PREHISTORIC AGRICULTURAL STRATEGIES IN THE SAFFORD BASIN, SOUTHEASTERN ARIZONA

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Introduction

This paper presents an overview of the prehistoric agricultural strategies of the Safford Basin (Figure 1) based primarily on studies of the settlement patterns and water management features and systems that have been conducted over the last several years. The information was largely obtained by survey, although a few small excavations and historical information have proven to be important and substantive. This article synthesizes data from a range of recent investigations (Clark 2004, 2006; Doolittle and Neely 2004; Huckleberry 2005; Lascaux and Huckleberry 2006; Lascaux and Montgomery 2005; Neely 2001, 2005a, 2008b; Neely and Doolittle 2006; Neely and Murphy 2008; Rinker 1998; Seymour et al. 1997) with the goal of providing a current status report on region. It is intended to supplement data on the prehistoric settlements in the area provided by Neuzil and Woodson in the preceding chapter.

With the information at hand, the Safford Basin was second only to the Phoenix Basin in the area of agriculturally utilized land in the prehistoric American Southwest. Also, at least partially because of its physiographic and topographic characteristics, the Safford Basin had what was probably one of the most complex, diversified, and intensively developed water management and irrigation systems of any area in southern Arizona. Studies have benefited from the fact that some of the water management systems and fields of the Safford Basin are extremely well preserved and visible through survey, but have been hindered through early agricultural development of the Gila River floodplain and lower terraces.

The process of agriculture can be viewed as a system of human interactions with the environment (Bye and Shuster 1984:127). The goal of the prehistoric agriculturalists was to achieve a necessary productivity, or harvest a required yield, through manipulations of the environment. The agriculturalist must determine what aspects of the environment can be modified to achieve the necessary crop yield required to sustain occupation in a chosen area or region. In the Safford Basin, we shall see that the ancient farmers were able to achieve this goal by using multiple environmental sub-zones or micro-environments and by manually modifying the landscape to receive additional sources of moisture and/or better retain and more efficiently use the moisture that was naturally available. It is highly probable that a great deal of effort was also expended in the selection and modification of plants to achieve this goal, however, at this time we do not have the evidence to do more than make a few general statements in that regard (see Observations, below). Thus, for the present, the reconstruction of agricultural strategies must depend on the evidence provided by water management infrastructure, agricultural fields, and archaeological sites.

Survey of the Safford Basin has revealed evidence of a three-part agricultural strategy: (1) dry-farming/runoff fields receiving moisture only from rainfall and snowfall; (2) fields irrigated by canals taking water from the Gila River; and (3) fields in the Pinaleño Mountain foothills irrigated by canals taking water from springs and runoff from rainfall and snowmelt. Each of these three strategies can be at least partially explained by variations in topography and other micro-environmental conditions.

Dry-Farming/Runoff Agriculture

Some researchers (e.g., Bradfield 1971:18; Glassow 1980:45) have suggested that dry-farming/runoff agriculture was probably a minor contributor to the subsistence base in the American Southwest. However, recent studies in the Safford Basin (Doolittle and Neely 2004) and the

Tucson area (Fish et al. 1992) have shown dry-farming played a large and integral role in the subsistence and economic systems by supplying food, fiber, and perhaps other products.

Evidence of dry-farming/runoff agricultural systems is widespread throughout the Safford Basin, and arguably comprises the largest total area of prehistoric cultivation. While a systematic inventory of dry-farming/runoff fields is still being compiled, it is evident that they occur east and west from one end of the Basin to the other and from south to north from the foothills of the Pinaleño Mountains to across the Gila River for a distance of at least three kilometers north of the river. North of the river, the two greatest concentrations of dry-farmed/runoff fields are on the high terraces north of the community of Pima (Figure 1) near the west end of the basin, and north of the large and important Buena Vista site (AZ CC:2:3[1]) near the east end of the basin. South of the Gila River, the densest concentration of these fields occurs between Ash Creek on the west and Graveyard Wash on the east.

The use of dry-farmed/runoff fields is securely dated to the Late Formative (ca. A.D. 800-1200) and the Classic (ca. A.D. 1200-1450) Periods. However, there is growing evidence that reasonably extends the use of Safford Basin dry-farmed fields into the Early Formative (ca. 150 B.C. - A.D. 800) Period.

Two forms of dry-farming/runoff fields have been recognized: those showing no apparent modifications ("unimproved" fields) and those with water management features ("improved" fields). Unimproved fields are difficult to discern, and those recorded as such are done so tentatively. It has been only through the proximity of sites and fieldhouses, as well as the presence of roasting pits, ceramic sherds and other trash (perhaps representing the use of household garbage as mulch and fertilizer), and presumed agricultural tools that these fields have been defined. *Ak chin* or floodwater farming may be included in this unimproved field category and may well have been important in the Safford area, although as yet I have not been able to identify tangible evidence of their existence. However, circumstantial evidence in the form of site locations (i.e., sites often located adjacent to major secondary drainages, or near more than one major secondary drainages, in locations where the drainages cannot be easily tapped with canals) strongly suggests their presence. Settlement distributions in the Hohokam area would argue that floodwater farming was an extremely important component of the agricultural strategy throughout southern Arizona (Wallace, personal communication 2008). Aerial/satellite imagery, soil studies, and chemical analyses of soils (e.g., Arnold 1998; Berlin et al. 1977; Lyons and Scovill 1978; Sandor 1995; Wilkinson 1990, 2003), provide appropriate ways to more accurately identify these fields.

The identification of improved fields is a completely different story. The presence of water management features constructed of unmodified rock makes the identification of these fields unquestionable. In most cases, the size and shape of these fields may be determined quite accurately.

Dry-Farmed Fields North of the Gila River

Two of the largest dry-farmed/runoff field complexes have been studied and reported in detail (Doolittle and Neely 2004; Seymour et al. 1997). These extensive terrace-top fields are easily recognized because of the water management features constructed on their surfaces. Several types of water management features appear at each location. Rock-piles predominate at the Sanchez agricultural sites to the east (Figure 1), while rock-bordered grid fields are in the vast majority north of Pima. These features represent a great investment in time and labor to construct, but their maintenance was probably minimal.

North of Buena Vista, Seymour and his colleagues (1997) recorded 36 sites with rock field features. The latter range from about 0.01 hectare to about 56 hectares in area, with an average area of about 5.1 hectares, and a total field area of about 184.3 hectares. The fields north of Pima (AZ CC:1:2 – Figures 1 and 2) cover an area of approximately 600 hectares, and consist of multiple separate areas of irregularly juxtaposed rock-bordered grids (Doolittle and Neely 2004). They comprise a total gridded area of about 82.2 hectares. A number of lines of evidence indicate that agave was the primary, if not the only, crop grown on the fields in these two areas (Doolittle and Neely 2004; Seymour et al. 1997).

Ceramics and radiocarbon assays have been used to determine the chronological span during which these fields were in use. Seymour et al. (1997) found little evidence of habitation associated with the Sanchez agricultural sites, and only 19 sherds were recovered during their survey. Two diagnostic sherds dated to A.D. 1000 - 1150 ("Mimbres Black-on-white") and A.D. 1000 - 1350 ("Alma Semi-obliterated Corrugated"). Two radiocarbon assays provided calibrated two-sigma date ranges of A.D 430-660 and 1020-1260 (Seymour et al. 1997:10-4). Doolittle and Neely (2004) were more fortunate in that north of Pima they found relatively great numbers of ceramic sherds in the fields, as well as associated roasting-pits, habitation sites, and fieldhouses. The sherds represented types having a probable date range from ca. A.D. 750 to 1385 (Neely and Doolittle 2004:132-135). Three radiocarbon assays[2] (TX-9215, TX-9216, TX-9217) provided 13C/12C corrected and CALIB calibrated one-sigma date ranges of 1460$\pm$60BP (A.D. 556-647), 1450$\pm$40BP (A.D. 584-644), and 580$\pm$40BP (A.D. 1313-1357), respectively (Fish et al. 2004:89-90; Neely and Doolittle 2004:132-135). The early radiocarbon dates recovered from both projects have been considered with some circumspection; however, both sites produced surprisingly similar early dates. In considering these dates, two factors should be considered. First, they could represent the early use of both areas for the collecting of wild agave. Second, the recent evidence for canal irrigation at ca. 190 B.C. (Huckleberry 2005; Lascaux and Huckleberry 2006) and ca. A.D. 1 (Clark 2004, 2006; Nials et al. 2004) in the Safford Basin, discussed below, lend credence to the practice of dry-farming by at least ca. A.D. 500. Even earlier evidence of dry-farming/runoff agriculture and canal irrigation (e.g., Damp et al. 2002; Fish et al. 1986; Mabry 2007; Thiel and Mabry 2006; Wills 1988) elsewhere in the American Southwest also supports the credibility of these early dates.

Dry-Farmed Fields South of the Gila River

South of the Gila River there is more variety in the topography, and a corresponding greater diversity of dry-farming/runoff fields. Three topographic settings were the targets of such field systems: the high north-projecting extensions of the Pinaleño Mountain foothills, the low foothills of the Pinaleño Mountains, and the area between the foothills of the Pinaleño Mountains and the floodplain of the Gila River. Contrasting case studies are provided for the first and last of these three settings.

The first example is found on a north-south oriented promontory of the Pinaleño Mountains located about 3.5 kilometers southwest of Highway 70 as it passes through the community of Thatcher (see "A" on Figure 1). The top of this promontory is just over 1,000 meters in elevation, about 40 meters above the relatively flat lower *bajada* floor lying to the north and east. The entire top (about 1.64 hectares) and remaining rather steeply sloping (about 25°) upper surface of this long, narrow promontory had been augmented with rock-piles (averaging about 1.7 meters in diameter and 10 cm high), contoured linear borders (averaging about 9 meters long and 20 cm high), and rock-bordered grids (see Doolittle and Neely 2004). Unique water management features consisting of nested chevron-shaped rock alignments (with the points oriented downslope) were also present at this locality. A total field area of about 10.8 hectares resulted from these modifications. No sherds were found, therefore the field's date of use is not known.

East of the fields described above, a second example of dry-farmed/runoff fields lies between Freeman Wash and Graveyard Wash, just south of the City of Safford (see "B" on Figure 1). Remnants of this 360 hectare field complex were seen in recently sub-divided suburbs of south Safford. The separated fields comprising this complex are easily distinguished due to the stone water management constructions found on their surfaces. Some check-dams and a few low terraces are present, but the majority of the features consist of rock-piles and linear borders. Contour-following linear borders completely encircle many of the low knolls characterizing the topography. The few sherds found indicate Late Formative and Classic Period use. A probable agricultural tool, consisting of wide prismatic blades (Figure 3) struck from rhyolite cores, was found on these fields.

It is probable that the latter fields extended northward to just south of the 914-meter (3,000 foot) contour line (U.S.G.S. 7.5 Topographic Map, Safford Quadrangle). North of the 914-meter contour the topography abruptly drops some 6-9 meters, marking the edge of the first (T3) terrace above the river floodplain (see Huckleberry 2005:Figure 3.2). The Highline Canal courses along the toe of this terrace. From that point on the topography becomes nearly level, sloping very gently towards the Gila River. As discussed below, this floodplain area was, and still is, utilized for irrigation agriculture.

Gila River Floodplain and Lower Terrace Agriculture

Although probably constituting the second largest total area of prehistorically used agricultural lands in the basin, Gila River floodplain and lower terrace agriculture and its associated irrigation systems represent the most difficult components to research in the study of agricultural development in the Safford Basin. This is due to the destruction and concealment of fields and canals by intensive past and present farming practices and the growth of communities along the river. This problem is exacerbated by a paucity of written historical documents and numerous and complex historical canal modifications. Fortunately, in a few cases, public works have aided the study of agricultural development with excavations that have disclosed historic and prehistoric remains. While a good picture of the prehistoric fields and canal systems associated with the Gila River will probably never be achieved, several lines of evidence have permitted an initial reconstruction. What is offered herein will hopefully be augmented and modified in the future.

This preliminary reconstruction of floodplain and lower terrace canal systems in the Safford area draws from the limited available excavation data, the distribution of prehistoric settlements, analogies with the larger of the irrigated fields in the foothills of the Pinaleño Mountains (to be discussed, below), the irrigated fields documented for the Phoenix Basin (e.g., Howard 2006), and historic irrigation practices. These reconstructions, when augmented by Doolittle's (1998, this volume) study of the riverine floodplain fields of the region, present a developing picture of Gila River floodplain and lower terrace agriculture in the Safford Basin. A few of the historical canals in the Safford Basin are proposed to be refurbishments of prehistoric canals while others appear to closely follow the paths of prehistoric antecedents. For the time being, we must assume that the remaining functioning canals are of historical origin.

The historical information, as obtained by Fewkes (1898, 1904) at the end of the nineteenth century and subsequently from interviews with elderly residents of the basin (Colvin 1997, 1998; Colvin and Cook 2006; Ramenofsky 1984), indicates that historical canal-irrigated cultivation of the Gila River floodplain was conducted initially by Hispanic agriculturalists, and subsequently by Anglo farmers, in the latter part of the nineteenth century. However, considering the arrival of the priest Bartolomé Sanchez in the Cliff, New Mexico Upper Gila River area in 1757, some 100 kilometers east of the Safford Basin (Ackerly 1997; Doolittle 2000:387; Sanchez 1856), it seems plausible that Hispanic agriculturalists occupied the Safford Basin earlier than 1870. As also reported by the early Hispanic and Anglo agriculturalists in the Safford Basin (Fewkes 1898:613, 1904:178), Padre Sanchez noted the presence of prehistoric agricultural irrigation canals in the Upper Gila River region (Ackerly 1997:354; Doolittle 2000:387; Sanchez 1856).

Prehistoric canals are proposed for both sides of the Gila River in the Safford Basin (Figure 1). The names of the canals used herein have been adopted from historical sources (Colvin 1997, 1998; Fewkes 1898, 1904; Ramenofsky 1984) and the U.S.G.S. 7.5 minute topographic maps of this area. Neely and Murphy (2008) have published a more detailed consideration of these canals.

The Prehistoric Canals South of the Gila River

Current evidence implies that there were at least four pre-historic primary canals taking water to irrigate fields on the south side of the river. From east to west, they are historically named the San José, the Montezuma, the Union, and the Sunflower Canal (Figure 1).

San José Canal. The San José Canal has been attributed as having a prehistoric counterpart by historical sources (Colvin 1997, 1998; Fewkes 1898:613, 1904:178; Ramenofsky 1984). The original head or offtake for the San José Canal appears to be in approximately the same location as its prehistoric predecessor (Doolittle 1998, this volume), and the present course of this canal also probably approximates its original course, at least to a point a short distance southwest of the present community of Solomon/Solomonville (Neely and Murphy 2008). The prehistoric existence of this canal is indicated by: (1) the manner in which the modern canal conforms to the unmodified topography of the landscape; (2) the presence of probable prehistoric canal segments near the present functioning canal; (3) the occurrence of archaeological sites paralleling the course of the canal; and (4) the historical information that this canal was ancient and had been refurbished by 19th century Hispanic and Anglo agriculturalists.

The archaeological sites probably associated with the proposed prehistoric counterpart of the San José Canal are (from east to west on the south side of the river – Figure 1): the Yuma Wash site (AZ CC:2:16 - Brown 1973; Neuzil 2005); AZ CC:2:4; the Buena Vista (Curtis) site (AZ CC:2:3 - Brown 1973; Fewkes 1898, 1904; Mills and Mills 1978; Tuohy 1960); the San José site (at the west edge of the present community - Fewkes 1898:614, 1904:173); and Epley's Ruin (AZ CC:2:64 - Fewkes 1898, 1904; Lascaux and Huckleberry 2006; Lascaux and Montgomery 2005). As indicated by the reports of Bandelier (1892), Fewkes (1898, 1904), and Hough (1907), these sites represent the few sites that have at least partially escaped historical cultivation and settlement.

Montezuma Canal. The Montezuma Canal is believed to be the next functioning canal down-stream to have a prehistoric analog. Currently, this canal is a branch of the historical Highline Canal. The historical, and possible original, offtake and about three kilometers of the upper portion of this canal are no longer visible. From an interview (Frank Quinn [an elderly Safford historian], personal communication 1997), an early offtake may be projected as having been located about 1.3 kilometers northwest of the small community of San José, and approximately 6.5 kilometers down stream from the present head of the San José Canal (Figure 1). The present course of this canal west of Solomon probably closely parallels its original course and currently terminates in an open field area at a distance of a little over seven kilometers. Paralleling sites, and historical information by Colvin (1997, 1998), Fewkes (1898:613, 1904:178), and Ramenofsky (1984:49-50) provide support for a prehistoric analog. Like the Union and Sunflower canals (below), this canal has potentially associated archaeological evidence that also suggests that it may be a refurbished canal and/or closely follows the course of a prehistoric antecedent. Recent excavations, at the northeast edge of Solomon and Epley's Ruin (AZ CC:2:64 - see "C" on Figure 1) by Tierra Right-of-Way Services, Inc., found segments of three prehistoric canals and one historical canal with NE-SW orientations near the functioning canal (Huckleberry 2005; Lascaux and Huckleberry 2006; Lascaux and Montgomery 2005). The earliest of the radiocarbon assayed prehistoric canals has been dated to cal. 190 B.C - A.D. 10.

The archaeological sites on the south side of the river that were probably associated with the proposed prehistoric analog of the Montezuma Canal are (from east to west): the San José site (at the west edge of the present community - Fewkes 1898:614, 1904:173); Epley's

Ruin (AZ CC:2:64); and the University of Arizona Agricultural Station Site (AZ CC:2:2).

Union Canal. The Union Canal appears to be the currently functioning correlate of a third prehistoric canal (Figure 1). This canal presently receives waters from a modern "aqueduct" (see USGS 7.5 minute topographic map, Safford Quadrangle, 1985) leading from the historical Highline Canal. The early historical, and possible prehistoric, head of this canal took water from the Gila River approximately 3.4 kilometers east-northeast of where the aqueduct now joins the channel (Figure 1). This head location is documented by an interview (Mr. Frank Quinn, personal communication 1997), and from older maps (Bureau of Land Management 1973). The course of the historical canal, from its offtake from the river to where it enters the current community of Thatcher, appears to be in about the same location as its proposed prehistoric predecessor. This observation is based on: (1) the topography of the landscape; (2) the presence of archaeologically documented remnants of prehistoric canals (Botsford and Kinkade 1993; Crary 1997) near the present functioning canal, (3) archaeological sites paralleling the course of the canal (Frank Quinn, personal communication 1997; Neely and Murphy 2008); and (4) historical information (Colvin 1997, 1998).

The archaeological sites on the south side of the river that were probably associated with the proposed prehistoric correlate of the Union Canal are (from east to west): the University of Arizona Agricultural Station Site (AZ CC:2:2); Methodist Church site (AZ CC:2:15 – Brown 1973; Crary 1997); the BLM site (AZ CC:2:64 [BLM] - Botsford and Kinkade 1993); sites AZ CC:2:236 (ASM), AZ CC:2:289 (ASM), and AZ CC:2:290 (Clark 2004); the Daley site (AZ CC:2:235 - Clark 2004; Lee et al. 1981); and AZ CC:2:291 (Clark 2004). Other sites (e.g., the

Safeway site), for which I have been unable to obtain information, were also probably associated.

Sunflower Canal. The Sunflower Canal is the fourth canal on the south side of the Gila River that is proposed to have had a prehistoric counterpart. This canal has its present head at a well and is surrounded by fields of irrigated cotton. Not visible due to historical use of the field, the early historical, and possible original, head for this canal has been projected to the point of outtake from the Gila River as seen in Figure 1, as indicated during an interview with Frank Quinn (personal communication 1997). Clark's (2004) archaeological discovery of nearby prehistoric canal segments and associated habitation sites has led to this canal being proposed as a refurbishment or realignment of a prehistoric canal. Among other features, Clark’s work disclosed segments of two ancient canals (AZ CC:2:296 and 297) that generally parallel the Sunflower Canal and are only a few meters to its north (see "E" on Figure 1). The prehistoric canals have been radiocarbon dated (Nials et al. 2004) to A.D. 1-300 and A.D. 900-1400. Early historical canals also found during Clark’s excavations indicate a long, continuous history of canal use at this location.

The archaeological site on the south side of the river that was probably associated with the proposed prehistoric counterpart to Sunflower Canal is: AZ CC:2:289 (Clark 2004). It seems likely that sites AZ CC:2:10 and AZ.CC:2:236 (Clark 2004) may also have been associated.

The Prehistoric Canals North of the Gila River

Michelena - Tidwell Canal. Presently known as the Tidwell Canal, this canal (see Colvin 1997, 1998; Colvin and Cook 2006:11), perhaps also incorporating the Brown, Mejia, and Sanchez Canals in its history, is the easternmost of the canals on the north side of the river that may have had a prehistoric antecedent. The proximity of sites does suggest a prehistoric analog, but the area lacks thorough survey and, therefore, this canal is only briefly mentioned.

The archaeological sites (from east to west on the north side of the river) that may have been associated are: AZ CC:2:8; the Earven Flat Site (AZ CC:2:5) - Ahlstrom 1997; Brown 1973; Tuohy 1960); AZ CC:2:6; the Sanchez sites (Seymour et al. 1997); and AZ CC:2:9.

Graham Canal. The head of the Graham Canal is located about 6.5 kilometers west of the terminus of the Michelena - Tidwell Canal (Figure 1). This canal has somewhat better evidence of having a possible prehistoric correlate: a possibly related historical document and the proximity of a number of paralleling prehistoric sites.

The historical documentation deals with the town of “Smithville” (now named Pima), and is derived from Mormon records: “St. Joseph Stake History, Pima Ward” and “St. Joseph Stake History, Eden Ward” (Williams 1937:22). The document states (Williams 1937:22) that the Mormons “ … had enlarged fifteen to twenty miles of the old ditches (the old ditches were widened from three to four feet to, in many cases, eight to ten feet and deepened proportionally).” While the "old ditches" mentioned in this document could refer to earlier historical channels, they could equally well refer to prehistoric canals. Note also that this canal has a length somewhat greater than 24 kilometers (Figure 1).

Archaeological sites (from east to west on the north side of the river) that may be associated with a prehistoric canal correlate are: AZ CC:2:10; the Peterson Wash Site (AZ CC:2:31 [BLM] - Taylor 1983); the Safford Grid sites (AZ CC:1:2 and AZ CC:1:20 - Doolittle and Neely 2004); the Peck Wash Site (Neely and Doolittle 2004:131-132); the Eden site (AZ CC:1:4 - Tuohy 1960); and the Owens-Colvin site (AZ CC:1:19 - Neily et al. 1993; Rule 1993).

The above findings correspond with and are reinforced by Doolittle's (this volume) reconstruction of the potentially irrigated agricultural area of the Gila River floodplain. Additionally, they appear to expand the minimal area of about 7,000 hectares that Doolittle (this volume) estimates was available for irrigated cultivation through the discovery that most, if not all, of the proposed prehistoric Gila River canals on the south side of the Gila River apparently were engineered to access the upper (T1b) terrace immediately above the floodplain (see Huckleberry 2005:Figure 3.2).

Foothill Agricultural Complexes

Ongoing survey has discovered several complexes of habitation, agriculture, and water management located in the *bajadas* or foothills on the south side of the Safford Basin. These complexes were evidently constructed along the northern face of the Pinaleño Mountains wherever springs and/or runoff amounts of sufficient size were present. Seven apparently complete (Figure 4) and two partial ("F" and "G" on Figure 1) complexes have been recorded. Bandelier (1892), Hough (1907), and Sauer and Brand (1930) noted canals in this area of the basin that probably were parts of the same complexes. Bandelier's (1892:414) reference to another canal with branches, in a similar topographic situation about 12 miles southeast of Globe, Arizona, implies that these complexes are not unique to the Safford Basin.

The foothill complexes appear to have provided the smallest total area of cultivation in the Safford Basin. However, they represent some of the most complex and innovative agricultural and water management technology found, and undoubtedly played an important role in the overall prehistoric subsistence and settlement systems. Two of the nine complexes recorded will be briefly described. The Lefthand Canyon (Neely 2005a) and the Marijilda Canyon (Neely 2008b) complexes are in many ways similar, but each has its unique aspects.

The Physiographic Setting

The head or offtake of at least one canal lies at the highest elevation within each complex. The presence of a spring and/or a likely point of offtake from a drainage carrying runoff from precipitation and snowmelt from higher elevations mark the head of the canal. The canals begin at elevations as high as about 1,311 meters and descend northward to elevations as low as 845 meters. The documented canal complexes range from about 600 meters to 12.5 kilometers in length. The watershed catchment area of the Marijilda Canyon complex (Locus 6 on Figure 4) is the largest. It has a collection area of at least 2830 hectares (USGS 1998), and is augmented by an estimated 1550 hectares of watershed from the adjacent Deadman and Rincon Canyons (USGS 1998).

The termini of the complexes have been placed at the furthest point down slope that the canals can be traced, although some were probably more extensive. The canals of the seven more complete complexes, as well as that of the Wes Jernigan Site (AZ CC:1:38 – see "F" on Figure 1), do not reach the Gila River floodplain. However, based on evidence (Bandelier 1892:410; Neely and Rinker 1997) from the Bandelier Site (AZ CC:1:7 – see "G" on Figure 1), some of them did. The Bandelier Site is situated near the edge of the first (T3) terrace above the Gila River floodplain (see Huckleberry 2005:Figure 3.2), and is the westernmost of the documented complexes within the Safford Basin. The foothill canal passing through this site may have augmented the historical Gila River Dodge-Nevada Canal, suggesting that this historical canal may have a prehistoric analog.

Details of the Foothill Complexes

Of the seven more complete complexes, the western-most (AZ CC:1:70 - Neely and Rinker 1997) was found in Taylor Canyon (Locus 1 on Figure 4), and the Jacobson Canyon complex (Neely and Crary 1998) is the furthest to the east (Locus 7 on Figure 4). In scale and complexity, Taylor Canyon was the smallest and simplest, while the Marijilda Canyon complex (Locus 6 on Figure 4 - Neely 2008b; Neely and Crary 1998) was the largest and most sophisticated. Visible surface evidence from the complexes varies greatly in quantity and quality. There are characteristics that most, if not all, of the complexes have in common, however, there are also features that vary so as to make each complex unique in certain ways.

General Characteristics

All of the recognized complexes were characterized by irrigated gardens and fields, some of which were rock-bordered or rock-terraced, and small canals, some of which were rock-bordered, to convey waters from springs as well as rainfall and snowmelt runoff from the mountains. Habitation sites, fieldhouses, reservoirs, and dry-farmed/runoff fields were integral parts of these complexes.

Canals: Canals were relatively small (50 cm to 2.0 meters wide), with shallow (10 cm to 1.0 m deep), broadly U-shaped channels. In places, a low-mounded spoil bank is visible to one or both sides of the channel. Most canals were visible at ground surface level, although down-cutting had "perched" one about 3.5 meters above the present floor of a paralleling drainage from which it had obtained water. The canal offtakes branch from a cutbank on one or both sides of a drainage. All complexes were augmented with waters from side drainages. In several cases the augmenting waters had been channeled and serviced sites and fields along their course before emptying into the primary canal.

Earthen canals were often partly rock-bordered, and small trowel tests indicated that some were rock-bottomed as well. The use of unshaped cobbles, small boulders, and slabs of local rock to border one or both walls of the canals (Figure 5) makes them clearly visible. As found in other areas (e.g., Fish and Fish 1984; Lindsay 1961), the rock lining provides channel wall stability in areas of loose soils. On occasion, the canals seem to be excessively sinuous in areas with steeper slopes, perhaps to slow the water flow to better maintain the average grade of about 1.5 to 2.0%.

Canals were excavated along steep slopes and into terraces, finger-like ridges, and drainage floodplains. They often branch into somewhat smaller secondary canals, and even smaller tertiary or field canals/ditches. Water could be turned out from the primary canal directly into gardens and fields through small sluices or gates in the canal walls, or into ditches that led to the gardens and fields. Canals were found to course adjacent to and through habitations sites, gardens, and fields.

A total of about 13.33 kilometers of canals/ditches was mapped in Lefthand Canyon. Although not mentioned in my report on this site (Neely 2005a), at least one canal appears to continue northward from the northern extreme of Figure 6. This canal courses north to Cottonwood Wash, where it turns eastward and apparently continues to the Cottonwood Wash Site (AZ CC:1:32). This adds approximately 1.5 km to the total length of Lefthand Canyon canals. For Marijilda Canyon, a total of about 30 km of canals and ditches was recorded.

Reservoirs: Most of the foothill complexes have at least one reservoir in association. These reservoirs show evidence of an associated prehistoric canal or a human-modified drainage channel (e.g. Lamb Tank - Figure 6). Some of the reservoirs have been historically modified and a few are currently being used to supply irrigation waters. These impoundments probably functioned like the Papago reservoirs of southern Arizona and northwestern Sonora. Castetter and Bell (1942:169-170) describe the Desert Papago *balsa* as an embanked reservoir with a gate that allowed water to enter a ditch leading to a cultivated field. They observed that it was possible to raise a crop from the water of a single filling of a *balsa*. Both Marijilda and Lefthand Canyons have such reservoirs, and a discussion of the origin, modification, and use of the Lefthand Canyon reservoir has been published (Neely 2005a).

Gardens and Fields: It is evident that both “improved” and “unimproved” gardens and fields were present and canal irrigated (Neely 2005a). Areas that were devoid of linear borders of rock and rock-faced terraces were recorded as “unimproved” gardens and fields on the basis of their size, associated artifacts, and locations in relation to habitation sites (see Doolittle 2000:82-85). Relatively large numbers of sherds in open areas suggest that household garbage was used as mulch and fertilizer in some gardens and fields (see Donkin 1979:2; Neely et al. 1990:134-135; Roberts and Barrett 1984; Stewart and Donnelly 1943:42-43; Wilken 1969:231; Wilkinson 1982, 2003). The distribution of sherds and agricultural tools (Neely 1995:252-256, 2001, 2004a:26-30) were used to approximate the shape and size of “unimproved” fields. In Lefthand Canyon, several “unimproved” irrigated fields, not discernable during pedestrian survey, were clearly evident on aerial photographs. Four of the best-defined unimproved fields recorded were rectangular in plan view, and about 43 by 54 m (0.23 ha), 64 by 93 m (0.5952 ha), 93 by 122 m (1.1346 ha), and 100 by 143 (1.43

ha) in size (Neely 2005a:157). The majority of all "improved" gardens and fields appear to have been irrigated (e.g., Figure 7) while many of the “unimproved” fields were not.

Dry-Farming/Runoff Agriculture: All of the foothill complexes have dry-farming/runoff fields. Recognition of probable dry-farming/ runoff fields is based largely on the presence of habitation/ fieldhouse sites and specific artifact types. Although probable “unimproved” dry-farming/runoff fields have been tentatively identified, their determination, especially their shapes and sizes, is highly speculative. “Improved” fields of this type were clearly visible and were recorded in detail. The present sample suggests that a broad range of field sizes (from about 0.01 ha to over 2.0 ha) were used. In addition, multiple topographic and geographic locations were used, and in specific topographic situations the range of field size and the use of certain water-management features appears positively correlated.

The Sites: All complexes have features and sites paralleling their canals or adjacent to their fields (e.g., Figure 6). Roasting pits, fieldhouses, and habitation sites were found in both the Lefthand Canyon and Marijilda Canyon complexes. In Lefthand Canyon, these features represent the late part of the Early Formative Period (ca. A.D. 700-800) as well as the Late Formative (ca. A.D. 800-1200) and Classic (ca. A.D. 1200-1450) Periods of occupation. In Marijilda Canyon, only Late Formative and Classic Period remains were identified.

The roasting pits were low (about 10-25 cm high), circular mounded areas of fire-cracked rock that averaged about 3.0 meters in diameter (cf. Fish et al. 2004:87-89).

Fieldhouses were small one or two-room structures with a foundation of piled unmodified cobbles and small boulders (cf. Neely 2004b:102, Figures 8.3 and 8.4).

The habitation sites found usually consist of an estimated one to twenty pithouses, pitrooms, and/or surface masonry rooms. A compound wall of stone and adobe surrounds some. These sites tend to parallel irrigation canals, from which they undoubtedly obtained a domestic water supply. The 18 sites recorded for Lefthand Canyon and 56 site found in Marijilda Canyon range in area from about 4.5m^2 for a fieldhouse to about 0.58 ha for a pithouse village. In addition, some of the complexes are characterized by at least one unusually large habitation site. In Lefthand Canyon, two such sites were found, while one large site was located in Marijilda Canyon.

Specific Characteristics of Lefthand Canyon

Canals: The canals of Lefthand Canyon may be considered as two distinct and separate systems: one each for the north and south segments of the canyon (Neely 2005a). The south segment has primarily rock-bordered canals, while the north segment has principally earthen canals. Frequently the rock-bordered canals of the south portion of Lefthand Canyon terminate in “tail-water” or "second garden" features (Figure 7; Crosswhite 1981:64; Rea 1979; Welch 1994:108, Table 5.4). Occasionally, an alignment of cobbles was constructed across the canal, but only to obstruct the lower part of the channel. These partial blockages of the channel may have acted to slow water flow (cf. Lindsay 1961:183-184), but often mark the presence of canal offtakes.

“Improved” Gardens and Fields: The “improved” gardens and fields in Lefthand Canyon, most specifically in the south segment, are better defined, preserved, and are more complex than those of Marijilda Canyon. In Lefthand Canyon, a complex garden was mapped in detail (Figure 8). The larger rock-bordered garden “plots” are clearly discernable and range from about 4.5 m^2 to 40.5 m^2 in area, with an average area of about 15.9 m^2. Small “gates" allowed controlled amounts of water to be diverted, directly or by a smaller canal/ditch, from primary canals into garden plots and field areas as well as into smaller stone-bordered areas that I have termed "planters".

"Planters" consist of rock-bordered areas that vary in form and range in area from approximately 0.7 m^2 to 4.0 m^2. Their use was most likely as smaller irrigated garden areas. These are a bit larger, but generally similar to the planting “basins” recorded in the gardens at Hopi (Hack 1942:36-37; Maxwell and Anschuetz 1992:Figure 3.2) and the “waffle” gardens at Zuni (Bohrer 1960; Doolittle 2000:97-98; Forde 1931; Stewart 1940). If originally clay-lined, it seems possible that some of these features may have been designed to hold water. The impounding of a small amount of water could provide a source from which the agriculturalist could dip to apply water directly to the base of wilting plants. This labor-intensive hand-watering has been documented ethnographically in the Southwest among the Zuni (Doolittle 2000:98; Ladd 1979:497, Figure 12) and the Akimel O'odham (Castetter and Bell 1942:160), as well as in the Basin of Oaxaca in southern Mexico (Kirkby 1973:117-119) and in Guatemala (Wilken 1987:178-193). Prehistoric hand watering has been suggested for the Tonto Basin (Welch 1994:106) and the Valley of Oaxaca (Neely et al. 1990:146-150). There are about 50 of these planters present in the south segment of Lefthand Canyon.

Further down canyon (north) from the gardens are what appear to be erosional channels that have been cleared of rocks. The rocks had apparently been thrown to either side of the channels and also used to modify the channels, through the construction of terracing walls, into a series of leveled areas that proceed down-slope in a stair-step fashion (Figures 7 and 9). Varying from one to five rocks in height, there are at least 170 borders and terraces present in this complex that provided approximately 4.0 ha of field area. A geomorphologist (S.

Christopher Caran) has concurred that this entire terraced area is the product of human landform modification (Neely 2005a:152). One sees a striking similarity between these fields/gardens and Pima Bajo "gardens in a gully" (Doolittle 1992:79, Figure 4-3). One complex of 96 mapped rock-faced terraces was found to extend about 575 meters. The southernmost 22 fields in this complex (Figure 9) are about 470 meters in length, and provide a total cultivable field area of about 0.12 hectare. Twelve of the terrace walls in this mapped area had a small cobble-filled or cobble-outlined area located down-slope from, and immediately in front of, the lowest portion of the wall (Figure 9). These may have served as a type of "splash-pad" or "run-off box" to prevent the erosion produced by water flowing over the lowest part of the terrace wall onto the terrace below. Nearly identical features have been recorded in similar contexts at some of the prehistoric terraced fields in the Tehuacan Valley of southern Puebla, Mexico (Woodbury and Neely 1972:117-119, Figure 36).

The Habitation Sites: In addition to smaller sites, two large sites were also present: the Goat Hill Site (AZ CC:1:28 [ASM] – Brown 1973; Woodson 1995, 1999, 2006) and the Spear Ranch Site (AZ CC:1:11 – Brown 1973; Neely 2005a; Neuzil 2005; Rinker 1998). The Goat Hill Site is the only habitation site found in the south segment of the canyon. This 35-room masonry pueblo is situated atop an artificially leveled butte, and has a central plaza as well as a D-shaped kiva. It was occupied during the Classic Period, from about A.D. 1275 to 1325, and has been attributed to northeastern Arizona Kayenta-Tusayan immigrants into the Safford Basin (Woodson 1995, 1999, 2006). In the north segment of the canyon, the Spear Ranch Site, the largest site in the canyon, is estimated to have had about a hundred rooms and an area of about 1.0 ha. This large pueblo with a central plaza has a longer history of use than Goat Hill, and exhibits a greater variety of construction techniques. Excavations by Eastern Arizona College revealed surface structures overlying pit-rooms (Wesley Jernigan, personal communication 1996). Adobe and rock-reinforced adobe was used in construction. North of the main pueblo was found a rectangular kiva excavated into a plaza with room blocks to the west and south. Ceramics indicate this latter construction dates to about the same time period as the Goat Hill Site. Spear Ranch Site ceramics generally mirror the types and chronology found elsewhere in the northern segment of the canyon, indicating a range of occupation from ca. A.D. 800 to 1385. However, Anna Neuzil (personal communication 2005) informed me that she found ceramics with a terminal date in the 1400s at this site.

Specific Characteristics of Marijilda Canyon

Canals: A few differences were noted for the Marijilda complex canals when compared with those described for Lefthand Canyon.

(1) Some parts of the Marijilda primary canal, from Carls Spring to a point just south of where it branches (Figure 10), coursed along a low aqueduct-like ridge, up to about 30 cm high, evidently constructed to maintain channel grade across low swales in the topography.

(2) A short distance down-stream (north) of where the primary canal branches to the northeast (Figure 10), one of the branches passes over a nearly 80 meter long, 1.25 meter high, raised aqueduct. Constructed of packed earth and stone, this aqueduct supported the canal channel as it passed over a shallow depression in the landscape. This aqueduct is similar to that studied by Midvale (1946), and later recorded by Van West and Altschul (1997:344-346), for the lower Verde River area north of Phoenix.

(3) This same canal becomes more unusual as it continues along the western side of a long, narrow mesa landform a bit further along

its course. As the terrain becomes more irregular, the canal was cut into the sheer side of the mesa (Figures 10 and 11). The perched nature of this aqueduct on the side of the mesa over 30 meters above the floor of the basin is truly impressive!

(4) In places of weakness along this same canal, usually where small drainages descending the side of the mesa intersect the canal, both the upslope and downslope sides of the canal were bolstered with dry-laid masonry of unmodified cobbles and small boulders. Small check-dams of unmodified stone were also constructed across the drainages up-slope from the canal.

(5) At the mesa's northeastern extreme, this same canal was purposefully carried over the precipitously steep, and now badly eroded slope. Fragmentary evidence was found that the canal had been excavated deeply into the nose of the mesa, and its channel was lined and filled with cobbles to form a type of "French-drain". This type of conduit would have allowed water to flow down the extremely steep slope of the mesa's nose with a minimum amount of erosion and water loss through overflow and splashing.

The Habitation Sites: In addition to smaller sites, one large site, the Marijilda Site (AZ CC:5:6 – Brown 1973; Hough 1907; Neuzil 2005) is present in Marijilda Canyon. This site is estimated to have over 50 rooms and three plazas. It is constructed of unmodified stone in a fashion reminiscent of the late structures found at Point of Pines, located north of the Safford Basin. Salado Polychromes formed the dominant decorated pottery at this site, but Mogollon Brownware pottery and the masonry architecture suggest cultural affiliation with the Point of Pines and Reserve regions (Brown 1973:60-61). This site appears to date exclusively to the Classic Period (ca. A.D. 1200-1450).

Observations

A number of observations have resulted from the study of the three components of the prehistoric agricultural system in the Safford Basin. In order to highlight the most important results, brief summaries are presented below.

1) **<u>Adaptability and Flexibility</u>**: The agricultural strategies of the Safford Basin appear to have been supremely adaptive and flexible. A profound knowledge of the local environment as well as careful planning, probably refined and perfected through trial and error, resulted in all major environmental niches being used in an attempt to provide adequate crop production in this arid area that frequently suffered from moisture and river flow variability and deficiencies (Neely 2004a). Once established, a continuing flexibility and adaptability is illustrated by the apparent constant modifications of the agricultural system components. The historical record of canal and field modifications on the Gila River floodplain (Colvin 1997, 1998) document the dynamic state of the environment and socio-political conditions, their correlated human responses, and provide an analog for the ancient past.

The overarching agricultural strategy (i.e., diversified plant collecting and cultivation in varying contexts) found in the Safford Basin is not unique. While certain aspects of the strategy have yet to be formally recorded elsewhere, findings in the Casa Grande area (Crown 1987), the Tucson Basin (Mabry 2007; Thiel and Mabry 2006), and the Marana Community area (Fish et al. 1992), indicate that generally analogous processes of adaptation were conducted outside this basin.

2) **<u>Agricultural Intensification</u>**: Field and water management infrastructure (i.e., check-dams, linear borders, terracing, canals, rock-bordered grids) was designed to modify the naturally occurring

topography and available moisture/river flow to further enhance the availability and productivity of cultigens. Thus, infrastructure augmented the existing environment and generated new microenvironments. The increase in number and area of agricultural fields and infrastructure across topographic and environmental sub-zones through time document an on-going (but not necessarily gradual) process of agricultural intensification. In addition to the Safford Basin, this process has been recognized in other Southwestern regions (e.g., Crown 1984, 1987; Fish and Fish 1984; Fish et al. 1992). The high-energy cost and investment represented by the time and labor expended in the planning, construction, and maintenance of the soil and water management infrastructure was obviously considered worth the effort. Ethno-archaeological work is called for, such as that currently being conducted in the Middle Gila region by Kyle Woodson (personal communication 2006), to obtain estimates of the time/labor parameters pertaining to the energy costs and investments expended on such projects and their affects on productivity.

3) **Mixed Subsistence System**: With the data at hand, it appears that a "mixed" (Welch 1994) or "broad-spectrum" (Flannery 1965) subsistence system with “shifting cultivation” (as defined by Spencer [1966] and Wilcox [1978]) existed in the Safford Basin throughout much of its prehistory. The subsistence system evidently incorporated an adaptively modifiable balance of collecting wild flora in conjunction with plant cultivation (see Spencer 1973:70) in diversified contexts. Modifications in the balance were occasioned by changes in climate, access to micro-environmental zones, etc. This long-lived pattern has also been proposed by Crown (1987) for the nearby Casa Grande area to the west, and by Welch (1994) for the Tonto Basin a short distance to the northwest.

Precisely how this pattern was modified through time is still unknown. Some (e.g., Gilman 1997:156) hypothesize that domesticated plants slowly replaced a predominantly wild plant food base. This proposed trend has been supported by changes in the numbers and morphology of tools found in the Safford Basin area (Gilman 1997; Hard 1990; Mauldin 1993). Others (e.g., Diehl 2004:164) are equivocal on this hypothesized trajectory of agricultural dependence. However, if there was a diminishing use of wild plants and a concomitant increasing use of domesticated plants through time, this shift evidently does not appear to have been a smooth transition but one of sporadic or “punctuated" changes (cf. Gould and Eldredge 1977) emphasizing one or the other plant communities.

One finds continuity as well as change in the archaeology of the Safford Valley through time. Subsistence strategies may have changed in the emphasis placed on certain foodstuffs and how they were obtained, but there appears to have been continuity in the resources utilized. The postulated long-term use of AZ CC:1:2 for first gathering wild agave and then cultivating the plant serves as a good example (Neely and Doolittle 2004:128-130, 134). This continuity of subsistence practices has been noted for the Casa Grande area (Crown 1987:148-149), and elsewhere in the Southwest.

Although, like many historic indigenous groups, the prehistoric agriculturalists probably undertook the cultivation of several plants in a field simultaneously, there is some evidence that some fields were dedicated to the growth of specific plants. A number of studies (e.g., Doolittle and Neely 2004; Fish et al. 1992; Fish et al. 2004; Seymour et al. 1997) have convincingly shown that some dry-farmed fields were dedicated primarily, if not solely, to the cultivation of agave for the production of dietary mescal, weavable fiber, and very probably other by-products (see Parsons and Parsons 1990). It seems likely that many dry-farmed fields throughout the Safford Basin served a similar purpose. A feature frequently found adjacent to dry-farmed fields is the roasting pit. The excavation of these features has and will undoubtedly continue to yield insights into the crops grown in the associated fields, as well as samples for dating their use and when the fields were most likely cultivated.

4) **Sequencing of the Agricultural Strategies**: Because of the relatively small amounts of survey, and more importantly the paucity of excavation, in the Safford Basin the sequence of appearance of the three types of agricultural strategies, as well as their dating, must be considered to be provisional.

With the data at hand, the earliest agricultural strategy used in the Safford Basin was Gila River irrigated floodplain and lower terrace cultivation. The evidence for this primacy is excellent, was recovered through excavation in two different locations, and indicates one of the earliest dates (between 190 B.C. and A.D. 10) for canal irrigation in the American Southwest. It is informative that, arguably, the technologically most sophisticated of the agriculture and water management approaches has the earliest date.

Chronologically, the next documented agricultural strategy used in the Safford Basin is that based on dry-farming and runoff. Dry-farmed fields have been securely dated to ca. A.D 700-1450, but their beginnings may be at least as early as ca. A.D. 500 (Neely and Doolittle 2004:134-135). The development of rock, and probable brush, constructions to modify the topography, as well as maximize soil and water conservation and use, introduced a higher level of technological sophistication to this simplest of the three agricultural approaches. The collection and subsequent cultivation of Agave sp. evidently played an important role in the development of dry-farming/runoff fields and formed an integral part of the overall subsistence strategy and economy.

Foothill agricultural complexes appear to be the most recent additions to the Safford Basin agricultural system, dated by ceramics to begin at ca. A.D. 700-750 (Neely 2005a). A major advantage of the foothill systems was that, until recently, there was a frequent availability of water for the entire year. Snowmelt was present and springs functioned on the north side of the Pinaleño Mountains frequently eight to 10 months of the year, often into the first week or two of July, when the monsoonal rains start. This insured water availability for domestic use and probably enough water for well-planned irrigation farming to permit at least two crops during the 220-250 day growing season this area usually enjoys (Bronitsky and Merritt 1986:21, 24; Sellers et al. 1974:422). This water availability made the Foothill Complex areas both habitable and desirable during the "Great Drought" years between AD 1275 and 1299 (Dean and Robinson 1982). As indicated in Lefthand and Marijilda Canyons, the foothills would have been a not already overly occupied location for habitation by the migrants from the four-corners and Point of Pines regions who came to the Safford Basin.

5) **Agricultural Strategy Origins**: The origin of the agricultural strategies and water management technology used in the Safford Basin is not known, but radiocarbon dates obtained from excavated canal segments indicate that agriculture and water management were being utilized quite early. If these technologies were introduced into the Safford Basin from elsewhere, the even earlier dates of agriculture and canal irrigation coming from sites in the Tucson Basin (Mabry 2007; Thiel and Mabry 2006) would certainly indicate that area as the closest possible

source. As noted elsewhere (Neely and Murphy 2008), there is now good evidence for the coeval residence of several ethnically diverse groups in the Safford Basin, including the Hohokam who have been documented as the earliest developers of agriculture in what is now southern Arizona. Although no one has yet published corroborating information, another possible source of these technologies are the river valleys of northern Sonora, as suggested at the La Playa site (Henry Wallace, personal communication 2008).

Until evidence to the contrary is found, it is perhaps more appropriate and productive to attribute developments in agriculture and water management strategy to group necessities and environmental conditions (i.e., availabilities and limitations) rather than as resulting from direct contact with or influence from far distant regions or groups. Thus, development within the greater Southwest should seriously be considered. There is circumstantial corroboration for independent development because, among other examples, it now appears that similar sophisticated agricultural strategies and water management techniques were developed in an independent fashion in Mesoamerica and in the American Southwest (Neely 2005b, 2008a). Although the temporal controls are not good, Neely (2005b, 2008a) has also noted that similar strategies and techniques appear to have been developed in a roughly contemporaneous fashion in different parts of Mesoamerica.

6) **Plant Utilization**: Diehl (2004) and Smith (2004) have provided new but limited evidence on prehistoric plant use from the Gila River floodplain and lower terraces in the Safford Basin and consider the plant remains reported from several other investigations in the area. Their findings can be augmented by the plant remains and pollen recovered by Haury and Huckell (1993) from a ceremonial cave (AZ

CC:1:24) in the Pinaleño Mountains, and by Rinker (1998) from Late Formative and Classic period sites in Lefthand Canyon.

The archaeologists conducting work on the identification of plants that preceded Diehl and Smith's studies should be commended, and their findings are important. Unfortunately, for various reasons, their work did not employ the same research design, nor did their small samples and limited number and type of sampling venues provide the equivalent data, necessary to dovetail with and more completely augment the work by Diehl and Smith. Coordinated fine-grained work with macro-floral and pollen materials from readily identifiable dry-farmed and foothill irrigated fields and their associated sites is needed. Additional similar work must also be accomplished in various contexts in other floodplain and lower terrace sites, and special efforts must be made to discover and test floodplain and lower terrace fields as well. Side-looking and ground-penetrating radar aerial photography, ideally implemented between crop harvest and planting, may assist the discovery of sites, fields, and associated canal networks underlying the now intensively cultivated floodplain.

7) **Moisture Availability and Plant Use**: Current climatic reconstructions are not yet detailed enough, and archaeological dating is not yet precise enough, to determine if changes in available moisture and Gila River flow correlate with changes in the use of plants. However, assuming a provisional moisture and Gila River flow reconstruction (Neely 2004a:18-20) is correct, there is an interesting correlation between the variability and unpredictability of available moisture and Gila River flow during the Classic Period and Diehl's (2004:161-163) findings that Classic Period Gila River floodplain and lower terrace farmers made more extensive use of wild plants than their Late Formative Period antecedents.

8) **Gardens**: The precise nature of garden use by the prehistoric agriculturalists remains speculative. However, in addition to the generally accepted proposals that the gardens were used for growing herbs and exotic plants for domestic, medicinal, and ceremonial uses, it is feasible that they may also have been used to foster the growth of well-tended, hardy seedlings to be transplanted. It is also conceivable that seedlings grown in these gardens received special ceremonial consecrations that were then carried to the larger fields with transplanting. As with gravel-mulched fields (e.g., Maxwell and Anschuetz 1992:65-66), the maximum use of rock in the construction of many of these gardens may have increased the temperature of the plots and planters, thereby accelerating seed germination and plant development. This heat storage may also have guarded against early frost damage and lengthened the growing season by protecting against late frosts. Fisher (2005) has put forward the new and innovative, but as yet untested, idea that some features, such as the "reservoir" (Figure 6) and the "planters" (Figure 8) recorded in Lefthand Canyon, may have been used for the production of natural organic fertilizer that could have been comprised of highly organic soils, composted organics, human waste material, and blue-green algae to produce soluble nitrates which could be delivered in either a liquid or dried form to enhance crop growth.

9) **Gila River Canal Systems**: The six prehistoric Gila River canal systems postulated for the Safford Basin have correlates in areas such as the Middle Gila and lower Salt. For example, the canals in the Middle Gila Region in the vicinity of the Casa Grande ruin discussed by Crown (1984, 1987) were found in similar topographic locations and in similar relationships with sites and fields as those occurring in the Safford Basin. Although farther removed, the pattern of sites and

fields vis-à-vis canals is also generally similar to that in the Phoenix area (e.g., Abbott et al. 2006:Figure 10; Howard 2006; Hunt et al. 2005:Figure 3).

The rejuvenation of the Safford Basin Gila River canals should not be considered to be an isolated event. A growing body of evidence suggests that the refurbishment of prehistoric canals was common worldwide. Examples are: the Hohokam canals of the Phoenix Basin (Masse 1981; Howard 2006); Sonora, Mexico (Doolittle 1988); Puebla, Mexico (Neely 1964, 2005b; Neely and Rincon Mautner 2004; Woodbury and Neely 1972); Peru (Gelles 1996); and Sri Lanka (Stanbury 1996).

10) **Settlements vis-à-vis Fields**: The placement of settlements in proximity to fields and water management infrastructure in all environmental sub-zones within the basin facilitated the planting, tending, and harvesting of crops. In addition, it placed habitation in varied natural and human-developed ecotones (Clements 1904; Laurance et al. 2001; Odum 1983), making available greater numbers and varieties of wild plants and animals to supplement the diet and for other uses.

Also, the locations of agricultural fields and sites within the basin, especially the foothills vis-à-vis the Gila River floodplain, perhaps suggest patterns of land use similar to the "highland-lowland" (cf. Fish et al. 1992; Kirkby 1973) or "infield-outfield" (Wolf 1966:21) phenomena.

11) **Agricultural Systems and Population**: Considering the extent of the dry-farmed and foothill field systems found, it is possible to debate Doolittle's (1998, this volume) statement that "... non-alluvial agricultural systems do not affect population estimates ..." for the Safford Basin. As noted, Doolittle (this volume) estimates that approximately 7,000 hectares were available for irrigated agriculture. The present study indicates that the Gila River canals also serviced

the T1b terrace immediately above the floodplain, which expands Doolittle's estimate by over 1,000 hectares. However, the estimated 8,000+ hectares of land available for irrigated agriculture is a good deal less than the roughly estimated area of over 20,000 hectares available for dry-farming/runoff cultivation! Assuming contemporaneity, one cannot but imagine that such a large area of dry-farming/runoff cultivation would have some affect on population estimates for the basin. Even if most of the resulting field products were traded out of the basin, the planting, care, and harvesting of those products would have required a larger population.

12) **Domestic Water Supply**: The proximity of the proposed prehistoric canals of the Safford area to prehistoric occupation sites (Figures 1 and 6), and the fact that some of these canals actually passed through sites, strongly indicates that the canals served as domestic water sources as well as for agricultural irrigation. This is particularly evident for the Lefthand Canyon sites as well as the Buena Vista (Curtis) site (AZ CC:2:3), Epley's Ruin (AZ CC:2:64), the University of Arizona Agricultural Station Site (AZ CC:2:2), and the Methodist Church site (AZ CC:2:15). Although evidence of its existence is now difficult to find as it lies beneath the city of Safford, the Methodist Church Site was evidently one of the largest sites in the Safford Basin. This site is estimated as once covering an area of about 70 hectares. The Union Canal apparently courses along the north edge of this site, as do the prehistoric canal segments (see "D" on Figure 1) archaeologically documented by Botsford and Kinkade (1993) and Crary (1997). The practice of using canals to supply domestic water is also indicated by the relative locations of sites in relation to canals in the Casa Grande (Crown 1987:Figure 2) and Phoenix (Abbott et al. 2006:Figure 10; Howard 2006; Hunt et al. 2005:Figure 3) areas.

13) **<u>Socio-Political Considerations</u>:** Our knowledge of the society and culture of the prehistoric inhabitants of the Safford Basin is not yet detailed enough to determine their impacts on agricultural strategy. The one possible cultural event that that we are now aware of that may have had an affect was the influx of peoples from northeastern Arizona during the Classic Period (Clark 2001; Woodson 1999). However, in spite of the apparent correlation of several sites throughout the Safford Basin (Neuzil 2005), including the Goat Hill and Marijilda sites, having strong northern cultural attributes that date to this period and are associated with foothill agricultural complexes, the earlier dating of foothill complexes precludes the total attribution of the foothill strategy to this event (Neely 2005a, 2008b). On the other hand, it is probable that the in-migration of these peoples may have expanded and intensified this strategy within the basin.

Summary and Conclusions

The archaeology of the Safford Basin is only recently becoming known, and the majority of our knowledge is based on survey. Thus, the following conclusions must be considered as first approximations.

All three of the agriculturally utilized environmental zones were in use for cultivation by ca. A.D. 700-750, most likely as a strategy of diversification to ameliorate the risks presented by aridity and the highly variable and unpredictable water resources (Neely 2004a). Perhaps in response to population growth through time, as suggested by an increase in site numbers and size, there appears to be an increase in field area as well as the use of soil and water management infrastructure. In other words, the use of several environmental sub-zones to harvest both wild and domesticated plants and the construction of labor-intensive field and water management systems were superbly adaptive risk reducing strategies to insure the recovery of adequate foodstuffs to support the human population. Furthering these strategies was the placement of sites that facilitated access to water and fields in the three environmental sub-zones while increasing the diversity and numbers of wild plants and animals available to augment the diet.

These approaches not only played an important role in the adaptive process for ameliorating the problems presented by variability in available moisture, they may also have been devised to help resolve possible difficulties that resulted from an increasing local population as well as from ethnically, and probably linguistically, diverse immigrant peoples and other as yet unperceived socio-political pressures. Thus, while the availability and predictability of moisture and river flow apparently played important roles in shaping the development of the agricultural system of the Safford Basin, it is also recognized that the modification of the environment to the degree necessary to sustain groups of humans must be considered as a problem of social organization. It has been proposed (Neely 1997, 2005a; 2008b; Neely and Doolittle 2004) that although the three agricultural strategies involved relatively large areas and complex infrastructure, that they may be modeled to be products of a group, or groups, with a kin-based organization that was strengthened by cross-cutting ceremonial affiliations. Aspects of this organizational model have received additional support in recent publications (Abbott et al. 2006; Hunt et al. 2005) considering Hohokam exchange and plausible ethnographic analogies for the social organization of Hohokam canal irrigation.

In conclusion, now that the visible aspects of the prehistoric agricultural strategies have been investigated and are at least partially known, it is clear that we must seek further information on plant remains and the overall subsistence system. In addition, it is vitally important that we coordinate that study with a search for information to obtain insights into the interrelationships of the subsistence system with the economic, socio-political, and ceremonial systems.

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NOTES

[1]All sites are listed in this chapter with their Arizona State Museum (ASM) numbers unless otherwise indicated.

[2]Radiocarbon dates have been analyzed using the CALIB Radiocarbon Calibration Program (Copyright 1986-2005 M. Stuiver and P. J. Reimer). To be used in conjunction with Reimer et al. (2004) and Stuiver and Reimer (1993).

References Cited

Abbott, David R., Scott E. Ingram, and Brent G. Kober

2006 Hohokam Exchange and Early Classic Period Organization in Central Arizona: Focal Villages or Linear Communities? *Journal of Field Archaeology* 31(3):285-305.

Ahlstrom, Richard V. N.
1997 Safford Valley Settlement Patterns. In "The Sanchez Copper Project: Vol. 1. Archaeological Investigations in the Safford Valley, Graham County, Arizona," edited by Gregory R. Seymour, Richard V. N. Ahlstrom, and David P. Doak, *SWCA Archaeological Report* 94-82 (Revised 1997): 9.1-9.10. SWCA Environmental Consultants, Tucson.

Ackerly, Neal W.
1997 Mimbreño and Gileño Apache Irrigation Systems, 1853-1859. *The Kiva* 62(4):349-363. Arizona Archaeological and Historical Society. Tucson.

Arnold, James E.
1998 Archaeological Remote Sensing. Electronic document, http://weather.msfc.nasa.gov/archeology/remote_sensing.html Last updated: May 12, 1998.

Bandelier, Adoph F.
1892 Final Report of Investigations Among the Indians of the Southwestern United States, Carried on Mainly in the Years from 1880 to 1885, Part II. *Papers of the Archaeological Institute of America, American Series* IV. University Press, Cambridge.

Berlin, G. L., J. R. Ambler, R. H. Hevly, and G.G. Schaber
1977 Identification of a Sinagua Agricultural Field by Aerial Thermography,Soil Chemistry, Pollen/Plant Analysis, and Archaeology. *American Antiquity* 42: 588-600.

Bohrer, Vorsila L.
1960 Zuni Agriculture. *El Palacio* 67:181-202.

Botsford, Manton, and Gay Kinkade
1993 Cultural Resources Assessment of the BLM Safford District Office Project. MS. on file, Bureau of Land Management, Safford District, Arizona.

Bradfield, Maitland
1971 The Changing Pattern of Hopi Agriculture. Occasional Paper No. 30, Royal Anthropological Institute of Great Britain and Ireland. London.

Bronitsky, Gordon and James D. Merritt
1986 The Archaeology of Southeast Arizona: A Class I Cultural Inventory. *Arizona Bureau of Land Management, Cultural Resources Series, Monograph* No. 2. Phoenix.

Brown, Jeffrey L.
1973 Origin and Nature of Salado: Evidence from the Safford Valley, Arizona. Unpublished Ph.D. dissertation, Department of Anthropology, University of Arizona. Tucson.

Bureau of Land Management
1973 *Safford. Arizona-New Mexico: 30 by 60 minute series (1:100,000-scale) metric planimetric map.* Bureau of Land Management, U. S. Department of the Interior. Washington, D.C.

Bye, Robert A., Jr., and Rita Shuster
1984 Developing an Integrated Model for Contemporary and Archaeological Agricultural Subsistence Systems. In Prehistoric Agricultural Strategies in the Southwest, edited by S. K. Fish and P. R. Fish, pp. 147-159. *Arizona State University Anthropological Research Papers* 33. Tempe.

Castetter, Edward F. and Willis H. Bell
1942 *Pima and Papago Indian Agriculture*. University of New Mexico Press, Albuquerque.

Clark, Jeffrey J.
2001 Tracking Prehistoric Migrations: Pueblo Settlers Among the Tonto Basin Hohokam. *Anthropological Papers of the University of Arizona* 65. University of Arizona Press. Tucson.

2006 Irrigation and Migration: Bits and Pieces of Safford Basin Archaeology. *Archaeology Southwest* 20(2):6. Center for Desert Archaeology. Tucson.

Clark, Jeffery J. (Editor)
2004 The Ancient Farmers of the Safford Basin: Archaeology of the U.S. 70 Safford-to-Thatcher Project. *Center for Desert Archaeology, Anthropological Papers* 39. Tucson.

Clements, F. E.
1904 Studies in the Vegetation of the State, III. The Development and Structure of Vegetation. *The Seminar, University of Nebraska*. Lincoln.

Colvin, Verna Rae
1997 Building Canals on the Gila River. In "Link the Past with the Present." *1997 Symposium Papers*, pp. 4-18, Graham County Historical Society, Safford.

1998 First Came the Water, and then the People: History of Water in Graham County. Unpublished photocopied manuscript, Bureau of Land Management, Safford District. Safford..

Colvin, Vera Rae and Patricia A. Cook
2006 Historic Canals of the Safford Basin. *Archaeology Southwest* 20(2):9-11. Center for Desert Archaeology. Tucson.

Crary, Joseph S.
1997 The Chronology and Cultures of Upper (Northern) Southeast Arizona: The Formative and Classic Periods. MS prepared

for the symposium *The Archaeology of a Land Between: Regional Dynamics in the Prehistory and History of Southeast Arizona*, sponsored by the Amerind Foundation, October 12-17, 1997. Dragoon.

Crosswhite, Frank S.
1981 Desert Plants, Habitat, and Agriculture in Relation to the Major Patterns of Cultural Differentiation in the O'odham People of the Sonoran Desert. *Desert Plants* 3:47-76.

Crown, Patricia L.
1984 Prehistoric Agricultural Technology in the Salt-Gila Basin. In Hohokam Archaeology Along the Salt-Gila Aqueduct, Central Arizona Project, Vol. 7, Environment and Subsistence, edited by L.S. Teague and P.L. Crown, pp. 207-260. *University of Arizona, Arizona State Museum Archaeological Series* 150. Tucson.

1987 Classic Period Hohokam Settlement and Land Use in the Casa Grande Ruins Area, Arizona. *Journal of Field Archaeology* 14:147-162.

Damp. Jonathan E., Stephen A. Hall, and Susan J. Smith
2002 Early Irrigation of the Colorado Plateau near Zuni Pueblo, New Mexico. *American Antiquity* 67(4):665-676.

Dean, Jeffrey S., and William J. Robinson
1982 Dendrochronology of Grasshopper Pueblo. In "Multidisciplinary Research at Grasshopper Pueblo, Arizona," edited by W. A. Longacre, S. J. Holbrook, and M. W. Graves, pp. 46-60. *Anthropological Papers of the University of Arizona* 40. Tucson.

Diehl, Michael W.
2004 Plant Remains and Resource Use in the Safford Basin. In The Ancient Farmers of the Safford Basin: Archaeology of the U.S. 70 Safford-to-Thatcher Project, edited by J.J. Clark, pp. 147-164. *Center for Desert Archaeology, Anthropological Papers* 39. Tucson.

Donkin, R. A.
1979 Agricultural Terracing in the Aboriginal New World. *Viking Fund Publications in Anthropology* 56. University of Arizona Press for the Wenner-Gren Foundation for Anthropological Research, Tucson and New York.

Doolittle, William E.
1988 Pre-Hispanic Occupance in the Valley of Sonora, Mexico: Archaeological Confirmation of Early Spanish Reports. *Anthropological Papers of the University of Arizona* 48. University of Arizona Press, Tucson.

1992 House-Lot Gardens in the Gran Chichimeca: Ethnographic Cause for Archaeological Concern. In *Gardens of Prehistory: The Archaeology of Settlement Agriculture in Greater Mesoamerica*, edited by T. W. Killion, pp. 69-91. University of Alabama Press. Tuscaloosa.

1998 Landscapes, Locales, Fields, and Food. MS prepared for the symposium *The Archaeology of a Land Between: Regional Dynamics in the Prehistory and History of Southeast Arizona*, sponsored by the Amerind Foundation, October 12-17, 1997. Dragoon.

2000 *Cultivated Landscapes of Native North America*. Oxford Geographical and Environmental Series. Oxford University Press. Oxford.

Doolittle, William E. and James A. Neely (Editors)
2004 The Safford Valley Grids: Prehistoric Cultivation in the Southern Arizona Desert, pp. 125 - 141, edited by William E. Doolittle and James A. Neely. *Anthropological Papers of the University of Arizona* 70. University of Arizona Press. Tucson.

Fewkes, Jesse W.
1898 A Preliminary Account of Archaeological Field Work in Arizona 1897. In *Annual Reports of the Smithsonian Institution for 1897*, pp. 601-623. Government Printing Office, Washington, D.C.

1904 Two Summer's Work in Pueblo Ruins. In *Twenty-Second Annual Report of the Bureau of American Ethnology, 1900-1901, Part 1*, pp. 3-196. Smithsonian Institution, Washington, D.C.

Fish, Paul R. and Suzanne K. Fish
1984 Agricultural Maximization in the Sacred Mountain Basin, Central Arizona. In Prehistoric Agricultural Strategies in the Southwest, edited by S. K. Fish and P. R. Fish, pp. 147-159. *Arizona State University Anthropological Research Papers* 33. Tempe.

Fish, Paul R., Suzanne K. Fish, Austin Long, and Charles Miksicek
1986 Early Corn Remains from Tumamoc Hill, Southern Arizona. *American Antiquity* 51(3):563-572.

Fish, Suzanne K., Paul R. Fish, and John H. Madsen (Editors)
1992 The Marana Community in the Hohokam World. _*Anthropological Papers of the University of Arizona* 56. University of Arizona Press. Tucson.

Fish, Suzanne K., Paul R. Fish, Arthur MacWilliams, Guadalupe Sánchez de Carpenter, and Karen R. Adams
2004 Growing Conditions and Crops: The Field Evidence. In The Safford Valley Grids: Prehistoric Cultivation in the Southern Arizona Desert, pp. 79-94, edited by William E. Doolittle and James A. Neely. *Anthropological Papers of the University of Arizona* 70. University of Arizona Press. Tucson.

Fisher, Richard D.
2005 Ancient Knowledge of the Chaco Canyon Anasazi. Electronic document, http://canyonsworldwide.com/chaco/chaco.htm, accessed October 20, 2005.

Flannery, Kent V.
1965 The Ecology of Early Food Production in Mesopotamia. Science 147:1247-1256.

Forde, C. Darryl
1931 Hopi Agriculture and Land Ownership. *Journal of the Royal Anthropological Institute of Great Britain and Ireland* 61:357-407.

Gelles, Paul H.
1996 The Political Ecology of Irrigation in an Andean Peasant Community, In *Canals and Communities: Small-Scale Irrigation Systems,* edited by Jonathan B. Mabry, pp. 88-115. University of Arizona Press, Tucson.

Gilman, Patricia L.
1997 Wandering Villagers: Pit Structures, Mobility, and Agriculture in Southeastern Arizona. *Arizona State University Anthropological Research Papers* 49. Tempe.

Glassow, Michael A.
1980 Prehistoric Agricultural Development in the Northern Southwest. Anthropological Papers No. 16, Ballena Press, Socorro.

Gould, Stephen Jay and Niles Eldredge
1977 Punctuated Equilibria: The Tempo and Mode of Evolution Reconsidered. *Paleobiology* 3:121.

Hack, John T.
1942 The Changing Physical Environment of the Hopi Indians of Arizona.*Papers of the Peabody Museum of American Archaeology and Ethnology*, Vol. 35, no. 1. Harvard University. Cambridge.

Hard, Robert J.
1990 Agricultural Dependence in the Mountain Mogollon. In *Perspectives on Southwestern Prehistory*, edited by Paul E. Minnis and Charles L. Redman, pp. 135-149, Westview Press, Boulder.

Haury, Emil W.
1976 *The Hohokam Desert Farmers and Craftsman: Excavations at Snaketown, 1964-1965*. University of Arizona Press, Tucson.

Haury, Emil W. and Lisa W. Huckell (Editors)
1993 A Prehistoric Cotton Cache from the Pinaleño Mountains, Arizona. *Kiva* 59:95-145.

Hough, Walter
1907 Antiquities of the Upper Gila and Salt River Valleys in Arizona and New Mexico. Bureau of American Ethnology Bulletin 35. Smithsonian Institution, Washington.

Howard, Jerry B.
2006 *Hohokam Irrigation Communities: A Study of Internal Structure, External Relationships and Sociopolitical Complexity*. Unpublished Ph.D dissertation, School of Human Evolution and Social Change, Arizona State University, Tempe.

Huckleberry, Gary
2005 Geomorphology of the Safford Basin and Canal Studies at Epley's Ruin, AZ CC:2:64 (ASM). In Archaeological Investigations along US 70 and State Route 75 from Solomon to Apache Grove, Graham and Greenlee Counties, Southeast Arizona, Vol. 2, Epley's Ruin (AZ CC:2:64[ASM]): A Long-Lived Irrigation Community in the Safford Basin from 200 B.C. to A.D. 1450, edited by Annick Lascaux and Barbara K. Montgomery. *Tierra Archaeological Report No. 2005-94*. Tierra Right of Way Services, Ltd., Tucson. Chapter III Draft. Report in progress.

Hunt, Robert C., David Guillet, David R. Abbott, James Bayman, Paul Fish, Suzanne Fish, Keith Kintigh, and James A. Neely
2005 Plausible Ethnographic Analogies for the Social Organization of Hohokam Canal Irrigation. *American Antiquity* 70(3):433-456.

Kirkby, Anne V. T.
1973 Use of Land and Water Resources in the Past and Present Valley of Oaxaca, Mexico. *Museum of Anthropology, Memoir* No. 5, University of Michigan, Ann Arbor.

Ladd, Edmund J.
1979 Zuni Economy. In *Handbook of North American Indians*, vol. 9, edited by Alfonso Ortiz, pp. 492-498. Smithsonian Institution, Washington.

Lascaux, Annick and Gary Huckleberry
2006 Epley's Ruin. *Archaeology Southwest* 20(2):15. Center for Desert Archaeology. Tucson.

Lascaux, Annick and Barbara K. Montgomery (Editors)
2005 Archaeological Investigations along US 70 and State Route 75 from Solomon to Apache Grove, Graham and Greenlee Counties, Southeast Arizona, Vol. 2, Epley's Ruin (AZ CC:2:64[ASM]): A Long-Lived Irrigation Community in the Safford Basin from 200 B.C. to A.D. 1450. Tierra Archaeological Report No. 2005-94. Tierra Right of Way Services, Ltd., Tucson. Chapter III Draft. Report in progress.

Laurance, W. F., R. K. Didham, and M. E. Powers
2001 Ecological Boundaries: A Search for Synthesis. *Trends in Ecological Evolution* 16:70-71.

Lee, Betty Graham, Pauline A. Irish, Lynn T. Irish, Lorraine Lucas, Susan Holland, Carol Davies, Carole Moon, and Jim Daley
1981 The Daley Site: An Archaeological Salvage Report. *Museum of Anthropology, Eastern Arizona College, Publication* No. 1. Thatcher, Arizona.

Lindsay, Alexander J., Jr.
1961 The Beaver Creek Agricultural Community on the San Juan River, Utah. *American Antiquity* 27 (2):174-187.

Lyons, Thomas R. and Douglas H. Scovill
1978 Non-Destructive Archaeology and Remote Sensing: A Conceptual and Methodological Stance. In *Remote Sensing and Non-Destructive Archaeology*, edited by Thomas R. Lyons and James I. Ebert, pp. 3-19. National Park Service. Washington, D.C.

Mabry, Jonathan B. (editor)
2007 Las Capas: Early Irrigation and Sedentism in a Southwestern Floodplain. *Center for Desert Archaeology, Anthropological Papers* 28. DRAFT REPORT. Tucson.

Masse, W. Bruce
1981 Prehistoric Irrigation Systems in the Salt River Valley, Arizona. *Science* 214:408-415.

Mauldin, Raymond
1993 The Relationship Between Ground Stone and Agricultural Intensification in Western New Mexico. *Kiva* 58:317-330.

Maxwell, Timothy D. and Kurt F. Anschuetz
1992 The Southwestern Ethnographic Record and Prehistoric Agricultural Diversity. In *Gardens of Prehistory: The Archaeology of Settlement Agriculture in Greater Mesoamerica*, edited by Thomas W. Killion, pp. 35-68. University of Alabama Press, Tuscaloosa.

Mills, Jack P. and Vera M. Mills
1978 The Curtis Site: A Prehistoric Village in the Safford Valley. Privately published. Elfrida, Arizona.

Neely, James A.
1964 A Water Management and Irrigation Survey of the Tehuacán Valley, Puebla, México. Field notes on file, Department of Anthropology, University of Texas. Austin.

1995 Mogollon/Western Pueblo Soil and Water Control Systems of the Reserve Phase: New Data from West-Central New Mexico. In " Soil, Water, Biology, and Belief in Southwestern Prehistoric and Traditional Agriculture," edited by H. Wolcott Toll, *New Mexico Archaeological Council, Special Publication* 2:239-262. Albuquerque.

1998 A Developmental Cultural Model for the Safford Valley of Southeastern Arizona and Adjacent Areas. MS prepared for the symposium *The Archaeology of a Land Between: Regional Dynamics in the Prehistory and History of Southeast*

Arizona, sponsored by the Amerind Foundation, October 12-17, 1997. Dragoon.

2001 Prehistoric Agricultural Fields and Water Management Technology of the Safford Valley, Southeastern Arizona. *Antiquity* 75:681-682.

2004a Paleoclimatic and Archaeological Contexts. In The Safford Valley Grids: Prehistoric Cultivation in the Southern Arizona Desert, edited by William E. Doolittle and James A. Neely, pp. 18 - 30. *Anthropological Papers of the University of Arizona* 70. University of Arizona Press. Tucson.

2004b Archaeological Perspective. In The Safford Valley Grids: Prehistoric Cultivation in the Southern Arizona Desert, edited by William E. Doolittle and James A. Neely, pp. 95 - 111. *Anthropological Papers of the University of Arizona* 70. University of Arizona Press. Tucson.

2005a Prehistoric Agriculture and Settlement Systems in Lefthand Canyon, Safford Valley, Southeastern Arizona. In "Inscriptions: Collected Papers in Honor of Richard and Nathalie Woodbury," edited by R. N. Wiseman, T. O'Laughlin, and C.T. Snow, pp. 145-169. *Papers of the Archaeological Society of New Mexico* 31. Albuquerque.

2005b Mesoamerican Formative Period Water Management Technology: An Overview with Insights on Development and Regional Interaction. In New Perspectives on Formative Mesoamerican Cultures, edited by Terry G. Powis, pp. 127-146. *British Archaeological Reports (BAR) International Series* 1377. Archaeo Press. Oxford.

2008a Prehistoric Water Management in Highland Mesoamerica. In Water and Humanity: Historic Overview, edited by V. L. Scarborough and Y. Yasuda. *The UNESCO History of Water and Civilization, Vol. VII.* Springer. New York.

2008b Prehistoric Settlement and Agriculture in Marijilda Canyon, Safford Basin, Southeastern Arizona (tentative title - manuscript in preparation).

Neely, James A., S. Christopher Caran, and Barbara M. Winsborough

1990 Irrigated Agriculture at Hierve el Agua, Oaxaca, Mexico. In "Debating Oaxaca Archaeology," edited by Joyce Marcus, pp. 115-189. *Museum of Anthropology, University of Michigan, Anthropological Papers* No. 84. Ann Arbor.

Neely, James A., and Joseph S. Crary

1998 The Marijilda Canyon Canal: A Complex Irrigation and Domestic Water System in the Safford Valley, Southeastern Arizona. Paper presented at the 63rd Annual Meeting of the Society for American Archaeology. Seattle.

Neely, James A., and William E. Doolittle
2004 Answers and Ideas. In The Safford Valley Grids: Prehistoric Cultivation in the Southern Arizona Desert, pp. 125 - 141, edited by William E. Doolittle and James A. Neely. *Anthropological Papers of the University of Arizona* 70. University of Arizona Press. Tucson.

2006 Dry-Farming and the Rock-Bordered Grid Fields of the Safford Basin. *Archaeology Southwest* 20(2):7. Center for Desert Archaeology. Tucson.

Neely, James A. and Everett J. Murphy
2008 Prehistoric Gila River Canals of the Safford Basin, Southeastern Arizona: An Initial Consideration. In *Crossroads of the Southwest: Culture, Ethnicity, and Migration in Arizona's Safford Basin* (Proceedings of the Arizona Archaeological Council [AAC] Fall 2005 Meeting), edited by David E. Purcell. Cambridge Scholars Publishing. Newcastle upon Tyne, United Kingdom.

Neely, James A. and Carlos A. Rincon Mautner
2004 Los Canales "Fosilizados" del Valle de Tehuacan: Un Proyecto Arqueológico con Levantamiento Cartográfico y Recolección Multidisciplinaria de Muestras. Informe Final al Consejo de Arqueología del Instituto Nacional de Antropologia e Historia de Mexico. Mexico, D.F.

Neely, James A., and Jennifer R. Rinker
1997 Foothill Irrigation and Domestic Water Systems of the Safford Valley, Southeastern Arizona: A Progress Report on the 2nd Field Season of Survey and Mapping of Water-Management Systems and Associated Sites in the Vicinity of Pima, Arizona. Unpublished report on file at the Arizona State Museum. Tucson.

Neily, Robert B., Joseph S. Crary, Gay M. Kinkade, and Stephen Germick
1993 The Owens-Colvin Site Revisited: A Preliminary Report of the Excavations at a Bylas Phase Settlement near Eden, Arizona. Unpublished paper presented at the 66th Anniversary of the Pecos Conference. Springerville, Arizona.

Neuzil, Anna A.
2005 In the Aftermath of Migration: Assessing the Social Consequences of Late 13th and 14th Century Population Movements into Southeastern Arizona. MS, unpublished Doctoral dissertation, Department of Anthropology, University of Arizona. Tucson.

Nials, Fred L., James P. Holmlund, and Susan D, Hall
2004 Prehistoric and Historic-Period Canals. In Ancient Farmers of the Safford Basin: Archaeology of the U.S. 70 Safford-to-Thatcher Project, edited by Jeffery J. Clark, pp.59-83. Center for Desert Archaeology, Anthropological Papers 39. Tucson.

Odum, E. P.
1983 *Basic Ecology*. Saunders College Publishing. Philadelphia.

Parsons, Jeffrey R. and Mary Parsons
1990 Maguey Utilization in Highland Central Mexico: An Archaeological Ethnography. *University of Michigan, Museum of Anthropology, Anthropological Papers* 82. Ann Arbor.

Ramenofsky, Elizabeth L.
1984 *From Charcoal to Banking: The I. E. Solomons of Arizona*. Westernlore Press. Tucson.

Rea, Amadeo M.
1979 The Ecology of Pima Fields. Environment Southwest No. 484. San Diego Society of Natural History, San Diego.

Reimer, Paula J., M. G. L. Baillie, E. Bard, A. Bayliss, J. W. Beck, C. Bertrand, P. G. Blackwell, C. E. Buck, G. Burr, K. B. Cutler, P. E. Damon, R. L. Edwards, R. G. Fairbanks, M. Friedrich, T. P. Guilderson, KA Hughen, B Kromer, FG McCormac, S Manning, C Bronk Ramsey, R. W. Reimer, S. Remmele, J. R. Southon, M. Stuiver, S. Talamo, F. W. Taylor, J. van der Plicht, and C. E. Weyhenmeyer
2004 IntCal04 Terrestrial Radiocarbon Age Calibration, 0-26 Cal Kyr BP. *Radiocarbon* 46(3):1029-1058.

Rinker, Jennifer Rebecca
1998 The Bryce-Smith Project: Irrigated Agriculture and Habitation from A.D. 1000 to 1450, Lefthand Canyon, Safford Valley, Arizona. Unpublished Master's thesis, Department of Anthropology, University of Texas, Austin.

Roberts, Daniel G. and David Barrett
1984 Nightsoil Disposal Practices of the 19th. Century and the Origin of Artifacts in Plowzone Proveniences. *Historical Archaeology* 18:108-115.

Rule, Pam
1993 The Owens-Colvin Site of the Safford Valley. *Eastern Arizona College Museum of Anthropology Publication* 3. Thatcher, Arizona.

Sanchez, Bartolomé
1856 Carta del Padre Bartolomé Sanchez, al Padre Prior y Rector Juan Antonio Baltasar en el año 1757. In *Documentos para la Historia México*, pp. 88-94. Cuarta Série, Tomo I. Imprenta de Vincente García Torres. Mexico.

Sandor, Jonathan A.
1995 Searching Soil for Clues about Southwest Prehistoric Agriculture. In "Soil, Water, Biology, and Belief in Prehistoric and Traditional Southwestern Agriculture," edited by H. Wolcott Toll, *New Mexico Archaeological Council, Special Publication* 2:119-137. Albuquerque.

Sauer, Carl, and Donald D. Brand
1930 Pueblo Sites in Southeastern Arizona. *University of California Publications in Geography* 3:415-458. University of California Press, Berkeley.

Sellers, William D., Richard H. Hill, and Margaret Sanderson-Rae (editors)
1974 *Arizona Climate: 1931-1972 (Revised, Second Edition).* The University of Arizona Press, Tucson.

Seymour, Gregory R., Richard V. N. Ahlstrom, and David P. Doak (editors)
1997 The Sanchez Copper Project: vol. 1. Archaeological Investigations in the Safford Valley, Graham County, Arizona, *SWCA Archaeological Report* 94-82 (Revised 1997). SWCA Environmental Consultants, Tucson.

Smith, Susan J.
2004 Pollen Analysis. In The Ancient Farmers of the Safford Basin: Archaeology of the U.S. 70 Safford-to-Thatcher Project, edited by J. J. Clark, pp. 165-171. *Center for Desert Archaeology, Anthropological Papers* 39. Tucson.

Spencer, Joseph E.
1966 *Shifting Cultivation in Southeast Asia*. University of California Press. Berkeley.

1973 *Oriental Asia: Themes Toward a Geography*. Prentice-Hall Publishers. Englewood Cliffs.

Stanbury, Pamela C.
1996 The Utility of Tradition in Sri Lankan Bureaucratic Irrigation: The Case of the Kirindi Oya Project. In *Canals and Communities: Small-Scale Irrigation Systems*, edited by Jonathan B. Mabry, pp. 210-226. University of Arizona Press, Tucson.

Stewart, Guy R.
1940 Conservation in Pueblo Agriculture: II. Present-Day Flood Water Irrigation, *The Scientific Monthly* 51:329-340.

Stewart, Guy R. and M. Donnelly
1943 Soil and Water Economy in the Pueblo South West. *Scientific Monthly* 56: 31-44, 134-144.

Stuiver, Minze and Paula J. Reimer
1993 Extended ^{14}C Data Base and Revised CALIB 3.0 ^{14}C Age Calibration Program. Radiocarbon 35:215-230.

Taylor, C.
1983 AZ.CC:2:31 (BLM) site survey record. Safford Office, Bureau of Land Management. Safford.

Thiel, J. Homer and Jonathan B. Mabry (editors)
2006 Rio Nuevo Archaeology Program, 2000-2003: Investigations at the San Agustin Mission and Mission Gardens, Tucson Presidio, Tucson Pressed Brick Company, and Clearwater Site. *Center for Desert Archaeology, Technical Report No. 2004-11.* Tucson.

Tuohy, Donald R.

1960 Archaeological Survey and Excavation in the Gila River Channel Between Earven Dam Site and Buttes Reservoir Site, Arizona. Unpublished report to the National Park Service, on file Arizona State Museum Library. Tucson.

USGS (United States Geological Survey)
1998 Hydrologic Data - Arizona NWIS-W Data Retrieval. Electronic document, http://water-data.usgs.gov/nwis w/AZ/?statnum=09458050, accessed February 10, 1998.

Van West, Carla and Jeffrey H. Altschul
1997 Environmental Variability and Agricultural Economics along the Lower Verde River, A.D. 750-1450. In *Vanishing River: Landscapes and Lives of the Lower Verde Valley, The Lower Verde Archaeological Project*, edited by S. M. Whittlesey, R. Ciolek-Torrello, and J. H. Altschul, pp. 337-392. SARI Press. Tucson.

Welch, John R.
1994 Ethnographic Models for Tonto Basin Land Use. In "The Roosevelt Rural Sites Study, Vol. 3: Changing Land Use in the Tonto Basin," edited by Richard Ciolek-Torrello and John R. Welch, pp. 79-120. *Statistical Research Technical Series* 28, Statistical Research, Inc., Tucson.

Wilcox, David R.
1978 The Theoretical Significance of Fieldhouses. In "Limited Activity and Occupation Sites," edited by A. E. Ward, pp.250-32. *Center for Anthropological Studies, Contributions to Anthropological Studies* 1:25-32. Albuquerque.

Wilken, Gene C.
1969 Drained-field Agriculture: An Intensive Farming System in Tlaxcala, Mexico. *Geographical Review* 59: 215-241.

1987 *Good Farmers: Traditional Agricultural Resource Management in Mexico and Central America*. University of California Press, Berkeley and Los Angeles.

Wilkinson, T. J.
1982 The Definition of Ancient Manured Zones by Means of Extensive Sherd-Sampling Techniques. *Journal of Field Archaeology* 9:323-333.

1990 Settlement and Land Use at Kurban Höyük and Other Sites in the Lower Karababa Basin. In "Town and Country in SE Anatolia, Vol. 1". *Oriental Institute Publications* 109. Chicago.

2003 *Archaeological Landscapes of the Near East.* University of Arizona Press. Tucson.

Williams, Oran A.
1937 Settlement and Growth of the Gila Valley in Graham County as a Mormon Colony 1879-1900. MS, Master's thesis, Department of History, University of Arizona. Tucson.

Wills, Wirt H.
1988 *Early Prehistoric Agriculture in the American Southwest*. School of American Research Press. Santa Fe.

Wolf, Eric R.
1966 *Peasants*. Prentice-Hall, Inc. Englewood.

Woodbury, Richard B. and James A. Neely
1972 Water Control Systems of the Tehuacán Valley. In Chronology and Irrigation. The Prehistory of the Tehuacán Valley, Vol. 4, edited by R. S. MacNeish, pp. 81-153. University of Texas Press for the R. S. Peabody Foundation. Austin.

Woodson, Michael Kyle
1995 The Goat Hill Site: A Western Anasazi Pueblo in the Safford Valley of Southeastern Arizona. Unpublished Master's thesis, Department of Anthropology, University of Texas, Austin.

1999 Migration in Late Anasazi Prehistory: The Evidence from the Goat Hill Site. *Kiva* 65:63-84.

2006 The Goat Hill Site and Ancestral Pueblo Migrations into the Safford Basin. *Archaeology Southwest* 20(2):4. Center for Desert Archaeology. Tucson.

Figures

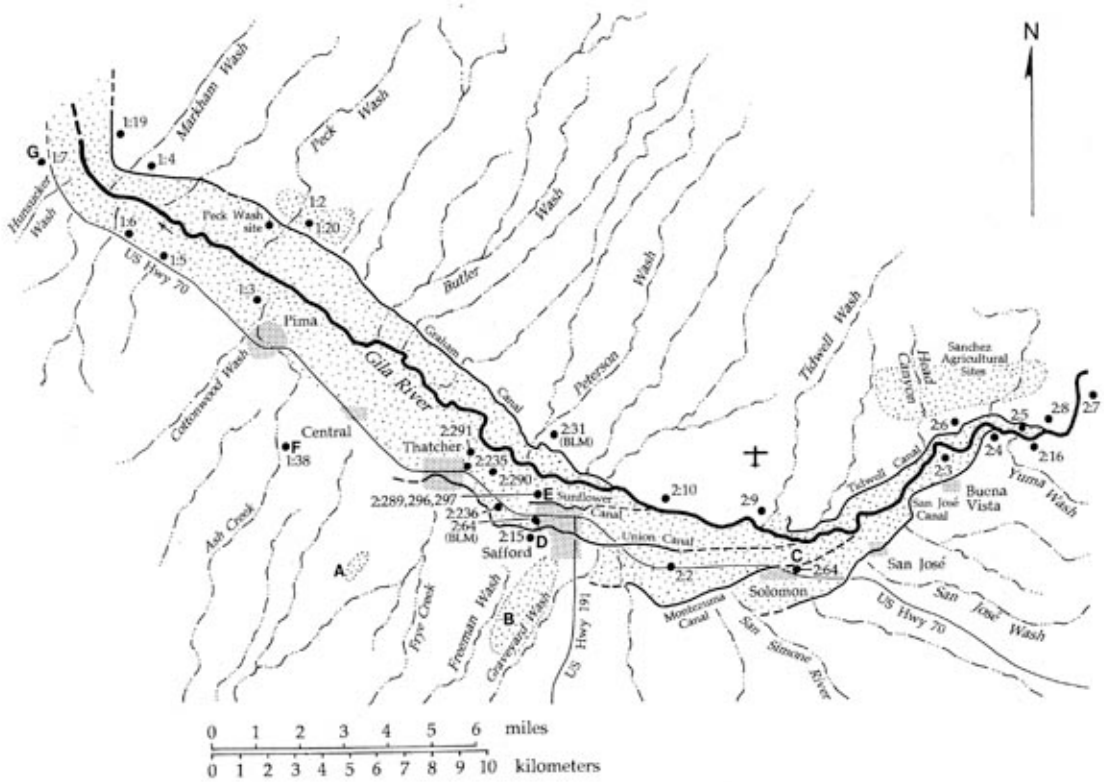

Figure 1. Map of a portion of the Safford Basin centering on the City of Safford. This map shows the location of sites mentioned in the text as well as the canals proposed to have prehistoric counterparts. The numerals (e.g., 2:290) represent the grid square and site number in the Arizona State Museum (ASM) site survey (AZSITE) system. The state and quadrangle designations (i.e., AZ and CC) have not been included due to lack of space. Note that sites 2:31 and 2:64 are from the Bureau of Land Management (BLM) survey files. The stippling paralleling the Gila River approximates the extent of the floodplain and lower terraces available for irrigated cultivation.

Figure 2. Aerial photograph of a portion of the rock-bordered grid fields with rockpiles and checkdams that cover the first terrace north of the Gila River in the vicinity of Pima. The steeper slope shown in the left portion of the photo has contour terraces that have been divided into grids.

Figure 3. Obverse and reverse views of a prismatic blade struck from a rhyolite core. These blades have been found on the dry-farmed/runoff fields located southwest of Safford, between Freeman Wash and Graveyard Wash (see Figure 1). The scale is in centimeters.

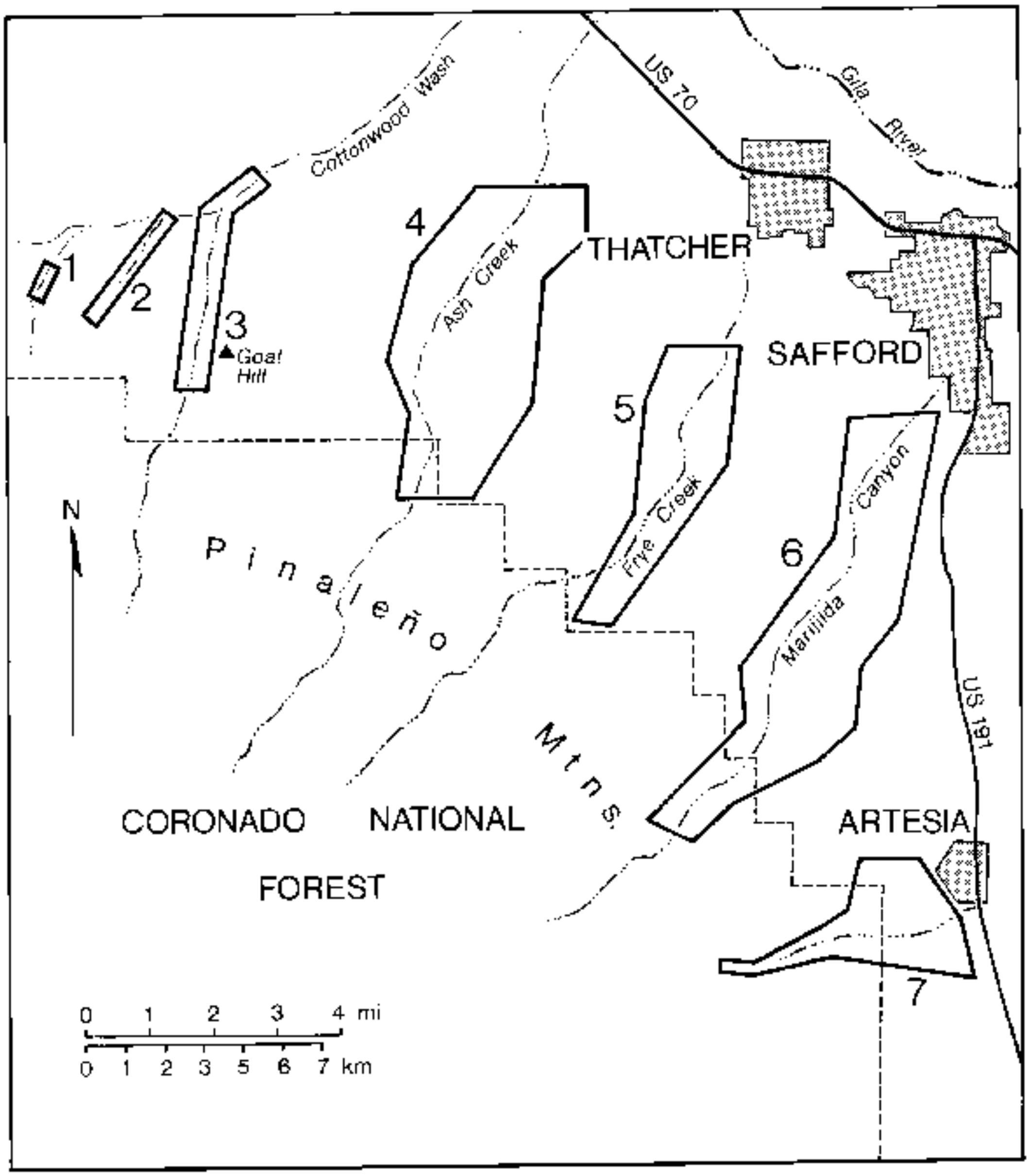

Figure 4. A schematic map of the seven habitation and agricultural areas recorded in the foothills on the northern face of the Pinaleño Mountains. The seven areas are: 1, Taylor Canyon; 2, Sand Wash - Middle Wash; 3, Lefthand Canyon; 4, Ash Creek Canyon; 5, Frye Creek Canyon; 6, Marijilda Canyon; and 7, Jacob Canyon.

Figure 5. A well-defined portion of the rock-bordered canal located just west and below the Goat Hill site in the south segment of Lefthand Canyon. The interior of the canal channel is about 50 cm in width; a ten-centimeter long scale may be seen at the left interior edge of the channel in the middleground.

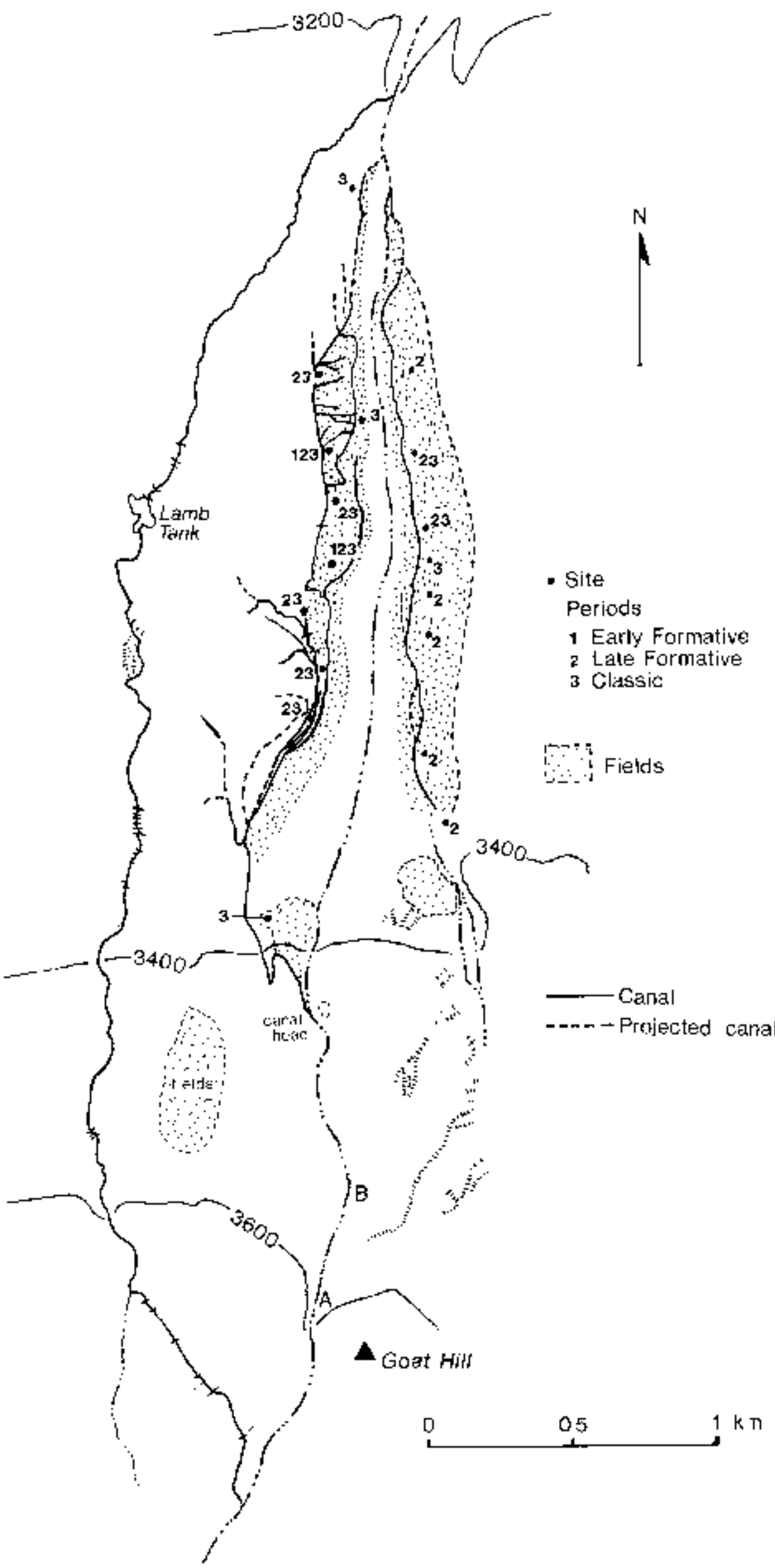
3200
3400
3400
3600
Lamb Tank
canal head
fields
B
A
Goat Hill
N
• Site
Periods
1 Early Formative
2 Late Formative
3 Classic
Fields
Canal
Projected canal
0
0.5
1 km

Figure 6. A map of Lefthand Canyon, showing locations of the habitation sites, canals, and agricultural fields. Note that “A” and “B” match the corresponding letters and area found on Figure 7, and serve to locate the agricultural canals and fields from the south segment of the canyon on this map. The small cross lines shown perpendicular to the modified drainage or canal leading to and from Lamb Tank are checkdams that probably functioned to raise the water level to enter small side channels leading to fields on either side of the drainage/canal.

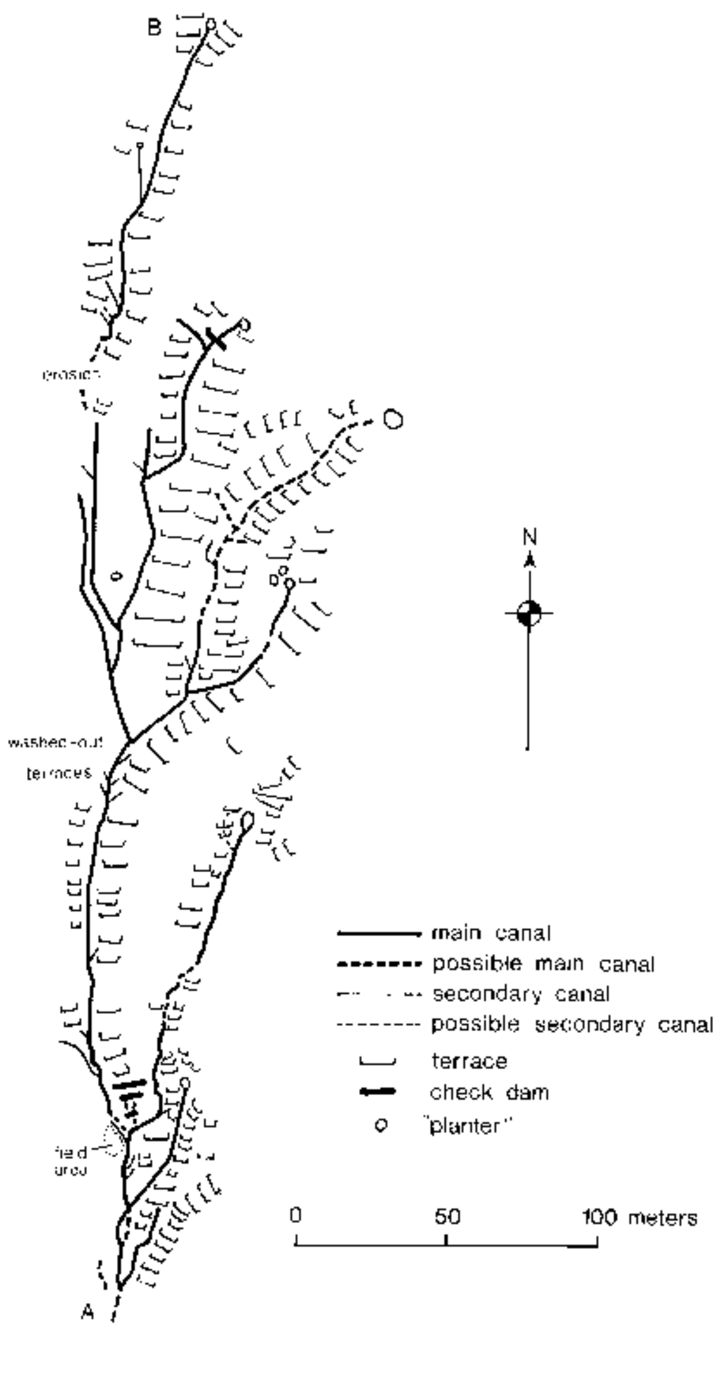
B
erosion
washed-out
terraces
field
area
A
N
main canal
possible main canal
secondary canal
possible secondary canal
terrace
check dam
"planter"
0
50
100 meters

Figure 7. A map of the rock-bordered canals and rock-faced terraced fields located just northwest and below the Goat Hill site in the south segment of Lefthand Canyon. Note that this area lies between "A" and "B" indicated on Figure 6.

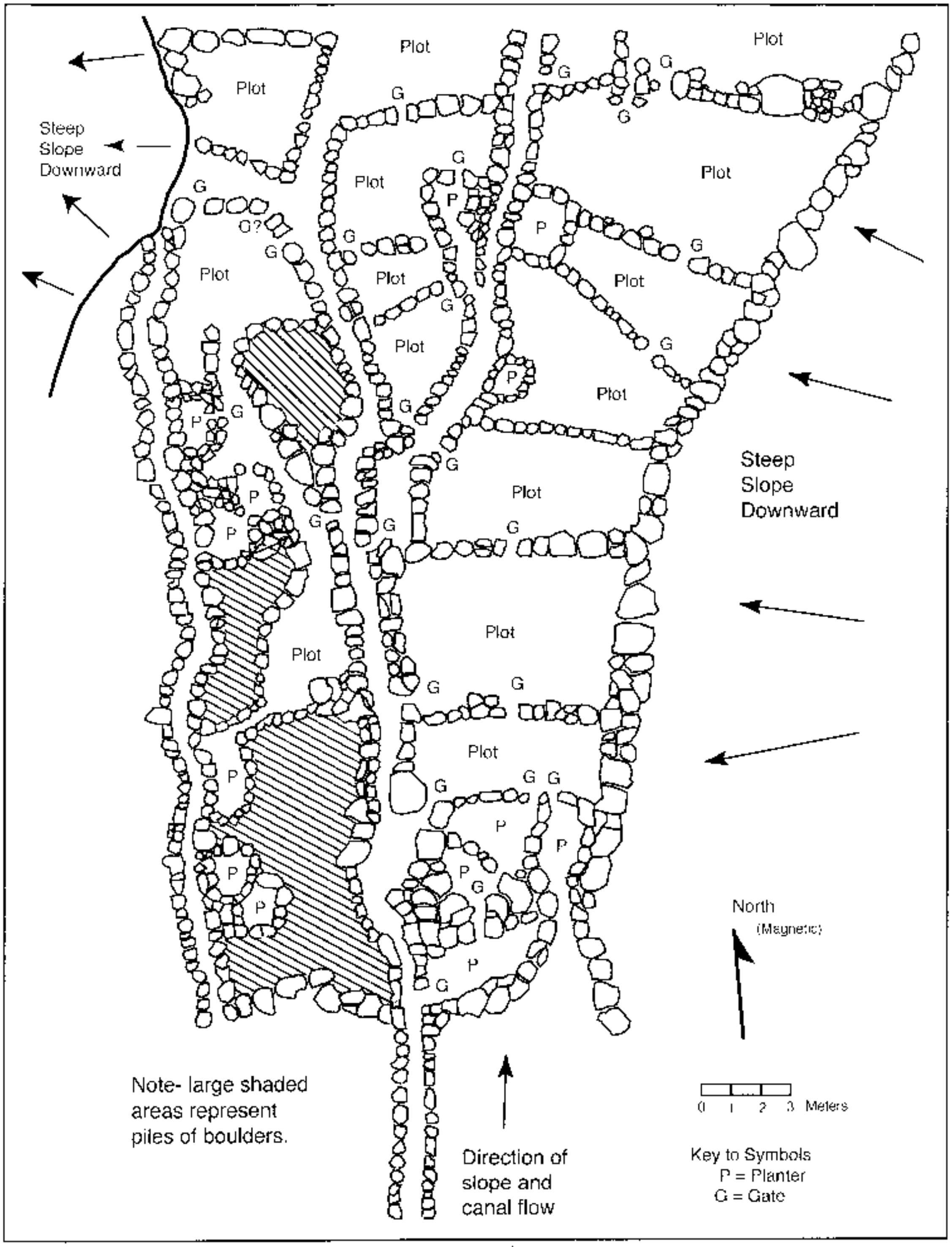

Figure 8. A detail map of the garden area lying just northwest and below the Goat Hill site in the south segment of Lefthand Canyon.

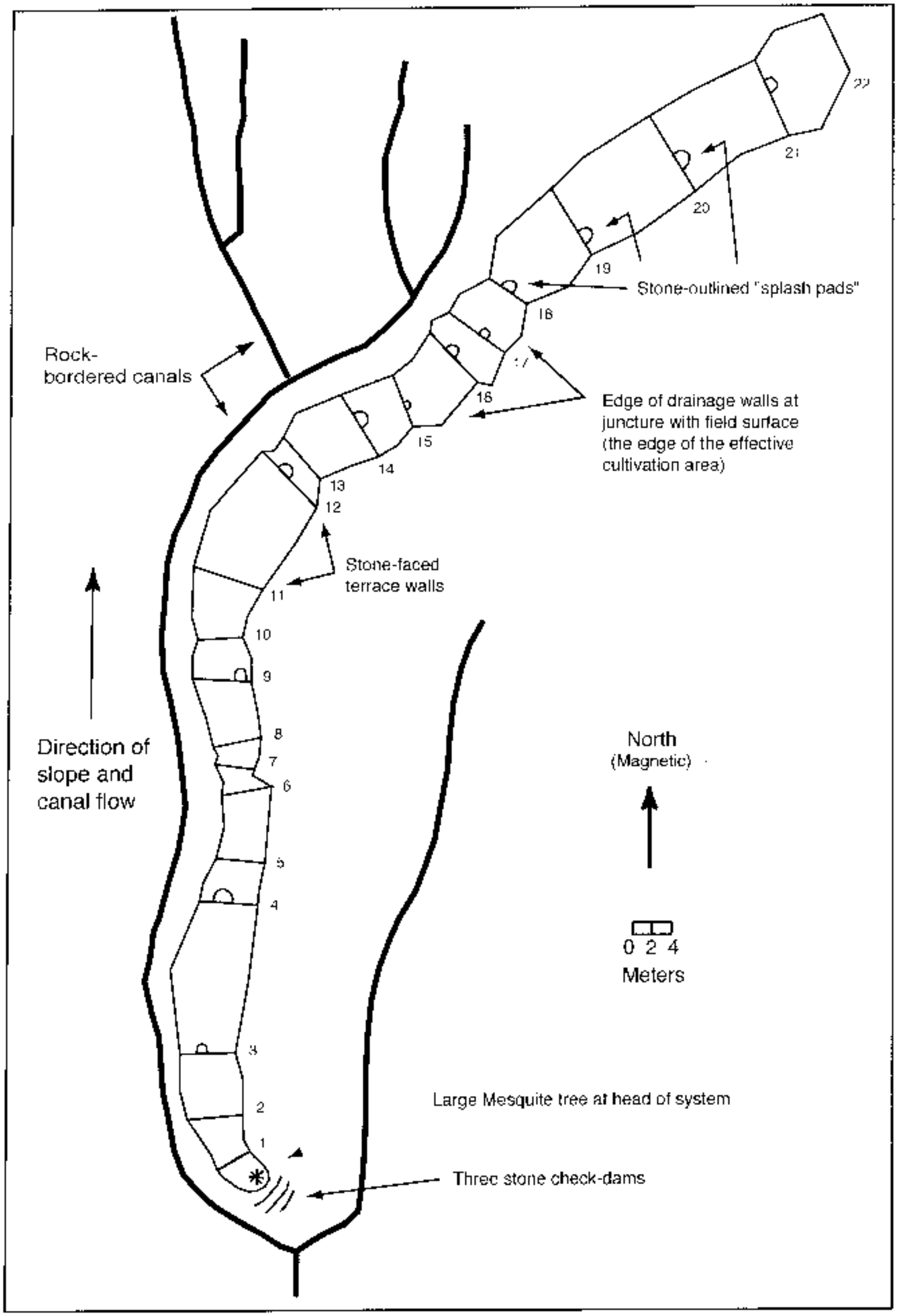
Rock-
bordered canals
Direction of
slope and
canal flow
Stone-outlined "splash pads"
Edge of drainage walls at
juncture with field surface
(the edge of the effective
cultivation area)
Stone-faced
terrace walls
North
(Magnetic)
0 2 4
Meters
Large Mesquite tree at head of system
Three stone check-dams
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

Figure 9. A schematic map of 22 of the rock-faced terraced fields located in one of the “erosion” channels in the southern portion of Lefthand Canyon. See Neely 2005a:Figures 7 and 8 for photographs of portions of this terraced field system, and Neely 2005a:Figures 9 and 10 for photographs of an example of a “splash pad" or “run-off box".

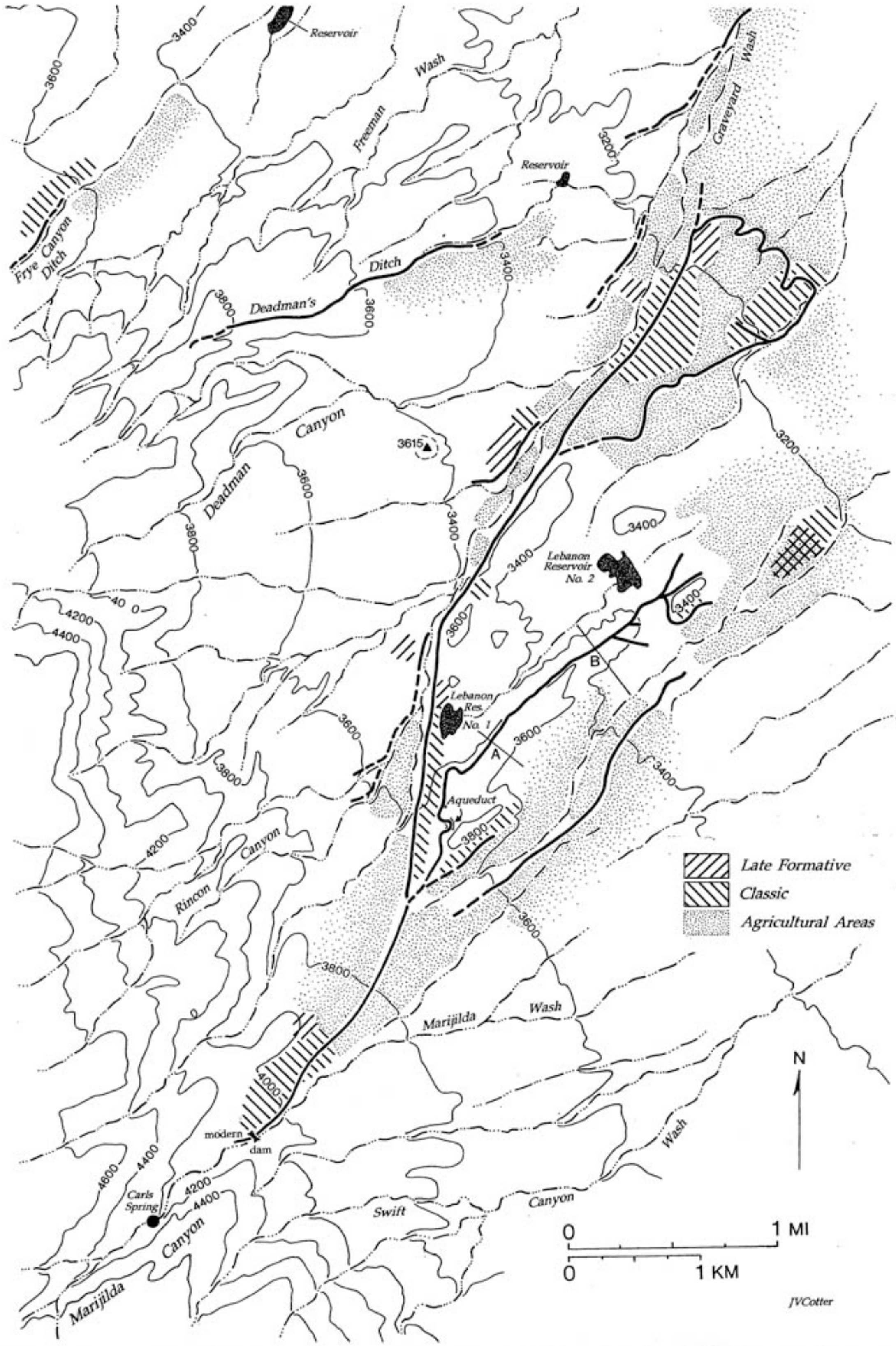
Reservoir
Freeman
Wash
Graveyard
Wash
Frye Canyon
Ditch
Deadman's
Ditch
Reservoir
Deadman
Canyon
Lebanon
Reservoir
No. 2
Lebanon
Res.
No. 1
Aqueduct
A
B
Rincon
Canyon
Late Formative
Classic
Agricultural Areas
Marijilda
Wash
modern
dam
Carls
Spring
Marijilda
Canyon
Swift
Canyon
Wash
N
0
1 MI
0
1 KM
JVCotter

Figure 10. A topographic map of Marijilda Canyon (Figure 4, Locus 6) and adjacent areas, showing the locations of the prehistoric canals, site concentrations, and agricultural areas. "A" and "B" correspond to cross-sections "A" and "B" in Figure 11.

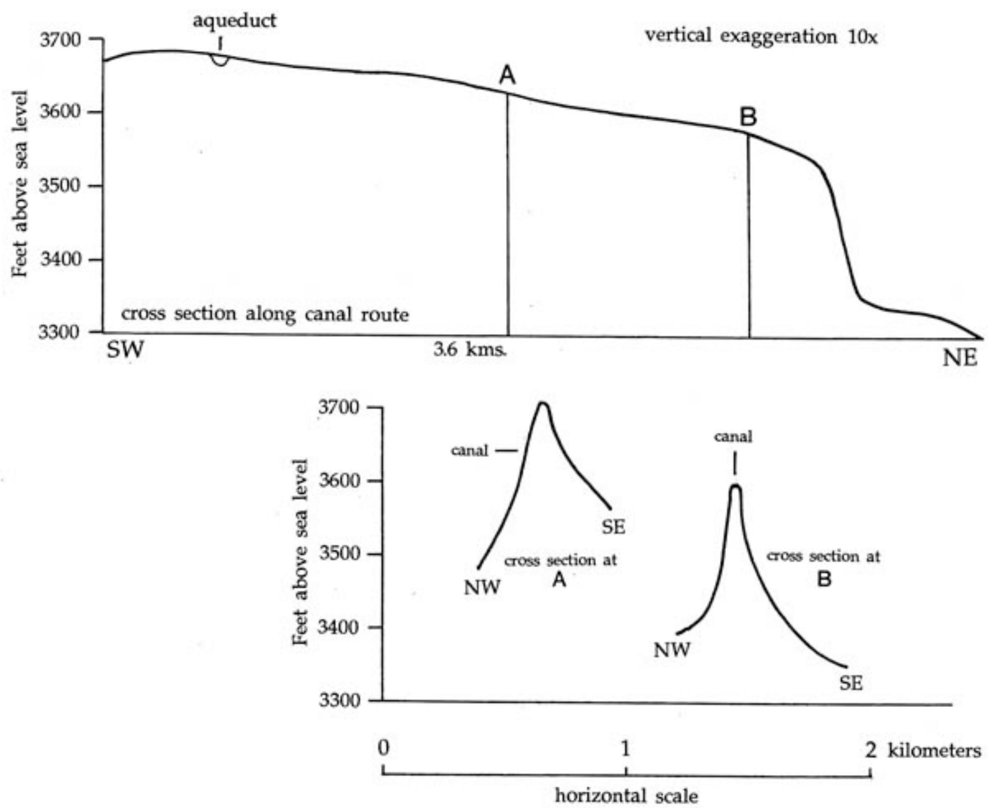

Figure 11. Cross-sections of the aqueduct canal constructed along the western side of a long, narrow mesa landform near the mouth of Marijilda Canyon. Cross-sections "A" and "B" correspond to "A" and "B" in Figure 10.