HISTORICAL PERSPECTIVES INC.

October 1, 2012 [rev.]

136-33 37TH AVENUE PROJECT

BLOCK 4977, LOT 94
136-33 and 136-35 37th Avenue, Flushing, Queens
and
BLOCK 4977, LOT 26
13716 Northern Boulevard, Flushing, Queens

ARCHAEOLOGICAL TESTING OF PROPERTY BOUNDARY:

REMOTE SENSING
AND
PHOTO DOCUMENTATION OF EXISTING SURFACE HEADSTONES

I. INTRODUCTION

The 136-33 37th Avenue Realty, LLC (Realty) has initiated construction of a new mixed-use building on two privately owned lots in the Flushing neighborhood of Queens County, New York. The location is designated Block 4977, Lots 94 and 95, and falls within the block bounded by Main Street on the west, 37th Avenue on the south, Union Street on the east, and Northern Boulevard on the north (Figure 1). The northern boundary of Lot 94 abuts the Religious Society of Friends' (Friends) historic burial ground (ca.1717 – ca.1830) located on Lot 26. In accordance with New York City Environmental Quality Review (CEQR) regulations and procedures, the New York City Landmarks Preservation Commission (LPC) reviewed the proposed action in 2009 and requested an Archaeological Documentary Study.

The requested Documentary Study was completed by Historical Perspectives (HPI) and submitted to LPC. LPC concurred with the Documentary Study's findings of the potential for historic-era archaeological resources and concern for human remains. The city agency requested field testing within the northern portion of Lot 94. HPI prepared a field testing protocol that complied with LPC's *Guidelines* and included a consultation agreement with the Friends.

Archaeological field investigations were completed in December of 2009. All archaeological testing was undertaken within the Block 4977, Lot 94 fence lines and only in areas that had been an active parking pad for 136-33 37th Avenue. The archaeological excavations and soil screening were initiated after a backhoe removed surface asphalt, under the direction of an HPI professional. The remnants of twentieth century concrete foundations, historical features and artifact concentrations were noted and/or identified during the field investigation. No human remains were recovered. The resulting testing report was filed with and approved by LPC (12/3/2010).

Subsequent construction activities in 2012 by Realty contractors along the Lot 94 boundary shared with the Friends have raised concerns that intrusions into the Friends property have occurred. In order to allay concerns that human remains might have been disturbed, representatives of both Realty and the Friends met on site (4/09/2012) and agreed to complete limited hand excavations along the property boundary within Lot 26. During this joint field meeting, LPC also recommended consideration of an additional examination in the form of a noninvasive survey conducted along the property boundary following HPI's field excavations,

Following the field meeting, HPI prepared a field protocol which was forwarded to LPC, SHPO and the Friends, and approved by the city and state agencies on 4/16/2012 and 4/26/2012, respectively. This protocol called for archaeological testing to be confined to an approximately 42-inch wide strip running the length of the shared boundary between Lot 94 and the Friends property. The main objectives for the field investigation were to determine the depth of the recent (2012) construction disturbance, including the location of a pole shaft, and if these intrusions impacted potential burial shafts. The archaeological testing was limited both horizontally and vertically by the impacts of the recent construction activities.

The field investigation called for a series of shovel shaved test units to be excavated by hand at irregular intervals within the 42-inch boundary testing strip. The test units, which would be approximately 1 x .5 meters in size, would be excavated to document the soil stratigraphy (color, texture, depth, intrusions, etc.) and potential recent construction disturbance.

On Friday, April 27, HPI conducted archaeological testing on the property boundary within the Friends parcel immediately north of Lot 94. The original testing strategy called for the investigation of six to eight test units. During the field examination this number was increased to eleven (11), in order to both excavate the test units at tighter intervals and to ensure that the entire length of the property boundary was examined (Figure 2). A field report on the archaeological hand excavation was prepared and submitted to SHPO, LPC, and the Friends (5/17/2012). The report concluded that further below ground excavation might potentially damage fragile burials that exist within the project site since the extent of non-monumented burials was unknown. It was recommended that the southern 20-25 feet of the Friends property be examined using Ground Penetrating Radar (GPR).

HPI, in partnership with Dr. Tim Horsley, of Horsley Archaeological Prospection, LLC (HAP), prepared a protocol that included conducting GPR on the southernmost 30 feet (9.24 meters) of Lot 26, concurrently with a photo documentation survey of the testing area. When the protocol was prepared, the testing area was increased from the original 20-25 feet (6.15 – 7.69 meters) based on the recommendation from Dr. Horsley. The HPI archaeologists meet the standards of the New York Archaeological Council, the National Park Service 36 CFR 61, and the LPC (2002:7). The protocol was sent to all parties (Realty, the Friends, LPC, and SHPO), reviewed and approved by LPC and SHPO on 6/22/2012 and 6/25/2012, respectively.

II. METHODOLOGY FOR ADDITIONAL ARCHAEOLOGICAL TESTING

- **Photo documentation**

Photographs were taken of the existing conditions and remaining grave markers within the 30-foot (9.24-meter) testing area. These photographs include wide area photos to show the overall site (from different perspectives) as well as individual anomalies and headstones noted on the ground surface.

- **Ground Penetrating Radar**

In many cases, as an alternative to invasive excavation, remote sensing (a geophysical study) has been employed in the location of historic cemeteries to determine if intact burial shafts and/or coffins are present. According to the NYAC Standards,

> Fragile and sensitive cultural features, such as burials, are the types of cultural resources that could be severely damaged by subsurface discovery methods. The tool most commonly used in this process is ground penetrating radar (2000).

GPR is an instrumental, non-invasive technique that uses electrical currents, similar to radar to detect electrical differences in the substrate. This works best when electrical differences are great, as with detecting metal or concrete, but less effective when they are less dramatic (as in clay rich or salty soils). This technique is often able to pick up subtle difference in the soil (e.g., grave shafts). Although GPR has proven successful on some sites, there are many environmental factors that can adversely affect the results of a GPR survey in urban situations. The success of GPR surveys is dependent on soil and sediment mineralogy, ground moisture, clay content, the surface topography and vegetation, the depth of the potential resource, and finally the degree of subsurface intrusions. While GPR can be adapted to a great variety of site conditions, in many urban situations the presence of utilities and metal fragments in the soil can skew the results.

There were three objectives identified for this phase of testing. The first objective was to determine the extent of historical disturbance in the boundary testing area. The second objective was to determine if potential burial shafts are present within the testing strip. The third objective was to establish, to the extent possible, the limits of the Friends interments in relation to Lot 94. The resulting GPR analysis provided data for the creation of a detailed map of the north side of the boundary area between Lot 26 and Lot 94. Additional details regarding the methodology employed during the GPR testing of the Friends' Burial Ground are included in the HAP report.

III. RESULTS OF FIELD EXAMINATION

HPI and HAP conducted the GPR and photo documentation on Sunday July 1, 2012. A second visit was conducted on Sunday July 29, 2012 in order to accurately locate the GPR survey grid markers as well as specific landscape and cemetery features with a total station (electronic transit).

- **Photo documentation**

For documentation purposes during the initial field day, the HPI field team established a metric grid covering the burial ground. The site datum was located 18 meters directly south of the southeast corner of the Meeting House. The HPI field team then examined all of the remaining visible headstones. Measurements, relative to the site grid, were taken to the northwest corner of each stone and then transferred to a base map provided by HAP (Figure 3).

The HPI team also completed the photodocumentation of the GPR testing area (Photographs 1-3). Additional photographs of all of the exposed stones were taken and are attached in an electronic format.

The Friends provided HPI with a survey conducted by the WPA in 1935 (Appendix A). The survey contained a diagram of the location of the stones (not to scale) and a listing of the existing inscriptions. Each of the headstones photographed in August 2012 has been numbered to correspond to the 1935 WPA survey. Upon review, the team noted that several of the headstones had become indecipherable over the last 70 years and other stones had been removed, relocated within the cemetery, or possibly buried under the topsoil. One of the missing stones was that of Luisa Tucker (see Appendix A). This stone was the southernmost marker (Number 58) identified in the 1935 survey. It was described as broken and lying flush with the ground surface at that time. HPI attempted to gently probe in the location of this stone to see if it might be recovered. Unfortunately, the team was unable to locate any of the broken Luisa Tucker headstone fragments. Similarly, the Number 127 marble headstone [John Fitch] recorded in 1935 along the western limits of the burial ground was not evident during the 2012 survey.

One broken headstone, Sophia Bassett and George W. Fil…, was photographed at the base of a tree in the burial ground but was not listed on the 1935 survey.

Several of the headstones that were observed in the 30-foot (9.24-meter) testing area appear to have been relocated (shown in light gray on HAP Figures 15 and 16). Further, the HPI team noted the most severely displaced headstone (Rebecca Wright) was on its side within the main cemetery (Photograph 4). Wright's marker was designated as headstone Number 1 in the 1935 WPA survey. At that time it was located along the western boundary (see Appendix A). It has subsequently been moved approximately 45.5 feet (14 meters) to the east.

See Photographs 5-8 for examples of headstones. For orientation purposes, note that the arrow in the photographs is indicating NORTH and the scale is in meters. Photograph 8 is the only obvious plot of grouped stones.

- **Ground Penetrating Radar**

In order to conduct the GPR testing, the field teams from HAP and HPI, along with volunteers from the Friends, cleared all of the excess brush from the southernmost 48 feet (15 meters) of Lot 26, adjacent to the boundary with Lot 94. Once the brush was removed, Dr. Horsley established a grid and confirmed that there was sufficient ground exposed for his examination. See Photographs 9 – 11. Testing was conducted over the locations of known interments as well as the open area in order to assist with his analysis of the data. The results of the GPR testing are presented in the HAP report (attached).

IV. REFERENCES

Landmarks Preservation Commission (LPC)
2002 *Landmarks Preservation Commission Guidelines for Archaeological Work in New York City*.

Mascia, Sara
2012 Archaeological Testing of Property Boundary 136-33 37th Avenue, Block 4977, Lot 94 and Block 4977, Lot 26 13716 Northern Boulevard, Flushing, Queens, New York. Historical Perspectives, Inc.

2010 Archaeological Field Investigation 136-33 37th Avenue, Block 4977, Lots 94 and 95, 136-33 And 136-35 37th Avenue, Flushing, Queens, New York. Historical Perspectives, Inc.

New York Archaeological Council (NYAC)
2000 *Standards for Cultural Resource Investigations and the Curation of Archaeological Collections.* New York Archaeological Council.

Schaefer, Richard
2009 Archaeological Documentary Study 136-33 37th Avenue, Block 4977, Lots 94 and 95, 136-33 And 136-35 37th Avenue, Flushing, Queens, New York. Historical Perspectives, Inc.

Photograph 1
Religious Society of Friends' historic burial ground – north end, view is east to west.

Photograph 2
Religious Society of Friends' historic burial ground – north end, view is northeast to southwest.

Photograph 3
Religious Society of Friends' historic burial ground.

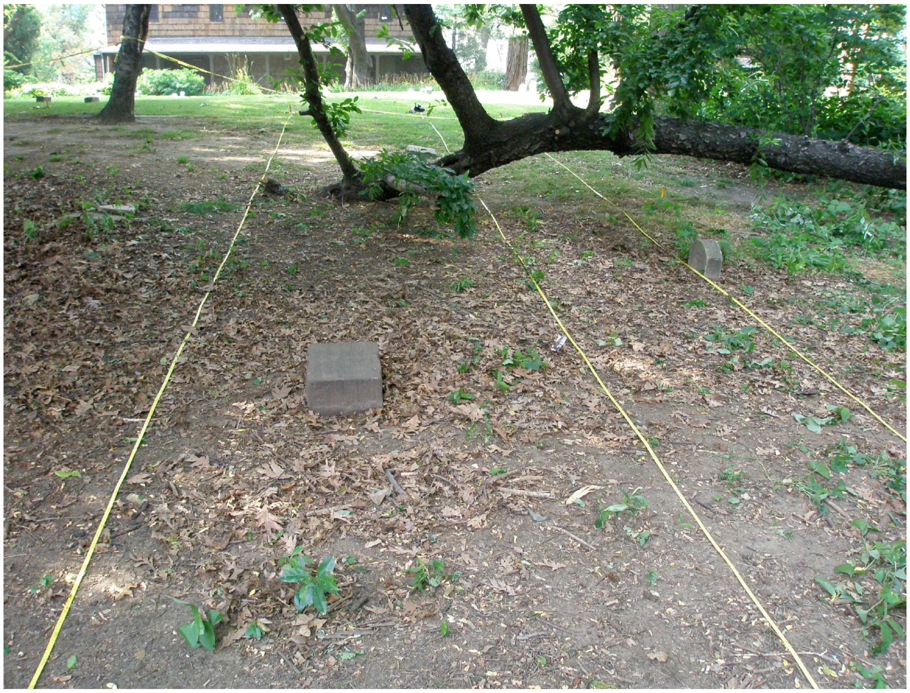
Photograph 4
Headstone Number 1: Rebecca Wright, displaced from original interment

Photograph 5
Headstone Number 7: Timothy Matlack, died 1845.

Photograph 6
Headstone Number 43: Michael M. Titus, died 1837.

Photograph 7
Headstone Number 90: Catharine Wright, died 1848.

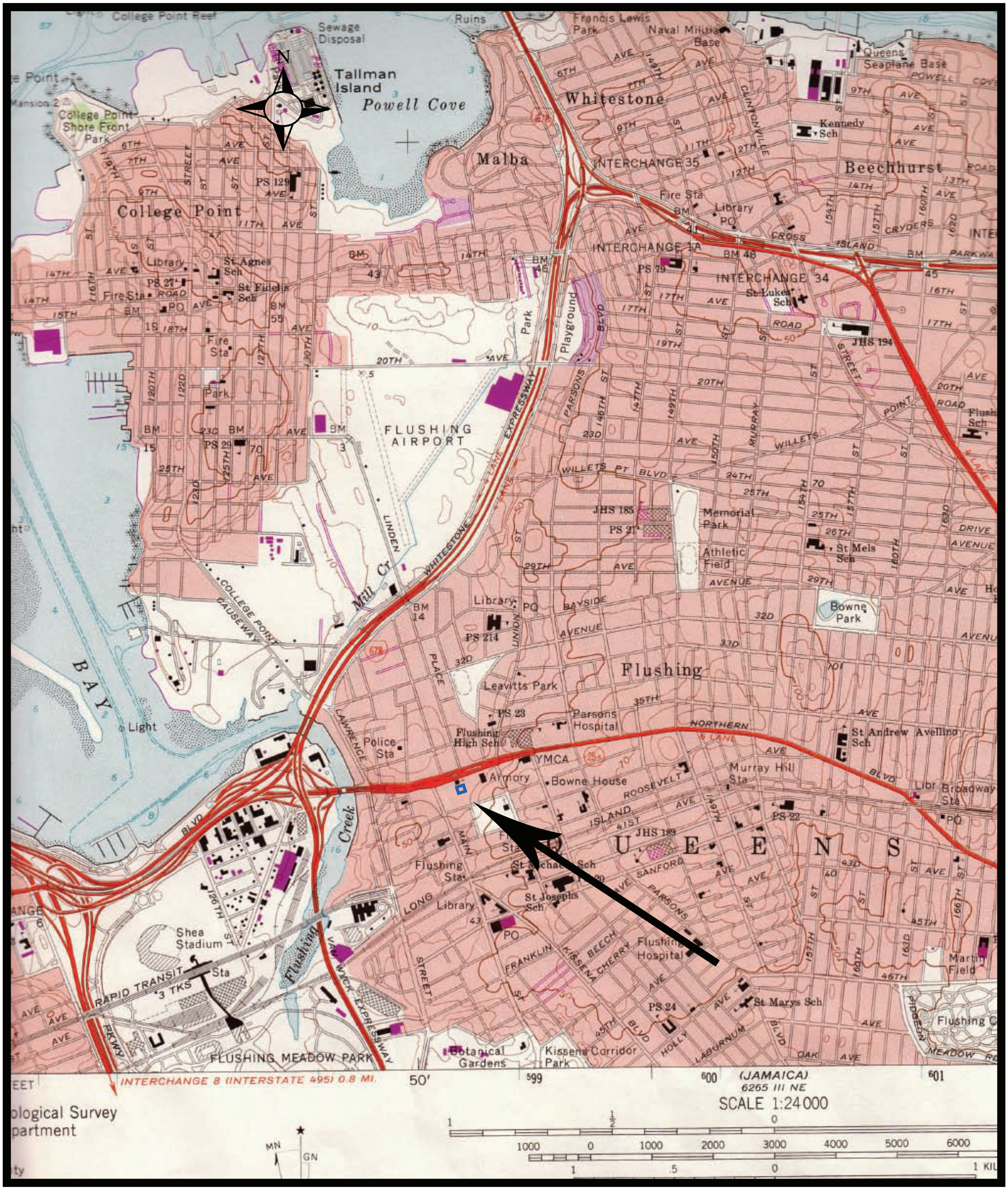
Photograph 8
Enclosed plot containing both Wright (e.g., Headstone Numbers 65 and 67) and Byrd interments (e.g., Headstone Number 66).



Photograph 9
GPR testing grid, view is south to north with Meeting House in the background.
Headstone Number 102 in center of photograph: Captain Leonard Dove, died 1848.
Headstone Number 119 in right rear of photograph: Susan Powell, died 1862.
Headstone Number 91 in left rear of photograph: four Pearsall children, 1837 – 1843.

Photograph 10
GPR testing, view is northwest to southeast toward southern lot line.
Headstone Number 110 in left center of photograph: Josiah Paine, died 1849.

Photograph 11
GPR testing, view is west to east, at south end of lot.
Headstone Number 110 in center of photograph: Josiah Paine, died 1849.

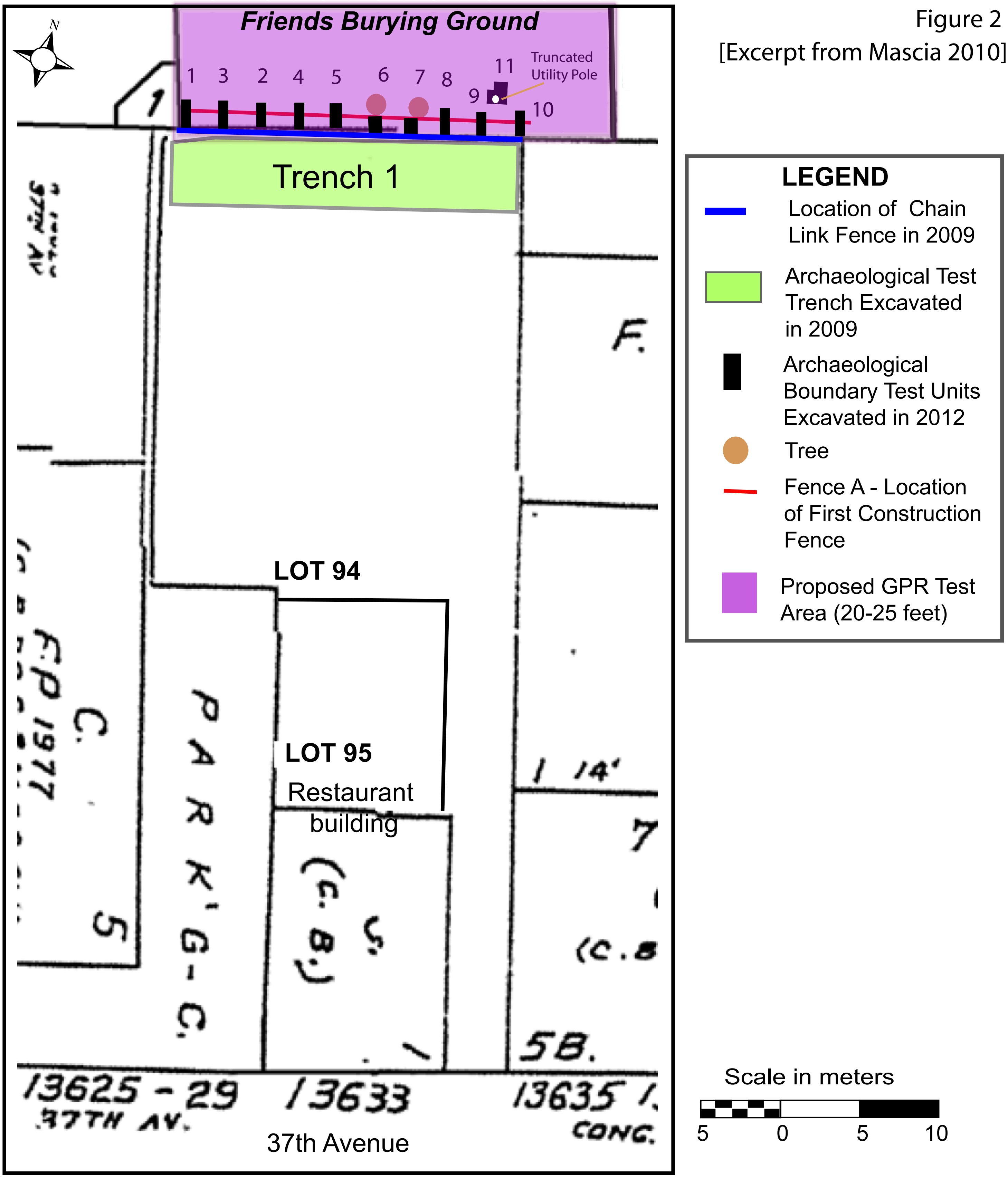


LEGEND

Arrow indicates the Area of Potential Effect

Archaelgoical Testing of Property Boundary
BLOCK 4977, LOT 94 136-33 37th Avenue, Flushing, New York
FIGURE 1. USGS, Flushing, N.Y., 1979

Figure 2
[Excerpt from Mascia 2010]



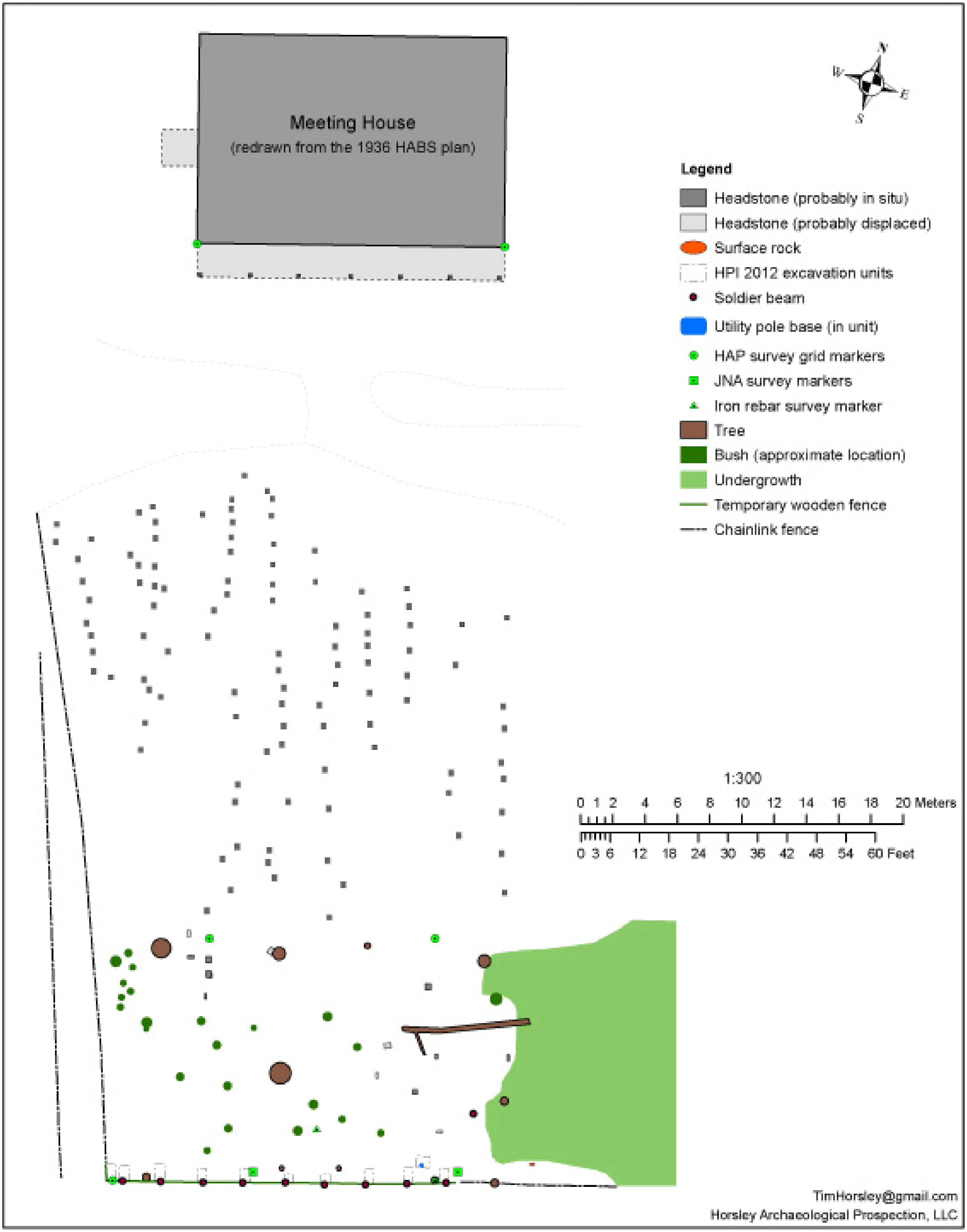
Archaelgoical Testing of Property Boundary
BLOCK 4977, LOT 94 136-33 37th Avenue, Flushing, New York

Figure 9: Proposed Area for GPR Study.
(Base map: Sanborn, *Insurance Maps of the Borough of Queens*, 2006, updated)

Friends' Burial Ground, Flushing, Queens County, NY.

Map of surface features produced from total station measurements. July, 2012.

Figure 3



APPENDIX A
WPA SURVEY 1935

NO. 31

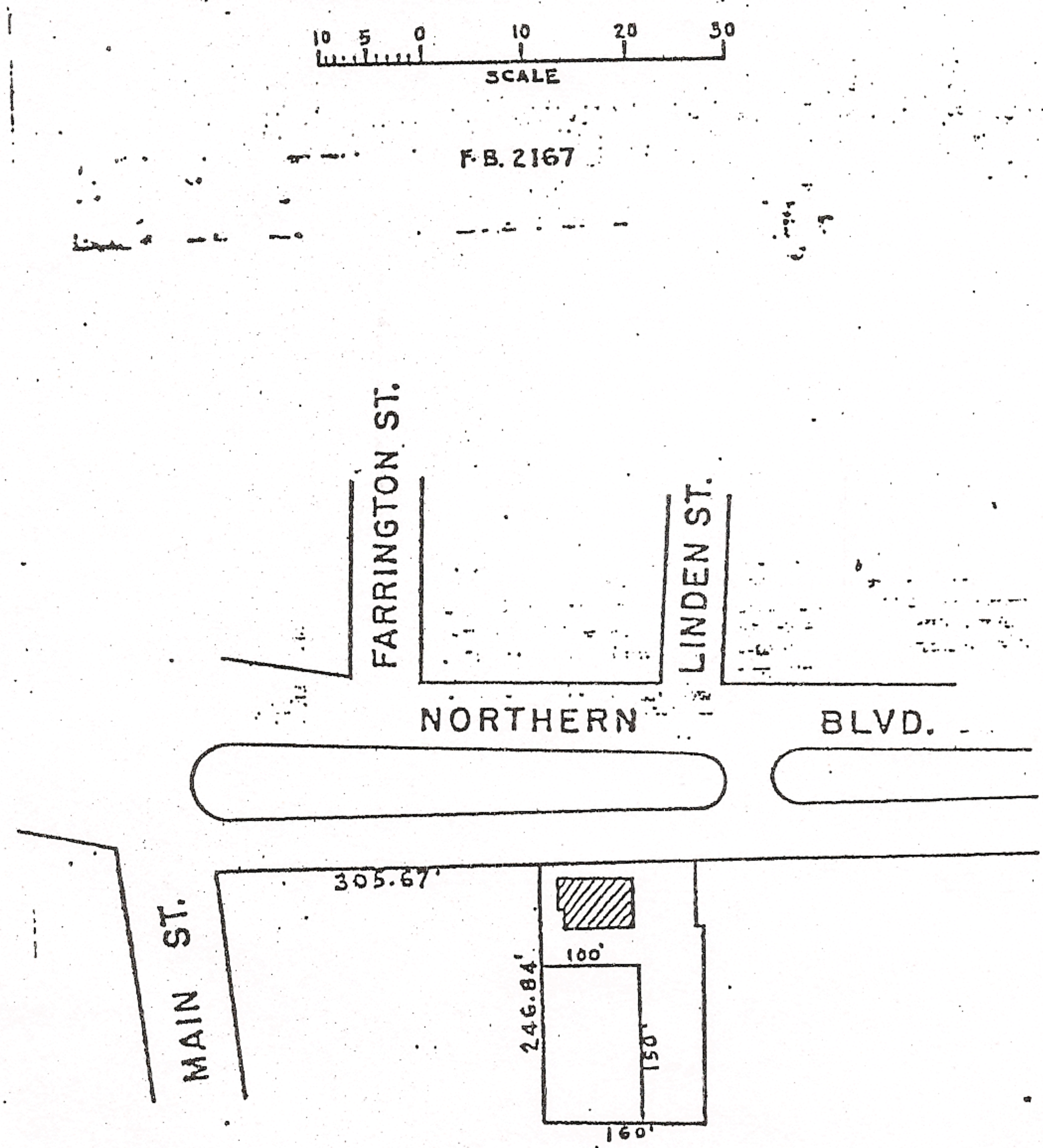
RELIGIOUS SOCIETY OF FRIENDS CHURCHYARD

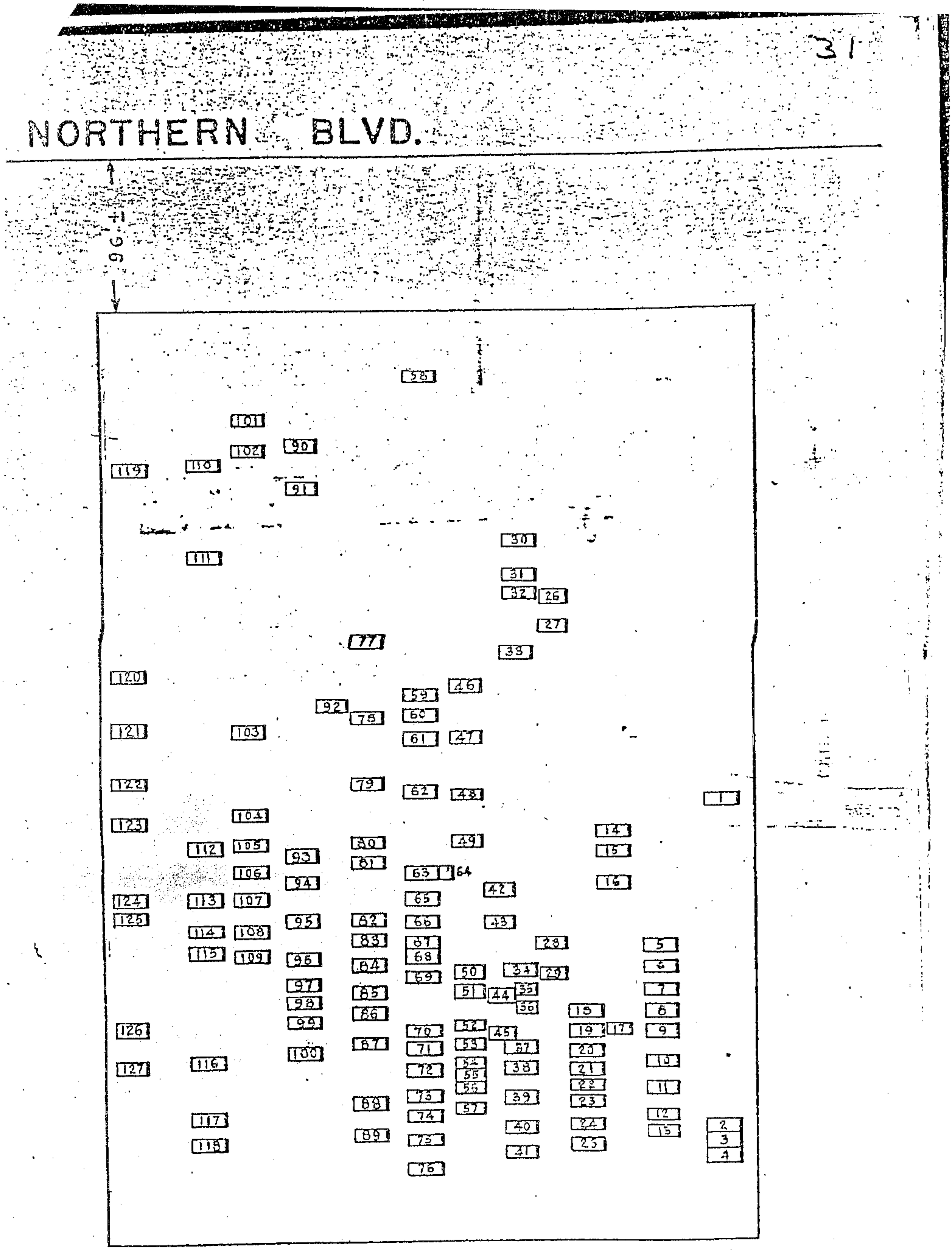
NORTHERN BLVD. E. OF MAIN ST.

FLUSHING

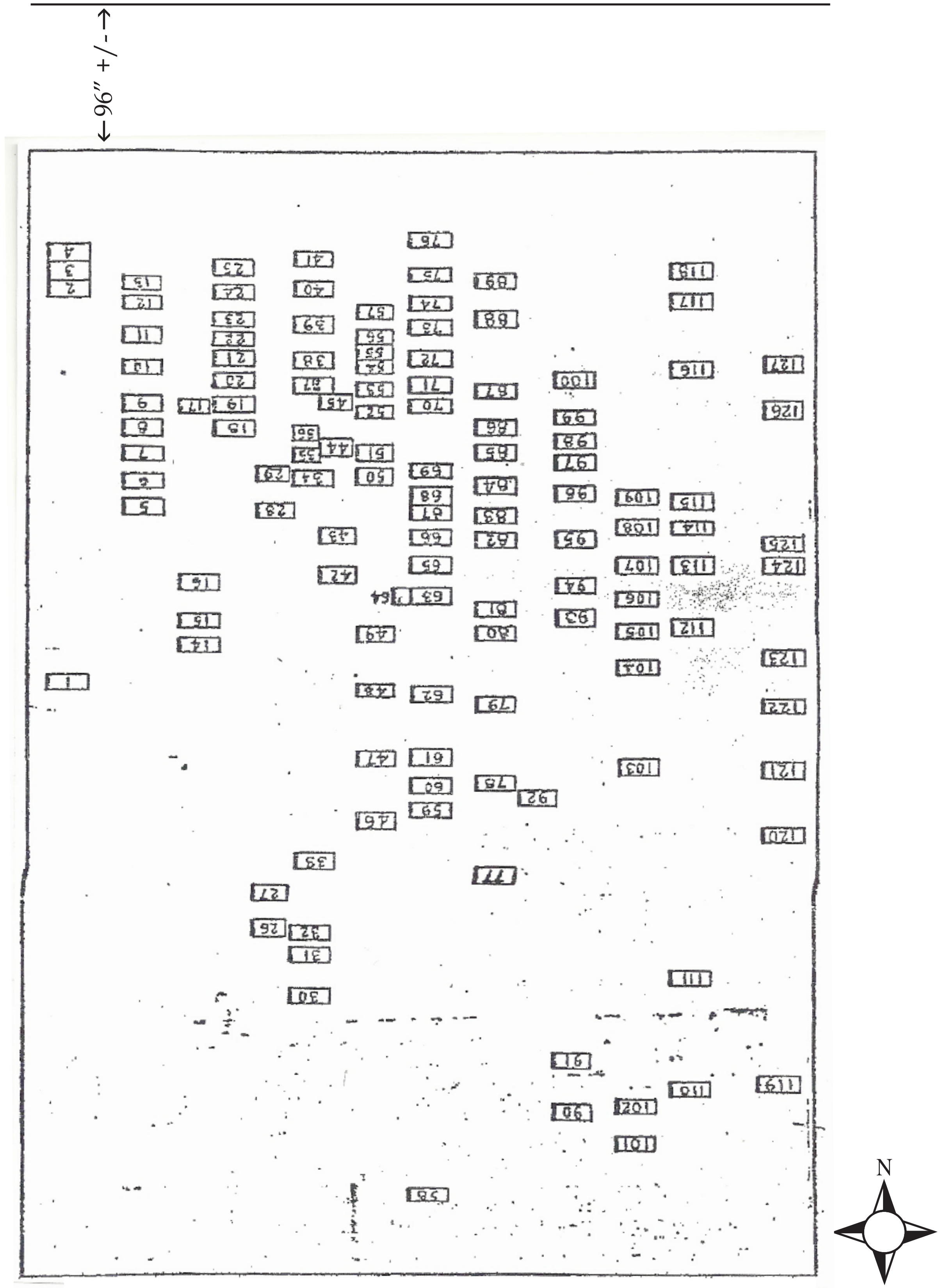
SURVEYED DEC. 5, 1935

F.B. 2167




NORTHERN BLVD.

NORTHERN BLVD.



Lot No. 94

Note: The original 1935 Survey erroneously labeled Northern Boulevard to the south of the Friends' parcel. This figure gives the correct orientation.

No. 31. RELIGIOUS SOCIETY OF FRIENDS CHURCHYARD. NORTHERN BLVD opp LINDEN ST. FLUSHING.

No. 1. BROWNSTONE; chipped.
(On top) REBECCA WRIGHT
and her son ROBERT.

No. 2. MARBLE.
(on top) RACHEL J. KIMBER
(On beveled face) Died 2nd Mo. 19th. 1885, in the 71th year of her age.

No. 3. MARBLE.
(On top) JOSHUA KIMBER
(On bev. face) Died 8th Mo. 27th 1856. in the 64th year of his age.

No. 4. MARBLE.
(On top) W.C.K. & L.C.K.
WILLIAM C. KIMBER, died 3rd Mo. 8th 1827. Aged 13 mos. 9 d'ys.
LYDIA C. KIMBER, died 9th Mo. 8th 1829. Aged 19 mos. 9 d'ys.

No. 5. BROWNSTONE; chipped;
inscr. on Top.
ABIGAL SMITH died 7th 1st mo. (18)43. Aged 82.

No. 6. BROWNSTONE; chipped;
inscr. on top.
NATHANIEL SMITH. Died 20th 5th mo. 1835. Aged 77.

No. 7. MARBLE; inscr. on top.
TIMOTHY MATLACK, died 4th of 8th Month, 1845. Aged 53 years.

No. 8. MARBLE - inscr. on top.
HANNAH MATLOCK. Born July 21, 1783. Died July 25, 1866.

No. 9. MARBLE.
(On top) CORNELL BOWNE
Died 12. Mo. 19. 1864 in the 64th year of his age.

No. 10. BROWNSTONE; inscr. on top.
ISAAC W. BOWNE.

No. 11. MARBLE; inscr. on top.
ANN P. WILLETS. 1851.

No. 12. MARBLE.
(On top) MARIA FARRINGTON
Died 3rd Mo. 26, 1857. Aged 70 years.

No. 13. MARBLE.
(On top.) THOMAS LEGGETT.
Born 1st Mo. 30th 1793. Died 8th Mo. 1st, 1865.

No. 14. SLATE SLAB; flush with ground.
ELIZABETH HICKS.

No. 15. SLATE SLAB, flush with ground.
ANN HICKS.
charles hicks

No. 16. BROWNSTONE; inscr. on top.
JOHN LOWERRE. Died A.D. 1831. Aged 64½ years.
ELIZABETH LOWERRE. Died A.D. 1844. Aged (7)4 years.
LEWIS son of C.P. & A.B. LOWERRE. Died A.D. 1846. Aged 1 year 7 mo.

No. 17. SLATE SLAB, flush with ground.
CAROLINE HICKS.

No. 18. SLATE SLAB, flush with ground.
SCOTT HICKS.

No. 19. GRANITE; flush with ground, eroded.
MARY FARRINGTON. Died (1831) Aged 79.

No. 20. GRANITE; flush with ground; chipped.
WALTER FARRINGTON - -
(Rest of inscr. illegible.)

No. 21. GRANITE; flush with ground; broken.
ABA(HM) FARRINGTON. Died 1838, Aged 47.

No. 22. GRANITE; flush with ground.

ANN F. LEGGETT, died 1833.
Aged 39.

No. 23. MARBLE. flush with ground. ELIZABETH LEGGETT,
Died 4th month 17th 1849, aged 64 years. 7 months and 7 days.

No. 24. MARBLE; flush with ground. SAMUEL LEGGETT,
died 1st month 5th 1847, aged 64 years. 3 mos. & 1 day.

No. 25. BROWNSTONE; horizontal
CAROLINE LEGGETT 1833
MARGARETE LEGGETT 1831.

No. 26. MARBLE; horizontal
H.L.B. & S.L.B.

No. 27. MARBLE; horizontal.
F. C. EWBANK.

No. 28. BROWNSTONE; horizontal
ABAGAIL PINKHAM, Born 1st Mo. 1792. Died 10th Mo. 1861.

No. 29. MARBLE; horizontal;
no apparent inscr.

No. 30. MARBLE.
FANNIE BASSETT. Died III, 1835.

No. 31. BROWNSTONE; horizontal.
ELIZABETH JENNER.

No. 32. BROWNSTONE; horizontal.
EDWARD JENNER.

No. 33. MARBLE; horizontal.
RICHARD FRANKLIN, died 1835, aged 11 Years.

No. 34. GRANITE; flush with ground. MARGARET PEARSALL
died 1833, aged 65 Years.

No. 35. GRANITE; flush with ground. (Tree obscures face inscription) SAML PERSALL. Died 1841. Aged 77 years.

No. 36. GRANITE; horizontal. HANNAH BOWNE.

No. 37. GRANITE; horizontal. WILLETT BOWNE.

No. 38. GRANITE; horizontal. CHARLES BOWNE.

No. 39. A concrete marker.

No. 40. MARBLE; horizontal ELIZABETH W. LAWRENCE Died November 24th. 1852, aged 88 years.

No. 41. GRANITE; horizontal. SAMUEL BOWNE.

No. 42. GRANITE.; flush with ground. In Memory of ALICE TITUS, wife of M.M. TITUS who departed this life 1st Mo. 21st 1842. Aged 67 Years.

No. 43. GRANITE; flush with ground In Memory of MICHAEL M. TITUS, who departed this life March 21st 1837, aged 65 years.

No. 44. BROWNSTONE; horizontal. JORDAN WRIGHT. Died 1837.

No. 45. BROWNSTONE; horizontal. ELIZH CHAPMAN, Died July 12th 1838. Aged 88.

No. 46. BROWNSTONE; horizontal. MARY GILMORE. Died 5th Mo. 20th D. 1838. A.6.9.Y.

No. 47. MARBLE. (On top.) THOMAS KING

No. 48. MARBLE; horizontal. LYDIA FRANKLIN. Died 1837. Aged 64 years. LYDIA F. SMART. Died 1840 Aged 8 years.

No. 49. MARBLE; horizontal. ANTHONY FRANKLIN Died 1854 aged 87 years.

No. 50. GRANITE; horizontal. SCOTT H BOWNE.

No. 51. GRANITE. horizontal GEORGE W. QUINBY.

No. 52. GRANITE. horizontal. PHILIP BOWNE

No. 53. GRANITE; horizontal JOHN W. BOWNE.

No. 54. GRANITE; horizontal. HANNAH H. BOWNE.

No. 55. GRANITE; flush with ground. ELIZA F. BOWNE. Died 1870

No. 56. GRANITE; flush with ground, inscription entirely chipped off.

No. 57. GRANITE. flush with ground; chipped BENJ. C.B. (Probably BOWNE)

No. 58. MARBLE; flush with ground; broken. LOUISA TUCKER, departed (t)his life Jan(uary) - 0 th 1841, Aged 2 years 4 months and 25 days.

No. 59. MARBLE; horizontal. WHITE D. ANDREWS deceased 8th 10th Month 1839, aged 38 yrs. 7 mos. & 29 days. Also his sons WILLIAM HENRY deceased 19th 2nd Month 1837, aged 3 yrs, 6 mos. & 29 days. And JAMES EDWIN, deceased 27th 2nd Month 1839 aged 4 yrs. 3 mos. & 27 days.

No. 60. MARBLE; horizontal. NATHANIEL WEEKS ANDREWS deceased 29th 8th Month 1842. Aged 9 Years, 8 Months & 23 Days.

No. 61. BROWNSTONE; horizontal. D.D. WRIGHT, Died 1841.

No. 62. MARBLE; horizontal. JOHN L. FRANKLIN. Died 1863. Aged 73 Years.

No. 63. GRANITE. (On top.) JOHN D. WRIGHT. Born 9 Mo. 19. 1799. Died 8 Mo. 24. 1879.

No. 64. MARBLE. (On top.) WILLIAM B. CLEMENT, son of HENRY & RUTH CLEMENT Died 2nd Mo. 9th 1855. Aged. 5 Years & 4 Days.

No. 65. BROWNSTONE; horizontal MARY B. WRIGHT. Died 11 Mo. 28th 1843. Aged 46 years. Also CAROLINE E. WRIGHT. Died 1 Mo. 6th, 1864.

No. 66. BROWNSTONE; horizontal. JAMES & ELIZABETH BYRD. Died 1842.

No. 67. GRANITE; horizontal JAMES B. WRIGHT. Born 12. Mo. 16. 1822. Died 3. Mo. 20. 1879. Also PHEBE C. wife JAMES B. WRIGHT. Born 2 Mo. 1. 1824. Died 3 Mo. 22. 1916.

No. 68. MARBLE; horizontal. A.L. Died 1843. Aged 70.

No. 69. BROWNSTONE; horizontal. HENRY MITCHELL Æ. 86 Years 1843.

No. 31. RELIGIOUS SOCIETY OF FRIENDS CHURCHYARD. NORTHERN BLVD. opp. LINDEN ST. FLUSHING.

The following are all marble and bear the name on top.

No. 70. EDWARD O. TOWNSEND
Died 1st Mo. 29th 1864. Aged 18 Years.

No. 71. ELIZABETH TITUS
Died 6th Mo. 22nd 1856.
Aged 81 Years.

No. 72. SILAS HICKS
Died 3rd Mo. 30th 1861.

No. 73. WILLIAM L TITUS
Born 12th Mo. 21st 1794.
Died 11th Mo. 26th 1859.

No. 74. ANNA L. HICKS.
Born 9 Mo. 5th. 1826.
Died 7 Mo. 3rd. 1891.

No. 75. SARAH T. HICKS.
Died 11th Mo. 21st 1874.
Aged 84 Years 8 Mo.

No. 76. PHEBE L. TITUS.
Died 1st Mo. 26th 1882
Aged 76 Years.

No. 77. BROWNSTONE; horizontal.
CATHARINE BROWNE.
Died August 1st 1843.
Aged 79 years.

No. 78. MARBLE; inscription illegible.

No. 79. MARBLE; horizontal.
C.L.B. & R.L.B.

No. 80. MARBLE: horizontal
HARRIET LAWRENCE.
& H.L.B.

No. 81. BROWNSTONE.
(On Top.) W. T. P.

No. 82. MARBLE.
(On top.) ANN WHITSON
Born 8 mo. 26. 1779.
Died 10 mo. 10. 1869.

No. 83. MARBLE.
(On Top.) THOMAS WHITSON
Born 3 month 1, 1776.
Died — month 1, 1846.

No. 84. SLATE; flush with ground. JACOB PEARSALL
Died 1846.

No. 85. SLATE; flush with ground. ESTHER LAWRENCE
Died 1847.

No. 86. SLATE; flush with ground. GILBERT LAWRENCE
Died 1870.

No. 87. GRANITE; flush with ground; ROBERT LAWRENCE
Died 1847.

No. 88. MARBLE;
(On Top) SARAH COOK.
Born 2nd Month 1st, 1774.
Died 11th Month 30th 1863.

No 89. MARBLE.
(On Top.) WILLIAM F. COOK.
Born 5th Mo. 17th 1814.
Died 7th Mo. 20th. 1868.

No. 90. MARBLE; horizontal.
In memory of CATHARINE WRIGHT,
who Departed this life September 7,
1848. Aged 78 Years.

No. 91. MARBLE; flush with ground; broken. CATHARINE E.
Died April 18, 1837. Aged 12 days.
ADELIA Died Aug. 3, 1839.
Aged 5 months & 3 days.
MARY E. Died Aug. 8, 1840,
Aged 3 months.
ADELINE Died Aug. 25, 1843.
Aged 6 months & 21 d.
Of such is the Kingdom of Heaven
Children of THOMAS & ELIZA
PEARSALL.

No. 92. MARBLE; horizontal.
S. L. W. 1848.

No. 93. MARBLE; horizontal.
WILLIAM R. THURSTON.
Died 4th Mo. 25th 1855.
Aged 88 yrs. 9 Mos, 14 Days.

No. 94. MARBLE; horizontal
ABIGAIL E. THURSTON
Died 5 Mo. 28th 1851.
Aged 66 yrs, & 18 days.

No. 95. MARBLE;
(On Top) DEBORAH L. EMBREE
Born 5th Mo. 18th 1778.
Died 5th Mo. 24th, 1853.

No. 96. MARBLE;
(On Top.) JOHN L. EMBREE
Born 2nd Mo. 21st 1783.
Died 4th Mo. 20th. 1850.

No. 97. BROWNSTONE; horizontal. WILLIAM LAWRENCE
Died May 9, 1893.

No. 98. BROWNSTONE; horizontal.
DEBORAH ANN LAWRENCE
Died April 28, 1886.

No. 99. BROWNSTONE; horizontal.
AMELIA WRIGHT
Died 6 Mo. 11, 1863.
Aged 64 Years.

No. 100. BROWNSTONE;
no apparent inscription.

No. 101. BROWNSTONE; horizontal.
Captain LEONARD DOVE.
Died Nov. 30th. 1848,
aged 54 years, 11 months & 2 days.

No. 102. BROWNSTONE; horizontal.
GILE H. LOWERRE
Born 3 mo. AD 1803.
Died 3 mo. 1850, aged 47 years.

No. 103. SLATE; flush with ground.
ABRAHAM WHITSON
Died 1857.

The following are marble with name on top.

No. 104. ROBERT S. WINES.
Died 9th month 29th 1861.
Aged 23 years & 2 months.

No. 105. EDWARD S. WINES
Died 6th Mo. 1st. 1863.
Aged 34 years 10 months.

No. 106. ELIZABETH T.
wife of GILBERT H. WINES.
Died April 12th 1864.
in her 36th year.

No. 107. JANE. L. WINES.
Died 10th Mo. 9th. 1865.
in the 69 Year of her age.

No. 108. JOHN WINES
Born 7th. Mo. 24th 1789.
Died 5th Mo. 30th. 1869.

No. 109. BROWNSTONE. horizontal.
MARGARET KISSAM.
Died Nov. 18, 1886.

No. 110. MARBLE; horizontal.
JOSIAH PAINE. Died Aug 11th 1849.
Aged 52.

No. 111. GRANITE.
(On top.) JULIETT, daughter of
LEMUEL & SUSAN A. POWELL.
Died 4th Mo. 16. 1858. Aged 6 years, & 2 days.

No. 112. SLATE. horizontal.
LEWIS UNDERHILL

No. 113. MARBLE;
(On Top) CARRIE daughter of
ROBERT C. & PHEBE S. EMBREE.
Born 6th Mo. 1st. 1853.
Died 1st Mo. 3rd. 1860.

No. 114. MARBLE.
(On top) MICHAEL A. TITUS.
Died 8th Mo. 6th 1859. Aged 41 years, 3 Mos & 8 Days.

No. 115. MARBLE; no inscription apparent.

No. 116. MARBLE.
(On top.) PHEBE BYRD.
Died 6th Mo. 29th 1864.
Aged 79 Years & 7 Mos.

No. 117. MARBLE; horizontal:
JANE WHITE: Died 7th Mo. 19. 1866: Aged 79 Years.

No. 118. MARBLE.
(On top.) OUR MOTHER
SUSAN W. COCK.
Died 4 mo. 2nd 1872.
Aged 83 years.

The following are marble with name on top.

No. 119. SUSAN A. POWELL.
Died 9th Mo. 2nd. 1863.
Aged 47 Years.

No. 120. LAURA HAMMOND.
Died 2 Mo. 25th 1865.
Aged 71 Years.

No. 121. SAMUEL L. B. Son of B.C. & E.R. BYRD.
died 10 Mo. 26. 1863. Aged 7 Yrs. 2 Mos. & 5 D's.

No. 122. ABEGAIL L. WILLETS.
Died July 16th 1865. Aged 78 Years & 3 Days.

No. 123. ELIZABETH A. JACKSON, Born 6th Mo. 10th 1817. Died 9th Mo. 17th, 1889.

No. 124. EUGENE, son of
SAML & PHE J. WHITSON
Died 1 Mo. 7, 1867. Aged 1 Mo. 4 Ds.

No. 125. MARY WHITSON
Died 3 Mo. 15th. 1865. Aged 86 Ys. 5 Mo. 7 Ds.

No. 126. MARBLE; horizontal.
CATHERINE J. WHITE.
Born 9th Mo. 14 1827.
Died 10th Mo. 6. 1872.

No. 127. MARBLE.
(On Top.) JOSEPH FITCH.
Born 13th June, 6th Mo. 1811.
Died 27th Oct. 10th Mo. 1868.
THO LOST TO SIGT TO MEMORY DEAR.

Religious Society of Friends' Burial Ground, Flushing, Queens County, New York

Report on Geophysical Surveys, July 2012

for

Historical Perspectives, Inc.

T.J. Horsley

August 2012

Horsley Archaeological Prospection, LLC

HAP2012-20

RELIGIOUS SOCIETY OF FRIENDS' BURIAL GROUND, FLUSHING, QUEENS, NEW YORK
REPORT ON GEOPHYSICAL SURVEYS, July 2012

Summary

A non-invasive geophysical survey was conducted within the southern portion of the burial ground associated with the Friends' Meeting House in Flushing, Queens, in an attempt to map the locations and extent of graves. In addition to a number of trees and bushes, this part of the cemetery contains fewer headstones than the main open lawn area, assumed to be related to the Friends' established pre-nineteenth century practice of not commemorating individual burials with headstones. Comparison with an unscaled survey undertaken in 1935 suggests that some of these grave markers may have been moved since that time. In order to address recent concerns about the potential impact of neighboring construction work, it was hoped that a ground-penetrating radar survey could help to identify the presence of burials and determine the southern extent of historic interments.

Ground-penetrating radar (GPR) involves the transmission of high-frequency radar pulses into the ground from a surface antenna. Where this energy meets discontinuities in the soil, such as soil strata and buried remains, some pulses are reflected back to a receiving antenna while others continue down to be reflected by more deeply buried features. Numerous energy reflections have been recorded within the survey area; however, the majority of these appear to be due to a dense network of tree roots. While a number of these responses resemble reflections produced by burial voids, they can be distinguished as roots based on attributes such as length, orientation, and proximity to existing trees. No unambiguous evidence for any burials can be identified, but five possible burials are suggested based on their association with headstones. A further 40 reflections have been suggested as tentative burials; however, it is more likely that these are instead produced by tree roots. Without further investigation using more intrusive methods it is not possible to determine their cause with any more certainty.

These ambiguous results are not particularly surprising given the age of the graves and the local environmental conditions. Burials become more difficult to detect over time, and at this cemetery, the nature of the sandy soils, underlying glacial parent material and presence of young and mature trees, all appear to have advanced decomposition of the remains and removed any measurable geophysical signature.

Evidence for other disturbances has been detected along the southern boundary, with a concentration in the southwestern corner of the property. These may be associated with 19th and 20th century activities identified during previous archaeological investigations, and would require further work using intrusive methods to determine their nature and age.

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RELIGIOUS SOCIETY OF FRIENDS' BURIAL GROUND, FLUSHING, QUEENS, NEW YORK

REPORT ON GEOPHYSICAL SURVEYS, July 2012

1. Introduction

1.1 Horsley Archaeological Prospection, LLC, (HAP), has conducted a geophysical survey within the southern portion of the burial ground associated with the Meeting House belonging to the Religious Society of Friends, (Friends) on Northern Blvd., Flushing, Queens County, New York. The work was undertaken in response to a request from Historical Perspectives, Inc., (HPI), to attempt to locate and map the positions of any potential burials within 20-25 feet (*c*.6-8m) of the southern cemetery boundary.

1.2 The Friend's Meeting House and Burial Ground occupy Block 4977, Lot 26, located at 13716 Northern Boulevard. The oldest part of the Meeting House is believed to date to around 1694, with the burial ground reported to date between 1717 and 1830. The Friends' established pre-nineteenth century practice of not commemorating individual burials with headstones argues for more burials within Lot 26 than are indicated by today's remaining headstones. Headstones identified in a survey in 1935 indicate dates ranging from 1837 – 1893 (RSoFC 1935), and it is not clear whether earlier burials are present for which headstones, possibly of wood, have been lost. Furthermore, comparison between the 1935 headstone survey and the positions of headstones today suggests that some were moved during the last 77 years.

Recent construction work by 136-33 37th Avenue Realty, LLC (Realty), to the south of the Friend's property, in Block 4977, Lot 94, has raised concerns about potential impact on the Burial Ground and buried human remains, as well as questions about the precise location of the property boundary. In December 2009, HPI conducted archaeological investigations in Realty's adjoining Lot 94 that revealed several historic features and artifact locations, but no evidence for human remains (Mascia, 2010). In April 2012, HPI undertook limited excavation in eleven test units along the southern edge of Lot 26, all tests located within a 1.1m (42 inches) strip adjacent to the current temporary wooden fence and soldier beams associated with the current construction work. This evaluation indicated disturbances extending almost completely across the entire boundary and mostly associated with twentieth century activities, with some nineteenth century deposits identified in the eastern units. The more recent disturbance includes repairs to the former chain link fence, installation of numerous plantings, and disposal of modern trash and debris. The base of a recently installed and removed utility pole was also revealed, but no evidence for burials was identified (Mascia, 2012).

It was therefore decided to undertake a non-invasive ground-penetrating radar (GPR) investigation in an attempt to accurately locate any potential burials and assist with determining the southern extent of inhumations associated with this cemetery.

1.3 The Friend's Burial Ground is centered on 598730E, 4513070N (Universal Transverse Mercator coordinates, zone 18T), or 40.7627, -73.8302 (latitude, longitude, decimal degrees). The geophysical survey was located at the southwestern portion of Lot 26 and encompassed as much as possible of the full width of the burial ground. To the west, the survey was bounded by a chainlink fence and a number of young trees; the southern edge was defined by the temporary wooden fence erected by Realty contractors. The eastern extent of the survey area was dictated by dense vegetation that prevented the GPR from collecting usable data, although it was possible to record data across 30m, (98 feet), within around 5m (16.4 feet) of the southern boundary. The survey extended 15m, (49 feet), into the burial ground, to produce a total survey area of around 360 square meters, (3875 square feet). This greater area increases the confidence with which the geophysical data are interpreted by including a number of known graves and a sufficiently large area to assess the nature of background variations.

The location of this survey area, as it relates to surface features mapped by HAP, is shown in Figure 1.

1.4 HPI found that the soils they encountered during previous excavations are very sandy, with some silty sand and loam in places (Mascia, 2010; 2012). The natural parent material in the area is predominantly glacial till, which consists of a mixture of clay, silt, sand, gravel and boulders. This Late Pleistocene surficial material varies between 1-50m in thickness, and overlies various gneisses of the Hartland Formation, Pelham Bay Member (Baskerville 1992; Caldwell 1991).

1.5 Geophysical surveys were undertaken on July 1, 2012. Occasional thunderstorms had brought around 5cm (2 inches) of rain earlier in the preceding week, but on the day of the survey the weather was dry, presenting favorable conditions for GPR.

1.6 The objectives of this investigation were to accurately map burials in the Friend's Burial Ground, and to define their southern extent.

2 Geophysical prospection methods

2.1 Geophysical methods include a range of non-destructive techniques for detecting subsurface disturbances associated with buried remains. It is important to note that these techniques do not detect the features themselves, but rather physical variations – or *anomalies* – that require interpretation. For a buried feature to be detected there must therefore be some physical contrast between it and the background soil and subsoils; if no such contrast exists, that feature will be effectively invisible. It is also important to note that it is not possible to date buried features using geophysical techniques alone. Only through investigation using more intrusive methods can datable artifacts and material be obtained.

2.2 Many archaeological features exhibit physical contrasts to the natural soils and sediments, either through the addition of foreign material into the soil (e.g. building materials such as bricks and rocks), or by altering the soils and subsoils (e.g. conversion of magnetic properties through heating, or the silting up of cut features such as pits and ditches). Of the range of archaeological features commonly encountered, burials present difficult targets for geophysical prospection methods since there may be little contrast to allow their detection. Bones are too small to be detected with any method and, despite digging of the grave and interment of a body or human remains, the grave is usually immediately backfilled with the same material that was removed. Despite this, previous investigations have shown that graves may be located by identifying disruptions in the natural stratigraphy of the soil, or detecting the less-compact soil of the grave fill, or, if present, detecting an air-filled cavity.

2.3 A selection of non-destructive geophysical techniques is available for archaeological prospection, including magnetometry, earth resistance and ground-penetrating radar (GPR). Each method measures a different physical property and therefore a particular method or combination of methods may be chosen that will be best suited to the conditions at a site. Based on the type of features and natural conditions expected at the Friend's Burial Ground, it was decided to employ GPR to answer the survey objectives.

2.4 Sandy soils present ideal conditions for GPR survey as they are usually well-drained, thereby reducing the water content of the ground that can attenuate the GPR signal. HAP has had success locating and mapping graves in cemeteries in similar sandy soils in the northeastern U.S., although these were over more recent burials from the late 19th century to 20th century (e.g. Horsley 2009; 2010; 2011a; 2011b). As noted above, graves are often detected with GPR due to either an air space left as the inhumation and casket, (if present), decomposes, or a contrast in the texture and compaction between grave fill and natural subsoils. Sandy soils may limit or even prevent either situation from occurring, as the granular material can more easily collapse and flow to fill up any air spaces as the grave is backfilled, or during decomposition. Unfortunately, in such instances a burial will be extremely difficult to detected using any geophysical method.

Further details on this technique may be found in the appendix.

3 Methodology

3.1 In order to accurately locate any resulting anomalies, geophysical surveys are undertaken over a regular grid. For these surveys, HAP established a baseline along the southern temporary wooden fence. Using tapes, an area of 20m x 15m was set out from this baseline to encompass the area of interest (see Figure 1). This grid was extended to the east where possible to include areas of lower vegetation. The locations of the survey grid corners, plus a number of other surface features, were recorded by HAP using a total station instrument.

3.2 The GPR survey was conducted using a Sensors and Software Noggin ground-penetrating radar system. A 250 MHz antenna was employed as this frequency has been shown to provide a good combination of subsurface resolution and depth penetration for historic graves.

3.3 It was decided to undertake two orthogonal surveys: the first along traverses spaced 0.25m apart and oriented parallel to the temporary fence (roughly east-west); and a second survey along traverses aligned roughly north-south and spaced 0.5m apart. Since the GPR is more sensitive to buried features that lay perpendicular to the direction the antenna is pushed, conducting the survey twice at closely-spaced traverses in perpendicular orientations should significantly improve the likelihood of detecting and correctly identifying burials.

Along each transect, individual profiles were made at 0.05m intervals; the distance being measured and measurements triggered using a survey wheel integrated into the cart used to collect the data.

3.5 All data were collected and recorded onto the dedicated data recorder and subsequently downloaded onto a PC. Processing was undertaken using the 2D data analysis module in *Reflex-Win Version 3.5*. Minimal processing was undertaken prior to the production of time-slices: a standard procedure consisting of *de-wowing*, *gain correction* and *time-zero correction*. The data were also migrated in an attempt to better interpret many of the reflections, with both migrated and un-migrated datasets used for analysis and interpretation. To allow conversion of time into real depth, the average velocity of the ground was found by matching computer-generated hyperbolae to the data; this velocity is specific to different sediments and water content and for this site it was found to be 0.09m/ns. It is worth noting that this is the average velocity for the entire profile, and the component velocities will be different for different materials, such as topsoil, sands and gravel. Therefore the calculated depths given here should be taken as approximations.

Following processing, the individual radargrams, (two examples of which are presented in Figure 2), were combined to produce a 3-dimensional block of data which were 'sliced' horizontally to produce the amplitude time-slices corresponding to different depths. These were produced in the 3D data interpretation module of *Reflex-Win Version 3.5*. Thick slices of 0.1m (0.33') have been produced from the ground surface down to 2.0m and a selection of these is presented in Figures 3-14. These allow the horizontal relationships between reflections to be more easily identified.

3.6 Time-slices were subsequently imported into *ArcView*, a Geographical Information System (GIS) package to allow the results to be georeferenced and integrated with maps of surface features, as seen in the accompanying figures.

4. Results

4.1 Two examples of the processed radargrams (Figures2b and c) and a selection of amplitude time-slices (Figures 3-14) are presented here to illustrate the discussion below and to accompany the interpretations shown in Figures 15 and 16. It should be noted that these interpretations have been produced with reference to all radargrams and time-slices, and with differing degrees of processing.

4.2 The GPR results show that clear reflections due to natural and anthropogenic sources have been detected down to at least 2.5m, (8.2'), although it is evident that only geological features, probably due to a stone/boulder-rich layer, are present below around 1.5m. The soils above this appear to be largely stone and boulder free, which would ordinarily present a quiet background against which anomalies of interest could be identified; however, the data in these more shallow layers are overwhelmingly dominated by tree roots. Roots are commonly seen in GPR data and can usually be distinguished from burials and other features on account of their greater lengths and variable orientations. Mapping the locations of existing trees also helps to correctly identify the origins of such anomalies. At the Friends' Burial Ground, the density of roots is very high, creating a very 'noisy' background that makes it difficult to confidently identify reflections due to anthropogenic features such as burials, (compare the radargrams in Fig. 2 and see Figure 15). Most of these root reflections can be seen to radiate out from the mapped tree locations, and their dendritic pattern becomes evident when the reflections from successive time-slices are combined.

The time-slices also reveal the importance of collecting data along perpendicular traverses; while many of the same reflections are recorded in the north-south and east-west data, the patterns of roots look quite different in the pairs of slices for each depth range, (see the discussion in Section 3.3 above). While it is expected that most burials are oriented parallel to the east-west property boundary, a north-facing stone within the survey area suggests that some burials might also be aligned north-south – although this stone may not be in its original position.

4.3 Despite the high resolution orthogonal surveys, no unambiguous evidence for burials has been provided by the GPR data, although a few 'possible' graves are suggested. These are shown in Figures 15 and 16. Each has a relatively shallow origin, around 0.5-0.9m deep, (1.6-3.0'), which is not unusual in historic cemeteries, especially those on sandy soils. Analysis of the individual radargrams and time-slices reveals that these particular reflections possess many of the characteristics expected from burials: each is around 1.5-2.0m in length, and between 0.50-0.95m in width; they are also oriented approximately east-west within the plot, consistent with the orientation suggested by the headstones in the open lawn area of the burial ground. These possible burials can also be associated with grave markers, strengthening this interpretation; however, none of them can be confidently identified as definite or even probable burials.

4.4 As noted in Section 2.4, while sandy soils present ideal conditions for GPR to be employed, at this site they do not appear to have provided suitable conditions for a geophysical contrast associated with an inhumation. Due to the particular properties of granular materials such as sand, the normal soil compaction and texture variations that can be detected using GPR may be too subtle to produce identifiable reflections. Even a small air space is likely to become filled with sand as a casket decomposes, also removing a distinctive feature that can allow a burial to be detected.

4.5 The difficulty in identifying burials with a high degree of certainty is also likely a factor of the age of these burials. Work in similar environments on glacially-derived soils has shown that inhumations buried more than approximately 60 years ago become increasingly difficult to positively identify (e.g. Horsley 2009; 2010; 2011a; 2011b; and see Figure 2a). This is due to decomposition of the inhumation that results in a reduction in the physical contrast necessary to produce a geophysical anomaly. The rate of decomposition and hence loss of an associated geophysical response is due to both the local natural conditions (soil type, drainage, etc.), and also whether the inhumation was placed within a coffin or simply wrapped in a shroud. At the Friends' Burial Ground, it is possible that some the burials are without a coffin and these will be more difficult to positively identify using any non-invasive geophysical method.

4.6 In an attempt to ensure that no inhumations are missed, around 40 other reflections have been highlighted as 'tentative burials'. These are not convincing as burials on account of their irregular shapes or unusual dimensions, although a rectangular shape is presented in Figures 15 and 16 to indicate how a burial, if present, might be positioned. It is much more likely that these reflections are instead due to individual or clusters of tree roots; however, it is possible that tree roots could be masking the subtle reflections produced by inhumations, and so such areas cannot be ruled out. There is also the possibility that tree roots are actually drawn to, and cluster around, the locations of burials, although this cannot be proven.

One such tentative burial is visible in the southeastern corner of the GPR survey, outside of what is believed to have been the cemetery boundary. This particular reflection is very shallow, between only 0.1-0.5m below surface, (0.3-1.6'). As such, it is more likely due to some other activity, possibly human or animal, rather than a grave; however, a burial cannot be ruled out.

4.7 While many of these tentative burials are rather unconvincing, it is more important to observe that no such reflections have been identified within some 2.0m, (6.5 feet), from the temporary wooden fence. While this cannot be taken as proof that no burials are present within this margin, there is no clear geophysical evidence for any inhumations in this area.

4.8 The interpretation in Figure 15 includes a number of reflections identified as 'soil disturbance'. These have been separated according to their depths and are likely due to excavation and burial of material that is not sand. None of these is believed to be due to a grave, but rather some other recent or historic activity. All are along the southern boundary of Lot 26 and may be related to 19th and 20th century features identified by

HPI in their investigations. A distinct area of disturbance, possibly indicating a cluster of pits up to 1.55m in depth, has been detected in the far southwestern corner of the survey area. This appears to suggest a concentration of activity in this corner of Lot 26. Further investigation using more intrusive methods would be necessary to accurately determine the origin of these, and identify how old they are.

4.9 The utility pole base revealed by HPI in an excavation unit was not detected; however, this is more a factor of the GPR survey methodology employed here. The particular combination of antenna frequency and traverse intervals was chosen to maximize the potential for locating and mapping burials, not smaller features such as the post. A feature around 0.25m in diameter would require a much closer traverse interval than adopted here, and would not have been feasible for this entire area.

4.10 It is interesting to note that HPI's excavation units from earlier in 2012 have also not produced distinct GPR reflections. Archaeological excavations many years old, sometimes decades, are frequently observed in geophysical data due to the same physical contrasts that allows other features to be detected. It therefore might seem surprising that an excavation only a few months old has not been detected, until one considers the properties of the sandy soil present within the Friends' Burial Ground. Digging a hole into sandy soil and then backfilling it with the same material will not produce a contrast detectable with any geophysical method, unless some other contrasting material is also placed into the hole.

4.11 Other indications of ground disturbance are visible in the data in the form of buried metallic objects. Metal produces a distinct type of reflection as the GPR energy is seen to 'ring down' throughout the radargram. This makes it appear as though the causative object extends down tens of centimeters, when, in fact, it may only be a few cm thick. The presence of metal in the ground, mostly close to the southern boundary, again indicates historic or modern activities consistent with those identified during HPI's previous investigations, and most of these metal reflections are clearly associated with areas of soil disturbance described in Section 4.6. It is not possible to identify what these metal objects might be, nor when they date from, using the geophysical data alone.

4.12 Below the dense reflections associated with tree roots, the background noise is seen to increase below around 1.0m, and by 1.4m the individual reflections can be seen to cluster, suggesting that they are caused by a natural deposit of large rocks or boulders at this depth. The radargrams also show these deeper groups of reflections between around 1.4-2.0m. This is also shown in Figure 15 as a natural deposit.

A few discrete reflections have been identified away from this broader deposit, but at similar depths, and may therefore be due to isolated boulders within the sand.

5. Conclusions

5.1 A GPR survey has been unsuccessful in confidently locating and mapping burials within the southern portion of the Friends' Burial Ground. While this may in part be due to the increased difficulty in positively identifying inhumations older than around 80 years, the dense network of tree roots that has been detected throughout the survey area complicates the picture and may be masking the more subtle reflections due to burials. Furthermore, it appears that the sandy soils may be limiting the physical contrasts necessary for their detection, and may have removed features such as air-filled cavities that can allow burials to be located. While GPR offers the best method for non-invasively searching for buried remains, at the Friends' Burial Ground there may simply be too little contrast remaining for them to be detected.

5.2 While many of the tentative burials identified throughout the survey area may instead be due to root activity, no potential burials have been identified within 2.0m, or 6.5', of the temporary wooden fence that currently marks the southern boundary. While this cannot be taken as absolute proof that no burials are present within this margin, there is no clear geophysical evidence for any inhumations in this area.

5.3 Evidence for disturbed ground along the southern boundary is consistent with that identified through excavation by HPI. A concentration of disturbance and group of pits is suggested in the southwestern corner of Lot 26; however, it is not possible to determine their cause or age from their geophysical anomalies alone.

The results and subsequent interpretation of geophysical surveys should not be treated as an absolute representation of the underlying features. It is normally only possible to prove the nature of anomalies through intrusive means, such as trial excavations. This type of ground truthing, however, is not recommended for cemeteries.

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Report:	T.J. Horsley	**Date of report**:	08/10/12

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Appendix - Ground-penetrating RADAR

Ground-penetrating RADAR, or GPR, involves the transmission of high-frequency radar pulses into the ground from a surface antenna. Where this energy meets discontinuities in the soil, such as soil strata and buried remains, some pulses are reflected back to a receiving antenna while others continue down to be reflected by more deeply buried features. The elapsed time between the energy transmission and reflection provides information on the depth of buried targets, and is used to produce a vertical slice through the ground – a radargram. Unlike other geophysical prospection techniques, such as magnetometry or earth resistance, this profile allows vertical relationships between deposits to be investigated. Furthermore, many closely-spaced transects may be combined to form a three-dimensional block of data that can be re-sampled horizontally. This is used to produce a series of subsurface plans for increasing depths, referred to as time-slices. The depth penetration of the radar pulses is dependent on both the frequency of the antennas employed and the electrical conductivity of the soils and sediments. Lower frequencies may be employed to provide deeper penetration, but at the expense of resolution.

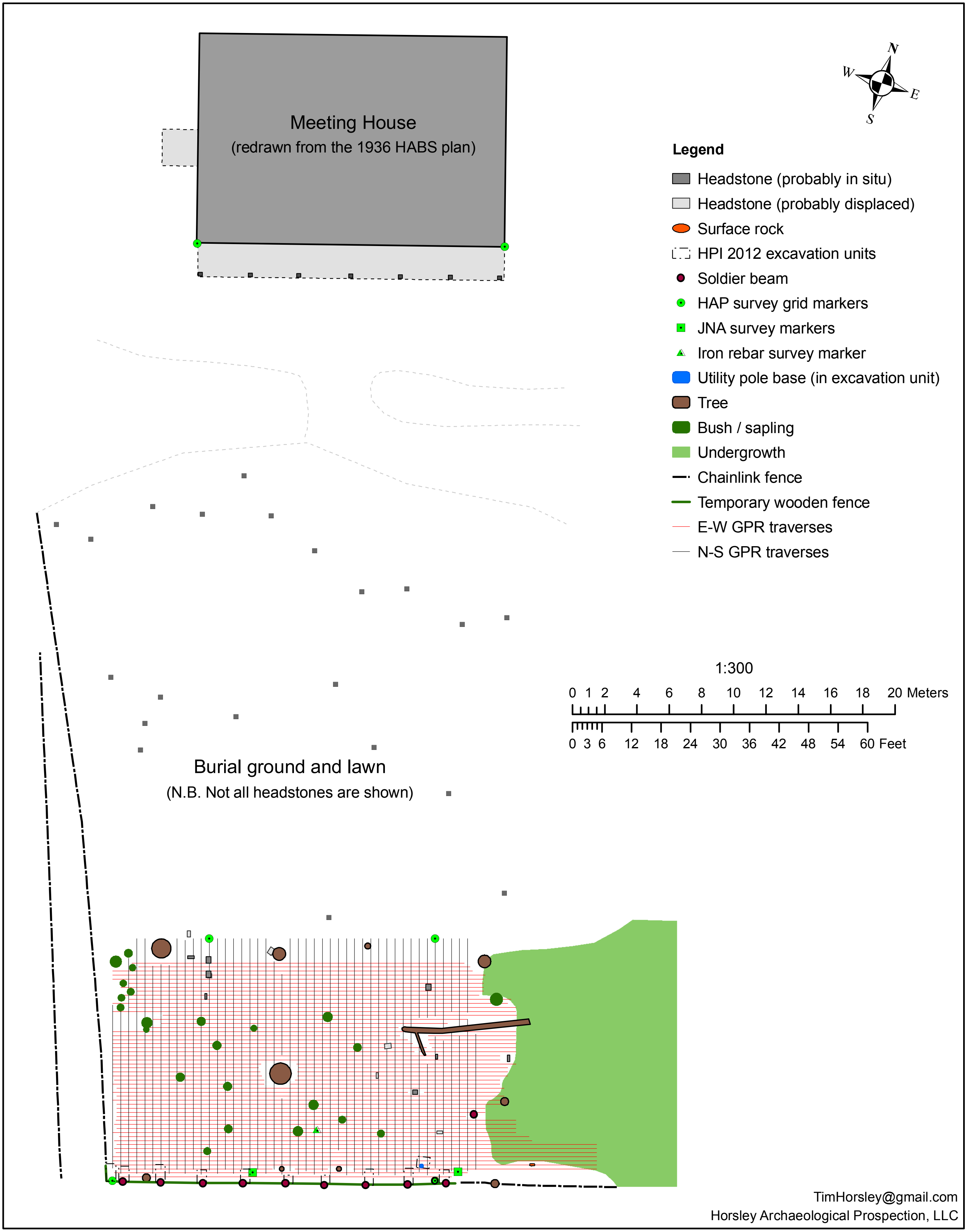
Radargrams are measured in terms of time (two-way travel time of the radar pulse); however, it is possible to calculate real depth values if the velocity of the material through which the radar energy is travelling is known. This can either be achieved in the field or by fitting computer-generated hyperbolae to the data after data collection. Further information on this technique may be found in Conyers (2004; 2006), Gaffney & Gater (2003: 47-51, 74-76), and Goodman et al. (1995).

Whilst previous investigations have shown that GPR can often detect later historic graves (e.g. Bevan 1991; Conyers 2006; King et al. 1993), early historic and prehistoric graves are far more difficult to identify. If the fill of the grave itself is less compact than the surrounding sediments, the sides and base of the grave may be detected using GPR; however the inhumations themselves are unlikely to produce any clear reflection. It is therefore not usually possible to distinguish between any detected pit anomalies and graves. It is hoped that the presence of any cut features will be identified by detecting discontinuities in the natural stratigraphy of the soil caused by cutting and backfilling of the grave shaft.

Historic features such as foundations, floor layers and rubble spreads, produce clearly identifiable radar reflections. Lenses and deposits of sand, gravel, or boulders will produce similar reflections, and distinguishing between them may be difficult and require additional information from other geophysical techniques or intrusive methods.

Friends' Burial Ground, Flushing, Queens County, NY. July, 2012.

Figure 1. Location of GPR survey traverses relative to a number of important surface features.



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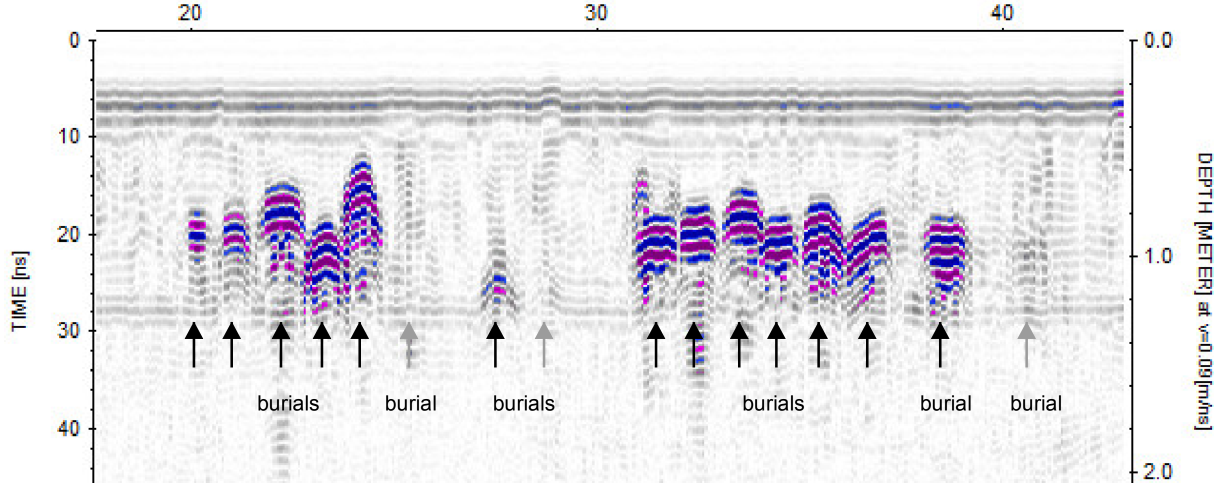
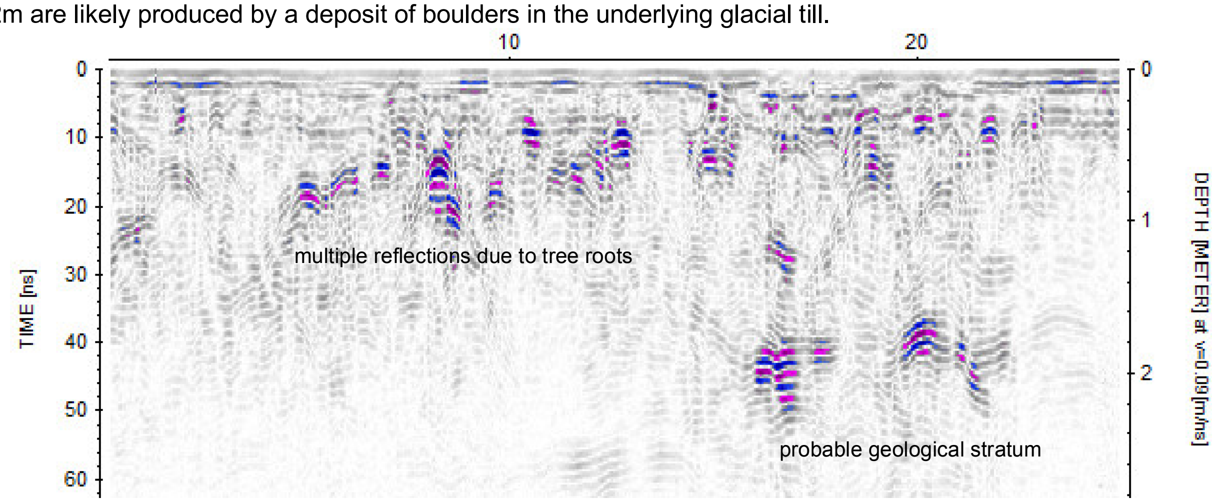
Friends' Burial Ground, Flushing, Queens County, NY. July, 2012.

Figure 2. Examples of processed radargrams from the Friend's Burial Ground and a cemetery in Northern Illinois.

a) Comparable radargram from a historic cemetery on similar sandy glacial soils in Lake County, IL. Both strong and weak reflections have been produced as the GPR passed north-south (i.e. transversely) over 16 known burials. The three weaker reflections are over graves more than 60 years old. The clear reflections are produced by burials dating to between 1960 - 1984.



b) Example radargram from an E-W traverse (i.e. probably passing longitudinally over interments) at the Friend's Burial Ground, (traverse N3.75m). The smaller, narrower and shallower reflections are due to tree roots, whereas the deeper reflections at around 2m are likely produced by a deposit of boulders in the underlying glacial till.



c) Example radargram from a N-S traverse at the Friend's Burial Ground, (traverse E7.5m). Again, these narrow and shallow reflections are most likely due to tree roots, but the broader reflection between 1.2-1.3m is possibly due to a burial.

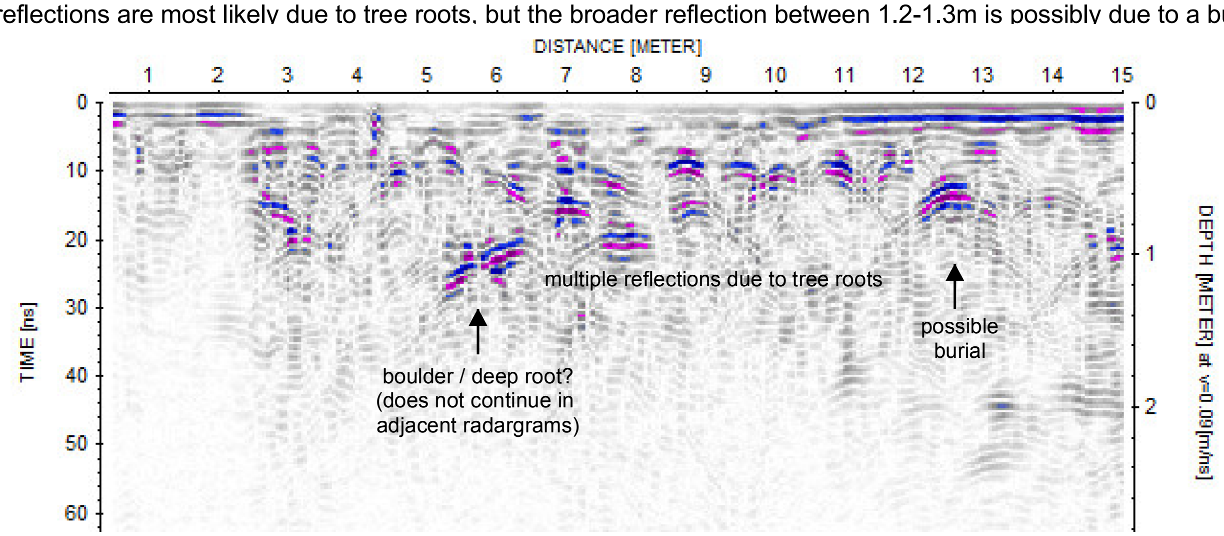


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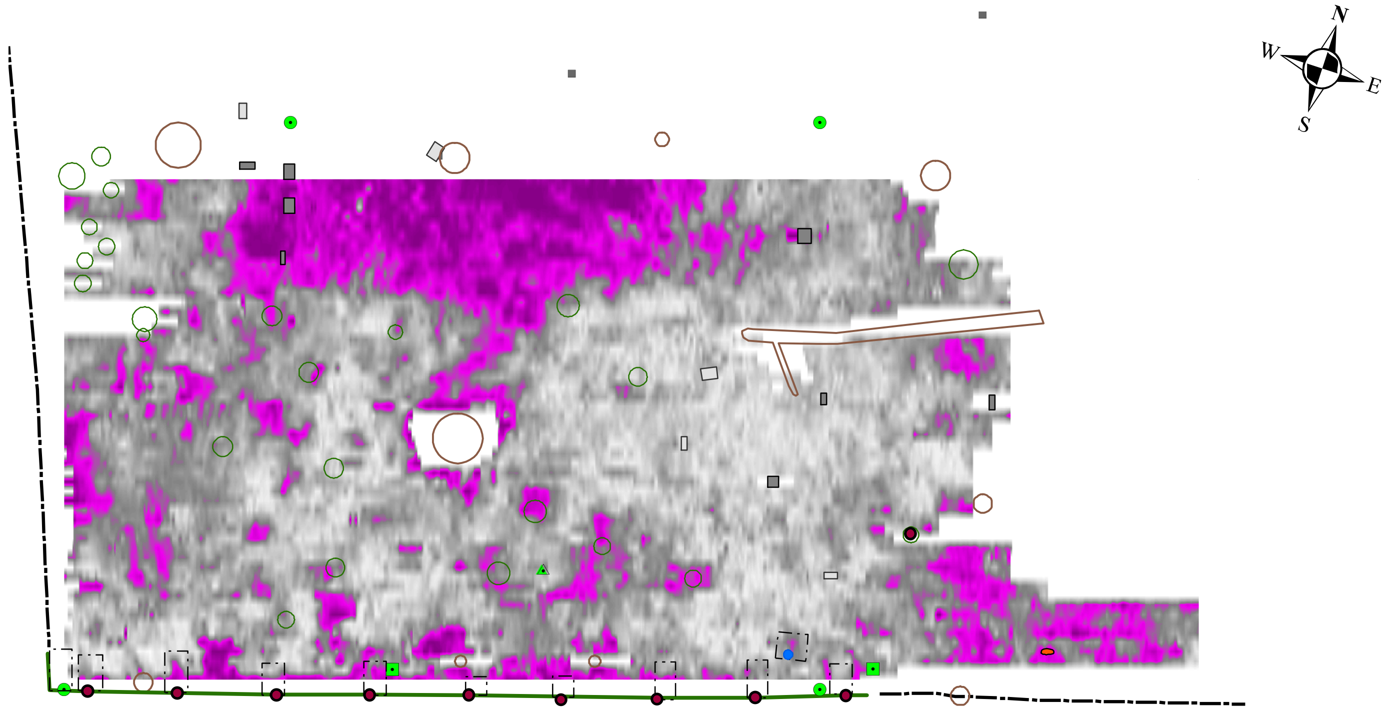
Figure 3. Time-slices from the two orthogonal surveys corresponding to approx. 0.0m - 0.1m. below surface (0-4").

a) Time-slice from the E-W survey



b) Time-slice from the N-S survey

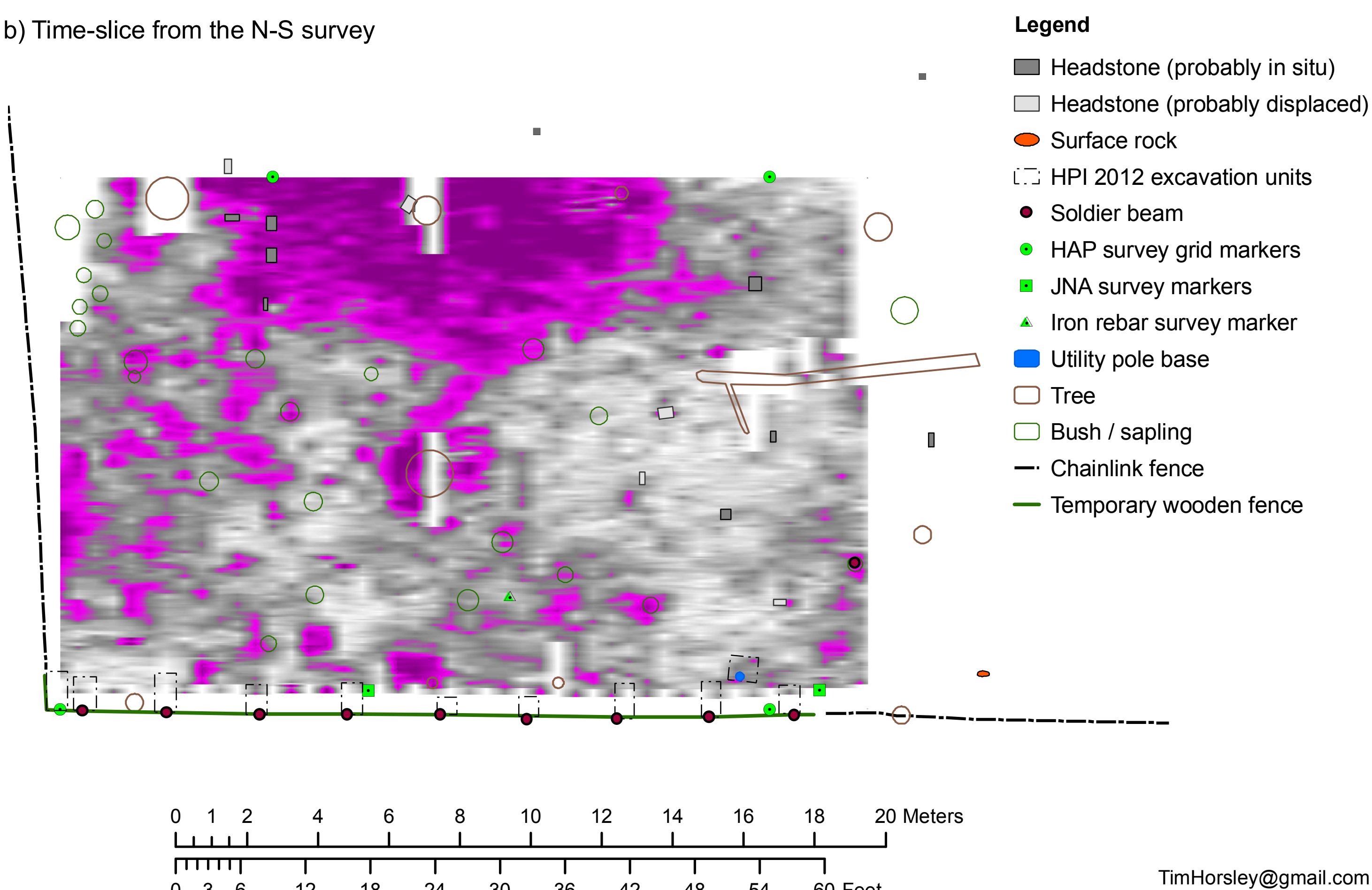


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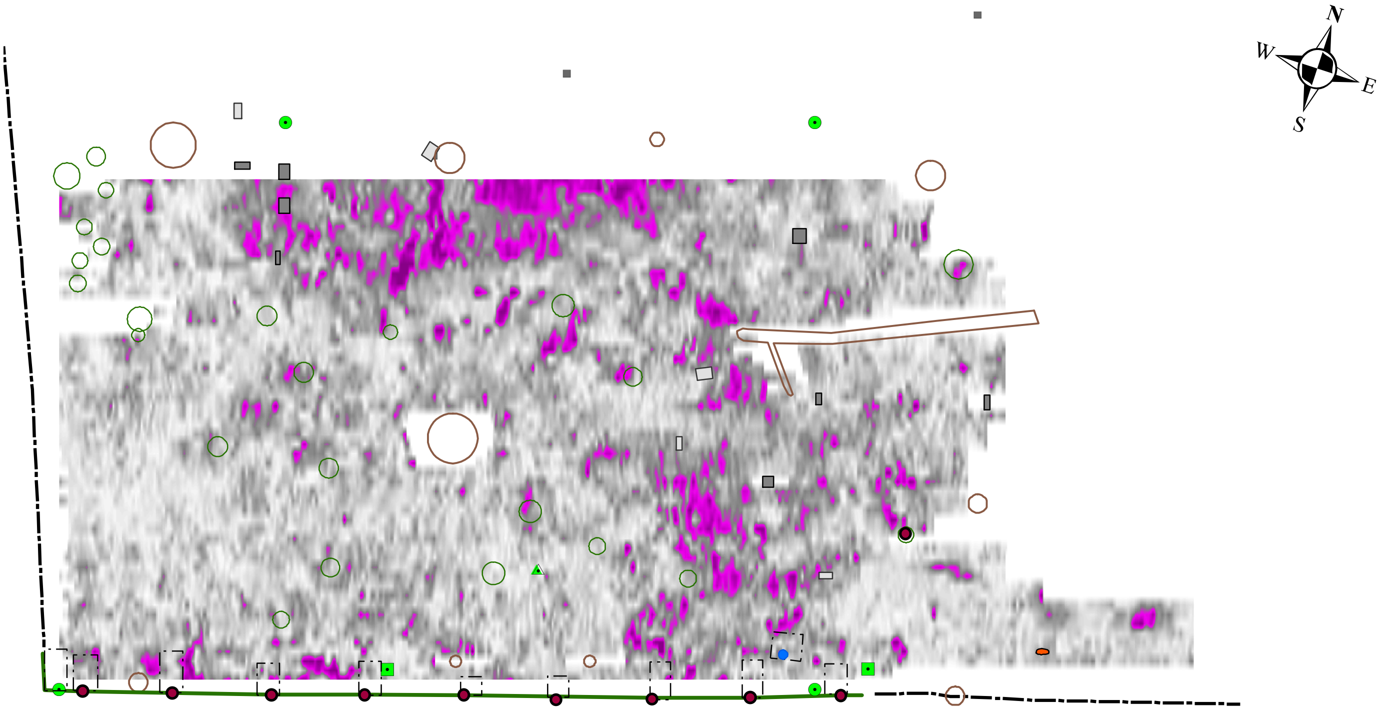
Figure 4. Time-slices from the two orthogonal surveys corresponding to approx. 0.1m - 0.2m.b.s. (4-8").

a) Time-slice from the E-W survey



b) Time-slice from the N-S survey

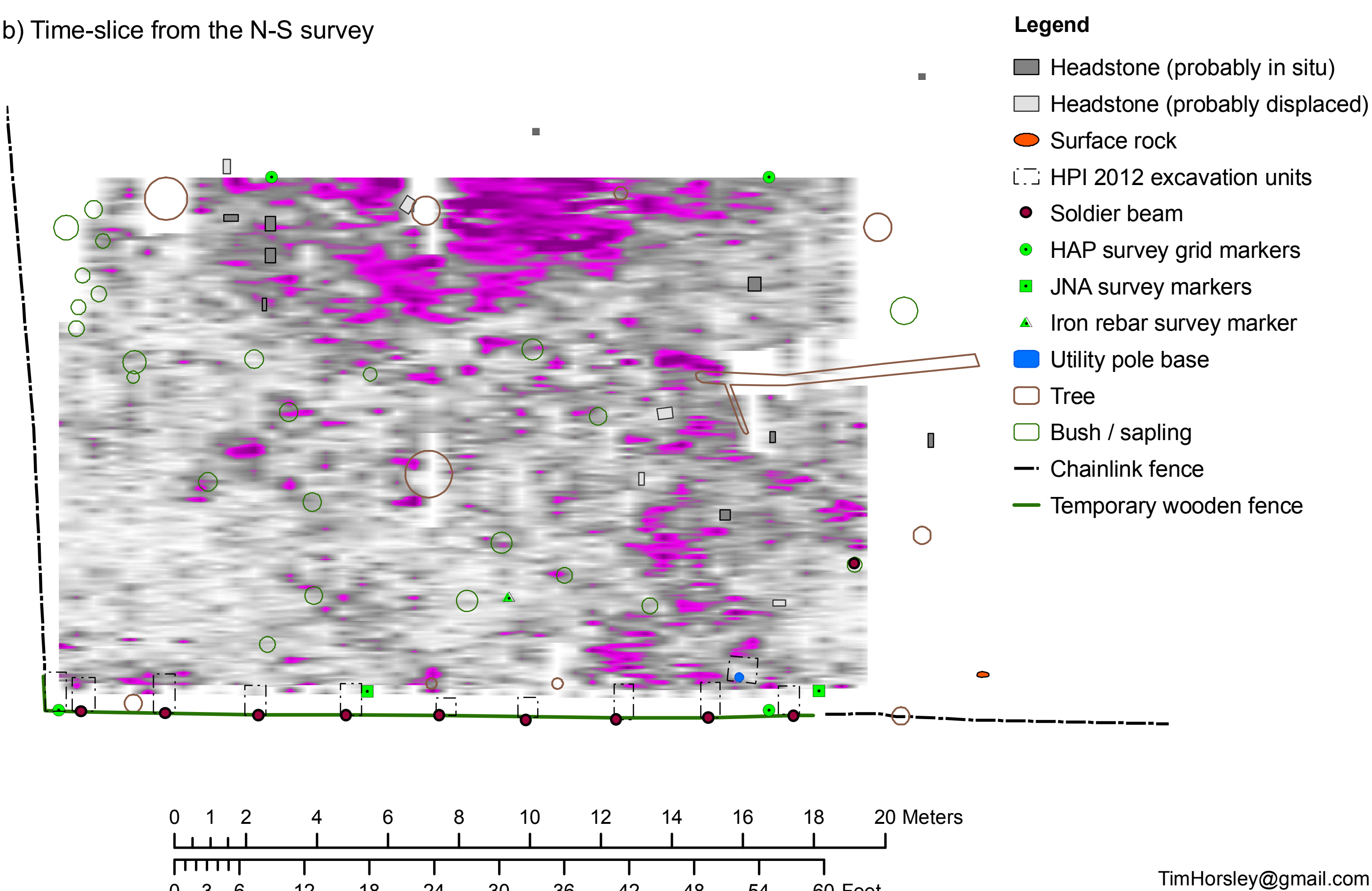


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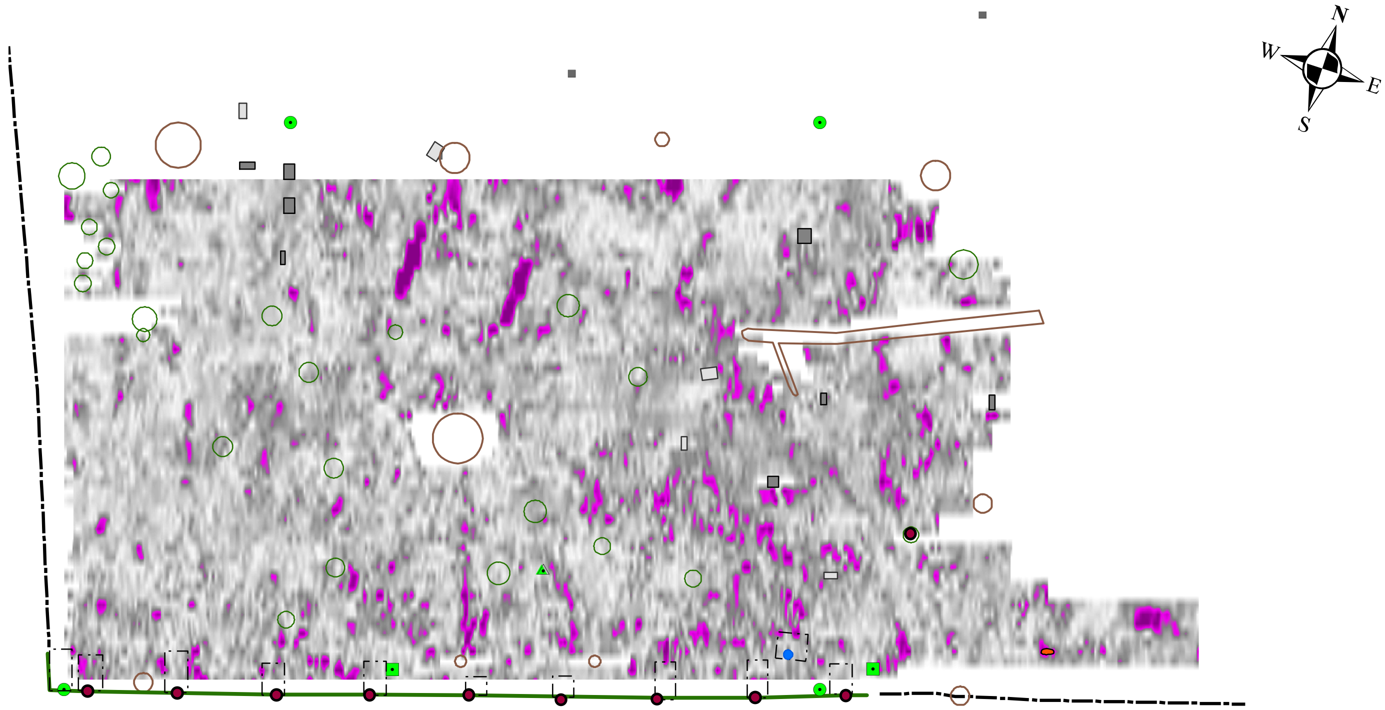
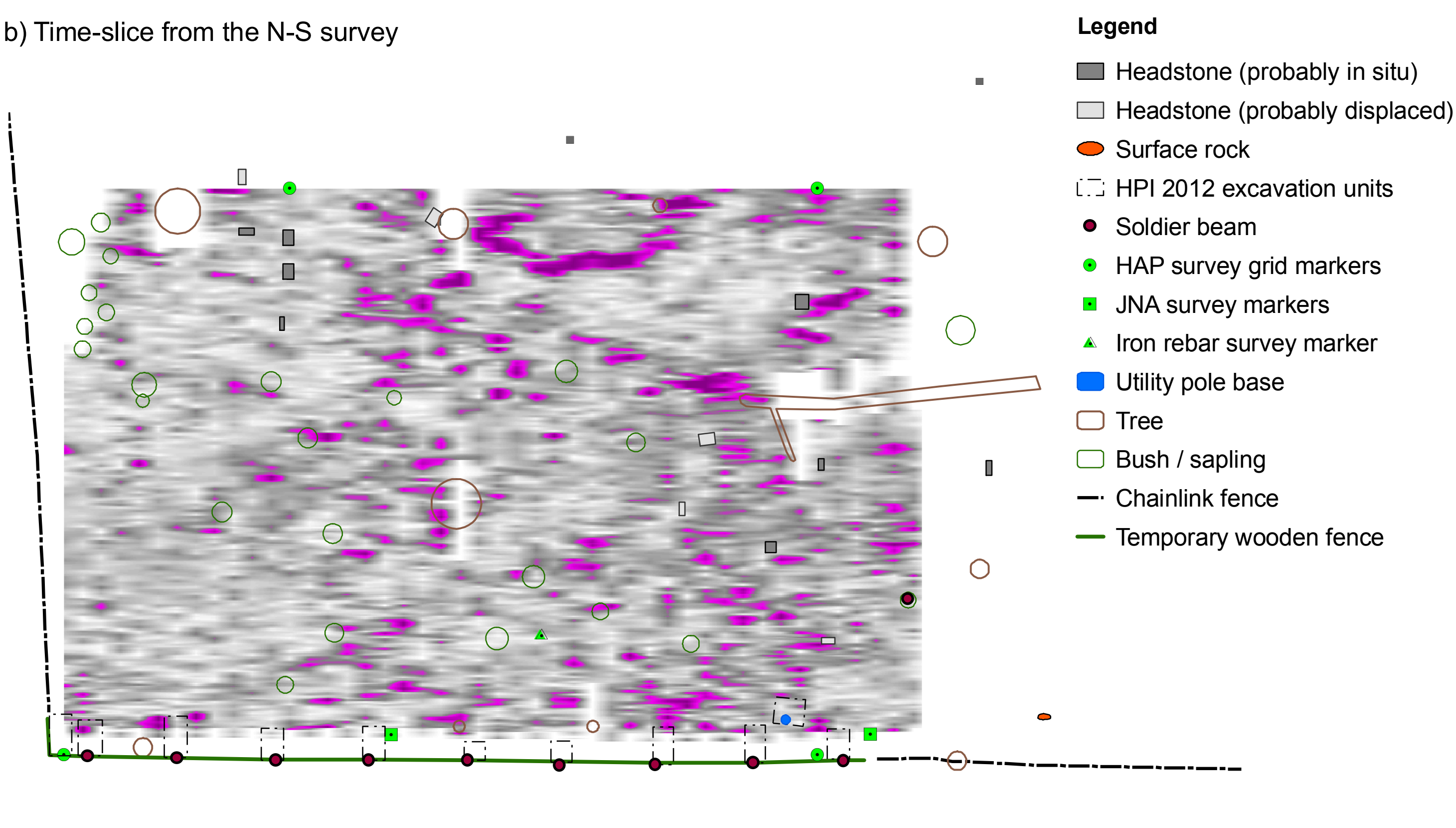
Figure 5. Time-slices from the two orthogonal surveys corresponding to approx. 0.2m - 0.3m.b.s. (8-12").

a) Time-slice from the E-W survey



b) Time-slice from the N-S survey



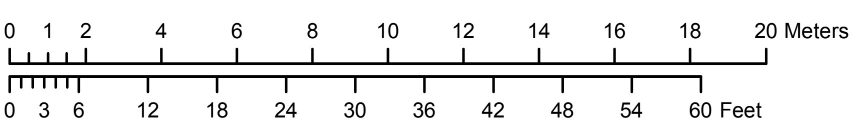


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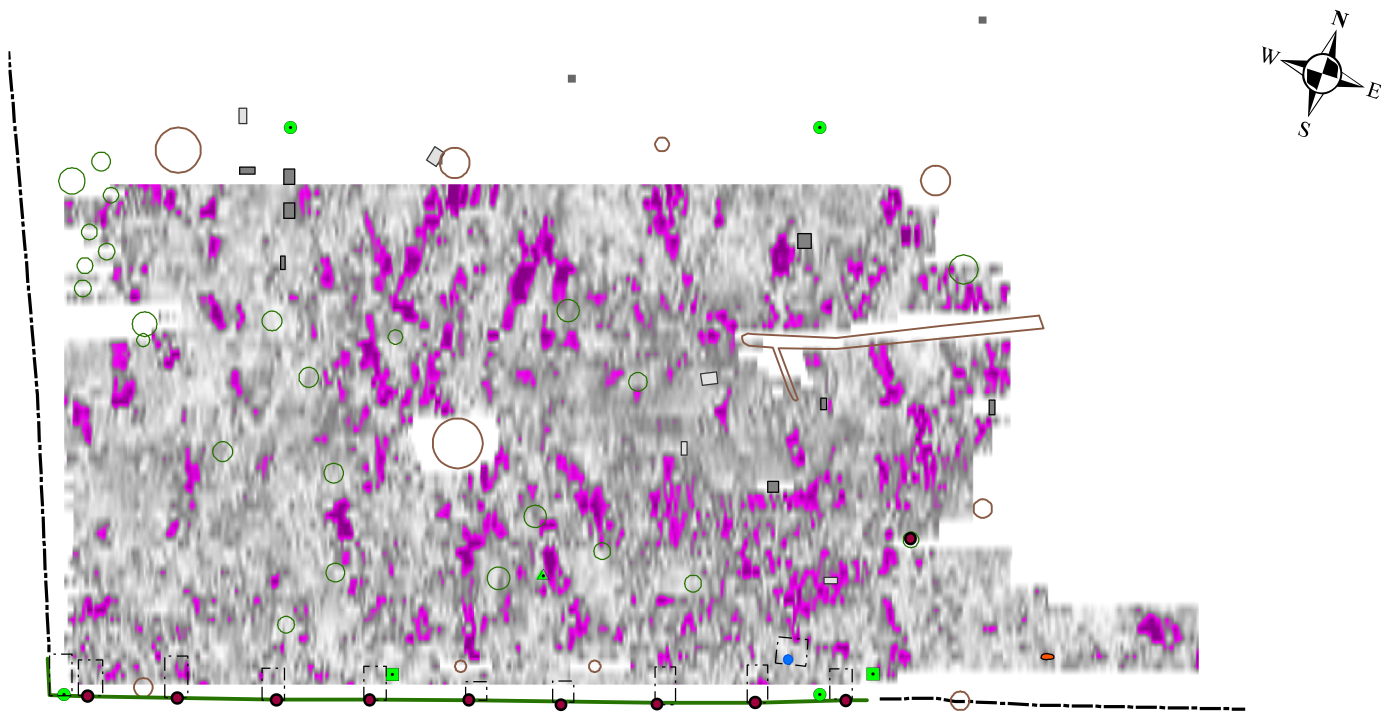
Figure 6. Time-slices from the two orthogonal surveys corresponding to approx. 0.3m - 0.4m.b.s. (12-16").

a) Time-slice from the E-W survey



b) Time-slice from the N-S survey

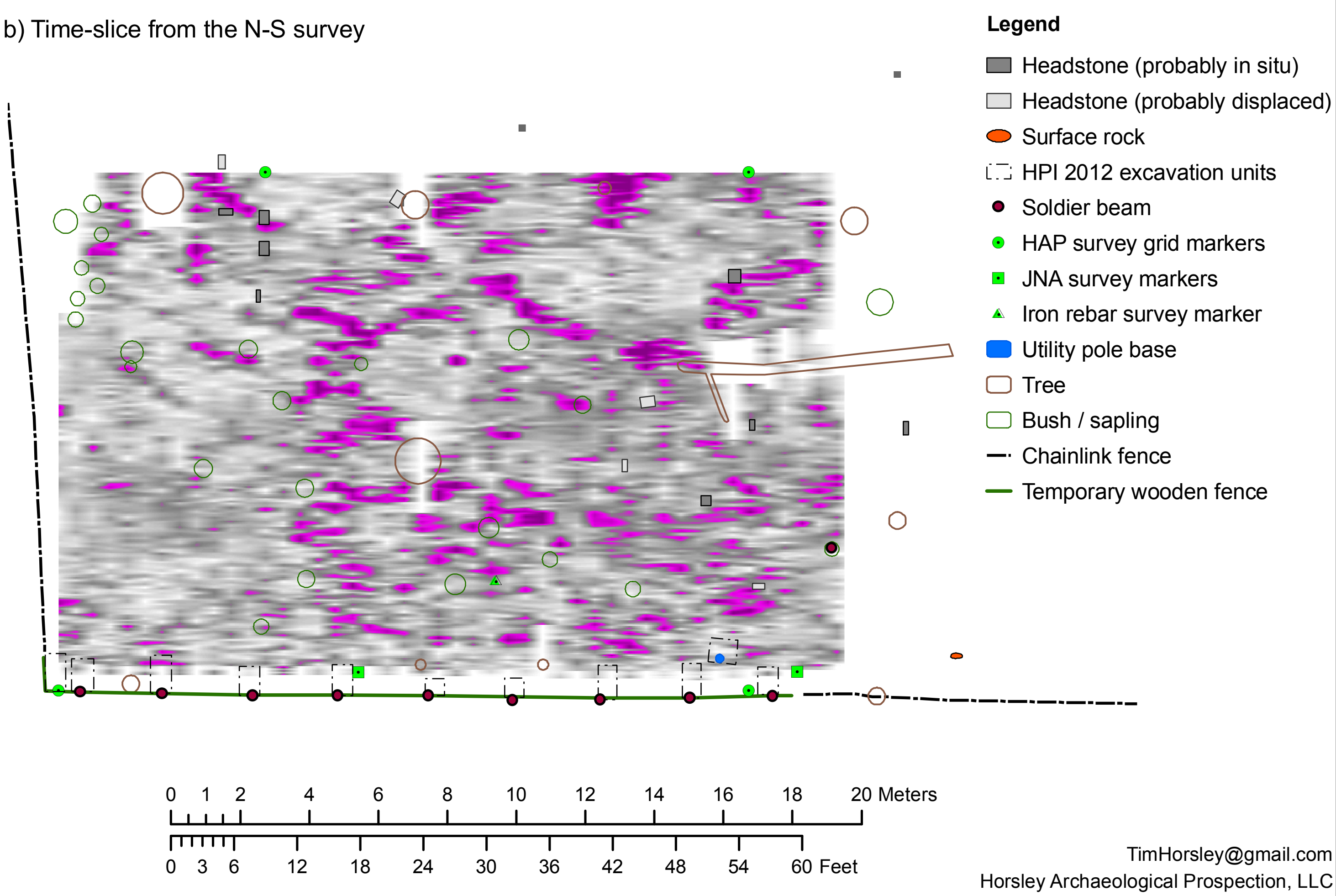


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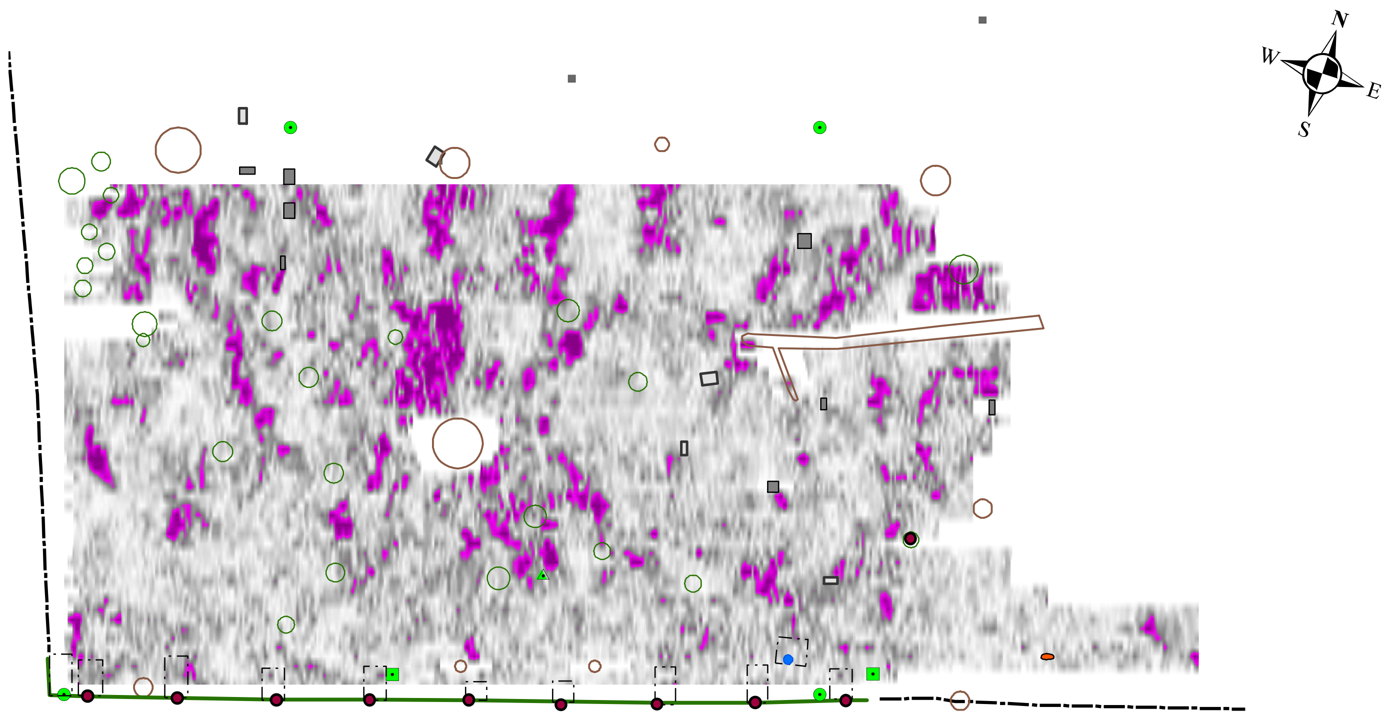
Figure 7. Time-slices from the two orthogonal surveys corresponding to approx. 0.4m - 0.5m.b.s. (16-20").

a) Time-slice from the E-W survey



b) Time-slice from the N-S survey

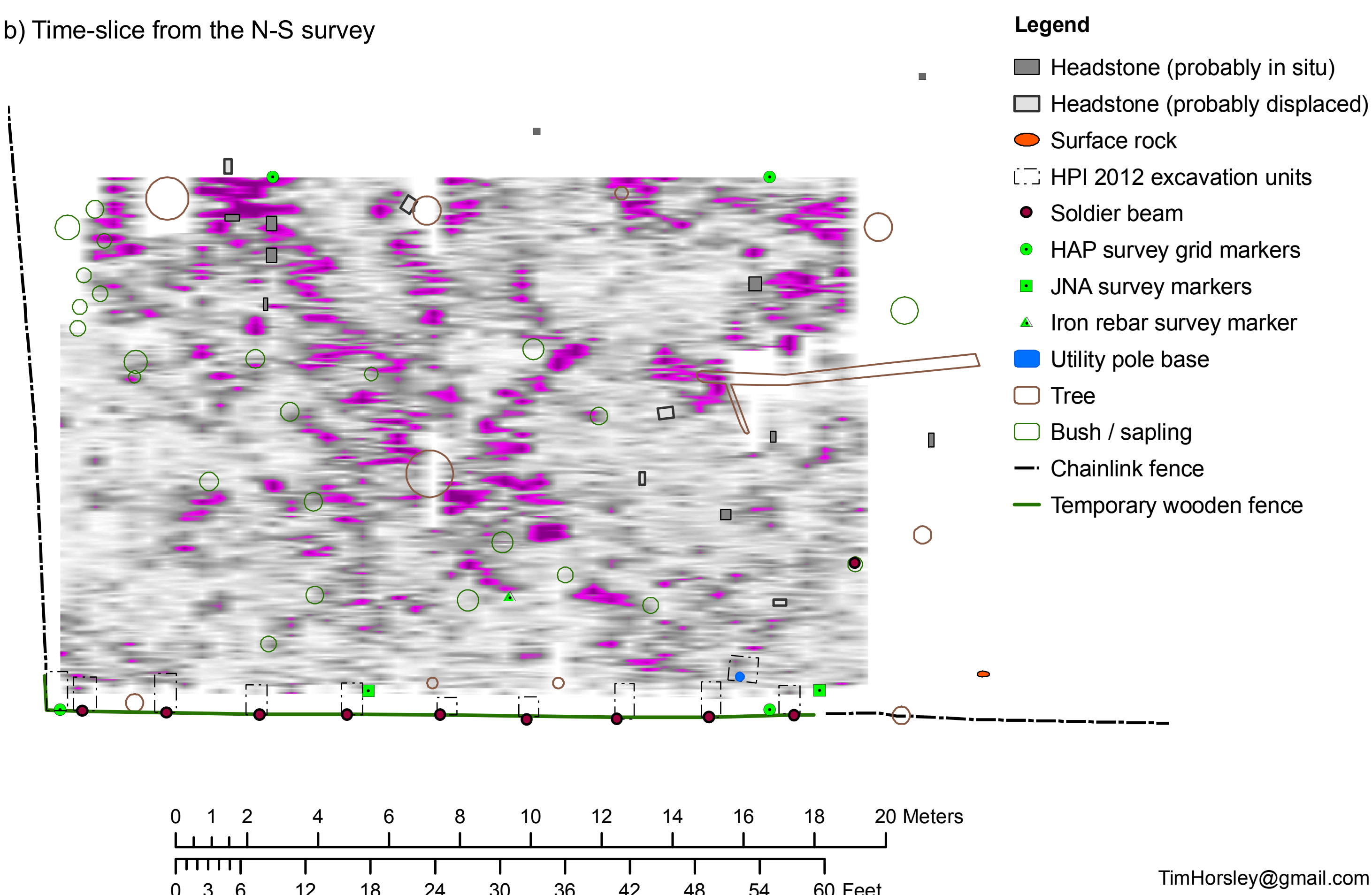


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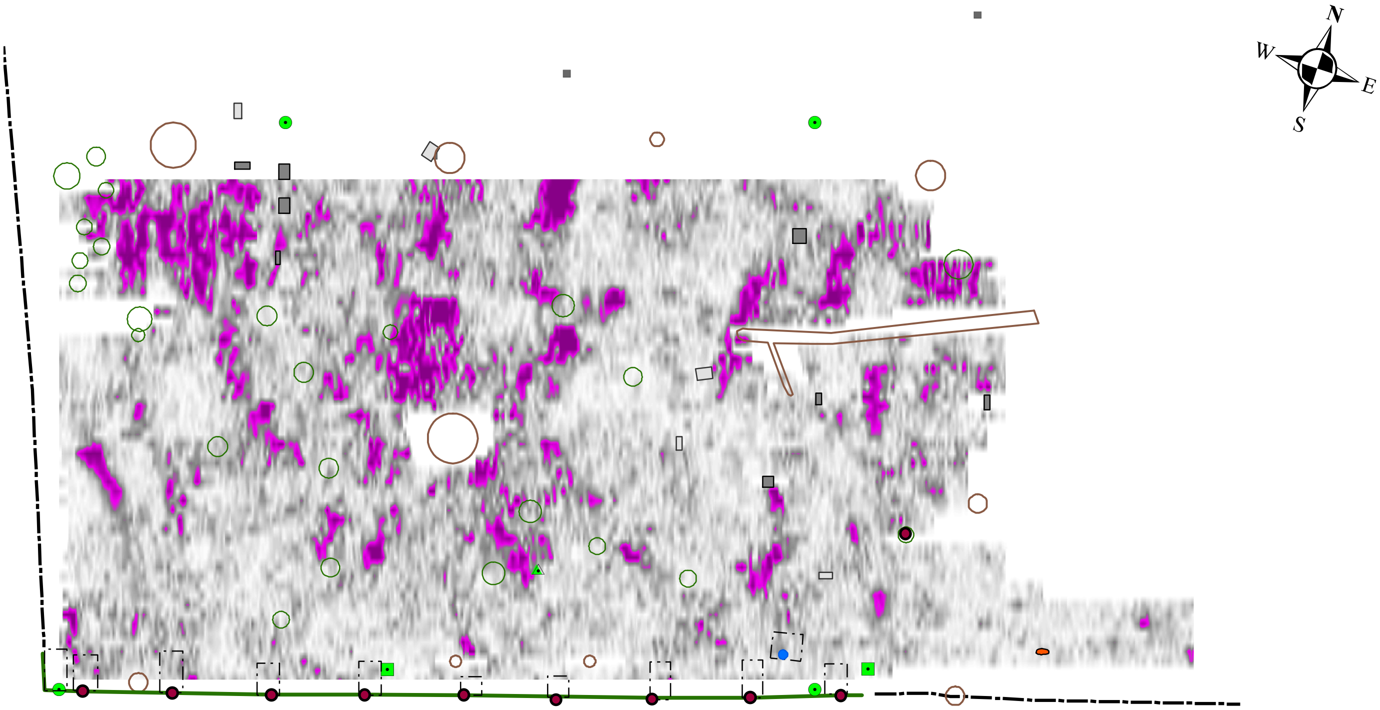
Figure 8. Time-slices from the two orthogonal surveys corresponding to approx. 0.5m - 0.6m.b.s. (20-24").

a) Time-slice from the E-W survey



b) Time-slice from the N-S survey

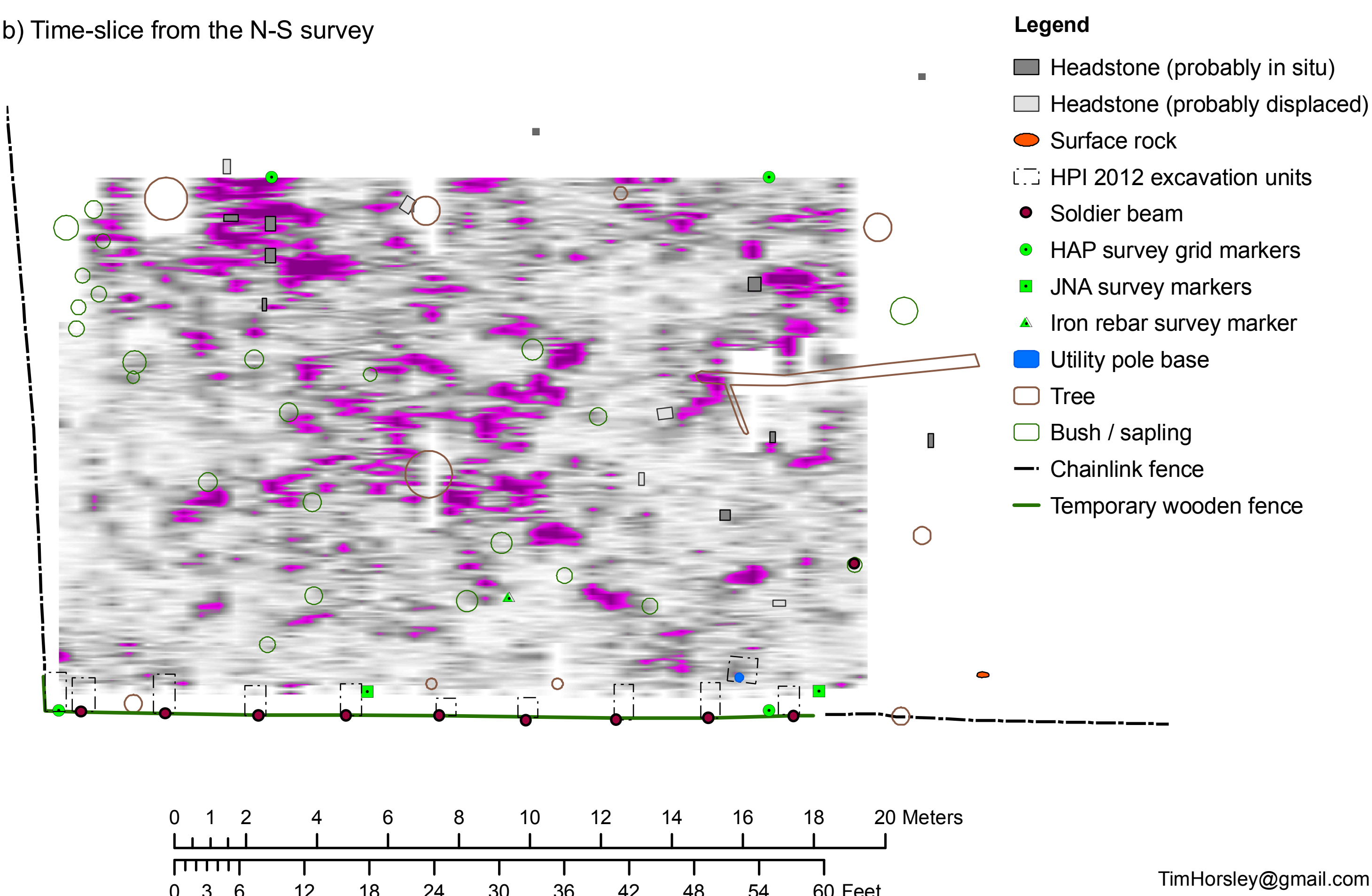


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Figure 9. Time-slices from the two orthogonal surveys corresponding to approx. 0.6m - 0.7m.b.s. (24-27.5").

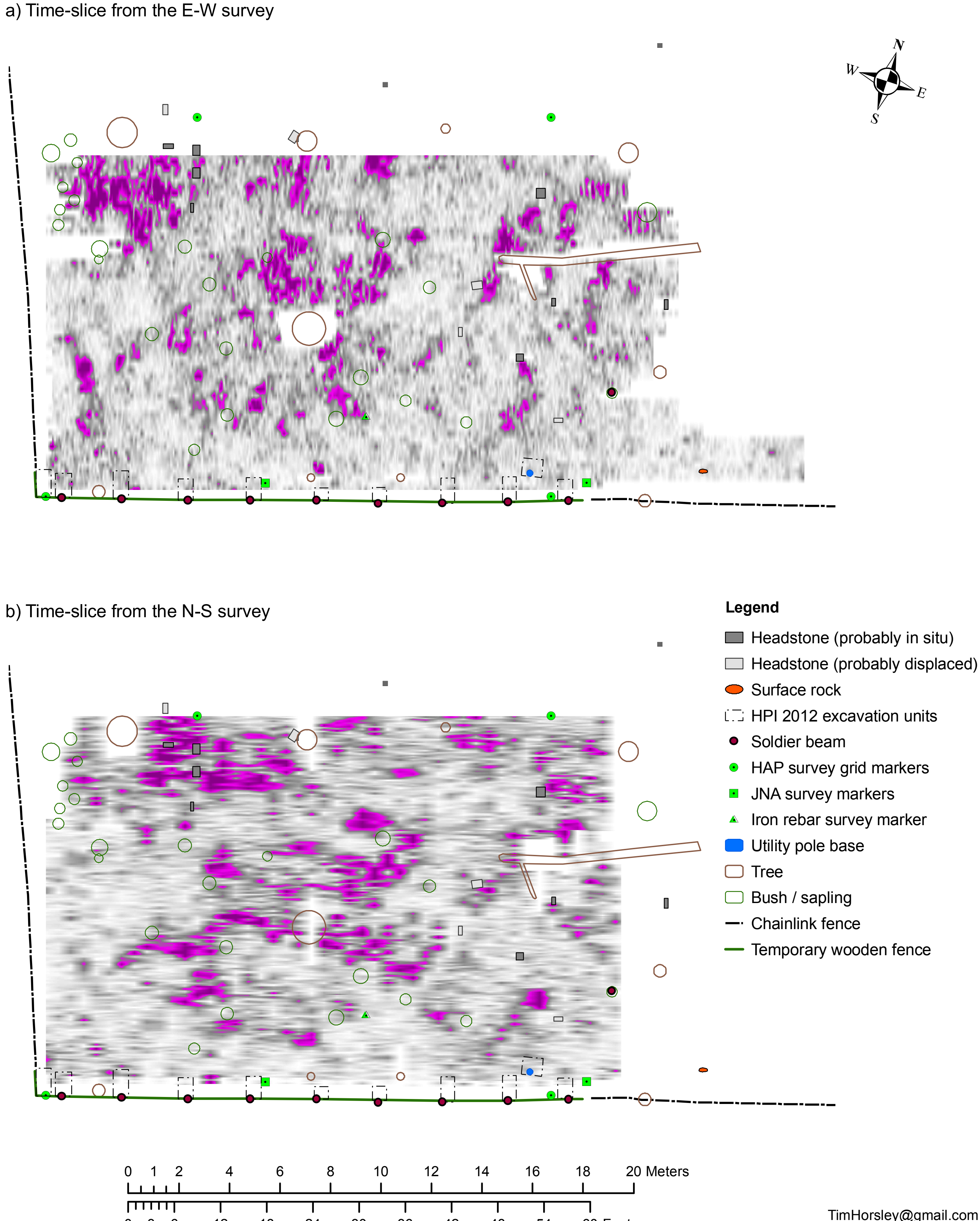

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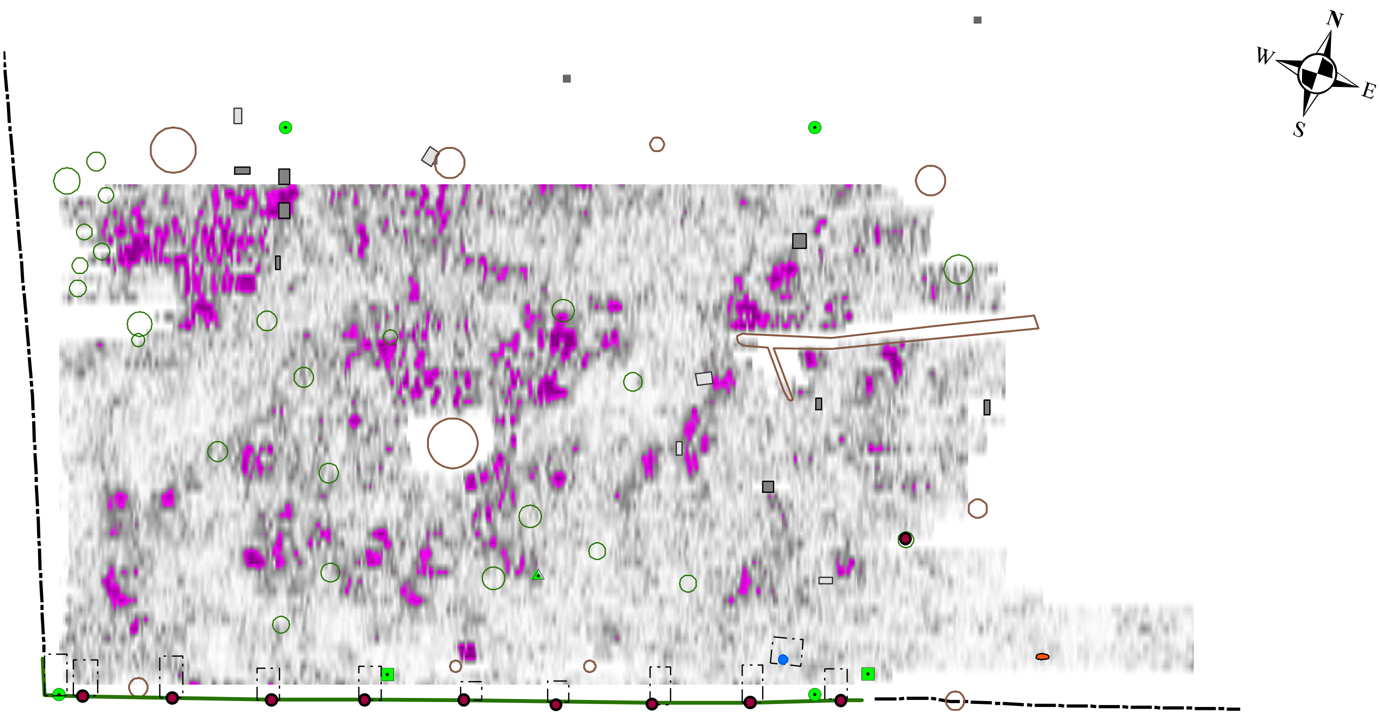
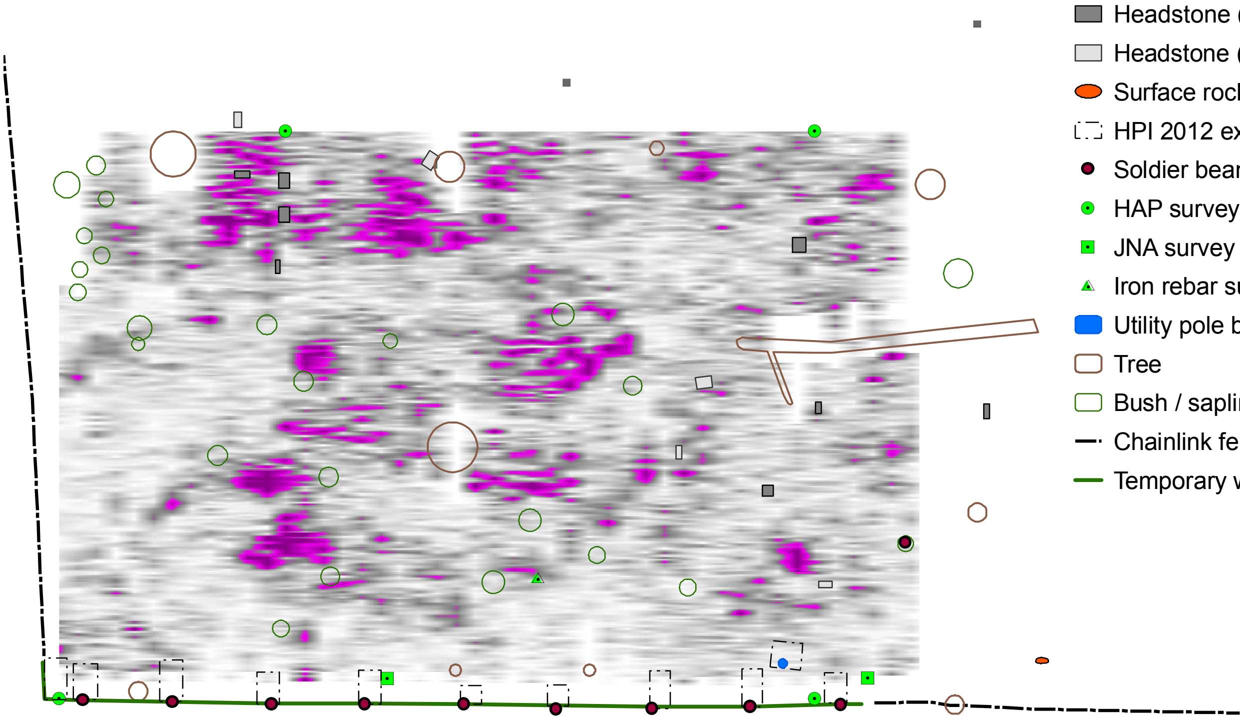
Figure 10. Time-slices from the two orthogonal surveys corresponding to approx. 0.7m - 0.8m.b.s. (27.5-31.5").

a) Time-slice from the E-W survey



b) Time-slice from the N-S survey



Legend

- Headstone (probably in situ)
- Headstone (probably displaced)
- Surface rock
- HPI 2012 excavation units
- Soldier beam
- HAP survey grid markers
- JNA survey markers
- Iron rebar survey marker
- Utility pole base
- Tree
- Bush / sapling
- Chainlink fence
- Temporary wooden fence

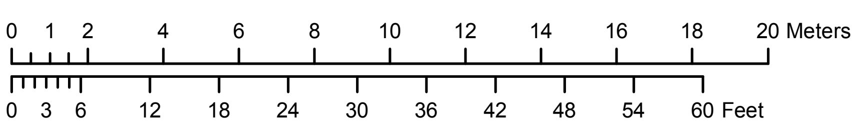


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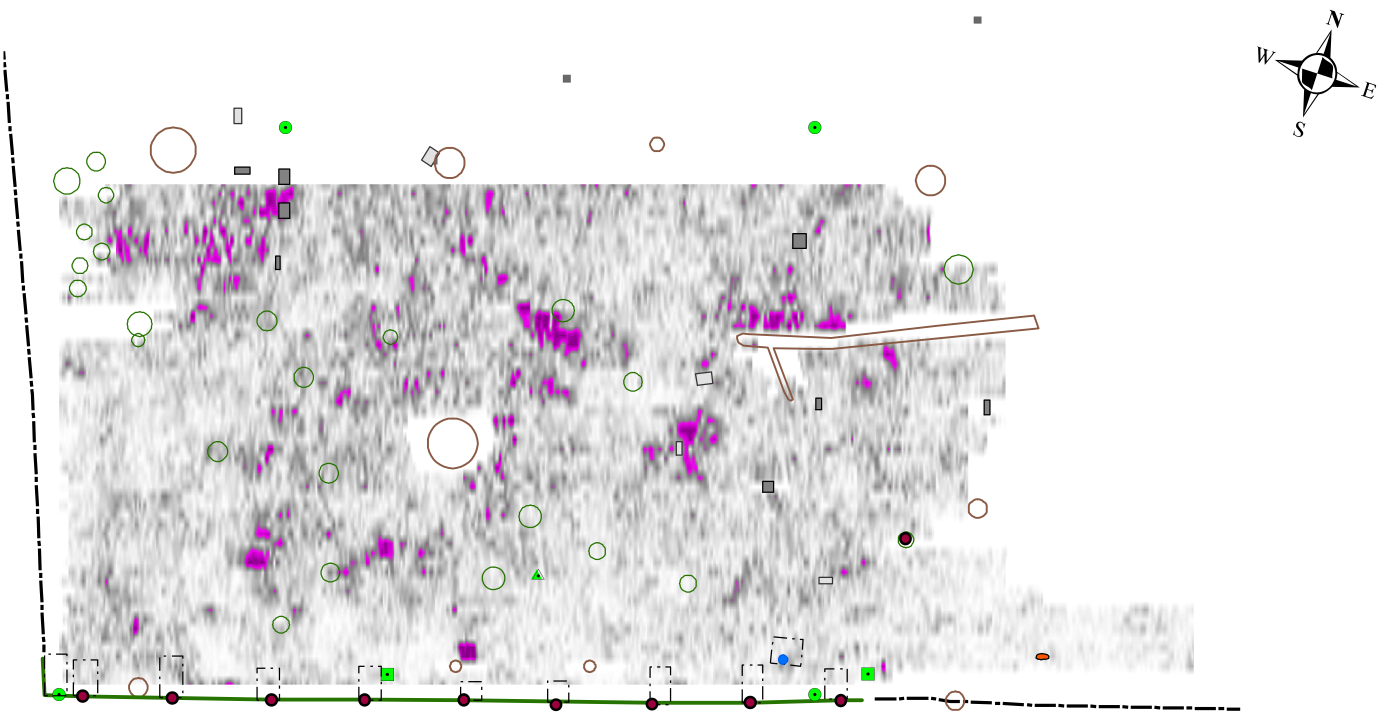
Figure 11. Time-slices from the two orthogonal surveys corresponding to approx. 0.8m - 0.9m.b.s. (31.5-35.5").

a) Time-slice from the E-W survey



b) Time-slice from the N-S survey

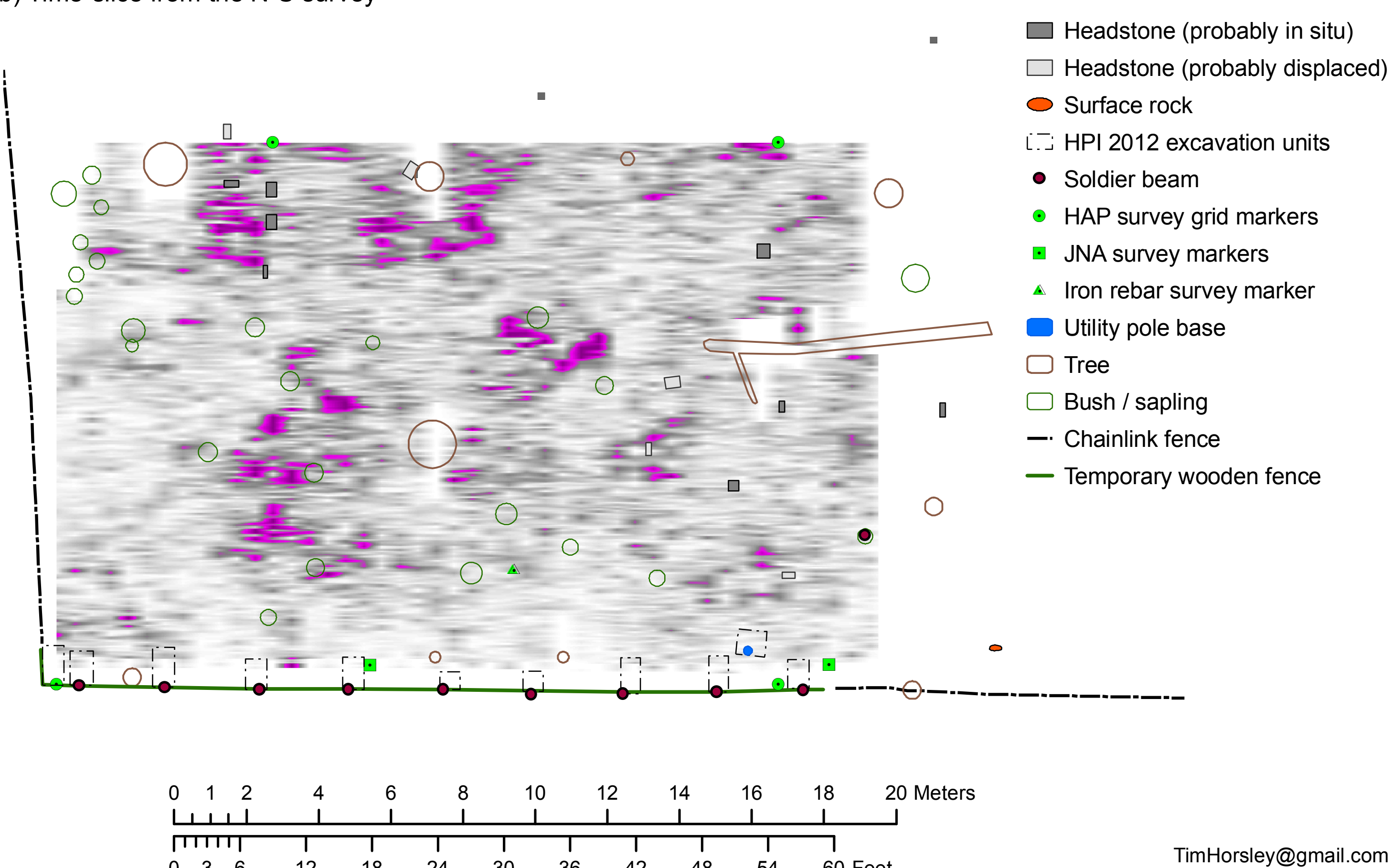


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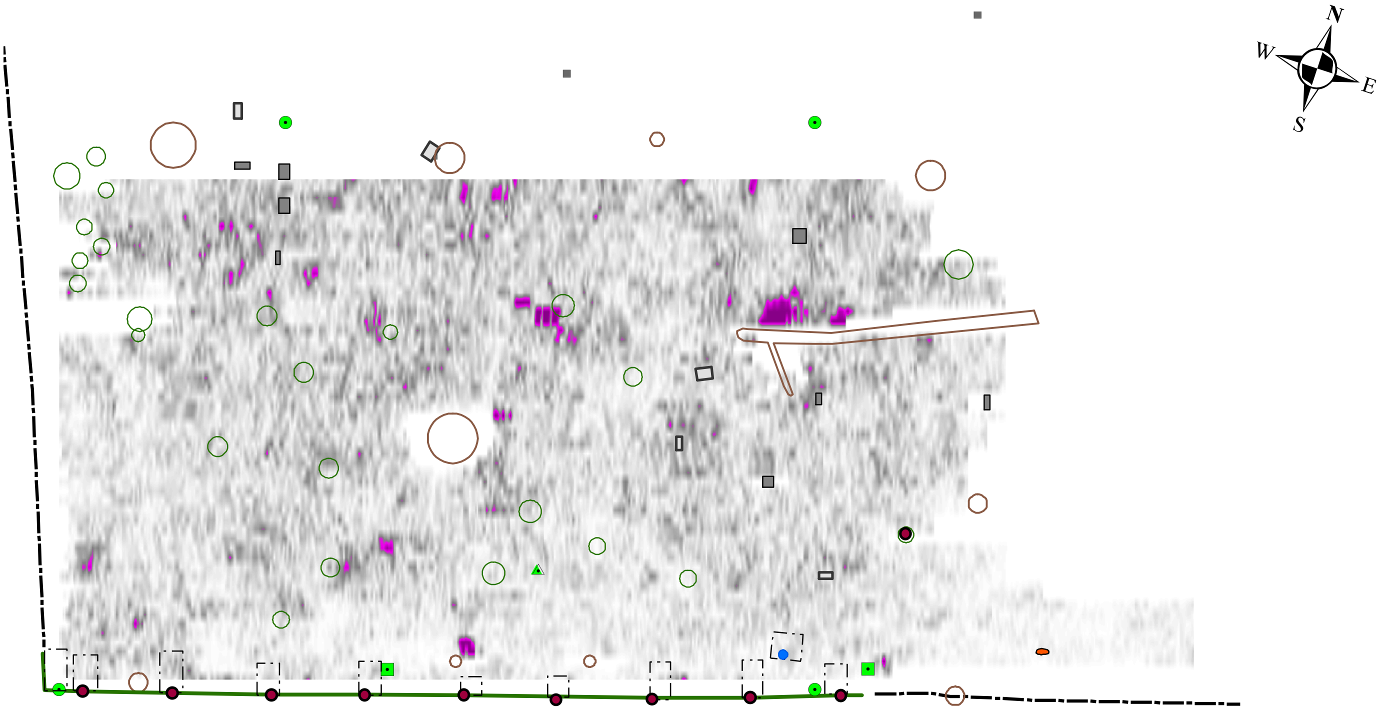
Figure 12. Time-slices from the two orthogonal surveys corresponding to approx. 0.9m - 1.0m.b.s. (35.5-39.5").

a) Time-slice from the E-W survey



b) Time-slice from the N-S survey

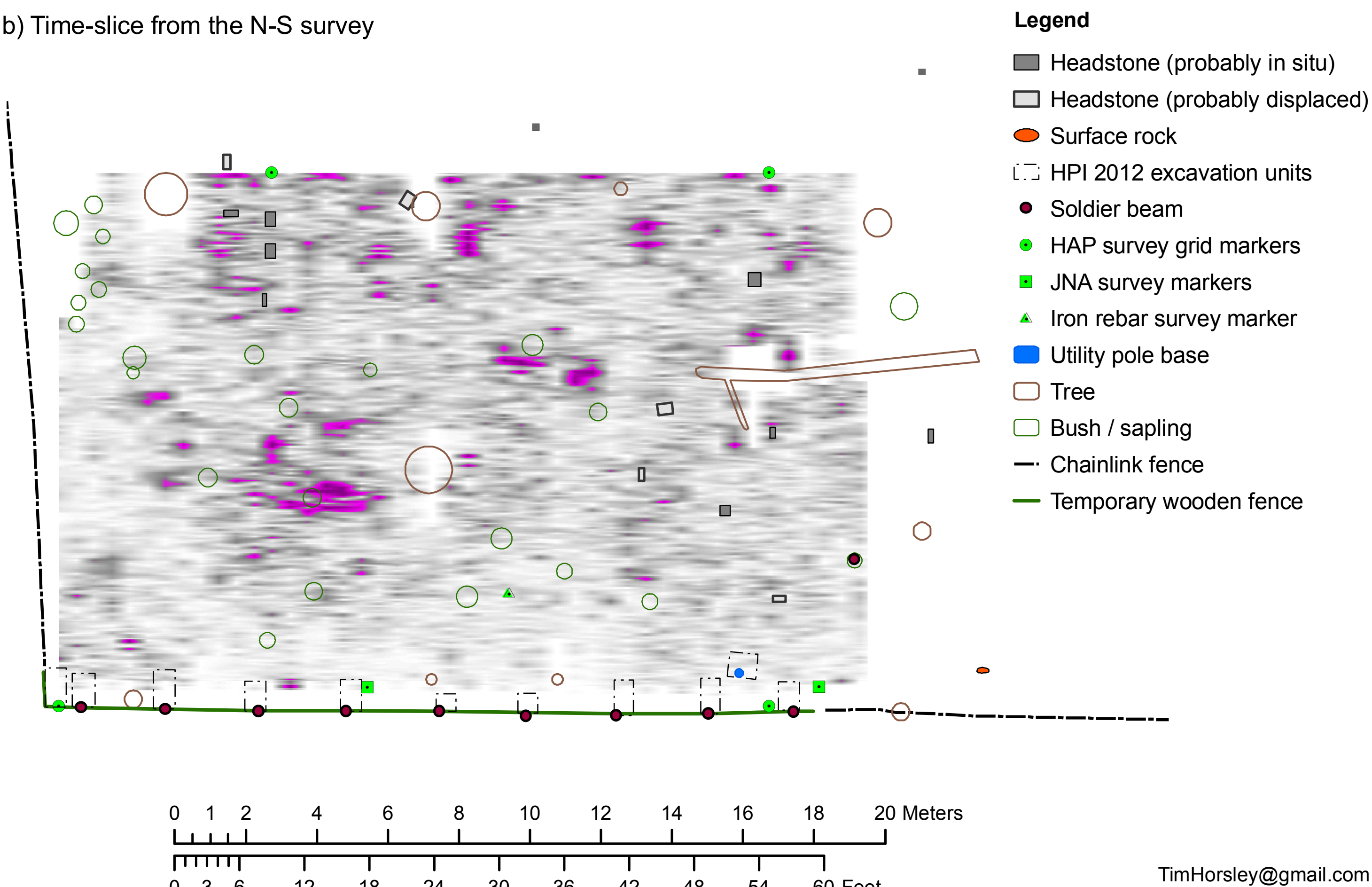


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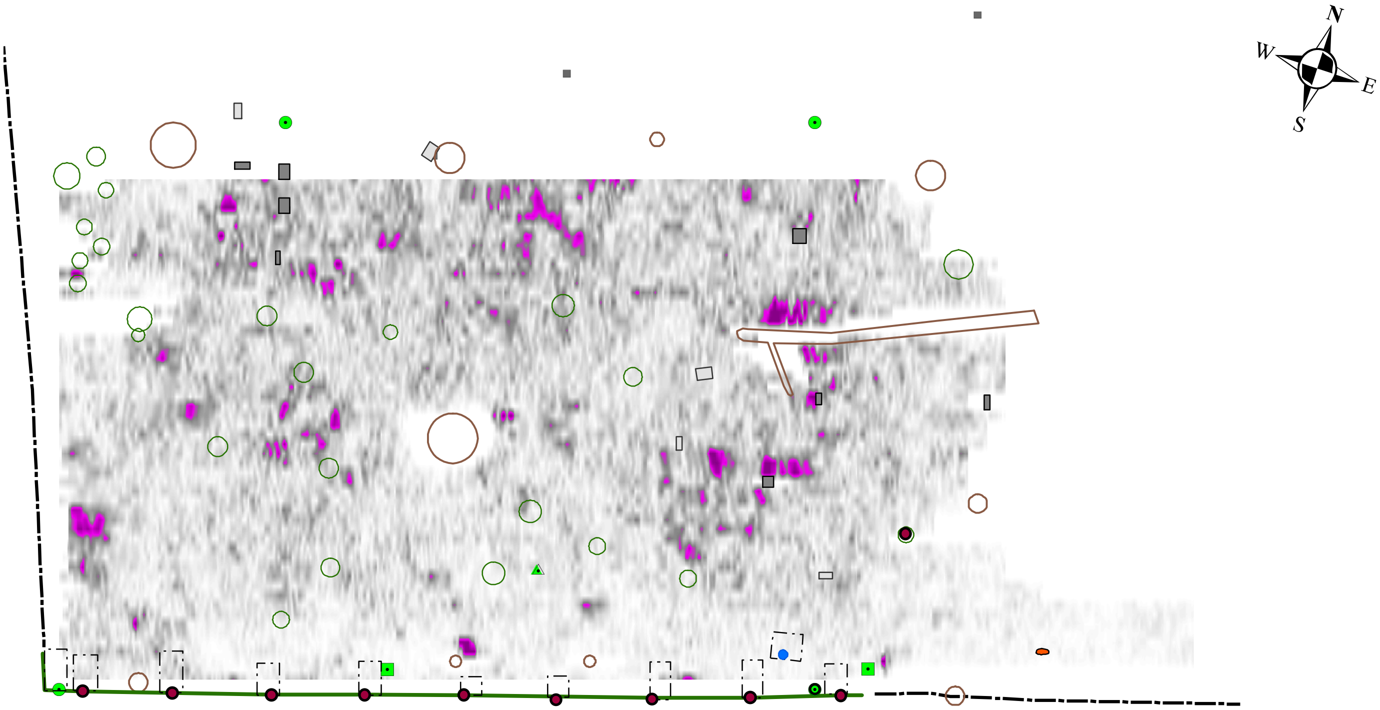
Figure 13. Time-slices from the two orthogonal surveys corresponding to approx. 1.1m - 1.2m.b.s. (43-47").

a) Time-slice from the E-W survey



b) Time-slice from the N-S survey

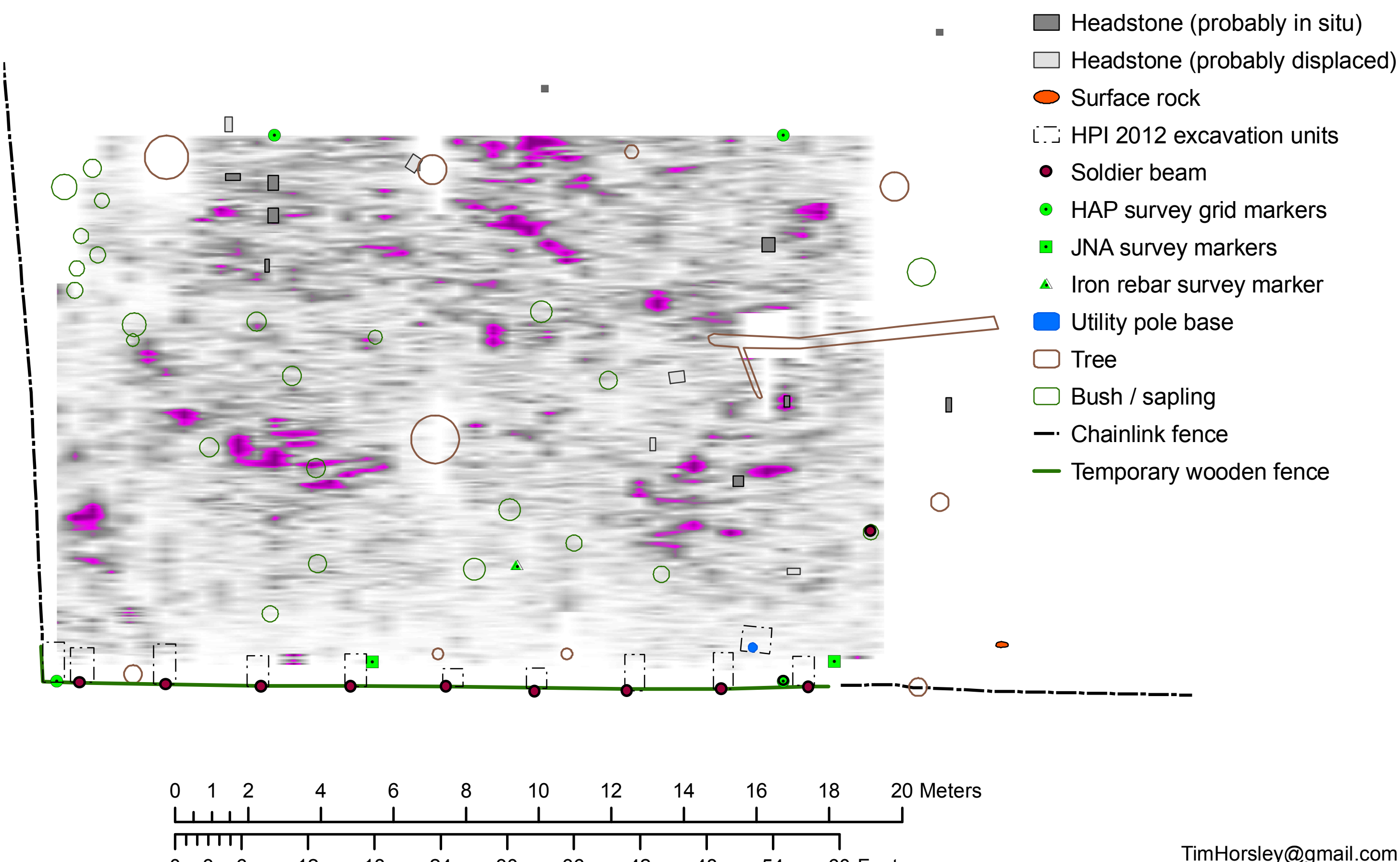


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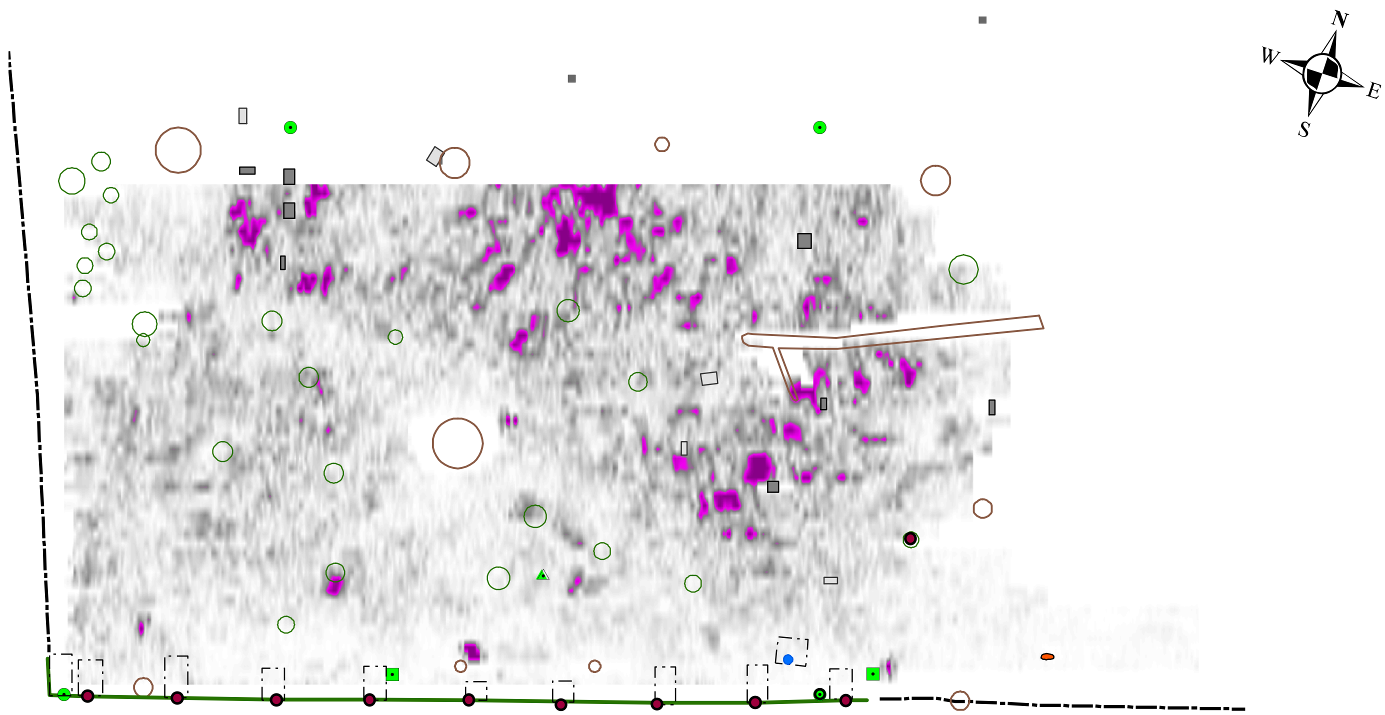
Figure 14. Time-slices from the two orthogonal surveys corresponding to approx. 1.4m - 1.5m.b.s. (55-59").

a) Time-slice from the E-W survey



b) Time-slice from the N-S survey

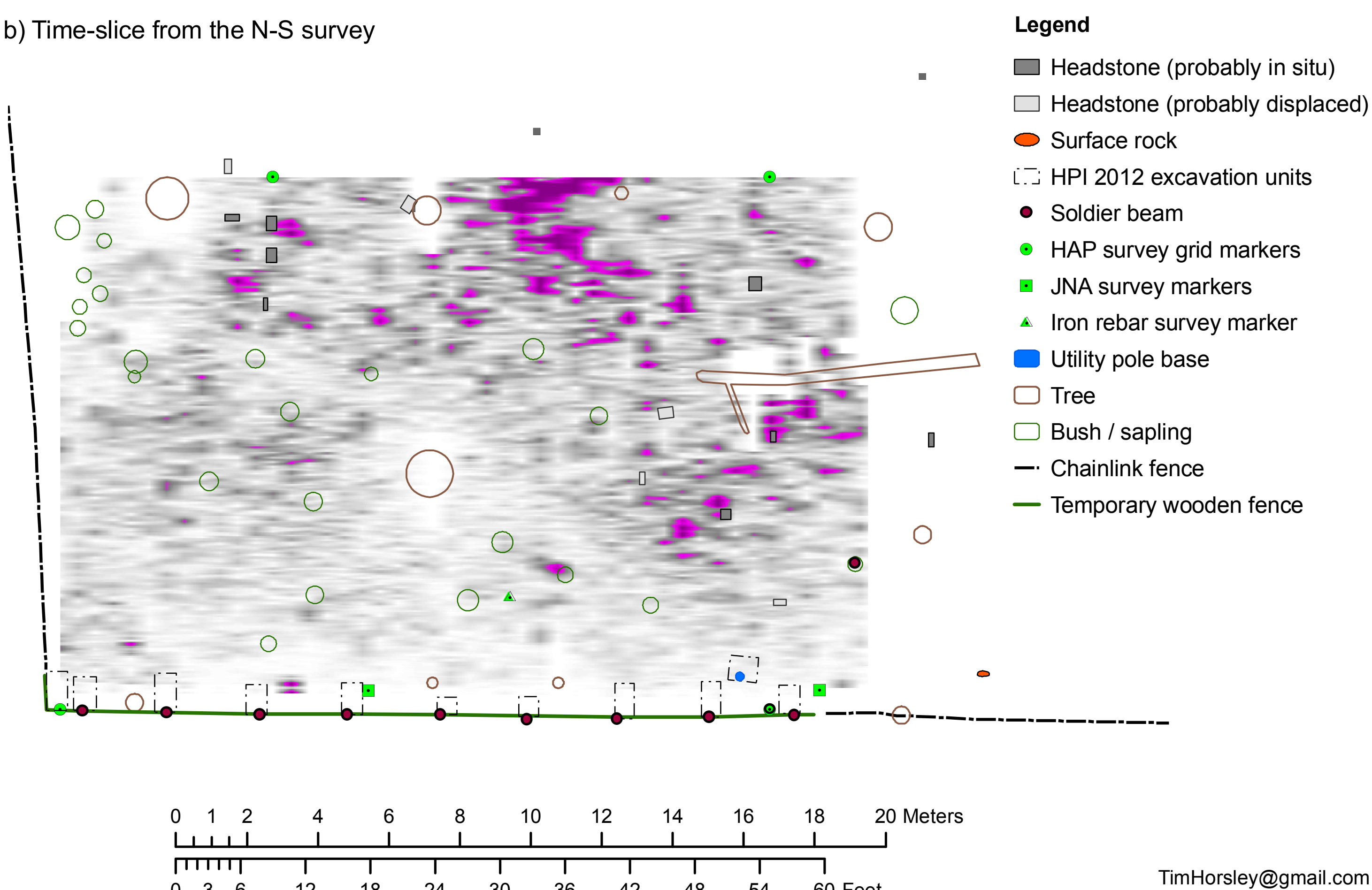


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Figure 15. Interpretation of all GPR reflections (see text for details).

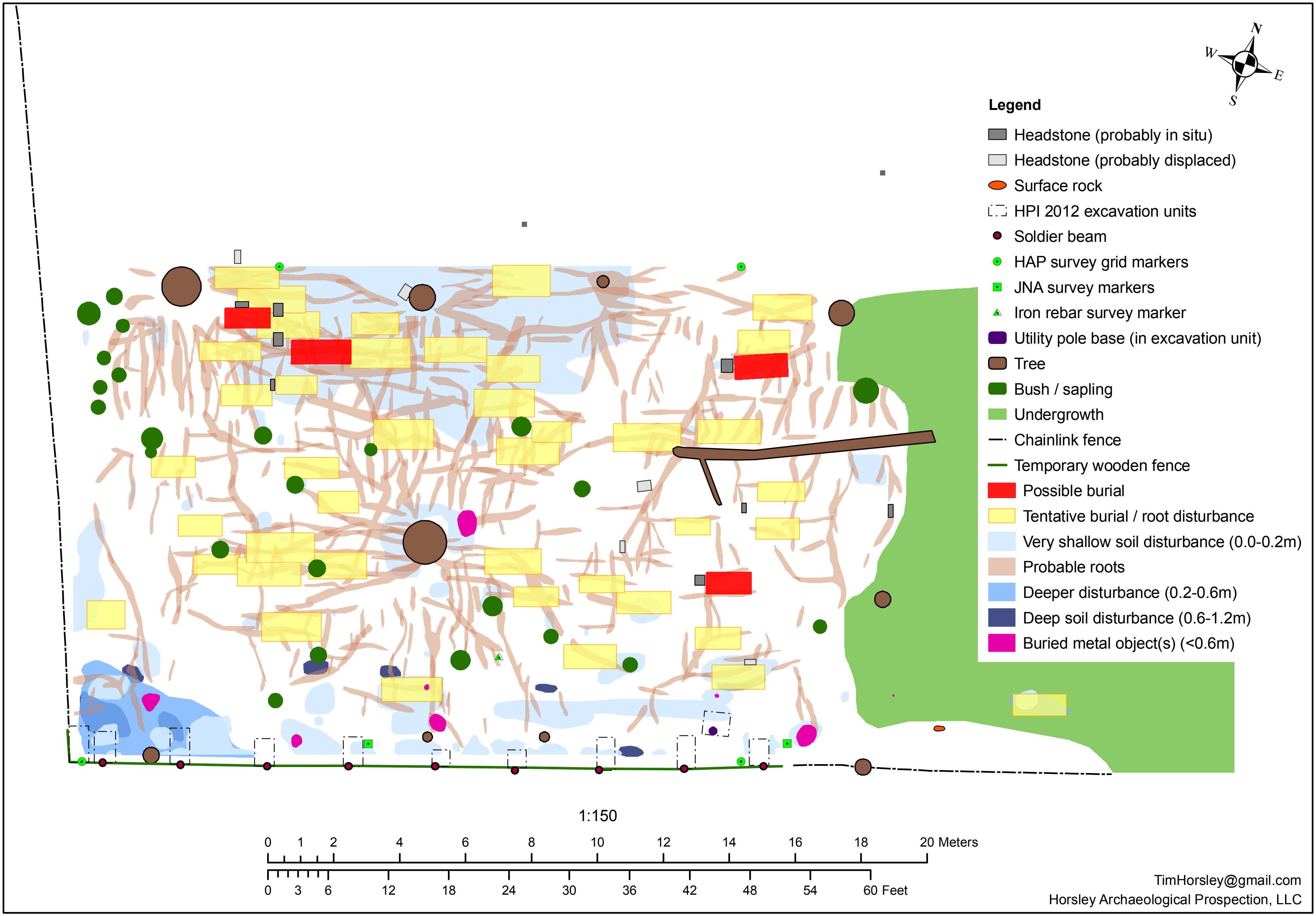

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Figure 16. Interpretation of significant anomalies (see text for details).

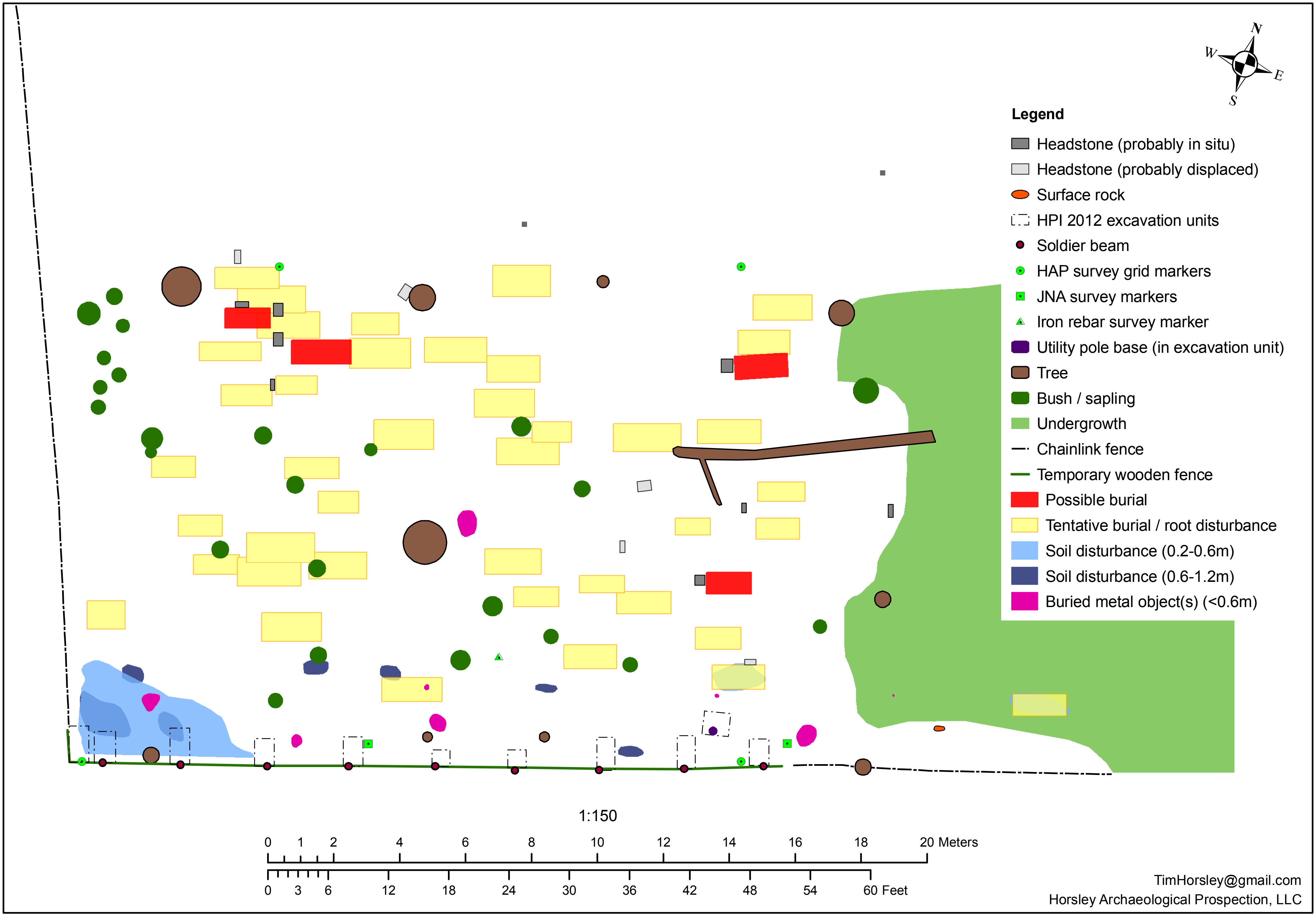

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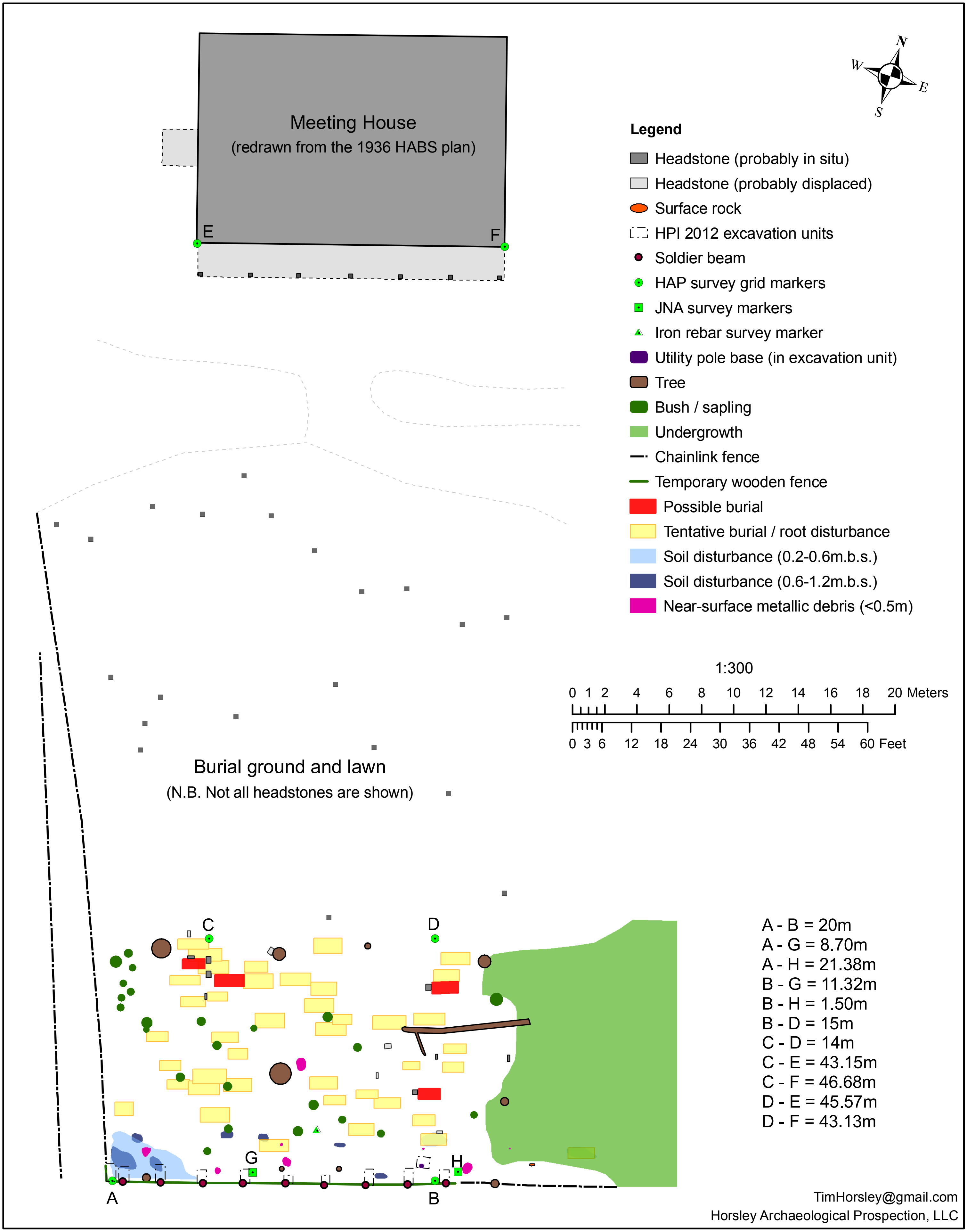
Figure 17. Tie-in measurements for relocating the geophysical survey grid and anomalies of interest.



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