 of these wells are actively pumping groundwater for domestic use. The estimated annual water use from the 4,540 domestic wells is roughly 1,160 acre-feet. The annual water use estimate for domestic wells was determined by the following Equation:

(Total Number of domestic wells in the Upper Verde [4,540])(Average number of people per household [2.35])(Average Residential GPCD [97])(Days in a year [365])) / Gallons in

one acre-foot (325,851) = Annual volume of water pumped by the active exempt wells in acre-feet.

Solution: (4,540)(2.35)(97)(365) / 325,851 = 1,160 acre-feet annually.

- 2.35 is the average number of people per household in Yavapai County (ADES, 1990 census for Yavapai County.
- 97 is the average Gallons Per Capita Per Day (GPCD) for residential use between 1990-1997 for the Upper Verde water providers.

The actual volume of groundwater being pumped annually by domestic wells is unknown. Domestic well owners are not required to report annual groundwater usage. In the Middle Verde, there are approximately 9,630 wells currently listed in the ADWR's Wells Registry. Approximately 3,480 of these wells are categorized as domestic and are estimated to pump 1,218 acre-feet of water annually. The annual water use for domestic wells was calculated using the same method and equation used for calculating the domestic wells' usage in the Upper Verde.

(Total Number of Domestic wells in the Middle Verde [3,480])(Average number of people per household [2.35])(Average GPCD [133])(Days in a year [365]) / Gallons in one acre-foot (325,851) = Annual volume of water pumped by the domestic wells in acre-feet.

Solution: (3,480)(2.35)(133)(365) / 325,851 = 1,218 acre-feet annually.

- 2.35 is the average number of people per household in Yavapai County (ADES, 1990 census for Yavapai County.)
- 133 are the average Gallons Per Capita Per Day (GPCD) for residential use only between 1990-1997 for the Middle Verde water providers.

3.4 IRRIGATION USES

Introduction

During the latter part of the 1800s and early part of the 1900s, the development of agriculture played a significant role in the overall development of the Williamson Valley, Big and Little Chino (Upper Verde), and Verde Valley (Middle Verde) areas. The agricultural farming base that developed throughout this time continued to prosper until sometime in the early 1960s when it began to decline. In the Verde Valley numerous ditches were taken out of service or were never reconstructed after periodic floods destroyed them. The majority of the larger ditches, however, did continue to operate and many are still in existence today.

This section focuses on the irrigation practices associated with farming throughout the study area and presents an estimate of the total water that is currently being utilized by these practices. Figures 3.6 and 3.7 demonstrate the percentage of water used for agriculture in comparison to residential, commercial, industrial, and "other" demands for the Upper and Middle Verde areas respectively. An estimate of the water demand for the maximum potential land that could be farmed based on historically irrigated lands is also presented.

It is important to note that pasture is the predominant crop grown in the Upper and Middle Verde areas and is typically deficit irrigated. Due to the lack of information, however, regarding actual irrigation deliveries for each individual farm it was not possible to determine the levels of deficit irrigation being practiced and therefor was not taken into consideration for this study when calculating crop irrigation requirements.

Lands in the Upper Verde region (Big Chino Wash, Walnut Creek, Williamson Valley Wash, and Granite Creek/Little Chino Wash Subwatersheds) predominantly utilize groundwater as the source of irrigation water. Irrigated lands in the Middle Verde (Verde River Valley, Oak Creek, Wet Beaver Creek, and West Clear Creek Subwatersheds) in contrast, rely almost exclusively on surface water for irrigation. For the Middle Verde the majority of the farming occurs in the younger alluvium. The water table is fairly shallow in the younger alluvium and there is a direct hydraulic connection between the groundwater and surface water flows of the Verde River and its major tributaries.

The estimate of current and maximum potential acreage that is or has been farmed is based on field investigations and aerial photography reviews that were performed by ADWR from 1991 through 1997. All lands that displayed evidence that farming had occurred (i.e., irrigation laterals or pipes were present, fields were leveled, furrows were present, etc.) were designated as potential farmland and were included in the maximum potential acreage total. Aerial photography from the United States Department of Agriculture's Soil Conservation Service (1940), Arizona Department of Transportation (1960), National High Altitude Photography (1980), and ADWR (1987; 1995) were used to identify historical farming acreage. The use of aerial photography also aided in the identification of surface water diversions and conveyance systems. A complete listing of investigated surface water diversions within the

Figure 3.6 1997 Upper Verde Water Use by Sector

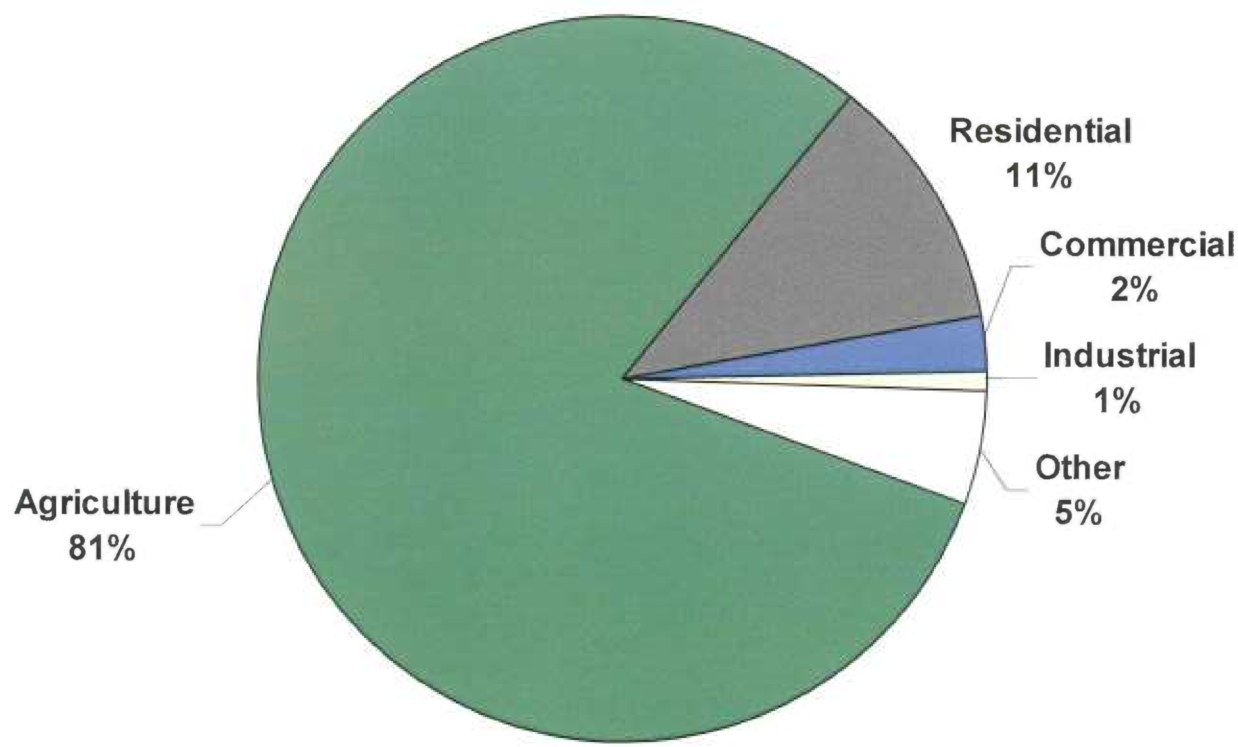
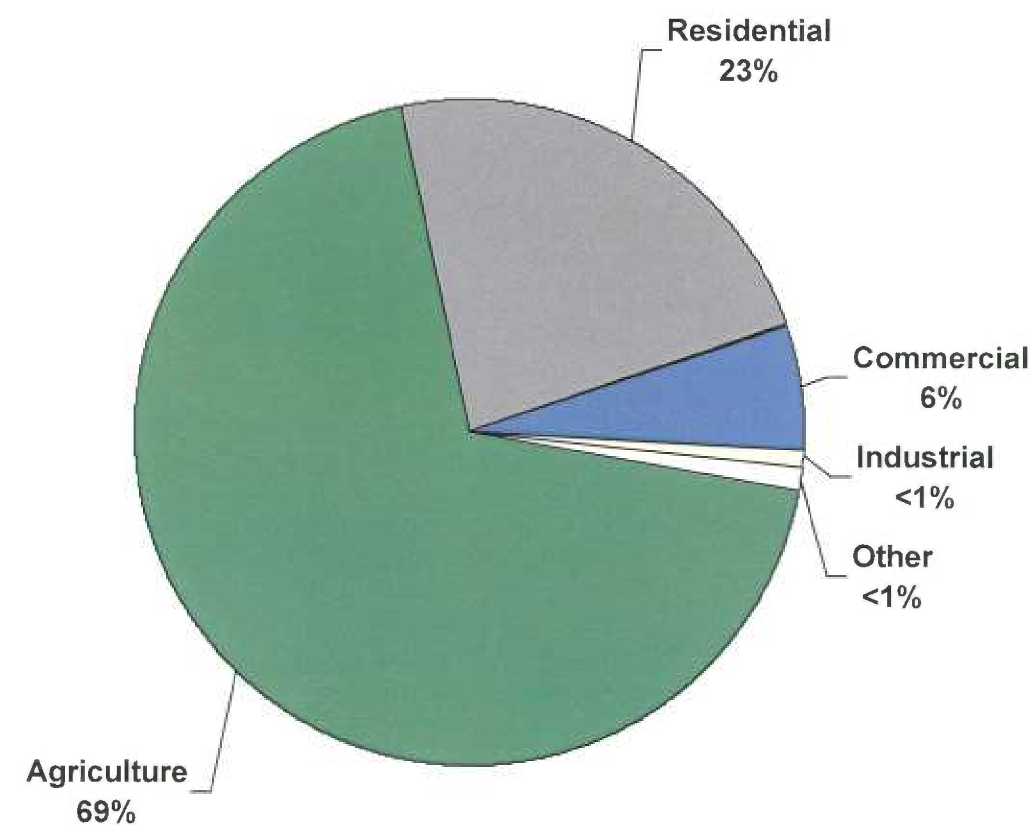


Figure 3.7 1997 Middle Verde Water Use by Sector



study area can be found in Appendix B and Figures B.1 through B.36. All maps exist as GIS covers at ADWR.

Irrigation Diversion Systems

In the Upper Verde, the Chino Valley Irrigation District supplied surface water to farmed areas within the Prescott AMA. The majority of the agricultural surface water use occurred in the Chino Valley area. In 1998, the City of Prescott entered into an agreement with the CVID and acquired its surface water rights. The provisions of the agreement stipulate that beginning in 1999, surface water will no longer be available to the district. The estimated annual average surface water diversion to the main canal was about 3,250 acre feet for the period 1991 to 1997 (ADWR, 1998). Over 30 irrigation diversions exist in Verde Valley (Alam, 1997). Many diversion organizations in the Middle Verde were established to operate and maintain diversion structures, canals, and discharge facilities that supply surface water to the farmed areas in the Verde Valley. These groups represent a significant water use component within the study area, serving an estimated 15,000 acre-feet of irrigation water annually to approximately 4,770 acres. The data presented here is intended as a general reference and guide for future water resource planning by the local organizations. Water use estimates and the acreage being served are based on field investigations conducted in 1996 and 1997, historical records, interviews/oral communications, and survey responses. See Appendix B for profiles of each irrigation diversion, including personnel, history, water resources, facilities, and service area maps. Table 3-9 lists selected diversions located in the Verde Valley.

TABLE 3-9

SELECTED IRRIGATION COMPANIES AND LOCATIONS

UPPER VERDE	VERDE RIVER	OAK CREEK	WET BEAVER CREEK	WEST CLEAR CREEK
Chino Valley Irrigation District	Bridgeport Irrigation Association	Chavez-Sycamore Irrigation Association	Leonard Maxwell Ditch Association	Pioneer Ditch Company
	Cottonwood Ditch Association	Copper Cliffs Improvement Association		
	Diamond S Ditch Association	Cornville Ditch Association		
	Eureka Ditch Company	Jordan Ditch Association		
	Jordan Meadows Irrigation Association	Kinsey Ditch Association		
	Hickey Ditch Association	Mason Lane Water Users Association		
	Ok Ditch Company	Owenby Ditch Water Users Association		
	Verde West Irrigation Company	Point Willow Ditch Association		
	Verde (Woods) Ditch Company	Red Rock Ditch Association		
		Spring Ditch Association		
		Rippling Waters Irrigation Association		

Agricultural Water Demand

Approximately 11,330 acres within the Verde Watershed study area were actively irrigated between 1996 and 1997, of which 5,950 acres and 5,380 acres were located in the Upper and Middle Verde areas respectively. An additional 6,110 acres of previously irrigated lands were identified from historical aerial photographs that were not farmed between 1996 and 1997. (This total includes land that was fallow at the time of investigation.) Of the 6,110 acres of historically irrigated lands identified, 5,250 acres were located in the Upper Verde area and 860 acres were located in the Middle Verde area. The current agricultural water demand in the Big Chino Valley area and Middle Verde is based on the total acres of actively irrigated lands, and in the Little Chino Valley area the agriculture demand is based on 1997 reported data and estimates. The maximum potential agricultural water demand is estimated based on historical cropping patterns, crop consumptive use values (CU), irrigation requirements (IR), water duties, and the sum of the current and historically irrigated lands identified within the Verde Watershed study area (6,110 + 11,330 = 17,440 acres).

In this report, the agricultural water demand for farming in the Upper Verde area is determined independently of the agricultural water demand for farming in the Middle Verde area. This is due to significant elevation differences in the two regions, which result in different consumptive use values for the crops produced in the two areas and also due to the differences in sources of water. Agricultural production in the Upper Verde region relies mostly on groundwater supplemented by a small amount of surface water and effluent (Little Chino sub-basin), while agricultural production in the Middle Verde region relies mostly on surface water.

Another difference between the Upper and Middle Verde water demand calculations is the inclusion of an efficiency factor for irrigated lands in the Upper Verde area and not in the Middle Verde area. Irrigation efficiency is a measure of how efficiently water is applied for farming and is based on the ratio of how much water is required by the crop (consumptive use) to how much water is actually applied (water supplied). An efficiency factor was not taken into consideration for the Middle Verde for the following reason: most farming within the Middle Verde area occurs within the younger alluvium where the groundwater table is very shallow and a direct hydraulic connection between the surface water and groundwater systems exists. As a result, the only losses attributed to irrigation in the Middle Verde are from the consumptive use of each crop type. All water applied in excess of the irrigation requirement (IR) in the Middle Verde is assumed to return immediately to the floodplain alluvial aquifer, and therefore would not be considered as a gain or loss in the water budget.

Irrigation requirement (IR) is equal to the consumptive use of a specific crop less the effective precipitation. Crop consumptive use is defined as a measure of the amount of water lost to evapotranspiration plus the quantity of water contained within a plant. Effective precipitation is considered to be that fraction of the total precipitation that is used by the plant during the growing season.

Irrigation Requirement (IR):
(Consumptive use [inches] - Effective Precipitation [inches]) / 12 = IR (acre-feet/acre).
Example: (IR of Alfalfa in Williamson Valley region: [34.8 - 5.1] / 12 = 2.48 acre-feet/acre).
(Note: For the purposes of this report, leaching requirements and/or other water needs, such as conveyance losses, were not included in the calculation of IR values.)

The annual total water demand for each specific crop, excluding allowances for irrigation efficiencies, is determined by the following formula:

Total Water Demand for Specific Crop:
(No. of Acres of Crop A Identified)(IR for Crop A) = Total Water Demand for Crop A.

Cropping patterns were determined from field observations conducted by ADWR. The predominant crop categories for the Upper and Middle Verde areas were Alfalfa, Corn, Pasture, Turf/Landscaping, Vegetables, Orchards, and Nursery Trees. The consumptive use values for each of these crops were developed by the Natural Resources Conservation Service (NRCS) and the Prescott AMA. The NRCS consumptive use values were developed specifically for certain areas of the watershed, including Verde Valley, Chino Valley, and Williamson Valley, and therefore, were applied to all farming practices in the Upper Verde region outside the Prescott AMA and to all irrigated lands in the Middle Verde region. For irrigated lands located within the Prescott AMA, consumptive use values were developed by the Prescott AMA and presented in the ADWR Second Management Plan (1990). The agriculture demand for the Little Chino Valley (Prescott AMA) was obtained from reported deliveries of groundwater, surface water and effluent, and estimated discharge for irrigation at Del Rio Springs. The components of agriculture water demand in the Little Chino are described in the following section.

UPPER VERDE

Total Water Demand

The current water demand for farming in the Big Chino Valley area is equal to the total water supplied (water duty), which was determined using the consumptive use, less effective precipitation, divided by an efficiency factor and the acres currently farmed. The current water demand is calculated by multiplying the total acres of irrigated land in production by the weighted water duty per acre. The weighted water duty is based on the water duties for each crop type and the number of acres historically produced of each crop type. The potential water demand for historically irrigated lands not currently in production in the Upper Verde area was calculated the same way.

In the Little Chino Valley area the agriculture demand is comprised of groundwater, surface water, effluent and diverted discharge from Del Rio Springs. Groundwater is the only reliable source of irrigation water in Little Chino Valley. The total agriculture demand and percentage breakdown for 1997 is as follows:

Source of Water and Percentage of Use		Volume of Water (Acre-feet)
Groundwater	77%	5,073
CVID Surface Water Delivered	7%	484
CVID Effluent Delivered	2%	151
Del Rio Springs	14%	900
Total Agriculture Demand	100%	6,608

The estimated water deliveries are based on 1997 reported data from the ADWR Registry of Groundwater Rights (ROGR), Chino Valley Irrigation District (CVID) monthly surface water delivery reports, City of Prescott annual effluent flow summary and estimates of discharge from Del Rio Springs for agriculture reported in the ADWR Report on the Safe-Yield Status of the Prescott AMA.

The predominant method of irrigation in the Upper Verde area is flood irrigation without a pumpback system and, therefore, a 50 percent irrigation efficiency was applied to all irrigated lands in the Upper Verde area. This means that the water demand for the crop is approximately twice the amount of water that is actually consumed by the crop. The additional 50 percent of water, however, is assumed to recharge back to the groundwater system.

Irrigation efficiencies are typically based on soil types, crop types, field slopes, and farming practices and may range from less than 50 percent to approximately 85 percent. As presented in the Prescott AMA's Second Management Plan (SMP), five types of irrigation systems with their expected irrigation efficiencies were identified. The five classifications with their corresponding irrigation efficiencies are as follows:

Type of Irrigation System	Expected Irrigation Efficiency
Flood irrigation - Slope without pumpback system	50%
Flood irrigation - Slope with pumpback system	70%
Sprinkler	75%
Trickle	85%
Flood irrigation - Level basin	85%

(Note: As reported in the Prescott AMA's SMP, "slope" is a graded furrow or graded border flood irrigation system. The slope, or grade, may vary from 0.05% to 1.0%.)

Water Duty:
Irrigation Requirement (IR) / Efficiency Factor (0.5) = Water Duty.

Weighted and Total Weighted Water Duty:
(Total Acres Crop A)(Water Duty for Crop A) / Total Acres Farmed = Weighted Water Duty (WWD).

Examples:
Weighted Water Duty Crop A: (Total Acres Crop A)(Water Duty) / Total acres farmed = WWD Crop A.
Weighted Water Duty Crop B: (Total Acres Crop B)(Water Duty) / Total acres farmed = WWD Crop B.
Weighted Water Duty Crop C: (Total Acres Crop C)(Water Duty) / Total acres farmed = WWD Crop C.

WWD Crop A + WWD Crop B + WWD Crop C = Total Weighted Water Duty.

The weighted water duties for each specific crop are then added together to get the total weighted water duty.

Current Total Water Demand for Upper Verde Area:
(Total Irrigated Acres)(Total Weighted Water Duty) = Current Total Water Demand for Upper Verde.

Maximum Total Water Demand for Upper Verde Area:
(Historically Irrigated Acres Not in Production)(Total Weighted Water Duty) + Current Total Water Demand for Upper Verde = Maximum Total Water Demand for the Middle Verde Area.

The weighted irrigation requirements for the Upper Verde and Middle Verde were calculated in the following way:

Weighted and Total Weighted Irrigation Requirement:
(Total Acres Planted in Crop A)(IR for Crop A) / Total Acres Farmed = Weighted IR.

Examples:
Crop A: (Total Acres Crop A)(IR Crop A) / Total acres farmed = Weighted IR for Crop A.
Crop B: (Total Acres Crop B)(IR Crop B) / Total acres farmed = Weighted IR for Crop B.
Weighted IR Crop A + Weighted IR Crop B = Total Weighted IR.

The weighted IR values for each specific crop are then added together to get the total weighted IR. Tables 3-10 and 3-11 present the primary crop categories identified, crop acreage, crop IRs, and total weighted IR for the irrigated land of the Upper Verde study area. This data is the result of extensive field investigations by ADWR staff between 1995 and 1998, and the use of aerial photographs.

TABLE 3-10

UPPER VERDE CROP ACREAGE AND WEIGHTED IR FOR BIG CHINO WASH, WALNUT CREEK, AND WILLIAMSON VALLEY WASH SUBWATERSHEDS

CROP TYPE	IRRIGATED ACRES	PERCENTAGE OF TOTAL ACRES	IR* AF/AC	WEIGHTED IR AF/AC
Alfalfa	364	9.6	2.48	0.24
Corn	1,357	35.9	1.74	0.62
Pasture	1,465	38.7	2.18	0.84
Turf/Landscaping	58	1.5	3.65	0.06
Vegetables	513	13.6	1.37	0.19
Orchard	23	0.6	2.48	0.02
Nursery Trees	2	0.1	1.65	NA
Total	**3,782**	**100**		**2.00**

*IR values from NRCS.

TABLE 3-11

UPPER VERDE CROP ACREAGE AND WEIGHTED IR FOR GRANITE CREEK / LITTLE CHINO WASH SUBWATERSHED (INCLUDING CHINO VALLEY IRRIGATION DISTRICT)

CROP TYPE	IRRIGATED ACRES	PERCENTAGE OF TOTAL ACRES	IR* AF/AC	WEIGHTED IR AF/AC
Alfalfa	95	4.4	2.81	0.12
Corn	294	13.6	1.45	0.2
Pasture	1,708	78.8	3.65	2.88
Turf/Landscaping	61	2.8	3.65	0.1
Vegetables	9	0.4	1.37	0.01
Orchard	1	0.0	2.48	NA
Total	**2,168**	**100**		**3.30**

*IR values from ADWR SMP, 1990.

Description of Irrigated Lands

Williamson Valley

There has been farming in Williamson Valley since 1865 (Statements of Claimants, filed with Maricopa County Superior Court, 1985). Approximately 1,300 acres are being farmed within Williamson Valley. An additional 320 acres of land were identified that exhibited evidence of farming, but were not currently in production. Field investigations and aerial photographs indicate that the estimated maximum number of potential acres that could be irrigated in Williamson Valley is 1,620 acres. Over the last five years, approximately 300 acres of historically irrigated farmland has been removed from farming for development purposes. This is a common trend that is occurring throughout the entire study area.

Cropping patterns and irrigation practices have remained fairly constant since the mid 1900s and are not expected to deviate in the near future. The primary crops grown in the Williamson Valley are alfalfa and pasture; other crops include orchards and small grains. Pasture lands have historically been the primary crops irrigated in Williamson Valley. Flood irrigation with no pumpback system is the primary method of irrigation.

Farming in Williamson Valley is expected to continue to decline, but relatively slowly in comparison to other locations within the study area. As a result, the water demand for farming in Williamson Valley should remain at its current level for several years into the future. The estimated volume of water supplied for each of the five cropping categories along with the average number of acres for each crop type historically grown in Williamson Valley are presented in Table 3-12.

TABLE 3-12

WILLIAMSON VALLEY CURRENT CROPPING PATTERNS

CROP	TOTAL WEIGHTED WATER DUTY (AF/AC)	ACRES	PERCENT OF IRRIGATED LAND	CALCULATED WATER SUPPLIED ANNUALLY (ACRE-FEET)
Alfalfa	4.00	61	4.7	244
Pasture		1,190	91.4	4,760
Orchard		23	1.80	92
Vegetables		25	1.9	100
Nursery Trees		2	0.25	8
Total		**1,302**	**100.00**	**5,204**

Pasture is grown on approximately 91 percent of the irrigated land making it the predominant crop grown within the Williamson Valley. Farming in Williamson Valley relies exclusively on groundwater to maintain its crops. Occasional storm events will produce supplemental runoff, but groundwater is the only reliable source. There are currently 151 wells for irrigation in Williamson Valley (ADWR Wells Registry, 1999). All farming in Williamson Valley is located outside the Prescott AMA and, as a result, groundwater withdrawals are not regulated by ADWR.

The current estimated annual total volume of water supplied for the 1,300 acres that are being irrigated in Williamson Valley is around 5,200 acre-feet. Based on the acreage, the cropping ratio, the irrigation requirement (IR), and incorporating a 50 percent irrigation efficiency factor, the current total weighted water duty for all irrigated lands within Williamson Valley is four acre-feet per acre. The potential maximum annual total water supplied for irrigation would be 6,480 acre-feet if all current and historically irrigated lands were put into production.

Big Chino Valley and Walnut Creek

Ranching began around 1869 in the northwestern portion of the Big Chino Valley (Statements of Claimants, filed with Maricopa County Superior Court, 1985). As early as 1872, water was being diverted from Walnut Creek for ranching operations. Farming was slow to develop with large scale farming beginning around 1910 and peaking in the late 1950s to the early 1960s. Approximately 1,130 acres were identified as being actively irrigated in 1995 and 1996. In 1998, active irrigation was increased by an additional 1,350 acres bringing the total number of acres currently in production to 2,480 acres. In addition, an estimated 2,910 acres of historically irrigated lands have been identified as not currently in production. Field investigations and aerial photos indicate that the estimated maximum potential acres that could be irrigated are 5,390 acres.

Cropping patterns have remained fairly constant since the mid 1900s and are not expected to deviate in the near future. The primary crops grown in the Big Chino Wash and Walnut Creek areas are corn, alfalfa, pasture, and vegetables. The primary form of irrigation practice is flood irrigation with no pumpback system. The estimated volume of water supplied for each of the five cropping categories along with the average number of acres for each crop type historically grown in Big Chino Valley are presented in Table 3-13.

TABLE 3-13

BIG CHINO VALLEY CURRENT CROPPING PATTERN (INCLUDES WALNUT CREEK)

CROP	TOTAL WEIGHTED WATER DUTY (AF/AC)	ACRES	PERCENT OF IRRIGATED LAND	CALCULATED WATER SUPPLIED ANNUALLY (ACRE-FEET)
Alfalfa	4.00	303	12.2	1,212
Pasture		275	11.1	1,100
Corn		1,357	54.7	5,428
Turf/Landscaping		58	2.3	232
Vegetables		488	19.7	1,952
Total		**2,481**	**100.00**	**9,924**

Corn is grown on approximately 55 percent of the irrigated land making it the predominant crop grown within the Big Chino Valley. Farming in the Big Chino Valley relies almost exclusively on groundwater to maintain its crops. There are currently 333 wells for irrigation in the Big Chino Valley (ADWR Wells Registry, 1999). All farming in Big Chino Valley is located outside the Prescott AMA and, as a result, groundwater withdrawals are not regulated by ADWR.

The current estimated annual total volume of water supplied for the 2,480 acres that are currently being irrigated in the Big Chino Valley is 9,920 acre-feet. Based on the acreage, the cropping ratio, the IR values, and incorporating a 50 percent irrigation efficiency factor, the total weighted water duty for all farming in Big Chino Valley is four acre-feet per acre. If all 5,390 acres of current and historically irrigated lands were placed into production, the maximum annual total water supplied for irrigation would be approximately 21,560 acre-feet.

Little Chino Valley

Ranching and farming related activities in the Little Chino Valley began around 1864 with the development of Del Rio Springs in the northern part of the Valley (Statements of Claimants, filed with Maricopa County Superior Court, 1985). Between 1919 and 1927 several small irrigation districts were formed that eventually became part of what is now known as the Chino Valley Irrigation District (CVID). Over one-third of all irrigated lands within the Little Chino Valley occurs within the CVID.

CVID originally delivered surface water diverted from Willow Creek Reservoir and Watson Lake (via Granite Creek) for irrigation purposes to approximately 900 acres. In 1997, 830 acres were estimated to be in production. Continual encroachment by urbanization around the CVID continues to reduce the number of irrigated acres within the CVID. Recently, CVID approved the sever and transfer of many existing surface water rights from land within CVID to the City of Prescott.

Approximately 2,170 acres were identified as actively being irrigated in 1996 and 1997. In addition, an estimated 3,210 acres of historically irrigated lands have been identified as not currently in production. Field investigations and aerial photos indicate that the estimated maximum number of potential acres that could be irrigated in the Little Chino Valley are 5,380 acres.

Cropping patterns have remained fairly constant since the middle 1900s and are not expected to deviate in the near future. The primary crops grown in the Little Chino area are corn, alfalfa, pasture and vegetables. The primary form of irrigation practice is flood irrigation with no pumpback system. The estimated volume of water demand for each of the six cropping categories along with the average number of acres for each crop type historically grown in Little Chino Valley are presented in Table 3-14.

TABLE 3-14

LITTLE CHINO VALLEY CURRENT CROPPING PATTERNS

CROP	TOTAL WEIGHTED WATER DUTY (AF/AC)	ACRES	PERCENT OF IRRIGATED LAND	CALCULATED ANNUAL WATER DEMAND (ACRE-FEET)*
Alfalfa	6.60	95	4.4	627
Pasture		1,708	78.8	11,273
Corn		294	13.6	1,940
Turf/Landscaping		61	2.8	403
Vegetables		9	0.4	59
Orchard		1	<0.1	7
Total		**2,168**	**100.00**	**14,309**

*FAO Estimate

Pasture is grown on over 78 percent of the irrigated land making it the predominant crop grown within the Little Chino Valley.

There are currently 656 wells for irrigation in the Little Chino Valley (ADWR Wells Registry, 1999). All farming in the Little Chino Valley is located within the Prescott AMA, and as a result, groundwater withdrawals are regulated by ADWR, which requires all farmers larger than five acres to complete and submit an Annual Water Use Summary Report to ADWR.

According to the information presented in the Annual Water Use Summary Reports, the actual volume of water supplied annually to the 2,170 acres that are being irrigated in the Little Chino Valley is 6,610 acre-feet. Based on FAO 24 method for determining crop consumptive use, which the Prescott AMA utilizes, the current estimated total annual volume of water demand for the 2,170 acres is 14,310 acre-feet. The total weighted water duty for all farming in the Little Chino Valley taking into consideration acreage, the cropping ratio, the IR values (Equation 3.01), and incorporating a 50 percent irrigation efficiency factor is 6.60 acre-feet per acre. As a comparison, the calculated total annual water demand based on 50 percent efficiency and NRCS crop consumptive use values for the 2,170 acres is 9,240 acre-feet. If all current and historically irrigated lands in the Little Chino were placed into production, the potential estimated maximum annual total water demand for irrigation would be 35,510 acre-feet based on the AMA's current crop consumptive use values.

MIDDLE VERDE

Total Water Demand

The current water demand for farming in the Middle Verde area was determined by multiplying the current number of irrigated acres for each crop that were identified by the irrigation requirement value for each specific crop. The potential water demand for historically irrigated lands not currently in production in the Middle Verde is calculated by multiplying the number of historically irrigated lands not currently in production by a total weighted irrigation requirement. The total weighted irrigation requirement is based on the IR for each crop type and the number of acres produced of each crop type. As stated previously, no irrigation efficiency factor was applied to farming in the Middle Verde region and as a result the irrigation water demand for the Middle Verde region is based on the irrigation requirement rather than total water supplied. Table 3-15 lists the Middle Verde crop acreage and weighted IR numbers.

Current Total Water Demand for Middle Verde Area:

(Current Total Acres Irrigated)(Total Weighted IR) = Current Total Water Demand for Middle Verde.

Maximum Total Water Demand for Middle Verde Area:
(Historically Irrigated Acres Not in Production)(Total Weighted IR) + Current Water Demand for Middle Verde Area = Maximum Total Water Demand for Middle Verde Area.

TABLE 3-15

MIDDLE VERDE CROP ACREAGE AND WEIGHTED IR FOR VERDE RIVER, VERDE RIVER VALLEY, OAK CREEK, WET BEAVER CREEK, AND WEST CLEAR CREEK SUBWATERSHEDS

CROP TYPE	IRRIGATED ACRES	PERCENTAGE OF TOTAL ACRES	IR* AF/AC	WEIGHTED IR AF/AC
Alfalfa	301	5.59	3.57	0.2
Corn	81	1.51	1.86	0.03
Pasture	3,621	67.29	3.11	2.09
Turf/Landscaping	1.081	20.09	3.35	0.67
Vegetables	97	1.80	1.13	0.02
Orchard	200	3.72	3.63	0.14
Total	**5,381**	**100**		**3.15**

*IR values from NRCS.

Description of Irrigated Lands

Verde Valley Including Perkinsville (Middle Verde Area)

The first irrigation ditch to be constructed in the Verde Valley occurred in the late 1860s. By the early 1900s, more than 50 ditches had been constructed on the Verde River and its tributaries to divert surface water for irrigation purposes. Approximately 40 ditches are still in operation today, ranging in size from one ditch serving a few acres to several ditches serving several hundred acres. The 15 largest ditches are supervised and operated as incorporated ditch companies, formal ditch associations, or are operated under court order.

Farming in the Middle Verde area relies mostly on surface water to maintain crops. Occasional droughts or below average precipitation years, however, may cause shortfalls in surface water availability. During those periods of time, approximately 1,200 irrigation wells located in the Middle Verde (ADWR Wells Registry, 1999) may be used to meet the irrigation demands for the area. Depending on the depth and location of the well, these wells withdraw water from the floodplain alluvium of the Verde River and tributary creeks or from the underlying regional aquifer. The majority of these wells appear to have been drilled within the last 40 to 50 years. The exact amount of groundwater utilized for irrigation purposes is unknown and varies from year to year according to surface water availability. All farming in the Middle Verde area is located outside the Prescott AMA and, as a result, groundwater withdrawals are not regulated by ADWR.

Approximately 5,380 acres were being actively irrigated in 1996 and 1997, with around 860 acres of historically irrigated lands currently not in production. Field investigations and aerial photographs indicate that the estimated maximum number of acres that could be irrigated in the Middle Verde is 6,240 acres (5,380 + 860).

Cropping patterns have remained fairly constant over the past 40 years and are not expected to deviate in the near future. The primary crops grown in the Verde Valley area are alfalfa, corn, wheat, vegetables, orchards, and pasture. The primary form of irrigation practice is flood irrigation with no pumpback system. The estimated volume of water supplied for each of the six cropping categories along with the average number of acres for each crop type historically grown in the Middle Verde area are presented in Table 3-16.

TABLE 3-16

MIDDLE VERDE CURRENT CROPPING PATTERNS

CROP	TOTAL WEIGHTED WATER DUTY (AF/AC)	ACRES	PERCENT OF IRRIGATED LAND	WATER SUPPLIED ANNUALLY (ACRE-FEET)
Alfalfa	3.15	301	5.60	948
Pasture		3,621	67.30	11,406
Corn		81	1.50	255
Turf/Landscaping		1,081	20.10	3,405
Vegetables		97	1.80	306
Orchard		200	3.70	630
Total		**5,381**	**100.00**	**16,950**

Pasture is grown on approximately two-thirds of the irrigated land, making it the predominant crop grown within the Middle Verde area.

The total annual irrigation requirement for the 5,380 acres that are currently being irrigated in the Middle Verde area is approximately 16,950 acre-feet. Based on the acreage, the cropping ratio, and the IR, the total weighted IR for all farming in the Middle Verde area is 3.15

acre-feet per acre. If all historically irrigated lands were placed into production, the estimated maximum annual total IR would be approximately 19,660 acre-feet.

Irrigation Summary

The current annual irrigation water demands for the Upper and Middle Verde study regions are approximately 29,440 acre-feet and 16,950 acre-feet respectively. The current annual total agricultural water demand for the Upper and Middle Verde regions combined is approximately 46,390 acre-feet. The maximum potential annual water demands for agriculture in the Upper and Middle Verde regions are 58,790 acre-feet and 19,660 acre-feet respectively. The maximum annual potential water demand for agriculture in the Upper and Middle Verde regions combined is estimated to be 78,460 acre-feet. Table 3-17 displays the calculated agricultural demand for the Upper and Middle Verde.

TABLE 3-17

UPPER AND MIDDLE VERDE IRRIGATION USE AND AGRICULTURAL WATER DEMAND

FARMED AREA	TOTAL WEIGHTED IR (AF/AC)	APPLICATION EFFICIENCY	TOTAL WEIGHTED WATER DUTY (AF/AC)	ACTUAL ACRES	CURRENT TOTAL IR (AF)	ACTUAL ESTIMATED DEMAND (AF)	MAXIMUM POTENTIAL ACRES	MAXIMUM POTENTIAL ESTIMATED DEMAND (AF)
Upper Verde Outside Prescott AMA	2	0.5	4	3,782	7,564 (2 X 3782)	15,128	5,820	23,280
Upper Verde Inside Prescott AMA	3.3	0.5	6.6	2,168	7,154 (3.3 X 2168)	6,610	5,380	35,510
Middle Verde Including Perkinsville	3.15	NA	NA	5,381	16,950 (3.15 x 5381)	16,950	6,241	19,672
Total				**11,331**	**31,668**	**46,387**	**17,450**	**78,462**

3.5 INDUSTRIAL/COMMERCIAL USES

Industrial/commercial water users within the study area are primarily groundwater users. For this study, industrial/commercial water users were divided into two categories based on their annual consumptive use of water. All industrial/commercial facilities utilizing approximately 100 acre-feet of water or more annually were classified as large water users. All other industrial/commercial facilities were classified as small water users. Figure 3.8 displays the locations of identified industrial/commercial users in the Verde River Watershed study area.

Estimates of water use by the industrial/commercial sector are based on field investigations and/or surveys conducted between 1995 and 1997. The estimated total consumptive use for all industrial/commercial water users during 1997 for the Upper and Middle Verde regions was approximately 5,930 acre-feet.

In the Upper Verde, an estimated 1,380 acre-feet of water was consumed by two sand and gravel operations, one golf course, and other smaller industrial users. Effluent and groundwater usage accounted for 72.5 and 27.5 percent respectively.

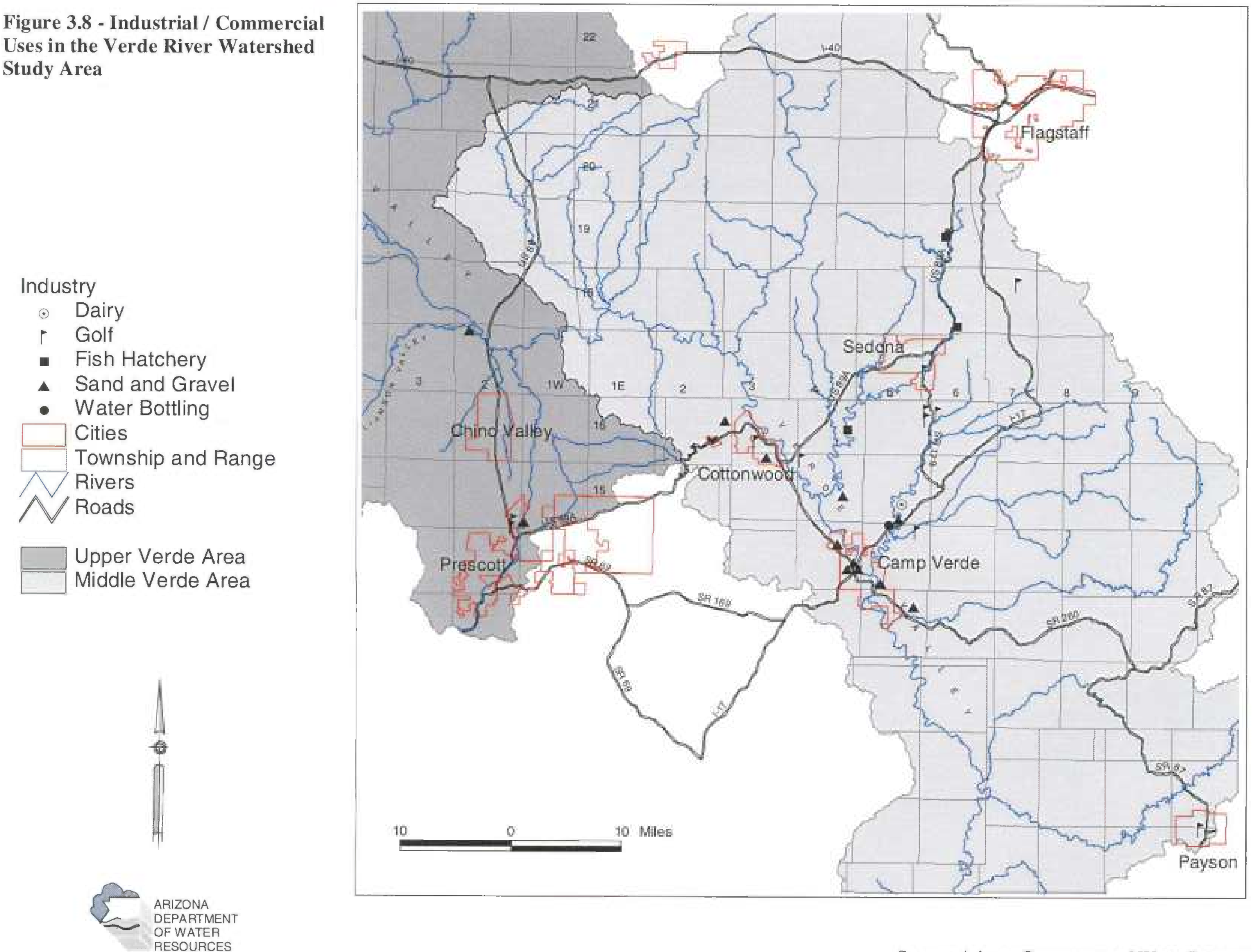
In the Middle Verde, out of an estimated 4,550 acre-feet of water, 4,444 acre-feet were consumed by large facilities in 1997, while the remaining 106 acre-feet of water was consumed by small facilities. Groundwater, effluent, and surface water accounted for 67, 21.5, and 11.5 percent use respectively.

Industrial water users that were field investigated and/or surveyed included 10 golf courses, ten sand and gravel operations, two small-scale power plants, and two water bottling companies. Commercial users that were field investigated and/or surveyed included one dairy operation and three fish hatcheries. Industrial users had greatly differing water demands depending on operational characteristics.

Of the 28 facilities identified, 11 of them consumed 100 acre-feet of water or more. Specifically, seven golf courses and four sand and gravel operations were identified as the large water users. All of the large water users utilize groundwater as their source of water with the exception of five golf courses, which utilize treated effluent and diverted surface water. Golf and sand and gravel facilities are discussed in more detail later in this section. Turf related facilities requiring water for irrigation of parks, school grounds, cemeteries, and open spaces were identified but not classified as industrial/commercial users because of their relatively insignificant size and total water use. These irrigated turf areas were mapped, however, and included in the Section 3.3, "Irrigation Uses."

Two small power-generating facilities within the study area were identified along Fossil Creek and the East Verde River. Both facilities divert surface water to turn water wheels or turbines to generate electricity. Because of the operational characteristics of these systems, however, water is rarely depleted and not considered a consumptive use of water. All water that is diverted to generate electricity is returned directly to the surface water system.

Figure 3.8 - Industrial / Commercial Uses in the Verde River Watershed Study Area



Source: Arizona Department of Water Resources

Three fish hatcheries were identified in the study area. Sterling Springs Hatchery, Page Springs Hatchery, and one small private hatchery are all located along Oak Creek. The Arizona Game and Fish Department currently operates the two larger facilities. Like the power generating facilities previously mentioned, little or no water is consumed by the hatcheries and all water diverted is returned directly to the surface water system.

Two water-bottling companies were also identified. Both companies pump and filter groundwater yet were not significant users of water. In 1995, one bottling company pumped and reportedly sold 2.5 million gallons (7.7 acre-feet) of water. The actual groundwater use of both facilities is unknown, but estimates place their use at or less than 20 acre-feet of water annually.

Golf Courses

Of the ten golf facilities that were included as industrial users, five are supplied by privately owned wells, two are supplied water by surface water diversions, and three are utilizing effluent. Groundwater and effluent is supplied from private wells and/or municipal/private water providers. Table 3-18 presents the approximate turf acreage and an estimation of the total water and effluent consumption per year for the ten golf facilities that were in operation in the study area between 1997 and 1998.

The Prescott AMA's recommended annual application rate of 4.9 acre-feet per acre for turf related facilities, assuming a 75 percent field efficiency, is used in this report to estimate the annual water demand for courses not utilizing effluent. Two municipal water suppliers provided estimated effluent use. Four golf courses currently utilizing groundwater or surface water have developed plans to receive treated effluent in the future. Water use efficiency varied among the facilities due to irrigated acreage differences, turf type vegetation, water application systems, management practices, and differences in facility use. The potential water demand from golf course irrigation is expected to increase as more golf courses are constructed and existing facilities are expanded to meet demand.

TABLE 3-18

ESTIMATED ANNUAL WATER USE FOR GOLF COURSE FACILITIES

FACILITY NAME	LOCATION	COURSE SIZE (HOLES)	IRRIGATED ACRES	ESTIMATED WATER DEMAND (AC-FT/YEAR)*	SOURCE AND NUMBER OF WELLS	POTENTIAL FOR EFFLUENT USE
Sedona Golf Resort	Sedona	18	93	456	GW; 1 well	System in place, but not currently receiving effluent
Poco Diablo Resort	Sedona	18	7	34	SW; instream pump	None
Oak Creek Village Association	Village of Oak Creek	9	143	701	GW; 4 wells	System in place, but not currently receiving effluent
Canyon Mesa Country Club	Village of Oak Creek	9	23	113	GW; 1 well	None
Pineshadows Golf Course	Clarkdale/Cottonwood	9	20	98	GW; 2 wells	System in place, but not currently receiving effluent
Verde Santa Fe Golf Course	Cornville	18	93	456	GW; 2 wells	System in place, but not currently receiving effluent
Beaver Creek Golf Resort	Wet Beaver Creek	18	100	490	SW; Diversion	None
Antelope Hills Golf Courses	Prescott	36	176	Effluent-862**	City of Prescott	Currently using effluent
Pinewood Country Club	Munds Park	18	110	Effluent- 539	Pinewood Sanitary District	Currently using effluent
Payson Municipal Golf Course	Payson	18	90	Effluent- 441	Northern Gila County Municipal Wastewater Treatment	Currently using effluent
Total			**855**	**4,190**		

Source: ADWR, 1997-98, Industrial/Commercial Survey.
GW - Groundwater; SW - Surface Water; NA - Not Available.
*Based on Prescott AMA recommended application rate of 4.9 acre-feet per acre per year.
**Estimate from Prescott AMA Third Management Plan.

Seven of the ten golf courses within the study area used approximately 2,350 acre-feet of surface water and groundwater annually to irrigate an estimated 480 acres of turf and landscaping. Approximately 525 acre-feet of the 2,350 acre-feet is surface water, while the remainder is from groundwater sources. The three remaining courses, Antelope Hills in Prescott (two 18-hole courses comprising approximately 176 acres of irrigated turf), Pinewood Country Club (approximately 110 acres of irrigated turf), and the Payson Municipal Golf Course (approximately 90 acres of irrigated turf) utilized effluent to irrigate their turf. The actual annual volume of effluent utilized by the three golf courses is unknown. Based on the 4.9 acre-feet per acre consumptive use applied to all golf courses in the study area, approximately 1,840 acre-feet of effluent are being utilized. Two of the three golf facilities using effluent reported an annual estimated combined use of approximately 2,440 acre-feet in 1997. ADWR has not verified this number. All but one golf facility (Antelope Hills) are located in the Middle Verde section and utilizing effluent to maintain their turf. The estimated annual volume of irrigation (effluent) for the golf facilities in the Upper Verde region in 1997 was 860 acre-feet.

Sand and Gravel Operations

Sand and gravel facilities mine unconsolidated stream deposits to produce materials for construction. The washing of aggregate accounts for the bulk of water use by sand and gravel facilities. Dust control, washing of equipment, and other activities are secondary water uses.

Sand and gravel facilities demands vary from year to year based on the demand for aggregate material. The estimated total demand for water in 1997 was 1,540 acre-feet. Approximately 1,400 acre-feet of this number was groundwater and 140 acre-feet was effluent. This estimate was derived from field investigations and survey responses conducted between 1995 and 1997. Factors taken into consideration included facilities operating on an eight hour per day schedule, unless specified, and the maximum rated discharge capacity for privately owned wells. The annual water demand for each sand and gravel operation (most of which are located in Middle Verde) were determined by using the following formula:

Equation for determining sand and gravel operation water demand:
(Well pumping rate[gpm])(60 min/hr)(Hours of operation per day)(365 days per year) / 325,581 gallons per acre-foot = Water demand in acre-feet per year.

Example: (255 gpm)(60)(5)(365) / 325,851 = 86 acre-feet per year.

The estimated water demand of all sand and gravel operations were added together to calculate the total demand.

A total of 10 sand and gravel operations in the study area were identified to be in operation. The six largest operations in the study area used an excess of 100 acre-feet of water annually. These large industrial users had an estimated total consumptive use of 1,490 acre-feet per year. The four other small sand and gravel operations annual water demand was estimated to be 50 acre-feet of water. The remaining 180 acre-feet of water are utilized by Yavapai Materials and other small industrial users in Prescott. Table 3-19 presents more detailed information on sand and gravel operations within the study area.

TABLE 3-19

WATER DEMAND FOR SAND AND GRAVEL FACILITIES

COMPANY NAME, YEAR ESTABLISHED	LOCATION/ FACILITY NAME	WELL CAPACITIES (GPM)	WELL ESTIMATED PUMPING RATES (GPM)	ESTIMATED WATER DEMAND (AC-FT/YEAR)	PRODUCTS PRODUCED
B & B Materials, 1987	Dry Beaver Creek	W1 - 100 gpm	W1 - 100 gpm	50	Sand, gravel, asphalt, rock
		W2 - 450 gpm	W2 -235 gpm	130	
		W3 - 30 gpm	W3 - 30 gpm	20	
Superior Companies, 1983	Gypsum Plant- West clear Creek	W1 - 255 gpm	W1 - 160 gpm (5 hours/day)	50	Gypsum
	Industrial Road- Camp Verde	W1 - 250 gpm	W1 -250 gpm	130	NA
		W2 - 60 gpm	W2- 60 gpm	30	
	Cherry Pit- West Clear Creek	W1- 250 gpm	W1 - 120 gpm	70	NA
Valley Concrete, NA	Cottonwood	W1 -500 gpm	W1 - 500 gpm	270	Sand, gravel, ready mix, asphalt
		W2 - 80 gpm	W2 - 80 gpm	40	
		W3 - 60 gpm	W3 - 25 gpm	10	
Phoenix Cement, 1959	Clarkdale	W1- 400 gpm	W1 & W2 tied in system- 450 gpm (11.5 hours/day)	350	Portland cement
		W2 - 500 gpm			
Dunbar Stone	Near Paulden	NA	NA	200	Sand, gravel
Yavapai Materials	N. of Prescott	NA	NA	*140 effluent	Sand, gravel
Other Sand & Gravel Operations				50	NA
Total Water Use				**1,540**	

NA = not available.
*Estimated.

3-6 STOCK USES

Cattle's ranching have played an important role in the early development of the Verde River study area. In the Big Chino, Williamson Valley, and portions of Little Chino and Verde Valleys, cattle ranching are still actively occurring. To provide a means to supply water for cattle usage, ranchers constructed impoundments to capture runoff. Depending on precipitation and spring runoff, most stockponds only contain water for several months out of each year. In some cases, ranchers will install a pump that is operated by a windmill to provide a continuous supply of water from the groundwater system for livestock and wildlife.

In addition to the impoundments constructed specifically for livestock, numerous other impoundments have been constructed for the purpose of erosion control, irrigation tailwater recovery, waste refuse disposal, recreational use, firefighting, railway right-of-way protection, etc. Livestock and wildlife also use most if not all of these impoundments. For purposes of this report, all impoundments are classified in this category.

Land ownership in the Big Chino and Williamson Valleys is a mix of private, state, and federal land arranged in a checkered pattern. Many ranches currently lease state and federal land (i.e., forest service land) for grazing rights. As a result, stockponds are constructed on private, state, and forest service land.

An inventory of impoundments was completed in 1996 utilizing aerial photography and topographic quadrangle maps. This survey included only impoundments in the Verde River Watershed upstream from the USGS gaging station below Camp Verde. Impoundments in the East Verde River region and below Camp Verde were not included in this study.

Approximately 2,635 impoundments ranging in size from 0.1 acres to approximately 350 acres in surface area were identified. Approximately 1,680 were located in the Upper Verde region, while the remaining 955 were located in the Middle Verde region. An estimated 2,030 of the impoundments were less than 1.5 acres in size. The three largest impoundments in the Upper Verde were Willow Creek Reservoir at 350 acres, Watson Lake at 100 acres, and James Bond (Del Rio Springs) at 40 acres. The four largest impoundments in the Middle Verde region were Odell Lake at 7 acres, Howser and Lake Montezuma at 6.25 acres each, and Willow Valley Lake at 5 acres. No estimate of total capacity for these stockponds and impoundments has ever been calculated.

In addition to providing a source of water for livestock, these impoundments may act as recharge basins and impede the flow of runoff that would have otherwise occurred had there not been an impoundment constructed. No estimate of recharge has been calculated for these impoundments and no determination of the impacts from restricting and/or impounding the natural runoff has ever been studied.

3.7 CULTURAL AND NATURAL USES

The natural water uses within the Verde Watershed are an important factor related to water loss along both tributaries and the main channel of the Verde River. These water losses include evaporation of running surface water, evapotranspiration (ET) from naturally occurring vegetation in riparian areas (which is the single largest use of water in the Verde Watershed area), and diversions into wetland areas such as Tavasci Marsh and Pecks Lake.

An ET of 35,000 acre-feet per year was estimated for the area between the USGS gaging station on the Verde River near Paulden to the confluence of the Verde and East Verde Rivers (Anderson, 1976). This estimate of ET is based on the type and concentration of vegetation and phreatophytes located along the main channel of the Verde River and its tributaries. This estimate also includes evaporation from flowing surface water along the main stem of the Verde River and its tributaries. For the Upper Verde region, ET was not considered due to the lack of riparian vegetation. With more than 30 years elapsing since the last ET study of the area was completed, it is strongly recommended that another ET study be completed.

Tavasci Marsh and Pecks Lake are located in the Middle Verde area near the Town of Clarkdale and City of Cottonwood. Pecks Lake is an ancient oxbow lake that is fed by surface water diversions from the Verde River through the Allen Ditch. Allen Ditch also supplies surface water to Tavasci Marsh.

Tavasci Marsh is a wildlife management area located downstream from Pecks Lake near Tuzigoot National Monument. In addition to surface water diversions through Allen Ditch, Tavasci Marsh receives seepage loss from Pecks Lake. Tavasci Marsh also receives water from Shea springs and other springs located in the area. Both of these wetland areas are owned by Phelps Dodge Corporation. Water from Pecks Lake and Tavasci Marsh drains back to the Verde River. No estimates of consumptive use in the wetlands have been made.

CHAPTER 4

Water Resources of the Upper and Middle Verde River Watersheds

CHAPTER 4: WATER RESOURCES OF THE UPPER AND MIDDLE VERDE RIVER WATERSHEDS

4.1 INTRODUCTION

Since the mid 1980s, much growth has occurred in the Verde Watershed resulting in concerns about the future of a dependable water supply. Cities such as Prescott and Payson are looking to acquire new sources of water by purchasing retired land with water rights or by drilling new and deeper wells into the regional aquifer. Many communities have also started treating their wastewater to a standard that will permit its reuse for certain activities, such as irrigation for golf courses, city parks, and landscaping around public facilities.

This section focuses on the current water resource conditions of the Upper and Middle Verde regions, taking into consideration the changes in water demand over time and their resulting effect on the available water resources. Overviews of the groundwater and surface water systems, water quality, and water budgets for the Upper and Middle Verde are based on previous research and on current available data compiled by ADWR. The water resources of the Upper Verde are discussed separately from those of the Middle Verde due to the differences in groundwater and surface water resources and demands.

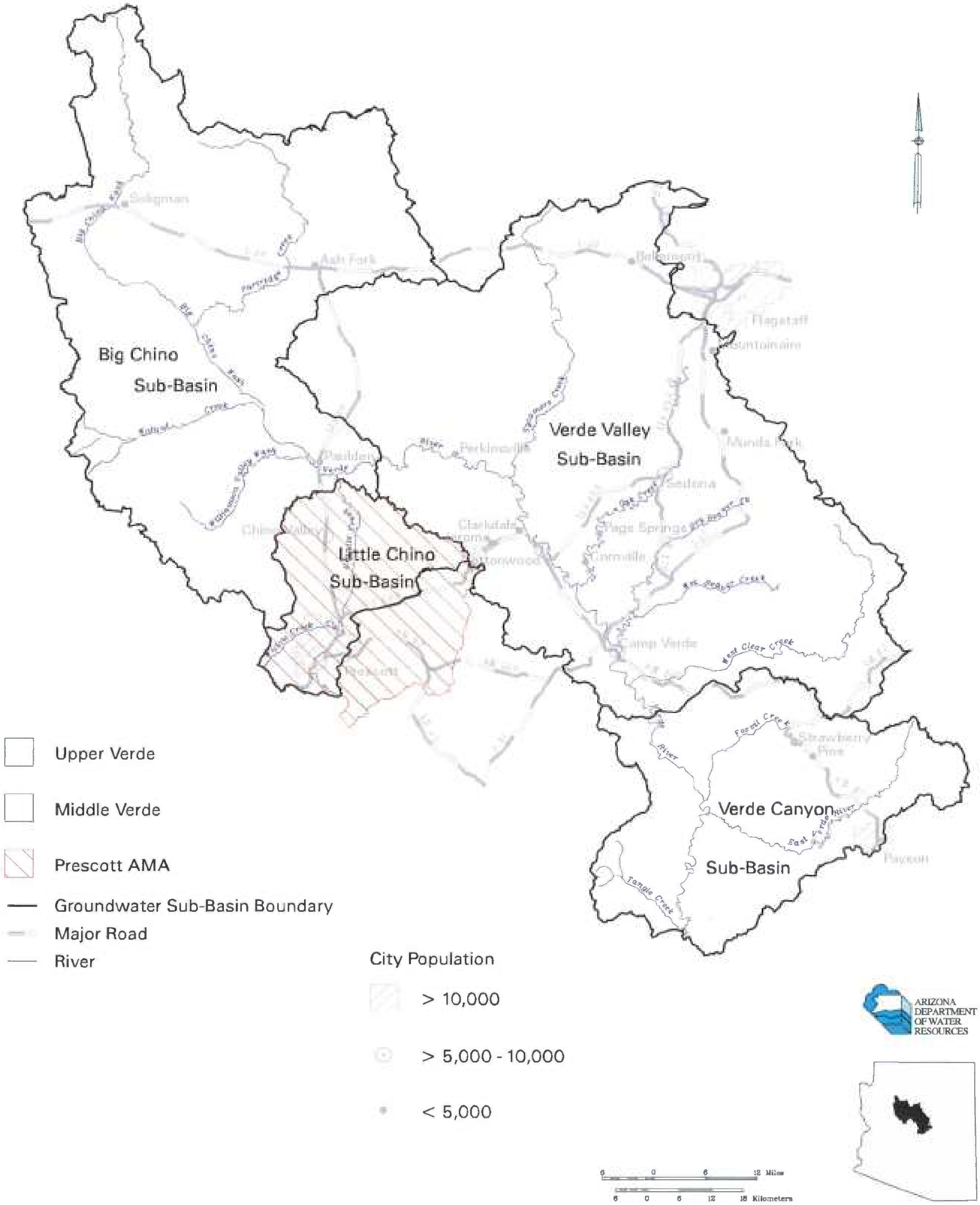
4.2 UPPER VERDE

GROUNDWATER SYSTEM

Geology

The groundwater system in the Upper Verde Subwatershed is found within the Big Chino and Little Chino groundwater sub-basins (Figure 4.1). Geologic units that contain groundwater and are considered to be principal aquifers within the Big Chino and Little Chino sub-basins include the younger alluvium located along creeks and washes, Tertiary and Quaternary basin-fill deposits exposed at the surface, Tertiary volcanic rocks found both at the surface and deep below the land surface, and Paleozoic sedimentary and Precambrian rocks, which form the impermeable floor and sides of the structural groundwater basins. The Paleozoic and Precambrian units may not contain water over large areas but may provide important localized sources of water for domestic and livestock uses. Geology of the Upper Verde Watershed has

Figure 4.1 - Groundwater Sub-Basins of the Verde River Watershed Study Area



Source: Arizona Department of Water Resources, Water Resources of the Upper and Middle Verde River, AZ, 1999.

been previously studied by Krieger (USGS, 1965), Schwalen (1967), the United States Bureau of Reclamation (USBR, 1974 and 1993), Wallace and Laney (USGS, 1976), Remick (ADWR, 1983), Water Resource Associates, Inc. (WRA, 1989), Corkhill and Mason (ADWR, 1995), Schwab (1995), and others.

Tertiary sedimentary and associated volcanic rocks have been identified as major water bearing units in the Big Chino, Williamson, and Little Chino Valleys. These units supply water for domestic, commercial, industrial, and agricultural uses. Hydrologic reports by the United States Bureau of Reclamation (1993) and Corkhill and Mason (1995) specifically described three main aquifers in the Upper Verde. These aquifers are the "Chino Valley Unit," which is located in the Big Chino Valley and Williamson Valley sub-basins and the "Upper Alluvial Unit" and "Lower Volcanic Unit" located in the Little Chino Valley sub-basin.

Aquifer Characteristics and Locations

Younger Alluvium

The young or recent Quaternary alluvium is usually highly permeable and locally yields small amounts of water to numerous shallow wells used primarily for domestic purposes in the Upper Verde area. This unit is composed of unsorted poorly bedded clay, sand, silt, pebbles, and cobbles and is found in the lower lying south-central portions of Big Chino Valley along the Big Chino Wash and other creeks and washes. It also occurs along the Granite Creek drainage north of Prescott in Chino Valley. The younger alluvium is generally less than 30 feet thick and is unconfined (Krieger, 1965). This unit is not generally considered to contain large volumes of groundwater in storage.

Chino Valley Unit

The Chino Valley Unit is the principal aquifer of the Big Chino Valley and Williamson Valley groundwater sub-basins and is composed of widespread valley fill sediments interbedded with basalt flows and alluvium in the major drainages (USBR, 1993). The valley fill contains unconsolidated and semi-consolidated alluvial sediments, terrace and pediment gravels, streambed and lacustrine deposits, and one or more layers of volcanics. The 1993 USBR study estimated the thickness of the valley fill unit in Big Chino Valley to be approximately 1,200 feet thick in a 200 square mile area and 300 feet thick in a 430 square mile area. The Chino Valley Unit was estimated to be more than 2,400 feet thick in the central and upper regions of Big

Chino Valley and from 300 feet to more than 800 feet thick in the southeastern portions of Big Chino Valley and Williamson Valley (Schwab, 1995). The depth of the basin was estimated to be at least 3,500 feet (WRA, 1989). Schwab (1995) also indicated that basalt flows were encountered at depths ranging from five to 147 feet below land surface in the southeastern portion of Big Chino Valley, just northwest of Paulden.

The interbedded basalt layers of the Chino Valley Unit have been estimated to be greater than 200 feet in thickness and described as "massive to extremely fractured and cavernous" in the northern portions of Big Chino Valley (WRA, 1989). The basalt flows in the northern areas were reported to occur approximately 730 feet beneath the surface. Geophysical survey data and driller logs indicated that volcanic rocks occurred at depths ranging from 370 feet to more than 600 feet below the land surface in the upper and central portions of Big Chino Valley (Schwab, 1995). Water Resource Associates (1989) described the volcanic units occurring in the northern portions of the valley as ranging from 74 feet to more than 400 feet in thickness.

Overlying the Chino Valley Unit in the central portion of the Big Chino sub-basin is a thick unit of clay considered being of lacustrine origin. These clay deposits are considered to be a poor groundwater source and have been estimated to be greater than 700 feet thick (WRA, 1989). Groundwater in the Chino Valley Unit occurs under both confined and unconfined conditions in both Big Chino and Williamson Valleys. Typically, confined conditions occur where buried basalt flows are interbedded with clays and volcanic ash.

Upper Alluvial Unit

Sedimentary deposits (valley fill) occur within the Little Chino groundwater sub-basin in the northern portions of the Prescott AMA and are known as the Upper Alluvial Unit (Corkhill and Mason, 1995). The Upper Alluvial Unit is believed to overlie a Lower Volcanic Unit and a Precambrian Basement Unit in most of the Little Chino sub-basin. The saturated alluvial deposits are a main source of groundwater in the Little Chino Valley. The Upper Alluvial Unit is composed of older Tertiary and younger Quaternary unconsolidated and semi-consolidated, poorly sorted gravel, sand, fanglomerate, silt, volcanic rocks, volcanic ash, and varying amounts of clay. Recent alluvium is found at the surface in most locations of the sub-basin. The volcanic rocks found in the Upper Alluvial Unit were deposited as thin and discontinuous layers within ancient drainages and are differentiated from the extensive volcanic flows comprising the Lower Volcanic Unit of the Little Chino sub-basin (Corkhill and Mason, 1995).

The saturated units form an aquifer that is unconfined and very extensive. Within the Upper Alluvial Unit there are some areas where confined aquifer conditions may be found. These limited areas apparently occur due to fine-grained sediment (clays) or lava flows that form a restrictive layer where vertical groundwater flow is impeded. The full extent of confined areas within the Upper Alluvial Unit including the thickness is unknown and further subsurface geologic investigations are required to fully understand the hydrologic character of the Upper Alluvial Unit. Well records indicate that in the Little Chino sub-basin, the Upper Alluvial Unit has been tapped mainly by shallow domestic wells with limited pumping capacities, typically yielding 10 to 30 gallons per minute (gpm) (Corkhill and Mason, 1995).

Lower Volcanic Unit (Little Chino Sub-basin)

The Lower Volcanic Unit is composed of a thick sequence of Tertiary basaltic and andesitic lava flows that are interbedded with layers of pyroclastic and alluvial material (WRA, 1992). The Lower Volcanic Unit contains groundwater under confined conditions in the northwestern areas of the Little Chino Valley, but a clear determination of the exact depth at which confined conditions exist has not been made. Confined conditions have been observed in the Lower Volcanic Unit in the northwestern portions of the Little Chino sub-basin. The thick sequences of fine-grained alluvial and pyroclastic material overlying the basalt form a confining layer that restricts the vertical movement of groundwater. Groundwater is believed to flow through the fractures, cavities, and open spaces in the basalt deposits.

The total thickness of the Lower Volcanic Unit in the Little Chino Valley is not well understood. It is believed that the productive thickness of the unit is only a few hundred feet based on average depth-of-penetration of water wells tapping the unit and from depth-to-bedrock maps produced from gravity surface data (Oppenheimer and Sumner, 1980).

Along the margins of the Little Chino sub-basin, the Upper Alluvial Unit and Lower Volcanic Unit appear to have a good hydraulic connection with each other acting as a single aquifer system (Corkhill and Mason, 1995). Groundwater recharge to the underlying Lower Volcanic Unit is believed to occur mainly in these areas.

Limestone Aquifers

Other known aquifers in the Upper Verde include the Mississippian Redwall Limestone (near Paulden) and Paleozoic Martin Formation. The Martin Formation, which contains units of limestone, is buried deep below the land surface in the northern portions of the subwatershed approximately 1,700 feet below land surface near the Town of Ashfork and yields water to several wells (Schwab, 1995).

Numerous wells have penetrated the Redwall Limestone underlying the basin-fill sediments and basalt flows. Schwab noted in 1995 that some of the wells in the limestone had direct contact with overlying basalt flows while, in other wells, there was sand and gravel between the basalt flows and the limestone. The limestone unit is known to contain channels, sinkholes, fissures, and caves formed from the dissolution of limestone by rainwater and groundwater as evidenced in well driller reports. The amount of water that could be produced from this aquifer is unknown.

Precambrian Basement Unit

Precambrian rocks form the basement unit of the Upper Verde groundwater sub-basins and are generally not considered a good aquifer. Basement rocks include granite, diorite, gabbro, schist, metavolcanics, and metasediments (Corkhill and Mason, 1995). This unit is formally known in the Little Chino sub-basin as the Precambrian Basement Unit and forms the impermeable floor and sides of the sub-basin. The Basement Unit underlies the Lower Volcanic Unit in the Little Chino Valley and is exposed at the land surface throughout the mountainous areas surrounding the valleys of the Upper Verde. The domestic wells that have tapped faults, joints, and weathered zones in the granite and schist units typically yield 1 to 2 gallons per minute.

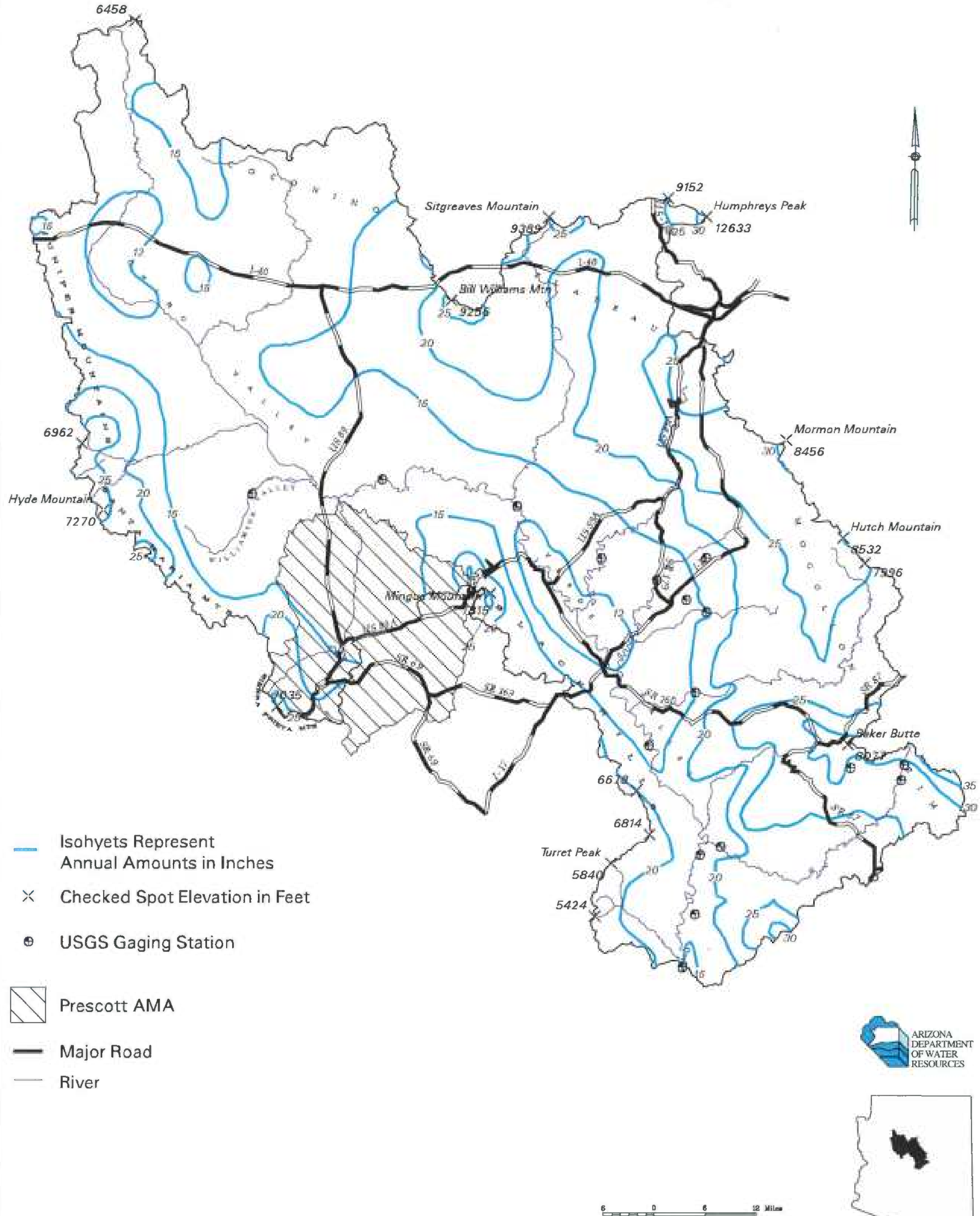
Movement of Groundwater

Precipitation and Recharge

Annual precipitation ranges from approximately 12 inches in the Chino Valley area to approximately 24 inches in the higher mountains bordering the basins (Figure 4.2). Schwalen (1967), USBR (1993), and Corkhill and Mason (1995) provided detailed descriptions of the regional precipitation setting.

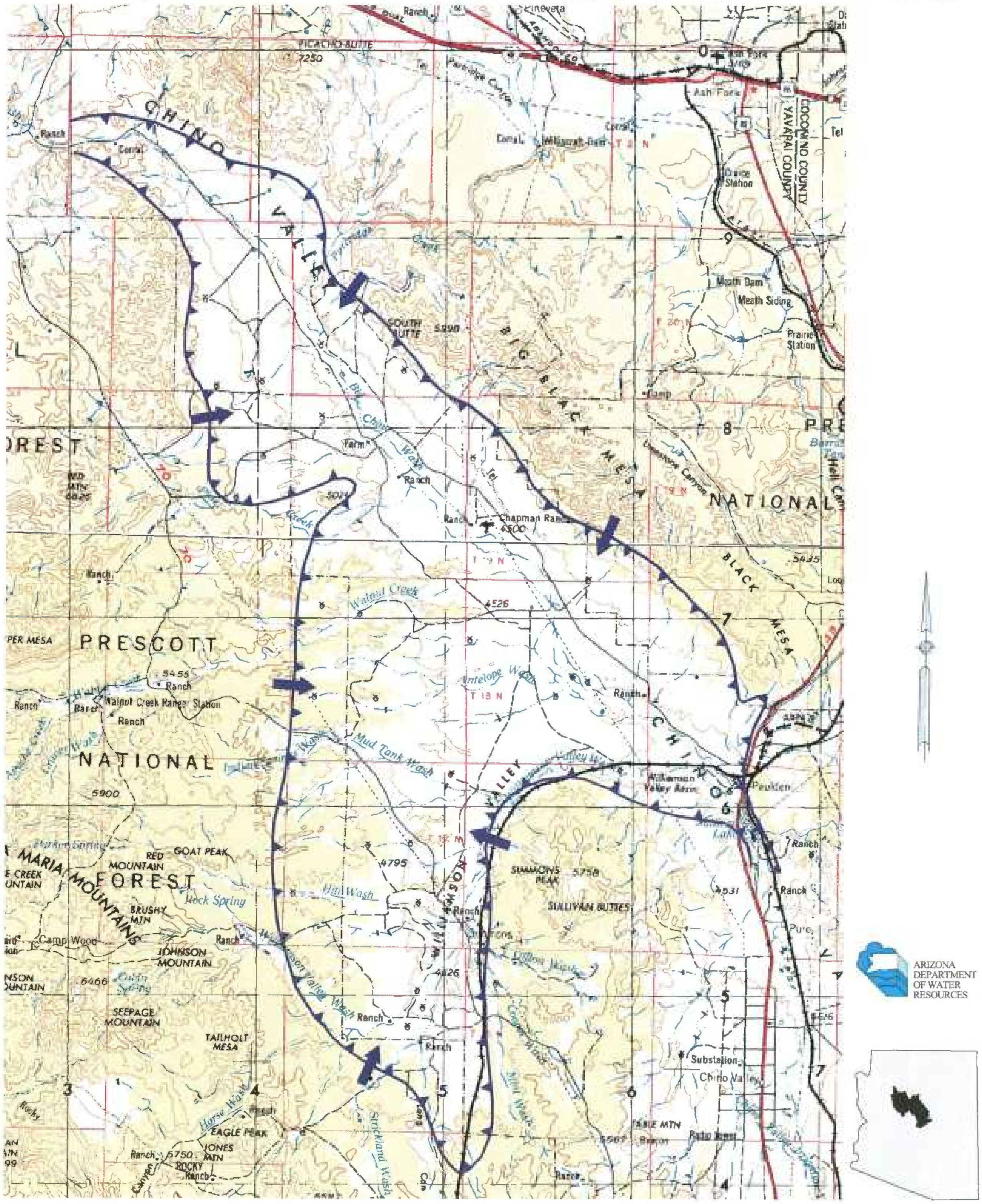
In the Big Chino Valley, the major source of groundwater recharge to the sub-basin is by infiltration of runoff along the mountain fronts and surface water flows along the main drainages. Underflow into the Big Chino from upgradient tributary basins is another source of recharge (Figure 4.3).

Figure 4.2 - Precipitation in the Verde River Watershed Study Area



Source: University of Arizona.

Figure 4.3 - Approximate Extent of the Principal Aquifer in the Alluvial Portion of the Big Chino Sub-basin and Area Depicting Mountain Front Recharge



Approximate Extent of the Principal Aquifer in the Alluvial Portion of the Basin

Direction of Mountain Front Recharge Flow

Source: Principal Aquifer digitized from Groundwater Conditions in the Big Chino Sub-Basin of the Verde River Basin Arizona Department of Water Resources, Hydrologic Map Series Report Number 28, November 1995.

Previous studies have indicated that a small percentage of the annual precipitation in Big Chino Valley reaches the groundwater table. The USBR (1993) study stated that between 0.43 and 0.85 inches per year of precipitation in the upland areas adjacent to the Big Chino Valley resulted in recharge. This report assumes there is negligible recharge resulting from direct precipitation in the valley on the basin floor. Most precipitation is lost as surface runoff, evaporation, or transpired by plants (Schwab, 1995). Krieger reported in 1965 that the principal sources of groundwater in the Prescott area are from seepage losses from surface flow of washes and from direct infiltration from rainfall and melting snow. He stated that much more recharge is contributed by seepage losses than by direct infiltration from precipitation.

Studies have indicated that reasonable estimates of long-term natural recharge from ephemeral streams may be obtained from annual streamflow data (Corkhill and others, 1993), and reasonable approximations of potential recharge from watersheds may be determined from median annual flow data (Corkhill and Mason, 1995). Corkhill and Mason examined the streamflow data for Granite and Willow Creeks. They estimated the average streamflows were about 4,800 and 1,400 acre-feet per year respectively and the median flow was about 2,300 and 900 acre-feet per year for the period 1933 to 1947. The estimated total natural recharge from all watershed areas in the Little Chino sub-basin was approximately 4,400 acre-feet for the same period. The estimated natural recharge with the reductions for diversions on Granite Creek was about 2,050 for the period 1949 to 1993 (Corkhill and Mason, 1995). Based on available gaging data, precipitation data, and estimated watershed area, they determined that the median annual flow provided a reasonable approximation of long-term recharge in Little Chino.

In the Big Chino, natural recharge estimates are based on the best data available for the major drainages, which include Williamson Valley Wash, Walnut Creek, and Partridge Creek. The discharge rates were determined for Williamson Valley Wash and Walnut Creek using the streamflow gaging data for the periods 1965 through 1985 and October 1991 through September 1992. An estimate of storm flow from a 1993 USBR report was used for Partridge Creek. Review of the streamflow data reveals that the average streamflow for Williamson Valley Wash and Walnut Creek were about 11,160 and 1,545 acre-feet per year, respectively. The flow for Partridge Creek was about 3,000 acre-feet per year, which is an estimate of large flow associated with exceptional storm events. The median flow in Williamson Valley Wash and Walnut Creek was 4,300 and 497 acre-feet per year respectively. The estimated total natural recharge from the average annual data was about 15,700 acre-feet per year for the Big Chino sub-basin. Natural recharge was estimated using the median annual flow data from Williamson Valley Wash and the method described by Corkhill and Mason (1995). A tentative application of the best available data and median annual flow resulted in estimates of natural recharge ranging from 7,500 acre-feet to 8,500 acre-feet, depending upon the estimated watershed area and precipitation. Improved data and refined applications may provide a closer and more confident estimate of natural recharge than current estimates.

The groundwater study of the Prescott AMA and Little Chino Valley by Corkhill and Mason (1995) noted that prior to 1940 long-term groundwater recharge and discharge were in approximate balance with water levels remaining more or less constant. This assumption was originally proposed by Schwalen (1967) who noted that prior to the construction of dams on Granite Creek and Willow Creek, in 1915 and 1937 respectively, recharge to the artesian basin of Little Chino Valley had reached approximate equilibrium with natural discharge.

Groundwater Flow Patterns

In the northern portion of Big Chino Valley, groundwater flows down the valley from the northwest towards the southeast and parallels the surface drainage of the area. Groundwater in Williamson Valley, which forms the southwest portion of the Big Chino Basin, flows in a north-northeast direction converging with the groundwater from Big Chino Valley. Big Chino and Williamson Valley subsurface flows appear to converge north and west of Sullivan Buttes and then flows eastward toward Paulden exiting the sub-basin north and east of Paulden (Schwab, 1995) exiting to the Verde River. Groundwater discharge to the surface water system occurs in a few isolated places in the northwestern portion of Big Chino Valley, most notably along Apache and Walnut Creeks as they exit the Santa Maria and Juniper Mountains.

Groundwater in Little Chino Valley moves through the valley fill in a general northward direction toward Chino Valley and Del Rio Springs (Krieger, 1965). Corkhill and Mason (1995) noted that although groundwater declines occurred in most of the Little Chino sub-basin during the time period 1940 to 1960, the general pattern and direction of groundwater flow in 1960 was similar to the pre-1940 steady state condition. The current pattern of groundwater flow is expected to be similar to that observed in the past. Outflows generally occur only as groundwater underflow, which exits the Little Chino sub-basin through a bedrock gap immediately south of Sullivan Lake.

Groundwater in Chino Valley discharges from artesian wells and springs such as the Del Rio Springs. The mean annual discharge at Del Rio Springs during the period 1940 to 1945 was estimated to be approximately 2,800 acre-feet (ADWR, 1998). In 1984, the estimated mean annual discharge had decreased to approximately 1,800 acre-feet (Corkhill and Mason, 1995). In 1997, the mean annual discharge of Del Rio Springs as recorded by the USGS gaging station (09502900) was 1,520 acre-feet for water year 1997. The average annual diverted flow for agriculture is estimated to 900 acre-feet (ADWR, 1998). It should be noted that a certain volume of Del Rio springs discharge is diverted above the gage and therefore remains unmeasured. At Del Rio Springs, about 1,500 to 2,000 acre-feet per year have been estimated to exit the sub-basin as underflow to the Big Chino sub-basin (Corkhill and Mason, 1995) and (ADWR, 1998).

Well Distribution and Groundwater Withdrawals

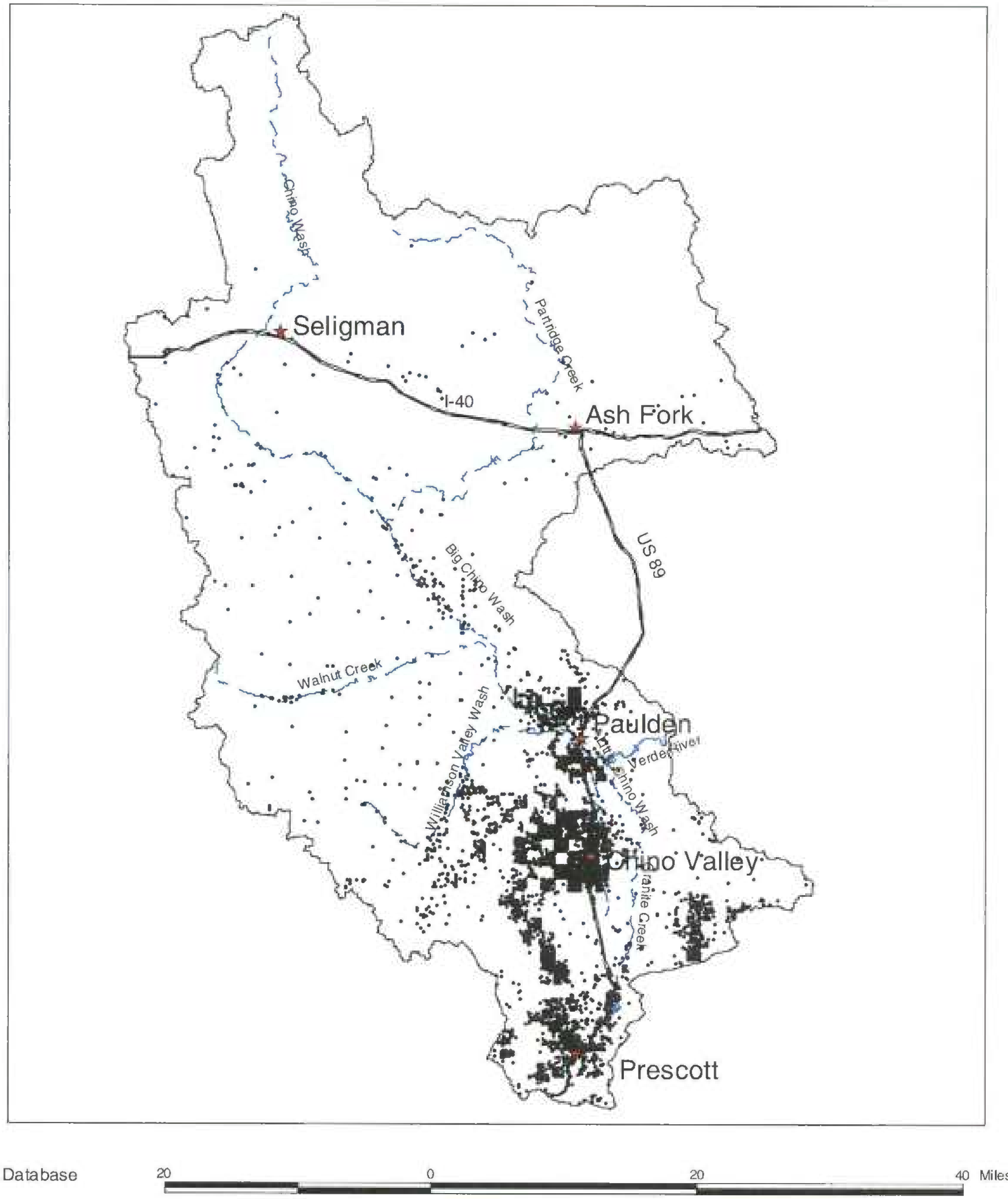
Groundwater withdrawals are a result of the operation of wells in the region. Based on ADWR's well registry database that was accessed for wells in March 1999, approximately 9,400 wells currently exist in the Upper Verde Subwatershed. This report identifies the eight primary classifications of wells as listed in this database. Wells that pump 35 gpm or less typically serve private residences and, for purposes of this report, are classified as "domestic wells." Wells pumping greater than 35 gpm are generally used by municipal, industrial, and agricultural users and are classified as "other." This category also includes commercial, mining, stock, and index wells. [Note: Index wells provide water levels and other related data that are measured or collected and are thus not considered to be a consumptive use.] Of the 9,400 wells located in the Upper Verde, 2,690 are listed as unknown, no code, or miscellaneous; this includes recharge, test, and de-watering. These wells pump from 35 gpm to well over 1,000 gpm according to well records, but the total volume of water being pumped is unknown.

It should be pointed out that ADWR's well registry database sometimes lists inaccurate well locations. Additionally, the database does not denote whether wells are still in operation, or are actually in existence, or if they have been abandoned. The intention of this report is to identify information deficiencies, one of which is a proper accounting of groundwater use and demand in any specific region of the study area.

The distribution of total wells in the Upper Verde can be observed in Figure 4.4. The geographical distribution of domestic wells (<35 gpm) in the Upper Verde appears in Figure 4.5. This figure shows the major concentration of wells occurring in the Prescott AMA area.

Figure 4.4 - All Wells in the Upper Verde

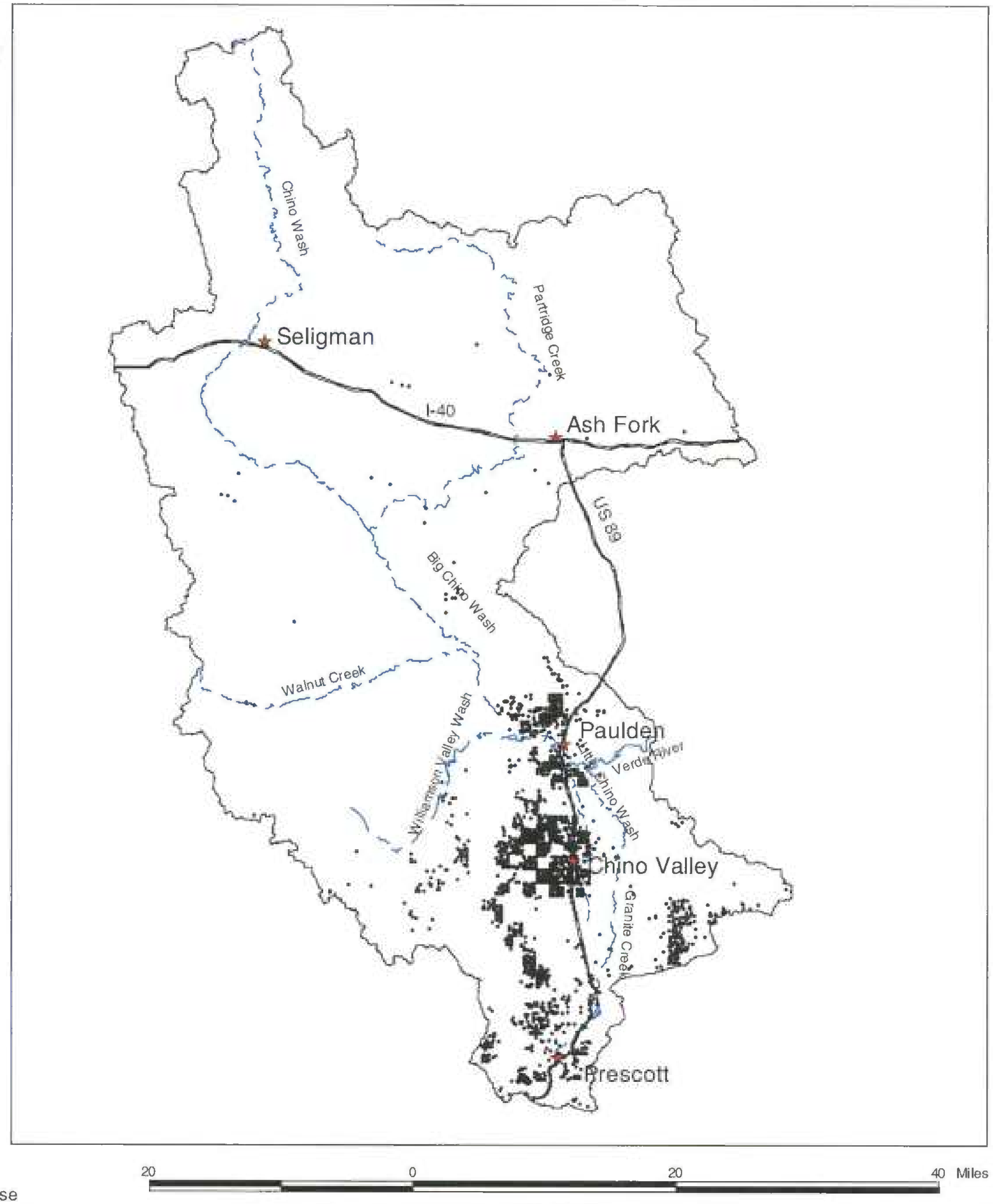
Cities
Roads
9398 Wells
Rivers:
Intermittent River
Perennial River
Basin



ARIZONA
DEPARTMENT
OF WATER
RESOURCES

Source: Arizona Department of Water Resources Wells 55 Registry Database

Figure 4.5 - Domestic Wells in the Upper Verde



Source: Arizona Department of Water Resources Wells 55 Registry Database

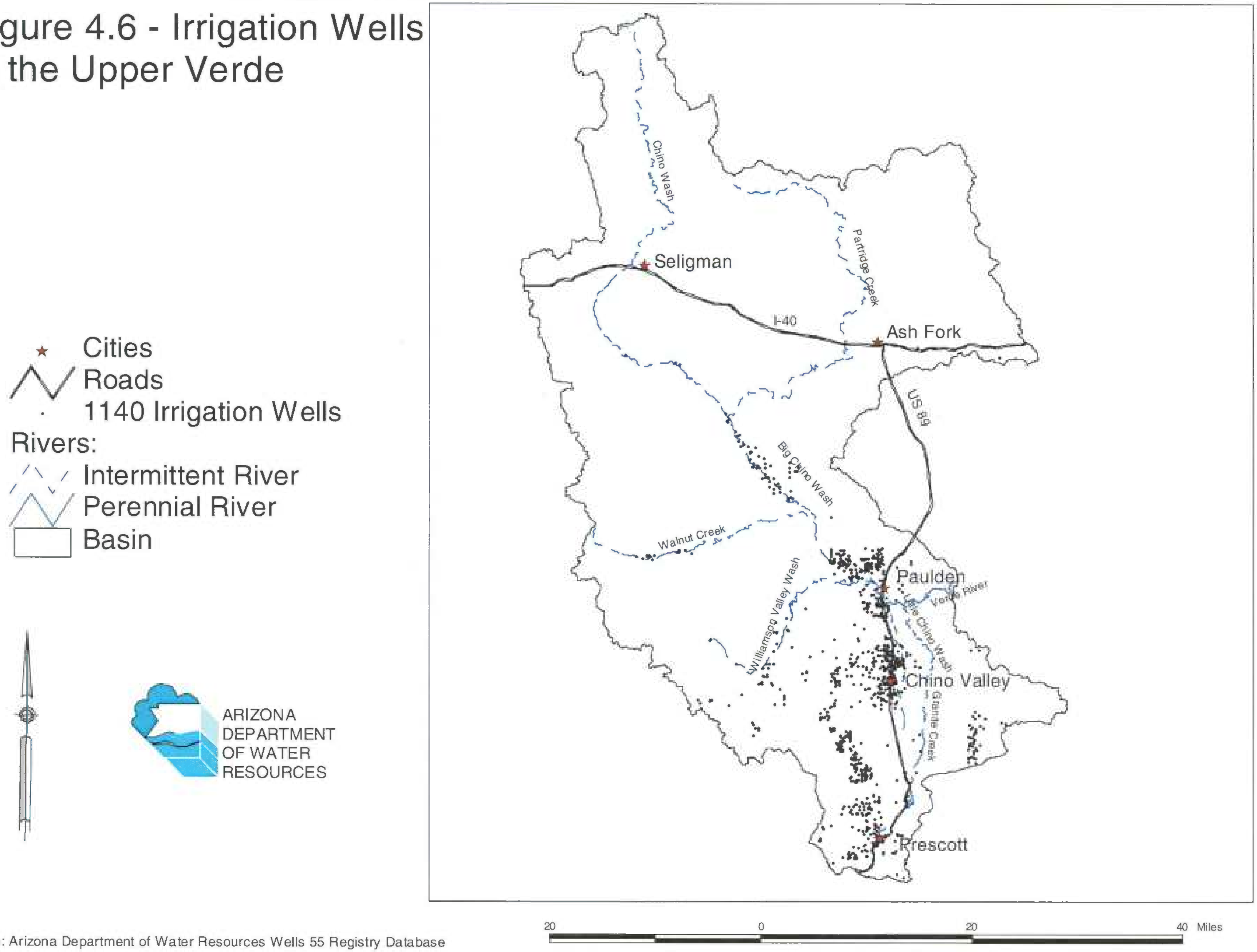
Irrigation, industrial, and index wells in the Big Chino and Little Chino groundwater sub-basins and other areas of the Upper Verde can be seen in Figures 4.6, 4.7, and 4.8, respectively.

The annual measurement of depth to water data for 23 index wells (Groundwater Site Index [GWSI] database) located throughout the Upper and Middle Verde were analyzed (Figure 4.9) and hydrographs were developed for each of these wells. Fluctuations in depth to water provided insight into the impacts on the groundwater system resulting from periods of drought, periods of excessive precipitation recharge, and increases or reductions in groundwater pumping. The hydrographs are discussed later in this Chapter.

Approximately two-thirds of all GWSI wells drilled in the Big Chino Valley and Williamson Valley groundwater sub-basins are located within the central area of the valley fill. Domestic wells are concentrated in the Paulden area and irrigation wells are predominately located along the Big Chino Wash and Walnut Creek drainages where agricultural fields have been historically developed.

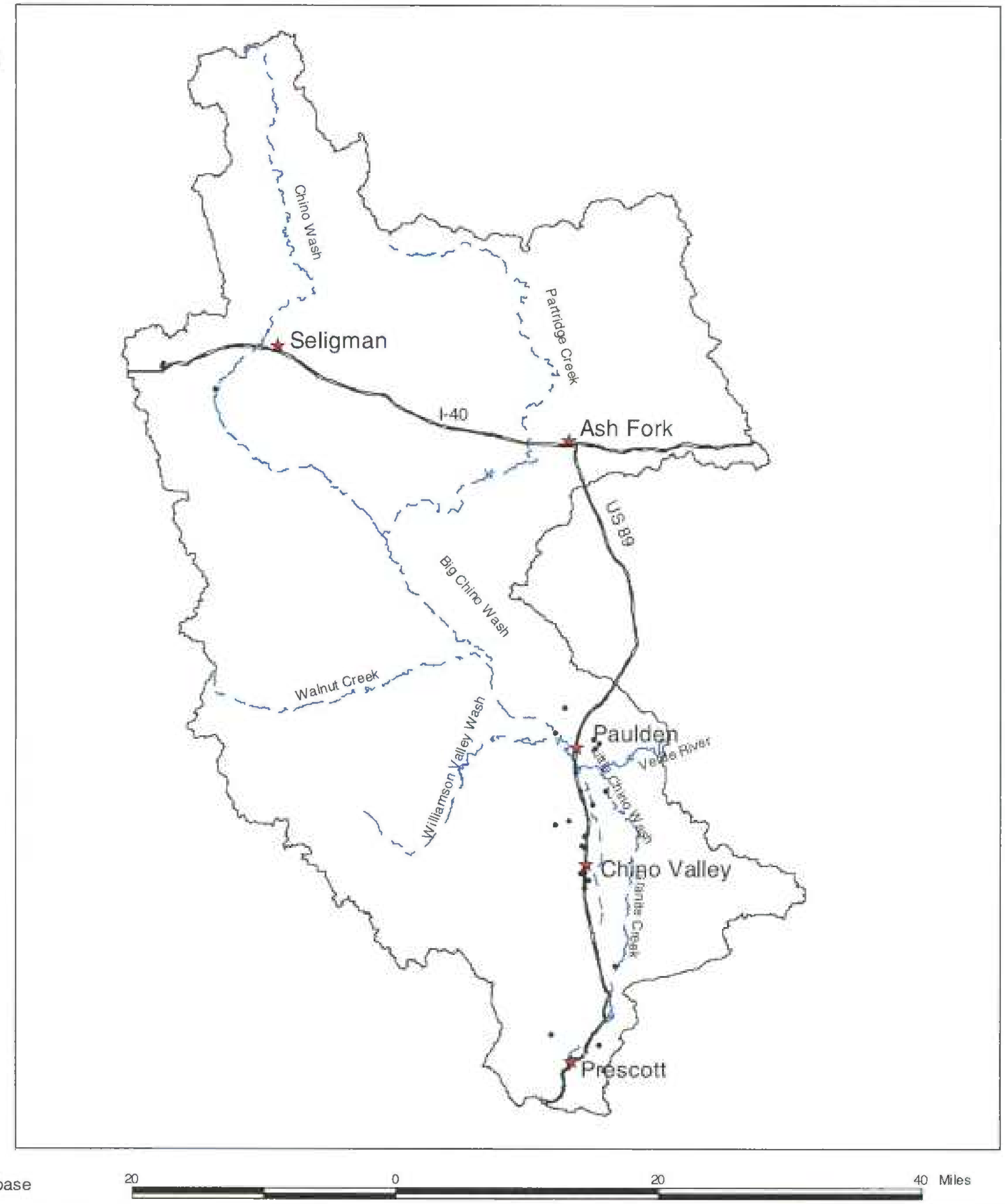
In the Little Chino Subwatershed, the groundwater uses are concentrated in the Little Chino Valley, the City of Prescott area, and north of Prescott Valley. In the Little Chino Valley, numerous domestic wells pump groundwater from the Upper Alluvial Unit aquifer while most irrigation and water provider wells pump groundwater from the deeper lower Volcanic Unit aquifer (Corkhill and Mason, 1995). The City of Prescott well field and pumping station are located in the Town of Chino Valley, and consist of five high capacity wells at depths between 600 and 700 feet (Wells 55 Registry). North of Prescott Valley the Upper Alluvial Unit aquifer is the major source of groundwater, although many domestic wells tap fractured volcanic or crystalline rocks near the margins of the sub-basins (Corkhill and Mason, 1995). Five City of Prescott wells north of Prescott are at depths between 20 and 30 feet (Wells 55 Registry). Table 4-1 shows the estimated annual groundwater withdrawals by area for the Upper Verde region.

Figure 4.6 - Irrigation Wells in the Upper Verde



Source: Arizona Department of Water Resources Wells 55 Registry Database

Figure 4.7 - Industrial Wells in the Upper Verde



Cities
Roads
33 Industrial Wells
Rivers:
Intermittent River
Perennial River
Basin

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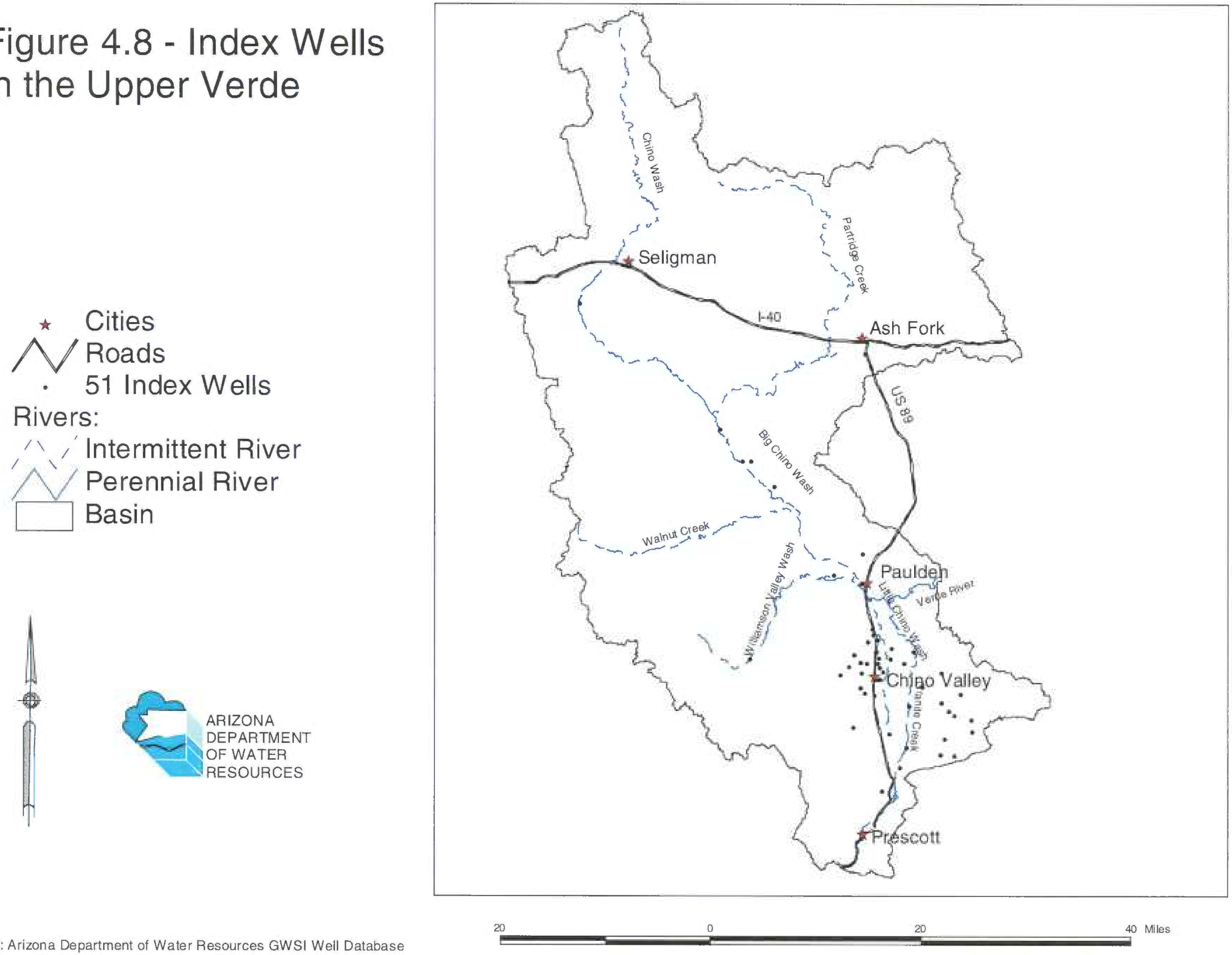
Source: Arizona Department of Water Resources Wells 55 Registry Database

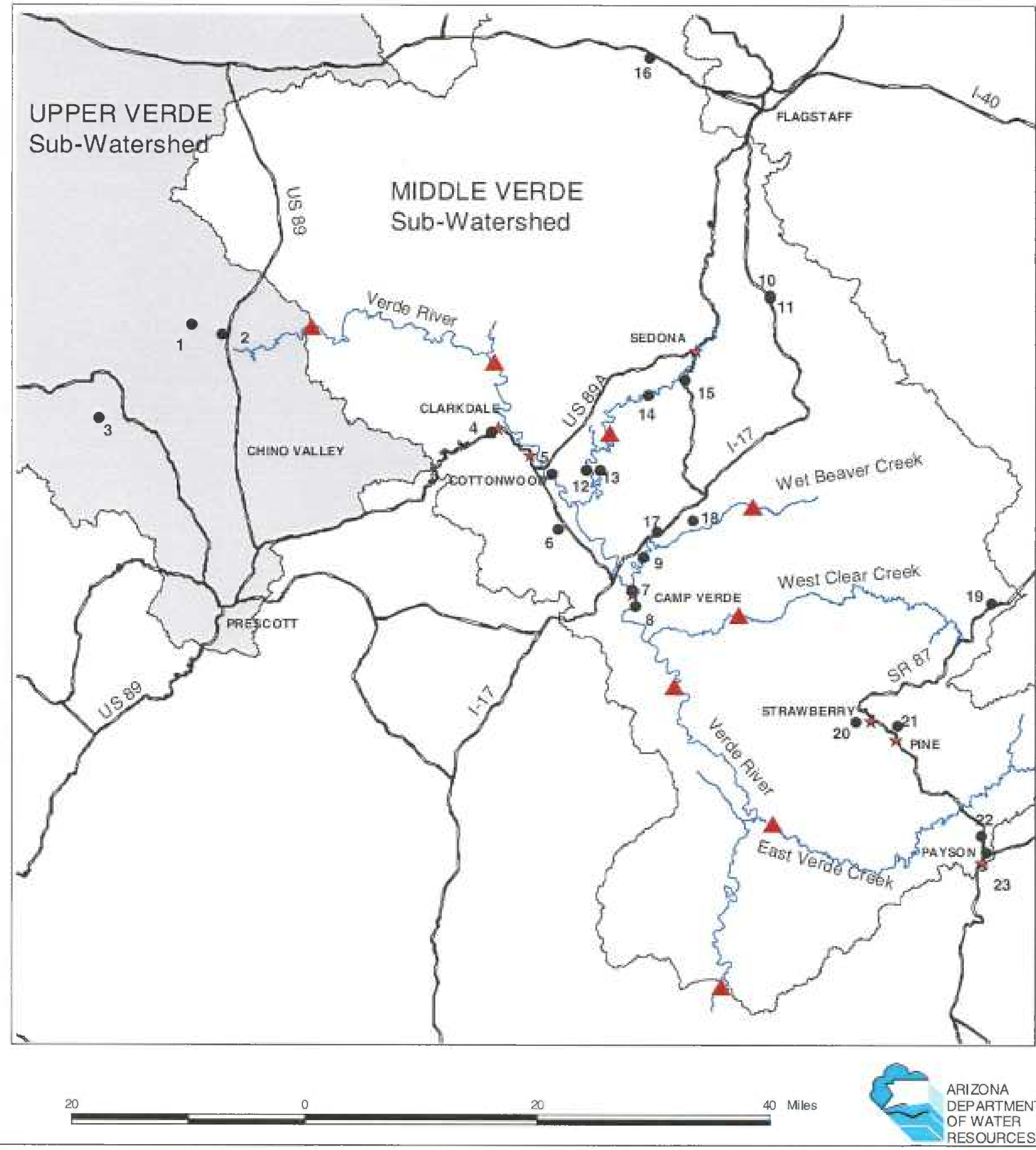
Figure 4.8 - Index Wells in the Upper Verde



Source: Arizona Department of Water Resources GWSI Well Database

Figure 4.9
ADWR Index Wells
Upper & Middle Verde

- Index Wells
- USGS Stream Gages
- Cities
- Rivers
- Roads
- Upper Verde
- Middle Verde



Index Well Numbers:

1- 345338112311801
2- 345301112283701
3- 344636112394401
4- 344556112040501
5- 344250111583401
6- 343843111575301
7- 343409111511101
8- 343254111505401
9- 343638111501301
10- 345612111385201
11- 345619111385501
12- 344312111540801
13- 344307111552701
14- 344850111494801
15- 344957111463102
16- 351409111500302
17- 343833111490101
18- 343924111454901
19- 343314111183801
20- 342417111305101
21- 342408111270401
22- 341547111192501
23- 341436111190001

TABLE 4-1

ESTIMATED ANNUAL GROUNDWATER WITHDRAWALS BY AREA (ACRE-FEET)

YEAR	LOCATION BIG CHINO	LITTLE CHINO	VERDE
1974	11,000	13,000	4,000
1975	12,000	15,000	4,000
1976	10,000	14,000	4,000
1977	9,000	18,000	9,000
1978	6,000	15,000	8,000
1979	5,000	15,000	8,000
1980	5,000	15,000	7,000
1981	6,000	15,000	8,000
1982	NA	14,000	9,000
1983	NA	14,000	9,000
1984	1,000	15,000	10,000
1985	3,000	14,000	12,000
1986	5,000	13,000	10,000
1987	3,000	9,000	14,000
1988	3,000	10,000	18,000
1989	4,000	15,000	24,000
1990	4,000	13,000	23,000

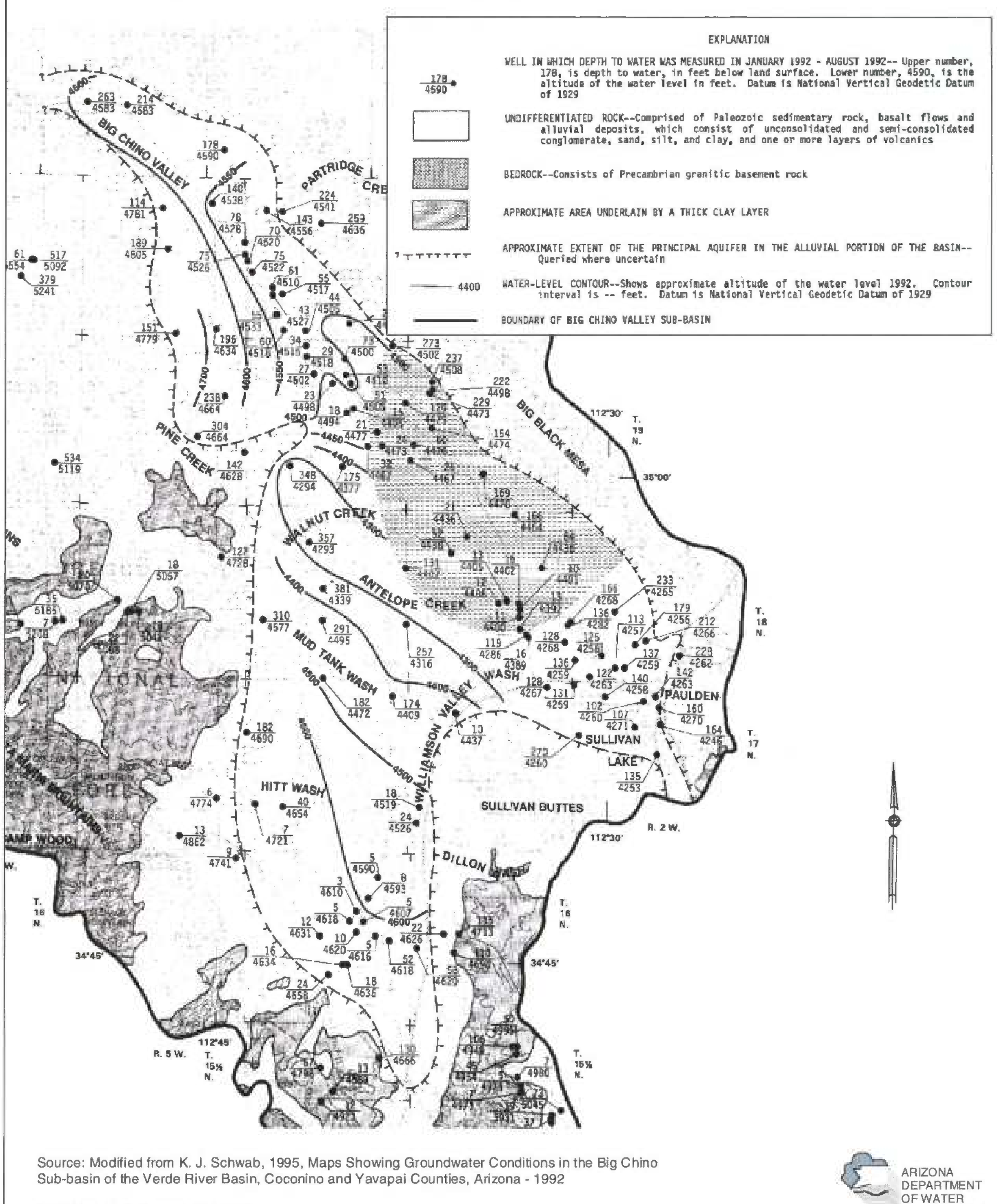
Source: USGS Survey, OFR 94-476, 1994.
NA: Not available

Groundwater Levels

Big Chino Sub-basin

A study conducted in Chino Valley in 1993 by the Bureau of Reclamation noted that groundwater pumping for irrigation and recreation purposes during the 1950s and 1960s was estimated to have exceeded the amount of water that was replenished by natural recharge. It was also noted that most groundwater pumping for irrigation and recreational use had ceased by 1993. Field investigations conducted by ADWR in 1996 confirmed those findings. A more recent field investigation conducted in 1998 identified an additional 1,200 acres of new farming, which could increase the amount of groundwater pumping from the 1996 total by as much as 4,800 acre-feet of water annually. See Figure 4.10 for a map showing depth to water and altitude of water levels in the Big Chino sub-basin.

Figure 4.10 - Depth to Water and Altitude of the Water Level in the Big Chino Groundwater Sub-basin, Spring 1992



Source: Modified from K. J. Schwab, 1995, Maps Showing Groundwater Conditions in the Big Chino Sub-basin of the Verde River Basin, Coconino and Yavapai Counties, Arizona - 1992

Base from U. S. Geological Survey
Prescott, Arizona, 1954, Rev. 1970, 1:250,000
Williams, Arizona, 1954, Rev. 1970, 1:250,000

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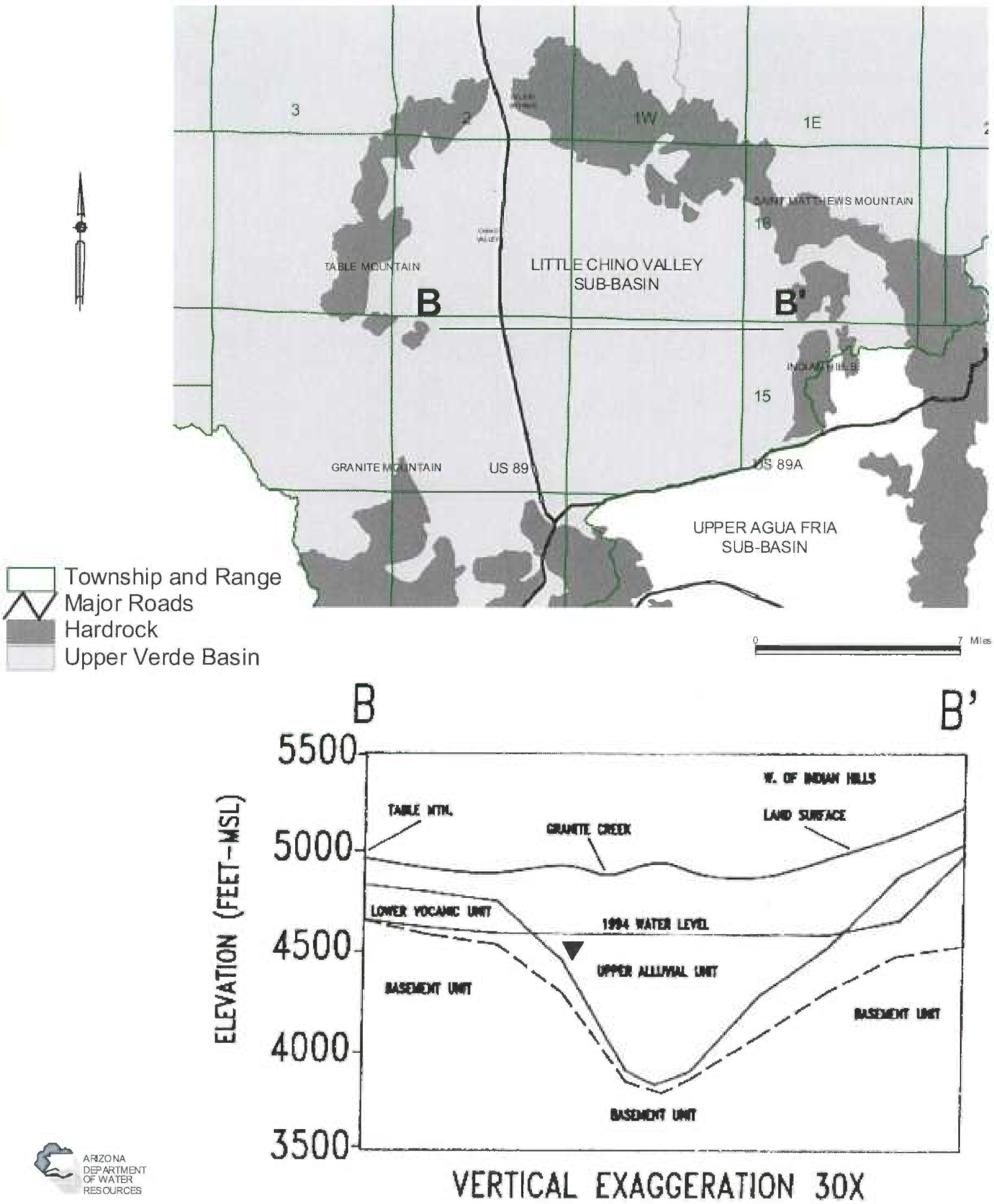
Little Chino Sub-basin

Schwalen (1967) noted that groundwater pumping was not significant in the Little Chino sub-basin prior to 1937. By 1940, however, the annual and seasonal lowering in the artesian pressure had become a cause for concern due to the increase in groundwater withdrawals for irrigation. The steady-state groundwater conditions appeared to have ended in the Little Chino sub-basin around 1940. Between 1940 and 1960 the continual pumpage for irrigation had caused water levels to decline in both the Upper Alluvial Unit and Lower Volcanic Unit aquifers throughout most of the Little Chino sub-basin (Corkhill and Mason, 1995).

From 1960 to the early 1980s, water levels in most of the Little Chino sub-basin continued to decline at a rate consistent with the declines experienced during the period from 1940 to 1960. Water levels in the "perched" areas also began to decline around the end of the 1970s due to the reduction in agricultural recharge and an increase in shallow domestic well pumpage. By 1981, groundwater usage had resulted in an 80-foot decline of water levels in the confined zone of the Lower Volcanic Unit aquifer. Annual mean groundwater discharge at Del Rio Springs had also declined from approximately 2,800 acre-feet per year between 1940 and 1945 to approximately 2,400 acre-feet per year between 1984 and 1989 (Corkhill and Mason, 1995).

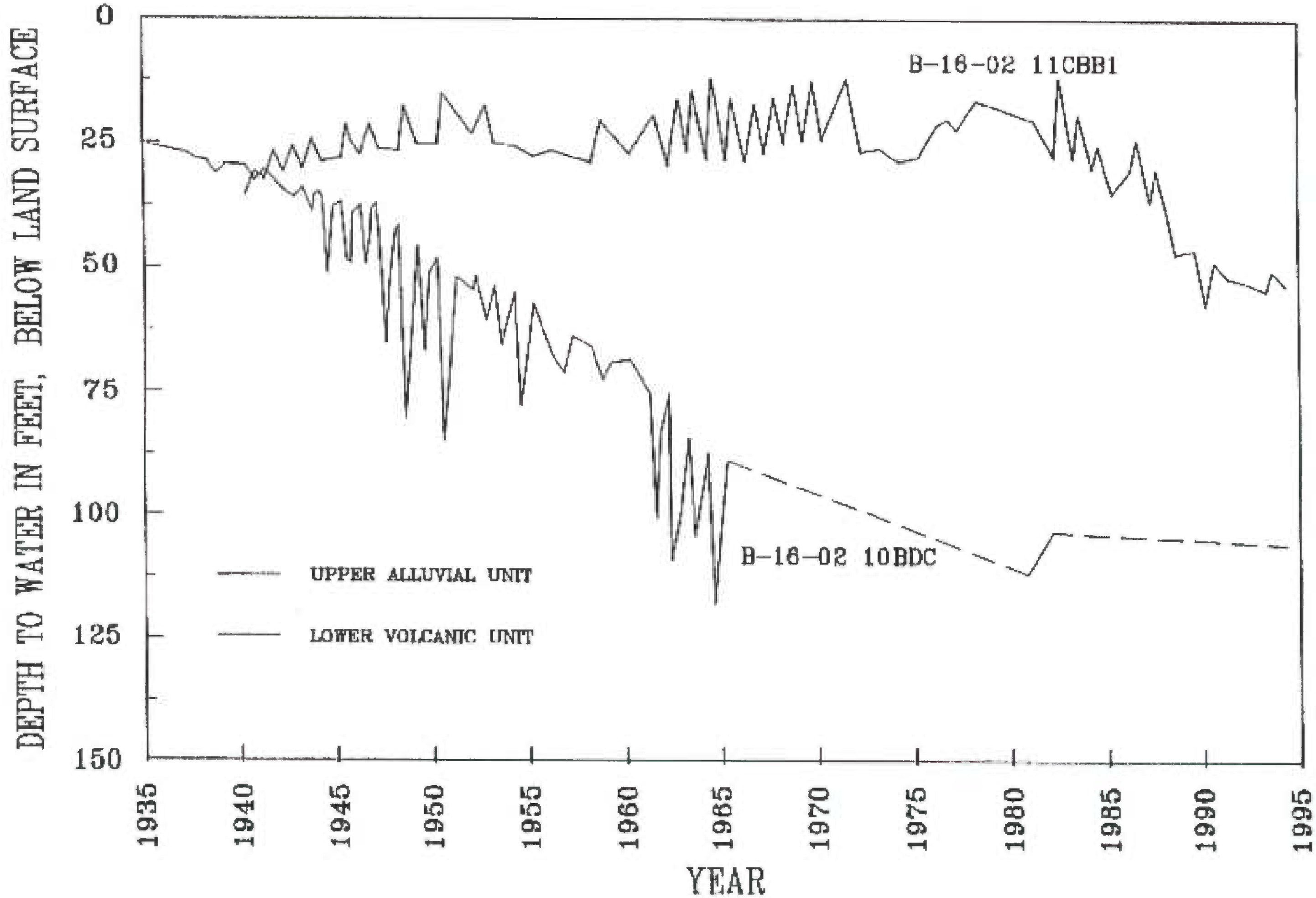
Water levels in many areas of the Little Chino sub-basin continued to decline from 1981 to 1993, but at a much slower rate than had previously been occurring due to the reduction in farming activities (ADWR, 1995). The "perched" water levels of the Upper Alluvial Unit aquifer in the agricultural areas of the Little Chino sub-basin were reported to have risen slightly or remained constant during this same time period. This was due to the presence of intervening, fine-grained layers in the unsaturated (vadose) zone, which restricted the downward flow of excess, deep-percolating irrigation water. Seasonal water levels fluctuated as much as 20 feet in the "perched" area of the Upper Alluvial Unit aquifers as a result of agricultural recharge. Water levels rose in the Upper Alluvial Unit aquifer during the summer months and declined during the winter months. Seasonal fluctuations of about 40 feet occurred in the Lower Volcanic Unit aquifer. Low water levels were observed during the summer months when there was more pumping and high water levels occurred during the winter months when there was less pumping (Corkhill and Mason, 1995). Figure 4.11 describes the hydrogeologic cross sections of the Little Chino groundwater sub-basin. Figure 4.12 presents hydrographs of wells located in Little Chino

Figure 4.11 - Hydrogeologic Cross-section of Little Chino Valley



Source: Corkhill and Mason, 1995, Arizona Department of Water Resources.

Figure 4.12 - Hydrographs of wells located in the Little Chino Groundwater Sub-basin



Source: Corkhill and Mason, 1995, Arizona Department of Water Resources, Modeling Report #9.

that show seasonal water level fluctuations in the Upper Alluvial Unit and Lower Volcanic Unit aquifers for the period 1935 to 1995. Figure 4.13 is a map showing groundwater elevations in the Prescott AMA during 1994.

Figure 4.14 shows three specific well hydrographs for the Upper Verde. The fluctuations in depth to water provides insight into the impacts on the groundwater system resulting from periods of drought, periods of high precipitation, and increases in groundwater pumping as observed in these hydrographs.

Limited, long-term, continuously monitored data is available for this area. These three wells were selected because they have the longest continuous period of record.

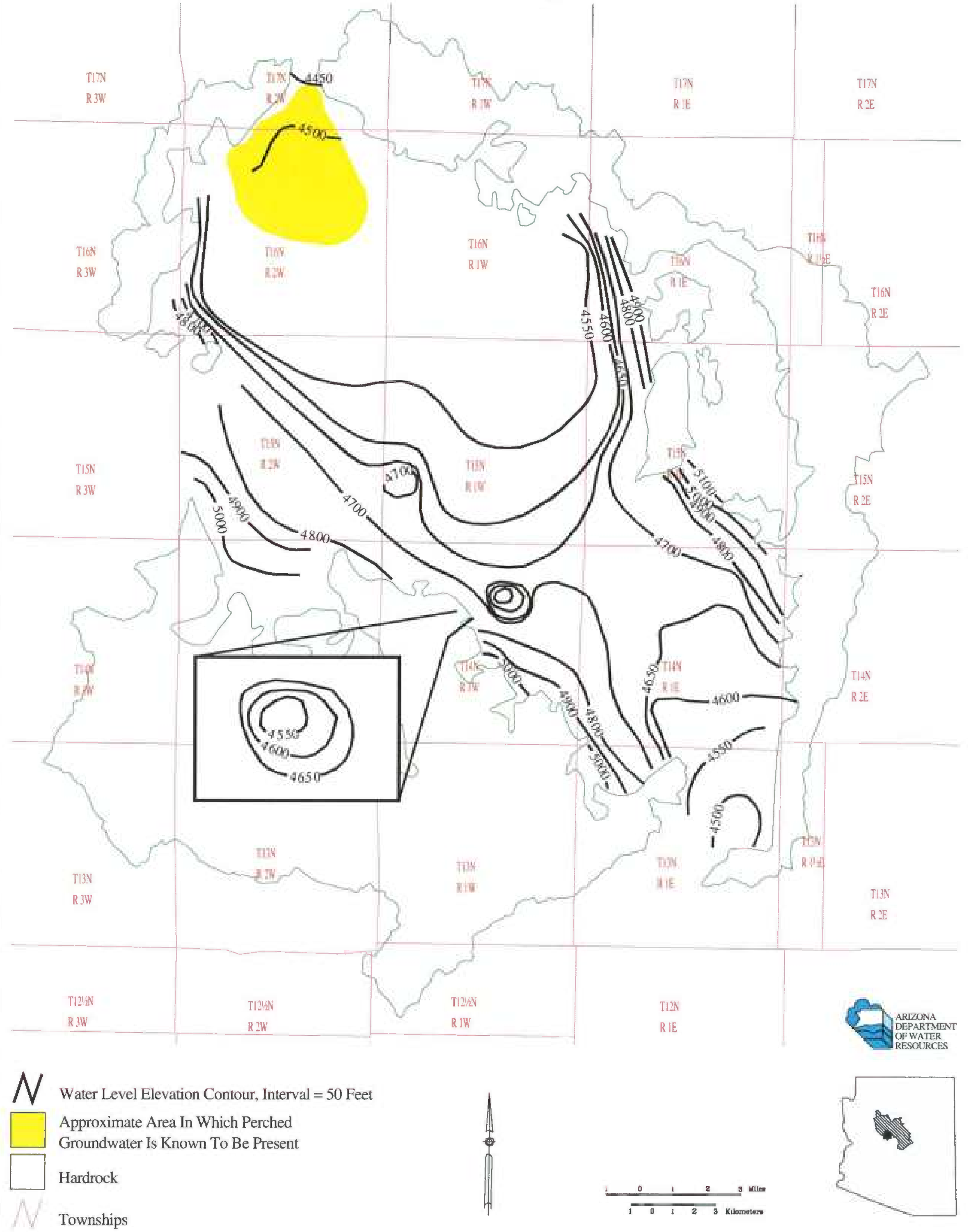
Well Hydrograph Analysis:

- Two wells located in the Upper Verde area near Wineglass Ranch: 1) Well Site ID#345338112311801 - depth 342 feet; had virtually no change in depth to water over 33 years; 2) Well near Simmons, ID#344636112394401 - depth 352 feet; registered no change in over 32 years of monitoring (Figure 4.10).
- An index well located near Paulden: Well ID#345301112283701 - no well depth given; 15 years of data has demonstrated a slight increase in depth to water from 97 feet in 1983 to its current depth to water of 105 feet.

Groundwater Storage Estimates

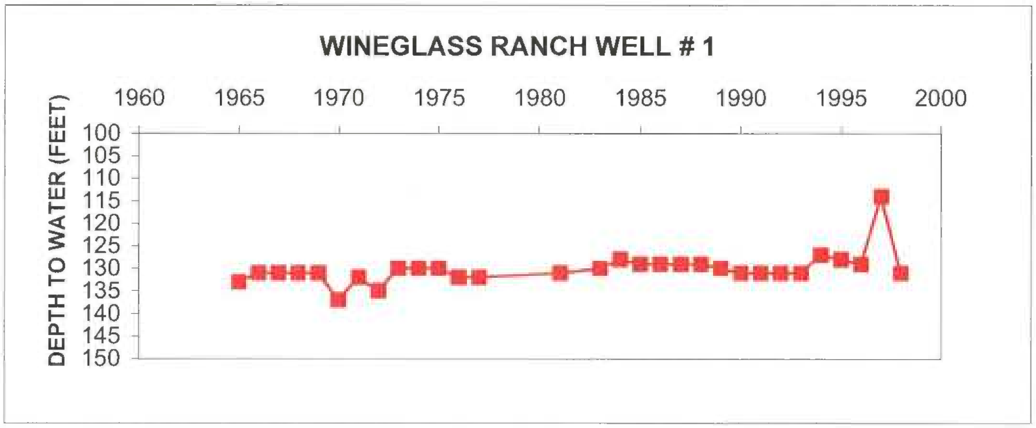
The 1974 USBR report states that more than 16 million acre-feet of groundwater are estimated to underlie both Big Chino and Williamson Valleys. A current estimate of groundwater storage for the entire Big Chino sub-basin is not known. Corkhill and Mason estimated the groundwater storage in the Upper Alluvial Unit of the Little Chino sub-basin in 1995 to be approximately 1.4 million acre-feet. Corkhill estimated the volume of groundwater storage in the Lower Volcanic Unit of the Little Chino sub-basin in 1998 to be about 0.9 million acre-feet making the total groundwater storage estimate for Little Chino Valley sub-basin approximately 2.3 million acre-feet. The current estimated total groundwater storage in the alluvial valleys of Big Chino and Little Chino sub-basins is shown in Table 4-2.

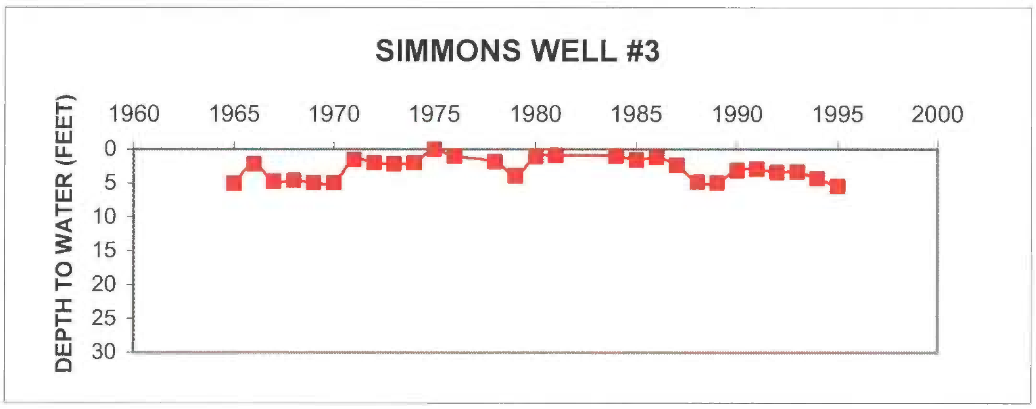
Figure 4.13 –Groundwater Elevations (1994)
Prescott Active Management Area



Source: Modified from Composite Water Level Elevation Map from Plate 3 of the Prescott Model Report, ADWR, 1995.

Figure 4.14 Upper Verde Well Hydrographs
*Well numbers correspond with well locations on figure 4.9
**Well hydrographs derived from ADWR Wells Registry Database





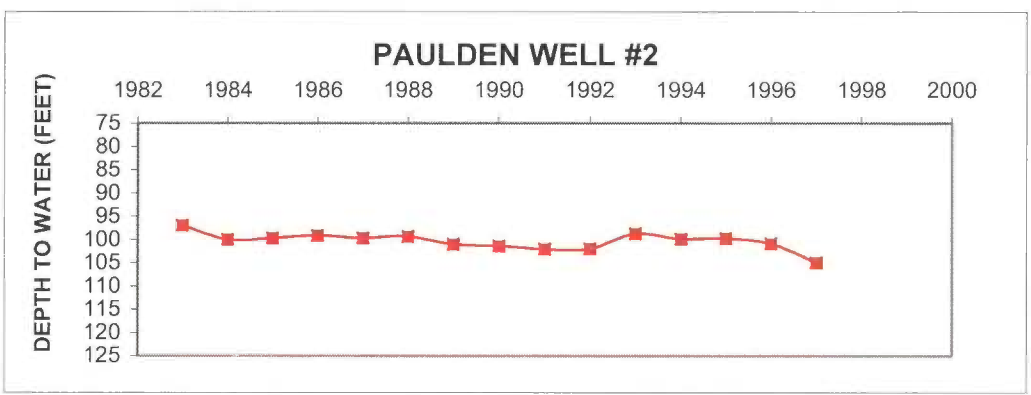


TABLE 4-2

GROUNDWATER IN STORAGE IN THE ALLUVIAL VALLEYS OF THE UPPER VERDE

LOCATION	DEPTH BELOW LAND SURFACE (FEET)			
	0 TO 300	300 TO 700	700 TO 1,200	0 TO 1,200
	Groundwater Storage (acre-feet)	Groundwater Storage (acre-feet)	Groundwater Storage (acre-feet)	Groundwater Storage (acre-feet)
Little Chino Valley*	NA	NA	NA	2,300,000*
Williamson Valley	730,000	1,800,000	1,300,000	3,830,000
Big Chino Valley	2,300,000	6,000,000	4,500,000	12,800,000
Total	**3,030,000**	**7,800,000**	**5,800,000**	**18,830,000**

Source: USBR, 1974.
*Corkhill and Mason, 1995.

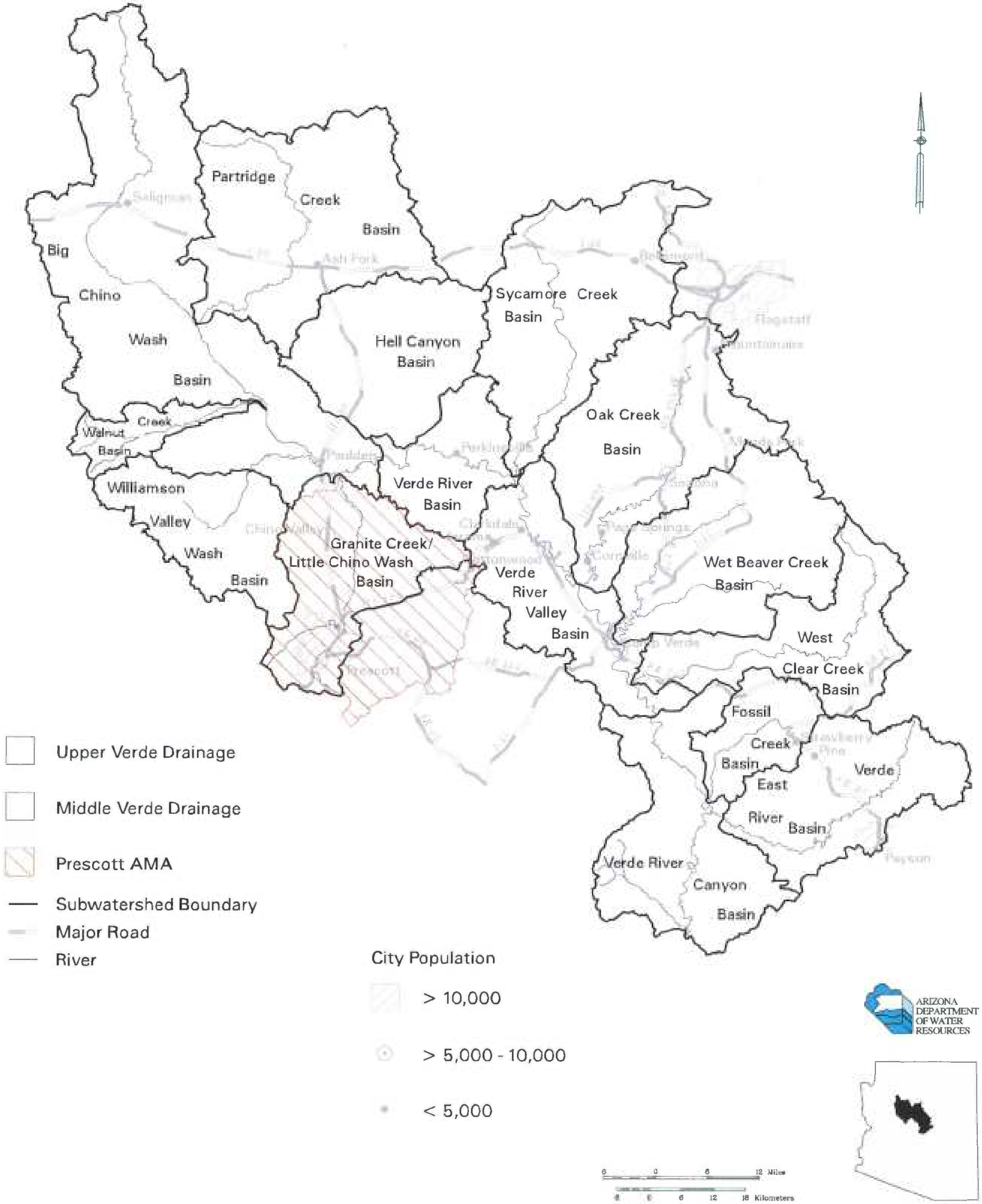
The estimated groundwater storage in the floodplain alluvium between Sullivan Lake and Clarkdale is believed to be nearly zero (USBR, 1974). The total amount of groundwater in storage in the Big Chino Valley, Williamson Valley, and Little Chino Valley areas can only be estimated due to the lack of data and/or incomplete hydrogeologic assessment in the Upper Verde.

SURFACE WATER SYSTEM

Description

The Upper Verde Subwatershed is approximately 2,100 square miles and encompasses both the Big and Little Chino Subwatersheds and as such will be discussed separately. The surface water system in the Big Chino Subwatershed consists of the Big Chino Wash, Partridge Creek, Walnut Creek, Williamson Valley Wash, and the Verde River. The Little Chino surface water system consists of Granite Creek and Little Chino Wash (Figure 4.15). Of the six surface water drainages comprising the Upper Verde Subwatershed, only five are known to directly contribute water to the groundwater system in the Upper Verde from ephemeral stream channel infiltration. See Figure 4.16 for a description of stream types and common relationships to the water table. These are the Big Chino Wash, Partridge Creek, Walnut Creek, Williamson Valley Wash, Granite Creek, and Little Chino Wash. Selected gaging locations along drainages in the Upper Verde are presented in Table 4-3.

Figure 4.15 - Surface Water Drainages of the Verde River Watershed Study Area



Source: Arizona Department of Water Resources, Water Resources of the Upper and Middle Verde River, AZ, 1999.

Figure 4.16 - Perennial and intermittent reaches and their relationship to the water table.

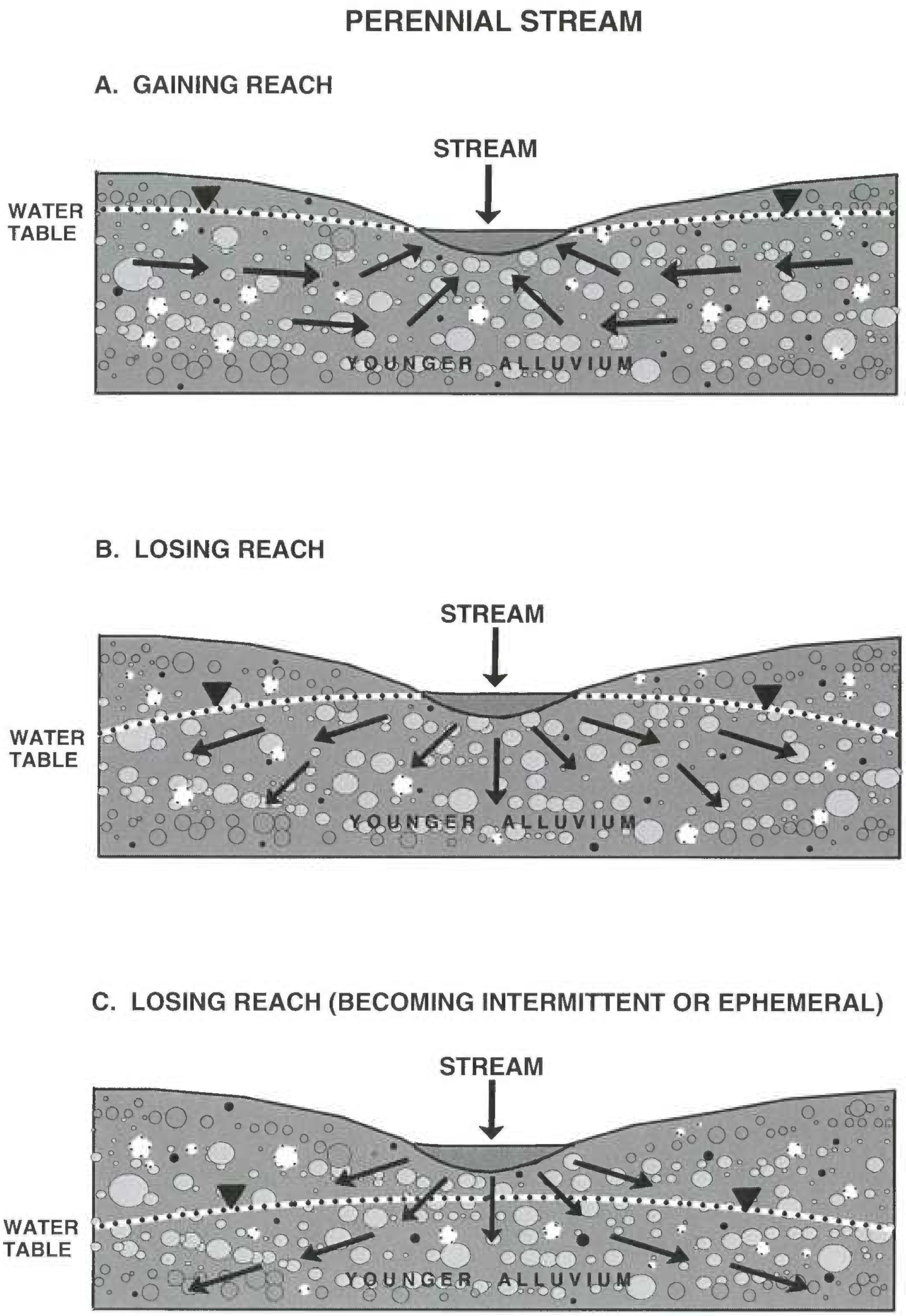
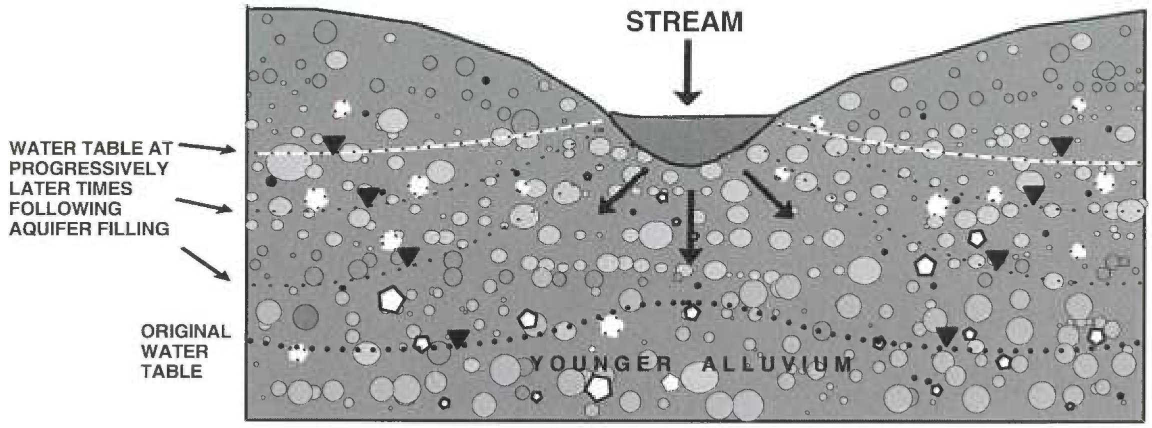


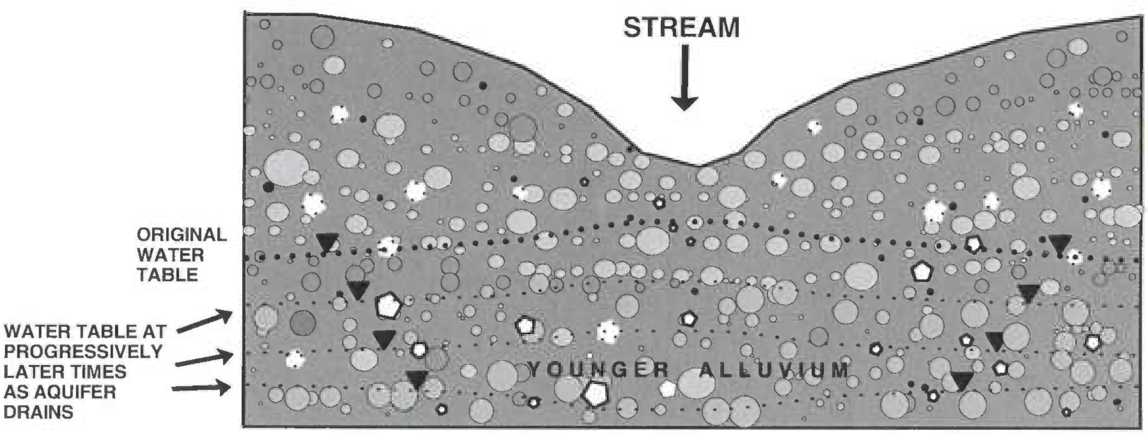
Figure 4.16 - continued

INTERMITTENT STREAM

A. FLOWING REACH



B. DRY REACH



Source: Technical Assessment of the Arizona Interlocutory Appeal Issue No. 2 Opinion, Arizona Department of Water Resources,1993.

TABLE 4-3

SELECTED USGS GAGING STATIONS IN THE UPPER VERDE

LOCATION	GAGE #	DRAINAGE AREA (SQ MILES)	PERIOD OF RECORD
Walnut Creek near Ashfork	09502750	None Given	10/91 to 9/92
Mint Wash near Paulden	09502780	52.5	1972 to 1975
Williamson Valley Wash	09502800	255	3/65 to 9/85
Del Rio Springs	09502900	None Given	8/96 to Present
Granite Creek at Prescott	09502960	30	11/94 to Present
Granite Creek near Prescott	09503000	36.3	7/32 to 9/47, 10/94 to Present
Willow Creek near Prescott	09503500	25.2	6/32 to 3/37
Verde River near Paulden	09503700	2,507	7/63 to Present

Source: USGS Water Resources Data - Arizona.

Big Chino Subwatershed

The Big Chino Subwatershed encompasses approximately 1,800 square miles. Drainage is characterized by numerous ephemeral and several perennial streams that originate in the mountains and uplands surrounding the Big Chino basin. The headwaters of Big Chino Wash originate in an area just east of Aubrey Cliffs on the Coconino Plateau, approximately 20 miles northwest of Seligman, and includes several drainages west of Seligman. Runoff from the Coconino Plateau flows south to a location west of Seligman where the drainage is impounded by flood control structures at State Route 66, the Atchison Topeka & Santa Fe Railroad right-of-way, and Interstate 40. Approximately five miles below these impoundments, local drainages converge to form the broad basin of the Big Chino Wash.

Big Chino Wash forms the major north-south drainage and primarily receives runoff from Turkey Canyon, Pine Creek, Walnut Creek, Williamson Valley Wash, and Partridge Creek. Turkey Canyon, Pine Creek, Walnut Creek, and Williamson Valley originate in the Juniper and Santa Maria Mountains to the west, while Partridge Creek originates on the Coconino Plateau northwest of Ashfork. Big Chino Wash continues its flow southeastwardly for approximately 40 miles to Sullivan Lake, which is considered to be the headwaters of the Verde River.

In its upper reach, Big Chino Wash is an ephemeral stream. Ephemeral flows in the Big Chino Wash either infiltrate into the basin floor or flow southeast to Sullivan Lake and join the Verde River. Walnut and Apache Creeks are ephemeral streams with short perennial reaches and Williamson Valley Wash is ephemeral with intermittent reaches. Perennial flow that is not diverted infiltrates into the streambed. Ephemeral flows may be great enough during exceptional storms to flow into the Big Chino Wash and the Verde River. Sullivan Dam was constructed in the 1930s to prevent head erosion on the Verde River (USBR, 1993). Sullivan Lake today is less than five surface acres in size and several feet deep at the dam. The streamflow gaging station on the Verde River near Paulden (09503700) is the first USGS gaging station on the Verde River, approximately 10 miles downstream of Sullivan Lake.

Flow Data at Gaging Stations

Big Chino Subwatershed

1. Gaged Tributaries - Annual Inflows

The Big Chino Subwatershed is ephemeral except for short perennial reaches along Walnut and Apache Creeks and intermittent reaches along Williamson Valley Wash. Runoff from precipitation and snowmelt may result in flows of short duration. The average and median discharges were obtained from the records of two inactive USGS gaging stations located in Williamson Valley Wash and Walnut Creek. Runoff measurements were used to estimate natural recharge. Refer to Figure 2.1 for stream locations.

Streamflow data is unavailable for Big Chino Wash. The streamflow gage on the Verde River near Paulden is the only active gage in the Big Chino Wash and Verde River system. Limited stream gage data, however, are available for the Williamson Valley Wash near Paulden (09502800) and Walnut Creek near Ashfork (09502750). Streamflow measurements were recorded for Williamson Valley Wash from 1965 to 1985 and Walnut Creek from October 1991 to September 1992. Inflow estimates for the Big Chino Subwatershed were determined from USGS streamflow measurements, runoff from direct precipitation, and an estimate of storm flow on Partridge Creek from the U. S. Bureau of Reclamation, 1993.

Williamson Valley Wash is an ephemeral stream with intermittent reaches. The USGS gaging station for Williamson Valley Wash is located approximately 12 miles northwest upstream of Sullivan Lake Dam. Nineteen years of data have been collected at this station. The mean discharge and average annual runoff for Williamson Valley Wash are approximately 15 cubic feet per second (cfs) and 11,160 acre-feet, respectively. The median of yearly mean discharge and runoff are 6 cfs and 4,300 acre-feet respectively.

Walnut Creek is an ephemeral stream with a short perennial reach on the North Fork of Walnut Creek. The USGS installed a streamflow gage to estimate recharge in the Big Chino

Sub-basin from the Juniper Mountains (USBR, 1993). The mean discharge and average annual runoff are 2 cfs and 1,550 acre-feet respectively for water year 1992, the only period of record available.

2. Ungaged Tributaries – Annual Inflows

Partridge Creek is an ungaged ephemeral stream that drains into the northern reach of Big Chino Wash from the northeast. Runoff flows across the Big Chino Fault, along the western flank of Big Black Mesa, on the east side of the basin. Surface flows in Partridge Creek only occur during exceptionally large storm events. The annual runoff from Partridge Creek is estimated to be 3,000 acre-feet (USBR, 1993).

3. Gaged Tributaries – Annual Outflows

Streamflow from the USGS gaging station at the Verde River near Paulden gage was used to estimate the Upper Verde watershed outflow. Average and median discharges recorded at this location were used to estimate the outflow from the Big Chino and Little Chino Subwatersheds to the Verde River. Perennial flow in the Verde River system begins near the confluence of Granite Creek, approximately two miles downstream from Sullivan Lake. Upstream from Granite Creek the Verde River has been described as intermittent with numerous stagnant pools that are maintained by infrequent surface runoff (USBR, 1993). The USGS gaging station on the Verde River near Paulden is approximately eight miles downstream from Granite Creek. The annual average discharge and runoff of the Verde River as measured at the USGS gaging station near Paulden for Water Years 1963 through 1997 is approximately 45 cfs or 32,500 acre-feet. The median of the yearly mean discharge for the same period is 29 cfs, which equal or 21,000 acre-feet of annual runoff (Hydrodata, Hydrosphere, 1998). The Verde River discharge for water year 1997 was 25 cfs, which is equal to 18,190 acre feet of annual runoff. Surface water flow in the Upper Verde River is the result of groundwater discharge (baseflow) and flood flows from Big Chino Wash and Granite Creek during major storms.

Little Chino Subwatershed

The Little Chino Subwatershed encompasses an area of 316 square miles. The major drainages are Granite Creek, Willow Creek, and Little Chino Wash. Surface runoff in this sub-watershed flows northward towards the Verde River. Granite Creek is the major drainage with several tributaries originating in the higher elevations south and east of Prescott. The primary tributaries of Granite Creek that originate in mountains south of Prescott are: Aspen Creek, Bannon Creek, Butte Creek, Government Canyon, Groom Creek, Manzanita Creek, and Miller Creek. The Granite Creek flow is partly regulated by Goldwater Reservoirs on Bannon Creek. These streams drain into Granite Creek near Prescott above Watson Lake. Granite Creek flows east through Prescott and then north beside State Route 89 to Watson Lake. Two USGS gaging stations are located along Granite Creek above Watson Lake to measure daily flows. Granite Creek is dammed to form Watson Lake above the Granite Dells. Water is released to Granite Creek and is diverted downstream first by one private landowner near Granite Dells and then by the Chino Valley Irrigation District (CVID) below Granite Dells.

Granite Creek also receives inflows from Lonesome Valley, which is located north of Prescott Valley. In Lonesome Valley, surface runoff flows northwest through grassy covered undulating topography towards Granite Creek a few miles upstream of the Verde River. The Lonesome Valley area is mostly used as open range and is currently being subdivided for residential development near Prescott Valley.

The Willow Creek drainage area is approximately 25 square miles with the headwaters located in the Sierra Prieta Mountains six miles west of Prescott. It flows approximately 10 miles to the northeast where it is impounded by Willow Creek Reservoir. Water is released from the reservoir to Willow Creek where it is diverted by CVID about one mile downstream near State Route 89. Streamflow in Willow Creek that is not diverted by the CVID, flows into Granite Creek just downstream from Granite Dells. Flow measurements of Willow Creek were recorded by the USGS from 1932 to 1937, but no current flow data is available.

Little Chino Creek and its tributary, Big Draw Wash, are ephemeral streams that drain the west and north-central basin. The streams follow a northeasterly course through the Chino Valley area below Del Rio Springs to Sullivan Lake.

1. Gaged Tributaries

Runoff was determined from streamflow data recorded at the USGS gaging stations on Granite Creek near Prescott (0950300) and Willow Creek (0903500). The average annual streamflow for these two creeks was approximately 4,800 and 1,400 acre-feet respectively for the period 1933 through 1947 (Corkhill and Mason, 1995). The median annual flow for these two creeks was approximately 2,300 and 900 acre-feet respectively for the same time period.

Natural recharge in the Little Chino sub-basin was estimated to be approximately 2,050 acre-feet per year (ADWR, 1998) for the period of groundwater development from 1940 to present. Currently, there is streamflow data available only for the gages on Granite Creek at Prescott (09502960) from November 1994 to the current year and on Granite Creek near Prescott (09503000) from October 1994 to the current year. The average annual streamflow at these two gages was 2,380 acre-feet (3.29 cfs) and 2,340 acre-feet (3.23 cfs) respectively for water year 1997.

It should be noted that the streamflow data for the period 1933 to 1947 provided a reasonable estimate of streamflow conditions in a less urbanized and developed watershed than today. Current data is needed in order to observe and predict the present effects of urbanization and groundwater withdrawals that may influence future stream behavior and water supply.

2. Gaged Tributaries - Annual Outflows

There are no measured annual surface outflows from the Little Chino Subwatershed. Surface runoff typically infiltrates into the sandy channel of Granite Creek. It is assumed that much of the infiltrated water eventually recharges the groundwater system. Surface water flows of Granite Creek and the Verde River were observed and measured by Knauth and Greenbie (1997) as part of an isotopic investigation of groundwater and surface water interactions in the headwaters region of the Verde River. In May 1996, they measured the streamflow of Granite Creek about 300 feet upstream of the Verde River and the Verde River about ¼ mile below the confluence with Granite Creek. The total discharges were 0.13 cfs and 4.62 cfs respectively. They observed that the Verde River baseflow became measurable at the mouth of Granite Creek where creek underflow emerged into the Verde River. In July 1997, they conducted another measurement of the Verde River below Granite Creek. They observed that the Verde River baseflow increased by a factor of 4 to 5 approximately ¼ mile downstream from Granite Creek, and assumed from isotopic analysis that the source of the Verde River baseflow was mainly from the Black Mesa Aquifer with as much has 25 percent coming from the Granite Creek drainage. The annual total mean discharge of Granite Creek was estimated by ADWR at 25 percent of the streamflow of the Verde River about ¼ mile below the confluence with Granite Creek. Streamflows measured on May 22, 1996 and July 11, 1997, were 4.62 cfs and 4.44 cfs respectively (Knauth and Greenbie, 1997). The average discharge of the Verde River below Granite Creek was 4.53 cfs or about 3,280 acre-feet per year. Assuming about 25 percent of the baseflow of the Verde River ¼ mile below Granite Creek was from the Granite Creek drainage, the annual total mean discharge of Granite Creek was estimated to be about 820 acre-feet.

Additional studies should be forthcoming from the USGS and others that may shed further light on the accuracy of this current estimate.

Surface Water Diversion Points

A total of 11 surface water diversions were identified in the Upper Verde. Seven were located in the Big Chino sub-basin and four were located in the Little Chino sub-basin. In the Big Chino sub-basin, three diversions are located on Walnut Creek; one on Apache Creek, one at Colcord Spring, one diversion is located on a pond that receives water from three separate springs (Section 1 spring, Little Spring, and Cienega Spring), and one diversion is located on Horse Wash. All of these diversions are located on reaches of creeks or springs that flow perennially in most years, except Horse Wash.

Three diversions on Walnut Creek divert surface water for irrigation to approximately 100 acres, of which 35 acres are irrigated exclusively with surface water and 60 acres are irrigated with a combination of surface water and groundwater. The diversion on Apache Creek diverts surface water for irrigation on approximately 10 acres. The diversion on Colcord Spring diverts surface water for irrigation on approximately 70 acres. The diversion of surface water from each of the three springs is utilized for domestic use, irrigating approximately 15 acres, and for generating electricity. The diversion on Horse Wash is used to divert surface water for irrigation of approximately 10 acres of land when water is available. A total of approximately 205 acres of land may be irrigated with surface water in the Big Chino sub-basin.

In the Little Chino Subwatershed, CVID diverts water from controlled releases to Granite Creek and Willow Creek from Watson Lake and Willow Creek Reservoir. Irrigation water is conveyed to the north by pipe and open ditch to CVID for irrigation purposes. Although the actual annual volume of surface water diverted and received by CVID at their headgate is unknown, estimates of these volume totals are as follows for the period 1991 to 1996. CVID estimated the annual volume of water diverted from Watson Lake and Willow Creek Reservoir for the time period 1991-1996 ranged from 1,580 acre-feet to 12,270 acre-feet (Exhibit EE CVID Water Supply 1915-1996, City of Prescott Severance and Transfer Application, 7/30/98. Accuracy of Exhibit EE reconfirmed in a letter from CVID's attorney to ADWR, December 23, 1999.)

The volume of surface water estimated to be received by CVID at their headgate for the period 1991 to 1996 ranged from about 790 acre-feet to 6,360 acre-feet (Exhibit EE CVID Water Supply 1915-1996, City of Prescott Severance and Transfer Application, 7/30/98. Accuracy of Exhibit EE reconfirmed in a letter from CVID's attorney to ADWR, December 23, 1999.) The amount of water received by CVID at their headgate is significantly different than the amount of water estimated to be diverted from Watson Lake and Willow Creek Reservoir due to seepage and evaporation losses along the way. Approximately 50 percent of the total water diverted from Watson Lake and Willow Creek Reservoir is estimated to be lost due to seepage in the unlined ditch (Corkhill and Mason, 1995).

The estimated average annual volume of surface water diverted and received by CVID for the same time period 1991 to 1996 was about 7,856 acre-feet and 3,928 acre-feet respectively. No surface water was reportedly delivered in 1990. It should be noted that in 1997 CVID estimated the annual volume of surface water diverted from Watson Lake and Willow Creek Reservoir ranged from 330 acre-feet to 2,550 acre-feet for the same time period 1991 to 1996. (Reported to Mr. Tim Gibson of ADWR by Ms. Sue Rees, office manager of CVID, 1997.)

Water is also diverted from Granite Creek to one private user that irrigates approximately 80 acres of pasture below Granite Dells. Del Rio Ranch diverts surface water north of Del Rio Springs for irrigation of approximately 150 acres of pasture. The City of Prescott has developed surface water supplies in the Little Chino Subwatershed from Bannon Creek, and in the Hassayampa River Watershed from Hassayampa Lake, Groom Creek, Wolf Creek, and the Hassayampa River. A pipeline connects the Hassayampa water sources with upper and lower Goldwater Lake on Bannon Creek in the Little Chino Subwatershed. However, the City of Prescott sold Hassayampa Lake in the early 1990s and it no longer diverts water from it. Goldwater Lake used to have an active water treatment plant to purify water for municipal use. Today, the lake is used solely for recreation. Water releases flow downstream in Bannon Creek to Granite Creek and finally Watson Lake.

4.3 MIDDLE VERDE GROUNDWATER SYSTEM

Geology

The groundwater system in the Middle Verde Subwatershed incorporates areas of the Verde Valley and Verde Canyon groundwater sub-basins (Figure 4.1). Known water-bearing units in these groundwater sub-basins include the younger or recent stream alluvium and Quaternary gravel along streams, Tertiary Verde Formation, Permian Supai Formation and Coconino Sandstone, Pennsylvanian Naco Formation, Mississippian Redwall Limestone, Devonian Martin Formation, and Cambrian Tapeats Sandstone. These units form a regional aquifer, which appears to be hydraulically interconnected. A hydraulic connection between different rock formations exists when groundwater can flow from one formation into another.

Prior studies have indicated that the majority of groundwater in the Middle Verde occurs in the younger alluvium and Verde Formation along the Verde River and in the Supai Formation along Oak Creek in Verde Valley. This section addresses the Verde Valley area specifically. The major populated areas of the Verde Valley, such as Cottonwood, Camp Verde, and Sedona are supplied groundwater from these aquifers for non-agricultural use. For further information on groundwater resources and other water bearing units of the Middle Verde not discussed in this report, see Levings (1980), Owen-Joyce and Bell (1983), and Owen-Joyce (1984).

Aquifer Characteristics and Locations

Younger Alluvium

Unconsolidated Quaternary alluvium (flood plain alluvium) forms the channel, floodplain, and terrace gravel along the Verde River and its major tributaries. Stream channel and floodplain deposits collectively consist of unconsolidated gravel, sand, silt, and clay. When the stream alluvium becomes saturated it forms an aquifer along the Verde River, Oak Creek, Beaver Creek, and West Clear Creek. It is considered the third largest aquifer in Verde Valley. Gravel terrace deposits cover large areas bordering the Verde River but are generally found above the water table (i.e., overlaying the Verde Formation saturated zone). The stream alluvium exceeds one mile in width through much of the Verde Valley but narrows dramatically where the river passes over consolidated rocks at the upstream and downstream reaches. The alluvium is typically about 60 feet thick, and may exceed 100 feet in the Camp Verde area (Owen-Joyce, 1984). The groundwater in the alluvium is in hydraulic connection with surface flows and with the Verde Formation beneath it. The majority of wells within the Middle Verde region are located in the stream alluvium. The measured volume of water currently being pumped from the stream alluvium is unknown.

Verde Formation

The Verde Formation forms the primary aquifer in the Middle Verde (and Verde Valley area) and is mostly unconfined. The aquifer is composed of sandstone, siltstone, mudstone, limestone, evaporites, and interbedded volcanic rocks. The formation was deposited in an ancient valley whose boundaries were similar to those of the present Verde Valley. The lakebeds and associated fluvial deposits appear as a great white mass blanketing the floor of the Verde Valley. Within the Verde Formation, the limestone units comprise the major water bearing units. The interbedded limestone units are usually confined between units of nearly impermeable mudstone. It has been estimated that the Verde Formation is mostly confined, and is at least 1,800 feet thick and covers approximately 325 square miles of the Verde Valley (Twenter and Metzger, 1963; Owen-Joyce, 1984). This formation underlies younger Quaternary gravel, stream alluvium, and terrace deposits in a basin covering an area extending from north of Clarkdale to south of Camp Verde. The Verde Fault forms the western boundary of the Verde Formation aquifer where upthrown, impermeable Precambrian and Paleozoic rocks are brought into contact with the regional aquifer. To the north and east, the Verde Formation overlies older Paleozoic sedimentary rocks.

The late Tertiary Verde Formation and younger stream alluvium combined are commonly referred to as the "Verde aquifer" and have previously been identified as the major sources of groundwater in the central valley area near the Verde River (Owen-Joyce, 1984). Major populated areas of the Middle Verde, including Camp Verde, Cottonwood, Clarkdale, and Cornville are dependent on groundwater from the Verde aquifer.

Supai Formation

The Supai Formation, of Permian age, is the main water-bearing unit of the regional aquifer underlying the Sedona and Page Springs area and is mostly confined. Groundwater occurring in the upper, middle, and lower members of the Supai Formation forms the second largest aquifer in Middle Verde. The middle and lower members of this Formation have been identified as the major producers of groundwater. This aquifer is composed of alternating beds of sandstone, mudstone, siltstone, limestone, thin-bedded dolomite pebble conglomerates, and layers of chert. Twenter and Metzger (1963) reported that sandstone lenses in the lower member are the principal aquifers in the Sedona area. Around the Oak Creek Canyon area, springs discharge from the upper limestone member.

The approximate thicknesses of the Supai Formation range from 0 to 1,050 feet for the upper member (mostly dry, little water-bearing potential), 0 to 290 feet for the middle member, and 0 to 465 feet for the lower member (Levings, 1980). Sedimentary sequences of the Hickey Formation, volcanic rocks, and Quaternary gravel overlie the Supai Formation. In the area around Page Springs, the Supai Formation is overlain by the Verde Formation. Locally, the Supai and Verde formations appear to be hydraulically connected. Groundwater appears to flow from the Supai Formation into the Verde Formation where part of it is discharged through fractures and solution cavities to springs and flowing wells.

Movement of Groundwater

Precipitation and Recharge

Infiltration of precipitation through permeable rocks of the Colorado Plateau and infiltration through stream channels provides the majority of the recharge to the regional aquifer. Levings (1980) supports the fact that groundwater in the regional aquifer is derived mainly from the infiltration of precipitation, in the form of rain or snowmelt from mountains that border the Verde Valley. In the Sedona vicinity, the main area of groundwater recharge was identified to be between the Mormon Mountain anticline and the Mogollon Rim, which received an average of 18 to 22 inches of precipitation per year (Sellers and Hill, 1974; Figure 4.2). Precipitation locally infiltrates the permeable outcrops of basalt and limestone, which provides avenues for the downward movement of water to the regional aquifer.

Five precipitation stations in the Middle Verde were examined: Montezuma, Beaver Creek recording stations (RS), Childs, Sedona RS, and the Tuzigoot station. Data was compiled for the past 30 years for every station except Tuzigoot, which had 19 years of recent data. These stations were chosen, due to their close proximity to the Verde River gaging stations observed in this study for the purpose of determining the precipitation effect on streamflow. The data indicated that 1996 monthly and annual precipitation were below the average at the reviewed precipitation stations, while 1992 had above average precipitation for most months. Average annual precipitation totals for the Middle Verde region over the last 30 years ranged from a high of 22.63 inches at Irving to a low of 12 inches at Cottonwood. The overall average annual precipitation for the Middle Verde region was calculated to be 16.92 inches. Historically, the average annual precipitation for the Middle Verde region was determined to be approximately 17 inches (Twenter and Metzger, 1963). Figure 4.17 lists the precipitation stations referenced in the Middle Verde with historical monthly precipitation averages, as well as the monthly precipitation amounts for 1992 and 1996.

The actual percentage of precipitation that is recharged back to the groundwater system is unknown, but has been estimated to be eight percent, based on a study of geologic conditions by Twenter and Metzger in 1963. For this study, the eight percent recharge factor is not used as a component of the Middle Verde water budget and is mentioned only as a point of interest and for the purpose of showing what the potential recharge factor would be if the eight percent were used.

The area of recharge for the Middle Verde region measures approximately 1,664,000 acres (Owen-Joyce and Bell, 1983). Multiplying the surface area of the Middle Verde region by the average rainfall (16.92 inches or 1.41 feet) and incorporating the eight percent recharge factor, yields approximately 187,699 acre-feet of water annually recharged to the groundwater system in an average precipitation year. If it were assumed that the system was in a steady state condition, the actual volume of precipitation recharge that would be required to balance the system would fluctuate from year to year based upon a number of factors including the condition of the watershed, the annual volume of precipitation, the number and size of storm events during any one year, and fluctuations in municipal, industrial, and agriculture demands.

Another source of recharge is from irrigation for agricultural production. Previous studies in the Middle Verde area indicate that water diverted from surface water supplies for irrigation purposes are an important recharge source. Owen-Joyce (1984) reported as much as 70 percent of the water diverted for irrigation may be recharged. Since the majority of diversions in Verde Valley are not gaged, an accurate estimate of recharge from agricultural irrigation is not possible.

Groundwater Flow Patterns

Twenter and Metzger (1963) reported that the regional movement of groundwater in the Middle Verde groundwater basin is from the Mormon Mountain anticline and the crest of the Black Hills towards the Verde River (Figure 4.18). Movement of groundwater occurs in a

Figure 4.17 Middle Verde Referenced Precipitation Stations

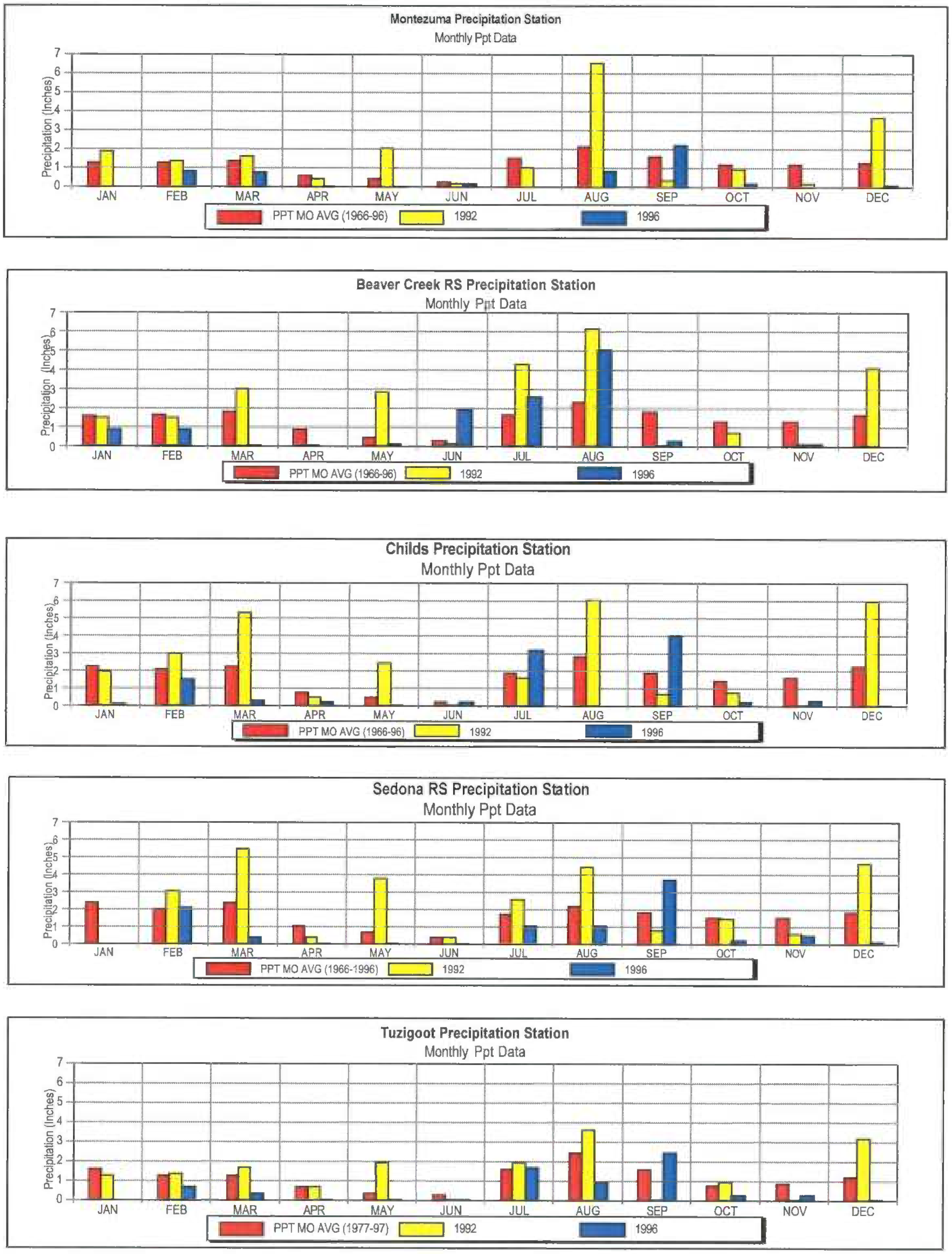


Figure 4.18 - Groundwater Movement in the Middle Verde

EXPLANATION

Approximate ground-water divide

General direction of ground-water movement

Anticline

Fault
U, *upthrown side;* D, *downthrown side*

-------6000.........

Structure contour
Drawn on top of Kaibab limestone; projected and dashed in areas where Kaibab is absent. Contour interval 500 feet

Verde Valley boundary

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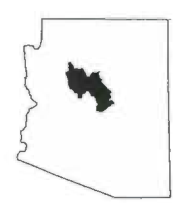


Source: Twenter, F.R. and Metzger, D.G., "Geology and Ground Water in Verde Valley-the Mogollon Rim Region Arizona."; Geological Survey Bulletin 1177, p 74.

southwesterly direction from areas near and around the Mogollon Rim. Water level contours in Levings' (1980) study of the Sedona area indicate groundwater movement to be in a southwestwardly direction from its main area of recharge between the Mormon Mountain anticline and the Mogollon Rim, through the Sedona area toward the Verde River. These groundwater level contours support Twenter and Metzger's earlier regional groundwater flow interpretations. Water infiltrates rock units of the regional aquifer and upon reaching the aquifer, moves downgradient towards the valley streams. Groundwater in the regional aquifer discharges through springs and seeps, which maintain the baseflows of the Middle Verde streams.

The elevation of the water table in the alluvium and the potentiometric surface of the Verde Formation were mapped by Owen-Joyce (1984) for an area along the Verde River from south of Camp Verde to Cottonwood Basin. Water level contours in Owen-Joyce and Bell's (1983) hydrologic study indicated groundwater movement to be in a southwesterly direction from the Mormon Mountain Anticline toward the Verde Fault on the west side of Verde Valley. Once reaching the fault zone, movement of groundwater is downgradient through the permeable stream alluvium of the Verde River in a southeasterly direction through the fractures and joints parallel to the fault.

Movement of groundwater through the regional aquifer is determined by complex relationships between water-bearing rock formations and structural features such as fractures, faults, and folds. Groundwater generally flows downward through fractures, solution channels, bedding planes, and permeable beds eventually discharging as springs, seeps, and gaining reaches near the Verde River and its tributary streams. Geologic structures can determine the flow path and occurrence of groundwater. Oak Creek Fault, for example, has been identified as a major structure regionally influencing the movement of groundwater from the Mogollon Rim area to the Verde River (Owen-Joyce and Bell, 1983). This fault is believed to act as a highly permeable zone along which groundwater can move more easily. Other faults in the area have similar roles in facilitating groundwater movement and discharge in the form of springs and seeps. The movement of groundwater can also be impeded by lateral and vertical changes in rock composition.

Groundwater Discharge

Groundwater discharge to the surface water system occurs in several areas of the Verde Valley from springs, bank discharge, and groundwater wells. Many of the smaller tributaries originate from spring flows. Discharge from springs in stream banks are considered to be the primary sources of gains in streamflow in certain reaches of Oak Creek and the Verde River, such as in the Page Springs and the Peck's Lake/Tavasci Marsh areas, respectively.

Precipitation that does not infiltrate into the groundwater table is assumed to be transpired by plants or lost as evaporation. For the water budget, evapotranspiration (ET) is considered an outflow component, taking into consideration open water and soil evaporation as well as the transpiration from vegetation along the stream reaches. The ET rates used were listed in the *Upper Verde River Area* report and were previously determined by Anderson (1976). Anderson estimated 35,000 acre-feet of ET occurs from the area between the USGS gaging station on the Verde River near Paulden to below the USGS gaging station on the East Verde River near Childs. Approximately 2,200 acre-feet of the total 35,000 acre-feet of ET was estimated to be occurring between the USGS gaging station on the Verde River near Paulden and the USGS gaging station on the Verde River near Clarkdale. Approximately 3,800 acre-feet of annual ET was estimated for the reach between the USGS gaging station on the Verde River near Camp Verde and the USGS gaging station on the Verde River below Tangle Creek. The remaining 29,000 acre-feet of annual ET comprises the reach between the USGS gaging station on the Verde River near Clarkdale and the USGS gaging station on the Verde River near Camp Verde, which includes the major tributaries along that reach. For the seasonal water budget, 50 percent of the ET was assumed to take place during June, July, and August. The remaining 50 percent was estimated to occur during the months of April, May, September, and October with no ET occurring during the winter months (Anderson, 1976).

Groundwater discharge was addressed as unmeasured groundwater and/or spring flow. As listed in Arizona Land Resources Information Systems (ALRIS), there are approximately 335 springs located in the Middle Verde region. These springs range in output from negligible to more than 16,130 acre-feet per year as recorded at Page Springs. Some of the other measurable springs in the area as noted by Twenter and Metzger (1963) are identified in Table 4-4.

TABLE 4-4

AVERAGE GROUNDWATER DISCHARGE FROM SELECTED SPRINGS IN THE MIDDLE VERDE

SPRING	ANNUAL DISCHARGE (ACRE-FEET)	DATE MEASURED	SPRING LOCATION
Bubbling Pond	5,968 to 7,259 (r)	7-14-59	NWNW,SEC23,T16N,R4E
Buckhorn spring	1,613 (e)	5-28-59	SEC20,514N,R8E
Montezuma Well Spring	1,613 (m)	7-14-59	NE,SEC31,T15N,R6E
Summers Spring	3,065 to 4,355 (r)	10-10-51	NESE,SEC5,T17N,R3E
Wet Beaver Creek Spring	1,936 to 2,420 (e)	10-19-59	SEC14,T15N,R7E

Sources: Twenter & Metzger, 1963 and Forest Service Map-Coconino National Forest, 1985.
e – estimated, m – measured, r – range of several measurements

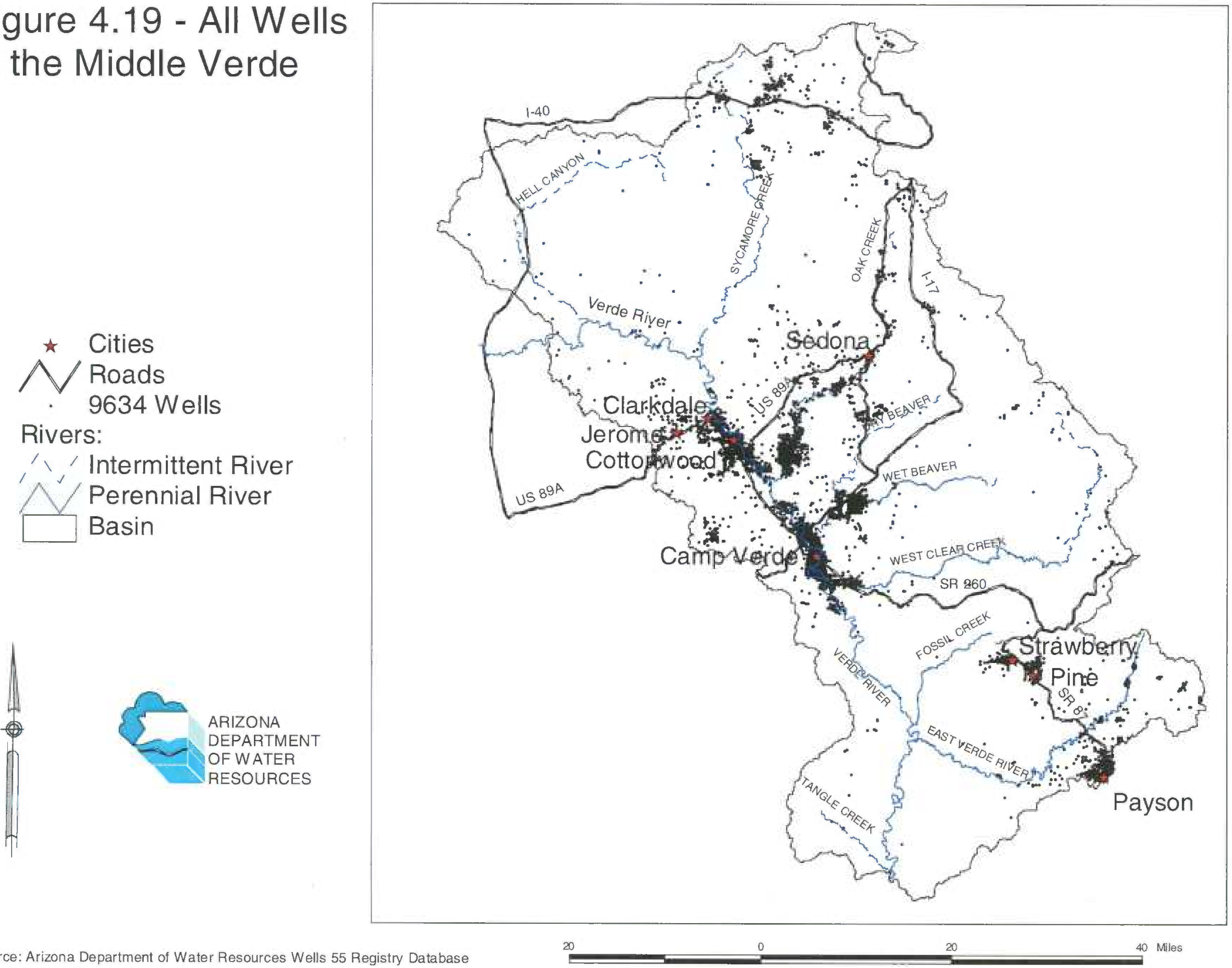
Well Distribution and Groundwater Withdrawals

Groundwater withdrawals are a result of the operation of wells in Middle Verde. According to ADWR's well registry database, which was accessed for a well count in March 1999, approximately 9,630 wells currently exist in the Middle Verde Subwatershed. The annual groundwater withdrawal by all the wells or by domestic wells specifically is unknown. These wells pump anywhere from 35 gpm to over 1,000 gpm according to well records. See Chapter 3 for more detailed information on the annual groundwater withdrawals by domestic and all other wells. Refer back to Table 4-1 for estimated annual groundwater withdrawals by area.

The total well distribution for the Middle Verde, in addition to the locations of major concentrations of wells occurring near and adjacent to the Verde River and major tributaries, can be observed in Figure 4.19. The geographical distribution of domestic wells (<35 gpm) is presented in Figure 4.20. Irrigation, industrial, and index wells in the Middle Verde can be seen in Figures 4.21, 4.22, and 4.23, respectively.

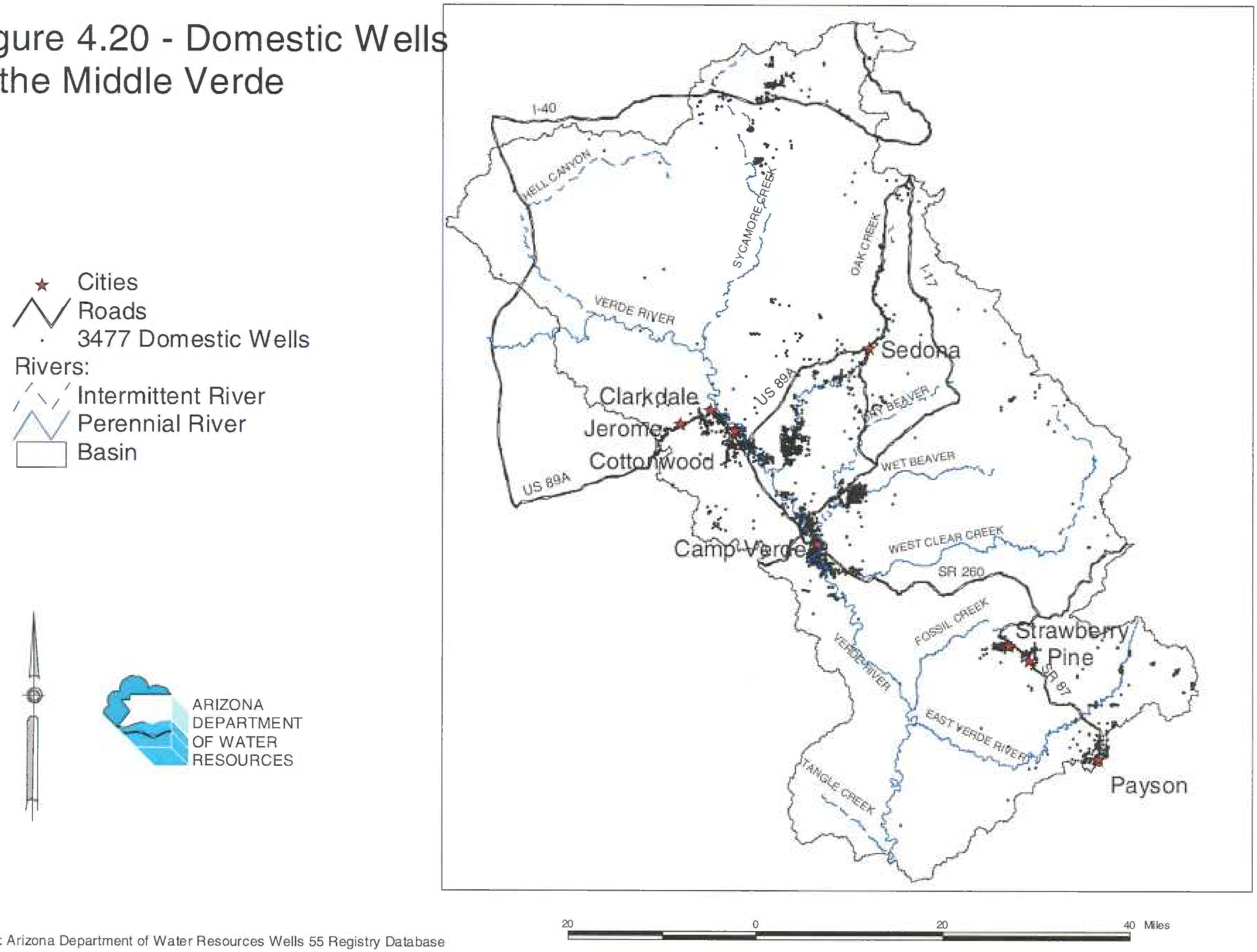
In the Verde Valley groundwater sub-basin, it appears that over 75 percent of all wells are located in the Verde Valley area along perennial streams where agricultural fields have historically been developed. The majority of wells are located near or in the younger alluvium and may be pumping from subsurface flows of the Verde River and its tributaries, depending on the depth of the well. Figure 4.24 demonstrates the direct and indirect effects on streams from well pumpage. The geographical distribution of wells in the Middle Verde that are believed to be pumping within the younger alluvium (subflow zone) is shown in Figure 4.25.

Figure 4.19 - All Wells in the Middle Verde



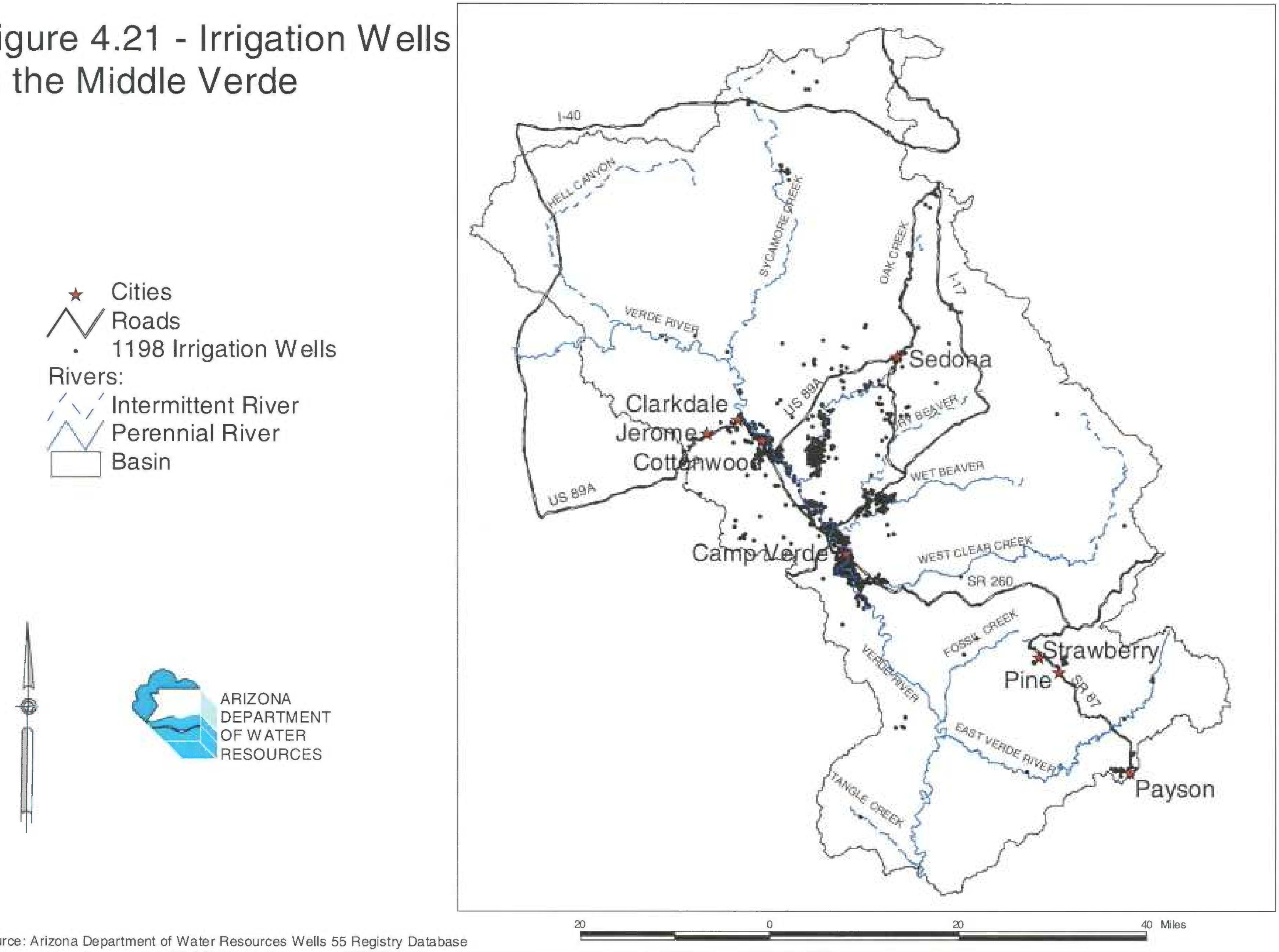
Source: Arizona Department of Water Resources Wells 55 Registry Database

Figure 4.20 - Domestic Wells in the Middle Verde



Source: Arizona Department of Water Resources Wells 55 Registry Database

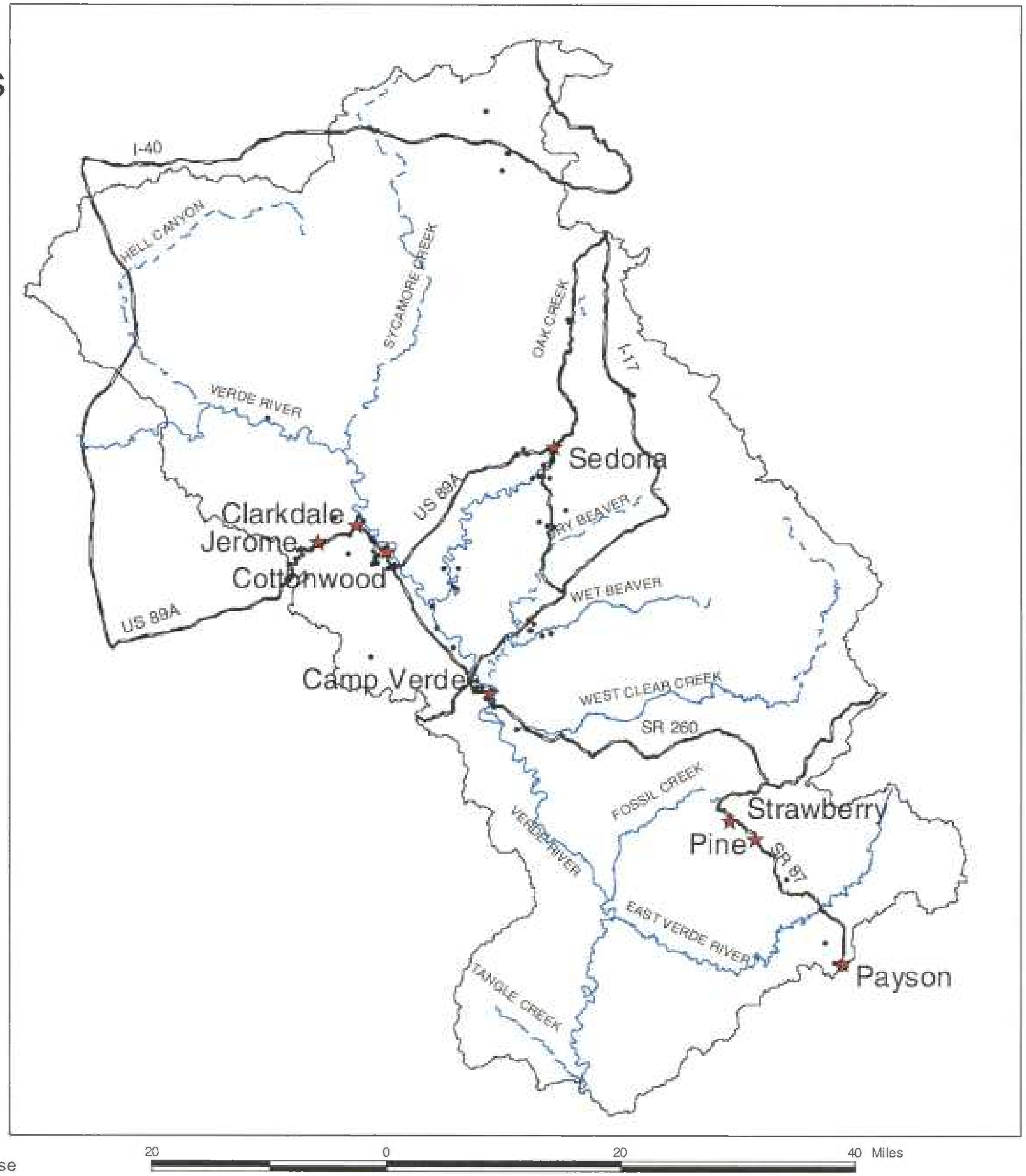
Figure 4.21 - Irrigation Wells in the Middle Verde



Source: Arizona Department of Water Resources Wells 55 Registry Database

Figure 4.22 - Industrial Wells in the Middle Verde

★ Cities
Roads
• 106 Industrial wells
Rivers:
Intermittent River
Perennial River
Basin



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Source: Arizona Department of Water Resources Wells 55 Registry Database

Figure 4.23 - Index Wells in the Middle Verde

- Cities
- Roads
- 48 Index Wells

Rivers:

- Intermittent River
- Perennial River
- Basin

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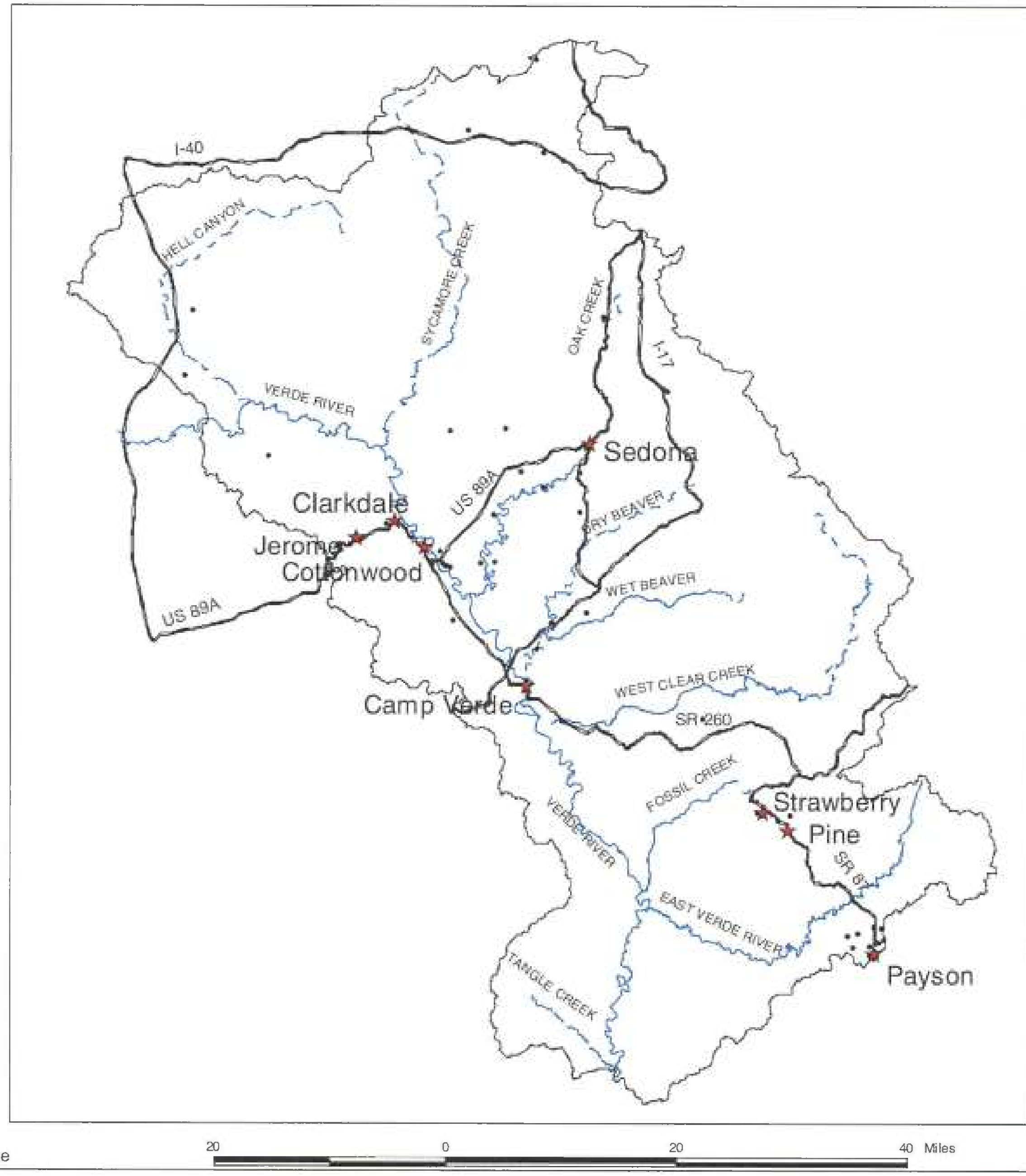
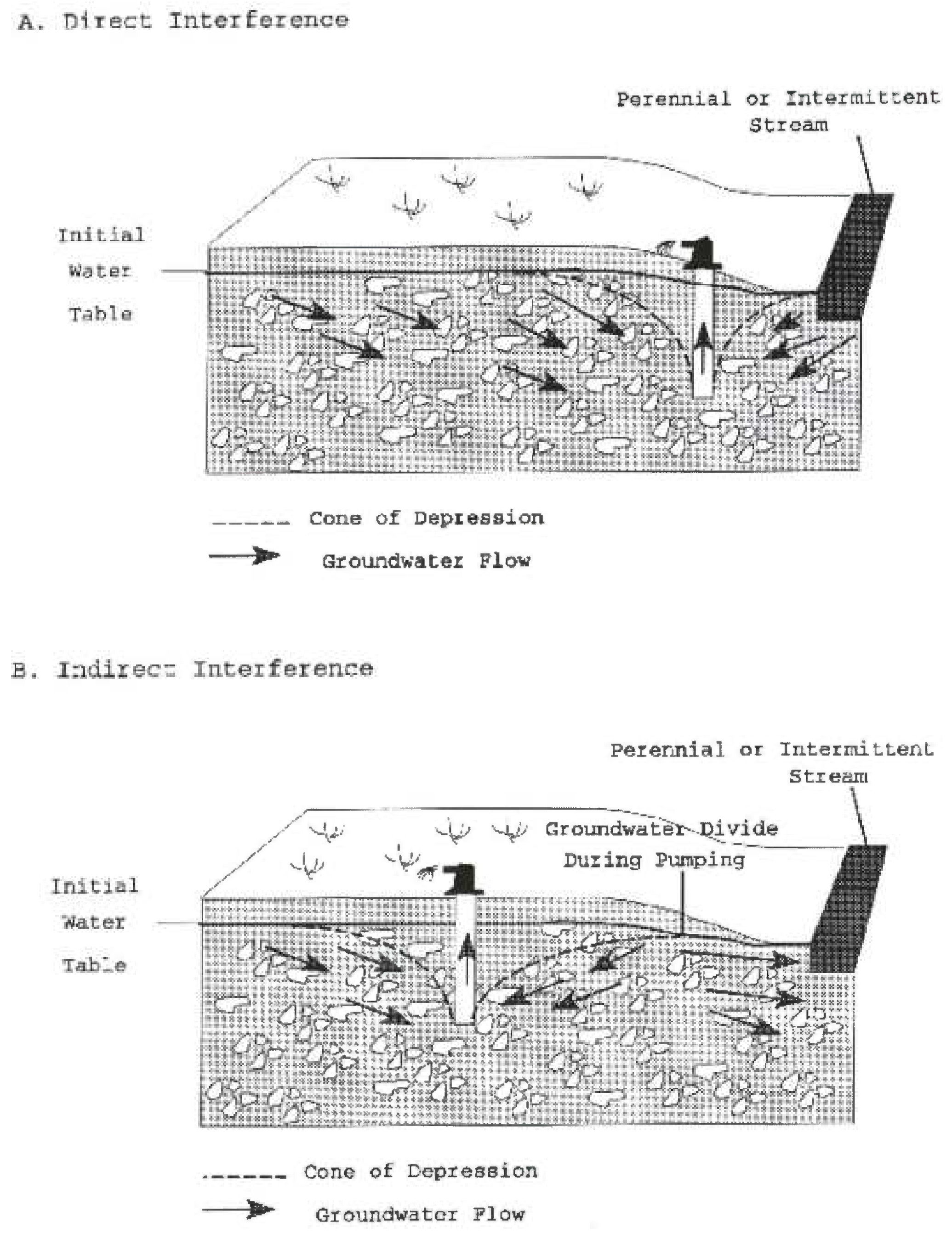


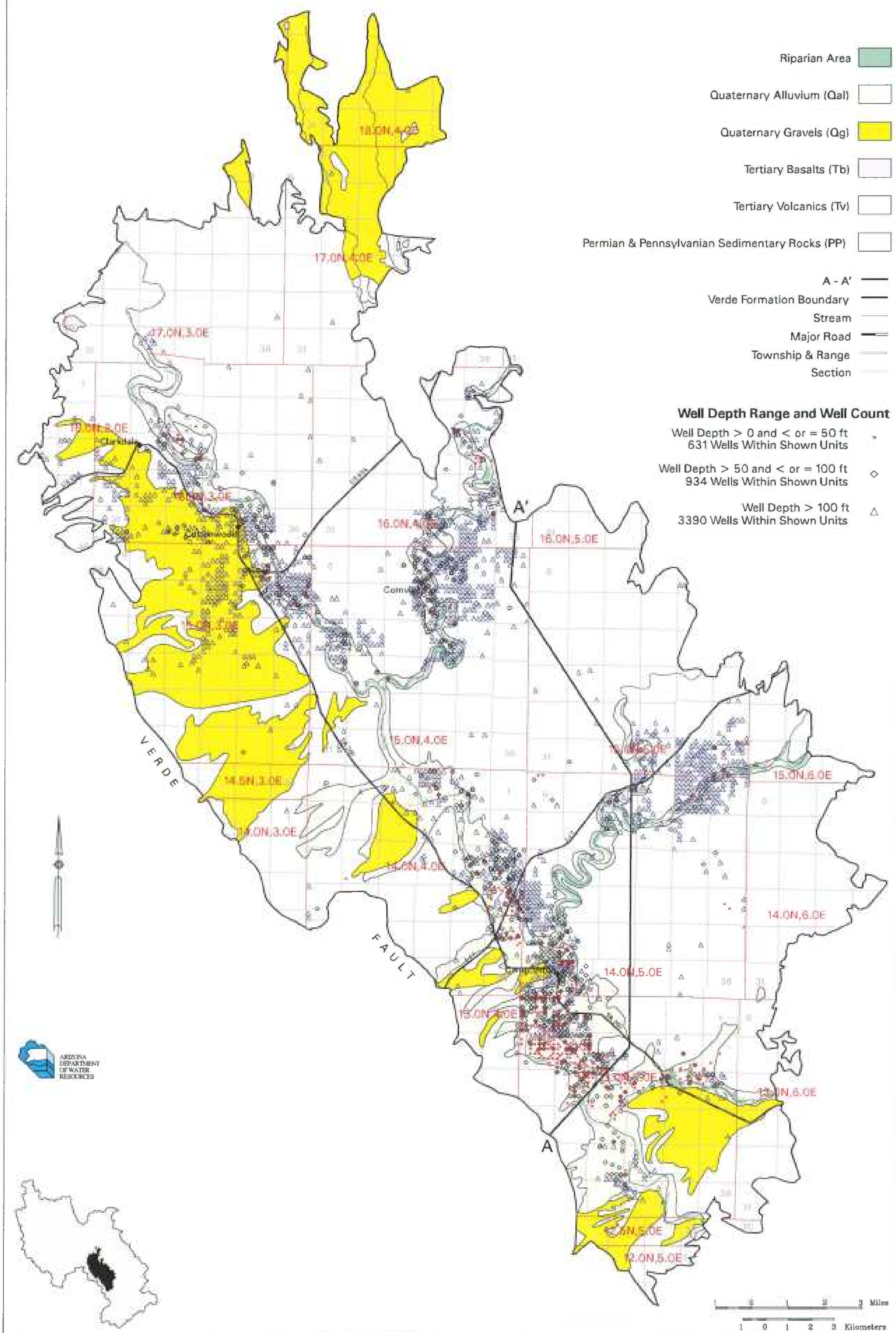
Source: Arizona Department of Water Resources GWSI Well Database

Figure 4.24 - Direct and indirect effect on streams from well pumpage.



Source: Technical Assessment of the Arizona Interlocutory Appeal Issue No. 2 Opinion, Arizona Department of Water Resources, 1993.

Figure 4.25 - Well Distribution Within the Younger Alluvium, Quaternary Age Gravels and Tertiary Age Verde Formation in the Verde River Valley Area, Yavapai County, Arizona.



Source: Arizona Department of Water Resources Well Registry; Geologic Information Modified from Owen-Joyce, S.J. and Bell, C.K., 1983.

The major concentration of wells occurs in the Camp Verde area, where as many as 1,800 residences were estimated to be served by private wells in 1990 (Geraghty and Miller, 1991). Other areas within the Middle Verde region with large concentrations of wells include Cottonwood, Clarkdale, Cornville, and Page Springs.

Groundwater Levels

Verde Valley Sub-basin

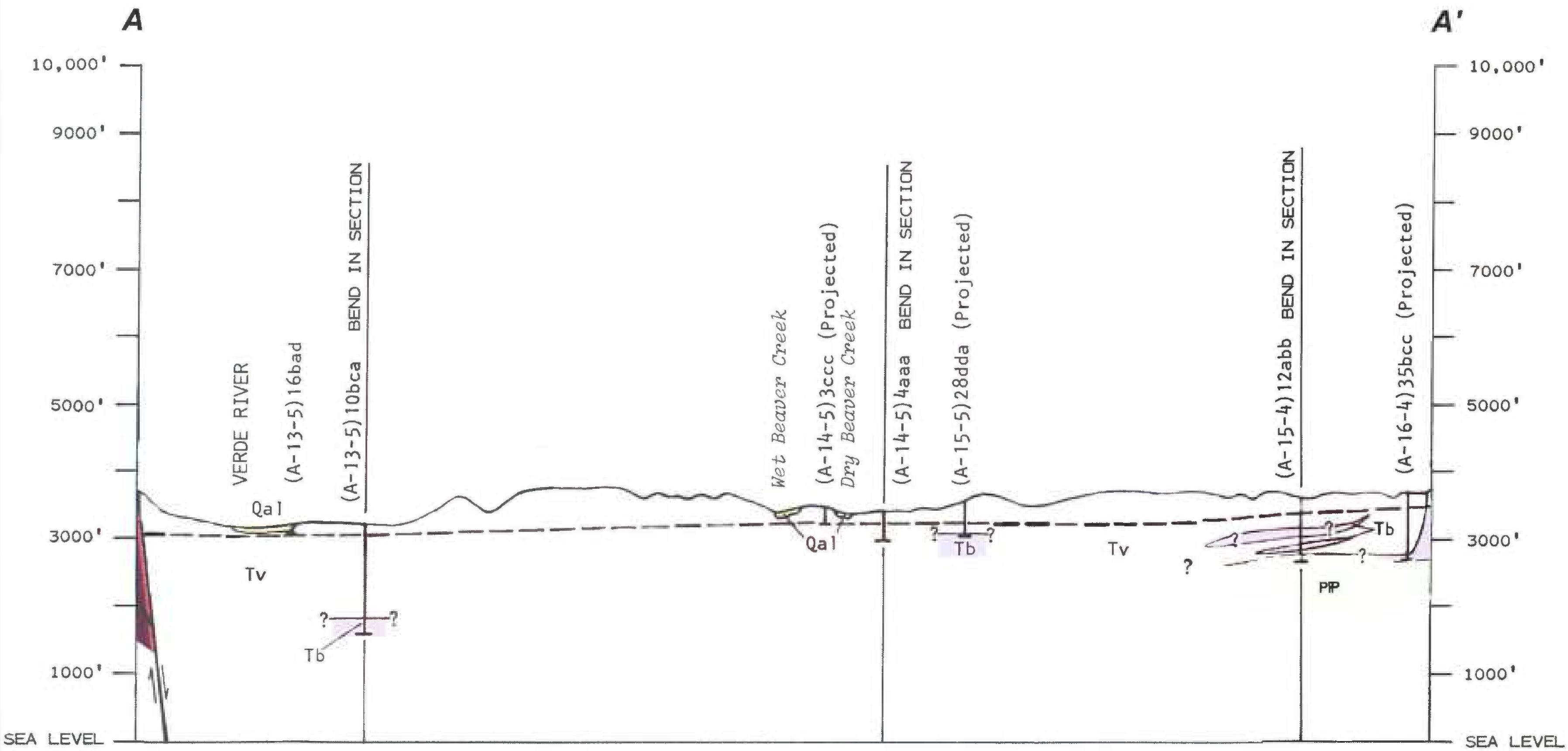
Throughout most of the Verde Valley area, the groundwater is unconfined and close to the land surface. There are, however, certain areas with locally confined (artesian) conditions occurring throughout the Verde Formation near and around Page Springs, Cottonwood, and Camp Verde. Depth to water in wells that penetrate the Verde Formation range from near land surface to more than 480 feet below the surface (Owen-Joyce and Bell, 1983).

Owen-Joyce (1984) reported that groundwater level elevations in the wells in the alluvium adjacent to the river were found to be higher than the streambed itself. This indicated that groundwater was flowing from the alluvium towards the river in the Camp Verde area. Figure 4.26 shows a geologic cross section of the Verde Formation in the Verde Valley.

Owen-Joyce (1984) reported that seasonal fluctuations of alluvial water levels were caused by changes in river stage and from recharge that resulted from agricultural irrigation practices. Water level fluctuations due to deep percolation of irrigation water were most noticeable farthest from the river, away from the influences of river stage. The extent and geographic distribution of irrigated acreage, amount of water being applied, crop consumptive use, and infiltration rates all influenced the amount and location of irrigation return flows.

In 1993, Sullivan and Richardson estimated that during the growing season, more than half of the flow of the Verde River is diverted into irrigation ditches, and in some reaches, the river loses all surface flow. Water levels in the alluvium were found to fluctuate over the course of the year, with recharge from streamflow, flood flows, and irrigation return flows keeping the alluvium saturated. Twenter and Metzger (1963) noted that "In areas where discharge only slightly exceeds recharge, the overall decline in water level over the years may be only slight; the level will decline markedly during periods of greatest discharge, such as the summer growing season, but will recover almost to its previous level when discharge is greatly reduced, such as during the winter. This probably is the nature of groundwater fluctuations in Verde Valley."

Figure 4.26 - Geologic Cross Section of the Verde Valley



Source: Modified from Owen-Joyce, S.J. and Bell, C.K., 1983.

Well Analysis

Evaluating trends in well hydrographs can provide insight into understanding the status of a groundwater or surface water system. The annual measurements of depth to water data for 23 wells located throughout the Upper and Middle Verde were analyzed (see Figure 4.9 for well locations). Linear regression analysis was performed on the depth to water data to determine potential trends for each well. Fluctuations in depth to water provided insight into the impacts on the groundwater system resulting from periods of drought, periods of high precipitation recharge, and increases in groundwater pumping. Figure 4.27 lists the well hydrographs for the Middle Verde. These wells were selected because they have the longest, continuously monitored period of record.

Well Hydrograph Analysis:

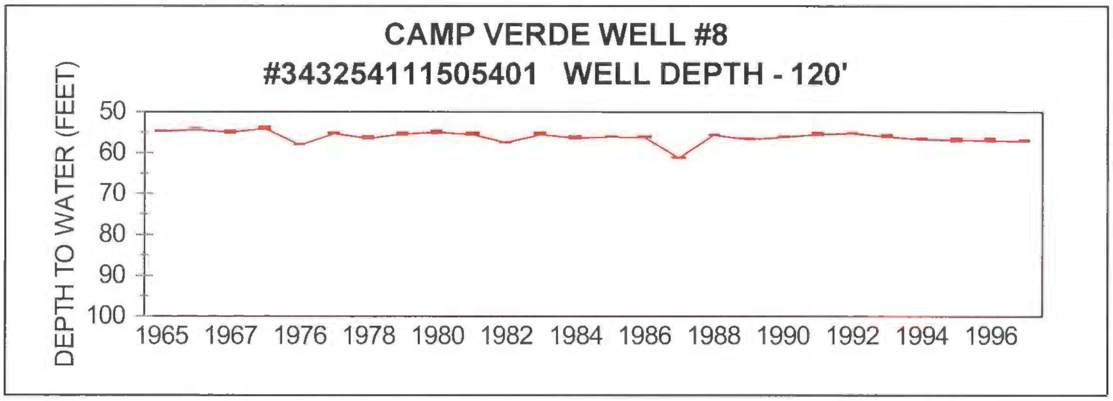
Three wells in the Camp Verde area: Well Site ID#343254111505401 - depth 120 feet; had a slight increase in depth to water over a 32 year period. ID#343638111501301 - depth 160 feet; had a 15 feet decrease in depth to water over a 39 year period. ID#343409111511101 - depth 99 feet; had an increase in depth to water of 23 feet over a 19 year period.

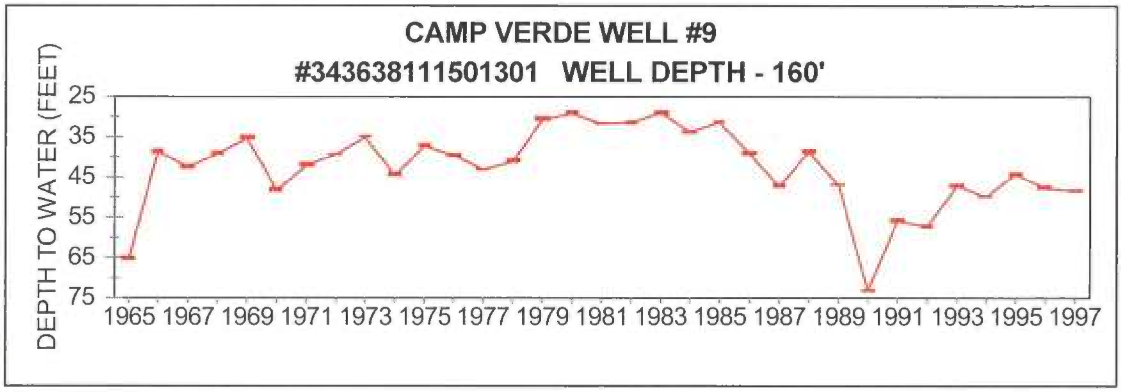
- Four wells in the Cornville area: ID#343843111575301 - with no listed depth, had virtually no change in depth over a five-year period. ID#344312111540801 - 300 foot depth and ID#344307111552701, at 250 feet deep, both registered increased depths to water of 13 feet over 20 and 31 years of study respectively. ID#344250111583401 - depth 400 feet; registered an increase in depth to water of 25 feet over a 32 year period. All of these wells were located in the floodplain alluvium.
- Two wells located in the Lake Montezuma area: ID#343833111490101 - depth 503 feet; had a 90 feet increase in depth to water over a 19-year period, and ID#343924111454901 - depth 240 feet, showed a 12 feet increase in depth to water over six years. These wells are located outside the alluvium.
- A well in the Clarkdale area: ID#344556112040501 - depth 395 feet; well revealed a 26 feet increase in depth to water over a five-year period.

Figure 4.27 Middle Verde Well Hydrographs

* Well numbers correspond with well locations on figure 4.9

**Well hydrographs derived from ADWR Wells Registry Database





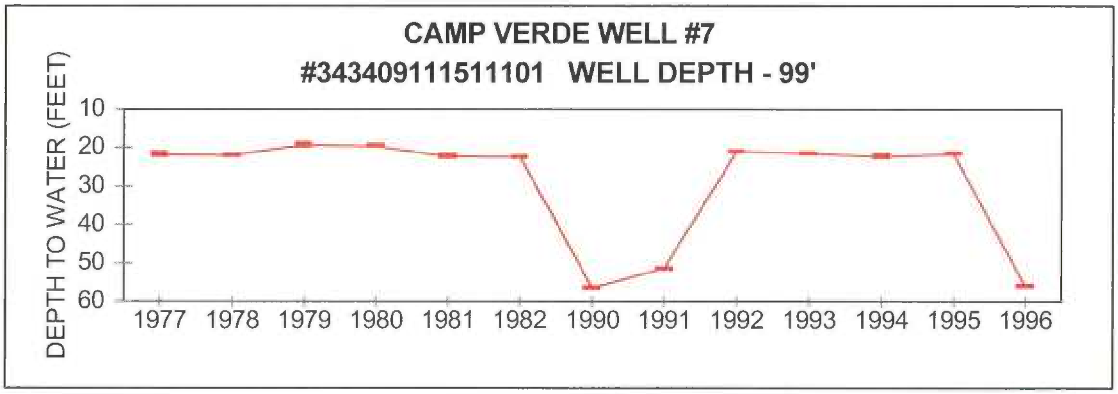
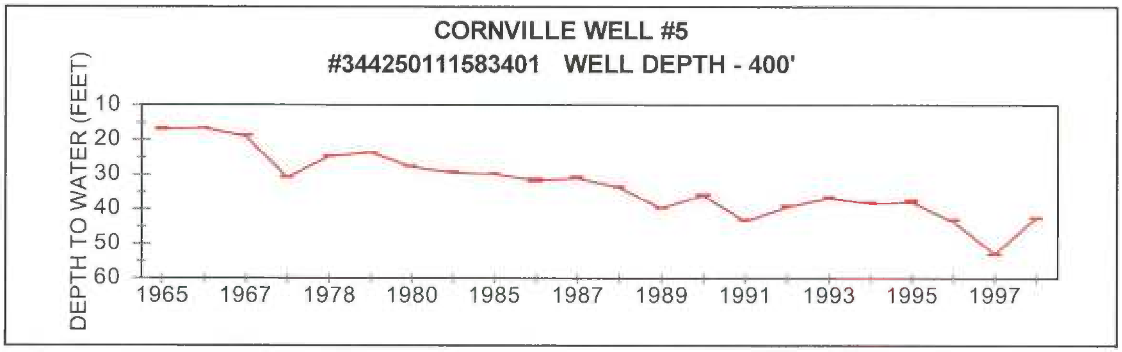
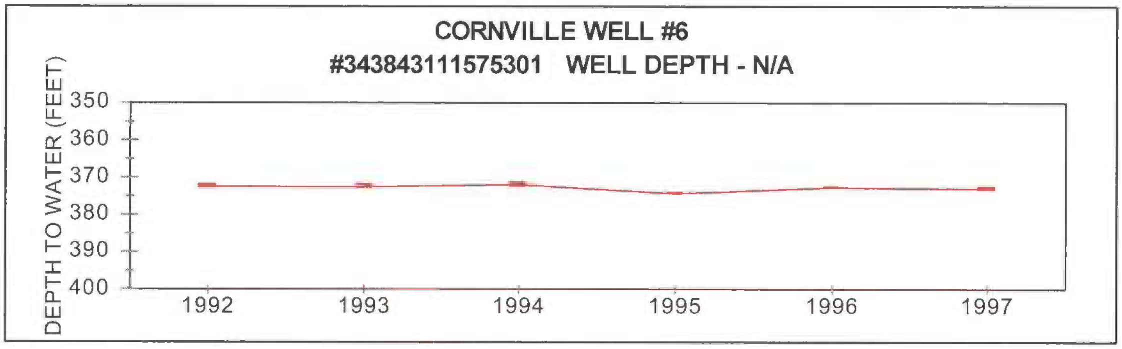
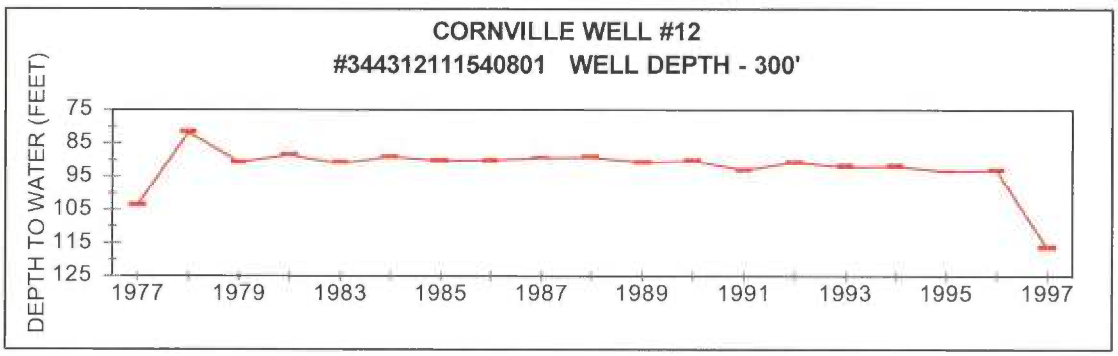
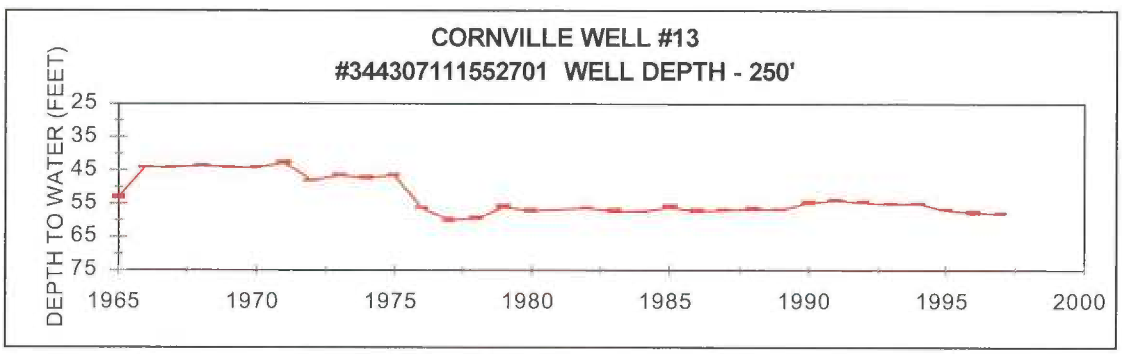


Figure 4.27 Continued









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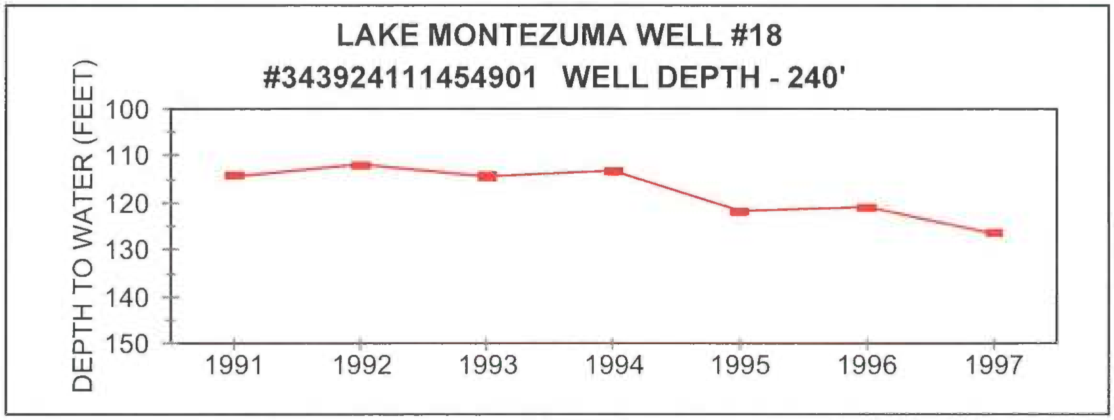

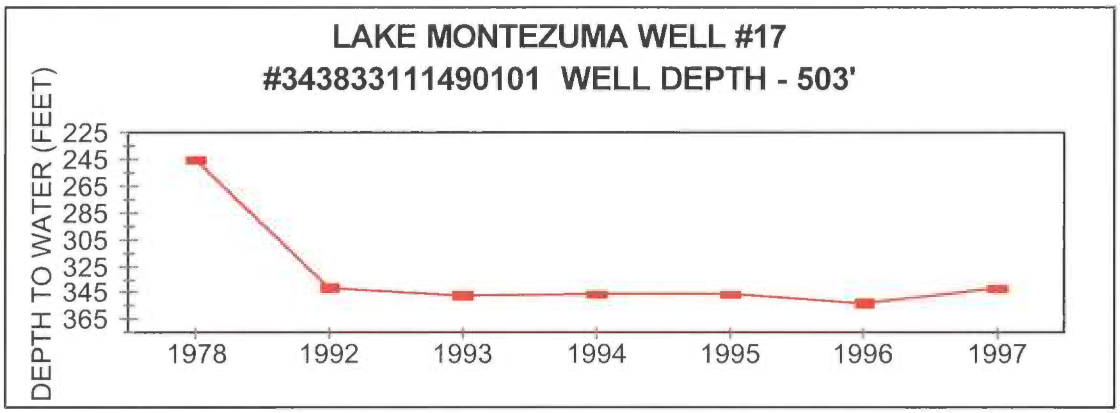

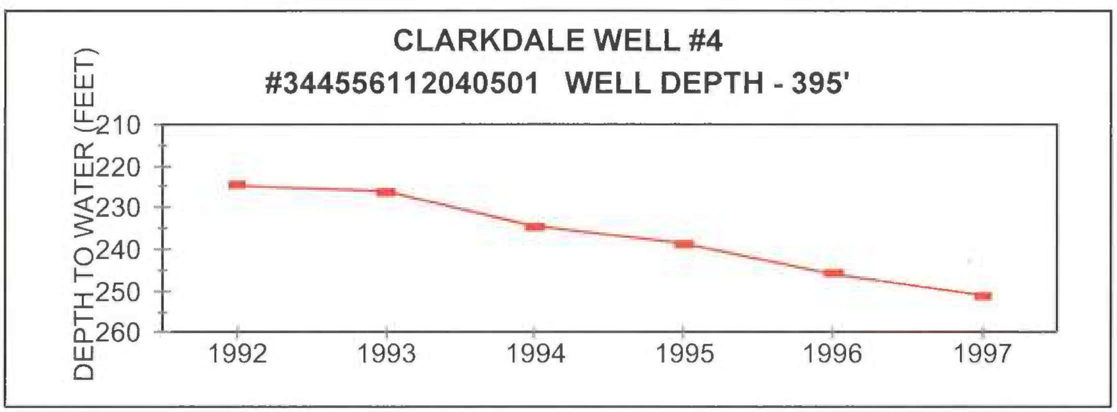

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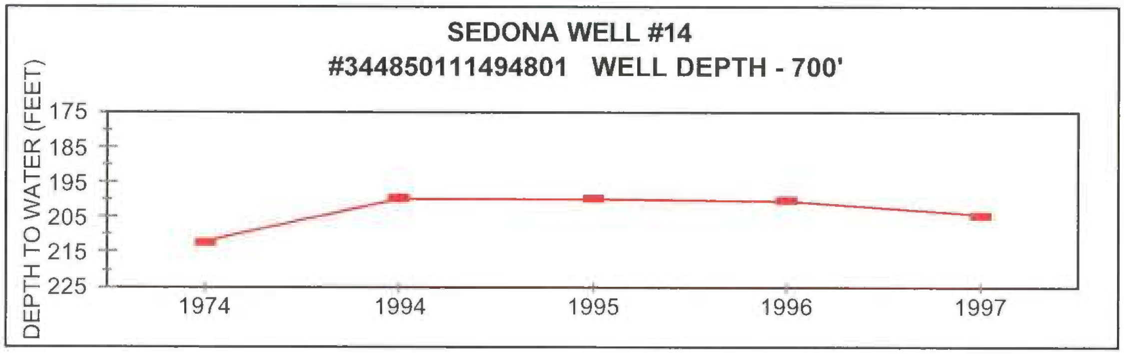

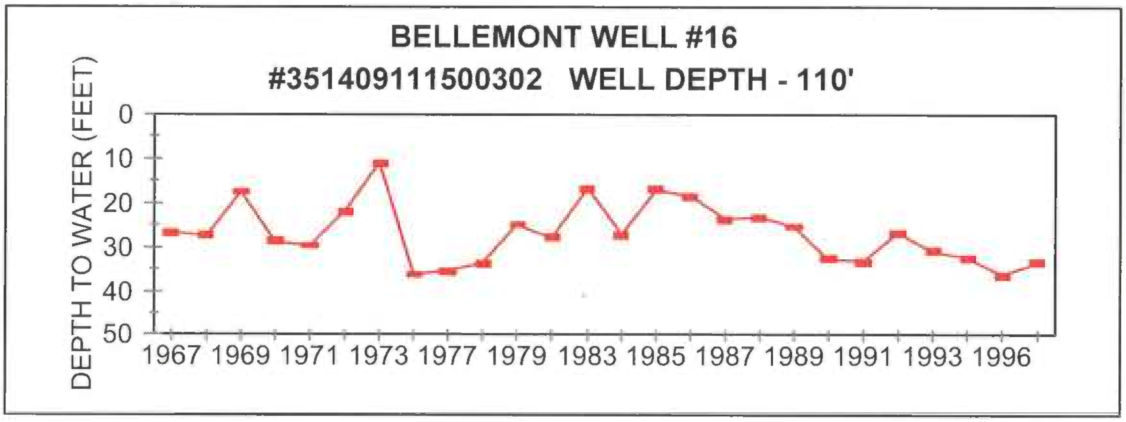

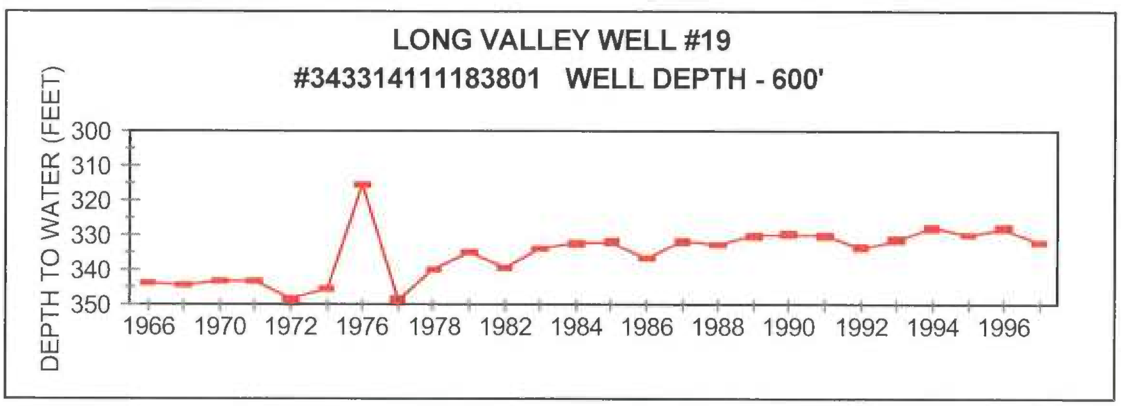

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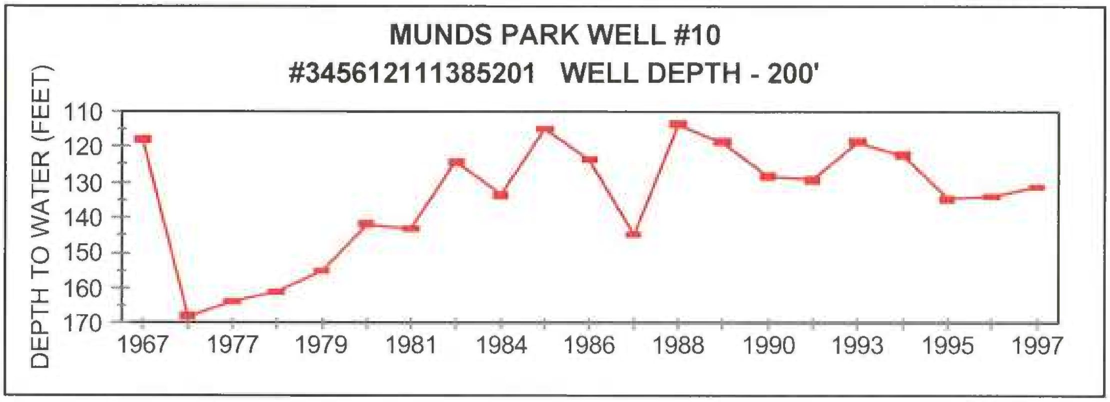

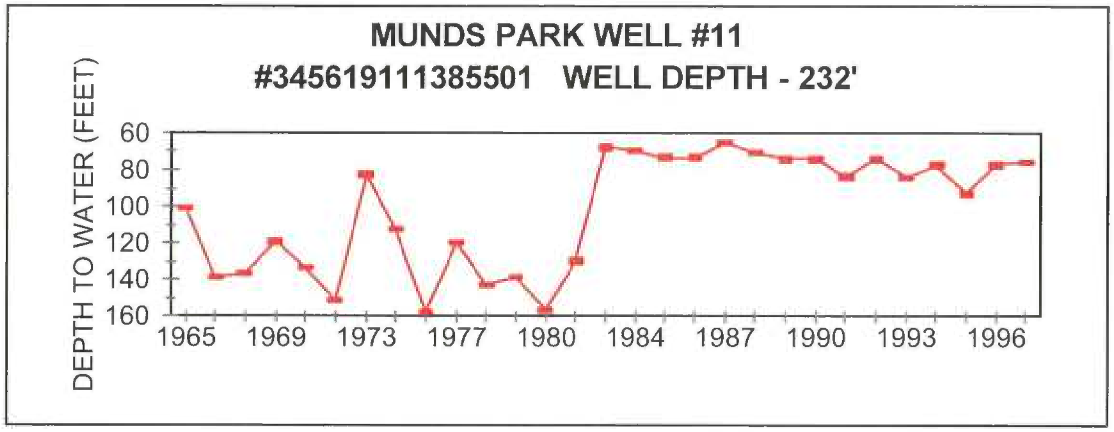

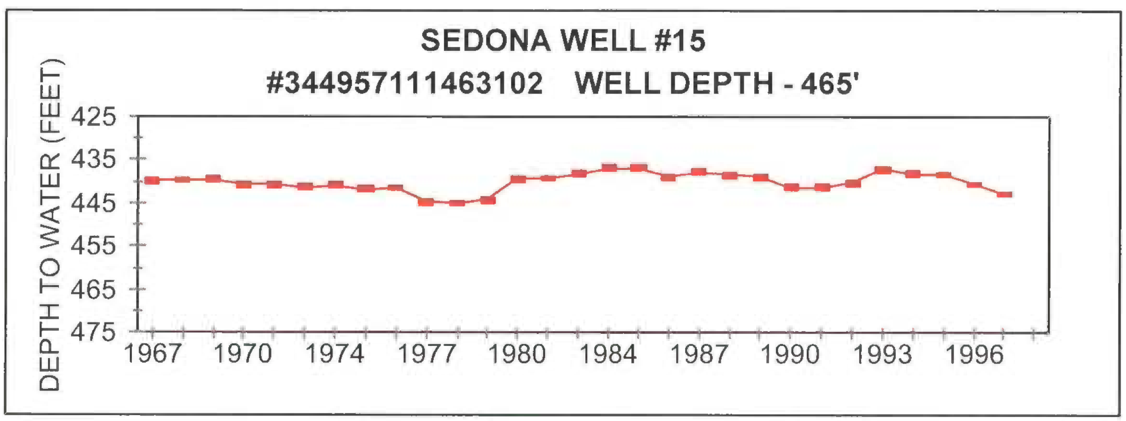

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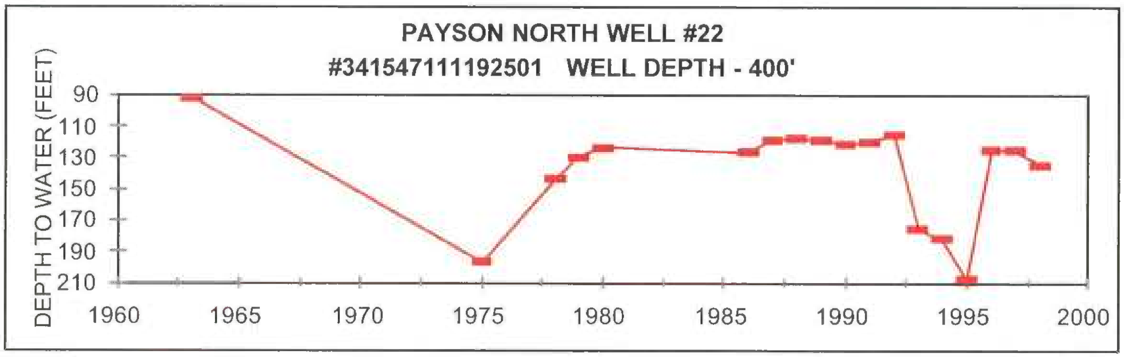
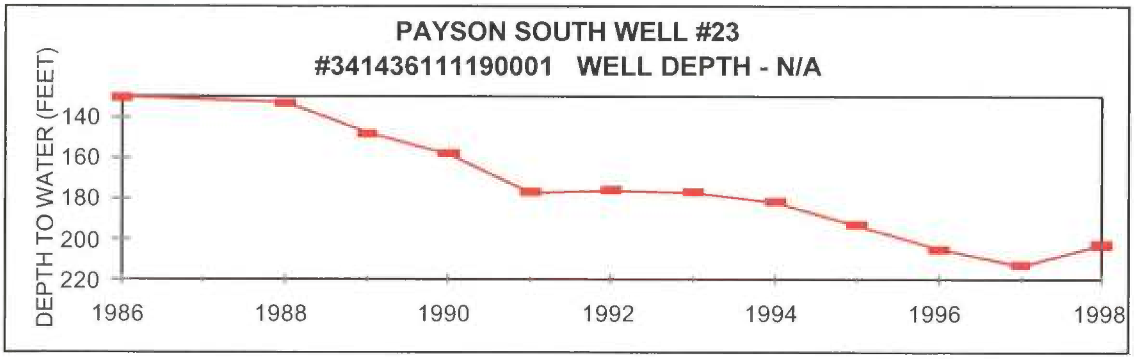
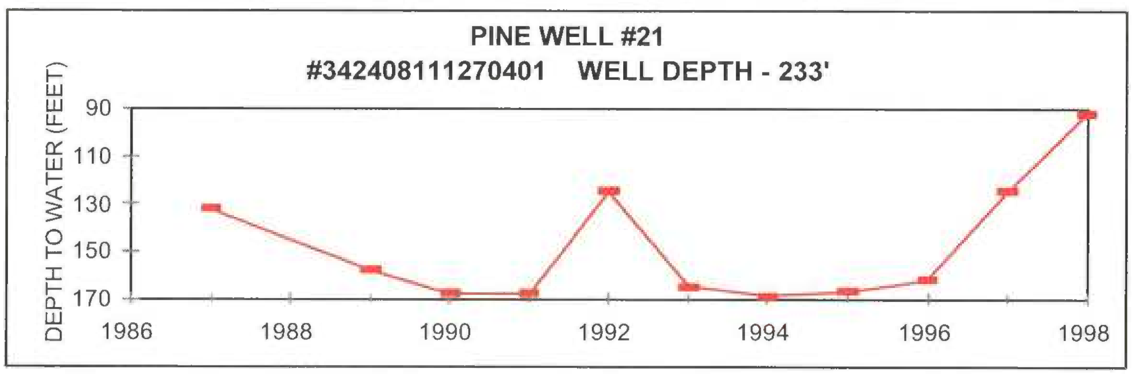
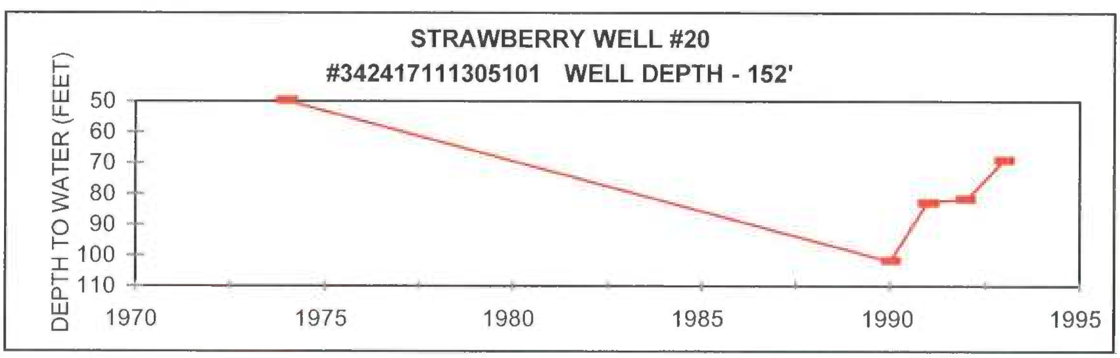








- Two wells located in the Munds Park area: ID#345612111385201 - depth 200 feet; showed a 13 feet increase in depth to water over 30 years, and well ID#345619111385501 - depth 230 feet; had a 25 feet decrease in depth to water over 32 years. Neither of these wells is located in the younger alluvium.
- The results of two wells located near Sedona: ID#344957111463102 - depth 465 feet; had a slight increase of four feet depth to water over a 31-year period. ID#344850111494801 - depth 700 feet; had an eight feet decrease in depth to water over 23 years.
- A well located in the northern part of the study area near Bellemont: ID#351409111500302 - depth 110 feet; well showed a seven feet increase in depth to water over 30 years.
- A well located in the eastern portion of the study area near Long Valley: ID#343314111183801 - depth 600 feet; well revealed a 12 feet decrease in depth to water over 31 years.
- Four wells located in the Payson area: ID#341436111190001 - depth unknown; had a depth to water of 140 feet in 1986 which increased to 213 feet in 1998. ID#341547111192501 - depth 400 feet; revealed a depth to water in 1963 of 92 feet, which increased to 135 feet in 1998. Near Strawberry: ID#342417111305101 - depth 152 feet; well showed an increase in depth to water over a 19-year period from 50 feet to 69 feet in 1993. Near Pine: ID#342408111270401 - depth 233 feet; had a fluctuating depth to water starting at 132 feet in 1987, and ending at 92 feet in 1998.

Groundwater Storage Estimates

The estimating of total groundwater storage has proven to be the most challenging aspect of the water resource analysis in the Middle Verde region. At this time, a reasonable estimate of the total groundwater storage in the Middle Verde Subwatershed cannot be calculated due to the lack of information. Groundwater storage capacities for specific water-bearing units in the Middle Verde region, however, have been studied and groundwater storage capacities estimated. As an example, the stream alluvium in the Camp Verde area is a specific geologic unit with an estimated water storage capacity of 17,500 acre-feet (Freeze and Cherry, 1979).

Hydrogeologic complexities need to be addressed (identified and studied) to estimate storage capacities in the regional aquifer, which underlies a major portion of the Middle Verde.

SURFACE WATER SYSTEM

Description

The surface water system in the Middle Verde Subwatershed consists of seven surface water drainages. These are the Verde River Valley, Oak Creek, Wet Beaver Creek, West Clear Creek, East Verde River, Fossil Creek, and Verde River Canyon drainages. (Refer back to Figure 4.15.)

The Middle Verde Subwatershed surface water system encompasses the Verde River and its tributaries from the gaging station on the Verde River near Paulden to the gaging station on the Verde River below Tangle Creek. Along this reach of the Verde River are many measured and unmeasured springs and gaged tributaries, such as Oak Creek, Wet Beaver Creek, West Clear Creek, Fossil Creek, and the East Verde River. Table 4-5 lists the gaging stations that this section of the report focused on, as well as the drainage area, period of record, and annual mean for each station.

TABLE 4-5

SELECTED USGS GAGING STATIONS IN THE MIDDLE VERDE

LOCATION	GAGE #	DRAINAGE AREA (SQ MILES)	PERIOD OF RECORD	ANNUAL MEAN (ACRE-FEET)
Verde River near Paulden	09503700	2,507	7/63 to Present	32,500
Verde River near Clarkdale	09504000	3,503	1915 to 1921, 4/65 to Present	140,400
Oak Creek near Cornville	09504500	355	1940 to 1945, 4/48 to Present	64,930
Wet Beaver Creek	09505200	142	10/60 to Present	33,430
West Clear Creek	09505800	241	12/64 to Present	48,300
Verde River near Camp Verde	09506000	5,009	1934 to 1945, 10/88 to Present	329,200
Fossil Creek	09507500	Diversion	1/52 to Present	28,000
East Verde River near Childs	09507980	331	9161 to 1965, 5/67 to Present	50,140
Verde River below Tangle Creek	09508500	5,858	8/45 to Present	424,700

Source: USGS Water Resources. Data – Arizona, 1997.

Flow Data at Gaging Stations

1. Gaged Tributaries - Annual Budget - Inflows

The annual budget reflects the yearly flow totals for the gaging stations discussed in the seasonal budget section. Seven years of seven-day low flow annual totals for 1990-1996 were graphed with annual total flows for the same period. The results demonstrate the slight fluctuations in the seven-day low flow totals, as well as the variations in total flow, which are directly related to yearly precipitation events. Figure 4.28 compares the Middle Verde stream gages average seven-day low flows with the average total flows for 1990-1996.

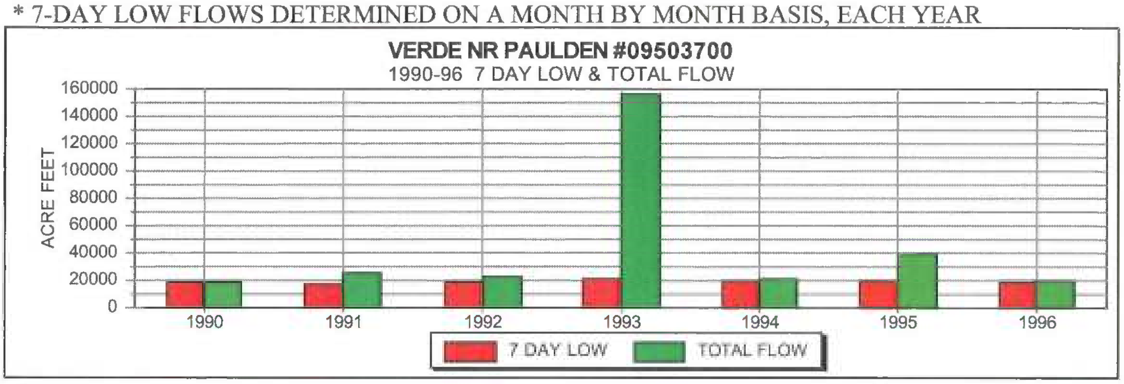
In order to demonstrate long-term streamflow fluctuations, historical seven-day low flow and total flow data were collected for each gaging station for the month of June for the years 1965 through 1997. The June seven-day low flow results revealed some variation from year to year for the past seven years. As expected, there was an increase in variation for the annual total flows, which is again directly related to the significant fluctuations in annual precipitation totals. Figure 4.29 presents historical June seven-day low flows and total flows. Comparisons of the seven-day low flow yearly totals for the gaging stations Verde near Paulden, Verde near Clarkdale, Verde near Camp Verde, and Verde below Tangle Creek for the years 1990 through 1996 indicate the Verde River as a gaining stream (Figure 4.30). Figure 4.31 demonstrates the interaction between monthly precipitation amounts and streamflow using five gaging stations located nearest to the precipitation stations for the years 1992 (a wet year) and 1996 (a dry year).

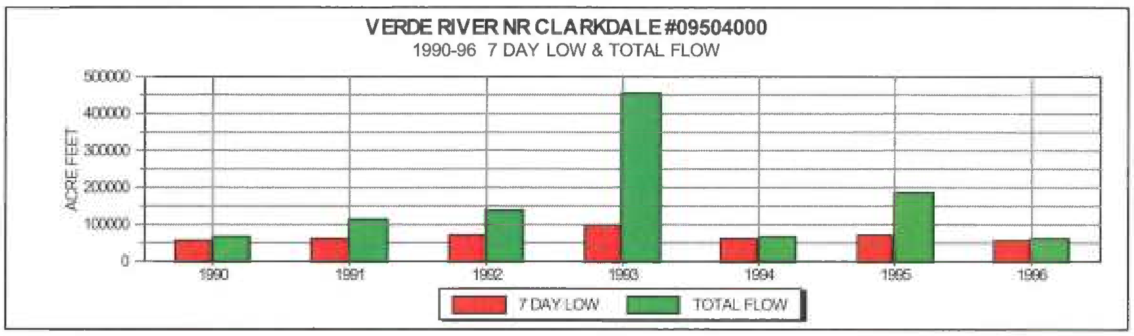
2. Gaged Tributaries - Annual Budget - Outflows

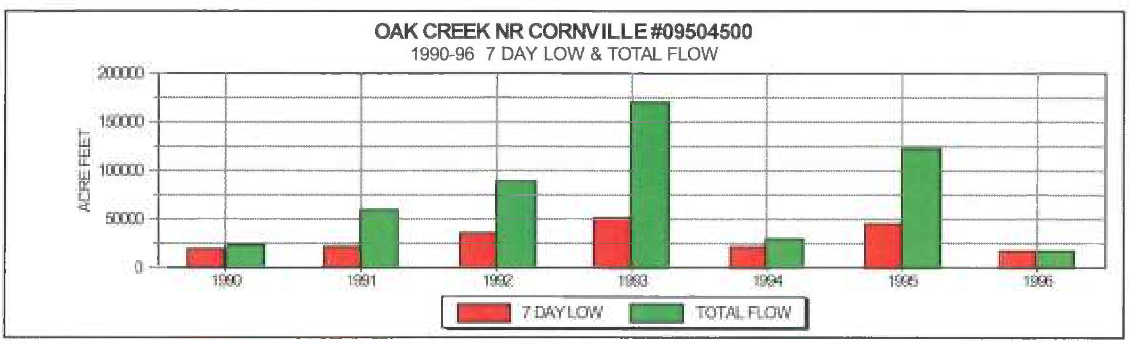
The annual surface water outflow results for 1990 through 1996 are based on the seasonal outflow results and, therefore, this section consists of a summary of the totals from the seasonal outflow section. The seven-year average annual seven-day low flow and total flow values for the 1990-1997 study period for the Verde River below Camp Verde gaging station were 138,614 and 369,157 acre-feet respectively. The annual evapotranspiration rate amounted to approximately 35,000 acre-feet per year (Owen-Joyce and Bell, 1983), and the agriculture irrigation requirement totaled 16,140 acre-feet for 1997. The municipal/private water provider's use total, which included residential, commercial, industrial, and others, for the study period ranged from 4,751 acre-feet in 1990 to 7,311 acre-feet in 1997. The private industrial wells that furnish water for sand and gravel operations and golf courses averaged 1,204 acre-feet and 3,436 acre-feet of water per year respectively.

Figure 4.28 Average 7-Day Low Flows & Average Total Flows for 1990-1996

* 7-DAY LOW FLOWS DETERMINED ON A MONTH BY MONTH BASIS, EACH YEAR







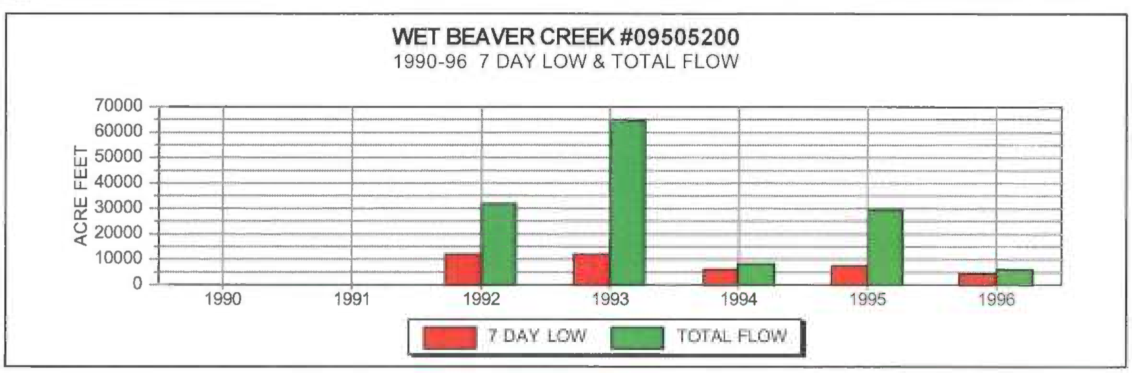
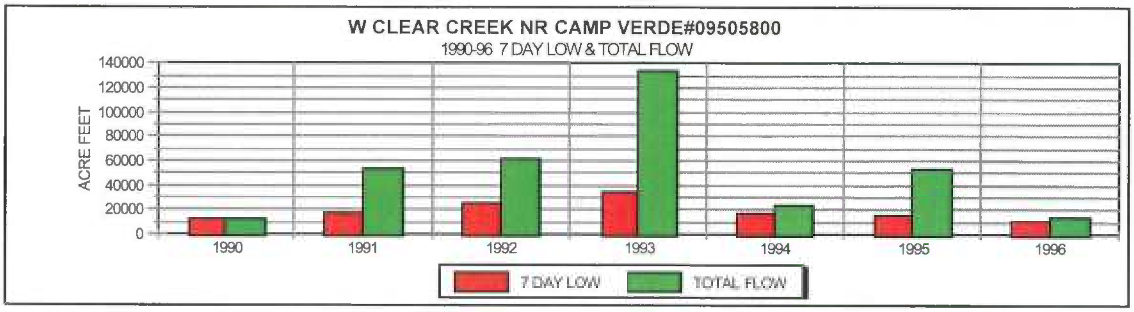
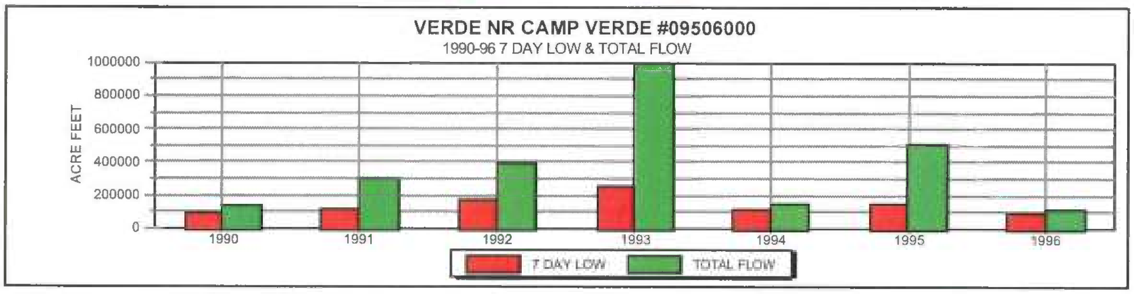
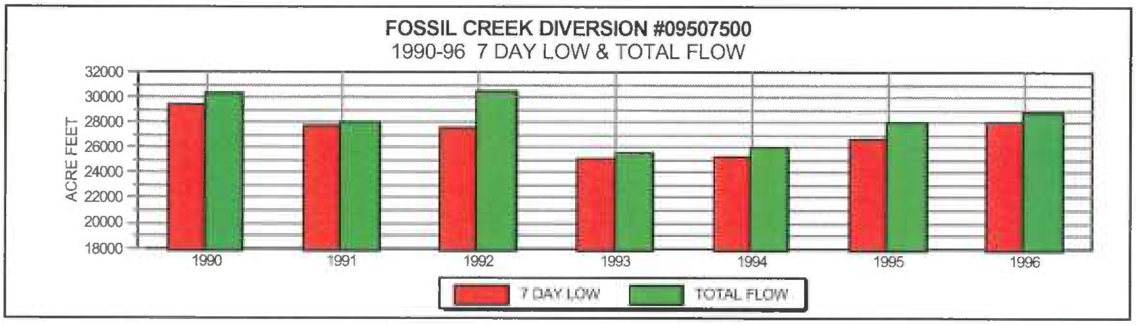
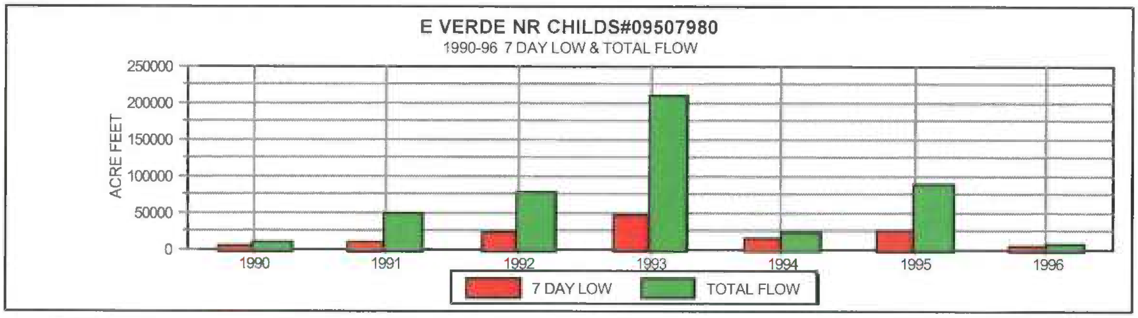


Figure 4.28 Continued









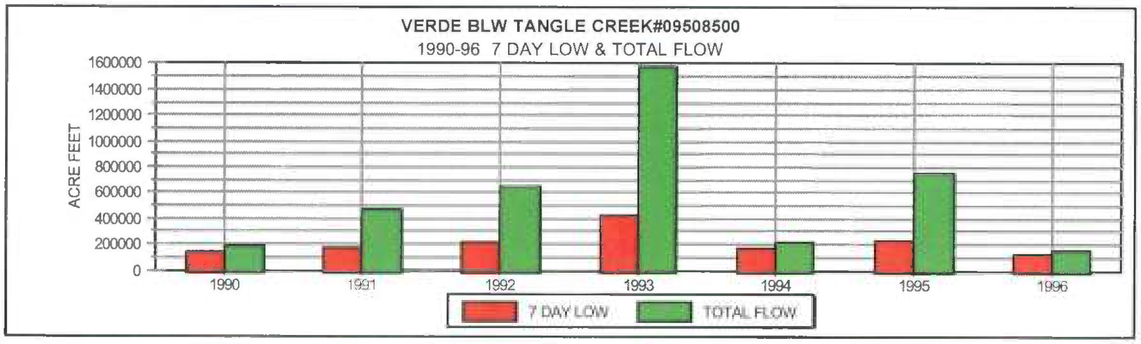
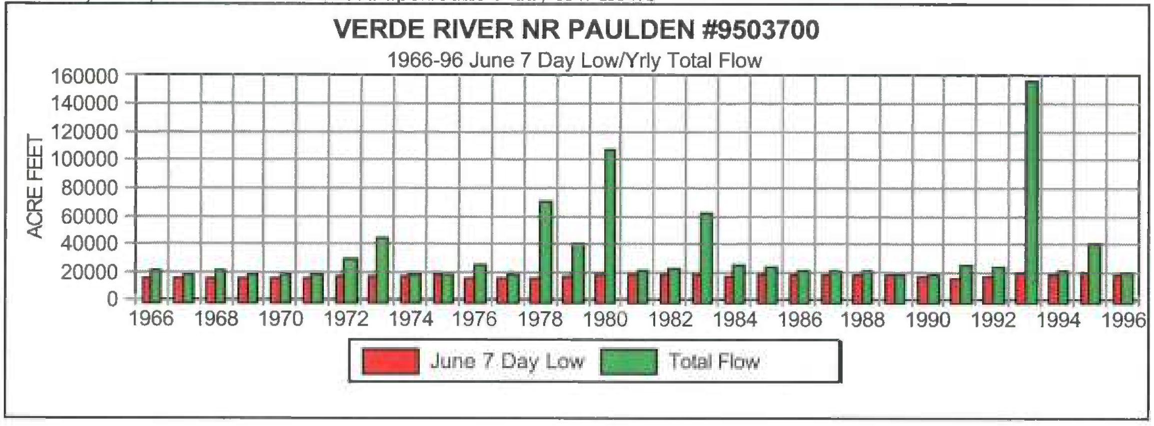
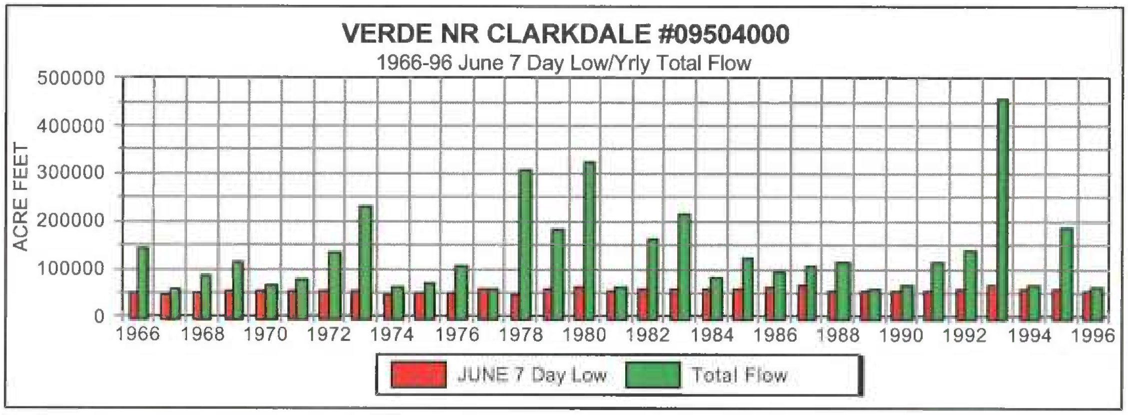
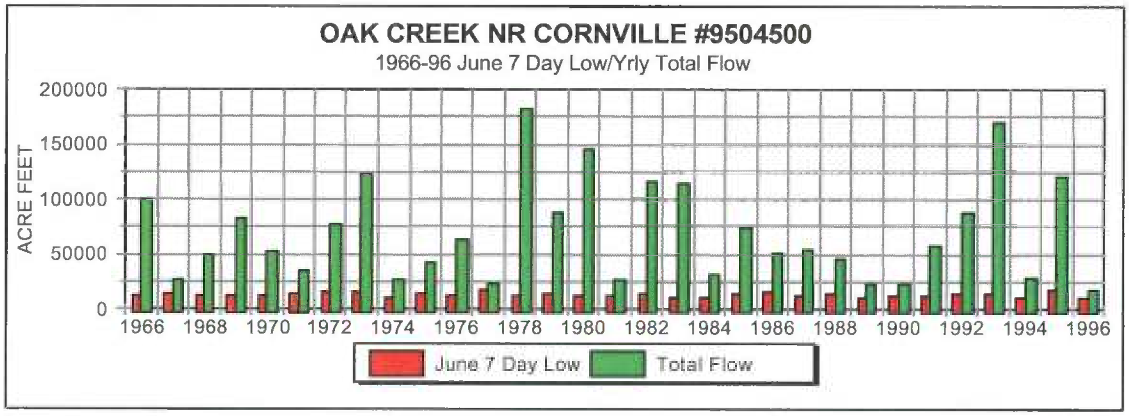


Figure 4.29 Historical June 7-Day Low Flows & Total Flows

*Yearly 7-day low flow totals based upon June 7-day low flows







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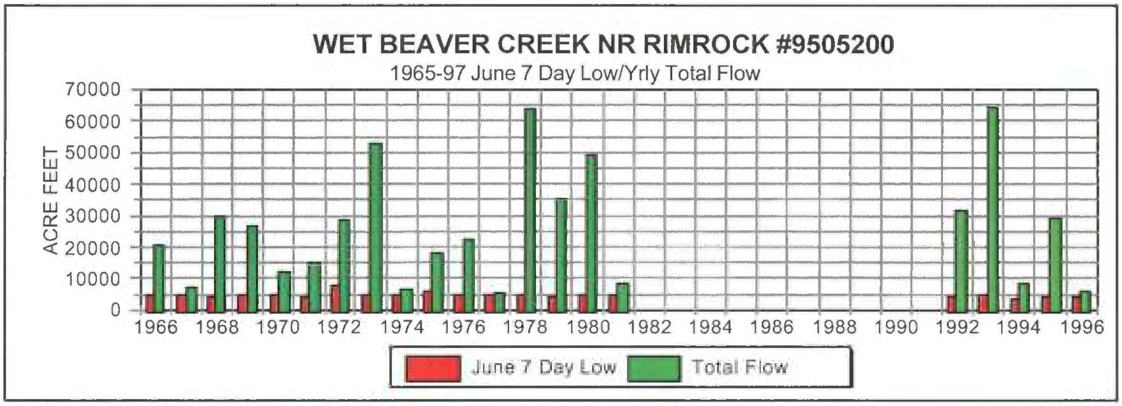

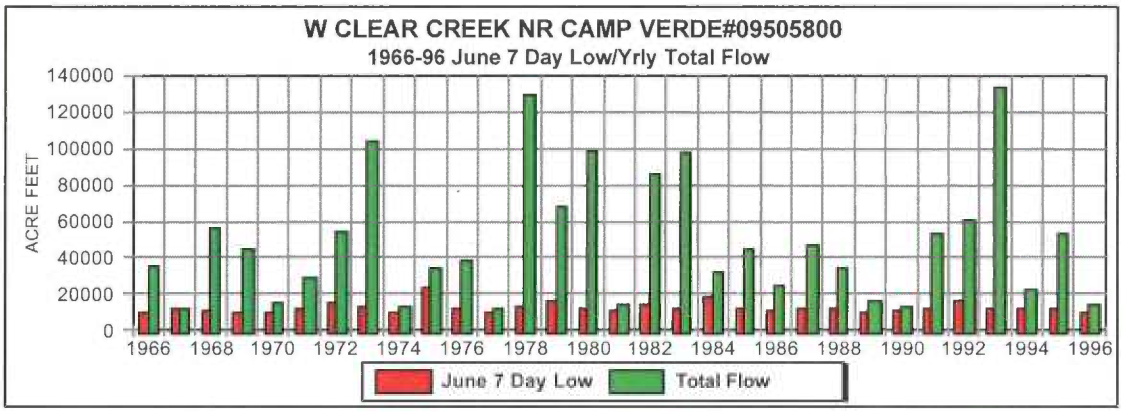

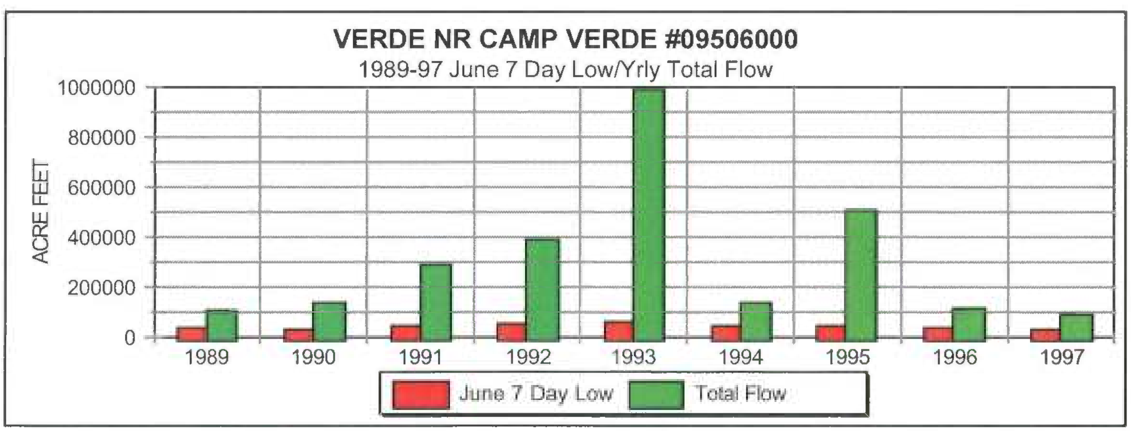

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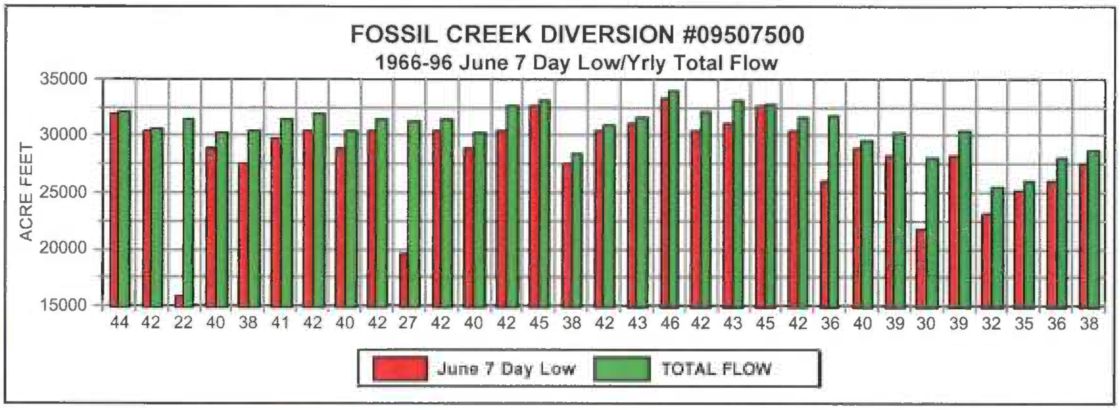
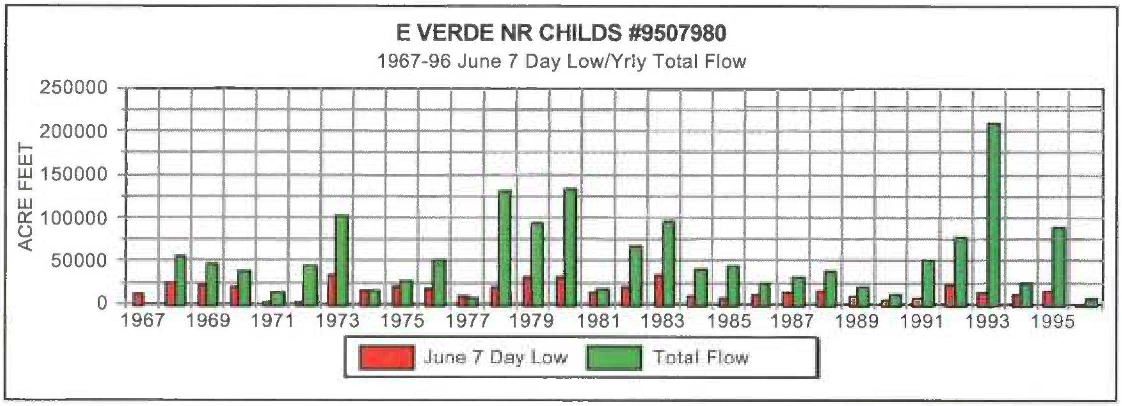




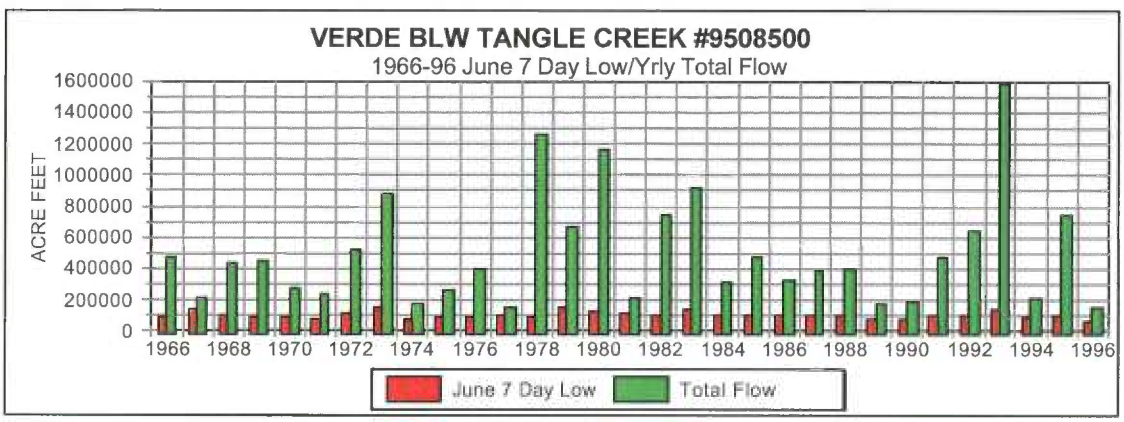
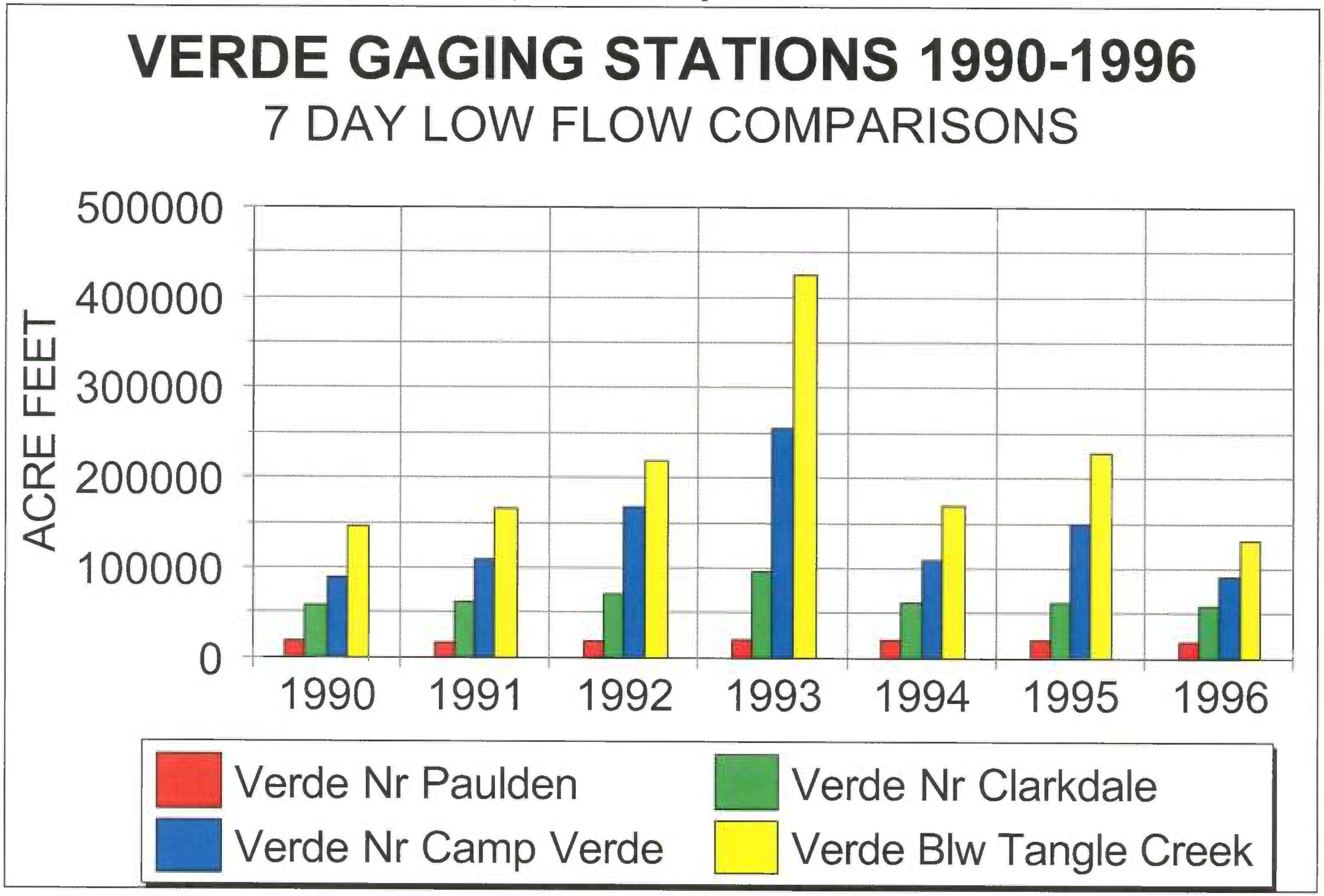
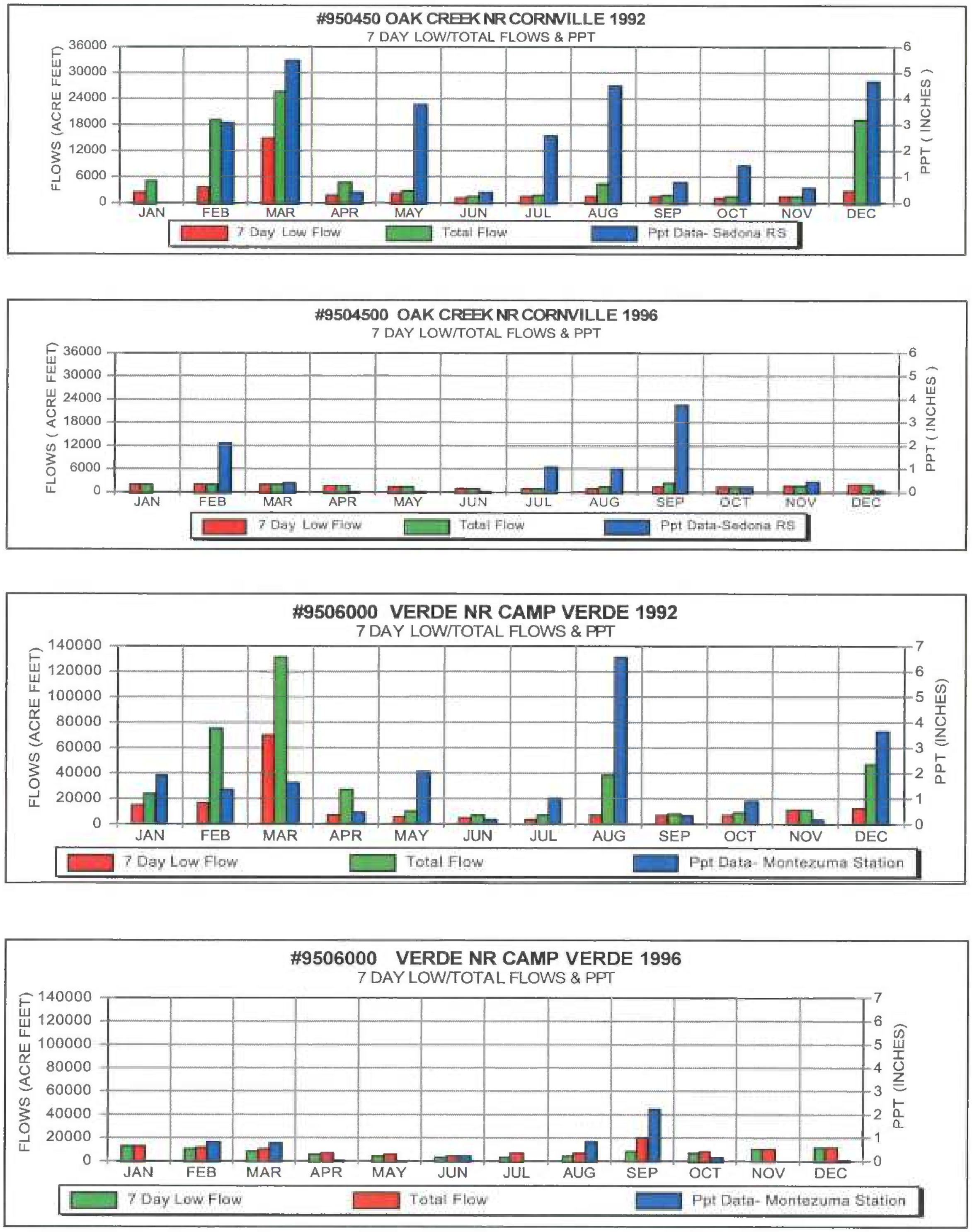


Figure 4.30 Verde Gaging Stations 7-Day Low Flow Comparisons 1990-1996



*Calendar Years

Figure 4.31 Gaged Stream Flow and Precipitation Station Comparisons- 1992 & 1996



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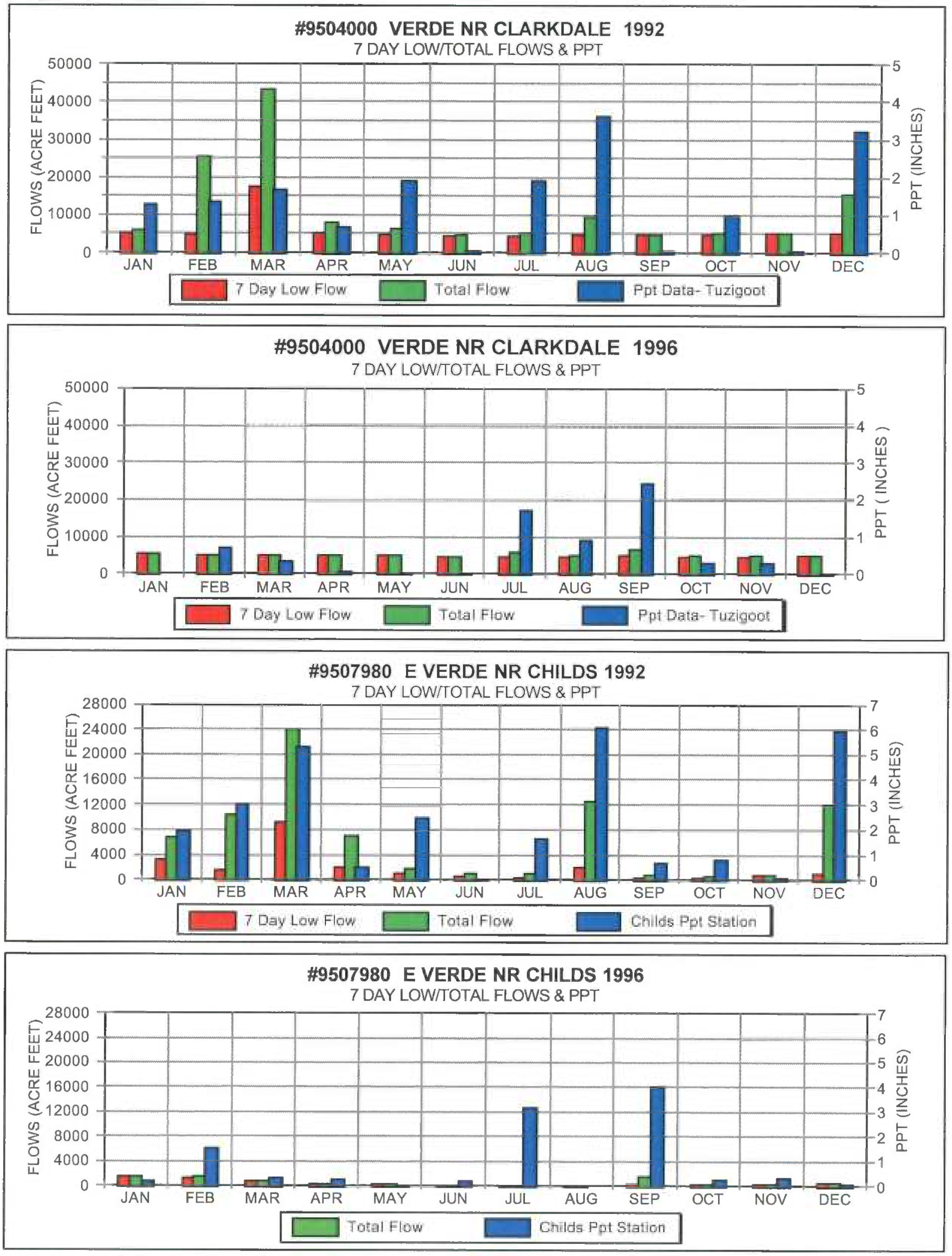

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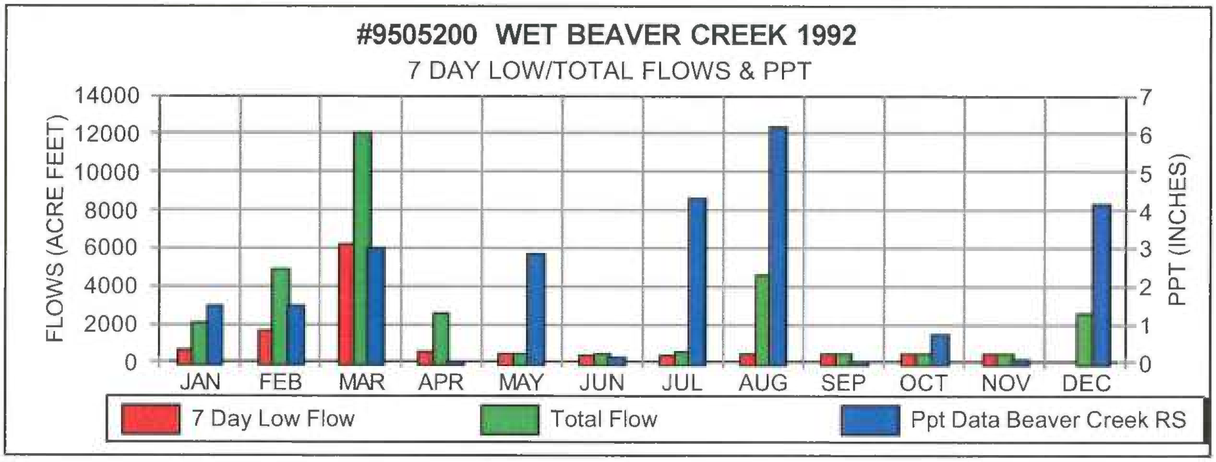
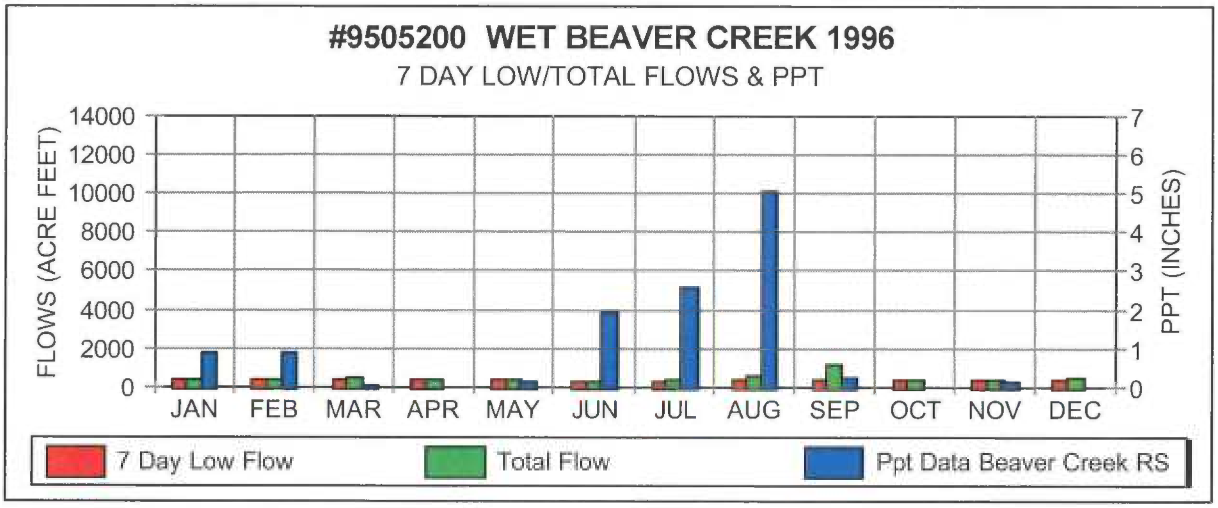




3. Gaged Tributaries - Seasonal Budget - Inflows

Total flow and baseflow (seven-day low flow) data for the Verde River and its tributaries were evaluated in order to better understand the seasonal aspect of water availability and use. Baseflow as defined by Owen-Joyce et al, 1983, is "groundwater that has been discharged into a stream channel as spring or seepage water." For this report, seven-day low flow numbers were used instead of actual baseflow numbers due to a lack of available baseflow data for the gaging stations. The difference between seven-day low flow and baseflow is that baseflow numbers do not reflect increased flow rates attributed to precipitation, while seven-day low flow numbers are influenced by precipitation.

The Verde River and its tributaries seven-day low flow figures were derived from data collected from the USGS streamflow value records. Each gaging station record was analyzed on a month to month basis for the years 1990-1996. Identifying the seven-day low flow within each month and finding the mean for the seven-day flow, approximated seven-day low flow levels. All flow data for this report were calculated based on calendar year results, which excludes 1997 flow data because figures were only available through September for 1998.

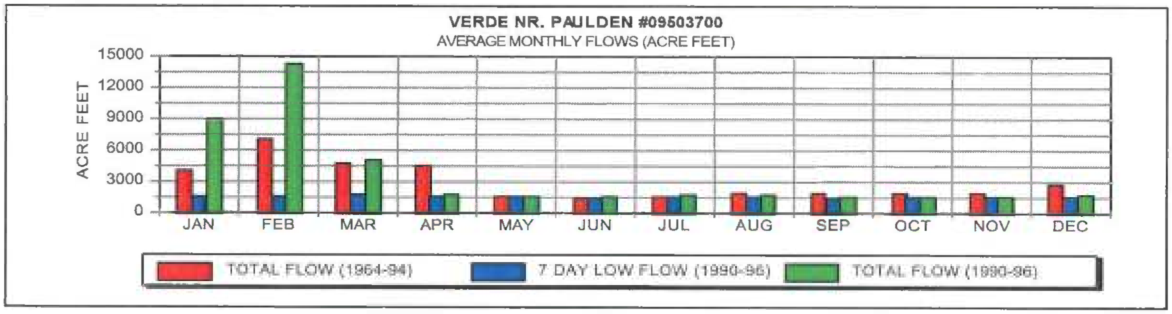
According to Twenter and Metzger, 1963, streamflow runoff or discharge above baseflow levels is defined as runoff (total flow) from precipitation and snowmelt upstream. Total flow amounts were used to represent the total amount of water flowing through the gaging stations per month. The monthly total averages for each station were collected from the USGS gaging station historical data bank accessed through the Verde River Watershed Association website, (www.verde.org) that were collected for an average of 31 years.

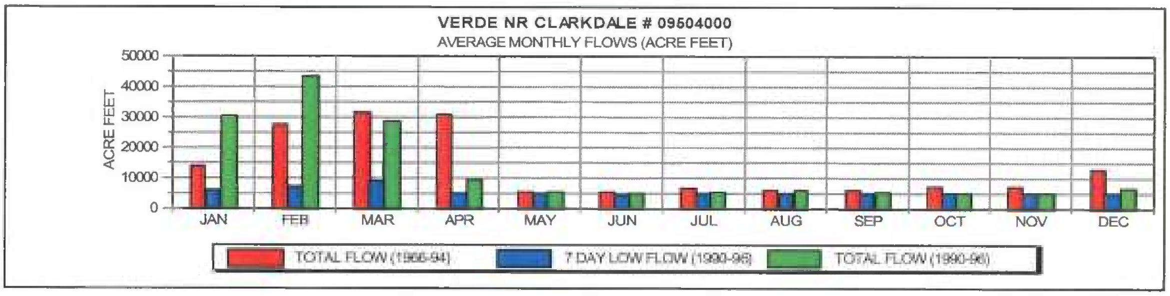
4. Gaged Tributaries - Seasonal Budget - Outflows

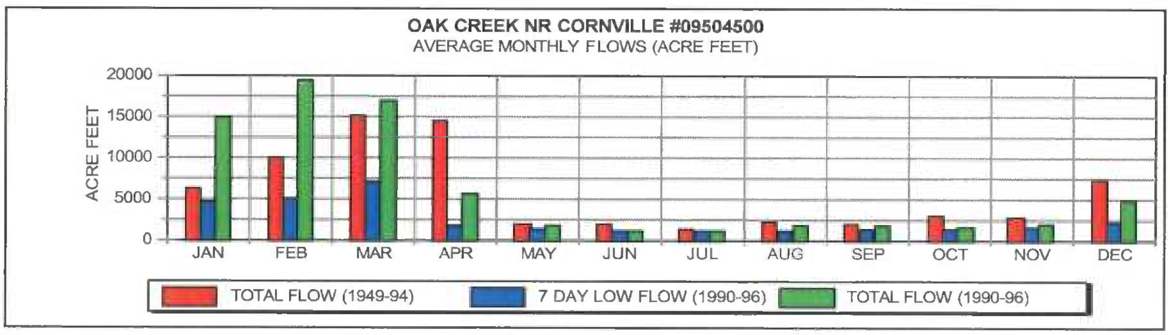
Surface water outflows for the water budget of the Middle Verde study area were measured at the Verde River near the Camp Verde gaging station (USGS station 09506000). This gaging station was selected as the measuring point for outflows because virtually all water demand in the Middle Verde occurs above this station. Monthly seven-day low flow and total flow values were computed using the same methods as for the surface water inflows.

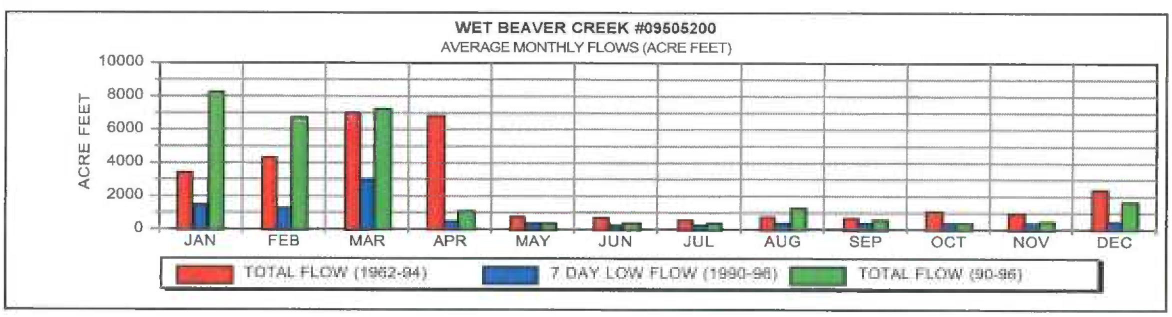
Figure 4.32 shows graphs of monthly mean seven-day low flow data and average total flow data for the period 1990 through 1996, along with historical monthly flow data for each gaging station in the Middle Verde study area.

Figure 4.32 Mean 7-day Low Flows and Average Total Flows; Historical and 1990-96









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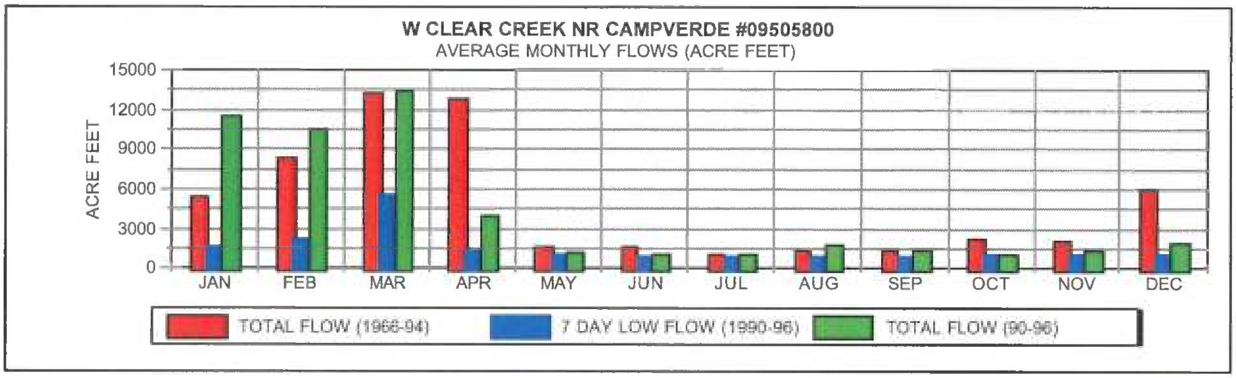

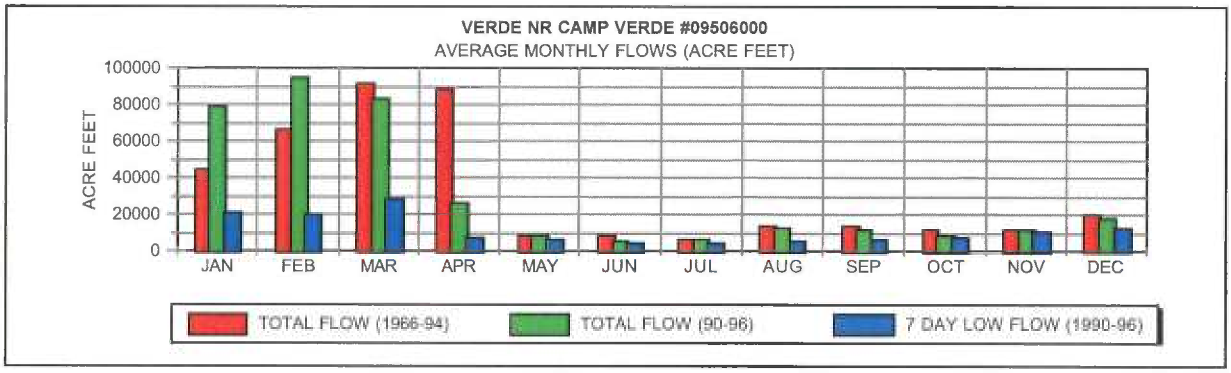

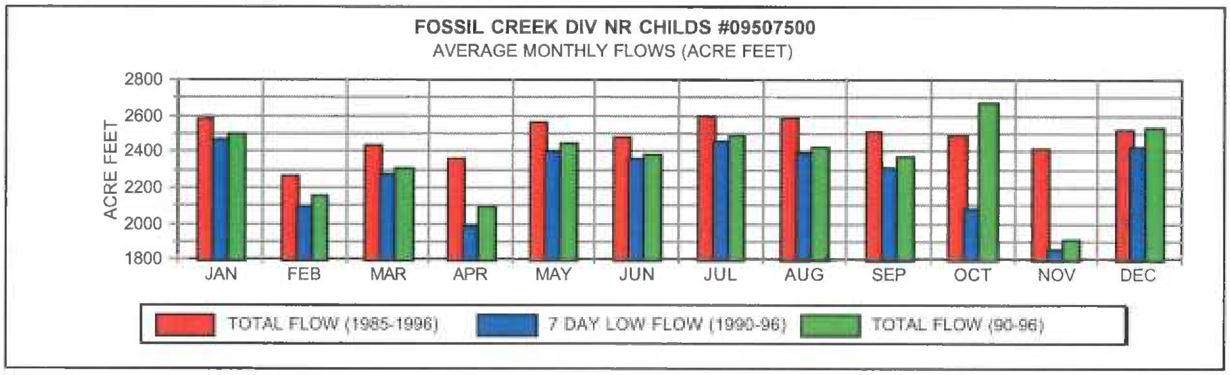

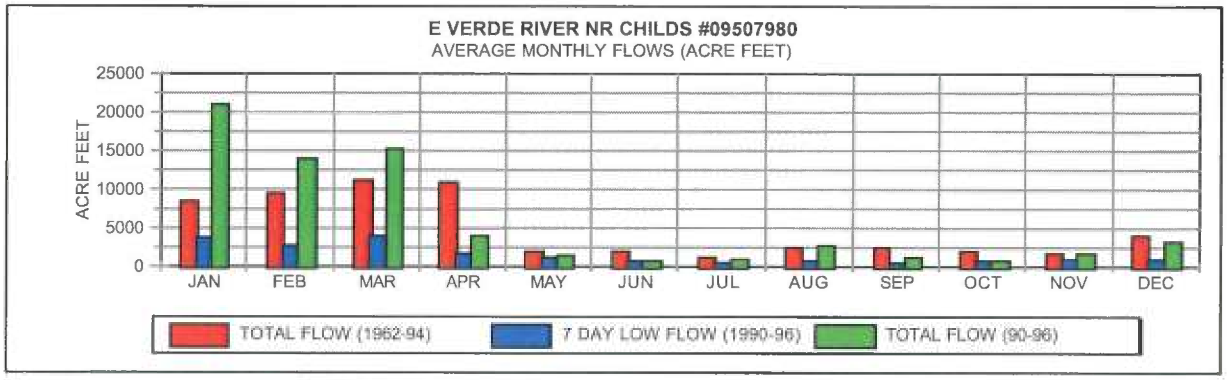

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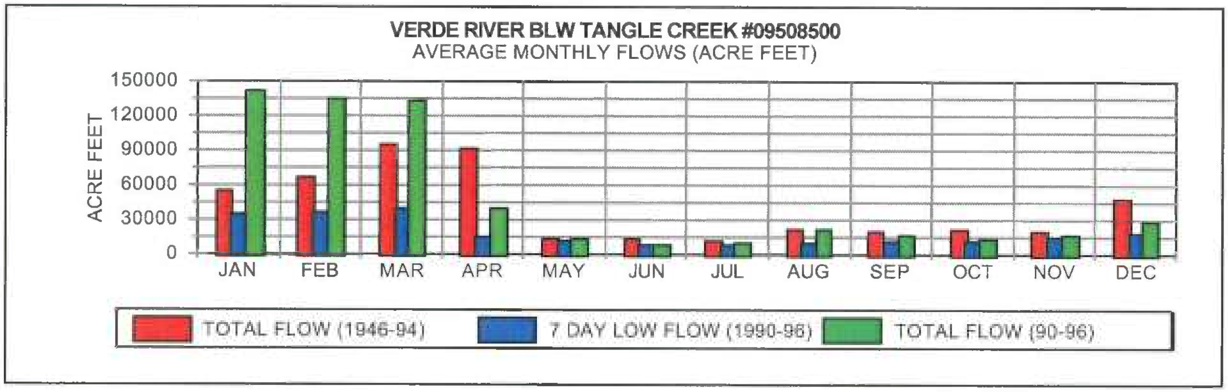


Tributary Flow Analysis

Baseflow (Seven-Day Low Flow) Estimates and Seasonal Flow Regime

The historical monthly flow averages were graphed and compared to the seven-year averages for seven-day low flow and total flow values, with the results revealing fluctuations reflecting seasonal precipitation events and water demand. Annual peak streamflows typically occurred during the months of January, February, and March due to precipitation events and snowmelt. Minimum monthly streamflows occurred during the month of June, before the arrival of the monsoon storms. Because all flow data was calculated utilizing calendar year figures, 1997 flow data was not incorporated since it was only available through September 1997. Refer back to Figure 4.32 for the total flows versus seven-day low flow data collected at each gaging station, with average monthly total flow data represented with historical (1965-1994) and recent data.

Unmeasured Tributary Flow

Inflow from mountain front recharge was accounted for as unmeasured tributary streamflows attributed to precipitation. Precipitation averages for the last 30 years (1967 to 1997) ranges from 11.58 inches in Chino Valley to 22.63 inches at the Irving precipitation station located near Fossil Creek. Precipitation data was retrieved from the National and Oceanic Atmospheric Association (NOAA) website (ncdc.noaa.gov). The *Upper Verde River Area* report stated that an average of 20 inches of precipitation falls on the Plateau Uplands, where the majority of recharge from precipitation for the area occurs (Owen-Joyce and Bell, 1983). These flows are unmeasured, but are estimated in the water budget section as residuals.

Baseflow (Seven-Day Low Flow)

Hydrographs were also developed and evaluated for the seven-day low flows of the Verde River and its primary tributaries to identify any trends that may be occurring. Seven-day low flows for the past 30 years for the months of June and December were determined from the data collected by the nine USGS gaging stations located on the Verde River and its tributaries within the Verde Valley. Flow data for eight of the nine gaging stations were available for the full 30 years. The ninth gaging station located on the Verde River below Camp Verde had nine complete years of flow data.

Once again, the months of June and December were selected for seven-day low flow analysis because of their consistent low rate of streamflow and the relatively low incidence of storm events that occur during these months. June typically experiences the lowest seven-day low flows throughout the year, which is indicative of low storm events and high demand. December tends to have a slightly higher seven-day low flow, but minimal or no demands from agriculture, evapotranspiration (ET), and the municipal sector make it more indicative of what the actual seven-day low flow tends to be.

Seven-Day Low Flow - Linear Regression Analysis

Linear regression analysis indicates that seven of the nine stations had increases in June seven-day low flows over the 30-year period. The gaging stations at Fossil Creek and the East Verde near Childs were the exceptions, with the gaging station on the East Verde near Childs indicating a decrease of approximately 8,700 acre-feet per month. This change could be a result of the inflow releases from Blue Ridge reservoir. December seven-day low flows indicated slightly increasing trends over the past 30 years for six of the nine stations. The three exceptions that indicated slightly decreasing trends over the same time period were Fossil Creek, Oak Creek, and the Verde River near Tangle Creek. Figure 4.33 shows linear regressions of seven-day low flow streamflow data for the months of June and December for an average of 30 years per station.

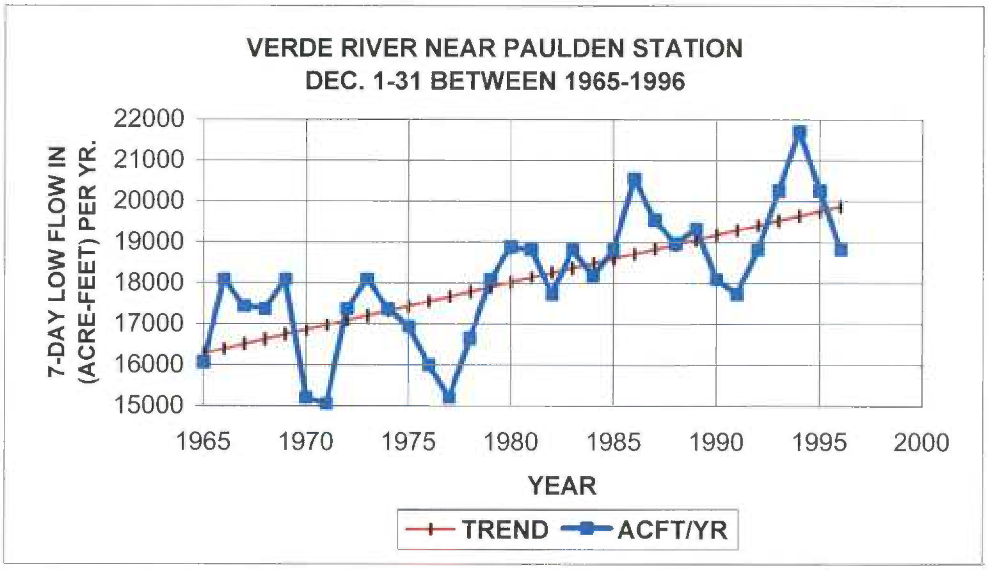
Precipitation

Precipitation trend analysis was also performed on the five referenced gaging stations located within the Middle Verde region (Figure 4.34). The analysis was performed on data collected over a 32-year period (1965-1997) for four of the stations and for 19 years (1978-1997) at the Tuzigoot station. Some years were missing totals due to missing data for some months during that year. The analysis revealed a slightly upward trend for the Beaver Creek recording station (RS) and the Montezuma Castle stations, a fairly steady trend for the Sedona RS and Childs stations, and a slight downward trend was noted at the Tuzigoot station.

Surface Water Diversions Points

A total of 74 surface water diversions were identified in the Middle Verde area. These diversions supply water for domestic, agricultural, commercial, and other uses.

Figure 4.33 Linear Regression Analysis
Verde River Near Paulden Gaging Station Dec. & June 1965-1996



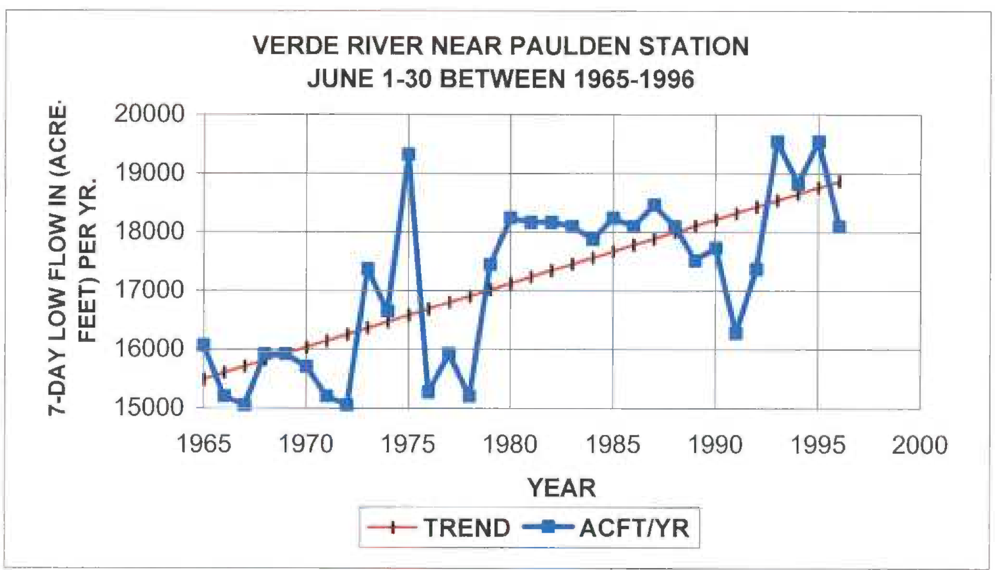
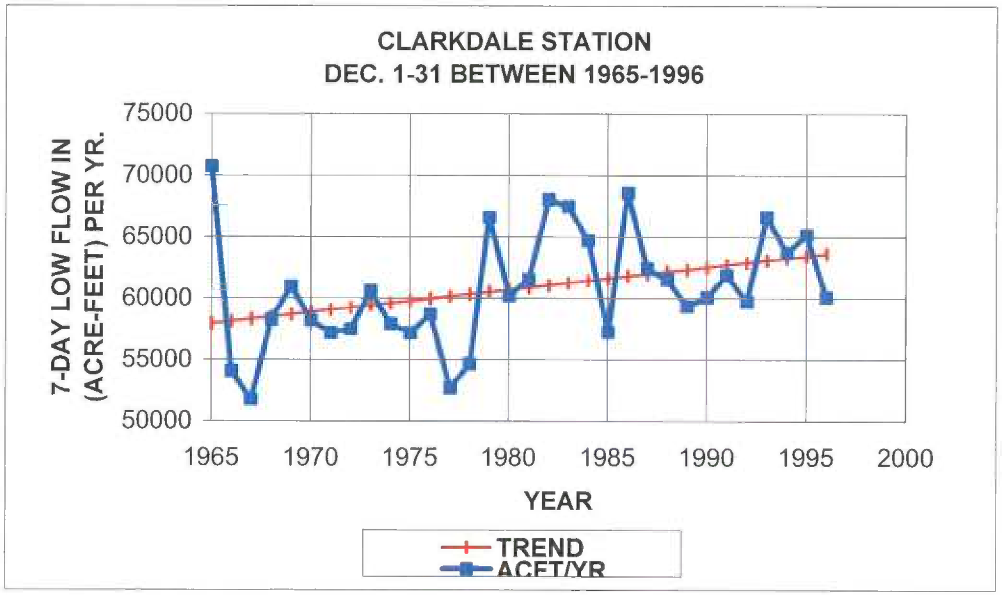


Figure 4.33 Continued
Clarkdale Gaging Station Dec. & June 1965-1996



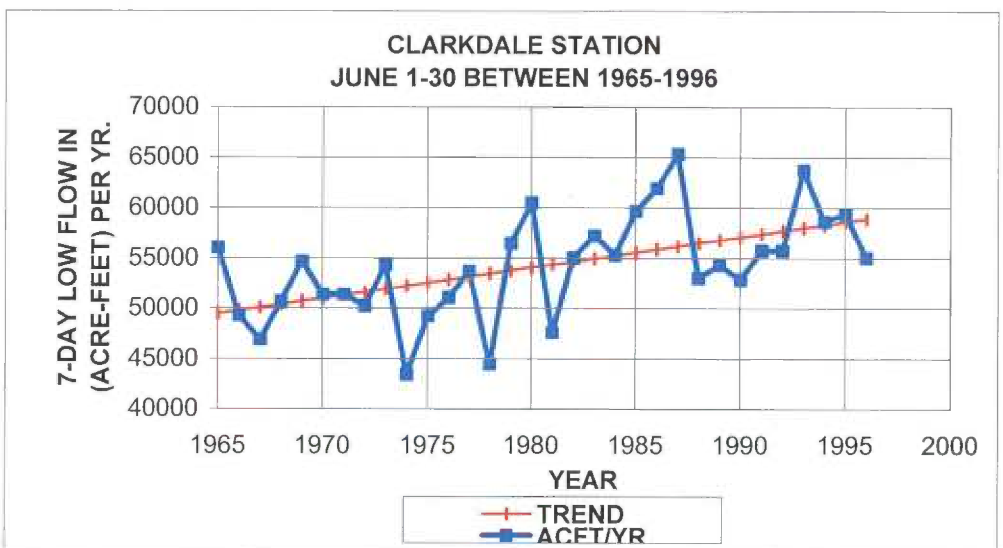
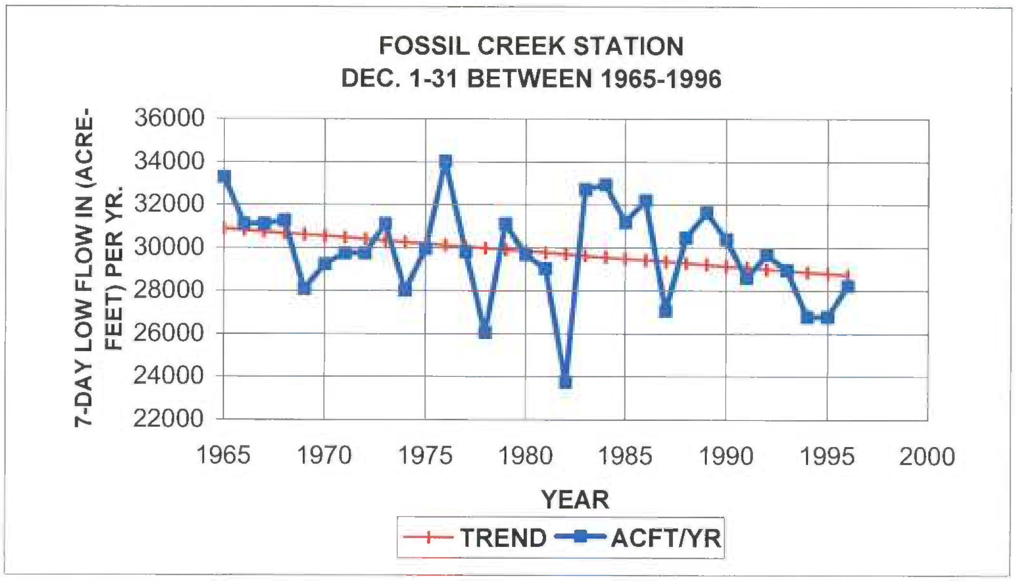


Figure 4.33 Continued
Fossil Creek Gaging Station Dec. & June 1965-1996



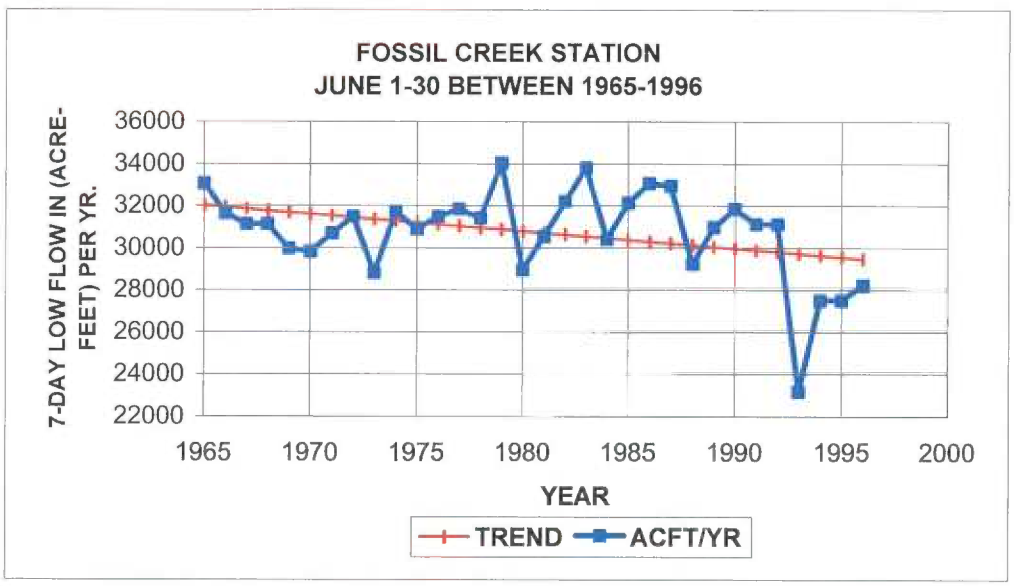
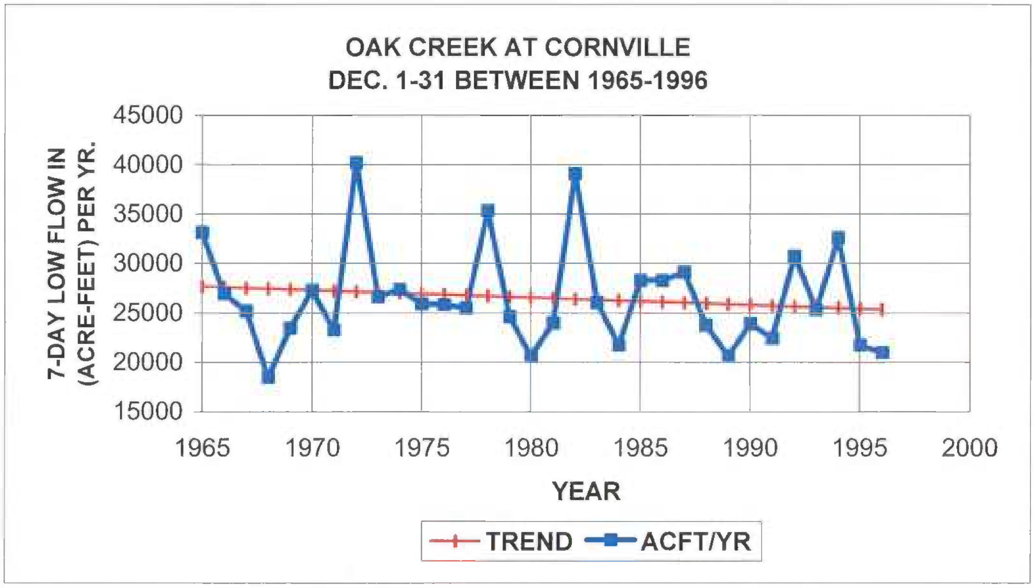


Figure 4.33 Continued
Oak Creek At Cornville Gaging Station Dec. & June 1965-1996



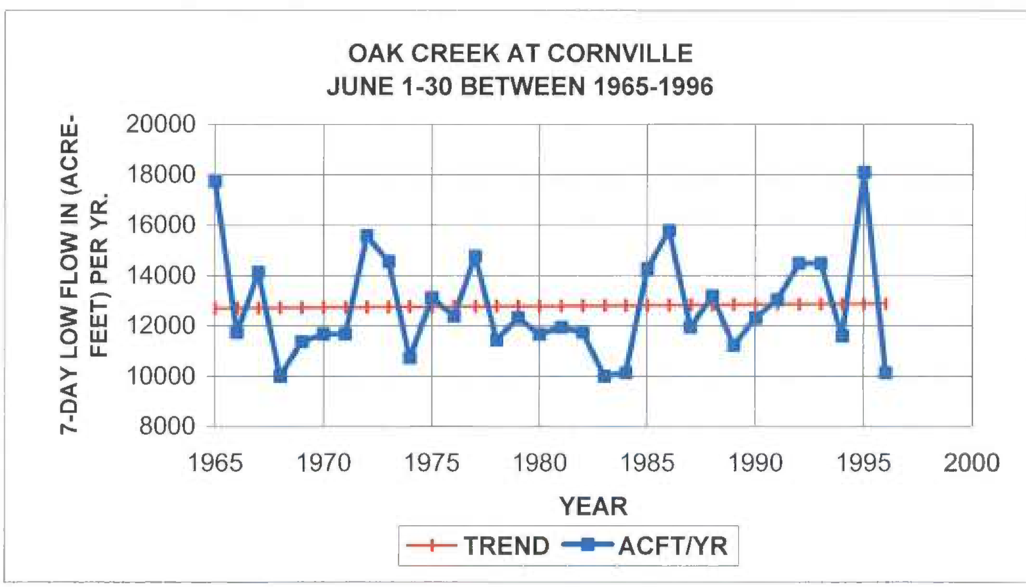
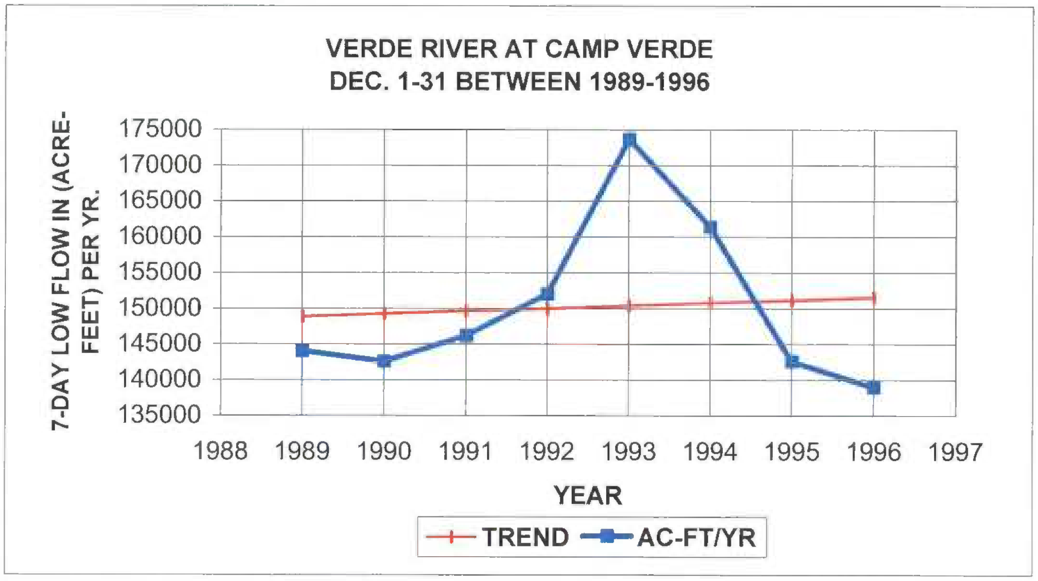


Figure 4.33 Continued
Verde River At Camp Verde Gaging Station Dec. & June 1989-1996



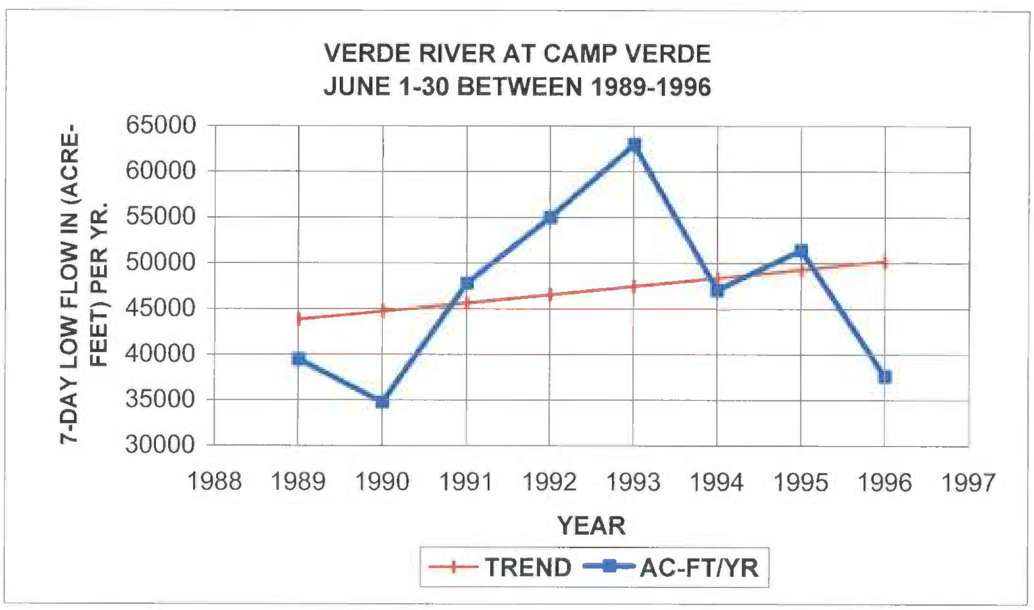
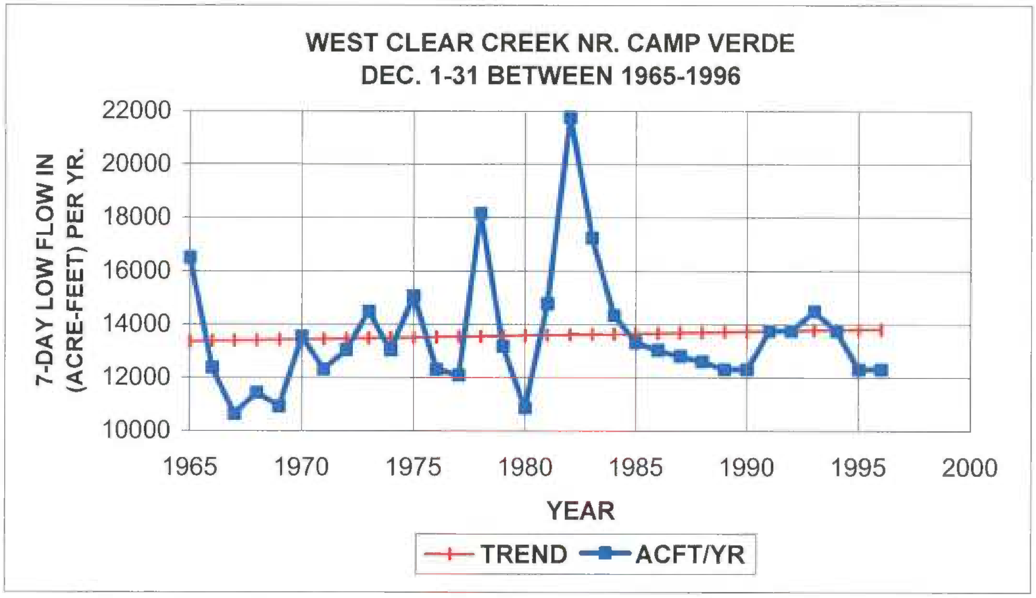


Figure 4.33 Continued
West Clear Cr. Nr. Camp Verde Gaging Station Dec. & June 1965-1996



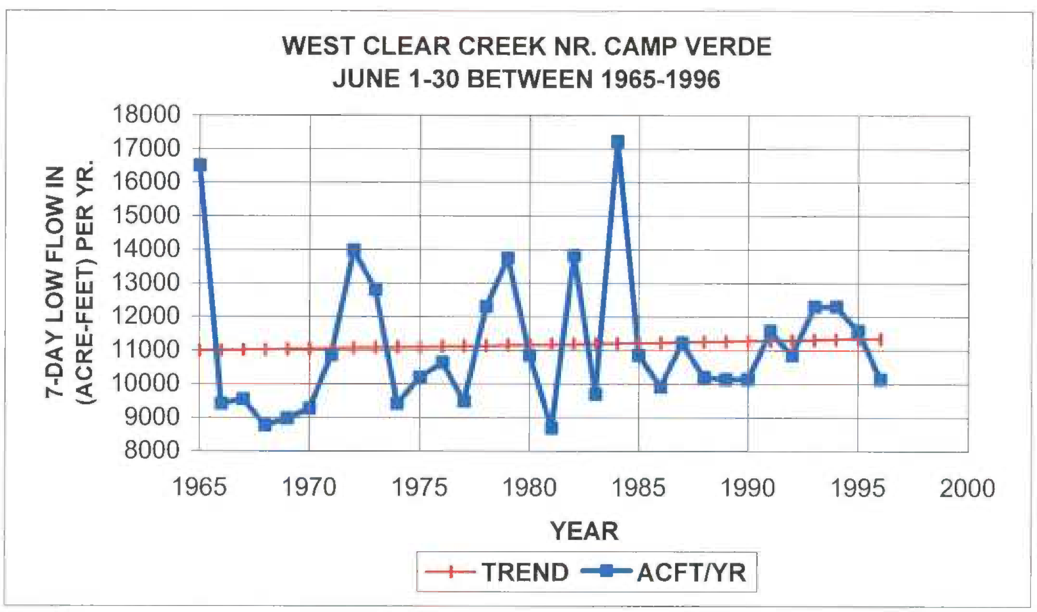
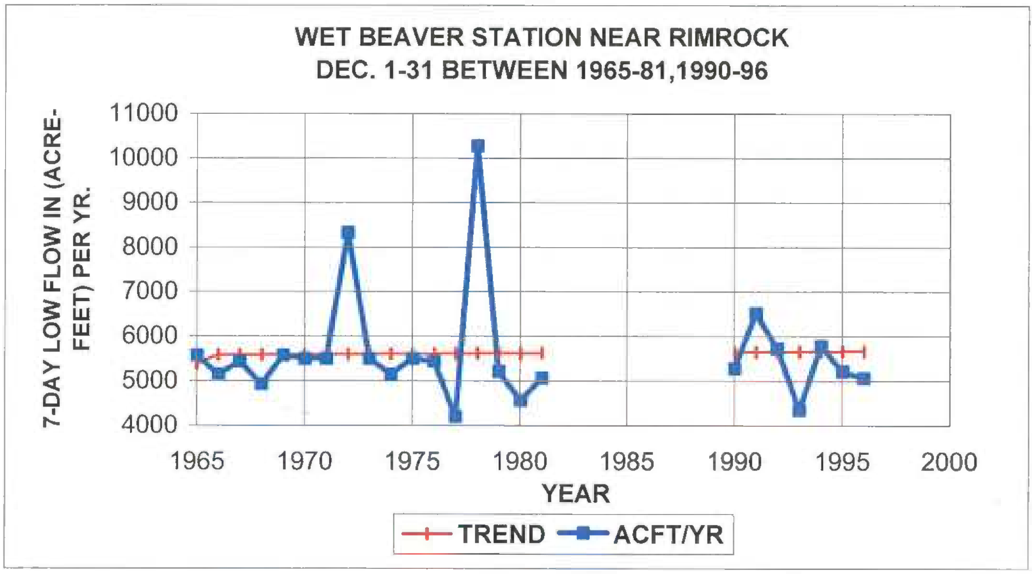


Figure 4.33 Continued
Wt. Beaver Station Near Rimrock Dec. & June 1965-1981,1982 & 1990-1996



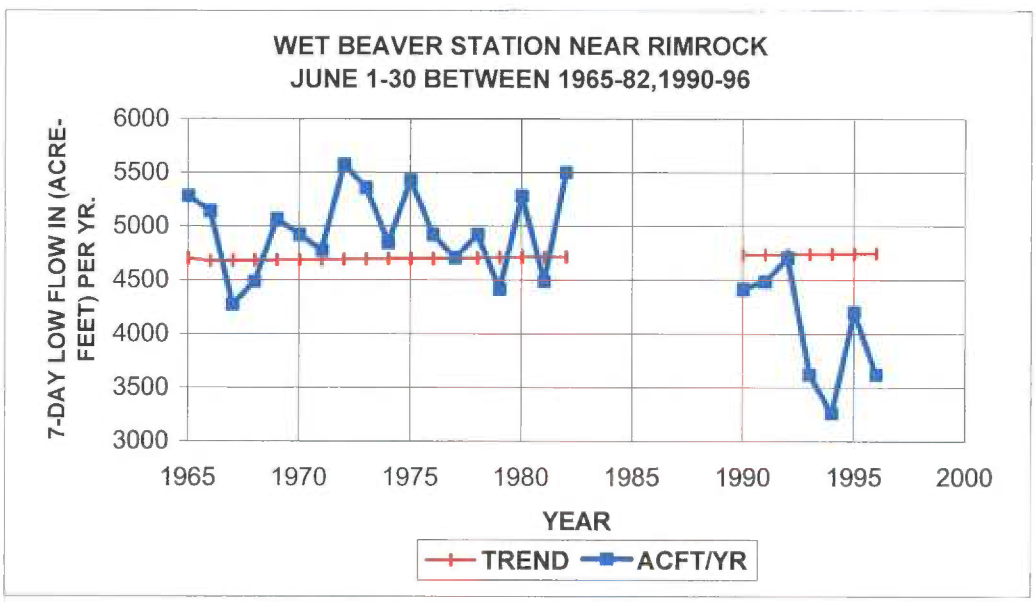
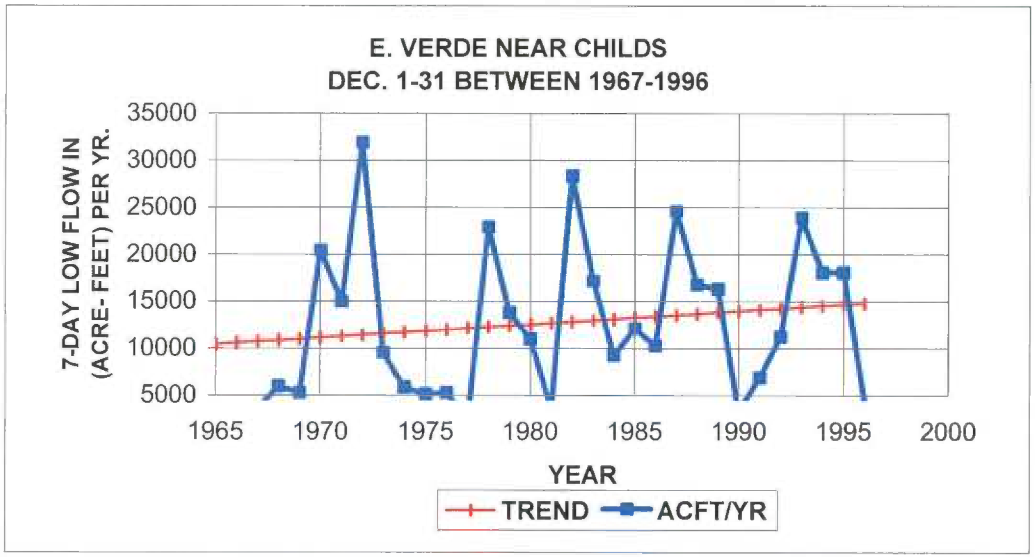


Figure 4.33 Continued
East Verde Near Childs Gaging Station Dec. & June 1967-1997



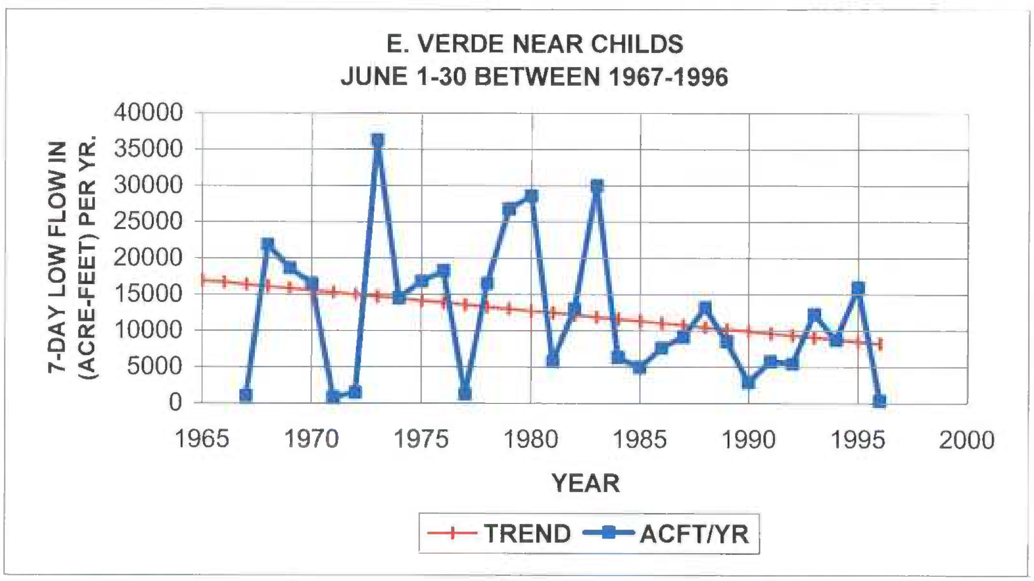
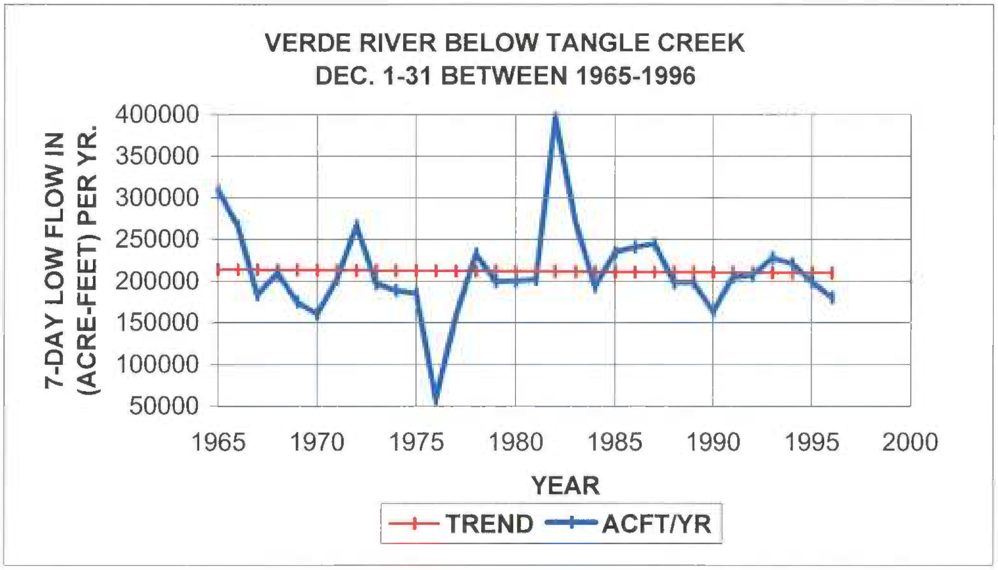


Figure 4.33 Continued
Verde R. Below Tangle Creek Gaging Station Dec. & June 1965-1996



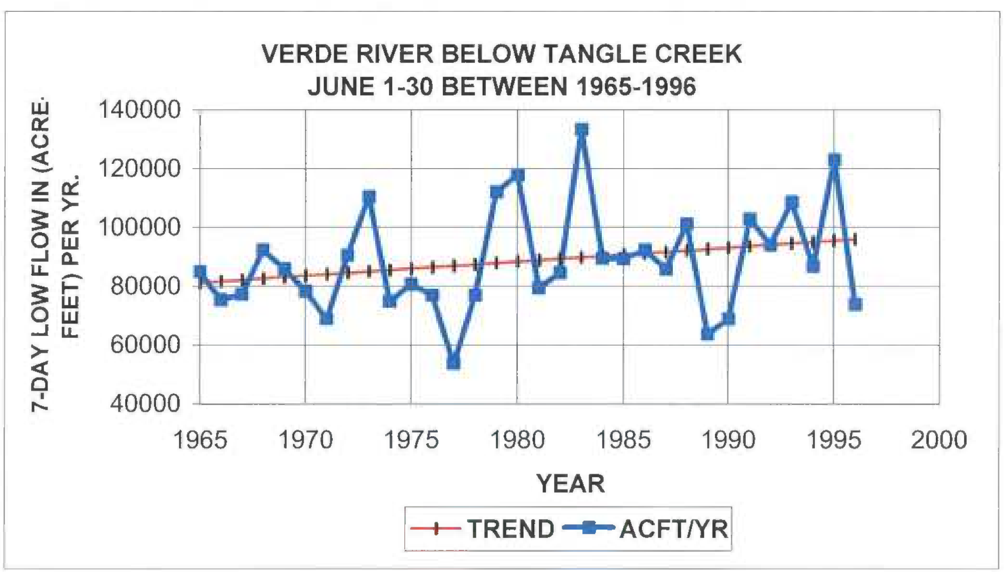
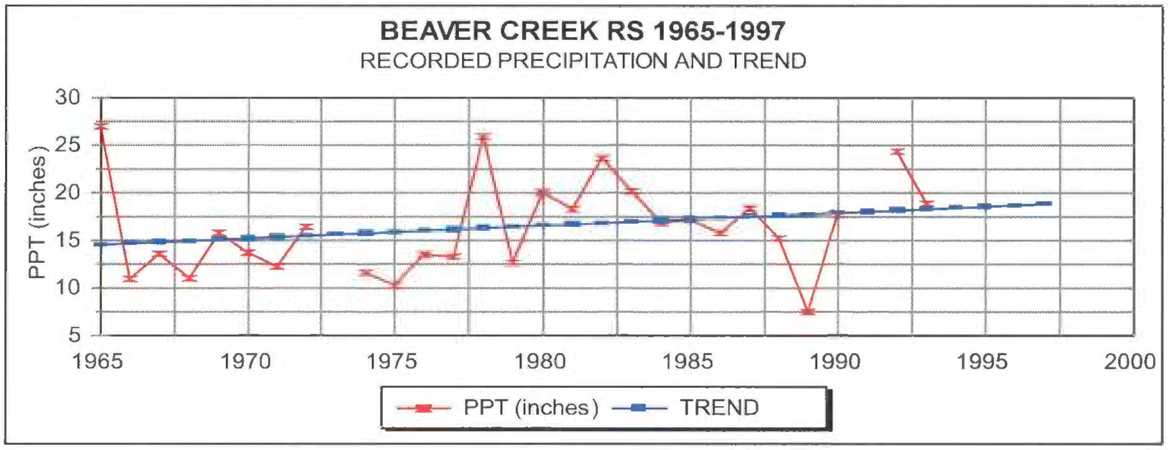
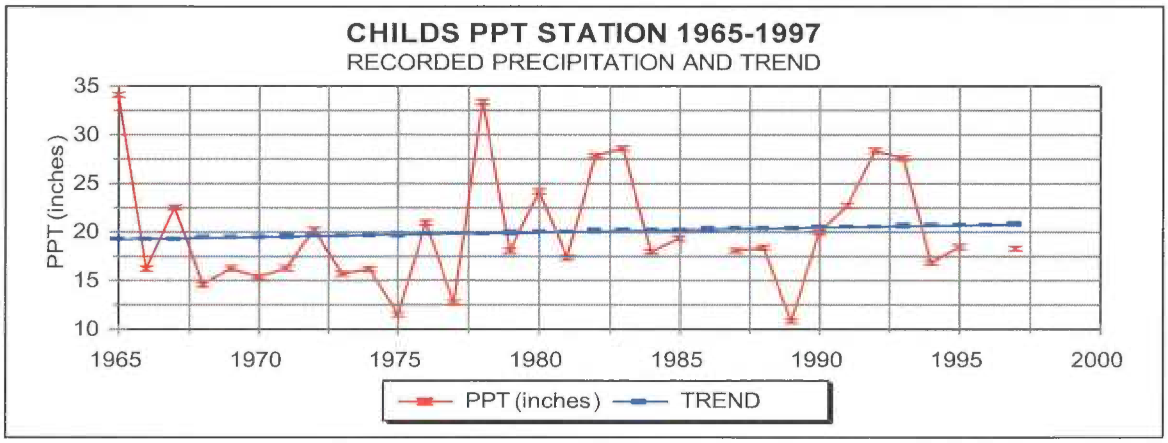


Figure 4.34 Precipitation Trend Analysis





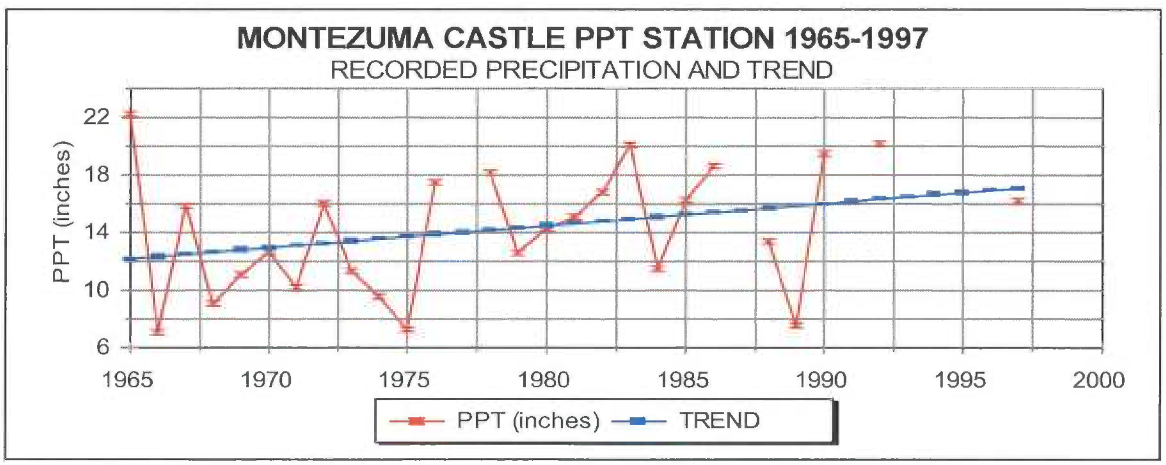
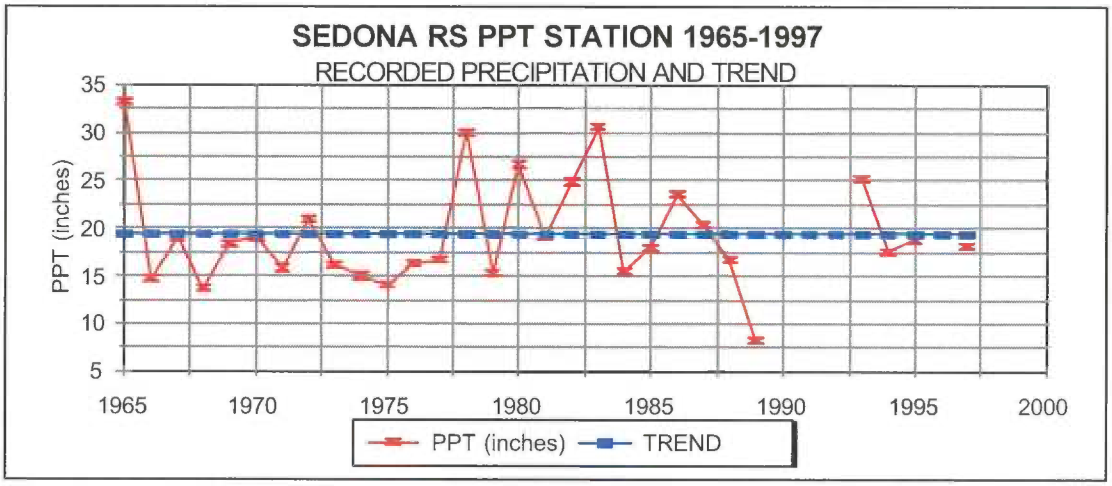
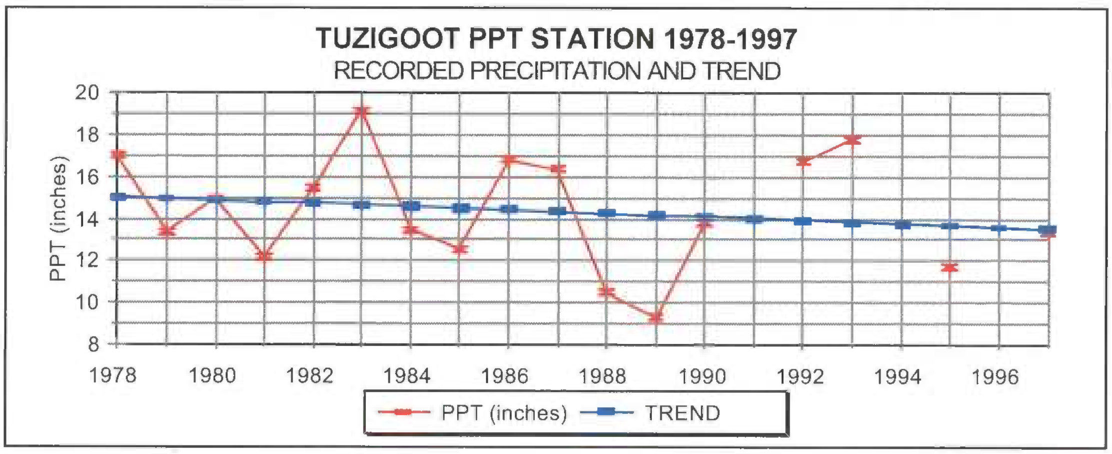


Figure 4.34 Continued





A total of 25 surface water diversions are located along the Verde River. The first diversion occurs in Perkinsville where surface water is diverted from the Verde to irrigate approximately 40 acres of land. The remaining 24 diversions are located from near Clarkdale to below Camp Verde and consist of nine diversion structures, 13 instream pumps, and two springs. All surface water diverted by these 24 diversions is used for irrigation.

Thirty-two surface water diversions are located along Oak Creek. The first diversions occur north of Sedona where two springs are diverted to supply surface water to the Arizona Game and Fish's Sterling Hatchery facility. Other diversions along Oak Creek include 16 surface water diversions, eight springs, and eight instream pumps. Seven additional ditch diversions were also identified along Oak Creek, but are no longer in service and are not included in the total number of active diversions for the Middle Verde.

Twelve surface water diversions are located along Wet Beaver Creek. Eight are diverted surface flows from Wet Beaver Creek and four are diverted surface flows from springs within the area. All 12 diversions divert surface water for irrigation purposes.

Three surface water diversions are located along West Clear Creek and divert surface water for irrigation purposes. One surface water diversion is located along Webber Creek at its confluence with the East Verde River. Surface water diversions from this location are diverted for the irrigation of lawns and pastures located within the Flowing Springs Irrigation Association service area. See Appendix B for more detailed information on the major surface water diversions within the Middle Verde.

4.4 WATER QUALITY

Introduction

National regulations and guidelines for the quality of water provided by public water systems have been established by the U. S. Environmental Protection Agency (EPA) (1977, p. 17146). Contaminants in drinking water that have been shown to affect human health, such as arsenic and fluoride, are governed by primary drinking water regulations established by the EPA. Primary regulations are enforceable by the EPA and the states. Any physical, chemical, biological, or radiological substance in water are regulated according to a specified limit known as "Maximum Contaminant Level" (MCL). Regulated categories of primary MCLs include nutrients, pesticides, semi-volatile organics, volatile organics, bacteria/virus, major metal cations and anions, metals, radionuclides, and others. Table 4-6 lists several Arizona domestic water source standards that have been exceeded in the Verde Watershed study area.

Secondary regulations were established as recommended guidelines for the States to follow. Contaminants that affect the aesthetic quality of drinking water, such as dissolved solids, sulfate, magnesium, chloride, and sodium, are governed by secondary drinking water regulations established by the EPA and the states. As given in the secondary drinking water regulations by the EPA and in accordance of the Safe Drinking Water Act (Public Law 93-523), the recommended MCLs for dissolved solids in public water supplies is 500 mg/L (milligrams per liter [mg/L = parts per million]) (Owen-Joyce et al., 1983).

TABLE 4-6

SELECTED GROUNDWATER STANDARDS FOR PUBLIC WATER SYSTEMS IN ARIZONA AND KNOWN CONTAMINANT LEVELS IN THE VERDE WATERSHED STUDY AREA

INORGANIC – MAJORS	**AQUIFER WATER QUALITY STANDARDS (AWQS) MCL or SMCL (MEASURED AS µg/L* UNLESS STATED)**
Total Dissolved Solids (TDS)	500.0 mg/L
Fluoride (F) – Dissolved	4.0 mg/L
Nitrate (NO3 as N)	10.0 mg/L
Sulfate (SO4)	SMCL = 250.0 mg/L
INORGANIC – METALS	
Arsenic (As) – Dissolved	50
Iron (Fe)	SMCL = 300
Lead (Pb)	50
Mercury (Hg)	2
VOLATILE ORGANIC COMPOUNDS	
Trichloroethene (TCE)	5
Tetrachloroethylene (PCE)	5
PHYSICAL, BACTERIOLOGICAL	
PH	SMCL = 6.5 to 8.5
Fecal Coliform	800 colonies/100 ml

Sources: SRP, 1995 Annual Water Quality Report; ADEQ, 1998.
*µg/L = parts per billion; mg/L = parts per million.

Upper Verde

Groundwater quality data in the Upper Verde is scarce due to the fact that limited sampling has been performed until recently. The best and most recent data are found for areas within the Prescott AMA. Groundwater quality in the Prescott AMA is generally of good quality for most uses. Previous sampling, however, has occasionally detected higher levels of total dissolved solids (TDS), organics, sulfate, nitrate, and metals exceeding federal and state drinking water standards. Total dissolved solids in the two groundwater sub-basins of the Prescott AMA are generally low, ranging from less than 130 mg/l to over 800 mg/l. Most readings were found to be within the 200 to 400 mg/l range. Near Del Rio Springs, TDS concentrations in the underlying regional aquifer were found to be lower than in the perched aquifer system (Prescott AMA SMP, 1995).

Previous studies of groundwater quality in the Prescott AMA (W. H. Remick, 1982) have identified fluoride concentrations in water samples from wells ranging 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). In his 1982 study, Remick reported that the average annual, maximum daily air temperature for the lower elevations of the Prescott AMA (below 5,000 feet) is about 72°F. The average annual, maximum daily air temperature for the higher elevations of the Prescott AMA (above 5,000 feet) is about 69°F. The maximum concentration levels for fluoride at the lower and higher elevations are 1.6 mg/L and 1.8 mg/L respectively. Of the 364 samples collected in that study, only eight samples contained fluoride in excess of the maximum concentration level allowed. The eight samples were all from wells located in bedrock in the mountains of the Little Chino Valley sub-basin.

The most recent groundwater quality sampling within the Prescott AMA and the Verde River groundwater basin, comes from the Arizona Department of Environmental Quality (ADEQ) in their 1998 Water Quality Assessment. In this report, the number of wells exceeding Arizona's Aquifer Water Quality Standards in the Prescott AMA were obtained from the ADEQ Water Quality Database and summarized according to general constituent categories. The categories included radiochemicals, fluoride, metals, nitrate, volatile organic carbons (VOC) and semi-volatile organic carbons (SOC), and pesticides. Data was collected from domestic, irrigation, industrial, stock, and index wells in areas suspected of contamination. Out of 147 samples taken from wells in the Prescott AMA, two exceeded the fluoride standard, one exceeded the radiochemical standard, and two more exceeded the nitrate standard. Based on these recent tests, it appears that groundwater quality has had little change when comparing the more recent data against historical data.

The quality of surface water in the Prescott AMA has been reported as very good. Surface flows from Granite Creek met all parameters set by federal and state drinking water standards. The TDS concentration in water used for irrigation in the Prescott AMA typically ranges from 200 to 500 mg/L.

Water quality data in the areas in and around Williamson Valley, Walnut Creek, and Big Chino Wash is insufficient to determine current water quality problems in these areas. Supplemental collection of groundwater quality data by ADEQ in these areas is currently underway and should facilitate future evaluations.

Middle Verde

In the Middle Verde, fluoride concentrations have been found to be less than 4 mg/L; the maximum contaminant level allowed in public water supplies by the state (ADEQ, 1997). Contaminant levels have ranged up to 1.6 mg/L to 1.8 mg/L in the Middle Verde (Levings et al., 1980). Arsenic has been found in water from some wells near Cornville and Rimrock down to Camp Verde ranging from 1 μg/L to 240 μg/L (micrograms per liter). The maximum contaminant level of arsenic allowed in public water supplies is 50 μg/L (U. S. Environmental Protection Agency, 1976, p. 14).

Previous studies have indicated that groundwater quality in the regional aquifer is of acceptable quality and suitable for most uses. In the northern and eastern portions of the Middle Verde, groundwater has been found to contain less than 500 mg/L of TDS (mainly calcium, magnesium, and bicarbonate).

In the southwestern portion of the Middle Verde, most wells obtain their water from the Verde Formation. The chemical quality of water in the Verde Formation is varied owing to differences in lithology and the poor hydraulic connection between the beds that make up the formation. Groundwater has been found to change composition as it flows downgradient through the Verde Formation. Wells in the formation generally contain less than 500 mg/L of TDS with certain areas having wells ranging from 500 mg/L to 2,000 mg/L TDS. Water from a few wells contains more than 2,000 mg/L of TDS. From Cottonwood to south of Camp Verde there is a marked increase in sodium and sulfate concentrations. South of Camp Verde the water from the Verde Formation is salty and unsuitable for domestic purposes. Water that contains more than 1,000 mg/L of dissolved solids generally contains a predominance of sodium, magnesium, and sulfate owing to solution of salts, one of which is gypsum (Levings et al., 1980).

Groundwater in the alluvium along the Verde River south of Camp Verde has been found to contain large concentrations of TDS, 810 to 3,790 mg/L, which are mainly magnesium, sodium, calcium, and sulfate (Owen-Joyce et al., 1983).

The chemical quality of surface flows has been found to be similar to that of groundwater, which is generally a calcium magnesium bicarbonate type. Surface flows within the Verde Formation contain increased dissolved solids as a result of groundwater inflow to the river.

Currently, the greatest single use of surface water is for irrigation; surface water in the Middle Verde River area is generally well suited for that use. Studies have found that in most of the streams in the area the sodium hazard is low, but the salinity hazard generally ranges from low to medium in the tributaries and the Verde River north of Camp Verde and medium to high downstream of Camp Verde (Owen-Joyce et al., 1983).

The presence of fecal coliform bacteria in surface waters of the Middle Verde have been detected and studied for some time. Fecal coliform bacteria are present in the intestines and feces of warm-blooded animals. Contaminant levels for fecal coliform organisms have a maximum allowable limit of 800 colonies per 100 milliliter as set forth by the Arizona Water Quality Control Council (Owen-Joyce et al., 1983). Fecal coliform bacterial contaminant levels exceeding the allowable limit are considered hazardous to human health.

The USGS, ADEQ, and Salt River Project (SRP) have previously evaluated the bacteriological quality of surface flows under the single sample category. Samples taken in Oak Creek and the Verde River have periodically exceeded the maximum allowable limits. This data indicates that there are sites where, for at least short periods, fecal pollution may be a potential hazard to swimmers during the summer months when streamside recreation and tourism is at its peak. High fecal coliform counts may also be attributed to livestock and other wild animals defecating in or close to streams (Owen-Joyce et al., 1983).

CHAPTER 5

Water Budget Analysis

CHAPTER 5: WATER BUDGET ANALYSIS

5.1 INTRODUCTION

The purpose for developing a water budget is to evaluate the hydrologic components of a watershed, such as inflows, outflows, and change in groundwater storage. Through analysis of these components, determinations regarding their relative importance and the impacts they have on each other and on the system as a whole can be made. This type of analysis also helps in understanding the relative certainty or uncertainty of each component.

To better understand the dynamics of the hydrologic system, particularly to help address the difficult questions of the effect of pumping and the timing and location of diversions and return flows, the preliminary water budgets developed in this report will ultimately need to be more detailed and cover a longer period of time.

A balanced water budget for a regional aquifer occurs when there is no net change in the amount of water stored and the inflows equal the outflows. The *Upper Verde River Area* report, written in 1983 by Owen-Joyce and Bell, included a water budget that focused on a portion of the study area referred to in this report as the Middle Verde (Verde River near Clarkdale to the Verde River near Camp Verde). Their water budget was based on the assumption that the inflows and outflows of the system were in balance, with no change in storage for the regional aquifer. The components of the water budget section of their report were as follows:

<u>Owen-Joyce & Bell Water Budget (1983)</u>

Inflows		
1-	Infiltration of precipitation and streamflow	169,000 AF
2-	Baseflow of the Verde River near Paulden	16,000 AF
	Total Inflows	**185,000 AF**
Outflows		
1-	Baseflow of Verde River near Camp Verde	80,000 AF
2-	Fossil Springs	31,150 AF
3-	Evapotranspiration	35,000 AF
4-	Irrigation- Consumptive Use	31,000 AF
5-	Groundwater Withdrawal	8,000 AF
	Total Outflows	**185,000 AF**

In the Owen-Joyce and Bell water budget, the inflow component of precipitation and streamflow accounted for all flows into the Verde River. This component was derived by first determining the total outflows, and then computing the recharge percentage needed to balance the system, which compared favorably with the 8 percent recharge factor that was originally developed and proposed by Twenter and Metzgers in 1963. Fossil Springs was treated as an outflow because the mouth of the spring was outside the study area, but the contribution to the system was taken into account through the precipitation and streamflow component.

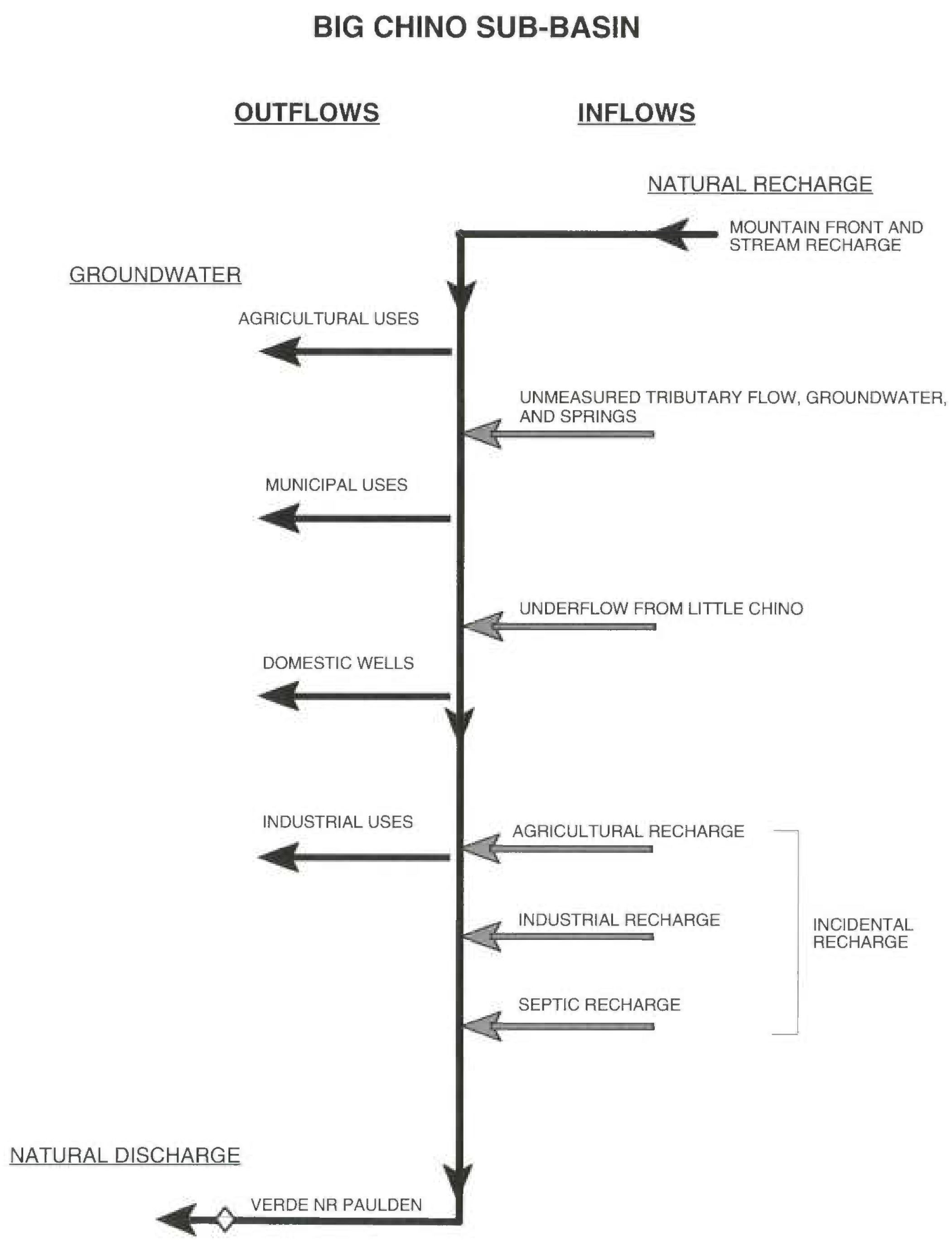
For the current report, the water budget study area is divided into two regions: 1) the Upper Verde, which is comprised of the area above the USGS gaging station #09503700 (Verde River near Paulden) including Williamson Valley and Big and Little Chino Valleys; and 2) the Middle Verde, which encompasses the area between the USGS gaging station #09503700 to the gaging station #09508500 (Verde River below Tangle Creek).

The Upper Verde water budget was divided into two sub-budgets: the Big Chino and Little Chino sub-basins. The annual water budget for the Upper Verde River Watershed discussed in this section includes the amounts of water recharged to and withdrawn from the aquifers of the Big Chino and Little Chino. The inflow and outflow components of the groundwater budget for the Big and Little Chino sub-basins upstream of the USGS stream gage on the Verde River near Paulden were determined from area streamflow data, precipitation data, studies and reports, field investigations, water use data analysis, and estimates of groundwater and surface water conditions. Figure 5.1 shows components that are representative of the water budget for the Upper Verde region.

For the Middle Verde, this study developed a number of water budgets in order to explore the behavior of the hydrologic system on an annual and seasonal basis and during wet and dry years. In order to concentrate on the area with the highest demands, the Middle Verde section was examined from the USGS gaging station #09504000 (Verde River near Clarkdale) to the USGS gaging station #09506000 (Verde River near Camp Verde), labeled Reach 2. Two additional sub-budgets were developed for the reaches between the USGS gaging stations #09503700 (Verde River near Paulden) and #09504000 (Verde River near Clarkdale), labeled as Reach 1, and the USGS gaging stations #09506000 (Verde River near Camp Verde) to the USGS gaging station #09508500 (Verde River below Tangle Creek), labeled as Reach 3.

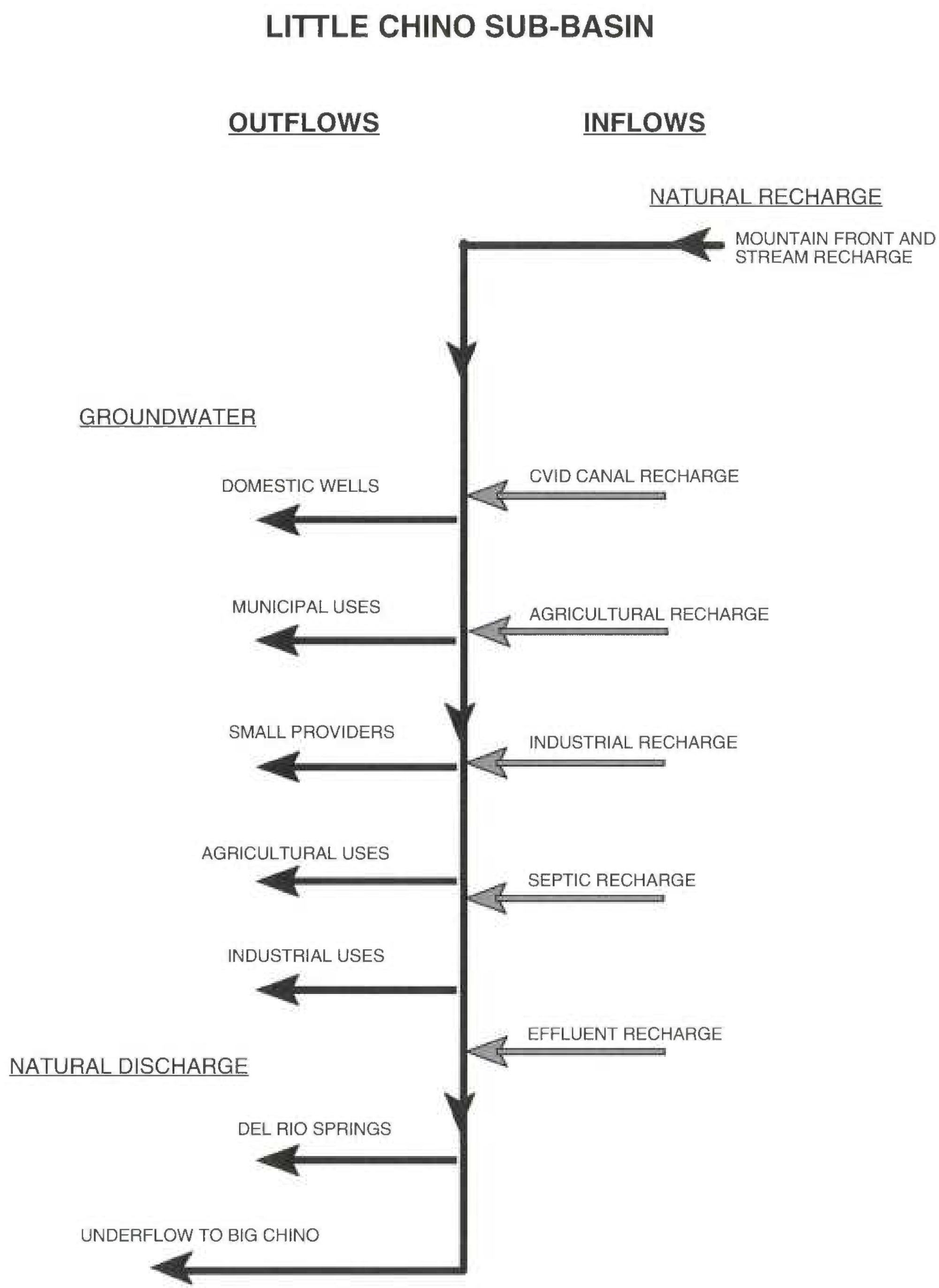
For the Middle Verde, a normalized budget for each reach was developed in order to calculate seven-year averages. Seasonal water budgets and annual water budgets were

Figure 5.1 - Upper Verde Water Budget Components



◇ USGS Gaging Station

Figure 5.1 - Continued



developed to explore the system behavior. The seasonal water budgets were designed to reflect the month to month changes in water availability and demand due to agriculture and municipal use as well as seasonal streamflow fluctuations. The annual budget reveals the total yearly water usage based upon the inflows and outflows of the system and is essential in evaluating long-term effects to the overall water budget and groundwater storage in particular.

Seasonal and annual water budgets were developed for the years 1992 and 1996 for the Middle Verde region. The year 1992 was a wet year, with monthly precipitation levels consistently greater than the 30-year monthly average precipitation levels. The year 1996 was considered a drought year, with monthly and annual precipitation totals having been lower than the 30-year monthly and annual precipitation averages. Both seven-day low flow and total flow analyses of the main budget, as well as the two sub-budgets, for both 1992 and 1996, were prepared for this report. Seven-day low flows were used as surrogates for baseflows, although they are influenced somewhat by precipitation. Figure 5.2 lists the components that comprise the water budget for the Middle Verde region.

The annual and seasonal budgets, as well as the normalized budget for all three reaches, were presented in the following format:

- 1992 - 7 Day Low Flow
- 1992 - Total Flow
- 1996 - 7 Day Low Flow
- 1996 - Total Flow

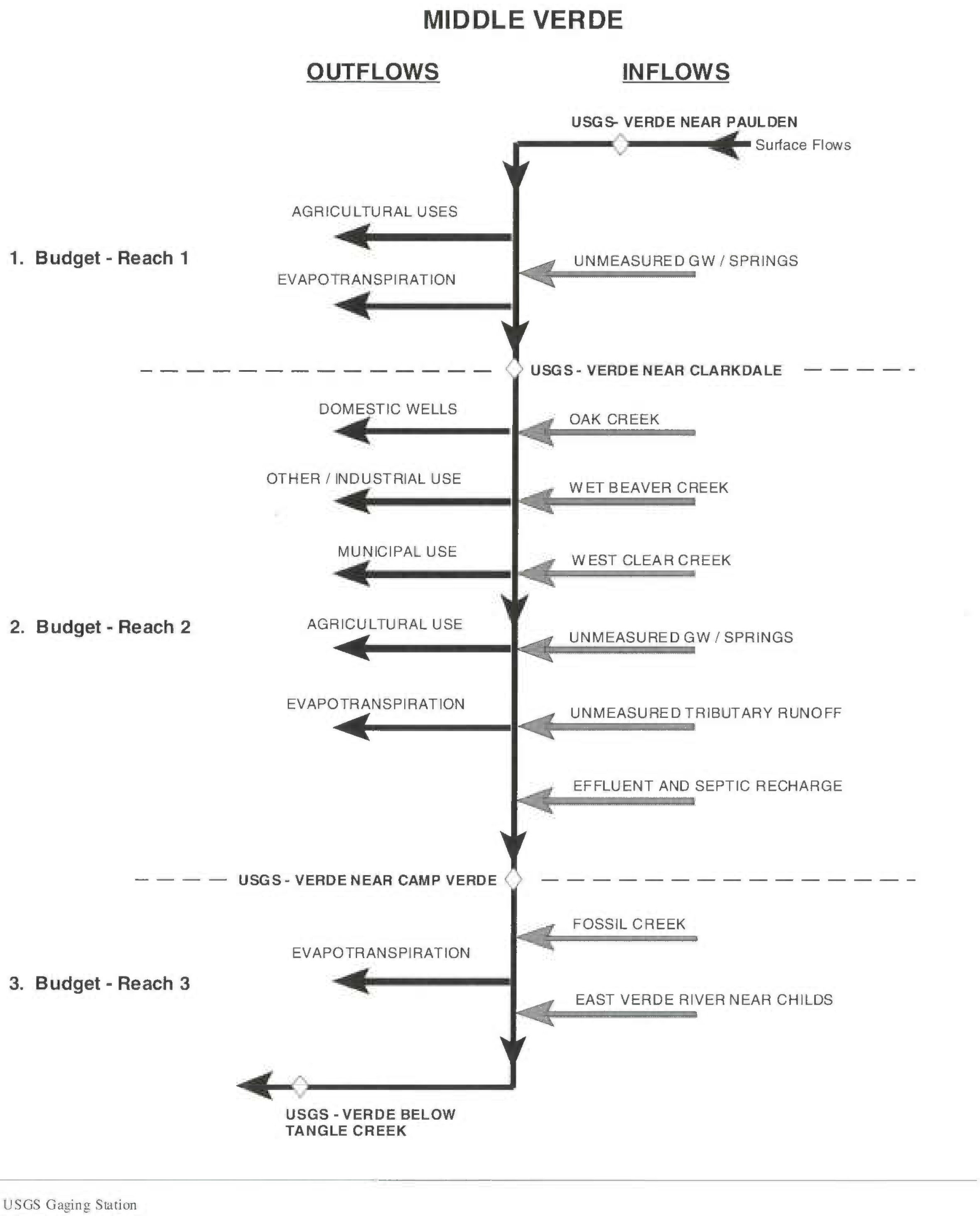
5.2 UPPER VERDE WATER BUDGET

Introduction

The Upper Verde section of the study area was divided into two sub-budget sections: Reach 1 - the Big Chino sub-basin that includes Big Chino Wash, Williamson Valley and Walnut Creek; and Reach 2 - the Little Chino sub-basin that includes Granite Creek and Little Chino Wash. The annual water budgets were compiled using yearly totals of inflows and outflows for each sub-basin.

The Big Chino and Little Chino groundwater budgets are based on the best available data for a one-year analysis of the water demands and supplies between 1996 and 1997. Groundwater

Figure 5.2 - Middle Verde Water Budget Components



and surface water inflow and outflow components were identified and evaluated for budget analysis in each sub-basin. The water budget components were compiled from field measurements, reported data, ADWR databases, numerous reports, and calculated estimates. The Big Chino has not been studied extensively and consequently there is a limited amount of current information and data available for regional precipitation, streamflow data, and groundwater conditions. The Little Chino sub-basin was recently reviewed and evaluated by ADWR in the Preliminary Determination Report on the Safe-Yield Status of the Prescott Active Management Area, dated August 28, 1998. The water budget in the Safe-Yield status report showed the Little Chino to be in an overdraft condition due to the outflows exceeding the inflows. The components of their 1997 budget are discussed in the section of this chapter that describes the Little Chino sub-basin.

Sub-Basin Water Budgets

Reach 1 - Big Chino Sub-basin to the Verde River near Paulden

For the period of record studied, the Big Chino sub-basin may have been in a near equilibrium condition and for budgetary purposes that assumption has been made. However, it is possible that were additional water level, gaging data, and recharge estimates available we might in fact find a non-equilibrium condition. The components of the Big Chino water budget are as follows:

Big Chino Sub-basin Water Budget (1997)

Figures based on 1996 and 1997 calculated data and estimates.

Inflows	
Natural Recharge	
Mtn. Front & Streams	15,700 AF
Underflow from Little Chino	1,500 AF
Unmeasured Tributary Flows, Groundwater and Springs	9,560 AF
Incidental Recharge	
Agriculture	7,570 AF
Industrial	100 AF
Septic	340 AF
Total Inflows	**34,770 AF**

Outflows

Natural Discharge	
Verde near Paulden	19,050 AF
Groundwater Pumpage	
Small Providers	140 AF
Domestic (Exempt) Wells	250 AF
Agriculture	15,130 AF
Industrial	200 AF
Total Outflows	**34,770 AF**

Change in Groundwater Storage = Inflows – Outflows:
0 AF = 34,770 AF – 34,770 AF.

The inflows for this reach of the study area consist of the gaging station at Williamson Valley Wash near Paulden, the gaging station at Walnut Creek near Ash Fork, natural recharge from mountain fronts and streams, recharge from agriculture and septic systems, unmeasured tributary flows, groundwater, and springs.

The inflow components that contribute to the groundwater supply in the Big Chino are comprised of incidental and natural recharge, unmeasured streams, and springs. Incidental recharge is the estimated excess water that has returned to the aquifer from agriculture, industrial uses, and septic recharge. Natural recharge is the mountain front recharge and streamflow that infiltrates to the aquifer as a result from precipitation and snowmelt. Incidental recharge from agriculture was estimated to be 7,570 acre-feet per year, based upon estimates of irrigated acres, the consumptive use value for the irrigated crops, and the estimated irrigation efficiency described in Chapter 3, Section 3. Industrial recharge was estimated to be 100 acre-feet per year based on an estimate of pumpage by the users. Septic recharge was estimated at 340 acre-feet per year. Natural recharge from mountain front runoff and streamflow was estimated to be 15,700 acre-feet per year based on the best available, average annual, streamflow data. A tentative analysis of natural recharge based on the median annual flow resulted in estimates that ranged from 7,500 to 8,500 acre-feet, depending upon the estimated watershed area and the amount of precipitation (Chapter 4, Section 4.2). The volume of unmeasured streams, springs, and groundwater is assumed to be the residual component of inflow in the Big Chino water budget and was added in to balance the difference between the total outflows and total inflows. This was determined after total inflow and outflow components were calculated. Unmeasured waters, the residual component in the Big Chino, were estimated to be about 9,560 acre-feet.

This number may include higher than realized estimates of natural and incidental recharge. The total inflows (34,770) less unmeasured waters (9,560) in the Big Chino sub-basin were estimated to be approximately 25,210 acre-feet.

The outflows for this reach of the study area are separated into surface water and groundwater. The surface water outflows include the Verde River flows recorded at the USGS gaging station near Paulden and agriculture. A normalized annual budget for the period 1990-1996, excluding 1993, was used to calculate the average annual surface water outflows exiting the Big Chino at the Paulden gaging station. Average annual outflows for this period were 19,050 acre-feet. Groundwater outflows also include agriculture, municipal/industrial, and domestic wells. Estimated groundwater pumpage was obtained from surveys and records from the Abra Water Company, Ashfork Water Service, Granite Mountain, and Inscription Canyon Ranch, as described in Chapter 3, Section 3.2. The estimated total municipal outflow for 1997 is 140 acre-feet. Agriculture demand for groundwater and surface water was estimated to be approximately 15,130 acre-feet, based on estimates of irrigated acres and the estimated crop consumptive use described in Chapter 3, Section 3.4. Domestic use was estimated to be 250 acre-feet for approximately 990 domestic wells registered in the ADWR Wells Registry database. Industrial water use for sand and gravel operations was estimated to be 200 acre-feet per year, based on pumpage estimates provided by the users. The estimated total outflow in 1997 for the Big Chino sub-basin was 34,770 acre-feet.

Based on available data and taking into consideration an estimated 9,560 acre-feet of unmeasured tributary flow, groundwater, springs, and/or higher estimates of natural and incidental recharge, there appears to be no change in groundwater storage in the Big Chino.

Reach 2 - Little Chino Sub-basin to the Verde River near Paulden

The Verde River Watershed Study compiled the Little Chino sub-basin water budget based on 1997 data and on data presented by ADWR in the 1998 Report on the Safe-Yield Status of the Prescott AMA. Modifications from the original Safe-Yield Report were a result of the availability of additional data. The Little Chino sub-basin water budgets in the Safe-Yield Status Report and in this study both indicated that outflows exceeded inflows and there was an overdraft condition. The components of the 1997 Little Chino sub-basin water budget for this study were as follows:

Little Chino Sub-basin Water Budget (1997)

Figures based on 1997 reported data and estimates.

Inflows	
Natural Recharge	
Mtn. Front & Streams	2,050 AF
Incidental Recharge	
CVID Canals	640 AF
Agriculture	3,305 AF
Industrial	285 AF
Septic	1,610 AF
Artificial Recharge	
COP WWTP (Airport)	2,270 AF
Total Inflows	**10,160 AF**
Outflows	
Natural Discharge	
Underflow to Big Chino	1,500 AF
Del Rio Springs	2,100 AF
Groundwater Pumpage	
City of Prescott	6,510 AF
Small Providers	250 AF
Exempt Wells	1,160 AF
Agriculture	5,070 AF
Industrial	180 AF
Total Outflows	**16,770 AF**

Change in Groundwater Storage = Inflows – Outflows:
-6,610 AF = 10,160 AF – 16,770 AF.

The inflows for the Little Chino reach of the study area consist of Granite and Willow Creek's surface water flows as recorded at USGS gaging stations near Prescott, mountain front and stream recharge, Chino Valley Irrigation District (CVID) canal and agricultural recharge, effluent and septic recharge, industrial recharge, unmeasured tributary flows, and groundwater and springs contributions.

Surface water and effluent recharge from the CVID unlined canal was estimated to be about 50 percent of the total annual diversion from Granite Creek, Willow Creek, and the City of Prescott Wastewater Treatment Plant (COPWWTP). The surface water and effluent recharge from the CVID canal was estimated to be 490 acre-feet and 150 acre-feet respectively, based upon records provided by the CVID and COPWWTP. This study assumes that the same volumes of water were delivered to the CVID as reported in the Safe-Yield Status Report. The 2,270 acre-feet of effluent recharge from the airport wastewater treatment plant, as reported in the Safe-Yield Status Report, was also assumed to be the same for this study.

Agricultural demand was estimated to be 6,610 acre-feet. Assuming a 50 percent irrigation efficiency would result in about 3,305 acre-feet of incidental recharge from agriculture occurring. Incidental recharge from septic systems and industrial use was estimated to be about 1,610 and 286 acre-feet respectively. Septic system recharge volumes were based on water provider records, average populations per household as reported by the DES, and the estimated daily indoor water use per person as reported by AMWUA. This study includes septic system recharge whereas the Safe-Yield Status Report did not estimate a volume of recharge for septic systems.

Mountain front recharge and streamflow recharge were estimated to be about 2,050 acre-feet annually for the period 1943 to 1993 (Corkhill and Mason, 1995) and (ADWR, 1998). Total inflows for this study were estimated to be 10,160 acre-feet. The total inflows reported in the Safe-Yield Status Report were 7,670 acre-feet.

The outflows were separated into surface water and groundwater. The surface water outflows consist of the Del Rio Springs baseflow. The groundwater outflows include municipal/industrial, domestic wells, agriculture, and the Del Rio Springs underflow discharge. Domestic use was estimated to be 1,160 acre-feet for approximately 3,550 domestic wells registered in the ADWR Wells Registry database.

In the Little Chino sub-basin, groundwater supplies the City of Prescott, small water providers, and domestic users not in water service areas. The estimated outflows from groundwater use for each, were 6,510 acre-feet, 250 acre-feet, and 1,160 acre-feet, respectively. Detailed information regarding the municipal and domestic outflow components can be found in Chapter 3, Section 3.2. Agriculture groundwater pumpage was estimated to be 5,070 acre-feet, which was about 77 percent of the total agriculture demand in 1997. Water discharges at Del Rio Springs were estimated to be 1,500 acre-feet for underflow to the Big Chino sub-basin and

2,100 acre-feet of baseflow (ADWR, 1998). The estimated total outflow from the Little Chino sub-basin for this study was 16,905 acre-feet. As a comparison, the Safe-Yield Status Report completed in 1998 by ADWR estimated a total outflow of 16,820 acre-feet for the Prescott AMA.

The Verde River Watershed Study estimated the Little Chino sub-basin inflows and outflows to be 10,160 acre-feet and 16,770 acre-feet, resulting in a groundwater overdraft of approximately 6,610 acre-feet in 1997. As a comparison, the 1998 ADWR Report on Safe-Yield Status for the Prescott AMA estimated a 1997 groundwater overdraft of 9,150 acre-feet. The primary differences between the overdraft estimates were attributed to additional and revised estimates of incidental recharge from agriculture, industrial use and septic systems. Both budgets, however, indicate that the Little Chino is in an overdraft condition.

Summary

Big Chino Sub-basin

Groundwater is the major water source in the Big Chino sub-basin. Most of the water use is associated with irrigation, with some surface water diversions on Walnut Creek, Apache Creek, and Williamson Valley Wash. Groundwater use for agriculture in the Big Chino sub-basin has increased since 1990, and municipal use has steadily increased as more land is subdivided and developed in the region. Reports by Schwab (1995) and the USBR (1993) suggest that groundwater use for irrigation in the Big Chino sub-basin is declining as the transition from agriculture to municipal use takes place. ADWR estimated agriculture demand at 15,130 acre-feet for the period 1996-1997, based on recent field investigations and analysis of aerial photography that revealed an increase in groundwater irrigated acres in the Big Chino sub-basin (Section 3, Tables 3-12 and 3-13). Municipal use, mostly small water providers increased from 80 acre-feet in 1990 to approximately 140 acre-feet in 1997. Domestic water use from 990 wells was estimated to be 250 acre-feet per year and more development is occurring. Most of these wells are located in the vicinity of Paulden. Industrial water use is estimated to be 200 acre-feet per year based on information provided by the sand and gravel operation located in the vicinity of the confluence of the Big Chino and Williamson Valley Washes. There is potential for more industrial use in sand and gravel operations along the Big Chino Wash as long as the wash remains open from encroachment by development. Natural recharge from mountain front runoff and streams was estimated to be 15,700 acre-feet per year based on the best available average annual streamflow data. Analyzing the best available data and median annual flow data resulted in estimates of natural recharge ranging from 7,500 acre-feet to 8,500 acre-feet (Chapter 4, Section 4.2).

Analysis of the data and information presented in the 1997 Big Chino groundwater budget indicate that a balanced water budget may be attributed to unmeasured tributary flow, groundwater and springs, and possibly also to higher than realized recharge estimates.

Little Chino Sub-Basin

The main groundwater uses are for agriculture, municipal, small water providers, and domestic. Some surface water and effluent also supply irrigation and industrial water uses. Agriculture demand for the entire sub-basin was estimated to be 6,610 acre-feet based on reported and estimated data. This estimate includes surface water, effluent, groundwater and Del Rio Springs discharges. Agriculture groundwater pumpage was about 5,070 acre-feet based on reported water use. Domestic water use from 3,550 wells was estimated to be 1,160 acre-feet per year. Groundwater use by the City of Prescott increased from about 5,075 acre-feet in 1992 to 6,510 acre-feet in 1997 and groundwater use by the small water providers increased from 75 acre-feet to 250 acre-feet for the same period. Industrial water use was estimated to be 180 acre-feet in 1997.

Recharge from the CVID canal was estimated at 480 acre-feet from surface water diverted from Granite Creek and Willow Creek and 150 acre-feet of effluent from the COPWWTP in 1997. The annual surface water deliveries depend upon available supplies stored in Watson Lake and Willow Creek Reservoir. The City of Prescott is contracted to deliver 300 acre-feet per year to the CVID canal. Other effluent from the COPWWTP was estimated to be 2,270 acre-feet in 1997 (ADWR, 1998). Incidental recharge from agriculture and septic systems was estimated to be 3,305 acre-feet and 1,610 acre-feet respectively in 1997. Agriculture and septic recharge may change with the expansion of the City of Prescott service area, increased subdivision and development of land in Chino Valley, and the purchase of the Watson Lake and Willow Creek Reservoir by the City of Prescott from the CVID. With Prescott in control of these two lakes, the surface water irrigation supply will probably decrease in time. As agriculture declines in the area, the recharge from agriculture and the CVID canal may decrease. As development increases in the expanded city service area, more houses will have sewer hookups and many may convert from septic to sewer, therefore, decreasing the recharge from septic systems. Natural recharge from mountain front infiltration and streams was estimated to be 2,050 acre-feet for the period 1940-1993 (Corkhill and Mason, 1995) and (ADWR, 1998). The Del Rio Springs underflow and baseflow estimates are 1,500 acre-feet and 2,100 acre-feet, respectively (ADWR, 1998).

The Verde River Watershed Study analysis of the Little Chino sub-basin groundwater budget components shows that there is an overdraft occurring in the Little Chino sub-basin. Groundwater losses exceeded all recharge by approximately 6,610 acre-feet in 1997. ADWR reported an overdraft of 9,150 acre-feet for the Little Chino sub-basin in its 1998 report on Safe-Yield Status for the Prescott AMA. The difference between overdraft estimates can be accounted for in the difference between the estimates of incidental recharge. These budgets indicate that the groundwater supply is being depleted. Given the current trend towards population increases in the area, it appears that the overdraft of the Little Chino sub-basin groundwater supply will continue into the future.

5.3 MIDDLE VERDE WATER BUDGET

Introduction

The Middle Verde section of the study area was divided into three sections and water budgets were developed for each section. The first section, labeled Reach 1, encompasses the area between the USGS gaging stations on the Verde River near Paulden and the Verde River near Clarkdale. The second section, labeled Reach 2, encompasses the area between the USGS gaging stations on the Verde River near Clarkdale and the Verde River below Camp Verde. The third section, labeled Reach 3, encompasses the area between the USGS gaging stations on the Verde River below Camp Verde and the Verde River below Tangle Creek (see Figure 5.2 for an overview of the Middle Verde section and the boundaries of each reach).

All three reaches of the Middle Verde were examined in a similar format. The annual water budgets were compiled using yearly totals of contributing inflows and the yearly demand totals for the years 1992 and 1996 (refer to Chapters 3 and 4); 1992 representing a wet year, and 1996 representing a dry year. The seasonal water budgets examined the contributing inflows and outflows on a month to month basis for the years 1992 and 1996, which present a better understanding of the behavior of the system in relation to the monthly changes in water supplies and water demands. Normalized budgets, which averaged the total inflows for the 1990-1996 time period, excluding the year 1993, and used 1997 figures for the outflows were also calculated. The year 1993 was excluded because of the extremely high volume of flow, which occurred during the months of January and February. The normalized budget as well as the annual and seasonal budgets for the years 1992 and 1996 were then examined using seven-day low flows and total flow figures in order to demonstrate the influence of precipitation and runoff in streamflow levels.

Both annual and seasonal budgets were analyzed by subtracting inflows from outflows for both total flow and seven-day low flow numbers. The unmeasured groundwater/springs inflow contribution was determined by using the inflow-outflow difference for the December seven-day low flow. This difference was assumed to represent a fairly accurate estimate of unmeasured groundwater or spring flow contribution to the system, because during this month there is virtually no ET or agriculture demand and municipal demand was typically at its lowest. The unmeasured groundwater or spring flow was assumed to be a contributing factor all year and was, therefore, added into the inflows for each month. The calculated difference between the inflow and outflow, including the unmeasured groundwater/spring flow contribution during months that indicated a positive difference, was then assumed to represent either a surplus or groundwater storage/unmeasured flow contribution. During the months that revealed a deficit after the addition of groundwater discharge contribution, the inflow and outflow difference was presumed to come from either groundwater in a drought month or from unmeasured flows in a month with recorded precipitation. In the months where inflow exceeded outflow, the surplus was attributed to precipitation events.

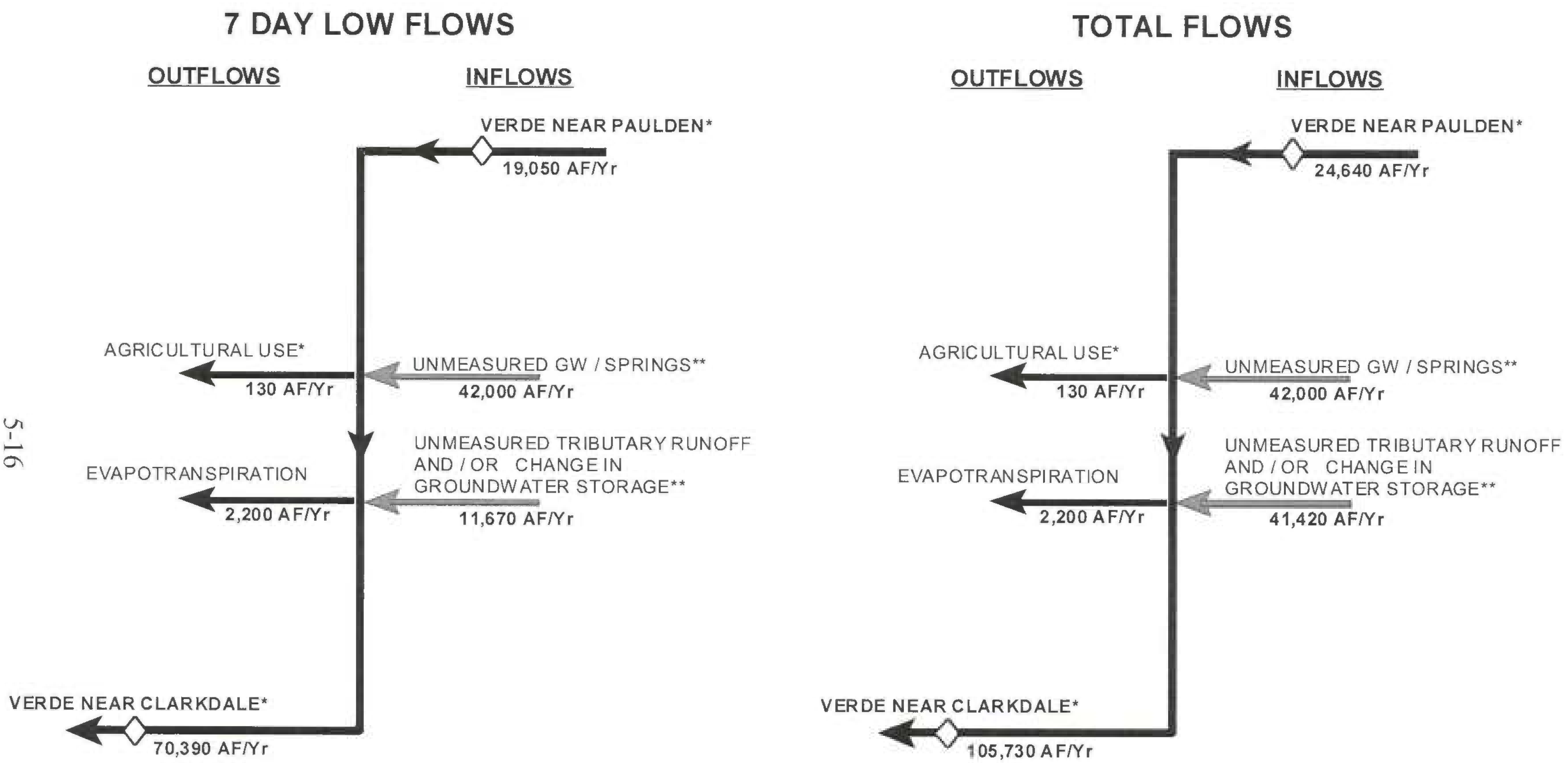
Water Budgets by Reach

<u>**Reach 1 - Verde River near Paulden to the Verde River near Clarkdale**</u>

The inflows for this reach are the Verde near Paulden, unmeasured groundwater, springs, and unmeasured tributary flow. Outflows include the irrigation at Perkins Ranch, an evapotranspiration factor and the gaging station on the Verde River near Clarkdale. The normalized 1990-1996 budget reveals Reach 1 to be a gaining reach (Figure 5.3).

The 1992 (wet year) seven-day low flow annual budget (Figure 5.4) reveals a deficit of 22,950 acre-feet after subtracting the outflows from the inflows, which is assumed to come from groundwater storage or unmeasured spring and tributary flows. The 1992 total flow annual budget shows a deficit of 66,720 acre-feet, which is also assumed to come from groundwater

Figure 5.3 - Normalized Annual Budget 1990-1996 Excluding 1993 - Reach 1: Verde River Near Paulden to Verde River Near Clarkdale, 7 Day Low and Total Flows.



TOTAL OUTFLOWS = 72,720 AF/Yr   TOTAL INFLOWS = 72,720 AF/Yr

NET GAIN IN REACH: 70,390 - 19,050 = 51,340 AF/Yr

51,340 AF/Yr = 71 CFS

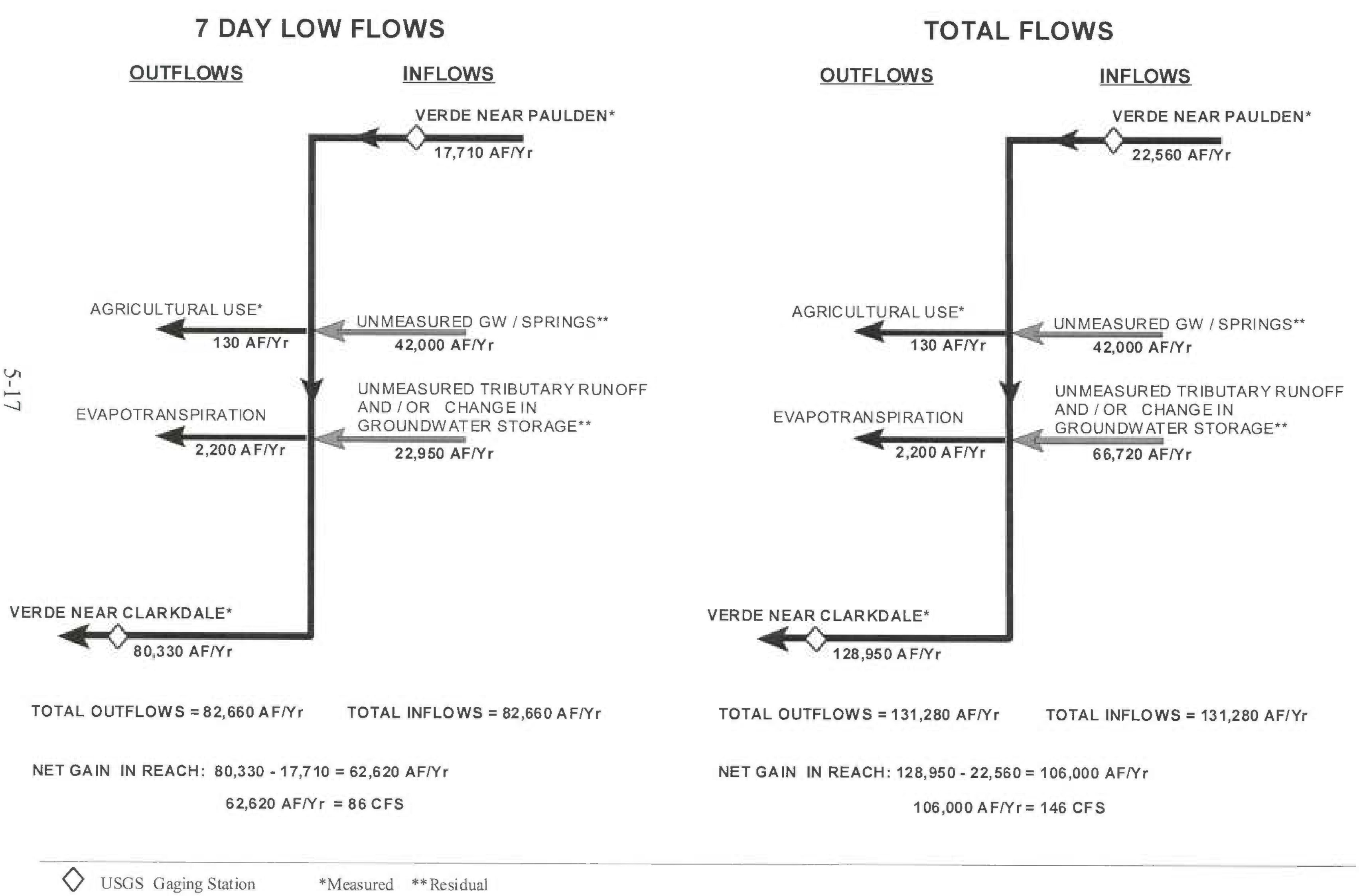
TOTAL OUTFLOWS = 108,060 AF/Yr   TOTAL INFLOWS = 108,060 AF/Yr

NET GAIN IN REACH: 105,730 - 24,640 = 81,090 AF/Yr

81,090 AF/Yr = 112 CFS

◇ USGS Gaging Station   *Measured   **Residual

Figure 5.4 - 1992 Wet Year - Reach 1: Verde River Near Paulden to Verde River Near Clarkdale, 7 Day Low and Total Flows.



storage or unmeasured spring and tributary flows. The 1996 (dry year) seven-day low flow and total flow annual budgets (Figure 5.5) inflow minus outflow total reveals 60 acre-feet and 2,780 acre-feet deficits respectively and are assumed to come from groundwater storage or unmeasured flows.

The 1992 (wet year) seasonal budget (Table 5-1) reveals an unmeasured groundwater springs inflow contribution of 3,500 acre-feet per month. The inflow minus outflow remainder for this reach reveals a surplus flow during the seven-day low flow in the months of June and July only. The deficit for the remaining ten months is assumed to come from groundwater storage or unmeasured flows. The 1996 (dry year) seasonal budget (Table 5-2) unmeasured groundwater, springs, and tributary inflow contributions were also calculated to be 3,500 acre-feet per month. The inflow minus outflow results indicate there were surplus flows for the seven-day low flow during the months of February, June, October, and November with a deficit for the remaining eight months assumed to be supplied by groundwater storage or unmeasured spring and tributary flows.

Reach 2 - Verde River near Clarkdale to the Verde River near Camp Verde

The inflows for Reach 2 begin at the Verde River near Clarkdale, and include the gaged streams of Oak Creek, Wet Beaver, West Clear Creek, unmeasured groundwater, springs and tributaries, and recharge from effluent and septics. The outflows include private domestic wells, municipal wells, agricultural consumptive use, evapotranspiration, other industrial water use, and the outflow at the gaging station on the Verde River near Camp Verde. The normalized water budget for Reach 2 for years 1990-1996 reveals a gaining stream (Figure 5.6).

The 1992 (wet year) seven-day low flow and total flow annual water budgets (Figure 5.7) for Reach 2 both reveal deficits estimated at 20,750 acre-feet and 77,330 acre-feet respectively, and is assumed to come from unmeasured groundwater, springs and tributary flows. The 1996 (dry year) seven-day low flow and total flow annual budgets (Figure 5.8) for this reach both reveal deficits estimated at 4,480 acre-feet and 22,910 acre-feet respectively, which is also assumed to come from the unmeasured groundwater, springs and tributary runoff.

The 1992 seasonal water budget for Reach 2 (Table 5-3), from the Verde River near Clarkdale to the Verde River near Camp Verde was analyzed by subtracting the outflows from the inflows. The unmeasured groundwater and springs contribution was determined to be 4,150 acre-feet. The 1992 seasonal budget for the Middle Verde shows a surplus for the seven-day low

Figure 5.5 - 1996 Dry Year - Reach 1: Verde River Near Paulden to Verde River Near Clarkdale, 7 Day Low and Total Flows.

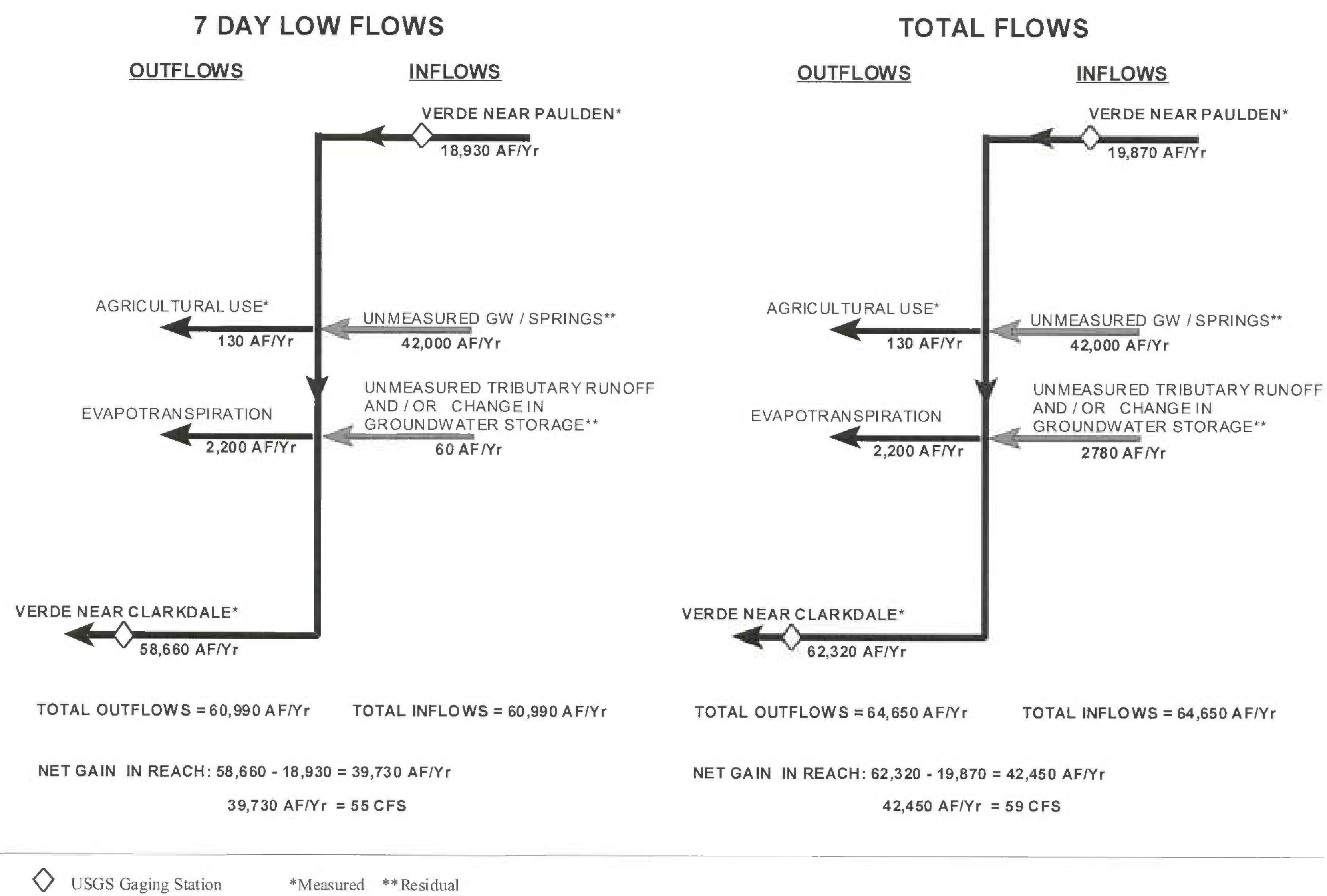


TABLE 5-1

REACH 1: VERDE NEAR PAULDEN TO VERDE NEAR CLARKDALE
SEASONAL BUDGET 1992

INFLOWS (ACRE-FEET)	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low
Verde Near Paulden	1460	1410	3960	1280	2260	1480	1720	1490	1500	1480	1440	1430
Unmeasured Groundwater/Springs	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
TOTAL INFLOWS	4960	4910	7460	4780	5760	4980	5220	4990	5000	4980	4940	4930
OUTFLOWS (ACRE-FEET)	**JANUARY** Total Flow	7 Day Low	**FEBRUARY** Total Flow	7 Day Low	**MARCH** Total Flow	7 Day Low	**APRIL** Total Flow	7 Day Low	**MAY** Total Flow	7 Day Low	**JUNE** Total Flow	7 Day Low
Verde Near Clarkdale	5940	5290	25600	4940	43440	17520	7980	5060	6290	4980	4800	4470
Evapotranspiration (2200 Acre-feet)	0	0	0	0	220	220	220	220	220	220	370	370
Agriculture Use (Perkins Ranch)	0	0	0	0	0	0	20	20	20	20	20	20
TOTAL OUTFLOWS	5940	5290	25600	4940	43660	17740	8220	5300	6530	5220	5190	4860
Inflow - Outflow = Groundwater Storage or Unmeasured Flow	-980	-380	-18140	-160	-37900	-12760	-3000	-310	-1530	-240	-250	
Surplus												70

INFLOWS (ACRE-FEET)	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low
Verde Near Paulden	1500	1480	2760	1480	1530	1490	1590	1480	1400	1370	2030	1540
Unmeasured Groundwater/Springs	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
TOTAL INFLOWS	5000	4980	6260	4980	5030	4990	5090	4980	4900	4870	5530	5040
OUTFLOWS (ACRE-FEET)	**JULY** Total Flow	7 Day Low	**AUGUST** Total Flow	7 Day Low	**SEPTEMBER** Total Flow	7 Day Low	**OCTOBER** Total Flow	7 Day Low	**NOVEMBER** Total Flow	7 Day Low	**DECEMBER** Total Flow	7 Day Low
Verde Near Clarkdale	5180	4550	9650	4800	4980	4760	5100	4920	5080	5060	15700	5040
Evapotranspiration (2200 Acre-feet)	370	370	370	370	220	220	220	220	0	0	0	0
Agriculture Use (Perkins Ranch)	20	20	20	20	20	20	0	0	0	0	0	0
TOTAL OUTFLOWS	5570	4940	10040	5190	5220	5000	5320	5140	5080	5060	15700	5040
Inflow - Outflow = Groundwater Storage or Unmeasured Flow	-570		-3780	-210	-190	-10	-230	-160	-180	-190	-10170	0
Surplus		40										

*Numbers rounded to the nearest 10.

SOURCE:

TABLE 5-2

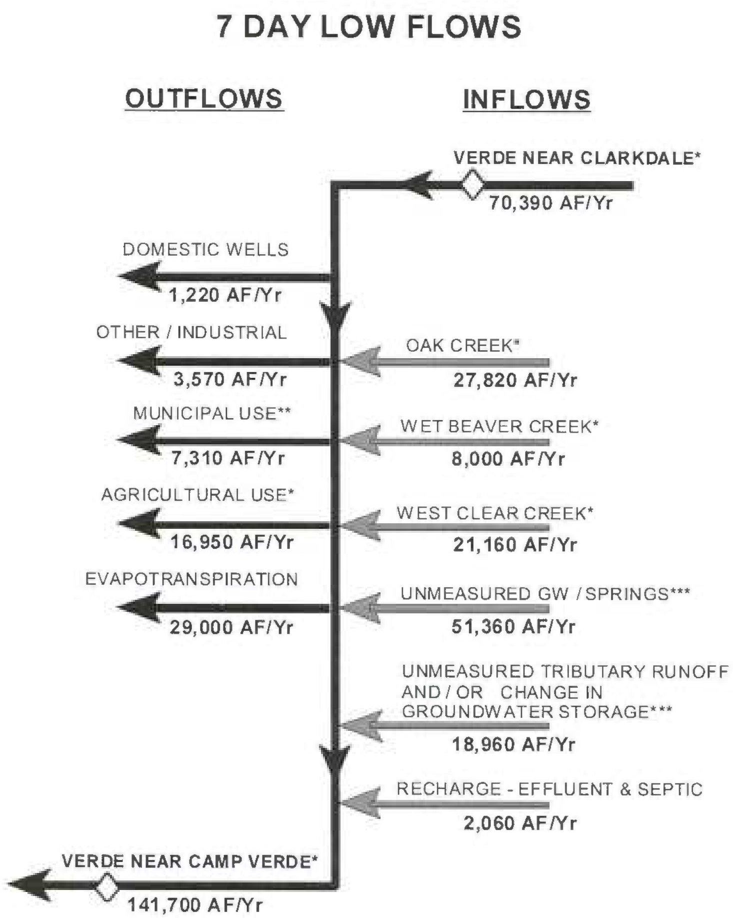
REACH 1: VERDE NEAR PAULDEN TO VERDE NEAR CLARKDALE
SEASONAL BUDGET 1996

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
INFLOWS (ACRE-FEET)	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low
Verde Near Paulden	1680	1660	1600	1500	1680	1600	1580	1550	1580	1540	1510	1490	2240	1480	1480	1470	1470	1430	1550	1540	1560	1550	1600	1600
Unmeasured Groundwater/Springs	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
TOTAL INFLOWS	5180	5160	5100	5000	5180	5100	5080	5050	5080	5040	5010	4990	5740	4980	4980	4970	4970	4930	5050	5040	5060	5050	5100	5100
	JANUARY		**FEBRUARY**		**MARCH**		**APRIL**		**MAY**		**JUNE**		**JULY**		**AUGUST**		**SEPTEMBER**		**OCTOBER**		**NOVEMBER**		**DECEMBER**	
OUTFLOWS (ACRE-FEET)-	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low
Verde Near Clarkdale	5500	5470	5040	4830	5160	5100	4880	4820	4980	4920	4580	4400	5690	4670	4990	4730	6710	4760	4820	4730	4830	4700	5140	5100
Evapotranspiration (2200 Acre-feet)	0	0	0	0	220	220	220	220	220	220	370	370	370	370	370	370	220	220	220	220	0	0	0	0
Agriculture Use (Perkins Ranch)	0	0	0	0	0	0	20	20	20	20	20	20	20	20	20	20	20	20	0	0	0	0	0	0
TOTAL OUTFLOWS	5500	5470	5040	4830	5380	5320	5120	5060	5220	5160	4970	4790	6080	5060	5380	5120	6950	5000	5040	4950	4830	4700	5140	5100
Inflow - Outflow = Groundwater Storage or Unmeasured Flow	-320	-310			-200	-220	-40	-10	-140	-120			-340	-80	-400	-150	-1980	-70					-40	0
Surplus			60	170							40	200							10	90	230	350		

*Numbers rounded to the nearest 10.

SOURCE:

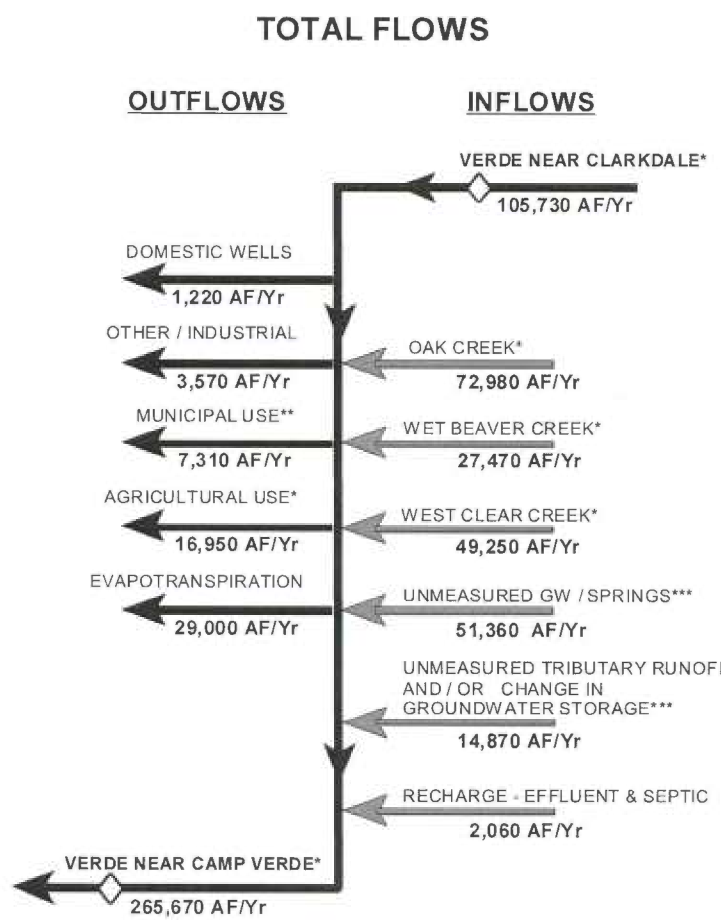
Figure 5.6 - Normalized Annual Budget 1990-1996 Excluding 1993 - Reach 2: Verde River Near Clarkdale to Verde River Near Camp Verde, 7 Day Low and Total Flows.



TOTAL OUTFLOWS = 199,750 AF/Yr TOTAL INFLOWS = 199,750 AF/Yr

NET GAIN IN REACH: 141,700 - 70,390 = 71,310 AF/Yr

71,310 AF/Yr = 98 CFS



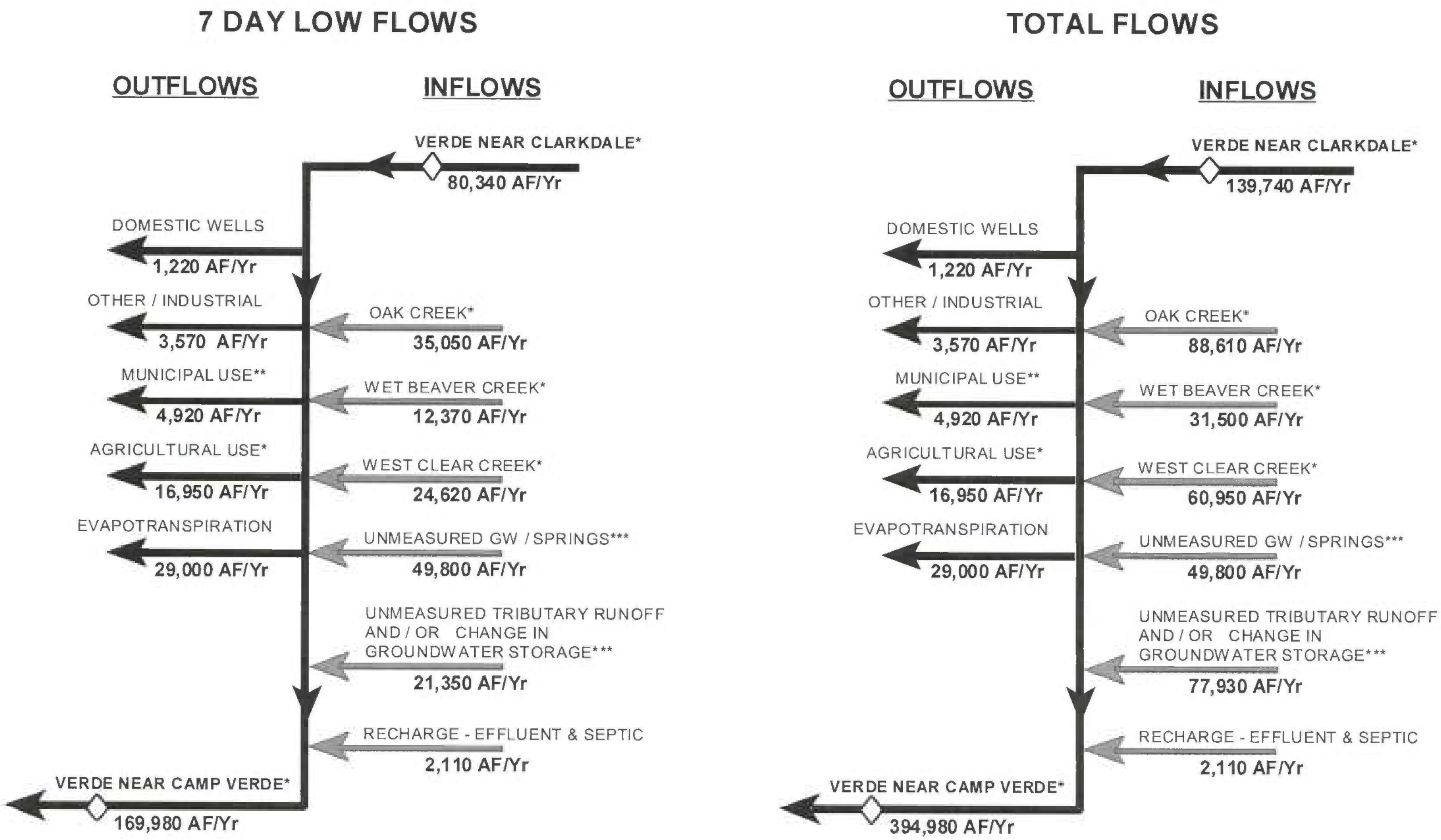
TOTAL OUTFLOWS = 323,720 AF/Yr TOTAL INFLOWS = 323,720 AF/Yr

NET GAIN IN REACH: 265,670 - 105,730 = 159,940 AF/Yr

159,940 AF/Yr = 221 CFS

◇ USGS Gaging Station *Measured **Reported ***Residual

Figure 5.7 - 1992 Wet Year - Reach 2: Verde River Near Clarkdale to Verde River Near Camp Verde, 7 Day Low and Total Flows.



7 Day Low Flows

TOTAL OUTFLOWS = 225,640 AF/Yr   TOTAL INFLOWS = 225,640 AF/Yr

NET GAIN IN REACH: 169,980 - 80,340 = 89,640 AF/Yr

89,640 AF/Yr = 124 CFS

Total Flows

TOTAL OUTFLOWS = 450,640 AF/Yr   TOTAL INFLOWS = 450,640 AF/Yr

NET GAIN IN REACH: 394,980 - 139,740 = 255,240 AF/Yr

255,240 AF/Yr = 353 CFS

◇ USGS Gaging Station   *Measured   **Reported   ***Residual

Figure 5.8 - 1996 Dry Year - Reach 2: Verde River Near Clarkdale to Verde River Near Camp Verde, 7 Day Low and Total Flows.

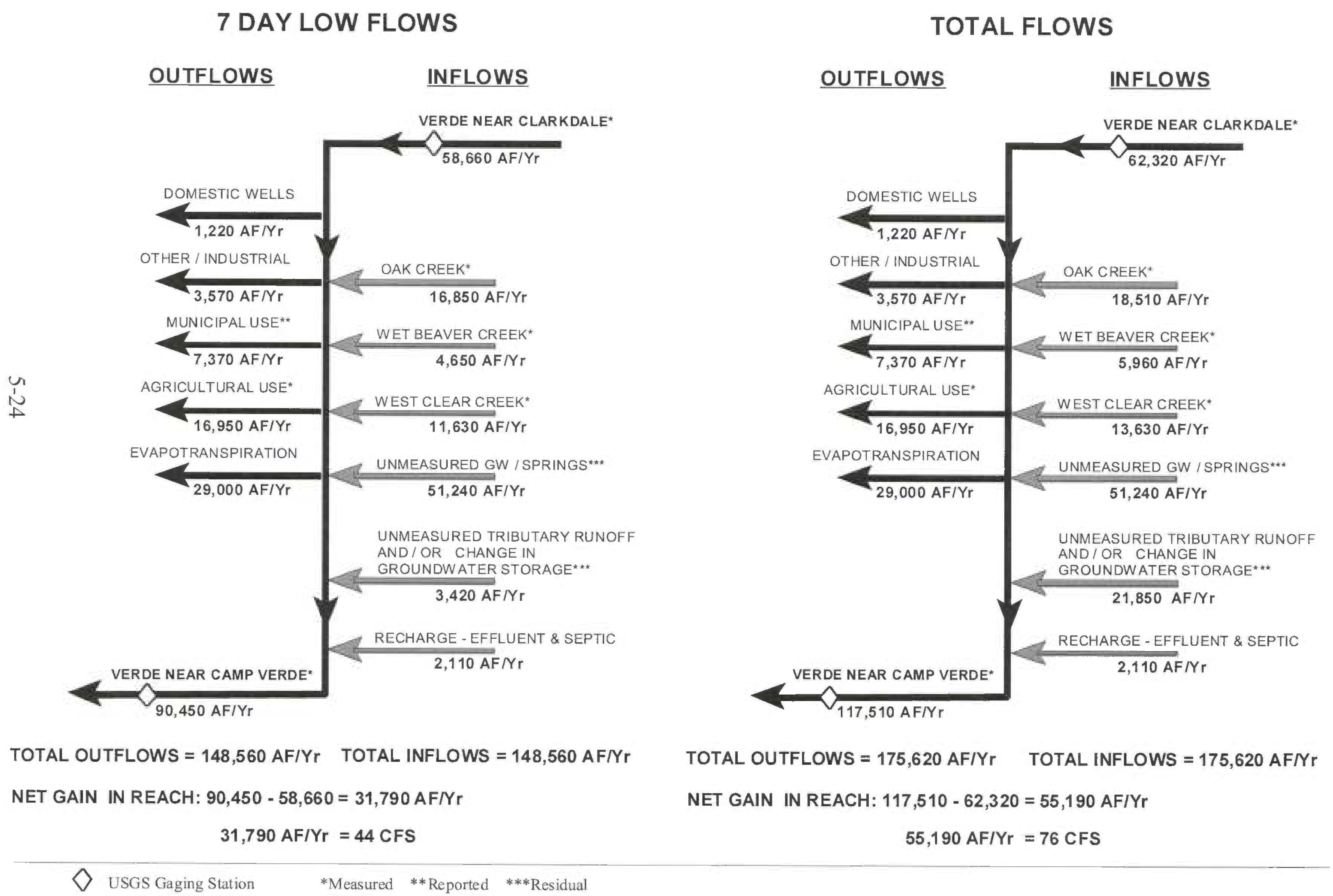


TABLE 5-3

REACH 2: VERDE NEAR CLARKDALE TO VERDE NEAR CAMP VERDE
SEASONAL BUDGET 1992

INFLOWS (ACRE-FEET)	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low
Verde Near Clarkdale	5940	5350	25600	4970	43440	26120	7980	5060	6290	4980	4800	4580	5180	4610	9650	4800	4980	4760	5100	4980	5080	5060	15700	5070
OakCreek Near Cornvile	5100	2400	19170	3780	25820	14880	4600	1790	2710	1970	1400	1190	1810	1350	4390	1350	1700	1310	1560	1080	1350	1340	19000	2610
Wet Beaver	2100	620	4910	1670	12080	6150	2570	540	440	420	410	390	550	370	4610	450	420	420	420	420	430	430	2560	490
West Clear Creek	3810	1290	12800	3390	19590	10140	5250	1550	1610	1290	1150	890	1010	920	6250	980	1050	1010	1030	980	1030	1010	6370	1170
Unmeasured Groundwater/Springs	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150
Recharge-Effluent/Septic	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
TOTAL INFLOWS	21280	13990	66810	18140	105260	61620	24730	13270	15380	12990	12090	11380	12880	11580	29230	11910	12480	11830	12440	11790	12220	12170	47960	13670
OUTFLOWS (ACRE-FEET)-	**JANUARY**		**FEBRUARY**		**MARCH**		**APRIL**		**MAY**		**JUNE**		**JULY**		**AUGUST**		**SEPTEMBER**		**OCTOBER**		**NOVEMBER**		**DECEMBER**	
	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low
Verde Near Camp Verde	23420	17450	75760	17320	131000	70010	26540	6780	10120	6150	7330	4520	6860	3810	37850	6520	8360	6550	8730	6890	11540	11070	47470	12910
Evapotranspiration	0	0	0	0	2900	2900	2900	2900	2900	2900	4830	4830	4830	4830	4830	4830	2900	2900	2900	2900	0	0	0	0
Municipal (1992)	310	310	310	310	310	310	310	310	560	560	560	560	560	560	560	560	360	360	360	360	360	360	360	360
Private Industrial (3570)	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Irrigation (April 1 - October 1) (16950)	0	0	0	[illegible]	0	0	2820	2820	2820	2820	2820	2820	2820	2820	2820	2820	2820	2820	0	0	0	0	0	0
Domestic Wells	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
TOTAL OUTFLOWS	24130	18160	76470	18030	134610	73620	32970	13210	16800	12830	15940	13130	15470	12420	46460	15130	14840	13030	12390	10550	12300	11830	48230	13670
Inflow - Outflow=Change in Groundwater Storage, or Unmeasured Tributary Inflows	-2850	-4170	-9660		-29350	-12000	-8240		-1420		-3850	-1750	-2590	[illegible]	-17230	-3220	-2360	-1200			-80		-270	0
Surplus				110				60		160									50	1240		340		

*Numbers rounded to the nearest 10.

SOURCE:

flow category for the months of February, April, May, October, and November with the deficit for the remaining seven months assumed to be supplied by groundwater storage or unmeasured flow. The 1996 seasonal water budget for Reach 2 (Table 5-4) unmeasured groundwater and springs contribution was determined to be 4,270 acre-feet. The unmeasured groundwater contribution for both the wet year (1992) and the dry year (1996) were virtually the same, which indicates a fairly consistent year to year groundwater contribution to the system. The 1996 seasonal budget had surpluses in February, March, October, and November with the deficit for the remaining eight months assumed to be supplied by groundwater storage or unmeasured flow.

Reach 3 - Verde River near Camp Verde to the Verde below Tangle Creek

The inflows for this reach begin at the USGS gaging station on the Verde River below Camp Verde and also include the gaged streams of Fossil Creek and the East Verde near Childs, and unmeasured groundwater, springs, and tributary runoff. The outflows include an evapotranspiration factor and the USGS gaging station on the Verde River below Tangle Creek. The normalized water budget indicates this reach to be a gaining stream (Figure 5.9).

The results of the seven-day low flow inflow minus outflow for the 1992 (wet year) annual water budget (Figure 5.10) indicated that the addition of an unmeasured quantity of runoff was not required in order to balance the water budget. In fact, the inflows exceeded the outflows by 22,530 acre-feet. For the total flow analysis, however, an additional 84,310 acre-feet of unmeasured runoff was required in order to balance the annual water budget for the same year.

For the calendar year 1996 (dry year) annual water budget (Figure 5.11), the results of the seven-day low flow and total flow analysis of the inflow minus outflow indicated a deficit was occurring. An additional 4,480 acre-feet and 3,320 acre-feet of unmeasured runoff were need to balance the seven-day low flow and total flow water budgets for 1996 respectively.

The 1992 (wet year) seasonal budget (Table 5-5) for Reach 3 revealed an unmeasured groundwater and springs contribution of 2,310 acre-feet each month. Analyzing the inflows minus outflows indicated that surpluses were occurring in seven-day low flows for the months of June, July, and September. The remaining nine months showed a deficit situation with the residual contribution assumed to be from groundwater storage or unmeasured spring and tributary flows.

TABLE 5-4

REACH 2: VERDE NEAR CLARKDALE TO VERDE NEAR CAMP VERDE
SEASONAL BUDGET 1996

INFLOWS (ACRE-FEET)	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low
Verde Near Clarkdale	5500	5470	5040	4830	5160	5100	4880	4880	4980	4980	4580	4520	5690	4730	4990	4610	6710	4820	4820	4800	4830	4820	5140	5100
Oak Creek Near Cornvile	1980	1910	1890	1830	2060	2030	1490	1490	1120	1050	850	830	950	920	1050	800	2210	1190	1360	1350	1730	1670	1820	1780
Wet Beaver	450	440	450	430	450	440	400	360	370	360	340	300	360	330	640	410	1190	370	390	390	440	390	480	430
West Clear Creek	1120	1110	1050	940	1080	1080	970	950	910	890	830	830	990	920	1310	980	2260	890	1010	980	990	950	1110	1110
Unmeasured Groundwater/Springs	4130	4130	4130	4130	4130	4130	4130	4130	4130	4130	4130	4130	4130	4130	4130	4130	4130	4130	4130	4130	4130	4130	4130	4130
Recharge-Effluent/Septic	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
TOTAL INFLOWS	13360	13240	12740	12340	13060	12960	12050	11990	11690	11590	10910	10790	12300	11210	12300	11110	16680	11580	11890	11830	12300	12140	12860	12730
OUTFLOWS (ACRE-FEET)	**JANUARY**		**FEBRUARY**		**MARCH**		**APRIL**		**MAY**		**JUNE**		**JULY**		**AUGUST**		**SEPTEMBER**		**OCTOBER**		**NOVEMBER**		**DECEMBER**	
	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low
Verde Near Camp Verde	13210	12910	12000	10770	10540	8670	7030	5830	5320	4920	4300	3090	7280	3500	6360	3930	20080	8030	8370	6880	11020	10120	12000	11800
Evapotranspiration (29000 Acre-feet)	0	0	0	0	2900	2900	2900	2900	2900	2900	4830	4830	4830	4830	4830	4830	2900	2900	2900	2900	0	0	0	0
Municipal (1996)	460	460	460	460	460	460	460	460	850	850	850	850	850	850	850	850	530	530	530	530	530	530	530	530
Private Industrial (3570 Acre-feet)	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Irrigation (April 1 - October 1)	0	0	0	0	0	0	2800	2800	2800	2800	2800	2800	2800	2800	2800	2800	2800	2800	0	0	0	0	0	0
Domestic Wells	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
TOTAL OUTFLOWS	14070	13770	12860	11630	14300	12430	13590	12390	12270	11870	13180	11970	16160	12380	15240	12810	26710	14660	12200	10710	11950	11050	12930	12730
Inflow - Outflow = Groundwater Storage or Unmeasured Flow	-710	-530	-120		-1240		-1540	-400	-580	-280	-2270	-1180	-3860	-1170	-2940	-1700	-10030	-3080	-310				-70	0
Surplus				710		530														1120	350	1090		

*Numbers rounded to the nearest 10.

SOURCE:

Figure 5.9 - Normalized Annual Budget 1990-1996 Excluding 1993 - Reach 3: Verde River Near Camp Verde to Verde River Below Tangle Creek, 7 Day Low and Total Flows.

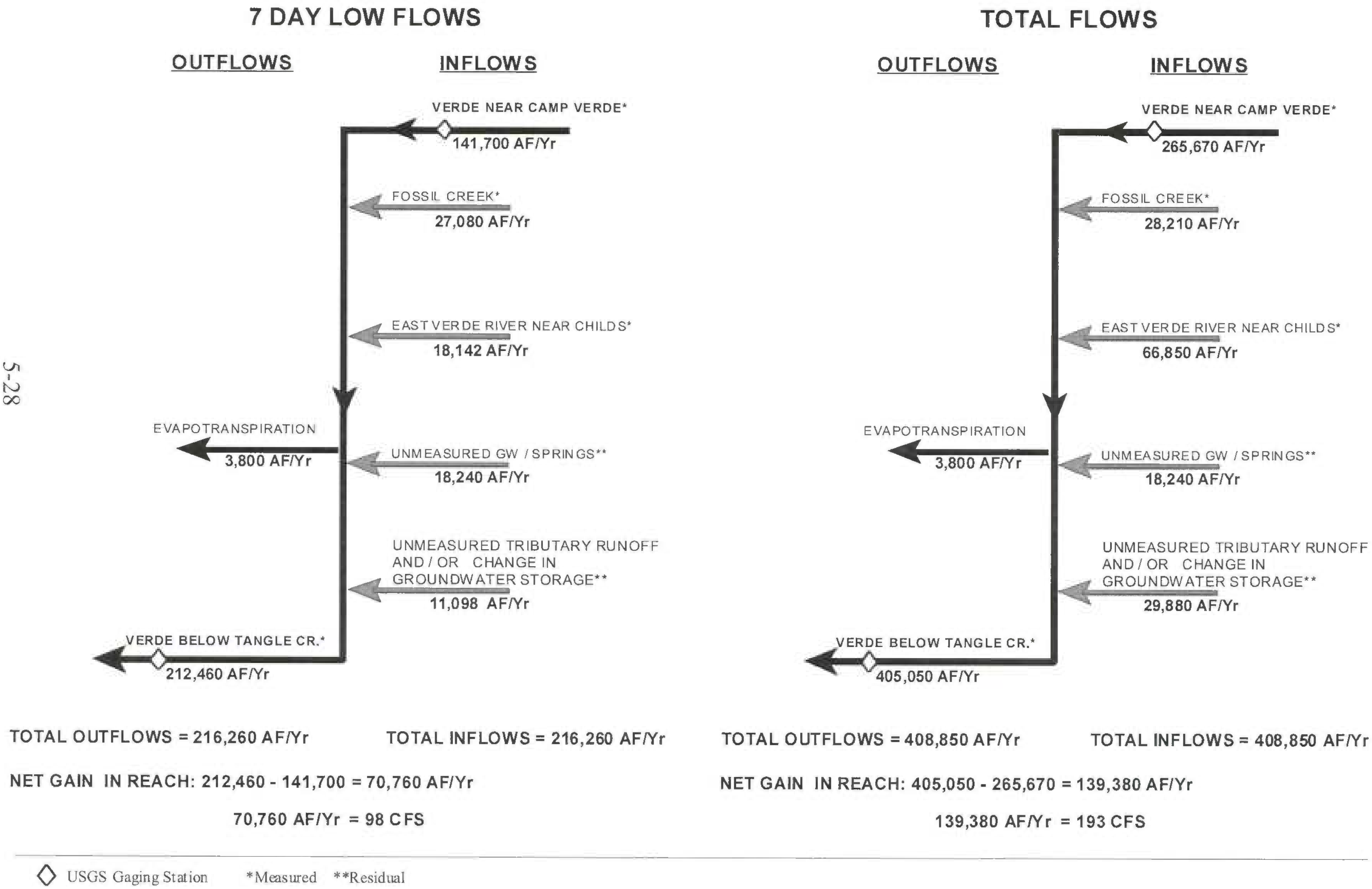


Figure 5.10 - 1992 Wet Year - Reach 3: Verde River Near Camp Verde to Verde River Below Tangle Creek, 7 Day Low and Total Flows.

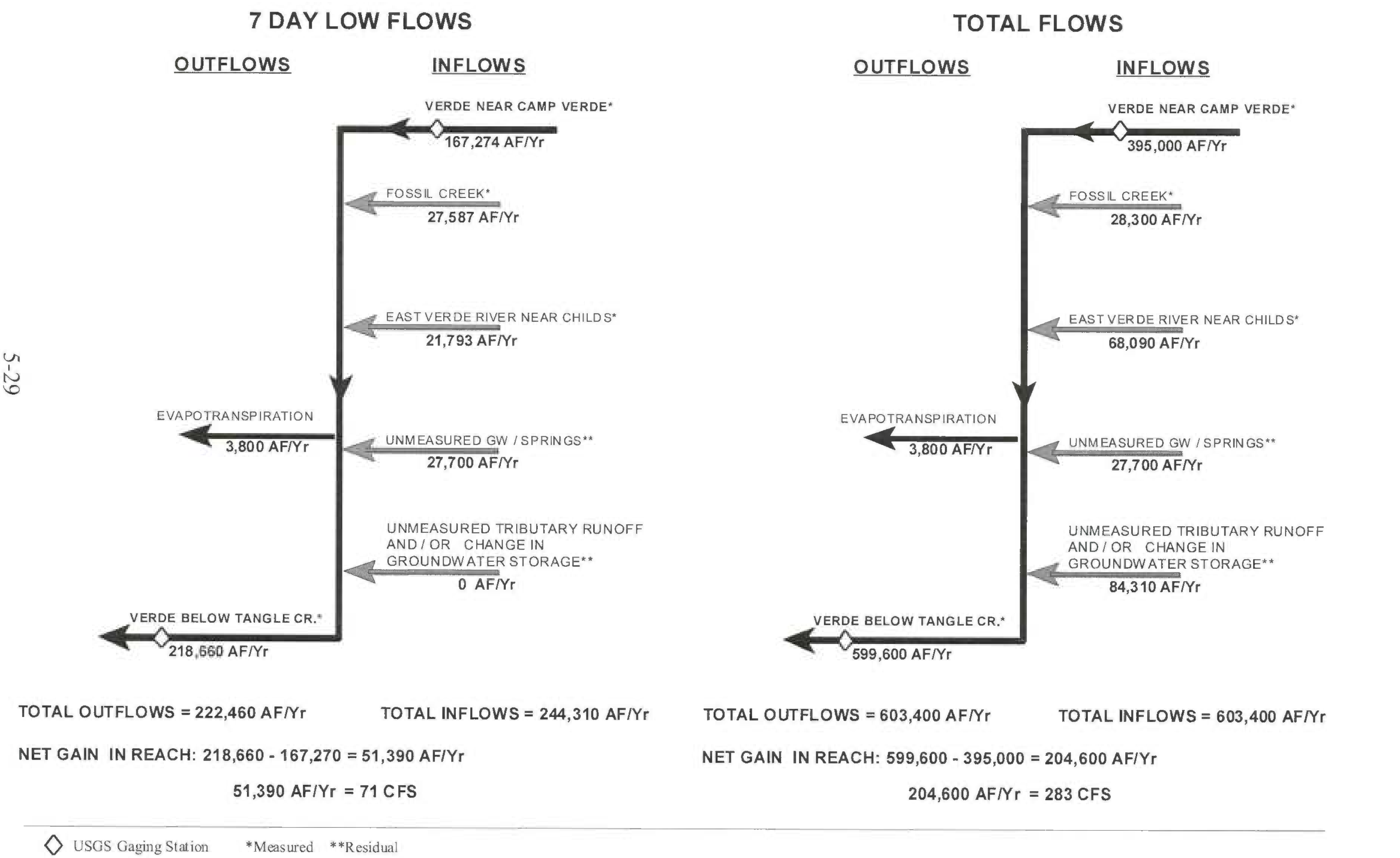
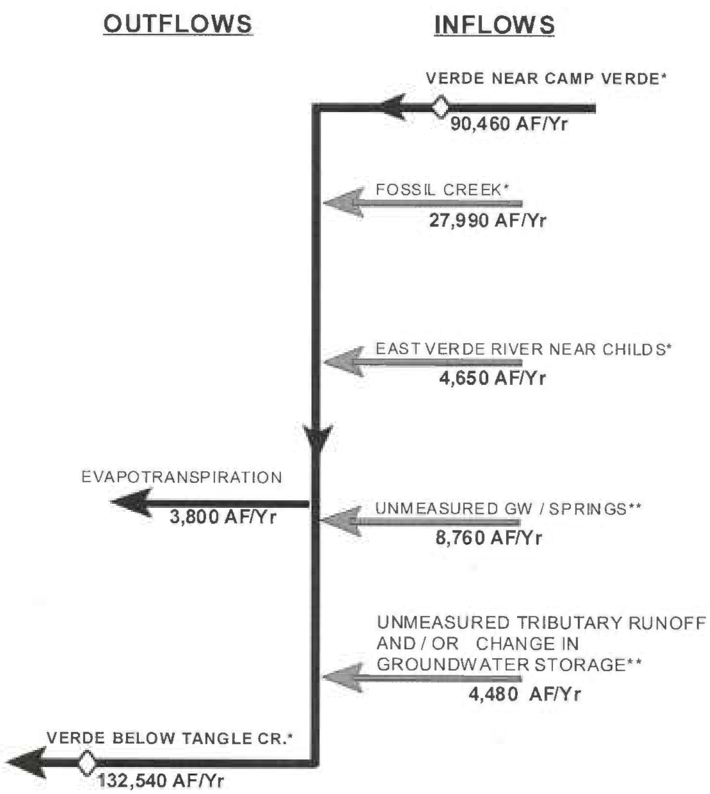


Figure 5.11 - 1996 Dry Year - Reach 3: Verde River Near Camp Verde to Verde River Below Tangle Creek, 7 Day Low and Total Flows.

7 DAY LOW FLOWS



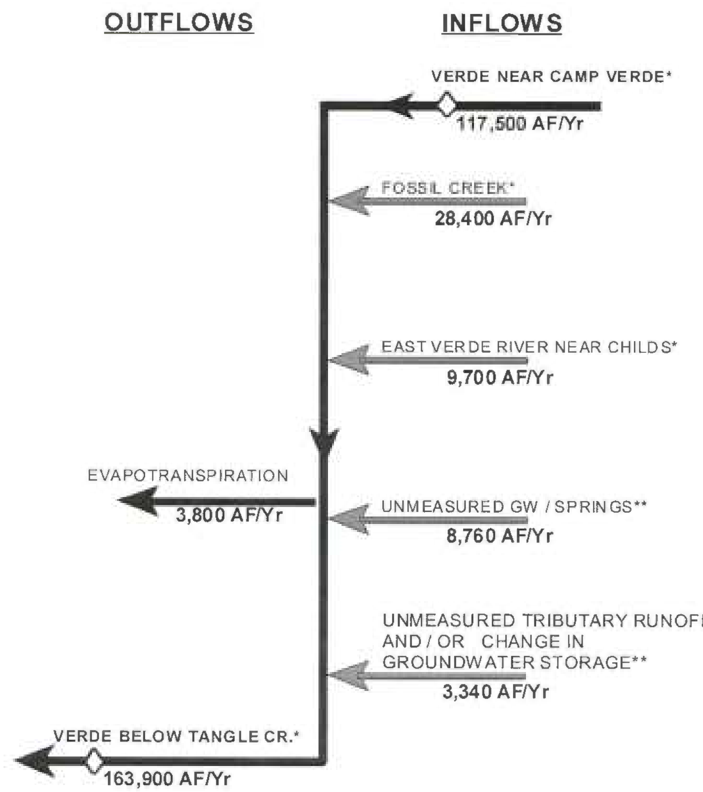
TOTAL OUTFLOWS = 136,340 AF/Yr

TOTAL INFLOWS = 136,340 AF/Yr

NET GAIN IN REACH: 132,540 - 90,460 = 42,080 AF/Yr

42,080 AF/Yr = 58 CFS

TOTAL FLOWS



TOTAL OUTFLOWS = 167,700 AF/Yr

TOTAL INFLOWS = 167,700 AF/Yr

NET GAIN IN REACH: 163,900 - 117,500 = 46,400 AF/Yr

46,400 AF/Yr = 64 CFS

◇ USGS Gaging Station *Measured **Residual

TABLE 5-5

REACH 3: VERDE NEAR CAMP VERDE TO VERDE BELOW TANGLE
SEASONAL BUDGET 1992

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
INFLOWS (ACRE-FEET)	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low
Verde Near Camp Verde	13210	12910	12000	10770	10540	8670	7030	5830	5320	4920	4300	3090	7280	3500	6360	3930	20080	8030	8370	6890	11020	10120	12000	11800
Fossil Creek	2530	2520	2360	2280	2550	2520	2520	2500	2570	2550	2590	2560	2620	2580	2610	2550	2490	2140	2490	2210	2500	660	2560	2520
East Verde Near Childs	6680	3070	10330	1500	23950	9220	6910	1990	1770	1050	1010	450	1090	370	12450	1840	640	360	560	340	660	660	11950	950
Unmeasured Groundwater/Springs	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310	2310
INFLOW TOTALS	24730	20810	27000	16860	39350	22720	18770	12630	11970	10830	10210	8410	13300	8760	23730	10630	25520	12840	13730	11750	16490	13750	28820	17580
	JANUARY		**FEBRUARY**		**MARCH**		**APRIL**		**MAY**		**JUNE**		**JULY**		**JULY**		**SEPTEMBER**		**OCTOBER**		**NOVEMBER**		**DECEMBER**	
OUTFLOWS (ACRE-FEET)	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low
Verde Below Tangle	44940	25200	10890	22320	221200	61470	52530	14580	15580	13030	12290	7740	11090	6580	68500	11500	13890	11310	12710	11370	14920	14990	74030	17580
Evapotranspiration (3800)	0	0	0	0	380	380	380	380	380	380	630	630	630	630	630	630	380	380	380	380	0	0	0	0
TOTAL OUTFLOWS	44940	25200	10890	22320	221580	61850	52910	14960	15960	13410	12920	8370	11720	7210	69130	12130	14270	11690	13090	11750	14920	14990	74030	17580
Inflow - Outflow = Groundwater Storage or Unmeasured Flow	-20210	-4390		-5460	-182230	-39130	-34140	-2330	-3990	-2580	-2710				-45400	-1500				0		-1240	-45210	0
Surplus			16110									40	1580	1550			11250	1150	640		1570			

*Numbers rounded to the nearest 10.

SOURCE:

Unmeasured groundwater, springs, and tributary contributions for calendar year 1996 (dry year) seasonal water budget (Table 5-6) were calculated to be 730 acre-feet per month. Calculating the inflows minus outflows revealed that surpluses in the seven-day low flows were occurring in the months of February, May, July, and November. The remaining seven months indicated a deficit situation was occurring with the residual assumed to be from groundwater storage or unmeasured spring and tributary flows.

Summary

Groundwater use in the Middle Verde has increased over the past 15 years. Municipal groundwater use was estimated to be 8,000 acre-feet per year in 1983. ADWR estimated municipal groundwater use to be 10,860 acre-feet in 1997. Municipal groundwater use in 1997 decreased slightly from 1996, possibly due to increased water conservation efforts. The results of the compilation of data for the municipal water providers reveals a continuous increase in annual water usage in the Verde Valley from 1990 to 1996 for residential, commercial, industrial and other categories of water users. The total number of wells located in the Middle Verde according to ADWR's Wells Registry in March 1999 is 9,630, with the majority of wells located along the stretch of the river referred to as Reach 2; 3,480 wells were designated as domestic, with an estimated annual water demand of 1,200 acre-feet. The residential sector received approximately 82 percent of the total water supplied by municipal/private water providers. Water use by the private industrial water users that do not receive water from a municipal/private water supplier indicated fluctuations in total water usage during the same seven year time period.

Water consumption in 1996 in the Middle Verde was estimated to be approximately 16,900 acre-feet per year, which is significantly less than the 1983 estimate of 31,000 acre-feet made by Owen-Joyce and Bell. The evapotranspiration figure of 35,000 acre-feet per year was estimated by Anderson (1974) and was used by both Owen-Joyce and Bell and by ADWR in this study. No recent data on evapotranspiration is available.

Based on the analysis and the trends presented in this study, the groundwater system of the Middle Verde appears to be in a long-term balanced state. During periods of drought, the groundwater system may be experiencing a deficit situation, while the reverse would be true for those periods of excessively high precipitation. Increases in groundwater pumping combined with periods of drought, however, will result in greater voids to fill during the wet years. This will ultimately require longer periods of excessively high precipitation in order to produce the same amount of surface water flows in the Verde River and its tributaries.

TABLE 5-6

REACH 3: VERDE NEAR CAMP VERDE TO VERDE BELOW TANGLE
SEASONAL BUDGET 1996

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
INFLOWS (ACRE-FEET)	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low	Total Flow	7 Day Low
Verde Near Camp Verde	13210	12910	12000	10770	10540	8670	7030	5830	5320	4920	4300	3090	7280	3500	6360	3930	20080	8030	8370	6880	11020	10120	12000	11800
Fossil Creek	2450	2400	2250	2110	2460	2400	2380	2380	2440	2400	2360	2320	2370	2340	2350	2340	2260	2260	2470	2260	2380	2320	2540	2400
East Verde Near Childs	1390	1350	1410	1220	690	620	340	330	130	120	30	20	40	30	110	90	1370	300	170	150	280	270	380	380
Unmeasured Groundwater/Springs	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730
TOTAL INFLOWS	17780	17390	16390	14830	14420	12420	10480	9270	8620	8170	7420	6160	10420	6600	9550	7090	24440	11320	11740	10020	14410	13440	15650	15310
	JANUARY		**FEBRUARY**		**MARCH**		**APRIL**		**MAY**		**JUNE**		**JULY**		**AUGUST**		**SEPTEMBER**		**OCTOBER**		**NOVEMBER**		**DECEMBER**	
OUTFLOWS (ACRE-FEET)-	**Total Flow**	**7 Day Low**	**Total Flow**	**7 Day Low**	**Total Flow**	**7 Day Low**	**Total Flow**	**7 Day Low**	**Total Flow**	**7 Day Low**	**Total Flow**	**7 Day Low**	**Total Flow**	**7 Day Low**	**Total Flow**	**7 Day Low**	**Total Flow**	**7 Day Low**	**Total Flow**	**7 Day Low**	**Total Flow**	**7 Day Low**	**Total Flow**	**7 Day Low**
Verde Below Tangle	17910	17830	16300	14770	14030	14020	10510	10120	7590	7190	6100	6070	10100	5040	10180	7320	24210	12500	10690	9960	13280	12440	15450	15310
Evapotranspiration (3800)	0	0	0	0	380	380	380	380	380	380	630	630	630	630	630	630	380	380	380	380	0	0	0	0
TOTAL OUTFLOWS	17910	17830	16300	14770	14410	14400	10890	10500	7970	7570	6730	6700	10730	5670	10810	7950	24590	12880	11070	10340	13280	12440	15450	15310
Inflow - Outflow = Groundwater Storage or Unmeasured Flow	-130	-440				-1980	-410	-1230				-540	-310		-1260	-860	-150	-1560		-320				0
Surplus			90	60	10				650	600	690			930					670		1130	1000	200	

*Numbers rounded to the nearest 10.

SOURCE:

CHAPTER 6

Conclusions and Recommendations

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

The Verde Planning Study provides a comprehensive assessment of water supplies and demands in the Upper and Middle Verde River areas. The objective of the study was twofold: 1) identify and present a comprehensive overview of the current state of water resources for the Verde River Watershed study area; and 2) identify areas where further studies are needed in order to fully understand the impacts of current and future uses of water resources within the Verde River Watershed study area. This chapter highlights the major findings of this effort. In addition, this chapter describes the limitations in the data and information used to prepare this report. It is hoped that this study will be used by the water managers and planners of the Upper and Middle Verde regions as a building block for future studies and advanced planning on behalf of the water users of the Verde River system.

Table 6-1 presents the water demand by major sector located within the study area.

TABLE 6-1

CURRENT WATER DEMAND FROM ALL SOURCES IN THE VERDE RIVER STUDY AREA

SUBWATERSHED	USE SECTOR	ESTIMATED WATER DEMAND (ACRE-FEET)
Upper Verde	Agricultural	29,440
	Municipal	6,900
	Domestic Wells	1,410
	Private Industrial	1,380
	Subtotal	**39,130**
Middle Verde	Agricultural	16,950
	Municipal	7,310
	Domestic Wells	1,220
	Private Industrial	4,550
	Other (Evapotranspiration)	35,000
	Subtotal	**65,030**
Total Water Demand		**104,160**

6.1 UPPER VERDE

Background

The Upper Verde watershed area for purposes of this study includes the Little Chino sub-basin within the Prescott AMA, Big Chino Valley, and Williamson Valley. It also includes the reach of the Verde River between Sullivan Lake and the USGS gaging station at Paulden. Figure 6.1 shows the Upper and Middle Verde study areas.

The 1997 population for Yavapai County was estimated to be 142,000. At the current rate of increase, the population of this county is expected to exceed 325,000 by the year 2050. Current and projected population figures are available for Prescott, Chino Valley, and other communities (Section 2.3).

Land use is changing from agricultural to urban use, especially in the Williamson Valley and Chino Valley. Much of the urban expansion is within existing municipal boundaries or planned developments, but much of the urbanization around Paulden is largely unregulated at this time (Section 2.3).

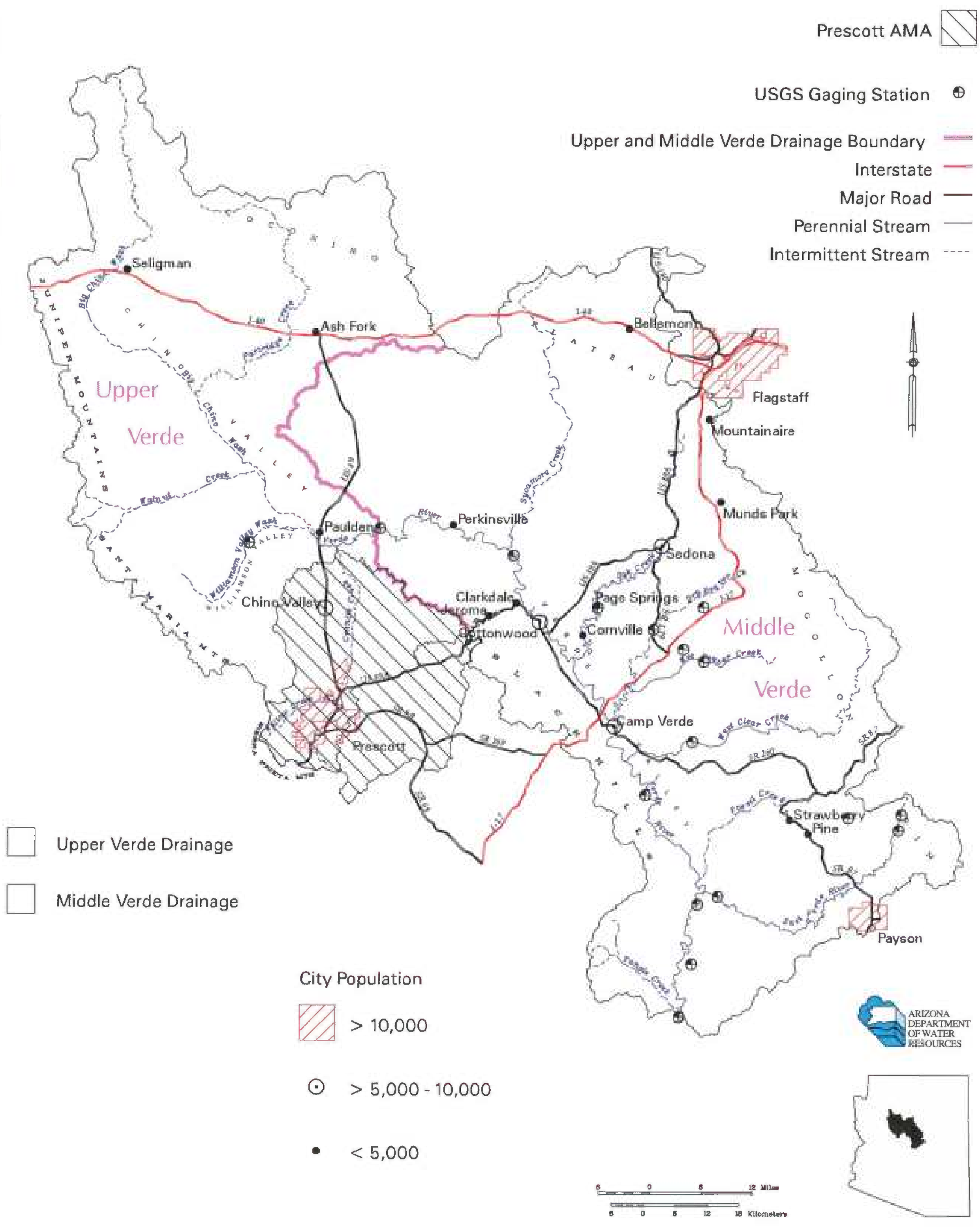
According to the ADWR Safe Yield Status Report for the Prescott AMA (ADWR, 1998), the Little Chino sub-basin was in an overdraft condition during 1997. Inflows were estimated at 6,990 acre-feet and outflows were estimated at 16,820 acre-feet, which equates to an overdraft of 9,830 acre-feet. Based on the information compiled in 1996 and 1997 for this study an estimated an overdraft of 6,610 acre-feet occurred in 1997. The difference in the overdraft between the two reports has been attributed to estimates of recharge and agricultural water demand measurements. Reliable data is unavailable in this region, which makes it problematical to present a precise water budget (Section 5.2).

Water Uses

There were nine municipal water providers identified in the Upper Verde. Of those, five delivered 20 acre-feet or more annually. Most of these large providers have metered flows and the data is readily available. Water use has increased from about 5,140 acre-feet in 1990 to 6,900 acre-feet in 1997. Water use by sector for 1997 is presented in Figure 6.2 (Section 3.2).

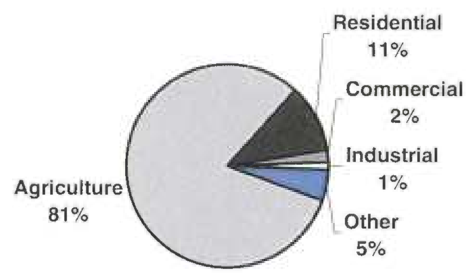
The total estimated recharge from septic systems for the Upper Verde in 1996 was about 1,950 acre-feet. Of this total, 1,610 acre-feet of recharge were estimated for the Little Chino Valley and 340 acre-feet for the Big Chino Valley (Section 3.2). Wastewater treatment hookups in the Big Chino Valley were not found.

Figure 6.1 - Verde River Watershed Study Area



Source: Arizona Department of Water Resources.

Figure 6.2 - 1997 Upper Verde Water Use by Sector



There were two gravel operations and one golf course in the Upper Verde that each used 100 acre-feet or more annually. The total combined water use for all industrial operations in the Upper Verde was 1,380 acre-feet in 1997. Based on figures published by the Prescott AMA, 180 acre-feet of groundwater and 1,000 acre-feet of effluent are being used in the Little Chino. Of these, approximately 860 acre-feet of effluent are used by the golf course, based on a water duty of 4.9 acre-feet per acre. The 180 acre-feet of groundwater and the remaining 140 acre-feet of effluent were being used by one sand and gravel operation and other smaller industrial users. In the Big Chino, 200 acre-feet of groundwater were being used by one sand and gravel operation and some smaller industrial users (Section 3.5).

There were approximately 1,680 water impoundments identified in the Upper Verde ranging in size from 1/10 to 350 surface acres. These included irrigation, recreation, and storage reservoirs, tailwater and floodwater control structures, and stockponds. The majority of the impoundments are stockponds located primarily on forest service, state, and BLM lands (Section 3.6)

The total number of registered wells in ADWR's Well Registry for the Upper Verde was approximately 9,400. As of April 1999, there were 3,550 registered domestic wells in the Little Chino groundwater sub-basin pumping an estimated 900 acre-feet annually. In the Big Chino Valley groundwater sub-basin, 990 registered domestic wells were pumping an estimated 250 acre-feet annually. The estimated use per domestic well is 0.25 of an acre-foot per year, based on a GPCD of 97 and 2.35 persons per household. Many wells in ADWR's well registry have been coded for multiple uses, and the sum of the well counts by category is inaccurate due to this coding. Well capacity and metering of pumped water is not regulated by ADWR outside designated AMAs and, therefore, well use estimates for non-AMA areas of the Verde watershed are generally estimates (Section 4.2).

Total actively irrigated acreage for the entire Upper Verde Valley was about 5,950 acres in 1997, using approximately 16,530 acre-feet of water. The potential acreage, actively or historically irrigated, is approximately 11,200 acres with a potential water use of 58,800 acre-feet. A breakdown for each major area is discussed below. The main crops grown in Little Chino, Big Chino, and Williamson Valleys were corn, alfalfa, pasture, and vegetables. No monitoring of diversion flows and metering of wells is required outside the Prescott AMA (Section 3.4).

Monitoring of all wells for irrigation purposes would increase the accuracy of agricultural water use estimates.

In the Little Chino Valley, crop production peaked in the 1960s and has since declined. Currently about 2,170 acres are being irrigated using 6,610 acre-feet of water. The estimated water use based on a weighted water duty of 6.6 acre-feet (FAO 24 method for calculating crop consumptive use) for the 2,170 acres would be 14,310 acre-feet. Historically irrigated land accounts for an additional 3,210 acres with an estimated potential water use of 21,200 acre-feet. In the Little Chino Valley, the source of irrigation water was 55 percent groundwater, 41 percent surface water from the Chino Valley Irrigation District (CVID) and Del Rio Springs, and 4 percent effluent from CVID. Little Chino Valley lies entirely within the Prescott AMA (Section 3.4).

Crop production in the Big Chino Valley also peaked in the 1960s and has since declined. However, there has been an increase in irrigated crops since the mid-1990s and especially in 1998. Currently in the Big Chino Valley including Walnut Creek, about 2,480 acres are being actively irrigated using an estimated 9,900 acre-feet of water based on a weighted water duty of 4.0 acre-feet (NRCS crop consumptive use values). Historically irrigated lands account for an additional 1,700 acres with a potential water use of 6,900 acre-feet. Groundwater provides almost 100 percent of the irrigation needs. In the upland areas such as the Cross U and Yavapai

Ranches, irrigation is provided by 100 percent surface water. Along Walnut and Apache Creeks and Horse Wash, the source for irrigation is commingled water. The mix of source water depends on the availability of runoff. The Big Chino Valley and the fringe areas lie outside the Prescott AMA with no regulation over groundwater withdrawal (Section 3.4).

Crop production in Williamson Valley has remained constant until recently. Currently, about 1,300 acres are actively being irrigated using an estimated 5,200 acre-feet of water based on a water duty of 4.0 acre-feet. Groundwater provides 100 percent of the irrigation needs. Historically irrigated lands account for an additional 320 acres that could potentially use an additional 1,300 acre-feet of water based on a water duty of 4.0 acre-feet. In the mid-1990s, two ranches discontinued irrigation and are now being subdivided into planned area developments. These developments are outside the Prescott AMA with no regulation over groundwater withdrawal (Section 3.4).

Water Resources

Surface Water

The surface water system in the Big Chino sub-basin consists of the Big Chino Wash, Partridge Creek, Walnut Creek, Williamson Valley Wash, and the Verde River. The Big Chino sub-watershed is ephemeral except for short perennial reaches along Walnut and Apache Creeks and intermittent reaches along Williamson Valley Wash. Limited discharge data is available for Walnut Creek and Williamson Valley Wash. The mean discharge and average annual runoff for Walnut Creek and Williamson Valley Wash are 1,550 acre-feet and 11,160 acre-feet respectively. Partridge Creek is an ungaged ephemeral stream with an estimated annual runoff of 3,000 acre-feet (Section 4.2).

The Little Chino surface water system primarily consists of Granite Creek, Willow Creek, and Little Chino Wash. Limited stream gage data is only available for Granite and Willow Creeks. The average annual streamflow for these two creeks was approximately 4,800 and 1,400 acre-feet respectively for the period 1933 to 1947. Currently, there is streamflow data available for the gages on Granite Creek at Prescott from November 1994 to the current year and on Granite Creek near Prescott from October 1994 to the current year. The average annual streamflow at these two gages was 2,380 acre-feet and 2,340 acre-feet respectively for water year 1997. The annual total mean discharge of Granite Creek outflow was estimated to be 820 acre-feet from streamflow measurements of the Verde River about a quarter mile below the confluence with Granite Creek. The USGS gaging station on the Verde River near Paulden is approximately eight miles downstream from Granite Creek. The average annual runoff of the Verde River as measured at the USGS gaging station near Paulden for the past 30 years (1967-1997) is approximately 32,500 acre-feet (USGS) (Section 4.2).

Groundwater

The 1974 USBR report estimated groundwater storage at more than 20 million acre-feet in the Big Chino Valley. A current estimate of groundwater storage for the entire Big Chino sub-basin is not known. A more recent study conducted in 1995 by Corkhill and Mason estimated the groundwater storage in the Upper Alluvial Unit of the Little Chino sub-basin at approximately 2.3 million acre-feet. The volume of groundwater storage in the Paleozoic Limestone and Lower Volcanic Units is not known. The current estimated total groundwater storage in the alluvial valleys of Big Chino and Little Chino sub-basins is shown in Table 6-2. At Del Rio Springs, about 1,500 to 2,000 acre-feet per year has been estimated to exit the sub-basin as underflow to the Big Chino sub-basin (Corkhill and Mason, 1995) and (ADWR, 1998) (Section 4.2).

TABLE 6-2

GROUNDWATER IN STORAGE IN THE ALLUVIAL VALLEYS OF THE UPPER VERDE

LOCATION	DEPTH BELOW LAND SURFACE (FEET)			
	0 TO 300 GROUNDWATER STORAGE (ACRE-FEET)	300 TO 700 GROUNDWATER STORAGE (ACRE-FEET)	700 TO 1,200 GROUNDWATER STORAGE (ACRE-FEET)	0 TO 1,200 GROUNDWATER STORAGE (ACRE-FEET)
Little Chino Valley*	NA	NA	NA	2,300,000*
Williamson Valley	730,000	1,800,000	1,300,000	3,830,000
Big Chino Valley	2,300,000	6,000,000	4,500,000	12,800,000
Total	**3,030,000**	**7,800,000**	**5,800,000**	**18,830,000**

Source: USBR, 1974.
*Corkhill and Mason, 1995.

Groundwater quality in the Prescott AMA has been reported to be good for most uses. Water quality studies were conducted by Remick (1982), ADEQ (1998), and others. Surface water has been reported in the same area as very good. In Big Chino and Williamson Valleys, there are little data to determine current water quality problems, but no current problems have been identified (Section 4.4). With the increasing population in the area, water quality issues are more likely to occur. Continuous monitoring and sampling of the quality of water should be implemented. Supplemental collection of groundwater quality data in areas such as Williamson Valley and along Walnut and Big Chino Washes is currently underway and should facilitate future evaluation.

Identified Problems and Recommendations

This study has involved a thorough and comprehensive examination of available data and previous reports on the Verde watershed. In the course of this examination, a number of areas of hydrologic uncertainty have been identified. The following section discusses these areas and makes recommendations for further study that would increase understanding of the hydrologic system and afford planners and managers the opportunity to make better decisions regarding the water resources of the area.

Water Budget

Water budgets are a comparison of inflows to and withdrawals from a hydrologic system to help determine if the hydrologic system is being over-utilized. Constructing a water budget involves estimating a large number of different types of inflows and outflows. These estimates are subject to interpretation and sometimes to large degrees of uncertainty. Because water budgets are a crucial tool in determining the safe yield of a groundwater basin, it is critical that they be based on well-understood data and estimates. Typically, the estimates for recharge and changes in groundwater storage are among the least precise components of a water budget. These components are uncertain because they are based on inferences from scanty data. These components are discussed below.

Estimated annual natural recharge values for the Little and Big Chino Valleys were 2,050 acre-feet and 15,700 acre-feet, respectively (Sections 4.2 and 5.2). These estimates were made using available precipitation data, USGS stream gaging station information, and the areal extent of the region. The estimates of recharge are made indirectly and are subject to a number of interpretive steps. There are only four precipitation recording stations in the Upper Verde. Mean annual precipitation ranges from 10 to 20 inches in the valleys and plateaus and is higher along the mountain slopes. Precipitation contours for the region were interpolated using data from the four existing recording stations.

More precipitation stations would increase the accuracy of these estimates.

A lack of gaged stream data in the Upper Verde makes it difficult to estimate inflow and discharge. Spring discharge is not measured except at Del Rio Springs.

More stream gages and spring discharge measurements would increase the accuracy of recharge estimates for planning and management purposes. (Section 4.2)

Hydrographs were compiled on wells in the Upper Verde area that revealed fluctuating water levels over a 30-year period. Many wells in the Little Chino sub-basin show long-term declines.

More wells need to be monitored on a regular basis in order to identify seasonal fluctuations and long-term trends in water levels and groundwater storage. (Section 4.2)

The Laboratory of Climatology, Arizona State University conducted Pan evaporation studies in 1975.

Studies should be conducted to determine an understanding of total loss of water through evaporation. (Section 2.2)

Big Chino Basin/Verde River Connection

No clear understanding of a hydrogeologic connection between the Big Chino Valley and the Verde River has been established. Krieger (1965), USBR (1974, 1993), USGS (1976), WRA (1989), Corkhill and Mason (1995), Schwab (1995), and others have conducted studies of the hydrogeology in the Upper Verde. Most of these studies have interpreted the existence of a large regional aquifer underlying the Big Chino Basin, but a complete understanding of the extent and capacity of the underlying aquifers of the Big and Little Chino Valleys has yet to be achieved. Knauth and Greenbie (1997) observed and measured surface water flows of the Granite Creek and Verde River a quarter mile downstream of their confluence to determine surface water and groundwater flow interaction. Based on their studies, they assumed from isotopic analysis that the source of the Verde River baseflow was mainly from the Black Mesa Aquifer with up to 25 percent coming from the Granite Creek drainage.

In the Big Chino Basin, water levels in some parts of the basin show a rise probably related to declines in irrigation. In addition, rising baseflow levels of the Verde River at Paulden since the 1960s may be tied to these rising groundwater levels. There is a concern that increased growth or farming in the Big Chino Basin and increased groundwater use may affect the baseflows of the Upper Verde River. The connection between Big Chino and the Verde River is not well understood and additional water level monitoring would be critical to understanding this link.

Geophysical, geohydrological, and geochemical studies are required to better understand the regional groundwater system and further delineate the connection between the Big Chino Sub-basin and the Verde River. *Further geochemical and isotopic studies are recommended for a larger area near and around Paulden.*

More aquifer hydraulic-property data from pumping tests is required. In-depth geologic and long-term hydrologic studies may be used to better understand groundwater flow in the Upper and Middle Verde areas.

Detailed descriptions of rock units could be developed using borehole geologic logs. Currently, sub-surface descriptions are limited due to the lack of borehole geologic logs. The size, shape, and depth of the groundwater sub-basins and hydrologic characteristics of the rocks forming them are important. Additional studies describing the geologic framework, the physical system in which groundwater occurs, are recommended. The results of these studies would aid in the development of comprehensive regional groundwater models for both the Upper and Middle Verde sub-basins. (Section 4.2)

6.2 MIDDLE VERDE

Background

For purposes of this study, the Middle Verde watershed area includes the reach of the Verde River between the USGS gaging station near Paulden to the USGS gaging station below Tangle Creek. Figure 2.1 shows the Upper and Middle Verde study areas.

Forecasts based on current growth rates in the Verde Valley project a population increase of 128 percent between 1994 and 2040. There is sufficient data for demographic analysis in the region.

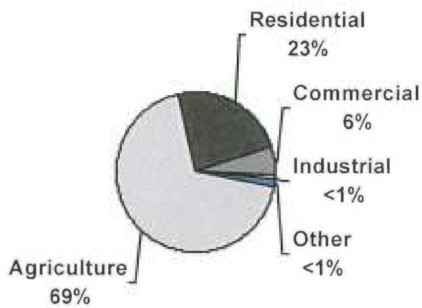
Current demographic data for the region is available from Arizona Department of Economic Security and Arizona Department of Commerce (Community Profiles). (Section 2.3)

Undeveloped land is being urbanized in areas around Cornville, between Clarkdale and Sedona, and other areas throughout the Verde Valley. Agricultural lands that appear to be economically productive are not being retired to the extent occurring in the Upper Verde region. There is also urban development within Payson and in areas around Pine and Strawberry (Section 2.3).

Water Uses

There are 18 water providers identified in the area delivering 20 acre-feet or more annually. Most meter their flows, and current demand data is readily available from the municipal sector. Water delivery increased from 4,751 acre-feet in 1990 to 7,311 acre-feet in 1997. Water use by sector for 1997 is presented in Figure 6.3 (Section 3.2).

Figure 6.3 - 1997 Middle Verde Water Use by Sector



The exact number of wastewater treatment plant hookups is unknown. Septic recharge numbers were estimated to be 2,120 acre-feet in 1996. This estimate was based on domestic well counts, water provider hookups, and wastewater treatment plant hookups (Section 3.2).

As of April 1999, the total number of registered wells in ADWR's well registry was 9,630 in the Middle Verde. The estimated use per domestic well is 0.35 of an acre-foot per year based on a residential GPCD of 133 and 2.35 people per household. The total number of registered wells may change daily as new wells are put into operation and other well applications may be cancelled. Many wells in the database have been coded for multiple uses. The sum of the well count by category is inaccurate due to this multiple use coding. The number of unregistered wells is not known. This area is not in an AMA, therefore, well size, pumpage, and metering is not regulated by ADWR.

The majority of irrigated lands are supplied with surface water diverted from the Verde River and its major tributaries. Approximately 1,200 irrigation wells have the capacity to pump groundwater for irrigation in times of drought. Currently, 5,381 acres are being actively irrigated using an estimated 16,950 acre-feet of water based on a weighted water duty of 3.15 acre-feet per acre. Crops presently in production are alfalfa, pasture, corn, turf, vegetables, and orchards. Historically, irrigated land accounts for an additional 860 acres that would require an extra 2,710 acre-feet of water annually. There is no monitoring of the diversion flows on any of the ditches, and in some stretches of the river the entire flow of the river is diverted. Excess water is directly returned to the river. Measuring surface water diversions would limit the need to divert the entire surface water flows of the river. This would minimize the potential drying of surface water flows in small stretches of the river that are currently occurring (Section 3.4).

Four sand and gravel operations and eight golf courses in this area each use 100 acre-feet or more annually. One smaller golf course was identified as using less than 100 acre-feet annually. The total combined water use for all industrial operations in the Middle Verde was 4,550 acre-feet in 1997. Of this total water use, approximately 3,044 acre-feet are groundwater, 524 acre-feet are surface water, and 980 acre-feet are effluent. Golf courses account for 3,330 acre-feet, sand and gravel operations account for 1,200 acre-feet, and water bottling companies account for 20 acre-feet of the total water. Effluent was used for irrigation on two of the nine golf courses. An additional 900 acre-feet of effluent was being delivered to one golf course for an unverified and undetermined use (Section 3.5).

Water Resources

Surface Water

There are approximately 955 impoundments in the Middle Verde ranging in size from 1/10 to about 7 surface acres. These include irrigation, recreation, and storage reservoirs, tailwater and floodwater control structures, and stockponds. The majority of these impoundments are stockponds located primarily on forest service, state, and BLM lands. No estimates of total capacity for these impoundments have been calculated (Section 3.6).

Mean annual precipitation in the Verde Valley is between 10 to 20 inches. Along the mountain slopes precipitation often exceeds 30 inches. There are at least seven precipitation stations, including Payson and Flagstaff. Precipitation contours for the region were interpolated using data from existing precipitation stations (Section 2.2).

Evapotranspiration studies in the region were conducted by Anderson in 1976. The result of this study revealed an estimated annual evapotranspiration rate of 35,000 acre-feet based on the riparian vegetation present at the time of the study.

A current analysis of the ET rates in this watershed is recommended. (Section 4.3)

Groundwater

Twenter and Metzger (1963), Levings (1980), Owen-Joyce (1983), and Owen-Joyce and Bell (1984) have conducted studies assessing the hydrogeology of the Middle Verde. No estimate of groundwater in storage exists in the Middle Verde. The Middle Verde has such a lack of data and understanding that even an approximation of groundwater in storage is not currently possible.

As in the Upper Verde, further geologic information would increase the understanding of the hydrogeology of the region. (Section 4.3)

Identified Problems and Recommendations

Well hydrographs compiled throughout the area reveal fluctuating water levels over the past 30 years.

More wells need to be monitored on a regular basis in order to identify seasonal fluctuations and long-term trends in water levels. (Section 4.2)

Two wetland areas were identified in the region: Tavasci Marsh, a wildlife management area, and Pecks Lake, an old oxbow lake fed by surface water diversions and spring flow. Both of these areas are located on property owned by the Phelps Dodge Corporation. Riparian areas along the Verde River and its tributaries depend on a continuous flow of water as well as on stable subflow levels (Section 3.7).

Water quality in the Middle Verde has been adequately studied. Similarities were noted between the chemical quality of surface water and groundwater, which is generally well-suited for irrigation. Periodic increases of fecal coliform levels have been noted in both Oak Creek and Verde River that are usually associated with tourism during the summer months (Section 4.4).

There are sufficient streamflow gages on the Verde River and its main tributaries throughout the Verde Valley, but there is a lack of stream baseflow data. There is also inadequate data on the number of springs and spring discharge in the Verde River system.

Baseflow monitoring sites that are more sensitive to changes in baseflow need to be developed throughout the entire Middle Verde area. More research needs to be conducted on stream baseflow and spring discharge. (Section 4.3)

A direct correlation between the amount of precipitation and streamflow has been observed. Monthly groundwater contributions to the system in the form of baseflow have remained fairly constant regardless of the amount of precipitation received (Section 4.3).

Water Budget

The Verde River was studied in three reaches. Each of these reaches indicated the river to be a gaining stream. Water budgets were prepared for a dry year and a wet year to demonstrate the impact precipitation may have on the Verde River system. Seasonal and annual water budgets were also prepared in order to exhibit the monthly influence of each component on the system. Results reveal the extent of influence that precipitation has on the system relative to the amount, duration, and the time period of the precipitation events. Linear regression analysis on streamflows showed a marginal increase in tributary flow in most of the streams over a 30-year period (Section 4.3).

In the Middle Verde more data needs to be acquired and analyzed in order to prepare a useful and definitive tool for the communities to plan their future. Analysis of long-term water supplies and demands needs to be performed. Included in this effort should be the development and analysis of long-term water budgets that would take into consideration seasonal differences.

6.3 LONG-TERM WATER RESOURCE RECOMMENDATION

A regional planning effort that must include at a minimum, participants from ADWR, Yavapai County, each of the communities, the private water companies, the irrigation water providers, and the developers within the Verde River Watershed is recommended. Planning issues should include the identification and approval of further technical studies to determine the actual status of the water resources, identification of current and alternative water supplies, identification of current and future demands based upon projected growth and their impacts on the water resources, identification of legal, political and economic issues encompassing source and use of current, future and alternative water resources. To some extent the foundation for this effort has already been initiated by the Verde Watershed Association and the Yavapai County Water Advisory Board.

The Verde River hydrologic system is very dynamic and yet very fragile. Although this study estimates that the current state of the Big Chino portion of the Upper and all of the Middle Verde are in a steady state, the actual status of the water resources within the entire Verde Watershed is unknown.

The population of the major cities and towns within the Verde Watershed has more than doubled in the last 20 years and is projected to more than double again within the next 50 years. Municipal water usage has increased by more than 39 percent over the last eight years and at the present rate of growth will increase by more than 400 percent over the next 50 years.

Land uses are changing as more farms and ranches are subdivided and commercially developed directly affecting water usage. The number of wells is increasing proportionally with the rapid increase in urbanization, which will affect the volume of water available in the regional aquifer.

It is unclear whether the current demands for surface water and groundwater within the Verde River Watershed have caused any significant impacts on baseflow levels of the Verde River itself. Increasing water demands at the current rate of population growth without long-term water resource planning, however, will impact the availability of both surface water and groundwater. The Little Chino sub-basin of the Prescott AMA has already experienced significant groundwater declines in some areas and these declines have reduced flow in Del Rio Springs. Similar effects on other springs will be seen in the future with unplanned continued development. Without proper planning, Arizona is in danger of losing enormous economic, aesthetic, and environmental benefits associated with the Verde River and its tributaries and the riparian areas associated with each.

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APPENDIX A

APPENDIX A

EXHIBIT 1

WATER SERVICE PROVIDER SURVEY

Please complete the following survey and return it in the enclosed stamped envelope. You may use additional paper if necessary.

1. Company Name, Owner, and Contact Person: ____________________________.
   ____.
   Address: ____.
   Phone Number(s): ____.

2. How long has the water company been in operation? ______________________.

3. Original date the water company was formed? ___________________________.

4. How many wells does the water company own? ___________________________.

5. Does the water company operate wells not owned by the company? _____________.
   If yes, how many wells does the company operate that are not owned by the company? __________

6. Are all wells metered? __________ If no, how many wells are metered? __________.

7. What is the total water storage capacity of your company in gallons? ______________.

8. What percentage of your water supply comes from the following sources?
   Surface water: ________%
   Groundwater: ________%
   Effluent: ________%

9. If effluent is a source of water, for what purpose is it used?
   Agriculture Irrigation: _____Yes _____No
   Golf Course Irrigation: _____Yes _____No
   Other (explain) ____
   ____.

10. What percentage of your annual water delivered occurs during the following months?
    January through April: ________%
    May through August: ________%
    September through December: ________%

11. Does your company perform water use planning? _____Yes _____No
    If so, may we have a copy of your most recent plan? _____Yes _____No

12. Please provide a map of the service area.

13. How did the drought of 1996-1997 impact your abilities to meet the demand for water?

14. As a result of the drought, has your company developed a plan to minimize impacts from future droughts? _____Yes _____No

15. May we have a copy of your plan? _____Yes _____No
If so, please include it with any other plans pertaining to water resource management that we may have copies of.

16. What is your current charge for water to your customers? _________________________.

17. If possible, please provide the number of connections and total gallons delivered for the years 1990 through 1997.

CATEGORY		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups								
	Volume Delivered (Gallons)								
Commercial	Hookups								
	Volume Delivered (Gallons)								
Industrial	Hookups								
	Volume Delivered (Gallons)								
Other	Hookups								
	Volume Delivered (Gallons)								

TABLE 2a

1990-1997 UPPER VERDE WATER PROVIDER TOTAL WATER USE IN ACRE FEET

	Company	1990	1991	1992	1993	1994	1995	1996	1997
1	Abra	n/a	n/a	n/a	n/a	n/a	n/a	52	56
2	Antelope Lakes	0	0	0	0	0	0	0	0
3	AshFork	79	78	71	72	n/a	85	80	81
4	Chino Meadows II	38	43	47	59	74	86	102	112
5	Granite Dells	2	2	3	2	2	2	3	4
6	Granite Mnt.	2	2	2	2	3	7	8	9
7	Granite Oaks	6	13	23	34	52	51	104	111
8	Inscription Ranch	0	0	0	0	0	0	0	6
9	Jackson Acres	0	0	0	6	6	6	5	5
10	Pinehurst	um	um	um	um	um	um	um	um
11	Prescott, City of	5014	5240	5075	5633	5638	5685	6352	6509
11	Totals	5141	5378	5221	5808	5775	5922	6706	6893

Acre-Feet

UM = UNMETERED

UPPER VERDE PERCENT INCREASE IN DEMAND

1997 - 1990 / 1990 0.34079

UPPER VERDE 0.34

TABLE 2b

1990-1997 MIDDLE VERDE WATER PROVIDER TOTAL WATER USE IN ACRE FEET

	Company	1990	1991	1992	1993	1994	1995	1996	1997
1	A.W.C.-Sedona	1514	1608	1539	1763	1914	2070	2379	2442
2	A.W.C.-Pinewood	175	189	192	220	223	223	250	243
3	A.W.C.-Rimrock	131	159	157	183	195	205	230	233
4	Beaver Cr. Store	um	um	um	um	um	um	um	um
5	Big Park	441	499	470	499	550	574	616	642
6	Boynton Canyon	25	24	28	40	n/a	49	48	49
7	Camp Verde	206	225	225	255	262	288	304	321
8	Cathedral Rock	um	um	um	um	um	um	um	um
9	Clemenceau	159	161	171	185	188	184	214	208
10	Cordes Lakes	555	n/a	623	724	758	841	908	872
11	Cottonwood Water	1198	1201	1118	1268	1388	1438	1667	1685
12	Indian Garden Homes	um	um	um	um	um	um	um	um
13	Jerome, Town of	um	um	um	um	um	um	um	um
14	Lake Verde	8	8	9	11	11	11	12	12
15	Little Park	10	12	11	12	n/a	14	17	17
16	Montezuma Estates	um	um	um	um	um	um	um	um
17	Montezuma Heights	n/a	n/a	n/a	n/a	n/a	12	16	18
18	Oak Creek Valley	n/a	22	21	25	27	34	35	36
19	Oak Creek Water Co.	163	170	172	186	211	225	262	245
20	Pine Valley	19	22	23	25	28	n/a	34	32
21	Rancho Shangri-La	um	um	um	um	um	um	um	um
22	Rocky Springs	um	um	um	um	um	um	um	um
23	Rock Water	um	um	um	um	um	um	um	um
24	Sedona Shadows	65	62	67	82	81	n/a	88	n/a
25	Steve Holland	um	um	um	um	um	um	um	um
26	Verde Heights	n/a	n/a	n/a	n/a	n/a	5	6	5
27	Verde Lakes	82	92	95	110	124	199	284	250
27	Totals	4751	4454	4921	5588	5960	6372	7370	7310

Acre-Feet

UM = UNMETERED

MIDDLE VERDE PERCENT INCREASE IN DEMAND

1997-1990/1990 0.538623

MIDDLE VERDE 0.54

ABRA WATER COMPANY

LOCATION	CONTACT
Paulden, Arizona	Kevan Larson (President)

HISTORY

ABRA Water Company has been in operation since 1960 and was formed to service approximately 5,000 lots initially with more to be added later. Transit pipe, pumps, and storage tanks were installed to service the area. Lakes were also developed for recreation purposes for the subdivision, however, the lakes are no longer filled. Irrigation water was used substantially during the early 1960s. ABRA Water Company is affiliated with Ray Development Company, one of the first companies to develop the subdivisions. The Antelope Lakes Water Company service area was once part of ABRA's service area. The First Nevada Mortgage Company, Inc. purchased ABRA Water Company around 1990.

Responded to both the 1995 and 1998 surveys.

WATER SOURCES

The company owns four metered wells and one unmetered well. They also operate and maintain two wells not owned by the company. The total storage capacity of the system is 120,000 gallons. ABRA Water Company is entirely dependent on groundwater for its water supply for mostly permanent residential customers in the Paulden area.

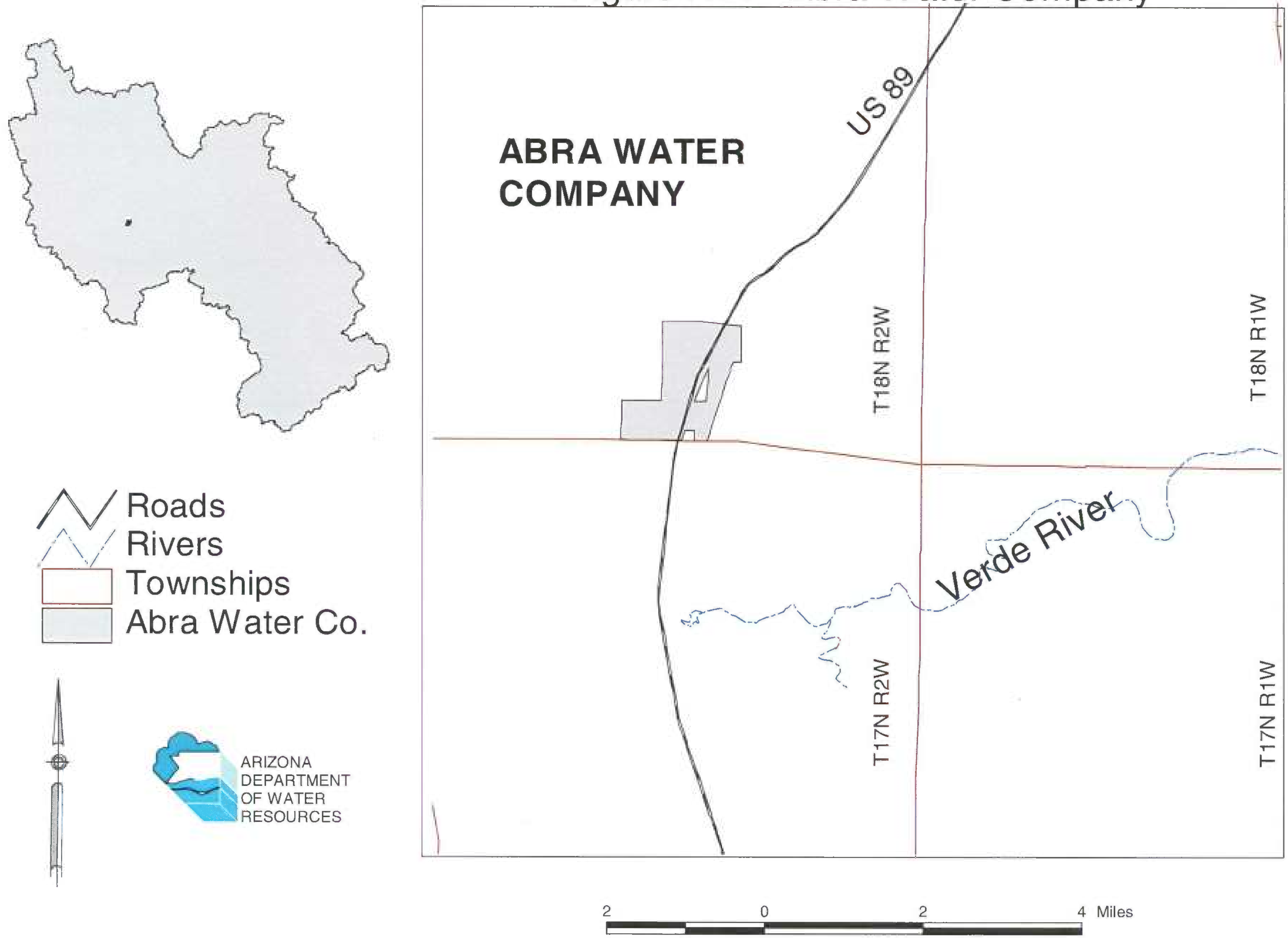
WATER PLANNING

ABRA Water Company does not perform water use planning nor does it have an emergency back-up plan. The company was not affected by the 1996-1997 drought in any way.

The current charge for water is not known.

The company would like to expand to the south along Highway 89 to provide water to the commercial and residential subdivisions sometime in the future.

Figure A .1 - Abra Water Company



Source: Arizona Department of Water Resources

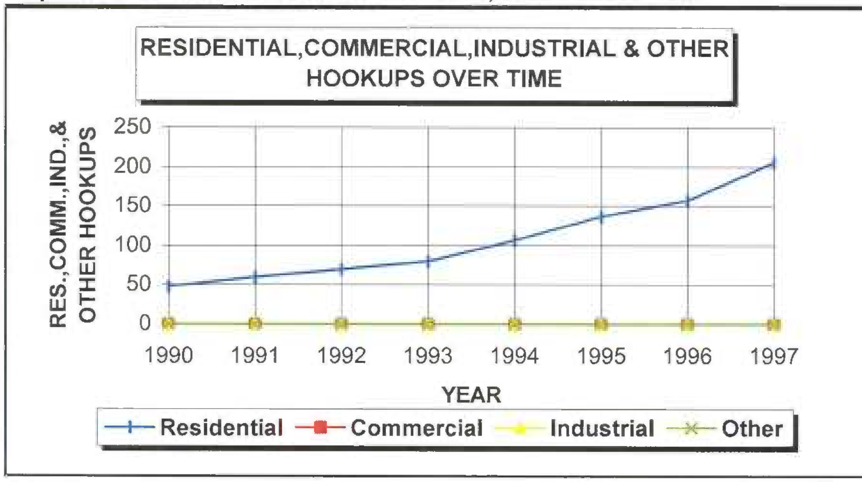
Abra Water Co.
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

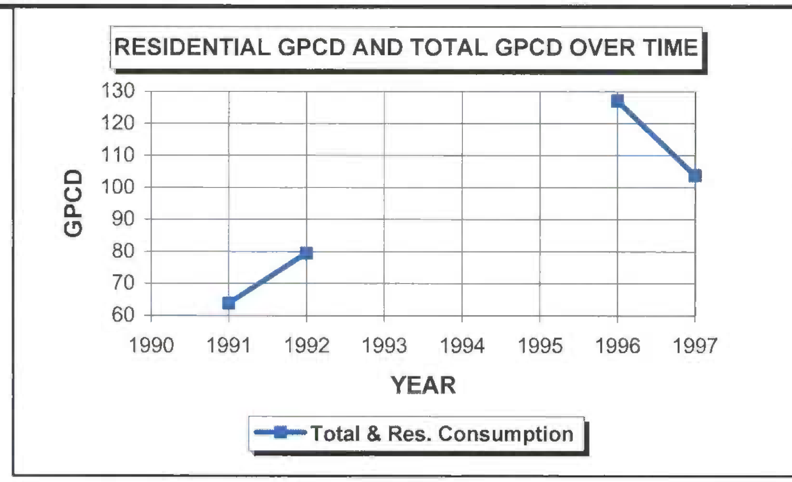
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	48	60	70	80	107	137	157	206
	Gallons delivered (millions)		3.2885	4.7773				17.1314	18.372
	Population	112.8	141	164.5	188	251.45	321.95	368.95	484.1
GPCD	Total & Res. Consumption		63.90	79.57				127.21	103.97
Commercial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Industrial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Totals	Hookups	48	60	70	80	107	137	157	206
	Gallons delivered (millions)		3.2885	4.7773				17.1314	18.3719

*GPCD = Total Consumption / local area population / 365 days

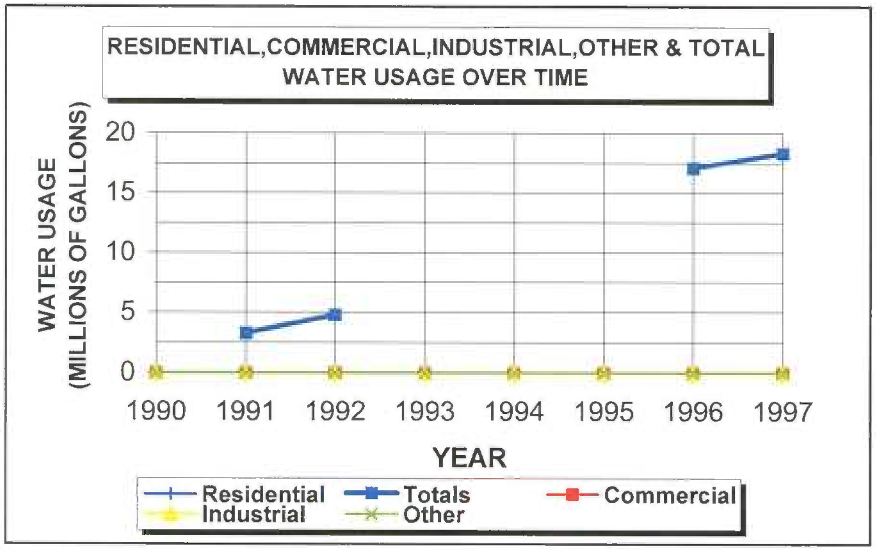
Population (Local area population)= Avg. persons per household x Residential hookups

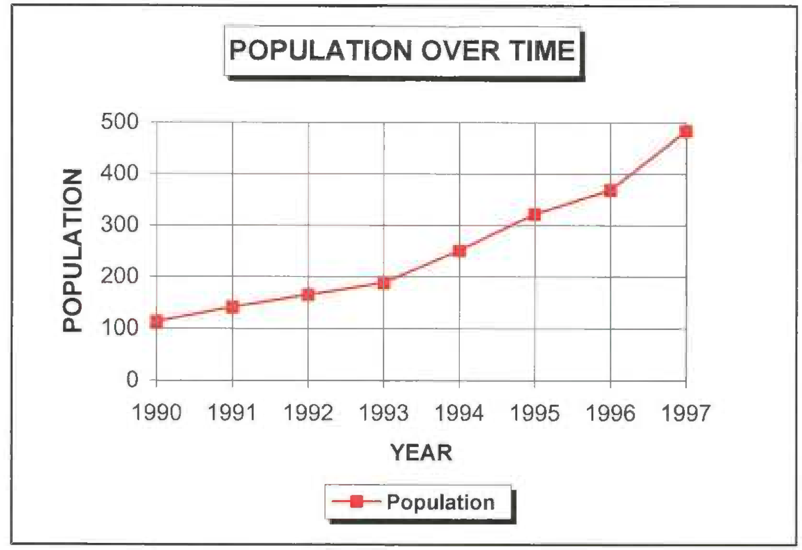
Population Statistics used for GPCD: ADES, 1990 Census Data





ABRA WATER COMPANY





Seasonal Water Delivery The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - Aug.	Sept.- Dec.
30%	45%	25%

ASH FORK WATER SERVICE

LOCATION

Ash Fork, Arizona
P.O. Box 436, Ash Fork, Az. 86320

CONTACT

Lewis Hume

HISTORY

Sometime during the late 1800s, the Atchison Topeka & Santa Fe Railroad hauled water in tank cars from Del Rio Springs to supply potable water to residents and workers in the area. This continued until the Dunbar Stone Company purchased what has become known as the Ash Fork Water Service and installed a well sometime in the early 1970s. The Dunbar Stone Company managed the distribution system until the citizens of Ash Fork formed a cooperative organization, Ash Fork Development Association, Inc., to develop and operate a community water system. The Ash Fork Water Service has been in operation since about 1973 and currently has 173 residential hookups that serve a population of more than 400, of which the majority are permanent residents. The water service has stated that they also supply the outlying areas of Ash Fork as well, consisting of approximately 1,000 people.

Responded to both the 1995 and 1998 surveys.

WATER SOURCES

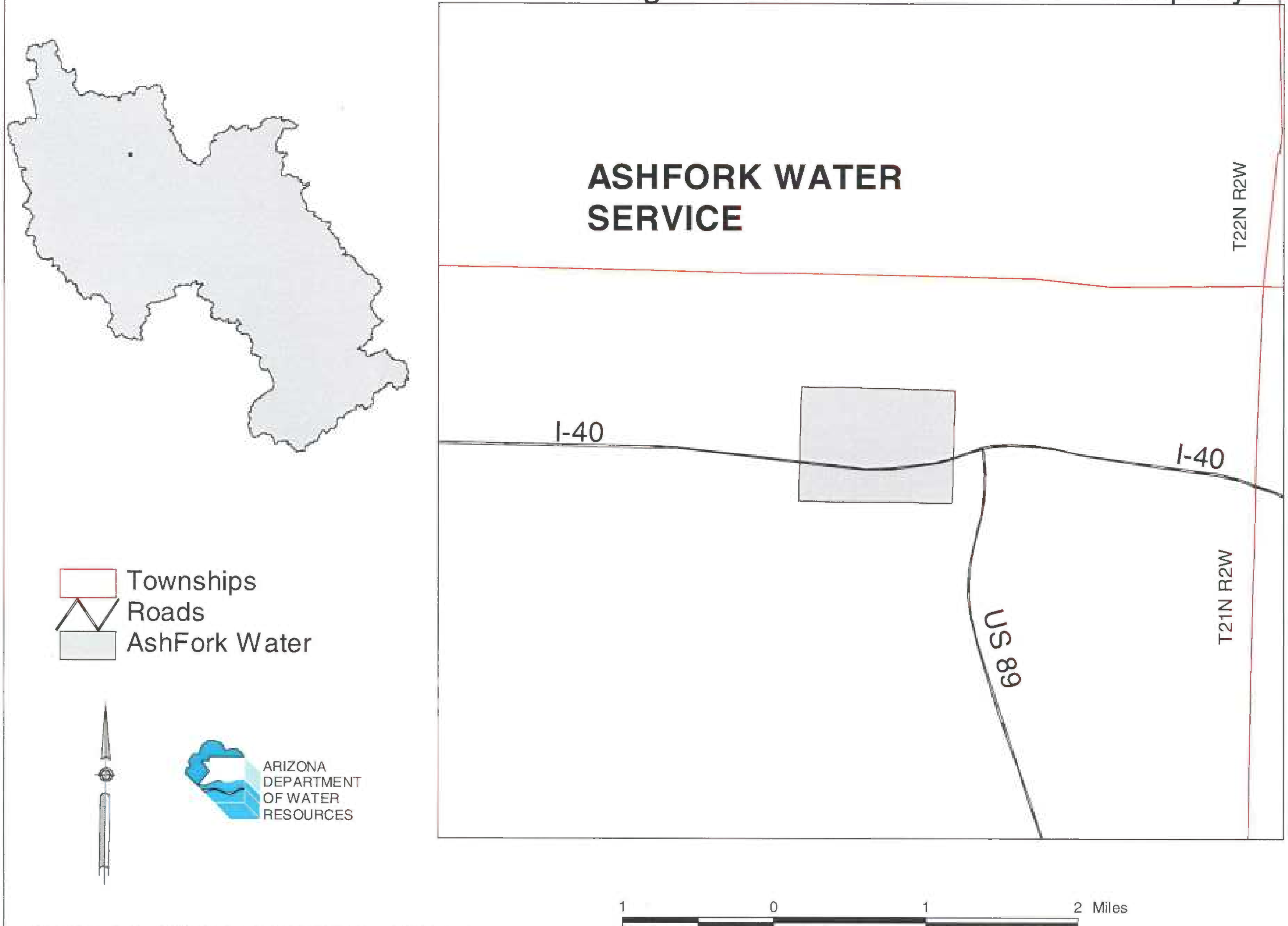
Ash Fork Water Service relies exclusively on groundwater for its source of water. The groundwater is generated from one well that is owned, operated, and metered by Ash Fork Water Service. Among the current 370 connections are residential, commercial, industrial, and other hookups. The water is used mostly for domestic purposes and the total storage capacity of the system is 1,000,000 gallons.

WATER PLANNING

Ash Fork Water Service does not perform water use planning and there is no emergency system in place. Water must be hauled from a nearby community in an emergency situation. The storage tanks hold seven days worth of water. The water service does have a verbal agreement with Ash Fork Development Association, Inc. and Atchison Topeka & Santa Fe Railroad on using water from the Johnson Canyon Steel Dam for fire protection, domestic, and irrigation purposes. During the 1989 water crisis, water was purchased from Aubrey Water Company. The amount of water purchased is unknown. The main impact from the 1996-1997 drought was felt mostly through cattlemen needing water for cattle. There have been some modifications to the system over the years including additional storage facilities and improving the main line.

The current charge for water depends on the size of the meter. It ranges from a low $11.00 per 1,000 gallons for a 5/8" x 3/4" meter to a high of $70.00 per 1,000 gallons for a 6" meter.

Figure A . 2 - AshFork Water Company



Source: Arizona Department of Water Resources

AshFork Water Service

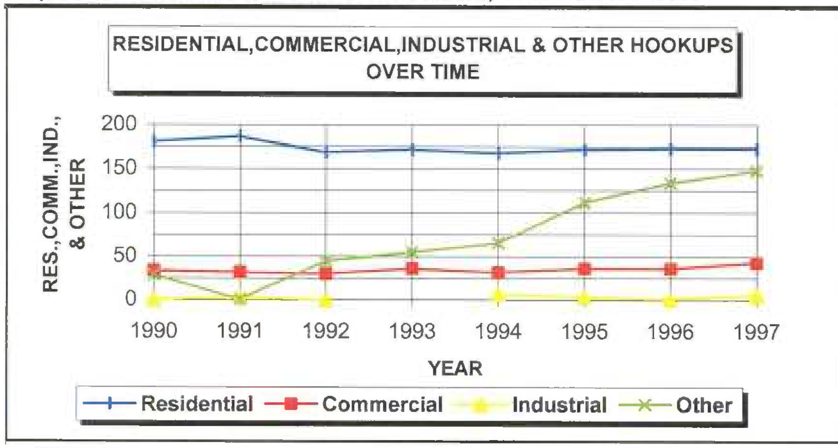
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

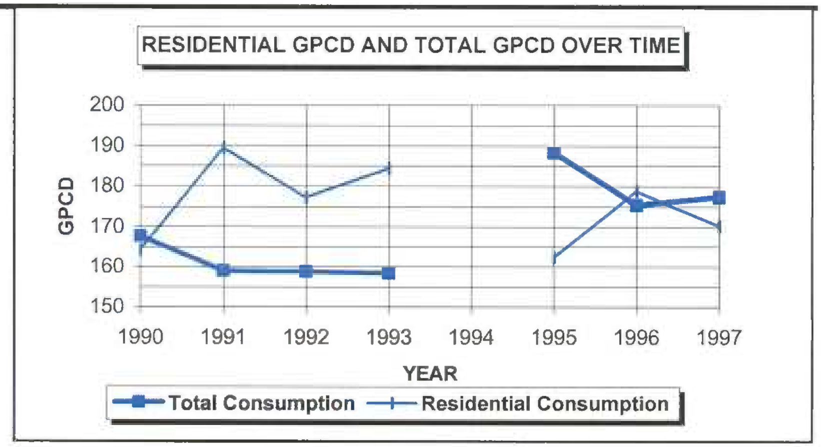
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	181	187	169	172	168	172	173	173
	Gallons delivered (millions)	10.075	11.015	10.289	10.679		11.182	11.46	11.044
	Population	425.35	439.45	397.15	404.2	394.8	404.2	406.55	406.55
GPCD*	Total Consumption	167.89	159.20	158.93	158.56		188.45	175.54	177.52
	Residential Consumption	164.41	189.56	177.36	184.52		162.57	178.86	170.44
Commercial	Hookups	34	32	30	36	32	36	36	43
	Gallons delivered (millions)	11.771	10.479	11.736	10.937		10.439	8.471	9.866
Industrial	Hookups	0	4	0		7	4	1	6
	Gallons delivered (millions)	0	1.175	0			1.102	1.429	1.01
Other	Hookups	29	1	45	55	66	112	134	148
	Gallons delivered (millions)	4.219	2.867	1.014	1.777		5.079	4.688	4.423
Totals	Hookups	244	224	244	263	273	324	344	370
	Gallons delivered (millions)	26.065	25.536	23.039	23.393		27.802	26.048	26.343

*GPCD =Total or Residential Consumption / local area population / 365 days

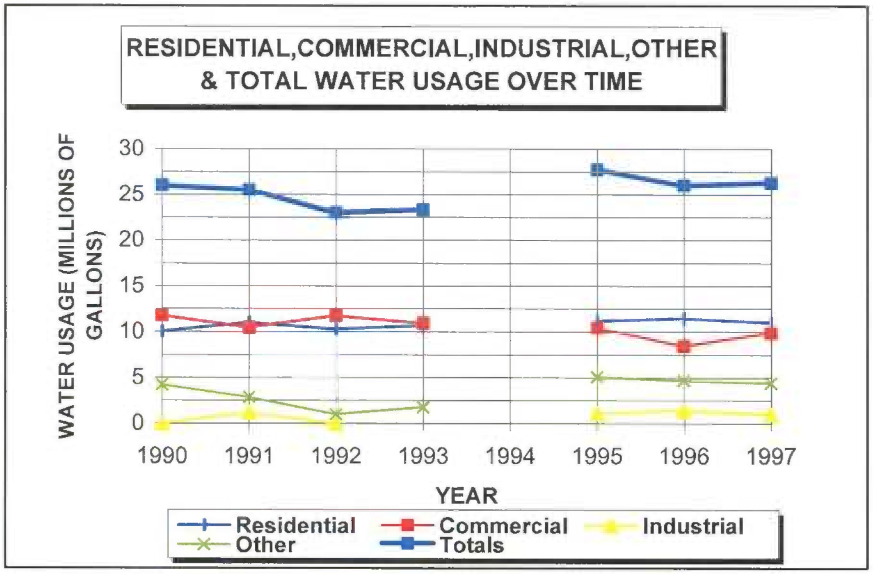
Population (local area pop.) = Avg.persons per household (2.35 Yav. Cnty.)xRes.hookups

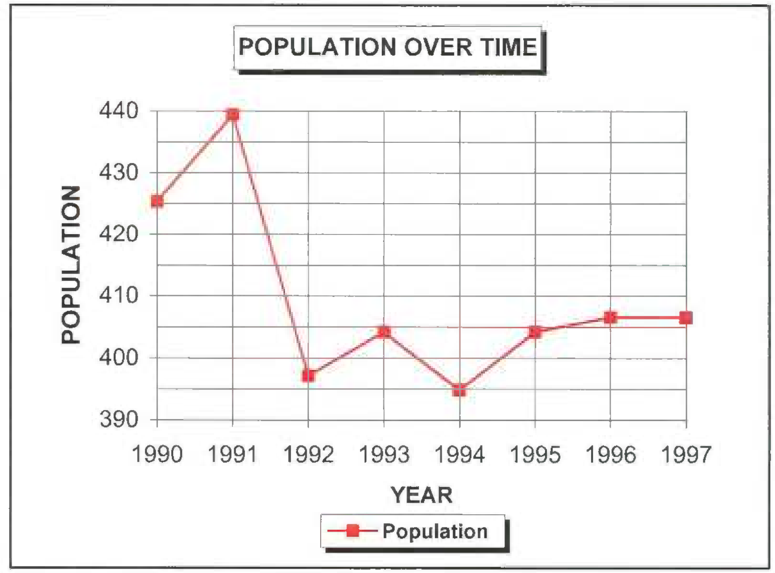
Population Statistics used for GPCD: ADES, 1990 Census Data





ASHFORK WATER SERVICE





Seasonal Water Delivery The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
28%	42%	30%

CHINO MEADOWS II WATER COMPANY, INC.

LOCATION

Chino Valley, Arizona
501 N. Highway 89, P.O. Box 350
Chino Valley, Az. 86323

CONTACT

Paul D. Levie (Owner)
Dewey J. Levie (Son)
Sharon Brevaire (Secretary)

HISTORY

Chino Meadows II Water Company, Inc. was formed and incorporated by the homeowners of Chino Meadows II in March 1979 and has been in continuous operation for 19 years. In 1987, both Paul D. Levie and G. E. Palmer purchased stock from the original shareholders and in May 1995, Mr. Levie acquired ownership of the company by purchasing 100 percent of the stock.

Responded to both the 1995 and 1998 surveys.

WATER SOURCES

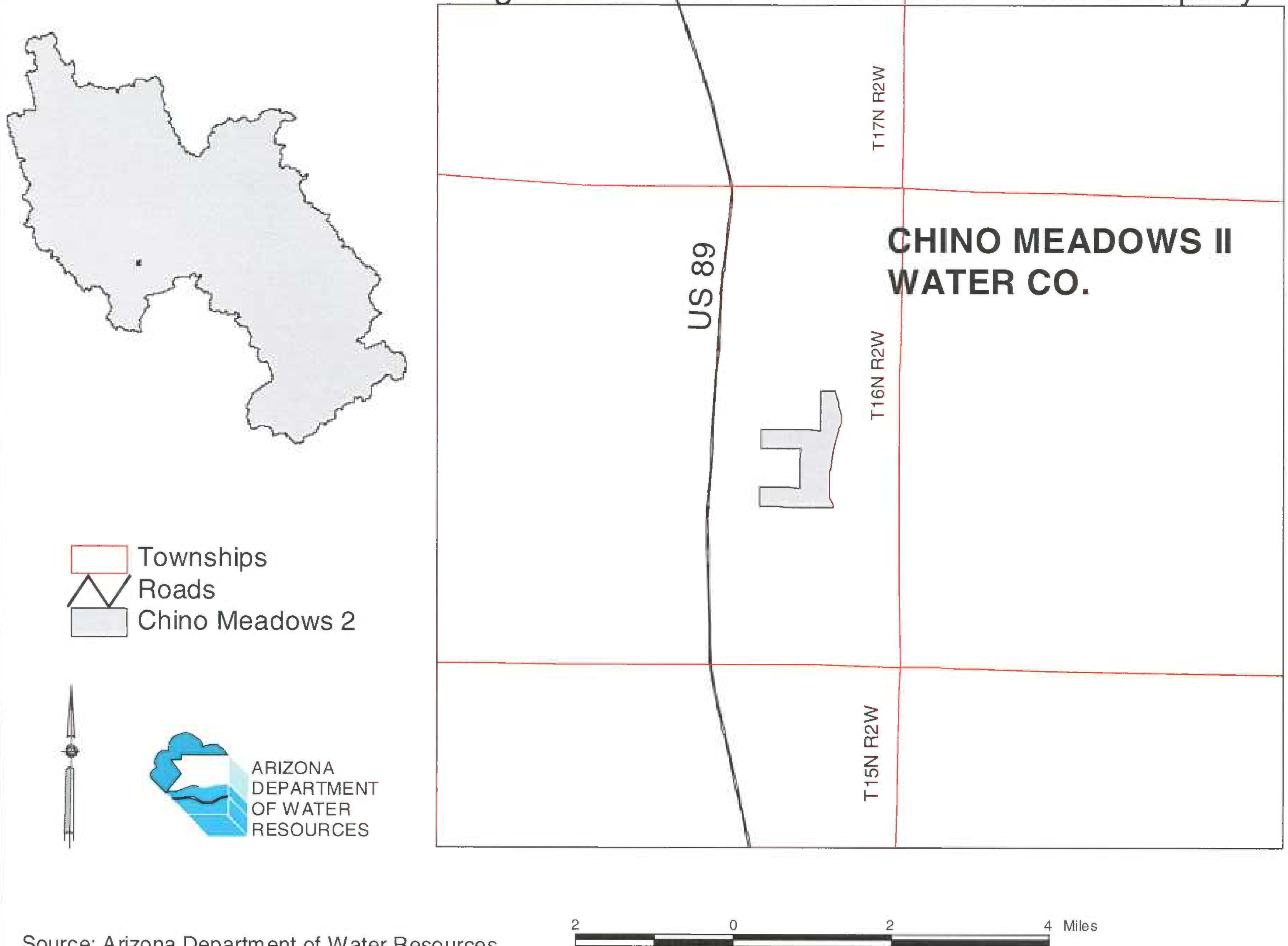
Chino Meadows II Water Company, Inc. depends entirely on groundwater for its water supply. The company owns, operates, and meters two wells that generate the groundwater for domestic use. Chino Meadows II currently serves an estimated population of more than 1,500 people, based on 583 permanent residential connections. The total storage capacity of the system is 97,000 gallons.

WATER PLANNING

Chino Meadows II Water Company does not perform water use planning nor does it have an emergency back-up plan. The company has expanded operations to meet the increasing demand of water in its service area by including all units of Chino Meadows II, III, IV, and V. This involves identifying and locating additional wells and storage facilities.

The current cost for water depends on the size of the meter and ranges from a low $18.75 per 1,000 gallons for a 5/8" x 3/4" meter to a high of $150.00 per 1,000 gallons for a 2" meter. There is also a commodity charge of $3.12 per 1,000 gallons exceeding the initial 1,000 gallons.

Figure A . 3 - Chino Meadows II Water Company



Source: Arizona Department of Water Resources

Chino Meadows II Water Co., Inc.

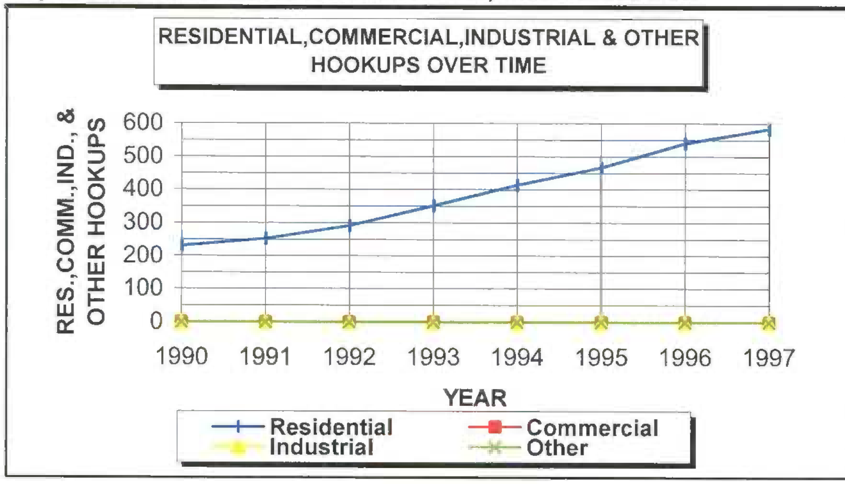
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

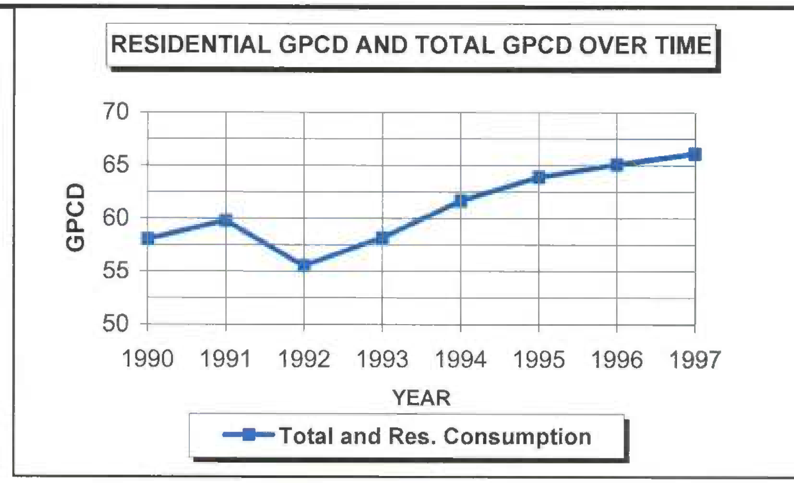
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	230	252	291	351	413	466	541	583
	Gallons delivered (millions)	12.625	14.24625	15.27634	19.31134	24.07473	28.13723	33.28274	36.433
	Population	595.7	652.68	753.69	909.09	1069.67	1206.94	1401.19	1509.97
GPCD*	Total and Res. Consumption	58.06	59.80	55.53	58.20	61.66	63.87	65.08	66.10
Commercial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Industrial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Totals	Hookups	230	252	291	351	413	466	541	583
	Gallons delivered (millions)	12.6250	14.2463	15.2763	19.3113	24.0747	28.1372	33.2827	36.433

*GPCD = Total or Residential Consumption / local area population / 365 days

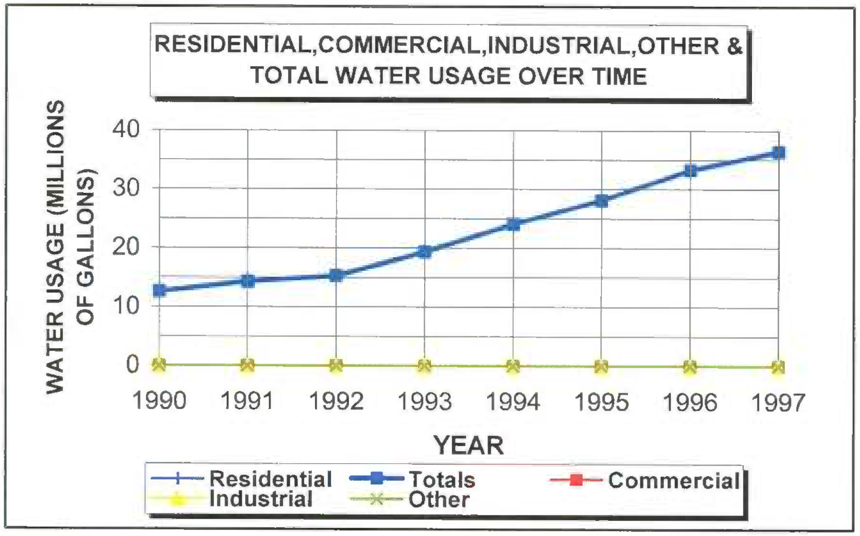
Population (Local area population)= Avg. persons per household x Residential hookups

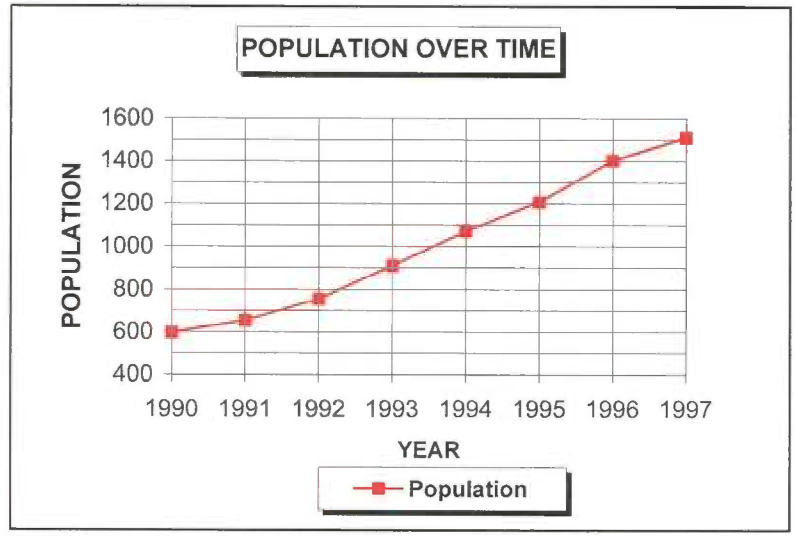
Population Statistics used for GPCD: ADES, 1990 Census Data





CHINO MEADOWS II WATER CO.





Seasonal Water Delivery The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
29%	38%	33%

GRANITE OAKS WATER USERS ASSOCIATION

LOCATION

Prescott, Arizona
2132 Stringfield Drive, Prescott, Az. 86301

CONTACT

Kimble McClymonds (Operator)

HISTORY

Granite Oaks Water Users Association was formed in 1989 and retained its first customer in July of that year. It was established by Swayze McCraine as a community co-op to service the residents of both Granite Oaks and Royal Oaks Subdivisions. The association was also established to supply water for a contracting firm building roads within these subdivisions. The company currently has 324 permanent residential connections that serve a population estimated to be more than 800.

Responded to both the 1995 and 1998 surveys.

WATER SOURCES

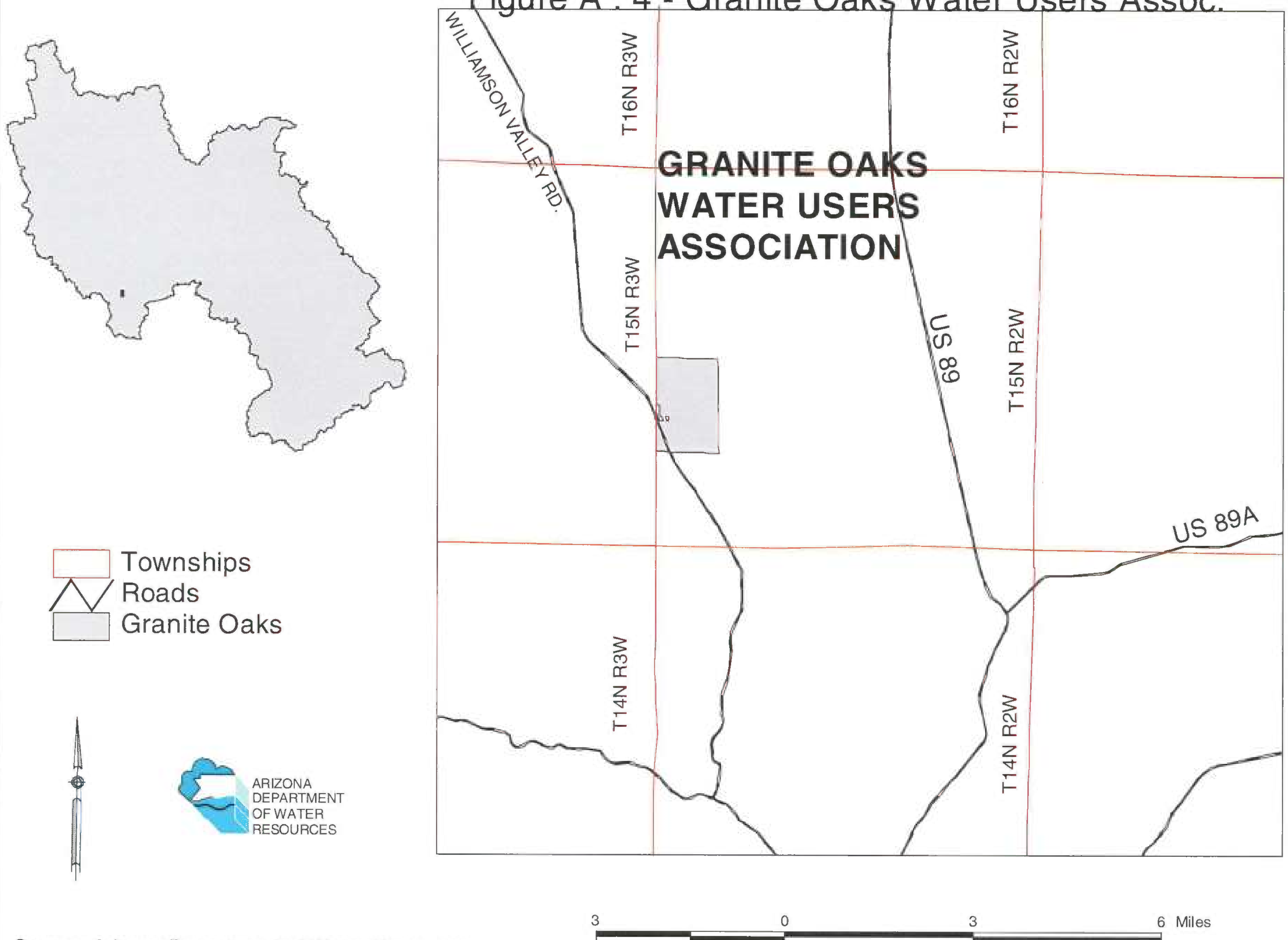
Granite Oaks Water Users Association relies exclusively on groundwater for its source of water. The groundwater is generated by two wells that are owned, operated, and metered by Granite Oaks. The total storage capacity of the system is 210,000 gallons.

WATER PLANNING

Granite Oaks Water Users Association does not perform water use planning nor was it impacted by the 1996-1997 drought. There is an emergency back-up plan that relies on sources within the system to provide water. There is no agreement with another company to provide water in an emergency situation.

The current charge for water is $20.00 for the initial 1,000 gallons and $2.00 per 1,000 gallons thereafter.

Figure A . 4 - Granite Oaks Water Users Assoc.



Source: Arizona Department of Water Resources

Granite Oaks Water Users Assoc.

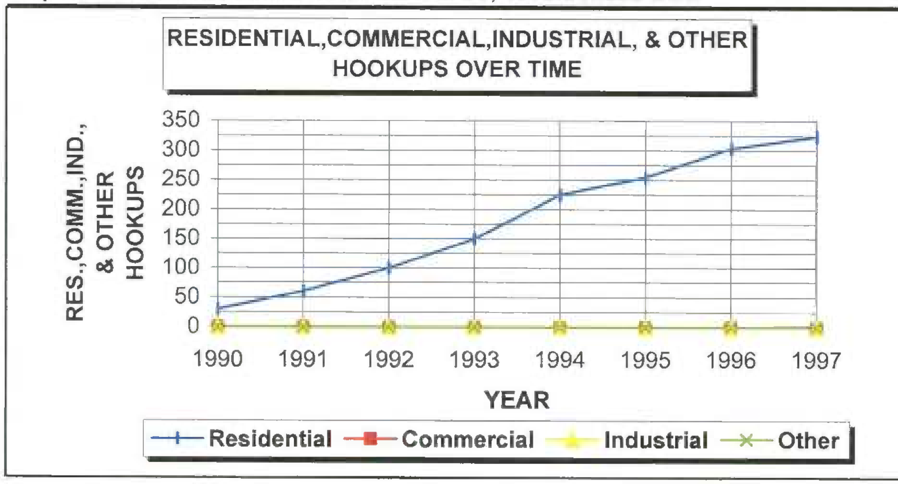
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

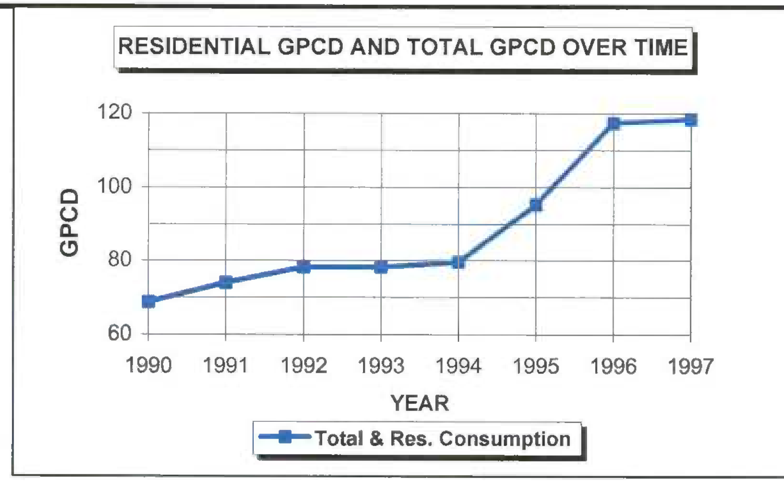
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	30	60	100	150	225	255	304	324
	Gallons delivered (millions)	1.95	4.2	7.4	11.1	16.928	23.001822	33.758163	36.3
	Population	77.7	155.4	259	388.5	582.75	660.45	787.36	839.16
GPCD*	Total & Res. Consumption	68.76	74.05	78.28	78.28	79.58	95.42	117.47	118.51
Commercial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Industrial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Totals	Hookups	30	60	100	150	225	255	304	324
	Gallons delivered (millions)	1.950	4.20	7.40	11.10	16.928	23.002	33.758	36.30

*GPCD = Total or Residential Consumption / local area population / 365 days

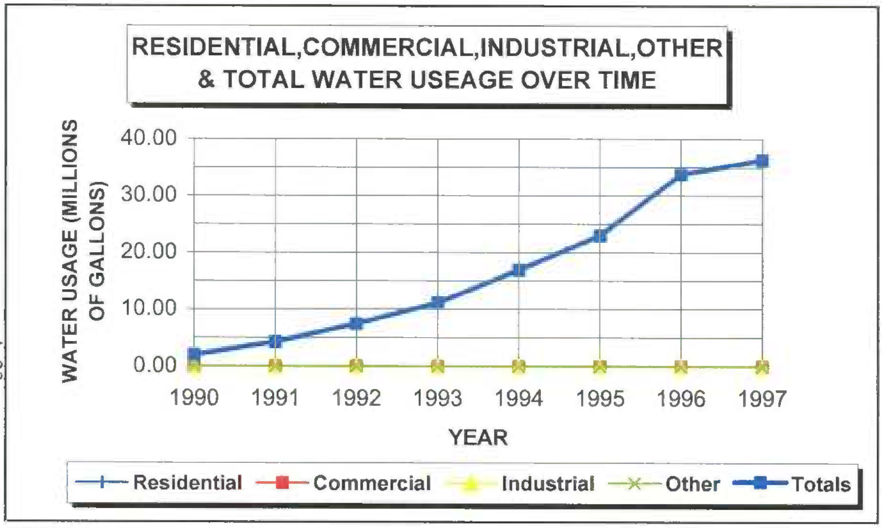
Population (Local area population) = Avg. persons per household x Residential hookups

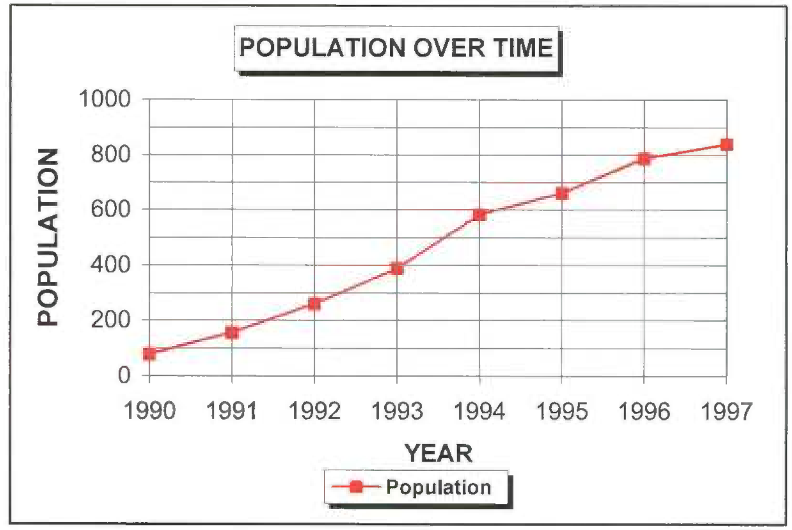
Population Statistics used for GPCD: ADES, 1990 Census Data





GRANITE OAKS WATER USERS ASSOC.





Seasonal Water Delivery The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
22%	50%	28%

CITY OF PRESCOTT

LOCATION

Prescott, Arizona
P.O. Box 2059, Prescott, Az. 86302

CONTACT

Brad Huza (Environ. Services Dir.)
Anessa Grippe (Admin. Assistant)

HISTORY

The City of Prescott water division has been in operation for approximately 100 years; although the actual date is not known. The City of Prescott has residential, commercial, industrial, and other connections that include government, construction, and turf facilities. The majority of these hookups are residential.

Responded to the 1998 survey.

WATER SOURCES

The City of Prescott is dependent on groundwater for nearly all of its water supply while some effluent is used for both agriculture and golf course irrigation. The groundwater is generated by five production wells that are owned, operated, metered, and maintained by the City of Prescott, with a total storage capacity of 22,500,000 gallons.

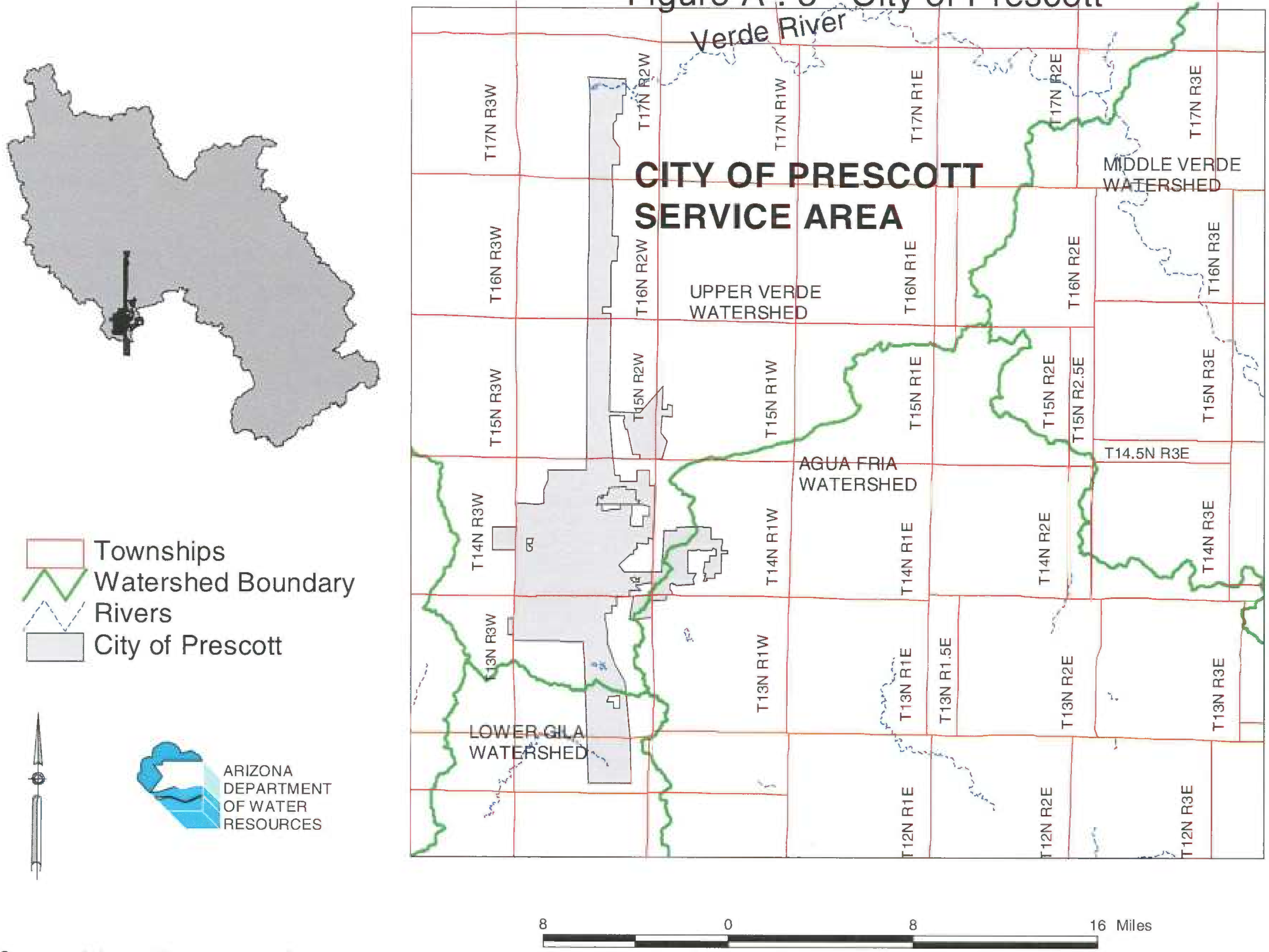
Within the last six months (summer 1998), the City of Prescott purchased both Watson and Willow Lakes from the Chino Valley Irrigation District (CVID). CVID created the lakes and used them to supply water for shareholders' crops. The data in the City of Prescott table does not reflect this information since it is up to the year 1997.

WATER PLANNING

The City of Prescott does not perform water use planning nor was it impacted from the 1996-1997 drought. They have not developed a plan to minimize impacts from future droughts.

The current charge for water is a minimum $5.98 per month plus an additional charge depending on how much water is used. These rates are from the city code and restricted to inside the city limits. The rates have been in effect since September 1, 1995. There are various additional charges for residential and commercial uses. The City of Prescott also charges additional fees for alternative water sources, such as CAP water, ranging from $0.10 for the first 3,000 gallons up to $0.16 for anything over 10,000 gallons. These fees are charged for every 1,000 gallons.

Figure A . 5 - City of Prescott



Source: Arizona Department of Water Resources

City Of Prescott

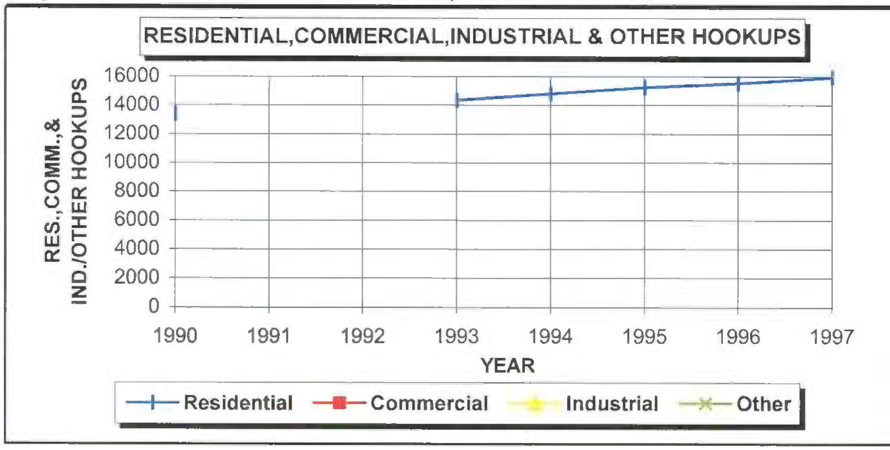
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

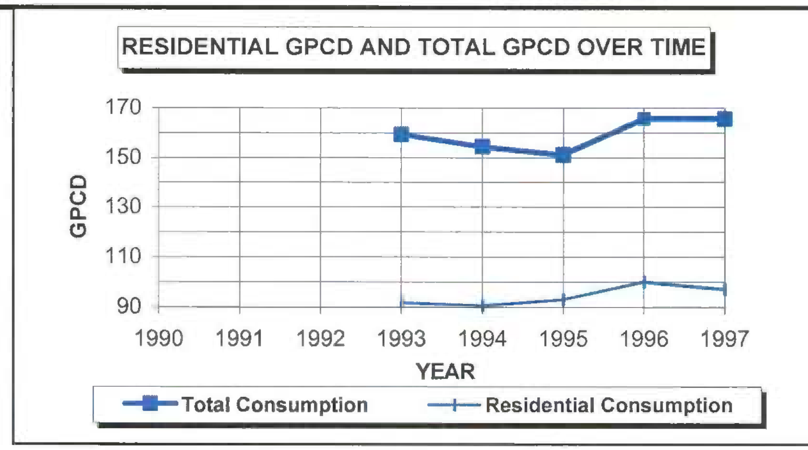
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	13393			14334	14802	15248	15542	15931
	Gallons delivered			967549374	1058787654	1077100480	1140120063	1250094776	1244783405
	Population	29464.6			31534.8	32564.4	33545.6	34192.4	35048.2
GPCD*	Total Consumption				159.47	154.56	151.29	165.84	165.79
	Residential Consumption				91.99	90.62	93.12	100.17	97.31
Commercial	Hookups								
	Gallons delivered			249862546	250840099	272900212	202157960	213041383	283979146
Industrial	Hookups								
	Gallons delivered			21962357	25416378	22418548	14174518	15673433	17758879
Other	Hookups								
	Gallons delivered			414319545.7	500507136	464630940	495977806	590963373	574344972
Totals	Hookups	13393	N/A	N/A	14334	14802	15248	15542	15931
	Gallons delivered			1.654.E+09	1.836.E+09	1.837.E+09	1.852.E+09	2.070.E+09	2.121.E+09

*GPCD = Total or Residential Consumption / local area population / 365 days

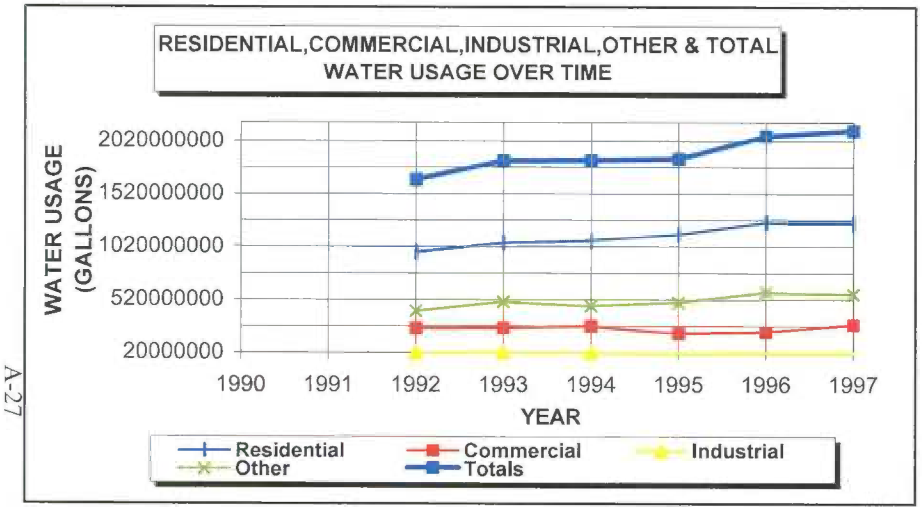
Population (Local area population) = Avg. persons per household x Residential hookups

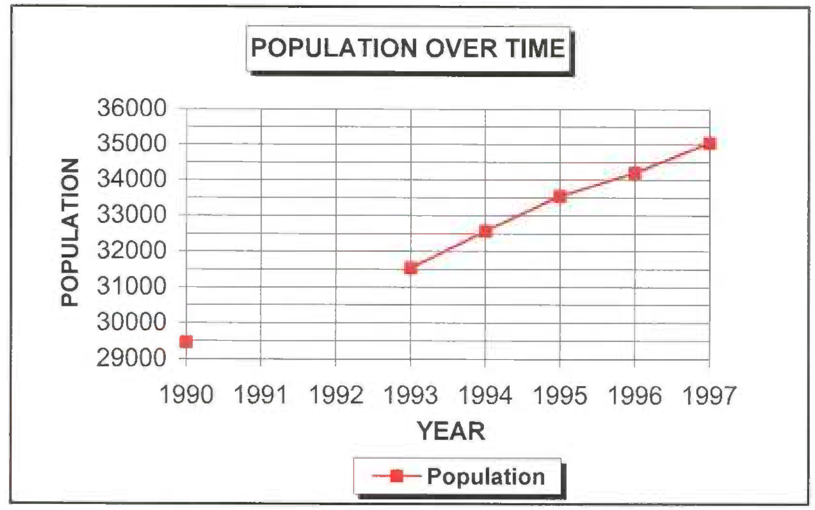
Population Stats. used for GPCD: ADES, 1990 Census Data





CITY OF PRESCOTT





Seasonal Water Delivery: The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
26%	45%	29%

ARIZONA WATER COMPANY
PINEWOOD

LOCATION

Munds Park area near Flagstaff, Arizona
P.O. Box 29006, Phoenix, Az. 85038

CONTACT

William Garfield
Ray Miller (Manager)

HISTORY

Pinewood System, owned by the Arizona Water Company, is one of the many water systems currently in operation throughout Arizona. The Arizona Water Company was established and has been in operation since April 1, 1955. Pinewood System started its operations around the same time and was developed for the purpose of supplying domestic water to the residents of the Munds Park area. Pinewood System currently claims more than 2,700 hookups, that include residential, commercial, and other connections. The majority of the residents are seasonal.

Responded to the 1998 survey.

WATER SOURCES

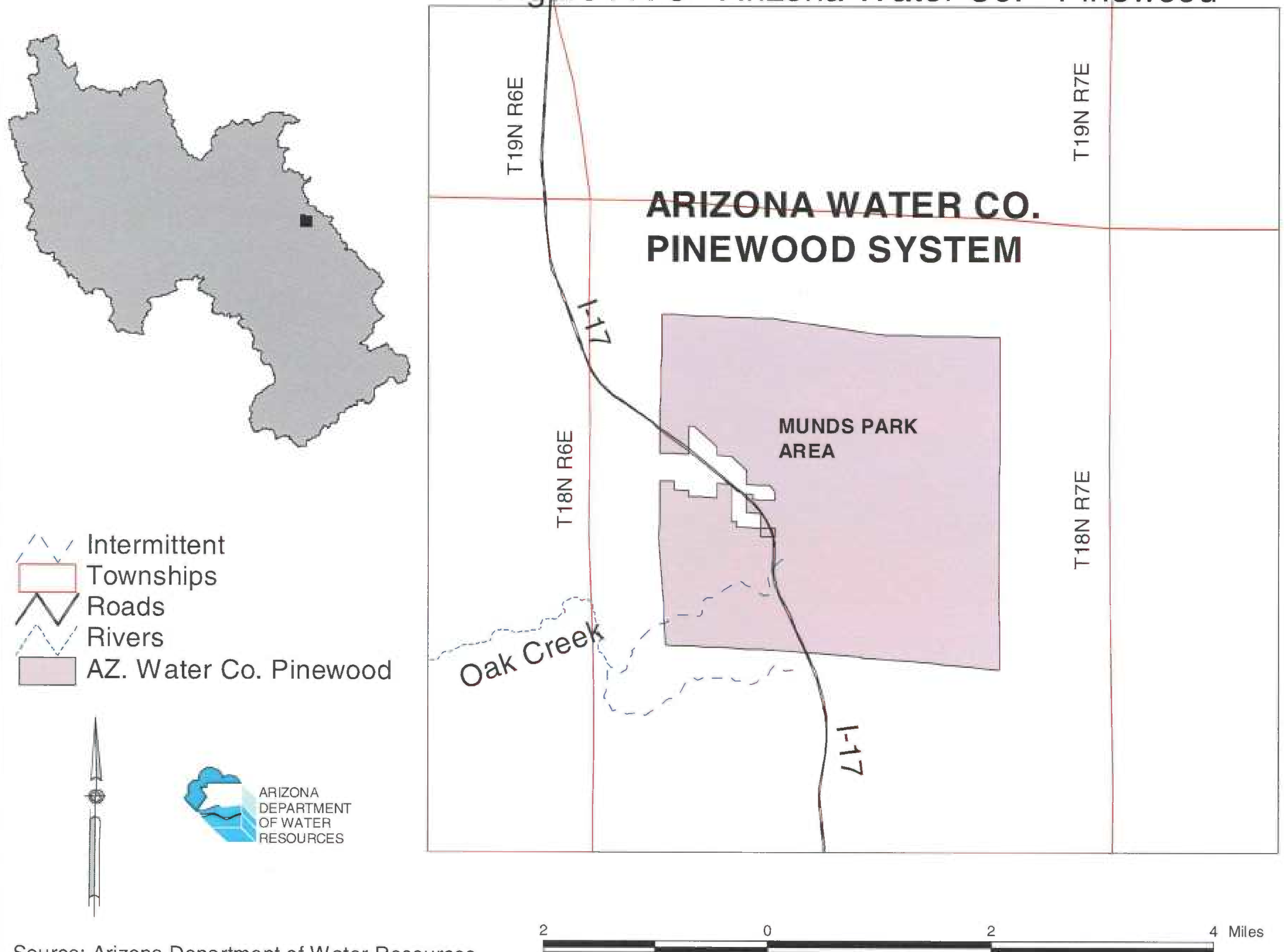
Pinewood System is entirely dependent on groundwater for its source of water. Groundwater is generated by two wells that are owned, operated, and metered by Pinewood System. The total storage capacity of the system is 1,240,000 gallons.

WATER PLANNING

Pinewood System does perform water use planning and is confined to identifying and locating new sources of water including one new well budgeted for 1998. It is not known if there is a back-up system or supply in case of a water shortage. There was little or no impact felt from the 1996-1997 drought in which stable consumption in the resort area was maintained.

The current charge for water depends on the size of the meter and ranges from a low $16.21 per 1,000 gallons or less for a 5/8" x 3/4" meter to a high of $673.27 per 1,000 gallons or less for a 10" meter. The Arizona Water Company also charges a commodity rate of $0.3967 for every 100 gallons of water used over the initial 1,000 gallons. No GPCD was developed for Pinewood System because the population in this area is mostly seasonal.

Figure A . 6 - Arizona Water Co. - Pinewood



Source: Arizona Department of Water Resources

Az.Water Company — Pinewood Water System

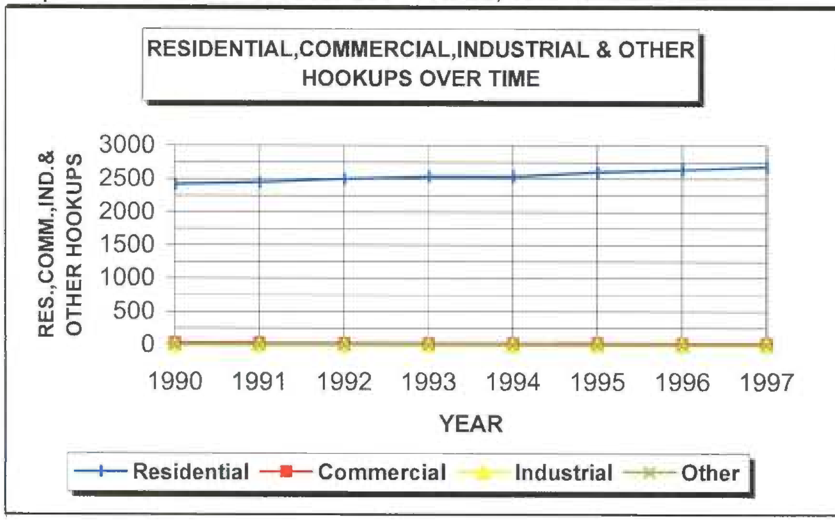
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

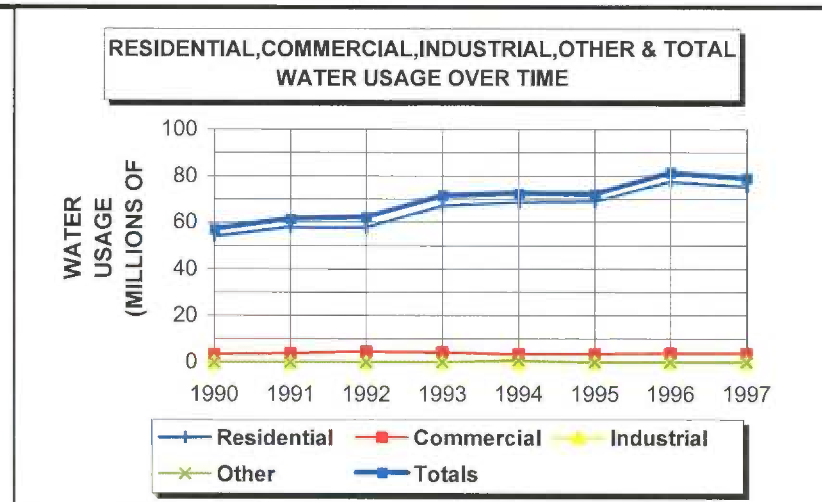
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	2418	2447	2506	2538	2541	2602	2643	2686
	Gallons delivered (millions)	53.9547	57.9872	57.7465	67.3202	68.6988	69.0476	77.679	75.5063
	Population	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GPCD*	Total Consumption	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Residential Consumption	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Commercial	Hookups	26	25	23	23	23	24	21	21
	Gallons delivered (millions)	3.3698	3.6502	4.5725	4.2771	3.3034	3.4602	3.7992	3.6929
Industrial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	1	0	3	0	0	0	0	2
	Gallons delivered (millions)	0.0072	0.000	0.1209	0.000	0.7781	0.0397	0.0371	0.0747
Totals	Hookups	2445	2472	2532	2561	2564	2626	2664	2709
	Gallons delivered (millions)	57.3317	61.6374	62.4399	71.5973	72.7803	72.5475	81.5153	79.2739

*GPCD = Total or Residential Consumption / local area population / 365 days

Population (Local area population) = Avg. persons per household x Res. hookups

Population Statistics used for GPCD: ADES, 1990 Census Data





ARIZONA WATER CO.-PINEWOOD

Due to insufficient data, both GPCD and population over time graphs are not presented here.

Seasonal Water Delivery: The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
23%	54%	23%

ARIZONA WATER COMPANY
RIMROCK

LOCATION

Rimrock, Arizona, on Wet Beaver Creek
P.O. Box 29006, Phoenix, Az. 85038

CONTACT

William Garfield
Ray Miller (Manager)

HISTORY

Rimrock System is one of the many water systems currently owned and operated by the Arizona Water Company. The Arizona Water Company was established and has been in operation since April 1, 1955. Rimrock System started operations around the same time the subdivisions were built for the purpose of supplying domestic water to the residents of Lake Montezuma. Currently, Rimrock System claims over 950 hookups that include residential, commercial, and other connections. The majority of the connections are permanent and the water provided is for residential use.

Responded to the 1998 survey.

WATER SOURCES

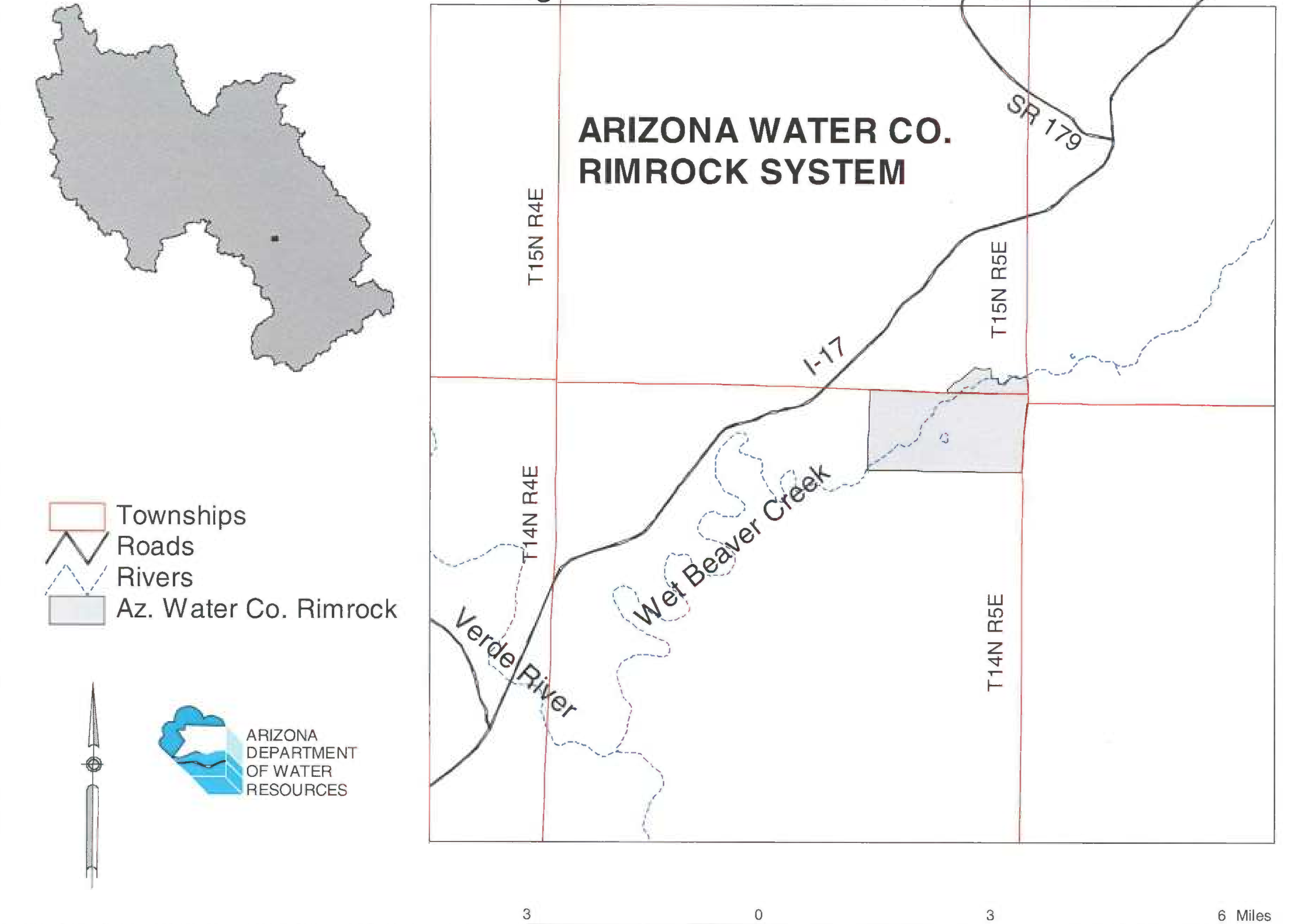
Rimrock System relies entirely on groundwater for its source of water. Groundwater is generated by six wells that are owned, operated, and metered by Rimrock System. The total storage capacity of the system is 460,000 gallons.

WATER PLANNING

Rimrock System does perform water use planning, however, it is not known if there is an emergency back-up plan for this system. There was no impact felt from the 1996-1997 drought and no plan has been developed to deal with future droughts.

The current charge for water is dependent on meter size. For example, a low $13.21 per 1,000 gallons or less is charged for a 5/8" x 3/4" meter to a high of $673.27 per 1,000 gallons or less for a 10" meter. There is also a commodity charge of $0.2382 per 100 gallons of water used over the initial 1,000 gallons.

Figure A . 7 - Arizona Water Co. - Rimrock



Source: Arizona Department of Water Resources

Az.Water Company Rimrock Water System

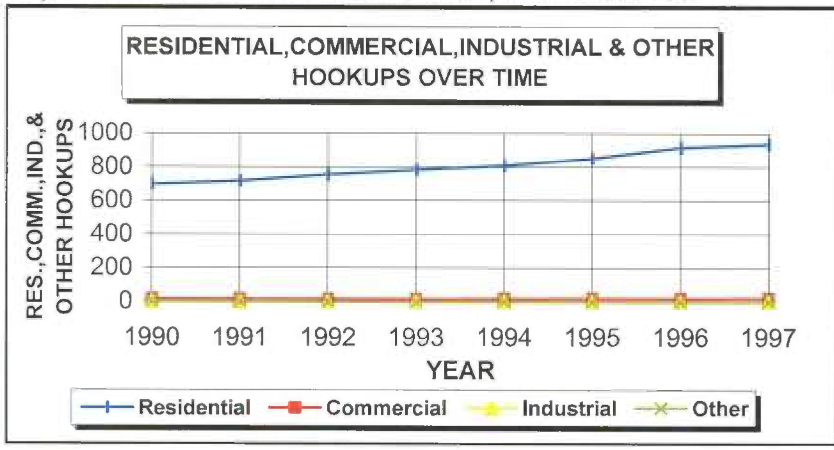
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

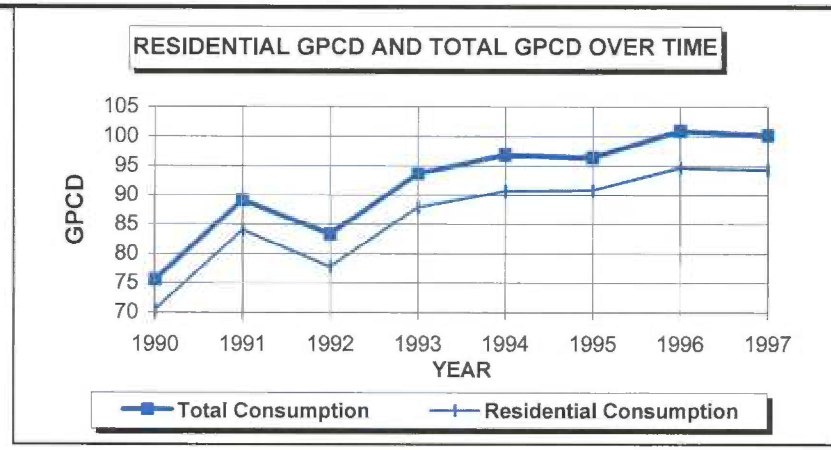
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	699	718	756	784	809	853	916	936
	Gallons delivered (millions)	39.9295	48.9275	47.6991	55.8854	59.4279	62.7738	70.3301	71.5973
	Population	1551.78	1593.96	1678.32	1740.48	1795.98	1893.66	2033.52	2077.92
GPCD*	Total Consumption	75.64	89.20	83.39	93.70	96.91	96.46	100.97	100.24
	Residential Consumption	70.50	84.10	77.87	87.97	90.66	90.82	94.75	94.40
Commercial	Hookups	15	15	15	15	17	18	19	20
	Gallons delivered (millions)	2.8836	2.7114	2.928	3.6387	4.0126	3.3847	3.315	3.0534
Industrial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	1	1	1	0	1	1	1	1
	Gallons delivered (millions)	0.0280	0.2568	0.4576	0	0.0889	0.5123	1.3002	1.3767
Totals	Hookups	715	734	772	799	827	872	936	957
	Gallons delivered (millions)	42.8411	51.8957	51.0847	59.5241	63.5294	66.6708	74.9453	76.0274

*GPCD = Total or Residential Consumption / local area population / 365 days

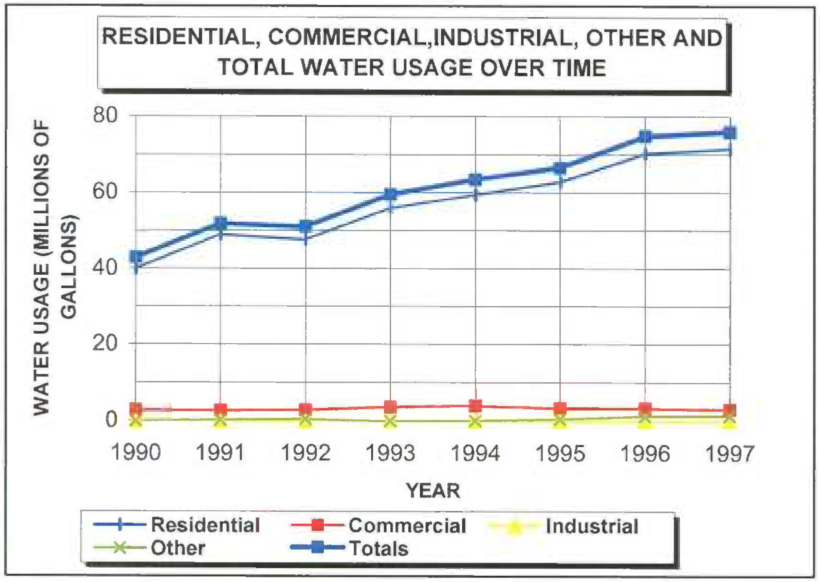
Population (Local area population) = Avg. persons per household x Residential hookups

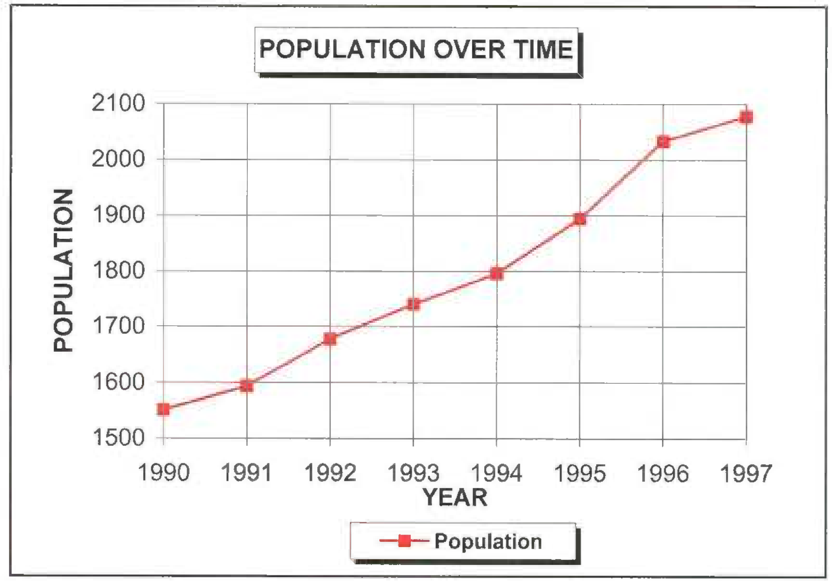
Population Statistics used for GPCD: ADES, 1990 Census Data





ARIZONA WATER COMPANY - RIMROCK





Seasonal Water Delivery: The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
27%	45%	28%

ARIZONA WATER COMPANY
SEDONA

LOCATION

Sedona, Arizona
P.O. Box 29006, Phoenix, Az. 85038

CONTACT

William Garfield
Ray Miller (Manager)

The Oak Creek area is included in this report in the Sedona System of the Arizona Water Company.

HISTORY

Sedona System is one of many water systems currently owned and operated by the Arizona Water Company. The Arizona Water Company was established and has been in operation since April 1, 1955. Sedona System came into operation around the same time and was developed for the purpose of supplying domestic water to the residents of Sedona. Sedona System is divided into two systems and currently claims more than 5,000 hookups. Both systems supply potable water for residential, commercial, industrial, and other uses. The current population estimated to be served by Sedona System is 9,100 people and the majority of water currently served by this system is for residential use.

Responded to the 1998 survey.

WATER SOURCES

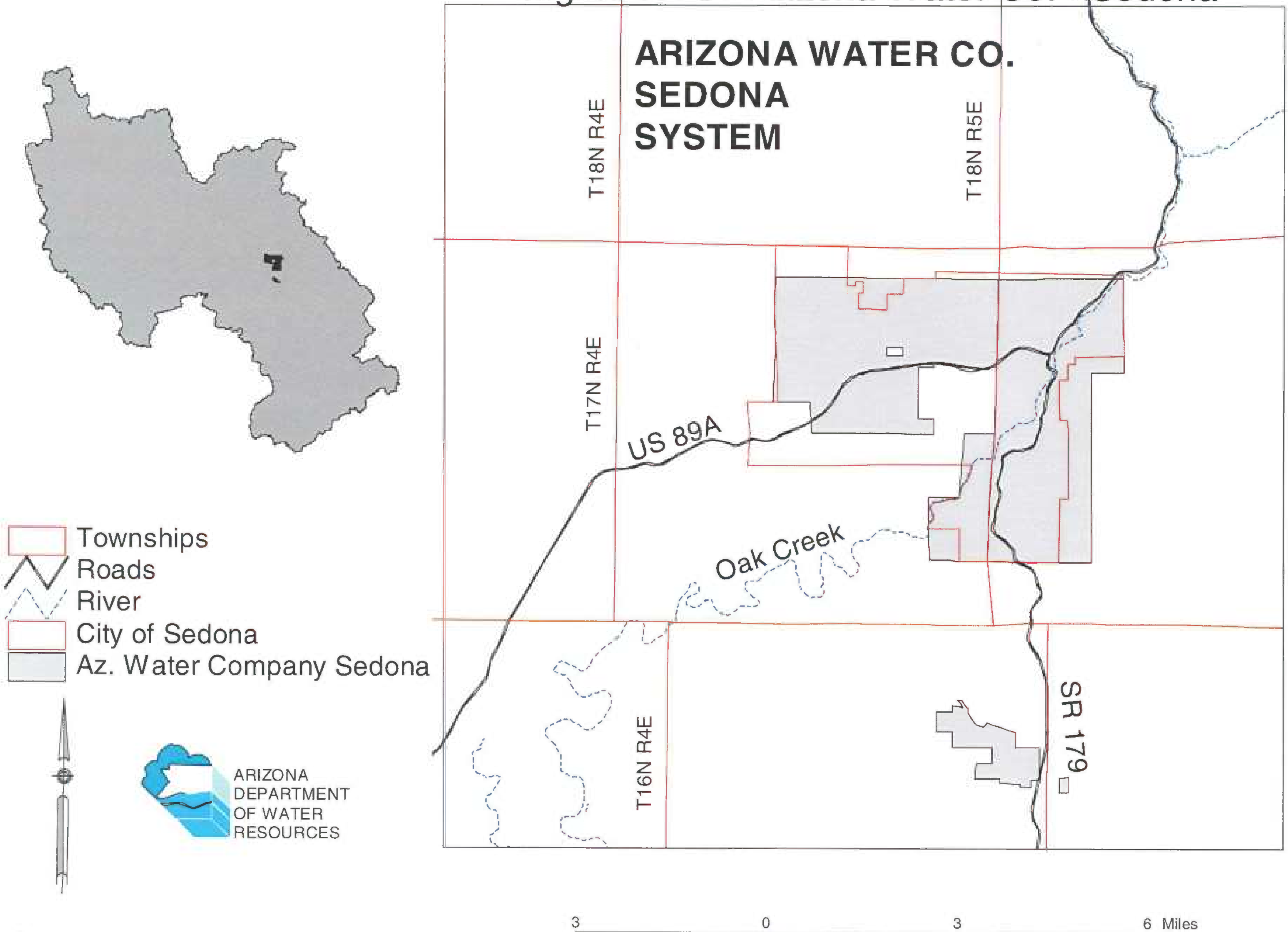
Sedona System relies exclusively on groundwater for its source of water. The water supply is generated by 11 wells; seven in Sedona and four in the Oak Creek area and has a total storage capacity of 3,470,500 gallons. Sedona System owns, operates, and meters all wells and storage facilities.

WATER PLANNING

Sedona System performs water use planning and has negotiated agreements with Oak Creek Water Company and Big Park Water Company to purchase water during times of serious water shortages. Both the Arizona Department of Transportation and the U.S. Forest Service have purchased water from the company. The company's planning efforts have been affected by increased population of the area and, thus, its ability to meet the growing demand for water in its service area. As a result, the Arizona Water Company is currently identifying and developing new and additional water supplies for the Sedona System to meet the increasing demands. Sedona System has experienced more of an impact from the recent customer growth than from the 1996-1997 drought.

The current cost of water depends on the size of the meter and ranges from a low $13.47 per 1,000 gallons for a 5/8" x 3/4" meter to a high of $673.27 per 1,000 gallons for a 5/8" x 10" meter. The Arizona Water Company also charges a commodity rate of $0.1447 for every 100 gallons of water used over the initial 1,000 gallons.

Figure A . 8 - Arizona Water Co. - Sedona



Source: Arizona Department of Water Resources

Az.Water Company   Sedona Water System

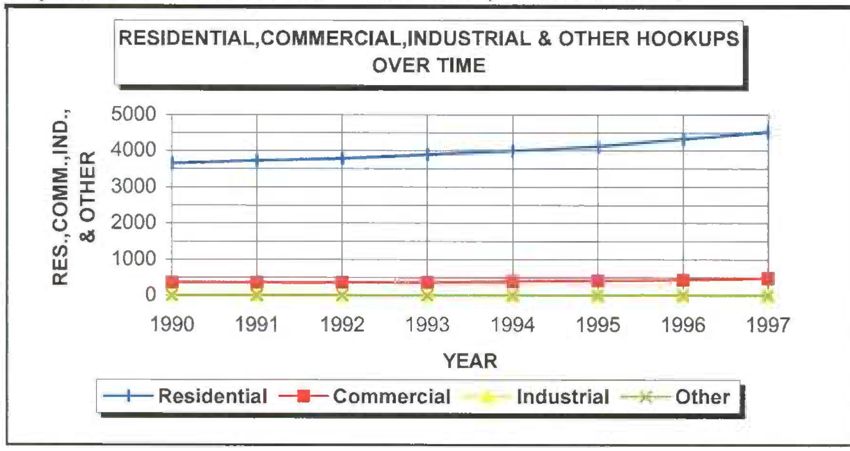
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

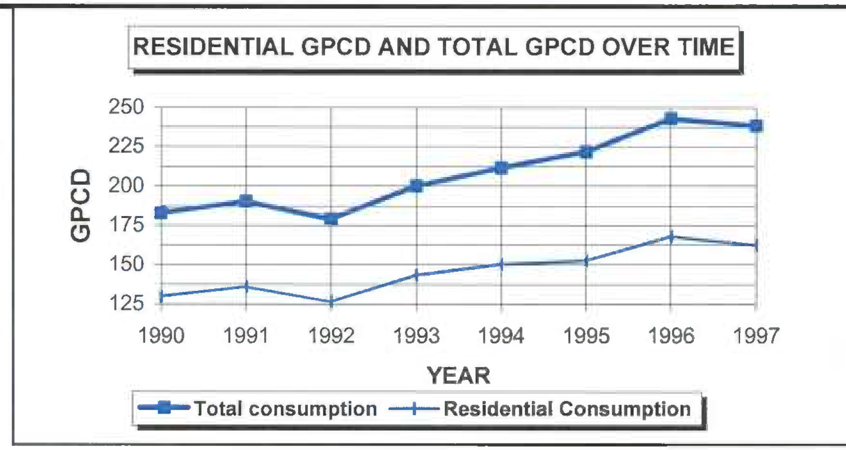
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	3653	3732	3794	3889	3997	4125	4325	4522
	Gallons delivered (millions)	350.3777	374.7984	354.3422	411.6292	443.2101	464.6385	537.2289	543.5172
	Population	7379.06	7538.64	7663.88	7855.78	8073.94	8332.5	8736.5	9134.44
GPCD*	Total consumption	183.18	190.46	179.30	200.38	211.68	221.80	243.13	238.69
	Residential Consumption	130.09	136.21	126.67	143.56	150.39	152.77	168.47	163.02
Commercial	Hookups	354	360	359	362	383	408	438	475
	Gallons delivered (millions)	136.2481	144.7043	141.4402	156.5641	165.4042	206.5585	226.7017	241.3096
Industrial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	4	5	9	4	12	7	15	9
	Gallons delivered (millions)	6.7386	4.5614	5.7689	6.3726	15.1923	3.3761	11.369	10.9857
Totals	Hookups	4011	4097	4162	4255	4392	4540	4778	5006
	Gallons delivered (millions)	493.3644	524.0641	501.5513	574.5659	623.8066	674.5731	775.2996	795.8125

*GPCD = Total or Residential Consumption / local area population / 365 days

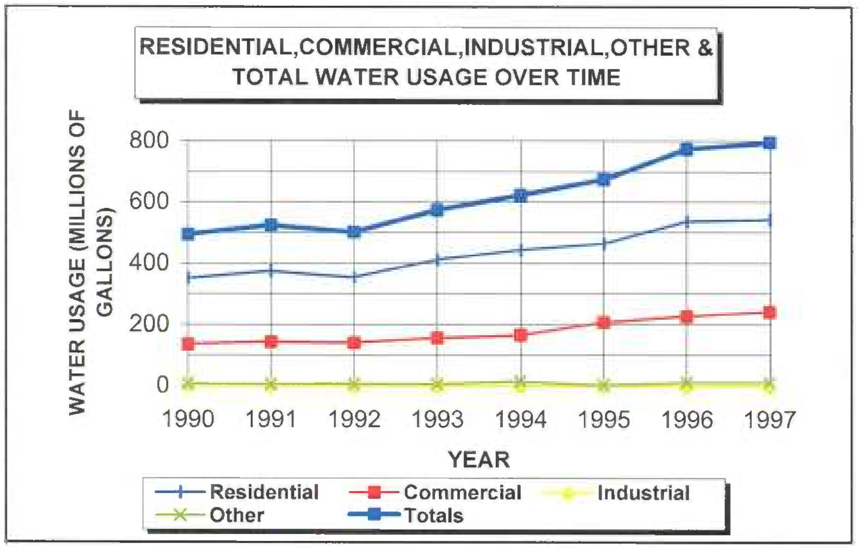
Population (local area population) = Avg. persons per household x Residential hookups

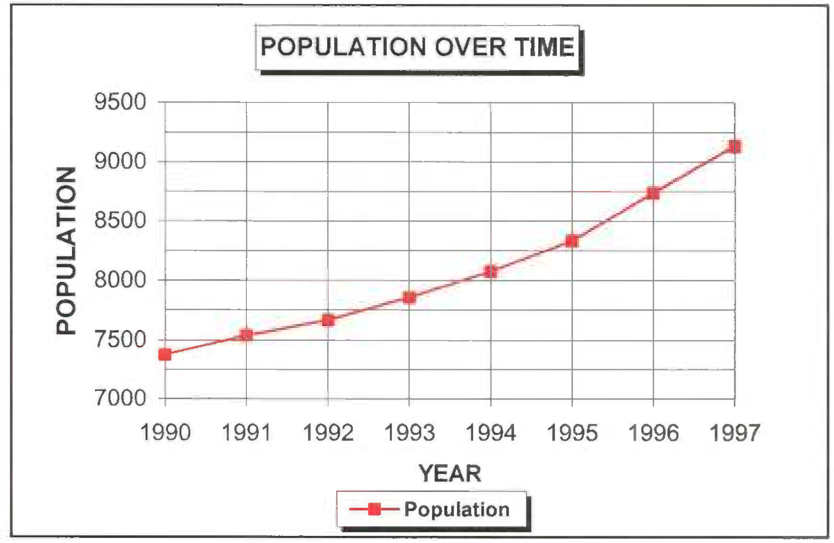
Population Statistics used for GPCD: ADES, 1990 Census Data





AZ. WATER COMPANY - SEDONA





Seasonal Water Delivery: The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
25%	45%	30%

BIG PARK WATER COMPANY

LOCATION

Sedona, Arizona
45 Castle Rock Road, Suite 4, Sedona, Az. 86351

CONTACT

Steve Gudovic (Owner)

HISTORY

Big Park Water Company is a private company that was established in February1968 by a land developer to service lots in the Village of Oak Creek. Zora Poe purchased the water company in 1975 and on January 3, 1996, the ownership changed again to Mr. Steve Gudovic. Little Park Water Company is a subsidiary of Big Park Water Company and was formed in March 1979. Both Big Park and Little Park Water Companies are owned and operated by Steve Gudovic. Between 1987 and 1993, Big Park Water Company expanded operations by purchasing three different water companies and adding two wells and a storage tank.

Responded to both the 1995 and 1998 surveys.

WATER SOURCES

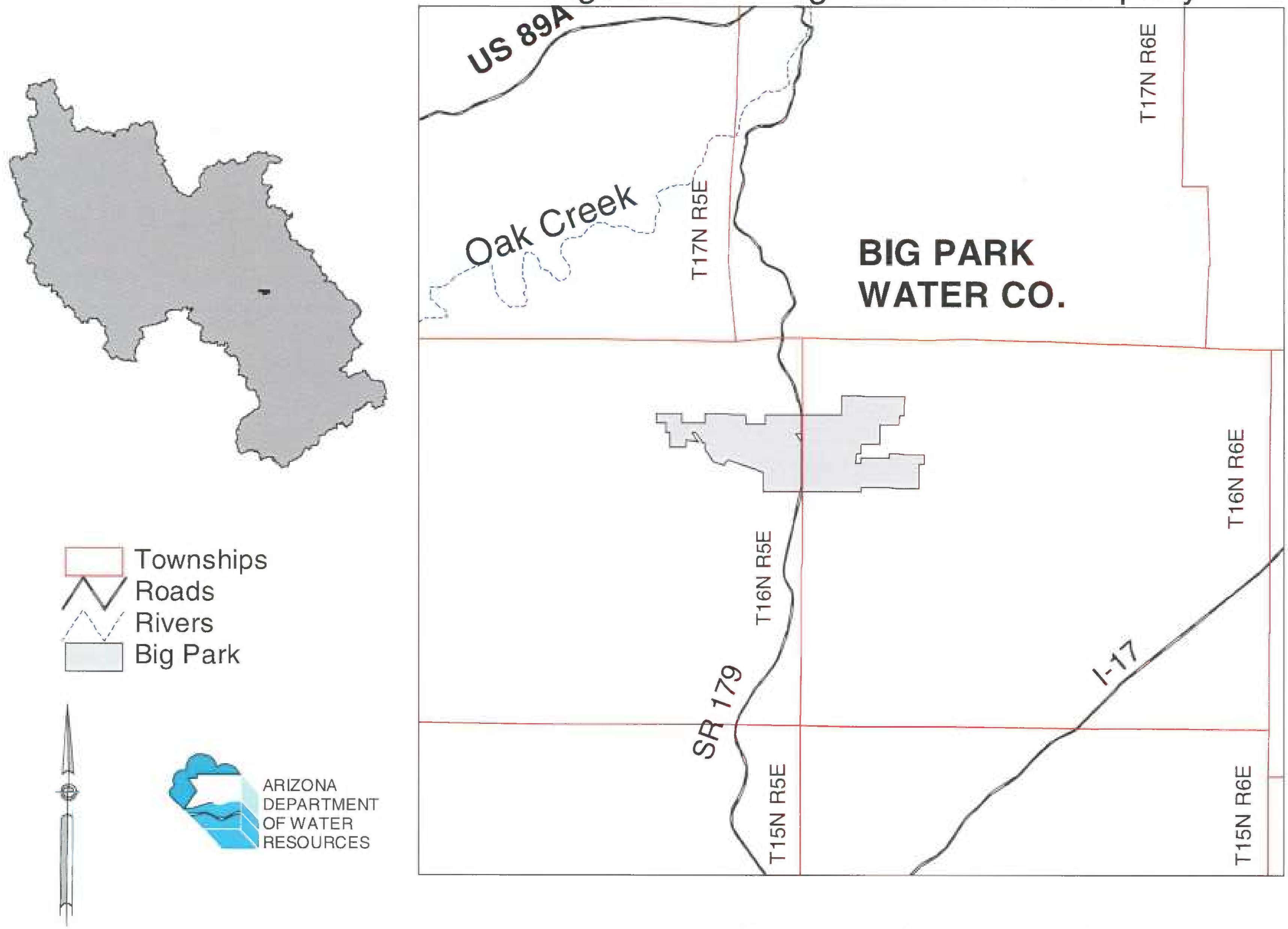
Big Park Water Company relies exclusively on groundwater for its source of water. The groundwater is generated by seven wells that are owned, operated, and metered by Big Park Water Company. Currently, the company supplies water to residential and commercial users with over 4,000 permanent residents and has a total storage capacity of 529,000 gallons.

WATER PLANNING

Big Park Water Company plans to expand on an as-needed basis for customer growth by adding more wells, increasing storage capacity, and expanding the current CC&N boundary. The company does have an emergency back-up plan located within the system where the system wells are interchanged. If one well needs repairs, valves can be opened to have water flow to service customers from the well needing repairs. A wastewater treatment system that is owned and operated by Yavapai County is also utilized by some customers while others rely on a sewer system.

The current charge for water depends on meter size. For example, a 5/8" x 3/4" meter is currently $18.00 per 1,000 gallons and ranges up to a high of $600.00 per 1,000 gallons for a 6" meter.

Figure A . 9 - Big Park Water Company



Source: Arizona Department of Water Resources

Big Park Water Co.

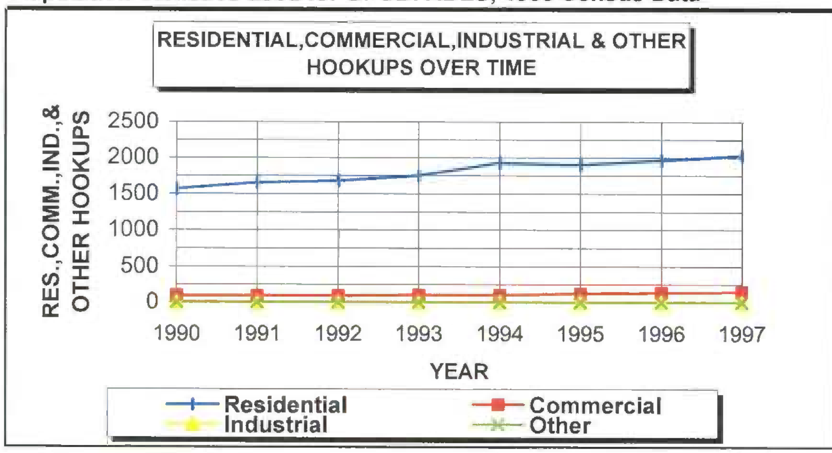
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

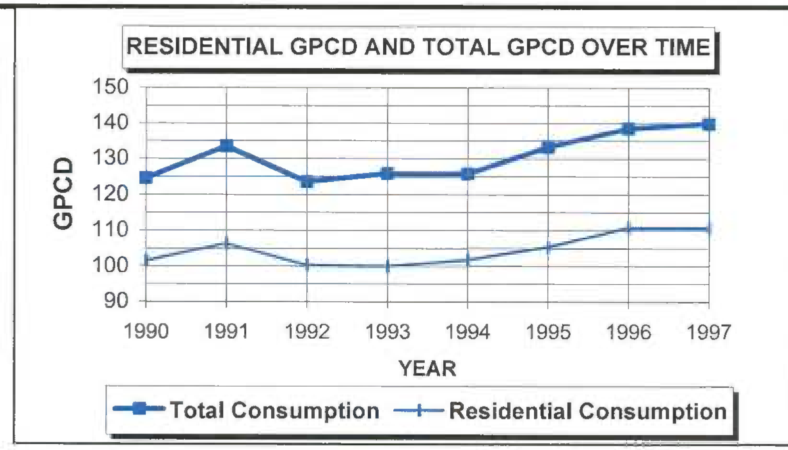
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	1566	1651	1680	1750	1931	1905	1964	2028
	Gallons delivered (millions)	117.28	129.47	124.369	128.985	144.977	148.102	160.345	165.413
	Population	3163.32	3335.02	3393.6	3535	3900.62	3848.1	3967.28	4096.56
GPCD*	Total Consumption	124.59	133.55	123.59	125.92	125.83	133.28	138.57	139.89
	Residential Consumption	101.58	106.36	100.41	99.97	101.83	105.44	110.73	110.63
Commercial	Hookups	93	89	89	96	98	120	130	142
	Gallons delivered (millions)	26.577	33.094	28.723	33.487	34.171	39.097	40.307	43.753
Industrial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Totals	Hookups	1659	1740	1769	1846	2029	2025	2094	2170
	Gallons delivered (millions)	143.857	162.564	153.092	162.472	179.148	187.199	200.652	209.166

*GPCD = Total or Residential Consumption / local area population / 365 days

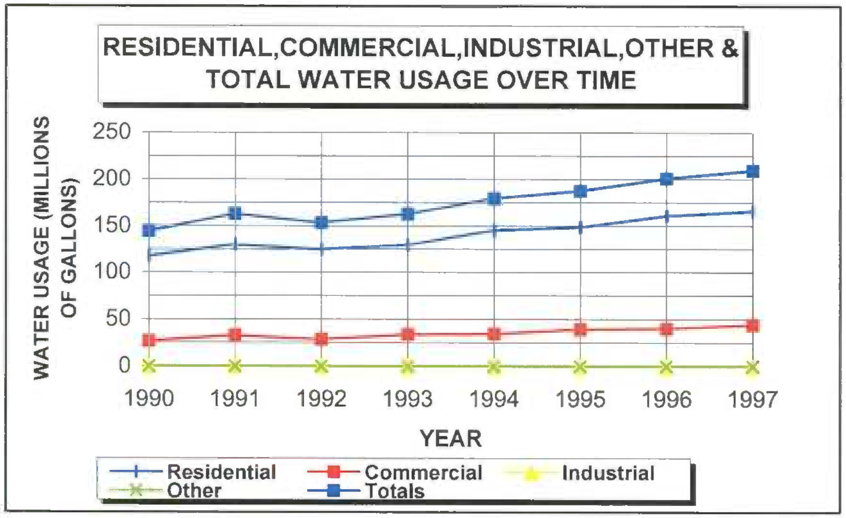
Population (Local area population)=Avg. persons per household x Residential hookups

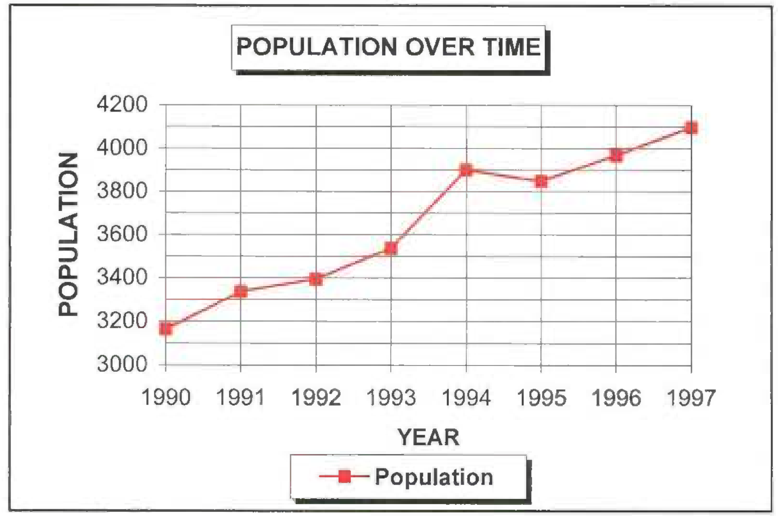
Population Statistics used for GPCD: ADES, 1990 Census Data





BIG PARK WATER CO.





Seasonal Water Delivery: The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
26%	45%	29%

BONITA CREEK LAND AND HOMEOWNERS ASSOCIATION

LOCATION **CONTACT**

Approximately 15 miles northeast of Payson, Arizona
2052 E. Gemini Drive, Tempe, Az. 85283

Karl Cox (President)

HISTORY

Bonita Creek Land and Homeowners Association has been in operation since July 18, 1956, when they received their CC&N. This association consists of 160 acres in four different developments within national forest land. Most of the homes in Bonita Creek are weekend or seasonal homes. This reflects the relatively low water use figures.

In 1990, the Dude fire destroyed most of the homes within Bonita Creek. Also in 1990, there were 52 hookups, and one year later in 1991 that number was reduced to 15.

Responded to the 1998 survey.

WATER SOURCES

Bonita Creek owns two unmetered wells that produce only seasonal output. The total storage capacity of the system is 10,000 gallons and the association relies on 100 percent surface water for its supply of water. Water is pumped from a spring that forms Bonita Creek on the association's property.

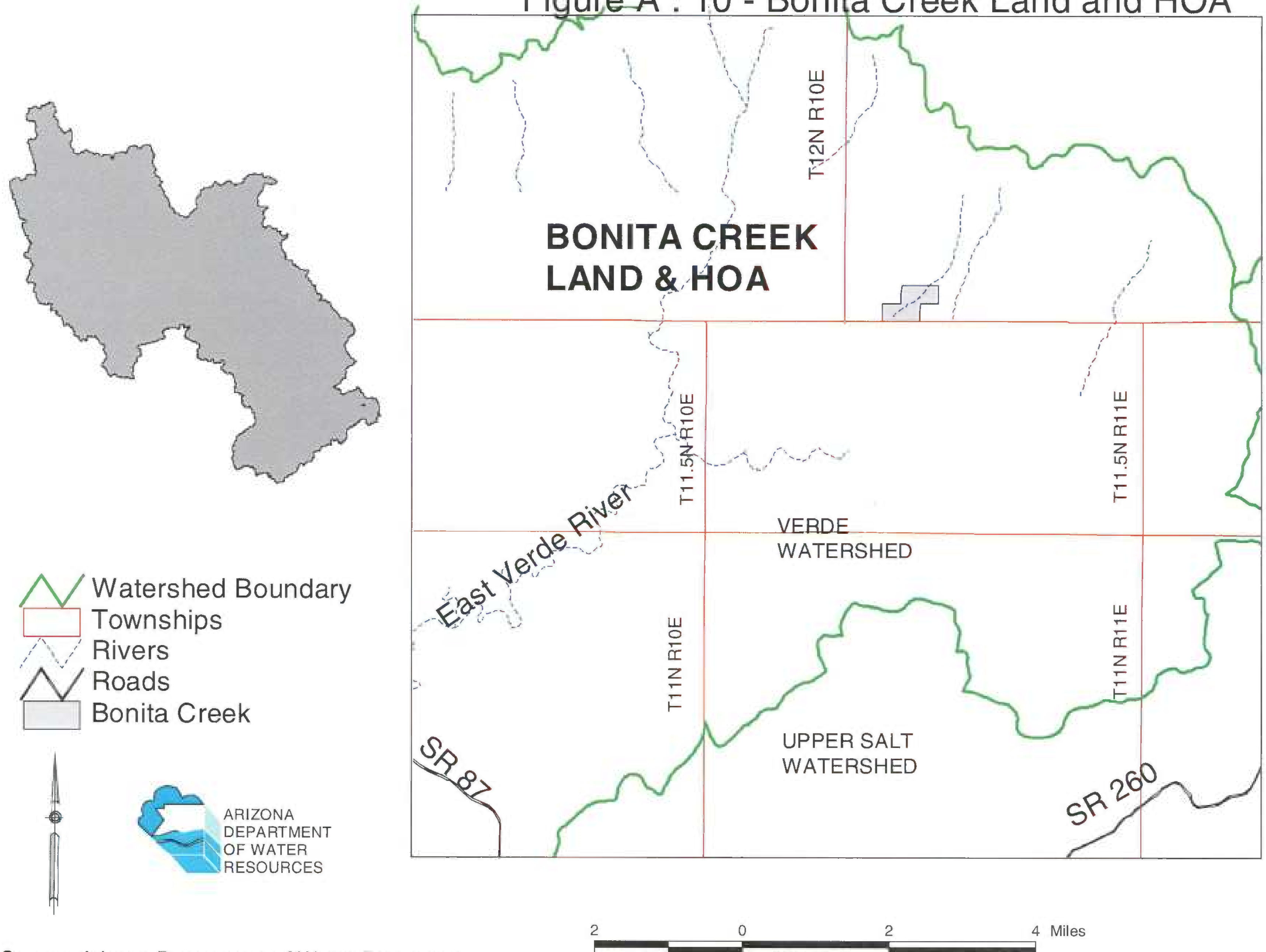
WATER PLANNING

Since April 1995, Bonita Creek Land and Homeowners Association implemented a new water rate that encourages conservation practices. Previous to this new rate structure a flat monthly fee was charged, which led to abusive water practices. Close supervision of water pumped, water sold, and the loss of water has been implemented to reduce these factors. Finally, a practice of restricted development (175 lots) has also been implemented to reduce water use.

The current charge for water is $19.75 as a base fee plus $4.75 per 1,000 additional gallons. The average water bill for Bonita Creek residents is about $27.50.

A GPCD was not determined for Bonita Creek because of the seasonal population.

Figure A . 10 - Bonita Creek Land and HOA



Source: Arizona Department of Water Resources

Bonita Creek Land and Homeowners Asscoiation

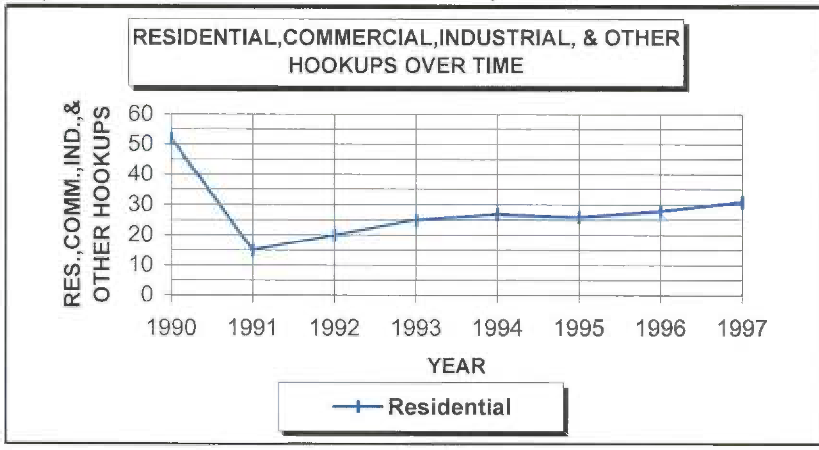
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

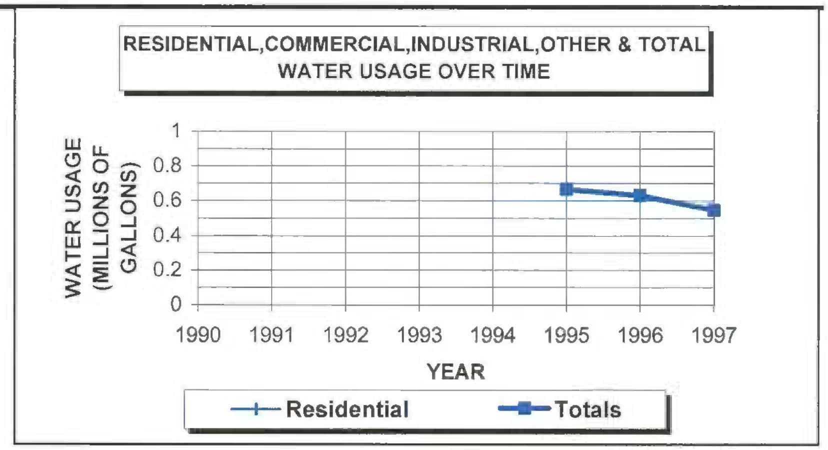
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	52	15	20	25	27	26	28	31
	Gallons delivered (millions)						0.667	0.633	0.55
	Population for service area:								
GPCD*	*Gallons per capita per day								
Commercial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Industrial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Totals	Hookups	52	15	20	25	27	26	28	31
	Gallons delivered (millions)						0.667	0.633	0.55

*GPCD = Total or Residential Consumption / local area population / 365 days

Population (Local area population) = Avg. persons per household x Residential hookups

Population Statistics used for GPCD: ADES, 1990 Census Data





BONITA CREEK LAND & HOMEOWNER ASSOCIATION

Due to insufficient data, GPCD and population over time graphs are not presented here.

Seasonal Water Delivery The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
16%	45%	39%

BOYNTON CANYON ENCHANTMENT HOA
WATER UTILITY COMPANY

LOCATION

Sedona, Arizona
525 Boynton Canyon Road, Sedona, Az. 86336

CONTACT

Barbara Robertson

HISTORY

Boynton Canyon Water Utility Company was formed in 1989 by the homeowners association sometime after the property was built in the mid to late 1980s. The system provides domestic water primarily to the Enchantment Resort that includes 162 casitas and maintenance and health facilities. There are also five private homes located on the resort grounds that are seasonal.

Responded to the 1998 survey.

WATER SOURCES

Boynton Canyon Water Utility Company is dependent on groundwater for most of its source of water. Groundwater is responsible for 75 percent of the water supply and effluent is responsible for the other 25 percent. Effluent is being used to irrigate approximately 50 acres of agriculture. Groundwater is supplied by three wells that are owned, operated, and metered by the water utility company along with three gravity fed storage tanks. The total water storage capacity of the system is 200,000 gallons.

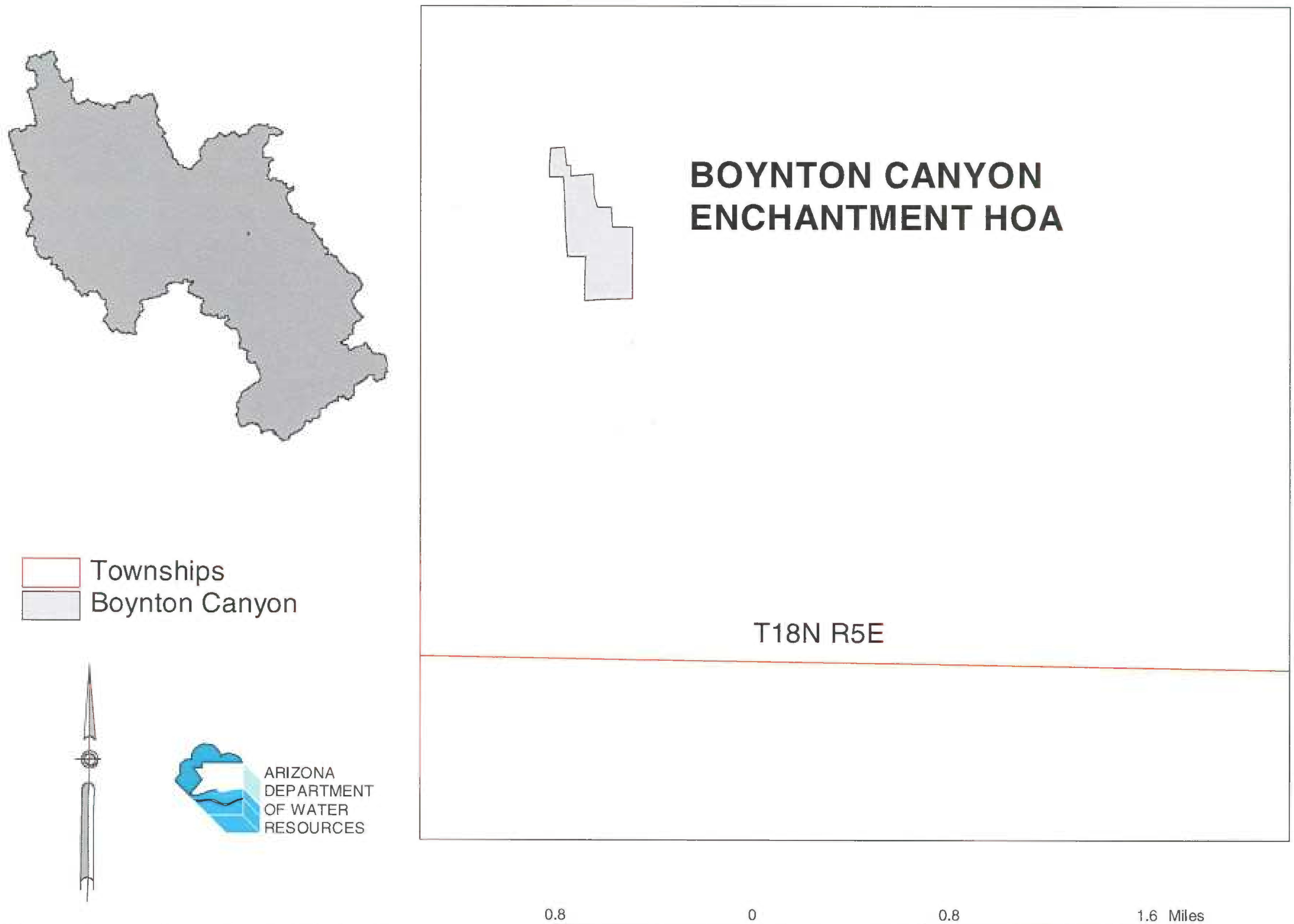
WATER PLANNING

Boynton Canyon Water Utility Company does not perform water use planning nor does it have an agreement with another company to provide water in an emergency situation. In the event of a water shortage, water must be hauled to fill the storage tanks. The company does have a wastewater treatment plant that has been in operation since 1985. There are no current plans for expansion except for possible future additions within the resort area.

The current charge for water is $0.04 per 100 gallons.

A GPCD was not determined for Boynton Canyon Water Utility Company because of the extremely low number of residential connections that would not have given an accurate population estimate.

Figure A . 11 - Boynton Canyon Ench. HOA



Source: Arizona Department of Water Resources

Boynton Canyon Enchantment HOA

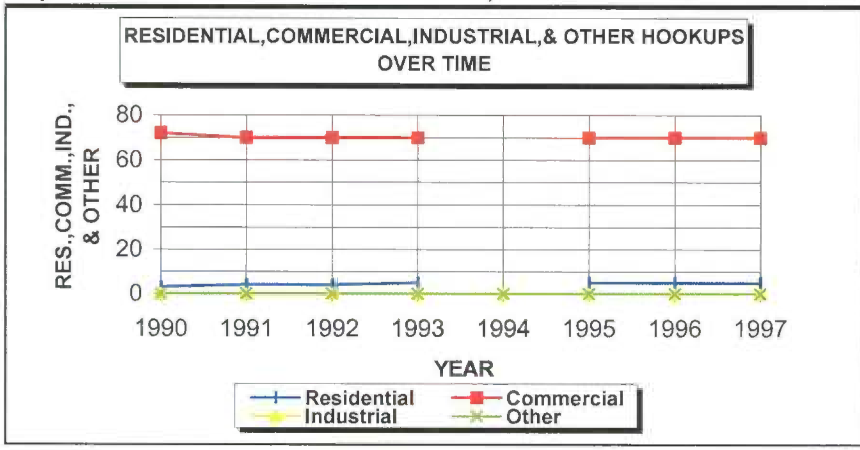
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

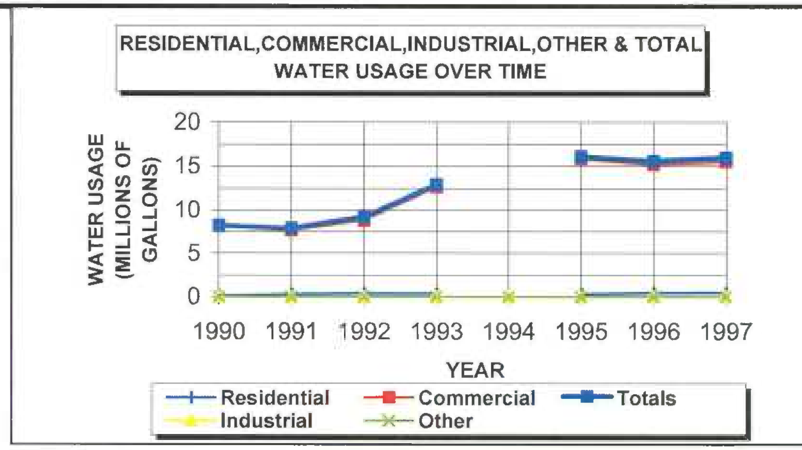
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	3	4	4	5		5	5	5
	Gallons delivered (millions)	0.123	0.28	0.39644	0.34395		0.280636	0.40637	0.475
	Population	7.05	9.4	9.4	11.75	0	11.75	11.75	11.75
GPCD*	Total Consumption								
	Residential Consumption								
Commercial	Hookups	72	70	70	70		70	70	70
	Gallons delivered (millions)	8.126	7.65708	8.809081	12.596137		15.800424	15.14641	15.474392
Industrial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Totals	Hookups	75	74	74	75	N/A	75	75	75
	Gallons delivered (millions)	8.249	7.9371	9.20552	12.94009		16.081060	15.55278	15.94939

*GPCD = Total or Residential Consumption / local area population / 365 days

Population (Local area population) = Avg. persons per household x Residential hookups

Population Statistics used for GPCD: ADES, 1990 Census Data





BOYNTON CANYON ENCHANTMENT HO.A.

Due to insufficient data, GPCD and population graphs are not presented here.

Seasonal Water Delivery The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
30%	40%	30%

CAMP VERDE WATER SYSTEM, INC.

LOCATION

Camp Verde, Arizona
P.O. Box 340, Camp Verde, Az. 86322

CONTACT

Stanley Bullard (Vice President)

HISTORY

Camp Verde Water System, Inc. was initially established in 1865 to serve water to what was then known as Fort Verde. This included water being hauled by truck and wagon until 1932 when Camp Verde School gained control of the system and began selling water to residential customers. Mr. Gil Harris purchased the company in 1957 and then sold it to Mr. James W. Bullard in the spring of that year. Mr. Bullard incorporated Camp Verde Water System, Inc. in 1969 and the Bullard family has owned and operated the company ever since. Camp Verde Water System, Inc. currently serves over 900 connections with a population of more than 2,300 people.

Responded to both the 1995 and 1998 surveys.

WATER SOURCES

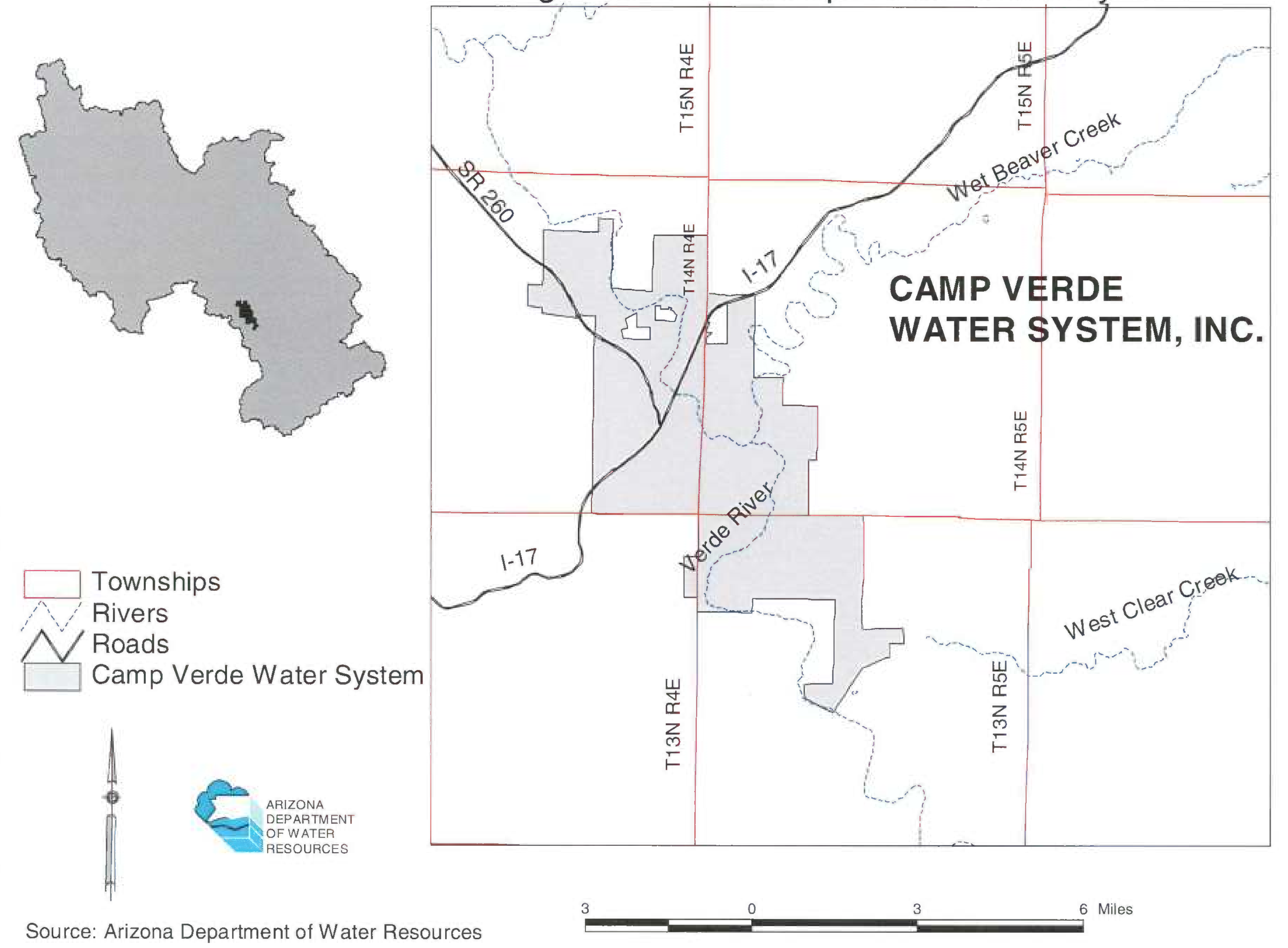
Camp Verde Water System, Inc. relies entirely on groundwater for its source of water. The groundwater is generated by eight wells that are owned, operated, and metered by Camp Verde Water System, Inc. The company supplies water for residential, commercial, industrial, and other uses. The total storage capacity of the system is 1,000,000 gallons.

WATER PLANNING

Planning efforts of Camp Verde Water System, Inc. are concentrated on identifying and locating additional water sources and providing additional storage facilities on an as needed basis to meet the demands of growth in the area. The company does have an emergency back-up water supply within the system in the form of multiple wells. The majority of Camp Verde Water System, Inc.'s customers are permanent residential users with some seasonal. The 1996-1997 drought did not impact its ability to deliver water.

The cost of water is currently based on meter size. For example, a three quarter inch meter has a $20.48 minimum charge and a $3.29 charge for each additional 1,000 gallons over the minimum.

Figure A . 12 - Camp Verde Water System



Camp Verde Water System, Inc.

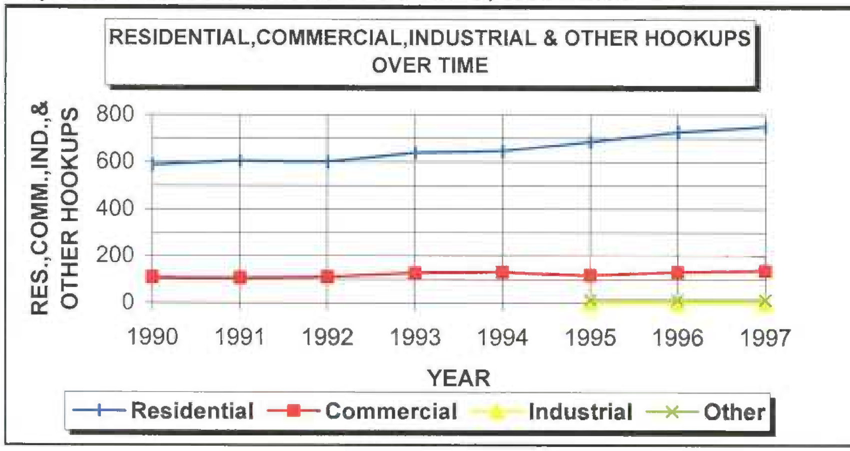
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

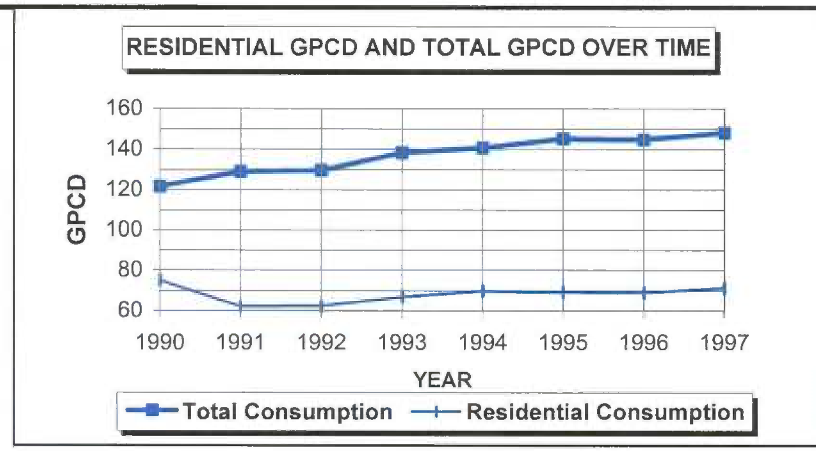
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	588	606	601	640	647	687	729	752
	Gallons delivered (millions)	41.547	35.384	35.219	40.152	42.465	44.802	47.151	50.33
	Population	1511.16	1557.42	1544.57	1644.8	1662.79	1765.59	1873.53	1932.64
GPCD*	Total Consumption	121.90	129.20	129.82	138.27	140.81	145.40	144.83	148.26
	Residential Consumption	75.32	62.25	62.47	66.88	69.97	69.52	68.95	71.35
Commercial	Hookups	109	107	111	128	132	118	132	136
	Gallons delivered (millions)	25.691	38.06	37.967	42.861	42.995	37.978	40.414	46.349
Industrial	Hookups						1	1	1
	Gallons delivered (millions)						0.372	0.329	1.801
Other	Hookups						15	15	15
	Gallons delivered (millions)						10.548	11.148	6.103
Totals	Hookups	697	713	712	768	779	821	877	904
	Gallons delivered (millions)	67.238	73.444	73.186	83.013	85.460	93.70	99.042	104.583

*GPCD = Total or Residential Consumption / local area population / 365 days

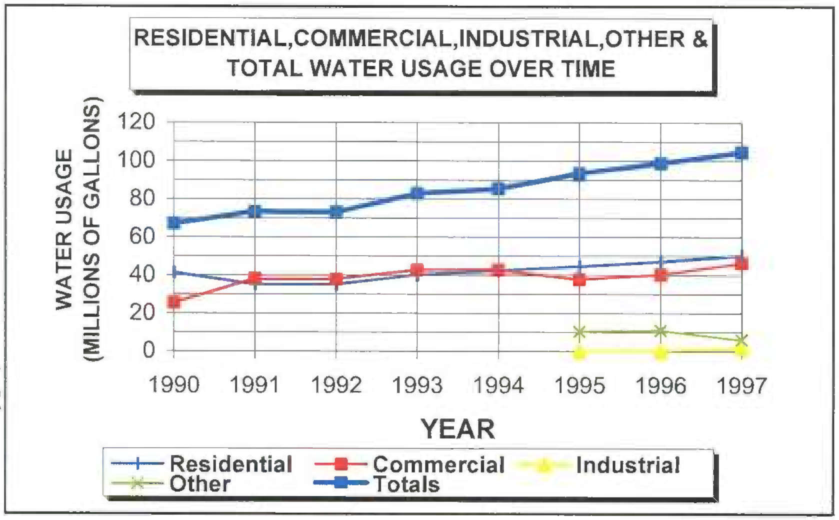
Population (Local area population) = Avg. persons per household x Residential hookups

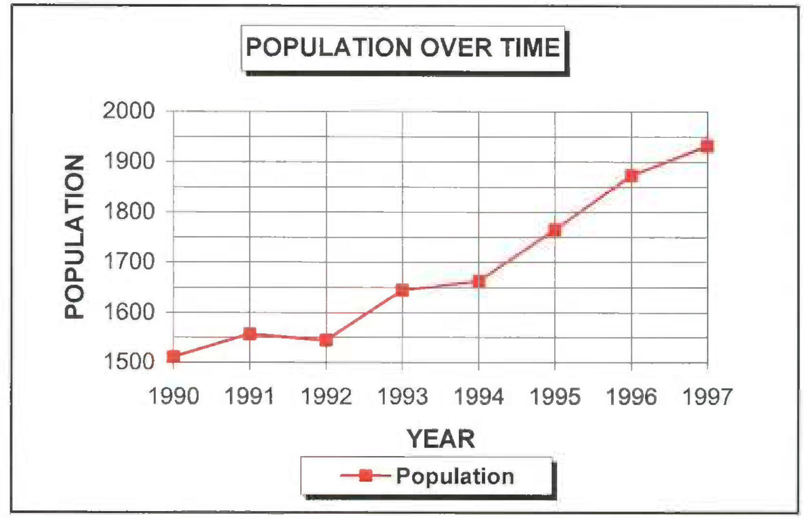
Population Statistics used for GPCD: ADES, 1990 Census Data





CAMP VERDE WATER SYSTEM





Seasonal Water Delivery The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
28%	44%	28%

CLEMENCEAU WATER COMPANY

LOCATION

Cottonwood, Arizona
P.O. Box 58 Cottonwood, Az. 86326

CONTACT

George T. Siler (Owner)

HISTORY

The United Verde Extension Mining Company established, built, and operated the Clemenceau Water System from 1912 until 1937 to serve the miners and their families that were housed in what was known then as Clemenceau Townsite. Bessie M. Siler purchased Clemenceau Townsite in 1937 and then transferred ownership to George T. Siler in 1954. Clemenceau Water Company has been in continuous operation since it was sold to the Siler family in 1937. In 1951, the Arizona Corporation Commission granted a franchise to Clemenceau Water Company.

Responded to both the 1995 and 1998 surveys.

WATER SOURCES

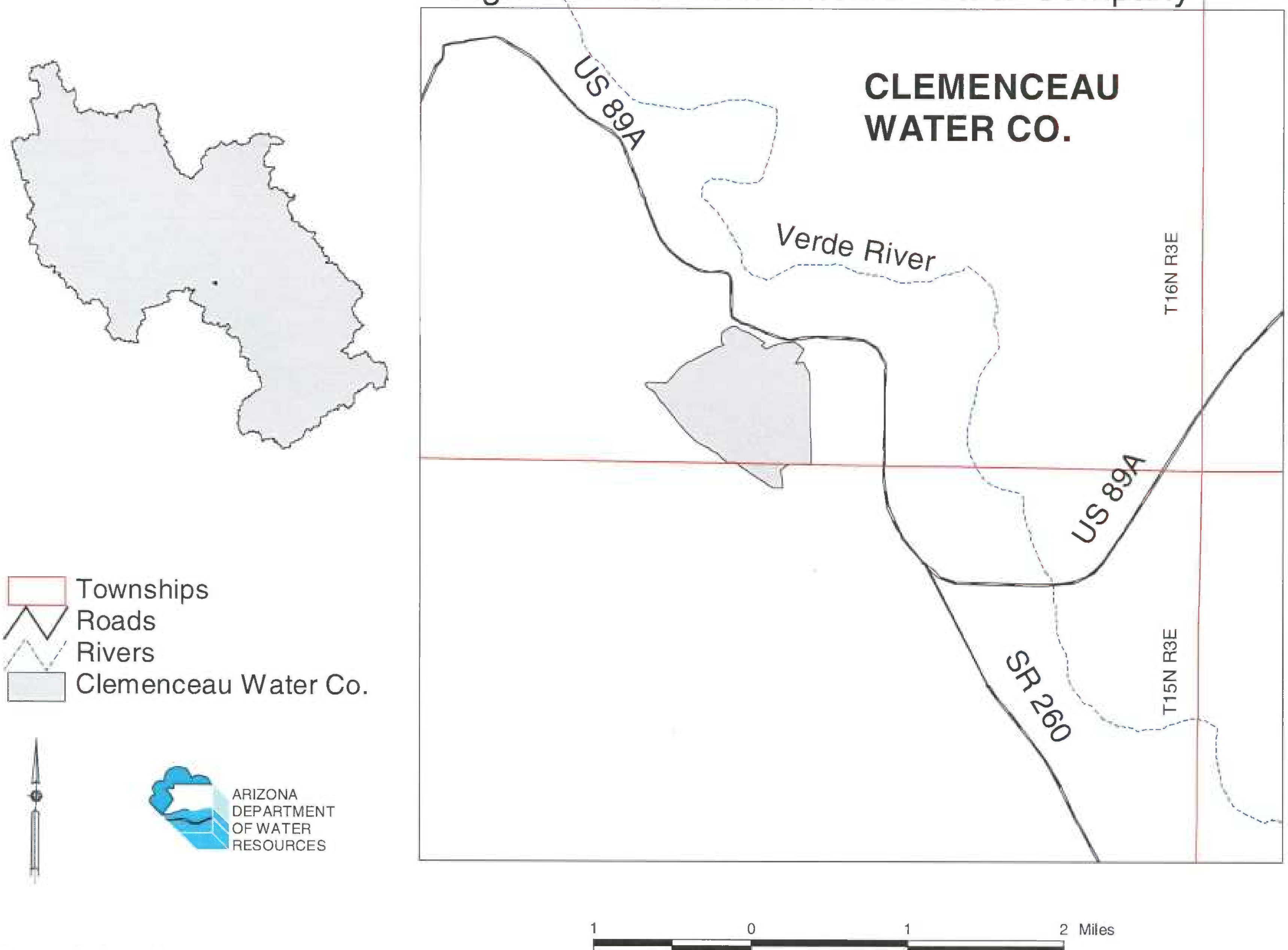
Clemenceau Water Company owns, operates, and meters three wells that serve a population of more than 500, including a local school, an apartment complex, small businesses, and a city park. The company is entirely reliant on groundwater for its water supply. The total storage capacity of the system is 220,000 gallons.

WATER PLANNING

Clemenceau Water Company does not perform water use planning, but does have an agreement with Cottonwood Water Works for water in an emergency situation. There is an emergency cross-connect to Haskel Springs and provides ~ 2 percent of the water for the company. There was no impact on water delivery from the 1996-1997 drought.

The current charge for water depends on the size of the meter and ranges from a low $10.00 per 1,000 gallons for a 5/8" x 3/4" meter (monthly service charge) to a high of $600.00 per 1,000 gallons for a 6" meter. There is also a commodity charge of $1.60 per 1,000 gallons of water used over the initial 1,000 gallons.

Figure A . 13 - Clemenceau Water Company



Source: Arizona Department of Water Resources

Clemenceau Water Co.

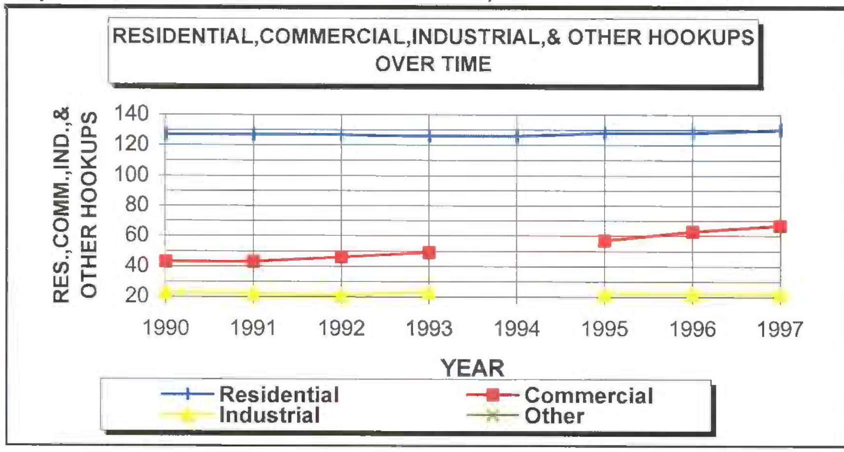
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

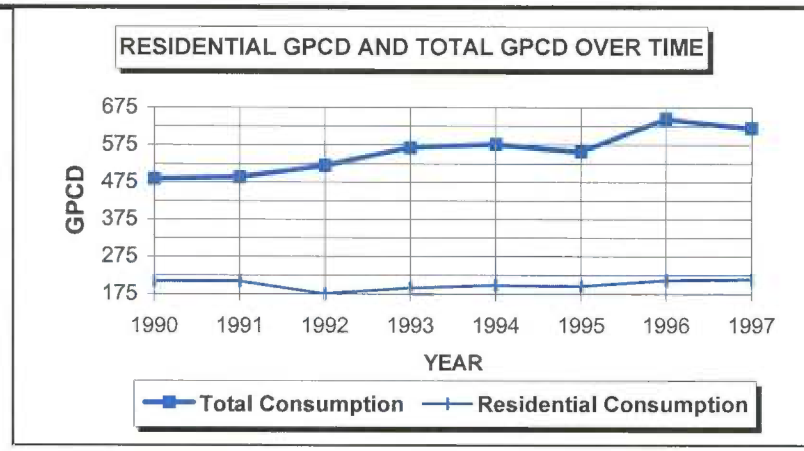
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	127	127	127	126	126	128	128	130
	Gallons delivered (millions)	22.425	22.443	18.805	20.301	21.023	21.143	22.773	23.424
	Population	293.37	293.37	293.37	291.06	291.06	295.68	295.68	300.3
GPCD*	Total Consumption	484.92	489.84	520.79	568.65	576.47	556.66	644.83	619.80
	Residential Consumption	209.42	209.59	175.62	191.09	197.89	195.91	211.01	213.70
Commercial	Hookups	43	43	46	49		57	63	67
	Gallons delivered (millions)	4.7	4.575	6.863	14.497		13.419	15.161	16.749
Industrial	Hookups	23	22	21	23		22	22	22
	Gallons delivered (millions)	24.8	25.434	30.098	25.614		25.515	31.658	27.763
Other	Hookups	0	0	0	0		0	0	0
	Gallons delivered (millions)	0	0	0	0		0	0	0
Totals	Hookups	193	192	194	198	200	207	213	219
	Gallons delivered (millions)	51.925	52.452	55.766	60.412	21.023	60.077	69.592	67.936

*GPCD = Total or Residential Consumption / local area population / 365 days

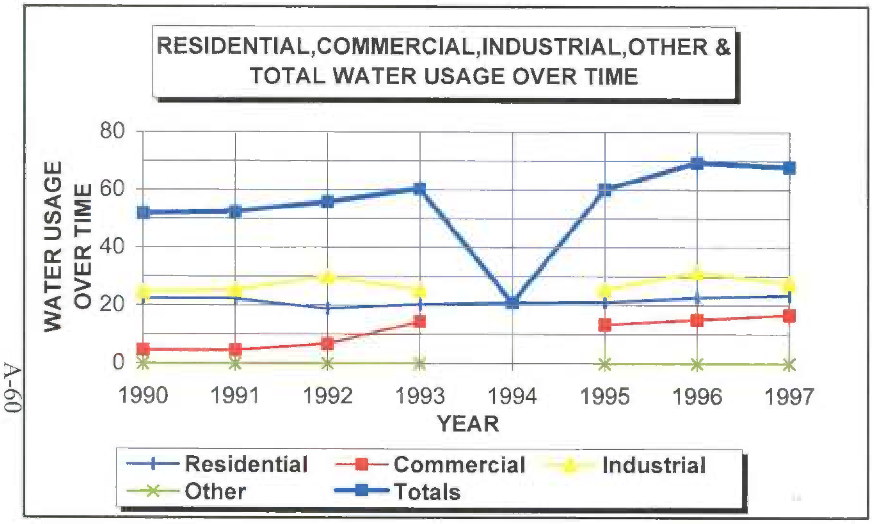
Population (Local area population) = Avg. persons per household x Residential hookups

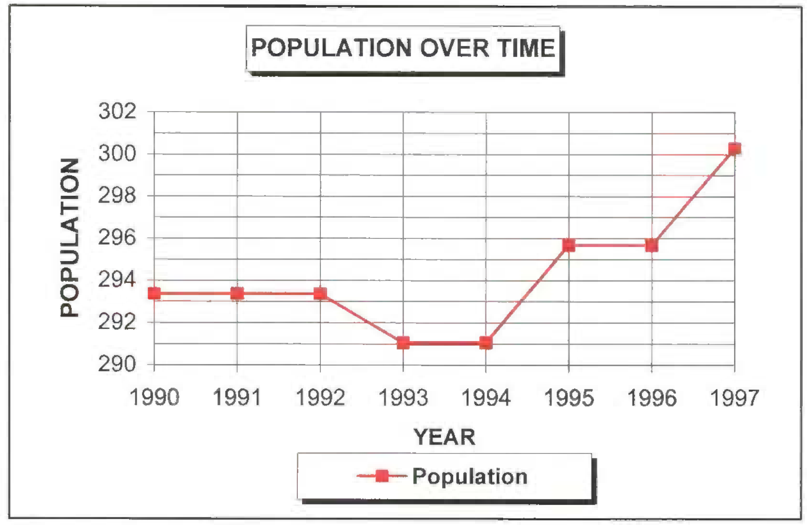
Population Statistics used for GPCD: ADES, 1990 Census Data





CLEMENCEAU WATER CO.





Seasonal Water Delivery The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
22%	51%	27%

CORDES LAKES WATER COMPANY

LOCATION

Cottonwood/Verde Village, Arizona
P.O. Box 219, Tempe, Az. 85280

CONTACT

Neil Folkman

HISTORY

Cordes Lakes Water Company is a private water company that was formed in the early 1970s after being purchased from Queen Creek Land & Cattle in 1974. The company has over 3,300 permanent residential and commercial connections within eight different units that serve domestic water to residents of Verde Village.

Responded to the 1998 survey.

WATER SOURCES

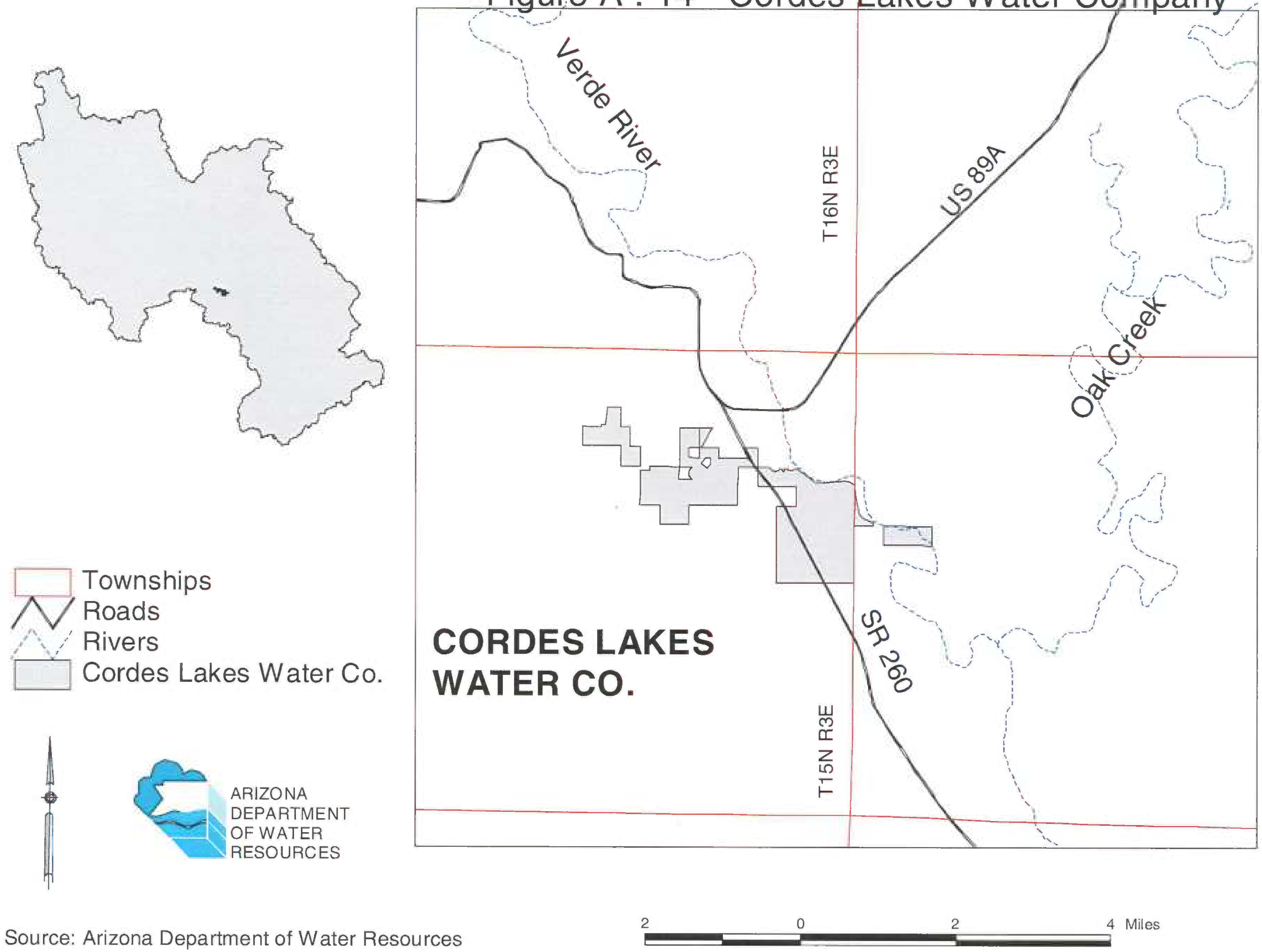
Cordes Lakes Water Company relies exclusively on groundwater for its source of water. The groundwater is generated by 15 interconnected wells that are owned, operated, and metered by Cordes Lakes Water Company. The total storage capacity of the system is 800,000 gallons.

WATER PLANNING

Cordes Lakes Water Company does not perform water use planning nor are there any agreements with another company to provide water. In the event of an emergency, the company must rely on sources within its own system. No water has ever been purchased from or sold to another company. Cordes Lakes Water Company was not affected by the 1996-1997 drought.

The current charge for water is not known.

Figure A . 14 - Cordes Lakes Water Company



Source: Arizona Department of Water Resources

Cordes Lakes Water Co.

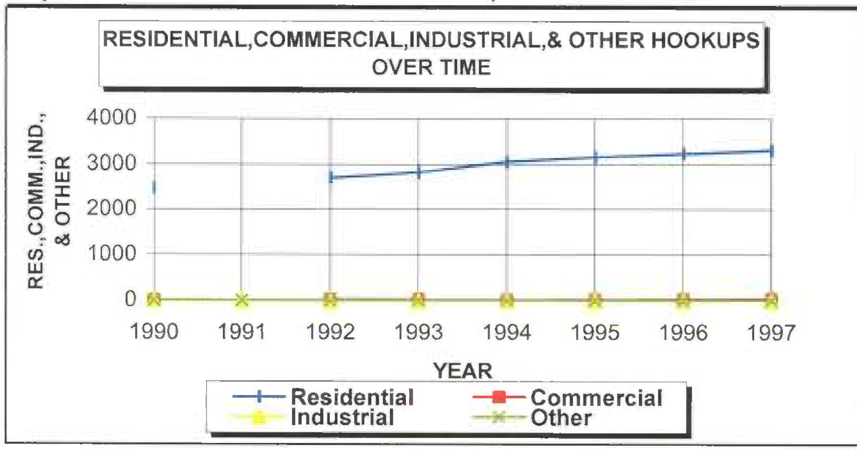
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

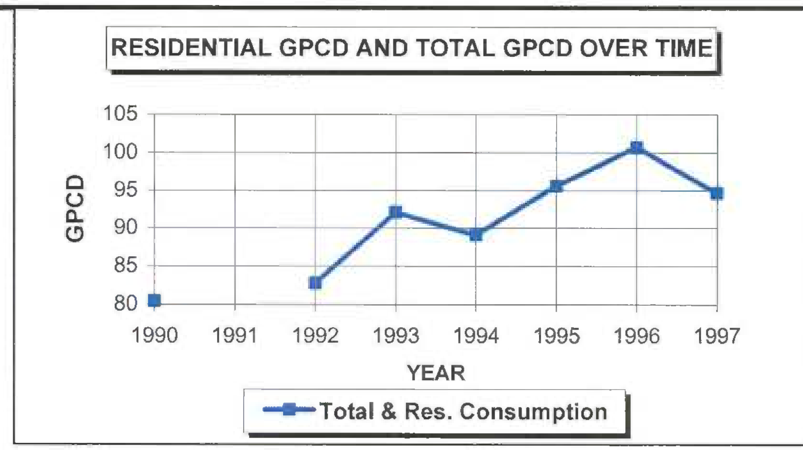
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	2476		2697	2820	3051	3154	3233	3301
	Gallons delivered (millions)	181		202.915	236	247	274	296	284
	Population	6165.24		6715.53	7021.8	7596.99	7853.46	8050.17	8219.49
GPCD*	Total & Res. Consumption	80.43		82.78	92.08	89.08	95.59	100.74	94.66
Commercial	Hookups	8		11	11	10	16	18	30
	Gallons delivered (millions)								
Industrial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Totals	Hookups	2484		2708	2831	3061	3170	3251	3331
	Gallons delivered (millions)	181.0		202.915	236.0	247.0	274.0	296.0	284.0

*GPCD = Total or Residential Consumption / local area population / 365 days

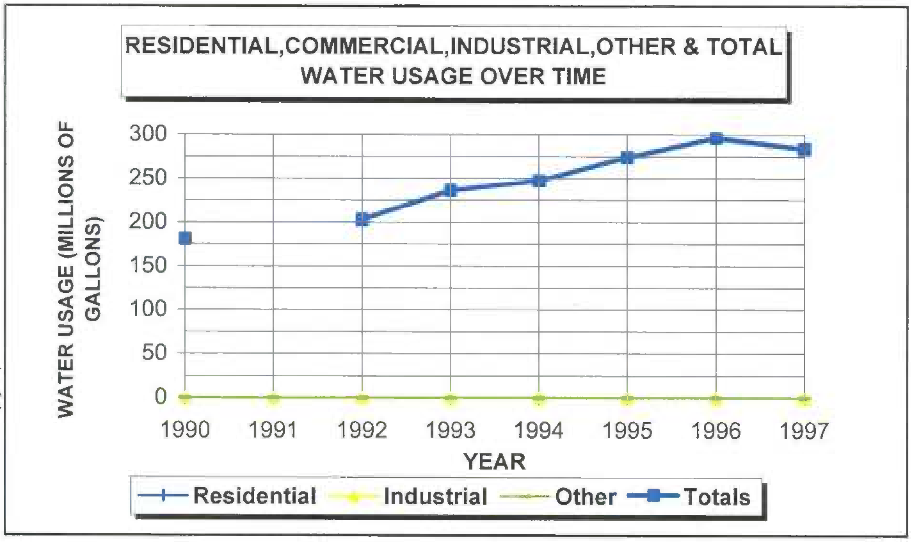
Population (Local area population) = Avg. persons per household x Residential hookups

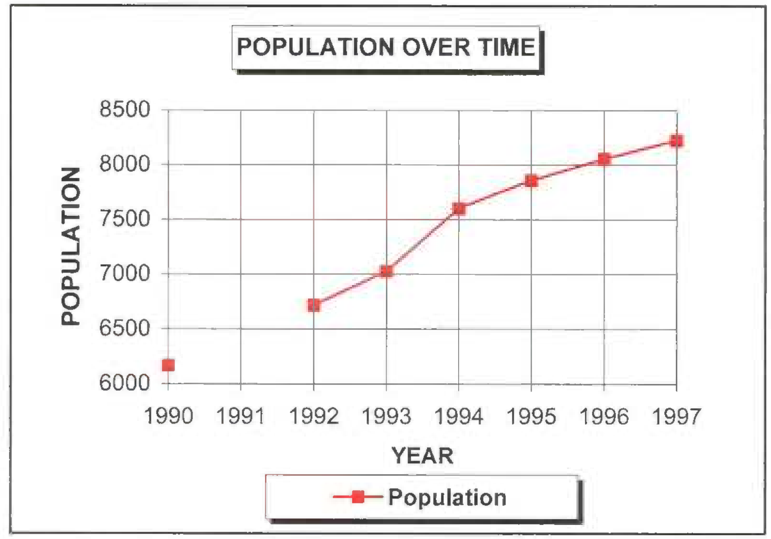
Population Statistics used for GPCD: ADES, 1990 Census Data





CORDES LAKES WATER CO.





Seasonal Water Delivery The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
25%	46%	29%

COTTONWOOD WATER WORKS, INC.

LOCATION
Clarkdale, Cottonwood, Arizona
1042 N. Main St. Cottonwood, Az. 86326

CONTACT
Charles D. Garrison

HISTORY

Cottonwood Water Works Company was formed by Charles D. Willard around 1910 for the purpose of supplying potable water to homeowners located in and around the Towns of Cottonwood and Clarkdale. Around the same time, the Town of Clarkdale constructed a smelter to process ore from the Town of Jerome. As the Towns of Cottonwood and Clarkdale grew to meet the labor demands of mining and other industrial and commercial ventures, Cottonwood Water Works also expanded its operations to supply water for those workers and homeowners.

In 1969, the company changed its legal operating status by incorporating. The company continues to be the primary supplier of treated water to mostly permanent residential and commercial users. It currently serves a population of more than 7,000 people.

Responded to both the 1995 and 1998 surveys.

WATER SOURCES

The company relies almost entirely on groundwater for its source of water. A small fraction of the company•s source of water is also supplied by an intermittent spring. Groundwater is generated by 12 wells that are owned, operated, and metered by the company. The total storage capacity of the system is 2,960,000 gallons. Customers rely on both individual septic systems and a wastewater treatment system that are operated by the City of Cottonwood.

WATER PLANNING

The planning efforts of Cottonwood Water Works Company are confined to the identification, location, and construction of new wells and storage tanks on an as needed basis to meet demands of their customers. No other water use planning is currently being performed. The company does have an agreement with Marcus J. Lawrence Medical Center to provide water in case of an emergency. There was no impact on water deliveries during the drought of 1996-1997.

The current charge for water depends on the size of the meter and a flat fee for a minimum number of gallons. For each additional 1,000 gallons over the minimum, a fee of $1.15 plus tax is also charged.

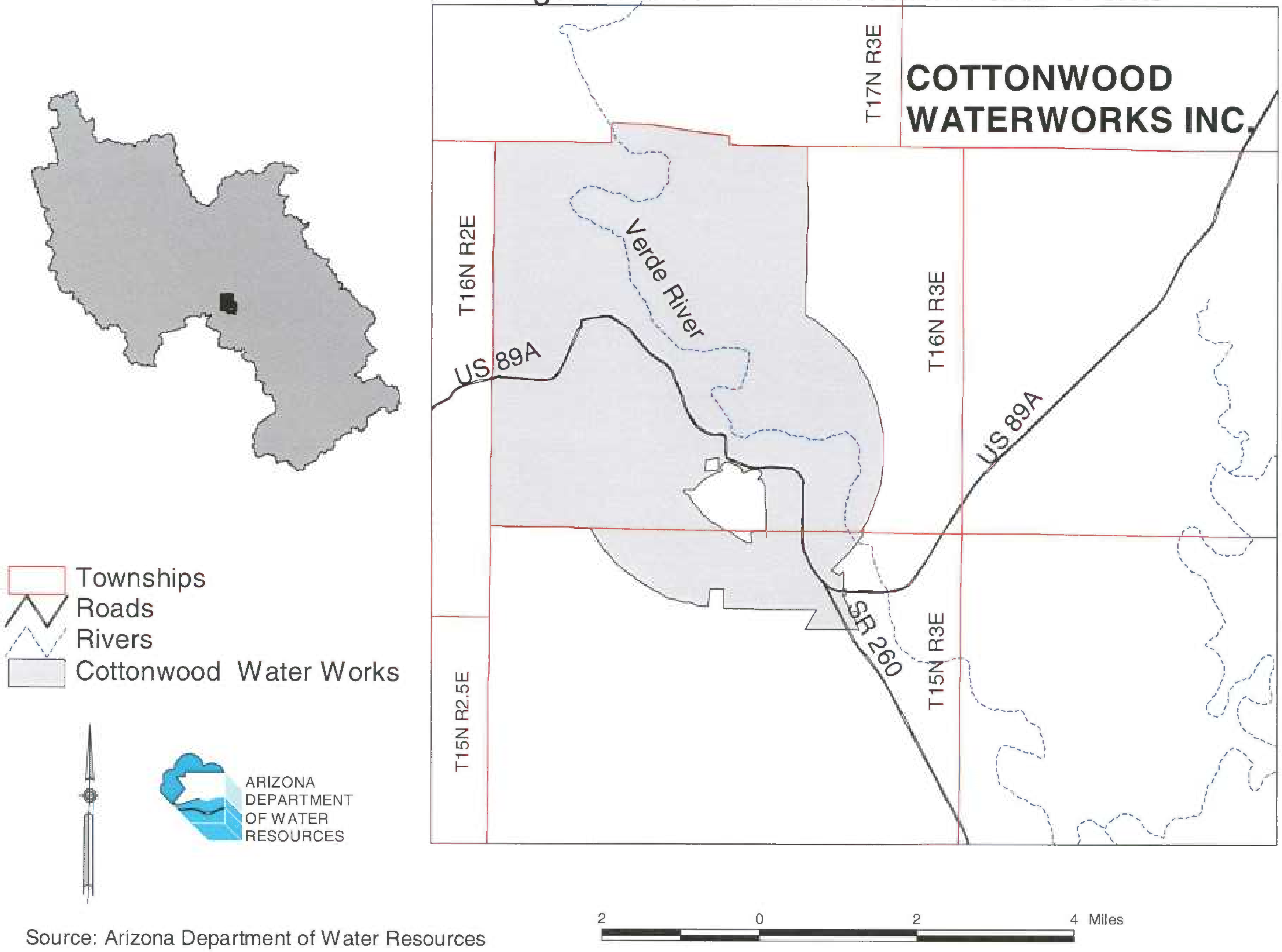


Figure A.. 15 - Cottonwood Water Works

Cottonwood WaterWorks

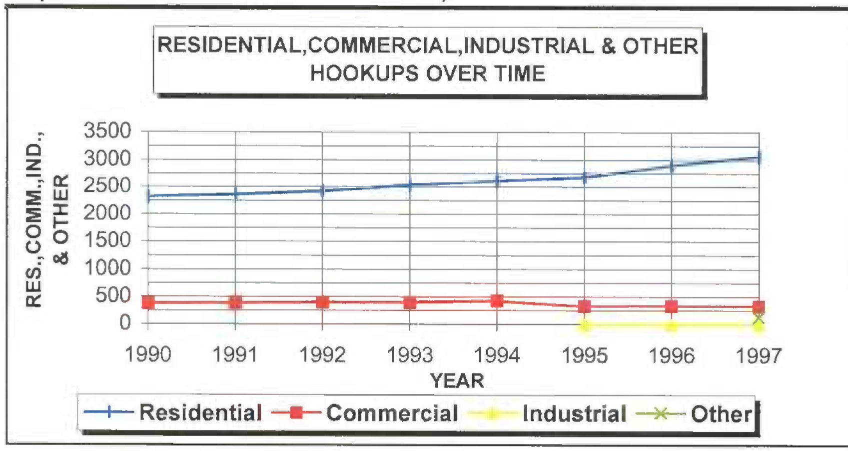
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

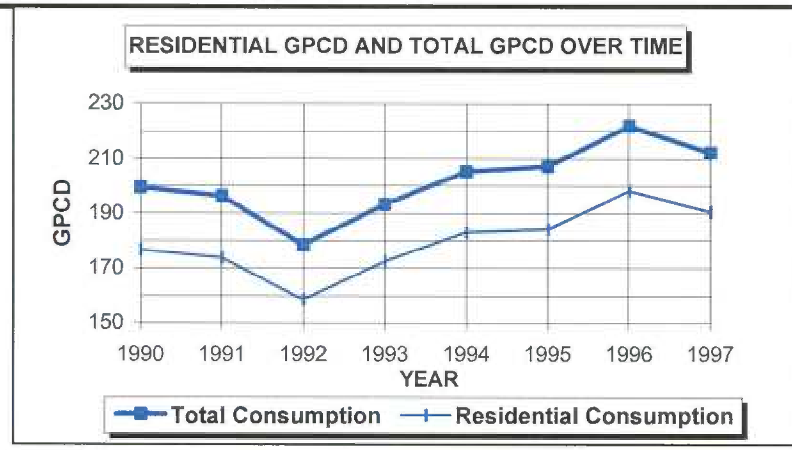
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	2320	2362	2421	2536	2611	2680	2903	3067
	Gallons delivered (millions)	345.7	346.4	323.7	369.1	402.9	415.9	485.2	493.219
	Population	5359.2	5456.22	5592.51	5858.16	6031.41	6190.8	6705.93	7084.77
GPCD*	Total Consumption	199.58	196.48	178.47	193.29	205.41	207.31	222.04	212.38
	Residential Consumption	176.73	173.94	158.58	172.62	183.01	184.06	198.23	190.73
Commercial	Hookups	378	386	397	397	425	329	335	328
	Gallons delivered (millions)	44.7	44.9	40.6	44.2	49.3	50.9	56	52.74
Industrial	Hookups						1	1	1
	Gallons delivered (millions)						1.64	2.283	2.162
Other	Hookups								129
	Gallons delivered (millions)								1.094
Totals	Hookups	2698	2748	2818	2933	3036	3010	3239	3525
	Gallons delivered (millions)	390.40	391.30	364.30	413.30	452.20	468.44	543.48	549.215

*GPCD =Total or Residential Consumption / local area population / 365 days

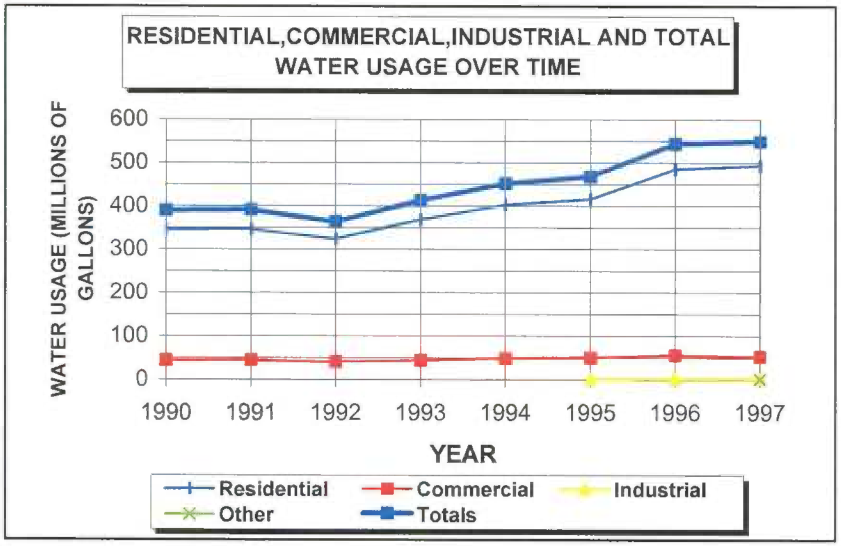
Population (Local area population) = Avg. persons per household x Residential hookups

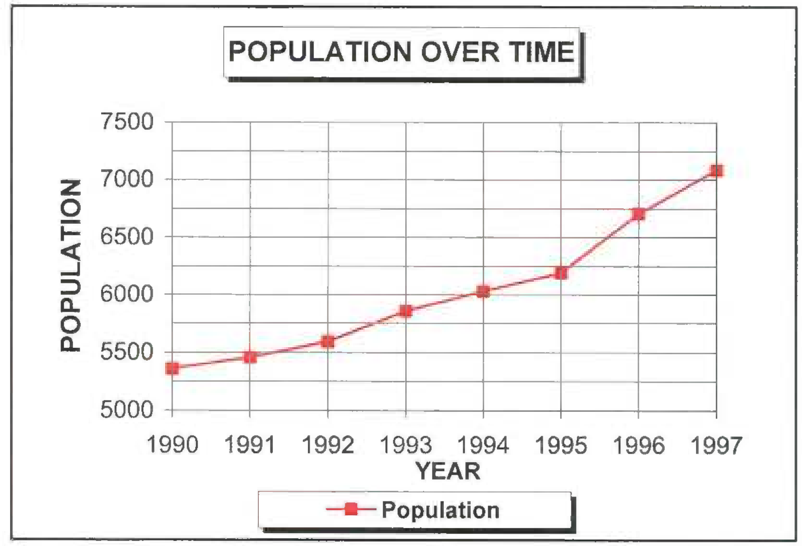
Population Stats.used for GPCD: ADES, 1990 Census Data





COTTONWOOD WATERWORKS





Seasonal Water Delivery The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
25%	47%	29%

OAK CREEK VALLEY PROPERTY OWNERS ASSOCIATION

LOCATION

Cornville, Arizona
890 N. Oak Creek Valley Road., Cornville, Az. 86325

CONTACT

Eric Vigland

HISTORY

Oak Creek Valley Property Owners Association was initially established in 1876. The current owners, DeNure, have owned it now for 20 years. The association received a certificate of approval to construct a water system on February 5, 1974 from the Arizona State Department of Health Services. A well was drilled in 1977 and the approval to operate it was granted in 1980.

Responded to both the 1995 and 1998 surveys.

WATER SOURCES

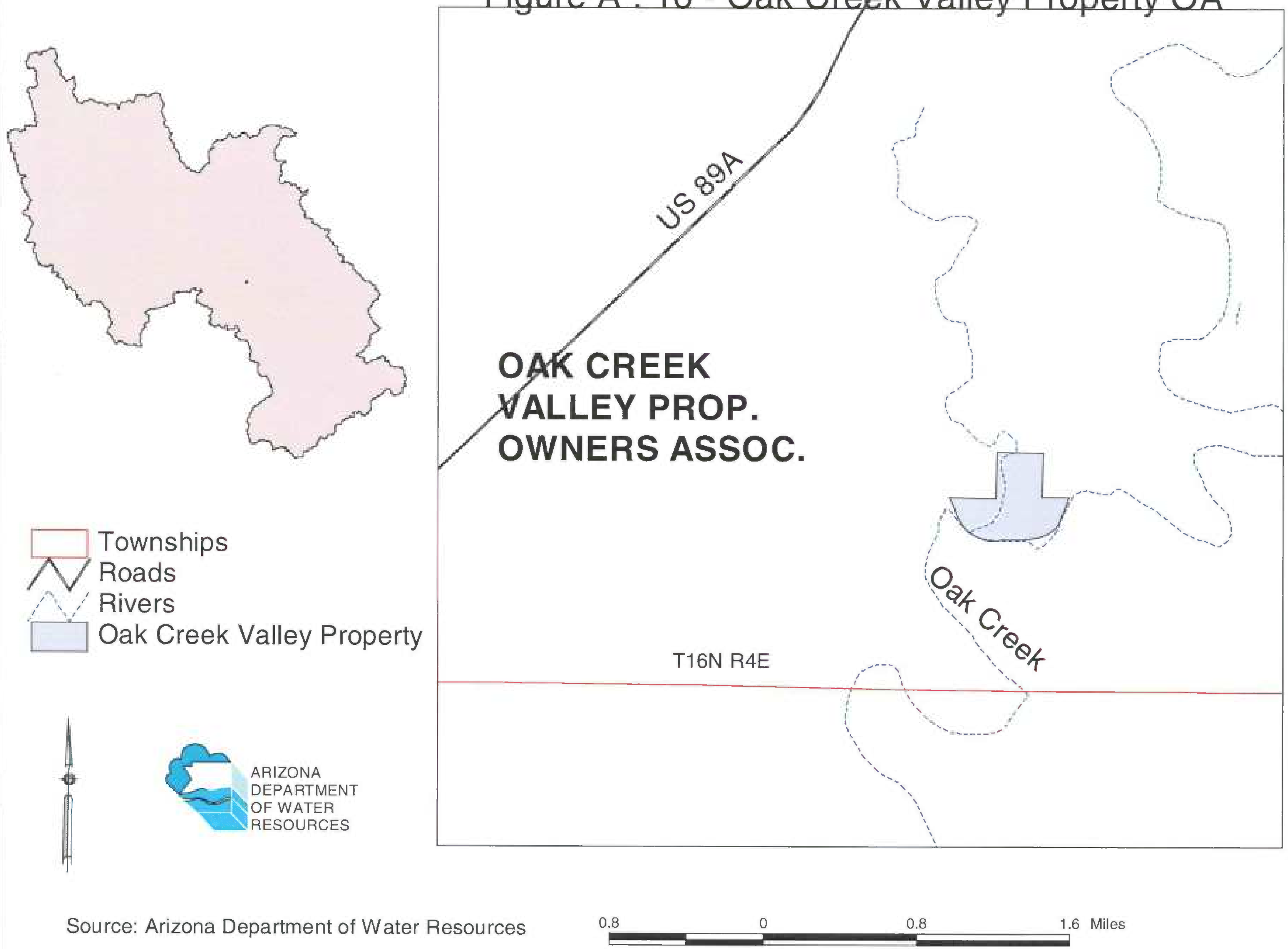
Oak Creek Valley Property Owners Association relies entirely on groundwater for its water source. The groundwater is supplied by two wells of which the association meters one well, but owns and operates both wells. The total storage capacity of the system is 35,000 gallons. The association currently has 116 permanent residential connections and a potential for as many as 183.

WATER PLANNING

Oak Creek Valley Property Owners Association does not perform water use planning, however, they do have a back-up well that could provide water for a short time in an emergency situation. There is also stand-by equipment on hand that can be used to repair a well within eight hours, including spare booster pumps and motors available on site. Water has never been purchased from or sold to another company. There was no impact from the 1996-1997 drought and no plans exist to minimize future droughts.

The current charge for water is $13.82 per month and $1.94 per 1,000 gallons. There is also a wastewater treatment plant that has been in operation since 1977. Effluent is not used for either irrigation or for recreation and wildlife use.

Figure A . 16 - Oak Creek Valley Property OA



Source: Arizona Department of Water Resources

Oak Creek Valley Property Owners Association

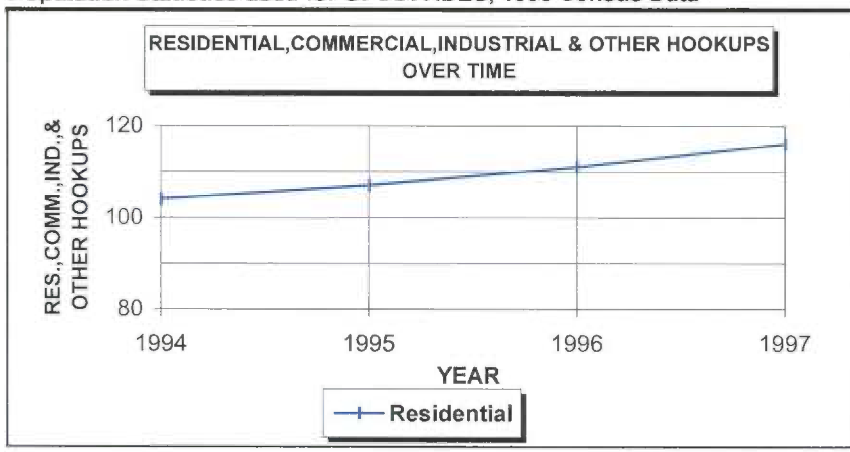
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

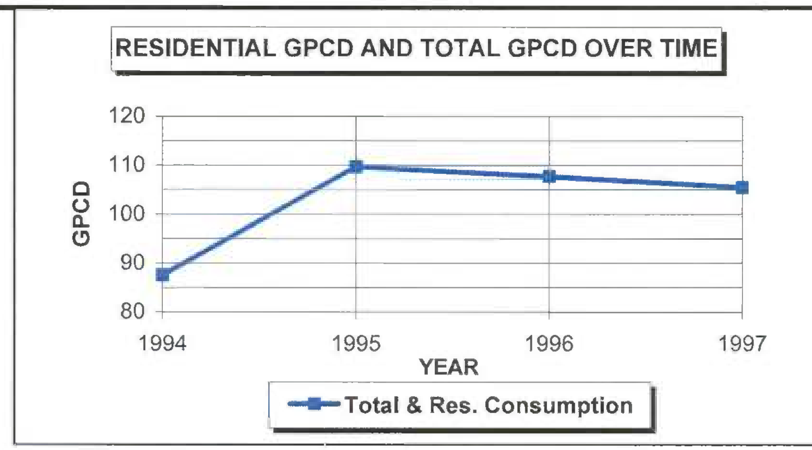
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups					104	107	111	116
	Gallons delivered (millions)		7.10795	6.67875	7.98755	8.70676	11.225	11.43	11.7
	Population					272.48	280.34	290.82	303.92
GPCD*	Total & Res. Consumption					87.54	109.70	107.68	105.47
Commercial	Hookups								
	Gallons delivered (millions)								
Industrial	Hookups								
	Gallons delivered (millions)								
Other	Hookups								
	Gallons delivered (millions)								
Totals	Hookups					104	107	111	116
	Gallons delivered (millions)		7.1080	6.6788	7.9876	8.7068	11.225	11.43	11.7

*GPCD = Total or Residential Consumption / local area population / 365 days

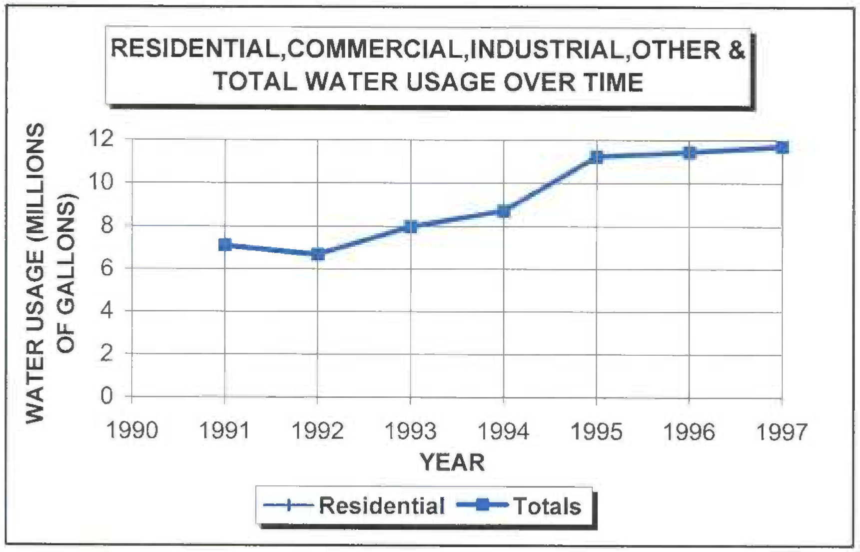
Population (Local area population) = Avg. persons per household x Residential hookups

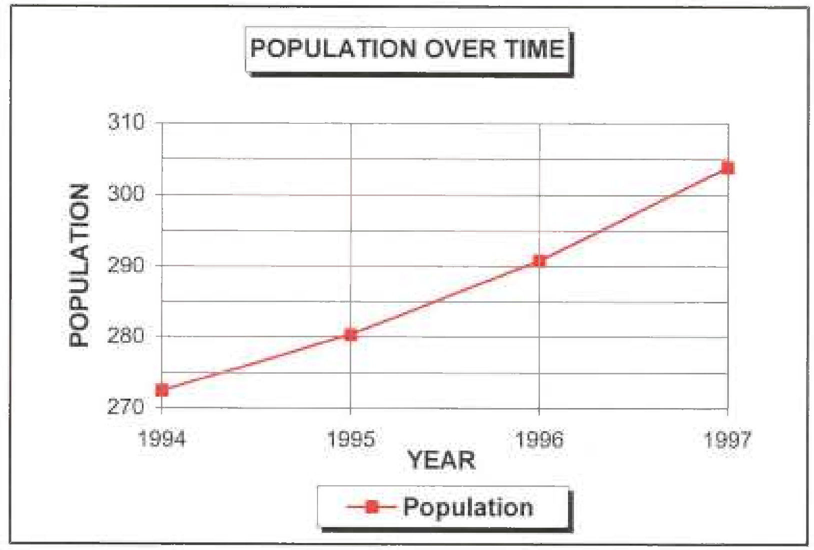
Population Statistics used for GPCD: ADES, 1990 Census Data





OAK CREEK VALLEY PROP. OWNERS ASSOC.





Seasonal Water Delivery The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
25%	50%	25%

OAK CREEK WATER COMPANY #1

LOCATION

West Sedona, Arizona
P.O. Box 3430, West Sedona, Az. 86340

CONTACT

John Madzik (President)

HISTORY

Oak Creek Water Company #1 was formed in 1947 and has been in operation since July 1953 when the company was incorporated. The company was developed to supply domestic water to property owners and residents in the Oak Creek development area. Oak Creek Water Company #1 currently claims more than 640 hookups and serves an estimated population of more than 1,200 mostly permanent customers.

Responded to both the 1995 and 1998 surveys.

WATER SOURCES

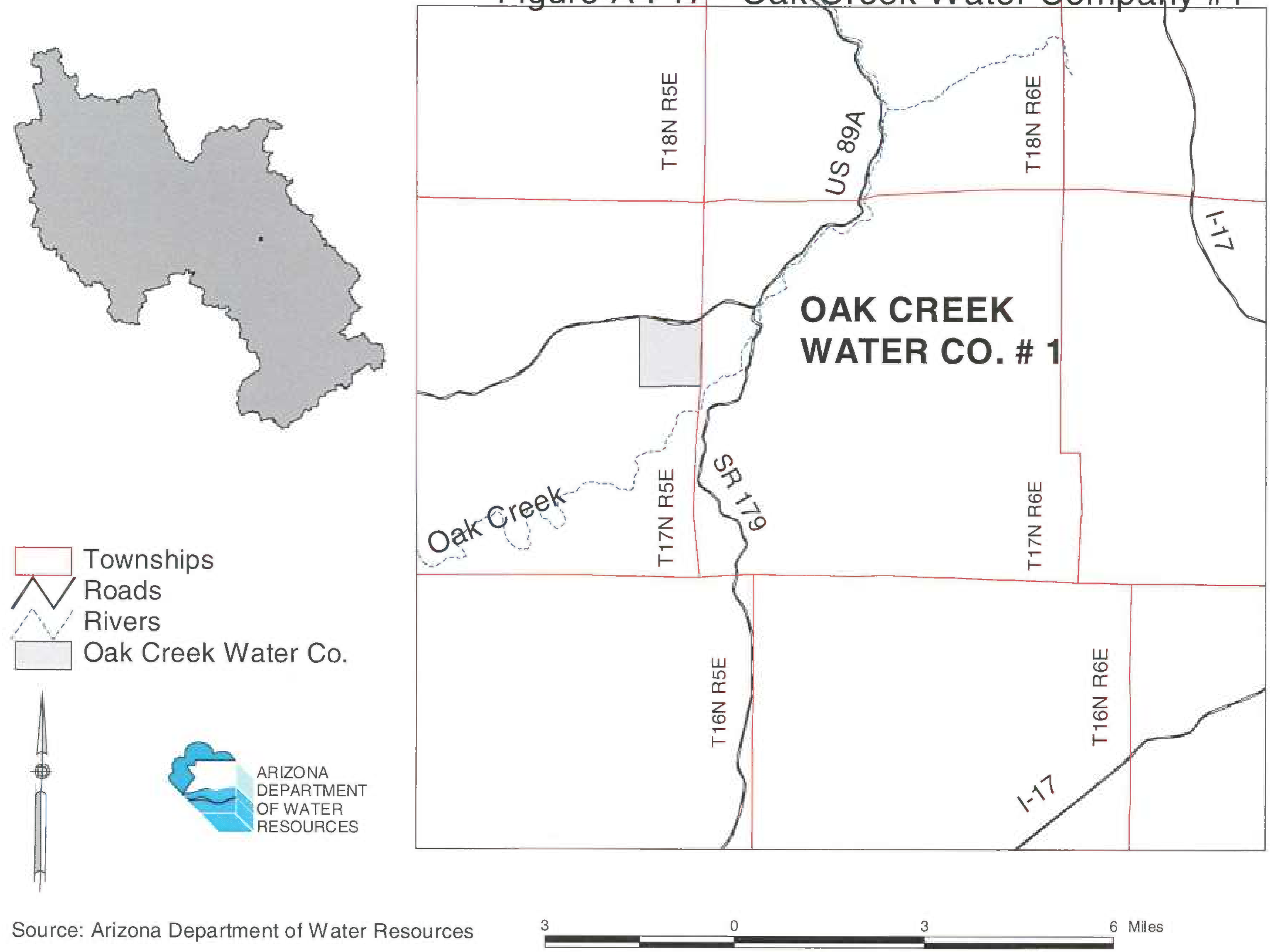
Oak Creek Water Company #1 relies exclusively on groundwater for its water supply. Groundwater is supplied by three wells that are owned, operated, and metered by the company. The total storage capacity of the system is 354,000 gallons. There are 600 plus residential and commercial connections and no industrial connections. Some of the commercial connections include the airport and a hotel.

WATER PLANNING

Oak Creek Water Company #1 does have a five-year plan for future requirements that includes an additional well and storage capacity between 150,000 to 200,000 gallons. Also included are plans to redrill the #2 well and have emergency power to pump water to storage tanks should power fail. During the 1996-1997 drought, the company lost one well and had to drill another one in a different location. Since 1964, a new well has been added along with pressure and storage tanks. In 1993, Oak Creek Water Company #1 sold 185,500 gallons of water to the Arizona Water Company. Residents served by Oak Creek Water Company #1 utilize both individual septic tank systems and the City of Sedona•s wastewater treatment plant.

The current charge for water is a minimum $7.00 per 1,000 gallons and $1.85 per 1,000 additional gallons of water.

Figure A . 17 - Oak Creek Water Company #1



Source: Arizona Department of Water Resources

Oak Creek Water Co. # 1

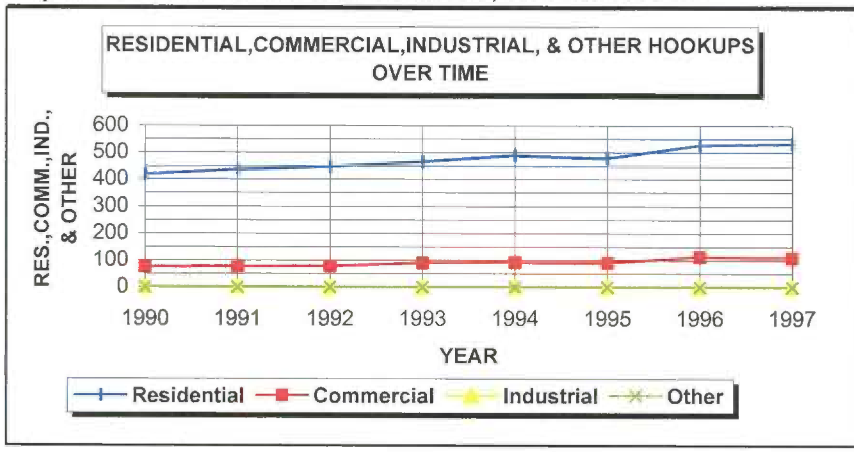
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

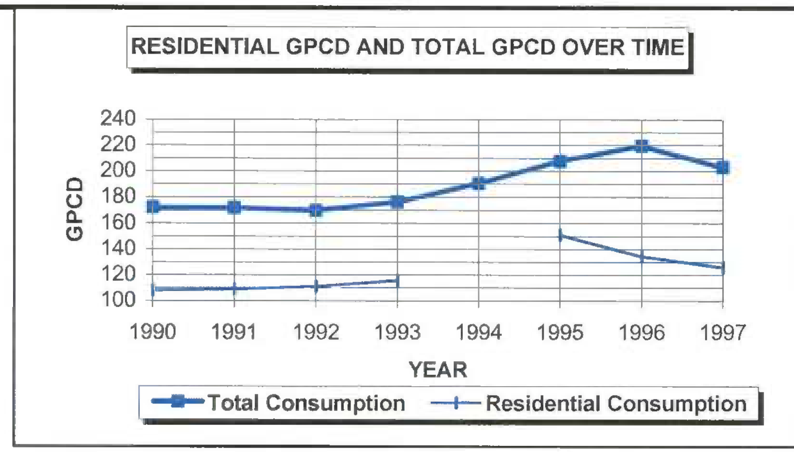
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	418	436	447	465	489	479	527	532
	Gallons delivered (millions)	33.244	34.944	36.556	39.619		53.333	52.237	49.366
	Population	844.36	880.72	902.94	939.3	987.78	967.58	1064.54	1074.64
GPCD*	Total Consumption	172.27	172.00	169.83	176.36	190.67	207.83	219.57	203.11
	Residential Consumption	107.87	108.70	110.92	115.56		151.01	134.44	125.86
Commercial	Hookups	75	76	77	90	92	90	113	109
	Gallons delivered (millions)	19.848	20.346	19.415	20.846		20.066	33.08	30.304
Industrial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Totals	Hookups	493	512	524	555	581	569	640	641
	Gallons delivered (millions)	53.092	55.290	55.971	60.465		73.399	85.317	79.670

*GPCD = Total or Residential Consumption / local area population / 365 days

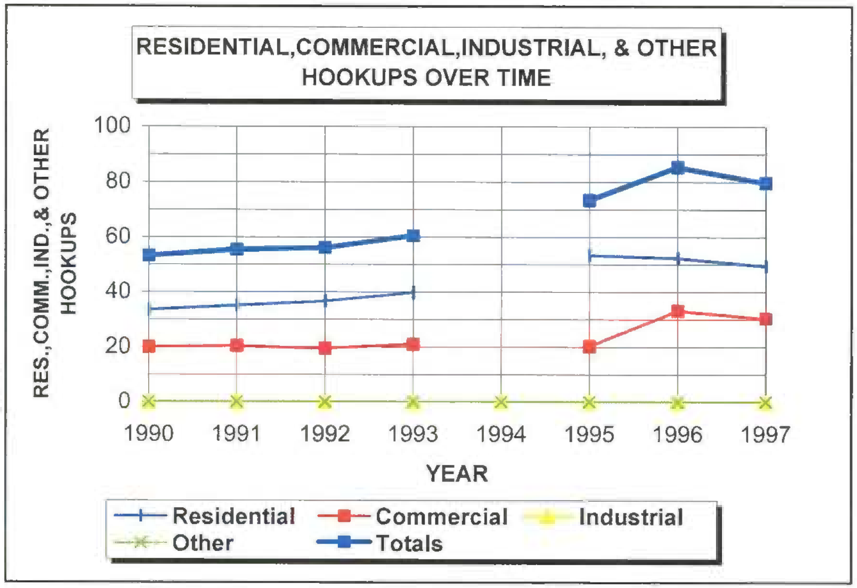
Population (Local area population)= Avg. persons per household x Residential hookups

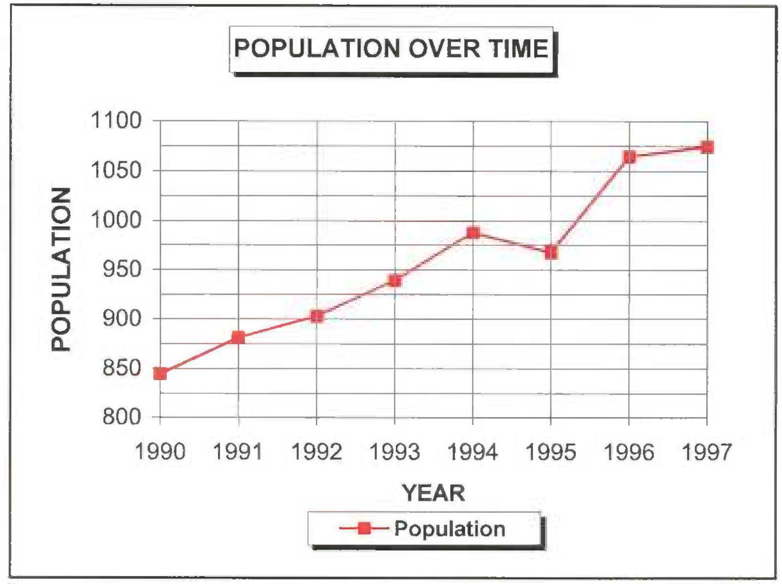
Population Statistics used for GPCD: ADES, 1990 Census Data





OAK CREEK WATER CO. # 1





Seasonal Water Delivery: The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
25%	46%	29%

TOWN OF PAYSON WATER DEPARTMENT

LOCATION

Payson, Arizona
303 N. Beeline Highway, Payson, Az. 85541

CONTACT

Colin "Buzz" Walker

HISTORY

The initial provider of water for the Town of Payson was the Payson Water Company, which began operations in 1949 and received a Certificate of Convenience and Necessity from the Arizona Corporation Commission in 1953. The Payson Water Company continued to supply water to the Town of Payson until 1966 when they sold the company to United Utilities. United Utilities took over operation of the water company and supplied water to the Town of Payson until August 1, 1980, when the Town of Payson acquired the water utility service. The Town of Payson has operated the water utility service ever since and currently serves a population of more than 11,000 people that includes both residential and commercial customers.

Responded to the 1998 survey.

WATER SOURCES

The Town of Payson relies on groundwater and treated effluent for its sources of water. Although the vast majority is groundwater, a small amount of treated effluent supplied by the Northern Gila County Sanitary District is utilized to meet the demands of the municipal golf course and park. The Town of Payson currently owns and operates 48 wells, of which 22 are metered. The total storage capacity of the system is 6,630,000 gallons.

WATER PLANNING

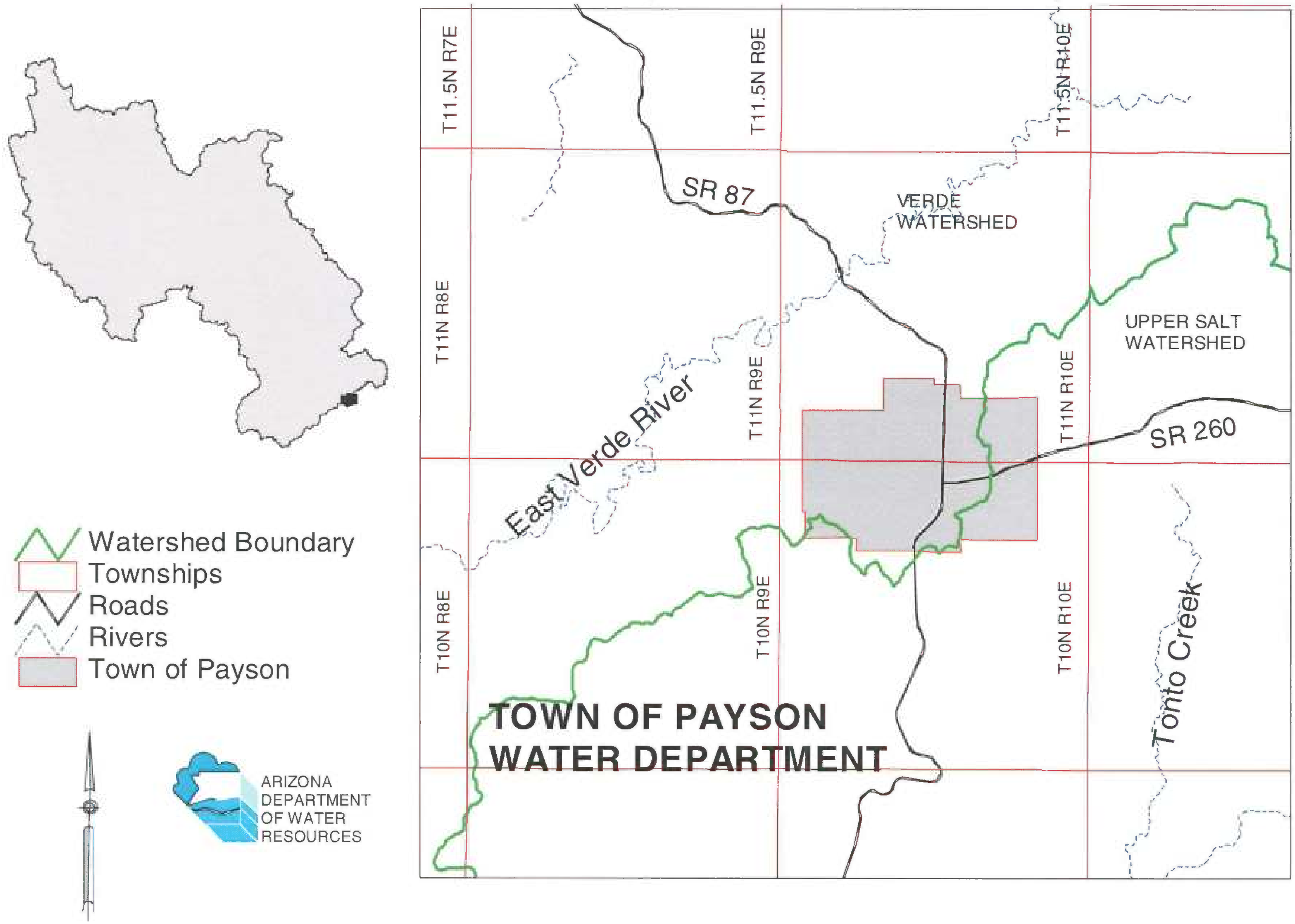
The Town of Payson Water Department conducts water use planning based on a water balancing method of evaluating supply versus demand. Its water balancing method takes into consideration the seasonal fluctuations resulting from tourism and residential populations for predicting peak water demand months.

In response to both future demand and during times of water shortages, the Town of Payson developed and adopted a water conservation ordinance. The ordinance identifies four levels of water conservation with each level requiring greater numbers of water use restrictions. The mayor and city council have also adopted a new pricing structure for water use.

The current cost of water is based on the amount of water consumed each month. Customers are charged an initial rate of $13.65 per 1,000 gallons of usage up to a total of 2,000 gallons. A rate of $1.83 is charged for each 1,000 gallons of usage over 2,000 and up to 10,000 gallons. A rate of $2.20 is charged for each additional 1,000 gallons of usage greater than 10,000 gallons.

The Town of Payson was affected by the 1996-1997 drought in which production capacity was reduced by 10 percent.

Figure A . 18 - Town of Payson



Source: Arizona Department of Water Resources

Town Of Payson Water Co.

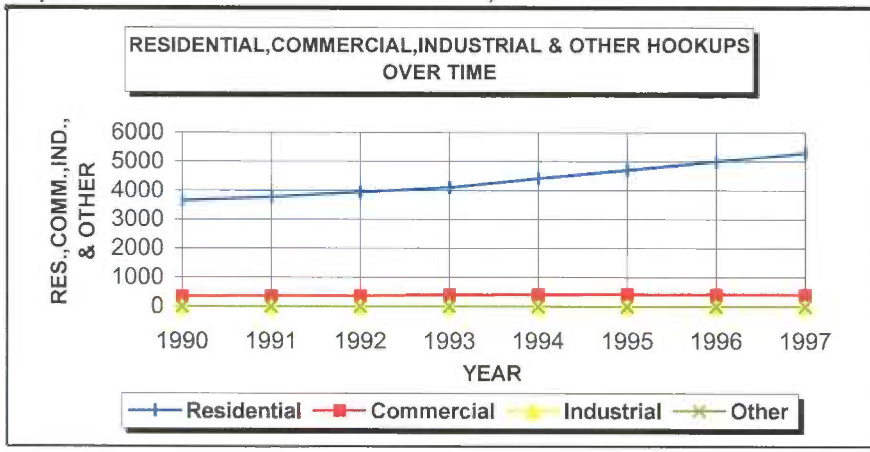
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

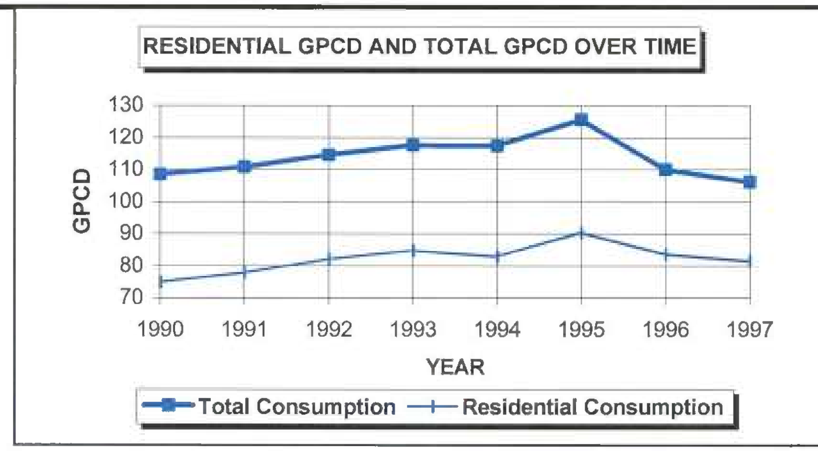
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	3659	3778	3944	4107	4425	4705	4996	5305
	Gallons delivered (millions)	223.976	240.5862	264.655	284.5309	300.0609	347.4173	341.3038	353.5101
	Population	8196.16	8462.72	8834.56	9199.68	9912	10539.2	11191.04	11883.2
GPCD*	Total Consumption	108.58	110.83	114.63	117.69	117.48	125.56	110.05	106.26
	Residential Consumption	74.87	77.89	82.07	84.74	82.94	90.31	83.56	81.50
Commercial	Hookups	350	356	360	387	404	416	398	408
	Gallons delivered (millions)	100.8479	101.7451	104.9934	110.6664	124.9578	135.6061	108.2161	107.3658
Industrial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Totals	Hookups	4009	4134	4304	4494	4829	5121	5394	5713
	Gallons delivered (millions)	324.8239	342.3313	369.6484	395.1973	425.0187	483.0234	449.5199	460.8759

*GPCD = Total or Residential Consumption / local area population / 365 days

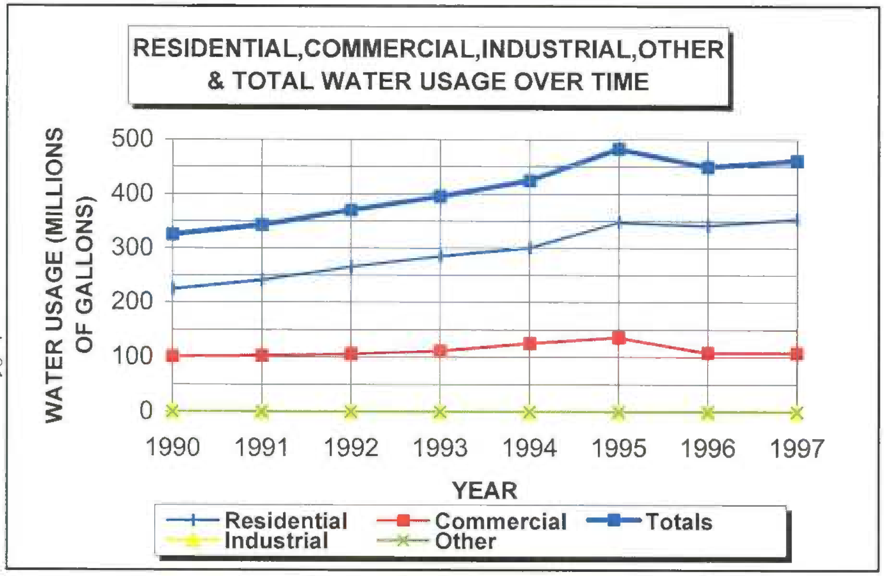
Population (Local area population) = Avg. persons per household x Residential hookups

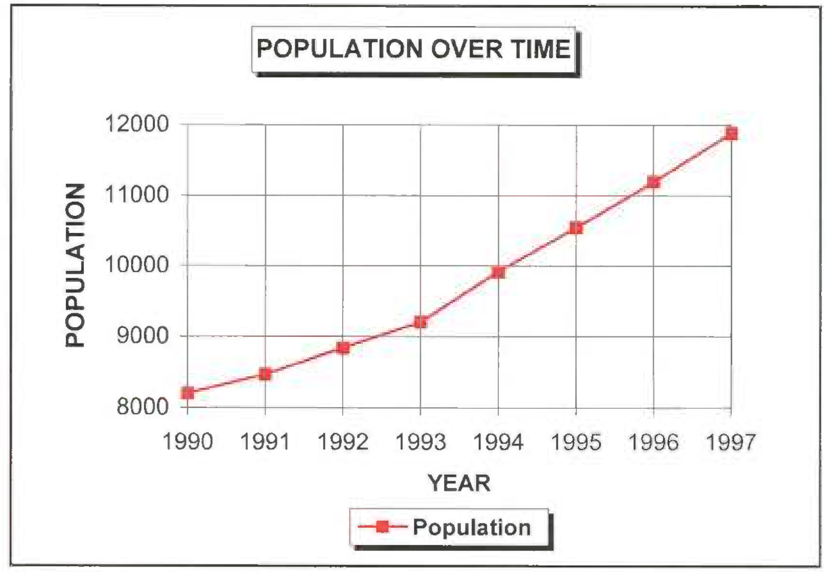
Population Statistics used for GPCD: ADES, 1990 Census Data





TOWN OF PAYSON WATER CO.





Seasonal Water Delivery The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
25%	44%	31%

PINE VALLEY WATER COMPANY

LOCATION

Sedona, Arizona
480 Raintree Road, Sedona, Az. 86351

CONTACT

Judy and Pete Mandeville (Owners)

HISTORY

Pine Valley Water Company was established in July 1972 during development of the subdivision to provide domestic water to the Pine Valley Subdivision. Sedona Modular Home Sales, Inc. was the original developer and owner until Lance Enterprises, Inc. became the new owner in 1979. Pine Valley Water Company currently has 124 mostly permanent connections.

Responded to both the 1995 and 1998 surveys.

WATER SOURCES

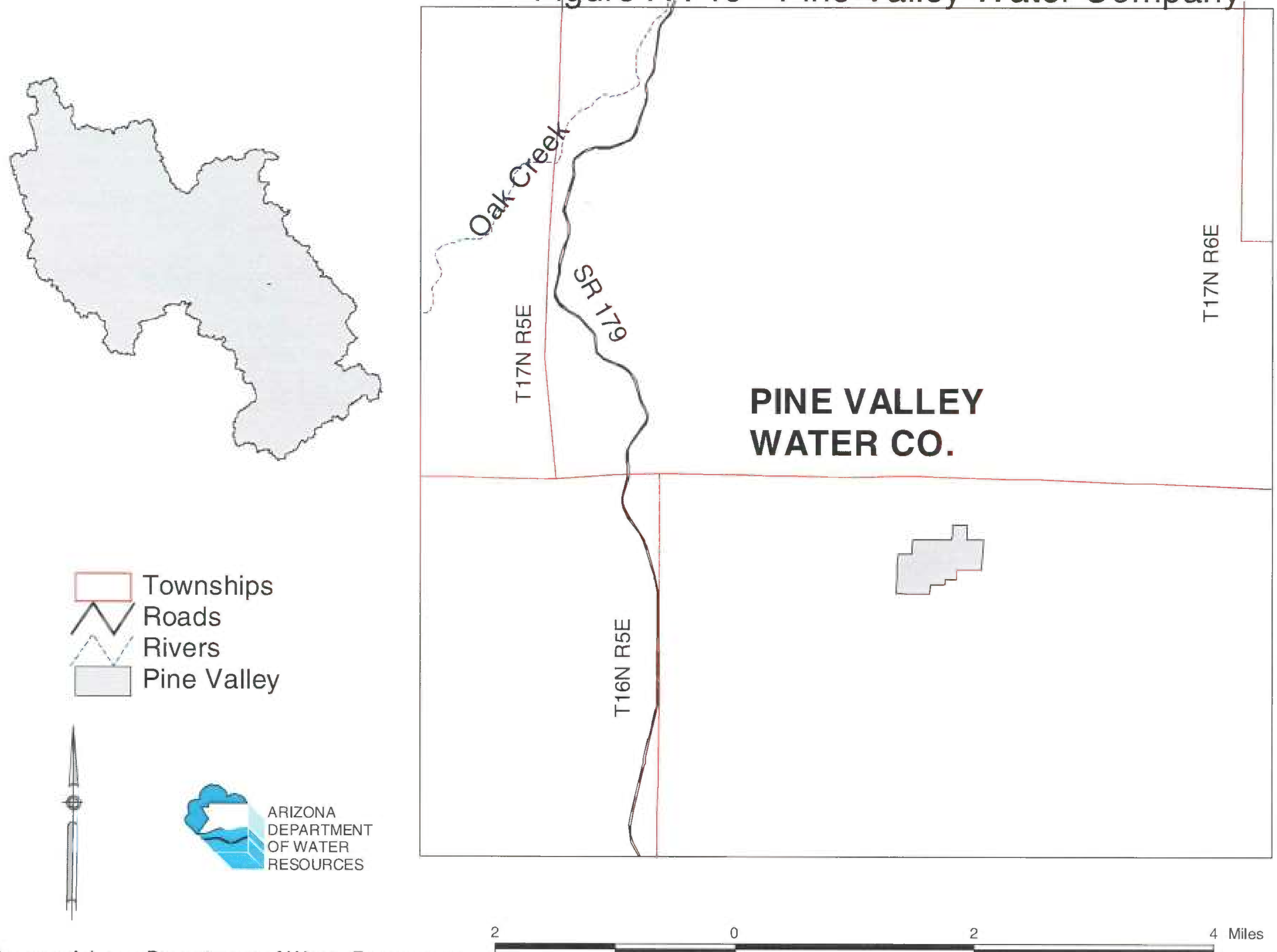
Pine Valley Water Company relies entirely on groundwater for its water supply. The groundwater is generated by one well which is owned, operated, and metered by Pine Valley. The total storage capacity of the system is 190,000 gallons and most of the connections are residential with only a few seasonal.

WATER PLANNING

Pine Valley Water Company does not perform water use planning. It can, however, receive water from Big Park Water Company in case of a water emergency, although this is not an actual agreement. There are some plans for expansion that would include connecting all of the houses in the subdivision. Pine Valley Water Company•s water delivery was not impacted from the 1996-1997 drought.

The current water charges are $16.50 per 1,000 gallons, $2.75 per 4,000 gallons, and $3.26 per 5,000 gallons.

Figure A . 19 - Pine Valley Water Company



Source: Arizona Department of Water Resources

Pine Valley Water Co.

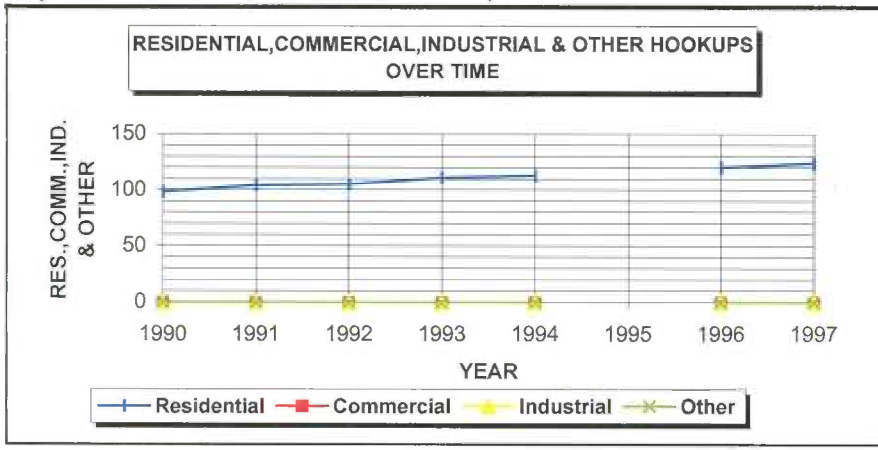
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

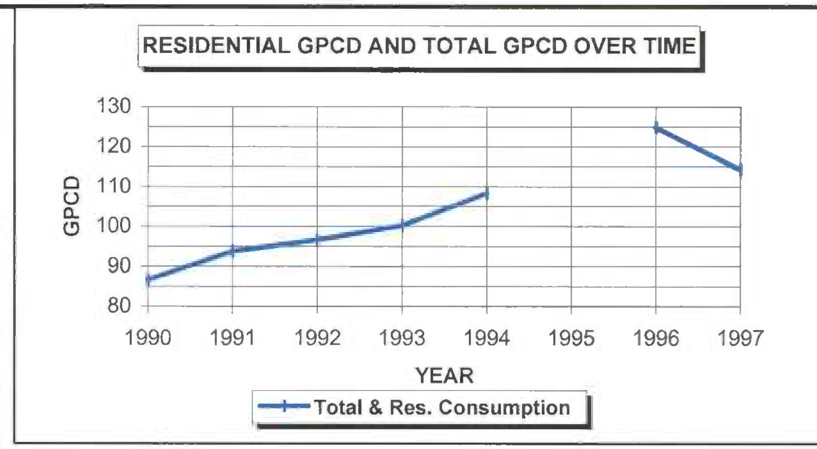
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	98	104	105	111	113		120	124
	Gallons delivered (millions)	6.263115	7.187628	7.481264	8.200619	9.021492		11.05	10.455
	Population	197.96	210.08	212.1	224.22	228.26		242.4	250.48
GPCD*	Total & Res. Consumption	86.68	93.74	96.64	100.20	108.28		124.89	114.36
Commercial	Hookups	0	0	0	0	0		0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Industrial	Hookups	0	0	0	0	0		0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	0	0	0	0	0		0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Totals	Hookups	98	104	105	111	113		120	124
	Gallons delivered (millions)	6.263115	7.187628	7.481264	8.200619	9.021492		11.050	10.455

*GPCD =Total or Residential Consumption / local area population / 365 days

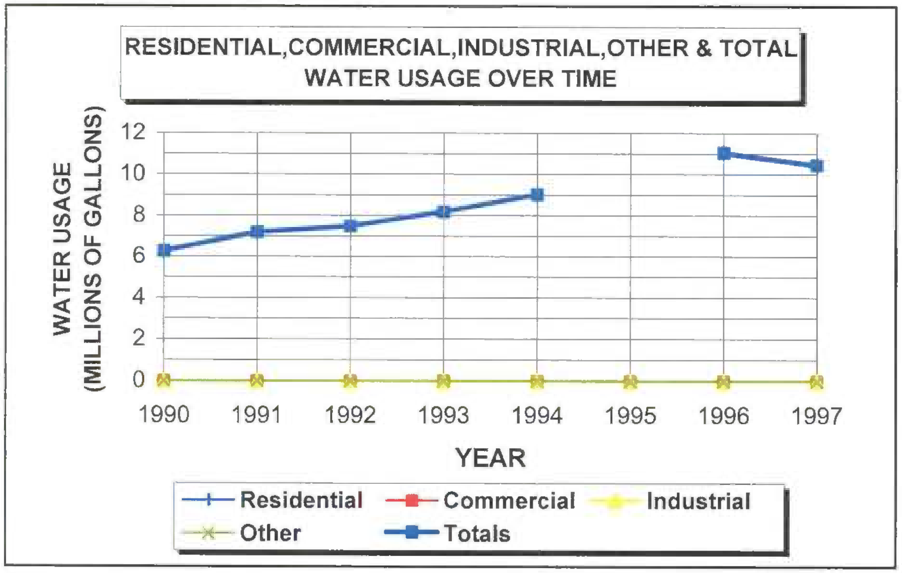
Population (Local area population)= Avg. persons per household x Residential hookups

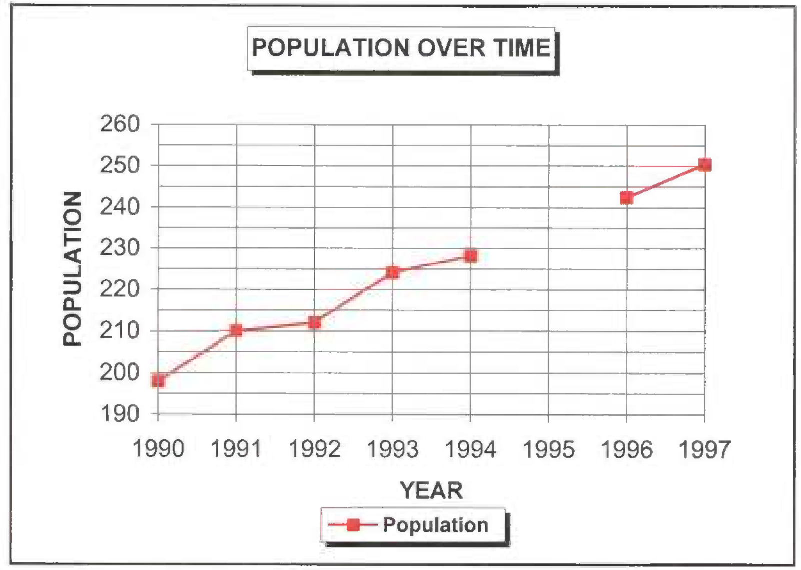
Population Statistics used for GPCD: ADES, 1990 Census Data





PINE VALLEY WATER CO.





Seasonal Water Delivery The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
25%	50%	25%

SEDONA SHADOWS

LOCATION

Sedona, Arizona
6770 W. Highway 89A #278, Sedona, Az. 86336

CONTACT

Wendy Ferguson

HISTORY

The property was initially developed in 1972 by an unknown developer and then purchased in 1979 by Sedona Venture. The water company was formed to provide domestic water to permanent residents within the subdivision and has been in operation since 1984 when municipal operations started. Sedona Venture was recently purchased by the Sedona Shadows Subdivision now known as Sedona Shadows.

Responded to both the 1995 and 1998 surveys.

WATER SOURCES

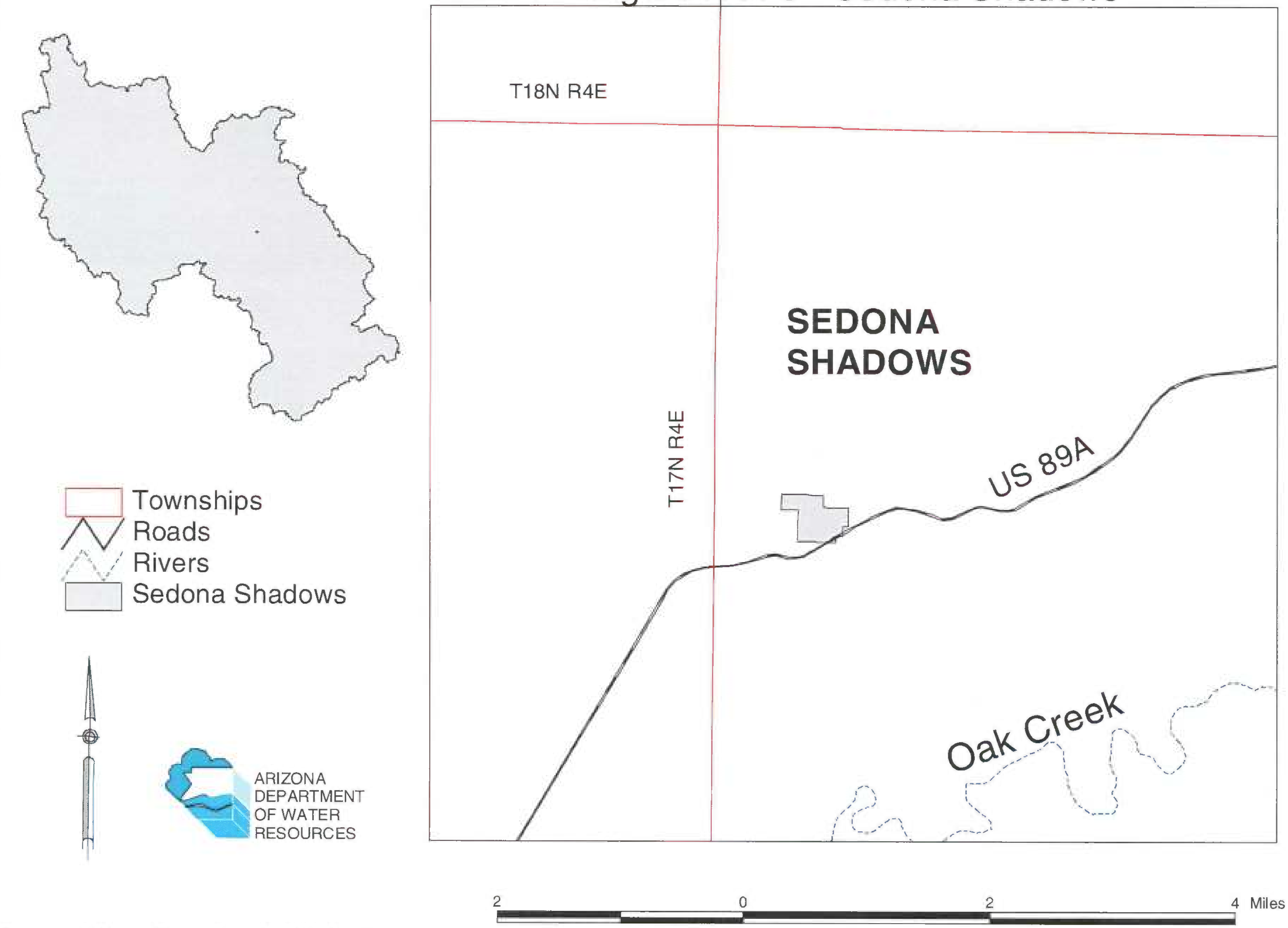
Sedona Shadows relies entirely on groundwater for its water supply. The groundwater is generated by one well which is owned, operated, and maintained by the subdivision. The subdivision actually owns two wells, however, one well is permanently capped and both wells are unmetered. The total storage capacity of the system is 110,000 gallons.

WATER PLANNING

Sedona Shadows does not perform water use planning nor does it have an agreement with another company to provide water in an emergency situation. There are pumps and motors within the system that can operate staggered or offset to provide water. There is also a wastewater treatment plant that has been in operation since 1972 for the residents of Sedona Shadows. It is not known if the 1996-1997 drought had any impact on its ability to provide water.

The current charge for water consists of a base fee of $5.00 per month plus an additional $5.00 per 1,000 gallons of use.

Figure A . 20 - Sedona Shadows



Source: Arizona Department of Water Resources

Sedona Shadows

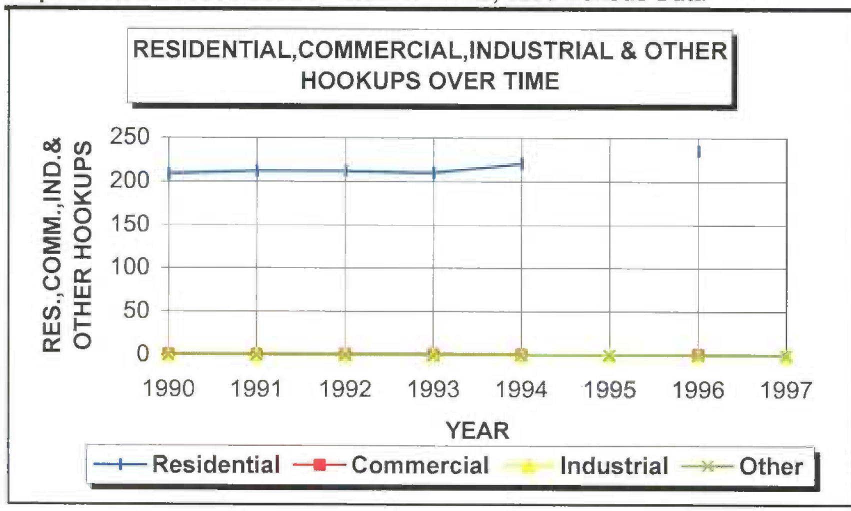
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

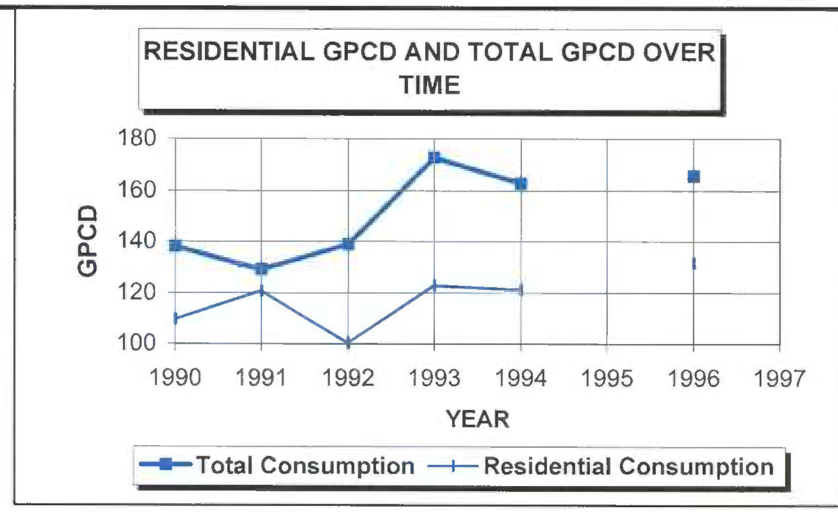
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	208	212	212	210	220		235	
	Gallons delivered (millions)	16.787	18.835	15.672	19.023	19.638		22.793	
	Population	420.16	428.24	428.24	424.2	444.4		474.7	
GPCD*	Total Consumption	138.00	129.03	138.87	172.90	162.65		165.58	
	Residential Consumption	109.46	120.50	100.26	122.86	121.07		131.55	
Commercial	Hookups	1	1	1	1	1		1	
	Gallons delivered (millions)	4.376	1.334	6.034	7.747	6.744		5.897	
Industrial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Totals	Hookups	209	213	213	211	221		236	
	Gallons delivered (millions)	21.163	20.169	21.706	26.770	26.382		28.690	

*GPCD = Total or Residential Consumption / local area population / 365 days

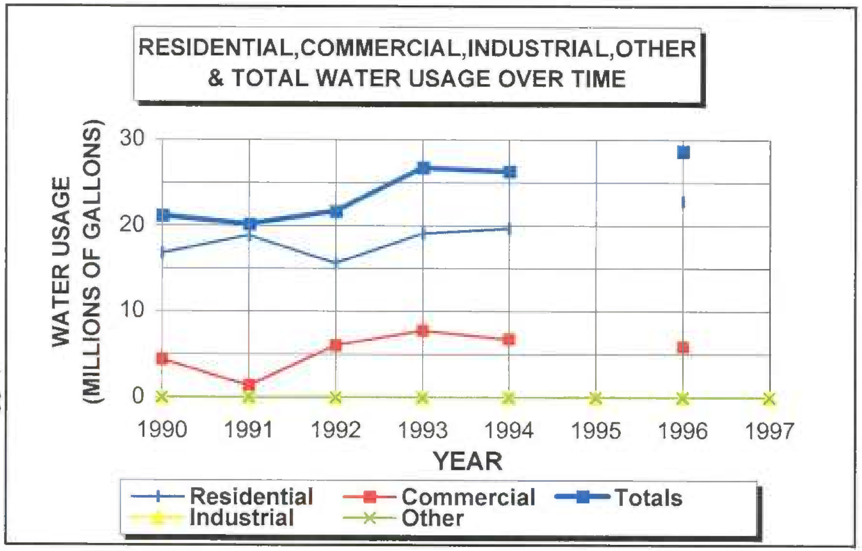
Population (Local area population)= Avg. persons per household x Residential hookups

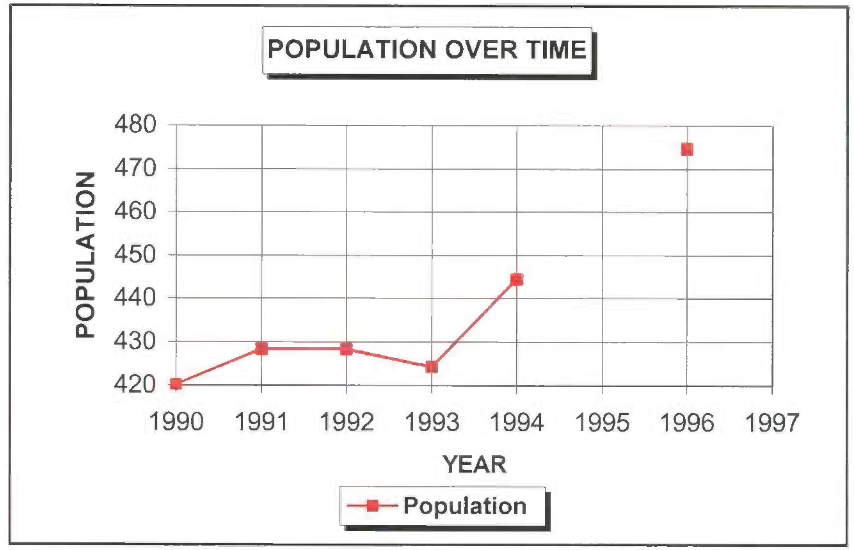
Population Statistics used for GPCD: ADES, 1990 Census Data





SEDONA SHADOWS





Seasonal Water Delivery The following presents the percentage of total annual flow delivered during each period as defined.

*** These figures are taken from Arizona Water Company's Sedona System, since Sedona Shadows were not able to provide them.**

*Jan. - April	*May - August	*Sept. - Dec.
25%	45%	30%

STRAWBERRY WATER COMPANY

LOCATION

Strawberry, Arizona
HC 1 Box 702, Pine, Az. 85544

CONTACT

Lufkin Hunt
Mary Hunt

HISTORY

The Strawberry Water Company was established and has been in operation since 1953 to supply domestic water to the residents of Strawberry, Arizona. The current owners, Lufkin and Mary Hunt, have owned and operated the Strawberry Water Company since January 1972.

Responded to 1998 survey.

WATER SOURCES

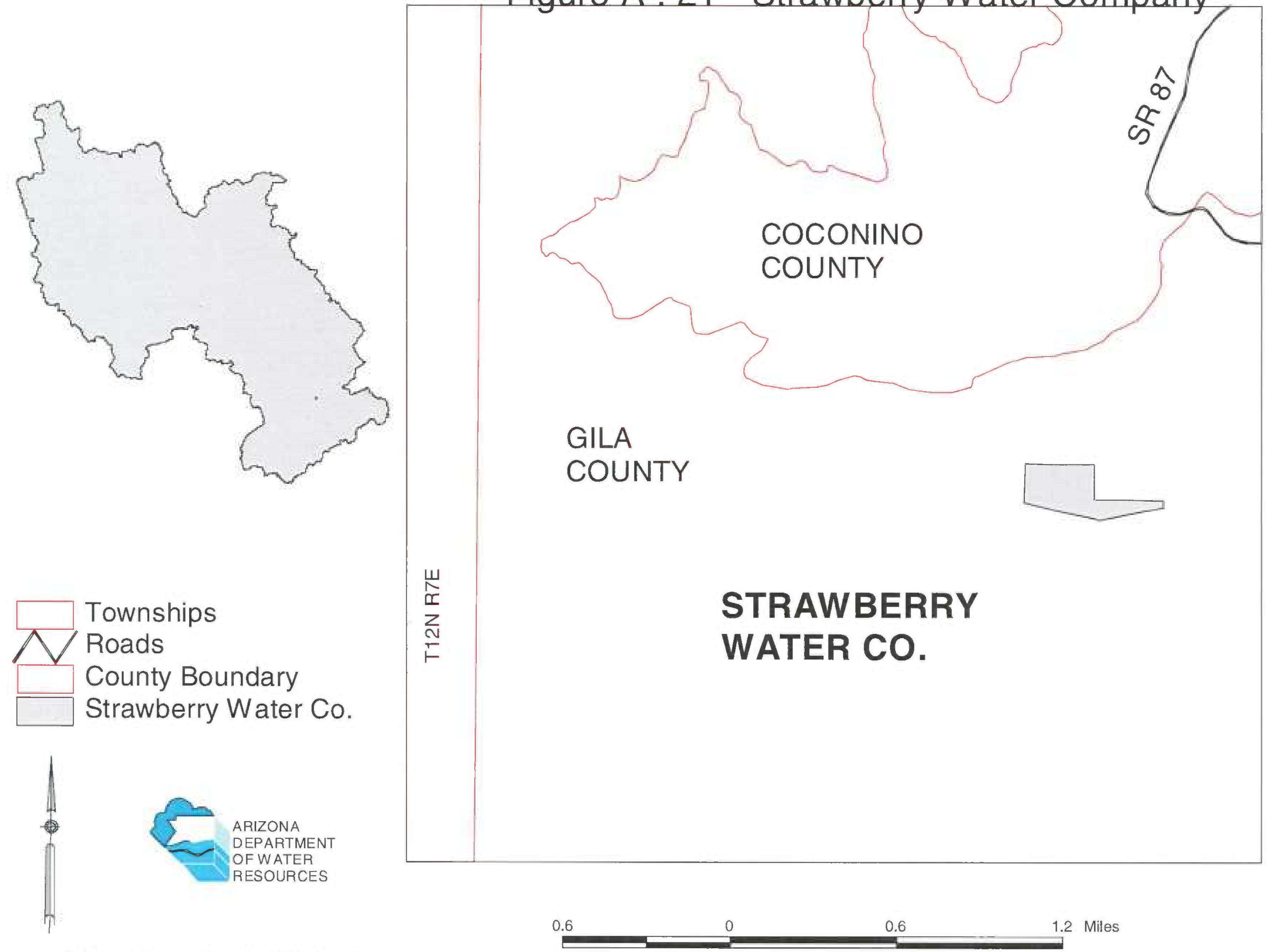
The Strawberry Water Company relies entirely on groundwater for all of its water supply. The groundwater is supplied by three unmetered wells that are owned, operated, and maintained by the Strawberry Water Company. The total storage capacity of the system is 10,000 gallons.

WATER PLANNING

The Strawberry Water Company does not perform water use planning. In case of an emergency or during drought conditions such as in 1996-1997, water must be hauled in. During this time, the Strawberry Water Company had to limit water use and hauled in 50,000 gallons of water.

The current charge for water is $12.00 per month.

Figure A . 21 - Strawberry Water Company



Source: Arizona Department of Water Resources

Strawberry Water Co.

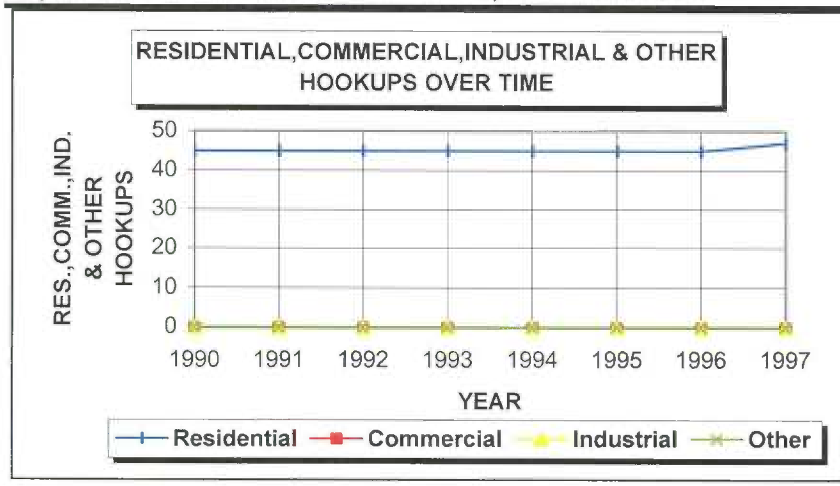
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	45	45	45	45	45	45	45	47
	Gallons delivered (millions)								
	Population for service area:								
GPCD	*Gallons per capita per day								
Commercial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Industrial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)								
Totals	Hookups	45	45	45	45	45	45	45	47
	Gallons delivered (millions)								

*GPCD = Total or Residential Consumption / local area population / 365 days

Population(Local area population)=Avg. persons per household x Residential hookups

Population Statistics used for GPCD: ADES, 1990 Census Data



Seasonal Water Delv. The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept-Dec.
20%	45%	35%

Due to insufficient data, water usage,GPCD, and population over time graphs are not presented here.

VERDE LAKES WATER CORPORATION

LOCATION **CONTACT**

Approximately six miles east of Camp Verde, Arizona
2867 S. Verde Lakes Drive #B, Camp Verde, Az. 86322

Wes Zwetsch
Donna Williamson

HISTORY

Verde Lakes Water Corporation was formed in March 1979 to provide domestic water to the Verde Lakes Subdivision. This corporation was established and is owned by property owners and water users of the subdivision. Currently, there are 668 residential and commercial connections and most of the population is permanent.

Responded to both the 1995 and 1998 surveys.

WATER SOURCES

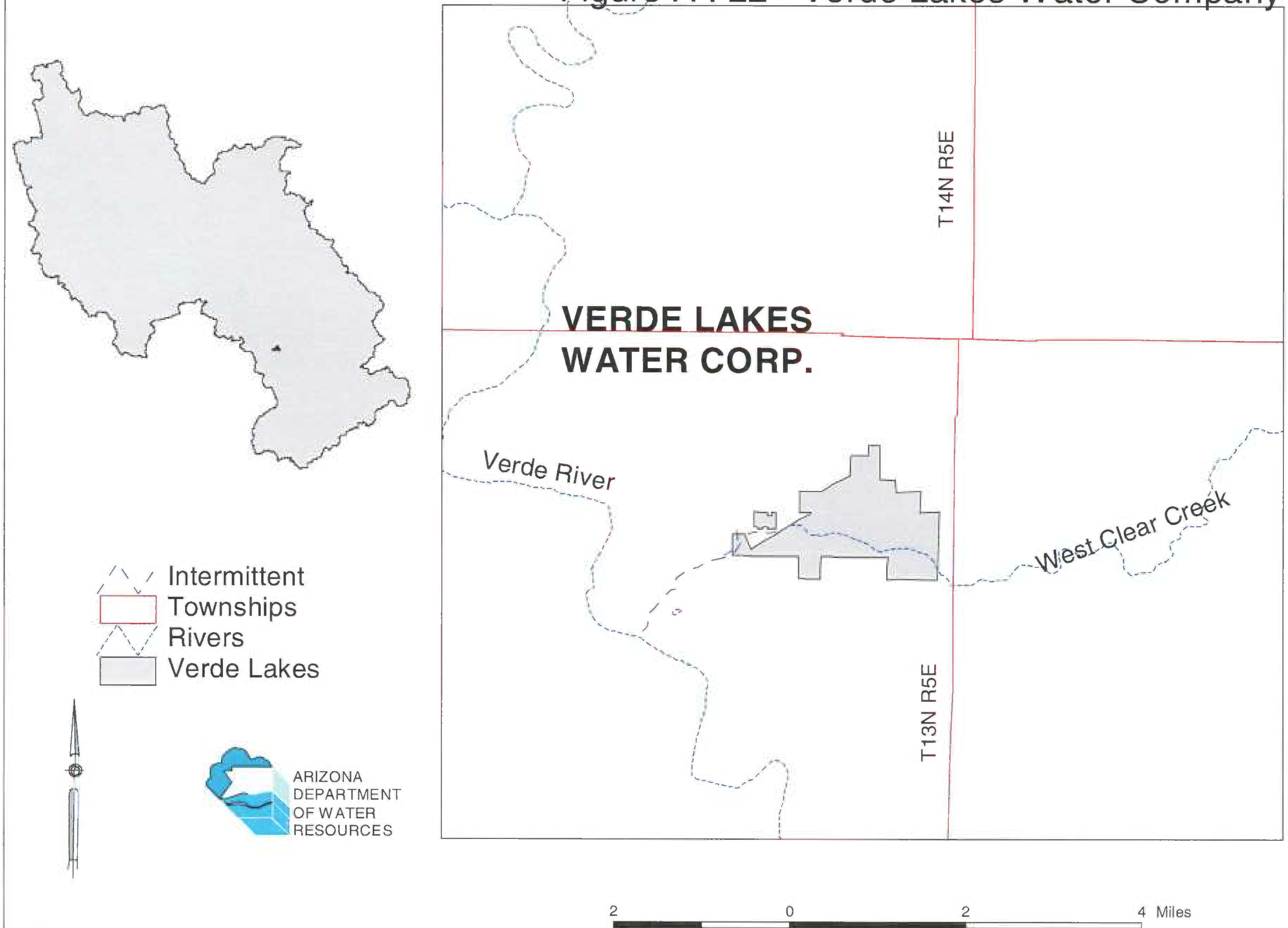
Verde Lakes Water Corporation is completely reliant on groundwater for its water supply. The groundwater is generated by four wells that are owned, operated, and metered by the Verde Lakes Water Corporation and has a total storage capacity of 225,000 gallons. There is one other well currently under construction.

WATER PLANNING

Verde Lakes Water Corporation does not perform water use planning. It was affected by the 1996-1997 drought, and as a result of the drought, it developed a plan against any future droughts. A higher volume pump was installed in one well and another water source had to be located. Also, several water conservation conditions were set up in case of an emergency.

The current water charge is $8.75 per 1,000 gallons (monthly minimum charge). The company has proposed a rate increase to $9.25 per 1,000 gallons. For 1,001 to 6,000 gallons, the current rate is $1.80 with a proposed rate of $1.90. For 6,001 to 15,000 gallons, the current rate is $2.50 with a proposed rate of $2.60. For 15,001 gallons or more, the current rate is $2.50 with a proposed rate of $3.50.

Figure A . 22 - Verde Lakes Water Company



Source: Arizona Department of Water Resources

Verde Lakes Water Corp.

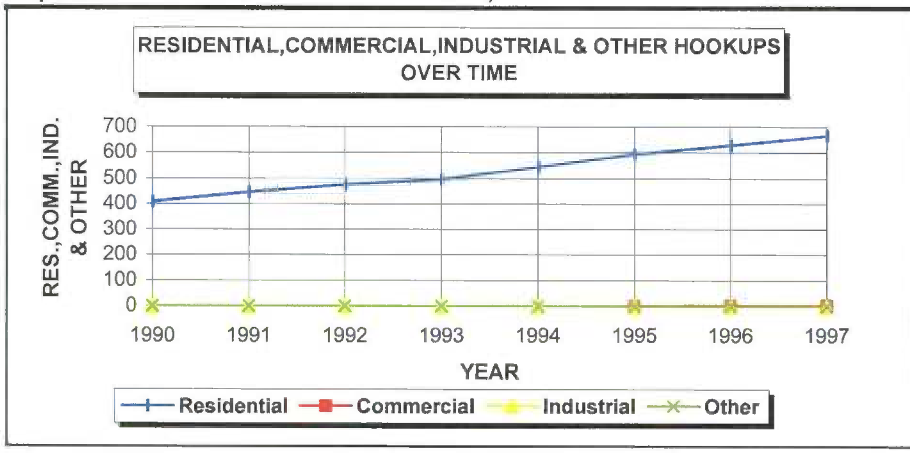
CUSTOMER HOOKUPS AND WATER DELIVERIES 1990-1997

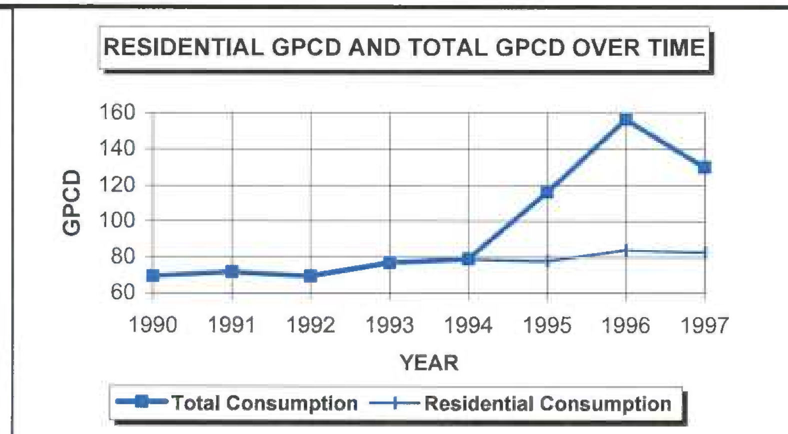
		1990	1991	1992	1993	1994	1995	1996	1997
Residential	Hookups	409	446	476	497	545	594	629	666
	Gallons delivered (millions)	26.641577	30.049979	30.994947	35.833834	40.327319	43.2828	49.513328	51.655166
	Population	1051.13	1146.22	1223.32	1277.29	1400.65	1526.58	1616.53	1711.62
GPCD*	Total Consumption	69.44	71.83	69.42	76.86	78.88	116.44	156.79	130.38
	Residential Consumption	69.44	71.83	69.42	76.86	78.88	77.68	83.92	82.68
Commercial	Hookups						1	2	2
	Gallons delivered (millions)						21.6	43	29.8
Industrial	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Other	Hookups	0	0	0	0	0	0	0	0
	Gallons delivered (millions)	0	0	0	0	0	0	0	0
Totals	Hookups	409	446	476	497	545	595	631	668
	Gallons delivered (millions)	26.641577	30.049979	30.994947	35.833834	40.327319	64.882800	92.513328	81.455166

*GPCD = Total or Residential Consumption / local area population / 365 days

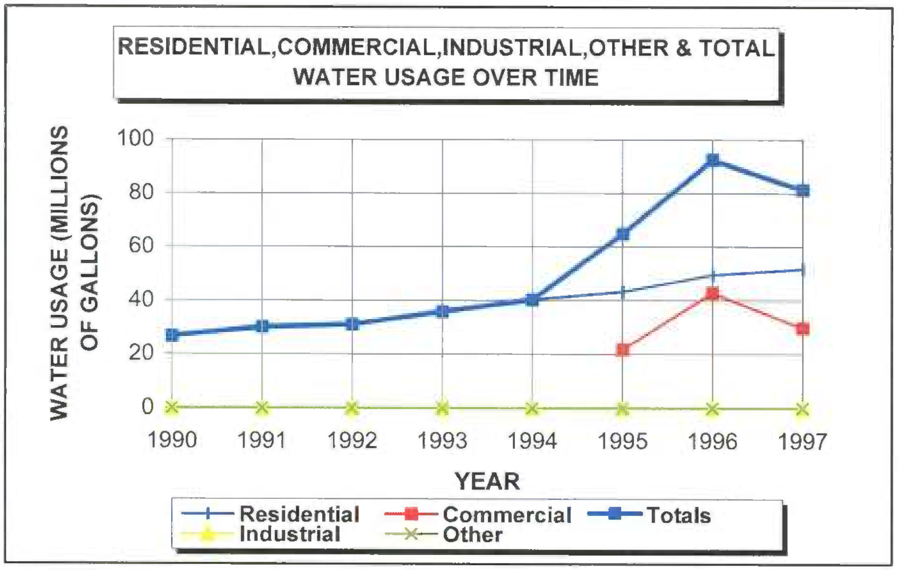
Population (Local area population) = Avg. persons per household x Residential hookups

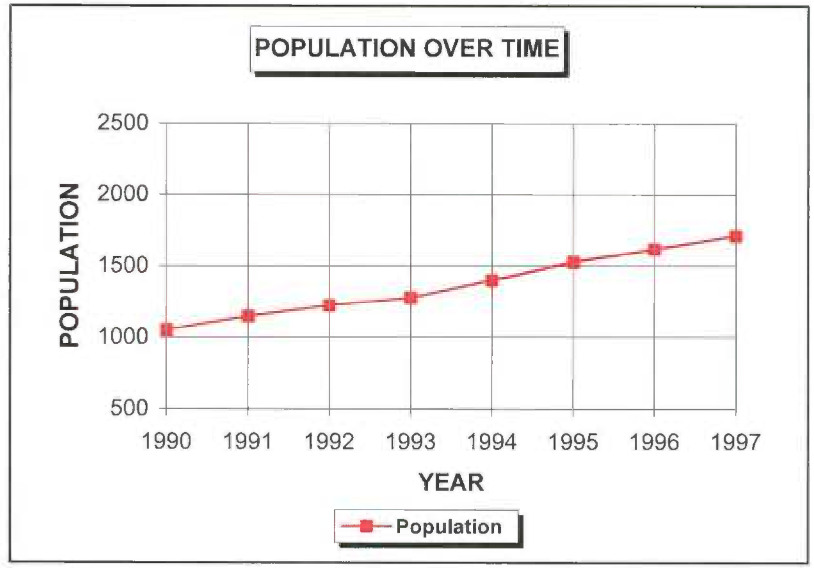
Population Statistics used for GPCD: ADES, 1990 Census Data





VERDE LAKES WATER CORP.





Seasonal Water Delivery The following presents the percentage of total annual flow delivered during each period as defined.

Jan. - April	May - August	Sept. - Dec.
25%	49%	26%

APPENDIX B

APPENDIX B

EXHIBIT 2

SURVEY FOR DITCH COMPANY/WATER PROVIDER

Please provide as much information as you can in the spaces provided. You may use additional sheets if necessary. If a question does not apply to your company, indicate this with "N/A."

Water Provider/Ditch Name: ______________________________

Date: ______________________________

1. What was the construction date of the ditch? ______________________

2. Provide the number of users on the ditch system: ______________________

3. Provide the number of irrigated acres: ______________________

4. Are you still maintaining flow records? _____Yes _____No
   If yes, could you provide us with a record?

5. How is your ditch water flow measured? ______________________
   ____
   ____
   ____

6. Are there any return flows, either directly to the river or downstream to another irrigation provider? _____Yes _____No
   If yes, estimate the number of gallons: ______________________

7. Provide the amount of annual delivery of water since 1990: ______________________

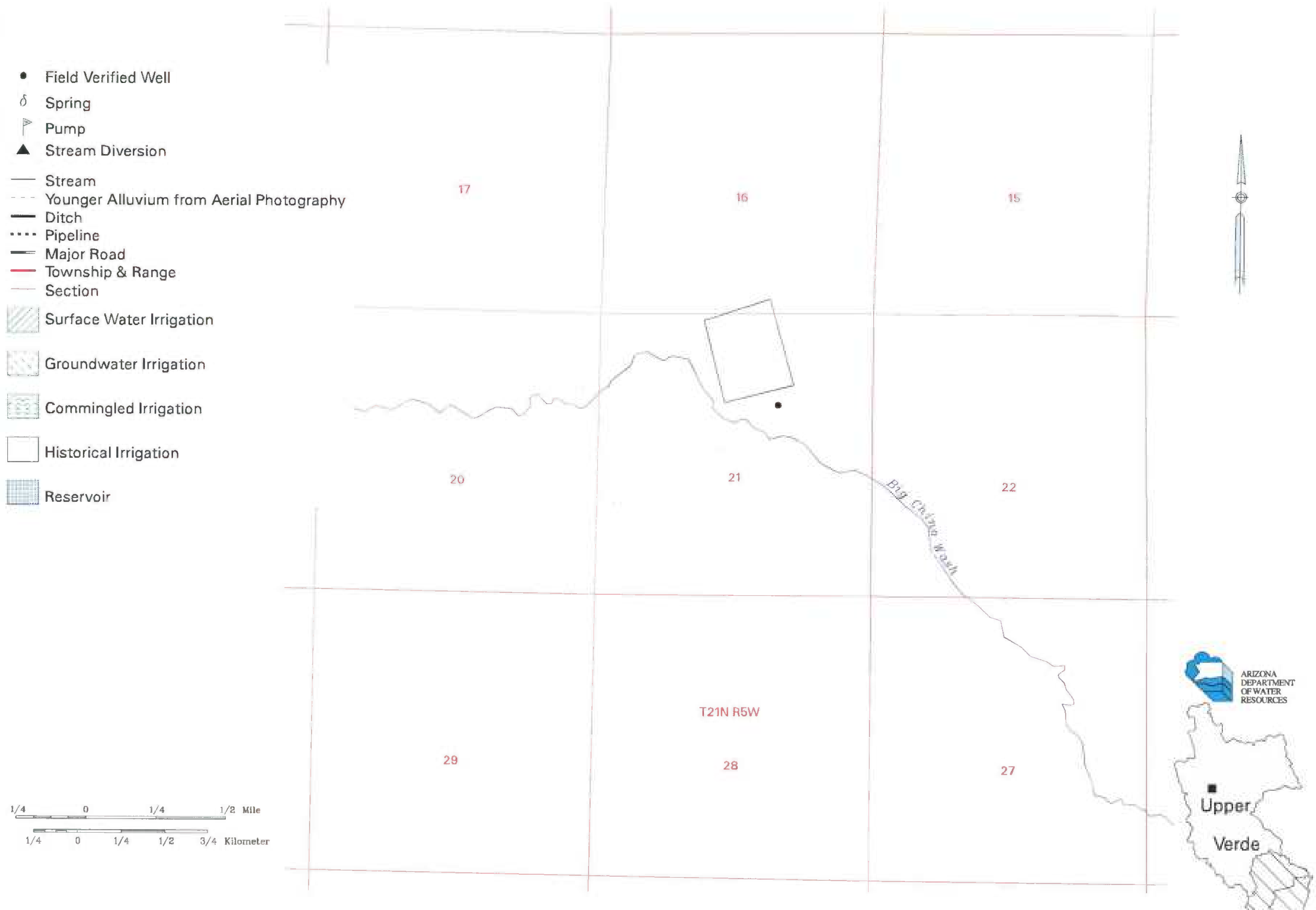
8. How did the drought of 1996-1997 impact your abilities to meet the demand for water?
   ____
   ____
   ____
   ____
   ____

9. As a result of the drought, has your company developed a plan to minimize impacts from future droughts? _____Yes _____No

10. May we have a copy of your plan? _____Yes _____No
    If yes, please include it with any other plans pertaining to water resource management that we may have copies of.

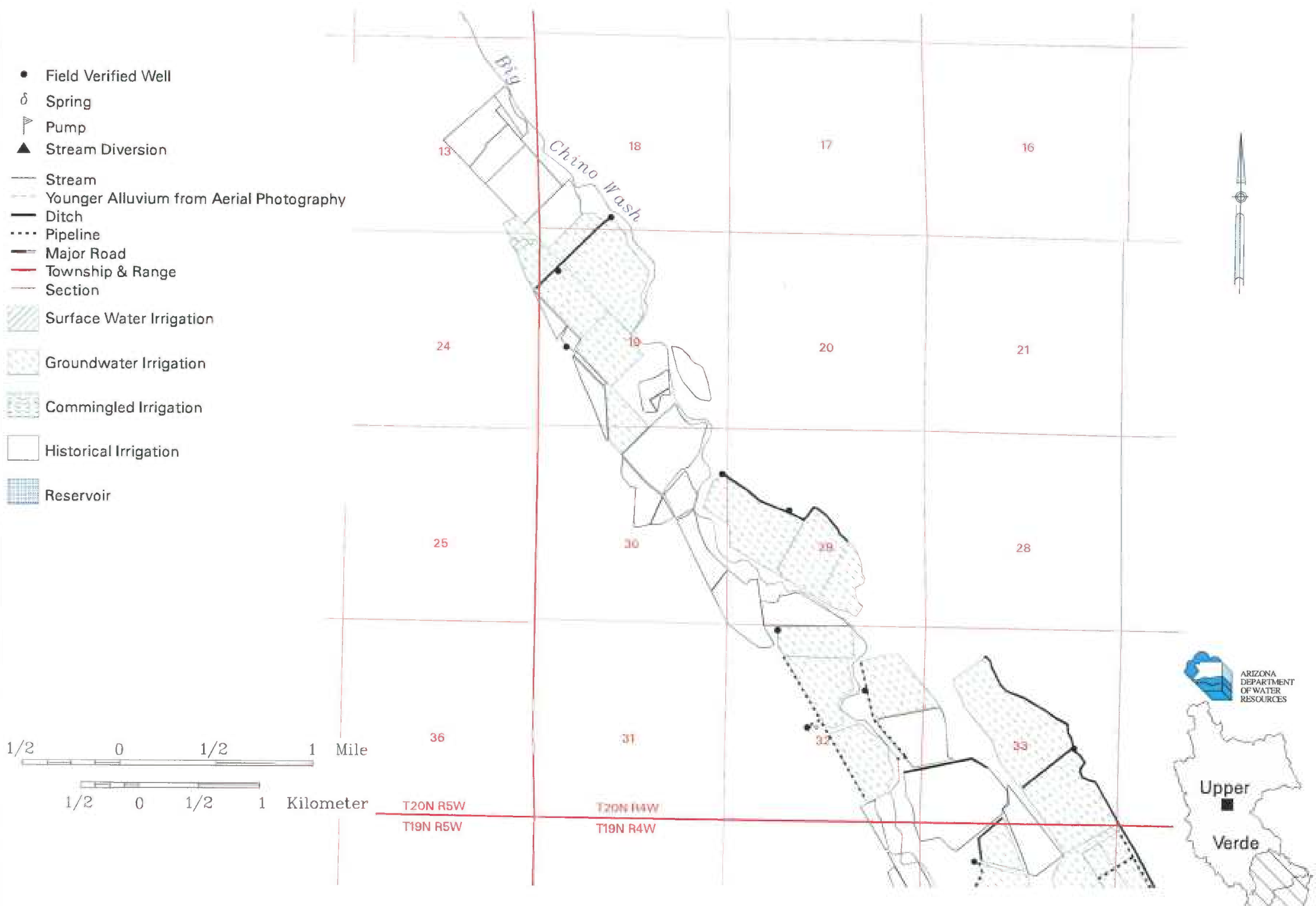
11. What is your current charge for water to your customers (members)? ______________

Figure B.1 - Current and Historical Irrigation in the Northern Big Chino Valley Area



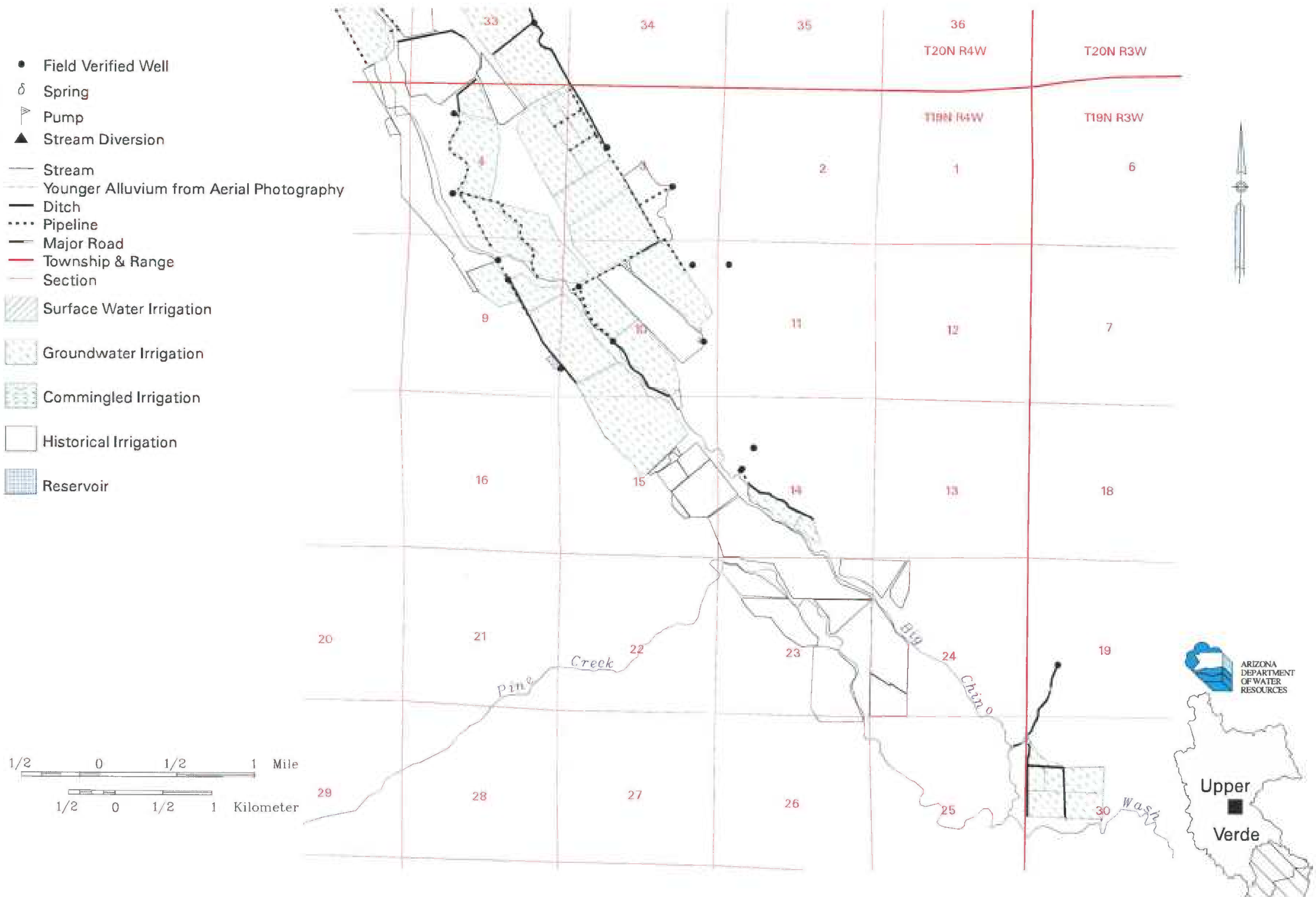
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.2 - Current and Historical Irrigation in the Big Chino Valley Area



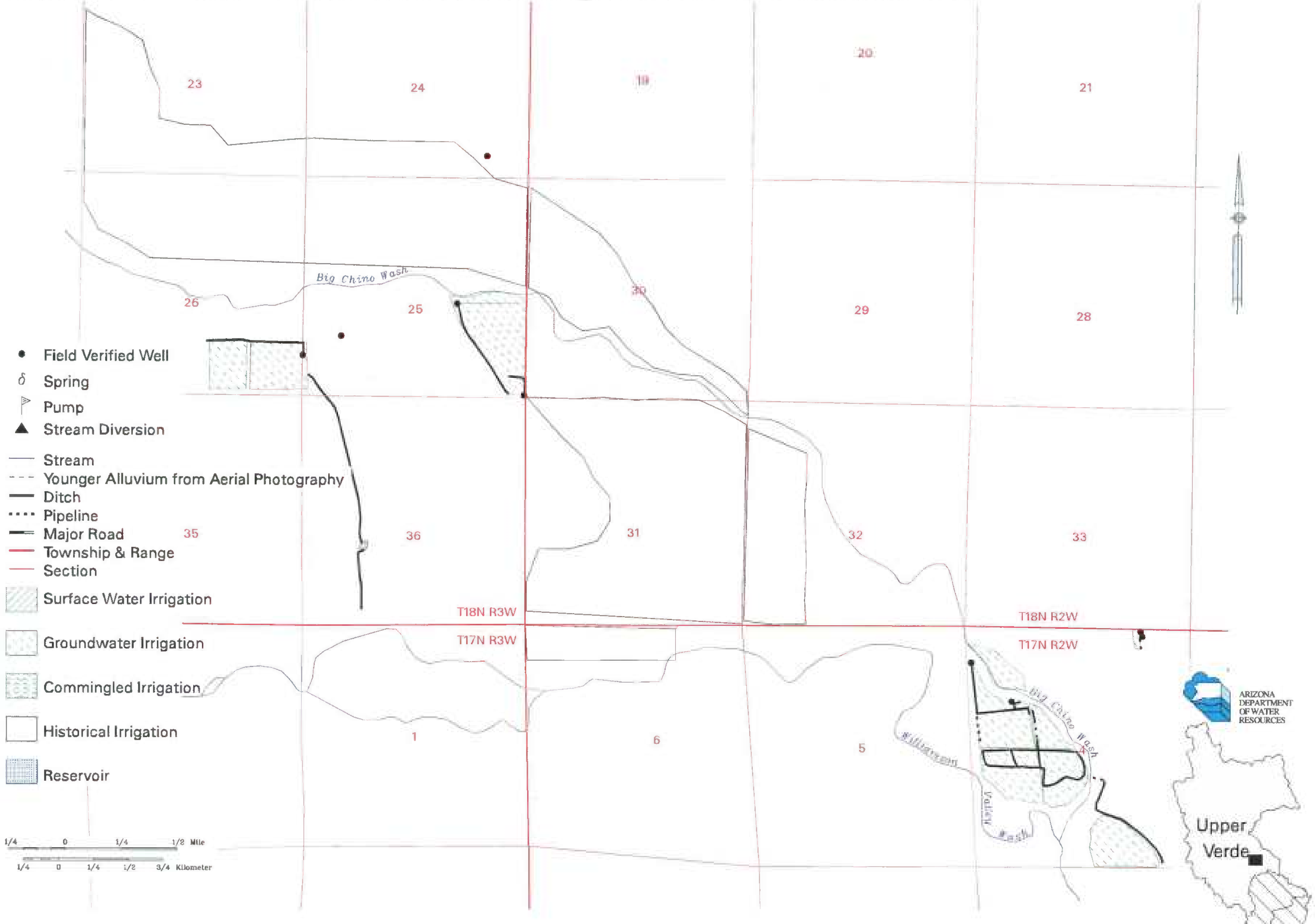
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.3 - Current and Historical Irrigation in the Big Chino Valley Area



Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.4 - Current and Historical Irrigation in the Paulden Area

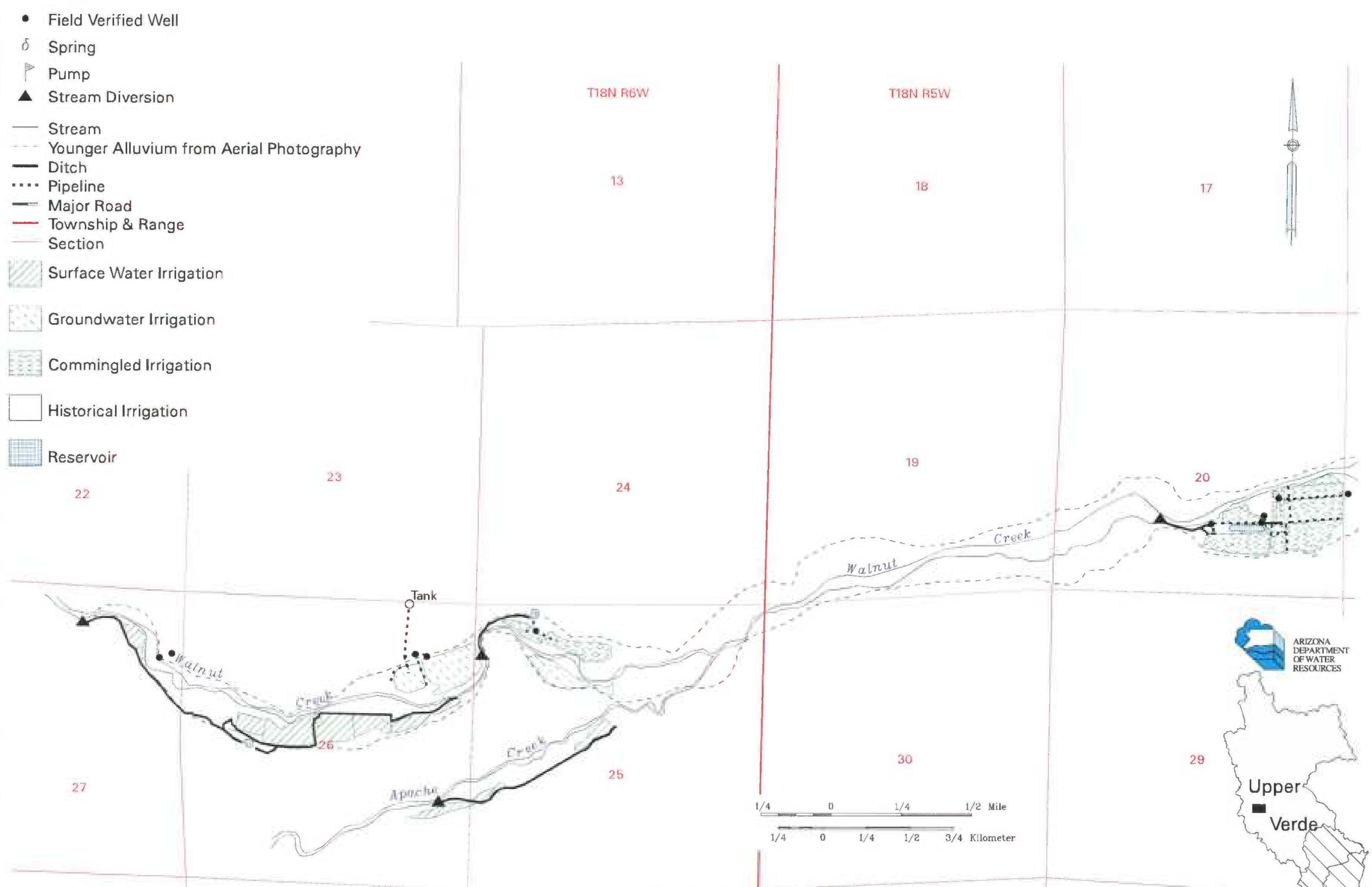


Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.5 - Current and Historical Irrigation in Yavapai Ranch Area

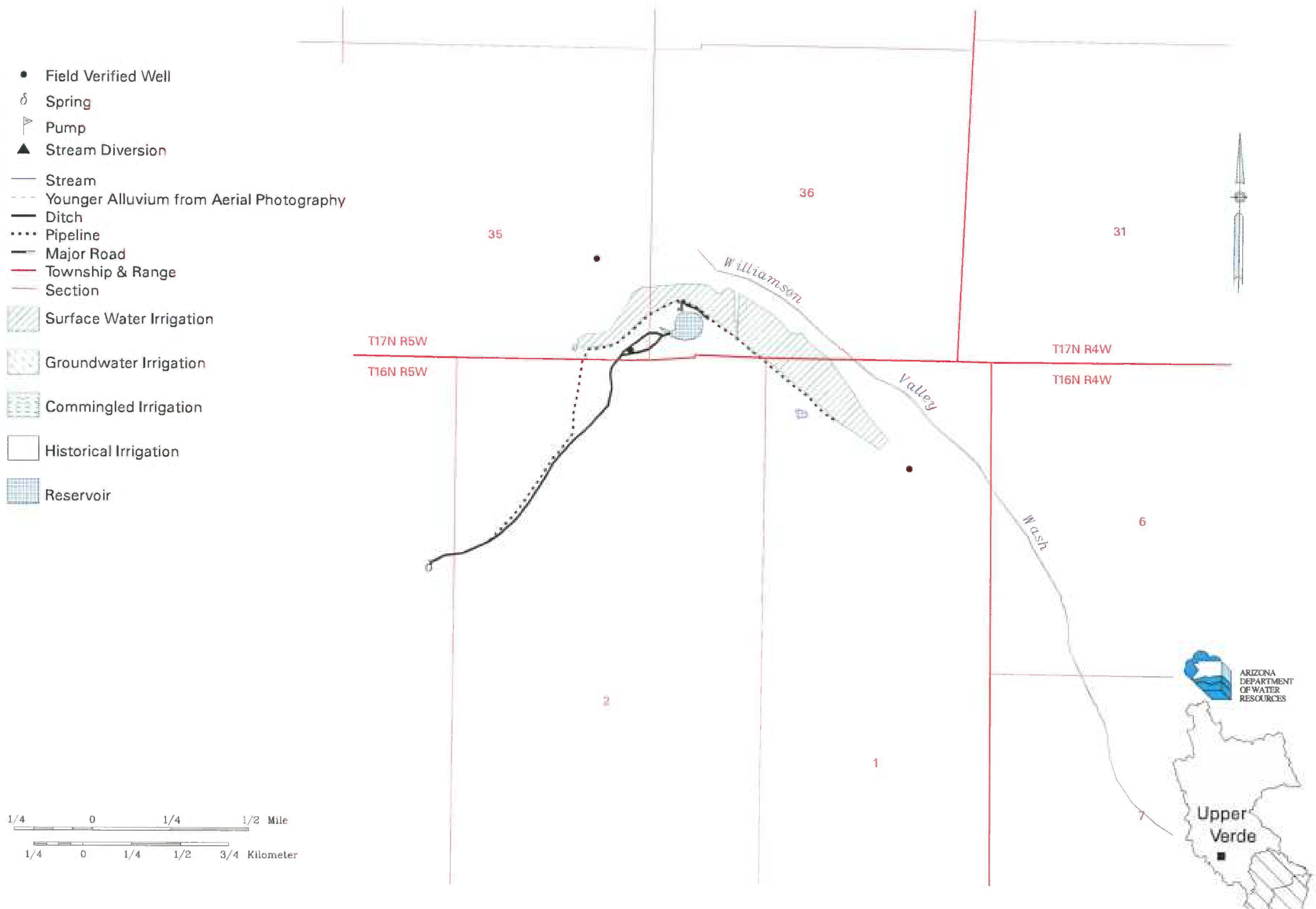
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.6 - Current and Historical Irrigation Along Apache and Walnut Creeks



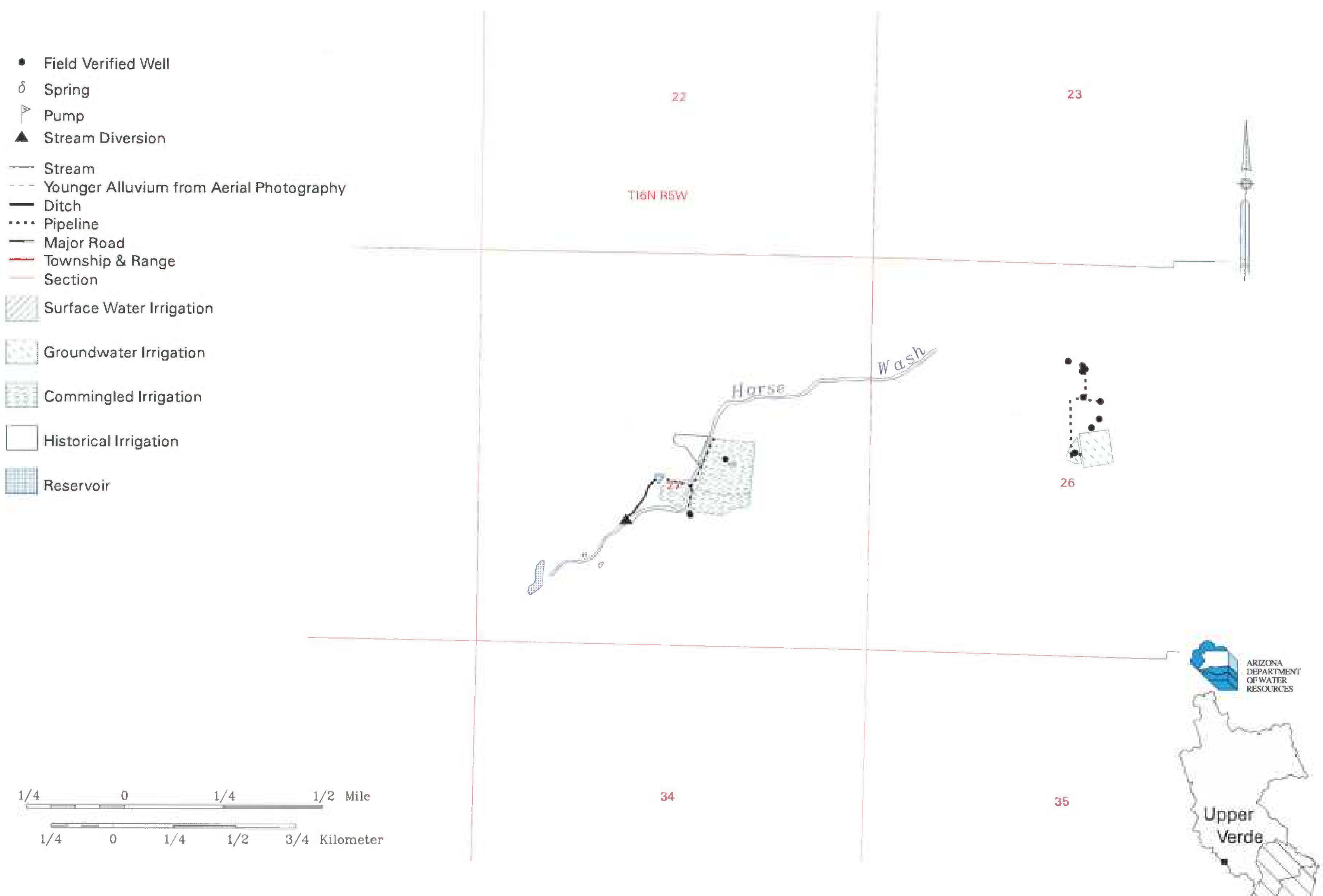
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.7 - Current and Historical Irrigation Along West Williamson Valley Wash



Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.8 - Current and Historical Irrigation Along Horse Wash

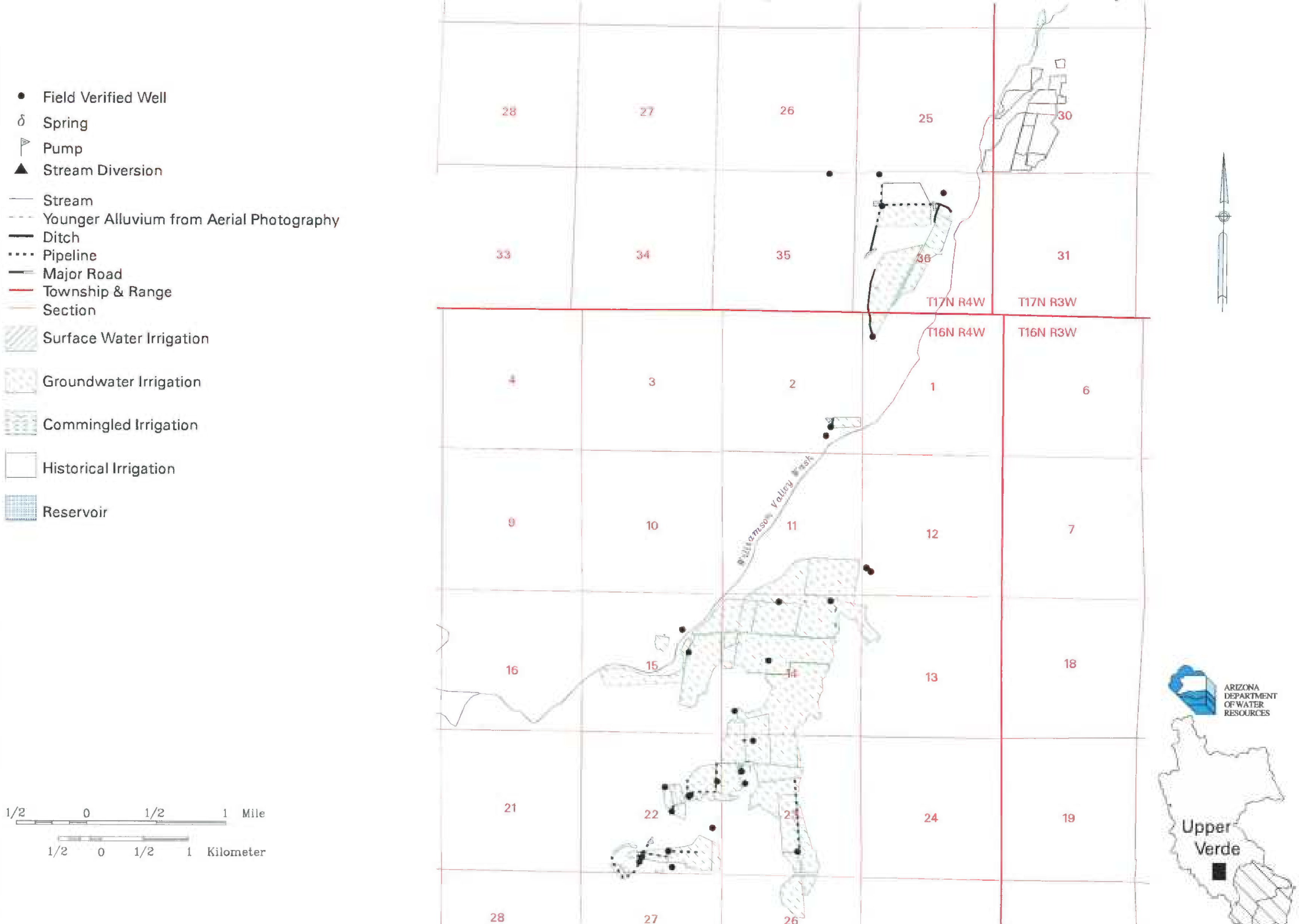


Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.9 - Current and Historical Irrigation in the Strickland Wash Area

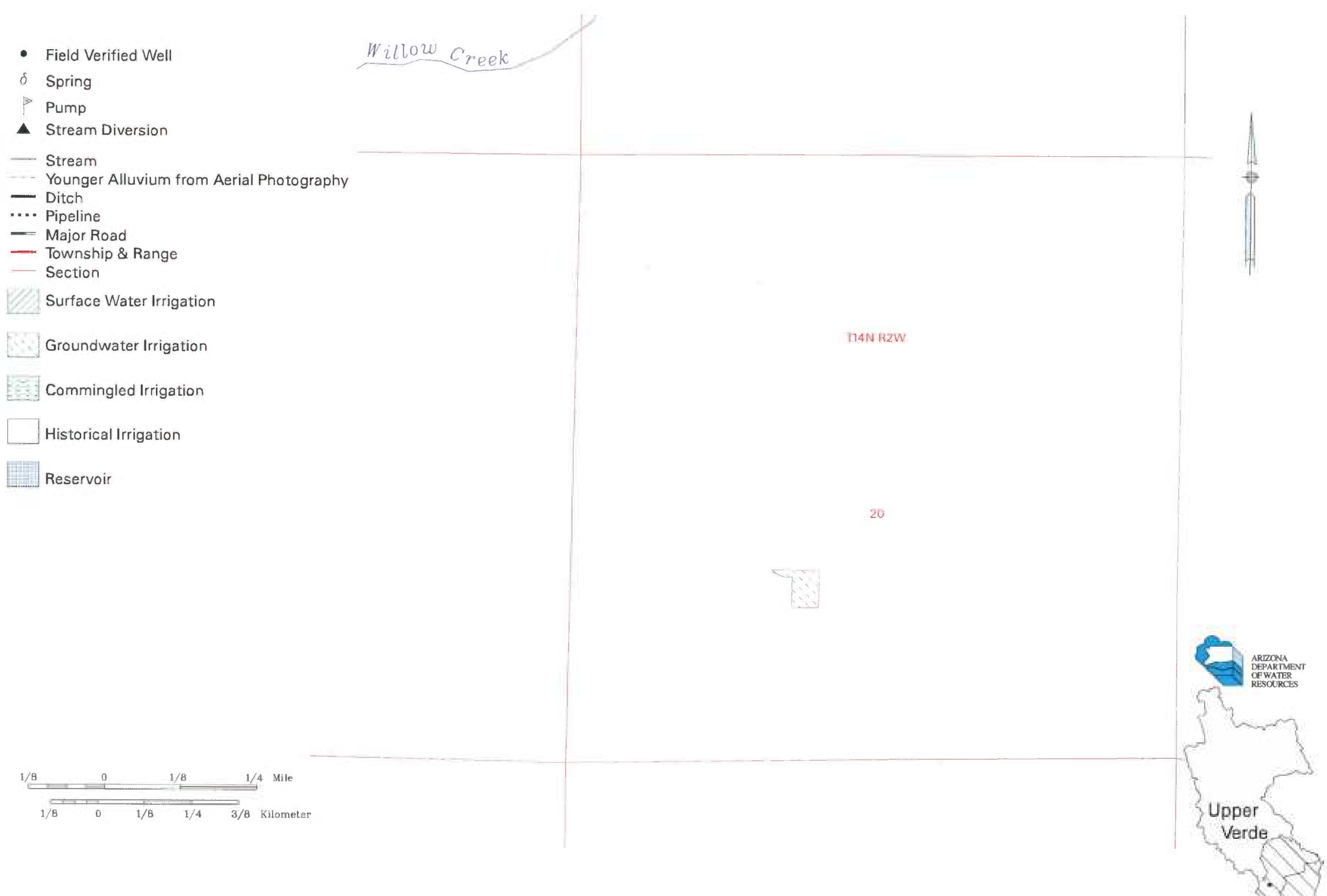
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.10 - Current and Historical Irrigation Along East Williamson Valley Wash



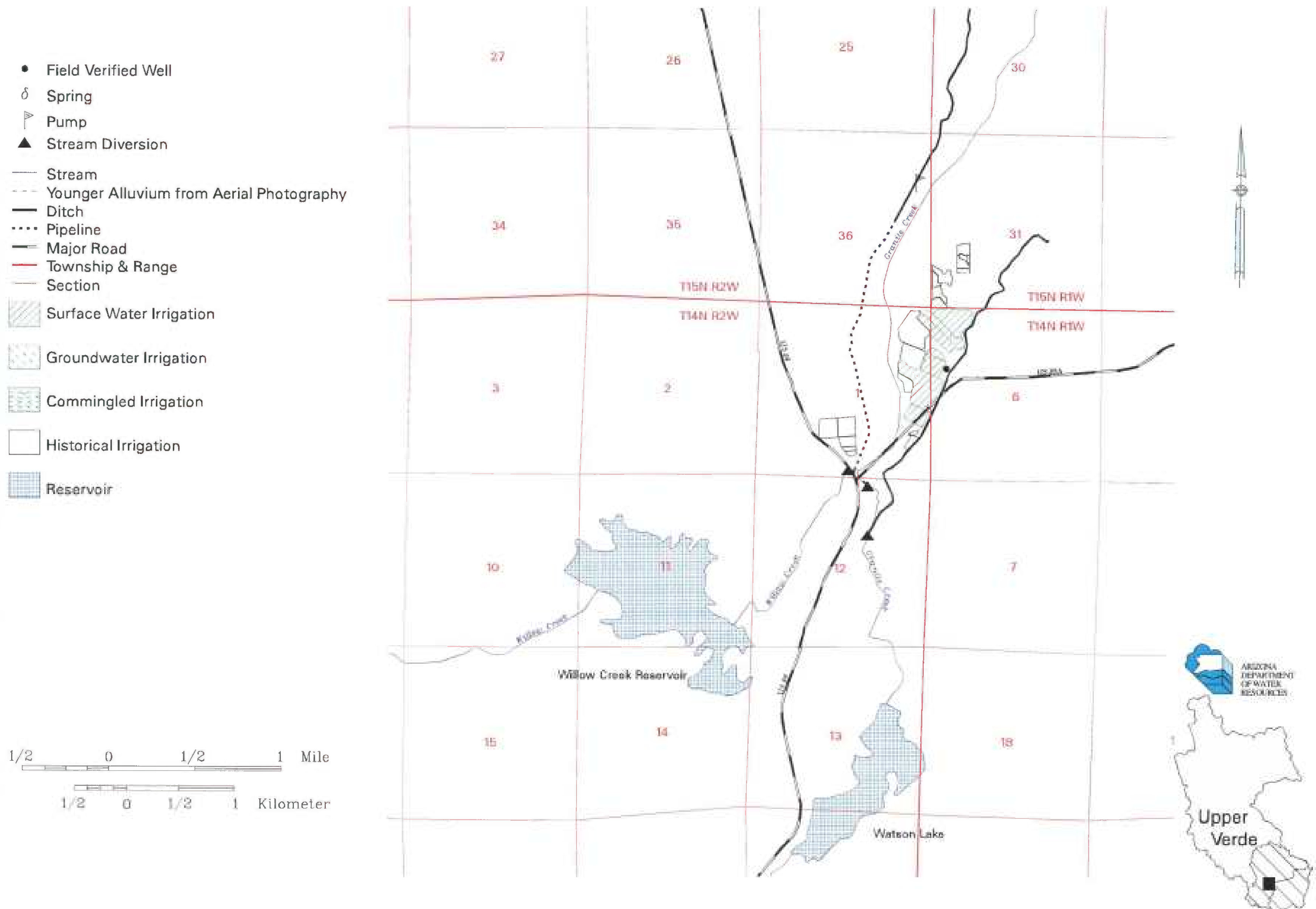
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.11 - Current and Historical Irrigation in the Prescott Area



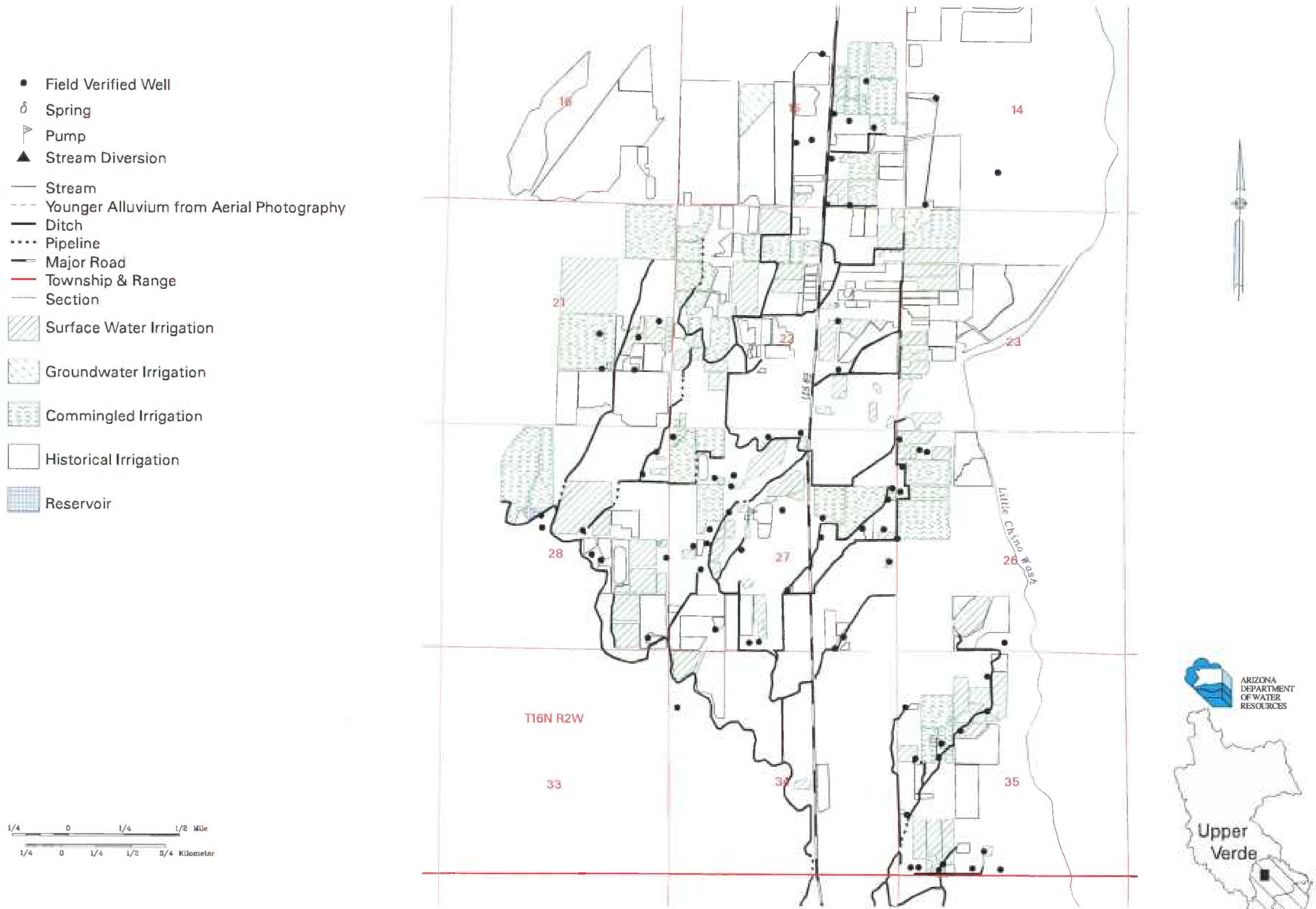
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.12 - Current and Historical Irrigation Along Granite and Willow Creeks



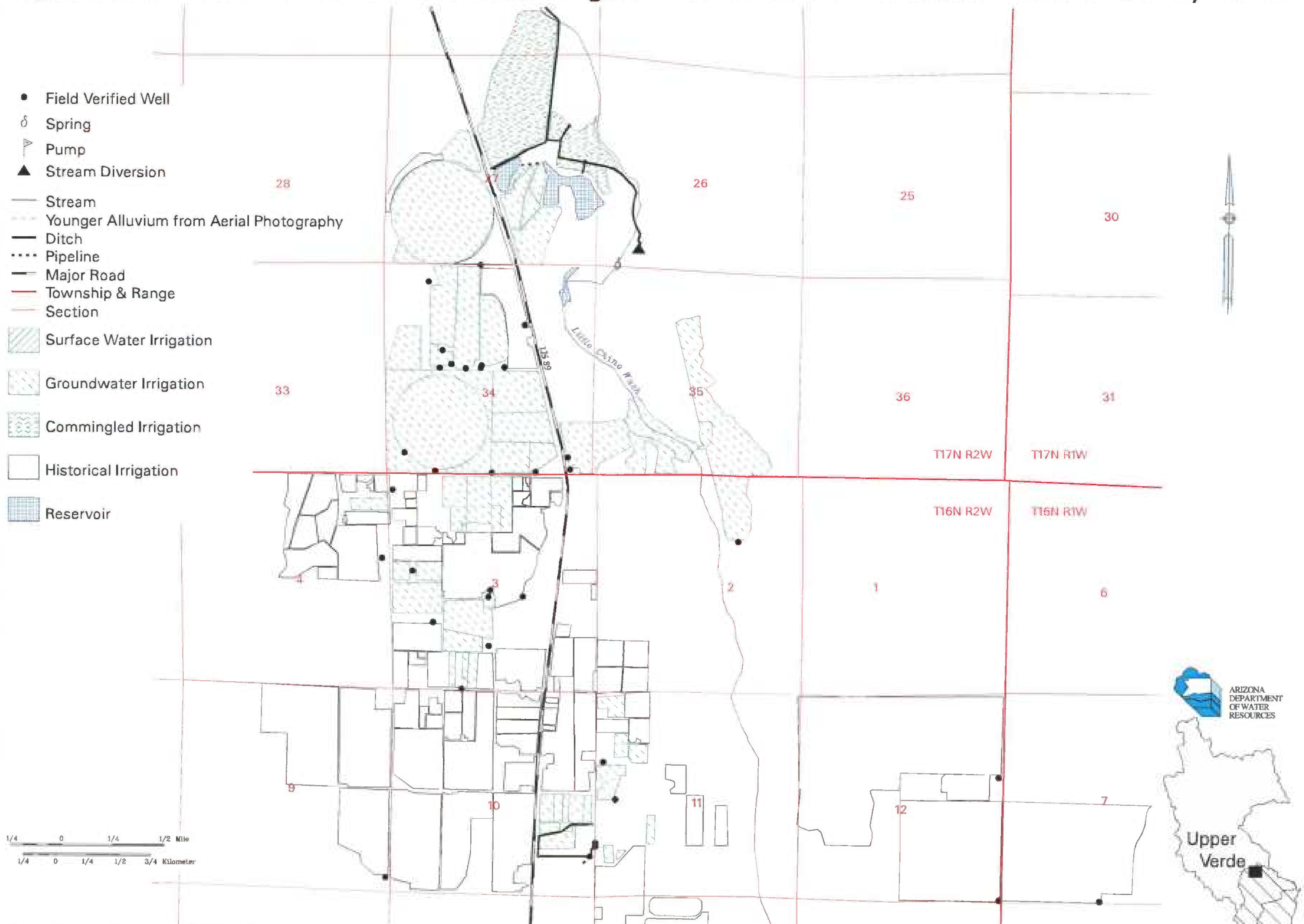
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.13 - Current and Historical Irrigation in the Southern Little Chino Valley Area



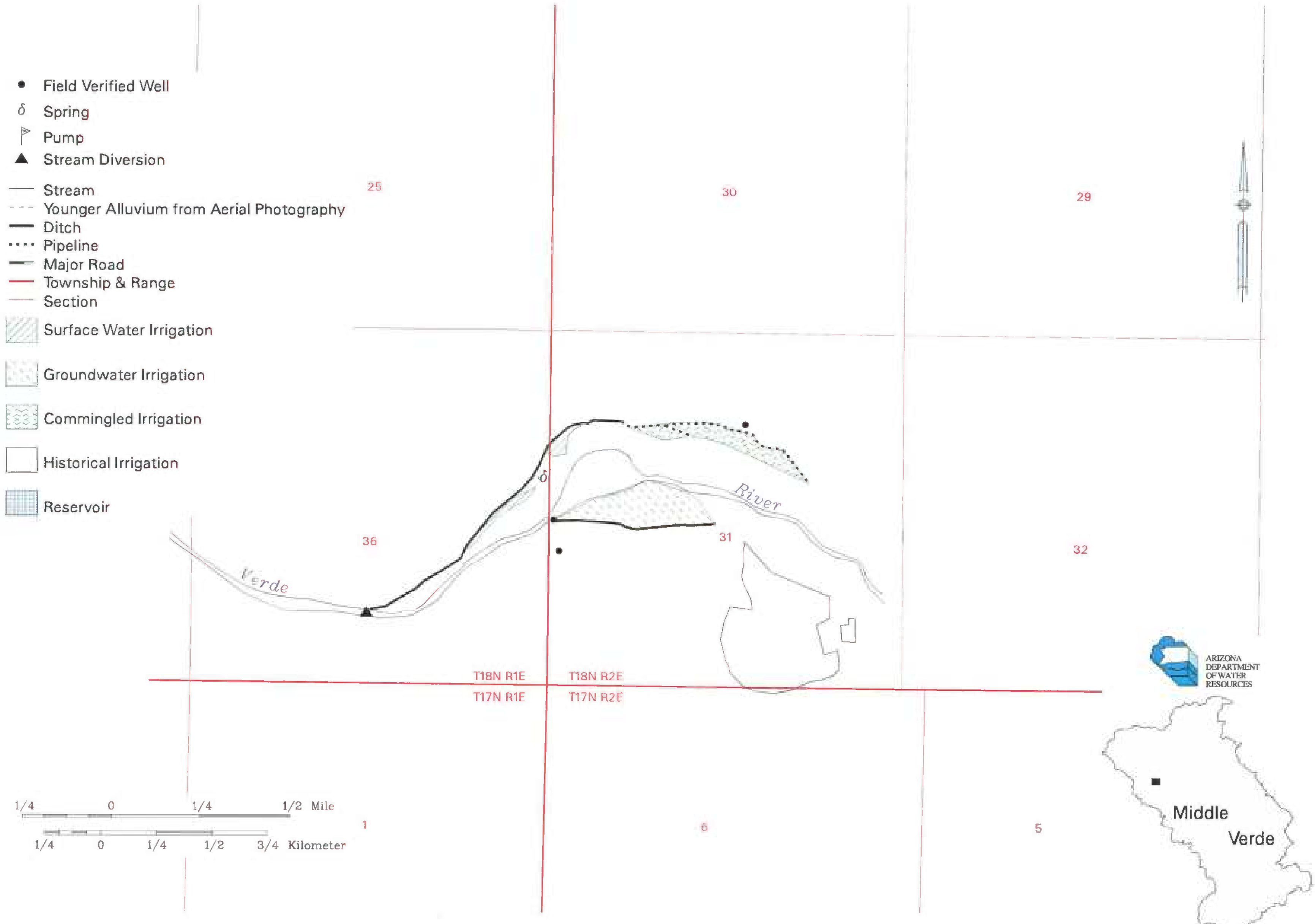
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.14 - Current and Historical Irrigation in the Northern Little Chino Valley Area



Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.15 - Current and Historical Irrigation in the Perkinsville Area

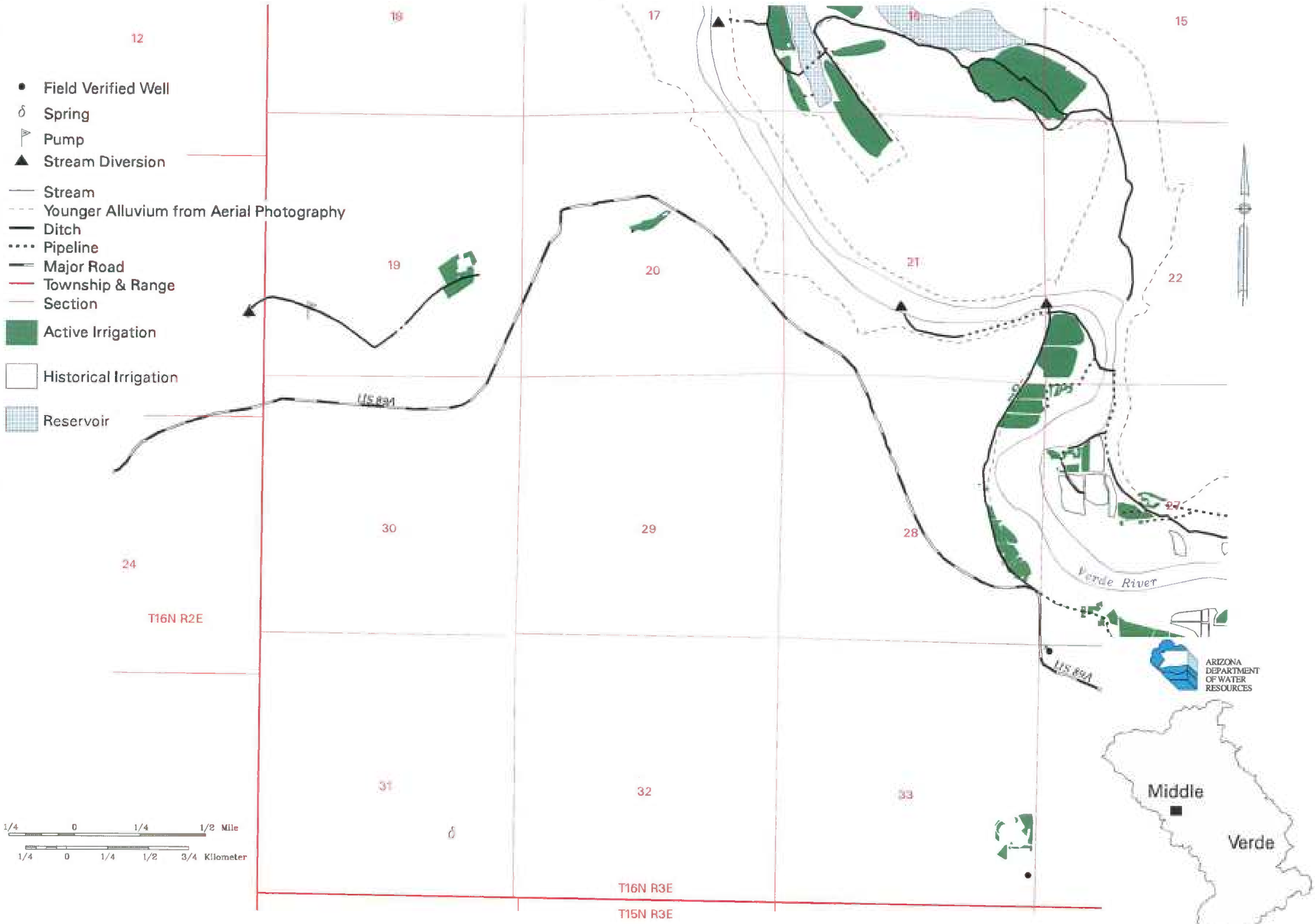


Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.16 - Current and Historical Irrigation in the Clarkdale Area

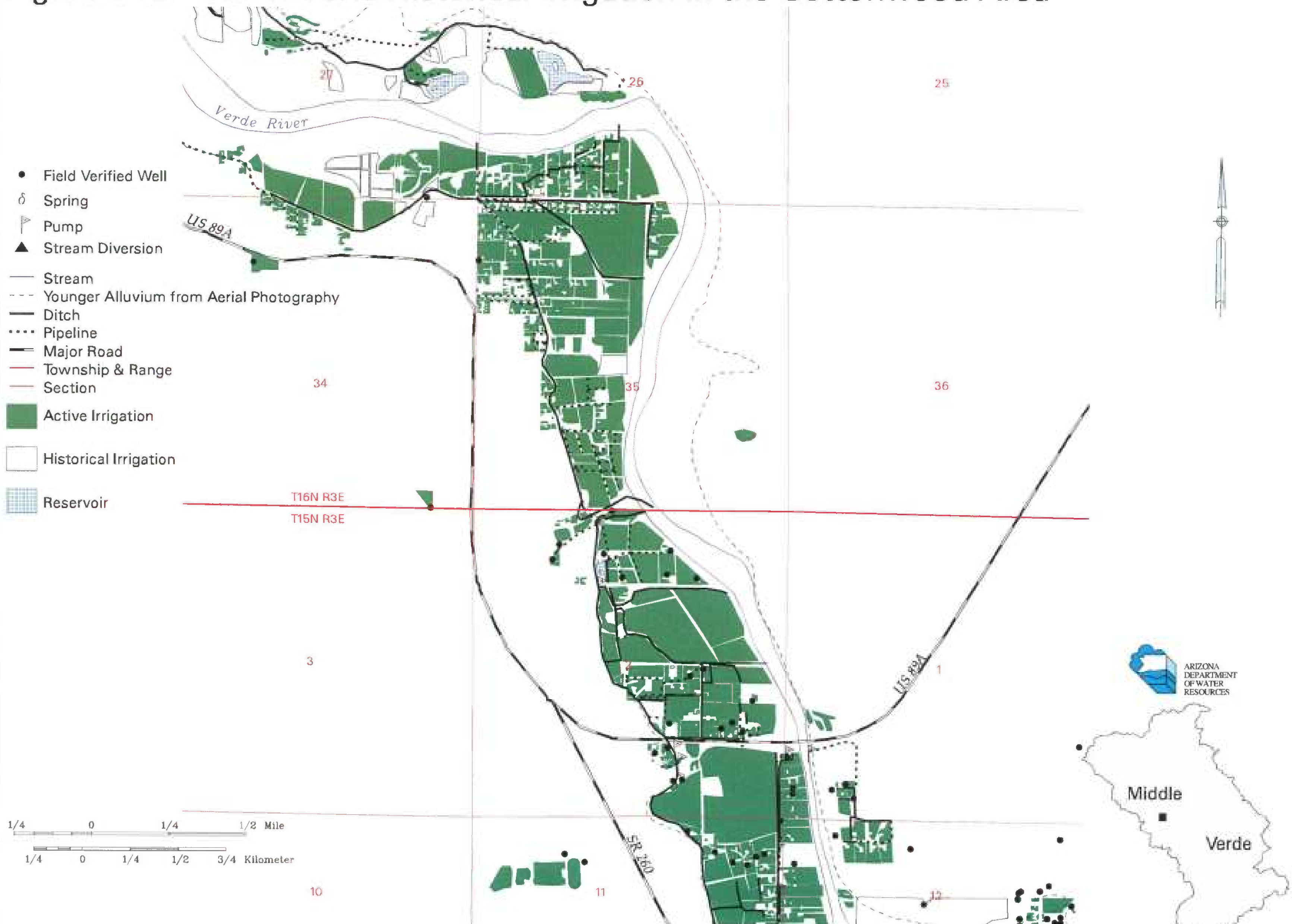
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.17 - Current and Historical Irrigation in the Clarkdale Area



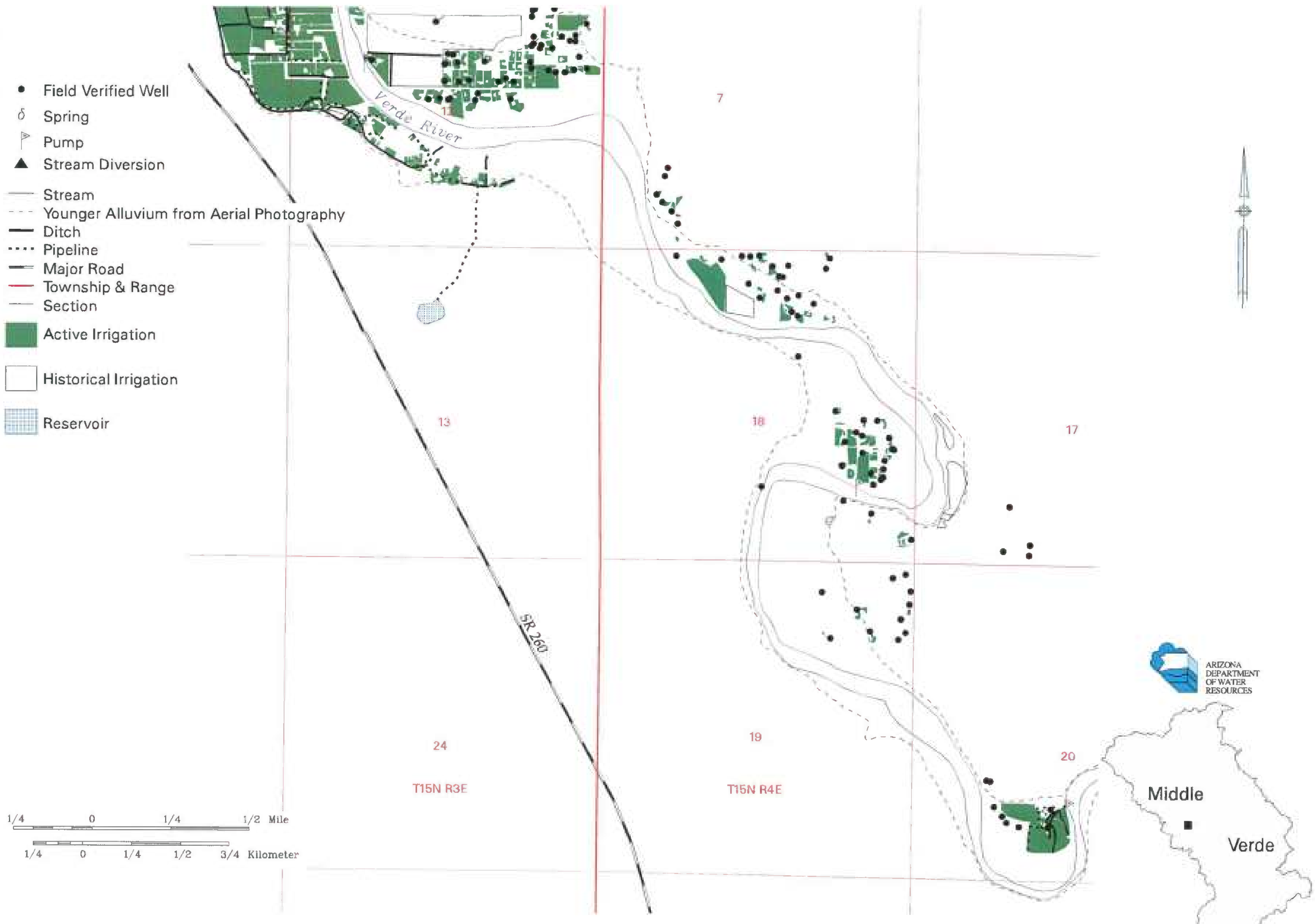
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.18 - Current and Historical Irrigation in the Cottonwood Area



Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.19 - Current and Historical Irrigation in the Cottonwood Area

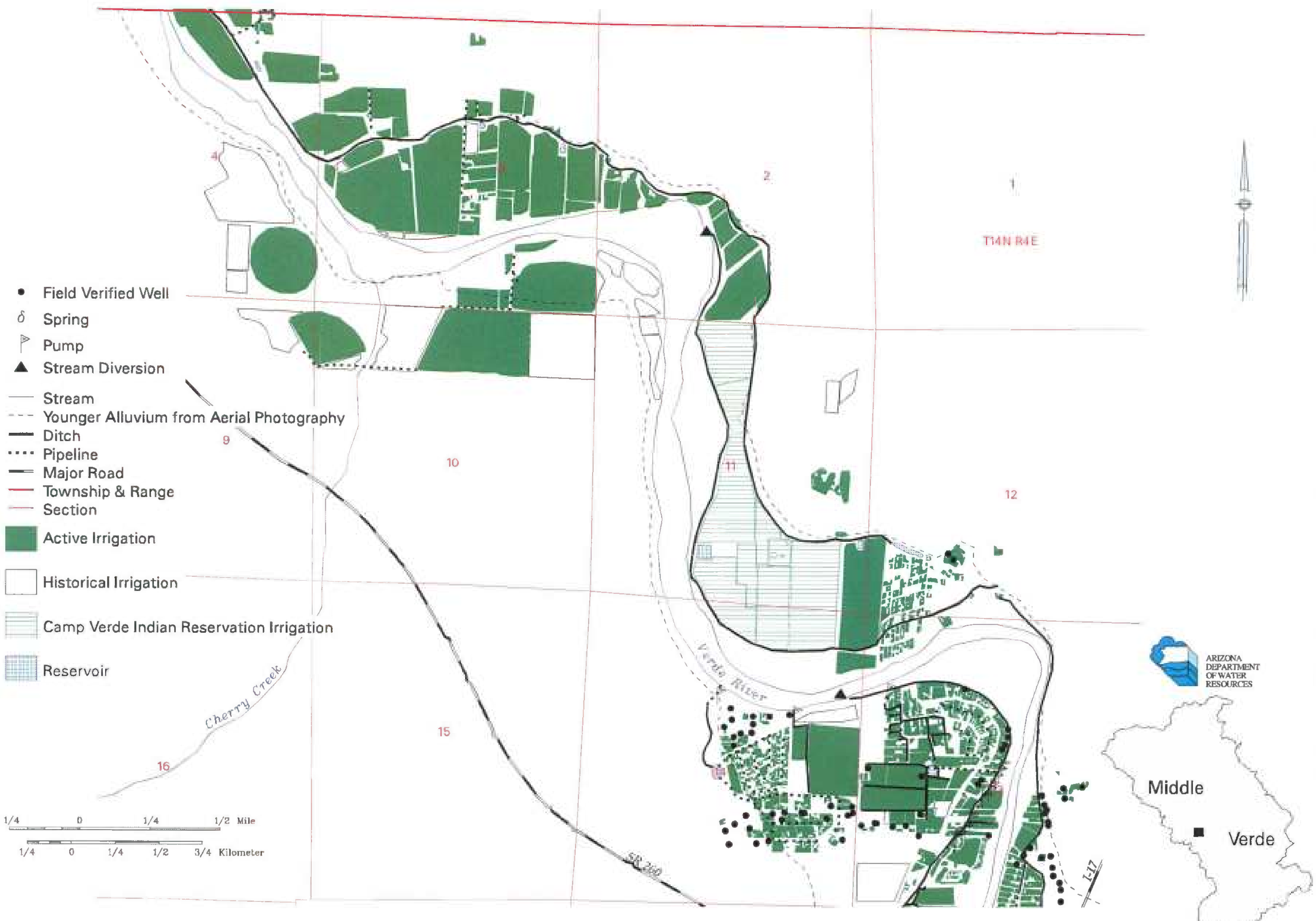


Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.20 - Current and Historical Irrigation in the Area North of Camp Verde

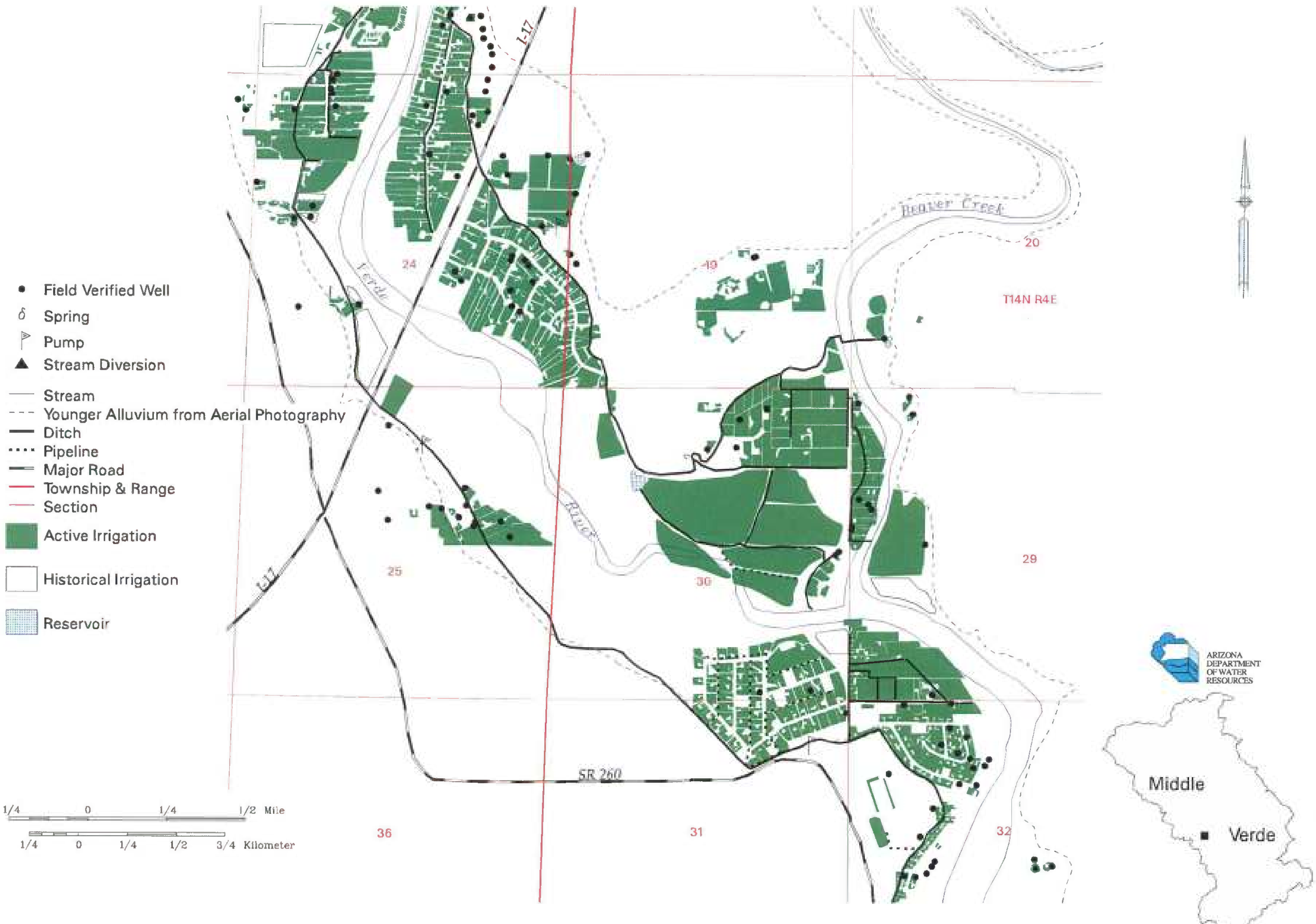
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.21 - Current and Historical Irrigation in the Area North of Camp Verde



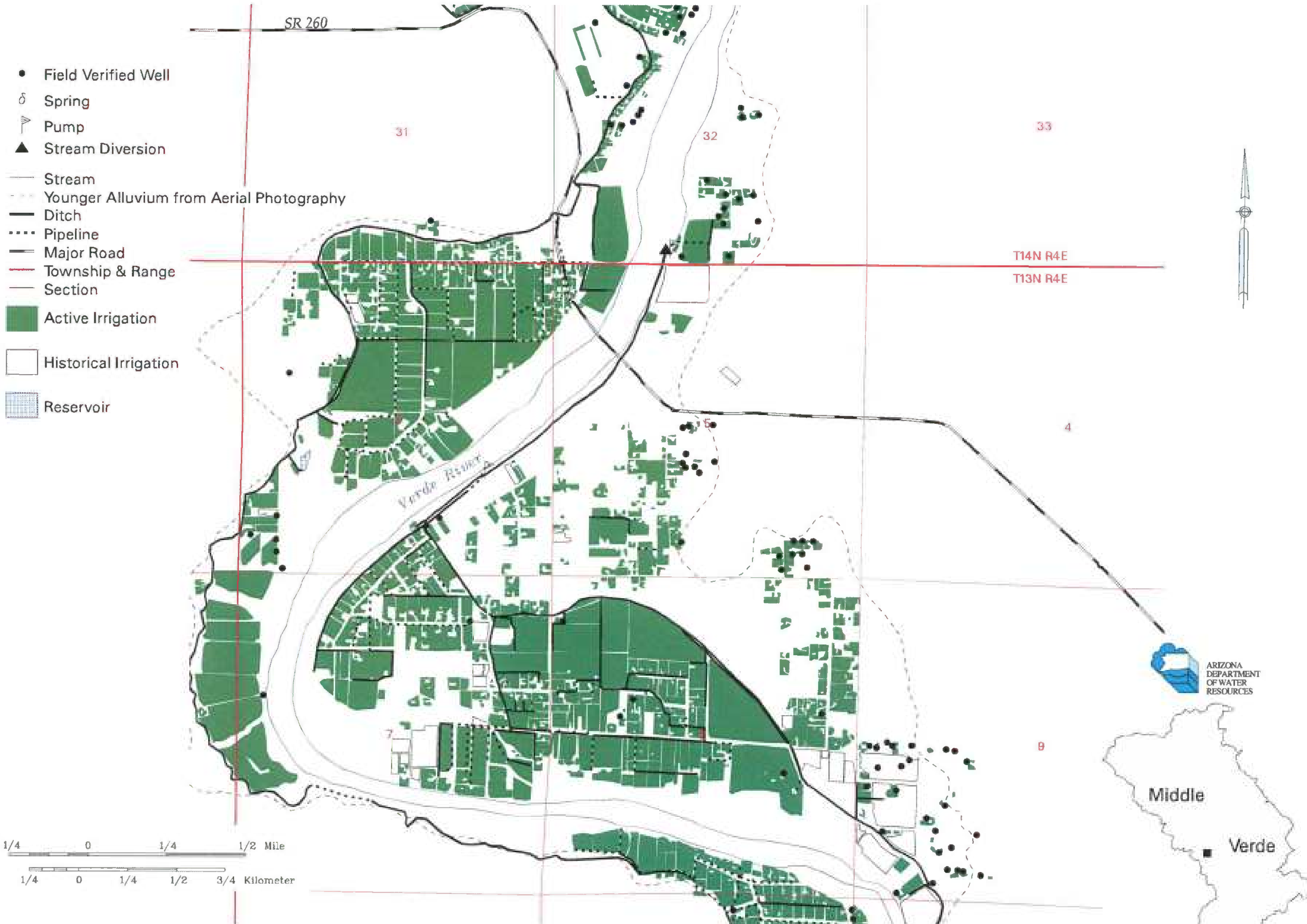
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.22 - Current and Historical Irrigation in the Camp Verde Area



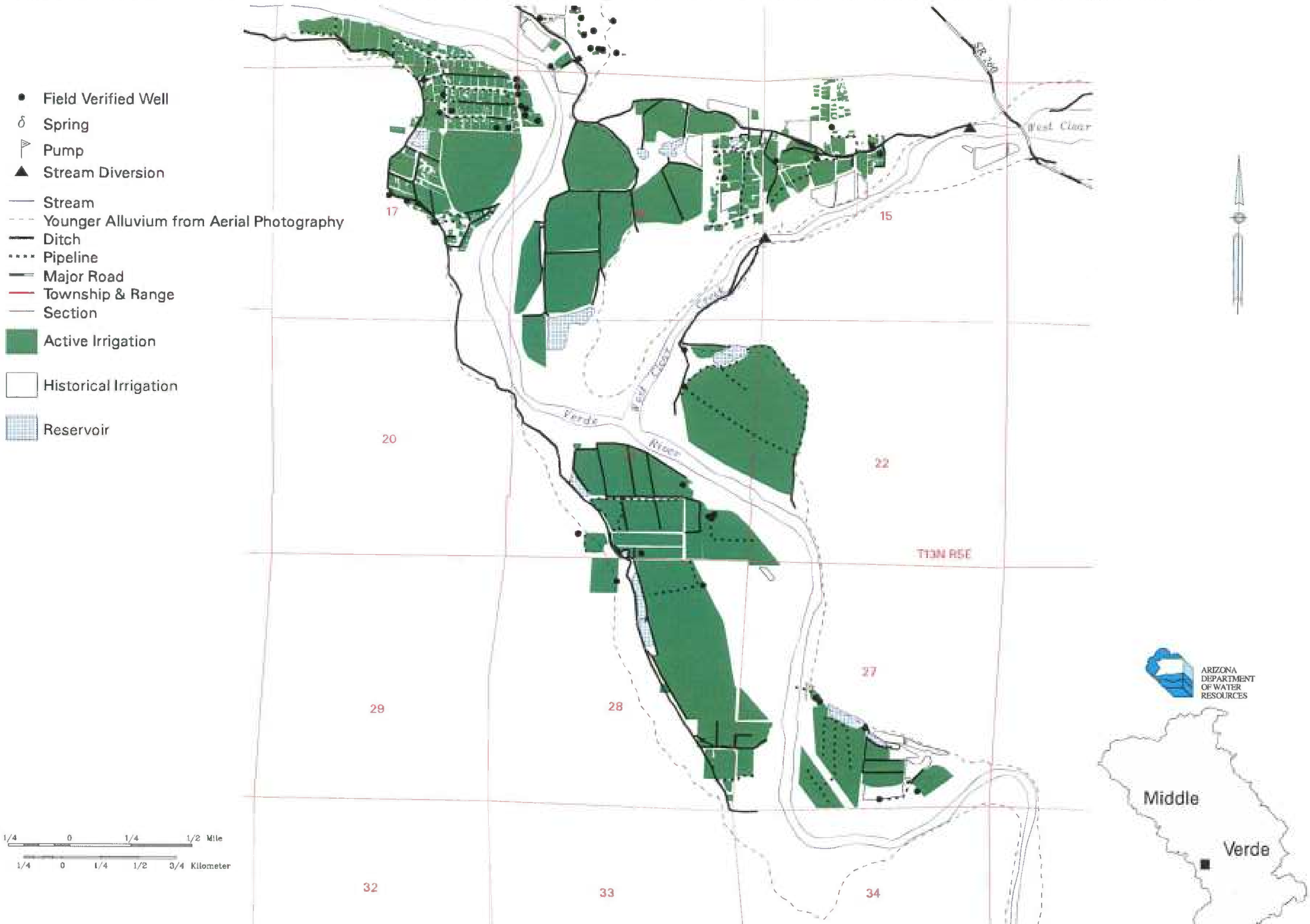
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.23 - Current and Historical Irrigation in the Camp Verde Area



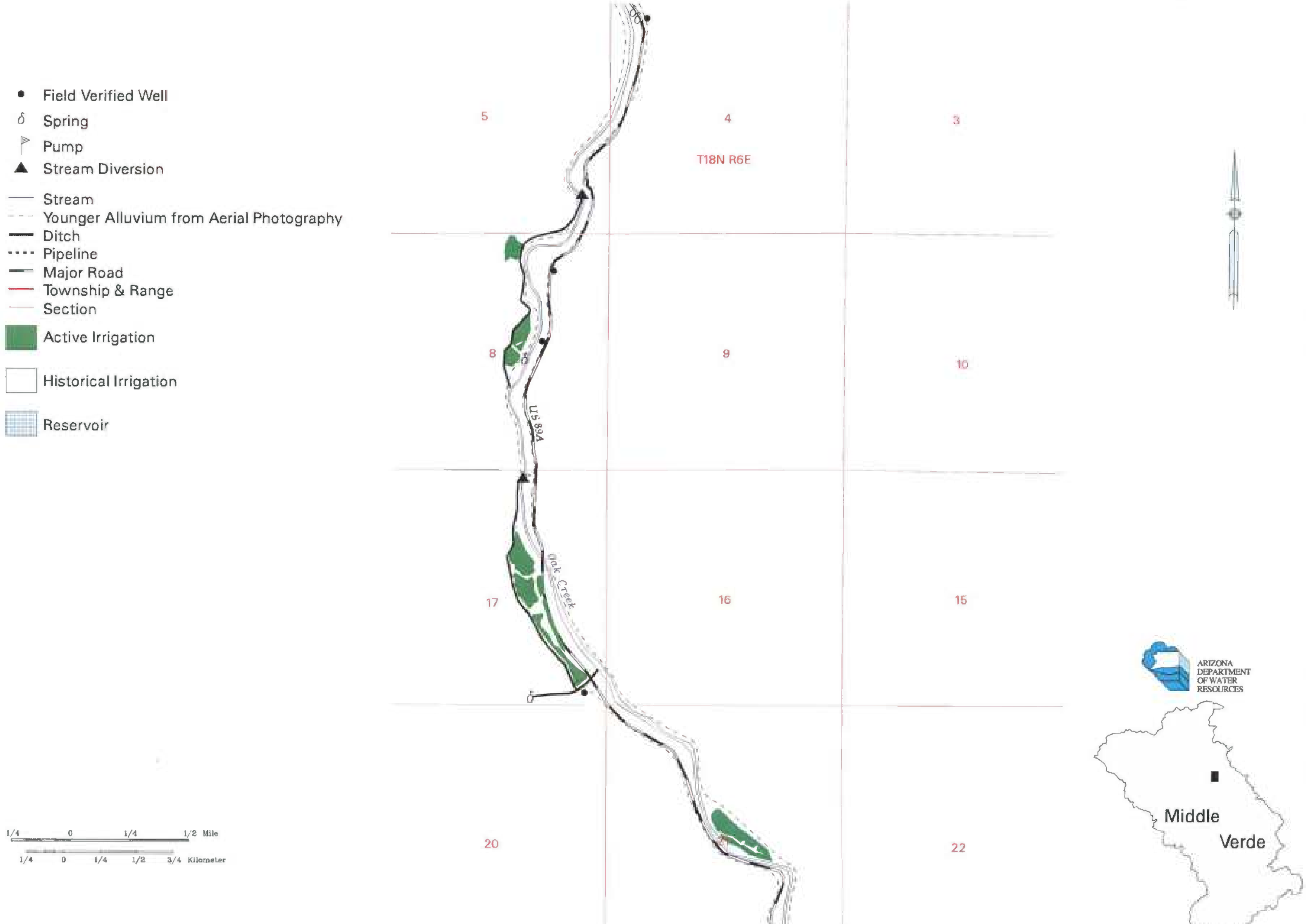
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.24 - Current and Historical Irrigation in the Area South of Camp Verde



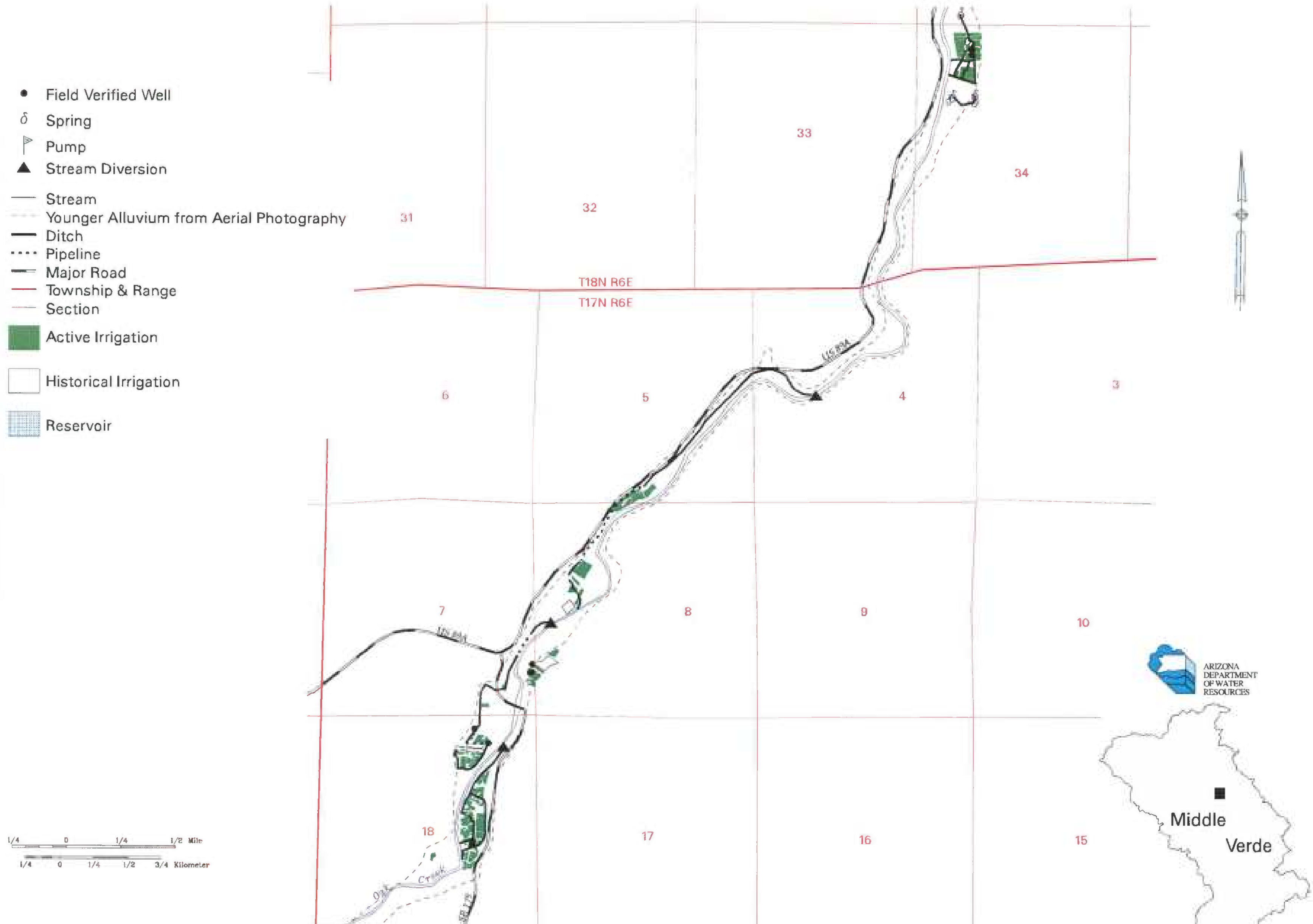
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.25 - Current and Historical Irrigation in the Northern Oak Creek Canyon Area



Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.26 - Current and Historical Irrigation in the Sedona Area



Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.27 - Current and Historical Irrigation in the Southern Oak Creek Canyon Area

Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.28 - Current and Historical Irrigation in the Southern Oak Creek Canyon Area

Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.29 - Current and Historical Irrigation in the Page Springs Area

Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.30 - Current and Historical Irrigation in the Page Springs Area

Source: Arizona Department of Water Resources Surface Water Division Investigations.

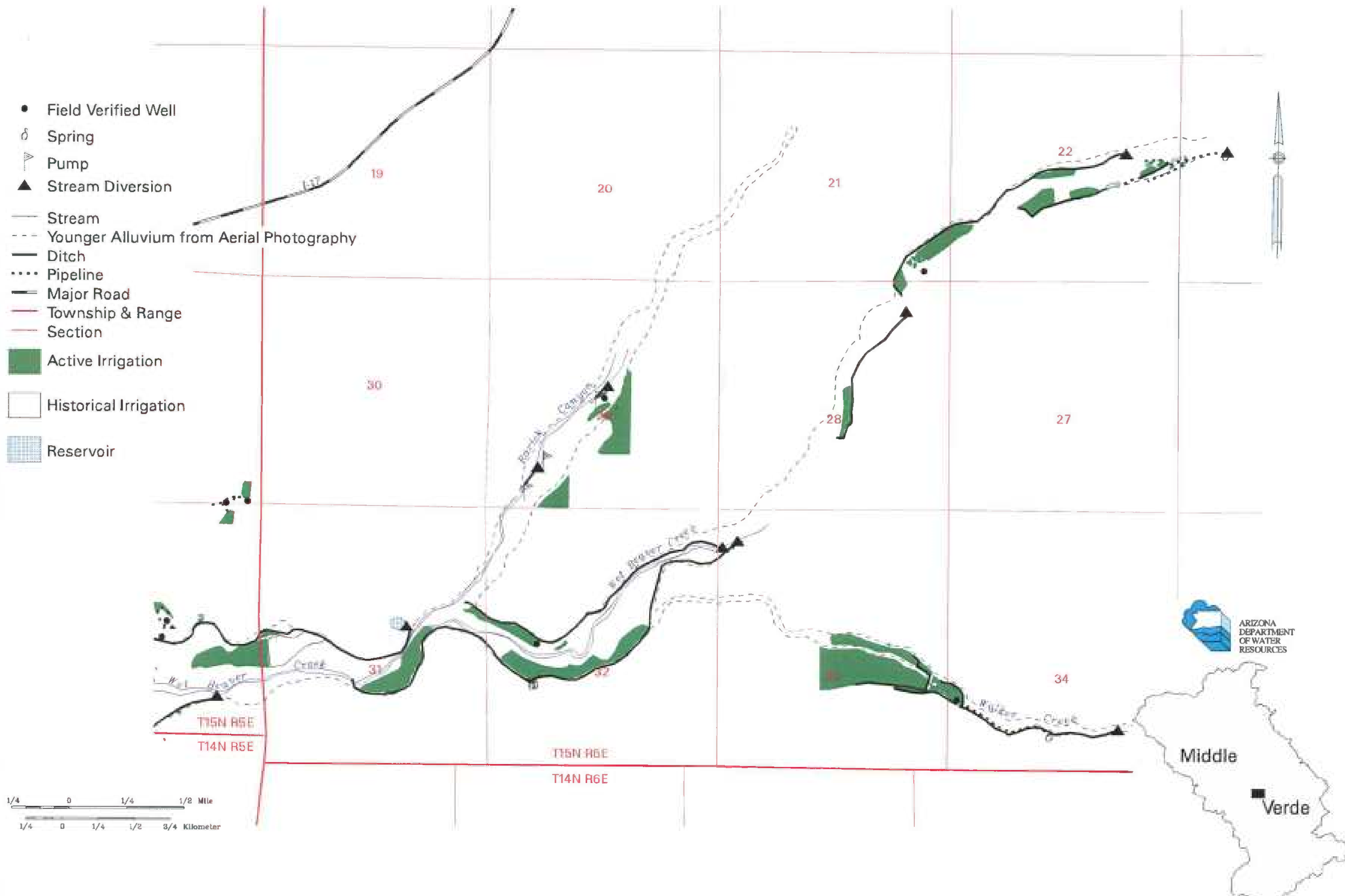
Figure B.31 - Current and Historical Irrigation in the Cornville Area

Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.32 - Current and Historical Irrigation in the Cornville Area

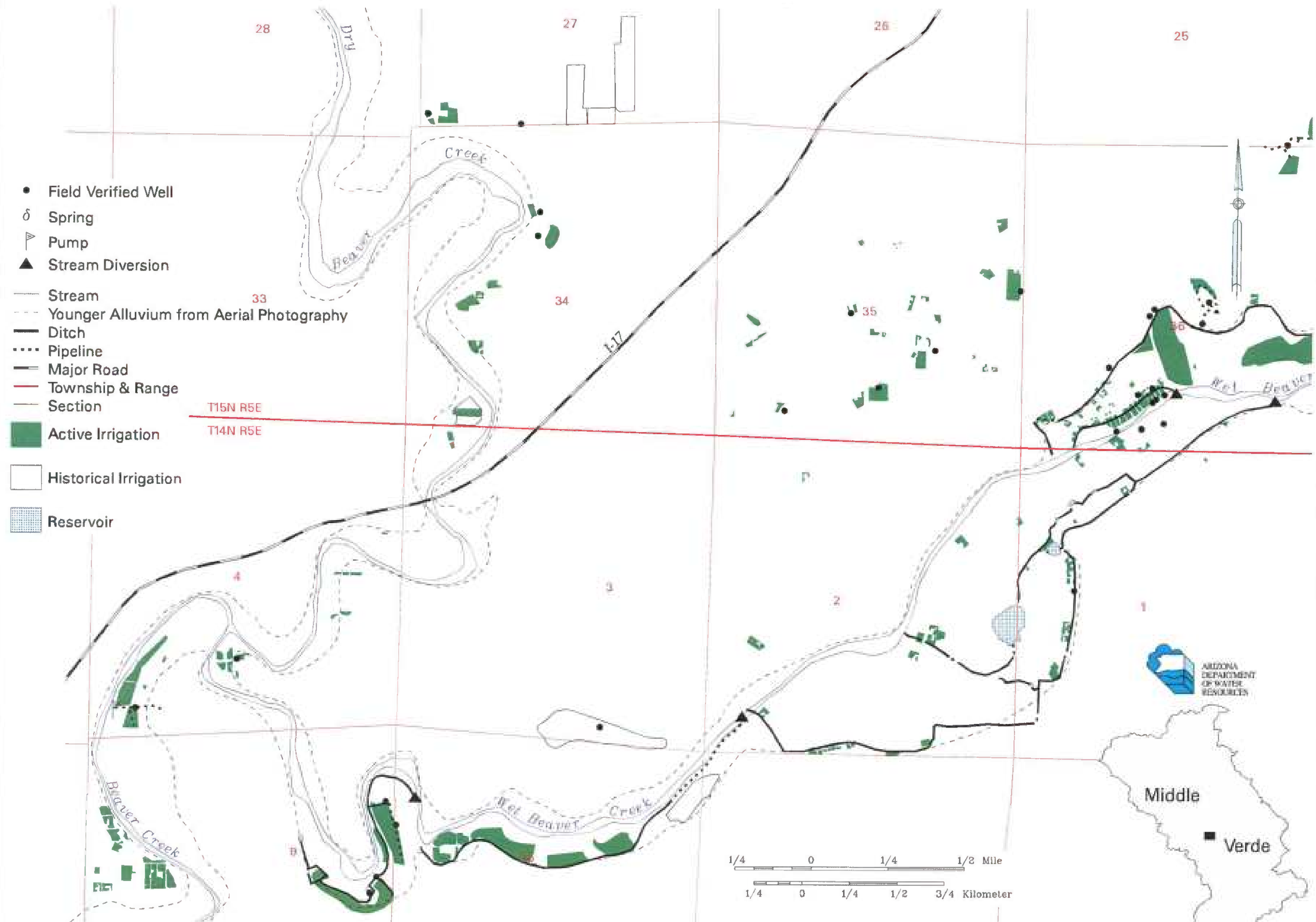
Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.33 - Current and Historical Irrigation Along Beaver Creek



Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.34 - Current and Historical Irrigation Along Beaver Creek

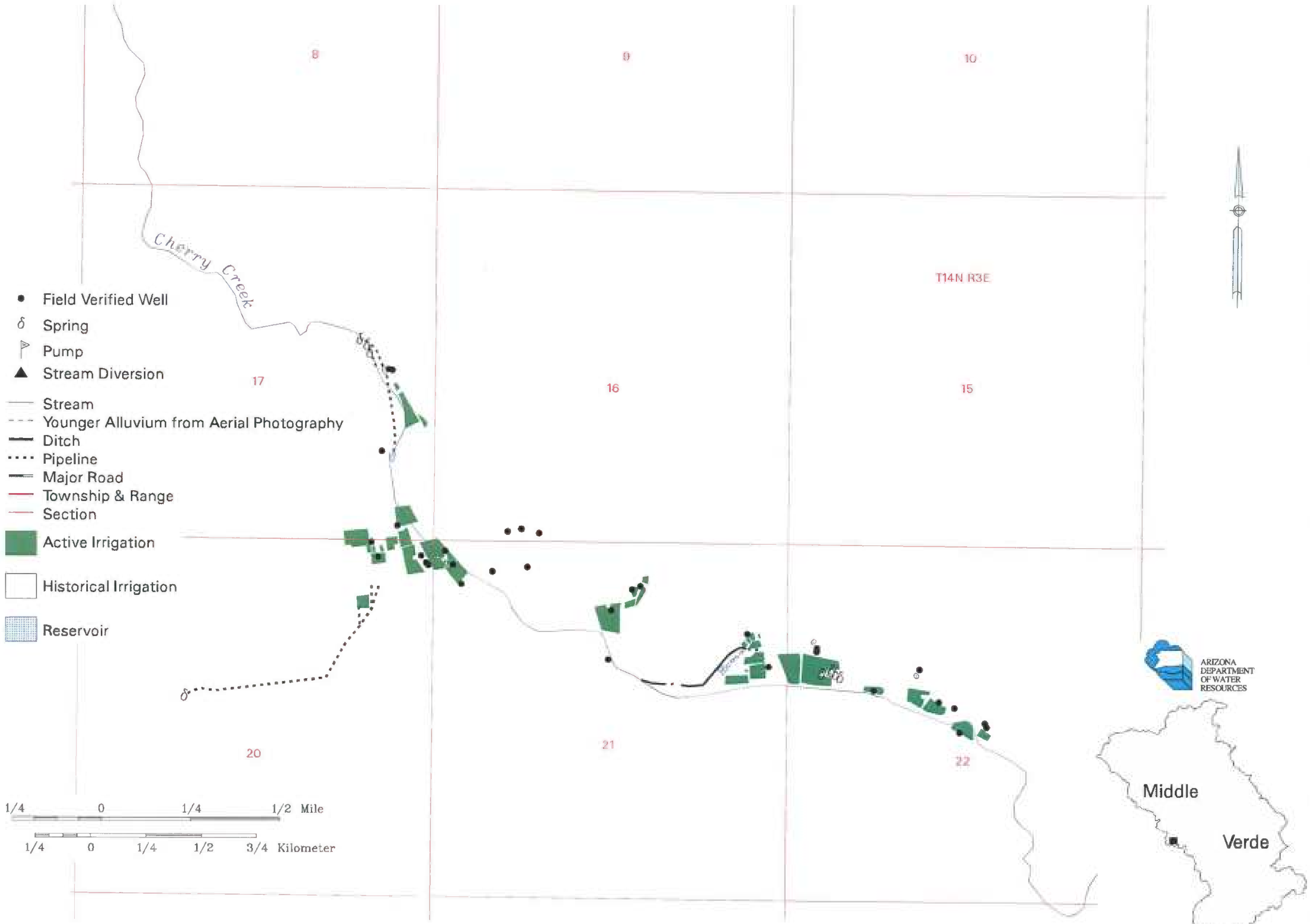


Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.35 - Current and Historical Irrigation Along West Clear Creek

Source: Arizona Department of Water Resources Surface Water Division Investigations.

Figure B.36 - Current and Historical Irrigation Along Cherry Creek



Source: Arizona Department of Water Resources Surface Water Division Investigations.

CHINO VALLEY IRRIGATION DISTRICT

PERSONNEL

Director:	Mr. Edward Holmes
Maintenance:	Mr. David Rees
Administration:	Ms. Helen Wells
Secretary:	Ms. Sue Rees
Shareholders:	Est. 500[1]

HISTORY

In the early 1900s, the Arizona Land and Irrigation Company purchased land and appropriated water rights for farming in the Chino Valley area. Between 1916 and 1927, all rights and interests were transferred to Hassayampa Alfalfa Farms, then Chino Mutual Water Users Association, and finally Chino Valley Irrigation District (CVID). In 1916, construction on Granite Creek Dam was completed and the first irrigation flows began. In 1935, the Willow Creek Reservoir was completed. Currently, CVID and the City of Prescott are negotiating an agreement to facilitate the sever and transfer of Willow Creek and Granite Creek surface water rights from land within CVID to Prescott. The agreement will significantly change irrigation policy and administration in the district.

WATER RESOURCES

The Chino Valley Irrigation District ditch conveys surface water for irrigation purposes from Willow Creek Reservoir and Watson Lake to the Chino Valley Irrigation District. These reservoirs have a combined storage capacity of 10,580 acre-feet. Willow Creek Reservoir water is released from April to June, then Watson Lake releases commence and continue until late September. In addition, the City of Prescott has an annual agreement to pump 300 acre-feet of infiltrated effluent into the CVID ditch near the Prescott Airport. Under the new agreement there will be provisions for surface water, effluent credits, and groundwater use within the district.

---

[1]Subject to change per terms of agreement with the City of Prescott.

The CVID ditch provides water to an estimated 940 acres of land including grass and alfalfa pastures, hay, corn, small orchards, and domestic lawns. The estimated annual volume of water consumed by crops irrigated by the CVID in 1997 was 3,102 acre-feet. Based on 50 percent field application efficiencies given to irrigated lands within the Prescott AMA, the actual irrigation water demand of the CVID in 1997 was 6,204 acre-feet.

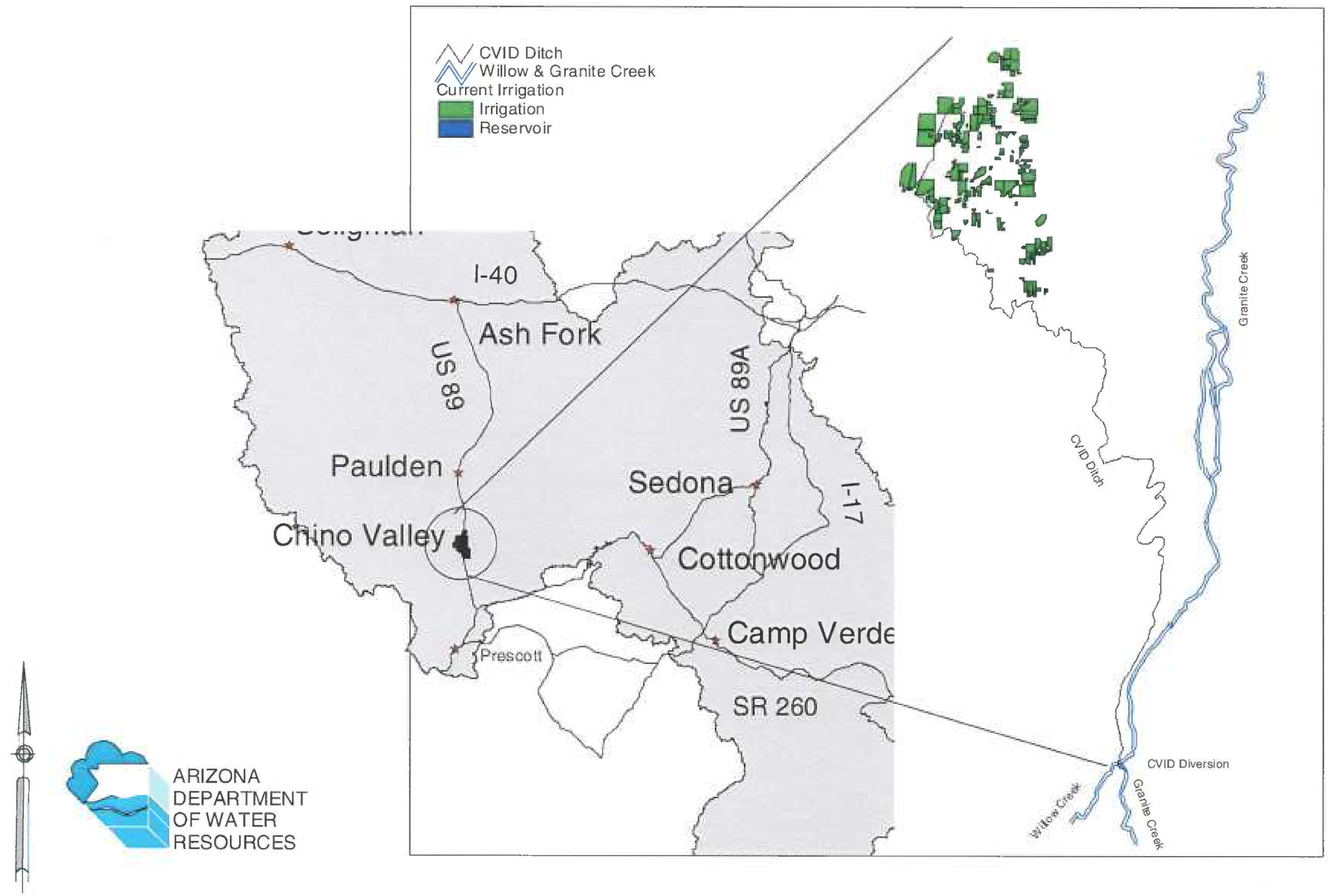
Shareholders submit water requests to the CVID office and the ditch boss diverts the number of hours of water requested. The current cost for water, distribution, and administration is $5.00 per acre. The collected fees cover the cost of maintenance and repairs on the ditch network.

FACILITIES

The dams, main canal, and laterals are owned and maintained by the CVID[2]. The main canal consists of pipeline and 13 miles of open earthen ditch that meanders 15 miles to northwest Chino Valley. The main canal in Chino Valley is called the High Line Ditch. It is an earthen ditch that conveys water northwest approximately three miles. There are four laterals along the main canal that convey northeast and together they are about five miles long. Most users rely on flood irrigation from the main canal and laterals to convey their irrigation in earthen ditches, concrete lined ditches, and more recently gated pipe. Some users have small surface water reservoirs to supply pump driven sprinkler irrigation systems primarily for uneven pastures and large landscaped areas. In addition, the City of Prescott pumps 300 acre-feet of infiltrated effluent into the CVID ditch southeast of the Prescott Airport. There is no surface water return flow of excess irrigation and tailwater.

[2] Ownership and operation of dams is subject to change per terms of agreement with the City of Prescott.

Figure B.37 - Chino Valley Irrigation District



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

BRIDGEPORT IRRIGATION ASSOCIATION, INC.

PERSONNEL

President:	N/A
Manager/Contact Person:	Mr. James B. Stuart, Association Secretary/Treasurer
Board of Directors:	N/A
Shareholders:	Est. 10

HISTORY

The Bridgeport Ditch was originally constructed on December 12, 1913 for the purpose of supplying irrigation water to lands located on the east bank of the Verde River in Bridgeport. The Bridgeport Ditch, due to its location by the Verde River, was continuously being washed out during flooding events. An instream pump was put in place by the association to divert water for irrigation purposes. The Bridgeport Irrigation Association instream pump is considered to be one of several smaller diversions of Verde River water in the Verde Valley.

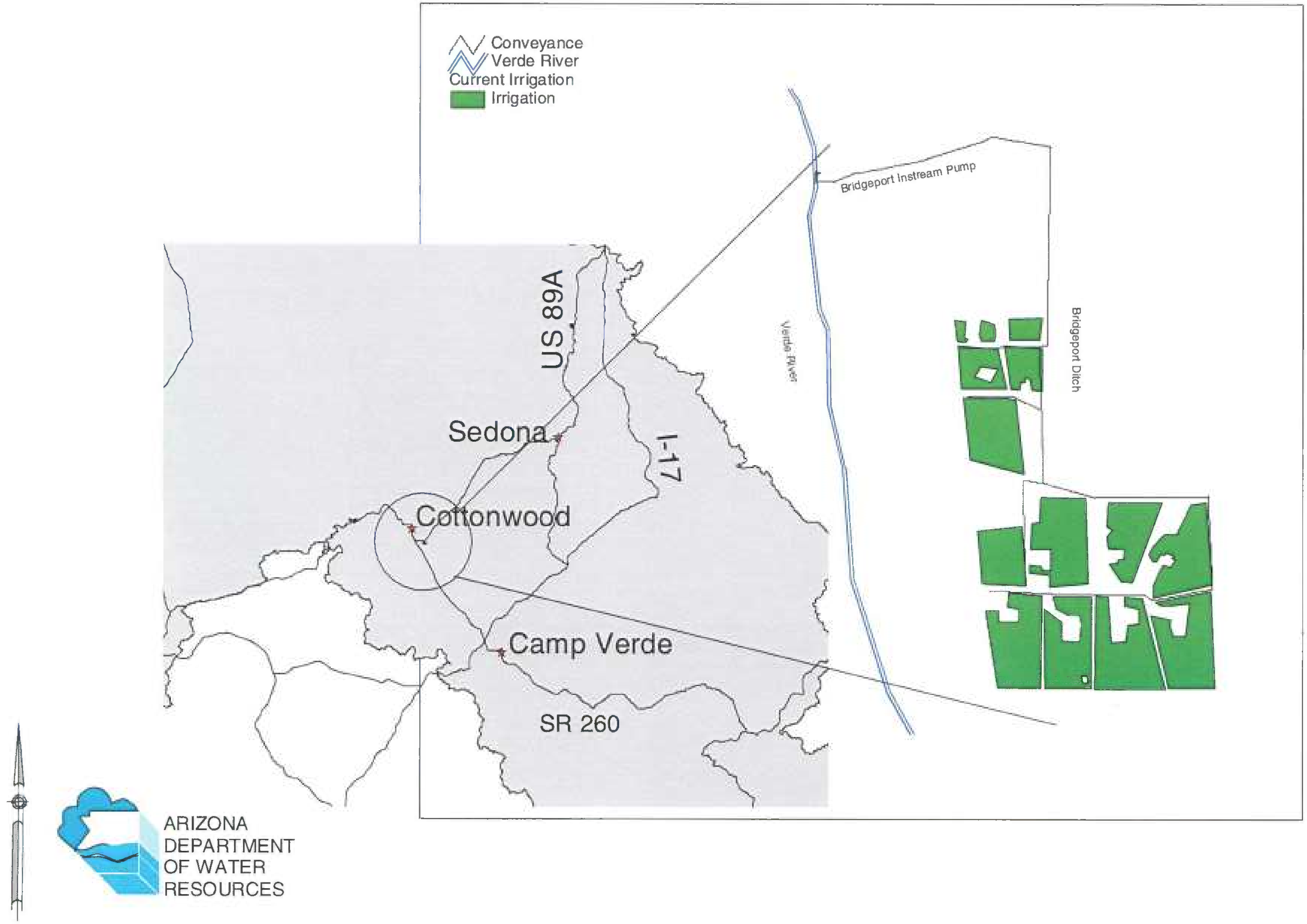
WATER RESOURCES

The Bridgeport Irrigation Association relies exclusively on the diversion of surface water from the Verde River for its shareholders• water demands. Verde River surface flows are diverted annually and supplied to ten shareholders. Thirteen acres are currently estimated to be served by the Bridgeport Irrigation Association. The estimated water demand for irrigating lawns and pastures is 41 acre-feet. The current fee for water is $25.00 annually.

FACILITIES

The Bridgeport Irrigation Association operates one instream pump to divert Verde River water into an unlined open channel ditch. The pump is currently located southeast of the Town of Cottonwood approximately three miles below the diversion structure for the Cottonwood Ditch. A series of laterals and individual turnouts distributes water to the private properties. There are no return flows to the Verde River.

Figure B.38 - Bridgeport Irrigation Association



ARIZONA
DEPARTMENT
OF WATER
RESOURCES

Source: Arizona Department of Water Resources field investigations 1995 - 1998.

CHAVEZ-SYCAMORE IRRIGATION ASSOCIATION

PERSONNEL

President:	N/A
Manager/Contact Person:	Ms. Eleanor Graham
Board of Directors:	N/A
Shareholders:	Est. 10

HISTORY

The Chavez-Sycamore Ditch was originally constructed in 1910 for the purpose of delivering irrigation water from Oak Creek to lands located on the north and west banks of Oak Creek, southwest of the City of Sedona. Water diverted and delivered by the ditch has primarily been used for the purpose of growing and maintaining small pasture grasses, lawns and orchards. This purpose has not changed significantly since this ditch was originally constructed.

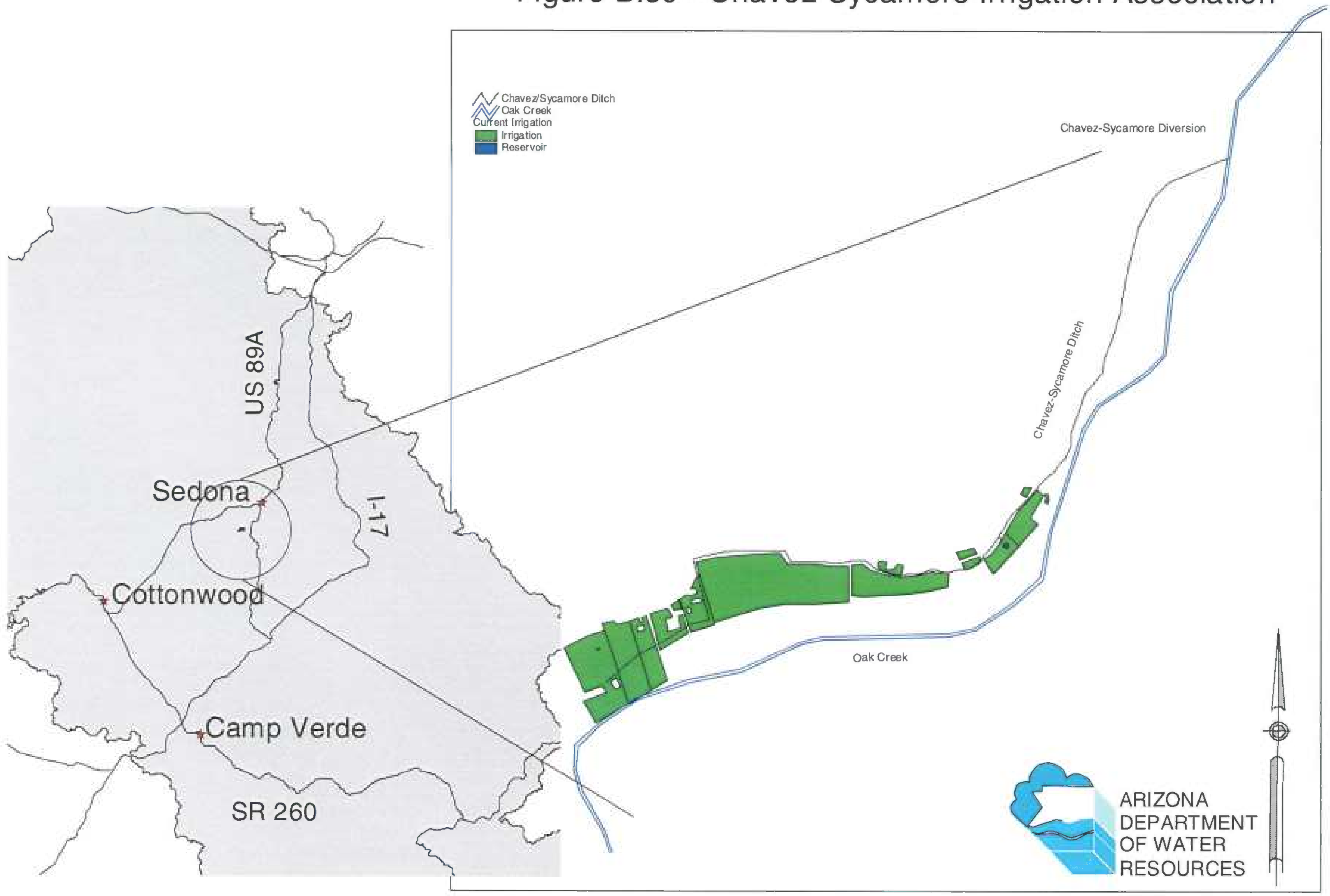
WATER RESOURCES

The Chavez-Sycamore Ditch relies exclusively on the diversion of water from Oak Creek to meet the water demands of their shareholders. The current number of acres served water by Chavez-Sycamore Ditch is approximately 13 acres. The estimated annual volume of water consumed by the crops irrigated by the Chavez-Sycamore Ditch in 1997 was approximately 41 acre-feet. Shareholders are currently assessed a fee of $40.00 per year to receive water. The revenues generated are used to cover the cost of maintenance and repairs on the ditch. The operation of the ditch is on the honor system. Shareholders take delivery of water on an as needed basis when available.

FACILITIES

The Chavez-Sycamore Ditch diversion structure is constructed of rock and soil aggregates and is located on Coconino National Forest land. The ditch is approximately three quarters of a mile in length and has two turnouts. The first user is located approximately one half mile downstream from the diversion structure. The ditch consists of unlined and lined open channel with the unlined section existing from the diversion point to the first turnout. All water not used by shareholders is returned directly to Oak Creek. Water is diverted continuously in the ditch, except for periods of time when maintenance is performed. Maintenance on the ditch generally occurs in early spring or late winter.

Figure B.39 - Chavez-Sycamore Irrigation Association



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

COPPER CLIFFS IMPROVEMENT ASSOCIATION
(STAUDE-HART DITCH)

PERSONNEL

President:	N/A
Manager/Contact Person:	Ms. Faith Fuller, Association Secretary
Board of Directors:	N/A
Shareholders:	Est. 17

HISTORY

The Copper Cliffs Improvement Association supplies water for irrigation purposes to lands located on the west bank of Oak Creek, in Sedona. The actual construction date of the diversion structure and ditch are unknown. It is believed by some that the current ditch follows the ancient ditches constructed by the Yavapai Apache Tribe, which farmed the area long ago. The Staude-Hart Ditch diversion structure has been reconstructed many times due to the flooding events that have historically taken place. The primary use of the irrigation water supplied by the Staude-Hart Ditch is to maintain small gardens and lawns.

WATER RESOURCES

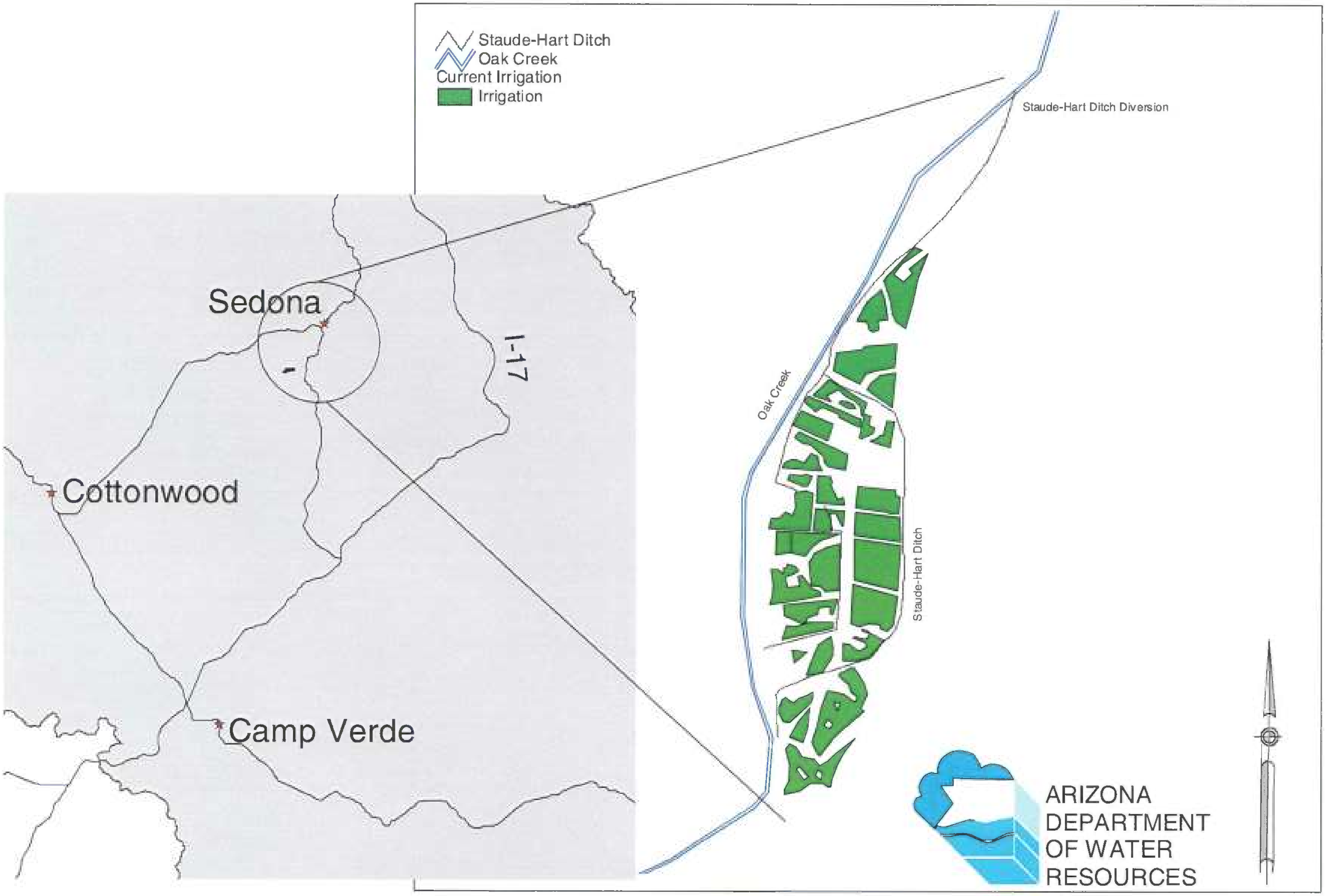
Copper Cliffs Improvement Association relies exclusively on the diversion of surface water from Oak Creek to meet shareholders' water demands. The Staude-Hart Ditch originally delivered irrigation water to approximately 15 acres. That number has been reduced to approximately 12 acres due to urbanization within the Sedona area. The estimated annual volume of water consumed by crops irrigated by Staude-Hart Ditch in 1997 was 47 acre-feet.

The association does not charge a separate or additional fee for the use of surface water diverted through the ditch.

FACILITIES

The Staude-Hart Ditch diversion structure is constructed of rock and soil and is located creek side opposite the Los Abrigados Resort property. The ditch is approximately 1 mile in length with several turnouts. The ditch consists of piped and lined sections. The first water user is located approximately 200 yards downstream from the point of diversion. All water not used by the shareholders is returned directly to Oak Creek. Water flows continuously, except for periods of time when repair work is needed on the ditch. The operation and maintenance of the ditch is supervised by association members.

Figure B.40 - Copper Cliffs Improvement Association



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

CORNVILLE DITCH ASSOCIATION

PERSONNEL

President:	Mr. Herb Browning
Manager/Contact Person:	Mr. Herb Browning
Board of Directors:	N/A
Shareholders:	Est. 60

HISTORY

Cornville Ditch was originally constructed around 1872 for the purpose of supplying water from Oak Creek to lands located north and south of McGuireville Road on the west bank of Oak Creek. Cornville Ditch is the second largest supplier of irrigation water on the Oak Creek and has supplied irrigation water to as many as 190 acres as reported in 1914. Since its original construction, the Cornville Ditch has been known by several names including: Lower Oak Creek Ditch, Fain, Chick, and Hayden Ditch. The primary use of the water delivered by Cornville Ditch is for the maintenance of pastures, landscaping, and small vegetable gardens.

WATER RESOURCES

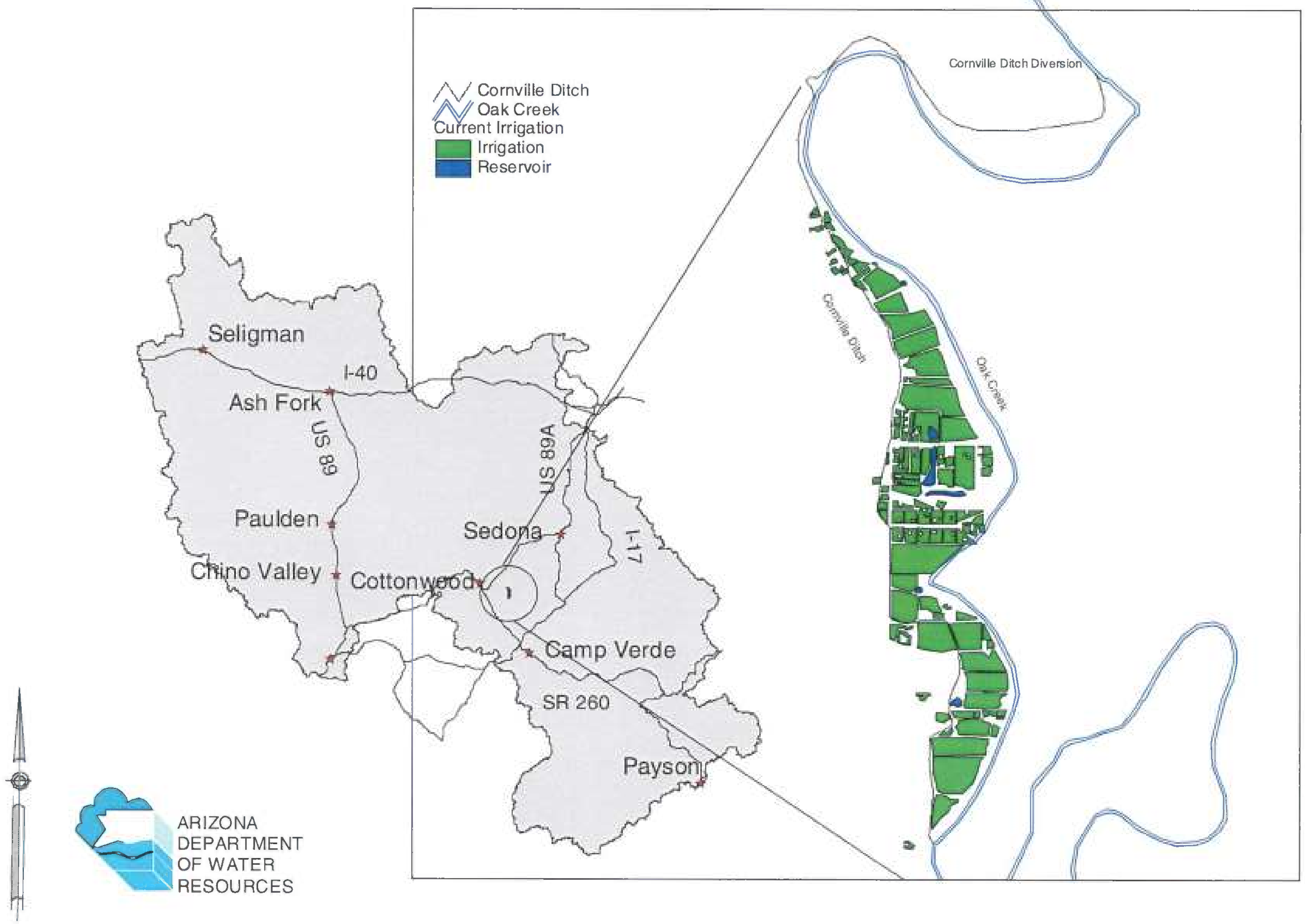
The Cornville Ditch Association only supplies surface water diverted from Oak Creek to shareholder lands adjacent to the ditch. It is estimated that the Cornville Ditch delivered water to approximately 165 acres at the time of its original construction in 1876. The estimated number of acres currently served by the Cornville Ditch is 134. The estimated annual volume of water consumed by the crops irrigated from the Cornville Ditch in 1997 was 422 acre-feet.

The Cornville Ditch Association assesses a monthly fee to its shareholders for the use of water based on the number of acres served. The association does not charge an additional fee for the actual volume of water used. The current assessment is $5.00 per acre per month. This fee is billed quarterly and goes to cover the cost of operations and maintenance.

FACILITIES

The Cornville Ditch diversion structure is constructed of rock and soil aggregates and diverts most of the Oak Creek surface flows into the ditch. The diversion structure for the Cornville Ditch is located at the Merritt Ranch. The first user is approximately two miles downstream from the point of diversion. The ditch length is approximately four miles of unlined open channel with several turnouts. All water not used by its shareholders is returned directly to Oak Creek. Water flows continuously in the ditch, except for periods of time in the winter when maintenance is performed on the ditch. Several reservoirs located in the southern portion of Cornville can be utilized for storage. The operation and maintenance of the ditch is supervised by members of the association.

Figure B.41 - Cornville Ditch Association



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

COTTONWOOD DITCH ASSOCIATION

PERSONNEL

President:	Mr. Andy Groseta
Manager/Contact Person:	Mr. Peter Groseta
Board of Directors:	5 Member Elected Board
Shareholders:	Approximately 200

HISTORY

The Cottonwood Ditch was originally constructed in 1869 for the purpose of supplying water from the Verde River for agricultural production. It is generally recognized as the first major ditch constructed to serve irrigation water to the Verde Valley. The Cottonwood Ditch delivers water for irrigation purposes to lands located on the west bank of the Verde River, above and below the Town of Cottonwood. Since its original construction, the Cottonwood Ditch has been known by several names including: Upper Verde Reservation Ditch, Old Government Reservation Ditch, and Upper Verde Canal. Irrigation water served by Cottonwood Ditch is predominantly utilized for the maintenance of pasture lands.

WATER RESOURCES

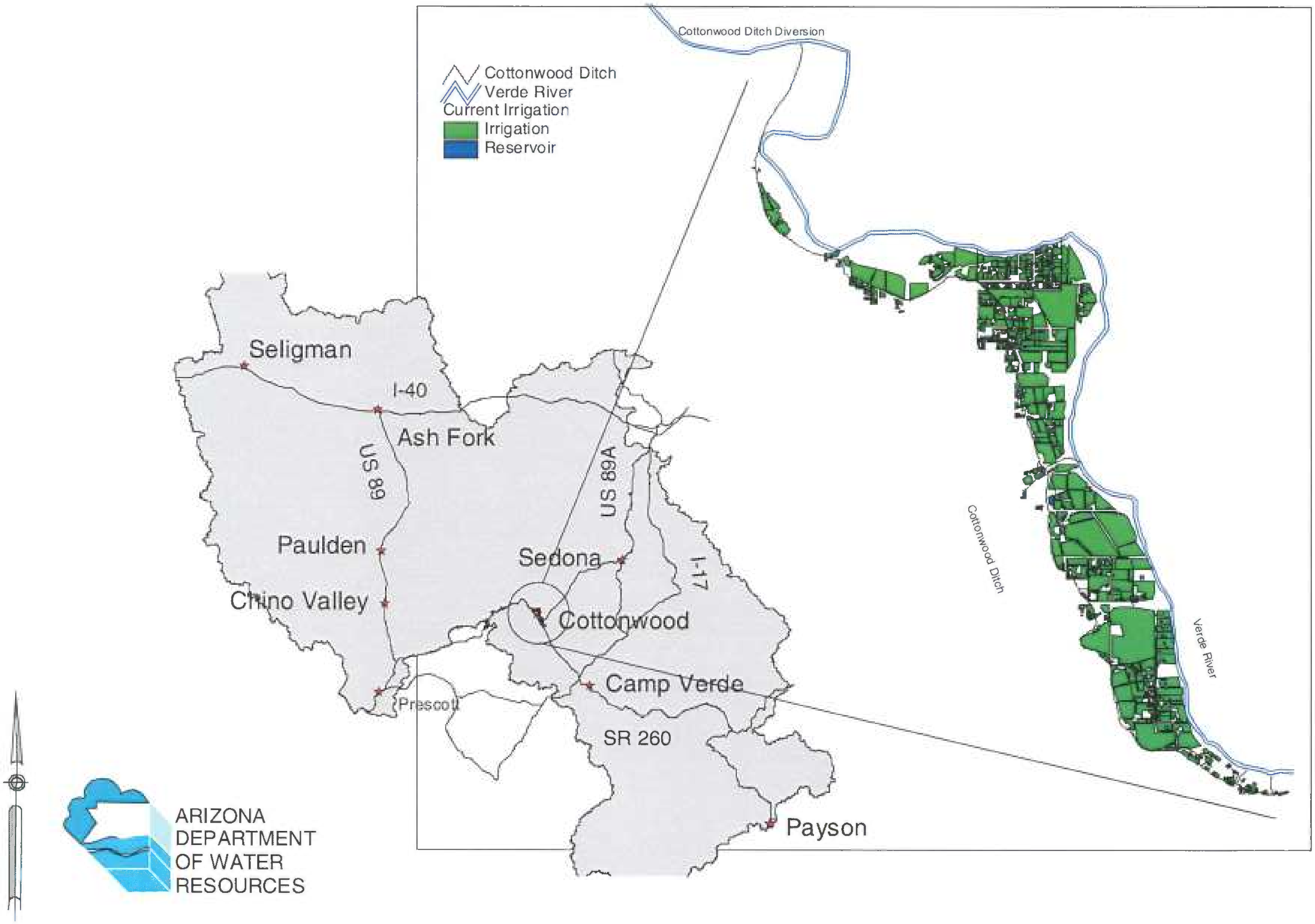
The Cottonwood Ditch delivers surface water diverted from the Verde River to shareholder lands adjacent to the ditch. It is estimated that the Cottonwood Ditch originally delivered water to approximately 850 acres. This number has been significantly reduced over time due to the increase in urbanization of shareholder lands. The estimated number of acres irrigated in 1963 were 725 (Alam, 1997). The total number of acres currently estimated to be served water is 585. The estimated annual volume of water consumed by crops irrigated by the Cottonwood Ditch in 1997 was 1,843 acre-feet.

The current fee for water is $10.00 per acre per share. This fee is used to cover the cost of operations and maintenance.

FACILITIES

The Cottonwood Ditch diversion structure is constructed of rock and soil and is currently located just west of Old Town Cottonwood, approximately one half mile below the diversion structure for the Hickey Ditch. Virtually all surface water in the Verde River at the Cottonwood diversion structure is diverted into the Cottonwood Ditch. The ditch is approximately eight miles in length with five main turnouts. With the exception of two small sections where it is piped and concrete lined, the entire ditch is an unlined open channel. All water not used by its shareholders is returned directly to the Verde River. Water flows continuously in the ditch, except during the winter when maintenance is performed on the ditch. The operation and maintenance of the ditch are supervised by a ditch boss.

Figure B.42 - Irrigation Along Cottonwood Ditch



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

DIAMOND S DITCH ASSOCIATION

PERSONNEL

President:	N/A
Manager/Contact Person:	Mr. Charles Hilbers
Board of Directors:	6
Shareholders:	Est. 84

HISTORY

The Diamond S Ditch was originally constructed around 1877 for the purpose of supplying irrigation water to lands located on the west and northern banks of the Verde River, southwest of the Town of Camp Verde. The primary crops supported by irrigation water from the Diamond S Ditch are lawns, pastures, orchards, and small gardens.

WATER RESOURCES

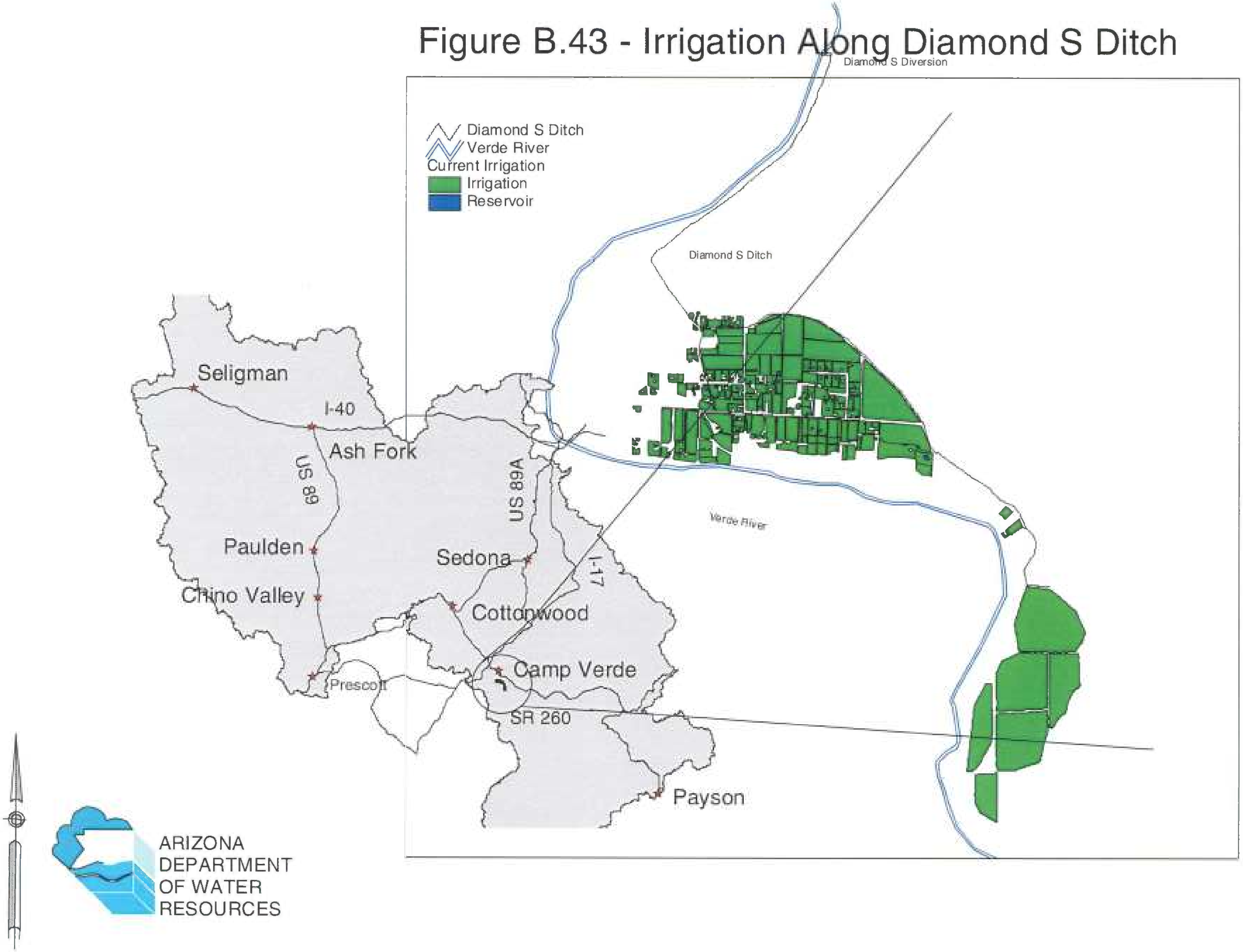
The Diamond S Ditch Company relies exclusively on the diversion of surface water from the Verde River to meet the water demands of its shareholders. It is estimated that 640 acres were originally served water by the Diamond S Ditch. The Diamond S Ditch currently delivers water to approximately 439 acres. The estimated annual volume of water consumed by crops irrigated by the Diamond S Ditch in 1997 was 1,383 acre-feet.

Shareholders are assessed an annual fee. The collected fees cover the cost of cleaning, diversion repair, and other maintenance performed on the ditch.

FACILITIES

The Diamond S Ditch Company diversion structure is constructed of aggregate and large concrete pieces and is located on the east bank of the Verde River. The ditch is approximately four to five miles in length and has four main turnouts. Of the four main turnouts, the first sluice gate that is one quarter mile down from the diversion dam can return 80 percent of the water back to the Verde River. The second sluice gate, another one half mile down, can return all of the water. The ditch has three main laterals that can receive equal amounts of water. The first lateral, however, typically receives the largest quantity of water due to the demands of the shareholders located on the first lateral. All water not used by the shareholders is returned directly to the Verde River. Water is diverted continuously into the ditch except for a short period in the winter when maintenance is performed. The operation of the ditch is supervised by the elected board of directors.

Figure B.43 - Irrigation Along Diamond S Ditch



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

EUREKA DITCH COMPANY

PERSONNEL

President:	N/A
Manager/Contact Person:	Mr. John McReynolds
Board of Directors:	7 Members
Shareholders:	Est. 186

HISTORY

The Eureka Ditch was constructed around 1868 for the purpose of supplying irrigation water to lands located in the Middle Verde area on the west and north banks of the Verde River. Like the Hickey, Cottonwood, and OK Ditches, the Eureka Ditch is considered to be one of the original ditches serving irrigation water to the Verde Valley. T. A. Hayden, in his report of 1940, indicated the first irrigation from Eureka Ditch occurred around 1877. The primary crops grown on lands served by the Eureka Ditch are alfalfa, pastures, lawns, and gardens.

WATER RESOURCES

The Eureka Ditch delivers surface water diverted from the Verde River to shareholders' lands adjacent to the ditch. It is estimated that Eureka Ditch originally delivered water to as many as 444 acres. The estimated number of acres currently being irrigated by the Eureka Ditch is 349. The estimated annual volume of water consumed by crops irrigated by the Eureka Ditch in 1997 was 1,100 acre-feet.

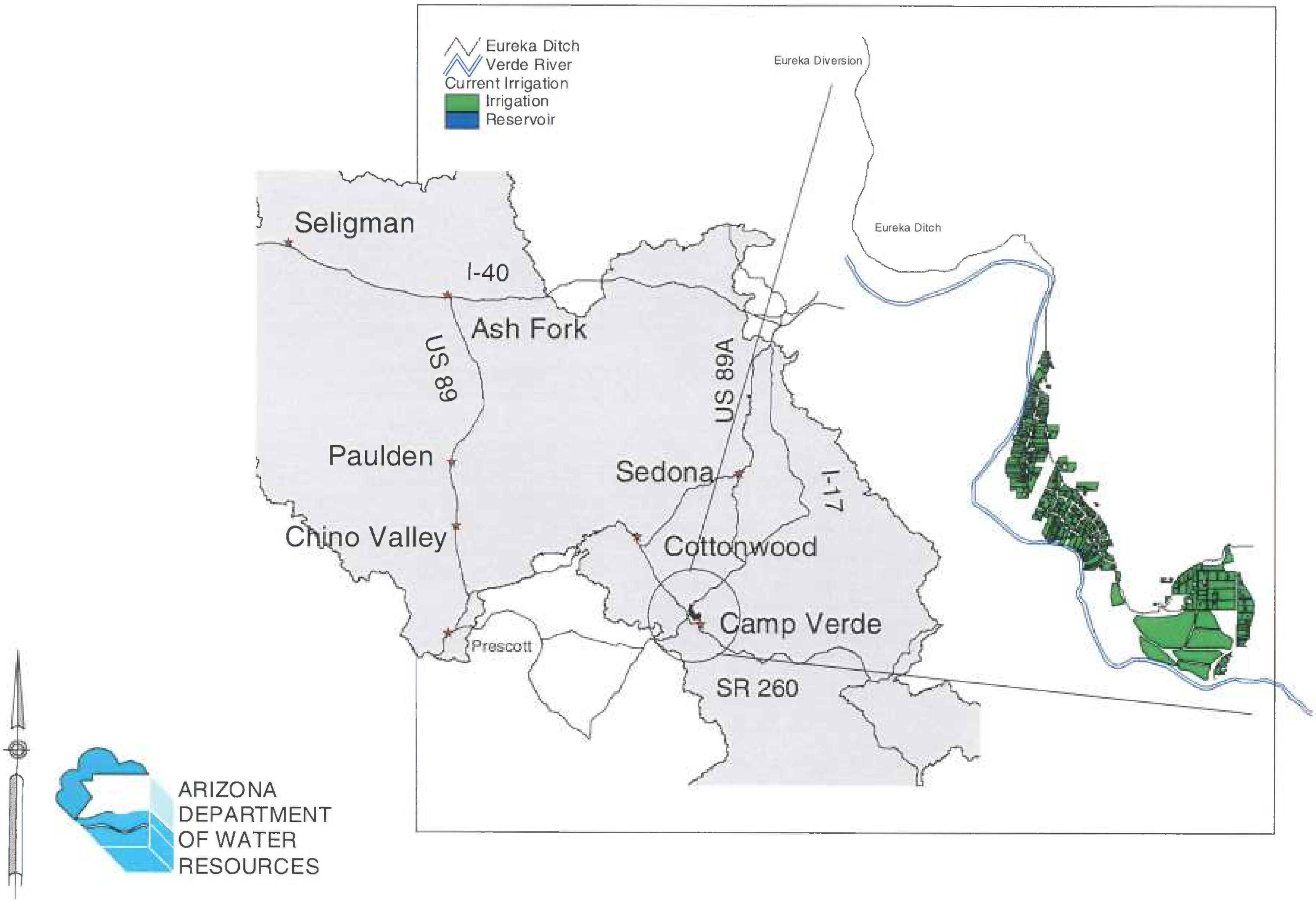
Water is diverted on a continuous basis into the ditch, while association members take delivery of water on an "as needed" basis. Water deliveries are never scheduled.

Eureka Ditch also receives surplus flows from the OK Ditch. The excess flows enter the Eureka Ditch at Bullard's Dairy. The total cost of maintenance and repairs is divided equally between the association members. Association members are currently assessed a fee of $85.00 per acre to receive water for irrigation.

FACILITIES

The Eureka Ditch diversion structure is a rock and earth embankment located approximately one quarter mile north of the Camp Verde Indian Reservation. The ditch is approximately six miles in length and consists of mostly unlined open channel with several turnouts that are used to regulate the flow of water in the ditch. The first user is approximately 3 miles downstream of the diversion dam. Water flows continuously in the ditch, except for periods of time in the winter when maintenance is performed. The operation and maintenance of the ditch are coordinated by members of the association.

Figure B.44 - Irrigation Along Eureka Ditch



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

HICKEY DITCH ASSOCIATION

PERSONNEL

President:	N/A
Manager/Contact Person:	Mr. Les Bovee and/or Mr. Charles Mayberry Dead Horse Ranch State Park
Board of Directors:	N/A
Shareholders:	Est. 4

HISTORY

Hickey Ditch was originally constructed between 1874 and 1876 for the purpose of supplying water from the Verde River for agricultural production. It is one of the earliest ditches constructed to serve irrigation water to the Verde Valley. What makes the Hickey Ditch so unique is that it is one of the few ditches that actually delivers water to lands located on both sides of the Verde River above the Town of Cottonwood. Today, irrigation water served by Hickey Ditch is predominantly used for the maintenance of pastures, small orchards, and landscaping.

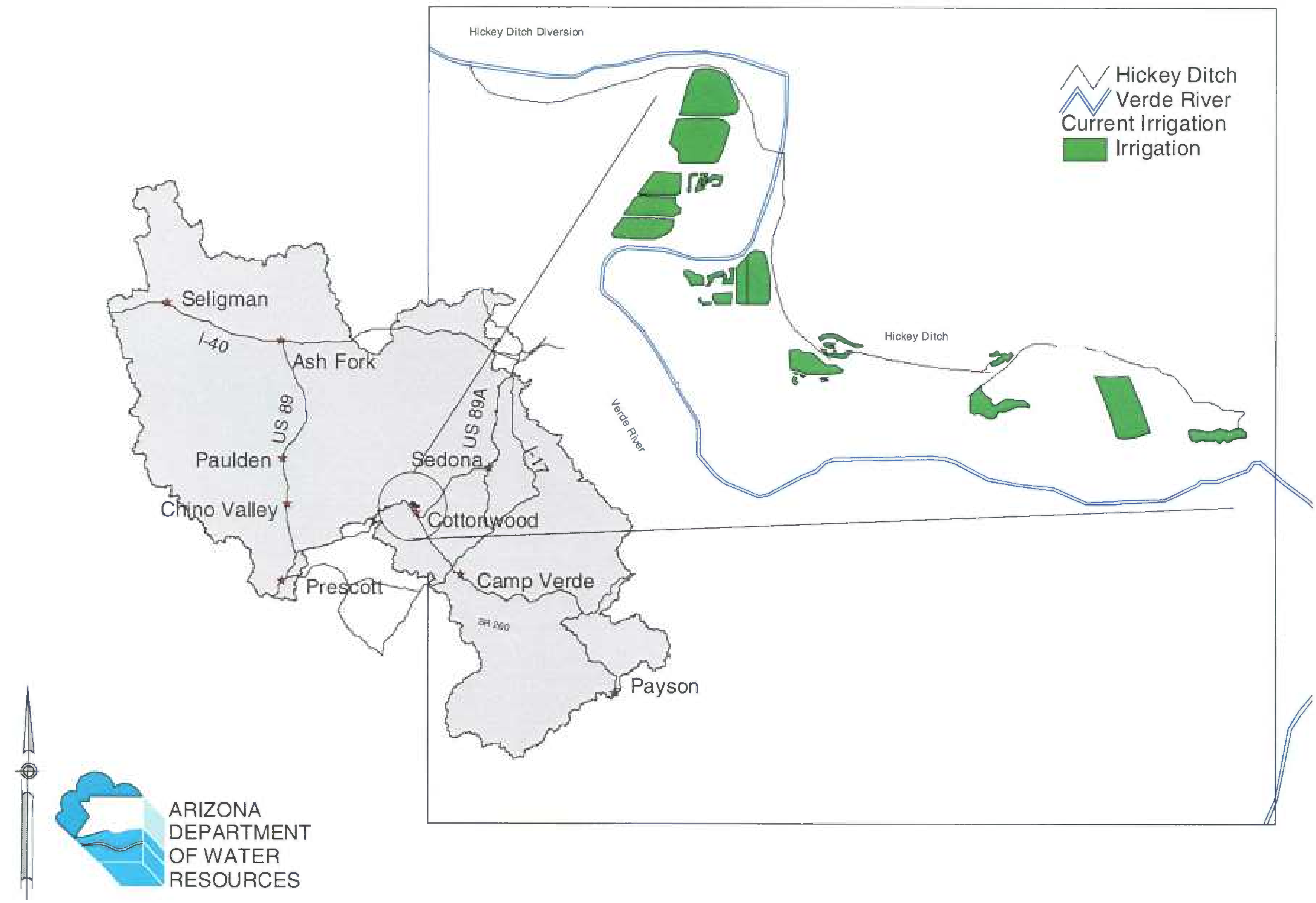
WATER RESOURCES

The Hickey Ditch owns no groundwater pumps and, therefore, only delivers surface water diverted from the Verde River to lands located adjacent to the ditch. It is estimated that the Hickey Ditch originally delivered water to as many as 175 acres. The current estimate of the number of acres irrigated by the Hickey Ditch is 65. The current cost of water is unknown. The estimated annual volume of water consumed by crops irrigated by the Hickey Ditch in 1997 was 205 acre-feet.

FACILITIES

The Hickey Ditch diversion structure is constructed of rock and soil aggregates and is currently located west of Old Town Cottonwood approximately one quarter mile above the diversion structure for the Cottonwood Ditch. The original diversion structure was located on the east bank of the Verde River, but due to flooding, the location was changed to the west bank. To facilitate delivery of water to the lands on the east bank of the Verde River, an 18 inch corrugated pipe was suspended above and across the river. The ditch is approximately 2.8 miles in length and includes four flumes that are essential for transporting water across the Cottonwood Ditch and for diverting water from the Hickey Ditch. Arizona State Parks has installed flow monitoring recorders along the ditch and collects flow measurements on a regular basis. There are also three turnouts back to the river that are used to regulate flows in the ditch. The operations and maintenance of the ditch are coordinated by the last user on the ditch (Dead Horse Ranch State Park) which works in conjunction with the upstream users of the ditch. All water diverted and not used by the shareholders is returned directly to the Verde River.

Figure B.45 - Irrigation Along Hickey Ditch



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

JORDAN MEADOWS IRRIGATION ASSOCIATION, INC.

PERSONNEL

President:	Mr. Frank Gordon
Manager/Contact Person:	Mr. Tony Kreider
Board of Directors:	N/A
Shareholders:	Est. 57

HISTORY

The Jordan Meadows Ditch is believed to have been constructed between 1910 and 1916 for the purpose of irrigating lands located on the east bank of the Verde River in Camp Verde. Irrigation water supplied by the Jordan Meadows Ditch is utilized to support and maintain the production of barley, oats, pastures, lawns, orchards, and small vegetable gardens.

WATER RESOURCES

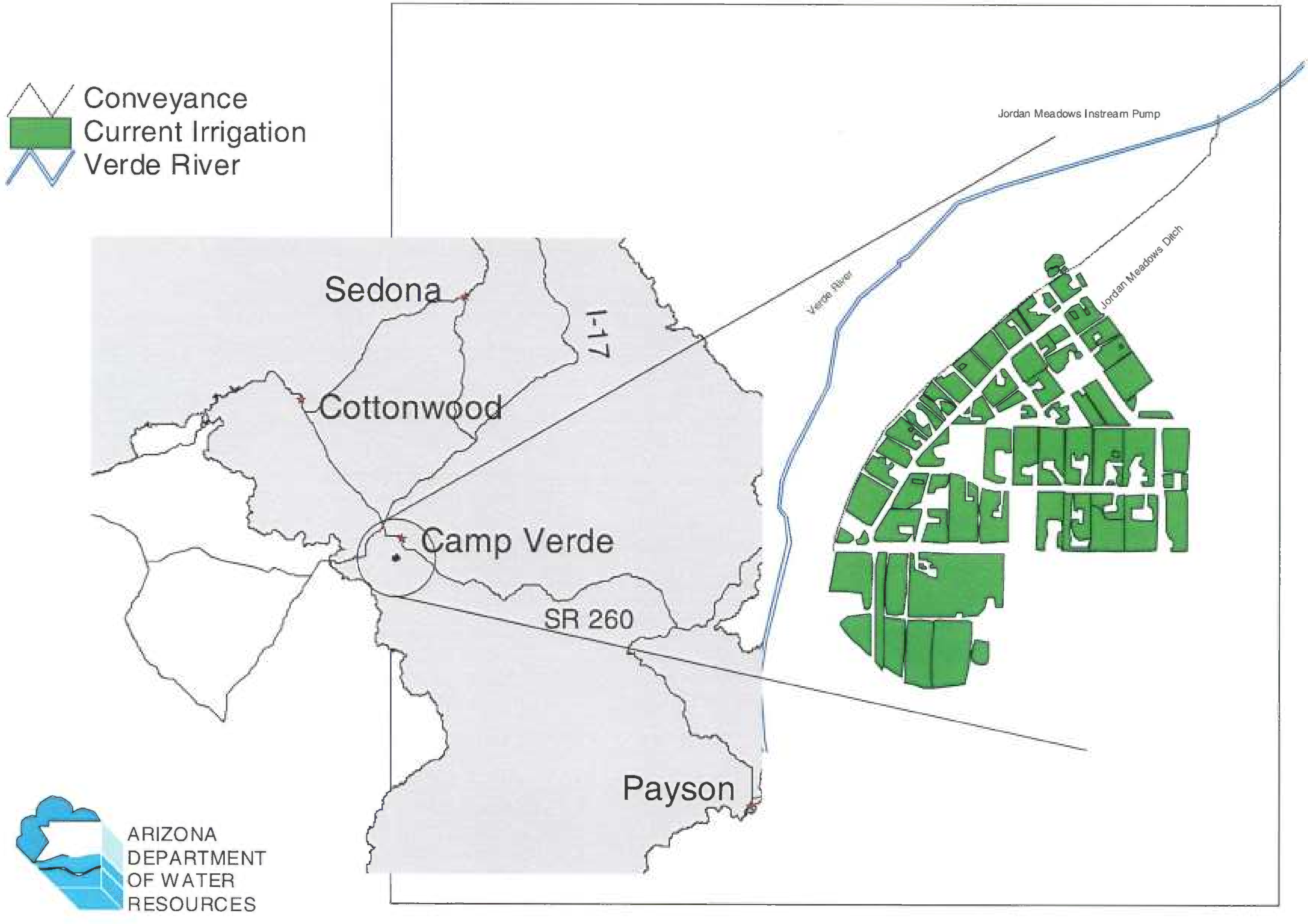
Jordan Meadows Association, Inc. relies exclusively on the diversion of surface water to meet the water demand of its shareholders. The estimated number of acres served by the Jordan Meadows instream pump is 72. The estimated annual volume of water consumed by crops irrigated by this association in 1997 was 227 acre-feet.

Jordan Meadows Association, Inc. assesses an annual fee of $75.00 per acre to its shareholders. In addition to the annual assessment, the association charges a usage fee of $50.00 per hour. At the beginning of each irrigation year members are allocated hours based on written requests and the availability of pump times. Special assessments may be imposed for additional costs of repairs and maintenance.

FACILITIES

Jordan Meadows Association, Inc. utilizes an instream pump upstream of an aggregate check dam to divert Verde River surface flows. The aggregate check dam creates pool of water in the stream channel to ensure proper operation of the instream pump. The ditch consists of mostly unlined open channel with the exception of a section of 18 inch PVC pipe that is used to transfer water across the Diamond S Ditch. A series of laterals and individual turnouts distribute the water to the shareholders. Water flows continuously in the ditch except for mid February when repair work is performed. All water not used by shareholders is returned to the Verde River. Maintenance of the pump and small lateral canals is performed by association members.

Figure B.46 - Jordan Meadows Irrigation Association



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

KINSEY DITCH ASSOCIATION

PERSONNEL

President:	N/A
Manager/Contact Person:	Mr. Lawrence A. Matthews
Board of Directors:	N/A
Shareholders:	Est. 7

HISTORY

The Kinsey Ditch was constructed around 1877 for the purpose of supplying irrigation water to lands located on the north and west banks of Oak Creek north of Page Springs. The actual date of the original construction is unknown. The primary use of the water delivered by the Kinsey Ditch is for landscaping and small vegetable gardens. The ditch association is composed of seven shareholders that operate the ditch under an informal arrangement.

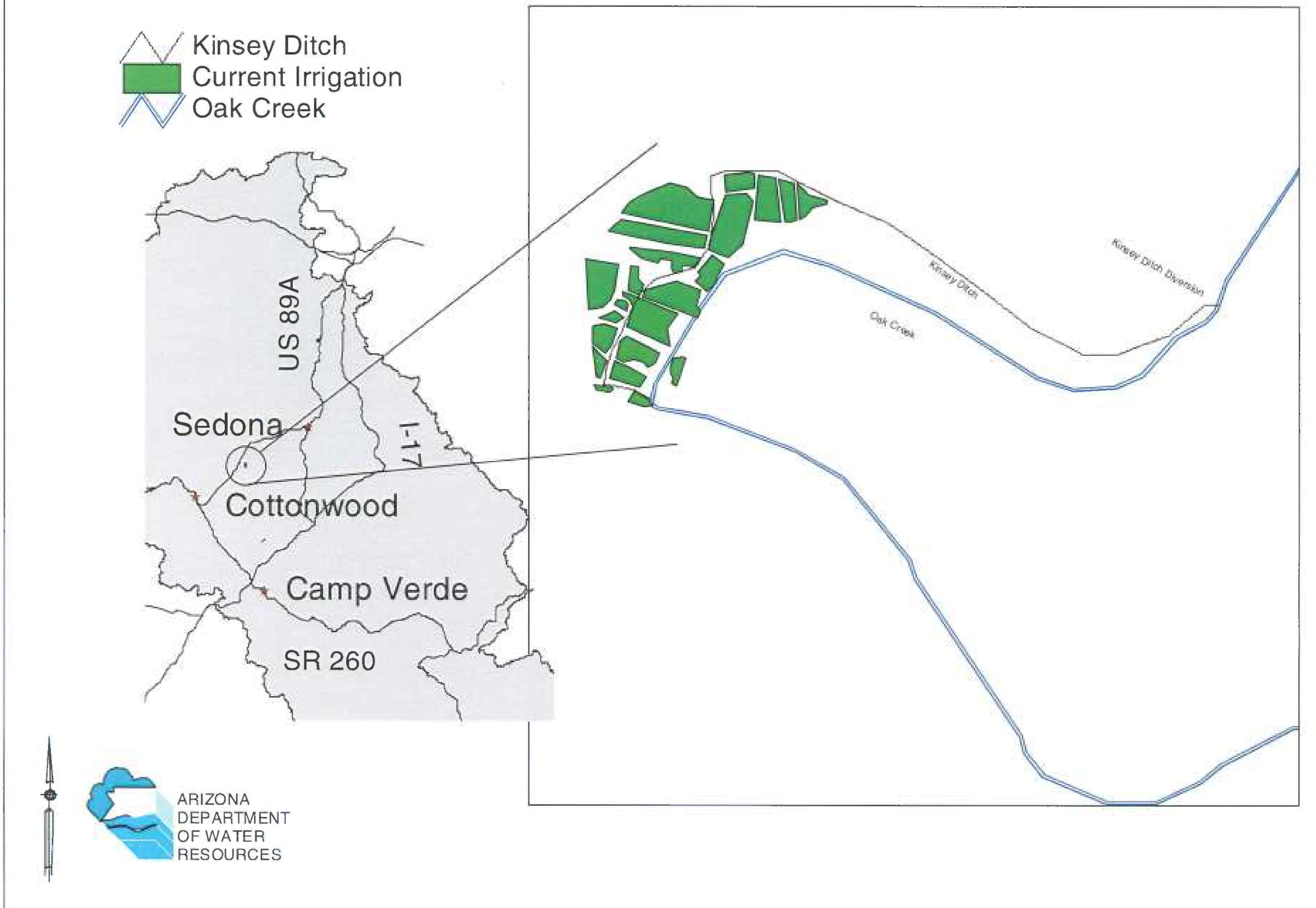
WATER RESOURCES

The Kinsey Ditch delivers surface water diverted from Oak Creek to the Hidden Valley Community shareholders' lands adjacent to the ditch. Approximately 11 acres of land currently receive water from the Kinsey Ditch. The estimated annual volume of water consumed by crops irrigated by the Kinsey Ditch in 1997 was 35 acre-feet. The current cost of water for irrigation from this ditch is not known. A fee is collected, however, to cover the cost of maintenance and repairs on the ditch.

FACILITIES

The Kinsey Ditch diversion structure is constructed of rock and soil aggregates and is presently located on Coconino National Forest land. The ditch is approximately one mile in length and consists mostly of unlined open channel. The first user is approximately one half mile downstream from the point of diversion. All water not used by its shareholders is returned directly to Oak Creek. Water flows continuously in the ditch, except for periods of time when maintenance is performed. The operation and maintenance of the ditch are supervised by the members of the association.

Figure B.47 - Kinsey Ditch Association



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

LEONARD MAXWELL DITCH ASSOCIATION

PERSONNEL

President:	N/A
Manager/Contact Person:	Mr. Jerry Lane
Board of Directors:	N/A
Shareholders:	Est. 4

HISTORY

The actual construction date of the Leonard Maxwell Ditch is not known, but is reported to have occurred either in 1871 or 1899. The ditch was constructed for the purpose of supplying irrigation water to lands located on the north bank of the Wet Beaver Creek, northeast of Camp Verde. In addition to being called the Leonard Maxwell Ditch, it has also been referred to as the Lightfoot Ditch. Leonard Maxwell Ditch is used mainly for irrigating pastures and lawns. The first user is approximately one quarter of a mile downstream from the point of diversion.

WATER RESOURCES

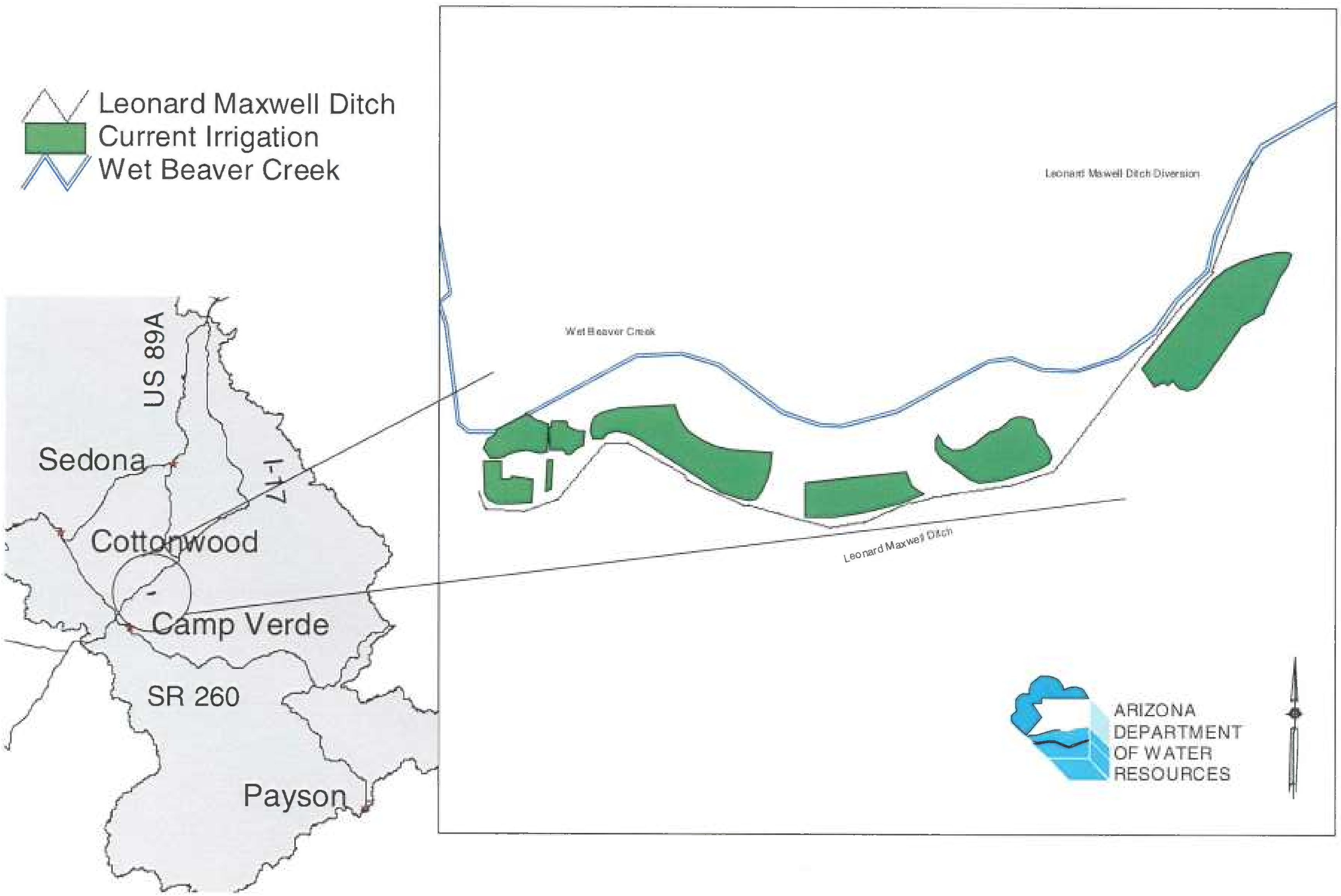
The Leonard Maxwell Ditch relies exclusively on the diversion and delivery of surface water from the Wet Beaver Creek to meet its shareholders' demands. The ditch was originally estimated to serve irrigation water to as many as 40 acres. Currently, 25 acres are estimated to be served irrigation water by the Leonard Maxwell Ditch. The estimated annual volume of water consumed by crops irrigated by this ditch in 1997 was 79 acre-feet.

The four properties currently served by the ditch have an informal arrangement regarding costs of operation. Fees are collected to cover the cost of cleaning, repair, and other maintenance performed on the ditch.

FACILITIES

The Leonard Maxwell Ditch diversion structure is constructed of rock and soil aggregates and is located on the Wet Beaver Creek. The ditch is approximately one mile in length and consists of approximately three quarters of a mile of unlined open channel and one quarter mile of PVC pipe. All water not used by the shareholders is returned directly to Wet Beaver Creek. Water flows continuously in the ditch, except for periods of time when maintenance is performed on the ditch. The operation and maintenance of the ditch is supervised by the members of the association.

Figure B.48 - Leonard Maxwell Ditch Association



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

MASON LANE WATER USERS ASSOCIATION

PERSONNEL

President:	N/A
Manager/Contact Person:	Ms. Marty McElroy and/or Mr. Bill Waddoups
Board of Directors:	N/A
Shareholders:	Est. 70

HISTORY

The Mason Lane Ditch was constructed around 1878 for the purpose of supplying water from Oak Creek to lands located on the east and south banks of Oak Creek in the northern portion of Cornville. A new diversion structure was constructed in 1942 to facilitate the operation of the ditch. The Mason Lane Water Users Association operates the ditch and is considered to be the largest provider of irrigation water on Oak Creek. In addition to being called the Mason Lane Ditch, it has also been referred to as the Oak Creek Ditch. The primary crops grown by lands served by the Mason Lane Ditch are alfalfa, pasture, lawns, and fruit orchards.

WATER RESOURCES

The Mason Lane Water Users Association relies exclusively on the diversion of surface water from Oak Creek to meet shareholders• water demands. Approximately 240 acres of land were estimated to be originally served by the Mason Lane Ditch. Today, that number has been reduced to approximately 233 acres due to the increase in urbanization. The estimated annual volume of water consumed by crops irrigated by the Mason Lane Ditch in 1997 was 734 acre-feet.

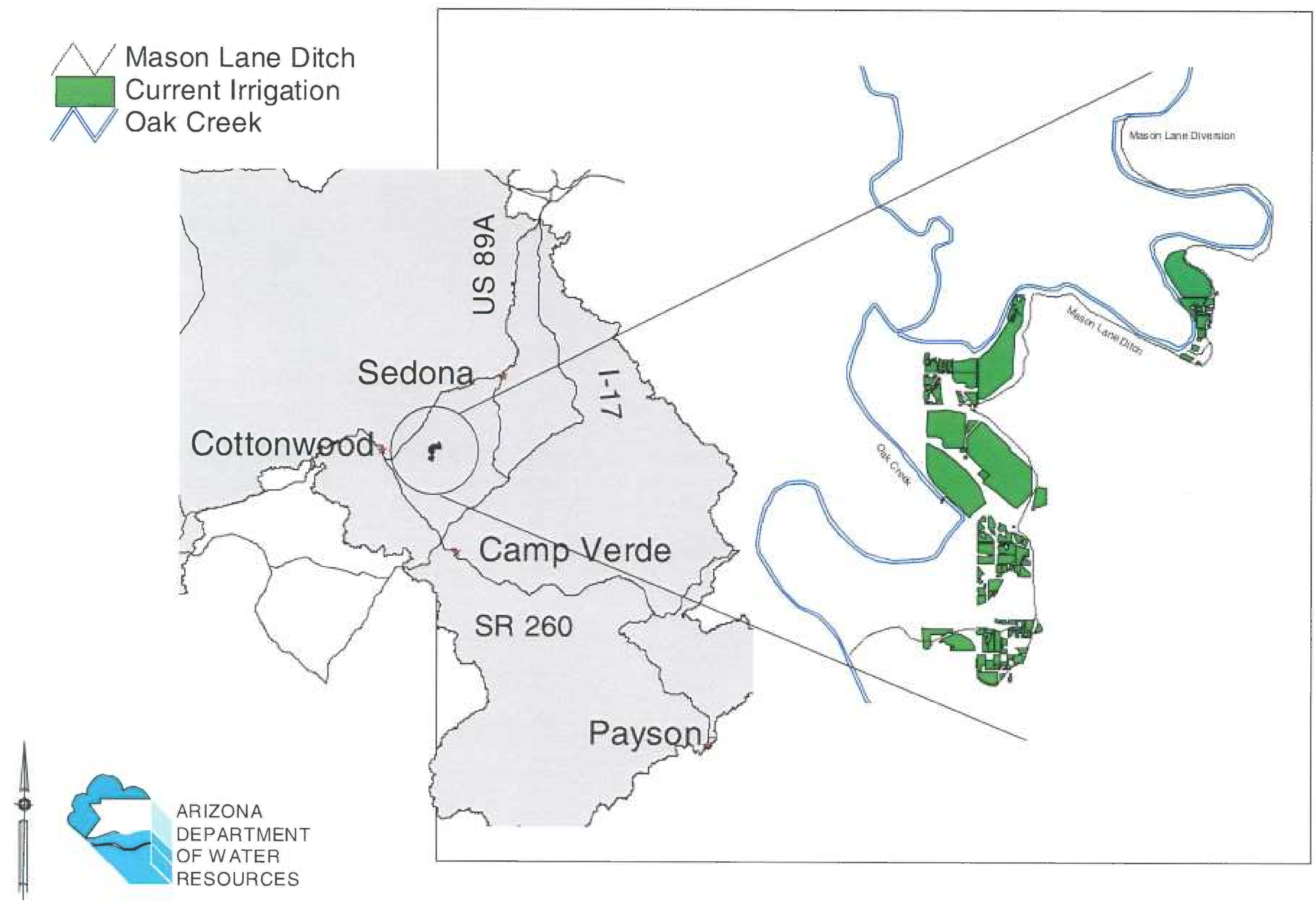
The Mason Lane Water Users Association incorporates a unique way of dividing the diverted flows of water among its members. The number of shares owned by an association member determines the amount of continuous water flow the member is entitled to receive. As an example: if a member owns one tenth of the total shares of the association, that member is entitled to receive one tenth of the total flow of water in the ditch and thus constructs a delivery gate capable of receiving that amount of flow at anytime. Mason Lane Water Users Association currently assesses an annual fee of $50.00 per acre, which covers the costs of operations and maintenance.

FACILITIES

The Mason Lane diversion structure is constructed of a telephone pole, cedar posts, and sheets of tin that have been located on a basalt rock outcrop in Oak Creek. The diversion structure is located southeast of Page Springs Hatchery and diverts the majority of the surface water flows of Oak Creek into the ditch. The ditch is approximately five miles in length with the first user located approximately 1.5 miles downstream from the diversion structure. The entire ditch is mostly unlined open channel. Included in the system are several small reservoirs for storage and flow regulating purposes located in the northern portion of Cornville.

Water is diverted continuously from Oak Creek, except for periods of time in the winter when maintenance is performed on the ditch. All water that is not used by the shareholders is returned directly to Oak Creek. The Mason Lane Water Users Association coordinates and supervises the operation and maintenance of the ditch.

Figure B.49 - Mason Lane Water Users Association



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

OK DITCH COMPANY

PERSONNEL

President:	Mr. George Kovacovich
Manager/Contact Person:	Mr. Richard T. McDonald, Secretary/Treasurer
Board of Directors:	N/A
Shareholders:	Est. 134

HISTORY

The OK Ditch was constructed around 1873 to 1876 for the purpose of supplying irrigation water to lands located in the Middle Verde area on the west and north banks of the Verde River, including the Camp Verde Indian Reservation. Like the Hickey and Cottonwood Ditches, the OK Ditch is considered to be one of the original ditches serving irrigation water to the Verde Valley. The OK Ditch, or the Middle Verde Canal as it has also been referred to, originally provided water for agricultural production that included pasture, small grains, and alfalfa. Today, the primary crops grown by shareholders of the OK Ditch are pasture and lawns.

WATER RESOURCES

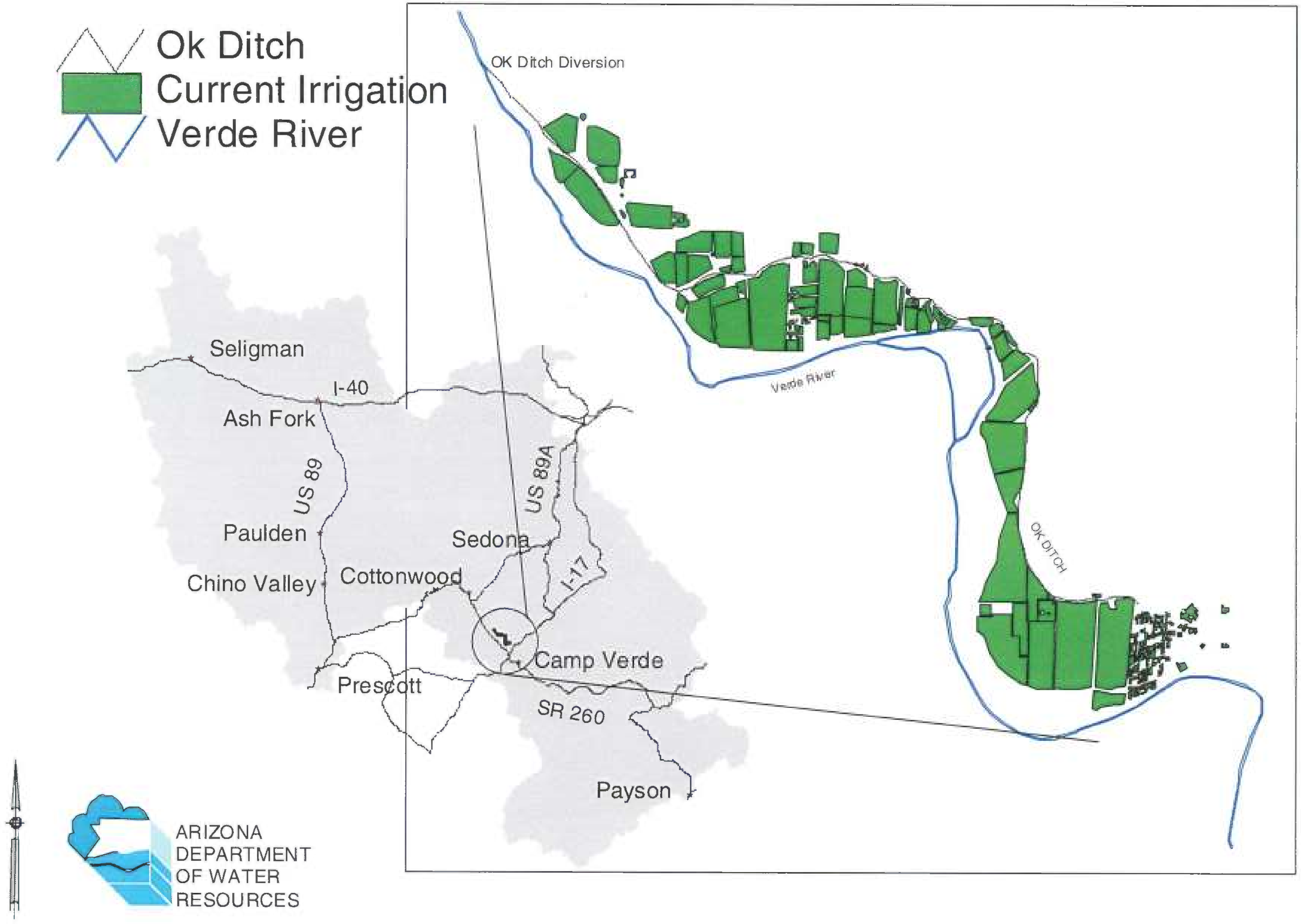
The OK Ditch Company delivers surface water diverted from the Verde River to shareholder lands adjacent to the ditch. The actual number of acres irrigated by the OK Ditch has varied over time with the original estimate set at 610 acres (O. A. Turney, 1901; H. L. Hancock, 1914). Currently, the estimated number of acres receiving water from the ditch is 392. The estimated annual volume of water consumed by crops irrigated by this ditch in 1997 was 1,235 acre-feet. The greatest demand for water by the shareholders of the OK Ditch occurs in July and August.

The OK Ditch Company charges a fee for maintenance and repairs only. The total cost of maintenance and repairs in 1997 was $3,850. This amount was evenly divided among all the shareholders.

FACILITIES

The OK Ditch diversion structure is an embankment constructed of rock and soil located on the Verde River approximately one mile below the mouth of Oak Creek on Prescott National Forest land. The ditch is approximately 5.5 miles in length with several turnouts located upstream of the first user to regulate flows in the ditch. The entire ditch is mostly unlined open channel. All water that is diverted and not used by the OK Ditch Company members flows into two small reservoirs where it is then diverted into the Eureka Ditch for their use. Water is diverted continuously from the Verde River, except for periods of time in the winter when maintenance is performed on the ditch. The OK Ditch Company does not employ a ditch boss and the operation and maintenance are performed by the shareholders.

Figure B.50 - Irrigation Along OK Ditch



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

OWENBY DITCH WATER USERS, INC.

PERSONNEL

President:	N/A
Manager/Contact Person:	Mr. Bruce L. Campbell, Los Abrigados Resort & Spa
Board of Directors:	Managing Committee
Shareholders:	Est. 32

HISTORY

The Owenby Ditch was originally constructed in 1904 for the purpose of supplying irrigation water to lands located on the west bank of Oak Creek in Sedona. Since its original construction, the crops produced in the area served by the ditch have been confined to mostly lawns and small gardens.

WATER RESOURCES

Owenby Ditch Water Users, Inc. delivers surface water diverted from Oak Creek to shareholders' lands adjacent to the ditch. It is estimated that the Owenby Ditch originally delivered water to approximately 103 acres. Today, that number has been greatly reduced to approximately six acres as a result of the development of Sedona. The estimated annual volume of water consumed by private lawns and small gardens irrigated by the Owenby Ditch in 1997 was 19 acre-feet. The majority of water diverted from Oak Creek is for the purpose of landscaping in and around Los Abrigados Resort, which has ponds and simulated rivers on the property.

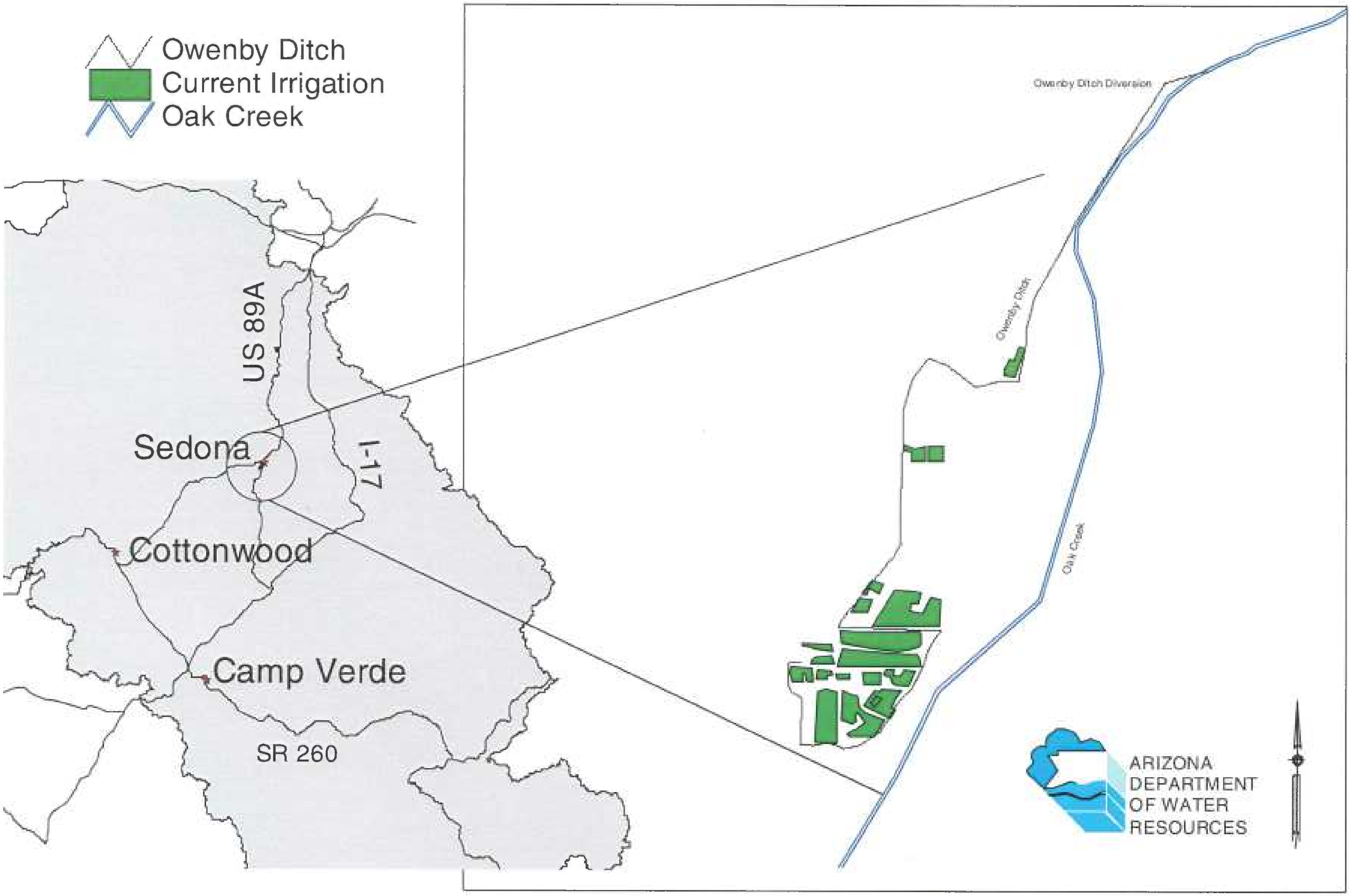
The current fee for water is determined by the size of the property served. The annual assessments are as follows:

Property Size	Assessment	Property Size	Assessment
1/4 acre	$ 60.50	1/2 acre	$ 75.63
3/4 acre	$113.45	1 acre	$151.25

FACILITIES

The Owenby Ditch diversion structure is constructed of rock and soil and diverts a portion of the Oak Creek surface flows into the ditch. The diversion structure for the ditch is currently located creek side at the L•Auberge Resort property. The ditch is approximately 1.25 miles in length and has several turnouts. Owenby Ditch has repeatedly been constructed just downstream of the diversion due to abnormally high flood stages of Oak Creek. The ditch consists of open channeled lined sections, piped sections, and even a concrete flume located at the entrance to the Los Abrigados Resort. All water not used by the shareholders is returned directly to Oak Creek. Water flows continuously in the ditch, except for periods of time when repair work is needed. The operation and maintenance of the ditch are supervised by the managing committee.

Figure B.51 - Owenby Ditch Water Users Association



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

PIONEER DITCH COMPANY

PERSONNEL

President:	N/A
Manager/Contact Person:	Ms. Barbara Ploe
Board of Directors:	N/A
Shareholders:	Est. 30

HISTORY

Pioneer Ditch claims to be the oldest ditch in the Verde Valley with an original construction date estimated to be around 1865. The Pioneer Ditch, also known as the Melvin Ditch, was constructed for the purpose of supplying irrigation water to lands located southeast of Camp Verde on the west and north banks of West Clear Creek. The ditch currently serves the Sierra Verde Estates Subdivision, which was originally a dairy farm. Primary crops supported by water from the Pioneer Ditch are corn, pastures, lawns, and small gardens.

WATER RESOURCES

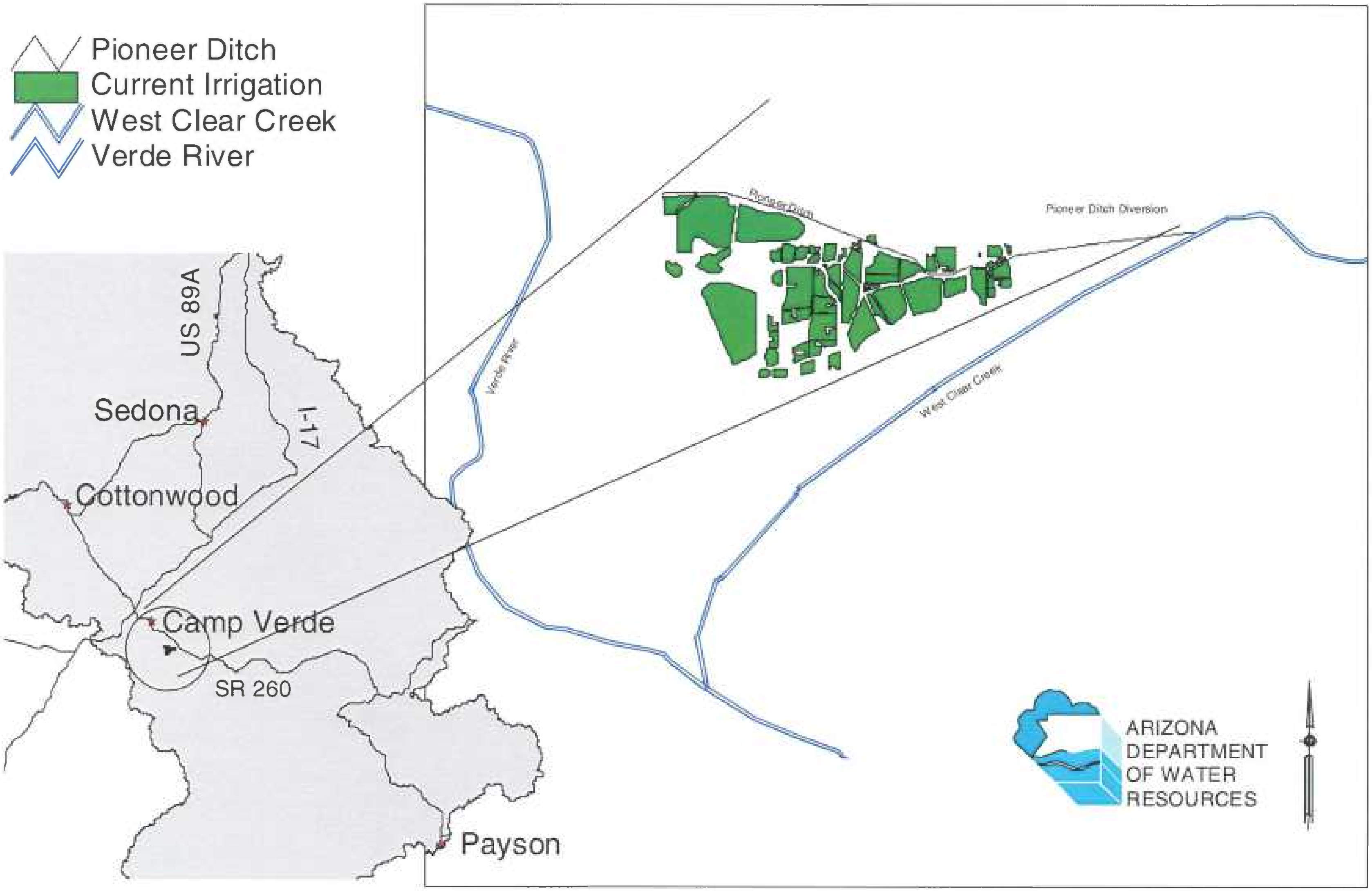
The Pioneer Ditch Company relies exclusively on the diversion of surface water from West Clear Creek to meet shareholder demands for irrigation water. Previous reports estimated that the Pioneer Ditch originally delivered water to approximately 260 acres. Pioneer Ditch currently supplies water to approximately 139 acres. The estimated annual volume of water consumed by crops irrigated by the Pioneer Ditch in 1997 was 438 acre-feet.

The Pioneer Ditch Company assesses a fee for maintenance and/or repair only.

FACILITIES

The Pioneer Ditch diversion structure is a soil and rock embankment located approximately two miles northeast of the confluence between the Verde River and West Clear Creek on private land. The diversion dam diverts most of the surface water flows of West Clear Creek. The ditch is approximately two miles in length and is mostly an unlined open channel. Included in the distribution system is a one acre storage pond that is used for reserve storage. Flows within the ditch are regulated by two turnouts located upstream of the first water user. The first water user is approximately one half mile west of the diversion dam. Water flows continuously in the ditch, except for periods of time from March to mid-April when maintenance is performed. The operation and maintenance of the ditch are supervised by a ditch boss and association members.

Figure B.52 - Irrigation Along Pioneer Ditch



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

POINT WILLOW DITCH ASSOCIATION

PERSONNEL

President:	Mr. Leonard Nawrocky
Manager/Contact Person:	Mr. Bob Rike, Secretary/Treasurer
Board of Directors:	N/A
Shareholders:	Est. 10

HISTORY

Point Willow Ditch was originally constructed around 1901 for the purpose of supplying irrigation water to lands located on the north and west banks of Oak Creek in Page Springs. The actual date of construction is unknown. Irrigation water delivered by Point Willow Ditch is utilized for the maintenance of pastures, lawns, and orchards. The ditch is controlled by an association composed of ten shareholders.

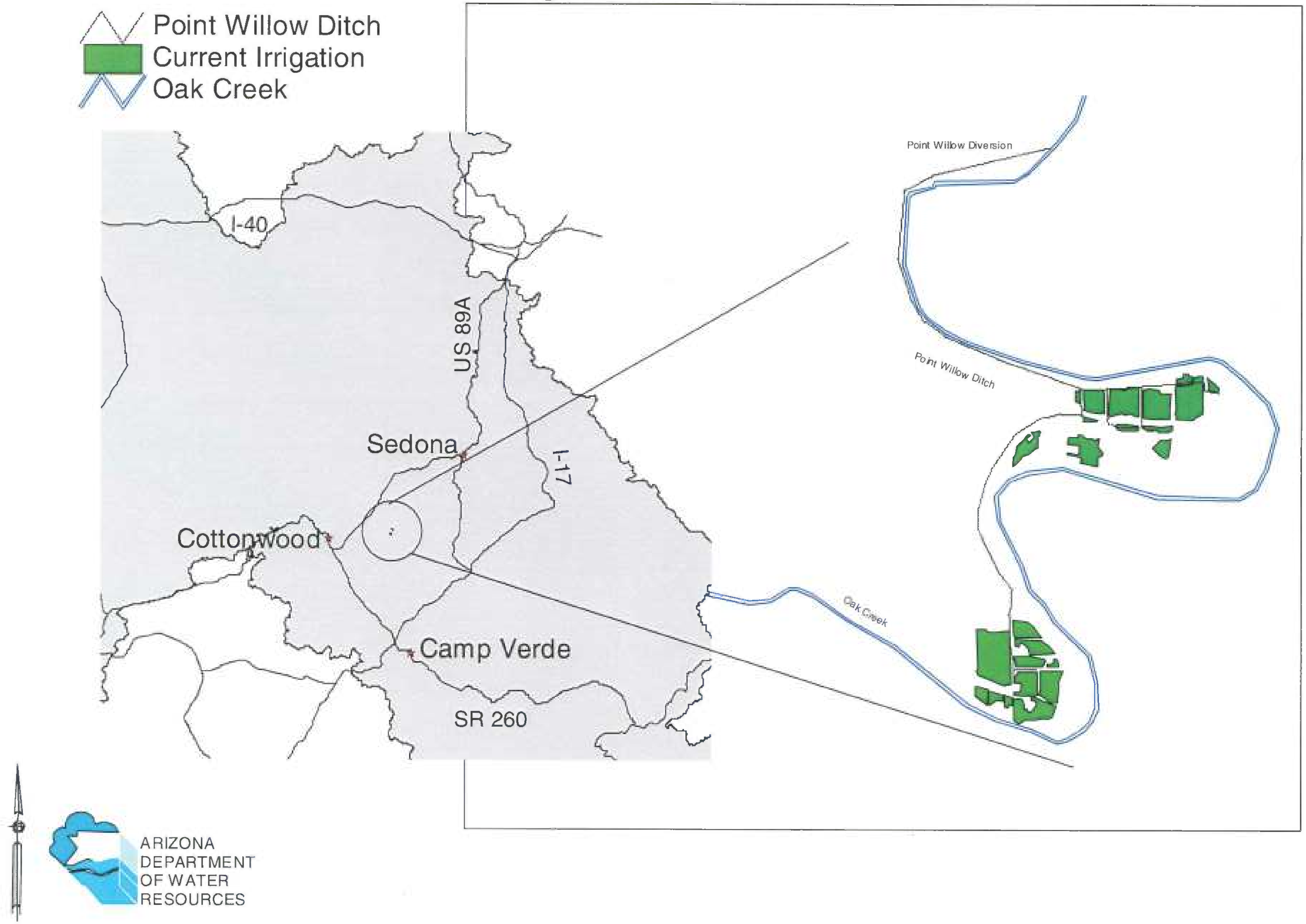
WATER RESOURCES

The Point Willow Ditch Association relies exclusively on the diversion of surface water from Oak Creek to meet shareholders' demands for irrigation water. The total number of acres originally served by the ditch was estimated to be 21. Point Willow Ditch currently delivers water to 24 acres. Flood irrigation of the shareholder lands is on a rotational basis. Shareholders are assessed a fee based on the cost of repairs and maintenance of the ditch. The estimated annual volume of water consumed by crops irrigated by the Point Willow Ditch in 1997 was 76 acre-feet.

FACILITIES

The Point Willow Ditch diversion structure is constructed of rock and soil and is located on the opposite side of Oak Creek directly behind Page Springs Fish Hatchery. The ditch is approximately 1.5 miles in length and has five turnouts back to Oak Creek to regulate flows in the ditch. The first user is approximately three quarters of a mile downstream from the diversion structure. The entire ditch is mostly an unlined open channel. All water that is diverted and not used by association members is returned directly to Oak Creek. Water is diverted continuously from Oak Creek, except for periods of time in the winter when maintenance is performed on the ditch. The operation and maintenance of the ditch are supervised by association members.

Figure B.53 - Point Willow Ditch Association



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

RED ROCK DITCH ASSOCIATION

PERSONNEL

President:	N/A
Manager/Contact Person:	Mr. Fred E. Schuerman
Board of Directors:	N/A
Shareholders:	Est. 43

HISTORY

The Red Rock Ditch was originally constructed around 1889 for the purpose of supplying irrigation water to lands located on the north and west banks of Oak Creek and southwest of the City of Sedona. The original construction date for the ditch is not known but is based on the earliest known cultivation of the area, which took place around 1880 (Hayden, 1940). The ditch has been historically known as Schuerman Ditch.

WATER RESOURCES

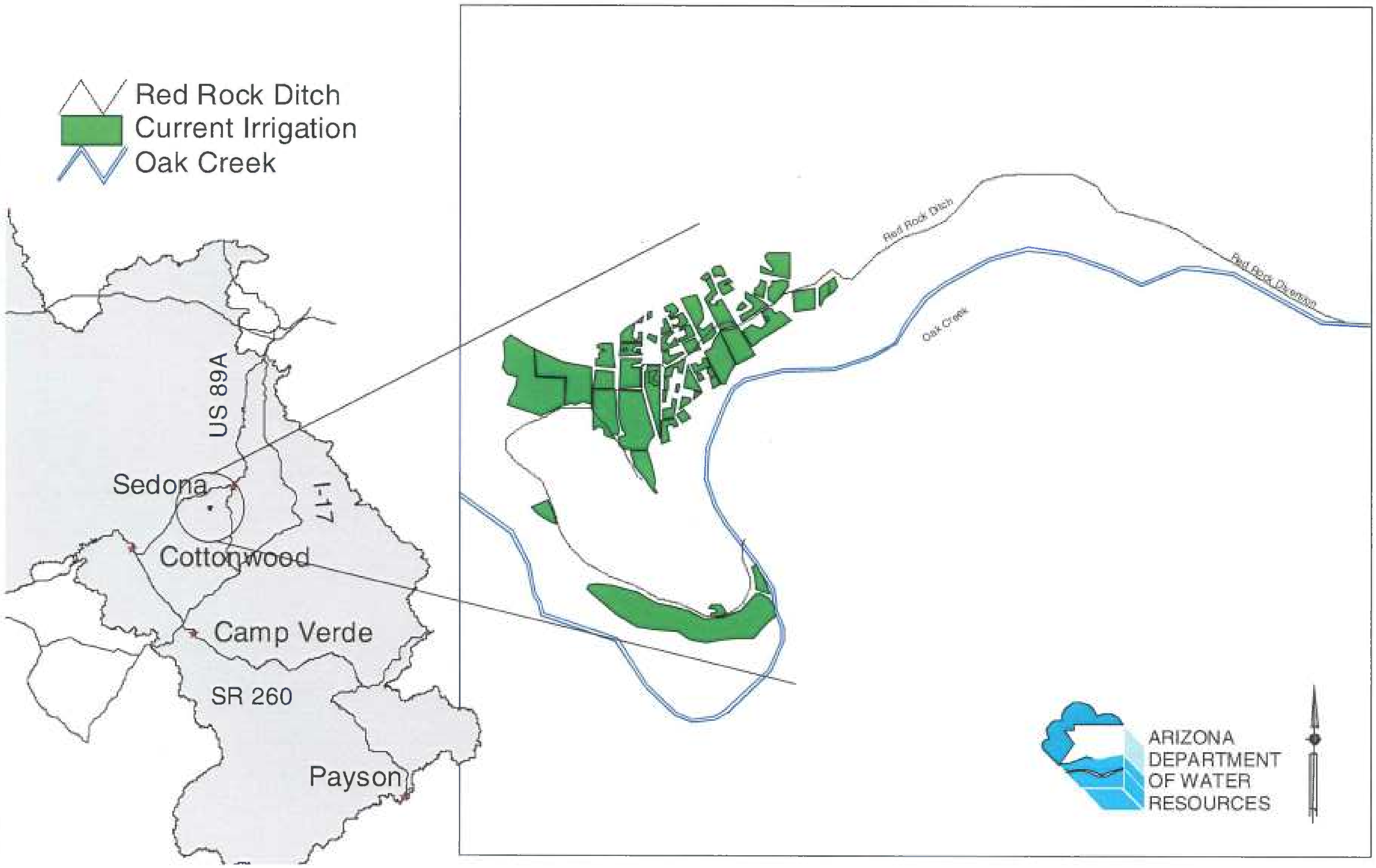
The Red Rock Ditch delivers surface water diverted from Oak Creek to shareholder lands adjacent to the ditch in the community of Red Rock. Red Rock Ditch is currently estimated to serve 43 shareholders. The current number of acres being served by the ditch is approximately 39. The estimated annual volume of water consumed by crops irrigated by Red Rock Ditch in 1997 was 123 acre-feet.

Three large properties are currently assessed an annual fee of $150.00, while the remaining 40 smaller properties are assessed an annual fee of $75.00. These fees cover the cost of cleaning and repairs of the ditch and diversion structure.

FACILITIES

The Red Rock Ditch diversion structure is constructed of rock and soil aggregates and is currently located at Red Rock Crossing on Oak Creek. The ditch is approximately 1.5 miles in length with the first user located approximately one half mile downstream from the point of diversion. The ditch has several turnouts and runs for the most part as an unlined open channel. All water not used by its shareholders is returned directly to Oak Creek. Water flows continuously in the ditch, except for periods of time when maintenance is performed. The operation and maintenance of the ditch are supervised by the association members.

Figure B.54 - Red Rock Ditch Association



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

RIPPLING WATERS IRRIGATION ASSOCIATION, INC.

PERSONNEL

President:	N/A
Manager/Contact Person:	Mr. George Miraval, Jr.
Board of Directors:	N/A
Shareholders:	Est. 47

HISTORY

The actual date of construction of Rippling Waters Irrigation Ditch is unknown, but is thought to have occurred around 1960. The ditch supplies water for irrigation purposes to lands located on the south bank of Oak Creek in the northern portion of Cornville. The primary use of the water delivered by the Rippling Waters Irrigation Ditch is for the maintenance of lawns and gardens.

WATER RESOURCES

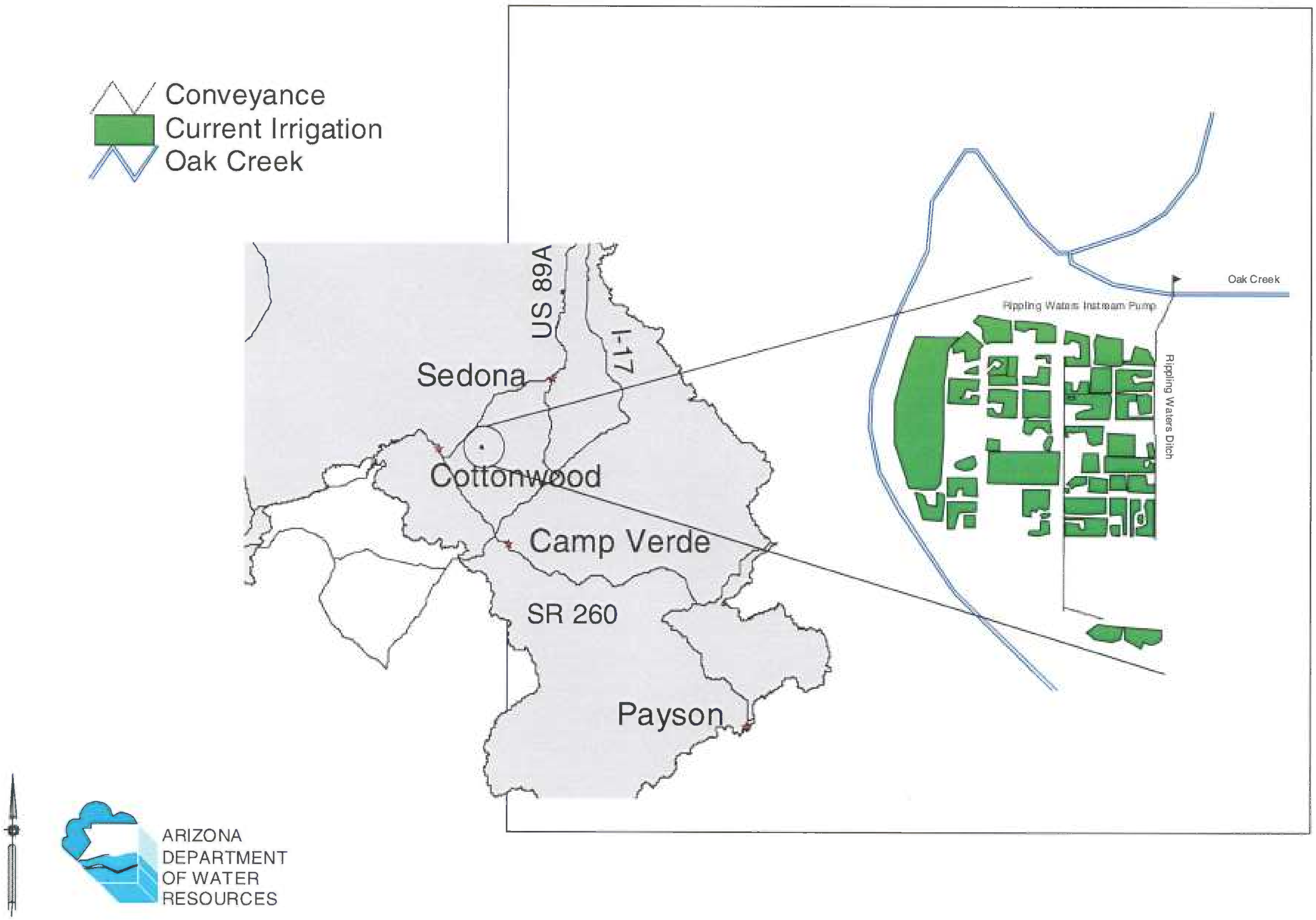
Rippling Waters Irrigation Association, Inc. relies exclusively on surface water diverted from Oak Creek to meet its shareholders• water demands. Approximately 26 acres of land are currently irrigated by water diverted from Oak Creek. The estimated annual volume of water consumed by crops irrigated by the Rippling Waters Ditch in 1997 was 82 acre-feet. The association is currently considering a plan to minimize impacts from future droughts.

Rippling Waters Irrigation Association, Inc. is a non-profit organization and, therefore, only assesses a fee to its shareholders based on the overall cost of operation and maintenance.

FACILITIES

Rippling Waters Irrigation Association, Inc. diverts water using two instream pumps located just east of the confluence of Spring and Oak Creeks. The delivery system consists of an unlined main canal with a series of smaller laterals and a small storage reservoir. The association does not currently measure the flow of water in its system. The first irrigation user is located approximately 300 feet downstream of the diversion pumps. There are no turnouts back to the river and, therefore, it relies exclusively on the operation of the pumps and reservoirs to control flows in the system. Rippling Waters Irrigation Association, Inc. does not currently measure the flow of water in its system. Water flows continuously in the ditch, except for periods of time in the winter when maintenance is performed on the ditch. Maintenance on the pumps and laterals is performed by members of the association.

Figure B.55 - Rippling Waters Irrigation Association



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

SPRING DITCH ASSOCIATION

PERSONNEL

President:	N/A
Manager/Contact Person:	Mr. Al Sepulveda or Ms. Donna Knipschild
Board of Directors:	N/A
Shareholders:	Est. 17

HISTORY

Page Spring Ditch was originally constructed in 1896 for the purpose of supplying irrigation water to lands located on the east and north banks of Oak Creek. Spring Ditch is also known as Page #2 Ditch. Water historically has been diverted from Page Spring located on a mountain side. The spring is located within the Arizona Game and Fish, Page Springs Hatchery property. Water is diverted for irrigation purposes to lands located immediately south of the hatchery in Page Springs. The original construction date for the ditch was in 1896. Spring Ditch Association is very informal and composed of approximately 17 shareholders. Mostly pastures, lawns, small gardens, and orchards are served by the ditch.

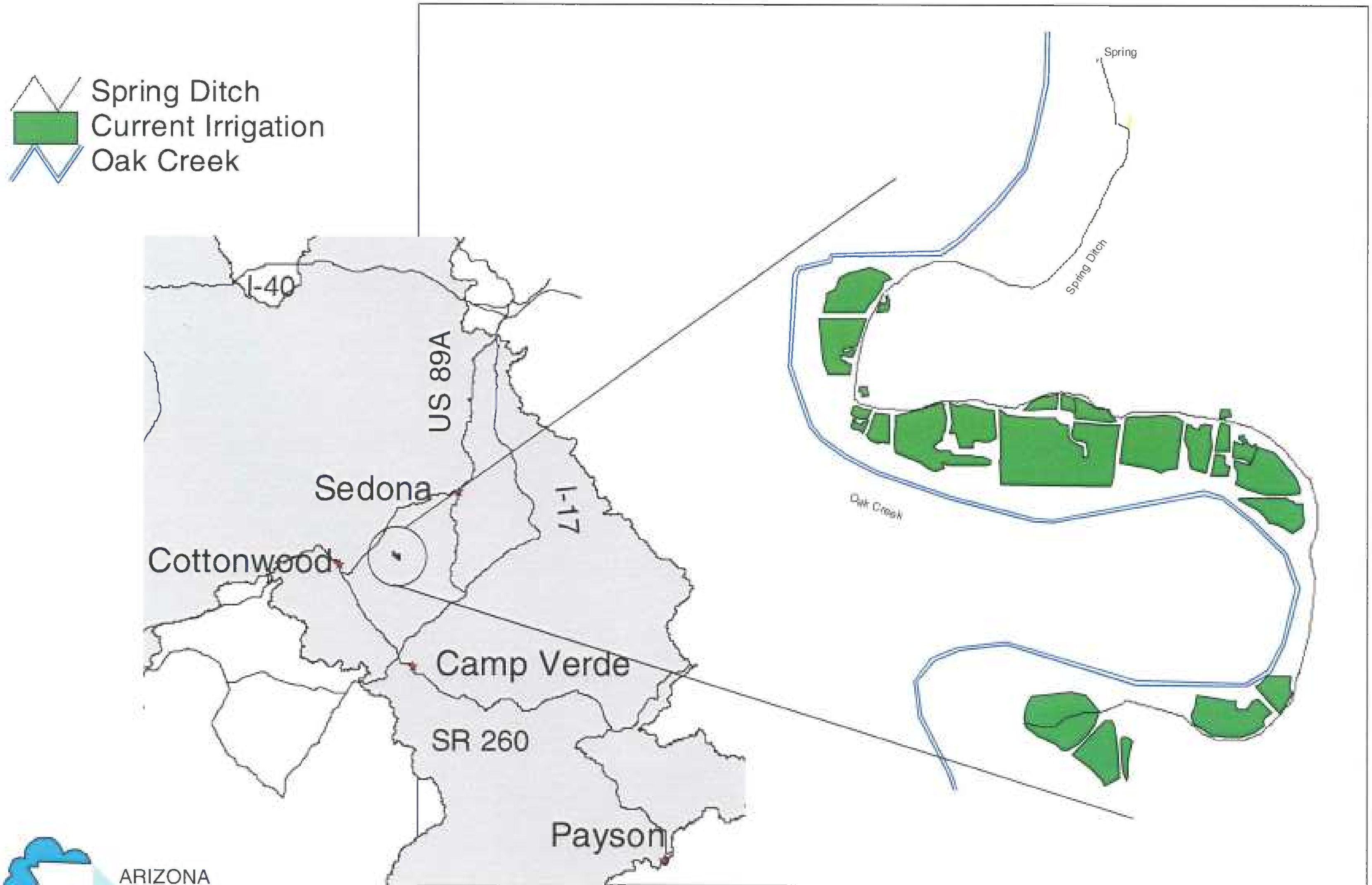
WATER RESOURCES

The water source for Spring Ditch Association and the hatchery is a spring inside a "natural cave" on a side hill near Oak Creek. In addition to supplying the state facility, water must be delivered for downstream water rights requirement. Spring Ditch is presently estimated to irrigate 53 acres. The estimated annual volume of water consumed by crops irrigated by Spring Ditch in 1997 was 167 acre-feet. Fees are collected only to cover the cleaning, canal repair, and other maintenance performed on the ditch.

FACILITIES

A pipeline connects spring outflows to a cement collection box. Sluice gates release water to the hatchery and to the ditch. The ditch is piped within the Arizona Game and Fish Department land. Water then flows through an unlined open channel. The ditch is approximately 1.5 miles in length. All water not used by the shareholders is returned directly to Oak Creek. Water flows continuously in the ditch, except for those periods of time when maintenance is performed on the ditch. The operation and maintenance of the ditch are supervised by a ditch boss, members of the association, and the hatchery.

Figure B.56 - Spring Ditch Association



ARIZONA DEPARTMENT OF WATER RESOURCES

Source: Arizona Department of Water Resources field investigations 1995 - 1998.

VERDE WEST IRRIGATION COMPANY

PERSONNEL

President:	N/A
Manager/Contact Person:	Ms. Peggy Bullard
Board of Directors:	N/A
Shareholders:	Est. 175

HISTORY

The Verde West Irrigation Company was established in the late 1800s for the purpose of supplying Verde River water to lands located in the Middle Verde area on the south bank of the Verde River. The original use of the water supplied by the Verde West Irrigation Company was for agricultural production. Today, the primary use of the water is for maintaining lawns and landscaping. Currently, the Verde West Irrigation Company supplies water to four subdivisions. These subdivisions are Buena Vista (city lots), Verde West Acres, Verde West Estates #1, and Verde West Estates #2.

WATER RESOURCES

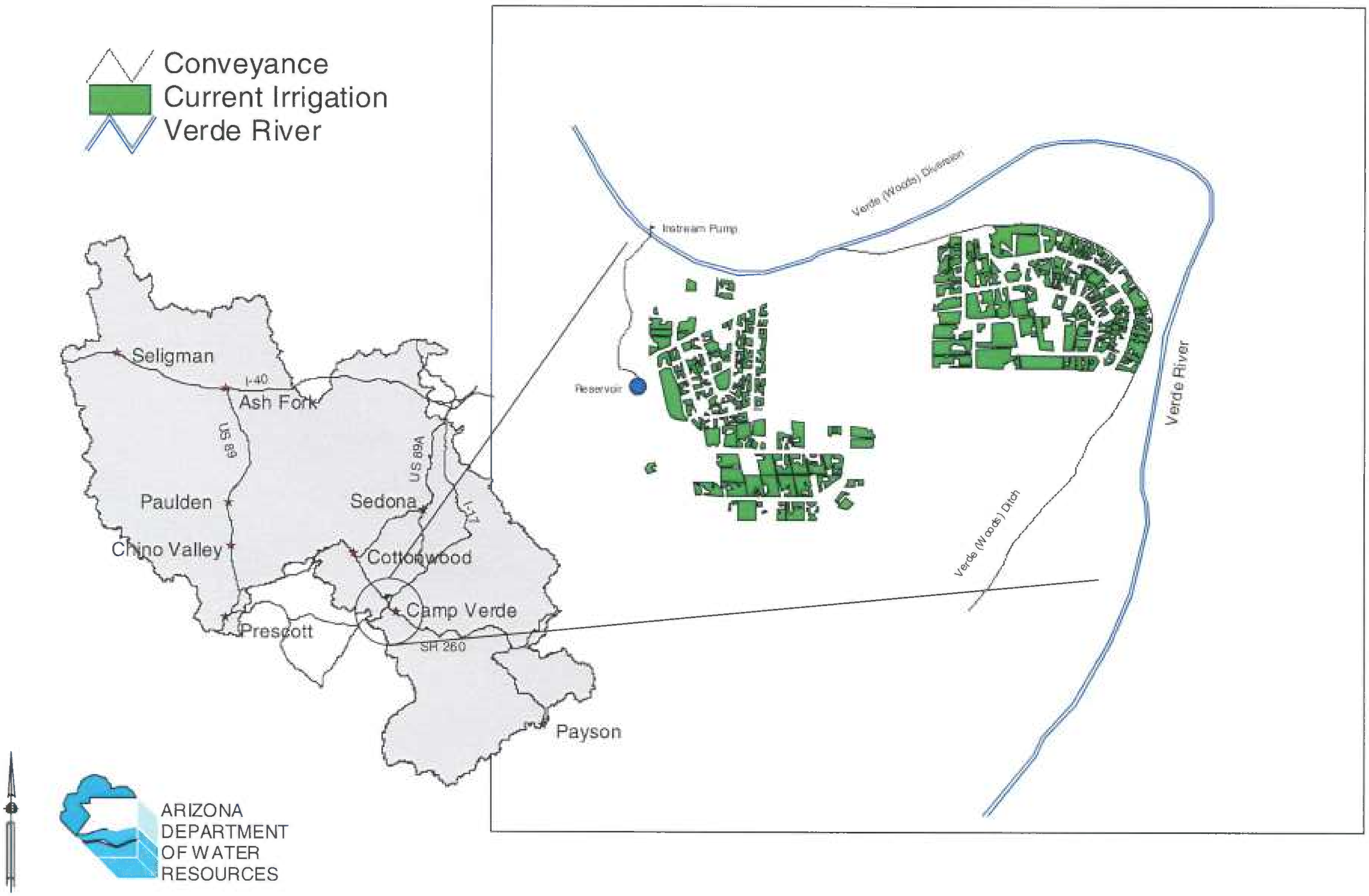
The Verde West Irrigation Company relies exclusively on the diversion of surface water from the Verde River to make deliveries to the four subdivisions. The number of acres currently irrigated by the company are approximately 73. The estimated annual volume of water consumed by crops irrigated by the Verde West Irrigation Company in 1997 was 230 acre-feet.

Per acre costs of water delivered by the Verde West Irrigation Company to its members are not known at this time.

FACILITIES

The Verde West Irrigation Company utilizes two instream pumps for diverting Verde River water surface flows into the their delivery system. The upper pump, known as the Wilson pump, is located one half mile west of the Verde (Woods) Ditch diversion. The lower pump is located east of the Verde Ditch diversion. This pump serves the Buena Vista city lots adjacent to the Verde Ditch. The transmission system consists of concrete lined and unlined open channel sections, underground pipe, and storage reservoirs. There are no turnouts back to the river and, therefore, relies exclusively on the operation of the instream pumps and reservoirs to control flows in the system. Peak flows occur during the summer months and water deliveries are scheduled on a daily basis. The lower pump generally begins operating in March with the upper pump following shortly thereafter. The operation and maintenance of the pumps are supervised by the association.

Figure B.57 - Verde West Irrigation Association



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

VERDE (WOODS) DITCH COMPANY

PERSONNEL

President:	N/A
Manager/Contact Person:	Court Management/Mr. Vince Higginbotham
Board of Directors:	N/A
Shareholders:	Est. 500

HISTORY

The Verde Ditch is considered to be the oldest ditch in the Verde Valley and was originally constructed around 1868 for the purpose of diverting water for irrigation to lands located on the west bank of the Verde River in Camp Verde. In 1871, the present day lower end of the canal was added to the original ditch. Since its original construction, the Verde Ditch has also been referred to as the Woods Ditch. The primary crops supported by the irrigation water from the Verde Ditch include corn, hay, permanent pastures, residential lawns, orchards, and small gardens. Yavapai Apache Indian Reservation lands also receive water from this ditch. The distribution of water under the authority of court-appointed commissioners (one for each of three districts) is allocated according to the rights held by both upper and lower shareholders.

WATER RESOURCES

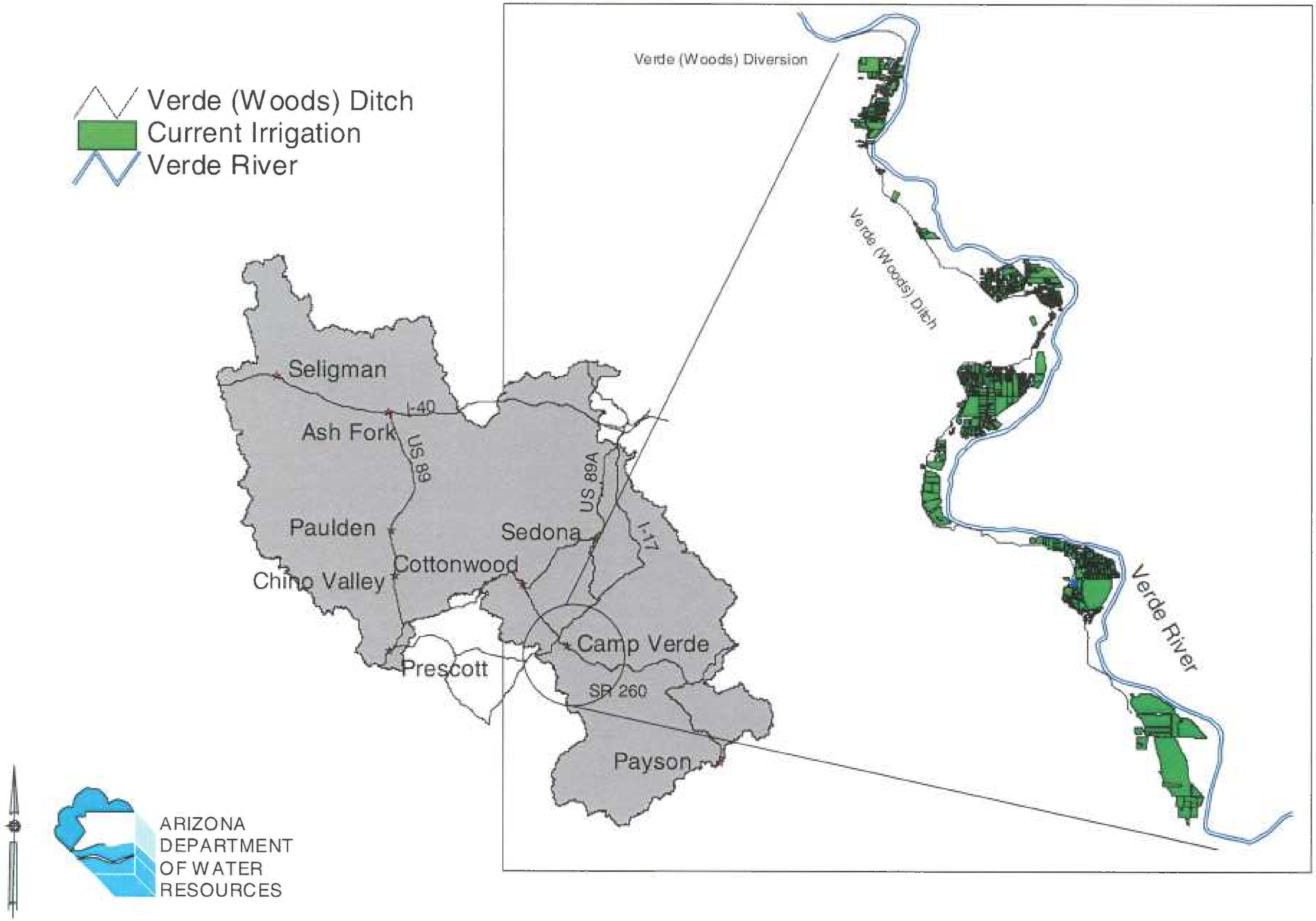
The Verde Ditch delivers surface water diverted from the Verde River to shareholder lands adjacent to the ditch. It is estimated that the Verde Ditch originally delivered water to approximately 1,170 acres (H. L. Hancock, 1914). Urbanization of shareholder lands in recent years has resulted in a reduction in the number of irrigated acres. The current estimate of actively irrigated acres is 1,110. The estimated annual volume of water consumed by crops irrigated by the Verde Ditch in 1997 was 3,497 acre-feet.

Shareholders are currently assessed a fee of $65.00 per acre annually to receive water. This fee covers the cost of operations and maintenance.

FACILITIES

The Verde Ditch diversion structure is constructed of rock and soil and diverts virtually all of the non-flood Verde River surface flows into the ditch. The diversion structure for the Verde Ditch is currently located in the Middle Verde area. The ditch is approximately 17 miles in length with four main regulatory turnouts. The ditch consists of mostly unlined open channel with a few small sections that are piped. Approximately eight to ten siphons and an estimated twenty instream pumps currently extract water from the ditch for irrigation purposes. Several reservoirs are also located within the distribution system to facilitate reserve storage. All water not used by the shareholders is returned directly to the Verde River. Water flows continuously in the ditch, except for periods of time in the winter when maintenance is performed on the ditch. The operation and maintenance of the ditch are supervised by the company and the shareholders.

Figure B.58 - Irrigation Along Verde (Woods) Ditch



Source: Arizona Department of Water Resources field investigations 1995 - 1998.

APPENDIX C

APPENDIX C

PAGE

WATER RESOURCES

Linear Regression Analyses:

Figure C.1 - VERDE NEAR PAULDEN GAGING STATION
7-DAY LOW FLOW DEC. 1965-96

k	x YEAR	CFS	AC/FT	y ACFT/YR	x^2	xy	m	b	Y TREND
1	1965	22.2	44.02	16068.25	3861225	31574109	116.1442	-211949	16274.28
2	1966	25	49.58	18094.88	3865156	35574524	116.1442	-211949	16390.50
3	1967	24.1	47.79	17443.46	3869089	34311285	116.1442	-211949	16506.64
4	1968	24	47.59	17371.08	3873024	34186285	116.1442	-211949	16622.79
5	1969	25	49.58	18094.88	3876961	35628809	116.1442	-211949	16738.93
6	1970	21	41.64	15199.70	3880900	29943399	116.1442	-211949	16855.07
7	1971	20.8	41.25	15054.94	3884841	29673279	116.1442	-211949	16971.22
8	1972	24	47.59	17371.08	3888784	34255770	116.1442	-211949	17087.36
9	1973	25	49.58	18094.88	3892729	35701188	116.1442	-211949	17203.51
10	1974	24	47.59	17371.08	3896676	34290512	116.1442	-211949	17319.65
11	1975	23.4	46.40	16936.80	3900625	33450186	116.1442	-211949	17435.80
12	1976	22.1	43.82	15995.87	3904576	31607838	116.1442	-211949	17551.94
13	1977	21	41.64	15199.70	3908529	30049797	116.1442	-211949	17668.08
14	1978	23	45.61	16647.29	3912484	32928330	116.1442	-211949	17784.23
15	1979	25	49.58	18094.88	3916441	35809758	116.1442	-211949	17900.37
16	1980	26.1	51.76	18891.05	3920400	37404278	116.1442	-211949	18016.52
17	1981	26	51.56	18818.67	3924361	37279785	116.1442	-211949	18132.66
18	1982	24.5	48.58	17732.98	3928324	35146761	116.1442	-211949	18248.80
19	1983	26	51.56	18818.67	3932289	37317423	116.1442	-211949	18364.95
20	1984	25.1	49.77	18167.25	3936256	36043833	116.1442	-211949	18481.09
21	1985	26	51.56	18818.67	3940225	37355060	116.1442	-211949	18597.24
22	1986	28.4	56.32	20555.78	3944196	40823775	116.1442	-211949	18713.38
23	1987	27	53.54	19542.47	3948169	38830878	116.1442	-211949	18829.53
24	1988	26.2	51.95	18963.43	3952144	37699297	116.1442	-211949	18945.67
25	1989	26.7	52.95	19325.33	3956121	38438074	116.1442	-211949	19061.81
26	1990	25	49.58	18094.88	3960100	36008801	116.1442	-211949	19177.96
27	1991	24.5	48.58	17732.98	3964081	35306358	116.1442	-211949	19294.10
28	1992	26	51.56	18818.67	3968064	37486791	116.1442	-211949	19410.25
29	1993	28	55.52	20266.26	3972049	40390656	116.1442	-211949	19526.39
30	1994	30	59.49	21713.85	3976036	43297417	116.1442	-211949	19642.53
31	1995	28	55.52	20266.26	3980025	40431189	116.1442	-211949	19758.68
32	1996	26	51.56	18818.67	3984016	37562065	116.1442	-211949	19874.82
				578384.58	125518896	1.146E+09			

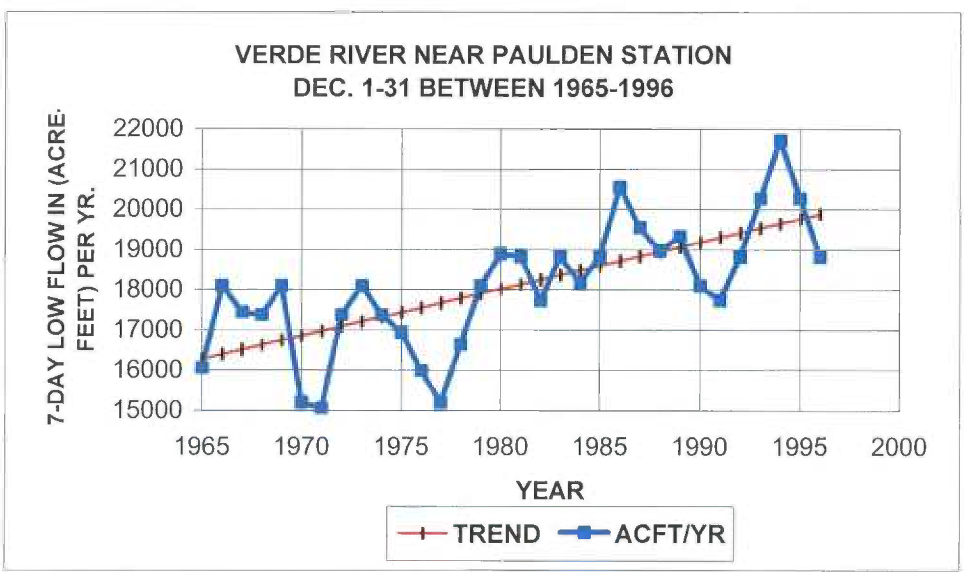


Figure C.2 - VERDE NEAR PAULDEN GAGING STATION
7-DAY LOW FLOW JUNE 1965-96

k	x			y	x^2	xy	m	b	Y
	YEAR	CFS	AC/FT	ACFT/YR					TREND
1	1965	22.2	44.02	16068.25	3861225	31574109	108.89	-198475.4	15488.80
2	1966	21	41.64	15199.70	3865156	29882600	108.89	-198475	15598.02
3	1967	20.8	41.25	15054.94	3869089	29613059	108.89	-198475	15706.91
4	1968	22	43.63	15923.49	3873024	31337428	108.89	-198475	15815.80
5	1969	22	43.63	15923.49	3876961	31353352	108.89	-198475	15924.68
6	1970	21.7	43.03	15706.35	3880900	30941512	108.89	-198475	16033.57
7	1971	21	41.64	15199.70	3884841	29958599	108.89	-198475	16142.46
8	1972	20.8	41.25	15054.94	3888784	29688334	108.89	-198475	16251.35
9	1973	24	47.59	17371.08	3892729	34273141	108.89	-198475	16360.23
10	1974	23	45.61	16647.29	3896676	32861741	108.89	-198475	16469.12
11	1975	26.7	52.95	19325.33	3900625	38167520	108.89	-198475	16578.01
12	1976	21.1	41.84	15272.07	3904576	30177619	108.89	-198475	16686.90
13	1977	22	43.63	15923.49	3908529	31480740	108.89	-198475	16795.79
14	1978	21	41.64	15199.70	3912484	30064997	108.89	-198475	16904.67
15	1979	24.1	47.79	17443.46	3916441	34520606	108.89	-198475	17013.56
16	1980	25.2	49.97	18239.63	3920400	36114475	108.89	-198475	17122.45
17	1981	25.1	49.77	18167.25	3924361	35989331	108.89	-198475	17231.34
18	1982	25.1	49.77	18167.25	3928324	36007498	108.89	-198475	17340.22
19	1983	25	49.58	18094.88	3932289	35882137	108.89	-198475	17449.11
20	1984	24.7	48.98	17877.74	3936256	35469429	108.89	-198475	17558.00
21	1985	25.2	49.97	18239.63	3940225	36205673	108.89	-198475	17666.89
22	1986	25	49.58	18094.88	3944196	35936422	108.89	-198475	17775.77
23	1987	25.5	50.57	18456.77	3948169	36673607	108.89	-198475	17884.66
24	1988	25	49.58	18094.88	3952144	35972612	108.89	-198475	17993.55
25	1989	24.2	47.99	17515.84	3956121	34839004	108.89	-198475	18102.44
26	1990	24.5	48.58	17732.98	3960100	35288625	108.89	-198475	18211.32
27	1991	22.5	44.62	16285.39	3964081	32424207	108.89	-198475	18320.21
28	1992	24	47.59	17371.08	3968064	34603191	108.89	-198475	18429.10
29	1993	27	53.54	19542.47	3972049	38948133	108.89	-198475	18537.99
30	1994	26	51.56	18818.67	3976036	37524428	108.89	-198475	18646.87
31	1995	27	53.54	19542.47	3980025	38987218	108.89	-198475	18755.76
32	1996	25	49.58	18094.88	3984016	36117371	108.89	-198475	18864.65
				549649.92	125518896	1.089E+09			

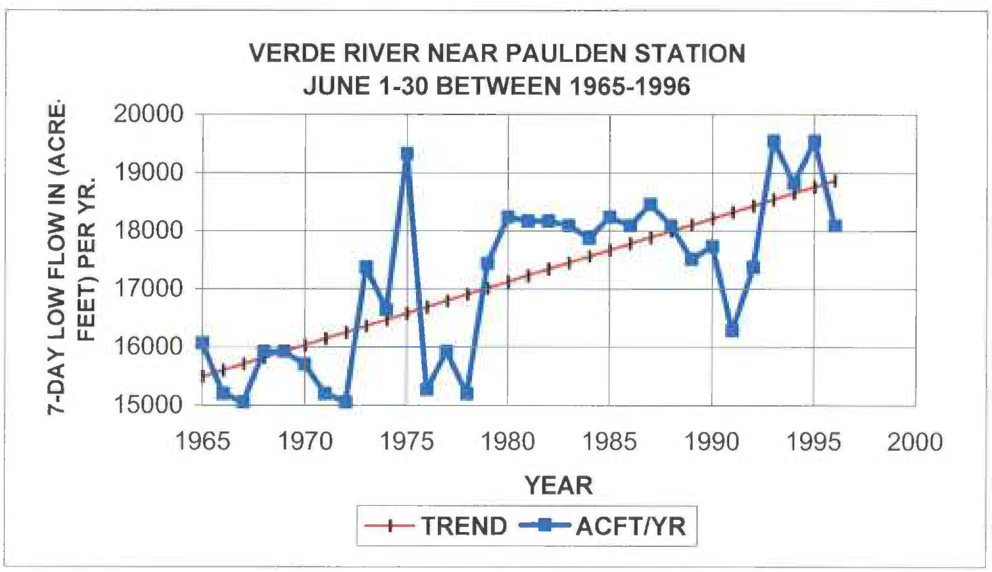


Figure C.3 - VERDE NR. CLARKDALE GAGING STATION 7-DAY LOW FLOW DEC. 1965-96

k	x YEAR	CFS	AC/FT	y ACFT/YR	x^2	xy	m	b	Y TREND
1	1965	97.7	193.74	70714.77	3861225	138954526	182.607	-300870.2	57952.54
2	1966	74.7	148.13	54067.49	3865156	106296678	182.607	-300870.0	58135.36
3	1967	71.5	141.78	51751.34	3869089	101794891	182.607	-300870.0	58317.97
4	1968	80.5	159.63	58265.50	3873024	114666499	182.607	-300870.0	58500.58
5	1969	84.2	166.97	60943.54	3876961	119997828	182.607	-300870.0	58683.18
6	1970	80.4	159.43	58193.12	3880900	114640442	182.607	-300870.0	58865.79
7	1971	79	156.66	57179.81	3884841	112701396	182.607	-300870.0	59048.40
8	1972	79.4	157.45	57469.32	3888784	113329505	182.607	-300870.0	59231.00
9	1973	83.7	165.98	60581.64	3892729	119527579	182.607	-300870.0	59413.61
10	1974	80	158.64	57903.60	3896676	114301706	182.607	-300870.0	59596.22
11	1975	79	156.66	57179.81	3900625	112930115	182.607	-300870.0	59778.83
12	1976	81.1	160.82	58699.77	3904576	115990754	182.607	-300870.0	59961.43
13	1977	72.8	144.36	52692.28	3908529	104172630	182.607	-300870.0	60144.04
14	1978	75.5	149.72	54646.52	3912484	108090822	182.607	-300870.0	60326.65
15	1979	92	182.44	66589.14	3916441	131779908	182.607	-300870.0	60509.25
16	1980	83.2	164.99	60219.74	3920400	119235093	182.607	-300870.0	60691.86
17	1981	85	168.56	61522.58	3924361	121876221	182.607	-300870.0	60874.47
18	1982	94	186.40	68036.73	3928324	134848799	182.607	-300870.0	61057.07
19	1983	93.2	184.82	67457.69	3932289	133768607	182.607	-300870.0	61239.68
20	1984	89.4	177.28	64707.27	3936256	128379230	182.607	-300870.0	61422.29
21	1985	79.1	156.86	57252.18	3940225	113645586	182.607	-300870.0	61604.90
22	1986	94.7	187.79	68543.39	3944196	136127166	182.607	-300870.0	61787.50
23	1987	86.2	170.93	62391.13	3948169	123971173	182.607	-300870.0	61970.11
24	1988	85	168.56	61522.58	3952144	122306879	182.607	-300870.0	62152.72
25	1989	82	162.61	59351.19	3956121	118049517	182.607	-300870.0	62335.32
26	1990	83	164.59	60074.99	3960100	119549220	182.607	-300870.0	62517.93
27	1991	85.5	169.55	61884.47	3964081	123211985	182.607	-300870.0	62700.54
28	1992	82.5	163.60	59713.09	3968064	118948470	182.607	-300870.0	62883.14
29	1993	92	182.44	66589.14	3972049	132712156	182.607	-300870.0	63065.75
30	1994	88	174.50	63693.96	3976036	127005756	182.607	-300870.0	63248.36
31	1995	90	178.47	65141.55	3980025	129957392	182.607	-300870.0	63430.97
32	1996	83	164.59	60074.99	3984016	119909670	182.607	-300870.0	63613.57
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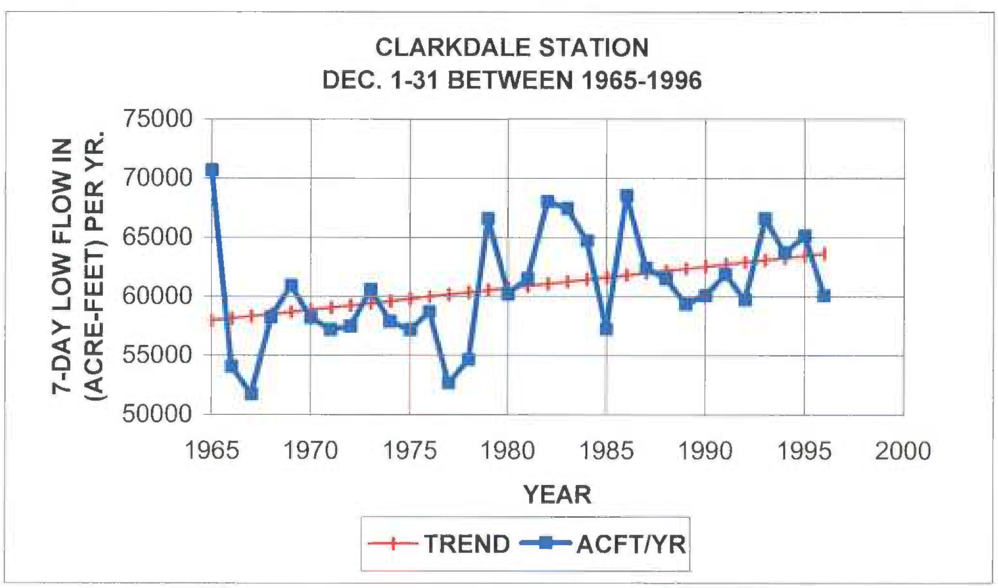

Figure C.4 - VERDE NR. CLARKDALE GAGING STATION
7-DAY LOW FLOW JUNE 1965-96

k	x YEAR	CFS	AC/FT	y ACFT/YR	x^2	xy	m	b	Y TREND
1	1965	77.4	153.48	56021.73	3861225	110082705	303.2086	-546328.5	49476.32
2	1966	68.1	135.04	49290.44	3865156	96905004	303.2086	-546328	49780.11
3	1967	64.8	128.50	46901.92	3869089	92256069	303.2086	-546328	50083.32
4	1968	70	138.81	50665.65	3873024	99709999	303.2086	-546328	50386.52
5	1969	75.5	149.72	54646.52	3876961	107599003	303.2086	-546328	50689.73
6	1970	71	140.79	51389.45	3880900	101237207	303.2086	-546328	50992.94
7	1971	71	140.79	51389.45	3884841	101288596	303.2086	-546328	51296.15
8	1972	69.4	137.62	50231.37	3888784	99056268	303.2086	-546328	51599.36
9	1973	75	148.73	54284.63	3892729	107103565	303.2086	-546328	51902.57
10	1974	60	118.98	43427.70	3896676	85726280	303.2086	-546328	52205.78
11	1975	68	134.84	49218.06	3900625	97205669	303.2086	-546328	52508.99
12	1976	70.5	139.80	51027.55	3904576	100830434	303.2086	-546328	52812.19
13	1977	74.2	147.14	53705.59	3908529	106175949	303.2086	-546328	53115.40
14	1978	61.4	121.76	44441.01	3912484	87904324	303.2086	-546328	53418.61
15	1979	78	154.67	56456.01	3916441	111726444	303.2086	-546328	53721.82
16	1980	83.5	165.58	60436.88	3920400	119665027	303.2086	-546328	54025.03
17	1981	65.7	130.28	47553.33	3924361	94203150	303.2086	-546328	54328.24
18	1982	76	150.71	55008.42	3928324	109026688	303.2086	-546328	54631.45
19	1983	79	156.66	57179.81	3932289	113387553	303.2086	-546328	54934.65
20	1984	76.4	151.50	55297.94	3936256	109711109	303.2086	-546328	55237.86
21	1985	82.4	163.40	59640.71	3940225	118386805	303.2086	-546328	55541.07
22	1986	85.5	169.55	61884.47	3944196	122902562	303.2086	-546328	55844.28
23	1987	90.2	178.87	65286.31	3948169	129723896	303.2086	-546328	56147.49
24	1988	73.2	145.16	52981.79	3952144	105327806	303.2086	-546328	56450.70
25	1989	75	148.73	54284.63	3956121	107972119	303.2086	-546328	56753.91
26	1990	73	144.76	52837.04	3960100	105145700	303.2086	-546328	57057.11
27	1991	77	152.69	55732.22	3964081	110962840	303.2086	-546328	57360.32
28	1992	77	152.69	55732.22	3968064	111018572	303.2086	-546328	57663.53
29	1993	88	174.50	63693.96	3972049	126942062	303.2086	-546328	57966.74
30	1994	81	160.62	58627.40	3976036	116903026	303.2086	-546328	58269.95
31	1995	82	162.61	59351.19	3980025	118405624	303.2086	-546328	58573.16
32	1996	76	150.71	55008.42	3984016	109796806	303.2086	-546328	58876.37
				1733633.78	125518896	3.434E+09			

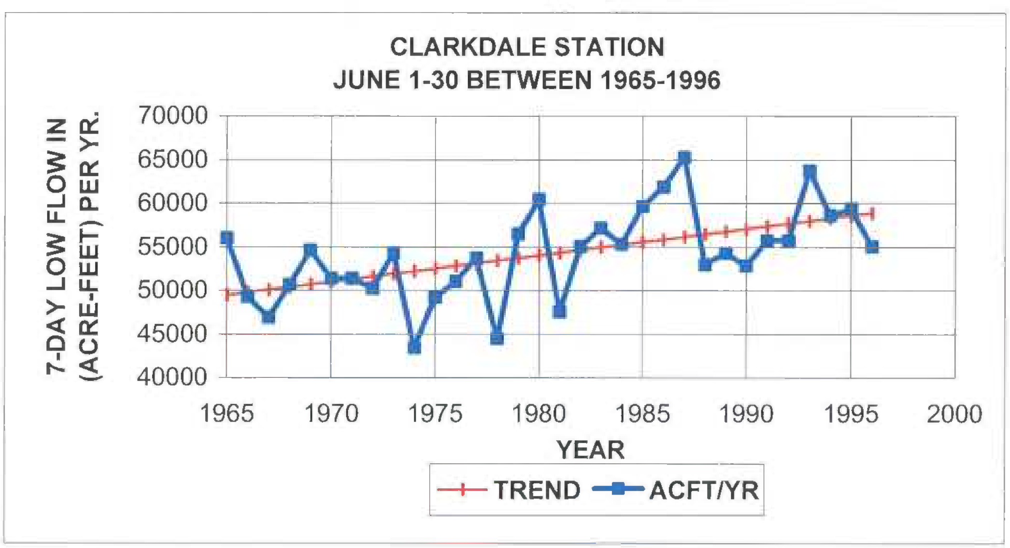

Figure C.5 - FOSSIL CREEK GAGING STATION
7-DAY LOW FLOW DEC. 1965-96

k	x YEAR	CFS	AC/FT	y ACFT/YR	x^2	xy	m	b	Y TREND
1	1965	46	91.22	33294.57	3861225	65423830	-69.89	168214.99	30890.01
2	1966	43	85.27	31123.19	3865156	61188182	-69.89	168215	30820.11
3	1967	43	85.27	31123.19	3869089	61219305	-69.89	168215	30750.22
4	1968	43.2	85.67	31267.94	3873024	61535314	-69.89	168215	30680.34
5	1969	38.8	76.94	28083.25	3876961	55295911	-69.89	168215	30610.45
6	1970	40.4	80.11	29241.32	3880900	57605396	-69.89	168215	30540.57
7	1971	41.1	81.50	29747.97	3884841	58633258	-69.89	168215	30470.68
8	1972	41.1	81.50	29747.97	3888784	58663006	-69.89	168215	30400.79
9	1973	43	85.27	31123.19	3892729	61406044	-69.89	168215	30330.91
10	1974	38.7	76.74	28010.87	3896676	55293450	-69.89	168215	30261.02
11	1975	41.4	82.10	29965.11	3900625	59181098	-69.89	168215	30191.14
12	1976	47	93.20	34018.37	3904576	67220289	-69.89	168215	30121.25
13	1977	41.2	81.70	29820.35	3908529	58954840	-69.89	168215	30051.37
14	1978	36	71.39	26056.62	3912484	51539994	-69.89	168215	29981.48
15	1979	43	85.27	31123.19	3916441	61592783	-69.89	168215	29911.60
16	1980	41	81.30	29675.60	3920400	58757678	-69.89	168215	29841.71
17	1981	40.1	79.52	29024.18	3924361	57496900	-69.89	168215	29771.82
18	1982	32.8	65.04	23740.48	3928324	47053623	-69.89	168215	29701.94
19	1983	45.2	89.63	32715.53	3932289	64874904	-69.89	168215	29632.05
20	1984	45.5	90.23	32932.67	3936256	65338422	-69.89	168215	29562.17
21	1985	43.1	85.47	31195.56	3940225	61923196	-69.89	168215	29492.28
22	1986	44.5	88.24	32208.88	3944196	63966831	-69.89	168215	29422.40
23	1987	37.4	74.16	27069.93	3948169	53787957	-69.89	168215	29352.51
24	1988	42.1	83.48	30471.77	3952144	60577878	-69.89	168215	29282.63
25	1989	43.7	86.66	31629.84	3956121	62911755	-69.89	168215	29212.74
26	1990	42	83.29	30399.39	3960100	60494786	-69.89	168215	29142.86
27	1991	39.5	78.33	28589.90	3964081	56922496	-69.89	168215	29072.97
28	1992	41	81.30	29675.60	3968064	59113785	-69.89	168215	29003.08
29	1993	40	79.32	28951.80	3972049	57700937	-69.89	168215	28933.20
30	1994	37	73.37	26780.42	3976036	53400148	-69.89	168215	28863.31
31	1995	37	73.37	26780.42	3980025	53426928	-69.89	168215	28793.43
32	1996	39	77.34	28228.01	3984016	56343098	-69.89	168215	28723.54
				953817.05	125518896	1.889E+09			

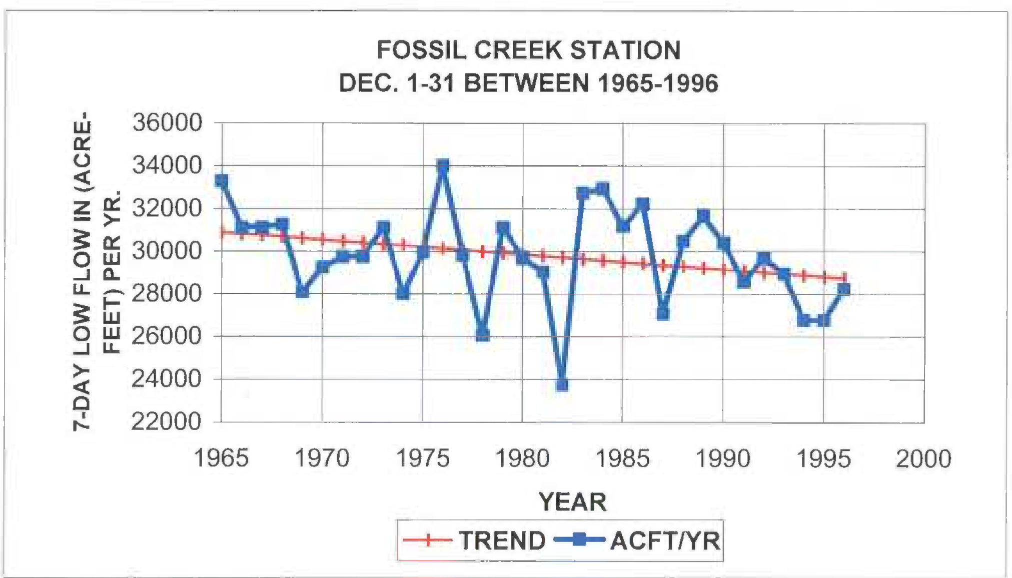

Figure C.6 - FOSSIL CREEK GAGING STATION
7-DAY LOW FLOW JUNE 1965-96

k	x YEAR	CFS	AC/FT	y ACFT/YR	x^2	xy	m	b	Y TREND
1	1965	45.7	90.62	33077.43	3861225	64997153	-82.32	193771.82	32021.35
2	1966	43.7	86.66	31629.84	3865156	62184268	-82.32	193771.8	31938.94
3	1967	43	85.27	31123.19	3869089	61219305	-82.32	193771.8	31856.62
4	1968	43	85.27	31123.19	3873024	61250428	-82.32	193771.8	31774.31
5	1969	41.4	82.10	29965.11	3876961	59001307	-82.32	193771.8	31691.99
6	1970	41.2	81.70	29820.35	3880900	58746097	-82.32	193771.8	31609.67
7	1971	42.4	84.08	30688.91	3884841	60487838	-82.32	193771.8	31527.36
8	1972	43.5	86.26	31485.08	3888784	62088583	-82.32	193771.8	31445.04
9	1973	39.8	78.92	28807.04	3892729	56836292	-82.32	193771.8	31362.73
10	1974	43.8	86.86	31702.22	3896676	62580184	-82.32	193771.8	31280.41
11	1975	42.7	84.67	30906.05	3900625	61039442	-82.32	193771.8	31198.10
12	1976	43.5	86.26	31485.08	3904576	62214523	-82.32	193771.8	31115.78
13	1977	44	87.25	31846.98	3908529	62961479	-82.32	193771.8	31033.46
14	1978	43.4	86.06	31412.70	3912484	62134327	-82.32	193771.8	30951.15
15	1979	47	93.20	34018.37	3916441	67322344	-82.32	193771.8	30868.83
16	1980	40	79.32	28951.80	3920400	57324564	-82.32	193771.8	30786.52
17	1981	42.2	83.68	30544.15	3924361	60507959	-82.32	193771.8	30704.20
18	1982	44.5	88.24	32208.88	3928324	63837995	-82.32	193771.8	30621.88
19	1983	46.7	92.61	33801.23	3932289	67027832	-82.32	193771.8	30539.57
20	1984	42	83.29	30399.39	3936256	60312390	-82.32	193771.8	30457.25
21	1985	44.4	88.05	32136.50	3940225	63790949	-82.32	193771.8	30374.94
22	1986	45.7	90.62	33077.43	3944196	65691779	-82.32	193771.8	30292.62
23	1987	45.5	90.23	32932.67	3948169	65437220	-82.32	193771.8	30210.31
24	1988	40.4	80.11	29241.32	3952144	58131740	-82.32	193771.8	30127.99
25	1989	42.8	84.87	30978.43	3956121	61616089	-82.32	193771.8	30045.67
26	1990	44	87.25	31846.98	3960100	63375490	-82.32	193771.8	29963.36
27	1991	43	85.27	31123.19	3964081	61966261	-82.32	193771.8	29881.04
28	1992	43	85.27	31123.19	3968064	61997385	-82.32	193771.8	29798.73
29	1993	32	63.46	23161.44	3972049	46160750	-82.32	193771.8	29716.41
30	1994	38	75.35	27504.21	3976036	54843395	-82.32	193771.8	29634.09
31	1995	38	75.35	27504.21	3980025	54870899	-82.32	193771.8	29551.78
32	1996	39	77.34	28228.01	3984016	56343098	-82.32	193771.8	29469.46
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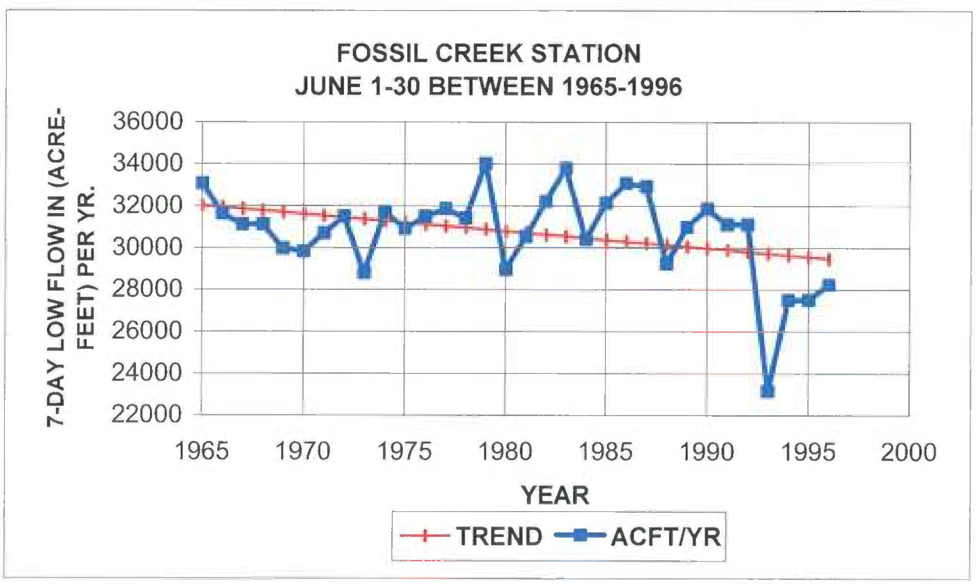

Figure C.7 - OAK CREEK AT CORNVILE STATION
7-DAY LOW FLOW DEC. 1965-96

k	x YEAR	CFS	AC/FT	y ACFT/YR	x^2	xy	m	b	Y TREND
1	1965	45.8	90.82	33149.81	3861225	65139379	-74.91	174872.55	27667.89
2	1966	37.2	73.77	26925.17	3865156	52934892	-74.91	174872.5	27592.95
3	1967	34.8	69.01	25188.07	3869089	49544926	-74.91	174872.5	27518.04
4	1968	25.5	50.57	18456.77	3873024	36322928	-74.91	174872.5	27443.13
5	1969	32.4	64.25	23450.96	3876961	46174936	-74.91	174872.5	27368.21
6	1970	37.7	74.76	27287.07	3880900	53755531	-74.91	174872.5	27293.30
7	1971	32.1	63.65	23233.82	3884841	45793858	-74.91	174872.5	27218.39
8	1972	55.5	110.06	40170.62	3888784	79216468	-74.91	174872.5	27143.47
9	1973	36.8	72.97	26635.66	3892729	52552149	-74.91	174872.5	27068.56
10	1974	37.8	74.96	27359.45	3896676	54007556	-74.91	174872.5	26993.65
11	1975	35.8	70.99	25911.86	3900625	51175925	-74.91	174872.5	26918.73
12	1976	35.7	70.79	25839.48	3904576	51058815	-74.91	174872.5	26843.82
13	1977	35.2	69.80	25477.58	3908529	50369184	-74.91	174872.5	26768.91
14	1978	48.8	96.77	35321.20	3912484	69865326	-74.91	174872.5	26693.99
15	1979	34	67.42	24609.03	3916441	48701270	-74.91	174872.5	26619.08
16	1980	28.5	56.52	20628.16	3920400	40843752	-74.91	174872.5	26544.17
17	1981	33.1	65.64	23957.61	3924361	47460034	-74.91	174872.5	26469.25
18	1982	54	107.08	39084.93	3928324	77466331	-74.91	174872.5	26394.34
19	1983	36	71.39	26056.62	3932289	51670277	-74.91	174872.5	26319.43
20	1984	30	59.49	21713.85	3936256	43080278	-74.91	174872.5	26244.51
21	1985	39.1	77.54	28300.38	3940225	56176263	-74.91	174872.5	26169.60
22	1986	39.1	77.54	28300.38	3944196	56204564	-74.91	174872.5	26094.69
23	1987	40.2	79.72	29096.56	3948169	57814863	-74.91	174872.5	26019.77
24	1988	32.8	65.04	23740.48	3952144	47196066	-74.91	174872.5	25944.86
25	1989	28.5	56.52	20628.16	3956121	41029405	-74.91	174872.5	25869.95
26	1990	33	65.44	23885.24	3960100	47531618	-74.91	174872.5	25795.03
27	1991	31	61.47	22437.65	3964081	44673351	-74.91	174872.5	25720.12
28	1992	42.5	84.28	30761.29	3968064	61276485	-74.91	174872.5	25645.21
29	1993	35	69.41	25332.83	3972049	50488320	-74.91	174872.5	25570.29
30	1994	45	89.24	32570.78	3976036	64946125	-74.91	174872.5	25495.38
31	1995	30	59.49	21713.85	3980025	43319131	-74.91	174872.5	25420.47
32	1996	29	57.51	20990.06	3984016	41896150	-74.91	174872.5	25345.55
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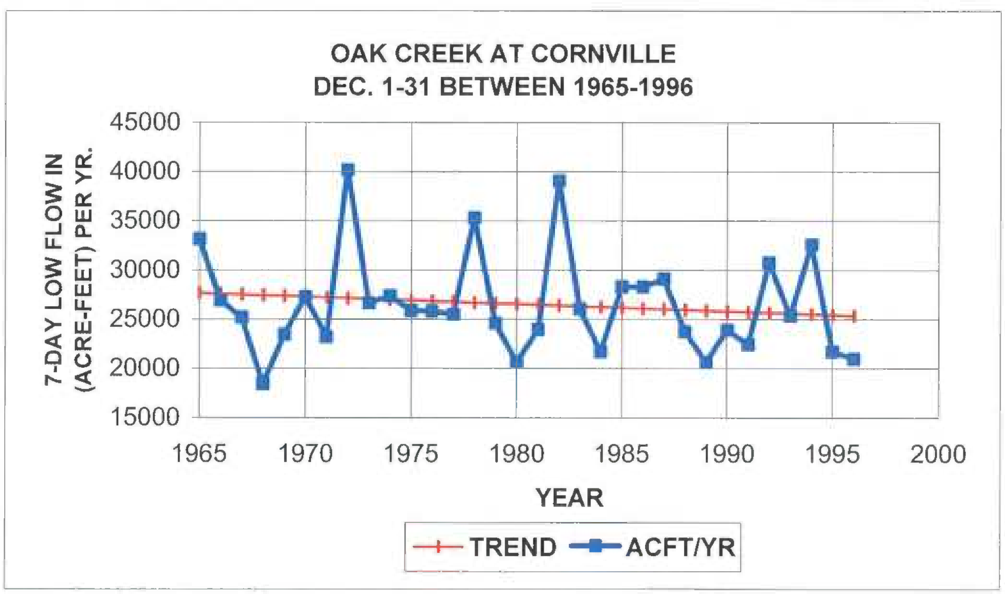

Figure C.8 - OAK CREEK AT CORNVILE STATION
7-DAY LOW FLOW JUNE 1965-96

k	x YEAR	CFS	AC/FT	y ACFT/YR	x^2	xy	m	b	Y TREND
1	1965	24.5	48.58	17732.98	3861225	34845301	5.97	956.4813	12686.97
2	1966	16.2	32.12	11725.48	3865156	23052292	5.97	956.4813	12692.94
3	1967	19.5	38.67	14114.00	3869089	27762243	5.97	956.4813	12698.91
4	1968	13.8	27.37	9988.37	3873024	19657114	5.97	956.4813	12704.88
5	1969	15.7	31.13	11363.58	3876961	22374892	5.97	956.4813	12710.85
6	1970	16.1	31.93	11653.10	3880900	22956606	5.97	956.4813	12716.82
7	1971	16.1	31.93	11653.10	3884841	22968259	5.97	956.4813	12722.79
8	1972	21.5	42.63	15561.59	3888784	30687460	5.97	956.4813	12728.76
9	1973	20.1	39.86	14548.28	3892729	28703755	5.97	956.4813	12734.73
10	1974	14.8	29.35	10712.17	3896676	21145816	5.97	956.4813	12740.70
11	1975	18.1	35.89	13100.69	3900625	25873862	5.97	956.4813	12746.67
12	1976	17.1	33.91	12376.89	3904576	24456744	5.97	956.4813	12752.64
13	1977	20.4	40.45	14765.42	3908529	29191231	5.97	956.4813	12758.61
14	1978	15.8	31.33	11435.96	3912484	22620331	5.97	956.4813	12764.58
15	1979	17	33.71	12304.52	3916441	24350635	5.97	956.4813	12770.55
16	1980	16.1	31.93	11653.10	3920400	23073137	5.97	956.4813	12776.52
17	1981	16.5	32.72	11942.62	3924361	23658325	5.97	956.4813	12782.49
18	1982	16.2	32.12	11725.48	3928324	23239899	5.97	956.4813	12788.46
19	1983	13.8	27.37	9988.37	3932289	19806940	5.97	956.4813	12794.43
20	1984	14	27.76	10133.13	3936256	20104130	5.97	956.4813	12800.40
21	1985	19.7	39.07	14258.76	3940225	28303642	5.97	956.4813	12806.37
22	1986	21.8	43.23	15778.73	3944196	31336560	5.97	956.4813	12812.34
23	1987	16.5	32.72	11942.62	3948169	23729981	5.97	956.4813	12818.31
24	1988	18.2	36.09	13173.07	3952144	26188061	5.97	956.4813	12824.28
25	1989	15.5	30.74	11218.82	3956121	22314238	5.97	956.4813	12830.25
26	1990	17	33.71	12304.52	3960100	24485985	5.97	956.4813	12836.22
27	1991	18	35.69	13028.31	3964081	25939365	5.97	956.4813	12842.19
28	1992	20	39.66	14475.90	3968064	28835993	5.97	956.4813	12848.16
29	1993	20	39.66	14475.90	3972049	28850469	5.97	956.4813	12854.13
30	1994	16	31.73	11580.72	3976036	23091956	5.97	956.4813	12860.10
31	1995	25	49.58	18094.88	3980025	36099276	5.97	956.4813	12866.07
32	1996	14	27.76	10133.13	3984016	20225727	5.97	956.4813	12872.04
				408944.18	125518896	809930224			

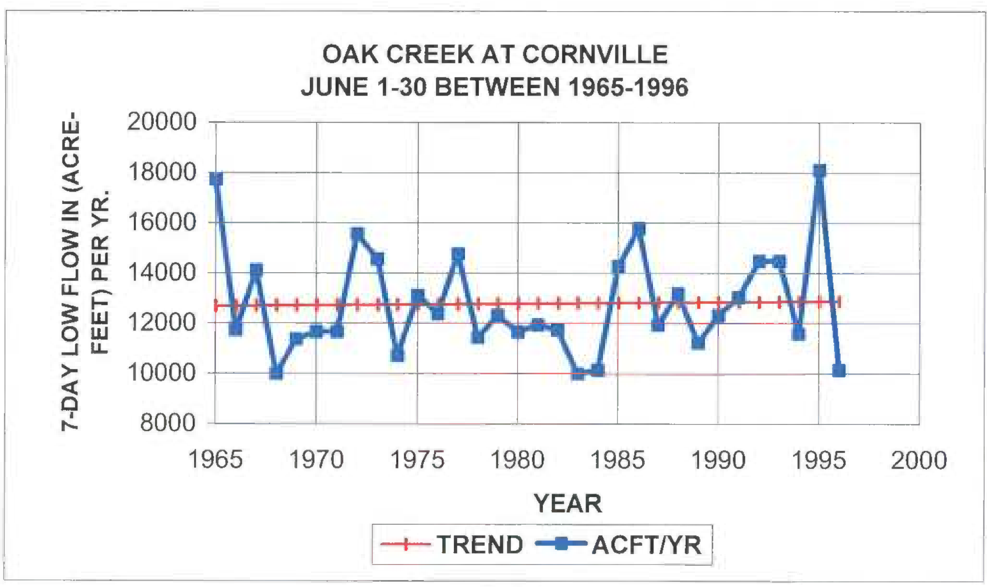

Figure C.9 - VERDE RIVER AT CAMP VERDE
7-DAY LOW FLOW DEC. 1989-96

k	x YEAR	CFS	AC/FT	y AC-FT/YR	x^2	xy	m	b	Y TREND
1	1989	199	394.62	144035.21	3956121	286486023	379.13	-605230.5	148860.5
2	1990	197	390.65	142587.62	3960100	283749354	379.13	-605230	149240.1
3	1991	202	400.57	146206.59	3964081	291097321	379.13	-605230	149619.2
4	1992	210	416.43	151996.95	3968064	302777924	379.13	-605230	149998.4
5	1993	240	475.92	173710.80	3972049	346205624	379.13	-605230	150377.5
6	1994	223	442.21	161406.29	3976036	321844132	379.13	-605230	150756.6
7	1995	197	390.65	142587.62	3980025	284462292	379.13	-605230	151135.7
8	1996	192	380.74	138968.64	3984016	277381405	379.13	-605230	151514.9
				1201499.7	31760492	2.394E+09			

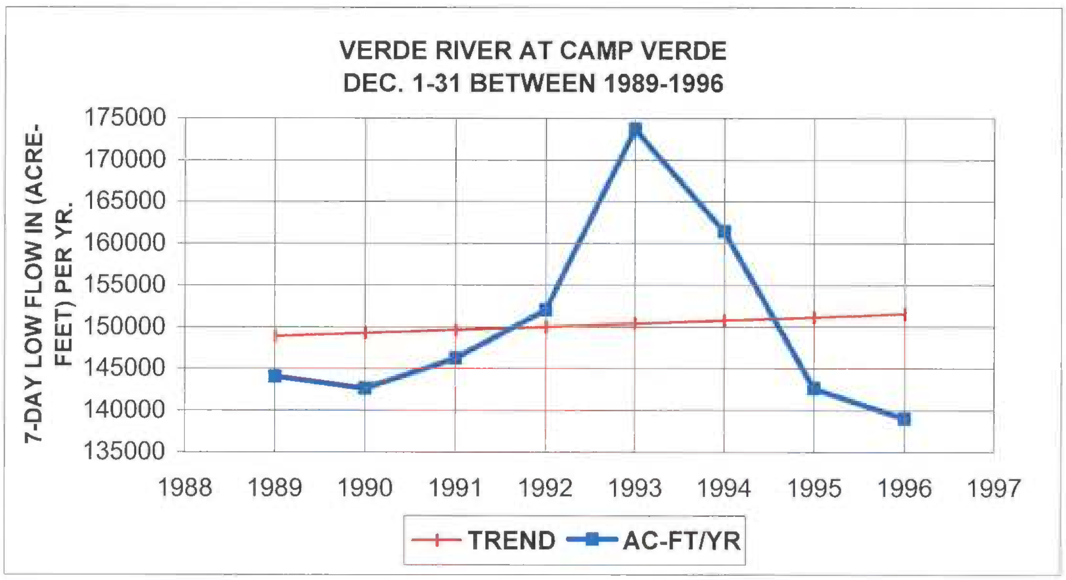

Figure C.10 - VERDE RIVER AT CAMP VERDE
7-DAY LOW FLOW JUNE 1989-96

k	x YEAR	CFS	AC/FT	y AC-FT/YR	x^2	xy	m	b	Y TREND
1	1989	54.5	108.07	39446.83	3956121	78459740	909.05	-1764285	43819.76
2	1990	48	95.18	34742.16	3960100	69136898	909.05	-1764285	44728.68
3	1991	66	130.88	47770.47	3964081	95111006	909.05	-1764285	45637.73
4	1992	76	150.71	55008.42	3968064	109576773	909.05	-1764285	46546.78
5	1993	87	172.52	62970.17	3972049	125499539	909.05	-1764285	47455.84
6	1994	65	128.90	47046.68	3976036	93811070	909.05	-1764285	48364.89
7	1995	71	140.79	51389.45	3980025	102521943	909.05	-1764285	49273.94
8	1996	52	103.12	37637.34	3984016	75124131	909.05	-1764285	50182.99
				376011.503	31760492	749241099			

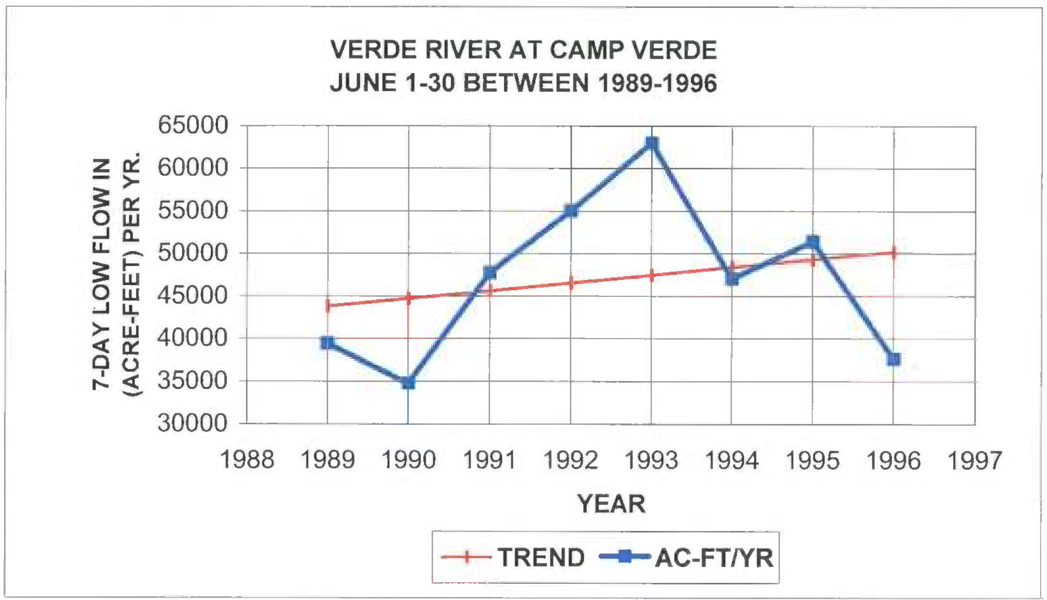

Figure C.11 - WEST CLEAR CREEK NR. CAMP VERDE
7-DAY LOW FLOW DEC. 1965-96

k	x			y	x^2	xy	m	b	Y
	YEAR	CFS	AC/FT	ACFT/YR					TREND
1	1965	22.8	45.21	16502.53	3861225	32427464	14.94	-15999.11	13353.20
2	1966	17.1	33.91	12376.89	3865156	24332975	14.94	-15999.1	13368.14
3	1967	14.7	29.15	10639.79	3869089	20928460	14.94	-15999.1	13383.08
4	1968	15.8	31.33	11435.96	3873024	22505971	14.94	-15999.1	13398.02
5	1969	15.1	29.94	10929.30	3876961	21519801	14.94	-15999.1	13412.96
6	1970	18.7	37.08	13534.97	3880900	26663884	14.94	-15999.1	13427.89
7	1971	17	33.71	12304.52	3884841	24252199	14.94	-15999.1	13442.83
8	1972	18	35.69	13028.31	3888784	25691827	14.94	-15999.1	13457.77
9	1973	20	39.66	14475.90	3892729	28560951	14.94	-15999.1	13472.71
10	1974	18	35.69	13028.31	3896676	25717884	14.94	-15999.1	13487.64
11	1975	20.8	41.25	15054.94	3900625	29733499	14.94	-15999.1	13502.58
12	1976	17	33.71	12304.52	3904576	24313722	14.94	-15999.1	13517.52
13	1977	16.7	33.12	12087.38	3908529	23896743	14.94	-15999.1	13532.46
14	1978	25.1	49.77	18167.25	3912484	35934829	14.94	-15999.1	13547.39
15	1979	18.2	36.09	13173.07	3916441	26069504	14.94	-15999.1	13562.33
16	1980	15	29.75	10856.93	3920400	21496712	14.94	-15999.1	13577.27
17	1981	20.4	40.45	14765.42	3924361	29250293	14.94	-15999.1	13592.21
18	1982	30.1	59.69	21786.23	3928324	43180307	14.94	-15999.1	13607.14
19	1983	23.8	47.20	17226.32	3932289	34159795	14.94	-15999.1	13622.08
20	1984	19.8	39.26	14331.14	3936256	28432984	14.94	-15999.1	13637.02
21	1985	18.4	36.49	13317.83	3940225	26435889	14.94	-15999.1	13651.96
22	1986	18	35.69	13028.31	3944196	25874224	14.94	-15999.1	13666.89
23	1987	17.7	35.10	12811.17	3948169	25455798	14.94	-15999.1	13681.83
24	1988	17.4	34.50	12594.03	3952144	25036938	14.94	-15999.1	13696.77
25	1989	17	33.71	12304.52	3956121	24473680	14.94	-15999.1	13711.71
26	1990	17	33.71	12304.52	3960100	24485985	14.94	-15999.1	13726.64
27	1991	19	37.68	13752.11	3964081	27380441	14.94	-15999.1	13741.58
28	1992	19	37.68	13752.11	3968064	27394193	14.94	-15999.1	13756.52
29	1993	20	39.66	14475.90	3972049	28850469	14.94	-15999.1	13771.46
30	1994	19	37.68	13752.11	3976036	27421697	14.94	-15999.1	13786.39
31	1995	17	33.71	12304.52	3980025	24547507	14.94	-15999.1	13801.33
32	1996	17	33.71	12304.52	3984016	24559812	14.94	-15999.1	13816.27
				434711.28	125518896	860986434			

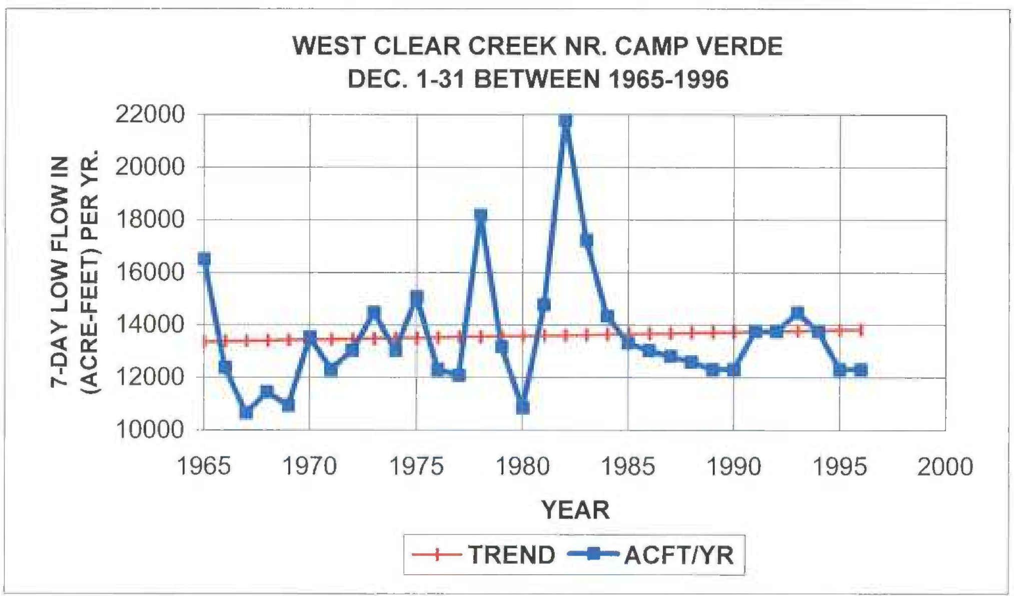

Figure C.12 - WEST CLEAR CREEK NR. CAMP VERDE
7- DAY LOW FLOW JUNE 1965-96

k	x YEAR	CFS	AC/FT	y ACFT/YR	x^2	xy	m	b	Y TREND
1	1965	22.8	45.21	16502.53	3861225	32427464	11.70	-12004.07	10987.70
2	1966	13	25.78	9409.34	3865156	18498753	11.70	-12004.1	10999.36
3	1967	13.2	26.18	9554.09	3869089	18792903	11.70	-12004.1	11011.06
4	1968	12.1	23.99	8757.92	3873024	17235586	11.70	-12004.1	11022.76
5	1969	12.4	24.59	8975.06	3876961	17671889	11.70	-12004.1	11034.46
6	1970	12.8	25.38	9264.58	3880900	18251215	11.70	-12004.1	11046.16
7	1971	15	29.75	10856.93	3884841	21398999	11.70	-12004.1	11057.86
8	1972	19.3	38.27	13969.24	3888784	27547348	11.70	-12004.1	11069.56
9	1973	17.7	35.10	12811.17	3892729	25276441	11.70	-12004.1	11081.26
10	1974	13	25.78	9409.34	3896676	18574027	11.70	-12004.1	11092.96
11	1975	14.1	27.96	10205.51	3900625	20155881	11.70	-12004.1	11104.66
12	1976	14.7	29.15	10639.79	3904576	21024218	11.70	-12004.1	11116.36
13	1977	13.1	25.98	9481.71	3908529	18745350	11.70	-12004.1	11128.07
14	1978	17	33.71	12304.52	3912484	24338331	11.70	-12004.1	11139.77
15	1979	19	37.68	13752.11	3916441	27215416	11.70	-12004.1	11151.47
16	1980	15	29.75	10856.93	3920400	21496712	11.70	-12004.1	11163.17
17	1981	12	23.80	8685.54	3924361	17206055	11.70	-12004.1	11174.87
18	1982	19.1	37.88	13824.48	3928324	27400128	11.70	-12004.1	11186.57
19	1983	13.4	26.57	9698.85	3932289	19232825	11.70	-12004.1	11198.27
20	1984	23.8	47.20	17226.32	3936256	34177021	11.70	-12004.1	11209.97
21	1985	15	29.75	10856.93	3940225	21550996	11.70	-12004.1	11221.67
22	1986	13.7	27.17	9915.99	3944196	19693159	11.70	-12004.1	11233.37
23	1987	15.5	30.74	11218.82	3948169	22291800	11.70	-12004.1	11245.07
24	1988	14.1	27.96	10205.51	3952144	20288553	11.70	-12004.1	11256.77
25	1989	14	27.76	10133.13	3956121	20154796	11.70	-12004.1	11268.47
26	1990	14	27.76	10133.13	3960100	20164929	11.70	-12004.1	11280.17
27	1991	16	31.73	11580.72	3964081	23057214	11.70	-12004.1	11291.87
28	1992	15	29.75	10856.93	3968064	21626995	11.70	-12004.1	11303.57
29	1993	17	33.71	12304.52	3972049	24522898	11.70	-12004.1	11315.28
30	1994	17	33.71	12304.52	3976036	24535203	11.70	-12004.1	11326.98
31	1995	16	31.73	11580.72	3980025	23103536	11.70	-12004.1	11338.68
32	1996	14	27.76	10133.13	3984016	20225727	11.70	-12004.1	11350.38
				357409.971	125518896	707882367			

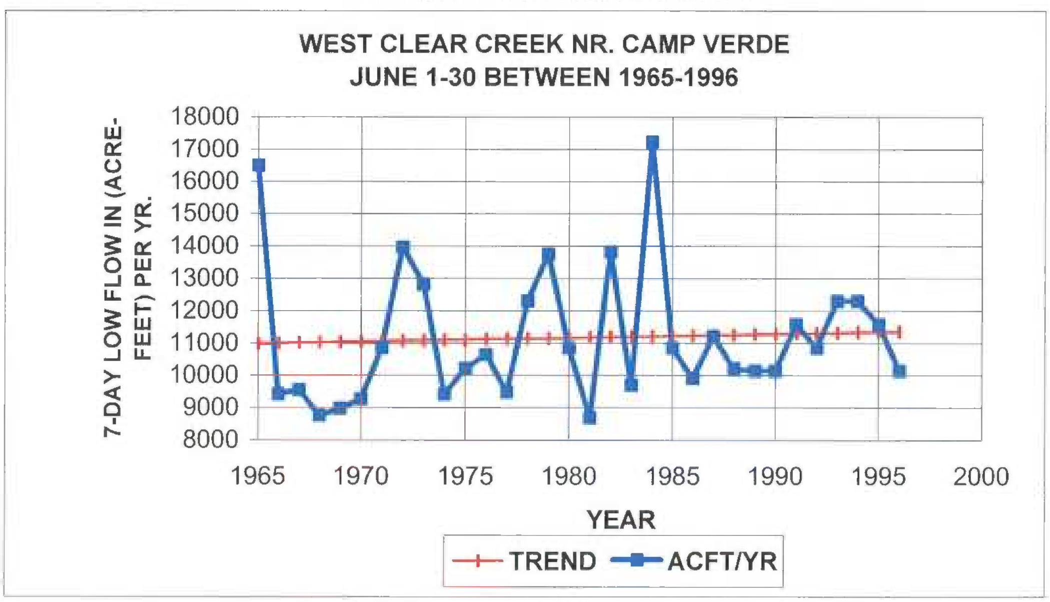

Figure C.13 - WET BEAVER CREEK GAGING STATION
7-DAY LOW FLOW DEC. 1965-81, 1990-96

k	x YEAR	CFS	AC/FT	y ACFT/YR	x^2	xy	m	b	Y TREND
1	1965	7.7	15.27	5573.22	3861225	10951380	0.008	5370.973	5386.36
2	1966	7.1	14.08	5138.94	3865156	10103165	2.837	2.361	5578.94
3	1967	7.5	14.87	5428.46	3869089	10677786	2.837	2.361	5581.78
4	1968	6.8	13.48	4921.81	3873024	9686114.2	2.837	2.361	5584.61
5	1969	7.7	15.27	5573.22	3876961	10973673	2.837	2.361	5587.45
6	1970	7.6	15.07	5500.84	3880900	10836659	2.837	2.361	5590.29
7	1971	7.6	15.07	5500.84	3884841	10842160	2.837	2.361	5593.12
8	1972	11.5	22.80	8323.64	3888784	16414223	2.837	2.361	5595.96
9	1973	7.6	15.07	5500.84	3892729	10853161	2.837	2.361	5598.80
10	1974	7.1	14.08	5138.94	3896676	10144276	2.837	2.361	5601.63
11	1975	7.6	15.07	5500.84	3900625	10864163	2.837	2.361	5604.47
12	1976	7.5	14.87	5428.46	3904576	10726642	2.837	2.361	5607.31
13	1977	5.8	11.50	4198.01	3908529	8299467.7	2.837	2.361	5610.14
14	1978	14.2	28.16	10277.89	3912484	20329664	2.837	2.361	5612.98
15	1979	7.2	14.28	5211.32	3916441	10313210	2.837	2.361	5615.82
16	1980	6.3	12.49	4559.91	3920400	9028618.8	2.837	2.361	5618.65
17	1981	7	13.88	5066.57	3924361	10036865	2.837	2.361	5621.49
18	1982	N/A	N/A		N/A	N/A	N/A	N/A	
19	1983	N/A	N/A		N/A	N/A	N/A	N/A	
20	1984	N/A	N/A		N/A	N/A	N/A	N/A	
21	1985	N/A	N/A		N/A	N/A	N/A	N/A	
22	1986	N/A	N/A		N/A	N/A	N/A	N/A	
23	1987	N/A	N/A		N/A	N/A	N/A	N/A	
24	1988	N/A	N/A		N/A	N/A	N/A	N/A	
25	1989	N/A	N/A		N/A	N/A	N/A	N/A	
26	1990	7.3	14.48	5283.70	3960100	10514570	2.837	2.361	5647.02
27	1991	9	17.85	6514.16	3964081	12969683	2.837	2.361	5649.85
28	1992	7.9	15.67	5717.98	3968064	11390217	2.837	2.361	5652.69
29	1993	6	11.90	4342.77	3972049	8655140.6	2.837	2.361	5655.53
30	1994	8	15.86	5790.36	3976036	11545978	2.837	2.361	5658.36
31	1995	7.2	14.28	5211.32	3980025	10396591	2.837	2.361	5661.20
32	1996	7	13.88	5066.57	3984016	10112864	2.837	2.361	5664.04
				134770.63	93981172	266666272			

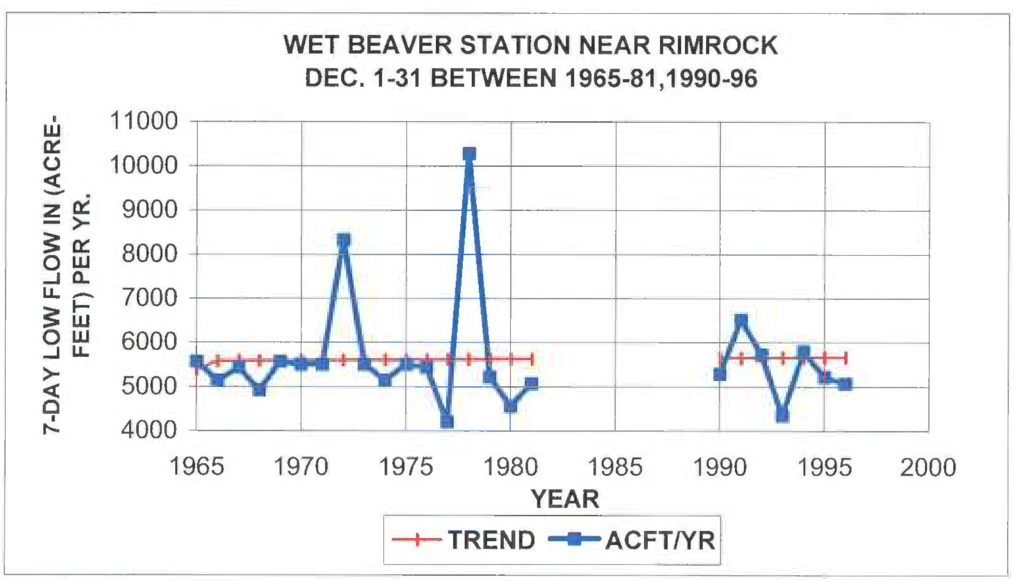

Figure C.14 - WET BEAVER CREEK GAGING STATION
7-DAY LOW FLOW JUNE 1965-82, 1990-96

k	x YEAR	CFS	AC/FT	y ACFT/YR	x^2	xy	m	b	Y TREND
1	1965	7.3	14.48	5283.70	3861225	10382477	0.01	4682.33	4701.89
2	1966	7.1	14.08	5138.94	3865156	10103165	2.37	9.17	4676.79
3	1967	5.9	11.70	4270.39	3869089	8399858.1	2.37	9.17	4679.17
4	1968	6.2	12.29	4487.53	3873024	8831457.1	2.37	9.17	4681.54
5	1969	7	13.88	5066.57	3876961	9976066.5	2.37	9.17	4683.92
6	1970	6.8	13.48	4921.81	3880900	9695957.8	2.37	9.17	4686.29
7	1971	6.6	13.09	4777.05	3884841	9415559.6	2.37	9.17	4688.66
8	1972	7.7	15.27	5573.22	3888784	10990393	2.37	9.17	4691.04
9	1973	7.4	14.67	5356.08	3892729	10567552	2.37	9.17	4693.41
10	1974	6.7	13.29	4849.43	3896676	9572767.9	2.37	9.17	4695.79
11	1975	7.5	14.87	5428.46	3900625	10721213	2.37	9.17	4698.16
12	1976	6.8	13.48	4921.81	3904576	9725488.7	2.37	9.17	4700.54
13	1977	6.5	12.89	4704.67	3908529	9301127.6	2.37	9.17	4702.91
14	1978	6.8	13.48	4921.81	3912484	9735332.3	2.37	9.17	4705.28
15	1979	6.1	12.10	4415.15	3916441	8737580.9	2.37	9.17	4707.66
16	1980	7.3	14.48	5283.70	3920400	10461733	2.37	9.17	4710.03
17	1981	6.2	12.29	4487.53	3924361	8889794.9	2.37	9.17	4712.41
18	1982	7.6	15.07	5500.84	3928324	10902669	2.37	9.17	4714.78
19	1983	N/A	N/A		N/A	N/A	N/A	N/A	
20	1984	N/A	N/A		N/A	N/A	N/A	N/A	
21	1985	N/A	N/A		N/A	N/A	N/A	N/A	
22	1986	N/A	N/A		N/A	N/A	N/A	N/A	
23	1987	N/A	N/A		N/A	N/A	N/A	N/A	
24	1988	N/A	N/A		N/A	N/A	N/A	N/A	
25	1989	N/A	N/A		N/A	N/A	N/A	N/A	
26	1990	6.1	12.10	4415.15	3960100	8786147.5	2.37	9.17	4733.77
27	1991	6.2	12.29	4487.53	3964081	8934670.2	2.37	9.17	4736.15
28	1992	6.5	12.89	4704.67	3968064	9371697.7	2.37	9.17	4738.52
29	1993	5	9.92	3618.98	3972049	7212617.2	2.37	9.17	4740.90
30	1994	4.5	8.92	3257.08	3976036	6494612.5	2.37	9.17	4743.27
31	1995	5.8	11.50	4198.01	3980025	8375031.9	2.37	9.17	4745.64
32	1996	5	9.92	3618.98	3984016	7223474.1	2.37	9.17	4748.02
				117689.07	97909496	232808445			

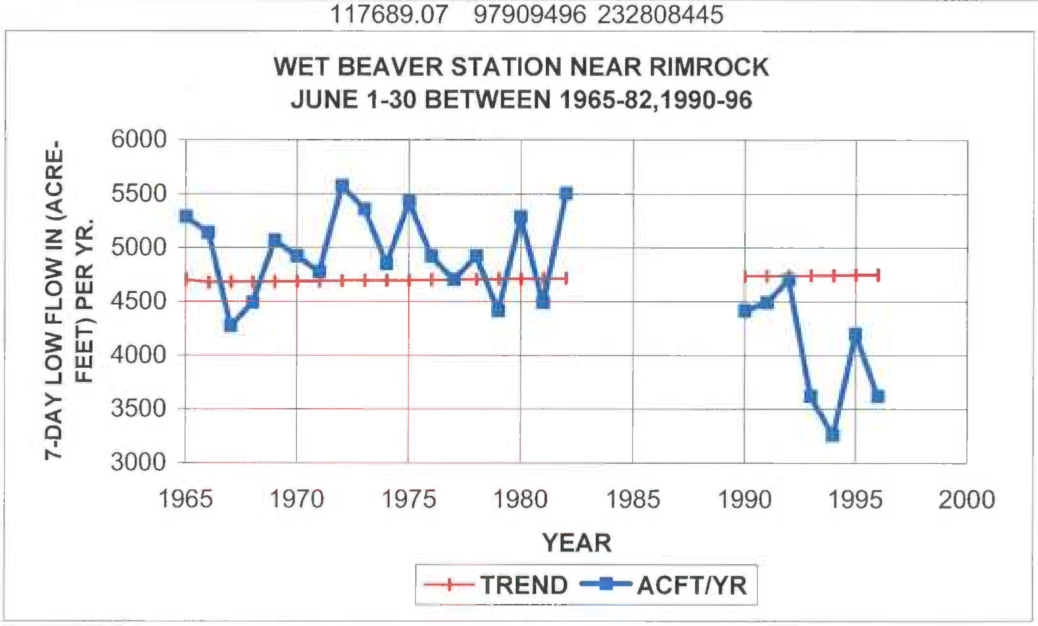

Figure C.15 - E.VERDE NR. CHILDS
7-DAY LOW FLOW DEC. 1967-96

k	x YEAR	CFS	AC/FT	y ACFT/YR	x^2	xy	m	b	Y TREND
1	1965	N/A	0.00	N/A	N/A	N/A	139.2520	-263184.3	10445.96
2	1966	N/A	0.00	N/A	N/A	N/A	139.2520	-263184	10585.43
3	1967	5	9.92	3618.98	3869089	7118523.8	139.2520	-263184	10724.68
4	1968	8.2	16.26	5935.12	3873024	11680314	139.2520	-263184	10863.94
5	1969	7.3	14.48	5283.70	3876961	10403612	139.2520	-263184	11003.19
6	1970	28.2	55.92	20411.02	3880900	40209707	139.2520	-263184	11142.44
7	1971	20.7	41.05	14982.56	3884841	29530619	139.2520	-263184	11281.69
8	1972	44.1	87.45	31919.36	3888784	62944977	139.2520	-263184	11420.94
9	1973	13.2	26.18	9554.09	3892729	18850227	139.2520	-263184	11560.20
10	1974	8.1	16.06	5862.74	3896676	11573048	139.2520	-263184	11699.45
11	1975	7.1	14.08	5138.94	3900625	10149415	139.2520	-263184	11838.70
12	1976	7.3	14.48	5283.70	3904576	10440598	139.2520	-263184	11977.95
13	1977	3.3	6.54	2388.52	3908529	4722111	139.2520	-263184	12117.20
14	1978	31.7	62.86	22944.30	3912484	45383828	139.2520	-263184	12256.46
15	1979	19	37.68	13752.11	3916441	27215416	139.2520	-263184	12395.71
16	1980	15.2	30.14	11001.68	3920400	21783334	139.2520	-263184	12534.96
17	1981	4.9	9.72	3546.60	3924361	7025805.7	139.2520	-263184	12674.21
18	1982	39.2	77.73	28372.76	3928324	56234818	139.2520	-263184	12813.46
19	1983	23.7	47.00	17153.94	3932289	34016266	139.2520	-263184	12952.72
20	1984	12.8	25.38	9264.58	3936256	18380919	139.2520	-263184	13091.97
21	1985	16.7	33.12	12087.38	3940225	23993442	139.2520	-263184	13231.22
22	1986	14.2	28.16	10277.89	3944196	20411888	139.2520	-263184	13370.47
23	1987	34	67.42	24609.03	3948169	48898143	139.2520	-263184	13509.72
24	1988	23.2	46.01	16792.04	3952144	33382583	139.2520	-263184	13648.98
25	1989	22.5	44.62	16285.39	3956121	32391636	139.2520	-263184	13788.23
26	1990	4.5	8.92	3257.08	3960100	6481584.2	139.2520	-263184	13927.48
27	1991	9.5	18.84	6876.05	3964081	13690221	139.2520	-263184	14066.73
28	1992	15.5	30.74	11218.82	3968064	22347894	139.2520	-263184	14205.98
29	1993	33	65.44	23885.24	3972049	47603273	139.2520	-263184	14345.24
30	1994	25	49.58	18094.88	3976036	36081181	139.2520	-263184	14484.49
31	1995	25	49.58	18094.88	3980025	36099276	139.2520	-263184	14623.74
32	1996	6.1	12.10	4415.15	3984016	8812638.4	139.2520	-263184	14762.99
				382308.52	117792515	757857299			

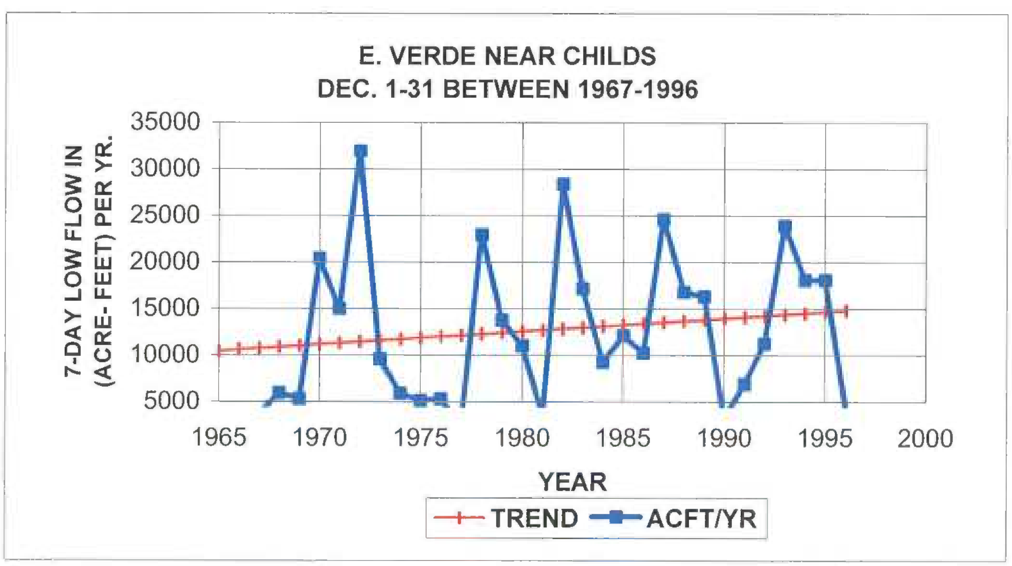

Figure C.16 - E.VERDE NR. CHILDS
7-DAY LOW FLOW JUNE 1967-96

k	x YEAR	CFS	AC/FT	y ACFT/YR	x^2	xy	m	b	Y TREND
1	1965	N/A	0.00		N/A	N/A	-281.515	570114.81	16937.45
2	1966	N/A	0.00		N/A	N/A	-281.515	570114.8	16656.31
3	1967	1.4	2.78	1013.31	3869089	1993186.7	-281.515	570114.8	16374.80
4	1968	30.2	59.89	21858.61	3873024	43017743	-281.515	570114.8	16093.28
5	1969	25.7	50.96	18601.53	3876961	36626416	-281.515	570114.8	15811.77
6	1970	22.8	45.21	16502.53	3880900	32509976	-281.515	570114.8	15530.25
7	1971	1.1	2.18	796.17	3884841	1569259.9	-281.515	570114.8	15248.74
8	1972	2	3.97	1447.59	3888784	2854647.5	-281.515	570114.8	14967.22
9	1973	50.1	99.35	36262.13	3892729	71545182	-281.515	570114.8	14685.71
10	1974	20	39.66	14475.90	3896676	28575427	-281.515	570114.8	14404.19
11	1975	23.2	46.01	16792.04	3900625	33164287	-281.515	570114.8	14122.68
12	1976	25.2	49.97	18239.63	3904576	36041517	-281.515	570114.8	13841.16
13	1977	1.7	3.37	1230.45	3908529	2432602.6	-281.515	570114.8	13559.65
14	1978	22.8	45.21	16502.53	3912484	32641996	-281.515	570114.8	13278.13
15	1979	37	73.37	26780.42	3916441	52998441	-281.515	570114.8	12996.62
16	1980	39.5	78.33	28589.90	3920400	56608007	-281.515	570114.8	12715.10
17	1981	8	15.86	5790.36	3924361	11470703	-281.515	570114.8	12433.59
18	1982	18	35.69	13028.31	3928324	25822110	-281.515	570114.8	12152.07
19	1983	41.4	82.10	29965.11	3932289	59420819	-281.515	570114.8	11870.56
20	1984	8.7	17.25	6297.02	3936256	12493281	-281.515	570114.8	11589.04
21	1985	6.8	13.48	4921.81	3940225	9769784.9	-281.515	570114.8	11307.53
22	1986	10.5	20.82	7599.85	3944196	15093297	-281.515	570114.8	11026.01
23	1987	12.6	24.99	9119.82	3948169	18121076	-281.515	570114.8	10744.50
24	1988	18.2	36.09	13173.07	3952144	26188061	-281.515	570114.8	10462.98
25	1989	11.7	23.20	8468.40	3956121	16843651	-281.515	570114.8	10181.47
26	1990	4	7.93	2895.18	3960100	5761408.2	-281.515	570114.8	9899.95
27	1991	8	15.86	5790.36	3964081	11528607	-281.515	570114.8	9618.44
28	1992	7.5	14.87	5428.46	3968064	10813497	-281.515	570114.8	9336.92
29	1993	17	33.71	12304.52	3972049	24522898	-281.515	570114.8	9055.41
30	1994	12	23.80	8685.54	3976036	17318967	-281.515	570114.8	8773.89
31	1995	22	43.63	15923.49	3980025	31767363	-281.515	570114.8	8492.38
32	1996	0.4	0.79	289.52	3984016	577877.93	-281.515	570114.8	8210.86
				368773.55	117792515	730092089			

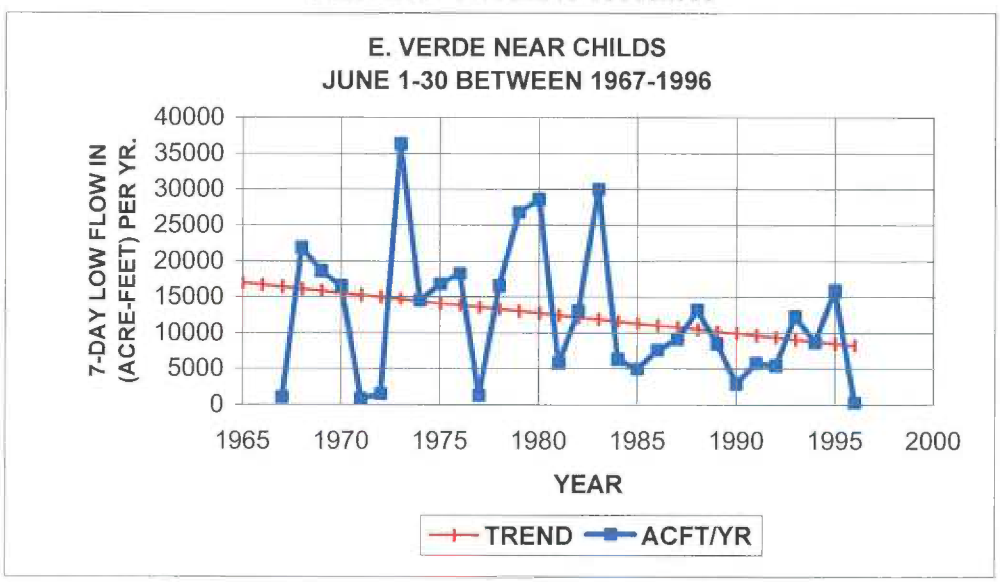

Figure C.17 - VERDE RIVER BELOW TANGLE CREEK
7-DAY LOW FLOW DEC. 1965-96

k	x			y	x^2	xy	m	b	Y
	YEAR	CFS	AC/FT	ACFT/YR					TREND
1	1965	427.4	847.53	309349.983	3861225	607872717	-130.4051	469995.53	213749.41
2	1966	367.2	728.16	265777.524	3865156	522518612	-130.405	469995.5	213619.27
3	1967	253.5	502.69	183482.033	3869089	360909158	-130.405	469995.5	213488.87
4	1968	290.2	575.47	210045.309	3873024	413369168	-130.405	469995.5	213358.46
5	1969	241.4	478.70	174724.113	3876961	344031778	-130.405	469995.5	213228.06
6	1970	222.1	440.42	160754.87	3880900	316687093	-130.405	469995.5	213097.65
7	1971	279.1	553.46	202011.185	3884841	398164045	-130.405	469995.5	212967.25
8	1972	368	729.74	266356.56	3888784	525255136	-130.405	469995.5	212836.84
9	1973	272.2	539.77	197016.999	3892729	388714539	-130.405	469995.5	212706.44
10	1974	260.4	516.37	188476.218	3896676	372052054	-130.405	469995.5	212576.03
11	1975	255.8	507.25	185146.761	3900625	365664853	-130.405	469995.5	212445.63
12	1976	81.1	160.82	58699.7745	3904576	115990754	-130.405	469995.5	212315.22
13	1977	219.4	435.07	158800.623	3908529	313948832	-130.405	469995.5	212184.82
14	1978	321.2	636.94	232482.954	3912484	459851283	-130.405	469995.5	212054.41
15	1979	275.7	546.71	199550.282	3916441	394910007	-130.405	469995.5	211924.01
16	1980	276.7	548.70	200274.077	3920400	396542671	-130.405	469995.5	211793.6
17	1981	278.5	552.27	201576.908	3924361	399323854	-130.405	469995.5	211663.2
18	1982	546.5	1083.71	395553.968	3928324	783987964	-130.405	469995.5	211532.79
19	1983	373.7	741.05	270482.192	3932289	536366186	-130.405	469995.5	211402.39
20	1984	267.7	530.85	193759.922	3936256	384419684	-130.405	469995.5	211271.98
21	1985	324.2	642.89	234654.339	3940225	465788863	-130.405	469995.5	211141.58
22	1986	332.8	659.94	240878.976	3944196	478385646	-130.405	469995.5	211011.17
23	1987	338	670.25	244642.71	3948169	486105065	-130.405	469995.5	210880.77
24	1988	273.8	542.95	198175.071	3952144	393972041	-130.405	469995.5	210750.36
25	1989	274.2	543.74	198464.589	3956121	394746068	-130.405	469995.5	210619.96
26	1990	226	448.16	163577.67	3960100	325519563	-130.405	469995.5	210489.55
27	1991	283	561.19	204833.985	3964081	407824464	-130.405	469995.5	210359.15
28	1992	286	567.14	207005.37	3968064	412354697	-130.405	469995.5	210228.74
29	1993	315	624.65	227995.425	3972049	454394882	-130.405	469995.5	210098.34
30	1994	306	606.80	221481.27	3976036	441633652	-130.405	469995.5	209967.93
31	1995	275	545.33	199043.625	3980025	397092032	-130.405	469995.5	209837.53
32	1996	249	493.77	180224.955	3984016	359729010	-130.405	469995.5	209707.12
				6775300.24	125518896	1.342E+10			

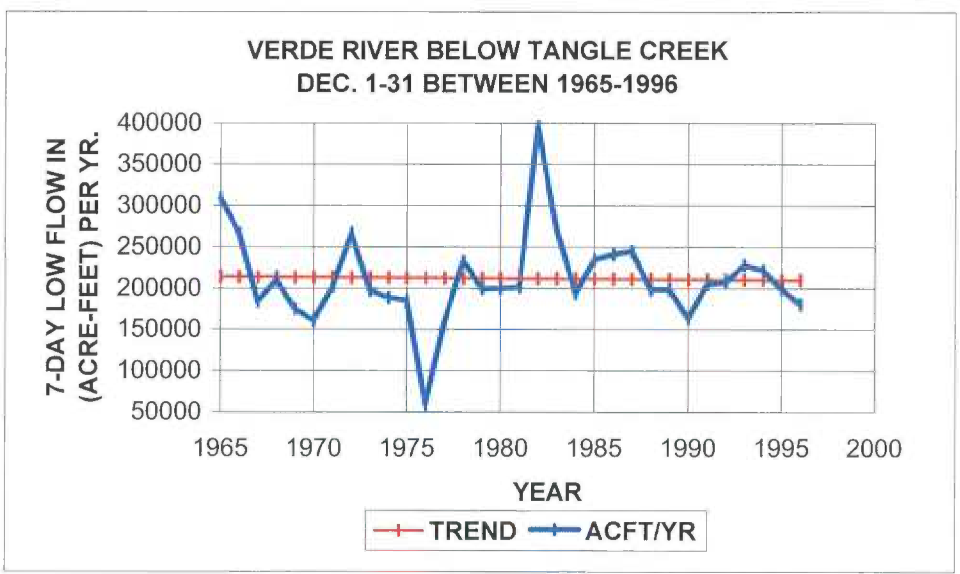

Figure C.18 - VERDE RIVER BELOW TANGLE CREEK
7-DAY LOW FLOW JUNE 1965-96

k	x YEAR	CFS	AC/FT	y ACFT/YR	x^2	xy	m	b	Y TREND
1	1965	117.4	232.80	84973.53	3861225	166972992	475.99	-854123.8	81187.59
2	1966	104.2	206.63	75419.44	3865156	148274617	475.99	-854124	81663.30
3	1967	106.8	211.78	77301.31	3869089	152051669	475.99	-854124	82139.28
4	1968	127.4	252.63	92211.48	3873024	181472199	475.99	-854124	82615.27
5	1969	118.8	235.58	85986.85	3876961	169308100	475.99	-854124	83091.25
6	1970	108.2	214.56	78314.62	3880900	154279799	475.99	-854124	83567.24
7	1971	95.2	188.78	68905.28	3884841	135812315	475.99	-854124	84043.22
8	1972	125.1	248.07	90546.75	3888784	178558200	475.99	-854124	84519.21
9	1973	152.7	302.80	110523.50	3892729	218062859	475.99	-854124	84995.19
10	1974	103.5	205.24	74912.78	3896676	147877833	475.99	-854124	85471.18
11	1975	111.4	220.91	80630.76	3900625	159245757	475.99	-854124	85947.17
12	1976	106.4	210.99	77011.79	3904576	152175293	475.99	-854124	86423.15
13	1977	74.2	147.14	53705.59	3908529	106175949	475.99	-854124	86899.14
14	1978	106.2	210.59	76867.03	3912484	152042983	475.99	-854124	87375.12
15	1979	154.8	306.97	112043.47	3916441	221734019	475.99	-854124	87851.11
16	1980	162.7	322.63	117761.45	3920400	233167664	475.99	-854124	88327.09
17	1981	109.7	217.54	79400.31	3924361	157292017	475.99	-854124	88803.08
18	1982	116.7	231.42	84466.88	3928324	167413349	475.99	-854124	89279.06
19	1983	184.1	365.07	133250.66	3932289	264236058	475.99	-854124	89755.05
20	1984	123.7	245.30	89533.44	3936256	177634348	475.99	-854124	90231.03
21	1985	123.4	244.70	89316.30	3940225	177292861	475.99	-854124	90707.02
22	1986	127.5	252.83	92283.86	3944196	183275751	475.99	-854124	91183.00
23	1987	118.7	235.38	85914.47	3948169	170712045	475.99	-854124	91658.99
24	1988	139.8	277.22	101186.54	3952144	201158844	475.99	-854124	92134.98
25	1989	88	174.50	63693.96	3956121	126687286	475.99	-854124	92610.96
26	1990	95	188.39	68760.53	3960100	136833445	475.99	-854124	93086.95
27	1991	142	281.59	102778.89	3964081	204632770	475.99	-854124	93562.93
28	1992	130	257.79	94093.35	3968064	187433953	475.99	-854124	94038.92
29	1993	150	297.45	108569.25	3972049	216378515	475.99	-854124	94514.90
30	1994	120	237.96	86855.40	3976036	173189668	475.99	-854124	94990.89
31	1995	170	337.11	123045.15	3980025	245475074	475.99	-854124	95466.87
32	1996	102	202.27	73827.09	3984016	147358872	475.99	-854124	95942.86
				2834091.7	125518896	5.614E+09			

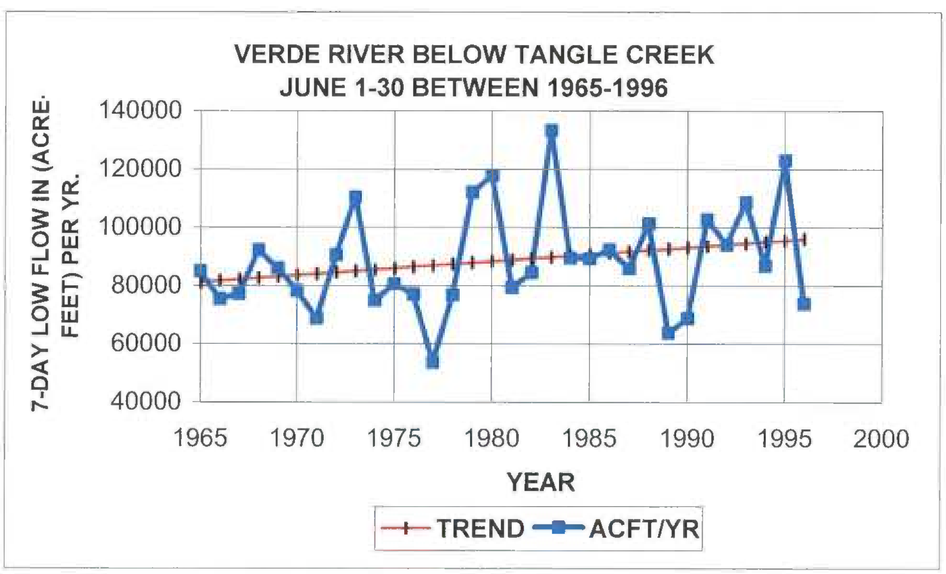

TABLE C.1

WELL HYDROGRAPH DATA

LOCATION	ID# 1
Wineglass Ranch	345338112311801 Well Depth- 342'
YEAR	**WATER LEVEL (feet)**
1965	133
1966	131
1967	131
1968	131
1969	131
1970	137
1971	132
1972	135
1973	130
1974	130
1975	130
1976	132
1977	132
1981	131
1983	130
1984	128
1985	129
1986	129
1987	129
1988	129
1989	130
1990	131
1991	131
1992	131
1993	131
1994	127
1995	128
1996	129
1997	114
1998	131

LOCATION	ID# 2
Paulden	345301112283701 Well Depth- n/a
YEAR	**WATER LEVEL (feet)**
1983	97
1984	100
1985	99.7
1986	99.2
1987	99.7
1988	99.4
1989	101
1990	101.4
1991	102.1
1992	102
1993	98.8
1994	99.9
1995	99.8
1996	100.9
1997	105

LOCATION	ID# 3
Simmons	344636112394401 Well Depth- 352'
YEAR	**WATER LEVEL (feet)**
1965	6.93
1966	3.15
1967	5.03
1968	2.19
1969	4.74
1970	4.6
1971	4.9
1972	4.9
1973	1.5
1974	2
1975	2.2
1976	2
1978	0
1979	1.01
1980	1.8
1981	3.9
1984	1.1
1985	0.89
1986	1
1987	1.57
1988	1.2
1989	2.3
1990	4.8
1991	4.9
1992	3.1
1993	2.9
1994	3.4
1995	3.3
1996	4.3
1997	5.4

LOCATION	ID # 4
Clarkdale	344556112040501 Well Depth- 395'
YEAR	**WATER LEVEL (feet)**
1992	224.7
1993	226.3
1994	234.5
1995	238.7
1996	245.9
1997	251.2

LOCATION	ID# 5
Cornville	344250111583401 Well depth- 400'
YEAR	WATER LEVEL (feet)
1965	16.95
1966	16.82
1967	19.1
1977	30.9
1978	24.85
1979	23.8
1980	27.73
1983	29.45
1985	29.97
1986	31.8
1987	31.2
1988	33.8
1989	39.8
1990	36.1
1991	43.4
1992	39.5
1993	36.8
1994	38.3
1995	38
1996	43.4
1997	52.9
1998	42.4

LOCATION	ID# 6
Cornville	343843111575301 Well Depth- n/a
YEAR	WATER LEVEL (feet)
1992	372.6
1993	372.6
1994	371.9
1995	374.3
1996	372.7
1997	373.1

LOCATION	ID# 7
Camp Verde	343409111511101 Well depth-99'
YEAR	**WATER LEVEL (feet)**
1977	21.87
1978	22.08
1979	19.34
1980	19.73
1981	22.38
1982	22.43
1990	56.5
1991	51.4
1992	21
1993	21.5
1994	22.3
1995	21.7
1996	56.1

LOCATION	ID#8
Camp Verde	343254111505401 Well depth- 120'
YEAR	**WATER LEVEL (feet)**
1965	54.79
1966	54.41
1967	54.99
1968	54.07
1976	58.15
1977	55.25
1978	56.5
1979	55.4
1980	55.03
1981	55.54
1982	57.58
1983	55.56
1984	56.4
1985	56.1
1986	56.3
1987	61.3
1988	55.7
1989	56.7
1990	56.2
1991	55.45
1992	55.2
1993	56
1994	56.7
1995	56.8
1996	57
1997	57.1

LOCATION	ID# 9
Camp Verde	343638111501301 Well depth- 160'
YEAR	WATER LEVEL (feet)
1965	65.36
1966	38.63
1967	42.61
1968	39.2
1969	35.5
1970	48.3
1971	42.1
1972	39.4
1973	35.2
1974	44.5
1975	37.3
1976	39.6
1977	43.2
1978	41.25
1979	30.7
1980	29.33
1981	31.76
1982	31.44
1983	29.06
1984	33.8
1985	31.4
1986	39.2
1987	47.3
1988	38.8
1989	47.1
1990	73.2
1991	55.8
1992	57.2
1993	47.2
1994	49.9
1995	44.3
1996	47.7
1997	48.5

LOCATION	ID# 10
Munds Park	345612111385201 Well Depth- 200'
YEAR	WATER LEVEL (feet)
1967	117.9
1976	168
1977	163.75
1978	161.1
1979	155.07
1980	141.9
1981	143.3
1983	124.5
1984	133.6
1985	114.9
1986	123.7
1987	144.9
1988	113.8
1989	118.6
1990	128.3
1991	129.3
1993	118.6
1994	122.5
1995	134.8
1996	134
1997	131.2

LOCATION	ID# 11
Munds Park	345619111385501 Well Depth- 232'
YEAR	**WATER LEVEL (feet)**
1965	101.04
1967	138.8
1968	136.7
1969	119.35
1970	133.5
1971	151.13
1973	82.93
1975	112.37
1976	157.6
1977	119.7
1978	142.8
1979	138.88
1980	156.38
1981	129.83
1983	67.76
1984	69.42
1985	73.4
1986	73.5
1987	65.6
1988	70.4
1989	74.3
1990	74.1
1991	83.8
1992	74.1
1993	84.3
1994	77.4
1995	92.9
1996	77.3
1997	75.8

LOCATION	ID# 12
Cornville	344312111540801 Well Depth- 300'
YEAR	**WATER LEVEL (feet)**
1977	103.65
1978	81.9
1979	90.7
1980	88.6
1983	91.19
1984	89.1
1985	90.2
1986	90.1
1987	89.5
1988	89.3
1989	90.8
1990	90.35
1991	93.05
1992	90.75
1993	92.25
1994	91.95
1995	93.55
1996	93.15
1997	116.55

LOCATION	ID# 13
Cornville	344307111552701 Well Depth- 250'
YEAR	**WATER LEVEL (feet)**
1965	53.08
1966	44.05
1967	44.12
1968	43.69
1969	44.06
1970	44.3
1971	42.8
1972	48.1
1973	46.7
1974	47.4
1975	46.6
1976	56.4
1977	60.05
1978	59.6
1979	56.05
1980	57.25
1982	56.3
1983	57.22
1984	57.4
1985	56.1
1986	57.2
1987	57
1988	56.6
1989	56.9
1990	54.9
1991	54.2
1992	54.8
1993	55.2
1994	55.1
1995	57.1
1996	57.7
1997	58.1

LOCATION	ID# 14
Sedona	344850111494801 Well Depth- 700'
YEAR	**WATER LEVEL (feet)**
1974	212.2
1994	199.6
1995	199.8
1996	200.4
1997	204.3

LOCATION	ID# 15
Sedona	344957111463102 Well Depth- 465'
YEAR	WATER LEVEL (feet)
1966	438.9
1967	439.8
1968	439.7
1969	439.6
1970	440.8
1971	440.8
1973	441.4
1974	440.9
1975	441.8
1976	441.5
1977	444.8
1978	445.1
1979	444.32
1980	439.5
1982	439.28
1983	438.3
1984	436.9
1985	436.9
1986	439.1
1987	437.8
1988	438.6
1989	439
1990	441.4
1991	441.4
1992	440.3
1993	437.2
1994	438.2
1995	438.4
1996	440.6
1997	442.8

LOCATION	ID# 16
Bellemont	351409111500302 Well Depth- 110'
YEAR	WATER LEVEL (feet)
1967	26.8
1968	27.4
1969	17.58
1970	28.65
1971	29.67
1972	22
1973	11.15
1976	36.3
1977	35.5
1978	33.8
1979	24.9
1980	27.84
1983	16.78
1984	27.3
1985	16.9
1986	18.5
1987	23.7
1988	23.4
1989	25.3
1990	32.6
1991	33.3
1992	26.8
1993	30.9
1995	32.5
1996	36.4
1997	33.52

LOCATION	ID#17
Lake Montezuma	343833111490101 Well Depth- 503'
YEAR	**WATER LEVEL (feet)**
1978	245.6
1992	341.1
1993	347
1994	346.2
1995	346.3
1996	352.5
1997	342

LOCATION	ID# 18
Lake Montezuma	343924111454901 Well Depth- 240'
YEAR	**WATER LEVEL (feet)**
1991	114.2
1992	112.1
1993	114.3
1994	113.3
1995	121.9
1996	121
1997	126.5

LOCATION	ID# 19
Long Valley	343314111183801 Well Depth 600'
YEAR	WATER LEVEL (feet)
1966	343.8
1969	344.35
1970	343.2
1971	343.3
1972	348.4
1974	345.5
1976	315.5
1977	348.6
1978	339.9
1979	335
1982	339.43
1983	333.8
1984	332.3
1985	332
1986	336.5
1987	331.8
1988	332.7
1989	330.2
1990	329.8
1991	330.1
1992	333.7
1993	331.4
1994	328
1995	330
1996	328.1
1997	332.1

LOCATION	ID# 20
Strawberry	342417111305101 Well Depth 152'
YEAR	WATER LEVEL (feet)
1974	50
1990	102
1991	83
1992	82
1993	69

LOCATION	ID# 21
Pine	342408111270401 Well depth-233'
YEAR	**WATER LEVEL (feet)**
1987	132
1989	158
1990	168
1991	168
1992	125
1993	165
1994	169
1995	167
1996	162
1997	125
1998	92

LOCATION	ID#22
Payson North	341547111192501 Well depth-400'
YEAR	**WATER LEVEL (feet)**
1963	92
1975	197
1978	144
1979	130
1980	124
1986	127
1987	119
1988	118
1989	119
1990	122
1991	120
1992	116
1993	176
1994	182
1995	208
1996	125
1997	126
1998	135

LOCATION	ID# 23
Payson South	341436111190001 Well depth-n/a
YEAR	**WATER LEVEL (feet)**
1986	140
1988	143
1989	158
1990	168
1991	187
1992	186
1993	187
1994	192
1995	203
1996	215
1997	223
1998	213

TABLE C.2

MONTHLY PRECIPITATION AVERAGES

Montezuma Precipitation Station

PPT MO AVG (1966-96)			1990	1991	1992	1993	1994	1995	1996
JAN	1.28	JAN	1.58	0.96	1.92	6.59	0.24	1.37	nr
FEB	1.29	FEB	1.28	2.63	1.37	nr	0.89	1.33	0.86
MAR	1.38	MAR	0.75	nr	1.61	1.59	1.67	1.46	0.76
APR	0.6	APR	0.83	0	0.44	0	1.09	0.61	0.02
MAY	0.4	MAY	0.45	0	2.07	0.3	0.28	0.78	0
JUN	0.29	JUN	0.27	0.16	0.2	0	0	0.13	0.2
JUL	1.52	JUL	6.01	1	1.02	0	0.09	0.19	nr
AUG	2.1	AUG	2.23	1.26	6.54	4.18	1.38	1.28	0.83
SEP	1.59	SEP	4.33	1.81	0.34	0.3	nr	4.66	2.24
OCT	1.2	OCT	0.78	0.57	0.9	1.66	0.42	0	0.14
NOV	1.16	NOV	0.37	2.43	0.16	2	0.73	0.42	nr
DEC	1.29	DEC	0.65	2.07	3.65	0.09	1.96	nr	0.06
AVG	**14.1**	TOTAL	**19.53**	**12.89**	**20.22**	**16.71**	**8.75**	**12.23**	**5.11**

Beaver Creek RS Precipitation Station

PPT MO AVG (1966-1996)			1990	1991	1992	1993	1994	1995	1996
JAN	1.59	JAN	1	0.93	1.47	6.71	0	3.46	0.9
FEB	1.67	FEB	1.77	1.27	1.48	2.9	nr	3	0.91
MAR	1.83	MAR	1.16	nr	3	1.56	1.75	1.93	0.06
APR	0.9	APR	0.89	0	0.02	0	1.71	0.91	nr
MAY	0.5	MAY	0.46	0	2.83	0	nr	0.6	0.16
JUN	0.26	JUN	0.03	0.03	0.14	0	0	0.07	1.93
JUL	1.66	JUL	2.2	1.28	4.32	0.5	2.07	0.2	2.56
AUG	2.33	AUG	2.86	0.84	6.18	2.83	1.49	3.03	5.06
SEP	1.79	SEP	4.69	1.37	0	0.66	2.24	2.07	0.25
OCT	1.3	OCT	0.54	0.98	0.71	1.94	0.71	0	nr
NOV	1.29	NOV	1.26	nr	0.09	1.42	1.1	0.44	0.13
DEC	1.66	DEC	0.89	3.43	4.16	0.4	1.76	nr	nr
AVG	**16.78**	TOTAL	**17.75**	**10.13**	**24.4**	**18.92**	**12.83**	**15.71**	**11.96**

Childs Precipitation Station

PPT MO AVG (1966-1996)			1990	1991	1992	1993	1994	1995	1996
JAN	2.26	JAN	1.65	1.16	1.94	9.77	0.21	4.8	0.16
FEB	2.1	FEB	1.5	1.17	2.99	4.8	3.35	3.2	1.5
MAR	2.26	MAR	1.27	8.31	5.29	2.11	1.71	2.47	0.33
APR	0.82	APR	1.51	0	0.51	0	1.22	1.15	0.23
MAY	0.51	MAY	0.22	0	2.48	1.19	0.22	0.37	0
JUN	0.27	JUN	0.02	0.05	0.02	0.01	0.06	0.12	0.2
JUL	1.9	JUL	4.25	1.57	1.63	0	1.54	0.15	3.18
AUG	2.81	AUG	2.35	3.23	6.09	3.35	1.48	3.54	nr
SEP	1.86	SEP	3.73	0.89	0.66	0.61	1.16	1.91	4.02
OCT	1.43	OCT	0.03	1.22	0.78	2.03	0.97	0	0.27
NOV	1.58	NOV	1.65	2.34	0.04	3.49	1.64	0.53	0.3
DEC	2.25	DEC	1.8	2.81	5.97	0.29	3.33	0.25	0.05
AVG	**20.05**	TOTAL	**19.98**	**22.75**	**28.4**	**27.65**	**16.89**	**18.49**	**10.24**

Sedona RS Precipitation Station

PPT MO AVG (1966-1996)				1990	1991	1992	1993	1994	1995	1996
JAN	2.35		JAN	nr	1.35	nr	10.17	0.31	4.64	nr
FEB	2.04		FEB	1.54	1.66	3.05	5.05	1.34	3.2	2.08
MAR	2.37		MAR	1.51	nr	5.47	1.89	1.74	3.06	0.41
APR	1.03		APR	1.28	0	0.43	0.02	2.31	1.88	0
MAY	0.72		MAY	0.93	0.18	3.8	0.65	0.81	0.82	0
JUN	0.36		JUN	0.13	0.2	0.38	0	0.02	0.16	0
JUL	1.68		JUL	1.5	0.98	2.61	0.02	0.99	0.23	1.07
AUG	2.15		AUG	2.23	0.98	4.47	2.53	1.98	3.39	1.03
SEP	1.79		SEP	3.61	2.02	0.77	0.5	2.63	1.31	3.74
OCT	1.52		OCT	0.29	1.22	1.42	2.25	1	0	0.22
NOV	1.57		NOV	0.27	3.51	0.57	1.77	1.61	0.06	0.46
DEC	1.78		DEC	0.91	2.74	4.64	0.38	2.81	0.03	0.1
AVG	**19.36**		**TOTAL**	**14.2**	**14.84**	**27.61**	**25.23**	**17.55**	**18.78**	**9.11**

Tuzigoot Precipitation Station

PPT MO AVG (1977-97)				1990	1991	1992	1993	1994	1995	1996
JAN	1.63		JAN	1.59	1.15	1.26	5.05	0.06	2.25	nr
FEB	1.28		FEB	0.79	0.78	1.36	2.72	0.51	1.25	0.69
MAR	1.3		MAR	0.61	3.13	1.67	1.65	0.73	0.69	0.34
APR	0.68		APR	0.71	0	0.69	0	0.65	0.35	0.06
MAY	0.39		MAY	0.24	0	1.91	0.11	0.62	0.5	0
JUN	0.25		JUN	0.32	0.27	0.04	0	0.11	0.1	0
JUL	1.6		JUL	3.18	0.83	1.91	0.29	0.19	0.1	1.7
AUG	2.42		AUG	1.87	1.3	3.61	4.38	1.98	3.19	0.91
SEP	1.6		SEP	3.52	0.86	0.06	0.09	1.87	2.96	2.43
OCT	0.76		OCT	0.3	0.49	0.98	1.51	0.5	0	0.29
NOV	0.9		NOV	0.26	1.34	0.06	1.8	0.18	0.23	0.3
DEC	1.18		DEC	0.4	nr	3.21	0.19	nr	0.09	0.03
AVG	**13.99**		**TOTAL**	**13.79**	**10.15**	**16.76**	**17.79**	**7.4**	**11.71**	**6.75**

TABLE C.3

STREAMFLOW & PRECIPITATION COMPARISON DATA

OAK CREEK NEAR CORNVILLE GAGING STATION #09504500					
1992	7 Day Low Flow 1992		Total Flow 1992		Ppt Data-Sedona RS 1992
	CFS	ACFT/MO	ACFT/MO		INCHES
JAN	39	2397	5100		nr
FEB	68	3775	19170		3.05
MAR	242	14876	25820		5.47
APR	30	1785	4600		0.43
MAY	32	1967	2710		3.8
JUN	20	1190	1400		0.38
JUL	22	1352	1810		2.61
AUG	22	1352	4390		4.47
SEP	22	1309	1700		0.77
OCT	17.5	1076	1560		1.42
NOV	22.5	1339	1350		0.57
DEC	42.5	2612	19000		4.64
1996	7 Day Low Flow 1996		Total Flow 1996		Ppt Data-Sedona RS 1996
	CFS	ACFT/MO	ACFT/MO		INCHES
JAN	31	1906	1980		nr
FEB	33	1832	1890		2.08
MAR	33	2029	2060		0.41
APR	25	1488	1490		0
MAY	17	1045	1120		0
JUN	14	833	853		0
JUL	15	922	946		1.07
AUG	13	799	1050		1.03
SEP	20	1190	2210		3.74
OCT	22	1352	1360		0.22
NOV	28	1666	1730		0.46
DEC	29	1783	1820		0.1

VERDE NEAR CAMP VERDE GAGING STATION #09506000						
1992	7 Day Low Flow 1992			Total Flow 1992		Ppt Data-Montezuma Station 1992
	CFS	ACFT/MO		ACFT/MO		INCHES
JAN	240	14753		23420		1.92
FEB	312	17322		75760		1.37
MAR	1139	70014		131000		1.61
APR	114	6783		26540		0.44
MAY	100	6147		10120		2.07
JUN	76	4522		7330		0.2
JUL	62	3811		6860		1.02
AUG	106	6516		37850		6.54
SEP	110	6545		8360		0.34
OCT	112	6885		8730		0.9
NOV	186	11067		11540		0.16
DEC	210	12909		47470		3.65
1996	7 Day Low Flow 1996			Total Flow 1996		Ppt Data-Montezuma Station 1996
	CFS	ACFT/MO		ACFT/MO		INCHES
JAN	210	12909		13210		
FEB	194	10771		12000		0.86
MAR	141	8667		10540		0.76
APR	98	5831		7030		0.02
MAY	80	4918		5320		0
JUN	52	3094		4300		0.2
JUL	57	3504		7280		
AUG	64	3934		6360		0.83
SEP	135	8033		20080		2.24
OCT	112	6885		8370		0.14
NOV	170	10115		11020		
DEC	192	11802		12000		0.06

VERDE NEAR CLARKDALE GAGING STATION #0950400						
1992	**7 Day Low Flow 1992**			**Total Flow 1992**		**Ppt Data-Tuzigoot 1992**
	CFS	**ACFT/MO**		**ACFT/MO**		**INCHES**
JAN	86	5286		5940		1.26
FEB	89	4941		25600		1.36
MAR	285	17519		43440		1.67
APR	85	5058		7980		0.69
MAY	81	4979		6290		1.91
JUN	75	4463		4800		0.04
JUL	74	4549		5180		1.91
AUG	78	4795		9650		3.61
SEP	80	4760		4980		0.06
OCT	80	4918		5100		0.98
NOV	85	5058		5080		0.06
DEC	82	5041		15700		3.21
1996	**7 Day Low Flow 1996**			**Total Flow 1996**		**Ppt Data-Tuzigoot 1996**
	CFS	**ACFT/MO**		**ACFT/MO**		**INCHES**
JAN	89	5471		5500		
FEB	87	4830		5040		0.69
MAR	83	5102		5160		0.34
APR	81	4820		4880		0.06
MAY	80	4918		4980		0
JUN	74	4403		4580		0
JUL	76	4672		5690		1.7
AUG	77	4733		4990		0.91
SEP	80	4760		6710		2.43
OCT	77	4733		4820		0.29
NOV	79	4701		4830		0.3
DEC	83	5102		5140		0.03

EAST VERDE RIVER NEAR CHILDS #09507980						
1992	7 Day Low Flow 1992			Total Flow 1992		Childs Ppt Station 1992
	CFS	ACFT/MO		ACFT/MO		INCHES
JAN	50	3074		6680		1.94
FEB	27	1499		10330		2.99
MAR	150	9221		23950		5.29
APR	33.5	1993		6910		0.51
MAY	17	1045		1770		2.48
JUN	7.5	446		1010		0.02
JUL	6	369		1090		1.63
AUG	30	1844		12450		6.09
SEP	6	357		635		0.66
OCT	5.5	338		562		0.78
NOV	11	655		658		0.04
DEC	15.5	953		11950		5.97
1996	7 Day Low Flow 1996			Total Flow 1996		Childs Ppt Station 1996
	CFS	ACFT/MO		ACFT/MO		INCHES
JAN	22	1352		1390		0.16
FEB	22	1221		1410		1.5
MAR	10	615		694		0.33
APR	5.5	327		343		0.23
MAY	2	123		131		0
JUN	0.4	24		25		0.2
JUL	0.55	34		36		3.18
AUG	1.5	92		106		
SEP	5	298		1370		4.02
OCT	2.5	154		173		0.27
NOV	4.5	268		275		0.3
DEC	6.1	375		380		0.05

WET BEAVER CREEK NEAR RIMROCK GAGING STATION #09505350						
1992	**7 Day Low Flow 1992**			**Total Flow 1992**		**Ppt Data-Beaver Creek RS 1992**
	CFS	**ACFT/MO**		**ACFT/MO**		**INCHES**
JAN	10	615		2100		1.47
FEB	30	1666		4910		1.48
MAR	100	6147		12080		3
APR	9	536		2570		0.02
MAY	6.9	424		440		2.83
JUN	6.5	387		413		0.14
JUL	6	369		549		4.32
AUG	7.3	449		4610		6.18
SEP	7	417		419		0
OCT	6.8	418		420		0.71
NOV	7.2	428		430		0.09
DEC	7.9	486		2560		4.16
1996	**7 Day Low Flow 1996**			**Total Flow 1996**		**Ppt Data-Beaver Creek RS 1996**
	CFS	**ACFT/MO**		**ACFT/MO**		**INCHES**
JAN	7.2	443		448		0.9
FEB	7.7	428		445		0.91
MAR	7.2	443		450		0.06
APR	6	357		402		
MAY	5.9	363		366		0.16
JUN	5	298		336		1.93
JUL	5.3	326		355		2.56
AUG	6.7	412		637		5.06
SEP	6.2	369		1190		0.25
OCT	6.3	388		391		
NOV	6.6	393		435		0.13
DEC	7	430		482		

TABLE C.4

7 DAY LOW FLOW SURFACE WATER DATA

USGS GAUGING STATION #09503700
VERDE RIVER NEAR PAULDEN-7 DAY LOW FLOW

	1990		1991		1992		1993		1994		1995		1996			
MONTH	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS MO/AVG	ACFT/MO AVG
JAN	26	1,598	25	1,537	23	1,414	26	1,598	27	1,660	26	1,598	27	1,660	26	1,581
FEB	26	1,444	25	1,388	23	1,277	36	1,999	28	1,555	25	1,388	27	1,660	27	1,507
MAR	27	1,660	27	1,660	24	1,475	30	1,844	28	1,721	30	1,844	26	1,598	27	1,686
APR	25	1,488	23	1,369	25	1,488	26	1,547	28	1,666	30	1,785	26	1,598	26	1,556
MAY	25	1,537	23	1,414	24	1,475	25	1,537	28	1,721	29	1,783	25	1,537	26	1,572
JUN	24	1,428	22	1,309	24	1,428	27	1,607	26	1,547	27	1,607	25	1,537	25	1,488
JUL	25	1,537	21	1,291	24	1,475	26	1,598	26	1,598	26	1,598	24	1,475	25	1,510
AUG	27	1,660	22	1,352	24	1,475	29	1,783	28	1,721	25	1,537	24	1,475	26	1,572
SEP	25	1,488	23	1,369	25	1,488	28	1,666	26	1,547	25	1,488	24	1,475	25	1,496
OCT	25	1,537	23	1,414	26	1,598	28	1,721	26	1,598	27	1,660	25	1,537	26	1,581
NOV	25	1,488	24	1,428	23	1,369	29	1,726	28	1,666	28	1,666	26	1,598	26	1,556
DEC	25	1,537	24	1,475	25	1,537	28	1,721	29	1,783	28	1,721	26	1,598	26	1,625
ACFT/YR		18,400		17,000		17,500		20,350		19,780		19,940		18,748		

7 DAY LOW FLOW YEARLY AVERAGE : 18,770

USGS GAUGING STATION # 09504000
VERDE RIVER NR CLARKDALE-7 DAY LOW FLOW

	1990		1991		1992		1993		1994		1995		1996			
MONTH	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS MO/AVG	ACFT/MO AVG
JAN	82	5,041	83	5,102	86	5,286	206	12,263	93	5,717	93	5,717	89	5,471	105	6,371
FEB	81	4,497	81	4,497	89	4,941	387	21,486	92	5,108	233	12,936	87	4,830	150	8,328
MAR	93	5,717	149	9,159	285	17,519	248	15,245	92	5,655	98	6,024	83	5,102	150	9,203
APR	81	4,820	80	4,760	85	5,058	93	5,534	89	5,296	90	5,355	81	4,820	86	5,092
MAY	74	4,549	79	4,856	81	4,979	91	5,594	86	5,286	86	5,286	80	4,918	82	5,067
JUN	69	4,106	77	4,582	75	4,463	85	5,058	80	4,760	81	4,820	74	4,403	77	4,599
JUL	82	5,041	76	4,672	74	4,549	83	5,102	78	4,795	80	4,918	76	4,672	78	4,821
AUG	76	4,672	75	4,610	78	4,795	82	5,041	79	4,856	81	4,979	77	4,733	78	4,812
SEP	78	4,641	77	4,582	80	4,760	84	4,998	81	4,820	83	4,939	80	4,760	80	4,786
OCT	79	4,856	77	4,733	80	4,918	87	5,348	80	4,918	84	5,163	77	4,733	81	4,953
NOV	80	4,760	79	4,701	85	5,058	89	5,296	83	4,939	88	5,236	79	4,701	83	4,956
DEC	82	5,041	86	5,286	82	5,041	92	5,655	88	5,409	90	5,532	83	5,102	86	5,295
ACFT/YR		57,740		61,540		71,360		97,020		61,560		70,910		58,240		

7 DAY LOW FLOW YEARLY AVERAGE: 68,339

USGS GAUGING STATION # 09504500
OAK CREEK NEAR CORNVILLE-7 DAY LOW FLOW

MONTH	1990 CFS	1990 ACFT/MO	1991 CFS	1991 ACFT/MO	1992 CFS	1992 ACFT/MO	1993 CFS	1993 ACFT/MO	1994 CFS	1994 ACFT/MO	1995 CFS	1995 ACFT/MO	1996 CFS	1996 ACFT/MO	CFS MO/AVG	ACFT MO/AVG
JAN	32	1,967	34	2,090	39	2,397	300	18,441	35	2,151	66	4,057	31	1,906	77	4,716
FEB	33	1,832	33	1,832	68	3,775	240	13,325	35	1,943	200	11,104	33	1,832	92	5,092
MAR	43	2,643	90	5,532	242	14,876	95	5,840	62	3,811	250	15,368	33	2,029	116	7,157
APR	28	1,666	30	1,785	30	1,785	35	2,083	25	1,488	48	2,856	25	1,488	32	1,879
MAY	20	1,229	25	1,537	32	1,967	22	1,352	20	1,229	26	1,598	17	1,045	23	1,422
JUN	17	1,012	18	1,071	20	1,190	20	1,190	16	952	25	1,488	14	833	19	1,105
JUL	19	1,168	17	1,045	22	1,352	18	1,106	15	922	19.5	1,199	15	922	18	1,102
AUG	15	922	21.5	1,322	22	1,352	17	1,045	14	861	24	1,475	13	799	18	1,111
SEP	19	1,131	20	1,190	22	1,309	23	1,369	24	1,428	25	1,488	20	1,190	22	1,301
OCT	24	1,475	21	1,291	17.5	1,076	27	1,660	27	1,660	27	1,660	22	1,352	24	1,453
NOV	31	1,845	30	1,785	22.5	1,339	32.5	1,934	26	1,547	28	1,666	28	1,666	28	1,683
DEC	33	2,029	31	1,906	42.5	2,612	35	2,151	45	2,766	30	1,844	29	1,783	35	2,156
ACFT/YR		18,920		22,390		35,030		51,500		20,760		45,800		16,840		

7 DAY LOW FLOW YEARLY AVERAGE: 30,180

USGS GAUGING STATION # 09505350
WET BEAVER CREEK NEAR RIMROCK-7 DAY LOW FLOW

MONTH	1990 CFS	1990 ACFT/MO	1991 CFS	1991 ACFT/MO	1992 CFS	1992 ACFT/MO	1993 CFS	1993 ACFT/MO	1994 CFS	1994 ACFT/MO	1995 CFS	1995 ACFT/MO	1996 CFS	1996 ACFT/MO	CFS MO/AVG	ACFT MO/AVG
JAN	7.2	443	7.5	461	10	615	120	7,376	6	369	10	615	7.2	443	24	1,475
FEB	7.2	400	7.3	405	30	1,666	55	3,054	7	389	45	2,498	7.7	428	23	1,263
MAR	9	553	60	3,688	100	6,147	125	7,684	30	1,844	7.5	461	7.2	443	48	2,974
APR	9	536	6.6	393	9	536	9	536	8	476	10	595	6	357	8	490
MAY	6.6	406	6.2	381	6.9	424	5	307	5.2	320	6.2	381	5.9	363	6	369
JUN	6.1	363	6.2	369	6.5	387	5	298	4.5	268	5.8	345	5	298	6	333
JUL	6.3	387	6.1	375	6	369	5.9	363	5.3	326	6.3	387	5.3	326	6	362
AUG	6.1	375	6.2	381	7.3	449	6.2	381	6	369	6.5	400	6.7	412	6	395
SEP	7.5	446	6.25	372	7	417	7.5	446	5.3	315	6.4	381	6.2	369	7	392
OCT	6.7	412	7.2	443	6.8	418	6	369	5.3	326	6.3	387	6.3	387	6	392
NOV	7.2	428	7.6	452	7.2	428	7.5	446	7.2	428	6.2	369	6.6	393	7	421
DEC	7.3	449	9	553	7.9	486	6	369	8	492	7.2	443	7	430	7	460
ACFT/YR		5,200		8,270		12,340		21,630		5,920		7,260		4,650		

7 DAY LOW FLOW YEARLY AVERAGE: 9,324

USGS GAUGING STATION # 09505800
WEST CLEAR CREEK NEAR CAMP VERDE-7 DAY LOW FLOW

	1990		1991		1992		1993		1994		1995		1996			
MONTH	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS MO/AVG	ACFT MO/AVG
JAN	17	1,045	18	1,106	21	1,291	78	4,795	18	1,106	20	1,229	17	1,045	27	1,660
FEB	17	944	18	999	61	3,387	82	4,553	19	1,055	73	4,053	17	944	41	2,276
MAR	18	1,106	84	5,163	165	10,143	250	15,368	77	4,733	24	1,475	17	1,045	91	5,576
APR	17	1,012	30	1,785	26	1,547	27.5	1,636	22	1,309	22	1,309	16	952	23	1,364
MAY	15	922	17	1,045	21	1,291	18	1,106	19	1,168	18	1,106	14	861	17	1,071
JUN	14	833	16	952	15	893	17	1,012	17	1,012	16	952	14	833	16	927
JUL	15	922	16	984	15	922	16	984	16	984	12	738	15	922	15	922
AUG	16	984	14	861	16	984	17	1,045	17	1,045	12	738	16	984	15	949
SEP	16	952	15	893	17	1,012	17	1,012	17	1,012	15	893	15	893	16	952
OCT	16	984	16	984	16	984	18	1,106	17	1,045	14	861	16	984	16	993
NOV	16	952	16	952	17	1,012	18	1,071	18	1,071	16	952	16	952	17	995
DEC	17	1,045	19	1,168	19	1,168	20	1,229	19	1,168	17	1,045	17	1,045	18	1,124
ACFT/YR		11,700		16,890		24,634		34920		16,710		15,350		11,460		

7 DAY LOW FLOW YEARLY AVERAGE: 18,809

USGS GAUGING STATION # 09506000
VERDE RIVER NEAR CAMP VERDE- 7 DAY LOW FLOW

	1989		1990		1991		1992		1993		1994		1995		1996			
MONTH	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS MO/AVG	ACFT/MO AVG
JAN	203	12,478	206	12,662	212	13,031	240	14,753	1153	70,874	218	13,400	321	19,731	210	12,908	345	21,229
FEB	208	11,548	192	10,659	147	8,161	312	17,322	956	53,077	226	12,547	675	37,476	194	10,770	364	20,195
MAR	127	7,806	211	12,970	489	30,058	1139	70,014	961	59,072	334	20,530	339	20,838	141	8,667	467	28,744
APR	103	6,128	133	7,913	162	9,639	114	6,783	147	8,746	140	8,330	163	9,698	98	5,831	132	7,883
MAY	85	5,224	82	5,040	74	4,548	100	6,147	131	8,052	108	6,638	131	8,052	80	4,917	98	6,077
JUN	55	3,272	48	2,856	66	3,927	76	4,522	87	5,176	65	3,867	71	4,224	52	3,094	65	3,867
JUL	50	3,073	162	9,958	53	3,257	62	3,811	66	4,057	44	2,704	77	4,733	57	3,503	71	4,387
AUG	126	7,745	107	6,577	89	5,470	106	6,516	82	5,040	60	3,688	74	4,548	64	3,934	88	5,439
SEP	76	4,522	152	9,044	90	5,355	110	6,545	110	6,545	112	6,664	132	7,854	135	8,032	114	6,820
OCT	92	5,655	136	8,359	89	5,470	112	6,885	163	10,019	119	7,314	129	7,929	112	6,884	119	7,314
NOV	157	9,341	199	11,840	156	9,282	186	11,067	178	10,591	170	10,115	182	10,829	170	10,115	174	10,397
DEC	199	12,232	197	12,109	202	12,416	210	12,909	240	14,752	223	13,707	197	12,109	192	11,802	207	12,754
ACFT/YR		89,029		109,990		110,620		167,270		256,010		109,510		148,030		90,460		

7 DAY LOW FLOW YEARLY AVERAGE 135,110

USGS GAUGING STATION # 09507500
FOSSIL CREEK DIV NR CHILDS-7 DAY LOW FLOW

	1990		1991		1992		1993		1994		1995		1996			
MONTH	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS MO/AVG	ACFT MO/AVG
JAN	42	2,582	42	2,581	41	2,520	41	2,520	39	2,397	37	2,274	39	2,397	40	2,467
FEB	43	2,387	44	2,442	41	2,276	20	1,110	39	2,165	39	2,165	38	2,109	38	2,093
MAR	44	2,705	41.5	2,551	41	2,520	16	983	38	2,335	39	2,397	39	2,397	37	2,269
APR	20	1,190	42	2,499	42	2,499	34	2,023	17	1,011	39	2,320	40	2,380	33	1,988
MAY	42	2,582	39	2,397	41.5	2,551	36	2,212	39	2,397	37	2,274	39	2,397	39	2,401
JUN	44	2,618	43	2,558	43	2,558	32	1,904	38	2,261	38	2,261	39	2,320	40	2,354
JUL	43	2,643	43	2,643	42	2,581	39	2,398	38	2,335	37	2,274	38	2,335	40	2,458
AUG	42	2,582	37	2,274	41.5	2,551	40	2,458	38	2,335	36	2,212	38	2,335	39	2,392
SEP	42	2,499	41	2,439	36	2,142	39	2,320	37	2,201	38	2,261	38	2,261	39	2,303
OCT	42	2,582	36	2,212	36	2,212	38.5	2,366	20	1,229	26	1,598	38	2,335	34	2,076
NOV	42	2,499	11	654	11	654	39	2,320	38	2,261	38	2,261	39	2,320	31	1,852
DEC	42	2,582	39.5	2,428	41	2,520	40	2,458	37	2,274	37	2,274	39	2,397	39	2,419
ACFT/YR		29,450		27,680		27,590		25,080		25,210		26,570		27,990		

7 DAY LOW FLOW YEARLY AVERAGE: 27,080

USGS GAUGING STATION # 09507980
EAST VERDE RIVER NEAR CHILDS- 7 DAY LOW FLOW

	1990		1991		1992		1993		1994		1995		1996			
MONTH	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS MO/AVG	ACFT MO/AVG
JAN	9	553	9.5	583	50	3,073	230	14,138	27	1,659	60	3,688	22	1,352	58	3,578
FEB	8.5	471	8	444	27	1,499	125	6,940	25	1,388	130	7,217	22	1,221	49	2,740
MAR	8	491	57	3,503	150	9,220	145	8,913	30	1,844	62	3,811	10	614	66	4,057
APR	5	297	28	1,666	33.5	1,993	60	3,570	30	1,785	36	2,142	5.5	327	28	1,683
MAY	8	491	19	1,167	17	1,044	37.5	2,305	24	1,475	30	1,844	2	122	20	1,207
JUN	4	238	8	476	7.5	446	17	1,011	12	714	22	1,309	0.4	24	10	603
JUL	4	245	0.5	31	6	368	15	922	8	491	11	676	0.55	34	6	395
AUG	5	307	1	61	30	1,844	25	1,536	6	369	10	614	1.5	93	11	689
SEP	8	476	2.5	148	6	357	20	1,190	20	1,190	6	357	5	297	10	574
OCT	3.5	215	0.5	31	5.5	338	25	1,536	20	1,229	19	1,167	2.5	153	11	667
NOV	4.5	267	5.5	328	11	654	32	1,904	25	1,487	24	1,428	4.5	268	15	905
DEC	4.5	276	9.5	583	15.5	952	33	2,029	25	1,536	25	1,537	6.1	374	17	1,041
ACFT/YR		4,330		9,020		21,790		46,000		15,170		25,790		4,880		

7 DAY LOW FLOW YEARLY AVERAGE: 18,140

USGS GAUGING STATION #09508500
VERDE RIVER BELOW TANGLE CREEK- 7 DAY LOW FLOW

	1990		1991		1992		1993		1994		1995		1996			
MONTH	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS	ACFT/MO	CFS MO/AVG	ACFT MO/AVG
JAN	269	16,535	298	18,318	410	25,203	1750	107,573	312	19,179	570	35,038	290	17,826	557	34,239
FEB	295	16,378	260	14,435	420	23,318	1950	108,264	310	17,211	1000	55,520	266	14,768	643	35,699
MAR	285	17,519	590	36,267	1000	61,470	1500	92,205	475	29,198	490	30,120	228	14,015	653	40,113
APR	201	11,960	260	15,470	245	14,578	300	17,850	225	13,388	237	14,102	170	10,115	234	13,923
MAY	122	7,499	165	10,143	212	13,032	265	16,290	200	12,294	188	11,556	117	7,192	181	11,144
JUN	95	5,653	142	8,449	130	7,735	150	8,925	120	7,140	170	10,115	102	6,069	130	7,727
JUL	200	12,294	107	6,577	107	6,577	115	7,069	110	6,762	140	8,606	82	5,041	123	7,561
AUG	125	7,684	130	7,991	187	11,495	175	10,757	140	8,606	119	7,315	119	7,315	142	8,738
SEP	220	13,090	155	9,223	190	11,305	177	10,532	186	11,067	190	11,305	210	12,495	190	11,288
OCT	180	11,065	152	9,343	185	11,372	180	11,065	187	11,495	187	11,495	162	9,958	176	10,828
NOV	212	12,614	220	13,090	252	14,994	267	15,887	250	14,875	257	15,292	209	12,436	238	14,170
DEC	226	13,892	283	17,396	286	17,580	315	19,363	306	18,810	275	16,904	249	15,306	277	17,036
ACFT/YR		146,180		166,700		218,660		425,780		170,020		227,370		132,540		

7 DAY LOW FLOW YEARLY AVERAGE: 212,464

TABLE C.5

TOTAL SURFACE FLOW DATA

USGS GAGING STATION # 09503700 VERDE RIVER NR PAULDEN		June 7 Day Low 1966-1996	Total Flow 1966-1996
YEAR	CFS	ACFT/YR	ACFT/YR
1966	21	15204	20900
1967	21	15204	18600
1968	22	15928	21060
1969	22	15928	18950
1970	22	15928	18570
1971	21	15204	18950
1972	23	16652	28710
1973	24	17376	44240
1974	23	16652	18050
1975	25	18100	18490
1976	22	15928	24440
1977	22	15928	18460
1978	21	15204	70890
1979	24	17376	39830
1980	25	18100	106700
1981	25	18100	21540
1982	25	18100	22990
1983	25	18100	62650
1984	24	17376	24980
1985	26	18824	24260
1986	25	18100	20480
1987	26	18824	20420
1988	26	18824	21430
1989	25	18100	18720
1990	24	17376	18920
1991	22	15928	25650
1992	24	17376	23150
1993	27	19548	156040
1994	26	18824	20590
1995	27	19548	40020
1996	25	18100	19530
AVERAGE	24	17280	33170
MEDIAN	24	17376	21430

USGS GAGING STATION # 09504000 VERDE RIVER NR CLARKDALE		June 7 Day Low 1966-1996	Total Flow 1966-1996
YEAR	CFS	ACFT/YR	ACFT/YR
1966	70	50680	141900
1967	65	47060	58420
1968	71	51404	85400
1969	77	55748	114500
1970	72	52128	64990
1971	74	53576	76150
1972	72	52128	133100
1973	75	54300	230500
1974	63	45612	61240
1975	71	51404	69610
1976	71	51404	108200
1977	78	56472	58630
1978	63	45612	309600
1979	81	58644	182500
1980	87	62988	324700
1981	75	54300	62390
1982	78	56472	161000
1983	81	58644	216700
1984	78	56472	82930
1985	83	60092	122700
1986	88	63712	95470
1987	92	66608	105500
1988	76	55024	112300
1989	76	55024	59390
1990	72	52128	64620
1991	77	55748	113400
1992	80	57920	139800
1993	89	64436	457900
1994	82	59368	64880
1995	83	60092	188000
1996	77	55748	63660
AVERAGE	77	55510	133230
MEDIAN	77	55748	108200

USGS GAGING STATION # 09504500 OAK CREEK-CORNVILLE		June 7 Day Low 1966-1996	Total Flow 1966-1996
YEAR	CFS	ACFT/YR	ACFT/YR
1966	17	12308	100600
1967	20	14480	27070
1968	17	12308	49660
1969	17	12308	82570
1970	17	12308	53670
1971	19	13756	35310
1972	22	15928	77150
1973	22	15928	123400
1974	16	11584	26480
1975	20	14480	42700
1976	18	13032	63190
1977	25	18100	24130
1978	17	12308	182400
1979	19	13756	87620
1980	17	12308	146300
1981	17	12308	27330
1982	19	13756	115700
1983	15	10860	113900
1984	15	10860	31530
1985	21	15204	74930
1986	22	15928	51030
1987	17	12308	54340
1988	20	14480	46760
1989	16	11584	22510
1990	17	12308	23670
1991	18	13032	59180
1992	21	15204	88600
1993	19	13756	170100
1994	14	10136	29140
1995	24	17376	122000
1996	14	10136	18500
AVERAGE	18	13360	70050
MEDIAN	18	13030	54340

USGS GAGING STATION # 09505200 WET BEAVER CREEK		June 7 day Low 1966-1981 1992-1996	Total Flow 1966-1981 1992-1996
YEAR	CFS	ACFT/YR	ACFT/YR
1966	7	5068	20710
1967	7	5068	7430
1968	6	4344	30050
1969	7	5068	26750
1970	7	5068	12020
1971	6	4344	15080
1972	11	7964	28380
1973	7	5068	52770
1974	7	5068	6840
1975	8	5792	18200
1976	7	5068	22250
1977	7	5068	5490
1978	7	5068	63950
1979	6	4344	35130
1980	7	5068	49330
1981	7	5068	8210
1982	NO DATA COLLECTED DURING THIS TIME FRAME		
1983			
1984			
1985			
1986			
1987			
1988			
1989			
1990			
1991			
1992	6	4344	31490
1993	7	5068	64630
1994	5	3620	8570
1995	6	4344	29420
1996	6	4344	5940
AVERAGE	7	4970	25840
MEDIAN	7	5070	22250

USGS GAGING STATION # 09505800 WEST CLEAR CK NR CAMP VERDE		June 7 Day Low 1966-1996	Total Flow 1966-1996
YEAR	CFS	ACFT/YR	ACFT/YR
1966	14	10136	35110
1967	17	12308	12510
1968	15	10860	56350
1969	13	9412	44220
1970	13	9412	15080
1971	16	11584	28940
1972	21	15204	54420
1973	18	13032	104200
1974	14	10136	13270
1975	33	23892	33970
1976	16	11584	38870
1977	14	10136	11940
1978	18	13032	128700
1979	22	15928	67950
1980	17	12308	98810
1981	15	10860	14370
1982	20	14480	85660
1983	16	11584	96910
1984	25	18100	31890
1985	16	11584	44790
1986	15	10860	24460
1987	16	11584	47100
1988	16	11584	33790
1989	14	10136	15740
1990	15	10860	12880
1991	17	12308	53240
1992	23	16652	60950
1993	17	12308	133400
1994	17	12308	22800
1995	16	11584	52914
1996	14	10136	13640
AVERAGE	**17**	**12450**	**48030**
MEDIAN	**16**	**11584**	**38870**

USGS GAGING STATION # 09506000 VERDE NR CAMP VERDE		June 7 Day Low 1989-1997	Total Flow 1989-1997
YEAR	CFS	ACFT/YR	ACFT/YR
1989	55	39809	112700
1990	48	34742	138000
1991	66	47770	295500
1992	76	55008	395000
1993	87	62970	990100
1994	65	47047	143500
1995	71	51389	504500
1996	52	37637	117500
1997	51	36914	92077
AVERAGE	**57**	**45920**	**309880**
MEDIAN	**65**	**47047**	**143500**

USGS GAGING STATION # 09507500 FOSSIL CREEK DIV NEAR CHILDS			
		June 7 Day Low 1966-1996	Total Flow 1966-1996
YEAR	CFS	ACFT/YR	ACFT/YR
1966	44	31856	32080
1967	42	30408	30520
1968	22	15928	31410
1969	40	28960	30290
1970	38	27512	30420
1971	41	29684	31500
1972	42	30408	31840
1973	40	28960	30480
1974	42	30408	31400
1975	27	19548	31180
1976	42	30408	31440
1977	40	28960	30290
1978	42	30408	32660
1979	45	32580	33190
1980	38	27512	28410
1981	42	30408	30880
1982	43	31132	31590
1983	46	33304	33970
1984	42	30408	32170
1985	43	31132	33050
1986	45	32580	32720
1987	42	30408	31550
1988	36	26064	31670
1989	40	28960	29580
1990	39	28236	30290
1991	30	21720	28070
1992	39	28236	30410
1993	32	23168	25550
1994	35	25210	25960
1995	36	26064	27990
1996	38	27512	28710
AVERAGE	39	28330	30690
MEDIAN	40	28960	31180

USGS GAGING STATION # 09507980 EAST VERDE RIVER NEAR CHILDS			
		June 7 Day Low 1967-1996	Total Flow 1967-1996
YEAR	CFS	ACFT/YR	ACFT/YR
1967	15	10860	n/a
1968	35	25340	56000
1969	30	21720	47500
1970	26	18824	36670
1971	2	1448	13970
1972	2	1448	43620
1973	47	34028	103000
1974	21	15204	15640
1975	26	18824	26020
1976	25	18100	50380
1977	13	9412	6480
1978	27	19548	132100
1979	42	30408	92980
1980	43	31132	132300
1981	19	13756	17000
1982	26	18824	65660
1983	46	33304	95500
1984	12	8688	39970
1985	10	7240	43190
1986	16	11584	23890
1987	17	12308	31390
1988	21	15204	37370
1989	13	9412	19040
1990	7	5068	10110
1991	8	5792	50170
1992	32	23168	78000
1993	17	12308	208800
1994	15	10860	23540
1995	22	15928	87730
1996	1	724	6320
AVERAGE	21	15350	54980
MEDIAN	20	14480	43190

USGS GAGING STATION # 09508500
VERDE RIVER BELOW TANGLE CREEK

		June 7 Day Low 1966-1996	Total Flow 1966-1996
YEAR	CFS	ACFT/YR	ACFT/YR
1966	125	90500	473500
1967	200	144800	212100
1968	150	108600	437600
1969	122	88328	453200
1970	119	86156	281400
1971	103	74572	237600
1972	155	112220	518700
1973	210	152040	876500
1974	112	81088	174500
1975	135	97740	259600
1976	132	95568	397700
1977	140	101360	157800
1978	130	94120	1261000
1979	215	155660	676500
1980	170	123080	1168000
1981	155	112220	212400
1982	147	106428	743600
1983	200	144800	921400
1984	145	104980	308900
1985	140	101360	479000
1986	150	108600	328100
1987	140	101360	388300
1988	140	101360	399100
1989	115	83260	175100
1990	110	79640	184000
1991	142	102808	473000
1992	150	108600	650500
1993	190	137560	1582000
1994	125	90500	219000
1995	150	108600	747500
1996	100	72400	156300
AVERAGE	146	105490	501740
MEDIAN	140	101360	399100

TABLE C.6

TOTAL FLOW & 7 DAY LOW FLOW COMPARISON DATA

Gaging Station Flow Data

VERDE RIVER NEAR PAULDEN USGS #90503700

*7 DAY DAY LOW FLOWS DETERMINED ON A MONTH BY MONTH BASIS, EACH YEAR

YEAR	7 DAY LOW ACFT/YR	TOTAL FLOW ACFT/YR
1990	18549	18920
1991	17218	25650
1992	17711	23150
1993	20590	156040
1994	20417	20590
1995	19942	40020
1996	18932	19530

VERDE RIVER NEAR CLARKDALE USGS #09504000

*7 DAY DAY LOW FLOWS DETERMINED ON A MONTH BY MONTH BASIS, EACH YEAR

YEAR	7 DAY LOW AC/FT	TOTAL FLOW AC/FT
1990	57738	64620
1991	61539	113400
1992	71365	139800
1993	97018	457900
1994	61557	64880
1995	70905	188000
1996	58244	63660

OAK CREEK NEAR CORNVILLE USGS #09504500

*7 DAY DAY LOW FLOWS DETERMINED ON A MONTH BY MONTH BASIS, EACH YEAR

YEAR	7 DAY LOW AC/FT	TOTAL FLOW AC/FT
1990	18918	23670
1991	22385	59180
1992	35031	88600
1993	51495	170100
1994	20758	29140
1995	45802	122000
1996	16844	18500

Gaging Station Flow Data

WET BEAVER CREEK NEAR RIMROCK USGS #09505200

*7 DAY DAY LOW FLOWS DETERMINED ON A MONTH BY MONTH BASIS, EACH YEAR

YEAR	7 DAY LOW AC/FT	TOTAL FLOW AC/FT
1990		
1991		
1992	12339	31490
1993	12340	64630
1994	5921	8570
1995	7262	29420
1996	4647	5940

WEST CLEAR CREEK USGS #09505800

*7 DAY DAY LOW FLOWS DETERMINED ON A MONTH BY MONTH BASIS, EACH YEAR

YEAR	7 DAY LOW AC/FT	TOTAL FLOW AC/FT
1990	11700	12880
1991	16891	53240
1992	24631	60590
1993	34916	133400
1994	16707	22800
1995	15350	52914
1996	11458	13640

VERDE RIVER NEAR CAMP VERDE USGS #09506000

*7 DAY DAY LOW FLOWS DETERMINED ON A MONTH BY MONTH BASIS, EACH YEAR

YEAR	7 DAY LOW AC/FT	TOTAL FLOW AC/FT
1990	89029	138000
1991	109992	295500
1992	167274	395000
1993	256006	990100
1994	109510	143500
1995	148026	504500
1996	90462	117500

Gaging Station Flow Data

FOSSIL CREEK NEAR DIVERSION USGS #09507500

*7 DAY DAY LOW FLOWS DETERMINED ON A MONTH BY MONTH BASIS, EACH YEAR

YEAR	7 DAY LOW AC/FT	TOTAL FLOW AC/FT
1990	29449	30290
1991	27683	28070
1992	27587	30410
1993	25076	25550
1994	25206	25960
1995	26574	27990
1996	27988	28710

EAST VERDE NEAR CHILDS USGS #09507980

*7 DAY DAY LOW FLOWS DETERMINED ON A MONTH BY MONTH BASIS, EACH YEAR

YEAR	7 DAY LOW AC/FT	TOTAL FLOW AC/FT
1990	4333	10110
1991	9025	50170
1992	21793	78000
1993	45996	208800
1994	15171	23540
1995	25793	87730
1996	4882	6320

VERDE BELOW TANGLE CREEK USGS #095085000

*7 DAY DAY LOW FLOWS DETERMINED ON A MONTH BY MONTH BASIS, EACH YEAR

YEAR	7 DAY LOW AC/FT	TOTAL FLOW AC/FT
1990	146183	184000
1991	166703	473000
1992	218659	650500
1993	425778	1582000
1994	170024	219000
1995	227367	747500
1996	132536	156300

TABLE C.7

AVERAGE MONTHLY FLOW DATA

USGS # 09503700 VERDE RIVER NEAR PAULDEN

AVERAGE MONTHLY FLOW

MONTH	AVERAGE TOTAL FLOW (1964-94) CFS	AVERAGE TOTAL FLOW (1964-94) ACFT/MO	AVERAGE 7 DAY LOW FLOW (1990-96) CFS	AVERAGE 7 DAY LOW FLOW (1990-96) ACFT/MO	AVERAGE TOTAL FLOW (1990-96) ACFT/MO
JAN	65	3,996	26	1,581	9,093
FEB	128	7,107	27	1,507	14,327
MAR	78	4,795	27	1,686	5,121
APR	78	4,641	26	1,551	1,699
MAY	25	1,537	26	1,572	1,626
JUN	25	1,488	25	1,496	1,509
JUL	26	1,598	24	1,510	1,696
AUG	31	1,906	26	1,572	1,794
SEP	31	1,845	25	1,496	1,571
OCT	32	1,967	26	1,581	1,606
NOV	32	1,904	26	1,556	1,583
DEC	44	2,705	26	1,625	1,713

TOTAL FLOW

MONTH	1990	1991	1992	1993	1994	1995	1996
JAN	1,590	1,540	1,460	52,940	1,710	2,730	1,680
FEB	1,450	1,390	3,960	80,140	1,580	10,170	1,600
MAR	1,650	9,370	2,260	7,580	1,730	11,580	1,680
APR	1,490	2,020	1,720	1,580	1,690	1,810	1,580
MAY	1,600	1,410	1,500	1,710	1,760	1,820	1,580
JUN	1,450	1,330	1,440	1,630	1,560	1,640	1,510
JUL	1,910	1,340	1,500	1,660	1,630	1,590	2,240
AUG	1,650	1,400	2,760	1,820	1,890	1,560	1,480
SEP	1,560	1,410	1,530	1,720	1,770	1,540	1,470
OCT	1,540	1,460	1,590	1,770	1,670	1,660	1,550
NOV	1,490	1,470	1,400	1,740	1,760	1,660	1,560
DEC	1,540	1,510	2,030	1,750	1,840	1,720	1,600

USGS # 09504000 VERDE RIVER NEAR CLARKDALE

AVERAGE MONTHLY FLOW

MONTH	AVERAGE TOTAL FLOW (1966-94) CFS	AVERAGE TOTAL FLOW (1966-94) ACFT/MO	AVERAGE 7 DAY LOW FLOW (1990-96) CFS	AVERAGE 7 DAY LOW FLOW (1990-96) ACFT/MO	AVERAGE TOTAL FLOW (1990-96) ACFT/MO
JAN	226	13,892	105	6,428	30,434
FEB	501	27,815	134	7,440	43,134
MAR	517	31,780	150	9,203	28,736
APR	194	30,762	86	5,092	9,317
MAY	90	5,532	82	5,067	5,379
JUN	77	5,355	77	4,599	4,774
JUL	106	6,516	78	4,821	5,389
AUG	104	6,393	78	4,812	6,120
SEP	106	6,188	80	4,786	5,576
OCT	121	7,438	81	4,953	5,061
NOV	134	7,200	83	4,956	5,071
DEC	213	13,093	86	5,295	6,850

TOTAL FLOW

MONTH	1990	1991	1992	1993	1994	1995	1996
JAN	5,180	5,180	5,940	172,200	5,710	13,330	5,500
FEB	4,640	4,590	25,600	188,900	5,140	68,030	5,040
MAR	7,360	38,500	43,440	44,590	5,930	56,170	5,160
APR	5,170	25,330	7,980	8,420	5,420	8,020	4,880
MAY	4,780	4,950	6,290	5,750	5,440	5,460	4,980,
JUN	4,320	4,650	4,800	5,280	4,860	4,930	4,580
JUL	6,530	5,120	5,180	5,160	4,890	5,150	5,690
AUG	6,560	5,230	9,650	5,890	5,110	5,410	4,990
SEP	5,190	4,760	4,980	5,130	6,890	5,370	6,710
OCT	4,950	4,830	5,100	5,460	4,990	5,280	4,820
NOV	4,860	4,940	5,080	5,450	5,040	5,300	4,830
DEC	5,080	5,330	15,700	5,700	5,460	5,540	5,140

USGS # 09504500 OAK CREEK NEAR CORNVILLE

AVERAGE MONTHLY FLOW

MONTH	AVERAGE TOTAL FLOW (1949-94) CFS	AVERAGE TOTAL FLOW (1949-94) ACFT/MO	AVERAGE 7 DAY LOW FLOW (1990-96) CFS	AVERAGE 7 DAY LOW FLOW (1990-96) ACFT/MO	AVERAGE TOTAL FLOW (1990-96) ACFT/MO
JAN	104	6,393	77	4,715	14,997
FEB	180	9,994	92	5,092	19,499
MAR	245	15,060	117	7,174	16,901
APR	171	14,578	32	1,878	5,763
MAY	33	2,029	23	1,422	1,717
JUN	21	1,964	19	1,113	1,127
JUL	24	1,475	18	1,111	1,196
AUG	35	2,151	18	1,111	1,763
SEP	40	2,083	22	1,301	1,780
OCT	48	2,951	24	1,453	1,647
NOV	66	2,856	28	1,683	1,914
DEC	119	7,315	35	2,164	4,817

TOTAL FLOW

MONTH	1990	1991	1992	1993	1994	1995	1996
JAN	2,000	4,500	****	80,180	2,170	9,050	1,980
FEB	1,900	1,970	****	60,970	2,810	47,780	1,890
MAR	5,250	22,200	****	12,580	6,840	43,560	2,060
APR	2,370	16,900	****	2,910	3,240	8,200	1,490
MAY	1,310	1,490	****	1,580	2,030	1,780	1,120
JUN	1,030	1,130	****	1,220	863	1,390	853
JUL	1,180	1,180	****	1,130	926	1,200	946
AUG	1,280	1,330	****	1,410	889	1,990	1,050
SEP	1,740	1,360	****	1,550	2,040	1,860	2,210
OCT	1,540	1,470	****	2,050	1,870	1,680	1,360
NOV	2,000	2,350	****	2,320	1,960	1,690	1,730
DEC	2,080	3,300	****	2,200	3,500	1,820	1,820

USGS # 09505200 WET BEAVER CREEK

AVERAGE MONTHLY FLOW

MONTH	AVERAGE TOTAL FLOW (1962-94) CFS	AVERAGE TOTAL FLOW (1962-94) ACFT/MO	AVERAGE 7 DAY LOW FLOW (1990-96) CFS	AVERAGE 7 DAY LOW FLOW (1990-96) ACFT/MO	AVERAGE TOTAL FLOW (1990-96) ACFT/MO
JAN	55	3,381	24	1,475	8,250
FEB	77	4,275	23	1,263	6,719
MAR	115	7,069	48	2,975	7,212
APR	77	6,843	8	496	1,074
MAY	12	738	6	377	396
JUN	7	714	5	307	340
JUL	9	523	5	297	399
AUG	12	738	6	395	1,286
SEP	11	714	7	392	587
OCT	17	1,045	6	392	404
NOV	16	1,012	7	421	477
DEC	39	2,397	8	468	1,723

TOTAL FLOW

MONTH	1990	1991	1992	1993	1994	1995	1996
JAN	****	****	2,100	36,970	370	1,360	448
FEB	****	****	4,910	12,500	970	14,770	445
MAR	****	****	12,080	10,750	3,440	9,340	450
APR	****	****	2,570	848	721	829	402
MAY	****	****	440	359	422	392	366
JUN	****	****	413	329	269	354	336
JUL	****	****	549	370	323	398	355
AUG	****	****	4,610	385	373	418	637
SEP	****	****	419	596	346	384	1,190
OCT	****	449	420	424	352	388	391
NOV	****	456	430	737	430	371	435
DEC	****	1,050	2,560	369	5,460	419	482

USGS # 09505800 WEST CLEAR CREEK NEAR CAMP VERDE

AVERAGE MONTHLY FLOW

MONTH	AVERAGE TOTAL FLOW (1966-94) CFS	ACFT/MO	AVERAGE 7 DAY LOW FLOW (1990-96) CFS	ACFT/MO	AVERAGE TOTAL FLOW (1990-96) ACFT/MO
JAN	88	5,409	27	1,660	11,520
FEB	149	8,272	41	2,276	10,460
MAR	215	13,216	91	5,576	13,341
APR	112	12,793	23	1,364	4,028
MAY	27	1,660	17	1,071	1,199
JUN	16	1,607	16	926	983
JUL	18	1,106	15	922	999
AUG	22	1,352	15	948	1,829
SEP	22	1,309	16	952	1,287
OCT	35	2,151	16	996	1,021
NOV	30	2,083	17	1,003	1,317
DEC	97	5,963	18	1,124	1,991

TOTAL FLOW

MONTH	1990	1991	1992	1993	1994	1995	1996
JAN	1,070	2,070	3,810	69,820	1,130	1,620	1,120
FEB	988	1,050	12,800	30,040	2,320	24,970	1,050
MAR	1,590	27,280	19,590	18,160	8,840	16,840	1,090
APR	1,070	13,810	5,250	4,110	1,680	1,310	966
MAY	934	1,220	1,610	1,300	1,220	1,200	910
JUN	871	984	1,150	1,040	1,010	994	833
JUL	1,010	1,020	1,010	1,000	1,050	908	992
AUG	1,030	952	6,250	1,170	1,070	1,020	1,310
SEP	1,260	938	1,050	1,400	1,050	1,050	2,260
OCT	966	998	1,030	1,150	1,090	906	1,010
NOV	994	1,090	1,030	2,990	1,140	986	992
DEC	1,100	1,830	6,370	1,220	1,200	1,110	1,110

USGS # 09506000 VERDE RIVER NEAR CAMP VERDE

AVERAGE MONTHLY FLOW

MONTH	AVERAGE TOTAL FLOW (1966-94) CFS	AVERAGE TOTAL FLOW (1966-94) ACFT/MO	AVERAGE 7 DAY LOW FLOW (1990-96) CFS	AVERAGE 7 DAY LOW FLOW (1990-96) ACFT/MO	AVERAGE TOTAL FLOW (1990-96) ACFT/MO
JAN	719	44,197	345	21,230	79,783
FEB	1,210	67,179	364	20,195	94,689
MAR	1,500	92,205	468	28,745	83,974
APR	726	89,250	133	7,884	26,429
MAY	137	8,421	99	6,078	8,066
JUN	86	8,152	65	3,868	5,323
JUL	112	6,885	71	4,387	6,517
AUG	223	13,708	88	5,440	12,527
SEP	237	13,269	115	6,820	12,173
OCT	198	12,171	119	7,315	8,961
NOV	210	11,781	175	10,398	12,097
DEC	325	19,978	207	12,755	18,614

TOTAL FLOW

MONTH	1990	1991	1992	1993	1994	1995	1996
JAN	13,060	21,960	23,420	440,000	13,930	32,900	13,210
FEB	11,570	9,970	75,760	342,100	15,420	196,000	12,000
MAR	19,550	122,600	131,000	105,500	29,130	169,500	10,540
APR	11,460	78,190	26,540	23,740	12,300	25,740	7,030
MAY	6,050	5,520	10,120	8,910	10,190	10,350	5,320
JUN	3,900	5,230	7,330	6,260	4,210	6,030	4,300
JUL	12,760	4,760	6,860	4,360	4,080	5,520	7,280
AUG	10,380	6,320	37,850	9,070	6,900	10,810	6,360
SEP	14,390	7,030	8,360	8,320	12,360	14,670	20,080
OCT	9,700	6,550	8,730	11,660	8,660	9,060	8,370
NOV	12,910	11,480	11,540	15,080	11,430	11,220	11,020
DEC	12,240	15,890	47,470	15,060	14,870	12,770	12,000

USGS # 09507500 FOSSIL CREEK DIV. TO CHILDS NEAR CHILDS

AVERAGE MONTHLY FLOW

MONTH	AVERAGE TOTAL FLOW (1985-96) CFS	ACFT/MO	AVERAGE 7 DAY LOW FLOW (1990-96) CFS	ACFT/MO	AVERAGE TOTAL FLOW (1990-96) ACFT/MO
JAN	42	2,581	40	2,467	2,497
FEB	41	2,265	38	2,093	2,150
MAR	40	2,434	37	2,270	2,308
APR	36	2,356	33	1,989	2,094
MAY	42	2,560	39	2,401	2,440
JUN	42	2,478	40	2,354	2,383
JUL	42	2,593	40	2,459	2,492
AUG	42	2,589	39	2,392	2,427
SEP	42	2,506	39	2,303	2,370
OCT	41	2,493	38	2,076	2,668
NOV	39	2,413	31	1,853	1,904
DEC	41	2,524	39	2,419	2,530

TOTAL FLOW

MONTH	1990	1991	1992	1993	1994	1995	1996
JAN	2,610	2,620	2,530	2,526	2,422	2,330	2,450
FEB	2,420	2,480	2,360	1,349	2,182	2,171	2,250
MAR	2,720	2,580	2,550	1,027	2,385	2,428	2,460
APR	1,690	2,520	2,520	2,059	1,136	2,344	2,380
MAY	2,670	2,400	2,570	2,244	2,428	2,324	2,440
JUN	2,650	2,580	2,590	1,952	2,267	2,285	2,360
JUL	2,680	2,660	2,620	2,440	2,336	2,324	2,370
AUG	2,630	2,320	2,610	2,483	2,336	2,256	2,350
SEP	2,510	2,450	2,490	2,321	2,249	2,303	2,260
OCT	2,600	2,260	2,262	2,490	2,367	2,360	2,470
NOV	2,510	657	655	2,493	2,303	2,320	2,390
DEC	2,610	2,520	2,626	2,563	2,471	2,410	2,540

USGS # 09507980 EAST VERDE RIVER NEAR CHILDS

AVERAGE MONTHLY FLOW

MONTH	AVERAGE TOTAL FLOW (1962-94) CFS	AVERAGE TOTAL FLOW (1962-94) ACFT/MO	AVERAGE 7 DAY LOW FLOW (1990-96) CFS	AVERAGE 7 DAY LOW FLOW (1990-96) ACFT/MO	AVERAGE TOTAL FLOW (1990-96) ACFT/MO
JAN	139	8,544	58	3,578	21,014
FEB	170	9,428	49	2,740	13,856
MAR	182	11,188	66	4,057	15,218
APR	89	10,829	28	1,683	3,849
MAY	32	1,967	20	1,234	1,377
JUN	20	1,904	10	603	714
JUL	21	1,291	7	404	879
AUG	39	2,397	11	689	2,676
SEP	33	2,321	10	574	1,146
OCT	30	1,844	11	668	803
NOV	35	1,785	15	905	1,741
DEC	66	4,057	17	1,059	3,104

TOTAL FLOW

MONTH	1990	1991	1992	1993	1994	1995	1996
JAN	1,230	3,150	6,680	111,800	1,680	21,170	1,390
FEB	607	732	10,330	49,910	4,930	29,070	1,410
MAR	881	33,390	23,950	19,070	3,390	25,150	694
APR	462	7,810	6,910	7,040	2,280	2,100	343
MAY	541	1,030	1,770	2,320	1,760	2,090	131
JUN	358	437	1,010	1,030	840	1,300	25
JUL	2,600	42	1,090	976	796	611	36
AUG	1,190	106	12,450	2,360	1,210	1,310	106
SEP	1,250	209	635	2,260	1,570	727	1,370
OCT	211	45	562	2,190	1,240	1,200	173
NOV	324	223	658	7,740	1,500	1,470	275
DEC	460	3,000	11,950	2,060	2,350	1,530	380

USGS # 09508500 VERDE RIVER BELOW TANGLE CREEK

AVERAGE MONTHLY FLOW

MONTH	AVERAGE TOTAL FLOW (1946-94) CFS	AVERAGE TOTAL FLOW (1946-94) ACFT/MO	AVERAGE 7 DAY LOW FLOW (1990-96) CFS	AVERAGE 7 DAY LOW FLOW (1990-96) ACFT/MO	AVERAGE TOTAL FLOW (1990-96) ACFT/MO
JAN	879	54,032	557	34,239	140,541
FEB	1,190	66,069	643	35,699	134,687
MAR	1,540	94,664	6,545	40,219	132,441
APR	870	91,630	654	13,923	39,421
MAY	219	13,462	183	11,275	12,669
JUN	135	13,031	130	7,727	8,637
JUL	180	11,065	123	7,561	10,294
AUG	339	20,838	142	8,737	20,580
SEP	270	20,171	190	11,288	16,920
OCT	338	20,777	176	10,827	12,717
NOV	375	20,111	238	14,169	16,856
DEC	772	47,455	277	17,036	27,517

TOTAL FLOW

MONTH	1990	1991	1992	1993	1994	1995	1996
JAN	18,360	28,580	44,940	763,900	19,380	90,720	17,910
FEB	15,980	14,410	108,900	472,100	28,720	286,400	16,300
MAR	27,100	232,200	221,200	163,800	39,860	228,900	14,030
APR	16,330	101,700	52,530	46,780	18,680	29,420	10,510
MAY	9,170	9,870	15,580	16,290	15,600	14,580	7,590
JUN	6,340	7,740	12,290	10,710	7,820	9,460	6,100
JUL	18,130	7,870	11,090	8,400	8,030	8,440	10,100
AUG	13,520	9,520	68,500	15,950	11,180	15,210	10,180
SEP	18,520	10,440	13,890	14,180	19,800	17,400	24,210
OCT	12,220	10,070	12,710	17,220	12,510	13,600	10,690
NOV	12,510	15,080	14,920	31,700	14,910	15,580	13,290
DEC	15,860	25,560	74,030	21,460	22,490	17,770	15,450

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