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**Hartlepool Water  
Wynyard Area Mains Reinforcement  
Alternative Route Option 5**

**Geophysical Survey Report MSNZ23**

**For  
Trent and Peak Archaeology**

**On Behalf Of  
Anglian Water**

**Magnitude Surveys Ref: MSNZ23**

**May 2016**



**magnitude  
surveys**

**Unit 17, Commerce Court**

**Challenge Way**

**Bradford**

**BD4 8NW**

**+44 (0)1274 926020**

**info@magnitudesurveys.co.uk**

**Report Written by:**

Graeme Attwood MSc MCifA

**Figures Produced by:**

Finnegan Pope-Carter BSc MSc

**Report Checked by:**

Chrys Harris BA MSc

**Draft Issued:**

27 May 2016

## **Abstract**

Magnitude Surveys was commissioned to assess the nature of the archaeological landscape across a c. 1.5 ha corridor of land around the south of Dalton Piercy, near Hartlepool, Tees Valley through geophysical survey. Due to unsuitable conditions for survey, approximately 50% was successfully surveyed using the magnetic method. Magnitude Survey was also commissioned to expand on the 2015 geophysical survey of an area in which an anomaly of probable archaeological origin was detected (MS Report MSNZ05B, 2015). Overall, the geophysical results primarily reflect agricultural and modern activity. No further anomalies of an archaeological origin have been detected.

## Contents

1. Introduction .....	1
2. Quality Assurance .....	1
3. Objectives.....	1
4. Geographic Background .....	2
5. Archaeological Background.....	2
6. Methodology.....	2
6.1. Data Collection.....	3
6.2. Data Processing.....	3
6.3. Data Visualisation .....	4
7. Survey Considerations .....	4
8. Results.....	5
8.1. Qualification.....	5
8.2. Discussion.....	5
8.3. Interpretation.....	5
9. Conclusions .....	6
10. Archiving .....	6
11. Copyright.....	6
12. References .....	7

## List of Figures

Figure 1:	Site Location		1:25,000 @ A4
Figure 2:	Location of Survey Areas		1:10,000 @ A3
Figure 3:	Magnetic Greyscale	Area 7: 2015 Expansion	1:1000 @ A3
Figure 4:	Magnetic Interpretation	Area 7: 2015 Expansion	1:1000 @ A3
Figure 5:	Magnetic Greyscale	Areas 2 & 3	1:1000 @ A3
Figure 6:	Magnetic Interpretation	Areas 2 & 3	1:1000 @ A3
Figure 7:	Magnetic Greyscale	Areas 2, 3 & 4	1:1000 @ A3
Figure 8:	Magnetic Interpretation	Areas 2, 3 & 4	1:1000 @ A3
Figure 9:	Magnetic Greyscale	Area 5	1:2500 @ A3
Figure 10:	Magnetic Interpretation	Area 5	1:2500 @ A3
Figure 11:	Magnetic Interpretation – Satellite Imagery	Areas 2-5	1:2500 @ A3
Figure 12:	Magnetic Interpretation – Historic Mapping	Areas 2-5	1:2500 @ A3

## 1. Introduction

- 1.1. Magnitude Surveys Ltd (MS) was commissioned by Trent and Peak Archaeology (TPA) on behalf of Anglian Water (AW) to undertake a geophysical survey across a corridor of land around Dalton Piercy (NZ 462 314), near Hartlepool, Tees Valley. A survey expanding on Area 6 (NZ 434 307) undertaken in 2015 (MS Report MSNZ05B, 2015) was also successfully completed.
- 1.2. The geophysical survey comprised hand pulled, cart-mounted fluxgate gradiometer survey.
- 1.3. The survey was conducted in line with the current best practice guidelines produced by Historic England (David et al., 2008), the Chartered Institute of Field Archaeologists (CIfA, 2014) and the European Archaeological Council (Schmidt et al., 2015).
- 1.4. The survey commenced on 16 May 2016 and took two days to complete.

## 2. Quality Assurance

- 2.1. Project management, survey work, data processing and report production have been carried out by qualified and professional geophysicists to standards exceeding the current best practice (CIfA, 2014; David et al., 2008, Schmidt et al., 2015).
- 2.2. Magnitude Surveys is a corporate member of ISAP (International Society of Archaeological Prospection).
- 2.3. Director Graeme Attwood is a Member of the Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, as well as a member of GeoSIG, the CIfA Geophysics Special Interest Group.
- 2.4. Director Finnegan Pope-Carter is a Fellow of the London Geological Society, the chartered UK body for geophysicists and geologists, as well as a member of GeoSIG, the CIfA Geophysics Special Interest Group.
- 2.5. All MS staff members have postgraduate qualifications in archaeological geophysics.

## 3. Objectives

- 3.1. The geophysical survey aimed to assess the potential archaeological landscape of the survey area.
- 3.2. The survey forms part of the archaeological mitigation required by the planning archaeologist and shall be used to inform the location of any trenches, should they be required.
- 3.3. The 2015 geophysical survey of the Embleton-Dalton Piercy northern route detected an anomaly of probable archaeological origin (MS Report MSNZ05B, 2015). This survey further expanded on the area immediately south of this anomaly to determine the limits of any associated archaeology.

## 4. Geographic Background

- 4.1. The underlying geology comprises Roxby formation (mudstone), Sherwood Sandstone Group (sandstone) and Ford formation (dolostone) with superficial deposits of Devensian till (BGS 2015). Historic England guidelines state mudstone geology can produce average magnetic responses, with variable responses over till, depending on depth (David *et al.* 2008).
- 4.2. The soils are primarily slowly permeable, seasonally wet slightly acid but base-rich loamy and clayey soils (Soilscapes, 2016).
- 4.3. Survey was undertaken across a corridor of farmland approximately 2 km long and was predominantly flat. A description of each individual area can be found in section 7.

## 5. Archaeological Background

- 5.1. The majority of the survey area has not been the subject of any previous archaeological geophysical surveys or other archaeological work.
- 5.2. The archaeological brief for the project states that:

*"...the general area was highly populated from at least the later Iron Age onwards (e.g. ring ditches at Red Gap Moor – HER 8076), with major multi-period sites at Stob House (HER 0609) and east of Brierton (HER 8263).*

*During the medieval period the area included nucleated settlements at Dalton Piercy (HER 0682) and Brierton (HER 0772) with a complex of dispersed farmsteads such as Amerston Hall (HER 8142) Close Farm (HER 0638), Red Gap (HER 0600) and High Stotfold (HER 8238)." (Rowe, 2015).*

- 5.3. Along the line of the proposed pipeline route, a number of artefacts have been recorded. These artefacts include prehistoric flint (HER 1670 & 1699), prehistoric animal remains (HER 825) and Romano British pottery (HER 1756 & 1758). A First World War army barracks (HER 8400) is recorded approximately 200 m south of the Pipeline at the eastern end north of Dalton Piercy (Tees Archaeology, 2015).

## 6. Methodology

### 6.1. Data Collection

6.1.1. Geophysical prospection comprised the magnetic method as described in the following table.

6.1.2. Table of survey strategies:

Method	Instrument	Traverse Interval	Sample Interval
Magnetic	Bartington Instruments Grad-13 Digital Three-Axis Gradiometer	1 m	200 Hz reprojected to 0.125 m

6.1.3. The magnetic data were collected using MS' bespoke hand-pulled cart system.

6.1.3.1. The cart system supports the magnetic and GPS instruments with a bespoke datalogger. The magnetic instrument comprises four Bartington Instruments Grad-13 Digital Three-Axis Gradiometers. Positional referencing is through a Hemisphere S321 GNSS Smart Antenna RTK GPS outputting in NMEA mode to ensure high positional accuracy of collected measurements. The Hemisphere S321 GNSS Smart Antenna is accurate to 0.008 m + 1 ppm in the horizontal and 0.015 m + 1 ppm in the vertical.

6.1.3.2. Magnetic and GPS data were logged on a USB flash drive housed in MS' bespoke data-logger and transferred to a laptop computer for processing.

6.1.3.3. A series of temporary sight markers were established in each survey area to guide the surveyor and ensure full coverage with the cart. Data were collected by traversing the survey area along the longest possible lines, to ensure that the data was efficiently collected and processed.

### 6.2. Data Processing

6.2.1. Magnetic data were processed in bespoke in-house software produced by MS. Processing steps were limited to:

Zero Median Traverse – The median of each sensor traverse is calculated within a specified range and subtracted from the collected data. This removes striping effects caused by small variations in sensor electronics.

Projection to a Regular Grid – Data collected using RTK GPS positioning requires a uniform grid projection to visualise data. Data are rotated to best fit an orthogonal grid projection and are resampled onto the grid using an inverse distance weighting algorithm.

Interpolation to Square Pixels – Data are interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

### 6.3. Data Visualisation

6.3.1. Geophysical results have been interpreted using greyscale images and XY traces in a layered environment. The geophysical results have been interpreted in consideration with satellite imagery and historic mapping.

6.3.2. This report presents geophysical results as greyscale images. Greyscale images should be viewed alongside the XY trace plots, found on the archive disk. XY trace plots visualise the magnitude and form of the geophysical response, aiding in anomaly interpretation.

## 7. Survey Considerations

Survey Area	No. Survey Blocks	Surveyed Y/N	Ground Conditions	Further notes:
7	1	Y	Cereal crop, approximately 30-40 cm tall	Expansion of 2015 survey
1	3	N	Chest high oil-seed rape precluded survey	Not surveyable due to tall crop
2	2	Y	Cereal crop, approximately 20-30 cm tall	
3	1	Y	Paddock, long thick grass	
4	1	Y	Paddock, long thick grass	
5	2	Y	Cereal crop, approximately 20-30 cm tall	
6	2	N	Paddock, contained horses.	Not surveyable due to presence of horses

Refer to Figure 2 for survey area locations.



## 8. Results

### 8.1. Qualification

8.1.1. *Geophysical techniques are not a map of the ground and are instead a direct measurement of subsurface properties. Detecting and mapping features requires that said features have properties that can be measured by the chosen technique(s) and that these properties have sufficient contrast with the background to be identifiable. The interpretation of any identified anomalies is inherently subjective. While the scrutiny of the results is undertaken by qualified, experienced individuals and rigorously checked for quality and consistency, it is often not possible to classify all anomaly sources. Where possible an anomaly source will be identified along with the certainty of the interpretation. The only way to improve the interpretation of results is through a process of comparing excavated results with the geophysical reports. MS actively seek feedback on their reports as well as reports of further work in order to constantly improve our knowledge and service.*

### 8.2. Discussion

8.2.1. The geophysical results, both greyscale images and XY traces, were interpreted in consideration with historic mapping (Ordnance Survey, 6" 2<sup>nd</sup> edition c.1882-1913; Figure 11) and satellite imagery (Bing, 2016; Figure 12).

8.2.2. The 2015 geophysical survey of the Embleton-Dalton Piercy northern route detected an anomaly of probable archaeological origin (MS Report MSNZ05B, 2015). This survey further expanded on the area immediately south of this anomaly to determine the limits of any associated archaeology. No further anomalies of an archaeological or potential archaeological origin were detected.

8.2.3. The magnetic method has responded well to the survey area's geological and pedological environment, detecting modern soil disturbance and anomalies associated with agricultural processes. A number of anomalies have been detected and classified as Undetermined. These anomalies exhibit characteristics of anomalies with possible archaeological origin, but due to the limited context of the survey area's size, an agricultural, geological or pedological origin cannot be entirely ruled out. Two buried utilities cross the survey areas. The strong responses from these utilities may mask weaker archaeological features, should they be present.

### 8.3. Interpretation

#### 8.3.1. General Statements

8.3.1.1. Geophysical anomalies will be discussed broadly as classification types across the survey area. Only anomalies that are distinctive or unusual will be discussed individually. Specific anomalies discussed within the text have been assigned numbers, which are emboldened within square parenthesis e.g. [1].

8.3.1.2. **Undetermined** – Anomalies are classified as Undetermined when the anomaly origin is ambiguous through the geophysical results and there is no supporting or correlative evidence to warrant a more certain classification. These anomalies are likely to be the result of geological, pedological or agricultural processes--

although an archaeological origin cannot be entirely ruled out. Undetermined anomalies are generally not ferrous in nature.

- 8.3.1.3. **Ferrous** – A number of discrete ferrous-like anomalies have been mapped throughout the survey. These responses are likely to be the result of modern metallic disturbance on or near the ground surface. Broad ferrous responses from modern metallic features, such as fences, gates, neighbouring buildings and services, may mask any weaker underlying archaeological anomalies should they be present.

### 8.3.2. Magnetic Results - Specific Anomalies

- 8.3.2.1. **Undetermined** – A number of linear anomalies have been detected across the survey area, which run parallel to current and historic field boundaries (Figures 11 & 12). These anomalies exhibit a stronger magnetic signature than similar parallel anomalies that have been categorised as agricultural in origin. These responses are likely the result of historic field boundaries; however, due to the narrow nature of the survey area, other origins cannot be entirely ruled out.

## 9. Conclusions

- 9.1. The geophysical survey has responded well to the survey area's environment. The geophysical results primarily reflect agricultural processes and modern site activity, including buried services. No anomalies of probable or archaeological origin have been identified. No further anomalies of an archaeological or potential archaeological origin were detected in the expansion of the 2015 geophysical survey (MS Report MSNZ05B, 2015).

## 10. Archiving

- 10.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). MS' archive stores unprocessed and processed data.
- 10.2. MS contributes all reports to the ADS Grey Literature Library subject to any time embargo dictated by the client.
- 10.3. Whenever possible, MS has a policy of making data available to view in easy to use forms on its website. This can benefit the client by making all of their reports available in a single repository, while also being a useful resource for research. Should a client wish to impose a time embargo on the availability of data this can be achieved in discussion with MS.

## 11. Copyright

- 11.1. Copyright and the intellectual property pertaining to all reports, figures, and datasets produced by Magnitude Services Ltd. is retained by MS. The client is given full licence to use such material for their own purposes. Permission must be sought by any third party wishing to use or reproduce any IP owned by MS.

## 12. References

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Ordnance Survey, 6<sup>th</sup> 2<sup>nd</sup> edition c.1882-1913. National Library of Scotland, 2016 [<http://maps.nls.uk>]. [Accessed 24/05/2016].

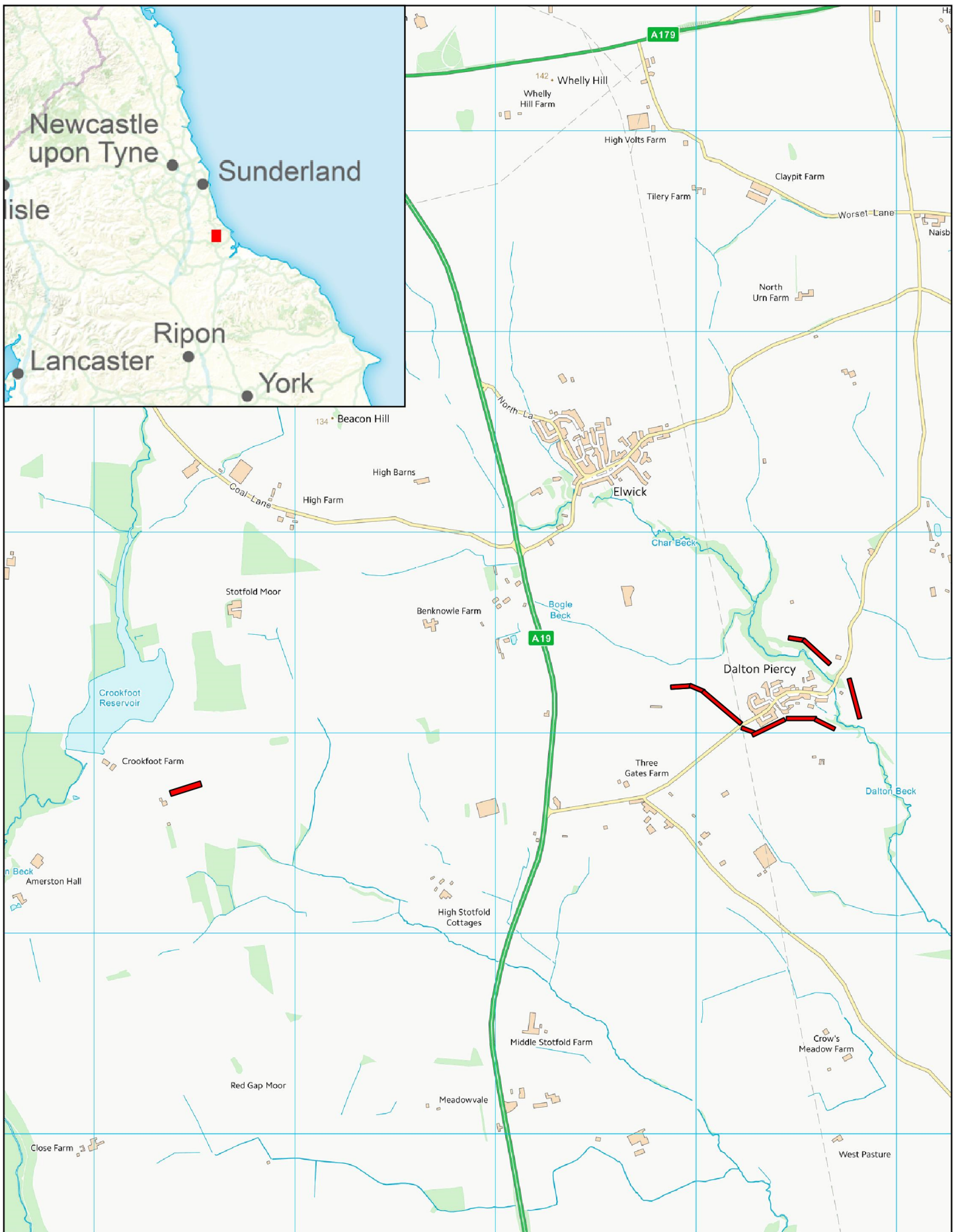
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Tees Archaeology, 2015. Hartlepool, <http://www.teesarchaeology.com/maps/landmap.html> [Accessed 17/11/2015].



MSNZ23 - Wynyard Area Mains Reinforcement: Route 5

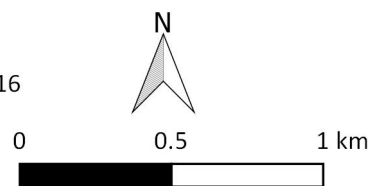
Figure 1 - Site Location

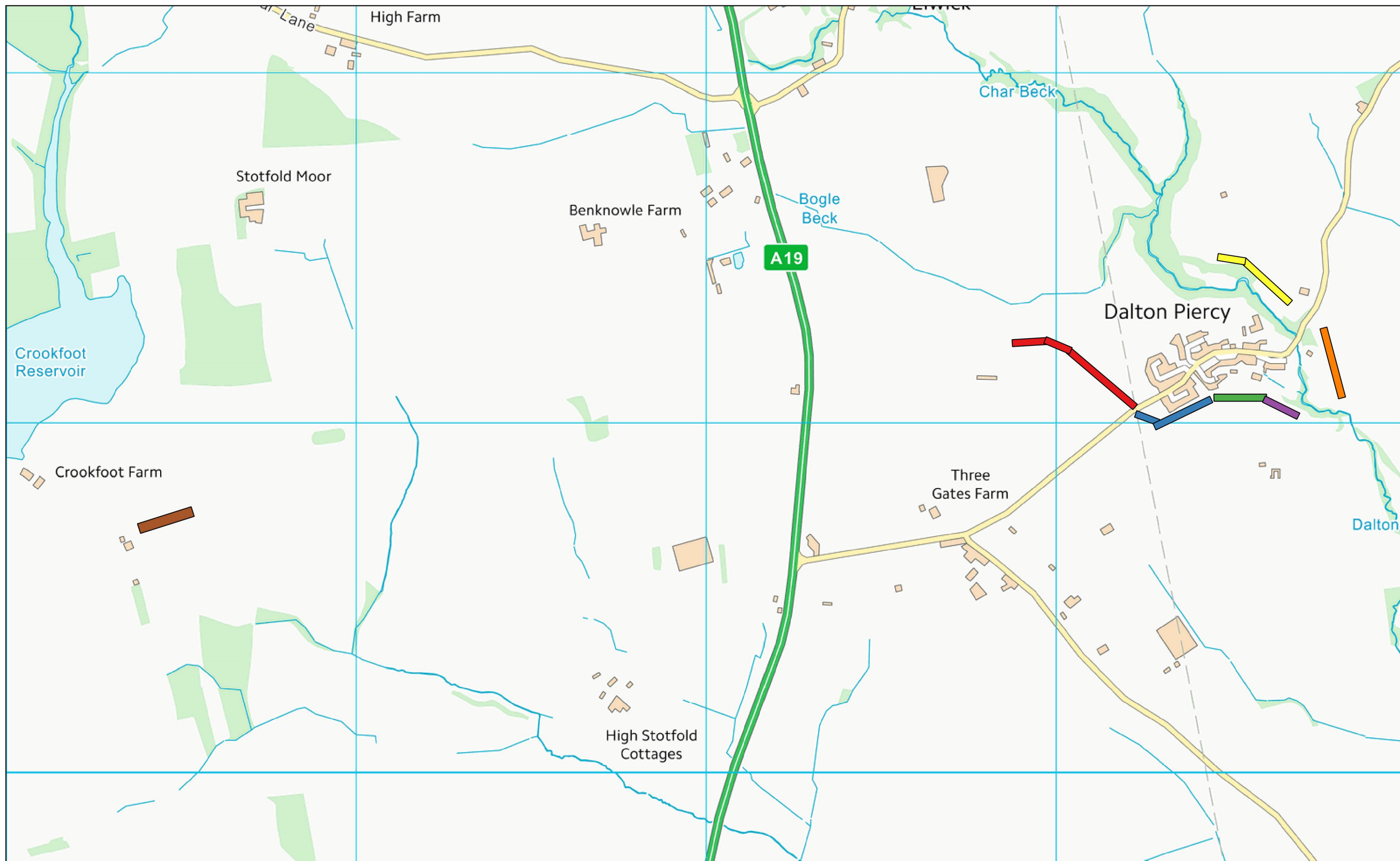
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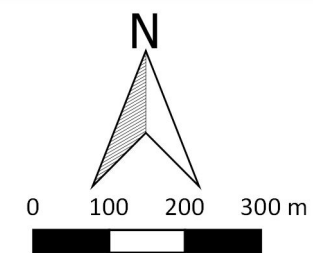
 Pipeline Corridor

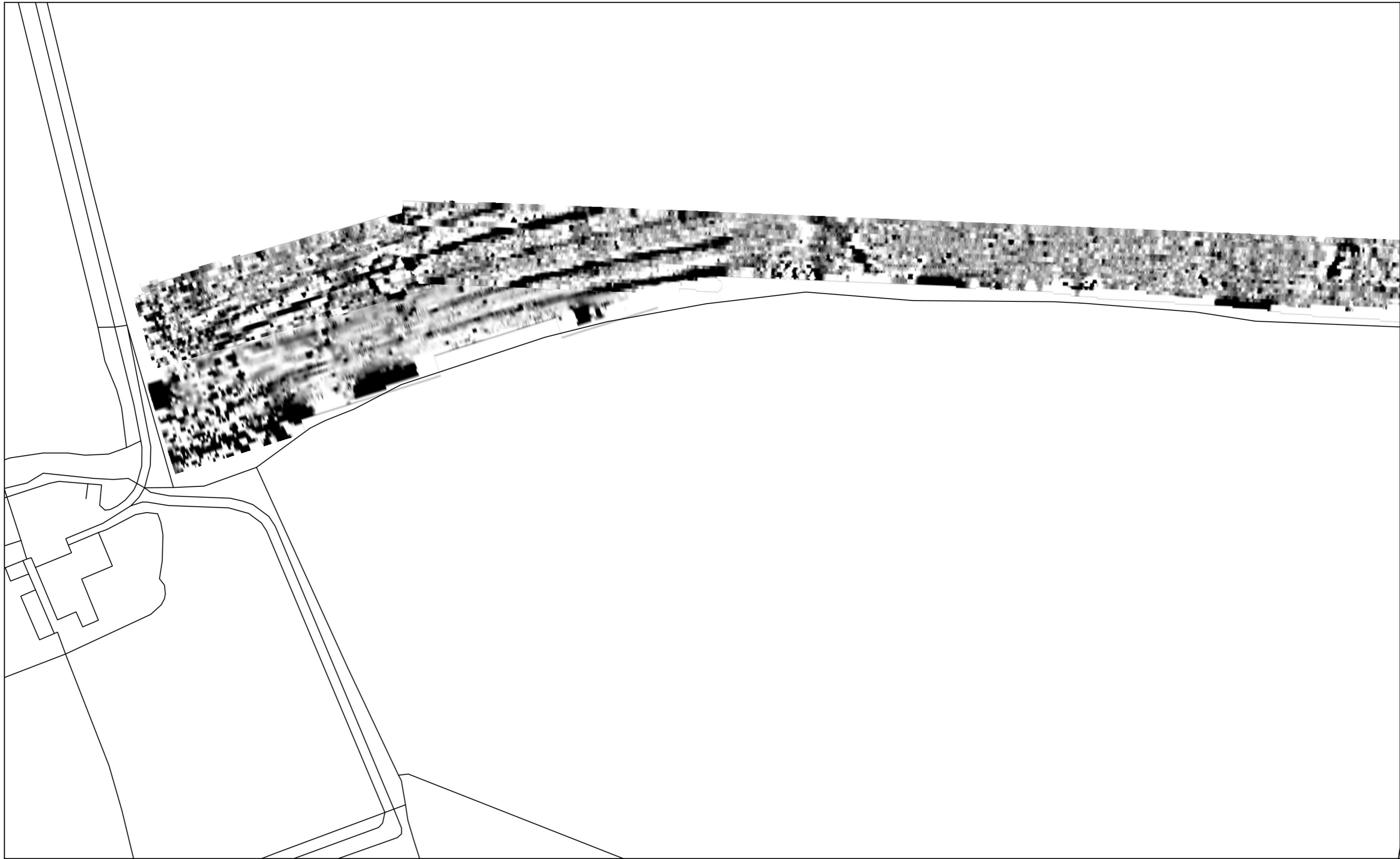




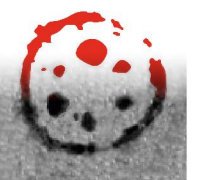
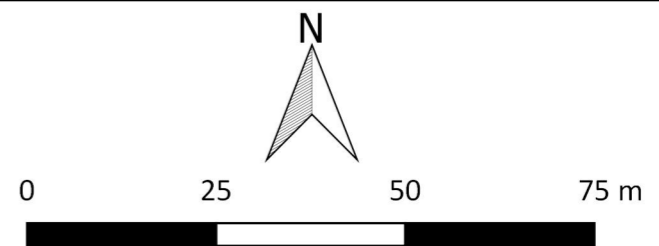
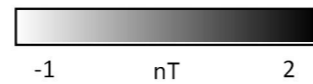
MSN23 - Wynyard Area Mains Reinforcement: Route 5  
 Figure 2 - Location of Survey Areas  
 1 : 10,000 @ A3  
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- |   |  |
|---|--|
| <span style="color: red;">■</span> Area 1 - Unsuited for Survey | <span style="color: purple;">■</span> Area 4                       |
| <span style="color: blue;">■</span> Area 2                      | <span style="color: orange;">■</span> Area 5                       |
| <span style="color: green;">■</span> Area 3                     | <span style="color: yellow;">■</span> Area 6 - Unsuited for Survey |
|   | <span style="color: brown;">■</span> Area 7                        |

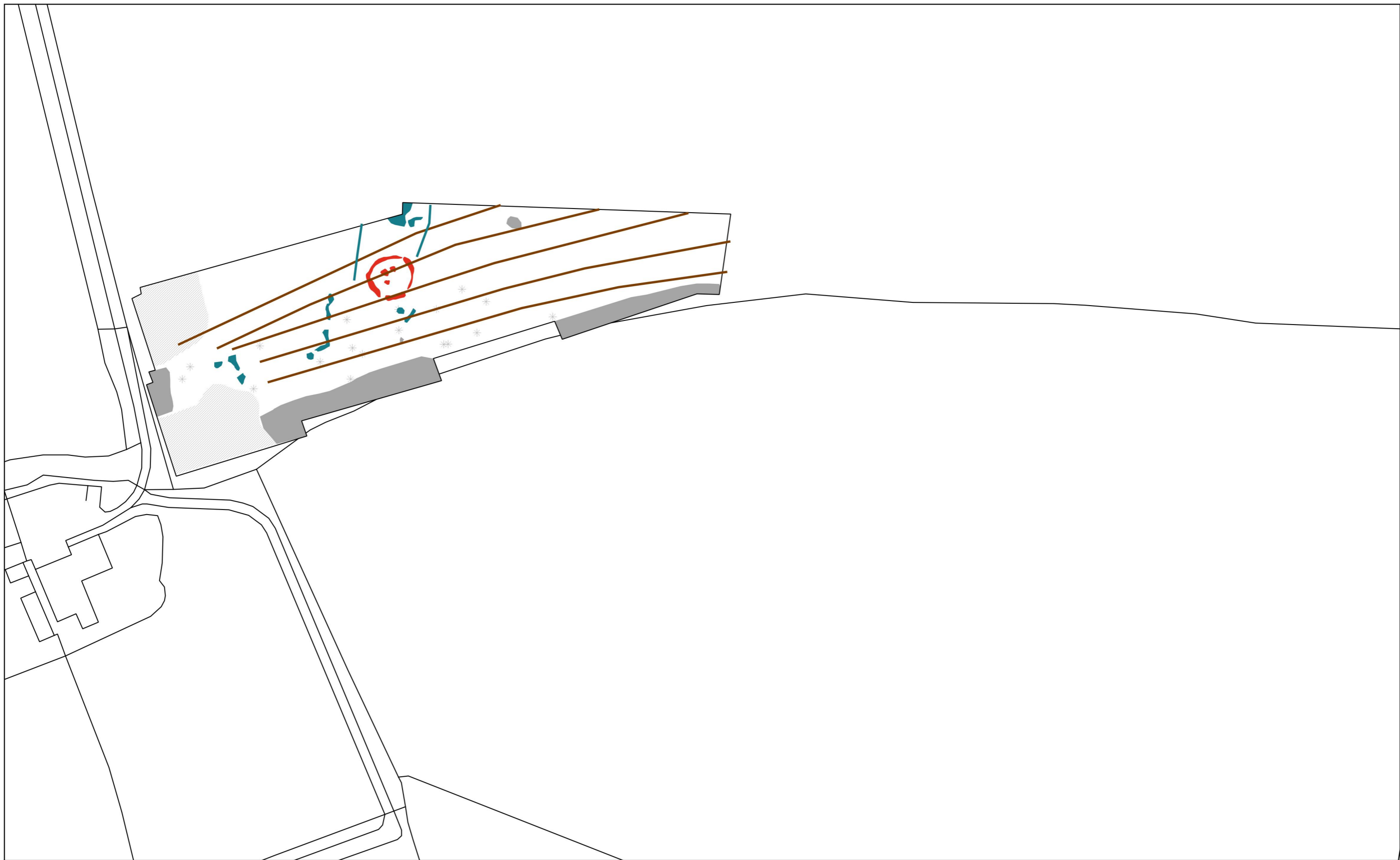




MSNZ23 - Wynyard Main Reinforcement Scheme - Route 5  
Figure 3 - Magnetic Greyscale  
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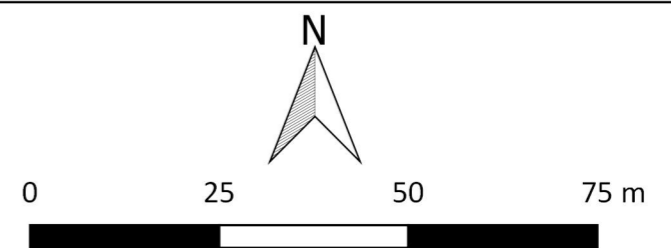
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MSNZ23 - Wynyard Main Reinforcement Scheme - Route 5  
 Figure 4 - Magnetic Interpretation  
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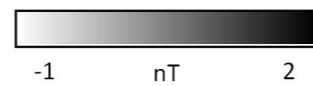
**Legend**

- |                               |                  |                       |
|-------------------------------|------------------|-----------------------|
| Archaeology Probable (Strong) | Ferrous (Spread) | Agricultural (Strong) |
| Undetermined (Strong)         | Survey Border    | Ferrous (Points)      |
| Ferrous (Dipolar)             | Undetermined     |                       |



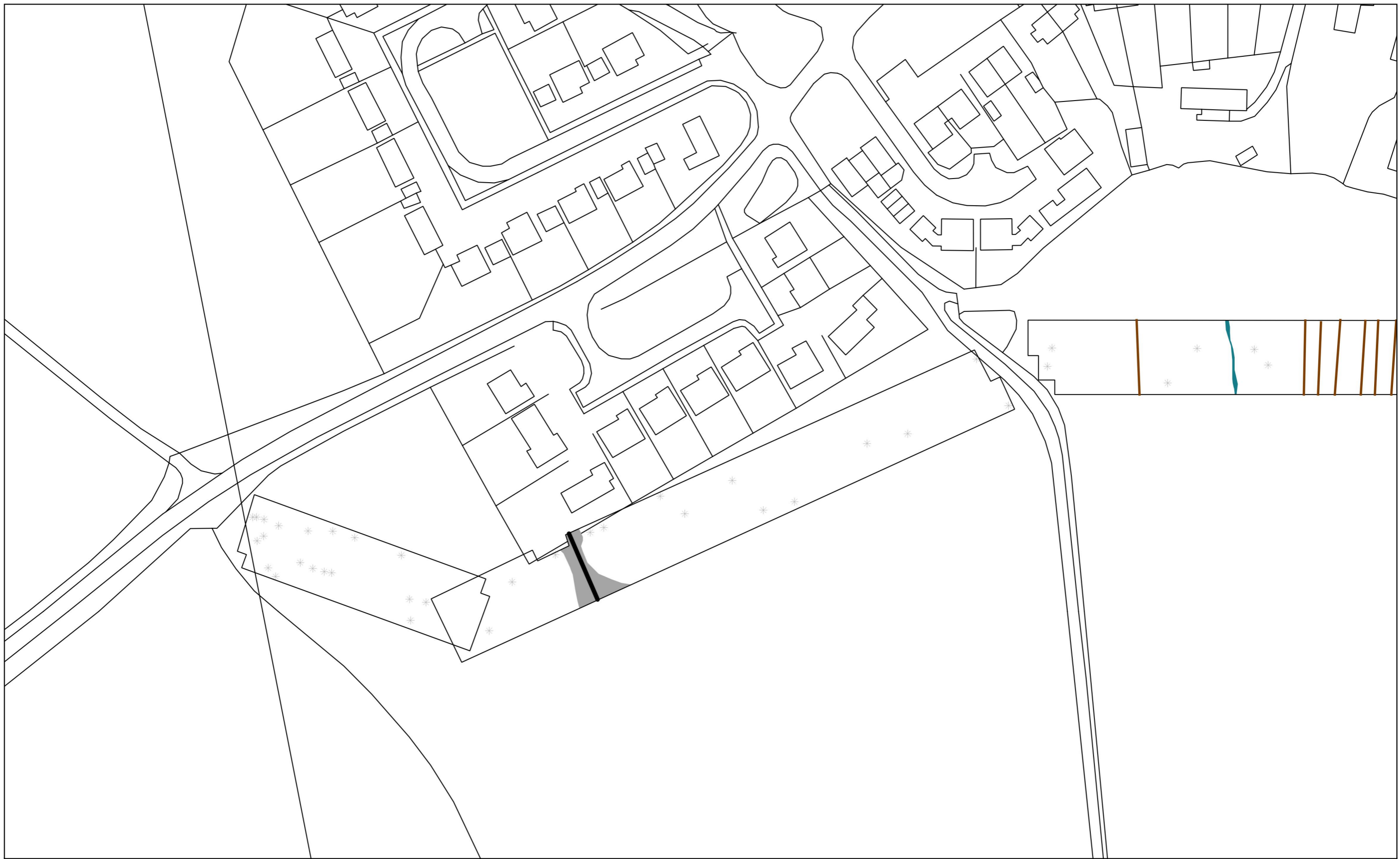


MSNZ23 - Wynyard Main Reinforcement Scheme - Route 5  
Figure 5 - Magnetic Greyscale  
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




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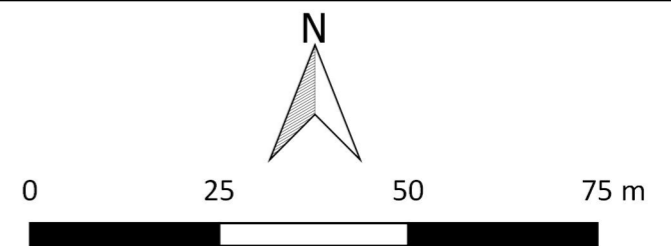




MSNZ23 - Wynyard Main Reinforcement Scheme - Route 5  
 Figure 6 - Magnetic Interpretation  
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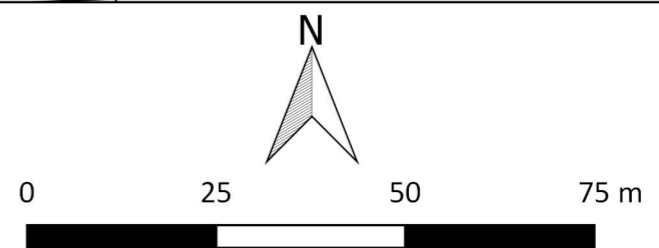
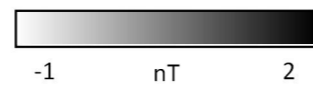
**Legend**

- |   |   |  |
|---|---|--|
|  Undetermined (Strong) |  Survey Border         |  Service          |
|  Ferrous (Dipolar)     |  Agricultural (Strong) |  Ferrous (Points) |













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Figure 7 - Magnetic Greyscale  
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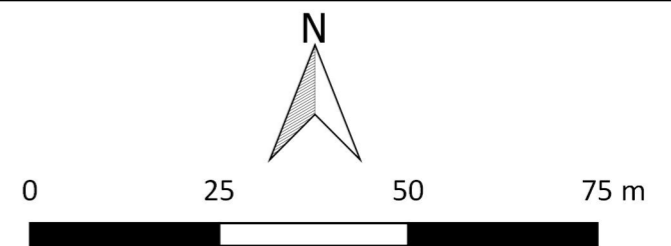




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 Figure 8 - Magnetic Interpretation  
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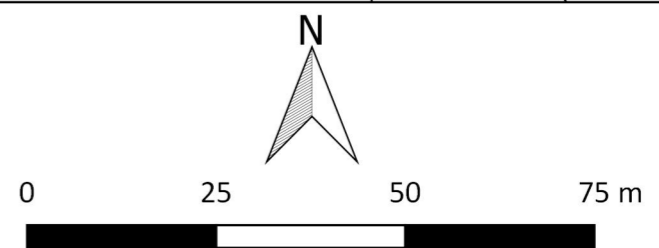
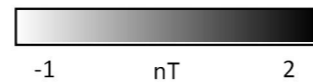
**Legend**

- |   |   |   |
|---|---|---|
|  Undetermined (Strong) |  Ferrous (Dipolar) |  Agricultural (Strong) |
|  Undetermined (Weak)   |  Ferrous (Spread)  |  Ferrous (Points)      |
|  Agricultural (Weak)   |  Survey Border     |   |





MSNZ23 - Wynyard Main Reinforcement Scheme - Route 5  
Figure 9 - Magnetic Greyscale  
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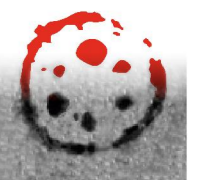
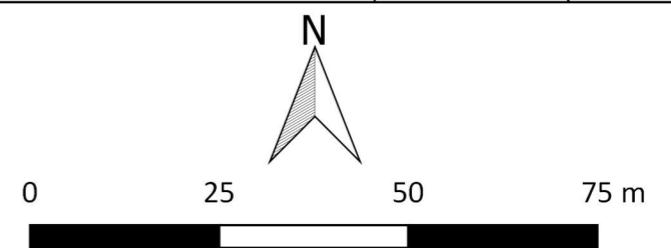




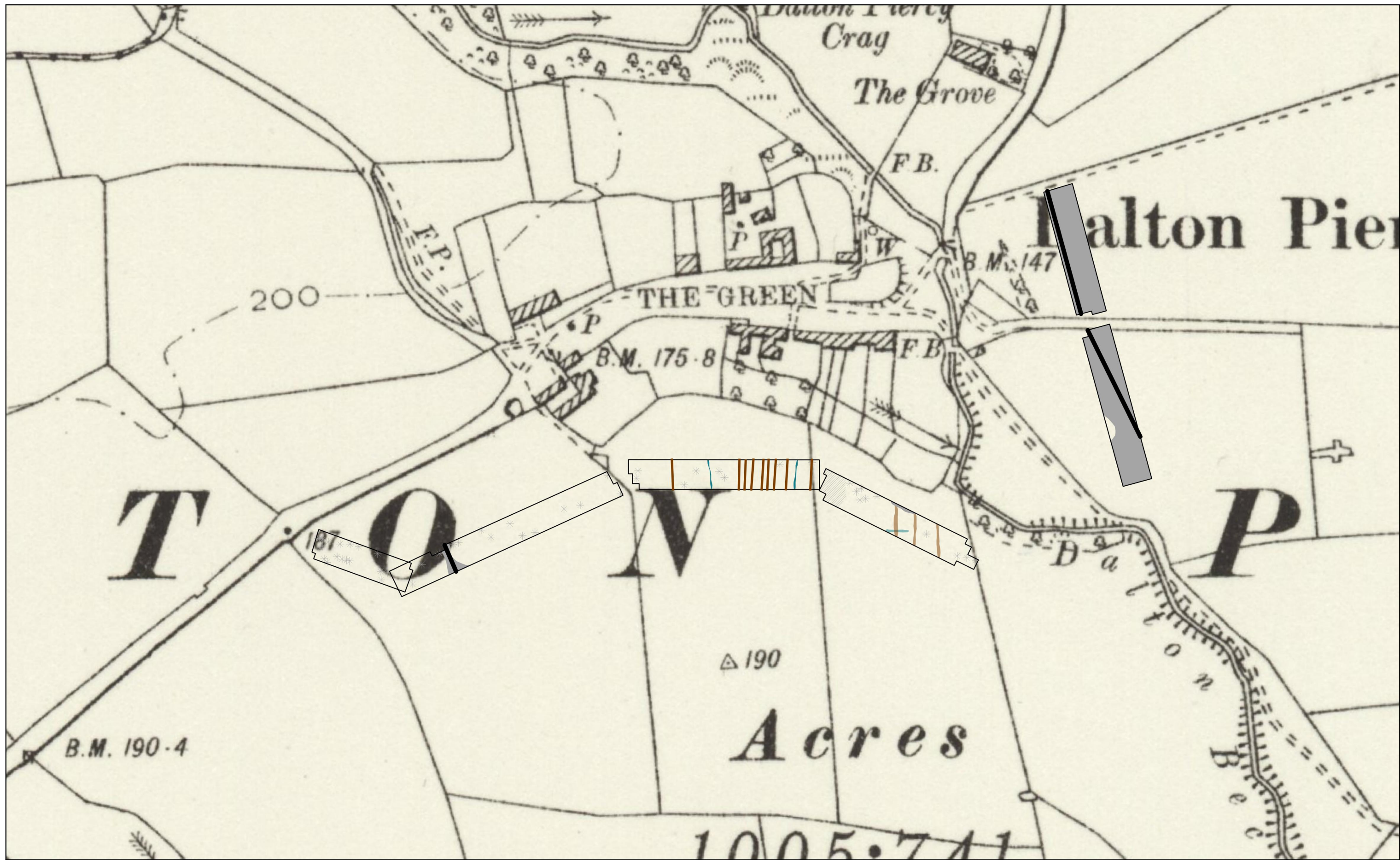
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Figure 10 - Magnetic Interpretation  
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### Legend

■ Ferrous (Dipolar) □ Survey Border — Service



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MSN223 - Wynyard Main Reinforcement Scheme - Route 5

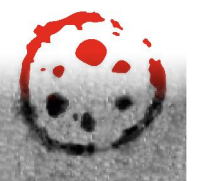
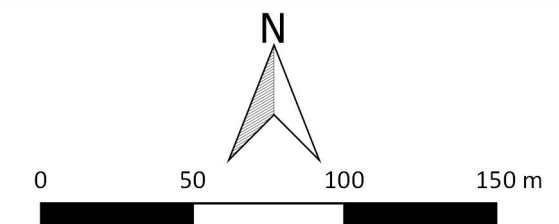
Figure 11 - Historic Mapping

1 : 2500 @ A3

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Historic mapping Ordnance Survey, 6" 2nd edition c.1882-1913. National Library of Scotland










- |  |   |   |
|--|---|---|
|  Undetermined (Strong) |  Ferrous (Dipolar) |  Agricultural (Strong) |
|  Undetermined (Weak)   |  Ferrous (Spread)  |  Service               |
|  Agricultural (Weak)   |  Survey Border     |  Ferrous Spike         |



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MSNZ23 - Wynyard Main Reinforcement Scheme - Route 5  
 Figure 12 - Satellite Imagery  
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- |   |   |   |
|---|---|---|
|  Undetermined (Strong) |  Ferrous (Dipolar) |  Agricultural (Strong) |
|  Undetermined (Weak)   |  Ferrous (Spread)  |  Service               |
|  Agricultural (Weak)   |  Survey Border     |  Ferrous Spike         |

