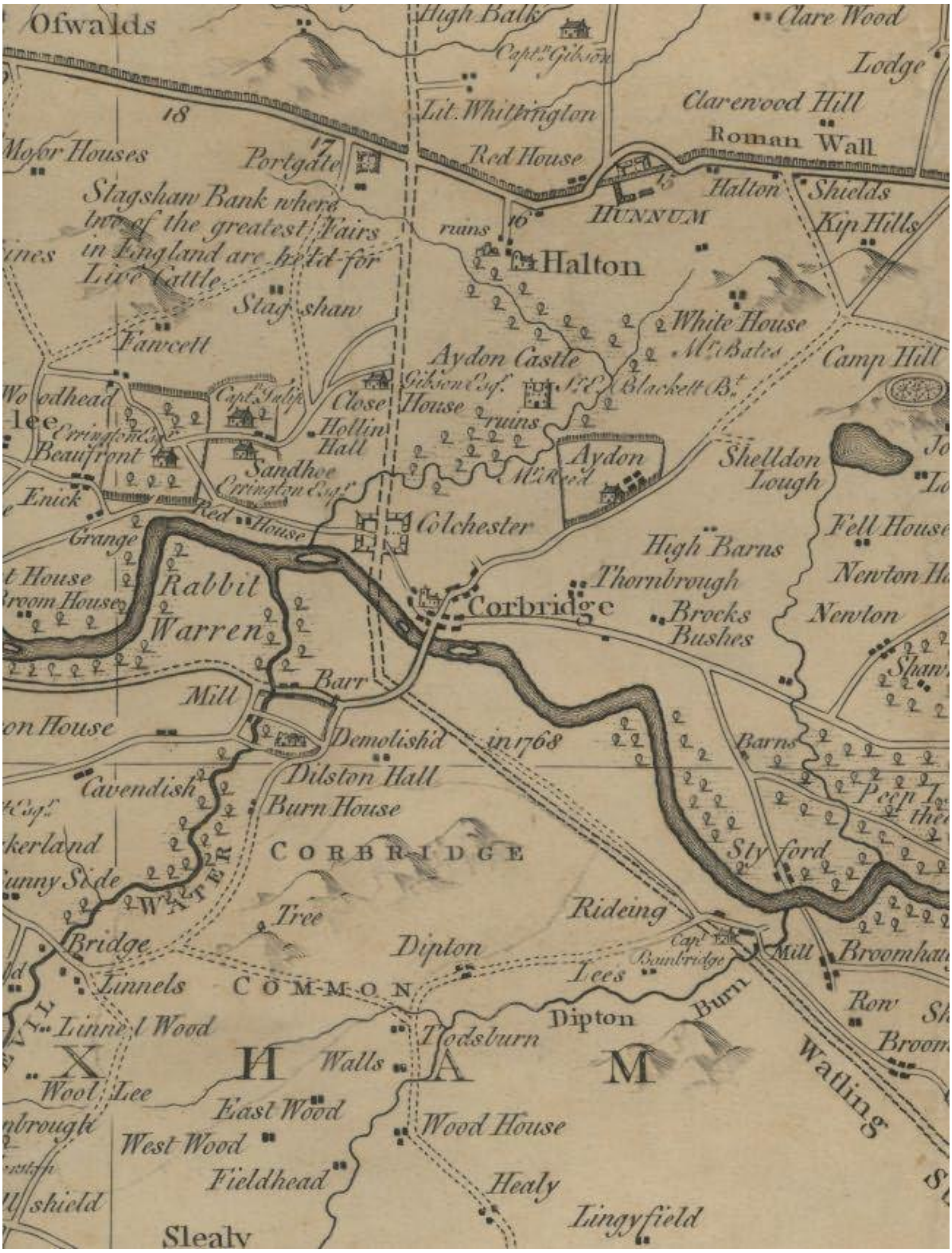
# GEOPHYSICAL SURVEYS AT CORBRIDGE PLAYING FIELD, CORBRIDGE 2019

REPORT BY ALEX TURNER




Extract from Armstrong's map of Northumberland, 1769

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## Introduction

As part of the Hadrian's Wall Community Archaeology Project, two geophysical surveys were undertaken, over a period of three days, in advance of excavation at the site of the former Playing Field, Corbridge, Northumberland. The surveys were undertaken by Project volunteers under the supervision of members of the WallCAP team.

## Location

The site is located to the northwest of the modern town of Corbridge, Northumberland and forms part of the northern edge of Corbridge Roman town (Corstopitum). The site is centred on Ordnance Survey grid reference NY 98420 65020 (Figure 1). The survey area was laid to

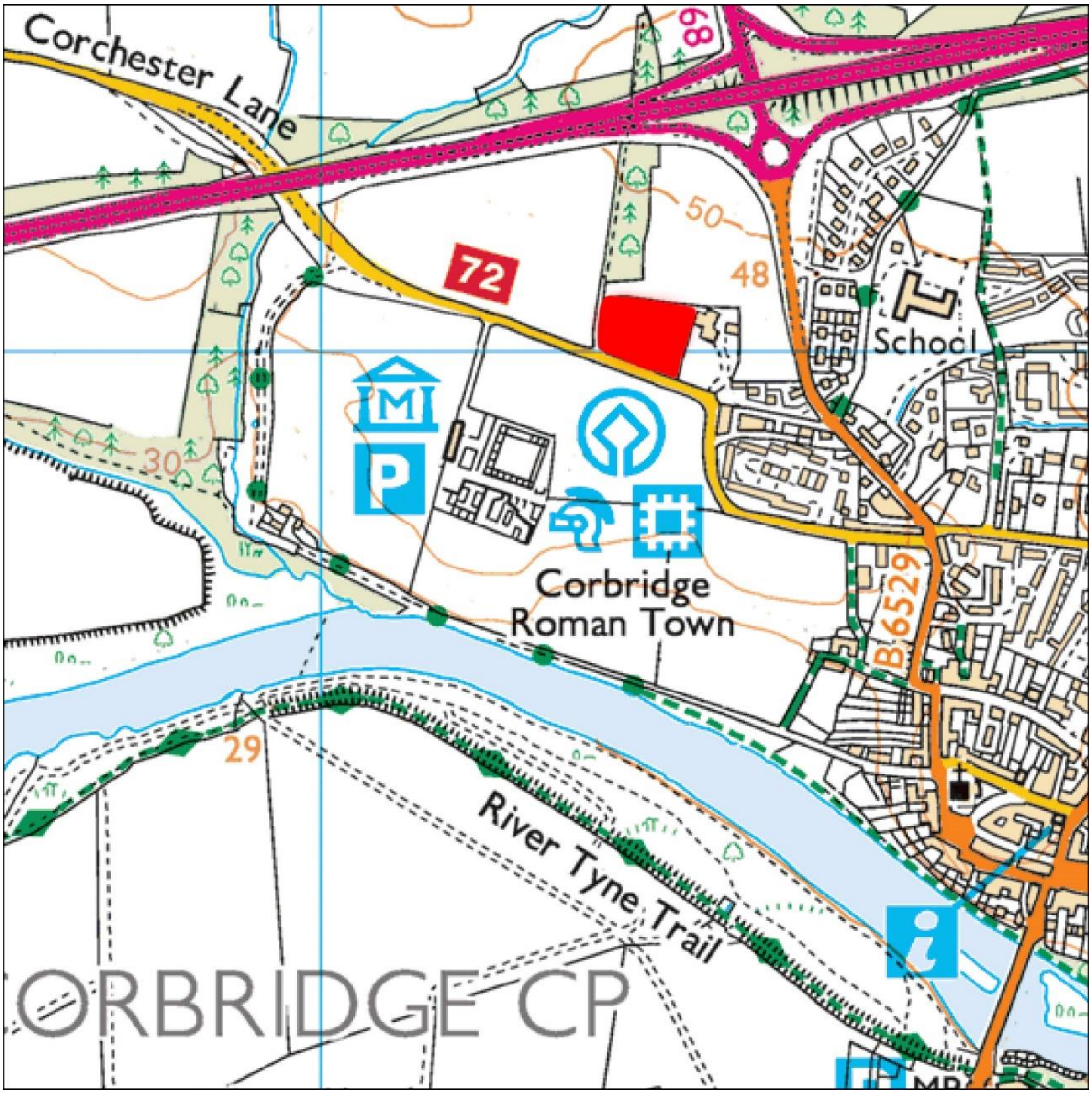


*Figure 1 - Location of Corbridge Roman town. The survey area is marked in red to the north*

grass and separated from the surrounding fields and road by a stand of trees and hedges. A disused pavilion and two metal goal posts created a problem with magnetic interference for the gradiometer survey. To overcome the presence of these ferrous intrusions the boundaries of potential survey targets, had to be sited at least one metre away from these objects. The bank to the north of the field, adjacent to a west-east trackway contain a dump of material that also included many ferrous items. This area was completely excluded from the surveys. The western edge of the survey field contained the pavilion and was covered in dense undergrowth. As a consequence this area was also excluded from the surveys. The area with trees, at the southern edge of the survey field and adjacent to the road, was excluded from the survey due to the effect of tree roots on ground moisture levels that would have led to the distortion of the electrical resistance survey in this area.

## Topography and Geology

### Topography


*Figure 2 - Lidar digital terrain model (DTM) of the survey area*

The topography of the survey area was largely flat, presumably as part of its legacy as a football field. The earthwork revealed by the lidar in the field to the south of Corchester Lane (Figure 2) does not appear to extend beyond the limit of the road. A slight slope existed north-south and east-west and it was this that presumably contributed to the flooding at the east end of the field during the first excavation season in 2019. This might have also been exacerbated by the broken field drains that show as intermittent responses on the geophysical plots (Figure 3).

### Geology

The underlying bedrock geology of the survey area is a Stainmore Formation mixture of mudstone, sandstone and limestone (Figure 4). The 'superficial' geology layer from the British Geological Survey 1:50,000 digital data describes the survey area as unmapped but an examination of the plough soil layer from the same data set shows that the area has a loam soil with the exception of the top north-eastern corner where it changes to a loam/clay (Figure 5). The dominant minerals in the soil are quartz and feldspar with some silica. Soil makeup has a significant effect on the effectiveness of any geophysical method. The background sub-surface makeup of the survey area was deemed, in this case to be suitable for both electrical resistance and gradiometer survey. The only limiting factor, attested to during the first excavation of the site, was that the eastern boundary of the site was prone to flooding and that the electrical resistance survey should be conducted during drier spells of weather. This flooding is unlikely to have been caused by the underlying geology and it more likely to be due to an aged and broken field-drainage system. Examination of the survey results showed a number of varied linear responses in this area that probably represent these compromised drains.

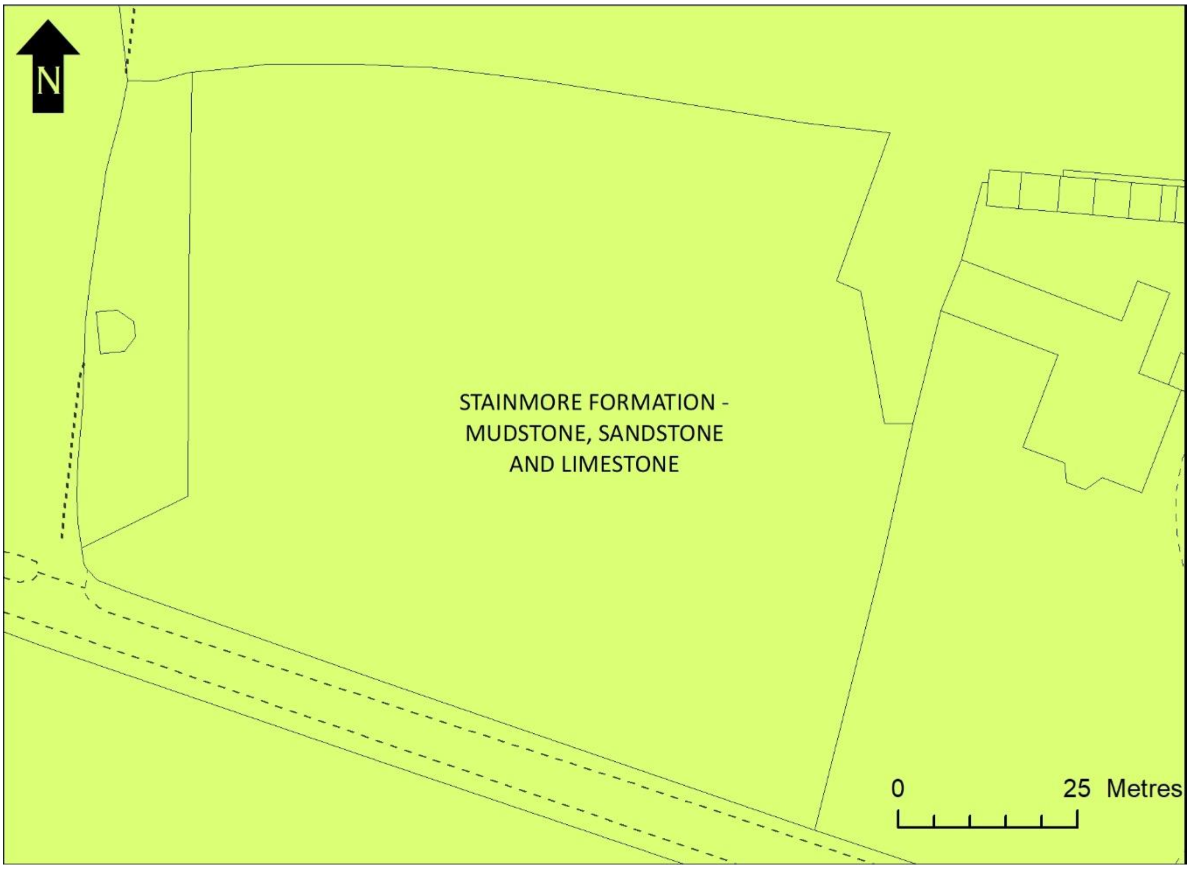


*Figure 3 - Bedrock geology for the survey area*

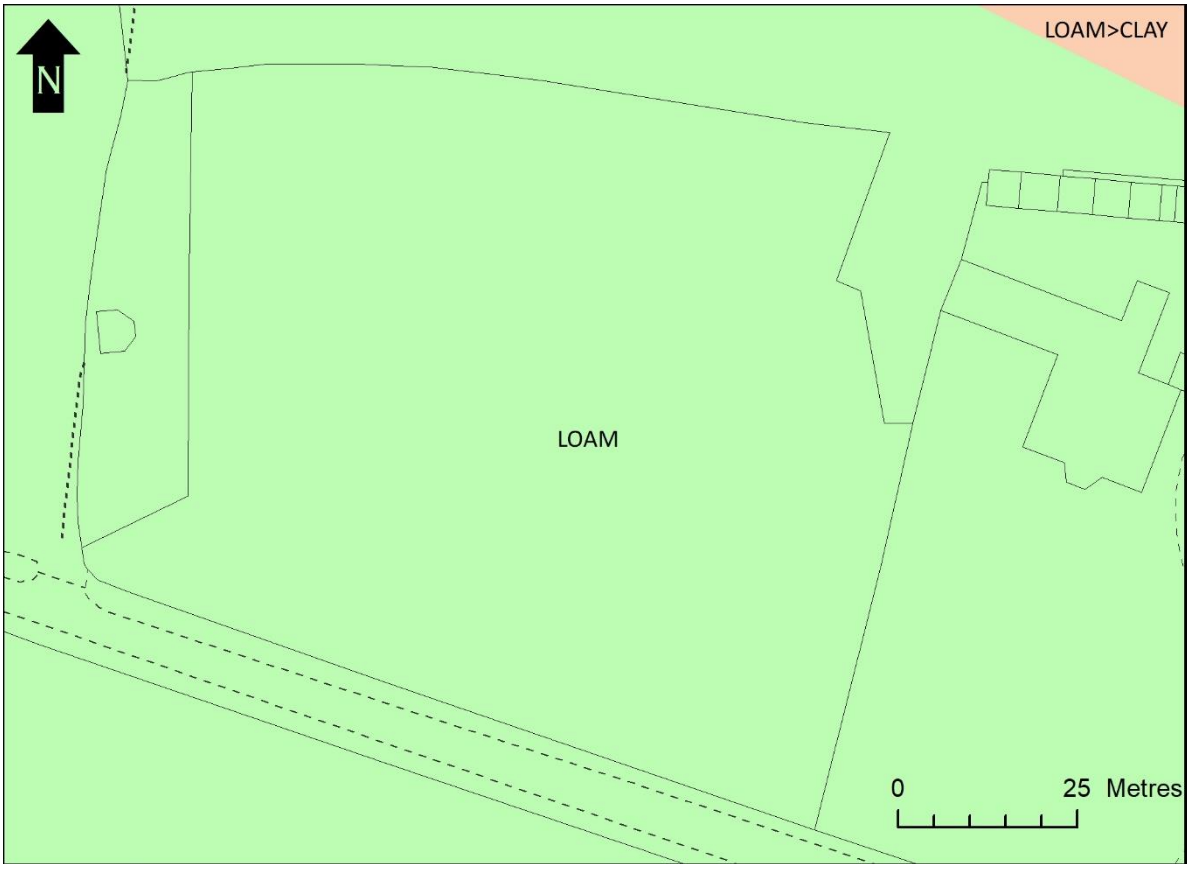

*Figure 4- Soil types for the survey area derived from BGS 1:50,000 geology data*

## Survey Methodology

### Methods - Survey Grids and Markers

A survey grid consisting of 17 full and partial 20m x 20m squares was laid out using a Leica GNSS differential survey grade GPS connected to the Leica RTK Smartnet network. Temporary grid pegs were used to mark out the grid and the lack of livestock in the fields meant these could be left overnight. The survey grid coordinates were derived from Mastermap digital data and stored as a feature class within the survey ArcGIS geodatabase. Grids and flags were numbered sequentially in an east-west series of rows from south to north. Given the time constraints of the survey, where partial grids were involved, these were restricted to a series of simple rectangles. The grid was layout was chosen to avoid any close proximity to the ferrous intrusions within or enclosing the field. The gradiometer grid (Figure 5) was more truncated at the eastern and western edges than the resistivity grid (Figure 6) due to the presence of the substantial metal goal posts and boundary fencing containing ferrous material. The position of trees in relation to the survey can be clearly seen on the 25cm resolution aerial photograph from 2018 (Figures 5 and 6) and the grid layout also took into account the possible interference with, in particular, the resistivity survey results.


*Figure 5 - Location and numbering of the gradiometer survey grids with 25cm AP as background*


*Figure 6 - Location and numbering of the resistivity survey grids with 25cm AP as background*

### Methods - Fluxgate gradiometer survey

The survey was carried out using a Bartington Grad 601/2 fluxgate gradiometer with two vertical sensors spaced one metre apart. Following an initial scan of the survey site, a magnetically sterile area was identified for the creation of the survey control point. This was used to calibrate the gradiometer before each day of survey and after any significant stoppages. In accordance with accepted practice (Schmidt et al 2016, 12) data was collected along a series of zig-zag traverses spaced one meter apart with sample readings being taken every 25 centimetres. This gave an effective resolution of 1600 reading for each 20m x 20m survey grid. The largely flat topography of the playing field enabled a consistent rate of data collection for the whole survey.

### Methods – Electrical resistance survey

Electrical resistance survey was carried out using a Geoscan RM15D Advanced equipped with a MPX15 multiplexer. Due to the number of volunteers and the time available, the data was collected using a 0.5 metre traverse and 0.5 metre sample. This enabled four times as much data to be collected as the standard 1 metre x 1 metre survey. This gave the same effective resolution for each survey square as the gradiometry at 1600 reading per 20m x 20m survey grid.

## Data processing and presentation

The data from both the resistivity and gradiometer surveys was processed using Geoplot 4.0. The resulting plots were exported as raster images to ArcGIS 7.1 where they were scaled and georeferenced using the latest vectored Mastermap data. This enabled comparison  with a combination of modern and historic Ordnance Survey mapping data, Environment Agency Lidar data and aerial photographs downloaded from Digimap. The integration of digital output from the geophysical survey with the Digital Terrain Model (DTM) obtained from the Environment Agency Lidar data also enabled detailed topographic examination of the survey terrain. Digital overlays were created for features identified within the survey output and formed the basis of the final interpretation of the data.

### Reference to Historic Ordnance Survey

As part of the interpretation process, an examination of all the editions of the Ordnance Survey at 1:2500, was carried out. Historic Google Earth images were also consulted for the first decade of this century but only proved to be useful in identifying the cricket practice strip and goal posts. The study of the historic maps showed that the present arrangement of field boundaries largely derives from the period when Corchester Towers was built, sometime between 1863 and 1881 when it was first mentioned in the census returns (Figure 8). Prior to that the area was part of a post-medieval enclosed field system (Figure 7). The change in use of Corchester Towers from a private house to a school in 1891 (Waugh 2020, 9) and the redesignation of the survey area as the school rugby pitch is the most probable explanation for the presence of the large number of north-south field drains. The term school only appears on the first edition National Grid 1:2500 Ordnance Survey map published in 1963 (Figure 9). The pavilion on the western edge of the survey area is the remains of the eponymous tower from the original Corchester Towers private dwelling, dismantled and moved there in 1891. The only other change to the boundaries occurred after its conversion to a series of flats in the early 1980s when the garden was extended to encompass part of the north-east corner of the field (Figure 10). This boundary constrained parts of both the gradiometer and resistivity surveys.

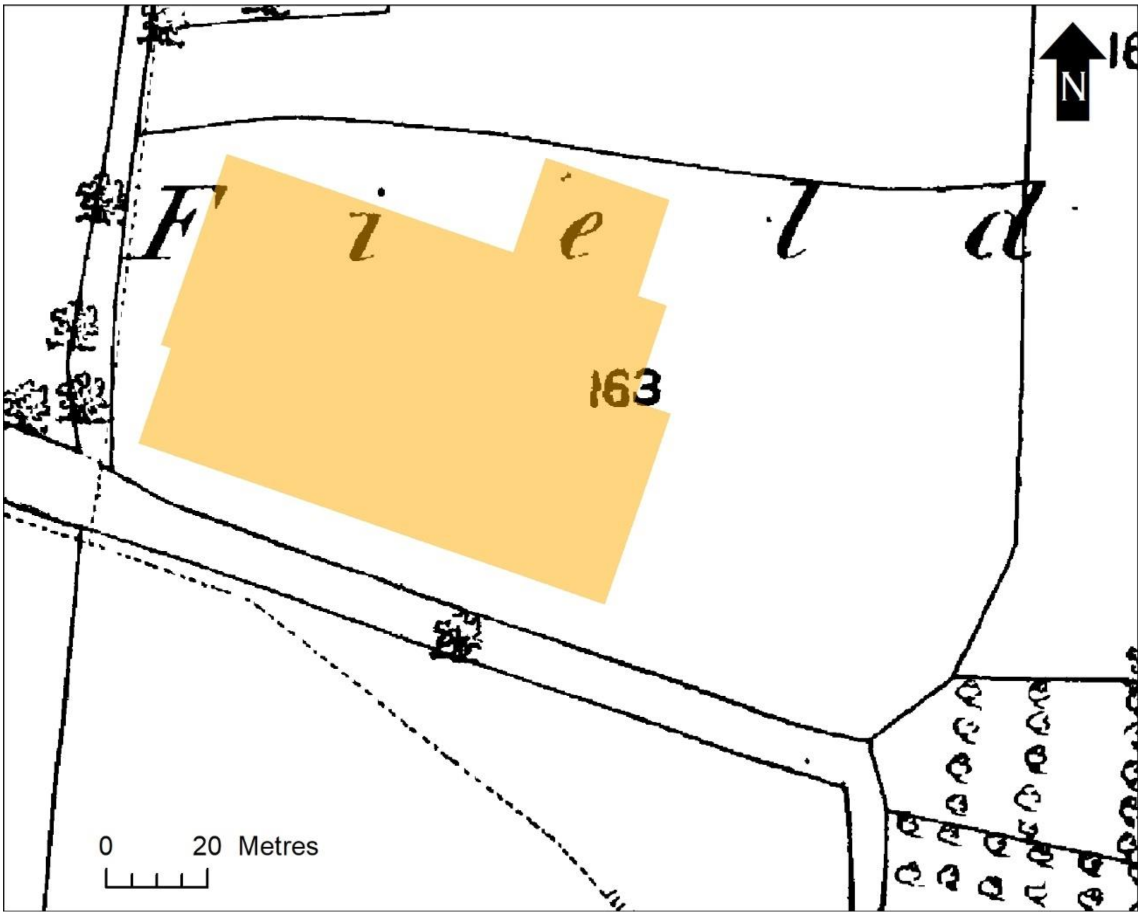


*Figure 7 - Survey area shown on Ordnance Survey 1:2500 County Series First Edition 1863*

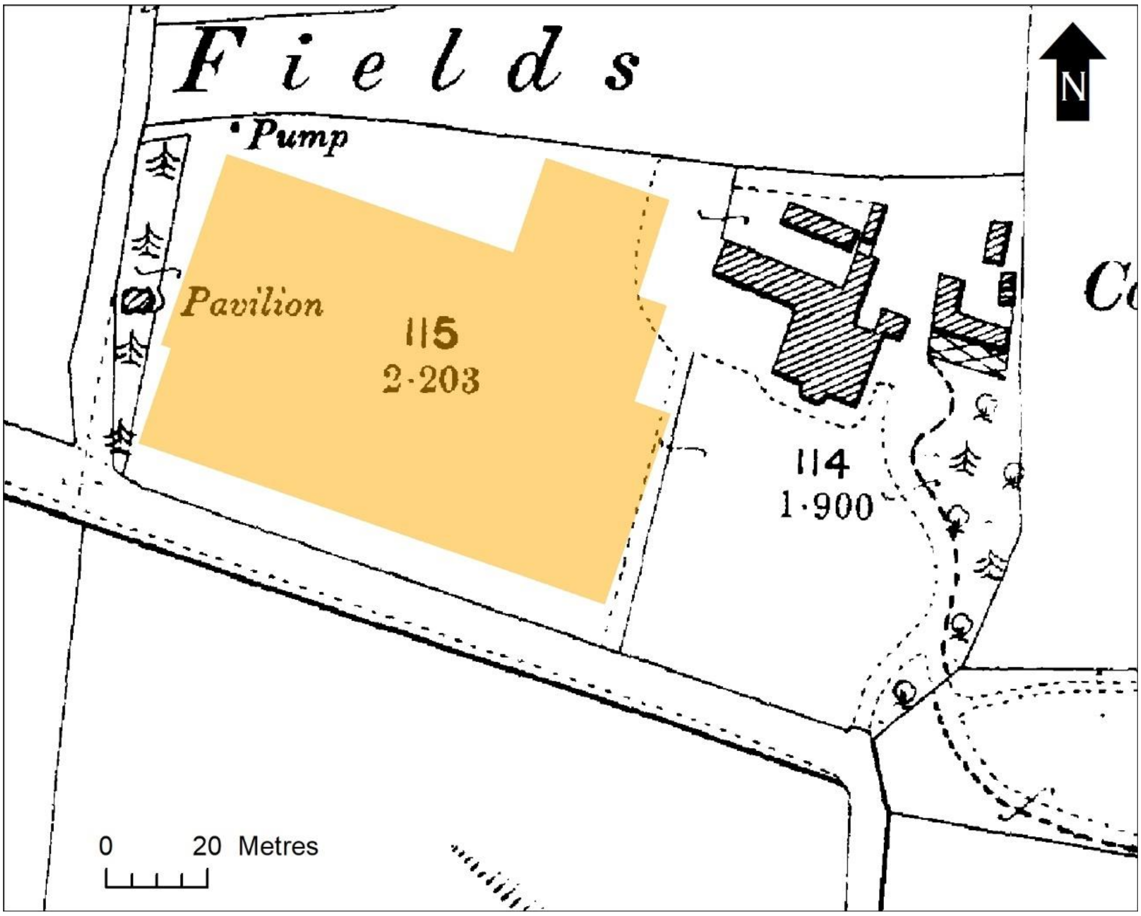


*Figure 8 - Survey area shown on Ordnance Survey 1:2500 County Series 1st Revision 1896*

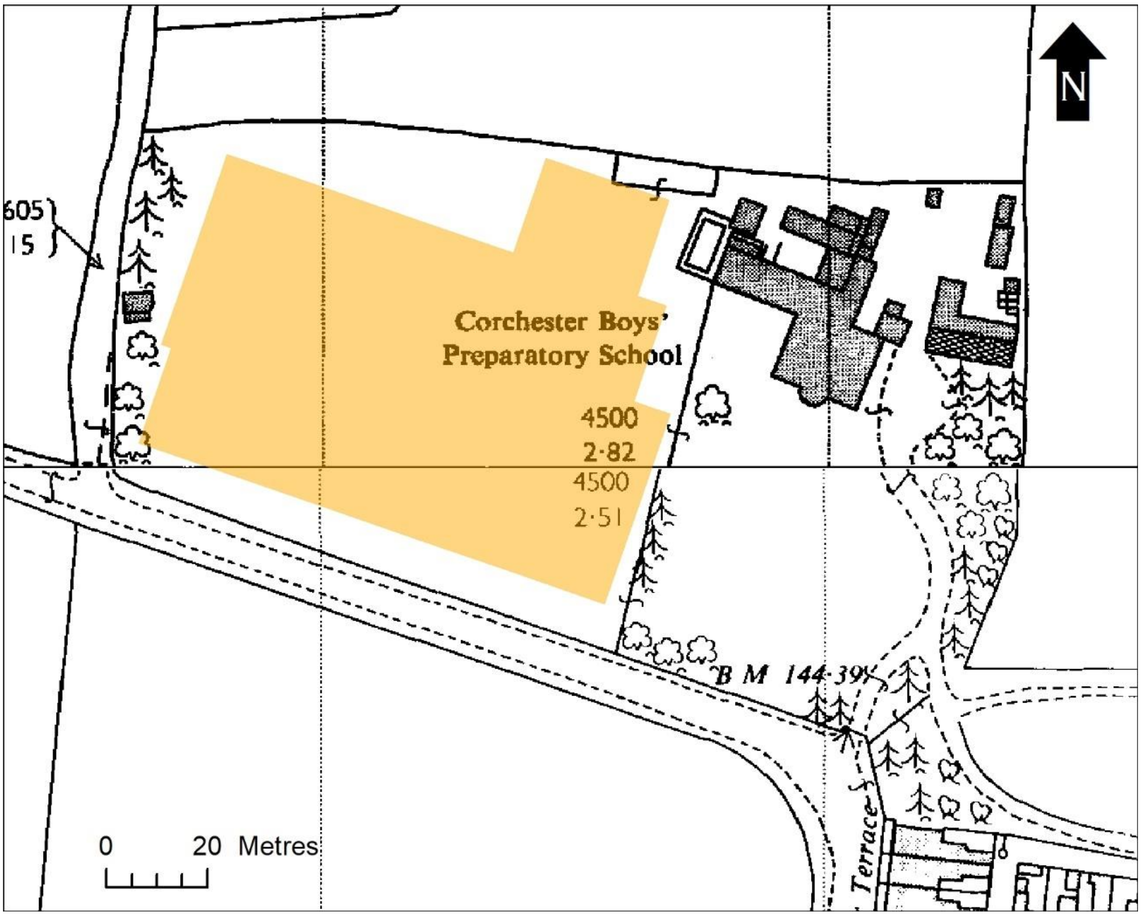

*Figure 9 - Survey area on National Grid 1:2500 1st Edition 1963*

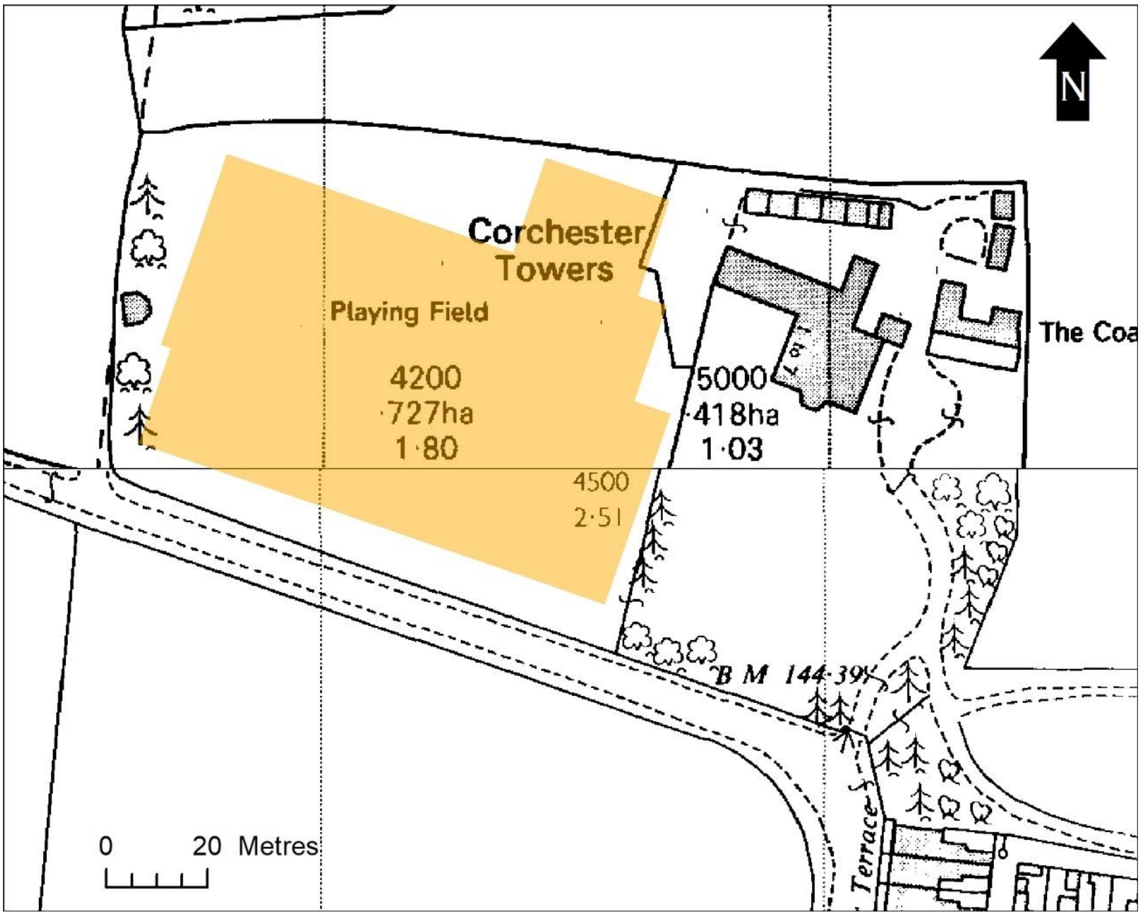

*Figure 10 - Survey area on National Grid 1:2500 2nd revision 1985*

## Survey Results and Interpretation

### Gradiometer Results – process summary

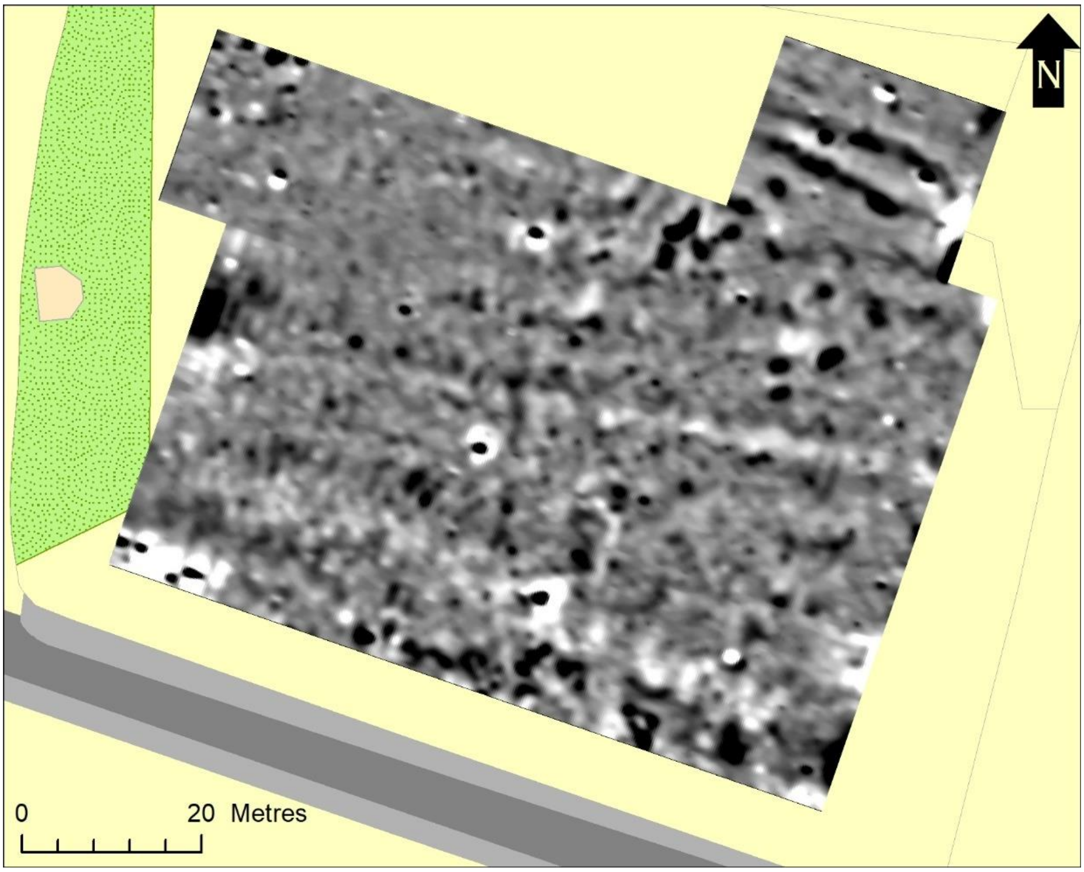


*Figure 11 - Plot of the results of the gradiometer survey with greyscale parameters +/-3SD*

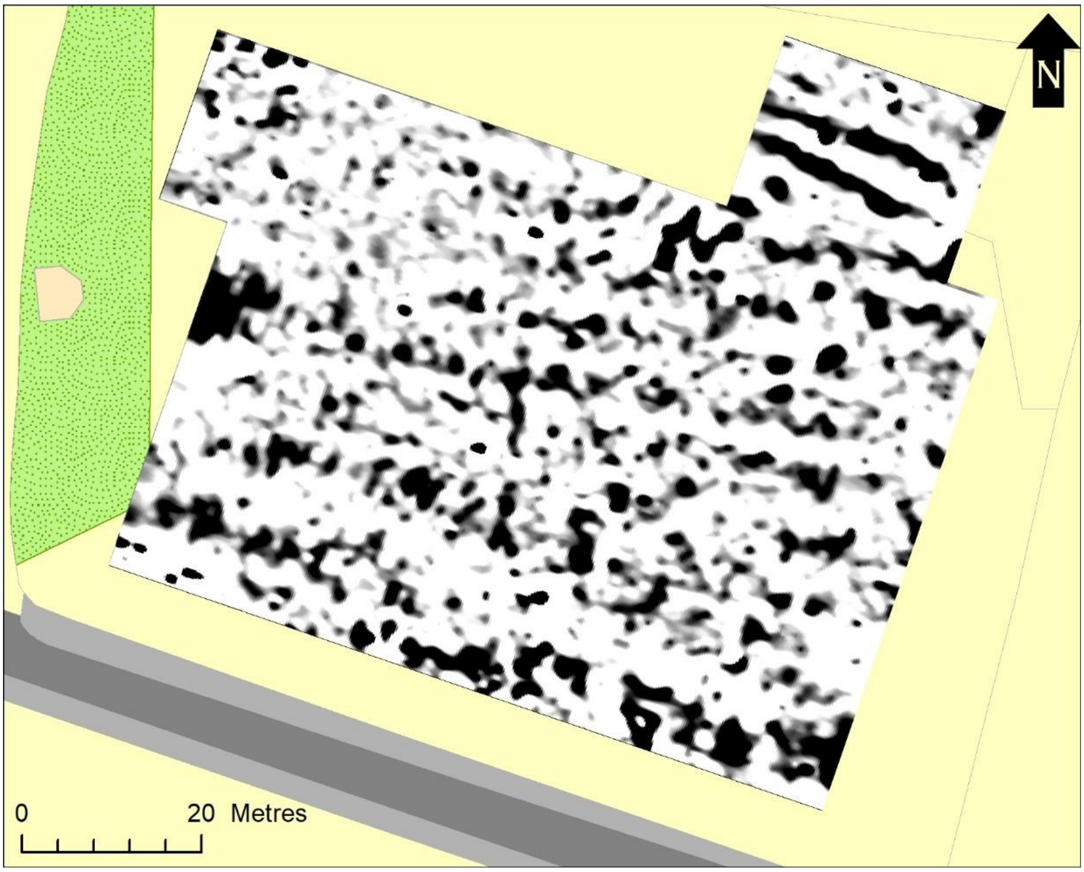


*Figure 12 - Plot of the results of the gradiometer survey with greyscale parameters -1SD-0SD*

The data was processed using Geoplot 4 and exported as a raster image to the ArcGIS 7.1 project for the survey (Figures 11 and 12). Only basic processing was necessary within Geoplot 4. The grids were despiked with a threshold of +/- 3SD and the Zero Mean Traverse filter was applied to reduce any striping as a result of changes in the orientation of the gradiometer during zig-zag survey. A uniform High Pass Filter, to filter any changes in the geological background, was applied with a window of 10 readings in both the X and Y direction. Interpolation was carried out between traverses so that the final data had an X and Y resolution of 0.25 metres. The plots were then scaled and georeferenced to the British National Grid in ArcGIS using coordinates derived from the differential GNSS. Although Figure 12 shows a very narrow set of plotting parameters, between -1SD and 0SD, it is a useful illustration that shows the underlying trend of linear features running in a west-east direction. The results from the gradiometer survey were slightly disappointing and revealed far less features than the resistivity survey.

### Gradiometer Results – Interpretation

The scaled and georeferenced geophysics plots were used to produce an interpretive overlay within ArcGIS. Each of the drawn polygons or polylines was given a unique reference number that is used within the interpretive discussion (Figure 13).

**47:** This was a relatively strong negative response that has been interpreted as a road. Unlike the response from the resistivity there didn't seem to be a discernible return linking with the road from the town on the south side of Corchester Lane. This top level of this feature was included in the excavation trench for 2019 and a more detailed investigated was undertaken in trench 4, 2021 (Figure 17).

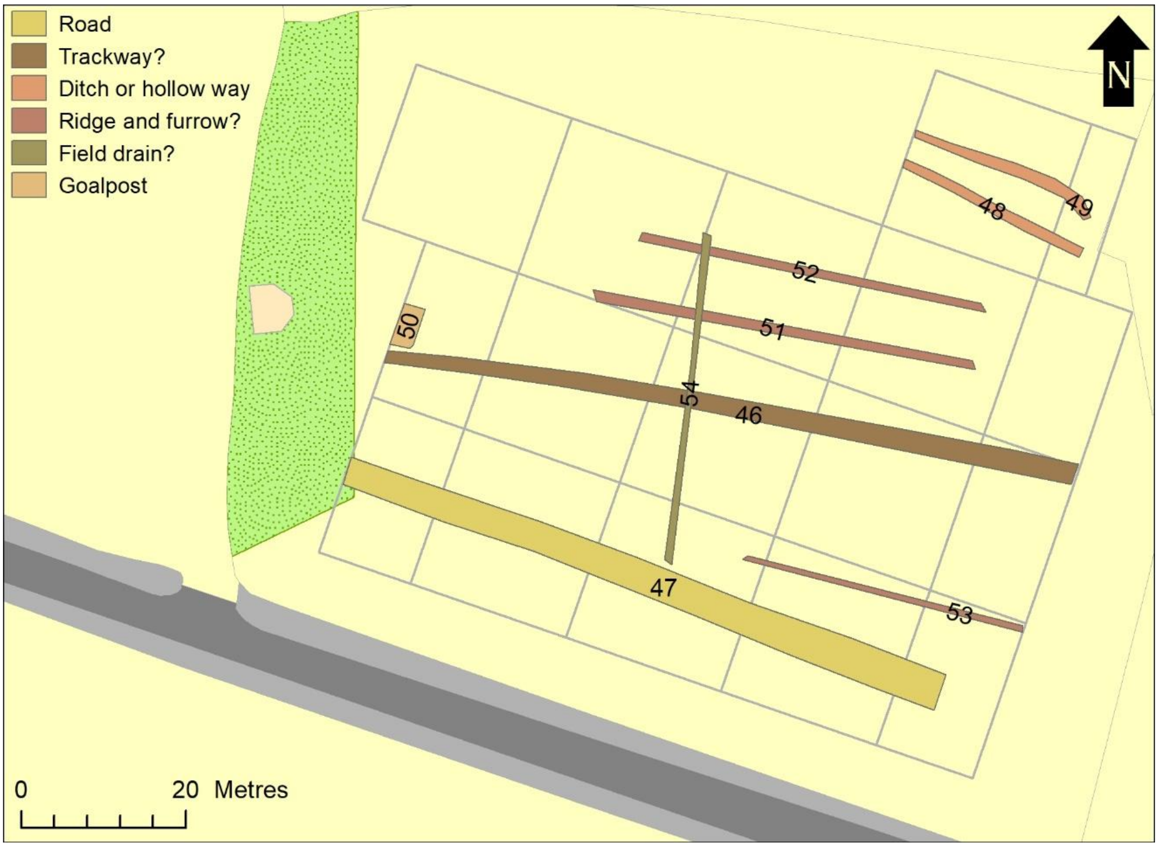


*Figure 13 - Interpretation of the geophysical survey results*

**46**: This negative linear feature running west-east produced a similar but weaker response than that from [47]. It has been interpreted as perhaps a trackway. It does parallel features [51]-[53], that have been interpreted as possible remains of ridge and furrow, but the response signature was very different.

**51-53:** These positive linear responses have been interpreted as the possible remains of ploughed out ridge and furrow. This is partly due to their spacing but also because they also appear on the resistivity survey and an earlier Wardell-Armstrong magnetic survey. Gradiometer survey by Haynes and Turner to the north of Corbridge and outside the Roman town has shown that even with physically visible remains still on the ground, these are not necessarily reflected in the gradiometer survey results (Haynes and Turner 2019). Feature [53] appears at the eastern edge of the trench 5 excavation in 2021 (Figure 17).

**48-49:** These roughly east-west linear features produced a strong positive response and possibly represent the edge of a trackway. Such a response from a linear ditch would not be unusual.

**50:** This is a strong magnetic response to the presence of the steel football goal post at the wester edge of the field.

### Resistivity Results – process summary

The data was processed using the same software as the gradiometer survey. The data was despiked with a threshold of +/- 3SD and then a Gaussian high pass filter was applied with a window of 10 reading in the x and y directions to minimise the effect of background geology. A low pass filter with a window of 1 reading in the X and Y directions was used to smooth the data and enhance any large weak features. Interpolation of the data was carried out in the X and Y directions to give data plots with a final spatial resolution of 0.25m x 0.25m. This was an equivalent resolution to the gradiometer data. The results, shown in Figure 14, clearly inidcate that the resistivity survey was able to detect far more linear anomalies than the gradiometer survey. To aid the identification and interpretation of these linear anomalies further plots were carried out using much narrower ranges within the data and as can be seen from Figure 15, a range of +/- 1 SD greatly enhances the visibility of these linear features.

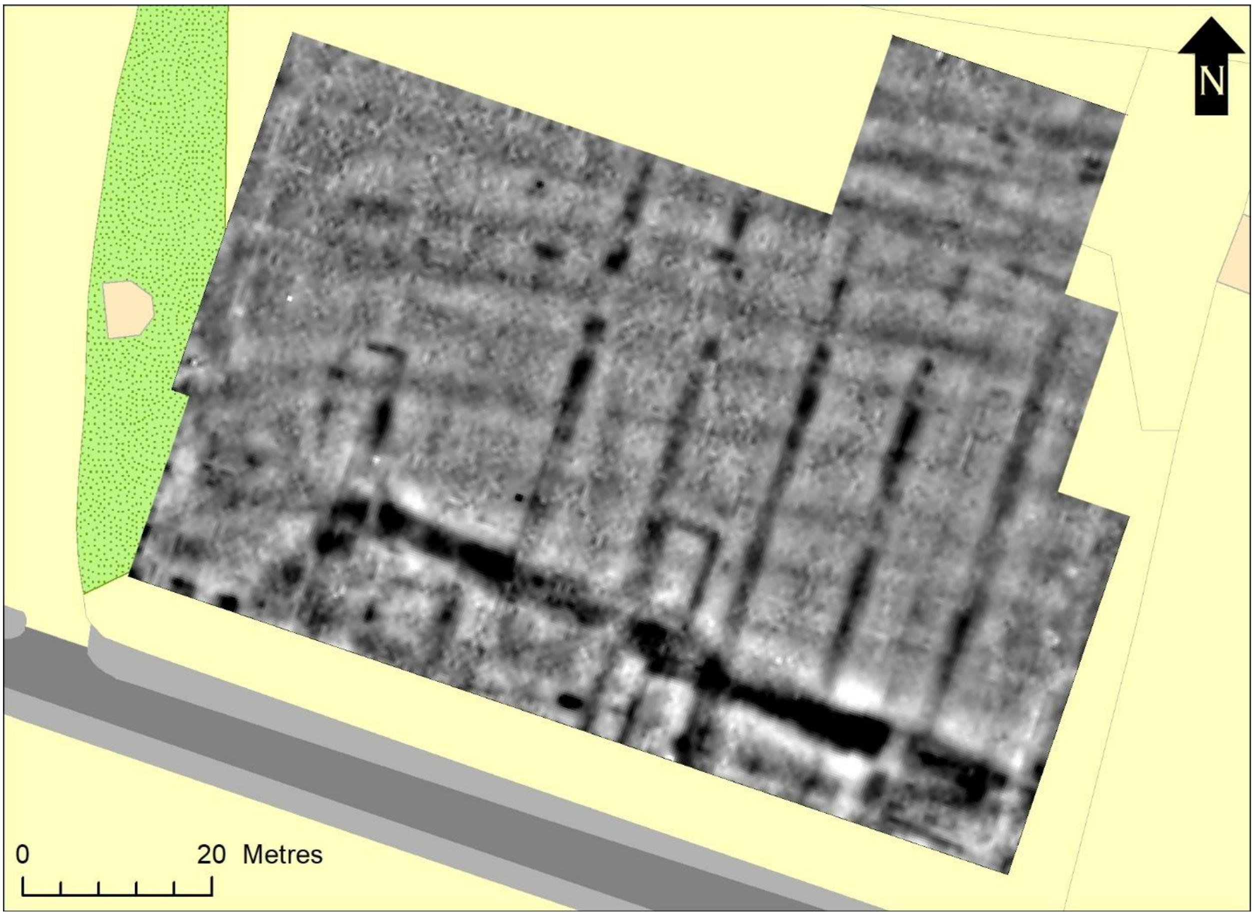


*Figure 14 - Plot of the resistivity data with greyscale parameters of +/- 3SD*

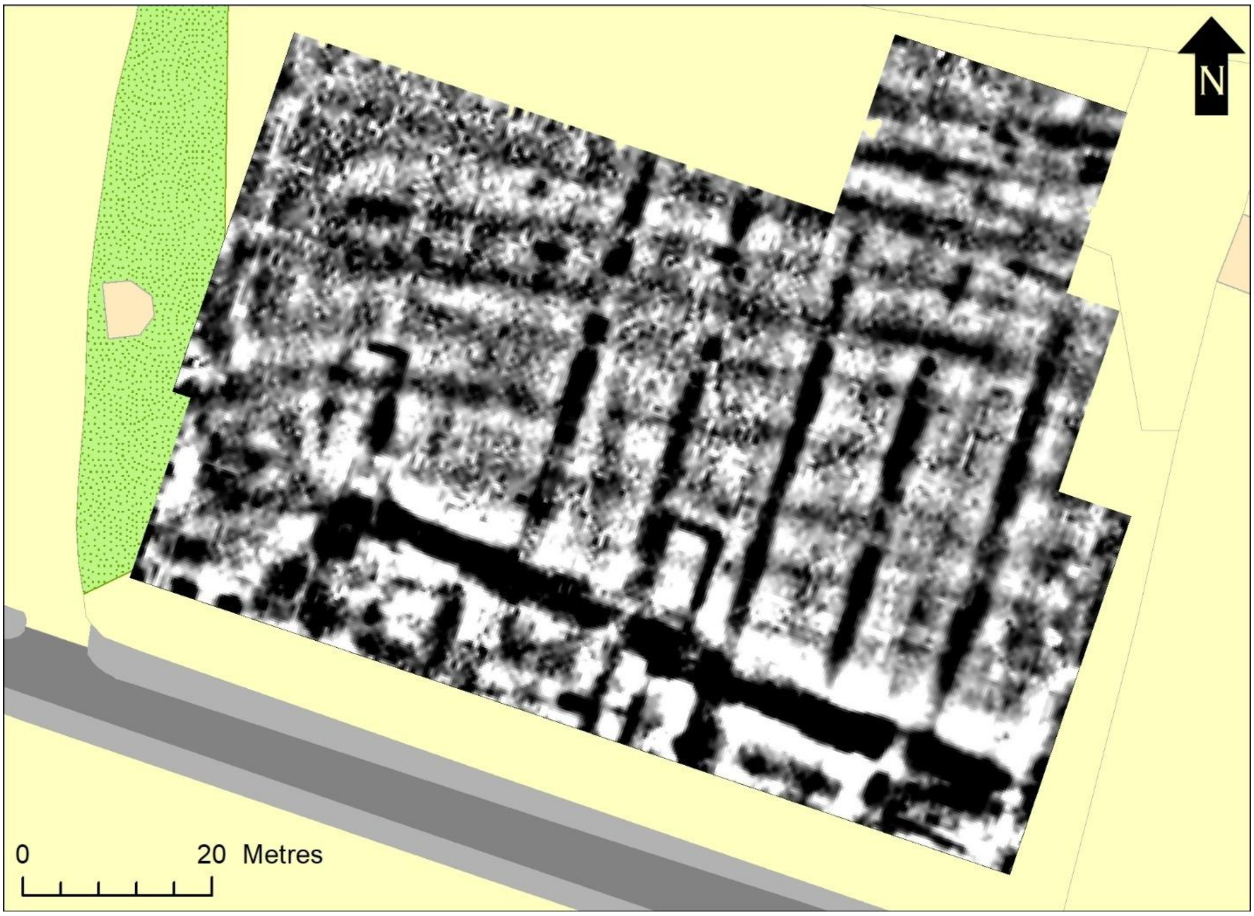


*Figure 15 - Plot of the resistivity data using greyscale parameters of +/- 1SD*

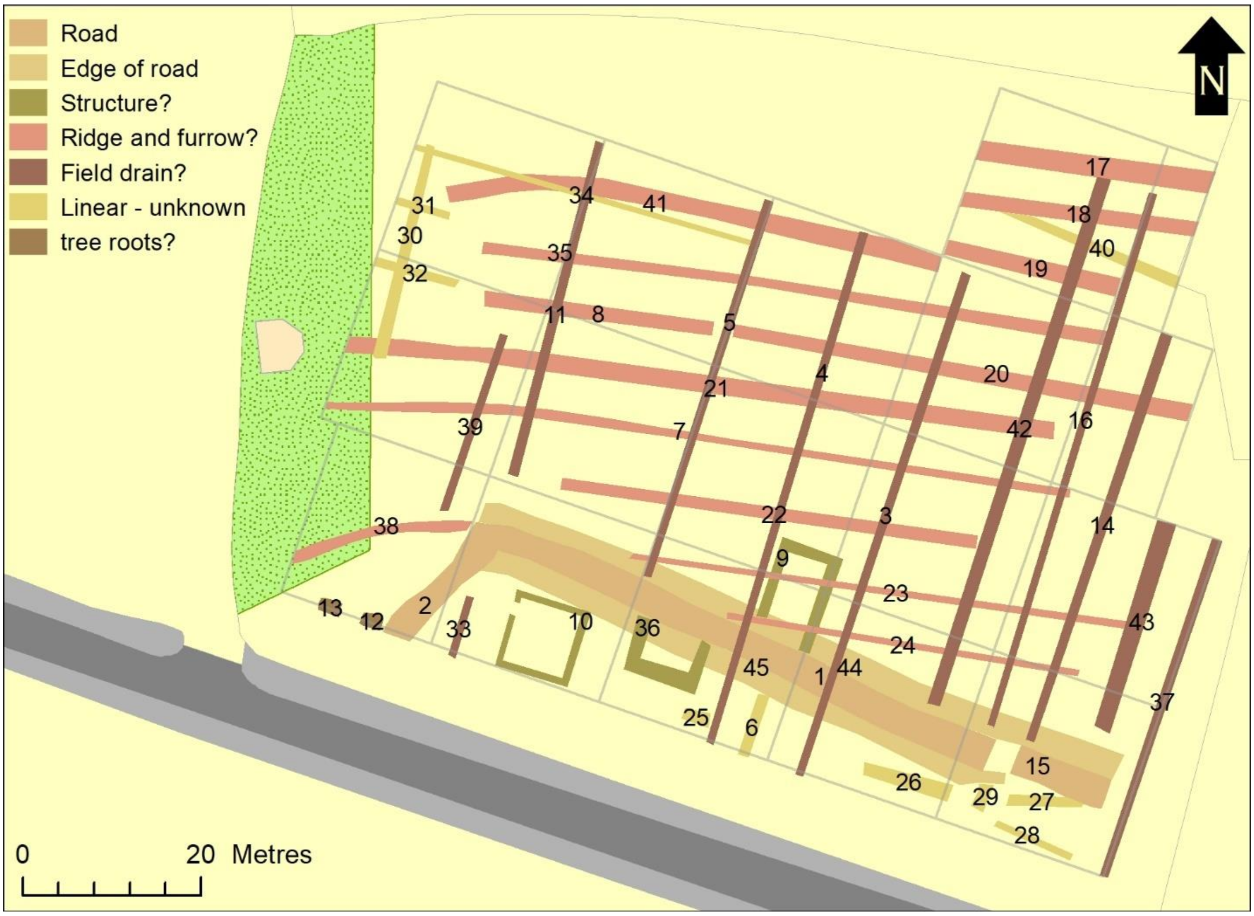


*Figure 16 - Interpretation of the resistivity survey results*


*Figure 17 - Resistivity interpretation with 2019 and 2021 trenches*

## Resistivity Results – Interpretation

**1-2** and **15**: The very strong responses appear to represent a road running east-west across the southern half of the survey area. This equates with [47] in the gradiometer survey but here there is clearly a return at the west end of the feature. When plotted against the transcription of cropmarks and excavation by Bishop and Dore (Bishop and Dore 1988, 335) it aligns with a north-south road emerging from the Roman town to the south of Corchester Lane. At the eastern edge of this feature, between [1] and [15], there appears to be a distinct break in the linear response. It is possible that one of the field drains running northeast-southwest is responsible for the break in the road, as there also seems to be a similar but less distinct response in the middle of [1]. The very top level of [1] was investigated in 2019 and this was followed by a more detailed examination in the trench 4 excavation of 2021 (Figure 19).

**44-45:** These low resistance anomalies run parallel to [1], [2] and [15] and could be associated with roadside ditches. They could equally be areas of excess moisture due to run off from the buried road surface. They are covered by both the 2019 and 2021 excavations (Figure 19).

**3-5, 11, 14, 16, 33, 37, 39 and 43:** These features are most likely the response from a series of fields drains, presumably associated with draining the playing field.

**7-8, 17-24, 35, 38 and 41:** These are possibly the remains of ridge and furrow. [23 with 38] and 41 have the distinct reverse S associated with this type of feature. The distance between these features also equates well with others visible in the lidar for the Corbridge area. Features [23] and [24] run east-west across the 2021 excavation trench 5 (Figure 19).

**6, 25-32, 40-41**: It is unclear what these partial, linear high resistance responses represent.


*Figure 18 - Resistivity interpretation with georeferenced Google Earth image from 2002*


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*Figure 19 - Resistivity interpretation with 2019 and 2021 trenches*

**9, 10, 36:** These high resistance anomalies may be parts of structures, as they all exhibit returns and appear to be perpendicular to the road. The caveat here, however, is that they also align with some of the probable north-south field drains which makes disaggregation of these features difficult. Feature [9] is a good example of this where the response for the western side of the feature appears to be directly adjacent to that of a field drain. This feature was briefly sampled in 2019 and was the more thoroughly investigated in the trench 5 excavation of 2021.

**12-13:** These two areas of high resistance are probably associated with the cricket practice strip in the southwest corner of the field. This was visible on the Google Earth image captured in January 2002 without leaves on the trees (Figure 16). The goal posts are also clearly visible on this image and confirm the interpretation of response [50] in the gradiometer survey.


*Figure 20 –Interpretation of the resistivity results with the Bishop and Dore 1988 transcription of the cropmarks and Edwardian excavations.*

## Summary

The success of both gradiometry and resistivity survey in detecting sub-surface features within the playing field at Corbridge is clearly evident from the results presented in this report. Although a much more time-consuming method, it appears that resistivity produced the clearest results. It is unfortunate that the Ground-penetrating Radar that was also employed during this phase of survey suffered from a technical malfunction and failed to produce useable results.

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