2598

Ancient Monuments Laboratory
Report 71/96

THE ABBEY OF ST. BENET AT HOLM, HORNING, NORFOLK, REPORT ON GEOPHYSICAL SURVEY, 1996

P K Linford

Ancient Monuments Laboratory Report 71/96

THE ABBEY OF ST. BENET AT HOLM, HORNING, NORFOLK, REPORT ON GEOPHYSICAL SURVEY, 1996

P K Linford

Summary

A geophysical survey was carried out on the site of the Abbey of St. Benet at Holm near Horning in Norfolk in August 1996 at the request of the English Heritage regional Inspector of Ancient Monuments. The site has suffered badly from erosion due to flooding of the adjacent river Bure and it was proposed that flood defences on the river bank be rebuilt. Thus, the survey was requested to detect archaeological features near the river that might be affected by the work and to improve understanding of this large and complex medieval abbey site. Unfortunately, owing to the extremely dry conditions pertaining at the time of the survey, results from the site were not good and little unequivocal evidence for the remains of buildings associated with the abbey has been recovered. However, a number of linear anomalies were detected in the resistivity survey that may be caused by buried wall footings and these have beeen mapped on an earlier topographic survey by the RCHME.

Author's address :-

Mr P K Linford
ENGLISH HERITAGE
23 Savile Row
London
W1X 1AB

THE ABBEY OF ST. BENET AT HOLM, HORNING, NORFOLK

Report on Geophysical Survey, August 1996.

Introduction

A geophysical survey was undertaken at the site of the Abbey of St. Benet at Holm near Horning in Norfolk (NMR No.: TG 31 NE 3, SAM No.: Norfolk 6) in response to a request from Philip Walker the Inspector of Ancient Monuments for Norfolk. English Heritage, working in conjunction with the Broads Authority and the National Rivers Authority, propose to rebuild the flood defences as, in recent years, the western side of the abbey precinct has been continually eroded by the river Bure, resulting in extensive flooding. Thus the survey was intended to provide information about buried remains that may be affected by this work, augmenting an earlier RCHME earthwork survey (RCHME 1994).

Additionally, the opportunity was taken to survey over the area where the abbey cloister was thought to have been situated as well as over some of the many earthworks visible in the outer precinct. These latter features divide the outer precinct into a number of distinct enclosures, some of which contain elaborate arrangements of ditches and platforms. It is thought that they represent the remains of a complex of fish ponds used to rear fresh water fish and, as such, are amongst the most extensive of any monastic house in England. Thus it was hoped that geophysical survey would improve the understanding of the layout of this important medieval Benedictine abbey.

The abbey itself (at NGR: TG 384 156) is located on a small sand and gravel eminence on the left bank of the river Bure known as Cow Holm. However, much of its surrounding precinct is situated on improved marshland over marine alluvium (Soil Survey 1983). The underlying solid geology in the area is Norwich Crag, Red Crag & Chillesford Clay and the site of the abbey lies in permanent pasture.

Method

Several parts of the abbey precinct area lie below O.D. so a period during high summer was chosen for the survey, to minimise the risk that these areas would be flooded and thus unavailable for survey. As buried wall footings were the principal targets for prospecting, resistivity survey was selected as the geophysical technique of choice. Initial test measurements at the site during the summer of 1995 had indicated promising results, detecting wall footings in the vicinity of the abbey ruins.

Unfortunately, the summer of 1996 was particularly dry in that part of Norfolk and little rain had fallen in the weeks preceding the survey. The soil was found to be extremely dry and difficulty was experienced making good electrical contact with the ground surface.

This greatly slowed the pace of the work and reduced the amount that could be achieved during the time allotted. Thus two separate areas were laid out for survey to maximise coverage of the areas of interest. Each area was subdivided into a grid of 30 metre squares, aligned on Grid North and located relative to the permanent markers established by the RCHME (RCHME 1994, 48). The two grids are depicted overlaid on RCHME interpretive plan 2 (*ibid.*, 7) in figure 1. The first area (squares 1-19) was designed to examine features in the outer precinct, whilst the second (squares 20-43) covered the abbey ruins and that section of the riverbank where remains appeared to be most abundant.

Each square was surveyed using the standard technique outlined in Annex 1, note 1 and a trace plot of the unprocessed results at 1:1000 scale is depicted in Plot 1. A linear greyscale plot of the same data is also provided as Plot 2. It is immediately clear from plot 2 that a wide variation in resistivity values occurs between the low lying marshy areas of the outer precinct to the north of the plot and the raised sandy area on which the abbey ruins are situated. Indeed, the mean measured resistance value in the vicinity of the abbey (51.34Ω) is over twice what it is in the outer precinct area (21.15Ω), whilst the standard deviation of the readings is some two orders of magnitude larger (16.39Ω as opposed to 0.12Ω).

Thus, the data was processed with a 1 metre Gaussian convolution mask, to reduce the somewhat "noisy" appearance produced by the poor electrical contact mentioned above. It was then treated with the Wallis statistical differencing algorithm (Pratt 1978, 326), using a 21 metre square window and an edge to background ratio of 0.85, to reduce the dynamic range and produce a more uniform contrast in the output image. The result of these operations is depicted as a 1:1000 scale linear greyscale plot in Plot 3.

Results

To aid the interpretation of geophysical anomalies, Plot 4 shows the data from Plot 3 with the relevant portion of the RCHME survey plan of the abbey grounds superimposed on it. Plot 5 is an interpretation plan showing the same portion of the RCHME survey plan annotated with the potentially significant geophysical anomalies detected in the resistivity survey.

Before examining the anomalies detected in the resistivity survey in detail it should be noted that the exceptionally dry conditions at the time of the survey had an adverse effect not only on the speed of surveying but also on the quality of the measurements recovered. Owing to the poor electrical contact with the ground the readings exhibit a higher degree of random error than is usual and the sensitivity of the technique to subsurface features has been reduced. Hence, the anomalies indicated on plot 5 have been classified into two groups. Those depicted with solid shading are the most likely to represent archaeological features, whilst those indicated with dashed lines are more speculative and may be caused by natural effects.

The discussion of the anomalies detected in the resistivity survey is split into four sections corresponding to broad groupings of the anomalies in Plot 5. In the discussion, bold numbers in square brackets refer to the areas numbers indicated on Plot 5.

1) The river front area

Perhaps the clearest linear high resistance anomalies in the survey occur in the vicinity of The Chequers **[1]**, an inn which occupied a site on the river bank after the demolition of the abbey and from which a ferry ran (RCHME 1994, 4). The clarity of these anomalies is unsurprising as the inn was in use until late in the last century and some upstanding wall footings still survive. These linear features closely reflect the hachures marked on the overlaid RCHME plan, reinforcing the contention that they represent the remains of the inn. The layout of these features is generally consistent with the shape of the inn building marked on the 1886 Ordnance Survey 25 Inch map of the area (*ibid.*, 15). However, they also extend to the north-west of the building shown on the map suggesting either that the inn once had an outhouse here, or the existence of an earlier building perhaps associated with the abbey.

Further north along the river bank, two linear high resistance anomalies have been detected **[2]** which are likely to be associated with the remains marked on the RCHME plan as building 16. Behind this building is a sub-rectangular high resistance anomaly possibly indicating the remains of a buried building floor **[3]**, and some highly conjectural linear anomalies **[4]** that *might* represent the badly degraded wall footings of further buildings.

2) The vicinity of the abbey

To the west of the abbey ruins, a number of more or less linear, high resistance anomalies have been detected **[5]**. It is possible that these represent the remains of walls of monastic structures but it is also quite conceivable that they are due to natural variations in drainage in the substrate of the sand and gravel island upon which the abbey is sited. Two similar but extremely speculative anomalies appear to the north of the abbey **[6]** and one further to the south at "h" on the RCHME plan **[7]**.

Within the ruins of the abbey building itself lies a high resistance anomaly of amorphous shape **[8]**. This is likely to be caused either by collapsed rubble from the walls and ceiling of the ruined building or by the remains of a stone floor in this area. Two linear high resistance anomalies run east from this area towards the altar **[9]** (now marked by a large wooden cross erected by the diocese of Norwich in 1977). It is quite plausible that these are the response to buried footings of the north and south walls of the abbey which still stand above ground level at the western end of the structure. A third similar anomaly runs perpendicular to these and appears to connect them at the eastern end of the abbey **[9]**, possibly suggesting that some remains of the eastern wall of the building survive below ground. Puzzlingly, this anomaly continues on beyond the line of the northern wall of the abbey, following the line of a scarp shown as hachures on the RCHME plan. Thus, it should be borne in mind that the resistivity survey may simply be detecting the break of slope and not indicating an extension to the abbey north of the altar.

To the south of the anomaly thought to be the remains of the south wall of the abbey, a fainter linear high resistance anomaly runs parallel to it **[10]**. It is possible that this indicates a southern aisle but the weak geophysical response makes this conclusion highly conjectural.

Also, beyond the eastern end of the abbey some very faint linear high resistance anomalies may be discerned **[11]**, apparently in the shape of an apse. However, any suggestion of a possible apsidal eastern end to the abbey must remain firmly in the realm of conjecture owing to the faintness of the anomaly and the generally poor quality if the resistance measurements obtained on the site.

3) The vicinity of enclosures 1 and 4

In this area the resistance meter has responded well to a complex of drainage leats visible as topographic features, detecting them as low resistance linear anomalies. At the western end of the survey area these appear to open out into a rectangular low resistance area **[12]**, suggesting a former pool. Flanking this to the north and surrounded by linear low resistance anomalies is a geometric area of high resistance. This stands on higher ground and might well suggest a building platform here.

Further north, two parallel high resistance anomalies are apparent running along either side of a bank **[13]**. These are the response to stone walls lining either side of the bank and are visible in places where the covering soil has eroded.

A scatter of linear and sub-linear high resistance anomalies occur in the southern part of enclosure 4 and the adjacent area of the inner precinct **[14]**. These might be a response to the rubble of collapsed structures and, certainly, they generally respect the east-west alignment of the bank thought to have separated the inner and outer precincts here.

4) Enclosure 5

In this area the depression labelled "s" on the RCHME plan has been detected clearly as an almost rectangular low resistance anomaly, closely following the mapped topography **[15]**. This would be entirely consistent with the suggestion that it functioned as a water filled pool. Surrounding this feature the survey has detected a large amorphous area of generally high resistance for which two causes may be suggested. First, it is possible that this is a response to the scattered stone rubble of structures that once stood in the vicinity. However, a second possibility is that this area marks the north-eastern extent of the sand and gravel island upon which the abbey stands; the high resistivity measurements being caused by the well drained subsurface.

Finally, two pairs of parallel, high resistance linear anomalies have been detected around the edges of enclosure 5 **[16a & b]**. Whilst faint, they do follow the line of banks marked on the RCHME plan and are likely to be a response to stone linings similar to those at **[13]**.

Conclusions

Unfortunately, the geophysical response of the abbey precincts to the resistivity technique has been poor and it is disappointing that no clear medieval building plans have been detected in the results. The particularly dry surface soil conditions over much of the site at the time of the survey must take some of the blame, as poor electrical contact has resulted in an atypically high level of random error in the measurements recovered. There is also a worry that the highly resistive near subsurface may have resulted in a reduced depth of electrical current penetration, meaning that only near-surface features have been detected.

However, archaeological sites on alluvial sand and gravel can present difficulties even in the best of conditions, as local differences in drainage produce a highly variable resistivity background and it is difficult to distinguish archaeological features from this. Furthermore, the fact that only part of the site is on this substrate, whilst other parts lie on improved marshland, highlights the difficulty in choosing an optimum time of year for resistivity survey at St. Benet's Abbey. There is always the danger that either the gravel areas will be too dry or the marshy areas too waterlogged.

Despite the above, the survey has had some success in detecting linear high resistance anomalies likely to be caused by buried wall footings and these have been corroborated in some places where portions of the buried walls are exposed. Also, the leats and ditches of the outer precincts seem to have been clearly detected and, in general, the survey finds are in agreement with the distribution of surface features mapped by the RCHME. In some places the geophysical evidence has augmented the topographic information and it is possible that a resistivity survey at a less dry time of year may have greater success in locating buried structures associated with the abbey.

Surveyed by: M. Cole
N. Linford
P. Linford
A. Payne

Dates: 19th-23rd August 1996

Report by: P. Linford

Date: 26th November 1996

References

Pratt, W. K., 1978, Digital Image Processing. Wiley Interscience: New York.

RCHME 1994, The Abbey of St, Benet at Holm, Horning Norfolk. Royal Commission on the Historical Monuments of England survey. December 1994.

Soil Survey of England and Wales 1983, 1:250,000 Sheet 4, Eastern England.

Enclosed figures and plans

Annex 1: Notes on standard procedures

1) **Resistivity Survey:** Each 30 metre square is surveyed by making repeated parallel traverses across it, all aligned parallel to one pair of the square's edges, and each separated by a distance of 1 metre from the last; the first and last traverses being 0.5 metres from the nearest parallel square edge. Readings are taken along each traverse at 1 metre intervals, the first and last readings being 0.5 metres from the nearest square edge.

Unless otherwise stated the measurements are made with a Geoscan RM15 earth resistance meter incorporating a built-in data logger, using the twin electrode configuration with a 0.5 metre mobile electrode separation. As it is usually only relative changes in resistivity that are of interest in archaeological prospecting, no attempt is made to correct these measurements for the geometry of the twin electrode array to produce an estimate of the true apparent resistivity. Thus, the readings presented in plots will be the actual values of earth resistance recorded by the meter, measured in Ohms (Ω). Where correction to apparent resistivity has been made, for comparison with other electrical prospecting techniques, the results are quoted in the units of apparent resistivity, Ohm-m (Ωm).

Measurements are recorded digitally by the RM15 meter and subsequently transferred to a portable laptop computer for permanent storage and preliminary processing. Additional processing is performed on return to the Ancient Monuments Laboratory using desktop workstations.

2) **Magnetometer Survey:** Each 30 metre square is surveyed by making repeated parallel traverses across it, all parallel to that pair of square edges most closely aligned with the direction of magnetic North. Each traverse is separated by a distance of 1 metre from the last; the first and last traverses being 0.5 metre from the nearest parallel square edge. Readings are taken along each traverse at 0.25 metre intervals, the first and last readings being 0.125 metre from the nearest square edge.

These traverses are walked in so called 'zig-zag' fashion, in which the direction of travel alternates between adjacent traverses to maximise survey speed. However, the magnetometer is always kept facing in the same direction, regardless of the direction of travel, to minimise heading error.

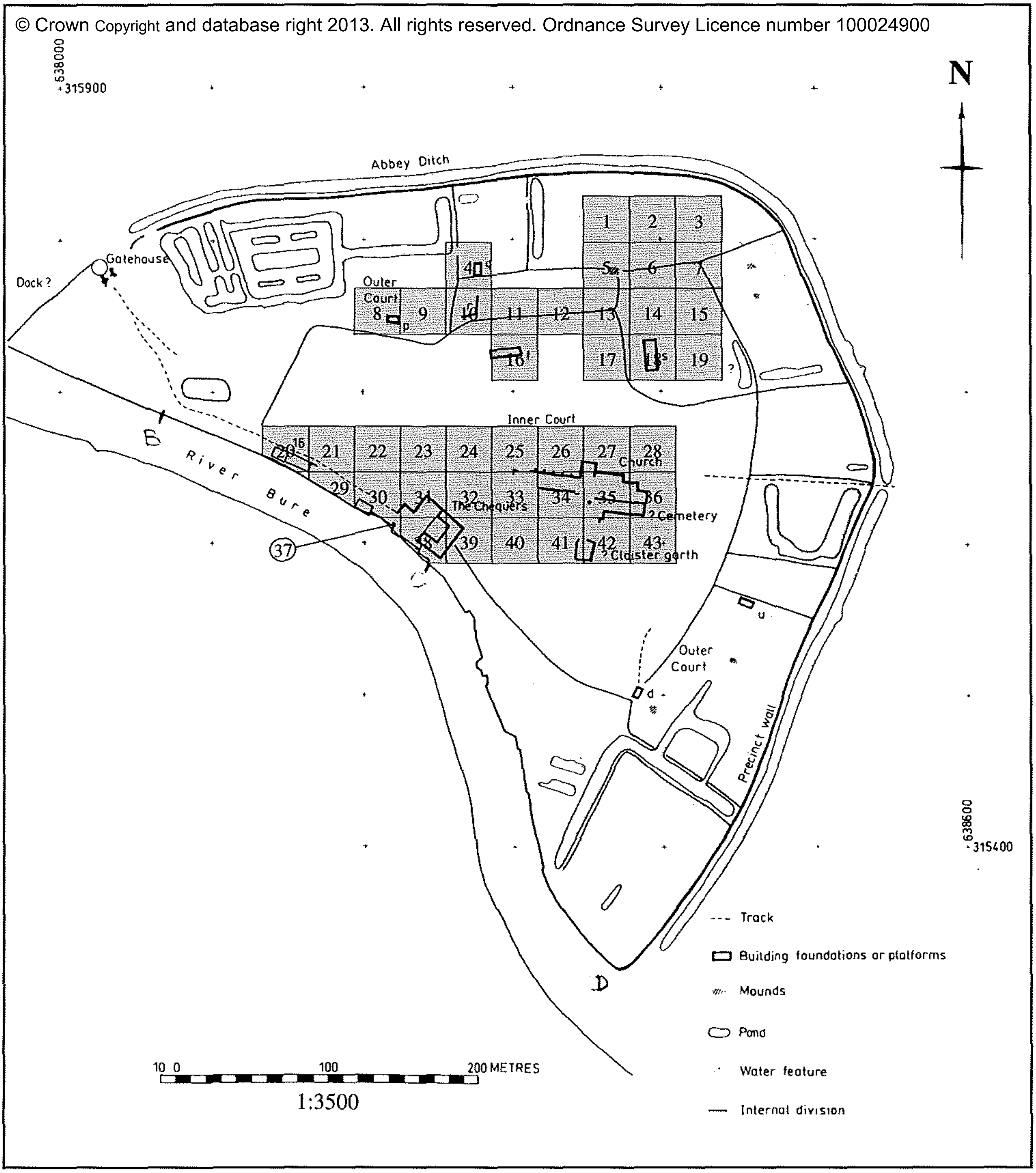
Unless otherwise stated the measurements are made with a Geoscan FM36 fluxgate gradiometer which incorporates two vertically aligned fluxgates, one situated 0.5 metres above the other; the bottom fluxgate is carried at a height of approximately 0.2 metres above the ground surface. The FM36 incorporates a built-in data logger that records measurements digitally; these are subsequently transferred to a portable laptop computer for permanent storage and preliminary processing. Additional processing is performed on return to the Ancient Monuments Laboratory using desktop workstations.

It is the opinion of the manufacturer of the Geoscan instrument that two sensors placed 0.5 metres apart cannot produce a true estimate of vertical magnetic gradient unless the bottom sensor is far removed from the ground surface. Hence, when results are presented, the difference between the field intensity measured by the top and bottom sensors is quoted in units of nano-Tesla (nT) rather than in the units of magnetic gradient, nano-Tesla per metre (nT/m).

3) **Resistivity Profiling:** This technique measures the electrical resistivity of the subsurface in a similar manner to the standard resistivity mapping method outlined in note 1. However, instead of mapping changes in the near surface resistivity over an area, it produces a vertical section, illustrating how resistivity varies with increasing depth. This is possible because the resistivity meter becomes sensitive to more deeply buried anomalies as the separation between the measurement electrodes is increased. Hence, instead of using a single, fixed electrode separation as in resistivity mapping, readings are repeated over the same point with increasing separations to investigate the resistivity at greater depths. It should be noted that the relationship between electrode separation and depth sensitivity is complex so the vertical scale quoted for the section is only approximate. Furthermore, as depth of investigation increases the size of the smallest anomaly that can be resolved also increases.

Typically a line of 25 electrodes is laid out separated by 1 or 0.5 metre intervals. The resistivity of a vertical section is measured by selecting successive four electrode subsets at increasing separations and making a resistivity measurement with each. Several different schemes may be employed to determine which electrode subsets to use, of which the Wenner and Dipole-Dipole are typical examples. A Campus Geopulse earth resistance meter, with built in multiplexer, is used to make the measurements and the Campus Imager software is used to automate reading collection and construct a resistivity section from the results.

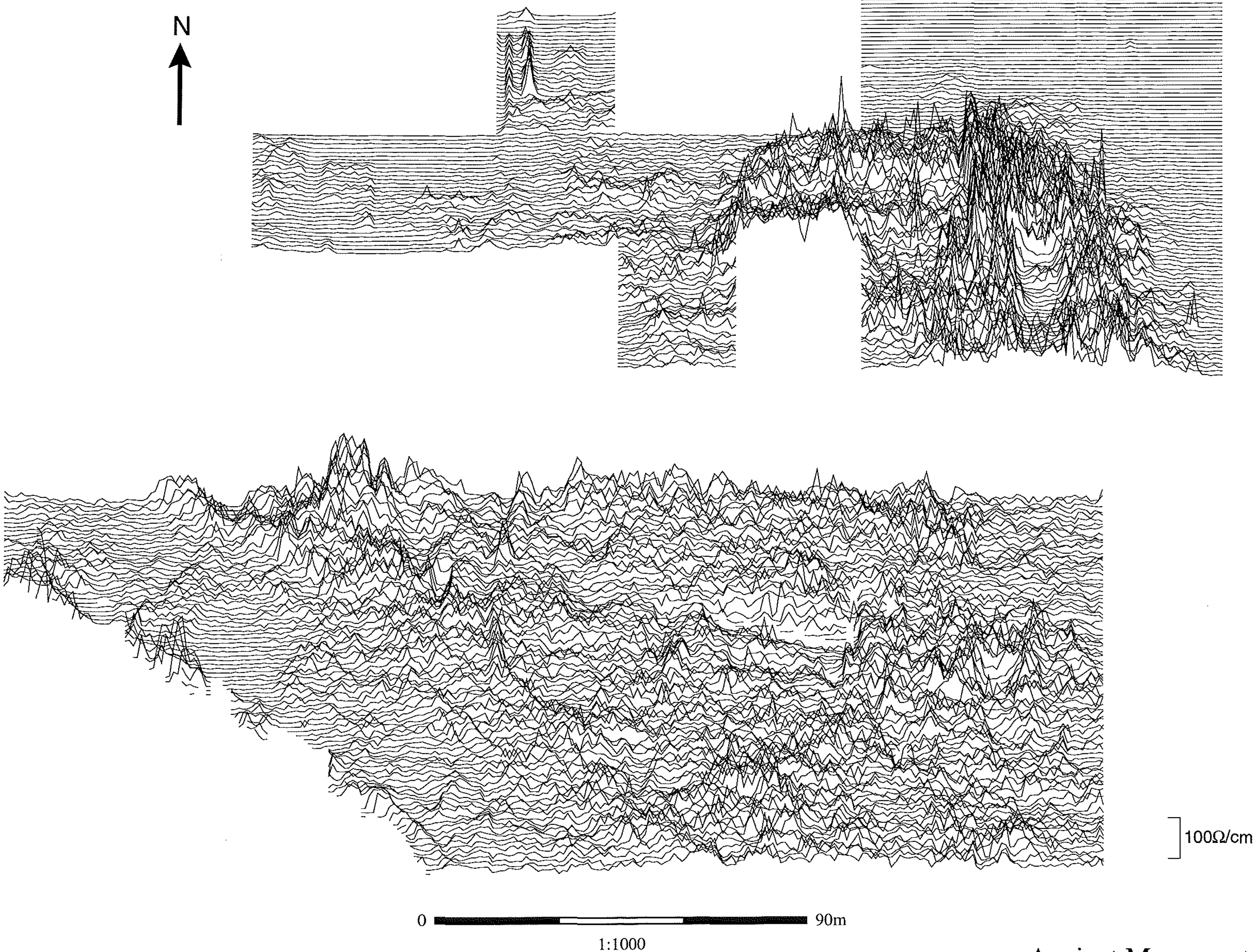
THE ABBEY OF ST. BENET AT HOLM, HORNING, NORFOLK
Location of geophysical survey, August 1996



TG 3815

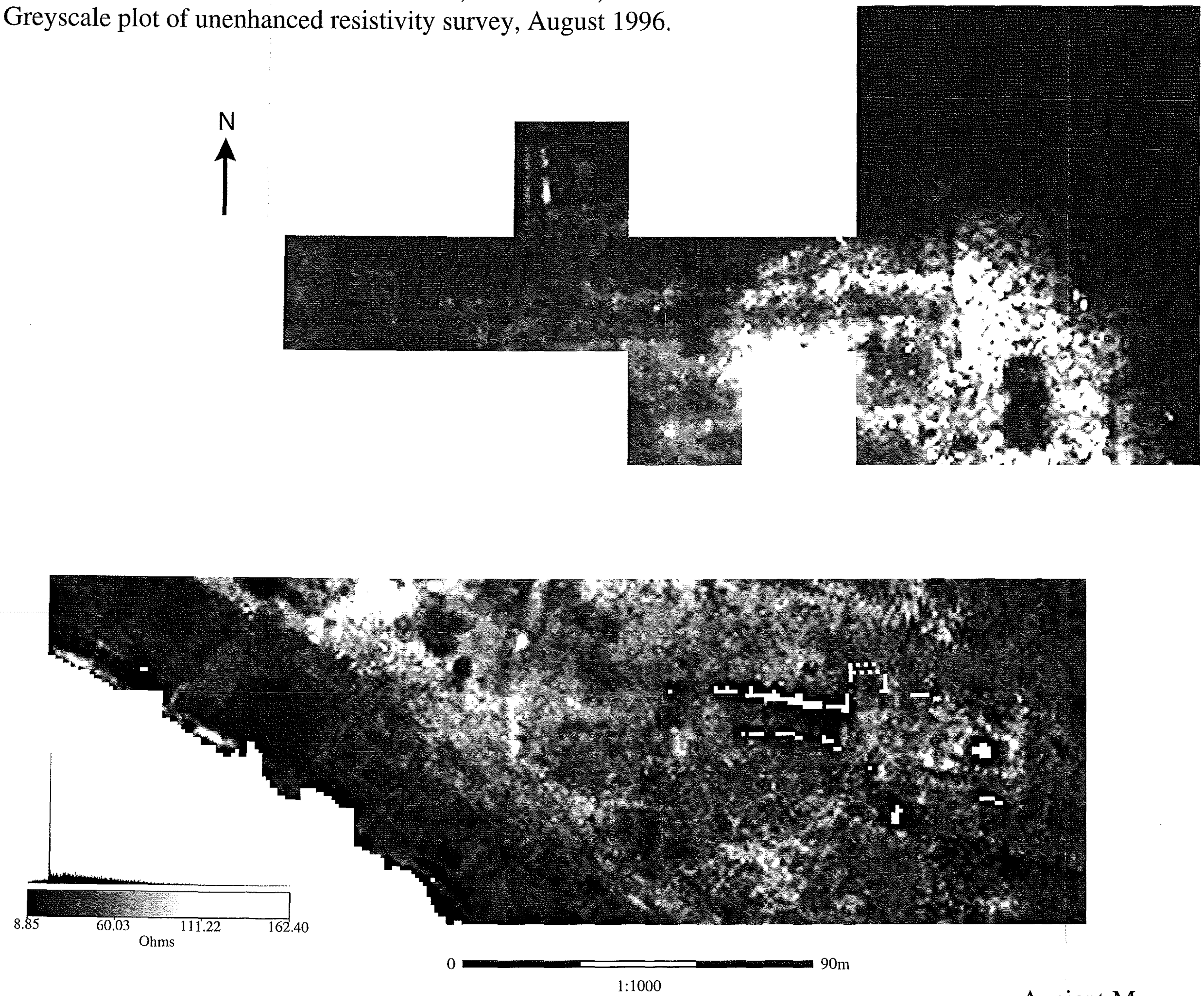
Figure 1; Location of geophysical survey grid superimposed on RCHME interpretation plan 2.

Plot 1) THE ABBEY OF ST. BENET AT HOLM, HORNING, NORFOLK:
Trace plot of unenhanced resistivity survey, August 1996.



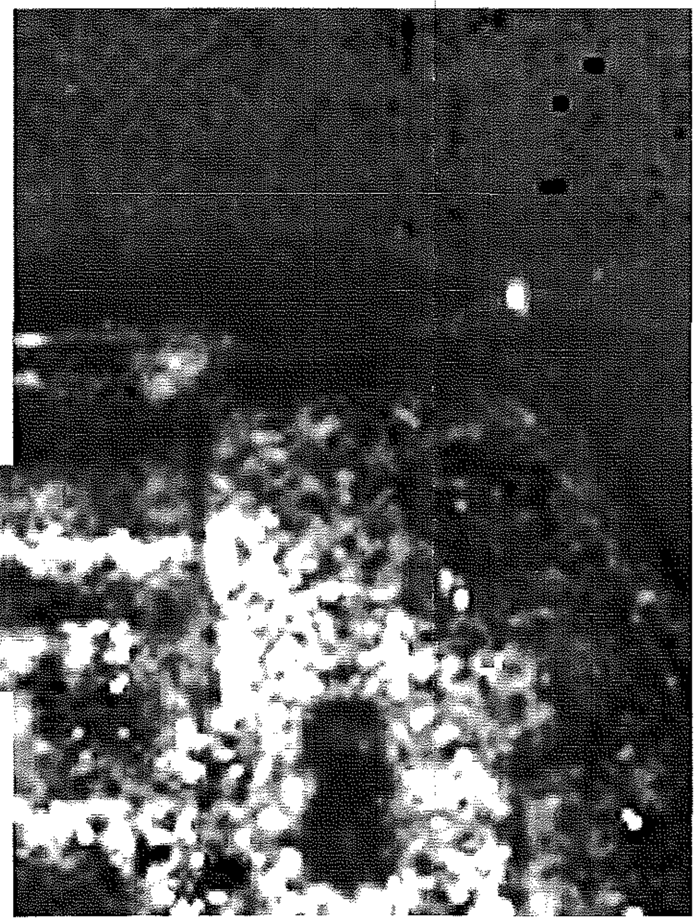
Ancient Monuments Laboratory 1996

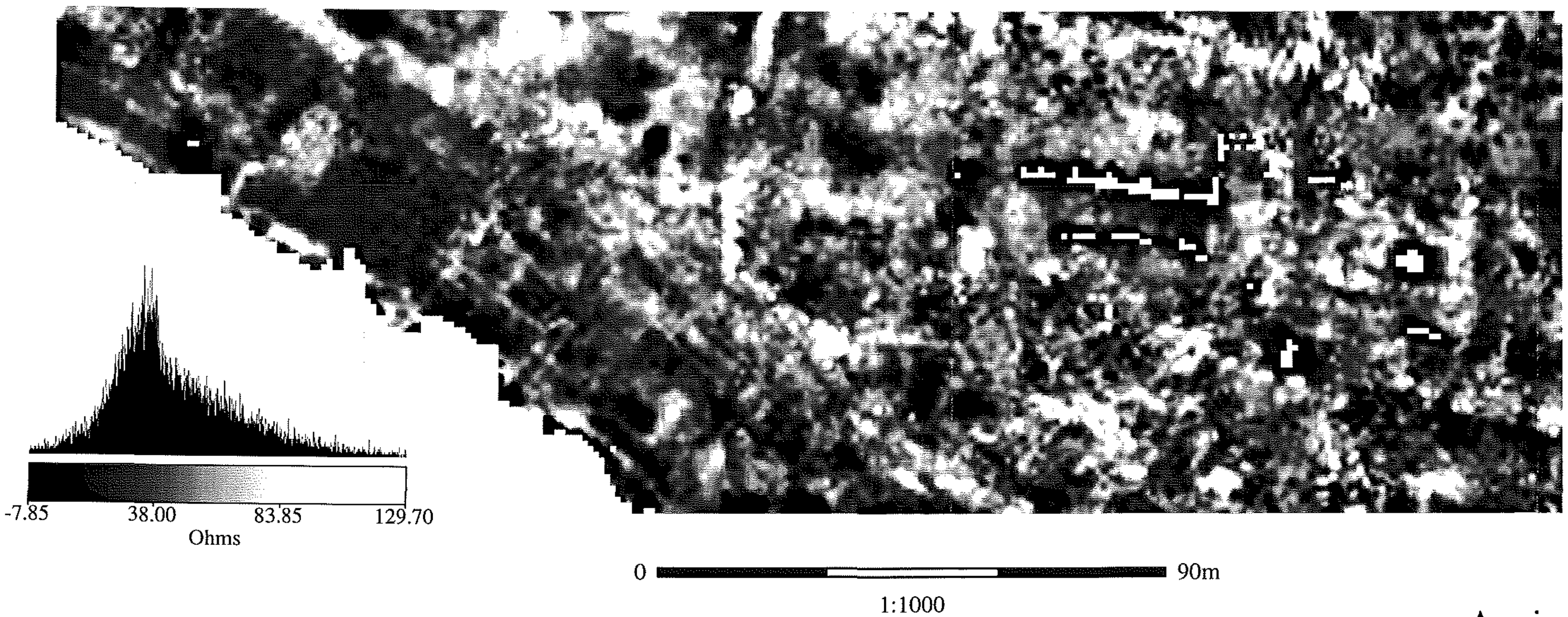
Plot 2) THE ABBEY OF ST. BENET AT HOLM, HORNING, NORFOLK:
Greyscale plot of unenhanced resistivity survey, August 1996.



Ancient Monuments Laboratory 1996

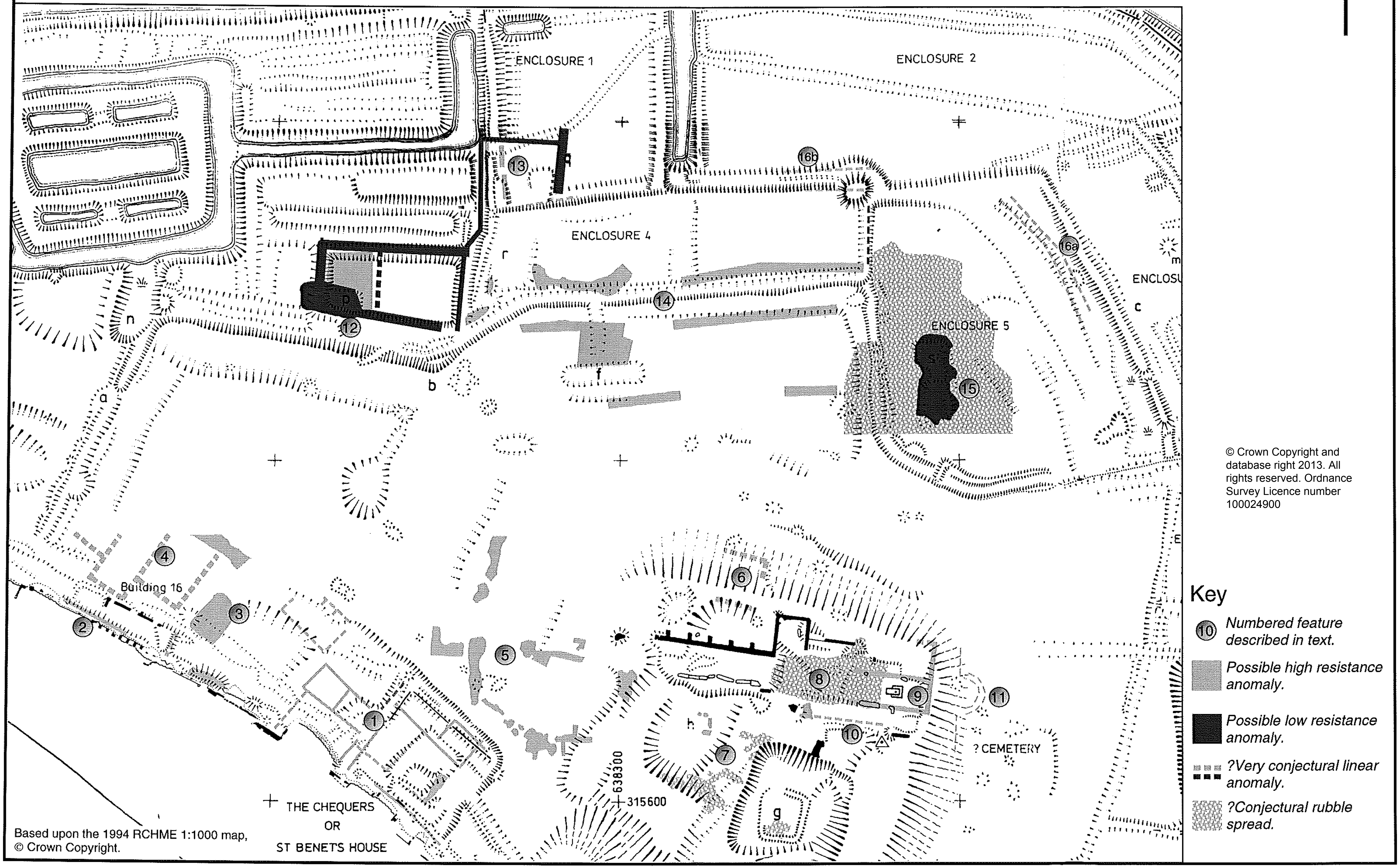
Plot 3) THE ABBEY OF ST. BENET AT HOLM, HORNING, NORFOLK:
Greyscale plot of resistivity survey after smoothing and contrast enhancement, August 1996.





Ancient Monuments Laboratory 1996

Plot 5) THE ABBEY OF ST. BENET AT HOLM, HORNING, NORFOLK: Interpretation plan showing potential archaeological anomalies.



Based upon the 1994 RCHME 1:1000 map, © Crown Copyright.