

Land at Gibside, Burnopfield, Tyne and Wear

geophysical surveys

on behalf of
The National Trust

Report 2008
August 2008

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1. Summary

The project

- 1.1 This report presents the results of geophysical surveys conducted in conjunction with restoration work that is ongoing throughout the Gibside Estate. The works comprised geomagnetic and earth electrical resistance surveys to identify iron pipes which formed the inflow and outflow of the Green House Field Pond, and to establish the location of stone culverts which drained the area around the Long Walk.
- 1.2 As an addition it was decided to investigate a further field which contained a raised hump in the centre in order to ascertain the function of this structure.
- 1.3 The works were commissioned by The National Trust and conducted by Archaeological Services Durham University.

Results

- 1.4 Ferrous pipes used to supply the pond in the Green House field were detected, and to the north a further ferrous pipe, possibly the supply for a fountain, was also identified.
- 1.5 A third ferrous pipe of unknown origin was identified in Area 2b.
- 1.6 A possible early planting regime was detected by the resistance survey of Area 1.
- 1.7 It was not possible to identify any stone culverts which crossed the Long Walk through either geomagnetic or earth electrical resistance survey.

2. Project background

Location (Figure 1)

- 2.1 The study areas were located throughout the Gibside Estate, Burnopfield, County Durham (NGR centre: NZ 1734 5858). Six surveys totalling 2.75ha were conducted. Area 1 comprised the Green House Field, an area of cut grass bounded by the Walled Garden to the southwest, the Orangery to the northwest and the Long Walk to the south east. Three surveys were carried out at intervals along the Long Walk (Area 2), while the sixth survey was positioned over a man made mound (Area 3), to the north of the Green House Field and the Long Walk.

Restoration proposal

- 2.2 The National Trust is undertaking an extensive restoration of the lands and gardens of the Gibside Estate.

Objective

- 2.3 The principal aim of the surveys was to assess the nature and extent of any sub-surface features of potential historic and horticultural significance, and so inform the restoration work.

Methods statement

- 2.4 The surveys were undertaken in accordance with instructions from the National Trust and a project design provided by Archaeological Services.

Dates

- 2.5 Fieldwork was undertaken between 28th July and 1st August 2008. This report was prepared between 4th and 12th August 2008.

Personnel

- 2.6 Fieldwork was conducted by Graeme Attwood (Supervisor) and Andrea Dixon. This report was prepared by Graeme Attwood with illustrations by Edward Davies and edited by Peter Carne. The Project Manager was Duncan Hale.

Archive/OASIS

- 2.7 The site code is **GGF08**, for **Gibside Green House Field 2008**. The survey archive will be supplied on CD to the Tyne and Wear Historic Environment Record. Archaeological Services is registered with the **Online Access** to the **Index** of archaeological investigationS project (OASIS). The OASIS ID number for this project is **archaeol3-46871**.

Acknowledgements

- 2.8 Archaeological Services is grateful for the assistance of National Trust personnel in facilitating this scheme of works.

3. Archaeological and historical background

- 3.1 Gibside is the ancestral estate of the Bowes-Lyons, created by the Landowner, industrialist and coal baron George Bowes between 1729 and 1760. The estate comprises an 18th century landscaped ‘forest’ garden with features including a Jacobean Hall, Palladian Chapel, the Column of Liberty, a Banqueting House, an Orangery (built by the Countess of Strathmore between 1772 and 1774), a Walled Garden and stables, Octagonal Pond, Lily Pond and the Great Avenue of Turkey Oaks.

4. Landuse, topography and geology

- 4.1 At the time of survey the Green House Field comprised a large area of short grass, which is often used for car parking, with a pond towards the centre of the field. The long walk comprised an avenue of short grass approximately 20m wide by 800m long. The final area was of short grass, the survey was centered on a small mound c.1m in height which had a circular stone basin at the summit.

Area	Size (ha)	Landuse	Topography	Hight OD	NGR
1	2.1	Grassed area	Gently Sloping SE/NW	59m	SE 3640 7390
2	0.25	Garden Avenue	Flat	64m	SE 3630 7410
3	0.25	Grassed area	Gently Sloping SE/NW	60m	SE 3612 7460

- 4.2 The underlying solid geology of the area comprises Carboniferous, Westphalian Coal Measures, which are overlain by Devensian Till.

5. Geophysical survey

Standards

- 5.1 The surveys and reporting were conducted in accordance with English Heritage Research and Professional Services Guideline No.1, *Geophysical survey in archaeological field evaluation 2nd edition* (David, Linford & Linford 2008); the Institute of Field Archaeologists Technical Paper No.6, *The use of geophysical techniques in archaeological evaluations* (Gaffney, Gater & Ovenden 2002); and the Archaeology Data Service *Geophysical Data in Archaeology: A Guide to Good Practice* (Schmidt 2001).

Technique selection

- 5.2 Geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance and can involve a variety of complementary techniques such as magnetometry, earth electrical resistance, ground-penetrating radar and electromagnetic survey. Some techniques are more suitable than others in particular situations, depending on a variety of site-specific factors including the nature of likely

targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

- 5.3 In this instance, based on previous work, it was known that small stone culverts and ferrous pipes exist in some parts of the gardens. It was also anticipated that former paths, structural remains and/or soil-filled features might be present on the site.
- 5.4 Given the nature and depth of targets (possibly over 1.5m) and the non-igneous geological environment of the study area, a pair of complementary geophysical survey techniques were employed: geomagnetic and earth electrical resistance techniques were both considered appropriate for detecting the types of feature mentioned above.
- 5.5 The geomagnetic technique (fluxgate gradiometry) involves the use of hand-held magnetometers to detect and record anomalies in the vertical component of the Earth's magnetic field which are caused by variations in soil magnetic susceptibility or permanent magnetisation; such anomalies can reflect, for example, stone, brick and soil-filled features.
- 5.6 Earth electrical resistance survey can be particularly useful for mapping stone and brick features such as the buried stone culverts mentioned above, as well as former paths or wall-foundations. When a small electrical current is injected through the earth it encounters resistance which can be measured. Since resistance is linked to moisture content and porosity, stone and brick features will give relatively high resistance values while soil-filled features, which retain more moisture, will provide relatively low resistance values.

Field methods

- 5.7 20m grids were established across each survey area, with the exception of the geomagnetic survey of Area 1 which employed a 30m grid system. These grids were then tied-in to known, mapped Ordnance Survey points using a Trimble Pathfinder Pro XRS global positioning system (GPS) with real-time correction providing sub-metre accuracy.
- 5.8 Measurements of vertical geomagnetic field gradient were determined using Bartington Grad601-2 dual fluxgate gradiometers. A zig-zag traverse scheme was employed and data were logged in 30m grid units in Area 1 and 20m grid units in areas 2 and 3. The instrument sensitivity was set to 0.1nT, the sample interval to 0.25m and the traverse interval to 1.0m, thus providing 3600 sample measurements per 30m grid unit and 1600 per 20m grid unit.
- 5.9 Measurements of earth electrical resistance were determined using a Geoscan RM15D resistance meter with a mobile twin probe separation of 0.5m. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was set to 0.1ohm, the sample interval to 1.0m and the traverse interval to 1.0m, thus providing 400 sample measurements per 20m grid unit.

- 5.10 Data were downloaded on site into a laptop computer for initial processing and storage and subsequently transferred to a desktop computer for processing, interpretation and archiving.

Data processing

- 5.11 Geoplot v.3 software was used to process the geophysical data and to produce both continuous tone greyscale images and trace plots of the raw (unfiltered) data. The greyscale images and interpretations are presented in Figure 2; the trace plots are provided in Figure 3. In the greyscale images, positive magnetic/high resistance anomalies are displayed as dark grey and negative magnetic/low resistance anomalies as light grey. Palette bars relate the greyscale intensities to anomaly values in nanoTesla/ohm.

- 5.12 The following basic processing functions have been applied to the geomagnetic data:

<i>clip</i>	clips, or limits data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic.
<i>zero mean traverse</i>	sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities.
<i>interpolate</i>	increases the number of data points in a survey to match sample and traverse intervals. In this instance the data have been interpolated to 0.25 x 0.25m intervals.

- 5.13 The following processing functions have been applied to the resistance data:

<i>despike</i>	locates and suppresses spikes in data due to poor contact resistance.
<i>interpolate</i>	increases the number of data points in a survey to match sample and traverse intervals. In this instance the data have been interpolated to 0.25m x 0.25m intervals.

Interpretation: anomaly types

- 5.14 A colour-coded geophysical interpretation plan is provided in Figure 2. Three types of geomagnetic anomaly have been distinguished in the data:

<i>positive magnetic</i>	regions of anomalously high or positive magnetic field gradient, which may be associated with high magnetic susceptibility soil-filled structures such as pits and ditches.
<i>negative magnetic</i>	regions of anomalously low or negative magnetic field gradient, which may correspond to features of low magnetic susceptibility such as wall footings and other concentrations of sedimentary rock or voids.
<i>dipolar magnetic</i>	paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including

fences and service pipes) and/or fired structures such as kilns or hearths.

Two types of resistance anomaly have been distinguished in the data:

- | | |
|------------------------|---|
| <i>high resistance</i> | regions of anomalously high resistance, which may reflect foundations, tracks, paths and other concentrations of stone or brick rubble. |
| <i>low resistance</i> | regions of anomalously low resistance, which may be associated with soil-filled features such as pits and ditches. |

Interpretation: features

- 5.15 A colour-coded archaeological interpretation plan is provided in Figure 2.

General comments

- 5.16 Small, discrete dipolar magnetic anomalies have been detected in all of the survey areas. These almost certainly reflect items of near-surface ferrous and/or fired debris, such as horseshoes and brick fragments, and in most cases have little or no archaeological significance. A sample of these is shown on the geophysical interpretation plan, however, they have been omitted from the archaeological interpretation plan and the following discussion.

Area 1 (geomagnetic survey)

- 5.17 A chain of dipolar magnetic anomalies orientated north-south have been detected; these almost certainly reflect a water inflow pipe which supplied the pond in the centre of the field. This pipe has also been detected crossing the Long Walk through Area 2a towards a reservoir in the field to the south.
- 5.18 A second chain of dipolar magnetic anomalies orientated northwest-southeast has been detected. This probably reflects a second ferrous pipe which may form the outflow pipe from the pond.
- 5.19 A further large dipolar magnetic anomaly has been detected to the immediate northwest of the pond. This may reflect ferrous material associated with the pond.

Area 1 (earth electrical survey, see inset box)

- 5.20 A linear low resistance anomaly, orientated northwest-southeast, was detected. This almost certainly reflects the same 'outflow' pipe which the geomagnetic survey detected.
- 5.21 Areas of anomalously high resistance data were detected along the western edge of the survey area. These areas may reflect former gravel paths which were present in the garden; however they may also be the result of the drier ground away from the pond or a reflection of earlier landscaping of the field.

- 5.22 Regular, small, discrete high resistance anomalies have been detected in parallel lines across the survey area. These may reflect an early planting regime.

Area 2a, b and c

- 5.23 Two chains of dipolar magnetic anomalies have been detected in these areas. These almost certainly reflect ferrous pipes. The first, detected in Area 2a, has been discussed above in 5.17. The second chain was detected in Area 2b and is orientated east-west. As this second chain does not appear in Area 1 it seems likely that it turns northeast towards the River Derwent, possibly connecting with the 'issues' noted on the map or another unidentified feature.
- 5.24 A group of dipolar magnetic anomalies have been detected in the northern extent of survey 2c. These have been caused by a number of features including a manhole cover and the estate road. While a pipe or culvert may be present it has not been possible to differentiate it from the other anomalies that have been detected.

Area 3

- 5.25 A chain of dipolar magnetic anomalies orientated northeast-southwest has been detected in this area. These anomalies come to an end in the middle of the survey area in the approximate position of the small mound and stone basin which were being investigated. It is likely that these dipolar magnetic anomalies reflect a ferrous pipe which fed a fountain or similar garden feature in the form of the mound and circular stone basin. A circular feature in this location was denoted on the first edition Ordnance Survey Map for the area (it does not appear on any later edition); this feature has been included on the archaeological interpretation figure.

6. Conclusions

- 6.1 2.5ha of geomagnetic survey and 0.25ha of earth electrical resistance survey was undertaken at the Gibside Estate to inform the restoration works taking place in the gardens.
- 6.2 Ferrous pipes used to supply the pond in the Green House field were detected, while to the north a further ferrous pipe, possibly the supply for a fountain, was also identified.
- 6.3 A third ferrous pipe of unknown origin has been identified in Area 2b.
- 6.4 A possible early planting regime was detected by the resistance survey of Area 1.
- 6.5 It was not possible to identify any stone culverts which crossed the Long Walk through either geomagnetic or earth electrical resistance. This is probably because of the depth at which these features exist.

7. Sources

Archaeological Services 2005 The Walled Garden at Gibside, Burnopfield; geophysical surveys, unpublished report **1846** for The National Trust, Archaeological Services Durham University

David, A, Linford, N, & Linford, P, 2008 *Geophysical survey in archaeological field evaluation*, 2nd edition, Research and Professional Services Guideline **1**, English Heritage

Gaffney, C, Gater, J, & Ovenden, S, 2002 *The use of geophysical techniques in archaeological evaluations*, Technical Paper **6**, Institute of Field Archaeologists

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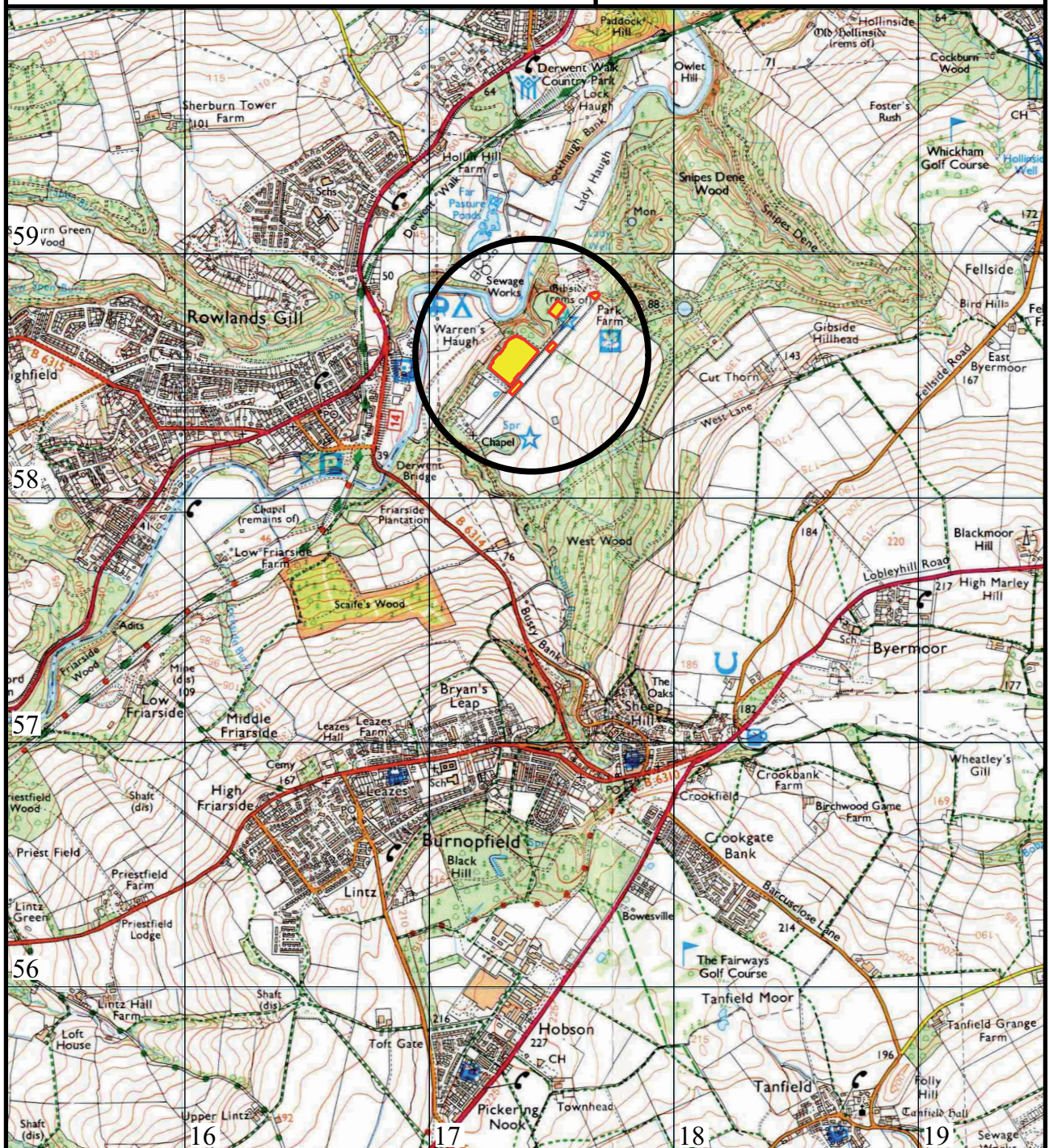
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Figure 1
Location of surveys

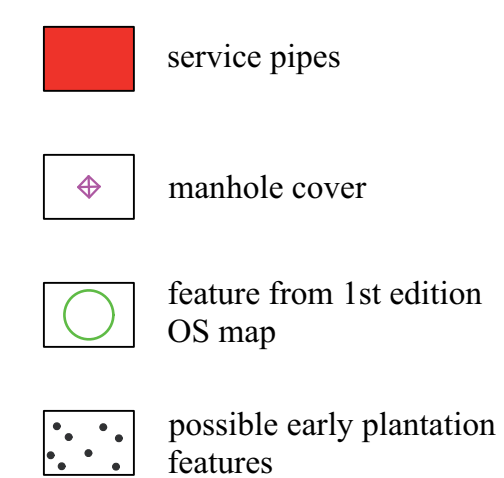
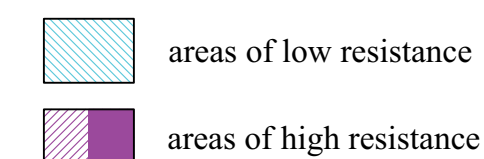
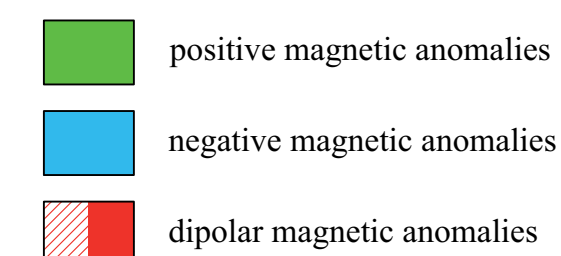
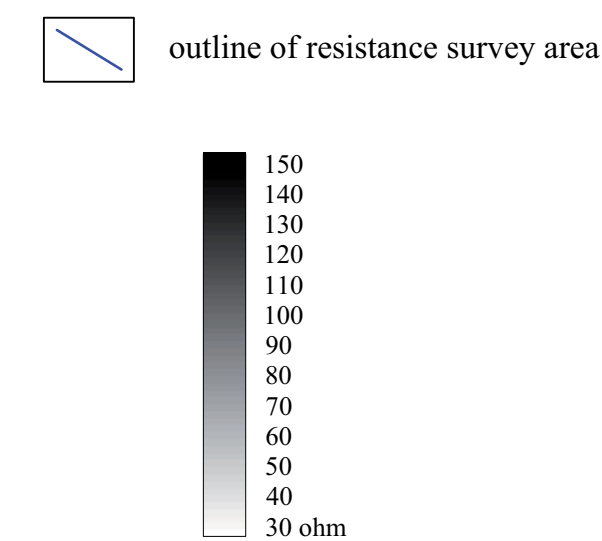
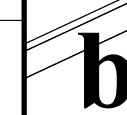
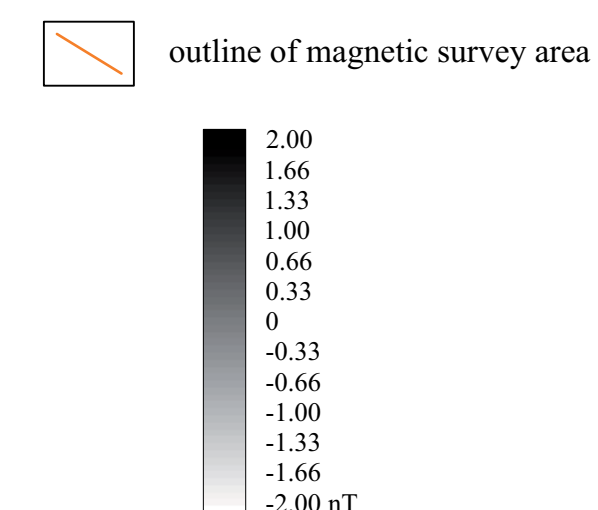
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 surveys

0 1km
scale 1:25 000 - for A4 plot





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Figure 2

Geophysical surveys, geophysical and archaeological interpretations