NAA

GEOPHYSICAL SURVEY REPORT

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DALE ROAD, SHILDON,

COUNTY DURHAM

prepared for

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DALE ROAD, SHILDON, COUNTY DURHAM:

GEOPHYSICAL SURVEY REPORT

Summary

Northern Archaeological Associates Ltd (NAA) was commissioned by Theakston Estates to undertake a geophysical survey of land to the east of Dale Road, Shildon County Durham (NGR NZ 24169 / 25315). The survey is in support of an outline planning application for the development of approximately 12.5 hectares of 'open access' pasture land for residential development. The survey covers 3.3 hectares at the eastern end of the site, which has not previously been surveyed. This report will be submitted to inform decisions regarding the need for any archaeological mitigation.

The survey was carried out between the 4th and 5th January 2017. The geophysical survey was successful in giving clear results and demonstrating underlying features within the surveyed area. The most dominant anomaly in the survey results corresponds with the route of a gas pipeline. The majority of the remaining anomalies that have been identified also seem to be modern in nature. Nothing of archaeological significance has been identified.

DALE ROAD, SHILDON, COUNTY DURHAM:

GEOPHYSICAL SURVEY REPORT

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1.0 INTRODUCTION

1.1 Northern Archaeological Associates Ltd (NAA) was commissioned by Theakston Estates to undertake a geophysical survey of land to the east of Dale Road, Shildon, County Durham(NGR NZ 24169 / 25315) (**Figure 1**). This assessment is in support of an outline planning application for the development of approximately 12.5 hectares of open grassland for residential development. The survey covers 3.3 hectares at the eastern end of the site, which has not previously been surveyed. The survey was carried out between the 4th and 5th January 2017 to evaluate the archaeological potential of the area and to inform the need for any archaeological mitigation work.

1.2 The development site is bounded to the north by Locomotion: The National Railway Museum at Shildon, Eden Grange to the east, All Saints Industrial Estate and fields around Hawthorn House to the south and street-front housing and allotments to the west. The western two thirds of the site were previously surveyed by GSB in 2008 (GSB 2008/12). The eastern third of the site is the subject of this geophysical report.

1.3 The solid geology of the area consists of Pennine Lower Coal Measure Formation, mudstone, siltstone and sandstone (BGS 2017). These deposits are overlain by boulder clay (Diamicton Till). The soils are mapped as being of the Brickfield 3 Association (Soil Survey of England and Wales 1983), consisting primarily of fine loamy and clayey gley soils prone to surface waterlogging and primarily used for pasture (Jarvis *et al*. 1984, 123-6).

Archaeological and historical background

1.4 Previous archaeological investigations at Dale Road Shildon included a desk-based assessment (DBA) for a much wider area, but including the current site, prepared as part of the 'Shildon On Track' community project (NAA 04/43); a geophysical survey (GSB 2008/12) to the west; and a trial trench evaluation (NAA 12/115). The geophysical survey completed by GSB in 2008 covered the western two thirds of the development area. The remaining area was not surveyed as initially this area was identified as a green space.

1.5 The DBA found a small number of archaeological sites either within, or in the immediate vicinity of the development area. Little evidence for prehistoric activity has been found in Shildon. Occasional flints have been found, but none within the study

area. Dere Street, the Roman road between York and Hadrian's Wall, passes 2km to the west of the study area running northwards from Piercebridge towards Binchester.

1.6 Medieval occupation in the Shildon area consisted of a large number of smaller settlements. This is not reflected in the post-medieval and modern settlement pattern. Old Shildon (the core to the northern part of modern Shildon), was present from the Medieval period if not earlier and remained relatively small until the advent of the railway.

1.7 New Shildon rapidly developed to the south of Old Shildon around the Soho Engine Works from the second quarter of the 19th century onwards. The original route of the Stockton and Darlington Railway, which opened in 1825, runs to the north of the development area. To the west of Shildon this line passed over Brusselton Bank by means of steam-powered cable inclines. As a result locomotives could only operate eastwards towards Darlington. Parts of this early system were horse-drawn and stables and outbuildings were constructed at Shildon.

1.8 The Soho Engine Works were set up between 1825 and 1840 adjacent to Shildon Station, but were disused by 1920. Most of the Stockton and Darlington Railway's locomotives were not only built at Shildon but also stationed there, and this required extensive sidings to be constructed alongside the railway line. The locomotives were serviced by coal drops which still survive. The railway sidings and main line were crossed by a footbridge known variously as East Thickley Footbridge or the Shildon Fancy Bridge. As the sidings expanded the bridge was progressively lengthened southwards from the northern span which bears the date 1857. The bridge survives and the two northern spans are listed as Grade II.

1.9 A mining report from the Coal Authority (Geoinvestigate 2008, 5) indicates that the western two thirds of the development area was subjected to opencast coal mining in the 1950s. However, the workings were not recorded on cartographic sources as the land use changed to mining and then was reinstated as agricultural land between two issues of Ordnance Survey mapping.

1.10 The geophysical survey undertaken in 2008 of the western two thirds of the development area did not identify any significant archaeological features (GSB 2008). Several vague trends in the data indicated the presence of linear features such as ditches, and discrete pit-type anomalies of uncertain origin. The whole area was

subject to magnetic debris which could be indicative of the backfilled remains of the former opencast mine.

1.11 The 2012 trial trench evaluation was designed to evaluate the archaeological potential of the proposed development area that was thought to fall outside of the area which was subjected to opencast mining. The extent of the open cast mining was recorded on a 1950s Coal Authority plan (Geoinvestigate, 2008). The evaluation revealed no significant archaeological features or finds. There were no medieval or later subsoil deposits identified apart from in one small area. This suggests that although this area was not quarried for coal extraction, it was subjected to substantial ground disturbance works during the same period of activity. The area was stripped of its soils, used as a storage area for quarry arisings, and re-profiled and sealed using clay when extraction came to an end.

2.0 AIMS AND OBJECTIVES

2.1 The aim of the survey was:

- To attempt to characterise the nature of any subsurface remains within the survey boundary and to identify possible concentrations of past activity in order to inform the requirement for any mitigation work at the site.
- To produce a report including XY trace plots and raw and processed greyscale images of the areas and interpretations of these results.

3.0 METHODOLOGY

Table 1: Survey summary

	Survey
Grid size	30mx30m
Traverse interval	1m
Reading interval	0.25m
Direction of 1st traverse	North
Number of Grids	38

3.1 The geophysical survey was undertaken as gradiometer survey using the Bartington 601-2 dual magnetic gradiometer system with data logger. The readings were recorded at a resolution of 0.1nT. All recorded survey data was collected with reference to a site

survey grid, comprised of individual 30m x 30m squares, and was established using Real Time Kinematic (RTK) differential GPS equipment and marked out using non-metallic survey markers. All grid nodes were set out with a positional accuracy of at least 0.1m as per existing guidelines (English Heritage 2008; CIfA 2014) and could be re-located on the ground by a third party. Further details are available in **Appendix A** Technical Information

3.2 The base line is shown on **Figure 2**

Table 2: Grid co-ordinates

Grid point A	**Grid point B**
NGR 424033.45729 / 525265.37791	NGR 424242.18199 / 525242.26946

3.3 The gradiometer survey was undertaken in accordance with current guidelines (English Heritage 2008 & CIfA 2014). In this report, the word anomaly is used to refer to any outstanding high or low readings forming a particular shape or covering a specific area.

3.4 The processing was undertaken using Geoplot 3.0 software and consisted of standard processing procedures **(Appendix A**).

3.5 For this project the data was processed using:

Table 3: Processing steps

Minimal Processing	**Increased Processing**
• Zero Mean Traverse +5/-5 • Clip Min = -15 Max = 15	• Zero Mean Traverse +5/-5 • Despike X=1 Y=1 Thr=3 • Clip Min = -20 Max = 20 • Clip Min = -10 Max = 10 • Destagger grids 11, 16, 26 & 31 • Interpolate Y, Expand - SinX/X ,x2

3.6 On the greyscale plot (**Figure. 3**), positive readings are shown as increasingly darker areas and negative readings are shown as increasingly lighter areas. The XY trace plot

demonstrates the readings as offsets from a central line. The interpreted data uses colour coding to highlight specific readings in the survey area.

Surface Conditions and other Mitigating Factors

3.7 The geophysical survey area consists of 3.3 hectares at the eastern end of the development site. Archaeological evaluation in 2012 (NAA 12/115) suggested that the area has been landscaped and consists of mining upcast sealed by yellow clay beneath a 0.2m thick topsoil.

3.8 The survey area is currently under tussocks of grass and areas of rough vegetation including brambles, dog roses and thistles. In places the vegetation was too dense to walk through, which accounts for some of the blank spaces on the geophysics results. The land rises from the east and the west to form a spur of higher ground in the middle of the survey area. The northern slope was relatively steep. Walking conditions were therefore difficult in places.

3.9 At present the land is frequently used by dog walkers. Well worn footpaths can clearly be seen on the ground and on Google earth images (Getmapping plc 2016). Areas of fly tipping were observed at the western end of the survey area. Three low round mounds with manhole access covers were seen evenly spaced east to west across the southern half of the site. These were not surveyed.

3.10 To the south the survey area is bordered by a single track tarmac road. Care was taken to stop surveying when vehicles were approaching and passing. The eastern edge of the site consisted of a relatively new, high wooden fence, which had resulted in the ground next to the fence being heavily disturbed. The northern boundary consisted of a dilapidated post and rail wooden fence with frequent gaps. The western extent of the survey area was defined by a path running south-west from the footbridge.

3.11 The results of geophysical survey may not reveal all potential archaeology and does not provide a comprehensive map of the sub-surface, only responses relative to the environment. Geological, agricultural and modern responses may mask other features and short lived features may not give strong responses. Only clear features have been interpreted and discussed in this report.

4.0 RESULTS

4.1 The gradiometer survey was successful and created clear results demonstrating previous use of the site and geological features.

4.2 **Figure 3** shows the minimally processed data, the data having been through the processing listed in the methodology, the XY trace plot of the survey area, and the interpretation of the data. Specific features and anomalies referred to in the text are numbered.

Description and interpretation

Modern

4.3 The two most obvious anomalies within the survey results are two long linear bipolar anomalies (**1** & **2**), one runs along the northern edge of the survey area and the other runs north-east to south-west down the western edge of the survey area. These anomalies represent a single gas pipeline which has a 90 degree angle in it. Bipolar anomalies have also been formed by the manhole mounds and covers (**3**) which overlie the route of a further service (**5** & **6**). There are several other smaller bipolar responses across the site, which are of an unknown origin (**4**).

4.4 Towards the southern side of the survey area numerous linear anomalies which have corresponding positive and negative responses can be seen (**7**). The majority of these correspond with an unofficial grass track which can be seen running across the site towards the south-east corner. This track contains numerous linear ruts which correspond with the linear responses.

4.5 The eastern boundary is dominated by an area of increased magnetic response or debris **(8)**. This is made up of clusters of dipolar responses. These responses have been produced as a result of the disturbance to the ground created as a result of the new fence being built. There are several other isolated areas of increased magnetic response or debris (**9**) across the site. These also correspond to areas of ground that have been heavily disturbed, such as the track area where the ground had been churned up.

4.6 The survey results show a spread of dipolar anomalies (**10**), which are typically due to the influence of modern material inclusions in the topsoil. Some of the larger responses may be due to the landscaping of the area after mining.

Agricultural

4.7 There are small areas of parallel linear trends (**11**). These represent past ploughing schemes relating to when the area was used as arable land.

4.8 There is a long positive linear anomaly (**12**) which runs east to west across the southern end of the survey area. This may relate to an in-filled cut feature such as a ditch, or a trench with a drainage pipe in it. At the western end of this long positive linear anomaly, there are several shorter positive linear anomalies (**13**), which correspond to an area where one of the earlier trial trenches found a French drain (NAA 12/115).

Natural

4.9 There is a positive curving linear anomaly (**14**) and some associated curving trends (**15**) within the north-west quadrant of the survey area. These anomalies follow the curving contours of the spur of higher ground within the middle of the survey area. It is suggested that these represent natural soil creep or areas of watterlogged ground. To the east of this group of anomalies there is another positive curving linear anomaly (**16**). This also follows the contour of the spur of higher ground.

Archaeological

4.10 Across the survey area there are numerous small discreet, roughly circular, positive anomalies (**17**). These may be archaeological in nature, representing possible pits, related to the past mining activity in the area or alternatively they could be natural in origin.

4.11 In the south-western corner of the survey area are two negative linear anomalies (**18**) which cross each other. These are caused by material with a lower magnetic responserelative to the background top soil.

5.0 CONCLUSIONS

5.1 Clear results have been produced from the survey. The most dominant anomaly in the survey results corresponds with the route of a gas pipeline. The majority of the remaining anomalies that have been identified also seem to be relatively modern in nature, relating to the period after the site was landscaped once the coal extraction had finished and subsequent agricultural practices, such as drainage, ploughing and a grass track. Nothing of archaeological significance has been identified.

5.2 In light of negative results to date and known modern land use, it is currently considered that further archaeological evaluation of the site is unlikely to be productive.

6.0 STORAGE AND CURATION

6.1 The records of the geophysical survey are currently held by NAA. It is intended that the site archive will be transferred to the appropriate repositories. All material will be appropriately packaged for long-term storage in accordance with both national guidelines (English Heritage 2008; CIfA 2014) and to the requirements of the appropriate museum.

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Google Earth (2017) Satellite imagery copyright Getmapping plc

APPENDIX A
TECHNICAL INFORMATION

Instrumentation

The Bartington 601-2 is a single axis, vertical component fluxgate gradiometer comprising a data logger battery cassette and two sensors. The sensors are Grad-01-1000L cylindrical gradiometer sensors mounted on a rigid carrying frame, each sensor contains two fluxgate magnetometers with 1m vertical separation.

The Magnetometer records two lines of data on each traverse, the grids are walked in a zig-zag pattern amounting to 15 traverses. The gradiometers are calibrated at the start of every day and recalibrated whenever necessary.

The difference in the magnetic field between the two fluxgates in each sensor is measured in nanoTesla (nT) and for this investigation the readings are measured at 0.1nT. The units' sensors can measure down to 1m from the ground level depending on the ground conditions.

Readings reach between +/-100nT and lower readings are created by upstanding or harder remains such as walls or areas of stone, higher readings are created by softer or cut features, such as ditches and pits (see below).

Magnetic anomalies and terminology

The different magnetic anomalies can represent different features created by soil and geology, human activity, modern services etc.

Positive linear anomalies are dark lines often caused by archaeological features, such as ditches and field boundaries but can also be natural.

Positive points represent cut features which can be archaeological or natural.

Positive linear anomalies with associated negative responses with strong readings are often modern services such as cables; however weaker responses can be archaeological features such as earthworks.

Negative linear anomalies represent earthworks, walls and other upstanding or compacted remains. Negative points can represent archaeological or natural features.

Bipolar readings are composed of negative and positive readings often created by linear features such as pipelines.

Dipolar readings are single positive responses with a surrounding negative response. Strong responses tend to be caused by ferrous objects.

Areas of heating/burning or heated objects produce thermoremanent responses as this creates a magnetic field. These can appear as bipolar responses or as magnetic debris depending on whether it is in situ, or moved into place.

Magnetic debris is noticeable as areas of positive and negative responses, which can relate to general ground disturbance, spreads of ferrous debris or areas of rubble.

High amplitude magnetic disturbance is caused by standing metal structures such as fencing and buildings. This can cause interference extending out from the structure, across the area and is often found at the edges of the survey area.

Variable weak magnetic responses can demonstrate natural features or changes in geology or soil type.

Limitations

Poor results can be due to several factors including short lived archaeological occupation/use or sites with minimal cut or built features. Results can also be limited in areas with soils naturally deficient in iron compounds or in areas with soils overlying naturally magnetic geology, which will produce strong responses masking archaeological features.

Overlying layers such as demolition rubble or layers of made ground can hide any earlier archaeological features. The presence of above ground structures and underground services containing ferrous material can distort or mask nearby features.

Particularly uneven or steep ground can distort results beyond the capabilities of processing to even out. Over processing of data can also obscure features.

Processing and figures

The processing is undertaken using Geoplot 3.0 software, and the following processing techniques:

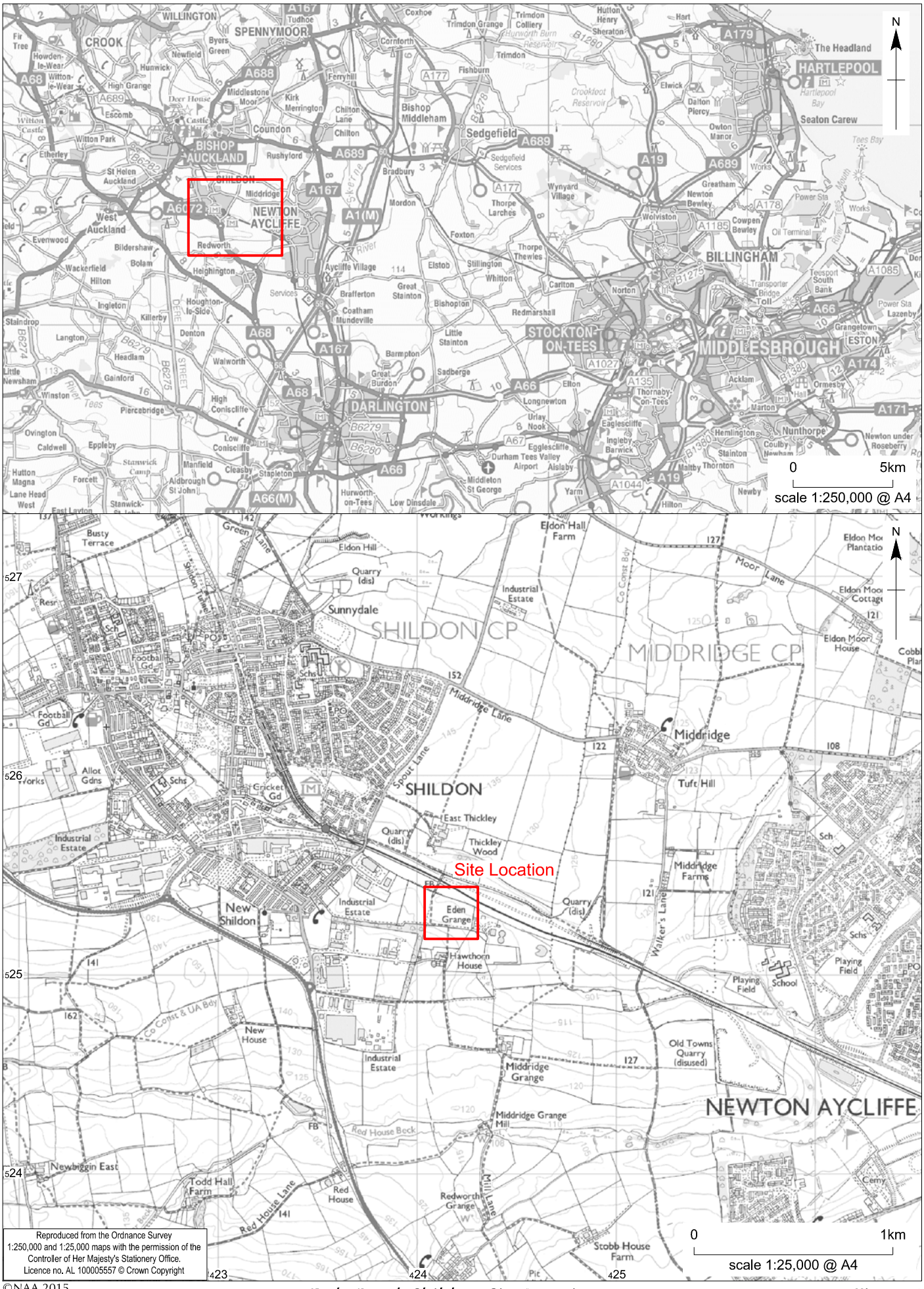
- Zero Mean Traverse - to remove directional effects inherent in the survey,
- Destagger - to shift the traverses back or forward to correct for user error,
- Clipping - to enhance the weaker features, by reducing the readings above a set value,
- Despike - removing data points that are above an appropriate mean to reduce the appearance of dominant readings, created by modern ferrous objects distorting the results,
- Multiply – this function multiplies the data by a positive or negative value. This normalises data between different operators,
- High pass filter - reduces geological effects from the data.
- Low pass filter - Decreases the correlation between neighbouring cells effectively smoothing the data
- Interpolation – reduces the blocky effect of the survey smoothing the appearance of the data.

The data is used to produce a series of images to demonstrate the results of surveys these are detailed below:

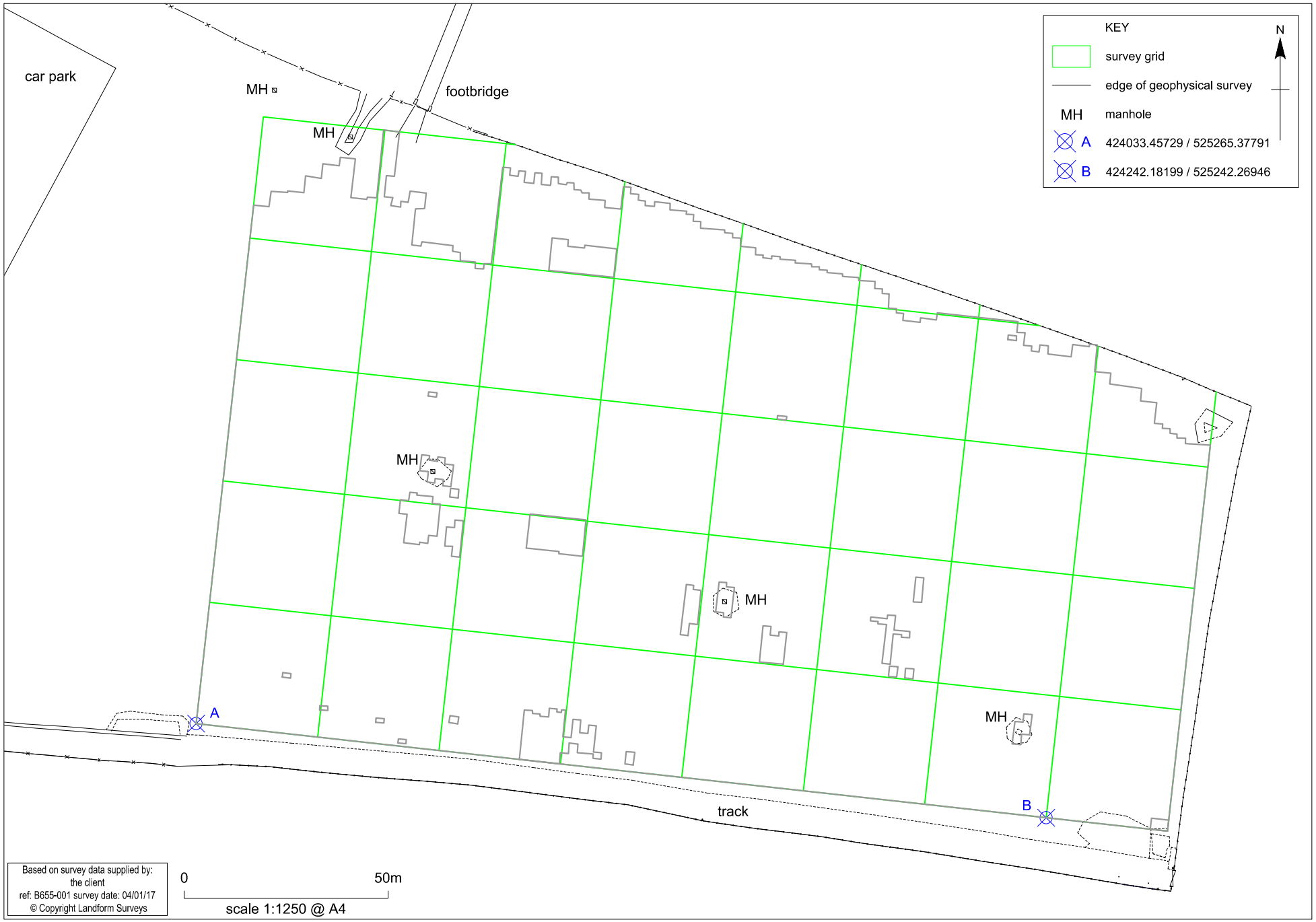
- Greyscale/Colourscale Plot – This demonstrates the results as a shaded drawing with highest readings showing as black, running through different shades to lowest showing as white. This can also be created using a colour pallet to demonstrate the different values.

- XY Trace Plot – This creates a line drawing showing the peaks and troughs of the readings as vertical offset from a centreline.

- Interpreted data – This is created to show features and particular high or low readings to re enforce and clarify the written interpretation of the data. This is based on the Greyscale plot but with different colours representing the various readings.



Dale Road, Shildon: Site Location *Figure 1*



Dale Road, Shildon: site grid

Figure 2

minimally processed data

N

15.82
13.21
10.59
7.98
5.36
2.75
0.14
-2.48
-5.09
-7.70
-10.32
-12.93
-15.54 nT

Pallette:grey55.ptt

0 50m

scale 1:2000 @ A4

processed data

NAA
Heritage Consultants

10.07
8.40
6.74
5.08
3.42
1.75
0.09
-1.57
-3.23
-4.90
-6.56
-8.22
-9.88 nT

Pallette:grey55.ptt

Based on survey data supplied by:
the client
ref: B655-001 survey date: 04/01/17
© Copyright Landform Surveys

XY plot

XY scale

56.29 nT

interpretation

KEY

positive response (probable archaeology) (greater / lesser)

negative response (probable archaeology)

trends

ridge and furrow / ploughing

increased magnetic response

dipolar response (ferrous objects)

bipolar response (modern)

above surface features causing anomalies

edge of geophysical survey

MH manhole

MH
track
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

Dale Road, Shildon: greyscale and xy plots and interpretation

Figure 3