the duration of the study and were compared with local temperature and precipitation information.

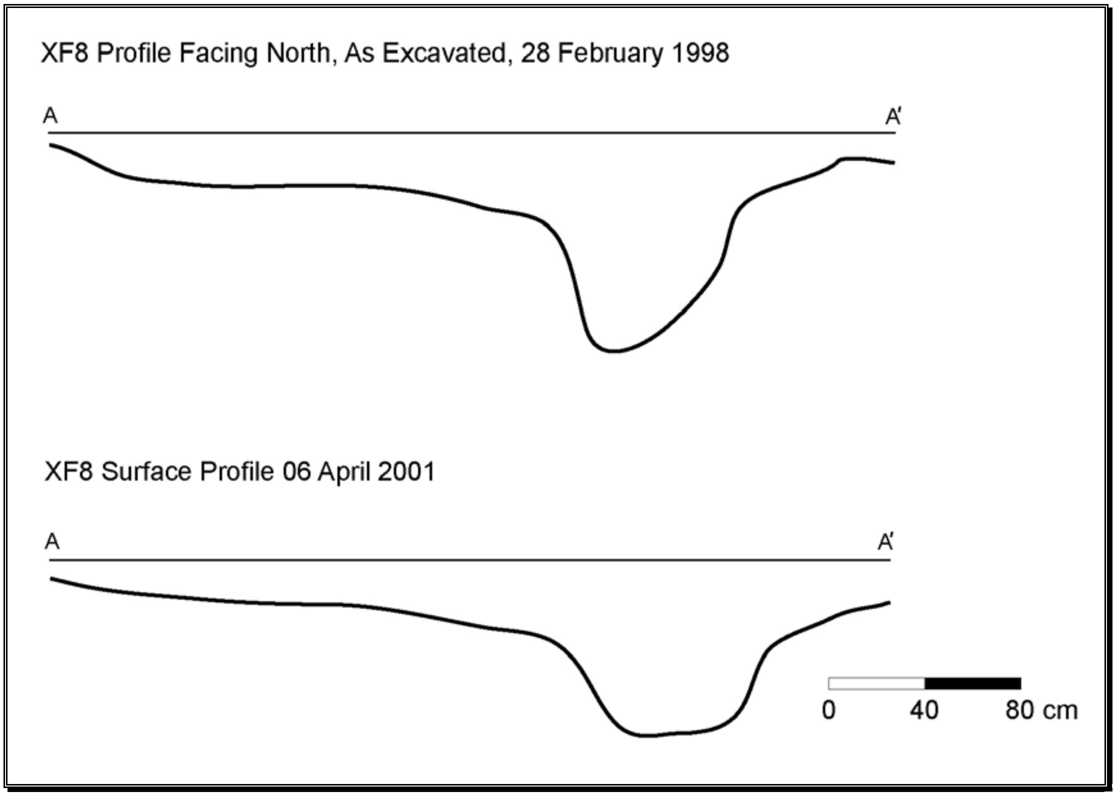

Figure 10.51 Morphological Comparisons for XF 8 over the Course of the Observation Period

Geomorphology

Geomorphological observations were constant in all experimental features and natural occurrences resulted in the accumulation of sediments in the feature bottoms and reshaping of the interior walls. Washing in of sediments, slumping of feature walls, smoothing resulting from rain, cracking from dry conditions or ice intrusions, and crusting indicative of differential surface drying were all observed in the experimental features (Table 10.2) (Figure 10.52 and Figure 10.53).

Hydrology

Hydrological occurrences were also constant with the presence of standing water, frost and ice, and snow observed in all experimental features. Shallow gullies or rivulets indicative of water drainage were noted for the shallow living floor portions of both XF 1 and XF 8 (Table 10.2 and Figure 10.54 and Figure 10.55).

Table 10.2 Qualitative Observations on Experimental Features

OBSERVATION	XF 1 living floor	XF 1 sub-basement	XF 2	XF 3	XF 4	XF 5	XF 6	XF 7	XF 8 living floor	XF 8 sub-basement
Geomorphology										
Washed in sediments		X	X	X			X	X		X
Slumping		X	X	X		X	X	X		X
Smoothing (wet conditions)		X	X	X	X	X	X	X		X
Cracking (dry conditions)		X	X	X	X	X	X	X		X
Crusting (dry conditions)		X	X	X			X	X		X
Subsidence					X	X				
Hydrology										
Standing water	X	X		X						X
Frost/Ice	X	X	X		X	X	X	X		X
Snow	X	X	X	X		X	X	X		X
Shallow gullies	X								X	
Floral Intrusion										
New Growth										
Moss		X	X	X					X	X
Mushrooms			X					X	X	
Plants	X	X	X	X	X	X	X	X	X	
Trees						X			X	X
Floral Debris										
Leaves	X	X	X	X			X	X		X
Sticks/ Branches	X	X	X	X				X		X
Flower Blossoms	X	X	X	X			X	X	X	
Fruit		X								
Seeds								X	X	
Faunal Intrusion										
Active Presence										
Centipedes/ Millipedes		X	X	X			X			X
Spiders		X					X			
Caterpillars		X					X			
Flies		X								X
Beetle		X	X							

Table 10.2 Qualitative Observations on Experimental Features (Continued)

OBSERVATION	XF 1 living floor	XF 1 sub-basement	XF 2	XF 3	XF 4	XF 5	XF 6	XF 7	XF 8 living floor	XF 8 sub-basement
Crickets		X	X				X			
Cicada				X						
Slugs		X	X				X			
Snails							X			
Frogs		X	X							
Toads		X	X				X			
Rat Snake		X								
Small mammal tracks			X		X					
Deer Tracks	X				X				X	
Active Burrowing										
Worms	X	X	X	X			X	X	X	X
Ants		X	X	X			X			X
Bees		X		X						
Beetles		X								
Frogs		X	X							
Toads		X	X							
Mammal Digging	X									
Mortality										
Worms		X								X
Bees		X								
Crickets		X								
Frogs		X								
Rat Snake		X								
Bird										X
Shrew		X								
Faunal Debris										
Feathers		X	X							
Bird Droppings		X								
Deer Hair									X	
Locust Shell		X								

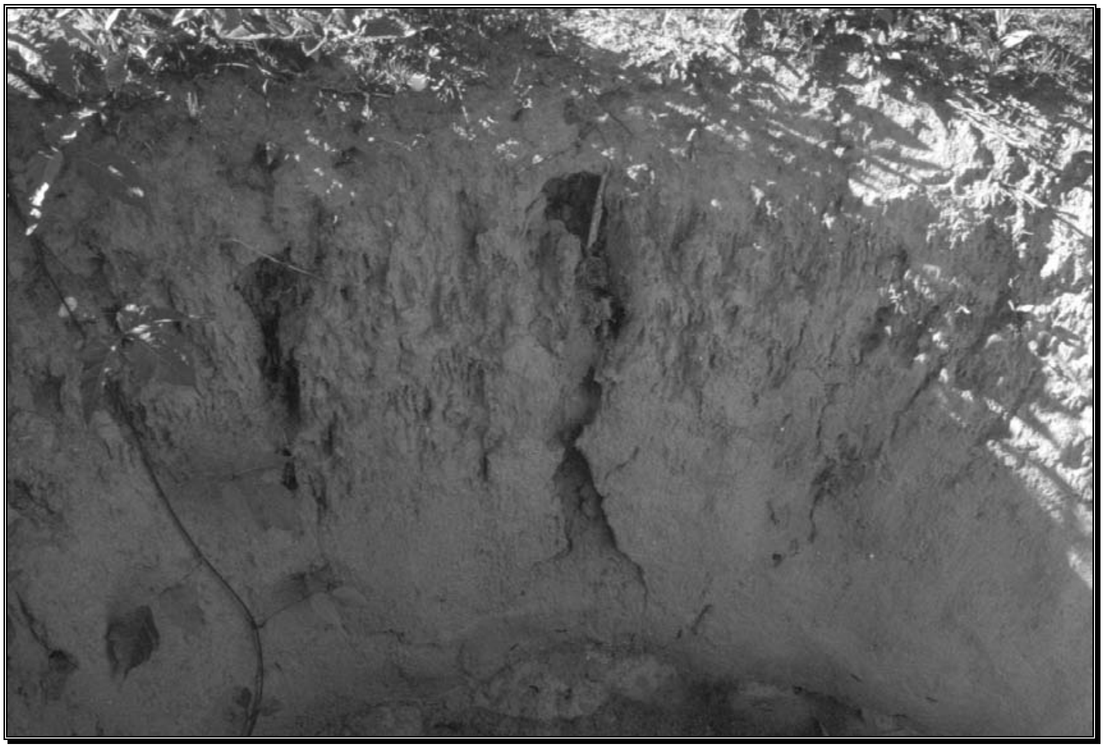

Figure 10.52 Geomorphological Observations-Drying and Cracking

Figure 10.53 Geomorphological Observations - Smoothing from Rainfall

Figure 10.54 Hydrological Observations - Standing Water in XF 1

Figure 10.55 Hydrological and Floralturbation Observations - Standing Water and Floral Debris in XF 8

Floralturbation

Observations associated with floral intrusions consisted of two basic types: intrusion of floral debris from plants in the vicinity and actual growth of plant life within the features themselves. Vegetation from around the experimental features was recorded as encroaching and enveloping the feature openings. Floral debris, such as leaves, sticks, flower petals, and fruit, were deposited within the experimental features (Figure 10.56) and transport was usually the result of storm events with rain and/or wind, and season (Fall and Winter). Plant growth within the experimental features was dominated by grasses, forbs, and vines; tree saplings were observed in XF 1, XF 5, and XF 8 (Figure 10.57). Moss and mushrooms were noted in five features (XF 1, XF 2, XF 3, XF 7, and XF 8) including both exposed and shaded locations.

Figure 10.56 Floralturbation Observations - Plant Growth in and Around XF 7 in April 1998

Figure 10.57 Floralturbation Observations - Plant Growth in and Around XF 7 in August 1998

Faunalturbation

Faunal intrusions consisted of four basic categories: active or live presence, active burrowing, mortality, and presence of debris. Insects, invertebrates (slugs and snails), amphibians, reptiles, and mammals were all observed in various features (Table 10.2). Ground and wall disturbing activities included active burrowing, scratching and digging by insects, invertebrates, and amphibians; worm disturbance was the most prevalent. Faunal residue within the features was sparse and consisted of feathers, droppings, hair, and a locust/cicada shell.

Evidence of animal mortality was observed in the sub-basement portions of XF 1 and XF 8. Worm drownings were the most common type of mortality noted and were associated with episodes of heavy rains creating standing water in the features. Cause of death for larger fauna, such as amphibians, reptiles, birds, and mammals, was undetermined. However, the depths of the sub-basements in XF 1 and XF 8 (over 1 m), may have contributed to entrapment. These portions of these features may have been too deep for easy escape of smaller fauna. A dead shrew was noted in the sub-basement of XF 1; scratch marks on the west and north walls were also observed and may indicate attempts at escape. The corpses of the dead frog and rat snake in XF 1 remained in the feature bottom and their deterioration was recorded for 2 weeks (Figure 10.58); however, the remains of the shrew (XF 1) and the bird (XF 8) disappeared within a few days of documentation. An active fox borrow was observed on the southern edge of the experimental plot.

Figure 10.58 Faunalturbation Observations - Remains of Frog and Rat Snake in XF 1

Depth Comparisons

The four shallow surfaces, the living floors of both XF 1 and XF 8, and the two backfilled features, XF 4 and XF 5, exhibited the smallest change in depth (less than 12 cm difference) (Table 10.3). None of the surfaces represented accumulation and infilling of sediments; the surfaces indicated no change (XF 1), erosional activity with no additional accumulation of sediments (XF 8), or subsidence (XF 4 and XF 5). The two shallow features, XF

3 and XF 7, exhibited only 5-10 cm of sediment accumulation and infilling. The four deeper surfaces, the sub-basements of both XF 1 and XF 8, and the two deep conical features, XF 2 and XF 6, exhibited the greatest change in depth from 0.21 m in XF 8 to 0.48 m in XF 1 (east end). The increase in sediment infilling and accumulation in these features was probably a direct result of the depth of the original feature creating larger areas of exposed soil susceptible to slumping.

Table 10.3 Experimental Feature Depth Comparisons

Feature Number	Original Depth (m)	Final Depth (m)	Change in Depth (m)	Type of Change	Percentage of Change
XF 1 center of sub-basement	1.00	0.70	0.30	Infilling	30.0
XF 1 east end of sub-basement	1.03	0.55	0.68	Infilling	66.0
XF 1 living floor	0.10	0.10	0.00	None	0.00
XF 2	0.97	0.59	0.38	Infilling	39.1
XF 3	0.42	0.37	0.05	Infilling	11.9
XF 4	Ground surf.	0.11	0.11	Subsidence	N/A
XF 5	2 cm above ground surf.	0.07	0.09	Subsidence	N/A
XF 6	1.17	0.64	0.53	Infilling	45.0
XF 7	0.37	0.32	0.05	Infilling	13.5
XF 8 center of sub-basement	0.37	0.52	0.21	Infilling	28.7
XF 8 living floor	0.16	0.23	0.07	Erosion	N/A

Changes in feature depth were recorded on a monthly basis and compared to both temperature and precipitation changes for the study time frame. Using monthly means, the temperature cycle was a relative constant and oscillated with seasonal changes. Monthly changes in precipitation were more discrete; however, with one exception, overall changes in depth were not directly associated with precipitation peaks. In September 1999, Hurricane Floyd impacted the Mid-Atlantic region; monthly precipitation was 10.51 inches. In XF 1, a marked increase in soil accumulation (i.e., decrease in feature depth) was associated (Figure 10.42). In all other experimental features, precipitation peaks did not correlate with decreases in feature depth (Figure 10.44, Figure 10.46, Figure 10.48 and Figure 10.50).

FEATURE CONTOUR MAPPING

Methodology

To more effectively display the variability of form encountered in both basin features and tree mold patterns, a series of three-dimensional surface contour plots was generated using Golden Software's SURFER® program. These plots were based upon measurements collected during feature excavations. The contour plots complemented the more traditional plan and profile views of features, and provided a more detailed depiction of the excavated forms not captured by the two-dimensional drawings.

Early excavations at Hickory Bluff recognized the limitations imposed by depicting basin features with only standard plan and profile views. The bottoms of the basins tended to vary with depth, the overall volume usually decreased, and the surfaces contained a degree of undulation, all of which were not well represented in drawings. An early effort to remedy this situation was to re-draw the feature at the completion of excavating each arbitrary level on the same map. This provided an indication of the changing planview shapes of the features by depth and a reasonable portrayal of their contours (Figure 10.59). These early contour maps, however, tended to be somewhat impressionistic as they were only recorded for the feature edges and not the undulated bottoms or in relation to the surrounding non-feature context.

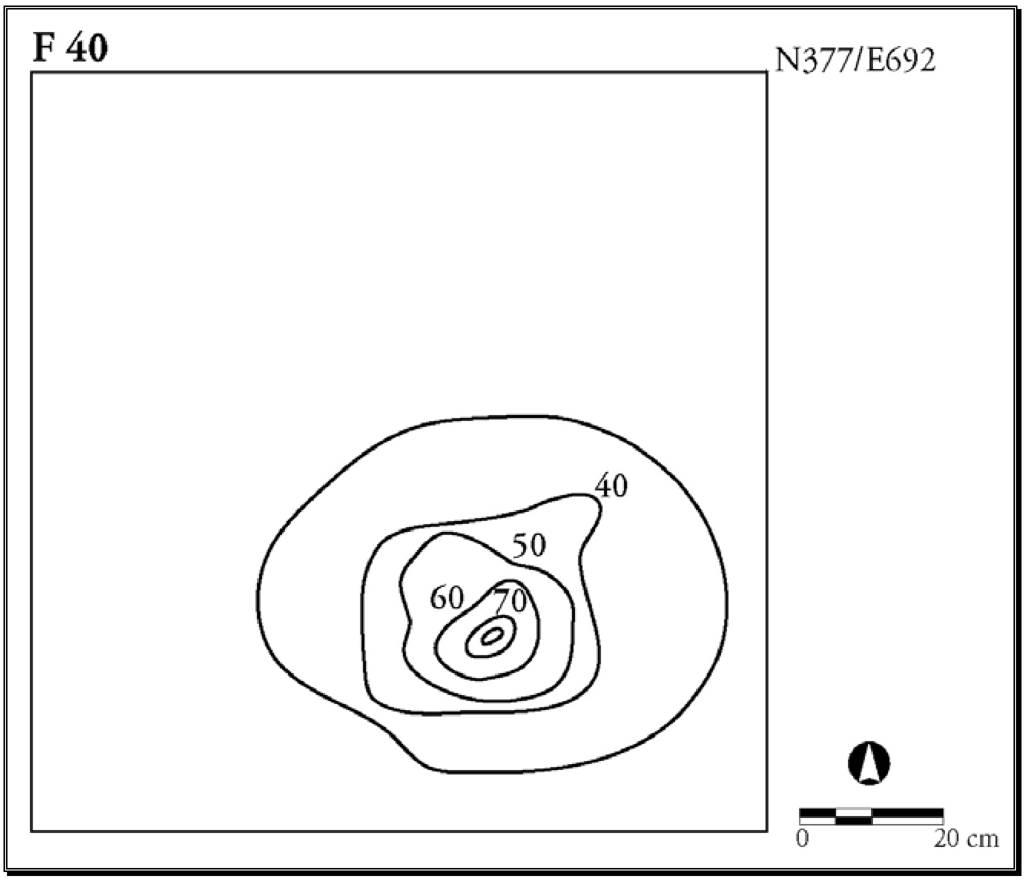

Figure 10.59 Sample Initial Contour Planview for Basin Features

The next stage of contour mapping included a new and important refinement to account for the limitations of the "impressionistic" contour maps: systematic grid point measurements. At the completion of full feature excavation, a series of measurements was recorded across the entire test-unit floor to account for variations along the bottom and the relation of the feature bounds to the surrounding natural stratigraphy. These measurements were initially recorded on a 20 cm grid across the unit floor. After these measurements were taken, contour lines were drawn between points with the same or similar depth measurements (Figure 10.60). These contours, in addition to the planview maps recorded for each level of excavation, illustrated the potential benefits of detailed contour mapping.

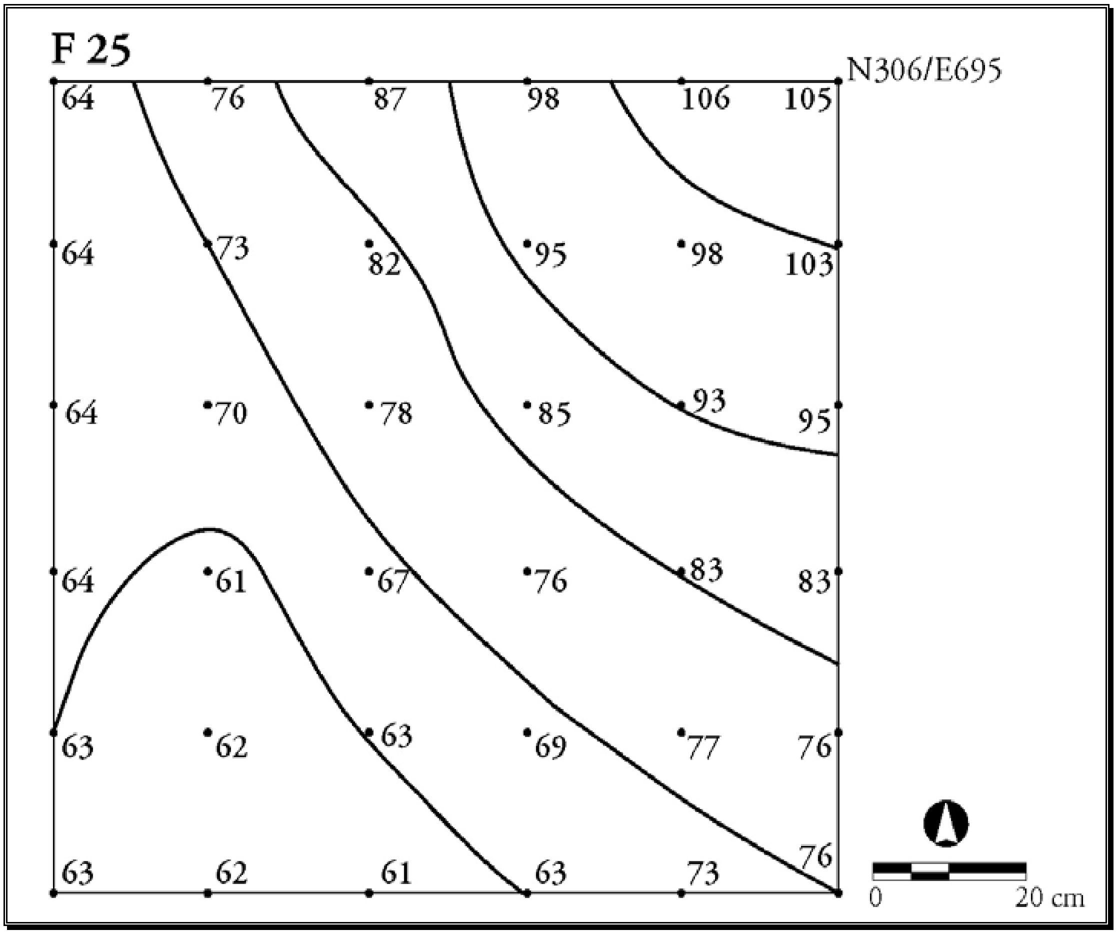

Figure 10.60 Sample Grid Coordinate Contour Planview for Basin Features

The data collected at a 20-cm spacing was used to generate a surface plot; however, the wide interval used for the map seemed to "regularize" the feature to a degree. As a result, the contour interval spacing was reduced to 10 cm and then further, to 5 cm, in an effort to account for the variation, undulation, and irregularity commonly encountered within basin features. The tighter interval allowed for more data points to be collected, so that more of the actual variation was recorded and less space had to be "smoothed" between points by the mapping program.

The raw data were collected in the field using a line-level and tape measure. Depth measurements were taken from the same datum point as the rest of the unit excavation to keep the information consistent. To aid in the collection of data, a 5 cm grid was first etched with a trowel across the floor of the unit, so that the depths could be taken quickly in succession without having to stop and measure placement within the unit. This allowed for the depth measurements to remain consistent with each other and minimized error introduced by repeated starts and stops. The process was aided further with the use of "drawing squares," which could be used for placement horizontally and vertically, as well as leveled to datum depth to provide a depth reference point (Figure 10.61). Better consistency in data recording was also achieved when the teams maintained their roles for the entire process; that is, one person gathered the measurements while the other recorded. Working in teams provided an internal check to ensure that all points were collected.

Figure 10.61 Employing the Use of "Drawing Squares" at Hickory Bluff

After measurements were taken for the full feature they were input into a large spreadsheet that recorded the x, y, and z coordinates for the full feature and enough of the surrounding plane of origin to provide relief. The surface contour plots were then generated using SURFER®, a computer mapping software package. The program takes the data points entered and connects the contours, projecting a surface. The nature of the program tends to somewhat smooth the lines, but still generates a reasonably accurate depiction of the excavated feature's shape (Figure 10.60).

Although some style of contour data measurements were obtained for most features on the site, not all were chosen to be computer-generated. Features were rejected from computer modeling for different reasons, including: incomplete excavation (i.e., either left in bisection or extending outside of excavation blocks); too much intersection between features, such that the boundaries were blurred; "undercutting," such that a single point had two different depth values; and insufficient surface around the feature to provide adequate contrast. A range of features and experimental tree bisections were included in the contour mapping program, to examine the range of variability of form between and among basin features and tree mold patterns.

Mapping Results

In total, plots of 19 features and tree bisections were generated with three-dimensional contouring. Of these, seven were basin features; five large – Features 1/313, 78 (Figure 10.62), 90 (Figure 10.63), 118 (Figure 10.64), 169 (Figure 10.65); one medium – Feature 137 (Figure 10.66); and one small – Feature 120 (Figure 10.67). Tree mold patterns accounted for seven contours and included varieties found archaeologically, Features 56 and 63 as well as excavated experimentally, BX 1, BX 3, BX 5, BX 7, and BX 10. Three features were included that represented a combination of natural and cultural modifications – Features 111, 116 (Figure 10.64), and 232 (Figure 10.68). The final two features were selected under different parameters. Feature 100 was a combination of biotic and geomorphic actions and was almost “bell-shaped.” BX 13 was determined after excavation to not be a tree but rather a modern trash pit dug at the site. It was included for comparison with the basins discovered archaeologically.

Overall, the data gathered and processed from the contour plotting was effective in depicting the excavated feature shapes. However, two of the projected contours were not reflective of the actual excavations. The first problematic feature was BX 10, which was completely excavated, but unfortunately located along the slope of the bluff. As a result, the contour depths taken not only recorded the feature, but also the contour of the bluff slope, which was great enough to mask the tree pattern. The combination geomorphic/biotic Feature 100 contour was also distorted, as it had too many undercut portions that could not be reliably generated by the computer to reflect the actual excavated shape (and led to the rejection of several other features before they were input).

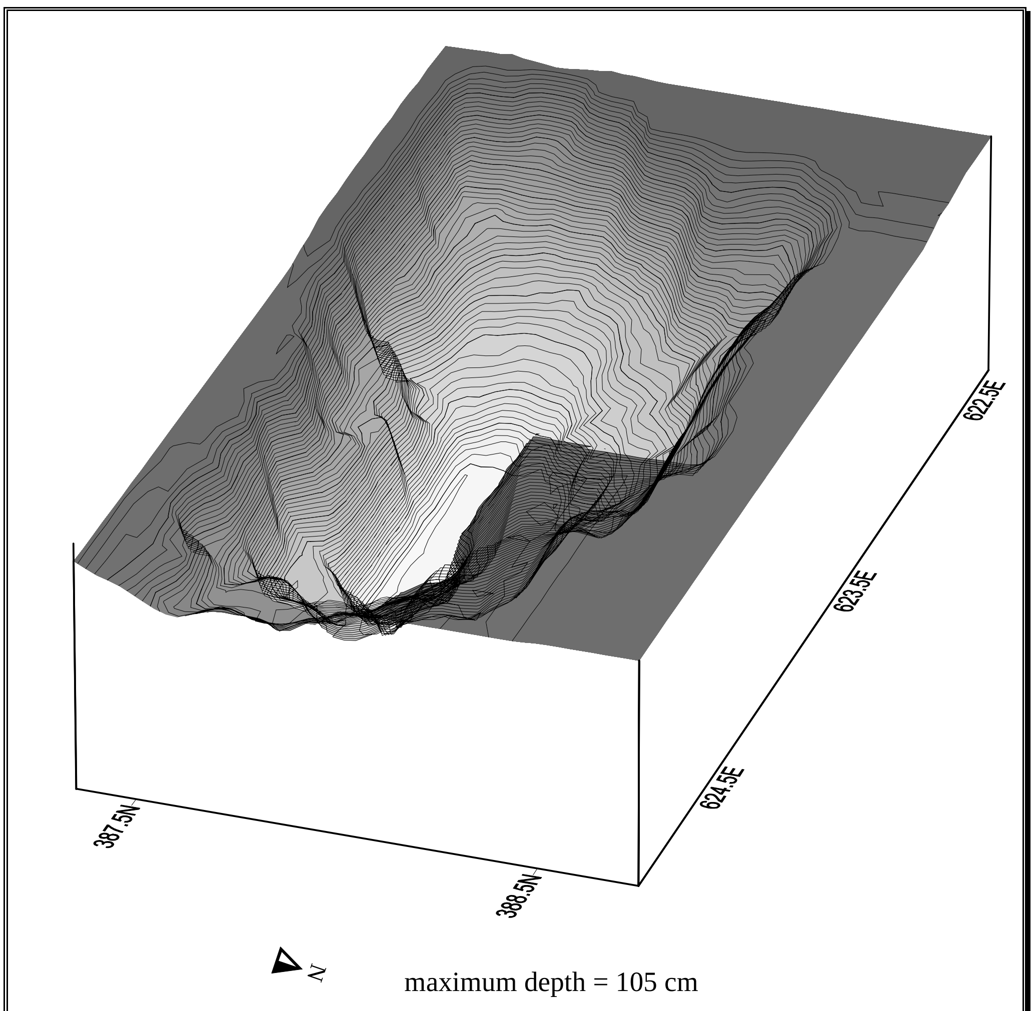

Figure 10.62 SURFER® Generated Topographic Contour Map of Feature 78

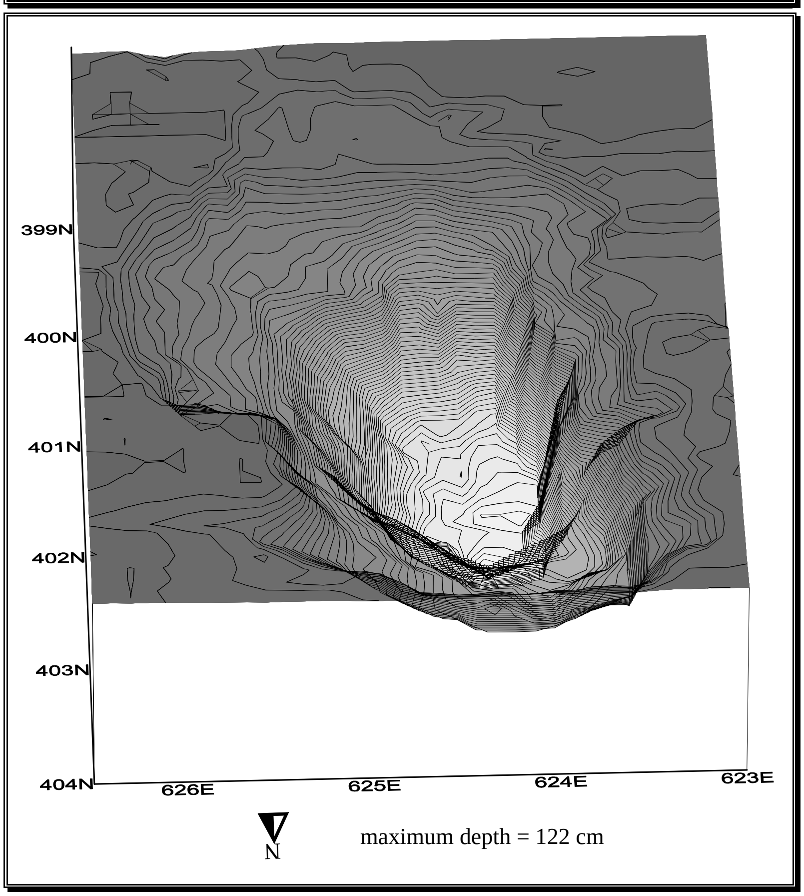

Figure 10.63 Final Excavation Photograph of Feature 90 and SURFER® Generated Topographic Contour Map

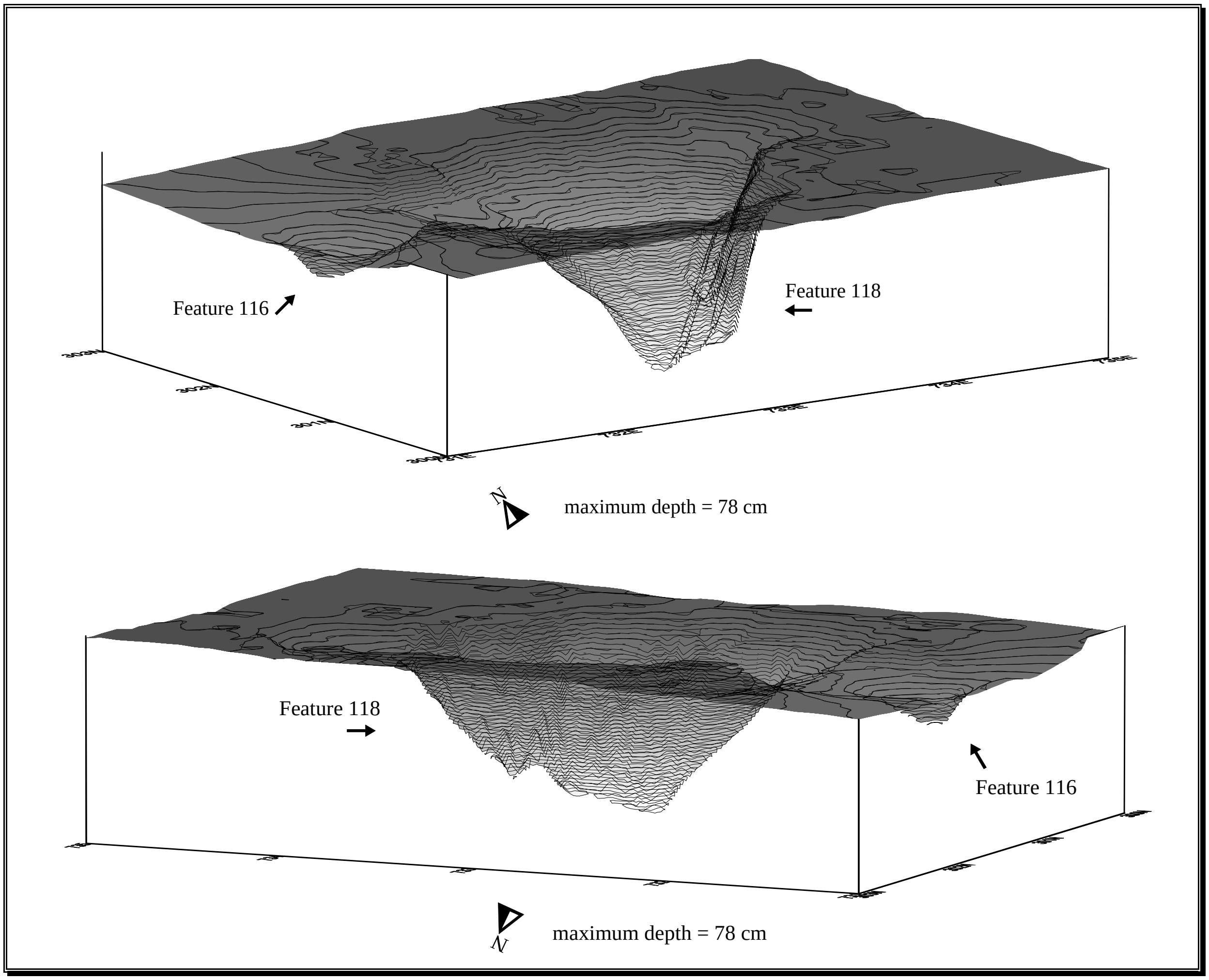

Figure 10.64 SURFER® Generated Topographic Contour Map of Features 116 and 118

Three of the tree bisections were processed in multiple ways as a result of the patterns they possessed. The upper portions of these tree molds penetrated the E-horizon and left a distinct pattern within that horizon. When the E-horizon was removed, the tree pattern was observed continuing into the B-horizon with a somewhat different shape (Figure 10.68). The contours of BX 1 (Figure 10.69), BX 3 (Figure 10.70), and BX 7 (Figure 10.71) were projected with each section separately, as a composite (which tended to obscure the variability of the upper portion), and as a side-by-side comparison. Although these examples were similar (containing distinctive upper and lower portions), they differed from each other in the size and type of root patterns displayed: these features exhibited either vertical tap roots or large roots cutting horizontally across the top of the pattern.

Feature 56 was also projected in several different ways to compare the differences obtained when the contour interval was changed (Figure 10.72 and Figure 10.73). The feature was identified archaeologically, but excavation determined that it was a tree mold pattern. It had a highly undulated base and form. As a result of this and its overall smaller size, contour information was collected on a 2.5-cm grid for greater resolution. Once the data were collected,

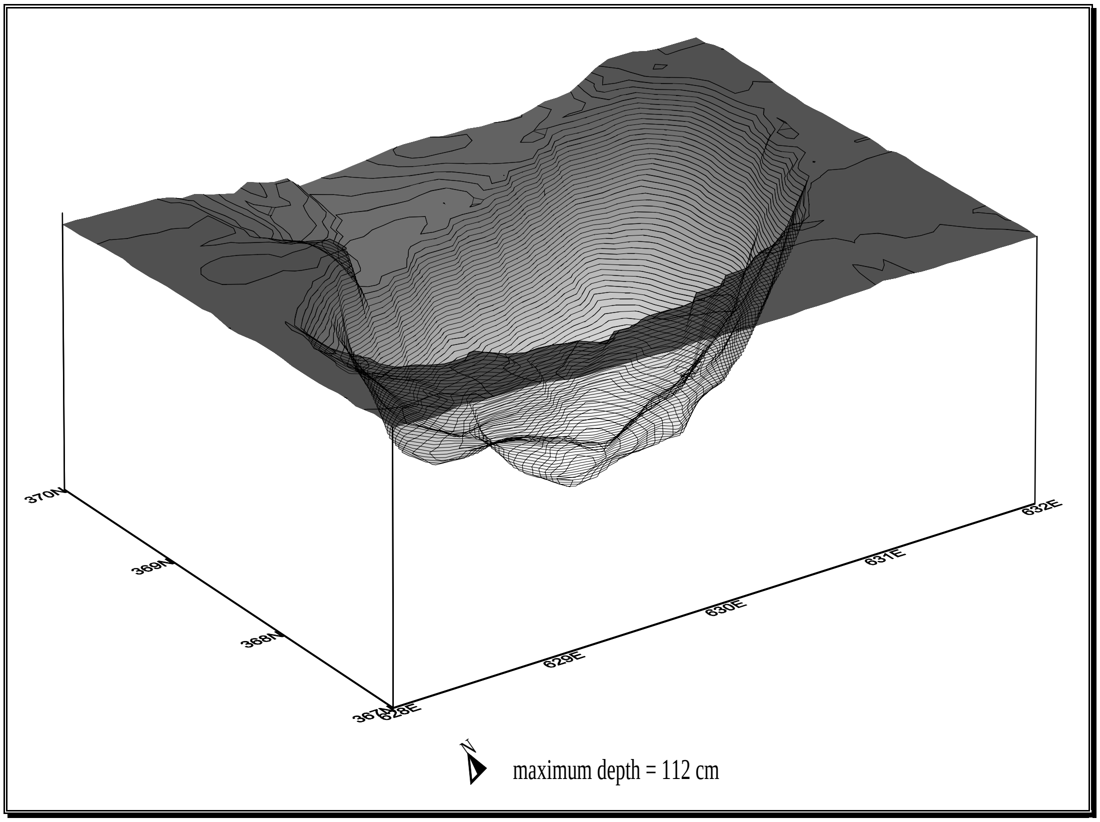

Figure 10.65 SURFER® Generated Topographic Contour Map of Feature 169

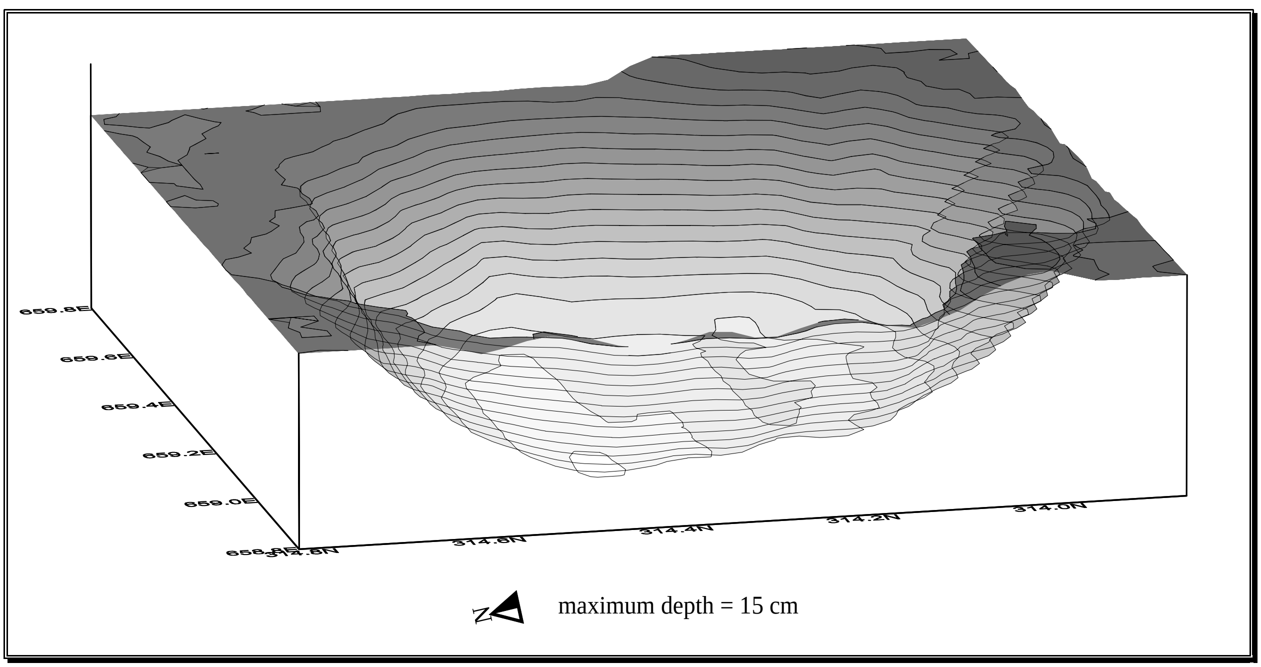

Figure 10.66 SURFER® Generated Topographic Contour Map of Feature 137

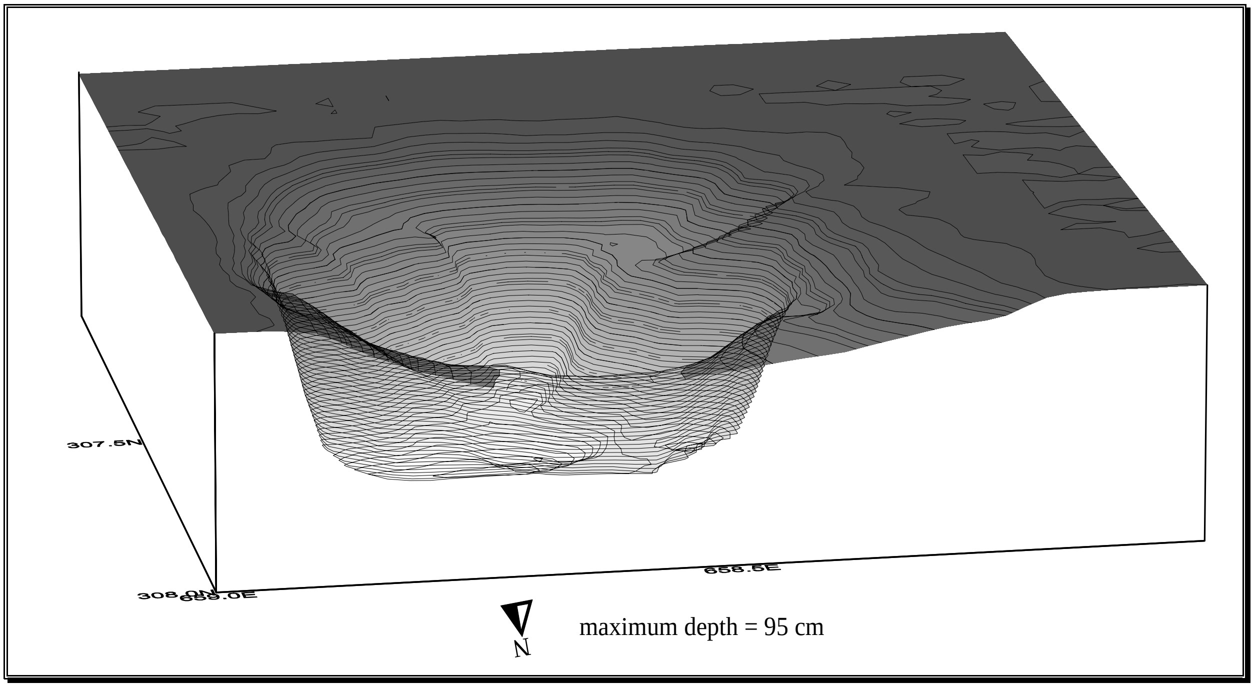

Figure 10.67 SURFER® Generated Topographic Contour Map of Feature 120

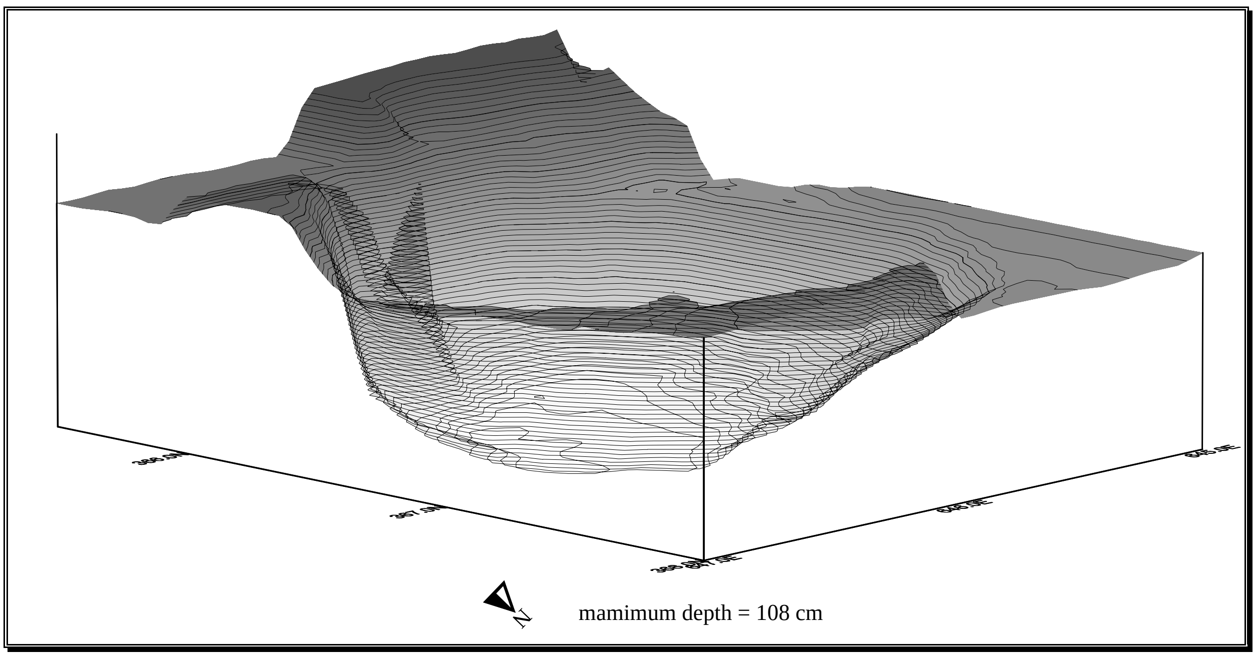

Figure 10.68 SURFER® Generated Topographic Contour Map of Feature 232

for comparative purposes, it was processed at the 2.5-cm, 5-cm, and 10-cm contour intervals. As expected, the level of intricacy decreased with each increase of the contour interval. Although the shape was not entirely regularized by this process, it was visibly smoothed out and revealed much less of the actual variation present in the feature. This was a good experiment for such purposes, as the feature was small and had a range of variation. However, it was decided that for the larger basin features, such a fine level of detail would have been of limited value. The 5-cm contour interval retained enough variability to illustrate the larger features at Hickory Bluff.

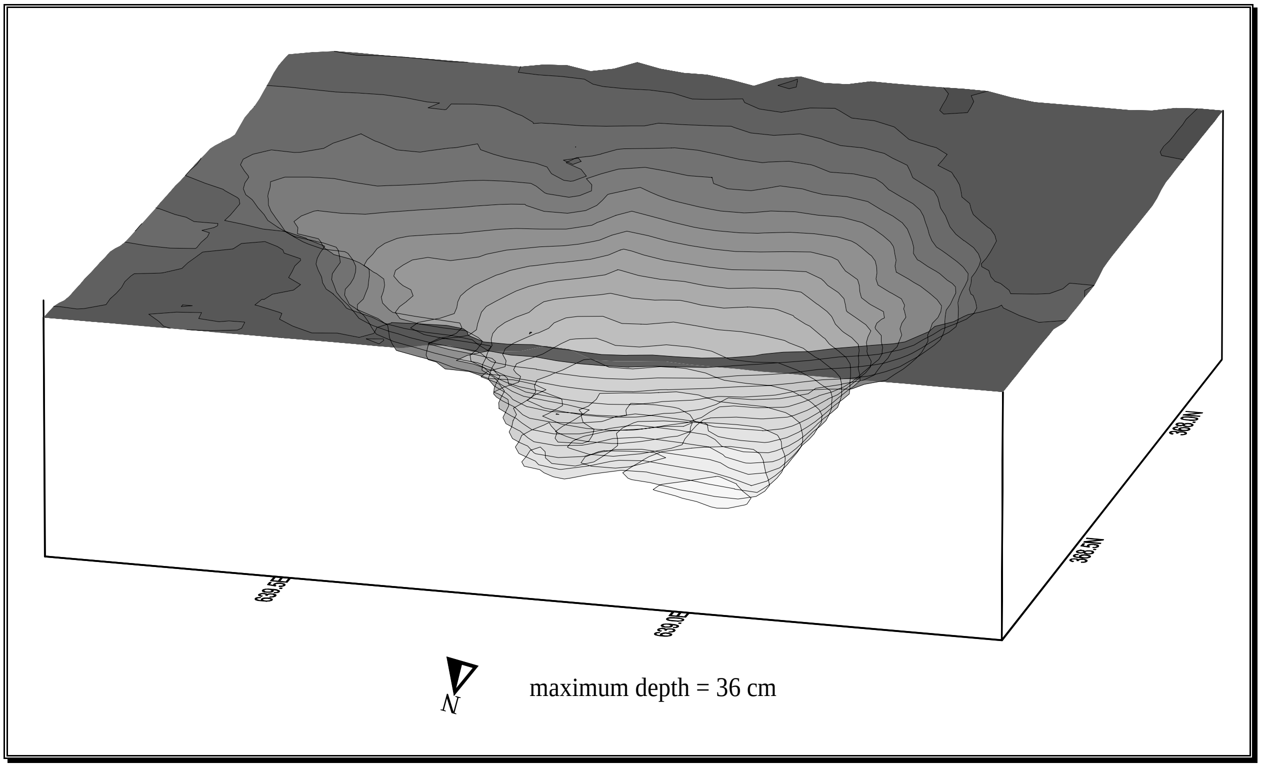

Figure 10.69 SURFER® Generated Topographic Contour Map of BX 1

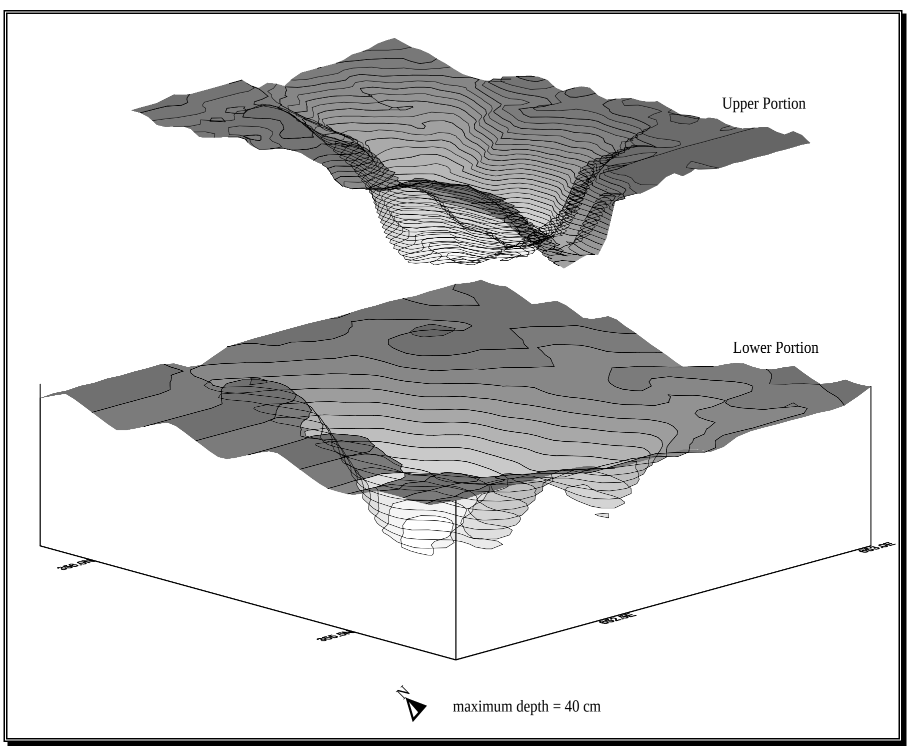

Figure 10.70 SURFER® Generated Topographic Contour Map of BX 3

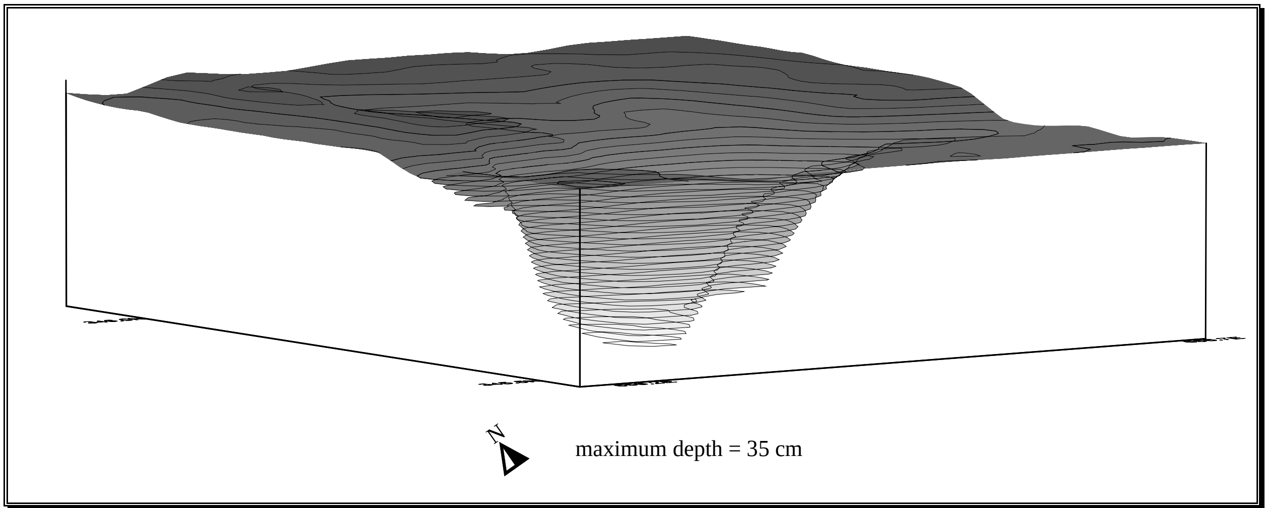

Figure 10.71 SURFER® Generated Topographic Contour Map of BX 7

Another variable plotted three-dimensionally was the location of artifacts. Although not all artifacts from a feature were piece-plotted in the field, Feature 90 had all of its tools, ceramics, and large thermally altered stone (TAS) piece-plotted during excavation. As a result, these data were displayed within the contour plot and illustrated a small part of the overall artifact distribution within Feature 90 (Figure 10.74). Most importantly, the plot illustrated the depth that artifacts, including formal tools and larger TAS, were being found. On a more limited scale, several artifacts were piece-plotted and displayed within Feature 120, a small, deep basin feature.

The computer generated contours allowed for a fuller and more detailed depiction of the features at the site, and demonstrated the amount of variability more efficiently than was possible with traditional planviews and profiles. The program also provided insights that could be used in future field excavations to guide the collection of this type of data. First, to enhance the feature reconstruction, more artifacts from within feature contexts should be piece-plotted three-dimensionally for inclusion in the models. As seen in the Feature 90 plot, examining the artifacts displayed within the feature, either along slopes or the edge, could help guide interpretations of feature formation. Another way to improve the consistency of the data and speed its gathering would be the use of a Total Station and data collector. When set from a known datum point, it could provide not only the depth below, but also the x and y coordinates relative to the datum. Such information could also be tied to UTM or State Plane coordinates, which could then aid in inter-site comparisons. The ever increasing availability and sophistication of such technology can only serve to improve both data collection and its analysis.

BASIN FORMATION MODEL

A variety of cultural and natural forces result in ground surface disturbances. Archaeologically, these cultural and natural forces can act independently or in concert to create and shape basin features. To model basin feature formation, a variety of information sources were considered. The Native American ethnographic record was reviewed to identify activities that could have resulted in ground excavations. The literature on natural ground surface disturbances was reviewed and the subsurface tree morphology study and the feature degradation

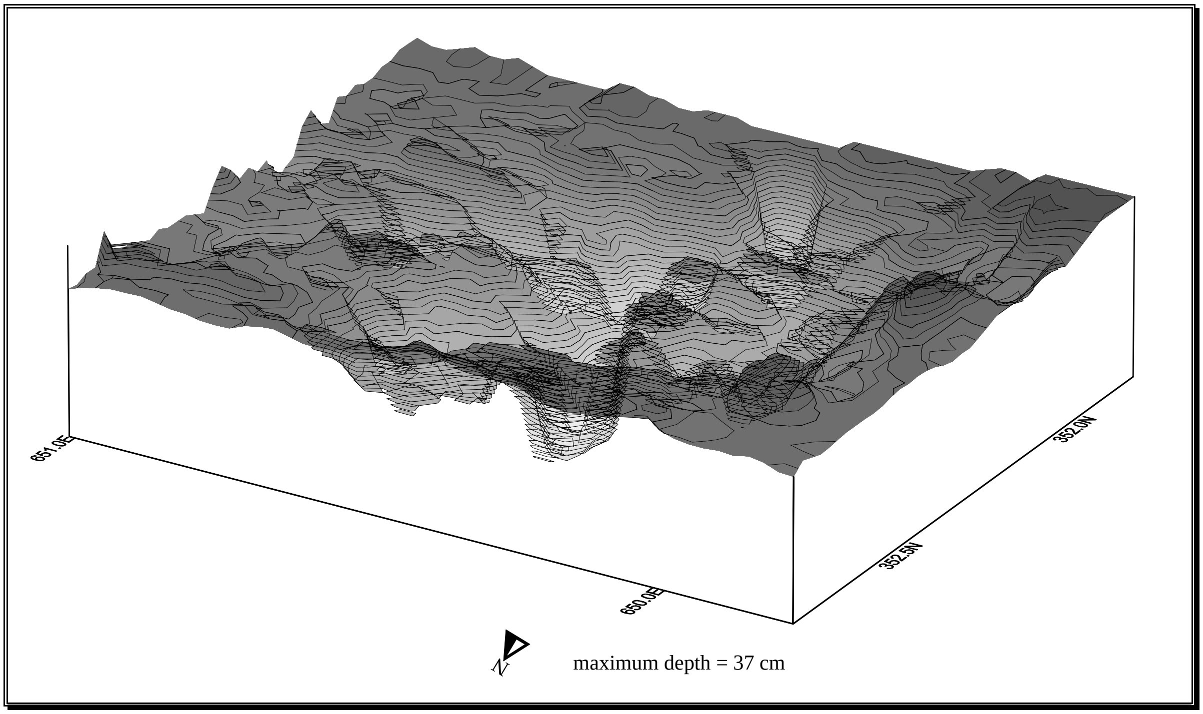

Figure 10.72 SURFER® Generated Topographic Contour Map of Feature 56 Demonstrating 2.5 cm Contour Intervals

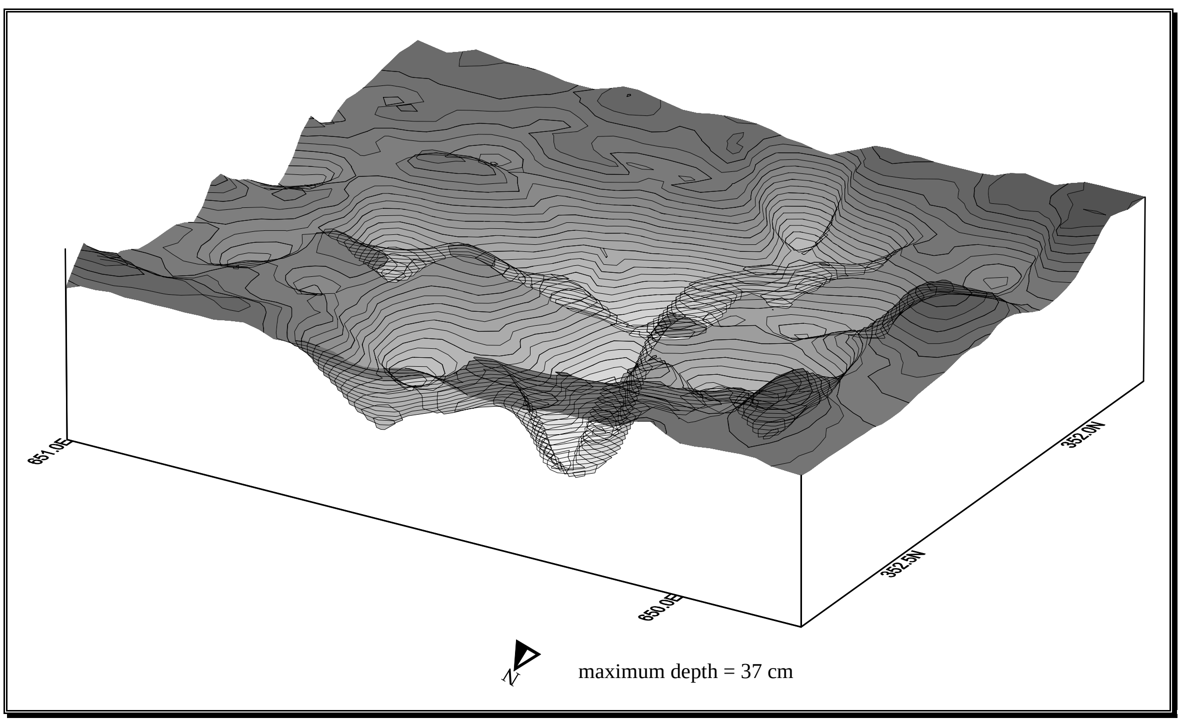

Figure 10.73 SURFER® Generated Topographic Contour Map of Feature 56 Demonstrating 5 cm Contour Intervals

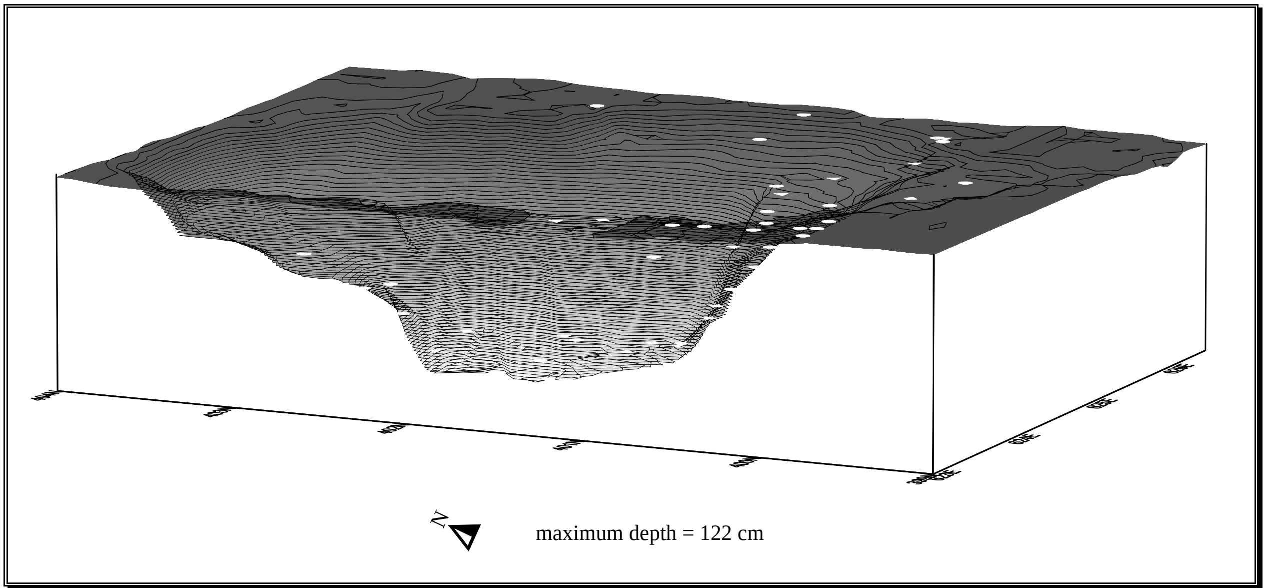

Figure 10.74 SURFER® Generated Topographic Contour Map of Feature 90 with Piece Plotted Artifacts

study were considered. Based on this review, seven basin formational scenarios were conceived. Based on these scenarios, expectations for the Hickory Bluff basin formation were outlined. Basin morphology was examined against cultural forms, tree related forms (tree rots, tree throws), and postdepositional disturbances. Basin content was examined through artifact numbers, geochemistry, and carbonized floral remains. Feature formation at Hickory Bluff was then examined relative to the modeled scenarios and their expectations.

Review of Cultural Ground Surface Disturbances

Historic and ethnographic texts were examined to identify information concerning Native American ground surface excavation practices in the region. While basin features represent a significant portion of the archaeological record, ethnographic and historical documentation detailing ground surface excavation was relatively sparse. However, a review of the regional literature revealed at least six types of ground surface excavations undertaken by Native Americans. These pertain to mortuary function, cooking/food preparation, storage, sweat lodge use, ceremonial activities and habitation construction. A review of the Delaware archaeological literature also produced several commonly applied functional interpretations to specific basin feature types: mortuary use, cooking, storage, and habitation construction (pithouse).

Mortuary Function

Ethnographic Information. Mortuary function is the most commonly referenced use for ground excavations in the ethnographic literature. This is not surprising, as burial customs are more likely to have been recorded by historical observers than mundane activities such as food preparation or storage. Among Coastal Virginia Algonquians, high status individuals were interred in above ground facilities. Common people, however, were buried in the ground, either individually, or in groups (Rountree 1989:113). Descriptions of the construction of burial pits for commoners include the digging of a deep hole, placing the corpse on sticks in the ground and covering with earth (Smith 1986a:169).

The use of ossuaries, or multiple secondary burials, is well known from an archaeological perspective in the coastal areas of Maryland (Curry 1999). Bodies of deceased individuals would be allowed to decompose, either above ground or in a temporary interment. At a certain time, the bones would be recovered and individuals collectively interred below ground. A late eighteenth century missionary account of the Nanticoke Feast of the Dead described the exhumation of the body after several months, defleshing, and subsequent reburial (Zeisberger 1910:90). Information on the primary interment disposition was lacking. No mention was made of whether reburial took place in an ossuary or individual grave.

Archaeological Information. Several important sites containing human burials have been investigated in the immediate vicinity of Hickory Bluff, offering a broad archaeological view of local mortuary practices. The most important of these sites was Island Field, located at the mouths of the St. Jones and Murderkill Rivers (Thomas and Warren 1970; Custer 1984b; Custer et al. 1990). Documented on the site were a large number of burial features. While the manner of interment varied (i.e., extended, flexed, redeposited and in-situ cremation), the majority were contained in oval to slightly irregular pit features between 1.0 and 1.5 m in greatest dimension (Custer et al. 1990:147-151). Also documented were a number of smaller, apparently intrusive pits and natural disturbances that impacted some of the remains (Custer et al. 1990:147-148). The St. Jones Adena site, located along the middle reaches of its namesake river, contained the remains of approximately 50 individuals (Thomas 1970, 1976). The individual interments represented dry bone cremations as well as secondary interments of disarticulated bone. Multiple individuals were recovered from what appeared to be large shallow pits. These varied in length from 2.1 to 4.8 m, with widths ranging from 2.4 to 3.0 m. Depths extended only 60 to 45 cm below the base of the modern plow zone (Thomas 1976:107). A burial feature was documented at the Carey Farm Site on the St. Jones River just below Dover (Custer et al. 1995b). The burial consisted of a single primary internment within an oval, bowl-shaped basin (Custer et al. 1995b:162).

Cooking/Food Preparation

Ethnographic Information. Native American dietary practices were recorded by early observers in the Chesapeake region. Rountree (1989) effectively summarizes much of this information. Relatively little mention is made of formal in ground cooking facilities, such as roasting pits or earth ovens, although such practices were probably common in the region. Tuckahoe or Arrow Arrum (*Peltandra viginica*) formed a staple in Coastal Algonquian diets (Rountree 1989:53). These tubers had to be processed to rid them of acids before they could be consumed. Rountree describes a process by which these foodstuffs were covered over in the ground and baked for twenty-four hours (Rountree 1989:53). Pehr Kalm, a Swedish traveler, wrote from New Jersey in 1789 describing a similar processing of the tuber in which “they [Indians] gathered a great heap of these roots, dug a great long hole, . . . into which they put the roots, and covered them with earth . . .; they made a great fire above it, . . . and then they dug up the roots, and consumed them with great avidity” (Fernald et al. 1958:114-115).

Drying and curing by smoking was the only method of meat preservation available to Native Americans. Wood fires can be made to burn generating maximum smoke and low heat by stoking them within ground surface excavations where available oxygen is limited. Such features are often referred to as smudge pits. Other types of fires are also likely to have been set in minor ground surface excavations simply for the practical purpose of delineating a hearth area, and to keep ashes and coals in place.

Archaeological Information. At the Delaware Park site, Thomas (1981) interprets small, saucer shaped basins as possible hearth locations. Custer's (1994) classification scheme of Woodland I features in Delaware defined two varieties of small shallow basins. Feature Types 3 and Type 4 are described as roughly circular to slightly irregular in plan, with a diameter of approximately 1 m. Profiles are shown as having a symmetrical, shallow saucer-like shape. The types are differentiated by maximum depth, with Type 3 described as having an average (plow truncated) depth of 20 cm while Type 4 averages 57 cm (Custer 1994:58). The shallow, saucer-shaped basin form is common across archaeological contexts, and is often interpreted as the remains of hearth/fire pits or food processing facilities.

Storage

Ethnographic Information. Subterranean storage of corn was common in the Piedmont and Great Valley of Virginia and Maryland (Potter 1993:173). In coastal areas, however, more ethnographic information exists regarding above ground storage than storage in subsurface pits (Potter 1993; DeBoer 1988). The differential use of pits, as opposed to above ground storage, figures prominently in investigations of socio-political complexity, particularly in regard to the production and control of corn surpluses (Potter 1993:172-173). Rountree (1989:49) makes some mention of harvested corn being stored in pits; however, the norm in the Chesapeake area appears to have been for corn to be stored in baskets inside houses (Rountree 1989:49, 65) or within special granaries (Potter 1993:45, 172).

A seventeenth century regional account from Virginia describes a variety of material goods buried in a pit in the woods, apparently for safekeeping. The description states that: "[t]heir Corne and (indeed) their Copper, hatchets, Howes, beades, perle and most things with them of value according to their owne estimation, they hide one from the knowledge of another in the ground within the woods, and so keepe them all years, or until they have fitt use for them" (Strachey 1953:115). A similar account from the 1750s records the use of this practice by Kirking Pauley, a Delaware Indian resident near Fort du Quesne at the upper reaches of the Allegheny River. Pauley stored household items in a pit in the woods for safekeeping while he and his family traveled (Browne et al. 1883-1972 37:177).

Archaeological Information. While ethnographic information on subterranean storage in the region is admittedly sparse, archaeological evidence of such practices is more common. At the Delaware Park site, Thomas (1981) identified a number of large pit features which he interpreted as below ground storage facilities based on their regular form and other attributes. Large cylindrical basin features interpreted as formal storage facilities were also identified at the Lums Pond site in New Castle County (Petraglia et al. 1998:83). In Custer's (1994) Delaware feature typology, similar cylindrical pits were classified as Type 5. Large cylindrical pits also were identified and excavated at the Puncheon Run site located across the St. Jones River from Hickory Bluff (Liebknecht et al. 1997).

While a (food) storage function for cylindrical basin features is inferred, more direct evidence for underground storage was uncovered at the Carey Farm site, where a large cache of argillite bifaces was found (Custer et al. 1995b:166). Also recovered from a bowl-shaped basin feature was a large Mockley vessel (Custer et al. 1995b:164-165). The vessel itself may have been cached below ground in the same manner as the argillite bifaces. It is perhaps equally likely that the vessel contained foodstuffs, perishable products or raw materials that were interred for storage purposes.

Sweat Lodge Use

Ethnographic Information. Ground surface excavations also may have been employed for sweat lodge constructions. A description of a seventeenth century communal sweathouse in Virginia described it as "a Hole" dug in to the riverside "like an Oven" (Banister 1970:45-46). In the center, a cluster of stones was heated in a fire. Other accounts of sweathouses from Virginia, Pennsylvania, and New York similarly describe them as oven-like structures dug into riverbanks (Smith 1986a:168; Wolley 1973). The dimensions of these features were not recorded.

Archaeological Information. Archaeological information on, or precedence for, sweat lodge related ground surface excavation is generally lacking in the region.

Ceremonial Activities

Ethnographic Information. Ground surface excavations also may have been employed in ceremonial practices. Although reported from outside the region, New England Algonquian groups excavated small pits of commemoration at locations of important events (Smith 1986c:462). The story of the event was passed on to others and subsequent offerings were made at the pit. This practice can be seen as similar to the use of altar stones as commemorative offering sites among the Chesapeake Algonquians. The John White late sixteenth century watercolor and derived engraving of a North Carolina Algonquian village of Secota shows a ceremonial area or "dance circle" ringed by large effigy posts set in the ground.

Archaeological Information. Direct archaeological evidence for ceremonial activity related ground surface disturbance is generally lacking for the region. It should be noted, however, that the traces of such activities would very likely mimic those of strictly economic ones and would be therefore be difficult to distinguish.

Habitation Construction (Pithouses)

Ethnographic Information. The construction and use of semi-subterranean structures and dwellings was relatively common among North American Indians, particularly in areas of more extreme climate. In general, ethnographic references to semi-subterranean house construction are lacking for the coastal Mid-Atlantic.

Archaeological Information. In Delaware, the archaeological interpretation of large basin features representing semi-subterranean structures is currently in debate.

Basin Formation Scenarios

To examine the various forces and events that could potentially result in basin formation, seven scenarios were constructed. These scenarios incorporated both natural and cultural causal forces, both individually and in various permutations.

Scenario 1 - Cultural Formation, Single Episode Excavations

This model of basin formation pertains to singular cultural events such as the excavation of a pit by site occupants for a specific purpose (Figure 10.75). Such features may have been deliberately back filled or left to fill in naturally. This scenario is perhaps the least common as it is predicated on the original ground excavation having had a single use life and then remaining unaffected by postdepositional forces or events.

Initial State. Cultural ground surface excavation

Cultural Interactions. Backfilled

Natural Interactions. Natural infilling

Expectations. Certain cultural ground surface disturbances such as cylindrical basins, can be expected to show pronounced signatures. Morphological attributes such as straight walls and flat bottoms would provide clear cultural signs. Other archaeological entities, such as bell-shaped pits also may be designed and shaped by humans. In general, straight lines, flat planes and right angles are rarely found in nature. These forms, expressed either in the morphology of a specific feature, or in spatial patterning of multiple entities, are the direct result of human input. Purposely constructed ground surface excavations can be expected to contain directly or indirectly collected organic material associated with the site occupation. This would leave specific geochemical traces, such as elevated presence of certain elements or modification of soil pH. Elevated artifacts counts are seen as a strong indicator of a cultural association. However, low artifact volumes are not necessarily viewed as a negative indicator for a cultural association, as this might be the result of a specific, deliberate on-site behavior(s).

Scenario 2 - Cultural Formation, Multiple Episode Excavations

The types of cultural ground surface disturbances articulated in Scenario 1 can be expected to be reused, altered or otherwise modified throughout the occupation of the site. In addition, original, remnant ground surface disturbances may have been opportunistically re-utilized during a later site visit (Figure 10.76). Such events would clearly alter the original morphology of a basin entity and make its formation difficult to assess from an archaeological perspective.

Initial State. Cultural ground surface excavation

Cultural Interactions. Intersecting ground surface excavations

Natural Interactions. None

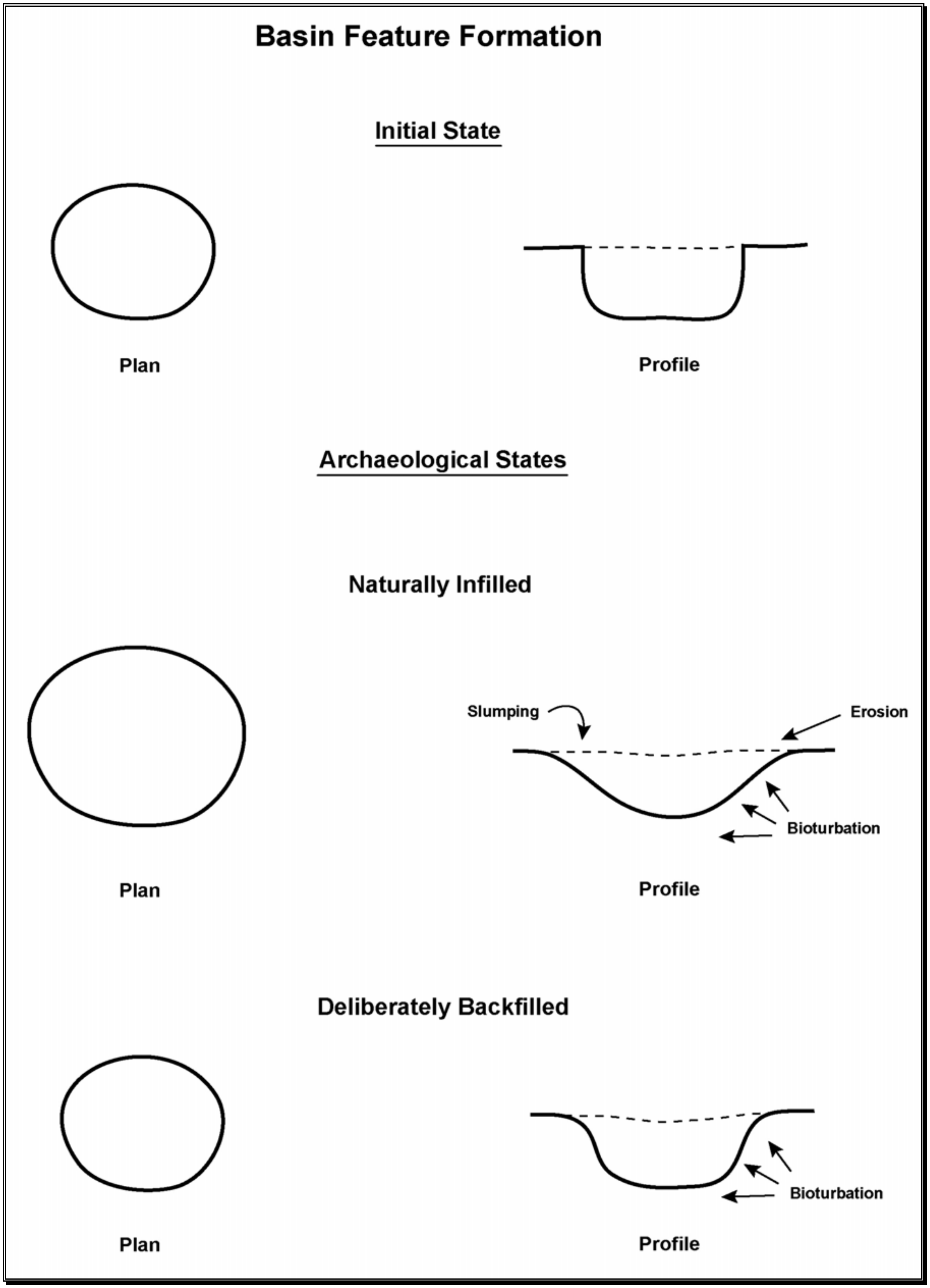

Figure 10.75 Basin Feature Formation Scenario #1 Cultural Formation: Single Episode Excavation

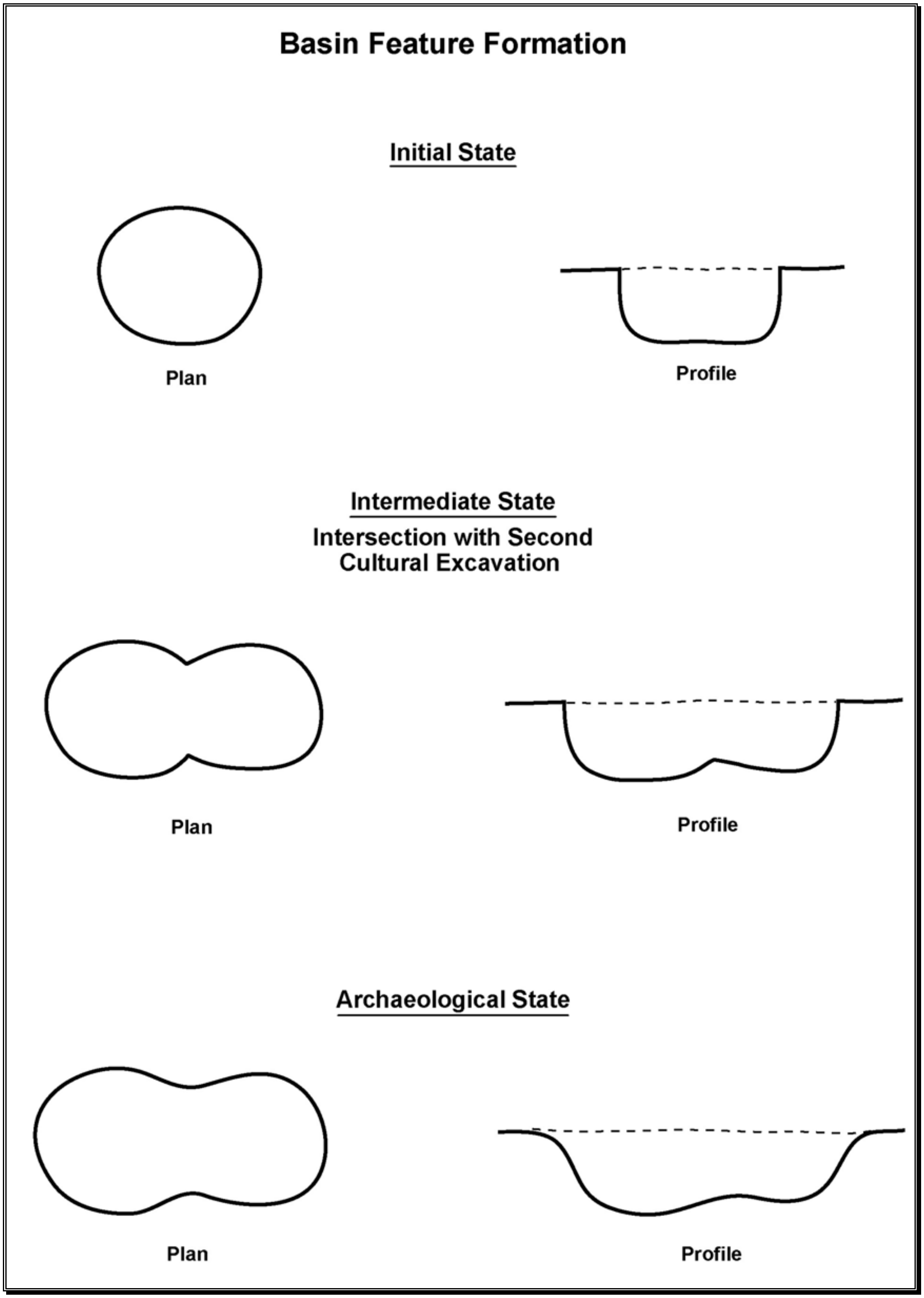

Figure 10.76 Basin Feature Formation Scenario #2 Cultural Formation: Multiple Episode Excavation

Expectations. Multiple episode ground surface excavations may be more difficult to recognize as distinctly cultural in origin. These multiple, or modified excavations, are expected to retain some morphological attributes that may be recognizable as cultural. The same expectations for geochemical traces and artifact data apply as in Scenario 1.

Scenario 3 - Cultural/Natural Formation, Cultural Excavations Intruded by Natural Disturbances

This category postulates that the cultural ground disturbances may interact with various combinations of natural postdepositional agents (Figure 10.77). Natural agents such as roots and burrowing animals seek out softer, less consolidated soils found in cultural features. Roots of deciduous tree are particularly adept at seeking out softer soils (Farb 1961). Consequently, few archaeological features of any significant age can be expected not to have been impacted to some degree by natural agents, and consequently this scenario of basin formation process is likely to be widely represented.

Initial State. Cultural ground surface excavation

Cultural Interactions. None

Natural Interactions. Disruption by biotic disturbances; bioturbation

Expectations. In cases of specific basin features that can clearly be ascribed a cultural origin, natural disturbances such as root or rodent channels are expected to be distinguishable by their contrasting morphologies (i.e., obvious root channels), providing the natural (biotic) disturbances do not fully mask the cultural basin form.

Scenario 4 - Cultural/Natural Formation, Cultural Excavation of a Natural Disturbance

Humans are no less inclined to exert more effort than necessary than are plant roots or burrowing animals (Figure 10.78). Human excavation or re-excavation of a variety of natural on-site disturbances could therefore be expected. Pre-existing disturbances such as tree rots, tree throws and other natural depressions are likely to have been enlarged/modified by the site occupants for a variety of purposes. In either scenario, the formation of the basin is postulated as having been the result of cultural and natural forces acting in concert.

Initial State. Natural ground surface disturbance

Cultural Interactions. Excavation

Natural Interactions. Bioturbation

Expectations. Basin features resulting from cultural modification of a natural entity can be expected to show morphological attributes of both natural and cultural disturbances, providing that the cultural excavation does not fully mask the morphology of the original disturbance. While the morphologies of such features may not be easily decipherable, a cultural use of a pre-existing ground surface disturbance is likely to leave geochemical signatures very similar to that of pure cultural features. Significant elevation in relative artifact counts could also be seen as a strong indicator of cultural use.

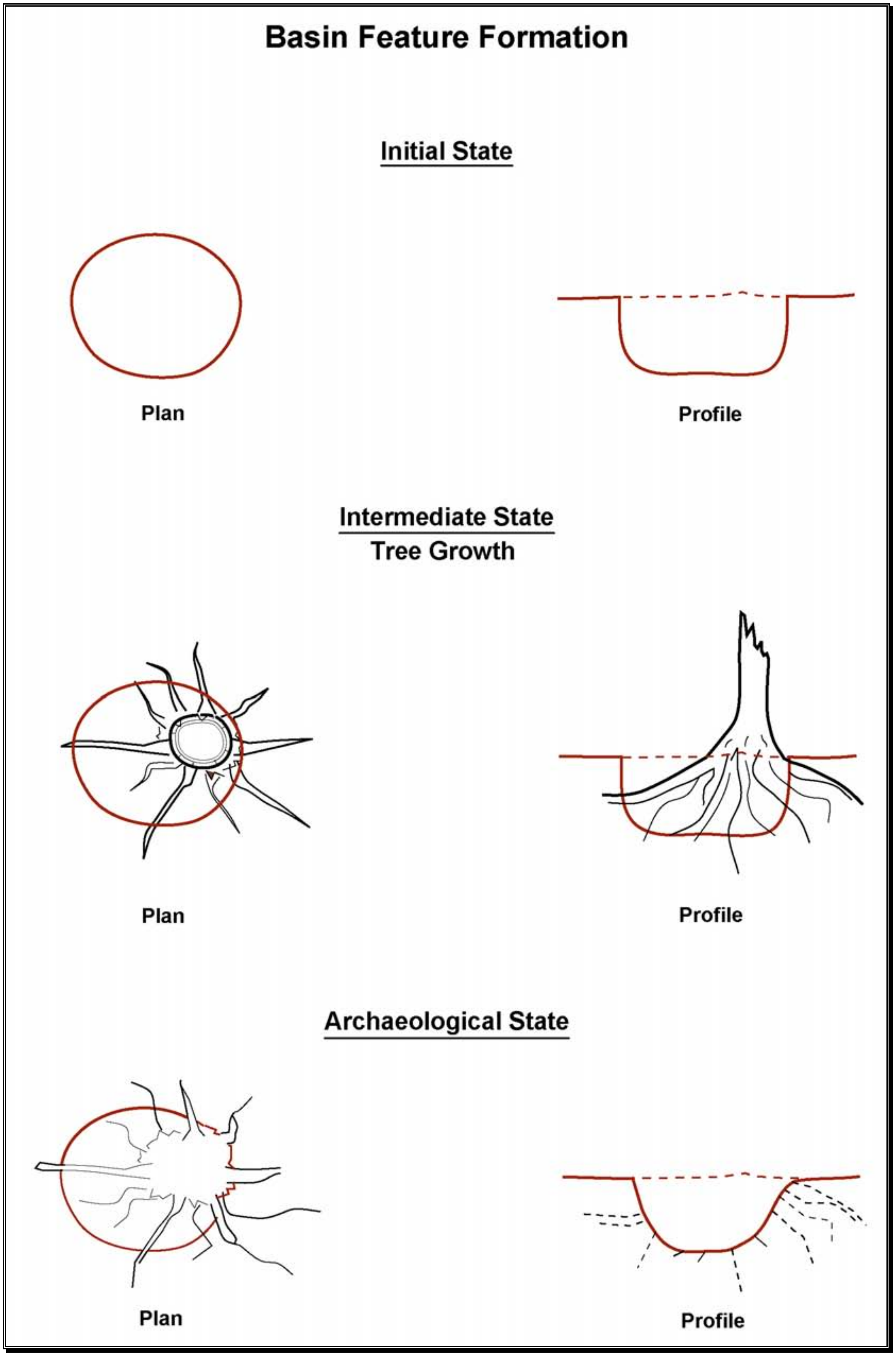

Figure 10.77 Basin Feature Formation Scenario #3 Cultural and Natural Formation: Intruded by Natural Disturbances

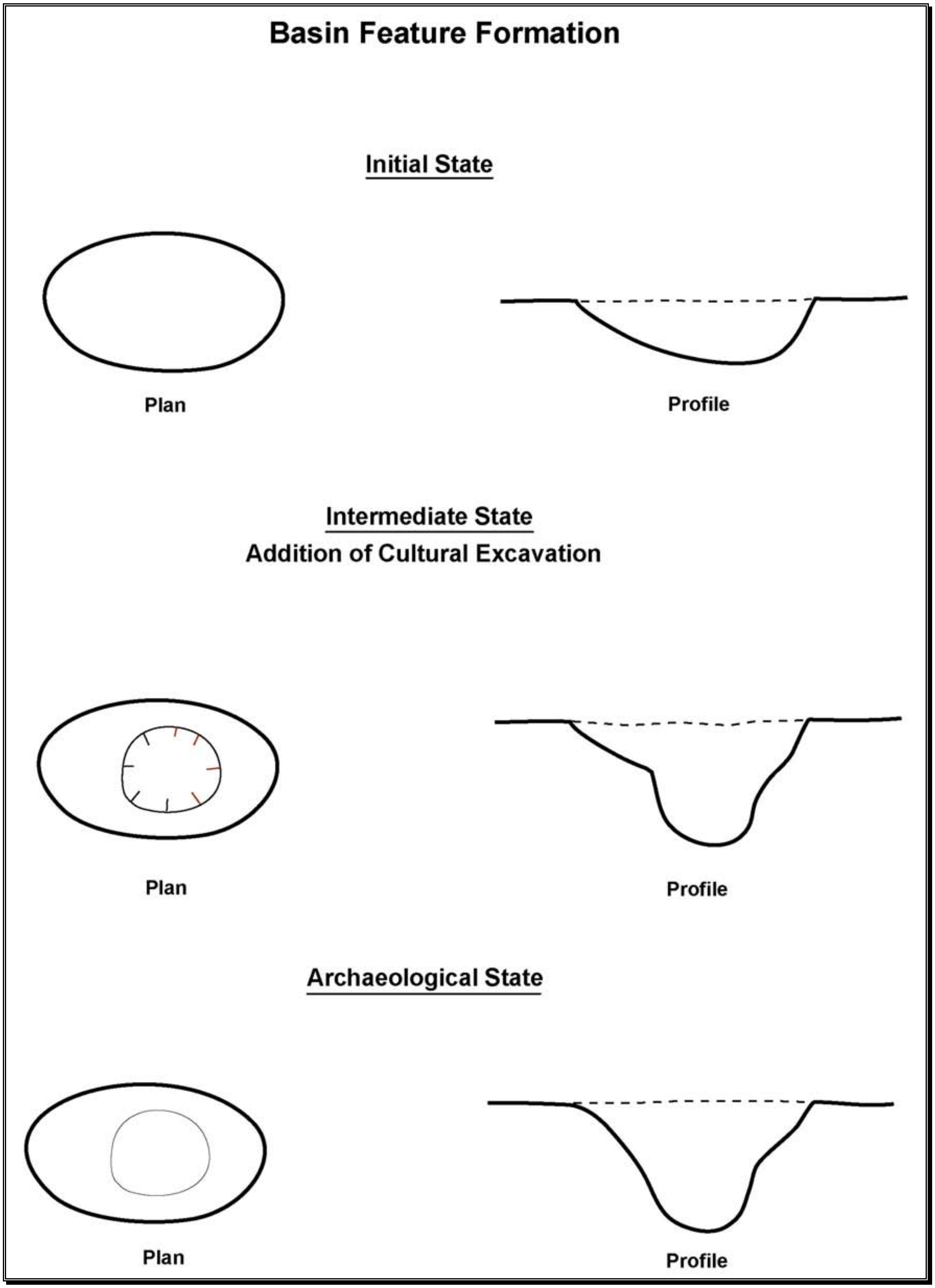

Figure 10.78 Basin Feature Formation Scenario #4 Cultural and Natural Formation: Cultural Modification of Natural Disturbance

Scenario 5 - Cultural/Natural Formation, Cultural Utilization of Natural Disturbances

Certain ground disturbances that were originally purely natural in origin were likely to have been utilized for cultural purposes (Figure 10.79). Ground disturbances such as tree throws, or in the case of sloping areas, wash gullies, and other erosional features, would have offered convenient locations for refuse disposal. Although the ground disturbances were natural in origin, and may have remained unmodified, the deliberate addition of artifacts would make their archaeological manifestation cultural in association. This scenario should be considered when evaluating the possible formation/use of any large basin entity, particularly when elevated artifact numbers of artifacts are recovered.

Initial State. Natural ground surface disturbance

Cultural Interactions. Deposition of artifacts

Natural Interactions. Bioturbation

Expectations. The morphology of the ground disturbance would be strictly that of a natural disturbance (e.g., tree rot, tree throw). Primary evidence of a cultural component can be expected to consist of elevated artifact counts resulting from use of the disturbance for refuse disposal. Such use can also be expected to leave geochemical traces. Similarly, the recovery of an absolute date from a basin context that is coeval with a known occupation period would indicate that the ground surface disturbance was open during that time.

Scenario 6 - Natural Formation

Examples of ground disturbances that could result from purely natural processes include root disturbances, rodent channels, tree throws, tree rots and anomalies generated by freeze/thaw cycles, erosional events or through ongoing soil development (Figure 10.80). In general, recent naturally caused ground disturbances are easily discriminated from potential cultural features by the presence of observable organic materials, soil voids, and other attributes. Disturbances of greater age can be significantly more difficult to discern due to decomposition of organic material, settling of the fill, and bioturbation of the interface with the undisturbed soil matrix. These factors can potentially work together and cause natural disturbances to mimic the properties of cultural features. The phenomenon of accelerated soil development, which can occur in both natural and cultural disturbances as a result of enhanced groundwater movement, must also be considered (Section 9.0). In this scenario, E-horizon development within a very old natural disturbance could potentially cause the fill to closely resemble that of cultural features. Similarly, nascent B-horizon development along the lower margins of a natural disturbance, again facilitated by enhanced groundwater movement, could cause these areas to become more firm and therefore, more closely resemble the form of a cultural entity. In fluvial settings, flood scours that subsequently filled in with organic-rich alluvium, when viewed archaeologically, could also mimic cultural ground disturbances.

Initial State. Natural ground surface disturbance

Cultural Interactions. None

Natural Interactions. Bioturbation

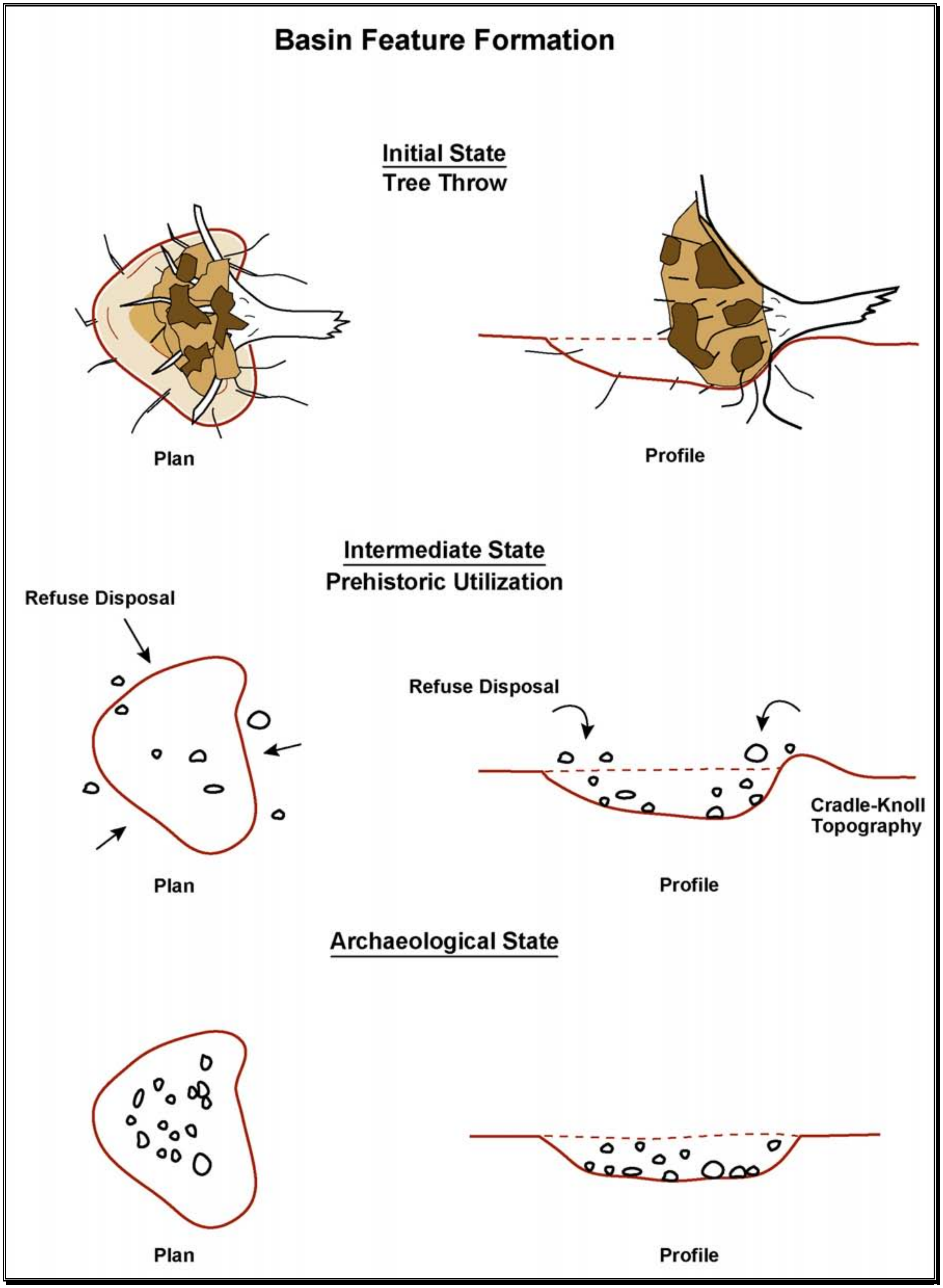

Figure 10.79 Basin Feature Formation Scenario #5 Cultural Utilization of a Natural Disturbance

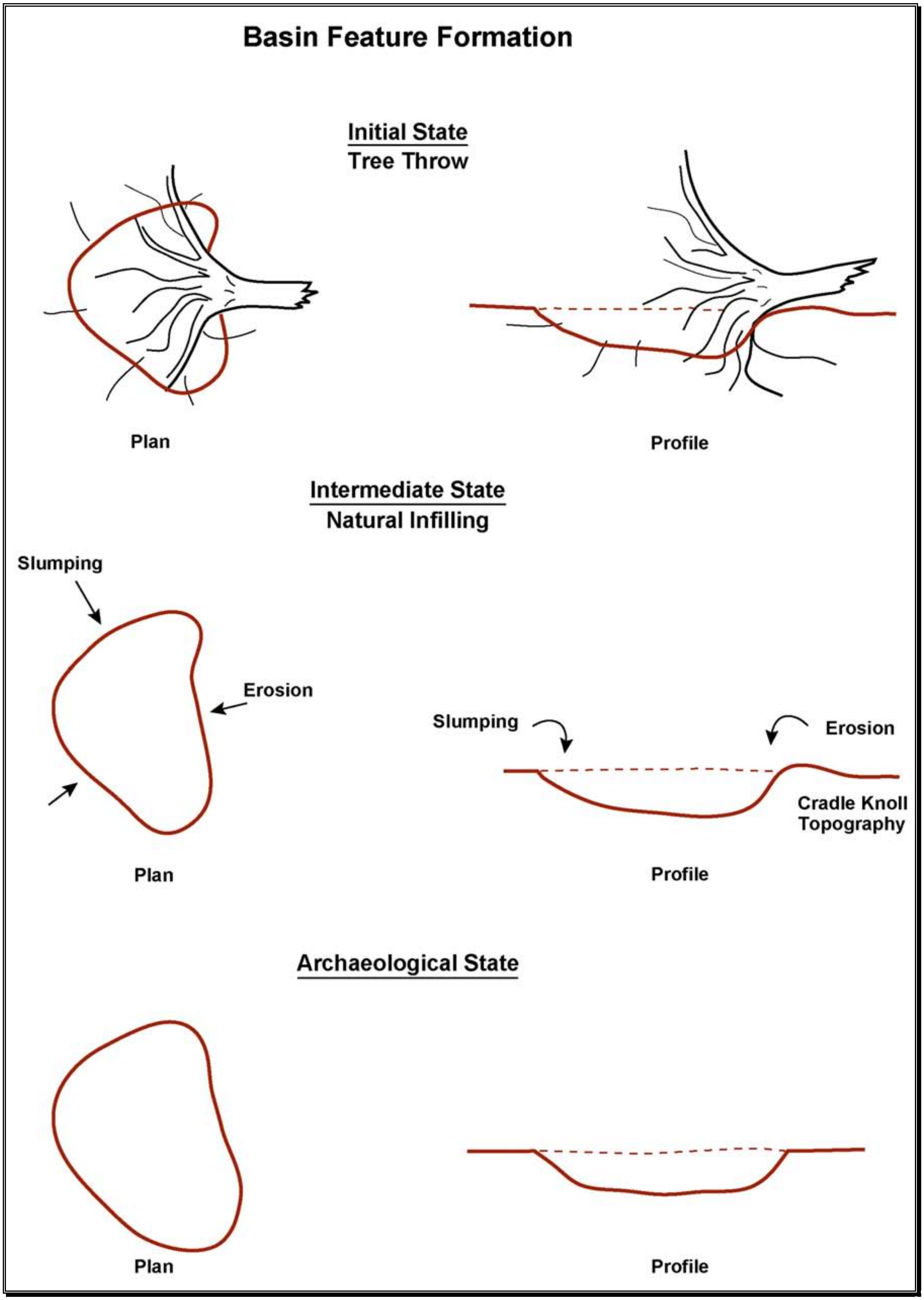

Figure 10.80 Basin Feature Formation Scenario #6 Natural Formation

Expectations. One finding of the subsurface tree morphology study was that in all the examined specimens, recognizable below grade disturbances associated with the tree/root mass were shallow. As recorded, these rarely penetrated the base of the E-horizon or exceeded a depth of 50 cm. Tree roots are known to radiate away from the trunk a distance equivalent at least to the spread of the crown (Farb 1961:94). These roots constantly branch and re-branch with distance from the trunk. Within a short distance from stump, the mass of the root system becomes essentially inconsequential in relation to the volume of soil through which it grows. The only appreciable concentration of root mass is present immediately below and around the base of the trunk (root ball). As the living tree bisection demonstrated, even directly under the tree location, the actual mass of the root system is relatively limited. The subsurface tree morphology study findings detailed how the root ball, or the concentration of roots radiating out from the base of the stump, leaves a shallow, restricted void as the tree remnants decompose. More peripheral roots were demonstrated as leaving only individual holes or divots, representative of linear disturbances (individual root channels) radiating out and away from the central core. Tree mold related entities, therefore, would be anticipated to exhibit only a shallow, saucer-like shape where the root ball decayed. Larger root casts would be expected to give the basin sides an irregular contour. Former voids left by smaller diameter roots radiating further away from the stump are unlikely to be archaeologically recognizable.

The archaeological documentation of modern tree throws as part of the subsurface tree morphology study proved useful in modeling archaeological expectations. The study encountered the oval to crescentic to D-shaped planviews typically described for tree throws (Langhor 1993). However, the archaeological documentation of tree throws demonstrated that the ground surface disturbances associated with the downing of even very large trees can be quite shallow. Archaeological manifestations of tree throws can be expected to exhibit similar size parameters as contemporary examples. The cradle and knoll morphology, demonstrated by various tree throw studies (Stephens 1956; Beke and McKeague 1984; Cremeans and Kalisz 1988), was observed in the study. This morphology is precipitated by the upward displacement of soils as roots are pulled from the ground. The ongoing process of the redeposition of the displaced soils back into the tree throw void was also observed in the field. This violent displacement and subsequent redeposition of portions of the soil column is expected to be reflected in the composition of the filled in ground surface disturbance. These fill characteristics (i.e., subsoil mottling, displaced gravel) are expected to be archaeologically recognizable, even in tree throws of some antiquity.

Scenario 7 - Culturally Induced Natural Events

This scenario of basin formation pertains to human input of what otherwise would be thought of as a purely natural event (Figure 10.81). A hypothetical example of this could be a culturally induced tree fall. In this scenario, a combination of grubbing and burning at the base of a large tree is utilized to sever a large portion of its root system causing it to fall. The resulting ground disturbance would be the result of both human input (digging, burning) and that of what is normally considered to be a natural event (tree fall).

Initial State. Natural ground surface disturbance

Cultural Interactions. Grubbing and burning

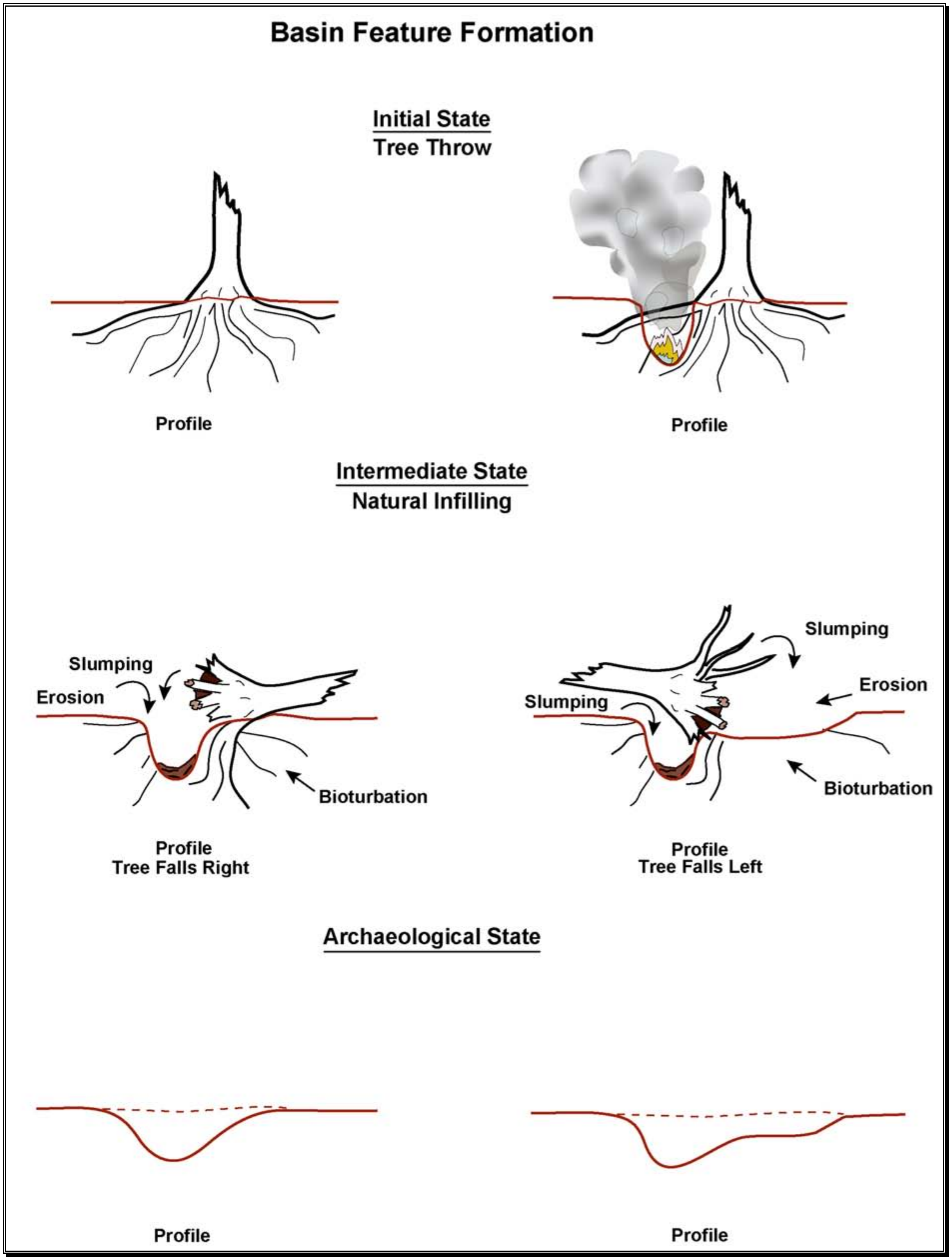

Figure 10.81 Basin Feature Formation Scenario #7 Cultural Formation

Natural Interactions. Bioturbation

Expectations. Basin formation may be the result of a culturally induced tree fall. It is postulated that a (crescentic) trench was excavated along one side of a mature tree, digging around the major root members. The exposed roots would be severed by constructing a fire within the excavation. This would have the effect of both killing the tree and making it unstable. The purpose of such activity would be to clear areas for habitation, down trees for limb fire wood, enhance growth of economically valuable trees such as mast-bearing species by eliminating competition, promote wild food producing plant species and/or semi-domesticates, or any combination of these impetuses. In terms of resultant ground surface disturbance morphology, archaeological expectations are twofold. Should the tree have fallen in the direction away from the trench, then the only archaeological manifestation would be the grubbing trench. If the tree fell in the direction of the trench, then a three throw-like disturbance where the roots pulled up with the trench in one end would be expected (Figure 10.78). Either morphology can be expected to have been subjected to the postdepositional forces and changes articulated in the previous scenarios. Artifact content would be contingent on occupation specific behavior and the ground surface disturbance’s location in relation to the core of the site occupation. However, as such landscape modification activities would be expected to have been undertaken some distance away from the habitation center, limited artifact numbers could be expected for basin formation.

BASIN FEATURE ANALYSIS

Methodology

A total of 108 basin features were identified on Hickory Bluff. In addition, 20 archaeological ground surface disturbances encountered on the site could confidently be assessed as tree molds. As this feature assemblage was far greater than could be studied in full, a representative sample was selected (Table 10.4). The set included five examples each of the large basin (B-1), medium basin (B-2) and small basin (B-3) types. These were defined as larger than 2 m in greatest dimension (B-1), between 1-2 m in greatest dimension (B-2), and less than 1 m in greatest dimension (B-3). Basin features were selected for the study sample based on a number of criteria, including completeness of excavation and lack of gross physical overlap with recent natural disturbances. The availability of geochemical and absolute dating data was also considered. A total of five archaeologically investigated tree mold features (D-2) were also analyzed for comparative purposes.

Table 10.4 Selected Basin Features by Type

B-1 Features	B-2 Features	B-3 Features	D-2 Features
2, 77, 90, 118, 169	3, 67, 13, 234, 298	4, 116, 120, 202, 267	20, 63, 119, 126, 314

The morphology of the basin features in the study set was first compared to known subsurface tree and tree throw morphologies. Evidence for a biological component to the basin formation, such as large scale root or rodent intrusions, was assessed. Evidence for cultural morphology was examined. Artifact data, specifically counts relative to adjacent non-feature contexts, were evaluated as potential cultural signatures.

Large Basin Feature Descriptions

Five large basins were selected for analysis. These were Features 2, 77, 90, 118 and 169. These features exhibited a distinctive oval to crescentic to D-shaped planview. In profile, these features generally showed one steeply sloping side and one shallow sloping, or flaring side. This specific D-shaped large basin form was replicated in the Experimental Feature Degradation Study (XF 1 and XF 8).

Feature 2. This large basin feature was roughly ovoid in plan. The profile showed moderately sloping walls and a undulating base. Fill was distinguished from the undisturbed soil by a finer texture, slightly darker color, and the presence of charcoal flecking. Dimensions were recorded as 3.90 x 2.54 x 1.15 m. The feature fill was subjected to extensive geochemical analysis. An AMS date of 2790+/- 40 years before present (B.P.) was obtained from the basin.

Feature 77. In planview, the exact configuration of Feature 77 remained unclear as its periphery was truncated on two sides by additional basin features. In profile, the feature clearly showed one steeply sloping side and one more gently sloping side that met at a rounded bottom. The below grade contour can be extrapolated to approximate an irregular sub-ovoid. Fill soils were finer in texture than the undisturbed matrix. Some mottling of subsoil was noted therein. Minor charcoal flecking was also present. Minimum greatest dimensions were 3.30 x 2.50 m with a depth of 1.32 m. Fill was subjected to geochemical analysis.

Feature 90. Feature 90 was elliptical to oblong in planview. One wall sloped steeply and the other at a more shallow angle. Dimensions were recorded at 4.60 x 2.65 m with a maximum depth of 1.22 m. The deepest portion of the feature showed a bluntly rounded contour. Fill was slightly, but discernibly, darker than the surrounding soils. An AMS date of 4070 +/- 40 years B.P. was obtained from the basin. The feature fill was subjected to geochemical analysis.

Feature 118. Feature 118 was an irregular semi-elliptical feature recorded in the plowed, southeastern periphery of the site. One wall sloped steeply to a rounded bottom while the other sloped at a shallower angle. Minor charcoal flecking was present throughout the fill. Dimensions were 3.00 x 1.10 m with a depth of 0.78 m.

Feature 169. Feature 169 was D-shaped in planview. Side walls were steep. The uppermost portion of the feature was truncated by excavation of another medium basin feature, so its full configuration remained undetermined. Walls sloped steeply to a rounded bottom. Fill was slightly darker than the undisturbed matrix soils. Minor charcoal flecking was also noted. Maximum dimensions were recorded as 3.40 x 1.65 m with a depth of 1.12 m. The feature fill was subjected to geochemical analysis.

Medium Basin Feature Descriptions

In contrast to the large basin variety, the medium basins exhibited greater morphological variation, at least in profile contour. Geochemical analysis was not conducted on any of the medium basins. The sample selected for study consisted of Features 3, 67, 139, 234, and 298.

Feature 3. Feature 3 intersected with another basin feature, making its exact plan configuration difficult to establish, although the identified portion was sub-ovoid in shape. Walls of the uninterrupted portion sloped steeply to a flat bottom. Fill was slightly darker and finer textured than the undisturbed soil matrix. Dimensions were recorded at 1.27 x 1.05 m with a maximum depth of 0.65 m. Feature 3 did not contain elevated numbers of artifacts in relation to adjacent non-feature contexts. Two separate AMS dates were obtained from the feature: 2600+/-60 years B.P. and 2790+/-60 years B.P.

Feature 67. This feature was very regular in form. In planview, the feature was sub-ovoid in shape. In profile, the basin was bilaterally symmetrical with steep walls and a nearly flat bottom. Fill was slightly darker and finer textured than the surrounding soils and minor amounts of charcoal flecking were noted. Dimensions in plan were 1.20 x 1.00 m, with a depth of 0.34 m.

Feature 139. Feature 139 was oval to irregular in planview. Walls sloped steeply to a rounded bottom. Planview dimensions were recorded at 1.36 x 0.84 m, with a depth of 0.66 m. Fill soils varied from the other basins in that they were notably coarser or sandier than the surrounding undisturbed matrix.

Feature 234. In planview, Feature 234 was oval to slightly irregular in form. The Feature 234 fill was essentially the same as Feature 1 and consisted of a sandy loam that was slightly darker in color than the adjacent E-horizon. In profile, the feature was essentially symmetrical with steeply sloping sides and a bluntly rounded bottom. Planview dimensions were recorded as 1.72 x 1.20 m, with a depth of 0.48 m below the base of Feature 1.

Feature 298. Feature 298 was roughly oval to irregular in plan although its exact configuration was difficult to ascertain. The south and west portions of the feature bottomed out quickly against a natural rise in the C-horizon sands. The north and west portions of the feature were indistinct and difficult to define archaeologically. The feature fill was siltier and retained more moisture than the adjacent C- and E/C-horizons. Small artifacts were recovered, mostly from the deeper, middle portion of the feature. Sidewalls sloped shallowly to a wide gently rounded base. Maximum dimensions were 1.72 x 1.34 m, with a depth of 0.30 m.

Small Basin Feature Descriptions

Small basins were defined as having a maximum plan dimension of less than one meter. In general, these features were often quite regular in form, exhibiting a circular to slightly oval configuration. Profiles, however, varied considerably both in dimension and configuration. Geochemical analysis was not performed on any of the small basin examples. Small basins chosen for study were Features 4, 116, 120, 202, and 267.

Feature 4. Feature 4 was essentially cylindrical in shape with very steep sides and a bluntly rounded bottom. Fill soils were typical of basin features in that they were very slightly darker and finer textured than the surrounding soils. The feature yielded an AMS date of 1540+/-50 years B.P. Maximum dimensions were 0.42 x 0.37 m with a depth of 0.92 m.

Feature 116. This feature was oval to irregular in plan. One wall sloped at a steep angle while the other one had a shallower pitch. A portion of the base was flat, while the other side appeared to be interrupted by a rodent burrow. The fill was consistent with that of other basins; it was very slightly darker than the surrounding undisturbed matrix and contained minor amounts of charcoal flecking. The feature dimensions were 0.47 x 0.42 m with a depth of 0.12 m.

Feature 120. In profile, Feature 120 exhibited a deep, shaft-like configuration. The feature orifice was oval in plan. The walls, however, were nearly vertical to a depth of at least 95 cm. The feature dimensions were 0.75 x 0.40 m in planview. Four separate fill strata were defined. The upper two strata yielded relatively large numbers of artifacts including five Wolfe Neck and three Hell Island ceramic sherds. Also recovered were calcined bone and carbonized hickory nutshell and wood. A wood charcoal fragment from Stratum I yielded an AMS date of 920+/-50 years B.P. The lowest stratum (IV) did not yield any artifacts. The unconsolidated soils interfaced with the upper portions of the C-horizon sands, making the bottom of the basin unrecognizable.

Feature 202. This feature was unique on the site. It consisted of a small bowl-shaped basin measuring 36 x 34 cm. The rounded bottom extended to a depth of 15 cm. Feature 202 contained artifacts in a configuration strongly suggestive of deliberate placement. A set of cobble tools was found at the bottom of the feature and large ceramic sherds were used to line portions of the basin walls. A large quartzite cobble capped the feature. The fill characteristics were consistent with the majority of basins on the site with soils only very slightly darker than the surrounding undisturbed matrix. Minor charcoal flecking was also present.

Feature 267. Feature 267 consisted of a small basin identified within Feature 129, a large shallow basin. Feature 267 was slightly oval in plan and measured 0.35 x 0.29 m. Walls were steep and well defined. The bottom was rounded and firm. Soils were slightly coarser (sandier) and lighter in color than the Feature 129 matrix. Two carbonized nut hulls and two small TAS fragments were recovered from within the small feature.

Tree Mold Feature Descriptions

Five archaeological tree molds (D-2) were selected for this analysis. These natural features consisted of Features 20, 63, 119, 126 and 134. The documentation of these disturbances was used to augment the finding of the Subsurface Tree Morphology study.

Feature 20. Feature 20 was oval to slightly irregular in plan. Dimensions were recorded at 0.39 x 0.60 m. Walls were steep and straight sided with some apparent root casts present. In profile, the feature was slightly conical in form, although the base of the feature extended past the excavation limits of 0.60 m.

Feature 63. This feature was determined to have been a tree burn location. The feature was delineated in planview as a broad, but amorphous area of discolored soils. Present within this area were numerous small patches of more strongly reddened (oxidized) soil and masses of charcoal. Linear pockets of loose and/or charcoal flecked soil, apparently representing root channels, were noted throughout. The area of discolored and disturbed soil measured 1.90 x 1.35 m, with a depth between 0.24 and 0.28 m.

Feature 119. This feature consisted of a shallow, saucer-like disturbance. The feature was slightly irregular both in profile and planview. Dimensions were recorded at 0.50 x 0.45 m with a depth of 0.12 m.

Feature 126. Feature 126 was identified in the plowed portion of the site. The feature was highly irregular in outline, with a number of linear disturbances radiating outwards from the central core. The core measured approximately 0.28 x 0.15 m with a depth of 0.29 m. Fill was darker and siltier in texture than the surrounding undisturbed soils.

Feature 314. Feature 314 was not identified in planview. The profile undulated strongly, having variable steeply sloped to gradually tapering side walls. Numerous apparent root channels radiated from and undercut the main body of the feature. As a result, its exact morphology was difficult to ascertain. Plan dimensions were recorded at 0.82 m by undetermined width (excavated width was 8-10 cm). Maximum depth was 0.64 m.

Analysis

The features were analyzed by comparing feature attribute data with the attribute variables presented in the basin formation scenarios and expectations. The attributes were grouped in two categories: basin morphology and basin content. Basin morphology was assessed in terms of known cultural morphologies, known tree related morphologies (tree rot, tree throw), and evidence for postdepositional changes. Basin content was examined relative to artifacts, geochemistry and absolute dating.

Basin Morphology

Cultural Morphology. A total of four basins, Features 4, 67, 202 and 234 exhibited morphologies highly suggestive of a purposeful cultural construction. Feature 4 was the most distinctive. This small basin feature exhibited an essentially cylindrical form. Feature 202, also a small basin, exhibited a very regular, bilaterally symmetrical plan and profile. Profile was bowl-shaped while the planview was almost circular. Feature 67, a medium basin, exhibited a similarly regular and symmetrical form together with a nearly flat (level) bottom. Medium basin Feature 234 also exhibited a very regular, deep bowl-like shape. The remaining features did not exhibit morphologies that could be considered entirely the result of a cultural formation.

Tree Related Morphology. Four of the five known tree mold features consisted of a shallow depression from which numerous linear disturbances were seen to emanate. The sides of these features were irregular and indistinct. The fifth tree mold, Feature 20, exhibited a narrow outline and deep tapering profile consistent with observed pine tree stump/tap root molds.

Two basins, Feature 298 and Feature 116, exhibited strong tree like attributes, based on findings of the Subsurface Tree Morphology Study (i.e., shallow, saucer-like forms and irregular, diffuse sides/edges). Feature 116 exhibited linear disturbances extending outwards from the main body of the basin. In form and dimension, this feature was very similar to the archaeologically documented tree molds. Feature 298 was much larger in area but also had a shallow rounded profile. Its morphology was consistent with the documented tree throw ground disturbances. Feature 120 exhibited a narrow, shaft-like configuration. In form, this basin bears a strong similarity to a conifer (pine) tree stump/tap root mold. In contrast to deciduous trees, which were shown to leave shallow, saucer-like depressions, pines often leave a narrow vertical disturbance extending a considerable distance below grade. This was demonstrated by BX 14 and BX 2. BX 14 showed a deep narrow sub-grade disturbance while BX 2 revealed a very large, vertical taproot in proportion to tree size. As a group, the large basins (Features 2, 77, 90, 118, 169) bear some similarities to observed tree throw morphologies. In planview, the large basin features displayed the oval to crescentic plan configuration documented for the tree throw disturbances (Langhor 1993). However, when comparing the basins to tree throws documented in the present study, the tree throw disturbances were shown to be significantly shallower than the large basin features. The large basins also did not exhibit the diffuse and indistinct edges typically observed in the tree bisections and tree throw disturbances.

Postdepositional Effects. Each of the basin features was reviewed for evidence of postdepositional disturbances such as rodent burrowing, extensive root channeling and similar phenomena. The large basin features did not exhibit signs of disturbance other than minor root channeling and general bioturbation expected of an archaeological entity. Medium basin Feature 3 intersected with an adjacent basin feature and had also been intruded upon by roots and/or rodent tunnels. Feature 116 exhibited a relatively large amount of disturbance in the form of root and/or rodent channels. The banded stratification in Feature 120 is considered consistent with the results of infilling of a narrow disturbance through erosion and internal slumping.

Basin Content

Elevated Artifact Counts. The presence of elevated numbers of artifacts within a basin is seen as key indicator for a cultural association. While the presence of elevated numbers of basin artifacts in relation to adjacent non-feature contexts is not necessarily indicative of a cultural formation, it does suggest that the ground surface disturbance was open during the site occupation. Strongly inflated artifact counts are seen as indicative of the basin having been deliberately utilized for refuse disposal. Decreases in basin artifact densities, in relation to adjacent non-basin contexts, however, are not necessarily seen as a negative indicator for a cultural formation. Rather, this suggested that the basin's formation, whether natural or cultural, predated the bulk of the site occupation. Decreases in relative artifact counts for basin contexts may also be potentially the result of deliberate cultural deposition of artifacts following the basin infilling.

Relative artifact density values (inside versus outside basin context) expressed in artifacts per m^2 were used to address whether the ground surface disturbances may have been utilized for the disposal of refuse. Values expressed in artifacts per m^3 (basin volume) fail to control for potential natural and cultural infilling processes, which can occur both before and after the cultural deposition of artifacts (primary deposit). This can operate to greatly distort relative artifact density values. Specifically, relative artifact densities expressed in m^2 were used to assess whether the artifacts recovered from basin contexts were the result of the interruption of an occupation surface, or whether the physical interruption of the ground surface plane (basin) was culturally utilized.

Calculation of feature and non-feature area densities was a multi-stepped process that employed Geographic Information Systems (GIS) to aid in computing the total area and the corresponding artifact count. The total feature area was calculated by computing the sum of the feature area by test unit. This process was used to produce a more accurate total area and to examine potential differences of artifact density within a single feature. The number of artifacts that were recovered from the feature in each unit was then derived, and this total was divided by the sum of all feature areas, to provide the artifact per m^2 value. To achieve the most comparable results between feature and non-feature contexts, a similar methodology was employed. The majority of features on the site and those within this feature sample were identified at the base of the A-horizon. Therefore, artifacts from the A-horizon within units were not included in the computation for non-feature area artifact density.

To establish non-feature artifact density per unit, the feature area was subtracted from the unit area (usually 1 m). This procedure was conducted for the units that included the feature edges. When available, and to provide a wider control, test units that were adjacent to, but did not contain the feature in question, were included. In areas with overlapping and intersecting features, non-feature areas were comparatively small; this was especially true around Features 77, 169, 234, and 267. Feature 202 was located within the backhoe strip, which was not subjected to controlled excavation and, therefore, had no immediately adjacent non-feature artifacts with which to compare. As a result, the two nearest test units, located about 3 m south and east, were utilized as a comparative control. All of the available non-feature areas were then summed for the total non-feature area considered. The below A-horizon artifacts recovered from these areas were also summed and then divided by the total non-feature area to provide the non-feature artifact density per m^2 value.

The calculated values of artifact density were comparable (Table 10.5). However, some caveats are warranted. In several cases, basins considered in the study were located near or adjacent to evident TAS clusters, for example Features 139 and 169. The non-feature artifact densities around those TAS clusters were likely inflated due to the dispersion of TAS artifacts from the visible boundaries of the TAS features. In addition, the calculated areas in locations with overlapping features contained error, due to the inability to adequately account for areas of overlap; this was especially true of Features 77 and 234.

GIS based plots were generated to illustrate the artifact counts within each feature by unit, as well as the non-feature proveniences in the adjacent units. These figures show total artifact counts and are not displayed in artifact density per square meter, but provide for a means of visual comparison within and between features (Appendix C).

Several basin features clearly contained elevated artifact numbers. Feature 90, a large basin, yielded over 800 artifacts (Figure 10.82). This represented a relative increase by a factor 1.3 against adjacent non-feature contexts. A second large basin, Feature 118, contained 71 unidentified (weathered) ceramic sherds (Figure 10.83). This feature was situated along the site periphery in an area that otherwise yielded very little cultural material. Artifact density within Feature 118 represented an increase by a factor of 3.8.

Feature 120 contained artifact assemblage suggestive of purposeful cultural input (Figure 10.84). Early and Middle Woodland ceramic sherds, debitage and TAS fragments were recovered from a discrete stratum near the top of the feature. This stratum was notably darker and more organic than the lower strata, which were also devoid of cultural material. Also recovered in association with the artifacts was a calcined bone fragment and carbonized nut hulls and wood charcoal. This represented a relative increase by a factor of 2.7 over adjacent non-feature contexts.

Table 10.5 Tabulation of the Feature Areas, Volume and Artifact Densities

Large Basins (B-1)

Feature	Type	Total Artifacts	Feature Volume in Liters (est.)	Feature Artifact Density per 100 Liters	Feature Area in m^2	Feature Artifact Density per m^2	Non-feature Artifact Density per m^2
2	B-1	164	5058.1	3.2	7.41	22.1	27.2
77	B-1	656	5260.3	12.4	4.46	147.0	191.3
90	B-1	899	6158.0	13.7	7.27	123.6	46.6
118	B-1	73	1208.6	6.0	3.13	23.3	6.1
169	B-1	238	2878.1	8.2	5.10	46.6	137.0

Medium Basins (B-2)

Feature	Type	Total Artifacts	Feature Volume in Liters (est.)	Feature Artifact Density per 100 Liters	Feature Area in m^2	Feature Artifact Density per m^2	Non-feature Artifact Density per m^2
3	B-2	10	436.8	2.2	1.09	9.1	4.9
67	B-2	38	235.0	16.1	0.89	42.6	69.0
139	B-2	118	426.6	27.6	0.91	129.6	226.4
234	B-2	117	429.0	27.2	1.79	65.3	23.9
298	B-2	42	274.1	15.3	1.57	26.7	102.6
314	D-2	2	19.1	10.4	N/A	N/A	46.3

Small Basins (B-3)

Feature	Type	Total Artifacts	Feature Volume in Liters (est.)	Feature Artifact Density per 100 Liters	Feature Area in m^2	Feature Artifact Density per m^2	Non-feature Artifact Density per m^2
4	B-3	13	17.1	76.0	0.18	72.2	58.8
116	B-3	0	8.8	0.0	0.14	0.0	3.2
120	B-3	29	246.6	1.7	0.33	87.8	32.8
202	B-3	12	12.9	93.0	0.09	133.3	39.0
267	B-3	2	28.9	6.9	0.08	25.0	57.0

Tree Mold Features (D-2)

Feature	Type	Total Artifacts	Feature Volume in Liters (est.)	Feature Artifact Density per 100 Liters	Feature Area in m^2	Feature Artifact Density per m^2	Non-feature Artifact Density per m^2
20	D-2	0	161.4	0.0	0.18	0.0	1.2
63	D-2	8	260.2	3.0	1.63	4.9	61.5
119	D-2	1	9.9	10.1	0.17	5.8	16.3
126	D-2	0	19.8	0.0	0.03	0.0	1.0
314	D-2	2	19.1	10.4	N/A	N/A	46.3

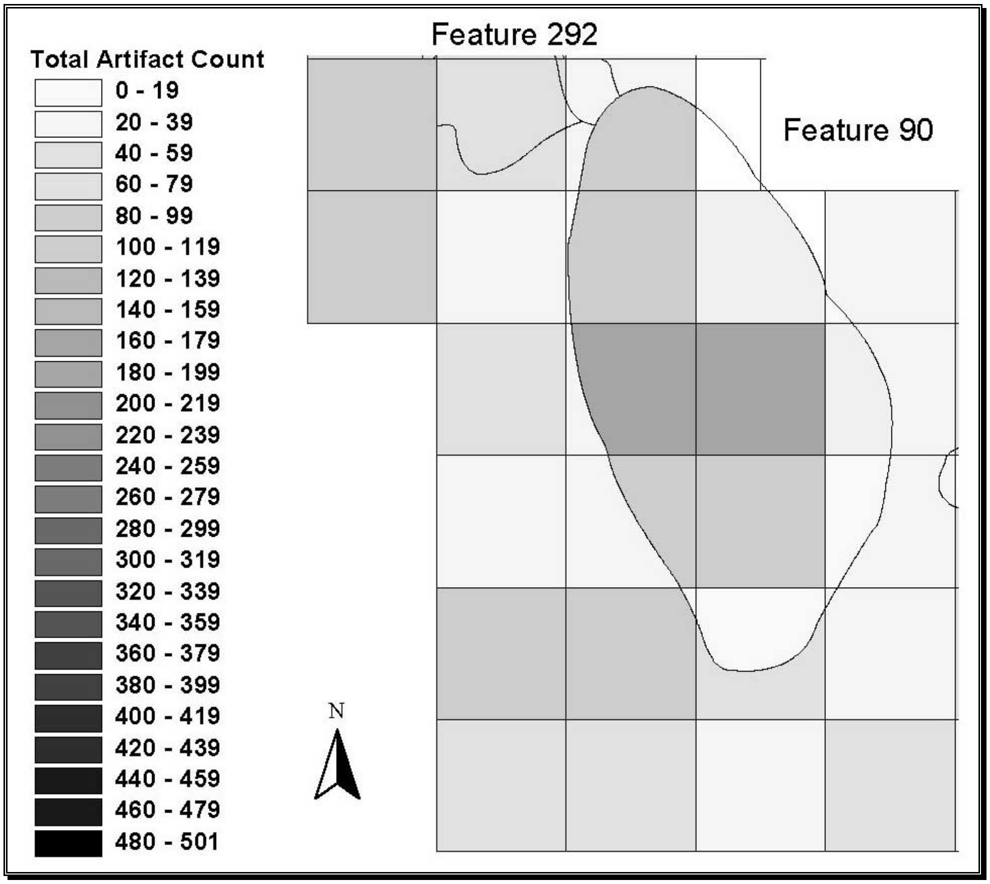

Figure 10.82 GIS Generated Planview with Artifact Content of Feature 90

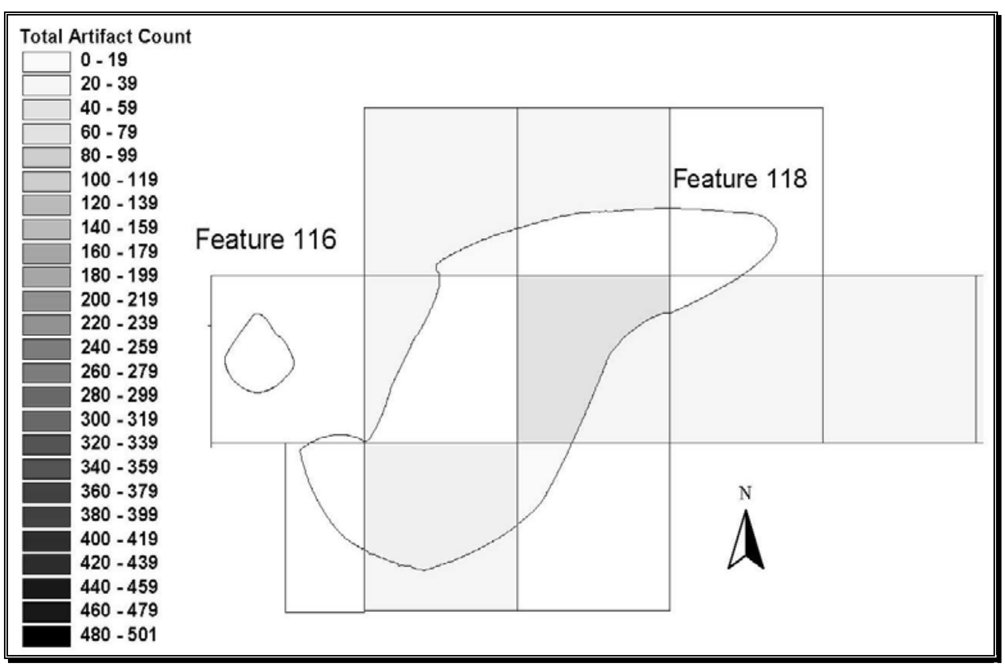

Figure 10.83 GIS Generated Planview with Artifact Content of Feature 118

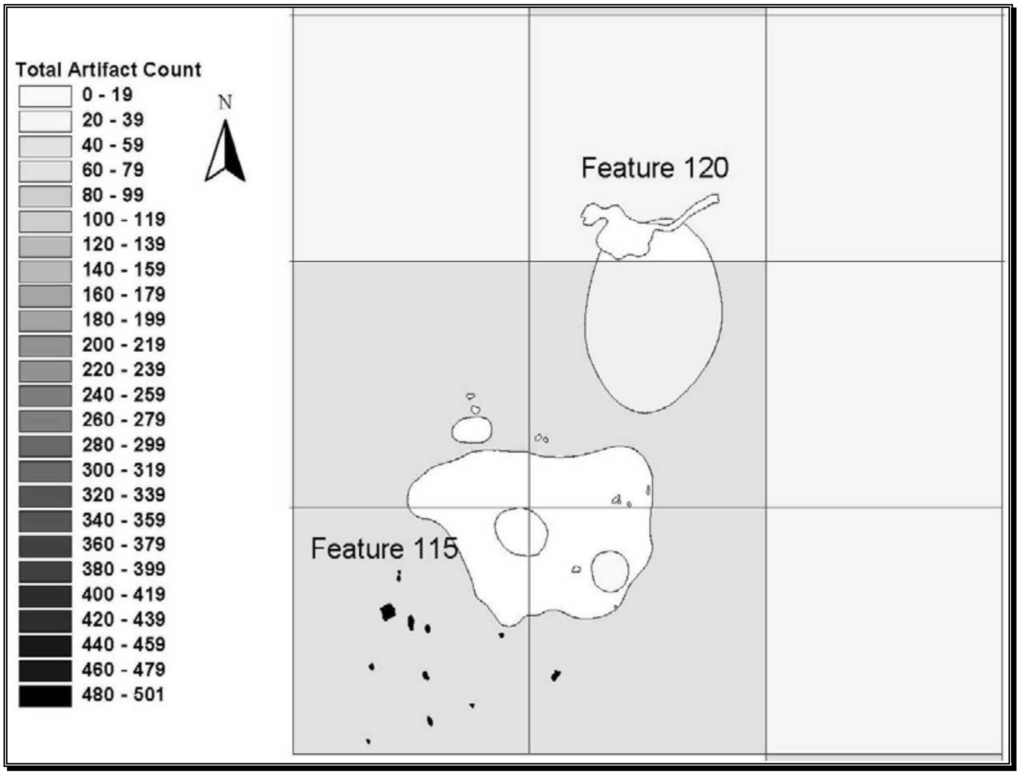

Figure 10.84 GIS Generated Planview with Artifact Content of Feature 120

Medium basin Features 3 and 234 yielded significantly elevated numbers of artifacts (Figure 10.85 and Figure 10.86). Features 139 and 298 exhibited decreased artifact densities compared to surrounding non-feature units (Figure 10.87 and Figure 10.88).

Only two tree mold features, Features 63 and 119, contained sufficient artifacts numbers to allow for statistical comparison against non-disturbance contexts. Both contained decreased levels of cultural materials relative to the surrounding matrix (Figure 10.89 and Figure 10.90).

Small basin Feature 202 also yielded elevated numbers of artifacts (Figure 10.91). In contrast to the above features (except for Feature 120) into which artifacts appear to have been haphazardly discarded, the items in Feature 202 were identified in a configuration that indicated deliberate placement. Evidence of deliberate placement aside, the Feature 202 artifact counts represented an increase by a factor of 3.4 over adjacent non-feature context.

Geochemistry. Geochemical analysis was conducted on four of the five large basin features (Features 2, 77, 90, 169). These large basin features were shown to have particularly high levels of phosphorous (P) viewed to be result of the archaeological presence of P-rich, organic material (Section 9.0). In addition, the elevated P levels recorded in absence of any actual organic matter were seen as suggestive that the material from which the P was derived was associated with the basins original use/formation rather than having been introduced through disturbances such as roots or rodent action. The presence of P in relative combination with other chemical markers suggested that some of the P contributing material may have been bone (Section 9.0). These results suggested that Feature 2, 77, 90 and 169 were open and had accumulated culturally generated organic waste during the site occupation.

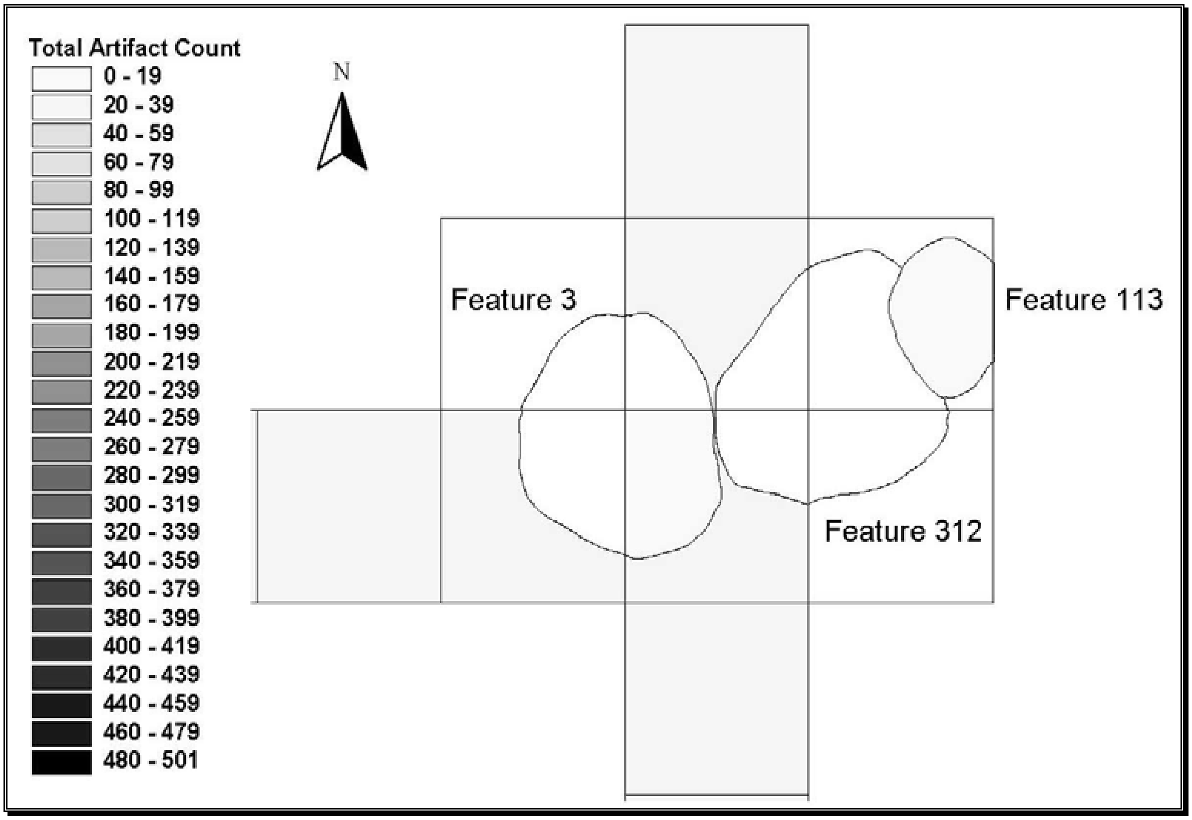

Figure 10.85 GIS Generated Planview with Artifact Content of Feature 3

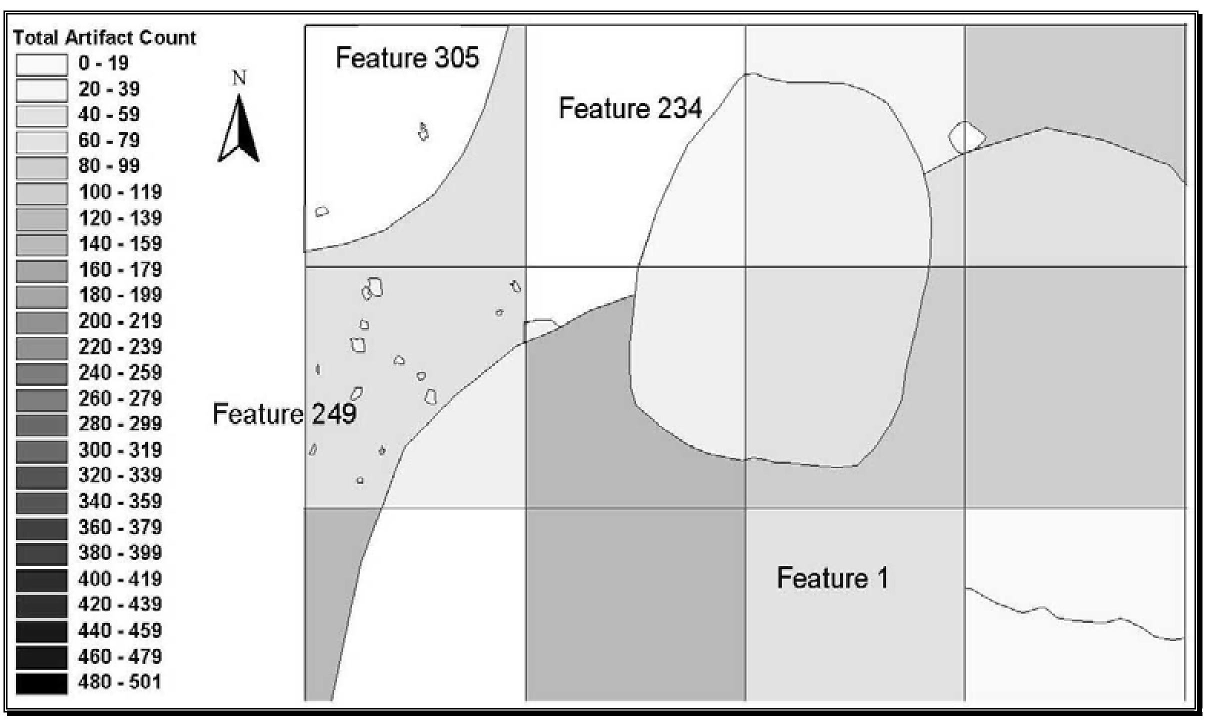

Figure 10.86 GIS Generated Planview with Artifact Content of Feature 234

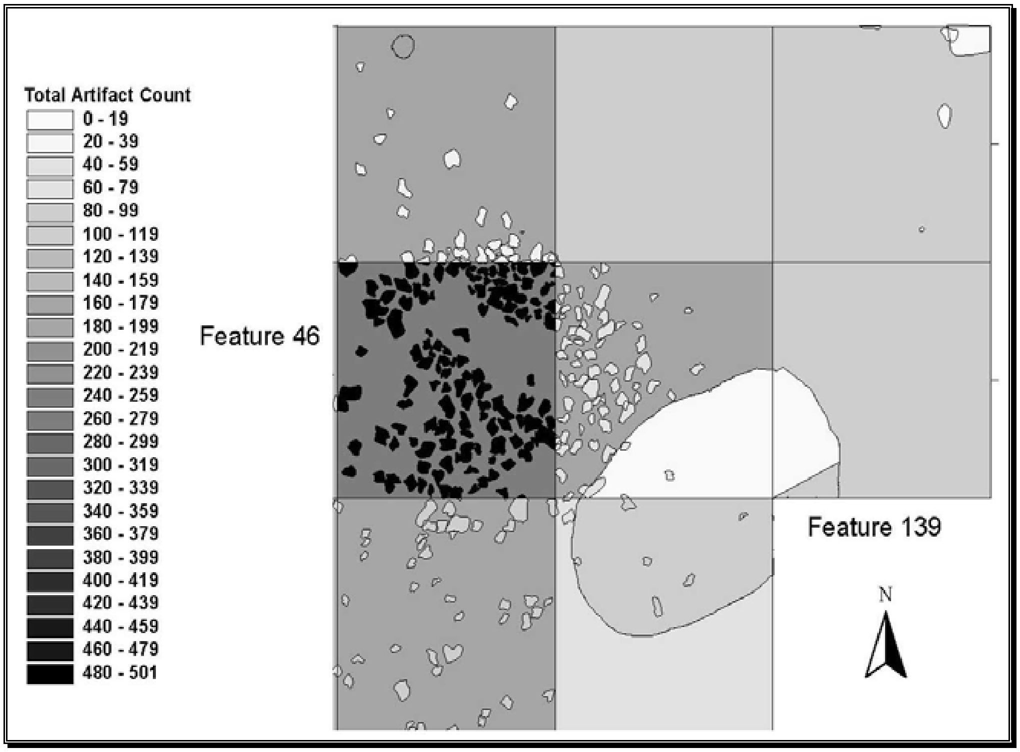

Figure 10.87 GIS Generated Planview with Artifact Content of Feature 139

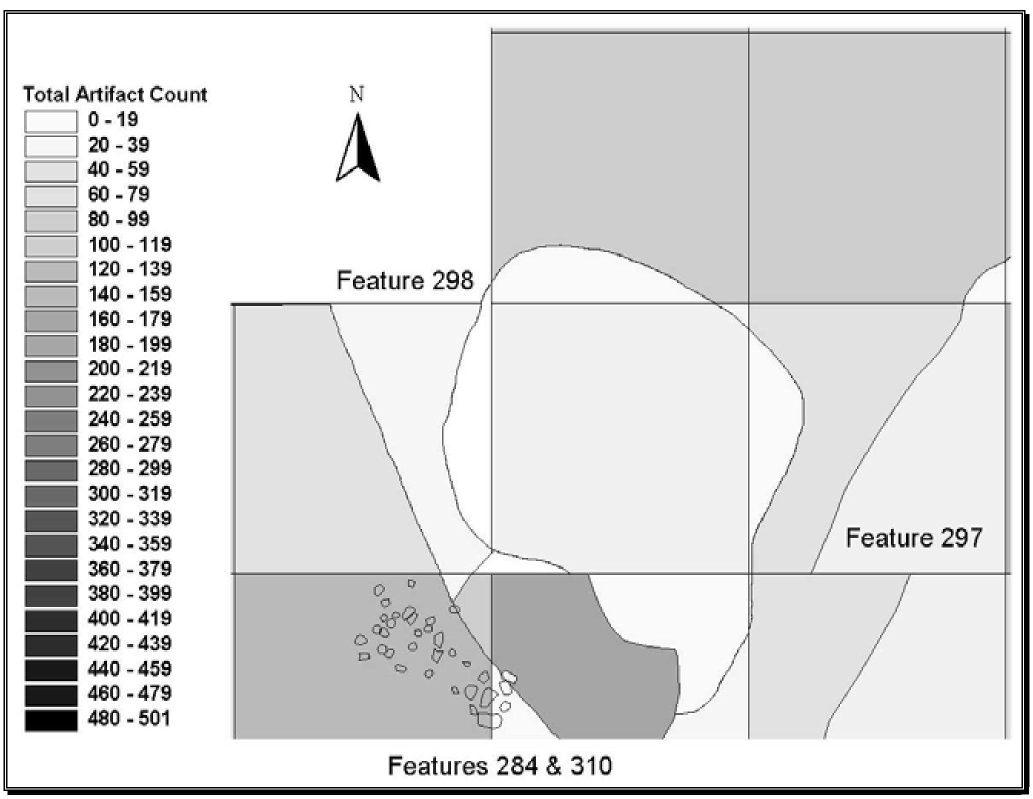

Figure 10.88 GIS Generated Planview with Artifact Content of Feature 298

Figure 10.89 GIS Planview with Artifact Content of Feature 63

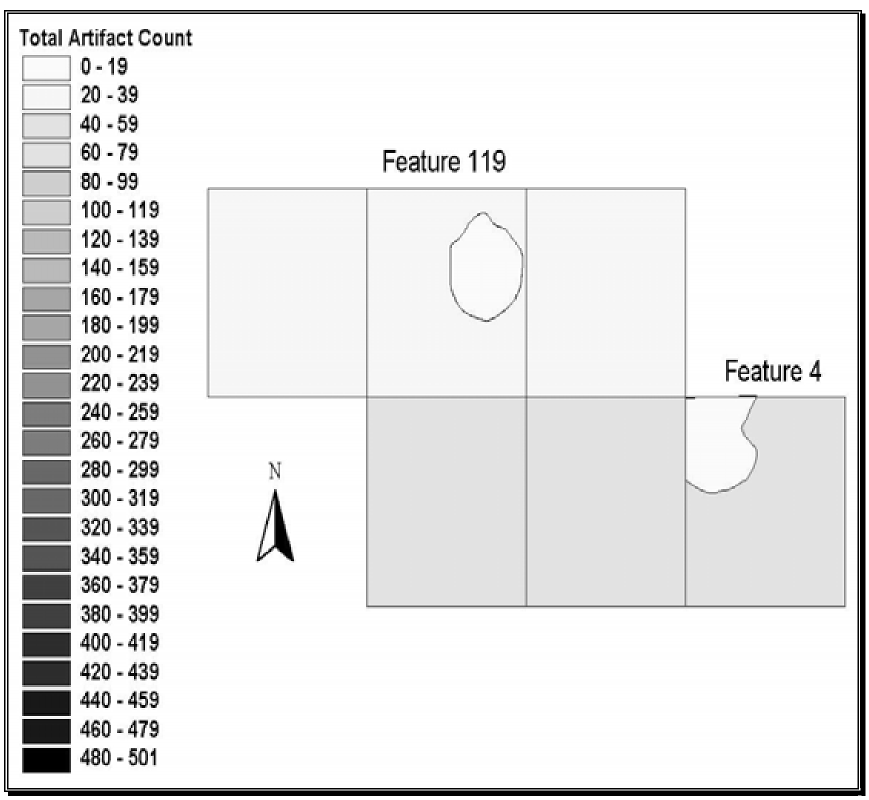

Figure 10.90 GIS Generated Planview with Artifact Content of Feature 119

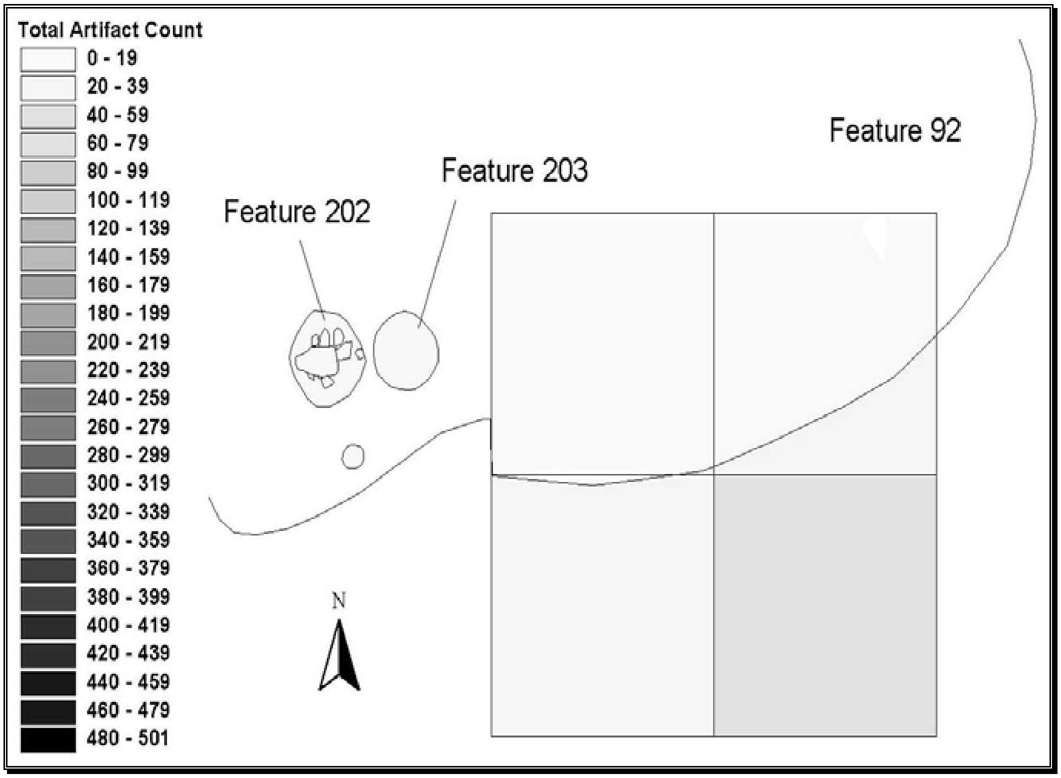

Figure 10.91 GIS Generated Planview with Artifact Content of Feature 202

Component Period Ecofacts (AMS Dating). Of the 15 basins in this feature sample, six were subjected to radiocarbon (AMS) dating. Features 2, 3, 4, 90, and 120 yielded Woodland I period dates coeval with major site occupation components recognized through the recovery of chronologically diagnostic artifact types. Results of the radiocarbon dating are tabulated in Table 10.6.

Summary Results of Basin Feature Analysis

Feature 2 was a large basin. In planview, the basin conformed to documented tree throw morphology. In profile, the feature was considerably deeper than the observed tree throw forms. Analysis of the basin content did not indicate elevated artifact numbers. Geochemical analysis of the fill suggested cultural input. An occupation period radiocarbon date of 2790+/-40 years B.P. was obtained from the feature.

Feature 3 was a medium basin that did not exhibit any clear tree related or cultural morphologies. Elevated numbers of artifacts were present in comparison to immediately adjacent non-basin contexts. No geochemical analysis was performed. The feature yielded two overlapping occupation component period radiocarbon dates of 2600+/-60 years B.P. and 2790+/-60 years B.P.

Table 10.6 Summary of Basin Feature Attributes

Large Basins (B-1)

Morphology				Content			
Feature	**Tree Rot Morphology**	**Tree Throw Morphology**	**Cultural Morphology**	**Post-depositional Disturbance**	**Elevated Artifacts**	**Anthro Geochemistry**	**Radiocarbon Dating**
2	No	Partial	No	Minor	No	Yes	2790+/-40 years B.P.
77	No	Partial	No	Minor	No	Yes	N/A
90	No	Partial	No	Minor	Yes	Yes	4070+/-40 years B.P.
118	No	Partial	No	Minor	Yes	N/A	N/A
169	No	Partial	No	Minor	No	Yes	N/A

Medium Basins (B-2)

Morphology				Content			
Feature	**Tree Rot Morphology**	**Tree Throw Morphology**	**Cultural Morphology**	**Post-depositional Disturbance**	**Elevated Artifacts**	**Anthro Geochemistry**	**Radiocarbon Dating**
3	No	No	No	Yes	Yes	N/A	2600+/-60 years B.P. 2790+/-60 years B.P.
67	No	No	Yes	Minor	Yes	N/A	N/A
139	No	No	No	Minor	No	N/A	N/A
234	No	No	Yes	Minor	Yes	N/A	N/A
298	Partial	Partial	No	Unknown	No	N/A	N/A

Small Basins (B-3)

Morphology				Content			
Feature	**Tree Rot Morphology**	**Tree Throw Morphology**	**Cultural Morphology**	**Post-depositional Disturbance**	**Elevated Artifacts**	**Anthro Geochemistry**	**Radiocarbon Dating**
4	No	No	Yes	Minor	Yes	N/A	1540+/-50 years B.P.
116	Yes	Partial	No	Yes	No	N/A	N/A
120	Yes	No	No	Minor	Yes	N/A	920+/-50 years B.P.
202	No	No	Yes	Minor	Yes	N/A	N/A
267	No	No	No	Minor	No	N/A	N/A

Feature 4 was a small basin. Its cylindrical form is viewed as being cultural in origin. While the feature yielded artifact numbers that were only slightly elevated in numbers relative to adjacent contexts, they were recovered from an apparent primary deposit at the base of the feature. An occupation component period radiocarbon date of 1540+/-50 years B.P. was obtained from wood charcoal recovered from the fill.

Feature 67, a medium basin, exhibited an apparent cultural morphology that included regular shaped sides and a flat bottom. The basin was shown to have decreased numbers of artifacts over adjacent non-feature contexts. Other than the basin morphology, no other data were available.

Feature 77 was a large basin. In planview the feature exhibited the oval to crescentic form documented for tree throw morphologies. In profile, however, the feature had a considerably greater depth than the observed tree throws. The fill did not contain elevated numbers of artifacts. Geochemical analysis revealed elevated levels of phosphorous, which is viewed as evidence for cultural input.

Feature 90 exhibited the same partial tree throw morphology as the other large basins in the feature lot. Planview was oval to oblong, with a deep, asymmetrical profile. Feature 90 contained elevated artifact numbers and geochemical signatures indicative of a cultural input. It appears that the basin was naturally formed, and cultural material was subsequently introduced.

Feature 116 exhibited tree mold morphology. It was shallow with irregular sides. Several linear disturbances were noted extending from the central core. However, it remains undetermined if the basin was purely a tree mold, or if multiple formation processes were represented. No artifacts were recovered from the feature fill.

Feature 118 was a large basin with partial tree throw morphology. The feature fill yielded elevated artifact numbers indicating that, as a ground surface disturbance, the feature was extant during site occupation. The basin appears to have captured cultural material after its formation. No geochemical or AMS data was available for the basin.

Feature 120 had a morphology that was consistent with a pine tree stump/tap root mold. The lower two-thirds of the feature fill were devoid of artifacts. The interbedding of sandy, culturally sterile soils within the lower portion of Feature 120 suggests internal slumping of soils within a deep narrow disturbance. The feature contained elevated artifact numbers in relation to immediately adjacent non-feature contexts. Elevated numbers of artifacts and other cultural material were recovered from discrete strata within the upper portion of the fill. An occupation component period date of 920+/-50 years B.P. was obtained from the upper portion of the feature. Overall, the morphological and content attributes of Feature 120 suggested a formation consisting of a tree stump/taproot void that captured cultural material.

Feature 139 did not exhibit clear tree related or cultural morphologies. Analysis demonstrated that the feature contained relatively fewer artifacts than surrounding area. Fill was atypical for basin features in that it was sandier and lighter in color than the undisturbed matrix soil.

Feature 169 exhibited the partial tree throw morphology common to the large basins in this feature sample. Relative counts inside the feature were lower than adjacent non-feature contexts. Results of geochemical analysis were suggestive of a cultural input.

Feature 202 was a small basin that had a regular, symmetrical morphology viewed as being cultural in origin. The basin also contained artifacts in a configuration that was clearly indicative of deliberate placement. The basin feature represented a deliberate excavation in which artifacts were interred. Statistical analysis also showed the presence of elevated artifact numbers.

Feature 234 was a medium basin that appeared to have a cultural morphology. This was seen in its well-defined edges, steep side walls and bluntly rounded bottom, which gave the basin a bilaterally symmetrical form. The feature contained elevated artifact numbers in comparison to the surrounding non-feature soil matrix.

Feature 267 was a small basin that also exhibited a bilaterally symmetrical form. The steep, well-defined sides and bluntly rounded bottom are viewed as evidence of a cultural formation. The two TAS fragments and two carbonized nut hulls recovered from the feature may also be suggestive of cultural activity.

Feature 298 was a medium basin exhibiting tree-related morphology. This was expressed in its irregular, shallow saucer-like configuration and indistinct sides. Its shape and dimensions are consistent with observed modern tree throw disturbances. Relative artifact counts were less than adjacent non-feature contexts.

HISTORICAL INFLUENCES ON HICKORY BLUFF FEATURES

From 1905 to 1995, the eastern portion of Hickory Bluff was an apple orchard (Appendix A). Initial field preparation, planting of the orchard, operation and maintenance, and eventual abandonment, neglect and destruction contributed to the postdepositional processes acting on this portion of the site. Remnant tree molds or tree throws resulting from the abandonment and destruction of the apple orchard may have contributed to discontinuities observed in the two linear backhoe stripped areas of Hickory Bluff.

The Apple Orchard

Rectangular and hexagonal orchard planting configurations were both common planting strategies available to early twentieth century farmers. Trees planted in a square or rectangular pattern at a 30-foot spacing could accommodate up to 48 trees to the acre. Hexagonal planting could incorporate up to 15 percent more trees per acre (up to 55 trees) than the rectangular system (Paddock and Whipple 1913:42; Figure 10.92). The square or rectangular method of planting was apparently the most satisfactory method of planting an orchard (Paddock and Whipple 1913:42). The hexagonal method did not have wide middle areas and could not accommodate large, modern, orchard machinery (Paddock and Whipple 1913:42). To get a maximum of 55 trees to an acre, and still use the square or rectangular system, journals suggested a distance of 26 feet between trees and 30 feet between rows, although some journals recommended a spacing as wide as 50 feet for apple trees (Paddock and Whipple 1913:46).

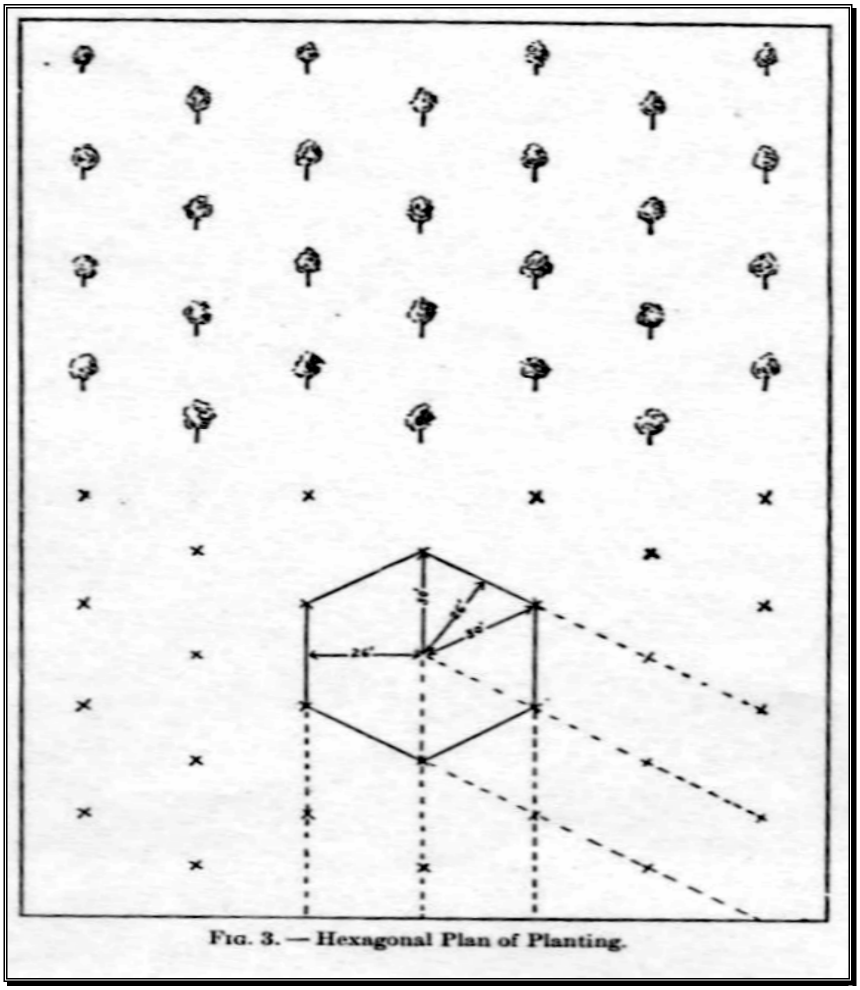

Figure 10.92 Schematic of the Hexagonal Tree Planting Pattern for an Orchard, circa 1913 (Paddock and Whipple 1913:42**)**

A 1926 Army Air Corp aerial photograph for the Hickory Bluff vicinity indicated that only the eastern portion was contained within a fruit orchard, which extended halfway between the St. Jones River and Route 113 (Figure 10.93). A rectangular planting scheme was utilized at that time. Based on the aerial photograph, the average spacing between the trees was approximately 10 m (30 feet).

A 1937 DelDOT aerial photograph for the site indicated the eastern portion of the site still was contained within the orchard, which extended the most of the length of the tract from near the St. Jones River to Route 113 (Figure 10.94). The patterning of the trees shows both rectangular and hexagonal planting strategies on the parcel. The average spacing between the trees remained at approximately 10 m (30 feet).

Backhoe Features

Two areas of Hickory Bluff were mechanically stripped: the area for a proposed drainage ditch (Liebeknecht et al. 1997) in the southern portion of the site and a 6 x 120 m linear area within the northern portion of the site. Sixty-three features were identified in the plowed field/

orchard portion of the proposed drainage ditch and consisted of both large (n=30) and smaller basins (n=33). Depths, as determined by soil probes, varied from 15 cm to 90 cm. Fifty-four features were identified in the north backhoe strip area; 19 features occurred in the plowed field/ orchard portion (Table 10.7).

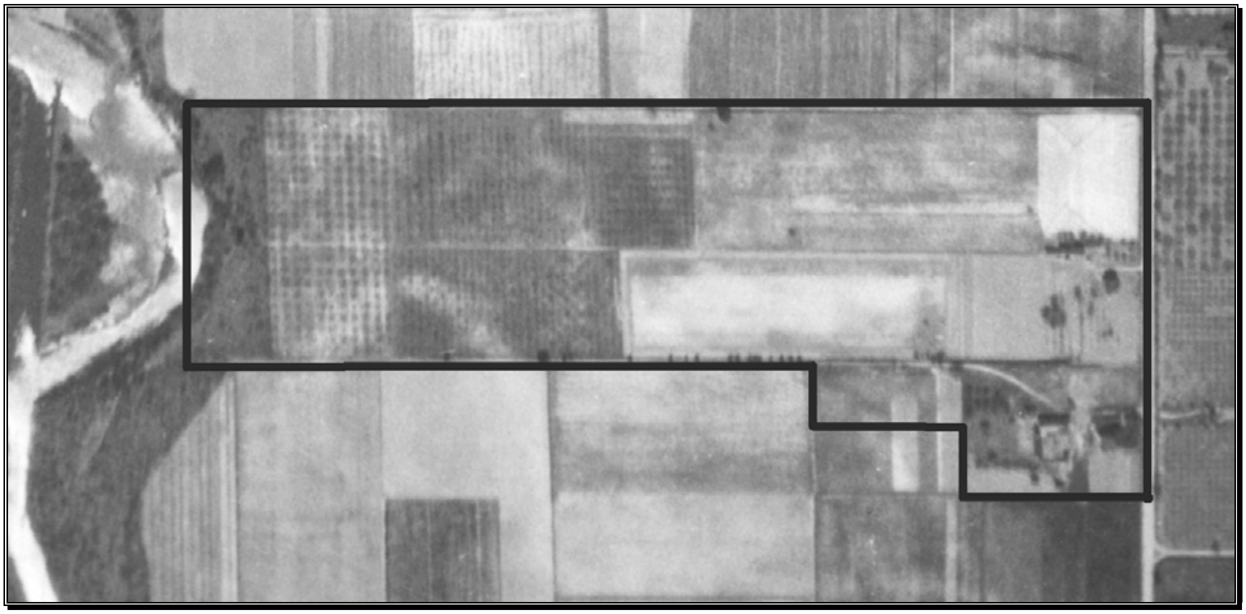

Figure 10.93 1926 Army Air Corp Aerial Photograph Depicting the Apple Orchard at Hickory Bluff

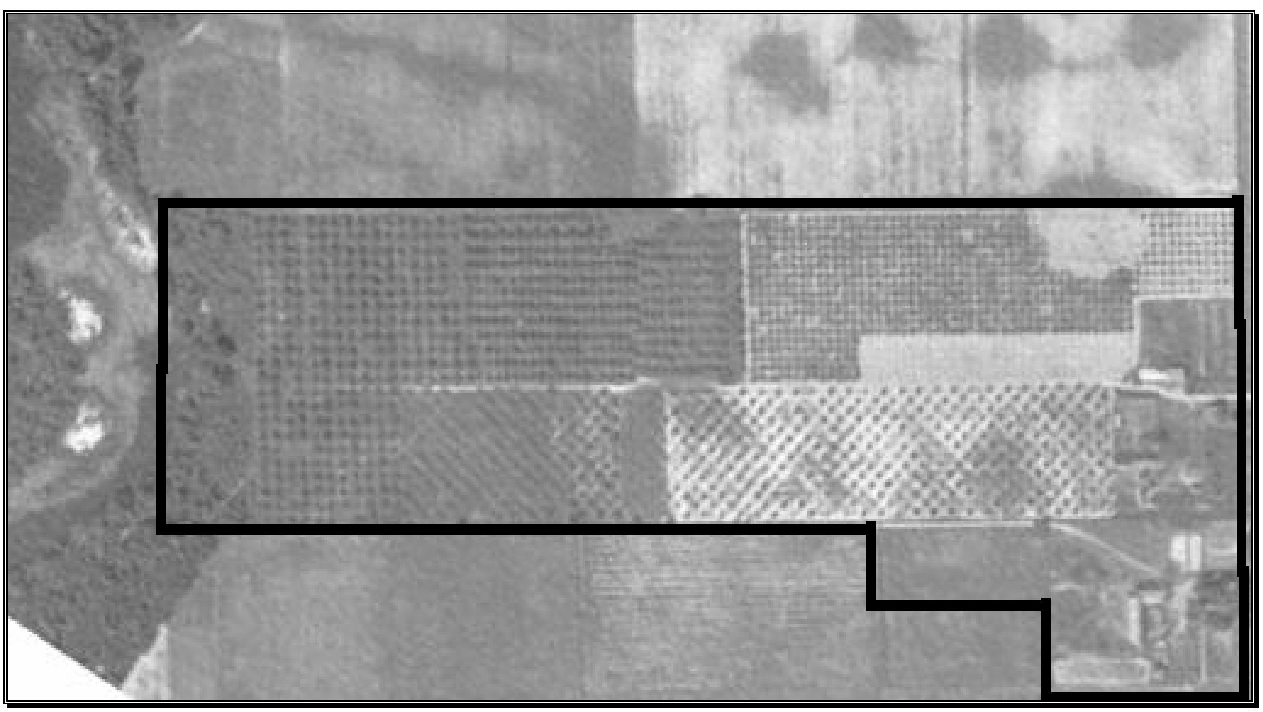

Figure 10.94 1937 DelDOT Aerial Photograph Illustrating Expansion of the Apple Orchard at Hickory Bluff

Table 10.7 Hickory Bluff Features Located in the Plowed Area of the North Backhoe Strip

Feature Type	**A**	**B**	**C**	**D**	**E**	**F**
Feature Number	229, 240, 246	243, 253, 266, 269	none	218, 220	none	223, 237, 238, 239, 241, 242, 245, 247, 248, 256

The orchard grid pattern was derived from the aerial photographs, scaled, and superimposed on the feature locations in the plowed portion of Hickory Bluff (Figure 10.95). Although feature patterning in the south backhoe strip was linear, few features intersected with the superimposed orchard grid. Because of the narrowness of the north backhoe strip (only 6 m or about 18 feet), feature correspondence with the orchard grid was problematic. Even though evidence of tree molds and tree throws from the abandonment and destruction of the historical apple orchard would be expected, few of the features identified through mechanical removal of the plow zone corresponded with orchard tree locations.

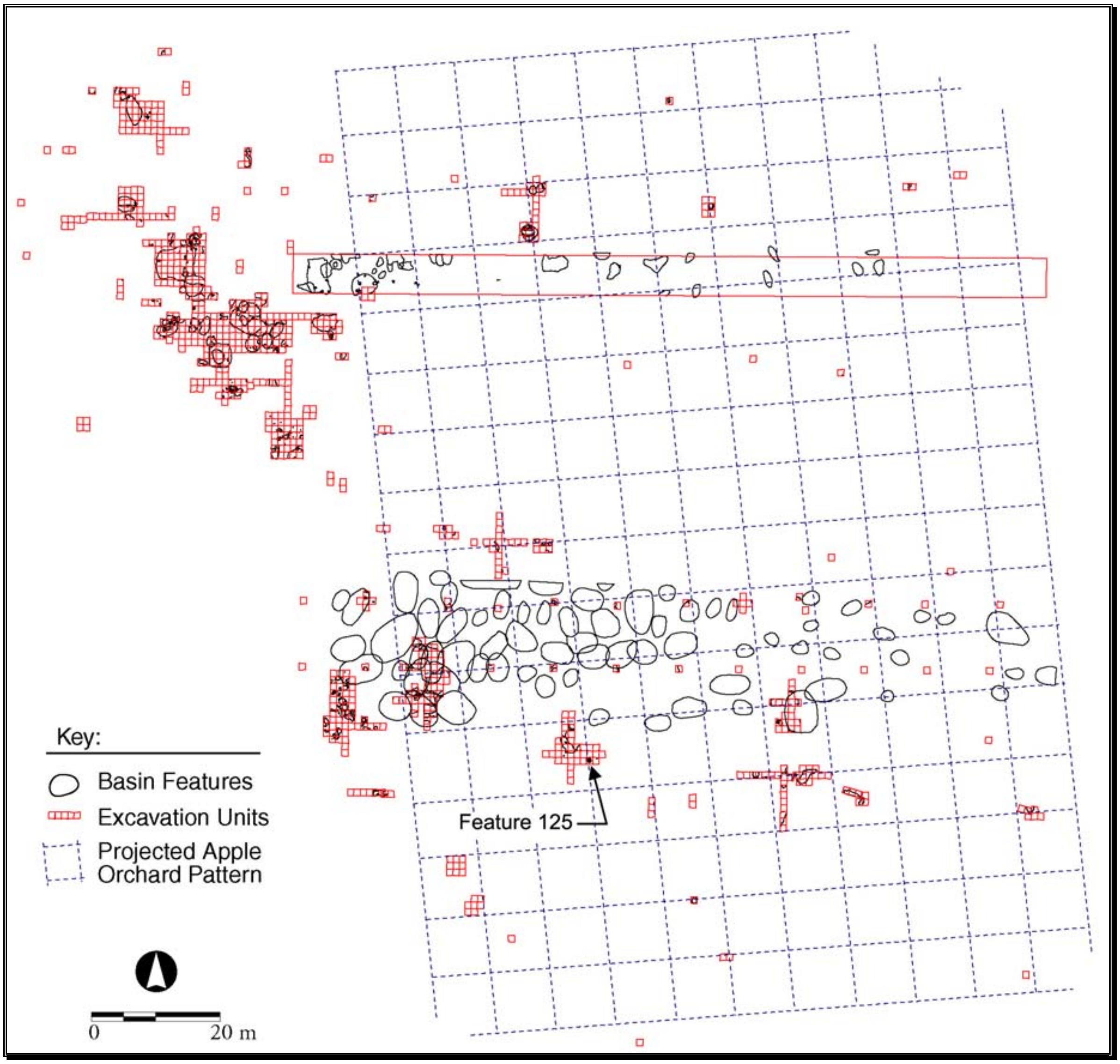

Figure 10.95 Orchard Grid Overlay on Hickory Bluff Basin Features