



2009 ARCHAEOLOGICAL INVESTIGATIONS AT THE WALTERS, BEEDLE, AND LYON LOTS, LINCOLN HOME NATIONAL HISTORIC SITE



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Archeological Report 5

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NATIONAL PARK SERVICE
Midwest Archeological Center

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AVAILABLE

Making the report available meets the criteria of 43CFR Part 7, Subpart A, Section 7.18 (a) (1).



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INTRODUCTION

Established in 1971, the Lincoln Home National Historic Site (LIHO) commemorates the life of the 16th President of the United States. The park contains the neighborhood where Abraham Lincoln spent most of his adult life in Springfield, Illinois (Townsend 2008:76-149). The Park consists of a four-block historic neighborhood, which is partly restored to the year of Abraham Lincoln's election as President. The centerpiece of the park consists of the restored house where Lincoln's family lived from 1844 to 1861, when he became the 16th President of the United States.

The Walters, Beedle, and Lyon house lots are located in the northeastern corner of the park (Figure 1). Archeological inventory and evaluation were requested by the park as part of the replacement project for the existing heating, ventilation, and air conditioning (HVAC) system at the Lyon and Beedle houses. LIHO proposed the installation of two sets of geothermal wells in the currently vacant Walters lot, with HVAC lines running from the geothermal wells to the Beedle and Lyon houses. Archeological inventory and evaluation were performed to gain information that will advise the park in the placement of wells and HVAC lines, minimizing impact to archaeological deposits within the project area. Geophysical survey covered all three lots, and those results were used to plan subsurface investigations. Evaluation focused on the areas most affected by ground-disturbing activities proposed in the plan provided by LIHO.

All field records and artifacts were accessioned as LIHO-424 and MWAC-1306A (geophysical data collection) and MWAC-1306B (subsurface inventory and testing). They are curated at the Midwest Archeological Center while undergoing study and will be transferred to Lincoln Home National Historic Site for permanent curation upon completion of the project.

ENVIRONMENTAL SETTING

Lincoln Home National Historic Site is located in the Till Plains section of the Central Lowland province of the Interior Plains division of the North American continent (Fenneman 1938:499-518). The region is relatively young with a moderately to strongly dissected rolling Illinoian till plain covered by moderate amounts of Wisconsinian age loess. The loess-mantled plains are dissected by the Sangamon River and its South Fork (Steinkamp 1980:1). The region is underlain with Pennsylvanian limestones, shales, and siltstones (USDA 2006:337).

The area lies within the Illinoian biotic province (Dice 1943:21-23). The province is covered with alternating prairies and deciduous forests. Tall prairie grasses include big bluestem, indiangrass, prairie dropseed, and switchgrass (USDA 2006:338). The region lies within the oak-hickory deciduous forests of the Eastern United States with basswood, walnut, hickory, sugar maple, white ash, black oak, shingle oak, and white oak found on better-drained soils on scattered upland locations while silver maple, cottonwood, sycamore, and black willow are found on the flood plains along major streams. Wildlife in the region includes white-tailed deer, cottontail rabbit, coyote,

red fox, raccoon, skunk, opossum, muskrat, squirrel, and smaller mammals (Shelford 1963:328-355; USDA 2006:338). Turkey, Canada goose, red-tailed hawk, great horned owl, blue heron, redheaded woodpecker, quail, mallard duck, and wood duck are among the numerous avifauna present in the region along with a variety of song birds (Shelford 1963:328-355; USDA 2006:338). A variety of reptiles, amphibians, and insects are also present in the region (Shelford 1963:328-355). Several species of fish, such as bluegill, sunfish, crappie, catfish, carp, largemouth bass, and mussels are found in the streams (Shelford 1963:328-355; USDA 2006:338).

The dominant soils included mollisols, entisols, inceptisols, and alfisols (USDA 2006:337-338). The soils in the region have a mesic soil temperature regime with aquic or udic soil moisture regimes. The soils have a mixed mineralogy. The project area lies within the Ipava-Tama-Sable soil association of “nearly level to strongly sloping, somewhat poorly drained, well drained, and poorly drained, moderately permeable and moderately slowly permeable soils; on uplands” (Steinkamp 1980:3-4). The project area is located within the urban land soil-mapping unit (533). This unit consists of nearly level to gently sloping soil material that has been severely impacted by the construction of streets, buildings, parking lots, and other structures (Hornickel 2004:100; Steinkamp 1980:38). Originally, the soils formed in calcareous loess, which covered the uplands.

The area has a temperate continental climate with moderate temperatures and wide seasonal variations, including long hot summers and cold winters (Hornickel 2004:15,148-149; Steinkamp 1980:1-2,88-89; Trewartha and Horn 1980:297-302; USDA 2006:337). The average January temperature is -4° C with an average daily minimum temperature of -8.4° C while the average July temperature is 24.7° C with an average daily maximum temperature of 30.6° C. Average annual precipitation is 91 cm. Average snowfall for the year is 61.2 cm. Thunderstorms commonly occur in the late spring and summer months. The number of frost-free days averages 185 days.

HISTORIC BACKGROUND

The project area covering the Lyon, Beedle, and Walters lots at Lincoln Home encompasses lots 13-16 of Block 7 of the Elijah Iles addition to Springfield, Illinois. Elijah and Malinda Iles sold several lots, including 14, 15, and 16 to Peter Van Bergen in 1836, who sold these lots to William Walters in 1839. The Iles’ sold lots 12 and 13 to Abraham Lincoln in 1838, who kept the property until selling Lot 13 and the north half of Lot 12 to Alexander Graham in 1853 (Banton et al. 1987).

Walters

The north end of Block 7 is known as the Walters lot. This is by far the most complicated in terms of land use and structural history of the three project areas. Newspaper man William Walters purchased lots 14, 15, and 16 in 1839. It is assumed that he built the house shown on early maps as a two-story frame structure, built in an ell on the corner of 8th and Capitol Ave (formerly Market St). He lost it in 1845, but his brother-in-law, Charles Lanphier, paid the debts and assumed ownership. Lanphier deeded the property back to his sister, Anna Walters, in 1849, after William Walters’

death (Banton et al. 1987). Anna ran a boarding house on the west end of lots 16 and 15, living in the house just to the south (discussed below), and left the neighborhood in 1864.

Before she left, Walters sold the south 10 ft of Lot 14 to Henson Lyon and then sold the north portion of Lot 14 and the south 8 ft of Lot 15 to Washington Crowder. The Walters property (i.e., the north part of Lot 15 and all of Lot 16) went through several owners between 1864 and 1890, when then-owner Elizabeth Booth divided it into east and west parcels. The west parcel, 87 ft wide, contained a large outbuilding at the southwest corner as of 1884 (Sanborn map shown on p. 177 of Banton et al. 1987). The east parcel, 65 ft in width, was largely filled with the boarding house.

Sometime after 1890, the outbuildings and boarding house were replaced with four two-story frame structures as shown in the 1896 Sanborn-Perris map (Banton et al. 1987). These structures, used as apartments and offices, changed and expanded over the subsequent decades. Slight modifications to these buildings were made through the years and are indicated in later Sanborn maps. Three of these buildings were purchased and removed by the NPS in the 1970s (Raynolds 1974); the western-most building was removed prior to NPS acquisition of the lot. NPS contracts called for removal of foundations, cellar floors, and architectural debris, with the resulting pits backfilled with “clean” off-site fill, and the area capped with topsoil (V. Pollock, personal communication 2009).

Beedle

The Beedle lot consists of the south 8 ft of Lot 15 and the north 30 ft of Lot 14 of Block 10 (Banton et al. 1987). The Beedle house was built around 1840, probably when lots 14-16 were owned by William Walters. As mentioned above, he transferred ownership to his sister, Anna, in 1849. She split the property around 1859, selling the south 10 ft to Harrison Lyon, and then transferring the Beedle lot (as described above) to Washington Crowder in 1864. This marked the first of six transfers of ownership by 1884; an additional four transfers occurred before ownership by the United States government in 1980. The Walters family owned the Beedle house for many years, using it as a rental property during the period of significance for LIHO (Banton et al. 1987). The Beedle house is named for one of those renters; William Beedle was a railroad worker who lived there around 1860.

Banton and colleagues (1987) interpreted architectural modifications made to the Beedle house over the years, based largely on interpretation of Sanborn maps. In summary: by 1884, the one-story structure of 1840 included a two-story front wing, an addition on the rear, and a north porch. Additionally, three sheds were in place along the west end of the lot. By 1896, the house had some changes in roofing and specific footprints, and only one shed stood along the rear of the lot. The house underwent drastic changes by 1917, with an extension of the north wall by 4 ft and a second story added to the rear ell. The outbuilding remained in the rear of the lot, however. No other structural changes were recorded in the Sanborn maps until NPS ownership.

Lyon

The Lyon House sits just south of the Beedle house, on the south 10 ft of Lot 14, all of Lot 13, and the north 20 ft of Lot 12. The house was built around 1854 by Alexander Graham, who had purchased Lot 13 and the north portion of Lot 12 from Abraham Lincoln in 1853. The property was transferred from Graham to another party, who sold it to Henson Lyon in 1857. This property subsequently transferred with the Lyon estate in 1868, and the south 10 ft of Lot 10 was added to the Lyon Lot sometime prior to 1918. In all, some eight separate families owned or occupied the Lyon House between the Lyon ownership and acquisition by the city of Springfield in 1969. Details on the chain of ownership are available in Banton et al. 1987.

The Area of Potential Effect (APE) for the current project only intersects the northwest corner of the house and lot adjacent to it. Little information on the original footprint of the structure is available, but Banton et al. (1987) indicate a one-story rear addition is evident on the 1884 Sanborn map, which was augmented slightly by 1896, then reduced by 20 ft by 1917. The overall footprint transformed during this span from an 85-ft long linear form to a shorter, broader floor plan. Part of this transition included the attachment of two single-story, 10-ft-x-10-ft additions to the rear of the house, the northernmost part of which intersects the APE for the current project.

Banton and colleagues (1987) indicate that the NPS waterproofed the northwest corner of the basement, installed plumbing, and repointed the foundation in 1983.

PREVIOUS INVESTIGATIONS

Beginning with the 1951 excavations by Richard Hagen in the backyard of the Lincoln House, more than 30 archeological projects have been undertaken at Lincoln Home NHS (Osborn 2001). They have sampled most of the lots at the park and ranged from full-scale excavations aimed at identifying structures, to small-scale emergency monitoring during infrastructure repairs, or assisting in restoration or stabilization activities.

Unlike the rest of the park, most of the Walters, Lyon, and Beedle house lots have not been subjected to formal archeological investigations. The only related project was archeological monitoring conducted by the park's Historical Architect during emergency electrical repairs at the Beedle house lot in 1991 (Krupka 1991). Francis Krupka documented manual excavation to locate the ends of a defective power line and subsequent mechanical excavation of a 30-in deep trench (averaging 4-6 in wide) within the previous line's existing trench fill.

Krupka documented a collection of building materials, housewares, personal items, faunal remains and mineral fragments from the utility trench, which extended from the northwest corner of the Beedle house Lot to the north wall of the house.

The author makes note of two historic cisterns in the Beedle Lot. "Historic Cistern No. 1" is located east of the back door of the house, just beyond the current

boardwalk location. “Historic Cistern No. 2” is plotted within a group of mature locust trees just north of the northeast corner of the house. Based on examination of drainage tiles recovered from the utility trench in these areas, Krupka believed the cisterns date to early 20th century (Krupka 1991:6). Unfortunately, the author does not reveal the source of information regarding the existence and location of these cisterns in his report.

While the scale of the project did not allow for any more extensive investigation and the trench passed through previously disturbed soils, the significance of some of the recovered artifacts suggest that potentially undisturbed archeological deposits are still present in the backyard of the Beedle house. This especially relates to the two cisterns, as well as outbuildings that once stood in the rear of the lot. Krupka also postulates a backyard rubbish pit in the west half of the back yard. Locations of the historic outbuildings and cisterns are shown in Figure 7.1.

INVENTORY: GEOPHYSICAL INVESTIGATIONS

Geophysical survey played an integral role in the inventory phase of the current project, providing a cost effective, systematic means to investigate the locations and extent of possible archeological features across the project area. To this end, NPS staff applied magnetic, resistance, conductivity, and ground-penetrating radar survey techniques across the three house lots. For administrative purposes, each house lot was considered an archeological site and has been assigned a state number. The Walters House Lot is assigned site number 11SG1373, The Beedle house Lot is 11SG1374, and the Lyon House Lot is 11SG1375.

Survey Methods

Initially, the Ushikata S-25 TRACON surveying compass was set up at the southwest corner of the Lyon House lot backyard. The geophysical grid was oriented 6.5° east of magnetic north. The wooden hub stake was placed 2.5 m north of the south yard fence and 2.5 m east of the west yard fence. From that initial mapping point, the north-south baseline was established along the west fence that separated the yards from the park’s bus parking lot. The north-south baseline extended 52 m to the north. The east-west baseline was established along the southern edge of the Lyon House lot and extended to 43 m to the east. Using the surveying compass and 100-m tape, the mapping station, and grid reference points used to establish the north-south and east-west base lines, the remainder of the geophysical grid corners were established in the three house lots that were included in the HVAC project. Two complete 20-m-x-20-m grid units and seven partial grid units, totaling 0.54 ac, were surveyed during the geophysical investigations at the geophysical project area of the three sites in Lincoln Home National Historic Site (Figure 2). Survey grid corner stakes in the three lots along with the fence corners separating the three lots were mapped with a Trimble GeoXH global positioning system (GPS) handheld receiver and external antenna.

Twenty-meter ropes were placed along the north-south base lines connecting the grid unit corners. These ropes formed the east and west boundaries of each grid

unit during the data collection phase of the survey. Additional ropes were placed at 1-m intervals across the grid unit in an east-west orientation. These ropes serve as guides during the data acquisition. The ropes were marked with different color tape at half-meter and meter increments designed to help guide the survey effort. A sketch map of surface features was completed for each survey area after the guide ropes were placed on the grids (Figure 2).

The four geophysical techniques utilized in this study include magnetic, conductivity, resistance, and ground-penetrating radar surveys. The following discussion presents a brief overview of each technique; more detail on methods and data processing related to these techniques can be found in DeVore (2006).

Magnetic Survey

Magnetic survey is a passive technique that records the local effects of magnetic materials on the earth's magnetic field. Anomalous conditions result from magnetic materials and minerals buried in the soil matrix. Iron artifacts have very strong effects on the local earth's magnetic field. Other cultural features that affect the local earth's magnetic field include fire hearths and soil disturbances (e.g., pits, mounds, wells, pithouses, and dugouts), as well as geological strata. Magnetic surveying applications to archeological investigations have included the detection of architectural features, soil disturbances, and magnetic objects/artifacts (Bevan 1991; Clark 2000:92-98; Gaffney et al 1991:6; Heimner and DeVore 1995, 2000; Weymouth 1986:343).

Magnetic field strength is measured in nanoteslas (nT; Sheriff 1973:148). In North America, the earth's magnetic field strength ranges from 40,000 to 60,000 nT with an inclination of approximately 60° to 70° (Milsom 2003:43; Weymouth 1986:341). The project area has a magnetic field strength of approximately 55,900 nT (Peddie 1992; Sharma 1997:72-73) with an inclination of approximately 68° 23' (Peddie and Zunde 1988; Sharma 1997:72-73). Magnetic anomalies of archeological interest are often in the ± 5 nT range, but may vary more over the historic features likely in the project area. Target depth in magnetic surveys depends on the magnetic susceptibility of the soil and the buried features and objects. For most archeological surveys, target depth is generally confined to the upper 1-2 m below the ground surface with 3 m representing the maximum limit (Clark 2000:78-80; Kvamme 2001:358).

A single fluxgate gradiometer was used to collect magnetic data at the three house lots in the geophysical project area, and the survey was designed to collect 8 samples per meter along 0.5-m traverses or 16 data values per square meter. The data were collected in a zigzag fashion with the surveyor alternating the direction of travel along each traverse across the grid. Sixty-four hundred data values were collected for a complete 20-m-x-20-m grid unit surveyed during the project. The magnetic data were recorded in the memory of the gradiometer and downloaded to a laptop computer at the completion of the survey. The magnetic data were imported into Geoscan Research's GEOPLOT software (Oswin 2009:76-79,135-136) for processing. Both shade-relief and trace-line plots were generated in the field to confirm successful data collection and transfer before the instrument's memory was cleared.

Conductivity Survey

Electromagnetic induction (EM or EMI) survey in the conductivity or quadrature phase is an active geophysical technique, in which an electromagnetic field is induced into the ground. This survey technique measures the apparent soil conductivity in millisiemens per meter (mS/m; Sheriff 1973:197). The present survey was conducted with a Geonics EM38 ground conductivity meter operating in the quadrature phase or conductivity component operating mode.

Differences in conductivity are related to electrical and magnetic properties of the soil matrix. Contrasting values may be caused by materials buried in the soil, differences in soil formation processes, or disturbances from natural or cultural modifications to the soil. EM instruments are also sensitive to surface and buried metals. Due to their high conductivity, metals show up as extreme values in the acquired data set. The application of conductivity to archeology relies on the ability of the instrument to detect lateral changes on a rapid data acquisition with high-resolution basis, where observable contrasts exist. Lateral changes in anthropogenic features result from compaction, structural material changes, buried metallic objects, excavation, habitation sites, and other features affecting water saturation (Heimmer and De Vore 1995:37).

The EM38 ground conductivity meter was connected to the DL720 Polycorder for digital data acquisition. Readings were collected every 0.25 seconds in 0.5-m traverses, resulting in 4 samples per linear meter and 8 samples per square meter across the three geophysical survey areas. The data were collected in a unidirectional mode, with the surveyor conducting the data acquisition in the same direction of travel for each traverse across the grid. The data and header files stored in the polycorder were downloaded into the laptop computer at the end of the survey. The survey of the grid unit began in the lower right hand or southwest corner of the grid, with the initial or first traverse headed towards the east. The EM38 was used in the quadrature or conductivity phase, the vertical dipole mode, and one orientation parallel to the direction of travel along the traverses. It provided an exploration depth of approximately 1.5 m with its effective depth around 0.6 m in the vertical dipole mode. The instrument was nulled and calibrated at the same point, to balance and align the instrument, before the start of each conductivity survey.

Thirty-two hundred data measurements were collected for each complete 20-m-x-20-m grid unit during the survey. The data were downloaded to a laptop computer at the end of each day's survey effort.

Resistance Survey

Resistance survey is an active geophysical technique, in which current is injected into the ground. Resistance (or resistivity) values relate to electrical properties of the soil matrix, and differences in the strength of the returning current are influenced by materials buried in the soil, differences in soil formation processes, and disturbances from natural or cultural modifications to the soil. In archeology, resistance survey is used to identify areas of compaction and excavation, as well as buried objects such as

brick or stone foundations. It is highly sensitive to contrasts in water saturation, directly related to soil porosity and permeability (Clark 2000; Heimmer and De Vore 1995:30); thus, this technique is especially useful for location of buried features affecting water saturation, such as wells, cisterns, and privies (Heimmer and De Vore 1995:37).

This resistance survey was performed using a Geoscan Research RM15-D resistance meter with the PA20 multiple-probe array. It was designed to collect 2 samples per meter along 0.5-m traverses or 4 data values per square meter. The data were collected in a zigzag fashion with the surveyor maintaining the alternating the direction of travel for each traverse across the grid beginning in the lower left-hand corner facing the grid or at the northwest corner of the grid. Sixteen hundred data values were collected for a complete 20-m-x-20-m grid unit with a traverse interval of 0.5 m. The resistance data were recorded in the memory of the resistance meter and downloaded to a laptop computer at the completion of each day's survey effort. The resistance data were imported into Geoscan Research's GEOPLOT software for processing. Both shade-relief and trace-line plots were generated before the instrument's memory was cleared.

Ground-Penetrating Radar Survey

The ground-penetrating radar (GPR) survey is an active geophysical technique that uses pulses of radar energy (i.e., short electromagnetic waves) transmitted into the ground through the surface-transmitting antenna. Radar waves are reflected off buried objects, features, or interfaces between soil layers. These reflections result from contrasts in electrical and magnetic properties of the buried materials or reflectors. The contrasts are a function of the dielectric constant of the materials (Sheriff 1973:51). The depth of the object or soil interface is estimated by the time it takes the radar energy to travel from the transmitting antenna and for its reflected wave to return to the receiving antenna. The depth of penetration of the wave is determined by the frequency of the radar wave. The lower the frequency, the deeper the radar energy can penetrate the subsurface; however, resulting resolution, or the ability to distinguish objects, features, and soil changes, decreases. These low-frequency antennas generate long-wavelength radar energy that can penetrate several tens of meters under certain conditions, but can only resolve larger targets or reflectors. The higher the radar wave frequency, the higher the resulting resolution but the penetration depth decreases. High frequency antennas generate much shorter wavelength energy, which may only penetrate a meter into the ground. The generated reflections from these high frequency antennas are capable of resolving objects or features with maximum dimensions of a few centimeters. A resulting trade-off exists between subsurface resolution and depth penetration: the deeper the penetration, the lower the resulting resolution.

The success of the survey is dependent on soil and sediment mineralogy, clay content, ground moisture, depth of the archeological resource, and surface topography and vegetation. The ground-penetrating radar signal can be lost or attenuated (i.e., quickly dissipated) in soils that have high moisture content, high electrical conductivity, highly magnetic materials, or high clay content. Dry soils and sediments, especially those with low clay content, represent the best conditions for energy propagation.

The TerraSIRch SIR System-3000 survey cart system operated an antenna at a nominal frequency of 400 megahertz (mHz). The antenna was mounted in a cart that recorded the location of the radar unit along the grid line. The GPR profiles were collected along 0.5 m traverses beginning in the southwest corner of the grid unit with the initial profile collected from west to east. The data were collected in a zigzag or bidirectional fashion with the surveyor alternating the direction of travel for each traverse across the grid. One hundred five radar profiles were collected across the geophysical project area in the three lots for a distance of 3,389 m.

Data Processing and Interpretation

Processing of geophysical data requires care and understanding of various strategies and alternatives (Kvamme 2001:365; Music 1995; Neubauer et al. 1996). Walker and Somers (Geoscan Research 2003) provide strategies, alternatives, and case studies on the use of several processing routines commonly used to process magnetic, resistance, and conductivity data in the GEOPLOT software. Kvamme (2001:365) provides a series of common steps used in computer processing of geophysical data:

Concatenation of the data from individual survey grids into a single composite matrix;

Clipping and despiking of extreme values (that may result, for example, from introduced pieces of iron in magnetic data);

Edge matching of data values in adjacent grids through balancing of brightness and contrast (i.e., means and standard deviations);

Filtering to emphasize high-frequency changes and smooth statistical noise in the data;

Contrast enhancement through saturation of high and low values or histogram modification; and

Interpolation to improve image continuity and interpretation.

It is also important to understand the reasons for data processing and display (Gaffney et al. 1991:11). They enhance the analyst's ability to interpret the relatively huge data sets collected during the geophysical survey. The type of display can help the geophysical investigator present an interpretation of the data to the archeologist who will ultimately use the information to plan excavations or determine the archeological significance of the site from the geophysical data.

For details regarding computer software used in geophysical data processing see De Vore 2006.

David (1995:30) defines interpretation as a "holistic process and its outcome should represent the combined influence of several factors, being arrived at through

consultation with others where necessary.” Interpretation may be divided into two different types: geophysical interpretation of the data and the archaeological interpretation of the data. At a simplistic level, geophysical interpretation involves the identification of the factors linked to contrasts in the geophysical data. Archeological interpretation takes the geophysical results and tries to apply cultural attributes or causes. In both cases, interpretation requires both experience with the operation of geophysical equipment, data processing, and archeological methods, and knowledge of the geophysical techniques and properties, as well as known and expected archeological phenomena. Although there is variation between sites, several factors should be considered in the interpretation of geophysical data. These may be grouped under natural factors (such as geology, soil type, geomorphology, climate, surface conditions, topography, soil magnetic susceptibility, and seasonality), and cultural factors (known and inferred archeology, landscape history, survey methods, data treatment, modern interference, etc.) (David 1995:30).

Each instrument responds primarily to a single physical property: magnetometry to soil magnetism, electromagnetic induction to soil conductivity, resistivity to soil resistance, and ground-penetrating radar to dielectric properties of the soil (Weymouth 1986:371).

The use of multiple instrument surveys provides the archeologist with very different sources of data that may provide complementary information for comparison of the nature and cause (i.e., natural or cultural) of a geophysical anomaly (Clay 2001). Further refinements in the geophysical interpretations may be made with feedback from subsequent archeological investigations.

Interpreting the Magnetic Gradient Data

Interpretation of the magnetic gradient data (Bevan 1998:24) from the project requires a description of the buried archeological feature or object (e.g., its material, shape, depth, size, and orientation). The magnetic anomaly represents a local disturbance in the earth’s magnetic field caused by a local change in the magnetic contrast between buried archeological features, objects, and the surrounding soil matrix. Local increases or decreases over a very broad uniform magnetic surface would exhibit locally positive or negative anomalies (Breiner 1973:17). Magnetic anomalies tend to be highly variable in shape and amplitude. They are generally asymmetrical in nature due to the combined effects from several sources. To complicate matters further, a given anomaly may be produced from an infinite number of possible sources. Depth between the magnetometer and the magnetic source material also affect the shape of the apparent anomaly (Breiner 1973:18). As the distance between the magnetic sensor on the magnetometer and the source material increases, the expression of the anomaly becomes broader. Anomaly shape and amplitude are also affected by the relative amounts of permanent and induced magnetization, the direction of the magnetic field, and the amount of magnetic minerals (e.g., magnetite) present in the source compared to the adjacent soil matrix. The shape (e.g., narrow or broad) and orientation of the source material also affects the anomaly signature. Anomalies are often identified in terms of various arrays of dipoles or monopoles (Breiner 1973:18-19). A magnetic object is made of magnetic poles (North or positive and South or negative). A simple

dipole anomaly contains the pair of opposite poles that are relatively close together. A monopole anomaly is simply one end of a dipole anomaly (and may be either positive or negative depending on the orientation of the object), with the other end too far removed to have an effect on the magnetic field.

Determining the type of cultural cause from magnetic data requires information on anomaly type and morphology. Isolated artifacts tend to appear as compact circles in contour outline, due to the small size of the objects in relation to the survey interval. Archeological features or dense clusters of artifacts are more likely to appear as lines or lenses. Magnetic anomalies may be associated with iron, but also other materials, such as fired earth or volcanic rock. Such materials are not usually distinguishable from the magnetic data collected during the survey (Bevan 1998:24).

The first step in interpreting the magnetic anomalies from the LIHO project area is to identify areas of high magnetic contrast, and especially the strong positive (North pole of the dipole) and the weak negative (South pole of the dipole) magnetic anomalies. Numerous magnetic anomalies from the single fluxgate gradiometer survey occur across the three lots (Figure 3). A number of linear magnetic anomalies appear to represent the locations of some of the buried utility lines in the three yards, including gas, water, electrical, and fiber optic communications. These modern features are identified by strong linear anomalies of positive and negative values arranged in a beaded fashion. Modern boardwalks are also identified as linear anomalies with alternating positive and negative values, similar to the buried utility lines, but with patterning of positive and negative values set much closer together.

In addition to the linear patterned anomalies, various monopole and dipole magnetic anomalies may represent archeological materials. Several isolated magnetic dipoles within the three yard sites may be ferrous materials, such as brick and nails, left after the demolition of the buildings. Other dipoles cluster in groups, which may also represent demolition materials. Other isolated magnetic dipole anomalies may represent buried ferrous objects, such as nails, bolts, or tools, lost in the yards of the three lots. This dataset is combined with those of the other instruments in order to augment interpretation and guide subsurface evaluative efforts, discussed below.

Interpreting the Conductivity Data

Interpretation of the conductivity data results in the identification of lateral changes in the soil matrix. The conductivity data may be divided into three classes of anomalies; linear anomalies, point anomalies, and broad anomalous areas. Linear anomalies may represent foundations of buildings, trenches, buried utility lines, paths, trails, or roads that are longer than they are wide. Point anomalies tend to represent buried objects or vertical structures such as cisterns, wells, or storage pits. Occasionally, these anomalies may have negative values resulting from the saturation of the receiving coil by the overwhelming conductive metal response of buried metals to the generated electromagnetic field. Comparisons between these negative conductivity anomalies and the magnetic anomalies can elucidate the nature of the buried object. If the magnetic and conductivity point anomalies coincide, it is assumed that the buried object is made from ferrous material. The presence of a magnetic anomaly and the lack of a

corresponding conductivity anomaly suggest that the magnetic anomaly is composed of non-metallic material such as fired clay typically found in fire related features (i.e., fire hearths or pits, concentrated areas of ceramics, ash lenses, or bricks). The presence of a negative conductivity anomaly, in the absence of a corresponding magnetic anomaly, strongly suggests that the buried object is some type of non-ferrous metal (e.g., brass, copper, lead, etc.). Broad anomalous areas typically represent large areas of soil disturbances or compaction often found associated with gardens, basements or cellars, parking pads, compacted dirt floors, or areas of concrete or asphalt.

There are a few negative value conductivity anomalies spread across the survey area (Figure 4). Several of these coincide with magnetic anomalies suggesting that the use of these two complementary data sets helps in the identification of the buried ferrous metal objects. In addition, the density of these point conductivity anomalies is much less than the associated magnetic dipole anomalies, suggesting that several magnetic anomalies represent other materials, such as bricks or other construction debris related to the demolition of the buildings or other remodeling episodes of the houses and other associated outbuildings. Other clusters of conductivity anomalies do not appear to be associated with the magnetic clusters but may also represent building locations in the yards of the three lots. The buried utility lines are present as linear conductivity anomalies and in several cases are better represented by the conductivity data than the magnetic data. The boardwalks and the board fence lines are also indicated by linear conductivity anomalies.

Interpreting the Resistance Data

Interpretation of the resistance data results in the identification of lateral changes in the soil. Since the array parameters are kept constant throughout the survey, the resulting resistance values vary with changes in the subsurface sediments/soil matrix and buried archeological resources. For each probe separation, the depth penetration is approximately the same as the distance between the current and potential probe on the mobile array frame, which is 0.5 m for this project. The resistance measurement for each point represents the average value for the hemispheric volume of soil with the same radius. If the soil below the survey area were uniform, the resistance would be constant throughout the area. Changes in soil characteristics (e.g., texture, structure, moisture, compactness) and the composition of archeological features result in differences in the resistance across the surveyed grid. Large general trends reflect changes in the site's geology, whereas small changes may reflect archeological features. An advantage to the resistance survey and its interpretation is its usefulness in areas that have high concentrations of metal objects such as the three project areas in this study.

The resistance data from the geophysical survey area illustrates a number of resistance anomalies (Figure 5). Several areas of contrasting resistance values appear to represent the locations of the buildings that have been removed from the three yards by the previous owners or by the National Park Service. Such areas are clearly indicated in the Walters lot and along the back fences in all three lots. Other locations near the houses may be areas of ash from the fireplaces or stoves that have been dumped outside the back doors of the houses.

Interpreting the Ground-Penetrating Radar Data

Analysis and interpretation of the GPR data may be conducted in several different ways. The individual radargrams for each profile line may be analyzed for hyperbolic reflections. The radargrams may be combined and processed to provide planar time slices of the data. The time slices may also be combined to form 3D cubes of the GPR data. The majority of the GPR radargrams show numerous small reflections along any given profile. Most of the analysis of the GPR data is done with the 3D display while moving through the numerous time slices, but in order to provide a graphic representation of the anomalous areas, an individual time slice was selected.

The ground-penetrating radar data from the geophysical project area, illustrated by the time slice 4 layer (Figure 6), contains a number of high-amplitude strength reflections across the three yards. Several of the GPR anomalies correspond to magnetic, conductivity, and resistance anomalies representing the board fences, boardwalks, buried utility lines, and foundation remains of historic buildings that once occupied the lots.

Combined Geophysical Data Set Interpretations

A different way of looking at the geophysical data collected during the investigations of the survey area is to combine the complementary data sets into one display. Several different geophysical anomalies overlap, suggesting a strong correlation between the geophysical data and buried archeological features (Ambrose 2005; Kvamme 2007:345-374). These areas of overlap would be considered areas of high probability for buried features, and given priority for ground-truthing, or test excavation. While these correlations are important, individual isolated occurrences also need ground-truthing in order to determine their unique nature as well. The locations of the possible buildings, outbuildings, privies, buried utility lines, artifact locations and concentrations are present in the geophysical data from the geophysical project area (Figure 7). Areas of particular archeological interest include the northeast corner of the project area, in the location of the previous Walters House (and subsequent structures); in the west end of the Beedle house lot in the location of previous outbuildings, and across the back yard of the Lyon House lot. A series of strong isolated anomalies through the center yard of the Beedle house lot also indicates the potential for artifacts and feature remnants within the path of planned activities.

Summary of geophysical results

Geophysical surveys resulted in the identification of numerous subsurface anomalies. The magnetic, conductivity, resistance, and ground-penetrating radar data collected at the three sites within the geophysical project area provided information on the physical properties (magnetic, soil conductivity, soil resistance, and ground-penetrating radar reflection properties) of the subsurface materials. Buried archeological resources identified may include remnants of buildings and their associated artifact deposits; artifact-rich features such as wells, privies, or cisterns; scattered artifacts associated with demolition; and buried modern and abandoned utility lines.

EVALUATION: SUBSURFACE INVESTIGATIONS

Geophysical data add to historical sources and previous archaeological work to develop a comprehensive view of potentially significant archeological deposits within the Area of Potential Effect (APE) for the geothermal well projects for the Beedle and Lyon houses. These sources of data are all relevant to design of evaluative testing efforts. Field work was limited to areas within the APE of the HVAC project: the geothermal well fields and lines. Specific focus within this area was given to testing locations of geophysical anomalies. Evaluation efforts are described here in relation to the APE within each house lot.

Walters

Two series of five geothermal wells are planned, at 10-ft (or greater) intervals, to be connected to manifolds somewhere on the Walters lot. Because the 1890s buildings were documented to have garden-level apartments, it is assumed that their complete removal would have severely disturbed or obliterated any remains of previous structures. It was determined that placing the well systems within the footprints of the removed 1890s buildings would avoid adverse impacts during the HVAC project in this area. Historical records and geophysical data were used to estimate the boundary of disturbances related to the building removal. Mechanical trenching was used to confirm the southern boundary of the two westernmost building footprints.

A small John Deere tractor, fitted with a 24-in toothless backhoe bucket, was used to open two trenches, one targeting the southern boundary of the westernmost building footprint (716 East Capitol), and a second aiming for the southern end of the next apartment building footprint to the east (720 East Capitol). Backhoe Trench (BHT) 1, placed on the Geophysical grid at 7-8 m East, extended from 31-37 m North (Figure 8). This excavation extended beyond the base of disturbance anticipated by geothermal lateral lines (V. Pollock, personal communication on-site).

BHT 1 revealed two sets of archeological deposits, separated by a dual drain tile (see profile in Figure 9). The southernmost portion of the trench contained low-fired bricks, soft mortar, and artifacts that date to the mid to late 19th century. The portion of the trench located north of the drain tiles contained construction debris more typical of the late 19th century, including high-fired bricks and fragments, and harder, highly consolidated (Portland cement) mortar. Figure 10 depicts examples of artifacts found north and south of the drain tile. It appears that the drain tiles were placed around the exterior of the late 19th-century building (or a later addition), while the area to the south retains at least partly intact deposits originating prior to 1896.

BHT 2 was placed at 17 m East, from 31 to 36 m North, in order to confirm the southern boundary of the next apartment building to the east (see profile in Figure 11). This trench was also excavated below the base depth anticipated for geothermal lines within the well field. The entirety of this trench appeared to be within the former building footprint, as the sediment profile revealed over 1 m of clean “bluff fill” (dark yellowish-brown silty clay) under approximately 40 cm of black clay loam,

presumably deposited as topsoil after removal of the previous building. This profile was consistent all the way to the lot boundary fence, so an extension of this trench (BHT 2B) was placed immediately south of that fence, within the Beedle house Lot, in order to confirm the extent of the building footprint. BHT 2B exposed a very different profile, including a series of burned fill and construction debris deposits (see profile in Figure 12).

It appears that the apartment foundation removal and fill at 720 E Capitol extended only to the Beedle lot line. It also appears that this building was removed in a manner consistent with general expectations of NPS contracts in the early 1970s (including complete removal of all building elements and contents, using clean off-site sediment as fill). This is in stark contrast to the archeological deposits observed at 716 E Capitol, where architectural and domestic debris appear to have been left in place after building demolition. Property surveys conducted in 1974, contracted by the NPS upon acquiring this land (Raynolds 1974), indicate that the building at 716 was absent at that time, although artifact content indicates that the structural demolition likely occurred not long before (see Crest toothpaste in Figure 10). This information, in combination with geophysical and archeological data indicating existence of intact pre-1890s deposits in the 716 E Capitol parcel, shows this area to retain some archeological integrity and potential significance, with information relevant to the period of interest for Lincoln Home NHS.

Beedle

Evaluation of archeological deposits in the Beedle Lot focused on areas with potential to contain significant resources at risk of impact by the proposed HVAC project. Based upon geophysical results, Figure 7 shows a series of point anomalies within the APE. Directional boring is proposed to connect each system of wells to the HVAC systems at each house. Impact of this activity is not expected to exceed a prism 10 cm (4 in) in diameter along the route of the boring. In order to maintain ground water temperature effectively for the geothermal HVAC systems, depth of boring is proposed to occur at or below 4 ft.

Extensive disturbance took place in this lot in 1979, when the NPS restored the exterior of the Beedle house and removed the post-1884 additions to the structure (Banton et al. 1987:192). LIHO archives show the extent of disturbance of this project (Figure 13). A member of the park staff indicated that he was on duty at that time, and observed the removal of foundation and footings (V. Pollock, personal communication 2009). Areas between the foundation footings and behind the house addition, however, were considered potential candidates to retain architectural features such as cisterns, privies, or walkways.

Geophysical data and historical records were used to develop expectations for potentially significant archeological features within the proposed boring impact areas. Interpretations were tested with a combination of subsurface techniques: tile probes, 1-in soil cores, 3-in bucket auger cores, hand-excavated test units, and mechanically excavated trenches.

Tile probes: A 5-m-x-5-m grid of tile probes, each spaced 1 m apart, was placed in the Beedle lot, at 10-15 m East, and 25-30 m North on the Geophysical grid (see Figure 8). At each of the 36 data points, the tile probe was inserted into the ground, with observations recorded on changes in compaction and encounter with subsurface obstacles, such as concrete or brick. This was intended to determine whether architectural or landscaping features were extant in this area of the back yard.

Results of this inventory indicate bricks or other hard materials at five data points across the inventory grid. These five points were all isolated, and follow-up probes in adjacent areas were negative. These results do not support the presence of any intact architectural features in this area of the yard.

Backhoe Trench 4/Test Unit 2 – BHT 4 was excavated to evaluate an anomaly in resistance data at approximately 27 m North, and 10-12 m East (see Figure 7). Trench 4, extending along the 27 North line from 10-12.7 m East, uncovered a circular clay lens at approximately 55 cm below surface (Figure 15). Given the geophysical signature at this location, it was possible that this represented the top of a capped cistern or privy deposit. Continued trenching was shifted 75 cm to the south in order to bisect the southern portion of this potential feature (designated Feature 1). This southern portion of BHT 4 extended along a line at 26.25 m North, from about 10-11 m East, and was excavated to a depth of 115 cm below datum (bd), or about 110 cm below surface (bs).

Test Unit 2, measuring 0.5 m x 1 m, was opened within BHT 4 at 26-27N and 10.5-11E to bisect Feature 1. Excavation proceeded in 10-cm levels, with contents screened through ¼-in mesh, to 110 cmbd. This effort exposed a series of mottled clay and loam strata, some with concentrations of charcoal, one with concentration of ash. All had a variety of historic artifacts throughout (Figure 16). Ultimately, this excavation did not reveal an intact architectural feature as was initially anticipated, but mixed deposits. Flat glass analysis of the Test Unit 2 sample (n=29) shows two distinct 19th-century modes, separated from each other by more than 50 years (interpretation of dates is discussed in Chapter VII), consistent with mixed deposits. It is concluded that this part of the Beedle lot is highly disturbed, and corresponds closely with the extent of house modifications completed by the NPS in the late 1970s. Figure 17 shows the trench and unit profile.

Test Unit 1, a one-meter square excavation unit, was placed at 15-16 m North, and 25-26 m East, to evaluate a subtle anomaly in the resistance data lying within the potential route of directional boring. This unit also intersected the southeast corner of the tile probe survey area, in which three adjacent probes encountered hard substances (e.g., bricks or gravel) at 25-39 cmbs.

Excavation revealed a layer of rubble, including brick and mortar fragments as well as sand lenses, between 25 and 35 cmbs (explaining both the resistance and tile probe results). Below this deposit, crew encountered the possible remains of a midden deposit containing a quantity of domestic debris (various ceramic wares and egg shell fragments) and personal items (pipestem, slate pencil, button). All 20 flat glass fragments derived from this deposit correspond to the early 19th century. The applicability of particular formulae to, and the interpretation of specific dates for, the

LIHO flat glass assemblage is debatable, as discussed in Chapter VII. However, the distribution of flat glass thickness measurements from this test unit (n=26) is unimodal, suggesting a single construction episode reflected in this area, and a relatively cohesive (and perhaps intact) midden deposit.

Excavation was discontinued at 50 cmbs, with sediment coring (using 1-in soil core) indicating that the midden deposit extends to approximately 60 cmbs. Sediments below this level are consistent with an undisturbed prairie soil. Figure 18 illustrates a sample of artifacts from Test Unit 1, while Figure 19 shows the West wall profile.

Test Unit 4, a one-meter square excavation unit, was placed near Test Unit 1 to explore the cause of a discrete anomaly in the GPR data at 18 m East/23 m North. This unit, extending from 17 -18 East and 23-24 North, was excavated in similar fashion to other test units (in 10-cm levels with fill screened through ¼-in hardware mesh); however, the top 20 cm were sample-screened (volume of 10 gallons). This approach was chosen in order to determine the nature of cultural materials within this upper zone, while maintaining focus on the primary goal of excavation here, which was to determine the cause of the GPR anomaly and check for architectural/building features within the potential route of the underground borings.

Excavation revealed the source of the anomaly to be a large (30 cm wide) and intact concrete slab. This slab, approximately 20 cm in height, lay across the southwest quadrant of the unit, extending into the wall but with some 80 cm of its length exposed. The top of this slab lay at 26 cmbs and was found to extend sufficiently into the southwest unit wall to preclude its removal without extending the unit to do so. Excavation continued around this artifact to 40 cmbs, then continued only in the north half of the test unit, with the slab documented and left in-place (see Figure 20).

This slab was but one element of a deposit of large construction-related fragments and debris laying roughly between 30 and 60 cmbs, perhaps resulting from NPS actions taken during Beedle house renovations in the late 1970s. Distribution of flat glass thickness measurements is multimodal, with four peaks in the curve. This rather large sample (n=58) appears to represent multiple construction episodes, consistent with large-scale demolition and disposal activities reflected in NPS archival photos (see Figure 13).

This area, just 2 m southeast of Test Unit 1, contains many of the larger demolition fragments removed from the Beedle house in the late 1970s. Sediment descriptions indicate midden remnants, mixed with less dense construction debris below this zone. This mixing of construction with domestic artifacts, and the mottling of clay sediments below 60 cmbs (as observed in bucket auger and 1-in soil cores), extends to approximately 100 cm below the current surface. Cores below this point reveal an intact B/C horizon, with unmottled, dense yellow clay below 120 cmbs. The absence of a buried A-horizon (or intact topsoil), the presence of large debris, and coarsely mixed sediments is consistent with the filling of a crawl space during removal of superstructure and lot grading. Figure 21 shows the North wall profile, while Figure 22 illustrates a sample of artifacts.

Test Unit 5 was placed in the northwest portion of the Beedle Lot to evaluate deposits at risk from subsurface boring from the western end of the Walters Lot, was located at 29-30 m North, 5-6 m East (Figure 8). This part of the project area is within a potential boring path, so Test Unit 5 was excavated in order to evaluate the edge of an anomaly in the GPR data, and the possibility of a privy or other early outbuilding in this part of the APE.

As with Test Unit 4, the MWAC team sampled the top 20 cm of fill for artifacts, then screened all fill from each 10-cm level below that. Artifact content in this unit is relatively sparse, with small amounts of construction debris mixed with domestic materials (Figure 23). Unfortunately, excavation revealed two PVC pipe conduits running through this unit at some 50 cm below surface; the team had thought that the line was located slightly to the north, but was mistaken. No differences were apparent in the field between intact and trench sediments, although slight differences in color are detected in profile photographs. All sediment is dark brown clay loam, with a slight change at 30 cmbs between the top soil and B-horizon. Excavation terminated at 57 cmbs; cores below that level (using a bucket auger and 1-in soil core) indicate homogenous sediments with sparse artifacts. The soil profile grades to dark yellowish brown clay loam by 110 cmbs, and the cores terminate at 114 cm below surface. These data indicate that this area of the lot has been disturbed relatively recently for electrical trenching (Krupka 1991 documents this NPS project), but it does not appear that the drastic disturbances of 1978, apparent further east on the Beedle lot, impacted this corner. The substantial (n=65) flat glass sample, derived largely from the lower levels of this unit, indicates a bimodal curve, with most pieces dated to the mid-19th century, and a few to the early 20th century. Viewing the contents by level shows apparently younger specimens lying beneath older ones, not surprising given the stratigraphic context here. However, the overall distribution highlights the potential of this western portion of the lot to contain archeological deposits of interest for interpretation at Lincoln Home NHS.

Lyon

A small portion of the Lyon Lot lies within the APE for the geothermal project. A line, bored across the Beedle lot from the well field in the Walters lot, will penetrate the Lyon House foundation to connect to the air handling system. A tour of the Lyon basement and information from park staff indicated that most of that foundation had been recently replaced. A single four feet wide section of historic brick foundation remains in the north end of the west foundation wall, just north of the back porch; this small section of historic wall likely corresponds to the last remaining section of original, intact builders' trench for the Lyon House.

Resistance data show a distinct anomaly within the APE, approximately 5 m in diameter and centered under the boardwalk at 17 m North, 21 m East. This is similar in density to the anomaly that correlated with the location of a known cistern off the south end of the north wall, and was investigated for the presence of a similar feature. The backhoe was used to open a trench, 68 cm east-west by 2.5 m north-south, with the southwest corner at 16 m North, 22 m East (Figure 8). This trench was mechanically scraped to remove sod and top soil, and to explore for the presence of

architectural materials. As no clear evidence of built features was apparent by 34 cm below surface, trenching was paused and a hand-excavation unit (designated Test Unit 3) was placed at the south end of the trench to collect a more controlled sample of deposits corresponding with the resistance anomaly. Excavation and screening of TU3 to 50 cmbs revealed highly compacted clay loam (a pick-axe was required to remove sediments), with sediment and artifact contents not unlike that found elsewhere in the project area: fragmented domestic and construction debris, mixed within a dark brown clay loam matrix.

Given the difficulty of hand excavation here and the lack of unique or especially informative findings, the backhoe was reinstated in order to provide stratigraphic and other data relevant to the source of the anomaly. BHT 3 was continued to 70 cmbs, and halted again when loose, organic-rich deposits containing large diagnostic artifacts were intersected. A sample of this deposit, 5 cm in depth by 50 cm in width, was sifted through ¼-in screen and artifact content collected. The profile was documented, and the floor of the trench probed with a 1-in soil core to determine the total depth of this feature and its relation to original grade.

The top 25 cm of exposed sediments comprise very dark grayish brown clay loam with occasional clay mottles. Under this layer lies a lens (approximately 10 cm in thickness) of dark reddish-brown ashy, sandy debris (similar to that found in BHT 2). Below this, on the north end of BHT 3, is a lens (also 10 cm thick) of olive brown clay mottled with topsoil, flecks of mortar and debris. The source of the resistance anomaly is interpreted as the highly porous, organic-rich deposit lying below this, extending from 50 cmbs to approximately 95 cmbs. This unit is very dark gray silty clay with organic material, coal fragments, low-fired brick, soft mortar, and domestic debris throughout. Coring data below this level indicate an intact soil profile, with dark gray clay loam grading into the B-horizon at approximately 130 cm below modern surface. Coring terminated at 154 cmbs, showing a continuation of grade toward a yellower clay. Figure 24 shows west wall profile of Trench 3.

The organic and artifact-rich deposit documented in BHT 3 and Test Unit 3 is designated Feature 2. This feature appears to be a trash deposit, containing early domestic and construction materials (see Figure 25). Pottery and bottle fragments indicate a pre-1890 and likely 1860s date for this deposit. Twenty-six fragments of flat glass were recovered from this unit. The distribution of thickness measurements for this small sample is dominated by a mode at 1820 (as per Ball's formula), with a minor second peak tied to a slightly later date. Although, as mentioned elsewhere, interpretation of dates requires further qualification (as discussed in the Artifacts section), analysis suggests this feature contains construction debris from removal of early house elements. This location appears to contain intact historic stratification, which may offer significant information on the history of the neighborhood.

ARTIFACTS

Archeological testing resulted in the recovery of 1,849 artifacts. They were cleaned, sorted, identified, and quantified by MWAC staff. Information was recorded

onto catalog cards and catalog records were created using Re:Discovery museum software. All records are on file at MWAC.

Artifacts were first sorted by material class and subclass. Ceramics were sorted into subcategories by paste (stoneware, yellowware, whiteware, porcelain); metals were distinguished as ferrous or non-ferrous; glass was subdivided into flat and curved subgroups. Artifact classes with potential to provide temporal information were treated in greater detail. Curved glass was sorted by color, and bottle fragments with technologically or chronologically relevant traits were individually researched. Historic ceramic fragments with potentially diagnostic patterns were treated similarly. Flat glass fragments were weighed and measured, with data on thickness and color collected for each fragment.

Artifacts are presented according to interpreted function. Categories include: architectural, domestic, personal, and items of unknown function.

Architectural Items

Architectural materials listed here are all items related to the construction of a house or structure. This includes building hardware, limestone, mortar, plaster, window (flat) glass, and nails.

Nails

Nails compose the most numerous group of construction hardware. They can provide important information useful for interpretation of deposit chronology. Machine-cut nails, which replaced hand-wrought nails near the end of 18th century, were cut from a sheet of iron or steel and dominated the 19th century. Wire nails, which were manufactured from spools of wire, were being made in North America by the 1850s, but were not used in construction for several decades after that, and did not actually dominate until the 1890s (Adams 2002; Nelson 1968; Wells 1998).

Eighty-four whole or fragmented nails were recovered during this project. The majority of them are so badly corroded that it is not possible to identify their method of manufacture. Of the identifiable group, nine are wire nails and twelve are cut nails. Although all test units produced some nails, the majority come from Test Units 1 and 4, which were placed right outside the Beedle house footprint and within the crawlspace, respectively. Both cut and wire nails are present in all stratigraphic levels, which may be indicative of a mixed and disturbed nature of deposits in the site area. However, the small sample size greatly limits any statistical analysis.

Brick

One hundred forty-two small brick specimens were sampled from the project area, selected to represent the chronological and technological range of this materials class encountered during the project. One complete brick was collected from BHT 3, located just off the northwest corner of the Lyon House. It measures 8½ in x 4 in

x 2¼ in, and has soft lime mortar adhering to all sides. Several other brick samples collected exhibit a layer of such mortar still adhering to the surface. Given the non-systematic collection method for this material class, little can be said regarding distribution of brick types, but it should be noted that both high- and low-fired bricks were encountered.

Several artifacts (Figure 23 g-i) are probably fragments of structural clay tiles (also referred to as structural terra cotta block or hollow tile block). They have either rectangular or rounded grooves on external surfaces, which served to improve adherence of mortar. One piece (see Figure 23 h) has the mortar still attached. It is very hard and looks like it must have been mixed with a significant amount of Portland cement. These kind of blocks were manufactured as early as the 1890s but were mostly in use in the first two decades of the 20th century (Winstel 1991). Most of these fragments came from Test Unit 5, which was located in a previously disturbed area near the North boundary of the Beedle house lot, and may have been related to the turn-of-the-century apartment buildings that were located to the north in the Walters lot.

Mortar

Because the components of mortar changed over time, this material class has potential to be a useful tool in dating historic structures and archeological deposits. Major changes occurred towards the end of 19th century and in the early 20th century with the introduction of Portland cement. Over time, as more of it was added to the mix, mortar gradually became faster-setting and harder.

Throughout most of the 19th century in America, mortar consisted mostly of lime and sand. Portland cement was patented in Europe in 1824 and first manufactured in the United States in 1872, but was not in common use in the U.S. until the early 20th century. Until the turn of the century, Portland cement was considered primarily an additive, or “minor ingredient” to help accelerate mortar set time. By the 1930s, however, most masons used a mix of equal parts Portland cement and lime putty. Thus, the mortar found in masonry structures built between 1873 and 1930 can range from pure lime and sand mixes to a wide variety of lime, Portland cement, and sand combinations (Mack et al. 1980).

The mortar collection from LIHO consists of 121 specimens, including 69 hard- (Figure 16l, 23i) and 55 soft-lime mortar (Figure 10h, 16k). Although a representative sample was attempted, some pieces were discarded in the field, rendering quantitative analysis untenable. The mortar sample may also be biased against soft mortar due to its friable nature. However, nominal mortar data can still be useful in relative dating of archeological deposits.

The distribution of mortar suggests some mixing of deposits, which is not surprising considering the extent of ground disturbance during NPS restoration projects (see Figure 13). Both types of mortar are present in most levels in all test units. Hard 20th-century mortar was recovered from levels as deep as 90-100 cmbd (TU2), mixed with thin early flat glass, while soft mortar was encountered in levels containing more modern material (TU1, Level 3).

Flat glass

Flat, window, or plate glass can be a useful tool for dating archeological deposits (Moir 1982; Roenke 1978; Schoen 1990). Technological evolution of the manufacturing process during the 19th century resulted in successively thicker average pane thicknesses through time, until a major innovation in the production process in the early 20th century reversed this trend. Histogram distributions of fragment thickness data can thus be interpreted chronologically; several studies have correlated thickness with construction dates (e.g., Moir 1987; Schoen 1990).

Formulae derived from these studies differ, and have varying results, depending on the subject data used to create them. Beyond production technology, factors affecting the relationship between flat glass thickness and date of building construction include geography, structural function, and economic setting at the time of construction. One would expect that a building constructed in a community with good access to a glass factory would be built using window glass more recently produced than one built in a remote setting, where transport of glass is more costly. One would also expect a higher rate of windowpane recycling in the latter setting, which would further separate dates of pane manufacture from building construction.

Choosing the best formula to apply to a given assemblage is thus ruled largely by geography. Ball (1982) derived the chronological formula using samples from Kentucky, Alabama, and Arkansas, to the south of Springfield. Schoen (1990) used assemblages from ten sites, six of which were along the middle and upper Missouri River in Nebraska and the Dakotas. Given that little is known about the supply chain for window glass into Springfield in the early 19th century, both formulae were applied and compared for interpreted dates.

A digital calipers was used to measure sherd thickness, to .01mm, on a total of 245 glass fragments. All pieces were measured, but if larger than one inch in diameter, three measurements were taken to offset effects of flow, idiosyncrasies across individual pieces, and individual measurement errors. All pieces were also weighed (to .01 g).

Comparing the Schoen-derived dates to those derived from Ball's formula suggests that the Schoen formula is a better tool for the LIHO sample. Given the fact that the earliest-documented construction dates in the project area were circa 1840, the earlier modes on the Ball histogram require scrutiny.

In order to ensure that this analysis considered only window glass, fragments likely to represent other sources, such as lamp chimney or windshield, were removed. Removing from analysis all pieces thinner than 1 mm, and all those with thickness greater than 2.75 mm leaves an assemblage of 214 fragments. The distribution of thickness measurements shows two modes within the 19th century: one associated with the 1840s, and one with the 1880s. Given historic knowledge of the project area, these modes are generally consistent with initial construction dates of around 1840 for the Walters and Beedle houses, as well as the reworking of structures documented during the late 19th century.

Overall, flat glass analysis is useful here for interpreting deposits in terms of general shape of thickness histograms, and prove useful here as a means of evaluating the nature and condition of archeological deposits across the project area. As discussed individually for each test unit, flat glass distributions indicate two essential states of integrity of deposits across the tested areas. Deposits sampled in Test Units 1, 2, and 4 show large-scale mixing, with multimodal thickness distributions, while those in Test Units 3 and 5 show more strongly modal curves.

Mean flat glass fragment size (measured here by weight), provides another perspective on condition of the artifact deposit; processes responsible for large-scale mixing or disturbance of archeological deposits should also impact individual fragment size, so mean size should be smaller in more disturbed areas. Mean weight in Test Units 1, 2, and 3 is approximately half of that in Test Units 4 and 5; higher fragmentation suggests greater disturbance in the former Test Unit areas. This holds true for Test Units 1 and 2, located in zones likely in the thick of wholesale structural demolition in the 1970s, while the highly compact nature of sediments in Test Unit 3 can explain the smaller fragments there. The larger relative shard size in Test Unit 4, also within the larger demolition zone, requires a closer look. The prevalence of construction-related debris in this unit suggests this specific area was used for the disposal of larger structural fragments during the late 1970s event, and that the archeological deposit here is really a primary deposit of that particular event. The sample from Test Unit 5, with its strong mode associated with the 1880s-1890s and large mean shard size, appears to represent a relatively undisturbed deposit (despite the electrical trenching that intersected the test unit).

Based on flat glass analysis, certain portions of the project area – namely those sampled by Test Units 3 and 5 – likely retain intact archeology relevant to 19th-century activities at Lincoln Home NHS.

Domestic Items

The domestic items category includes artifacts related to the storage, serving, and consumption of food or drink. Therefore, the discussion here focuses on ceramics, curved glass, and fauna.

Ceramics

Ceramics recovered during the project were separated into classes defined by paste type, including whiteware, porcelain, ironstone, yellowware, and redware. Whiteware has, by far, the highest representation, with 251 fragments recovered during the investigations. They come from all proveniences and span various styles and decorative techniques.

Transfer-printed whiteware is represented by 66 fragments. Colors include blue, brown, green, mulberry, black, red and lavender, with blue being the most numerous: 41 fragments (see Figure 18a, d, e; Figure 22 l, m, p; Figure 23a, b, c; Figure 25d, e, f, h). Five pieces (see example in Figure 23c) are examples of the Blue Willow pattern,

which likely dates to the first half of the 19th century (Gaston 1990). Another category, represented by nine fragments (see example in 22m), is Flow Blue whiteware, which was most popular in the mid-1800s (Williams 1981; Gaston 1983). Six of those came from the compacted deposit in TU3 in the Lyon House lot. One sherd came from BHT1 south of the drain tile, an area with what appeared to be undisturbed deposits potentially related to the original outbuildings in the back of the Walters lot. Seventeen other fragments of transfer-print whiteware, recovered from Test Unit 1, are identified to pattern: “Lawrence” in lavender of unknown manufacture and date (Williams and Weber 1986:216 and Snyder 1997:103) (see Figure 18a).

Fourteen of the whiteware sherds are hand-painted (see Figure 18b), including examples of both under- and over-glaze decoration. Five fragments from the same provenience (Feature 2 in BHT3) appear to be from the same object, which was hand-painted on the body and sponge decorated on the rim (Figure 25g). Sponge, or spatterware, with hand-painted decoration, is represented by 4 more (Figure 18c) sherds. This was most popular from 1850 to 1890 (Derven 1980:125) and was used on cheap dinnerware and serving pieces (Hunt 2007:21).

Three fragments of blue edge-decorated whiteware (Figure 25i) were found in Feature 2 in BHT3 as well. Edge decoration was popular in the first half of the 19th century and began to fade by the 1860s. These particular pieces have unscaloped and unmolded edges, which is characteristic of later edge decoration. Miller and Hunter (1990) place this variety in the 1870-1890 timeframe. This and other artifacts found in Feature 2 (transfer print whiteware, bottle fragments) suggest a post-1860s date for this deposit of domestic debris.

Overall, the majority of the whiteware assemblage is undecorated (169 fragments). This supports the interpretation of a late 19th-century and later deposition time frame for these materials, as popularity of the highly embellished printed table service was declining in favor of simpler molded and plain white-surfaced types in the later 1800s (Lofstrom 1976; Miller 1980; Richner 1992, 1996).

Porcelain, a finer ceramic ware, is represented by 27 fragments. They derive from all proveniences and represent serving dishes, bowls, saucers, and cups. Most of the pieces are undecorated. One sherd has remnants of a decal, one is pink-and-white glazed with gilt edging, and one is handpainted with double-gilt edging (Figure 10f).

One fragment of ironstone with a maker’s mark was recovered from the early deposit south of the drain tile in BHT1 (Figure 10g). The mark reads “Royal Premium, Semi-Porcelain, T. & R. Boote, England.” It is printed in brown or black and can be dated to 1842-1906 (see Coysh A. W. and R. K. Henrywood 1982: 47) although this particular version of the mark suggests a late 19th-century date (Thorn 1947:48).

Two utilitarian wares, yellowware and redware, are also present in the ceramic assemblage. Only four fragments of yellowware were recovered, two of which have brown glaze, and one of which has raised decoration (Figure 22j). This type of ware was popular between 1870 and 1900, although some production still continued through about 1930. The redware assemblage consists of 36 pieces, the majority of which are

unglazed. Seven of those fragments come from two possible terra cotta flower pots that had rim decoration (Figure 16b-d). The remaining 29 fragments are glazed with either orange or brown glaze. This ware likely competed poorly against newer, more durable stonewares leading to a fall-off in production by the turn of the 20th century (McConnell 1988).

Stoneware is represented by only 3 specimens, one with salt glaze, and two with dark brown Albany-type glaze.

Curved glass

Curved glass includes various glass containers used for storage or consumption of food and drink.

Glass vessels, and especially historic bottles, can be extremely useful in dating archeological deposits. Bottle manufacturing methods evolved through time as the use of molds became increasingly popular, leading to standardization and mechanization of the bottle manufacturing process. Analysis of bottle characteristics linked to certain manufacturing techniques allows for chronological interpretation. Furthermore, where a maker's mark or other distinguishing characteristics are present, historical documentation can provide detailed information about the manufacturer, bottle contents, and place of manufacture, thus allowing for more precise chronological, functional, and economic analyses.

Two hundred forty-nine fragments of curved glass are present in the collection. Of these, 169 (69%) are colorless, 58 (23%) are aqua color, with the remainder split among green, amber, black/olive, purple, and cobalt blue. Most of the bottles represented are highly fragmented; only two complete bottles were recovered. Both came from BHT1 south of the drain tile which, as also supported by the dating of other artifacts from that provenience, indicates the presence of undisturbed 19th-century deposits in the southwest corner of the Walters lot.

One of these is a small colorless round-corner Blake type prescription bottle with a tooled finish (Figure 10e). The Blake style is rectangular in cross-section with beveled corners and four flattened sides. Similar to other druggist bottle styles, the neck on the Blake style is relatively short, only 25 to 30 percent of the body height. Blake druggist bottles were almost always blown in cup-bottom molds and have tooled finishes. It was the most popular style of rectangular druggist bottle and was a standard offered by most glassmakers that produced druggist bottles from the 1880s well into the 1920s and beyond (Lindsey 2010). The bottle's embossed panel reads "G. A. Hulett, Dispensing Druggist, Franklin Building," while the base provides maker information. The mark, "W. T. & CO., A, U.S.A.," belongs to Whitall Tatum & Company from Millville, New Jersey. The specific combination and placement of letters in this particular mark can be dated to 1890-1901. The combination "W. T. & CO" was no longer used after 1901, whereas "U. S. A." was in use after 1890, a fact that probably reflects the company's entry into the international market (Lockhart et al. 2006).

The other complete bottle was also likely a prescription bottle (Figure 10d). It is an oval-type aqua bottle with tooled finish that Fike (1987:8) calls “ring or oil.” It has no maker’s mark or embossing.

Two fragments of what appears to be the same bottle were found within Feature 3 in BHT3 (Figure 25a). It is a very dark olive (almost black) beer or ale bottle made in a 3-piece mold with large kick-up in the base and rather crudely applied finish. The 3-piece mold was in use throughout the 19th century and for beer bottles even into early 20th century. However, the applied finish most certainly dates the bottle to before 1890 or 1895. The shape, dark color and crude finish resemble what Lindsey (2010) calls “Black glass ale bottle,” which he dates to the mid-1860s. This type of ale bottle faded in popularity by the 1870s.

The other piece from the same provenience is a neck and shoulder fragment from a small rectangular aqua color bottle (Figure 25b). The color and shape is typical of mid-19th-century proprietary medicine and the crudely rolled (inwards) finish dates it to around 1865-1870 (Lindsey 2010).

The presence of these two bottles alongside sponge- and edge-decorated pottery in the undisturbed deposit outside of the Lyon house (Feature 3) supports its early date (mid-1860s and certainly pre-1890) and archeological significance with information relevant to the period of interest for Lincoln Home NHS.

Fauna

One hundred seventy-four animal bones and fragments were recovered during excavations. These derived from all test units, as well as Backhoe Trenches 1 and 3 (Feature 2). No formal analysis was conducted on this assemblage, but catalog records indicate a number of calcined or burnt bones (n=47) and multiple examples of butchering or cut marks (n=14). Test Unit 1 produced the most pieces, making up 32 percent of the assemblage (n=51), followed in frequency by Test Unit 5, which produced 20 percent of the assemblage (n=34). This is consistent with interpretation of the former unit as the location of a kitchen midden. It is also consistent with a debris deposit located at the back of the lot, near former outbuildings, as is the case for the latter unit. Without further analysis, little more can be said about this class of domestic artifacts. However, this small assemblage has potential to provide information on diet, economy, and post-depositional processes within the study area.

Personal Items

Three glass beads were recovered during the excavations. A blue opaque bead (Figure 23d) similar to variety #246 (see Ross 2000) was found in TU 5. The other two came from Test Unit 2 (Figure 16g, h): a green opaque bead with slight patina, similar to variety #312, and a 6-sided light amber drawn bead, similar to variety #336.

Several buttons were recovered throughout the site area. They are made of various materials: glass (Figure 16i), wood, metal, and shell (Figure 22o).

Test Unit 2 in BHT4 produced a plastic comb tooth (Figure 14e) and a sewing pin made of cuprous metal (Figure 16f).

An interesting artifact came from Test Unit 4. It is a Boilo Armitype detachable dental mirror head (Figure 22n), made by Specialty Mfg. Co. (see "Oral Hygiene," vol. 9, pp 57, 236, 318, 448, 754, 1175, 1482, 1645. Published by Robert C. Ketterer, 1919. Accessed via Google Books, 01/05/2010). It is worth noting that early 20th century (1917 and 1941) Sanborn Fire Insurance maps indicate the presence of doctor's offices in three of the four buildings in the neighboring Walters lot (from Banton 1987).

A Crest toothpaste tube (Figure 10c) is an example of modern materials recovered from the northern section of BHT1 - north of the drain tile. Crest with Fluoristan was first launched in 1955 and Fluoristan was replaced by Fluoristat by 1981. This particular tube is plastic, which likely dates it to post-1969 when the shift from metal to plastic tubes occurred. This, in combination with the 1974 survey maps showing no structure at 716 East Capitol, indicates that the removal occurred not long before the Walters lot was acquired by the Park Service.

Miscellaneous

One hundred six small painted stones (see Figure 22k) were collected from several test units, with an overwhelming concentration in Test Unit 4 (n=100). They are small rocks, painted blue (n=103) or green (n=3); they are currently interpreted as aquarium or terrarium fill.

CONCLUSIONS

Investigations at the Walters, Beedle, and Lyon house lots (state site numbers 11SG1373, 11SG1374, and 11SG1375, respectively) were conducted in two sessions during October and November, 2009. Geophysical inventory was conducted across all three lots October 4-10, 2009, incorporating magnetic, electrical resistance, electrical conductivity, and ground-penetrating radar. This effort identified a number of areas of potential sensitivity across the project area, and helped to focus efforts during subsurface evaluation. Subsurface investigations were conducted November 2-7, 2009. As mentioned, efforts during this phase were focused, in part, by results of geophysical inventory, but were also bounded by the Area of Potential Effect (APE) specific to the HVAC projects for the Beedle and Lyon houses.

Geophysical investigations and historic records identified potentially sensitive areas within the APE, so subsurface testing was particularly intense in several areas. In order to minimize impacts of the geothermal project, former apartment building footprints in the Walters Lot, visible in geophysical data, were proposed for well field locations. Backhoe trenching was used to confirm the location of basement walls and the absence of sensitive deposits in two building footprints. This was confirmed for one of the suggested locations, but not the other. Potentially sensitive and informative archeological remains were found to remain near and within the footprint of the building formerly at 716 East Capitol (westernmost on the Walters Lot). For this reason,

it is recommended that well fields for both the Beedle and Lyon houses be located within the building footprint at 720 East Capitol, or the second footprint east of the north end of that lot (see Figure 26).

A cluster of geophysical anomalies, Sanborn maps, and the results of backhoe trenching near the west end of the project area all indicate a high potential for intact and informative archeological deposits at the west end of the Beedle house lot. This is supported by analyses of artifacts from Test Unit 5, located near that end of the yard. Fortunately, moving of the well field slightly to the east also removes this area of the lot from the APE for the HVAC project. Any future undertakings in this part of the Beedle and Walters lots should be taken with extreme care; detailed evaluation of deposits is recommended as part of future project planning.

No large clusters of anomalies were identified within the APE for lines running from the new well field to the Beedle and Lyon houses, although several strong point anomalies were investigated within the APE of the Beedle and Lyon House yards. Excavations resulted in a better understanding of the extent of disturbance associated with NPS remodeling activities at Beedle, and were used to develop recommendations for specific line placement. Areas to avoid include a section of original foundation at the northwest corner of the Lyon House as well as an intact trash deposit off the back corner of the house (Feature 3), and two cisterns identified by previous park staff off northwest corner of the Beedle house (see Krupka 1991). Figure 26 provides recommendations for HVAC project activities and sensitive areas to avoid.

Two areas outside of the current project APE are worthy of note here for future reference. Figure 7 shows clusters of geophysical anomalies particularly concentrated in two areas. One is located in the northeast quadrant of the Walters Lot, the other in the back yard of the Lyon House. Both areas show a high potential to contain archeological deposits holding information relevant to the late 19th century, if not earlier. Any future park activities in these parts of the block should include detailed archeological investigation as a part of project planning.

This project examined three lots within the Lincoln Home National Historic Site, including some areas with histories of intensive disturbance. Preliminary assessment supported a belief that the project area was without integrity or potential to yield significant information about the past. However, examination of artifact content and distribution, as well as geophysical information and historical documents, has demonstrated that this is not necessarily true. Results of this project are relevant not only for the current undertaking, but will be useful for design of future projects, indicating the existence of several areas with potential to inform on the period of interest for the park.

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FIGURES

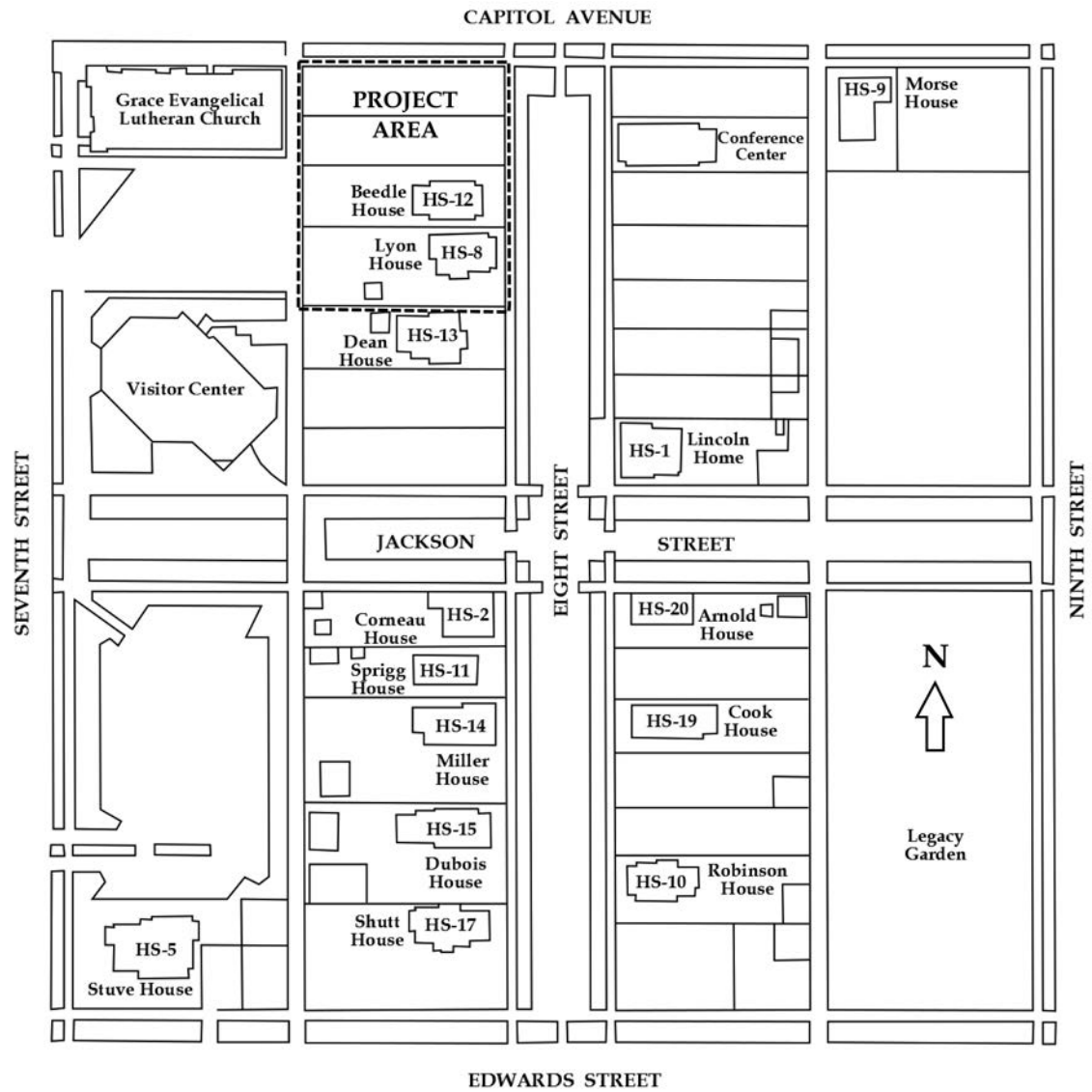


Figure 1. HVAC geophysical project area at the Lincoln Home National Historic Site.

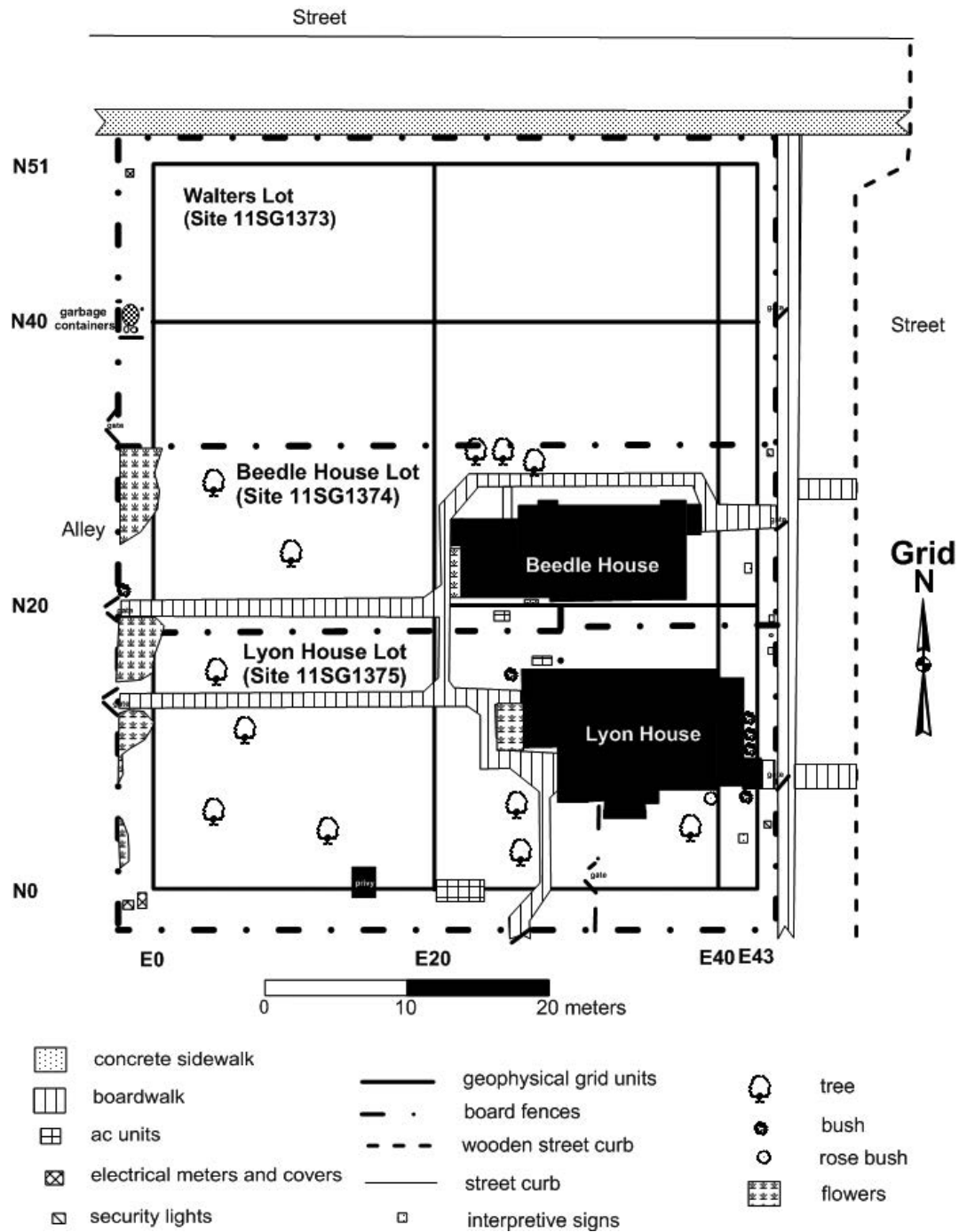


Figure 2. Sketch map of the geophysical project area at the Lincoln Home National Historical Site.

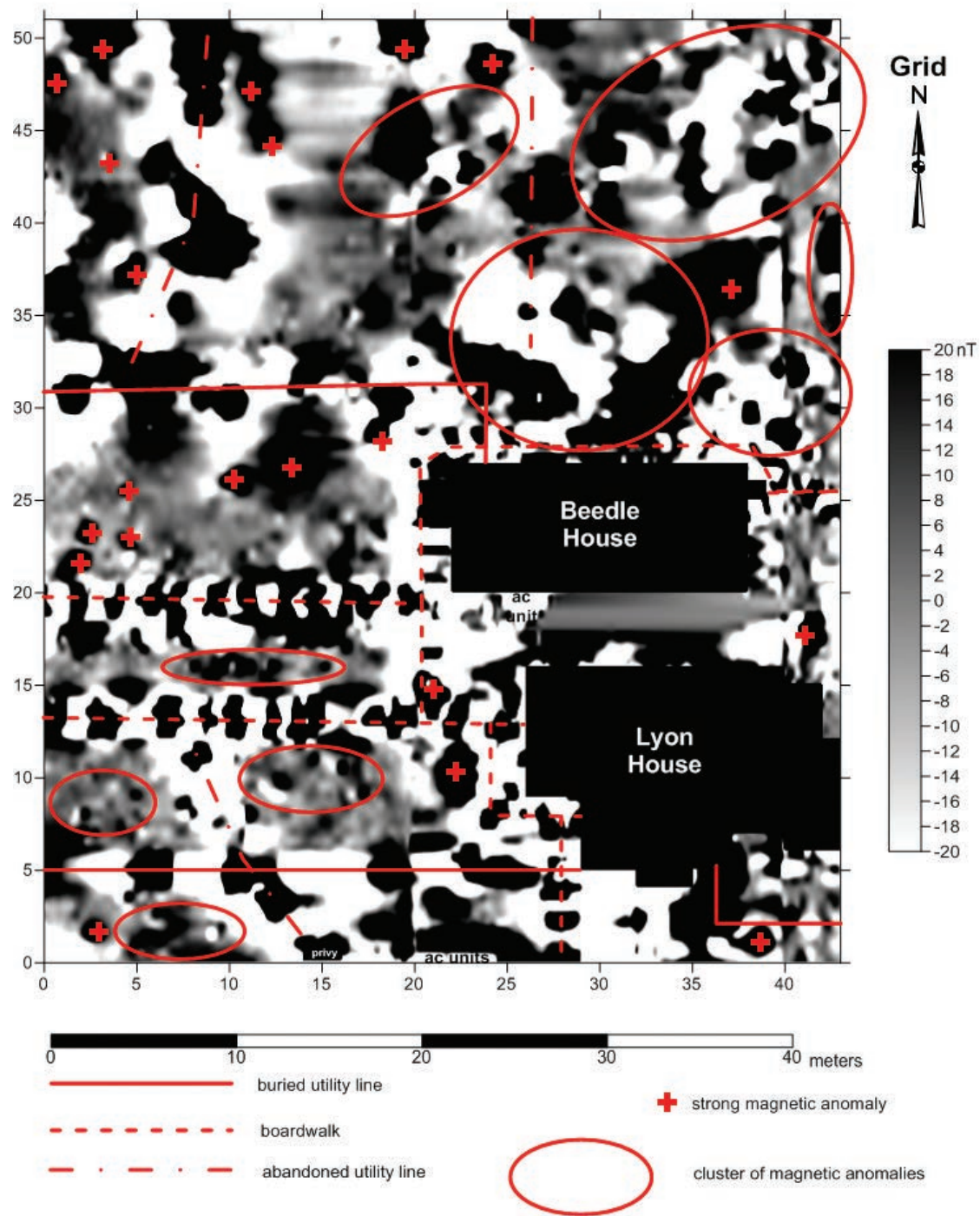


Figure 3. Interpretative map of the single fluxgate gradiometer data.

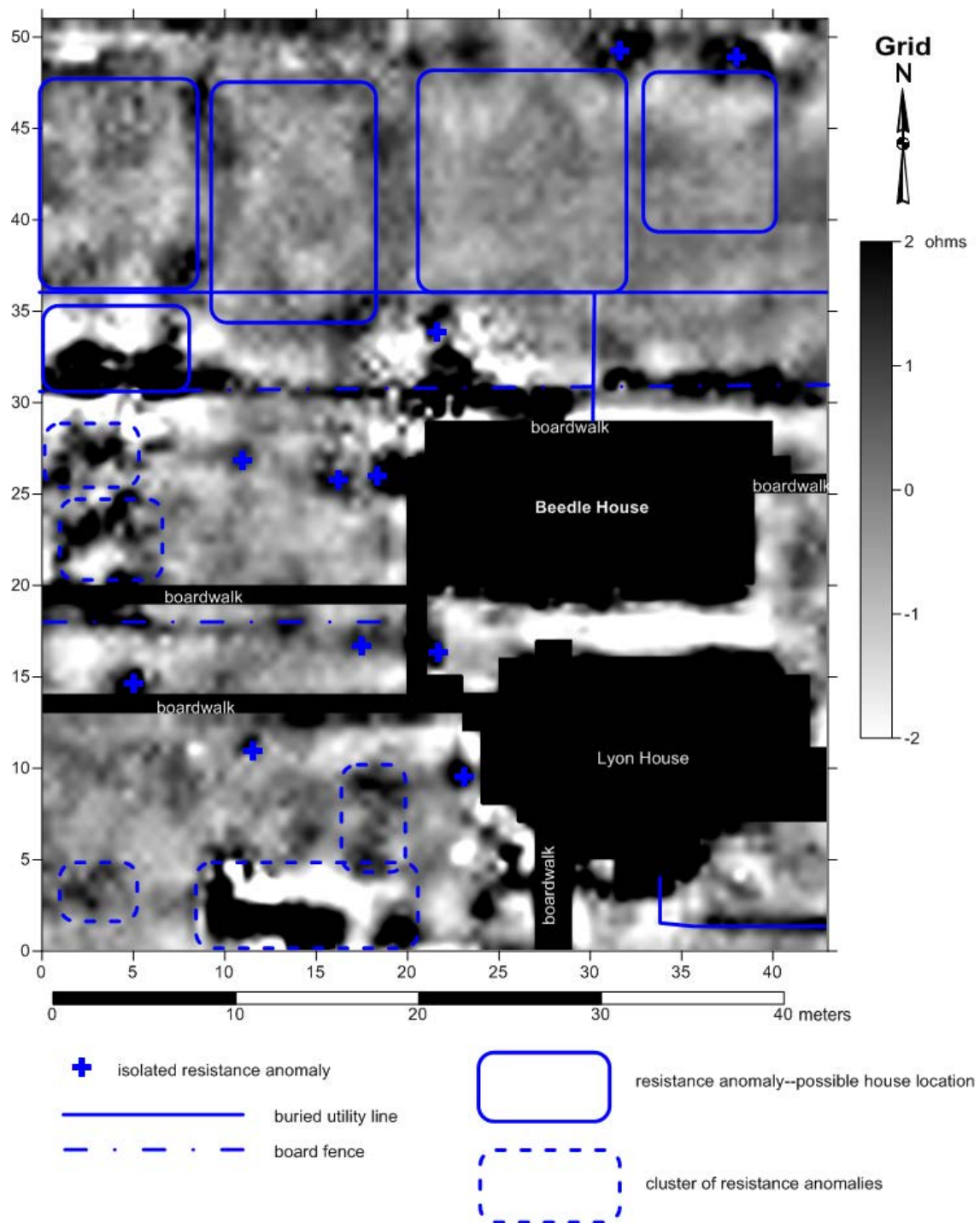


Figure 5. Interpretative map of the resistance data.

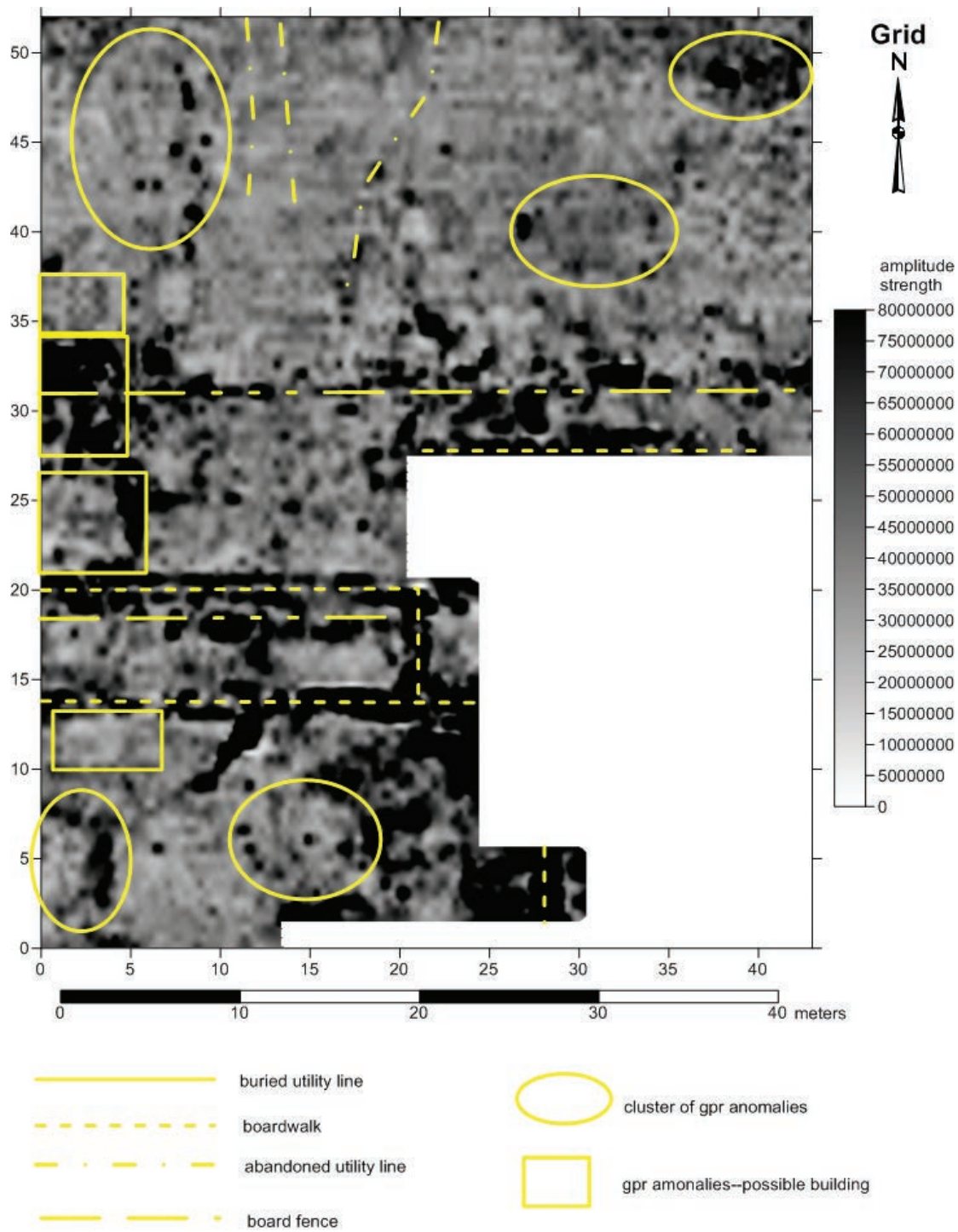


Figure 6. Interpretative map of time slice 4 (7-10 ns) GPR data with a 50 ns window.

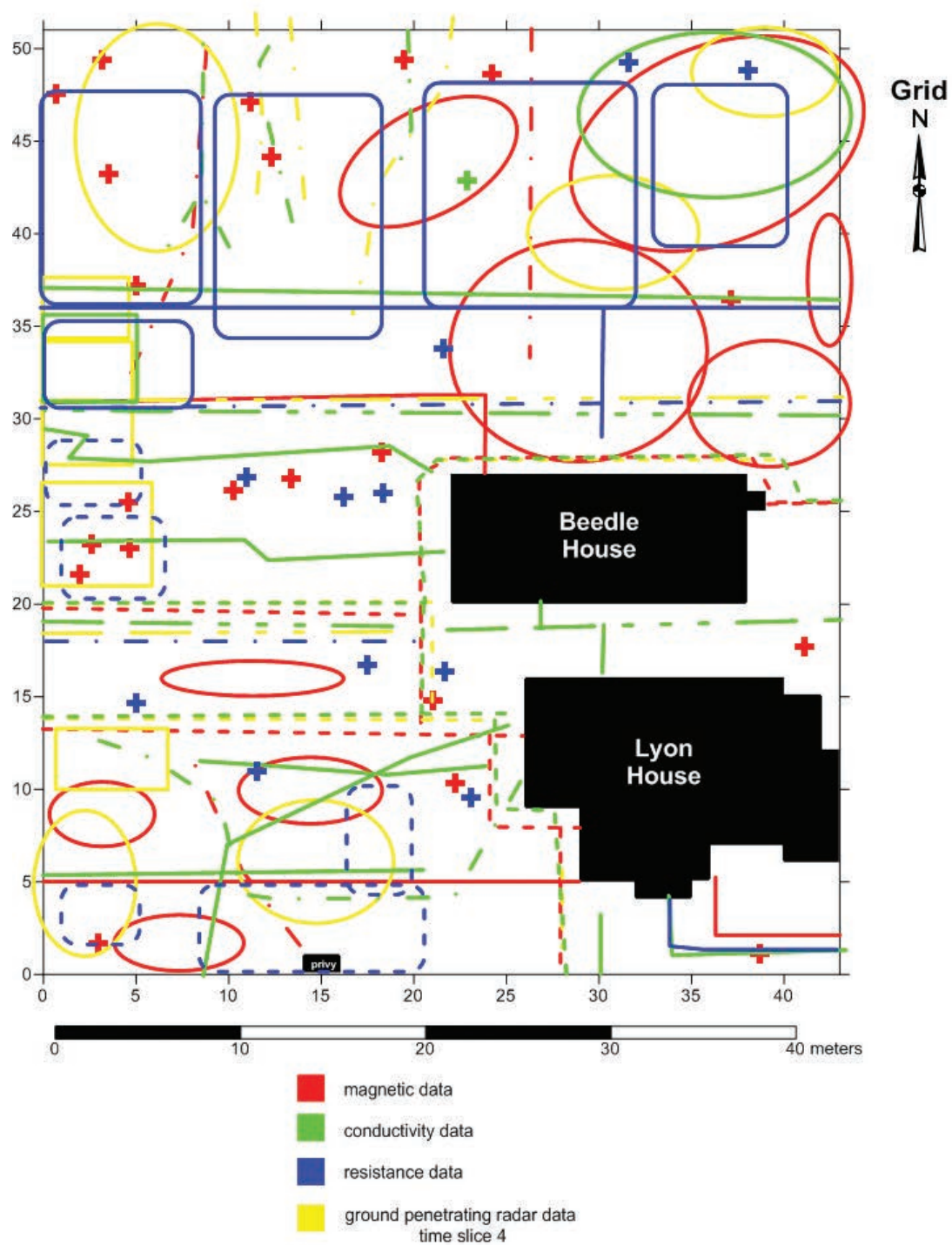


Figure 7. Combined geophysical anomalies from the geophysical project area.

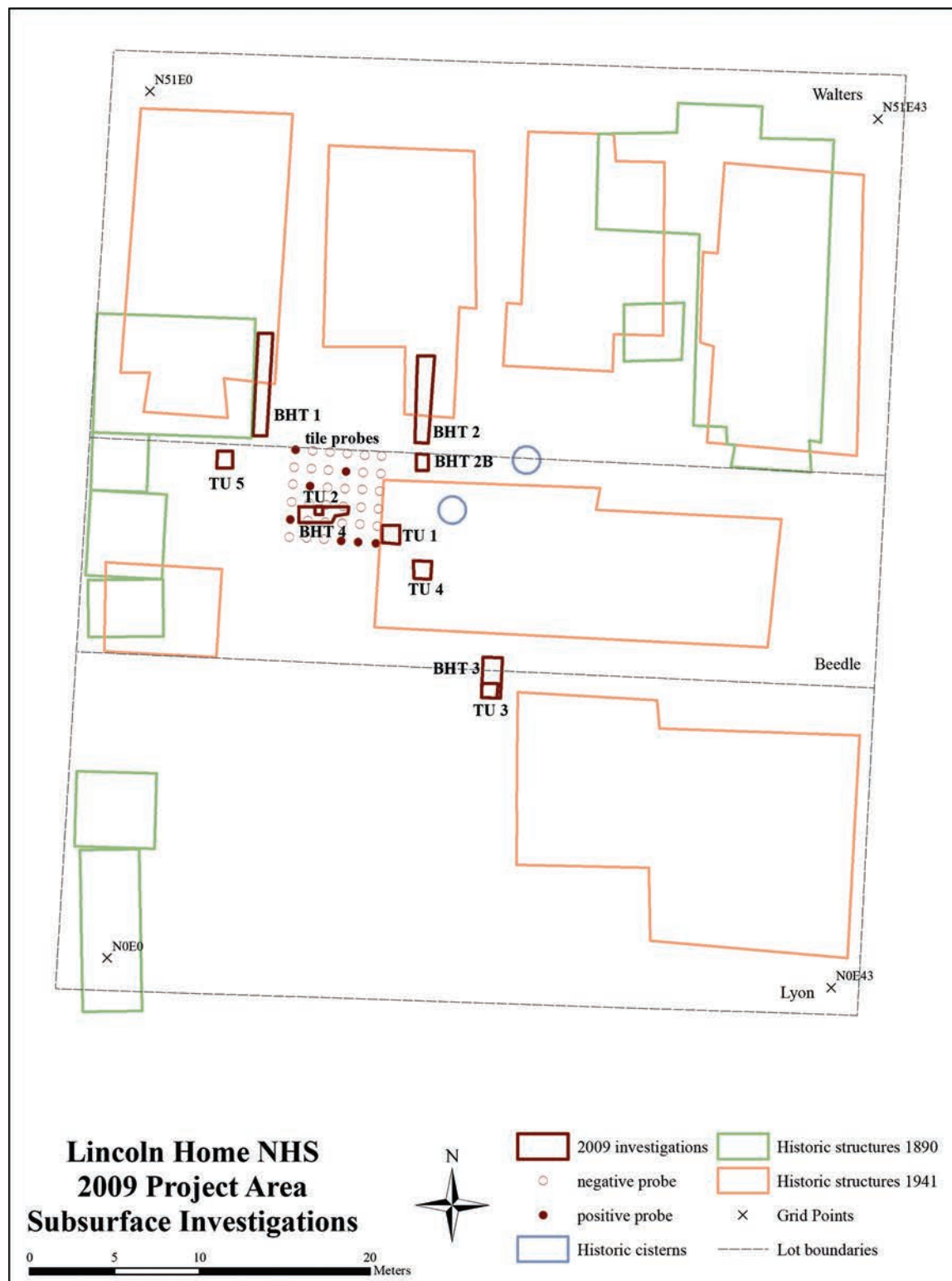
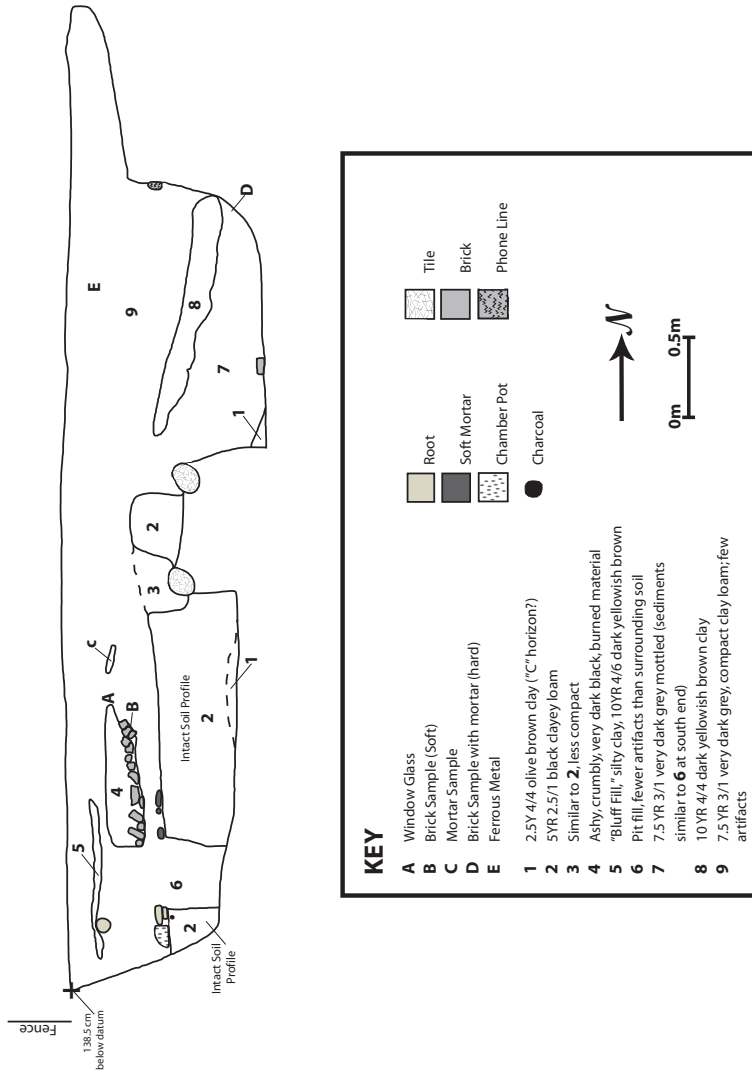


Figure 8. Subsurface investigations at Lincoln Home National Historic Site.

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Backhoe Trench 1, West Wall Profile

Dawn Bringelson, Gosia Mahoney, and Laura McClatchey



3 May 2010

Figure 9. Backhoe Trench 1. west profile.

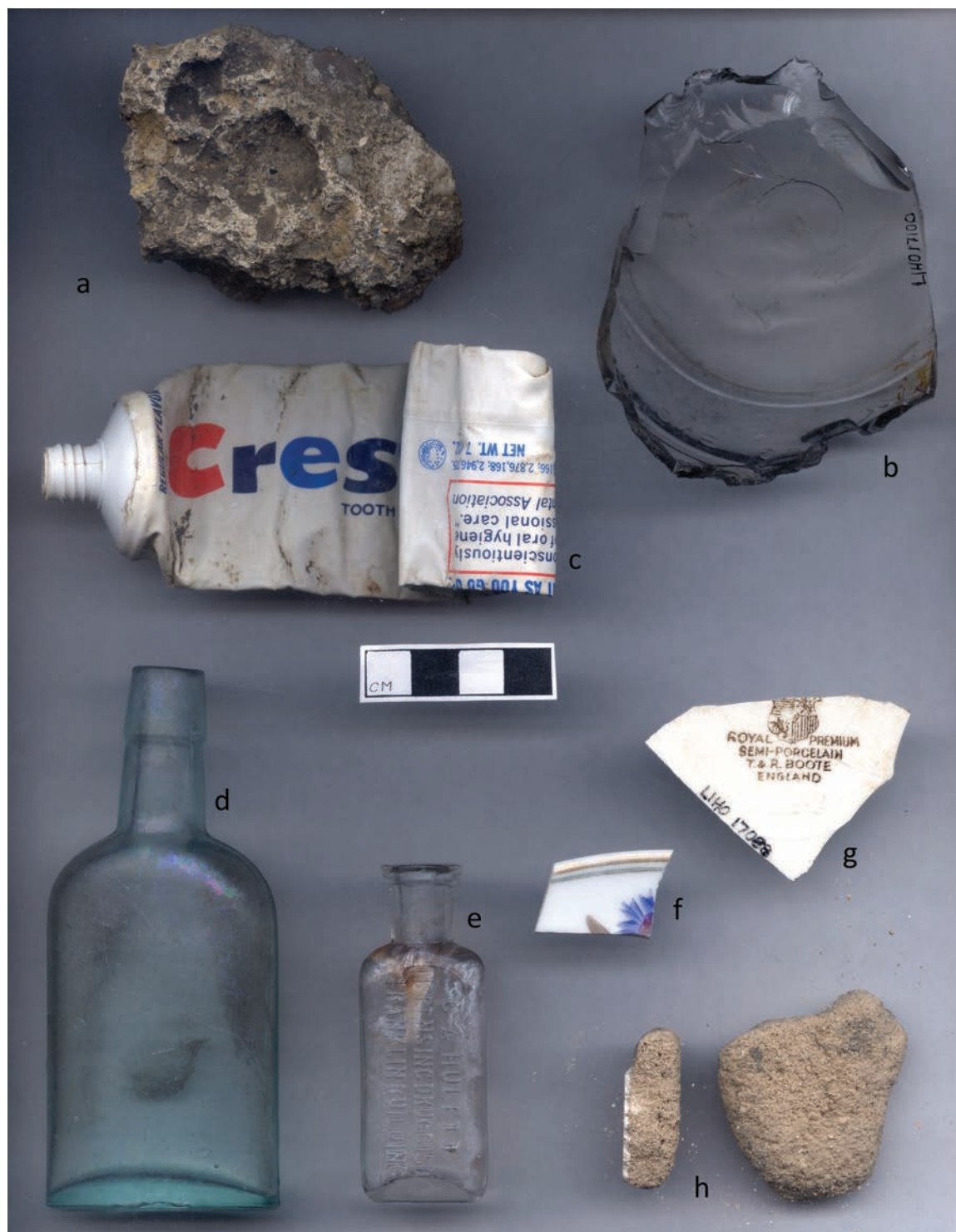
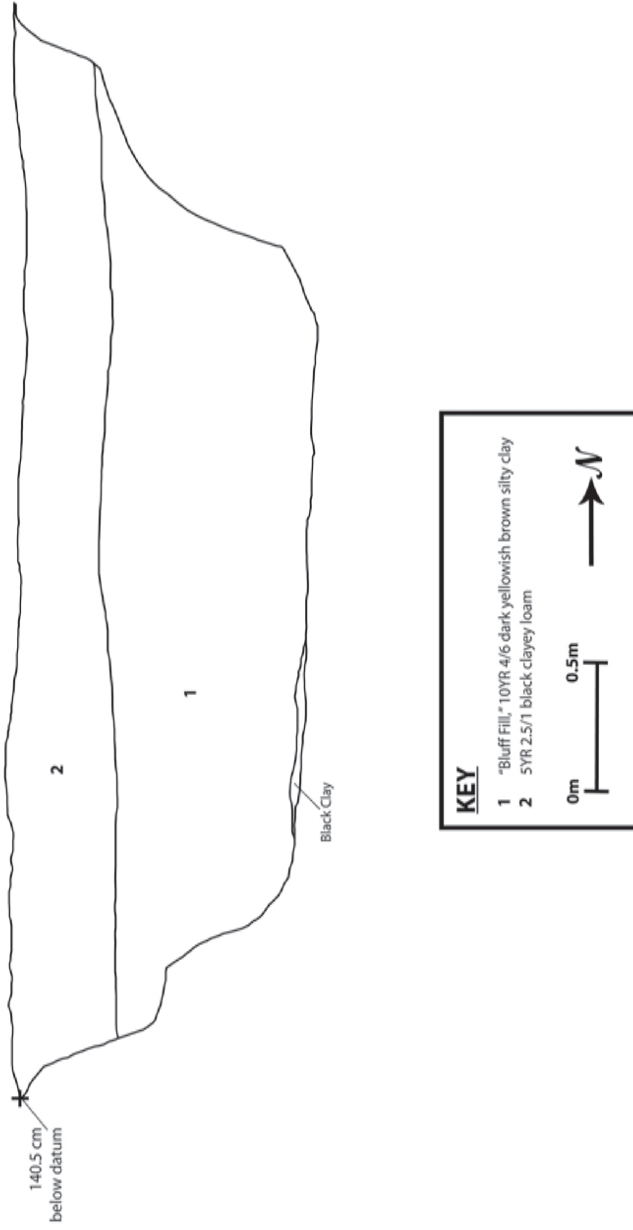


Figure 10. Artifacts recovered from BHT1. Upper two rows – north of drain tile; lower – south of drain tile.

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Backhoe Trench 2, West Wall Profile

Dawn Bringelson and Laura McClatchey

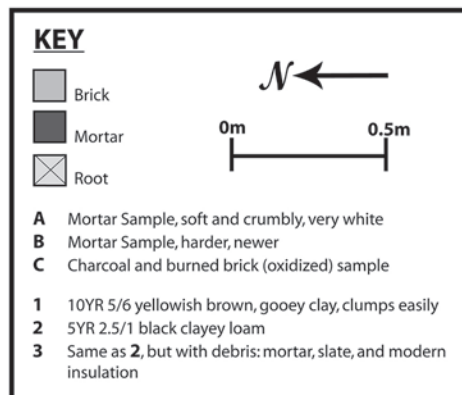
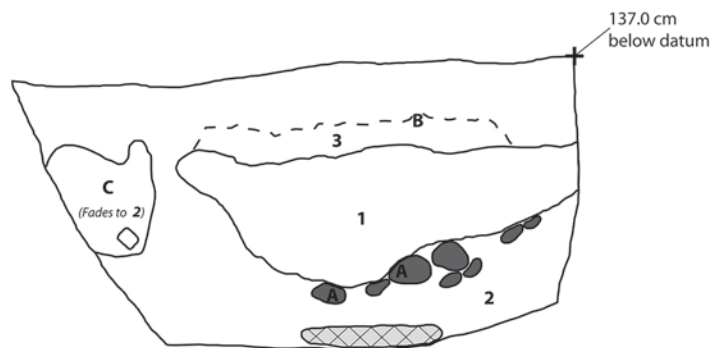


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Figure 11. Backhoe Trench 2. west wall profile.

LIHO 2009 Backhoe Trench 2B (South of Fence)

Laura M^cClatchey and Gosia Mahoney



05/10/2010

Figure 12. Backhoe Trench 2B (South of fence). East profile.



Figure 13. Photo showing the extent of disturbance during the 1979 restoration work in the back of the Beedle house. Courtesy of Lincoln Home National Historic Site Photo Archive Database. <http://liho.missouri.edu/Default1.asp>. Photo ID B8F12P136



Figure 14. Beedle house backyard, 2009 project area. BHT4/TU2 in foreground.



Figure 15. Circular lens (Feature 1) in BHT4 visible at 55 cm below surface.

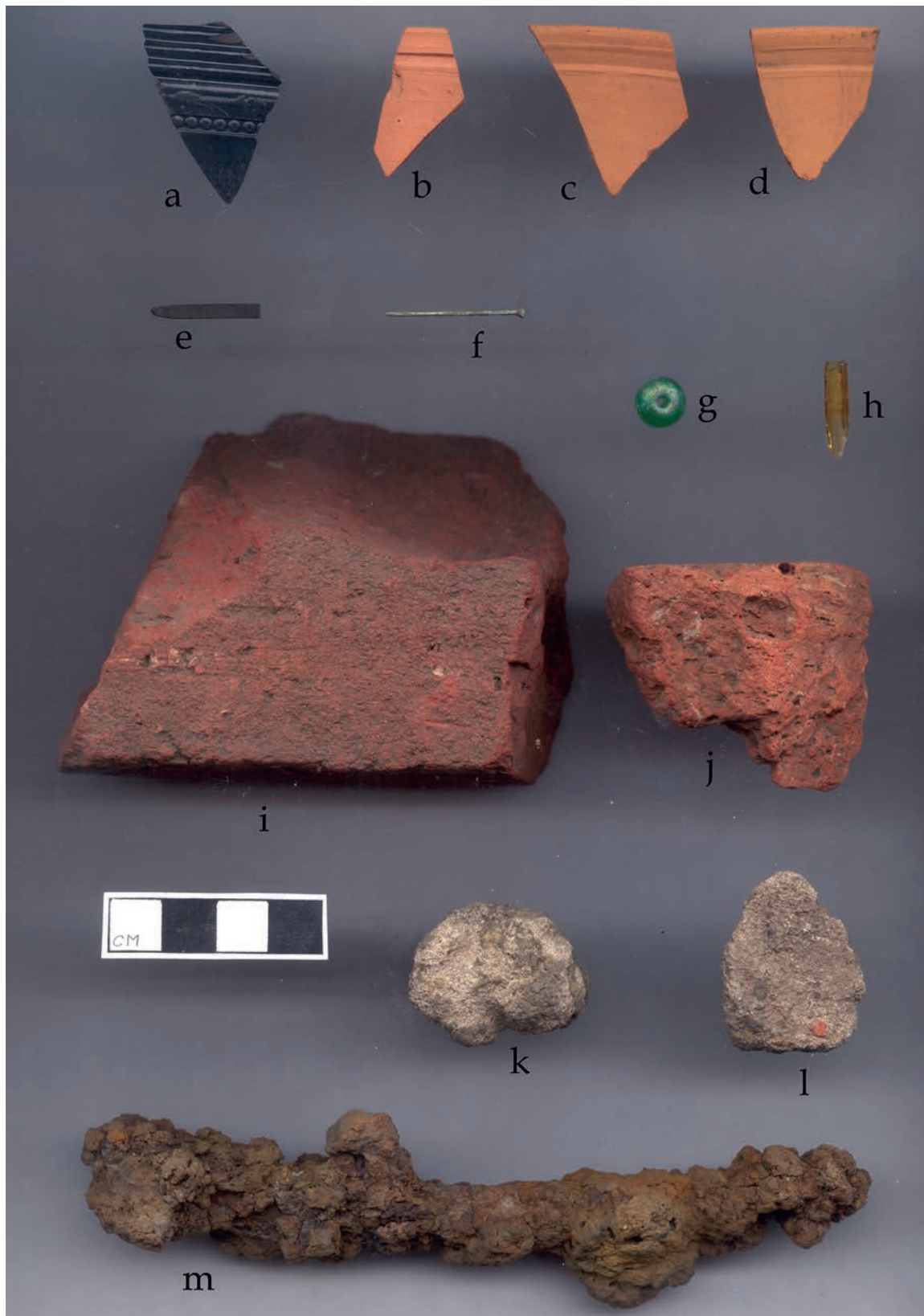
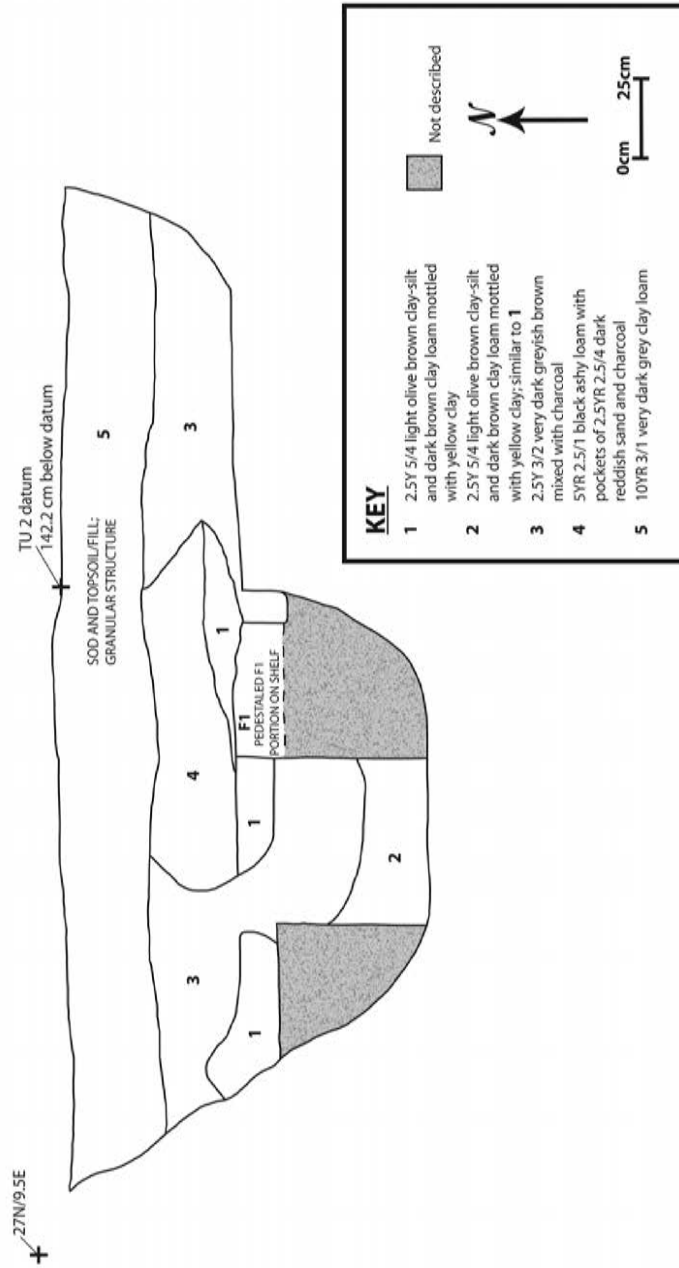


Figure 16. Artifacts recovered from Test Unit 2.

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Backhoe Trench 4, North Wall Profile

Gosia Mahoney and Dawn Bringelson



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Figure 17. Backhoe Trench 4. north wall profile.

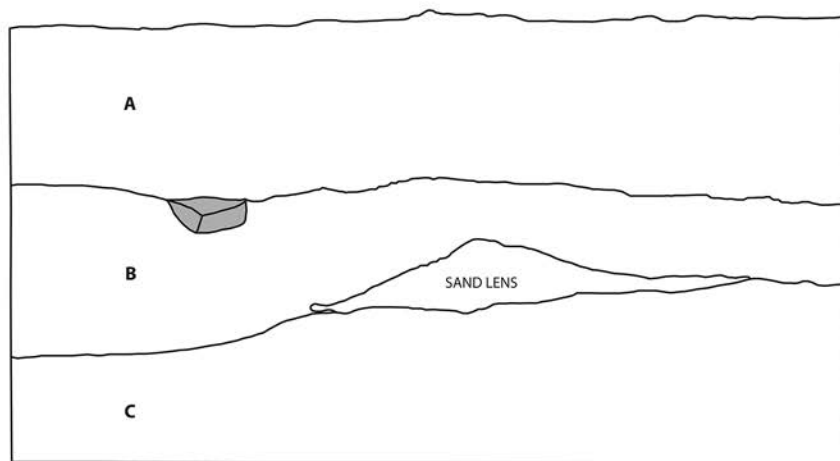


Figure 18. Artifacts recovered from Test Unit 1.

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Test Unit 1, West Wall Profile

Lisa Stanley-Smith and David Wolf



KEY

- A** 10YR 3/2 very dark greyish brown; topsoil
- B** Mottled 10YR 6/6 brownish yellow with 10YR 3/2 very dark greyish brown; construction debris throughout this layer
- C** 10YR 2/1 black clay loam



Brick



0cm 20cm

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Figure 19. Test Unit 1, west wall profile.

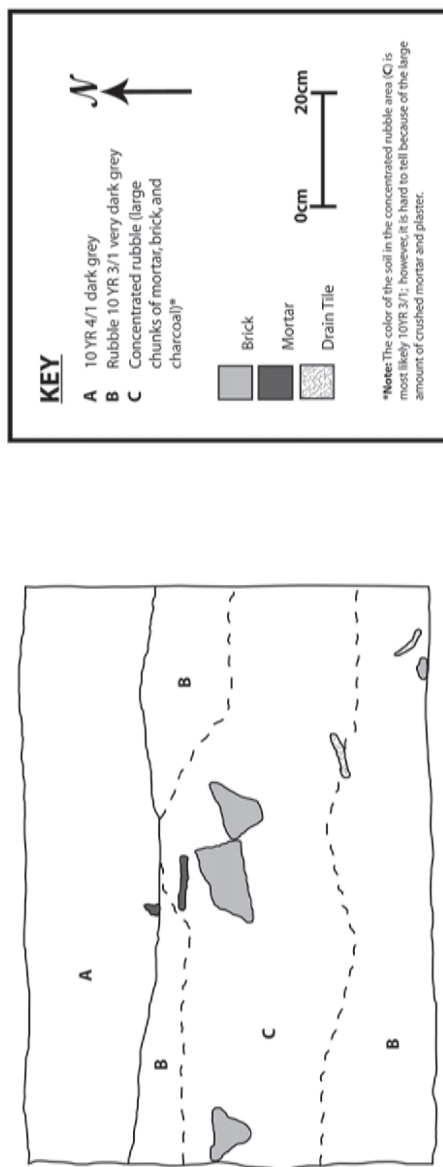


Figure 20. Test Unit 4. 0-70 cm bs.

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Test Unit 4, North Wall Profile

Laura McClatchey



05/10/2010

Figure 21. Test Unit 4, north wall profile.



Figure 22. Artifacts recovered from Test Unit 4.



Figure 23. Artifacts recovered from Test Unit 5.





Figure 25. Artifacts recovered from Feature 2 in Backhoe Trench 3, Test Unit 3.

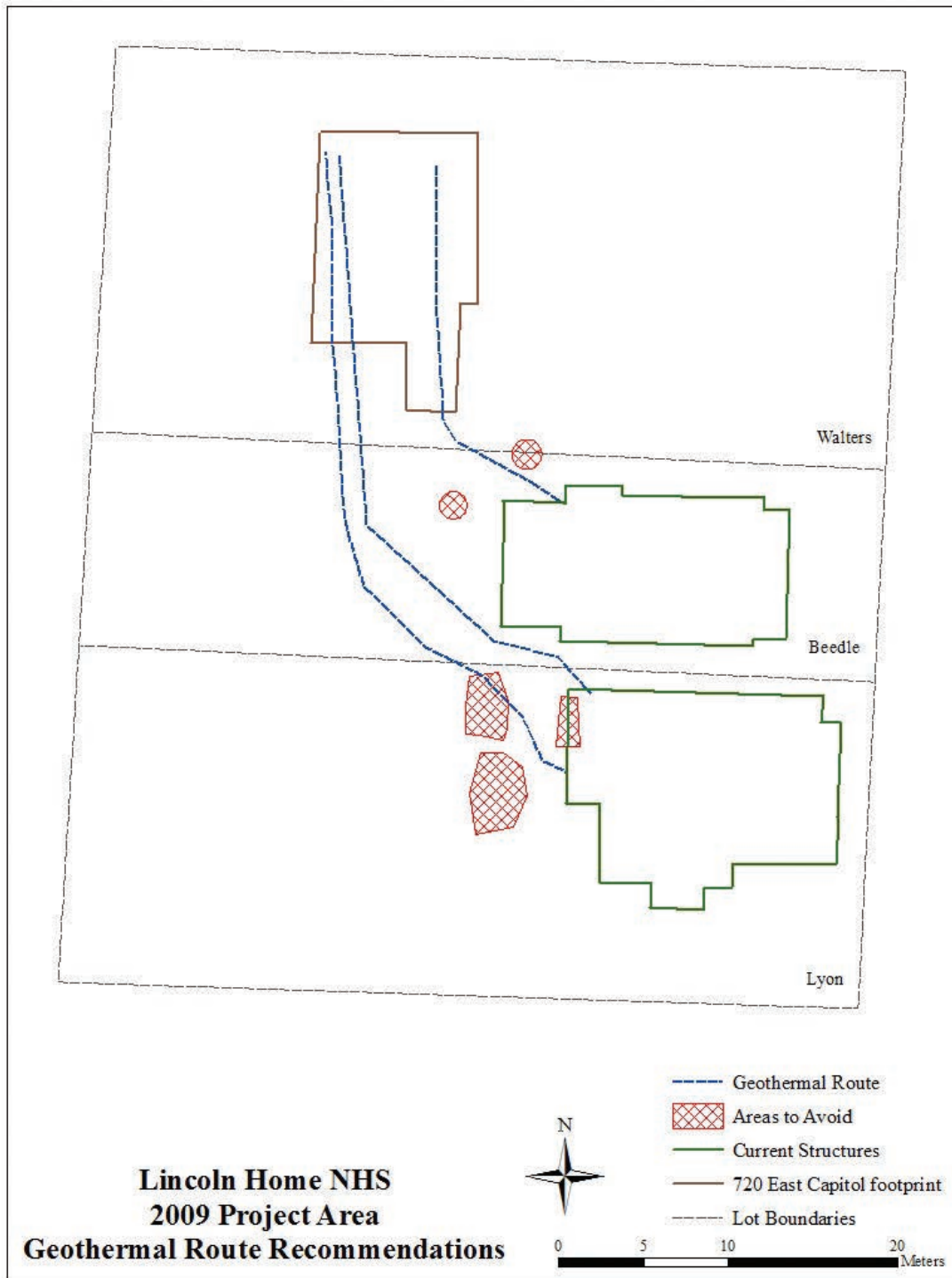


Figure 26. Geothermal route recommendations.