Historic England

Research Report Series 71/2023

Fort Cumberland, Eastney, City of Portsmouth

Report on Geophysical Surveys, May 2017 to May 2023

Megan Clements, Neil Linford and Andrew Payne

Geophysics

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Summary

Ground Penetrating Radar (GPR) and fluxgate magnetometer surveys were conducted at Fort Cumberland, Eastney, City of Portsmouth, as part of a wider non-invasive study to inform the ongoing management and development of the site. The aim of the survey was to identify subsurface remains across the site, particularly the location of any surviving archaeological remains and utilities. A hand-held fluxgate gradiometer survey (1.2ha) was conducted over accessible areas of the parade ground and was heavily influenced by the response to ferrous utilities, although anomalies due to possible ditches and fired brick have also been detected. The vehicle towed GPR survey (2.5ha), using a composite of previous instrument tests together with newly acquired data, covered the Parade Ground and accessible areas in the dry moat. In addition to both current and historic utilities the survey revealed the location of temporary military buildings known from aerial photography and the outer edge of the 1747 fort rampart and ditch.

Contributors

The geophysical fieldwork was conducted by Megan Clements, Neil Linford and Andrew Payne.

Acknowledgements

The authors are grateful to the Fort Cumberland Facilities Management Team for helping to coordinate access for the with other users of the site. Thanks are also due to our colleagues Brian Kerr, Tom Cromwell and Wayne Cocroft for very useful discussion of the survey results and to Matthew Bristow for the Uncrewed Aerial Vehicle (UAV) photography.

Archive location

Fort Cumberland, Portsmouth.

Date of survey

The fieldwork was conducted between May 2017 and May 2023 through a series of unrelated instrument tests, a targeted evaluation survey in January 2021, and a series of staff training surveys conducted between January and May 2023. The report was completed on 11th October 2023. The cover image shows a low level oblique aerial view over the fort looking south-east towards Hayling Island and Langstone Harbour captured by UAV (photograph supplied by Matthew Bristow).

Contact details

Dr Neil Linford, Geophysics team, Historic England, Fort Cumberland, Fort Cumberland Road, Eastney, Portsmouth PO4 9LD (02392 856761, neil.linford@historicengland.org.uk).

Contents

Introduction

Ground Penetrating Radar (GPR) and fluxgate magnetometer surveys were conducted at Fort Cumberland, Eastney, City of Portsmouth, as part of a wider Historic England programme of building and environment surveys of the site to assess its current condition and better understand the asset in its care (Linford 2023). Geophysical survey was requested to better understand the nature of any surviving subsurface remains prior to the commencement of any conservation and improvement works to secure the future beneficial reuse of the standing buildings. The work has been agreed under the Shared Services Agreement and addresses Historic England corporate plan tier three objective "S4A.2 Support the English Heritage Trust in creating new knowledge". The National Collection (looked after by English Heritage) and the sites and collections in our care are effectively managed, with the most significant elements repaired and maintained in a sustainable way.

The fort (National Heritage List for England Entry Number 1015700), is named after the Duke of Cumberland, and was constructed around 1747 as an irregular pentagon with two principal south and east bastions. Only the guardhouse and storeroom, with 19th century additions, survive from the original fort (Plate 1). A second fort, built between 1785 and 1812 on the same site but to a different and larger plan, remains largely intact. During the 1860s additional accommodation was added and in the 1890s the fort was modernised to take new breech loading guns on the left, south and centre bastions. The fort is designated as a grade II* listed building (NHLE 1104273), together with the former guardhouse (NHLE 1104274), hospital and ancillary buildings (NHLE 1104275) and officers' quarters (NHLE 1104276) that are grade II listed.

Previous test GPR and magnetometer surveys have been conducted on the parade ground, together with an evaluation survey along the route of a new electricity cable that identified the outer edge of the 1747 fort rampart and ditch, subsequently confirmed through an archaeological watching brief of the cable trench. Additional geophysical field work was conducted for staff training purposes. A combination of magnetic and GPR survey was suggested following the previous success of these techniques at the site.

The site lies over sand, silt and clay of the Wittering Formation, formed between 56 and 41.2 million years ago, overlain by superficial Storm Beach Deposits of gravel (Geological Survey of Great Britain 1994). Weather conditions varied between the different periods of fieldwork but were generally undertaken when settled and dry.

Method

Magnetometer survey

Measurements were recorded over a series of 30m grids (Figure 1) established with a Trimble R8s GNSS using a Bartington Grad 601 dual fluxgate gradiometer. Readings were taken at 0.25 m intervals along parallel traverses separated by 1.0 m. Post-acquisition, the median value of each traverse was subtracted from all measurements on that traverse (Zero Median Traverse) to correct for heading errors and instrument drift. A linear greyscale image of the magnetometer data is presented in Figure 2 superimposed on the OS base mapping. Figure 5 shows a trace plot and linear greyscale image of the minimally processed data.

Ground Penetrating Radar survey

A 3d-Radar (Kontur) MkIV GeoScope Continuous Wave Step Frequency (CWSF) Ground Penetrating Radar (GPR) system was used to conduct the survey collecting data with a DXG1820 multi-element vehicle towed, ground coupled antenna array (Linford *et al.* 2010; Eide *et al.* 2018). A roving Trimble R8s Global Navigation Satellite System (GNSS) receiver was mounted on the GPR antenna array, that together with a second R8s base station was used to provide continuous positional control for the survey collected along the instrument swaths shown on Figure 3. The GNSS base station receiver was adjusted to the National Grid Transformation OSTN15 using the Trimble VRS Now Network RTK delivery service. This uses the Ordnance Survey's GNSS correction network (OSNet) and gives a stated accuracy of 0.01-0.015m per point with vertical accuracy being half as precise.

Data were acquired at a 0.075m x 0.075m sample interval across a continuous wave stepped frequency within a range from 40MHz to 2.99GHz in 4MHz increments using a dwell time of 2ms. A single antenna element was monitored continuously to ensure data quality during acquisition together with automated processing software to produce real time amplitude time slice representations of the data as each successive instrument swath was recorded in the field (Linford 2013).

Post-acquisition processing involved conversion of the raw data to time-domain profiles (through a time window of 0 to 75ns), adjustment of time-zero to coincide with the true ground surface, background and noise removal, and the application of a suitable gain function to enhance late arrivals. Representative profiles from the full GPR survey data set are shown on Figure 6. To aid visualisation amplitude time slices were created from the

entire data set by averaging data within successive 2.5ns (two-way travel time) windows (e.g. Linford 2004). An average sub-surface velocity of 0.115m/ns was assumed following constant velocity tests on the data and was used as the velocity field for the time to estimated depth conversion. Each of the resulting time slices therefore represents the variation of reflection strength through successive ~0.14m intervals from the ground surface, shown as individual greyscale images in Figures 4, 7, 8 and 9. Further details of both the frequency and time domain algorithms developed for processing this data can be found in Sala and Linford (2012).

Due to the size of the resultant data set a semi-automated algorithm has been employed to extract the vector outline of significant anomalies shown on Figure 11. The algorithm uses edge detection to identify bounded regions followed by a morphological classification based on the size and shape of the extracted anomalies. For example, the location of possible pits is made by selecting small, sub circular anomalies from the data set (Linford and Linford 2017).

Results

Magnetometer survey

A graphical summary of significant magnetic anomalies [**m1**-**30**] discussed in the following text superimposed on the base OS mapping data is provided in Figure 10.

Strong ferrous disturbance is concentrated adjacent to: the officers' quarters [**m1**], hospital block [**m2**], laying out shed [**m3**], cookhouse [**m4**], perimeter curtain walls [**m5**] and [**m6**], main bastion structures [**m7-9**], and the modern access road [**m10-13**]. This disturbance is most likely related to ferrous objects incorporated into the building structures, such as cast-iron drainpipes, drain covers and underpinning of foundations as well as, perhaps, demolition debris from temporary huts and sheds previously located within and around the parade ground.

A rectilinear pattern of ferrous disturbance [**m14**] of more regular form is found to the south of the parade ground aligned with the perimeter road but does not correspond with smaller concrete plinths visible on the surface here. This perhaps suggests the location of previous temporary buildings constructed in the Second World War close to the south sally port.

Another rectilinear area of intense disturbance at [**m15**] adjacent to the hospital block has no apparent expression on the ground surface, other than a slight raised plateau following the 3.0m contour, and the appearance of an occasional vegetation mark. Some form of service structure or temporary building incorporating a considerable amount of ferrous material appears to be the most likely interpretation for [**m15**], possibly associated with the presence of a ferrous pipe [**m16**] extending from the north west corner of [**m15**] towards a wider network of pipes [**m18-22**]. While [**m15**] might indicate the remains of either a buried storage tank or temporary building there are no corresponding structural anomalies in the GPR data (cf [**gpr61-64**]) or evidence for an historic extension to the south-west elevation of the Hospital building (Fellows and O'Hara 2001). This perhaps suggests a more ephemeral structure similar to the other temporary huts found at the site.

A spread of less intense disturbance [**m17**] is present in the south-east of the parade ground within an area containing linear anomalies likely to be related to pipes, drains and other services. The disturbance at [**m17**] could relate to the construction or maintenance of the services, possibly ferrous and ceramic material from previous drains and pipes dispersed within the near-surface deposits.

The network of service pipes found throughout the parade ground are likely to be associated with active and historic water, gas and electricity supplies or drains. Services occur at [**m18**] and [**m19**] in the southern and central part of the parade ground trending NNW-SSE, with a further network of pipes at [**m20-23**] appearing to connect to the hospital block and garage cookhouse buildings to the north. Several other more isolated pipes are present at [**m24**] south of officers' quarters near the south-east bastion and at [**m25**] in the vicinity of the north bastion.

A number of weaker positive linear anomalies [**m26-29**] across the parade ground may indicate ditch-like trenches, possibly containing non-ferrous pipes, cables or non-ceramic drains back-filled with more magnetic material than the surrounding shingle deposits. A linear arrangement of seven small localised positive anomalies are found at [**m30**] following the edge of the perimeter road adjacent to officers' quarters 3 and 4 and seem most likely to be associated with either the construction of the road or a former fence-line.

Ground Penetrating Radar survey

A graphical summary of the significant GPR anomalies, [**gpr1-110**] discussed in the following text, superimposed on the base OS map data, is provided in Figure 11.

The very near-surface data shows responses to visible surface features including vehicle tracks to the works compound [**gpr1**] immediately to the north of the garage cookhouse block, concrete expansion joints [**gpr2**] in the access road by the Ravelin shed, compacted foot paths across the parade ground [**gpr3**], ferrous service inspection covers for example at [**gpr4**] and extant concrete building platforms [**gpr5**]. More significant anomalies show the outline of former huts, for example at [**gpr6**], and a curious network of polygonal high amplitude responses [**gpr7**], both also visible from aerial photography (Google Earth image labelled April 2022 accessed October 2023). Some amorphous areas of high-amplitude response are also found at [**gpr8**], in the vicinity of [**gpr7**], and along the southern branch of the dry moat at [**gpr9**].

The underlying beach gravel deposits across the site appear as dipping reflectors within the GPR profiles (Figure 6) and are evident as high-amplitude anomalies [**gpr10**] following an approximate south-west to north-east alignment. In places, this geological response obscures the interpretation of more significant anomalies, although interventions such as service trenches can be identified where these disturb the dipping deposits.

North Moat to Ravelin shed

An extension of the brick wall [**gpr11**] to the east is found between 2.5 and 17.5ns (0.14 to 1.01m) with possible buttresses [**gpr12**] on the north face and a more fragmented

continuation [**gpr13**] to the east of the modern access road. A linear high-amplitude anomaly [**gpr14**] to the north of [**gpr11**] could, possibly, represent a further continuation of the defences but it is not so well defined. Linear services exit from the sally port [**gpr15**] along the access road and further to the east at [**gpr16**]. Additional services [**gpr17-19**] originate from the control box mounted on the bastion wall to the west of the sally port although the survey coverage in this area was restricted by presence of mature trees. The services [**gpr20-22**] continue around the north bastion in the vicinity of a sub-circular high-amplitude anomaly [**gpr23**] that may well represent a sump or cistern associated with historic drainage. Anomaly [**gpr23**] could also be associated with the root ball of a former tree, although none of the extant trees in this area have produced a similar response.

To the east of the sally port a linear low-amplitude anomaly [**gpr24**] correlates with a known service. A series of rectilinear low-amplitude anomalies [**gpr25-28**] and more fragmented high-amplitude responses [**gpr29-31**] could indicate the location of former buildings in the moat, although this could be associated with the temporary accommodation sited here in 2019 for security personnel during the 75th anniversary of D-Day.

Known services [**gpr32**] and [**gpr33**] continue to either side of the access road in the west moat in the vicinity of the Ravelin shed. The low-amplitude rectilinear anomaly at [**gpr34**] may possibly represent the location of a temporary hut, although this is less convincing than responses [**gpr35**] and [**gpr6**] further to the south that correlate with former buildings recorded by aerial photography here (Historic England Archive (RAF photography) RAF_3G_TUD_UK_162, April 20, 1946). The services [**gpr36-43**] appear to enter and exit the fort through a control box to the north of the modern vehicle entrance. Some of these services cross the access road to the Ravelin shed, although the data here is partially obscured by expansion joints [**gpr2**] between the individual concrete rafts. A further low-amplitude rectilinear anomaly [**gpr44**] to the south of the vehicle entrance is most likely to represent the location of a temporary building shown here on aerial photography (Historic England Archive (RAF photography) RAF_3G_TUD_UK_162, April 20, 1946).

Parade Ground

Modern services [**gpr45-48**] enter the parade ground from the north sally port and are then distributed throughout the site. Electricity supplies are further distributed from the hospital building control box towards the guardhouse [**gpr49**], officers' quarters [**gpr50**], laying out shed [**gpr51**], garage cookhouse [**gpr52**] and casemates [**gpr53**] and [**gpr54**]. A plethora of additional linear anomalies are found across the parade ground and appear to be

associated with unknown historic services. A number of these [**gpr55-58**] fall towards an initial high-amplitude anomaly found to the north of the parade ground between 12.5 and 30.0ns (0.72 to 1.73m), giving way to a central low-amplitude response [**gpr59**] and apparent polygonal ditch [**gpr60**] from 32.5ns (1.87m) onwards. This area of the parade ground is associated with a notable area of more lush vegetation in the summer months and suggests a possible drainage sump for the linear anomalies that fall into this structure (Google Earth image labelled April 2022 accessed October 2023). One of the linear anomalies [**gpr58**] was observed during the watching brief for a new electricity supply cable and appeared to represent a brick lined drain (T Cromwell *pers comm*).

A rectilinear anomaly [**gpr61**] is found between 7.5 and 12.5ns (0.43 to 0.72m) adjacent to the hospital building and approximately the area of ferrous disturbance [**m15**]. It is difficult to determine whether [**gpr61**] represents a historic service, compacted foot path or linear boundary, apparently extending from officers' quarters 1 and 2. This area is complicated by the confluence of both active [**gpr62**] and historic services [**gpr50**], hampering the confident interpretation of discrete high [**gpr63**] and low-amplitude [**gpr64**] anomalies found here. Deeper time slices suggest a more rectilinear form to [**gpr64**], similar to the response to other known temporary buildings. Together with the magnetic data, it seems likely that [**gpr61**], [**gpr63**] and [**gpr64**] are associated with either the supply of historic services to the Hospital building, perhaps a water supply or drainage feature, or an adjacent temporary building. Aerial photographs show a rectilinear feature matching the dimensions and location of [**gpr64**] surrounded by an enclosing fence, perhaps corroborating the interpretation as some form of pond, tank or cistern (Historic England Archive (RAF photography) RAF_3G_TUD_UK_162, April 20, 1946). A broad low-amplitude anomaly [**gpr65**] is also found here and may represent a ditch or path perhaps heading towards the Motor Transport shed.

A more subtle dipping linear anomaly [**gpr66**] crosses the parade ground from east to west with a distinct change in orientation that correlates with the presumed location of the outer edge of the 1747 fort rampart and ditch (Plate 1). Further fragmented rectilinear anomalies [**gpr67**] and [**gpr68**] are found to either side of [**gpr66**] but appear to share the same orientation and could represent associated structural remains. Other fragmented responses here may be associated with known or historic services [**gpr69**] or, perhaps, further structural remains [**gpr70**]. Further to the east [**gpr66**] is partially obscured by the presence of recent services and fragmented rectilinear anomalies [**gpr71**] and [**gpr72**] to former buildings shown on aerial photography matching the dimensions of the laying out shed (Historic England Archive (RAF photography) RAF_3G_TUD_UK_162, April 20, 1946).

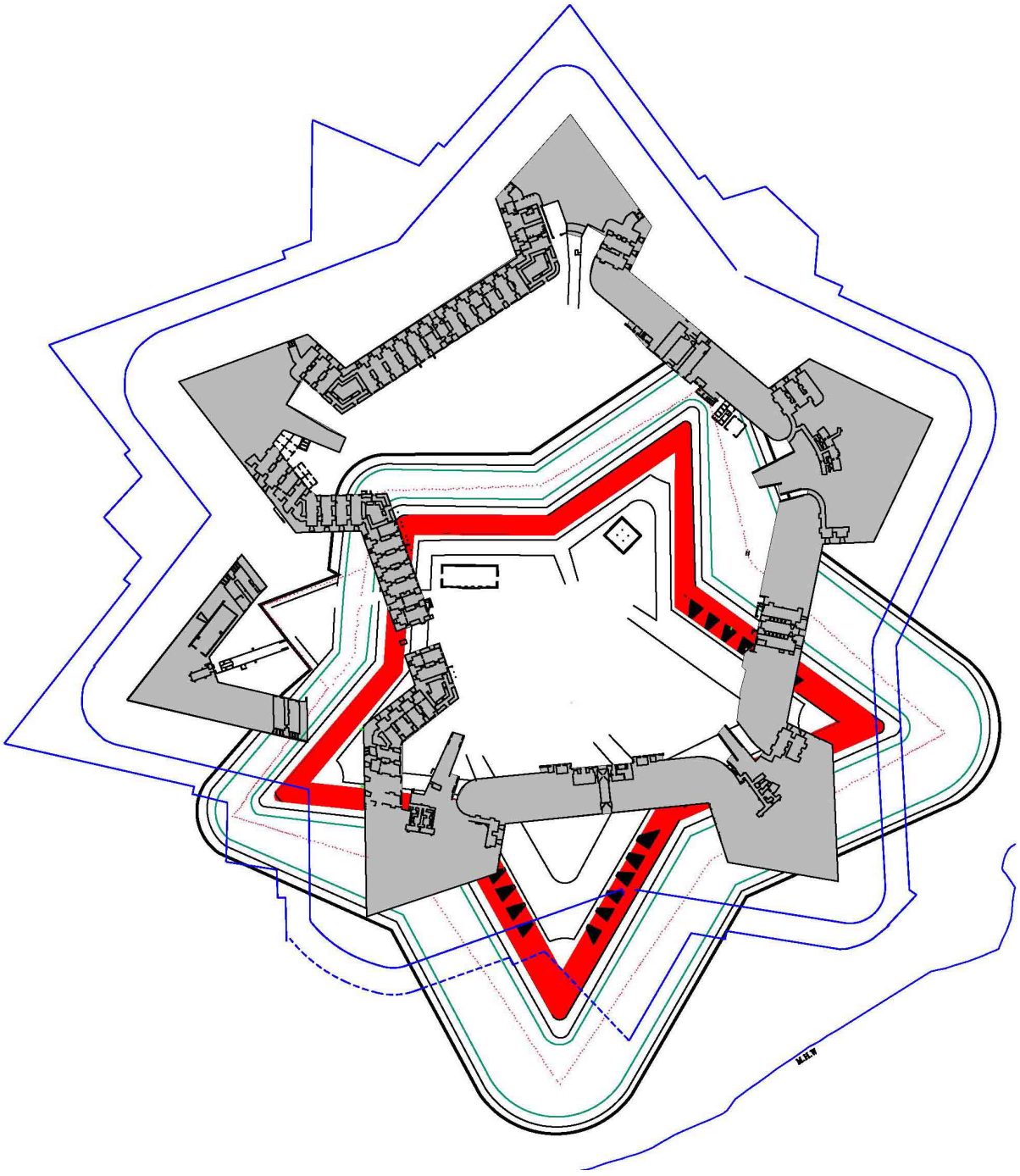

Plate 1: schematic plan of the second Fort Cumberland (1782-1812) and later buildings superimposed over the first fort (shown in red) © Historic England.

The pattern of polygonal high amplitude responses [**gpr7**] found to the south of the parade ground in the very near-surface appears to be associated with a series of slightly deeper rectilinear anomalies [**gpr73-80**] extending to 25.0ns (1.44m) coinciding with the intersection of nodes of the network. Two additional rectilinear responses [**gpr81**] and [**gpr82**] are found immediately to the north with the long axes orthogonal to [**gpr73-80**], although association with [**gpr7**] is more difficult to determine here. There appears to be no correlation with the magnetic data, suggesting the response to [**gpr7**] is not due to either a ferrous or ceramic source. One possibility might be a network of copper cables forming a ground mat to earth a radio communication or prototype radar detection system. Stanchions for such a system may have been anchored to [**gpr73-80**], however it is questionable whether these would have been placed so close to the adjacent buildings and curtain wall of the fort. There does not appear to be any contemporary records or aerial photographs for structures in this area, perhaps indicating a short-lived experimental system.

The well-head at [**gpr83**] is also found at a node of [**gpr7**] together with two linear services [**gpr84**] and [**gpr85**], that may both be associated with the distribution of water. The utility survey records two services of unknown function that partially correspond with [**gpr84**] and [**gpr85**], although the location of the inspection cover confirmed by anomaly [**gpr83**] was taken from records. It is difficult to fully understand the relationship, if any, between [**gpr7**] and [**gpr83-85**] as they may well be totally unconnected.

Fragmented structural remains [**gpr86**] are found to the south of the parade ground either in association with concrete building pads here or sharing the same orientation, again corroborating aerial photographs showing range of former buildings here. Linear anomalies [**gpr87-92**] are likely to represent services, although [**gpr88**] may well be associated with railway tracks observed here during the excavation of a telecom cable trench [**gpr92**] (Fellows 2001).

Three more prominent low-amplitude anomalies [**gpr93-95**] are found from 22.5ns (1.29m) onwards and could, perhaps, be due to bomb damage. As [**gpr93-95**] appear as disturbance within the response to the underlying beach deposits it seems likely that the surface of the parade ground has been levelled and any surface bomb damage repaired.

South and East Moat

The former buildings shown on aerial photography against the east wall of the dry moat are only partially visible [**gpr96**] and [**gpr97**] together with a possible service [**gpr98**]. Fragmentary remains of former buildings are also found further south [**gpr99**] with linear anomalies [**gpr100**] associated with services recorded on the utility survey plan

(Greenhatch Group 2023). There is a prominent rectilinear low-amplitude anomaly [**gpr101**] at the corner with the south moat that corresponds with a visible outline in the surface tarmac. The aerial photography shows temporary buildings extending down the whole length of the east moat and it is possible that [**gpr101**] is associated with the adjacent drainage conduit.

Linear anomalies [**gpr102-104**] are possibly related to further services with areas of high-amplitude response [**gpr9**] in the very near-surface presumably associated with deformation or repairs to the tarmac surfacing. There is also evidence for the services shown extending from the south sally port at [**gpr105**] along the line of the shallow wall with further linear anomalies [**gpr106**] here no doubt associated with the recently removed wooden huts sharing the same alignment or attendant services.

A sparse scatter of fragmentary anomalies [**gpr107**] are found immediately to the west of the sally port, perhaps reflecting the appearance as an open area of concrete without any apparent buildings shown on the aerial photography and the absence of any services. Some fragmentary rectilinear responses [**gpr108**] could possibly represent remains of temporary buildings.

Access to the dry moat was restricted as it turns to the north in the vicinity of the Forgotten Veterans camp and the area used for the storage of the Paddington Brunel bridge. The radar response here is mainly due to the underlying beach deposits although a low-amplitude linear anomaly [**gpr109**] corresponds with a surface drain from the road. Further to the north a high-amplitude anomaly [**gpr110**] corroborates an unknown service recorded by the utility survey.

Conclusions

Both the Ground Penetrating Radar (GPR) and magnetic techniques have successfully identified anomalies throughout the accessible areas of the site. The magnetometer survey has responded to strongly magnetised fired brick and ferrous material, presumably associated with post-medieval structures and more recent ferrous services. GPR has also detected a range of services, together with evidence for structural remains associated with both original elements of the fort defences and more recent temporary buildings shown on contemporary aerial photography. In particular, the GPR survey has revealed evidence for the survival of the outer edge of the original 1747 fort rampart and ditch, the majority of which was over built by the later defences. Services revealed by both techniques complement and enhance a recent utility survey and suggest the presence of some additional historic drainage conduits, cabling and pipe work. This includes a large central drain or cistern found to the north of the parade ground fed from a network of radial conduits and possible water supply pipes from the capped well-head further to the south. Evidence for more ephemeral features shown on aerial photography from the 1940s has also been revealed, for example the rectilinear anomaly adjacent to the hospital building and a curious pattern polygonal response found to the south of the parade ground.

List of Enclosed Figures

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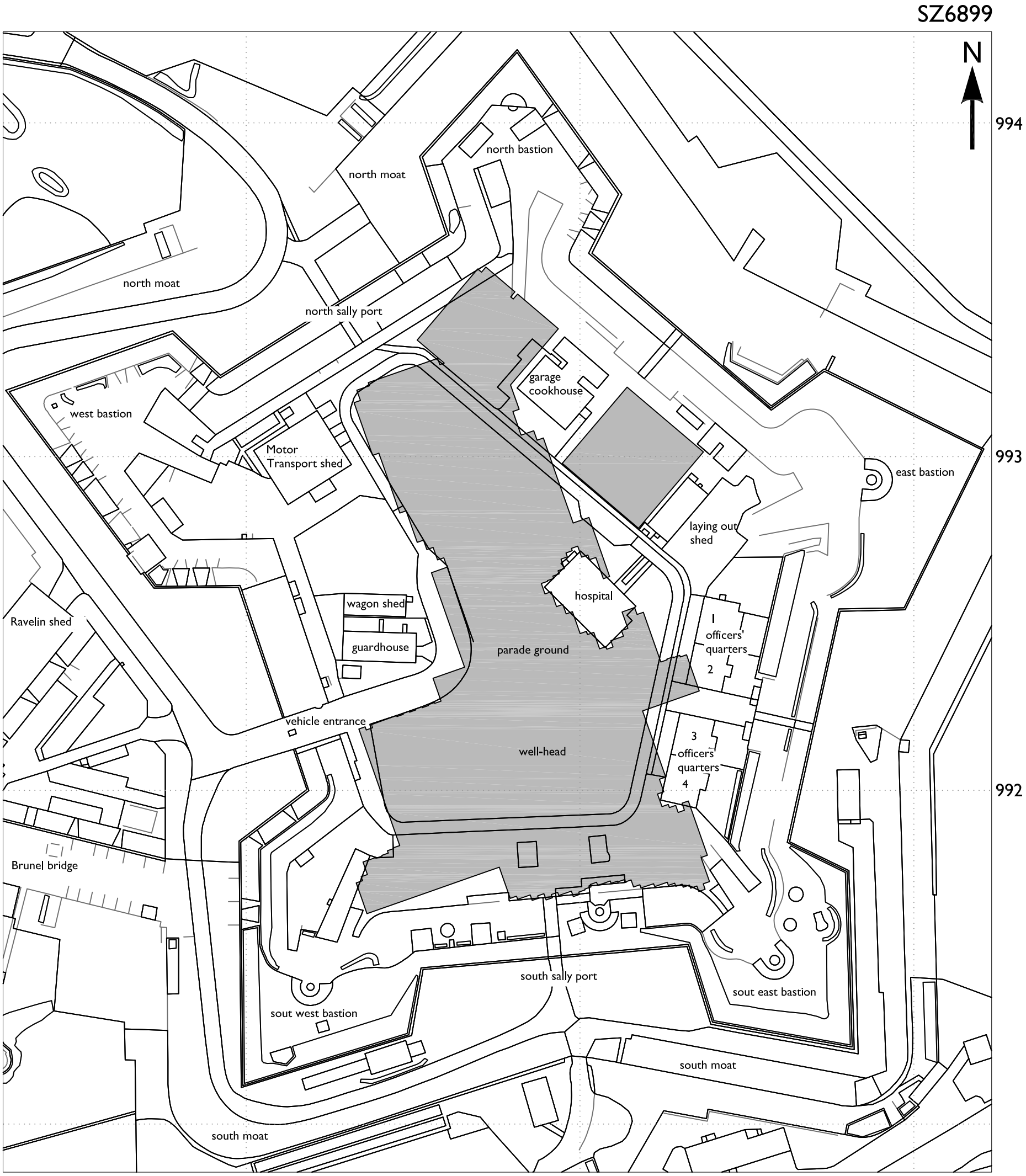
Figure 1

FORT CUMBERLAND, EASTNEY, CITY OF PORTSMOUTH
Location of fluxgate magnetometer survey, January to May 2023



0 150m
1:1250

magnetometer survey

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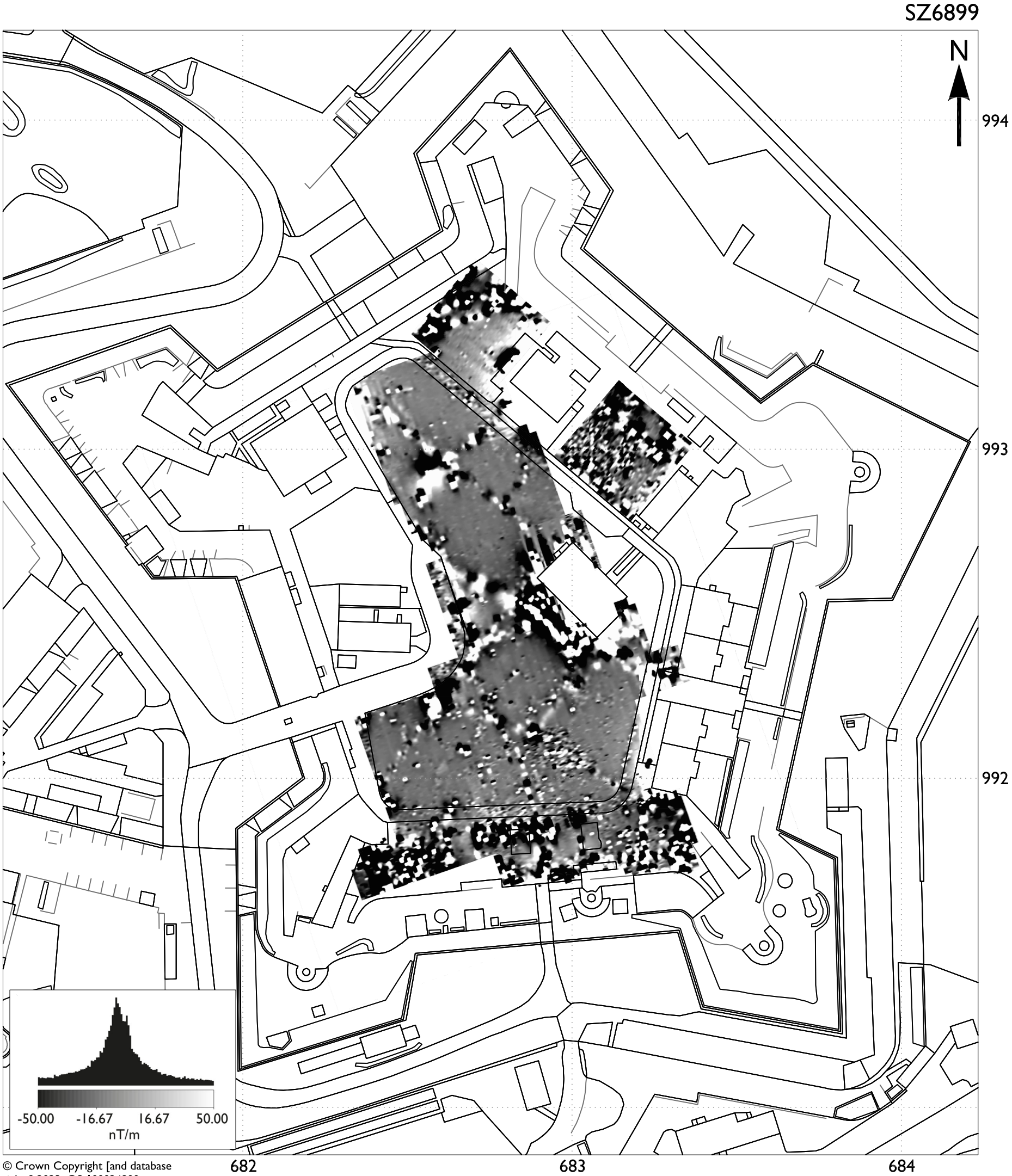
Figure 2

FORT CUMBERLAND, EASTNEY, CITY OF PORTSMOUTH

Linear greyscale image of fluxgate magnetometer survey, January to May 2023



0 150m

1:1250

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Figure 3

FORT CUMBERLAND, EASTNEY, CITY OF PORTSMOUTH

Location of GPR instrument swaths, May 2017 to May 2023

SZ6899

N

994

993

992

991

2023-01-26-023

2022-02-11-066

2022-02-11-026

2022-02-11-055

2020-08-11-026

2020-08-11-015

680 681 682 683 684 685 686

0 60m

1:2000

GPR survey swaths

2020-08-11-015 Location of selected GPR profiles shown on Figure 6

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Figure 4

FORT CUMBERLAND, EASTNEY, CITY OF PORTSMOUTH

GPR amplitude time slice between 25.0 and 27.5ns (1.44 to 1.58m), May 2017 to May 2023

SZ6899

N

994

993

992

991

2023-01-26-023

2022-02-11-066

2022-02-11-026

2022-02-11-055

2020-08-11-020

2020-08-11-015

680 681 682 683 684 685 686

0 60m

1:2000

Low High

relative reflector strength

2020-08-11-015 Location of selected GPR profiles shown on Figure 6

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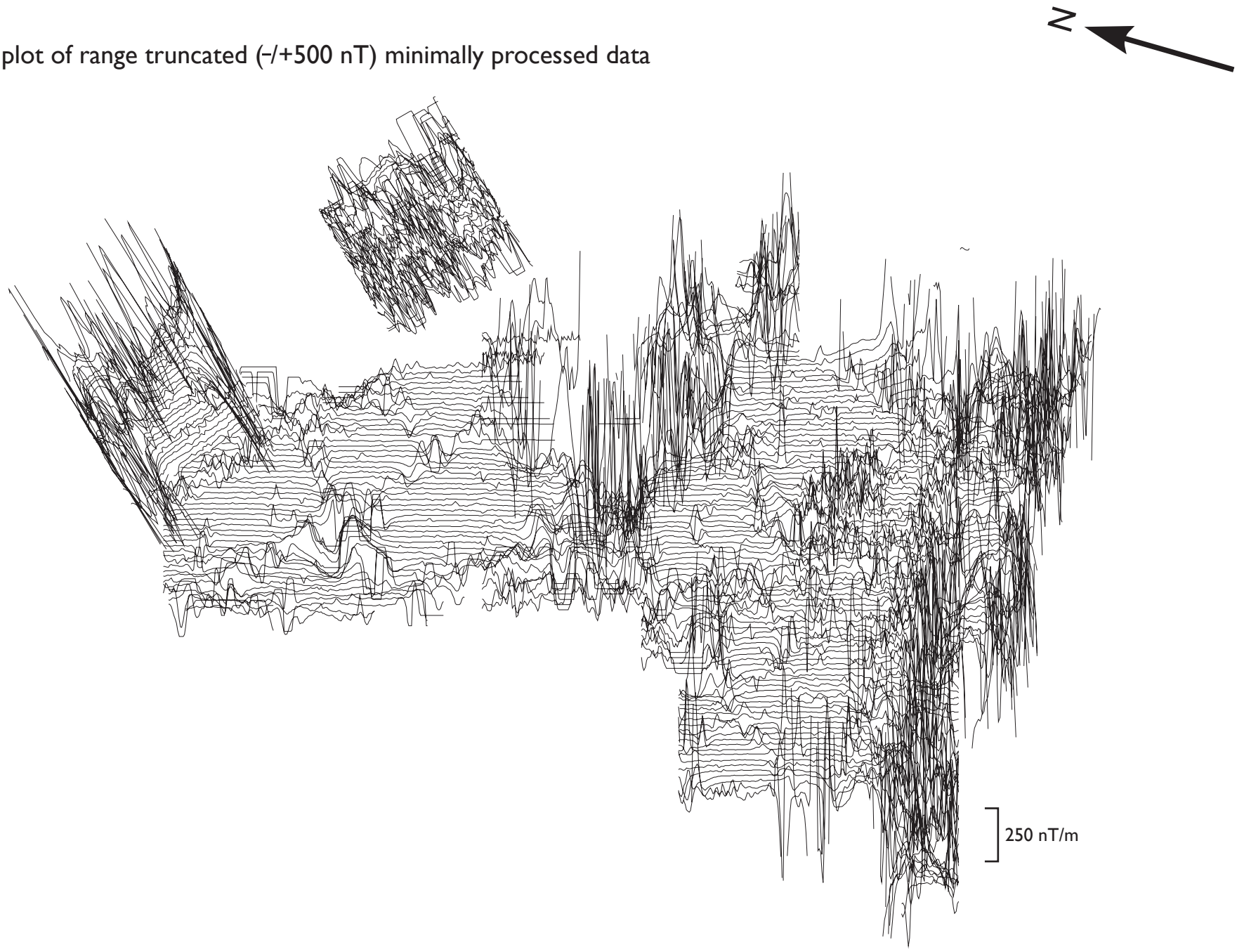
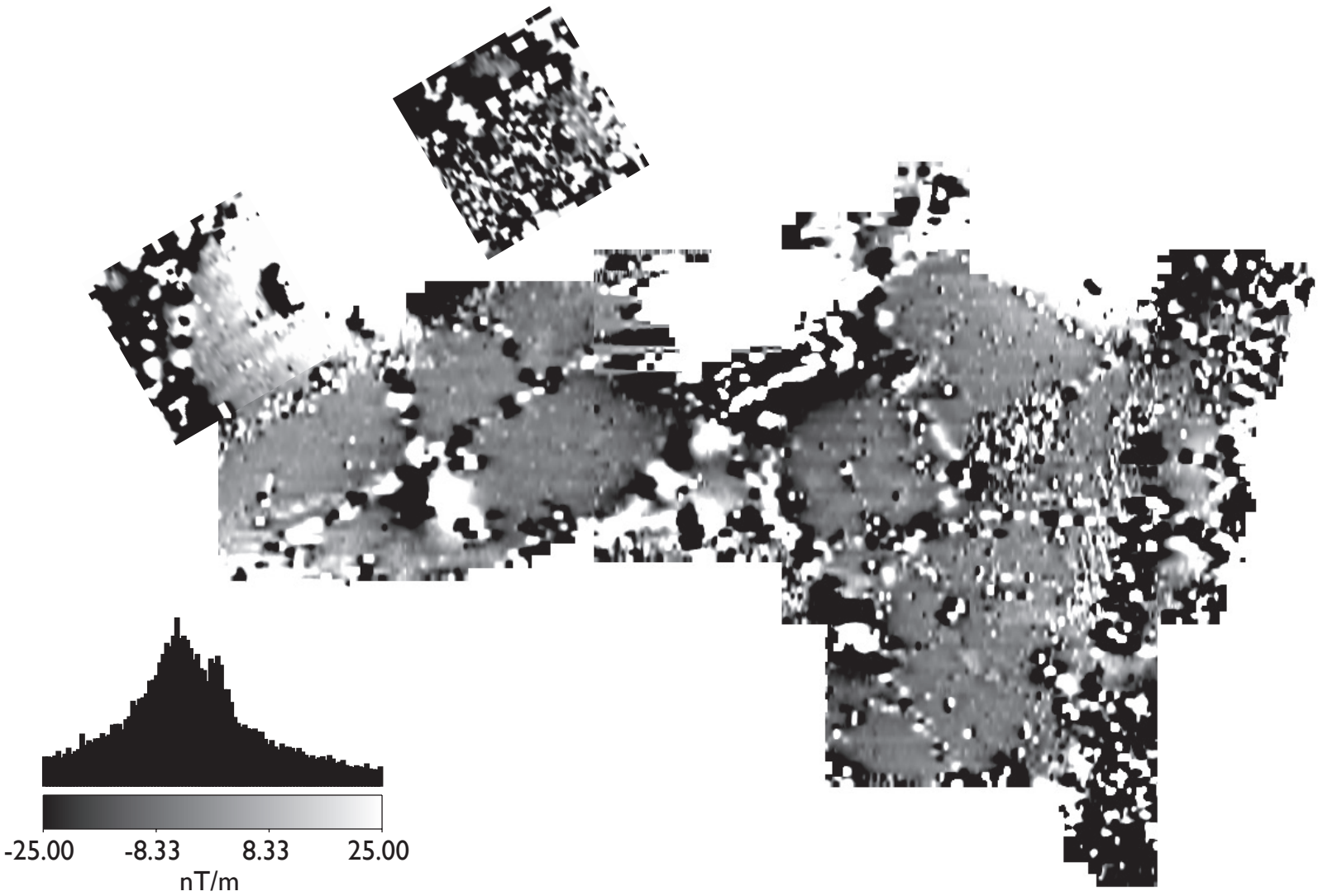
Figure 5

FORT CUMBERLAND, EASTNEY, CITY OF PORTSMOUTH
Fluxgate magnetometer survey, January to May 2023

(A) Trace plot of range truncated (-/+500 nT) minimally processed data



(B) Linear greyscale image of minimally processed data



0 90m

1:1000

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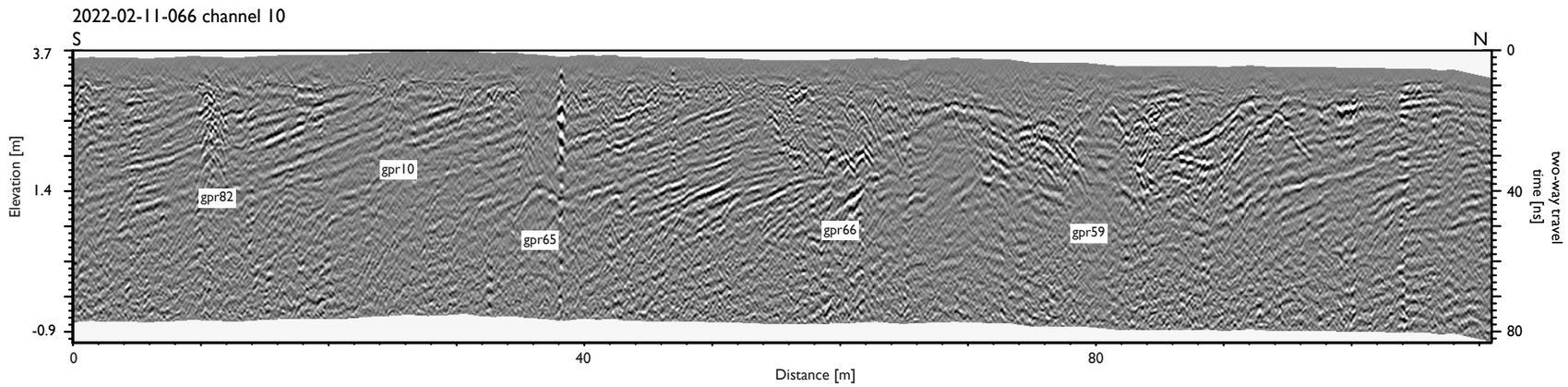
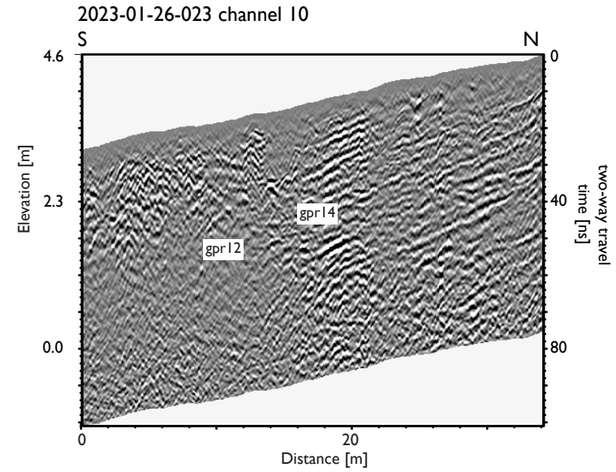
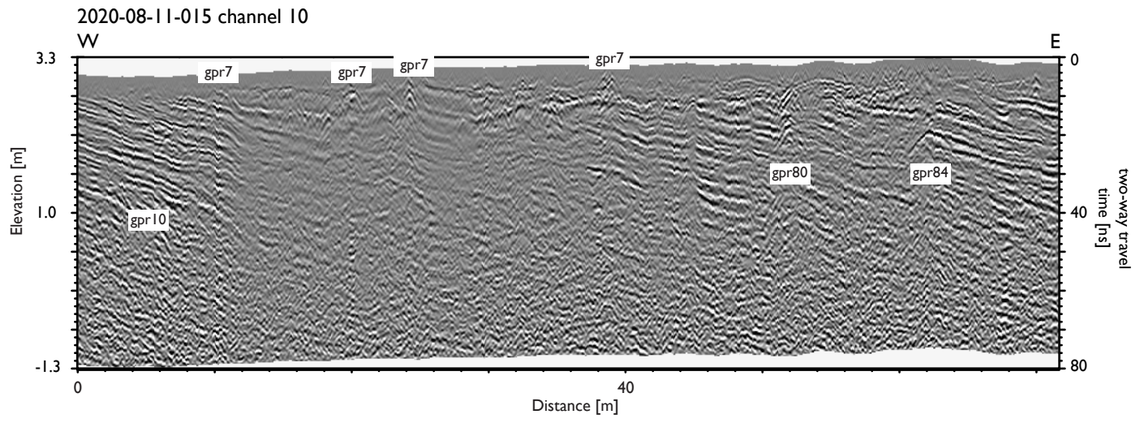
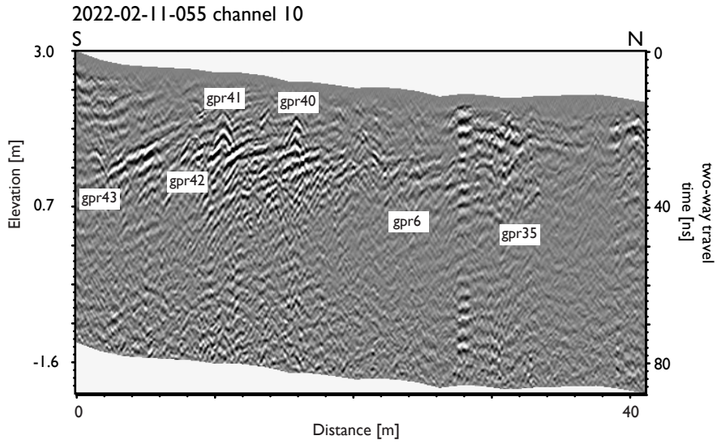
FORT CUMBERLAND, EASTNEY, CITY OF PORTSMOUTH
Representative topographically corrected GPR profiles, May 2017 to May 2023

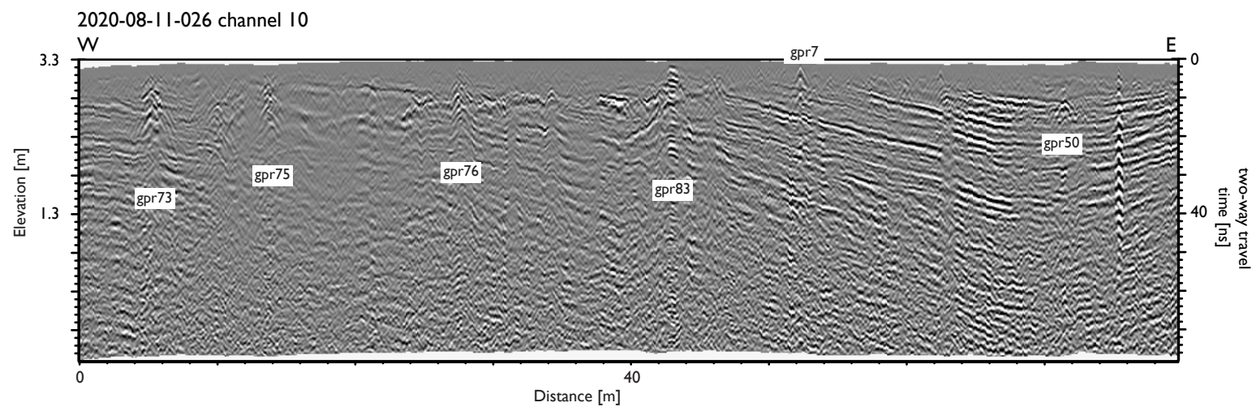
Figure 6

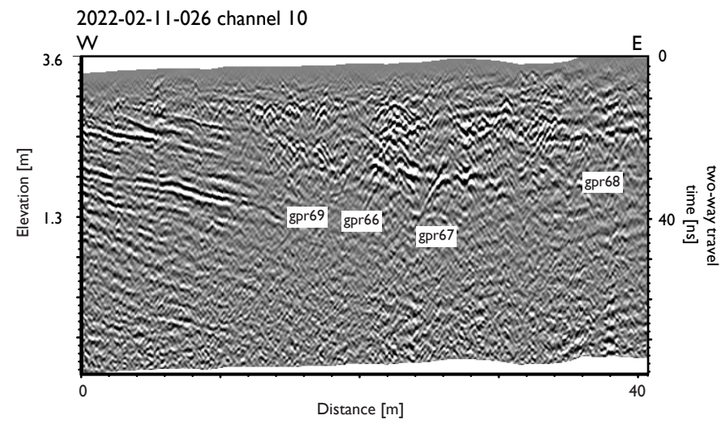












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Historic England

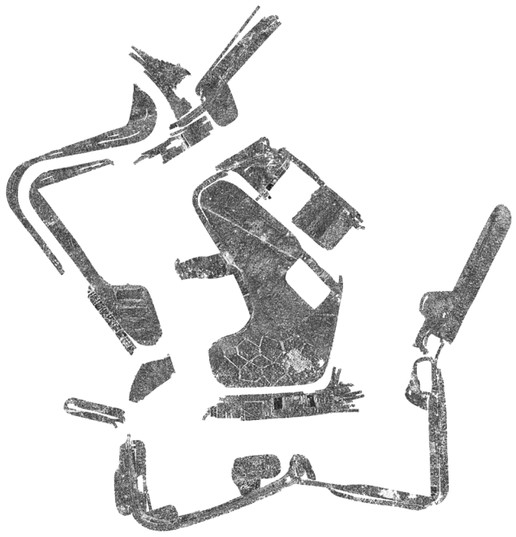
Figure 7

FORT CUMBERLAND, EASTNEY, CITY OF PORTSMOUTH

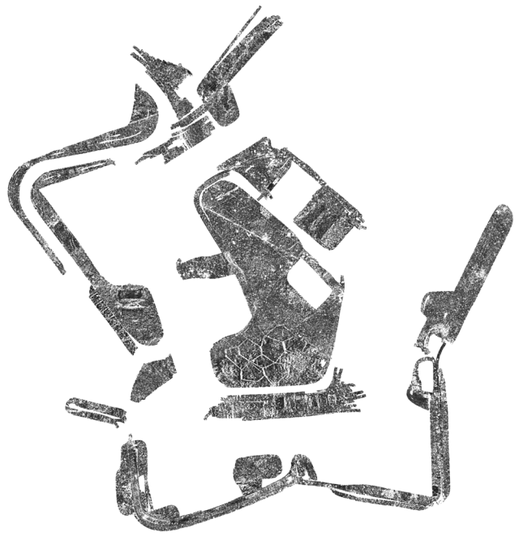
GPR amplitude time slices between 0.0 and 20.0ns (0.0 to 1.15m), May 2017 to May 2023

N

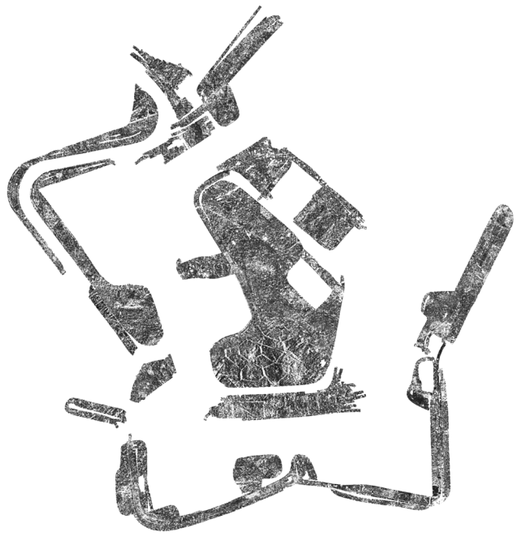
0 - 2.5ns (0.0 - 0.14m)



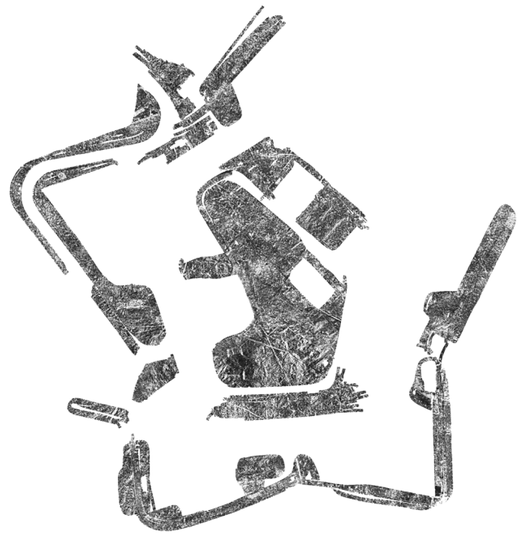
2.5 - 5.0ns (0.14- 0.29m)



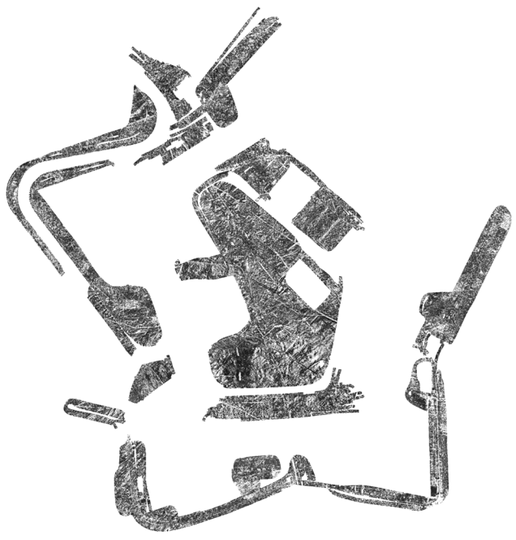
5.0 - 7.5ns (0.29 - 0.43m)



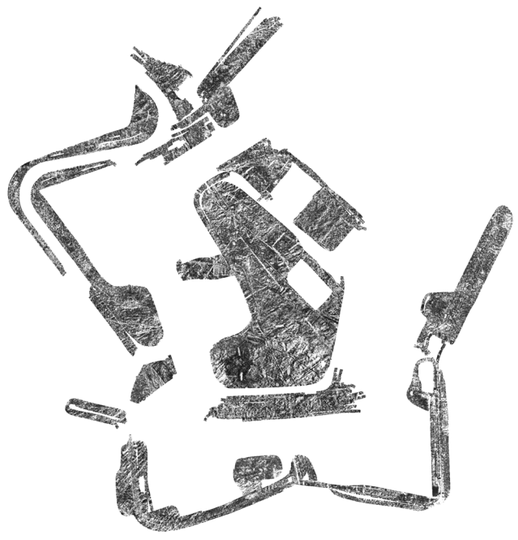
7.5 - 10.0ns (0.43 - 0.58m)



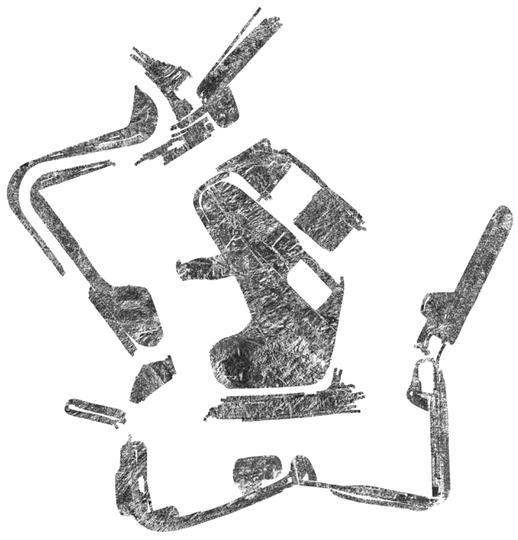
10.0 - 12.5ns (0.58 - 0.72m)



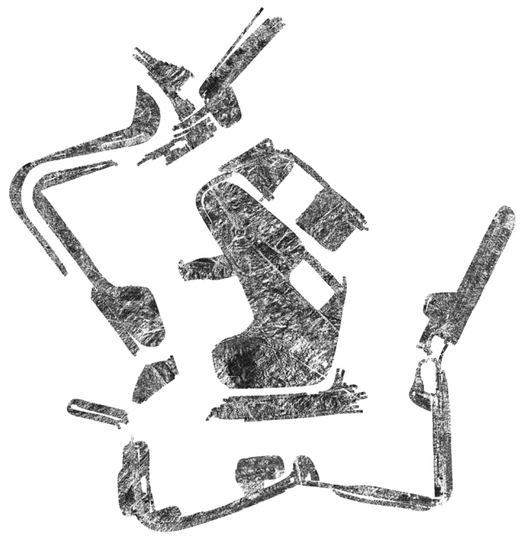
12.5 - 15.0ns (0.72- 0.86m)



15.0 - 17.5ns (0.86 - 1.01m)



17.5 - 20.0ns (1.01 - 1.15m)



0 90m

1:4000

Low *High*

relative reflector strength

Geophysics Team 2023

Historic England

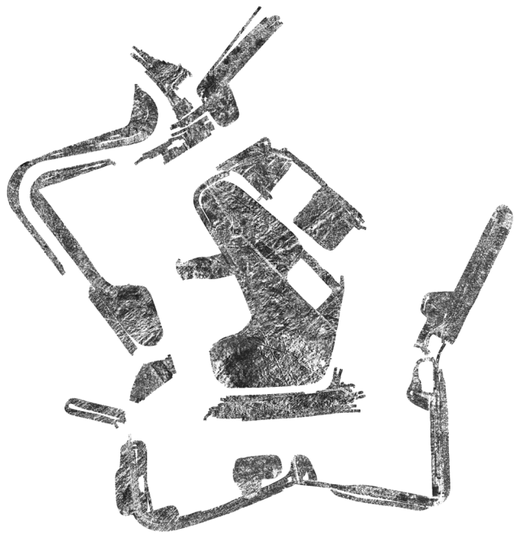
Figure 8

FORT CUMBERLAND, EASTNEY, CITY OF PORTSMOUTH

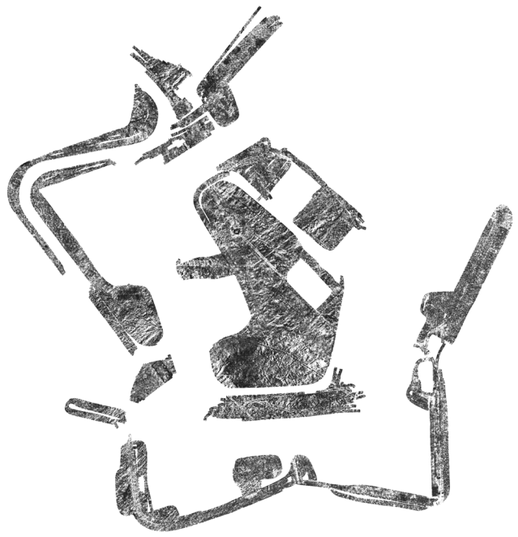
GPR amplitude time slices between 20.0 and 40.0ns (1.15 to 2.3m), May 2017 to May 2023

N

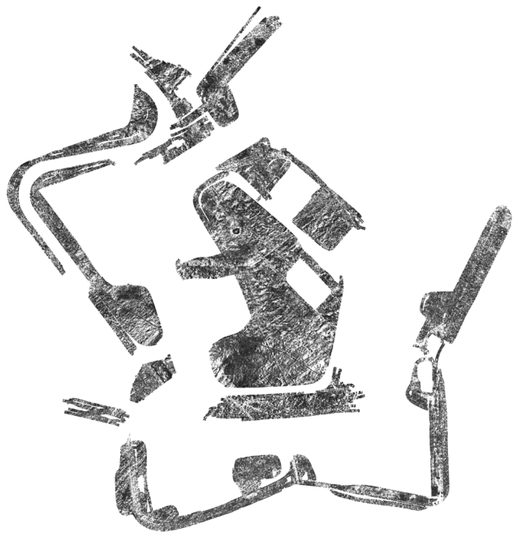
20.0 - 22.5ns (1.15 - 1.29m)



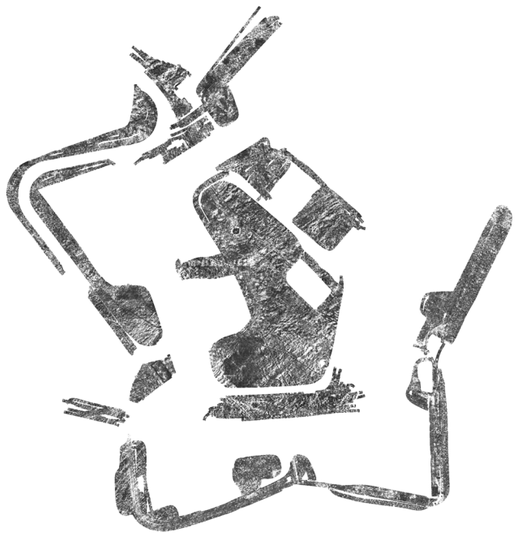
22.5 - 25.0ns (1.29 - 1.44m)



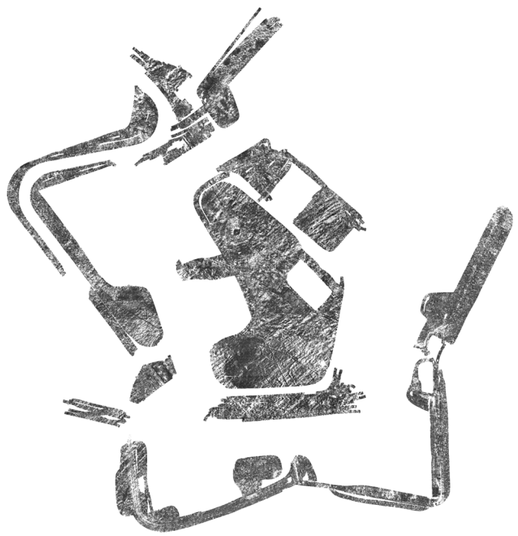
25.0 - 27.5ns (1.44 - 1.58m)



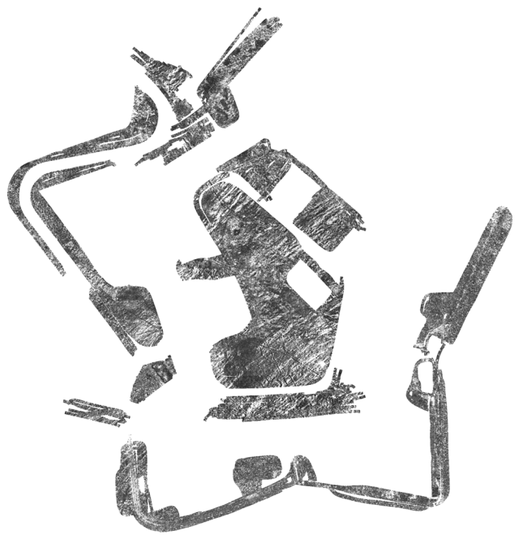
27.5 - 30.0ns (1.58 - 1.73m)



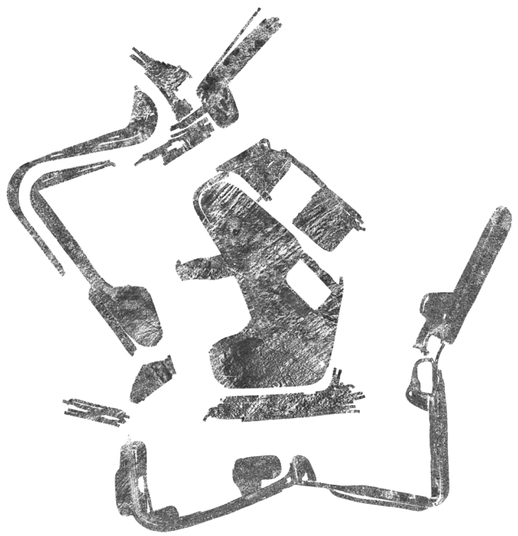
30.0 - 32.5ns (1.73 - 1.87m)



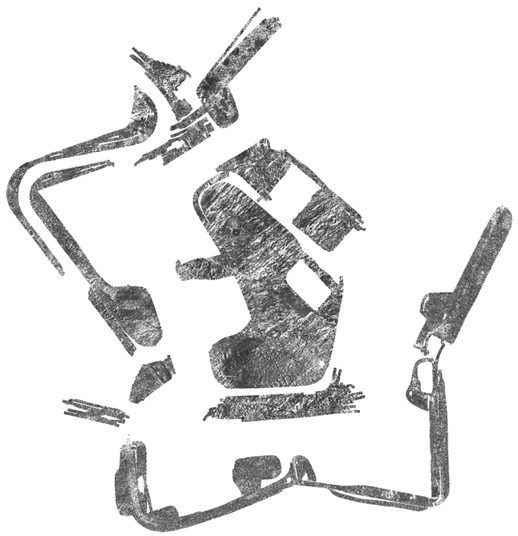
32.5 - 35.0ns (1.87 - 2.01m)



35.0 - 37.5ns (2.01 - 2.16m)



37.5 - 40.0ns (2.16 - 2.3m)



0 90m

1:4000

Low *High*

relative reflector strength

Geophysics Team 2023

Historic England

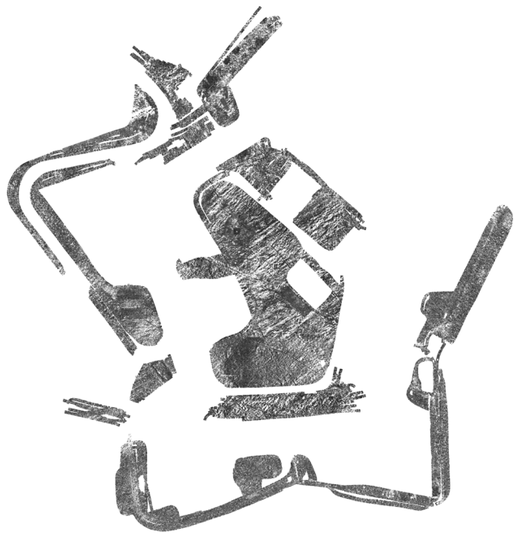
Figure 9

FORT CUMBERLAND, EASTNEY, CITY OF PORTSMOUTH

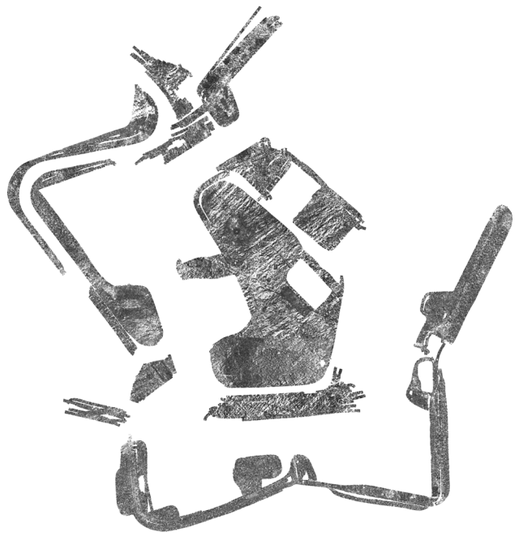
GPR amplitude time slices between 40.0 and 60.0ns (2.3 to 3.45m), May 2017 to May 2023

N

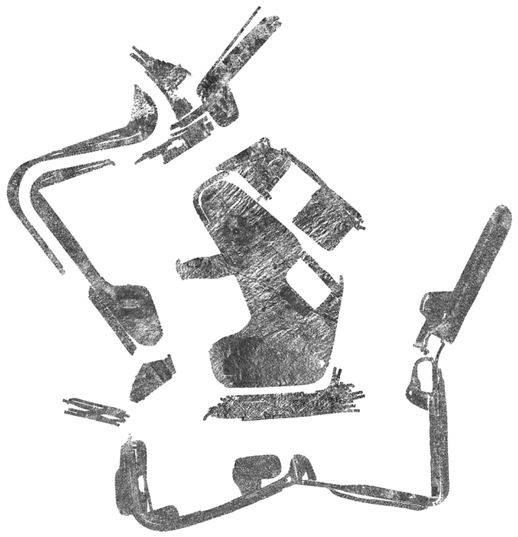
40.0 - 42.5ns (2.3 - 2.44m)



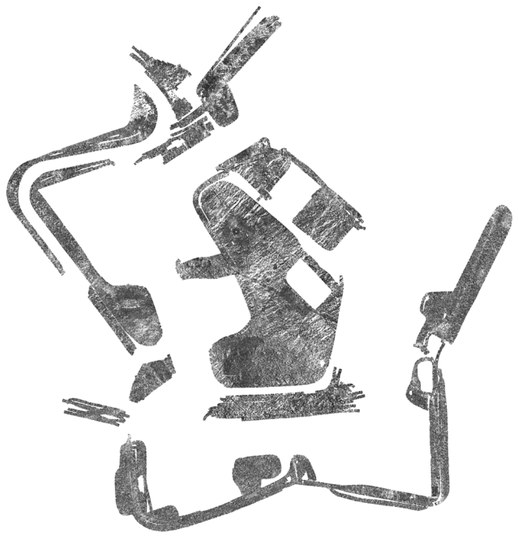
42.5 - 45.0ns (2.44 - 2.59m)



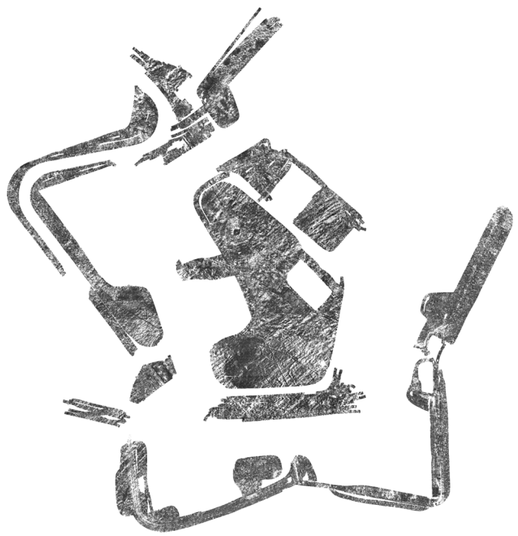
45.0 - 47.5ns (2.59 - 2.73m)



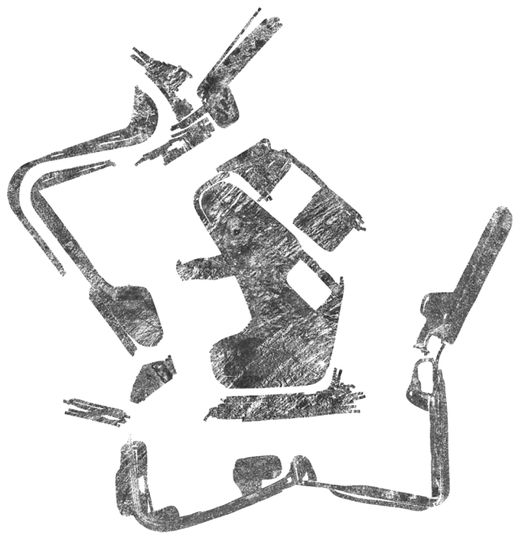
47.5 - 50.0ns (2.73 - 2.88m)



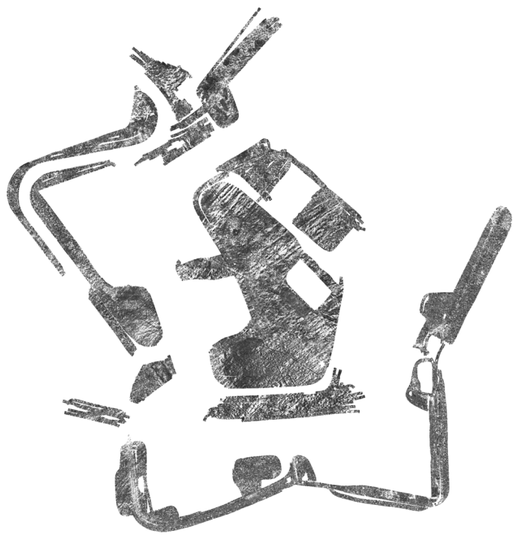
50.0 - 52.5ns (2.88 - 3.02m)



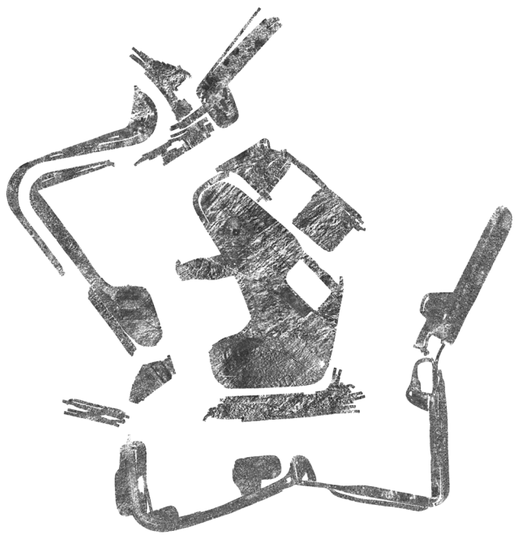
52.5 - 55.0ns (3.02 - 3.16m)



55.0 - 57.5ns (3.16 - 3.31m)



57.5 - 60.0ns (3.31 - 3.45m)



0 90m

1:4000

Low *High*

relative reflector strength

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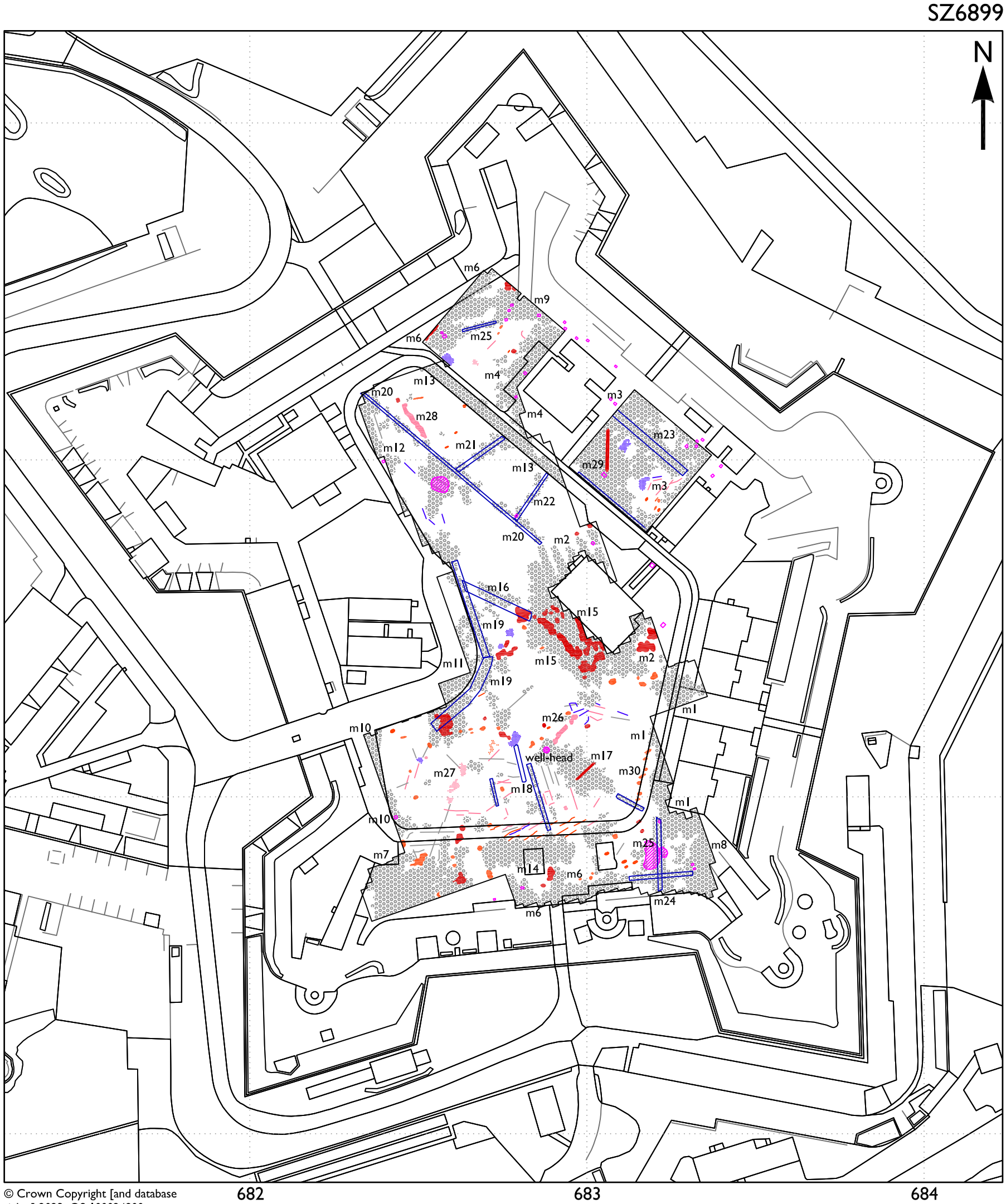
Figure 10

FORT CUMBERLAND, EASTNEY, CITY OF PORTSMOUTH

Graphical summary of significant magnetic anomalies, January to May 2023



0 150m
1:1250

positive magnetic
negative magnetic
strong positive magnetic
raised magnetic
magnetic noise
ferrous services
surface evidence

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Figure 11

FORT CUMBERLAND, EASTNEY, CITY OF PORTSMOUTH

Graphical summary of significant GPR anomalies, May 2017 to May 2023

SZ6899

N

994

993

992

991

2023-01-26-023

2022-02-11-066

2022-02-11-026

2022-02-11-055

2020-08-11-026

2020-08-11-015

680 681 682 683 684 685 686

0 60m

1:2000

low amplitude reflectors

high amplitude reflectors

anomalies of known or recent origin

2020-08-11-015 Location of selected GPR profiles shown on Figure 6

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