Lithic Analysis and Spatial Patterning at the Bremer Site (21DK06), Dakota County, Minnesota

A Thesis
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by
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Abstract

The purpose of this study was to conduct a lithic and spatial analysis of the Bremer Site (21DK06), Dakota County, Minnesota in order to better understand how lithic tools and raw materials were curated at the site, what lithic activities took place at the site, what raw materials were present, and if these raw materials were differentially used. Providing answers to these questions will greatly increase our understanding of the Bremer site, its inhabitants, and their role in the region.

These questions are addressed by many different analyses. The results of the chipping debris analysis demonstrate the differential use of raw materials by locality and quality at the Bremer site. Locally available Prairie du Chien chert was the primary material used at the site, yet non-local materials had a large presence there, as well, indicating trade of raw materials throughout the region. Additionally, materials were preferentially chosen based on quality and texture. This indicates a non-random selection of materials based on quality for bifacial tool creation.

Two distinctive cultural horizons were identified through the vertical stratigraphy of artifacts within Block 1 with observable differentiations in raw material availability and use. These results indicate cultural differences through time represented in the lithic artifacts and an increase in trade and cultural contact over time at the same site.

The horizontal artifact distributions and activity areas at the site were identified through a spatial analysis of the site. This analysis also indicated a division of knapping events by raw material type and by artifact type over space. These studies and results increase our knowledge of the inhabitants of the Bremer site, their lifeways and site occupation, and their relationship to the larger region in which they lived.

A supplementary file of the complete lithic data is available for download.

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CHAPTER 1. INTRODUCTION AND MINNESOTA ARCHAEOLOGY LITERATURE REVIEW

1.1 Importance of the Bremer Site

The Bremer site is located along the southern shores of Spring Lake in Dakota County, Minnesota along the Mississippi River. There are many archaeological sites in the Spring Lake area that have been extensively documented, surveyed, and excavated since the 19th century. The high density of archaeological sites in this area indicates that this was an important and advantageous area to camp, hunt, and travel in pre-contact times. By more closely exploring the Bremer site, we may identify the activities that took place there as well as gain a better understanding of the importance of the Spring Lake area to pre-contact Native Americans.

Despite studies of several archaeological sites in the region, there are many aspects of pre-contact cultures in southeastern Minnesota which are still unknown. Studying a multi-component site in southeastern Minnesota, such as the Bremer site, may help shed some light on these understudied areas and increase our understanding of the Native American cultures in this region.

Additionally, detailed lithic and spatial analyses have rarely been completed on archaeological sites in this region. By intensively studying the lithics of the Bremer site, I hope to highlight the benefits of studying lithic debitage and demonstrate the wide variety of information that can be gained from lithic analysis. Similarly, I hope to demonstrate the benefits of identifying lithic raw materials in a scientifically reproducible, objective, and inexpensive way. By studying the spatial distribution of artifacts at the Bremer site using Geographic Information Systems (GIS), I aim to identify activity areas at the site and gain a broader understanding of how the site was used and how those activities varied over time and space.

The Bremer site itself has been a subject of research since 1956 when it was first excavated by the Science Museum of Minnesota. By continuing analyses of the Bremer site through a lithic and spatial analysis of artifacts recovered during the many excavations that have taken place there, the legacy of the Bremer site, the Spring Lake area, and those who occupied the area in the past live on and are better understood.

1.2 Minnesota Cultural and Environmental History

1.2.1 A Note on Choice of Chronology

In the *Archaeology of Minnesota* (2012), Gibbon proposes a new cultural chronology to describe past cultures in Minnesota. His chronology includes the Paleoindian and Archaic, Initial Woodland, Terminal Woodland, and Mississippian Period. Most notably, the Woodland Period is not divided into the traditional Early, Middle, and Late periods, but rather into Initial and Terminal periods. This is done because traditional markers of the tripartite Woodland cultural period are either absent in Minnesota or vastly delayed compared to other areas in the Midwest (Gibbon 2012:93). Despite this recent reconfiguration of the cultural chronology, I will continue to use the more traditional terminology to describe the cultural chronology of southeastern Minnesota, where the Bremer site is located. This is because the cultural chronology of southeastern Minnesota is not as well understood as other regions of the state, particularly because there is disagreement about the presence or absence of the Early Woodland in that part of the state (Gibbon 1986; Gibbon 2012:93; Perkl 2009:1-2). Given the potential presence of an Early Woodland phase in the Spring Lake area, I will use the more traditional chronology.

1.2.2 Paleoindian and Archaic periods (11,200 – 500 BCE)

The environment of the Paleoindian and Archaic periods in Minnesota was characterized by the retreat of glaciers, an open boreal coniferous forest landscape, and now-extinct megafauna such as giant beavers and mastodon (Gibbon 2012:38, 42). The first evidence of human habitation in Minnesota has been documented to 11,200 to 10,500 BCE (Buhta et al. 2011:10; Gibbon 2012:48). There are 133 identified early Paleoindian sites in Minnesota, and many Paleoindian points have been found in the southeastern portion of the state. These points are lanceolate in style, and include Clovis, Folsom, Midland, and Plainview points (Buhta et al. 2011:32, 122-123; Gibbon 2012:48). The Paleoindian period (11,200-10,500 BCE) is characterized by the use of these fluted spear points by small, mobile bands of Native Americans (Gibbon 2012:48, 58). The Archaic period (10,500-500 BCE) is characterized by a warming climate and rapidly changing vegetation, and continually mobile hunter-gatherer groups who began to use a wider array of stone tool types. Additionally, squash seeds from the multicomponent King Coulee site in southeastern Minnesota date to the Late Archaic (2530 +- 60 BP) and are the earliest evidence of horticulture in the upper Midwest (Perkl 1998:279). This change in lithic tool types likely represents a subsistence strategy that was altered with the warming climate (Gibbon 2012:60-61, 90).

1.2.3 Early Woodland (500-200 BCE)

The presence of an Early Woodland culture in Minnesota is contested (Gibbon 1986). However, there are five known sites in Minnesota with evidence of Early Woodland habitation, all of which are in southeastern Minnesota (Arzigian 2008:30). An Early Woodland type of ceramic, La Moille Thick, is only found at five known sites in Minnesota: the La Moille Rockshelter in Winona County, the Schilling Site on Spring Lake, the Kunz site in northeastern Watonwan County, the Commissary Point area in Goodhue County, and possibly the Anderson site in Anoka County (Gibbon 1986:84). This suggests the presence of Early Woodland in southeastern Minnesota (Arzigian 2008:30; Gibbon 1986:84). In general, the Early Woodland is characterized by the first appearance of ceramics (Gibbon 2012:93), but not much else is known about this time period given the limited evidence (Arzigian 2008:33). However, it is likely that mobile hunter-gatherer bands, similar to those during the late Archaic, continued during the Early Woodland (Arzigian 2008:33).

1.2.4 Middle Woodland (200 BCE – 200/300 CE)

The Middle Woodland phase is composed of regionally-specific components. In southeastern Minnesota, it is associated with Howard Lake and Sorg contexts, the latter of which is named for and represented by pottery found at the Sorg Site, as well as the Lee Mill Cave Site, both of which are at Spring Lake (Arzigian 2008:35, 50; Gibbon 2012:98). The Middle Woodland in southeastern Minnesota is identified as having thick, grit-tempered ceramics decorated with punctates, bosses, incised lines, cord-wrapped-stick impressions, and dentate stamping. Lithics include Snyders and Manker points, and raw materials are generally local but also include some non-local materials such as Hixton silicified sandstone and Knife River Flint (Arzigian 2008:35).

Little is known about Middle Woodland settlements and lifeways in Minnesota (Arzigian 2008:49). Settlements were likely seasonal camps overlooking rivers and lakeshores, with very few features (Arzigian 2008:50). Most distinctively, burial mounds were created during the Middle Woodland, some of which have some degree of similarity to Havana burial mounds due to similarities in ceramic styles, as well as Hopewellian burial mounds (Arzigian 2008:44).

1.2.5 Late Woodland (500-1150 CE)

The Late Woodland in southeastern Minnesota is defined by the creation of effigy mounds, the intensification of horticulture, the use of cord-impressed Madison ware-like ceramics, and triangular bow and arrow projectile points. Late Woodland peoples were likely groups of hunters, fishers, and horticulturalists that grew squash, corn, and sunflower, among other local plants (Arzigian 2008:93).

As populations increased in the Late Woodland, it became difficult for people to survive solely on hunting and gathering; therefore, horticulture and fishing became more prominent means of subsistence. People likely still maintained seasonal camps, with summer camps being near major river sources for mussel gathering and fishing, and these groups dispersing into smaller camps for the winter in valleys (Theler and Boszhardt 2006:460). Some of these groups were likely band-level societies. Late Woodland effigy mounds and ceramics in Minnesota are similar to those found in Wisconsin and Iowa, indicating that there was contact between these groups. This contact was likely facilitated by river systems which functioned as travel and trade routes (Arzigian 2008:101-102).

1.2.6 Oneota/Mississippian (1150 CE – 1650 CE)

The Oneota culture represents a transformation of Native American society and an abrupt end of the Woodland culture, with new subsistence-settlement patterns, material culture, and ideology (Gibbon 2012:159). Oneota peoples were more dependent on maize and lived in larger and more permanent settlements than Woodland peoples, but they built burial mounds as did previous cultures in the region. In terms of material culture, Oneota settlements are recognized by the presence of shell-tempered globular jars that with smooth surfaces and incised-line decorations (Anfinson 1997:90; Gibbon 2012:159).

1.2.7 Minnesota Environmental History

1.2.7.1 Minnesota Glacial History

During the last glacial period, which lasted from 60,000 to 12,500 years ago in Minnesota, all but a few small areas in the southeastern part of the state were covered in varying thicknesses of glaciers, although not always at the same time (Gibbon 2012:37). Two main lobes covered Minnesota: the Superior Lobe, which covered the northeastern part of the state to the east-central part, and the Des Moines Lobe, which extended from the northwestern part of the state to the south and east. These glacial lobes began their retreat around 15,500 years ago, leaving the southern part of the state glacier-free by 14,000 years ago and had moved northwards completely out of the state by 12,500 years ago, leaving Glacial Lake Agassiz in their wake (Gibbon 2012:21, 38).

The extent of glaciers in Minnesota greatly influenced the presence and location of lithic raw materials across the state. Glaciers transported rocks away from their original sources and into new areas, leaving deposits known as glacial till. Glacial till frequently includes raw materials used by Native Americans to create lithic tools, and occurs in areas of the state which were once glaciated (that is to say, a vast majority of it) (Bakken 2011:8). These glacially distributed lithic raw materials that are moved from their primary contexts alters our understanding of where Native peoples may have acquired these raw materials, which can have serious consequences on how trade, economy, and tool production of Native groups are interpreted. Understanding how glaciers moved (i.e. generally from north to south when expanding and from south to north when retreating), as well as the pattern of outwash and meltwater flows, can help in our understanding of how glacial till was deposited, and thus aid in our understanding of natural and cultural lithic raw material distribution.

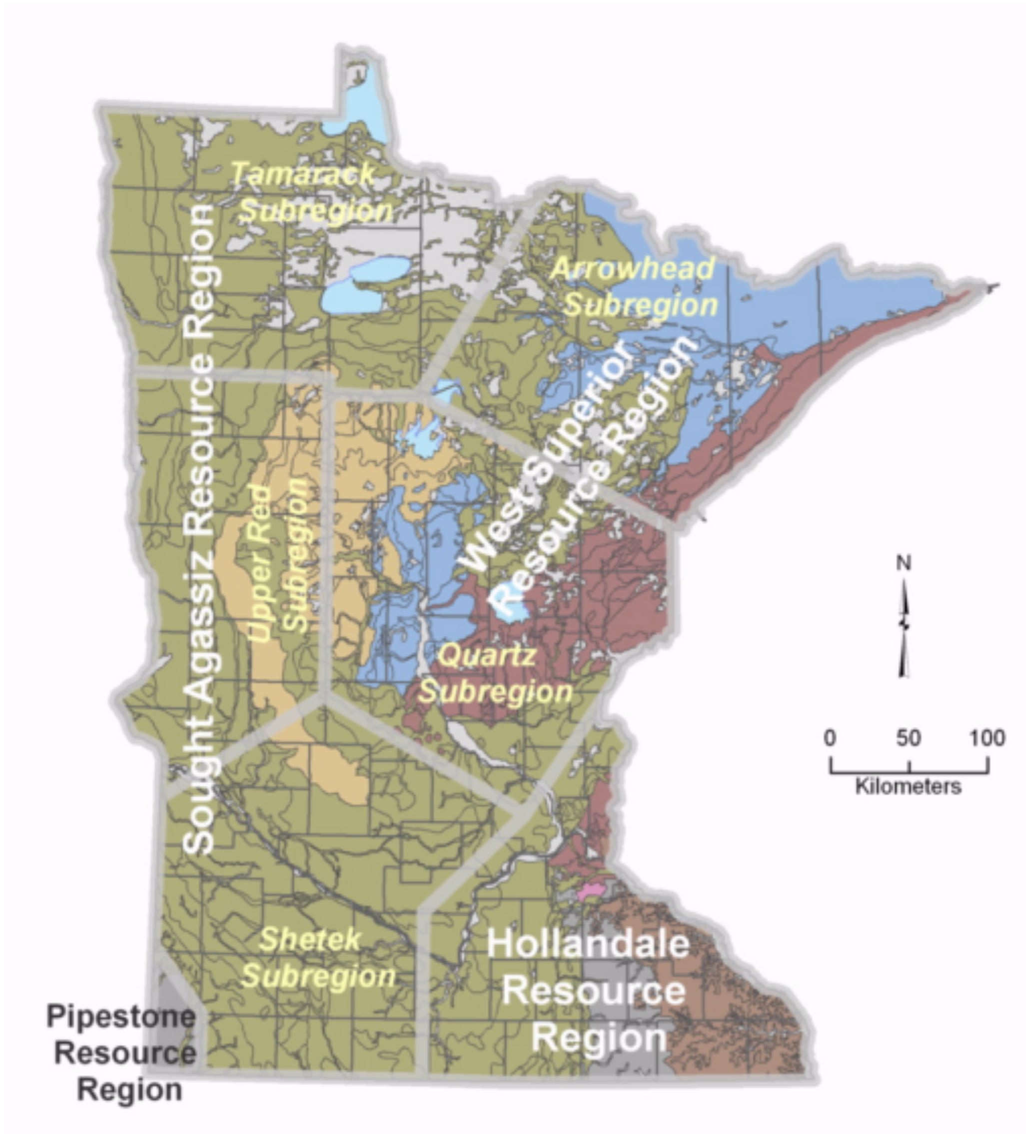

Figure 1. Lithic raw material resource regions and subregions in Minnesota, compared to generalized Quaternary geology (after Hobbs and Goebel 1982; green shows Des Moines or Red River lobes, gold shows Wadena lobe, blue shows Rainy lobe, red shows Superior lobe, grey shows old tills, brown shows areas not recently glaciated.) Image from Bakken 2011, after Hobbs and Goebel 1982.

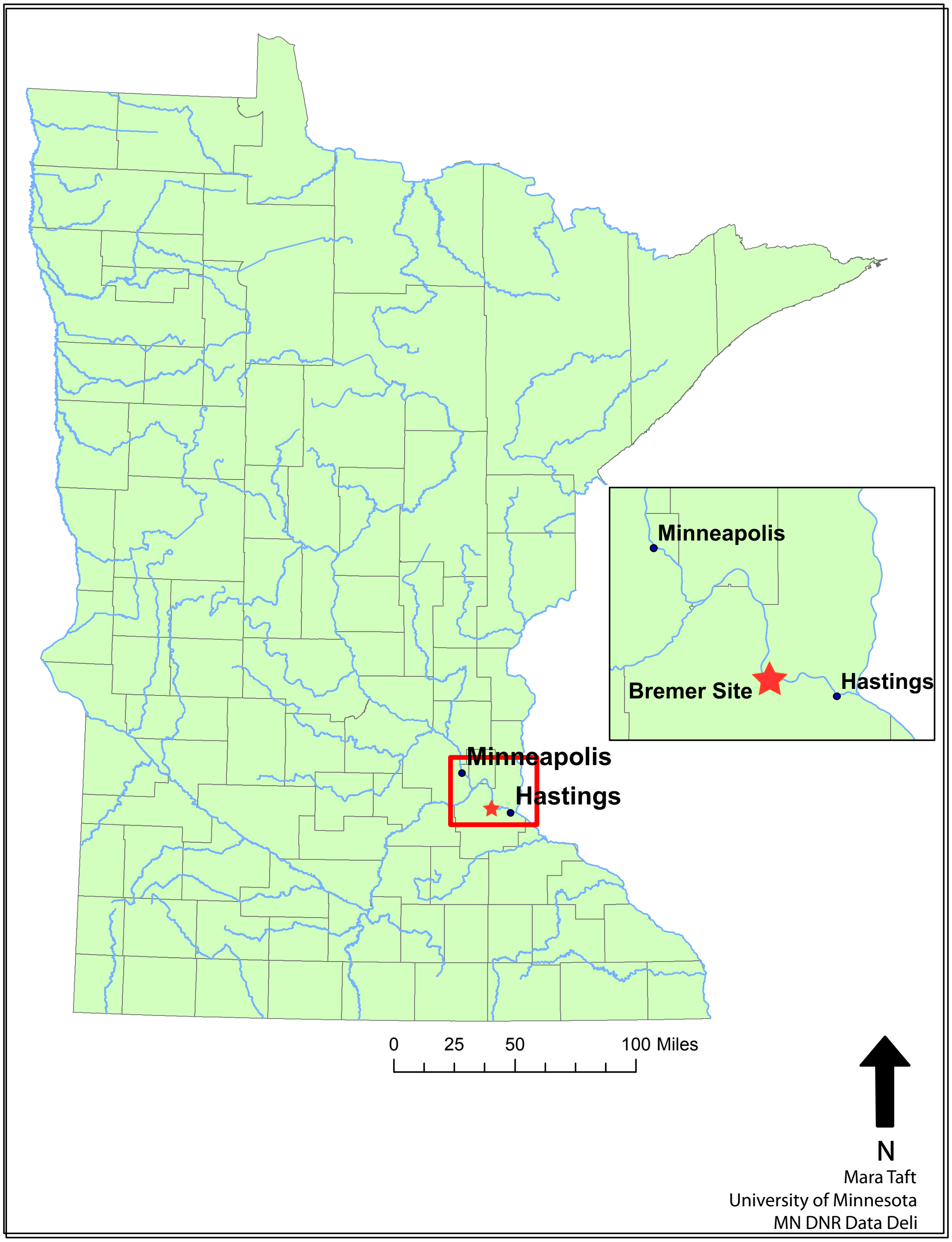

Figure 2. Map of Minnesota with Bremer site location inset.

1.2.7.2 Pre-Contact Spring Lake environment

Southeastern Minnesota, which includes Spring Lake, was only lightly glaciated during the Pleistocene Ice Age compared to other regions in Minnesota. Due to the deep erosion caused by glaciers and their deposits, the region has many more rivers than lakes, as well as bedrock outcrops that contain raw material well-suited for tool use (Gibbon 2012:29). Starting about 2500 BCE in the Late Holocene, which marks the start of a similar climate and animal and plant communities to what is present today, the rivers were surrounded by deciduous forests of elm, ash, and cottonwood trees while the uplands were dominated by forests filled with maple, elm, and basswood. In the western part of southeastern Minnesota, prairies and oak barrens dominated the landscape (Gibbon 2012:29; Baker et al. 2002:112, 121). Animals common to the region included deer, elk, and bison in the forests and mussels, fish, and various waterfowl in the rivers. Edible vegetation included aquatic flora such as water lilies, as well as prairie turnips and acorns in the prairies and forests (Gibbon 2012:29).

1.2.7.3 Historic Spring Lake environment

Spring Lake is located along the Mississippi River in southeastern Minnesota in a transition zone between deciduous forest to the northeast and prairie to the southwest. The topography in this region is highly varied due to water erosion. There are numerous river terraces along the southern edge of the lake which are dissected by ravines, creating drainage channels that lead into Spring Lake (Fleming and Hager 2010:56; Gibbon 2012:29; Leisman 1959:1). Historic documents from the mid-19th century indicate that at that time, Spring Lake was a marsh that was fed by numerous springs along its southern edge and was drained by a small creek at the northeastern edge of the marsh (Leisman 1959:1).

A mill was constructed at the mouth of the drainage creek in 1855. This mill raised the water level of Spring Lake so that the eastern half became a shallow open lake, while the western half remained a marsh. This led to an increase in wildlife and fish, as well as an increase in fishermen and hunters to the area (Leisman 1959:3).

In 1932, Hastings Lock and Dam (USACE Lock and Dam #2) was erected in the Mississippi River, which led to an increase in water level upstream of Hastings, MN, so much so that Spring Lake became a part of the Mississippi River (Fleming and Hager 2010:56; Leisman 1959:3). This, in turn, led to the disappearance of marsh vegetation at Spring Lake. Today, the river terraces and uplands have become reforested due to the incorporation of the Spring Lake area into the Dakota County Parks system as Spring Lake Park Reserve (Fleming and Hager 2010:58; Leisman 1959:3).

1.3 Overview of Spring Lake Sites

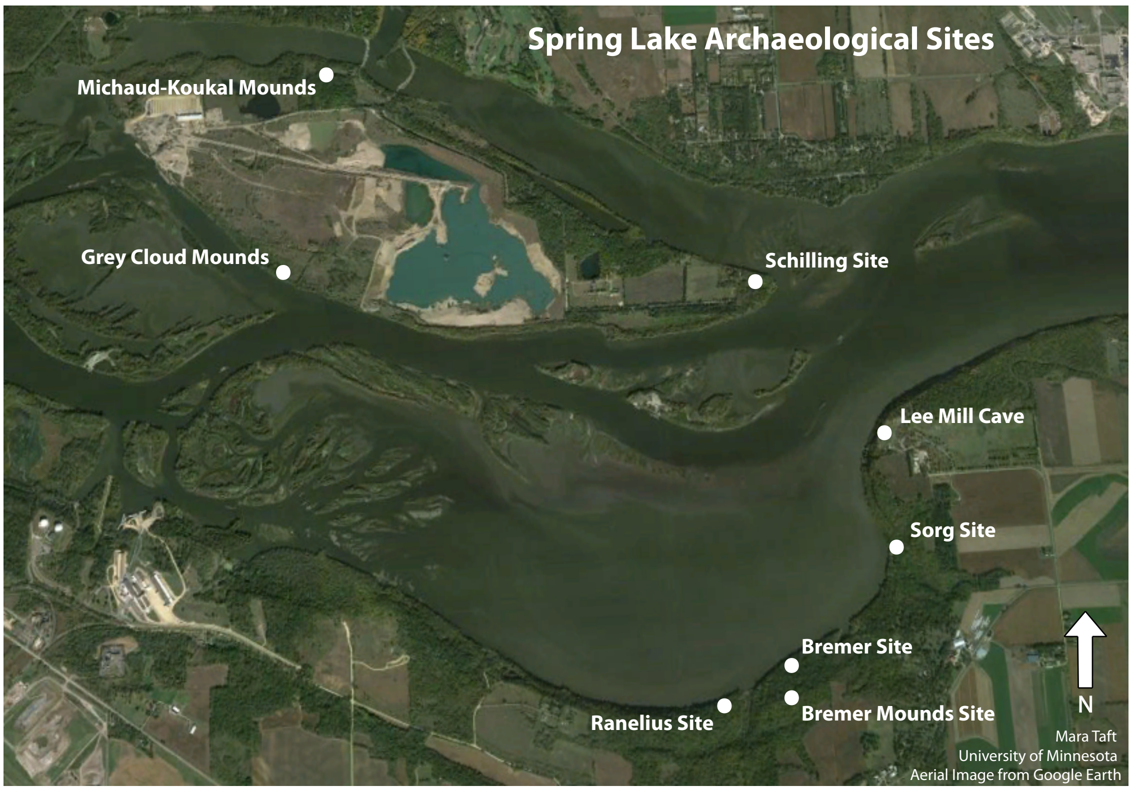

Figure 3. Map of archaeological sites in the Spring Lake area.

There are numerous archaeological sites along Spring Lake which have been documented and researched since the mid-19th century. The large number of sites in this area indicates that this area was important in pre-contact times, likely due in part to its proximity to major river trade routes. It is important to understand the Bremer site within the context of these other sites in the Spring Lake area.

1.3.1 Lee Mill Cave (21DK02)

Lee Mill Cave (21DK02) is a small rock shelter in the bluffs along the eastern side of Spring Lake, well above the water line (Johnson and Taylor 1956:i). The cave itself has a wide opening that forms into a narrow tunnel that gently slopes upward (Johnson and Taylor 1956:3). Lee Mill Cave is unique along Spring Lake because of the preservation of faunal and botanical remains that are not preserved at other sites, due to the fact that it is a cave environment. Although there is some bone preservation at the Schilling and Sorg sites, the preservation is not as good as at Lee Mill Cave.

Three occupation levels have been recorded at the site: the earliest occupation is represented by Feature 1, a fire pit. No diagnostic artifacts were found in this occupation level, making it difficult to determine the cultural affiliation; however, the lack of ceramic artifacts indicate a possible Archaic component. The second occupation is indicated by a parallel cord-impressed, grit tempered ceramic type, as well as notched and stemmed points; this occupation period is likely associated with a Havana occupation (Johnson and Taylor 1956:14, 24). The most recent occupation is indicated by shell-tempered ceramics that have been compared with Oneota, as well as thin, grit-tempered ceramics that are associated with the Late Woodland tradition, and likely represent a separate component (Johnson and Taylor 1956:24-25). The cultural sequence in the cave has been interpreted as a transition period between the Woodland and Oneota traditions, and was likely an occupation site for autumn hunting parties due to the nature of the faunal remains found at the site (Johnson and Taylor 1956:26).

1.3.2 The Sorg Site (21DK01)

The Sorg site (21DK01) is located on a gently sloping outwash plain at the base of a bluff along the eastern end of Spring Lake (Johnson 1959:5). It was first excavated in 1954, and again in 1955 and 1956 by the Science Museum of Minnesota (Johnson 1959:3-4).

Two occupational periods have been defined at Sorg – the Sorg Phase, and the Nininger Phase. The Sorg Phase is likely Hopewellian, as determined by diagnostic ceramic artifacts (Johnson 1959:25); the Nininger Phase, on the other hand, is identified as being from the Late Woodland period due to small triangular points, thin, grit-tempered pottery, and a lack of Oneota ceramics (Johnson 1959:26).

1.3.3 Bremer Mounds Site (21DK05)

The Bremer Mounds site (21DK05) consists of two mounds on a 100 foot terrace above the Bremer Site on the southern shoreline of Spring Lake. It was excavated along with the Bremer Site in 1955-1956 by the Science Museum of Minnesota and various Twin Cities colleges and universities. Mound 1 is linear, measuring 220 feet long, 50 feet wide, and 1.5 feet tall. Mound 2 is smaller and ovoid, with a radius of approximately 25 feet (Jenson 1959:59-66). During the excavation of Mound 1, several burials were found along with artifacts within the mound fill, including pottery sherds and four triangular stemless points (Jenson 1959:62-66). A cache of clam shells and bone fragments were found in Mound 2; however, it was not specified whether the bone fragments were human or animal. In both mounds, a prepared clay floor was found that was only partially excavated (Jenson 1959:66).

Peter Jenson, a Masters student at the University of Minnesota in the 1950s, completed his thesis research on the Bremer Site and Bremer Mounds site, which were excavated in 1955-1956 (Fleming 2012b:1). One aspect of Jenson's thesis was determining the relationship between the Bremer Site and Bremer Mounds sites. The Bremer Site was discovered by archaeologists during the Science Museum of Minnesota's Spring Lake survey while in the area surrounding the Bremer Mounds site. Due to the small amount of artifactual material found in the Bremer Mounds site, it is difficult to make conclusions about any temporal relationship between these two sites. However, their close proximity and the similarity of cultural materials found at the two sites would suggest that there is some relationship. Jenson believed that people who occupied the Bremer Site during the later occupation (which he calls Component B) built the mounds, due to the similar triangular stemless points found at both sites (Jenson 1959:70-72).

1.3.4 Bremer (21DK06)

The Bremer Site (21DK06) is located on the southern shore of Spring Lake (Fleming 2012b:1; Jenson 1959:1). It is a multi-component habitation site with at least three well represented habitation components: a Middle Woodland Havana-like component, a Late Woodland component, and an Oneota component. Additionally, poorly defined Paleoindian and Archaic components are present at the site (Fleming 2012b:2). An overview of the Bremer site, history of excavations there, as well as previous analyses completed are summarized in section 1.5.

1.3.5 The Ranelius Site (21DK04)

The Ranelius site (21DK4) is a multi-component campsite on a glacial outwash terrace on the southern shore of Spring Lake. It was first excavated in 1954 and 1955 by Leland Cooper and Elden Johnson, and again in 2010 by Ed Fleming (Fleming and Hager 2011:56).

The Ranelius site was occupied periodically throughout the Late Woodland and Late Precontact periods (Fleming and Hager 2011:91). The presence of a Waubesa contracting-stem point suggests that occupation of the site could be as early as Early Woodland, although no other diagnostic Early Woodland artifacts were found; similarly, no diagnostic Middle Woodland artifacts were found (Fleming and Hager 2011:61-62). Late Woodland and Oneota components are well represented by pottery and projectile points found at the site (Fleming and Hager 2011:92).

1.3.6 Grey Cloud Island: Introduction

Grey Cloud Island is surrounded by the Mississippi River on all sides, and is just north of Spring Lake. It is approximately five miles long and one to two miles wide, and was split into two islands, Upper and Lower Grey Cloud Island, when the Hastings Lock and Dam was built in 1932 which caused water levels of the Mississippi River to rise (Birk 1973:1).

Grey Cloud Island was surveyed in the Fall of 1971 by the Minnesota Historical Society (Birk 1973:1). Four main archaeological sites were surveyed on the islands, as well as several historical sites and smaller, peripheral sites. Artifacts, specifically ceramics and lithics from the Schilling Site, suggest that the island has been occupied since at least the Early Woodland period (Birk 1973:14).

1.3.7 Grey Cloud Island: Schilling Site (21WA1)

The Schilling Site is arguably the most noteworthy site on Grey Cloud Island. Located on the eastern tip of Lower Grey Cloud Island, it includes two separate mound groups and a settlement (Birk 1973:55, 64). The site was first surveyed in 1887 by Theodore Lewis, who recorded a total of 31 circular conical mounds in one group and 3 circular conical mounds and 1 linear mound in the other group (Winchell et al. 1911). In 1947, the site was examined by Lloyd Wilford of the University of Minnesota, who excavated a trench through one of the mounds, but found sterile soil (Birk 1973:55; Withrow et al. 1987:1-2). In 1955 many artifacts were collected along the eroding shoreline near the Schilling Site, and due to the extent of artifacts found during surface survey, in 1958 Elden Johnson of the Science Museum of Minnesota excavated 23 trenches throughout the site (Birk 1973:57; Withrow et al. 1987:1-2).

Johnson's excavations were important for several reasons. He was able to establish a chronology of the site, and concluded that the had been occupied from the Early Woodland to the Late Prehistoric Period, including some Oneota cultural materials. (Birk 1973:57). This is an especially important finding because the presence of an Early Woodland period in Minnesota is contested (Gibbon 1986). However, the presence of a La Moille Thick pottery rim sherd, a diagnostic ceramic type for the Early Woodland period, was found at the site, indicating that there was an Early Woodland presence at the site (Birk 1973:62; Gibbon 2012:94). The Schilling site is one of only five sites in Minnesota which have a documented Early Woodland presence, making it especially rare and important (Gibbon 1986:84).

However, the component represented by the most artifacts at the Schilling site was the Middle Woodland period. This included two different types of ceramics, all of which were grit-tempered, as well as an asymmetrical point type which also dates to the Middle Woodland (Birk 1973:57; Withrow et al. 1987:30).

1.3.8 Grey Cloud Island: Grey Cloud Mounds (21WA9)

Grey Cloud Mounds site is a series of earthen mounds on the southern edge of Lower Grey Cloud Island, originally overlooking a slough and the Mississippi River. Theodore Lewis originally surveyed the mounds in 1882 and 1887 and found 48 mounds (Birk 1973:46; Winchell et al. 1911); the site was again surveyed in 1947 by Wilford who detected 12 mounds in the group. Wilford excavated a trench through Mound 5, which did not yield any cultural material (Birk 1973:46, 49). In 1971, Birk and the Minnesota Historical Society surveyed the mounds again and relocated 40 of the original 48 mounds (Birk 1973:49).

Two trenches were then excavated near one of the mounds still in existence. In the trenches, a fire hearth was discovered with many associated fire-cracked rocks, charcoal, and calcified bone fragments. In addition, a shell-tempered ceramic body sherd and several pieces of lithic debitage were discovered; notably, the body sherd was decorated with incised lines in an identical way to those found at Lee Mill Cave which date to the Oneota period (Birk 1973:51; Johnson and Taylor 1956:10, 24). Given the presence of the sherd, it is believed that the site is associated with Oneota cultures, although it should be noted that the relationship between the fire hearth and the mounds is not completely understood (Birk 1973:54).

1.3.9 Grey Cloud Island: Michaud-Koukal Site (21WA2)

The Michaud-Koukal Site consists of two mound groups spread over both the Upper and Lower Grey Cloud Islands. TH Lewis mapped the main group of mounds in 1887, during which Lewis recorded 19 circular mounds; in 1971, the mounds were resurveyed and three more mounds were identified (Birk 1973:66; Winchell et al. 1911). Three of the mounds were tested in 1947 by Wilford, and two of the mounds proved negative while a third contained several bone fragments (Birk 1973:68).

The second mound group was first recorded by 1902 by Brower (Birk 1973:71). While the original number of mounds in this group is unknown, it is thought to have been between 7 and twenty mounds. In the 1970's, five circular conical mounds remain (Birk 1973:71).

1.3.10 Grey Cloud Island: Larson Plant Floodplain Site (21WA24)

The Larson Plant Floodplain Site is located on the floodplain of Upper Grey Cloud Island. The site was located during a surface survey when many deer bones, several of which were calcified, were discovered eroding from the river bank. In response to this discovery, eight excavation units or trenches were dug, six of which had cultural artifacts (Birk 1978:39, 41); 78 of the 131 bone fragments recovered are calcified, indicating that these faunal remains were in direct contact with a high heat source (Birk 1973:41). In addition to the deer bones, a small triangular point was found, made from white chert; typologically, this point style dates to the Late Woodland or Late Precontact period. The lack of other cultural materials and a real fireplace indicates that this was a temporary camp (Birk 1973:44).

1.3.11 Grey Cloud Island: Other Sites

There are several other prehistoric and historic sites on the Grey Cloud Islands. On Upper Grey Cloud Island, the area known as Robinson's Rocks was once home to a Native American campsite as well as homes to several of the island's first European settlers in the 19^{th} century. Additionally, the Grey Cloud Townsite, established in 1856, was located on Lower Grey Cloud Island. It grew in size until 1900, when it decreased in size to a large farm (Birk 1973:76). Areas of the town were later excavated by archaeologists, and lithic debitage as well as a cordmarked, grit tempered ceramic sherd indicate the presence of Woodland peoples prior to the building of the town (Birk 1973:83). In addition to these formal sites, there have been several isolated artifact finds throughout Grey Cloud Island that indicate cultural use throughout the site by both Native American and European groups (Birk 1973:89).

1.3.12 The Hamm Site

The Hamm site was discovered during a survey of the Spring Lake shoreline in 1952. A 20 foot by 18 inch trench was excavated perpendicular to the lake shore. One retouched lithic artifact was found, as well as several pieces of chipping debris and shell-tempered sherds. An outcropping of dolomite in the area likely served as a source of raw material for local inhabitants, as chert appears as nodules within the dolomite and can be exposed through weathering (Johnson 1956:27).

1.3.13 The Bud Josephs Site

The Bud Josephs site was discovered while the Science Museum of Minnesota was conducting a brief survey along the shores of Spring Lake in 1952 in order to identify potential future research sites. The Bud Josephs site is located on the property of Bud Josephs, which is on a spit of land along the Spring Lake shoreline northwest of the Ranelius site. One five-foot test pit was excavated in an area adjacent to the shoreline. Within this excavation, two worked lithic artifacts were recovered as well as several pieces of unworked chert and chert nodules; however, no pottery or other artifacts were recovered. The researchers discovered that the area had been disturbed by lake ice pressure, but that further inland it was undisturbed and worthy of further testing (Johnson 1956:27).

1.3.14 Ordway Sites

Four previously unknown sites were discovered along the Mississippi River just north of Spring Lake during an archaeological survey of the Katharine Ordway Natural History Study Area, conducted by Macalester College and the Science Museum of Minnesota. Three sites contain Early Woodland, Middle Woodland, and Late Woodland components, while the fourth site was a lithic scatter with no diagnostic material (Legge and Fleming 2013:ii).

1.4 History of Excavations at the Bremer Site

1.4.1 Overview

The Bremer Site (21DK06) is located on an outwash terrace on the southern shore of Spring Lake, southeast of the Twin Cities along the Mississippi River (Fleming 2012b:1, Jenson 1959:1). It is a multi-component habitation site with at least three habitation components: a Middle Woodland Havana-like component, a Late Woodland component, and an Oneota component (Fleming 2012b:2).

Due to the site's location, it has gone through some erosion and disturbance. Erosional outwash from the uplands above the site has resulted in the creation of minor ravines in the site. Additionally, the Hastings Lock and Dam was built on the Mississippi River in 1932 and has caused a considerable rise in water level at the site, leading to erosion along the lake shore which likely included a portion of the site (Jenson 1959:7).

1.4.2 Previous Excavations

There have been several excavations at the Bremer site. The site was initially excavated by the Science Museum of Minnesota in 1956 as a part of the museum's exploratory Spring Lake Archaeology Program (Jenson 1959:4; Fleming 2012b:1). Scott Meyer, an independent archaeologist, led a shovel test survey of the Bremer Site in 1996 with a group of high school students from the Area Learning Center in Apple Valley, MN. Ninety-eight shovel tests and two units were excavated. From 2011-2013, the Science Museum of Minnesota, in conjunction with the University of Minnesota, ran an archaeological field school at the site (Fleming 2012b:2). Additionally, in the summer of 2014, the University of Minnesota completed a two-week excavation at the site, funded by the Clean Water Land and Legacy Amendment and the Minnesota Historical and Cultural Heritage Grants, in order to collect micromorphology samples.

The 1956, excavations at the Bremer Site consisted of 39 units that were 5 by 10 and 10 by 10 feet in measurement, and which were dug along the entire length of the terrace. The units were very concentrated on the western edge, due to the high amount of material recovered from this area (Jenson 1956; Fleming 2012b:1-2). Every unit tested positive for cultural material, and the collection indicates at least Middle Woodland, Late Woodland, and Oneota components (Fleming 2012b:2).

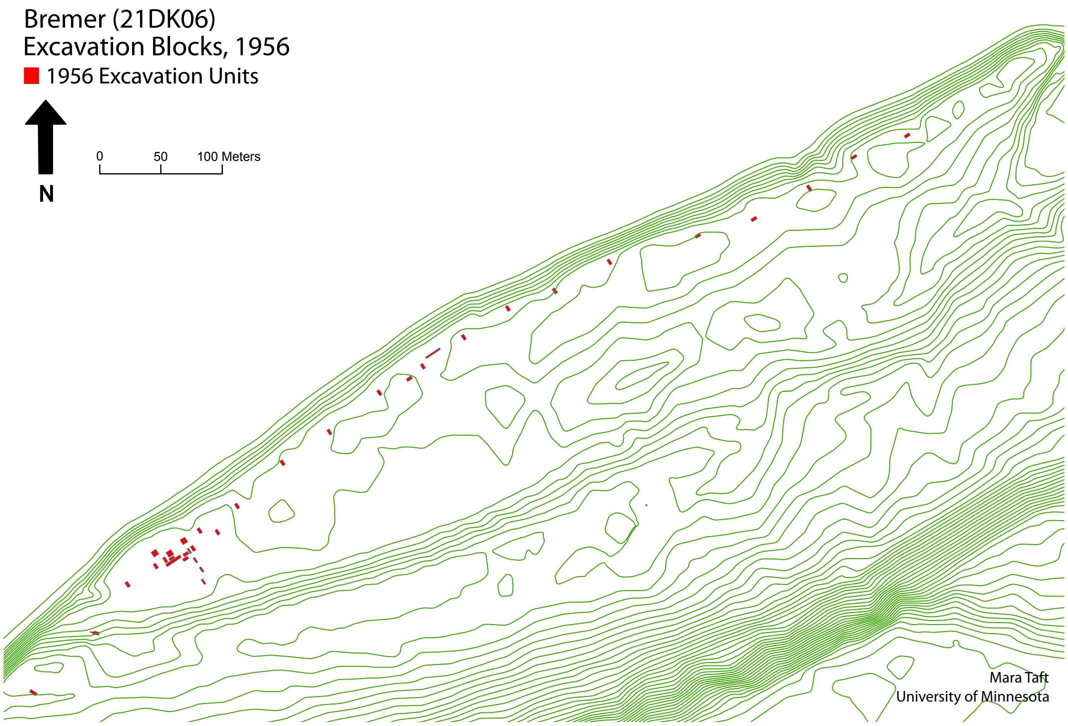

Figure 4. Map of Bremer excavation units from 1956.

In 1996, Scott Meyer completed a shovel test survey of the Bremer site with a crew of high school students. He excavated 98 shovel tests at intervals of 10 meters in four transects starting at the eastern edge of the terrace; over 80 percent of the shovel tests contained cultural materials. Two 1 x 2 meter units were also excavated, although the location of these units and whether or not they contained cultural material is unknown (Meyer 1996:1). However, all maps, notes, and artifacts from this survey were lost, and an analysis or report of the excavation was never finished. Meyer did write a letter to the State Archaeologist about the excavations, indicating that he identified a Middle and Late Woodland component at the site (Fleming 2012b:2; Meyer 1996:1).

From 2011 through 2013, the Science Museum of Minnesota and the University of Minnesota conducted an archaeological field school at the Bremer site in order to systematically sample the entire terrace and provide archaeological training to students (Fleming 2012b:1).

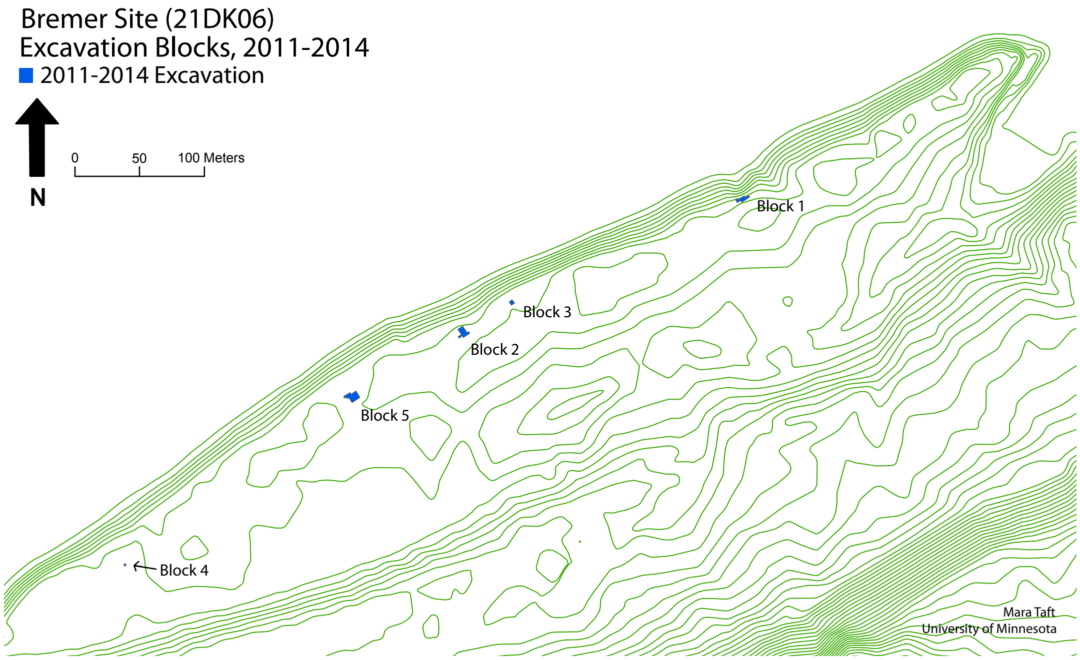

Figure 5. Map of Bremer excavation units from 2011 through 2014.

Figure 6. Map of Bremer shovel test pits (STPs) by year, from 2011 through 2013.

In 2011, 69 shovel test pits were dug in six, staggered 10-meter interval transects from the eastern property line along the shoreline. Cultural material was found in 73% of the shovel test pits (Fleming 2012a:2). Additionally, 16 1 by 1 meter units were excavated in a total of three blocks. Block 1 consisted of six contiguous excavation units, and was placed near a shovel test pit that contained a Howard Lake-style Middle Woodland rim sherd. Block 2 contained six excavation units, and was placed next to exposed Late Woodland pottery and chipping debris. Block 3 consisted of four units and was placed near a shovel test pit that contained a large amount of lithic chipping debris (Fleming 2012a:2).

The second season of the University of Minnesota-Science Museum of Minnesota archaeology field school was conducted in 2012, which included excavation of shovel test pits and the continued excavation of blocks. The shovel test pits were excavated on the lower terrace as well as the upper terrace, which is a natural rise in the landscape. The shovel test pits on the upper terrace did not contain any cultural material (Fleming 2014:1). The shovel test pits from 2011 and 2012 on the lower terrace were 80% positive for cultural artifacts. Block 1 was expanded to include four units to the east, Block 2 was expanded to include six units to the south, Block 4 consisted of one unit and was excavated in full, and Block 5, consisting of four units, was excavated.

During the 2013 field school, Block 2 was expanded to include four units to the east of the 2012 excavation units, and Block 5 was intensively expanded to include 17 units to the west of the 2012 excavation. Additionally, a third transect of shovel tests was excavated approximately 20 to 25 meters inland from the terrace edge (Fleming 2014:2).

The University of Minnesota and the Science Museum also completed a brief excavation of the site in 2014 in order to collect soil samples and micromorphology data. One unit was expanded off of Block 1, Block 2 was expanded by two units, and Block 5 was expanded by three units. Importantly, the northeast corner from a 1956 excavation unit was uncovered in Block 5 Unit Y, which helped locate the 1956 excavation units. Additionally, one shovel test pit was dug off-site in order to collect control soil samples.

The preliminary results of these excavations and shovel test surveys reveal some interesting occupation patterns at Bremer. The shovel tests indicate that much of the terrace was occupied throughout history, but that occupation was primarily along the modern-day Spring Lake shoreline as there is little evidence of cultural material on the upper terrace below the Bremer Mounds (Fleming 2014:2).

1.4.3 Artifacts and Interpretations from Previous Excavations

1.4.3.1 1956 Excavations

From the 1955-1956 excavation, two distinctive groups of pottery were uncovered. The most abundant, Bremer Triangular Punctated, was represented by 406 grit-tempered sherds with a hard surface and an average thickness of 0.46 cm. This pottery type is commonly decorated with triangular punctuates over a cord-wrapped paddle surface treatment, and dates to the Late Woodland period (Jenson 1959:15, 30).

Figure 7. Bremer Triangular Punctate ceramic rim sherd; photo courtesy of Ed Fleming, Science Museum of Minnesota. Scale is in cm.

The less abundant group is represented by an assemblage of 19 sherds which have large grit temper, a soft surface, and are about twice as thick as Bremer Triangular Punctated. Jenson originally identified these sherds as being Fox Lake, but they have since been identified as Sorg and Howard Lake (Fleming, personal communication 2015). Three of these sherds have interior decoration of incised lines over cord-wrapped paddle surface treatment, while the rest of the sherds are untreated (Jenson 1959:15-16). Bremer Triangular Punctated is most common at the Bremer Site, but is also found at the Sorg and Schilling sites, which may indicate some relation between these sites. Jenson notes that all of the Sorg and Howard Lake pottery was found in a small, confined area of the site west of square 11, which is located on the western end of the site, whereas the Bremer Triangular Punctated pottery was found throughout the site but is isolated stratigraphically from the Fox Lake sherds. Additionally, the Sorg and Howard Lake sherds were found consistently stratigraphically lower than Bremer Triangular Punctated, which led Jenson to conclude that the Sorg and Howard Lake sherds represent an older component of the site than the Bremer Triangular Punctated sherds (Jenson 1959:52).

Lithic artifacts found during the 1956 excavation include retouched and ground stone artifacts. Retouched stone artifacts include projectile points, knives, utilized flakes, end scrapers, gravers, side scrapers, and drills (Jenson 1959:35). Lithic material identified includes oolitic chert, chert, quartz, flint, chalcedony, and quartzite; unfortunately, Jenson does not provide details about specific chert types in this analysis. Projectile points were the most common chipped stone tool, and include triangular stemless points that are associated with the Late Woodland pottery, side notched points, and stemmed points. Jenson concluded that due to their abundance, projectile points were the major hunting weapon, and were mostly used with a bow and arrow rather than spear due to their small size (Jenson 1959:48). Jenson concluded that the side notched points were older than the triangular stemless points, because the side notched points were consistently found in excavation levels below the triangular stemless points (Jenson 1959:53-54). Other stone tools include pendants and a quartzite hammerstone. The pendants were made of sandstone and had holes that were drilled through; these were found in association with the Sorg and Howard Lake pottery, leading Jenson to conclude that they are associated with the same time period. Despite these theories, Jenson notes that most of the lithics occurred throughout the site in no discernable pattern, horizontally or vertically (Jenson 1959:33-34).

Few faunal remains were uncovered, possibly due to the high acidity in the soil at the site, which causes deterioration of organic matter (Jenson 1959:33). The faunal remains that were found, however, include deer teeth, deer foot bone, proximal and metacarpal bones from a deer, long bone from a deer, several unidentifiable bird bones, and a muskrat mandible (Jenson 1959:47).

Jenson identified two main temporal components in these sites. Component A relates to the Middle Woodland period. Component A contains material such as Sorg and

Howard Lake thick, large grit-tempered pottery, side notched projectile points, ridged and ovoid knives, small end scrapers, and ground sandstone pendants (Jenson 1959:56-57).

Component B dates to the Late Woodland period and is represented by the Bremer Triangular Punctated pottery, small triangular stemless arrowheads, ridged knives, large pear-shaped knives, end scrapers, side scrapers, gravers, drills, and hammerstones (Jenson 1959:57).

1.4.3.2 2011-2014 Excavations

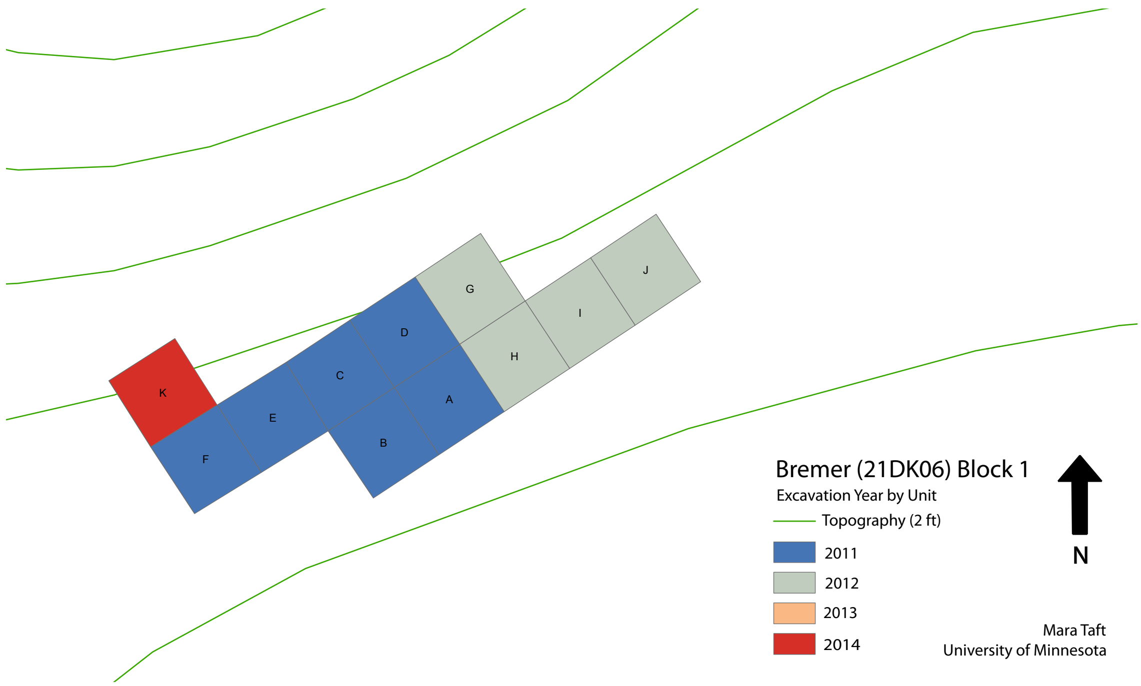

Figure 8. Map of Block 1 units by excavation year.

Block 1 was excavated in 2011, 2012, and 2014, and consisted of 11 1 by 1 meter units placed adjacent to a shovel test pit that contained a diagnostic Middle Woodland rimsherd. Block 1 contained evidence of an Oneota component, represented by thin, shell-tempered sherds in the upper levels of the block, and a Middle Woodland component, represented by thick, grit-tempered sherds and a corner-notched, Manker-style projectile point in the lower levels of the block (Fleming 2012a:2).

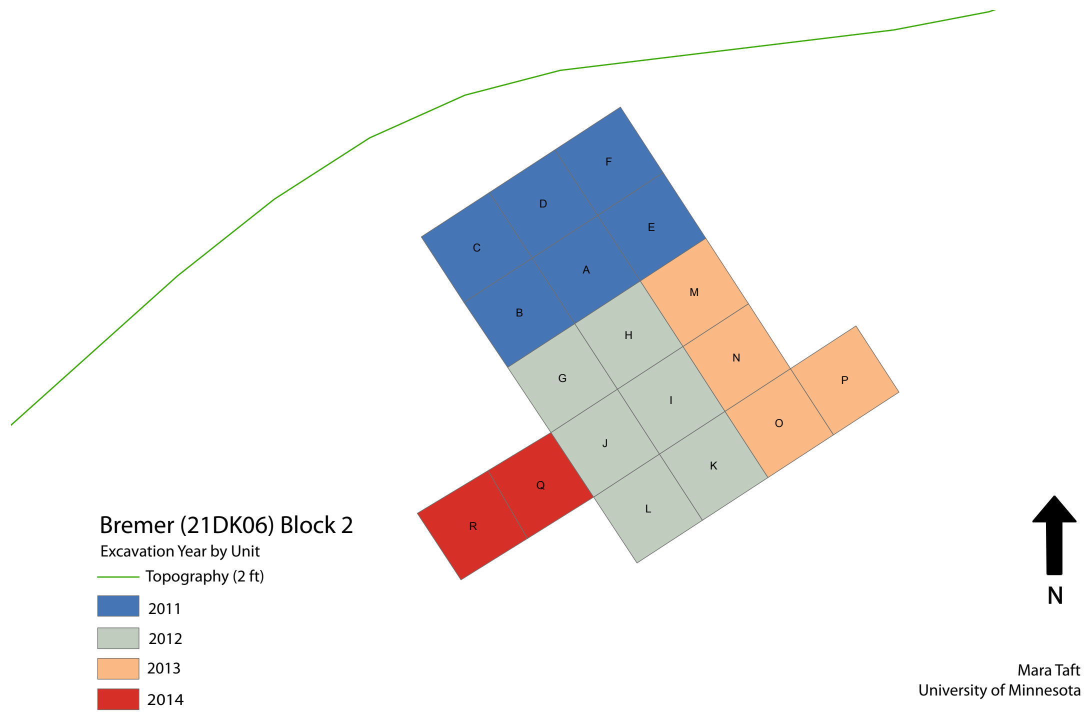

Figure 9. Map of Block 2 units by excavation year.

Block 2 was excavated in 2011, 2012, 2013, and 2014, and consisted of 18 1 by 1 meter units containing Late Woodland artifacts such as thin, grit-tempered cordmarked ceramic sherds and chipping debris. Unlike Block 1, Oneota shell-tempered ceramics are absent from Block 2. Block 2 also contained several features, such as pit features, all of which contained greasy soil (Fleming 2012a:2).

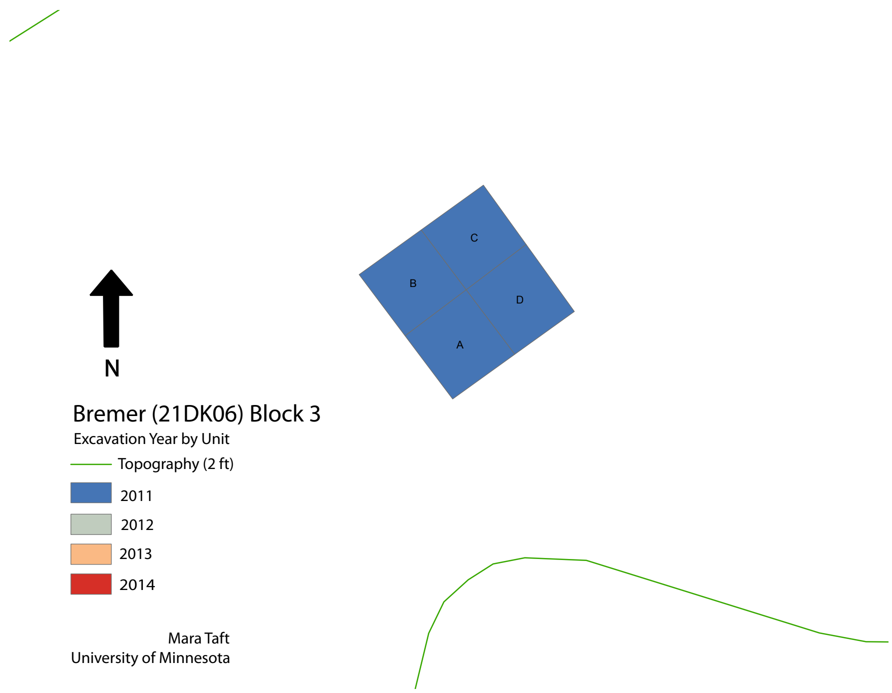

Figure 10. Map of Block 3 units by excavation year.

Block 3 was excavated in 2011 and consisted of 4 1 by 1 meter units. It contained a dense lithic scatter and Late Woodland cordmarked sherds. One small side-notched projectile point was also found in Block 3 (Fleming 2012a:3).

Block 4 was excavated in 2012, and consisted of one 1 by 1 meter unit. It contained a few pieces of lithic chipping debris as well as fire-cracked rock, but no ceramic artifacts.

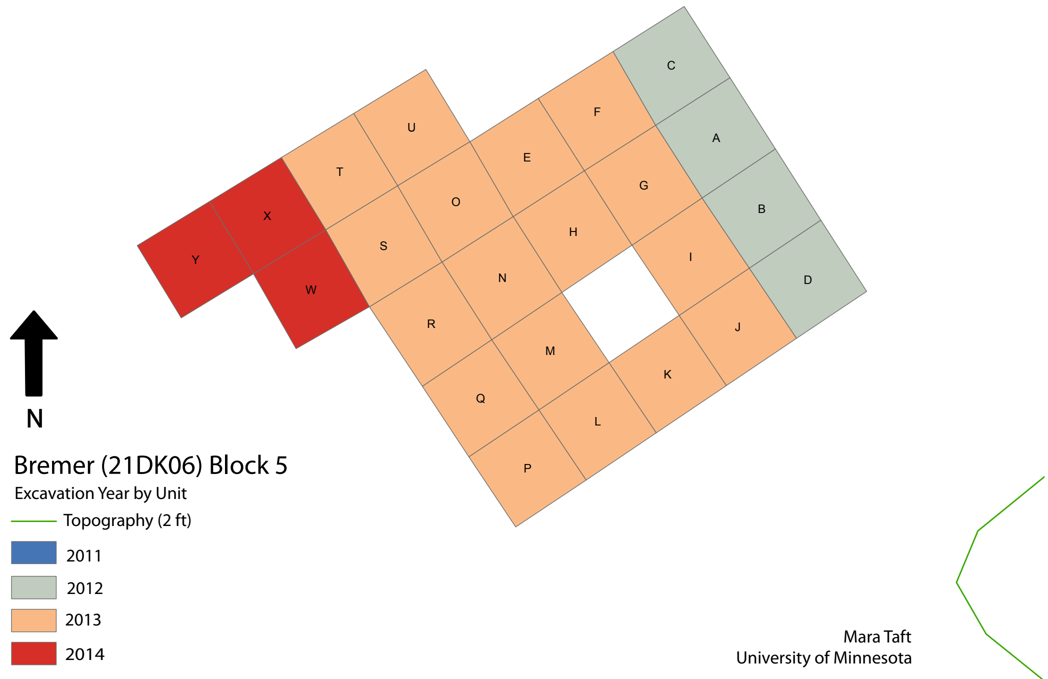

Figure 11. Map of Block 5 units by excavation year.

Block 5 was excavated in 2012, 2013, and 2014, and consisted of 24 1 by 1 meter units. It contained shallow circular features, post molds, and a large circular feature that was very dark and greasy compared to the surrounding areas. Diagnostic artifacts include Bremer Triangular Punctate, Nininger Cord-wrapped Stick Impressed, and Sorg Banded Dentate ceramics. The first two types date to the Late Woodland, while Sorg Banded Dentate ceramics date to the Middle Woodland. Projectile points include Kramer, Waubesa, Lost Island, and Madison varieties, which date from the Late Archaic through Middle Woodland periods (Morrow 1984:49, 53, 54). Of note, Oneota shell-tempered ceramics are absent from Block 5 (Fleming 2014:2).

CHAPTER 2. LITHIC AND GEOGRAPHIC INFORMATION SYSTEMS BACKGROUND

2.1 History of Lithic Analysis

Lithic analysis has long been an essential aspect of archaeological research. Debitage, or detached lithic pieces that are discarded during knapping (Andrefsky 2005:254), is one type of lithic artifact that may be analyzed in order to gain a greater understanding of knapping events in the past. Lithic analysis, and especially the analysis of lithic debitage, has been strongly influenced by numerous innovative researchers and analyses; however, none perhaps as much as Sullivan and Rozen's 1985 paper, "Debitage Analysis and Archaeological Interpretation". Sullivan and Rozen proposed a new methodology for debitage analysis that was not based on problematic typologies and presumed technological origins of individual artifacts (1985:755). The paper had a strong, very mixed reception when it first was published in 1985. One aspect of the paper called for a new way of completing debitage analysis that focuses on reproducibility; in doing so, the authors proposed four "interpretation-free" categories of lithic debitage. Some researchers maintained that it is impossible to understand any aspect of the past without some degree of interpretation on the part of the researcher (Ensor and Roemer 1989:175). Ultimately however, the Sullivan and Rozen paper proved to be very influential for future lithic studies and changed the way that debitage analysis continues to be done today (Andrefsky 2001:2; Johnson 2001:18; Carr and Bradbury 2001:129). Now, lithic researchers focus on analyzing lithic debitage in a reproducible, scientific manner in order that the results may be duplicated and verified. The approach to lithic analysis called for in the Sullivan and Rozen paper – reproducibility, clear definitions and goals – are objectives which I strive to follow in my research of lithic debitage at the Bremer site.

2.2 Debitage Analysis: Methodology

There are many ways to analyze lithic artifacts for a variety of different attributes. The analysis of the Bremer lithic assemblage will strongly focus on the lithic debitage, given the high percentage of debitage compared to tools at the site, and due to the extensive variety of information that can be gained by studying debitage. There are several ways of analyzing lithic debitage, and the analysis of the Bremer lithic assemblage will draw on many of these techniques.

2.2.1 Debitage Aggregate Analysis

Aggregate, or mass, analysis is a straightforward and common way of analyzing lithic debitage. Aggregate analysis is based on the principle that the relative proportion of large versus small debitage in an assemblage is diagnostic of different knapping trajectories and site functions. Debitage is sieved through nested screens with mesh of various sizes, counted and weighed by screen size, and then compared against other attributes diagnostic of technological trajectories, such as bifacial reduction (Andrefsky 2001:3-4, 2005:131-132). When multiple assemblages which are stratified in the same manner are compared, this type of analysis helps inform researchers about differences and similarities of artifact production and activities at each site (Andrefsky 2001:3).

However, aggregate analysis may not convey clear results when dealing with a mixed assemblage. When a lithic assemblage contains debitage from many different knapping events, it is difficult to differentiate knapping activities by any individual debitage attribute and results may be difficult to interpret (Andrefsky 2001:5).

2.2.2 Debitage Technological Analysis

Debitage technological analysis involves analyzing lithic debitage by identifying and counting flakes which are diagnostic of a particular knapping technology. This can help researchers gain insight as to the type of tools created or retouched on the site, as well as site activities (Andrefsky 2001:6, 2005:120).

This analysis is primarily used because it allows researchers to infer activities which took place at a site. Analyzing individual pieces of debitage by technological differences allows researchers to identify what type of tool was being created at a site even if that tool no longer remains at the site (Andrefsky 2001:6). Individual flakes can contain a plethora of information about activities which were carried out at a site, hence the advantage of identifying lithic debitage by technological type. Additionally, debitage technological analysis can help to determine the kinds of tools and reduction techniques used, which cannot be done with an aggregate analysis (Andrefsky 2001:6-7).

One problematic aspect of debitage technological analysis is maintaining a consistent and replicable definition of technology type from which to base the analysis (Sullivan and Rozen 1985:757; Andrefsky 2001:7). It is easy to have a well-defined, mutually exclusive typology that does not suggest much about past behavior at the site in question due to lack of consistent terminology and analytical techniques. Typologies must be used in conjunction with other critical information in order to gain meaningful insights about activities at a site. For example, a typology in which debitage is separated by reduction technique and size is not informative of past behaviors unless it is analyzed in with additional information (Andrefsky 2001:8-9).

2.2.3 Lithic Attribute Analysis

Lithic Attribute Analysis examines the distribution of an attribute(s) over an entire assemblage. Attributes that may be measured are much more specific than Aggregate Analysis and not necessarily linked to size grade. Researchers may measure attributes such as cortex amount and platform type to gain an understanding of differences in technology, artifact type, and reduction stages within a site or assemblage (Andrefsky 2001:9). A benefit of attribute analysis is that it allows the researcher to make conclusions about the lithic activity at a site that the previous two lithic analyses do not (Andrefsky 2001:9).

2.3 Lithic Analytical Characteristics

Of the many lithic debitage attributes which may be measured, there are several that were used to analyze the Bremer lithic assemblage and which may help to answer specific questions about the site and activities which took place there.

2.3.1 Completeness of Debitage

The number of pieces of debitage in the analysis is the simplest element to record. However, one has to be very careful with this particular aspect, as it can greatly be misconstrued and skew results. When a core or tool is being knapped, debitage produced from the knapping process may or may not break in the process. Thus, debitage comes in whole and fragmented form, and if the raw debitage count is recorded for a site for all of the debitage regardless of whether or not it is complete, then the number may be skewed by counting fragments individually that may have come from the same flake when originally knapped (Carr and Bradbury 2001:132-133). When a researcher begins their analysis, a decision needs to be made about which flakes will be considered in the analysis: complete flakes, all flakes which contain a platform (i.e. whole and proximal flake fragments), or all flakes regardless of completeness. The decision should be made consciously and with an awareness of how this decision may bias results and conclusions made about the site (Carr and Bradbury 2001:133).

2.3.2 Debitage Size Class

Debitage size may be used to understand several aspects of lithic knapping activities. The size of debitage has been shown to be directly related to the size of the piece being knapped or retouched (Sievert and Wise 2001:90). Additionally, the size of debitage reflects the stage of lithic reduction. Through experimental knapping, it has been shown that flake size decreases with the reduction stage of the piece being knapped (Andrefsky 2005:98, 102; Carr and Bradbury 2001:133; Sievert and Wise 2001:90). This is informative because it can indicate whether a majority of knapping was taking place at the site or elsewhere.

2.3.3 Debitage Length, Width, and Thickness

Debitage length, width, and thickness are recorded on complete flakes only, and are indications of tool production and stage of reduction. Maximum flake length and width may help to determine the size of the objective piece, the surface area of the flake, and the reduction stage. (Andrefsky 2005:98, 101-102; Odell 1989:186).

2.3.4 Debitage Weight

Weight is the most reliable size characteristic for determining reduction stage because it covaries closely with other flake dimensions such as length, width, and thickness (Andrefsky 2005:98; Shott 1994:80).

2.3.5 Debitage Cortex

The presence or absence of cortex on a specimen can indicate the reduction stage of the flake (Andrefsky 2005:103-106). Knapping is a reductive process, and thus flakes produced in the first stages of knapping a core may be expected to be larger and have cortex on the dorsal surface. Similarly, flakes produced during a later stage of the knapping process may be expected to not have any, or very little, cortex on the dorsal surface (Sievert and Wise 2001:93). There are many ways of measuring cortex on flakes (Sievert and Wise 2001:93-94).

Cortex may also indicate if a majority of knapping was taking place at a quarry, or if cobbles were brought back to the site to knap (Andrefsky 2009:86). For instance, if very little of the debitage at a site has dorsal cortex, and many of the flakes are smaller in size, it may be hypothesized that a majority of the knapping taking place at that location was retouching, and that the initial cores were knapped elsewhere (Andrefsky 2009:86).

2.3.6 Debitage Technology

Debitage can be classified by technological reduction technique used. Flakes can be categorized as bifacial thinning flakes, core reduction flakes, and bipolar flakes (Andrefsky 2005:120-126). Identifying the debitage technology at a site is especially useful in order to identify the types of tools being created or retouched at a site. For instance, identifying a large amount of bifacial thinning flakes with very little to no cortex indicates the retouch of a biface on site, and bipolar flakes indicate bipolar knapping techniques on site. Studying the debitage technology, as opposed to just the typology of tools present at the site, can help researchers gain a much more complete picture of lithic reduction activities that occurred at the site, and what tools may have been curated off-site as opposed to discarded on-site (Andrefsky 2009:86).

2.3.7 Platform Size and Typology

Analyzing the type and size of platform can help researchers determine the type of hammer used, the type of objective piece being modified, stage of tool production, and the size of the detached pieces (Andrefsky 2005:89-90). The shape of the platform is the remnant of the point of applied load inflicted on the objective piece.

Thus, they can indicate the kind of technology used for applied force (Andrefsky 2001:10). Platform types include plain, dihedral, facetted, cortical, and crushed, and each can be an indicator of a certain reduction technique. Generally, platforms with many facets and crushing are the result of bifacial thinning and later stage biface production (Andrefsky 2005:90).

2.3.8 Raw Material Type

Debitage can be classified by raw material type in order to make inferences about sourcing, trade, relative value of raw materials, and many other factors highly relevant to site interpretation (Ingbar 1994; Andrefsky 2005; Bakken 2011). Different raw materials have a variety of different textures, levels of brittlenesss, and breakage patterns, meaning that certain raw materials are more advantageous for certain tool types. When possible, pre-contact peoples likely selectively chose materials for certain tasks based on various qualities of the raw material (Andrefsky 2009:76). Additionally, locality of raw material has been shown to influence the degree to which stone tools are retouched before they are discarded, and thus raw material identification may help to understand local material economy and curation (Andrefsky 1994:388). Identification of raw material types can help researchers understand trade or economic relations among groups, mobility or sedentism, and raw material tool preferences (Odell 2003:24-28, 89).

3.4 Lithic Terminology

There are several lithic definitions which should be defined to promote replicability of data collected in this study.

Flake: A piece of stone with any one or combination of the following characteristics: a striking platform, bulb of percussion, or compression rings that is the result of a flintknapping activity (Andrefsky 2005:16; Sievert and Wise 2001:90).

Bifacial Thinning Flake: A type of flake (see above definition) that is the result of bifacial trimming or retouching. It has a lipped platform, is generally thin, and has an overall curved shape (Andrefsky 2005:253).

Shatter: Debitage in which it is impossible to distinguish the dorsal or ventral side of the piece; the unintentional result of flintknapping activities (Andrefsky 2005:261).

Length: The length of complete flakes was measured from the striking platform to the most distal end.

Width: The width of complete flakes was measured perpendicularly to the length measurement, at the midpoint of the length of the flake.

Thickness: The thickness of complete flakes was measured at the intersection of the length and width.

2.4 Raw Material Analysis: Methodology

2.4.1 Introduction

Analyzing lithic raw material can open up a wide range of questions one can ask about an archaeological site and lithic assemblage. However, Andrefsky notes that, "…lithic raw-material identification by the archaeological community is poorly developed, owing partly to the lack of consistent lithic material definitions used by geologists and archaeologists," (2005:41). While using lithic raw material as a data attribute can reveal very interesting and useful information about a site and assemblage, there are very few reproducible ways of identifying lithic raw material. A database and methodology developed by Dan Wendt, associated with the Minnesota Historical Society, may be a solution to this problem.

2.4.2 Minnesota Historical Society Comparative Collection and Reference Database

Dan Wendt, an expert on Minnesota lithics and raw materials, has developed a database that can be used to more accurately identify lithic raw materials. Based on studies of raw materials from the Minnesota Historical Society's lithic comparative collection, the database is designed to identify a raw material type based on certain characteristics that are measured by the user. These characteristics include color, hue, texture, transparency, luster, and pattern. This database is a unique and improved methodology for classifying lithic raw materials because it uses very clear definitions of attributes and raw materials, and can be used to identify differentiation within a single raw material type. Additionally, as opposed to other reproducible methods for identifying lithic raw materials such as neutron activation analysis and x-ray fluorescence analysis (Odell 2003:33-34), this database is inexpensive and does not require special equipment.

My goal with using this raw material database and analyzing these specific raw material characteristics is to use a more scientifically accurate and reproducible way of determining lithic raw material types. This database has not been used on such a large collection before, and using this database and raw material identification techniques on such a large assemblage will test the practicality of this methodology.

Due to the high level of variability within one raw material type, measuring a variety of different characteristics about that material, and using a database with recorded information about the variability of those characteristics within raw material types, is greatly helpful with raw material identification. Based on the criteria entered into the database, there may not be just one type of raw material that matches those sets of criteria. Thus, the database will show all of the raw material types that match the user's recorded attributes. While not necessarily having one correct answer may be frustrating, it is a more accurate way of measuring raw material and more accurately reflects the level of uncertainty that goes along with lithic raw material identification.

Below are the attributes measured for each piece of lithic debitage in the assemblage and their definitions (per Luedtke 1992; Dan Wendt, personal communication June 2014):

Color

Color is defined as the way light reflects off of the rock's surface (Luedke 1993:61). There are three aspects of color: Hue, Value, and Chroma. Hue refers to the part of the color spectrum that is being reflected. Value (also referred to as lightness or brightness) describes a color in relation to extremes of black and white. Chroma is the degree of saturation of the color. A Munsell Rock Color chart is used to determine the exact color of the rock in question, as Munsell takes into account all three aspects of color (Luedke 1993:61-62).

Translucency

Translucency is defined as …"the degree to which light passes through the rock without being absorbed or reflected" (Luedke 1993:63). Because translucency varies with the thickness of the rock, in order to consistently measure translucency, one must hold the debitage a consistent length away from a light source, and then measure from the point at which the light no longer passes through the material. More generally, translucency can be measured on a scale from Transparent (allows almost all light through, such as window glass), Opaque (materials which do not allow any light through, such as most metals), and Translucent (materials which allow some light through – most cherts fall into this category) (Luedke 1993:64).

Texture

Texture is the measurement of the grain size within the chert (Luedke 1993:65). Texture is measured on a scale including Fine, Medium, Coarse, and Very Coarse Sand, and Fine, Medium, and Coarse Sand. Using a Sediment Texture Chart, which includes physical examples of each of these texture samples, is a reliable, accurate, and reproducible way to measure sediment size (Dan Wendt, personal communication June 2014).

Luster

Luster is the appearance of the reflected light off of a material's surface, and is measured in both quality and quantity. Generally, it is measured using subjective terms, although several quantifiable ways have been suggested (Luedke 1993:65). However, for this study, I used consistent, subjective terms: dull, satin, waxy, glassy, and sugary. These are terms which Wendt uses for the raw material database.

Color Pattern

Color pattern is defined as the way the colors present in the chert mix together (Dan Wendt, personal communication June 2014). There are several different defined types used in Wendt's database: banded, mottled, speckled, streaked, webbed, dendritic, wood grain, and none.

2.4.3 Sources of Regional Raw Material information

For the purposes of this study, there are several resources that were be used to identify and gain additional information about Minnesota and relevant Midwestern raw material types. This includes, first and foremost, Kent Bakken's definitive dissertation on Minnesota raw material types, titled "Lithic Raw Material Use Patterns in Minnesota" (2011). This is the most prominent and comprehensive source of cumulative information about raw materials and their availability in Minnesota. Additionally, Stephen Mulholland's article "The Lithic Resurces of Northeastern Minnesota" (2009), John Mossler's "Paleozoic Stratigraphic Nomenclature for Minnesota" (2008), as well as the Minnesota Historical Society's comprehensive comparative collection of regional raw material types have provided comparative and identification guidance throughout this project.

2.4.4 Considerations of Minnesota Raw Materials

One of the common goals of raw material analyses is to determine the source of the raw material, which be informative of cultural activities such as trade, economic relations, and relative values of cherts (Andrefsky 2005:42). However, Minnesota's glaciation means that glaciers could have moved chert cobbles far from their original source. There are many chert cobbles throughout the state that do not originally outcrop in that area, but that are available in that area in the glacial till. Due to this, it is difficult to tell whether a specific raw material was retrieved at a non-local quarry, or locally as a glacial cobble. Glaciers ultimately traveled strongly from north to south and more slightly from west to east. Thus, some predictions can be made about sourcing – if a chert outcrops south of a site in question, for instance, but also appears at that site it is reasonable to assume that particular chert was brought there by humans.

Another consideration for a raw material analysis is the form and size in which the raw materials are available. Some cherts, such as Grand Meadow Chert, are available as cobbles, while other materials such as Hixton Silicified Sandstone are available as large outcrops (Bakken 2011:148-149). These original forms of lithic raw material affect how they are used and transported, as some forms of raw material are inherently advantageous for certain tool types, and some are easier to transport from quarry site to knapping and use site.

2.5 Tool Typology

Projectile point styles vary through time and space, and thus can help understand the occupation periods and chronology represented at a site. A lithic analyst should look at the size, morphology, and raw material of the point to fully understand it (Morrow 1984).

Projectile points may help to answer several different questions regarding the site, its occupants, and activities that took place at the site. Projectile points have been recorded and studied by typology, such that by examining the shape and type of notching, one can identify the typology and provide an approximate date or cultural period during which the particular point style was created (Gibbon 2012, electronic document; Morrow 1984:1). There are several different projectile point guides for the Midwest that will be used to identify projectile points from the Bremer site, including an electronic point guide by Guy Gibbon (2012), Robert Boszhardt's "A Projectile Point Guide for the Upper Mississippi River Valley" (2003), and Toby Morrow's "Iowa Projectile Points" (1984). One aspect of projectile points which should be kept in mind is that it is possible that past peoples picked up an older, discarded projectile point and reused it, making its provenience and typology information incorrect (Morrow 1984).

2.6 Geographic Information Systems (GIS) Methodology and Theory

2.6.1 Introduction and Definitions

Another aspect of understanding the lithic assemblage at an archaeological site includes the spatial patterning of said assemblage. This may be done through a Geographic Information System (GIS). A GIS is a computer-based system used for the collection, maintenance, storage, analysis, and output of spatial information (Bolstad 2012:1). GIS has many applications, and has recently begun to be used in archaeology to answer a wide variety of questions about spatial data and the past. In order to clarify GIS issues and their relevance to archaeology, there are a few GIS-specific definitions that are important to understand.

GIS data is portrayed in one of two ways: vector or raster structure. Using a vector structure, spatial data is portrayed by points, lines, and polygons in order to show discrete boundaries and locations of real-world objects (Conolly and Lake 2006:25). A raster data model instead uses cells, or pixels, to portray spatial information. Raster data models are used most frequently with variables that change continuously across space, such as elevation (Bolstad 2012:34). It is important to distinguish between raster and vector data models because this may affect data analysis and interpretation. Both are very different ways of portraying data, and sometimes have mutually exclusive uses; however, both vector and raster may be used for most archaeological data (Conolly and Lake 2006:24).

Additionally, space is an important concept to understand in spatial analysis. There are two ways of understanding space: absolute space and relative space. Absolute space is the view that space is a container for all material things, but space exists independently of said material things. Relative concept of space views space as dependent on material things; that is, one cannot think about space without the material objects that inhabit it (Conolly and Lake 2006:3). Within archaeology, the latter understanding is often used in order to analyze spatial distributions of artifacts, how they relate to site function, and site activity areas (Conolly and Lake 2006:5-6).

2.6.2 Spatial Analysis at Bremer

ArcGIS has been used to analyze the Bremer site in order to answer specific questions about the site and where specific lithic activities took place. While there are a wide variety of ways that GIS can be used to answer archaeological questions about the past, there are a few very specific questions about the Bremer site with which spatial analysis and GIS can help answer.

Understanding site formation processes at Bremer, both horizontally and vertically, may be done through GIS techniques. By spatially plotting artifact density by excavation units horizontally across the site specific artifact concentrations may become apparent and help form a greater understanding of when the site was occupied and where certain activities took place.

Identifying site activity areas may be done by mapping artifact scatters that occur horizontally across the site. This has been done by Craig et al. (2006), where artifacts from an archaeological site were photomapped in situ, and then displayed through a GIS where activity areas were identified through density mapping by artifact type. While the artifacts from the Bremer site were not photomapped in situ, many of the same concepts used are still applicable at Bremer. Similar analyses may be done with the Bremer artifacts by mapping artifact type and count over the excavated area within excavation units. Through this technique, an interpretation may be made about spatial distribution of lithic activities at the site.

CHAPTER 3. METHODS AND TERMINOLOGY

3.1 Chipping Debris Analysis

The lithic chipping debris analysis was designed to collect data about the chipping debris typology, weight, and site provenience in order to inform about the site lithic activities and raw material use patterns. All lithic artifacts at least greater than 1 cm^2 in minimum direction from the 2011-2014 excavations were analyzed. Lithic artifacts smaller than 1 cm^2 and lithic artifacts from shovel test pits and surface finds were excluded from this study. In addition, fire-cracked rock (FCR) was not analyzed. Analysis was confined to artifacts larger than 1 cm due in part to the difficulty in correctly analyzing the artifact typology and raw material type of artifacts smaller than 1 cm^2, and also because ¼" screens were used during excavations and thus artifacts smaller than this (6 mm) were not recovered.

The lithic analysis was completed using a data-entry program created by Shannon McPherron and Simon Holdaway, called Entrer-Trois (available at www.oldstoneage.com). This involved writing code to accommodate the specific lithic categories measured. The use of a data entry system such as Entrer-Trois helps to expedite the data entry process and reduce data entry errors, and allows the user to only have to answer questions related to that specific artifact.

Data collected for each of the artifacts can be separated into seven different categories: provenience, typology, size, platform, cortex, raw material, and other. Provenience information includes site name, the excavation year, block number, excavation unit, and depth (in 10 cm levels). Typology includes the artifact type: complete flake, proximal flake, medial flake, distal flake, shatter, complete tool, proximal tool, medial tool, distal tool, or core. For complete and proximal flakes, the flake type is identified as a bifacial thinning flake, flake, or bipolar flake. Platform type for complete and proximal flakes is identified as plain, facetted, dihedral, punctiform, cortical, crushed, or missing. Platform length and width measurements are measured in millimeters for plain, facetted, dihedral, and punctiform platforms. For complete, proximal, medial, and distal tools, the specific tool type is identified. Additionally, length, width, and thickness measurements are recorded in millimeters for all complete flakes and complete tools. For every artifact, the weight (g) and approximate amount of cortex was recorded. Amount of cortex present was recorded using the following categories: 0%, 1-10%, 11-40%, 41-60%, 61-90%, or 91-100% cortex.

3.2 Raw Material Analysis

Raw material categories included Munsell color, translucency, luster, pattern, texture, raw material type, and level of certainty. Munsell color was identified by using the Munsell Rock Color Book as a comparative tool. Translucency was measured by holding the artifact up to a light, and measuring how far light was transmitted through the material from the edge of the piece. Luster was identified as either dull, satin, waxy, glassy, or sugary. Pattern was identified as mottled, banded, speckled, streaked, dendritic, webbed, zoned, woodgrain, or absent. Because these are fairly subjective terms on their own, comparative images, supplied by Dan Wendt, were used for each of these terms. Texture was measured as very coarse sand, coarse sand, medium sand, fine sand, coarse silt, medium silt, or fine silt. The sand grain sizing folder, available through Forestry Suppliers, was used as a comparative tool. Finally, the raw material type was identified, using the University of Minnesota lithic comparative collection, Minnesota Historical Society (MHS) lithic comparative collection, and Dan Wendt's MHS lithic comparative collection database when needed. The level of certainty of correct raw material identification was also recorded on a scale of 1 (very certain) to 4 (very uncertain). Other categories measured included if the material was heat-treated (yes or no) and the quality of material on a subjective scale of 1 (very good) to 5 (very poor).

3.3 Projectile Point Analysis

Projectile points from all Bremer site excavations (1956, 2011-2014) were included in this study. Projectile points were analyzed from all excavations, rather than just 2011-2014, as projectile points act as chronological markers and can help understand when the site was occupied. Toby Morrow's Iowa Projectile Point Guide (1984) as well as the input of Ed Fleming were helpful in this identification. It should be noted that chipping debris from the 1956 excavation was not analyzed because there is evidence that the excavators did not collect all chipping debris, but were more likely to collect all diagnostic artifacts found. Additionally, the exact location of the 1956 excavation units is not known, as the site datum they used was a fence post that is no longer there; thus, the exact provenience of the points is unknown. However, their mere presence at the site helps to suggest the time frames at which the site was occupied.

3.3 Spatial (GIS) Analysis

In order to create a GIS with which to map artifact distribution across the site, a GIS database was created using total station data collected at the site over the course of four years. The database is a personal geodatabase created through ArcMap Catalog and contains shapefiles with Northing and Easting coordinates for the shovel test pits, excavation block extents, as well as local landmarks such as the site datum and fence posts. These coordinates are mapped onto a 2 foot topography shapefile of the southern shore of Spring Lake obtained from the Science Museum of Minnesota and the Dakota County GIS catalog.

The tables for shovel test pits, excavation blocks, and units were joined with artifact data using a primary key. By doing this, maps of the artifact distribution across the Bremer site could be created, and include information such as artifact type, count, weight, and a variety of characteristics by excavation unit and shovel test pit. These types of analyses are important for seeing concentrations of artifacts and identifying site activity areas.

CHAPTER 4. DISCUSSION AND RESULTS

The lithic assemblage at the Bremer site is the subject of this analysis. By analyzing the lithic assemblage at Bremer, I aim to better understand the lithic activities that took place at the site and where these activities occurred. Questions that may be answered about lithic activities at the site are constrained by the nature of the lithic assemblage. Within the assemblage, there is a high percentage of chipping debris, and a relatively low percentage of lithic tools. Additionally, there is a high amount of variability of lithic raw material types at the site. These inherent factors of the lithic assemblage helped formulate which aspects of the site and site activities could be addressed through a lithic analysis. Specifically, I aim to better understand how lithic tools and raw materials were curated at the site, what lithic activities took place at the site, what raw materials were present, and if these raw materials were differentially used.

4.1 Lithic Analysis

4.1.1 Lithic Tool Curation

Curation of lithics is the transportation of lithic tools between sites and the efficiency of tool use. The term 'curation' was first applied to lithics by Lewis Binford in 1973 (Binford 1973:242; Shott 1996:261). As this definition can be slightly ambiguous, several authors have attempted to clarify the subject and suggest methods of studying tool curation (Shott 1996, 2014; Kuhn 1994). Shott defines curation as "the degree of use or utility extracted, expressed as a relationship between how much utility a tool starts with – its maximum utility – and how much of that utility is realized before discard," (1996:267).

Curation is likely something that concerned all mobile hunter-gatherers (Kuhn 1994:427). High quality, or even workable, raw materials rarely exist everywhere a mobile group may go for hunting or gathering purposes, so it is often advantageous to carry a small supply of high quality raw materials when traveling to unknown territory (Andrefsky 1994:383). This is for two reasons: first, to minimize the weight one needs to carry, and second, because it is not always practical or convenient to make new lithic tools as needed (Kuhn 1994:427). Additionally, it is most beneficial to carry material which is at least decorticated or already knapped into a useable form. Decorticating curated raw material prior to travel is advantageous because cortex is not generally a useable aspect of lithic raw material; therefore, it is best to remove it in order to reduce the weight (Douglass et al. 2008:514). Any mobile group who utilizes stone tools also had some need for curation of said stone tools.

Binford states that raw materials are most likely to be obtained during the execution of basic subsistence tasks. Only when things have gone very wrong and there is a severe lack of available raw materials will hunter-gatherers go out of their way for the sole purpose of gaining raw material (Binford 1979:259). Thus, the lithic raw materials represented in a site assemblage also represent the area covered by the site inhabitants during their normal hunting and gathering subsistence activities (Binford 1979:260). It follows that non-local raw materials which are in the site assemblage represent lithics that were brought to the site either through long-distance foraging operations (Binford 1979:261) or through trade.

It is expected that tools which are likely to be curated include light-weight, high quality, small retouched tools that have high remaining utility (Andrefsky 1994:376; Kuhn 1994:429). These curated lithic tools may be more likely to be derived from non-local raw material, but this is not necessarily the case. It is also expected that non-curated lithic tools will be larger, with a higher average mass than curated tools. Therefore, we can predict that the presence of curated tools at the Bremer site will be represented by small, thin, bifacial retouch flakes with very little to no cortex. Additionally, this material is likely to be higher quality, and perhaps non-local. Non-curated lithic tools will be represented in the Bremer lithic assemblage by larger, thicker flakes with a high percentage of cortex, and the material from which they are made is more likely to be locally available.

4.1.2 Minnesota Raw Materials

A background of Minnesota lithic raw materials is necessary in order to understand the relationships between lithic raw materials at the Bremer site. In order to identify trends in the differential treatment of raw materials based on locality, each raw material present at the site is identified by its general locality to the Bremer site. All raw materials are categorized as either "local", meaning that the raw material naturally outcrops very close to the site; "non-local", meaning that the raw material must have traveled at least 90 miles (the distance to the nearest source of non-local raw material, Grand Meadow Chert) to get to the Bremer site, and that this raw material could not have occurred in glacial till near the Bremer site; and "non-local, but available in glacial till", meaning all raw materials which may not naturally outcrop near the Bremer site but that commonly occur in glacial till throughout Minnesota and are available locally to the Bremer site. This distribution of glacial till is also likely aided by the Mississippi River, on which Bremer is located.

Kent Bakken identifies three raw material types which may be considered non-local, or exotic, to the state of Minnesota. These are Knife River Flint, which naturally outcrops in western North Dakota, Hixton Group silicified sandstone, which outcrops in western Wisconsin, and Burlington chert, which outcrops in western Illinois and eastern Iowa (Bakken 2011:128). However, for the purposes of this study, Knife River Flint is categorized as "non-local, but available in till" because it has been documented in glacial till throughout Minnesota (Bakken 2011:96; Morrow 1994:128), so is more widely available, while Hixton Group silicified sandstone and Burlington do not appear in the glacial till in southeastern Minnesota due to the extent of the glaciation in Minnesota and the nature of glacial movement from north to south, rather than south to north (Mossler 2008:13). However, while Knife River Flint may be available as small cobbles in the glacial till, it is also a well documented exotic material that was widely traded in pre-contact times, starting in the Paleoindian period and becoming more intense during the Middle Woodland (Bakken 2011:2, 47-48, 148). However, due to the chance that Knife River Flint could have been available locally in the glacial till, and due to the small sample size of Knife River Flint at the Bremer Site (N=20), Knife River Flint is considered to be non-local, but available in the till. Additionally, Grand Meadow Chert is considered a non-local material for this study because it outcrops approximately 90 miles south of the Bremer site, meaning that it is very unlikely that Grand Meadow Chert would be available in the glacial till around Spring Lake.

4.1.2.1 Lake Superior Agate (Non-Local but available in till)

Agate naturally outcrops in Thunder Bay but is known to have a very large distribution within glacial till, including at least as far south as Minneapolis-St. Paul and Grand Meadow, MN (Bakken 2011:99; Julig et al. 1989:298, 302; Bakken 2011:99 quoting personal communication with Wendt; Bakken 2011:99 quoting personal communication with Gonsior). Agate cobbles have been noted in large quantities around Spring Lake (Fleming, personal communication 2015). Agate commonly occurs as small to medium-sized pebbles; however, on rare occasions it has been known to occur in much larger pieces, as well. When knapped, agate is known to break along its many concentric rings, making it an average quality material for knapping. However, when it does not fracture along these rings, it is of acceptable flaking quality (Bakken 2011:99). Agate was used primarily for small scraping and cutting tasks, and its use for larger tools such as projectile points is rare (Mulholland 1997:64).

4.1.2.2 Basalt (Non-Local but available in till)

Basalt has marginal to submarginal knapping qualities, and is generally not considered to be a commonly used raw material for lithic tool creation. However, it was occasionally used for hammerstones, celts, axes and other chopping tools (Bakken 2011:126).

There are widespread basalt outcrops, including on the North Shore of Lake Superior, but the exact location of many of these remains unknown (Bakken 2011:87; Mulholland 1997:64). Bakken elaborates, "Availability [of basaltic rock] can be considered broad… Relative abundance would certainly vary from place to place, but there is probably no feasible way to assess this," (2011:127). However, it is commonly available in cobble form.

4.1.2.3 Burlington (Non-Local)

Burlington chert outcrops along the Mississippi River along the western edge of Illinois, eastern Iowa, and Missouri, and is available in nodules, layers of nodules, or nodular beds up to 50 cm thick (Morrow 1994:123; Yerkes 1983:499). Burlington is widely known to be one of the highest quality lithic materials available in the Midwest (Morrow 1983:16).

4.1.2.4 Grand Meadow Chert (Non-Local)

Grand Meadow Chert has very few to no inclusions or faults, making it of excellent knapping quality. This quality can be improved through heat-treatment, although this is considered unnecessary for percussion flaking (Gonsior 1992:5).

Grand Meadow Chert is available in cobble form and is accessed through open pit mining in the town of Grand Meadow in Mower County, Minnesota. Secondary sources are also known, including gravel pits along the Root River in Fillmore County (Bakken 2011:110; Gonsior 1992:5). Grand Meadow Chert is frequently found as cylindrical, elongated, and rounded nodules that can reach up to one foot in length (Gonsior 1992:5).

Due to the fact that the main quarry source for Grand Meadow Chert is south of the Bremer site by approximately 90 miles, it is very unlikely that it could be found in the glacial till near the Bremer site. Thus, for this study it is considered to be a non-local raw material.

4.1.2.5 Granite (Non-Local but available in till)

Granite is a poor quality flaking material, and its pre-contact use was likely restricted to hammerstones rather than flaked lithic tools. Thus, the presence of granite flakes in a lithic assemblage likely reflects damage to the hammerstone rather than intentional flaking of granite (Bakken 2011:127). Granite comes in cobbles, although its abundance and outcrop locations are unknown (Bakken 2011:149). Given that there are no known granite outcrops near Spring Lake, granite is classified as non-local but available in till for the purposes of this study.

4.1.2.6 Gunflint Silica (Non-Local but available in till)

Very little is known about the location, package size, or quality of Gunflint Silica. It can occur as poor to excellent quality (Romano 1994:3). Historic literature has identified the source of Gunflint Silica as Gunflint Lake in northeastern Minnesota, although the material from this source is of far inferior quality compared to Gunflint

Silica artifacts that have been found (Romano 1991:4). Additional evidence suggests that it may be widely available throughout the state. Gunflint Silica chunks have been found in road cuts near Pine City in Pine County, MN (Romano 1994:3). Its use has been documented throughout pre-contact periods in northeastern Minnesota (Mulholland 1997:60).

4.1.2.7 Hixton Silicified Sandstone (Non-Local)

Hixton Silicified Sandstone is a part of the Hixton Group, a term developed by Bakken in response to problems with how Hixton and other, similar quartzites are referred to within the region but outside their primary source area (Bakken 2011:130). There is some debate about the quality of Hixton Group silicified sandstone. It has been described as between medium (Doperalski 2013:112 quoting personal communication with Wendt) and high (Boszhardt 1998:87) quality.

Hixton Group silicified sandstone occurs most prominently at Silver Mound, Wisconsin, which is approximately 110 miles southeast of the Bremer site. Silver Mound is one of the largest and most extensively used quarry and workshop sites in the upper Midwest (Behm 1984:169; Carr and Boszhardt 2010). However, Hixton Group silicified sandstone is also known to occur in secondary deposits near Cochrane, WI, as well as in Buffalo, Trempealeau, Jackson, Monroe, and La Crosse counties in Wisconsin (Gonsior 1996:10). It can occur in very large cobbles, in some cases larger than one meter (Bakken 2011:133).

4.1.2.8 Jasper Taconite (Non-Local but available in till)

Jasper Taconite is a medium to high quality material which reportedly outcrops near Thunder Bay in 10 to 30 cm thick bands (Bakken 2011:103 quoting personal communication with Wendt; Julig et al. 1989:296). However, it is also very common in glacial till throughout the Minnesota, and into Wisconsin and Iowa, and can occur in cobbles that range from one to five pounds (Bakken 2011:102-103; Fox 2009:357; Morrow 1994:119; Romano 1991:3). Jasper Taconite was used extensively through all cultural periods in northeastern Minnesota (Mulholland 1997:59).

4.1.2.9 Knife River Flint (Non-Local but available in till)

Knife River Flint is one of the higher quality raw materials available in North America (Ahler 1983:1). Its primary source is in western North Dakota, where it occurs as cobbles and boulders (Clayton et al. 1970:294-285). However, it is widely available in glacial till, although as much smaller cobbles and generally lower quality as compared to the original source (Bakken 2011:96; Morrow 1994:128).

4.1.2.10 Prairie du Chien (Local)

Prairie du Chien chert is considered to be of low to moderate quality due in part to the high frequency of oolites and fractures within the material, but can be improved through heat-treatment (Gonsior 1992:5; Withrow 1983:49). However, Prairie du Chien can be highly variable; some varieties are very high quality with few to no oolites, while other nodules have a very high frequency of oolites and calcified fractures, making it difficult to flake (Wendt 2014:4). Prairie du Chien is the most common chert in southeastern Minnesota; it occurs in cortified nodules and nodular beds up to 30 cm thick (Gonsior 1992a:4; Morrow 1994:118; Wendt 2014:9).

Prairie du Chien chert may be differentiated by the formation from which it originated. Prairie du Chien from the Shakopee formation is typically oolitic; occasionally, the oolites may become calcified and can resemble Hixton Silicified Sandstone when not examined closely. Prairie du Chien chert from the Oneota formation does not have oolites but instead has a mottled color pattern (Wendt 2014:4).

4.1.2.11 Quartz (Non-Local but available in till)

Quartz is very widespread throughout Minnesota, but the location of its exact outcrops is unknown. Low quality quartz is frequently found as pebbles or cobbles that may be knapped using a bipolar strategy (Bakken 2011:123; personal communication with Dan Wendt, January 2015). It is of generally poor quality and fractures easily, making it a difficult material to knap.

4.1.2.12 Quartzite (Non-Local but available in till)

Quartzite is of poor flaking quality, although quartzite cobbles may have been used for hammerstones. It is very common in glacial till throughout Minnesota and Iowa as cobbles and pebbles up to 12 cm in diameter (Bakken 2011:125; Morrow 1994:118).

4.1.2.13 Swan River Chert (Non-Local but available in till)

Swan River chert has low to medium quality and can be easy or difficult to knap depending on the sample (Campling 1980:293-294). It occurs as pebbles, cobbles, and large boulders, and has been observed in high frequency in southwestern Manitoba (Low 1995:83; Ahler 1977:139). However, its distribution stretches from southern Canada to northern Montana, North Dakota, and Minnesota (Bakken 2011:94; Grasby et al. 2002:275-276).

4.1.2.14 Taconite (Non-Local but available in till)

Taconite is a flint-like rock containing low-grade iron ore (MNDNR). It outcrops in Ontario from the Gunflint formation outcrops, but is also available in secondary deposits (Fox 2009:357). Today, it is mined in northeastern Minnesota near Hibbing (MNDNR). Taconite is of sub-marginal quality, but its use in archaeological contexts has been documented at several sites in Ontario, Canada, one of which is a multicomponent Woodland site (Dawson 1978:59; Julig et al. 1987:59).

4.1.2.15 Tongue River Silica (Non-local but available in till)

Tongue River Silica is low to medium quality, and can be very difficult to work (Anderson 1978:149). Its primary source is in North Dakota, but is seen as various sized cobbles in glacial till in Iowa, South Dakota, and throughout Minnesota (Bakken 2011:111-113; Morrow 1994:128; Ahler 1977:139).

4.1.3 Overview of Assemblage Data

The lithic assemblage (N=1771, M=2157.8g) of the Bremer site is quite diverse in many ways. Sixteen different raw material varieties were identified, including material from local outcrops, material from non-local outcrops, and material from non-local outcrops but which is available locally at the Bremer site in the glacial till. Local material includes Prairie du Chien chert, which is 67.31% of the assemblage count and 66.28% of the assemblage mass. The high percentage of locally outcropping chert indicates that inhabitants of the Bremer site relied heavily on this locally available resource.

Non-local material (N=351, M=235.2g) consists of Burlington and Grand Meadow Chert, which outcrop south of the Bremer site by at least 90 miles, and Hixton Silicified Sandstone, which outcrops to the east of the site by about 110 miles. Non-local material consists of 19.82% of the assemblage, suggesting that non-local material was not a primary material used at the site, but that it was more commonly used than chert available in the glacial till. The presence of non-local raw material indicates possible trade networks with peoples nearer these raw material outcrops, or possibly widespread subsistence travel.

Non-local (till) raw material (N=188, M=440.2g) includes agate, basalt, granite, Gunflint Silica, Jasper Taconite, Knife River Flint, quartz, quartzite, sandstone, Swan River Chert, Taconite, and Tongue River Silica. Non-local (till) material makes up 10.62% of the lithic assemblage, indicating that while this material was locally available in the glacial till, it was not a primary source of raw material, either. This could be due to the fact that raw material cobbles in glacial till tend to be much smaller and of poorer quality than raw material at outcrop locations, making them more difficult to knap.

Unknown raw material (N=40, M=52.3g) includes raw material which could not be identified at all, or with any degree of confidence. Unknown raw material was therefore excluded from this study, as its identity and origins are unknown.

Artifact classes at the site include complete and fragmentary flakes, shatter, complete and fragmentary tools, and cores. The debitage (including complete, proximal, medial, distal flakes and shatter) consists of 95% of the total lithic assemblage, while tools (complete, proximal, medial, and distal tools) and cores consist of 5% of the assemblage.

Raw Material	Count	Mass (g)	Percent of Assemblage Count	Percent of Assemblage Mass
LOCAL	1192	1430.1	67.31	66.28
Prairie du Chien	1192	1430.1	67.31	66.28
NON-LOCAL	351	235.2	19.82	10.90
Burlington	89	69.6	5.03	3.23
Grand Meadow Chert	249	137.3	14.06	6.36
Hixton Silicified Sandstone	13	28.3	0.73	1.31
NON-LOCAL (TILL)	188	440.2	10.62	20.40
Agate	4	2.8	0.23	0.13
Basalt	45	173.4	2.54	8.04
Granite	8	14.3	0.45	0.66
Gunflint Silica	3	9.8	0.17	0.45
Jasper Taconite	15	29.3	0.85	1.36
Knife River Flint	20	11.8	1.13	0.55
Quartz	58	109.4	3.27	5.07
Quartzite	8	30.4	0.45	1.41
Sandstone	4	4.2	0.23	0.19
Swan River Chert	9	29.2	0.51	1.35
Taconite	9	14.5	0.51	0.67
Tongue River Silica	5	11.1	0.28	0.51
OTHER	40	52.3	2.26	2.42
Unknown	40	52.3	2.26	2.42
ASSEMBLAGE TOTAL	1771	2157.8	100.00	100.00

Table 1. Artifact Count and Mass by Raw Material Type at Bremer (21DK06).

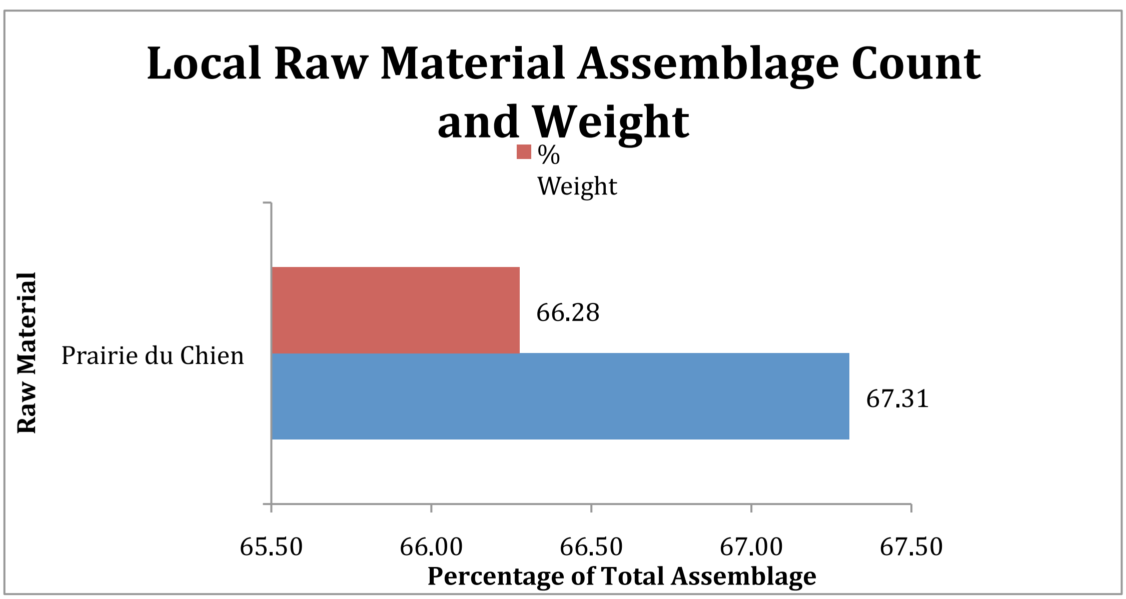

Figure 12. Local Raw Material Percent Count and Mass of Total Assemblage.

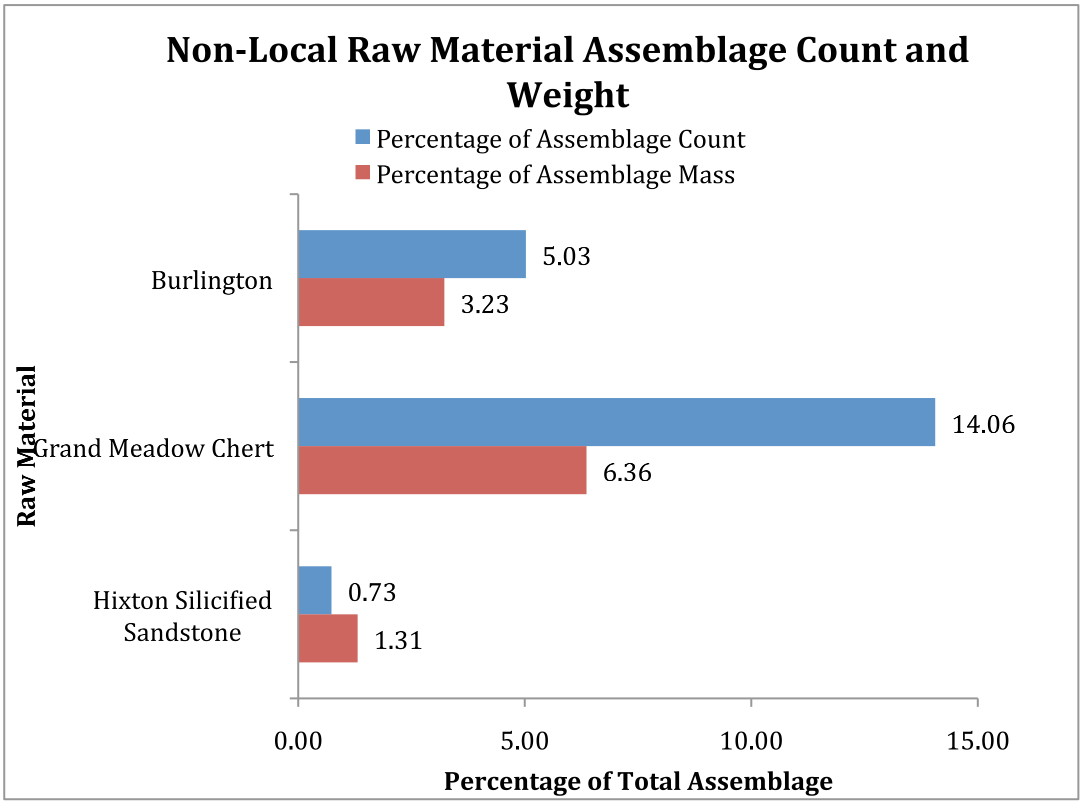

Figure 13. Non-Local Raw Material Percent Count and Mass of Total Assemblage.

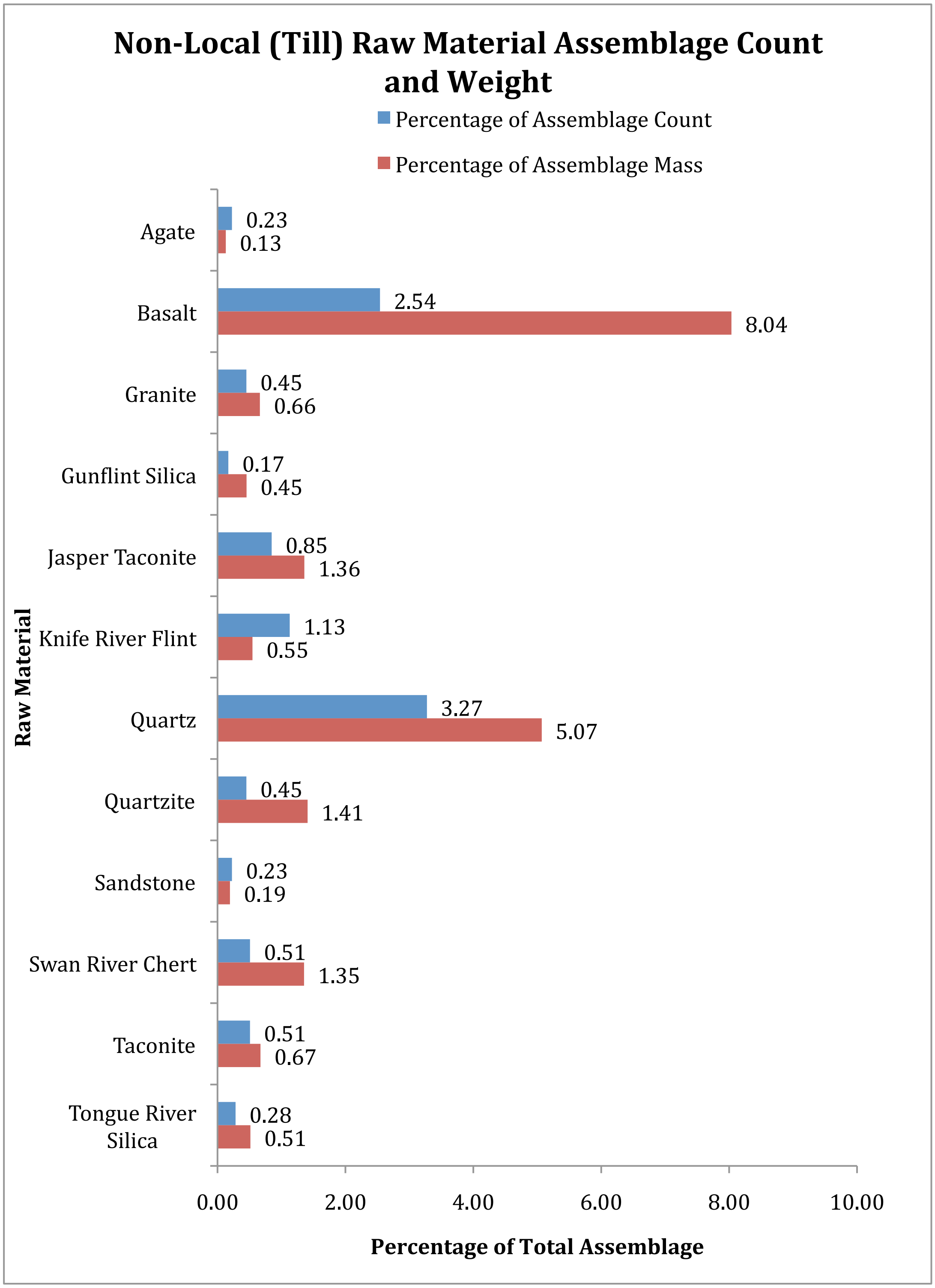

Figure 14. Non-Local (Till) Raw Material Percent Count and Mass of Total Assemblage.

Raw Material	Complete Flake	Proximal Flake	Medial Flake	Distal Flake	Shatter	Complete Tool	Proximal Tool	Medial Tool	Distal Tool	Core	Grand Total
LOCAL	244	246	302	276	75	22	11	8	2	6	1192
Prairie du Chien	244	246	302	276	75	22	11	8	2	6	1192
NON-LOCAL	111	76	52	78	12	10	3	4	5	0	351
Burlington	19	16	21	24	2	4	1	1	1	0	89
Grand Meadow Chert	90	55	29	51	9	6	2	3	4	0	249
Hixton Silicified Sandstone	2	5	2	3	1	0	0	0	0	0	13
NON-LOCAL (TILL)	37	26	30	47	40	4	3	1	0	0	188
Agate	2	0	0	1	0	0	1	0	0	0	4
Basalt	7	1	10	22	3	1	1	0	0	0	45
Granite	0	0	2	4	2	0	0	0	0	0	8
Gunflint Silica	1	1	0	0	0	0	0	1	0	0	3
Jasper Taconite	4	5	2	1	3	0	0	0	0	0	15
Knife River Flint	6	8	0	4	2	0	0	0	0	0	20
Quartz	8	10	8	9	22	0	1	0	0	0	58
Quartzite	2	0	3	0	2	1	0	0	0	0	8
Sandstone	1	0	2	1	0	0	0	0	0	0	4
Swan River Chert	4	0	0	1	4	0	0	0	0	0	9
Taconite	2	1	2	2	2	0	0	0	0	0	9
Tongue River Silica	0	0	1	2	0	2	0	0	0	0	5
OTHER	11	5	5	7	11	1	0	0	0	0	40
Unknown	11	5	5	7	11	1					40
Grand Total	403	353	389	408	138	37	17	13	7	5	1771

Table 2. Count of Artifact Type by Raw Material, total lithic assemblage included.

Raw Material	BTF	Flake	Grand Total
LOCAL	274	217	491
Prairie du Chien	274	217	491
NON-LOCAL	131	57	188
Burlington	27	8	35
Grand Meadow Chert	102	44	146
Hixton Silicified Sandstone	2	5	7
NON-LOCAL (TILL)	26	37	63
Agate	0	2	2
Basalt	1	7	8
Granite	0	0	0
Gunflint Silica	2	0	2
Jasper Taconite	6	3	9
Knife River Flint	12	2	14
Quartz	3	15	18
Quartzite	1	1	2
Sandstone	0	1	1
Swan River Chert	0	4	4
Taconite	1	2	3
Tongue River Silica	0	0	0
OTHER	5	11	16
Unknown	5	11	16
Grand Total	436	322	758

Table 3. Counts of Bifacial Thinning Flakes and Flakes by Raw Material Type, only includes complete and proximal flakes.

Raw Material	Biface	Projectile Point	Retouched Flake	Scraper	Grand Total
LOCAL	8	11	13	15	47
Prairie du Chien	8	11	13	15	47
NON-LOCAL	1	7	6	8	22
Burlington	0	3	2	2	7
Grand Meadow Chert	1	4	4	6	15
Hixton Silicified Sandstone	0	0	0	0	0
NON-LOCAL (TILL)	1	3	2	2	8
Agate	0	1	0	0	1
Basalt	0	0	0	2	2
Granite	0	0	0	0	0
Gunflint Silica	0	0	1	0	1
Jasper Taconite	0	0	0	0	0
Knife River Flint	0	0	1	0	1
Quartz	0	0	0	0	0
Quartzite	1	0	0	0	1
Sandstone	0	0	0	0	0
Swan River Chert	0	0	0	0	0
Taconite	0	0	0	0	0
Tongue River Silica	0	2	0	0	2
OTHER	0	0	0	1	1
Unknown	0	0	0	1	1
Grand Total	10	21	21	26	78

Table 4. Counts of major tool type categories by raw material, includes all lithic tools from 2011-2014 excavations.

Raw Material	0%	1-10%	11-40%	41-60%	61-90%	91-100%	Grand Total
LOCAL	126	47	26	16	21	8	244
Prairie du Chien	126	47	26	16	21	8	244
NON-LOCAL	53	25	19	7	3	4	111
Burlington	13	4	1	1	0	0	19
Grand Meadow Chert	38	21	18	6	3	4	90
Hixton Silicified Sandstone	2	0	0	0	0	0	2
NON-LOCAL (TILL)	19	7	1	7	2	1	37
Agate	1	0	0	1	0	0	2
Basalt	3	1	0	3	0	0	7
Granite	0	0	0	0	0	0	0
Gunflint Silica	1	0	0	0	0	0	1
Jasper Taconite	2	1	0	0	1	0	4
Knife River Flint	4	1	0	1	0	0	6
Quartz	3	3	0	1	0	1	8
Quartzite	2	0	0	0	0	0	2
Sandstone	0	0	0	0	1	0	1
Swan River Chert	2	0	1	1	0	0	4
Taconite	1	1	0	0	0	0	2
Tongue River Silica	0	0	0	0	0	0	0
OTHER	5	4	0	1	0	1	11
Unknown	5	4		1		1	11
Grand Total	203	83	46	31	26	14	403

Table 5. Count of Complete Flakes by Cortex Percentage and Raw Material type.

4.1.4 Expediency and Curation of Lithic Artifacts at the Bremer Site

The hypothesis states that local materials are brought onto the site as cobbles which are then decorticated on-site and knapped into tools. Non-local materials are brought onto the site as preforms and bifaces, which are then retouched and sharpened on site. Exhausted tools may be discarded on site, while tools with high utility may be curated off site. Materials which outcrop non-locally but which are commonly available throughout the state in glacial till will have similar use patterns as the local material, although material which is found in till can have extremely variable quality and generally is available in smaller package sizes. In this study, this latter material category is called "Non-Local (Till)".

4.1.4.1 Cortex by Raw Material Type and Locality

The hypothesis states that local and non-local materials were brought onto the Bremer site in different forms; thus, there should be a difference between amounts of cortex between local and non-local raw material types. Specifically, it is expected that local raw materials will have a high amount of flakes with cortex, non-local raw materials will have the least amount of flakes with cortex, and non-local (till) will have an amount of cortical flakes between that of the local and non-local raw materials. This analysis will help to determine whether certain raw materials, based on locality, were brought into the site as bifaces or preforms and reworked at the site, or were brought in as cobbles and decorticated at the site. Only complete flakes were used for this analysis so as to not bias the results by including incomplete flakes with only partial cortex remaining.

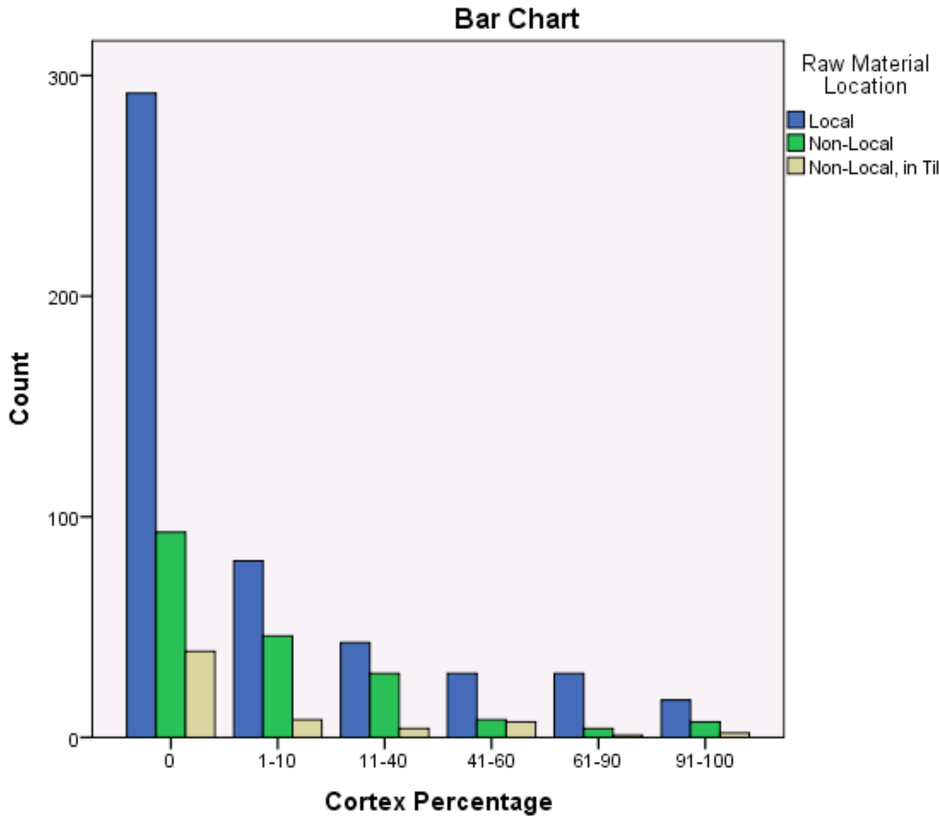

Figure 15. Count of Complete Flakes by Raw Material Locality and Cortex Percentage.

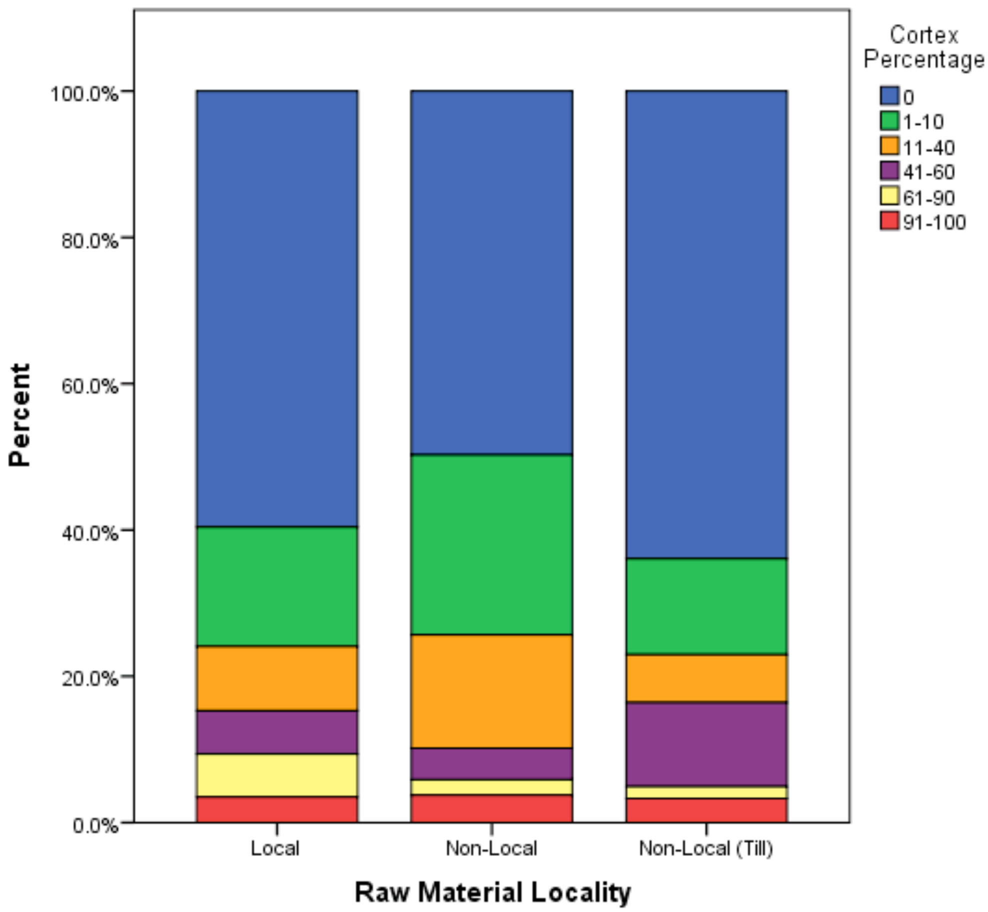

Figure 16. Percentage of Complete Flakes by Raw Material Locality and Cortex Percentage.

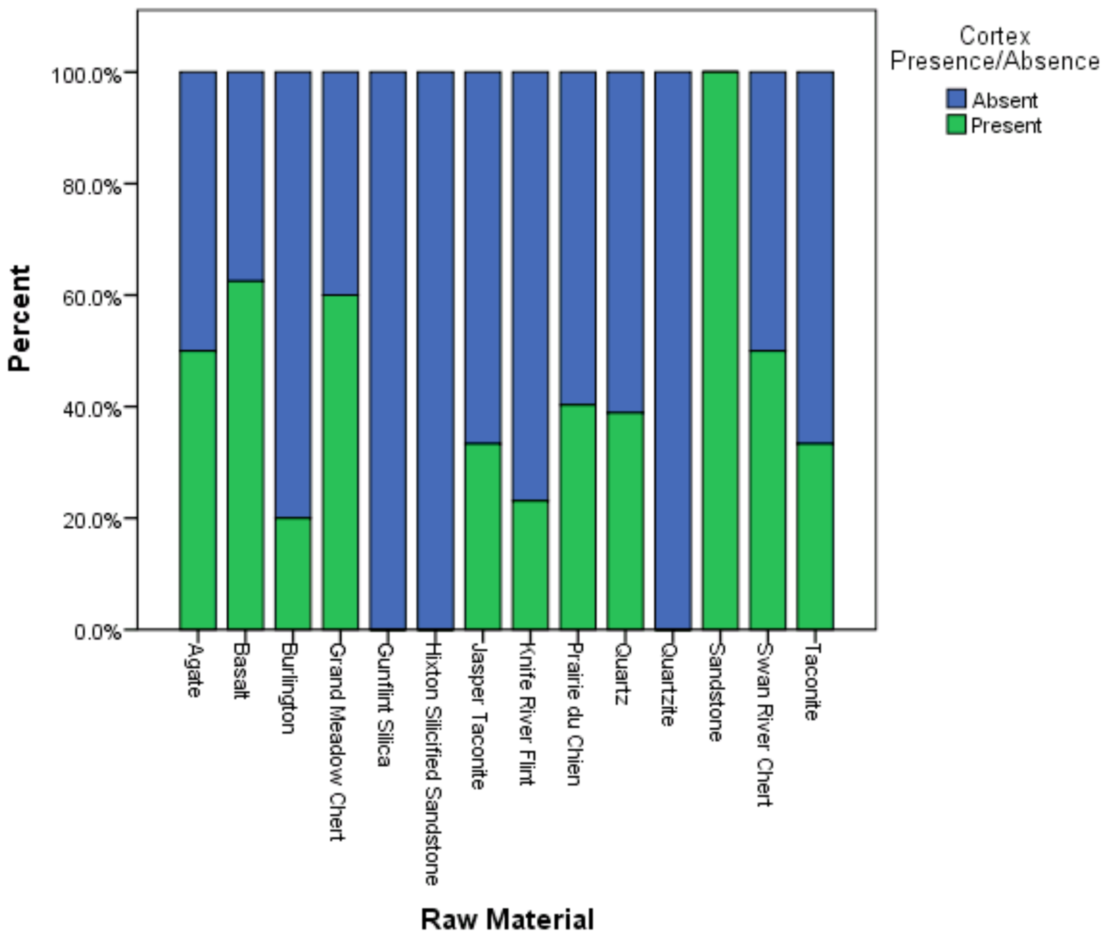

Figure 17. Percent Presence or Absence of Cortex by Raw Material Type for Complete Flakes Only. Cortex Absence is defined as 0% recorded cortex, while Cortex Presence is defined as 1%-100% recorded cortex.

The results indicate that the hypothesis must be rejected. Local materials have the second-highest percentage of flakes with cortex present, rather than the highest percentage of flakes with cortex present as predicted. Non-local raw materials have the highest percentage of flakes with cortex present, rather than the lowest percentage. Non-Local (Till) materials have the lowest percentage of flakes with cortex.

Of the non-local raw material types, Grand Meadow Chert has by far the highest percentage of flakes with cortex (60%), while Burlington has a very low percentage of flakes with cortex present (20%), and there are no Hixton Silicified Sandstone flakes with any cortex present. The high percentage of Grand Meadow Chert flakes with cortex present compared with other raw material types that do not outcrop locally is significant, and could be an indication of several different things. The difference in cortex amounts could reflect differential availability between the non-local raw materials, or it could be a factor of the natural form of the material. While Burlington and Hixton Silicified Sandstone are available as tabular outcrops with a small proportion of cortex compared to useable raw material, Grand Meadow Chert is naturally available in small cobbles with a high percentage of cortex compared to chert. It is likely that Grand Meadow Chert was widely available in nodule form through trade or subsistence travel, and was decorticated on site. Given the very low percentage of Burlington and Hixton Silicified Sandstone flakes with cortex, it is much more likely that these two non-local raw materials were not widely available, and they were instead gained through trade or long-distance travel and brought onto the site as preforms or bifaces. These results also reflect that many of these non-local (till) materials were likely obtained from the local glacial till, rather than from the natural outcrop of these materials.

Given the relatively small sample size of Non-Local (Till) complete flakes (N=37) compared to Local complete flakes (N=244), this result could be skewed due to a limitation of sample size. However, these materials would likely have been treated similarly at the site due to the fact that both categories are available locally or in local glacial till.

4.1.4.2 Raw Material Locality by Flake Type

The hypothesis states that local and non-local (till) materials were used principally for primary flaking, and non-local materials were used primarily for retouching bifaces. Therefore, we expect local materials to be represented by a greater amount of ordinary flakes than bifacial thinning flakes, whereas we expect the non-local materials to be dominated by bifacial thinning flakes. Non-local (till) flakes will likely have a higher than expected rate of flakes and a lower than expected rate of bifacial thinning flakes. Some raw materials, like basalt and sandstone, will likely have a high amount of flakes and low amount of bifacial thinning flakes due to primary use of these two materials for hammerstones rather than retouched tools. However, other non-local (till) material as a whole will likely have a higher than expected amount of flakes, and a lower than expected amount of bifacial thinning flakes due to these materials being retouched on site. All complete and proximal flakes were used for this analysis.

			Flake Type		Total
			BTFLAKE	FLAKE	
Raw Material Location	Local	Count	273	217	490
		Expected Count	285.5	204.5	490.0
		% within Raw Material Location	55.7%	44.3%	100.0%
	Non-Local	Count	131	56	187
		Expected Count	109.0	78.0	187.0
		% within Raw Material Location	70.1%	29.9%	100.0%
	Non-Local (Till)	Count	26	35	61
		Expected Count	35.5	25.5	61.0
		% within Raw Material Location	42.6%	57.4%	100.0%
Total		Count	430	308	738
		Expected Count	430.0	308.0	738.0
		% within Raw Material Location	58.3%	41.7%	100.0%

Table 6. Crosstabulation of Raw Material Locality and Flake Type.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	18.136[a]	2	.000
Likelihood Ratio	18.429	2	.000
N of Valid Cases	738		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 25.46.

Table 7. Chi-Square of Raw Material Locality and Flake Type.

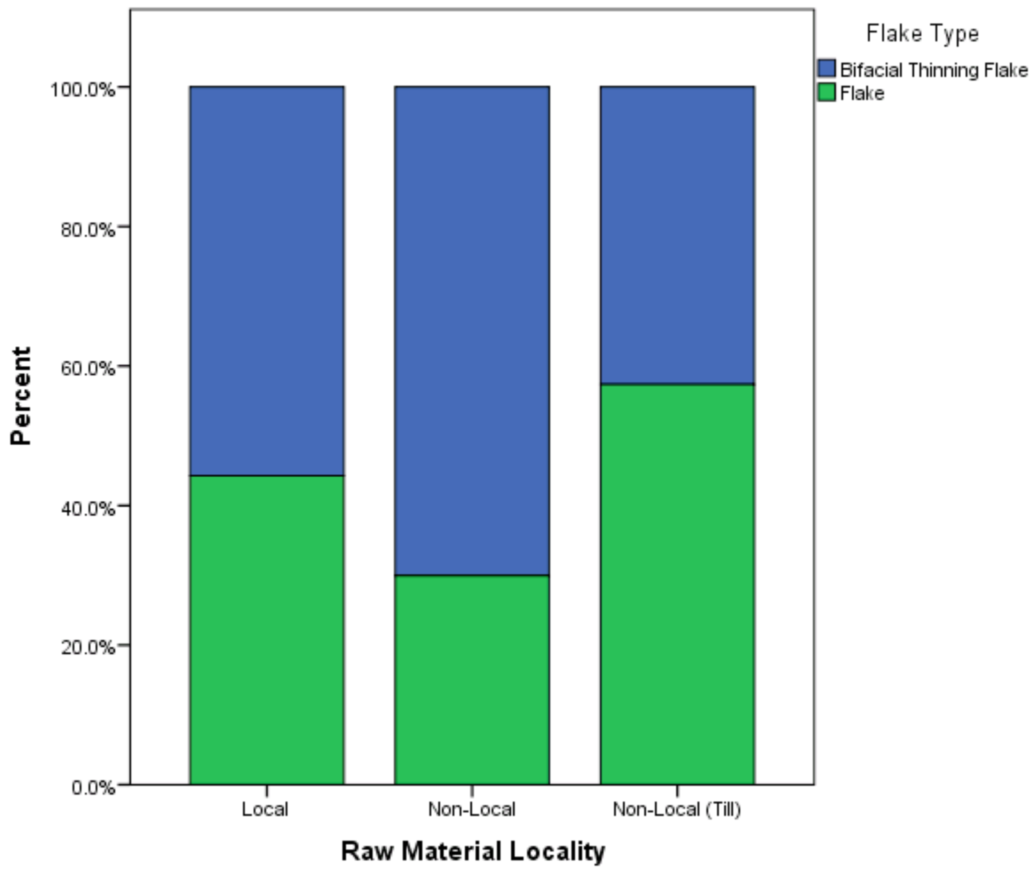

Figure 18. Percent Flake Type by Raw Material Locality; Includes Complete and Proximal Flakes Only.

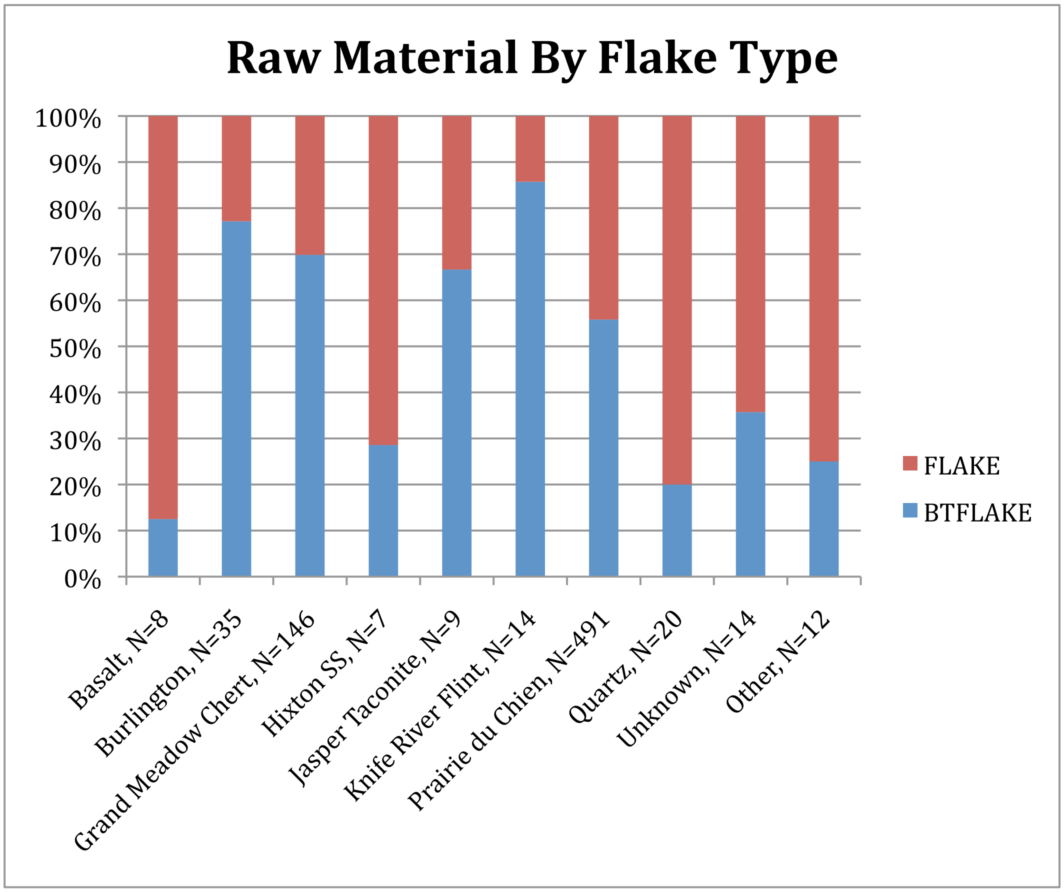

Figure 19. Percentage of Flake Type by Raw Material Type; Complete and Proximal Flakes Only.

A chi-square test was performed in order to determine if there was a statistically significant difference between flake type and raw material locality. A value of 18.136 was returned with a degree of freedom of 2. The differences between flake types among these raw material localities are statistically significantly different, p=0.00. The probability of getting this strength of association between the variables tested when there is no true statistical difference is 0%. Hence, the hypothesis is supported.

As stated in the hypothesis, there is a non-random distribution of flake types by raw material locality. Local material has a lower than expected amount of bifacial thinning flakes (N=273, Expected Count=285.5) and a higher than expected amount of ordinary flakes (N=217, Expected Count=204.5). This reflects that site inhabitants were likely using local material for primary flaking at the site, and much less for retouching bifaces. This conclusion is also supported by the high percentage of flakes made from local material with cortex present.

Additionally, non-local material has a higher than expected amount of bifacial thinning flakes and a lower than expected amount of flakes, reflecting that a majority of non-local materials were brought into the site as preforms or bifaces, rather than as cobbles, and retouched on site. However, this conclusion is not supported by the cortex data, which indicates that approximately 50% of flakes made of non-local material had cortex present. This discrepancy could be due to several different factors. It could be a differentiation between raw material types within the non-local materials. For instance, Burlington has a very low percentage of complete flakes with cortex present (32%), and a high percentage of bifacial thinning flakes (77%), indicating that Burlington was primarily brought to the site as bifaces and retouched on site. There are no complete Hixton Silicified Sandstone flakes with cortex present, yet only 30% of those flakes are bifacial retouch flakes. This likely reflects the form in which Hixton Silicified Sandstone outcrops, which has very little cortex, rather than being indicative of certain knapping behavior on site. The sample size of Hixton Silicified Sandstone complete flakes (N=7) makes it difficult to draw many conclusions about the use of this non-local material at the Bremer site, however. Grand Meadow Chert has a high percentage of complete flakes with cortex present (70%), and a high percentage of bifacial thinning flakes (70%), indicating that there was some cortex present on the material as it was brought onto the site.

Non-local (till) material has a lower than expected amount of bifacial thinning flakes and a higher than expected amount of flakes. This reflects the hypothesis that many of these materials were found locally and brought to the site as cobbles and decorticated on site, rather than being brought in as bifaces and retouched. This also reflects the idea that many of these materials were likely obtained from the local glacial till, rather than received from the natural source of these materials.

4.1.4.3 Raw Material Locality by Lithic Artifact Type

The hypothesis states that local materials will be represented by a higher than expected amount of flakes, and a lower than expected amount of tools. Non-local materials should have a lower count of flakes and a higher amount of tools than expected, while non-local (till) materials should have a higher amount of flakes and a lower amount of tools than expected. All complete and proximal flakes and tools were used in this analysis.

			Artifact Type		Total
			Flake	Tool	
Raw Material Location	Local	Count	490	34	524
		Expected Count	487.7	36.3	524.0
		% within Raw Material Location	93.5%	6.5%	100.0%
	Non-Local	Count	187	13	200
		Expected Count	186.1	13.9	200.0
		% within Raw Material Location	93.5%	6.5%	100.0%
	Non-Local, in Till	Count	61	8	69
		Expected Count	64.2	4.8	69.0
		% within Raw Material Location	88.4%	11.6%	100.0%
Total		Count	738	55	793
		Expected Count	738.0	55.0	793.0
		% within Raw Material Location	93.1%	6.9%	100.0%

Table 8. Crosstabulation of Raw Material Locality by Artifact Type (Flakes and Tools).

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.541[a]	2	.281
Likelihood Ratio	2.182	2	.336
N of Valid Cases	793		

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 4.79.

Table 9. Chi-Square Test of Raw Material Locality by Artifact Type (Flakes and Tools).

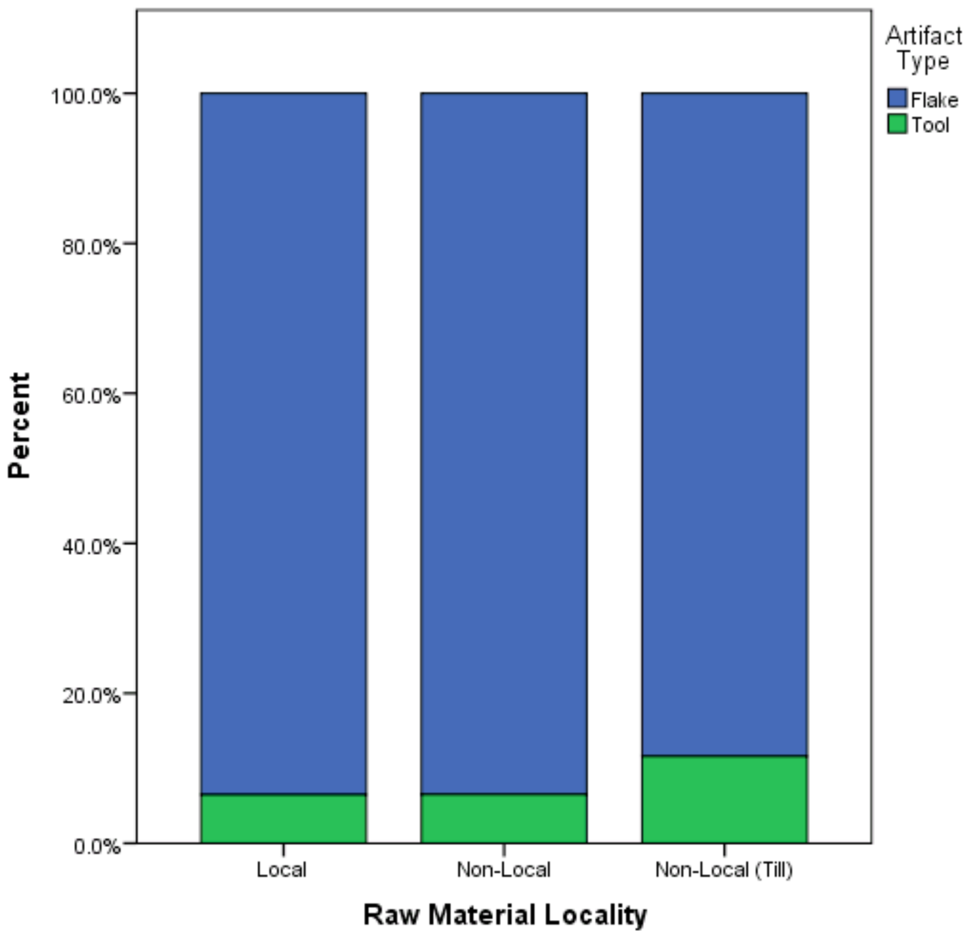

Figure 20. Raw Material Locality by Artifact Type (Flakes and Tools).

The results indicate that the hypothesis must be rejected. All materials had actual counts essentially equivalent to their expected counts (p=.281). The graph indicates that while local and non-local flake and tool ratios are nearly identical, non-local (till) material has a slightly higher ratio of tools than flakes. However, this difference is not statistically significantly different (p=0.281).

It is unclear why there are so few patterns when flakes and tools are compared by raw material locality. It is expected that tools would be more likely to occur on higher-quality, non-local material, but this is not the case.

This could be due to several factors. The tools which were collected at the site only represent the tools which were discarded there; thus, non-local tools may have been curated off site and carried elsewhere, leaving no record of them at the Bremer site except for retouch flakes. Additionally, raw materials from different localities may not have been differentially used for knapping tools. However, it is most likely that the sample size of tools (N=55) is too small to draw any significant conclusions from this assemblage.

4.1.4.4 Raw Material Locality by Flake Surface Area and Weight

Flake Surface Area

The hypothesis states that local material has the highest average flake surface area, while non-local material has the smallest average flake surface area, and non-local (till) has an intermediate average flake surface area. This hypothesis is supported by lithic tool curation research, which states that the curation of lithic tools is highly affected by their portability. Small, light-weight lithics are the most advantageous for curating, while larger, heavier lithics are the least advantageous (Kuhn 1994:426). All complete flakes were used in this analysis.

Raw Material	N	Mean	Std. Deviation	Std. Error
Local	245	233.377372	167.0800777	10.6743546
Non-Local	111	179.851305	93.492551	8.8739202
Non-Local (Till)	36	354.966424	453.5313903	75.588565
Total	392	229.387098	201.1228793	10.1582394

Table 10. Descriptives of Mean Flake Surface Area by Raw Material Locality.

Test of Homogeneity of Variances

Surface Area (Length*Width)

Levene Statistic	df1	df2	Sig.
19.471	2	389	.000

Table 11. Test of Homogeneity of Variances of Mean Flake Surface Area by Raw Material Locality.

Robust Tests of Equality of Means

Surface Area (Length*Width)

	Statistic[a]	df1	df2	Sig.
Welch	9.400	2	85.705	.000

Table 12. Welch Statistic of Mean Flake Surface Area by Raw Material Type.

Multiple Comparisons

Dependent Variable: Surface Area

	(I) Locality	(J) Locality	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	Local	Non-Local	53.5260665*	22.4464268	.046	.715924	106.336209
		Non-Local (Till)	-121.5890524*	35.0175387	.002	-203.975493	-39.202612
	Non-Local	Local	-53.5260665*	22.4464268	.046	-106.336209	-.715924
		Non-Local (Till)	-175.1151189*	37.6281336	.000	-263.643556	-86.586681
	Non-Local (Till)	Local	121.5890524*	35.0175387	.002	39.202612	203.975493
		Non-Local	175.1151189*	37.6281336	.000	86.586681	263.643556
Games-Howell	Local	Non-Local	53.5260665*	13.8812214	.000	20.848841	86.203292
		Non-Local (Till)	-121.5890524	76.3385421	.262	-308.094120	64.916015
	Non-Local	Local	-53.5260665*	13.8812214	.000	-86.203292	-20.848841
		Non-Local (Till)	-175.1151189	76.1076713	.069	-361.151660	10.921422
	Non-Local (Till)	Local	121.5890524	76.3385421	.262	-64.916015	308.094120
		Non-Local	175.1151189	76.1076713	.069	-10.921422	361.151660

*. The mean difference is significant at the 0.05 level.

Table 13. Tukey and Games-Howell post hoc test of Mean Flake Surface Area by Raw Material Locality.

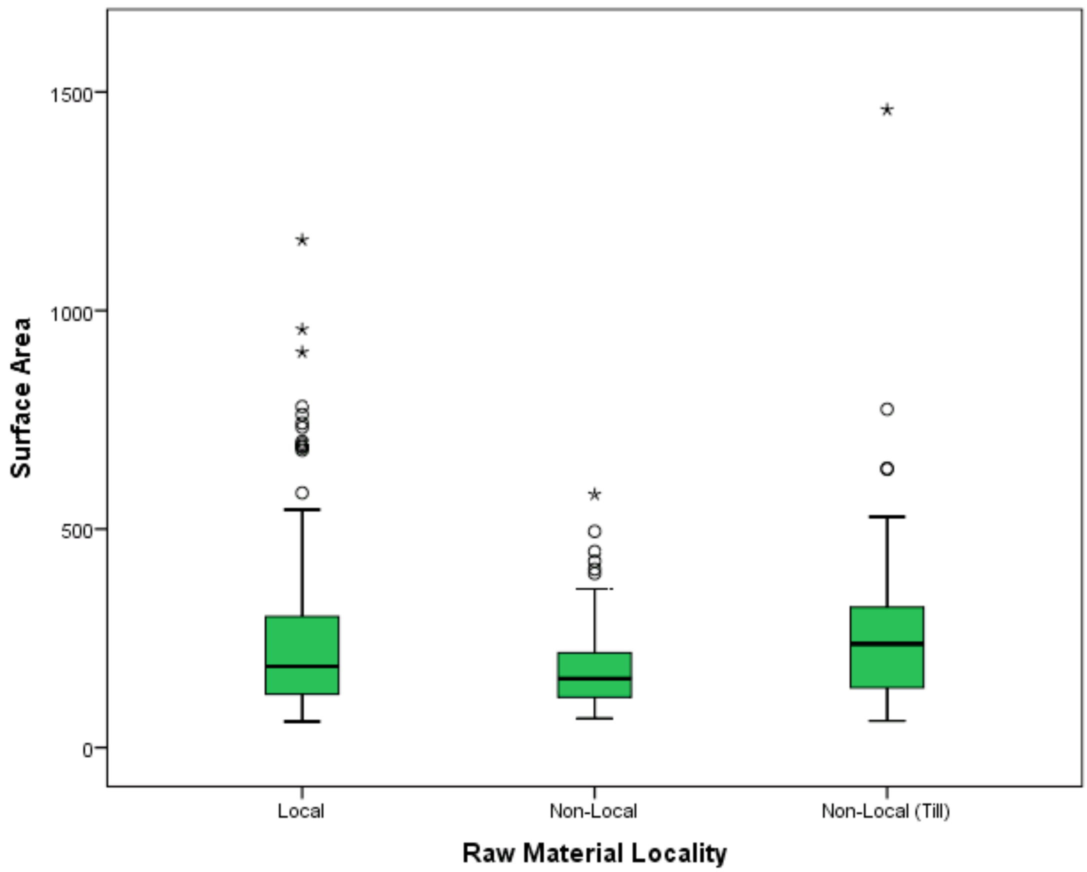

Figure 21. Complete Flake Surface Area (mm) by Raw Material Locality.

A Welch statistic was run in order to test whether the mean surface areas of complete flakes categorized according to the proximity of their source are significantly different or not. A Levene's Test of Homogeneity of Variance was .000, indicating that the assumption of homogeneity of variances is violated. Therefore, the Welch ANOVA was used (Welch statistic = 9.400, df1=2, df2=85.71), which showed that there is a statistically significant difference between these means (p=.000).

A Games-Howell post-hoc test, which was used because the assumption of homogeneity of variances is violated, in order to determine what pairs of means show a statistical difference. This test revealed that the difference between the means of surface area between local and non-local raw materials is significantly different, p=.000, but not between local and non-local (till), p=.069 nor between non-local and non-local (till), p=.262.

Therefore, the stated hypothesis is not supported. Local material has the second largest mean flake surface area (233.38 mm), while non-local material has the smallest mean flake surface area (179.85 mm), and non-local (till) has the largest mean flake surface area (354.97 mm). This result could be due to several very large non-local (till) outlier flakes (see Figure 21), or the small sample size of non-local (till) flakes (N=36).

Non-Local material has the smallest average flake surface area, which supports the hypothesis that non-local material was used primarily for retouching bifaces, and is therefore represented by smaller sized retouch flakes. Additionally, the larger average flake surface area of local and non-local (till) flakes indicates that these materials were used for primary flaking rather than retouch, and are therefore represented by flakes with larger surface areas. Additionally, these results support the hypothesis that non-local (till) material was in fact available very locally to the site, as the large average flake surface area represents a pattern of primary flaking rather than retouch.

Flake Weight

Given the previous results, it follows that non-local (till) material has the highest average weight per flake, local material has the second-highest average weight per flake, and non-local material has the lowest average weight per flake.

Raw Material	N	Mean	Std. Deviation	Std. Error
Local	245	1.186122	1.9811952	0.1265739
Non-Local	111	0.56036	0.5684555	0.0539554
Non-Local (Till)	36	2.877778	4.9739384	0.8289897
Total	392	1.164286	2.2647527	0.1143873

Table 14. Descriptives of Mean Flake Weight by Raw Material Locality.

Test of Homogeneity of Variances

Weight (g)

Levene Statistic	df1	df2	Sig.
27.075	2	389	.000

Table 15. Test of Homogeneity of Variances for Mean Flake Weight by Raw Material Locality.

Robust Tests of Equality of Means

Weight (g)

	Statistic[a]	df1	df2	Sig.
Welch	13.810	2	84.576	.000

a. Asymptotically F distributed.

Table 16. Welch Statistic of Mean Flake Weight by Raw Material Locality.

Multiple Comparisons

Dependent Variable: Weight (g)

	(I) Locality	(J) Locality	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	Local	Non-Local	.6257621*	.2501304	.034	.037275	1.214249
		Non-Local (Till)	-1.6916553*	.3902158	.000	-2.609724	-.773587
	Non-Local	Local	-.6257621*	.2501304	.034	-1.214249	-.037275
		Non-Local (Till)	-2.3174174*	.4193068	.000	-3.303929	-1.330906
	Non-Local (Till)	Local	1.6916553*	.3902158	.000	.773587	2.609724
		Non-Local	2.3174174*	.4193068	.000	1.330906	3.303929
Games-Howell	Local	Non-Local	.6257621*	.1375941	.000	.301761	.949763
		Non-Local (Till)	-1.6916553	.8385970	.122	-3.739892	.356582
	Non-Local	Local	-.6257621*	.1375941	.000	-.949763	-.301761
		Non-Local (Till)	-2.3174174*	.8307437	.022	-4.349726	-.285109
	Non-Local (Till)	Local	1.6916553	.8385970	.122	-.356582	3.739892
		Non-Local	2.3174174*	.8307437	.022	.285109	4.349726

*. The mean difference is significant at the 0.05 level.

Table 17. Tukey and Games-Howell post hoc test for Mean Flake Weight by Raw Material Locality.

Weight (g)

	Locality	N	Subset for alpha = 0.05	
			1	2
Tukey HSD[a,b]	Non-Local	111	.560360	
	Local	245	1.186122	
	Non-Local (Till)	36		2.877778
	Sig.		.194	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 73.406.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Table 18. Tukey test of Raw Material Locality by Mean Flake Weight.

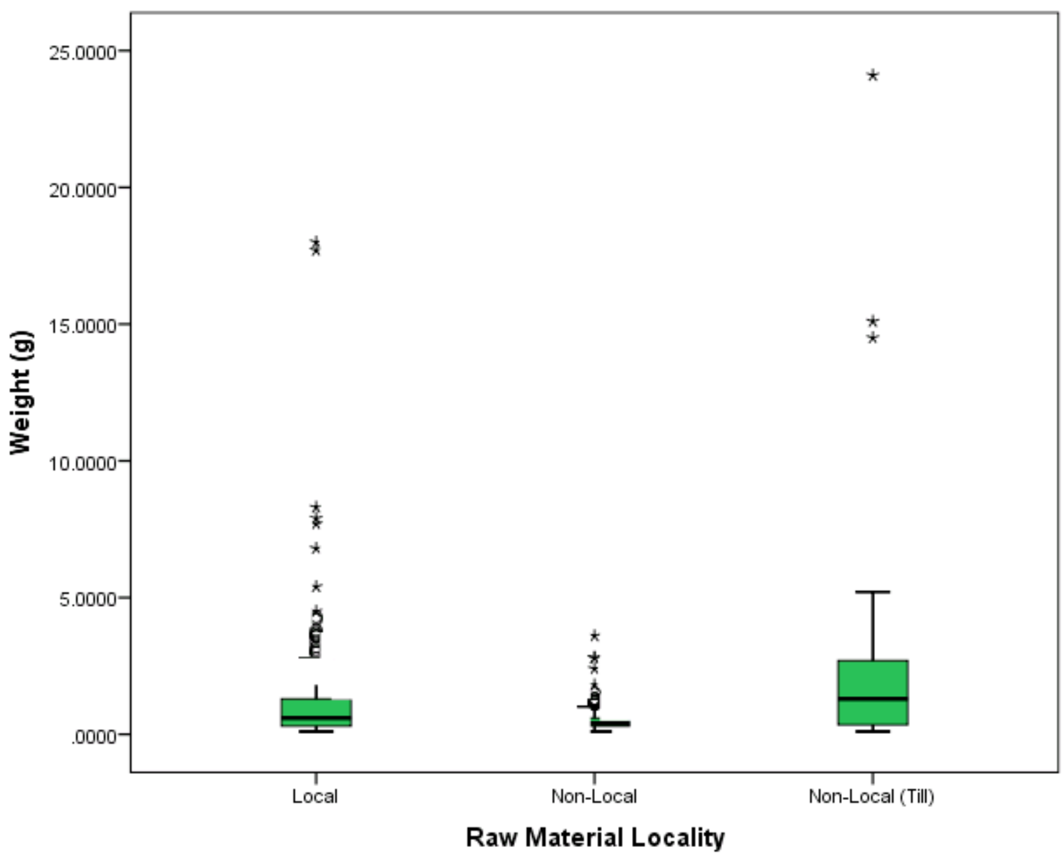

Figure 22. Weight of all Complete Flakes by Raw Material Locality.

A Welch statistic was run in order to test whether the mean weight of complete flakes by raw material locality are significantly different or not. A Levene's Test of Homogeneity of Variance was .000, indicating that the assumption of homogeneity of variances is violated. Therefore, the Welch ANOVA was used (Welch statistic = 13.810, df1=2, df2=84.576), which showed that there is a statistically significant difference between these means (p=.000).

A Games-Howell post-hoc test, which was used because the assumption of homogeneity of variances is violated, in order to determine what pairs of means show a statistical difference. This test revealed that the difference between the means of weight between local and non-local raw materials is significantly different, p=.000, and is also significant between non-local and non-local (till), p=0.022, but not between local and non-local (till), p=.122.

Indeed, the results for flake weight match those of flake surface area. Non-local (till) material has the highest mean weight of flakes, followed by flakes made of local material, while non-local material has the smallest average flake weight. This supports the hypothesis that local and non-local (till) material was primarily used for, and is now represented by, primary flakes, while non-local material was primarily used for retouching bifaces and preforms on site.

4.1.4.5 Relative Flake Thinness by Raw Material Locality

The hypothesis states that non-local material is represented by thinner flakes on average than local and non-local material. This hypothesis is based on the above results, which indicate that non-local material was brought onto the site as bifaces or preforms and retouched on site, while local and non-local (till) material was largely brought onto the site as cobbles and knapped on site. All complete flakes were used for this analysis.

Raw Material	N	Mean	Std. Deviation	Std. Error
Local	245	90.14342	52.984977	3.385086
Non-Local	111	102.23307	49.6218073	4.7098935
Non-Local (Till)	36	91.13264	60.3015752	10.0502625
Total	392	93.657612	52.9090045	2.6723083

Table 19. Descriptives of Relative Flake Thinness by Raw Material Locality.

Test of Homogeneity of Variances

Relative Thinness (surface area/thinness)

Levene Statistic	df1	df2	Sig.
.815	2	389	.443

Table 20. Levene Statistic of Relative Flake Thinness by Raw Material Locality.

ANOVA

Relative Thinness (surface area/thickness)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11417.927	2	5708.963	2.050	.130
Within Groups	1083132.912	389	2784.403		
Total	1094550.839	391			

Table 21. ANOVA of Relative Flake Thinness by Raw Material Locality.

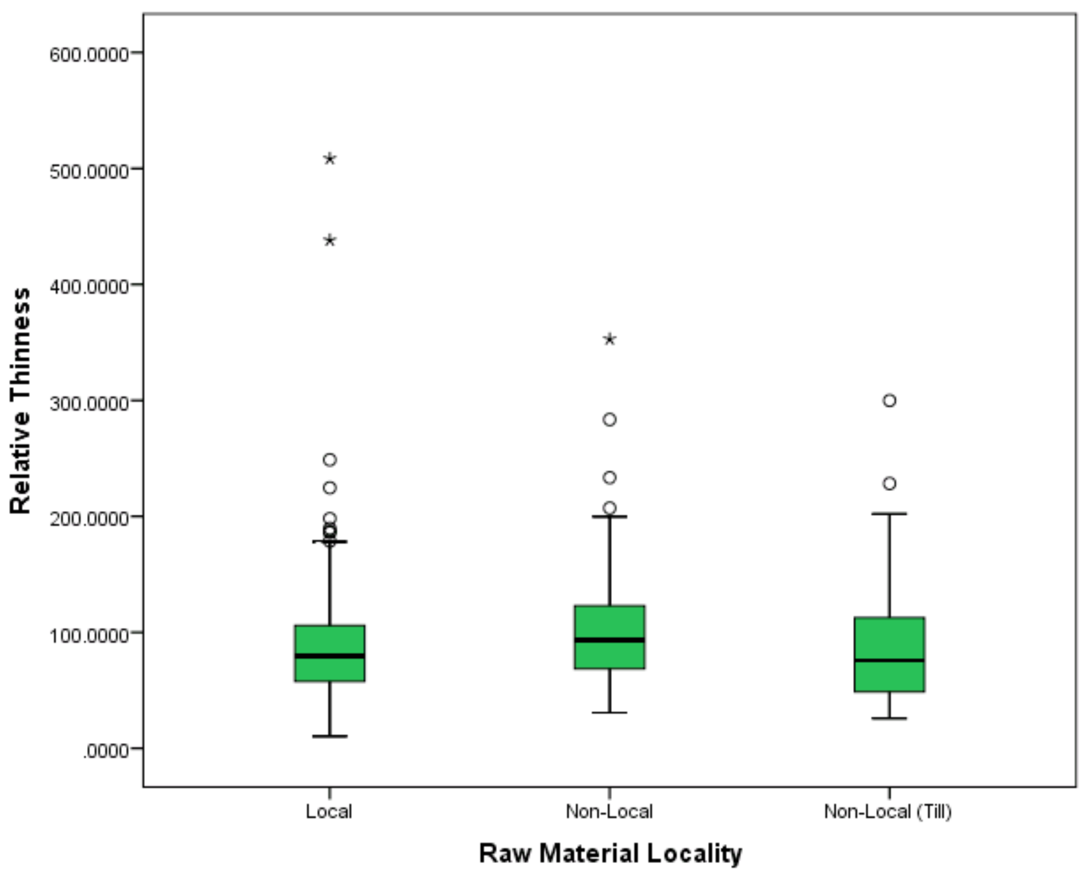

Figure 23. Relative Thinness of Complete Flakes by Raw Material Locality.

A One-way ANOVA was run in order to test whether the relative flake thinness of complete flakes by raw material locality are significantly different or not. A Levene's Test of Homogeneity of Variance was .443, indicating that the assumption of homogeneity of variances is not violated. Therefore, the ANOVA was used (df=2, F=2.050, p=.130), which showed that there is not a statistically significant difference between these means (p=.117).

The relative thinness of flakes made of non-local material (Mean=102.23) is slightly higher than that of local (Mean=90.14) and non-local (till) flakes (Mean=93.66), meaning non-local flakes are slightly thinner on average than flakes made of other materials (see Figure 23). This supports the hypothesis that non-local material was used for bifacial thinning more so than local or non-local (till) materials. However, there is not a statistically significant difference between relative flake thinness and locality of raw material.

4.1.5 Raw Material Quality

Raw material quality has been shown to be closely linked to lithic artifact type and tool creation on archaeological sites (Andrefsky 1994:382). Higher quality raw material tends to have less inclusions and have a finer texture, while lower quality raw materials have more inclusions (such as oolites) and a coarser texture. Andrefsky notes, "If certain kinds of lithic raw materials are more effective for certain kinds of tasks and less effective for other tasks, it would not be unreasonable to suspect that hunter gatherers would take advantage of such variations in stone quality for the production of tools," (1994:382). Tools which require less skill for production tend to be made of lower quality, coarser textured, local material, while tools which require much more skill for production tend to be made of non-local, high quality and finer textured raw materials (Andrefsky 1994:383).

Thus, it is hypothesized that at the Bremer site, raw material quality is closely linked to texture and flake type. Higher quality material is likely used primarily for retouching bifaces, while lower quality material is used for primary knapping. For this analysis, quality is a subjective measurement with 1 being very good, and 4 being poor quality. Texture was measured on a categorical scale of rock textures, including Coarse Sand, Medium Sand, Fine Sand, Coarse Silt, Medium Silt, and Fine Silt.

4.1.5.1 Raw Material Quality by Flake Type

It is hypothesized that raw material with a higher quality will be used for bifacial thinning, and thus have a higher than expected amount of bifacial thinning flakes and a lower than expected amount of ordinary flakes, while lower quality materials will have a lower than expected amount of bifacial thinning flakes and a higher than expected amount of flakes. This reflects the idea that higher quality materials were used primarily for bifacial thinning, and lower quality materials were used more for primary knapping. All complete and proximal flakes were used in this analysis.

			Flake Type		Total
			BTFLAKE	FLAKE	
Quality	Very Good	Count	252	120	372
		Expected Count	214.6	157.4	372.0
		% within Quality	67.7%	32.3%	100.0%
	Good	Count	122	92	214
		Expected Count	123.5	90.5	214.0
		% within Quality	57.0%	43.0%	100.0%
	Poor	Count	51	83	134
		Expected Count	77.3	56.7	134.0
		% within Quality	38.1%	61.9%	100.0%
	Very Poor	Count	10	24	34
		Expected Count	19.6	14.4	34.0
		% within Quality	29.4%	70.6%	100.0%
Total		Count	435	319	754
		Expected Count	435.0	319.0	754.0
		% within Quality	57.7%	42.3%	100.0%

Table 22. Crosstabulation of Raw Material Quality and Flake Type.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	47.734[a]	3	.000
Likelihood Ratio	47.833	3	.000
N of Valid Cases	754		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 14.38.

Table 23. Chi-Square Test of Raw Material Quality by Flake Type.

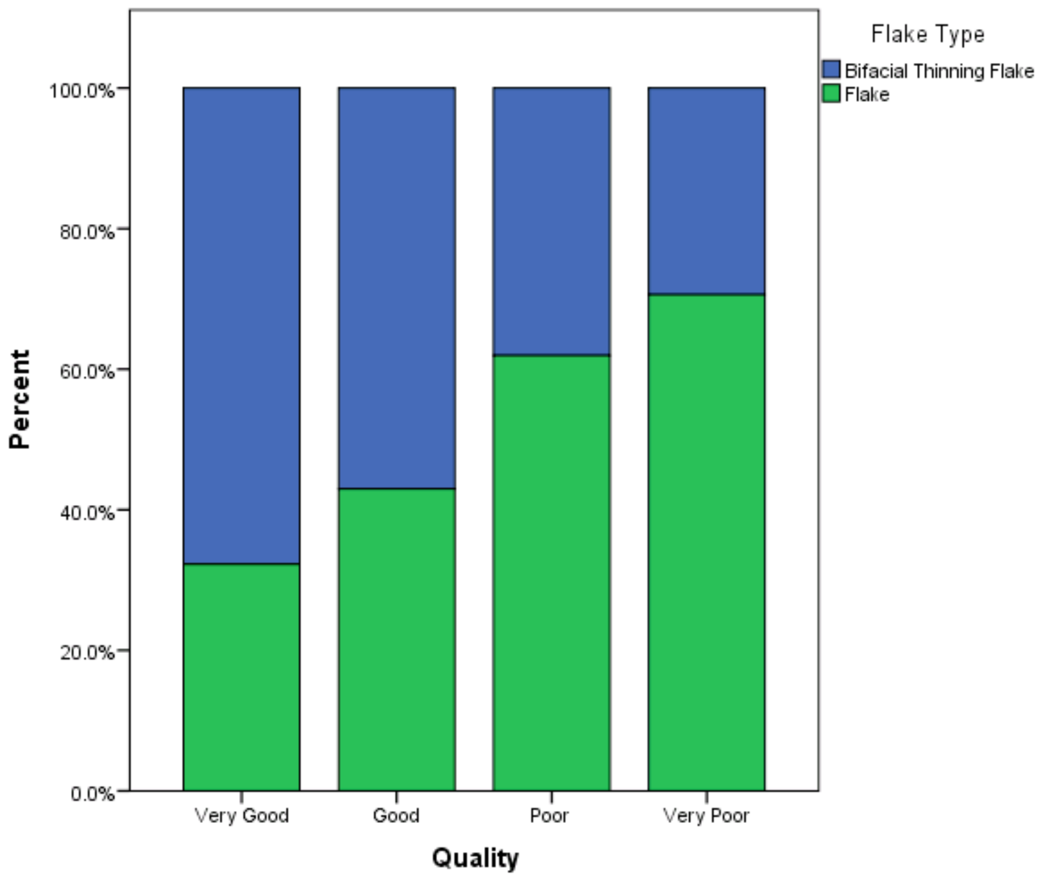

Figure 24. Raw Material Quality by Percent Flake Types.

The data supports the hypothesis. The highest quality materials (1) have a higher than expected amount of bifacial thinning flakes and a lower than expected amount of flakes, while lower quality materials (2, 3, and 4) have a lower than expected amount of bifacial thinning flakes and a higher than expected amount of flakes. This supports the hypothesis that raw materials were differentially selected and used for specific knapping tasks and tool creation based on raw material quality.

A chi-square test was performed in order to determine whether there was a statistically significant difference between raw material quality and flake type. A value of 47.734 was returned with a degree of freedom of 3. The differences between flake types among raw material quality is statistically significantly different, p=0.00. The probability of getting this strength of association between the variables tested when there is no true statistical difference is 0%. Hence, the hypothesis is supported.

The relationship between raw material quality and flake type is graphically illustrated in Figure 24. There is a clear relationship between raw material quality and flake type; as the raw material quality decreases, the percentage of flakes increases and percentage of bifacial thinning flakes decreases. This indicates that higher quality material was primarily used for bifacial thinning, while lower quality material was used more often for primary flaking rather than bifacial thinning.

4.1.5.2 Raw Material Texture by Flake Type

Raw material texture is closely related to raw material quality. Flake texture was measured on a scale based on Forestry Suppliers' sand grain sizing folder, which includes Fine, Medium, Coarse, and Very Coarse Sand, and Fine, Medium, and Coarse Silt. Raw materials with a coarse texture are more difficult to knap than raw materials with a finer texture (Andrefsky 1994:383). Thus, it is hypothesized that fine and medium silt textured materials were used primarily for bifacial retouch, while fine and medium sand were used for primary knapping events. Thus, flakes with fine and medium silt texture have a higher than expected amount of bifacial thinning flakes and a lower than expected amount of flakes, while flakes with fine and medium sandy texture have a lower than expected amount of bifacial thinning flakes and a higher than expected amount of flakes. All complete and proximal flakes were used in this analysis.

			Flake Type		Total
			BTFLAKE	FLAKE	
Texture	Fine Sand	Count	59	67	126
		Expected Count	72.7	53.3	126.0
		% within Texture	46.8%	53.2%	100.0%
	Fine Silt	Count	235	120	355
		Expected Count	204.8	150.2	355.0
		% within Texture	66.2%	33.8%	100.0%
	Medium/ Coarse Sand	Count	35	64	99
		Expected Count	57.1	41.9	99.0
		% within Texture	35.4%	64.6%	100.0%
	Medium/ Coarse Silt	Count	106	68	174
		Expected Count	100.4	73.6	174.0
		% within Texture	60.9%	39.1%	100.0%
Total		Count	435	319	754
		Expected Count	435.0	319.0	754.0
		% within Texture	57.7%	42.3%	100.0%

Table 24. Crosstabulation of Raw Material Texture by Flake Type.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	37.599[a]	3	.000
Likelihood Ratio	37.512	3	.000
N of Valid Cases	754		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 41.88.

Table 25. Chi-Square Test of Raw Material Texture by Flake Type.

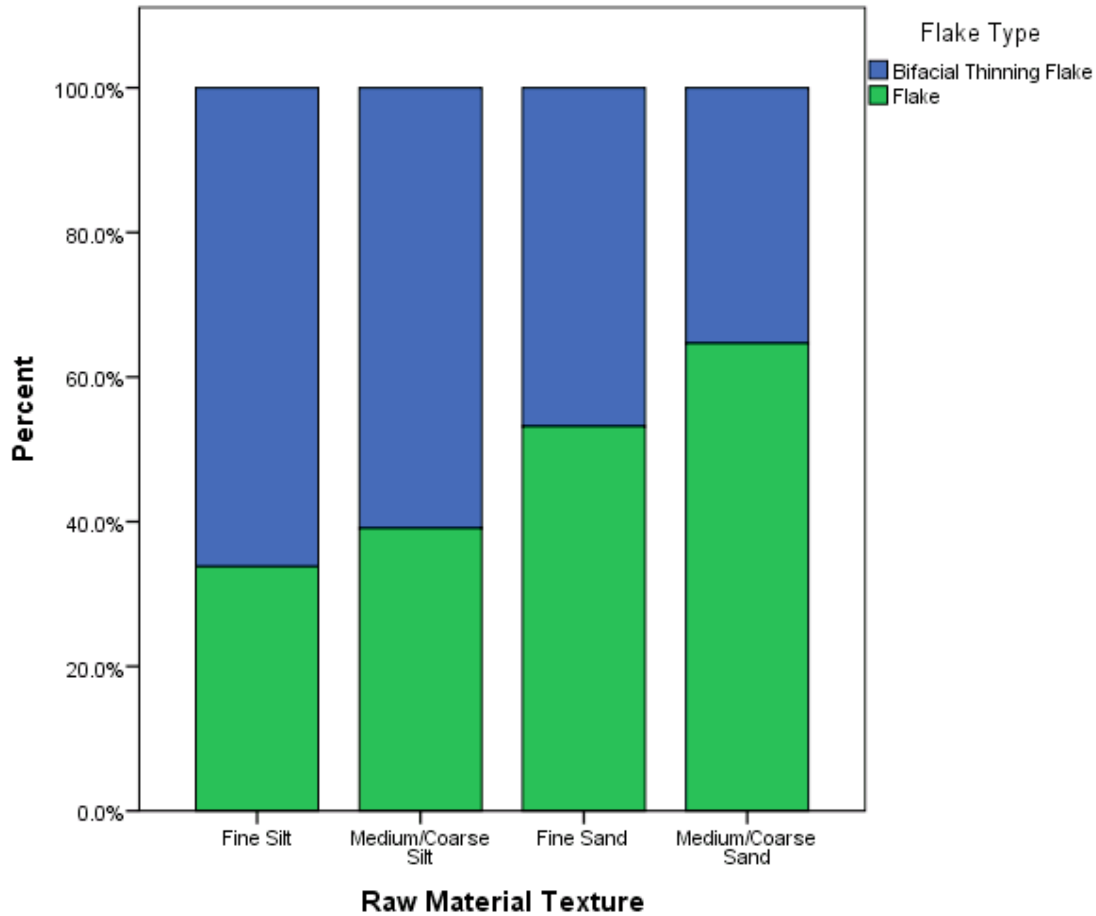

Figure 25. Graph of Raw Material Texture and Flake Type.

The data supports the hypothesis. Fine and Medium Silt textured materials have a higher than expected amount of bifacial thinning flakes and a lower than expected amount of flakes, while Fine Sand and Medium Sand textured materials have a lower than expected amount of bifacial thinning flakes and a higher than expected amount of flakes. This supports the hypothesis that raw materials were differentially selected and used for specific knapping tasks and tool creation based on raw material texture, which may be a substitute for quality.

A chi-square test was performed in order to determine if there was a statistically significant difference between raw material texture and flake type. A value of 37.599 was returned with a degree of freedom of 3. The differences between flake types among raw material quality is statistically significantly different, p=0.00. The probability of getting this strength of association between the variables tested when there is no true statistical difference is 0%. Hence, the difference is statistically significant, and the hypothesis is supported.

The relationship between raw material texture and flake type is graphically illustrated in Figure 24. There is a clear relationship between raw material texture and flake type; as the raw material texture becomes more coarse, the percentage of flakes increases and percentage of bifacial thinning flakes decreases. This indicates that material with a finer texture was primarily used for bifacial thinning, while material with a coarser texture was used more often for primary flaking rather than bifacial thinning.

4.2 Spatial Patterning of Lithics at the Bremer site

4.2.1 Distribution of Total Lithics

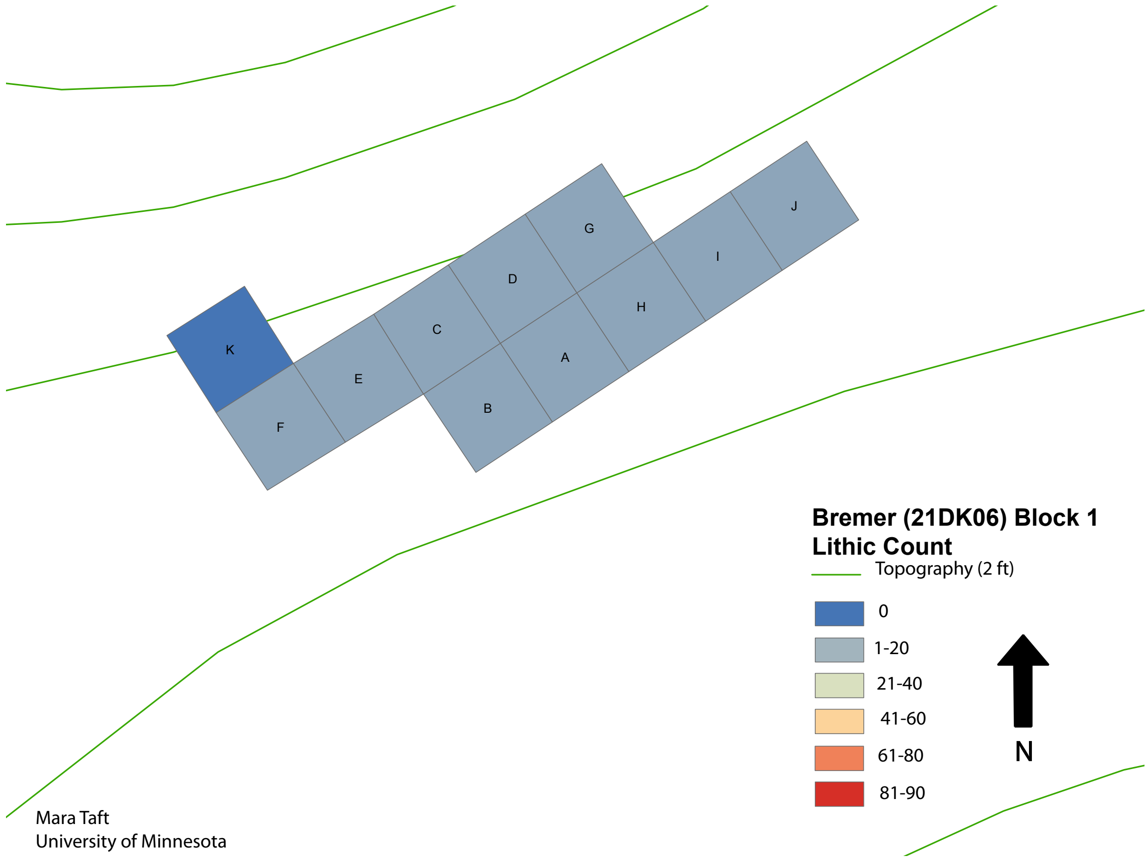

Figure 26. Block 1 Units by Total Lithic Count, Excavation Years 2011-2014.

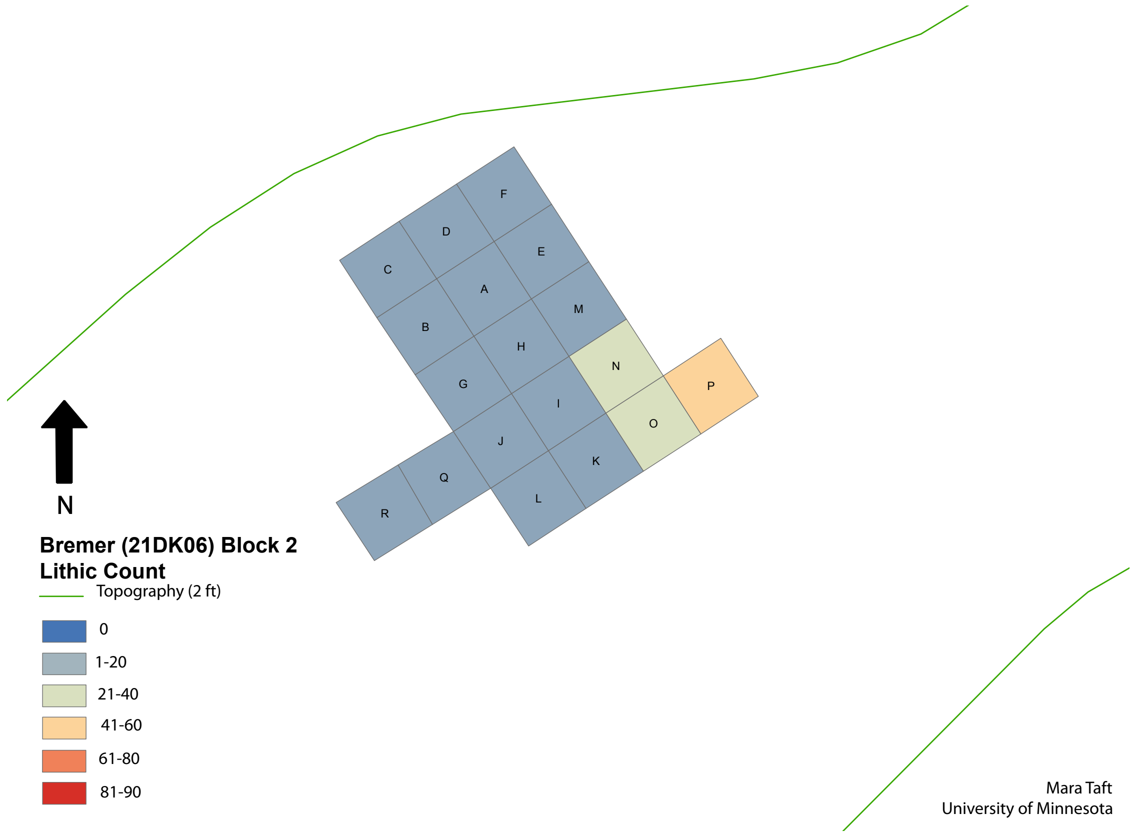

Figure 27. Block 2 Units by Total Lithic Count, Excavation Years 2011-2014.

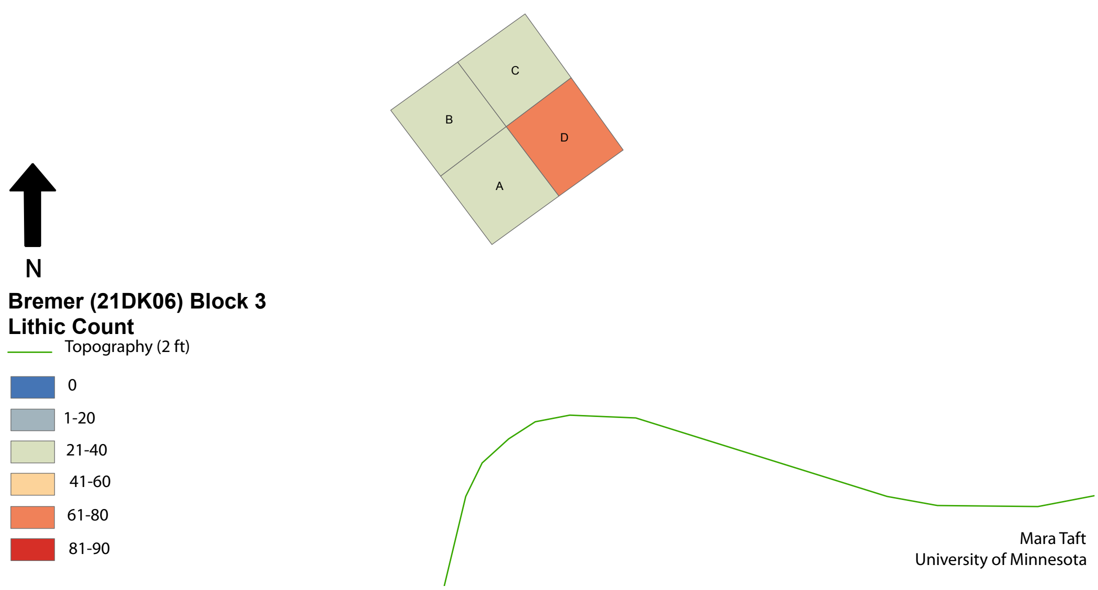

Figure 28. Block 3 Units by Total Lithic Count, Excavation Years 2011-2014.

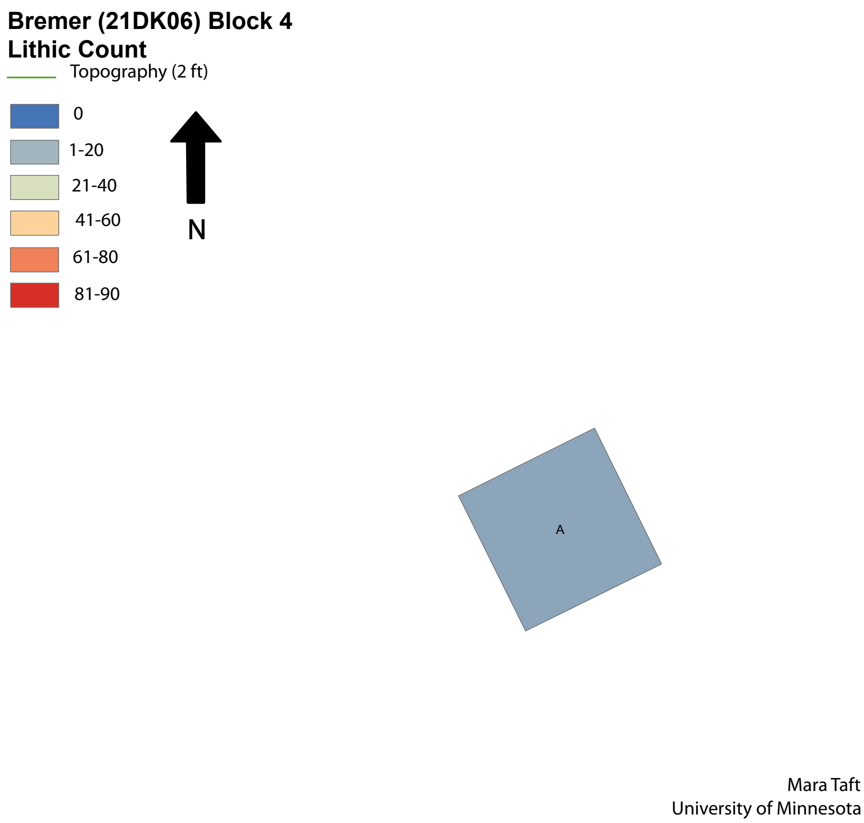

Figure 29. Block 4 Units by Total Lithic Count, Excavation Years 2011-2014.

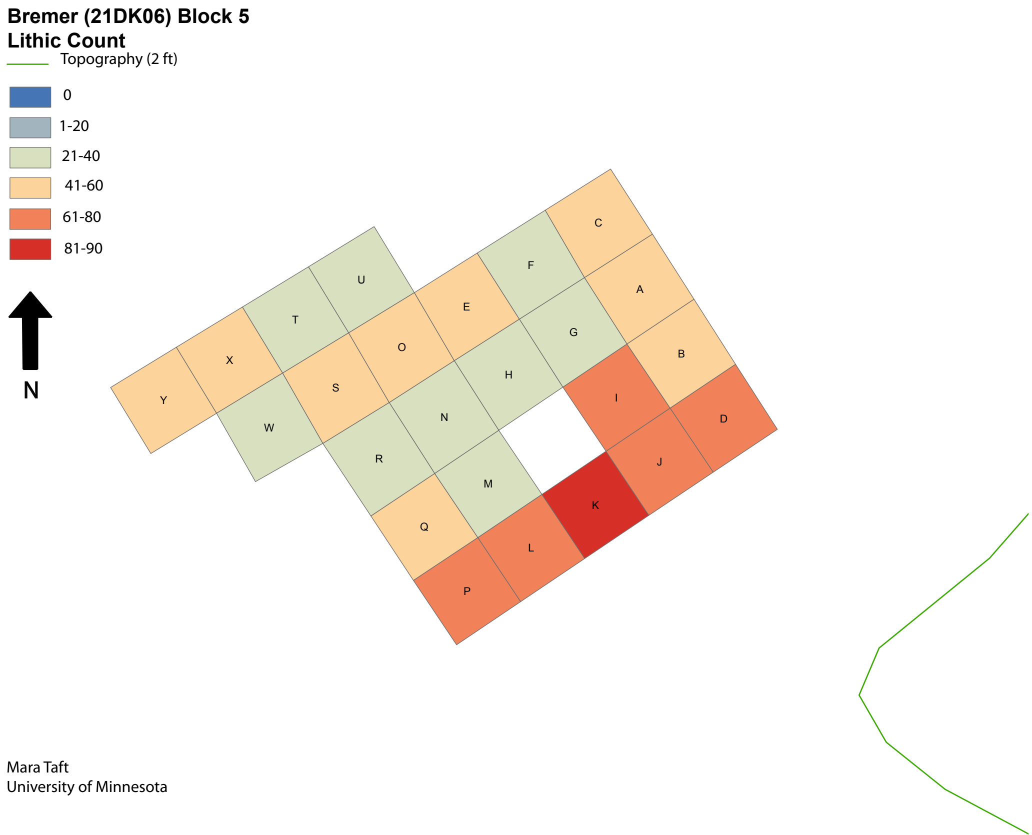

Figure 30. Block 5 Units by Total Lithic Count, Excavation Years 2011-2014.

The distribution of total lithic artifacts from the 2011-2014 excavations mapped by block and unit indicates spatial patterning of lithics throughout the excavation area. Some areas, especially Block 1 and Block 4, have especially low lithic counts, and thus large-scale lithic tool creation or retouching did not occur there. However, in other areas of the site such as Blocks 3 and 5, there are very high concentrations of lithic artifacts, indicating a large-scale knapping event took place there. Within Block 5, especially, it appears as though several large knapping events may have occurred along the southern edge of the block. Block 2 has relatively few lithics throughout, except for a rise in lithic count in units N, O, and P. This likely indicates an isolated knapping event in this area, but that Block 2 as a whole does not represent a high density concentration of knapping.

4.2.2 Distribution of Lithics by Raw Material Types

4.2.2.1 Prairie du Chien

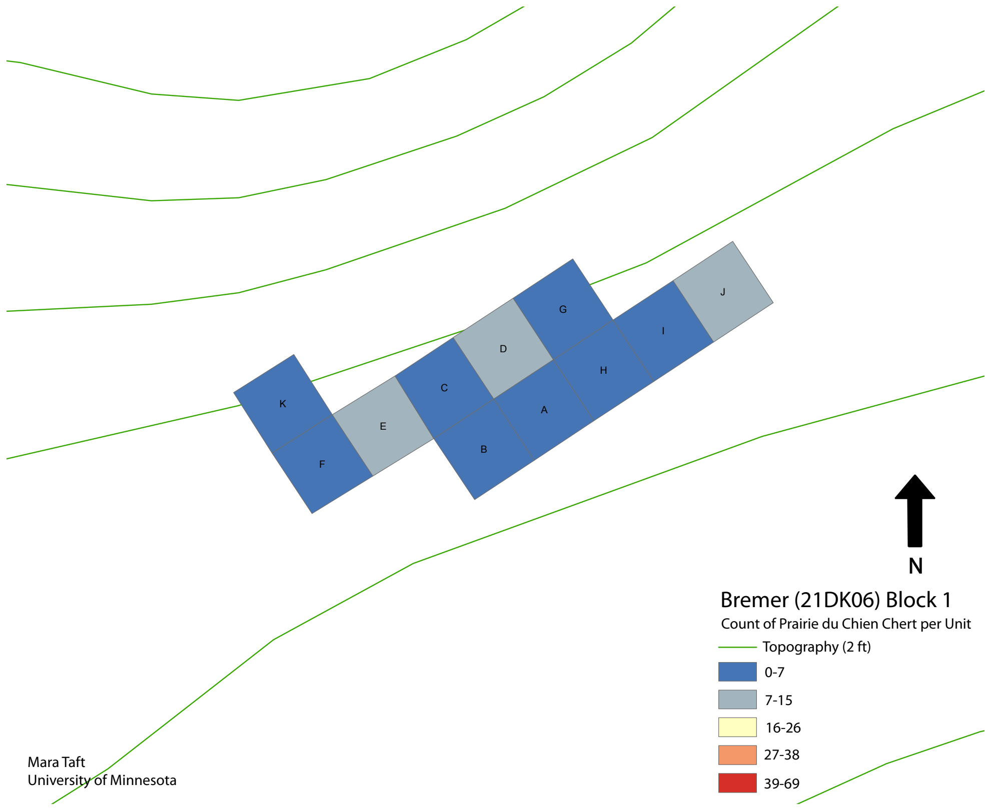

Figure 31. Block 1 Units by Prairie du Chien, All Lithic Artifacts Included.

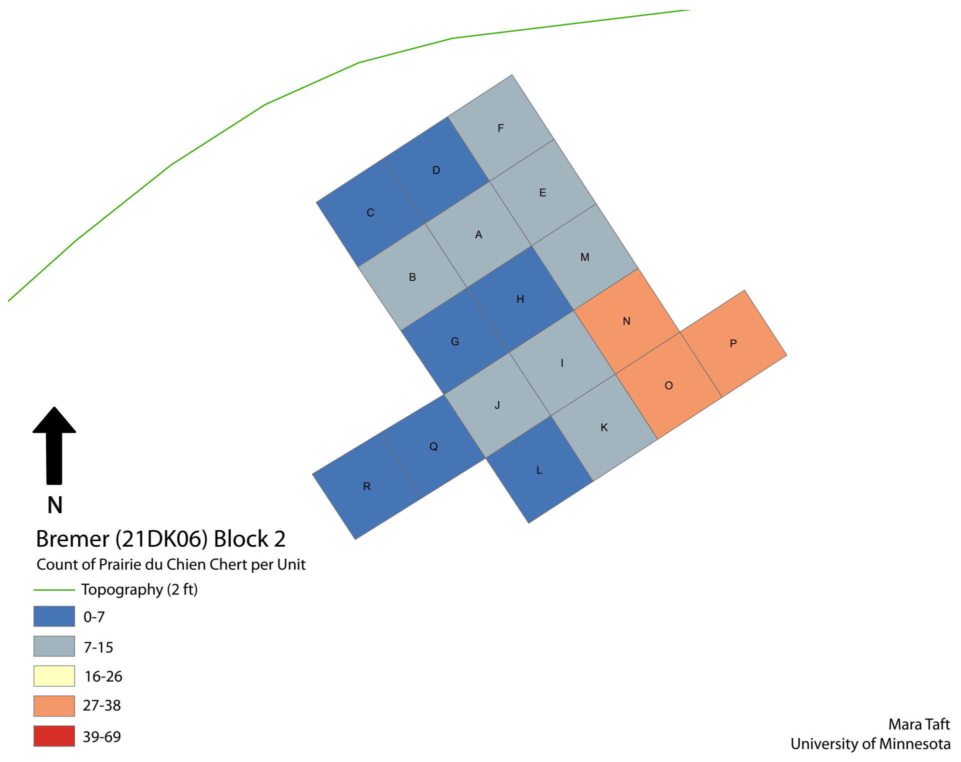

Figure 32. Block 2 Units by Prairie du Chien, All Lithic Artifacts Included.

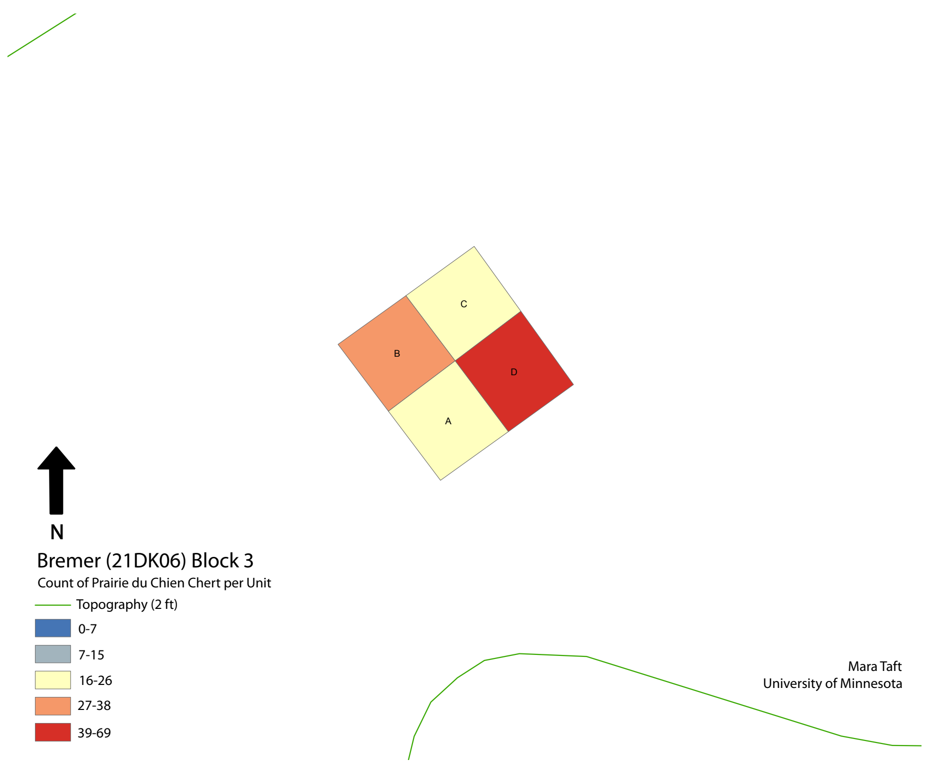

Figure 33. Block 3 Units by Prairie du Chien, All Lithic Artifacts Included.

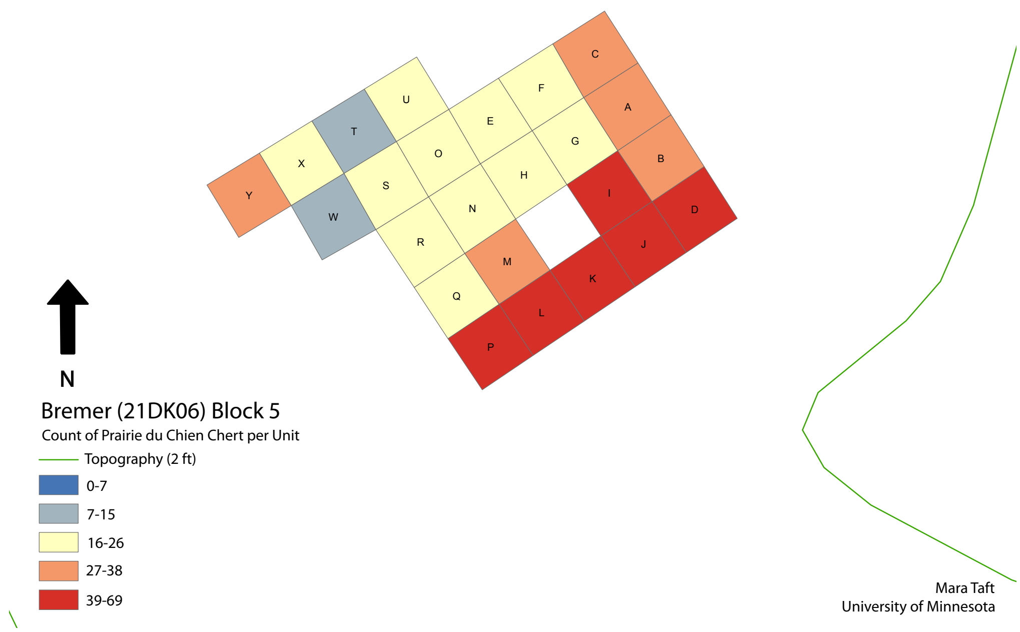

Figure 34. Block 5 Units by Prairie du Chien, All Lithic Artifacts Included.

The above maps indicate the distribution of all lithic material made of Prairie du Chien chert, While Prairie du Chien made up 60% of the total lithic assemblage, it was not spatially distributed evenly throughout the site; rather, there are concentrations of Prairie du Chien that may indicate a knapping event. The same units (N, O, and P) in Block 2 that contained a high concentration of lithics also contain a high concentration of Prairie du Chien. Block 3 also has a high concentration of Prairie du Chien. Additionally, there is a very high concentration of Prairie du Chien lithic artifacts along the southern edge of Block 5, which likely represents several knapping events.

4.2.2.2 Grand Meadow Chert

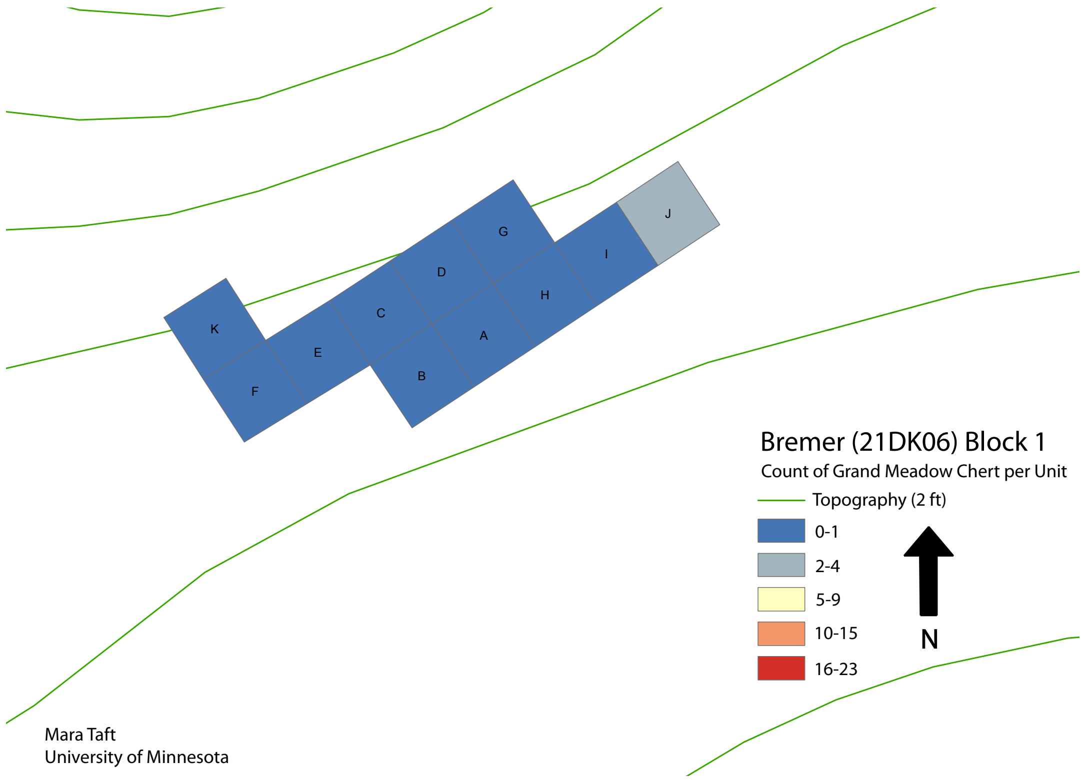

Figure 35. Block 1 Units by Grand Meadow Chert, All Lithic Artifacts Included.

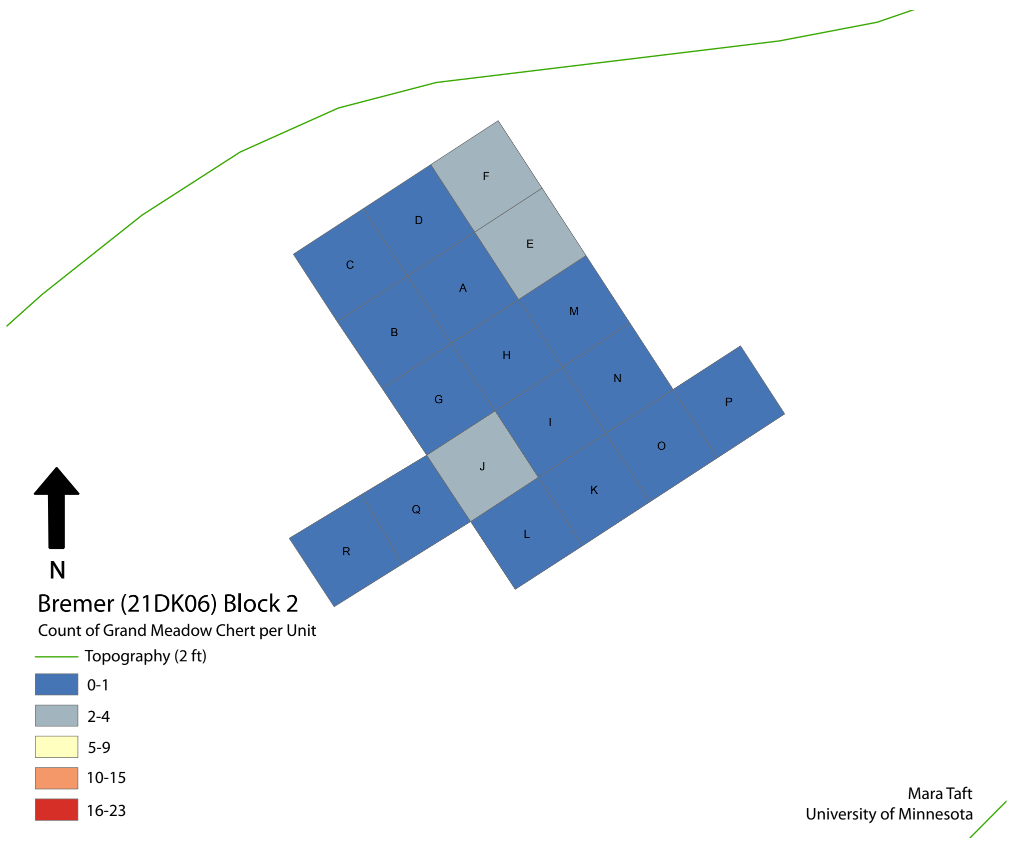

Figure 36. Block 2 Units by Grand Meadow Chert, All Lithic Artifacts Included.

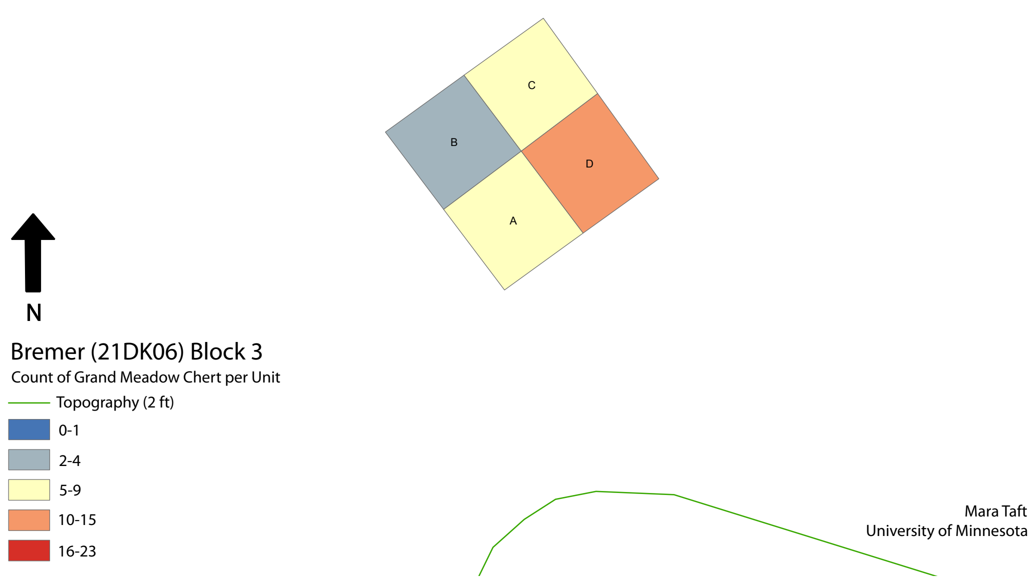

Figure 37. Block 3 Units by Grand Meadow Chert, All Lithic Artifacts Included.

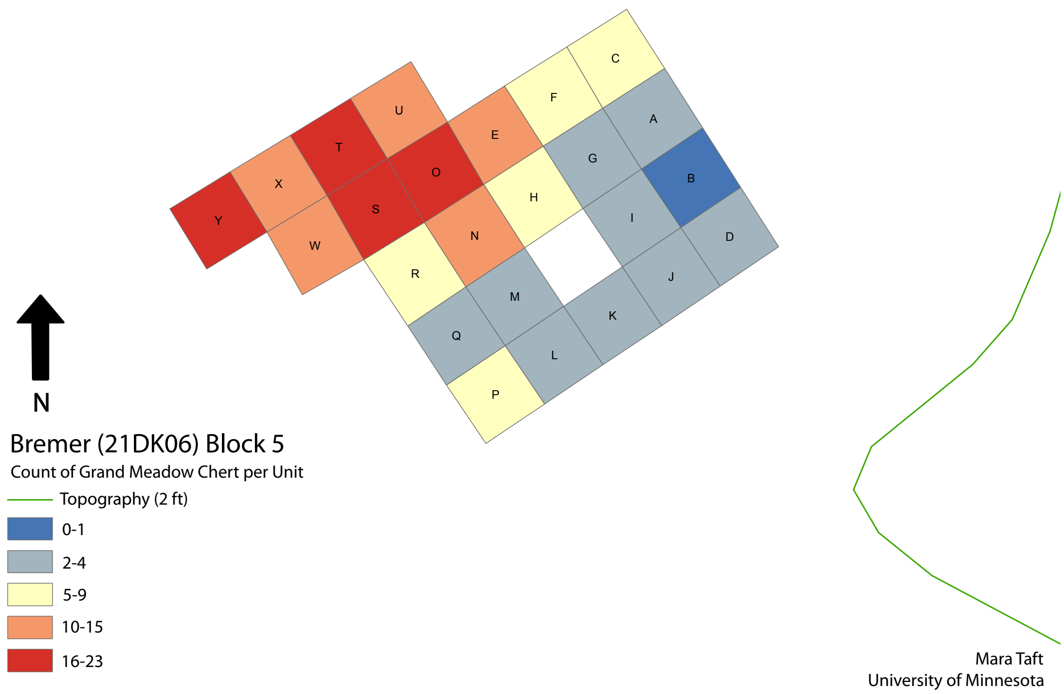

Figure 38. Block 5 Units by Grand Meadow Chert, All Lithic Artifacts Included.

The above maps exhibit the distribution of Grand Meadow Chert lithic artifacts by count and excavation unit. Within Block 2, there are very few Grand Meadow Chert flakes compared with Prairie du Chien flakes; this indicates that a Prairie du Chien knapping or retouch event occurred in units N, O, and P, rather than Grand Meadow Chert. Block 3 does have Grand Meadow Chert presence, but not as high as Prairie du Chien.

Most interestingly, there is a high concentration of Grand Meadow Chert in Block 5, but in a separate area as the Prairie du Chien concentration. Grand Meadow Chert is highly concentrated in the northern corner, whereas the Prairie du Chien concentration is along the southern edge of Block 5. This indicates that there were at least two separate knapping events that took place in Block 5, and that these were separated by raw material type. However, units W, X, and Y contained evidence of an excavation unit from 1956, and thus artifacts from these units are likely disturbed and do not represent the entire assemblage that was once in this area prior to the 1956 excavation. Although, the presence of artifacts from these units indicates that the excavation practices used during the 1956 excavation likely did not include the collection of all artifacts, and likely focused on larger, diagnostic artifacts.

4.2.3 Distribution of Lithics by Flake Type

4.2.3.1 Bifacial Thinning Flakes

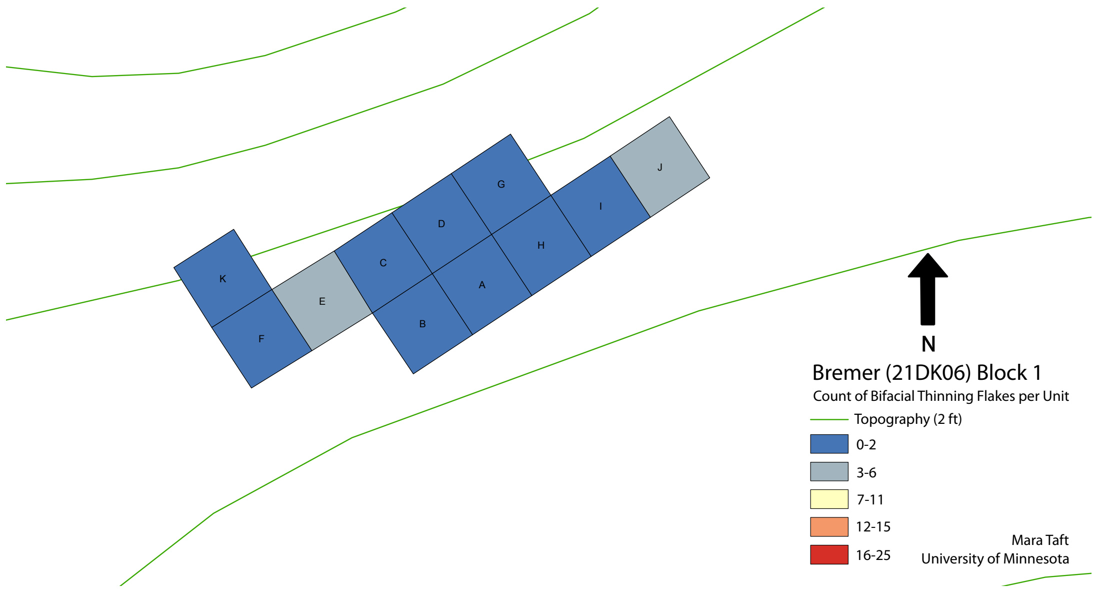

Figure 39. Block 1 Units by Bifacial Thinning Flake Count, Complete and Proximal Flakes Only.

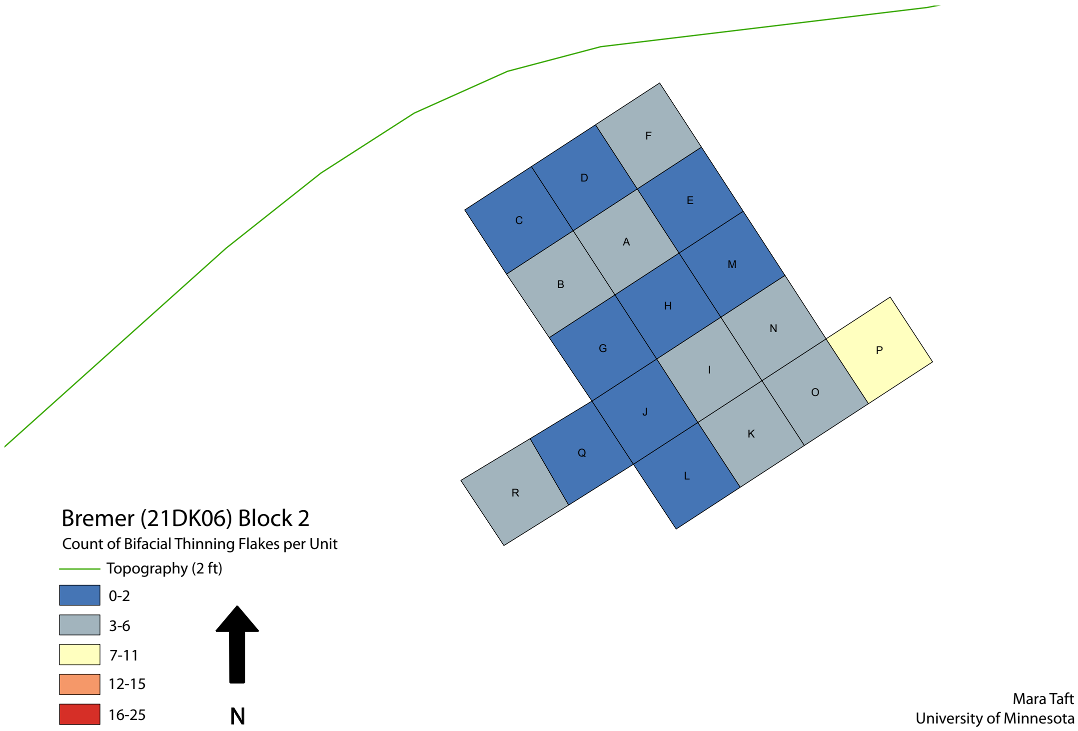

Figure 40. Block 2 Units by Bifacial Thinning Flake Count, Complete and Proximal Flakes Only.

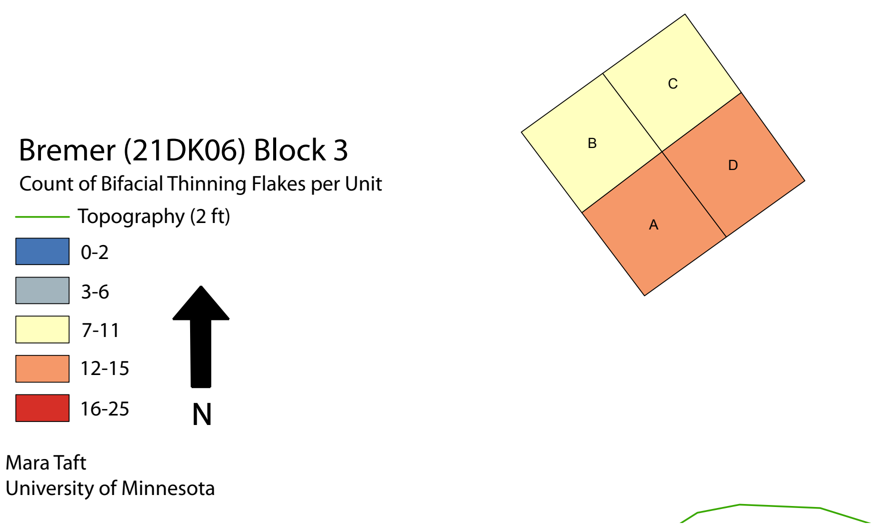

Figure 41. Block 3 Unit by Bifacial Thinning Flake Count, Complete and Proximal Flakes Only.

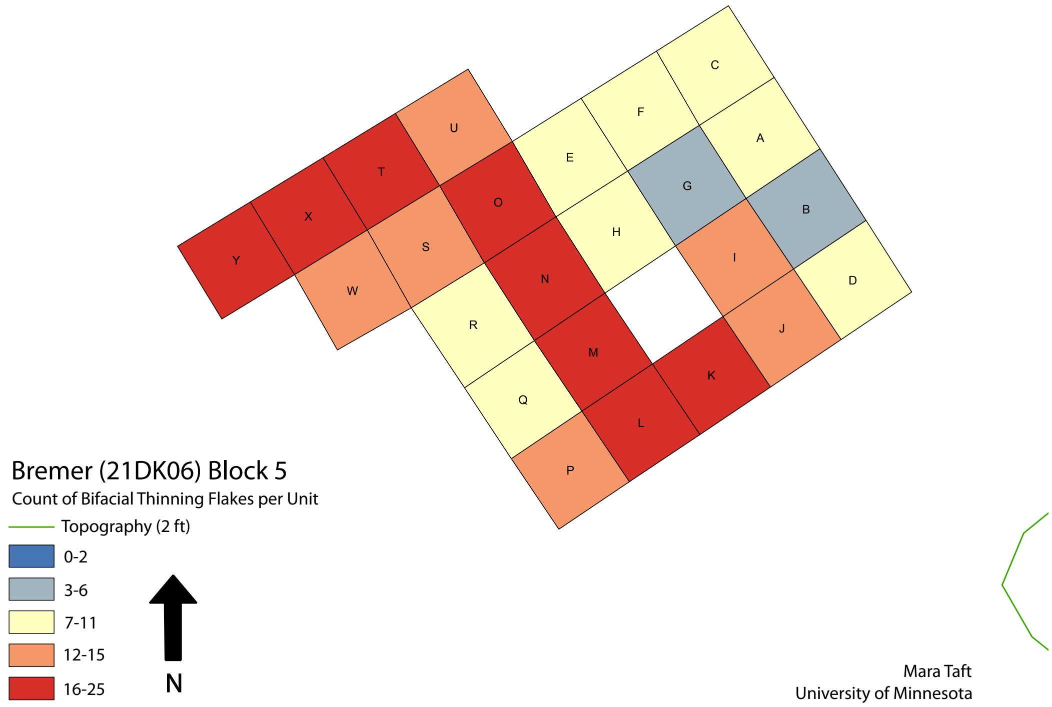

Figure 42. Block 5 Units by Bifacial Thinning Flake Count, Complete and Proximal Flakes Only.

The above maps show the distribution of bifacial thinning flakes (complete and proximal flakes only) throughout the excavation units. It is beneficial to show this distribution because it may help indicate where certain retouch events took place, not just knapping events in general. These results indicate that the Block 2 Prairie du Chien knapping event in units N, O, and P contained some bifacial thinning flakes. Block 3 also had a high amount of bifacial thinning flakes. However, the bifacial thinning flake patterning within Block 5 is interesting. There are bifacial thinning flakes present throughout the entire block, but especially in the northern corner, and throughout the middle of the block. This indicates that the Grand Meadow Chert lithic concentration in the northern corner primarily consists of bifacial thinning flakes, and thus likely represents a Grand Meadow Chert biface or preform being retouched. Although as mentioned above, units W, X, and Y contain part of an excavation unit from 1956, and thus some of this artifact data is disturbed and incomplete.

4.2.3.2 Flakes (Non-Bifacial Thinning Flakes)

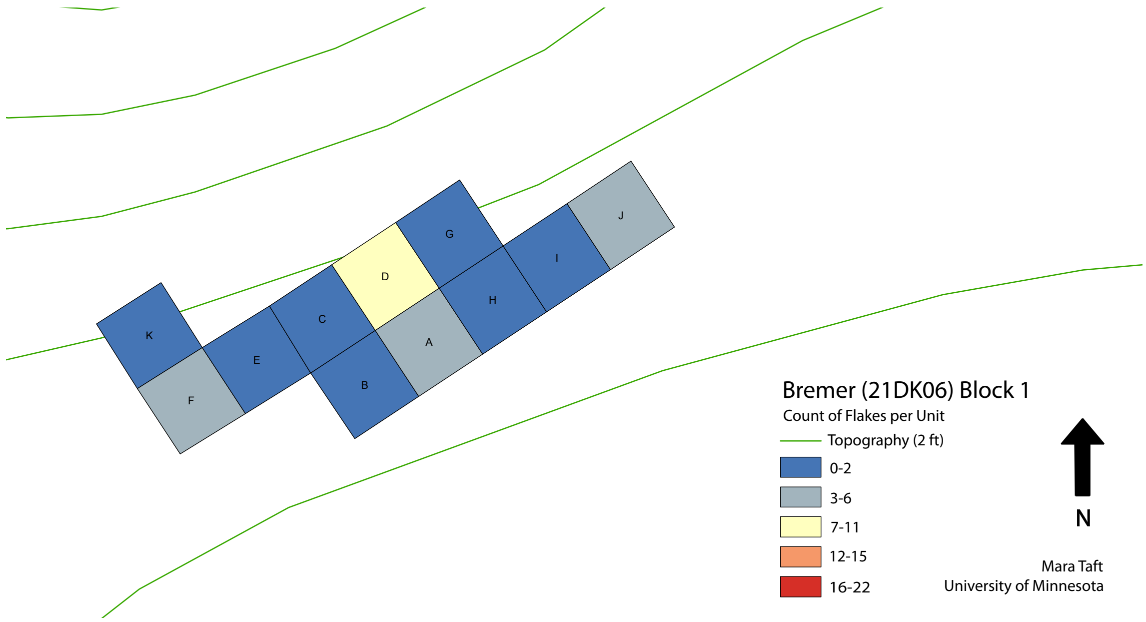

Figure 43. Block 1 Unit by Flake Count, Complete and Proximal Flakes Only.

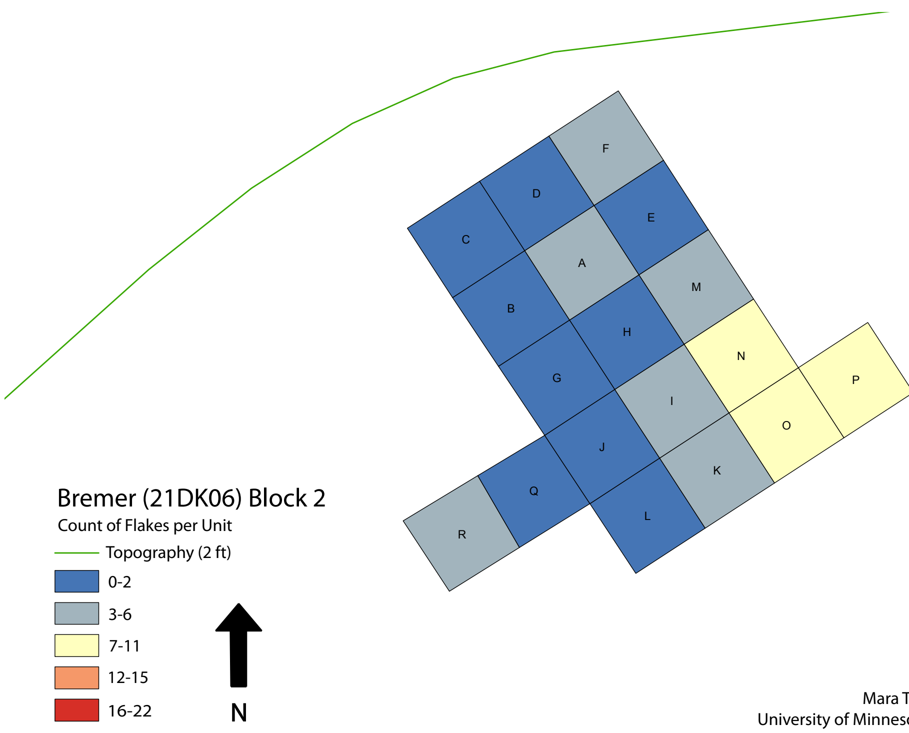

Figure 44. Block 2 Unit by Flake Count, Complete and Proximal Flakes Only.

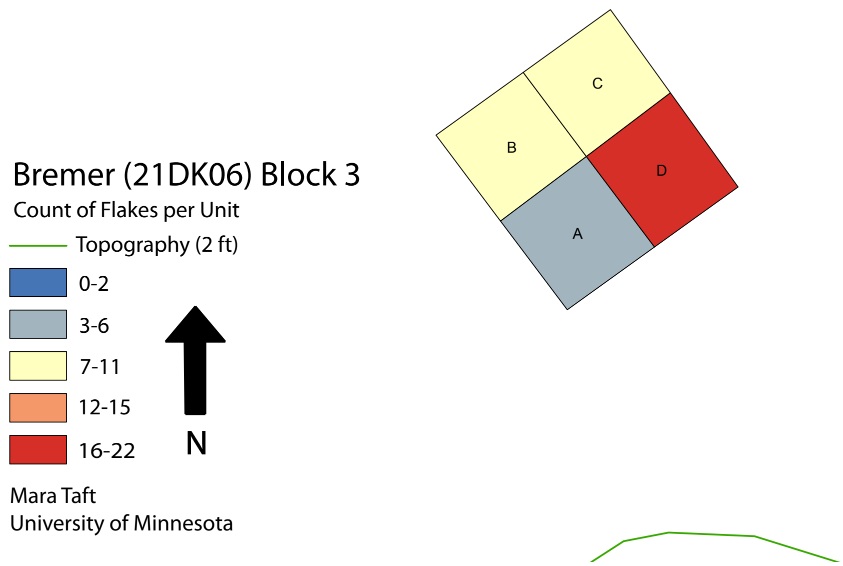

Figure 45. Block 3 Units by Flake Count, Complete and Proximal Flakes Only.

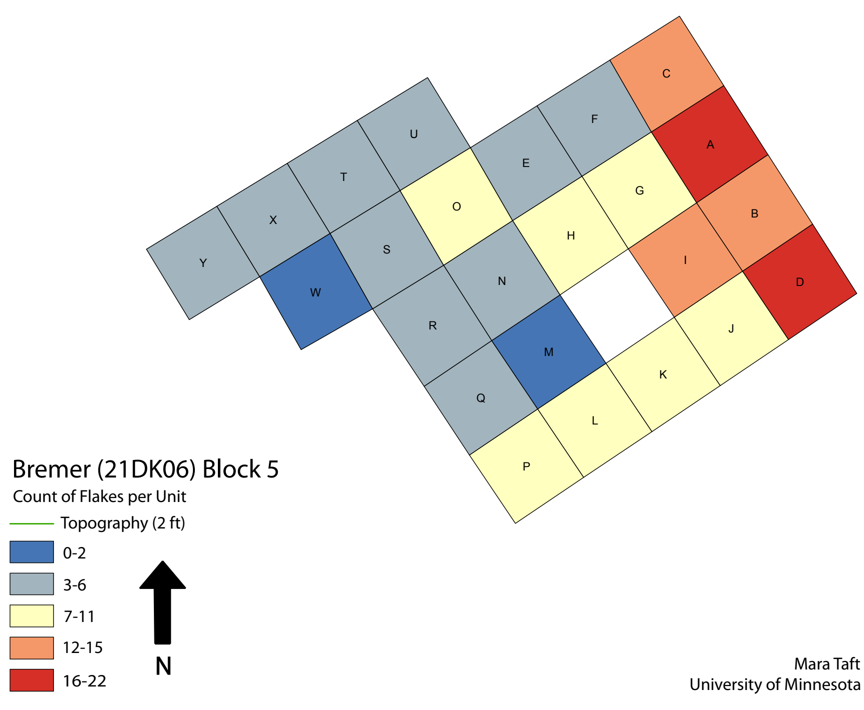

Figure 46. Block 5 by Flake Count, Complete and Proximal Flakes Only.

The above maps indicate the distribution of flakes (non-bifacial thinning flakes) by count across the excavation units. Although Block 1 does not contain many lithic artifacts compared to other blocks, it does have a slightly higher concentration of flakes, indicating that a non-retouch knapping event likely took place there.

The Prairie du Chien knapping event in units N, O, and P of Block 2 has a high concentration of flakes, which extends past the area of bifacial thinning flakes. This indicates that the Prairie du Chien concentration in Block 2 was a knapping event where primary flakes as well as bifacial thinning flakes were produced.

Block 3 contains a high concentration of flakes; however, Block 3 also has a high concentration of bifacial thinning flakes, Prairie du Chien artifacts, and Grand Meadow Chert artifacts. Given the high density of lithic artifacts in Block 3, it is difficult to differentiate the raw material and flake type as one or many knapping events.

Block 5 contains a high concentration of flakes along the southern and eastern sides of the block. This is also the location of the Prairie du Chien concentration, indicating that the Prairie du Chien knapping event (or events) that took place in Block 5 contained both bifacial retouch and primary knapping. However, these two knapping events appear to be spatially separated, with the bifacial retouch event occurring in the highest concentration along the southern edge, and the primary knapping occurring primarily along the eastern edge of the block. There are very few flakes in the northern corner, indicating that the Grand Meadow Chert concentration was a bifacial retouch knapping event. These results support the hypothesis that raw materials were differentially treated at the site, and that this differential treatment is exhibited through the spatial distribution of knapping events.

4.3 Occupation Periods

The Bremer site is a multicomponent habitation site with at least Middle Woodland, Late Woodland, and Oneota components, as well as a possible Archaic component. The vertical distribution of artifacts throughout the site was analyzed in order to determine if specific occupation periods could be identified.

Vertical artifact distribution was analyzed by block and by excavation year for lithic count and weight. Each excavation year was analyzed separately because the datums for each block were placed in a different location each excavation year. The datum could be at slightly different elevation depending on the year, meaning that the depths measured from the datum could vary by year, as well.

While each block was analyzed for lithic count and weight, only Block 1 contained a discernable pattern in occupation periods. Block 1 has documented Middle Woodland and Oneota components, which can be seen through the vertical artifact stratigraphy.

4.3.1 Excavation Block 1:

Block 1	2011 Excavation		2012 Excavation	
Depth (cmbd)	Lithics	Ceramics	Lithics	Ceramics
0-10	2	0	1	0
10-20	6	2	2	0
20-30	11	0	5	0
30-40	12	0	6	8
40-50	8	0	3	4
50-60	4	4	1	3
60-70	9	4	6	2
70-80	6	3	4	2
80-90	2	0	4	0
90-100	3	0	2	0

Table 26. Block 1: Count of Lithic and Ceramic Artifacts by Depth per Excavation Year.

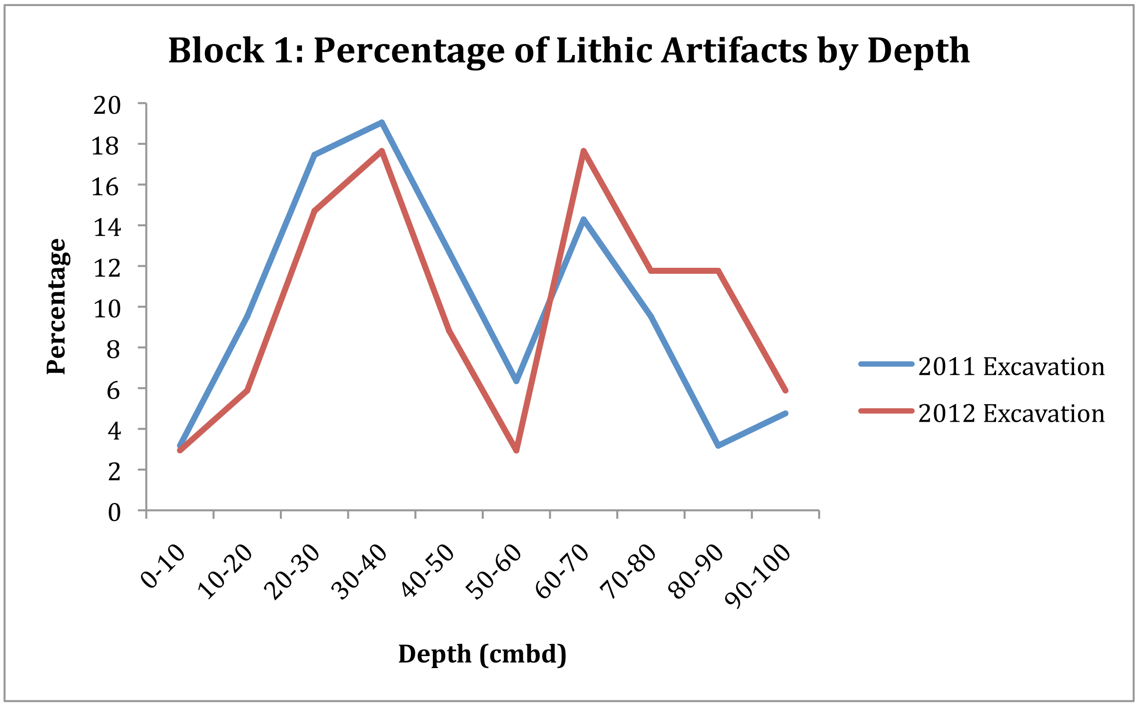

Figure 47. Block 1 Percentage of Lithic Artifacts by Depth, 2011-2012 Excavations.

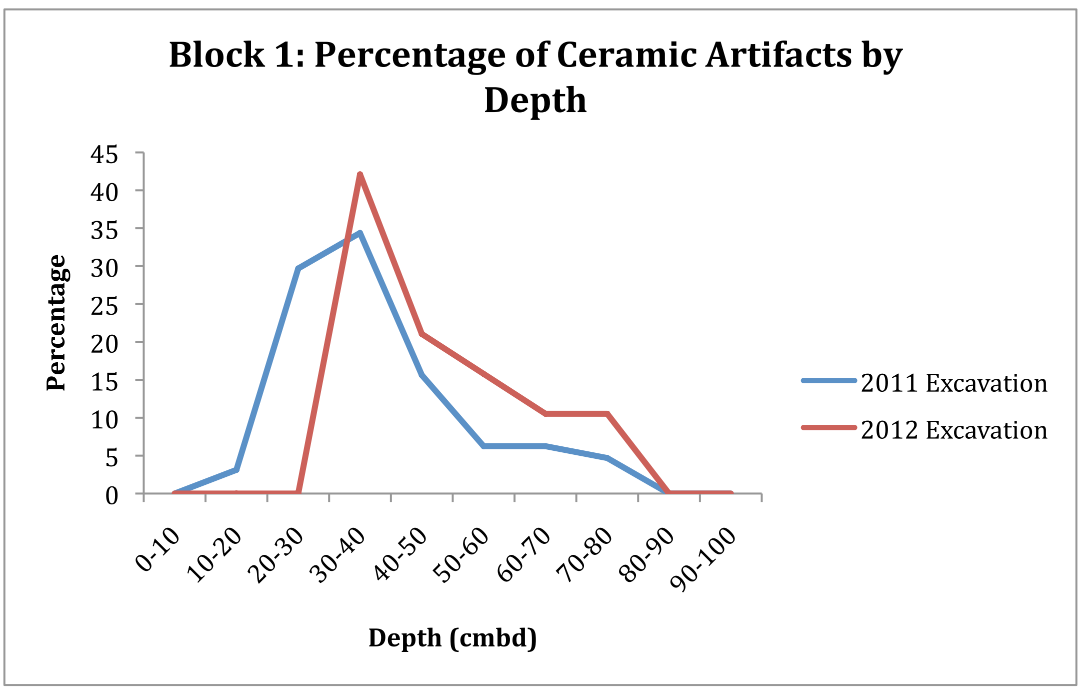

Figure 48. Block 1 Percentage of Ceramic Artifacts by Depth, 2011-2012 Excavations.

Depth (cmbd)	Ceramic Count	Grit Temper	Shell Temper
10-20	2	N/A	N/A
20-30	19	0	19
30-40	30	6	24
40-50	14	7	7
50-60	7	7	0
60-70	6	5	1
70-80	5	5	0
80-90	0	0	0
90-100	0	0	0

Table 27. Block 1: Count of Ceramic Artifacts by Temper Type and Depth.

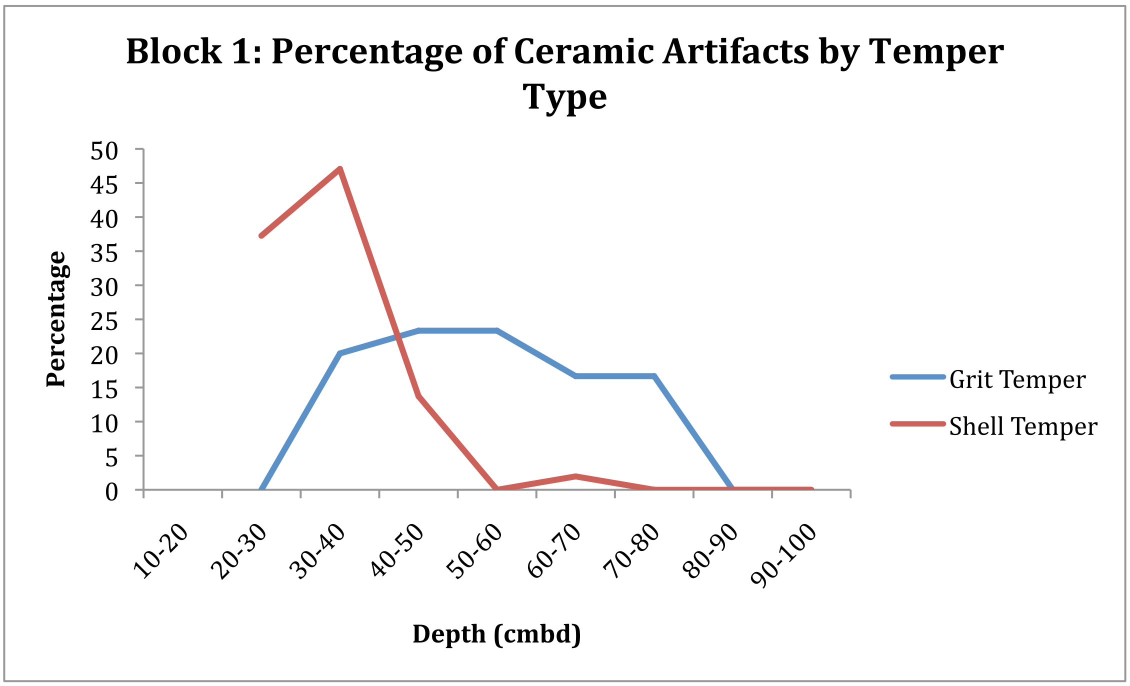

Figure 49. Block 1 Ceramic Tempers by Depth, 2011-2012 Excavations.

Raw Materials	0-50 cmbd	51-100 cmbd
Basalt	2	1
Burlington	5	1
Grand Meadow Chert	2	2
Prairie du Chien	38	23
Quartz	0	4
Tongue River Silica	2	0
Other	2	5
Unknown	5	5
Grand Total	56	41

Table 28. Block 1: Count of Raw Material Types by Cultural Horizon. The "Other" category includes raw materials with a maximum N=1 for both horizons.

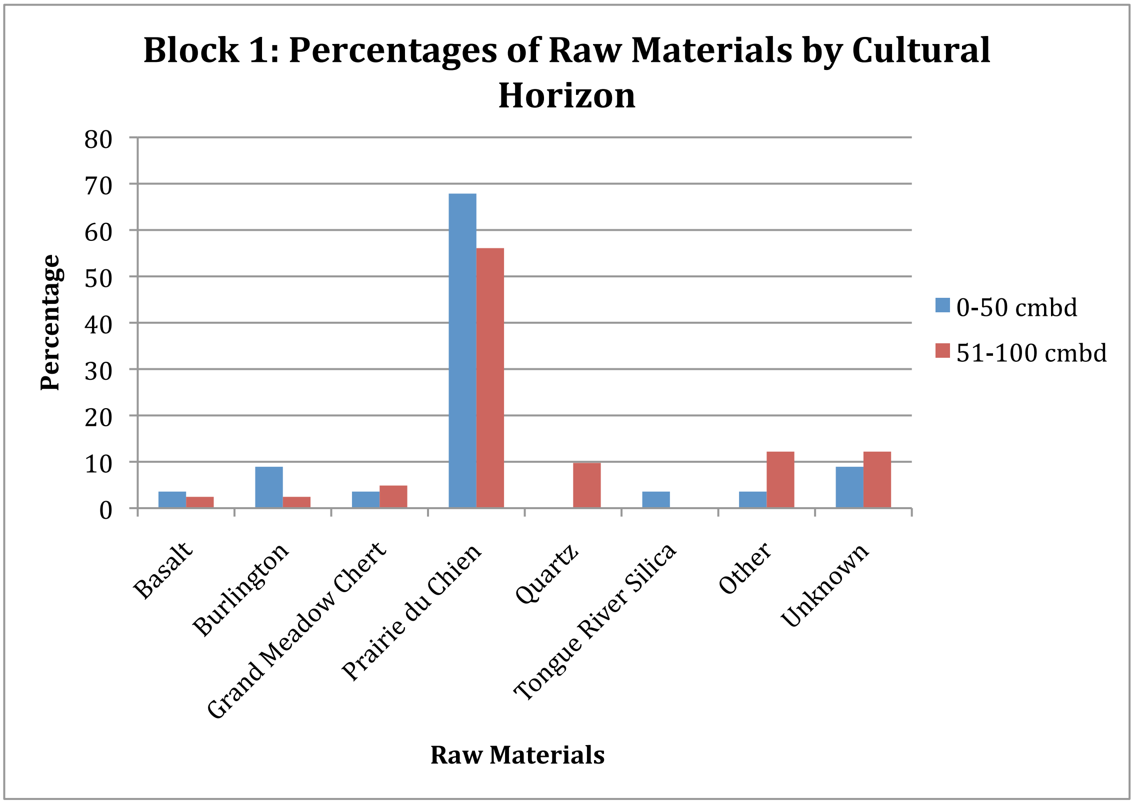

Figure 50. Block 1 Percentage of Raw Material Types by Occupation Level, 2011-2012 Excavation.

Block 1 has two distinctive cultural horizons. The increased number of lithics and ceramics from 0-50 cmbd indicates one horizon, and the increased number of lithics and ceramics from 51-100 cmbd indicates the second. A distinctive decrease in all artifact types in the 50-60 cmbd levels indicates a break between these horizons.

The artifact concentration in the 0-50 cmbd levels is characterized by a high amount of lithic artifacts, of which Prairie du Chien is a dominant raw material type. Other raw materials present in the 0-50 cmbd levels include basalt, Burlington chert, Grand Meadow Chert, and Tongue River Silica. Additionally, there is a high amount of ceramic artifacts, of which a vast majority are shell-tempered, although there are grit-tempered pottery sherds present as well. These artifacts indicate that the 0-50 cmbd levels represent an Oneota occupation.

The artifact concentration in the 51-100 cmbd level is characterized by a high amount of lithic artifacts, including Prairie du Chien, Basalt, Burlington, Grand Meadow Chert, and Quartz raw material types. Overall, there are far less non-local (Burlington) raw material types in the lower occupation level than the upper. This perhaps indicates fewer trade opportunities at that time period in the region, or a smaller subsistence territory. There are far fewer ceramic sherds in the lower horizon than in than the upper, and all of these are grit-tempered. These artifacts indicate that within Block 1, the 51-100 cmbd level represents a Middle Woodland occupation.

Other excavation blocks were also analyzed for artifact count and weight by level between excavation years. However, Block 1 was the only one with a discernable pattern of distinguishable cultural horizons.

4.3.2 Excavation Block 2:

Block 2	2011 Excavation		2012 Excavation		2013 Excavation		2014 Excavation	
Depth	Lithics	Ceramics	Lithics	Ceramics	Lithics	Ceramics	Lithics	Ceramics
0-10	20	30	8	5	12	6	0	0
10-20	30	37	25	38	31	26	2	1
20-30	16	14	25	44	56	18	7	9
30-40	6	4	16	18	33	0	5	3
40-50	4	2	5	5	2	0	0	3
50-60	0	0	0	4	0	0	2	0
60-70	N/E	N/E	N/E	N/E	N/E	N/E	0	0
70-80	N/E	N/E	N/E	N/E	N/E	N/E	0	0
80-90	N/E	N/E	N/E	N/E	N/E	N/E	N/E	N/E
90-100	N/E	N/E	N/E	N/E	N/E	N/E	N/E	N/E

Table 29. Block 2: Count of Lithic and Ceramic Artifacts by Depth per Excavation Year. N/E indicates levels which were not excavated.

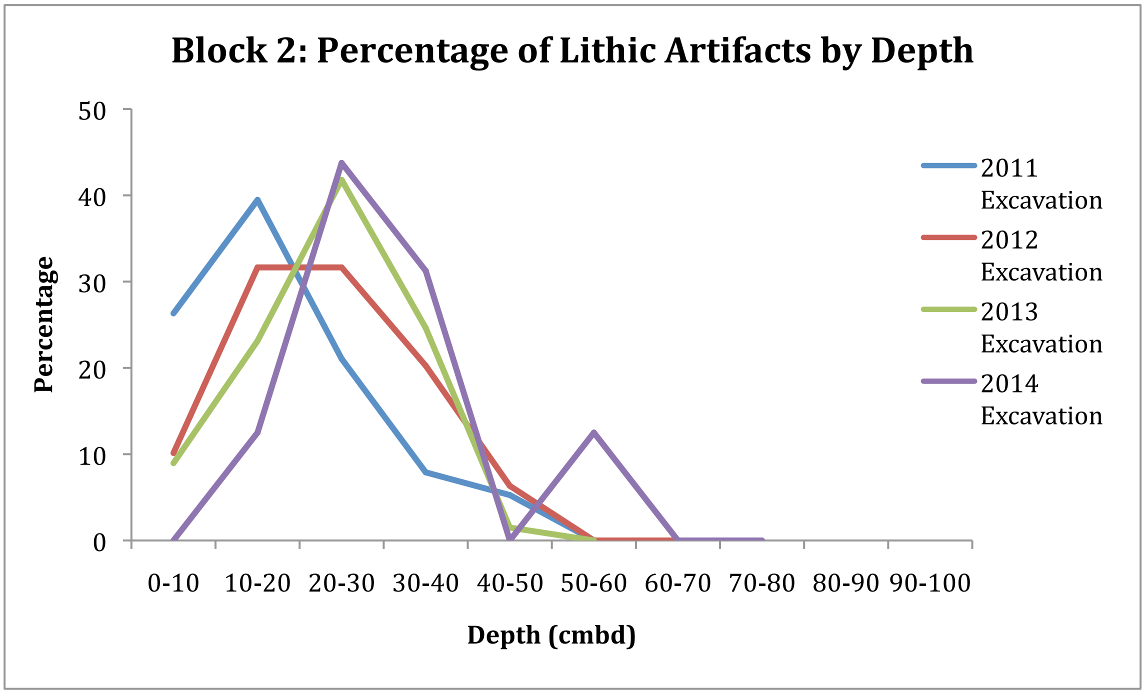

Figure 51. Block 2 Percentage of Lithic Artifacts by Depth, 2011-2014 Excavations.

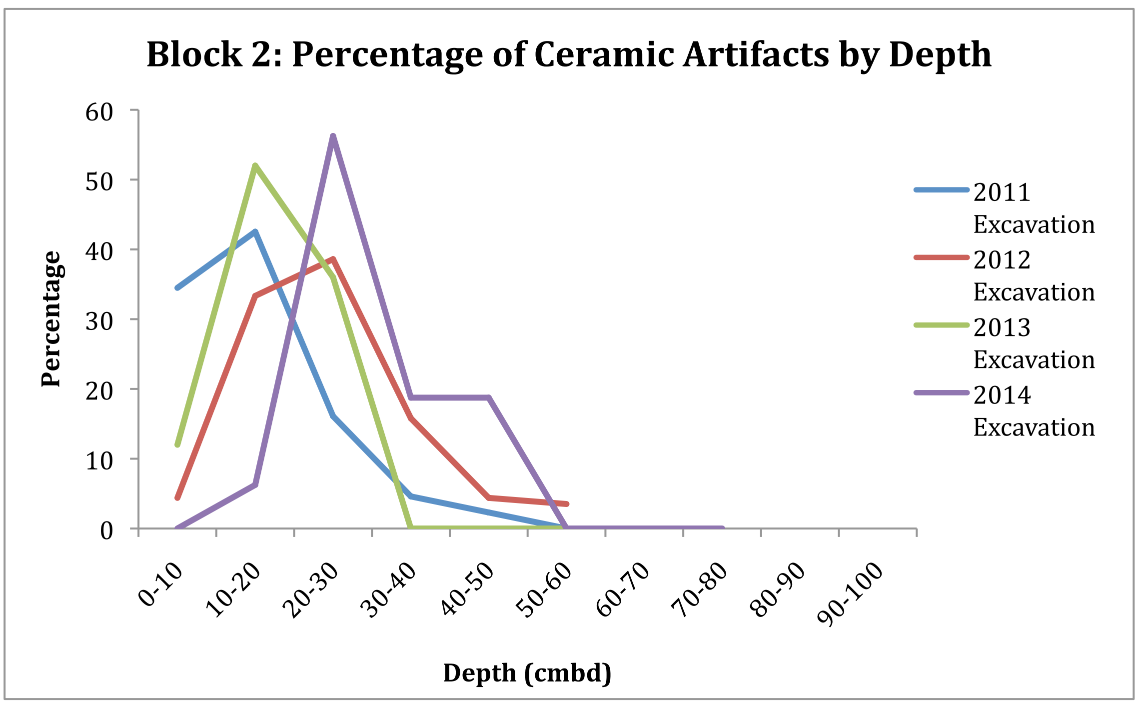

Figure 52. Block 2 Percentage of Ceramic Artifacts by Depth, 2011-2014 Excavations.

The vertical artifact distribution of Block 2 indicates that both lithic and ceramic artifacts were present from the surface through 60 cmbd, with a high concentration between 20 through 40 cmbd. The artifact distribution does not indicate the presence of two separate cultural horizons. Block 2 has produced Late Woodland features and diagnostic artifacts, such as grit-tempered, Madison Plain variety ceramics (Fleming 2012b:3, 2013:2).

4.3.3 Excavation Block 3:

Block 3	2011 Excavation	
Depth	Lithics	Ceramics
0-10	18	4
10-20	42	12
20-30	94	7
30-40	27	3
40-50	3	0
50-60	N/E	N/E
60-70	N/E	N/E
70-80	N/E	N/E
80-90	N/E	N/E
90-100	N/E	N/E

Table 30. Block 3: Count of Lithic and Ceramic Artifacts by Depth per Excavation Year. N/E indicates levels which were not excavated.

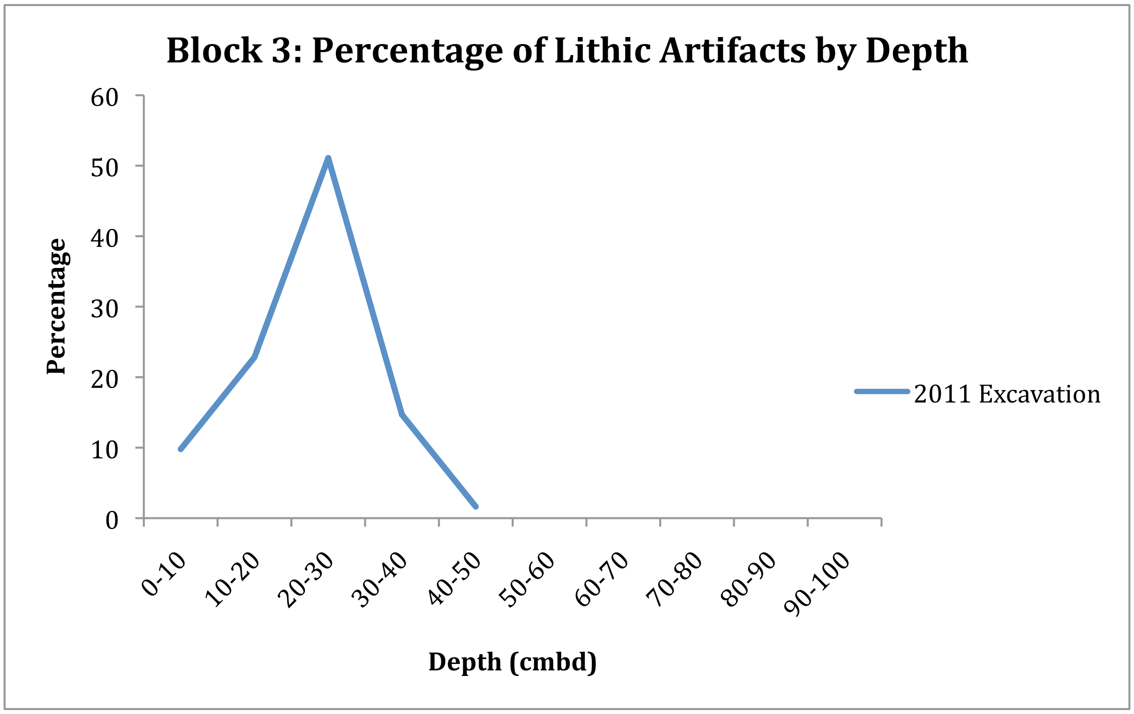

Figure 53. Block 3 Percentage of Lithic Artifacts by Depth, 2011 Excavation.

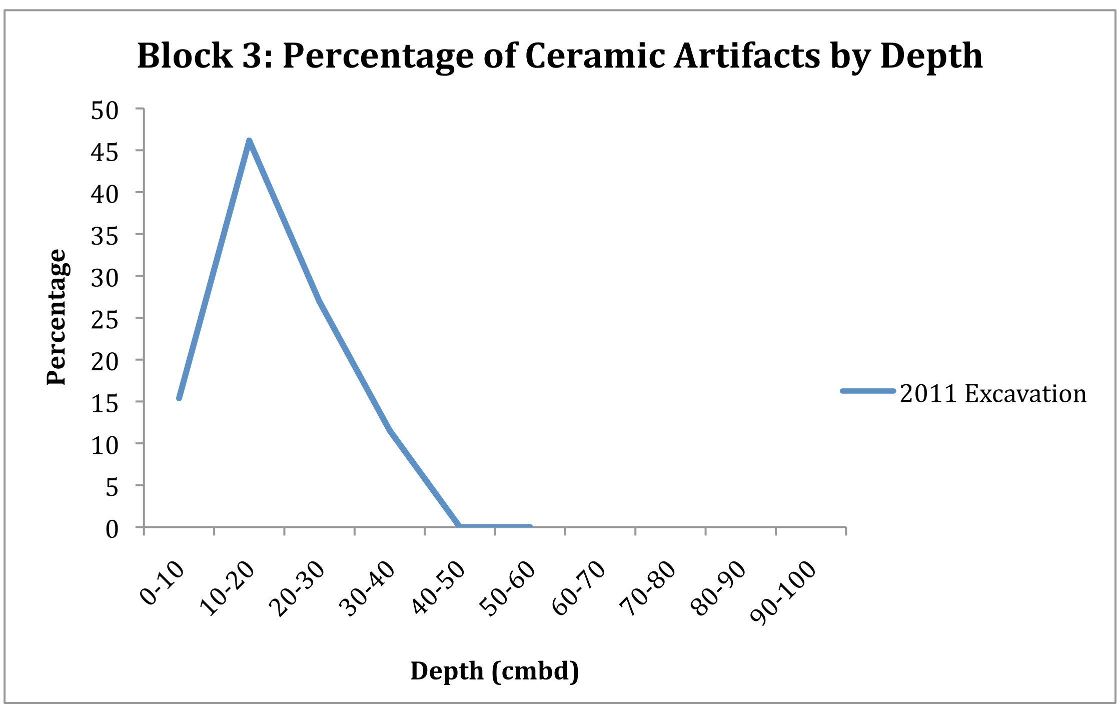

Figure 54. Block 3 Percentage of Ceramic Artifacts by Depth, 2011 Excavation.

The stratigraphic artifact distribution of Block 3 indicates the presence of lithic and ceramic artifacts from the surface through 50 cmbd, with a high concentration of artifacts between 10 through 30 cmbd. The artifact distribution does not indicate distinctive cultural horizons. Block 3 likely also represents a Late Woodland occupation, due to the presence of Late Woodland grit-tempered ceramics (Fleming 2012a: 3).

An in-depth analysis of the Block 4 artifact distribution is not included, due to the low amount of artifacts (N=4).

4.3.4 Excavation Block 5:

Block 5	2012 Excavation		2013 Excavation		2014 Excavation	
Depth	Lithics	Ceramics	Lithics	Ceramics	Lithics	Ceramics
0-10	16	2	253	105	5	0
10-20	39	16	228	186	27	8
20-30	66	34	177	108	38	13
30-40	47	17	119	68	23	12
40-50	22	4	53	25	13	9
50-60	6	0	4	2	16	1
60-70	3	1	4	0	8	0
70-80	N/E	N/E	N/E	N/E	3	0
80-90	N/E	N/E	N/E	N/E	N/E	N/E
90-100	N/E	N/E	N/E	N/E	N/E	N/E

Table 31. Block 5: Count of Lithic and Ceramic Artifacts by Depth per Excavation Year. N/E indicates levels which were not excavated.

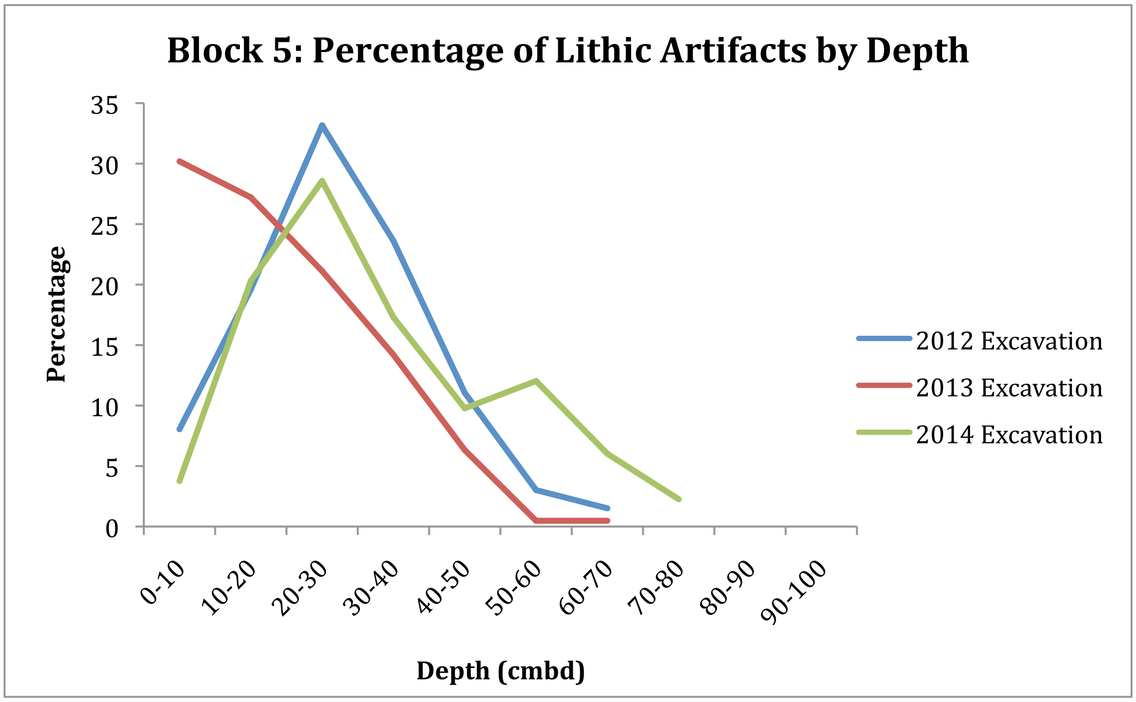

Figure 55. Block 5 Percentage of Lithic Artifacts by Depth, 2012-2014 Excavation.

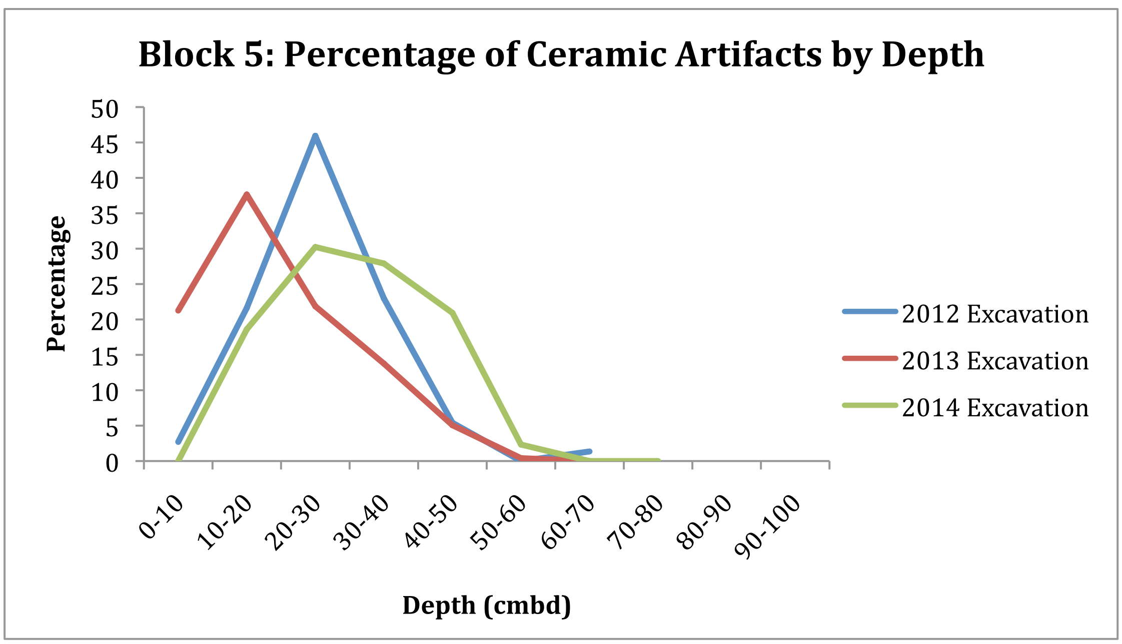

Figure 56. Block 5 Percentage of Ceramic Artifacts by Depth, 2012-2014 Excavation.

An analysis of the Block 5 stratigraphic artifact distribution reveals that lithic and ceramic artifacts were present from the surface through the end of the excavation at 70 and 80 cmbd. As with Blocks 2 and 3, there is a high concentration of artifacts between 10 through 40 cmbd, but no separate cultural horizons as in Block 1. The artifacts present include Late Woodland ceramics, such as Bremer Triangular Punctated and Nininger Cord-wrapped Stick Impressed, as well as sherds from a Middle Woodland, Sorg Banded Dentate vessel (Fleming 2013:2). Projectile points recovered from Block 5 include Kramer, Waubesa, Long Island, and Madison varieties, indicating that Block 5 may have been multicomponent (Fleming 2013:2; Morrow 1984).

CHAPTER 5. CONCLUSIONS AND FUTURE STUDIES

The Bremer site is a multicomponent habitation site in southeastern Minnesota situated along Spring Lake and the Mississippi River. Spring Lake has been occupied continuously since the Archaic period, and there have been many archaeological sites recorded along its shores. The chronological history and widespread use of the Spring Lake area confirms how important and advantageous this region was for people in the past.

The objective of this study was to complete a lithic and spatial analysis of the Bremer site. These analyses were performed in order to more fully understand the lithic activities which took place at the Bremer site, the raw material utilization at the site, where these activities occurred, and what implications these findings might have for our understanding of the inhabitants of the site.

These questions were addressed by many different analyses. A comprehensive chipping debris analysis was completed with the goal of demonstrating the utility of such an in-depth analysis at a Minnesotan archaeological site. Additionally, a reproducible raw material identification methodology was utilized in order to integrate a more inclusive understanding of lithic raw materials into Minnesota archaeology. A spatial analysis of the artifact distribution was completed in order to understand the large lithic assemblage within the context of the entire site, and to identify activity areas across the site.

The lithic analysis included an in-depth raw material analysis which involved collecting data on the color, pattern, luster, translucency, and texture of each artifact in order to more accurately and reproducibly identify the raw material type, as well as understand the variation of lithic raw materials. This methodology proved to be very useful for later interpretations and analyses, although it was more time consuming than traditional raw material identification methods. On average, each flake took three minutes to analyze, and the analysis of the entire collection took approximately 85 hours to complete. Spending extra time measuring different attributes of each raw material and using the Minnesota Historical Society comparative collection database had many advantages, including the knowledge gained of variation within and between Minnesota raw material types, the use of a reproducible methodology for raw material identification, and the benefit of using a database to cross-check identifications, not to mention the possibility for future research focusing on raw material attribute variations.

The results of the chipping debris analysis demonstrate the differential use of raw materials by locality and quality at the Bremer site. Locally available Prairie du Chien chert was the primary material used at the site, yet non-local materials had a large presence there, as well. Non-local materials included Burlington and Hixton Silicified Sandstone, which were likely curated onto the site as preforms or bifaces, and retouched on the site before being curated off site. However, Grand Meadow Chert was likely available on a more local scale through trade or a widespread subsistence range by the site inhabitants. Non-Local (Till) materials were locally available at the Bremer site, yet make up a relatively small portion of the assemblage, indicating that they were not preferred over other available materials. Additionally, materials were preferentially chosen based on quality and texture. Materials of a higher quality were more often represented as bifacial thinning flakes, while materials of a poorer quality were more often represented as normal flakes. This indicates a non-random selection of materials based on quality for bifacial tool creation.

Two distinctive cultural horizons were identified through the vertical stratigraphy of artifacts within Block 1. By analyzing count, mass, and artifact type by depth of the Block 1 assemblage, a Middle Woodland and Oneota component were identified. There are observable differentiations in raw material availability or use between these two temporal and cultural components. These results indicate cultural differences through time represented in the lithic artifacts and an increase in trade and cultural contact over time at the same site.

The horizontal artifact distributions and activity areas at the site were identified through a spatial analysis of the site. This established a visual means of identifying areas of the site with high and low lithic concentrations, suggesting higher and lower use areas. This analysis also indicated a division of knapping events by raw material type and by artifact type over space.

The Bremer site was used throughout pre-contact periods by hunting and gathering groups due to its advantageous location next to a marsh and a large riverway.

The analyses completed in this thesis indicate that areas of the site were used differentially for creating and resharpening tools of various raw materials. The presence of both local and non-local raw materials indicates that while site inhabitants primarily utilized local resources, they were also connected to groups throughout the region, likely through trade. These studies and results increase our knowledge of the inhabitants of the Bremer site, their lifeways and site occupation, and their relationship to the larger region in which they lived. Additionally, the lithic and raw material methodologies used above allow for further research and understanding of new archaeological questions which may increase our understanding of the peoples of southeastern Minnesota and their ways of life.

Future Studies

This research and data may be expanded in many different directions in order to further increase our knowledge of the Bremer site, its inhabitants, and their role in the Spring Lake area, as well as raw material use patterns within Minnesota.

Raw Material Analysis

The raw material attribute data collected for each flake may be used to analyze the visual variability within and between Minnesota raw material types. Raw material attributes recorded include color, texture, color pattern, luster, translucency, and raw material type. The successful use of this methodology may serve as a model for future studies which hope to visually identify lithic raw materials. Data recorded for each of these variables may help further our understanding of lithic raw material availability and variability in southeastern Minnesota.

It would be especially helpful to analyze the variability of color within Minnesota raw materials and the degree to which color changes upon heat treatment for each raw material type. This would be extraordinarily helpful for future archaeologists in identifying heat treatment of raw materials, whose effects can be extremely variable by raw material type and temperature.

The Bremer Site

There are many other analyses which may be done with this data assemblage in order to more fully understand the Bremer site. Analyzing the spatial distribution of heat treatment of lithic debitage compared to known burn features at the site could indicate lithic heat treatment areas. The addition of other artifact data, such as ceramic and phytolith data, to the GIS would greatly increase our understanding of site activities and activity areas spatially throughout the site.

Spring Lake: The Broader Context

It would be extremely interesting and beneficial to expand this study, including the methodology used, to analyze the other sites in the Spring Lake area. Examining comparable assemblages from sites within close proximity would greatly increase our understanding of how these sites relate to each other, how raw material and lithic artifacts vary between sites, and how that variability may change through time.

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