REPORT

Boston Alternative Energy Facility – Environmental Statement

Appendix 8.2 Geophysical Survey Report: Boston Alternative Energy Facility

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Royal HaskoningDHV
Enhancing Society Together

HASKONINGDHV UK LTD.

Rightwell House
Rightwell East
Bretton
Peterborough
PE3 8DW
Industry & Buildings
VAT registration number: 792428892

+44 1733 334455 **T**
+44 1733 262243 **F**
info@uk.rhdhv.com **E**
royalhaskoningdhv.com **W**

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Author(s):	Danielle Farrar, Vic Cooper
Drafted by:	Danielle Farrar
Checked by:	Vic Cooper
Date:	27/11/20 VC
Approved by:	Paul Salmon
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Unit 17, Commerce Court

Challenge Way

Bradford

BD4 8NW

01274 926020

info@magnitudesurveys.co.uk

Report By:

Alison Langston BA PCIfA, Isabella Carli BA MA PCIfA, Dr Kayt Armstrong MCIfA

Report Approved By:

Finnegan Pope-Carter BSc (Hons) MSc FGS

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Abstract

A fluxgate magnetometer survey and an electromagnetic survey were successfully completed across c.12.7ha area of land off Nursery Road, Boston, Lincolnshire. Though the magnetic survey was affected by a highly magnetically contrasted topsoil (related to the soil and water chemistry of the survey environment), anomalies of anthropogenic origin could be identified. These include a possible enclosure ditch and two locations of possible burning or production activity. The location of these anomalies, close to the field edges, and the strongly contrasted background of the survey area have made it difficult to suggest a possible date (and therefore degree of possible archaeological significance). Other anomalies interpreted as ditches and made ground have corresponding anomalies within the electromagnetic data and are more secure in their interpretation. The electromagnetic data also allowed the identification of a probable palaeochannel in the underlying sediments, and a potential spur or unmapped extension of a known medieval earthwork or a natural slight rise in the topography that was exploited to build this. Overall, the results do not suggest the presence of significant or extensive archaeological features, but there are areas of potential interest.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by Royal HaskoningDHV to undertake a geophysical survey on a c.12.7ha area of arable land off Nursery Road, Boston, Lincolnshire (TF 3395 4224).

1.2. The geophysical survey comprised hand-carried GNSS-positioned fluxgate gradiometer and electromagnetic (EM) survey. Magnetic survey is the standard primary geophysical method for archaeological applications in the UK for its ability to detect a range of different features. The technique is particularly suited for detecting fired or magnetically enhanced features, such as ditches, pits, kilns, sunken earth houses, and industrial activity (David *et al*., 2008). The EM survey was collected separately to the gradiometer survey. Electromagnetic survey is particularly suited for the detection of paleo-landscape environments such as paleo channels and map changes in soil magnetic susceptibility across an expansive landscape; however, EM instrumentation has also demonstrated an ability to identify archaeological features (David et al., 2008).

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 for Archaeologists (CIfA, 2014) and the European Archaeological Council (Schmidt et al., 2015).

1.4. It was conducted in line with a WSI produced by MS (Magnitude Surveys, 2020).

1.5. The magnetic survey commenced on 11/08/2020 for two days and a revisit for the EM survey commenced on 17/08/2020 and took two days to complete.

2. Quality Assurance

2.1. Magnitude Surveys is a Registered Organisation of the Chartered Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, and a corporate member of ISAP (International Society of Archaeological Prospection).

2.2. The directors of MS are involved in the cutting edge of research and the development of guidance/policy. Specifically, Dr. Chrys Harris has a PhD in archaeological geophysics from the University of Bradford, is a Member of CIfA and is the Vice-Chair of the International Society for Archaeological Prospection (ISAP); Finnegan Pope-Carter has an MSc in archaeological geophysics and is a Fellow of the London Geological Society, as well as a member of GeoSIG (CIfA Geophysics Special Interest Group); Dr. Kayt Armstrong has a PhD in archaeological geophysics from Bournemouth University, is a Member of CIfA, the Editor of ISAP News, and is the UK Management Committee representative for the COST Action SAGA; Dr. Paul Johnson has a PhD in archaeology from the University of Southampton, has been a member of the ISAP Management Committee since 2015, and is currently the nominated representative for the EAA Archaeological Prospection Community to the board of the European Archaeological Association.

2.3. All MS managers have relevant degree qualifications to archaeology or geophysics. All MS field and office staff have relevant archaeology or geophysics degrees and/or field experience.

3. Objectives

3.1. The objective of this geophysical survey was to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The survey area was located c.1.7km southeast from the centre of Boston, Lincolnshire (Figure 1). The survey was undertaken across two fields under arable use and two fields under pasture. The survey area was bounded to the north, east, and west by industrial estates, to the northeast by The Haven River, to the southwest by arable fields, and to the south by an arable field and industrial estate (Figure 2). Tall crop in Areas 1 & 2, a carpark in Area 2, and rubble in the area to the northeast of Area 2 prevented survey over a c.3.7ha area of land.

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	The area consisted of a flat field with maize crop.	The area was bounded to the east by a road, to the west by metal fencing, to the north by a track, and to the south by an earthen bank. The crop ranged from sparse to extremely dense across the field. Various forms of debris from small farm equipment could be seen throughout the field. Tall dense crop prevented survey over two areas located in the centre-west and centre-south of the survey area.
2	The area consisted of a flat field with maize crop.	The area was bounded to the west and north by a road, to the east by a large metal fence and by a pond to the southeast. Survey was not undertaken over a carpark present in the northern part of the survey area. Tall dense crop prevented survey over the southwest corner of the field.
3	The area consisted of flat grassland pasture.	The area was bounded to the south by a wooden fence with electrified fence wires. Bounded on all other sides by large metal fences.
4	The area consisted of flat grassland pasture.	The area was bounded to the north by a wooden fence with electrified fence wires. Bounded on all other sides by large metal fences. A metal water trough was present in the northwest corner of the survey area.

4.3. The underlying geology comprises mudstone of the Ampthill Clay Formation across the entire survey area. Superficial deposits consist of clay and silt tidal flat deposits (British Geological Survey, 2020). Within this landscape, interleaved peat and silt deposits are present and relate to the period prior to drainage and land reclamation.

4.4. The soils consist of loamy and clayey soils of coastal flats with naturally high groundwater (Soilscapes, 2020).

5. Archaeological Background

5.1. The following is a summary of an Cultural Heritage Desk-Based Assessment produced and provided by HaskoningDHV UK Ltd. (Moan, 2019).

5.2. There is no prehistoric activity recorded within 1km of the survey area.

5.3. Roman activity has been identified in the wider environs in the form of sherds of grey-ware pottery dated to the 4th century AD, found c.700m east of the survey area. A Roman pit was identified c. 900m east of the survey area, which contained burnt clay and animal bone. A former land surface dated to the Roman period was identified during trial trenching in the industrial area directly to the east of Area 2 however no anthropogenic evidence was found.

5.4. Medieval activity within the survey area is represented by a section of the extant / known earthwork named 'Roman Bank' on historical mapping, which runs northwest to southeast along and just within the eastern boundary of Areas 3 and 4. The earthwork measures 4km in length and was used as a flood defence. The origins of this section of the bank are unclear however a section of the bank located c.30km to the south of the survey area was dated to the late Saxon period. Within the wider environs of the survey area medieval activity has been recorded in the form of pottery finds and kilns, a coin, and settlement features such as postholes, pits and drainage channels. Many of these were located close to St. Nicholas' Church (c.660m north of the survey area), which has standing remains that potentially date from the 13th century.

5.5. Post-medieval activity is widespread within 1km of the survey area and consists mainly of farmsteads, drains and sluices. Within the wider environs, but with no exact location, several maritime losses are recorded. Pottery findspots have also been recorded within the wider environs. Within the survey area field boundaries and ditches are shown on historic mapping some of which have been removed to create larger fields. A pond is seen on the historic mapping within Area 2 as well as an outbuilding associated with Battery Farm in the north of Area 1 and a footpath along the Roman Bank that runs along the eastern boundary of Areas 3 and 4.

6. Methodology

6.1. Magnetometer surveys are generally the most cost effective and suitable geophysical technique for the detection of archaeology in England. Therefore, a magnetometer survey should be the preferred geophysical technique unless its use is precluded by any specific survey objectives or the site environment. For this site, the addition of an electromagnetic survey was utilised for reasons detailed below.

6.2. Electromagnetic survey measures both the soil's electrical conductivity and magnetic susceptibility making it a complementary technique to the fluxgate gradiometer, particularly in wet environments where traditional magnetic survey may struggle with high or low magnetic contrasts. The conductivity component of the EM data is especially useful in considering past environmental features such as former channels or drier ground. The particular EM instrument selected makes measurements at three different pseudodepths, also giving a picture of how the deposits on the site vary over the first 6m or so of overburden.

6.3. Geophysical survey therefore comprised the magnetic and electromagnetic methods as described in Section 6.4.

6.4. Data Collection

6.4.1. Geophysical prospection comprised the magnetic and electromagnetic methods as described in the following table.

6.4.2. Table of survey strategies:

Method	Instrument	Traverse Interval	Sample Interval
Magnetic	Bartington Instruments Grad-13 Digital Three-Axis Gradiometer	1m	200Hz reprojected to 0.125m
Electromagnetic Induction – Conductivity and Magnetic Susceptibility	GF Instruments CMD Explorer in HCP orientation	4m	5Hz reprojected to 0.25m

6.4.3. The magnetic and electromagnetic data were collected using MS' bespoke hand-carried GNSS-positioned system.

6.4.3.1. MS' hand-carried system was comprised of Bartington Instruments Grad 13 Digital Three-Axis Gradiometers and GF Instruments CMD Explorer in HCP orientation to facilitate a greater depth penetration. Positional referencing was through a multi-channel, multi-constellation GNSS Smart Antenna RTK GPS outputting in NMEA mode to ensure high positional accuracy of collected measurements. The RTK GPS is accurate to 0.008m + 1ppm in the horizontal and 0.015m + 1ppm in the vertical.

6.4.3.2. Magnetic, electromagnetic and GPS data were stored on an SD card within MS' bespoke datalogger. The datalogger was continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allowed for data collection, processing and visualisation to be monitored in real-time as fieldwork was ongoing.

6.4.3.3. A navigation system was integrated with the RTK GPS, which was used to guide the surveyor. Data were collected by traversing the survey area along the longest possible lines, ensuring efficient collection and processing.

6.5. Data Processing

6.5.1. Magnetic data were processed in bespoke in-house software produced by MS. Processing steps conform to Historic England's standards for "raw or minimally processed data" (see sect 4.2 in David et al., 2008: 11).

Sensor Calibration – The sensors were calibrated using a bespoke in-house algorithm, which conforms to Olsen et al. (2003).

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.

6.5.2. Electromagnetic data were processed by bespoke in-house software produced by MS. Processing steps conform to the EAC guidelines for "minimally enhanced data" (Schmidt et al., 2015). Data plots contained within the report conform to the EAC guidelines for minimally processed data.

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.

6.6. Data Visualisation and Interpretation

6.6.1. Magnetic data

6.6.1.1. This report presents the gradient of the sensors' total field data as greyscale images, as well as the total field data from the upper and/or lower sensors. The gradient of the sensors minimises external interferences and reduces the blown-out responses from ferrous and other high contrast material. However, the contrast of weak or ephemeral anomalies can be reduced through the process of calculating the gradient. Consequently, some features can be clearer in the respective gradient or total field datasets. Multiple greyscale images of the gradient and total field at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figures 8 & 11). XY trace plots visualise the magnitude and form of the geophysical response, aiding in anomaly interpretation.

6.6.1.2. Geophysical results have been interpreted using greyscale images and XY traces in a layered environment, overlaid against open street maps, satellite imagery, historic maps, LiDAR data, and soil and geology maps. Google Earth (2020) was consulted as well, to compare the results with recent land usages.

6.6.1.3. Geodetic position of results - All vector and raster data have been projected into OSGB36 (ESPG27700) and can be provided upon request in ESRI Shapefile (.SHP) and Geotiff (.TIF) respectively. Figures are provided with raster and vector data projected against OS Open Data.

6.6.2. Electromagnetic data

6.6.2.1. The quadrature-phase and in-phase results are presented as greyscale images. Multiple greyscales images at different plotting ranges have been used for data interpretation. The EM interpretation is partly derived from the quadrature phase, which is a proxy for apparent electrical conductivity. These datasets roughly correspond with a bulk soil volume equated to c. 2.2m, 4.2m and 6.7m deep, respectively. However, as the EM is measuring a bulk soil volume, it will be sensitive to features above and below these theoretical exploration depths. The second set of EM interpretation is derived from the in-phase component of the EM response which relates to the soil's magnetic susceptibility, making it a complementary technique to the fluxgate magnetometer. The in-phase roughly corresponds with a bulk soil volume of half that of the quadrature-phase. The different receiving coil responses are referred to as In1, In2, and In3 configurations for the magnetic susceptibility and C1, C2, and C3 configurations for the conductivity. These depths are described as comparatively shallow, middle, and deep soil volumes, respectively. From this point onward, the respective quadrature-phase and in-phase datasets will be referred to as EM conductivity and EM magnetic susceptibility, respectively.

7. Results

7.1. Qualification

7.1.1. Geophysical results 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.

7.2. Discussion

7.2.1. The geophysical results are presented in consideration with historic maps and satellite imagery (Figure 5).

7.2.2. The survey environment presented some challenges for the fluxgate magnetometer survey. The resulting magnetic data is characterised by strongly enhanced anomalies across most of the survey area, which are likely to be caused by specific chemical processes in the tidal flat deposits (see Section 4.4.3) (Figure 4). Peri-marine landscapes characterised by salt marshes, tidal flats and saltwater creeks have likely caused the distinct pattern visible in the magnetic results. Research suggests that this enhancement is a specific result of the saline conditions (Kattenberg & Aalbersberg 2004). Usually in wet environments the magnetic enhancement of the soil is impeded by the lack of oxygen, but in coastal environments the presence of salts and the wetting and drying action of the tide produces iron oxides with strong magnetic properties. Despite this, some anthropogenic anomalies are apparent in the magnetic data and are generally interpreted as more recent interventions related to drainage and development.

7.2.3. The electromagnetic survey, both conductivity and magnetic susceptibility, have responded well to the survey environment. The data is characterised by strong responses interpreted as agricultural features such as drains and field boundaries (Figure 13). Whilst it does not show the superficial palaeoenvironmental features in as much detail as the gradiometer survey, strong responses for more deeply buried palaeochannels and clay deposits are also identifiable. In both surveys, spreads of ferrous debris have been identified in the north and centre of the survey area (Figures 7 & 13). It is likely that these are areas of made ground, related to the industrial usage of the surrounding areas and ongoing development. Two services identified in the centre of the survey area have produced broad magnetic haloes which limited the interpretation of underlying anomalies in this area (Figures 5 & 17).

7.2.4. Evidence of agricultural activity has been detected in the centre of the survey area. A weak positive linear anomaly has been identified, running east to west. This anomaly appears to align with a stream visible on 2nd edition OS maps and OS Zoomstack mapping (Figures 5 & 10). No stream was seen in this location during survey, so it is possible this is either no longer extant, or it has been canalised and runs in a culvert.

7.2.5. Across the survey area, a series of anomalies undetermined in origin have been detected in the gradiometer data. These do not appear to align with any features on historic or satellite mapping, or with modern ploughing trends and former field boundaries (Figure 5).

7.2.6. Two discrete anomalies in the west of the survey area have been identified as possible localised burning or firing, as they exhibit a characteristic double-peak signal (Figure 7). It is possible that these might be related to salt production activity, as the survey area is within a saline environment; however, it is equally likely that these anomalies are modern in origin, due to their location close to a spread of ferrous debris.

7.2.7. A further series of weak linear anomalies in the southwest have been detected forming a right angle, and could possibly be a field system, although the edges of the survey area have limited any further interpretation (Figure 10).

7.2.8. The EM results suggest that a former and now buried landform in the shape of a ridge, cutting across the north east corner of the survey area might relate to, or have formed the basis of, the embankment shown on historic maps, which has been dated to the late Saxon period (see Section 5.4).

7.2.9. The EM results also contain evidence of former landscapes, with a possible palaeochannel identified in Area 2 (Figure 13), and patches of differences in local conductivity which may relate to local differences in the texture of the sediments close to the surface. There is also evidence in the conductivity data of localised de-watering or drying in the deeper sediments, particularly in areas closer to the developed parts of the surrounding environment. This is likely due to changes in the hyper-local hydrology caused by the development and associated drainage and ground works.

7.2.10. Both the magnetic survey and the EM survey show evidence of patches of ferrous or mixed debris, which could have been deposited by recent construction activity, or be related to efforts to consolidate wet ground at field entrances.

7.3. Interpretation

7.3.1. General Statements

7.3.1.1. Geophysical anomalies will be discussed broadly as classification types across the survey area. Only anomalies that are distinctive or unusual will be discussed individually.

7.3.1.2. **Data Artefact** – Data artefacts usually occur in conjunction with anomalies with strong magnetic signals due to how the sensors respond to very strong point sources. These are usually visible as minor ‘streaking’ following the line of data collection. While these artefacts can be reduced in post-processing through data filtering, this would risk removing real features. Therefore, these artefacts are indicated as necessary to preserve the data as 'minimally processed'.

7.3.1.3. **Ferrous (Spike)** – Discrete ferrous-like, dipolar anomalies are likely to be the result of isolated modern metallic debris on or near the ground surface.

7.3.1.4. **Ferrous/Debris (Spread)** – A ferrous/debris spread refers to a concentrated deposition of discrete, dipolar ferrous anomalies and other highly magnetic material.

7.3.1.5. **Magnetic Disturbance** – The strong anomalies produced by extant metallic structures along the edges of the field have been classified as 'Magnetic Disturbance'. These magnetic 'haloes' will obscure the response of any weaker underlying features, should they be present, often over a greater footprint than the structure they are being caused by.

7.3.1.6. **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.

7.3.2. Magnetic Results - Specific Anomalies

7.3.2.1. **Agricultural –** In the north of Area 2, two weak and aligned linear anomalies [**2a**] have been detected (Figure 10), running on an east to west orientation. These anomalies correspond with a stream visible on 2nd edition OS map and still recorded in the current OS Zoomstack mapping (Figure 5). As no stream is visible on satellite imagery and was not recorded during survey, this anomaly likely relates to an underground canalisation or a ditch which has been ploughed out during recent consolidation of the land parcel. This is corroborated by the EM results (see Section 7.3.3.2).

7.3.2.2. **Undetermined** – In the southeast of Area 1, two distinct strong magnetic anomalies have been identified [**1a**] (Figure 7). These are sub-circular in shape and exhibit a positive magnetic signal with a negative signal in the centre, most noticeable when looked at in the XY trace plots (Figure 8). The anomalies measure between c. 4m and c. 5m in diameter. Despite being a-typical, this signal usually suggests a ferrous origin but can also be indicative of burnt or fired material. Considering the peri-marine environment in which these anomalies occur (see Section 7.2.2), their characteristics might also be indicative of heating activities related to salt production, which is known to take place in these types of environments. However, given the proximity of anomalies [**1a**] to a broad ferrous anomaly which likely relates to modern debris of mixed material, they could also be modern in origin.

7.3.2.3. **Undetermined** – Running on a roughly north to south alignment in the northwest of Area 2 is a linear anomaly [**2b**] (Figure 10). This anomaly shows a strong positive magnetic signal, that is sometimes more apparent as a linear disruption in the locally strong background rather than a discrete anomaly in and of itself (Figure 9). This suggests a cut feature with a somewhat magnetically enhanced fill that is sometimes more visible as a negative, or disruption to, the local soils rather than as an anomaly which is stronger than them. Anomaly [**2b**] does not correspond with anything recorded on historic maps or visible on satellite imagery and has therefore been classified as "Undetermined". It appears to have a right-angled return at its southern end, and could possibly therefore be part of a field system or enclosure, although the edge of the survey area limits further interpretation. [**2b**] is considered likely to be modern, agricultural or natural in origin; however, an archaeological origin cannot be entirely ruled out.

7.3.3. Electromagnetic Results – Specific Anomalies

7.3.3.1. **Archaeology Possible - Earthwork (Strong)** – through all the depths of the conductivity data from the EM there is a pronounced, sharp-edged low conductivity band running northwest to southeast cutting across the northeast corner of the site passing through Areas 1, 3 and 4 [**1b, 3a, 4a**] (Figures 12, 14 & 16). This band runs up to and intersects with the line of the medieval earthwork that runs along the northeast side of the site (see Section 5.4). Due to this the band has been interpreted as a spur from that earthwork, or potentially a natural sand or gravel bar which changed the local topography and was exploited for the siting of the earthwork on naturally higher ground. Patches of higher conductivity along the flanks of this anomaly probably relate to localised water-pooling in areas where this drier sediment body inhibits the throughflow of pore water within the sediment. This interpretation is strengthened by the existence of a corresponding zone of higher magnetic susceptibility, which in this environmental context appears to be associated with drier sediments. It is possible that rather than a bank (whether artificial or natural), this is another coincidentally straight paleochannel like the more sinuous one interpreted in Area 2 (see below).

7.3.3.2. **Drain, Agricultural (Strong and Weak) –** Bisecting Area 2 (Figure 13) from east to west, there is a strong linear, high conductivity anomaly [**2a**] with a halo of weaker, but still increased, conductivity around it and particularly to the south of it. There is a low susceptibility anomaly in the same location in the in-phase data (Figure 16). These all correspond well with the linear anomalies seen in the magnetic data which have been interpreted as a canalised or ploughed-out drainage ditch or stream. Wetter environments will be more conductive, and less magnetic, and the area immediately surrounding a ditch will potentially also be wetter (and therefore less magnetically susceptible) thanks to the hyper-local hydrology.

7.3.3.3. **Service –** Only one of the anomalies interpreted as a service in the magnetic data has a corresponding anomaly in the electromagnetic data, appearing as a low magnetic susceptibility linear anomaly in the upper parts of the in-phase data **[2b]** (Figure 17). This suggests the service carries water or another liquid rather than cabling. It also suggests this is carried within a plastic or concrete pipe rather than a metal one.

7.3.3.4. **Palaeochannel – Strong and Weak –** Within the southern half of Area 2 there is a broad swath running roughly east to west along a sinuous curve, which is both low conductivity and high susceptibility, though all depths of the EM data **[2c]** (Figures 13, 15 & 17). This has been interpreted on the basis of its geophysical character and its morphology and orientation in the landscape as a former palaeochannel. This is somewhat the inverse of what might usually be expected, as these are usually wetter and therefore less susceptible than the surrounding soil matrix. However, given this coastal location and the presence of saline water within the sediments, it is possible that the former channels and creeks have filled with sand and gravel, or other non-local material that is less conductive and more susceptible than the tidal flat deposits they cut through, or are submerged by. This is borne out by the lack of any corresponding anomaly visible in the magnetic data, which seems to be being wholly influenced by the magnetically stronger shallow environment. It is also possible that this area relates to a sand or gravel bar rather than a channel, but the morphology is suggestive of a channel rather than a bank.

8. Conclusions

8.1. The fluxgate magnetometer survey has been impacted by the unusual soil chemistry in the formal tidal flat deposits that immediately underlie the survey area. These have produced a strongly mottled magnetic background against which it has been difficult to discern more subtle weaker anomalies. Despite this, anomalies of undetermined, but likely anthropogenic origins have been detected in the form of a linear ditch or cut feature, as well as two possible areas of burning. The character and location of these anomalies combined with the small and broken-up survey area has made it very difficult to arrive at a firm interpretation. Whilst no anomalies strongly suggestive of substantial archaeological features were detected by the magnetometer survey, it is possible that these anomalies have an archaeological origin.

8.2. The magnetometer survey also identified services and a canalised or recently ploughed-out stream within Area 2. These have corresponding anomalies in the electromagnetic data which bears out their interpretation.

8.3. The electromagnetic survey has responded well to the survey environment and, given that it relies on bulk measurements of larger soil and sediment volumes, has largely avoided the issues caused by the highly magnetic topsoil environment within the survey areas. The survey resolution is not sufficient to image more typical archaeological features, but has allowed the identification of a possible earthwork or bank related to the medieval 'Sea Bank' marked on OS maps of the area, and a possible palaeochannel running roughly east to west through Area 2, towards the estuary of the River Witham, known as The Haven.

8.4. Overall, the survey results present a complicated coastal landscape with evidence of recent and past management and reclamation in the form of drains and ground consolidation. The tidal flat deposits have created a noisy magnetic environment which may be masking more subtle archaeological features, but there are hints of anthropogenic activity in the form of enclosures and possible burning, which may relate to salt production. There is also evidence of the survival of a palaeolandscape of channels and creeks or sand bars below the tidal flats.

9. Archiving

9.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). This stores the collected measurements, minimally processed data, georeferenced and un-georeferenced images, XY traces and a copy of the final report.

9.2. MS contributes reports to the ADS Grey Literature Library upon permission from the client, subject to the any dictated time embargoes.

10. Copyright

10.1. 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.

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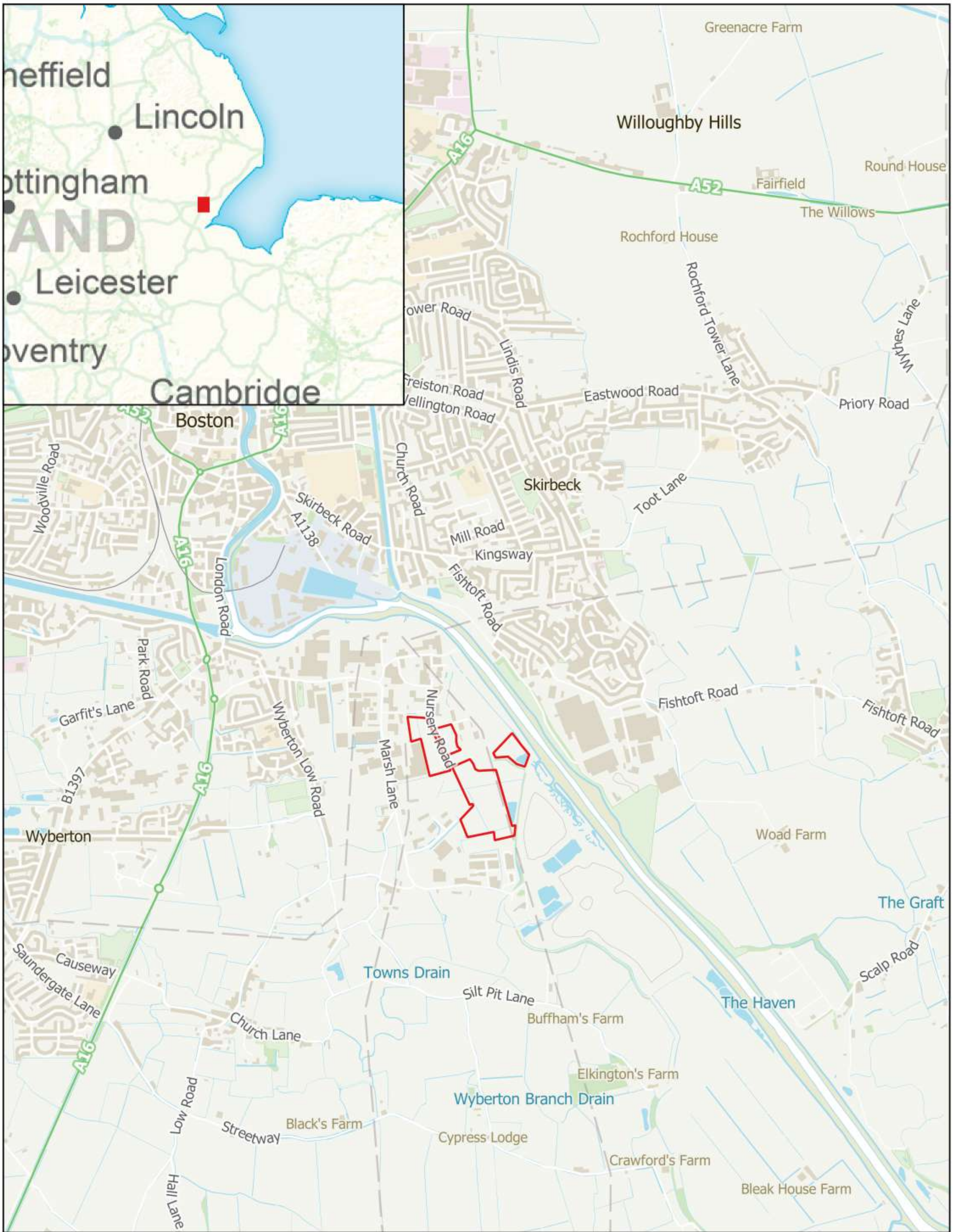
12. Project Metadata

MS Job Code	MSTF731
Project Name	Boston Alternative Energy Facility
Client	Royal HaskoningDHV
Grid Reference	TF3395042241
Survey Techniques	Magnetometry, EM
Survey Size (ha)	12.7ha (Magnetometry), 12.7ha (EM)
Survey Dates	2020-08-11 to 2020-08-18
Project Lead	Finnegan Pope-Carter BSc (Hons) MSc FGS
Project Officer	Lauren Beck BA
HER Event No	To be applied for after report submission
OASIS No	N/A
S42 Licence No	N/A
Report Version	1.0

13. Document History

Version	Comments	Author	Checked By	Date
0.1	Initial draft for Project Lead to Review	AL, IC, LT, KA	LB	27 August 2020
0.2	Draft for Director Approval	LB	FPC	28 August 2020
1.0	Final report following client corrections and Director approval	LS	FPC	02 September 2020



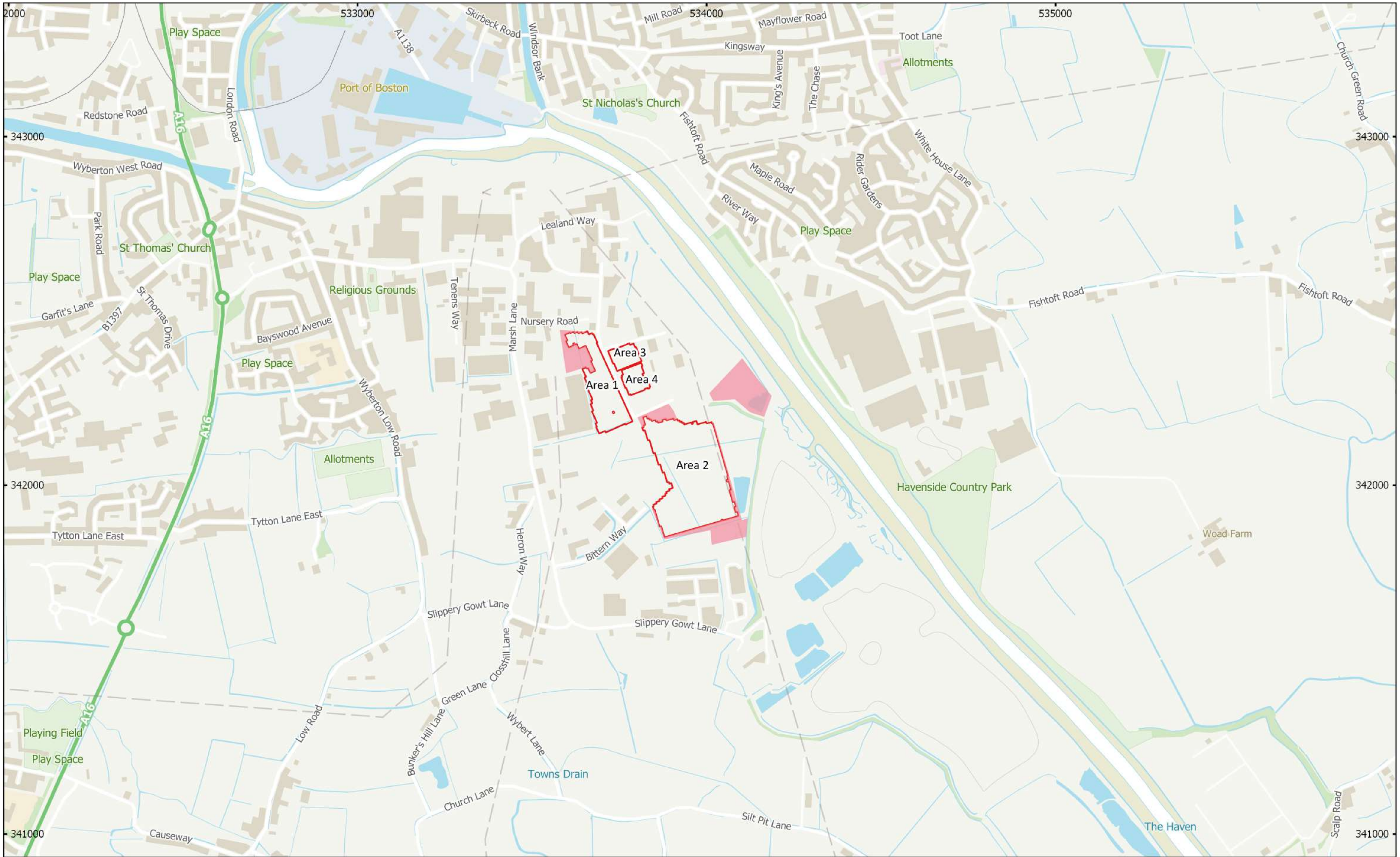
MSTF731 - Boston Alternative Energy Facility
Figure 1 - Site Location
1:25,000 @ A4

N

0 0.5 1 km

Site Boundary

magnitude surveys



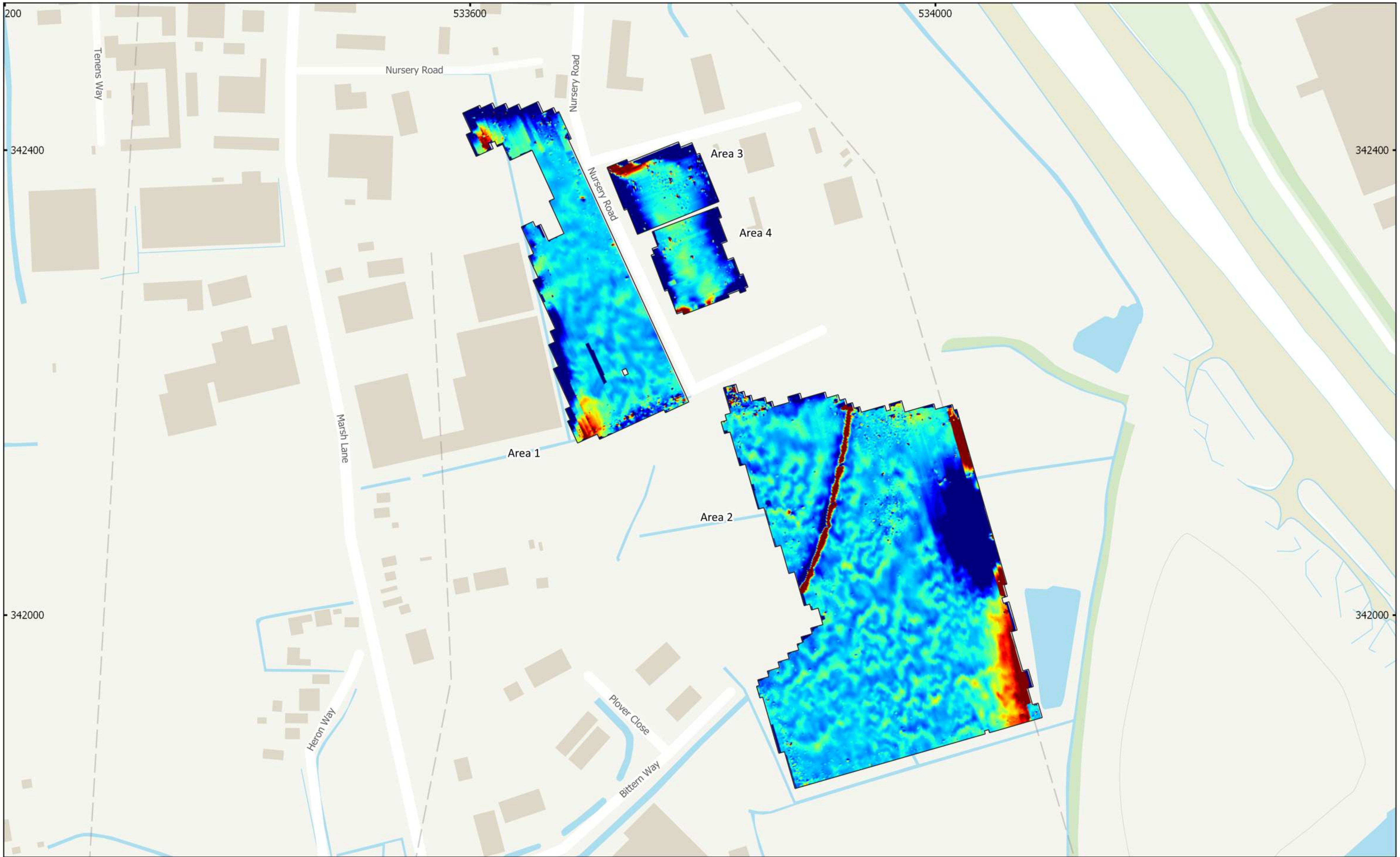
MSTF731 - Boston Alternative Energy Facility
Figure 2 - Location of Survey Areas
1:10,000 @ A3

Survey Extent
Unsurveyable Areas

N

0 250 500 750 m

magnitude surveys



MSTF731 - Boston Alternative Energy Facility
Figure 3 - Magnetic Total Field (Lower Sensor) (Overview)
1:3,000 @ A3

magnitude surveys

MSTF731 - Boston Alternative Energy Facility
Figure 4 - Magnetic Gradient (Overview)
1:3,000 @ A3

magnitude surveys

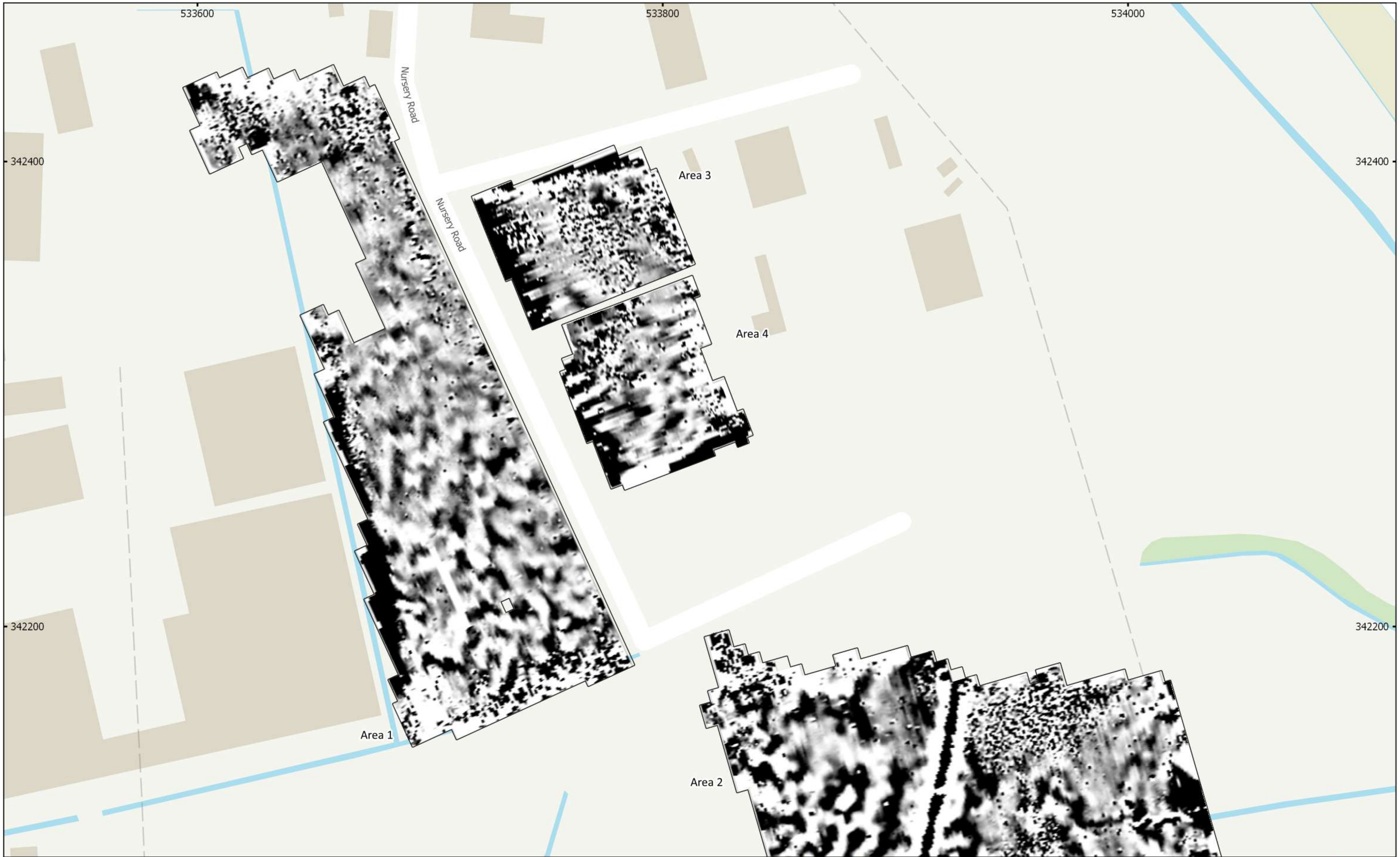
MSTF731 - Boston Alternative Energy Facility
Figure 5 - Magnetic Interpretation Over Historic Mapping and Satellite Imagery (Overview)
1:3,000 @ A3

- Agricultural (Strong)
- Agricultural (Weak)
- Natural (Strong)
- Natural (Weak)
- Natural (Zone)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Undetermined (Strong)
- Undetermined (Weak)
- Service
- Ferrous (Spike)

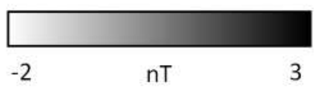
N

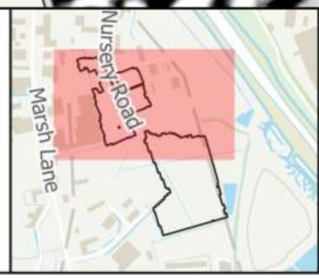
0 50 100 150 m

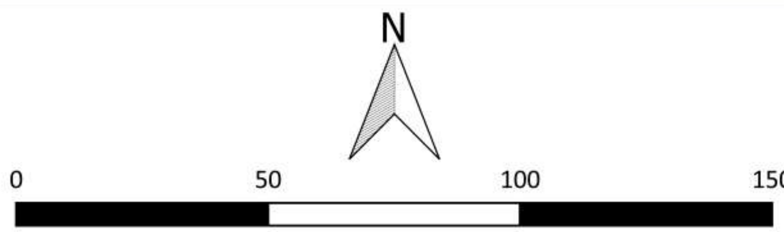
magnitude surveys



MSTF731 - Boston Alternative Energy Facility
Figure 6 - Magnetic Gradient (North)
1:1,500 @ A3







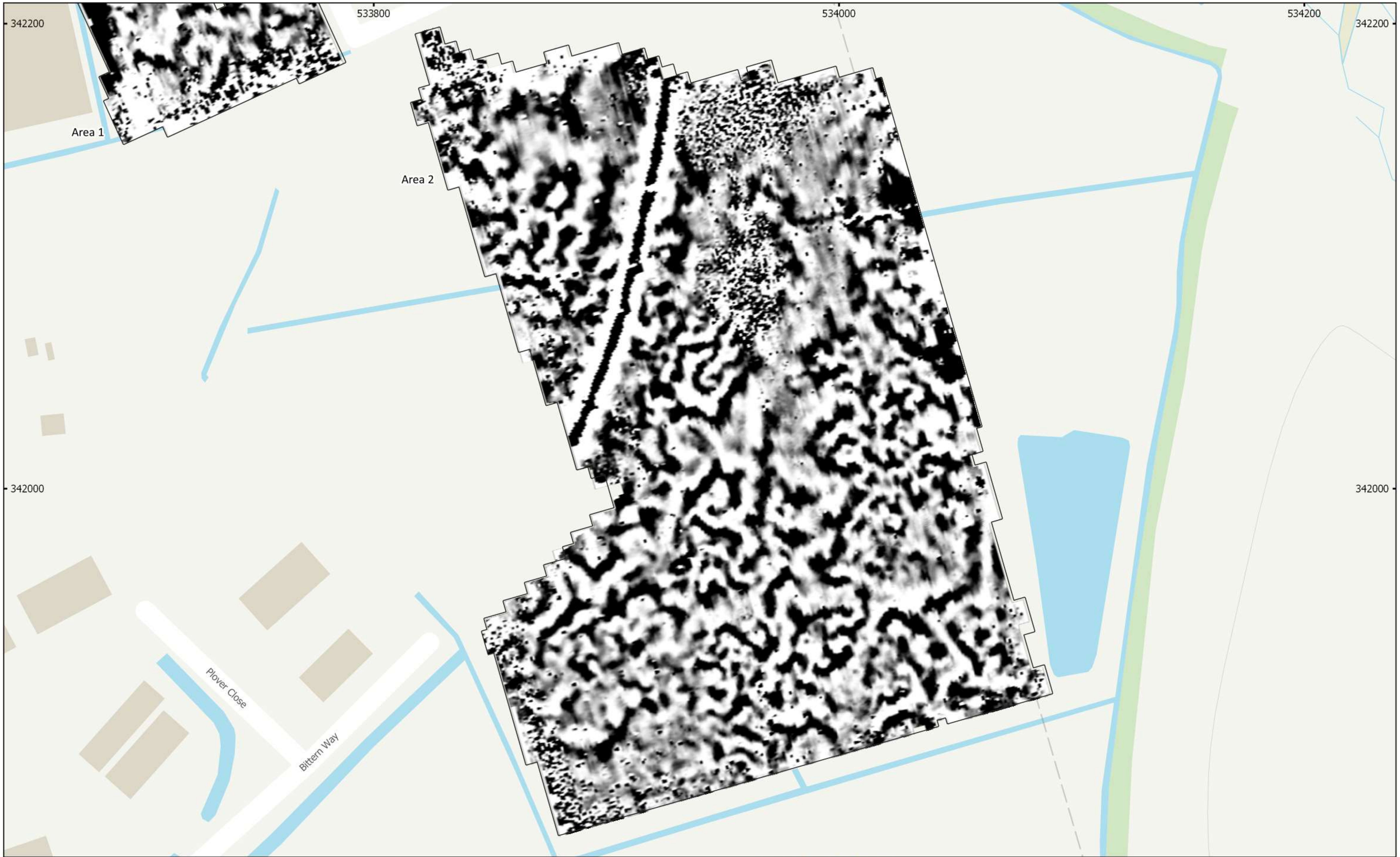
magnitude surveys

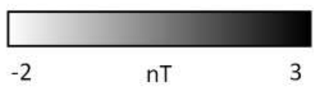
MSTF731 - Boston Alternative Energy Facility
Figure 7 - Magnetic Interpretation (North)
1:1,500 @ A3

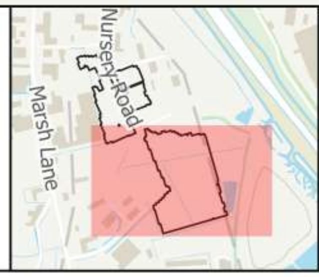
magnitude surveys

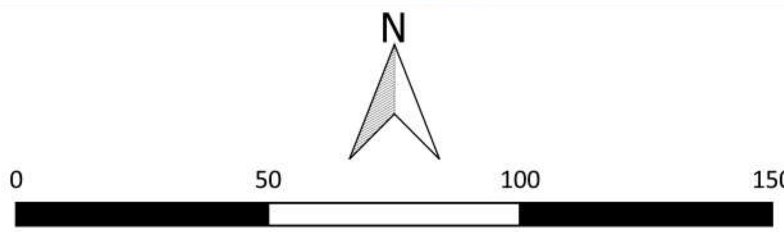
MSTF731 - Boston Alternative Energy Facility
Figure 8 - XY Trace Plot (North)
90nT/cm at 1:1,500 @ A3

magnitude surveys







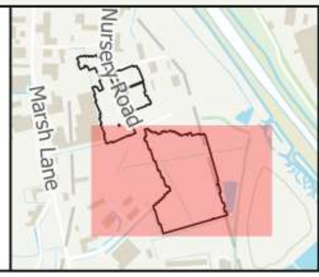


MSTF731 - Boston Alternative Energy Facility
Figure 9 - Magnetic Gradient (South)
1:1,500 @ A3

magnitude surveys

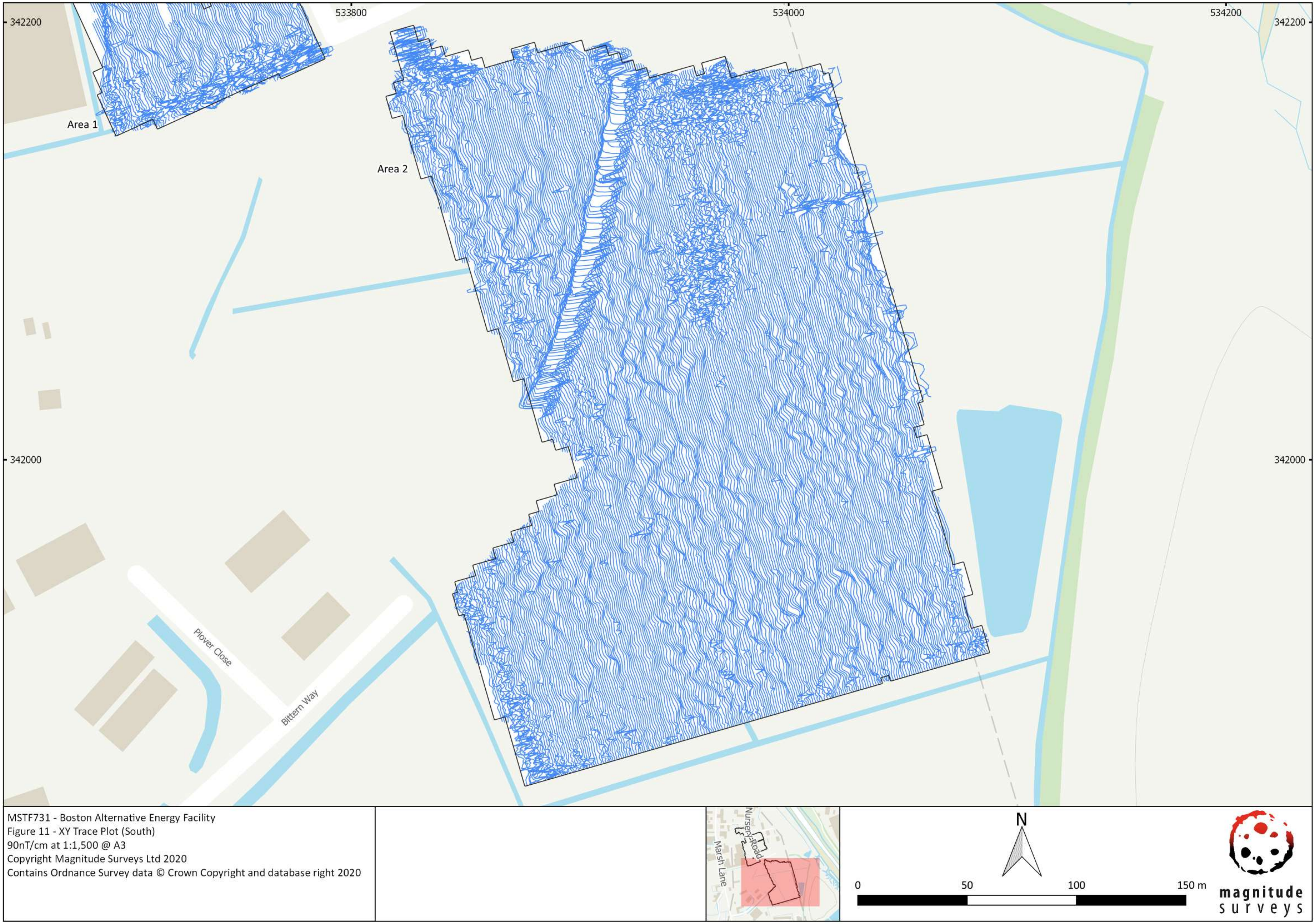
MSTF731 - Boston Alternative Energy Facility
Figure 10 - Magnetic Interpretation (South)
1:1,500 @ A3

Agricultural (Strong)
Agricultural (Weak)
Natural (Strong)
Natural (Weak)
Natural (Zone)
Magnetic Disturbance
Ferrous/Debris (Spread)
Undetermined (Strong)
Undetermined (Weak)
Service
Ferrous (Spike)



N
0 50 100 150 m

magnitude surveys



MSTF731 - Boston Alternative Energy Facility
Figure 11 - XY Trace Plot (South)
90nT/cm at 1:1,500 @ A3

magnitude surveys

MSTF731 - Boston Alternative Energy Facility
Figure 12 - EM (Conductivity 1) (Overview)
1:3,000 @ A3

Low High
5 percentile 95

N

0 50 100 150 m

magnitude surveys

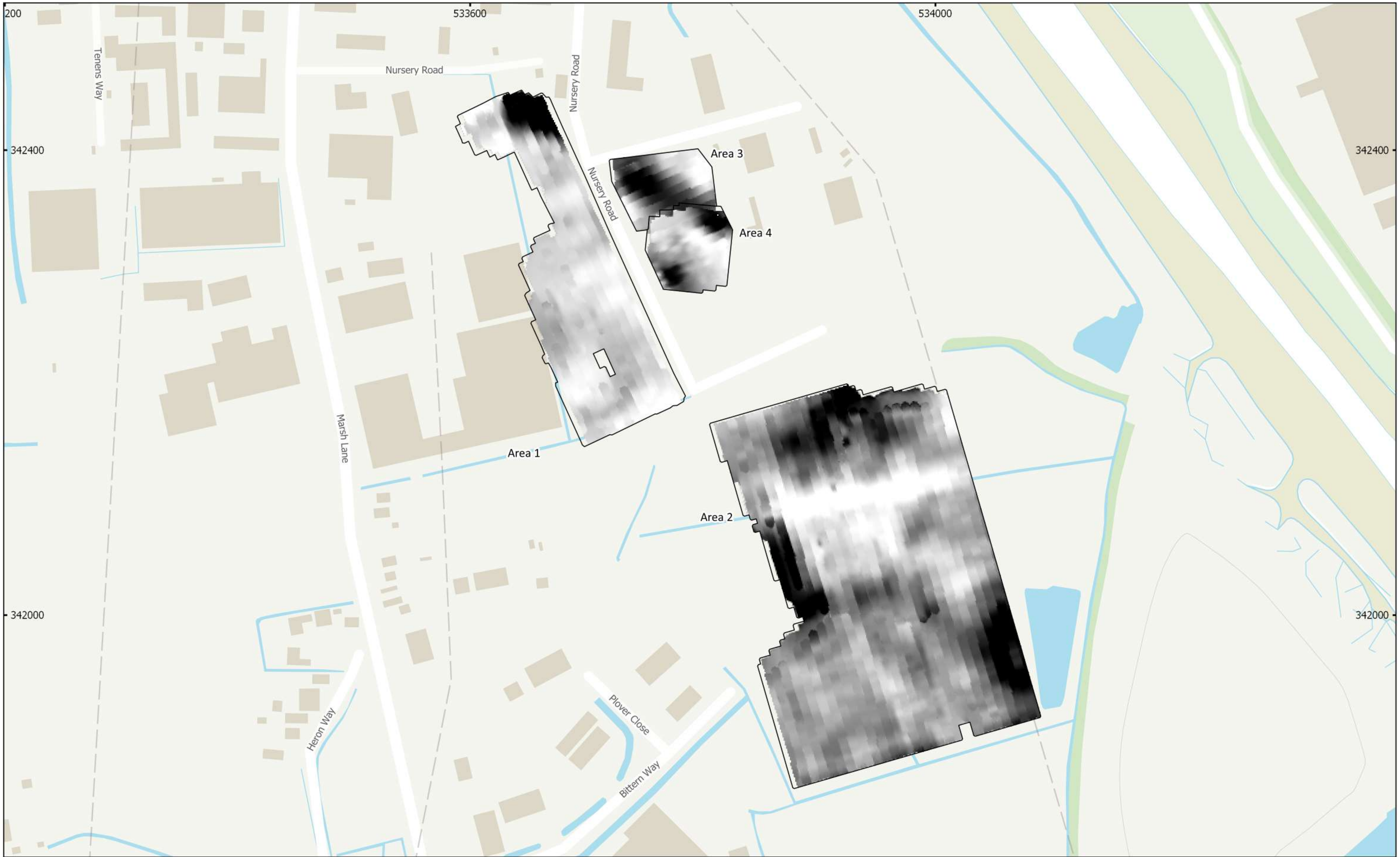
MSTF731 - Boston Alternative Energy Facility
Figure 13 - EM Interpretation (Conductivity 1) (Overview)
1:3,000 @ A3

- Archaeology Possible - Earthwork (Strong)
- Archaeology Possible - Enhancement (Zone)
- Agricultural Enhancement (Zone)
- Drain - Agricultural (Strong)
- Drain - Agricultural (Weak)
- Drain - Natural
- Palaeochannel - Strong
- Palaeochannel - Weak
- Clay or Saline Soil? - Strong
- Clay or Saline Soil?- Weak
- Industrial / Modern (Zone)
- High Strong - Undetermined
- High Weak - Undetermined
- Low Strong - Undetermined
- Low Weak - Undetermined

N

0 50 100 150 m

magnitude surveys



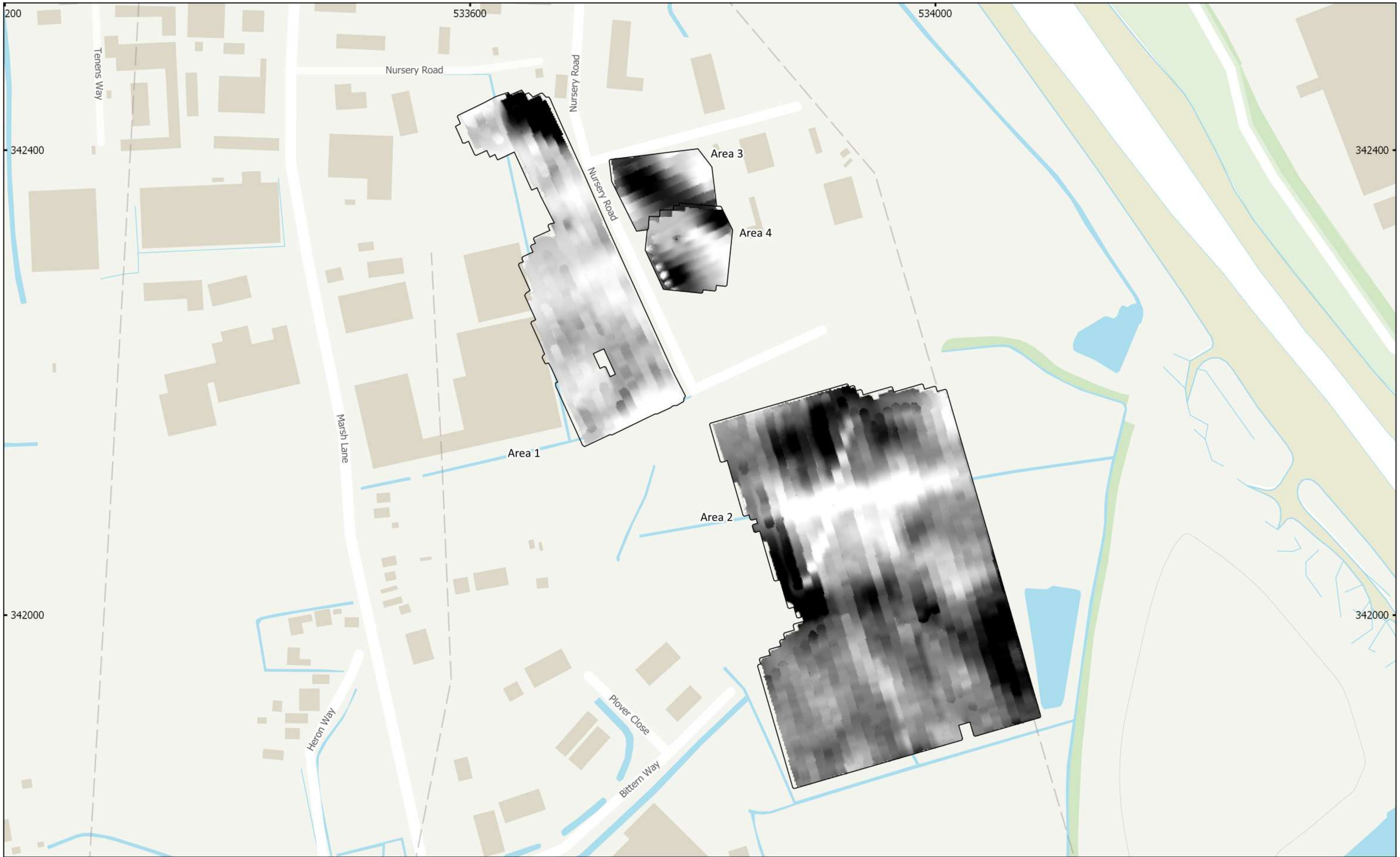
MSTF731 - Boston Alternative Energy Facility
Figure 14 - EM (Conductivity 3) (Overview)
1:3,000 @ A3

magnitude surveys

MSTF731 - Boston Alternative Energy Facility
Figure 15 - EM Interpretation (Conductivity 3) (Overview)
1:3,000 @ A3

- Archaeology Possible - Earthwork (Strong)
- Archaeology Possible - Enhancement (Zone)
- Agricultural Enhancement (Zone)
- Drain - Agricultural (Strong)
- Drain - Agricultural (Weak)
- Drain - Natural
- Palaeochannel - Strong
- Palaeochannel - Weak
- Clay or Saline Soil? - Strong
- Clay or Saline Soil?- Weak
- Industrial / Modern (Zone)
- High Strong - Undetermined
- High Weak - Undetermined
- Low Strong - Undetermined
- Low Weak - Undetermined

magnitude surveys



MSTF731 - Boston Alternative Energy Facility
Figure 16 - EM (In Phase) (Overview)
1:3,000 @ A3

magnitude surveys

MSTF731 - Boston Alternative Energy Facility
Figure 17 - EM Interpretation (In Phase) (Overview)
1:3,000 @ A3

- Archaeology Possible - Earthwork (Strong)
- Drain - Agricultural (Strong)
- Palaeochannel - Strong
- Palaeochannel - Weak
- Clay or Saline Soil? - Strong
- Clay or Saline Soil?- Weak
- Industrial / Modern (Zone)
- Service

magnitude surveys