highways england

A303 Stonehenge

Amesbury to Berwick Down

Geophysical Survey Report

Phase 4

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Foreword

The geophysical survey was carried out by Wessex Archaeology and was commissioned by Arup Atkins Joint Venture on behalf of Highways England. The assistance of Andrew Holmes and Michael Baker is gratefully acknowledged in this regard.

Wessex Archaeology would also like to thank the landowners for their assistance during the survey, including Mrs Hosier (SW1; SW9) and the National Trust.

The fieldwork was undertaken on behalf of Wessex Archaeology by L&M Survey Services. Paul Hilton and Nicholas Crabb processed and interpreted the geophysical data. The geophysical work was quality controlled by Tom Richardson. Illustrations were prepared by Nicholas Crabb and Nancy Dixon. The project was managed on behalf of Wessex Archaeology by Ben Urmston.

The following report presents the results the multi-channel ground penetrating radar survey and discusses how this relates to the gradiometer survey results of the area.

Executive Summary

A multi-channel ground penetrating radar (GPR) survey was conducted over an area south of the current route of the A303. The survey forms part of an ongoing programme of archaeological investigation being undertaken along the A303 between Amesbury and Berwick Down to inform the Project Control Framework (PCF) Stage 2 Options Assessment Phase for the A303 improvement scheme (NGR 406767, 140697 to NGR 415261, 142253). The project was commissioned by Arup Atkins Joint Venture (AAJV) with the aim of establishing the presence, or otherwise, of potentially significant archaeology at the proposed location of the western portal. It also aimed to better define the extent and character of any features identified within the gradiometer survey of the area.

The site comprises two arable fields covering a total area of 18.9 ha. The geophysical survey was undertaken between the 12th and 25th September 2017, and conditions for data collection were generally good with the field under short stubble.

The multi-channel GPR survey has been successful in detecting a high density of anomalies of archaeological origin across the survey area, including some significant sites relating to the prehistoric funerary landscape of the WHS. These largely correspond with known archaeological remains identified from aerial sources and represent complexes of prehistoric funerary monuments. In addition, two further previously unidentified funerary monuments were also located.

Evidence was also identified for a lynchet, drainage, and a former field boundary that correlates with Ordnance Survey mapping and aerial photography for the scheme. Areas of superficial geological deposits, agricultural ploughing trends, and evidence of previous archaeological investigations were also located.

1 Introduction

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by Arup Atkins Joint Venture (AAJV) to carry out a multi-channel GPR survey over an area directly south of the route of the A303 (hereafter "the Scheme", see **Figure 1**). This area was previously covered by a gradiometer survey and forms part of an ongoing programme of archaeological investigation being undertaken along the A303 between Amesbury and Berwick Down to inform the PCF Stage 2 Options Assessment Phase for the A303 improvement scheme.

1.1.2 Three phases of geophysical survey were undertaken in 2016 and 2017. Phase 1 comprised eight areas of gradiometer survey (SW1 - SW4, NW4, SE1, NE1 and NE2) covering a total of 227.8 ha. This also included eight targeted single-channel GPR areas (Areas 1 - 8). The second phase included four areas of gradiometer survey (SW5 - SW8) covering a total of 97.1 ha, and seven areas of targeted GPR survey (Areas 9 - 16). The third phase added three further areas (NW5, NW6 and SW9) covering a total of 78.2 ha, with one GPR Area (Area 17).

1.1.3 This multi-channel GPR survey is referred to as Area 18, and covers part of SW1 and the entirety of SW9.

1.1.4 A written scheme of investigation (WSI) for the geophysical survey [1] was submitted to and approved by Wiltshire Council Archaeological Service (WCAS), acting on behalf of the Local Planning Authority, Wiltshire Council (WC), prior to the commencement of the fieldwork.

1.2 Scope of the document

1.2.1 This report presents a brief description of the methodology, followed by the detailed survey results and the archaeological interpretation of the geophysical data.

1.3 Site location, topography, and geology

1.3.1 The site is located within the centre of the Stonehenge, Avebury and Associated Sites World Heritage Site (WHS), approximately 850 m south-west of Stonehenge. The western extent of this area is 320 m east of Longbarrow roundabout and 2.7 km west of Winterbourne Stoke. It is also 2.5 km north-west of the village of Normanton in the county of Wiltshire (**Figure 1**).

1.3.2 The area surveyed with multi-channel GPR (Area 18) covers two areas that were previously subjected to gradiometer surveys undertaken by Wessex Archaeology (SW1 and SW9).

1.3.3 The survey comprises 20.4 ha of agricultural land. It covers two fields separated by a fenced field boundary and is covered with grass in the eastern triangular field and short stubble in the west. Both fields are bounded to the north by the A303 and open agricultural land to the east and west. Part of the south is also open farmland, with the small woodland known as Normanton Gorse bordering the survey area to the southeast.

1.3.4 There is a gradual slope from 107 m above Ordnance Datum (aOD) at the eastern extent of the field to 96 m aOD at the centre of the area. The land then rises gradually in the western field to 103 m aOD near Longbarrow roundabout.

1.3.5 The solid geology comprises chalk of the Seaford Formation. There is however an isolated area of Newhaven Chalk directly to the south-east of the area. In addition, there are several recorded bands of Head deposits, comprising clay, silt, sand, and gravel, traversing the area [2]; in the west, there is a slightly arching area recorded on a north-east to south-west orientation; and at the centre of the western field, a 'Y'-shaped region extends towards the south-west, south-east and north-east, all of which correspond with the topography of the area.

1.3.6 The soils underlying most of the site are likely to consist of brown rendzinas of the 343h (Andover 1) association. In the east, they are of the 341 (Icknield) association [2]. Soils derived from such geological parent material such should allow good penetration of the GPR pulses, as demonstrated on other areas of the Scheme.

1.4 Archaeological background

1.4.1 The archaeological context has been presented in brief within the *Archaeological Geophysical Survey Design Brief* [3], which examined the potential for the survival of buried archaeological remains within the development area and surrounding landscape.

1.4.2 The survey area is situated within the centre of the Stonehenge, Avebury and Associated Sites World Heritage Site (WHS). It is also located within a landscape containing nationally and regionally important multi-period archaeology. A high density of archaeological features was identified by the Historic England National Mapping Programme, many of which are potentially of national and international significance in terms of their contribution to the 'Outstanding Universal Value' (OUV) of the WHS. The Stonehenge World Heritage Site Mapping Project [4] includes the current course of the A303 and much of the data on known archaeological remains from this area is derived from aerial sources.

1.4.3 The WHS is internationally important for its complexes of outstanding prehistoric monuments [5]. The 26 square kilometres of the WHS encompasses Stonehenge, Avebury and a range of Neolithic and Bronze Age ceremonial and funerary monuments with associated sites that survive exceptionally well in the surrounding landscape. The area was a focus for ceremonial and funerary activity throughout the Neolithic and Bronze Age periods and there is a general potential across the Stonehenge WHS for the discovery of previously unrecorded archaeological remains relating to prehistoric and later activity.

1.4.4 This survey area contains one scheduled monument, as well as evidence for possible Roman activity (WSHER 2016). The scheduled monument is a Bronze Age bowl barrow located approximately 100 m west of the division between the eastern and western fields (NHLE No. 1010832). This has been excavated by antiquarian Richard Colt Hoare, and later re-excavated by Field in 1960. It revealed 7 burials and identified that the original grave contained two skeletons and a cremation.

1.4.5 A further scheduled monument is excluded from the survey area in the south. This is a Bronze Age pond barrow with a 6m deep shaft at its centre and is known

as the Wilsford Shaft (NHLE number: 1010833). This was excavated in 1960-2 and recovered several artefacts including stitched vessels, Middle Bronze Age pottery, amber beads, bone pins, and animal bones. The feature is interpreted as being a 'ritual shaft' containing votive offerings [6].

1.4.6 An extant Bronze Age bell barrow (NHLE no. 1012370), which was also excavated by Hoare, lies immediately east of the easternmost extent of the site. There are two further scheduled Bronze Age barrows (NHLE number: 1010831-2), located 95 m and 180 m south of the southern boundary. To the south-east of the area there is a dense concentration of monuments forming the Normanton Down round barrow cemetery (NHLE No. 1009614; 1009617). This comprises several fine examples of all the major barrow types including two disc barrows and the bowl barrow known as Bush Barrow (NHLE No. 1009618).

1.4.7 Part of a prehistoric or Romano-British field system extends into the north-west of the site. However, most of this feature lies outside of the survey area to the south-west. Other archaeological features of this area include part of a complex of linear features, which may be Bronze Age in origin.

1.4.8 To the north-west, part of a World War I military airfield, known as the Stonehenge Aerodrome, covered the area. It was built in 1917 and closed in 1921. Aerial photographs show that the complex was dismantled by 1934 and in 1943 the aerodrome is only visible as earthwork remains and cropmarks in aerial photographs of the area.

Recent investigations within the area

1.4.9 Extensive surveys in association with the A303 Stonehenge Improvements have demonstrated the potential for the presence of archaeological remains (e.g. [7] [8] [9] [10]). In addition, the WHS Research Framework has been compiled and updated [11] [12] [13], and numerous major research projects have been carried out, such as the Stonehenge Riverside Project and the Stonehenge Hidden Landscapes Project [14] [14, pp. 9, and Figure 1.9]. More recent large-scale geophysical survey has provided extensive and detailed mapping of the archaeological landscape [15] [16] [17].

1.4.10 A series of evaluation trenches and trial pits were excavated across the northern portion of the area in 2001, along with a watching brief [18] [19] [20]. These interventions identified two burials directly north of the Bronze Age bowl barrow mentioned above (NHLE No. 1010832), several pits, and part of a field system.

1.4.11 Three previous phases of detailed gradiometer survey and ground penetrating radar (GPR) survey have been conducted over fifteen areas along the route of the A303 [21] [22] [23], all of which form part of the ongoing programme of archaeological investigation being undertaken along the A303 between Amesbury and Berwick Down to inform the PCF Stage 2 Options Assessment Phase for the A303 improvement scheme (NGR 406767, 140697 – NGR 415261, 142253). All three phases were successful in detecting a high density of anomalies of archaeological interest, much of which corresponds with known archaeological remains derived from aerial sources. These remains represent complexes of prehistoric funerary monuments, with evidence identified for field systems, settlement, Romano-British buildings, and a variety of other significant archaeological features.

1.4.12 Gradiometer survey areas SW1 (Phase 1) and SW9 (Phase 3) cover most of the multi-channel GPR survey area. The result of this survey identified significant archaeological remains associated with the funerary landscape. These were largely associated with the scheduled monument, but a further, highly fragmented Bronze Age round barrow was located, which had not been identified previously. A linear anomaly was also identified that has been previously noted on aerial photography and is thought to form part of a wider complex of earthworks potentially dating to the Bronze Age. In addition, a former field boundary, superficial geological deposits, and agricultural ploughing trends were also located.

2 Methodology

2.1 Introduction

2.1.1 The survey adhered to the methodology set out below, prepared in accordance with guidelines and recommendations published by English Heritage (now Historic England) in 2008 [24], as per the WSI [1].

2.2 Aims and objectives

2.2.1 The aim of this geophysical survey is to gather information to inform the design proposals and wider environmental disciplines for the selection of the final route options.

2.2.2 The project specific objectives for this geophysical survey are defined by the Client as being to:

- determine the presence/absence of potentially significant archaeology within the WHS and wider proposed assessment corridors;
- define the extent and character of any features within each survey site; and
- produce an interpretive report on the findings of the survey to inform the options screening process.

2.2.3 More specifically the GPR survey aims to:

- improve the understanding of the extent and character of key features previously identified by the detailed gradiometer survey; and
- establish whether any change to the interpretation is needed on the basis that further significant features are present within these survey areas.

2.3 Fieldwork methodology

2.3.1 The vehicle-based GPR system provides real-time positioning enabling full site coverage without the need to set up individual grid nodes across the survey areas. However, in order to ensure survey accuracy, the boundaries of the survey extent were established using a real-time kinematic (RTK) Global Navigation Satellite System (GNSS) instrument. The dataset was then positioned using a robotic total station. This allow positions to be determined with a precision of 0.01 m and therefore exceeds Historic England recommendations [24].

GPR Survey

2.3.2 The GPR survey was conducted using a Malå Imaging Radar Array (MIRA). This multi-channel GPR system uses separate shielded transmitter and receiver

antennae mounted hydraulically in front of a motorised vehicle. The MIRA system contains 16 separate transmitter and receiver antennae with a central frequency of 400 MHz. The data were recorded every 8 cm with a horizontal profile spacing of 8 cm within a time window of 60 ns.

2.3.3 Previous surveys using differing antenna frequency have been undertaken. This has provided a field test using 500 MHz, 400 MHz, and 250 MHz antennae in accordance with European Archaeologiae Consilium [25] and Historic England guidelines [24]. It established that 400 MHz antennae are likely to provide the detailed information regarding the nature of archaeological remains within each area and therefore no further survey was undertaken using alternative antennae.

2.3.4 Data were collected in the zigzag method, with 16 profiles collected simultaneously along each 1.28 m swathe.

2.4 Data processing

GPR Survey

2.4.1 Data from the survey were subjected to common GPR correction processes. These comprise amplitude and wobble correction of the radar profile to correct for variance in temperature and soil moisture content, background removal, and bandpass filtering to suppress noise in the data from the surrounding area. These steps were applied to all the GPR datasets.

2.4.2 Further details of the geophysical survey equipment, methods, and processing are described in **Appendix A**.

2.4.3 The approximate depth conversions have been calculated on the assumption that the GPR pulse through the ground is travelling at a certain velocity, which are summarised in **Appendix B** (**Table 1**). The approximate depth conversions for Area 18 are shown in **Appendix C** (**Table 2**).

2.4.4 It is possible to determine more precisely the average velocity of the GPR pulse through the ground if previously excavated features at known depths can be identified in the data; however, this is rarely possible. Instead, the radargrams were analysed for suitable hyperbolic reflections, which can be used to determine the velocity of the GPR pulse through the subsurface deposits. The measured signal times for two-way travel can then be converted to depths.

3 Geophysical survey results and interpretation

3.1 Introduction

3.1.1 The GPR survey was undertaken over two fields that were previously covered by detailed gradiometer survey (SW1 and SW9) [21] [23] (**Figure 2**).

3.1.2 The 400 MHz antennae used in this survey has the potential to detect features to a depth of up to 2 or 3 m in optimal conditions, although the total depth reached varies depending on the specific conditions of each area.

3.1.3 For ease of interpretation, the most representative timeslices have been selected for presentation with the interpretation image detailing the salient results from each relevant 0.13 m section. This is then followed by a graphical summary of all the timeslice interpretations to provide a more complete understanding of how these features may relate to one another.

3.1.4 The multi-channel GPR survey has identified several point reflectors, planar returns, and linear responses, along with anomalous areas of high and low amplitude. Results are presented as a series of greyscale timeslices, and archaeological interpretations at a scale of 1:2000 (**Figures 3 – 22**). A graphical summary of these features is provided in **Figures 23** and **24**. The greyscale plots display black representing high amplitude responses and white relating to low amplitude responses. Where significant archaeological features have been identified, a more detailed view and interpretation of these features is provided separately (**Figures 25 – 30**).

3.1.5 All features are described in terms of their geophysical character. It is important to stipulate that all the depths referred to in this report are approximate levels below the current ground surface. The interpretation of the GPR data highlights the presence of potential archaeological features, possible archaeological features, and high amplitude responses alongside a series of linear trends.

3.1.6 It should be noted that small features and waterlogged features may produce responses that are below the detection threshold of the GPR antenna. Excessive disturbance can also impede the ability of geophysical techniques to detect archaeology. It may therefore be the case that more archaeological features are present than have been identified through the geophysical survey.

3.2 GPR survey results and interpretation

3.2.1 The geophysical survey of GPR Area 18 was undertaken on behalf of Wessex Archaeology by L&M Survey Services between 12th and 25th September 2017, and an overall coverage of 18.9 ha was achieved. Field conditions at the time of survey were generally good, being largely covered with short stubble in the west and grass in the easternmost field. A buffer zone of 100 m was maintained immediately to the east of the existing pig farm, which resulted in an approximately 1.5 ha reduction to the originally proposed area (**Figures 2-3**). A total depth of 3.02 m was reached with an effective time window of 60.48 ns.

3.2.2 The multi-channel GPR survey has identified a number of features that are likely to be associated with archaeological remains. These are predominantly located over the known scheduled monument and anomalies previously identified in the

gradiometer survey of the area. These are also mostly associated with possible archaeological features, such as linear and curvilinear ditches.

3.2.3 The uppermost timeslices display numerous, closely spaced linear trends on various alignments. In the eastern field, these are predominantly orientated north-west to south-east and parallel with the extant field boundaries. In the westernmost field, there are generally much fewer linear trends of this nature. They are also mostly on a north-north-east to south-south-west alignment and slightly more widely spaced (10 m apart). These are characterised by high and low amplitude responses and are visible within the data from the ground surface until Timeslice 5 (0.5 m; **Figures 3-6**), although elements of this can be seen to 'ring' throughout deeper timeslices. These are associated with modern ploughing furrows. A similar arrangement of features is seen in the gradiometer data; however, these linear trends have been more clearly identified within the GPR dataset.

3.2.4 In addition to these probable ploughing furrows, there are numerous pairs of linear trends that traverse the area on less regular alignments. These are more prevalent in the north-eastern field, where several semi-circular arrangements can be seen. These are also visible in the timeslices as high and low amplitude responses from the ground surface until Timeslice 5 (0.5 m). The anomalies are thought to relate to wheel ruts and tractor turns caused by modern ploughing.

3.2.5 The shallowest responses thought to be associated with archaeological remains appear in Timeslice 5 (0.5 m; **Figures 7-10**). A small curvilinear anomaly at **10000** can be seen near the north-western extent of the area. This is characterised by a high amplitude response and does not relate to any known archaeological features in the area. To the east of this, two concentric annular high amplitude anomalies have been identified (**10001**), which relate to a scheduled monument (NHLE no.1010832). Close to the eastern boundary, a fragmented curvilinear arrangement of high amplitude response has also been identified (**10002**). The anomalies at each of these three locations are associated with different types of probable Bronze Age barrows and were previously identified in the gradiometer survey. Several more specific aspects of their precise form and preservation can be discerned from the GPR dataset, and are discussed in detail later in this report.

3.2.6 In the easternmost field, there is a linear anomaly that traverses the area on a north-north-east to south-south-west alignment (**10003**). This is faintly visible within Timeslice 4 (0.38 m), and is perhaps most clearly visible within Timeslice 5 (0.5 m; **Figures 8** and **10**), where a 2.5 m wide, low amplitude response can be seen to extend for at least 128 m. On both the eastern and western sides there is a corresponding high amplitude response, although this is only visible in Timeslices 4 and 5; it is therefore likely that the low amplitude response represents a ditch-like feature, with the high amplitude representing remnant bank material. The low amplitude response is present throughout the timeslices until Timeslice 13 (1.51 m), although it changes slightly in character with increasing depth, becoming slightly narrower. For example, within Timeslice 8 (0.88 m; **Figures 12** and **14**), it is closer to 1.5 m wide and is only visible as weak linear trends.

3.2.7 The ditch and bank identified at **10003** were previously identified by the gradiometer survey (**8002**) and extend outside the GPR survey area. This feature

also corresponds with a linear earthwork previously identified on aerial photographs and likely forms part of a wider complex thought to date to the Bronze Age.

3.2.8 A further linear anomaly at **10004** lies east of the centre of the survey area. This is 4 m wide and 127 m long. It is situated on a north-east to south-west alignment and characterised by a low amplitude response. It is clearly identifiable within Timeslice 5 (0.5 m; **Figure 8** and **10**) and can be seen within the dataset until Timeslice 7 (0.76 m), although broken and isolated linear trends can be identified in Timeslice 8 (0.88 m; **Figure 12** and **14**). This is interpreted as possible archaeology and is thought to be a probable ditch-like feature, which lies within a broad, amorphous band of high amplitude response interpreted as superficial geology (**10014**). Some 20 m south-east, a similar geological feature can be seen (**10015**), which is aligned broadly parallel with **10004**. It also follows the edge of a decline in topography in the area and may therefore be associated with a former field boundary or lynchet.

3.2.9 As was the case with **10003**, this feature also likely continues beyond the survey extents to the south-west. It seemingly terminates towards the north-east and does not traverse the whole field. This is consistent with an anomaly previously identified in the gradiometer survey of the area (**8004**). It also closely follows the alignment of other features to the south-east in SW1 that have been identified as being Bronze Age in origin. However, the relatively short length, shallow depth, and location close to a change in topography suggests that it perhaps more likely represents a lynchet or similar feature. Further investigation would clarify the exact origin of this feature, and an archaeological interpretation cannot be ruled out based on the results of this geophysical survey.

3.2.10 To the north-west of **10004**, five high amplitude linear responses are orientated on the same north-east to south-west alignment (**10005**). These are faintly visible between Timeslices 4 and 6 (0.38 to 0.63 m), and are spaced at regular 35-39 m intervals. Two further examples of this can be seen to the south-east of **10004**, which are also spaced at similarly regular intervals (**10006**). The shared orientation with a possible lynchet, and location below the modern ploughing identified in the upper timeslices, suggests that these may be associated with earlier ploughing of the area. However, the regular spacing is also consistent with drainage. There are no clearly identifiable corresponding features within the gradiometer survey results and, if they are associated with land drains, it is therefore unlikely that they are ceramic.

3.2.11 In the western part of the area, there is a weak linear trend that runs north-west to south-east at **10007**. This extends south-east from a small gap in the data where a former field boundary is visible on the ground surface. It relates to a former field boundary depicted on the 1972 edition Ordnance Survey map of the area and was also identified in the gradiometer survey of the area (**4411**).

3.2.12 Elsewhere within the uppermost timeslices, there are numerous regular areas of high and low amplitude. These are located to the immediate south of the A303, and do not extend beyond 50 m south of the northern boundary of the area. They are visible from Timeslice 4 (0.38 m) and have largely disappeared by Timeslice 6 (0.63 m). They predominantly take two forms, the first being approximately 50 x 2 m rectangular areas, such as those at **10008**. The second is square and measures roughly 10 x 10 m, for example those identified at **10009**. Both are

associated with previous archaeological investigations undertaken during 2001 [18] [19] [20], and relate to evaluation trenches and trial pits. There is a slight variation between the recorded position of these investigation areas and their location in the GPR dataset. However, for the most part these areas of high and low amplitude clearly correlate with the previous investigations.

3.2.13 The evaluation trenches and trial pits were not clearly present in the gradiometer survey of the area. This is likely due to the amount of ploughing that has occurred in the intervening period. Furthermore, many of these investigation areas have not been identified within the GPR survey results. Those located in the eastern portion of the area are generally better represented, most likely due in part to a variability in the intensity of ploughing between these areas. However, in the north-west of the survey area, some of the geotechnical investigation pits can be identified (**10010**). These were dug within previously excavated archaeological trial pits, which are not evident in the data. The geotechnical pits are likely present in the data due to their greater depth.

3.2.14 Perhaps the most clearly visible responses within this GPR dataset are associated with superficial geological deposits. Within the uppermost timeslices, these are identifiable as broad (20-30 m wide) amorphous bands of high and low amplitude responses. These are first visible in Timeslice 4 (0.38 m) and can be seen to continue through the remainder of the dataset. Within Timeslice 5 (0.5 m; **Figures 7-10**), in the eastern part of the survey area, there is a variety of linear and curvilinear anomalies running from the south-western corner and arching slightly towards the centre of the area (**10011**; **10012**). From this point two further high amplitude bands extend towards the north-east (**10013**). Also in the western part of the area, two roughly parallel linear bands are aligned north-east to south-west (**10014**; **10015**). These are visible throughout the entirety of the dataset, although their size and position shifts as the dataset descends. For example, in Timeslice 8 (0.88 m; **Figures 11-14**), Timeslice 11 (1.26 m; **Figures 15-18**) and Timeslice 15 (1.76 m; **Figures 19-22**), a series of high and low amplitude response can be seen to shift laterally. Much of this is likely associated with recorded head deposits of clay, silt, sand, and gravel [2]. It also correlates well with the similarly interpreted anomalies in the gradiometer survey results (**4409**; **8004**). The changing position is likely representative of varying deposits or concentrations of stonier material within this area.

3.2.15 In addition to head deposits there are more isolated bands of high and low amplitude that are interpreted as superficial geological features. For example, there are short, thin, irregularly-shaped linear anomalies dispersed throughout the dataset. These vary in size, but do not exceed 30 x 3.5 m, although some are significantly smaller. They can be seen from Timeslice 6 (0.63 m) and continue throughout the remainder of the dataset. They are perhaps most easily viewed in Timeslice 8 (0.88 m) and Timeslice 11 (1.26 m) at **10013** in the centre of the survey area. It is likely that these are associated with isolated bands of local geomorphology, where dipping bands of weathering, marl, or flint bedding within the chalk appear as a series of high amplitude reflectors.

3.2.16 **Figures 25** – **32** focus on three areas of the GPR survey where anomalies associated with different types of probable Bronze Age barrows have been identified (**10000** – **10002**). For this, additional timeslices were created to enhance the finer details of any features contained within the areas. The selected timeslices also focus on the upper part of the dataset, where most of these

responses occur. In addition, aspects of the results are labelled on **Figures 26**, **28** and **30** (**A – Q**) in order to highlight specific interpretations.

10000

3.2.17 Close to the north-western corner of the survey area, a curvilinear anomaly measuring 4 m in diameter has been identified. This is characterised by high and low amplitude responses that can be clearly identified from Timeslice 5 (0.50 m). It is consistent throughout most of the timeslices as an annular feature (**A**), but is no longer visible beyond 1 m below the ground surface. This is suggestive of an annular ditch feature, with the ditch element measuring 1 m wide. Towards the east of the feature, there is evidence for a possible break in the ditch (**B**), however this is only visible in the deeper timeslices, such as Additional Timeslice 3 (0.91 m) (**Figures 25-26**).

3.2.18 Within this ring ditch, two possible pit-like features are visible. The first of these can be identified in Additional Timeslice 1 (0.79 m), near the eastern part of the feature (**C**). The second, can be most clearly identified in Additional Timeslice 2 (0.87 m) and is visible as a faint, roughly circular, high amplitude response measuring 0.7 m in diameter (**D**). This is located in the western part of the feature and measures 0.9 m in diameter. Both anomalies are consistent with pit-like features within the ring ditch, although neither is extensive in depth. It is also possible that they represent isolated flint nodules within the natural chalk bedrock.

3.2.19 Within the gradiometer survey of the area, this feature was identified as a small possible pit-like feature, as opposed to a small ring ditch. One possible explanation for this disparity is that the central area of the ring ditch is infilled by a strongly magnetic material. Such material would not be easily detected by GPR survey and is therefore not clearly visible within the results. This may suggest that this feature represents a shallow pond barrow, perhaps with a surrounding ditch feature. However, further investigation would be required to confirm the precise nature of this. Nonetheless, the GPR survey has enabled an increased archaeological significance to be applied to this anomaly.

10001

3.2.20 Approximately 100 m west of the division between the eastern and western fields the GPR survey covered a scheduled bowl barrow (NHLE no. 1010832; **10001**). This was previously identified in the gradiometer survey as two clear annular anomalies and a smaller internal circular feature (**8000**). It is equally clearly identifiable within the GPR dataset, though several other aspects of the feature have also been revealed.

3.2.21 Responses associated with the Bronze Age bowl barrow are visible from Timeslice 4 (0.38 m) through to Timeslice 11 (1.26 m). However, the precise form and character of the response varies as it descends through the timeslices. For example, in Additional Timeslice 4 there is a concentration of high amplitude responses in a circular area at the centre of the feature (**E**; **Figures 27-28**). This covers an area 12.5 m in diameter and is no longer visible after a depth of 0.5 m. It covers the internal area of the monument and most likely pertains to remnant bank material located just below, and possibly within, the plough soil.

3.2.22 Within Additional Timeslice 5 (0.59 m) the outermost ditch is identifiable as a strong high and low amplitude response (**F**). This has an internal diameter of 13 m, with the ditch measuring a maximum of 3 m wide. As this descends the

response associated with the ditch becomes much thinner, as can be seen in Additional Timeslices 7 (0.97 m) and 8 (1.08 m) where the anomaly is less than 1 m wide. This is most likely associated with the gradual tapering of the profile of the ditch. However, it is not possible to establish the exact character of this based on these results alone, particularly as the re-cutting of such features is common on some sites [26].

3.2.23 To the north of the outermost ditch, a rectangular area of predominantly high amplitude is visible (**G**; **Figures 27-28**). This measures 20 x 5 m and relates to an area excavated in 2001 that revealed two Early Bronze Age burial pits [20]. Extending from this evaluation trench is an additional southerly element of this, and there is also evidence of further excavation in the south of the feature (**H**). It is likely that these are associated with investigations undertaken in the 1960s that determined that the barrow contained a total of 11 burials.

3.2.24 Within the centre of Additional Timeslice 5 (0.59 m), there are several small (<1m diameter) circular anomalies (**I**). These are interpreted as possible archaeology and may be pit-like features. As these are seemingly randomly dispersed, and are not present for an extensive depth range, it is difficult to ascribe more specific archaeological interpretations to these features. However, given the number of burials that have been identified within and surrounding the barrow, it is possible that they may represent further remains of this nature. Despite this, it is equally plausible that they may simply be attributable to isolated stones or natural pitting in the chalk bedrock.

3.2.25 The innermost ditch first becomes visible from around 0.6 m below the ground surface and is faintly visible within Additional Timeslice 6 (0.74 m) (**J**; **Figures 29-30**). Within this, an intermittent curvilinear high and low amplitude response can be identified. This has an internal diameter of 7 m, with the ditch itself measuring 1 m in width. This is clearer within Additional Timeslice 4 (0.97 m) but is only faintly visible within Additional Timeslice 8 (1.08 m), beyond which it is no longer identifiable. This suggests the internal ditch is much smaller in scale than the outer ditch. The variable depth range may suggest that they belong to two different phases of the feature, although it is impossible to establish this based on these geophysical survey results alone. It is possible that the outer ditch represents a later monumentalisation of the smaller internal ditch, however further investigation would be required to confirm this.

3.2.26 Within the centre of the two ditches there is evidence for a central circular feature. This is represented by a high and low amplitude response, but is poorly defined. It can be defined from approximately 0.65 m below the ground surface and is continually present in the timeslices until around 1.25 m. It is at its maximum diameter within Additional Timeslice 6 (0.74 m), where it measures approximately 2.7 m (**K**). From this point, it gradually reduces in size and within Additional Timeslice 8 (1.08 m), it is closer to 1.5 m in diameter. This suggests that the pit gradually tapers as it descends and provides some indication its profile.

3.2.27 There are no responses that can be clearly identified as external archaeological features in the immediate vicinity of the barrow. Whilst there are isolated high and low amplitude anomalies, these are not consistently present through many timeslices and do not display any obvious form that might be considered indicative of archaeological remains. This is also broadly consistent with the gradiometer survey results. However, as so many burials have been located

within the ring ditch and its immediate vicinity, it is possible that there may be further remains of this nature that cannot be identified by either geophysical survey technique.

10002

3.2.28 In the south-eastern corner of the GPR survey area, there is a series of high and low amplitude responses that are thought to be associated with further archaeological remains. These were previously identified in the gradiometer survey (**8001**) but are not identified by the HER or in aerial photographs of the area. The fragmented nature of this feature within the gradiometer results suggest that the feature is likely to have been significantly affected by ploughing. However, it is also considered possible that it is associated with a circular arrangement of pit-like features.

3.2.29 **10002** is first visible from around 0.4 m below the ground surface. A faint curvilinear arrangement of anomalies can be identified within Additional Timeslice 1 (0.43 m) (**L**; **Figures 29-30**). This is characterised by several roughly circular high amplitude responses that measure a maximum of 1.2 m in diameter, with the smallest being 0.7 m. They are consistently visible until an approximate depth of 0.75 m below the ground surface. Within additional Timeslice 2 (0.55 m), there are some responses that are more curvilinear in form, located towards the north-east (**M**) and south-west (**N**) of the feature. There are also faint curvilinear trends that correspond with this position until Additional Timeslice 3 (0.66 m) (**O**). This suggests that the feature identified in the gradiometer survey is could be formed of a circular arrangement of pit-like features, as opposed to a ring ditch. However, the limited depth range of the feature (0.43 – 0.75 m), suggests that it is also highly damaged by ploughing. Nonetheless the result of this GPR survey suggests that this feature may not be associated with a Bronze Age barrow and could therefore have origins in the Neolithic period.

3.2.30 Within the centre of **10002**, there are some very small (0.5 m) high amplitude anomalies (**Figures 29-30**), which are not consistently present through many of the timeslices but can be identified within Additional Timeslice 2 (0.55 m). It is possible that these are associated with a pit-like feature, however it is not possible to find a clear correlation for the central pit identified in the gradiometer survey results.

3.2.31 There are no obvious additional features surrounding **10002**, although the results of the gradiometer and GPR surveys are not entirely complementary in this case. Many of the pits identified in the gradiometer survey results are not corroborated by this GPR dataset. It is possible that ploughing has truncated these features leaving only a subtle interface which has not been detected by GPR.

4 Discussion

4.1.1 The main aim of the GPR survey was to improve the understanding of the extent and character of key features previously identified by the detailed gradiometer survey. It also aimed to establish whether any refinement of the interpretation is needed on the basis that further significant features are present within these survey areas. On both counts the use of a multi-channel GPR has been highly beneficial towards answering these questions. However, there are also several examples where the gradiometer results have arguably provided a clearer picture.

Thus, the combined use of both techniques has ultimately resulted in a better understanding of the nature and extent of archaeological remains within the area.

4.1.2 The GPR survey has been successful in detecting numerous anomalies that are considered to be of archaeological origin across the area. These are primarily ditch-like features, which take several forms and date to a variety of periods. They largely correspond with archaeological remains known from aerial sources and represent complexes of prehistoric monuments. However, several previously unrecorded archaeological features have also been identified. Of particular importance is a possible pond barrow (**10000**) and circular pit alignment (**10002**). These were both identified in the gradiometer survey, but the precise nature of these features has been significantly enhanced by the GPR dataset.

4.1.3 Elsewhere within the area a scheduled monument was surveyed (NHLE no. 1010832). The results of the GPR survey has helped define the character and extent of the remains of a bowl barrow (**10001**) as well as identifying the impact of previous investigations on the monument.

4.1.4 In addition to features associated with the funerary landscape of the Stonehenge WHS, a linear anomaly (**10003**) was identified that likely forms part of a wider complex of earthworks dating to the Bronze Age. A possible lynchet (**10004**) and evidence for drainage are also indicated in the interpretation.

4.1.5 A former field boundary was identified, which correlates with OS mapping and aerial photography, along with a variety of responses associated with a complex of superficial geological deposits. Numerous agricultural ploughing trends and evidence for previous archaeological investigations, in the form of trial pits, geotechnical pits, and evaluations trenches, were also detected.

4.1.6 A particularly notable difference between the gradiometer and GPR surveys of the area is that a significantly larger number of possible pit-like features were identified in the initial gradiometer survey. One possibility is that many of these features could be natural in origin, perhaps associated with natural undulations or tree throws being silted up with more magnetic topsoil than the background chalk bedrock. On the other hand, it is also possible that a lack of physical contrast and limited feature size of many of these features may have prevented successful detection with GPR. Further investigation is required to better understand the nature of these discrete features and may aid the discrimination between archaeological and natural origins.

4.2 Conclusion

4.2.1 In conclusion, the multi-channel GPR survey has been successful in fulfilling the overarching geophysical survey objectives. It has been particularly successful at identifying funerary monuments both within and outside the boundary of the WHS. It also corroborates the gradiometer survey and has enabled more precise and confident archaeological interpretations to be made. While it is impossible to comment precisely on phasing and dating, the surveys have assisted in the recognition of an extensive range of additional archaeological features. This therefore adds substantively to our knowledge of the development of the prehistoric and historic landscape within, and adjacent to, the WHS.

4.3 Recommendations

4.3.1 Following the results of the geophysical survey, any route close to Longbarrow roundabout and Normanton gorse will require further archaeological investigation to determine the significance, extent, and survival of archaeology identified by this phase of geophysical survey. A written scheme of investigation (WSI) should be produced for any proposed evaluation work and submitted for approval to the Wiltshire Council Archaeological Service (WCAS), in their capacity as archaeological advisors to the Local Planning Authority, Wiltshire Council (WC), prior to the commencement of further intrusive investigation.

4.3.2 Additionally, it is recommended that any future trial trenching in this area should investigate the locations identified as superficial geology or potential spreads of material, to ensure that these responses are not masking weaker archaeological responses. Trenches should also be planned to investigate areas where no anomalies of potential archaeological interest have been identified within the site.

5 Figures

Area of GPR survey

Previous area of gradiometer survey

World heritage site

Scheduled monument

Coordinate system:
OSGB36 (OSTN02/OSGM02)

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Location of geophysical survey areas

Figure 1

Coordinate system:
OSGB36 (OSTN15/OSGM15)

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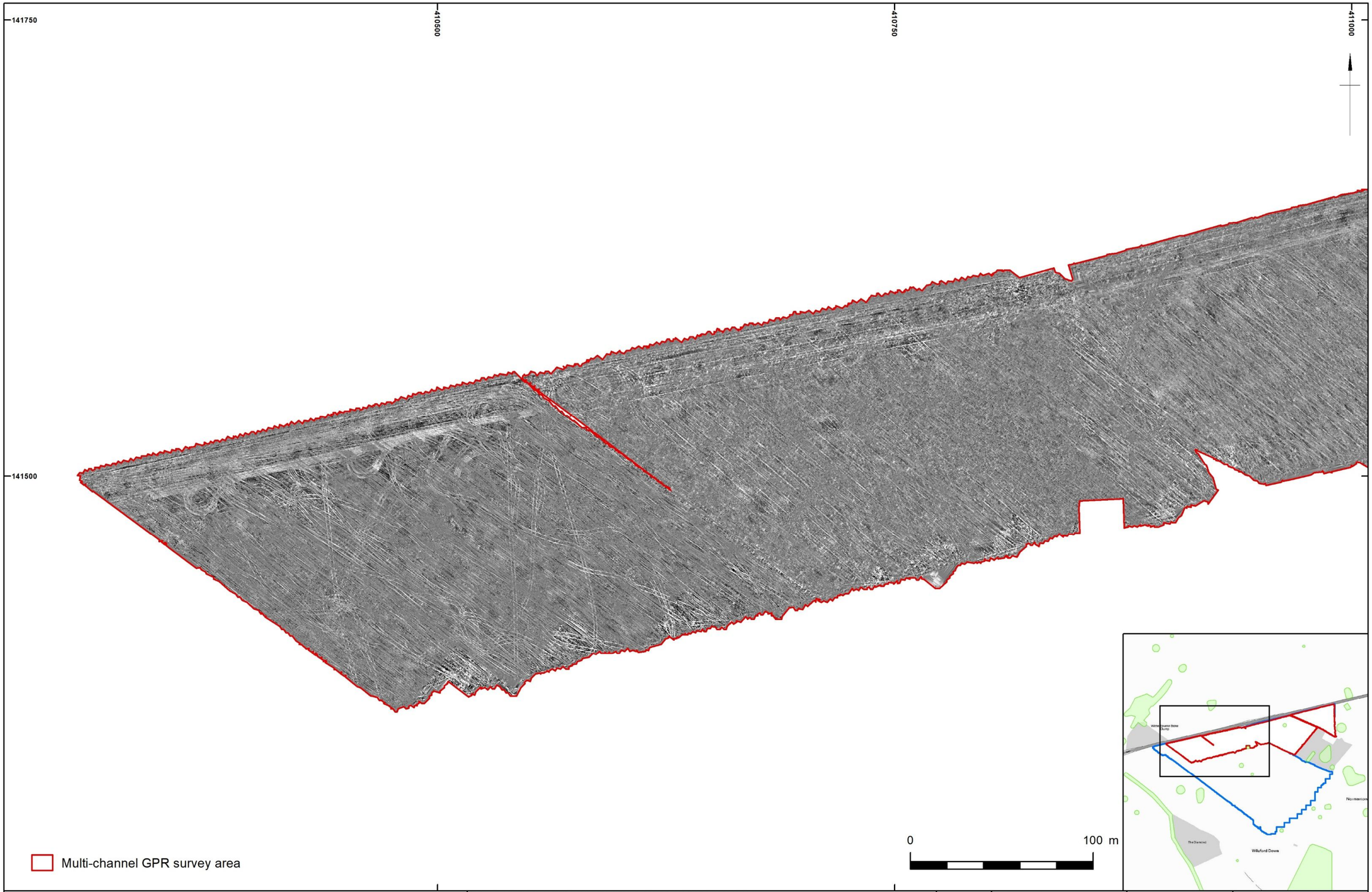
Location of gradiometer and multi-channel GPR survey area

Figure 2



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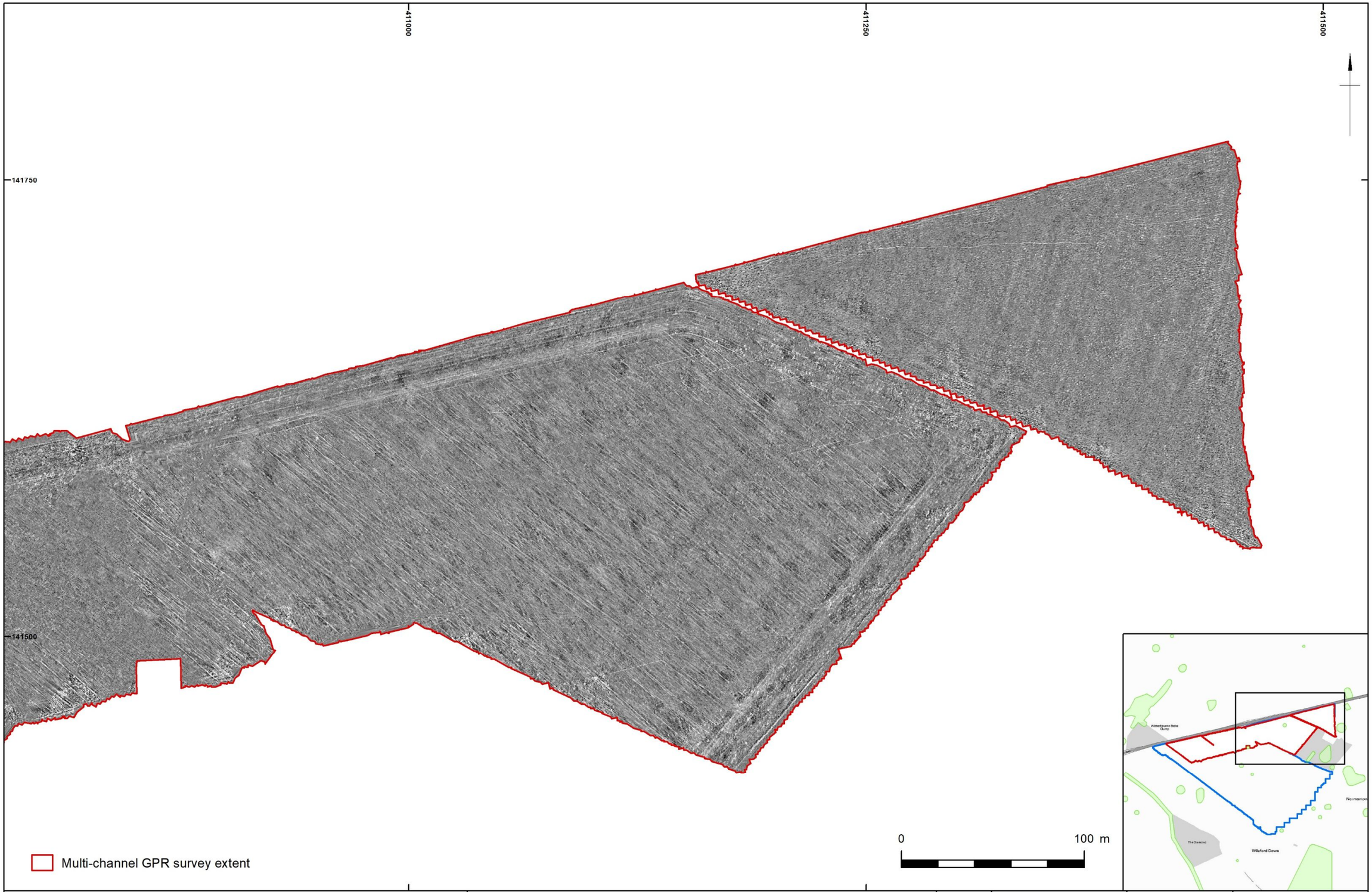
Multi-channel GPR survey results: Area 18 (west) - Greyscale Timeslice 3 (0.25 m - 5.04 ns)

Figure 3



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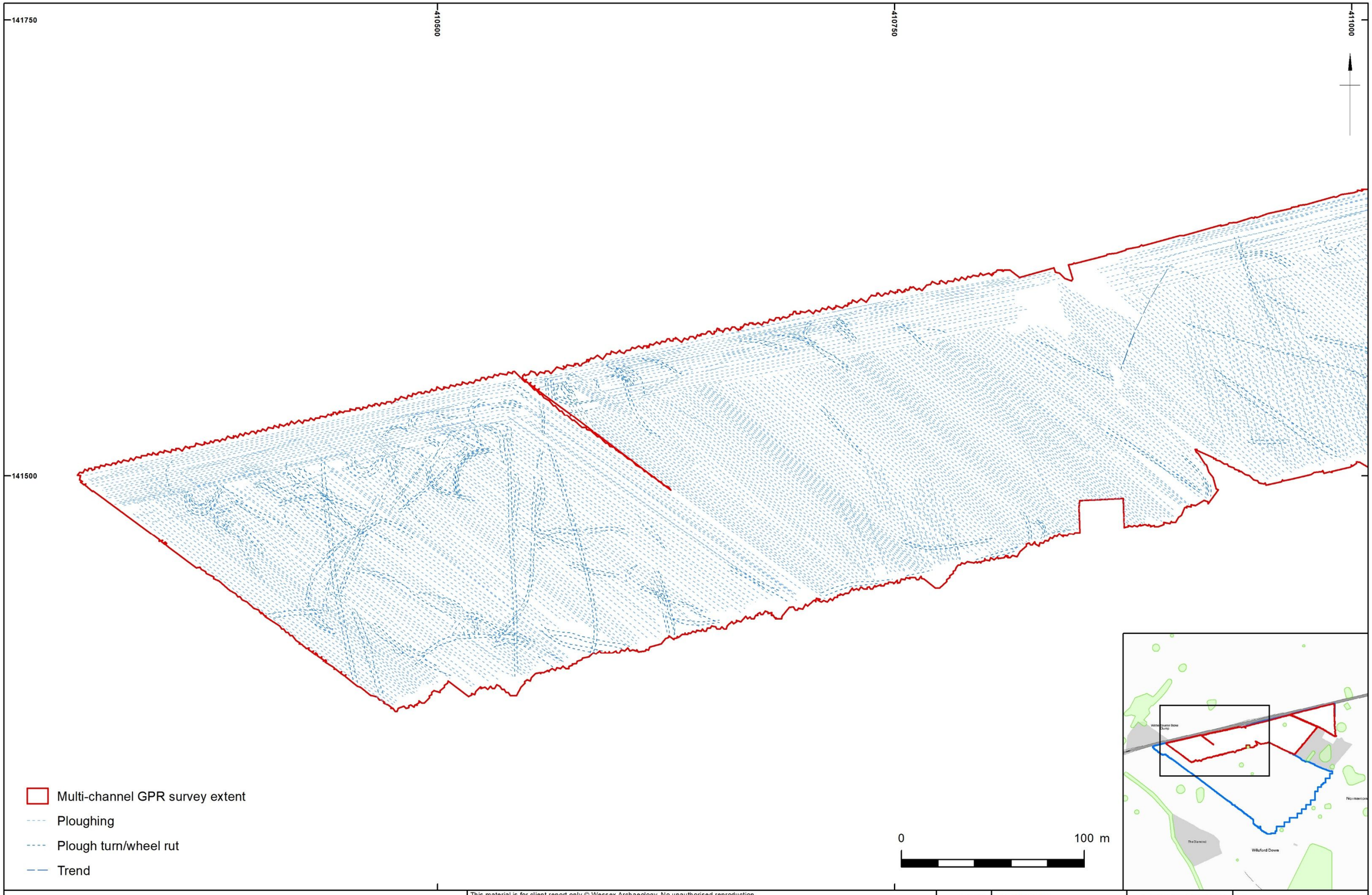
Multi-channel GPR survey results: Area 18 (west) - Greyscale Timeslice 2 (0.25 m - 5.04 ns)

Figure 4



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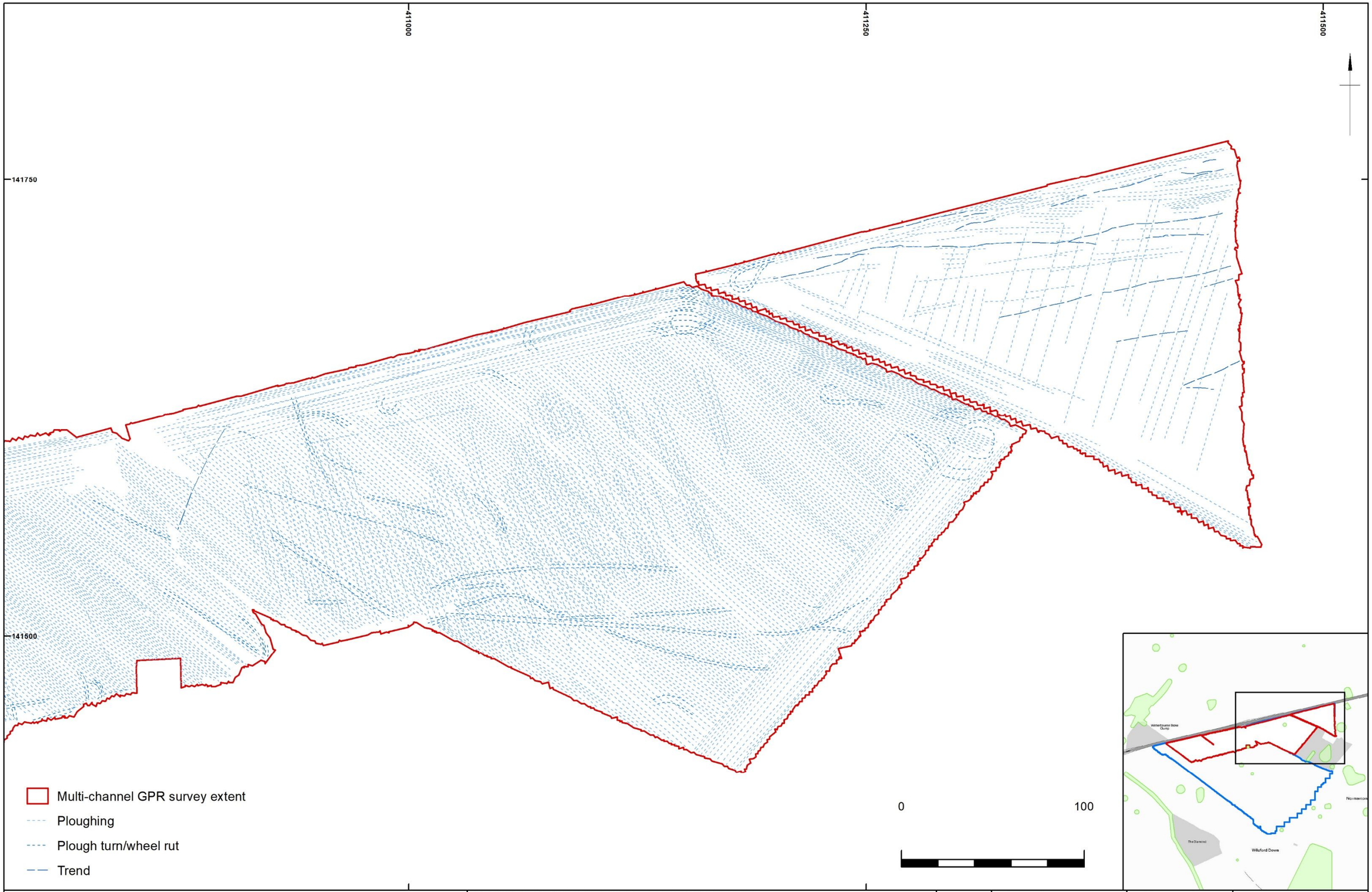
Multi-channel GPR survey results: Area 18 (west) - Interpretation,Timeslice 3 (0.25 m - 5.04 ns)

Figure 5



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Multi-channel GPR survey results: Area 18 (east) - Interpretation,Timeslice 3 (0.25 m - 5.04 ns)

Figure 6

Coordinate system:
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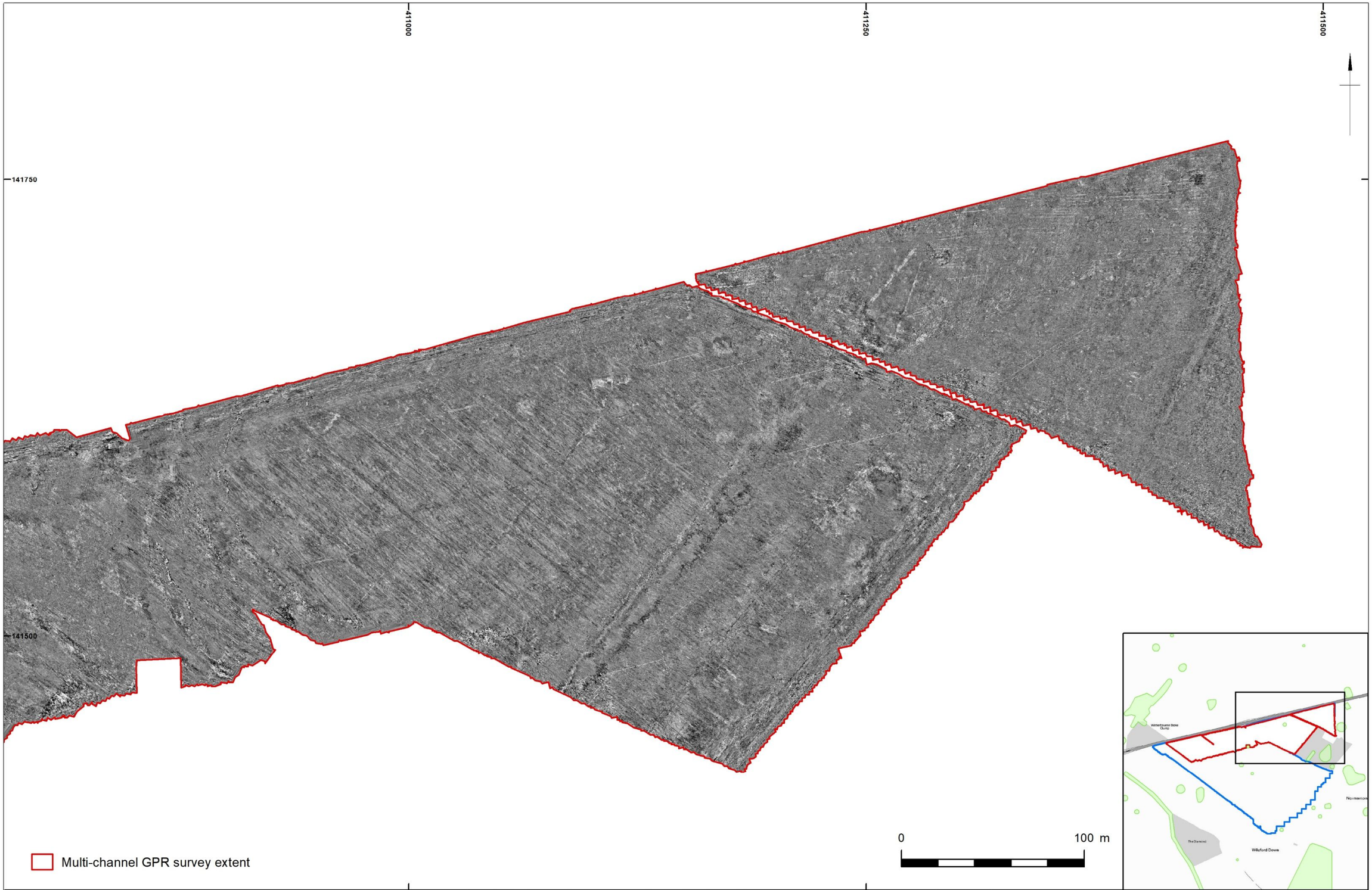
Multi-channel GPR survey results: Area 18 (west) - Greyscale Timeslice 5 (0.50 m – 10.08 ns)

Figure 7



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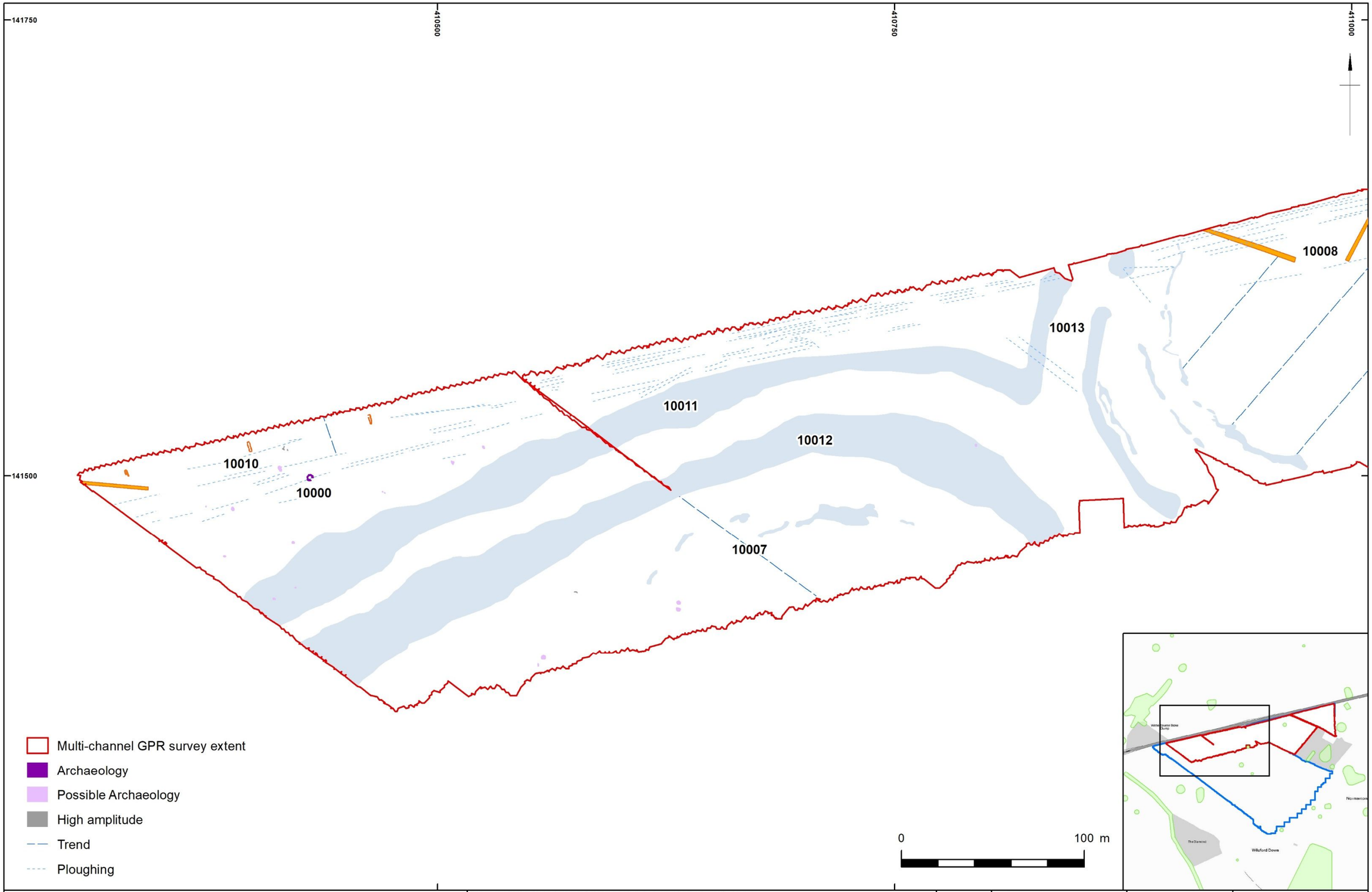
Multi-channel GPR survey results: Area 18 (east) - Greyscale Timeslice 5 (0.50 m – 10.08 ns)

Figure 8



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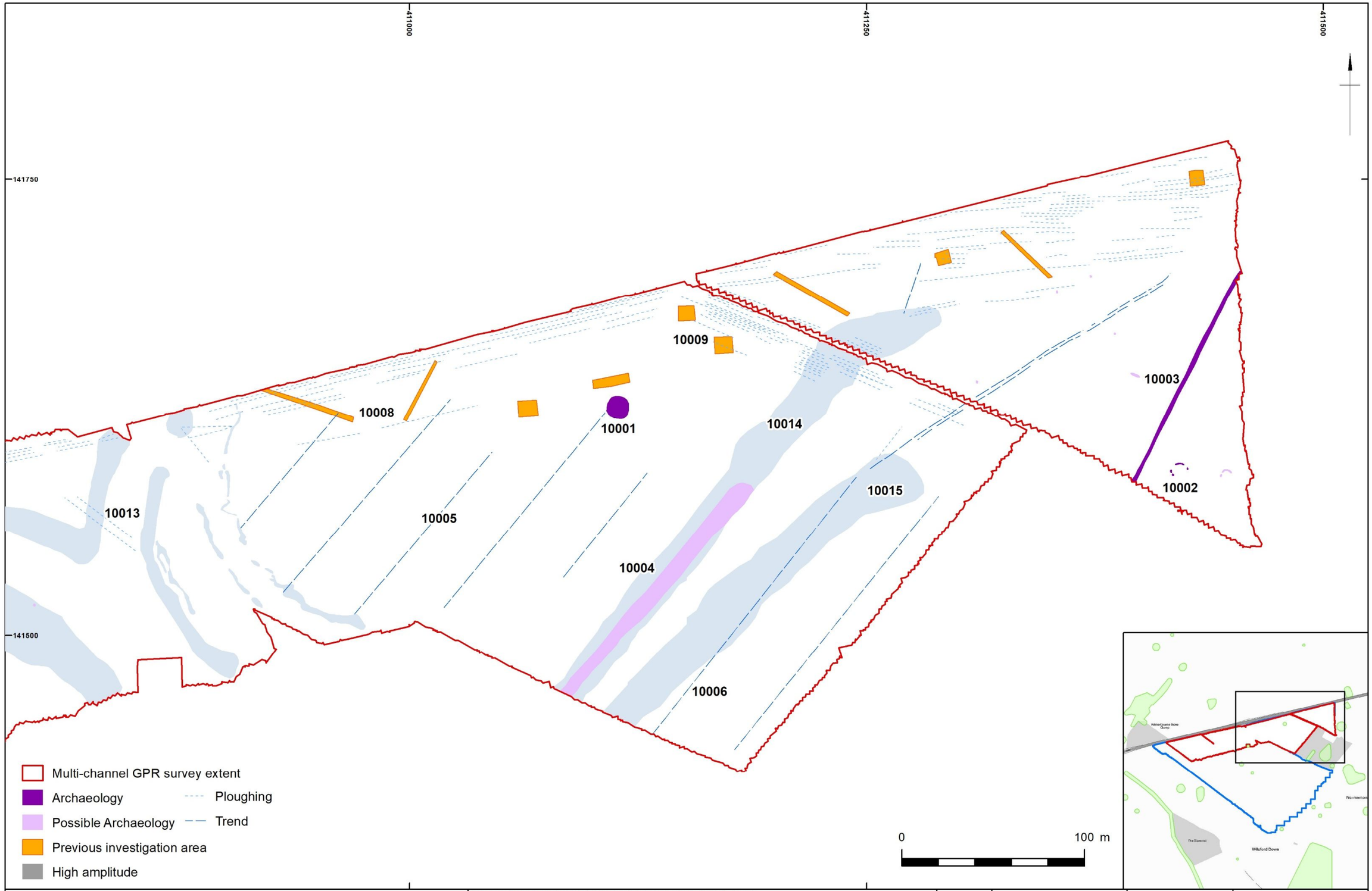
Multi-channel GPR survey results: Area 18 (west) - Interpretation,Timeslice 5 (0.50 m - 10.08 ns)

Figure 9



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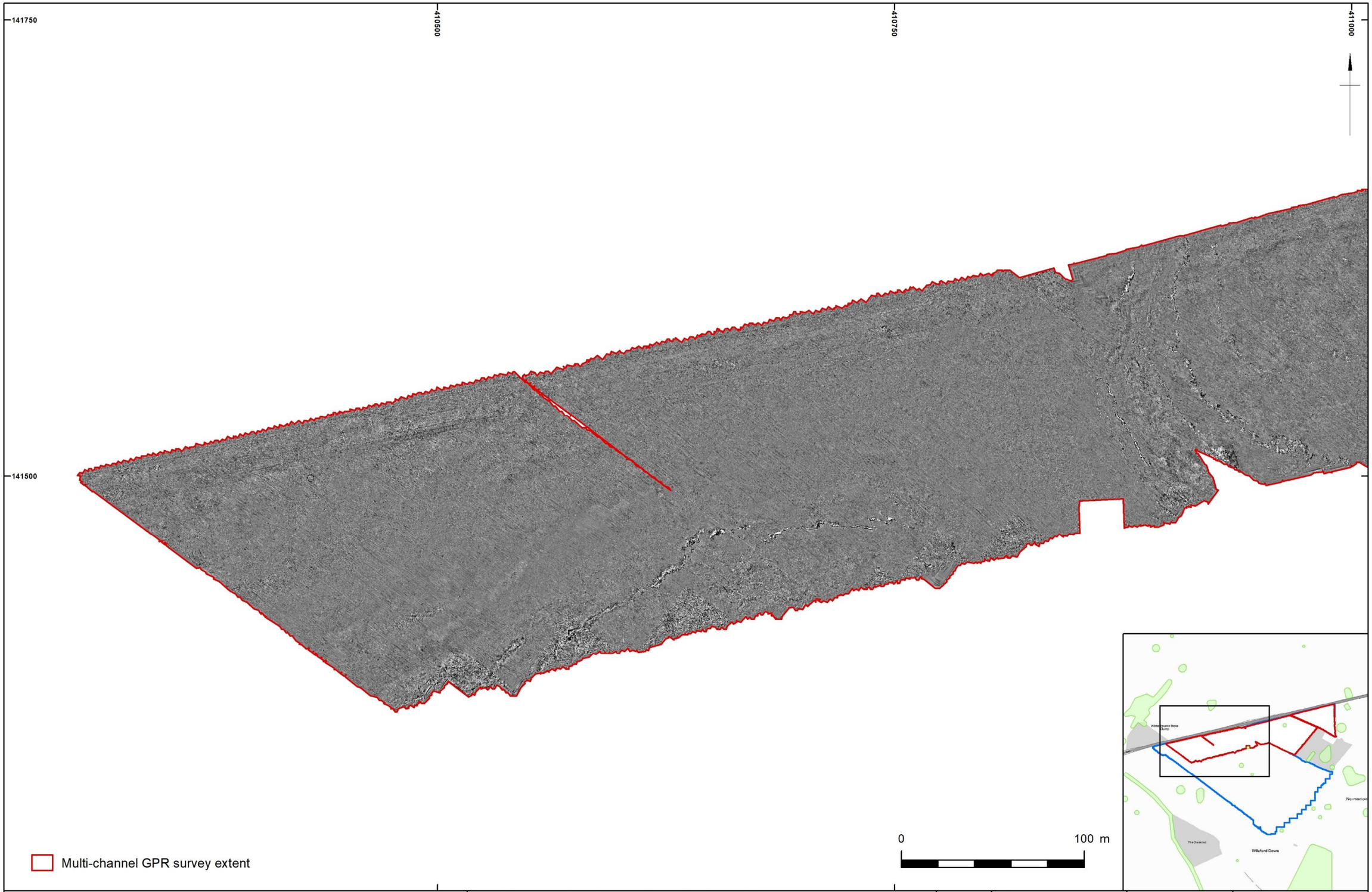
Multi-channel GPR survey results: Area 18 (east) - Interpretation Timeslice 5 (0.50 m – 10.08 ns)

Figure 10



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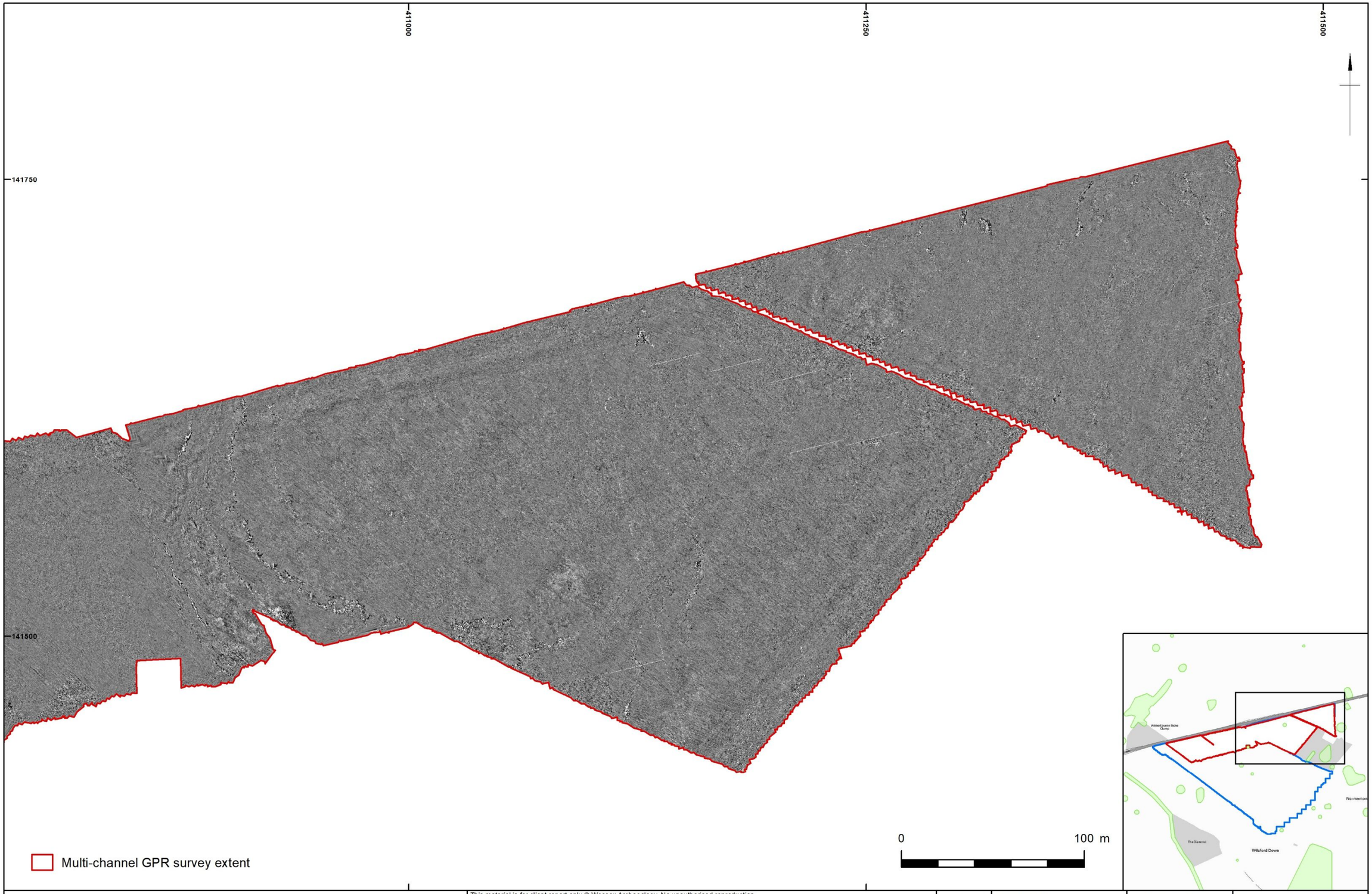
Multi-channel GPR survey results: Area 18 (west) - Greyscale Timeslice 8 (0.88 m – 17.64 ns)

Figure 11



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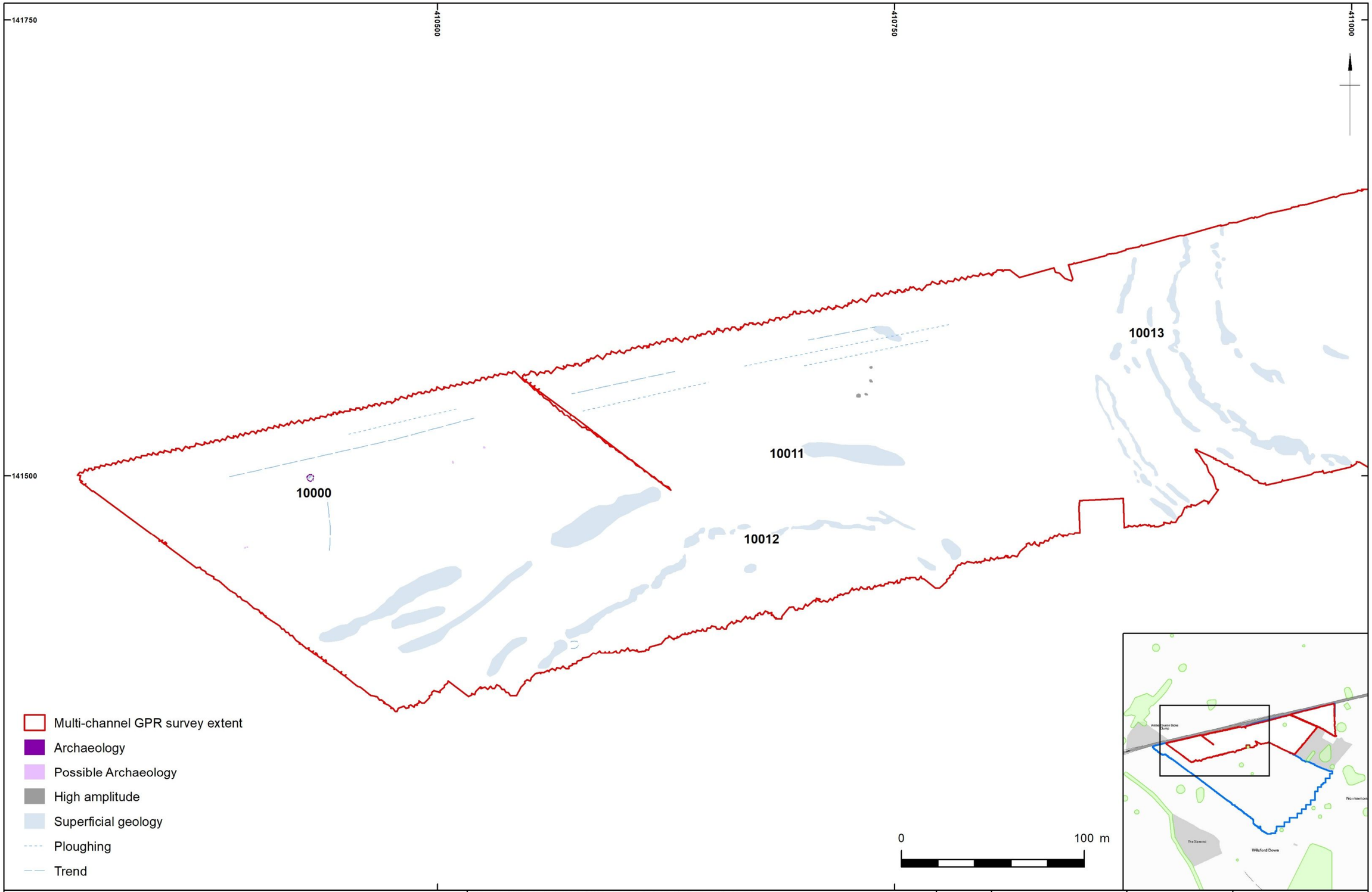
Multi-channel GPR survey results: Area 18 (east) - Greyscale Timeslice 8 (0.88 m – 17.64 ns)

Figure 12



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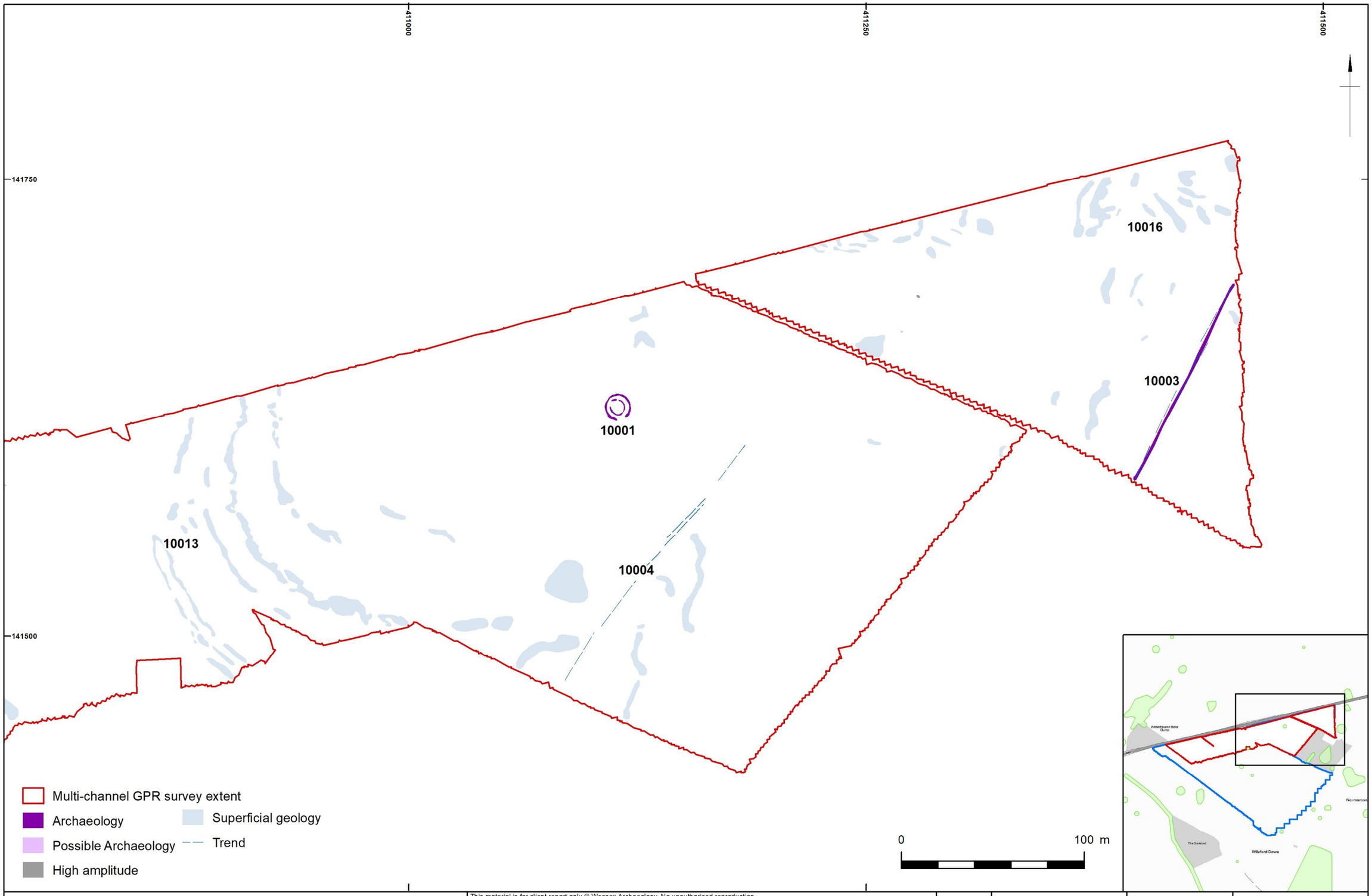
Multi-channel GPR survey results: Area 18 (west) - Interpretation, Timeslice 8 (0.88 m – 17.64 ns)

Figure 13



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Multi-channel GPR survey results: Area 18 (east) - Interpretation, Timeslice 8 (0.88 m – 17.64 ns)

Figure 14

Coordinate system:
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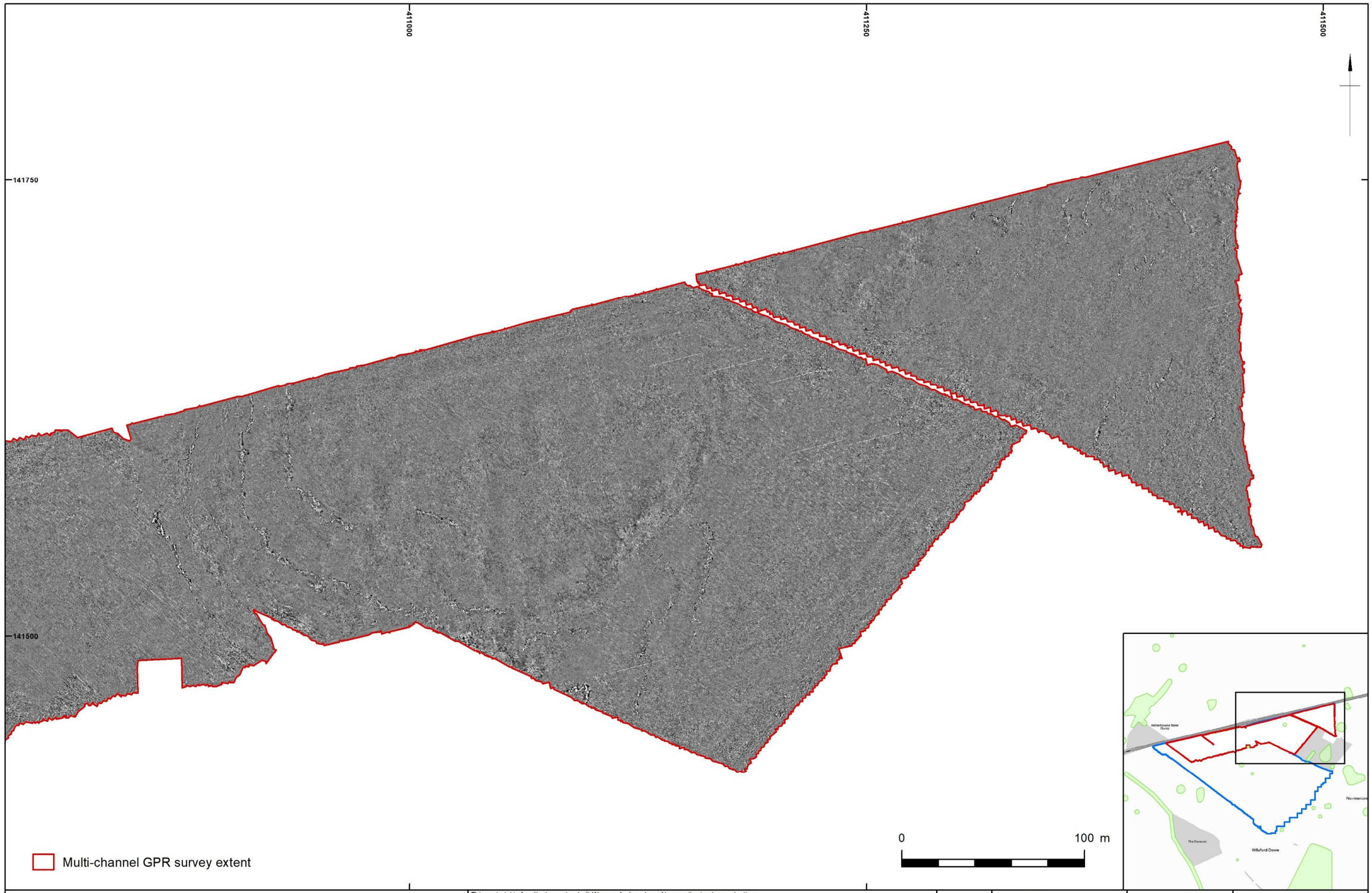
Multi-channel GPR survey results: Area 18 (west) - Greyscale Timeslice 11 (1.26 m – 25.20 ns)

Figure 15



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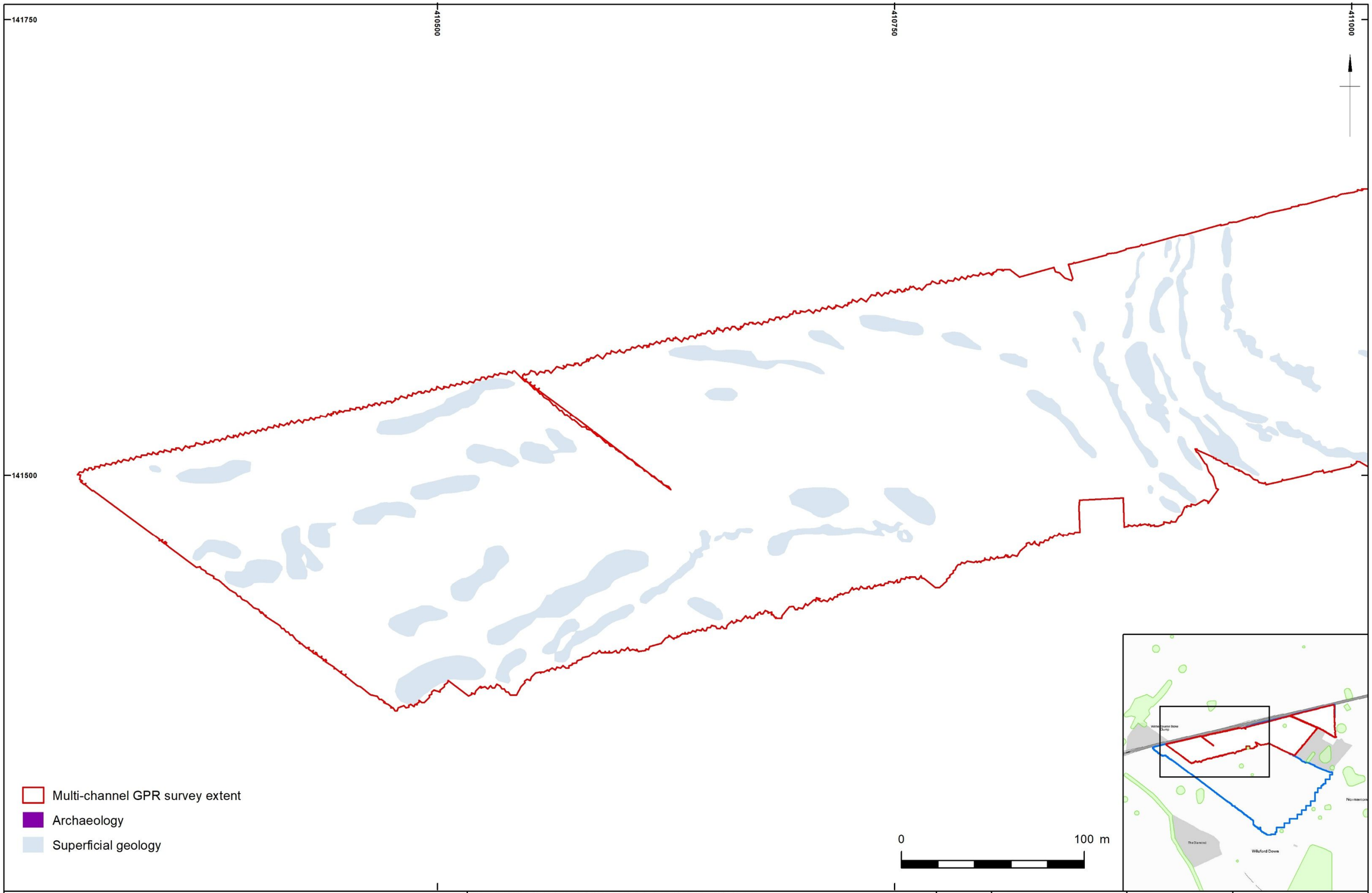
Multi-channel GPR survey results: Area 18 (east) - Greyscale Timeslice 11 (1.26 m – 25.20 ns)

Figure 16



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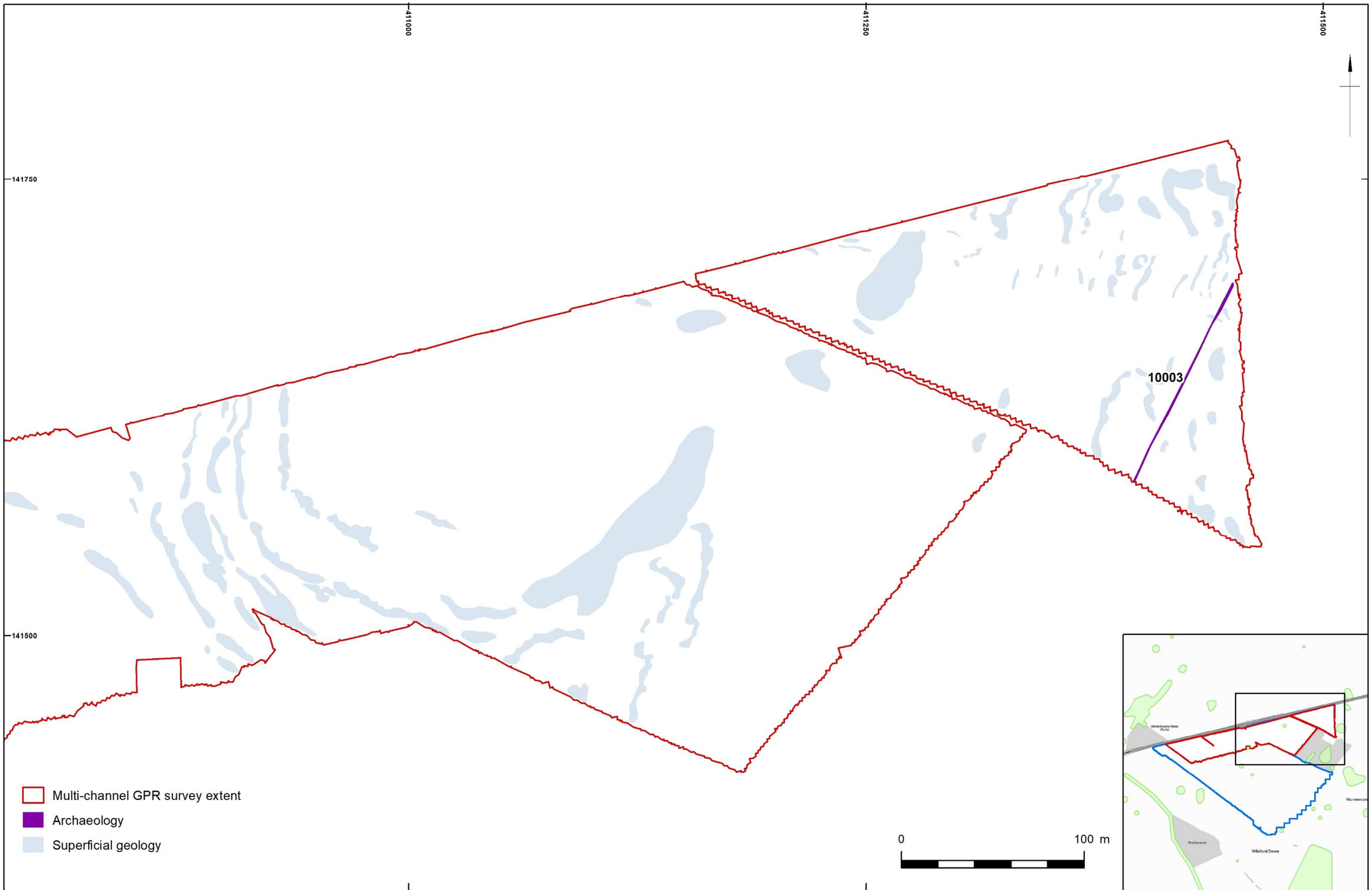
Multi-channel GPR survey results: Area 18 (west) - Interpretation, Timeslice 11 (1.39 m – 27.72 ns)

Figure 17



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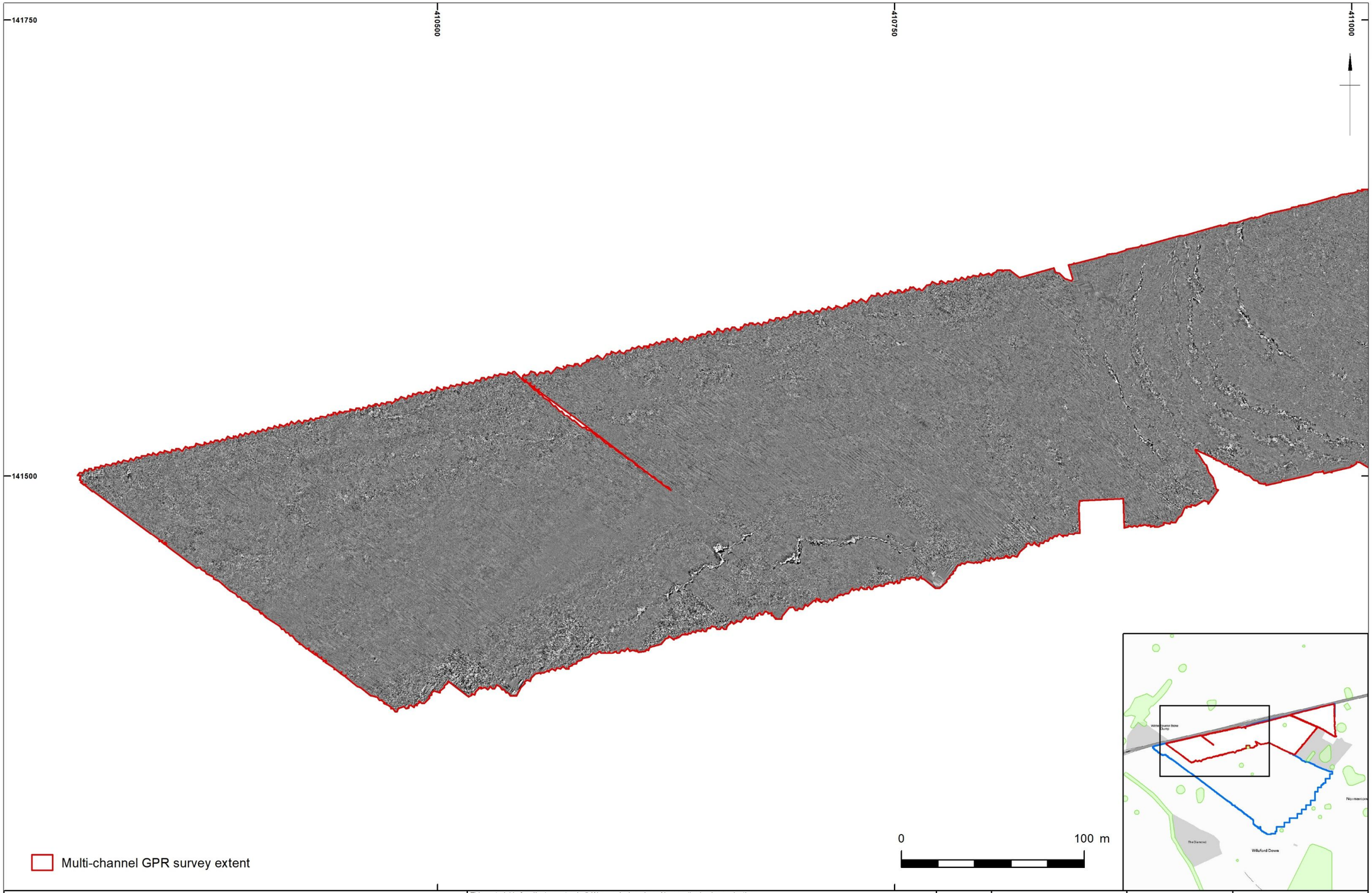
Multi-channel GPR survey results: Area 18 (east) - Interpretation, Timeslice 11 (1.39 m – 27.72 ns)

Figure 18



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Low Amplitude — High Amplitude

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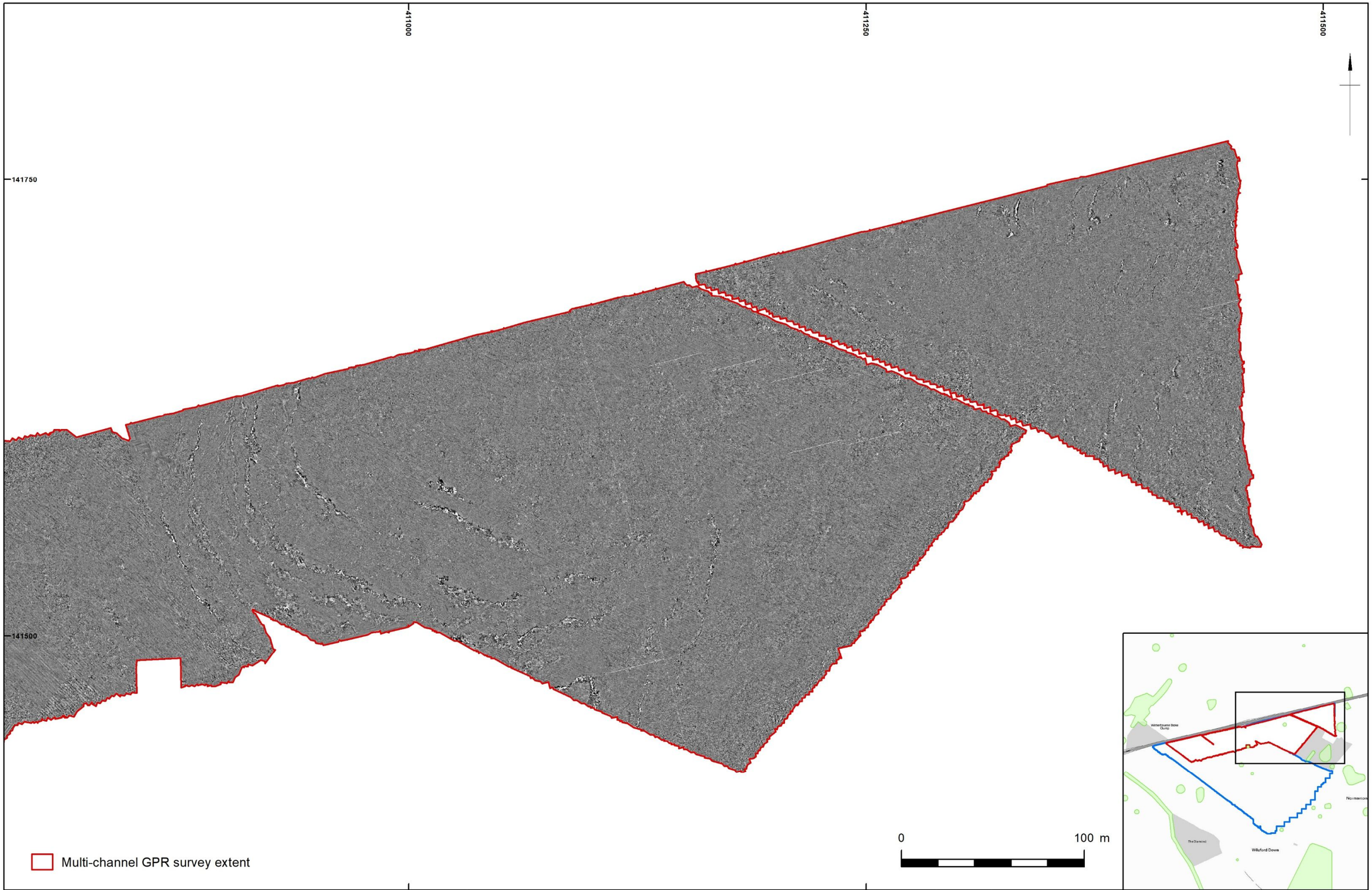
Multi-channel GPR survey results: Area 18 (west) - Greyscale Timeslice 15 (1.76 m – 35.28 ns)

Figure 19



Coordinate system:
OSGB36 (OSTN15/OSGM15)

Low Amplitude — High Amplitude

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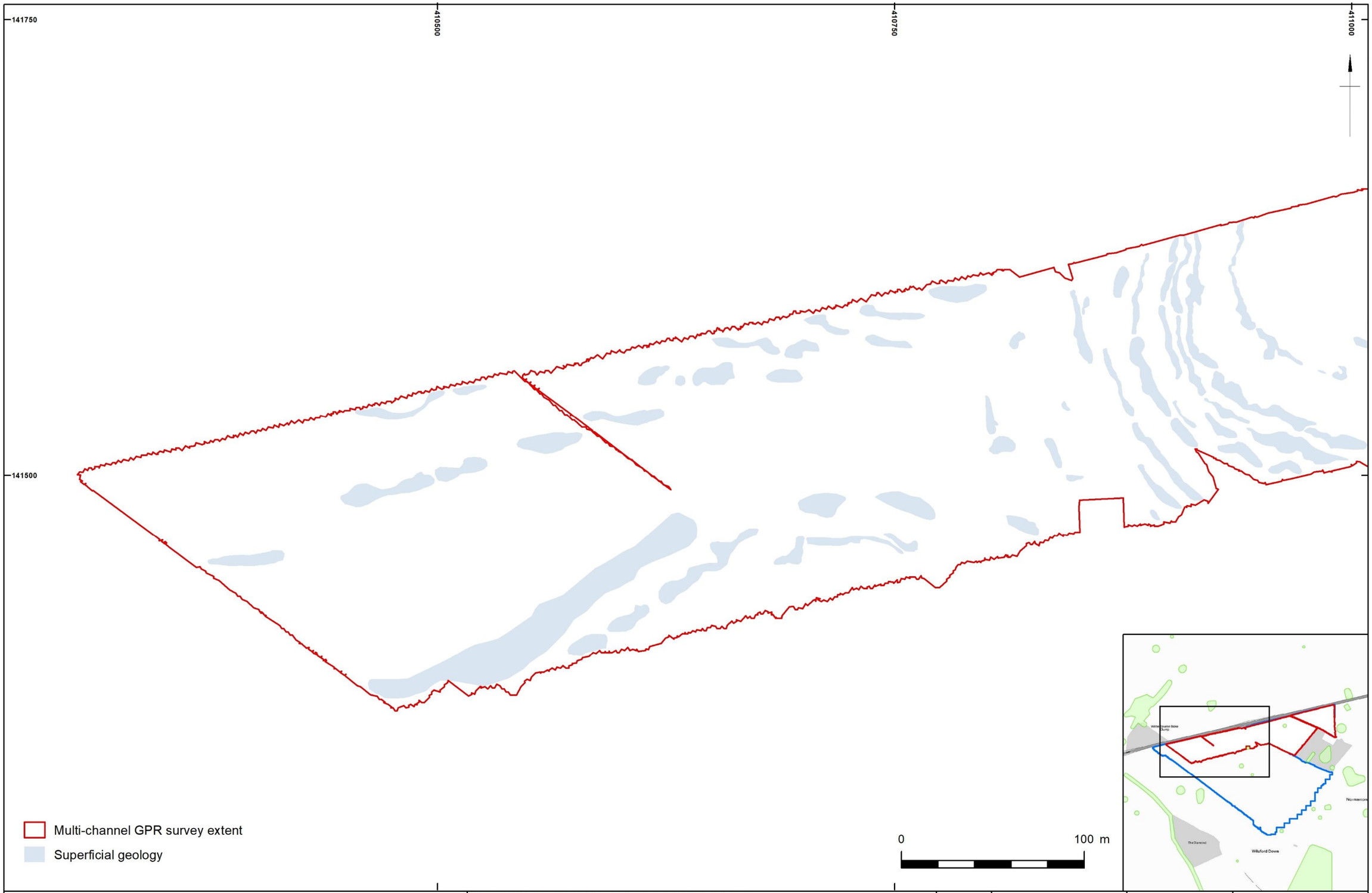
Multi-channel GPR survey results: Area 18 (east) - Greyscale Timeslice 15 (1.76 m – 35.28 ns)

Figure 20



Coordinate system:
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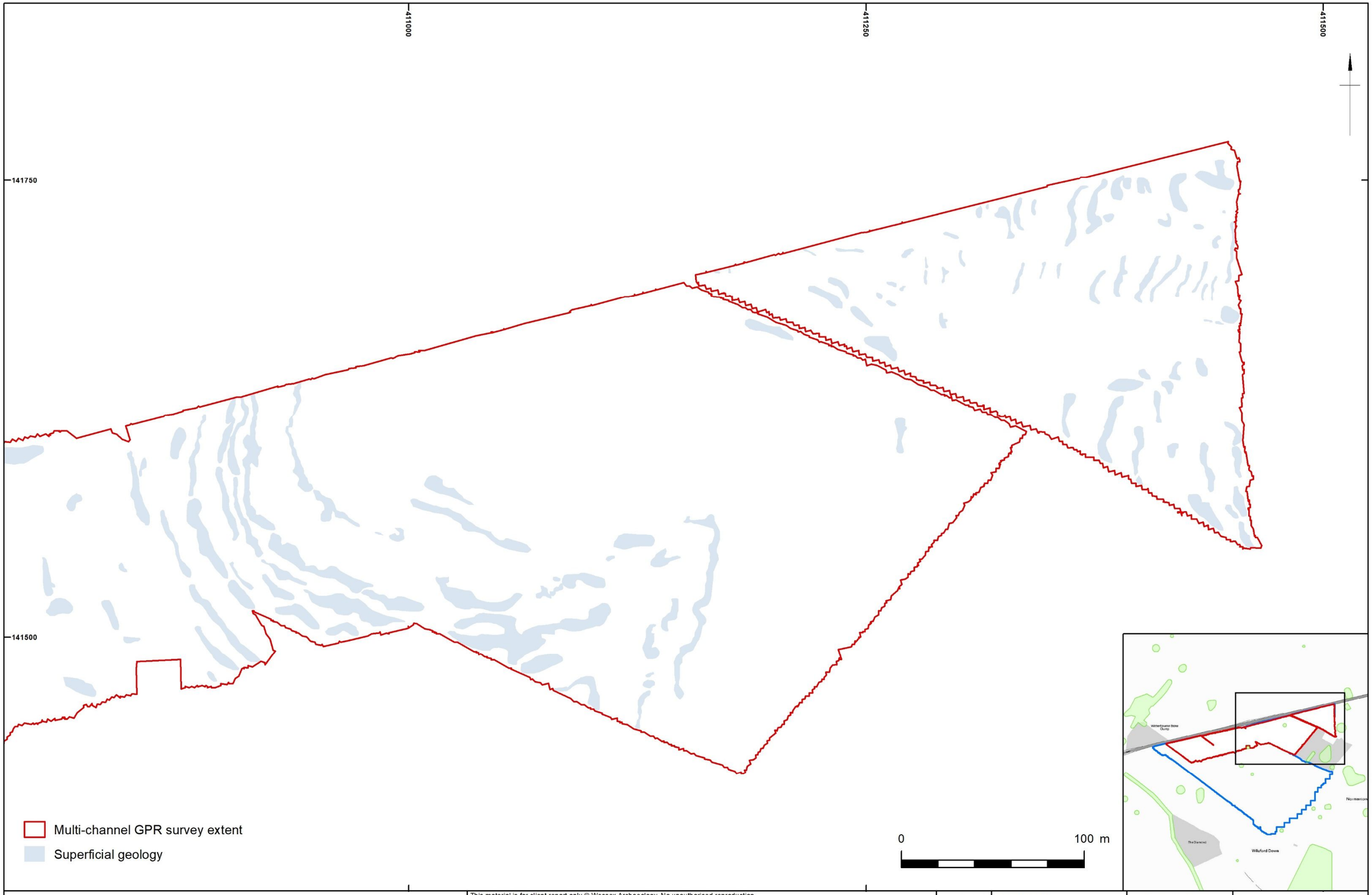
Multi-channel GPR survey results: Area 18 (west) - Interpretation, Timeslice 15 (1.76 m – 35.28 ns)

Figure 21



Coordinate system:
OSGB36 (OSTN15/OSGM15)

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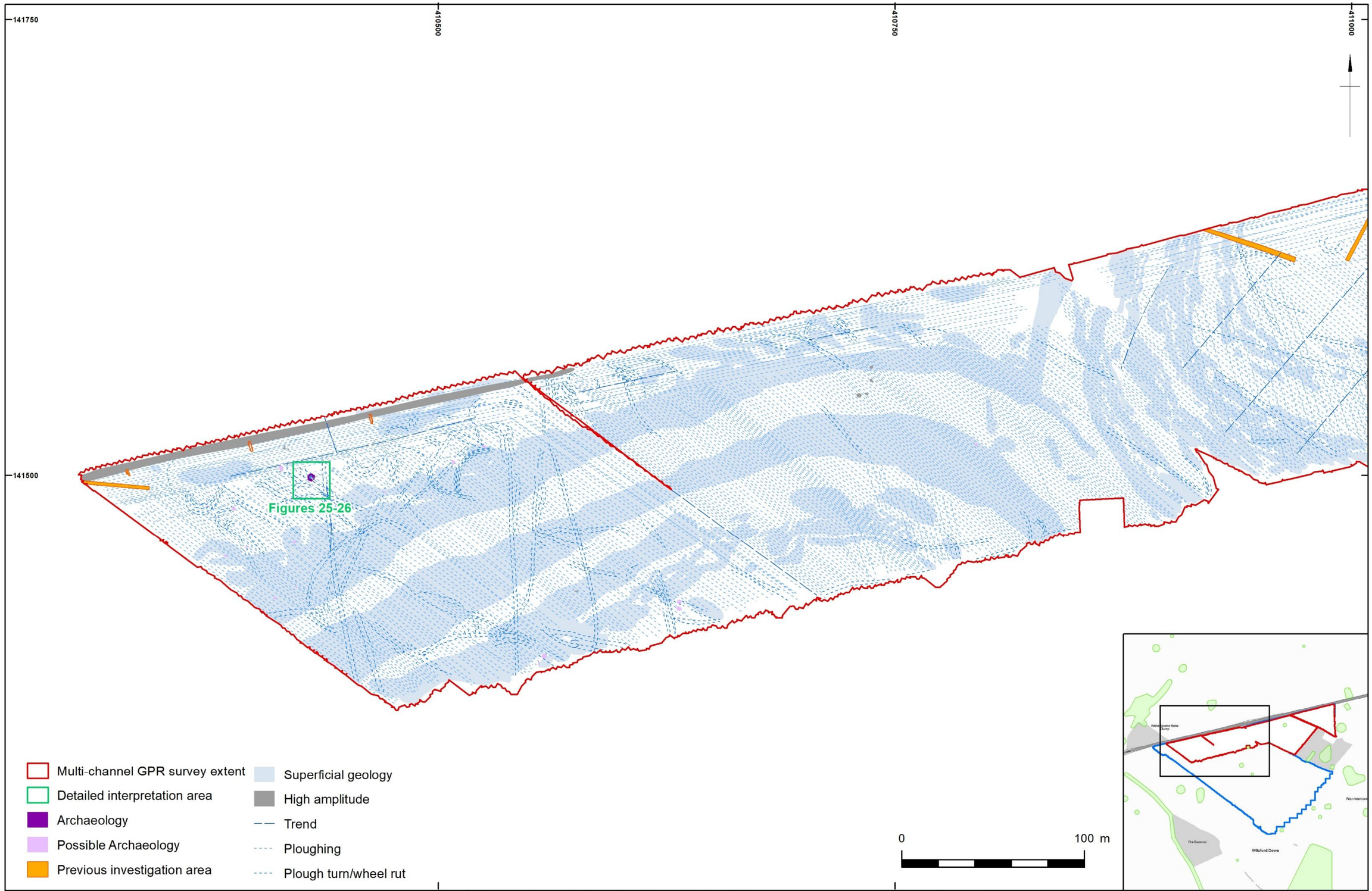
Scale:	1:2000 at A3	Illustrator:	NLC
Path:	\\projectserver\wessex\PROJECTS\113225\GIS\FigsMXD\2017_11_03		

Multi-channel GPR survey results: Area 18 (east) - Interpretation, Timeslice 15 (1.76 m – 35.28 ns)

Figure 22



Coordinate system:
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Scale:	1:2000 at A3	Illustrator:	NLC
Path:	\\projectserver\wessex\PROJECTS\113225\GIS\FigsMXD\2017_11_03		

Multi-channel GPR survey results: Area 18 (west) - Graphical summary of all timeslices

Figure 23

411000
411250
411500
141750
141500

Figures 27 - 28

Figures 29 - 30

Multi-channel GPR survey extent
Detailed interpretation area
Archaeology
Possible Archaeology
Previous investigation area
Superficial geology
High amplitude
Trend
Ploughing
Plough turn/wheel rut

0 100 m

Coordinate system:
OSGB36 (OSTN15/OSGM15)

Date:	03/11/2017	Revision Number:	0
Scale:	1:2000 at A3	Illustrator:	NLC
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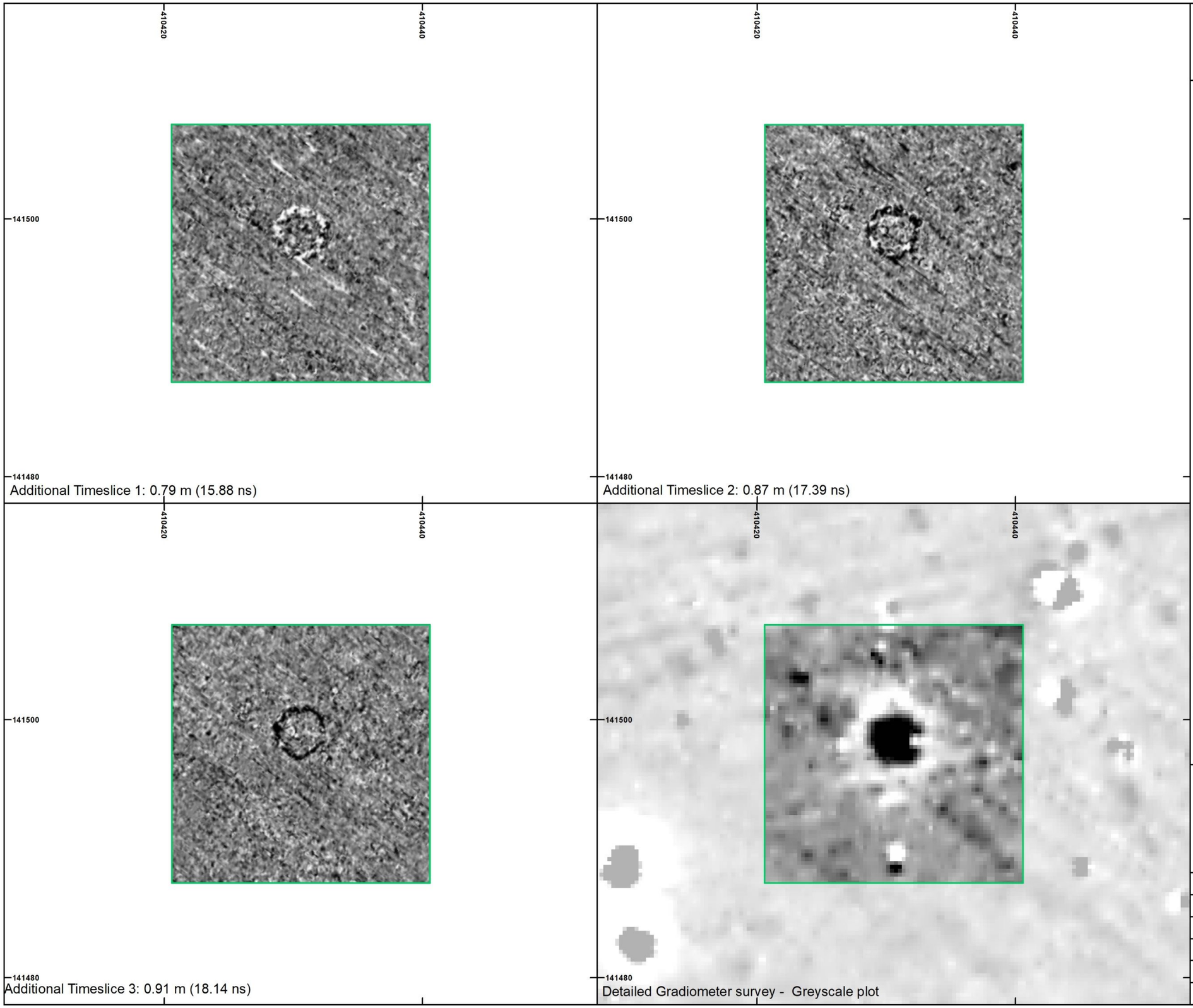
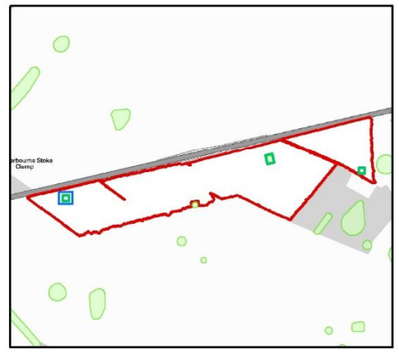
Multi-channel GPR survey results: Area 18 (east) - Graphical summary of all timeslices

Figure 24





Detailed interpretation area

Low Amplitude — High Amplitude

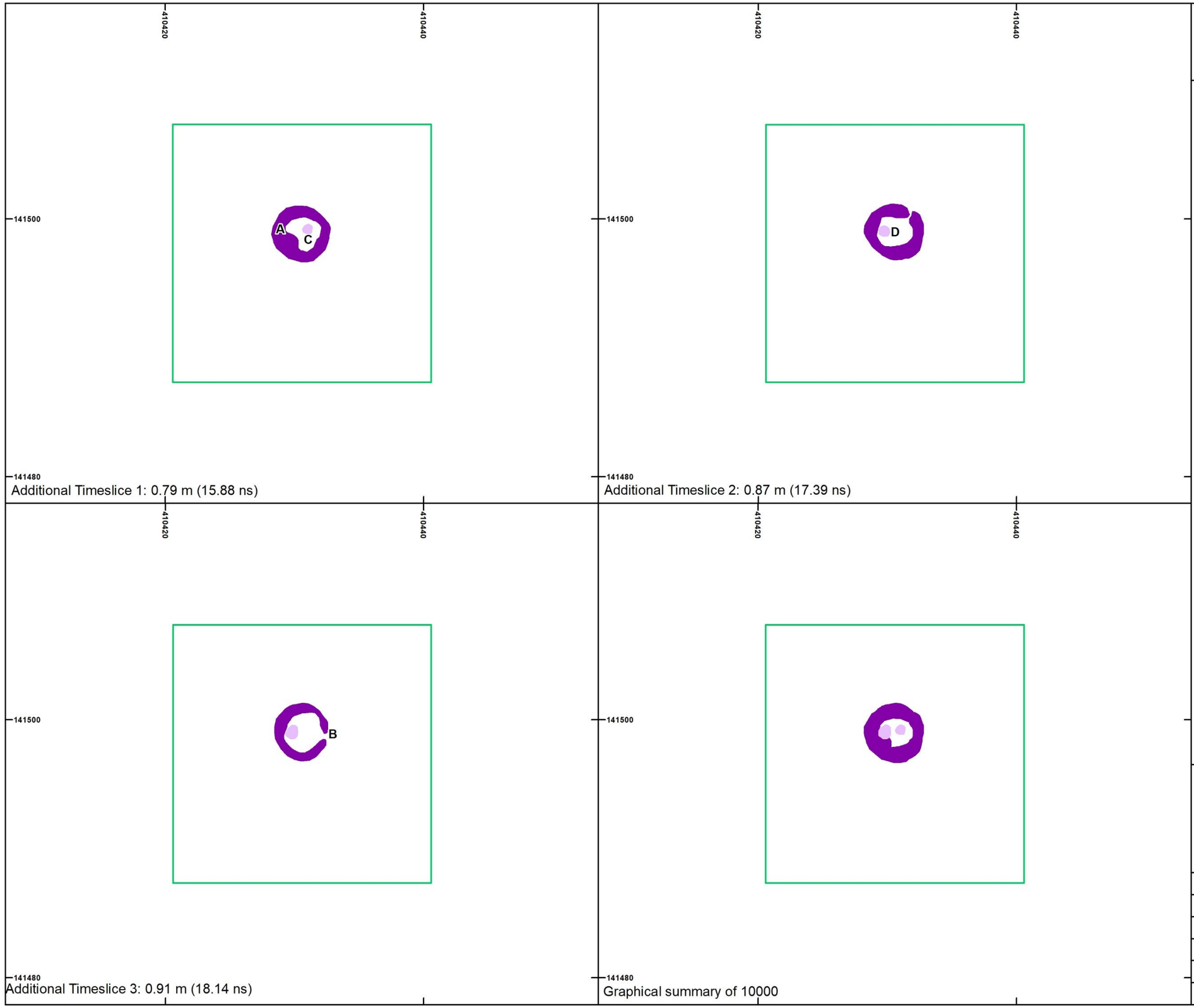
0 — 10 m

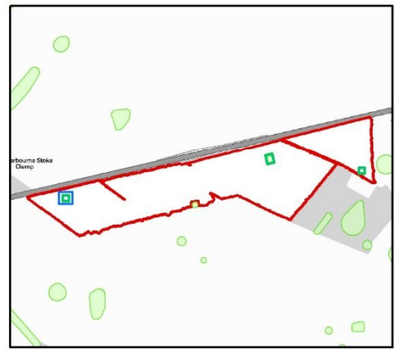
Coordinate system:
OSGB36 (OSTN15/OSGM15)

Date:	06/11/2017
Revision Number:	0
Scale:	1:300 at A3
Illustrator:	NLC
Path:	X:\PROJECTS\113225\GIS\
	FigsMXD\2017_11_06

Multi-channel GPR survey results: Greyscale timeslices (Detailed view of 10000)

Figure 25





Detailed interpretation area
Archaeology
Possible archaeology

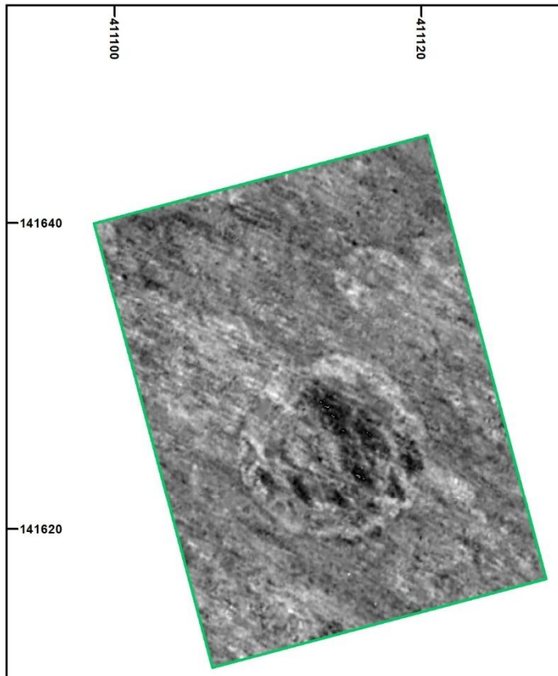
0 10 m

Coordinate system:
OSGB36 (OSTN15/OSGM15)

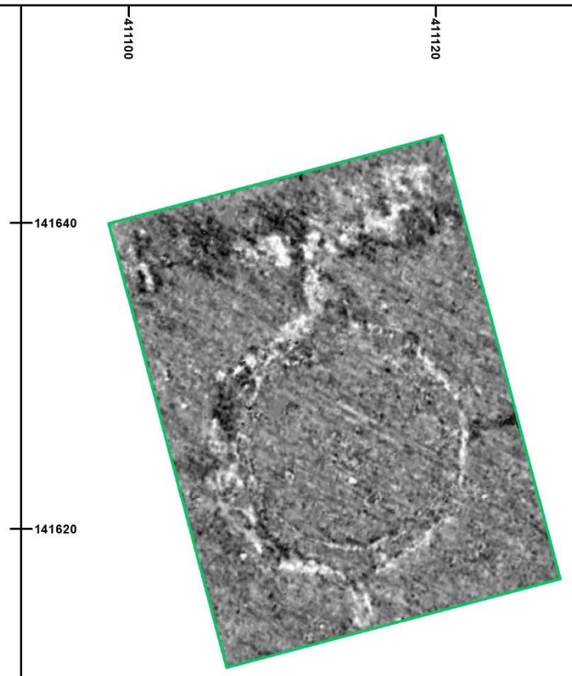
Date:	06/11/2017
Revision Number:	0
Scale:	1:300 at A3
Illustrator:	NLC
Path:	X:\PROJECTS\113225\GIS\
	FigsMXD\2017_11_06

Multi-channel GPR survey results: Detailed interpretation of 10000

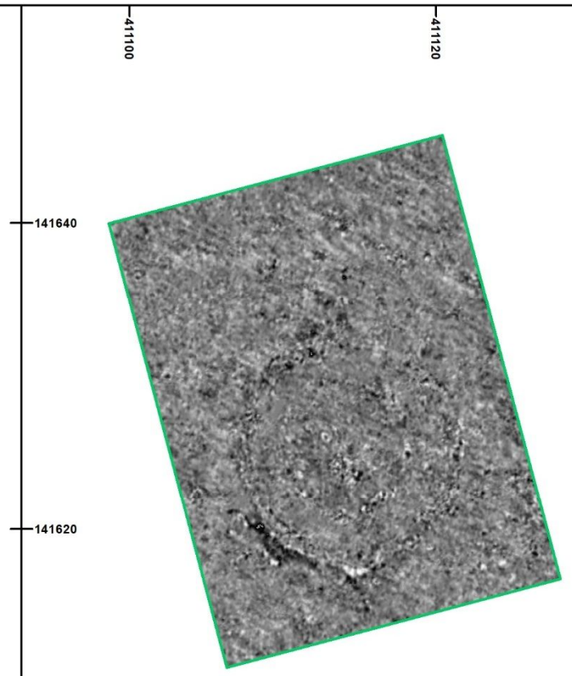
Figure 26



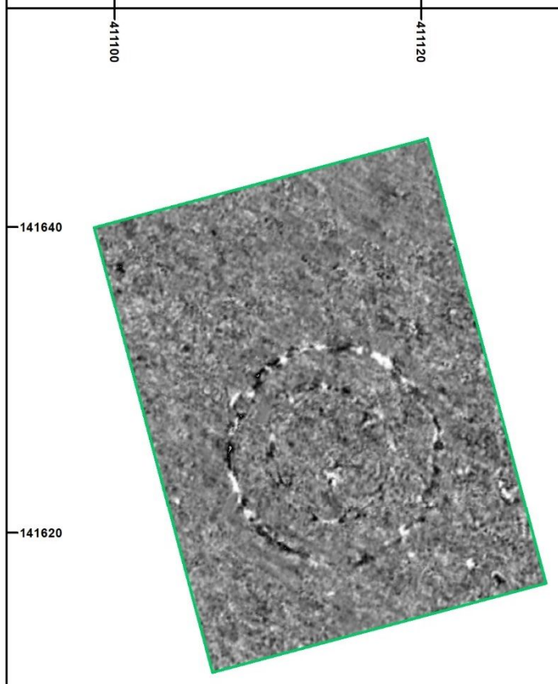
Additional Timeslice 4: 0.40 m (8.06 ns)



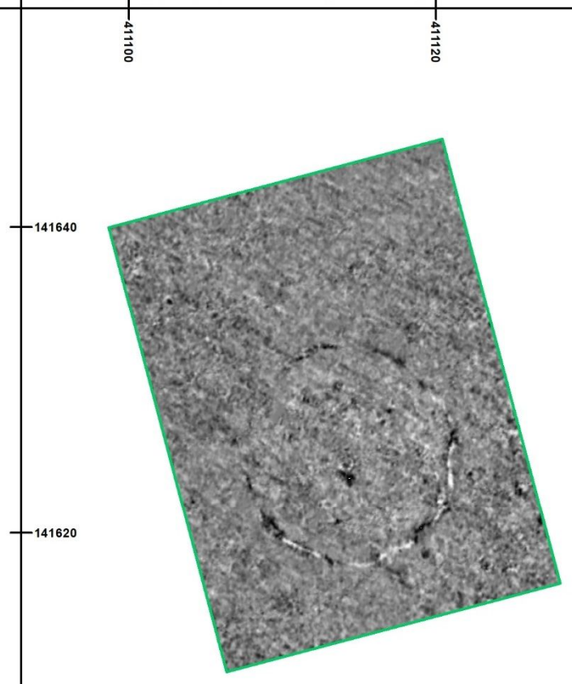
Additional Timeslice 5: 0.59 m (11.84 ns)



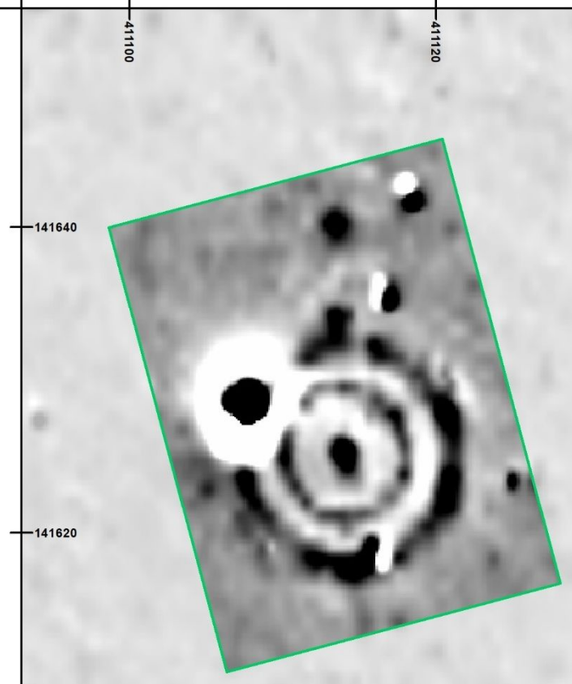
Additional Timeslice 6: 0.74 m (14.87 ns)



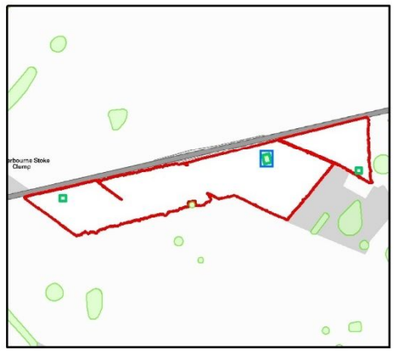
Additional Timeslice 7: 0.97 m (19.40 ns)



Additional Timeslice 8: 1.08 m (21.67 ns)



Detailed Gradiometer survey - Greyscale plot



Detailed interpretation area

Low Amplitude — High Amplitude

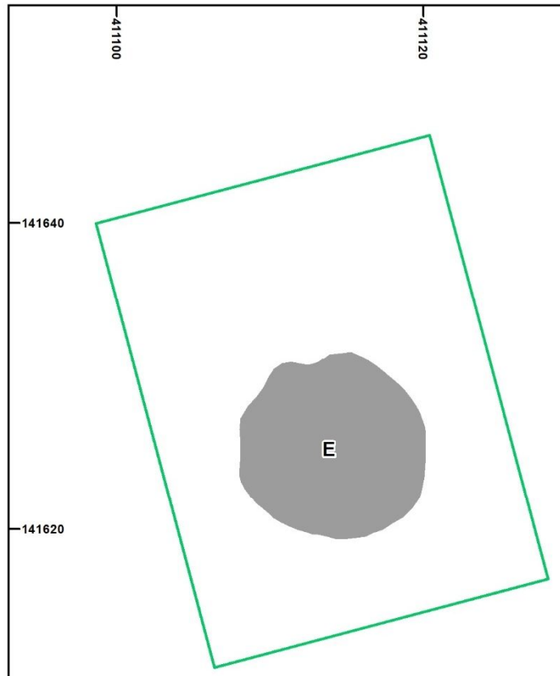
0 — 10 m

Coordinate system:
OSGB36 (OSTN15/OSGM15)

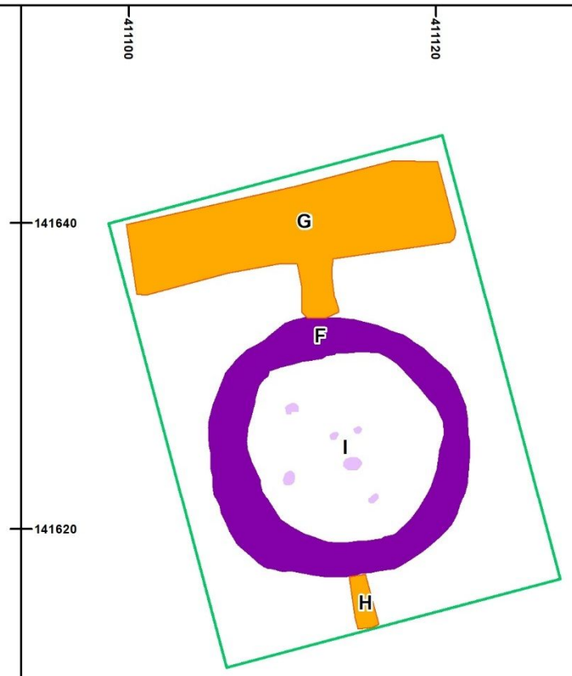
Date:	06/11/2017
Revision Number:	0
Scale:	1:400 at A3
Illustrator:	NLC
Path:	X:\PROJECTS\113225\GIS\
	FigsMXD\2017_11_06

Multi-channel GPR survey results: Greyscale timeslices (Detailed view of 10001)

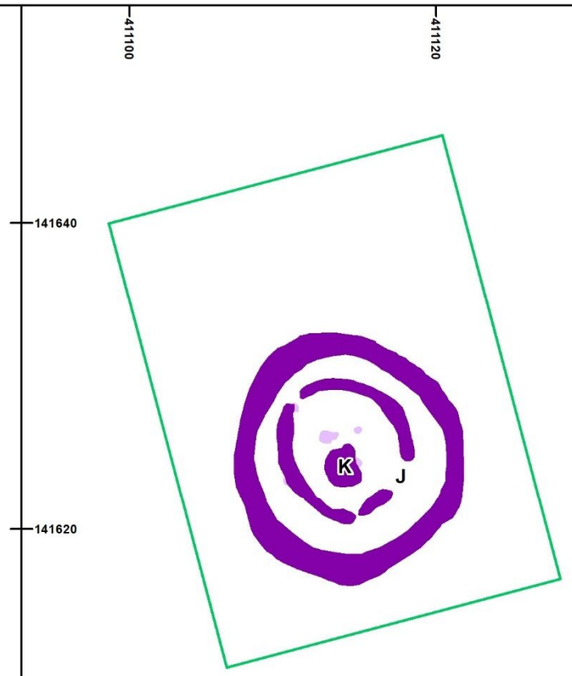
Figure 27



Additional Timeslice 4: 0.40 m (8.06 ns)



Additional Timeslice 5: 0.59 m (11.84 ns)



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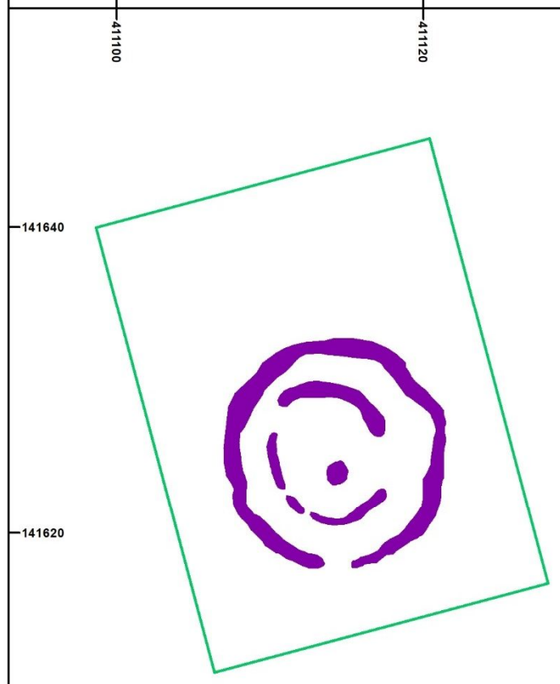
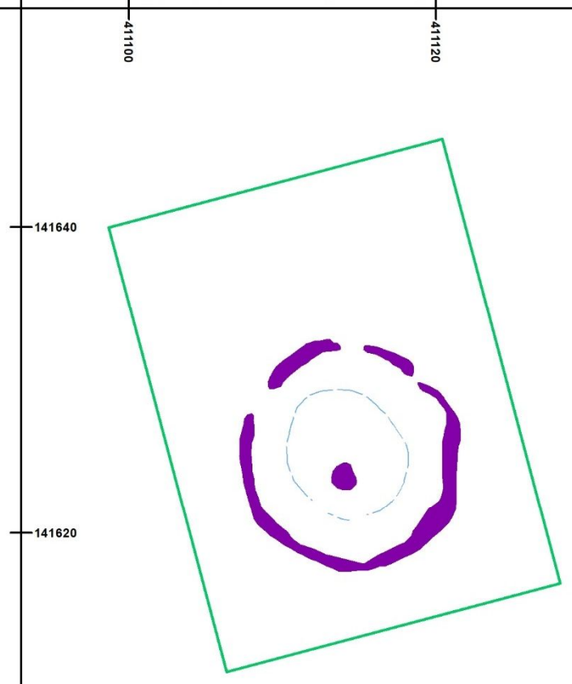
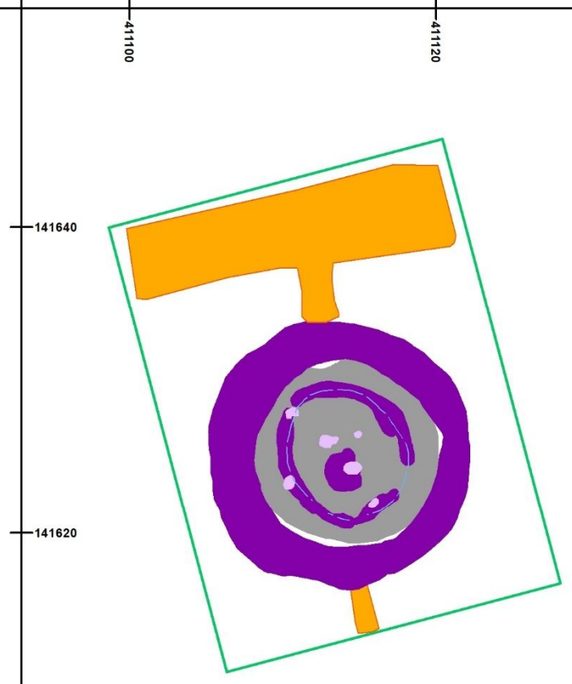


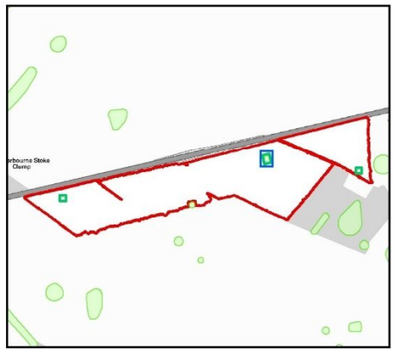
Additional Timeslice 7: 0.97 m (19.40 ns)



Additional Timeslice 8: 1.08 m (21.67 ns)



Graphical summary of 10001



Detailed interpretation area
Possible archaeology
Archaeology
Previous investigation area
High amplitude
Trend

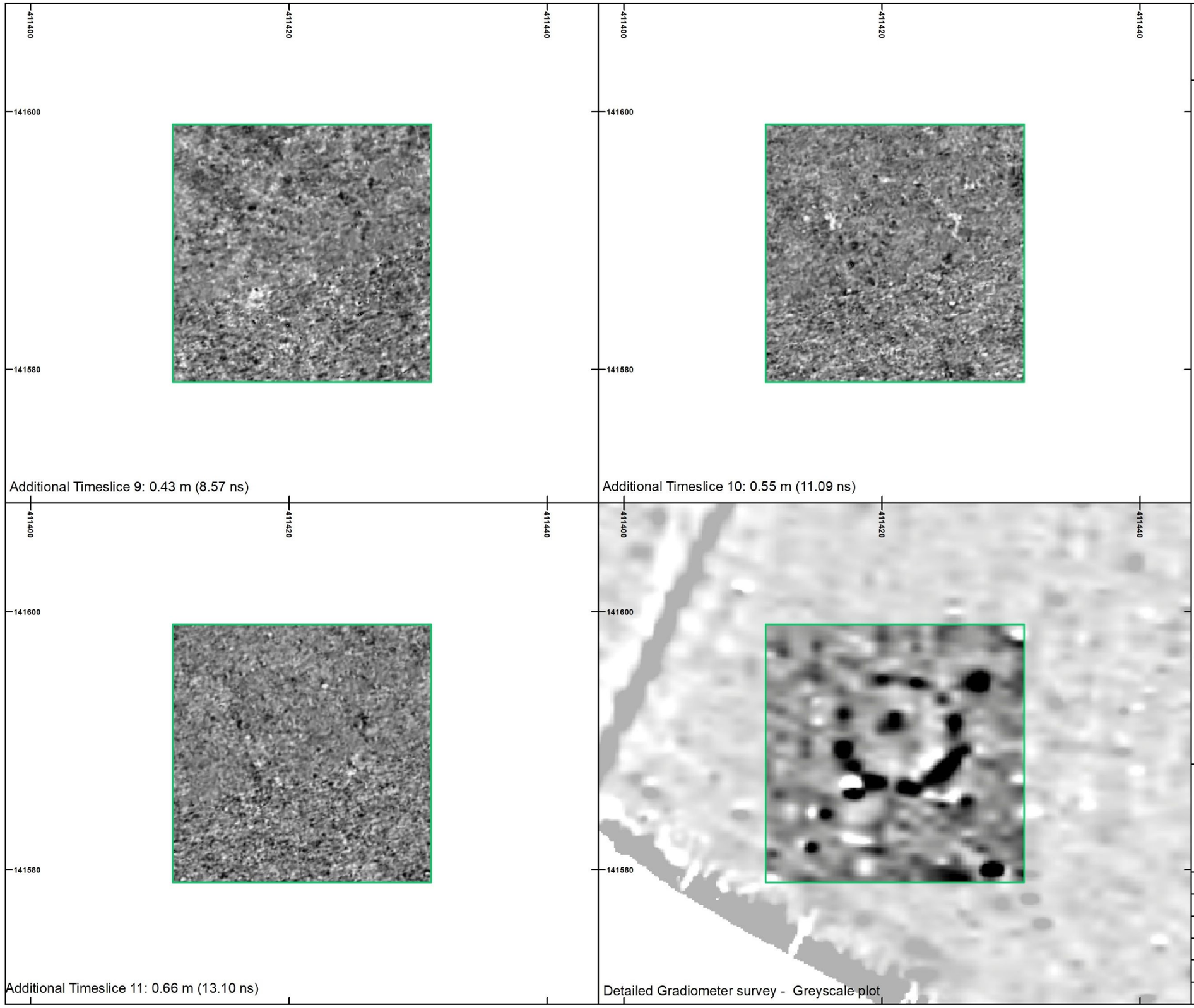
0 10 m

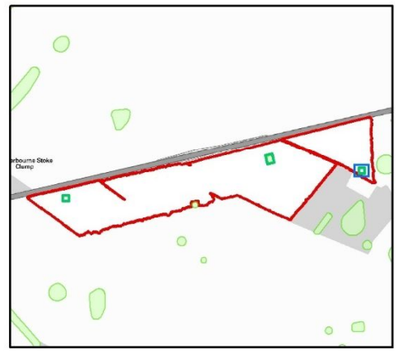
Coordinate system:
OSGB36 (OSTN15/OSGM15)

Date:	06/11/2017
Revision Number:	0
Scale:	1:400 at A3
Illustrator:	NLC
Path:	X:\PROJECTS\113225\GIS\
	FigsMXD\2017_11_06

Multi-channel GPR survey results: Greyscale timeslices (Detailed view of 10001)

Figure 28





Detailed interpretation area

Low Amplitude — High Amplitude

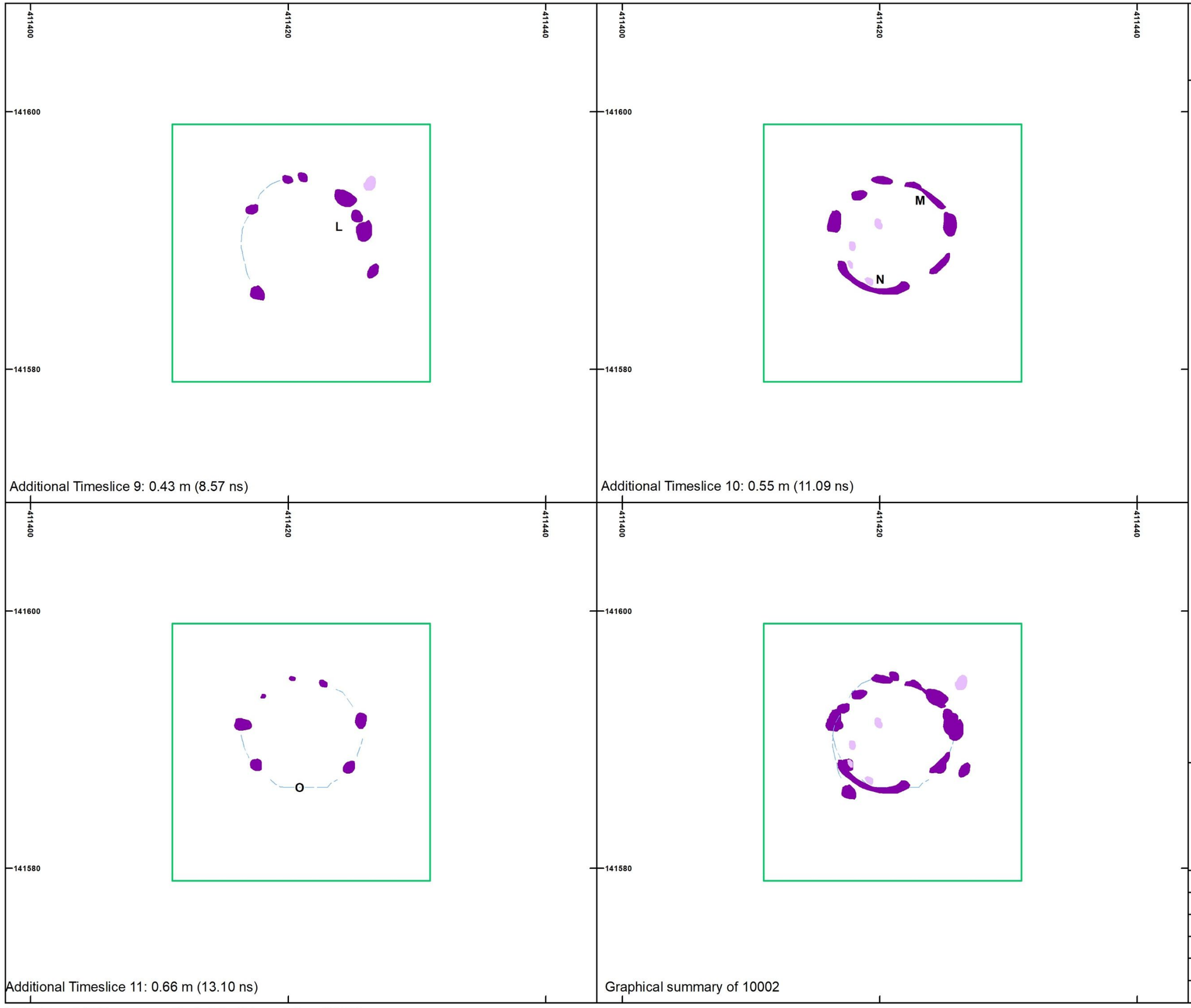
0 — 10 m

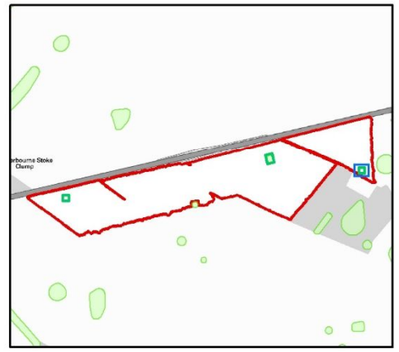
Coordinate system:
OSGB36 (OSTN15/OSGM15)

Date:	06/11/2017
Revision Number:	0
Scale:	1:300 at A3
Illustrator:	NLC
Path:	X:\PROJECTS\113225\GIS\
	FigsMXD\2017_11_06

Multi-channel GPR survey results: Greyscale timeslices (Detailed view of 10002)

Figure 29





Detailed interpretation area
Archaeology
Possible archaeology
Trend

0 10 m

Coordinate system:
OSGB36 (OSTN15/OSGM15)

Date:	06/11/2017
Revision Number:	0
Scale:	1:300 at A3
Illustrator:	NLC
Path:	X:\PROJECTS\113225\GIS\
	FigsMXD\2017_11_06

Multi-channel GPR survey results: Detailed interpretation of10002

Figure 30

Abbreviations List

AAJV	Arup Atkins Joint Venture
CIfA	Chartered Institute for Archaeologists
GPR	Ground Penetrating Radar
GPS	Global Positioning System
NRHE	National Record of the Historic Environment
WCAS	Wiltshire Council Archaeological Service
WHER	Wiltshire Historic Environment Record
WHS	World Heritage Site

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Appendices

Appendix A GPR: equipment and data processing

A.1 Survey Methods and Equipment

A.1.1.1 The ground penetrating radar (GPR) data were collected using a vehicle-based multi-channel shielded antenna with central frequencies suitable for the types of target being investigated.

A.1.1.2 The depth of penetration of GPR systems is determined by the central frequency of the antenna and the relative dielectric permittivity (RDP) of the material through which the GPR signal passes. In general, soils in floodplain settings may have a wide range of RDPs, although around 8 may be considered average, resulting in a maximum depth of penetration 2-3 m with the GPR signal having a velocity of approximately 0.1m/ns. Lower frequency antennae are able to acquire data from deeper below the surface, whereas higher frequencies allow high resolution imaging of near-surface targets at the expense of deep penetration.

A.1.1.3 The GPR beam is conical in shape; whilst most of the energy is concentrated in the centre of the cone, the GPR signal illuminates a horizontal footprint, which becomes wider with increasing depth. At any given depth, it is impossible to resolve any feature smaller than the horizontal footprint. The size of the footprint is dependent upon central frequency, and its size increases with depth and as the central frequency decreases.

A.1.1.4 The vertical resolution is similarly dependent upon the central frequency; for the 400 MHz antenna, features in the order of 0.05m may be resolved vertically. Antennae with lower frequencies can penetrate more deeply but are therefore less able to resolve both horizontally and vertically. Choice of antenna frequency is guided largely by the anticipated depth to the target and required resolution.

A.1.1.5 GPR data for detailed surveys are collected along traverses of varying length separated by 0.08 m. The data sampling resolution is governed by the data logger, with a minimum separation of 0.05m between traces is collected for all surveys.

A.2 Post-Processing

A.2.1.1 The radar data is collected using the MIRA-Acquisition software and is downloaded from the GPR system for processing and analysis using commercial software (MIRA-rSlicer, GPR Slice). This software allows for both the data and the images to be processed in order to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

A.2.1.2 Typical data and image processing steps may include:

- Gain - Amplifies GPR data based upon its position in the profile, which boosts the contrast between anomalies and background. A wobble correction is also applied during this step;
- Background Filter - is used to remove banding noises that are seen across the radargrams

- Bandpass - Removes GPR data lying outside a specified range, which removes high- and low-frequency noise.

A.2.1.3 Typical displays of the data used during processing and analysis:

- Timeslice - Presents the data as a series of successive plan views of the variation of reflector energy from the surface to the deepest recorded response. The variation in amplitude is represented using a colour scale with red indicating high amplitude and blue indicating low amplitude responses.
- Radargram - Presents each radar profile in a vertical view with distance along the profile expressed along the x axis and depth along the y axis. The amplitude variation is expressed using a greyscale.

Appendix B Relative Velocity to depth conversion for GPR Areas 18

Table 1 Velocity values for all GPR Areas

Area	Velocity m/ns
SW1 and SW9 – Area 18	0.010

Table 2 Relative velocity to depth conversion based on a dielectric constant of 10.41 for the 400 MHz antennae at GPR Area 18

Time Slice	Time (ns)	Depth (m)
1	0.0	0
2	2.52	0.13
3	5.04	0.25
4	7.56	0.38
5	10.80	0.5
6	12.60	0.63
7	15.12	0.76
8	17.64	0.88
9	20.16	1.01
10	22.68	1.13
11	25.20	1.26
12	27.72	1.39
13	30.24	1.51
14	32.76	1.64
15	35.28	1.76
16	37.80	1.89
17	40.32	2.02
18	42.84	2.14
19	45.36	2.27
20	47.88	2.39
21	50.40	2.52
22	52.92	2.65
23	55.44	2.77
24	57.96	2.90
25	60.48	3.02

Appendix C Geophysical interpretation

C.1.1.1 The interpretation methodology used by Wessex Archaeology separates the anomalies into four main categories: archaeological, modern, agricultural, and uncertain origin/geological.

C.1.1.2 The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided into three groups, implying a decreasing level of confidence:

- Archaeology – used when there is a clear geophysical response and anthropogenic pattern.
- Possible archaeology – used for features which give a response but which form no discernible pattern or trend.

C.1.1.3 For the interpretation of GPR datasets two additional categories are also employed:

- High Amplitude – used for features which give a notably high amplitude response but display no discernible patterns.
- Low Amplitude – used for features which give a notably low amplitude response but display no discernible patterns.

C.1.1.4 The modern category is used for anomalies that are presumed to be relatively modern in date:

- Modern service – used for responses considered relating to cables and pipes; which are normally represented by distinctive hyperbolic responses.

C.1.1.5 The agricultural category is used for the following:

- Former field boundaries – used for ditch sections that correspond to the position of boundaries marked on earlier mapping.
- Ridge and furrow – used for broad and diffuse linear anomalies that are considered to indicate areas of former ridge and furrow.
- Ploughing – used for well-defined narrow linear responses, usually aligned parallel to existing field boundaries.
- Drainage – used to define the course of ceramic field drains that are visible in the data as regularly distributed high amplitude responses.

C.1.1.6 The uncertain origin/geological category is used for features when the form, nature and pattern of the anomaly are not sufficient to warrant a classification as an archaeological feature. This category is further sub-divided into:

- Trend – used for low amplitude or indistinct linear anomalies.
- Superficial geology – used for diffuse edged spreads considered to relate to shallow geological deposits. They can be distinguished as areas of amorphous areas of high and low amplitude response, although they can appear more regular in form in confined areas.

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