GSB

PROSPECTION Ltd

GEOPHYSICAL SURVEY REPORT
2007/42

Antonine Wall Phase III
Shirva

Client:

HISTORIC SCOTLAND

EUROPEAN UNION CULTURE PROGRAMME 2000

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Specialising in Shallow and Archaeological Prospection

GSB Survey No. 2007/42

Antonine Wall Phase III: Shirva

NGR	NS 68700 75200 (Wester Shirva) to NS 69000 75500 (Shirva)
Location	Approximately 1km east of the outskirts of Kirkintilloch, in fields to the north and south of the B8023
District / Parish	East Dunbartonshire / no parish data available
Topography	Undulating
Current land-use	Rough pasture
Soils	Alluvial soils. (SSS, 1982)
Geology	Alluvium / Glacial Sand and Gravel
Archaeology	Antonine Wall, Military Way, possible associated features
Survey Methods	Magnetic (fluxgate gradiometry) and resistance

Aims

To clarify the line of the Antonine Wall between Wester Shirva and Shirva farms; to locate, if possible, any traces of the Military Way; to identify any other features which might be associated with the Wall. The work forms part of a continuing programme of research commissioned by **Historic Scotland**, as part of their proposal to promote the Antonine Wall to World Heritage Status.

Summary of Results*

The line of the Antonine Wall has been confirmed and found to correlate most closely with investigations carried out by the Centre for Field Archaeology (CFA). Of the main elements only the Ditch has been conclusively detected and appears most clearly in the magnetic data. Limited, more tentative evidence for the Rampart has been identified, again primarily in the magnetic data, in the field adjacent to Wester Shirva Farm. No clear evidence for the Military Way was found in this field.

Further eastwards the Rampart is likely to run under the modern road, while the Military Way and any possible associated features lie in a field that was largely unsuitable for survey.

Resistance survey in the field next to Wester Shirva farm produced anomalies that might indicate part of a rectilinear enclosure. Surface obstructions precluded the expansion of the survey area, thus the true nature and significance of these anomalies cannot be fully assessed.

Project Information

Project Co-ordinator: C Stephens
Project Assistants: M Brolly, J Smith & G Taylor
Date of Fieldwork: 2nd - 5th July 2007
Date of Report: 11th April 2008

***It is essential that this summary is read in conjunction with the detailed results of the survey.**

Survey Specifications

Method

The survey grid was set out using tapes and tied in to the Ordnance Survey (OS) grid using a Trimble differential GPS system; see tie-in diagram included on the Archive CD.

Technique	Traverse Separation	Reading Interval	Instrument	Survey Size
Magnetometer - Scanning (Appendix 1)	-	-	-	-
Magnetometer – Detailed (Appendix 1)	1m	0.25m	Bartington Grad 601-2	3.9ha
Resistance – Twin Probe (Appendix 1)	1m	1m	Geoscan RM15/MPX 0.5m probe separation	1.1ha
Ground Penetrating Radar (GPR) – 250MHz (Appendix 1)	-	-	-	-

Data Processing

	Magnetic	Resistance	GPR
Tilt Correct	Y	N	-
De-stagger	Y	N	-
Interpolate	Y	Y	-
Filter	N	Y	-

Presentation of Results

Report Figures (Printed & Archive CD):	Desk based information, location diagram, data plots and interpretations on base map (Figures 1-8).
Reference Figures (Archive CD):	Data plots at 1:500 for reference and analysis. Some areas have been subdivided for display at this scale. (See List of Figures). Tie-in information (Figure T1).
Plot Formats:	See Appendix 1: Technical Information, at end of report.

General Considerations

Of all the fields surveyed only one (Area 4) presented no hindrances to survey, being undulating, under short pasture and free from obstructions. Area 1 comprised rough pasture and numerous pieces of wire fencing were caught in the long grasses. Area 2 was steeply sloping in places, low lying and boggy in others and contained an area of brick debris. The conditions have particularly impacted on the magnetic survey, not only making it difficult to maintain an even walking pace with the instrument, but also contributing to elevated background noise levels. These factors have hampered the identification and interpretation of weaker, potentially archaeological responses. Most of the field containing Area 3 was boggy and severely overgrown, with a ground cover of dense, tall (1m high) marsh grasses and weeds. Survey by either technique was not possible in these conditions and was confined to a narrow, marginally more accessible strip adjacent to the boundary.

The impact of the geology on both techniques has been detailed in previous reports (GSB 2006/11 and GSB 2006/80); its effects on the current results have not been particularly severe.

Results of Survey

1. Background Information (Desk Based)

The Antonine Wall

1.1 The exact line of the Antonine Wall between Wester Shirva and Shirva farms remains open to debate. MacDonald places the line, showing a distinct bend, in the field north of the B8023 road, positing that it "must have taken advantage of the brow of the gentle slope" at this location (MacDonald 1934 p149). The 1950s OS survey makes no changes this line, but notes that scarcely any trace of the ditch was visible. In contrast, the OS 1980 resurvey posits an entirely new course for the Wall, in a straight line immediately south of the B 8023. The notes cite a lack of evidence to support MacDonald's line. The new alignment was based on two pointers: an old hollow way at (A) (now containing the modern road) "which must almost certainly be the remains of the Ditch line" and the sharp bend in the Board Burn at (B) "typical of an obstruction detour" (OS1980 notes).

1.2 In 1995 a geophysical survey was carried out at Shirva with the primary aim of locating the rampart base (Strang & Walker, 1995). It comprised a number of single resistance traverses, mostly located on the high ground north of the B8023, but with a few positioned on the boggy ground south of the road. The results were far from conclusive, but the authors suggested the most likely route for the rampart lay immediately north of the modern road.

1.3 Most recently, in 1998 and 1999, a program of geophysical (resistance) survey and trial trenching was carried out along this stretch of the Wall by the Centre for Field Archaeology (CFA) (Glendinning, 1998 and Glendinning & Cressey, 1999; also summarised in Dunwell et. al., 2002). The excavations revealed sections of the Antonine Ditch in several of the trenches and gave rise to a new projected line of this feature (revised on the basis of the second phase of fieldwork) north of the existing road.

The Military Way

1.4 Evidence for the Military Way at Shirva is scant. MacDonald suggests that, between Shirva Farm and the Board Burn, it may lie beneath the existing road since "an abundant growth of rushes suggests that in Roman times the ground to the south would be too marshy to afford a comfortable passage for wheeled traffic." (Macdonald 1934 p 149). In the 1995 resistance survey, transects in the field south of the B8023, approximately at (C) revealed some indications of a possible track which might be interpreted as the Military Way (Strang & Walker, 1995). No evidence for this feature was identified in the CFA investigations.

Other Features

1.5 Based on conventional spacings a fortlet might be expected somewhere in the vicinity of Shirva, although there is no physical evidence for this (Hanson & Maxwell, 1986). No anomalies or features suggesting a fortlet were identified by the CFA's work and their report concludes that the higher, well drained ground at Shirva or Wester Shirva farms would be a more suitable location for such a structure (Glendinning, 1998).

1.6 The CFA trial trenches covered a number of linear high and low resistance anomalies. It is worth noting that, apart from the sections of Antonine Ditch mentioned above, most of the other responses were revealed to be natural in origin.

1.7 Both Hadrians Wall and the Antonine frontier in Germany (the *limes*) had towers/turrets erected along their line at roughly one third of a mile intervals. To date, no evidence for similar features has been uncovered along the Antonine Wall and it is unknown whether any such towers were constructed. If they did exist they are presumed to be roughly 3m square, built of timber, with foundation postholes within the Rampart (Breeze, 2006 pp86-87).

2. Results of Magnetic (Gradiometer) Survey

Labels (Mn) in the text below refer to specific anomalies annotated on the Geophysical Interpretation, Figure 4. The Archaeological Interpretation is given in Figure 5.

Area 1

2.1 A number of linear dipolar (ferrous) anomalies cross this survey block; these have been produced by pipes (M1), wire fences at the field edges and remains of further fences caught in the long grass. The magnetic responses produced by these modern surface obstructions are of a magnitude that will have masked any weaker archaeological type anomalies, if present. Although large parts of the data are free from this disturbance, most critically, the northern edge of the site, close to the line of the Antonine Wall, has been affected.

2.2 A curving negative anomaly (M2), corresponds with a low resistance linear and represents the Antonine Ditch; previous geophysical surveys (GSB 2006/11 and GSB 2006/80) have shown that this feature often presents as a negative rather than a positive response. The position of the anomaly differs from the line shown on the OS mapping but interpretation is confirmed by the CFA excavations which identified sections of the Ditch at this point.

2.3 South of the Ditch the results are somewhat confusing. Several anomalies, varying in form, have a position and alignment that could suggest association with the Rampart but none of them are definitive.

2.4 At roughly 6m south of the ditch, positive magnetic linear (M3) is in the "correct" position (based on the standard distances), but being at most 2m wide is narrower than the Rampart. (M3) could represent the denuded remains of the feature, produced by magnetic cobbles of the base, though there is no definitive corroborative evidence in the resistance data to support this interpretation. Moreover, at the western end it appears to curve towards the ditch. While the form and pattern of (M3) suggests an anthropogenic origin, its position could be fortuitous and it may represent an unrelated feature.

2.5 Between (M2) and (M3) a series of intermittent pit-type responses, roughly 3m in diameter follow the curving line of the ditch. These could be archaeological, but they are too large to represent postholes associated with a tower. They could reflect debris from the Rampart but are equally likely to have a modern or natural origin.

2.6 Parallel intermittent positive anomalies (M4) lie some 11m from the Ditch and, taken as a group, have a maximum width of 3.5m. They are therefore further south than the standard distance, but closer to the dimensions of the Rampart. Variations in the gap between the Ditch and Rampart are known, usually due to localised natural factors or ground conditions, and this could be the case here. Alternatively, if (M3) is the Rampart then (M4) might represent a damaged section of the Military Way (the responses being produced by a band of magnetic cobbles). This would place the road only some 5m from the Rampart, considerably closer than the standard range of distances for this feature, making this interpretation very cautious. It should be noted that there are no corresponding anomalies in the resistance data to support either interpretation and a more recent anthropogenic origin cannot be discounted.

2.7 The significance of negative anomalies (M5) and (M6) is even more uncertain. (M5) lies roughly 17m south of the Ditch and is roughly 3.5m wide. It has no parallels in the resistance data but follows a curve which might, arguably, bring it to join with a high resistance response further to the west. (M6) is narrower (c.2.5m wide), lies immediately adjacent to responses (M3) and coincides in part with a low resistance anomaly (paragraph 3.4 below). Both have a form comparable to that of the Ditch, suggesting features either cut in to the magnetic subsoils or constructed of non-magnetic material. While it is possible that cobbles and stone from the Rampart Base or Military Way might be non-magnetic, survey at other locations along the Wall has failed to produce such strong coherent responses over non-magnetic stone features (GSB 2007/46). It is therefore difficult to assess how either feature could have produced the recorded anomalies. While the pattern of the results would tend to suggest an anthropogenic, rather than

natural origin, the precise function of (M5) and (M6) remains unclear and a more recent origin (for example drainage features) must also be considered.

2.8 A few other short linears and weak trends have been highlighted as being of possible archaeological interest by virtue of their alignment and position with respect to the Antonine Wall. In all cases, natural or modern origins are equally tenable.

Area 2

2.9 The pipes (M1) noted in paragraph 2.1 above converge at the field edge and form a single broader band of dipolar (ferrous) responses across this survey block. The extensive area of ferrous noise at (M7) has been produced by the debris from a former building and the anomalies at the northern grid edge by the adjacent boundary fence.

2.10 In the areas unaffected by ferrous disturbance, a number of, mostly positive, short linear and amorphous anomalies and weak trends can be discerned. None of these form any patterns which would suggest an archaeological origin.

Area 3

2.11 Ferrous responses from the adjacent fence dominate the northern edge of this narrow sample, obliterating any weaker anomalies, if present. This is arguably the area of most interest, since it lies over the line of the Antonine Ditch postulated by the OS 1980 survey and closest to the line of the Ditch suggested by the CFA study.

2.12 The form of the remaining anomalies in the data-set suggests they have a natural origin.

Area 4

2.13 Anomaly (M8) is a relatively coherent curving negative response that is likely to represent the remains of the Antonine Ditch. In the western half of the survey it is accompanied by short lengths of positive ditch type anomalies. It coincides reasonably well with the CFA excavation findings, although at the western end the magnetic response appears to curve away from the CFA's projected line for the Ditch. Interpretation at this point is complicated by the presence of an area of severe magnetic disturbance (see below).

2.14 No other anomalies have been identified which are clearly archaeological and/or can be related to any elements of the Antonine Wall. The responses at (M9) may be of interest since they appear to form a roughly rectilinear pattern; however, they are not especially coherent and lie on a break of slope, making a natural origin equally, if not more, likely.

2.15 Numerous other positive and negative magnetic anomalies and weaker trends are present in the data. None of these form any patterns that would support an archaeological interpretation and natural or modern origins are probable.

2.16 A large area of magnetic disturbance is present at the western end of the survey. The levels of response are such that they will have masked any weaker responses from archaeological features. The noise at (M10) can be related to a track leading into the field, the source for (M11) is not obvious on the surface, but is nonetheless likely to be modern in origin.

3. Results of Resistance Survey

Labels (Rn) in the text below refer to specific anomalies annotated on the Geophysical Interpretation, Figure 7. . The Archaeological Interpretation is given in Figure 8.

Area 1

3.1 The pipes discussed in paragraph 2.1 above have had only minimal impact on the resistance data, appearing as a narrow low resistance linear and trend (R1).

3.2 A clear curving low resistance anomaly (R2) coincides with the magnetic negative (M2) and represents the Antonine Ditch. In previous investigations the Ditch has sometimes appeared as a combination of low and high resistance values, the latter attributed to well drained (hence drier and more resistive) surface ditch fill. In this instance only the more conventional ditch type responses (i.e. low resistance) are present.

3.3 South of the Ditch a broad area of higher resistance is present, within which some more discrete high resistance anomalies can be seen. Of these only (R3) is distinctly linear; approximately 2m wide and 4m from the Ditch, it could represent a damaged section of Rampart base, but it is slightly closer to the Ditch than the standard distance, making this interpretation tentative. Some of the other high resistance responses might have been produced by a spread of Rampart material, but natural or modern factors may also be responsible.

3.4 Well defined low resistance anomaly (R4) partially coincides with the negative magnetic response (M6) and is likely to be anthropogenic in origin. Its shape and position, following the curve of the Ditch and approximately 5m to the south, put it in roughly the expected position for the Rampart; however, remnants of a stone base would normally be expected to produce higher, rather than low resistance. It could be that elements of the stone base survive but they have caused ponding of water in the soil above; alternatively, much of the stonework may have been removed and increased moisture has collected in the resulting depression. Neither of these interpretations tally satisfactorily with the magnetic results and remain tenuous at best. This low resistance anomaly was detected by the CFA resistance survey and they interpreted the response as a pipe. The corresponding magnetic anomaly (M6) is not characteristically ferrous (dipolar), so if it is modern, (R4) is likely to represent a non-ferrous pipe (e.g. copper), or a ditch cut for a plastic pipe or drain. It is difficult to see why a modern pipe or drain should curve in such a manner, but this interpretation cannot be entirely excluded.

3.5 High resistance anomalies (R5) form a broadly rectilinear pattern and may, therefore be of archaeological interest. They might represent the remains of an earthwork enclosure (with one axis measuring c.30m) lying roughly 25m south of the projected line of the Antonine Ditch. Unfortunately, the presence of farm buildings and a vegetable garden precluded expansion of the survey area; thus the precise origin of (R5) (whether archaeological or more recent) and its relationship, if any, with the Antonine Wall, remains unknown.

Area 4

3.6 Anomalies (R6) comprise indistinct bands of lower resistance, with some adjacent higher resistance and weaker trends, that correspond in part to negative magnetic response (M8). They are likely to represent the Antonine Ditch, though the results are far less conclusive than those from the magnetic survey. The linear high resistance anomalies (R7) may be of archaeological interest, possibly reflecting a spread of material from the Rampart; but, since they lie immediately adjacent to the modern boundary, any archaeological interpretation is tentative.

3.7 North of (R6) parallel bands of higher resistance are present; they terminate very obviously at trend (R8), beyond which the data suggest a more homogeneous ground. These bands could reflect underlying geology but the fact that they have a clear edge might suggest an anthropogenic origin. Some of these anomalies, particularly those closer to the ditch, could indicate material associated with the Upcast/Outer Mound.

3.8 An indistinct low resistance curvilinear anomaly (R9) appears to cut through some of the abovementioned bands and terminates in a broader area of low resistance. A modern origin, such as a drainage feature, seems most likely for this.

4. Conclusions

4.1 The line of the Antonine Ditch has been confirmed by the current survey and, along the "disputed" section, it is shown to run north of the B8023 road, following a gently curving path that agrees most closely with the CFA investigations. The Ditch appears more clearly in the magnetic data, as a coherent negative anomaly. The results from the resistance survey are less conclusive; the Ditch appears largely as low resistance responses, but in some instances, without the corroborative magnetic evidence, the interpretation would be uncertain.

4.2 Evidence for the Rampart is tentative and confined to the field immediately east of Wester Shirva Farm (Area 1). The magnetic survey has recorded several anomalies which might be associated with this feature, but none of them have precisely the correct form, dimensions or relative positions to be conclusively linked with an intact Rampart base. The interpretation has been hampered by the prevalence of ferrous responses produced by pipes, boundary fences and surface debris. Although not as severely affected by this material, the resistance survey has not helped to firm up any of the interpretations.

4.3 No anomalies have been identified in either data-set, that can be reasonably linked to the Military Way. For most of this stretch of the Wall, both the Rampart and the Military Way are likely to run south of the B8023 road, through Area 3. Unfortunately, much of the field containing this small sample was severely overgrown and boggy, making it unsuitable for survey.

4.4 The resistance data for Area 1 have produced tentative evidence for a possible rectilinear enclosure. Located on higher ground at Wester Shirva farm, this would be a suitable position for a mile fortlet. However, the presence of farm buildings and gardens precluded any expansion of the survey and the precise significance of the resistance anomalies remains unknown.

References

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List of Figures

Report Figures

Reference Figures on CD

Appendix 1: Technical Information

Instrumentation

Fluxgate Gradiometer: Geoscan FM36/256 and Bartington *Grad*601-2

Both the Geoscan and Bartington instruments comprise two fluxgate sensors mounted vertically apart; the distance between the sensors on the former is 500mm, on the latter 1000mm. The gradiometers are carried by hand, with the bottom sensor approximately 100-300mm from the ground surface. At each survey station, the difference in the magnetic field between the two fluxgates is measured in nanoTesla (nT). The sensitivity of the instrument can be adjusted; for most archaeological surveys the most sensitive range (0.1nT) is used. The fluxgate gradiometer suppresses any diurnal or regional effects. Generally, features up to 1m deep may be detected by this method. Having two gradiometer units mounted laterally with a separation of 1000mm, the Bartington instrument can collect two lines of data per traverse.

Resistance Meter: Geoscan RM15

This instrument measures the electrical resistance of the earth, using a system of four electrodes (two current and two potential.) Depending on the arrangement of these electrodes an exact measurement of a specific volume of earth may be acquired. This resistance value may then be used to calculate the earth resistivity. The most common arrangement is the Twin Probe configuration which involves two pairs of electrodes (one current and one potential): one pair remain in a fixed position, whilst the other measures the resistance variations across a grid. The resistance is measured in ohms and, when calculated, resistivity is in ohm-metres. The resistance method as used for standard area survey employs a probe separation of 0.5m, which samples to a depth of approximately 0.75m. The nature of the overburden and underlying geology will cause variations in this depth.

GPR: Sensors & Software Noggin Smartcart

The Noggin system includes an onboard digital video logger (DVL III), 250 MHz or 500MHz antenna, an odometer wheel and battery. It is, therefore, a fully integrated system. The built-in software uses the integrated odometer to provide an accurate distance measurement to the response. The data are recorded in digital format and can be processed to produce depth slice maps, 2D sections or 3D cubes.

Display Options

XY Trace

This involves a line representation of the data. Each successive row of data is equally incremented in the Y axis, to produce a stacked profile effect. This display may incorporate a hidden-line removal algorithm, which blocks out lines behind the major peaks and can aid interpretation. The advantages of this type of display are that it allows the full range of the data to be viewed and shows the shape of the individual anomalies. The display may also be changed by altering the horizontal viewing angle and the angle above the plane. The output may be either colour or black and white.

Greyscale

This format divides a given range of readings into a set number of classes. Each class is represented by a specific shade of grey, the intensity increasing with value. All values above the given range are allocated the same shade (maximum intensity); similarly all values below the given range are represented by the minimum intensity shade. Similar plots can be produced in colour, either using a wide range of colours or by selecting two or three colours to represent positive and negative values. The assigned range (plotting levels) can be adjusted to emphasise different anomalies in the data-set.

Relief Plot

This is a method of display that creates a three dimensional effect by directing an imaginary light source on a given data set. Particular elements of the results are highlighted depending on the angle of strike of the light source. This display method is particularly useful when applied to resistance data to highlight subtle changes in resistance that might otherwise be obscured.

3D Surface Plot

This is similar to the XY trace, but in 3 dimensions. Each data point of a survey is represented in its relative position on the *x* and *y* axes and the data value is represented in the *z* axis. This gives a digital terrain, or topographic effect.

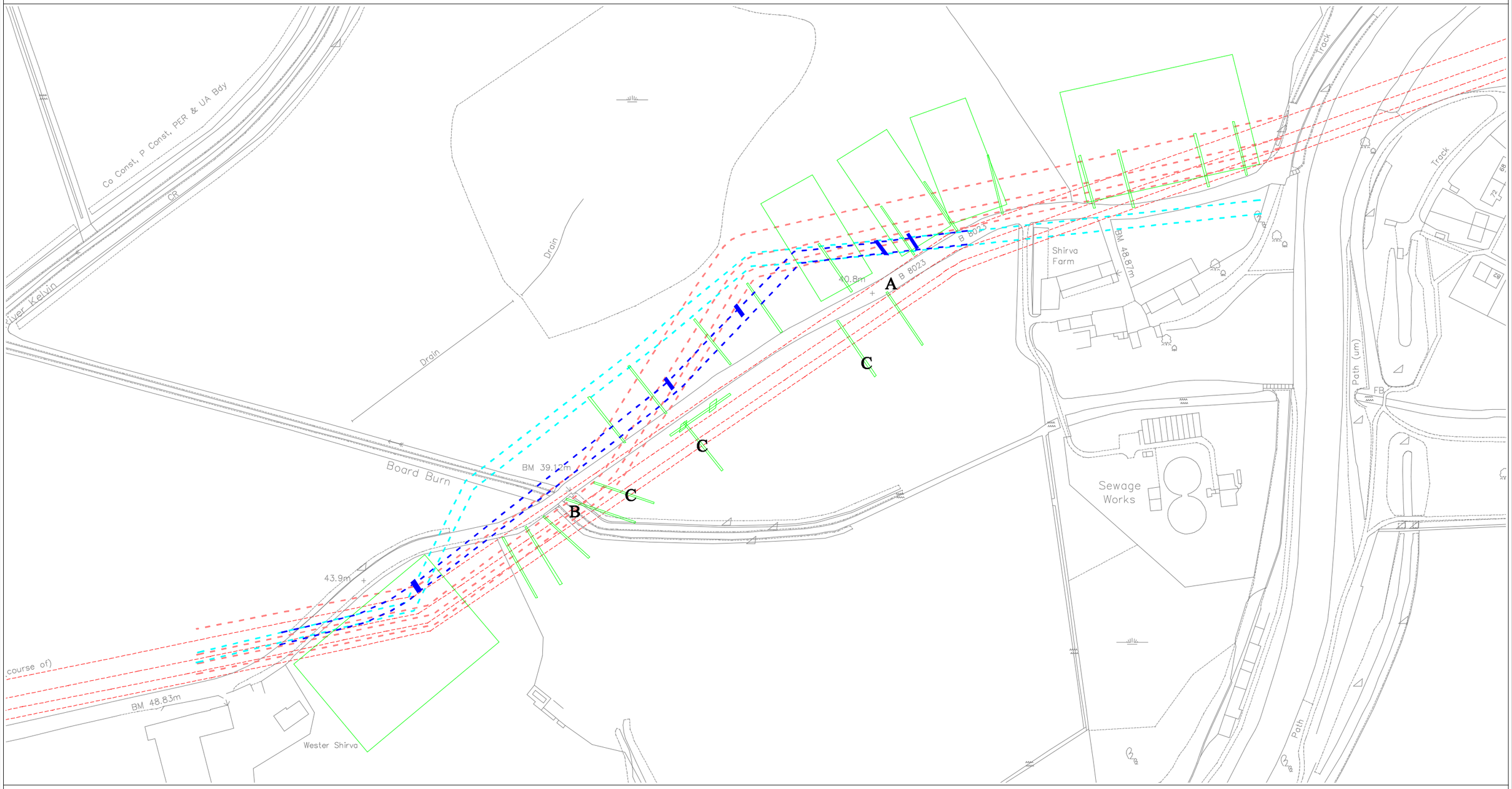
Radargram

Radar data comprise a record of reflection intensity against the time taken for the emitted energy to travel from the transmitter down to the reflector and back to the receiver. The resultant plot is effectively a vertical section through the ground along the line of the traverse, with time (depth) on the vertical axis, displacement on the horizontal axis and reflection intensity as a grey or colour scale.

Time Slice

If a number of radargrams are collected over a grid, or in conjunction with GPS data, it is possible to reconstruct the entire dataset into a 3D volume. This can then be resampled to compile 'plan' maps of response strength at increasing time (or depth) offsets, thus simplifying the visualisation of how anomalies vary beneath the surface across a survey area.

GSB PROSPECTION Ltd.	PROJECT: 2007/42 Antonine Wall III - Shirva	TITLE: Desk Based Assessment



Line of Antonine Wall - MacDonald

Line of Antonine Wall - OS 1980

Line of Antonine Ditch (CFA) - original / revised

Excavated section of Antonine Ditch (CFA)

Previous Geophysical Survey

0 metres 80

Figure 1

GSB PROSPECTION Ltd.	PROJECT: 2007/42 Antonine Wall III - Shirva	TITLE: Location of Survey Areas

Gradiometer Survey (showing reference plot subdivisions)

Resistance Survey

0 metres 100

Figure 2

GSB PROSPECTION Ltd.	PROJECT: 2007/42 Antonine Wall III - Shirva	TITLE: Magnetic Data - Greyscales

8
nT
-5

0 metres 80

Figure 3

GSB PROSPECTION Ltd.	PROJECT: 2007/42 Antonine Wall III - Shirva	TITLE: Magnetic Data - Geophysical Interpretation

Positive Magnetic Anomaly

Negative Magnetic Anomaly (Discrete / Amorphous)

Trend

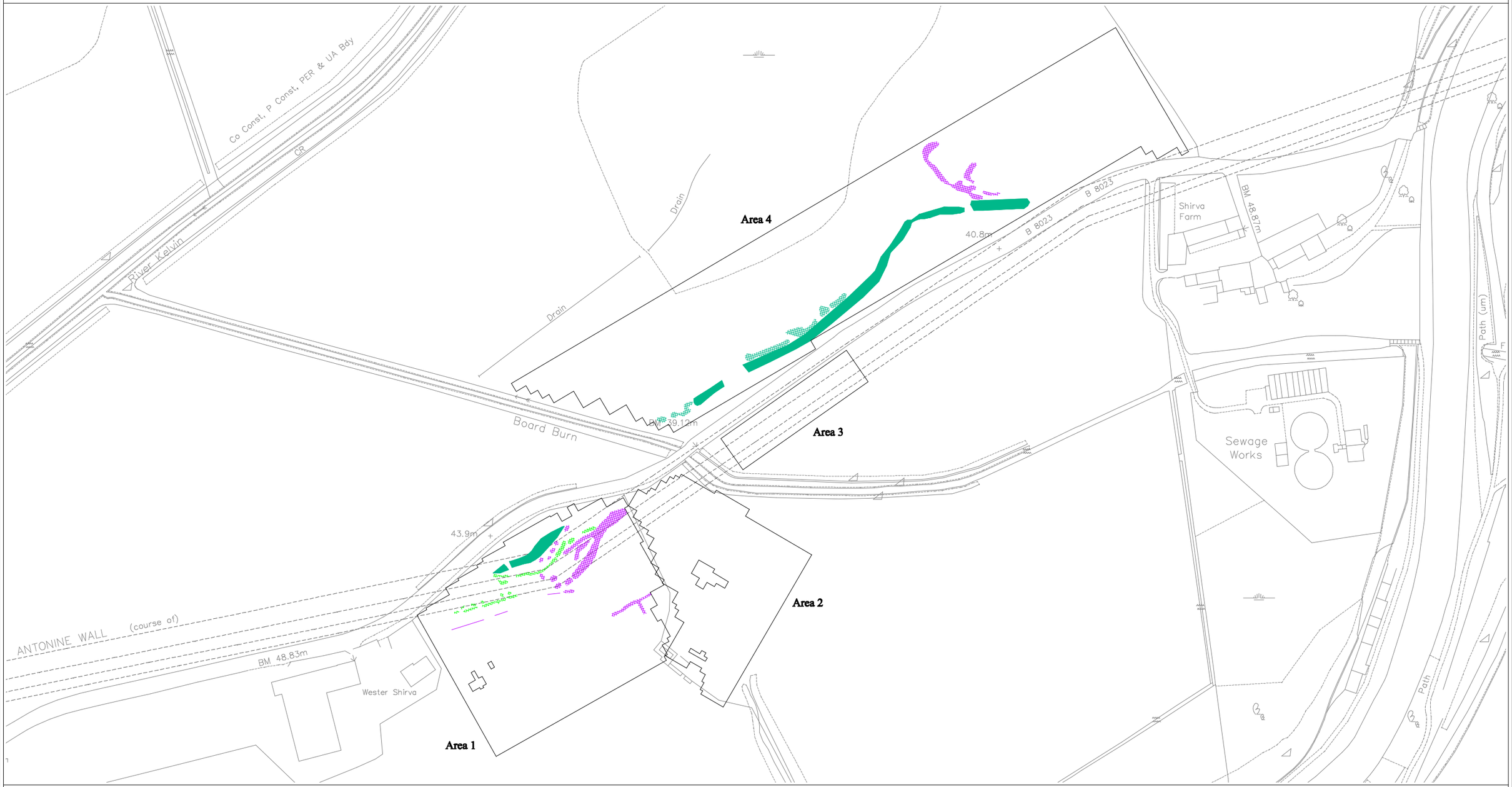
Magnetic Disturbance

Magnetic Dipole (Ferrous)

0 metres 80

Figure 4

GSB PROSPECTION Ltd.	PROJECT: 2007/42 Antonine Wall III - Shirva	TITLE: Magnetic Data - Archaeological Interpretation



Antonine Wall - Ditch / ?Ditch

Antonine Wall - ?Rampart

?Archaeology

0 metres 80

Figure 5

GSB PROSPECTION Ltd.	PROJECT: 2007/42 Antonine Wall III - Shirva	TITLE: Resistance Data - Greyscales

0 metres 80

1
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Figure 6

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Discrete High Resistance Anomaly

Discrete Low Resistance Anomaly

Area of High Resistance

Area of Low Resistance

Trend

0 metres 80

Figure 7

GSB PROSPECTION Ltd.	PROJECT: 2007/42 Antonine Wall III - Shirva	TITLE: Resistance Data - Archaeological Interpretation

Antonine Wall - Ditch / ?Ditch

Antonine Wall - ?Rampart

?Archaeology

0 metres 80

Figure 8