Appendix 12B: Geophysical Survey Report

ARCHAEOLOGICAL EVALUATION REPORT:

GEOPHYSICAL SURVEY BY MAGNETOMETRY ON LAND ADJACENT TO VPI IMMINGHAM, ROSPER ROAD, SOUTH KILLINGHOLME, NORTH LINCOLNSHIRE

Planning Reference: Pre-planning
NGR: TA 16910 16921
AAL Site Code: SKRR 22
North Lincolnshire Museum Site Code: SKAY
Project Reference: Humber Zero
Project Number: 60668866
OASIS Reference Number: allenarc1-510227

Report prepared for AECOM
on behalf of VPI Immingham LLP

By
Allen Archaeology Limited
Report Number AAL2022125

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Allenarchaeology

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Cover image: View from the southern corner of the site looking north-northwest

Executive Summary

- AECOM, on behalf of VPI Immingham LLP, commissioned Allen Archaeology Limited to undertake a geophysical survey using magnetometry on land adjacent to VPI Immingham, Rosper Road, South Killingholme, North Lincolnshire, to inform and support a future planning application for a Post-Combustion Carbon Capture (PCC) Scheme.

- The site lies within a wider area of archaeological interest, with an Iron Age/Roman occupation site immediately to the north of and potentially extending into the survey area, as well as a potentially important Bronze Age occupation/activity site to the southeast that may also extend into the survey area.

- The survey revealed a large amount of magnetic noise across large portions of the site, likely related to construction of the VPI compound to the north of the site and the construction of the road running along the eastern and southeastern edges of the site. Potentially this magnetic noise could mask more ephemeral archaeological features, which could represent a continuation of known archaeological activity immediately to the north and to the southeast of the site.

- The survey also revealed the location of a buried modern service, as well as features likely corresponding to field boundaries see on historic OS maps. Amorphous and sinuous positive features likely correspond to former palaeochannels, possibly relating to a former creek of the Humber Estuary.

- Modern land drainage was also identified along with features that could represent modern cultivation trends or possibly former enclosure features.

1.0 Introduction

1.1 AECOM, on behalf of VPI Immingham LLP, commissioned Allen Archaeology Limited (AAL) to undertake a geophysical survey using magnetometry on land adjacent to VPI Immingham, Rosper Road, South Killingholme, North Lincolnshire, to inform and support a future planning application for a Post-Combustion Carbon Capture (PCC) Scheme.

1.2 The site works and reporting conform to current national guidelines as set out in '*EAC Guidelines for the Use of Geophysics in Archaeology*' (EAC 2016), '*The Use of Geophysical Techniques in Archaeological Evaluations*' (Gaffney et al. 2002), the Chartered Institute for Archaeologists '*Standard and guidance for archaeological geophysical survey*' (CIfA 2020), and a specification by this company (AAL 2022).

2.0 Site Location and Description

2.1 The VPI Site is situated within the administrative district of North Lincolnshire, approximately 1.6km north of Immingham and 1.5km west of the Humber Estuary. The survey area comprised two irregular shaped areas, c.5.8ha and c.2.2ha in size, separated by a watercourse, south of the existing Combined Heat and Power Plant (CHP). The site is currently pasture, and centres on NGR TL 16910 16921 (Figure 1).

2.2 The local geology of the area comprises bedrock deposits of Burnham Chalk Formation with overlying superficial deposits of Tidal Flat Deposits – Clay and Silt and Devensian Till (http://mapapps.bgs.ac.uk/geologyofbritain/home.html). Responses of magnetometry to the bedrock of chalk is good, with superficial Till and Tidal Flat deposits variable, likely moderate to good (English Heritage 2008).

3.0 Planning Background

3.1 The archaeological works have been undertaken prior to the formal submission of a planning application for a Post-Combustion Carbon Capture (PCC) scheme at the VPI Immingham Combined Heat and Power (CHP) Plant, with associated infrastructure. The work will provide further information concerning the nature and extent of the archaeological resource, and to provide information to allow the Historic Environment Officer at North Lincolnshire Council to make a reasoned decision as to whether any further intrusive investigations will be required, and to establish any mitigation measures that may be appropriate.

3.2 The approach adopted is consistent with the recommendations of the National Planning Policy Framework (NPPF), with the particular chapter of relevance being '*Section 16. Conserving and enhancing the historic environment'* (Department for Levelling Up, Housing and Communities 2021).

4.0 Archaeological and Historical Background

4.1 A desk-based assessment has previously been compiled for this site (Hounsell 2022), and the results of this are summarised below.

4.2 Within the wider VPI site there is a large amount of archaeological activity. A series of excavations were undertaken in advance of the construction of the extant Immingham CHP plant between 1999 and 2002 - which also included a borehole survey. This work identified an early Iron Age occupation site that was associated with what appeared to be the ancient foreshore of the Humber and an associated ancient tributary (these identified by the borehole survey). A later Iron Age/Romano-British settlement developed slightly further way from the tributary on slightly higher ground. There was also evidence for a medieval ridge and furrow field system across the VPI site. This work is located largely underneath the CHP plant, but the southern extent of the work does extend into the current area of investigation.

4.3 Approximately 260m to the southeast there is evidence for a potentially important Bronze Age occupation/activity site, which may extend into the VPI Site and possibly be associated with the later Iron Age/Roman activity.

4.4 A cropmark, visible on an aerial photograph, runs through the northern part of the survey area, and likely represents a post-medieval boundary, this is visible on the 1887 OS map.

5.0 Geophysical Survey Methodology

5.1 The geophysical survey consisted of a detailed gradiometer survey of as much of the development area as was suitable, coming to approximately 7.9 hectares. The survey was undertaken in a series of 30m grids across the site.

Summary of Survey Parameters

5.2 Fluxgate Magnetometer

Instrument:	Bartington Grad601-2 Dual Fluxgate Gradiometer
Sample Interval:	0.25m
Traverse Interval:	1.00m
Traverse Separation:	1.00m
Traverse Method:	Zigzag
Resolution:	0.01nT
Processing Software:	Terrasurveyor 3.0.37.30
Surface Conditions:	Pasture
Area Surveyed:	7.92 hectares
Date Surveyed:	Monday 10th to Wednesday 12th October 2022
Surveyor:	Robert Evershed BSc (Hons)
Survey assistant	Ben Jenkins BSc (Hons)
Data Interpretation:	Robert Evershed BSc (Hons)

Data Collection and Processing

5.3 The grids were marked using pre-programmed grids on the Leica GS08 Netrover. Magnetic data was collected on a north-northwest to south-southeast alignment due to the layout of the site

boundaries. A traverse pattern close to north – south is preferable as the fluxgate gradiometer is set up and balanced with respect to the cardinal points. Since the data is plotted as north – south traverses there is considerable merit sampling the north – south response of a magnetic anomaly with as many data points as is possible, this is accomplished as the density collected along the traverse line is greater than that between traverses (Aspinall *et al*. 2008).

5.4 The data collected from the survey has been analysed using Terrasurveyor 3.0.37.30. The resulting data set plots are presented with positive nT/m values and high resistance as black and negative nT/m values and low resistance as white.

The data sets have been subjected to processing using the following filters:

- De-striping
- Clipping
- De-staggering

5.5 The de-stripe process is used to equalise underlying differences between grids or traverses. Differences are most often caused by directional effects inherent to magnetic surveying instruments, instrument drift, instrument orientation (for example off-axis surveying or heading errors) and delays between surveying adjacent grids. The de-stripe process is used with care as it can sometimes have an adverse effect on linear features that run parallel to the orientation of the process.

5.6 The clipping process is used to remove extreme data point values which can mask fine detail in the data set. Excluding these values allows the details to show through.

5.7 The de-staggering process compensates for data correction errors caused by the operator commencing the recording of each traverse too soon or too late. It shifts each traverse either forward or backwards by a specified number of intervals.

5.8 Plots of the data are presented in processed linear greyscale (smoothed) with any corrections to the measured values or filtering processes noted, and as separate simplified graphical interpretations of the main anomalies detected.

6.0 **Geophysical Survey Results** (Figures 2 – 8)

6.1 For the purposes of interpreting the anomalies, the survey data has been processed to the values of -3 to 3 nT/m (Figure 3). This enhances faint anomalies that may otherwise not be noted in the data, with a number of anomalies identified across the data set. These are discussed in turn and noted as single- or double-digit numbers in square brackets. Positive anomalies represent material that is more magnetically susceptible than the surrounding material, with negative anomalies representing material that is less magnetically susceptible.

6.2 There were a few areas where it was not possible to survey (Figure 9). These included a small area [1] corresponding with a short steep section with poorly cut vegetation, a large earth mound/bank [2], and areas with piles of modern rubbish [3] and [4].

Plate 1: Area unsuitable for surveying [1], looking northeast

Plate 2: Earth mound/bank [2], looking east-northeast

Plate 3: Piles of modern rubbish [3], looking south

Plate 4: Piles of modern rubbish [4], looking west

6.3 The whole of the northern part of the site (shown in Figures 5-8 as 'Area unsuitable for geophysics'), was covered in made ground/hardcore/concrete or tarmac. A small area [5] was surveyed to demonstrate the ineffectiveness of magnetometry over this area. The results there show a very large amount of magnetic noise, producing readings of up to -100 to 100 nT/m. The area had also been surveyed to identify whether it was possible to see the route of a gas pipe through this area, however no readings were produced which could be interpreted as such. This is likely either because the gas pipe took a route through an unsurveyed part of this area, the magnetic noise produced by the hardcore/made ground etc. effectively masked any readings or the pipeline was at a depth where the magnetometer was not able to pick it up. There was however a very faint indication within the magnetic noise of a potential linear feature aligned roughly northeast to southwest within this area [6], -100 to 100 nT/m, which could represent a buried modern feature.

Plate 5: View across the very northern part of the site, showing tarmac and made ground, looking west-southwest

6.4 The area of magnetic noise [7], producing varying readings up to -100 to 100 nT/m, likely represents a combination of the effect of the metal fence along the northern edge of this area, and buried modern material.

Plate 6: Area associated with magnetic noise [7], looking roughly northeast

6.5 The large area of magnetic noise [8], producing readings up to -100 to 100 nT/m, partially surrounding the unsurveyed mound/bank, corresponds to an area of made ground clearly visible on Google Earth historic images dated December 2003 and May 2007. The image from May 2007 correlates almost exactly with the current area of magnetic noise. Lidar data from the site (Figure 8) shows that this area is slightly raised compared to the area immediately to the northeast, demonstrating the extent of the made ground in this area.

6.6 The area of magnetic noise [9], -100 to 100 nT/m, represents that effect of the metal fence along the edges of that part of the site.

Plate 7: Metal fence running along part of the northeastern edge of the site [9], looking south-southeast

6.7 The area of magnetic noise [10], producing varying readings up to -100 to 100 nT/m, represents a combination of metal fence and buried modern material within the topsoil.

6.8 The area of magnetic noise [11], producing varying readings up to -100 to 100 nT/m, represents a combination of metal pipes and modern waste material – some buried.

Plate 8: Area associated within magnetic noise [11], looking roughly southeast

6.9 The long area of magnetic noise [12], -100 to 100 nT/m, relates to an overgrown area and a metal pipe running along the edge of the survey area there.

Plate 9: Above ground metal pipe associated with magnetic noise [12], looking west-southwest

6.10 The area of magnetic noise [13], producing varying readings up to -100 to 100 nT/m, corresponds with an entrance to the site, and likely represents buried modern material and potentially demolition material from a former structure seen in this area on the 1951 OS map (Figure 7).

6.11 The area of magnetic noise [14], producing varying readings up to -100 to 100 nT/m, corresponds with the area previously excavated immediately to the southeast of the site and extending just into it. This area likely represents modern material/hardcore used in the backfilling of the excavation (Network Archaeology 2016).

6.12 The two areas of magnetic noise [15] and [16], both producing varying readings of up to -100 to 100 nT/m, likely represent areas of buried modern waste.

6.13 The area of magnetic noise along the southwestern edge of the site [17], producing readings of up to -100 to 100 nT/m, likely indicates that there is a buried modern service running adjacent to this field boundary.

6.14 The linear dipolar feature [18], -100 to 100 nT/m, most likely represents a buried modern service.

6.15 The parallel potential positive linear features [19], 1 to 3 nT/m, potentially represent ditches or drainage features. These features are very ephemeral because they run parallel with the direction of the walked traverses while surveying. Processing the results can reduce or even remove features which run in the same direction as the walked traverses.

6.16 The negative linear feature and likely associated parallel potential features [20], -1 and 1 nT/m respectively, probably represent a modern drainage feature.

6.17 The positive amorphous features [21], 2 to 5 nT/m, likely represent water action within the site, part of a palaeochannel, soil-filled hollows or former ponds.

6.18 The positive linear feature [22], 2 to 6 nT/m, most likely represents a modern drainage feature.

6.19 The positive linear feature [23], 1 nT/m, corresponds with a former field boundary seen on historic OS maps (Figure 7). The adjacent parallel positive linear features, with readings up to 2 nT/m, likely represent a former cultivation trend.

6.20 The positive linear features [24] and [25], 0.5 to 1 nT/m, likely represent modern land drainage.

6.21 The parallel positive linear features [26], 4 nT/m, may represent land drains or a former cultivation trend, but could represent parallel ditches possibly running adjacent to a former trackway.

6.22 The positive linear features [27], 2 nT/m, which are aligned roughly northeast to southwest and northwest to southeast, could represent further modern drainage features, but could represent small enclosure features or possibly former cultivation trends.

6.23 The linear positive feature [28], 2 to 3 nT/m, aligned northeast to southwest, aligns with a ditch identified as Early Roman in the recent excavation to the east and southeast (Network Archaeology 2016), although it also appears to correspond with a former field boundary seen on the historic OS maps (Figure 7).

6.24 Close to the southeast edge of the site there are a couple of negative features [29], -1 to -2 nT/m. The negative linear feature may correspond to a drainage feature, while the roughly circular/curvilinear features may represent an area of modern machine movement, possibly relating to the construction work on the road immediately adjacent to the southeast of the site.

6.25 The potential positive linear feature [30], 2 to 4 nT/m, could represent a former track or cultivation trend, it could also relate to construction activity associated with the road immediately adjacent to the southeast of the site.

6.26 Within the area of magnetic noise at the southeast corner of the site [14], there are possible positive linear and curvilinear features [31], 20 to 50 nT/m. The large amount of magnetic noise within this area makes identification and interpretation of features in this location tenuous at best, but it is possible these features represent a continuation of the archaeological activity identified immediately to the southeast in the recent excavations there.

6.27 Across a large proportion of the southern field there are many amorphous and sinuous positive areas [32], 2 to 6 nT/m. These features likely represent palaeochannels within the site, possibly related to a former creek of the Humber.

6.28 Scattered throughout the entire site are a large number of weak and strong dipolar responses, examples of which are highlighted as [33]. The characteristic dipolar response of pairs of positive and negative ‘spikes’ suggest near-surface ferrous metal or other highly fired material in the topsoil, which could represent small pieces of metal such as nails, horseshoes or parts of a tractor.

7.0 Discussion and Conclusions

7.1 The survey has potentially identified several features of archaeological interest, with some positive linear features towards the southeast edge of the site, potentially relating to archaeological features identified prior to the construction of the road running immediately adjacent to the east and southeast of the site. However, there is a large amount of magnetic noise within this area, likely a result of the construction work, and this makes identification of potential archaeological activity within this area tenuous at best.

7.2 There are large amounts of magnetic noise across the site, especially across the northern half. The area immediately south of the current VPI compound was not suitable for survey and this was clearly demonstrated by the small area within that part of the site that was surveyed in an attempt to locate the continuation of the modern service seen running across the western part of the southern half of the survey area. There was also a large amount of modern waste material or hardcore within the northern half of the surveyed area, corresponding with construction activity from the building of VPI Immingham buildings. It is possible that the amount of magnetic noise produced by this material could mask a continuation of archaeological activity identified immediately north of the current site.

7.3 Several positive linear features also appear to correspond with former field boundaries seen on historic OS mapping, and some likely modern land drainage was also identified. The survey also revealed large areas likely relating to palaeochannels, possibly relating to a former creek of the Humber Estuary. Borehole transects undertaken immediately to the north and extending into the site (Buglass and Bradley 2006) identified the former creek immediately to the northeast of the surveyed area, and palaeochannels within the surveyed area (corresponding with the area of magnetic noise [8]) and immediately to the north of this area. There were also positive linear features which could represent modern cultivation trends but might instead relate to former enclosure features land drainage.

8.0 Effectiveness of Methodology

8.1 The non-intrusive evaluation methodology employed is appropriate to the scale and nature of the site. Magnetometry was the prospection technique best suited to the identification of archaeological remains on the site. Other techniques would have required further justification and may have proved too time consuming or cost-prohibitive.

9.0 Acknowledgements

9.1 Allen Archaeology Limited would like to thank AECOM and their client VPI Immingham LLP for this commission.

10.0 References

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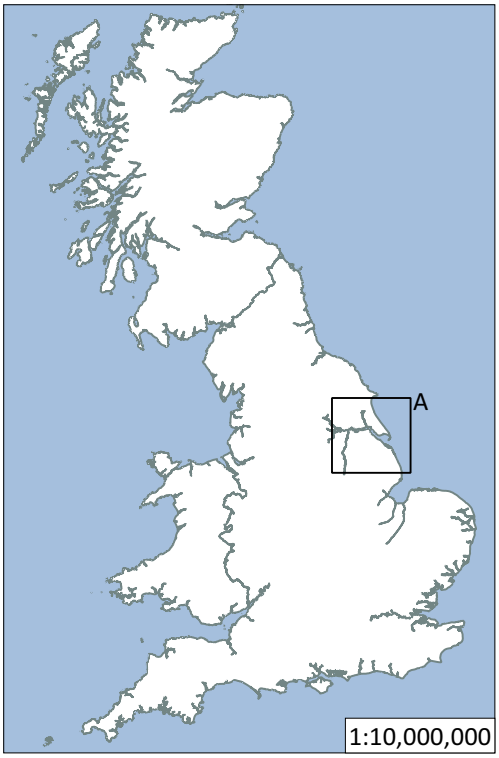

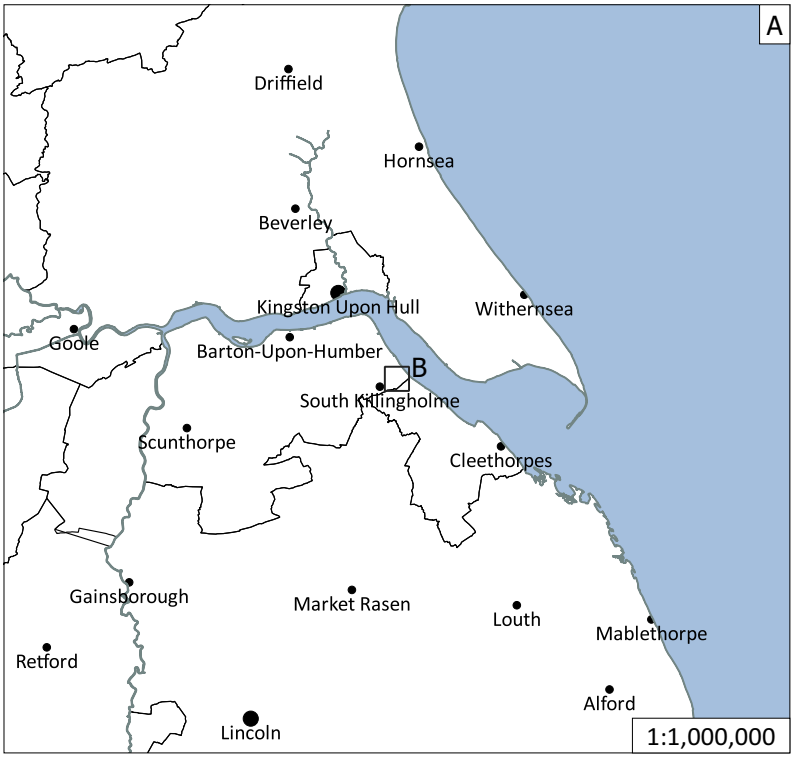

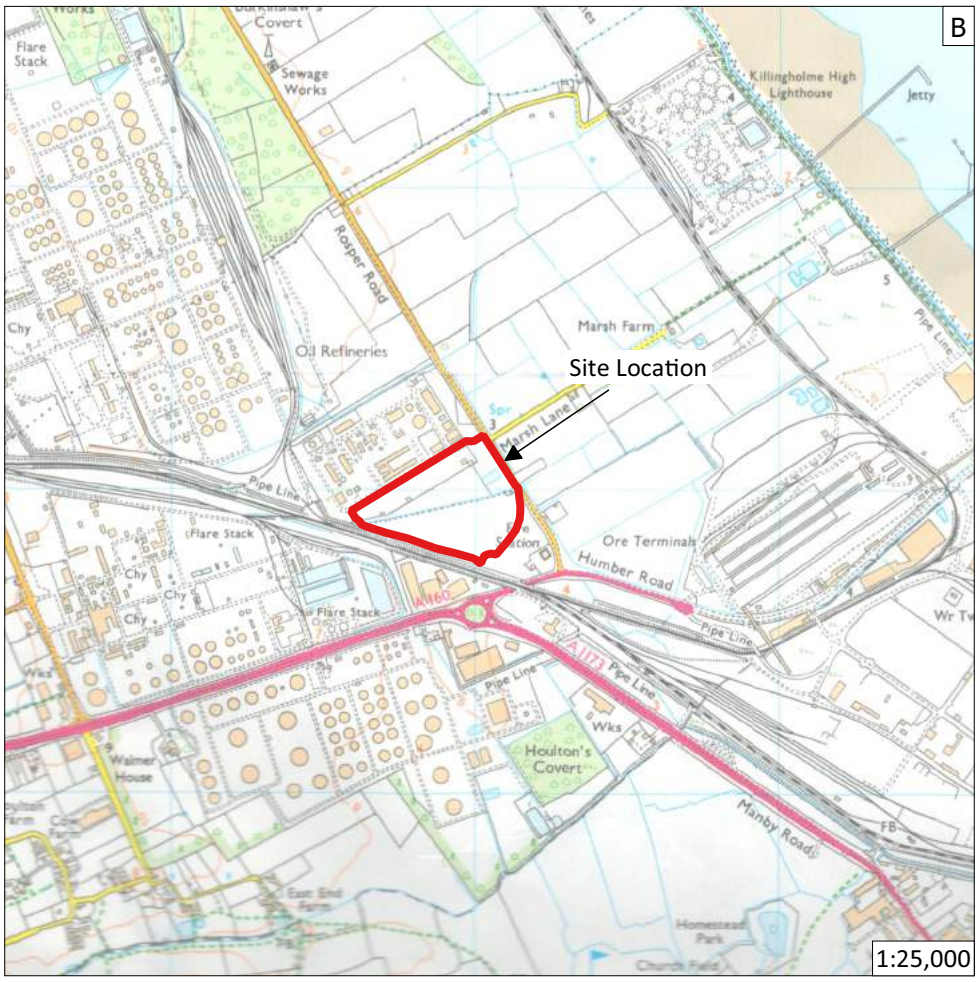

Figure 1: Site location outlined in red

Site Code	SKRR 22
Scale	1:10,000,000 1:1,000,000 1:25,000 @ A4
Drawn by	R Evershed
Date	14/10/2022

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N

Raw data (clipped to +/- 40 nT)

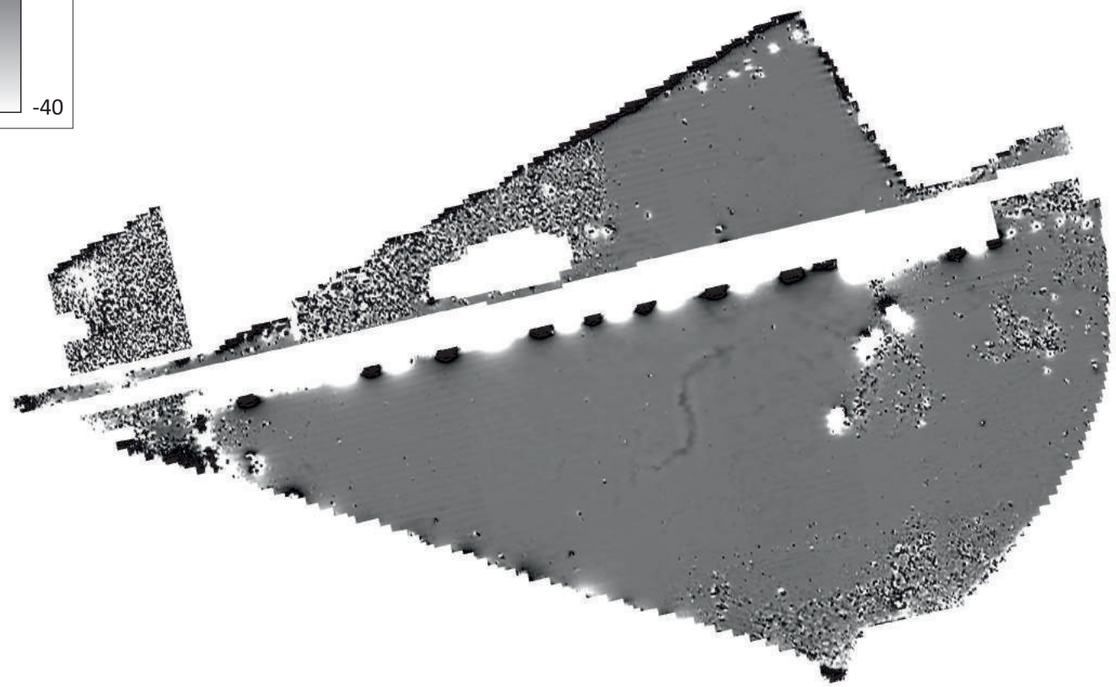
Trace Plot (ZMT and clipped to +/- 25nT)

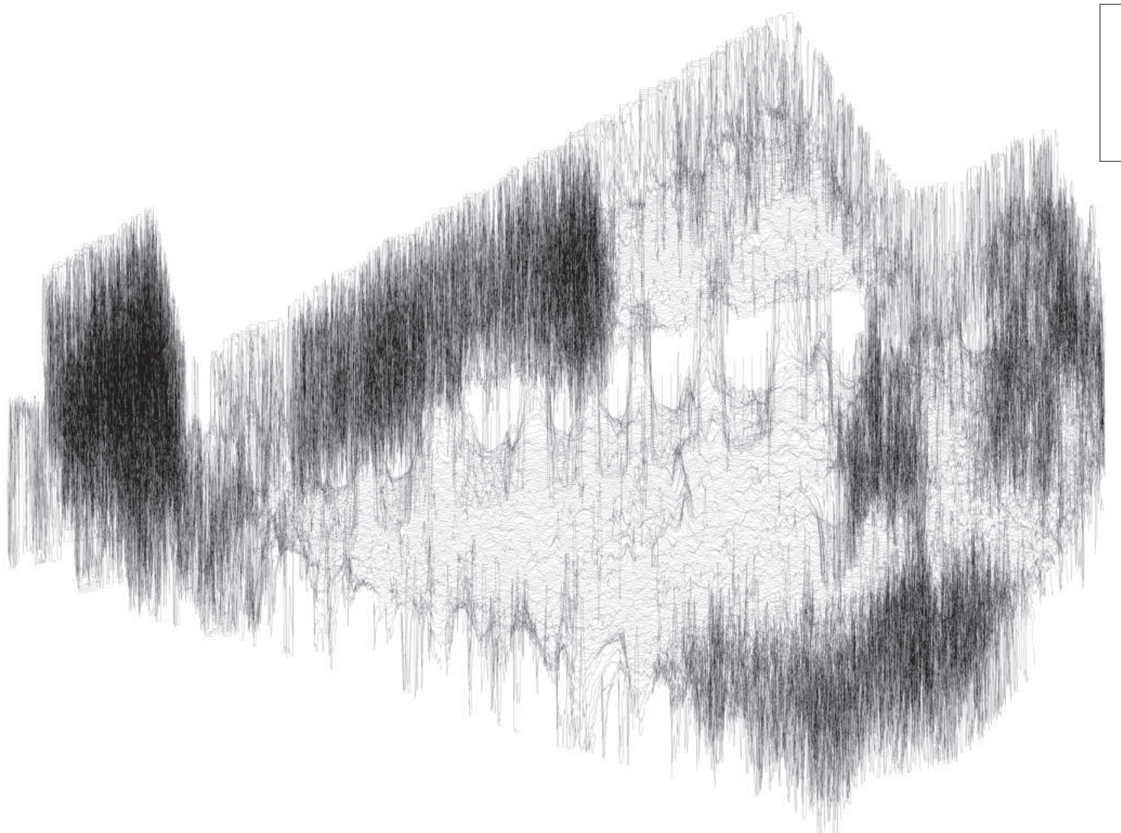
40

nT

-40

25nT





0 300m

Scale 1:3,000

Site Code	SKRR 22
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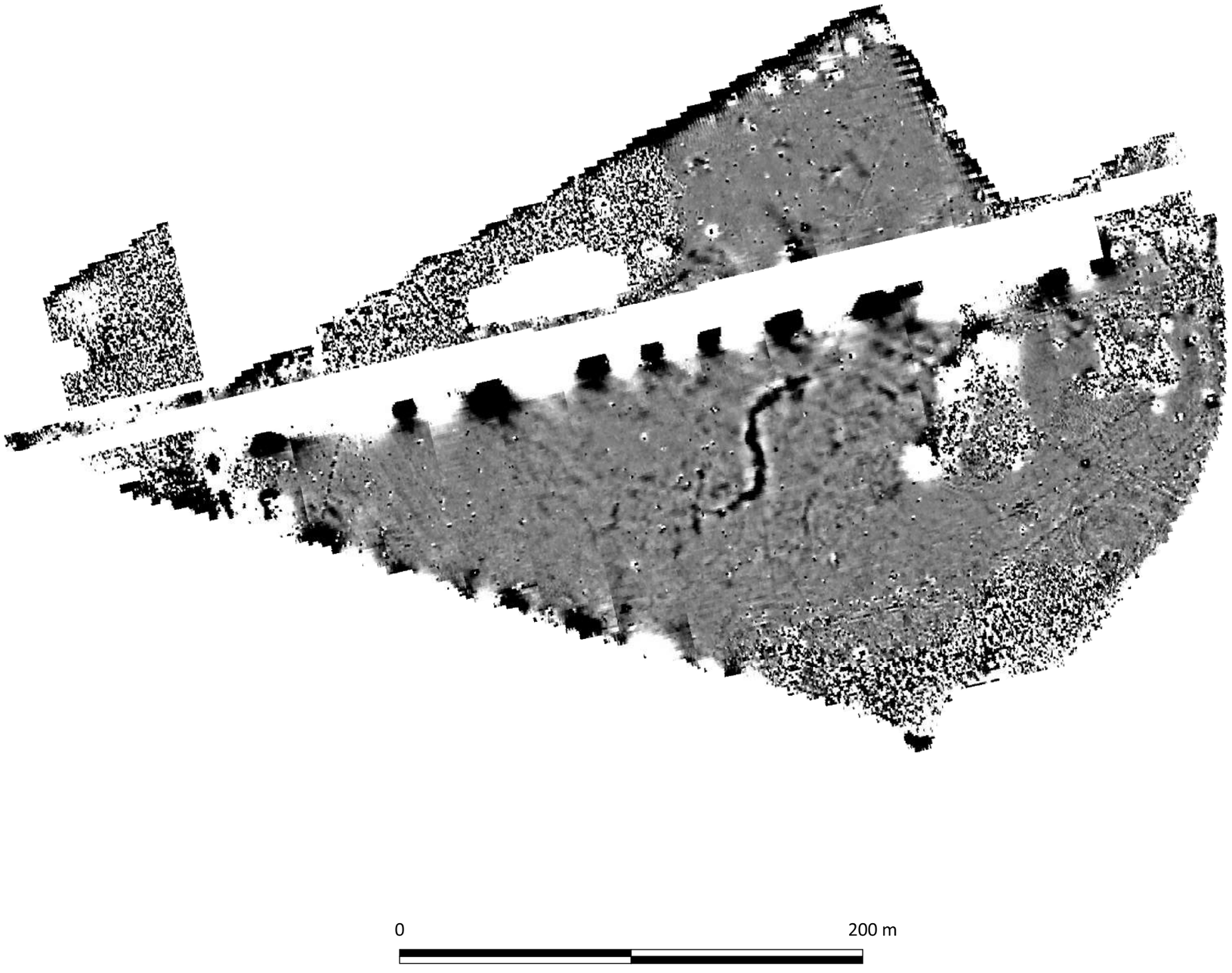
Figure 2**:** Greyscale raw data and processed trace plot



0 200 m

N

Key

3
nT
-3

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Figure 3: Processed greyscale plot

N

Key

- Positive anomaly
- Negative anomaly
- Magnetic noise
- Dipolar anomaly
- Linear dipolar anomaly
- Survey boundary
- Unsurveyed

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Figure 4: Geophysical interpretation

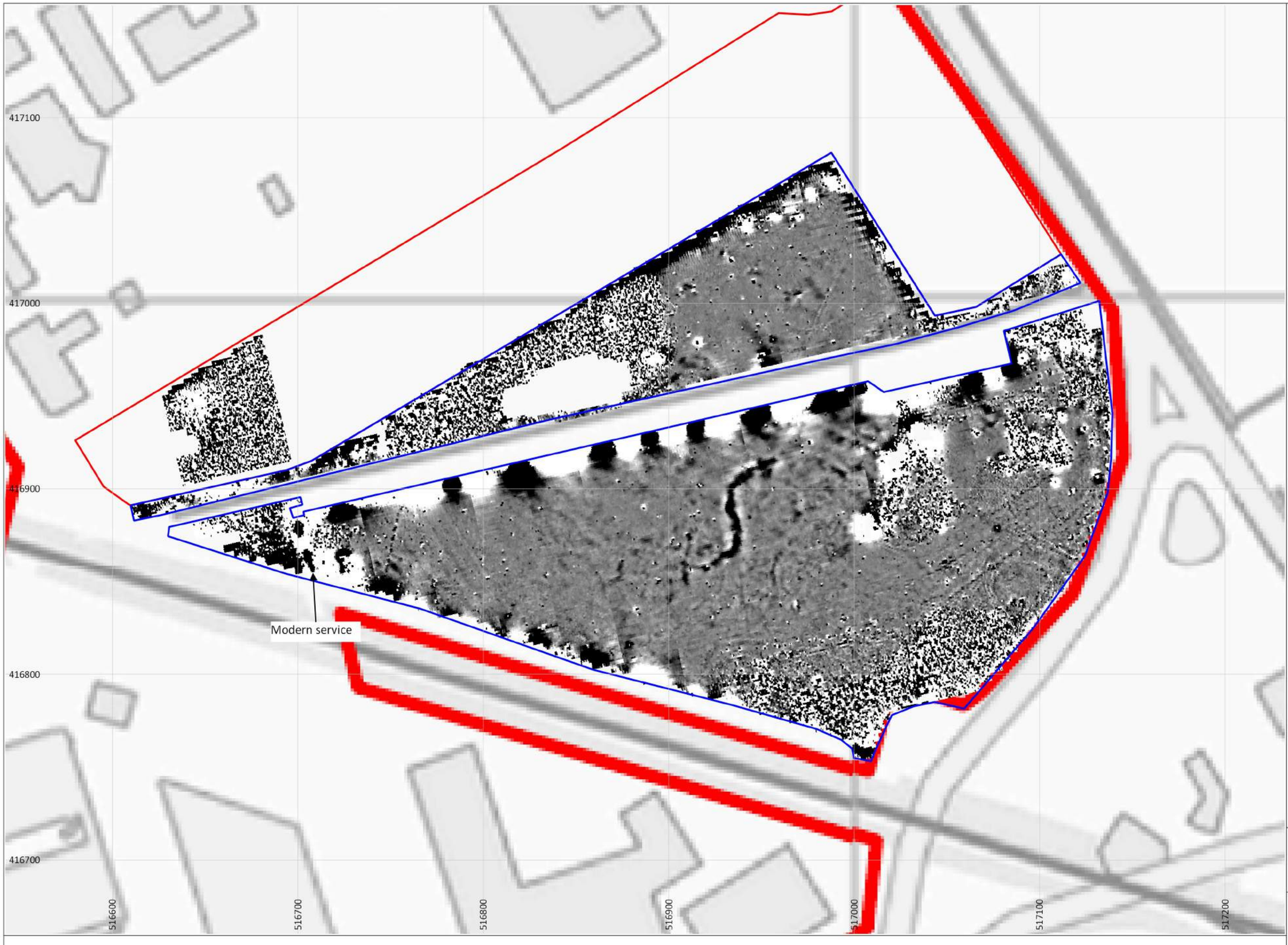

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Figure 5: Processed greyscale location

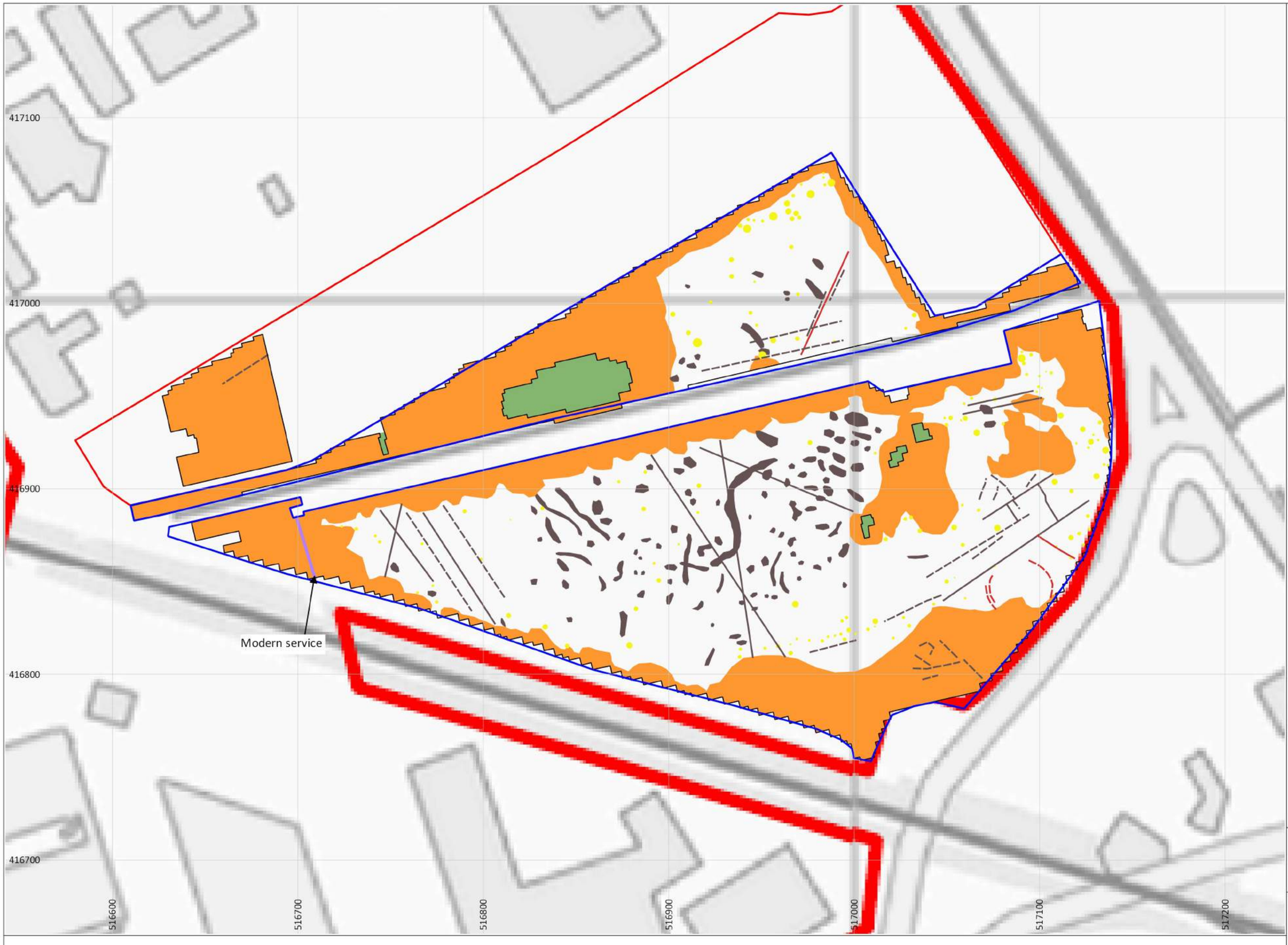


Figure 6: Geophysical interpretation location

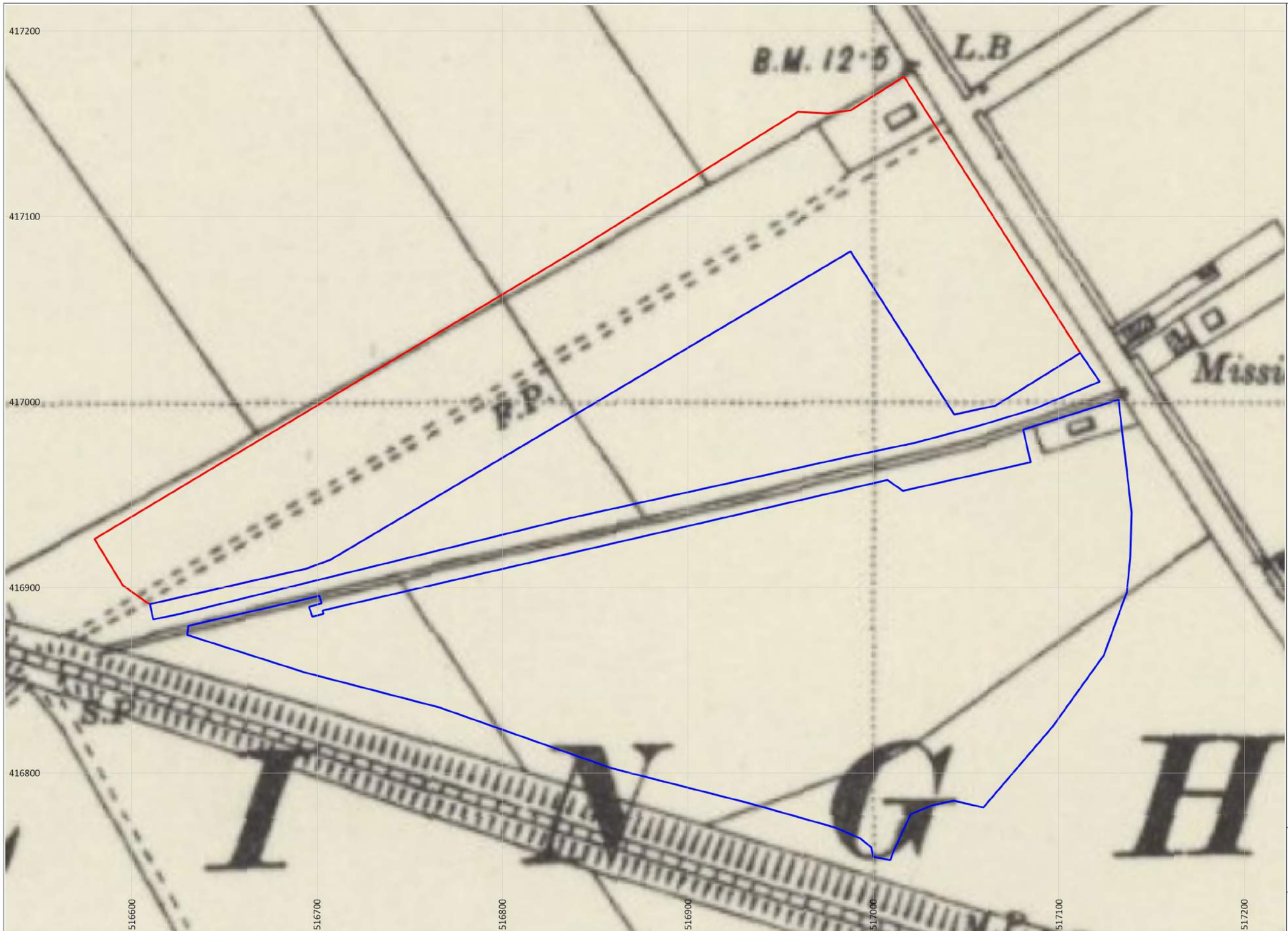
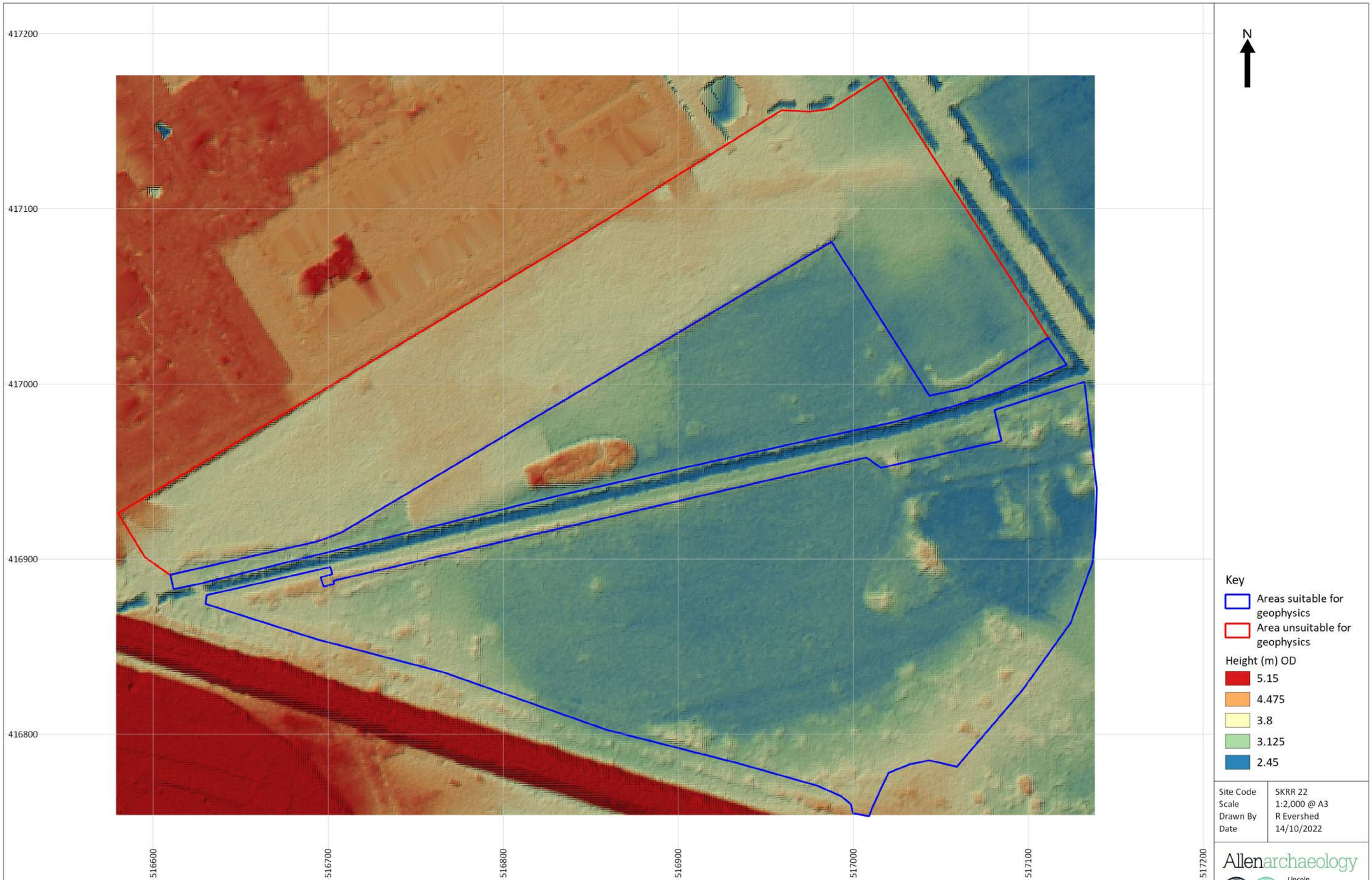


Figure 7: Geophysics areas superimposed over 1951 OS Map



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Drawn By	R Evershed
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Figure 8: Geophysics areas superimposed over Lidar data for the site

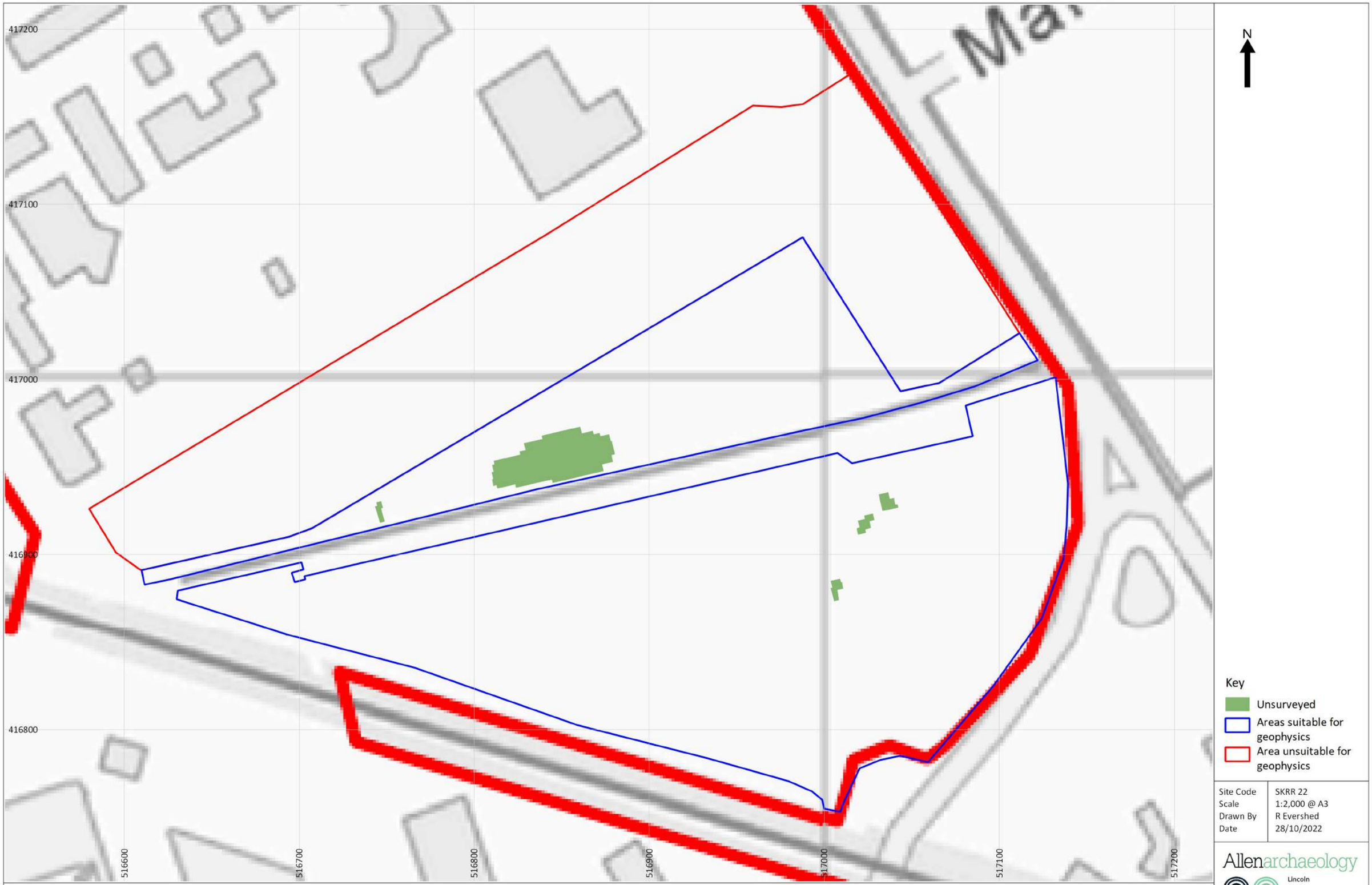

Figure 9: Unsurveyed areas within the areas suitable for geophysical survey

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