Appendix 5: Final Report on Soil Chemistry Analysis of Wingo's Quarter Site, Bedford County, Virginia *(Andrew Wilkins)*

Final Report on Soil Chemistry Analysis of Wingo's Quarter Site, Bedford County, Virginia.

By

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Prepared for

Engaging the Piedmont, Transitions in Virginia Slavery 1730-1790

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1. Introduction

This report summarizes the findings of chemical analysis performed on soils from Wingo's Quarter site (44BE0298), located in eastern Bedford County, Virginia, approximately 10 miles south-southwest of the city of Lynchburg and the James River (Figure 1). The site was the residence of enslaved African Americans and their overseer, John Wingo, for whom the quarter farm was named during its time as part of Thomas Jefferson's larger Poplar Forest property from 1773 to 1790. This analysis is part of *Engaging the Piedmont, Transitions in Virginia Slavery 1730-1790*, a multi-year, collaborative, interdisciplinary archaeological research project funded by a grant from the National Endowment for the Humanities that compares the material world of quarter sites at the Indian Camp plantation in modern Powhatan County with the Wingo's and North Hill quarters at Poplar Forest in Bedford County.

At Wingo's, questions about the site concerning building orientation, entrance locations, and the layout of activity areas remain due to the lack structural features other than sub-floor pits. Soil chemical distributions have been measured and interpreted on many Mid-Atlantic historic sites (Keeler 1973; Stone et al 1987; Pogue 1988; Neiman et al 2000; Heath and Bennett 2000; Fischer 2001) to address the very kind of site layout and activity areas questions that are now posed for Wingo's. Soil samples taken during excavations at Wingo's were analyzed for phosphorus (P), calcium (Ca), potassium (K), and magnesium (Mg). Spatial and statistical distributions of those elements sampled systematically from plowzone, subsoil, and feature contexts readings can be used to identify the deposition of organic refuse (P), bone (Ca), and ash (K) in order to infer aspects of the site's layout. Enhanced understanding of the spatial patterns of occupation and activity at Wingo's, gained through soil chemical analysis, can be used to augment other analyses of artifacts and ecofacts, as well as address comparative questions about landscape use at Wingo's, the North Hill, and Indian Camp quarter sites.

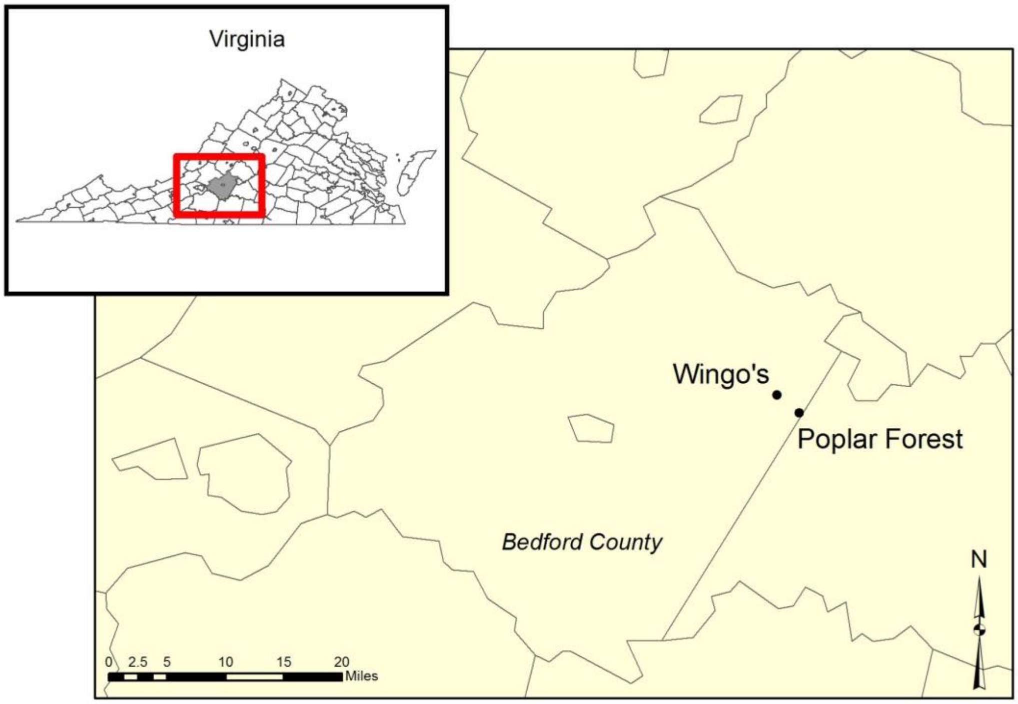

Figure 1: Map showing location of Wingo's site, created by Crystal Ptacek

A preliminary report was created summarizing the soil chemical analyses of 68 samples from plowzone (n = 49) and subsoil (n = 19) contexts taken during excavations in the summers of 2007, 2008, and 2009 (Wilkins 2011). These findings were used in concert with artifact distributions in order to form preliminary interpretations about the use of space in and around the quarter structure as well as to guide continuing excavations conducted in the 2011 and 2012 summer field seasons, during which an additional 118 plowzone and 55 subsoil samples were collected. Forty-three soil samples from feature contexts were also collected during across the 2007, 2009, 2011, and 2012. Fieldwork on the site was completed in the summer of 2012, and the results included in this report are inclusive of all 284 samples taken across five seasons of excavations.

2. Site Background

Thomas Jefferson inherited the tracts of land in Bedford County that would eventually become Poplar Forest and contain the site of Wingo's quarter after the death of his father-in-law in 1773. By1774, 15 enslaved African Americans, 10 adults and five children, were in residence. During his ownership, Jefferson was a mostly absentee owner of Poplar Forest, and a white overseer named John Wingo managed the farm quarter for four years, likely being replaced by another overseer or enslaved "headman" until 1790 when the plantation and slaves were passed to Jefferson's descendants. The property was sold out of the Jefferson family by 1811, though Wingo's may have been abandoned as early as the 1790s (Heath 2012).

With the aid of historic maps, staff from Thomas Jefferson's Poplar Forest undertook short-term survey projects in 2000 and 2001 in the southern portion of a field alongside Wolf

Branch. These surveys located a concentration of wrought nails and a small scatter of domestic artifacts dating to the second half of the 18th century. Beginning in 2007, a field school under the direction of Dr. Barbara Heath from the University of Tennessee, Knoxville conducted research over the course of subsequent summers. Excavation at the site has included a combination of small 2 ft. square quadrats placed at 50, 25 and 12.5 ft. intervals, and larger block excavations consisting of contiguous 5 × 5ft. quadrats. Two subfloor pits separated by a distance of less than five feet were located in the northeastern block excavation. These features are the only structural remains of a cabin with overall dimensions of at least 18 ft. east-west by 10.5 ft. north-south (Heath 2012).

Wingo's is a rare archaeological example of an 18th-century piedmont Virginia quarter farm, with a relatively brief occupation. Its location was likely determined by cultural assumptions of what was needed for high-yield agricultural production and efficiency: proximity to prime land for crop production, ready access to water, and nearby transportation routes (Lukezic 1990; Heath 2012). However, the enslaved people who resided there organized and utilized the domestic outdoor spaces around the cabin (Heath 2012; Wilkins et al. 2012). A close examination of the micro-landscape of the quarter adds to the small but growing body of research into house yards and domestic compounds of enslaved individuals and families that has emerged in the archaeological literature over the last twenty years involving methodological questions of how to understand landscapes characterized by low artifact densities and ephemeral architectural and landscape features, further obscured by post-occupational plowing (Heath and Bennett 2000; Fischer 2001; Wilkins 2009; Bon-Harper and Devlin 2012).

The structure at Wingo's was aligned east-west along the edge of a break in elevation. To the north, east, and west, the ground slopes less than 2%, while to the south, a more pronounced

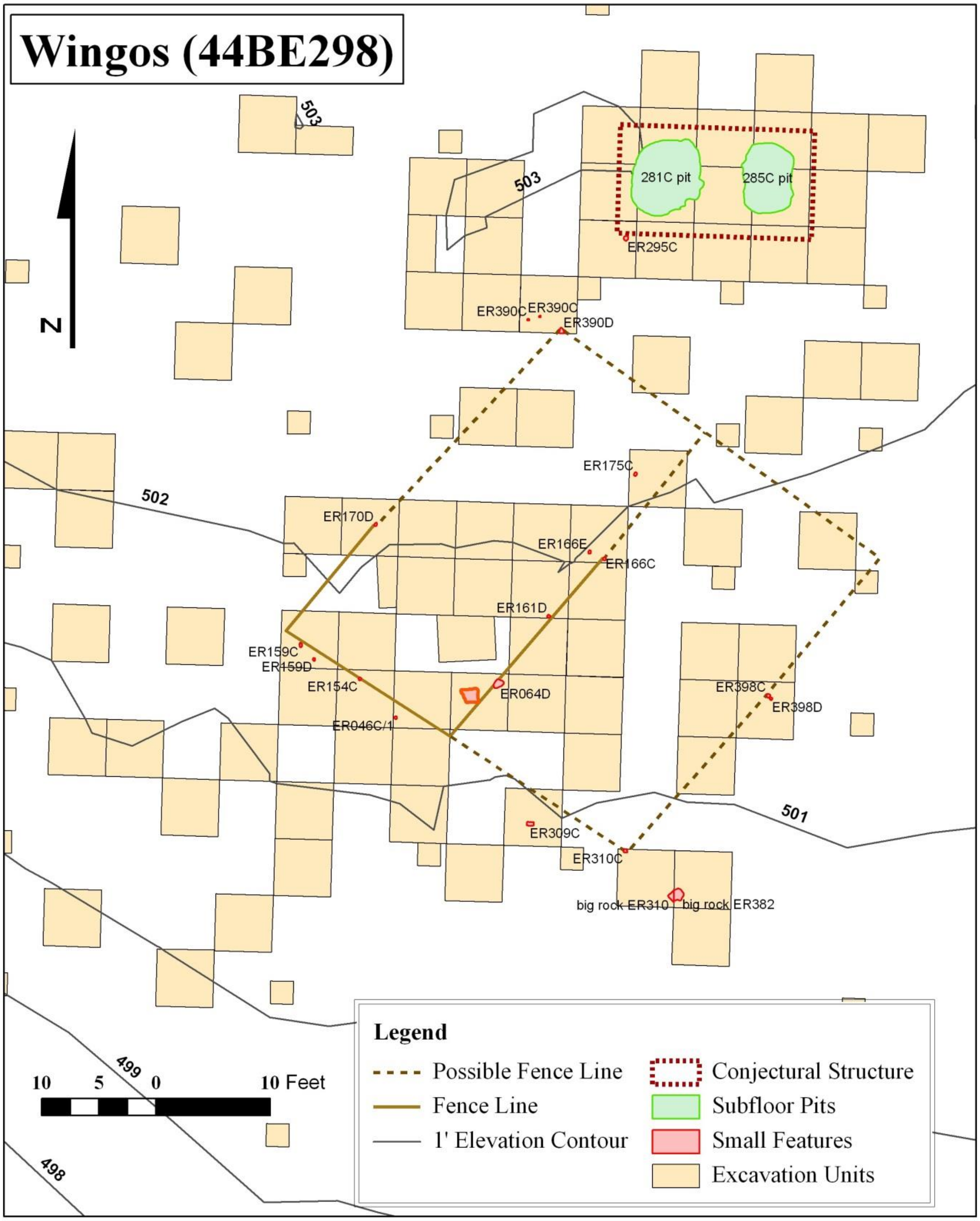

Figure 2: Plan map of Wingo's Site showing location of features and conjectural structures.

5-10% slope leads to the spring at the base of the hill. Extensive testing north of the cabin failed to produce historic artifacts (Heath 2012). In the block excavation south of the cabin, excavations uncovered several small circular stake holes and a larger post-hole that outline an informal enclosure measuring approximately 17 × 36 ft. A small rectangular post-hole and an additional stake holes were found aligned and to the east of the southern line of the enclosure, and may represent an eastern extension of roughly equal size. As indicated in Figure 2, the southern end of the western enclosure is outlined best by observed stake hole features, and the other dimension and conjectural fence lines are the less well-supported, and should be viewed as educated postulation based on a few isolated stake holes, artifacts, and soil chemical distributions discussed below.

Previous research has shown that soil conditions and recent human activities can affect soil chemical levels on archaeological sites (Skinner 1982; Mohler 2000; Holliday and Gartner 2007). The *Soil Survey of Bedford County, Virginia* (McDaniel et al. 1989) provides detailed maps of soil types across the county that shows the entirety of Wingo's in an area characterized as Cullen loam, 2% - 7% slopes (Table 1). This type of soil is a thermic, Typic Hapludult derived from weathered hornblende gneiss sediments and is found on ridge-top fields and woodlands terraces of the Piedmont uplands (McDaniel et al. 1989). Natural organic content is low (1-3%), and Cullen loam exhibits acidic (5-6) pH levels, no flooding, moderate water permeability, and a fairly high amount of clay (25-50%) in surface layers (McDaniel et al. 1989). The soil's taxonomic nomenclature of the Typic Hapludult subgroup classifies a large extent of soils in the southeastern United States that are moderately deep, well drained, with low amounts of organic humus, and have significant agrillic, or clayey, subsurface horizons (United States Department of Agriculture [USDA] 1999). The descriptor 'thermic' describes the annual soil temperature ranges between 15°-22°C, or 59°-72°F (USDA 1999:112). Many studies note that several elements of archaeological interest, notably phosphorus, are stable in all but neutral pH soils, are resistant to leaching in well drained soils, and fix well in all but very sandy soils (Cook and Heizer 1965:13; Sjoberg 1976:448; Holliday and Gartner 2007:305). In short, the Cullen loam matrix of Wingo's should retain at least some anthropogenic soil chemicals, which should, in theory, stand out against the relatively low background levels derived from small amounts of natural organic matter.

Table 1: Typical Profile of Cullen loam 2-7% percent slopes in woodland, Bedford County, Virginia (soil descriptions from McDaniel et al. 1989: 114)

Stratum	Depth	Soil Characteristics
Ap (plowzone)	0 – 5”	reddish brown (5YR 4/4) loam (15-27% clay); moderate to fine granular structure; slightly hard; fine to coarse roots; 10% quartz and hornblende gneiss gravel; strongly acid; abrupt boundary
Bt (subsoils)	5 – 62”	dark red (2.5YR 3/6) clay or clay loam (35-70% clay); medium subangular blocky structure; few roots; 0-5% quartz gravel; 2-45% weathered hornblende gneiss gravel; strongly to moderately acid; gradual boundary
C (substratum)	63”+	strong brown (7.5YR 5/8) saprolite of hornblende gneiss, crushes to clay loam (20-50% clay); 2% quartz gravel; moderately acid

3. Methods

a. Sampling

During the excavation of both 2 × 2 ft. and 5 × 5 ft. quadrats in the 2007, 2008, 2009, 2011, and 2012 field seasons, 235 soil samples were collected in 6 × 8 in. plastic bags using hand tools from plow zone, subsoil, and feature contexts. Most the sampled contexts were located around the core of the site, around the subfloor pits and just to the south (Figure 3). However, 70 samples (35 each from plow zone and subsoil contexts) were taken from 2 × 2 ft. quadrats in 2011 located approximately 80 – 160 ft. north and 120 – 200 ft. east of the main excavations blocks around the structure (Figure 4). These areas were tested in order to determine the spatial extent of the site, though no further concentrations of artifacts of chemicals were found.

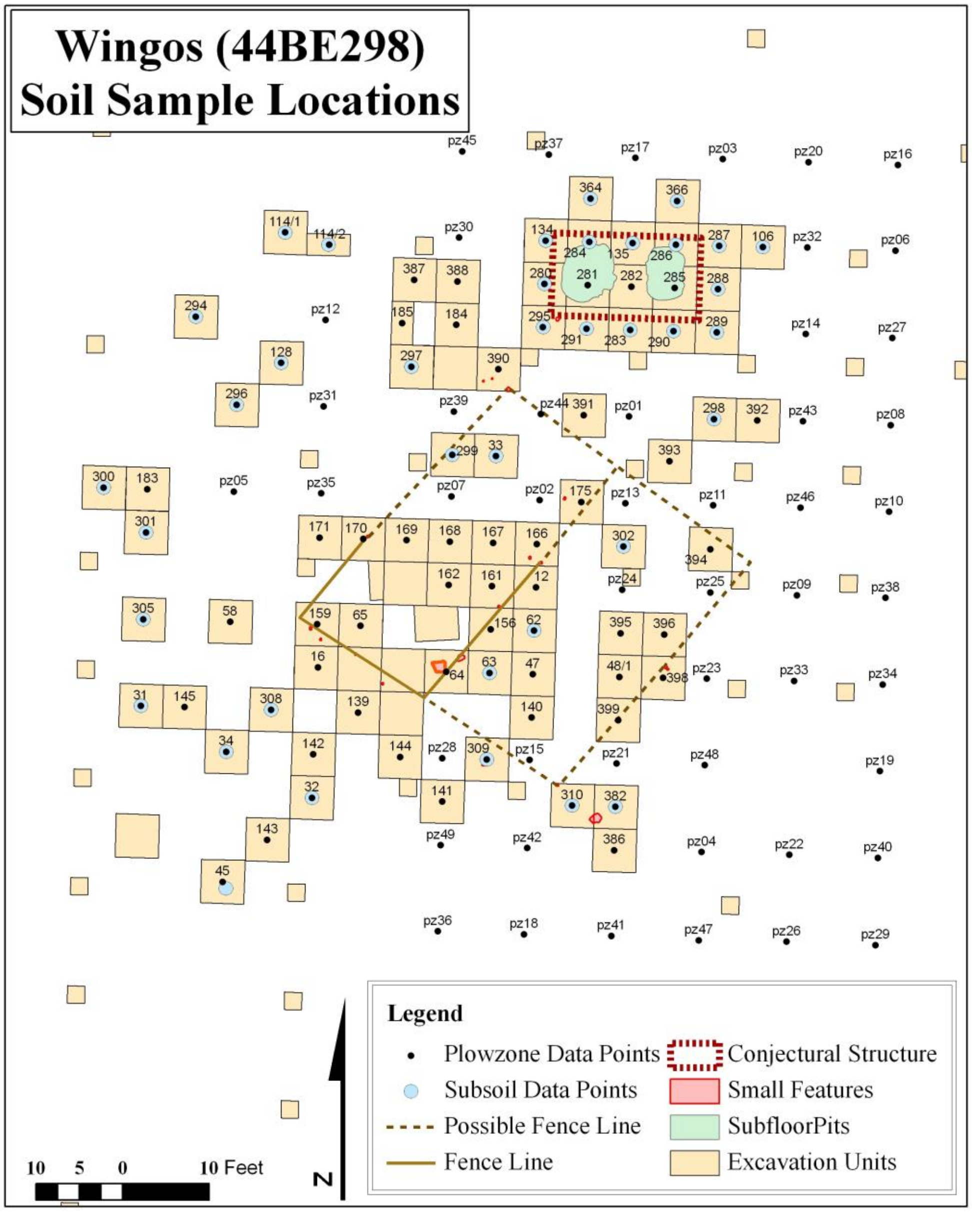

Figure 3: Plan of Wingo's Site showing location of soil samples around the site core.

Additionally, 49 samples were collected using a 1 in. diameter Oakfield-style soil corer from May 17-18, 2012 in order to acquire samples from areas around and away from the contiguous block excavations. This auguring process involved a systematic sampling strategy, placing pin flags at 10 ft. intervals in what would be the center of each sampled 5 × 5 ft. block on the grid (Figure 3). The corer was pushed into the soil, and a trowel was used to separate visually identified grass, topsoil and subsoil matrixes and the remaining column of plow zone was retained for analysis in a 3 × 5 in. cloth soil bag.

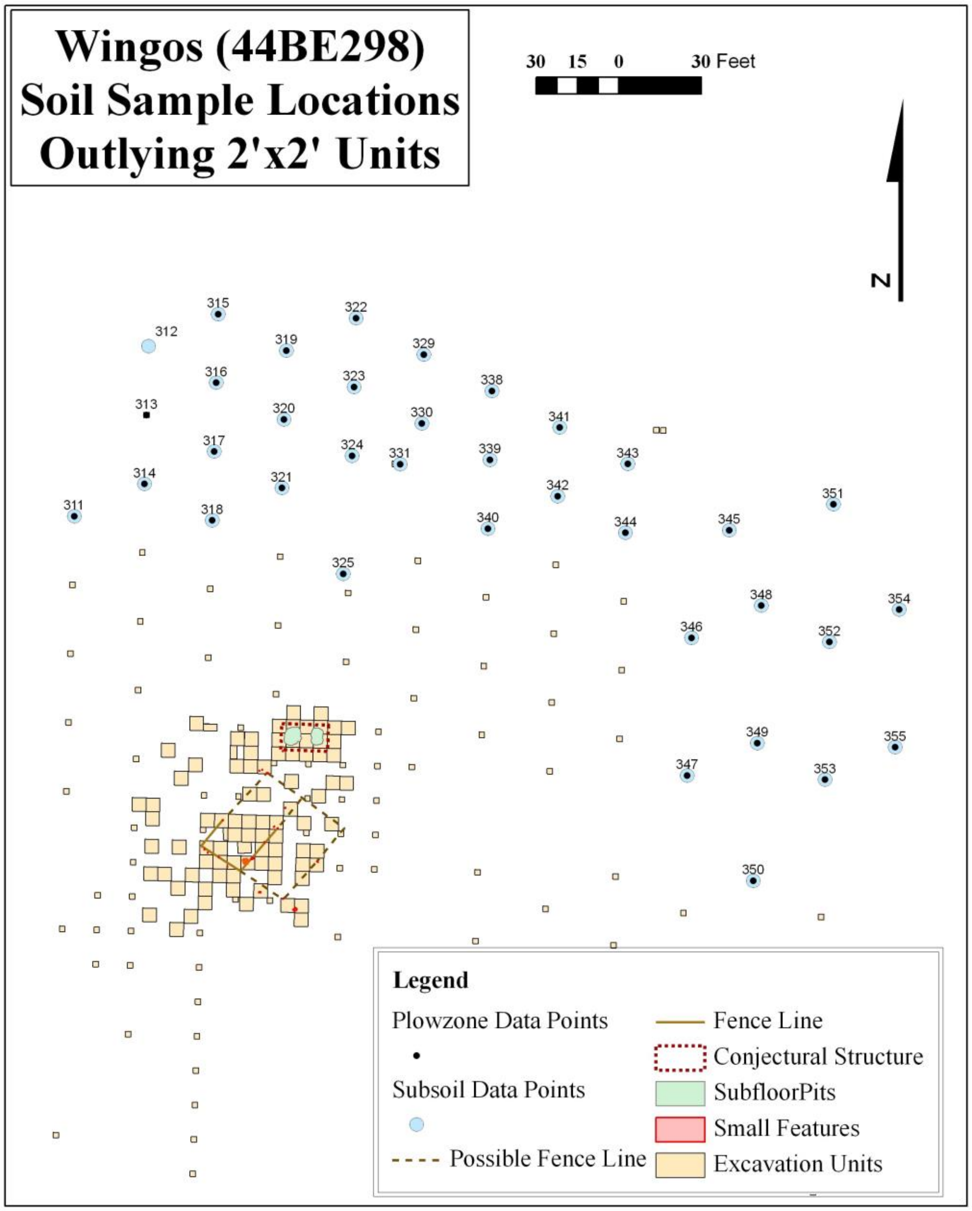

Figure 4: Plan of Wingo's Site showing location of soil samples in outlying areas to the north and east.

b. Laboratory Procedures

All samples were brought to the University of Tennessee's Archaeological Research Laboratory in Knoxville, TN for processing and analysis for phosphorus (P), calcium (Ca), potassium (K), and magnesium (Mg) using portable X-ray fluorescence (pXRF). All samples were screened through 2mm mesh in order to break up large clumps, remove debris, and collect any included artifacts. Approximately 15 grams of soil was then placed into a paper baking cup and dried overnight (16-24 hours) in a 60° C muffle furnace. Drying was found to be an effective preparation technique for pXRF analysis (Wilkins 2009), due to the ability of water to affect X-ray transmission at concentrations above 10% (Swanson and Colsman 2006:4). The soil samples were then packaged in open-ended plastic sample cups with polypropylene thin film windows that facilitate the transmittance of X-rays to bulk samples such as soil.

To the naked eye, the Wingo's soil samples appeared to be thoroughly dry after storage in bags for several months or even years; however, weighing a sub-sample of 67 plow zone and feature context soils before and after their time in the muffle furnace showed an average loss of 1 gram, or 5.23% of the total mass after a single overnight (20 hour) drying period. While all the plow zone contexts subjected to weighing before and after drying revealed water content by mass of between 1.16% and 2.99%, the feature contexts ranged in water content between 1.23% and 22.78%, with 14 samples exhibiting moisture content above 10%, the threshold at which X- ray transmission is supposedly inhibited (Swanson and Colsman 2006:4). This variability suggests that uniformly drying all soil samples prior to pXRF analysis is an important sample preparation. As a check against the appropriateness of using a drying time-period of roughly 20 hours (overnight), 20 of the same samples were left in the muffle furnace for an additional 4 days (90 hours), and over that extended time lost only an additional 0.83% of their mass. These results support the inference that even "air-dried" soil contains a measurable amount of water that can be effectively driven off at low temperature overnight, and that extended drying past about 24 hours yields little additional benefit.

Start	24 hours	% Change	After sampled	90 hours	% Change
18.2g	17.2g	-5.23%	8.3g	8.2g	-0.83%

Readings were made with a Bruker Tracer V-III+ pXRF device using a 15kV voltage and 35 amp setting, a vacuum purge system, and a titanium (Ti) filter in order to isolate the "light" range of elements that includes the elements of interest: Mg, P, K and Ca. Readings were 300 seconds in duration and several trial runs were made on the same sample to assure that these settings were producing consistent readings. The data used for analysis were the heights of the peaks for each element represented in the energy spectrum, measured in units of counts per second. XRF technology identifies and measures the elements present in an object or sample by exposing the target to X-ray energy and measuring the wavelengths of energy that the sample re-emits (Swanson and Colsman 2006:3). Each element on the periodic table emits (fluoresces) energy at a diagnostic wavelength, making it possible for an XRF device to identify the elements present by measuring those wavelengths of energy fluoresced by the target sample (Laing 1981: 27).

Spatial distributions of those chemical plow zone readings can be used to identify the locations of organic refuse (P), bone (Ca), and ash (K) in order to infer aspects of the site's layout. The use of any kind of XRF analysis in soil chemical analyses is a recent application of the technology, with only a few archaeological cases employing XRF to specifically analyze soils (Cook et al 2005; Marwick 2005; Eliyahu-Behar et al 2008). The author (Wilkins 2009) has recently completely one of the first comparative evaluations of pXRF against older soil chemical techniques routinely used for archaeological analysis, and then employed the pXRF readings for phosphorus to guide and inform the excavation of the Oval Site (ST92), an 18th-century slave quarter site at Stratford Hall Plantation in Westmoreland County, Virginia (Wilkins 2010). Due to the new and experimental nature of pXRF in soil chemistry, 44 plow zone samples from the Wingo's site were also analyzed by traditional wet chemistry analytical methods by the University of Delaware's Soil Testing Program. These samples were selected from the southern block excavation unit samples and the results were used as a control to compare to and evaluate the pXRF readings on the same samples.

Samples that were submitted to the University of Delaware underwent a "Routine Soil Test" that uses a Mehlich 3 extraction (Mehlich 1984) and inductively coupled plasma optical emission spectrometry (ICP-OES) for 11 elements: phosphorus (P), calcium (Ca), potassium (K), magnesium (Mg), manganese (Mn), copper (Cu), zinc (Zn), iron (Fe), boron (B), aluminum (Al), and sulfur (S). The Routine Test package also includes tests for pH, organic matter content, phosphorus saturation ratio (PSR), cation exchange capacity (CEC), and base saturation. The testing program is designed for agricultural uses but the P, Ca, K, and Mg results can be interpreted archaeologically.

c. Analytical Methods

All context proveniences and associated soil data were recorded in Microsoft Excel spreadsheets and from there imported into other programs for statistical and spatial analysis. Artifact counts were also recorded for plow zone and feature contexts and their analysis was used to augment soil chemical data. Basic descriptive statistics, histograms, boxplots, and correlations were performed using Statistics Package for Social Sciences (SPSS) version 22 software. Distribution maps and spatial statistics were produced using ESRI ArcGIS version 9.3 software. In order to produce maps and charts comparable between elements and artifact types that can vary greatly in overall abundance, relative values (Z scores) were calculated. The Z score for each observation is the number of standard deviations above (positive values) or below (negative values) the mean observation for each element. Interpolated distribution maps (splines) of the Z scores for each element are used below to compare the spatial distribution of relatively high, average, and low chemical readings and artifact concentrations across the site.

The statistical index of spatial autocorrelation was also used to assess the degree to dispersion, clustering, or randomness of the distributions (Hodder and Orten 1976:174). The test, known as Moran's I, produces an index value (I), characterizing the nature of the spatial patterning as dispersed, clustered or random. Z scores characterized the extremity of the patterning, and p values to evaluate statistical significance. Figure 5 shows an example of the graphical output of spatial autocorrelation analysis for a highly clustered pattern using ArcGIS version 9.3 software. A clustered pattern can be interpreted as the propensity of a given data point to have similar values as surrounding points, as opposed to a dispersed pattern that would indicate the values of a given point to be surrounded by significantly different values. A random pattern would indicate that value of a given point couldn't reliably be used as predictor of the values of surrounding areas.

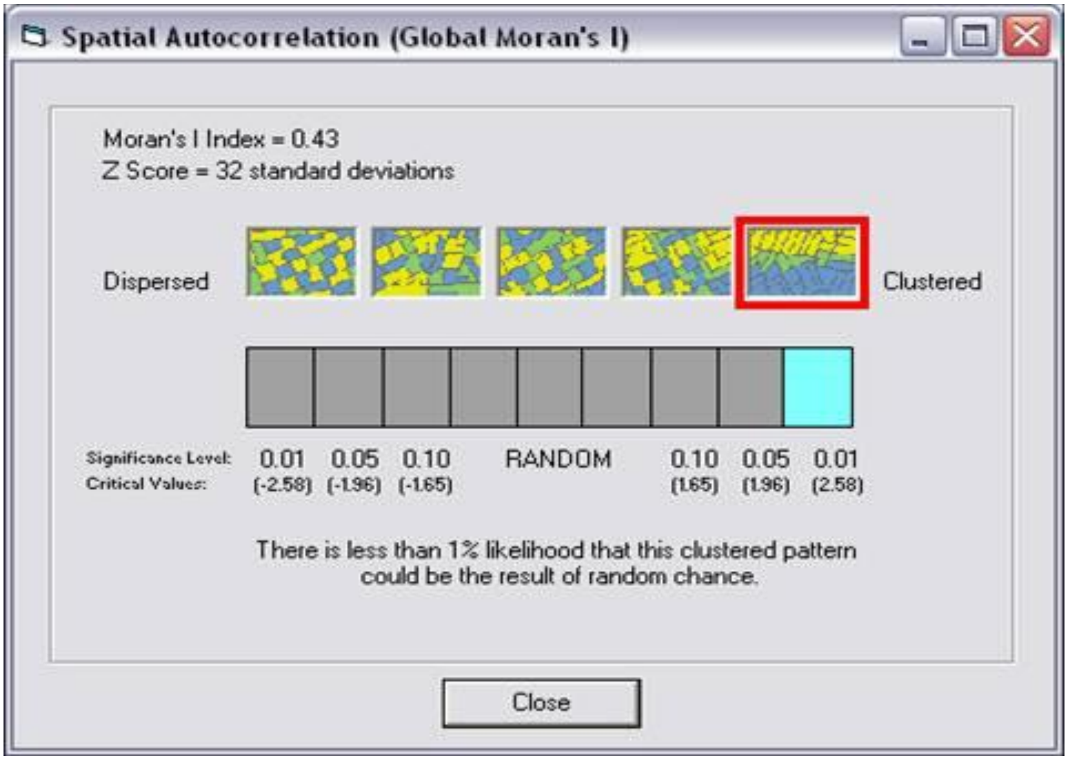

Figure 5: Example of graphic output for spatial autocorrelation in ArcGIS.

4. Plow zone

Concentrations of various soil chemicals in plow zone contexts have been used in past studies to interpret the location of deposition for a variety of materials, mostly related to organic refuse, and the following interpretations are synthesized from a variety of past scholarship (Asher and Fairbanks 1971; Keeler 1973; Stone et al. 1987; Pogue 1988; Woods 1988; Fisher 2001; Fesler 2010). Phosphorus (P) is most often associated with general organic refuse including human and animal waste and linked to kitchen and residential middens as well as gardens and animal pens. Calcium (Ca) is associated with animal bone, shell, and architectural products made with lime such as plaster. Potassium (K) is prevalent within plant tissue and has been linked to hearth areas and the presence ash. Magnesium (Mg) has been associated with areas of intense burning, but scholars disagree on the validity of that assertion any interpretations of Mg distributions are tentative.

a. Results

Plow zone soils were collected in order to assess the horizontal distribution of chemicals across in the site, hopefully providing information on the presence, location, and size of yard activities. According to Moran's I spatial autocorrelation index, the distributions of all soil chemical distributions, including both measurements of pXRF and the Mehlich 3 extraction and ICP-OES from the University of Delaware, show statistically significant clustering and exhibit a less than 1% likelihood of that patterning being due to random chance (Table 3). These results support the interpretation of these distributions as reflections of human activity, and not random geological variation.

Table 3: Spatial autocorrelation (Moran's I) statistics for plow zone soil chemical distributions at Wingo's.

Measure	Element	Moran's I	Z score	P value
pXRF	Phosphorus	0.097 (clustered)	7.682	0.00
pXRF	Potassium	0.091 (clustered)	7.230	0.00
pXRF	Calcium	0.292 (clustered)	22.035	0.00
pXRF	Magnesium	0.123 (clustered)	9.519	0.00
Mehlich 3	Phosphorus	0.426 (clustered)	32.003	0.00
Mehlich 3	Potassium	0.251 (clustered)	19.337	0.00
Mehlich 3	Calcium	0.447 (clustered)	33.494	0.00
Mehlich 3	Magnesium	0.403 (clustered)	30.199	0.00

The distribution of phosphorus (P) in the plowzone at Wingo's (Figure 6) shows moderate to high levels of phosphorus enrichment directly over and north of the subfloor pits in ERs 0135, 0286, and 0287. Phosphorus enrichment representing decayed plant and animal

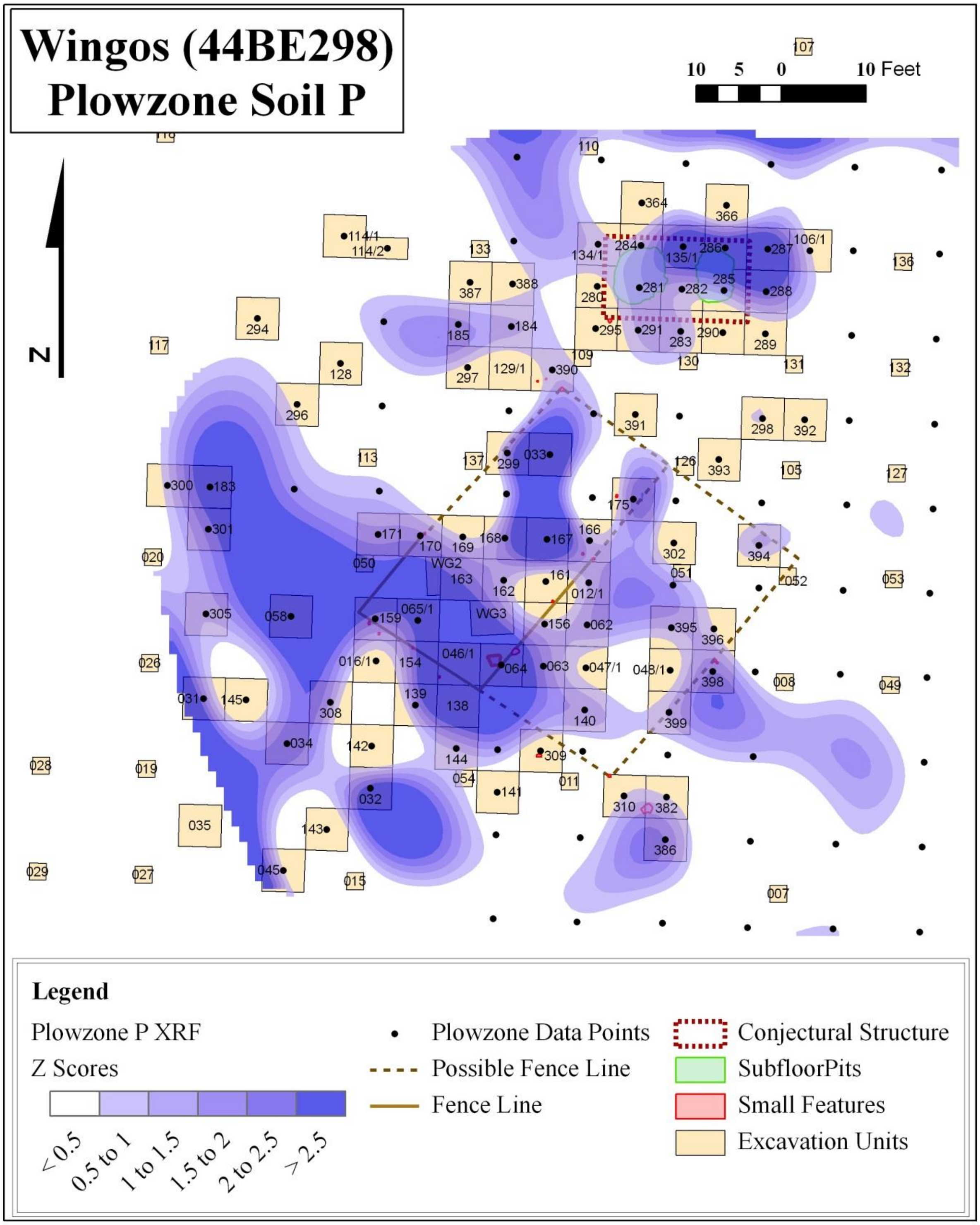

Figure 6: Distribution of plow zone soil phosphorus (pXRF) values at Wingo's.

matter is often found just outside of structures and to one side of doorways, and interpreted as the disposal of general household refuse (Keeler 1973; Pogue 1988; Heath and Bennett 2000; Wilkins 2010). The location of soil phosphorus concentrations on the north side of the subfloor pits indicates the possibility that the structure over the pits may have faced to the north, had its principle entrance on the northern façade, and that a front yard space may exist to the north of the block of quadrats that includes the subfloor pits. However, no other lines of evidence yet support this interpretation. No significant artifact concentrations, soil chemical concentrations, or features have been found to the north of the structure. Perhaps the building's main door did face north on to a clean yard area, but all the outdoor activities that left archaeological traces appear to have happened to the south of the structure.

Approximately 15 ft. south-southwest of the structure within the western enclosure, there is another concentration of high phosphorus values between ERs 033 and 0167. The southern end of the enclosure also exhibits high phosphorus values in a larger area centering on quadrats 046 and 064, and then extending west by northwest out of the enclosure over 058 and 0183. An isolated area of high phosphorus is also present south of the enclosure in the vicinity of 032.

While other isolated areas of moderate enrichment occur surrounding the eastern possible enclosure, the majority of space south-southeast and due west of the structure is not enhanced with phosphorus. Comparison of the pXRF soil phosphorus distributions with the Mehlich 3 measurements show similar spatial patterning (Figure 7) and the two measurement methods are moderately correlated (Table 4), which supports the validity of using pXRF for interpretive soil chemistry in archaeology.

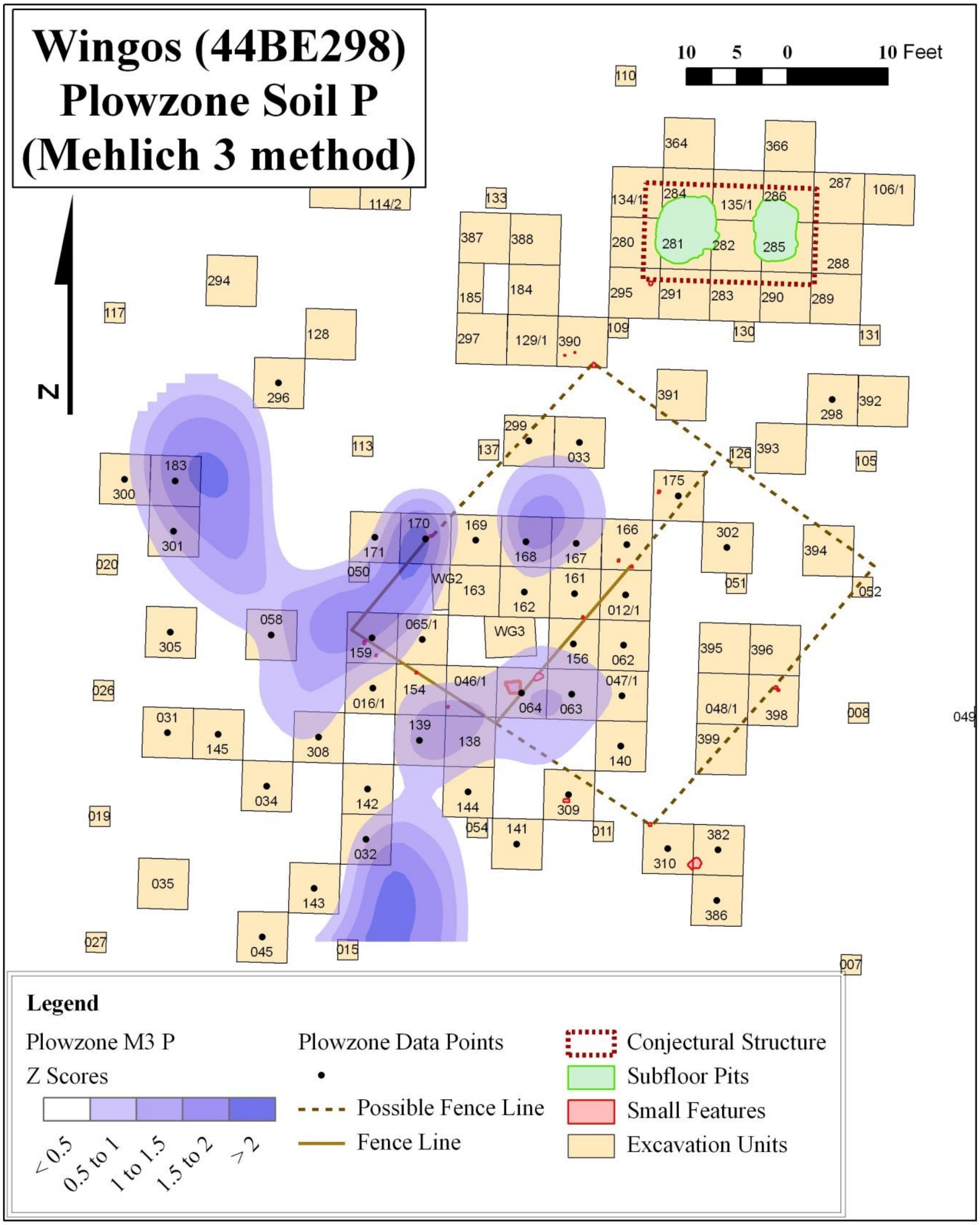

Figure 7: Distribution of plow zone soil phosphorus (M3) at Wingo's.

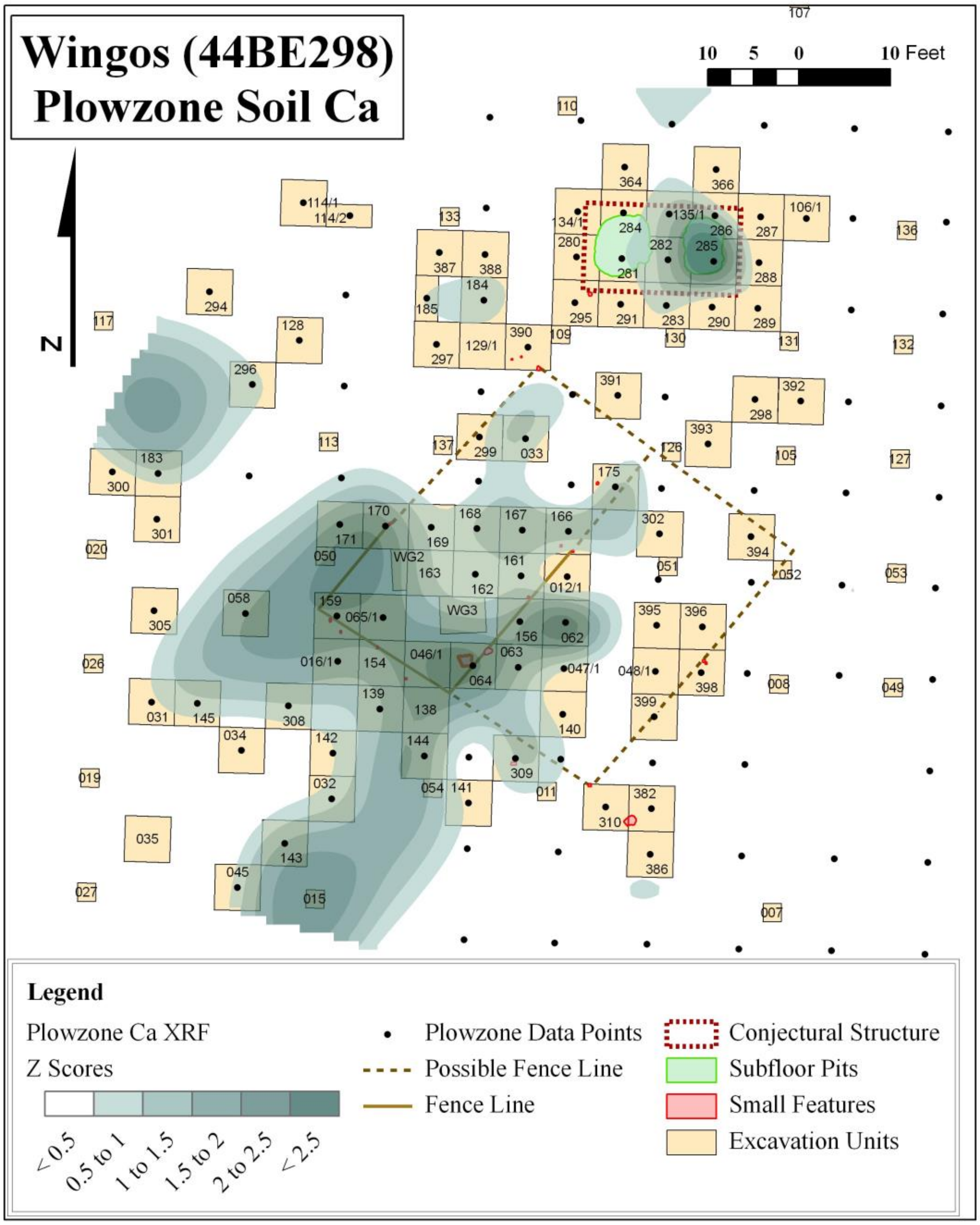

Figure 8: Distribution of plow zone soil calcium (pXRF) at Wingo's.

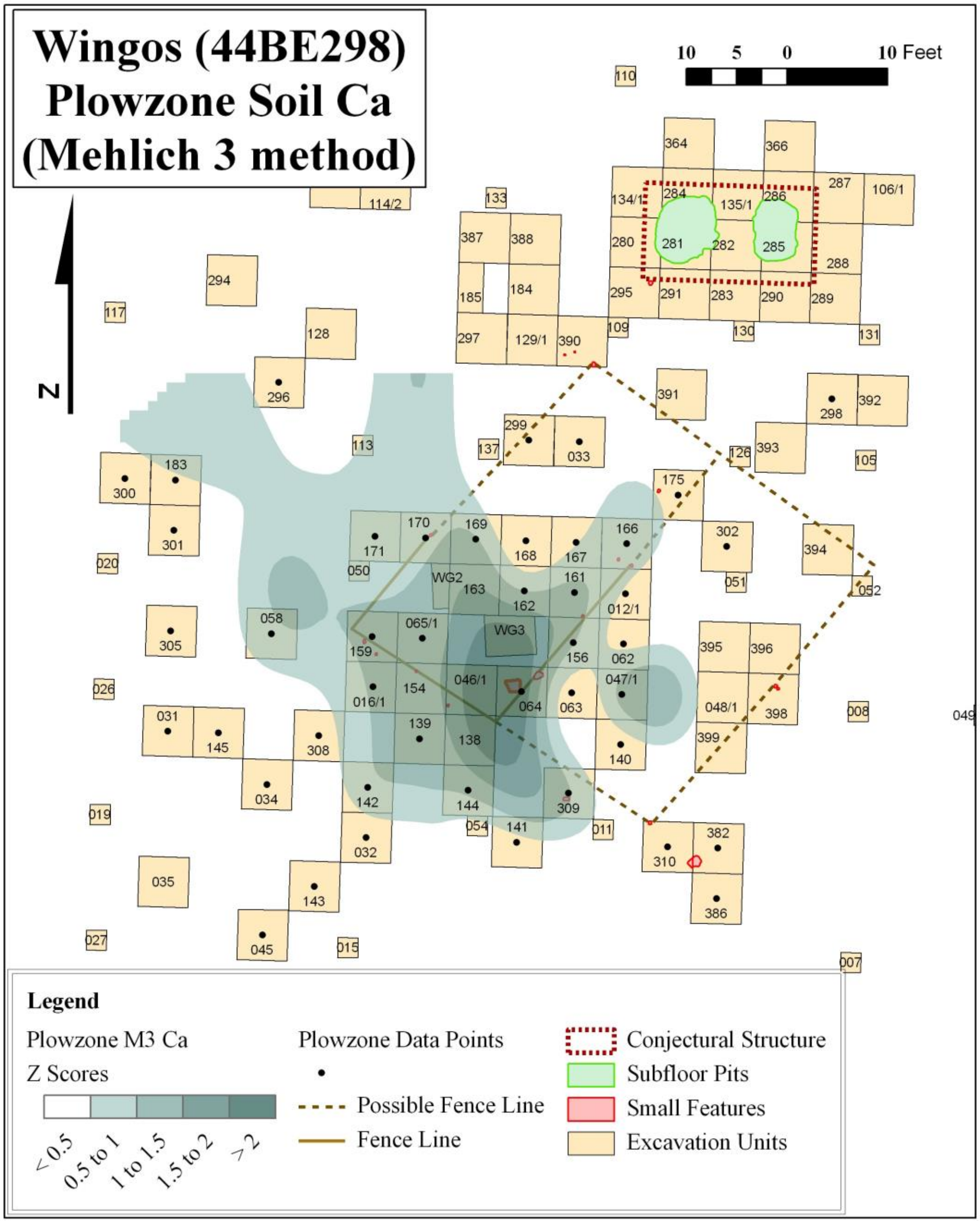

Figure 9: Distribution of plow zone soil calcium (M3) at Wingo's.

The distribution of calcium (Ca) at Wingo's (Figure 8) shows a high concentration of calcium directly over the subfloor pit of ER 0285, likely due to the high amount of bone recovered from in and around the pits. In the western enclosure, the northern area exhibits low to moderate calcium enhancement, and an area of high calcium values is in the shape of a "U" at the southern end of the enclosure running between ERs 0170 and 0171 in the west, continuing south to quadrats 0159 and 065, and then turning east and north to ERs 064, 0156, and 062. Only moderate and isolated calcium enhancements exist in the areas west and south-southeast of the structure. These trends mirror those of the phosphorus concentrations, which is likely due to bone comprising part of the refuse disposed along the possible fence, and bolsters the interpretations made in the discussion of the phosphorus distributions. Sharing another quality with phosphorus, the Mehlich 3 control results for calcium closely match the pXRF results spatially (Figure 9) and are strongly correlated statistically (Table 4). These comparative results suggest that calcium readings using pXRF are even more similar to traditional methods than phosphorus, and can be considered a viable option for archaeological interpretation.

The distribution of potassium (K) at Wingo's (Figure 10) is somewhat similar to that of phosphorus and calcium, especially in the largest and highest concentration in the southern end of the western enclosure around quadrats 064 and 063. There is also a smaller concentration in the northern end of the enclosure between 033 and 0167 and again south of the enclosure near 032, much like that seen in the phosphorus distribution. Potassium does not extend as far west of the southern enclosure or to the same degree as phosphorus. Potassium values over and around the subfloor pits are average to low, with the exception of ER 0282. The moderately high concentration of potassium there, between the two subfloor pits, may be due to ash deposition from the hearth of the structure likely located west of the subfloor pit in quadrat 0281. Other moderate and more isolated enhancements of potassium exist just west of the structure in 0184, southeast in 0289, and more sporadically in the area east of the eastern possible enclosure.

Unlike calcium and phosphorus, potassium values measured with pXRF do not correlate well with the Mehlich 3 control data either in spatial distribution (Figure 11) or statistical measures (Table 4). Soil nutrients such as phosphorus and potassium exist in the soil in several forms, determined by several compounds these elements form with others. Traditional agronomic soil tests such as the Mehlich 3 extract those forms that are readily “available” to plants as nutrients, while a large majority of the actual elemental concentration is bound more tightly in other forms. XRF devices can measure only elemental concentrations and do not distinguish between available and others not available. Archaeological soil chemistry was originally adapted from agricultural soil science in Europe; and as a result there is a tradition of using partial extractions of available plant nutrient chemicals within soil (Goffer 1980; Bethell and Mate 1989). While measurements of available chemicals have had successful application, Proudfoot (1976) notes that chemicals added by humans to soil enter the same cycles of transformations as "natural" nutrients and can therefore raise levels of all forms and all classifications. Since the 1970s, a small but growing body of research has shown that measurements of available soil chemicals, principally phosphorus, typically capture 10% or less of potential human impact on soil chemical levels (Herz and Garrison 1998). Several other studies note specifically that stronger total or near total measurements tend to be more closely correlated to observed anthropogenic activity than partial measurements (Ahler 1973; Skinner 1982; Neiman et al. 2000; Sullivan and Kealhofer 2004; Wilson et al. 2007; Holliday and Gartner 2007). Thus, while the distributions of potassium made with pXRF are less secure in their interpretive power than those of calcium and phosphorus, the correlation between potassium and those other elements as read by pXRF suggests that pXRF-read potassium is likely reflecting the deposition of ash and plant matter at Wingo’s (Table 4).

The distribution of magnesium (Mg) at Wingo’s (Figure 12) differs slightly from the overall pattern identified in the signatures of P, Ca, and K. Moderately high levels of magnesium are seen on in a large portion of the structure, and even higher levels are found directly over the subfloor pit in quadrat 0281. This concentration could be related to the occasionally noted relationship between Mg and burning, but many scholars have found that comparing artifacts and

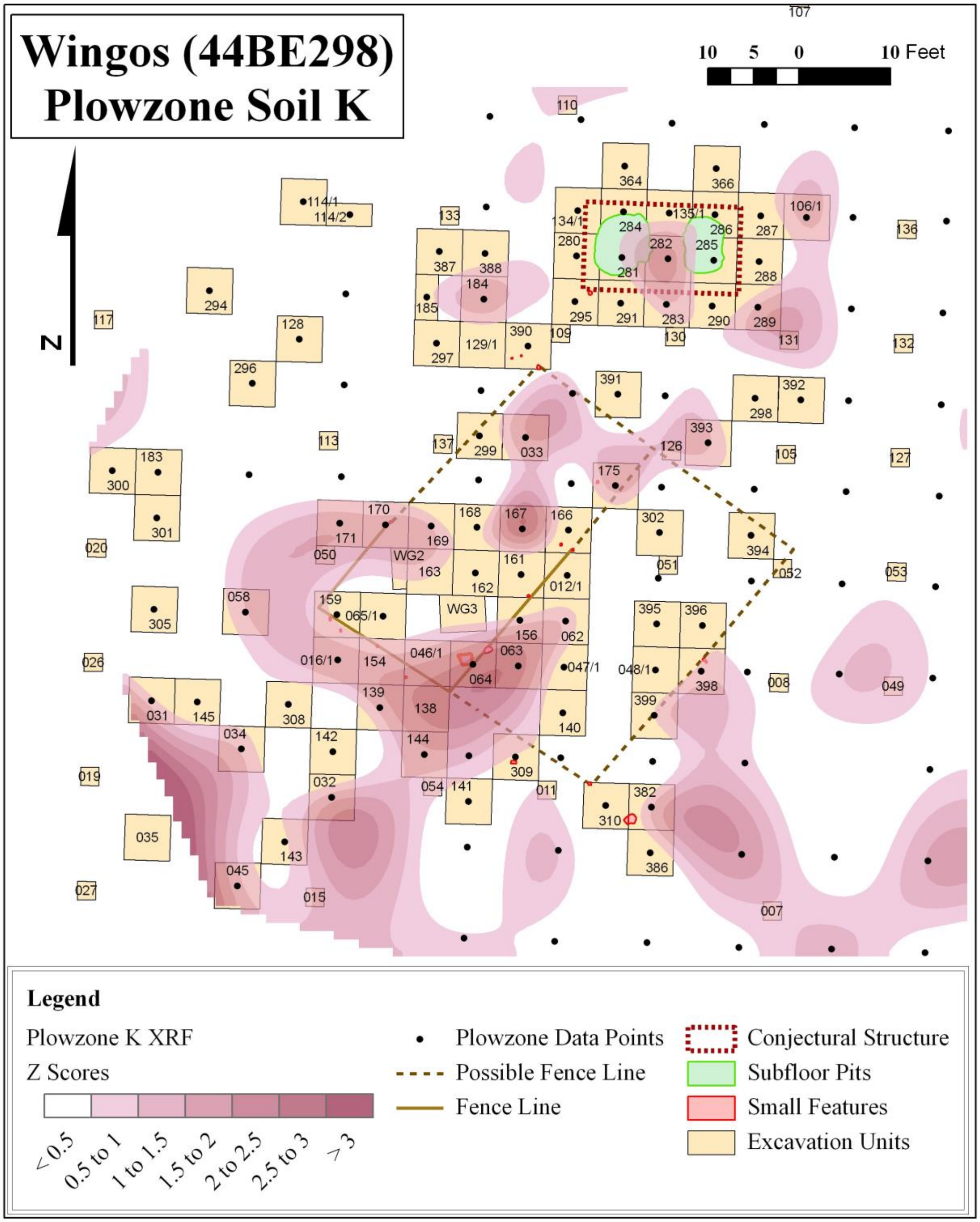

Figure 10: Distribution of plow zone soil potassium (pXRF) at Wingo's.

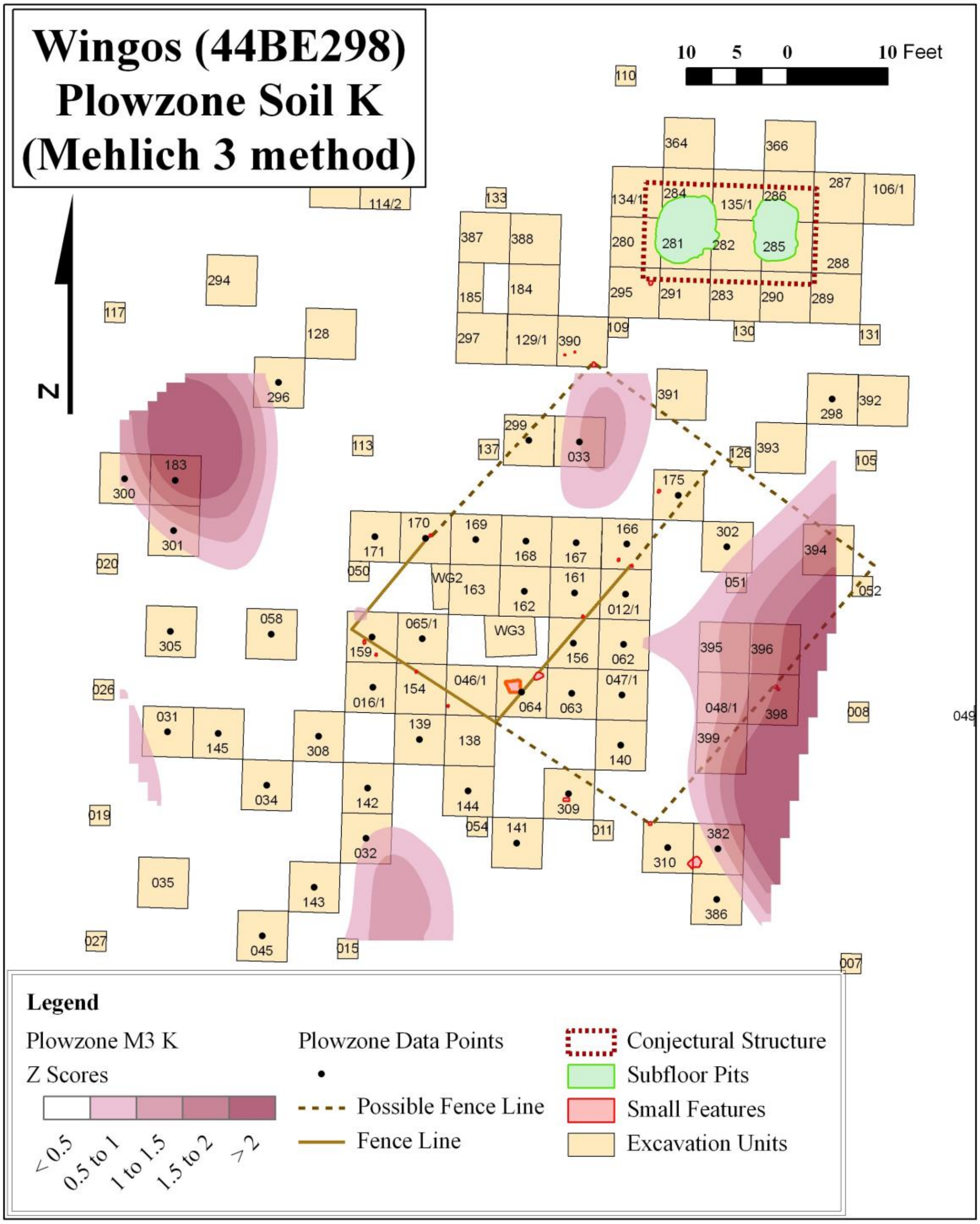

Figure 11: Distribution of plow zone soil potassium (M3) at Wingo's.

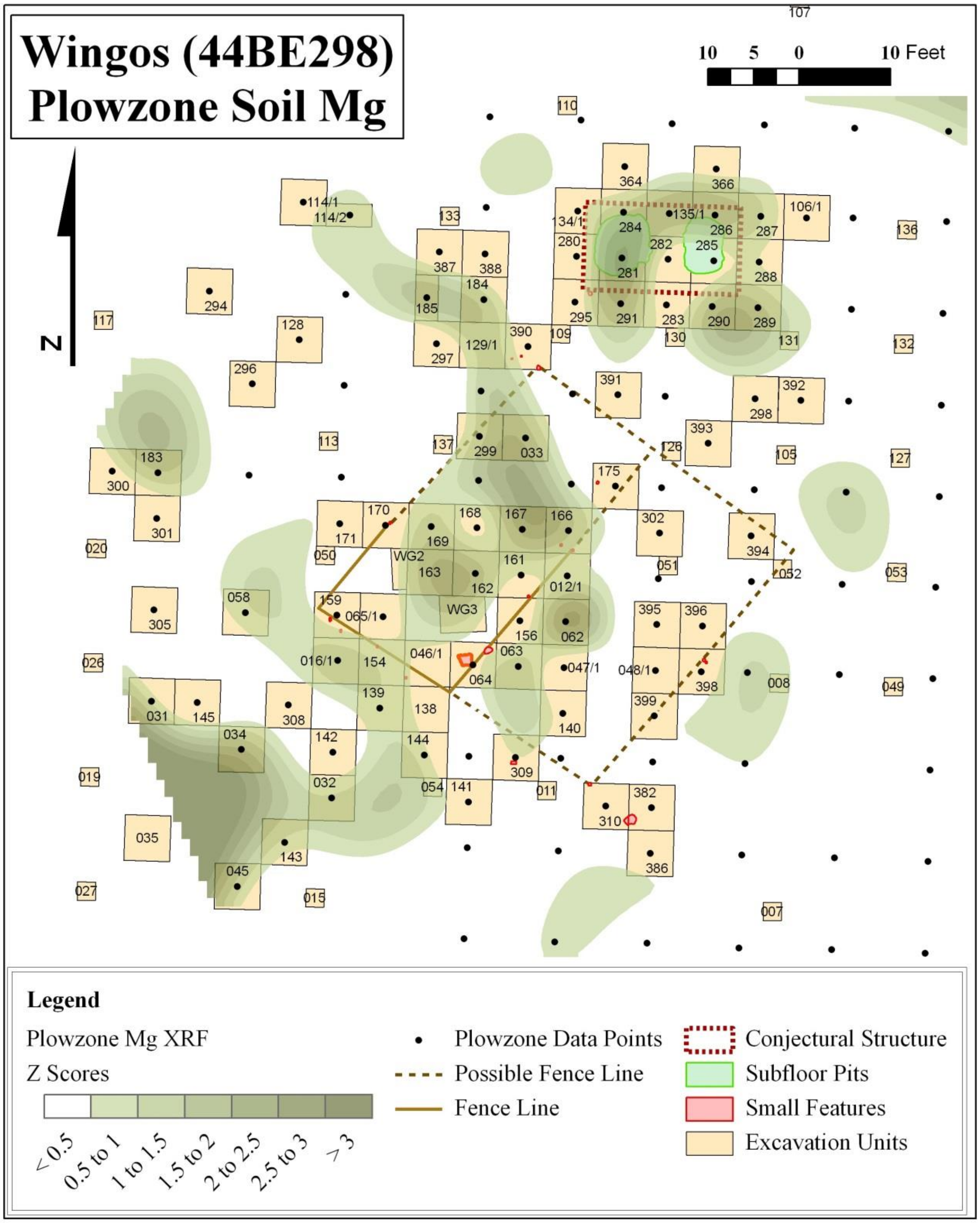

Figure 12: Distribution of plow zone soil magnesium at Wingo's.

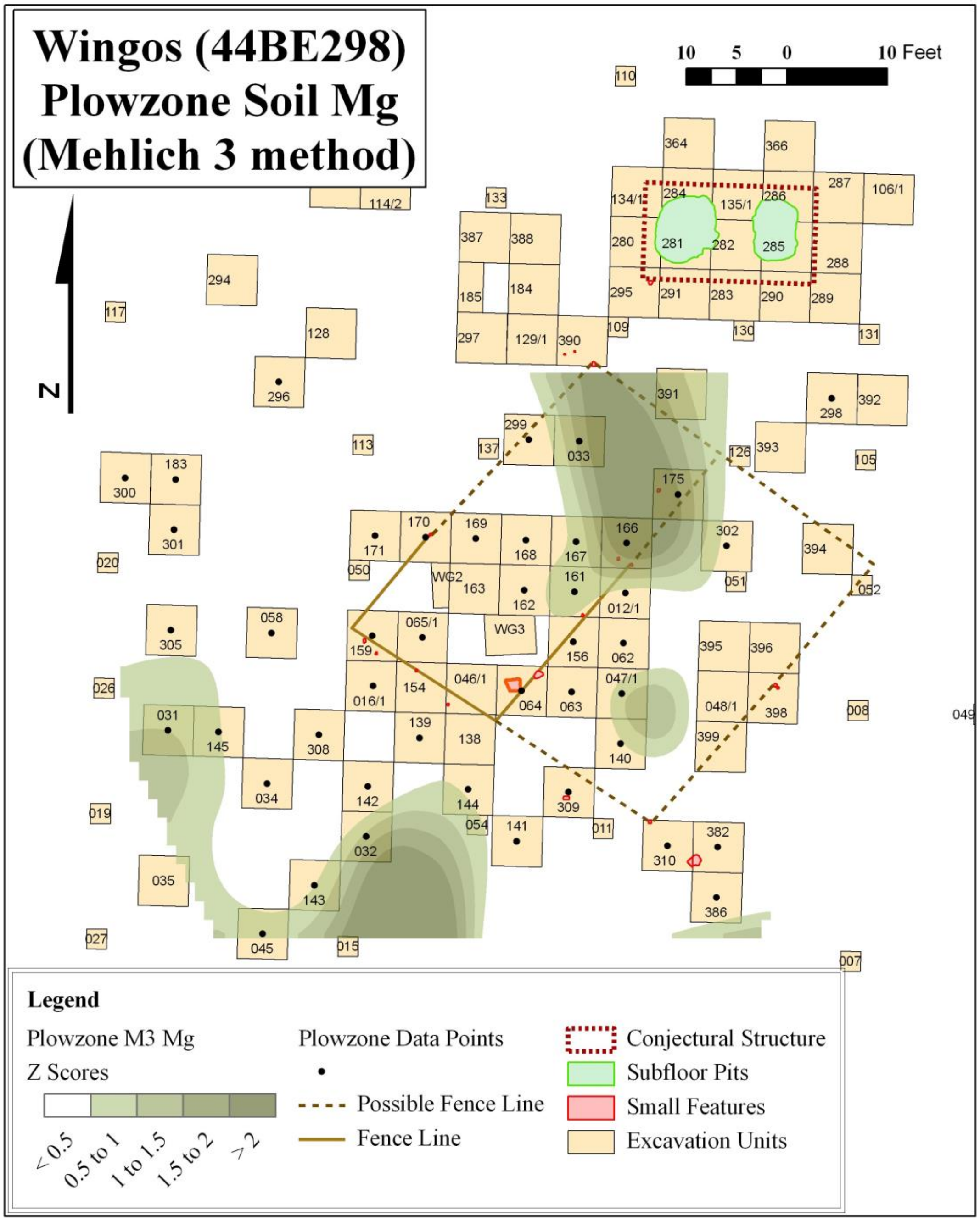

Figure 13: Distribution of plow zone soil magnesium (M3) at Wingo's.

known activities to distributions of magnesium proves very problematic in isolating an interpretable anthropogenic cause of elevated levels of the element in soils (Keeler 1973; Custer et al. 1986; Pogue 1988; Keeler 1973). An area of magnesium concentration appears around ERs 033 and 0167, and is again likely related to the high amounts of P, K, and Ca in that area due to refuse deposition. Like potassium, magnesium levels are moderately elevated in smaller and more isolated pockets to the west of the structure in quadrats 0184 and 0185, and just southeast of the structure in ERs 0289 and 0290. This combination of magnesium and potassium closer to the domestic space may relate not to refuse middens but rather ash-tipping. The magnesium in the western enclosure appears concentrated just to the north of the area of P, Ca, and K enrichment. The northwest corner of the possible eastern enclosure around quadrat 062 also exhibits a smaller and isolated magnesium concentration.

The comparison of Mehlich 3 measured magnesium and pXRF readings shows only moderate spatial association (Figure 13), most notably in the northern portion of the west enclosure and again to the south and southwest of the enclosures. Statistical correlation between the control Mehlich 3 values and pXRF readings for magnesium are present but not as strong as for calcium and phosphorus (Table 4). While the interpretive strength of magnesium has been questioned, distributions at Wingo's do seem spatially similar to potassium, and the link between "burning," ash deposition, and the two elements may reflect the location of ash and charcoal in association with the cleaning of hearth and outdoor fire areas.

Table 4: Correlation table of pXRF and Mehlich 3 soil chemistry at Wingo's.

		xrf_P	xrf_K	xrf_Ca	xrf_Mg	M3_P	M3_K	M3_Ca	M3_Mg
xrf_P	Pearson Correlation	1	.301**	.463**	.381**	.468**	.437**	-.049	.211
	Sig. (2-tailed)		.000	.000	.000	.003	.007	.771	.210
	N	167	167	167	167	37	37	37	37
xrf_K	Pearson Correlation	.301**	1	.412**	.339**	.255	-.074	.273	.128
	Sig. (2-tailed)	.000		.000	.000	.128	.662	.102	.451
	N	167	167	167	167	37	37	37	37
xrf_Ca	Pearson Correlation	.463**	.412**	1	.393**	.439**	-.169	.770**	.174
	Sig. (2-tailed)	.000	.000		.000	.007	.318	.000	.304
	N	167	167	167	167	37	37	37	37
xrf_Mg	Pearson Correlation	.381**	.339**	.393**	1	.083	.137	.308	.411*
	Sig. (2-tailed)	.000	.000	.000		.627	.418	.063	.012
	N	167	167	167	167	37	37	37	37

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

b.

c. Interpretations

The Wingo's quarter is archaeologically ephemeral, consisting of few features and a fairly small and homogeneous artifact assemblage characterized by high levels of fragmentation (Wilkins et al. 2012). Figure 14 shows the distribution of total artifacts (without daub weights), and the patterning is startling similar to the general pattern of all four soil elements. Immediately south and east of the cabin was an area that residents kept fairly clean, with an arc of deposition moving south and west, skirting the edges of the western enclosure, and moving back to the northwest. Individual and aggregate soil chemical signatures lend support to this pattern. The actual dimensions of the enclosure, and how it was used, remain somewhat unclear; soil chemical evidence suggests that organic waste and calcium were deposited along the southern third in greater than average amounts, while artifacts are less frequent, except along the edges.

The area immediately west of the cabin does contain a small and moderate concentration of artifacts, magnesium and potassium. However, contrary to earlier inferences (Wilkins 2011; Wilkins et al. 2012) the final distributions suggest that this area was not a major trash deposition area. Considering statistical relationships between individual soil chemicals and selected artifact types that exhibited significant correlations to at least one element can aid in clarifying the interpretation of some areas (Table 5). Artifacts that correlate to both magnesium and potassium include nails, bone, green bottle glass, as well as total artifact counts and richness. Richness in this study is an integer count of the number of artifact types in each plow zone unit. Those areas around the structure exhibiting potassium and magnesium concentrations may be due to small-scale household primary refuse deposition, or could even derive from the deconstruction of the building.

Calcium is most strongly correlated with the most types of artifacts, including richness and total counts (Table 5), suggesting that this element may be the best indicator of secondary-refuse deposition in middens. Bone and nails also correlate strongly with calcium (Figure 15), and are spatially concentrated together in the southern end of the western enclosure. That area may be the possible location of a small structure; perhaps indicating that the enclosure contained a henhouse or animal pen. The absence of artifacts and presence of multiple soil chemical concentrations in the northern portion of the western enclosure suggests an activity area.

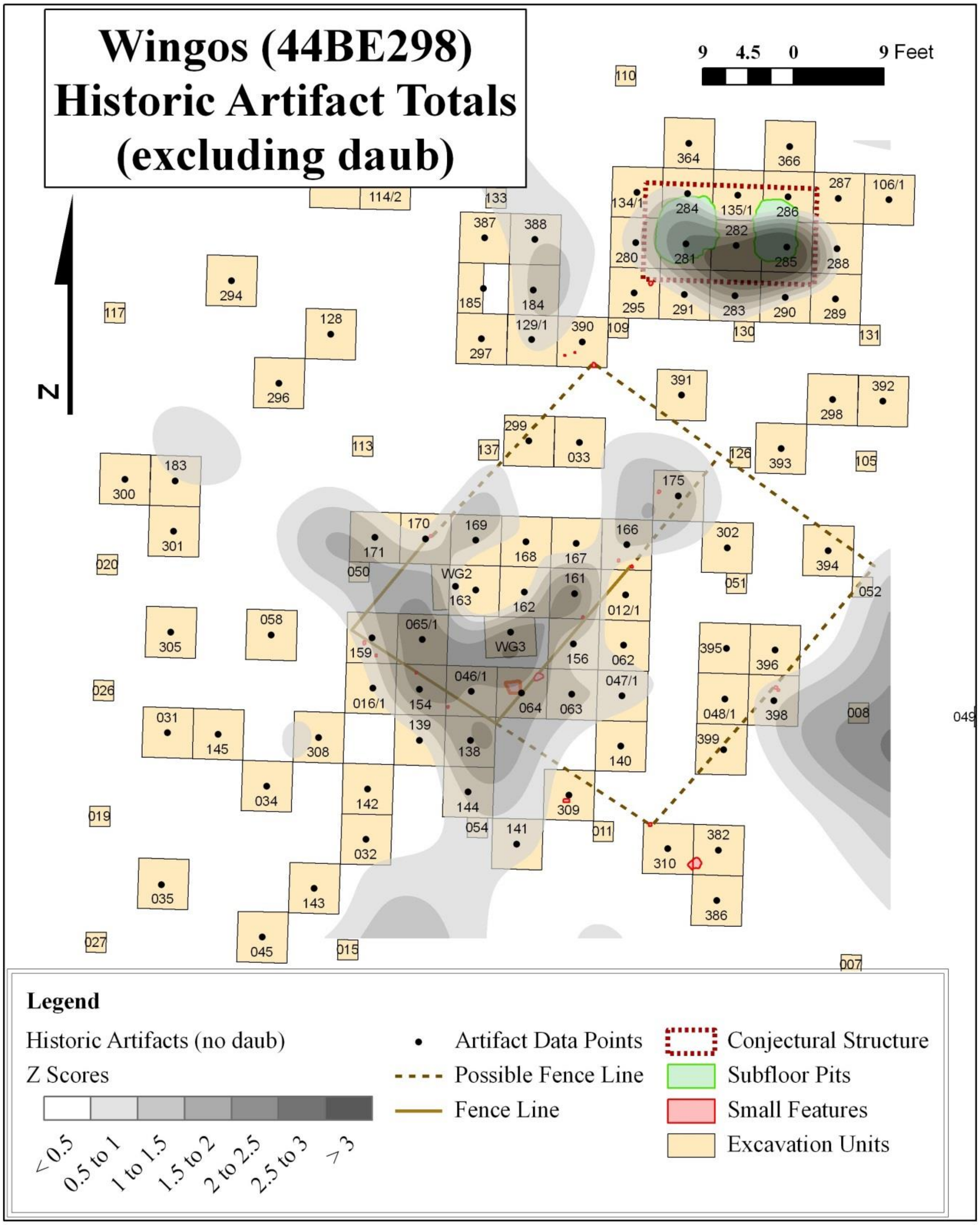

Figure 14: Distribution of total artifact density, excluding daub, at Wingo's.

Table 5: Correlations between soil chemicals and selected artifacts.

		xrf_P	xrf_K	xrf_Ca	xrf_Mg
Total Nails	Pearson Correlation	.350**	.471**	.668**	.332**
	Sig. (2-tailed)	.000	.000	.000	.000
	N	118	118	118	118
Tobacco Pipes	Pearson Correlation	.145	.126	.324**	.152
	Sig. (2-tailed)	.117	.174	.000	.101
	N	118	118	118	118
Redware	Pearson Correlation	.046	.067	.039	.240**
	Sig. (2-tailed)	.619	.474	.672	.009
	N	118	118	118	118
Green Bottle Glass	Pearson Correlation	.362**	.440**	.453**	.235*
	Sig. (2-tailed)	.001	.000	.000	.036
	N	80	80	80	80
Buttons	Pearson Correlation	.240**	.087	.214*	.198*
	Sig. (2-tailed)	.009	.348	.020	.032
	N	118	118	118	118
Charcoal (weights)	Pearson Correlation	.044	.033	.186*	.043
	Sig. (2-tailed)	.634	.720	.044	.644
	N	118	118	118	118
Daub (weights)	Pearson Correlation	-.010	.257*	.044	.219
	Sig. (2-tailed)	.931	.022	.697	.051
	N	80	80	80	80
Mortar (weights)	Pearson Correlation	.129	-.012	.249*	.054
	Sig. (2-tailed)	.254	.915	.026	.633
	N	80	80	80	80
Bone (weights)	Pearson Correlation	.023	.256**	.331**	.109
	Sig. (2-tailed)	.801	.005	.000	.241
	N	118	118	118	118
Richness (count of types)	Pearson Correlation	.390**	.537**	.730**	.489**
	Sig. (2-tailed)	.000	.000	.000	.000
	N	118	118	118	118
Total historic artifacts	Pearson Correlation	.318**	.474**	.609**	.406**
	Sig. (2-tailed)	.000	.000	.000	.000
	N	118	118	118	118

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

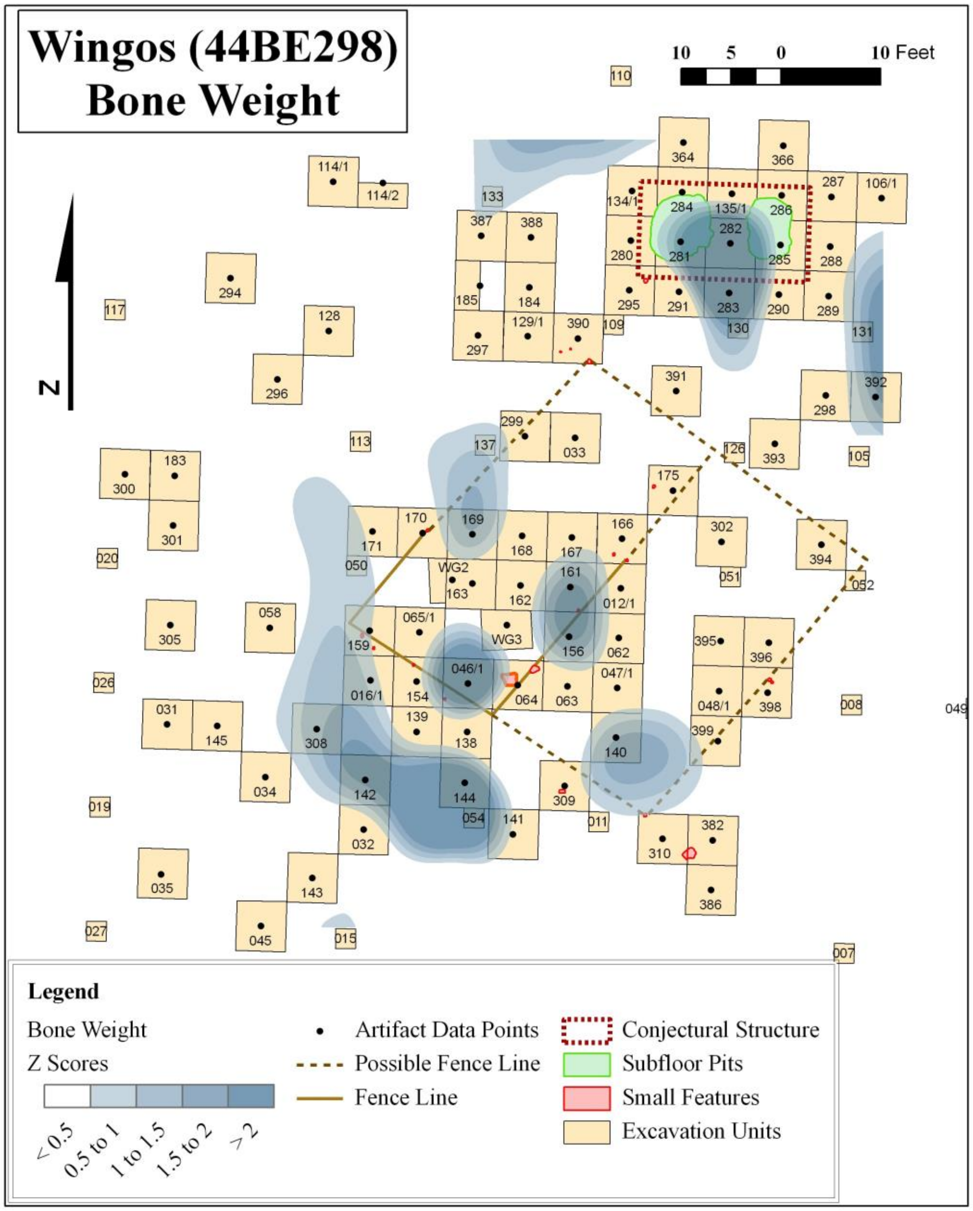

Figure 15: Distribution of relative bone weight at Wingo's.

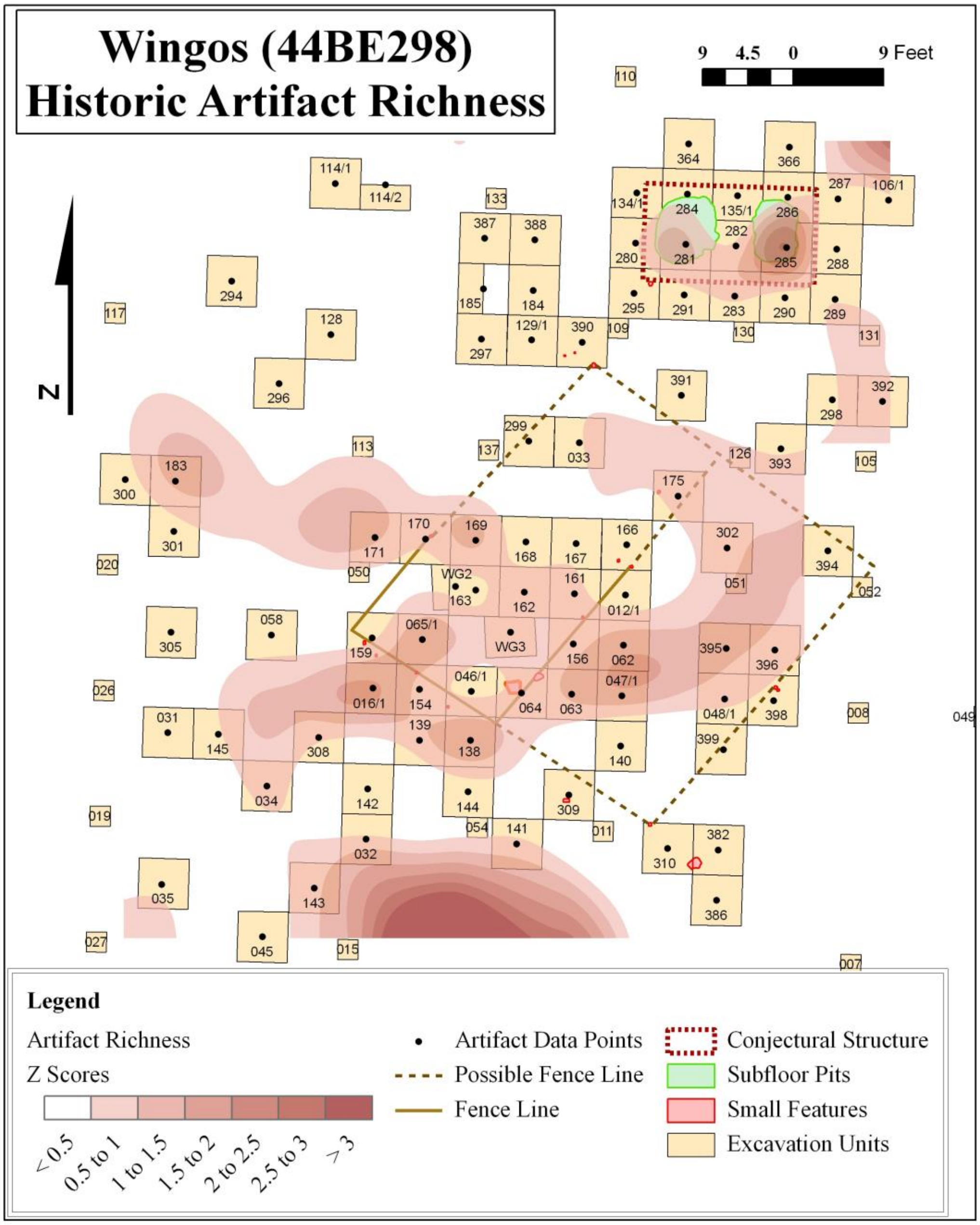

Figure 16: Distribution of historic artifact richness (number of artifact types) at Wingo's.

5. Subsoil

In order to compare the distribution of elements across space at Wingo's in both plowed and unplowed contexts, 74 subsoil samples were taken from both 5 × 5 ft. and 2 × 2 ft. test quadrats. Some elements, such as calcium, may have similar spatial distributions in both the plow zone and subsoil of plowed site. Other elements more resistant to leaching, such as phosphorus, are less likely to undergo vertical transport and patterning in the subsoil of plowed sites may be more reflective of underlying geology than anthropogenic activity. Therefore, evaluations of how the spatial patterning of elements differs between plow zone and underlying strata can add to a small but growing understanding of how and where soil chemistry can be applied to recover meaning from spatial data at plowed sites such as Wingo's. Knowing which methods and elements may or may not yield interpretable results from subsoil could potentially aid in the recovery of information from stripped or looted sites, salvage projects, and sites or areas that underwent plow zone excavation without prior soil chemical sampling.

All subsoil samples were identically stored, processed, prepared, and assayed with pXRF using the same procedures as plow zone and feature samples. Comparative analysis between plow zone and subsoil samples occurred only within the group of 72 units where both contexts were sampled and analyzed. Therefore, the chemical data for plow zone were remapped in addition to subsoil distributions, with only those 72 locations as data points so that the plow zone patterning would not reflect the additional samples from units and areas where subsoil had not also been chemically analyzed.

a. Results

Statistical comparison of subsoil and plow zone contexts for Mg, P, K, and Ca shows that only phosphorus (Pearson's = 0.214, $p = 0.071$) does not exhibit a statistically significant relationship between subsoil and plow zone contexts (Table 6). Both potassium (Pearson's = 0.643, $p < 0.001$) and calcium (Pearson's = 0.557, $p < 0.001$) have strong and statistically significant correlations between subsoil and plow zone. Magnesium's correlation is somewhat less strong but still significant (Pearson's = 0.357, $p = 0.002$). These results suggest that subsoil values for Mg, K, and Ca will likely be similar to plow zone and interpretable as archaeological evidence of anthropogenic activity. The fact that phosphorus does not share that relationship is likely due to the well-known stability and resistance to leaching of P within soil due its capacity to form strong bonds with other abundant soil elements such as iron, aluminum, and calcium (Smeck 1985; Stevenson and Cole 1999). This result also indicates the most studied and widely applied element in archaeological soil chemistry is not a viable option for understanding anthropogenic inputs through subsoil sampling on a plowed site. These results also support Fischer's (2001:95) findings in a similar comparison of the Quarter site at Poplar Forest, another plowed slave quarter site in Piedmont Virginia with similar geological and soil properties.

Spatially, the distributions of magnesium and potassium in the subsoil appear somewhat similar to their respective plow zone distributions (Figure 17). While the exact positioning and intensity of chemical enrichment varies, in general the areas immediately around the domestic structure and within the western enclosure appears to have the most intense chemical enrichment of the subsoil. Calcium varies in subsoil and plow zone slightly, however phosphorus distributions vary significantly (Figure 18). That variation could potentially influence differences in interpretation between analyses of either the plow zone or subsoil contexts alone.

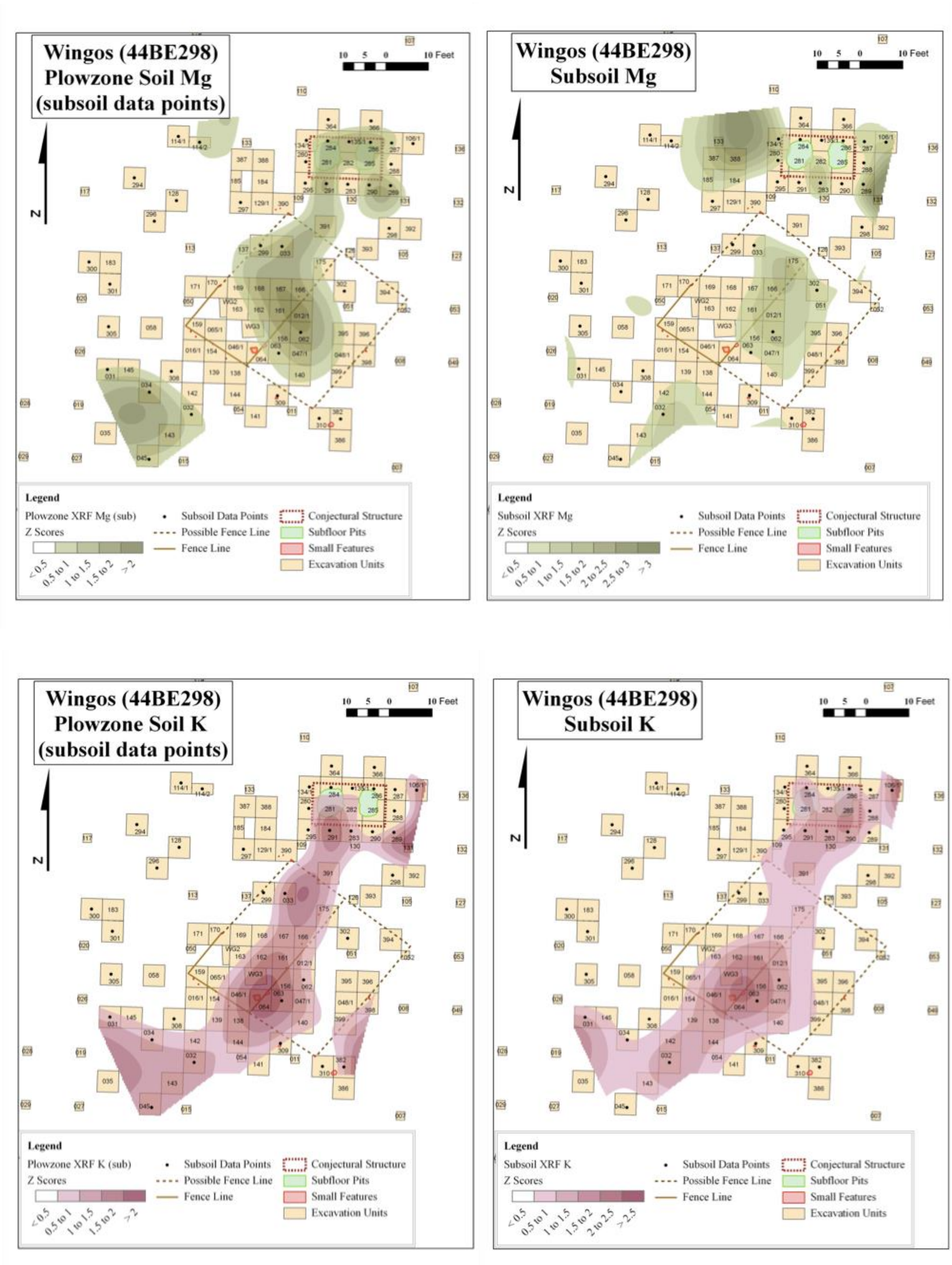

Figure 17: Distributions comparing plowzone (left) and subsoil (right) values of magnesium (top) and potassium (bottom) at Wingo's.

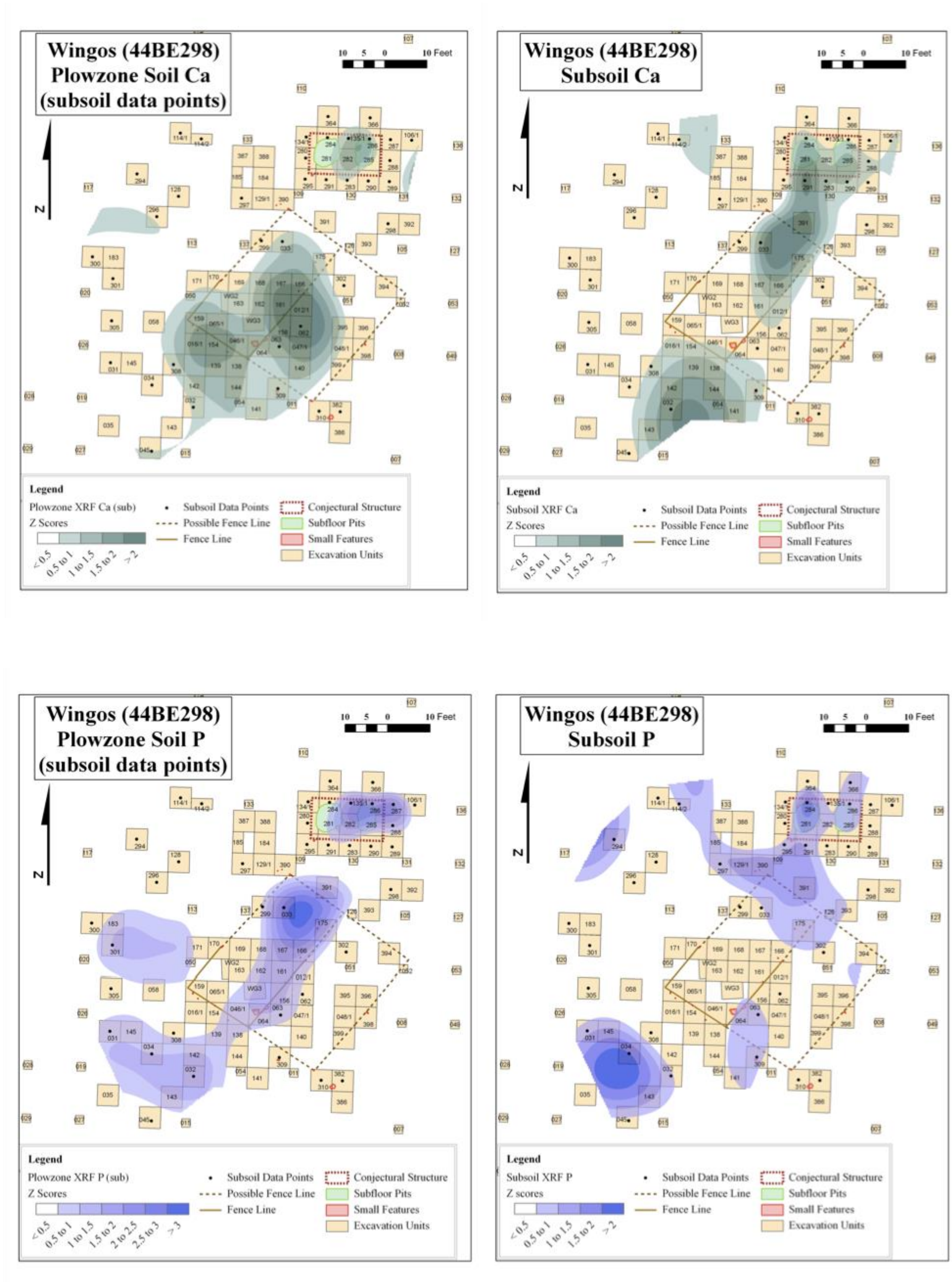

Figure 18: Distributions comparing plow zone (left) and subsoil (right) values of calcium (top) and phosphorus (bottom) at Wingo's.

Table 6: Correlations for subsoil elements versus plow zone elements and artifacts at Wingo's.

		sub_P	sub_K	sub_Ca	sub_Mg
pz P	Pearson Correlation	.214	.392**	.494**	.319**
	Sig. (2-tailed)	.071	.001	.000	.006
	N	72	72	72	72
pz K	Pearson Correlation	.349**	.643**	.654**	.475**
	Sig. (2-tailed)	.003	.000	.000	.000
	N	72	72	72	72
pz Ca	Pearson Correlation	.118	.430**	.557**	.417**
	Sig. (2-tailed)	.323	.000	.000	.000
	N	72	72	72	72
pz Mg	Pearson Correlation	.351**	.463**	.614**	.357**
	Sig. (2-tailed)	.002	.000	.000	.002
	N	72	72	72	72
Bone (count)	Pearson Correlation	.075	.220	.377**	.273*
	Sig. (2-tailed)	.529	.064	.001	.020
	N	72	72	72	72
Nails (count)	Pearson Correlation	.244*	.461**	.736**	.374**
	Sig. (2-tailed)	.039	.000	.000	.001
	N	72	72	72	72
Daub (weights)	Pearson Correlation	.158	.261	.514**	-.057
	Sig. (2-tailed)	.351	.118	.001	.737
	N	37	37	37	37
Tobacco pipes (count)	Pearson Correlation	.101	.226	.165	.324**
	Sig. (2-tailed)	.400	.056	.165	.005
	N	72	72	72	72
Creamware (count)	Pearson Correlation	.036	.163	.339**	.343**
	Sig. (2-tailed)	.763	.171	.004	.003
	N	72	72	72	72
Richness (count of types)	Pearson Correlation	.244*	.548**	.634**	.487**
	Sig. (2-tailed)	.039	.000	.000	.000
	N	72	72	72	72
Total historic artifacts	Pearson Correlation	.234*	.524**	.750**	.399**
	Sig. (2-tailed)	.048	.000	.000	.001
	N	72	72	72	72

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

b. Discussion

The subsoil distributions at Wingo's, specifically of potassium, calcium, and to a lesser extent magnesium, do appear as generally representative of the overlying plowzone distributions.

Statistical comparisons of these subsoil values against overlying artifact distributions from the plow zone further bolsters these conclusions (Table 6). Subsoil potassium is correlated strongly and significantly to artifact richness (Pearson = .548, $p < .001$) and total counts (Pearson = .524, $p < .001$). Potassium in subsoil also follows nail distributions to a slightly lesser extent (Pearson = .461, $p < .001$), which follows patterns seen in plow zone chemistry and may represent a correlation between ash deposition and the wood construction of the enclosure, possible pen, and domestic structure. This pattern could result both from activities such as cooking within certain areas, ash tipping, or more general refuse deposition.

Calcium appears to be the best general purposive indicator of human activity in subsoil at Wingo's, as it is highly correlated with artifact richness (Pearson = .634, $p < .001$) and total counts (Pearson = .750, $p < .001$). Nails, daub, bone and creamware also correlate spatially with calcium, suggesting its deposition both in association with domestic refuse and possibly specific activities such as butchering and bone deposition. Magnesium also correlates generally to artifact counts (Pearson = .399, $p = .001$) and richness (Pearson = .487, $p < .001$), but to a lesser extent than calcium or potassium, and may be roughly indicative of refuse disposal. Its relatively strong correlations to both potassium and calcium, along with artifacts like nails and bones, could associate it with ash deposition.

Not surprisingly, subsoil phosphorus does not appear in association with specific artifact distributions and is only weakly correlated to artifact richness (Pearson = .244, $p = .039$) and totals (Pearson = .234, $p = .048$). Therefore, this study suggests that phosphorus analysis of subsoil contexts is of little utility on plowed sites, neither being indicative of the locations of general refuse deposition nor specific activity areas. Potassium, calcium, and to a lesser extent magnesium values from subsoil contexts should be viable options for soil chemistry analysis of this kind and these conclusions are further supported by the Moran's I spatial autocorrelation statistics (Table 7) for the subsoil distributions at Wingo's, which show that potassium, calcium, and magnesium do exhibit statistically significant clustering. Phosphorus from the subsoil does not exhibits spatial clustering, and that patterning may likely be due to random chance and not anthropogenic inputs.

Table 7: Spatial autocorrelation (Moran's I) statistics for subsoil element distributions at Wingo's.

Measure	Element	Moran's I	Z score	P value
pXRF	Phosphorus	0.06 (random)	1.38	> 0.10
pXRF	Potassium	0.39 (clustered)	7.87	< 0.01
pXRF	Calcium	0.58 (clustered)	11.49	< 0.01
pXRF	Magnesium	0.17 (clustered)	3.45	< 0.01

6. Conclusions

The preceding report has provided site history, questions, research methods, and results of soil chemistry analysis; which is only one facet of the analyses ongoing at the site. The addition of soil chemistry to historical document research, artifact studies, and other analyses has yielded an increased understanding of the vernacular yard-space and landscape at Wingo's. With the post-depositional process of plowing, few physical remains of the structures and spaces at Wingo's have been preserved. Despite these limitations, a picture of the domestic landscape at Wingo's can be glimpsed through a combination of soil chemistry and artifact distributions. Two initial observations indicate the potential interpretive directions of Wingo's landscape. Many studies of slave quarters since the 1980s have emphasized the importance of spaces

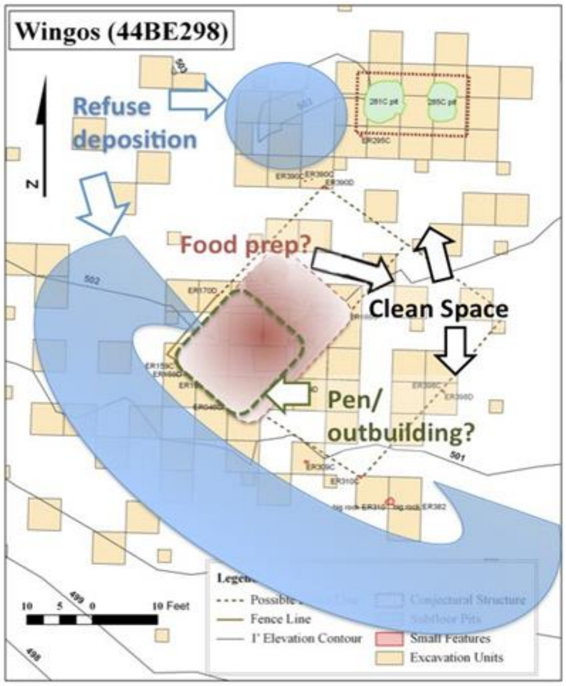

Figure 19: Map of Wingo's showing areas with uses interpreted through artifact and soil chemistry distributions.

outside and around domestic buildings, even suggesting a pattern of African American landscape use that centers on outdoor daily activities and social interactions (Heath and Bennett 2000), whereas those activities in white landscapes were more likely to occur indoors with general refuse disposal clustering near structures (Fesler 2010). Whether based either on West and Central African traditions or reactions to the conditions of North American slavery, or a combination thereof, the artifact and soil chemistry data at Wingo's support the interpretation that outdoor space was organized and utilized for multiple kinds of activities (Figure 19). To the west of the domestic structure and southwest of the enclosure, areas of major refuse deposition, or middens are clearly identifiable in both chemical and artifact distributions. Within the western half of the enclosure are chemical signatures but fewer and more limited artifacts that suggest activities such as gardening, butchering, and or cooking. In the southern portion of the same west half, a concentration of nails suggests the possibility of a small livestock pen or outbuilding. Immediately south of the structure and extending in the eastern half of the enclosure are cleaner spaces, still likely utilized with the occupants of Wingo's, but for less messy activities that could include daily chores, leisure, or activities associated with socializing.

Second, the orientation of the yard spaces at Wingo's are arranged at roughly a 45 degree angle offset from the apparent east-west orientation of the domestic structure as indicated by the two subfloor pits. Fesler (2006; 2010) has argued that spatial arrangements were shaped, used, and perceived by enslaved occupants in different ways than managers and planters may have intended. Drawing on ideas from Lefebrve (1991) and Tilley (1994), this argument is grounded in the idea that multiple participants can culturally construct any given physical location in several different meaningful ways. While a slave-owner may have conceived and imposed the nature and placement of a cabin according to his economic needs and desire for discipline, slaves could mold that space through use that spoke to their own needs when not attending to the demands of managers and owners (Heath 2001). These interpretive avenues are only mentioned briefly in this report as possibilities for the discussions of meaning and significance of the vernacular landscape at Wingo's.

Furthermore, studies of subsoil chemical distributions at Wingo's show that while certain elements such as calcium and potassium exhibit spatial continuity between plow zone and subsoil contexts, phosphorus does not. Thus, the well-known interpretability of soil phosphorus on archaeological sites is limited to the upper strata of a site, in this case the plow zone. This is likely due to the relative immobility of phosphorus in soils, which while making soil phosphorus patterning highly significant due to its longevity, also makes it unable to move vertically down the soil profile. Therefore, in instances where the topsoil or plow zone has been removed without soil sampling, phosphorus can no longer be analyzed as an anthropogenic signature. However, elements such as calcium and potassium do appear vertically mobile and may serve as viable options for interpretive soil chemistry analysis on sites where the topsoil or plow zone has been lost or removed.

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Appendix A: Data

Note: All pXRF data is recorded in counts per second, and all Mehlich 3 control method data is in pounds per acres.

ER #	Context	xrf Mg	xrf P	xrf K	xrf Ca	M3 P	M3 K	M3 Ca	M3 Mg
012B/1	Plowzone	18	23	185	319	7.35	50.34	1514.78	209.60
016B/1	Plowzone	21	19	242	447	8.13	42.27	1677.65	182.98
031B	Plowzone	19	26	223	353	7.22	91.98	1249.56	225.08
032B	Plowzone	20	29	240	382	10.09	123.36	1447.14	228.29
033B	Plowzone	24	35	246	393	7.29	160.48	1361.70	240.57
034B	Plowzone	25	27	230	305	5.49	47.16	1177.47	195.36
045B	Plowzone	21	21	239	377				
047B/1	Plowzone	13	20	202	369				
048B/1	Plowzone	14	19	163	274				
058B	Plowzone	19	35	232	458				
062B	Plowzone	28	24	229	512				
063B	Plowzone	21	26	270	435				
064B	Plowzone	16	34	269	502				
065B/1	Plowzone	15	29	199	476				
106B/1	Plowzone	12	21	237	315				
114/1B	Plowzone	15	17	169	233				
114/2B	Plowzone	19	14	173	275				
128B	Plowzone	13	17	153	304				
134B/1	Plowzone	16	22	205	320				
135B/1	Plowzone	24	31	205	409				
139B	Plowzone	19	25	238	424	11.04	35.02	1708.80	204.43
140B	Plowzone	15	24	193	342	5.90	57.26	1452.48	211.73
141B	Plowzone	15	17	203	354	5.40	39.78	1472.06	204.52
142B	Plowzone	13	13	160	360	6.69	51.82	1622.47	191.71
143B	Plowzone	19	15	215	429	5.11	42.64	1350.13	213.16
144B	Plowzone	18	23	243	446	7.61	34.16	1691.00	211.64
145B	Plowzone	11	17	192	385	6.56	34.42	1302.07	214.67
156B	Plowzone	14	22	224	453	8.10	63.37	1669.64	201.76
159B	Plowzone	15	27	213	489	12.26	110.66	1682.10	186.81
161B	Plowzone	17	18	176	384	5.71	54.26	1695.45	220.19
162B	Plowzone	24	23	187	368	7.46	109.34	1659.85	205.15
166B	Plowzone	23	23	196	410	7.32	82.73	1610.01	261.30
167B	Plowzone	26	36	277	424	9.94	92.69	1524.57	217.43
168B	Plowzone	16	26	209	399	12.51	114.79	1366.15	208.88
169B	Plowzone	21	21	232	384	6.36	79.26	1673.20	204.34
170B	Plowzone	13	25	240	470	14.27	48.42	1624.25	185.83
171B	Plowzone	15	25	243	468	9.38	48.18	1611.79	186.28
175B	Plowzone	14	27	241	399	3.67	57.88	1467.61	249.11
183B	Plowzone	22	30	186	388	13.11	252.82	1511.22	191.80
184B	Plowzone	21	23	243	382				
185B	Plowzone	24	25	212	364				

ER #	Context	Mg	P	xrf K	Ca	M3 P	M3 K	M3 Ca	M3 Mg
280B	Plowzone	13	20	206	327				
281B	Plowzone	28	24	219	359				
282B	Plowzone	15	23	255	422				
283B	Plowzone	15	23	231	377				
284B	Plowzone	22	23	200	340				
285B	Plowzone	15	24	184	536				
286B	Plowzone	24	31	205	409				
287B	Plowzone	20	32	201	277				
288B	Plowzone	17	28	177	331				
289B	Plowzone	23	19	235	326				
290B	Plowzone	23	18	205	314				
291B	Plowzone	25	23	266	336				
294B	Plowzone	11	19	181	288				
295B	Plowzone	14	18	204	294				
296B	Plowzone	9	20	153	370	6.00	98.85	1465.83	210.31
297B	Plowzone	12	20	167	309				
298B	Plowzone	13	21	174	233	3.08	73.80	1027.95	204.17
299B	Plowzone	21	25	185	350	6.89	42.20	1216.63	200.61
300B	Plowzone	15	22	196	342	7.98	135.34	1415.99	194.29
301B	Plowzone	11	27	159	281	10.88	146.41	1322.54	193.75
302B	Plowzone	15	17	171	330	5.12	108.61	1250.45	208.79
305B	Plowzone	9	23	154	311	6.75	69.77	1302.07	208.26
308B	Plowzone	14	24	196	391	8.63	30.54	1448.03	164.27
309B	Plowzone	17	18	216	395	7.15	75.14	1674.09	199.09
310B	Plowzone	10	21	178	311	7.45	36.63	1148.10	162.43
311B	Plowzone	9	20	172	296				
313B	Plowzone	19	17	194	259				
314B	Plowzone	19	22	206	255				
315B	Plowzone	10	20	180	277				
316B	Plowzone	11	19	170	237				
317B	Plowzone	12	15	163	246				
318B	Plowzone	15	16	179	277				
319B	Plowzone	9	21	148	489				
320B	Plowzone	8	17	151	256				
321B	Plowzone	17	20	204	197				
322B	Plowzone	13	19	161	292				
323B	Plowzone	11	17	158	276				
324B	Plowzone	12	22	160	233				
325B	Plowzone	9	26	219	305				
329B	Plowzone	10	19	176	257				
330B	Plowzone	23	21	194	241				
331B	Plowzone	16	17	170	272				
338B	Plowzone	8	28	195	232				
339B	Plowzone	17	18	206	234				
340B	Plowzone	15	21	165	253				
341B	Plowzone	9	10	188	199				
342B	Plowzone	12	15	175	261				

ER #	Context	Mg	P	xrf K	Ca	M3 P	M3 K	M3 Ca	M3 Mg
343B	Plowzone	16	14	210	224				
344B	Plowzone	15	25	144	237				
345B	Plowzone	12	18	159	217				
346B	Plowzone	12	18	195	236				
347B	Plowzone	11	21	198	227				
348B	Plowzone	17	20	166	248				
349B	Plowzone	9	22	180	220				
350B	Plowzone	13	14	177	249				
351B	Plowzone	13	16	182	288				
352B	Plowzone	13	18	155	212				
353B	Plowzone	12	15	196	227				
354B	Plowzone	8	19	148	256				
355B	Plowzone	14	20	131	278				
364B	Plowzone	11	16	163	315				
366B	Plowzone	15	14	151	291				
382B	Plowzone	7	21	232	232	7.69	142.58	1059.10	161.71
386B	Plowzone	14	26	198	324	7.61	60.05	1250.45	192.33
387B	Plowzone	12	17	183	293				
388B	Plowzone	10	20	205	321				
390B	Plowzone	14	22	190	312				
391B	Plowzone	14	18	160	293				
392B	Plowzone	12	18	188	322				
393B	Plowzone	11	18	235	285				
394B	Plowzone	11	23	195	301				
395B	Plowzone	7	23	144	297				
396B	Plowzone	13	21	207	302				
398B	Plowzone	15	26	224	285				
399B	Plowzone	16	23	218	267				
PZ01	Plowzone	9	14	204	342				
PZ02	Plowzone	18	13	203	290				
PZ03	Plowzone	13	22	177	260				
PZ04	Plowzone	16	10	260	314				
PZ05	Plowzone	12	25	181	312				
PZ06	Plowzone	10	20	176	249				
PZ07	Plowzone	23	22	150	356				
PZ08	Plowzone	10	16	208	265				
PZ09	Plowzone	16	13	198	360				
PZ10	Plowzone	9	19	206	262				
PZ11	Plowzone	14	17	196	315				
PZ12	Plowzone	16	23	150	255				
PZ13	Plowzone	16	19	198	322				
PZ14	Plowzone	14	17	201	258				
PZ15	Plowzone	12	18	209	366				
PZ16	Plowzone	18	20	176	254				
PZ17	Plowzone	9	18	163	364				
PZ18	Plowzone	18	20	209	315				
PZ19	Plowzone	10	17	211	259				

ER #	Context	Mg	P	xrf K	Ca	M3 P	M3 K	M3 Ca	M3 Mg
PZ20	Plowzone	14	18	196	309				
PZ21	Plowzone	14	19	182	279				
PZ22	Plowzone	6	19	195	293				
PZ23	Plowzone	20	19	213	317				
PZ24	Plowzone	11	24	209	321				
PZ25	Plowzone	11	12	165	275				
PZ26	Plowzone	7	21	239	278				
PZ27	Plowzone	11	18	179	308				
PZ28	Plowzone	11	24	237	345				
PZ29	Plowzone	12	9	198	279				
PZ30	Plowzone	14	22	204	268				
PZ31	Plowzone	8	16	162	345				
PZ32	Plowzone	8	18	197	287				
PZ33	Plowzone	10	17	231	312				
PZ34	Plowzone	14	9	215	265				
PZ35	Plowzone	14	22	185	368				
PZ36	Plowzone	8	13	219	265				
PZ37	Plowzone	11	18	208	265				
PZ38	Plowzone	12	17	204	297				
PZ39	Plowzone	21	13	164	307				
PZ40	Plowzone	9	13	249	249				
PZ41	Plowzone	11	15	209	299				
PZ42	Plowzone	14	18	232	289				
PZ43	Plowzone	11	18	189	319				
PZ44	Plowzone	11	22	231	347				
PZ45	Plowzone	13	27	191	308				
PZ46	Plowzone	20	20	179	310				
PZ47	Plowzone	10	18	211	267				
PZ48	Plowzone	17	22	223	251				
PZ49	Plowzone	10	19	191	339				
031Su	Subsoil	21	26	220	283				
032Su	Subsoil	26	24	232	397				
033Su	Subsoil	22	23	189	381				
034Su	Subsoil	10	35	200	300				
045Su	Subsoil	20	22	183	301				
062Su	Subsoil	27	20	230	314				
063Su	Subsoil	22	24	251	309				
106Su/1	Subsoil	26	16	243	311				
114/1C	Subsoil	12	20	116	262				
114/2C	Subsoil	19	24	143	314				
128C	Subsoil	13	11	146	256				
134Su/1	Subsoil	28	14	175	268				
135Su/1	Subsoil	15	23	182	291				
280Su	Subsoil	24	18	169	267				
283Su	Subsoil	29	21	227	352				
284Su	Subsoil	17	32	219	339				
286Su	Subsoil	18	26	209	312				

ER #	Context	Mg	P	xrf K	Ca	M3 P	M3 K	M3 Ca	M3 Mg
287Su	Subsoil	24	20	190	269				
288Su	Subsoil	21	20	212	324				
289Su	Subsoil	29	16	198	309				
290Su	Subsoil	14	20	237	346				
291Su	Subsoil	16	27	224	408				
294C	Subsoil	13	28	90	244				
295D	Subsoil	14	25	195	271				
296C	Subsoil	10	13	141	264				
297C	Subsoil	19	26	168	288				
298C	Subsoil	10	19	151	266				
299C	Subsoil	11	18	158	255				
300C	Subsoil	11	17	123	274				
301C	Subsoil	20	20	159	284				
302C	Subsoil	24	23	193	249				
305C	Subsoil	20	18	139	275				
308C	Subsoil	13	18	186	319				
309D	Subsoil	16	24	194	327				
310Su	Subsoil	20	21	174	264				
311C	Subsoil	15	23	150	184				
312C	Subsoil	14	23	219	300				
314C	Subsoil	18	17	146	216				
315C	Subsoil	9	17	181	269				
316C	Subsoil	14	18	210	250				
317B/2	Subsoil	16	19	151	224				
318C	Subsoil	11	11	134	217				
319C	Subsoil	16	16	161	194				
320C	Subsoil	10	13	123	194				
321C	Subsoil	12	24	142	216				
322C	Subsoil	13	23	121	237				
323C	Subsoil	13	20	161	239				
324C	Subsoil	13	14	188	227				
325C	Subsoil	20	14	194	270				
329C	Subsoil	12	20	142	222				
330C	Subsoil	19	20	171	275				
331C	Subsoil	16	11	168	203				
338C	Subsoil	17	25	185	229				
339C	Subsoil	15	23	154	247				
340C	Subsoil	18	23	198	288				
341C	Subsoil	16	18	146	221				
342C	Subsoil	11	19	194	240				
343C	Subsoil	14	27	210	239				
344C	Subsoil	11	17	143	223				
345C	Subsoil	11	14	166	224				
346C	Subsoil	22	26	167	213				
347C	Subsoil	11	12	163	225				
348C	Subsoil	14	18	155	244				
349C	Subsoil	9	19	168	198				

ER #	Context	Mg	P	xrf K	Ca	M3 P	M3 K	M3 Ca	M3 Mg

350C	Subsoil	18	17	179	216
351C	Subsoil	13	15	131	197
352C	Subsoil	20	22	148	210
353C	Subsoil	10	21	153	237
354C	Subsoil	11	25	164	217
355C	Subsoil	10	15	135	212
363C	Subsoil	24	17	171	203
364C	Subsoil	10	19	160	263
366C	Subsoil	15	25	155	233
382C	Subsoil	12	22	179	276