A WATER STORAGE ADAPTATION IN THE AMERICAN SOUTHWEST

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Ancient water storage basins in the American Southwest are examined as receptacles for potable water. High evaporation rates and limited rainfall indicate that many storage basins did not hold water year-round. Nonriverine populations drawing upon storage basins experienced greater settlement mobility than commonly is assumed. Data are examined from the Hot Wells Storage Basin of far western Texas and used to illustrate one water-use adaptation made by Puebloan groups.

PREHISTORIC MANAGEMENT OF WATER resources in desert settings has received considerable attention in recent years (Adams 1980; Downing and Gibson 1974; Evenari, Shanan, and Tadmor 1971). In the American Southwest a rich literature has evolved (Di Peso, Rinaldo, and Fenner 1974; Doolittle 1985; Fish and Fish 1984; Glassow 1980; Haury 1976; Rohn 1963; Vivian 1974; Woodbury 1961; Woosley 1980), drawing in part from the ethnographic record (Castetter and Bell 1942; Forde 1931; Hack 1942). A myriad of techniques were employed by Southwestern groups to cope with the rainfall deficit. Although much research time has been invested in the study of water diversion and transport schemes, especially with reference to canalization and irrigation, less attention has been focused on the storage of water.

Water storage involved several adaptations for capturing and holding water. However, some Southwestern storage basins may not have held water for the entire year-round. This suggests that some communities, even large ones, away from permanent natural water sources may have experienced greater settlement mobility within their populations than is commonly assumed from their architectural investment. The data from the excavation of the Hot Wells Storage Basin and related features near El Paso, Texas, will be used to address the degree to which water was managed by Puebloan groups living in south-central New Mexico and far western Texas.[1]

BACKGROUND FOR WATER STORAGE IN THE SOUTHWEST

Water storage basins are defined as human-made or human-modified depressions designed to hold water for an extended period. Although other terms exist in the literature of water management, water storage basin is an all-inclusive term permitting a discussion of the variability in water storage techniques.

Several aboriginal water storage basins have been identified in the American Southwest. These basins have been reported in nearly every environmental and geographical zone of the region. Generally, little metric data accompanies the description of these features as their simple identification can be difficult (Crown 1987).

Water storage basins range in size and form from shallow wells (Di Peso, Rinaldo, and Fenner 1974; Evans 1951; Hack 1942; Haury 1976; Howard 1959; Martin 1936) to large embanked watersheds (Martin 1936; Mindeleff 1891; Nelson 1914; Prudden 1903; Ritterbush 1984; Wheat 1952; Winter 1978). They can be fed and discharged through carefully designed canal systems (Di Peso, Rinaldo, and Fenner 1974; Haury 1976; Hodge 1893; Raab 1975; Rohn 1963, 1977; Toulouse 1945) or filled by less-controlled surface runoff (Garcia-Mason 1979; Hayes 1964; Martin 1936; Mindeleff 1891; Nelson 1914; Prudden 1903; Ritterbush 1984; Rohn 1963, 1971, 1977; Wheat 1952; Winter 1978; Woodbury 1956). To accommodate the process by which a storage basin collects water, functional typologies have been devised (Crown 1987; Di Peso, Rinaldo, and Fenner 1974; Wheat 1952). Crown's useful typology is based on the source of water contributing to the basin as well as the manner in which water moves into it. Using these criteria, she provides definitions for the terms *well, catchment basin,* and *reservoir.*

The advantage of a functional typology is that it permits the systematic cataloging of the many storage basins reported in the Southwest, while at the same time it allows a comparative assessment of the technology and energy investment (the latter to a lesser extent) that culminated in the construction of these features. However, unlike water diversion and transportation schemes in which the type and extent of canalization may help to suggest the socio-economic complexity of a community (Hunt and Hunt 1974), storage basins provide another level of interpretive latitude. Given that potable water is perhaps the most limiting of natural resources in determining the size of a group, comparing the simple dimensions of a storage basin can indicate the maximum number of people drawing from a single source. This assumes that (1) each basin was filled to capacity at the onset of the dry season with little or no subsequent replenishment, (2) monthly evaporation rates are known, (3) no other sources of water are immediately available, and (4) water consumption rates for a group are determinable. Given the many assumptions associated with other types of population estimates, a determination of group size based on water storage capacity may provide an alternative, independent index. Although water can be used to other ends, storage basins clearly provided the drinking needs of a nonriverine population. Because many storage basins are located away from permanent sources of water, these features become useful data sets in examining the size and mobility of a group.

In an attempt to reveal the amount of water available to a group dependent on water storage basins, a simple divisioning was made. The separation was based on whether or not the water source continuously replenished the basin. If a water basin were continuously recharged, then the volume of water available to a group as measured by the capacity of the storage basin would not be significant. Clearly, a well excavated to groundwater would provide considerably more water to its users than the mere volume of the well shaft itself.

For this reason, aquifer-conditioned wells are considered a kind of water storage feature, but one quite separate from surface runoff sources. Aquifer-conditioned storage basins also represent a type of feature drawing from artesian springs, but, in this case, transporting the water to a storage basin. Hack (1942) and Sharrock, Dibble, and Anderson (1961) both report on such features, though the amount of water actually available is again difficult to assess.

Runoff variety storage basins are those features which collect seasonal runoff either through canals or by way of less-controlled surface flow. The important distinction between runoff variety storage basins and aquifer-conditioned wells is that runoff varieties provide a fixed capacity of water following seasonal precipitation, whereas ancient wells generally do not permit an accurate assessment of the recharge rate. Well water levels are less immediately conditioned by seasonal precipitation and evaporation rates than are runoff varieties. Aquifer-conditioned storage basins drawing from a large underground catchment are presumably replenished throughout the year.

Some caution must also be used with regard to those "reservoirs" (storage basins fed by canals in Crown's terminology) which may have been replenished by canals issuing from permanent water sources. Such canal-fed storage basins have been suggested at Los Muertos (Fewkes 1919) and perhaps Casas Grandes (Di Peso, Rinaldo, and Fenner 1974), but little substantial data has been convincingly marshalled. In the case of Casas Grandes, Di Peso demonstrates the presence of a well dug more than 12 m to groundwater, indicating that runoff variety storage basins may not have been able to supply the drinking needs of this community and revealing a less-dependable water source for these basins.

Most authors indicate that runoff variety storage basins were primarily used to hold potable water stores, because they lacked the head necessary to drive water through irrigation channels (Di Peso, Rinaldo, and Fenner 1974; Rohn 1963). Given that most Southwestern examples represent runoff storage basins, basin capacity could provide an indirect measure of the size and/or mobility of a population drawing upon this most basic resource. Before we examine these data and their implications, it seems appropriate to describe a recently excavated water storage basin and related features, as well as the data-gathering methodologies employed. The relatively elaborate form of the Hot Wells Storage Basin (conditioned by an underlying caliche formation), coupled with its exaggerated location away from permanent water sources and within a peripheral zone of Puebloan activity, warrants description. Further, these data serve as an example of the kind of nonriverine adaptation to limited water resources that is found in the American Southwest.

SITE AREA

The site area rests in a desert valley known as the Hueco Bolson, located in southern New Mexico and western Texas within the Greater Chihuahuan Desert (Figure 1). The Hueco Bolson is a broad north/south-trending basin bound by parallel flanking mountains. Three major environmental or geograph-

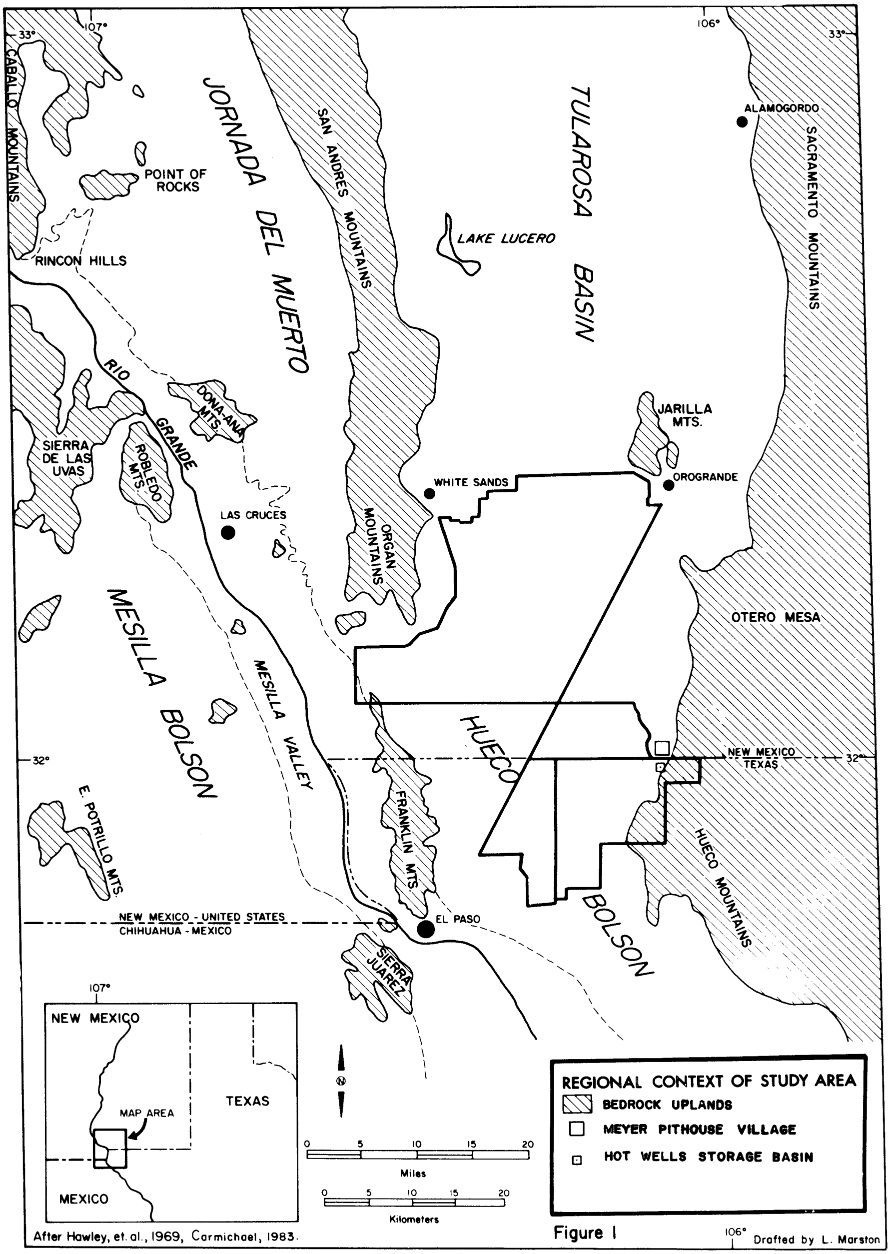

Figure 1. Map of Hueco Bolson and Adjacent Areas with Location of Meyer Pithouse Village and Hot Wells Storage Basin

The area circumscribed bv the bold line delimits the systematically surveyed archaeological zone.

ical zones define the area: (1) A readily accessible mountain zone consists of exposed bedrock uplands containing some spring activity. (2) A piedmont zone exists between the uplands and the basin floor, defined in part by alluvial fans and associated with longitudinal fault depressions or *playa* water catchment zones. The playas rest periodically along the lower margins of this zone. (3) The central basin zone consists of sandy soils stabilized by desert shrubs and grasses, the latter providing significant quantities of edible plant material (Hard 1984; O'Laughlin 1985; Whalen 1986). Playas occur in this zone but seldom hold water for extended periods. No ancient or recent springs have been identified in the piedmont or basin zones (Meinzer and Hare 1915).

Rainfall fluctuates from year to year throughout the Hueco Bolson, with an average of 210 mm recorded annually over a hundred-year period. An examination of weather station data further indicates that marked differences in precipitation occur from station to station within the Hueco Bolson. Perhaps the most telling statistic in documenting the water deficit is the average evapotranspiration rate which climbs to over 2,000 mm a year (Marston n.d.). Paleoenvironmental reconstruction in the Hueco Bolson is in its infancy, but those studies that are available (Carmichael n.d.; Van Devender and Spaulding 1979; Van Devender and Toolin 1982) indicate little significant environmental change since the period in which the storage basins would have been constructed.

The Hueco Bolson is further defined as an archaeological zone within the Jornada branch of the Mogollon culture area (Lehmer 1948). Survey and excavation in the Hueco Bolson have revealed a constellation of communities dating to the Pueblo period (A.D. 1150–1400) (Carmichael n.d.; Kegley 1982; Whalen 1977, 1978, 1980). Recent research has focused on Meyer Pithouse Village (A.D. 1150–1200), a small community in proximity to the larger 10-hectare Hot Wells Pueblo (A.D. 1150–1340) (Scarborough 1985, 1986). The latter sites lie 40 km northeast of the Rio Grande, the only permanent water source. However, seasonally replenished playas are located 1–4 km away. These sites rest on the alluvial toes of the piedmont zone in a coppice dune setting. During the Pueblo period, agricultural potential was greatest in this area (Whalen 1981).

THE STORAGE BASIN

Located 400 m from Hot Wells Pueblo and over 1 km from Meyer Pithouse Village is the El Paso phase (A.D. 1250–1400) Hot Wells Storage Basin (Figure 2). The storage basin lies 1 km south of a major drainage channel carrying intermittent runoff from the Hueco Mountains. Elevated 5 m above the drainage, the storage basin captured water from a limited area. Excavations carried out at both the pithouse village and the pueblo indicate that much of the present-day dunal surface was less apparent in the past. Aeolian sands generally overlay

Figure 2. Excavations in Progress at Hot Wells Storage Basin
Two of the six trenches were excavated with hand tools and screened for artifacts.

a silt loam surface on which most occupation occurs. The frequently buried occupation horizon has prevented the accurate mapping of the extent and gradient of the storage basin catchment.

The site area associated with the storage basin covers 3,400 m^2 as defined by artifact litter (Whalen 1978). It rests near the center of a concentration of El Paso phase debris featuring a disproportionate number of ceramic water jar fragments (Scarborough 1985). Excavations reveal the dimensions of the storage basin to be 24 m $\times$ 13 m $\times$ 1.8 m in depth (Figure 3), with a maximum of 182 m^3 of water contained by the feature. No clearly defined channels into the feature were located, though drainage and vegetational indicators suggest that overflow may have been directed towards Hot Wells Pueblo.

The overall form of the basin indicates that it was in part excavated into a buried caliche horizon (Reeves 1970; Giles 1977). The caliche in this area is indurated, initially suggesting a considerable energy outlay for the construction of the feature. The original occupation surface has been suggested by our profiles (Figure 4). From this surface, approximately 50 cm of very fine sandy loam was excavated before the caliche was contacted. Vertical cuts into a compacted sandy loam defined the inner margin of the storage basin. An additional two steps or treads were carved below into the caliche, completing the terraced "walk-in well" appearance (Figure 5). Although our trenches provided limited exposures, the elevations of the cut treads permitted a reconstruction of the original storage basin interior (Figure 6).

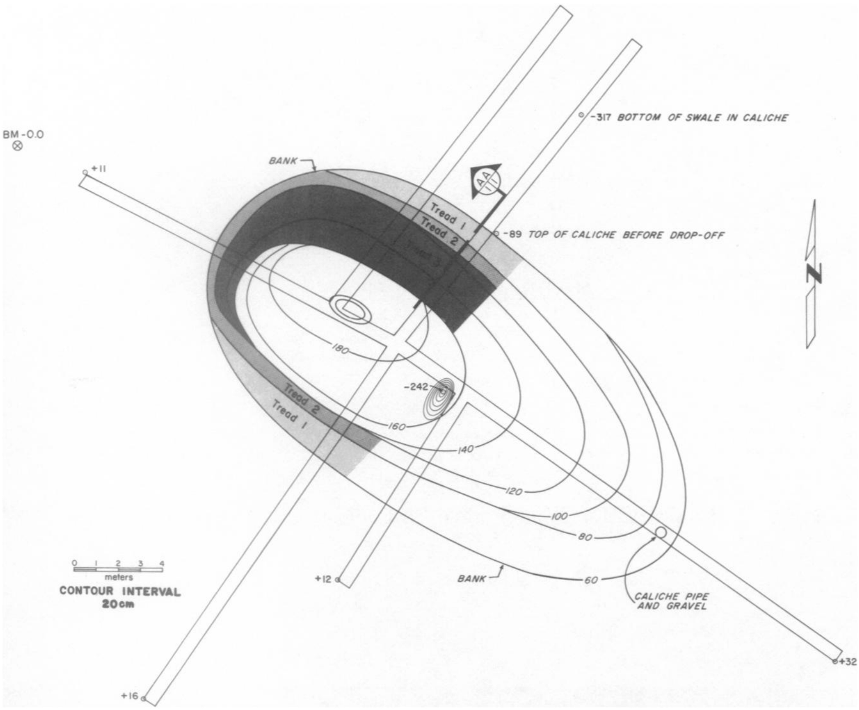

Figure 3. Plan View of Hot Wells Storage Basin with Locations of Excavated Trenches
Contour lines represent elevations below the assumed site datum.

The bottom of the storage basin was sealed by a 5–7 cm thick caliche plaster floor overlying a sterile, tan, very fine sandy loam with caliche gravels. These gravels formed a hearting over which the plaster was placed. Near the center of the feature, a subfloor pit 1.0 m × 1.8 m had been excavated to a depth of 40 cm. Unlike the blocky clays that composed the fill of the remainder of the storage basin, this depression contained a clay loam fraction. Moreover, it revealed a significantly higher percentage of organic matter than reported by twelve other samples from the same column (Scarborough 1985). Given the position of the pit as well as the high organic content and reduced amount of clay, it may represent a perishable dedicatory offering similar in design to that discovered at Casas Grandes (Reservoir 2; Di Peso, Rinaldo, and Fenner 1974).

Toward the southeastern end of the storage basin, another deliberately excavated depression was found excavated 20 cm lower than the bottom of the previous subfloor pit. Its planar dimensions as well as its function are unknown. Nevertheless, the position of the feature may indicate that it functioned as a silting tank to collect a large and turbid particle fraction associated with the initial runoff water replenishing the storage basin. The long axis of

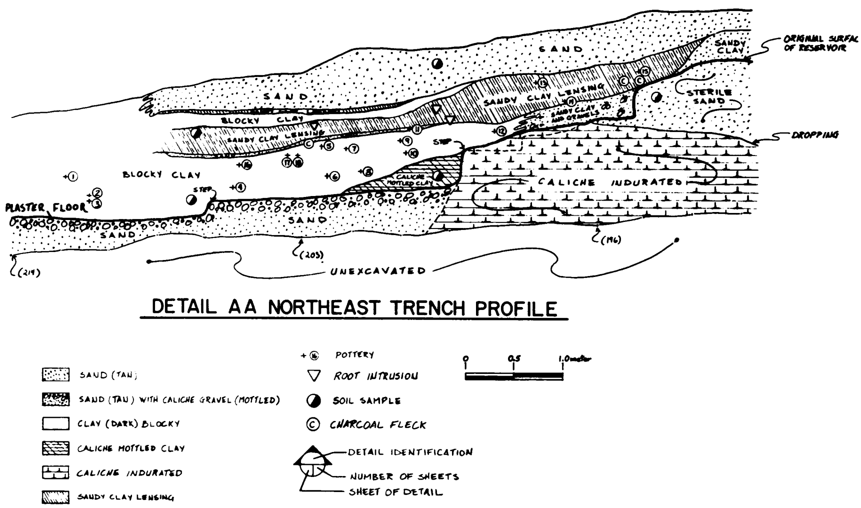

Figure 4. Profile of Hot Wells Storage Basin Illustrating Depositional History

Figure 5. Profile of Northeast Trench Exposure at Hot Wells Storage Basin
The carved caliche "steps" were immediately buried by fine clays.

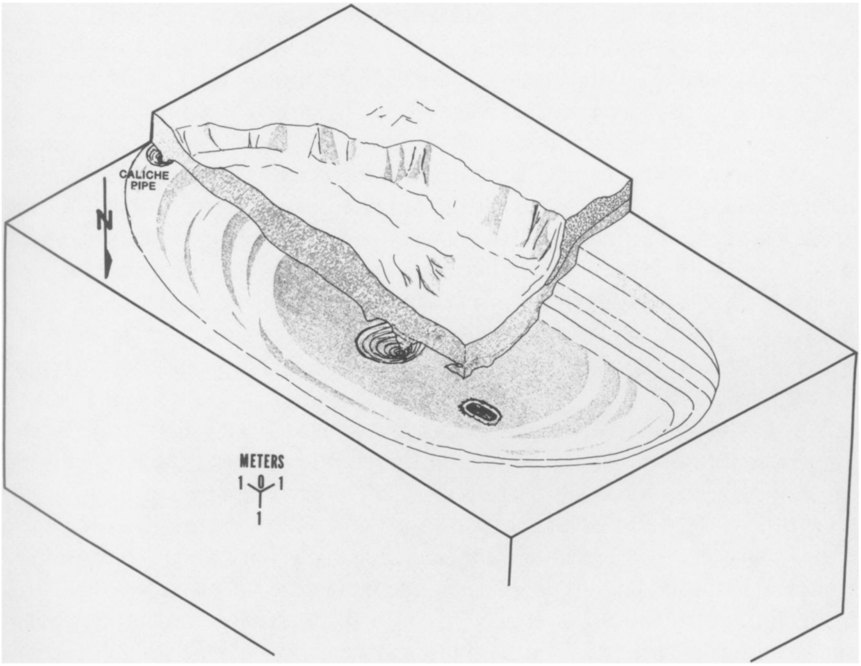

Figure 6. Reconstructed View of Hot Wells Storage Basin
The feature was carved into the thick caliche substratum. The caliche pipe is a natural break in the caliche probably caused by recent tree root disturbance. The other two subfloor depressions are deliberate features associated with the function of the storage basin.

the storage basin was oriented northwest/southeast, with slightly higher terrain draining into the southeastern end of the basin.

Water Capacity

A critical variable in placing the Hot Wells Storage Basin data in context is the amount of water that it would have provided. An examination of rainfall rates over a period of one hundred years from El Paso area weather stations indicates a general Southwestern trend in which the greatest period of rainfall extends over the months of July, August, and September (Marston n.d.). Although precipitation can fluctuate from year to year, well over 5 inches (12.7 cm) tends to fall at this time. Potential evaporation rates were also examined. By excluding the rainfall abundant months of July through September, an average evaporation rate of 66 inches (168 cm)/9 months of dryness is obtained. If the basin were recharged to capacity during the three rainfall abundant months, with little expectation of the feature being replenished during the remainder of the year, the evaporation rate alone would prevent an accumulated permanent water source. Given the surface area of the storage basin (248 m^2), as much as 417 m^3 of water would be lost to evaporation unless the feature were partially covered (no evidence exists for the latter). This would leave a deficit to sustain even the smallest of populations through the nine dry months.

By way of example, Evenari, Shanan, and Tadmor (1971:150) indicate that 18 m^3 of water per year will sustain a family of six plus their nomadic animals in the extremely arid Negev Desert. If the three rain recharge months in the Hueco Bolson are excluded, consumption needs are approximately 13.5 m^3/year. These figures indicate that humans and encroaching desert fauna can survive on very little water. Nevertheless, the elevated evaporation rates shown here would have prevented permanent and predictable storage of water. Even small groups would not have been capable of sustained year-round occupation in the Hueco Bolson, though precise seasonal population estimates remain enigmatic.

We do not know the extensiveness of storage basin construction in the immediate site area, to say nothing of the greater Hueco Bolson. Given the rapidity at which depressions are infilled after only one severe desert windstorm, it is likely that other storage basins lie invisible across the landscape. Clearly, an accurate assessment of their cumulative volume for any single period would be a useful figure in determining the number of people seasonally occupying the immediate area. However, even if the shallow profile and broad surface areas associated with the more distant playas are included in the volumetric totals, these depressions too would be affected by the same elevated evaporation rates. The paucity of water in the Hueco Bolson during the winter and spring months would have precluded long-term permanent occupation.

CALICHE CAVITIES

Dating to a slightly earlier period (A.D. 1150–1200) is the extensively excavated Meyer Pithouse Village. Of special interest is the contour map of the thick caliche horizon obtained by systematic postholing across the site (Figure 7). Less than 30 m to the south and west of the main site area is a shallow ridge of buried caliche. The caliche is the same indurated matrix as noted at the Hot Wells Storage Basin. Within the contours of the map were located five caliche cavities similar in form to another noted at the storage basin (Scarborough 1986). Three of these features were cross-sectioned using a backhoe, though the caliche horizon was too deeply buried to permit a clear assessment of one of them. The two cavities reported are oval in plan, 4–6 m at their maximum diameter, and drop at least 2 m below the caliche surface. Caliche was not identified at this depth, and the fill was a sterile sand. The history of these depressions may be in part due to recent localized faulting (Seager 1980; Taylor 1981), but given their cylindrical or conical appearance, they probably have a history similar to limestone solution cavities (cf. Giles 1961).

Regardless of the origin for these natural cavities, it is probable that the Hot Wells Storage Basin did not involve the energy investment in total caliche removal that seems apparent on first inspection. The distance between the

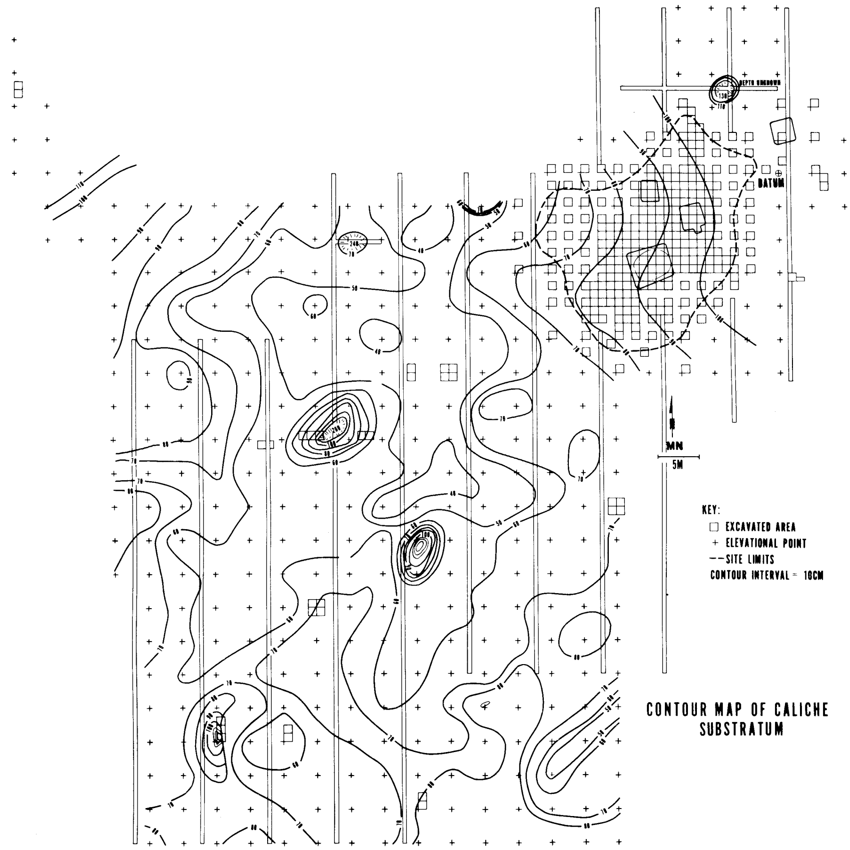

Figure 7. Buried Caliche Surface at Meyer Pithouse Village
Contour lines represent elevations below the assumed site datum.

storage basin and Hot Wells Pueblo makes it unlikely that the feature represents a borrow pit, since caliche can be obtained much nearer to the site. Given the absence of caliche nodules or spoil on the surface, the storage basin is understood to be a modified solution cavity.

Excavation at the main concentration of pithouses, features, and artifact densities at Meyer Pithouse Village indicates that approximately 40 cm of recent aeolian sands have buried the well-defined silt loam occupation surface. This represents an average depth of overburden, indicating that the invading shallow coppice dunes have sealed the ancient surface. If these sands were removed to a depth of 40 cm across the entire site area, much of the caliche horizon would be exposed. This is suggested by a homogeneous occupational stain noted immediately below the edge of the largest cavity (see below). Additionally, a fired surface manifest as a blue stain on the caliche was revealed 6 m west of this location, again suggesting the likelihood that this surface was exposed. All evidence points to a single residential component at the site, with four archaeomagnetic samples from four pithouse hearths revealing a late twelfth-century occupation (Scarborough 1985).

A portion of the largest cavity at the pithouse village was excavated in 10 cm units to a depth of 2.5 m (Figure 8). The same unconsolidated aeolian sands comprised the bulk of the fill, though some laminations were apparent. Resting below the surface of the caliche on a shelf at the margins of the depression and 1 m below the present surface, a shallow occupational stain was defined. Bits of charcoal, one projectile point, and a hammerstone were collected. Although not a preferred date, the point form suggests a Pueblo period occupation (Scarborough 1985).

At 220 cm from the surface, two flakes were collected. Charcoal flecks were noted in low frequencies throughout the entire exposure, with the density of surface artifacts in this zone away from the main site cluster generally being low. Although natural migration of artifacts may account for the apparent activity at this depression, it is more likely that this area was exposed when the occupants of Meyer Pithouse Village were present. It should be noted that the sides of the caliche cavities revealed no evidence of modification in the manner of the Hot Wells Storage Basin.

Although additional work is necessary, it is argued that the impervious caliche formed a natural ponding surface for rainfall. If the caliche horizon were exposed

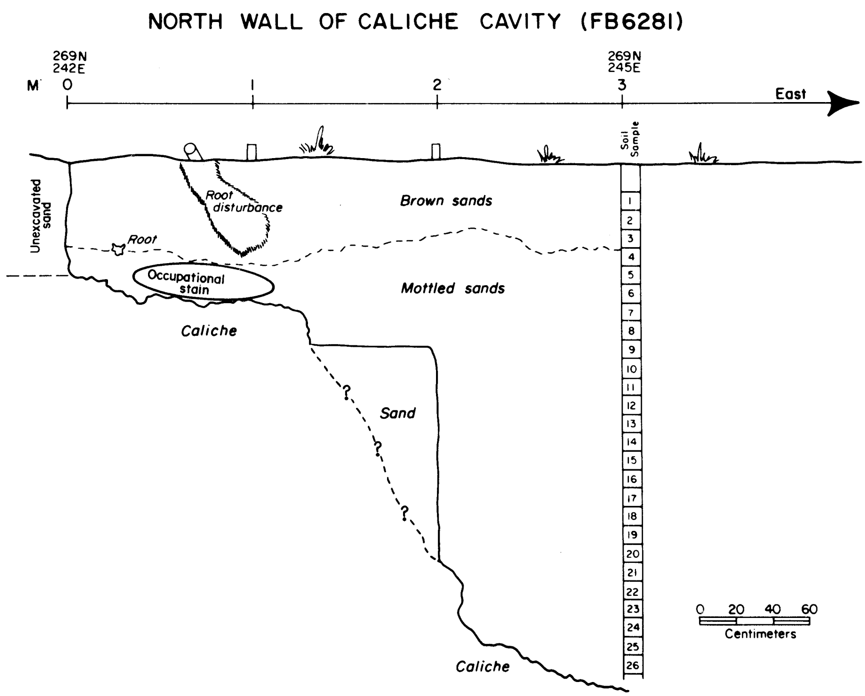

Figure 8. Profile of Caliche Cavity at Meyer Pithouse Village

at the time of occupation, as is indicated, it would have allowed the catchment and drainage of precipitation into these natural "sinks." At nearby Hueco Tanks State Park, the catchment of water into natural pools on an impervious igneous outcrop is readily observed, and an artificial storage basin is strongly indicated. Pueblo period pottery has been excavated from a small but deliberate stone dam found to be obstructing the flow of water through a natural cleft or channel in the outcrop (Kegley 1982). This site area has a long occupational history, though the deliberate impoundment of water appears associated with the Puebloan moment.

IMPLICATIONS

The Hot Wells Storage Basin and nearby caliche cavities permit an assessment of one adaptation made by a desert community at the margins of the American Southwest. Although "Puebloan" attributes have been reported as far south and east as the La Junta region (Kelley 1952), little investment in water management schemes has been reported for the Jornada Mogollon area. This is believed to be a consequence of survey sampling error. Further north and west of the Hueco Bolson, numerous examples of terracing and canalization exist (Di Peso, Rinaldo, and Fenner 1974; Haury 1976; Toulouse 1945; Woodbury 1961). Although water management is only one element in the successful adaptation of a more sedentary population, the presence of the Hot Wells Storage Basin indicates a technical adaptation made necessary by an increasing population (Whalen 1981).

Hard (1984) argues that the earlier Mesilla phase (A.D. 900–1100) population in the Hueco Bolson involved a mobile adaptation in response to the spatial and seasonal availability of food, water, and wood. Given a significant increase in population during the Pueblo period, greater quantities of water would have been necessary, even if the land-use strategy were little altered. It is less likely that a well-designed storage basin would have been constructed by a society that had recently become sedentary than by one using an earlier defined settlement mobility strategy that had experienced a population increase.

Some authors have suggested that, during dry periods of the year, some populations may have even relocated to the Rio Grande (Carmichael 1981; Scarborough 1985). Clearly, the present water regime, even coupled with the identified technology, would have made year-round sedentism in the Hueco Bolson extremely difficult. Although the excavated shape and surface area of a storage basin can be modified to best conserve water stores, the evaporation rates in the study area would have prevented pools of water from lasting through most years.

Recent literature has indicated that some prehistoric societies in the American Southwest moved their settlements frequently, even though significant architectural investments were sometimes made at a site (Nelson and Le Blanc 1986; Powell 1983). Although several factors influenced the duration or season that a site might have been occupied, the availability of water must be considered of critical importance. Given the presence of significant Pueblo period populations in the Hueco Bolson, a widely deployed series of natural and man-made runoff variety storage basins enhanced, if not determined, the length of time each site could be occupied.

THE GREATER SOUTHWEST

In an attempt to place the data in a broader context, the ceramic period literature treating storage basins in the Southwest was examined. Figure 9 illustrates the relationship of surface area to a volume index for reported storage basins having reliable metric data. (Storage basin capacity was computed using the equation for the volume of an elliptical cone [$V = 1/3 \cdot a/2 \cdot b/2 \cdot h$]. Although most storage basins actually have larger water-holding capacities, the nature of the metric data prevents greater precision. Excavation data seldom provide the exposure necessary to accurately assess the precise dimensions of a storage basin, as the feature may be more cubic or cylindrical than conical in cross section. The volume index allows a conservative assessment of volume for comparative purposes.) Generally, those storage basins having significantly greater surface area to volume ratios reflect little aboriginal excavation. They appear to be large impoundments constructed by damming intermittent drainages. Several of these features attain immense proportions (unplotted on Figure 9) but probably involved a reduced energy investment.

The four Riverine Hohokam storage basins include not only two of the largest features, but they are also well designed to reduce the evaporation to volume relationship. This is expected given the culture's overall investment in hydrology. Los Muertos is one of the largest sites with reported storage basins in the Salt-Gila River drainage (Nicholas and Neitzel 1984; Upham and Rice 1980), though Ruin XIV provides the only complete metric data (Haury 1945; Hodge 1893). The Santa Rosa Wash Reservoir is associated with a number of smaller communities in immediate proximity (Raab 1975, 1976).

Other parts of the Southwest exhibit a range of storage basin sizes. The extensive examinations of both Mummy Lake and the Casas Grandes storage basins (Di Peso, Rinaldo, and Fenner 1974; Rohn 1963) reveal sizeable populations in proximity. The less well understood storage basins at Gran Quivira (Howard 1959; Toulouse 1945) suggest immediate proximity to the late Pueblo period community. Only the Hot Wells Storage Basin and the much smaller Creeping Dune Site Reservoir indicate the presence of a storage basin some distance from a major community. Given that the latter appears to be an agricultural adaptation drawing its source from an artesian spring (similar to the case outlined by Hack 1942), the Hot Wells Storage Basin becomes somewhat enigmatic. This site rests in one of the most environmentally stressful locations in the Southwest, and it is likely that similar storage basins were periodically excavated to meet the needs of a dispersed population. The Hot

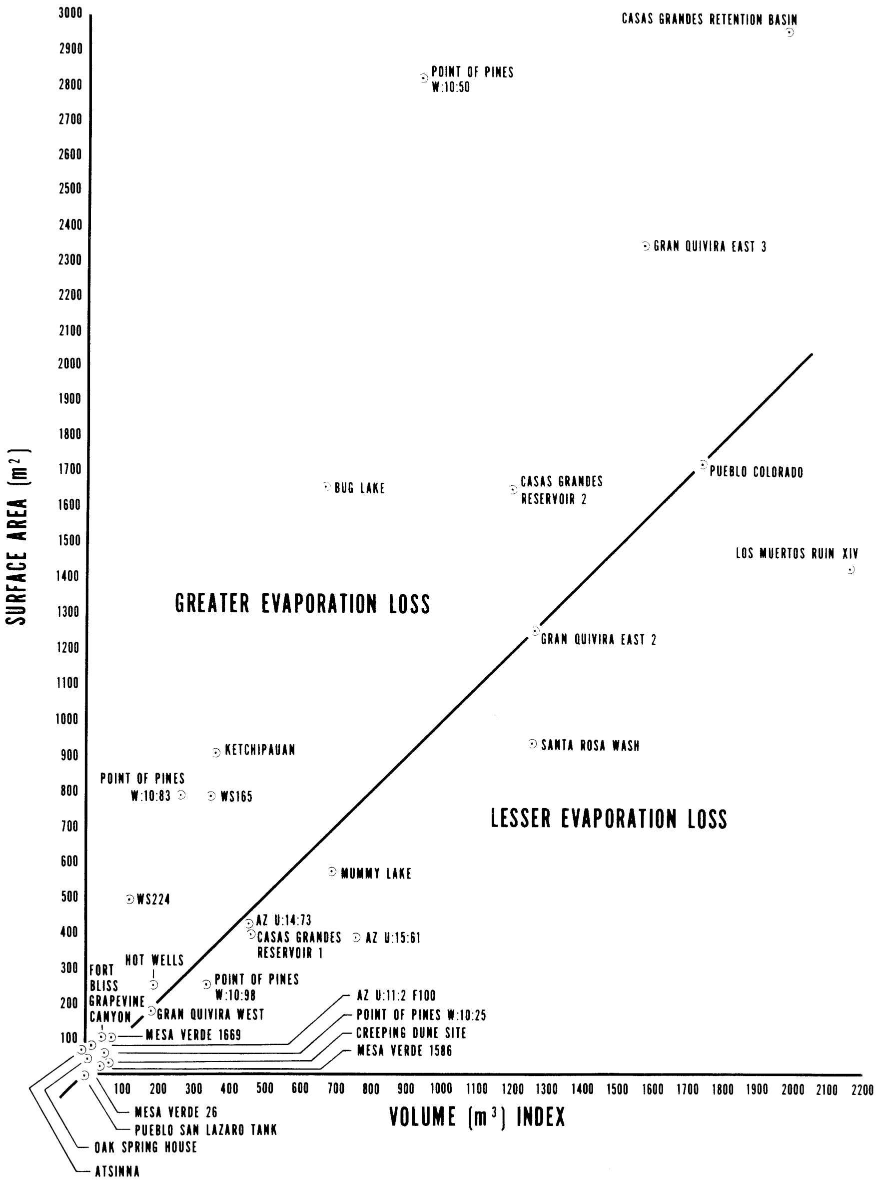

Figure 9. Graph Depicting the Size Range of Storage Basins in the American Southwest

The most efficient storage basins rest to the right of the diagonal line.

Wells Pueblo of over a hundred rooms probably obtained much of its water from a depression west of and away from the storage basin site.

The above sample of storage basins provides little indication that these features hold water year-round today. If they did, most metric data would be unavailable, particularly depth measurements which can only be taken during dry periods of excavation. Only one runoff variety storage basin (located in the Point of Pines, Arizona, area) suggests the presence of standing water throughout the whole year. Clearly, postabandonment infilling as well as changes in the catchment gradient have altered the amount of water contained in many of these features. However, many of these same features, even those in the Hohokam area, do not appear to have ever held permanent surplus water stores, especially in light of the prohibitive evaporation rates associated with the Hot Wells Storage Basin example.

The recent excavations carried out at Las Colinas near Phoenix, Arizona, further suggest this condition. Nials and Fish (n.d.) have demonstrated that two storage basins defined at this site only held water for a portion of the year. In an attempt to explain this *assumed* anomaly, Nials has argued that sediment was deliberately trapped in these depressions for use as potter's clay. Given the ready availability of clay from other sources and the energy expended for the construction of these features, their use as potable water storage basins must not be disregarded.

Generally speaking, storage basins having a capacity of over 1,000 m^3 appear after A.D. 1200 (Scarborough 1985). The single exception is the Santa Rosa Wash Reservoir, which simply underscores the early use of large storage basins in the water precocious Hohokam area. The appearance of large reservoirs reflects an apparent trend in some quarters of the American Southwest towards a greater settlement nucleation at this time.

The occupants of some areas of the American Southwest, especially those living in nonriverine settings, constructed storage basins as an adaptation to a relatively mobile seasonal round. In other areas in which large sedentary populations created additional stress on the environment, large storage basins were excavated to better cope with the reduced availability of water resulting from the increased number of consumers within a limited area. Under either condition, water stores extended the amount of time a population could acceptably occupy a zone. Storage basins, then, represent an increasing population's attempt to maintain earlier well-established settlement pattern strategies.

CONCLUSION

The location of the Hot Wells Storage Basin away from residential sites made it a neutral point for water acquisition. Given its distance from the main pueblo, the storage basin may have been located to accommodate smaller satellite populations similar in size to the slightly earlier Meyer Pithouse Village. The inability of the feature to hold water year-round and the erratic distribution of present-day rainfall in the Hueco Bolson, coupled with an increasing Pueblo period population, suggest that a number of natural and artificial basins were positioned throughout the study area. Further, these Pueblo populations were probably more mobile than is commonly assumed.

Although climatic conditions may have become slightly more severe in the recent historic past than they were in prehispanic times (Fritts 1976), major environmental changes since the Pueblo period cannot be argued in the El Paso area. As early as the 1600s, the Spanish document that "lack of water is so acute that they [Indians] are accustomed to preserve their urine to moisten the earth to make walls" (Hackett 1937:42). This statement was made about the inhabitants of Gran Quivira, just 200 km north of the site area.

Storage basins in the American Southwest allowed populations to better exploit an arid environment away from permanent water stores. However, high evaporation rates and limited rainfall prevented at least some storage basins from holding water for extended periods. The Hot Wells Storage Basin and related features suggest the severity of water shortages and indicate one water-use adaptation made by semisedentary Southwestern desert groups.

NOTE

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