XIII. ARTIFACT ANALYSIS

Formal Analysis

Tools

As is typical of prehistoric archaeological sites in northern Delaware and elsewhere in the Middle Atlantic, the majority of the artifactual material recovered from Lums Pond consisted of chipped stone. A variety of tools and debitage was recovered. Definitions of the artifact forms used in the text are contained in a glossary. Morphological and technological analysis of these artifacts, including the stylistic evaluation of projectile point types for the purposes of relative dating, was undertaken to support traditional typological analysis for intersite comparison. Type evaluation was conducted using standard projectile point typology studies for the Middle Atlantic and Northeast (e.g., Ritchie 1971; Broyles 1971; Kinsey 1972), along with recent research focused on the Delaware region (Custer 1989, 1994, 1996).

Bifaces are subdivided into two categories, *early stage* and *late stage*, on the basis a combination of attributes including width:thickness ratios, sinuosity of edge profiles, degree of shaping, and overall appearance. Taken together, these characteristics are related to the level of completion of the biface. They have been developed as descriptive and analytical devices and are based on several existing theoretical and experimental models (most notably those of Muto 1971; Callahan 1979; Collins 1979; Johnson 1981). Early stage bifaces result from the initial efforts at producing a bifacial edge on a cobble, pebble, or flake blank. Typically, early stage bifaces exhibit random flaking generally produced by hard-hammer percussion and appearing as wide and deep flake scars. The amount of flaking may vary from minimal to fairly extensive. Bifacial edges are typically sinuous in profile with little shaping evident. The bifaces are usually relatively thick in cross-section and often bear remnant cortex. In contrast, late stage bifaces typically display slightly greater width:thickness ratios than early stage bifaces, indicating that further thinning has been accomplished. Late stage bifaces also exhibit a greater degree of shaping and straighter edges in profile, suggesting more designed and patterned flaking. Edge modification may be present in the form of platform preparation, implying the use of more controlled flaking.

A distinction is made in this analysis between manufacturing rejects and discards based on the observation of a range of characteristics. For example, a biface may appear unfinished, with sinuous edges or an irregular shape, unpatterned percussion flaking. It may also bear evidence of incomplete mastery of the raw material, such as compounded step-fractures leading to stacks, uncleared material flaws or inclusions, or multiple perverse fractures (Purdy 1975; Johnson 1981; Custer and Bachman 1985). Various combinations of these characteristics suggest that an artifact was broken during manufacture or that the artisan was either unable to overcome flaws or recover from manufacturing errors, and so, rejected the piece before completion. Other bifaces that appeared to have been finished tools are assumed to have been discarded after breakage or when exhausted through use and resharpening.

Relatively few formal tools forms were identified in the chipped stone assemblages at Lums Pond. The most common category of non-bifacial tool was the uniface, usually seen as a form of flake tool in which the flake had been deliberately trimmed to shape. Trimming was on one face, typically the dorsal surface of the flake. Most of the unifaces from the site had been prepared for use as side- or endscrapers.

Debitage

The debitage recovered from the typical prehistoric archaeological site comprises a vast quantity of material that, due to its sheer volume, is difficult to analyze efficiently. Two main approaches have been taken to handling such a database: individual flake analysis and flake aggregate analysis (Ahler 1989:86). The conventional and more frequently chosen method, individual flake analysis, involves documenting physical and technological attributes on a flake-by-flake basis, an obviously laborious and time-consuming process. Flake aggregate analysis, also known as mass analysis, considers group characteristics of an archaeological assemblage such as the size distribution of flake debris as measured on an interval scale. The Lums Pond assemblages provided an opportunity to examine the effectiveness of both methods, there being enough material to warrant the use of flake aggregate analysis, yet there were sub-assemblages small enough to allow limited use of individual flake analysis. It was thus possible to compare the effectiveness of the two analytical techniques within the site assemblages.

Individual Flake Analysis

Efficient individual flake analysis relies on the ability of the researcher to identify a relatively small number of technological attributes that convey useful and particular information. Exhaustive attribute lists, while detailed, may often document redundancy. In contrast, ongoing research has suggested that it may be possible to isolate a few independent variables that carry the majority of the relevant technological information available from the artifacts (Shott 1994). As part of an experimental study, Magne and

Pokotylo (1981:36,Table 6) surveyed current literature on debitage analysis and identified a total of 38 separate variables that have been cited in the course of various studies. They chose eight of these variables as key to successful analysis (Table 44). Five, including weight, length, width, dorsal scar count, and cortex cover, can be tabulated for all flaking debris, including shatter. The remaining three variables record platform attributes and so can only be recorded on whole and proximal flakes. Using a multidimensional scaling analysis, they concluded that the number of uniquely significant variables could actually be reduced to a minimum of four: weight, dorsal scar count, platform scar count, and cortex cover. In their final conclusion, Magne and Pokotylo contended that these four variables can with 70-100 percent accuracy predict the stage of biface manufacture represented by a flake. Going a further step, they state that "debitage variablility can be *almost* entirely reduced to a single variable (weight of individual items)" (Magne and Pokotylo 1981:40, original emphasis).

Shott (1994)	Magne and Pokotylo (1981)	Riley et al. (1994)	LUMS POND
weight	weight*		weight
cortex	cortex*	cortex	cortex
scar count	scar count*	scar count	scar count
condition		type	segment
platform class	platform scar count*	platform shape	platform type
platform angle	platform angle		platform angle
raw material			raw material
	length	size	size grade
	width		
	platform width		
		scar orientation	scar orientation†
		biface edge	biface edge†
		platform preparation	platform preparation†
		retouch	retouch†

*Magne and Pokotylo's minimum attributes
†recorded for comparison with UD-CAR database

Table 44. Comparison of Attributes Employed in Selected Individual Flake Analyses. The Lums Pond Analysis Employs Shott's Variables as a Basic List and Adds the UD-CAR Variables for Regional Comparative Analysis

In a more recent survey of debitage analyses, Shott (1994:80-1) generated a list of seven minimum attributes (Table 44). To the minimum four variables identified by Magne and Pokotylo, Shott added dorsal platform angle, condition, and raw material type.

Weight he deemed "among the most informative size attributes in predicting stage or degree of reduction...partly because it covaries closely with linear dimensions" (Shott 1994:80). Cortex is documented at least on a presence/absence basis. Dorsal flake scar count is recorded to document the amount of previous flaking, and is measured on an interval-scale value, e.g., 0 to 5 and +5, with the latter adjusted for flake size, since "smaller flakes have fewer scars *ceteris paribus*" (Shott 1994:80). Dorsal platform angles, though difficult to measure reliably, are typically distributed within an assemblage in inverse relation to the degree of reduction. Platform scar count is included under the term platform class, refering to the type of platform, such as single or multi-facet. Condition corresponds with flake segment—proximal, distal, etc. Finally, raw material type is recorded since it is deemed to have a fundamental effect on manufacturing technology.

The existing lithic database for northern Delaware has been developed largely by researchers at the University of Delaware-Center for Archaeological Research (UD-CAR), with flaking debris classified using a slightly different set of attributes. The UD-CAR analysis includes a list of nine variables, which are included in Table 44 and have been coded in the Lums Pond analysis for comparative purposes. Several of the variables, such as the presence or absence of cortex, flake type, dorsal scar count, and platform shape, correspond with Shott's minimum attribute list. Others record additional data. For example, size is recorded as a linear measure on a grade interval (<2cm, 2-5cm, >5cm); dorsal scar orientation is recorded as an additional measure of the amount and complexity of previous flaking; additional platform variables include the presence of biface edges as an indicator of biface manufacture, and platform preparation, assumed to correlate with biface manufacture rather than a flake/core technology; and finally, retouch is recorded, defined as trimming to produce a working edge, and is assumed to denote flake/core technology.

The debitage analysis proposed for the Lums Pond assemblages is presented in the right-hand column in Table 44. Attributes listed in Shott's study were documented as minimum attributes. Additional variables from published UD-CAR were also recorded for comparative purposes. Critical analysis of the quantitative data from the site should thus provide an opportunity to test for redundancy among the listed variables. It should be noted that the UD-CAR analyses are geared toward differentiating between flake/core and biface reduction technologies, while Magne and Pokotylo's analysis assumes biface reduction and is aimed at determining the stage in the reduction sequence. Shott is uncharacteristically ambiguous in terms of the specific goal of his list.

Mass Analysis

One of the attributes recorded for the Lums Pond assemblages is size grade, and its use allows the application of mass analysis. Mass analysis, also referred to as flake aggregate analysis, consists of the grading of debitage according to established size intervals and the retrieval of various quantitative data from each grade (Ahler 1986, 1989). The intervals are based on the dimensions of the mesh openings of standard hardware screening (Table 45). The data are subjected to a variety of statistical manipulations from which inferences may be made as to the type or types of reduction activity represented in the assemblage. Various analyses based on similar interval data have been conducted (see, for example, Gunn et al. 1976; Henry et al. 1976; Johnson 1981; Stahle and Dunn 1984; Patterson 1990; Petraglia et al. 1993; Riley et al. 1994a; Healan 1995). Ahler's work appears to be the most comprehensive and best documented study thus far undertaken, and so provides the greatest potential for inter-assemblage comparability. His methods have been applied in the present study.

Size Grade	Mesh Opening
Grade 1:	2.54 cm (1")
Grade 2:	1.27 cm (1/2")
Grade 3:	0.64 cm (1/4")
Grade 4:	0.33 cm (1/8")

Table 45. Size Grades and Dimension of Screen Mesh Opening

Mass analysis involves quantifying several intuitive concepts associated with lithic reduction. The primary notion is that because lithic tool manufacture is a reductive process, both the tool and the debitage produced become smaller as the process continues. In short, debitage from later reduction stages should be smaller than that resulting from earlier stages, reflecting the diminishing size of the tool. Several simple count and weight measurements were thus taken for each graded sample, and relative counts within and between size-grades were determined. Weight variation within a size-grade becomes a measure of artifact shape—heavier flakes of the same size-grade will tend to be thicker. The data may then be used in differentiating between types of load application—the amount of force applied, its location relative to the edge of the tool, and the angle of attack. By implication, the manufacturing technique may be inferred—thin, marginal flakes imply biface thinning, while relatively thick, non-marginal flakes imply core reduction. In addition to flake size, there should be an observable progression during the reduction sequence in the removal of cortex, with later reduction stages producing on average less cortical material. Thus the frequency of cortex is recorded within each size-grade.

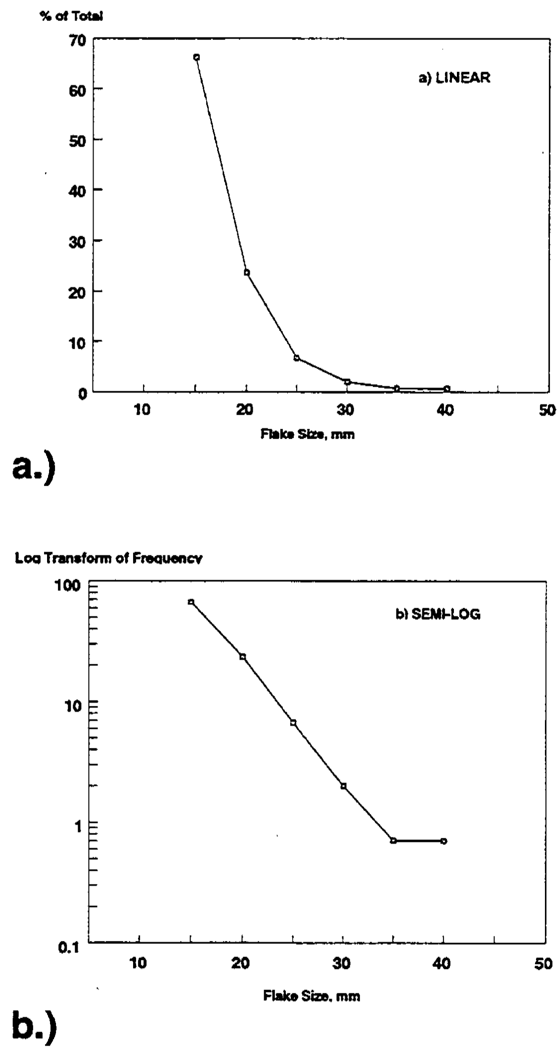

Figure 95. Patterson's Experimental Biface Reduction Flake Size Distribution

Patterson (1990) has used flake size interval data to demonstrate a mathematical relationship between flake size and reduction strategy. Using experimental and archaeological data sets he noted that biface reduction produces a distinctive concave curve when size interval frequencies are plotted on a simple linear graph (Figure 95a). He further observed that a semi-log plot of the same data, with size intervals plotted on a linear scale and frequency on a logarithmic scale, results in a straight-line curve or log-linear regression with a negative slope (Figure 95b). Direct comparisons between Patterson's data and the Lums Pond material on an interval by interval basis is impractical—the two data sets cannot easily be placed on the same set of axes since the data are reported at different scales. One potentially significant difference concerns that fact that Patterson ignores debitage measuring less than 1cm, equivalent to size-grade 3 and below in the present analysis. Shott's (1994:91-94, figure 1-4) use of Patterson's distribution on other experimental data sets, specifically those of Behm (1983) and Tomka (1989), employs an interval range that encompasses smaller flake sizes (the current size-grade 4 and below). Shott's results tend to confirm Patterson's overall findings, although he does caution that the available data sets are limited. He notes that there are inconsistencies that will require more experimental work to fully understand. For present purposes, though, the procedure appears useful in indicating the degree of similarity between the Lums Pond debris and a pattern generally associated with biface reduction.

Single Attribute Measures

In the analytical ground between individual and aggregate analyses are single attribute measures of individual flakes, corresponding with Magne and Pokotylo's notion of flake weight as a plausible indicator of reduction stage. Another, similar notion is Sullivan and Rosen's (1985) hypothesis that complete flakes and shatter indicate core reduction while broken flakes reflect biface reduction. The flurry of replies which followed Sullivan and Rosen's original report (Ensor and Roemer 1989; Amick and Maudlin 1989; Prentiss and Romanski 1989) indicates some of the difficulties that may arise from such analytical reductionism, over-simplifying the characterization of what is in fact a complex phenomenon. A single variable may be an insufficient descriptor; there appears to be a need for a degree of interplay between variables to allow for the expression of the complexity.

Chips

In addition to flakes, a second category of debitage was recognized, chips. Chips are defined in this taxonomy as flaking debris that does not bear flake attributes such as a striking platform, bulb of percussion, or distinctive dorsal and ventral surfaces. The frequency of chips in a lithic assemblage may bear implications for several aspects of lithic technology, including the types of reduction strategies in use, the reduction stages most heavily represented, or the raw materials employed. Note is also made of a subset of chips—potlids—defined as fragments spalled from a core or biface by heat. All of potlids recognized at the site were from cryptocrystalline material. Given the amount of heat treatment that was observed in the knapping material in the assemblages, all potlids were assumed to be cultural in origin and so are included in the chipped stone totals in the chip category as a form of non-diagnostic flaking debris.

Projectile Point Typology

Models of culture change in the Middle Atlantic have been characteristically difficult to develop due to the fact that in many ways the region is still in the culture-history stage in terms of analytical development. Area chronologies are not well-developed, and without them, diachronic studies of cultural process are seriously hindered. As Evans and Custer (1990) recently argued, there is a conspicuous need for standardized tool typologies, ideally based on contexts that represent limited time spans. That is, we need point types with well-defined time ranges. And it is indeed a fact that a large proportion of the projectile points recovered in northern Delaware cannot be comfortably placed into accepted stylistic categories, while those which do fit often fall within styles that are not associated with well-dated depositional contexts. Point typology and seriation in northern Delaware becomes an especially significant issue in light of the alternative model of cultural development proposed for Delmarva by Custer (1984). To reiterate briefly, the Delmarva chronology combines what is traditionally seen as the Early Archaic with the latter portion of the Paleo-Indian in a period referred to as Late Paleo-Indian. The traditional Middle Archaic period is identified as the Archaic, while the Late Archaic, Transitional, Early Woodland, and Middle Woodland periods are subsumed under the blanket term Woodland I. Gradual change within this latter 4,000 year span is recognized in a series of regional complexes such as Clyde Farm, Wolfe Neck, or Carey.

One of the specific issues in the analysis of regional chronology is the apparent proliferation of point types near the end of the Late Archaic, or the start of Woodland I in the Delmarva sequence. After a long period dominated by a relatively small number of side-notched styles such as Otter Creek, Brewerton, or Halifax, which had in their time replaced bifurcates as the major morphological group, various stemmed points began to appear. These ranged from long, narrow-bladed points such as Lackawaxen, Poplar Island, and Bare Island, through broadspears such as Savannah River, Perkiomen, Susquehanna, and Koens-Crispen/Lehigh. As Custer (1983, 1989) notes, few of these points have radiometric or even good contextual data associated with them, and thus they have not been especially useful as indices for relative dating. To in part remedy this situation, Custer (1994) has begun an effort to reclassify the stemmed varieties recovered in Delmarva. Dropping traditional type names, he adopts an alphabetic labeling initiated by Kent (1970) at the Piney Island site in the Lower Susquehanna Valley. Stratigraphically, the points from Piney Island occurred in the following order:

Type I	side-notched
Type D	stemmed
Type E	stemmed
Type B	contracting stem, also associated with broadspears

Using this typology Custer classified points from a series of Middle Atlantic sites which demonstrate relatively tightly dated contexts and contain one or more of these types. He set up a cross-tabulation to evaluate contextual associations, with the idea that points appearing in too many contexts (e.g., side-notched) are not good chronologically diagnostic types, while those with restricted time ranges are. Among the stemmed points, for example, Type B do not occur in early assemblages, while Type I do not occur in later assemblages, and therefore Type B are presumed to postdate 3000 BC, and Type I to predate 1200 BC. Custer further considered the frequency of occurrence of Types D and E at each of the dated sites, using a form of seriation which suggested that Type E occurs prior to Type D. This seriation data was then used to break the Clyde Farm/Barker's Landing complexes into three subperiods: Clyde Farm I 3000-2000 BC, Clyde Farm II 2000-1200 BC, Clyde Farm III 1200-500 BC. He summarized the point typology (Custer 1994:39, figure 20) placing Brewerton, Lackawaxen and what are termed the Piney Island Series points first, around 3000-2500 BC, then Lamoka and a large contracting stem variery from 2500-2000 BC, followed by broadspears and a "Generalized Side-Notched" point from 2000-1000 BC, with Fishtails coming near the end of the sequence.

This analysis is a worthy attempt at sorting out a complex chronological problem, reassessing existing databases using site specific contextual data rather than relying solely on artifact morphology. One aim of the Lums Pond study was to assess the proposed typology by examining the temporal contexts of the projectile point styles recovered. Based on information retrieved from preliminary work at the site, good chronological data were expected: 1) projectile points and ceramics for intrasite seriation and comparative analysis with regionally specific sequences; 2) charcoal expected from a variety of feature and intact stratigraphic contexts allowing absolute dating of depositional sequences, 3) depositional association of diagnostic artifacts and radiometric data. Previous work suggested that the major occupations at Lums Pond would be Woodland I, which is the core of the problem time period as identified by Custer.

Assemblage Analyses

The artifact analyses that follow are grouped by assemblage. Total frequencies are presented first within each of the three main site areas to provide a general accounting. These tables consist of basic descriptive data. The focus of more in-depth analyses for each area shifts to the assemblages contained within specific stratigraphic proveniences

AREA 1

Of the 1199 prehistoric artifacts recovered from all excavations in Area 1, approximately 88 percent consisted of chipped stone debris, the remainder comprising fire-cracked rock and a single ceramic fragment. Raw material types among the flaking debris included Iron Hill jasper, quartz, chert, quartzite, argillite, andesite, chalcedony, and rhyolite, in descending order of frequency. Block excavation was undertaken in the main area of artifact concentration as indicated by spatial analysis.

Artifacts recovered from the excavation block in Area 1 were considered a discrete assemblage, and detailed analysis of artifact attributes within that assemblage was conducted. Tables 46 and 47 display artifact type frequencies and lithic raw material frequencies for the block. Over 90 percent of the material consisted of chipped stone, and of that amount more than 60 percent consisted of Iron Hill jasper debitage.

Artifact Type	Count	Frequency(%)
Flakes	700	77.4
Fire-Cracked Rock	82	9.1
Chips (Potlids)	98	10.8
Early Stage Bifaces	8	0.9
Late Stage Bifaces	7	0.8
Points	5	0.6
Cores	3	0.3
Unifaces	1	0.1
Total	901	

Table 46. Artifact Frequencies, Area 1 Excavation Block

Raw Material	Count	Frequency(%)
Iron Hill Jasper	522	63.5
Quartz	168	20.4
Jasper	60	7.3
Chert	30	3.6
Quartzite	23	2.8
Argillite	10	1.2
Andesite	6	0.7
Chalcedony	2	0.2
Rhyolite	1	0.1
Total	822	

Table 47. Chipped Stone Raw Material Frequencies, Area 1 Excavation Block

Projectile Points

Six projectile points or point fragments were recovered from Area 1. Details are summarized in Table 48.

The two Iron Hill jasper points, one whole (1019-1), and one snapped midway along the blade (1096-1), were both straight-stemmed, narrow-bladed points with convex bases. They exhibited heavy percussion flaking and sinuous blade edges. Neither point conformed well to Custer's (1994) Woodland I/Piney Island series types, although they were similar to two of the types: Type E, a minority type in each association from Archaic through Clyde Farm I, II, and III; and Type B, seen as the most common type during Clyde Farm I and decreasingly frequent through Clyde Farm III. The Lums Pond points had rounded bases characteristic of either of the traditional Poplar Island or Bare Island types, as well as descriptions of some of the Lackawaxen stemmed varieties. Debating nuances of style may seem dubious in relatively unfinished points such as these, yet their overall shapes appeared to have been determined, and thus a general morphological assessment was warranted. The points appeared to be related to early Woodland I, narrow-bladed, stemmed varieties.

Artifact #	*Material*	*W:Th*	*Weight(gm)*	*Comments*
1019-1	IH jasper	2.2	14	complete, straight stemmed, convex base, prominent shoulders, straight blade edges, percussion flaking, manufacturing reject, multiple stacks
1096-1	IH jasper	1.8	9.1	proximal fragment, straight stemmed, convex base, rounded shoulders, percussion flaking, manufacturing reject, stacks, transverse snap
1081-1	IH jasper	n/a	4.5	distal fragment, straight blade edges, percussion flaking, manufacturing reject, transverse snap at coarse-grained inclusion
1095-1	jasper	2.6	3.8	complete, pebble, straight stemmed, flat-to-convex base, rounded shoulders, convex blade edges, non-invasive pressure flaking, manufacturing reject?
1095-2	chert	2.3	2.9	proximal fragment, slightly contracting stem, convex base, one prominent & one damaged shoulder, bending snap, discard
1086-26	quartz	n/a	0.9	base, contracting stem, flat base, transverse snap at stem neck

Table. 48. Projectile Points Recovered from Area 1 Excavation Block

The remaining points were fragments. Two bore a sufficient portion of the hafting element to allow stylistic characterization. One (1095-1) was of pebble jasper and bore a large patch of cortex on one face. The well-flaked blade edges were convex, giving the appearance of the Dry Brook fishtail type. Part of the base was damaged and reworked, and so typing was not positive. The second fragment (1095-2) was from a small, contracting stem point, possibly a scaled-down or pebble version of the Poplar Island type. Damage was evident on one shoulder, and the blade was truncated above the shoulders at a bending snap break.

Two other point fragments included the distal end of a long, narrow-bladed point of Iron Hill jasper (1081-1), which appeared to accord typologically with the two Iron Hill jasper points described above. Percussion flaking had left sinuous blade edges. The proximal end was broken along a transverse fracture at a large crystalline inclusion, suggesting that the piece was rejected during manufacture. A last fragment was the base of a small stemmed point made of quartz (1086-26). The stem was slightly contracting, with a flat base. The base had broken at a transverse snap at the neck. The small size of the artifact made it difficult to determine with confidence whether the point had been broken during manufacture or use.

Bifaces

Fifteen bifaces were recovered from the block excavation in Area 1. Among these were 8 classed as early stage and 7 classed as late stage. General attributes are summarized in Table 49.

Artifact #	*Material*	*W:Th*	*Cortex(%)*	*Weight(gm)*	*Comments*
Early Stage Bifaces					
1046-1	quartz	3.3	0	31.2	proximal fragment, perverse snap at flaw, manufacturing reject
1051-27	quartz	2.1	20	20.6	complete, pebble, stacks, manufacturing reject
1063-23	quartz	1.8	20	16.1	proximal fragment, pebble, multiple perverse fractures at flaws, manufacturing reject
1077-2	quartz	2.5	30	15.2	complete, pebble, cortical flake, bifacial retouch, discard
1021-1	IH jasper	2.1	0	15.1	proximal fragment, flake with initial edge, oblique transverse snap, manufacturing reject

Table 49. Bifaces Recovered from Area 1 Excavation Block.

Artifact #	Material	W:Th	Cortex(%)	Weight(gm)	Comments
1059-20	quartz	n/a	0	4.7	proximal fragment, multiple perverse fractures at flaws, manufacturing reject
1086-31	quartz	n/a	0	1.9	distal fragment, transverse snap, manufacturing reject
1073-1	quartz	n/a	0	0.8	distal fragment, multiple perverse fractures, manufacturing reject,
Late Stage Bifaces					
1077-1	quartz	1.8	0	8.1	complete, pebble, plano-convex (bipolar), percussion, manufacturing reject
1054-1	chert	1.6	0	7.3	proximal fragment, bi-convex, bending snap at one end, incipient stacks, manufacturing reject
1082-17	IH jasper	2.4	0	4.7	proximal ragment, coarse-grained, limonitic, incipient stacks, manufacturing reject, burned later
1085-1	IH jasper	2.0	0	4.4	proximal fragment, perverse snap at limonitic inclusion, manufacturing reject
1053-2	IH jasper	n/a	0	3.1	lateral fragment, heavily burned, manufacturing reject
1091-4	IH jasper	4.4	0	1.6	medial fragment, multiple perverse fractures, manufacturing reject
1050-25	quartz	n/a	0	1.0	distal fragment, point tip, bending snap break, discard

Table 49 (cont'd). Bifaces Recovered from Area 1 Excavation Block.

Width:thickness ratios, often recorded as an direct indication of reduction stage, were similar across both early and late stage bifaces. For the early stage bifaces the range of width:thickness was 1.82-3.33, with a mean of 2.50; for late stage bifaces the range was 1.60-4.36, with a mean of 2.45 (in both cases the measurable sample was 5). The lack of distinctiveness in the biface types from Area 1 may signal a problem with the paradigm (that is, relative thickness may not be as closely related to reduction stage as supposed), or it may have been related to raw material characteristics (although raw material types were evenly distributed within the width:thickness ranges). More likely the finding indicated that the bifaces recovered from the Area 1 workshop were manufacturing rejects, discarded because they were too thick and proportionaltely too narrow to successfully thin further.

Analysis of raw material distribution among bifaces indicated that all but one of the early stage bifaces were of quartz, while the majority of late stage bifaces were of Iron Hill jasper (Figure 96). The latter distribution was almost identical to that of projectile points. This suggested that Iron Hill jasper was brought to the area in a relatively late stage of reduction and that little early stage knapping of this material was carried out, while finished tools were removed from the workshop area. Quartz may have been reduced for flake tools, implying that the early stage bifaces were actually flake cores. Corroboration for these explanations was sought from analysis of the character of the associated flaking debris recovered from the excavation block.

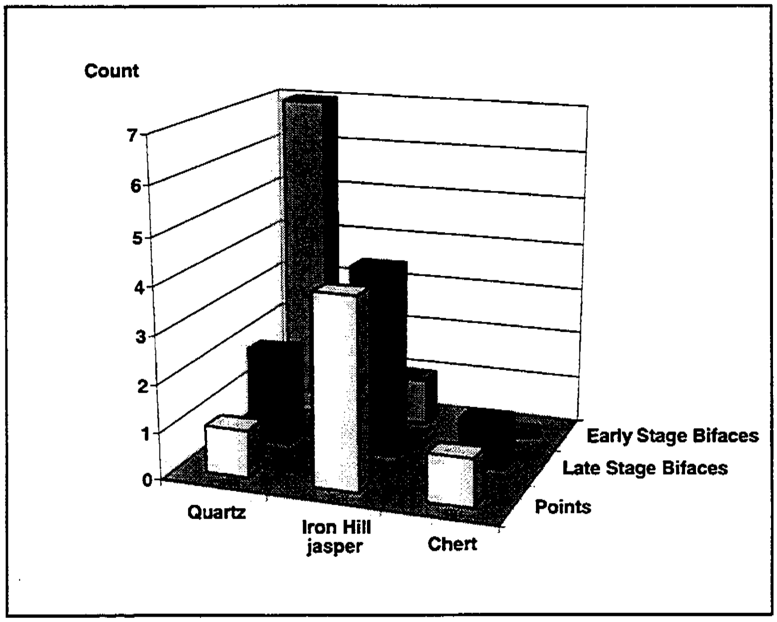

Figure 96. Raw Material Frequencies Among Bifacially Worked Artifacts

Uniface

The single uniface in the assemblage (1021-27) was made on a quartzite flake. One convex edge bore a minimal amount of trimming, and the bit produced along the edge bore an angle approaching 85 degrees.

Cores

Three cores were recovered from the excavation block. Their attributes are summarized in Table 50. The large quartzite core was part of a split cobble and had several flakes removed from the shear plane. The jasper and chert cores were considerably smaller and bore evidence of multi-directional flaking. The chert core retained pebble cortex.

Artifact #	*Material*	*Cortex(%)*	*Scars*	*Weight(gm)*	*Comments*
1067-5	quartzite	30	6	452.3	cobble, unidirectional, minimal flaking
1032-1	IH jasper	0	5	27.4	multidirectional
1094-1	chert	30	6	13.3	pebble, multidirectional

Table 50. Cores Recovered from Area 1 Excavation Block.

Flakes

Iron Hill jasper flaking debris comprised the largest proportion of chipped stone from the Area 1 excavation block at 70 percent (n=487). Most of the minority raw material types provided sample sizes that were too small for meaningful statistical analysis, but two variations were large enough to be selected. Quartz represented the most abundant raw material after Iron Hill jasper, comprising 19 percent of the flake assemblage (n=129), and so constituted a sample of adequate size. The composition of the second category, pebble material, resulted from field impressions of both flake-size distributions in the assemblage and the presence of remnant cortex, which together suggested that most of the quartz, quartzite, chert, and non-local jasper (i.e., jasper not derived from Iron Hill) had originated from pebble sources. On the assumption that reduction technologies would differ between outcrop jasper and pebble-based materials obtained from area stream beds, quartz, quartzite, chert, and pebble jasper were combined into a single analytical unit, representing 28 percent of the chipped stone (n=194). One goal of the flake analysis was objective confirmation of this assumption of differing reduction trajectories and techniques between Iron Hill jasper and pebble materials.

Figure 97 illustrates the size distribution of flakes based on weight for Iron Hill jasper, quartz, and all pebble material. Note that there is a change in the interval represented on the x-axis from 0.5gm to 5gm that occurs between 2 and 5gm, where the data are pooled. The consolidation in part accounts for the rise in the lines for Iron Hill apparent at this resolution. There were slightly fewer small jasper flakes, 41 percent weighing less than 0.5gm, as opposed to 48 percent for pebble material and 50 percent for quartz. The difference was made up in flakes in the middle weights, between 1 and 5gm. At both nid-range intervals there were almost twice as many Iron Hill jasper flakes as pebble flakes. While minor, these differences could signal either different reduction strategies or variations in the size of the raw material units. Further analysis of the data was conducted to investigate the patterns.

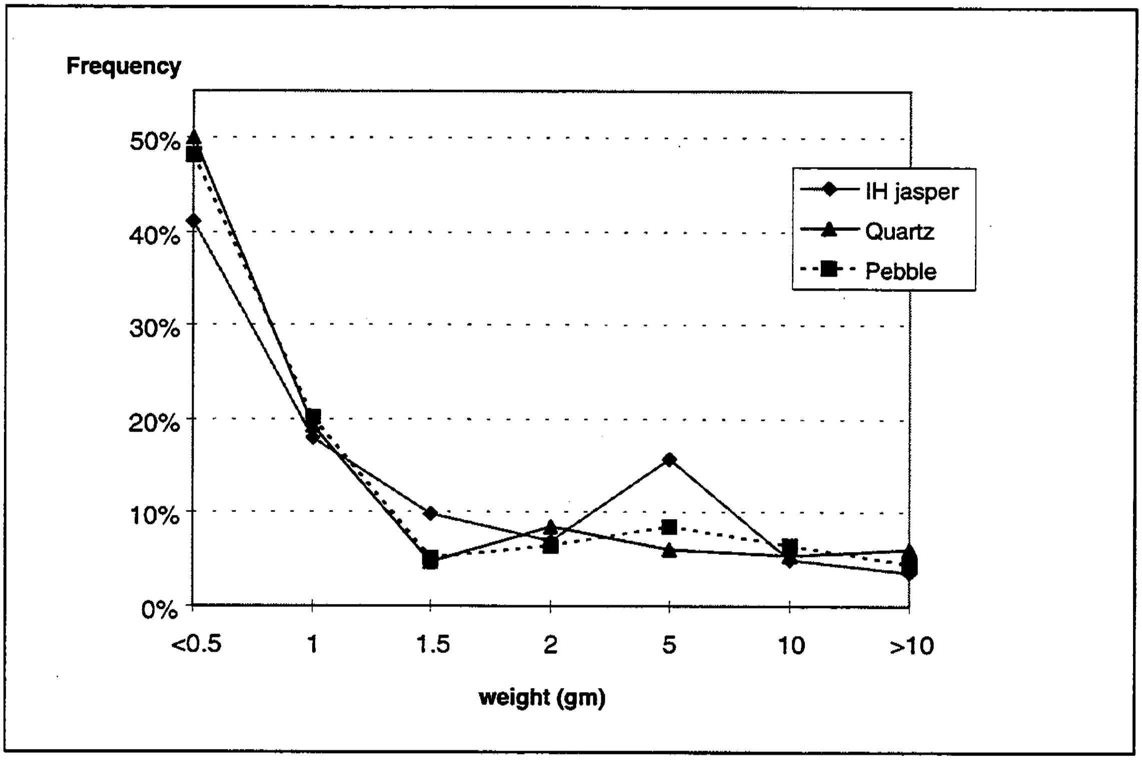

Figure 97. Area 1: Flake-Size Distribution, Size-Graded Data for Iron Hill Jasper, Quartz, and All Pebble Material

The size distribution of flakes based on linear dimension is illustrated in Figure 98, which shows a plot of size-graded data. Note that size-grade 4 comprises the smallest debris in the assemblage, defined as 0.33 cm and corresponding with the mesh opening of 1/8-inch wire screening fabric. Since 1/4-inch mesh was the smallest screening used in the field, the size-grade 4 material does not represent a systematic or complete sample. A similar fall-off for size-grade 4 debris can be seen for all three data sets, indicating the incomplete nature of each sample from that grade interval. Beyond this, the chart again shows a similarity in the distributions of the raw material types, although the frequency of Iron Hill jasper flakes in size-grade 2 was roughly double that of quartz or pebble material, indicating the presence of a greater number of large jasper flakes.

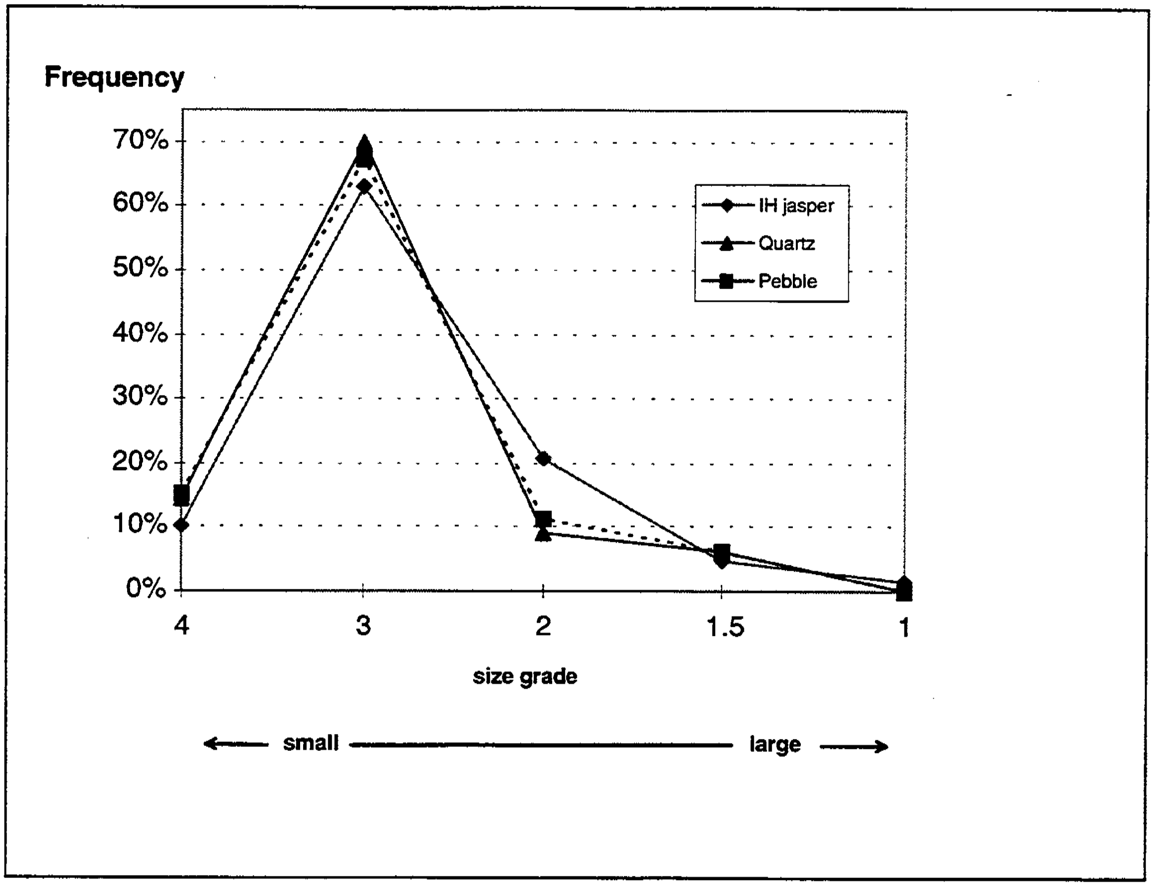

Figure 98. Area 1: Flake-Size Distribution, Size-Grade Data for Iron Hill Jasper, Quartz, and All Pebble Material

Examination of the weight distributions of the flakes comprising the size-grade 2 sample indicated that 84 percent of the Iron Hill jasper flakes in that size range weighed less than 5gm, in contrast to 50 percent of the pebble material. This implied that pebble flakes were on average heavier. Mean flake weights calculated for each size grade (Table 51) showed that the pattern held for each grade from which a complete sample was available—the mean weight of Iron Hill jasper flakes was consistently less than that of pebble material. Assuming little significant differences in raw material density, the implication was that the Iron Hill jasper flakes were proportionately thinner. This combined with the presence of more large jasper flakes indicated differences in the characterisitcs of the flaking techniques that produced the two types of debitage, either due to the type of raw material, the reduction strategy employed, or the form of the raw material units. A combination of these three variables suggests the presence of a substantial amount of biface reduction flakes, predominantly late stage, among the Iron Hill jasper debris, and bipolar debris among the pebble material.

Size Grade	IH jasper	Quartz	Pebble
1	16.8	n/a	n/a
1.5	8.5	15.2	10.2
2	3.5	6.3	4.8
3	0.7	0.8	0.8
4	0.2	0.2	0.2
grades 1-3	2.0	2.4	2.1

Table 51. Mean Flake Weight per Size Grade, Area 1

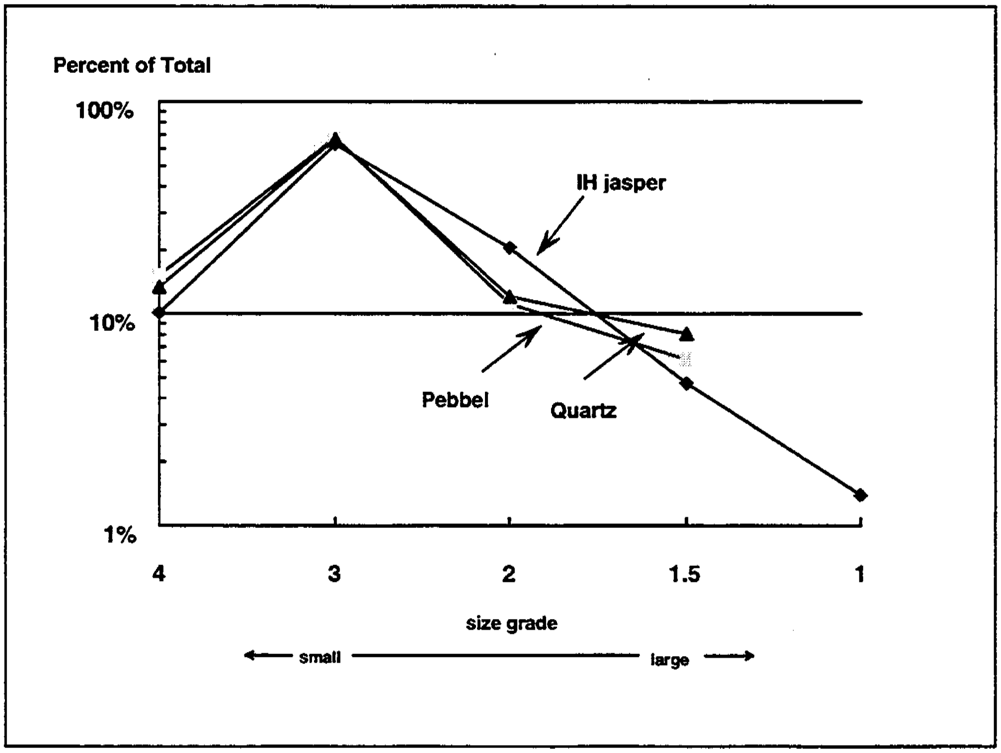

Figure 99. Area 1: Semi-Log Plot of Flake-Size Distribution, Size-Graded Data for Iron Hill Jasper, Quartz, and All Pebble Material

To further examine the difference in reduction technologies represented in the assemblage, the flake size distributions were plotted on a semi-log graph (Figure 99). As noted above, Patterson argues that biface reduction results in a straight-line plot on such a chart, while core or other reduction procedures exhibit more irregular plots. In the present case, the plot for Iron Hill jasper was relatively straight, except for the portion representing size-grade 4, which was incomplete. The plots for quartz and for pebble material were less regular than the Iron Hill jasper plot. Following Patterson's model, the

Iron Hill jasper debitage from the assemblage appeared to contain more material from a biface trajectory than did the pebble material.

Additional attribute data were collected from the flake assemblage which lent support to the conclusion that the Iron Hill jasper debitage recovered from Area 1 resulted more frequently from biface reduction than did the quartz or other pebble material. For example, the frequency of occurrence of remnant cortex on flakes was lower for Iron Hill jasper than for quartz or for pebble material (Table 52). This finding was clearly related to the initial form of the raw material. That is, little or no cortex was expected among flakes from outcrop material such as Iron Hill jasper (most of the cortex identified on these flakes was in fact remnant limonitic material from the outcrop within with the jasper occurs). In contrast, higher frequencies of cortical flakes would be expected from pebble raw material.

Cortex	**IH jasper**	**Quartz**	**Pebble**
Absent	96	71	70
Present	4	29	30
Platform Type	**IH jasper**	**Quartz**	**Pebble**
Simple / 2 Facet	49.	38	34
Complex / Bifacial	35	8	16
Cortical	1	19	19
Crushed	15	35	31
Segment	**IH jasper**	**Quartz**	**Pebble**
Whole	28	28	31
Broken	72	72	69

Table 52. Area 1: Additional Flake Attributes: Remnant Cortex, Platform Type, and Completeness, Listed as Percentages

Flake platform type is often viewed as directly related to reduction strategy—in general, the level of complexity is equated with the goal and stage of reduction. In the present analysis, two main levels of complexity were recognized as significant: simple, including single and two-facet platforms; and complex, or multi-faceted and bifacial platforms. Two additional platform types, cortical and crushed, were recorded for separate technological information. The frequency of occurrence of simple platfoms in the assemblage was roughly equivalent among the material types, if slightly higher for Iron Hill jasper flakes. The proportions of the remaining platform types were unequal, with a notably greater frequency of bifacial platforms occurring among Iron Hill jasper flakes, and more cortical and crushed platforms among pebble materials. Bifacial platforms are typically considered the most obvious attribute of bifacial reduction, particularly in later stages, while cortical and crushed platforms are often characteristic of early stage reduction or flake manufacture. The frequencies of cortical platforms among the raw material types in the present assemblage mirrored the general frequency of cortical flakes and reflected the form of the raw material. The presence of crushed platforms was an indication of percussor type and percussion technique, crushed platforms resulting more frequently from hard-hammer percussion than from soft-hammer or billet flaking. Hard-hammer percussion is in turn typically associated with initial core reduction and early stage biface manufacture. Flake platform crushing is also typical of bipolar reduction.[1] The presence of more crushed platforms on quartz and other pebble flakes in the Area 1 assemblage suggested a greater incidence of hard-hammer or bipolar percussion in the reduction of those material types. It was assumed that if the non-Iron Hill jasper debris included substantial amounts of material from earlier reduction stages, there would be a higher ratio of simple to complex platforms (more simple platforms) among those materials. As Table 52 indicates, pebble flakes showed a relatively low percentage of simple platforms, which may have been due to the fact that many of the early stage flakes in fact bore crushed or cortical platforms. In the end, platform attribute data supported the notion that most of the non-Iron Hill jasper flaking debris resulted from pebble reduction while most of the Iron Hill jasper debris resulted from biface reduction.

Another basic assumption in the description of biface reduction debris is that biface reduction results in flakes with more acute platform angles than does a core/flake technology. Likewise, the further along the reduction sequence, the thinner the resulting biface and the more acute the platform angles of the debitage. A higher frequency of acute angles was in fact observed among Iron Hill jasper flakes than among quartz or pebble flakes (Figure 100). The difference was not marked, yet 70 percent of the Iron Hill jasper flakes had platform angles of 70 degrees or less in contrast to just over 55 percent of flakes of pebble material. To assess the significance of the difference, a chi-square test was run using the count data on which the frequency distributions were based which there indicated that there was no statistically signifcant difference in the platform angles between the two materials.

[1] Note that crushed flake platforms can also result from pressure flaking, yet flakes the size of pressure flakes, size-grade 4, comprised a sufficiently small proportion of the assemblage that they would not have affected the interpretation.

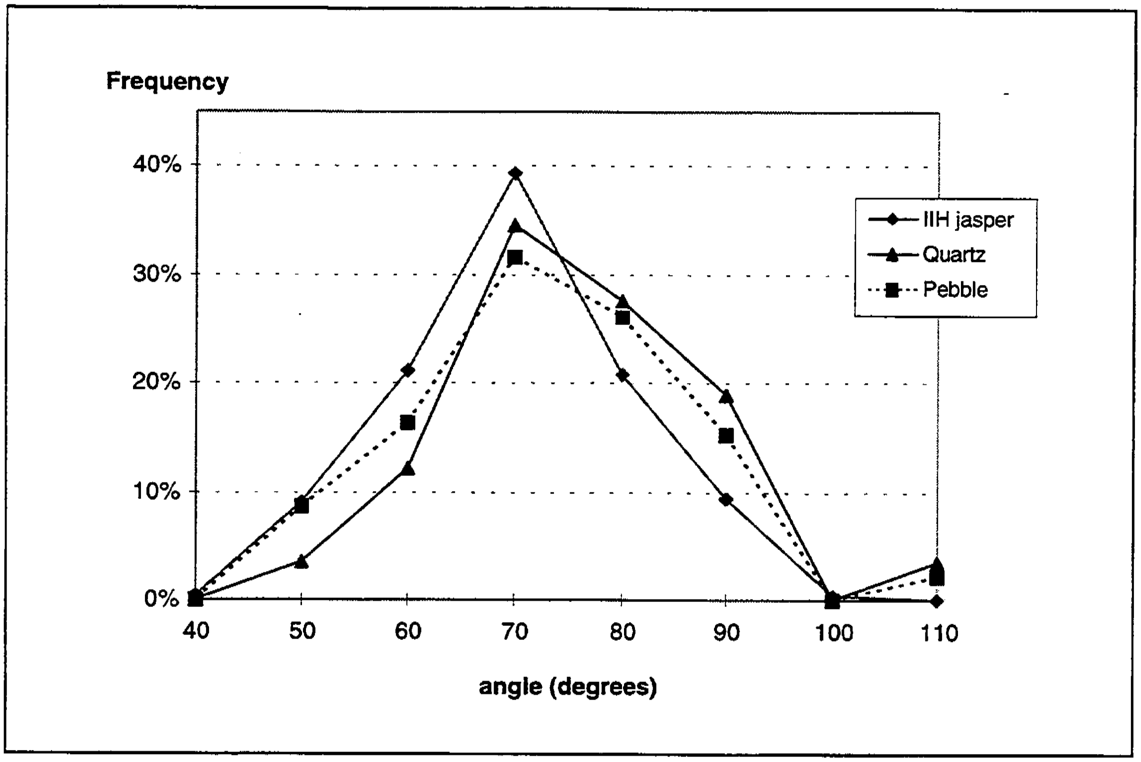

Figure 100. Area 1: Flake Platform Angles for Iron Hill Jasper, Quartz, and All Pebble Material

Flake completeness, recorded here as segment, has also been cited as an indicator of reduction strategy, with whole flakes presumed to be more representative of core/flake technology, and broken flakes more representative of biface technology. In the current assemblage, the relative frequencies of whole and broken flakes among the raw material types were virtually identical (Table 52). Assuming the direct relationship between flake segment and reduction trajectory to be valid, this finding suggested that there was no difference among the raw materials in the reduction technologies employed in Area 1. Judging from most of the previous evidence presented, there was a indeed difference in the assemblage between the reduction trajectories of Iron Hill jasper and pebble-based material, bringing the flake segment/reduction technology relationship into question. The ratio of flakes to chips, the latter defined as flaking debris without recognizable flake attributes, showed some variation: 30.4 for Iron Hill jasper, 4.6 for quartz, indicating more chips in relation to flakes among the quartz debris. Arguably this was due to a combination of the quality of the raw material, in that quartz tends to shatter more readily than cryptocrystalline material such as jasper, and the form of the raw material. In the latter instance it is assumed that quartz occurred in pebble form and thus required bipolar flaking to initate reduction, resulting in more large and chunky fragments liable to have no flake characteristics.

A final set of flake attributes was recorded, in this case documenting flake scar complexity. Like platform attributes, the patterning of dorsal flake scars is presumed to be correlated with manufacturing stage, greater complexity being equated with later reduction stages. Two variables were recorded: count, the number of dorsal flake scars; and orientation, the number of directions from which the flakes were removed. As recommended by Shott (1994), both variables were corrected for flake size, here by dividing by size-grade. The distributions of the corrected data showed a considerable amount of variation. The frequency curve for flake scar count peaked at a level of 2 for Iron Hill jasper flakes, in contrast to 1 for quartz or all pebble materials (Figure 101). Moreover, a higher proportion of pebble flakes lay at the low end of the graph at a level between 0 (indicating cortical flakes) and 0.3. To test the significance of the differences in the scar counts, the chi-square statistic was calculated for the Iron Hill jasper and pebble data, and the results implied that the distributions were statistically different.

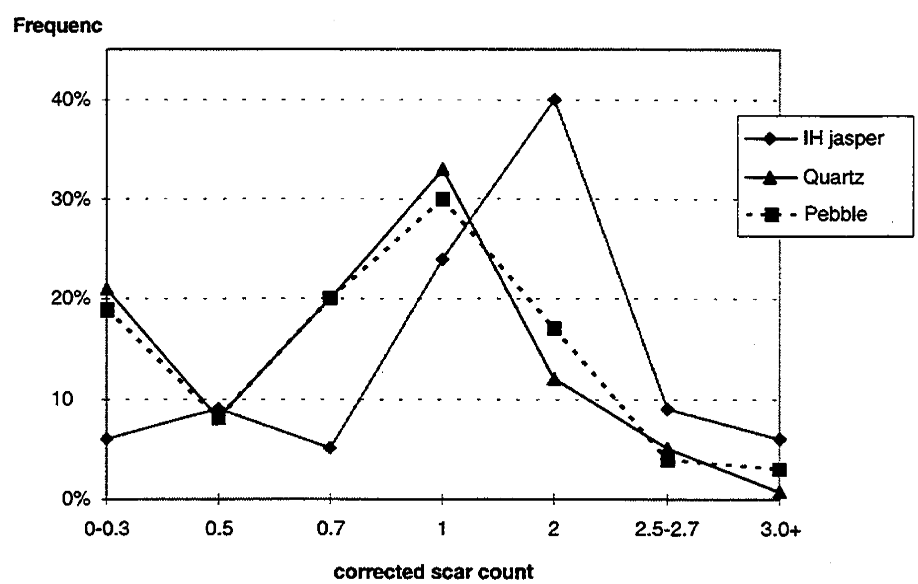

Figure 101. Area 1: Dorsal Flake Scar Counts for Iron Hill Jasper, Quartz, and All Pebble Material

It was assumed that flake scar orientation would correlate closely with scar count data. Yet the distribution curves for scar orientation among the three material types did not show the same variation as did the count curves (Figure 102). There was a slightly higher percentage of quartz flakes near the low end of the graph, indicating more quartz flakes with simple orientation patterns. The remainder of the variation occurred at the high end of the scale, where a greater proportion of Iron Hill jasper flakes displayed complex scar patterning. These differences were sufficient to raise chi-square statistics calculated for Iron Hill jasper flakes versus quartz and versus pebble material above table values, indicating statistical differences in both cases. Assuming that different reduction technologies are indeed represented, these results indicate that dorsal scar complexity is most notable at the extreme ends of the scale—cortical flakes and those with simple flake scar patterns resulting more frequently from core reduction or perhaps initial biface reduction, and flakes with more complex scar patterns generally resulting from biface reduction, particularly the later stages.

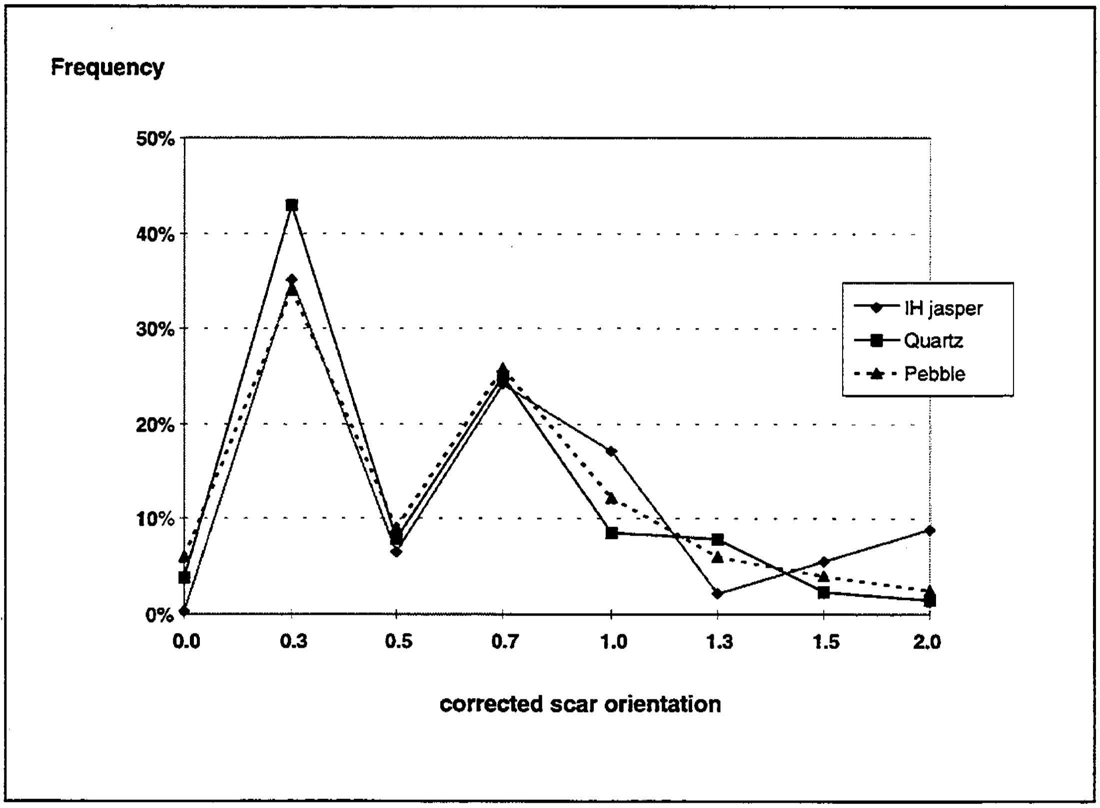

Figure 102. Area 1: Dorsal Flake Scar Orientations for Iron Hill Jasper, Quartz, and All Pebble Material

Evidence of heat treatment was recognized in the Iron Hill jasper debitage in the form of changes in color and texture. Iron Hill jasper is typically brown to yellow in color. It contains substantial amounts of hematite, a mineral that dehydrates when heated, turning dark red in color. Extensive burning of the jasper may result in the development of a glossy surface texture, often in combination with crazing or a gray coloration.

Approximately 35 percent of the Iron Hill jasper debitage from the Area 1 block excavation bore one or more of these characteristics, suggesting that part of the Iron Hill jasper assemblage had been heat treated during the reduction process.

In summary, cortical frequency and flake-size distribution data suggested that quartz and several other minority lithic raw materials from Area 1 did indeed originate from pebbles. Granting the validity of Patterson's interpretation of flake-size distribution graphs, the Iron Hill jasper in the assemblage appeared to have been the result of biface reduction, while the pebble material resulted from a core/flake technology. The size of the raw material units prior to reduction—how the material was brought to the site—is key to this interpretation. The initial stages of the reduction of small pebbles would often require bipolar flaking, resulting in the production of more large, thick debris. This material would have the effect of forcing up the right-hand tail of the size distribution graph (size-grade 1.5); that is , it would force the graph out of a straight-line trajectory. Thus, even if biface manufacture were a component of the pebble industry in this area of the site, the flaking debris would tend to bear more of the size-distribution attributes of a core/flake industry. Flake platform characteristics of the debitage supported the notion of more biface reduction debris among the Iron Hill jasper flakes. More complex platform types occurred among that material, including more remnant bifacial edges. In addition there was a greater frequency of occurrence of acute platform angles. Analysis of flake completeness was inconclusive, probably due in part to the inability to account statistically for the specific flaking characteristics of the raw material types (quartz is crystalline in structure and tends to shatter more readily than jasper). Dorsal flake scar data also lent support to the notion of a difference in reduction technologies, although the results of this analysis were not as clearcut as those of previous attributes. While there was a degree of statistical support for a difference in complexity in dorsal flake scar patterning between Iron Hill jasper and pebble flakes, the archaeological implications were unclear. In all, though, the notion of a biface trajectory for Iron Hill jasper in the Area 1 assemblage and a core/flake technology for quartz and other pebble material appeared to be supported by detailed flake analysis.

Raw material distribution analysis of bifaces in the assemblage indicated a high frequency of quartz among early stage bifaces and a higher frequency of Iron Hill jasper among late stage bifaces and projectile points. Combined with flake attribute analysis, the implication drawn was that Iron Hill jasper was brought to Area 1 in a relatively finished form, as late stage bifaces. While the full size range of Iron Hill jasper debitage was recovered, large Iron Hill jasper flakes were typically thinner than similar sized quartz flakes. While this may be partially accounted for by the flaking characteristics of the materials, it also suggests that Iron Hill jasper flakes were more often the result of thinning rather than of early stage reduction.

Intersite Comparative Analysis

Artifact assemblages from two sites, the Brennan site (7NC-F-61A) and Paradise Lane (7NC-D-125), were chosen for comparative analysis with the materials from Area 1 at Lums Pond. The choice of sites was made on the basis of geographic proximity to Lums Pond, as well as the similarities in the artifact assemblages. The Brennan site (Watson and Riley 1994) consisted of a small, secondary quarry reduction locale that was presumed to have been occupied during the early portion of the Woodland I period. Of over 1900 pieces of debitage recovered from the site, 98 percent were reported to consist of Iron Hill jasper. The Paradise Lane site (Riley et al. 1994) was more extensive, described as a staging/processing station, and was occupied somewhat later in the Woodland I (AD 400-1000). More than 10,000 artifacts were recovered at Paradise Lane, and of those 97 percent were reported as jasper flakes. Although an explicit distinction was not made, it is assumed that Iron Hill jasper made up a large part of the sample. Note should be made of sample size differences: the Lums Pond sample is the total sample of Iron Hill jasper from the excavation block (n=487), while the Brennan site analysis was based on a sub-sample of 200 flakes, just over 10 percent, and the Paradise Lane analysis on a sub-sample of 100 flakes, less than 1 percent. These latter two samples were referred to as random; the process used to randomize them was not described.

Artifact type frequencies and raw material distributions at the three sites are summarized are summarized in Tables 53 and 54.[2] Type frequencies showed considerable variation, at first glance suggesting differences in function between Lums Pond and the comparison sample. Flakes comprised almost 99 percent of the assemblages at Brennan and Paradise Lane, 88 percent at Lums Pond. Fire-cracked rock accounted for most of the difference—9 percent at Lums Pond, in contrast to less than 1 percent at Brennan or Paradise Lane. Moreover, there was substantially more lithic raw material variation documented at Lums Pond.

---

[2] For the Paradise Lane data, tables presented in the text of the report and the overall inventory in Appendix IV did not match; the differences appeared proportional throughout the assemblage, and so the former were chosen to provide the largest sample

	Lums Pond Area 1		Brennan		Paradise Lane	
artifact type	count	frequency	count	frequency	count	frequency
flake	798	88.3	1911	98.7	10240	99.0
fire-cracked rock	81	9.0	15	0.8	52	0.5
biface	15	1.7	6	0.3	30	0.3
point	5	0.6	0	0.0	9	0.1
core	4	0.4	3	0.2	12	0.1
uniface	1	0.1	1	< 0.1	2	< 0.1
other tools	0	0.0	1	< 0.1	1	< 0.1
hammerstone	0	0.0	1	< 0.1	0	0.0
TOTAL	904		1937		10346	

Table 53. Frequency Distributions of Artifact Types: Lums Pond, Area 1; Brennan; Paradise Lane

	Lums Pond		Brennan		Paradise Lane	
raw material	count	frequency	count	frequency	count	frequency
Iron Hill jasper	521	63.3	1890	98.3	10294	97.3
quartz	168	20.4	7	0.4	229	2.2
jasper	62	7.5	0	0.0	0	0.0
chert	29	3.5	2	0.1	28	0.3
quartzite	24	2.9	11	0.6	22	0.2
argillite	6	0.7	0	0.0	0	0.0
andesite	6	0.7	0	0.0	0	0.0
gabbro	3	0.4	0	0.0	0	0.0
chalcedony	2	0.2	10	0.5	3	< 0.1
rhyolite	1	0.1	2	0.1	0	0.0
slate	1	0.1	0	0.0	0	0.0
TOTAL	823		1922		10576	

Table 54. Frequency Distributions of Lithic Raw Material Types: Lums Pond, Area 1; Brennan; Paradise Lane

Detailed comparative analyses of the jasper flaking debris from the sites was conducted for insights into the apparent differences in the site assemblages. Several of the flake attribute categories were in fact difficult to compare. In the documentation of the two comparative sites, flake attribute data was reported across all material types; e.g, the frequency of complete flakes was reported as a proportion of all flakes, without regard to material type. Likewise, some platform data was reported across all flake segments. Since jasper flakes made up such a large percentage of the flakes at these sites, only a slight inaccuracy was expected in the percentage calculations, small enough to be of little interpretive consequence, yet it was understood that the figures were diluted somewhat by extraneous information.

Comparisons of central tendency statistics and a series of chi-square tests were conducted on data from each pair of sites to assess the differences in several of the recorded flake attributes. The results of the analyses are reported below.

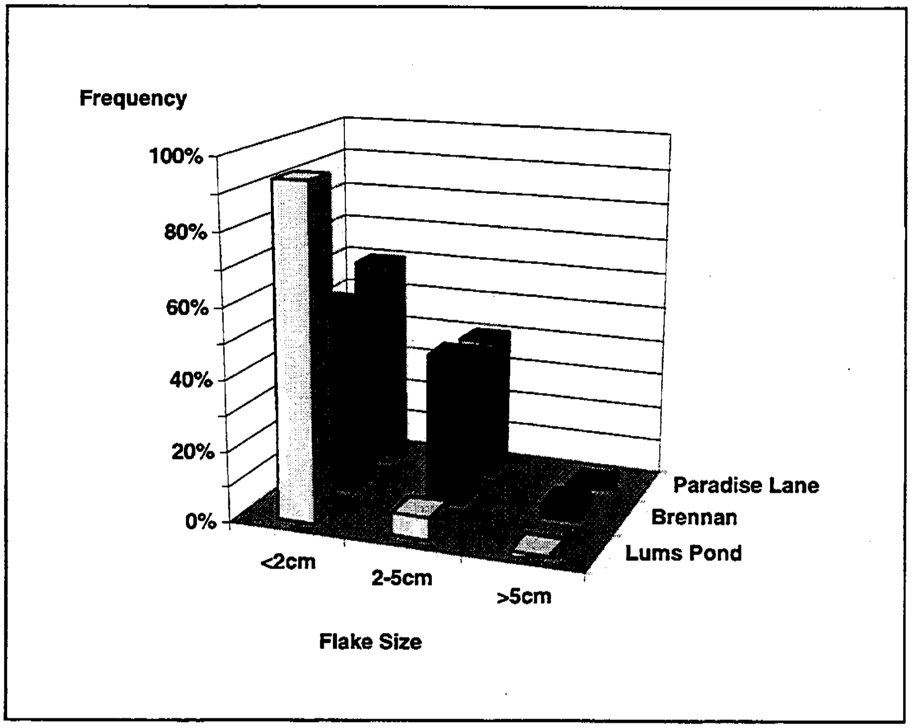

Figure 103. Comparison of Iron Hill Jasper Flake Size Distributions as Measured by Size-Grade

Flake Size Distribution: As indicated in Figure 103, the size distribution of Iron Hill jasper flakes in the Lums Pond assemblage was heavily skewed toward the small end of the grade scale in comparison to those from Brennan or Paradise Lane. Three size grades were used in the analysis to conform with the grades reported for the comparison sites, and the Lums Pond data were converted from standard mass analysis size grades (the conversion was not precise, but the imprecision was at the high end of the scale and thus did not affect the variation seen in the data). The analysis indicated that most of the jasper flakes at Lums Pond, almost 94 percent, measured less than 2cm. In contrast, that grade accounted for 54 percent at Brennan, 60 percent at Paradise Lane.

Lums Pond / Brennan:	ChiSq = 156.25 ChiSq Prob. = 0.000 df = 2	==> (unequal distribution)
Lums Pond / Paradise Lane:	ChiSq = 90.46 ChiSq Prob. = 0.000 df = 1	==> (unequal distribution)
Brennan/ Paradise Lane:	ChiSq = 4.03 ChiSq Prob. = 0.133 df = 2	==> (equal distribution)

Calculation of χ^2 statistics from count data from each pair of sites confirmed what was apparent from the proportions, that the Brennan and Paradise Lane distributions were similar, while Lums Pond was different from either of the two.

Remnant Cortex: All three site assemblages were similar in terms of the frequency of occurrence of flakes with remnant cortex. Only 4% of the jasper flakes at Lums Pond exhibited cortex, while none were reported in the samples from the comparison sites. The zero percentage figures are slightly misleading, since the numbers were calculated from small samples. Total population figures were listed elsewhere in the respective site reports and indicated that 0.7% of the jasper flakes at Brennan were cortical, and .04% were cortical at Paradise Lane. Thus cortical flake frequencies at the sites were not zero, but were nonetheless minimal.

Completeness: There were more broken jasper flakes in the Lums Pond assemblage (73 percent) than at either of the comparison sites (Brennan 67 percent, Paradise Lane 57 percent). Statistical tests performed on the count data suggested that among the three sites, the difference between the Lums Pond and Paradise Lane assemblages was significant:

Lums Pond / Brennan:	ChiSq = 2.28 ChiSq Prob. = 0.131 df = 1	==> (equal distribution)
Lums Pond / Paradise Lane:	ChiSq = 9.17 ChiSq Prob. = 0.002 df = 1	==> (unequal distribution)
Brennan/ Paradise Lane:	ChiSq = 2.59 ChiSq Prob. = 0.107 df = 1	==> (equal distribution)

A further point of interest was the occurrence of a larger proportion of proximal fragments in the Lums Pond assemblage—37 percent, in contrast to Brennan, 22 percent, Paradise Lane, 28 percent. It would seem safe to assume that the percentage of fragment types would be similar across the assemblages, unless proximal sections were removed for some unlikely reason. One possible, if non-archaeological, explanation may lie in variations in cataloging techniques.

Platform Preparation: The proportion of flakes exhibiting platform preparation was relatively close between the Lums Pond and Paradise Lane assemblages, at 14 percent percent and 13 percent respectively. The proportion at Brennan, 6.5 percent, was lower, even though a statistical test suggested that the difference was mathematically insignificant:

Lums Pond / Brennan:	ChiSq = 1.27 ChiSq Prob. = 0.259 df = 1 ==> (equal distribution)
Lums Pond / Paradise Lane:	ChiSq = 0.05 ChiSq Prob. = 0.817 df = 1 ==> (equal distribution)
Brennan/ Paradise Lane:	ChiSq = 1.18 ChiSq Prob. = 0.277 df = 1 ==> (equal distribution)

Platform Type: Comparable information on platform type from the two comparison sites was related to remnant bifacial edges. Whole and proximal jasper flakes from the Lums Pond assemblage showed a considerably greater frequency of platforms with bifacial edge remnants—35 percent, in contrast to 5 percent at Brennan, and 1 percent at Paradise Lane. Such a finding is generally considered evidence of a higher incidence of biface reduction.

Dorsal Flake Scars: As Table 55 below suggests, jasper flakes at Lums Pond exhibited a greater degree of complexity on their dorsal surfaces than did those from either Brennan or Paradise Lane. The implication is that on average, the flakes resulted from later stages of biface reduction.

Scar Count	*Mean*	*Std. Dev*	*CV*
Lums Pond	3.22	1.56	48
Brennan	1.78	0.78	44
Paradise Lane	2.14	1.35	63
Scar Direction	*Mean*	*Std. Dev*	*CV*
Lums Pond	1.97	1.07	54
Brennan	1.51	0.7	46
Paradise Lane	1.83	1.05	57

Table 55. Dorsal Flake Scar Complexity: Lums Pond, Area 1; Brennan; Paradise Lane

An additional measure of central tendency, the coefficient of variation, is reported in the third column of the table. This statistic is equivalent to the ratio of the standard deviation to the mean, and tends to counter the effect of a large mean on the standard deviation. The standard deviation for dorsal scar count at Lums Pond suggested a wider range of variation than in the Paradise Lane assemblage, yet the mean was larger for the Lums Pond data. The coefficient of variation indicated a more accurate picture, in which the variation at Lums Pond was in fact somewhat less than at Paradise Lane.

In summary, Iron Hill jasper flakes from the assemblage recovered from Area 1 at Lums Pond differed in a number of diagnostic attributes from similar assemblages at the Brennan or Paradise Lane sites. The Lums Pond jasper assemblage contained more small flakes, more broken flakes, and more flakes with remnant bifacial platforms. In addition, the flakes from Lums Pond exhibited more dorsal flake scar complexity. These findings combined suggested that the Iron Hill jasper debris from Lums Pond resulted from later stages in a biface reduction sequence than did the material from the comparison sites. That there was little difference in the frequency of remnant cortex between the assemblages would appear to reflect the outcrop source of the raw material, on which little cortex would be expected.

AREA 2

Of the 5245 prehistoric artifacts recovered from Area 2, approximately 53 percent consisted of chipped stone debris, the remainder comprising fire-cracked rock, hammerstones and anvil-stones, and fragments of prehistoric ceramic. Area-wide frequencies are listed in Table 56, and lithic raw material frequencies are detailed in Table 57. Raw material types among the flaking debris included quartz, jasper, chert, ironstone, quartzite, argillite, chalcedony, rhyolite, andesite, and slate, in descending order of frequency. Note that the frequency of Iron Hill jasper has been listed separately from that of other jasper materials. Descriptive statistics summarizing the main artifact types follow. Detailed analysis of flake attributes was not undertaken for the general run of artifacts from Area 2 since the multicomponent nature of the collective material made separation of individual chronological assemblages impractical.

Artifact Type	Count	Frequency(%)
Fire-Cracked Rock	2440	46.5
Flakes	2292	43.7
Chips (Potlids)	309	7.5
Points	34	0.6
Bifaces	31	0.6
Ceramic Fragments	25	0.5
Cores	13	0.2
Unifaces	11	0.2
Hammerstones	6	0.1
Anvilstones	2	0.1
Total	5245	

Table 56. Artifact Frequencies, Area 2

Raw Material	Count	Frequency(%)
Quartz	1058	38.0
Iron Hill jasper	643	23.1
Chert	358	12.9
Jasper	229	8.3
Ironstone	158	5.7
Quartzite	186	6.7
Argillite	81	2.9
Chalcedony	35	1.2
Rhyolite	24	0.9
Andesite	7	0.3
Slate	1	0.0
Total	2780	

Table 57. Chipped Stone Raw Material Frequencies, Area 2

Projectile Points

Forty-one projectile points or point fragments were recovered from Area 2. Details are summarized in Table 58. Raw material frequencies differed from those of the chipped stone debitage across the area, the main variation coming in the proportions of the majority lithic types, quartz and Iron Hill jasper (Table 59). Quartz comprised the highest proportion of the debitage from Area 2, but a smaller proportion of the points. In contrast, Iron Hill jasper comprised the greatest proportion of points and a substantially smaller percentage of the debitage. These data reflect area-wide frequencies, and take no account of the various temporal components represented.

Artifact #	*Material*	*Type*	*W:Th*	*Weight(gm)*	*Comments*
2052-1	quartz	Bare Island	2.5	5.1	Hafting element and part of blade, straight-to-slightly expanding stem, slightly convex base, rounded shoulders, transverse snap above shoulders, discard
2443-1	chert	Brewerton	2.4	3.3	Complete, wide side notches, straight base, assymetrically reworked blade, discard
2452-1	rhyolite	Brewerton	3.7	5.9	Complete, thin, side-notched, straight base, one shoulder and one basal tang damaged, slightly convex and reworked blade edges, discard

Table 58. Descriptive Statistical Data: Projectile Points Recovered from Area 2

Artifact #	*Material*	*Type*	*W:Th*	*Weight(gm)*	*Comments*
2343-2	IH jasper	Fishtail	2.1	3.7	Complete, expanding stem, damaged shoulders, slightly convex base, convex blade edges, manufactured on bending flake, reject
2153-1	jasper	Lamoka	1.9	7.8	Complete with short, straight-sided stem, prominent shoulders, convex base with pebble cortex, straight blade edges, minor transverse snap at tip
2379-1	chert	Lamoka	2.6	4.6	Complete, straight-to-slightly expanding stem, straight base, prominent shoulders, straight assymetrically resharpened blade edges, minor distal snap, discard (Onondaga chert?)
2001-1	jasper	Lamoka	2.0	4.1	Complete, straight-sided stem, unfinished base, convex blade edges, discard
2034-1	ironstone	Long-Bladed		11.7	Distal fragment, long, straight-sided blade, step-fractures, percussion flaking, transverse snap, reject
2045-1	quartz	Long-Bladed		5.9	Distal fragment, long, straight-sided blade, step-fractures, percussion flaking, transverse snap, reject
2163-1	IH jasper	Long-Bladed		4.3	Distal fragment, convex blade edges, prominent medial ridges, extensive potlids (postdepositional), reject
2011-1	IH jasper	Long-Bladed		5.1	Medial fragment, straight-sided blade, medial ridges, bending snap at distal end, overshot flake scar at proximal end, reject
2176-1	ironstone	Poplar Island	2.5	9.2	Hafting element and blade fragment, long contracting stem, straight blade edges, oblique snap at distal end, discard
2174-1	IH jasper	Poplar Island	2.1	18	Complete, slightly contracting stem, convex base, straight blade edges, medial ridge, several stacks, minor bending snap at distal end, discard

Table 58 (cont'd). Descriptive Statistical Data: Projectile Points Recovered from Area 2

Artifact #	*Material*	*Type*	*W:Th*	*Weight(gm)*	*Comments*
2202-1	quartzite	Poplar Island	2.3	6.6	Complete, long contracting stem, one sharp and one rounded shoulder, medial ridge, assymetrically reworked blade, discard
2343-1	quartzite	Poplar Island	1.7	8.8	Complete, contracting stem, damaged base, straight blade edges, medial ridges, stacks, minor distal snap, discard
2395-1	quartzite	Poplar Island	1.9	7.5	Complete, contracting stem, rounded base, prominent shoulders (one damaged), extensively reworked blade, one medial ridge, distal end reworked as awl or drill, discard
2594-1	argillite	Poplar Island	2.8	14.9	Complete, contracting stem, rounded base, prominent shoulders, straight but slightly assymetrical blade edges, one medial ridge, original flake scar on opposite face, discard
2009-1	quartzite	Stark	3.1	7.2	Complete, contracting stem, snapped base, prominent-to-sharp shoulders, stratight blade edges, damage and rework along one blade edge, haft wear, discard
2180-1	chert	Teardrop	2.3	2.5	Nearly complete, convex base and blade edges, oblique bending , snap at distal end, discard
2030-1	quartz	Teardrop	2.4	2.5	Complete, convex base and blade edges, cortex on one face, minor damage to base, distal end resharpened, reject
2149-1	chert	Teardrop	2.1	3.3	Complete, convex base and blade edges, reject
2349-1	IH jasper	Teardrop	3.4	2.4	Complete, convex base and blade edges, incompletely thinned base, discard
2377-1	quartz	Teardrop	2.0	3.8	Complete, convex base, straight-to-slightly convex blade edges, reject

Table 58 (cont'd). Descriptive Statistical Data: Projectile Points Recovered from Area 2

Artifact #	*Material*	*Type*	*W:Th*	*Weight(gm)*	*Comments*
2058-1	IH jasper	Triangle	3.3	3.3	Complete, equilateral triangle, slightly convex blade edges and base, large knot remaining on one edge, reject
2061-3	quartz	Triangle	2.4	2.9	Complete, isoceles triangle, straight blade edges, damaged base, minor perverse snap at tip
2446-2	chert	untyped	n/a	0.6	Distal fragment, oblique snap break
2233-20	quartzite	untyped	n/a	3.1	Distal fragment, straight-sided blade edges, transverse snap break
2001-2	IH jasper	untyped	n/a	2.6	Distal fragment, thin, finely flaked, convex blade edges, perverse snap at flaw
2160-1	IH jasper	untyped	n/a	1.5	Distal fragment, straight-sided blade edges, oblique snap break at flaw
2103-1	IH jasper	untyped	n/a	0.9g	Distal fragment, straight-sided balde edges, thin and finely flaked, extensive potlid damage (postdepositional)
167-1	ironstone	untyped	n/a	3.2	Distal fragment, straight blade edges, minor snap at distal end, transverse snap break at proximal end
2345-1	IH jasper	untyped	2.4	4.4	Complete, wide, straight-sided stem, straight base, rounded shoulder, convex blade edge, one edge heavily reworked from distal end to stem, discard
2106-1	jasper	untyped	2.1	4.3	Complete, straight stem, convex base, rounded shoulder, one edge heavily reworked from distal end to stem, discard
2123-1	quartz	untyped	n/a	1.6	Proximal fragment, convex base, corner-notched, well-ground notches, oblique bending snap across neck, discard
2016-1	quartz	untyped	n/a	0.5	Distal fragment, oblique snap break

Table 58 (cont'd). Descriptive Statistical Data: Projectile Points Recovered from Area 2

Nonetheless, the figures demonstrate a technological pattern cross-cutting chronology in which cryptocrystalline stone, particularly the locally procured outcrop jasper, was used more frequently for projectile point production that crystalline quartz. The remainder of the material types were minority raw materials and were present in roughly the same ratio of points to debitage.

	debitage	projectile points
quartz	40	24
IH jasper	19	32

Table 59. Comparison of Frequencies of the Majority Lithic Raw Materials within Artifact Categories from Area 2. Data Are Displayed as Percentages of Raw Material within Each Artifact Type

Typologically identifiable points were attributable to several portions of the Woodland I period, with the highest frequencies related to the Woodland I Clyde Farm complex (Figure 104). Detailed consideration of the point types and their chronological implications is included in a separate section below. At this time it should be noted that in Figure 104, several long-bladed point fragments not assignable to a specific stylistic type have been included with the Woodland I material.

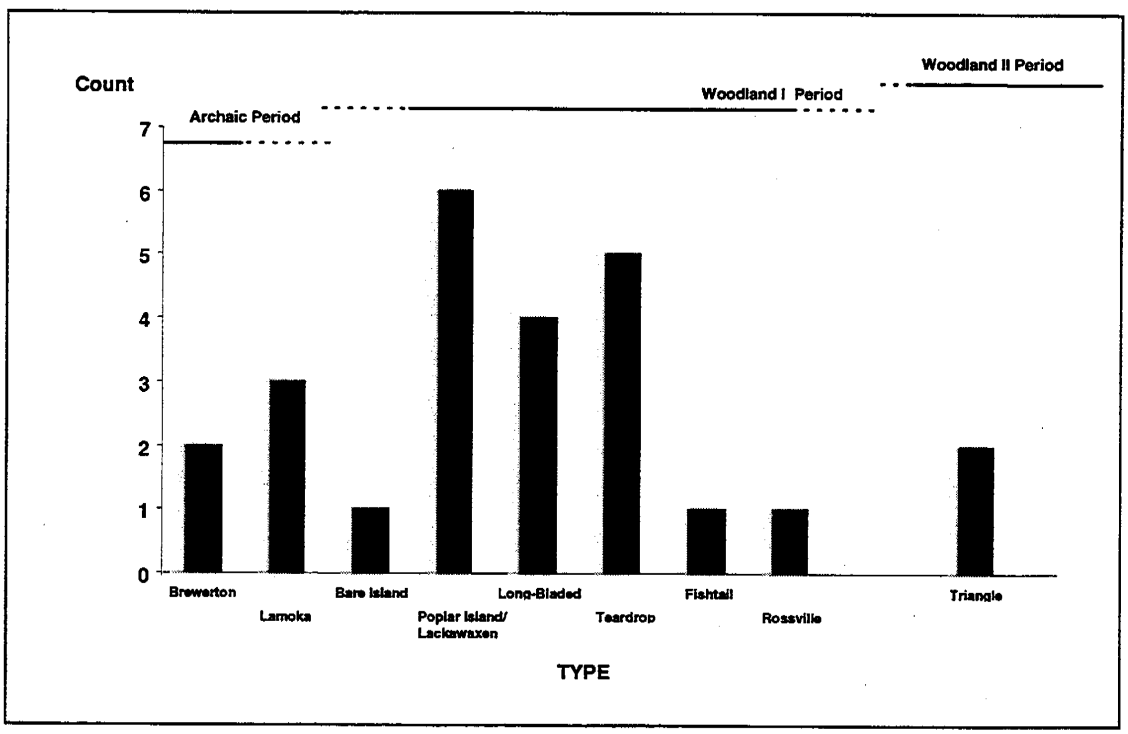

Figure 104. Chronologically Diagnostic Projectile Points from Area 2

A large proportion of the points from Area 2, 54 percent, were complete. The ratio of rejects to discards was examined as an indication of the extent of on-site manufacturing *versus* tool use followed by loss or abandonment. Nine of the points were identified as manufacturing rejects, in contrast to 20 discards (the remainder were too fragmentary for a judgement to be made). There were no correlations apparent between abandonment status and raw material type such as would imply a connection with manufacturing technology. Most of the points bore evidence commonly associated with use as cutting tools—asymmetrically resharpened blade edges indicating maintenance of a single, long cutting edge; or oblique or bending snap breaks typical of excessive force in a bending or prying motion. Only two specimens bore evidence that may have been associated with impact—a perverse fracture at the tip of a small, quartz triangle (2063-1), and an extensive snap across the neck and shoulders of a corner-notched fragment made from quartz (2123-2). The evidence implied that most of the points had in fact been used in knife-like functions, not as projectile tips. Futhermore most were finished tools that had been discarded or lost as a result of use, implying the absence of large-scale manufacture.

Bifaces

Early Stage There were 20 early stage bifaces recovered from Area 2, seven of Iron Hill jasper, 7 of quartz, 3 of ironstone, and 1 each of chert, pebble jasper and quartzite (Table 60). All of the early stage bifaces appeared to have been manufacturing rejects, most abandoned because they could not be thinned further due to material flaws, such as inclusions and incipient fracture planes, or due to their small size. Width:thickness ratios ranged from 1.4 to 12.3. The latter figure was atypical, recorded on an ironstone specimen (2433-2, 2434-1). Like the other ironstone bifaces from the area this example was manufactured on a wide, thin fragment of tabular material. Although the ironstone bifaces were thin in relation to width, the only evidence of reduction consisted of initial edging, such as is characteristic of early stage reduction. Thus these bifaces were classed as early stage. Most of the Iron Hill jasper bifaces were relatively coarse-grained, and three bore signs of heat treatment in the form of reddening or potlidding. All of the quartz bifaces were fragmentary, most with multiple snap breaks along internal flaw planes.

Artifact #	*Material*	*W:Th*	*Cortex(%)*	*Weight(gm)*	*Comments*
2082-25	IH jasper	n/a	0	4.2	Distal fragment, coarse grained, limonitic inclusions, perverse fracture, reject
2137-15	IH jasper	n/a	0	7.6	Distal fragment, varies from coarse to fine grain, limonitic onclusions, transverse fracture, reject
2142-1	IH jasper	1.85	10	29.3	Distal fragment, coarse grained, limonitic inclusion, multiple perverse fractures, reject
2220-1	IH jasper	2.5	0	13.8	Distal fragment, coarse grained, reddened, multiple perverse fractures, reject
2139-1	IH jasper	1.92	0	7.3	Dedial fragment, reddened, multiple perverse fractures, reject
2214-2	IH jasper	1.94	0	25.5	Complete, fine grained, partially reddened, small, reject
2396-1	IH jasper	1.88	0	26.2	Complete, fine grained, extensive limonitic inclusions, reject
2214-1	quartz	2	0	15.8	Distal fragment, multiple perverse fractures at flaw planes, reject
2169-4	quartz	n/a	0	12.1	Medial/lateral fragment, multiple perverse fractures, reject
2579-2	quartz	n/a	0	1.1	Lateral fragment, small, multiple perverse fractures, reject
2433-1	quartz	2.4	0	18.7	Medial fragment, multiple snaps at flaw planes, reject
2577-1	quartz	2.19	0	16.6	Proximal fragment
2422-6	quartz	1.36	0	4.3	Proximal fragment, transverse snap , small, reject

Table 60. Descriptive Statistical Data: Early Stage Bifaces Recovered from Area 2

Artifact #	Material	W:Th	Cortex(%)	Weight(gm)	Comments
2367-1	quartz	2.75	0	8.8	Proximal fragment, multiple fratures at flaw planes, reject
2131-1	ironstone	3.72	20	117.2	Proximal fragment, tabular material, initial edging, transverse snap, reject
2200-4	ironstone	5.55	10	53.6	Proximal fragment, tabular material, initial edging, transverse snap, reject
2434-1 2433-2	ironstone	12.33	80	36.9	two tabular fragments, transverse snap, manufacturing break, reject
2005-1	chert	1.79	10	64.9	Complete, step fractures and stacks, reject
2598-1	jasper	3.1	80	15.9	Complete, pebble, coarse material, inclusions, reject
2200-6	quartzite	2.85	0	48.1	Distal fragment, large flake fragment with initial edging, transverse fracture, reject

Table 60 (cont'd). Descriptive Statistical Data: Early Stage Bifaces Recovered from Area 2

Late Stage There were 10 late stage bifaces recovered from the area, 4 of quartz and 1 each of Iron Hill jasper, ironstone, chert, pebble jasper, argillite, and rhyolite (Table 61). Most appeared to have been manufacturing rejects, abandoned due to snap breaks or to knots or stacks that could not be cleared. Many of the late stage bifaces were small, and in several cases size appeared to have led directly to abandonment of the artifacts since they were too small for additional thinning. The quartz bifaces were again mostly fragments, broken along internal flaws. The single rhyolite specimen (2010-1) bore a bending snap break at the distal end, a form of break typically associated with use as opposed to manufacture, and thus the specimen may have been used and discarded rather than rejected during production.

Artifact #	Material	W:Th	Cortex(%)	Weight(gm)	Comments
2170-34	quartz	3	0	6.4	Proximal fragment, transverse snap, small, reject
2454-1	quartz	1.88	0	3.6	Proximal fragment, transverse snap, small, reject
2471-14	quartz	n/a	0	0.3	Proximal fragment, transverse snap, small, reject
2588-1	quartz	3.55	0	18.7	Complete, transverse snap at flaw, reject
2073-1	IH jasper	3.38	0	9.9	Complete, coarse grained, reddened, small, reject
2488-1	ironstone	2.31	10	41.1	Proximal, large knot on one face, transverse snap, reject
2552-1	chert	2.11	10	4.9	Distal fragment, almost complete, preverse fracture, small, reject
2126-3	jasper	n/a	0	0.7	Distal fragment, trnasverse fracture, small, reject
2208-1	argillite	1.69	0	18.4	Whole, stacks, reject
2010-1	rhyolite	4.29	0	9.3	Proximal fragment, step fractures, bending snap break, possible discard

Table 61. Descriptive Statistical Data: Late Stage Bifaces Recovered from Area 2

Unifaces

There were 11 unifaces among the artifacts recovered from Area 2 (Table 62). Most were endscrapers made on chert flakes. The distal ends or thick lateral edges of the flakes had been trimmed into a convex bit edge for use. Bit angles ranged from 65 to 85 degrees. Edge wear generally occurred as step fractures emanating from dorsal edges. In several instances, extensive undercutting of the bit edge was noted. One large, trimmed chert flake (2130-1) exhibited extensive undercutting along a broad, convex bit edge, a portion of which was rounded and polished. Assuming that the two types of wear, undercutting and polish, would result from use against different materials, the data suggest that the tool had been used for more than one activity.

Artifact #	*Material*	*Cortex(%)*	*Bit Angle*	*Weight(gm)*	*Comments*
2130-1	chert	30	80	17.4	trimmed flake, extensive undercutting, rounded, polished, endscraper
2233-12	chert	20	70	9.3	untrimmed flake, minimal edgewear distal edge
2221-1	chert	10	65-75	8.8	trimmed flake, minimal undercutting, endscraper
2096-17	chert	60	75	8.3	untrimmed flake, extensive undercutting, endscraper
2336-1	chert	30	65	5.4	untrimmed bipolar core fragment, endscraper
2486-1	chert	0	80	4.0	untrimmed bipolar core fragment, minimal undercutting, side-scraper
2208-5	chert	0	75	3.7	untrimmed flake, minimal undercutting, endscraper
2161-1	chert	40	75-85	3.4	trimmed flake, extensive undercutting, endscraper
2082-1	IH jasper	0	70-75	1.7	small, trimmed flake, extensive undercutting, endscraper
2421-1	quartz	0	70-85	21.3	large trimmed flake, flawed quartz, minimal undercutting, side-scraper
2208-33	quartz	0	75	4.7	trimmed flake, good quality quartz, extensive undercutting, endscraper

Table 62. Descriptive Statistical Data: Unifaces Recovered from Area 2

Cores

Thirteen cores were recovered from Area 2. Their attributes are summarized in Table 63. None of the Iron Hill jasper cores bore remnant cortex. One fragment (2105-26) had been extensively heated. Another, small specimen (2346-1) bore several flake removals from the edge of a flat shear plane. Cores from the remaining raw materials were derived from pebbles or cobbles, a conclusion based on the presence of remnant cortex. One chert piece (2208-2) had been flaked prior to being split by bipolar percussion. Most of the quartz fragments were extensively flawed, and were often broken across flaw planes leaving only fragments of the original core. There were several small, shattered bipolar fragments of quartz (e.g., 2335-53). One large, split quartz cobble (2205-1) had been flaked around the perimeter of the split face.

Artifact #	Material	Cortex(%)	Scars	Weight(gm)	Comments
2381-6	chert	50	1	32.1	pebble, bipolar
2208-2	chert	10	6	10.7	pebble, bipolar fragment
2233-3	chert	0	5	3.8	pebble, multidirectional, bipolar fragment
2006-1	IH jasper	0	5	35.5	multidirectional
2105-26	IH jasper	0	4	19.1	multidirectional, heated, fragment
2346-1	jasper	0	5	9.1	unidirectional from shear plane, fragment
2580-1	quartzite	0	6	202.4	cobble, multidirectional, fragment
2205-1	quartz	10	11	241.9	split cobble, unidirectional around perimeter of split face
2083-1	quartz	40	4	124	cobble, multidirectional, fragment
2169-16	quartz	30	3	60.9	cobble, multidirectional, fragment
2504-4	quartz	0	6	39.9	cobble, multidirectional, fragment
2011-21	quartz	20	4	22.6	pebble, bipolar
2335-53	quartz	20	1	7	pebble, bipolar fragment

Table 63. Descriptive Statistical Data: Cores Recovered from Area 2

Hammerstones

There were 6 hammerstones and 2 anvil stones among the material recovered from Area 2 (Table 64). All consisted of dense quartzite cobbles. One anvil (2057-1) was split longitudinally across the worn pit, the break presumably occurring as a result of use. Minor battering along the edge of the specimen indicated additional use as a hammerstone. The shapes of two of the hammerstones suggested that they had been used in the exercise of relatively fine control in percussion flaking. Both exhibited thin, battered edges: a wedge-shaped cobble (2100-1) bore battering along its narrowest edge, and a thin, flat specimen (2599-1) bore wear at both ends. The latter stone also exhibited minor pitting on one face suggesting secondary use as a light anvil stone. A small, irregularly shaped cobble (2450-19) showed battering off-center along a wide ridge. From the location of the wear it was assumed that the specimen was a bipolar hammerstone; its relatively light weight suggested use with small pebbles.

Artifact #	Material	Type	Segment	Weight(gm)	Comments
2057-1	quartzite	anvil	fragment	258.1	flat cobble fragment, shallow, irregular pit on one face, 10mm diameter, 2mm deep
2085-25	quartzite	anvil	whole	796.3	tabular cobble, wide shallow depression on one face, 30mm diam., 4mm deep
2100-1	quartzite	hammerstone	whole	413.2	flat, wedge-shaped cobble, narrow edge extensively battered
2132-1	quartzite	hammerstone	whole	279.4	long and narrow, pestle-like cobble, battered on both ends
2133-1	quartzite	hammerstone	whole	530.1	oblong cobble, minor battering on one end
2446-24	quartzite	hammerstone	fragment	65.4	small cobble, one end battered
2450-19	quartzite	hammerstone	whole	139.1	small cobble, battering on one face, bipolar
2599-1	quartzite	hammerstone	whole	220.0	flat, oval cobble, battering on both ends, one flake rmoval

Table 64. Descriptive Statistical Data: Hammerstones and Anvils Recovered from Area 2

Summary

Diagnostic lithics and supporting ceramic evidence implied that most of the material in Area 2 originated from the early part of the Woodland I period. In fact, the majority of the artifacts could have resulted from a limited number of temporal components representing only a few occupation episodes. Within the collection, there was some evidence of a preference for cryptocrystalline lithic raw material in point manufacture. The presence of many unbroken projectile points, relatively few manufacturing rejects, and almost no direct evidence of use as projectiles (impact damage), suggested that hunting was not a primary focus of activity during any major episode of site use.

Discarded and rejected bifaces showed no pattern in terms of raw material choice. Quartz and Iron Hill jasper were equally represented among early stage bifaces, and all bore characteristics of manufacturing rejects. Late stage bifaces were of various materials, and also were rejects—only one, a late stage rhyolite specimen, appeared to have been used. A relatively large number of unifaces were recovered. Most were similar in shape and manufacture—endscrapers made on thick chert flakes. Bit angles lay within a restricted range, and undercutting on a number of examples suggested that some had been used against hard materials (although some undercutting may have resulted from crushing during edge trimming). Only one example bore a well-rounded edge, characteristic of extensive use against a smoothly abrading surface such as hide. There was also a relatively large number of cores, mostly of pebble material. Evidence of bipolar percussion was visible on just over one-third of these specimens. Two anvil stones, a hammerstone with bipolar wear, and a hammerstone with minor wear typical of use as an anvil were also recovered, indicating that reduction of pebble lithic material was an important part of the tool manufacturing and maintenence economies at the site.

Lackawaxen, Poplar Island and Bare Island Points

Long and narrow-bladed, stemmed points manufactured of argillite, quartzite, ironstone, or quartz were the most frequently recovered projectile points in Area 2. They appear to represent a major occupation at the site, and so the chronological implications will be examined in some detail. Proper assessment of the implied chronology depends, of course, on morphological identification of the types. Similar points are known regionally as Lackawaxen, Poplar Island, and Bare Island.

These three point types are long, narrow-bladed, stemmed points with a variety of stem and base configurations. All three are types originally defined in eastern Pennsylvania, in the Delaware and lower Susquehanna valleys. Their distributions outside of those regions are variable. Each type was a key component of Kinsey's (1972:337) Piedmont tradition, which he indicated was distinct from Ritchie's (1965:79) Laurentian tradition, the latter characterized by broader and shorter-bladed, notched points. In the Piedmont tradition Kinsey included point types such as Morrow Mountain, Bare Island, Poplar Island, Lackawaxen, Wading River, Squibnocket, Sylvan Lake, Macpherson, Normanskill, and "probably" Lamoka.

Kinsey described the Lackawaxen type as a long, narrow-bladed, stemmed point, typically manufactured from shale or argillite. He recognized three main forms or subtypes: Expanding Stem, Straight Stem, and Converging Stem, accounting for 41 percent, 39 percent, and 20 percent respectively of a collection of 221 points he analyzed from the upper Delaware Valley. Descriptions suggest a considerable amount of overlap among the various Lackawaxen forms. This overlap is also apparent between the straight or converging stemmed varieties and the Bare Island and Poplar Island types, both of the latter originally defined by Kinsey (1959: 115) at the Kent-Halley site, on Bare Island in the lower Susquehanna River Valley.

Kraft (1975:30) reported an assemblage of 35 Lackawaxen points from Harry's Farm,. also on the upper Delaware River at Tock's Island. He described the three sub-types as slightly expanding, straight, and slightly tapering stemmed. The breakdown for the three sub-types was reported as 56 percent expanding stem, 28 percent straight stem, 16 percent converging stem.

Payne (1989) recorded examples of the Lackawaxen type at the Worrell site (28BU252), a site referred to as a "generalized hunting settlement" and located in the Middle Delaware Valley in Burlington County, New Jersey. The points included long-bladed forms with short, straight-sided or slightly expanding stems; shorter-bladed versions which may have been broken and reworked; and several converging stem variants. Payne's typing follows Kinsey (1972) closely.

At the Lower Black's Eddy site, farther up the Delaware Valley, Schuldenrein et al. (1991:43) noted a "Late Archaic—Piedmont Tradition," that included Bare Island, Poplar Island, Lackawaxen Stemmed, and "Lamoka–like." They noted over 60 examples of Lackawaxen Stemmed in the Lower Black's Eddy assemblage, that included a contracting stemmed variety (representing the largest percentage, in contrast to frequencies in Kinsey's and Kraft's asssemblages), as well as straight and expanding stemmed varieties. They conceded that there was a "wide range of morphological variability" in the forms, and that "the Lackawaxen type 'grades' into forms that could be called Bare Island or Poplar Island" (Schuldenrein et al. 1991:43). The Lackawaxen assemblage was entirely of argillite, and an argillite quarry location lay "several hundred meters" distant from the occupation site.

Lothrop and Koldehoff (1994:113ff) refer to a Lackawaxen/Poplar Island component at two sites along the Middle Delaware in southcentral New Jersey (28GL111, 28GL210). The illustrated examples of Lackawaxen from these locations are typically long-bladed with straight or slightly expanding stems, while the Poplar Island examples are almost shoulderless, with converging stems and well-rounded bases. Argillite was the sole raw material. Based on the overlapping horizontal distributions of the two types at the site, the researchers concluded that the materials represented a single occupation component.

As may be apparent, differentiation among these narrow-bladed, stemmed points is often debatable. The ambiguity inherent in their morphology is one of the factors that led to Custer's (1989, 1994) reconsideration of Woodland I period projectile point typology and chronology. He notes that few of the point types from the period have either radiometric or good contextual data associated with them. He places several styles into an inclusive category of stemmed points that he refers to as Bare Island/Lackawaxen, that he considers synonymous with Kinsey's Piedmont tradition (Custer 1989:148-9). The classification is ill-defined, morphologically, illustrating the overall variation within the group: the sub-types include two stemmed varieties (Types D and E) resembling either Bare Island or possibly Lackawaxen or Lamoka, a contracting stem variety (Type B) similar to Poplar Island, and a side-notched type (Type I) presumed to have originated earlier in the period. Raw material variation is not discussed.

The precise chronological position of the Lackawaxen point is unclear, while the relative chronologies of the Poplar Island and Bare Island types add to the uncertainty. Kinsey originally indicated a terminal date for Lackawaxen, of 3660±120 BP[†] for the Expanded Stem subtype at Brodhead-Heller (Kinsey 1972:411). He further proposed a relative seriation (youngest to oldest) of Straight Stem, Expanded Stem, Converging Stem, based on data from the Egypt Mills site. Early dates for Lackawaxen include three from Lackawaxen hearths at the Faucett site: 4130±180 BP, 4445±130 BP, and 4560±110 BP (Kinsey 1975:59-60). Kraft (1975:164) added a date of 3920±95 BP from Harry's Farm on Tock's Island. More recently, Lothrop and Koldehoff (1994:115) reported a date of 3830±90 BP from the Lackawaxen/Poplar Island deposit at 28GL111 in the Middle Delaware Valley. Work nearby at the Abbot Farm Complex produced a considerably later set of dates: 2840±120 BP at the Shady Brook site (Stewart 1986), and 2650±120 BP at Gropp's Lake (Stewart 1987).

Published chronological data from Delaware appear to cover the entire range recorded further north. Custer and Bachman (1983) reported a date of 4200±75 BP at the Hawthorne site in association with an artifact assemblage that included the Bare Island/Lackawaxen group. At Clyde Farm, Custer (1989:153) reported Bare Island/Lackawaxen points in association with Orient fishtails as well as Marcey Creek and Dames Quarter ceramics. This prompted the observation that the range of the Bare Island/Lackawaxen group extends to 2650 BP, the late end of the Dames Quarter range as indicated by Artusy (1976:1-2).

For comparative purposes, the morphological attributes for each of the traditional types are summarized in the paragraphs and tables that follow. Metrical data are taken from the largest and most completely reported assemblages, most of which were reported in the 1970s. Metrical data from the Lums Pond sample are compared against both the Lackawaxen and Poplar Island types.

[†] note: dates listed in uncalibrated radiocarbon years where possible

Lackawaxen: long, narrow-bladed stemmed point with rounded to pronounced shoulders. Blade edges are typically straight to slightly convex, stems vary from straight to extremes of expanding and converging, and bases are straight or rounded.

Kinsey (1972:408-10)*	Range	Mean
Expanded Stem n=97		
Length	44-78mm	57mm
Width	10-23mm	19mm
Thickness	4-8mm	7.1mm
Stratight Stem n=91		
Length	35-90mm	62mm
Width	19-25mm	22mm
Thickness	6-10mm	8.3mm
Converging Stem n=47		
Length	46-79mm	63mm
Width	19-26mm	22mm
Thickness	5-9mm	7.4mm
Kraft (1975:30) n=35†		
Length	44-95mm	67mm
Width	14-27mm	20mm
Thickness	5-20mm	11mm
Lums Pond n=11‡		
Length	40-73mm	57mm
Width	17-28mm	23mm
Thickness	7-12mm	9.8mm

Table 65. Comparative Descriptive Statistics for Lackawaxen

*Kinsey's dimensional sample sizes are 10 in each case; raw material distributions: Expanded Stem — 69% argillaceous shale, 15.1% shale, 15.5% argillite; Straight Stem — 41% argillaceous shale, 40 % flint, also shale, chert, argillite, siltstone, jasper; Converging stem — 53% shale, 21.5% argillaceous shale, 17% chert, also argillite, siltstone

†Kraft on raw material distribution = 43% agrillite, 29% flint, 28% shale or slate

‡Lums Pond raw material distribution = 28% ironstone, 28% quartzite, 18% argillite, also Iron Hill jasper, andesite, schist

Poplar Island: long, narrow-bladed point with well-rounded to occasionally pronounced shoulders. Blade edges are typically straight to slightly convex. The hafting element consists of a converging stem with a rounded base. Flaking is generally random.

	Range	Mean
Ritchie (1971:44)*		
Length	46-86mm	51mm
Width	n/a	n/a
Thickness	n/a	n/a
Kraft (1975:31) n=7[†]		
Length	53-108mm	n/a
Width	20-27mm	n/a
Thickness	6-12mm	n/a
Kinsey (1972:410) n=47[‡]		
Length	46-79mm	63mm
Width	19-26mm	22mm
Thickness	5-9mm	7.4mm
Lums Pond n=11[††]		
Length	40-73mm	57mm
Width	17-28mm	23mm
Thickness	7-12mm	9.8mm

Table 66. Comparative Descriptive Statistics for Poplar Island

*Kinsey prepared Ritchie's Poplar Island description based on data from Kent-Halley (Kinsey 1959: 115, his Type C, Tapered or Lobate Stemmed) and notes raw material distribution = 37.7% siltstone, 24.5% argillite, 20% quartz, in addition to quartzite, rhyolite, and chert (Ritchie 1971:45)

[†] Kraft on raw material distribution = 5 chert and one each agrillite and siltstone

[‡] Kinsey's dimensional sample size is 10; this is his Lackawaxen Subtype 3, Converging Stem, which resembles of is equivalent to Poplar Island; raw material distribution = 53% shale, 21.5% argillaceous shale, 17% chert, also argillite, siltstone

[††] Lums Pond raw material distribution = 28% ironstone, 28% quartzite, 18% argillite, also Iron Hill jasper, andesite, schist

Bare Island: narrow-bladed point of medium length. Blade edges are slightly convex. Shoulders are pronounced. Stem is relatively wide and typically straight-sided, while the base is straight or slightly convex. Raw material preference has been noted as quartz, based on the material distribution at the type site, Kent-Halley, where half of the Bare Island points were manufactured from quartz and another quarter from siltstone, in spite of locally available chert (Kinsey 1959).

Ritchie (1971:44) n=116*	Range	Mean
Length	30-97mm	51mm
Width	10-15mm	n/a
Thickness	n/a	n/a
Lums Pond n=3		
Length	38mm †	n/a
Width	20-23mm	21.3mm
Thickness	8-11mm	9.3mm

Table 67. Comparative Descriptive Statistics for Bare Island

*Kinsey prepared Bare Island description based on data from Kent-Halley (Kinsey 1959: 115, his Type A, Straight Stemmed) and notes raw material distribtuion = 48.7% quartz, 25.2% siltstone, 8.7% quartzite, also rhyolite, argillite, chert, gneiss, and schist

† Only one specimen with complete length, all are of quartz

In the end, there seems little to be gained by attempting to differentiate between Poplar Island and Lackawaxen among the long, narrow-bladed points at Lums Pond. Bare Island did appear to be morphologically different, with a wider, shorter, straight-sided stem, and manufactured from quartz as opposed to a coarse-grained material such as argillite or ironstone. Thus, most long-bladed points or fragments in the Lums Pond assemblages were classed as Poplar Island/Lackawaxcen, while several quartz examples with wide, straight-sided stems were classed as Bare Island. The level of precision available in the Lums Pond data made chronological discrimination among the types unnecessary—the temporal implications of the points as a group were a sufficient level of refinement.

Teardrop Points

Another ill-defined point type in the region is the Teardrop point. These points have been reported throughout the Middle Atlantic in contexts spanning the entire Woodland I period (see Mounier and Martin [1994:127-8] for a recent summary). At the Woodbury Annex site (28GL209), Mounier and Martin reported a series of six C^{14} dates for a Teardrop component. The dates had a similar range as the features in Area 2 at Lums Pond—2170±50 BP to 3430±250 BP, with most concentrated around 2600 BP. At Carey Farm, Custer (1996:78, Tbl. 10) placed the Teardrop point between 3150 and 2450 BP. Mounier and Martin do not provide dimensional data, but their illustrated examples ranged 30-50mm for length, 17.5-20mm for width. The six teardrop points in Area 2 averaged 28mm in length, 17mm in width, near the low end of the published data.

Block D

Block D was excavated along the northern edge of Area 2, in the only location the area in which there was significant artifact deposition below the plow zone. The artifacts from the sub-plow zone levels of the block were considered a discrete assemblage, and detailed attribute analysis of flaking debris was conducted. In total, prehistoric 1150 artifacts were recovered from Block D: 831 from the plow zone and 319 from sub-plow zone contexts. Approximately 83 percent consisted of chipped stone debris, the remainder comprising fire-cracked rock and hammerstones. Tables 68 and 69 display artifact type frequencies and lithic raw material frequencies for the plow zone and sub-plow zone deposits in the block (there is some overlap with area-wide frequency data reported above). Raw material types among the flaking debris included Iron Hill jasper, quartz, chert, quartzite, jasper, ironstone, argillite, chalcedony, andesite, and rhyolite.

	Plow Zone		Sub-Plow Zone	
Artifact Type	**Count**	**Frequency**	**Count**	**Frequency**
Flakes	563	67.7	260	81.5
Chips (Potlids)	59(	7.1	43	13.5
Fire-Cracked Rock	189	22.7	8	2.5
Unifaces	6	0.7	1	0.3
Points	5	0.6	0	0
Early Stage Bifaces	4	0.5	5	1.6
Cores	3	0.4	0	0
Late StageBifaces	2	0.2	0	0
Hammerstones	0	0	2	0.6
--TOTAL--	831		319	

Table 68. Artifact Frequencies: Block D

	Plow Zone		Sub-Plow Zone	
Raw Material	**Count**	**Frequency**	**Count**	**Frequency**
Iron Hill Jasper	253	39.4	51	16.4
Quartz	202	31.5	112	36.0
Chert	59	9.2	16	5.1
Quartzite	52	8.0	19	6.1
Jasper	29	4.5	36	11.6
Ironstone	24	3.7	55	17.7
Argillite	12	1.9	1	0.3
Chalcedony	8	1.2	17	5.5
Andesite	2	0.3	0	0
Rhyolite	1	0.2	4	1.3
--TOTAL--	642		311	

Table 69. Chipped Stone Raw Material Frequencies: Block D

Sub-Plow Zone Levels

Bifaces

There were four early stage bifaces in the assemblage, two of quartz, one of ironstone (Table 70). The quartz examples were small and had been abandoned during manufacture. One quartz specimen (2433-1) had split along several flaw planes, removing both ends of the artifact and most of one face, and thus the width of the artifact could not be measured. The ironstone biface consisted of two refitted fragments (2434-1 and 2433-2). The high width:thickness ratio of the piece reflects the form of the raw material, a thin tabular fragment, rather than extensive thinning—the biface in fact exhibited no evidence of thinning, only a minor amount of non-invasive flaking along its edges, and thus it was considered technologically an early stage biface.

Artifact #	*Material*	*W:Th*	*Cortex(%)*	*Weight(gm)*	*Comments*
2422-6	quartz	1.36	0	4.3	transverse snap , small, manufacturing reject
2367-1	quartz	2.75	0	8.8	multiple fratures at flaw planes, manufacturing reject
2433-1	quartz	2.4	0	18.7	multiple snaps at flaw planes, manufacturing reject
2434-1/ 2433-2	ironstone	12.33	80	36.9	two tabular fragments, transverse snap, manufacturing break, reject

Table 70. Descriptive Statistical Data: Early Stage Bifaces Recovered from Block D

Uniface

One uniface (2421-1/3) was recovered from the block consisting of a thick quartz flake fragment with trimmed edges. It was recovered in three pieces which refit, showing what appeared to have been postdepositional fractures along flaw planes. Together the fragments weighed 20.7gm. The bit angle varied from 70-80 degrees and there was little evidence of undercutting of the bit edge.

Hammerstones

Two hammerstones were recovered (Table 71). One (2100-1) consisted of a dense, irregularly shaped quartzite cobble which bore extensive battering on two edges. The second (2599-1)was an oval, tabular cobble, also of quartzite, bearing pecked and chipped areas at both ends and on part of one edge.

Artifact #	Material	Weight(gm)	Comments
2100-1	quartzite	413.2	battering along portions of two edges
2599-1	quartzite	220.0	battering at both ends and along one edge

Table 71. Descriptive Statistical Data: Hammerstones Recovered from Block D

Flakes

As flakes comprised the majority of the lithic artifacts from the block, the raw material distribution among them was similar to that for the block as a whole. Four principal raw material types were recognized: quartz, which accounted for 30 percent of the total (n=87); ironstone, 20 percent (n=51); Iron Hill jasper, 20 percent (n=51); and cryptocrystalline pebble material including chert, jasper, and chalcedony, together accounting for 19 percent (n=50). The grouping of the latter type was made on the basis of assumed differences in the form of the raw material. Chert, jasper, and chalcedony were assumed to be pebble in origin, as was quartz. Ironstone appeared to have originated from tabular blanks, and Iron Hill jasper from quarry blanks or cores.

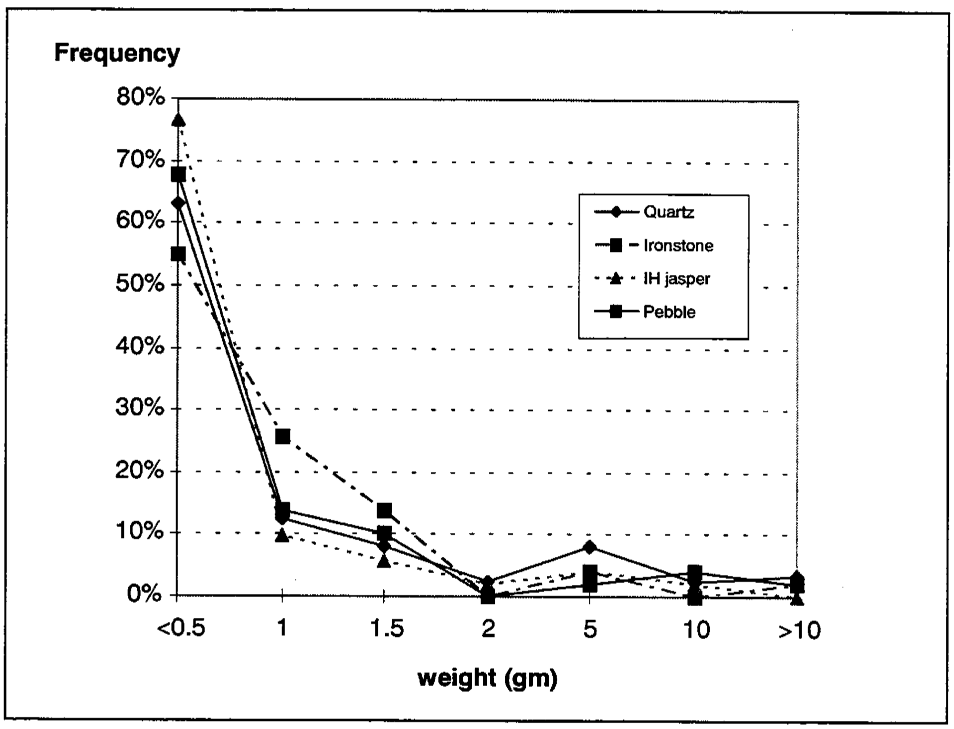

Figure 105. Flake Size Distributions Measured by Weight, Area 2, Block D

A graph of the size distribution of flakes as measured by weight is shown in Figure 105. The chart indicates that the greatest variation between the raw material types in the assemblage occurred among the smallest flakes. That is, more than 75 percent of the Iron Hill jasper flakes in the assemblage weighed less than 0.5gm, in contrast to ironstone flakes, where only about 50 percent occurred in that weight category. At the other end of the range, there were few large flakes of any material. This suggested either a technological difference, such as more late stage reduction debris among the Iron Hill jasper material, variation in the initial form of the raw material, or possibly the functioning of site formation processes, i.e., size sorting, in which small artifacts had filtered down through the profile from overlying deposits. To assess the latter possibility, materials from the plow zone and sub-plow zone levels of the block were compared. Differences were apparent in the frequencies of several artifact types, including flakes, fire-cracked rock, and bifaces, as well as in the relative frequencies of Iron Hill jasper and ironstone. There was no appreciable difference in the size distributions of flakes, and thus no evidence of size sorting—the small flakes in the sub-plow zone deposit appeared more likely to have been the result of technological variables rather than site formation processes.

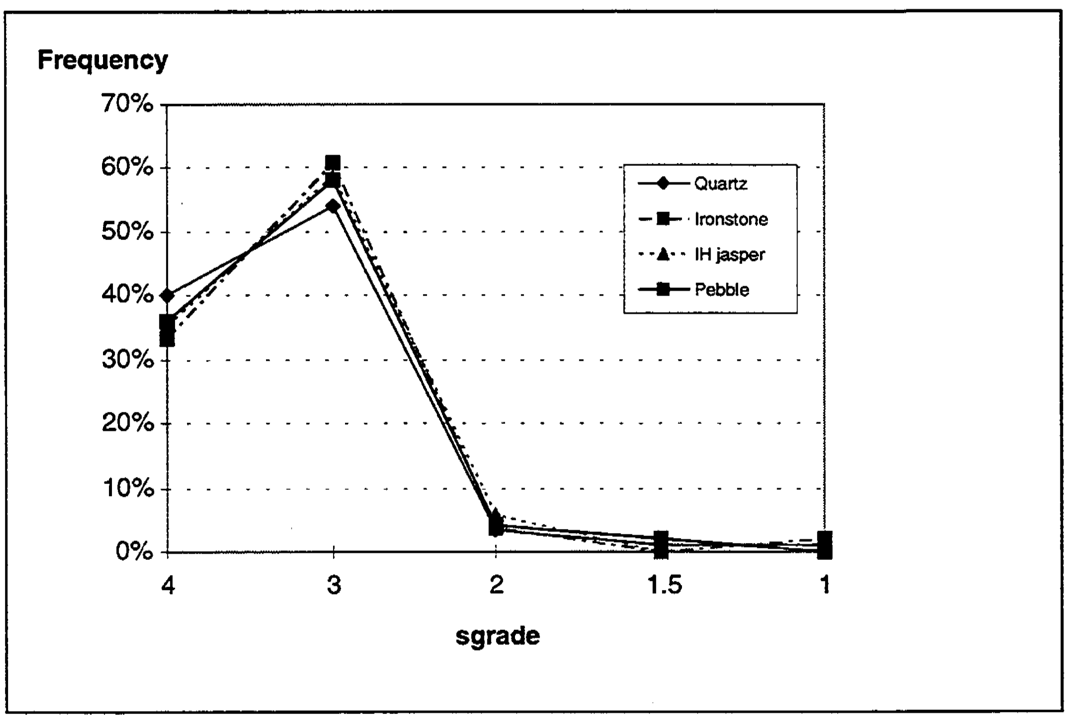

Figure 106. Flake Size Distributions Measured by Size Grade, Area 2, Block D

There was little if any difference in linear dimensions between the raw material types as reflected in the size-grade distributions graphed in Figure 106. Relatively few large flakes (size-grades 1 and 1.5) were present in the assemblage, which drove up the ratio of small to large flakes and suggested little primary or early stage reduction. There were too many size-grades with zero counts for a valid log-linear graph of the size distribution data to be drawn, and thus the data were not tested against Patterson's flake size distribution model.

Mean flake weight calculated over the four complete size-grades (1-3) was highest for quartz, lowest for Iron Hill jasper (Table 72), indicating a combination of differences in raw material form and reduction trajectory or stage. The result may also have been due to an imbalance in the largest flakes, size-grade 1.

Size Grade	IH jasper	Ironstone	Quartz	Pebble
1	0.0	39.5	39.2	0.0
1.5	0.0	0.0	10.7	9.0
2	4.7	2.5	8.9	11.3
3	0.5	0.6	0.6	0.6
4	0.2	0.2	0.2	0.2
grade 1-3	0.8	1.9	2.3	1.5

Table 72. Block D: Mean Flake Weight per Size Grade

Tabulation of the presence of remnant cortex (Table 73) confirmed notions about raw material form. The lowest frequency occurred among Iron Hill jasper flakes, which were presumed to have been knapped from bifaces, or possibly cores, derived from outcrop material. The frequency of cortex was higher for quartz and other pebble material, and highest, by a large factor, for ironstone. In the latter case, the tablular blanks from which the raw material was derived are typically thin and tend to retain bedding cortex—even the finished projectile points of ironstone from the site bore remnant cortex.

The highest frequency of broken flakes occurred among the quartz debitage (Table 73), a finding which may be related to the brittleness of the raw material in combination with the use of bipolar reduction. In contrast, other pebble based materials, which presumably required similar initial reduction technology, displayed the highest frequency of unbroken flakes in the assemblage. This implied that the degree of breakage observed among quartz flakes was indeed largely a factor of the flaking characteristics of the material. There were almost as many broken Iron Hill jasper flakes as quartz (69% and 71% respectively), while just under one-half of the ironstone flakes were complete.

Following Sullivan and Rozen (1975) on the correspondence between whole flakes and core reduction *versus* broken flakes and biface reduction, the data would imply that quartz, Iron Hill jasper and to some extent ironstone were used for flake production, while pebble cryptocrystalline materials were used mainly for biface manufacture. While this may have been the case for some of the materials, there was relatively compelling evidence from other attribute analyses to suggest that Iron Hill jasper was mainly used in biface reduction.

Cortex	**IH jasper**	**Ironstone**	**Quartz**	**Pebble**
Absent	96	61	90	82
Present	4	39	10	18
Platform Type	**IH jasper**	**Ironstone**	**Quartz**	**Pebble**
Simple / 2 Facet	28	6	46	58
Bifacial	41	17	9	5
Cortical	7	0	2	3
Crushed	24	78	43	34
Segment	**IH jasper**	**Ironstone**	**Quartz**	**Pebble**
Whole	31	45	29	64
Broken	69	55	71	36

Table 73. Block D: Additional Flake Attributes: Remnant Cortex, Platform Type, and Completeness Listed as Percentages

Analysis of platform attributes provided additional information about the differences in reduction technologies among the raw materials. The highest frequency of crushed platforms occurred among quartz and ironstone (78 percent of the latter). Crushed platforms on large flakes imply the use of hard-hammer percussion. In the present case hard-hammer percussion was probably related to the relative hardness of the materials as much as to the reduction stage. Few flakes of any raw material bore cortical platforms, conforming with the generally low frequency of occurrence of cortical flakes. Bifacial platforms were most frequent on Iron Hill jasper and ironstone flakes. Platform angles showed insufficient variation to allow interpretation. For most materials the highest frequencies ranged between 70 and 75 degrees, with pebble cryptocrystalline material peaking slightly lower than Iron Hill jasper or quartz. However, considering the precision with which platforms can be measured on small flakes, a variation of 5 degrees was not regarded as significant. Ironstone flakes showed a wide variation in platform angles, which may have been associated with inconsistencies in the material caused by bedding planes.

Finally, two variables recording dorsal scar complexity showed little variation between raw material types. Both variables, dorsal scar count and orientation, were corrected for flake size by dividing each variable by the appropriate size-grade. In each case the resulting curves were multi-modal, in part reflecting the additional intervals introduced by the ratio calculation. Yet the overall configurations of the curves were similar. This seemingly contradicts previously recorded data indicating the presence of flakes from different reduction techniques or stages. Several explanations are possible. For example, the results may imply that dorsal scar complexity is not a good indicator of reduction stage, although intuition suggests that overall, it should reflect the level of reduction fairly well. Alternatively, another influence may be present, such as measurement variability between raw material types (better readability for some materials), or a mix of stages for each type. Whatever the final conclusion, dorsal scar complexity in this instance was not diagnostic of reduction technology, pointing again to the observation that flake single attributes may not be capable of providing an accurate picture of a complicated process such as lithic reduction.

Plow Zone/Sub-Plow Zone Comparison

Separate analysis was conducted to determine the relationship between the artifacts in the plow zone and sub-plow zone layers in Block D. Diagnostic artifacts were recovered only in the plow zone. They consisted of projectile points, either narrow-bladed types classified as Poplar Island/Lackawaxen or long-bladed fragments that were probably related typologically and temporally. The time period implied by the artifacts was the early portion of the Woodland I period. A radiocarbon date of 810±60 BP was returned on a low carbon sediment sample from Stratum B, the sub-plow zone layer. This date appeared to be more closely related to soil formation processes than cultural deposition in the stratum. To further assess the potential for differences between the deposits, vertical artifact distributions were analyzed. The aim was to determine whether the material in the sub-plow zone levels was actually different in character from that in the plow zone, or whether it had merely filtered down from the overlying deposit.

As indicated by the frequencies of artifact types presented earlier in Table 68, a higher percentage of flakes occurred in Stratum B, the sub-plow zone deposit, along with a considerably lower frequency of fire-cracked rock. In addition, more potlidded flakes were found in Stratum B, along with a relatively large percentage of bifaces, all of them early stage bifaces. Lithic raw material variations were also evident (Table 69), with more than twice the relative frequency of Iron Hill jasper occurring in the plow zone as compared with Stratum B. In contrast, higher proportions of pebble jasper and chalcedony were recorded in Stratum B, as well as a much higher proportion of ironstone.

The data appeared to indicate a difference between the artifact assemblages in the two deposits. The size distributions of flakes were analyzed as further evidence of the relationship (Table 74). While more of the flakes in Stratum B were from higher size grades (smaller flakes) as gauged across all raw material types, the variation was not great. The lack of difference seen in the proportions of large and small flakes iondicated little evidence of the size sorting of artifacts within the soil column.

	Plow Zone		Sub-Plow Zone	
Size Grade	**count**	**frequency**	**count**	**frequency**
1	4	0.9	2	1.2
1.5	9	2.0	2	1.2
2	46	10.3	11	6.6
3	389	86.8	152	91.0
TOTAL	448		167	

Table 74. Flake Size Distributions, Plow Zone and Sub-Plow Zone Horizons, Block D

The greater amount of fire-cracked rock in the plow zone implied the presence of one or more hearths or other fire-related activity. The greater frequency of potlids in the sub-plow zone levels suggested either more heat treatment as part of lithic reduction, or more incidental or postdepositional artifact burning. Differences in the frequency of bifaces also implied different reduction activites: the bifaces in the plow zone were of quartz and Iron Hill jasper, while those below were of quartz and ironstone. There were corresponding differences in the incidences of Iron Hill jasper and ironstone debitage in the two deposits.

AREA 3

Descriptive statistics and in-depth analyses of the artifactual material from Area 3 are divided into three separate sections: Stage 1 sampling excavations; Block A data; and Block B data. Area 3 data analyses were handled differently because of the different depositional contexts contained in that part of the site. Due to the amount of material recovered from intact stratigraphic contexts in the two excavation blocks, less importance was placed on the poorer contexts represented by the area-wide and plow zone databases, and thus less analytical effort was directed toward them. Blocks A and B contained similar stratigraphic sequences, and the main strata identified within each block appeared to be linked chronologically. Nonetheless, there was sufficient variation in the artifacts from the excavated proveniences, as well as a great enough horizontal distance between the blocks, to suggest that the artifacts be analyzed separately.

Stage 1 Sampling

Random stratified sampling of Area 3 resulted in the recovery of 2544 prehistoric artifacts. Of those, 57 percent were chipped stone, the remainder consisting of fire-cracked rock, hammerstones, or fragments of prehistoric ceramic. Artifact type frequencies are listed in Table 75, lithic raw material frequencies in Table 76. Raw material types among the flaking debris included Iron Hill jasper, quartz, jasper, chert, quartzite, argillite, andesite, ironstone, chalcedony, and rhyolite in descending order of frequency. Iron Hill jasper is listed separately from other jasper materials. Descriptive statistics summarizing the main artifact types follow.

Artifact Type	Count	Frequency(%)
Flakes	1267	49.8
Fire-Cracked Rock	1074	42.2
Chips (Potlids)	112	4.4
Early Stage Bifaces	11	0.4
Late Stage Bifaces	8	0.3
Points	32	1.3
Cores	16	0.6
Unifaces	6	0.2
Vessel	12	0.5
Anvil	3	0.1
Hammerstone	3	0.1
Total	2544	

Table 75. Artifact Frequencies,Area 3, Stage 1

Raw Material	Count	Frequency(%)
Iron Hill Jasper	134	9.2
Quartz	334	22.9
Jasper	458	31.4
Chert	336	23.0
Quartzite	103	7.1
Argillite	11	0.8
Andesite	25	1.7
Ironstone	19	1.3
Chalcedony	31	2.1
Rhyolite	7	0.5
Total	1458	

Table 76. Chipped Stone Raw Material Frequencies, Area 3, Stage 1

Descriptive analysis of the projectile points from the Stage 1 units was undertaken and the results described below. Due to the mixed nature of the deposit, analysis of additional artifact types from the units was not carried out.

Projectile Points

Thirty-one projectile points or point fragments were recovered from the Stage 1 sampling units in Area 3. Details are summarized in Table 77. Added to the summary are two points recovered from Phase II test units in Area 3, bringing the total in the analysis to 33. Twenty-one points were typologically identifiable, attributable to portions of the Archaic, Woodland I, and Woodland II periods. Figure 107 represents the frequency of each diagnostic type arranged in rough chronological order. Woodland II period Levanna points were the most frequent (n=8) followed by Teardrop points (n=5).

Lithic raw material selection followed patterns documented elsewhere in the Middle Atlantic, with Teardrops typically made of quartz, long-bladed points such as Poplar Island and Bare Island made of quartz or coarse-grained material, and the remainder, including the bifurcate, Fishtail, Rossville, Adena, and Levanna types, made of cryptocrystalline material.

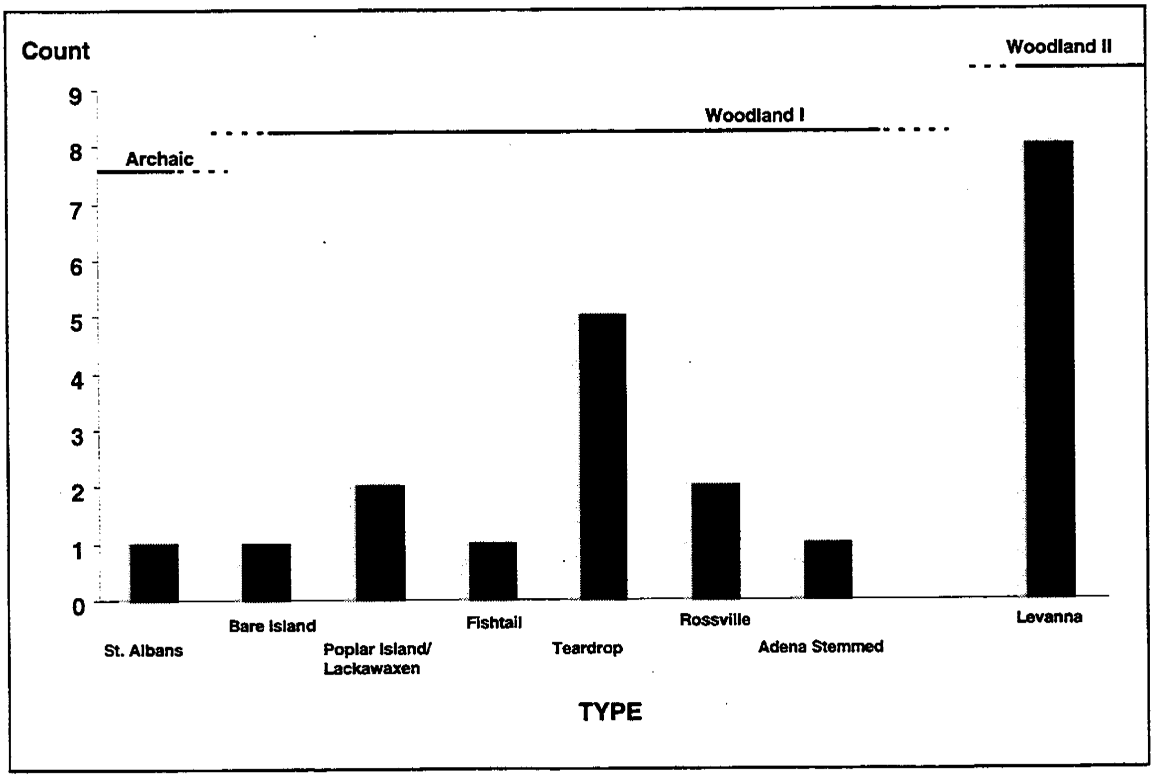

Figure 107. Projectile Point Type Frequencies, Area 3, Phase II and Phase III Stage 1 Testing Sample

Breakage and use patterns suggested functions as both projectiles and cutting 0implements. Several points recovered from Area 3, including the Fishtail, both of the Rossville points, and one of the Teardrops, bore asymmetrically reworked blades typical of the maintenance of the single edge of a cutting tool or knife. In contrast, a distal impact fracture was observed on one of the long-bladed points, a Poplar Island/Lackawaxen manufactured of andesite. Basal damage on several other specimens, including the Adena, Fishtail, St. Albans, one of the Teardrops, and five Levanna, may also have been impact related. A recurring pattern was noted among the Levanna specimens: five of seven of the triangles bore distal snap breaks along with damage to one basal tang. Such damage could have been associated with a twisting and cutting motion that snagged one of the protruding tangs, yet there were no indications of bending snap breaks. As likely, the damage resulted from impact. That the points were recovered at an apparent occupation site suggests that they were either returned to the site still embedded in the prey or, more probably, had been brought back for repair. In addition to the diagnostic points, two of the larger non-diagnostic distal fragments (252-1, 883-2) bore distal impact fractures and snap breaks at the neck. Several experimental studies have indicated that damage, often extensive, to the hafting element of a projectile point is a common result of impact (Flenniken and Raymond 1986; Cox and Smith 1989; Towner and Warburton 1990). In a review of point typology and artifact rejuvenation studies, Flenniken and Wilke (1989:152) noted that "of ... 92 corner-notched and side-notched projectile points...employed in simulated prehistoric hunting situations, 75% (n=69) of the points sustained impact fractures in the base, or haft, area by the time it became necessary to rework them." There was indication, then, that many of the Woodland II period points from Area 3 had been used as projectile tips, and that hunting may have been an important econmic activity during the latter portion of that period. Hunting may also have been significant during earlier periods of site use, although evidence of impact related damage on stemmed and notched points was less widespread and systematic.

Artifact #	*Material*	*Type*	*W:Th*	*Weight(gm)*	*Comments*
284-1	chert	Adena Stemmed	4.6	17.8	basal notched, straight stem, straight blade edges, one tang damaged, transverse snap near distal end, estimated length 77mm
795-1	quartz	Bare Island	1.9	9.6	straight stem, convex base, weak shoulders, narrow blade, straight to slightly convex blade edges, plano-convex cross section due to stacks on one face, transverse snap at distal end
353-2	jasper	Fishtail	2.1	3.1	small, expanding stem, rounded shoulders, convex blade edges, asymmetrically reworked, one basal tang damaged
170-1	chert	Levanna	4.3	3.3	proximal fragment, slightly convex base, perverse snap at flaw plane, pebble cortex on one face
247-1	jasper	Levanna	4.0	2.4	convex base, reworked blade, beveled, convex edges; minor snap at distal end

Table 77. Descriptive Statistical Data: Projectile Points Recovered from Area 3 Stage 1 Units.

Artifact #	*Material*	*Type*	*W:Th*	*Weight(gm)*	*Comments*
353-1	IH jasper	Levanna	4.6	2.7	concave base, concave blade edges, asymmetrically reworked, minor damage to one basal tang, transverse snap at distal end
301-1	chert	Levanna	5.8	1.6	convex base, straight blade edges, transverse snap at distal end
379-1	jasper	Levanna	4.6	2.0	concave base, asymmetrically reworked blade, minor damage to basal tangs, oblique snap at distal end
394-1	chert	Levanna	4.1	2.6	convex base, straight blade edges, transverse distal snap and minor damage to one basal tang
878-1	chert	Levanna	4.3	5.8	large, convex base, straight symmetrical blade edges, transverse snap at distal end and minor damage to one basal tang, unprovenienced plow zone find
878-2	IH jasper	Levanna	6.0	3.6g	large, convex base, reworked blade edges are convex and slightly beveled, transverse snap at distal end and minor damage to one basal tang, unprovenienced plow zone find
271-1	andesite	Poplar Is./ Lackawaxen	2.8	19.8	straight stem, convex base, straight blade edges, slightly asymmetrical, minor snap at distal end (could be bending or impact)
880-1	ironstone	Poplar Is./ Lackawaxen	2.5	11.4	contracting stem, straight base, prominent shoulders, straight blade edges, biconvex cross-section, transverse snap midway along blade
271-2	jasper	Rossville	2.7	2.2	small, contracting stem, asymmetrically reworked blade,
883-1	chert	Rossville	2.7	2.4	small, contracting stem, symmetrical, straight sided blade edges, unprovenienced plow zone find
297-1	chert	St. Albans	2.6	2.7	small, lobed/bifurcate base, straight, serrated blade edges, transverse snap at distal end and one lobe and part of blade edge damaged
171-1	jasper	Teardrop	3.2	3.5	small, synnetrical convex blade edges, slight damage to base, pebble cortex on one face

Table 77 (cont'd). Descriptive Statistical Data: Projectile Points Recovered from Area 3 Stage 1 Units.

Artifact #	Material	Type	W:Th	Weight(gm)	Comments
248-1	quartz	Teardrop	1.5	1.8	small, assymetrically reworked blade, slight bevel, minor snap at proximal end
347-1	quartz	Teardrop	2.4	4.2	slightly convex blade edges, oblique snap at flaw plane during manufacture or reworking
382-1	quartz	Teardrop	2.8	1.4	small, straight blade edges, beveled base, possibly a reworked distal fragment
879-1	quartz	Teardrop	2.1	3.2	irregularly thinned base, unprovenienced plow zone find
226-1	IH jasper		n/a	1.6	distal fragment, plano-convex, finely flaked, perverse snap break
239-1	jasper		n/a	0.5	distal fragment, oblique snap break, no impact
249-1	quartzite		3.4	22.9	contracting stem, percussion flaking, perverse snap midway along blade, incomplete? similar morphology and damage to 249-2
249-2	argilllite		2.9	24.6	contracting stem, percussion flaking, oblique snap midway along blade, incomplete? similar morphology and damage to 249-1
252-1	quartz		2.3	8.6	side-notched or stemmed, transverse snap at neck, blade edges convex, asymmetrically reworked, medial-distal refit (break appears postdepositional), minor impact fracture at tip
267-1	jasper		n/a	1.4	burned and potlidded blade fragment
295-2	jasper		n/a	0.2	small distal fragment, bending snap break
413-1	chert		n/a	0.7	small distal fragment, oblique snap break
460-1	chert		n/a	1.1	heavily damaged blade fragment, multiple perverse fractures, burned
469-1	chert		n/a	0.8	heavily damaged blade fragment, burned
883-2	jasper		2.2	5.6	side-notched or stemmed, weak shoulders, transverse snap at neck, slightly convex blade edges, distal impact fracture, unprovenienced plow zone find

Table 77 (cont'd). Descriptive Statistical Data: Projectile Points Recovered from Area 3 Stage 1 Units.

A total of 1952 prehistoric artifacts were recovered from the sub-plow zone levels of Block A. Stratigraphic and vertical artifact analyses indicated that at least two distinct depositional episodes were present in the sub-plow zone levels in Area 3, represented by Stratum C, a 2Ab soil horizon, and Strata D and E, a series of 2C soil horizons lying directly below. The deposits appeared relatively intact and chronologically discrete, and thus the artifact assemblages from them were analyzed separately.

Stratum C

One-hundred-fifty-five artifacts were recovered from Stratum C of Block A, 81 percent of which consisted of chipped stone debris. The remainder consisted of fire-cracked rock and a fragment of prehistoric ceramic. Artifact type frequencies are listed in Table 78, and lithic raw material frequencies are detailed in Table 79. Raw material types among the flaking debris included quartz, Iron Hill jasper, chert, jasper, quartzite, ironstone, rhyolite, and chalcedony, in descending order of frequency. Descriptive statistics summarizing the main artifact types follow.

Artifact Type	Count	Frequency(%)
Flakes	109	70.3
Fire-Cracked Rock	28	18.1
Chips (Potlids)	14	9.0
Points	1	0.6
Cores	1	0.6
Unifaces	1	0.6
Ceramic	1	0.6
Total	155	

Table 78. Artifact Frequencies, Woodland II Deposits, Block A

Raw Material	Count	Frequency(%)
Quartz	49	38.9
Iron Hill Jasper	22	17.5
Chert	24	19.0
Jasper	18	14.3
Quartzite	8	6.3
Ironstone	2	1.6
Rhyolite	2	1.6
Chalcedony	1	0.8
Total	126	

Table 79. Chipped Stone Raw Material Frequencies, Woodland II Deposits, Block A

Non-Flaking Debris

Two tool forms were recovered from Stratum C, a projectile point fragment and a uniface. The point fragment (303-4) consisted of the distal end of a small chert point, truncated at a bending snap break. The uniface (390-9) was made from a small, bipolar quartz core fragment. It bore a narrow rounded bit fashioned as an endscraper. The bit angle measured 75-80 degrees and showed scalar and hinge fractures emanating from the dorsal surface of the working edge.

Flakes

Three principal raw material types were recognized among the flakes from Stratum C. Quartz comprised 39 percent of the flake assemblage (n=42), Iron Hill jasper 18 percent (n=20), and cryptocrystalline pebble material (chert, jasper, and chalcedony) 33 percent (n=36). Minority raw materials included quartzite, ironstone, and rhyolite.

Size Grade	IH jasper	Quartz	Pebble
1	0	0	0
1.5	0	4.8	0
2	10.0	11.9	5.6
3	65.0	66.7	66.7
4	25.0	16.7	27.8

Table 80. Flake Size Distributions by Size Grade, Block A, Stratum C, Listed as Percentages

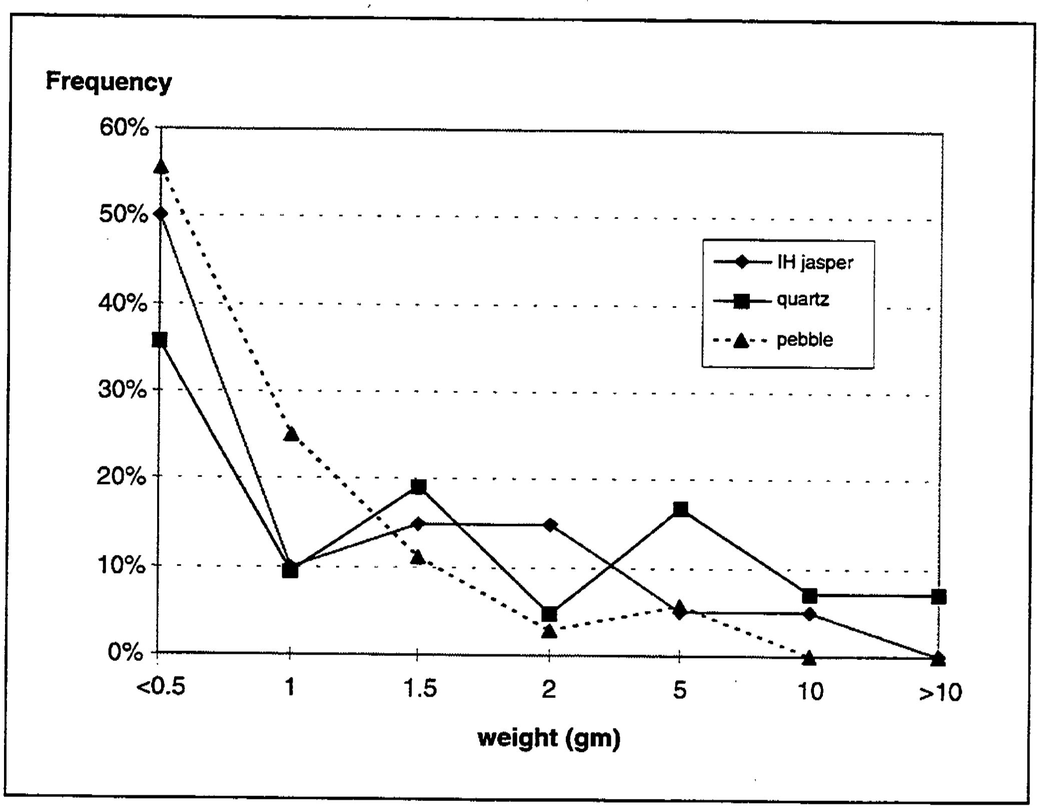

Figure 108. Flake Size Distributions by Weight, Block A, Stratum C

The size distributions of the flakes in the assemblage were analyzed by linear dimension and weight. In terms of linear dimension, most of the flakes of each material type (65-67 percent) occurred in size-grade 3 (Table 80). Notably, there were no flakes of any material in the largest group (size-grade 1), and only a small percentage of quartz flakes in next largest (size-grade 1.5), suggesting either little evidence of early stage reduction or the exclusive use of small cores or biface blanks. A difference in size distributions was more apparent when measured by weight (Figure 108), where more of the quartz flakes were heavier—31 percent weighed over 5 gm, in contrast with Iron Hill jasper (10 percent) or pebble material (<6 percent). Mean flake weights over grades 1-3 provided similar data (Table 81), indicating that quartz flakes were typically twice as heavy as Iron Hill jasper flakes when viewed across the majority of the range. Since the linear dimensions of each of the materials were roughly the same, as indicated by size-grade analysis, the data implied that quartz flakes were more massive, and thus thicker. The implied thickness was likely due to a combination of the use of bipolar percussion and the fracture mechanics of the quartz, a crystallline material type that tends to produce more thick or chunky debris than cryptocrystalline materials.

Little of the quartz debris was cortical, as indicated in Table 82. Given the assumption that, like the cryptocrystalline pebble material, the quartz utilized at the site originated in pebble form in local gravel bars, this lack of cortical flakes was surprising. It seemed to support the notion that relatively little early stage reduction was represented in the flake assemblage.

Size Grade	IH jasper	Quartz	Pebble
1	0.0	0.0	0.0
1.5	0.0	14.2	0.0
2	6.2	7.7	2.4
3	0.8	1.5	0.7
4	0.1	0.2	0.2
grade 1-3	1.5	3.1	0.8

Table 81. Mean Flake Weight per Size Grade, Block A, Stratum C

	IH jasper	Quartz	Pebble
Non-Cortical	95.0	92.9	69.4
Cortical	5.0	7.1	30.6
	n=20	n=42	n=36

Table 82. Cortex Frequency, Block A, Stratum C

Utilized Debitage

Utilized debitage recovered from Stratum C consisted solely of flakes, all of cryptocrystalline raw material (Table 83). Use was identified in most cases by scalar flaking along part of one edge of the artifact, usually unifacial and, unless noted in the table, located on the dorsal face. Hinge flaking was also common along the extreme margins. The wear patterns were often truncated by snap breaks, suggesting breakage during use. Flaking was occasionally steep, and in one instance (637-1) formed a concave edge or shallow notch. At least one flake fragment (637-2) bore evidence of multi-tasking, with three edges exhibiting three different wear patterns: shallow unifacial notching, shallow bifacial notching, and unifacial flaking along a convex edge.

Artifact #	*Material*	*Cortex*	*Weight(gm)*	*Comments*
277-5	chert	0	2.1	dulled edge
560-4	chert	0	0.3	unifacial scalar flaking along convex edge
637-1	IH jasper	0	1.6	unifacial scalar and hinge flaking, ventral face along two edges, one edge slightly notched
637-2	IH jasper	0	9.5	wide scalar flaking along portions of three edges, one edge unifacial and slightly notched, one edge bifacial and slightly notched, one edge unifacial, convex, and rounded
664-5	IH jasper	0	1.6	steep, unifacial scalar and hinge flaking along one edge, pattern truncated by snap breaks

Table 83. Utilized Debitage, Block A, Stratum C

Fire-Cracked Rock

Fire-cracked rock was recovered in relatively low frequency in Stratum C. Twenty-eight fragments were recovered, weighing a total of 849.8 gm. The mean weight of the fragments was 30.3 gm.

Stratum D/E

In total, 1733 artifacts were recovered from Stratum D/E of Block A. Eighty-seven percent consisted of chipped stone debris, the remainder fire-cracked rock, hammerstones, anvil stones, and a celt. Artifact type frequencies are listed in Table 84, and lithic raw material frequencies are detailed in Table 85. Raw material types among the flaking debris included quartz, Iron Hill jasper, chert, quartzite, jasper, ironstone, argillite, andesite, rhyolite, sandstone, chalcedony, and schist, in descending order of frequency. Descriptive statistics summarizing the main artifact types follow.

Artifact Type	Count	Frequency(%)
Flakes	1183	68.3
Fire-Cracked Rock	208	12.0
Chips (Potlids)	270	15.6
Cores	30	1.7
Unifaces	13	0.8
Early Stage Bifaces	14	0.8
Hammerstones	5	0.3
Late Stage Bifaces	4	0.2
Points	3	0.2
Anvils	2	0.1
Celt	1	0.1
Total	1733	

Table 84. Artifact Frequencies, Woodland I Deposits, Block A

Raw Material	Count	Frequency(%)
Quartz	642	41.7
Iron Hill Jasper	254	16.5
Chert	213	13.8
Quartzite	162	10.5
Jasper	137	8.9
Ironstone	63	4.1
Argillite	22	1.4
Andesite	19	1.2
Rhyolite	16	1.0
Sandstone	6	0.4
Chalcedony	5	0.3
Schist	1	0.1
Total	1540	

Table 85. Chipped Stone Raw Material Frequencies, Woodland I Deposits, Block A

Projectile Points

Three projectile points or point fragments were recovered from Stratum D/E of Block A. Details are summarized in Table 86. Both of the typologically identifiable points were attributable to the early portions of the Woodland I period. The long-bladed, Poplar Island point was manufactured from coarse-grained material, the smaller, Lamoka point from Iron Hill jasper.

Artifact #	*Material*	*Type*	*W:Th*	*Weight(gm)*	*Comments*
477-1	ironstone	Poplar Island	2.1	24.6	narrow bladed, straight edges, contracting stem, transverse snaps at proximal and distal ends, bedding plane cortex on both blade faces
662-1	IH jasper	Lamoka	2.3	4.8	slightly expanding stem, convex base, convex blade edges, reworked and burned post manufacture (reddened and potlidded)
577-1	quartz		n/a	1.4	small distal fragment, convex blade edges, perverse snap

Table 86. Descriptive Statistical Data: Projectile Points Recovered from Area 3 Block A, Stratum D/E

Bifaces

Early Stage Fourteen of the 18 bifaces in the assemblage were classed as early stage (Table 87) based on the degree of thinning and shaping evident, the degree of edge sinuosity, and the type of flaking employed. Six of the early stage bifaces were quartz and two of cryptocrystalline material—pebble chert. The remainder consisted of coarse-grained stone: 3 ironstone, 2 argillite, 1 quartzite. Width:thickness ratios varied from 2.05 to 5.25, the highest being two ironstone specimens (773-1, 855-1) which were somewhat atypical—like other ironstone bifaces from the site, they were manufactured on wide, thin fragments of tabular material, and the only evidence of knapping was in the form of initial edging, such as is characteristic of early stage reduction. A large proportion of the bifaces in the sample, nearly 60 percent, were complete. Remnant cortex was present on most of the bifaces made on tabular cobbles (ironstone and quartzite). The chert specimen had been manufactured on a small, bipolar core fragment and also bore cortex. There was relatively little evidence of heat treatment noted in the sample. Most heating was seen in the form of potlidding, and appeared to represent uncontrolled, postdepositional burning. One quartz specimen consisted of two refitted fragments (539-1, 565-3), one of which was reddened, possibly as a result of chemical weathering. The fragments refit across several horizontal and vertical proveniences, and the different weathering patterns bore implications for the site formation analysis discussed in a separate section of the report. All but one of the early stage bifaces bore evidence of rejection during manufacture, usually following catastrophic failure of the piece along transverse or oblique snap breaks, or due to the knapper's inability to continue thinning because of small size, excessive step fractures, or large knots or stacks on one or both faces. One ironstone specimen (773-1) exhibited dulled edges and a transverse snap break, suggesting either breakage during use or reuse of the rejected manufacturing fragment.

Artifact #	*Type*	*Material*	*W:Th*	*Cortex*	*Weight(gm)*	*Comments*
530-1	ESB	chert	n/a	10	21.3	incomplete width, multiple perverse fractures, manufactured on bipolar core, reject, refitted flake
539-1/ 565-3	ESB	quartz	3.62	0	25.1	two refitted medial fragments, manufactured on flake, step fractures, multiple tranverse snap breaks, reject
541-1	ESB	quartz	1.61	0	31.4	made on a small, bipolar core fragment, step fractures at flaws, reject
588-1	ESB	quartz	2.27	0	13.1	small proximal fragment, transverse snap along incipient fracture plane, reject
706-1	ESB	chert	1.41	10	44.7	made on a small, bipolar core fragment, reject
737-1	ESB	quartz	n/a	0	5.8	small medial fragment, multiple preverse fractures, reject
748-1	ESB	ironstone	2.52	30	103.7	tabular cobble, plano-convex cross-section, step fractures, oblique snap at extreme distal end, reject
762-1	ESB	argillite	2.2	0	49.6	heavily weathered, step fractures and stacks, reject
763-1	ESB	argillite	2.05	0	62.8	heavily weathered, step fractures, reject
770-1	ESB	quartz	n/a	0	37.6	small, manufactured on flake, multiple perverse freactures along flaw planes, reject, wear along margin of distal break
773-1	ESB	ironstone	5.25	70	93.2	tabular cobble, initial edging, transverse snap, width may be underestimated, dulled edges, discard
837-1	ESB	quartzite	3.06	70	737.2	tabular cobble, initial edging, reject
854-1	ESB	quartz	n/a	0	49.0	multiple step fractures, incomplete width, lateral snap break initiated along flaw plane, reject
855-1	ESB	ironstone	3.84	70	272.8	tabular cobble, initial edging, step fracture and lateral snap break, reject

Table 87. Descriptive Statistical Data: Bifaces Recovered from Area 3 Block A, Stratum D/E

Artifact #	Type	Material	W:Th	Cortex	Weight(gm)	Comments
594-1	LSB	argillite	4.38	0	18.5	four-fragment refit, heavily weathered, lateral spalls
700-1	LSB	quartz	2.15	0	24.3	plano-convex cross-section, step fractures, multiple flaw planes, minor proximal snap, reject
758-1	LSB	IH jasper	3.11	0	8.3	small proximal fragment,perverse snap, reject
760-2	LSB	ironstone	n/a	0	5.4	medial fragment, incomplete width, potlidded, heavily damaged

Table 87 (cont'd). Descriptive Statistical Data: Bifaces Recovered from Area 3 Block A, Stratum D/E.

Late Stage Four late stage bifaces were recovered, one each of quartz, argillite, ironstone, and Iron Hill jasper, the last being the only biface of Iron Hill jasper in the assemblage. One example, of quartz (700-1), was complete; the remainder were fragments. Two were manufacturing rejects, while two (760-2 ironstone, 594-1 argillite), bore heavy postdepositional damage masking evidence of abandonment status.

Unifaces

Of the 13 unifaces in the assemblage, 10 were cryptocrystalline, manufactured on chert, Iron Hill jasper, or pebble jasper flakes (Table 88). Most were endscrapers with convex bits. One (646-5) bore a narrow, beaked bit, while on several others the bit was irregularly shaped. The chert examples were made on bipolar flakes or cores and retained pebble cortex. Bit angles within the assemblage ranged from 60 to 85 degrees, with a mean of approximately 72 degrees. Visible wear on bit edges occurred as scalar and hinge flaking emanating from the dorsal edge. Few of the bits exhibited undercut edges. Rounding of the bit edge was noted in one-third of the specimens.

Artifact #	Material	Cortex	Bit Angle	Weight	Comments
417-1	chert	40	60-80	7.7gm	small bipolar core fragment, irregular bit, scalar flakes, rounded edge, endscraper
527-1	IH jasper	0	60-70	3.4gm	flake fragment, slightly rounded bit, multiple lateral fractures, endscraper

Table 88. Descriptive Statistical Data: Unifaces Recovered from Area 3 Block A, Stratum D/E

Artifact #	*Material*	*Cortex*	*Bit Angle*	*Weight(gm)*	*Comments*
549-1	chert	30	70-75	3.9	small cortical flake, irregular bit, scalar and hinge fractures, areas with slightly rounded edge, endscraper
564-1	chert	40	60-65	5.9	small cortical flake, round bit, minor hinge fractures, rounded bit edge, endscraper
576-1	chert	20	75-80	2.6	flake fragment, rounded bit, minor undercutting, rounded bit edge, potlidded (postdepositional), endscraper
586-1	IH jasper	0	75-80	6.6	flake fragment, minor bifacial trimming of platforn and bulb to form rounded bit, undercut, side-scraper
640-1	quartz	0	70	7.8	formed on flake fragment with sheared plane, minimal trimming, rounded bit, scalar flake scars, endscraper, broken laterally along flaw plane
646-5	chert	10	65-70	8.5	bipolar core fragment, narrow rounded bit, rounded edge, minor scalar and hinge fractures, endscraper
743-18	quartz	0	80-85	7.9	formed on flake fragment with sheared plane, minimal trimming, rounded bit, scalar flake scars, undercut, endscraper, irregular lateral break along flaw plane
768-2	quartz	0	60-70	16.8	formed on flake fragment with sheared plane, minimal trimming, rounded bit, scalar flake scars, rounded edge, side-scraper, broken laterally along flaw plane
769-1	chert	40	65-70	3.8	small cortical flake, irregular bit, minor trimming, rounded and polished edge and arrises, endscraper
857-1	chert	30	80	6.1	small cortical flake, rounded bit, hinge fractures and undercutting, endscraper
869-1	jasper	0	65-80	7.2	flake fragment, minor trimming, irregular bit, heavily potlidded, endscraper

Table 88 (cont'd). Descriptive Statistical Data: Unifaces Recovered from Area 3 Block A, Stratum D/E

Cores

Descriptive statistics for cores from Stratum D/E are summarized in Table 89, and include raw material type, percentage of remnant cortex, flake scar count, weight, and data pertaining to bipolar percussion, flake scar complexity (directionality), and other artifact specific attributes. A large percentage of the cores bore evidence of bipolar percussion. The proportion was very high among some raw material types: Iron Hill jasper 57 percent, pebble cryptocrystalline material 80 percent, quartz 90 percent. In contrast, none of the quartzite cores were bipolar. There was evidence throughout the assemblage of the testing and rejection of poor quality material both among pebbles and cobbles. Three cores (732-15 and 743-2, both Iron Hill jasper; 868-1, quartz) were in the form of small core tablets with flakes removed from around the edge. Both cores and flakes appeared to be too small to have represented part of a prepared core-flake industry, unless for some form of composite tool using very small flakes. The flaking may have been aimed at shaping the platform. One tested quartzite cobble (532-1) was battered at one end, indicating use as a hammerstone. Refits were present among the assemblage, both within and between proveniences, and are noted in the table. The technological and site formation implications are discussed in Chapter XVII, reporting the results of the refitting analysis.

Artifact #	*Material*	*Cortex*	*Scars*	*Weight(gm)*	*Comments*
709-3	chert	40	3	122.8	tested pebble, multiple flaws
743-1	chert	0	12	89.1	pebble, bipolar, multidirectional, multiple flaws
744-7	chert	10	5	14.2	pebble, bipolar, multidirectional, refit flake 744-5, intra-provenience
801-2	chert	20	7	15.0	pebble, bipolar, multidirectional, multiple flaws
521-1	IH jasper	0	6	13.5	bipolar, multiple flaws, refit 561-2, interprovenience (Stratum C)
592-1	IH jasper	0	5	11.3	small, bipolar, multidirectional, refit 737-32, interprovenience
732-15	IH jasper	10	7	32.1	small, unidirectional flaking from sheared platform, several refit flakes
737-32	IH jasper	0		3.3	refit 592-1 q.v.
743-2	IH jasper	0	7	17.6	small, unidirectional flaking from sheared platform

Table 89. Descriptive Statistical Data: Cores Recovered from Area 3 Block A, Stratum D/E

Artifact #	*Material*	*Cortex*	*Scars*	*Weight(gm)*	*Comments*
771-1	IH jasper	0	9	40.1	pebble, bipolar, multidirectional, multiple flaws
387-6	IH jasper	20	7	39.8	small, multidirectional, limonitic cortex
579-9	jasper	60	5	383.7	small cobble, multidirectional, bipolar, many flaw planes
532-1	quartzite	80	3	768.8	tested cobble, dense material, possible hammerstone use
640-8	quartzite	50	4	321.4	fragment of large tabular cobble, multidirectional, sheared at flaw plane
646-7	quartzite	50	6	493.0	small cobble, multidirectional, 3 refit flakes, interprovenience
709-4	quartzite	80	3	510.7	small tested cobble
718-1	quartzite	70	2	654.0	tested cobble
719-1	quartzite	80	3	687.3	tested cobble, tabular, dense, uniform material
738-3	quartzite	80	3	995.0	large tested cobble. dense material
838-2	quartzite	30	4	509.5	tabular cobble, tested
425-18	quartz	0	5	18.0	small, bipolar, multidirectional
425-19	quartz	0	7	24.1	small, bipolar, multidirectional
597-1	quartz	70	7	1043.1	large tested cobble, many flaw planes
710-1	quartz	50	1	61.3	split pebble, bipolar
716-1	quartz	0	10	298.6	small cobble, multidirectional, bipolar, many flaw planes
807-1	quartz	40	8	39.4	pebble, bipolar, multidirectional, multiple flaws
838-1	quartz	0	3	88.3	small cobble, bipolar, multidirectional
852-8	quartz	20	9	62.6	pebble, bipolar, multidirectional, multiple flaws
868-1	quartz	10	9	58.5	pebble, bipolar, multidirectional, flakes removed from shear plane
325-1	quartz	20	6	264.0	small cobble, bipolar, multidirectional, many flaw planes

Table 89 (cont'd). Descriptive Statistical Data: Cores Recovered from Area 3 Block A, Stratum D/E

	Flakes	Cores	Flake:Core
Iron Hill jasper	18.5%	23.3%	50.0
quartz	42.9%	33.3%	50.7
pebble material	17.2%	16.7%	40.8
quartzite	11.9%	26.7%	17.6
other	9.5%	0.0%	—

Table 90. Raw Material Distribution Among Cores and Flakes

Table 90 displays the relative distributions of raw materials among flakes and cores. The greatest differences were among the coarse-grained materials, where there was a higher proportion of quartzite cores than flakes and an absence of cores of materials such as andesite, argillite, sandstone, and rhyolite. Most of the quartzite cores were large tested cobbles, and thus had contributed little to the quartzite debitage frequency, implying that quartzite was not a major part of the flaking industry at the site. The figures for the other coarse-grained lithic materials were among the most direct indications of reduction strategy in the data. They implied that most of the coarse-grained material had been brought to the site in finished form, and that the flaking debris generally represented tool refurbishing, not manufacture. The flake-to-core ratios calculated for quartz and Iron Hill jasper suggested the presence of similar proportions of debitage.

Artifact #	*Material*	*Type*	*Segment*	*Weight(gm)*	*Comments*
566-1	sandstone	anvil	complete	144.9	small. oblong, extensive battering on both ends, wide and shallow pit on one face
644-1	sandstone	anvil	complete	553.1	oblong, extensive battering on both ends, along one edge, shallow pit on one face
506-1	quartzite	hammerstone	fragment	49.8	small fragment, refits 507-1 q.v.
507-1	quartzite	hammerstone	fragment	114.6	tabluar fragment, flaked at one end and battered along edge, refits 506-1
512-3	quartzite	hammerstone	fragment	139.4	tabular fragment, minor battering on one protruding edge
727-1	quartzite	hammerstone	complete	328.1	slightly oblong, minor battering at one end
849-1	quartzite	hammerstone	complete	213.6	oval, extensive battering on ends and one face, bipolar hammerstone

Table 91. Descriptive Statistical Data: Hammerstones and Anvils Recovered from Area 3, Block A, Stratum D/E

Hammerstones and Anvil Stones

There were 5 hammerstones and 2 anvil stones among the material recovered from Stratum D/E (Table 91). The hammerstones consisted of dense quartzite cobbles, the anvils of sandstone. Both anvils had been heavily utilized as hammerstones. One hammerstone (849-1) bore pecking across one relatively flat face, indicating that it had been used in bipolar percussion. The two refitted hammerstone fragments (506-1, 507-1) were from a relatively large tabular cobble, and judging from the shape of the cobble and the location of the fracture, the piece appeared to have been broken during use as an anvil.

Celt

One celt fragment (567-1) was recovered from Stratum D/E. It was made on a tabular fragment of dark gray hornblende schist, a metamorphic rock originating in the piedmont. One end had been battered, while the other had been unifacially flaked. Bedding planes in the material caused the flaking to be uneven and appear crude. The edge produced was only slightly dulled in one isolated area, suggesting that the artifact had not been heavily used and may in fact have been unfinished.

Utilized Debitage

Most of the utilized debitage consisted of flakes (Table 92). Raw materials included Iron Hill jasper (n=13), quartz (n=12), chert (n=1), and quartzite (n=1). Two quartz chips also bore evidence of edgewear. Use was identified in most cases by scalar flaking along part of one edge of the artifact, usually unifacial and, unless noted in the table, located on the dorsal face. Hinge flaking was also common along the extreme margins. The wear patterns were often truncated by snap breaks, suggesting breakage during use. Flaking was occasionally steep, and in several instances formed a concave edge deep notch (e.g. 425-14, 703-1). On one flake (575-1), scalar flaking occurred on alternate faces along opposite edges, indicating that the flake had been turned over repeatedly during use.

Artifact #	*Material*	*Cortex*	*Weight(gm)*	*Comments*
<u>*Flakes*</u>				
357-9	chert	0	0.4	unifacial scalar flaking along one edge
417-9	IH jasper	0	2.5	steep, unifacial scalar flaking along one edge, pattern truncated by snap breaks
425-14	quartz	0	15.0	steep, unifacial flaking, deep notch in one edge

Table 92. Utilized Debitage, Block A, Stratum D/E

Artifact #	*Material*	*Cortex*	*Weight(gm)*	*Comments*
520-1	quartz	10	29.1	dulled edge
529-1	IH jasper	0	1.2	narrow polyhedral blade fragment, steep scalar and hinge flaking along both edges, pattern truncated by snap break
533-1	quartz	0	12.3	bifacial lamellar and scalar flaking along one edge
546-1	quartz	0	54.0	unifacial scalar flaking along one edge
556-2	quartz	0	0.8	unifacial scalar flaking and notching along one edge, pattern truncated by sanp breaks
565-2	quartz	10	2.4	steep, unifacial, irregular scalar flaking along one edge
575-1	IH jasper	10	5.9	steep, unifacial scalar flaking along opposite edges, alternate beveling, concave wear pattern
588-3	IH jasper	0	0.3	unifacial scalar flaking along one edge, potlidded
599-2	IH jasper	0	2.3	unifacial scalar flaking along one edge, pattern truncated by snap breaks
634-1	IH jasper	0	9.2	steep, unifacial scalar flaking along one edge
634-12	quartz	0	29.7	invasive scalar flaking associated with trimming
658-5	IH jasper	0	3.4	unifacial scalar flaking along one edge
690-1	IH jasper	0	15.9	unifacial scalar flaking on alternate faces along portions of two edges
701-1	quartzite	100	12.9	wide, unifacial scalar flaking on ventral face along one edge
703-1	quartz	80	12.6	unifacial scalar flaking on ventral face along one edge, slightly concave
717-1	IH jasper	0	3.6	unifacial scalar flaking along two edges, one edge slightly concave
732-13	quartz	0	6.1	unifacial scalar flaking on ventral face along one edge, pattern truncated by snap breaks
763-4	quartz	0	2.9	unifacial scalar flaking along one edge, pattern truncated by snap break
772-1	quartz	80	82.0	unifacial scalar flaking along one edge
799-3	IH jasper	0	2.9	unifacial scalar and hinge flaking along beaked edge

Table 92 (cont'd). Utilized Debitage, Block A, Stratum D/E

Artifact #	*Material*	*Cortex*	*Weight(gm)*	*Comments*
801-1	IH jasper	0	1.5	unifacial scalar and hinge flaking along edge of distal snap break, slightly notched
843-6	quartz	0	0.7	unifacial scalar flaking along one edge
869-10	IH jasper	0	2.5	unifacial scalar and hinge flaking along small part of one edge
882-1	IH jasper	0	30.6	minor unifacial scalar and half-moon flaking along various edge segments
Chips				
557-1	quartz	0	7.1	steep, unifacial scalar flaking along one edge, pattern truncated by sanp breaks
752-1	quartz	0	12.7	unifacial scalar flaking along one edge

Table 92 (cont'd). Utilized Debitage, Block A, Stratum D/E

Flakes

The raw material breakdown among flakes mirrored the overall material distribution in the assemblage: quartz 43 percent (n=507); Iron Hill jasper 19 percent (n=219); cryptocrystalline pebble material 18 percent (n=208); and coarse grained stone, including quartzite 12 percent (n=141), and andesite, argillite, ironstone, and rhyolite at 1 to 4 percent each. Due to the relative size of the quartzite sample, it has been analyzed along with the major raw material types.

Size Grade	IH jasper	Quartz	Pebble	Quartzite
1	0.9	1.8	0.5	7.8
1.5	2.3	4.7	0.5	12.8
2	14.2	15.0	10.1	23.4
3	62.6	66.9	67.3	53.9
4	20.1	11.6	21.6	2.1

Table 93. Flake Size Distributions by Size Grade, Stratum D/E

As indicated in Table 93, analysis of size grade data, measuring the range of linear dimensions, indicated a relative sameness for quartz, Iron Hill jasper, and cryptocrystalline pebble material in the middle portion of the continuum—size-grade 3. Quartz displayed a slightly greater proportion of flakes in the lower grades, indicating more large flakes. Quartzite exhibited the greatest difference in all grades, with the distribution skewed toward larger pieces.

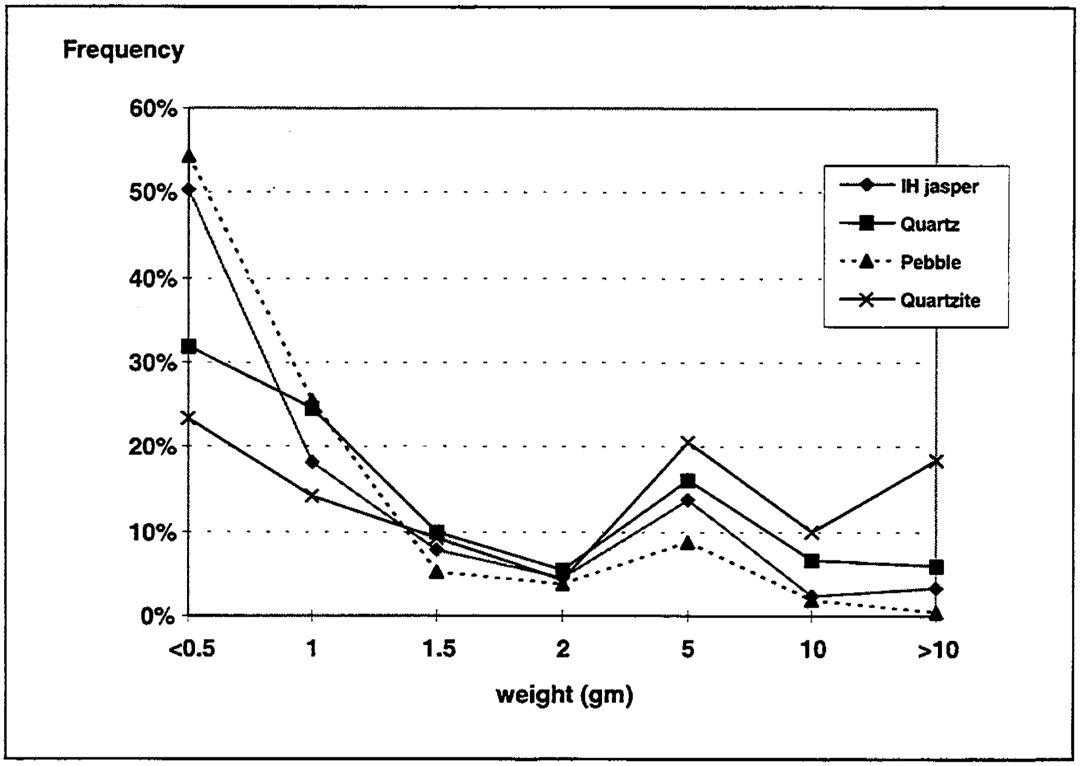

Figure 109. Flake Size Distribution by Weight, Block A, Stratum D/E

Weight distributions showed a similar pattern to the size-graded data (Figure 109), but revealed more variation among the material types. The group with the greatest proportion of small flakes in the assemblage was pebble cryptocrystalline, while quartzite showed the greatest proportion of large flakes. Quartz displayed a similar distribution to quartzite at the small end of the scale, indicating that there were considerably fewer small flakes in comparison to both pebble material and Iron Hill jasper. Notably, the remainder of the quartz graph paralleled the cryptocrystalline materials. The low incidence of small quartz flakes suggested little thinning or finishing of quartz, implying that knapping was more often aimed at the production of larger flakes, suitable for use as tools, rather than the reduction of a core into a bifacial tool. The parallel portions of the three graphs, at the high end of the scale, may reflect the size of the raw material pieces brought to the site—small pebbles for quartz and pebble cryptocrystalline and relatively small bifaces for Iron Hill jasper, in contrast to larger, cobble forms for quartzite. Some confirmation of this notion is seen in the size distribution of cores: all eight quartzite cores were cobble form; of the quartz cores with identifiable original forms, one-half were pebble and one-half cobble, the latter noted in each case as "small cobble;" and four of five cryptocrystalline cores were pebble.

The calculation of mean flake weights generally confirmed the size distribution data (Table 94). The largest flakes of quartz and quartzite (size grade 1) were considerably heavier than for other materials. In addition the means for the remaining grades were consistently higher, implying thicker flakes across the size range. The means calculated over the four complete grades, 1-3, indicated that quartz flakes were typically twice as heavy as Iron Hill jasper flakes, and quartizte several times heavier still.

Size Grade	IH jasper	Quartz	Pebble	Quartzite
1	23.3	59.0	17.0	52.4
1.5	10.6	14.8	4.2	15.2
2	3.5	4.7	3.5	4.7
3	0.7	1.1	0.6	1.1
4	0.1	0.2	0.1	0.3
grade1-3	1.8	3.6	1.1	7.9

Table 94. Block A. Stratum D/E: Mean Flake Weight per Size Grade

The proportions of cortical and non-cortical flakes among the various groups were tabularized (Table 95) and indicated differences between all materials. The most obvious difference was observed for quartzite, which showed a much higher incidence of cortical flakes in comparison with the other material types in the assemblage. Due to differences in sample size, the degree of variation among the remaining materials was less apparent. Difference of proportions tests were run for each pair of materials, and the results, presented in Table 96, indicated that in each case there was a statistical difference between the proportions of cortex bearing flakes. The frequency of non-cortical quartz flakes was relatively high, suggesting that some of that material may have been brought to the site partially reduced. The cortical frequency data were further broken down by size grade (Table 97). Iron Hill jasper flakes were consistently non-cortical across all grades (except grade 1.5, where a small sample may have been non-representative). For each of the other material groups, cortical percentage was highest in the low grades (larger flakes), and trended downward across the remaining grades (again, a small, potentially non-representative sample for pebble cryptocrystalline in grade 1.5 may have affected the trend for that group). These data again provide a clear indication of the difference in raw material form, highlighting the absence of cortical flakes among the Iron Hill jasper debris and the proportional reduction of cortex frequency among the other materials.

	IH jasper	Quartz	Pebble	Quartzite
Absent	93.6	83.6	72.1	30.5
Present	6.4	16.4	27.9	69.5

Table 95. Cortex Frequency, Block A, Stratum D/E

IH jasper	--		
Quartz	3.68	--	
Pebble	6.09	3.68	--
	IH jasper	**Quartz**	**Pebble**

Table 96. Results of Pairwise Difference of Proportion Tests for Cortical Flakes, Each Test Statistic Exceeds the Table Value of 2.58 with df=1.

sgrade	IH jasper	Quartz	Pebble	Quartzite
1	0	66.7	100.0	90.9
1.5	80.0	37.5	0	94.4
2	6.5	30.3	66.7	72.7
3	5.8	13.0	25.0	56.6
4	0	1.7	17.8	50.0

Table 97. Cortex Frequency by Size Grade, Block A, Stratum D/E

Platform Type	IH jasper	Quartz	Pebble	Quartzite
Simple / 2 Facet	42.7	34.1	25.9	30.9
Bifacial	24.5	6.3	25.9	4.1
Cortical	0.7	8.1	12.6	43.3
Crushed	30.8	49.7	31.1	21.6
Segment	**IH jasper**	**Quartz**	**Pebble**	**Quartzite**
Whole	41.1	43.6	43.8	51.1
Broken	58.9	56.4	56.2	48.9

Table 98. Additional Flake Attribute Data, Block A, Stratum D/E, Listed as Percentages

Analysis of other flake attributes was conducted with varying results. The ratio of whole to broken flakes was similar for each raw material type (Table 98), providing little basis for determining technological variability. Analysis of platform types contributed some additional information. Bifacial platforms, perhaps the most direct indication of biface reduction technology, occurred most frequently among cryptocrystalline materials—Iron Hill jasper and cryptocrystalline pebble types. The incidence of cortical platforms was distributed similarly to cortical flake proportions, the lowest proportion for Iron Hill jasper, the greatest for quartzite. The proportions of crushed platforms were relatively high across the board and within each group. Quartz exhibited the highest precentage of crushed platforms, possibly a result of bipolar percussion and brittleness of the crystallline material.

Finally, dorsal scar complexity was examined for additional information regarding variation in the flake assemblage. The underlying assumption of the analyses was that greater dorsal scar complexity indicates more flaking prior to the removal of the subject flake, and implies a later stage in the reduction continuum. The pattern of greatest interest was the tendency for Iron Hill jasper flakes to have somewhat higher dorsal scar counts and orientation totals. These results implied that Iron Hill jasper flakes were typically from later reduction stages than were flakes of other materials.

Flake-to-chip ratios were calculated for each raw material group (Table 99). The low ratios for quartz and pebble cryptocrystalline may reflect the use of bipolar percussion in the initial stages of reduction. This reduction technique represents a relatively uncontrolled form of percussion that often results in the splitting and shearing of the artifact, and thus is more likely to produce flaking debris without classic flake attributes, i.e., chips. The ratio for quartzite is high, indicating a low frequency of chips, and implying a different form of reduction.

	Flakes	Chips	F:Chip
IH jasper	219	22	10.0
Pebble	208	32	6.5
Quartzite	141	4	35.3
Quartz	507	108	4.7

Table 99. Flake-to-Chip Ratios, Block A, Stratum D/E

Fire-Cracked Rock

In total, 208 fragments of fire-cracked rock were recovered from Stratum D/E, with a total weight of 18.0 kg. The mean fragment weight was calculated as 86.6 gm.

Summary

The preceding flake analyses indicated that different manufacturing techniques were used for different stone types in the assemblage from Stratum D/E. The quartz and quartzite flakes from the deposit were larger and thicker than the Iron Hill jasper flakes, indicating different flaking procedures and possibly different end-products. The bifaces in the assemblage were mostly early stage and mostly of quartz or coarse-grained material. The relative absence of Iron Hill jasper bifaces could be an indication that few of those tools were manufactured on site, and that those that were had been finished and removed from the site area. Yet a substantial amount of Iron Hill jasper was recovered among the flaking debris. The data implied that the Iron Hill jasper flakes were largely maintenance related and not associated with the full range of reduction. Size distribution data, and in particular, weight distributions, lent some support to this conclusion. Patterning observed in cortical flake frequencies appeared to be characteristic of the form of the raw material, outcrop *versus* pebble origin.

There was also a relatively high frequency of occurrence of unifaces in the assemblage, probably the remnants of a particular processing activity. The tools were generally made on chert flakes, with a lower percentage made from quartz flakes. In both cases the form of the raw material may have influenced its choice. Both appeared to have been procured in pebble form, from which slightly curved flakes with thickened distal ends, such as are well-suited for endscraper manufacture, are easily struck.

Stratum D/E Artifact Clusters

Based on the results of spatial analyses conducted on artifact distributions in Stratum D/E (see Chapter XIV), two main clusters of litihic debitage were isolated. On the assumption that these clusters represented discrete activity areas, detailed analysis of the artifacts from each group was undertaken to determine whether patterns were present that were not brought out by the general stratum analysis. The results are reported below. The clusters are referred to by their general locations within the excavation block: northeast (NE), and southwest (SW). The units that made up the clusters are listed in Table 100.

NE Cluster	SW Cluster
N232 E241	N228 E237
N232 E240	N228 E238
N231 E239	N228 E239
N231 E240	N227 E237
N231 E241	N227 E238
N230 E239	
N230 E240	
N230 E241	

Table 100. Block A, Stratum D/E, Excavation Units Comprising Artifact Clusters

Comparison of artifact type frequencies and raw material types represented among flakes from the assemblages are detailed in Tables 101. Overall artifact counts indicated that the two clusters represented different levels of activity intensity. The NE cluster consisted of a total ot 712 artifacts, with a mean count of 89 artifacts per square-meter; the SW cluster, 282 artifacts, with a mean count of 56 artifacts per square-meter.

Artifact Type	NE Cluster		SW Cluster	
	count	frequency	count	frequency
Flakes	477	67.0	214	75.9
Fire-Cracked Rock	93	13.1	22	7.8
Chips(Potlids)	113	15.9	32	11.3
Core	11	1.5	5	1.8
Cobbles	7	1.0	0	0.0
Early Stage Bifaces	4	0.6	3	1.1
Hammerstones	2	0.3	0	0.0
Late Stage Bifaces	2	0.3	1	0.4
Unifaces	2	0.3	3	1.1
Points	1	0.1	2	0.7
-TOTAL	712		282	

Table 101. Artifact Type Distributions for Artifact Clusters, Block A, Stratum D/E

Comparison of artifact types showed that the NE group contained more fire-cracked rock and fewer flakes than did the SW cluster. The former appeared to be the more significant finding, since flake frequencies in the groups were relatively close with fire-cracked rock removed from the calculation (77 and 82 percent respectively). Nonetheless, neither area contained a especially large amount of fire-cracked rock, suggesting that fire-related activities were not the main focus of the occupations in either location.

Raw Material	NE Cluster		SW Cluster	
	count	frequency	count	frequency
Quartz	239	50.1	72	33.6
Iron Hill Jasper	86	18.0	41	19.2
Quartzite	47	9.9	44	20.6
Ironstone	34	7.1	5	2.3
Chert	33	6.9	35	16.4
Argillite	10	2.1	1	0.5
Jasper	9	1.9	12	5.6
Rhyolite	8	1.7	3	1.4
Andesite	7	1.5	1	0.5
Chalcedony	4	0.8	0	0.0
-TOTAL	477		214	

Table 102. Artifact Type Distributions for Artifact Clusters, Block A, Stratum D/E

Other artifact types occurred in roughly the same frequencies in both groups, with the exception of chips. There were more chips present in the NE cluster, probably associated with a higher incidence of quartz in that area. Quartz was in fact the majority raw material type among flakes in both clusters (Table 102), suggesting that it was the most important component of the lithic reduction process in both areas. Iron Hill jasper was represented equally in the two groups as a minority raw material, while other minority types showed some variation between the clusters. Ironstone flakes and bifaces, for example, were present in greater proportions in the NE area. More pebble cryptocrystalline flakes were present in the SW area, as were more chips of pebble chert. Quartzite flakes and cores were more frequent in the SW area as well.

Quartz, as the majority raw material type in both areas, was analyzed in more detail. Little difference could be discerned between the two assemblages. There were slightly fewer quartz cores in the SW group, following the flake distribution pattern, but considerably more quartz bifaces. Cortical frequencies were similar in both areas, although the frequency was low in comparison to other pebble or cobble materials, such as chert, jasper, or quartzite. As indicated in the artifact analysis for the entire stratum, the low cortical frequency may have been a reflection of the reduction trajectory of quartz, i.e., it was carrried to the site partially reduced, possibly for the manufacture of bifaces or some other specific tool type. Size distributions among the two quartz assemblages provided conflicting data. Size-grade frequencies suggested slightly larger quartz flakes in the SW group, while weight distributions showed little discrimination.

In sum, detailed analysis of the artifact assemblages from the clusters suggested that the NE group represented the remains of lithic reduction focused mainly on quartz. Little inital reduction of the material was conducted, the main trajectory possibly aimed at producing a particular tool form, either bifacial or a form of flake tool. The manufacture of ironstone bifaces and some reduction of Iron Hill jasper were also represented in the debitage. A hearth may have been present in the area, but the use of fire appeared to have been incidental to the main lithic reduction activity. Quartz reduction was also the main focus in the SW area, along with the knapping of pebble chert and jasper and quartzite cobbles as a secondary activity, the latter probably representing a core-flake technology producing flake tools. As in the NE area, a hearth may have been present, but was not critical to the main focus of activity.

BLOCK B

In total, 491 prehistoric artifacts were recovered from the sub-plow zone levels of Block B. As indicated in the analysis of Block A artifacts, stratigraphic and vertical artifact analyses indicated that at least two distinct depositional episodes were present in the sub-plow zone levels in Area 3: Stratum C, a 2Ab soil horizon, and Strata D and E, a series of 2C soil horizons lying directly below. The deposits appeared relatively intact and chronologically discrete, and thus the artifact assemblages from them were analyzed separately.

Stratum C

Of the 162 prehistoric artifacts recovered from Stratum C, approximately 72 percent consisted of chipped stone debris, the remainder consisting of fire-cracked rock and a fragment of prehistoric ceramic. Artifact type frequencies are listed in Table 103, and lithic raw material frequencies are detailed in Table 104. Raw material types among the flaking debris included quartz, chert, Iron Hill jasper, jasper, andesite, quartzite, and chalcedony, in descending order of frequency. Iron Hill jasper is listed separately from other jasper materials. Descriptive statistics summarizing the main artifact types follow.

Artifact Type	Count	Frequency(%)
Flakes	53	32.7
Fire-Cracked Rock	82	50.6
Chips (Potlids)	21	13.0
Points	2	1.2
Cores	2	1.2
Early Stage Bifaces	1	0.6
Non-diagnostic Ceramic	1	0.6
Total	162	

Table 103. Artifact Frequencies, Woodland II Deposits, Block B

Raw Material	Count	Frequency(%)
Quartz	42	53.2
Chert	11	13.9
Iron Hill Jasper	9	11.4
Jasper	7	8.9
Andesite	5	6.3
Quartzite	4	5.1
Chalcedony	1	1.3
Total	79	

Table 104. Chipped Stone Material Frequencies, Woodland II Deposits, Block B

Projectile Points

Two projectile points or point fragments were recovered. Details are summarized in Table 105. Both points were attributable to portions of the Archaic period. The general shape of the blade of the serrated fragment (476-1) was consistent with one of several varieties of bifurcate-based points from that period. Based on the results of radiocarbon dating and stratigraphic analyses detailed in Chapters IX and X, both artifacts appeared to have been out of place stratigraphically, and probably represented the scavenging of earlier artifacts by later inhabitants of the site area.

Artifact #	*Material*	*Type*	*W:Th*	*Weight(gm)*	*Comments*
476-1	chert	serrated	5.4	2.7	thin, symmetrical blade edges with prominent serrations, corner-notched or stemmed, transverse snap at neck, potlidded
502-1	quartz	Brewerton	2.5	10.3	thick, side-notched, concave base, base and notches ground, symmetrical blade with straight, beveled edges, pebble cortex on one face, massive damage to one basal tang and notch area

Table 105. Descriptive Statistical Data: Projectile Points Recovered from Area 3 Block B, Stratum C

Bifaces

One early stage biface (488-1) was recovered from Stratum C. It consisted of relatively coarse-grained Iron Hill jasper, and exhibited a partially thinned distal end and a perverse snap break that occured during a failed attempt at removing a large knot on one face. The artifact exhibited a width:thickness ratio of 2.0 and weighed 27.4 gm.

Cores

Two cores were recovered from Stratum C. Their attributes are summarized in Table 106. Both two specimens were small Iron Hill jasper cores exhibiting multidirectional flaking. Evidence of heating was evident on both, and in the latter case heating occurred after discard, as indicated by potlids that truncated flake scars.

Artifact #	*Material*	*Cortex*	*Scars*	*Weight(gm)*	*Comments*
480-3	IH jasper	0	7	10.8	small, multidirectional, heated, broken along crystalline vein
782-1	IH jasper	0	5	37.6	fragment, heavily burned and spalled after flaking, multidirectional

Table 106. Descriptive Statistical Data: Cores Recovered from Area 3 Block B, Stratum C

Flakes

The majority raw material type among the flakes from Stratum C was quartz, acounting for 51 percent (n=27). The remaining materials were present in samples ranging from 1 (chalcedony) to 6 (Iron Hill jasper and chert). Only the size distribution of quartz flakes was analyzed (Table 107), due to the small and potentially unrepresentative samples present for the remaining material types. Twenty-five of the quartz flakes (93 percent) were non-cortical. Since quartz was presumed to have been procured from local gravel bars in pebble or cobble form, the data suggested that the debris was from a relatively late portion of a reduction sequence.

sgrade	**count**	**frequency**	**mean weight**	
1.5	1	3.7	5.0gm	mean
2.0	2	7.4	4.0gm	weight
3.0	15	55.6	0.9gm	grades 1-3
4.0	9	33.3	0.2gm	1.5gm

Table 107. Size Distribution Data for Quartz Flakes, Block B, Stratum C

Fire-Cracked Rock

There were 82 fragments of fire-cracked rock recovered from Stratum C, with a total weight of 4.9 kg. The mean fragment weight was calculated as 60.3 gm.

Stratum D/E

Of the 329 prehistoric artifacts recovered from Stratum D/E of Block B, approximately 83 percent consisted of chipped stone debris, the remainder consisting of fire-cracked rock, hammerstones and anvil-stones, a celt fragment, and a fragment of prehistoric ceramic. Artifact type frequencies are listed in Table 108, and lithic raw material frequencies are detailed in Table 109. Raw material types among the flaking debris included quartz, Iron Hill jasper, jasper, quartzite, rhyolite, chert, andesite, argillite, and ironstone in descending order of frequency. Iron Hill jasper is listed separately from other jasper materials. Descriptive statistics summarizing the main artifact types follow.

Artifact Type	Count	Frequency(%)
Flakes	202	61.4%
Fire-Cracked Rock	51	15.5%
Chips (Potlids)	54	16.4%
Points	4	1.2%
Cores	4	1.2%
Early Stage Bifaces	3	0.9%
Late Stage Bifaces	3	0.9%
Unifaces	3	0.9%
Anvil	2	0.6%
Hamm	1	0.3%
Celt	1	0.3%
Ceramic	1	0.3%
Total	329	

Table 108. Artifact Frequencies, Woodland I Deposit, Block B

Raw Material	Count	Frequency(%)
Quartz	140	51.3%
Iron Hill Jasper	73	26.7%
Jasper	21	7.7%
Quartzite	22	8.1%
Rhyolite	5	1.8%
Chert	4	1.5%
Andesite	4	1.5%
Argillite	2	0.7%
Ironstone	2	0.7%
Total	273	

Table 109. Chipped Stone Raw Material Frequencies, Woodland I, Deposit, Block B

Projectile Points

Four projectile points or point fragments were recovered from Stratum D/E. Details are summarized in Table 110. Typologically identifiable points were attributable to portions of the Archaic and Woodland I periods. Based on the results of radiocarbon dating and stratigraphic analyses, reported elsewhere, the early Woodland I stemmed points appeared to have been in place stratigraphically. The remaining two points occurred in the deposit as a result of scavenging or postedepositional disturbance to the soil profile. Raw material selection was typical of documented patterns of lithic use, with the early and late points made from cryptocrystalline materials, and the Woodland I stemmed and notched points from coarse-grained and crystalline materials (Custer 1986:51; Kinsey 1972:339; McLearen 1991:95-7; Dent 1995:182).

Artifact #	*Material*	*Type*	*W:Th*	*Weight(gm)*	*Comments*
616-1	argillite	Poplar Island/ Lackawaxen	3.1	7.7	narrow, straight-sided stem, convex base, wide, symmetrical, convex blade edges, prominent shoulders, hinges and stacks on both faces, minor snap at distal end
621-1	IH jasper	Jack's Reef	5.0	6.7	corner-notched, concave base, wide blade with straight to convex edges, perverse snap midway along blade
787-1	quartz	Bare Island	2.6	6.7	straight-sided stem, slightly damaged base, prominent shoulders, asymmetrically reworked blade
877-1	chert	LeCroy	4.5	3.2	deeply bifurcated base, straight-sided blade, asymmetrically reworked, bothe edges serrated

Table 110. Descriptive Statistical Data: Projectile Points Recovered from Area 3 Block B, Stratum D/E

Bifaces

There were 6 bifaces recovered from the deposit, 3 early stage and 3 late stage (Table 111). Of the early stage bifaces, 2 were of quartz and one of ironstone. All were fragments and appeared to have been manufacturing rejects, abandoned due to material flaws, such as inclusions and incipient fracture planes, or due to their small size. Width:thickness ratios ranged from 1.7 to 3.6. The latter figure was recorded on the single ironstone specimen (828-2). Like other ironstone bifaces from the site, this example was manufactured on a wide, thin fragment of tabular material. The only evidence of working was in the form of initial edging, such as is characteristic of early stage reduction. A transverse snap break on the piece appeared to be related to manufacturing, while the edges were slightly dulled. The dulling was not truncated by the break suggesting use following breakage. The quartz examples were fragmentary, with multiple snap breaks along internal flaw planes. Crushing along the edges of one piece (861-1) was the result of manufacturing.

All of the late stage bifaces were of quartz. Each appeared to have been a manufacturing reject, abandoned due to snap breaks or insufficient size to allow additional thinning. Width:thickness ratios ranged from 1.5 to 2.4.

Artifact #	Type	Material	W:Th	Cortex	Weight(gm)	Comments
631-1	ESB	quartz	n/a	0	31.2	proximal fragment, multiple preverse fractures along flaw planes, reject
828-2	ESB	ironstone	3.6	0	96.6	tabular fragment, marginal flaking, dulled edges, transverse snap, reject
861-1	ESB	quartz	1.7	0	8.9	small proximal fragment, stacks, multiple perverse fractures, reject
794-1	LSB	quartz	1.5	0	22.1	complete, small, exaggerated plano-convex cross-section, step fractures, reject
830-1	LSB	quartz	1.8	0	17.0	small proximal fragment, oblique snap at flaw, reject
836-1	LSB	quartz	2.4	0	28.6	irregular cross-section, multiple flaw planes, minor snap at one end along flaw, reject

Table 111. Descriptive Statistical Data: Bifaces Recovered from Area 3 Block B, Stratum D/E

Unifaces

Three unifaces were recovered from Stratum D/E. All were scrapers made on quartz flakes (Table 112). The distal ends or thick lateral edges of the flakes had been trimmed into convex bit edges. Bit angles ranged from 65 to 80 degrees. Edge wear occurred as scalar flaking emanating from the dorsal edges of the specimens. Extensive undercutting of the edges was not noted.

Artifact #	Material	Cortex	Bit Angle	Weight(gm)	Comments
607-1	quartz	0	70	7.1	small, trimmed flake fragment, minimal edgewear, endscraper
623-5	quartz	0	65-80	9.4	small trimmed flake fragment, scalloped edge, slightly dulled prominences, sidescraper, perverse snaps at flaw planes
812-1	quartz	0	65-75	23.5	trimmed flake fragment, irregular scalar flaking, endscraper, multiple lateral and proximal breaks at flaw planes

Table 112. Descriptive Statistical Data: Unifaces Recovered from Area 3 Block B, Stratum D/E

Artifact #	*Material*	*Cortex*	*Scars*	*Weight(gm)*	*Comments*
399-3	quartz	0	4	24.4	pebble, bipolar, multidirectional, split along several flaw planes
679-4	IH jasper	70	2	241.2	large irregular cobble, minimal testing, extensively spalled along flaw planes, multiple refits with 680
680-10	IH jasper	70	2	252.6	large irregular cobble, minimal testing, extensively spalled along flaw planes, multiple refits with 679
817-1	chert	20	4	90.3	small cobble, unidirectional, many internal flaws and inclusions

Table 113. Descriptive Statistical Data: Cores Recovered from Area 3 Block B, Stratum D/E

Cores

Four cores were recovered from the deposit. Their attributes are summarized in Table 113. The two Iron Hill jasper specimens (679-4, 680-10) consisted of several refitted fragments making up a large irregular cobble that had been tested and discarded. The quartz specimen (399-3) bore no remnant cortex and exhibited direct evidence of bipolar percussion. All but the small chert core (817-1) bore multidirectional flake scars.

Artifact #	*Material*	*Type*	*Segment*	*Weight(gm)*	*Comments*
685-4	sandstone	anvil	whole	211.0	edge battering, wide and shallow pit on one face, one edge reddened, refit with 832-1
832-1	sandstone	anvil	whole	352.8	extensive edge battering, wide and shallow pit on one face (55mm wide, 2mm deep), refit with 685-1, no correlated reddening
673-6	quartzite	hammerstone	fragment	563.8	slight battering and abrasion at one end

Table 114. Descriptive Statistical Data: Hammerstones and Anvil Stones Recovered from Block B, Stratum D/E

Hammerstones

There were 2 fragments of an anvil stone and 1 hammerstone among the material recovered from Stratum D/E (Table 114). The anvil fragments (685-4, 832-1) refitted to form part of a flat, disk-like cobble of coarse sandstone. The edges of the stone were battered, indicating additional use as a hammerstone, yet the piece appeared to have been broken while being used as an anvil, since the break initiated in a wide shallow pit on the center of one face. One of the fragments (685-4) was reddened along one edge, evidence of burning. The refitted fragment (832-1) was recovered from a point more than a meter distant, suggesting that the burning was postdepositional.

Celt

The celt (812-3) recovered from Stratum D/E was made on a waterworn cobble of dense, indurated argillite weighing 383.9gm. It was extensively battered at one end. The artifact may have been scavenged for potential reuse at a later date, since several flakes were removed unifacially from the opposite end as well as from along one lateral edge, apparently to test the raw material.

Utilized Debitage

All of the utilized debitage identified in Block B consisted of flakes (Table 115). Most of the flakes were quartz (n=6), two were of Iron Hill jasper, and one of ironstone. Use was identified in most cases by unifacial scalar flaking along all or part of one edge of the artifact, usually located on the dorsal face. Two flakes, one of quartz (818-1) and one of Iron Hill jasper (683-1) bore wide notches. One quartz flake (672-1) exhibited a partially serrated edge.

Artifact #	*Material*	*Cortex*	*Weight(gm)*	*Comments*
617-1	IH jasper	40	9.1	steep edge, unifacial scalar and hinge flaking
683-1	IH jasper	20	18.9	minor unifacial scalar flaking in wide notches
618-6	ironstone	80	7.9	unifacial scalar and hinge flaking along one edge
672-1	quartz	0	5.9	unifacial scalar flaking creating serrated edge
778-1	quartz	0	8.6	steep unifacial scalar flaking along one edge
790-4	quartz	0	2.3	unifacial scalar and hinge flaking along one edge
818-1	quartz	0	2.8	unifacial scalar flaking and notching along one edge
819-3	quartz	0	2.5	unifacial scalar flaking along isolated portion of one edge
859-2	quartz	0	5.4	steep unifacial scalar flaking along one edge

Table 115. Utilized Debitage, Block B, Stratum D/E

Flakes

The raw material breakdown among flakes was as follows: quartz, 51 percent (n=102); Iron Hill jasper, 27 percent (n=55); quartzite, 11 percent (n=22); and cryptocrystalline pebble material, 6 percent (n=12). Other coarse grained stone, including andesite, argillite, ironstone, and rhyolite, comprised less than 3 percent each. Due to the relative size of the quartzite sample, it was included in several of the attribute analyses. Conversely, the sample size of the pebble cryptocrystalline materials was small and possibly unrepresentative. Data for this material type has been included in the various tables, but not in the general interpretation.

Size Grade	IH jasper	Quartz	Pebble	Quartzite
1	0	2.9	8.3	0
1.5	0	2.0	0	31.8
2	9.1	5.9	16.7	18.2
3	76.4	63.7	50.0	22.7
4	14.5	25.5	25.0	27.3

Table 116. Flake Size Distributions by Size Grade, Block B, Stratum D/E, Listed as Percentages

Analysis of the size distributions of flakes by size grade (Table 116) indicated that the distribution for quartz was skewed somewhat toward the low end of the range in comparison with the same distribution for Iron Hill jasper flakes. This result indicated that more large flakes were present in the quartz distribution, suggesting the possibility that different reduction strategies were represented in the two materials. The quartzite distribution showed an even higher proportion of large flakes, and stood out as distinct from the either of the first two material types.

Size distributions by weight (Figure 110) showed the same clear variation in the size of quartzite flakes. Well over one-half weighed 10 gm or more, implying that a large proportion of the material was the result of early stage reduction, or possibly a reduction strategy aimed at producing relatively large flakes suitable for tool use. In comparison, similar proportions of Iron Hill jasper and quartz flakes, 56 and 52 percent respectively, weighed less than 0.5 gm. Variation between the jasper and quartz flake weight distributions was not marked. To analyze those distributions further, mean flake weights per size grade were calculated (Table 117). In contrast to the general weight distribution curves, the size-graded means indicated a some between the jasper and quartz flakes. That is, quartz flakes were consistently heavier for each grade, implying that they were thicker than the Iron Hill jasper flakes. This finding may have resulted from a combination of differences in the knapping quality of the materials and in the reduction strategies or forms of percussion used. Examination of the relative frequencies of cortical flakes among each material (Table 118) implied that quartz flakes were not the result of extensive primary, or early stage reduction. Analysis of completeness among the material types (Table 118) showed Iron Hill jasper and quartz flakes displaying similar relative frequencies, and quartzite appearing distinct, with a higher proportion of complete flakes.

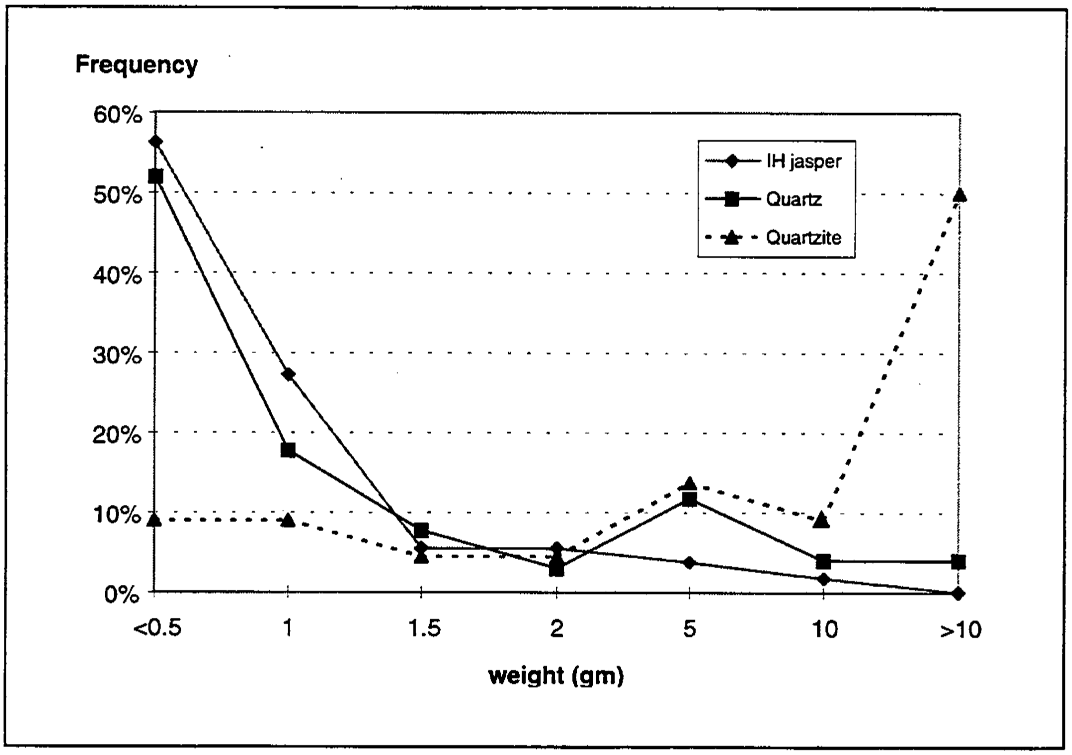

Figure 110. Flake Size Distribution by Weight, Block B, Stratum D/E

Taken in combination, the results of the various analyses initially appeared to imply that there was little difference in the technological treatment of Iron Hill jasper and quartz, with little evidence of early stage reduction apparent in either material. The data for quartzite were different, indicating more early stage reduction and possibly a focus on flake tool production. Further comparison of flake analyses with biface frequency data suggested that there may have been a difference in quartz and jasper reduction strategies. All but one of the bifaces, both early and late stage, were quartz. While one early stage biface was manufactured from ironstone, no bifaces were manufactured from cryptocrystalline material, whether Iron Hill jasper or pebble chert or jasper. This suggested that quartz was largely reduced into bifacial forms and Iron Hill jasper was of secondary importance in the lithic reduction activities. One final analysis shed further light on the issue. The incidence of various platform types showed a low frequency of bifacial platforms among quartz flakes, but high among Iron Hill jasper flakes (Table 118). Such a finding may imply that Iron Hill jasper bifaces were not manufactured on-site, but were merely retooled there during use, whereas a focus of quartz reduction was biface manufacture. Quartz flakes also displayed a relatively high frequency of simple platforms, characteristic of earlier stages of reduction, as well as a high frequency of crushed platforms, such as often result from bipolar percussion used to initiate fractures on pebbles or small cobbles. While the platform attribute data seem contradictory, they may merely indicate that there was no single trajectory followed for quartz reduction.

Size Grade	IH jasper	Quartz	Pebble	Quartzite
1	0	128.2	18.9	63.3
1.5	0	11.9	0	19.8
2	3.0	4.0	3.6	4.5
3	0.6	0.9	1.2	1.0
4	0.1	0.2	0.1	0
grades 1-3	0.8	6.5	3.7	26.6

Table 117. Mean Flake Weight per Size Grade, Block B. Stratum D/E

Cortex	IH jasper	Quartz	Pebble	Quartzite
Absent	92.7	92.2	58.3	22.7
Present	7.3	7.8	41.7	77.3
Segment	**IH jasper**	**Quartz**	**Pebble**	**Quartzite**
Whole	34.5	37.3	41.7	59.1
Broken	65.5	62.7	58.3	40.9
Platform Type	**IH jasper**	**Quartz**	**Pebble**	**Quartzite**
Simple / 2 Facet	12.5	50.0	11.1	41.2
Bifacial	75.0	12.1	44.4	0.0
Cortical	0.0	4.5	44.4	23.5
Crushed	12.5	33.3	0.0	35.3

Table 118. Additional Flake Attribute Data, Block B, Stratum D/E

Fire-Cracked Rock

There were 51 fragments of fire-cracked rock recovered from Stratum D/E, with a total weight of 3.8 kg. The mean fragment weight was calculated as 75.2 gm.

Ceramic Artifacts

A relatively small number of ceramic sherds were recovered from deposits across the Lums Pond site. All were small, heavily weathered fragments, most of which were difficult to classify in terms of known ceramic types. They were categorized mainly by tempering agent.

Area 2

Seventeen identifiable fragments were recovered in Area 2: 15 from pit features and 2 from the plow zone deposit. Two of the sherds were tempered with fine-to-medium grain sand. The sand tempered sherds were similar to ceramics from the region associated with the early portions of the Woodland I period. The remaining thirteen were tempered with crushed schist. Similar ceramics have been referred to in Delaware as "experimental" wares (Cara Blume, personal communication, 1996). Experimental wares represent an early period in the development and use of ceramics in the region, when there were few established manufacturing traditions, and various tempers, vessel shapes, manufacturing methods, and surface treatments were being tested for effectiveness (Wise 1975; Custer 1989). Radiocarbon dates from the pit features contaning the sherds indicated that both the sand- and schist-tempered types were in use at the Lums Pond site during the early part of the Woodland I period, around 2800 BP.

Area 3

Twelve identifiable ceramic fragments were recovered from Area 3. All were excavated from plow zone proveniences. Four sherds were sand tempered, 7 were shell tempered, and 1 was tempered with crushed quartz. The latter was identified as a type referred to as Wolfe Neck ware, a relatively thick ceramic ware that was typically quartz tempered and had an exterior roughened with cord markings or net impressions. The ware gives rise to the name for an associated cultural complex in the Piedmont/Fall Line, the Wolfe Neck Complex, dated to the middle portion of the Woodland I period. Radiocarbon dates for Wolfe Neck range from 505 BC, at the type site at Wolfe Neck Farm (7S-D-10), to 380 BC, at Dill Farm (7K-E-12) (Griffith 1982), although Custer (1989:166ff) begins the range at 700 BC.

The shell tempered sherds were generally characteristic of the so-called Townsend series wares, most commonly associated with the Woodland II period Slaughter Creek Complex on the Lower Coastal Plain. Townsend wares were a thin-walled, more highly fired type of pottery, often fabric-impressed and decorated with designs formed by incised lines (Blaker 1950; Griffith 1977). While most of the examples from Area 3 at Lums

Pond were poorly preserved, several did bear parallel incised lines as evidence of decorated exteriors. Shell tempered Townsend wares were usually acompanied by traingular projectile points, such as were recovered from Area 3.

REFERENCES CITED

Ahler, S.A.

1989 Mass Analysis of Flaking Debris: Studying the Forest Rather than the Tree. In *Alternative Approaches to Lithic Analysis*, edited by D.O. Henry and G.H. Odell, 85-118. Archeological Papers of the American Anthropological Association No. 1.

Amick, D.S., and R.P. Mauldin

1989 Comments on Sullivan and Rozen's "Debitage Analysis and Arcjaeological Interpretation." American Antiquity 54(1): 166-169.

Artusy, R.E.

1976 An Overview of the Proposed Ceramic Sequence in Southern Delaware. *Maryland Archeology* 12(2): 1-15.

Behm, J.A.

1983 Flake Concentrations: Distinguishing Between Flintworking Activity Areas and Secondary Deposits. *Lithic Technology* 12: 9116.

Blaker, M.C.

1950 Pottery Types from the Townsend Site, Lewes, Delaware. *Eastern States Archaeological Federation Bulletin* No. 9, July.

Broyles, B.J.

1971 *Second Preliminary Report: The St. Albans Site, Kanawha County, West Virginia.* West Virginia Geological and Economic Survey, Report of Archeological Investigations No. 3, Morgantown, West Virginia.

Callahan, E.

1979 The Basics of Biface Flintknapping in the Eastern Fluted Point Tradition: A Manual for Flintknappers and Lithic Analysts. *Archaeology of Eastern North America* 7: 1-180.

Collins, M.B.

1979 Excavations at Four Archaic Sites in the Lower Ohio Valley, Jefferson County, Kentucky. *Occasional Papers in Anthropology* No. 1. Department of Anthropology, University of Kentucky.

Cox, K.A., and H.A. Smith

1991 Perdiz Point Damage Analysis. *Bulletin of the Texas Archeological Society* 60: 283-301.

Custer, J.F.

1984 *Delaware Prehistoric Archaeology: An Ecological Approach.* Newark: University of Delaware Press.

1989 *Prehistoric Cultures of the Delmarva Peninsula: An Archaeological Study.* University of Delaware Press, Newark.

1994 *Stability, Storage, and Culture Change in Prehistoric Delaware: The Woodland I Period (3000 B.C.—A.D. 1000).* Delaware State Historic Preservation Office, Division of Historical and Cultural Affairs, Dover.

1996 *A Guide to Prehistoric Arrowheads and Spear Points of Delaware.* Center for Archaeological Research, Department of Anthropology, University of Delaware.

Custer, J.F., and D.C. Bachman
1983 *Phase III Data Recovery Excavations of the Prehistoric Components from the Hawthorn Site (7NC-E-46), New Churchman's Road, Christiana, New Castle County, Delaware.* Delaware Department of Transportation Archaeology Series 27.

1985 Analysis of Projectile Point Morphology, Use Wear, and Activity Areas at the Hawthorn Site (7NC-E-46), New Castle County, Delaware. *Journal of Middle Atlantic Archaeology* 2: 37-62.

Custer, J.F., S.C. Watson, and B.H. Silber
1996 *Final Archaeological Investigations at the Carey Farm (7K-D-3) and Islnd Field (7K-C-13) Sites, State Route 1 Corridor, Kent County, Delaware.* Delaware Department of Transportation Archaeology Series 146.

Dent R.J., Jr.
1995 *Chesapeake Prehistory. Old Traditions, New Directions.* Plenum Press, New York.

Ensor, H.B., and E. Roemer, Jr.
1989 Comments on Sullivan and Rozen's Debitage Analysis and Archaeological Interpretation. *American Antiquity* 54(1): 175-178.

Evans, J. and J.F. Custer
1990 Guidelines for Standardizing Projectile Point Typology in the Middle Atlantic Region. *Journal of Middle Atlantic Archaeology* 6: 31-42.

Flenniken, J.J. and A.W. Raymond
1986 Morphological Projectile Point Typology: Replication Experimentation and Technological Analysis. *American Antiquity* 51: 603-618.

Griffith, D.R.
1977 Townsend Ceramics and the Late Woodland of Southern Delaware. Unpublished Master's thesis, The American University, Washington, D.C.

1982 Prehistoric Ceramics in Delaware (An Overview). *Archaeology of Eastern North America* 10: 46-68.

Gunn, J.R., R. Mahula and J.B. Sollberger
1976 The Sollberger Distribution. *La Tierra* 3: 2-8.

Healan, D.M
1995 Identifing Lithic Reduction Loci wtih Size-Graded Macrodebitage: A Multivariate Approach. *American Antiquity* 60: 689-699.

Henry, D.O., C.V. Haynes and B. Bradley
1976 Quantitative Variations in Flaked Stone Debitage. *Plains Anthropologist* 21: 57-61.

Johnson, J.K.
1981 *Lithic Procurement and Utilization Trajectories: Analysis, Yellow Creek Nuclear Power Plant Site, Tishomingo County, Mississippi.* Tennessee Valley Authority Publications in Anthropology No. 28.

Kent, B.C.
1970 *Diffusion Spheres and Band Territoriality among the Archaic Cultures of the Northern Piedmont.* Ph.D. doissetation, Pennsylvania State University.

Kinsey, W.F., III
1959 Recent Excavations on Bare Island in Pennsylvania: The Kent Haley Site. *Pennsylvania Archaeologist* 29(3-4): 109-133.

1972 *Archeology in the Upper Delaware Valley.* Anthropological Series of the Pennsylvania Historical and Museum Commission, No. 2. Harrisburg.

Kraft, H.C
1975 *The Archaeology of the Tocks Island Area.* Archaeological Research Center, Seton Hall University Museum, South Orange, New Jersey.

Lothrop, J.C., and B. Koldehoff
1994 Archaic Settlement in the Lower Delaware Valley. *Journal of Middle Atlantic Archaeology* 10: 105-123.

McLaren, D.C.
1991 Late Archaic and Early Woodland Material Culture in Virginia. In *Late Archaic and Early Woodland Research in Virginia: A Synthesis*, edited by T.R. Reinhart and M.E.N. Hodges, 89-137. Richmond: Dietz Press.

Magne, M., and D. Pokotylo
1981 A Pilot Study in Bifacial Lithic Reduction Sequences. *Lithic Technology* 10: 34-47.

Mounier, R.A., and J.W. Martin
1994 For Crying Out Loud!: News About Teardrops. *Journal of Middle Atlantic Archaeology* 10: 125-140.

Muto, G.R.
1971 A Technological Analysis of the Early Stages in the Manufacture of Lithic Implements. M.A. thesis, Idaho State University.

Patterson, L.W.
1990 Characteristics of Bifacial-Reduction Flake-Size Distribution. *American Antiquity* 55: 550-558.

Payne, T.M.
1989 Investigations at a Lackawaxen Generalized Hunting Settlement in the Middle Delaware River Drainage. Paper presented at the Middle Atlantic Archaeological Conference, Rehoboth Beach, Delaware.

Petraglia, M.D., D.A. Knepper, and P. Glumac
1993 *Prehistoric Occupations In The Piedmont: Archaeological Excavations In Fauquier, Prince William, And Loudoun Counties, Virginia* . On file, Virginia Department of Historic Resources, Richmond.

Prentiss, W.C., and E.J. Romanski
1989 Experimental Evalustion of Sulllivan and Rozen's Debitage Typology. In *Experiments in Lithic Technology,* edited by D.S. Amick and R.P. Mauldin,. 15-31. BAR International Series, No. 528. Oxford..

Purdy, B.A.
1975 Fractures for the Archaeologist. In *Lithic Technology: Making and Using Stone Tools*, edited by E. Swanson, 133-141. Mouton, The Hague.

Riley, L., J.F. Custer, A. Hoseth, and E. Coleman
1994 *Final Archaeological Investigations at The Paradise Lane Site (7NC-D-125), Ogletown Interchange Improvement Project Area, New Castle County Delaware.* Delaware Department of Transportation Archaeological Series No. 117.

Riley, L., S.C. Watson, and J.F. Custer
1994a *Final Archaeological Investigations at Prehistoric Sites 7K-C-360 and Dover Downs (7K-365A and B), State Route 1 Corridor, Kent County, Delaware.* Delaware Department of Transportation Archaeological Series No. 105.

Ritchie, W.A.
1965 *The Archaeology of New York0 State.* Natural History Press, Garden City, New York.

1971 *A Typology and Nomenclature for New York Projectile Points.* New York State Museum and Science Service, Bulletin Number 384, Albany.

Schuldenrein, J., R.G. Kingsley, J.A. Robertson, L. Cummings, and D.R. Hayes
1991 Archeology of the Lower Black's Eddy Site, Bucks County, Pennsylvania: A Preliminary Report. *Pennsylvania Archaeologist* 61(1): 19-75.

Shott, M.J.
1994 Size and Form in the Analysis of Flake Debris: Review and Recent Approaches. *Journal of Archaeological Method and Theory* 1(1): 69-110.

Stahle, D.W., and J.E. Dunn
1984 *An Experimental Analysis of the Size Distribution of Waste Flakes from Biface Reduction.* Arkansas Archeological Survey Technical Paper No. 2.

Sullivan, A.P., III, and K.C. Rozen
1985 Debitage Analysis and Archaeological Interpretation. *American Antiquity* 50: 755-779.

Towner, R.H., and M. Warburton
1990 Projectile Point Rejuvenation: A Technological Analysis. *Journal of Field Archaeology* 17: 311-321.

Watson, S.C., and L. Riley
1994 *Final Archaeological Excavations at The Brennan Site (7NC-F-61A), State Route 896, New Castle County, Delaware.* . Delaware Department of Transportation Archaeological Series No. 116.

Wise, C.L.
1975 A Proposed Early to Middle Woodland Ceramic Sequence for the Delmarva Peninsula. *Maryland Archaeology* 11(1): 1-9.