

# Heckington Fen Solar Park

ENO10123

**Environmental Statement | Volume 3: Technical Appendices**  
**Appendix 10.2: Geophysical Survey Results for Energy Park**  
Applicant: Ecotricity (Heck Fen Solar) Limited

Document Reference: 6.3.10.2  
Pursuant to: APFP Regulation 5(2)(a)

February 2023



**APPENDIX 10.2 - GEOPHYSICAL SURVEY RESULTS FOR ENERGY PARK**

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<b>Prepared By</b>	Heckington Fen Energy Park Project Team (Pegasus) (Sumo) (Headland Archaeology) (ASWYAS) (Magnitude Surveys)	
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<b>Version</b>	<b>Date</b>	<b>Version Status</b>
Rev 1	February 2023	Application Version

# Heckington Fen Energy Park

## Summary of Geophysical Survey Results

<b>THE COLLECTION ACCESSION NO:</b>	LCNCC: 2022.55
<b>PEGASUS REF:</b>	P20-2370
<b>AUTHOR:</b>	Dr Elizabeth Pratt (MCIfA)
<b>DATE:</b>	18 <sup>th</sup> May 2022

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### **Introduction**

- 1.1 Pegasus Group, on behalf of Ecotricity (Heck Fen Solar) Limited, intend to make a Development Consent Order application for ground-mounted solar panels and an energy storage facility on c.586.85ha of agricultural land outlying Six Hundreds Farm on Six Hundreds Drove at East Heckington, a below-ground grid connection to Bicker Fen substation, and all associated infrastructure works.
- 1.2 Jan Allen and Matthew Adams, the archaeological advisors to Lincolnshire County Council, and Denise Drury, the archaeological advisor to North Kesteven and Boston District Councils, have identified a need for the application to be informed by staged assessment work to characterise the known and potential archaeological resource of the proposed development site and to assess the development impacts thereupon.
- 1.3 The staged assessment work includes geophysical (magnetometry) survey. Given the size of the proposed development site, a single contractor could not complete the survey during the relatively narrow window when ground conditions were anticipated to be dry and when crop was expected to be at a fairly damage-resistant stage of growth. As such, the site was split into quadrants, shown on Figure 1, and allocated to four contractors as follows:
  - Area 1 (c.112ha) – SUMO
  - Area 2 (c.178ha) – Headland Archaeology
  - Area 3 (c.112ha) – ASWYAS
  - Area 4 (c. 115ha) – Magnitude Surveys
- 1.4 The surveys were carried out in late March and early to mid-April 2022. Full details of the survey methodology and aims and objectives, and approaches to data processing, analysis, reporting, and archiving were outlined in an overarching Written Scheme of Investigation (WSI) prepared by Pegasus Group (PG 2022a), with the individual WSIs prepared by each contractor provided as an appendix. The documents were submitted to the archaeological advisors prior to commencement.
- 1.5 Each contractor has prepared a survey report for their respective Area. The intention of this Summary is to describe, illustrate and discuss the data from each Area in the

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context of the proposed development site as a whole, in order to fully understand the archaeological potential of the proposed development site and to inform discussions with the archaeological advisors regarding the need for, and the timing and scope of, additional archaeological evaluation and mitigation.

### **Results**

- 1.6 The survey data from all four Areas is principally characterised by magnetic responses deriving from the superficial geology and palaeochannels, and 18<sup>th</sup>-century and later agricultural activity. Only in Areas 2 and Area 4 have anomalies of a probable and/or possible archaeological origin been identified. The combined interpretation plots are illustrated on Figure 2.
- 1.7 In **Area 1**, geological responses are especially strong in the fields between Head Dike and Labour in Vain Drain. Magnetic disturbance and adjoining rectilinear trends in the far north correspond with the former enclosures and buildings of New Grange Farm, as first shown on the 1888 Ordnance Survey (OS) map. Linear trends representing other former field boundaries shown on the 1888 OS map were identified elsewhere, together with intermittent plough trends. Of uncertain origin are a broadly west/east-aligned linear crossing the four fields to the south of Labour in Vain Drain, two short parallel linears and discrete pit-like features in the south-west, indeterminate small clusters in fields directly north of Labour in Vain Drain, and several scattered pit-like responses.
- 1.8 In **Area 2**, geological responses account for 80% of the collected data. Broad sinuous anomalies representing former meandering channels and feeder streams can be seen. Magnetic disturbance recorded midway along the eastern boundary corresponds with the former location of an outfarm shown on the 1888 OS map. Former field boundaries shown on the 1888 OS map were identified predominantly in the central and southern fields. Modern field drains were detected in the far south-western corner. In the field to their east are some multidirectional linear trends that may form irregularly-shaped enclosures and are classified as possible archaeology.
- 1.9 In **Area 3**, geological responses again dominate the dataset. Palaeochannels and possible oxbow lakes are visible. Agricultural-derived anomalies comprise former field boundaries and the diamond-shaped coverts shown on the 1888 OS map, as well as plough trends. An area of magnetic disturbance just south of centre corresponds with a pond and sheepfold shown on the 1888 OS map. A fragmented linear anomaly that may represent a former continuation of Labour in Vain Drain (or an antecedent) was detected in the north-western corner. Discrete anomalies of uncertain origin were detected to the south-west, and a curving anomaly of uncertain origin was detected to the far south.
- 1.10 In **Area 4**, geological responses are present throughout. Former field boundaries and magnetic disturbance corresponding to former outfarms shown on the 1888 OS map were identified. A documented duck decoy to the north of centre was detected. Anomalies of uncertain origin include a small sub-square enclosure in the field south of the former Six Hundreds Farm, a discrete cluster to the far north, and various linear trends elsewhere. Anomalies of probable and possible archaeological origin include a sub-square enclosure and an oval spread in the north-eastern and eastern parts of the second-northernmost field, and linear and sub-square features along the eastern edge of the field to its south.

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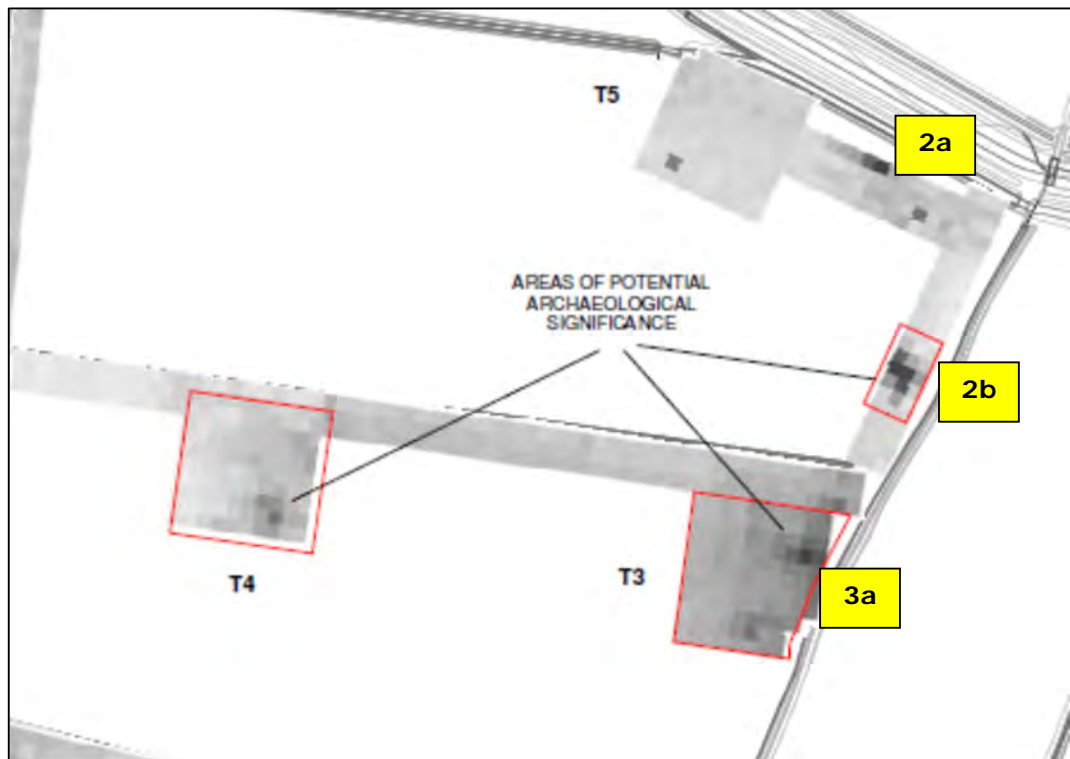
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**Discussion**

- 1.11 The proposed development site comprised saltmarsh before the engineered drainage of this part of the Lincolnshire Fens from the mid-17<sup>th</sup> century onwards. The mottled geological responses in the geophysical survey data relate to the underlying tidal flat superficial deposits; the sinuous trends represent dendritic palaeochannels that were created by sea level transgression and the inland movement of tidal channels. Such features are also clearly visible on historic aerial photographs.
- 1.12 The linear trends identified in the south-western part of Area 2 co-locate with a record for the discovery of briquetage (a coarse ceramic used to make evaporation vessels to extract salt from seawater, an activity known to have taken place in the Iron Age and Roman periods) before/during installation of the North Sea Gas Pipeline in 1971 (Lincolnshire HER ref. MLI87892). Other finds made in 1971 included Roman pottery sherds and tile from the neighbouring field to the south and from another field to the north of Rectory Farm, both in Area 3 (Lincolnshire HER refs. MLI87647, MLI87891).
- 1.13 Probable and possible archaeological anomalies [2b] and [3a] in Area 4 co-locate with areas of magnetic enhancement previously identified by the geophysical survey carried out for Heckington Wind Farm (Plate 1). The 2011 responses were considered suggestive of pits and/or burning, the latter perhaps associated with industrial activity such as salt production (although note that no associated surface finds are recorded in this location; the aforementioned briquetage was found c.1–1.5km to the west).



*Plate 1: Extract from Figure 4 of the geophysical survey report for Heckington Fen Wind Park (Pre-Construct Geophysics 2011)*

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- 1.14 Probable archaeological anomalies [2a] in Area 4 indicate a 45m-wide rectilinear form with discrete responses at its centre. No responses of interest are described in this location by the 2011 survey report although some enhancement is illustrated here in the greyscale (PCG 2011; Plate 1).
- 1.15 Aerial photographs dated 5<sup>th</sup> June 1950 show a pentagon-shaped cropmark of a former post-medieval duck decoy in the northern-central part of Area 4. This feature was discussed in the heritage assessment prepared for the Heckington Wind Farm (OAA 2011). It was only partly-detected by the present geophysical survey, probably because the remainder has been destroyed by repeated ploughing over the decades since the photograph was taken.
- 1.16 Almost all of the former field boundaries detected across the proposed development site are shown on the first edition Ordnance Survey maps of 1888. The only available detailed mapping of the site that pre-dates this is the Heckington parish enclosure map of 1764. It only illustrates land divisions in Area 1, demonstrating a mid-18<sup>th</sup> century origin for the Ordnance Survey-documented (and extant) field layout here and in all likelihood much of the rest of the site too.
- 1.17 OS mapping and aerial photographs document the removal, principally in the late-20<sup>th</sup> century, of certain 18<sup>th</sup>–19<sup>th</sup> century field boundaries and the demolition of all outfarms except for the now-ruinous Six Hundreds Farm located mid-way along Six Hundreds Drove. (NB A different complex, located at the south end of Six Hundreds Drove, appears to have been the original Six Hundreds Farm).
- 1.18 The detection of the probable and possible archaeological anomalies in Areas 2 and 4 and part of the former duck decoy in Area 4, and the uncertain linear and discrete trends and former field boundaries in all Areas, indicate that the geophysical survey technique has been successful on this site. That said, the limitations of magnetometry in identifying small discrete features such as post-holes should be recognised.
- 1.19 Notwithstanding this caveat, the survey results appear to indicate low archaeological potential for much of the site. The notable exceptions are the south-western part of Area 2 and the eastern margin of Area 4, where probable and possible archaeological anomalies have been identified. These responses may derive from Iron Age and/or Roman salt-working, peripheral to the rural settlements indicated by the extensive cropmarks and findspots recorded between Sidebar Lane and Sandless Lane to the west of the site (PG 2022b).
- 1.20 It is suggested that further evaluation of the site should now comprise targeted trial trenching of the survey anomalies of both probable/possible archaeological origin and uncertain origin, to ascertain the character, date, and buried depth of any features. A selection of 'blank' areas should also be lightly tested to clarify the potential masking effect of agricultural trends and/or superficial deposits on buried archaeology.

## **References**

ASWYAS, 2022. *Area 3, Heckington Fen Solar Park, Lincolnshire: Geophysical Survey*. Report No. 3759.

Headland Archaeology, 2022. *Area 2, Heckington Fen Solar Park, Lincolnshire: Geophysical Survey Report*. Project Code HFSF22.

Magnitude Surveys, 2022. *Geophysical Survey Report: Area 4, Heckington Fen Solar Park, Lincolnshire*. Project Code MSTF1200.

Oxford Archaeological Associates, 2011. *Heckington Fen Wind Park, North Kesteven, Lincolnshire. Cultural Heritage Technical Statement Appendix 6.4: Archaeological, Documentary and Cartographic Data*.

Pegasus Group, 2022a. *Heckington Fen Solar Park: Written Scheme of Investigation for Geophysical Survey*. Dated 11<sup>th</sup> April 2022.

Pegasus Group, 2022b (forthcoming). *Heckington Fen Solar Park: Heritage Statement*. Project Code P20-2370.

Pre-Construct Geophysics, 2011. *Geophysical Survey: Proposed Wind Energy Farm, Heckington Fen, Lincolnshire*.

SUMO Geophysics, 2022. *Geophysical Survey Report: Area 1, Heckington Fen Solar Park, Lincolnshire*. Report No. 05153.

## Figure 1: Geophysical Survey Areas

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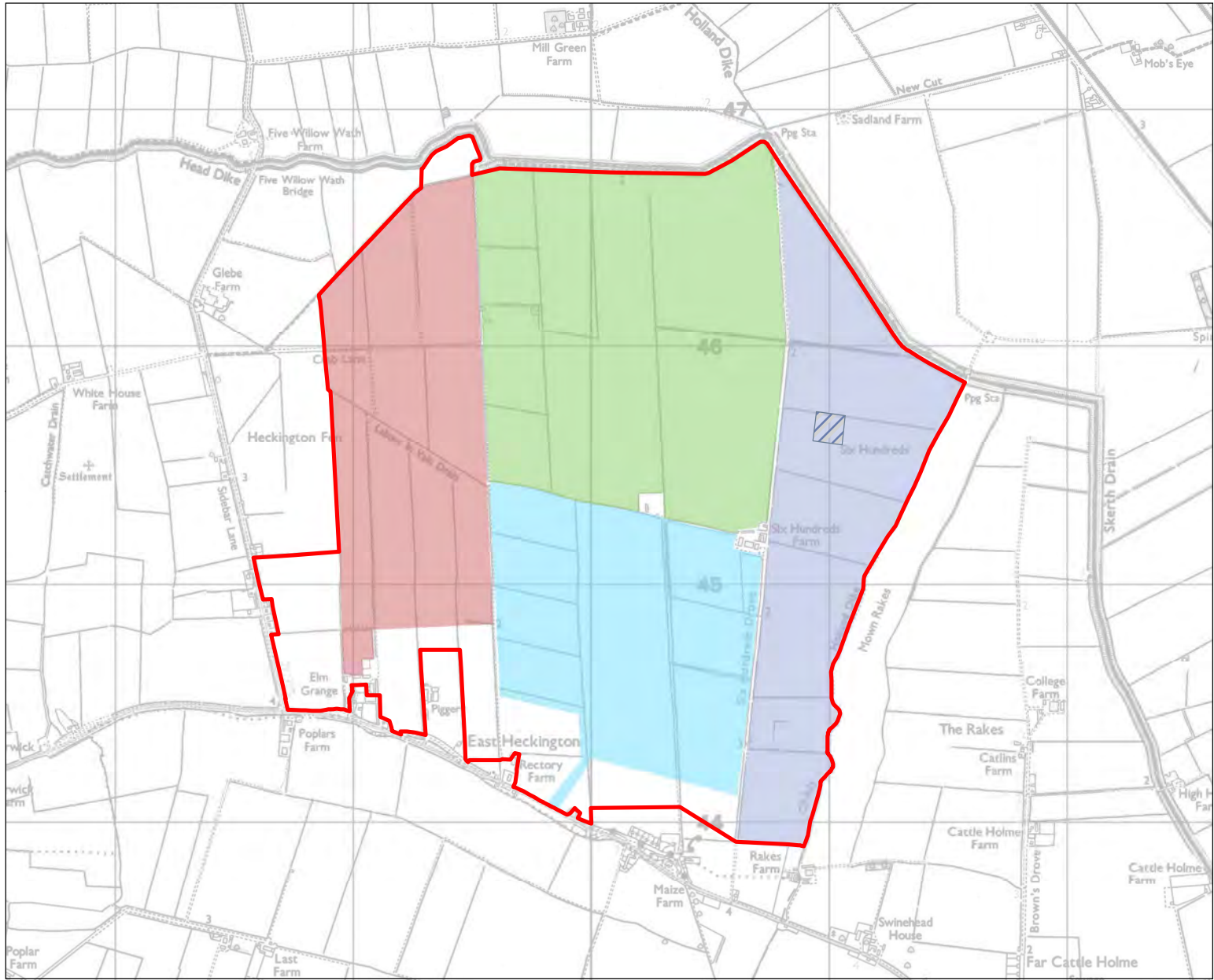
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


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**KEY**

-  Energy Park
-  Test Area "T4"
-  Area 1 - SUMO
-  Area 2 - Headland Archaeology
-  Area 3 - ASWYAS
-  Area 4 - Magnitude Surveys

Unshaded land to the north/west/south of Area 1 and to the south of Area 3 are proposed for ecological enhancement; there will be no groundworks here for construction, operation/maintenance or decommissioning.

**Figure 1: Geophysical Survey Areas**

**Heckington Fen Solar Park**

Client: Ecotricity (Heck Fen Solar) Ltd  
 DRWG No: P20-2370 Sheet No: - REV:-  
 Drawn by: EP Approved by: GS  
 Date: 18/05/2022  
 Scale: 1:25,000 @ A4



## Figure 2: Combined Interpretation Overview

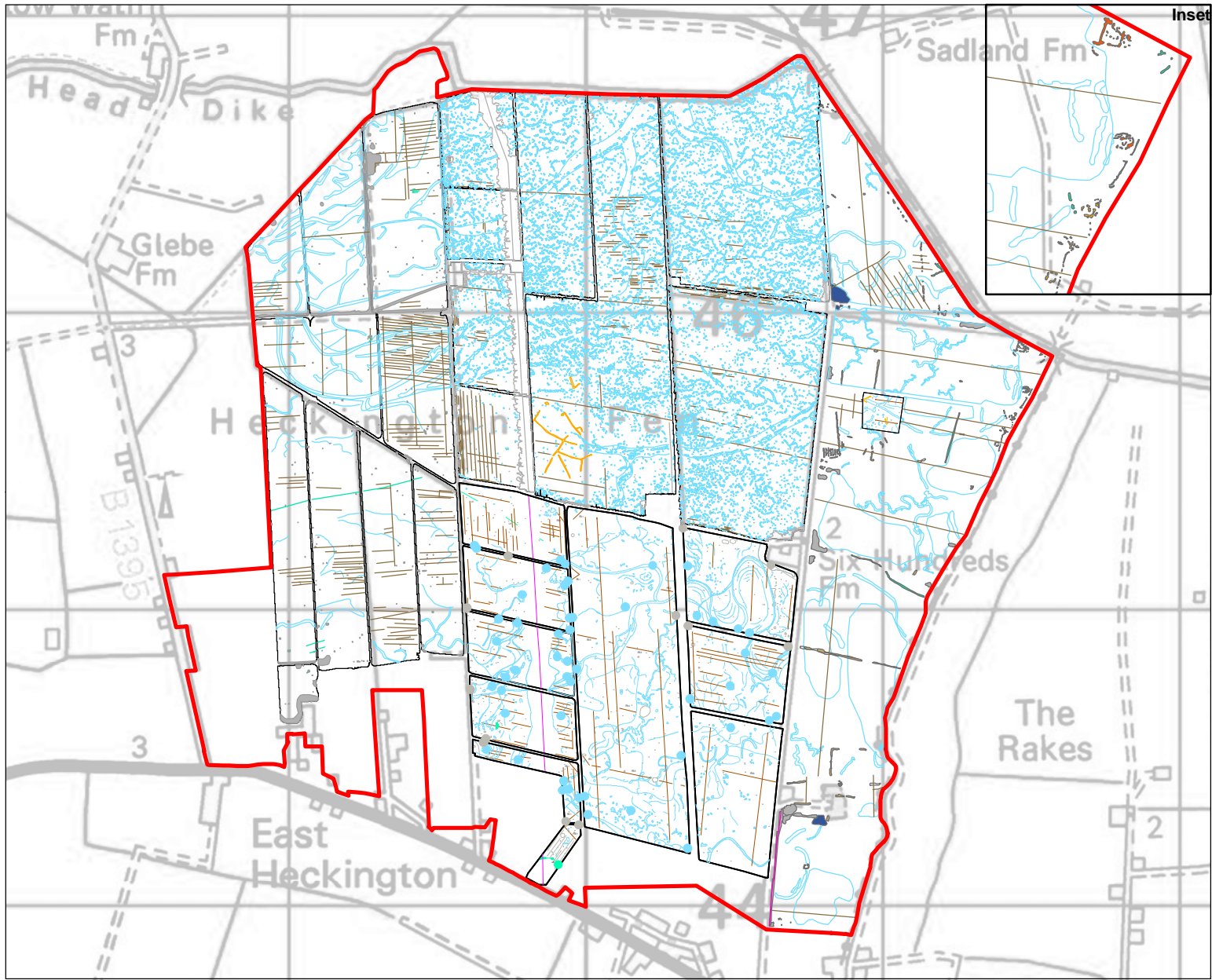
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**KEY**

- Energy Park
- Probable Archaeology – Red
- Possible Archaeology – Orange
- Agricultural – Brown
- Industrial/Modern – Purple
- Uncertain/Undetermined – Turquoise
- Magnetic Disturbance/Ferrous - Grey
- Natural/Geological – Pale blue
- Service – Pink

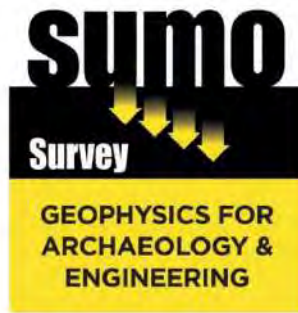
Inset shows the probable and possible archaeology recorded within the eastern boundary of Area 4.

**Figure 2: Geophysical Survey Interpretation (Combined)**

**Heckington Fen Solar Park**

Client: Ecotricity (Heck Fen Solar) Ltd  
 DRWG No: P20-2370 Sheet No: - REV:-  
 Drawn by: EP Approved by: GS  
 Date: 26/05/2022  
 Scale: 1:20,000 @ A4





## **GEOPHYSICAL SURVEY REPORT**

**Area 1, Heckington Fen Solar Park, Lincolnshire**

Client

**Pegasus Group**

For

**Ecotricity (Heck Fen Solar) Ltd**

Survey Report

**05153**

OASIS Ref. No.

**sumogeop1-506326**

Site Code  
**HECW22**

Accession No.  
**LCNCC: 2022.55**

Date

**19 May 2022**



**Survey Report 05153: Area 1, Heckington Fen Solar Park, Lincolnshire**

**Survey dates** 21 – 31 March 2022  
1 – 7 April

**Field co-ordinator** Robert Knight BA MA

**Field Team** Simon Lobel BSc  
George Slater BEng  
Liam Brice-Bateman BA

**Report Date** 19 May 2022

**CAD Illustrations** Thomas Cockcroft MSc

**Report Author** Thomas Cockcroft MSc  
Dr John Gater BSc DSc(Hon) MCIfA FSA

**Project Manager** Simon Haddrell BEng AMBCS PCIfA

**Report approved** Dr John Gater BSc DSc(Hon) MCIfA FSA

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## 3 SURVEY TECHNIQUE

- 3.1 Detailed magnetic survey (magnetometry) was chosen as the most efficient and effective method of locating the type of archaeological anomalies which might be expected at this site. All survey techniques will follow the guidance set out by CIFA (2014, updated 2020), Historic England (2008), and the European Archaeology Council (EAC) (2016).

Bartington Cart System      Traverse Interval 1.0m      Sample Interval 0.125m

The only processes performed on data unless specifically stated otherwise are as follows:

Zero Mean Traverse	This process sets the background mean of each traverse within each grid to zero. The operation removes instrument striping effects and edge discontinuities over the whole of the data set.
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## 4 SUMMARY OF RESULTS

- 4.1 A magnetometer survey of 112 hectares of land within the site of the proposed Heckington Fen Solar Park has not identified any responses indicative of archaeological features. A number of responses have been assigned to the category of uncertain, but they are likely to be the products of agricultural or natural processes. Natural magnetic responses associated with the former coastal landscape dominate the results in the northern half of the survey and are also visible to a lesser degree throughout the southern part of the survey. An area of magnetic disturbance coincides with the locations of former farm buildings and linear responses indicate former field boundaries and land drains. Relatively modern ploughing is visible in certain areas and the routes of buried services have been marked.

## 5 INTRODUCTION

- 5.1 **SUMO Geophysics Ltd** were commissioned to undertake a geophysical survey of roughly 112ha of c.587ha of agricultural land outlying Six Hundreds Farm on Six Hundreds Drove at East Heckington. This survey forms part of a staged programme of archaeological investigations being undertaken by **Pegasus Group** on behalf of **Ecotricity (Heck Fen Solar) Ltd**, to inform proposals for the Heckington Fen Solar Park.

- 5.2 Given the size of the proposed development site, a single contractor could not complete the survey during the relatively narrow window when ground conditions are anticipated to be dry and when crop should be at a fairly damage-resistant stage of growth. As such, the site was split into four quadrants, and allocated to four contractors as follows: SUMO Geophysics Ltd (Area 1 - 112 ha), Headland Archaeology (Area 2 - 178 ha), ASWYAS (Area 3 - 112 ha) and Magnitude Surveys (Area 4 - 115 ha).

- 5.3 Prior to the commencement of the surveys, an overarching Written Scheme of Investigation (WSI) for the entire site, encompassing individual WSIs from each contractor, was prepared by Pegasus Group (PG 2022) and submitted to the Archaeological Advisors at Lincolnshire County Council, North Kesteven District Council, and Boston Borough Council.

- 5.4 A small test area in the eastern part of the proposed development site was also subject to survey in advance of the main survey area. This was reported on separately and so is not discussed here.

### 5.5 Site Details

NGR / Postcode	NG34: 9LY & 9LZ and PE20 3QF
Location	The survey block lies approximately 5km east of Heckington and on the northern outskirts of East Heckington. The A17 road lies to the south, the B1395 to the west and Head Dike to the north. Agricultural fields surround the survey area.
HER	Lincolnshire
OASIS Ref. No.	sumogeop1-506326
HER Site Code	HECW22
Accession No.	LCNCC: 2022.55
District	North Kesteven
Parish	Heckington
Topography	Generally flat, low-lying at 1 to 3m aOD
Land Use	Agricultural
Geology	Bedrock: West Walton Formation - Mudstone and Siltstone
(BGS 2022)	Superficial: Tidal Flat Deposits, 1 - Clay and Silt
Soils (CU 2022)	Soilscape 21: loamy and clayey soils of coastal flats with naturally high groundwater



Survey Methods Magnetometer survey (fluxgate gradiometer)

Survey Area 112 ha

## 5.6 **Archaeological Background (PG 2022)**

*The following archaeological background has been provided by Pegasus Group and is informed by an initial high-level review of Lincolnshire Historic Environment Record (HER) data sourced from a 2km-radius study area measured from the boundaries of the proposed Heckington Fen Solar Park site (hereafter 'the site').*

- 5.6.1 Finds recorded c.0.5-1.5km to the west of the site include a Neolithic polished stone axe (MLI60769) and flint scrapers and other worked flints (MLI87872, MLI60936, MLI87875); Iron Age pottery (MLI87874, MLI88029, MLI88049, MLI88094); and fragments of Roman querns (MLI87877, MLI87889) and pottery (MLI91865, MLI60935, MLI87871, MLI88047, MLI88050, MLI88065). This material likely derives from the settlements indicated by cropmarks to the south and north-west of White House Farm (MLI60731, MLI90708), at Garwick (MLI60631), and to the west of Holme House (MLI84683).
- 5.6.2 Within the site itself, possible Roman salt-working in the fields extending north of Rectory Farm is indicated by sherds of Roman pottery and briquetage collected after ploughing in 1963 and during observation of the North Sea Gas Pipeline in 1971 (MLI87647, MLI87891, MLI87892). In addition, a geophysical survey carried out for a proposed wind farm identified further possible traces of salt-working in the north-eastern part of the site. More scatters of Roman pottery are recorded to the south-east of the site (MLI12571, MLI12578, MLI12602).
- 5.6.3 Also recorded at Garwick to the west of the site is a high-status Anglo-Saxon trading centre, identified primarily through metal-detecting survey (MLI116391). It appears to have been in use from at least the mid-6<sup>th</sup> century to the mid-8<sup>th</sup> century, and has yielded one of the county's largest assemblages of finds from this period. It lies c.800m south-west of the site at its closest point. Further research as part of the forthcoming heritage desk-based assessment will establish the area that was subject to metal-detecting survey and the likelihood of the trading centre, or peripheral activity, having extended into the site.
- 5.6.4 The settlement of East Heckington, located to the south of the site, was in existence by the 18<sup>th</sup> century (MLI87648). The vast majority of monuments recorded by the HER for the study area comprise 19<sup>th</sup>-century farmsteads and field barns. Six Hundreds Farm lies within the eastern part of the site (MLI121951) and Elm Grange (MLI121956), Home Farm (MLI121955) and Rectory Farm (MLI121954) lie outside the southern boundary of the site. Four former unnamed farmsteads are recorded in the northern and central parts of the site (MLI121935, MLI121934, MLI121933, MLI121950). Historic maps and aerial photographs show these buildings, as well as earlier arrangements of the field system within the site.

## 5.7 **Aims and Objectives**

- 5.7.1 To locate and characterise any anomalies of possible archaeological interest within the study area.

## 6 RESULTS

6.1 *The survey has been divided into eleven survey zones (SG Zones 1-11).*

### 6.2 ***Probable / Possible Archaeology***

6.2.1 No magnetic responses have been recorded that could be interpreted as being of definite archaeological interest.

### 6.3 ***Former Field Boundary – Corroborated***

6.3.1 Linear magnetic responses in SG Zones 2, 3, 6, 8, 9 and 10 coincide with former boundaries visible on historic Ordnance Survey (OS) mapping (see Figure 13). The boundaries are shown on the 1764 Enclosure Map for Heckington Parish, as well as Ordnance Survey mapping from 1888 to the 1970s.

### 6.4 ***Agricultural –Ploughing / Land Drains***

6.4.1 Closely spaced parallel and ill-defined linear anomalies have been recorded in SG Zones 4, 5 and 6. These are due to ploughing, probably relatively recent.

6.4.2 Numerous widely spaced and parallel linear anomalies indicate networks of land drains have been detected throughout the survey.

### 6.5 ***Service***

6.5.1 Linear responses, comprising negative and positive anomalies, indicate a pipe or cable which follows an existing boundary / track cutting through SG Zones 1 and 2 and then diagonally across SG Zone 3 to a small agricultural building in an adjacent field.

### 6.6 ***Uncertain***

6.6.1 A number of pit-like anomalies plus linear and curvilinear responses have been recorded throughout the survey which have been assigned to the category of Uncertain. They generally lack the defined morphology of anomalies that would usually be interpreted as being of archaeological interest.

6.6.2 A ring-like anomaly comprised of weak pit-like responses has been detected in SG Zone 5. It measures 12m in diameter. It could tentatively be interpreted as a ring-ditch; however, it is located within a strong complex of natural responses (see 6.6) which casts doubt over this interpretation. While archaeological origins cannot be entirely dismissed, it is likely that the responses are due to natural or other agricultural processes.

6.6.3 A number of pit-like responses have been detected in SG Zones 5, 6, 7, 8, 9, 10 and 11 and a linear response has been identified traversing SG Zones 7, 8 and 9. These have all been assigned to the category of Uncertain. They lack context, and are likely modern in origin, possibly uncorroborated field boundaries, or due to other agricultural / natural processes.

### 6.7 ***Magnetic Disturbance / Ferrous***

6.7.1 An area of magnetic disturbance in SG Zone 3 coincides with the location of a former farm known as New Grange which is visible on OS mapping from 1888 until the 1960s (see Figure 13). The demolition of the buildings and subsequent spreads of debris has resulted in the magnetic disturbance.

6.7.2 Ferrous responses close to boundaries in SG Zone 11 are due to neighbouring agricultural buildings. Smaller scale ferrous anomalies (“iron spikes”) are present throughout the data and are characteristic of small pieces of ferrous debris (or brick / tile) in the topsoil; they are commonly assigned a modern origin. Only the most prominent of these are highlighted on the interpretation diagram.

## 6.8 **Natural / Geological**

6.8.1 The northern half of the survey is dominated by magnetic responses associated with the former terrain which comprised a low-lying tidal saltmarsh. The latter contained channels, streams and infilled former streams which meandered across the landscape. These natural elements have resulted in the complex pattern of magnetic anomalies observed in the data. Similar magnetic responses are also present throughout the southern survey zones, though, apart from a few zones, the natural magnetic enhancement is much weaker.

## 7 **DATA APPRAISAL & CONFIDENCE ASSESSMENT**

7.1 Historic England guidelines (EH 2008) Table 4 states that the typical magnetic response on the local soils / geology is variable. The results from this survey indicate the presence of a range of magnetic responses; as a consequence, there is no *a priori* reason why archaeological features would not have been detected. It is possible that the effects of the alluvium may have masked weaker magnetic responses.

## 8 **CONCLUSION**

8.1 The magnetometer survey has not recorded any magnetic responses that could be interpreted as being of definite archaeological interest.

8.2 Natural magnetic responses associated with the former saltmarsh landscape dominate the results in the northern half of the survey and are also visible to a lesser degree throughout the southern part of the survey. A number of responses of uncertain origin have also been mapped. While archaeological origins for a ring-like anomaly in SG Zone 5 cannot be entirely dismissed, the majority of the uncertain responses are likely to be due to a combination of agricultural / natural processes.

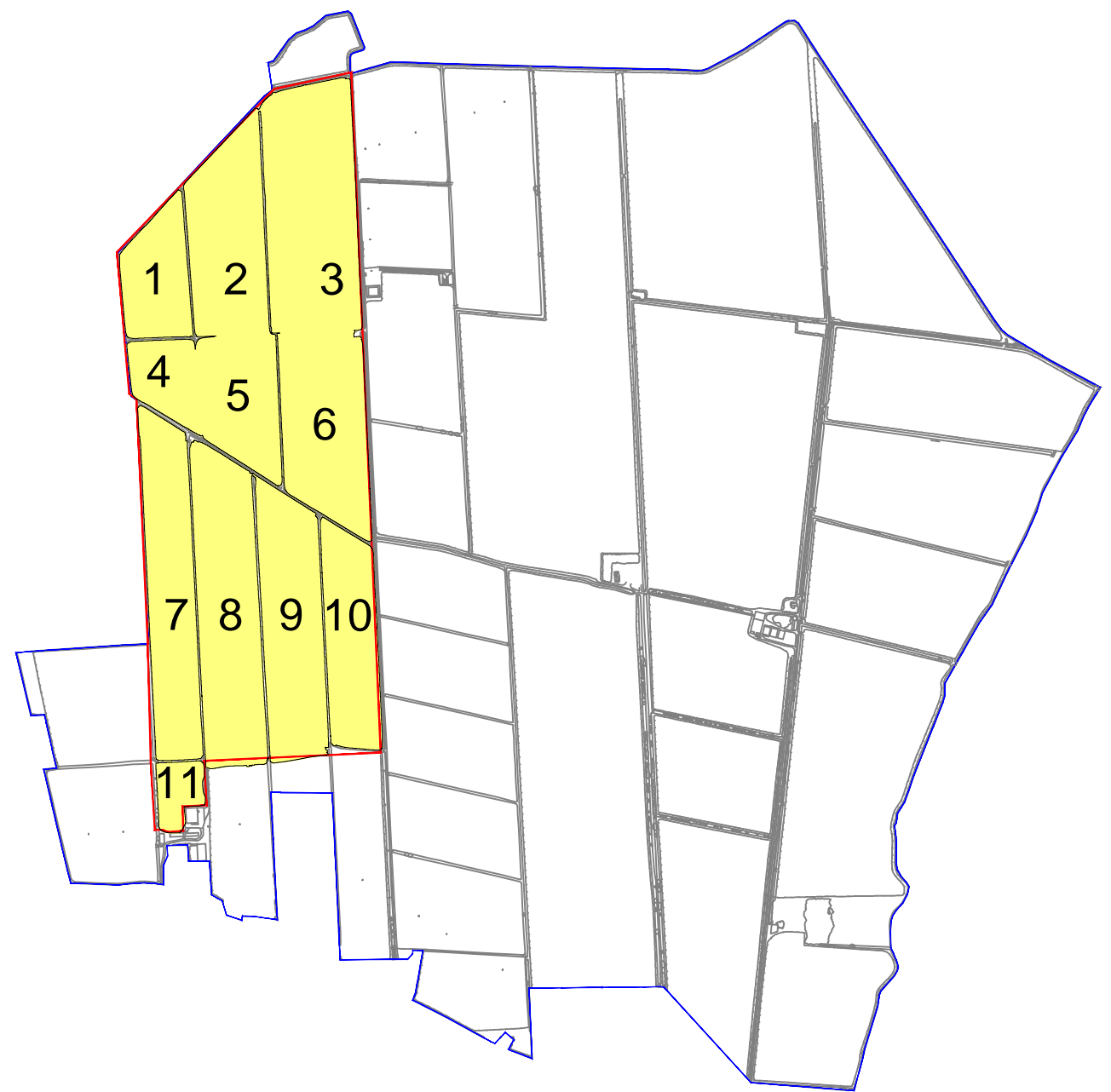
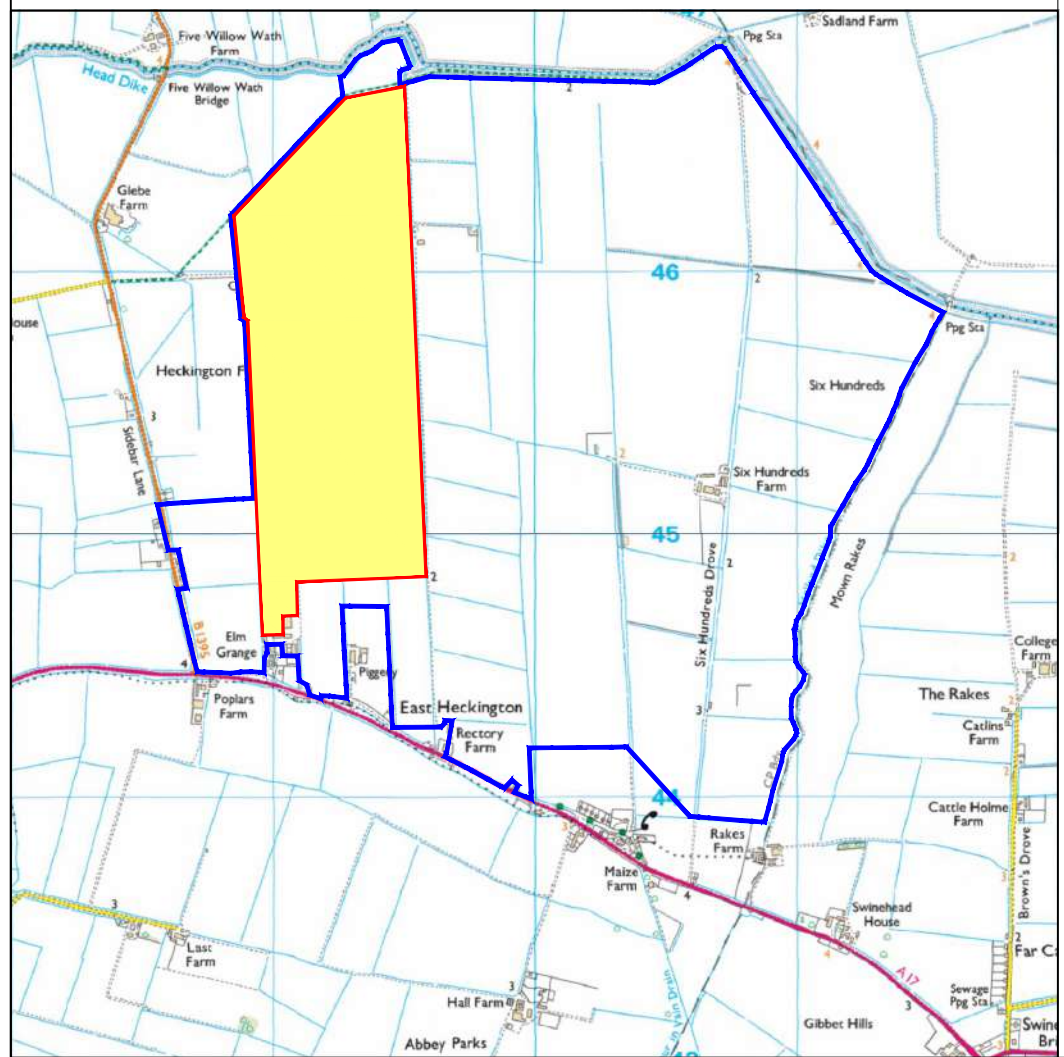
8.3 A strong complex of anomalies has been recorded in the north of SG Zone 3 which coincide with the location of the former New Grange Farm. The demolition of the buildings and subsequent spreads of debris has resulted in the magnetic disturbance. Former field boundaries, land drains, ploughing and land drains are also visible in the data. The routes of service pipes have also been marked.

## 9 REFERENCES




- BGS 2022 British Geological Survey, Geology of Britain viewer [accessed 22/04/2022] *website:*  
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- CifA 2014 *Standard and Guidance for Archaeological Geophysical Survey*. Amended 2016.  
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22/04/2022] *website:* [REDACTED]
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- EH 2008 *Geophysical Survey in Archaeological Field Evaluation*. English Heritage, Swindon  
(now withdrawn, but used for evaluating suitability of soil types)
- PG 2022 *Heckington Fen Solar Park Written Scheme of Investigation for Geophysical Survey*.  
*Pegasus Group, Cirencester*

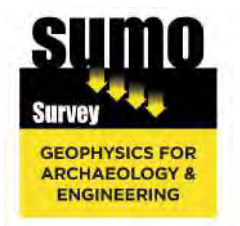
## 10 ARCHIVE

- 10.1 The minimally processed data, data images, XY traces and a copy of this report are stored in **SUMO Geophysics Ltd.'s** digital archive, on an internal RAID configured NAS drive in the Midlands Office. These data are also backed up to the Cloud for off-site storage.
- 10.2 A digital copy of each report will be uploaded to the OASIS database and provided to the Lincolnshire Historic Environment Record within 12 months of being signed-off by Pegasus Group, Ecotricity (Heck Fen Solar) Limited, and the archaeological advisors to Lincolnshire County Council and North Kesteven and Boston District Councils.

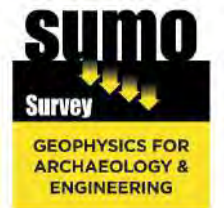
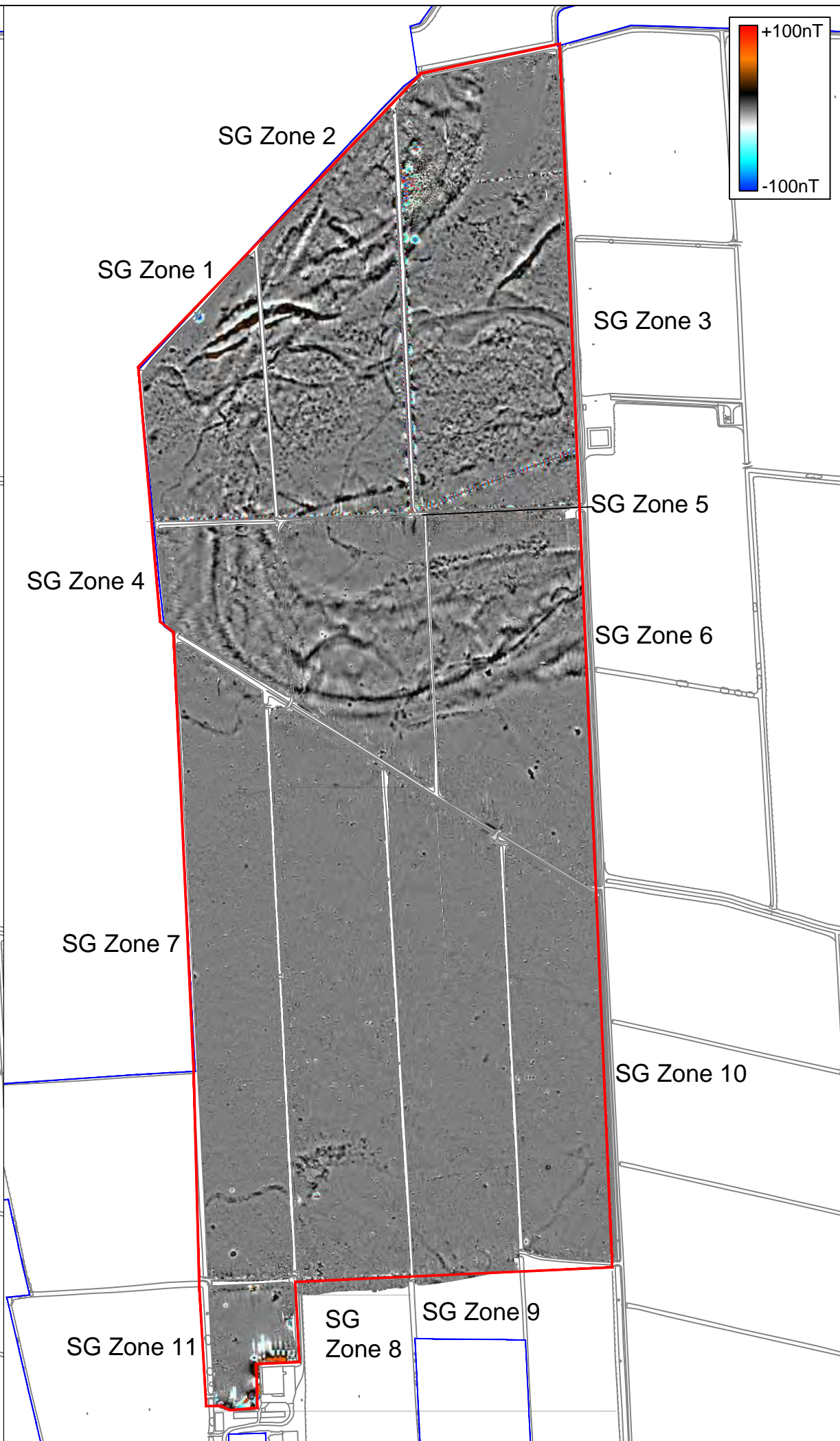
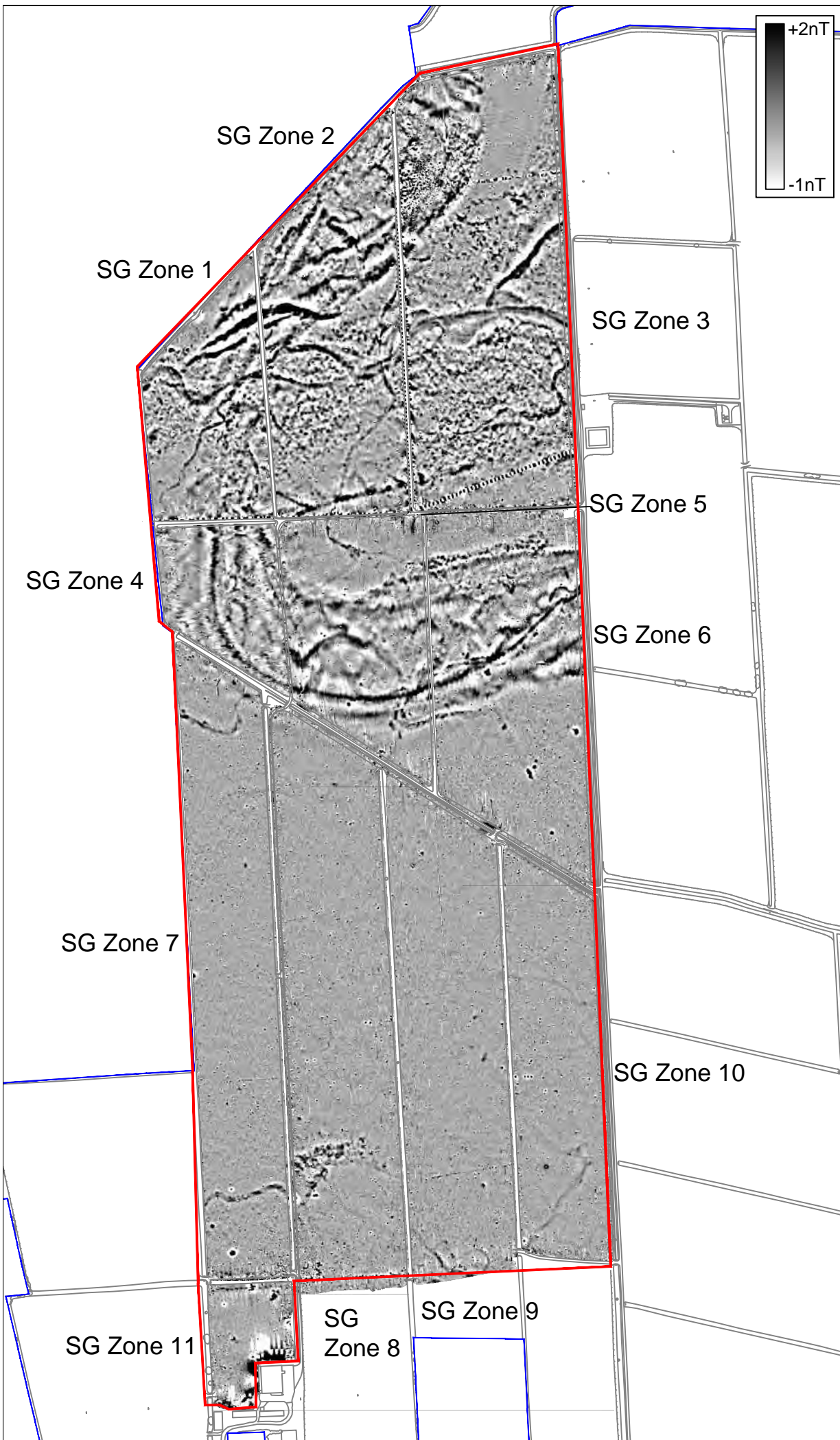


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	Survey Test Area	N 
	Wider Survey Area	



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Client:	Pegasus Group	
Project:	05153 - Area 1, Heckington Fen Solar Park, Lincolnshire	
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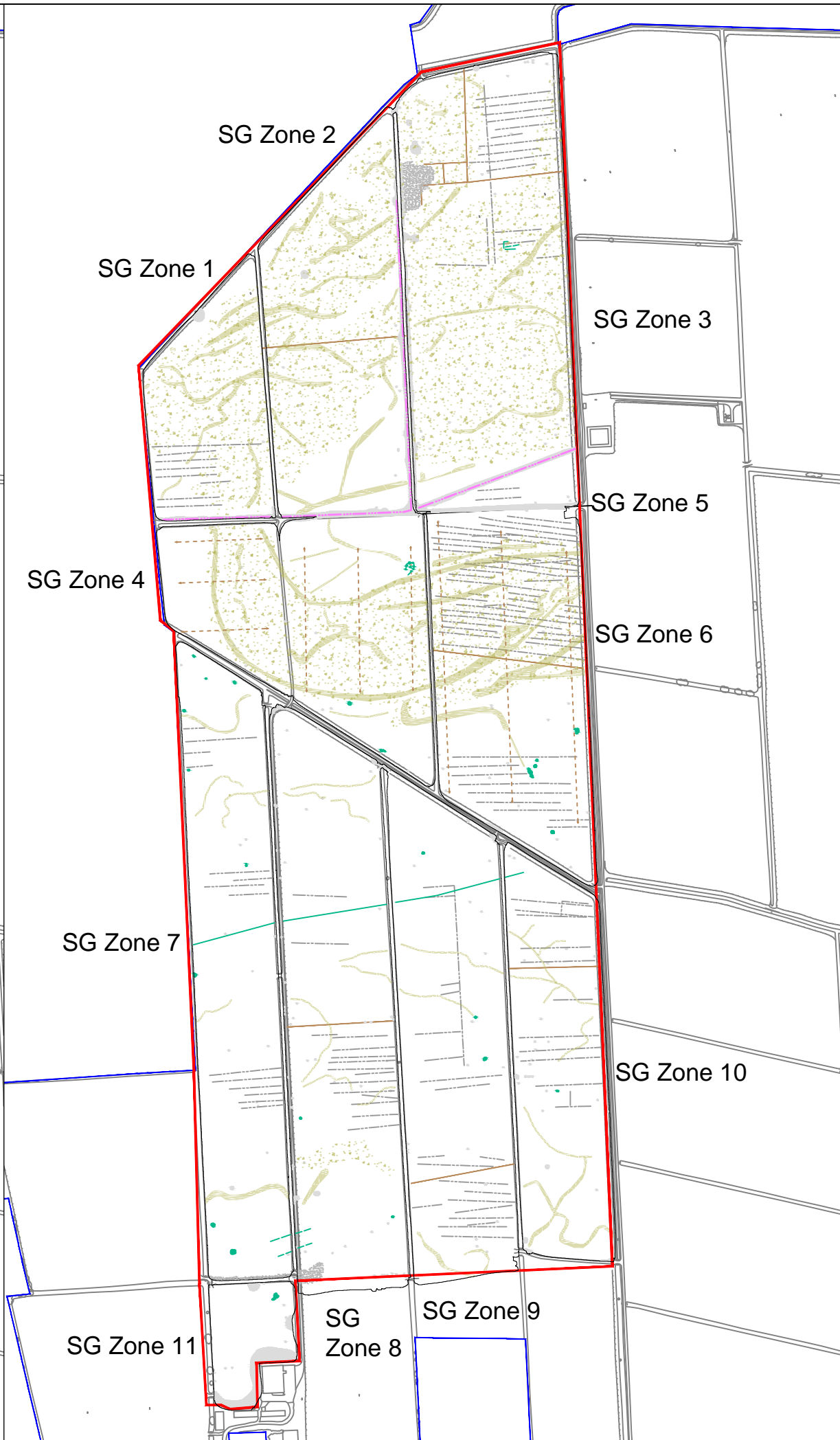
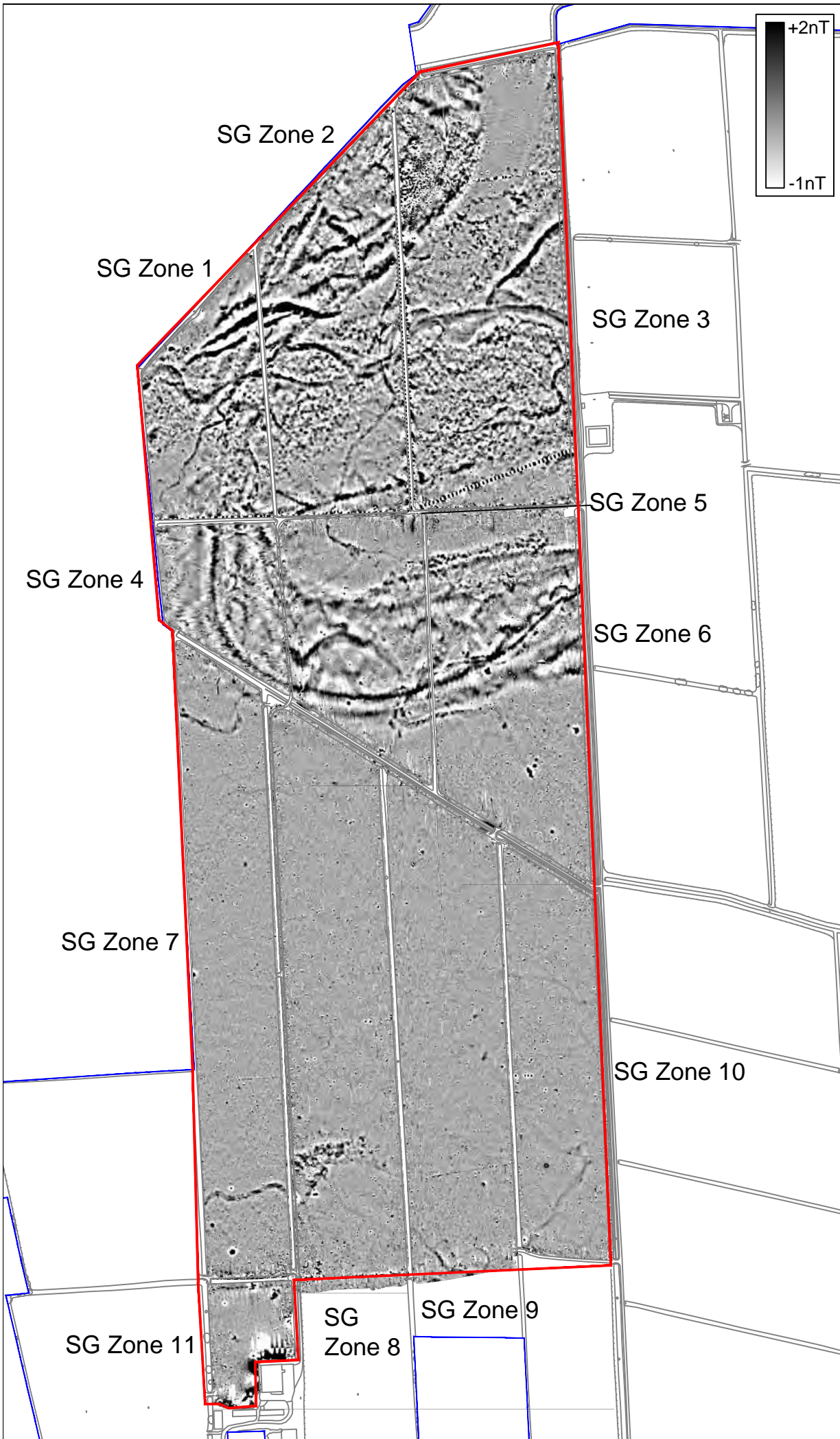
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Client: Pegasus Group

Project: 05153 - Area 1, Heckington Fen Solar Park, Lincolnshire

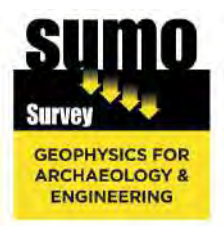
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Fig No: 02



**KEY**

	Agriculture (plough)
	Field drain
	Former field boundary (corroborated)
	Service
	Uncertain (discrete anomaly / trend)
	Magnetic disturbance
	Ferrous
	Natural / Geological



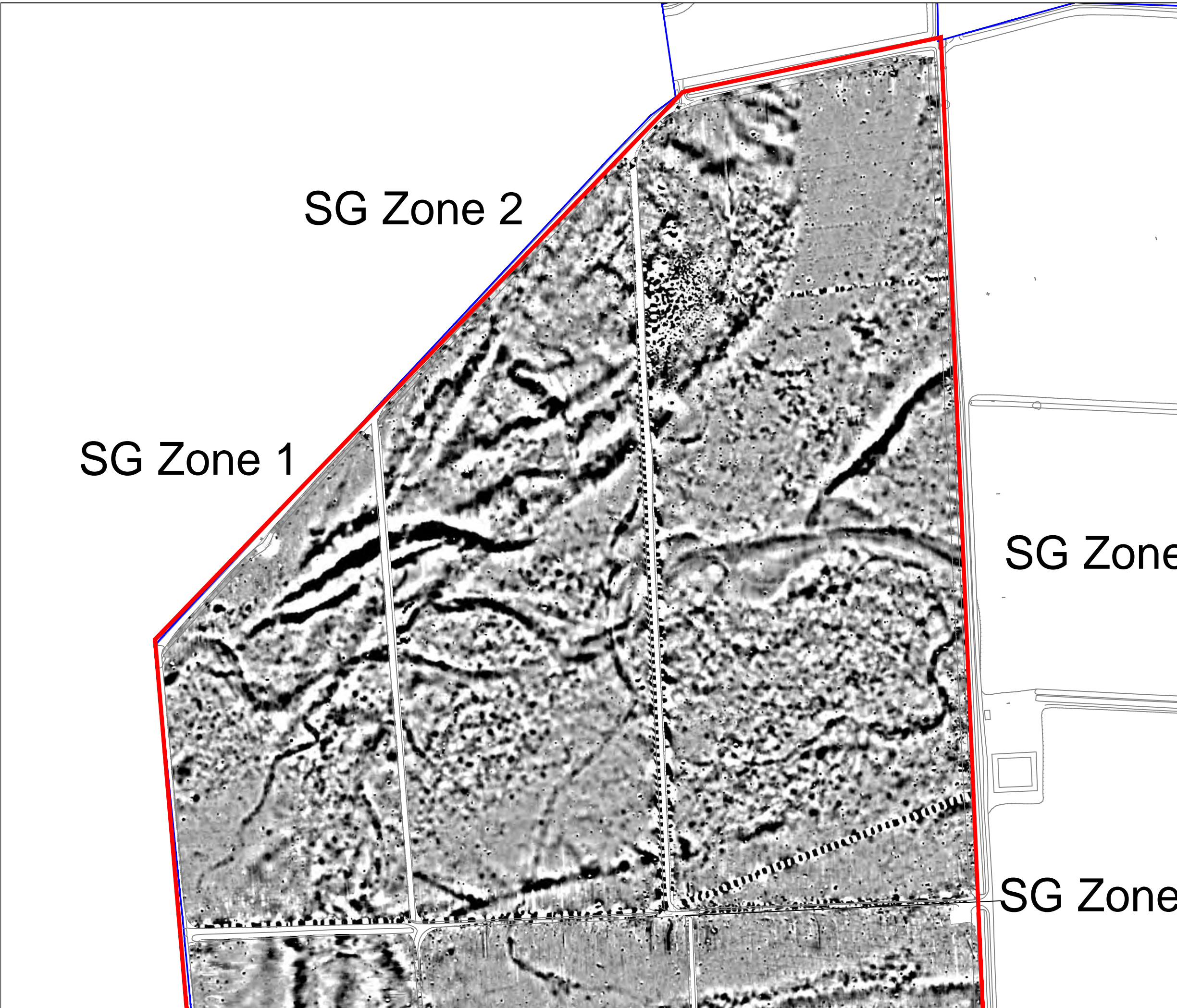
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Greyscale Plot / Interpretation

Client: Pegasus Group

Project: 05153 - Area 1, Heckington Fen Solar Park,  
Lincolnshire

Scale: 0 metres 400  
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Fig No: 03

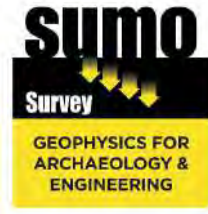
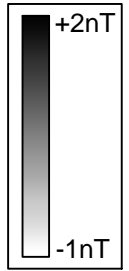


SG Zone 2

SG Zone 1

SG Zone

SG Zone



Title: Magnetometer Survey - Greyscale Plots

Client: Pegasus Group

Project: 05153 - Area 1, Heckington Fen Solar Park, Lincolnshire

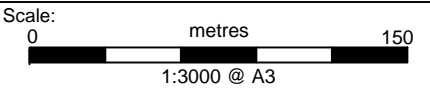
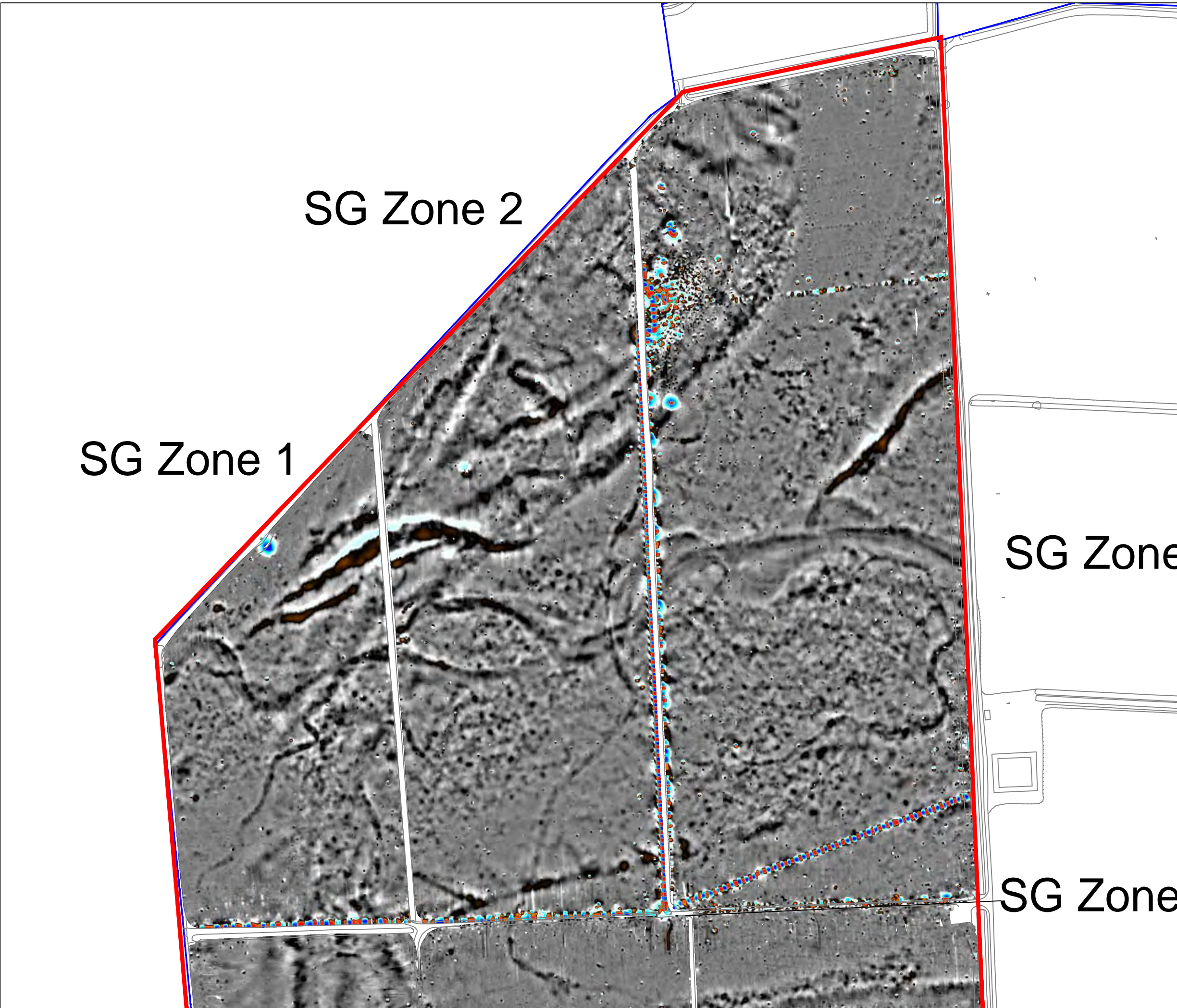


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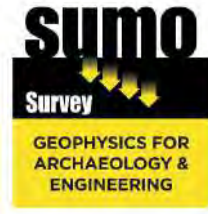
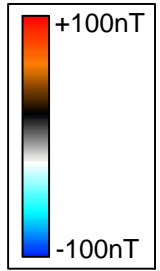


SG Zone 2

SG Zone 1

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SG Zone



Title: Magnetometer Survey - Colour Plots

Client: Pegasus Group

Project: 05153 - Area 1, Heckington Fen Solar Park, Lincolnshire

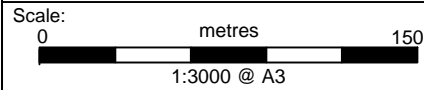
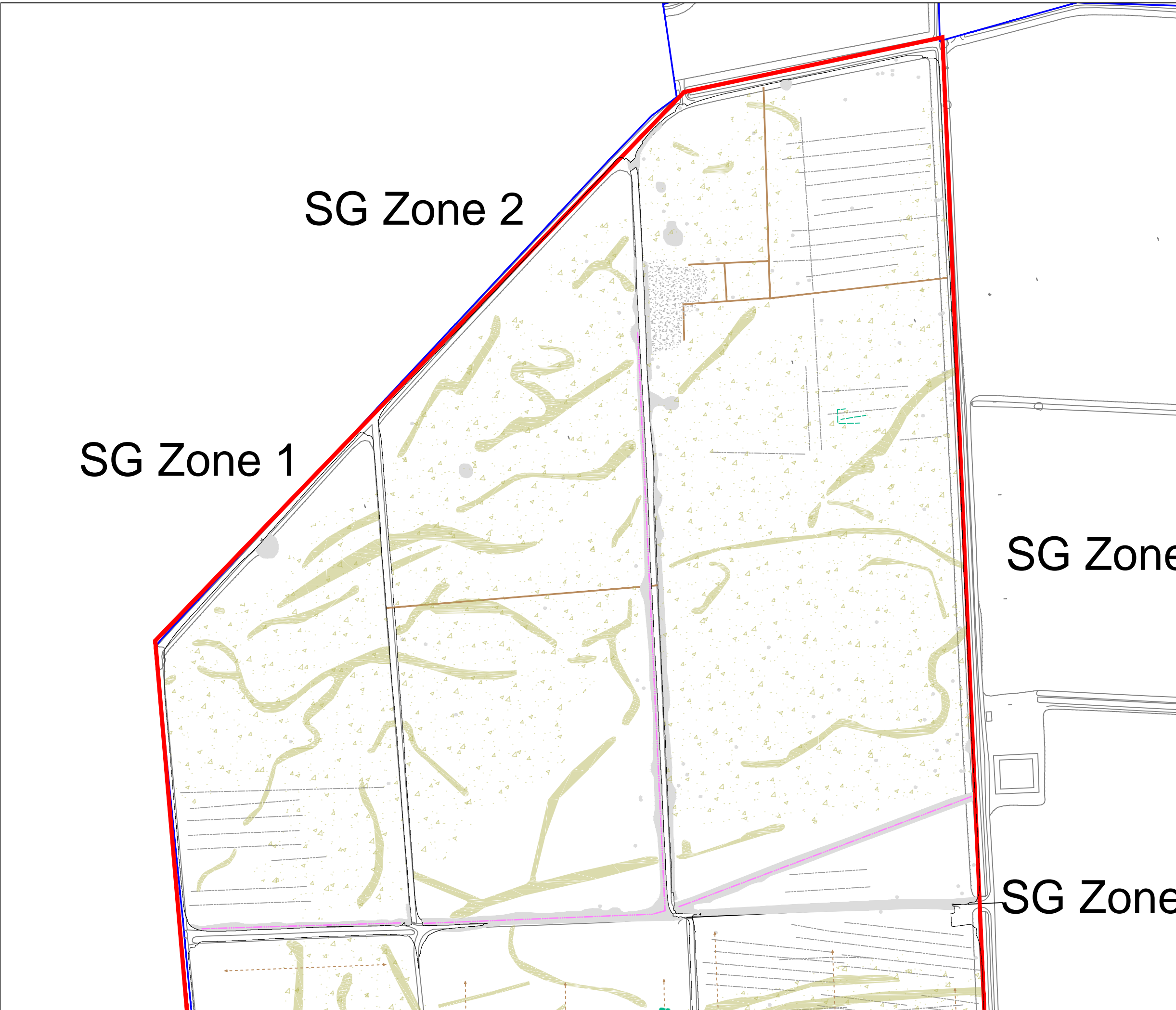
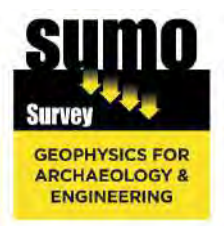


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**KEY**

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	Former field boundary (corroborated)
	Service
	Uncertain (discrete anomaly / trend)
	Magnetic disturbance
	Ferrous
	Natural / Geological



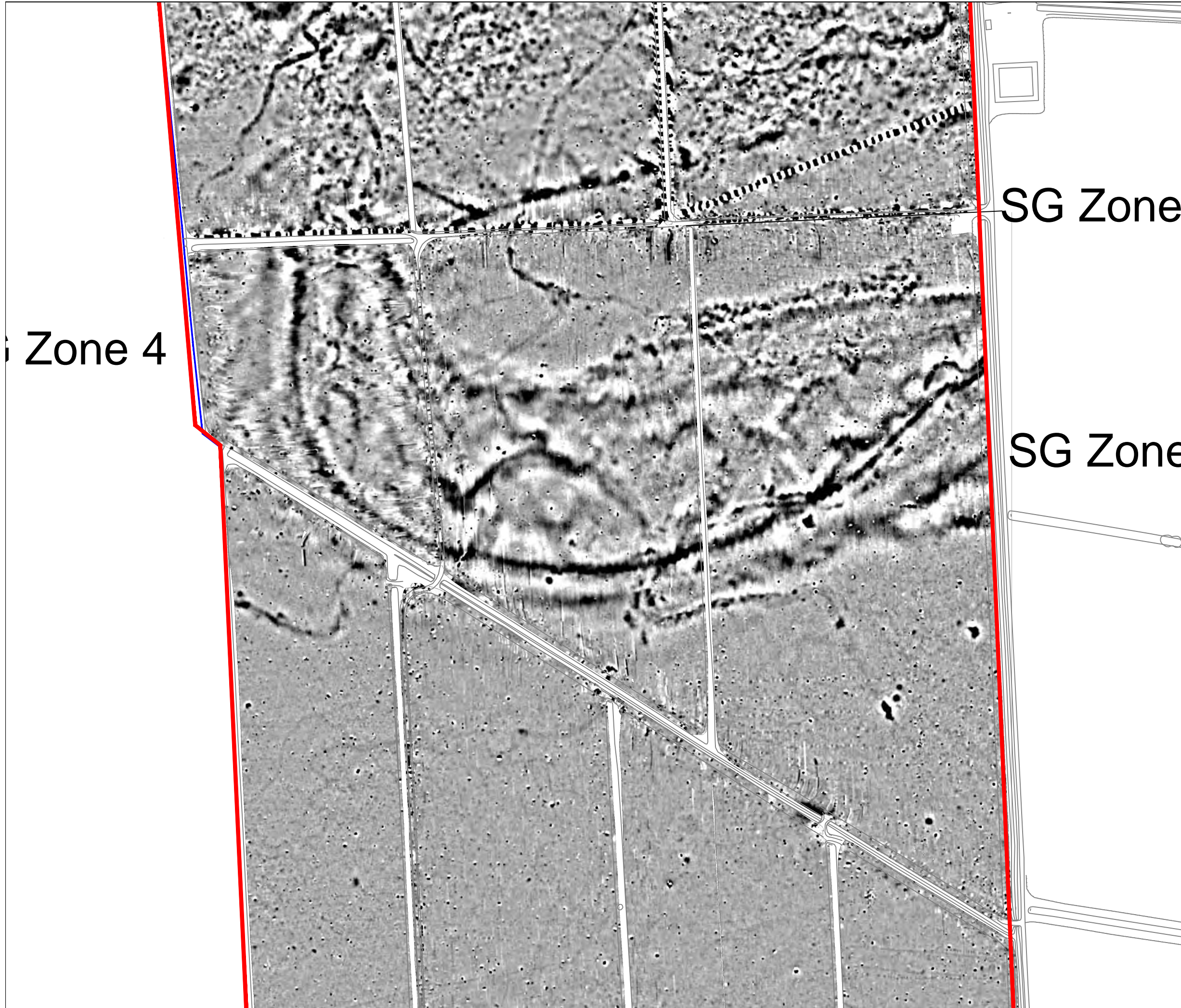
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Client: Pegasus Group

Project: 05153 - Area 1, Heckington Fen Solar Park, Lincolnshire

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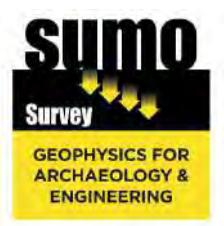
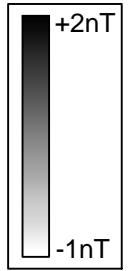
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Zone 4

SG Zone

SG Zone



Title:  
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Client:  
Pegasus Group

Project:  
05153 - Area 1, Heckington Fen Solar Park,  
Lincolnshire

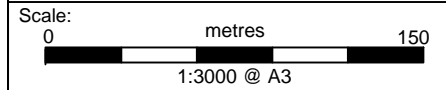
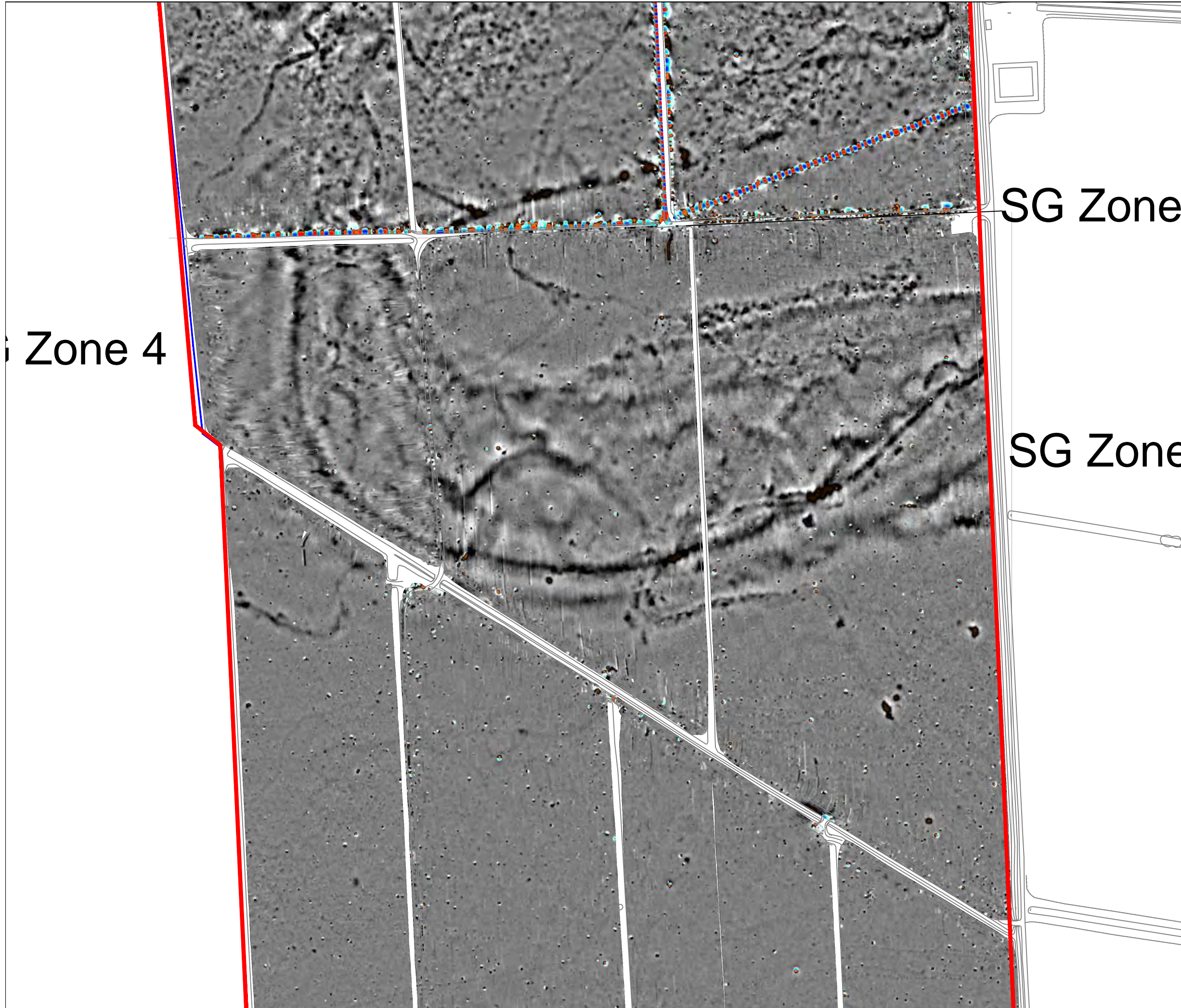


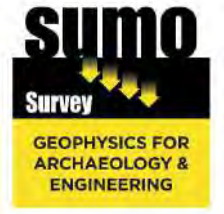
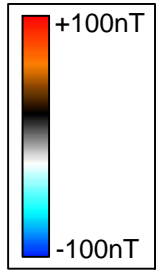
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SG Zone

Zone 4

SG Zone



Title:  
Magnetometer Survey - Colour Plots

Client:  
Pegasus Group

Project:  
05153 - Area 1, Heckington Fen Solar Park,  
Lincolnshire

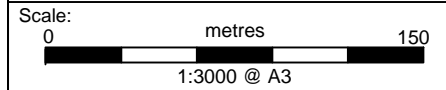
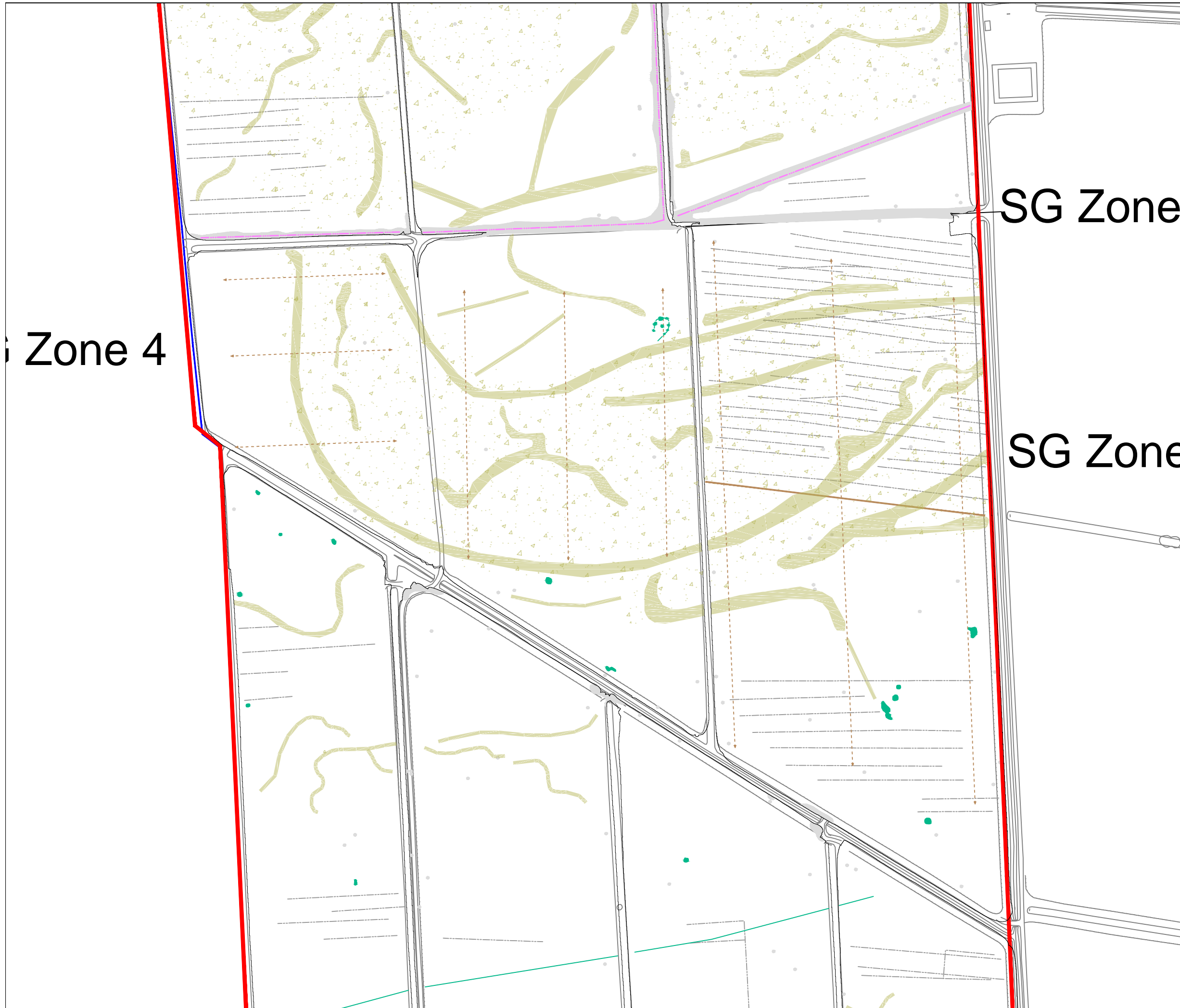


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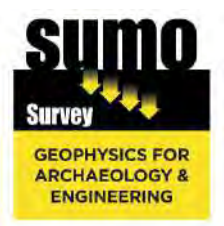
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Zone 4

SG Zone

**KEY**

	Agriculture (plough)
	Field drain
	Former field boundary (corroborated)
	Service
	Uncertain (discrete anomaly / trend)
	Magnetic disturbance
	Ferrous
	Natural / Geological



Title:  
Magnetometer Survey - Interpretation

Client:  
Pegasus Group

Project:  
05153 - Area 1, Heckington Fen Solar Park,  
Lincolnshire

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Fig No:  
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G Zone 7

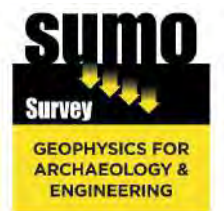
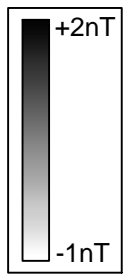
G Zone 11



SG Zone

SG  
Zone 8

SG Zone 9



Title: Magnetometer Survey - Greyscale Plots

Client: Pegasus Group

Project: 05153 - Area 1, Heckington Fen Solar Park, Lincolnshire

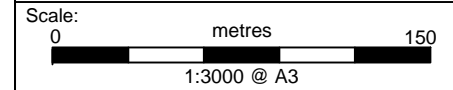
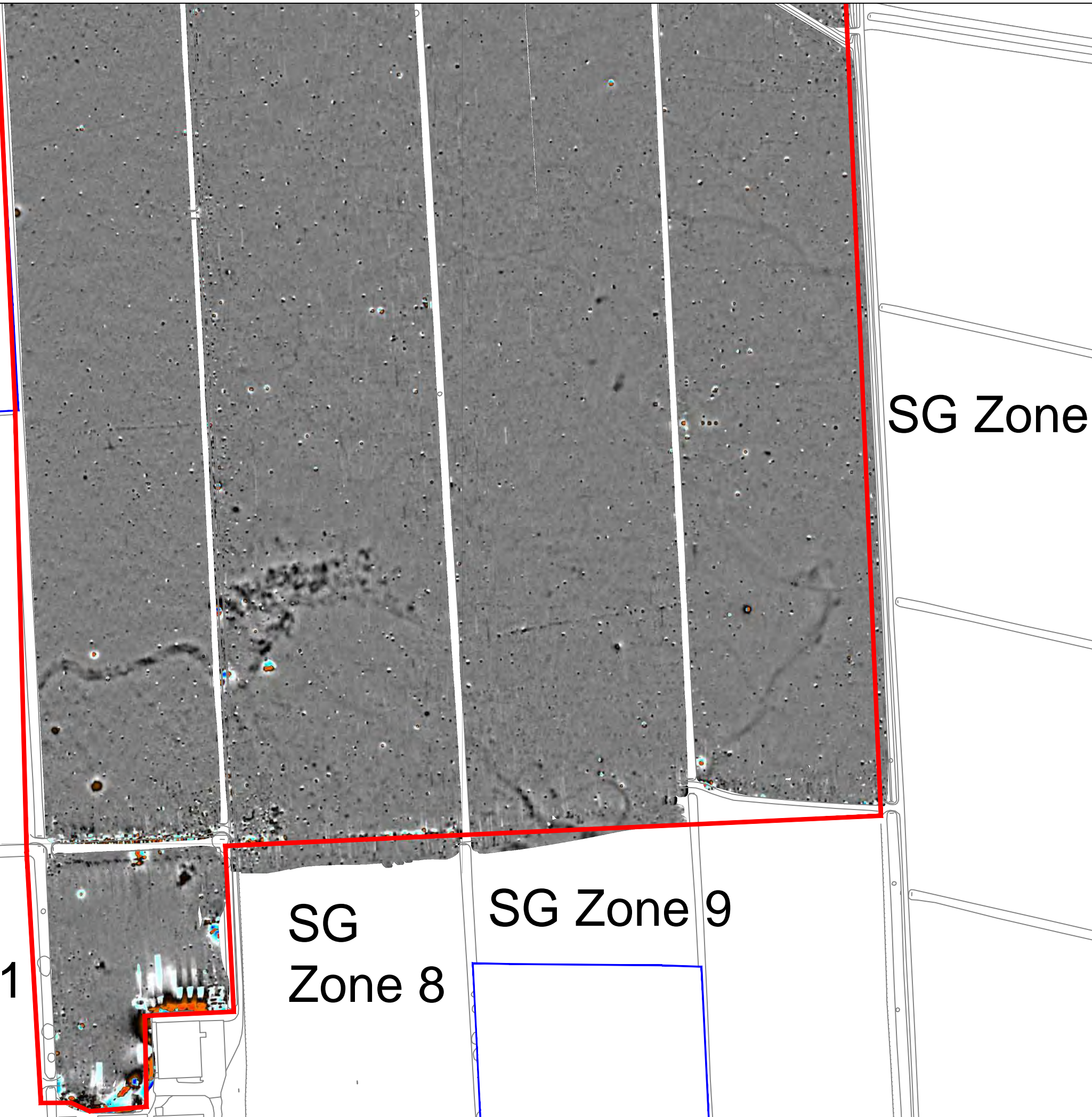


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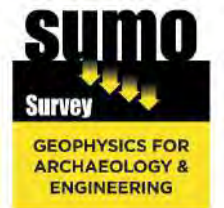
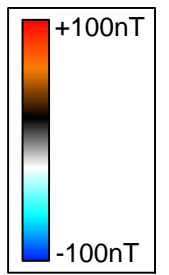
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SG Zone

SG  
Zone 8

SG Zone 9



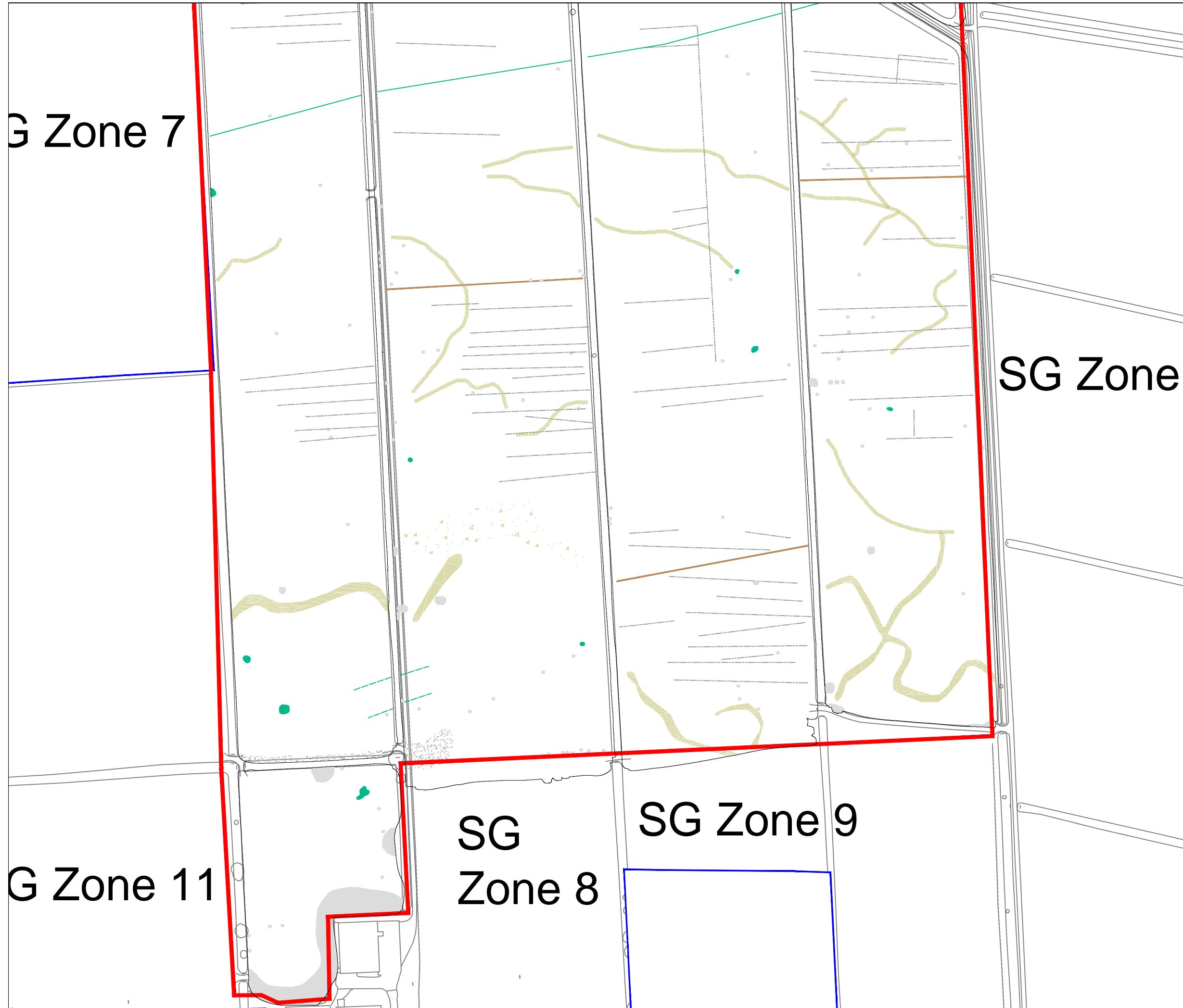
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Client:  
Pegasus Group

Project:  
05153 - Area 1, Heckington Fen Solar Park,  
Lincolnshire

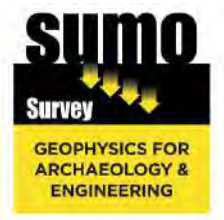
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**KEY**

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	Field drain
	Former field boundary (corroborated)
	Service
	Uncertain (discrete anomaly / trend)
	Magnetic disturbance
	Ferrous
	Natural / Geological



Title: Magnetometer Survey - Interpretation  
 Client: Pegasus Group  
 Project: 05153 - Area 1, Heckington Fen Solar Park, Lincolnshire

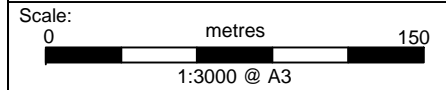


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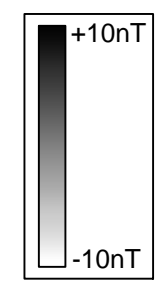
c. 1945 - 1965 Outline Series Map ©2022 National Library of Scotland



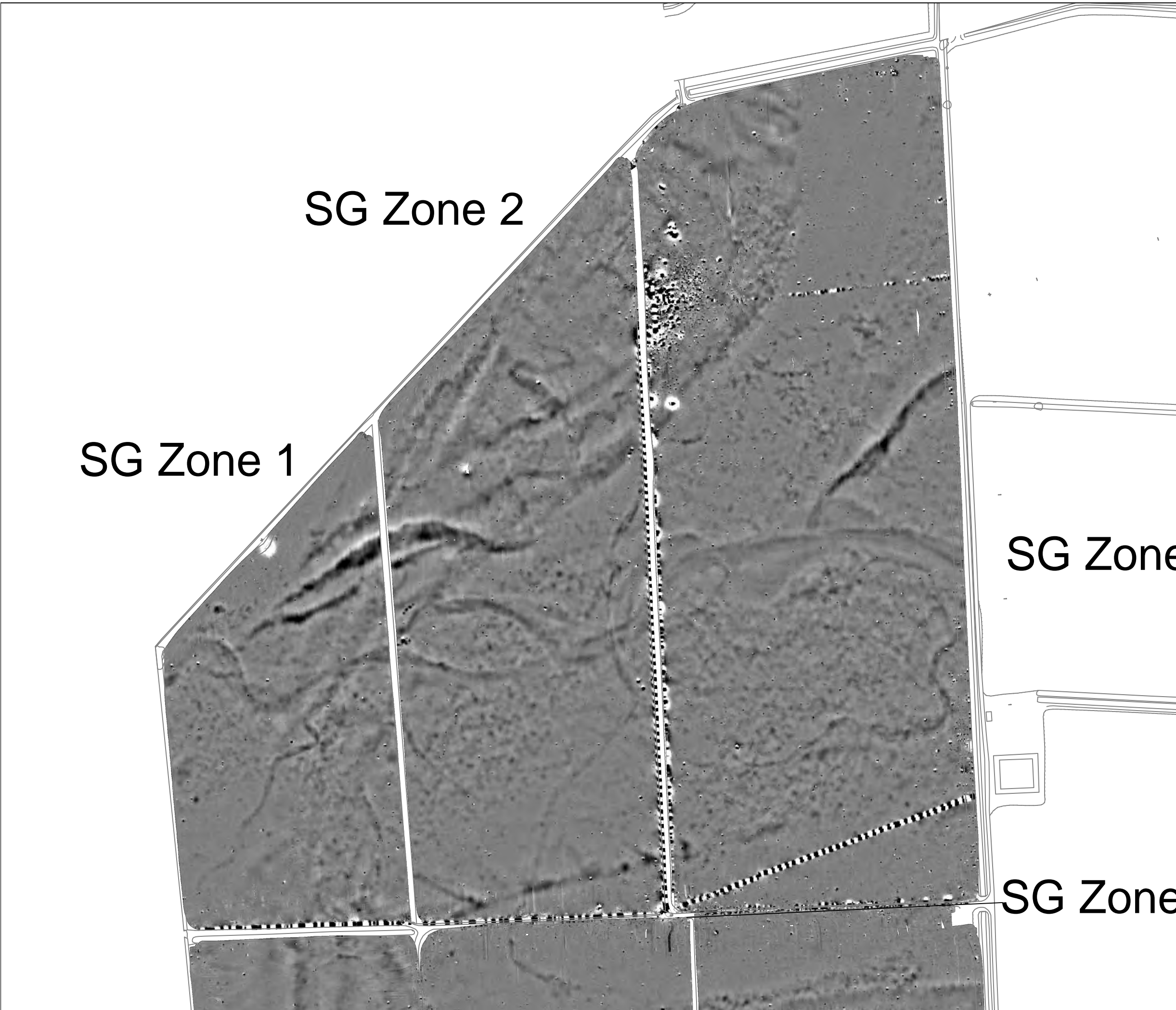
©2022 Google Earth



Title:	1945 - 1965 Outline Series Map / 2022 Aerial Imagery	
Client:	Pegasus Group	
Project:	05153 - Area 1, Heckington Fen Solar Park, Lincolnshire	
Scale:	0 metres 400 1:8000 @ A3	Fig No: 13



Title:	Minimally Processed Data - Greyscale Plots	
Client:	Pegasus Group	
Project:	05153 - Area 1, Heckington Fen Solar Park, Lincolnshire	
Scale:	0 metres 400 1:8000 @ A3	Fig No: 14



SG Zone 2

SG Zone 1

SG Zone

SG Zone



Title: Minimally Processed Data - Greyscale Plots

Client: Pegasus Group

Project: 05153 - Area 1, Heckington Fen Solar Park, Lincolnshire

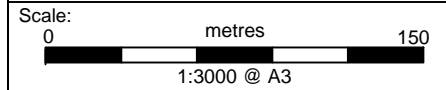
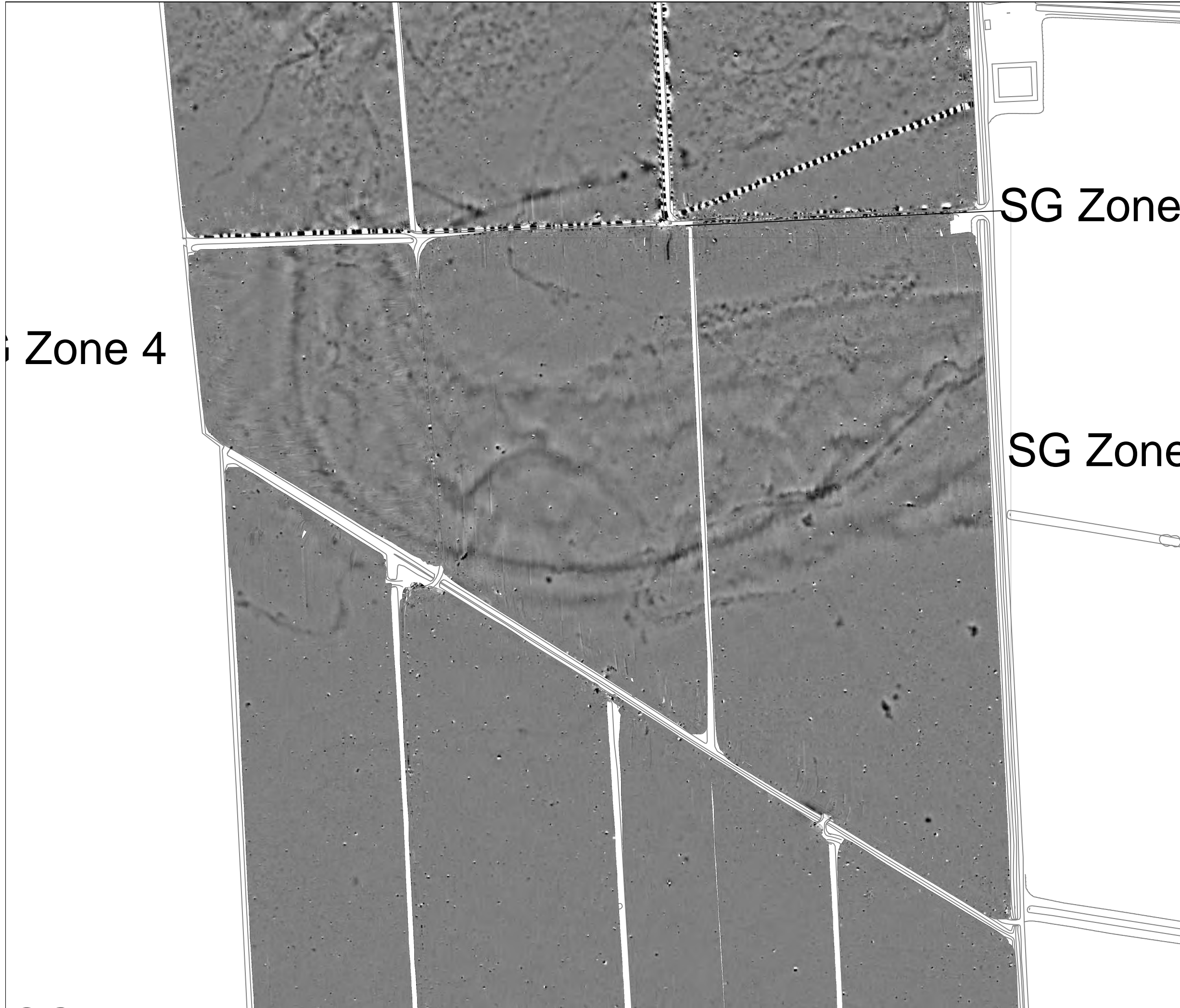


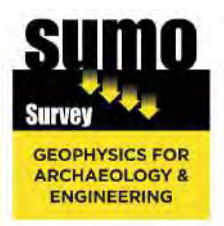
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SG Zone

SG Zone

Zone 4



Title:  
Minimally Processed Data - Greyscale Plots

Client:  
Pegasus Group

Project:  
05153 - Area 1, Heckington Fen Solar Park,  
Lincolnshire

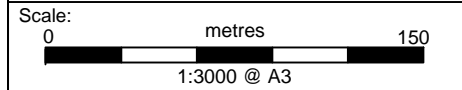
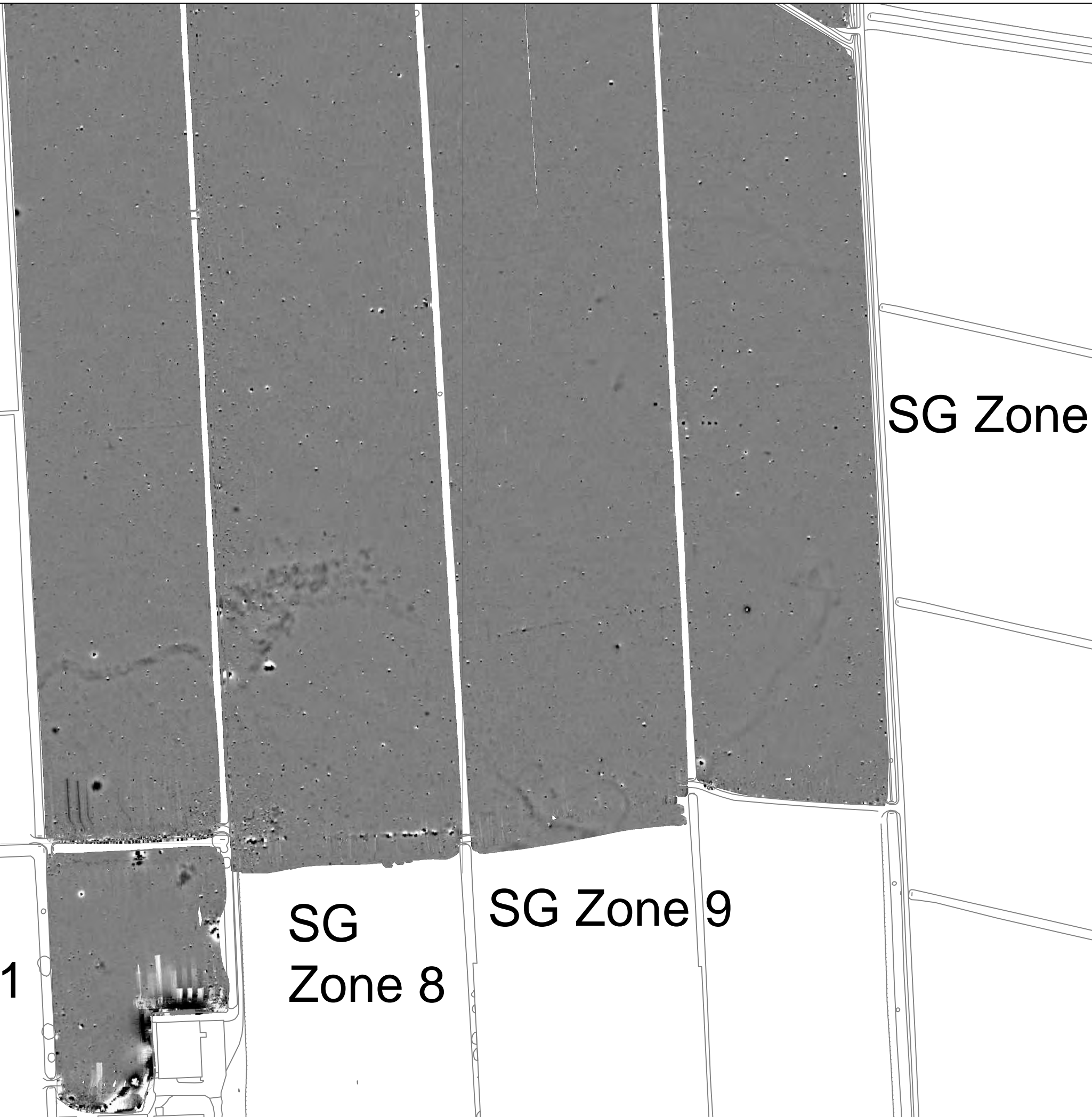


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G Zone 7

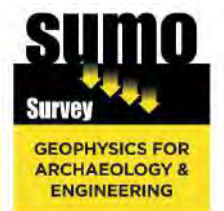
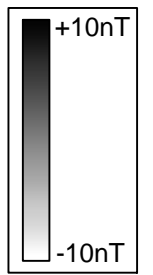
G Zone 11



SG Zone

SG  
Zone 8

SG Zone 9



Title:  
Minimally Processed Data - Greyscale Plots

Client:  
Pegasus Group

Project:  
05153 - Area 1, Heckington Fen Solar Park,  
Lincolnshire

Scale:  
0 metres 150  
1:3000 @ A3

Fig No:  
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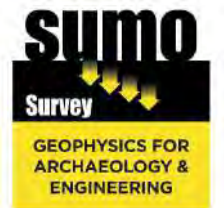


SG Zone 2

SG Zone 1

SG Zone

SG Zone



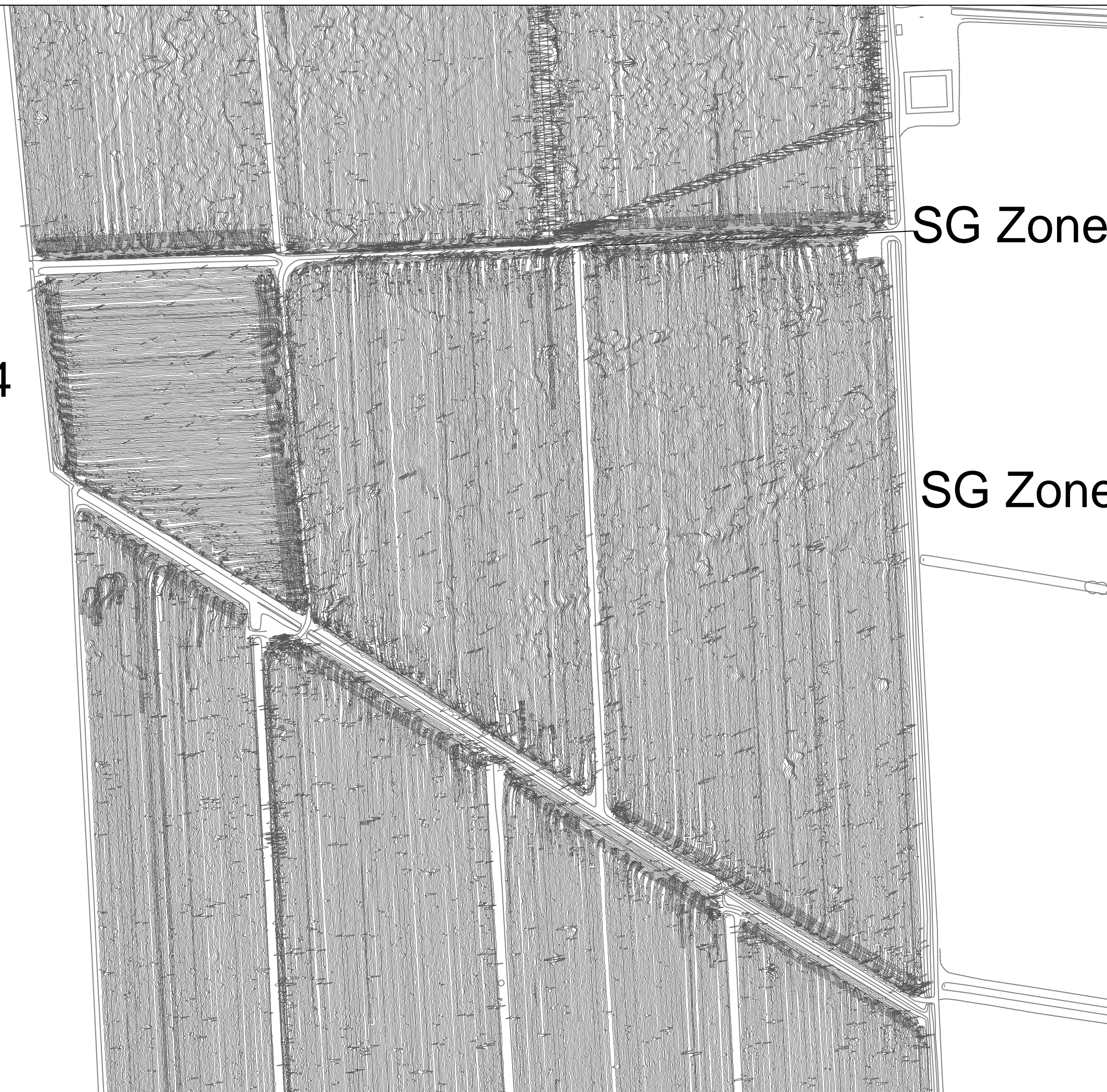
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Client: Pegasus Group

Project: 05153 - Area 1, Heckington Fen Solar Park, Lincolnshire

Scale: 0 metres 150  
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Fig No: 18



Zone 4

SG Zone

SG Zone



Title:		XY Trace Plots (clipped at +/-15nT)	
Client:		Pegasus Group	
Project:		05153 - Area 1, Heckington Fen Solar Park, Lincolnshire	
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G Zone 7

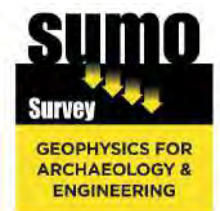
G Zone 11



SG Zone

SG  
Zone 8

SG Zone 9



Title:  
XY Trace Plots (clipped at +/-15nT)

Client:  
Pegasus Group

Project:  
05153 - Area 1, Heckington Fen Solar Park,  
Lincolnshire

Scale:  
0 metres 150  
1:3000 @ A3

Fig No:  
20



## Appendix A - Technical Information: Magnetometer Survey Method

### Grid Positioning

For hand held gradiometers the location of the survey grids has been plotted together with the referencing information. Grids were set out using a Trimble R8 Real Time Kinematic (RTK) VRS Now GNSS GPS system.

An RTK GPS (Real-time Kinematic Global Positioning System) can locate a point on the ground to a far greater accuracy than a standard GPS unit. A standard GPS suffers from errors created by satellite orbit errors, clock errors and atmospheric interference, resulting in an accuracy of 5m-10m. An RTK system uses a single base station receiver and a number of mobile units. The base station re-broadcasts the phase of the carrier it measured, and the mobile units compare their own phase measurements with those they received from the base station. This results in an accuracy of around 0.01m.

Technique	Instrument	Traverse Interval	Sample Interval
Magnetometer	Bartington Grad 601-2	1.0m	0.25m
Magnetometer	Bartington Cart System	1.0m	0.125m

### Instrumentation:

Bartington instruments operate in a gradiometer configuration which comprises fluxgate sensors mounted horizontally, set 1.0m apart. The fluxgate gradiometer suppresses any diurnal or regional effects. The instruments are carried, or cart mounted, with the bottom sensor approximately 0.1-0.3m 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. Generally, features up to 1m deep may be detected by this method, though strongly magnetic objects may be visible at greater depths.

### Bartington Grad 601-2

Hand-Held: Data will be collected using a Bartington Grad 601-2. The instrument consists of two paired sensors and readings are logged at 0.25m centres along traverses 1.0m apart across 30m grids. The collection of data at 0.25m centres provides an appropriate methodology balancing cost and time with resolution as per Historic England guidelines

### Bartington Cart System

Data will be collected using a cart carrying four paired Bartington magnetic sensors. Each data point is geographically referenced using an on-board Trimble RTK survey grade GPS system. Readings will be taken at 0.125m centres along traverses 1.0m apart.

### Data Processing

Zero Mean	This process sets the background mean of each traverse within each grid to zero.
Traverse	The operation removes striping effects and edge discontinuities over the whole of the data set.
Step Correction (De-stagger)	When gradiometer data are collected in 'zig-zag' fashion, stepping errors can sometimes arise. These occur because of a slight difference in the speed of walking on the forward and reverse traverses. The result is a staggered effect in the data, which is particularly noticeable on linear anomalies. This process corrects these errors.

### Display

Greyscale/ Colourscale Plot	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.
--------------------------------	---

## Interpretation Categories

In certain circumstances (usually when there is corroborative evidence from desk-based or excavation data) very specific interpretations can be assigned to magnetic anomalies (for example, *Roman Road, Wall, etc.*) and where appropriate, such interpretations will be applied. The list below outlines the generic categories commonly used in the interpretation of the results.

<i>Archaeology / Probable Archaeology</i>	This term is used when the form, nature and pattern of the responses are clearly or very probably archaeological and /or if corroborative evidence is available. These anomalies, whilst considered anthropogenic, could be of any age.
<i>Possible Archaeology</i>	These anomalies exhibit either weak signal strength and / or poor definition, or form incomplete archaeological patterns, thereby reducing the level of confidence in the interpretation. Although the archaeological interpretation is favoured, they may be the result of variable soil depth, plough damage or even aliasing as a result of data collection orientation.
<i>Industrial / Burnt-Fired</i>	Strong magnetic anomalies that, due to their shape and form or the context in which they are found, suggest the presence of kilns, ovens, corn dryers, metal-working areas or hearths. It should be noted that in many instances modern ferrous material can produce similar magnetic anomalies.
<i>Former Field Boundary (probable &amp; possible)</i>	Anomalies that correspond to former boundaries indicated on historic mapping, or which are clearly a continuation of existing land divisions. Possible denotes less confidence where the anomaly may not be shown on historic mapping but nevertheless the anomaly displays all the characteristics of a field boundary.
<i>Ridge &amp; Furrow</i>	Parallel linear anomalies whose broad spacing suggests ridge and furrow cultivation. In some cases, the response may be the result of more recent agricultural activity.
<i>Agriculture (ploughing)</i>	Parallel linear anomalies or trends with a narrower spacing, sometimes aligned with existing boundaries, indicating more recent cultivation regimes.
<i>Land Drain</i>	Weakly magnetic linear anomalies, quite often appearing in series forming parallel and herringbone patterns. Smaller drains may lead and empty into larger diameter pipes, which in turn usually lead to local streams and ponds. These are indicative of clay fired land drains.
<i>Natural</i>	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions.
<i>Magnetic Disturbance</i>	Broad zones of strong dipolar anomalies, commonly found in places where modern ferrous or fired materials (e.g. brick rubble) are present.
<i>Service</i>	Magnetically strong anomalies, usually forming linear features are indicative of ferrous pipes/cables. Sometimes other materials (e.g. pvc) or the fill of the trench can cause weaker magnetic responses which can be identified from their uniform linearity.
<i>Ferrous</i>	This type of response is associated with ferrous material and may result from small items in the topsoil, larger buried objects such as pipes, or above ground features such as fence lines or pylons. Ferrous responses are usually regarded as modern. Individual burnt stones, fired bricks or igneous rocks can produce responses similar to ferrous material.
<i>Uncertain Origin</i>	Anomalies which stand out from the background magnetic variation, yet whose form and lack of patterning gives little clue as to their origin. Often the characteristics and distribution of the responses straddle the categories of <i>Possible Archaeology / Natural</i> or (in the case of linear responses) <i>Possible Archaeology / Agriculture</i> ; occasionally they are simply of an unusual form.

Where appropriate some anomalies will be further classified according to their form (positive or negative) and relative strength and coherence (trend: weak and poorly defined).

## Appendix B - Technical Information: Magnetic Theory

Detailed magnetic survey can be used to effectively define areas of past human activity by mapping spatial variation and contrast in the magnetic properties of soil, subsoil and bedrock. Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.1 nanoTeslas (nT) in an overall field strength of 48,000 (nT), can be accurately detected.

Weakly magnetic iron minerals are always present within the soil and areas of enhancement relate to increases in *magnetic susceptibility* and permanently magnetised *thermoremanent* material.

Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological or fermentation processes.

Thermoremanence is a permanent magnetism acquired by iron minerals that, after heating to a specific temperature known as the Curie Point, are effectively demagnetised followed by re-magnetisation by the Earth's magnetic field on cooling. Thermoremanent archaeological features can include hearths and kilns; material such as brick and tile may be magnetised through the same process.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement allowing assessment and characterisation of subsurface features. Material such as subsoil and non-magnetic bedrock used to create former earthworks and walls may be mapped as areas of lower enhancement compared to surrounding soils.

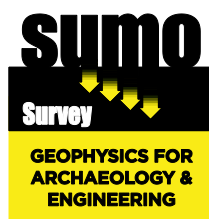
Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field whilst the lower sensor measures the same field but is also more affected by any localised buried feature. The difference between the two sensors will relate to the strength of a magnetic field created by this feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity and disturbance from modern services.

## Summary for sumogeop1-506326

OASIS ID (UID)	sumogeop1-506326
Project Name	Geophysical Survey at Heckington Fen Solar Park, Lincolnshire
Sitename	
Activity type	Geophysical Survey, MAGNETOMETRY SURVEY
Project Identifier(s)	05153
Planning Id	
Reason For Investigation	Planning requirement
Organisation Responsible for work	SUMO Geophysics Ltd.
Project Dates	21-Mar-2022 - 07-Apr-2022
Location	Heckington Fen Solar Park, Lincolnshire NGR : TF 19234 45627 LL : 52.9947130157344, -0.224960504769163 12 Fig : 519234,345627
Administrative Areas	Country : England County : Lincolnshire District : North Kesteven Parish : Heckington
Project Methodology	A temporary grid system was established over the site and marked out using canes. The location of the grid will be set out using an RTK GPS system theoretically accurate to some 0.01m and referenced to OS co-ordinates. Data will be collected using a cart carrying four paired Bartington magnetic sensors. Four sensors mounted 1m horizontally apart and very accurately aligned to nullify the effects of the earth's magnetic field. Readings relate to the difference in localised magnetic anomalies compared with the general magnetic background. Each data point is geographically referenced using an on-board Trimble RTK survey grade GPS system. Readings will be taken at 0.125m centres along traverses 1.0m apart. Readings relate to the difference in localised magnetic anomalies compared with the general magnetic background. At the end of every data collection a zone of data was recollected as a control.
Project Results	The magnetometer survey has not recorded any magnetic responses that could be interpreted as being of definite archaeological interest. Natural magnetic responses associated with the former coastal landscape dominate the results in the northern half of the survey and are also visible to a lesser degree throughout the southern part of the site. A number of responses of uncertain origin have also been mapped. While archaeological origins for a ring-like anomaly in Area 5 cannot be entirely dismissed, the majority uncertain responses are likely to be due to a combination of agricultural / natural processes. A strong complex of anomalies has been recorded in the north of Area 3 which coincide with the location of the former New Grange Farm. The demolition of the buildings and subsequent spreads of debris has resulted in the magnetic disturbance. Former field boundaries, land drains, ploughing and land drains are also visible in the data. The route of a couple service pipes have also been marked.

Keywords	Field Boundary - POST MEDIEVAL - FISH Thesaurus of Monument Types Drainage System - POST MEDIEVAL - FISH Thesaurus of Monument Types Plough Marks - POST MEDIEVAL - FISH Thesaurus of Monument Types Pipeline - 20TH CENTURY - FISH Thesaurus of Monument Types
Funder	
HER	Lincolnshire HER - unRev - STANDARD
Person Responsible for work	Thomas, Cockcroft, John, Gater
HER Identifiers	HER Event No - HECW22
Archives	



- Archaeological
- Geophysical
- Laser Scanning
- Measured Building
- Topographic
- Utility Mapping

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