THE DROVES
SOLAR FARM

The Droves Solar Farm

Appendix 8.5: Air Photo Services Report

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AIR PHOTO SERVICES

Archaeology • Research • Law • Environment • Planning

Assessment of airborne remote sensing and satellite imagery data for archaeology

The Droves Solar Farm
Swaffham, Norfolk

Air Photo Services Report 224 07 02 _01 Rev 0.0

December 2024

REGISTERED CIfA ORGANISATION

The Droves Solar Farm, Norfolk

Client	Island Green Power
Local Planning Authority	Norfolk Council
Air Photo Services Document Number	224 07 02 _01
Air Photo Services Project Number	224 07 02
National Grid Reference (NGR)	TF 804 124 (centre of site area)
Co-ordinates	580477,312403

Report Status	Rev 0.0
Issue date	20th December 2024
Report	
Interpretation, GIS and mapping	
QA	

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Summary

S1 This assessment of historical and modern aerial photographs, satellite imagery and visualised LiDAR data was prepared by Air Photo Services Ltd, on behalf of Island Green Power.

S2 The remit of this assessment is to provide information on the location and nature of any buried and upstanding archaeological features which are visible on the stated data sources to assess any buried, topographic and micro topographic features within the site and its immediate 100m buffer area.

S3 All available sources of historic aerial photographs, satellite imagery and Light detection and ranging (LiDAR) data, which is also known as Airborne Laser Scan (ALS) data, available at the time of the assessment were consulted. Evidence for the natural environment within and around the site was also examined and discussed in the context of the archaeological data which in this case is best recorded *via* the extant geophysical survey data rather than from airborne and satellite remote sensing sources.

S4 The site and environs have been ploughed and used for modern agriculture, particularly latterly for localised areas of outdoor pig rearing.

S5 Whilst crop marks show clearly over natural geological phenomena known as 'patterned ground', which is often visible in crops over some chalky substrates, very few traces of buried archaeological features are recorded by this survey. There are also no visible microtopographic features beyond residual small chalk and gravel pits which are recorded *via* visualised LiDAR data.

S6 There is no extant, microtopographic or crop marked evidence for Medieval ploughing (ridge and furrow).

Caveat

S4 Further features, including pre-modern sites, which may not be visible *via* the currently available sources of airborne remote sensing and satellite imagery data, could be present below the ground surface. There *may* be additional features revealed

within the site upon removal of the top and subsoils during development which are not detectible by airborne and satellite remote sensing methods.

1 Introduction

Aim and scope of the assessment

1.1. This assessment of historical and modern aerial photographs, satellite imagery and visualised LiDAR data was prepared by Air Photo Services Ltd, on behalf of Island Green Power, between September and December 2024.

1.2. The remit of this assessment is to provide information on the location and nature of any buried and upstanding archaeological features which are visible on the stated data sources to assess any buried, topographic and microtopographic features within the site and its immediate 100m buffer area.

1.3. All appropriate and accessible sources of airborne and satellite remote sensing data available at the time of the assessment were consulted. Evidence for the natural and agricultural environment within and around the site was also examined.

Location and description of the site

1.4. The site lies on level agricultural land with some small areas of deciduous woodland to the north of Swaffham, in Norfolk and is shown on **Figure 1** Location of the site at The Droves Solar Farm site in Norfolk **Figure 1**.

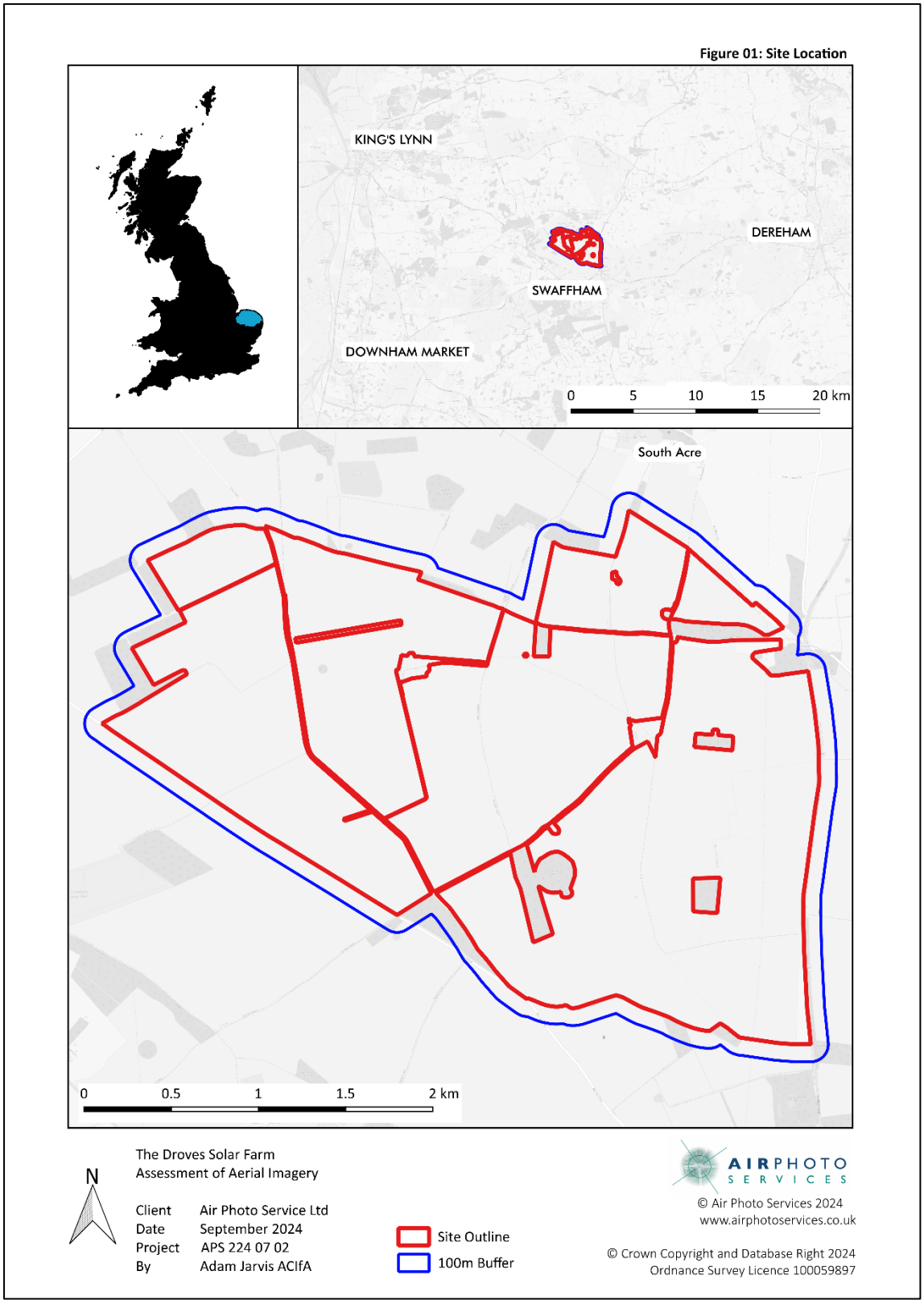

Figure 1 Location of the site at The Droves Solar Farm site in Norfolk

Standards and guidance

1.5. This assessment is undertaken in accordance with:

- Historic England Aerial Investigation and Mapping (formerly National Mapping Programme) Standards Technical Review, (Evans 2019)
- Using Airborne LiDAR in Archaeological Survey: The Light Fantastic. Historic England (2018)
- Chartered Institute for Archaeologists Code of Conduct: Professional Ethics in Archaeology, (CIfA 2022)

2 Sources of Data

2.1. The assessment examined the following sources of data:

- Vertical and oblique aerial photographs at the Historic England (HE) Archive[1]. Locations of the Historic England aerial photographs held as prints at the HE Archive in Swindon are shown on **Figure 2**
- The Cambridge University Collection of Aerial Photography (CUCAP) is currently closed for any consultation, but a search of their online database indicated very few images within the site boundary
- The collections of aerial photographs held at the Norfolk Historic Environment Record (NHER) was also searched and examined, but no specific photographs showed archaeological features within the site boundary and buffer areas. The locations of both CUCAP and NHER aerial photographs are shown on **Figure 3**
- Aerial and satellite imagery available as open-source data: multiple timelines of aerial photographs and satellite imagery at www.google.com/earth (Google Earth Pro) and www.Bing.com/maps , including aerial and satellite imagery
- Visualised Airborne Laser Scan (ALS) which is also known as Light Detection And Ranging (LiDAR) Data (UK Environment Agency open-source data), National LiDAR Programme (NLP) Digital Terrain Model (DTM) and Digital Surface Model (DSM) 1m resolution data gathered at an optimal date in 2023. **Figure 4** shows the open-source LiDAR data coverage at the site**. Figures 5** and **6** show the Hillshade and Simple Local Relief Model (SLRM) visualisations of these data
- Norfolk Historic Environment Record (NHER) data
- As yet there are no available Historic England funded Norfolk Aerial Investigation and Mapping (AIMP) project data within the site area or buffer

[1] HE enquiry reference 145534

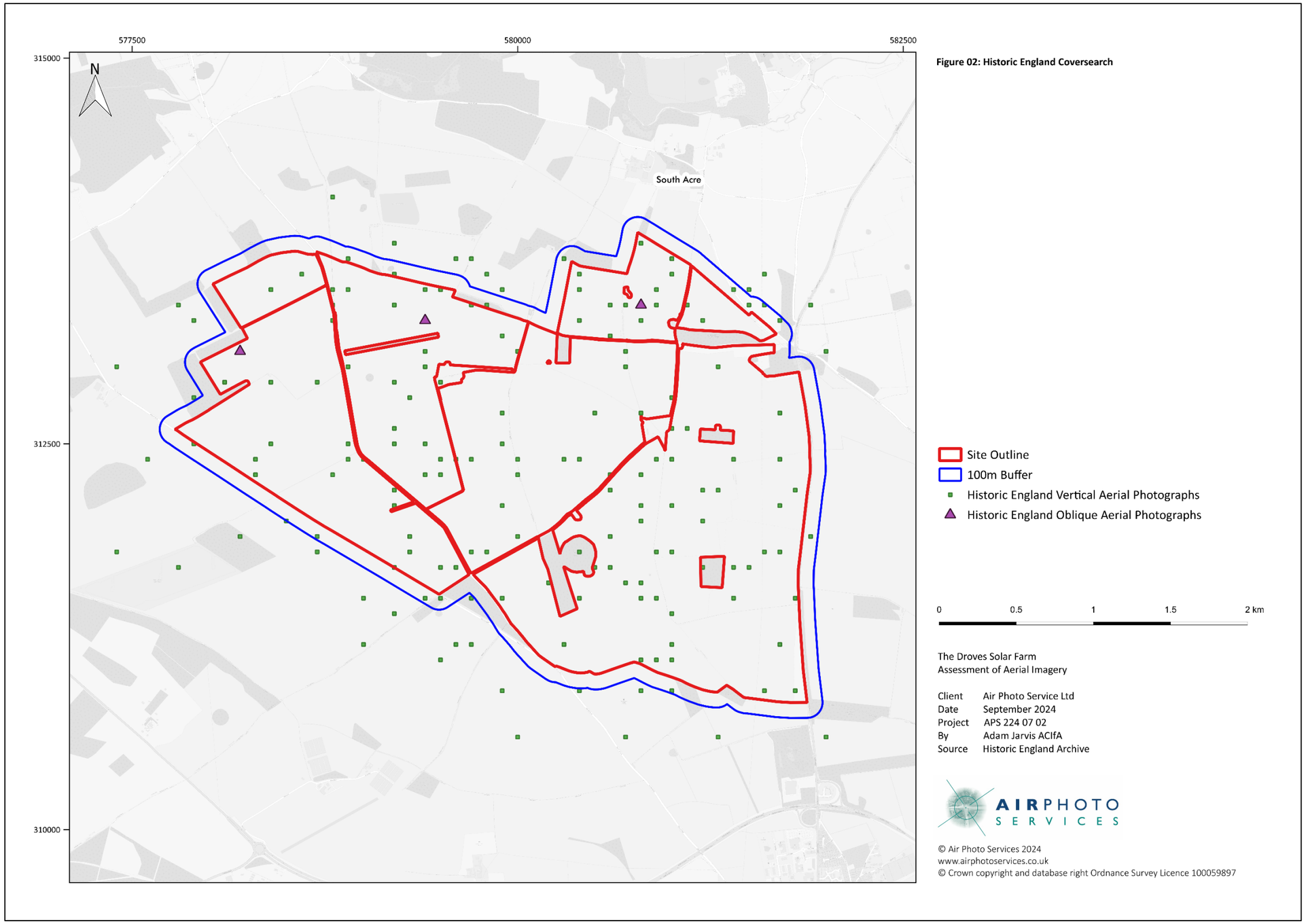

Figure 02: Historic England Coversearch

Figure 2 Aerial photographs held at the Historic England Archive at and around The Droves Solar Farm site in Norfolk

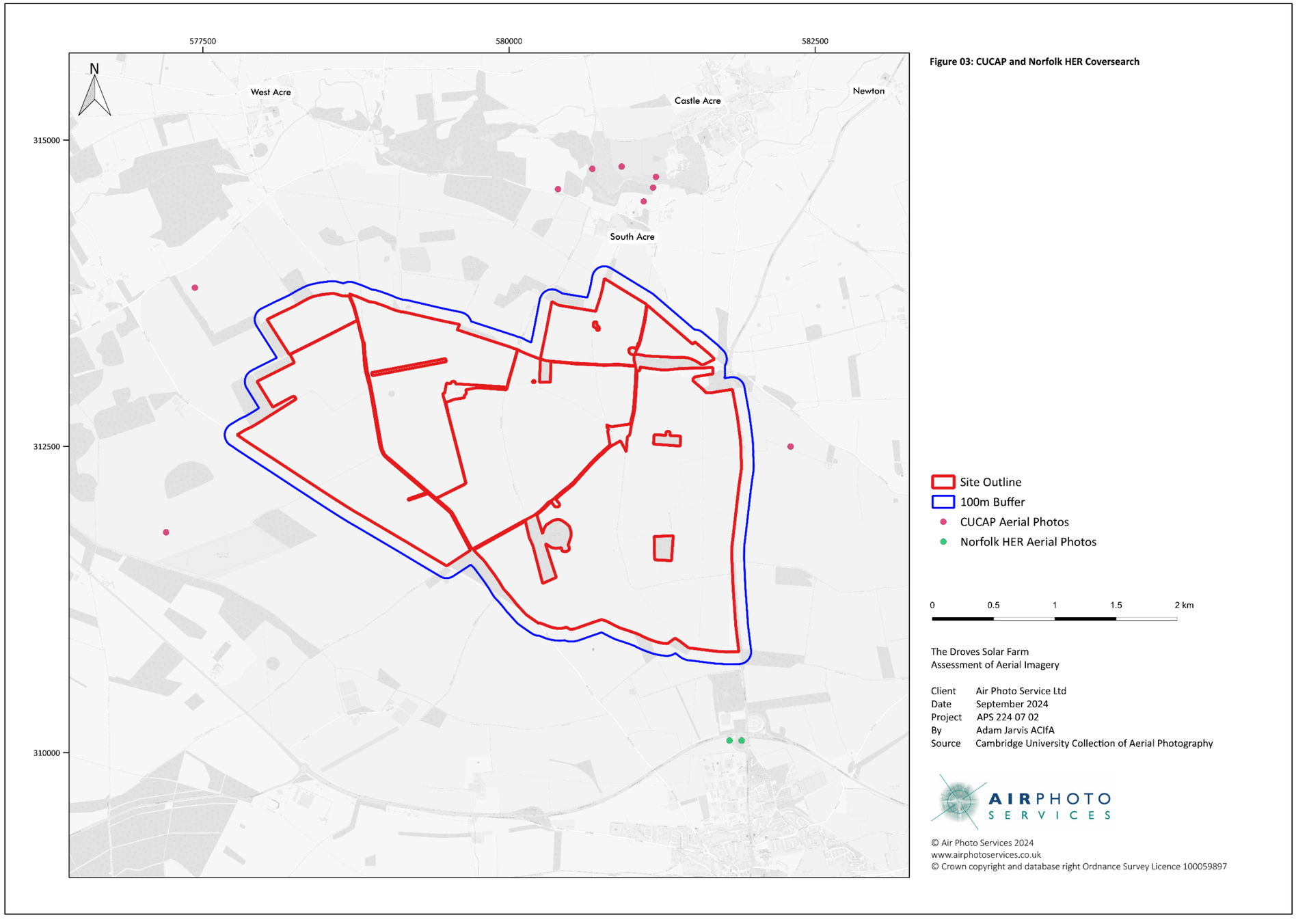

Figure 03: CUCAP and Norfolk HER Coversearch

Figure 3 Aerial photographs held at CUCAP and Norfolk HER over the Droves Solar Farm site and its environs

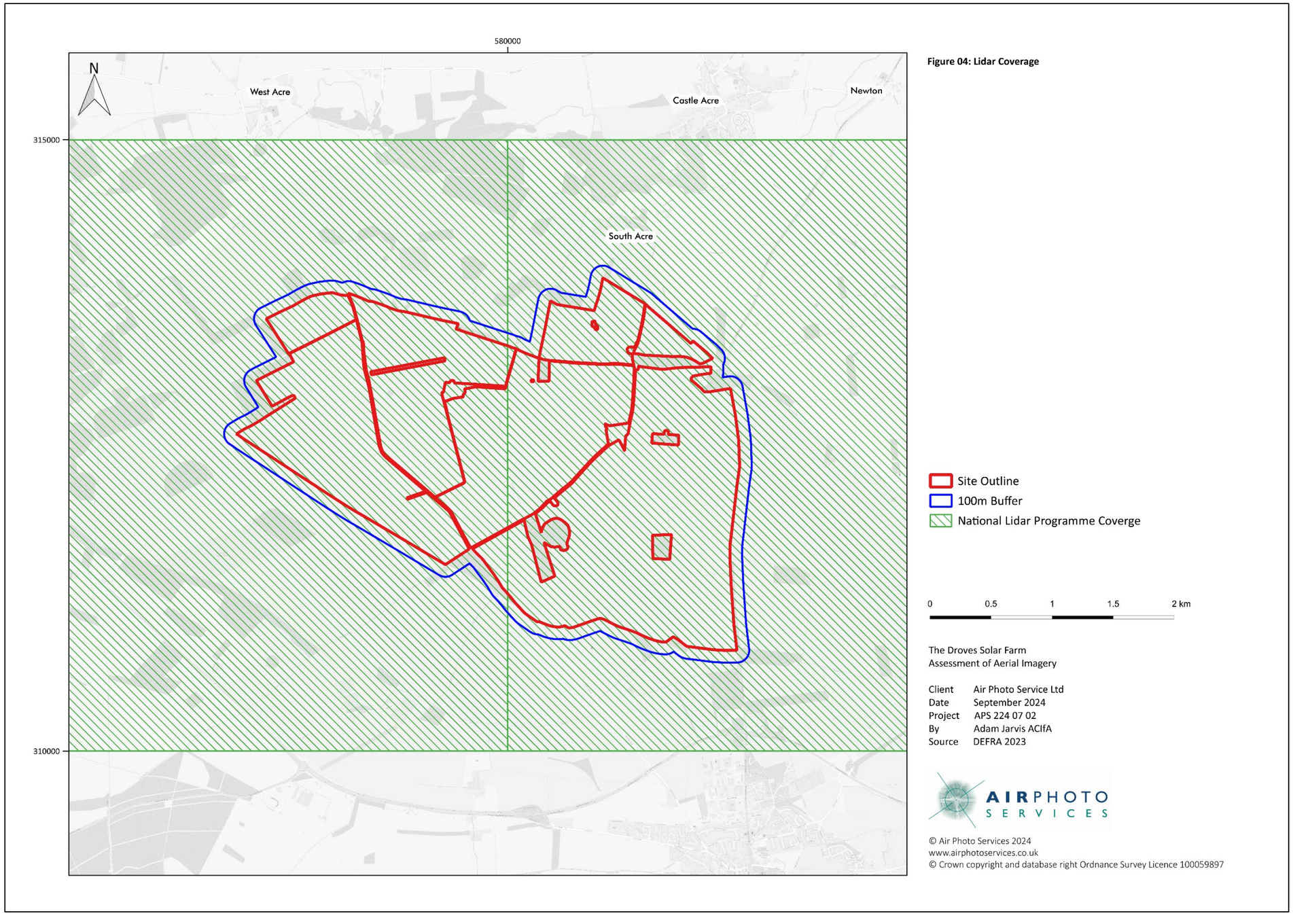

Figure 04: Lidar Coverage

Figure 4 LiDAR data coverage at The Droves Solar Farm Site in Norfolk

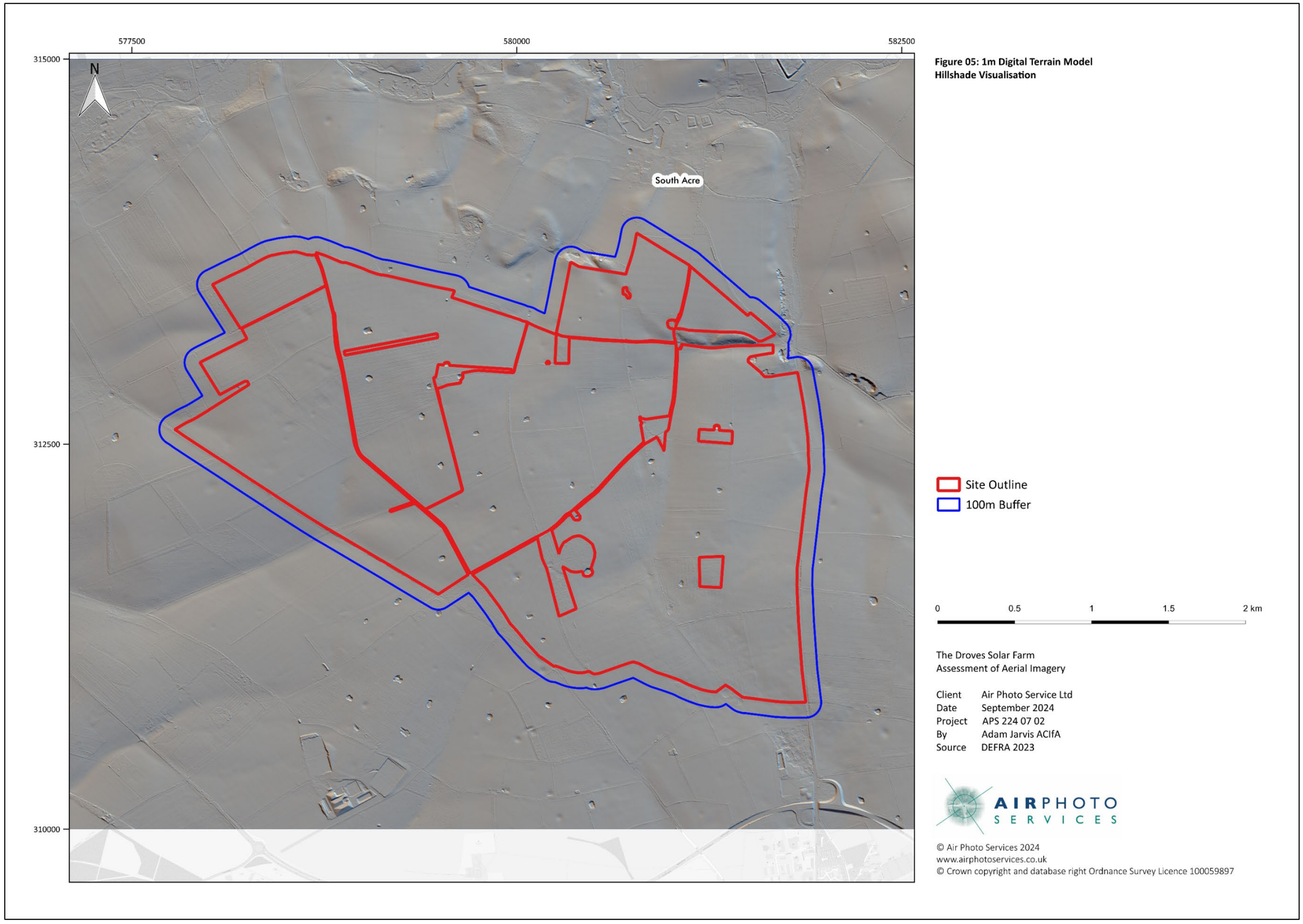

Figure 05: 1m Digital Terrain Model
Hillshade Visualisation

Figure 5 1m DTM hillshade visualisation of LiDAR data at the Droves Solar Farm site in Norfolk

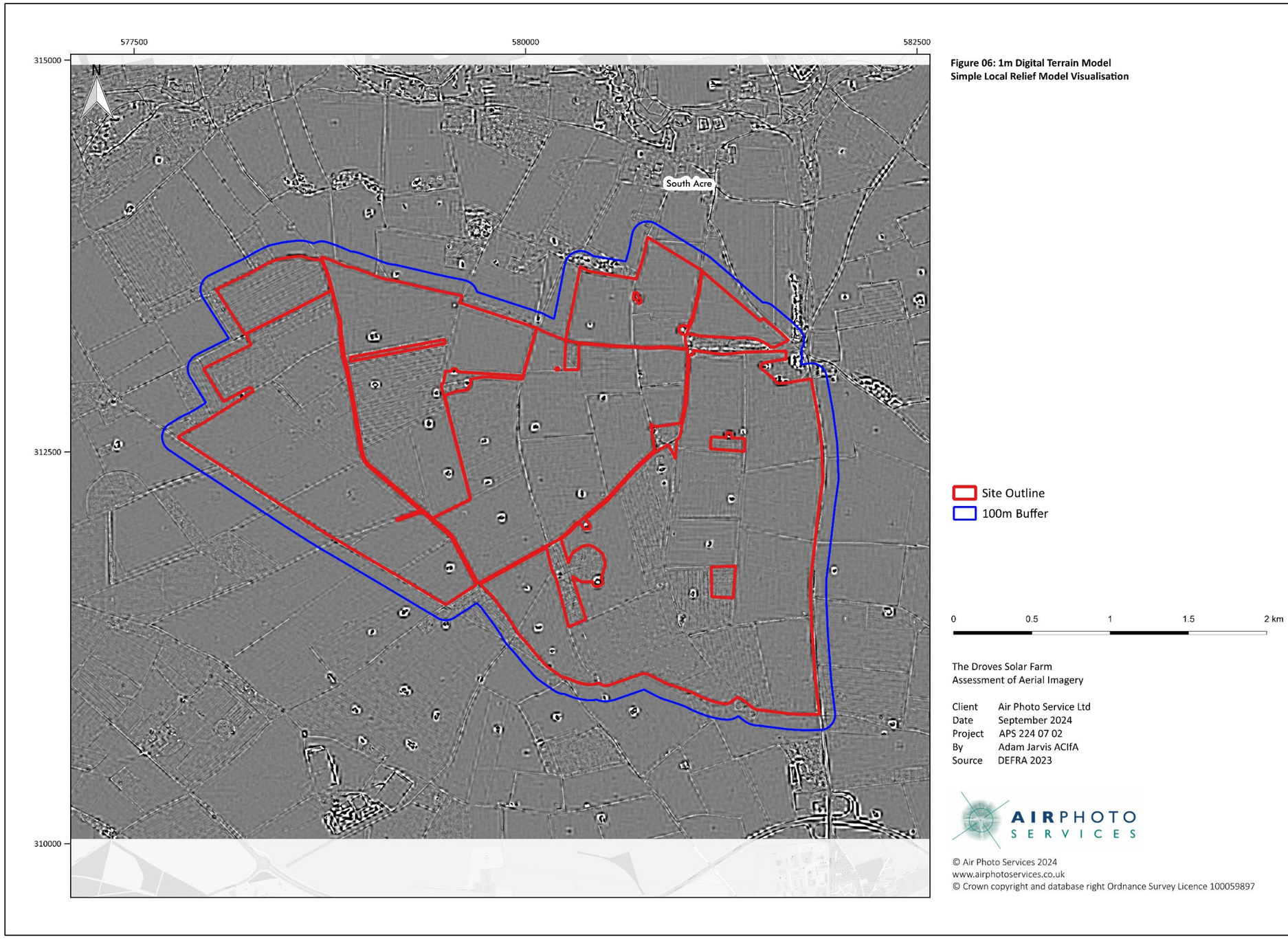

Figure 06: 1m Digital Terrain Model
Simple Local Relief Model Visualisation

Figure 6 1m DTM Simple Local Relief Model (SLRM) LiDAR data visualisation at The Droves Solar Farm site in Norfolk

3 Interpretation and mapping summary

3.1 Aerial photographs were closely examined by eye on screen and as paper copies, as appropriate, and then photographed or downloaded at high resolution. Vertical aerial photographs were examined with the aid of a mirror stereoscope where appropriate, or in detail on screen when consulted as digital files. Images were georeferenced[2] where appropriate using mapping control points derived from modern and historic OS mapping and accurate non-hillshade LiDAR data visualisations.

3.2 Layers from the final drawing have been used to prepare the illustration for this report and are provided digitally for import to a GIS, in Esri[3] Shapefile[4] format.

3.3 Open-source LiDAR data were downloaded from https://environment.data.gov.uk/DefraDataDownload/?mapService=EA/SurveyIndexFiles&Mode=spatial , visualised and imported to Quantum-Geographic Information System (now known as QGIS)[5] for interpretation, alongside all relevant airborne and satellite remote sensing data sources and the NHER data shapefiles.

3.4 Methods of acquisition, standards and guidance, processing, georeferencing transcription and interpretation are undertaken according to best-practice principles, the standards referred in Paragraph 1.6, and in line with Palmer (2008) and Scollar (2002).

[2] Georeferencing is the process of taking a digital image, it could be an air photo, a scanned map, or a picture of a topographic map, and adding geographic information to the image so that GIS or mapping software can 'place' the image in its appropriate real world location.

[3] Esri is an American multinational GIS software company, best known for its ArcGIS products.

[4] The shapefile format is a geospatial vector data format for geographic information system software. It is developed and regulated by Esri as a mostly open specification for data interoperability among Esri and other Geographic Information System (GIS) software products.

[5] QGIS is a GIS software that is free and open source. QGIS supports Windows, macOS, and Linux. It supports viewing, editing, printing, and analysis of geospatial data in a range of data formats. QGIS was previously known as Quantum GIS.

4 Environment and previously recorded heritage assets

4.1 The nature of the environment has a complex effect on both the preservation and visibility of both buried and upstanding features when recorded from the air. Many factors combine to influence very marked seasonal and temporal limitations to visibility of cropmarks[6], soil marks[7], earthworks[8] and relict or past buildings and foundations. Land use, agricultural regimes, weather, geology and soil types are all major contributing factors to the visibility of heritage assets from airborne and satellite-derived sources when assessing buried features which show as marks in crops, grass and soil.

4.2 In this site, natural features show as marks in crops caused by variations in areas of chalky substrate over well-defined 'patterned ground'. Marks in crops, grass and soil are also visible over former small sub-circular extractive pits which are infilled or overgrown and also show as microtopography via visualised LiDAR data.

Topography and land use

4.3 The site lies on level agricultural land to the north of Swaffham. Parts of the land have, in addition to arable cropping, been used as outdoor pig rearing facilities.

Geology and soil

4.1 **Figures 7** and **8** show the substrates and soils at the site and its environs.

4.2 The majority of the site lies on free-draining glaciofluvial drift and till with smaller area of chalk and chalk drift in the west and northeast areas of the site and buffer area (Cranfield University, 2024). These soils give rise to soils of the NEWMARKET, NEWPORT 4 and WORLINGTON soil associations.

[6] Where crops grow differentially over buried features such as ditches, banks and walls and reveal the pattern of past sites and landscape in the colour and density of their growth.

[7] Differently coloured and toned soil which is part of buried features which are being directly brought to the surface by ploughing or erosion and are visible in contrast to the surrounding soil.

[8] Upstanding ditched and embanked features which show from the air *via* their shadows or *via* the differential topography revealed by visualised LiDAR data.

4.3 These well-drained substrates often facilitate the appearance of differential marks in crops over buried features in times of Soil Moisture Deficit (SMD). However, few traces beyond natural 'patterned ground' and agricultural features are visible in the crops and soils. Geophysical survey, however, has indicated some buried features in greater extent and detail than indicated by the presently available aerial photos and satellite imagery in this area.

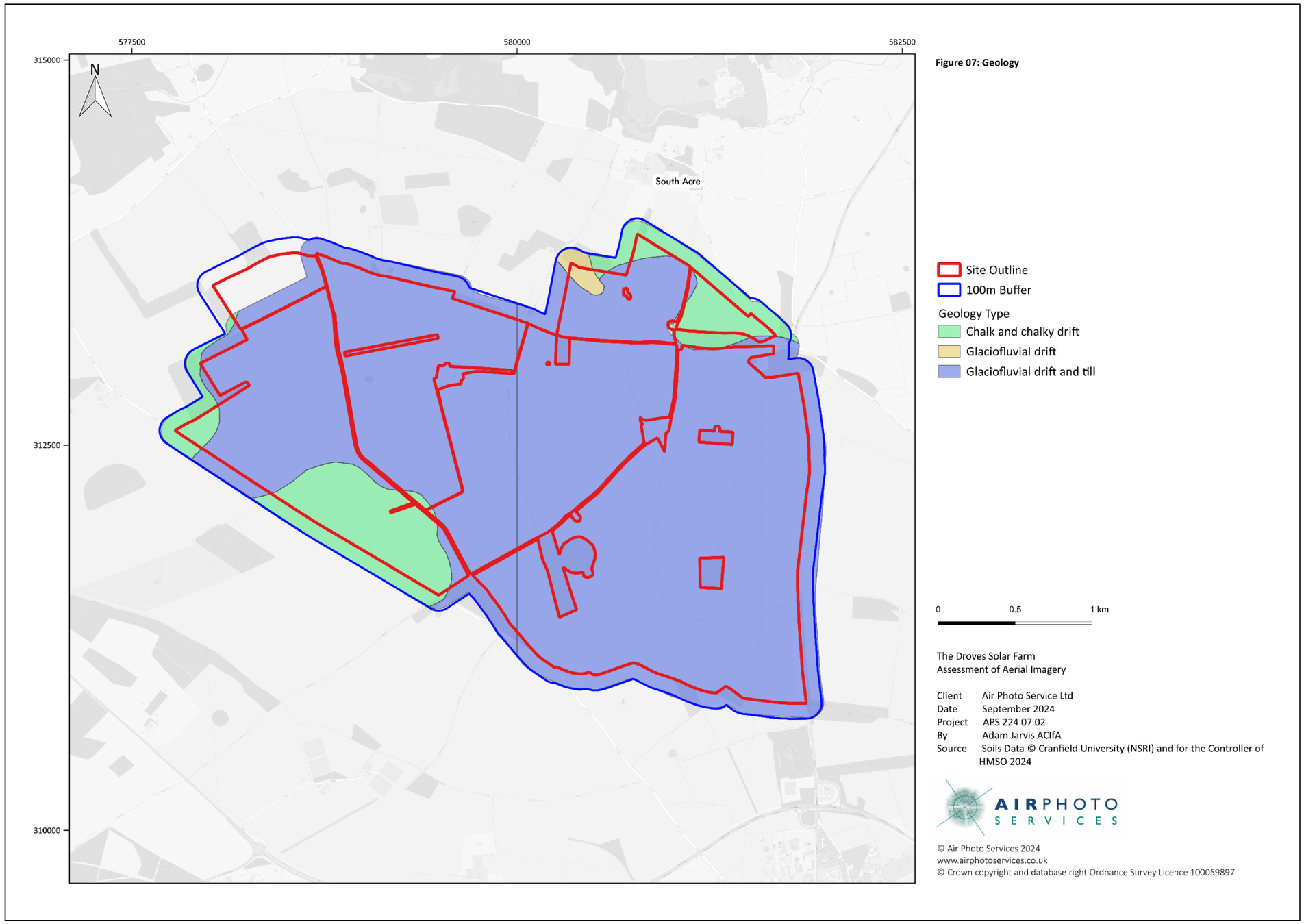

Figure 07: Geology

Figure 7 Geology at The Droves Solar Farm site in Norfolk

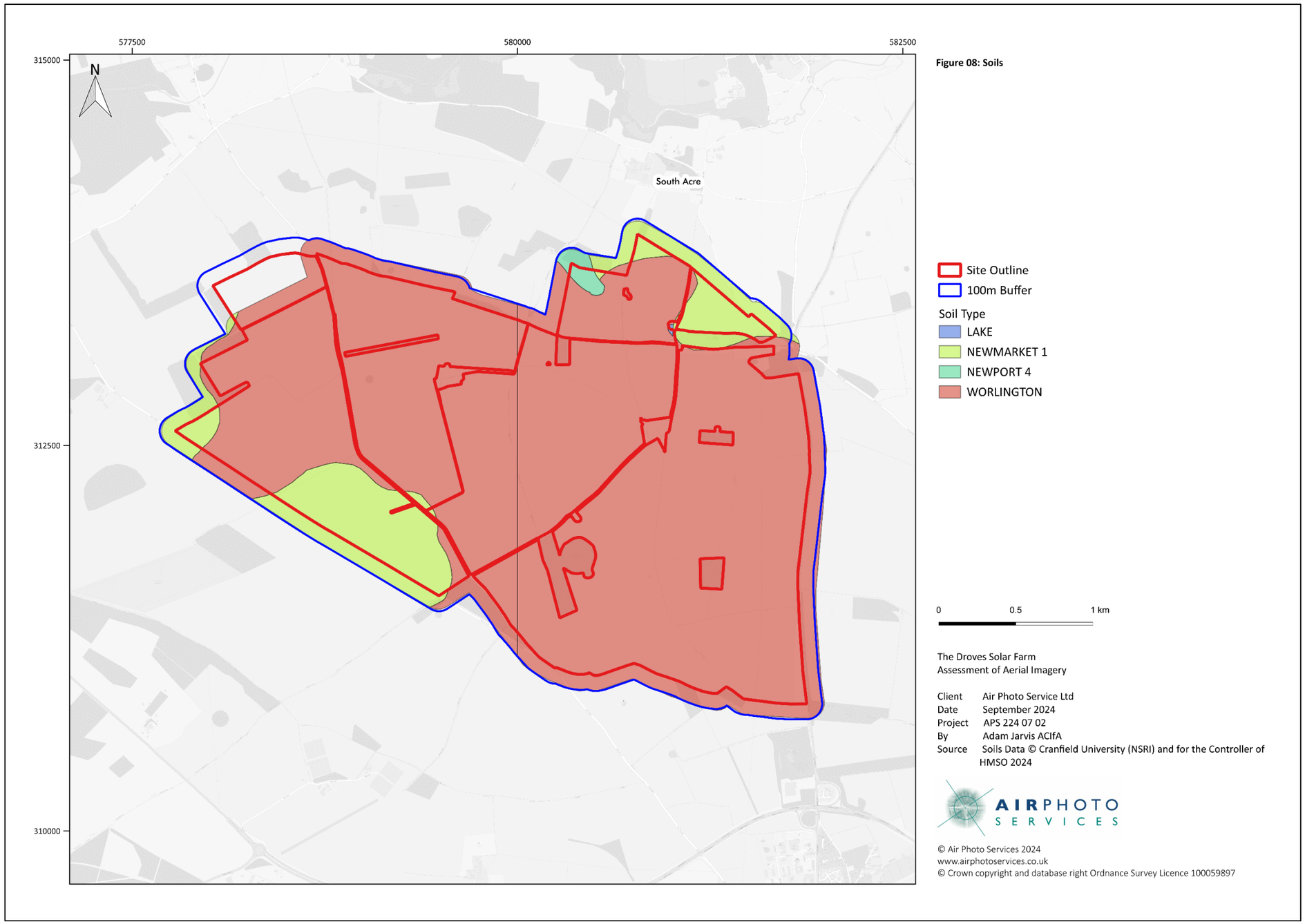

Figure 08: Soils

Figure 8 Soils at the Droves Solar Farm site, Norfolk

Previously recorded heritage assets

4.4 The NHER records multi-period artefact finds at varied locations within and around the site. A prehistoric burnt mound, which is not visible on any airborne remote sensing or satellite imagery sources, is recorded as NHER MNF 3986 and noted as APS05 to link with the NHER record only.

4.5 A World War II bombing decoy is recorded as MNF 29538. No trace remains above ground or as marks in crops or soil at this site, which is noted as APS_12, again to link with the NHER .

5 Results

5.1 **Figure 9** shows the features recorded by this assessment .

5.2 The assessment notes an undated ditch and two buried ditched enclosures which are shown in greater extent and detail *via* geophysical survey undertaken during the wider site assessment.

5.3 Areas of recent and former modern pig farming are recorded.

5.4 A prehistoric burnt mound and a WWII airfield bombing decoy are recorded by the NHER and are not visible for mapping *via* airborne and satellite remote sensing data sources.

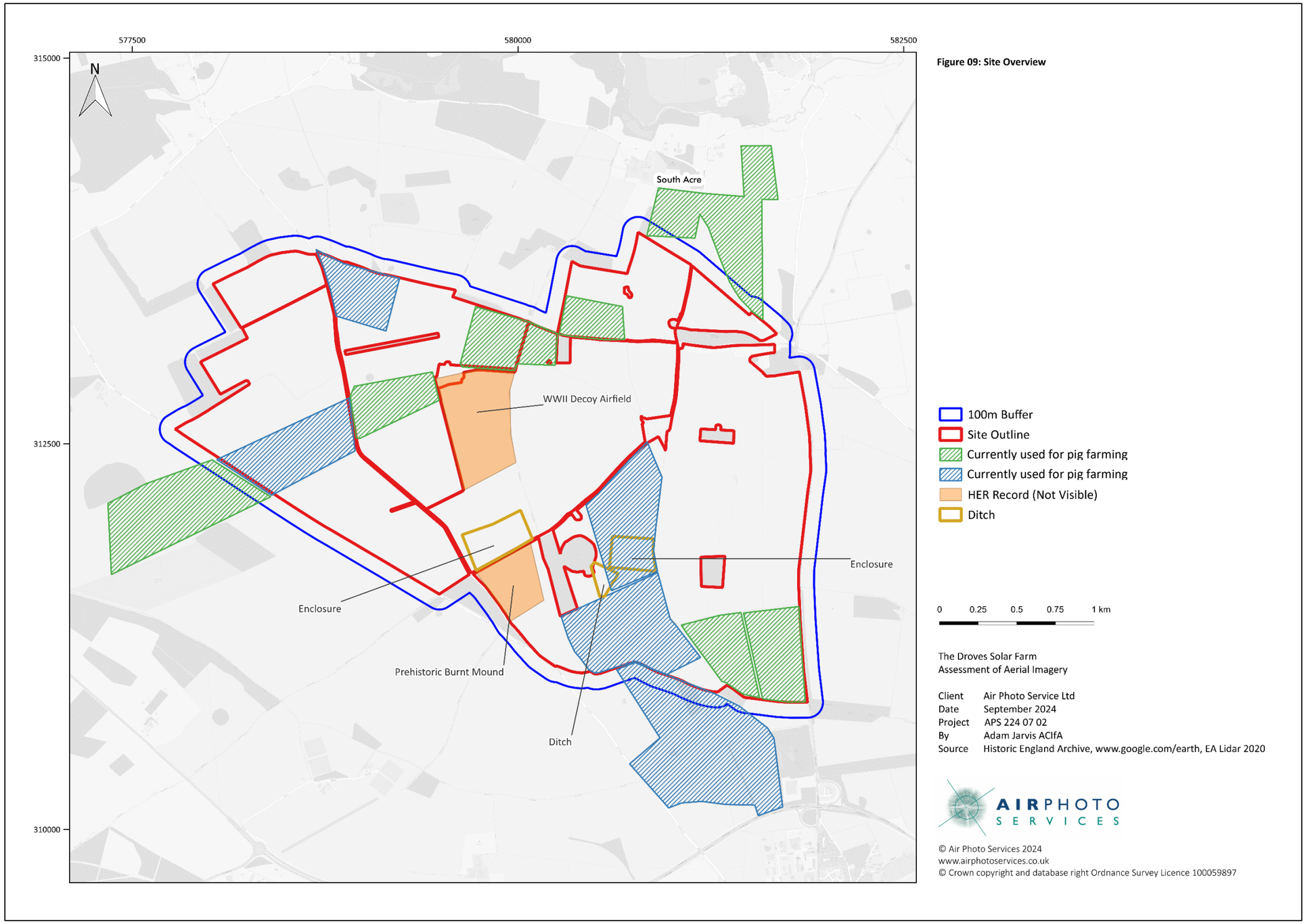

Figure 09: Site Overview

Figure 9 Overview of areas recorded at The Droves Solar Farm site in Norfolk

6 Summary and conclusion

6.1 Interpretation of historic and modern aerial photographs, satellite imagery and recent LiDAR data shows very little evidence for archaeological features at this site, where geophysical survey has provided more detailed results.

Caveat

6.2 Further features, including pre-modern sites may not be visible *via* the currently available sources of airborne remote sensing and satellite imagery data. There may be additional features revealed within the site upon removal of the top and subsoils during development which are not detectible by airborne and satellite remote sensing methods.

7 Note on the use of LiDAR Data

7.1. LiDAR data are collected for multiple environmental and engineering survey purposes and are therefore sometimes not in compliance with optimum timeframes for heritage survey requirements. These data were processed in accordance with standards set by Historic England (2018) Bennett *et al* (2012), Štular *et al* (2012) and Hesse (2010). An optimum LiDAR survey date for recovery of micro and macro topographic heritage data spans late November to mid-March in the northern hemisphere. This is when leaf canopy and vegetation are at their lowest and a higher proportion of bare earth is exposed in both woodland and open areas to ensure that the laser pulses reach and return to and from the ground in sufficient density to record topography to create an accurate and detailed DTM.

7.2. Whilst of excellent high resolution, some data are not gathered at an optimal time for specific heritage survey purposes, as they are provided to serve the needs of multi-disciplinary surveys. A lower resolution survey captured during the winter months very often provides more data due to the lack of intervening vegetation which prevents sufficient laser points from reaching the ground surface. A low density of vegetation and leaf canopy is essential to the effectiveness of LiDAR survey in that it ensures maximum penetration of light signals to the ground surface in vegetated areas.

7.3. The LiDAR data are, however, of assistance in recording some micro and more macro topographic features which may indicate relict or extant archaeological features and historic landscapes. They were used over the survey area in multiple visualisations alongside the aerial photographs and satellite image data. LiDAR data are best interpreted and used in conjunction with modern and historic aerial photographs and maps to provide ground truth information, and this was achieved in this survey.

7.4. For LiDAR data captured during ‘leaf/crop/grass on’ conditions, less data are recorded due to foliage and vegetation masking the route of the laser. Similarly, areas of water will absorb the laser giving no returned points. This Site is an open area of land and thus optimally responsive to the recording of topographic differences.

7.5. Most of the NLP LiDAR data were collected between October and March, with varied dates for smaller surveys. When the point cloud is processed into a DTM, reduced ground coverage results in a simplified geometry surface interpolated from the few available data points which can obstruct features of interest.

7.6. The horizontal cell resolution of LiDAR data can also influence the detection rates of archaeological features. This can occur where the spacing of point measurements is sufficiently wide to conceal or reduce the visibility of small archaeological features. This may have affected this assessment in areas where LiDAR data were gathered at 2m, 1m and 50cm resolutions as opposed to the more detailed 25cm resolution data. It is also important to note that LiDAR visualisation techniques are continually developing and advancing. The multiple visualisations now applied to DSM and DTM data *via* the RVT used for this survey are effective in heritage interpretation. Hillshade, and particularly fixed-direction hillshade, visualisations do not show the correct position of the actual features, only the position of their virtual 'shadows' on the ground. It is thus important to use multiple visualisations of LiDAR data to ensure accurate positioning of recorded features and optimise the results.

8 References

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Scollar, I. (2002). 'Making Things Look Vertical.' In Bewley RH and Raczkowski W (Eds) Aerial Archaeology: Developing Future Practice. *NATO Science Series*, 337. PP. 166 – 172.

Štular, B., Kokalj, Ž., Oštir, K., and Nuninger, L. (2012). 'Visualisation of LiDAR – derived relief models for detection of archaeological features' in *Journal of Archaeological Science* 39. PP. 3354-3360.

9 APPENDIX: Aerial photos and satellite images used for this assessment

Aerial Photographs

Historic England Archive enquiry reference 145534

Obliques

Photo reference (NGR and Index number)	Film and frame number	Date	Film type	Map Reference (6 figure grid ref)
TF 7813 / 1	CCC 9103 / M306	22 JUN 1933	Black & white	TF 782131
TF 7913 / 1	CCC 9103 / M307	22 JUN 1933	Black & white	TF 794133
TF 8013 / 1	CCC 11761 / M308	Unknown	Black & white	TF 808134

Verticals held as prints for consultation (P)

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RAF/3G/TUD/UK/100	5279	P	TF 805 127	6	30 MAR 1946	A	10000
RAF/3G/TUD/UK/100	5280	P	TF 811 126	6	30 MAR 1946	A	10000
RAF/3G/TUD/UK/100	5401	P	TF 785 120	8	30 MAR 1946	A	10000
RAF/3G/TUD/UK/100	5402	P	TF 792 121	8	30 MAR 1946	A	10000
RAF/3G/TUD/UK/100	5403	P	TF 799 121	8	30 MAR 1946	A	10000
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OS/71482	38	P	TF 808 109	2	07 SEP 1971	A	7500
OS/71482	45	P	TF 818 109	3	07 SEP 1971	A	7500
OS/71482	46	P	TF 818 115	3	07 SEP 1971	A	7500
OS/71482	47	P	TF 817 121	3	07 SEP 1971	A	7500
OS/71482	48	P	TF 817 127	3	07 SEP 1971	A	7500
OS/71482	49	P	TF 817 133	3	07 SEP 1971	A	7500
OS/95565	29	P	TF 820 106	1	19 JUN 1995	A	8000
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~~OS/93314~~	~~66~~	~~N~~	~~TF 781 129~~	~~3~~	~~11 MAY 1993~~	~~A~~	~~7600~~
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OS/93314	69	P	TF 800 131	3	11 MAY 1993	A	7600
~~OS/93314~~	~~70~~	~~N~~	~~TF 806 132~~	~~3~~	~~11 MAY 1993~~	~~A~~	~~7600~~
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Sortie number	Frame number	Held	Centre point	Run	Date	Sortie quality	Scale 1:
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Sortie number	Frame number	Held	Centre point	Run	Date	Sortie quality	Scale 1:
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Sortie number	Frame number	Held	Centre point	Run	Date	Sortie quality	Scale 1:
~~OS/05931(Y)~~	~~2339~~	~~N~~	~~TF 787 118~~	~~1~~	~~23 AUG 2005~~	~~A~~	~~10000~~
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~~OS/05931(Y)~~	~~2341~~	~~N~~	~~TF 806 117~~	~~1~~	~~23 AUG 2005~~	~~A~~	~~10000~~
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~~OS/05931(Y)~~	~~2346~~	~~N~~	~~TF 788 134~~	~~2~~	~~23 AUG 2005~~	~~A~~	~~10000~~
~~OS/05931(Y)~~	~~2347~~	~~N~~	~~TF 778 134~~	~~2~~	~~23 AUG 2005~~	~~A~~	~~10000~~
~~OS/AF/05C/597~~	~~6854~~	~~N~~	~~TF 814 117~~	~~2~~	~~12 JUL 2005~~	~~AC~~	~~10000~~
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Sortie number	Frame number	Held	Centre point	Run	Date	Sortie quality	Scale 1:
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~~ADA/680~~	~~246~~	~~N~~	~~TF 808 120~~	~~5~~	~~21 AUG 1995~~	~~A~~	~~10000~~

Norfolk Historic Environment Record specialist obliques

Grid	Accession Number	Frame	Flight No.	Day	Month	Year	NGR	Easting	Northing	Parish	Photographer	Copyright (Original)
TF8110	A	SLIDE		27	NOV	1973	TF 818 100			Swaffham	Derek Edwards	NCC
TF8110	B	SLIDE		27	NOV	1973	TF 818 100			Swaffham	Derek Edwards	NCC
TF8110	C	26	86	27	JUN	1980	TF 819 101	581900	310100	Swaffham	Derek Edwards	NCC
TF8110	D	27	86	27	JUN	1980	TF 819 101	581900	310100	Swaffham	Derek Edwards	NCC
TF8110	E	24	194	22	SEP	1987	TF 819 101	581900	310100	Swaffham	Derek Edwards	NCC

Google Earth Pro

Date	Data provider
2024 10 24	Airbus
2020 05 06	CNES Airbus/Google split image
2019 09 21	CNES Airbus
2018 09 27	Google
2006	Getmapping plc
2006 07 02	Infoterra/Bluesky
1999	Infoterra/Bluesky

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THE DROVES

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