



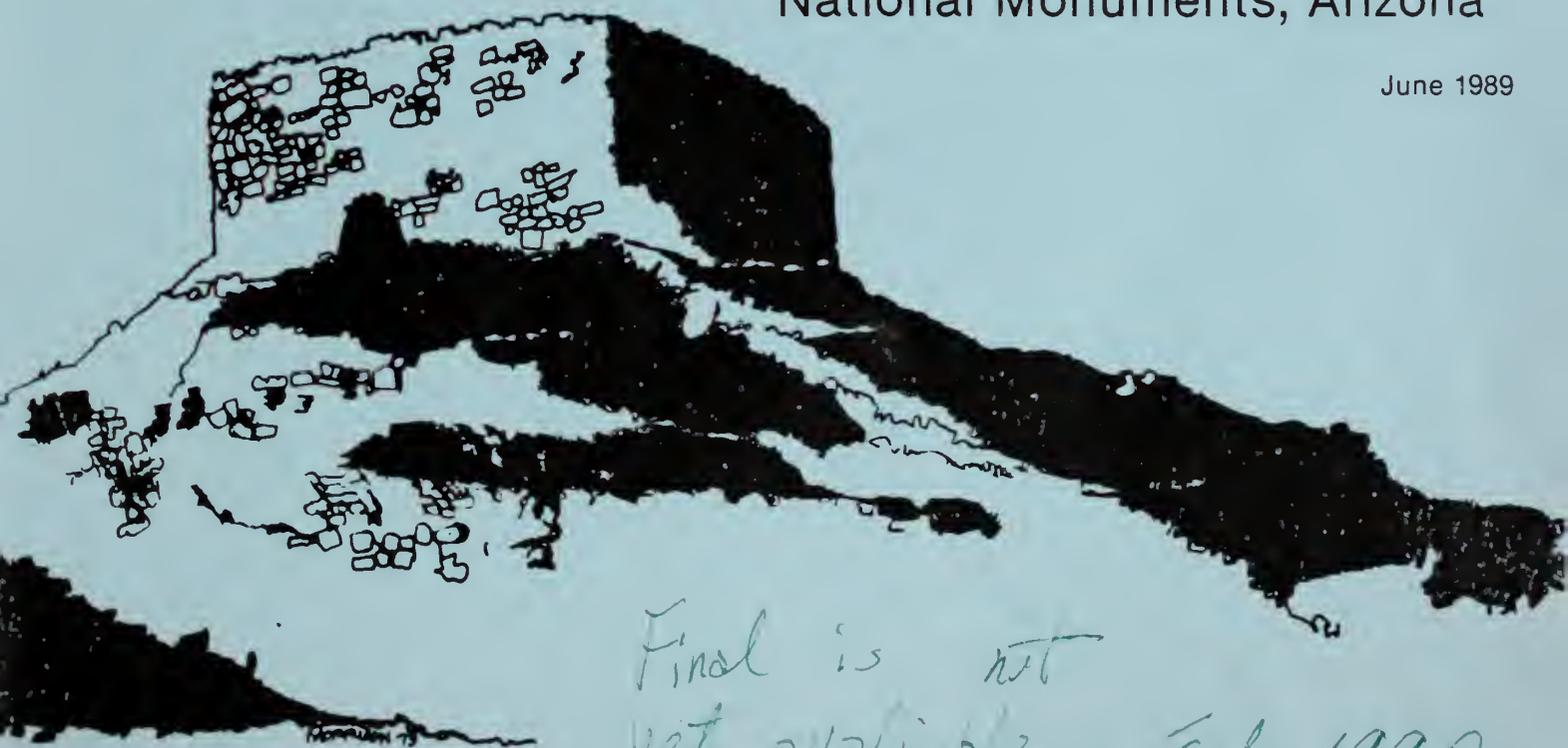
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WATER RESOURCES MANAGEMENT PLAN

Montezuma Castle and Tuzigoot
National Monuments, Arizona

June 1989



Final is not
yet available - Feb 1990

WATER RESOURCES MANAGEMENT PLAN
MONTEZUMA CASTLE AND TUZIGOOT
NATIONAL MONUMENTS, ARIZONA

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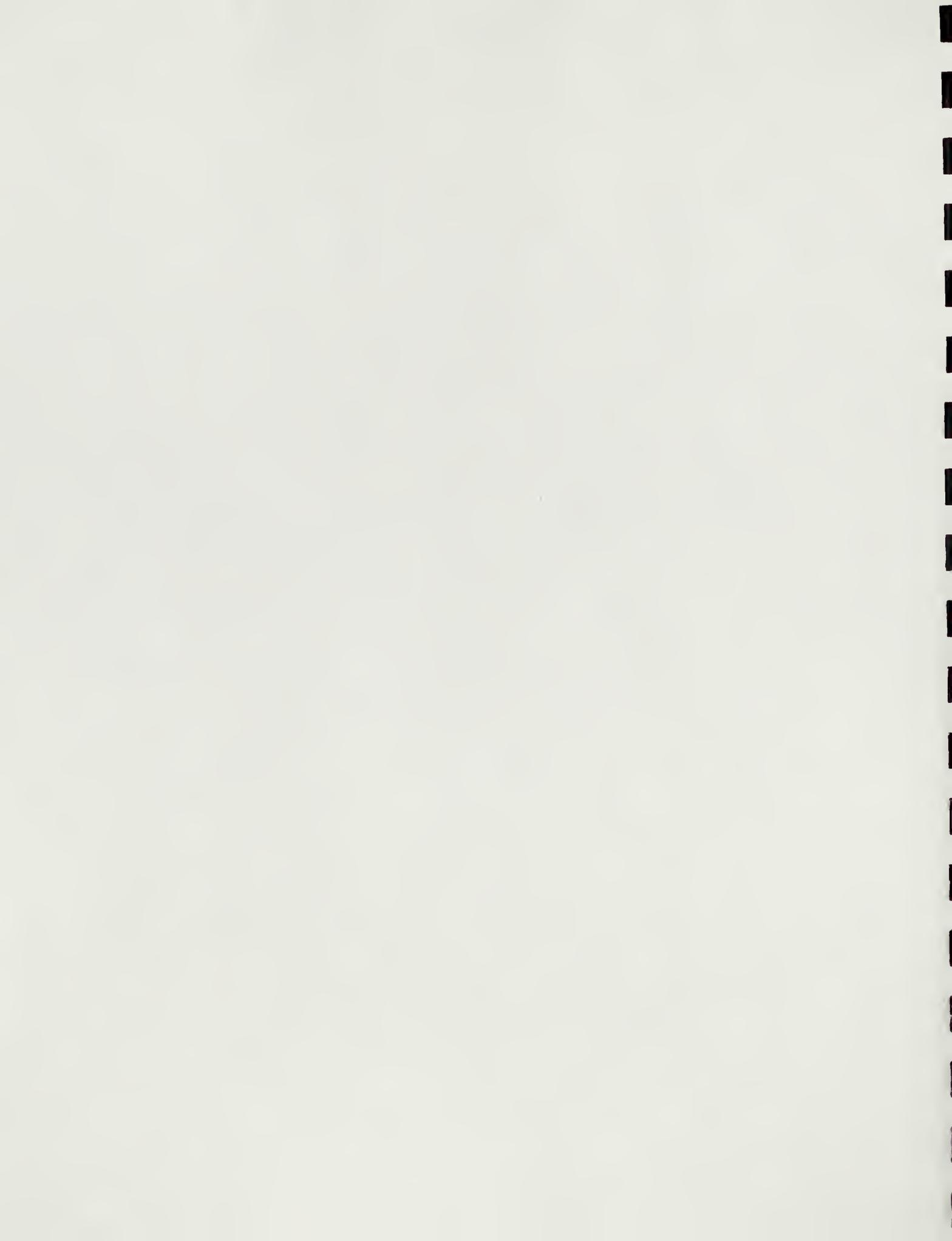


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INTRODUCTION

Montezuma Castle National Monument, including Montezuma Well, and Tuzigoot National Monument were established to preserve and protect examples of prehistoric Hohokam and Sinagua Indian cultures in the Verde Valley of central Arizona (Figure 1). These sites were occupied as early as 800 A.D., with floodplain farming providing primary subsistence.

Montezuma Castle established in 1906, preserves a 19 room, four story Sinagua cliff dwelling. Currently, this unit contains 580 acres along Beaver Creek in central Yavapai County, Arizona (Figure 2).

Montezuma Well is a limnocrene, a pooled spring, fed by artesian waters arising from two or three deep fissures near its center (Cole 1982). The Well was established in 1943 to protect Hohokam, Sinagua and historic Apache sites surrounding the Well. It occupies 278 acres along Wet Beaver Creek upstream of the Castle (Figure 2). Administratively, the Well is a unit of Montezuma Castle. It may be collectively referred to as Montezuma Castle National Monument within this plan.

Tuzigoot National Monument, established in 1939, contains the ruins of a 110 room Sinagua pueblo on almost 59 acres. Most of the area is on a hilltop, above the floodplain of the Verde River. It is located between the towns of Clarkdale and Cottonwood in Yavapai County, Arizona (Figure 3). Existing legislation enlarged the boundary to include an additional 732 acres, which are currently owned by the Phelps Dodge Corporation. However, the January 21, 1988, amendment to the monument's Master Plan (1975) approved reducing the boundaries to 360 acres. This was done to exclude the 108 acres of tailing field and adjacent lands. Potential lands for acquisition include Tavasci Marsh and prehistoric farmlands.

Management of water resources has been a primary concern since the establishment of the monuments. Comprehensive information relating to water matters are on file at Montezuma Castle. These files reflect issues of concern to National Park Service (NPS) personnel in the Verde Valley since the early 1900's. Monument facilities use wells within the regional aquifer to provide potable water to visitors and staff. Prehistoric, historic and recent stewards of these sites have been concerned with the conveyance of irrigation water. Monument staff coordinates irrigation schedules for NPS properties and users downstream from Montezuma Well. They have been active in filing for and acquiring water rights. The U.S. Geological Survey (USGS), under a cooperative agreement with NPS, has monitored discharge of Montezuma Well since 1977. This database establishes an historical record of discharge from the spring. It facilitates protection of this resource against future human-induced

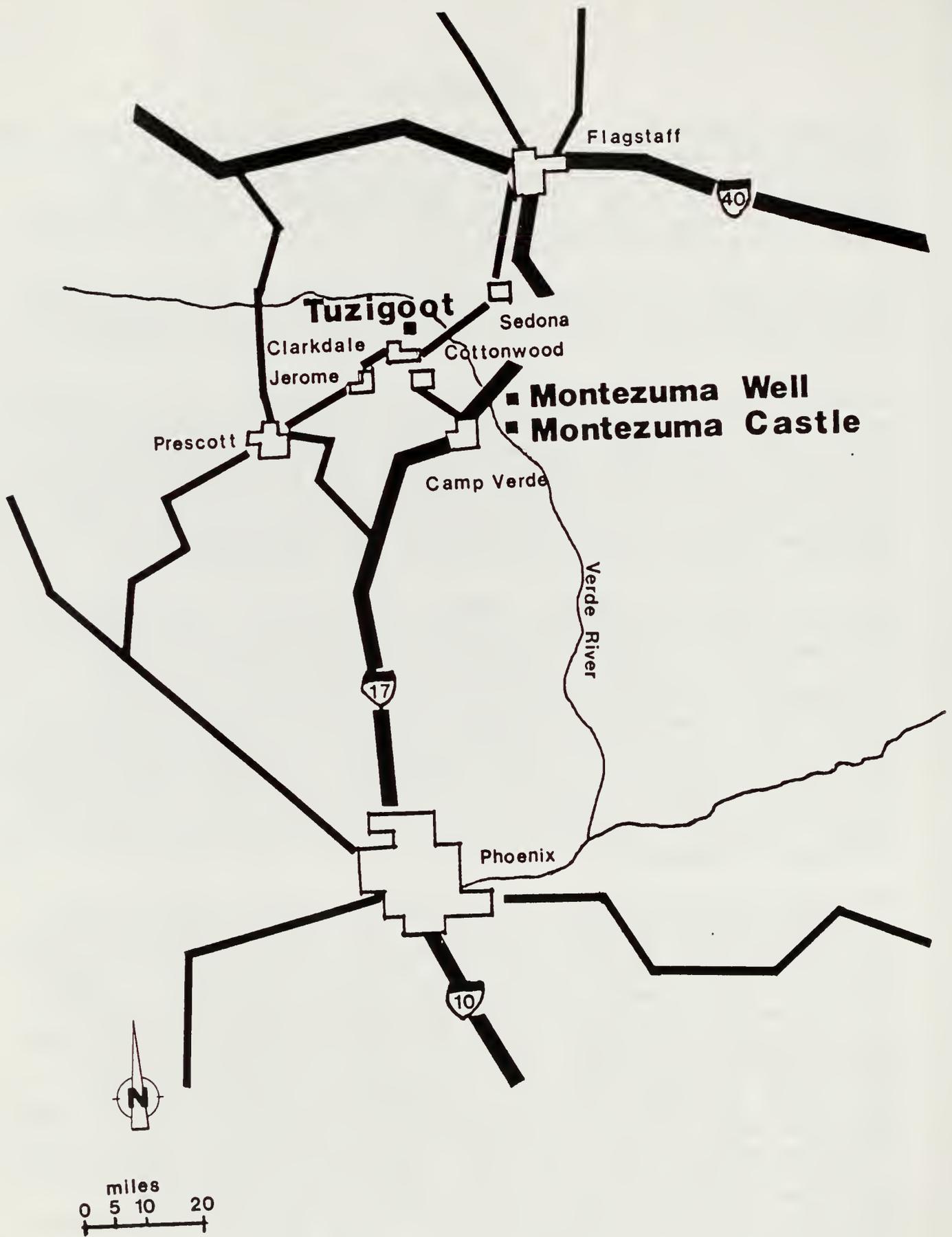


Figure 1. Verde Valley and environs.

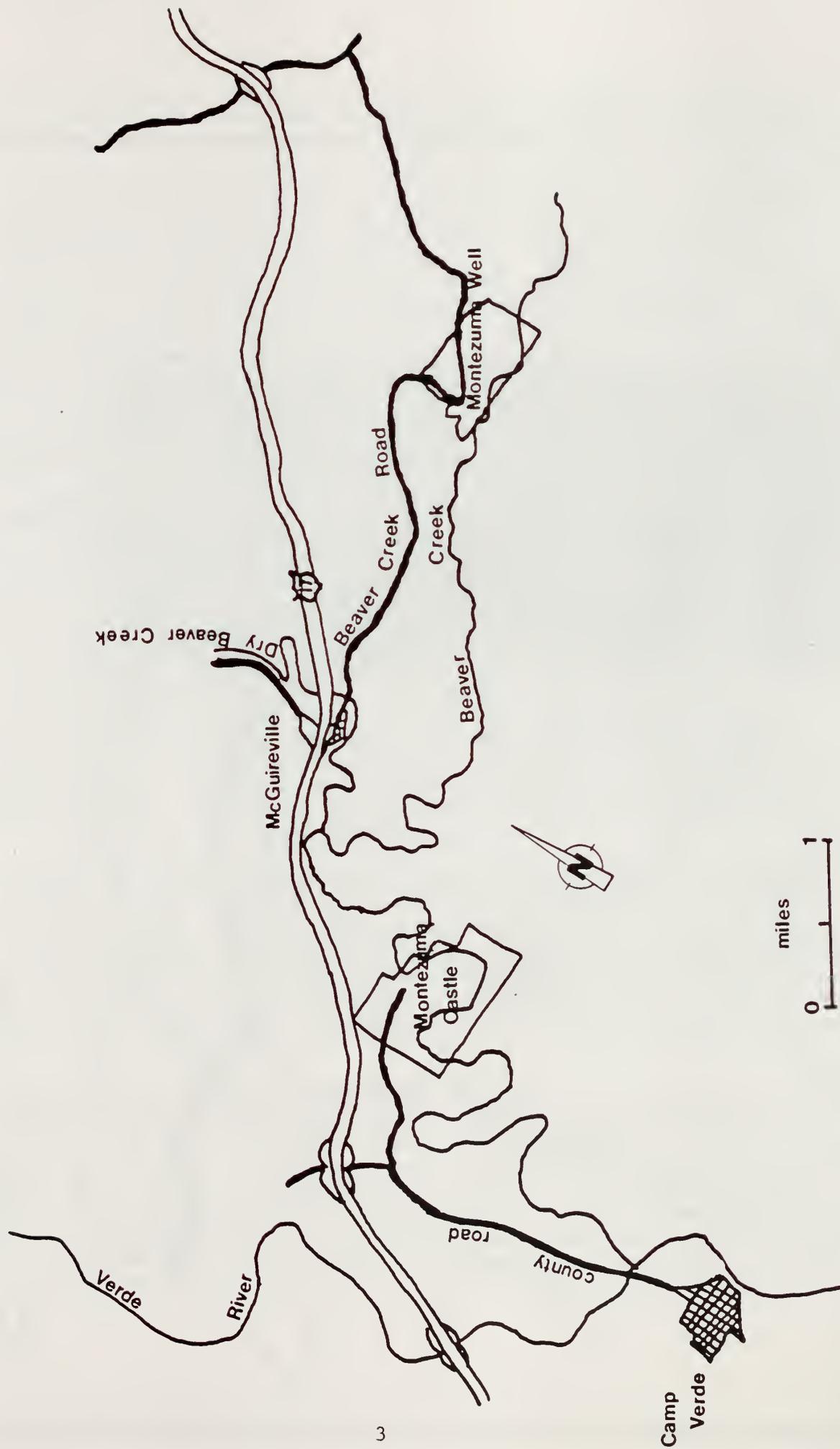
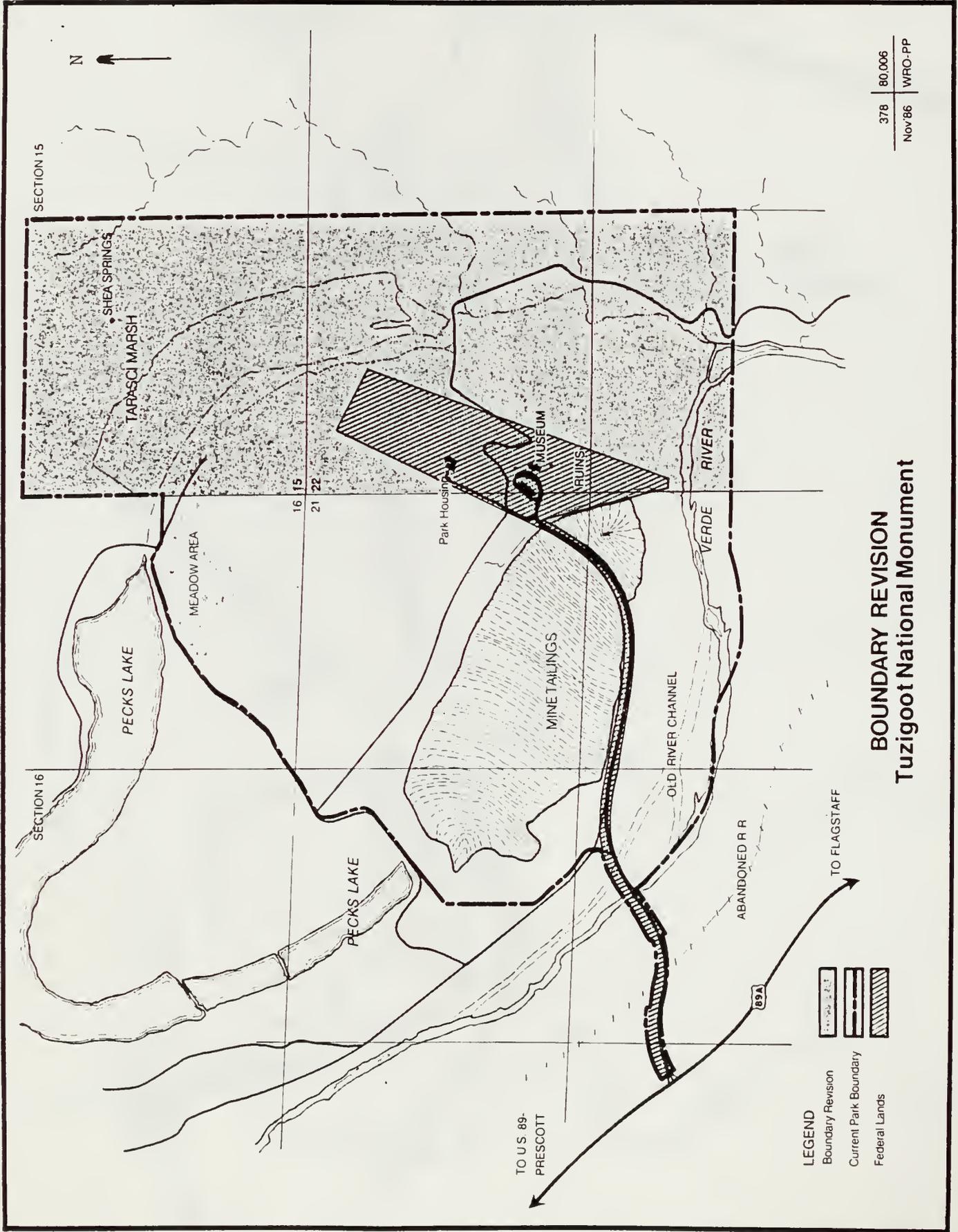


Figure 2. Montezuma Castle and Montezuma Well area map.



BOUNDARY REVISION
Tuzigoot National Monument

- LEGEND**
- Boundary Revision
 - Current Park Boundary
 - Federal Lands

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reductions in flow. Increasing visitation, regional growth and changes in adjacent land use suggest that the NPS role in water resource management, basin-wide, will continually evolve.

Water is a significant resource at Montezuma Castle and Tuzigoot National Monuments. A course of action needs to be determined with respect to protection, conservation, use and management of water resources which will comply with all legal requirements. The Environmental Protection Agency (EPA) and NPS have developed a memorandum of understanding on water quality management. This agreement has prompted the Director of the National Park Service to designate the Water Resources Management Plan as the working document for each park to attain compliance and insure cooperation with others in water planning. Although water quality provides the impetus for preparing a Water Resources Management Plan, the plan addresses all aspects of water resources.

Water management on lands under NPS jurisdiction is mandated by PL 92-217 (Clean Water Act of 1977), amending the Federal Water Pollution Control Act Amendment of 1972. Public land management agencies are subject to, and must comply with, all Federal, interstate, State and local requirements pertaining to water.

The Superintendent directs preparation and implementation of the Water Resources Management Plan. The plan is being written jointly for Montezuma Castle and Tuzigoot. It is an active, evolving management tool that provides an information base on water resources, identifies management objectives, and prescribes management actions. The plan includes a water resource project programming sheet, list of continuing and proposed projects, project statements and budget forms.

Water resources at Montezuma Castle and Tuzigoot must be managed to ensure a comprehensive interpretive experience, provide habitat and protect visitor health and safety. The 1916 National Park Service Organic Act directs NPS to regulate monument use and promote enjoyment of those lands in a manner consistent with conserving scenery and protecting cultural and natural resources. Managers must protect resources while facilitating public use, education and enjoyment.

Surface and ground waters create and sustain aquatic and riparian ecosystems at Montezuma Castle, Montezuma Well and Tuzigoot. Riparian and aquatic ecosystems are relatively rare in the arid Southwest. They are highly productive ecosystems which have been greatly reduced in areal extent and complexity by ground water overdrafts, overgrazing, streambed channelization, impoundments and climatological changes. Agricultural, industrial and municipal interests over the past 125 years have been major water users at the expense of natural systems. Potential conflicts

between water users and natural resources are associated with water rights, adjacent land use, and ground water withdrawal.

The Water Resources Management Plan is consistent with other NPS plans related to Montezuma Castle and Tuzigoot including the Master Plan and Environmental Assessment (1975), Natural and Cultural Resources Management Plan and Environmental Assessment (first drafted in 1975 and completely revised in 1989), Land Protection Plans (1984) and Statement for Management (1986). Other Federal legislation, executive orders, State statutes and management plans influencing water resources management are:

National Environmental Policy Act (NEPA, 1969) - Any major federal action that affects the human environment must include public review with the NEPA process. Concerning water resources this pertains to changes or increases in water use and treatment (i.e. constructing sewage treatment plants, pipelines, residences and visitor facilities).

Safe Drinking Water Act (1974) and amendments (1986) - This legislation applies to domestic drinking water supplies. Provisions of the recent amendments include more stringent regulation of contamination with which utility managers should be familiar.

Arizona State Water Quality Regulations (1978) - These are State regulations promulgated to aid in enforcement of Federal requirements of the Safe Drinking Water Act. They include standards for water quality and designated uses.

Clean Water Act (1977) and amendments (1987) - This act provides for pollution control activities and funding at the Federal level including grant programs research and related programs. It also includes provisions for setting standards and enforcement actions.

Arizona Groundwater Management Act (1980) - This act provides for the management and use of ground water in Arizona and establishing a Department of Water Resources. Included in this legislation are the determination of rights to withdraw and use ground water within the State.

Arizona Environmental Quality Act (1986) - This act establishes the Arizona Department of Environmental Quality and prescribes definitions, powers, duties, procedures, rights conditions and enforcement actions relating to water quality statewide.

Arizona State Water Law - Regarding the use of surface waters, NPS and other Federal land management agencies will abide by all water laws as interpreted by Arizona. The State is recognized as the administering agency for water rights.

Endangered Species Act (1973) - This act requires all entities using Federal funding to consult with the Secretary of Interior on activities that potentially impact endangered flora and fauna. It requires agencies to protect endangered species and designated critical habitats.

Executive Order 11987 (1977) - This states that "executive agencies shall, to the extent permitted by law, restrict the introduction of exotic species into the natural ecosystem on lands and waters which they own, lease or hold for purposes of administration; and, shall encourage the States, local governments and private citizens to prevent the introduction of exotic species into natural ecosystems of the United States."

Executive Order 11988 (1977) - This order seeks to minimize impacts on human life and reduce property loss by planning which avoids building in floodplains or, when possible, to remove people and structures. It recognizes restoring and preserving the natural and beneficial values of floodplains and provides for public review of federally funded projects affecting floodplains.

Executive Order 11990 (1977) - This orders Federal agencies to avoid impact from destroying or modifying wetlands. It supports building developments outside of wetlands and recognizes the beneficial value of wetlands.

Executive Order 12088 (1978) - This order requires that Federal agencies, including NPS, cooperate with State, intrastate and local agencies in the prevention, control and abatement of environmental pollution.

Actions within the Water Resources Management Plan which are not covered by the previously referenced plans will be addressed by subsequent environmental assessments or categorically excluded. Direction in this area is provided by individual project statements.

INFORMATION BASE

A. Introduction

The Resources Management Plans and Environmental Assessments for Montezuma Castle, including Montezuma Well, (1975, 1981, 1987, 1988) and Tuzigoot (1975, 1981, 1987, 1989) National Monuments serve as the reference documents for this Water Resources Management Plan. Natural resource project statements from the Resources Management Plans which consider water resources are used in this plan.

Montezuma Castle, Montezuma Well and Tuzigoot are in the Verde Valley of central Arizona. This area is transitional between the Basin and Range physiographic province to the south and west and

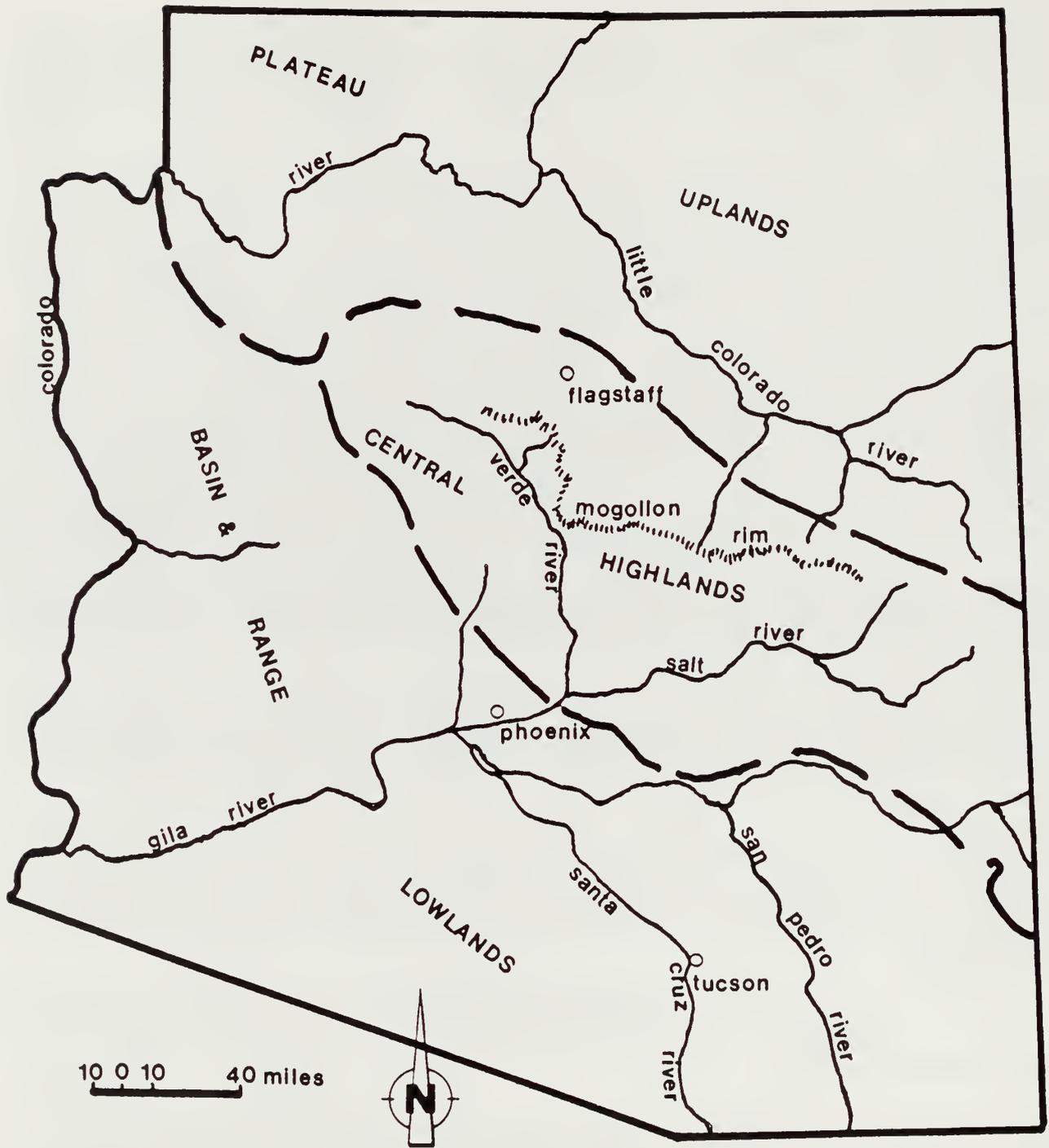


Figure 4. Water provinces of Arizona (Cross et al. 1960).

the Colorado Plateau physiographic province to the north and east (Figure 4). The Verde Valley is within the Central Highlands water province (Cross et al. 1960). The Mogollon Rim, which is the most distinctive feature of the Central Highlands, extends more than 200 miles from the White Mountains to the headwaters of the Verde River. Elevation of the Verde Valley is approximately 3200 feet above mean sea level (msl) while the Rim, only 20 miles north, has elevations in excess of 7000 feet above msl.

The Verde Valley is a downfaulted trough bounded on the northeast by the Mogollon Rim and on the southwest by the Black Hills. The two major geologic features defining the watershed are the Mormon Mountain anticline and the Verde Fault. The Mormon Mountain anticline, 15 to 30 miles east of the Verde Valley, is a northwest-tending, asymmetrical anticline which forms the ground water divide on the northeastern margin of the Valley. On the southwestern margin the Verde Fault, whose scarp is conspicuously defined by Mingus Mountain, the Black Hills and Squaw Peak, forms the ground water divide (Twenter and Metzger 1963). Valley margins are composed of Precambrian igneous and metamorphic rocks and Paleozoic sedimentary rocks capped by Cenozoic basalts. Mesozoic strata are not present in the Verde Valley (Twenter and Metzger 1963, Nations et al. 1981).

The valley is drained by the Verde River (Figure 5). Major perennial tributaries within the study area are Oak, Wet Beaver and Dry Beaver Creeks, all heading on the Mogollon Rim to the north and east. Two tributaries, West Clear Creek and Fossil Creek, discharge water from the Mogollon Rim into the Verde downstream of the river's confluence with Beaver Creek. Most drainages entering the Verde from the south and west are ephemeral, flowing only in response to snowmelt or rainfall (Owen-Joyce and Bell 1983).

Although Montezuma Castle, Montezuma Well and Tuzigoot are separated by up to 20 miles, they share a common watershed. Regional constraints imposed by the area's geology, history and development link the ground and surface waters of the Verde Valley. Water resources were (and are) the primary attraction for the peoples occupying and utilizing these areas.

The sequence of events which formed the Verde Valley during the Tertiary and Quaternary is presented by Nations et al. (1981). These authors provide a clear understanding of the relationship between regional geology and the hydrology of surface and ground waters. This relationship is critical as base flow is maintained by discharge from the regional aquifer in the Verde River and its perennial tributaries (Twenter and Metzger 1963, Owen-Joyce and Bell 1983). Additional references pertinent to

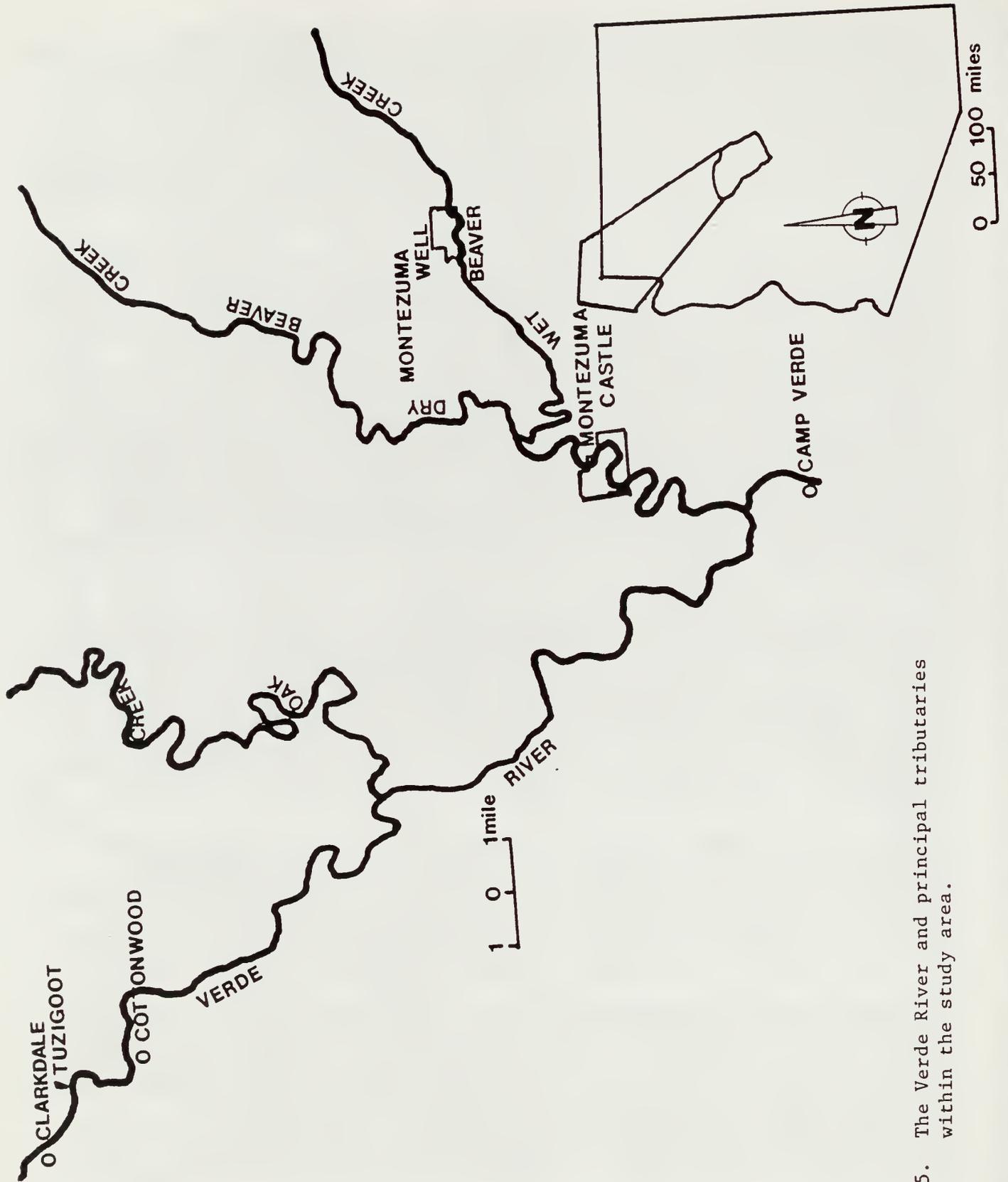


Figure 5. The Verde River and principal tributaries within the study area.

the following geologic sequence include Elston et al. (1974), Peirce et al. (1979) and McKee and Elston (1980). The sequence is described below:

- o Laramide (55 - 66 million years before present or mybp) uplift of central and northern Arizona and erosion of Mesozoic and Paleozoic rocks
- o Early Tertiary (35 - 55 mybp) transport of gravels from central Arizona northward across present location of the Verde basin
- o Hypothesized Oligocene (24 - 35 mybp) formation of ancestral Mogollon Rim and establishment of through-flowing Verde River drainage to the southeast
- o Miocene (5 - 24 mybp) interruption of Verde River drainage by tectonic and volcanic events in the Hackberry Mountain-Thirteen Mile Rock volcanic center
- o Miocene volcanoclastic, clastic and evaporite sedimentation within a closed Verde basin
- o Re-establishment of external drainage to the south by periodic overflow and partial breaching of the volcanic-tectonic dam
- o Periodic flooding of basin by fresh water, accumulation of lacustrine limestones and fluvial clastic sediments
- o Late Miocene (ca. 5 mybp) eruption of interbedded basaltic lava flows in the House Mountain and Beaver Creek areas
- o Pliocene (2 - 5 mybp) cessation of volcanism and continuation of lacustrine-fluvial sedimentation with absence of evaporites and abundance of aquatic plants and invertebrates
- o Complete breaching of the volcanic-tectonic dam and erosional excavation of much of the Verde Formation during the Quaternary (0 - 2 mybp)

Geologic events have had major effects on physico-chemical characteristics of soils in the Verde Valley. During the early Tertiary, transport of gravels from central Arizona northward across the present location of the Verde Valley occurred. At least twice during the Miocene, volcanic and tectonic events interrupted the southward drainage of the Verde River. Subsequently, two periods of lacustrine-fluvial sedimentation, with and without evaporites (Twenter and Metzger 1963), occurred during the Miocene and Pliocene, respectively.

Three thermic, semiarid soil associations within the Verde Valley characterize the monuments (Hendricks 1985). First, the Lithic Torriorthents - Lithic Haplustolls - Rock Outcrop Association occurs on well-drained uplands. Soils of this association are generally shallow. The Retriever - Courthouse soils (Soil Conservation Service 1969), which are shallow, gravelly, medium textured calcereous soils of the Verde Formation, are included in this association. Second, Bonita - Graham - Rimrock Association soils are of volcanic origin and are characteristically found on well-drained uplands. Clays underlain by basalt bedrock are typical. Third, the Penthouse - Latene - Cornville Association is comprised of well-drained medium to deep soils on dissected alluvial fans and valley slopes. All three associations are present at Montezuma Castle and Montezuma Well. Soils at Tuzigoot, are classified as Lithic Torriorthents - Lithic Haplustolls - Rock Outcrop or Penthouse - Latene - Cornville Associations.

B. Description of Water Resources

1. Overview

Water resources addressed by this plan include perennial and ephemeral streams, springs and wells in the regional aquifer. The water resources of Montezuma Castle include Beaver Creek (Figures 2, 5) and a well (A-14-5 17 aac) providing water to resident NPS staff and visitors. The well numbering system used by the U.S. Geological Service (USGS) in Arizona is in accordance with the Bureau of Land Management's system of land subdivision. The well numbering system is described in Appendix 1. Beaver Creek is fed by ephemeral discharge in Dry Beaver Creek and a perennial spring in Section 14, T 15 N, R 7 E which discharges into Wet Beaver Creek. Beaver Creek is perennial from the confluence of Wet and Dry Beaver Creeks to Montezuma Castle. A sewage lagoon is the only artificial impoundment at the Castle Unit.

Water resources at Montezuma Well unit consist of the natural well, Wet Beaver Creek (Figures 2, 5) and two wells (A-15-06 31 cba 1 and A-15-06 31 cba 2) in the Verde Formation providing public water supplies to resident NPS staff and visitors. Montezuma Well occurs in a circular limestone depression in the Verde Formation. Water enters the Well from at least three fissures at the bottom (Cole and Barry 1973). An outlet along the southeast margin discharges into an irrigation ditch of prehistoric origins which is still used today.

Water resources within Tuzigoot consist of a single well (A-16-03 22 BCC) providing a public water supply to resident NPS staff and visitors. However, Shea Spring (A-16-3 15 cdb) discharging into (and maintaining) Tavasci Marsh, which is north and east of the Monument, and the Verde River (Figures 3, 5), which is

immediately south, are significant resources within or bordering the legislated Monument boundary but privately owned by the Phelps Dodge Corporation. Discharge from the public water supply well and Shea Spring issues from the Verde Formation (Owen-Joyce and Bell 1983).

The regional aquifer includes the alluvium of the Verde River, Verde Formation, Coconino Sandstone, Supai Formation, Naco Formation, Redwall Limestone, Martin Formation and Tapeats Sandstone. They are hydraulically connected. Ground water movement within the Verde Valley is controlled by the Mormon Mountain anticline located 15 to 30 miles northeast of the Mogollon Rim and by the crest of the Black Hills. Ground water movement in this area is basinward (Twenter and Metzger 1963, Glotfelty 1985). The highest yields from wells (greater than 500 gallons/minute) occur in the Verde Formation, Coconino Sandstone and Redwall Limestone. Transmissivity within the regional aquifer ranges from a low of 20 to a high of 16,000 square feet per day (Owen-Joyce and Bell 1983).

Water resources within the Verde Valley have been utilized since prehistoric times. Irrigation ditches used by pueblo Indians are evident, on or near all three monuments. They are usually difficult to locate and document. Europeans entered the Verde Valley on a number of occasions from the early 1500's through the mid 1800's. Within the past 125 years changes in land use and water resources have been better documented. Anglo-American soldiers, miners, farmers and stockmen established permanent settlements by the 1860's. Riparian forests, woodlands and grasslands were altered by agricultural practices, timber harvesting and mining. During the next 100 years agriculture and mining interests dominated land and water uses in the Verde Valley. Recently, declining ore bodies and highly mobile retirees seeking 'sunbelt' communities are prompting another shift in land and water use patterns. Rapid urbanization is presently occurring throughout the Verde Valley. The estimated 1988 population of the Verde Valley is approximately 23,000. This is expected to increase to almost 36,000 by the year 2005 (Northern Arizona Council of Governments 1984).

The hydraulic connection between ground water and surface water resources and the probability that additional growth in the Verde Valley will rely on ground water (Owen-Joyce and Bell 1983) suggest that well drilling activity will increase with population growth. Records for lands occupied by an NPS facility and the four adjoining sections (a radius of approximately 1.5 miles) indicate that the number of wells drilled and the rate of well drilling (number per year) has apparently increased since the early 1970's (Table 1), particularly in the vicinity of the Castle and Tuzigoot (pers. comm. Arizona Department of Water Resources, Operations Division in February 1988) Data are

Table 1. Well drilling activity in the vicinity of Montezuma Castle, Montezuma Well and Tuzigoot from pre-1900 to 1986. The upper number indicates the number of wells drilled during each time interval and the number in parentheses indicates the number of wells drilled per year. Data summarized by the Arizona Department of Water Resources (1988).

Area	*-----Time Interval-----*					Sum
	<1900	1901/1950	1951/1970	1971/1980	>1980	
Montezuma Castle	0 (0)	1 (<0.1)	4 (0.2)	16 (2.3)	5 (0.8)	33
Montezuma Well	2 (<0.1)	2 (<0.1)	2 (0.1)	0 -	0 -	6
Tuzigoot	0 (0)	3 (<0.1)	8 (0.2)	22 (1.6)	13 (1.8)	43

incomplete for Tuzigoot because landowners are not required to report the year a particular well was drilled. Consequently, dates are lacking for 43 wells on lands adjacent to the monument. Drilling activity has, fortunately, been less in the area surrounding Montezuma Well and no new wells have been registered with ADWR since 1970. Discharge from Montezuma Well could be influenced by ground water extraction from the regional aquifer. Land and water use patterns in the Verde Valley indicate that water rights, water quality, aquifer protection, floodplain regulation, instream mining, instream flow, riparian habitats, wildlife and endangered species are among the concerns which are likely to surface in the future. The Water Resource Management Plan presents proposed actions and alternatives addressing these issues for the monuments.

2. Annual Precipitation

Between 29% and 36% of mean annual precipitation falls during December, January, February and March, usually as rain in the Verde Valley (Table 2). Winter precipitation is related to the eastward movement of middle latitude storms that form in the northern Pacific Ocean. They may produce major floods in the Verde Valley, particularly when rains fall on snowpack at higher elevations along the Mogollon Rim. Most precipitation falls during the summer (July, August and September). During this period, 37% to 46% of the average annual precipitation occurs (Table 2). Summer storms are typically of short duration and locally intense. These storms may produce local flash flooding.

Average annual precipitation at Montezuma Castle is approximately 12 inches (Table 2). Extreme values of mean annual precipitation range from less than four inches to more than 22 inches (Figure 6). Precipitation varies considerably between years in the Verde Valley.

3. Surface Waters of Montezuma Castle, Montezuma Well and Tuzigoot

Beaver Creek extends about nine miles, from the confluence of Wet Beaver Creek and Dry Beaver Creek to the Verde River. Approximately one and one-half miles of this stream flows through Montezuma Castle. The Castle is four miles above the confluence with the Verde River. Beaver Creek is perennial from it's origin to the Castle, however, part or all of the flow is diverted for irrigation during the summer (Owen-Joyce and Bell 1983, Glotfelty 1985).

A lined, three-celled, 0.9 acre sewage lagoon is located approximately 1300 feet northeast of the Visitor's Center at Montezuma Castle. It is above the 500 year floodplain of Beaver Creek and has a capacity of 1,124,000 gallons (NPS 1981, pers. comm. Tom Lew). An 0.7 acre expansion with 957,000 gallons of capacity is currently being designed (pers. comm. T. Lew, NPS)

A perennially flowing reach of Wet Beaver Creek and Montezuma Well are the only surface waters within the Well Unit. Wet Beaver Creek originates from springs in the Coconino Sandstone in Section 33, T 15 N, R 7 E. It flows west southwest for about 14 miles towards the Well, which is six miles above the confluence with Dry Beaver Creek.

Following is a description of Montezuma Well from Cole (1982): "The Well is a limnocrone fed by artesian waters arising from two or three deep fissures near the center. Cole and Barry (1973) presented a bathymetric map and a table of morphometric data applying to the Well basin. Other details that may facilitate further research are presented here. The water pours out of this spring lake from a point at the southeast border. Many years ago this outlet was dubbed the swallet by Monument personnel. It is also called the inner outlet. The water disappears into a limestone cave for about seven minutes' flow before emerging at the outer outlet (ca. 5 m lower altitude). This heads an effluent stream simply called the ditch. Under natural conditions the outer outlet would pour into Wet Beaver Creek. The ditch is human made and served originally as an Indian irrigation canal. A calibrated Parshall flume or "weir" present a few meters downstream served for making rough estimates of water entering the Well daily, without taking into account evaporation and unknown losses from the Well elsewhere." The weir installation, maintenance and discharge monitoring are carried out under a cooperative agreement between NPS and USGS.

Table 2. Average monthly and annual precipitation (inches) at Beaver Creek Ranger Station, Cottonwood, Montezuma Castle and Rimrock in the Verde Valley (Sellers and Hill 1974). The number in parentheses indicates the number of years for which records are available at each station.

	Beaver Creek (14)	Cottonwood (22)	Montezuma Castle (30)	Rimrock (21)
January	1.00	0.85	0.95	1.25
February	1.12	0.77	0.88	1.02
March	1.47	0.87	1.04	1.08
April	0.89	0.57	0.78	0.74
May	0.40	0.35	0.27	0.30
June	0.30	0.58	0.30	0.32
July	1.34	2.02	1.47	1.50
August	2.00	2.43	1.99	1.88
September	1.67	1.12	1.34	1.29
October	1.11	0.80	0.80	0.94
November	1.08	0.74	0.72	0.83
December	1.28	1.11	1.16	1.22
Total Year	13.66	12.21	11.70	12.37

There are no existing surface waters within Tuzigoot National Monument. Legislation providing for acquisition of additional lands surrounding the monument would provide frontage on the Verde River. Additionally, Tavaschi Marsh and its source, Shea Springs, are within the legislative boundary. Shea Springs has also been identified as Tuzigoot Spring. It is recorded as number A-16-3 15 cdb, based on the well numbering system used in Arizona (Appendix A).

4. Classification of Surface Waters by Existing Uses

The classification of surface waters has been developed to provide guidance in developing water quality management goals and monument-specific water quality standards where needed. Waters are classified below according to their primary (P) use. If other uses occur, they will be classified as secondary (S) uses.

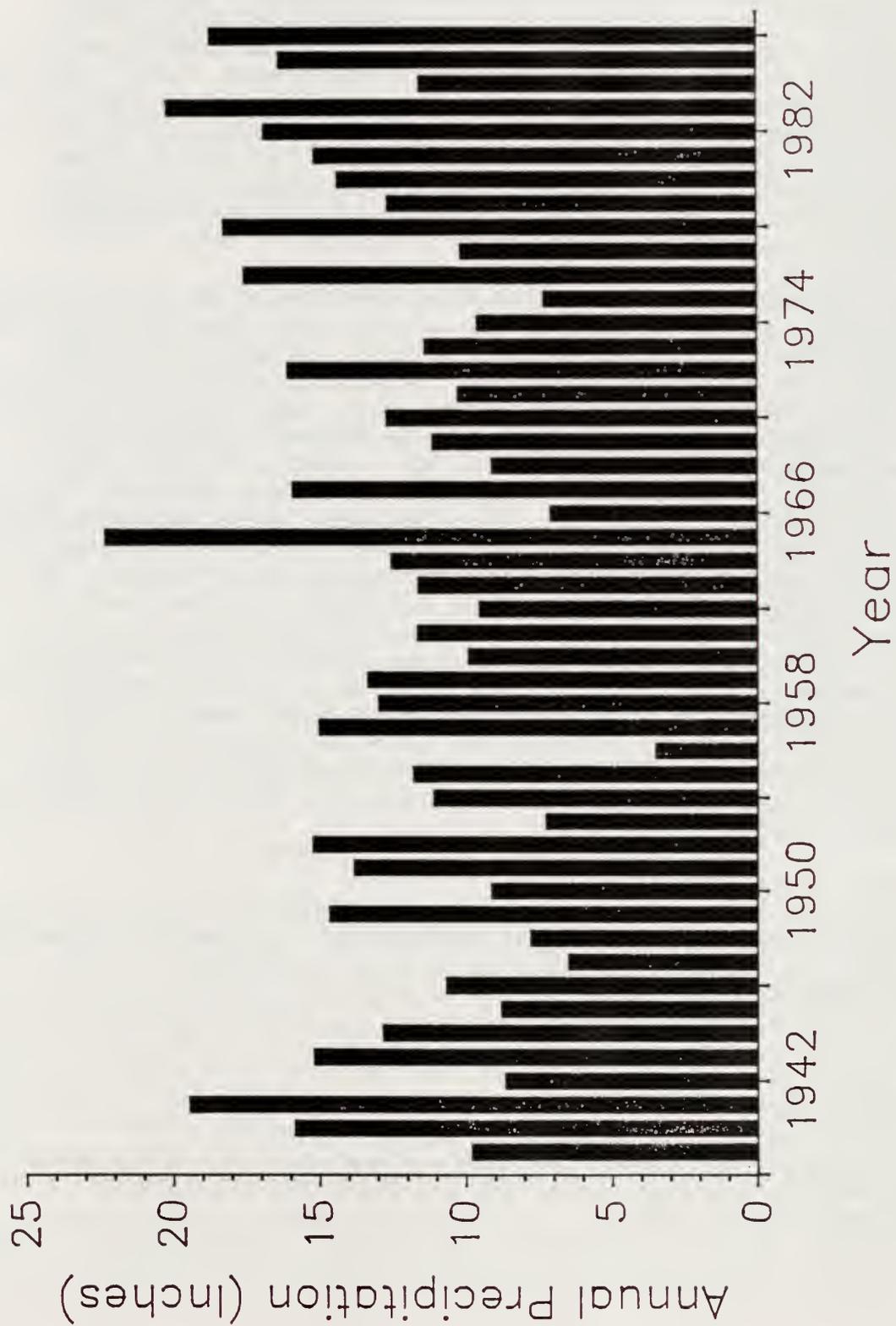


Figure 6. Average annual precipitation at Montezuma Castle.

The State of Arizona, through the Department of Environmental Quality, has promulgated water quality standards for surface waters of the state (Arizona Administrative Code Title 9 Chapter 21 1987). Six protected uses are recognized by the State, domestic water source, full body contact, incidental human contact, aquatic and wildlife, agricultural irrigation and agricultural livestock watering. Four protected uses are recognized for surface waters including the Verde River upstream from Bartlett Dam, Dry Beaver Creek, Wet Beaver Creek and unlisted tributaries or segments under the tributary rule. The tributary rule applies protected uses given for the nearest downstream listed surface water segment that is not effluent dominated to an unlisted water segment or tributary (Arizona Administrative Code Title 9 Chapter 21 1987).

Full body contact (FBC) is defined as the use of a surface water for an activity which normally causes the human body to come into direct contact with the water to the point of complete body submergence. It includes swimming, water skiing, skin diving and other similar activities during which water may be ingested accidentally and certain sensitive body organs, such as eyes, ears, nose, etc., may be exposed to the water. Aquatic and wildlife (A&W) is the use of a surface water for the growth and propagation of fish, waterfowl, fur-bearers, other aquatic life, semiaquatic life or wildlife. This water may be used for a cold water fishery (e.g., Wet Beaver Creek) warm water fishery (e.g., Dry Beaver Creek), wildlife habitat or other similar uses. Agricultural irrigation (AgI) is the use of surface water for irrigated farming. It does not include the use of a surface water for washing and cooling raw farm products and washing milk handling equipment and cooling dairy products. Agricultural livestock watering (AgL) is the use of a surface water supply for livestock, including but not limited to beef cattle, dairy cattle, sheep, swine, horses and poultry (Arizona Administrative Code Title 9 Chapter 21 1987).

- o Public Water Supply:

- Wells at Montezuma Castle, Montezuma Well and Tuzigoot - P

- o Non-Public Water Supply:

- None

- o Maintenance of Ecosystem, General:

- All surface waters of natural origin within the present boundaries of Montezuma Castle, Montezuma Well and Tuzigoot - P, A&W

- o Maintenance of Ecosystem, Species of Special Interest other than Threatened and Endangered Species:

Wet Beaver Creek - P, A&W
Beaver Creek - P, A&W
Montezuma Well - P, A&W

- o Maintenance of Ecosystem, Threatened, Endangered and Indigenous Species of the Monuments:

Wet Beaver Creek - P, A&W
Montezuma Well - P, A&W
Beaver Creek - P, A&W

- o Recreational Purposes, Contact:

Wet Beaver Creek - S, FBC
Beaver Creek - S, FBC

- o Recreational Purposes, Non-contact:

Wet Beaver Creek - P, A&W
Montezuma Well - P, A&W
Beaver Creek - P, A&W

- o Agricultural Irrigation and Livestock Watering:

Wet Beaver Creek- S, AgI, AgL
Montezuma Well - P, AgI, AgL
Beaver Creek - S, AgI, AgL

- o Disposal of Sewage Effluent:
None

5. Water Quantity

Waters of the Verde Valley Monuments, Wet Beaver Creek, Beaver Creek and Montezuma Well ultimately discharge into the Verde River. The Verde River drains an area in excess of 3,500 square miles above Clarkdale (Table 3). The river heads in central Yavapai County, receiving runoff from the Sierra Prieta, Mogollon Rim and Chino Valley. Direct runoff and base flow are the two major components of streamflow (Owen-Joyce and Bell 1983). The contribution of direct runoff is greatest during the late winter and spring when snowpack on upper reaches of the drainage, particularly the Mogollon Rim, are melting. Base flows in the Verde River and its perennial tributaries are maintained by discharge from the regional aquifer. Average discharge is 202 cubic feet per second (cfs) and the median of mean discharge, over the 24 year period of record is 170 cfs (USGS 1988).

Table 3. U.S. Geological Survey gaging stations on principal drainages influencing Montezuma Castle, Montezuma Well and Tuzigoot in the Verde Valley, Yavapai County Arizona (USGS 1988).

Station Name	Number	Period of Record	Watershed Area (sq.mi.)	Average Discharge (ac.ft./yr.)
Dry Beaver Creek near Rimrock	09505350	1960 - 85	142	35,570
Montezuma Well Outlet	09505260	1978 - 85	na	1,640
Verde River near Clarkdale	09504000	1965 - 85	3,520	146,300
Wet Beaver Creek near Rimrock	09505200	1961 - 85	111	-

Extremes for the period of record are 50,600 cfs and 55 cfs (Table 4).

Beaver Creek is perennial from it's origin to Montezuma Castle, however, part or all of the flow is diverted for irrigation during the summer (Owen-Joyce and Bell 1983, Glotfelty 1985). During the peak irrigation season (June) half of the 15 cfs streamflow gain in the Verde River at the mouth of Beaver Creek is attributable to subsurface irrigation return flows through the alluvium (Owen-Joyce 1984).

Mean discharge of Wet Beaver Creek at the gaging station, Wet Beaver Creek near Rimrock, is 30 cfs over a 16 year period of record. This gage, with a drainage area in excess of 100 square miles (Table 3), is six upstream from Montezuma Well and above Red Tank Draw an intermittent stream which occasionally contributes substantial discharge to Wet Beaver Creek. The median of yearly mean discharge is 24 cfs (USGS 1988) and base flow ranges from 6 to 8 cfs (Owen-Joyce and Bell 1983). Maximum discharge for the period of record is 3,960 cfs (Table 4).

Montezuma Well discharges at an average annual rate in excess of 2 cfs. The water pours out of this spring lake from a point at the southeast border referred to as 'the swallet' (inner outlet). The discharged water disappears into a limestone cave for about seven minutes' flow before emerging at the outer outlet. This

Table 4. Discharge at U.S. Geological Survey gaging stations on principal drainages influencing Montezuma Castle, Montezuma Well and Tuzigoot in the Verde Valley, Yavapai County Arizona. Values for extreme and total discharge are from the 1985 water year (USGS 1988). Additional information on the Beaver Creek drainage and all six gaging stations which have been operated by USGS is presented by Owen-Joyce and Bell (1983).

Station Name	Maximum Discharge (cfs)	Minimum Daily (cfs)	Extremes 1985 (cfs)	Total Discharge 1985 (cfs)
Dry Beaver Creek near Rimrock	26,600	0	0/4,250	19,481
Montezuma Well Outlet	3	1	1/2	627
Verde River near Clarkdale	50,600	55	81/4,760	64,958
Wet Beaver Creek near Rimrock	-	-	nd/3,960	-
nd - no data				

heads an effluent stream referred to as 'the ditch'. Under natural conditions the outer outlet would pour into Wet Beaver Creek (Cole and Batchelder 1969, Cole and Berry 1973, Cole 1982). Extremes for the eight year period of record are from slightly greater than 2 cfs to approximately 1 cfs (Table 4).

Montezuma Well is fed by artesian waters originating from two or three deep fissures near the center. Water reportedly enters from the fissures at rates varying from less than 2 to almost 3 cfs (Cole and Barry 1973). The source of this discharge is currently unknown, however, some evidence indicates that it may originate in the Supai Formation (Cole and Barry 1973, Owen-Joyce pers. comm. in Glotfelty 1985).

Discharge of Shea Springs has not been measured. It is estimated to discharge approximately 2 cfs (W. Reed, NPS Water Resources Division).

Periodically, USGS and NPS staff measure well levels, conduct drawdown tests and other pertinent evaluations of wells at Montezuma Castle, Montezuma Well and Tuzigoot. Data for all

three areas and associated correspondence are on file at monument headquarters.

C. Floodplain Management

In compliance with E.O. 11987, 11988, 11990 and regulations regarding floodplains and wetlands (45 FR 35916; 47 FR 36718), NPS prepares Statements of Findings for actions in floodplains. Federal Emergency Management Agency (FEMA) flood boundary and floodway maps are available for areas adjacent to Montezuma Castle, Montezuma Well and Tuzigoot. Only portions of the three NPS areas, adjacent to principal drainages, have been mapped by FEMA.

The 100-year floodplain is the base floodplain and the 500-year floodplain is the critical action floodplain. Certain activities or types of developments may only occur above the critical action floodplain. The Montezuma Castle evaporation ponds are an example of a development action which should be well removed from the potential for flooding. Other activities, for example picnic grounds and flood control structures, may occur above or at the base floodplain.

The NPS has conducted a floodplain study defining the base and critical action floodplain boundaries of Beaver Creek for the sewage treatment and disposal system at the Castle (1981). Elevations of the base and critical action floodplain boundaries are 3102.5 feet and 3106.5 feet, respectively.

A hydrologic study of gravel mining impacts along a two mile reach of the Verde River was prepared for Yavapai County by Simons, Li and Associates (1985). The study reach begins less than one mile downstream from Tuzigoot. The study suggests that gravel mining within the Verde River floodplain influences channel alignment, headcut propagation, downstream degradation, bank erosion and streamside vegetation. The effects, if any, on adjacent floodplain lands have not been evaluated.

Flood hazard of an unknown degree exists at Montezuma Castle and Montezuma Well. There are no significant flood hazards within the existing boundary at Tuzigoot, however, an unknown degree of hazard is associated with lands within the legislative boundary.

D. Wetland Protection

No wetland habitats (Cowardin et al. 1977) occur on the Federally owned lands of Montezuma Castle, Montezuma Well and Tuzigoot. However, a small area of pondweed association is present at Montezuma Well and significant stands of riparian deciduous forest and woodland associations are present at all three areas (Brown 1982). Cole (1982) reviews fossil pollen evidence suggesting that Montezuma Well was a wet meadow prior to its

formation. Tavaschi Marsh encompasses approximately 35 acres north of Tuzigoot and within the area proposed for acquisition by NPS.

E. Water Quality

Water quality data are available from a number of groundwater and surface water sources in the Verde Valley. The largest database is STORET, maintained by EPA and Arizona Department of Environmental Quality (ADEQ). Not all available data are in this database and there is a backlog of information awaiting entry. Water quality information is available from 30 stations in the vicinity of Montezuma Castle, Montezuma Well and Tuzigoot (Table 5).

An overview of regional water quality has recently been completed by Owen-Joyce and Bell (1983). Concentrations of major cations, anions and dissolved solids are related to contribution of groundwater aquifers (particularly the Verde Formation) to surface water flows. During periods of base flows, groundwater and surface water quality are similar. However, during periods of medium and high flows (spring and late summer) when the watershed receives runoff from snowmelt and rainfall, the high concentration of dissolved solids and ions associated with the Verde Formation are diluted (Owen-Joyce and Bell 1983).

Dissolved solids in 211 samples throughout the Verde Valley (including Oak Creek) during a variety of flows were analyzed by Owen-Joyce and Bell (1983). Extreme values for the watershed were 32 and 1570 mg/l. The positive relationship between concentration of dissolved solids and specific conductance during periods of low flow (June) is stronger at downstream stations near Camp Verde than upstream at Clarkdale. Coincident with increasing concentration of dissolved solids are changes in concentrations of major ions, particularly sodium and sulfate ions. The increase in concentrations of these ions is probably related to their solution by ground water moving through salt and gypsum deposits in the Verde Formation. Annually, the dominant ions are calcium, magnesium and bicarbonate (Owen-Joyce and Bell 1983).

Fecal coliform increases in the Verde River between Clarkdale and Cottonwood. This increase is probably related to a cattle grazing operation in Tavaschi Marsh. During January 1981, waters draining the marsh area had a fecal coliform count of 2,100 cfu/100 ml. Above the point where this drainage discharges into the Verde, fecal coliform concentration was less than 1 cfu/100 ml. Fecal coliform concentration in the Verde below Tavaschi Marsh increased to 203 cfu/100 ml (Northern Arizona Council of Governments 1982).

Table 5. Selected stations for which water quality data are available in STORET on principal drainages influencing Montezuma Castle, Montezuma Well and Tuzigoot in the Verde Valley, Yavapai County, Arizona. Additional information on water quality of the study area is provided by Owen-Joyce and Bell (1983).

Station Name	Station Number
Verde River ca. 0.6 mi. below confluence with Beaver Creek	700000000017870
Verde River bridge above Camp Verde	700000000017980
Verde River above Beaver Creek near Camp Verde	343424111513300
Beaver Creek above confluence with Verde River at Camp Verde	343428111511600
Verde River at I-17 Bridge	VR 7
Beaver Creek above confluence with Verde River	704600000000030
Verde River at I-17 Bridge near Camp Verde	343513111524600
Wet Beaver Creek below Top-of-Morning Ford	704600100002180 VV12
Wet Beaver Creek at Rusty Spur Ford	343752111473500
Dry Beaver Creek above mouth of Wet Beaver Creek at Montezuma Ave. Bridge	704600100002390 VV11
Wet Beaver Creek above Lake Montezuma	704600100002460 VV10
Wet Beaver Creek near Rimrock (USGS)	09505200
Red Tank Draw near Rimrock (USGS)	09505250
Rattlesnake Canyon near Rimrock (USGS)	09505300
Red Tank Draw above mouth	704600130000450
Dry Beaver Creek near Rimrock (USGS)	09505350
Verde River below Rio Verde Circle Ford	700000000022250 VV09
Verde River ca. 0.3 mi. below Dead Horse Ranch Ford	700000000022425 VV08
Verde River above Cottonwood	700000000022450 VV07
Verde River near Tuzigoot	700000000022022
Tavasci Marsh Wash at mouth near Clarkdale	344557112011600
Verde River at Tuzigoot Bridge	344557112014600
Verde River below Tuzigoot Bridge	700000000022000 VV06
Bitter Creek near Cement Plant Bridge	702600100000363 VV04
Verde River below Bitter Creek	700000000023025 VV02
Bitter Creek near Verde River	702600100000001 VV03
Verde River above Bitter Creek	700000000022100 VR 013.5 VV01
Peck's Lake	000240 AZTOX240
Verde River near Clarkdale (USGS)	09504000

The limnology of Montezuma Well has been studied extensively by Dr Gerald A. Cole (professor emeritus at Arizona State University), Dr. Dean W. Blinn (Northern Arizona University) and their students. Cole (1982) has summarized most of the research featuring the Well. The evolution and chemistry of CO₂ entering the Well's waters have been described in detail by Cole and Batchelder (1969) and Cole and Barry (1973). "The water is a

concentrated bicarbonate type with considerable amounts of NaCl" (Cole and Barry 1983).

The NPS has water quality data for wells at Montezuma Castle, Montezuma Well and Tuzigoot on file at monument headquarters. Most analyses are periodic tests of well water to assure compliance with public health standards for drinking water supplies. Some information, however, pertains to quality of surface waters, particularly Montezuma Well. The monument staff recognizes the need to develop a more comprehensive water quality program.

F. Park Biota

1. Overview

The juxtaposition of upland and lowland habitats dissected by floodplains produce unique and diverse biological communities in the Verde Valley. It is one of the most significant bioregions of Arizona. At the time of the arrival of the first European inhabitants, the Verde Valley was characterized by dense, heavily forested floodplain communities and grasslands in upland communities (Hawkins n. d.). The transformation of grassland and riparian habitats in the Verde Valley has been documented palynologically (the study of fossil spores and pollen) and photographically by Davis and Turner (1986). Their analysis documents the regional expansion of pinyon - juniper woodland and local expansion of woody desert shrubs, particularly creosote bush and mesquite.

Watershed management practices between the mid-1950's and early 1970's have affected Verde Valley biotic communities. Large scale vegetation manipulation projects in coniferous forest and woodland habitats on upper Beaver Creek have documented the potential for increased water yield from the watershed (Brown et al. 1974). A more recent study of these efforts indicates that in the absence of downstream recharge and pumping, less than one half of streamflow increases in the Verde River reaches consumptive users (Brown and Fogel 1987). The downstream effects of these experiments, particularly as they influence water resources of Montezuma Well and Montezuma Castle are unknown.

Evapotranspiration from the Verde River between Sullivan Lake and the confluence with the East Verde River (and including Oak Creek, Wet Beaver Creek and West Clear Creek) is approximately 35,000 acre-feet per year (Anderson 1976 in Owen-Joyce and Bell 1983). In the late 1960's an experiment was initiated to determine what reductions in evapotranspiration may be anticipated as a result of phreatophyte (water-loving plants) control. While a marginal increase in water yield may be realized, the negative effect of clearing cottonwood and mixed deciduous floodplain forests on breeding bird communities has

been dramatically indicated (Carothers and Johnson 1970, Carothers et al. 1974, Carothers and Johnson 1975). The effects of these manipulations on other wildlife groups is unknown.

The following describes the terrestrial and aquatic natural resources of Montezuma Castle, Montezuma Well and Tuzigoot with emphasis on plant communities, wildlife, sensitive species and Montezuma Well. It is summarized from the Natural and Cultural Resource Management Plans (1975, 1981, 1987) and other sources. Although these areas were established primarily to protect prehistoric and historic cultural resources, they also protect significant natural elements. The Montezuma Well ecosystem is apparently unique, without a known limnological analog (Cole 1982).

2. Plant Communities

Terrestrial plant communities have recently been mapped at all three areas (Ruffner Associates 1989). Seven distinct plant associations are recognized (Table 6).

Upland plant associations, the snakeweed - honey mesquite and creosote bush - crucifixion thorn Associations, are not strongly affected by surface waters. Wetlands, riparian forests, riparian woodlands and water resources are strongly inter-dependent, however. Hydrologic regime is known to affect riparian plant species and communities (e.g., Johnson et al. 1976, Reily and Johnson 1982, Turner and Karpiscak 1980). The mixed deciduous Association is best developed at Montezuma Castle along Beaver Creek and Montezuma Well along Wet Beaver Creek. The honey mesquite woodland Association occurs on the edge of floodplains at the Castle and Well. The pondweed Association is found only within Montezuma Well. Near Tuzigoot the Fremont cottonwood Association occurs along the Verde River and the cattail Association occurs in Tavaschi Marsh. Lists of typical plants of major habitat types are provided by Brown (1982).

3. Wildlife

A diversity of aquatic and terrestrial wildlife species are present in the Verde Valley. Birds, however, are probably the most commonly observed wildlife. Breeding bird density in undisturbed riparian habitats, particularly the Fremont cottonwood Association, is among the highest reported from North America. Breeding bird density is generally lower in habitats characterized by the mixed deciduous Association (Carothers et al. 1974). Lists of typical wildlife, fishes, amphibians, reptiles, birds and mammals, in major habitats are provided by Brown (1982).

A fishery dominated by introduced species exists in Wet Beaver Creek, Beaver Creek and the Verde River. Introduced species,

primarily gamefish, include smallmouth bass, largemouth bass, carp, green sunfish, yellow bullhead, channel catfish, flathead catfish, mosquito fish and flathead minnow. Rainbow trout, stocked by Arizona Game and Fish Department (AGFD), and brown trout occur in the upper reaches of Wet Beaver Creek (AGFD 1985). Native fishes include Sonora sucker, desert mountain sucker, spikedace, Colorado squawfish and razorback sucker.

Table 6. Biotic Communities of Montezuma Castle, including Montezuma Well, and Tuzigoot National Monuments Yavapai County, Arizona (Sensu Brown, 1982).

Warm Temperate Grasslands

Scrub - Grassland (Semidesert Grassland)

Shrub - Scrub Disclimax series

Snakeweed - Mesquite Association

Tropical - Subtropical Desertlands

Sonoran Desertscrub

Paloverde - Mixed Cacti (Arizona Upland) Series

Creosote Bush - Crucifixion Thorn Association

Warm Temperate Swamp and Riparian Forest

Interior Southwestern Riparian

Deciduous Forest and Woodland

Cottonwood - Willow Series

Fremont Cottonwood Association

Mixed Broadleaf Series

Arizona Sycamore - Velvet Ash - Fremont Cottonwood

- mixed deciduous Association

Tropical - Subtropical Swamp, Riparian and Oasis Forests

Sonoran Riparian and Oasis Forests

Mesquite Series

Mesquite Association

Tropical - Subtropical Marshland

Sonoran Interior Marshland

Cattail Series (Bulrush Series)

Cattail Association

Tropical - Subtropical Submergent Vegetation

Sonoran Inland Submergents

Pondweed Series

Pondweed Association

4. Rare, Threatened and Endangered Species

Several sensitive species, those protected or of special concern to the U.S. Fish and Wildlife Service (USFWS) and Arizona Game and Fish Department, are known from the Verde Valley. Arizona cliffrose is found on calcerous upland soils derived from the Verde Formation (Schaack and Morefield 1985). It is classified as endangered by USFWS. Suitable habitat for this plant exists at Montezuma Castle, Montezuma Well and Tuzigoot. It has not been documented, however, from any of these areas. It is probable that most activities associated with water resources management will have no adverse effect on this species. Southern bald eagle, another USFWS endangered species, is known to nest in the area. Wet Beaver Creek, Beaver Creek and the upper Verde River may be utilized by foraging eagles. Experimental populations of razorback sucker and Colorado squawfish have been re-introduced into the Verde River upstream of Clarkdale by AGFD. Spikedace are known from the Verde River upstream of Clarkdale. This species is classified as threatened by USFWS.

5. Montezuma Well

Montezuma Well is among the premier natural resources managed by NPS. It supports tens, if not hundreds, of taxa which are found no where else in the world. Many are not presently described. This unique characteristic was generally recognized when the Well was brought into the NPS system, however, its diversity and the complexity of interactions between organisms occupying this ecosystem are only now being recognized. Two long time workers, Dr. Gerald A. Cole and Dr. Dean W. Blinn believe that the Montezuma Well ecosystem may be globally unique. Cole (1982) and a composite list of publications by Blinn and his students are on file at monument headquarters.

G. Water Rights

Water rights to surface water in the Verde River watershed are currently being adjudicated in Superior Court of Maricopa County, Arizona. Issued in 1985, the summons requires all claimants of surface water rights in the watershed to file claims with the court. Groundwater users were also urged to file because of uncertainties regarding the hydraulic interconnections between groundwater and surface water. The NPS claims for Montezuma Castle, Montezuma Well and Tuzigoot include "All surface and ground water sources including creeks, springs, seeps and confined and unconfined aquifers within portions of the unit reserved or withdrawn from public domain and continuously administered by Federal agencies. This includes Beaver Creek and its unnamed tributaries." The claim at Montezuma Castle includes consumptive and non-consumptive uses of all groundwater wells and

surface waters. The Castle's water rights are reserved (pers. comm. O. Williams, NPS Water Resources Division). At Montezuma Well, two groundwater wells and the Wales Arnold Ditch are included in the claim. The NPS claims half the discharge from Montezuma Well for irrigation of lands within this Unit. Water rights for the Well unit are appropriative and reserved (Decree No. 3583; pers. comm. O. Williams, NPS Water Resources Division). The Tuzigoot claim includes only the Headquarters water system well. This unit's right is appropriative (pers. comm. O. Williams, NPS Water Resources Division)

H. Legal Jurisdictional Authority for Water Resources

Although the NPS is in the process of resolving water rights claims at these monuments, the rights were acquired when lands were withdrawn from the public domain, purchased by or donated to NPS. The Superintendent exercises proprietary jurisdiction over waters of these facilities.

The State of Arizona is recognized by NPS as the administering agency for water rights. The State also regulates water quality matters through ADEQ and the Water Quality Control Council. Finally, the Northern Area Council of Governments is the regional entity charged with developing and implementing the Verde River Water Quality Management Plan (1982).

I. Potable Water Supply Systems Summary

A summary of potable water supply systems for each unit is presented in Table 7.

J. Park Waste Disposal Systems

A summary of wastewater disposal systems for each unit is presented in Table 8.

K. Diversions

In the summer all or part of the flow of Beaver Creek above Montezuma Castle is diverted for irrigation (Owen-Joyce and Bell 1983). A number of current, historic and prehistoric irrigation ditches are also found in Montezuma Castle. Currently they are not mapped.

The ditch into which Montezuma Well discharges is one of several historic and prehistoric irrigation ditches present on the area. Currently, they are not mapped.

Table 7. Potable water supply systems at three NPS units in the Verde Valley, Yavapai County, Arizona.

UNIT/ Facilities Served	Raw Water Source	Treatment
MONTEZUMA CASTLE Interpretive Facility Picnic Grounds Employee Housing Maintenance	Well Verde Formation	Chlorinator
MONTEZUMA WELL Visitor Contact Point Picnic Grounds Employee Housing Maintenance	Well Verde Formation	Chlorinator
TUZIGOOT Museum/Administration Building Employee Housing Maintenance	Well Verde Formation	Chlorinator

Table 8. Wastewater treatment systems at three NPS units in the Verde Valley, Yavapai County, Arizona.

UNIT/ Facilities Served	Treatment	Comments
MONTEZUMA CASTLE Interpretive Facility Picnic Grounds Employee Housing Maintenance	Lined Sewage Lagoon Total Evaporation	Current capacity is one million gallons +; being considered for additional 957,000 gallons; 7,500 gallon septic tank provides 'primary' treatment;
MONTEZUMA WELL Visitor Contact Point Picnic Grounds Employee Housing Maintenance	Chemical Toilet Septic Tank Septic Tank Septic Tank	
TUZIGOOT Museum/Administration Building Employee Housing Maintenance	Septic Tank Septic Tank Septic Tank	

OBJECTIVES FOR WATER RESOURCES MANAGEMENT

A. Goals

The goals of this program are to restore or maintain natural aquatic and riparian environments in which physical, chemical and biologic processes function with as little artificial influence as possible and to inform all visitors and employees of riparian and aquatic resources, hazards and restrictions.

B. Objectives

- o To assure water rights claims are recognized.
- o To monitor the discharge of monument waters.
- o To monitor instream mining of sand, gravel and other minerals.
- o To provide background information and monitor the relationship between surface and ground waters in the Verde Valley.
- o To assure that Montezuma Well maintains its physical, chemical and biologic integrity.
- o To locate and document the magnitude and direction of changes in aquatic environments which are caused by upstream land use activities on private lands or by management activities, and to develop and implement management programs to mitigate those activities.
- o To monitor the quality of water entering and leaving the monuments with regard to compliance with local, State and Federal standards.
- o To comply with State and local water quality requirements at the monument's water and sewage systems.
- o To acquire sufficient knowledge about water quality and to provide information to State and local water management planning.
- o To detect and evaluate conditions or characteristics or external influences, particularly growth, land use and ground water development on properties adjacent to NPS areas.
- o To understand stream influences on riparian vegetation.

C. Specific Management Issues

1) Water rights and the Verde River adjudication.

Presently, water rights on the upper Verde River are being adjudicated in Maricopa County Superior Court. This process has been underway since 1985 and will possibly require several more years. It is necessary to keep informed on the adjudication process and aware of additional documentation which may be required by the Court.

2) Land acquisition.

Some lands within or adjacent to existing NPS areas are being considered for acquisition. These properties should be brought under NPS jurisdiction to enhance management and interpretive opportunities relating to water resources. The reason for excluding the tailings pile near Tuzigoot is to avoid the potential liability for spills or other impacts resulting from high flows in the Verde River and/or storm water runoff.

3) Instream mining.

Extraction of sand, gravel and other minerals from the floodplain may result in sediment transport, changes in channel configuration and alter stream course. Currently, no significant mining occurs upstream of Montezuma Castle, Montezuma Well or Tuzigoot which produces an adverse effect on NPS properties. Proposals from the private sector for instream mining should be closely monitored by NPS through Yavapai County Flood Control and the Regulatory Division of the Army Corps of Engineers.

4) Research at Montezuma Well.

Currently, the Superintendent requires all potential researchers to submit a proposal detailing the study's design, methods and expected significance. Potentially adverse effects of research efforts should be carefully evaluated prior to issuing permission to conduct research at the Well. Destructive sampling should be carefully justified.

5) Montezuma Well discharge.

In 1977, NPS contracted with USGS to initiate monitoring of discharge from the Well. This work provides NPS with a longterm record of continuous discharge measurements. A clearer understanding of the local aquifer and the aquifer(s) discharging into the Well would be very useful. This information could provide additional protection to the Well, particularly if additional ground water development to the north and west is proposed.

Res. rights?

How will monitoring discharge provide "protection"? Isn't a legal strategy required

- 6) Maintenance of adequate discharge to support riparian forest.

The large sycamore trees at Montezuma Castle are an integral component of each visitor's experience. Efforts should be undertaken to determine if adequate discharge is available from Beaver Creek to support these trees in the short term. Successional characteristics in riparian deciduous forests suggest that sycamore may not replace themselves over the long term.

- 7) Adjacent development influences on water quantity and quality.

The Verde Valley is growing rapidly. Private lands adjacent to NPS areas may be developed in the future. The effect of proposed development on water quantity, water quality and riparian resources should be evaluated.

PROGRAM IMPLEMENTATION

Specific actions regarding water resources at Montezuma Castle, Montezuma Well and Tuzigoot will be considered as monitoring, administration, research or mitigation. Some water resources issues (e.g., non-point pollution) may warrant simultaneous monitoring, administration research and mitigation activities. The water resources plan and supporting project statements (Appendix C), are reviewed annually by the Superintendent to assure that actions facilitate prudent management of water resources.

A. Monitoring

This program includes evaluation of water delivery monitoring systems within the Well Unit (Appendix C). Surface water discharge measurements and water quality analyses from domestic water wells and waste water treatment are on-going monitoring activities being conducted by the Superintendent and his staff. In the future it may be necessary to consider instream mining upstream from the units and adjacent development influences in an expanded monitoring program.

Measurement of discharge from waters of Montezuma Castle, Montezuma Well and Tuzigoot is being conducted by USGS. One station, Montezuma Well, is maintained under cooperative agreement with NPS. Other gaging stations in the Verde Valley are maintained by USGS and other cooperators however, these data are available to NPS.

Water quality analyses will be conducted at selected USGS gaging stations within the Verde Valley and at a network of fixed stations established by ADEQ. Groundwater quality is monitored

only insofar as it pertains to maintaining potable domestic water supplies.

B. Administration

The administrative project statement addresses preparation of a grazing management plan for the Well Unit (Appendix C). Regulatory compliance with relevant State statues addressing potable water and waste water systems is an on-going administrative action of the Superintendent and staff. Additional project statements addressing water rights, the Verde River adjudication and a formal protocol to administer research at Montezuma Well could be developed.

C. Research

Twelve project statements at Montezuma Castle and six at Tuzigoot address research activities relating to water resources. At Montezuma Castle research activities are focused on identity and inventory of water-related resource attributes, adjacent land use, inventory of Montezuma Well and environs, riparian ecosystem research, wetland delineation and protection, hydrologic characteristics of the archaeological and historic setting, identity of flood prone areas, effects of hydrologic characteristics on stream morphology, evaluation of hydrologic characteristics on regeneration of riparian vegetation and mapping of historic and prehistoric irrigation systems (Appendix C).

The NPS is supporting three on-going projects related to riparian vegetation in addition to on-going studies of Montezuma Well by Dr. Dean Blinn and associates.

D. Mitigation

To date no project statements have been developed which address mitigation of water-related attributes at Montezuma Castle. These could be developed in the future if dictated by external land uses, changes in internal land uses or in the event that current monitoring and research projects identify a need for mitigation. A mitigation project to preserve and restore the prehistoric scene has been developed at Tuzigoot.

E. Project Statement Descriptions and Programming Sheets

Prepare an Agricultural Use Plan (MOCA-N-08)

A 27 acre pasture is leased for grazing. The purpose of this lease is to maintain the presence of historical agriculture onsite and the water rights for Montezuma Well. The NPS is in the process of preparing an environmental assessment to discuss

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the agricultural use options for this pasture, including a non use option.

Identify and Inventory Water - Related Resource Attributes (MOCA-N-10)

Existing data regarding the relationship of water to the resources of the monument is incomplete, and perhaps inadequate. The first step to correct this is identifying and inventorying the nature and magnitude of resource attributes that are affected by, or dependent upon, surface and subsurface waters. The possibility of future impact to water-related resource attributes exists because of potential development adjacent to the Castle and Well units. Water removal from aquifers underlying the monument or alterations in surface flow regimes of tributaries are likely to affect water-related resource attributes

Evaluate Water Delivery Monitoring System (MOCA-N-11)

Rights to the use of water from Montezuma Well are held by the NPS and other users downstream. The system presently used to monitor deliveries to NPS and other water rights holders downstream should be evaluated to assure that partitioned water rights are being fairly and correctly metered.

Analysis of Adjacent Land Use and Status (MOCA-N-12)

The Verde Valley is growing rapidly. Rapid growth increases the rate and complexity of resource management issues to be addressed by the Superintendent and his staff. These concerns are magnified by the needs of two disjunct management units encompassing 870 acres. A land use study of monument and adjacent lands will be conducted. The objectives are to compare past and present land use patterns, evaluate present utilization conflicts and identify resource concerns currently impacting the monument. This project will also attempt to develop a system for quantifying the potential risks associated with each resource concern.

Inventory the Basic Natural Resources of Montezuma Well and Adjacent Riparian and Terrestrial Habitat (MOCA-N-13)

Montezuma is a spring fed limnocrone nearly circular in shape with a diameter of approximately 360 feet. It supports a unique assemblage of endemic organisms and has no known ecological equivalents. Increasing visitation, growth and changing land use patterns present potential threats to the long-term protection of this resource. A Resources Basic Inventory will provide the Superintendent with information on occurrence and status of endemic species in the Well and some aspects of their life history. This study will also indicate what species of native and alien organisms are present and provide an understanding of

relationships among the aquatic, riparian and terrestrial components of the ecosystem.

Identify and Inventory Aquatic Organisms and Their Habitat Requirements at Montezuma Well (MOCA-N-14)

The aquatic organisms endemic to Montezuma Well are water-related resource attributes of major significance. It is not unreasonable to anticipate that changes in water quantity and quality could occur due to development in locations peripheral to the site. An inventory of aquatic organisms and their habitat requirements at Montezuma Well will be studied. This effort could require assessment of residence time of water in the Well, water surface elevation, water quality, organism habitat requirements, changes in water quantity and off-site activities that could impact water quantity or quality. The project requires an interdisciplinary perspective.

Conduct Riparian Ecosystem Research (MOCA-N-15)

Riparian resources are of major management concern at Montezuma Castle and Montezuma Well. This effort will focus on an inventory and assessment of natural riparian resources and assessment of past, current and proposed management activities impacting riparian resources. Emphasis will be placed on ecological components, e.g. indicator species, that are of particular concern to interpreters and managers. Hydrologic and soil parameters important to riparian vegetation will be evaluated. Demography, distribution and health of riparian tree and shrub populations will be analyzed. The relationship between riparian habitats and major vertebrate groups will be assessed.

Delineate and Evaluate Strategies for Wetlands Protection (MOCA-N-17)

Wetlands, as defined by the Army Corps of Engineers, that have not been evaluated or delineated exist within both units of Montezuma Castle. External factors are impacting the quality and quantity of these water-related resources. A series of maps delineating wetlands will be compiled. Subsurface water movement, stability, stream dynamics, erosion potential and other hydrologic parameters are to be evaluated. Possible threats to wetland resources will be assessed to develop action oriented strategies. This effort is interdisciplinary in scope.

Protect the Hydrologic Characteristics of the Archaeological and Historical Setting at Montezuma Well (MOCA-N-18)

While discharge from the Well is being monitored, no information has been collected which addresses water surface elevation or inflow. A comprehensive hydrologic characterization of the groundwater system supporting and maintaining the Well will be

conducted. This information will make it possible to evaluate impacts of existing and potential off-site development on the Well through the use of mathematical modeling.

Identify Flood-Prone Areas for Protection of Lives and Property (MOCA-N-19)

Important visitor attractions are found in close proximity to active floodplains. The flood hazard assessment will identify areas within both units of Montezuma Castle that lie within the limits of selected design floods including the probable maximum flood. This information will ensure that public health and safety are protected from unreasonable exposure to flood hazards. This project will also include evaluation of potential mitigation measures.

Evaluate Effects of Hydrologic Characteristics on Morphological Properties of Flowing Streams (MOCA-N-31)

Stream channel features within Montezuma Castle, Beaver Creek and Wet Beaver Creek, are associated with water-related resource attributes such as the historic and prehistoric habitations. These quantifiable features can be dramatically modified through human-induced changes in the hydrologic regime. Characterization of existing channel features, sediment transport and modeling of existing and potential flow regimes will be undertaken.

Evaluate Effects of Hydrologic Characteristics on Regeneration of Vegetation in Riparian Areas (MOCA-N-32)

Hydrologic characteristics of streams, e.g. the periodicity of over-bank discharge, can strongly effect regeneration of riparian vegetation. This study will characterize existing hydrology, channel features, depth to subsurface water in the floodplain, sediment transport, existing flow regimes and potential flow regimes. The potential for change in any one, or several, of these characteristics may already exist or could arise due to off-site water development or on-site human impacts.

Conduct Inventory and Assessment: Fishes (MOCA-N-14)

The native fish fauna of Wet Beaver Creek and Beaver Creek has been modified by water development and introduction of alien fishes. Native fishes of these streams will be inventoried using non-destructive sampling. Seasonal sampling will allow inferences regarding relative abundance, habitat preferences, natural history and potential threats. These stream segments will be evaluated to determine if there are opportunities to re-introduce native species which have been extirpated.

Study of Montezuma Castle Irrigation System (MOCA-N-06)

Indian and European inhabitants of the Verde Valley relied on a network of irrigation ditches to deliver water to fields. However the system has not been systematically studied. Past records of canal systems will be gathered, existing aerial photography will be reviewed and new photography taken as needed. Visible canal systems will be mapped. Exposed canals will be examined and additional segments will be exposed and sectioned to examine mineral deposits and estimate discharge.

Identify and Inventory Water - Related Resource Attributes (TUZI-N-05)

Existing data regarding the relationship of water to the resources of the monument is incomplete, and perhaps inadequate. The first step to correct this is identifying and inventorying the nature and magnitude of resource attributes that are affected by, or dependent upon, surface and subsurface waters. The possibility of future impact to water-related resource attributes exists because of potential development adjacent to Tuzigoot. Water removal from aquifers underlying the monument or alterations in surface flow regimes of tributaries are likely to affect water-related resource attributes.

Restore Tavaschi Marsh (TUZI-N-06)

The marsh has been privately owned for a number of years, however, the NPS and Phelps Dodge Corporation have discussed the possibility of adding this feature to Tuzigoot. A feasibility study will address potential concerns including the marsh's ecological viability, affects of previous land uses, water quality issues and jurisdictional liabilities. This effort will be completed by an interdisciplinary team.

Analyze Adjacent Land Use and Status (TUZI-N-07)

The Verde Valley is growing rapidly. Rapid growth increases the rate and complexity of resource management issues to be addressed by the Superintendent and his staff. A land use study of monument and adjacent lands will be conducted. The objectives are to compare past and present land use patterns, evaluate present utilization conflicts and identify resource concerns currently impacting the monument. This project will also attempt to develop a system for quantifying the potential risks associated with each resource concern.

Delineate and Evaluate Strategies for Wetland Protection (TUZI-N-08)

Wetlands, as defined by the Army Corps of Engineers, that have not been evaluated or delineated exist adjacent to Tuzigoot.

External factors are impacting the quality and quantity of this water-related resource. A series of maps delineating wetlands will be compiled. Subsurface water movement, stability, stream dynamics, erosion potential and other hydrologic parameters are to be evaluated. Possible threats to wetland resources will be assessed to develop action oriented strategies. This effort is interdisciplinary in scope.

Conduct Riparian and Wetland Ecosystem Research (TUZI-N-09)

Riparian and wetland resources are of major management concern. This effort will focus on an inventory and assessment of natural riparian resources and assessment of past, current and proposed management activities impacting riparian resources. Emphasis will be placed on ecological components, e.g. indicator species, that are of particular concern to interpreters and managers. Hydrologic and soil parameters important to riparian vegetation will be evaluated. Demography, distribution and health of significant perennial plant populations will be analyzed. The relationship between riparian habitats and major vertebrate groups will be assessed.

Preserve and Restore the Prehistoric Scene (TUZI-N-05)

The acquisition of lands for addition to Tuzigoot National Monument is the objective of this project. It would preserve and restore the prehistoric scene and setting immediately to the east of the existing monument. This area includes riparian habitats, prehistoric croplands, desert uplands and Tavaszi Marsh.

F. Programming Sheets

On the following pages are the programming sheets showing the projects listed above.

1. Funded Natural Resources Activities for Montezuma Castle

NATURAL RESOURCES
 PROGRAMMING SHEET 1
 FUNDED ACTIVITIES
 (\$ in Thousands)

FY: 89
 Park: MOCA
 Region: WESTERN

Issue Code	Cult. Res. Code	RMP Proj #	Project Title	Fund Source Code	Actv. Type Code	Current FY \$ / FTE	Funding/FTE's		
							Out Year 1 \$ / FTE	Out Year 2 \$ / FTE	Out Year 3 \$ / FTE
N04		N08	Prepare a Grazing Management Plan	NF2	ADM	\$2.0/.1	\$2.0/.1	\$2.0/.1	\$2.0/.1

2. Unfunded Natural Resources Activities for Montezuma Castle

NATURAL RESOURCES
PROGRAMMING SHEET 2
PRIORITIZED UNFUNDED ACTIVITIES
(\$ in Thousands)

FY: 89
Park: MOCA
Region: WESTERN

Issue Code	Cult. Res. Code	RMP Proj #	Project Title/Priority	Fund Source Code	Actv. Type Code	Start Year \$ / FTE	Funding/FTE's		
							Out Year 1 \$ / FTE	Out Year 2 \$ / FTE	Out Year 3 \$ / FTE
N20		N10	Identify and Inventory Water-Related Resource Attributes / 2	NF8	RES	\$15/0	\$0/0	\$0/0	\$0/0
N13		N11	Evaluate Water Delivery Monitoring System / 3	NF8	MON	\$10/0	\$0/0	\$0/0	\$0/0
N16		N12	Analysis of Adjacent Land Use and Status / 4	NF3	RES	\$30/0	\$0/0	\$0/0	\$0/0
N20		N13	Inventory the Basic Natural Resources of Montezuma Well and Adjacent Riparian and Terrestrial Habitat / 5	NF3	RES	\$22/.7	\$10/.4	\$0/0	\$0/0
N20		N14	Identify and Inventory Aquatic Organisms and Their Habitat Requirements at Montezuma Well / 6	NF3	RES	\$25/0	\$22/0	\$18/0	\$0/0
N12		N15	Conduct Riparian Ecosystem Research / 7	NF3	RES	\$11.8/.4	\$0/0	\$0/0	\$0/0
N12		N17	Delineate and Evaluate Strategies for Wetland Protection / 9	NF8	RES	\$9/0	\$0/0	\$0/0	\$0/0
N08		N18	Protect Hydrologic Characteristics of the Archeological and Historical Setting at Montezuma Well / 10	NF8	RES	\$50/0	\$40/0	\$40/0	\$0/0
N23		N19	Identify Flood-Prone Areas for Protection of Lives and Property / 11	NF8	RES	\$35/0	\$0/0	\$0/0	\$0/0
N12		N31	Evaluate Effects of Hydrologic Characteristics on Morphological Properties of Flowing Streams / 23	NF3	RES	\$30/0	\$10/0	\$0/0	\$0/0
N06		N32	Evaluate Effects of Hydrologic Characteristics on Regeneration of Vegetation in Riparian Areas / 24	NF3	RES	\$35/0	\$20/0	\$30/0	\$0/0
N20		N34	Conduct Inventory and Assessment: Fishes / 26	NF3	RES	\$3/.1	\$3/.1	\$0/0	\$0/0

3. Unfunded Cultural Resources Activities for Montezuma Castle

CULTURAL RESOURCES
 PROGRAMMING SHEET 2
 PRIORITIZED UNFUNDED ACTIVITIES
 (\$ in Thousands)

FY: 89
 Park: MOCA
 Region: WESTERN

Issue Code	Cult. Res. Code	RMP Proj #	Project Title/Priority	Fund Source Code	Actv. Type Code	Start Year	Funding/FTE's		
							Out Year 1	Out Year 2	Out Year 3
						\$ / FTE	\$ / FTE	\$ / FTE	\$ / FTE
C03	SITE	C06	Study of Montezuma Castle Irrigation System / 6	CF5	RES	\$15/.5	\$0/0	\$0/0	\$0/0

4. Unfunded Natural Resources Activities for Tuzigoot

NATURAL RESOURCES
PROGRAMMING SHEET 2
PRIORITIZED UNFUNDED ACTIVITIES
(\$ in Thousands)

FY: 89
Park: TUZI
Region: WESTERN

Issue Code	Cult. Res. Code	RMP Proj #	Project Title/Priority	Fund Source Code	Actv. Type Code	Start Year	Funding/FTE's		
							Out Year 1	Out Year 2	Out Year 3
						\$ / FTE	\$ / FTE	\$ / FTE	\$ / FTE
N20		N05	Identify and Inventory Water-Related Resource Attributes / 2	NF8	RES	\$25/0	\$25/0	\$25/0	\$0/0
N20		N06	Restore Tavascki Marsh / 3	NF3	RES	\$59/0.8	\$48/0.6	\$33/0.6	\$0/0
N16		N07	Analysis of Adjacent Land Use and Status / 4	NF3	RES	\$10/0	\$10/0	\$7/0	\$0/0
N12		N08	Delineate and Evaluate Strategies for Wetland Protection / 5	NF8	RES	\$20/0	\$30/0	\$33/0	\$0/0
N12		N09	Conduct Riparian and Wetland Ecosystem Research / 6	NF3	RES	\$7/0.02	\$7/0.02	\$12/0.03	\$14/0.4

5. Unfunded Cultural Resources Activities for Tuzigoot

CULTURAL RESOURCES
PROGRAMMING SHEET 2
PRIORITIZED UNFUNDED ACTIVITIES
(\$ in Thousands)

FY: 89
Park: TUZI
Region: WESTERN

Issue Code	Cult. Res. Code	RMP Proj #	Project Title/Priority	Fund Source Code	Actv. Type Code	Start Year	Funding/FTE's		
							Out Year 1	Out Year 2	Out Year 3
						\$ / FTE	\$ / FTE	\$ / FTE	\$ / FTE
C13	SITE	C05	Preserve and Restore the Prehistoric Scene / 1	CF12	MIT	Land Acquisition Funding Needs are Uncertain. Legislative Ceiling is \$1,350,000			

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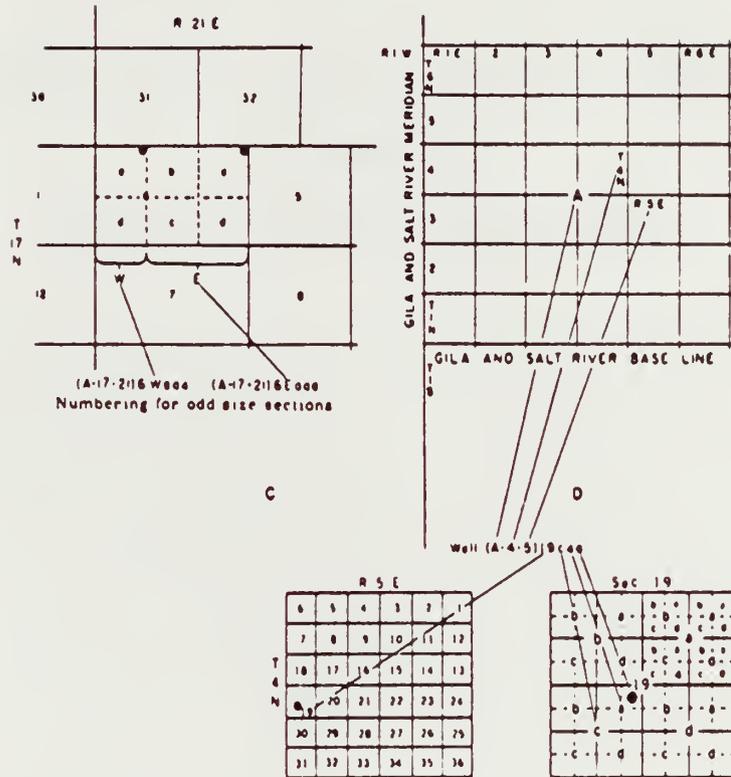
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Appendix A
Well-number System in Arizona

Appendix A.

Well-numbering system in Arizona



The well numbers and letters used by the Geological Survey in Arizona are in accordance with the Bureau of Land Management's system of land subdivision. The land survey in Arizona is based on the Gila and Salt River meridian and base line, which divide the State into four quadrants. These quadrants are designated counterclockwise by the capital letters A, B, C, and D. All land north and east of the point of origin is in A quadrant, that north and west is in B quadrant, that south and west in C quadrant, and that south and east in D quadrant. The first digit of a well number indicates the township, the second the range, and the third the section in which the well is situated. The lowercase letters a, b, c, and d after the section number indicate the well location within the section. The first letter denotes a particular 160-acre tract, the second the 40-acre tract, and the third the 10-acre tract. These letters are also assigned in a counterclockwise direction, beginning in the northeast quarter. If the location is known within the 10-acre tract, three lowercase letters are shown in the well number. In the example shown in figure 2, well number (A-4-5)19caaa designates the well as being in the NE 1/4 NE 1/4 SW 1/4 sec. 19, T. 4 N., R. 5 E. Where there is more than one well within a 10-acre tract, consecutive numbers beginning with 1 are added as suffixes.

When a section is more than 1 mile in any dimension, the section number applies as usual. The oversized section is divided so that a full square-mile unit of the section is adjacent to a normal section within the same township; the remainder is considered as a separate unit of land. Appropriate N., S., E., or W. letters are assigned to the units, depending upon where they lie in relation to the full square-mile unit. A well would be designated as shown in figure 2 with the appropriate letter following the section number in which the well is located.

Appendix B

Glossary

Appendix B

Glossary

Terms used in this report are defined below. The definitions were adapted from the American Geological Institute (1976), and Owen-Joyce and Bell (1983).

Alluvium - Detrital deposits resulting from the operations of modern rivers, thus including the sediments laid down in river beds, floodplains, lakes, fans at the foot of mountain slopes and estuaries.

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

Base flow - Ground water that has been discharged into a stream channel as spring or seepage water.

Ephemeral stream - A stream or reach of a stream which flows only in direct response to precipitation.

Evaporites - Sediments which are deposited from an aqueous solution as a result of extensive or total evaporation of a solvent.

Evapotranspiration - Water withdrawn from a land area by evaporation from water surfaces and moist soil and by plant transpiration.

Fluvial - Of, or pertaining to, rivers; growing or living in streams or ponds; produced by river action as, a fluvial plain.

Ground-water divide - A ridge in the water table or other potentiometric surface from which ground water moves away in both directions.

Hydraulic conductivity - The volume of water that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow. Hydraulic conductivity describes the ability of the aquifer material to transmit water and may have substantially different values for horizontal and vertical flow through the same material.

Hydraulic connection - The process by which movement between surface waters and ground water aquifers occurs.

Hydraulic gradient - The change in head per unit of distance in a given direction.

Lacustrine - Pertaining to, produced by or forming in a lake or lakes.

Limnocene - A pooled spring, frequently occurring in limestone.

Perennial stream - One which flows continuously.

Regional aquifer - The surface and ground waters of the study area. Large scale hydraulic connections facilitate movement of water regionally.

Transmissivity - The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. Transmissivity describes the ability of the entire thickness of an aquifer to transmit water and is the product of hydraulic conductivity and saturated thickness.

Water table - The surface in an unconfined aquifer below which the rocks are saturated with water. The water table is the level at which water stands in wells that penetrate the uppermost part of an unconfined aquifer.

Appendix C
Project Statements

PROJECT STATEMENT

1. Project Number: MOCA-N-08

2. Project Title: Prepare a Grazing Management Plan

3. Service Issue(s):

N19 - Loss of Park Resources Due to Consumptive Practices
(hunting, fishing, commercial fishing, grazing)

N03 - Impacts on Threatened, Endangered and Other Sensitive
Plants

4. Problem Statement: A 27 acre pasture is leased for agricultural uses, i.e., grazing, for the purpose of maintaining water rights. The acreage is within the floodplain of Wet Beaver Creek and is irrigated under an adjudicated water right from Montezuma Well. The current lessee maintains 22 head of cattle from April 1 through November 30 and five head of cattle from December 1 through March 31. All irrigation ditches within the monument boundaries are maintained by the permittee, with a minimum of two hand-clearings of the ditches per year. The use of monument waters is limited to the adjudicated water right for the subject parcel. Currently, the use pattern is that water is diverted from the ditch onto the lease for a period of eight days and then sent downstream to meet the demands of other adjudicated water right holders for the following eight days. The permittee maintains all fences. Upon termination of the lease, any improvements become the property of NPS.

The pasture is comprised of native and alien grasses, which appear to be under-utilized by the current stocking levels. Grazing impacts on vegetation, subsurface cultural resources and health and safety of visitors and park employees and visitors are negligible. The potential for an insect nuisance and degradation of water quality via return flows to Wet Beaver Creek exist; however, these issues have not been identified as management concerns by visitors, park staff or downstream residents.

5. Alternative Actions/Solutions and Their Probable Impacts:

a. No Action. This alternative entails maintaining the existing grazing lessee at currently authorized grazing levels. This alternative is precluded by Federal requirements for competitive leasing for special park uses, including agriculture and grazing.

b. Issue New Special Use Permit at Existing AUM's. A new special use permit would be issued following a competitive bidding procedure. The permittee would be limited to grazing 22 head of cattle for the period April 1 through 30 November and five head from 1 December through 31 March. Impacts resulting from this alternative include a competitive bidding process to select the permittee, potential under-utilization of the existing resource and an additional time commitment by NPS personnel to develop a new special permit.

c. Develop a Grazing Management Plan. This alternative calls for a production - utilization study to determine the carrying capacity, in AUM's, of the meadow and identify management actions (i.e., mowing, burning) to ensure continuing productivity of the pasture. A special use permit would be issued through a competitive bidding process. Impacts resulting from this alternative include the need for a production-utilization evaluation, a competitive bidding process to select the permittee, and an additional time commitment by NPS personnel to obtain and orient a new leasee.

d. Assess Alternative Land Uses. This alternative could include an alternative low-impact agricultural operation such as a haying meadow, or utilizing the area to provide open space, or allowing the area to return to natural conditions as the adjacent riparian land. In the event that a change in use is decided upon, an evaluation of possible effects on the NPS water right should be made prior to any physical action. Impacts resulting from this alternative may include the need for vegetation management to assure maintenance of the agricultural field. Vegetation changes expected without management may result in degradation of cultural features such as irrigation ditches by roots of perennial woody plants. An alternative agricultural operation could provide maintenance of the existing meadow scene, however, farm machinery may adversely impact cultural resource features, particularly if active cultivation is approved. Finally, this approach may provide a source for alien forage plants to become established within sections of the Well unit.

6. Description of the Recommended Project or Activity: Option c. is the recommended solution for this issue. The contract should have a cancellation clause to allow NPS maximum management flexibility. A permittee will be obtained by competitive bid and will bear all costs associated with fencing, general maintenance of the tract, and physical aspects of the water distribution system. Authority for this process is presented in NPS Guideline 53 for special park uses, including agricultural use. Additionally, the superintendent may choose to request that the Water Resources Division, Washington Office, evaluate the feasibility of modifying the existing adjudicated water right to facilitate alternative land uses. The superintendent will orient the permittee to assure that his operations are in compliance

with NPS management goals for the pasture area within the Well unit. The permittee will bear all costs associated with fencing, maintenance, assuring reliable delivery of waters, and meeting NPS obligations to downstream water users. The program will be implemented in the fall of 1989 to allow adequate time to select a new leasee. The new lease will begin January 1, 1990. Costs for maintaining the special use on the 27 acre parcel are to be borne by the permittee. Funding within the park does not exist to support this function other than to provide administrative support to complete the permit process. All associated operations and maintenance costs, including liability insurance, are to be borne by the permittee.

7. Compliance: This project will require an environmental assessment, which will be prepared individually for this specific action. NHPA compliance under Section 106 will likely also be required for this project.

8. Relationships: This project is related to four other projects listed in this plan. These are as follows:

- MOCA-N-21 Conduct Inventory and Assessment: Vegetation and Flora
- MOCA-N-29 Examination of Old Fields
- MOCA-N-30 Establish Program for Long-Term Monitoring of Cultural/Natural Setting
- MOCA-C-23 Obtain Historic Photographs of Montezuma Castle

9. Funding Requirement:

Costs for maintaining the special use on the 27 acre parcel are to be borne by the permittee. Funding within the park does not exist to support this function. Administrative functions necessary to complete the permit process are within the existing park base. This effort currently costs \$2,000 per year in salaries and support.

10. Annual Project Status and Accomplishments: This report will be initiated once final determination is made by WASO on the proper Servicewide format.

PROJECT STATEMENT

1. Project Number: MOCA-N-10

2. Project Title: Identify and Inventory Water-Related Resource Attributes

3. Service-wide Issue(s):
 - N20 - Lack of Basic Data: Insufficient Understanding of Park Ecosystems and Threats to Them
 - N11 - Degradation of Park Water Quality Due to External Activities
 - N12 - Alteration of Natural Flow Regimes/Groundwater Levels

4. Problem Statement: The water-related resource attributes of the monument have not been fully identified. The identification and inventory are needed to both identify the possibility of impact and to measure its magnitude, in the event impact does occur. This information will be required in water rights litigation or in any other similar arena in which the NPS seeks relief from such impact to protect the monument for the purposes for which it was created.

At present there exists an incomplete, and perhaps inadequate, understanding of the relationship of water to the resources of the monument. The first step in developing this understanding is identifying and inventorying the nature and magnitude of resource attributes that are affected by or dependent upon water, both surface and subsurface.

The possibility of future impact to water-related resource attributes exists because of residential and commercial development which is increasing in locations peripheral to the site. Water withdrawals from aquifers underlying the monument or alterations in surface water flow regimes are likely to affect water-related resource attributes. Without an identification and inventory, assessments to arrest and reverse effects will be delayed resulting in additional or longer-lasting effects.

5. Alternative Actions/Solutions and their Probable Impacts:
 - a. No Action. This action would leave the monument without an adequate data base to protect its water rights or to understand the relationships between water resources of the monument and early man's activities at the site. Water resource attributes might be lost under such stewardship.

b. Conduct a Thorough Inventory of All Water-related Resource Attributes in Montezuma Castle National Monument. Such a study will give the superintendent an adequate data base from which to make informed management decisions and to protect water rights. Such results will also be of use to all other resource related inventories conducted at the monument.

6. Description of the Recommended Project or Activity: Option b. is the recommended solution for this issue. The identification and inventory of water-related resource attributes will require a technical assessment of natural resources and scientific literature. This project will be best undertaken by an interdisciplinary team working as a unit. Field and office assessments will result in summary reports, maps and atlases. When completed, additional projects and/or studies may be required to evaluate the nature and magnitude of the relationship between water and water-related resource attributes.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least eight other projects listed in this plan. These are as follows:

MOCA-N-11	Evaluate Water Delivery Monitoring System
MOCA-N-12	Analysis of Adjacent Land Use and Status
MOCA-N-13	Inventory the Basic Natural Resources of Montezuma Well and Adjacent Riparian and Terrestrial Habitat
MOCA-N-14	Identify and Inventory Aquatic Organisms and Their Habitat Requirements at Montezuma Well
MOCA-N-15	Conduct Riparian Ecosystem Research
MOCA-N-16	Conduct Visitor Use Survey
MOCA-N-19	Identify Flood-Prone Areas for the Protection of Lives and Property
MOCA-N-31	Evaluate Effects of Hydrologic Characteristics on Morphological Properties of Flowing Streams

9. Funding Requirements:

Project Contract - \$15,000

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on a project.

PROJECT STATEMENT

1. Project Number: MOCA-N-11
2. Project Title: Evaluate Water Delivery Monitoring System
3. Service-wide Issue(s):

N13 - Lack of Secure Water Rights

N20 - Lack of Basic Data: Insufficient Understanding of Park Ecosystems and Threats to Them

4. Problem Statement: Rights to the use of the water yield from Montezuma Well are held by the NPS and others. The rights held by the NPS are used for administrative purposes and historic irrigation. The existing system for monitoring the delivery of water to parties having rights thereto is inadequately installed. The result of this installation inadequacy is a poor data set and possibly inappropriate apportionment of available water. Further, this data inadequacy may place the NPS in an undesirable position if it were to be involved in water rights-related litigation.

Population increases have occurred in this area as in many others in the southwest. Consequently, residential and commercial development have been steadily increasing in locations peripheral to the site. The nature and effect of increased water use and consumption associated with this development are presently unknown. However, it may be that water is being removed from the natural avenues of surface and subsurface water delivery that supply the 'Well'. If a significant diminution in water delivery occurs, the water rights of the United States may be impaired.

5. Alternative Actions/Solutions and their Probable Impacts:

a. No Action. This option would require that the monument continue to operate its water rights partitioning program under a antiquated delivery system that has not been monitored or evaluated for accuracy for many years.

b. Evaluate Water Monitoring System. Conduct an evaluation of the water monitoring system to ensure that the partitioned water rights are being fairly and correctly metered. The effects of population growth in the Verde Valley on spring flow also needs to be evaluated.

6. Description of the Recommended Project or Activity: Option b. is the recommended solution for this issue. Improving the water delivery monitoring system requires a careful analysis of all existing data, construction of a new monitoring system, and the correlation of old with new discharge data. This project will require some facility construction and the development of rating curves.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least four other projects listed in this plan. These are as follows:

MOCA-N-18 Protect the Hydrologic Characteristics of the
Archeological and Historical Setting at Montezuma Well
MOCA-N-29 Examine Old Fields
MOCA-C-06 Study Montezuma Castle Irrigation System
MOCA-C-16 Prepare Historic Structures Preservation Guide:
Prehistoric Structures

9. Funding Requirements:

Research Contract - \$10,000

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on a project.

PROJECT STATEMENT

1. Project Number: MOCA-N-12
2. Project Title: Analysis of Adjacent Land Use and Status.
3. Servicewide Issue(s):

- N16 - Visual and Biological Impacts of Urbanization and Other Near-Park Development on Park Resources
- N11 - Degradation of Park Water Quality Due to External Activities
- N12 - Alteration of Natural Flow Regimes/Groundwater Levels

4. Problem Statement: The Verde Valley of Arizona has an enormous array of recreational opportunities. According to Marshall A. Worden in the publication Papers in Community and Rural Development, 1981, "the Verde valley may well contain the greatest density of different types of vacation or recreational experiences of any similarly sized area in Arizona". Tourism at the Castle alone last year exceeded 657,000 people. Concomitant local population growth has also increased dramatically as economic employment opportunities increased. Consequently, the diversification of land use practices are changing at an alarming rate. Accelerated growth increases the frequency and complexity of resource issues while simultaneously reducing the amount of time that management has to react to resource concerns. In addition, having two discontinuous management districts of less than 870 acres magnifies the degree of danger associated with each potential threat. The ingredients and characteristics that have created such an unusually rich and diverse environment for resource concerns are many.

A few examples of nearby land uses are: urbanization, aggregate mining, surface water diversions, agriculture, grazing, ranching, and recreational opportunities such as camping, golf, fishing, horseback riding, and swimming. These activities are impacting cultural, water and other natural resources at Montezuma Castle, Montezuma Well and along Beaver Creek and its tributaries.

Beaver creek, a significant part of the historic scene and a major tributary of the Verde River, meanders southward approximately 10 miles from the well before joining the Verde River from the North. Six river miles upstream from its mouth, Beaver Creek passes Montezuma Castle. The castle is the best preserved example of cliff dwellings remaining from an extinct Sinaguan culture.

Dry Beaver Creek flows adjacent to Montezuma Well and is located about six miles upstream of the confluence of Wet Beaver Creek and Beaver Creek. Continued expansion of nearby population centers prompts concern for protection of this valuable resource.

Without the basic baseline information necessary for assessing future changes in the area's hydrological regime and proximate land utilization factors the historic and cultural scenes cannot be maintained adequately. An analysis of adjacent land use is a prerequisite step in determining the degree and magnitude of factors that may influence management's ability to resolve or anticipate potential resource utilization conflicts. Preliminary indications suggest that recent habitat conversions have already resulted in a loss of biological diversity and are impacting the adjacent riparian corridor.

5. Alternative Actions/Solutions and Their Probable Impacts:

a. Analysis of Adjacent Land Use and Status. Contract a Land Use research study that compares past and present land use patterns, evaluates present utilization conflicts and resource concerns that are currently impacting the monument. This project should also attempt to develop a system that quantifies the potential risks associated with each resource threat or concern.

b. No Action. With this action the monument will have to continue to operate without being able to estimate or predict significant external threats resulting from changing land use patterns. This places management in a difficult position of trying preserve and protect a cultural landmark without knowledge of existing external threats.

6. Description of the Recommended Project or Activity: Option

a. is the recommended solution for this issue. Let a research contract to document and map existing land uses, evaluate historical patterns of land use, and identify external threats resulting from adjacent land use practices. This would entail a three part research study as follows:

1) Identify issues, concerns, and opportunities by a) developing land utilization maps that illustrate present uses, historical changes, and legal land status; and b) developing a research program to quantify and evaluate potential threats resulting from land use conflicts.

2) Analyze the management situation and assess the risk level stemming from each external threat attributed to a land use pattern or concern.

3) Develop a cost effective monitoring protocol system for monument staff to reevaluate external threats on a periodic

basis. Recommend management actions to mitigate, or if possible eliminate, external threats stemming from external land uses. Make recommendations on how to develop community awareness programs through interpretive and outreach programs.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project will support the numerous other management activities or projects listed herein that evaluate or monitor the condition of the culture and natural resources of the monument. They are too numerous to list here. etc.

9. Funding Requirements:

Research Contract - \$30,000

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on a project.

PROJECT STATEMENT

1. Project Number: MOCA-N-13

2. Project Title: Inventory the Basic Natural Resources of Montezuma Well and Adjacent Riparian and Terrestrial Habitat

3. Service Issue(s):

N20 - Lack of Basic Data: Insufficient Understanding of Park Ecosystems and Threats to Them

4. Problem Statement: Montezuma Well is a unique, spring fed lake nearly circular in shape, with a diameter of about 360 ft. (112 meters). It was formed in a limestone sink approximately 10,000 years ago. No other ecological equivalent to Montezuma Well has yet been found (George Ruffner, Personal Communication). A sizeable community has developed just south of the monument in the past 20 years and it is still growing. A growing population necessarily increases demand for and consumption of groundwater, which consumption may have a negative impact on the Well. A survey of all resources associated with the Well is badly needed. Tens, if not hundreds, of taxa in Montezuma Well are found nowhere else on earth. The breadth of species diversity and the complexity of interactions among organisms in this one-of-a-kind ecosystem are only now beginning to be recognized. Ecological knowledge of the Well is very limited. Increasing visitation, growth, and changes in land use patterns present a real threat to the long-term protection of this unique resource.

5. Alternative Actions/Solutions and Their Probable Impacts:

a. No Action. This option will result in continued management of the Well without knowing what unique species and communities exist there. It is likely that any degradation of the Well may occur without NPS knowledge or management action to prevent it. Species, or entire ecological communities could be lost without anyone knowing it.

b. Continue Present Program. The National Park Service has funded very little biological research in the Well. A vegetation study around the rim of the Well was funded in 1987 and one within the sink was funded in 1988. Outside researchers, however, are encouraged to use their own funding sources to conduct studies in the Well, provided their research proposal demonstrates that they will do no harm to the resources. This

option may result in many of the same problems as the no action alternative due to the slow pace of research.

c. Fund and Conduct a Thorough Resources Basic Inventory of the Well and Adjacent Riparian and Terrestrial Areas. This option will provide the superintendent with broad based information on occurrence and status of rare species in the well and some aspects of their life history. This study will also indicate what species of native and alien plants and animals are present in the well and its adjacent areas. The study will also provide an understanding of the interrelationships among the aquatic, riparian, and terrestrial components of the ecosystem. This information about the well and its biota will allow the manager to make appropriate decisions in protecting the resources associated with the well on both a short term and a long term basis.

6. Description of the Recommended Project or Activity: Option c. is the recommended solution for this issue. Fund and conduct a thorough resources basic inventory of the well and adjacent riparian and terrestrial areas. This study will be conducted through a combination of research contracts and NPS scientists. It will consist of the following components:

1) A thorough bibliographic search, review, and summary of information from literature. Over 50 scientific reports and papers have been published on a variety of scientific subjects regarding the Well. They describe its geology, provide some data on water quality and quantity, water turnover rate, sediments, etc. This search should include historic photos and aerial photographs of the area.

2) A complete taxonomic listing of plants (including cryptogams) and animals that occur in the study site, including annotations on relative abundance, distribution, life history, phenology, etc., based on observations during this study as well as information from the literature. The species inventory within the Well and its associated outflow irrigation ditch will include phytoplankton and zooplankton.

3) An evaluation of interrelationships among the aquatic, riparian, and terrestrial species and ecological communities. The study will evaluate, for example, the ecological role of water fowl and other water birds, riparian songbirds (passerines) along the well and outflow ditch.

4) A written evaluation of key species and critical food chains, also discussing observations of, or potential for, any native species being threatened by alien species or human activities. A discussion of known or potential threats to ecosystem components, along with considerations of manipulative

management, habitat, or species protection or restoration, etc. will also be included here.

5) The preparation of interpretive and educational programs for use in presenting a more complete and accurate story of this unique resource.

6) Products from this study will be scientific report(s), species listings and annotations, taxonomically identified specimens to be curated in appropriate museums and herbaria, reference specimens of selected species for use in the monument by scientists, interpreters, etc. Specific suggestions will be made in writing and in an oral presentation to the monument staff on the implications of study findings to both management and interpretation. The researchers will also recommend any further studies that may be necessary to manage the resources of the well, the outflow ditch, and adjacent riparian and terrestrial habitats.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least nine other projects listed in this plan. These are as follows:

- MOCA-N-10 Identify and Inventory Water-Related Resource Attributes
- MOCA-N-15 Conduct Riparian Ecosystem Research
- MOCA-N-17 Delineate and Evaluate Strategies for Wetland Protection
- MOCA-N-22 Conduct Inventory and Assessment: Invertebrates
- MOCA-N-23 Conduct Inventory and Assessment: Amphibians and Reptiles
- MOCA-N-24 Conduct Inventory and Assessment: Rare and Endemic Species
- MOCA-N-25 Conduct Inventory and Assessment: Birds
- MOCA-N-27 Conduct Inventory and Assessment: Mammals
- MOCA-N-28 Inventory and Evaluate Control of Alien Species

9. Funding Requirements:

	<u>Year 1</u>	<u>Year 2</u>
Personnel Services	\$18,000	\$10,000
Travel and Per Diem	3,000	1,500
Limnological Supplies	1,000	0
Publication Costs	0	800
Total	\$22,000	\$12,300

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on a project.

PROJECT STATEMENT

1. Project Number: MOCA-N-14

2. Project Title: Identify and Inventory Aquatic Organisms and Their Habitat Requirements at Montezuma Well

3. Service-wide Issue(s):

N20 - Lack of Basic Data: Insufficient Understanding of Park Ecosystems and Threats to Them

4. Problem Statement: The aquatic organisms indigenous to Montezuma Well are water-related resource attributes of importance to this site. Their importance to the archaeological/historical story of this NPS unit is unknown but the organisms have importance in their own right due to their uniqueness. Their habitat requirements have been met historically through the particular combination of water quality and quantity in the Well. However, it is not known whether these characteristics have been stable over time or have been changing progressively. If changes have occurred, the present state-of-knowledge does not allow for an assessment of the nature, magnitude, or cause for such change or of the possible consequences.

It is not unreasonable to anticipate that changes in water quantity and quality will be manifest at the Well due to increasing residential and commercial development in locations peripheral to the site. If a significant diminution in water delivery occurs, or if water quality substantially changes, then this water-related resource attribute may be adversely affected. Once affected, there is presently no means whereby the consequences may be assessed.

5. Alternative Actions/Solutions and their Probable Impacts:

a. No Action. This option would mandate the monument continue to manage the Well without any empirical knowledge of the resources of the Well. The Well is a unique natural wonder that contains many rare and endemic species. It is only through the acquisition of scientific data that this habitat can be properly protected and interpreted.

b. Study Aquatic Organisms. Conduct a scientific inventory of aquatic organisms and their habitat requirements at Montezuma Well. The few studies that have been conducted thus far have found many unique endemic life forms in the Well. This resource

is obviously unusual and has led to the development of life forms found nowhere else on earth. It is imperative that the Well be systematically studied before unforeseen events degrade the Well and destroy unknown organisms.

6. Description of the Recommended Project or Activity: Option b. is the recommended solution for this issue. The identification and inventory of aquatic organisms and their habitat requirements requires monitoring water replacement rate and standing water surface elevation, characterizing existing water quality, characterizing organism habitat requirements, modelling and/or estimating potential changes in water quantity and quality and identifying activities or geographical areas that could impact water quantity or quality. This information would be necessary to ensure protection of this water-related resource attribute from off-site water development and use.

Accomplishing the above requires an interdisciplinary approach to characterize the existing hydrologic and water quality regimes as well as the biotic needs of the indigenous organisms. The analysis of data collected will require the use of both computer models and expert opinion to assess current conditions and to predict probable conditions.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least three other projects listed in this plan. These are as follows:

MOCA-N-10	Identify and Inventory Water-Related Resource Attributes
MOCA-N-13	Inventory the Basic Natural Resources of Montezuma Well and Adjacent Riparian and Terrestrial Habitat
MOCA-N-24	Conduct Inventory and Assessment: Rare and Endemic Species

9. Funding Requirements:

	<u>Year 1</u>	<u>Year 2</u>	<u>Year 3</u>
Research Contract -	\$25,000	\$22,000	\$18,000

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on a project.

PROJECT STATEMENT

1. Project Number: MOCA-N-15
2. Project Title: Conduct Riparian Ecosystem Research
3. Servicewide Issue(s):

N12 - Alteration of Natural Flow Regimes/Groundwater Levels
N18 - Visitor Use Impacts on Backcountry Park Resources
N21 - Loss of Fragile and Irreplaceable Cave Resources

4. Problem Statement: Two levels of concern are (a) completion of an inventory and assessment of natural riparian resources and (b) an assessment of past, current, and proposed management actions and visitor activities on natural riparian resources. Montezuma Castle National Monument was set aside because of its ". . . ethnological value and scientific interest. . ." The historic and prehistoric structures around which the major interest for visitors is focused are located on cliffs immediately adjacent to the floodplain and riparian lands along Beaver Creek. The surface and groundwater sources that currently support riparian ecosystems also served as water supplies for domestic and agricultural use for prehistoric humans. Additionally, riparian vegetation produces the cooler, more mesic landscape that is so attractive to visitors in this arid region. Additional information is also needed for increasing the interpretive values general understanding of these riparian lands.

Structures currently located in the riparian zone include surfaced walks, drinking fountains, interpretive displays, a picnic area, and a several-hundred-foot-long gabion structure of rock and reinforcing metal mesh constructed by the CCC in the 1930's to deflect flood waters from areas of high visitor-use. Visual examination of the riparian zone indicates that reestablishment rates of riparian trees (Arizona sycamore, net-leaved hackberry, chinaberry, velvet ash, etc.) seem low. Recruitment rates of young trees may be insufficient to replace the desirable riparian groves which are an important part of both the natural and cultural landscape. Examination of similar (control) areas nearby is needed to determine the relative condition of our groves and, if they are in poor condition, whether current and/or past management practices and/or visitor activities may be implicated and what changes would be needed to modify current impacts.

5. Alternative Actions/Solutions and Their Probable Impacts:

a. Conduct Riparian Ecosystem Research. This option would provide management with alternatives, including proposed actions and probable results, based on solid research findings. In addition to vegetation and faunistic implications of proposed management actions, attempts will be made to integrate information on soils, hydrology and flood regimes, and supporting information from current and past research programs in the area.

b. No Action. This option would cause the continued management of the monument with insufficient knowledge of existing ecosystem components and processes with possible losses to both the natural and cultural landscapes and reduction in visitor satisfaction.

6. Description of the Recommended Project or Activity: Option

a. is the recommended solution for this issue. An inventory of the riparian zone adjacent to both Montezuma Castle and Montezuma Well will examine biotic and abiotic ecosystem components with emphasis on vertebrates and flowering plants. An assessment of major components will be conducted for riparian trees, birds, and other groups that are determined to be of particular significance during the study. In addition, close monitoring of other studies is needed to interrelate and synthesis information of value to this project. Emphasis will be placed on ecological components, e.g. indicator species, that are of particular concern to interpreters and resource managers. Major project components, or subprojects, identified at the time of writing this project statement are listed below. However, additional components may be identified from information gathered during the course of the projects.

1) Conduct an inventory and assessment of tree and shrub populations, their demographic structure, distribution, and health.

2) Examine hydrologic and soil parameters associated with riparian groves.

3) Conduct an assessment of riparian plants and their interrelationships with hydrology, soil, and animals species.

4) Use information from the avian inventory and assessment to examine avian populations in relation to vegetational parameters and interpretive value.

5) Use information from the mammalian inventory and assessment to examine mammalian populations in relation to vegetational parameters with special emphasis on pest species, e.g. rock squirrels and ring-tailed cats.

6) Use information from the herpetological inventory and assessment to examine amphibians and reptiles with emphasis on their interrelationships with vegetational communities and interpretive values.

7) Use information from the invertebrate inventory and assessment to examine interrelationships with plants and other animals and interpretive value of such information.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least five other projects listed in this plan. These are as follows:

- MOCA-N-10 Identify and Inventory Water-Related Resource Attributes
- MOCA-N-12 Analysis of Adjacent Land Use and Status
- MOCA-N-13 Inventory the Basic Natural Resources of Montezuma Well and Adjacent Riparian and Terrestrial Habitat
- MOCA-N-14 Identify and Inventory Aquatic Organisms and Their Habitat Requirements at Montezuma Well
- MOCA-N-30 Establish Program for Long-Term Monitoring of Cultural/Natural Setting

9. Funding Requirements:

	<u>Year 1</u>	<u>Year 2</u>	<u>Year 3</u>	<u>Year 4</u>
Personal Services	\$ 8,000	\$ 8,000	\$12,500	\$12,500
Travel and Per Diem	1,500	1,500	2,000	500
Equipment and Supplies	500	500	500	2,000
Total	\$10,000	\$10,000	\$15,000	\$15,000

First Year: Begin research with riparian vegetation, especially woody plant communities of the castle and well sections, and make collections of riparian non-woody species.

Second Year: Begin collection of information documenting interrelationships between plant species and communities, and plants and animals in the riparian ecosystem.

Third Year: Start integration of information from other studies for riparian biota, particularly information on vertebrates, endemic invertebrates, and riparian processes.

Fourth Year: Complete integration of information from all files, studies, etc. and prepare reports for resources management

and interpretive programs. Provide management alternatives and projected results of management actions.

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on a project.

PROJECT STATEMENT

1. Project Number: MOCA-N-17
2. Project Title: Delineate and Evaluate Strategies for Wetlands Protection.
3. Service-wide Issue(s):
 - N12 - Alteration of Natural Flow Regimes/Groundwater Levels
 - N11 - Degradation of Park Water Quality Due to External Activities
 - N13 - Lack of Secure Water Rights
 - N16 - Visual and Biological Impacts of Urbanization and Other Near-Park Development on Park Resources

4. Problem Statement: Corp of Engineers and EPA regulations (33 CFR Section 238.3 and 40 CFR Section 230.3 respectively) define wetlands as "...areas that are inundated or saturated with surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." This definition has been in effect since 1977. Both Montezuma Castle management districts have wetlands that have not been evaluated or clearly delineated. External factors are impacting the quality and quantity of these water related resources, which directly affects management's ability to preserve and protect the resources.

The best known of these water resources is Montezuma Well, which is an unstratified, thermal limnocrene, with an area of 0.76 ha and a maximum depth of 17 meters with average subterranean flows of 1.5 million gallons a day. It is internationally recognized for its scientific and cultural uniqueness.

Beaver Creek, Wet Beaver Creek, and adjacent wetlands are integrated components of the cultural setting and are the primary resources responsible for maintaining the existing biological diversity. The Final Master Plan (1975) calls for staff to preserve the integrity of the cultural and natural settings. This cannot be accomplished without evaluating the permanence of the existing wetlands using a multidisciplinary approach. A multidisciplinary strategy must be developed to generate management options to reduce the external pressures exerted upon the Monument's resources. Furthermore, an examination of regulatory issues is mandatory to provide management with the appropriate context for decision making.

In addition to developing a multidisciplinary approach to collect the necessary field data and information, many technical judgments and inferences will have to be made to delineate and evaluate the wetlands in the appropriate jurisdictional setting. Operational methodologies will have to be developed for monitoring the health and stability of the water resources. Administrative policies, guidelines, and constraints will have to be reviewed extensively in the delineation process to secure and protect these wetlands.

5. Alternative Actions/Solutions and Their Probable Impacts:

a. No Action. With this alternative the monument will not be able to assess the degree of external threats and pressures exerted upon the monuments cultural, natural and water resources. Management will have to make decisions in the absence of knowledge and without quantification of hydrological factors that are used in evaluating, delineating, and protecting water resources and wetlands.

b. Delineate and Evaluate Strategies for Wetland Protection. The preferred action is to contract a multi-disciplinary research team to evaluate and delineate all wetlands and to quantify the current status of existing and potential threats to these resources. Subterranean water flow, stability, and other hydrological factors should be examined along with stream dynamics and erosion potentials. Administrative guidance for these actions may be found in Executive Order 11990, the 1975 Final Master Plan, the current Resource Management Plan, and numerous DOI regulatory requirements and or guidelines. In addition to quantifying water resource threats, the research team would develop action orientated strategies to protect the monument's water resources. Management alternatives and options would be identified to mitigate each threat after data collection and multiple factor analysis. All recommendations would be subsequently prioritized and evaluated on evidence.

6. Description of the Recommended Project or Activity: Option b. is the recommended solution for this issue. A multi-disciplinary team would be contracted or assembled to address the concerns outlined in the above problem statement. NPS specialists, along with other experts, would participate actively to develop the necessary management strategies involved in protecting these resources. Some technological analysis may have to be contracted to obtain the necessary field data and hydrological information.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA

compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least six other projects listed in this plan. These are as follows:

- MOCA-N-09 Develop Bibliographic Assessment and Computerized Bibliographic Information Retrieval System
- MOCA-N-13 Inventory the Basic Natural Resources of Montezuma Well and Adjacent Riparian and Terrestrial Habitat
- MOCA-N-14 Identify and Inventory Aquatic Organisms and Their Habitat Requirements at Montezuma Well
- MOCA-N-15 Conduct Riparian Ecosystem Research
- MOCA-N-18 Protect the Hydrologic Characteristics of the Archeological and Historical Setting at Montezuma Well
- MOCA-N-30 Establish Program for Long-Term Monitoring of Cultural/Natural Setting
- MOCA-N-33 Develop GIS System

9. Funding Requirements:

Research Contract - \$9,000

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on a project.

PROJECT STATEMENT

1. Project Number: MOCA-N-18
2. Project Title: Protect the Hydrologic Characteristics of the Archaeological and Historical Setting at Montezuma Well

3. Service-wide Issue(s):

N08 - Loss of Cultural Landscapes

N12 - Alteration of Natural Flow Regimes/Groundwater Levels

4. Problem Statement: The water surface level at Montezuma Well is, itself, a water-related resource attribute of this site. The height to which water rises in the Well is important to the archaeological and historical story of this NPS unit. Specifically, the visitor is presented with a unique, for this desert location, natural structure which had an obviously important relationship to the habitation of this area by ancient people. Subject to natural variation, the water surface elevation in the Well should be maintained as close to its prehistoric level as possible to convey to the visitor an appreciation of 1) the locations of water and dwellings, relative to one another, and 2) the delivery of water to the ancient irrigation systems.

Population increases have occurred in this area as in many others in the southwest. Consequently, residential and commercial development has been steadily increasing in locations peripheral to the Well Unit. The nature and effect of increased water use and consumption associated with this development is presently unknown. However, it may be that water is being removed from the natural avenues of surface and subsurface water delivery that supply the Well. If a significant diminution in water delivery occurs, this water-related resource attribute may be adversely affected and, as a consequence, the purposes for which this unit was established may be jeopardized.

While outflow from the Well has been monitored in the past, no information has been collected which assesses either water surface elevation or inflow to the system. Furthermore, questions have been raised as to the efficacy of current outflow measurement efforts due to shortcomings in the measurement installation. More importantly, there currently exists no means for alerting management to imminent adverse, and possibly irreversible, effects to this resource attribute from external water use.

5. Alternative Actions/Solutions and Their Probable Impacts:

a. No Action. This option will dictate that the Service continue to manage Montezuma Well without a scientifically designed and tested monitoring system. Management without factual data is a dangerous proposition.

b. Study Hydrologic Characteristics. Conduct a thorough hydrologic characterization of the groundwater system supporting and maintaining Montezuma Well. This information will make it possible to evaluate potential effects of off-site land development on water flows in the Well through the use of mathematical models of existing and potential water withdrawals.

6. Description of the Recommended Project or Activity: Option

b. is the recommended solution for this issue. The protection of the hydrologic characteristics of the archaeological and historic setting at the Well requires monitoring the standing water surface elevation and identifying geographical areas where existing and future water withdrawals may be of concern. To explain, the areas around the Well which recharge the aquifer supplying the springs within its perimeter, should be identified so that special attention may be directed toward monitoring off-site water development. If water development is found to affect this water-related resource attribute, then appropriate action may be taken, through state administration of water rights or through other means, to prevent both irreversible damage to the site and financial hardship to private development interests outside the unit.

However, to support allegations of impact from outside water development and use, the characteristics of the aquifer must be scientifically identified and potential impacts must be evaluated. This will require a thorough hydrologic characterization of the water system supporting the Well. This characterization will include assessments of piezometric water surface in the recharge area, aquifer characteristics and, possibly, ground water quality or age determination followed by mathematical modelling of existing and potential water withdrawal. Ancillary to these efforts would be an assessment of historical water levels using both computer simulation and historical research.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least four other projects listed in this plan. These are as follows:

- MOCA-N-13 Inventory the Basic Natural Resources of Montezuma Well and Adjacent Riparian and Terrestrial Habitat
- MOCA-N-14 Identify and Inventory Aquatic Organisms and Their Habitat Requirements at Montezuma Well
- MOCA-N-17 Delineate and Evaluate Strategies for Wetland Protection
- MOCA-N-30 Establish Program for Long-Term Monitoring of Cultural/Natural Setting

9. Funding Requirements:

	<u>Year 1</u>	<u>Year 2</u>	<u>Year 3</u>
Research Contract -	\$50,000	\$40,000	\$40,000

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on a project.

PROJECT STATEMENT

1. Project Number: MOCA-N-19
2. Project Title: Identify Flood-Prone Areas for Protection of Lives and Property
3. Service-wide Issue(s):
N23 - Protection of lives and property
4. Problem Statement: Important visitor attractions are found in close proximity to active floodplains. With this the case, park management is concerned that visitors and property may be at risk from flash flood hazards. There is not presently available for management's use, a flood hazard assessment which identifies the areas in MOCA that lie within the limits of selected design floods including the 'Probable Maximum Flood'. In addition, there are no mitigation recommendations, specifically applicable to the monument, which management may employ where hazards might exist.
5. Alternative Actions/Solutions and Their Probable Impacts:
 - a. No Action. This option leaves the monument operating without good data on the potential flood hazard of various locations and developments in the monument. It is an unacceptable option for this reason.
 - b. Examine Flood Prone Areas. Conduct a thorough hydrologic evaluation to delineate and evaluate flood hazards for all areas of the monument. This prudent study would give the superintendent the information necessary to ensure that public and employee safety is being protected from unreasonable exposure to flood hazards.
6. Description of the Recommended Project or Activity: Option b. is the recommended solution for this issue. A hydrologic investigation, designed to assess flood hazards in the monument, will include stochastic analyses of available data and on-site measurements of the channel. Flood hazard maps will be constructed which define the probable limits of flooded areas for selected design floods including the 'Probable Maximum Flood'. In companion to this assessment will be an assessment of potential means of mitigation including an evaluation of opportunities and constraints associated with each.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least two other projects listed in this plan. These are as follows:

MOCA-N-15 Conduct Riparian Ecosystem Research
MOCA-N-17 Delineate and Evaluate Strategies for Wetland
Protection

9. Funding Requirements:

Research Contract - \$35,000

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on a project.

PROJECT STATEMENT

1. Project Number: MOCA-N-31
2. Project Title: Evaluate Effects of Hydrologic Characteristics on Morphological Properties of Flowing Streams
3. Service-wide Issue(s):
N12 - Alteration of Natural Flow Regimes/Groundwater Levels
N06 - Disruption of Native Plant Communities and Accelerated Erosion Due to Past Land Practices
4. Problem Statement: The channel features found in MOCA streams (Beaver Creek and Wet Beaver Creek) are associated with water-related resource attributes such as the historic setting and the rationale for early habitation at the site. These measurable features can be dramatically altered through human-induced changes in the hydrologic regime (amount, duration, and timing of discharges). Alterations of this kind may affect existing channel form in such a way as to severely compromise site integrity and thereby diminish scientific values for scholars and the recreational and interpretive values for visitors.

The potential for changes in sediment and hydrologic regimes arises from mining, upstream diversions, and/or storage. Changes in existing diversion and storage arrangements are likely to occur as population pressure increases in this geographic area. Therefore, the alterations in channel form could arise in the near future if they have not already. In either case, the NPS presently lacks the data describing existing or potential impacts which could be used in litigation aimed at preventing or providing remedy for adverse effects of this kind.
5. Alternative Actions/Solutions and their Probable Impacts:
 - a. No Action. Continue to operate the monument without any type of hydrologic evaluation. This deprives the interpretive program of information relative to the relationship between the presence of the flowing streams and implications for life during the prehistoric occupation period. The effects of external activities on water quantity, quality, sediment load, and flood hazard will remain unknown.
 - b. Study Effects of Hydrologic Characteristics. Thoroughly evaluate hydrologic effects on morphological characteristics of

flowing streams in Montezuma Castle National Monument. Develop a mathematical model for such characteristics to assist the superintendent in protecting water rights, evaluating the potential effects of proposed upstream land developments, etc.

6. Description of the Recommended Project or Activity: Option b. is the recommended solution for this issue. An evaluation of hydrologic effects upon morphological characteristics of flowing streams from changes in hydrologic regimes will require the characterization of existing hydrology, channel features, sediment transport, as well as the modelling of existing and potential flow regimes. The collection of discharge and sediment data will be accompanied by the characterization of channel geometry, bed material, and depositional forms. Standard approaches for modelling sediment transport will be applied to existing and collected data to describe the likely future form of the channel under a set of hypothetical hydrologic regimes. Evaluation of the effects upon the historic scene, and other water-related resource attributes will be made using analytical methods as well as expert opinion.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least four other projects listed in this plan. These are as follows:

MOCA-N-09	Develop Bibliographic Assessment and Computerized Bibliographic Information Retrieval System
MOCA-N-10	Identify and Inventory Water-Related Resource Attributes
MOCA-N-11	Evaluate Water Delivery Monitoring System
MOCA-N-19	Identify Flood-Prone Areas for the Protection of Lives and Property

9. Funding Requirements:

Research Contract: Year 1 - \$30,000 (conduct field study)
Year 2 - \$10,000 (complete final report)

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on a project.

PROJECT STATEMENT

1. Project Number: MOCA-N-32

2. Project Title: Evaluate Effects of Hydrologic Characteristics on Regeneration of Vegetation in Riparian Areas

3. Servicewide Issue(s):

N06 - Disruption of Native Plant Communities and Accelerated Erosion Due to Past Land Practices

N08 - Loss of Cultural Landscapes

4. Problem Statement: Riparian vegetation at Montezuma Castle is a water-related resource attribute of specific concern to management. Many riparian plants have regeneration requirements which are related to the normal periodicity of over-bank discharges. Elimination of these discharges or a change in their periodicity may adversely affect vegetation replacement and the organisms dependent upon riparian vegetation. The potential for a change in over-bank flows can arise from upstream water development such as diversion and storage, or from on-site channel modifications. These effects may already exist or could arise in the future due to off-site water development or on-site human impacts.

5. Alternative Actions/Solutions and Their Probable Impacts:

a. No Action. This option will leave the monument operating without any empirical data as to the current status of vegetative reproduction in the riparian zone, or the hydrologic factors influencing the health of this ecosystem.

b. Study Effects of Hydrologic Characteristics. Conduct an evaluation of the effects of current hydrologic characteristics on vegetation in the riparian zone at the monument. This information will be valuable to the superintendent when responding to proposed developments upstream of the monument. It will also be very helpful in evaluating the long-term prospects for riparian ecosystems in the monument.

6. Description of the Recommended Project or Activity: Option b. is the recommended solution for this issue. An evaluation of hydrologic effects on regeneration of vegetation in riparian areas will require the characterization of existing hydrology, channel features, sediment transport, and riparian vegetation, as

well as mathematical modelling of existing and potential flow regimes. The collection of discharge and sediment data will be accompanied by the mapping of floodplain areas and their associated vegetation. Standard approaches for frequency analysis will be applied to existing and collected discharge data in a modelling effort which will describe areas and frequency of inundation under existing and possible conditions of off-site water development and on-site channel modification. Evaluation of the effects on riparian vegetation and organisms dependent thereon will be made by experts using results of the above described assessment.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least six other projects listed in this plan. These are as follows:

- MOCA-N-09 Develop Bibliographic Assessment and Computerized Bibliographic Information Retrieval System
- MOCA-N-10 Identify and Inventory Water-Related Resource Attributes
- MOCA-N-15 Conduct Riparian Ecosystem Research
- MOCA-N-17 Delineate and Evaluate Strategies for Wetland Protection
- MOCA-N-30 Establish Program for Long-Term Monitoring of Cultural/Natural Setting
- MOCA-N-31 Evaluate Effects of Hydrologic Characteristics on Morphological Properties of Flowing Streams

9. Funding Requirements:

	<u>Year 1</u>	<u>Year 2</u>	<u>Year 3</u>
Research Contract	\$35,000	\$20,000	\$20,000

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on a project.

PROJECT STATEMENT

1. Project Number: MOCA-N-34

2. Project Title: Conduct Inventory and Assessment:
Fishes

3. Service-wide Issue(s):

N20 - Lack of Basic Data: Insufficient Understanding of Park
Ecosystems and Threats to Them

4. Problem Statement: The native fish fauna of Wet Beaver Creek and Beaver Creek has been modified by water management practices and introductions of non-native fishes. Five species of native fishes (Gila Mountain Sucker, Gila Sucker, Roundtail Chub, Speckled Dace and Longfin Dace) are known from these waters. Several species have been extirpated from Wet Beaver Creek and Beaver Creek. These are reviewed by Minckley (1973).

Native fishes have been a significant resource consideration for monument staff because of the relatively low diversity of natives, threats posed by alien fishes, and water management practices. Arizona Game and Fish Department and U.S. Fish and Wildlife Service have conducted periodic inventories of the Wet Beaver Creek and Beaver Creek drainages. However, these efforts are generally targeting alien gamefishes. There are no known impacts on current park activities or health and safety of park employees and visitors resulting from the existing native fishery.

5. Alternative Actions/Solutions and Their Probable Impacts:

a. No Action. This alternative entails maintenance of the status quo. No research on the native fishery would be undertaken. There would be no efforts to evaluate opportunities for potential re-introduction of experimental native fish populations.

b. Inventory the Existing Native Fishery. This alternative requires completion of an inventory of native fishes in Wet Beaver Creek and Beaver Creek. The inventory would be conducted using electrofishing, seining and other non-destructive sampling techniques to characterize the composition of the fishery. Seasonal sampling would allow some insights into the relative abundance, natural history of native fishes and potential threats. Contract researchers would be retained to conduct the

inventory. The contractor would be required to obtain necessary permits from the State of Arizona, U.S. Fish and Wildlife Service and NPS.

6. Description of the Recommended Project or Activity: Option b. is the recommended solution for this issue. Conduct an inventory of native fishes in Wet Beaver Creek and Beaver Creek. This research project will document the occurrence of native fish species at Montezuma Castle. A variety of collecting techniques should be used to effectively sample the diversity of aquatic habitats found (i.e. pools, runs, riffles and backwaters). A seasonal sampling regime will allow the research to make initial determinations of relative abundance, reproductive activity, length-frequency relationships within species, habitat preferences and other natural history attributes. The study effort should be initiated with a comprehensive review of the native fishery literature regarding the Beaver Creek drainage and introduction of alien fishes. These data should be analyzed using descriptive statistics (e.g., mean, standard deviation, etc). The researcher should also develop recommendations for subsequent studies which may provide assessment level information on individual fish species having management significance. The drainages should be evaluated for opportunities to re-introduce extirpated species.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least four other projects listed in this plan. These are as follows:

MOCA-N-09	Develop Bibliographic Assessment and Computerized Bibliographic Information Retrieval System
MOCA-N-12	Analysis of Adjacent Land Use and Status
MOCA-N-28	Inventory and Evaluate Control of Alien Species
MOCA-N-30	Establish Program for Long-Term Monitoring of Cultural/Natural Setting

This project is also related to the other inventory and assessment projects listed in this plan.

9. Funding Requirements:

	<u>Year 1</u>	<u>Year 2</u>
Personnel Services	\$2,500	\$1,250
Travel and Per Diem	300	250
Supplies and materials	200	150
Publication Costs	<u>0</u>	<u>350</u>
Totals	\$3,000	\$2,000

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on a project.

PROJECT STATEMENT

1. Project Number: MOCA-C-06

2. Project Title: Study of Montezuma Castle Irrigation System

3. Service-wide Issue:

C03 - Insufficient Required Studies and Reports

4. Problem Statement: It is assumed that the prehistoric sites near Montezuma Well were small farming settlements that relied on irrigation ditches coming from the well. However, the ditch system has not been systematically studied to determine its age, extent, flow capacity, or the results of mineral deposits in the canal.

5. Alternative Actions/Solutions and Their Probable Impacts:

a. No Action. The interpretive story at the Well will rely on traditional lore and analogy with modern irrigation systems.

b. Review Documentation of Prehistoric Systems in the Southwest. This will add some background for interpretation but will not increase knowledge of the system at Montezuma Well.

c. Study Irrigation System. This option would conduct a thorough study of the Montezuma Castle irrigation ditch system to gather as much information as possible on flow rates, length of use, aerial extent of the system, etc.

6. Description of the Recommended Project or Activity: Option c. is the recommended solution to this issue. Past records of canal systems will be gathered, existing aerial photographs will be examined and new low-altitude low angle aerial photographs will be taken. Visible canal systems will be mapped. Exposed canals will be examined, and additional segments will be exposed and sectioned to examine mineral deposits and estimate flow rates. Feasibility of dating canals will be assessed. Canal system's age, extent and capacity will be compared to other prehistoric canal systems. Potential for further research will be assessed, and proposals for further work will be prepared.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA

compliance through Section 106 will require regional and SHPO review and approval.

8. Relationships: This project has no relationship to any other project in this plan. Findings, however, will be incorporated into the monuments's interpretive program and prospectus.

9. Funding Requirements:

Personnel Services	\$10,000
Travel and Per Diem	2,000
Aerial Photography	1,000
Supplies and Materials	600
Publication Costs	<u>800</u>
Total	\$14,400

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on a project.

PROJECT STATEMENT

1. Project Number: TUZI-N-05
2. Project Title: Identify and Inventory Water-related Resource Attributes

3. Service-wide Issue(s):

- N20 - Lack of Basic Data: Insufficient Understanding of Park Ecosystems and Threats to Them
- N11 - Degradation of Park Water Quality Due to External Activities
- N12 - Alteration of Natural Flow Regimes/Groundwater Levels

4. Problem Statement: The water-related resource attributes of the monument have not been fully identified. This identification is necessary in the event that water development and use by parties outside of the boundaries of the monument affects or is likely to affect the resources of this unit or the purposes for which it was created. The identification and inventory is needed to both identify the possibility of impact and to measure its magnitude in the event impact does occur. This information will be required in water rights litigation or in any other similar arena in which the NPS seeks relief from such impact.

At present there exists an incomplete, and perhaps inadequate understanding of the relationship of water to the resources of the monument. The first step in developing this understanding is identifying and inventorying the nature and magnitude of resource attributes that are affected by or dependent upon water, both surface and subsurface.

The possibility of future impact to water-related resource attributes exists because of residential and commercial development which is increasing in locations peripheral to the site. Water withdrawals from aquifers underlying the monument or alterations in surface water flow regimes are likely to affect water-related resource attributes. Without an identification and inventory, assessments to arrest and reverse effects will be delayed resulting in additional or longer-lasting effects.

5. Alternative Actions/Solutions and their Probable Impacts:

- a. No Action. This action would leave the monument without an adequate data base to protect its water rights or to understand the relationships between water resources of the monument and

early man's activities at the site. Water resource attributes might be lost under such stewardship.

b. Conduct a Thorough Inventory of All Water-related Resource Attributes in Tuzigoot National Monument. Such a study will give the superintendent an adequate data base from which to make informed management decisions and to protect water rights. Such results will also be of use to other resource related inventories conducted in the monument.

6. Description of the Recommended Project or Activity: Option b. is the recommended solution for this issue. Identification and inventory of water-related resource attributes require a technical assessment of physical resources and scientific literature. This project is best undertaken by an interdisciplinary team working as a unit. Field and office assessments will result in summary reports, maps and atlases. When completed, additional projects and/or studies may be required to evaluate the nature and magnitude of the relationship between water and water-related resource attributes.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of the Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least two other projects listed in this plan. These are as follows:

TUZI-C-06 Survey and Inventory Collections for Tuzigoot Objects
TUZI-N-09 Conduct Riparian and Wetland Ecosystem Research

9. Funding Requirements:

	<u>Year 1</u>	<u>Year 2</u>	<u>Year 3</u>
Research Contract	\$25,000	\$25,000	\$25,000

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on this project.

PROJECT STATEMENT

1. Project Number: TUZI-N-06
2. Project Title: Restore Tavaschi Marsh
3. Service-wide Issue(s):

N12 - Alteration of Natural Flow Regimes/Groundwater Levels
N17 - Loss of Biological Diversity

4. Problem Statement: Tavaschi Marsh is located 0.6 miles southeast of Peck's Lake and about 650 yards northeast of Tuzigoot National Monument Headquarters. Tavaschi Marsh is fed by springs that emerge upstream from the 35 acre marsh. Of the 35 Tavaschi Marsh acres, approximately 10 acres are covered by cattails (Typha), and 25 acres consists of open water and or intermittently submerged meadows populated by Ranunculus, Cyperus, and Eleocharis species.

The most unusual faunal elements of this area are two species of Cattail marsh inhabiting birds. It is likely that both Sora (Porzana carolinensis) and Virginia Rails (Rallus limicola) breed at Tavaschi Marsh. Both are uncommon Arizona species and are only two examples of the 73 species of birds that are known to occur in the marsh area. Other water orientated vertebrates known to occur at the marsh include the Bullfrog (Rana catesbiana), Leopard Frog (Rana pipiens), Sonoran Mud Turtle (Kinosternon sonoriense) and the Muskrat (Ondatra zibethicus). Numerous other species such as coyotes, deer, and rabbits undoubtedly occur in the area. The marsh is drained by the Verde River which extends North and South. Archaeologically, Tavaschi Marsh is situated adjacent to the Tuzigoot pueblo-type dwellings that were occupied until the 14th century. It is possible the early inhabitants utilized the area for hunting.

The marsh, an oxbow remnant of the Verde River, is owned by the Phelps-Dodge Corporation and is currently leased to the Tavaschi Family of Clarkdale, Arizona. Past negotiations have discussed the possibility of transferring Tavaschi marsh to the National Park Service (Arizona Academy of Science, Report No. 1, Tavaschi Marsh, 1973). Prior to reestablishing Tavaschi Marsh as a natural area this feasibility study which will delineate all potential concerns including, an ecological viability assessment, potential hydrological effects from nearby mine tailings, water quality issues, and jurisdictional liabilities, should be conducted. The marsh and its associated riparian habitats are valuable and scarce natural resources that are significantly integrated with

the surrounding cultural landscapes. There are few marshes of scientific interest available in Arizona.

5. Alternative Actions/Solutions and Their Probable Impacts:

a. No Action. This alternative entails maintenance of the status quo. The Tavaschi Marsh would remain under private ownership. Potential future development concerns of the marsh area would not be eliminated. Loss of cultural landscapes are expected along with visual and biological impacts resulting from the loss or conversion of this natural area to a more developed status.

b. Once Acquisition of the Marsh is Imminent, Conduct a Tavaschi Marsh Restoration Study. This action would entail assembling a NPS multidisciplinary team to evaluate all potential liabilities and develop strategies to restore the marsh area. Special attention would be given to marsh ecology, subterranean water flow and stability, adjacent stream dynamics, water quality and hydrological factors that influence the stability of Tavaschi Marsh in the general vicinity. Water quality issues and soils evaluations would require some laboratory testing. Spring gauges and local well information would have to be gathered in addition to information on potential point pollution sources. The multidisciplinary NPS team would be decided on how to prioritize the issues and allocate monetary resources.

c. Accept Tavaschi Marsh Without Examining the Issues. This option would transfer stewardship of the marsh to the National Park Service without examining potential liabilities or other marsh restoration issues that may arise. The monument staff would have little information on how to restore or manage the Tavaschi Marsh as a natural area. Ecological and hydrological concerns may not be addressed adequately to satisfy local or national interests.

6. Description of the Recommended Project or Activity: Option b. is the recommended solution for this issue. A Multidisciplinary team would be assembled to examine all restoration issues. The team would conduct ecological and hydrological inventories along with legal assessments prior to restoration. Water quality, hydrological dynamics, and ecological evaluations would require some analytical laboratory testing over the first and second years. The study would be conducted over three years to obtain the necessary seasonal data which may be highly variable. A final report would be issued in the third year identifying the resources, manpower, monitoring programs, and management strategies necessary for complete restoration.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of the Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least seven other projects listed in this plan. These are as follows:

- TUZI-N-03 Manage Vegetation: Rehabilitation, Landscaping, and Hazard Tree Removal
- TUZI-N-07 Analysis of Adjacent Land Use and Status
- TUZI-N-08 Delineate and Evaluate Strategies for Wetland Protection
- TUZI-N-09 Conduct Riparian and Wetland Ecosystem Research
- TUZI-N-13 Conduct Inventory and Assessment: Vegetation and Flora
- TUZI-N-18 Inventory and Evaluate Control of Non-Native Species
- TUZI-N-20 Resource Basic Inventory and Assessment: Mammals

9. Funding Requirements:

	<u>Year 1</u>	<u>Year 2</u>	<u>Year 3</u>
Personnel Services	\$25,000	\$20,000	\$20,000
Travel & Per Diem	5,000	4,500	3,500
Lab & Field Testing	10,000	20,000	5,000
Monitoring Equip.	15,000	0	0
Misc. Supplies	4,000	2,500	2,500
Reproductions/Reports	<u>0</u>	<u>1,000</u>	<u>2,000</u>
Total	\$59,000	\$48,000	\$33,000

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on this project.

PROJECT STATEMENT

1. Project Number: TUZI-N-07
2. Project Title: Analyze Adjacent Land Use and Status
3. Service-wide Issue(s):

N16 - Visual and Biological Impacts of Urbanization and Other Near-Park Development on Park Resources

4. Problem Statement: The Verde Valley of Arizona has an enormous array of recreational opportunities. According to Marshall A. Worden in the publication Papers in Community and Rural Development, 1981, "the Verde valley may well contain the greatest density of different types of vacation or recreational experiences of any similarly sized area in Arizona".

Concomitant local population growth has also increased dramatically as economic employment opportunities increased. Consequently, the diversification of land use practices are changing at an alarming rate. For example, one adjacent landowner is considering a development project that would build a large apartment complex adjacent to the Monuments boundary approximately 700 yards from the Tuzigoot ruins. Accelerated growth increases the frequency and complexity of resource issues while simultaneously reducing the amount of time that management has to react to resource concerns. The ingredients and characteristics that have created such an unusually rich and diverse environment for resource concerns are many.

A few examples of nearby land uses are: urbanization, aggregate stream mining, mine tailing deposition and storage, surface water diversions, agriculture, grazing, ranching, and recreational opportunities such as camping, golf, fishing, horseback riding, and boating. These activities are impacting the Monument's cultural and natural resources.

Without the basic baseline information necessary for assessing future changes in the area's hydrological regime and associated proximate land utilization factors coupled with development the historic and cultural scenes cannot be maintained adequately. An analysis of adjacent land use is a prerequisite step in determining the degree and magnitude of proximate factors that may influence management's ability to resolve or anticipate potential resource utilization conflicts. Preliminary investigations suggest that recent habitat conversions have already resulted in a loss of biological diversity and are

impacting the adjacent riparian corridor and the potential Tavaschi Marsh natural area.

5. Alternative Actions/Solutions and Their Probable Impacts:

a. Analysis of Adjacent Land Use and Status. Contract a Land Use research study that compares past and present land use patterns, evaluates present utilization conflicts and resource concerns that are currently impacting the Monument. The project should also attempt to develop a system that quantifies the potential risks associated with each resource threat or concern.

b. No Action. With this action the Monument will have to continue to operate without being able to estimate or predict significant external threats resulting from changing land use patterns. This places management in a difficult position of trying to preserve and protect a Cultural landmark without adequate knowledge of existing external threats.

6. Description of the Recommended Project or Activity: Option

a. is the recommended solution for this issue. The NPS will issue a research contract to document and map existing land uses, evaluate historical patterns of land use, and identify external threats resulting from adjacent land use practices. This would entail a three year research study divided into the following three phases:

1) Identify issues, concerns, and opportunities through the creation of land utilization maps that illustrate present uses, historical changes, and legal land status. Develop a research program to quantify and evaluate potential threats resulting from land use conflicts.

2) Analyze the management situation and assess the risks stemming from each external threat attributed to a land use pattern or concern.

3) Develop a cost effective monitoring protocol system to monitor external threats on a periodic basis, recommend management actions to mitigate or if possible eliminate external threats stemming from external land use patterns, and make recommendations on how to develop community awareness programs through interpretive and outreach programs.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of the Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project will support numerous other management activities or program that are trying to evaluate or monitor the condition of the culture and natural resources of the monument.

9. Funding Requirements:

	<u>Year 1</u>	<u>Year 2</u>	<u>Year 3</u>
Research Contract	\$10,000	\$10,000	\$ 7,000

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on this project.

PROJECT STATEMENT

1. Project Number: TUZI-N-08
2. Project Title: Delineate and Evaluate Strategies for Wetland Protection
3. Service-wide Issue(s):
N19 - Loss of Park Resources Due to Consumptive Practices (hunting, fishing, commercial fishing, grazing)
N16 - Visual and Biological Impacts of Urbanization and Other Near-Park Development on Park Resources

4. Problem Statement: Corp of Engineers and EPA regulations (33 CFR Section 238.3 and 40 CFR Section 230.3 respectively) define wetlands as "...areas that are inundated or saturated with surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions". This definition has been in effect since 1977. Tuzigoot National Monument and the potential Tavaszi Marsh natural area have water resources that have not been evaluated or clearly delineated. External factors may be impacting the quality and quantity of the water at Tuzigoot National Monument which directly affects managements ability to preserve and protect the potential Tavaszi Marsh natural area and the Monuments cultural resources. Ground water withdrawal may effect the stability of the 14th century archeological ruins.

The Verde River and adjacent wetlands are integrated components of the cultural setting and are the primary resources responsible for maintaining the existing biological diversity. The General Management Plan (1975) calls for monument staff to preserve the integrity of the cultural and natural settings. This cannot be accomplished without evaluating the permanence of the existing riparian areas and wetlands using a multidisciplinary approach. A multidisciplinary strategy must be developed to generate management options to reduce the external pressures exerted upon the monument's resources. Furthermore, an examination of regulatory issues is mandatory to provide management with the appropriate context for decision making.

In addition to developing a multidisciplinary approach to collect the necessary field data and information, many technical judgments and inferences will have to be made to delineate and evaluate the wetlands in the appropriate jurisdictional setting. Operational methodologies need to be developed so that the

monument can monitor the health and stability of the water resources. Administrative policies, guidelines, and constraints will have to be reviewed extensively in the delineation process to secure and protect the monument's resources.

5. Alternative Actions/Solutions and Their Probable Impacts:

a. No Action. With this alternative the monument will not be able to assess the degree of external threats and pressures exerted upon its cultural, natural and water resources. Management will have to make decisions in the absence of knowledge and without quantification of hydrological factors that are used in evaluating, delineating, and protecting cultural and natural resources and adjacent wetlands.

b. Delineate and Evaluate Monument Wetland Strategies for Protection. This option would entail contracting with a multidisciplinary research team to evaluate and delineate all wetlands and water resources issues and to quantify the current status of existing and potential water resource threats. Subterranean water flow, stability, and other hydrological factors should be examined along with stream dynamics and erosion potentials. Administrative guidance for these actions may be found in Executive Order 11990, the monument's 1975 General Management Plan, the current Resources Management Plan, and numerous DOI regulatory requirements and or guidelines. In addition to quantifying water resource threats, the research team would develop action orientated strategies to protect the Monuments water resources and the adjacent landscapes. Management alternatives and options would be identified to mitigate each threat after data collection and multiple factor analysis. All recommendations would be subsequently prioritized and evaluated on evidence.

6. Description of the Recommended Project or Activity: Option b. is the recommended solution for this issue. A multidisciplinary team would be contracted or assembled to address the above concerns as outlined in the above problem statement. NPS specialists, along with other subject experts, would participate actively to develop the necessary management strategies involved in protecting the Monuments resources. Some technological analysis may have to be contracted to obtain the necessary field data and hydrological information.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of the Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least three other projects listed in this plan. These are as follows:

TUZI-N-05 Identify and Inventory Water-related Resources
Attributes

TUZI-N-06 Restore Tavasci Marsh

TUZI-N-09 Conduct Riparian and Wetland Ecosystem Research

9. Funding:

	<u>Year 1</u>	<u>Year 2</u>	<u>Year 3</u>
Research Contract	\$20,000	\$30,000	\$33,000

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on this project.

PROJECT STATEMENT

1. Project Number: TUZI-N-09
2. Project Title: Conduct Riparian and Wetland Ecosystem Research
3. Servicewide Issue(s):
N20 - Lack of Basic Data: Insufficient Understanding of Park Ecosystems and Threats to Them

4. Problem Statement: Two levels of concern with this issue are: a) completion of an inventory and assessment of natural riparian and wetland resources; and b) an assessment of past, current, and proposed management actions and visitor activities on natural riparian and wetland resources. The prehistoric structures around which the major interest for visitors is focused are located on a hill immediately adjacent to the floodplain and riparianlands along the Verde River. Tavaschi Marsh is located in an ancient oxbow of the Verde River just north of the visitor's center. The surface and groundwater sources that currently support riparian ecosystems also served as water supplies for domestic and agricultural use for historic and prehistoric humans. Additionally, riparian vegetation produces the cooler, more mesic landscape that is so attractive to visitors in this arid region. Additional information is also needed for increasing the interpretive values and general understanding of these riparianlands.

Tavaschi Marsh has been partially drained and badly overgrazed. Methods for rehabilitating this area need to be developed.

5. Alternative Actions/Solutions and Their Probable Impacts:
 - a. Conduct Riparian Ecosystem Research and Provide Management Alternatives Based on Scientific Findings. This option will provide management alternatives including proposed actions and probable results based on solid research findings. In addition to vegetation and faunistic implications of proposed management actions, attempts will be made to integrate information on soils, hydrology and flood regimes, and supporting information from current and past research programs in the area.
 - b. No action: Manage with insufficient knowledge of existing

ecosystem components and processes with possible losses to both the natural and cultural landscapes and reduction in visitor satisfaction.

6. Description of the Recommended Project or Activity: Option a. is the recommended solution for this issue. An inventory of the riparian zone and wetlands adjacent to the ruins will examine both biotic and abiotic ecosystem components with emphasis on vertebrates and flowering plants. An assessment of major components will be conducted, e.g. for riparian trees, birds, and other groups that are determined to be of outstanding significance during the study. In addition, close monitoring of other studies is needed to interrelate and synthesis information of value to this project. Emphasis will be placed on ecological components, e.g. indicator species, that are of particular concern to interpreters and resource managers.

While additional subprojects may be identified from information gathered during the course of this study, major components of this project, as currently identified, are as follows:

- 1) Conduct an inventory and assessment of tree and shrub populations, their demographic structure, distribution, and health.
- 2) Examine hydrologic and soil parameters associated with riparianlands and wetlands.
- 3) Conduct an assessment of riparian and wetland plants and their interrelationships with hydrology, soil, and animals species.
- 4) Use information from the avian inventory and assessment to examine avian populations in relation to vegetational parameters and interpretive values.
- 5) Use information from the mammalian inventory and assessment to examine mammalian populations in relation to vegetational parameters with special emphasis on pest species, e.g. rock squirrels and ring-tailed cats.
- 6) Use information from the herpetological inventory and assessment to examine amphibians and reptiles with emphasis on their interrelationships with vegetational communities and interpretive values.
- 7) Use information from the invertebrate inventory and assessment to examine interrelationships with plants and other animals and interpretive values of such information.
- 8) Evaluate the ecological health of Tavasci Marsh. The

marsh is located along with Peck's Lake in an ancient abandoned meander (oxbow) of the Verde River encircling much of the hill on which the ruins and visitor's center are located. The marsh has been largely drained and heavily overgrazed during the past several decades. Means of rehabilitating the marsh will be examined.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of the Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least three other projects listed in this plan. These are as follows:

- TUZI-N-05 Identify and Inventory Water-related Resources Attributes
- TUZI-N-06 Restore Tavaschi Marsh
- TUZI-N-08 Delineate and Evaluate Strategies for Wetland Protection

9. Funding Requirements:

	<u>Year 1</u>	<u>Year 2</u>	<u>Year 3</u>	<u>Year 4</u>
Personnel Services	\$ 5,000	\$ 5,000	\$ 8,500	\$10,000
Travel and Per Diem	1,500	1,500	2,000	500
Supplies	500	500	500	1,500
Publication Costs	<u>0</u>	<u>0</u>	<u>1,000</u>	<u>2,000</u>
Total	\$ 7,000	\$ 7,000	\$12,000	\$14,000

First Year: Begin research with riparian and wetland vegetation, especially woody plant communities of the Verde River and wetland plants of Tavaschi Marsh, and make collections of riparian non-woody species.

Second Year: Begin collection of information documenting interrelationships between plant species and communities, and plants and animals in the riparian and wetland ecosystems.

Third Year: Start integration of information from other studies for riparian and wetland biotas, particularly information on vertebrates, endemic invertebrates, and riparian and wetland processes.

Fourth Year: Complete integration of information from all

files, studies, etc. and prepare reports for resources management and interpretive programs. Provide management alternatives and projected results of management actions.

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on this project.

PROJECT STATEMENT

1. Project Number: TUZI-C-05
2. Project Title: Preserve and Restore the Prehistoric Scene
3. Service-wide Issue(s):

C13 - Other (Preservation of Critical Cultural, Natural and Interpretive Setting, Integrity of the National Monument)

4. Problem Statement: Preserve and restore the prehistoric setting and scene immediately to the east and below the 100 room pueblo. This view area includes riparian areas, prehistoric croplands, desert uplands and Tavasci Marsh.

Tavasci Marsh, first identified as a significant Arizona rare type of habitat by the Arizona Academy of Science has also been identified in the National Natural Landmark Theme Study, Biotic Themes, Mojave-Sonoran Desert Region. The Marsh is of importance as a riparian habitat, with an extensive diversity of flora and fauna, and also represents geologic processes and lake formation.

The 60 acre marsh is a key aspect relating to the prehistoric occupation of the area. The marsh is being drained, heavy grazing is occurring, some development exists, a dirt road crosses the middle of the area and the flora and fauna is being adversely altered. The potential exists for extensive modern farming and development of most of the small valley for housing. Extensive development of adjacent lands is occurring for housing.

The 1975 Master Plan addressed the critical area and called for acquisition. The 1984 Land Protection Plan also recognized the critical area and called for acquisition. Discussions have been held with the owner of the property concerning possible exchange for other lands in the Southwest. The 1979, Natural Landmark Theme Study also recommended that Tavasci Marsh should be added to Tuzigoot National Monument.

5. Alternative Actions/Solutions and Their Probable Impacts:

a. No Action. This option would fail to provide protection to Tavasci Marsh and adjacent lands. Changing land use patterns in the area will almost guarantee that these lands will be developed for housing and intense recreational pursuits in the near future if no protection is provided.

b. Purchase These Lands for Addition to the Monument. This option would guarantee that this important part of the prehistoric scene at Tuzigoot National Monument could be permanently protected from urban development. This area also has important ecological values as a wetland that should be protected.

6. Description of the Recommended Project or Activity: Option b. is the recommended solution for this issue. Acquisition of the culturally significant lands including riparian areas, prehistoric croplands, desert uplands and Tavaszi Marsh will provide protection for these lands and better preserve a more complete picture of the prehistoric scene in the Tuzigoot area.

7. Compliance: This project will require an environmental assessment or impact statement under NEPA regulations. Such compliance will be prepared on an individual basis at the time that the project is funded. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least two other projects listed in this plan. These are as follows:

TUZI-N-06 Restoration of Tavaszi Marsh
TUZI-N-11 Examine Old Fields

9. Funding Requirements: The current legislatively mandated acquisition ceiling for Tuzigoot National Monument is \$1,350,000. The cost of purchasing these additional lands has not yet been determined.

10. Annual Project Status and Accomplishments: This report will be initiated once action begins on this project.

