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The Green Valley Site Complex:

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by:

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INTRODUCTION

This paper describes a series of sites from the Delaware Fall Line Zone that was excavated between 1976 and 1977 by various crews under the direction of the Bureau of Archaeology and Historic Preservation. A wide variety of artifacts was recovered and the sites represent an important portion of the archaeological record for northern New Castle County, Delaware. Because no report on the excavations was ever issued, the senior author chose the artifacts from the sites for analysis in a series of classes in the Department of Anthropology, University of Delaware. This paper reports the results of the analyses.

First, the environmental setting of the sites will be described. Second, the methods of analysis will be described. Third, the artifacts and their spatial distributions will be discussed. Finally, the activities at the sites will be compared and discussed in a regional perspective.

ENVIRONMENTAL SETTING

The Green Valley Site Complex consists of four sites located at the confluence of the White Clay Creek and Pike Creek (Figure 1). The sites have been destroyed by construction of the Green Valley townhouse complex. In this area of New Castle County the White Clay Creek parallels the Fall Line Zone which is an area of transition between the Piedmont Uplands to the north and the Coastal Plain to the south. In Figure 1 the Fall Line transition zone is located in the vicinity of Kirkwood Highway.

The Fall Line Zone represents an especially rich environmental setting. A wide variety of environments can be found within a short distance of the Fall Line including the primarily wooded upland areas of the Piedmont and the more open woodland, grasslands, and swampy areas of the Coastal Plain. The primary determinants of this environmental diversity are edaphic factors, such as slope, soils, and aspect (Odum 1971), which vary through the physiographic zones. These edaphic factors have remained relatively constant through the last 10,000 years since the end of the Pleistocene. Therefore, the modern environmental diversity of the area can be projected into the past through the whole span of human habitation of the area.

Paleoclimatic change throughout the Holocene complicates the pattern of diversity through time. Although the edaphic factors remain constant through time, the degree of diversity varies with changes in plant and animal communities. Recent research on the available paleoenvironmental data (Custer 1981:68-129) indicates that a series of environmental episodes can be identified for northern New Castle County. These episodes are listed below with their effects on Fall Line Zone diversity.

Late Glacial (12,000 BC-8080 BC) - Boreal forests dominate the Piedmont Uplands and a mosaic of grasslands, deciduous forests and coniferous forests is found in the Coastal Plain. The White Clay Creek area near the sites probably supported a mixed hydrophytic setting. The environmental diversity is very high.

Pre-Boreal/Boreal (8080 BC-6540 BC) - During this episode boreal forests dominate most of the Piedmont and Coastal Plain. Although the White Clay Creek would continue to support a mixed hydrophytic association, the dominant boreal vegetation would reduce the local environmental diversity.

Atlantic (6540 BC-3110 BC) - The beginning of the Atlantic episode coincides with the appearance of full Holocene environments. Both the Piedmont Uplands and the Coastal Plain are dominated by mesic forests of oak and hemlock. Variety in the environments would continue to be low; however, emerging seasonality would add some environmental diversity to the area.

Sub-Boreal (3110 BC-810 BC) - This episode coincides with the mid-postglacial xerothermic period of maximum warm and dry conditions. The Piedmont Uplands would be dominated by xeric forests of oak and hickory while the Coastal Plain would be dominated by open woodlands and grasslands. The variety of the area would be at its highest. Also, in the face of pronounced dry conditions, the permanent water sources of the White Clay would make the area even more attractive.

Sub-Atlantic (810 BC-Present) - Modern conditions appear in the local area during the Sub-Atlantic and the variety of environments is higher than during the Pre-Boreal/Boreal episode, but lower than during the Sub-Boreal.

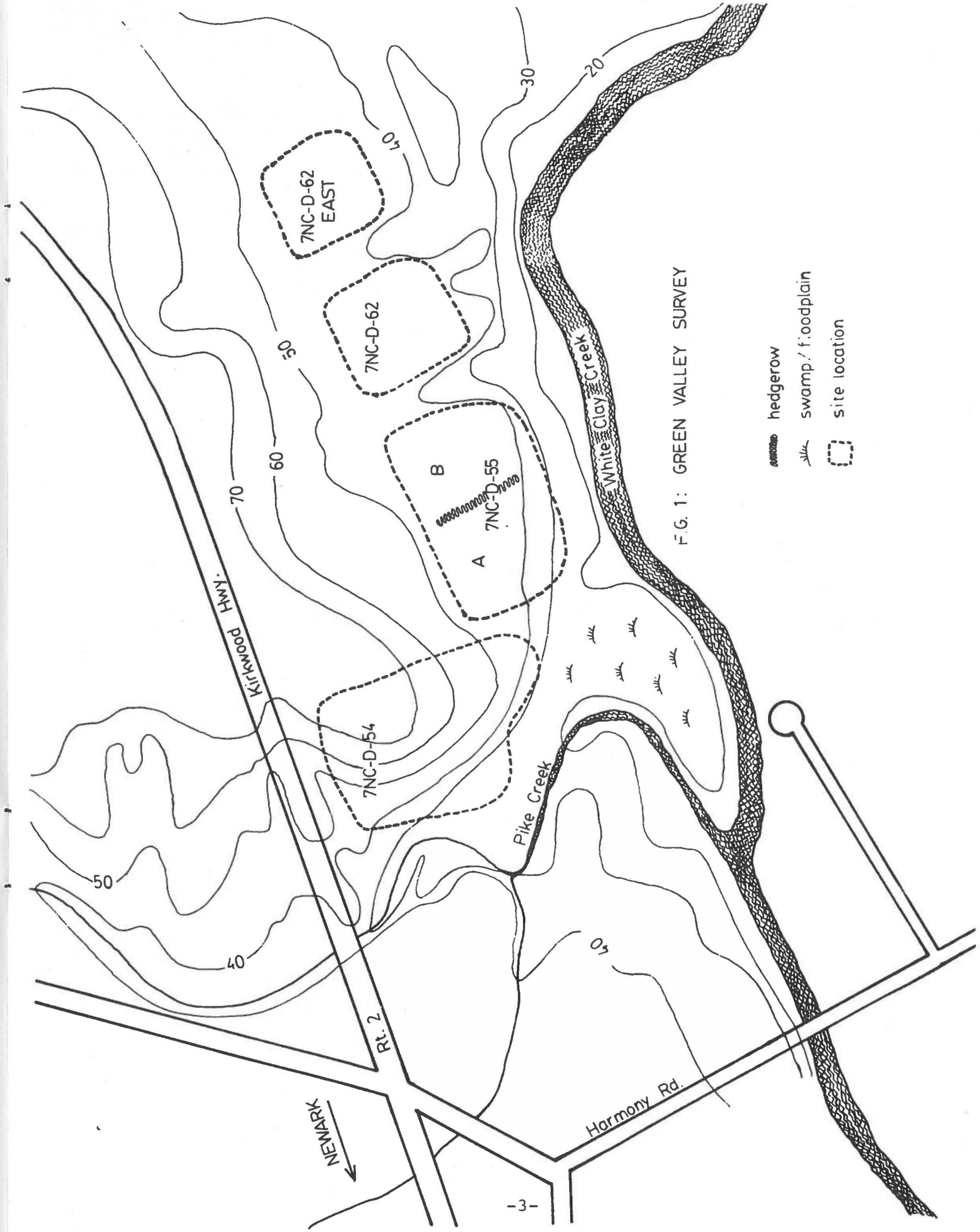


FIG. 1: GREEN VALLEY SURVEY

From the above descriptions it can be seen that the Fall Line zone would be most attractive, with respect to biotic resources, during the Late Glacial, Sub-Boreal, and Sub-Atlantic episodes. These episodes correspond to the Paleo-Indian, Late Archaic, and Woodland Periods.

An additional special resource of the Fall Line Zone is the wide array of secondary lithic resources (Custer and Galasso 1980: 3-6) found in the area. Secondary lithic resources are lithic resources which have been transported by natural agents from their place of formation. Spoljaric (1967, Spoljaric and Woodruf 1970) notes many of these secondary cobble deposits in the vicinity of the Green Valley sites. In sum, the Fall Line Zone represents an attractive setting in terms of biotic resources, water resources, and lithic resources. The attractiveness of the area would be highest during Paleo-Indian, Late Archaic, and Woodland times.

RESEARCH METHODS

The field research at the Green Valley sites generally consisted of both controlled surface collections by ten meter squares and systematic excavation of two meter test units. Profiles from the sites indicate that all excavated materials were from the plow zone. Below the plow zone sterile clays were encountered. Figure 2 shows a representative profile from the sites. No sub-surface features were discovered. Laboratory analysis of the materials focused on the identification of activity areas based on the distributions of different classes of artifacts on the surface and in the plow zone. Initial cataloging of artifacts was organized by provenience units. The artifact categories noted were projectile points, bifaces, flake tools, unutilized flakes, fire-cracked rocks, and ceramics. Raw materials were noted for lithic artifacts and included quartz, quartzite, jasper, chert, chalcedony, ironstone, rhyolite, and argillite. Presence or absence of cortex on lithic artifacts was noted in order to discern between lithic artifacts manufactured from secondary materials available at the site and lithic artifacts manufactured from primary materials carried into the site from elsewhere. For points and bifaces a number of attributes were recorded including length/width and widith/thickness ratios, presence or absence of "humps,"* and degree of resharpening. These attributes were chosen to reflect the manufacturing stages of the finished artifacts and were based on the work of Callahan (1979). Attributes recorded for flakes included the type of flake (complete, medial, or distal) and presence of cortex and resharpening. Finally, among the cryptocrystalline materials evidence of burning such as potlids, cracking, and reddening, was recorded.

*Humps are defined as irregular protrusions on the faces of points or bifaces that are surrounded by series of step or hinge fractures (Binford 1963).

Figure 2: Representative Profile - Green Valley Sites

Ap - Modern Plow Zone

B2 - Clayey sand, very red

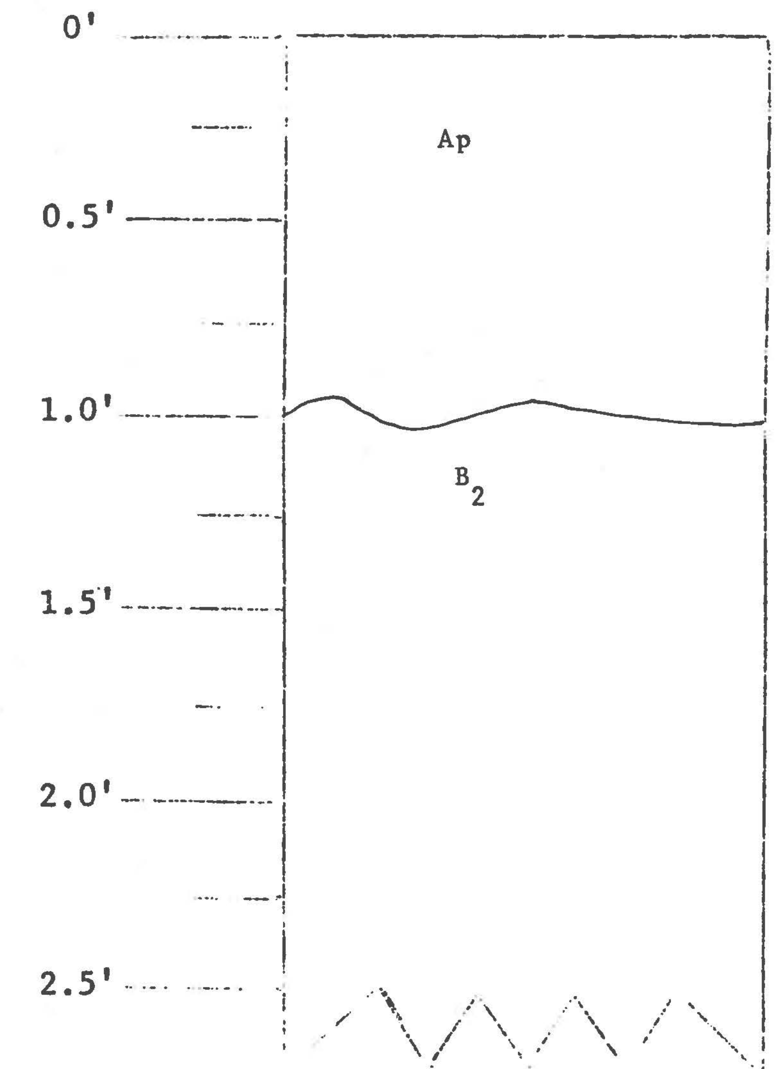


FIGURE 3: 7NC-D-54 DIAGNOSTIC ARTIFACTS

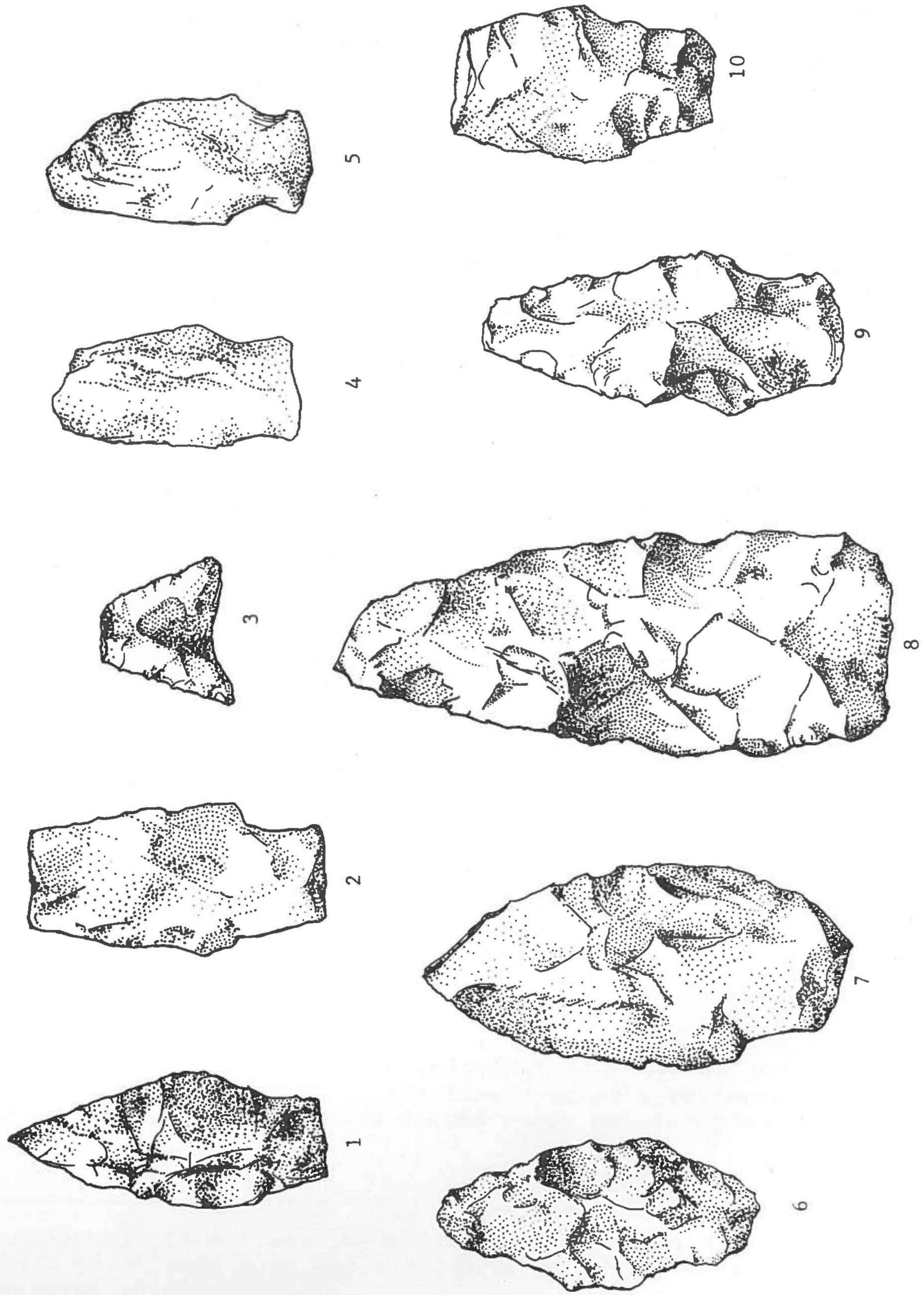


Figure 3: 7NC-D-54 - Diagnostic Artifacts - Key

1 - Late Archaic stemmed point, jasper, heavily resharpened

2 - Late Archaic stemmed point, quartzite, broken reject

3 - Late Woodland triangular, chert

4 - Late Archaic stemmed point, quartz, heavily resharpened

5 - Late Archaic notched point, quartz, heavily resharpened

6 - Late stage biface, jasper, very large hump

7 - Biface rejected as primary thinning began, jasper

8 - Late stage biface, jasper, heavily resharpened with hump

9 - Late Archaic stemmed point, jasper, heavily resharpened reject with impact fracture on tip with wear and side fracture with nibbling wear

10 - Late Archaic stemmed point, jasper, broken reject

After cataloging was finished, the distribution of the different artifact classes, raw materials, and special attributes were entered into the computer by provenience unit. The SYMAP computer program package (Dougenik and Sheehan 1975) was then used to produce maps of the distribution of the various artifact classes. These maps and tabulations of the various artifact classes and raw materials comprise the bulk of the analysis presented below.

SITE DATA

The data recorded and tabulated for each site is presented below. Specific field research techniques for each site are also described.

7NC-D-54

Heavy vegetation cover at 7NC-D-54 prevented the use of controlled surface collection techniques and only an uncontrolled general collection was available for the surface materials. However, sub-surface testing was carried out and 42 two meter test units were excavated. Figure 3 shows the diagnostic artifacts and bifaces from the site. A variety of stemmed and shallow side-notched points (Figure 3: #1,2,4,5,9,10) are similar to assemblages from nearby Delaware Park Site (7NC-E-41) which were radio-carbon dated to ca 1850 BC-AD 600 (Thomas 1981:IX-136-IX-142). Similar assemblages from other sites in the Middle Atlantic area (Kinsey 1959, 1972: 343-369; Ritchie 1961; Stephenson 1963:177-185; Wright 173) also support a Late Archaic through Middle Woodland date for these artifacts. A Late Woodland triangular projectile point (Figure 3:#3) shows an additional component at the site. Table 1 shows a cross-tabulation of artifact types and raw materials. Examination of portions of Table 1 shows patterns in tool production at 7NC-D-54. Tables 2 and 3 show the distribution of artifacts with and without cortex by raw materials.

Tables 2 and 3 show interesting patterns of raw material usage. A high percentage of quartzite artifacts with cortex is associated with a high percentage of early stage biface rejects also made from quartzite. This pattern is indicative of initial tool production from local secondary quartzite materials. The early stage rejects represent bifaces broken in manufacture. Table 2 and 3 show a different pattern of association for quartz and jasper. In these cases there is a fairly equal percentage of early and late stage tools as well as high percentages of non-cortex flakes. Low cortex percentages in these raw materials indicate use of primary lithic sources rather than locally available secondary materials. The presence of late points and bifaces indicates culling of tool kits (Binford 1978) and discarding of exhausted tools. These discarded tools are ultimately replaced by tools manufactured from the secondary quartzite locally available at the site. The early stage quartz and jasper points and bifaces probably represent processes similar

Table 1: 7NC-D-54 - Total Artifacts

Artifact Type	Quartz	Quartzite	Jasper	Burned Jasper	Chert	Other	TOTAL
Flakes with cortex	164	105	74	5	16	2	366
Flakes without cortex	446	25	278	90	14	8	861
Cores without cortex	0	0	6	1	0	0	7
Flake tools with cortex	0	0	0	0	1	0	1
Flake tools without cortex	5	0	5	0	0	0	10
Gravers without cortex	0	0	1	0	0	0	1
Bifaces, exhausted rejects without cortex	2	0	3	0	0	0	5
Bifaces, early stage rejects without cortex	7	1	4	0	0	0	12
Points, exhausted rejects without cortex	8	1	3	0	2	2	16
Points, early stage rejects without cortex	4	2	2	1	0	0	9
TOTAL	636	134	376	97	33	12	1288
Percentage	49%	10%	29%	8%	3%	1%	

Table 2: 7NC-D-54 - Cortex and Non-Cortex by Raw Material

	Quartz	Quartzite	Jasper	Chert	Other
Cortex	26%	78%	17%	51%	17%
Non-Cortex	72%	22%	83%	49%	83%

Table 3: 7NC-D-54 - Early and Late Stage Tools by Raw Material

	Quartz	Quartzite	Jasper	Chert	Other
Early Stage	52%	75%	46%	0%	0%
Late Stage	48%	25%	54%	100%	100%

to those for quartzite. Of the eight jasper bifaces and points that seem to be manufacturing rejects, seven have humps on one or both faces. It is suggested here that these tools were probably manufactured from cobble materials available at the site. No cortex is observed because flaking has removed it and the humps surrounded by step and hinge fractures indicate difficulties encountered while reducing width/thickness ratios of the artifacts. Callahan (1979) has documented these difficulties in experimental studies and Moeller (1980) has recognized similar difficulties in tools from the archaeological record. In these bifaces from 7NC-D-54, the attempts to reduce width/thickness ratios were carried fairly far along and, when ultimately unsuccessful, the biface or point was rejected. Quartz early stage bifaces show a similar pattern. In the category of "other" lithic materials high percentages of late reduction stage tools and artifacts without cortex are noted. These tools represent artifacts brought into the site, used, resharpened, and ultimately culled and discarded from the tool kits.

SYMAP data show that different tool production activities and culling of artifacts from tool kits were not generally carried out in any special locations of the site. Special spatial loci would be indicated by different locations of concentrations of either raw materials or artifacts with cortex. Figure 4 shows the location of all artifact concentrations as indicated by the maps produced by the SYMAP computer program. Table 4 shows the different artifacts and raw materials found in each concentration.

Table 4: 7NC-D-54 - Concentration Attributes

Concentration	Quartz	Quartzite	Jasper	Burned Jasper	Cortex	Tools	Fire-Cracked Rock
I	+	0	0	+	0	0	+
II	+	0	0	0	0	+	0
III	+	+	+	+	+	+	0

+ = present
0 = absent

Based on the presence and absence of raw materials and tool types as well as the burned jasper and fire-crakced rocks, activities

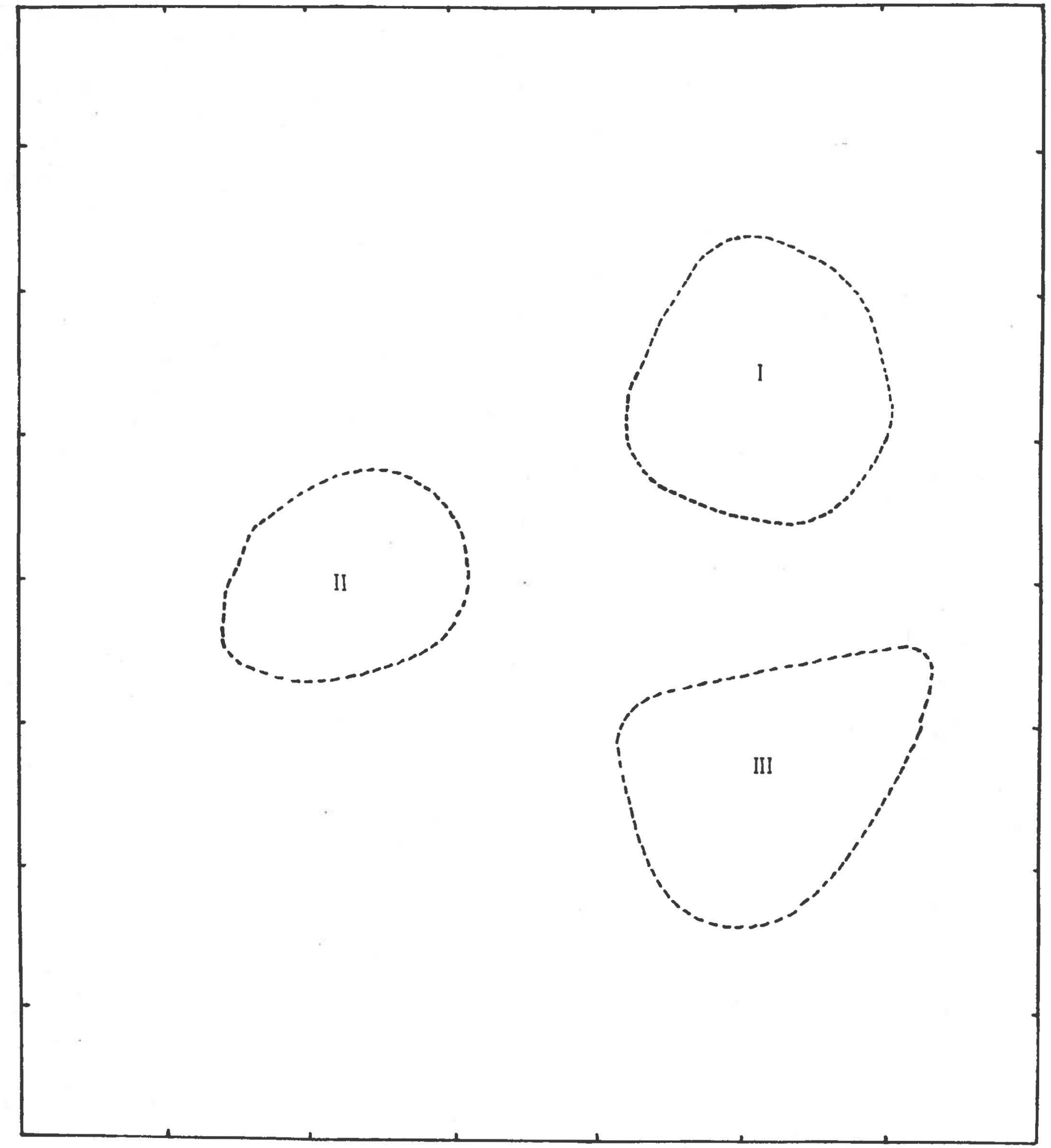


FIGURE 4: 7NC-D-54 ARTIFACT CONCENTRATIONS

can be hypothesized for the concentration areas. Concentration I with its fire-cracked rock and burned jaspers probably represents a living area with associated hearths. The presence of quartz artifacts without cortex could indicate that late stage reduction of tools, or resharpening of tools also took place in the area. Concentration II is not well-defined and no activities can be inferred. Concentration III with its wide array of raw materials, cortex and tools, as well as the absence of fire cracked rock, seems to be the major tool production area for the site. Concentration III contains the most artifacts and therefore tool production seems to be the major activity at the site.

7NC-D-55A

The field notes for this site indicate that the initial controlled surface collection methods were abandoned due to the small number of artifacts recovered. A limited amount of sub-surface testing also revealed a small number of artifacts. Diagnostic artifacts are depicted in Fugure 5 and are similar to the assemblages from 7NC-D-54. The projectile points are all from the Late Archaic through Middle Woodland periods as was the case at 7NC-D-55A. A summary of the artifacts is presented in Table 5.

Examinations of Table 5 reveals similar patterns to those noted for 7NC-D-55A. Table 6 shows the distribution of artifacts with and without cortex by raw material.

Table 5: 7NC-D-55A - Total Artifacts

Artifact Type	Quartz	Quartzite	Jasper	Burned Jasper	Chert	Other	TOTAL
Flakes with cortex	13	38	4	0	2	0	57
Flakes without cortex	11	23	4	2	14	1	55
Flake tools with cortex	0	0	3	0	0	0	3
Flake tools without cortex	2	0	0	2	2	0	6
Points, early stage rejects with no cortex	2	1	2	0	1	0	6
Points, exhausted rejects with no cortex	0	0	3	0	0	1	4
Bifaces, early stage rejects with no cortex	1	0	0	0	0	0	1
TOTAL	29	62	16	4	19	2	132
Percentage	22%	47%	12%	3%	4%	2%	

Table 6: 7NC-D-55A - Cortex and Non-cortex artifacts by raw material

	Quartz	Quartzite	Jasper	Chert	Other
Cortex artifacts	42%	61%	35%	10%	0%
Non-cortex artifacts	58%	39%	65%	90%	100%

In Table 6 quartzite shows a higher percentage of cortex artifacts than any of the other materials as was the case for 7NC-D-54. A similar preference for local quartzite cobbles for tool manufacture is hypothesized for 7NC-D-55A. Unfortunately, there are not enough bifaces and projectile points to check for tool manufacturing patterns and raw material usage. Similarly, there is not enough information to map out activity areas for 7NC-D-55A. All that can be noted for 7NC-D-55A is the selection of quartzite cobbles for early tool reduction.

7NC-D-55B

Controlled surface collection and extensive sub-surface testing were both carried out at this site. Many artifacts were recovered and sufficient spatial coverage was generated to allow the analysis of distributions of artifact classes. Table 7 lists the various artifacts found and Figure 5 shows some of the diagnostic artifacts. These points all fall within the Late Archaic - Middle Woodland time period as was the case for 7NC-D-54 and 7NC-D-55A. Mockley ceramics were also found at 7NC-D-55B and these ceramics support the Middle Woodland date (Artusy 1976:11).

Table 8 and 9 show tabulations of cortex and non-cortex artifacts and early and late stage tools by raw materials. All raw materials show more non-cortex artifacts than cortex artifacts. However, quartzite shows a close to equal distribution of cortex and non-cortex artifacts indicating some emphasis on the use of local quartzite cobble sources. A higher proportion of early stage bifaces and points made from quartzite also indicates manufacturing of replacement tools of quartzite at 7NC-D-55B. The late stage tools all have humps and fractures and probably represent rejected tools culled from the tool kits as quartzite replacements are manufactured. Flakes without cortex represent debitage from resharpening of tools as well as debitage from late stage tool reduction using some non-quartzite cobbles that are available locally.

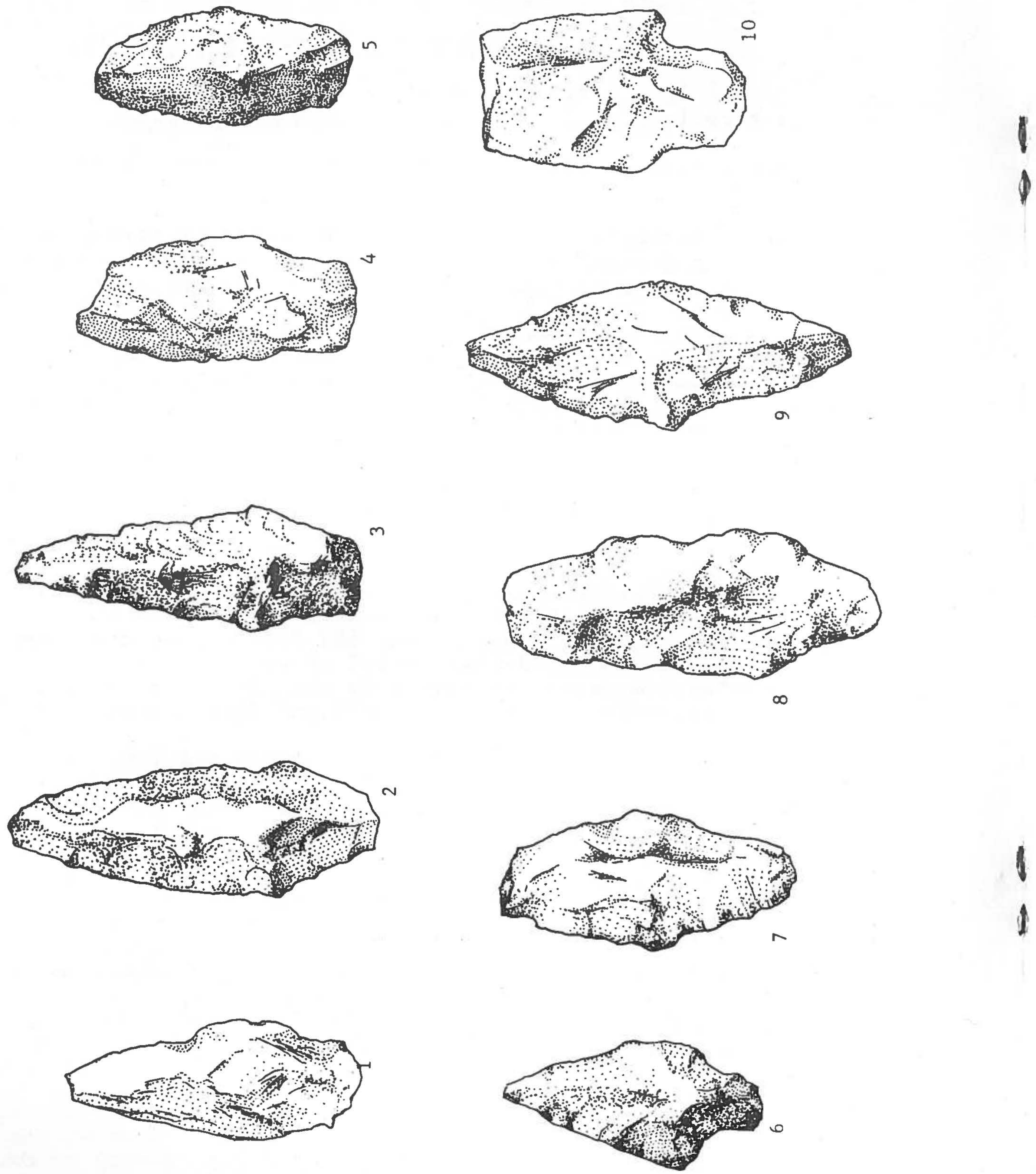


FIGURE 5: 7NC-D-55A, 7NC-D-55B DIAGNOSTIC ARTIFACTS

Figure 5: Diagnostic Artifacts - 7NC-D-55A, 7NC-D-55B - Key

7NC-D-55A

1 - Unfinished point, quartz, manufacturing reject

2 - Late Archaic stemmed point, sidarite, heavily resharpened

3 - Late Archaic stemmed point, jasper/chert, heavily resharpened with wear on impact fracture

4 - Late Archaic stemmed point, quartz, manufacturing reject

5 - Late Archaic stemmed point, jasper, manufacturing reject

6 - Late Archaic stemmed point, jasper, heavily resharpened

7 - Late Archaic stemmed point, jasper, broken pre-form

7NC-D-55B

8 - Late Archaic stemmed point, siltstone, pronounced hump with some resharpening

9 - Late Archaic stemmed point, sidarite, hump with some resharpening

10 - Possible broadspear, quartzite, broken in manufacture

Table 7: 7NC-D-55B - Total Artifacts

Artifact type	Quartz	Quartzite	Jasper	Burned Jasper	Chert	Other	TOTAL
Flakes with cortex	147	496	9	1	5	11	669
Flakes without cortex	789	551	92	55	66	19	1572
Utilized flakes with cortex	2	2	1	0	0	0	5
Utilized flakes without cortex	11	0	6	6	1	1	25
Early points without cortex	1	2	1	0	1	0	5
Late points without cortex	7	3	3	0	1	2	16
Early bifaces without cortex	2	5	1	0	0	0	8
Late bifaces without cortex	3	1	0	0	0	0	4
TOTAL	962	1060	113	62	74	33	2304
Percentages	42%	46%	5%	3%	3%	1%	

Table 8: 7NC-D-55B - Cortes and Non-cortex Artifacts by Raw Material

	Quartz	Quartzite	Jasper	Chert	Other
Cortex artifacts	25%	47%	6%	7%	33%
Non-cortex artifacts	75%	53%	94%	93%	67%

Table 9: 7NC-D-55B - Early and Late Stage Tools by Raw Material

	Quartz	Quartzite	Jasper	Chert	Other
Cortex artifacts	23%	64%	40%	50%	0%
Non-cortex artifacts	77%	36%	60%	50%	100%

Because both a controlled surface collection and extensive sub-surface excavations were carried out, it is possible to examine the spatial distributions of various artifact classes at 7NC-D-55B. From the analysis of these spatial distributions activity areas may be inferred. First, however, spatial data from the surface collection and excavations must be compared to see if they are similar enough to combine for analysis. It should be noted that at 7NC-D-55B profile measurements and descriptions indicate that all artifacts from the test excavations were found within the plow zone. Therefore, the plow zone excavations and surface collections represent subsets of the same population of artifacts found at the site. Comparison of these data sets represents a research question quite different from the traditional surface/ subsurface studies where disturbed surface materials are used to predict the distributions of undisturbed subsurface materials (Binford, et al. 1970; Redman and Watson 1970:279-291; Flannery 1976:51-62).

The work of Ammerman and Feldman (1978) is similar to the research question at 7NC-D-55B. Ammerman and Feldman (1978) have shown, by conducting multiple surface collections, that a single surface collection may not be representative of the true distribution of artifacts on the surface of a site due to unstated sampling biases such as time of day, time after plowing, weather conditions and time since rainfall. They also found that size of the artifact has a direct bearing on the probability of it being found. "The variability observed in replicated surface collections and the suggestion that the surface may operate as biased multinomial sampling process have wide implications for the kinds of analyses and inferences that can be made with surface material" (Ammerman and Feldman 1978:739). It seems that in order for the surface distribution of artifacts to be a good predictor for the undisturbed cultural features that it would have to be representative of the distribution of artifacts within the entire plow zone. The relationship between the surface collection at a site and the excavated plow zone should thus be direct and the distribution of artifacts across space should be similar. 7NC-D-55B provides an opportunity to test the relationship between the surface distribution of artifacts and the distribution of artifacts within the plow zone. First, SYMAP maps of various artifact classes were made of the subsurface distribution of artifacts using the centroids of the excavated two meter squares as data points for the subsurface(plow zone) contour maps. The outline of the subsurface maps were related to the surface collection grid for comparative purposes.

A general visual comparison of these subsurface maps to those produced for the surface shows some striking differences. Jasper was shown in more concentrations on the surface than on the subsurface maps. Also a large concentration in the northwest corner of the surface map was shown some twenty meters to the west on the subsurface map. Burned jasper had four major concentrations shown on the subsurface that were not shown on the surface maps. In the reverse of the situation with jasper a large concentration shown at S20/E20 on the surface maps was shown at S20/E30 on the subsurface maps. In one case a large surface concentration was not shown on subsurface maps. The distribution of quartzite on the subsurface maps proved to be very similar to the distribution shown on the surface maps. With quartz, only one surface concentration was not present on the subsurface maps. Likewise, only one concentration on the subsurface maps was not revealed by the surface maps. The distribution of artifacts with cortex was very similar when the surface and subsurface maps were compared. In general there was less of a magnitude in concentration shown on the total material maps for the subsurface than the surface.

It seems reasonable to suggest from the comparison of artifact distributions that the greater the amount of material found at a site, the more accurate the prediction of the subsurface from the surface distributions. There seemed to be more "misses" in the predictions of the surface maps when materials with small overall concentrations are mapped. Quartz, quartzite and cortex were all predicted well when surface and subsurface maps were compared, while the prediction of jasper and burned jasper was not good at all. From this one can conclude that the surface distribution of artifacts at site 7NC-D-55B was not a good predictor of the distribution of artifacts within the whole plow zone. Therefore, because the subsurface and surface samples of artifacts are different, they were combined for a more complete analysis of activity areas. In one sense, the surface collection and subsurface excavations may be viewed as separate iterations of the sampling of the plow zone artifact distributions and are comparable to the multiple surface collections suggested by Ammerman and Feldman (1978). Figure 6 shows the distributions of total artifacts at 7NC-D-55B for both subsurface and surface collection samples.

Concentrations of artifact classes were isolated by combining subsurface and surface data. Figure 7 shows the distribution of quartz and quartzite concentrations. It can be seen that these distributions overlap to a large degree. Figure 8 shows the distributions of quartz and quartzite, cortex, and tool concentrations. These distributions all overlap to a large degree and given the presence of early stage biface rejects, artifacts with cortex, and quartzite, this section of the site is considered to be an activity area for tool production. Cobbles were selected and reduced, debitage was produced as by-products of tool production, and tools that were broken in production or flawed were rejected in this section of the site. Figure 9 shows the distribution of jasper and burned jasper. Burned jasper concentrations are seen as indicative of hearth areas and possible living areas. Jasper bifaces in this area are in later stages of reduction and are heavily resharpened. The mean width/thickness ratio of the bifaces from the habitation area is 4.23 while the mean width/thickness

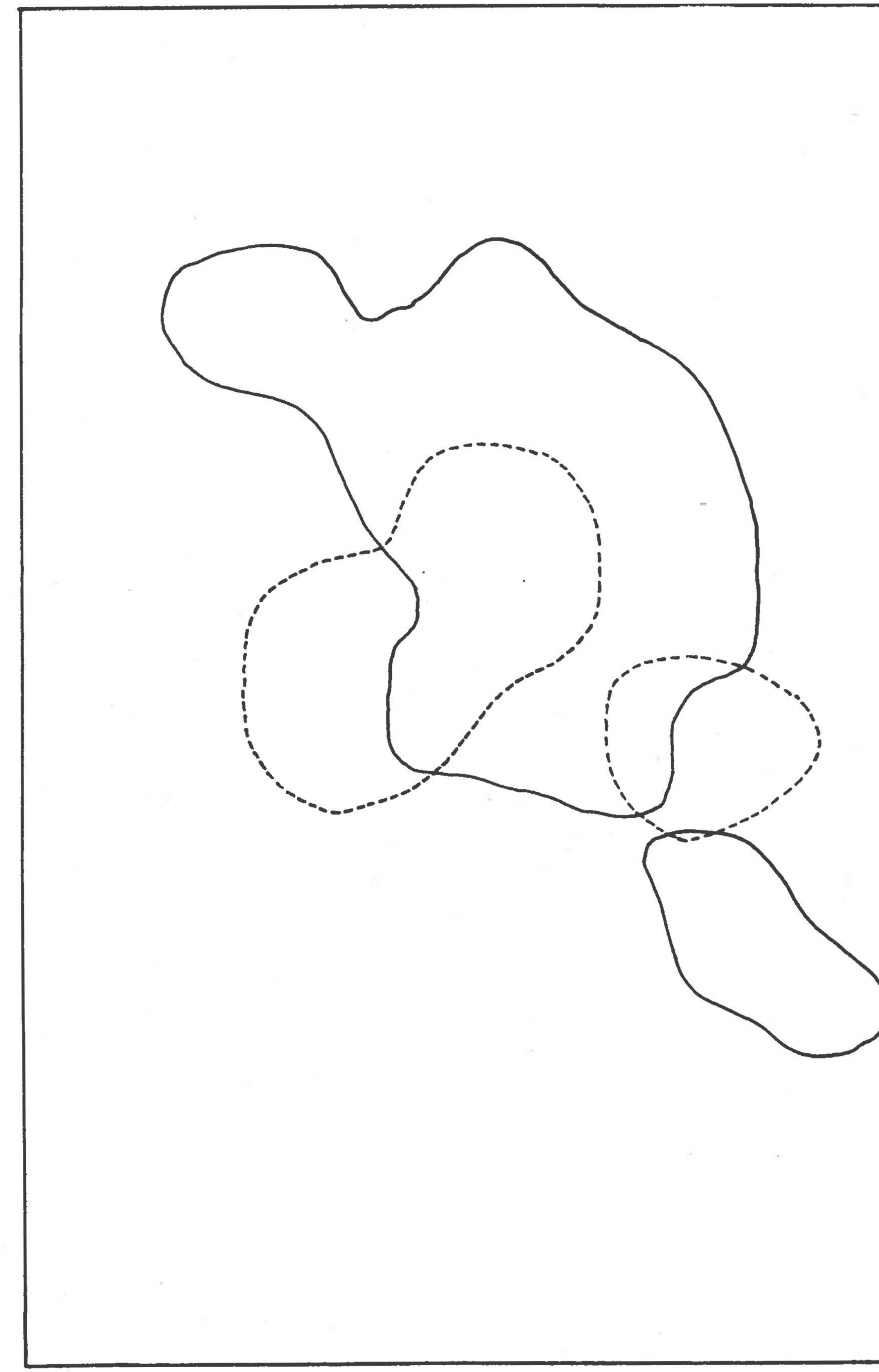
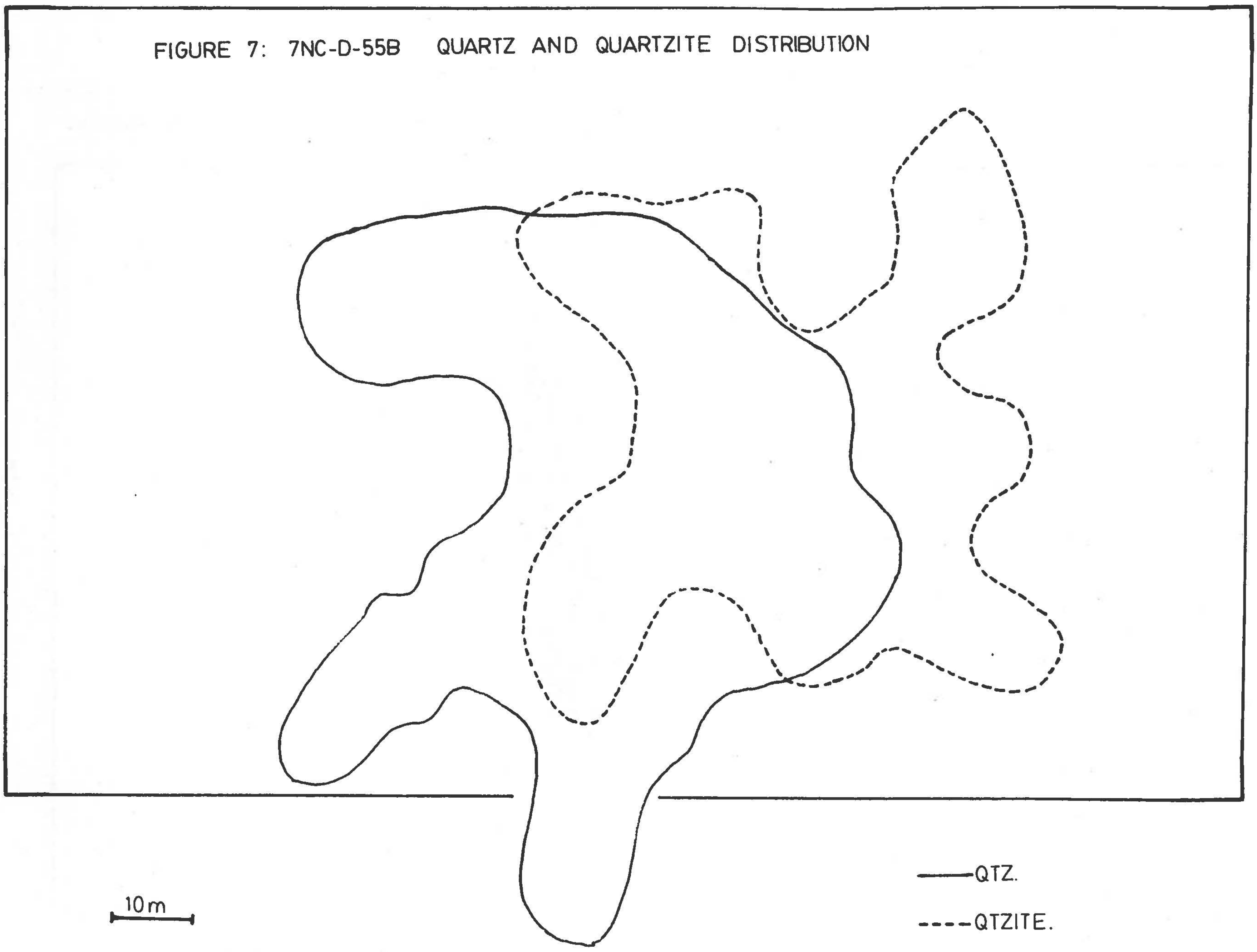


FIGURE 6: 7NC-D-55B TOTAL ARTIFACT DISTRIBUTION

FIGURE 7: 7NC-D-55B QUARTZ AND QUARTZITE DISTRIBUTION



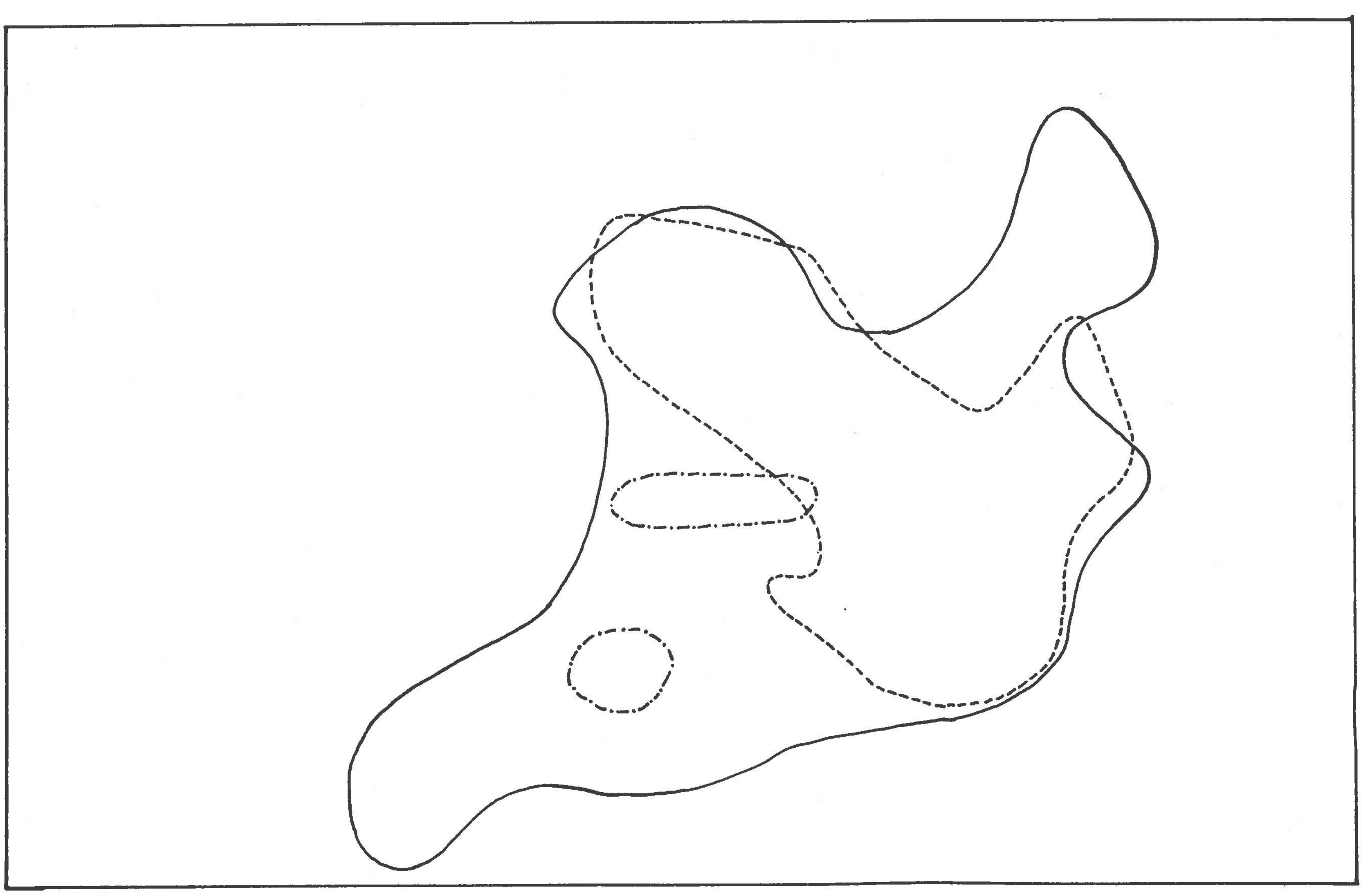


FIGURE 8: 7NC-D-55B QUARTZ, QUARTZITE, CORTEX, AND TOOL DISTRIBUTION

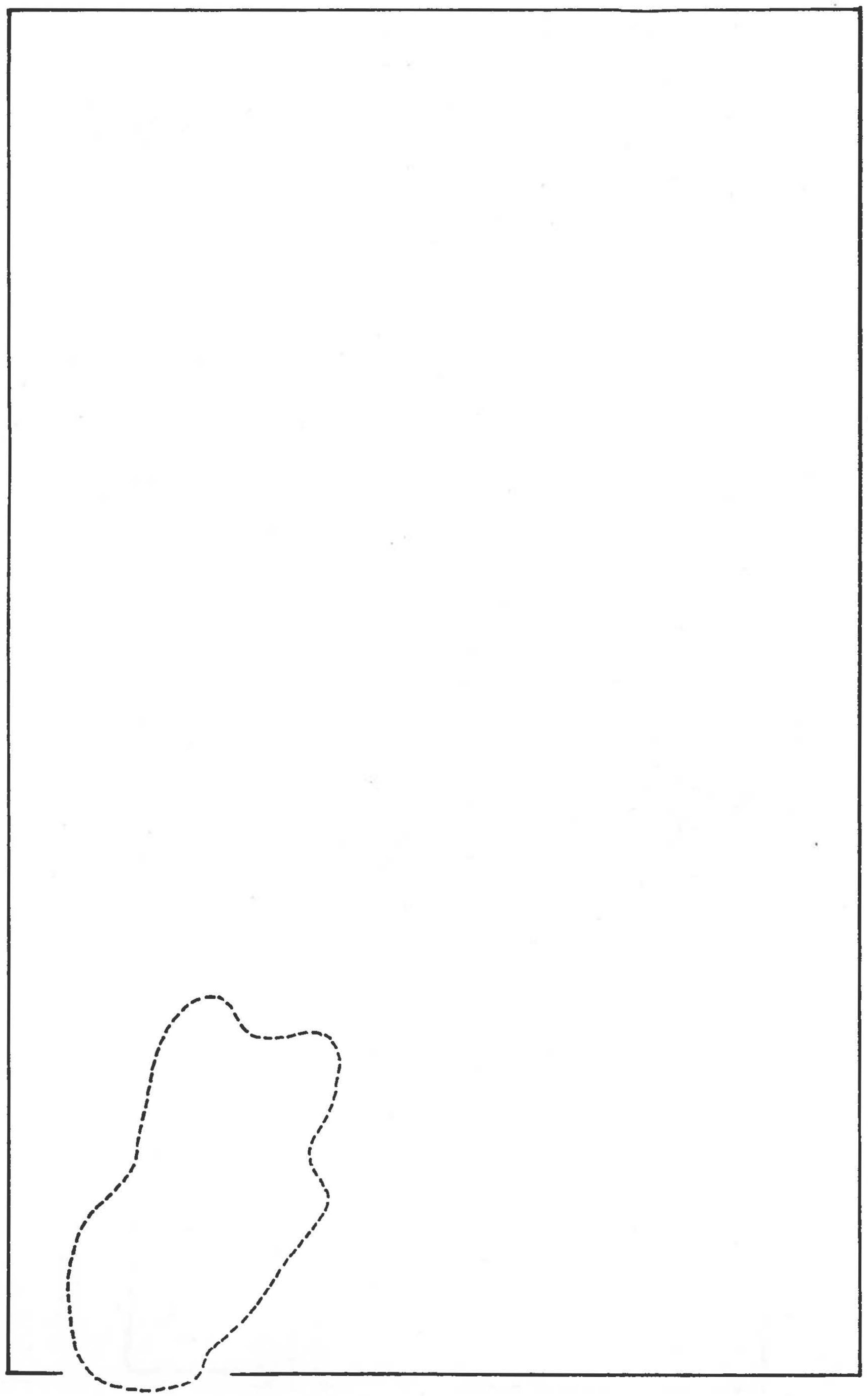


FIGURE 9: JASPER AND BURNT JASPER DISTRIBUTION 7NC-D-55B

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ratio of quartzite and quartz bifaces from the tool production area is 1.83. Larger width/thickness ratios are indicative of bifaces in later stages of reduction (Callahan 1979:18) and it is suggested here that the bifaces from the habitation area with high width/thickenss ratios and heavy reworking are rejects culled from tool kits brought to the site. In sum, two activity areas are noted for 7NC-D-55B; one tool production area and a habitation area.

7NC-D-62

No controlled surface collection was carried out at 7NC-D-62 due to low numbers of artifacts and only limited subsurface testing was carried out. Table 10 summarizes the artifacts.

Table 10: 7NC-D-62 - Total Artifacts

Artifact Type	Quartz	Quartzite	Jasper	Burned Jasper	Chert	Other	TOTAL
Flakes without cortex	95	87	39	5	15	15	256
Flakes with Cortex	51	121	4	1	6	9	192
Utilized flakes with cortex	0	0	0	0	2	0	2
Utilized flakes without cortex	7	3	2	0	1	0	13
Early points without cortex	2	0	0	0	0	0	2
Late points without cortex	0	5	1	0	1	0	7
Early bifaces without cortex	2	0	0	0	0	0	2
Late bifaces without cortex	0	0	0	0	1	0	1
TOTAL	157	216	46	6	26	24	475
Percentage	33%	45%	10%	2%	5%	5%	

No diagnostic artifacts were found. Table 11 shows the proportions of cortex and non-cortex artifacts by raw material. As was the case for the other sites, quartzite shows a higher proportion of artifacts with cortex which indicates selection of quartzite cobbles for primary tool production. No further analysis can be carried out due to the small number of artifacts.

Table 11: 7NC-D-62 - Cortex and Non-cortex Artifacts by Raw Materials

	Quartz	Quartzite	Jasper	Chert	Other
Cortex artifacts	32%	56%	10%	30%	38%
Non-cortex artifacts	68%	44%	90%	70%	62%

DISCUSSION

The sites comprising the Green Valley Complex share a number of similar features including major occupation during the Late Archaic - Middle Woodland periods (ca. 3000 BC - AD 800); a mix of the tool production activities at various manufacturing stages which produce debitage with and without cortex; and culling and rejection of used-up exhausted tools from tool kits brought into the site. However, some differences can be seen from site to site. Table 12 summarizes raw material percentages and cortex percentages from the four sites.

Table 12: Green Valley Site Comparison

Raw Material	7NC-D-54	7NC-D-55A	7NC-D-55B	7NC-D-62
Quartz	49%	22%	42%	33%
Quartzite	10%	47%	46%	45%
Jasper	37%	15%	8%	12%
Chert	3%	4%	5%	5%
Other	1%	2%	1%	5%
Cortex	28%	45%	29%	41%
No Cortex	72%	55%	71%	59%
Total Artifacts	1288	132	2304	475

Table 12 reveals some differences among the sites in terms of raw materials and artifacts with and without cortex. These differences will be interpreted as indicative of slightly different activities at each of these sites and different choices of raw material utilization. Underscoring this interpretation is the fact that all four sites are equally close to relatively similar

cobble beds. Therefore, any differences in artifact distributions and raw materials among the sites are not due to differences in available raw materials and must be due to differential use of raw materials by people living at the sites. Considering raw materials, some differences can be noted among the sites with respect to quartz, quartzite, and jasper. These raw materials are important because quartz and quartzite are the most common raw materials found in the cobble beds while jasper is more likely derived from nearby primary sources such as the Delaware Chalcedony Complex (Custer and Galasso 1980; Wilkins 1976). 7NC-D-54 stands out from the other three sites with its low quartzite and high jasper percentages. 7NC-D-55A, 55B and 62 all have quartzite as the most common raw material. 7NC-D-55A shows the highest quartzite percentage followed by 7NC-D-62 and 7NC-D-55B in order of decreasing frequency. 7NC-D-55A shows the lowest quartz frequencies with three other sites being relatively similar. Following the assumption that quartzite is indicative of primary early stage tool production, sites 7NC-D-55A, 55B, and 62 show more early stage tool production than 7NC-D-54. Cortex percentages support this view with 7NC-D-55A showing the highest percentage followed by 7NC-D-62, 55B, and 54 in order of decreasing frequency. In sum, 7NC-D-55A, 62, and 55B show the highest amount of early stage tool reduction primarily using quartzite. 7NC-D-54 is different with an emphasis on materials other than quartzite, primarily quartz and jasper, and later stages of tool production which do not produce as many flakes with cortex.

Activity area analysis carried out for 7NC-D-54 and 7NC-D-55B shows similarities even though the emphasis on early and late stage tool production differs between the sites. At both sites tool production, either early or late stage, is located at areas separate from habitation areas. Similar activity patterns have been noted for other tool production sites (Gardner 1974, Gross 1974) and are hardly surprising given the amount of debris that results from stone tool production. Another similarity in activity areas between the two sites is the presence of discarded, heavily resharpened, late stage bifaces in living areas near hearths. These tools represent tools carried into the site, culled from the tool kit, and discarded. They were then replaced with tools manufactured at the site. The separation of the activities of culling and discarding of old tools and manufacturing of new tools at the Green Valley sites also seems to be present at other tool production sites (Gardner 1974, Gross 1974).

The archaeological record at the Green Valley Site Complex reveals much about how Late Archaic/Woodland I groups of people manufactured tools, managed their tool kits, and organized their use of space at four specific sites. These data can also reveal more general features of adaptation through consideration of the Green Valley Complex from a regional perspective. Figure 10 shows the relationship of the Green Valley Site Complex to lithic

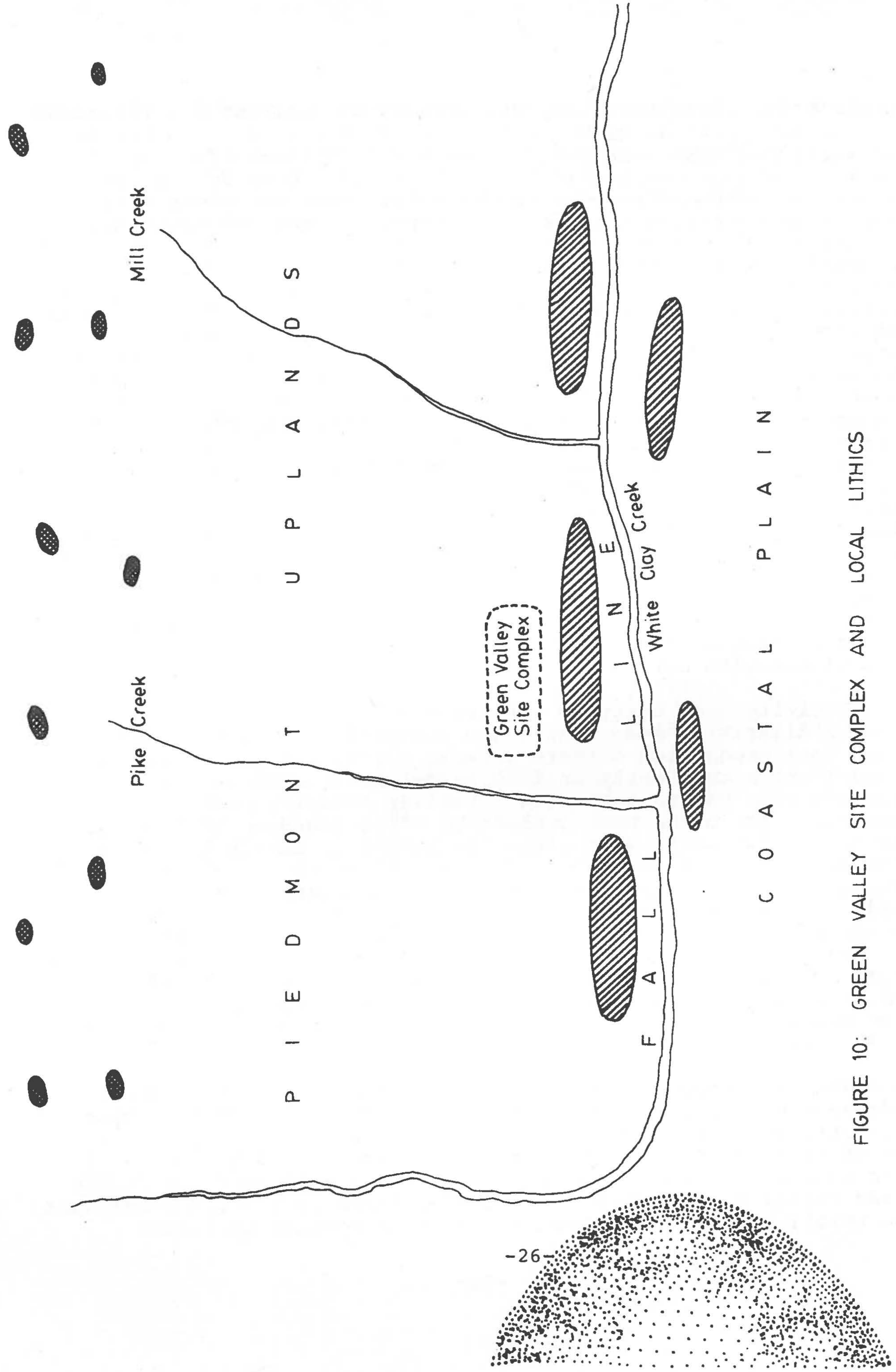

FIGURE 10: GREEN VALLEY SITE COMPLEX AND LOCAL LITHICS

resources of the local area. The Fall Line Zone is especially rich in lithic resources and it seems reasonable to suggest that some materials from all sources are present at the Green Valley Site. Late stage bifaces of jasper and quartz which were rejected at the Green Valley Site Complex probably were originally manufactured from Delaware Chalcedony Complex or Piedmont Upland quartz primary materials. The co-occurrence of these materials indicates that Late Archaic/Woodland I groups probably wandered through areas including these lithic resources as part of their seasonal hunting and gathering round. Maximum distance to these resources is approximately twelve kilometers, which can be used as an initial minimum estimate of the Late Archaic/Woodland I settlement system catchments, or wandering cycle zones.

The co-occurrence of the varied lithics from within the wandering cycle zone, the evidence of culling and discard of exhausted tools, and the evidence for manufacturing of replacement tools all seem to show that management of tool kits was a constant activity throughout the wandering cycle zone. As lithic sources were encountered, tool kits were evaluated. Old bifaces and points which would require more energy to refurbish than to replace, were discarded. New replacement tools were manufactured and the tool kit would be ready for further transport and use. The variety of raw materials from different sources in the discarded tools indicates that the above process was carried out at a number of different sites within the wandering cycle zone as lithic sources were encountered. Binford (1979) and Goodyear (1979) have suggested the use of the term "embedded procurement" to describe this pattern where tool kit refurbishing is carried out in conjunction with other subsistence activities on an "as-needed" basis. In this pattern lithic source locations are utilized serially. While lithic resources may have played a role in the site selection, as was probably the case in the Green Valley example, specialized quarry sites are lacking. Quarry activites, manufacturing activites, and habitation areas all occur at single locations.

It should be noted that limited archaeological reconnaissance in the Piedmont Uplands supports the embedded procurement model. Artifacts with cortex, probably derived from the Fall Line Zone, have been found at the West Main Street Rockshelter (7NC-D-89) on the Upper Christina, the Mitchell Site (7NC-A-2) in Hockessin, and numerous sites within the proposed Limestone Hills sub-division on the Upper Mill Creek. At the Mitchell Site and the Limestone Hills sites there are also clear indications of manufacturing of new tools from locally available quartz. However, more work at these Piedmont Upland sites will be needed to understand the culling and manufacturing processes at these sites.

In conclusion, even though the Green Valley Site Complex represents a series of small, disturbed sites, it can provide useful information on site-specific activity areas as well as regional settlement-subsistence systems.

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