

WATER RESOURCES

REPORT NO. 80-2

VF-KK-1-25

AZTEC RUINS WATER INVESTIGATION

Paul K. Christensen
National Park Service
Southwest Region
November 1979



Aztec Ruins Nat'l. Monument
Library
Classification No. _____
Accession No. _____

CONTENTS

	PAGE
ABSTRACT.....	1
INTRODUCTION.....	2
STATEMENT OF HYDROLOGIC PROBLEM AND ATTEMPTED SOLUTIONS PRIOR TO SUMMER 1979.....	2
METHODOLOGY.....	5
GENERAL OVERVIEW OF LOCAL HYDROLOGY.....	6
AZTEC RUINS WELL.....	8
SUBSURFACE DRAINLINE.....	9
OBSERVATION WELLS DRILLED 1964.....	9
OBSERVATION WELLS DRILLED JULY 5 AND 6, 1979.....	10
SURFACE FLOODING AUGUST 1979.....	12
CONCLUSIONS.....	12
SUGGESTIONS.....	14
REFERENCES.....	14-15

FIGURES

FIGURE 1. Location map showing regional setting of Aztec National Monument.....	3
FIGURE 2. Map of Aztec National Monument showing local features mentioned in report.....	4
FIGURE 3. Schematic comparision of drainline and observation wells at Aztec National Monument well data showing subsurface interrelationships with the alluvial aquifer beneath the monument.....	13

APPENDIX

	PAGE
TABLE I. Engineering data for subsurface drainline.....	17
TABLE II. Data of observation wells nos. 1-6.....	18
TABLE III. Data for observation wells nos. 7, 8, 8a, and 9.....	18
TABLE IV. Microscopic analyses of samples from observation wells nos. 7, 8, and 9.....	19

AZTEC RUINS WATER INVESTIGATION

by

Paul K. Christensen

ABSTRACT

Aztec Ruins National Monument is situated in northwestern New Mexico near the town of Aztec by the Animas River. The ruins at the monument have been a subject of concern in order to preserve them from avoidable water deterioration. A subsurface drainline was emplaced across the northern end of the monument to lower the water table beneath the ruins. Six observation wells were drilled to observe the fluctuation and depth to static water level. No records were kept of the above activities. A riparian woodland has encroached upon the northeast corner of the monument.

The monument lies on the alluvial fill of the Animas River. Pleistocene sand and gravel terraces are located about 1200 feet north of the monument. The valley sides are of the Paleocene Nacimiento formation, which is predominantly a shale. The Nacimiento also underlies the alluvium and terraces. The alluvium produces large quantities of fair quality water to wells. The Nacimiento is a poor aquifer.

The Aztec Ruins well log and samples from the three observation wells drilled July 1979 reveal that the monument is underlain by a clay unit 10 to 30 or more feet thick, and suggest that the drainline constructed lies in this clay aquitard. The drainline does not affect the groundwater in the sand and gravel aquifer beneath the clay aquitard. However, the drainline does remove some water from the aquitard.

Irrigation water on fields north of the monument drains into a pond on the north side of the monument. At times, this water flows through breaks in the dikes which contain the pond into the vegetal encroachment. This flooding is responsible for the encroachment.

INTRODUCTION

Aztec Ruins National Monument is located in northwestern New Mexico near the town of Aztec (see figure 1). The monument lies in the valley of the Animas River. The Animas River, a perennial stream originating in Colorado, flows within 530 feet of the southeast corner of the monument.

STATEMENT OF HYDROLOGIC PROBLEM AND ATTEMPTED SOLUTIONS PREVIOUS TO

SUMMER 1979

The ruins at Aztec Ruins National Monument have been a subject of concern to various individuals in order to preserve them from avoidable deterioration due to water. Several decades ago a subsurface drainline was emplaced across the northern end of the monument (figure 2) to intercept ground water flowing towards the river from areas north of the monument. No known preliminary hydrogeologic studies were made prior to the construction of the drainline. Engineering data were not permanently recorded.

In 1964 six observation wells were drilled in the neighborhood of the West Ruin (figure 2) to investigate the effectiveness of the drainline upon lowering the static water level beneath the ruins. Again, no engineering data were permanently recorded, and no samples for geologic analyses were taken.

The records of groundwater fluctuation in these observation wells during the observation period in the summer of 1964 are also not available. Data from the observation wells has not been collected since. The drainline was derooted recently and vegetation immediately above the drainline was removed to lessen the root infestation.

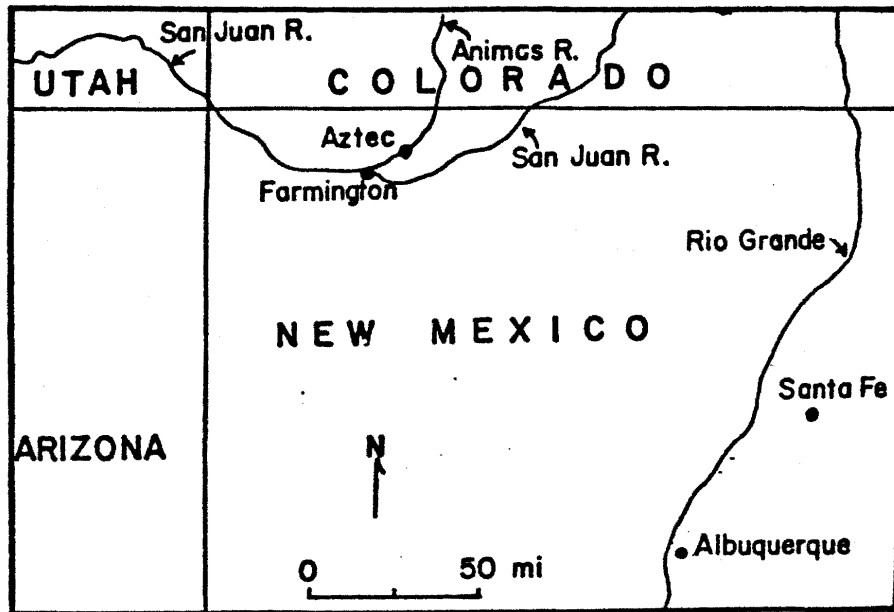


FIGURE 1. Location map showing regional setting of Aztec National Monument

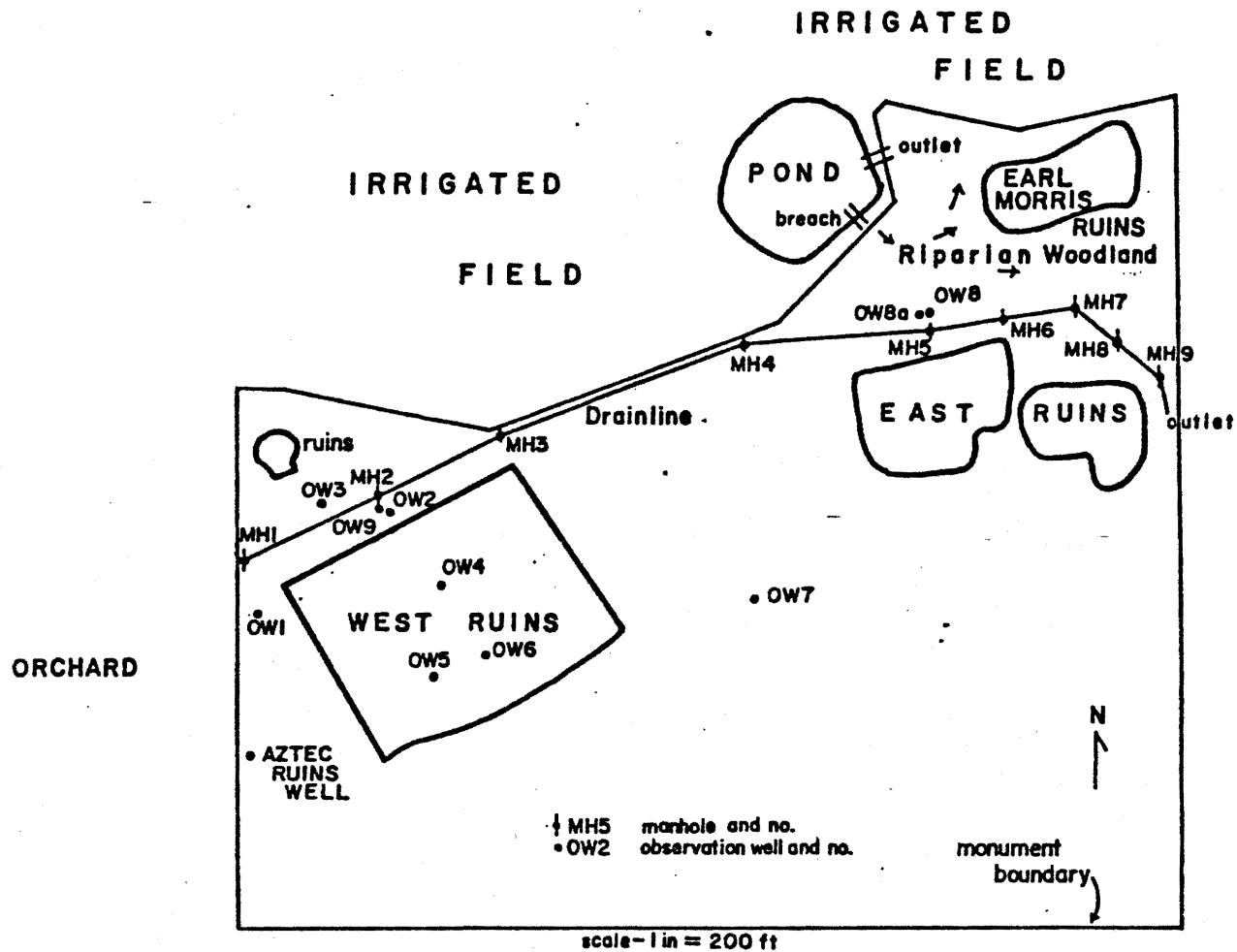


FIGURE 2. Map of Aztec National Monument showing local features mentioned in report.

A riparian woodland has encroached upon the northeast corner of the monument since 1962 as evidenced by aerial photographs taken in 1962 and 1978. North of the monument are irrigated fields and a stock pond. An irrigation-waste water ditch crosses the central portion of the monument in a north-south orientation. Figure 2 shows locations.

This investigation attempts to delineate and answer the following two questions:

1. Does the subsurface drainline affect the groundwater table?
2. Is the riparian woodland due to a surface or subsurface water problem?

What is the nature of the problem?

METHODOLOGY

The methods of investigation were:

June 1979

1. A first hand overview of surface conditions at the monument,
2. surveying and collection of pertinent engineering data of the observation wells and the drainline,

July 1979

3. the drilling of four new observation wells and collection of samples from each at one foot intervals,

August 1979

4. a visit to investigate water overflow from the pond onto the area encroached upon by the riparian woodland, and
5. the drilling log to the Aztec Ruins well which was completed June 1931

was consulted. The well is located near the west boundary of the monument (see figure 2).

GENERAL OVERVIEW OF LOCAL HYDROGEOLOGY

Aztec Ruins National Monument lies on the alluvial fill of the Animas River. The alluvium consists of clay, silt, sand, and gravel. The driller's log of the Aztec Ruins well shows that the alluvium is 77 feet thick at the well site. The alluvial gravels mostly consist of various extrusive, intrusive and metamorphic rock debris that is not found locally. The alluvial material is derived from the San Juan Mountains in southern Colorado. The alluvium is capped by a yellowish-brown loamy soil which is perhaps no thicker than 60 inches and consists of weakly stratified clay loams, silty clay loams, and loams. The alluvial fill is being eroded by regional gullying which began about 1880.

Pleistocene outwash terraces occur in the Las Animas Valley. The terraces were derived from late Pleistocene glacial moraines in the San Juan Mountains and are from 70-470 feet above the present level of the river. Often the terraces are covered with loess. The terraces are composed of coarse rounded gravels and sands, and are found along the sides of the valley and mark former Pleistocene river levels and channels. About 1200 feet north of Aztec Ruins, some of this glacial wash is extant as terraces. The Animas River has since eroded through these gravel deposits, so that only remnants remain. The terraces were deposited on pre-glacial alluvium and the sedimentary rocks which border the river valley.

The alluvium of the monument is underlain by the Nacimientto formation which is Paleocene in age. Both sides of the valley in the vicinity expose the Nacimientto. This formation is composed of gray, olive-green, and purple shales which grade into sandstone near the top of the unit. The sandstone units are gray-white to yellow, soft to hard sandstone. Characteristically, these sandstone units are discontinuous and silty. The Nacimientto formation lies 77 feet beneath the surface at the Aztec Ruin Well site. The well penetrated 2 feet of the Nacimientto formation, which the driller observed to be shale.

The sands and gravels of the Animas River are water bearing. Wells in the alluvium yield between 10-20 gpm, and with proper construction up to 500 gpm can be expected (Brown and Stone, 1979). Saturated thickness of the alluvial fill varies with the position and thickness of the gravels and sands in the deposit.

The water table in the alluvium fluctuates as a result of variation in precipitation, irrigation, and the discharge of the Animas River.

Precipitation is about 8.5 inches per year and is highest in the spring and summer. Irrigation is most intensive in late summer. Thus, observed water tables are highest in August and lowest in March.

Water quality is generally good in the Animas River valley fill because water is pumped from relatively clean gravels and sands which have a minor muddy matrix that is low in readily soluble materials. Another factor influencing water quality is the proximity of the aquifer to the surface whereby it is recharged relatively quickly with fresh water from runoff,

irrigation, and direct precipitation sources. General flow direction of water in the alluvial fill is in the direction of flow of the Animas River, i.e., to the southwest.

For the most part, the silty nature of the discontinuous sandstones near the top of the Nacimientto formation does not allow much ground water movement. The sandstone units are often artesian, but are generally of poor quality and low yield (Brown and Stone, 1979). Some drillers have recorded saline waters near the contact of the alluvium and the Nacimientto formation as well as with alluvium and other local sedimentary units.

AZTEC RUINS WELL

Aztex Ruins well was completed June 1931. The driller's log showed a total depth of 79 feet. The upper 77 feet is alluvium and the lower 2 feet is shale of the Nacimientto formation. The approximate surface elevation of the well 5635 feet (MSL). The alluvium was subdivided into an upper 10 foot layer of silt and clay, and a lower 67 foot layer of sand gravel. The depth to static water level was not recorded after completion, nor is it yet available.

The well supplied water to the monument from 1931 to 1958. In 1958 the use of water from this well was discontinued. The Aztec City water supply has been used since.

From a water quality test of 1933, the water from this well appears fresh. Alkalinity was reported as 360 ppm; chlorides, 32 ppm; sulfates, 528 ppm;

and hardness, 686 ppm. The water may have a high sulfate content because of a possible saline water source encountered near the contact of the alluvium and the Nacimiento formation that mixes with fresher alluvial water.

SUBSURFACE DRAINLINE

The subsurface drainline is 1437.2 feet long and is buried from 7 to 21 feet beneath ground level. The drainline is constructed of perforated 6" diameter vitrified clay pipe. It stretches from the fence on the west end of the monument near the northwest corner of West Ruins to the east end of the monument and runs between East Ruins and Earl Morris Ruins (see figure 2). The drainline surfaces, east of the East Ruins near the east boundary and drains into an easement ditch that flows along the east boundary of the monument.

Access to the drainline is through 9 manholes that are located along the drainline. Depth from the inner lip of the manhole to the bottom of the pipe of the drainline was measured. Locations and altitudes of the manholes and outlet were obtained by surveying techniques. Table I in the appendix contains these data.

Depth from the innerlip of the manhole to the bottom of the drainline decreases easterly towards the outlet, as does the elevation of the lips and the outlet. The segmental slopes of the drainline is presented also in Table I. The overall slope is 0.88%. The top of the manholes stand generally less than one foot above ground level.

OBSERVATION WELLS DRILLED 1964

The location and elevation of the observation wells no. 1 through no. 5,

constructed in 1964, was obtained by surveying techniques. The wells are situated around West Ruins. Figure 2 shows the location of each observation well and Table II in the appendix tabulizes elevation, depth to bottom of the hole, and depth to water of each observation well as observed June 7 and 8, 1979. Observation well no. 2 was not located at that time.

Total depth in these observation wells varies from 18 to 26 feet below surface level. The depth to static water level varied from 13 to 24 feet.

Fel Valasquez, who was present at the monument when these wells were drilled and who observed depths to water during the summer of 1964, supplied the following information. Four inch diameter sheet metal casing was installed in observation wells no. 1 through no. 5. The lower 5 foot segment of each casing was perforated. Observation well no. 6 was drilled by hand auger in the kiva. It has since been filled in. Velasquez himself drilled this well and observed no sand or gravel for the 12 feet drilled beneath the kiva floor. The kiva floor is about 12 feet beneath surface level. He observed that this well was always dry as was well no. 4 during the summer of 1964. Velasquez reported fluctuations of up to 4 to 6 feet in observation wells no. 1 through 3. Water in no. 5 was not more than 1 foot deep.

OBSERVATION WELLS DRILLED JULY 5 and 6, 1979

Four new observation wells, no. 7, no. 8, no. 8a, and no. 9, were drilled at the monument and samples taken at every one foot interval for analysis. The drilling method used was air rotary.

Observation wells no. 8 and no. 8a are located north of the East Ruins, north of the drainline, and just south of the riparian woodland encroachment. Observation well no. 9 is located near observation well no. 2 between the north side of West Ruins and drainline. Observation well no. 2 was located July 5. Observation wells nos. 2 and 9 are separated by about 4 feet. Observation well no. 7 is situated at the fork in the service road near the geographic center of the monument. Approximate locations are illustrated in figure 2. These locations have not been surveyed.

Table III in the appendix shows the approximate elevation, total drilled depth, and depth at which water was encountered. Observation wells no. 7, no. 8, and no. 9 have backfilled somewhat, but the exact depth is not known. Plastic 4" diameter casing was emplaced and the lower 5 feet of the casing was perforated.

Microscopic analysis of the cuttings revealed that the monument is underlain by alluvium deposited by a stream which was characterized by shifting channels. Table IV in the appendix contains the analyses. Water was encountered at wells no. 7 and no. 8 at approximately 23 feet beneath the surface in a gravel and sand aquifer. An artesian condition exists for observation wells no. 7 and 8. The static water table promptly rose several feet after being tapped. Observation well no. 9 was drilled 34 feet. No water-bearing sands or gravels were encountered. Drilling ceased at 34 feet because of the instability of the hole when drilling with the air rotary method. Observation well no. 8a was drilled 5 feet west of observation well no. 8 to a depth of 11 feet to check for an intermittent perched water table above the clay aquitard. No water was encountered in drilling this hole.

SURFACE FLOODING AUGUST 1979

In August 1979, flooding occurred from a breach in the pond across the riparian woodland in the northeast corner of the monument. The water originated from irrigation on fields north of the monument. The eastment ditch intended to collect the irrigation waste water and to guide this water through the central portion of the monument is not used. The water collects in the pond, and flows through the breach out onto the vegetal encroachment. An outlet with a headgate is constructed on the east dike of the pond. However, it also directs overflow onto the concerned area.

CONCLUSIONS

Figure 3 demonstrates the positional relationship between observation wells nos. 7, 8, and 9, the drainline, and Aztec Ruins well. The drainline is situated in the clay aquitard above the gravel-sand alluvial aquifer and is ineffectual on lowering the static water level of said aquifer. This sand-gravel aquifer is situated deep enough below the surface to present no problem to the preservation of the archaeological sites and is sealed off from significant upward movement by the clay aquitard. Data from observation wells nos. 6, 7, 8, and 9 and the Aztec Ruins well suggest that the monument sits on a clay aquitard. The clay aquitard is overlain by various sand and silt units which vary from 3 to 11 feet thick.

Static water levels taken at observation wells nos. 1, 3, 4, and 5 represent the piezometric head of the gravel-sand aquifer or water derived from the aquitard. The exact depths to which observation wells no. 1 through 5 were drilled is not known due to backfill, thus the origin of the water in

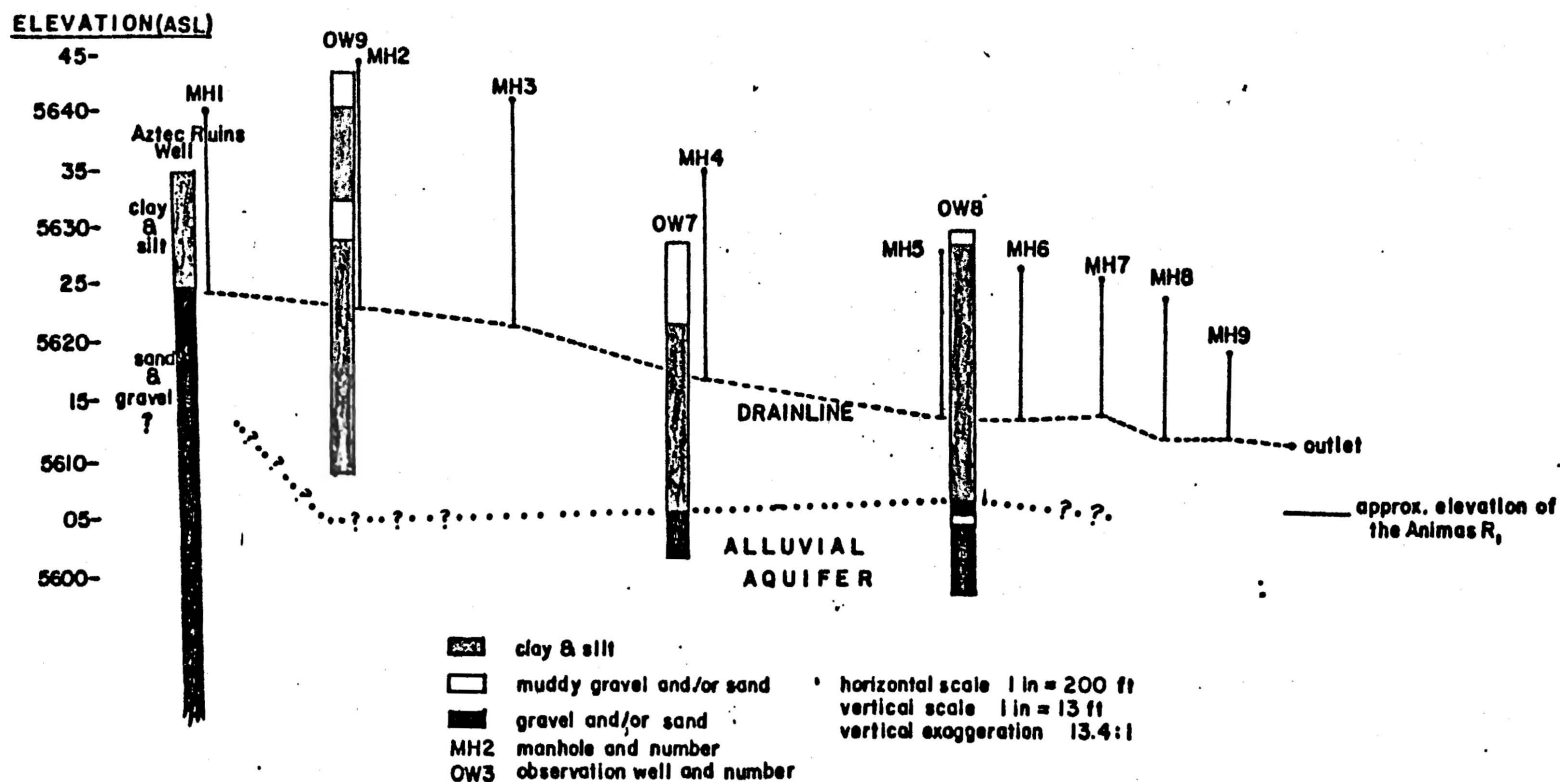


FIGURE 3. Schematic comparison of drainline, observation wells, and Aztec National Monument well/data showing subsurface interrelationships with the alluvial aquifer beneath the monument.

the holes is not known. The aquitard does bear water, but is severely limited in rapidly transmitting ground water.

A sandy unit exists about 10-13 feet below the surface at observation well no. 9. The unit appeared dry, but will probably produce some water as do the clay units. On both upper and lower contacts, this sand unit is sealed by clay. This sand unit may emit water into the observation wells around West Ruins. Since water is present in the drainline (Table I) and a very small flow is observable at the outlet of the drainline, the drainline does remove minor quantities of water from the aquitard. Seepage into the drainline is through perforations and manhole pipe connections.

The proximity of irrigated fields and observed flooding across the vegetal encroachment suggest that the water problem is of a surface nature. Groundwater probably has little or no effect upon the archeological sites on the monument.

SUGGESTIONS

To present further evidence that the sand-gravel aquifer is buried deeply enough to avoid damage to the ruins, it is suggested to conduct an electrical resistivity survey on the monument and immediate vicinity to determine the depths to the sand-gravel aquifer and the nature of alluvium beneath the monument, based on sample analysis of wells nos. 7, 8, and 9.

REFERENCES CITED AND SOURCES

Brown, D. R., and Stone, W. J., Hydrogeology of the Aztec quadrangle,
San Juan County, New Mexico: New Mexico Bureau of Mines and
Mineral Resources, Hydrogeologic Sheet No. 1, 1979.

U.S. National Park Service, Water Rights Dockets for Aztec National
Monument, Southwest Regional Office, Santa Fe, New Mexico (un-
published).

APPENDIX

TABLE I

Engineering Data for Subsurface Drainline

Manhole No.	Altitude (Ft, MSL) of inner lip of manhole	Distance (Ft) from previous manhole	Depth (Ft) to bottom of manhole	Altitude (Ft) (MSL, Ft) of bottom of manhole	Percent Slope	Depth of Standing Water (Ft)
1	5640.1	-	15.4	5624.7	-	0.09
2	5644.5	210.8	21.4	5623.1	-0.76	0.05
3	5641.2	208.0	19.2	5622.0	-0.58	2.73 (backed up)
4	5634.9	260.8	17.4	5617.5	-2.11	0.30
5	5628.2	284.0	13.7	5614.5	-1.06	0.20
6	5626.7	104.4	12.4	5614.3	-0.19	0.10
7	5625.9	104.8	11.5	5614.4	+0.10	0.09
8	5624.3	88.8	11.3	5613.0	-1.58	0.06
9	5619.5	87.6	7.1	5612.4	-0.68	0.06
Pipe Outlet	5612.0	88.0	-	-	-0.45	0.04
		<u>Overall Length</u>			<u>Overall Slope</u>	
		1437.2 feet			-0.88 per cent	

TABLE II

Data for Observation Wells Nos. 1 through 6

Observation Well No.	Altitude (MSL, Ft)	Total Depth (ft)	Depth to Water (Ft) June 7, 1979
	Of Ground Level		
1	5640.8	22.3	13.6
2 Approx.	5643	-	-
3	5644.4	25.8	24.0
4	5638.3	18.7	16.7
5	5639.9	21.3	20.1
6 Approx.	5638		backfilled

TABLE III

Data for Observation Wells Nos. 7, 8, 8a, and 9

Observation Well No.	Approximate Altitude (Ft, MSL)	Approximate Total Drilled Depth (Ft)	Depth (Ft) Water Encountered at
	Ground Level		
7	5629	28	23
8	5630	31	23
8a	5630	11	-
9	5643	34	-

TABLE IV

MICROSCOPIC ANALYSIS OF SAMPLES FROM OBSERVATION WELLS NO. 7, 8, & 9

OBSERVATION WELL #7

<u>INTERVAL (FT)</u>	<u>DESCRIPTION</u>
0-7	SAND- Light brown, very fine to coarse grained, predominantly coarse grained, angular to subrounded, very poor sorting, sand predominately quartz in composition, occasional pebble gravel, clay and silt matrix, friable, calcareous.
7-11	CLAY- Light brown, earthy, blocky, hard, calcareous, water swelling, slightly sandy and silty.
11-22	CLAY- Light grayish-brown, earthy to waxy, very hard, calcareous, slow water swelling, slightly silty and sandy, occasional pebble gravel.
22-24	CLAY- Light brown, earthy, hard, calcareous, water swelling, silty and sandy, pebble gravel common. Water encountered at about 23 feet.
24-24	MISSING- Assumed to be same as following unit.
25-27	GRAVEL- Predominately pebble, some cobble, sand matrix, very poor sorting, slightly silty and clayey, pebble composition-predominately igneous and metamorphic, trace gold, water bearing.

27-28 SAND- Light brown, speckled, very fine-very coarse grained, angular to subrounded, very poor sorting, composition-quartz, feldspar, mica, lithic fragments, pebble gravel common, slightly silty and clayey, trace gold, water bearing.

OBSERVATION WELL #8

0-1 SAND- Brown, very fine to coarse grained, predominately medium to coarse grained, angular to subrounded, very poor sorting, composition-predominately quartz, silt and clay matrix, calcareous.

1-3 CLAY- Brown, earthy, flakey to blocky, moderately hard, calcareous, water swelling, silty and sandy.

3-4 SILT- Light brown, earthy, friable to soft, sandy, slightly clayey, calcareous.

11-16 CLAY- Light brownish-gray, earthy, blocky, hard to very hard calcareous, slow water swelling, slightly sandy and silty, occasional pebble gravel.

16-23 CLAY- As above, occasional sand and pebble gravel.

23-24 GRAVEL- Pebble to cobble, matrix of sand, silt, and clay, water encountered at 23 feet.

24-25 CLAY- Light brown, earthy, hard, calcareous, silty, very sandy, very pebbly.

25-26 SAND- Light brown, speckled, very fine to very coarse grained, angular to subrounded, very poor sorting, friable, clay and silt matrix, composition of grains - quartz, feldspar, lithic, mica, some pebble gravel, water bearing.

26-30 GRAVEL- Pebble to cobble, with clean sand matrix, sand like that is interval 25-26.

30-31 SAND- As above, very clean.

OBSERVATION WELL NO. 9

0-3 SAND- Light brown, very fine to very coarse grained, angular to subrounded, very poor sorting composition-quartz, feldspar, mica, lithic, pebble to cobble gravel common, silty and clayey matrix, friable.

3-7 CLAY- Light brown, earthy, blocky, clacareous, hard, water swelling, slightly sandy and silty, occasional pebble gravel, cobbles in interval 4 to 5 foot.

7-10 CLAY- Light brown, earthy, blocky, clacerous, hard, water swelling, silty, slightly sandy.

10-13 SAND- Light brown, very fine to very coarse grained occasional pebble gravel, angular to subrounded, very poor sorting, friable, calcareous silt and clay matrix.

13-30 CLAY- Light brown, earthy, blocky, calcareous, hard, silty, sandy, occational pebble grave, mica and pyrite present, water swelling.

30-34 CLAY- Light brown, earthy, calcareous, blocky, hard,
 slightly sandy and silty, water swelling.