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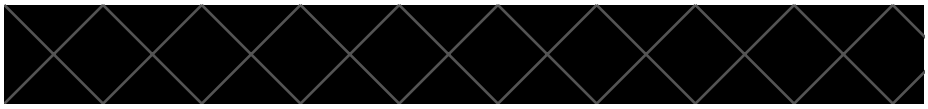

Stage 2b: Tasks 2.8 - 2.14

Landscape survey and deposit modelling interim report

Co-authored by the Project Team

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Landscape survey and deposit modelling interim report

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Purpose of document

This document has been prepared as an interim report on photogrammetry, GIS mapping, ground observation survey, geological boreholes and deposit modelling at [redacted] in fulfilment of Stage 2b, Tasks 2.8 - 2.14. for Historic England. The purpose of this document is to provide information regarding the nature and condition of deposits at the [redacted] quarry site to provide additional contextual information to inform Stage 3 of the project; Targeted Field Investigation.

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Project summary

OASIS ID	digventu1-349815
National Grid Reference	[redacted]
County	[redacted]
Title:	[redacted] Stage 2b: Tasks 2.8 - 2.14 Landscape survey and deposit modelling interim report
Author(s):	The Project Team
Origination date:	30/04/2019
Circulation:	Historic England Project Team
Reviewed by:	Brendon Wilkins – DigVentures
Approval:	Lisa Westcott Wilkins – DigVentures

Executive summary

This report details the results of survey, fieldwalking and geotechnical investigations at [redacted] The work was undertaken as part of an evaluation project supported by Historic England under the terms of NPPF Emergency Assistance Funding, in part completion of Stage 2b of the Project Design (Wilkson et al. 2018) in advance of Stage 3 archaeological test pits. It represents the completion of Tasks 2.8 – 2.15, contributing to the identification of the physical extent and character of the heritage asset in its environs (Aim 1), and leading to a greater understanding of the physical extent and state of preservation of the palaeochannel deposits (Questions 1, 2 and 3). This report provides an interim statement on the stratigraphy of composite cross sections and modelled extent/thickness of the palaeochannel deposits, character of the infilling strata, and leads to the proposal of test pit locations, fulfilling the requirements of Review 4 of the Project Design (Wilkins et al. 2018).

The aerial photogrammetric survey (Task 2.9) provided an orthorectified image and Digital Terrain Model of the existing land surface showing that changes in elevation reflecting broad changes in the underlying geology. The GPS survey and GIS mapping (Task 2.10) highlighted significant areas of modern disturbance caused by commercial quarrying and collection activities, with evidence that a machine excavator was used to extract and collect artefactual and vertebrate remains across the palaeochannel during informal collection activities by Neville and Sally Hollingworth. The GPS survey and GIS mapping highlighted substantial accumulations of up cast sediments and spoil heaps associated with these extraction activities, many of which may be masking undisturbed deposits. The fieldwalking and ground observation survey (Task 2.11) provided complementary information highlighting that the location of vertebrate remains, which were largely located in disturbed areas of the site adjacent to the Hollingworth's machine excavated trenches.

The geological boreholes (Task 2.12) and deposit modelling (Task 2.13) provided a greater understanding of the nature and geometry of the underlying Kellyways Clay Member and Oxford Clay Formation, helping to determine the horizontal and vertical extent of the incised fluvial channel (or channels), and characterise the nature of the infilling deposits. The Lower fill of the channel survived in thicknesses of up to 0.6m and comprised of multiple lithiofacies indicating a shifting fluvial environment from episodes of flood activity to times with slower moving water and marshy conditions. The vertebrate remains exposed by the Hollingworth's were concentrated in a facies likely to have formed in a fast moving large water body. The upper fill was shown to overflow the channel and be consistent with the and Gravel Member.

The landscape survey and deposit modelling provided the necessary information to make recommendations for further targeted field investigations. The proposed sampling strategy comprises four test pits ranging in size from 1m x 1m to 4m x 1m, covering an area of ~8m^2. The test pits target different depositional environments and sub-environments in which the channel sequence accumulated, alongside areas with concentrations of vertebrate remains, and will help examine the formation of the palaeochannel and the relationship between the biological remains and artefacts through a deposit-led approach (Aim 2 - Questions 4, 5 and 6).

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1 INTRODUCTION

1.1 Project summary

1.1.1 The [redacted] project has been formulated in response to the 2017 discovery of a Palaeolithic handaxe, found in close proximity to a well-preserved vertebrate assemblage and palaeochannel at [redacted] (hereafter 'the Site'; Figures 1 and 2). A programme of non-intrusive and intrusive investigation has been designed to assess the wider depositional context and taphonomic history of this and other associated material, supported by Historic England under the terms of NPPF Emergency Assistance Funding (Wilkins et al. 2018).

1.1.2 The potential significance of a newly discovered Site assigned to Marine Isotope Stages (MIS) 9-7 (~330-180 ka BP) has been presented in detail in the Project Design (Wilkins et al. 2018, Section 2). [redacted] with its combination of vertebrate and artefactual remains, and its attendant opportunities for the preservation of waterlogged material, provides a unique opportunity to investigate human-environment relations and concomitant impact of climate change. Furthermore, given its intermediary location at the headwaters of the River Thames, it provides potential for understanding connections and the movement of populations between well-known sites further downstream in the River Thames (e.g. Purfleet, Crayford, Stanton Harcourt) and sites at the northern extremities of occupation of Britain (e.g. Pontnewydd). An assessment of previously collected materials recovered from the site when it was discovered in 2017 suggested that the artefacts and the animal remains represented different periods of activity (Russ et al. 2019; Review Point 3, and see Section 2.1.2, below).

1.1.3 This document provides an interim report on aerial photogrammetry, GIS mapping, ground observation survey, geological boreholes and deposit modelling at [redacted] in fulfilment of Stage 2b, Tasks 2.8 - 2.14 of the Project Design, Review Point 4 (Wilkins et al. 2018). Its purpose is to provide a justification for further targeted intervention, undertaken in fulfilment of Stage 3 field investigation. Aerial photogrammetric survey and Digital Terrain Model (DTM) was undertaken by Adam Stanford, Aerial-CAM; geological boreholes, deposit modelling and lithostratigraphic data was undertaken by Dr Keith Wilkinson, University of Winchester; and onsite conservation assessment of vertebrate remains was provided by Nigel Larkin. Specialist contributions are presented here, providing the basis for initial statements of potential and significance as well as recommendations for any further trenching.

1.2 Location, topography and geology

1.2.1 [redacted] is located in the [redacted] and currently bounded to the north, south and west by lakes restored from former quarry workings (Figure 1). Field work is focused on palaeochannel deposits of Middle-Upper Pleistocene date currently exposed in the north-west corner of the quarry adjacent to the B4696 Spine Road. The palaeochannel is cut into rocks of the Middle Jurassic Kellaways Sand Formation. The thickness of the palaeochannel has been estimated at 1-2m (Hollingworth and Hollingworth 2017), though this has not been firmly established except through informal collecting. Surface investigation has confirmed that the channel sediments are highly fossiliferous, containing waterlogged plant

macrofossils, mollusc shell and vertebrates. One hand-axe has been recovered from the palaeochannel fill with a further hand-axe reported from the same quarry (though the precise location and circumstances of discovery remain unknown).

2 RESULTS OF PREVIOUS WORKS

2.1.1 Over the spring of 2017 discovery of a large collection of vertebrate remains and a flint handaxe was made at [redacted] by Neville and Sally Hollingworth, two local enthusiasts who regularly inspect adjacent quarry workings with the express permission of the Landowner. The material was collected form the surface and through machine excavated trenches during quarrying and drainage operations, and removed to a purpose-built storage facility at their family home. Through subsequent enquiries other material has come to light, including a further handaxe (found by Mark O'Dell) and two additional mammoth bones (recovered by Theo May and Ben Hinton) taking the total known assemblage from [redacted] at that time to 111 items. The assemblage comprised 2 handaxes, 108 bones, teeth and fragments thereof, and one fragment of preserved wood (H.001 to H.111). Neville and Sally produced a photographic catalogue of the 111 specimens (Hollingworth and Hollingworth nd), identifying vertebrate remains to genus and respective element where ever they were able. Additional material recovered from the Site that had not been included in the original catalogue of finds collated by Neville and Sally Hollingworth has also been assessed by the Project Team. This comprised a tooth and an extremely large longbone. The remains recovered by Neville and Sally were found distributed across the entire width of the palaeochannel, with concentrations of vertebrate material identified in specific areas. Once collected, a small number of marker flags were left in situ to identify the original location of the material. These have been surveyed by the Project Team (Russ et al. 2019, figure 2); however, no information is available to link individual find spots to specific items in the catalogue.

2.1.2 An assessment of previously collected material (Stage 2a: Russ et al. 2019) indicated that the two handaxes were Lower Palaeolithic (Acheulean), typically associated with MIS 13–9, ~550-300 ka BP in Britain. They demonstrated ridge rounding consistent with post-depositional movement in the burial environment, suggesting that they were redeposited at the site and represent evidence for hominin activity in the vicinity earlier than the accumulation of the vertebrate remains. The vertebrate remains included both steppe (*Mammuthus trogontherii*) and woolly mammoth (*Mammuthus primigenius*). If contemporary, this represents the presence of both warm (steppe) and cold (woolly) adapted taxa in the same environment. This suggested a date for the deposits at the end of the interglacial MIS 7 to the beginning of the MIS 6 glacial when environmental and climatic conditions would have been deteriorating. As the handaxes predate the vertebrate remains, and the vertebrate remains themselves exhibited no evidence for exploitation by hominins; hunting, scavenging or butchery, hominin activity and hominin-animal relationships could not be established. Surface condition of the bones and teeth suggested minimal post-depositional movement, indicating that potential survival for in situ remains still at [redacted] was high.

2.1.3 An assessment of existing geotechnical records (Stage 2a: Russ et al. 2019) suggested that is was difficult to draw precise inferences from the data recovered from previous boreholes and test pits in the vicinity, as these provided no indication for the presence of palaeochannel deposits that are now known to exist in the study area. It was considered plausible that the failure to recognise the palaeochannel deposits was

because the test pits/boreholes did not pass through the channel feature. Nonetheless, the review of the existing geotechnical resource highlighted a reasonably consistent thickness of 1.5-3.9m of gravel outcropping across the study area, and the fact that the bedrock surface slopes upwards immediately east of the study area. It was considered plausible that variation in gravel thickness may be explained both by infilling of bedrock-cut channels and the increasing elevation of the bedrock in an easterly direction.

3 AIMS, OBJECTIVES AND METHODOLOGY

3.1 Aims and objectives

3.1.1 The overarching aim of the project is to define and characterise the physical extent of the Site through a programme of non-intrusive investigations and intrusive excavation, obtaining baseline data that will facilitate its future management, research, presentation and enjoyment (Wilkins et al. 2018, Sections 4 and 5). The project model is framed as four overarching aims each with associated key questions/objectives that provide a framework for the methods, stages, products and tasks required to deliver the project.

3.1.2 This report has been produced in fulfilment of Stage 2b (Tasks 2.8 - 2.14; Review Point 4), and addresses questions 1-3 of Aim 1, Identify the physical extent and character of the [redacted] heritage asset in its environs (Wilkins et al. 2018, 18):

- Q1. Can the physical extent of the palaeochannel and any associated subsurface archaeology be determined by remote sensing and refined by geoarchaeological boreholes?
- Q2. What is the extent (lateral and vertical) of the palaeochannel deposits and can this inform an appropriate evaluation and sampling strategy?
- Q3. Can we model the deposits infilling the palaeochannel, characterising areas of high archaeological and palaeoenvironmental potential, and how should this model be refined through further intervention?

3.2 Methodology

3.2.1 Tasks 2.8 to 2.14 have been carried out according to the project model outlined in the Project Design, except where amended as below (Wilkins et al. 2018).

3.2.2 The Project Design proposed the drilling of 32 boreholes in order to model the extent of the palaeochannel and the thickness of the infilling deposits, while also characterising the latter. The borehole locations were planned in ArcGIS on the basis of an aerial photograph taken in 2017, uploaded to a Leica System 1200 RTK GPS and that device used to position the sample points in the field (i.e. 'BH#' in Figures 6-10). The same device was then used to record the precise (to 10mm precision) three-dimensional location of each sample position. Three borehole locations (BH4, BH5 and BH16) proved to be within large pools of water or drainage channels that could not be pumped dry and were therefore neither surveyed nor drilled, while one further location (BH17) was surveyed, but had reflooded before it could be further investigated. On the other hand several exposures beyond those envisaged in the Project Design were investigated, as machine excavated trenches by Neville and Sally

Hollingworth in 2017 were pumped to remove water, and the exposed sections cleaned and described ('ST#' and BH7A, BH8A, BH35-38 in Figures 6-10).

3.2.3 Eijkelkamp gouge augers of 75mm diameter powered by an Atlas Cobra TT two-stroke mechanical hammer were initially employed to drill two boreholes (BH 26 and BH 27). However, as the Quaternary strata in those locations was found to be <0.3m thick, the decision was made to record the stratigraphy of subsequent sample points from sections exposed in hand dug, spade-width (c. 0.2m) sections dug to the top of the Jurassic geological substrate. In the event three further boreholes were drilled with the Eijkelkamp/Atlas equipment in locations where the stratigraphy was thicker than 0.5m, i.e. BH9, BH39 and BH40. The stratigraphy exposed in the gouge auger (n = 5) and hand dug (both those dug by ARCA [n = 27] 'boreholes', and the Hollingworth trench walls [n = 15]) were photographed and described using standard geological protocols (Jones et al. 1999, Munsell 2000, Tucker 2011).

3.2.4 Positional data recorded by the RTK GPS was combined with the lithological descriptions from the boreholes and test pits within a RockWorks 15 (RockWare 2012) database on completion of the fieldwork. On the basis of lithostratigraphic properties combined with the mapping of the British Geological Survey (2019a) and information supplied by Dr Neville Hollingworth (personal communication, 2019), lithologically defined strata from the machine excavated trenches and boreholes were assigned to formal (i.e. Made Ground, Northmoor Sand and Gravel Member, Oxford Clay Formation, Kellaways Clay Member) and informal (i.e. 'Palaeochannel', 'Jurassic substrate') geological units. The RockWorks software was then employed to plot a series of lithostratigraphic composite north-south cross sections across the palaeochannel feature (e.g. Figures 9 and 10). The same package was also used to generate a surface model for the Jurassic substrate (the latter, a composite of the Oxford Clay Formation and Kellaways Clay Member) (Figure 7) and a model of the thickness of the palaeochannel fills (Figure 8). In both the latter cases the modelling protocols were those advocated by Wilkinson et al. (2018) for investigations of this type, i.e. use of a kriging algorithm and eight nearest neighbours, while it was also decided to exclude from model production those areas >10m from a sample point (the latter are unshaded in Figure 7 and Figure 8).

3.2.5 Fieldwalking was undertaken by six people over six days between 23rd – 30th April 2019. Fieldwalking was based on a 15m grid-system identical to the boreholes, with each grid divided into 1.5m wide observation corridors increasing resolution over the Project Design. A dGPS system was used to establish the grid layout, with transacts marked with survey flags. All finds were located in 3D using the dGPS system, as well classified more generally according to grid square.

4 RESULTS

4.1 Survey and GIS modelling

4.1.1 The landscape survey and GIS mapping provides fulfilment of Stage 2b (Tasks 2.10 and 2.11), and addresses aspects of Aim 1, Questions 1, 2 and 3 of the Project Design (Wilkins et al. 2018, see Section 3.1.2 above) by helping to identify areas of potentially in situ palaeochannel deposits, and understand the disturbance caused by commercial quarrying and fossil extraction at

4.1.2 An aerial photogrammetric survey (Task 2.9) was undertaken in order to produce an orthorectified image (Figure 2) and Digital Surface Model (DSM) (Figure 3) of the [redacted] A GPS survey and GIS mapping (Tasks 2.10–2.11) of the area was undertaken to identify the extent of existing machine excavated trenches, spoil heaps and any survey flags remaining from earlier investigations (Figure 4).

4.1.3 The aerial photographic survey (Figure 2) shows areas of standing water, which are located principally to the northern half of the survey area. There are several large interconnecting drainage channels that run along the southern, eastern and part of the northern boundaries of the survey area. A network of smaller curvilinear ditches interconnect with these larger drainage channels in the northern half of the survey area. There were thick accumulations of silt within the drainage channels themselves and in their immediate vicinity, with the depths of accumulated silt measuring up to 0.30 m. The high levels of silt accumulation likely result from a combination of water run-off and downslope movement of sediment from spoil heaps in the vicinity of fossil extraction locations.

4.1.4 The Digital Surface Model (Figure 3) shows an area of relatively low-lying ground ~80m above sea level in the northern half of the survey area, which equates with the major areas of standing water. It seems likely that the low-lying ground equates broadly with the location of the palaeochannel, although the natural geometry of the land surface is evidently obscured in part by the standing water, as well as, disturbance of the sediments by quarrying and fossil extraction activities. The ground rises gradually towards the south levelling out and forming a plateau ~82 m above sea level, which appears broadly equivalent to the top of the Jurassic surface.

4.1.5 The GPS survey and GIS mapping (Figure 4) identified several machine excavated trenches (referred to simply as 'trenches' in all figures) primarily targeting the infilling palaeochannel deposits. Most of the collection trenches were associated with large spoil heaps, many of which had collapsed obscuring the section edges of the sondages. Given the large areas of standing water, high levels of silt accumulation, and amassing of spoil, many other collection trenches may have been obscured. As such, the total number of collection trenches identified during the GPS survey and GIS mapping should be considered a conservative estimate.

4.1.6 Fifteen flags were identified whilst conducting the GPS survey (Figure 4). Each flag was placed by Neville Hollingworth and Sally Hollingworth to mark the location of artefact and vertebrate remains, many of which were subsequently collected. A flag marked the location of the handaxe collected by Sally Hollingworth. It was located at the base of a spoil heap, which most likely comprised of sediments associated with nearby vertebrate remains (Figure 4). However, a clear stratigraphic relation between the handaxe and the nearby vertebrate remains could not be established. All vertebrate remains flagged and left in situ were located during fieldwalking (see Section 4.2).

4.2 Fieldwalking

4.2.1 The fieldwalking provides part-fulfilment of Stage 2b (Task 2.11), and addresses aspects of Aim 1, Questions 1, 2 and 3 of the Project Design (Wilkins et al. 2018, see Section 3.1.2 above) by identifying artefactual remains on the surface, highlighting potential spatial variation and for in situ deposits, and establishing the condition of the site in general at

4.2.2 Fieldwalking was heavily influenced by the ground conditions, with all grid squares identified as having low visibility (Appendix 1; Figure 5). The visibility of each grid was affected by a combination of surface water coverage, silt accumulation, vegetation coverage, spoil heaps masking in situ sediments, and vehicle track marks. Though the visibility in all grid squares was suboptimal, likely effecting the quantities of recovered materials, some broad patterns are observable in the distribution of finds that help to establish the likelihood for encountering in situ palaeochannel deposits.

4.2.3 Fossilised bivalves (principally *Gryphaea* sp.) were the most numerous finds (n=242)(Appendix 2; Figure 5). The greatest concentrations of fossilised shells were found on high ground towards the southern limits of the survey area (e.g. grid squares 3, 6, 9, 13, and 17). However, fossilised shells were found in small numbers throughout the survey area (Figure 4, Figure 5). The distribution of fossilised shells likely reflects the disturbance of underlying geological deposits caused by commercial quarrying activity, water management and subsequent smaller-scale extractive activities undertaken by N. Hollingworth and S. Hollingworth. As such, the fossilised shells likely provide an indication of the location of in situ and disturbed geological deposits belonging to the Kellaway Clay Member and Oxford Clay Formation.

4.2.4 Non-fossilised wood fragments were distributed in a similar fashion to the fossilised shells, although found in much smaller quantities (n=39) (Appendix 2; Figure 5). Each wood fragment recovered was relatively small (≤10mm), and in waterlogged and/or, wholly or partially, charred condition. The wood fragments were found on mainly on high ground in areas immediately adjacent to drainage ditches and in the vicinity of track marks indicative of high levels of site traffic. As such, it is most probable that the wood fragments are intrusive and relate to recent activity.

4.2.5 Vertebrate remains were relatively numerous (n=50) (Appendix 2; Figure 5), although were mostly highly fragmented and could not be easily classified according to species. Of those parts well-preserved enough to be classified, all were preliminarily identified in the field as belonging to *Mammuthus* sp. Nearly all the vertebrate remains were found within or adjacent to locations of recent bone and fossil extraction (e.g. grid squares 24, 25, 30, 31, 38 and 39).

4.2.6 Five tusks, in whole and fragmentary condition, were amongst the vertebrate remains identified during fieldwalking. Each tusk had been previously exposed by Neville Hollingworth and Sally Hollingworth. In grid square 11, four adjoining laminar tusk fragments (up to 15mm in length) were identified, although the remains were mostly masked by waterlogging and the accumulation of silt in the vicinity. It is likely that the fragments were part of a more extensive spread of material, possibly still partially in situ and relatively undisturbed. A jaw bone fragment and long-bone fragments of suitable robusticity to be from *Mammuthus* sp. were found nearby on the surface in grids squares in 11, 14 and 15, although may belong to one or more individuals.

4.2.7 In grid square 20, a tusk was found at the edge of a trench excavated by Neville and Sally Hollingworth. It was identified from the proximal end, which was found embedded within sediment and likely continued vertically into the underlying deposits. Further excavation would be needed to fully ascertain the orientation of the tusk and its condition. The only other find spot in grid square 20 was a bone fragment that was found loose on the surface ~5.6m west of the tusk.

4.2.8 In grid squares 30, 31, 38 and 39, a series of intercutting machine excavated trenches were identified. Here, three tusks were partially exposed in plan and an isolated tusk fragment was found nearby on the surface. All three tusks were submerged beneath the surface of the water and blanketed by a thick layer of silt, partially obscuring the full extent of the remains. The three tusks mark the center of a spread of vertebrate remains, which mainly focused on grid squares 24, 30, 31, 37, 38, 39 and 40.

4.2.9 No lithic artefacts were identified through fieldwalking.

4.3 Onsite conservation assessment of vertebrate remains

Nigel Larkin

4.3.1 An onsite conservation assessment of the vertebrate remains was made by Nigel Larkin on Friday 26th April 2019. The following notes supplement comprehensive recommendations made during Stage 2a (Russ et al. 2019).

4.3.2 Five separate mammoth tusks were observed lying in saturated gravels. Each tusk was highly fragmented and held together by the surrounding gravels and mud. All were in extremely fragile condition and would be easily impacted by any disturbance. Keeping the tusks wet and covered will help to avoid deterioration from drying out and/or bleaching from exposure to sunshine. Tusks encountered during test-pitting may require consolidation prior to lifting and may be left in the ground if the conditions are stabilised.

4.3.3 The only pieces of bone observed during the visit were found loose on the surface and were in relatively fragmentary condition. These vertebrate remains may be subject to further deterioration through movement, weathering, and/or animal gnawing. There is also a limited risk of loss or theft. The collection of this material may limit further damage. There is limited evidence to link the fragmentary remains into the wider deposit model.

4.4 Geotechnical assessment and boreholes

Dr Keith Wilkinson

4.4.1 The geotechnical assessment and boreholes provides part-fulfilment of Stage 2b (Tasks 2.12 and 2.13), and addresses aspects of Aim 1, Questions 1, 2 and 3 of the Project Design (Wilkins et al. 2018, see Section 3.1.2 above) by helping define the physical extent of the palaeochannel and informing follow on evaluation and sampling strategies at

4.4.2 The Quaternary stratigraphy in the [redacted] rests on Jurassic strata of the Kellaways Clay Member and Oxford Clay Formation at between +80.2 and +82.0m OD (Figure 7). Contrary to the British Geological Survey (2019a) mapping, the Kellaways Clay Member (1.66.1-163.5 Ma, British Geological Survey 2019b) outcrops across the base of most of the quarry, while the younger Oxford Clay Formation (166.1-157.3 Ma) is only found in the north-west corner, towards which Kellaway Clay Member dips. The Kellaway Clay Member is characterised in the boreholes/trenches by grey (Munsell 5 Y 5/1) fine sandstones (fully lithified, and forming a characteristic north-westerly dipping 0.20-0.30m-thick tabular bed), conglomerates and muds, while

the Oxford Clay Formation outcrops as dark grey unlithified (Munsell 5 Y 4/1) silts, clays and fine sands.

4.4.3 The Oxford Clay Formation and Kellaways Clay Member are in turn incised up to 2m by a fluvial channel (or channels) (Figure 9). The borehole and trench section data suggest that the latter has a bipartite fill: a lower fill comprised of dark grey (Munsell 2.5 Y 4/1-2.5 Y 3/1) lenticular and horizontally-bedded sands and gravels, and lenticular bedded fine sands and silts and an upper fill of horizontally bedded strong brown (Munsell 7.5 YR 5/6-10 YR 4/6) sands and gravels.

Lower fill

4.4.4 The dark grey sands and gravels and fine sands and silts survive in thicknesses of up to 0.6m, while outcrops of >0.40m are modelled as lying on a north-east to south-west axis between PT41 and PT49 (Figure 8). The thickness of the Lower fill is modelled to rapidly decrease north-west of PT52 (Figure 8), while a similar rapid reduction in thickness is seen south-west of PT41 in the cross section shown in Figure 9. It is thus likely that these two zones mark the north and south margins of the channel infilled by the Lower fill. There is a rather less dramatic modelled shelving of the Lower fill in a westerly direction from BH12 and an easterly one from BH12, indicating that the channel was orientated in a broadly east-west direction in the northern part of the quarry. Indeed the modelled Jurassic substrate surface suggests that the thickest deposits of the Lower fill (and as will be discussed further below, the greatest density of fossil vertebrate remains), lie within troughs in the bedrock that are centred on PT40 and PT52 (cf. Figure 7 with Figure 8). As noted above, the Lower fill comprises multiple lithofacies, most of which have a local outcrop and therefore can only rarely be traced between boreholes/trenches (Figure 9 and Figure 10). The facies are broadly classified as follows:

4.4.5 Facies 1: Dark grey (Munsell 2.5 Y 4/1) normally-bedded, moderately sorted silts and fine sands, with moderate rounded and sub-rounded fine pebble and granular rounded limestone clasts, and frequent mollusc shells. The latter include the freshwater genera *Radix*, *Bithynia*, *Valvata* and *Pisidium*, while the fact that the latter bivalves are often found articulated suggests a gentle mode of formation. Facies 1 is most commonly encountered in hollows cut within Oxford Clay Formation where it is always overlain by deposits formed of Facies 2.

4.4.6 Facies 2: Dark grey (Munsell 2.5 Y 4/1) horizontally bedded clast- and matrix-supported gravels of sub-rounded and rounded limestone pebbles in a coarse sand and granular matrix. Clasts are occasionally imbricated, while there is localised normal bedding, but the strata are poorly sorted. Fossil vertebrates (including all the mammoth tusks exposed in the Hollingworth's machine excavated trenches) are concentrated in this facies, which must have formed rapidly (to enable preservation of the vertebrate remains in their observable state) and in moderately fast moving water. The presence of fragments of the freshwater mollusc genus *Unio*, suggests that the water body was large.

4.4.7 Facies 3: Dark grey (Munsell 2.5 Y 4/1) lenticular-bedded, well sorted silt containing moderate quantities of granular-size mollusc fragments (*Bithynia* sp. and *Valvata* sp.), which most probably was deposited during episodes of ebb and flow.

4.4.8 Facies 4: Dark greyish brown (Munsell 10 YR 4/2) lenticular-bedded, well sorted organic silt/clay containing frequent freshwater mollusc shell (*Bithynia* sp., Planorbidae) and moderate plant macro remains (the latter to pebble size). This facies likely formed in pools containing slack, vegetated water, and therefore at times when flow was at a minimum.

Upper fill

4.4.9 The upper fill is comprised of horizontal sheets ('sets') of predominantly matrix-supported, strong brown (mostly Munsell 7.5 YR 4/6) limestone pebble-gravels. Sets average 100-200mm in thickness, gravel clasts are mostly sub-rounded, but with a moderate sub-angular component (contra the Lower fill in which clasts are more rounded), while the matrix is comprised of medium and coarse sand, the latter mainly of limestone. There are occasional thin lenticular beds of organic mud (properties as Facies 4 above, but lacking Planorbid molluscs), while a single coarse pebble-sized wood fragment was noted in section between PT41 and PT42. The Upper fill overflows the palaeochannel and in the parent material for the present soil on the site. It is the Northmoor Sand and Gravel Member that was the subject of the aggregate extraction in the quarry, and which has been dated to the last (Devensian) cold stage at the

5 POTENTIAL AND SIGNIFICANCE

5.1.1 This interim report represents the completion of Stage 2b (Tasks 2.8 - 2.14: Review Point 3) and addresses Questions 1-3 of Aim 1, Identify the physical extent and character of the [redacted] heritage asset in its environs (Wilkins et al. 2018, 18):

5.2 Q1. Can the physical extent of the palaeochannel and any associated subsurface archaeology be determined by remote sensing and refined by geoarchaeological boreholes?

5.2.1 Survey and GIS modelling (Tasks 2.8–2.10) indicated changes in topography reflective of broad shifts in the underlying geology. An area of low-lying ground was identified in the northern half of the survey area which broadly corresponded with the location of the palaeochannel, although the natural geometry of the land surface was obscured by standing water, high levels of silt accumulation, amassing of spoil, and removal of the deposits through commercial quarrying and collection activities. Fieldwalking (Task 2.11) helped to identify concentrations of vertebrates remains on the surface that may be reflective of surviving subsurface remains, albeit heavily truncated by previous collection activities. Likewise, areas dominated by fossilised bivalves appeared reflective of the location of the underlying Jurassic bed. Geoarchaeological boreholes and deposit modelling (Tasks 2.12 and 2.13) have helped to clarify our understanding of the extent the palaeochannel deposits and refine our understanding of the geometry of the Jurassic surface.

5.3 Q2. What is the extent (lateral and vertical) of the palaeochannel deposits and can this inform an appropriate evaluation and sampling strategy?

5.3.1 Interim modelling of the lithological data from the geoarchaeological borehole (Tasks 2.12–2.13) indicates that the palaeochannel deposits may laterally extend over an area ~4200 m^2. Yet the palaeochannel deposits may only survive thinly across much of this

area, with ~0.60m being the maximum thickness. Even though palaeochannel deposits only survive in places very thinly they are highly variable in nature and are characterised by lenticular sand and gravel beds, with localised scours containing mollusca and plant macrofossils. The Lower fill of the palaeochannel comprises multiple lithofacies, most of which has a local outcrop and therefore could only rarely be traced between boreholes/trenches. Much of the variation is likely related to localised differences in formation of the channel associated with the river margins and greater depths of the watercourse, which would be an appropriate focus for evaluation and sampling.

5.4 Q3. Can we model the deposits infilling the palaeochannel, characterising areas of high archaeological and palaeoenvironmental potential, and how should this model be refined through further intervention?

5.4.1 Within the parameters of the first fieldwork stage, modelling (Task 2.13) was successful in identifying the lateral and vertical extent of the deposits infilling the palaeochannel. The highly variable and localised nature of the deposits makes the identification of specific areas of high archaeological and palaeoenvironmental potential problematic. However, four broad facies were identified. Facies 2 was associated with the mammoth tusks exposed in the Hollingworth's machine excavated trenches and likely formed rapidly in moderately fast moving water. Facies 1, 3 and 4 indicate both episodes of flooding and periods of slower moving water, which at times of low activity likely formed in marshy pools. This model will be substantially refined through further interventions targeted at understanding variation in the depositional environment and sub-environments across the channel undertaken during Stage 3 field investigation.

6 PROPOSED TEST PIT AND SAMPLING STRATEGY

6.1.1 The proposed test pit and sampling strategy provides part-fulfilment of Stage 2b (Task 2.14) and will help address questions 4-5 of Aim 2, Understand the formation of the [redacted] palaeochannel within its palaeoenvironmental context (Wilkins et al. 2019, 18):

- Q4. Can we reconstruct the depositional environment and sub-environments in which the channel sequence accumulated, as defined in Aim 1?
- Q5. Can we determine the position of artefacts within the depositional sequence, and determine their contextual relationship with biological remains (particularly vertebrates)?
- Q6. What are the typical and atypical features of the palaeochannel and can we infer its past micro-environment?

6.1.2 Four test pits will be excavated covering ~8m2 (Figure 10). All excavation will be undertaken following the methodology outlined in the Project Design (Wilkins et al., 2019), unless otherwise stated:

Test pit	Dimensions	Description
1	1.00 x 1.00m	1.00 x 1.00m test pit extending existing trench in which the handaxe and vertebrate remains were collected; currently covered by spoil heap which will be removed and sieved for discarded artefactual and vertebrate remains; adjacent trench sections will cleaned and characterised
2	1.60 x 1.25m	1.60 x 1.25m test pit extending existing trench in thickest part of palaeochannel sequence; adjacent trench sections will cleaned and characterised
3	4.00 x 1.00m	4.00 x 1.00m test pit extending existing trench with *in situ* vertebrate remains and located in area of rapidly thinning deposits towards the margins of the palaeochannel; adjacent trench sections will cleaned and characterised
4	1.00 x 1.00m	1.00 x 1.00m test pit focusing on thinning palaeochannel deposits on higher ground in the vicinity of vertebrate remains; no machine excavated trenches in close proximity

Table 1: Test pits descriptions

6.1.3 Non-intrusive techniques will be adopted to minimise further impact to the archaeological resource. Existing standing sections adjoining test pits will be cleaned and recorded to help characterise the nature of the deposits and determine the impact of previous collection trenches. Any spoil heaps requiring removal will be sieved, helping to establish to what extent artefactual and vertebrate remains have been previously discarded.

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Figure 2 - Aerial photographic survey

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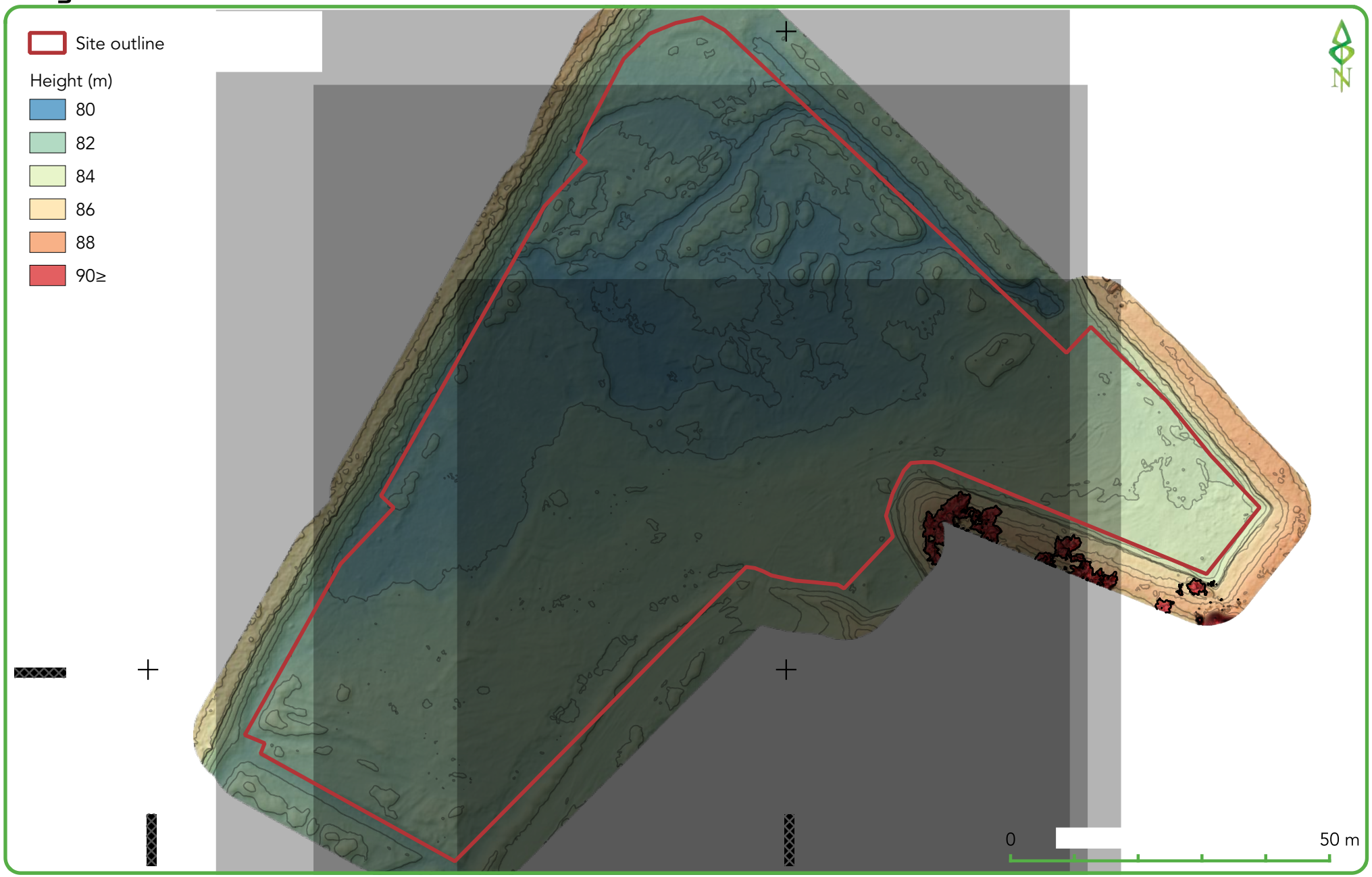

Figure 3 - Digital Terrain Model (DTM) with 0.5m contours

DigVentures

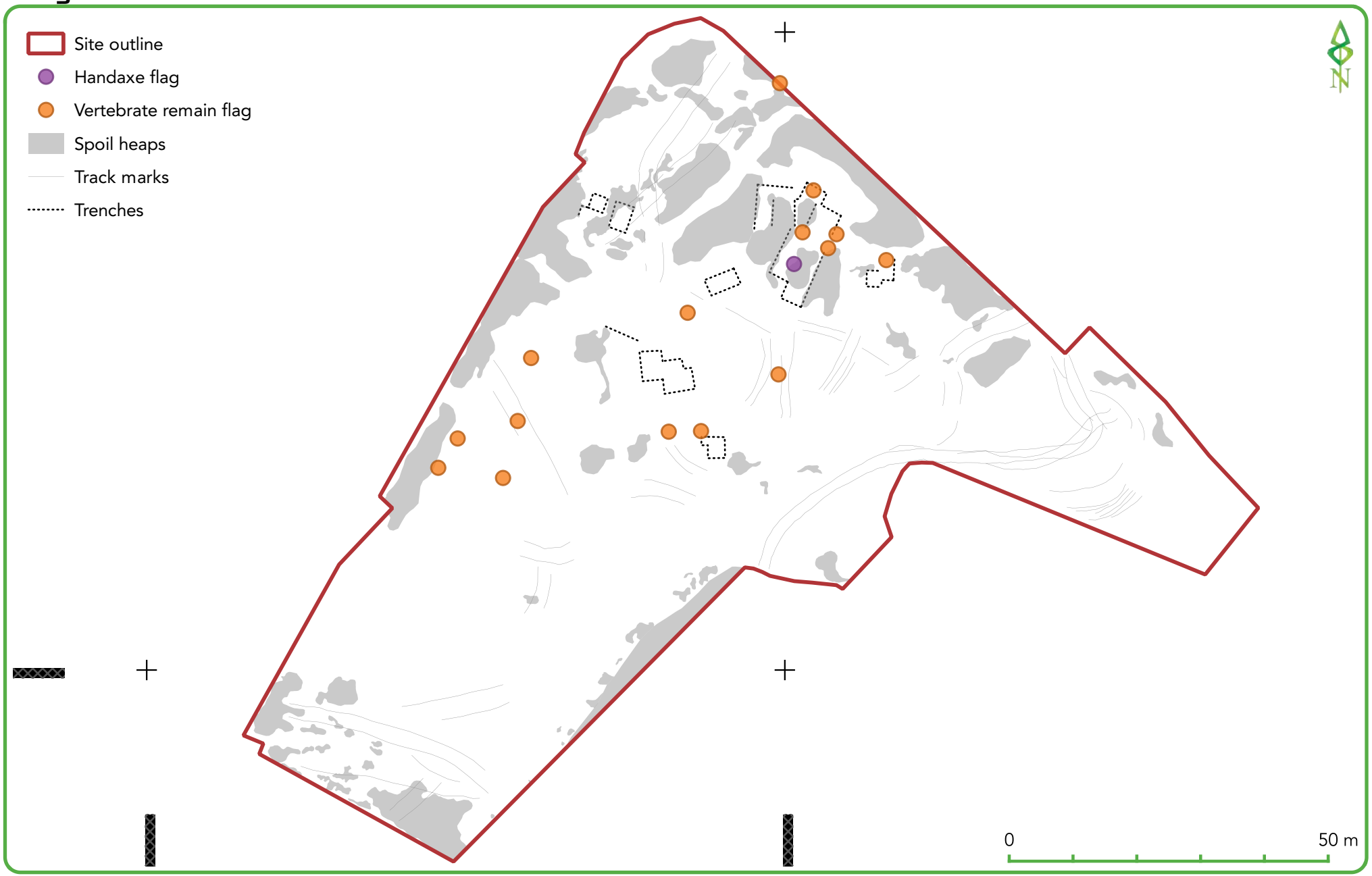

Figure 4 - dGPS survey

DigVentures

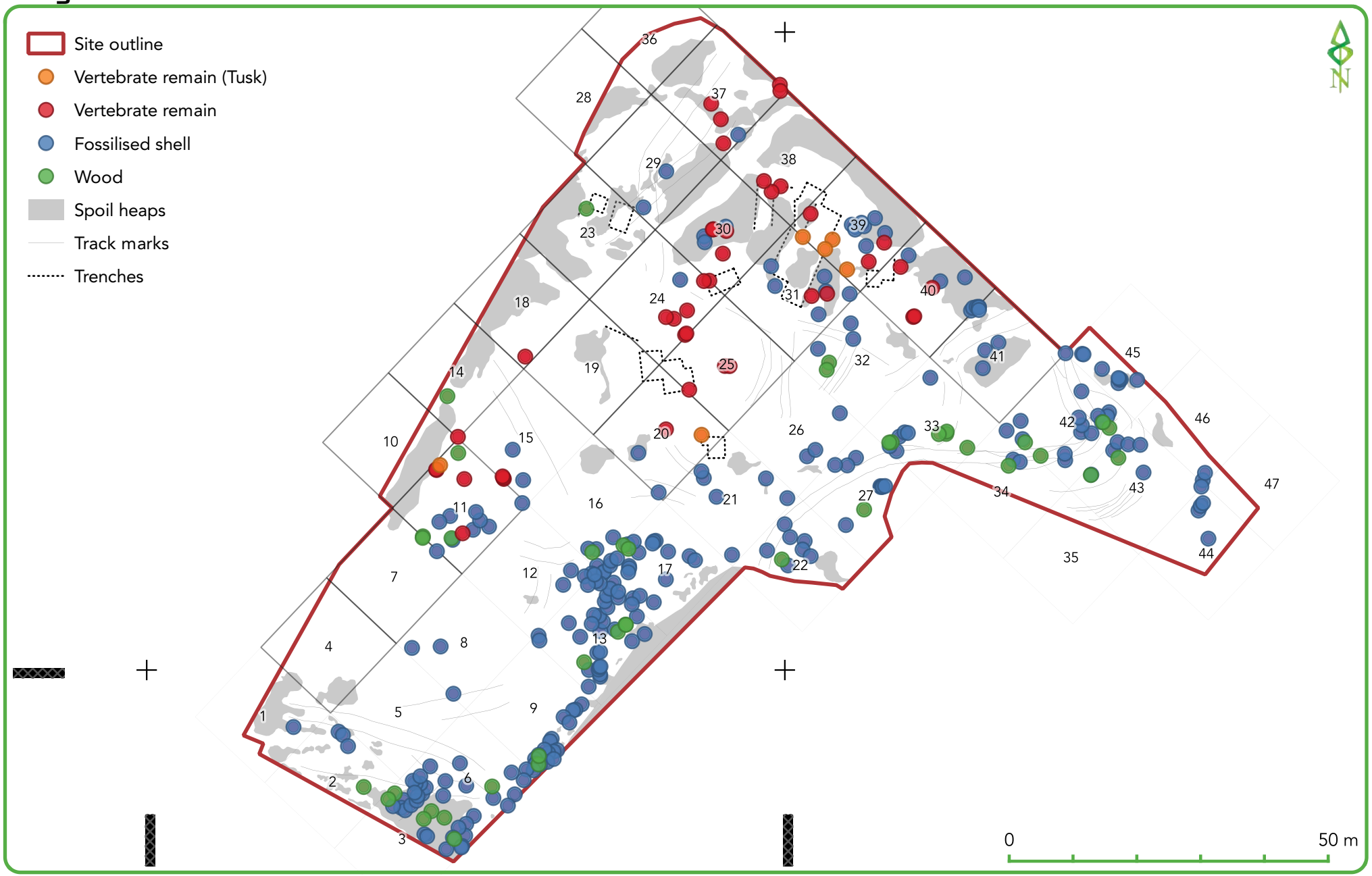

Figure 5 - [redacted]: Fieldwalking survey

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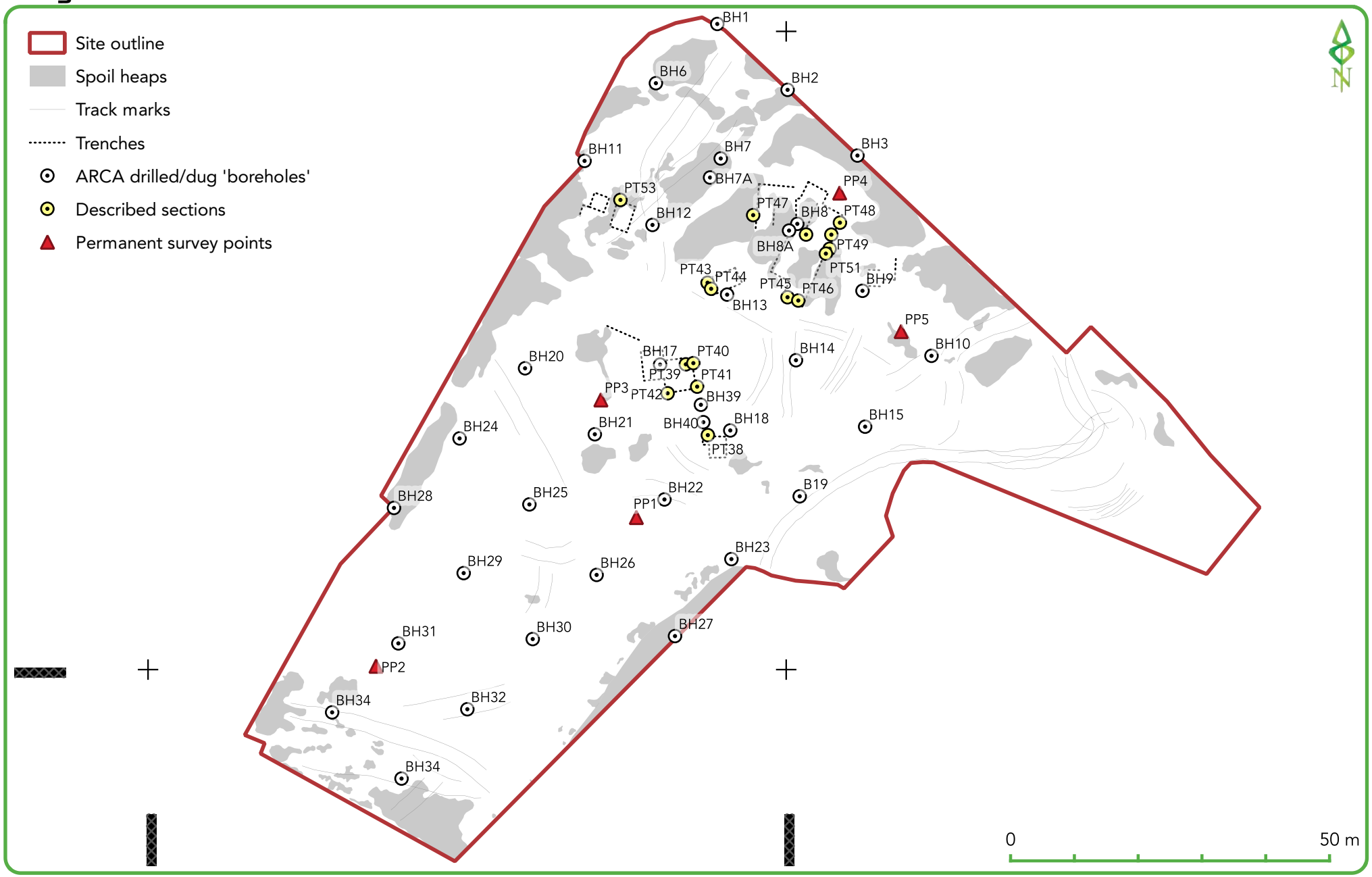

Figure 6 - Geotechnical boreholes and section locations

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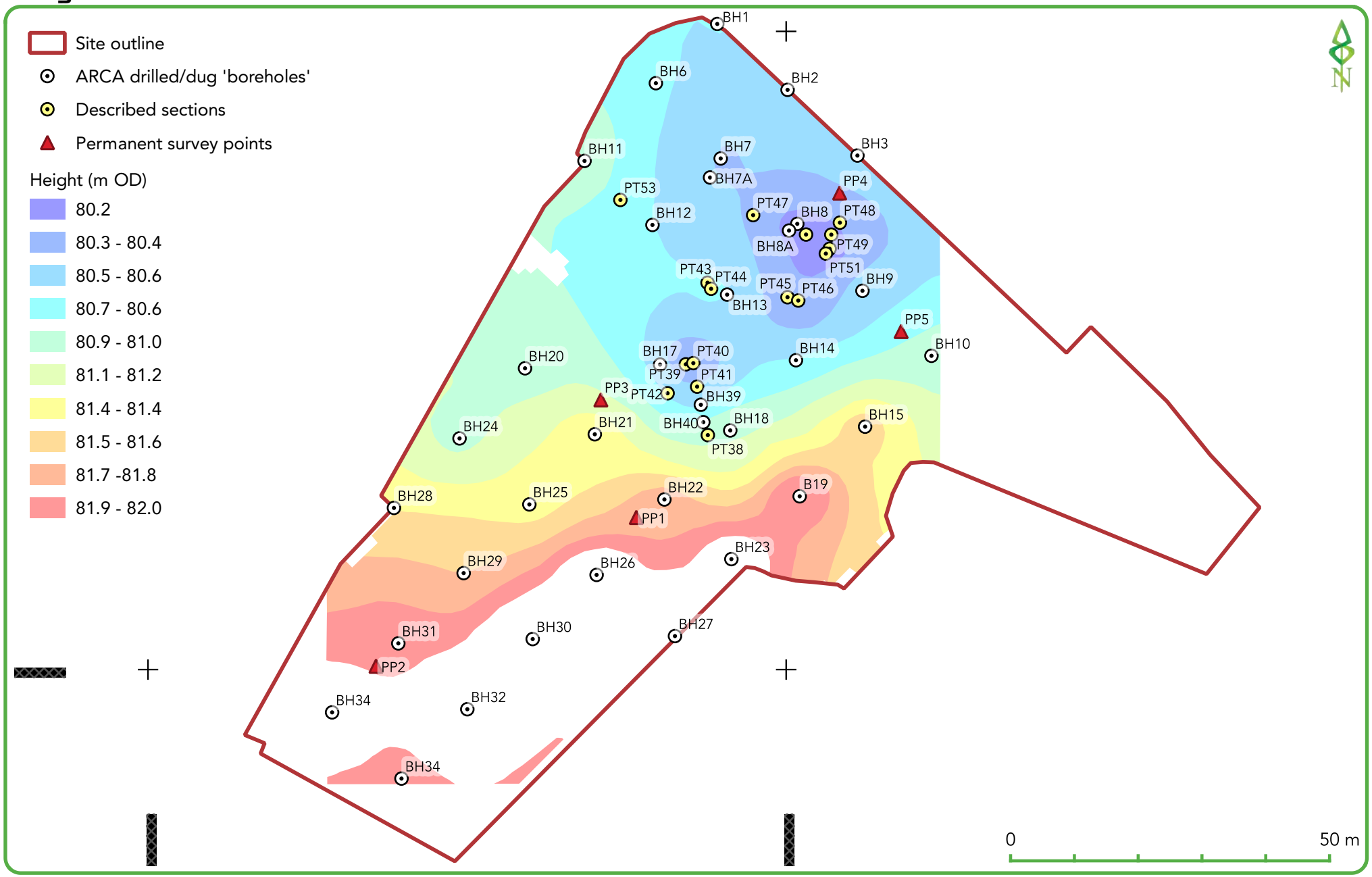

Figure 7 - Modelled surface of the Jurassic substrate

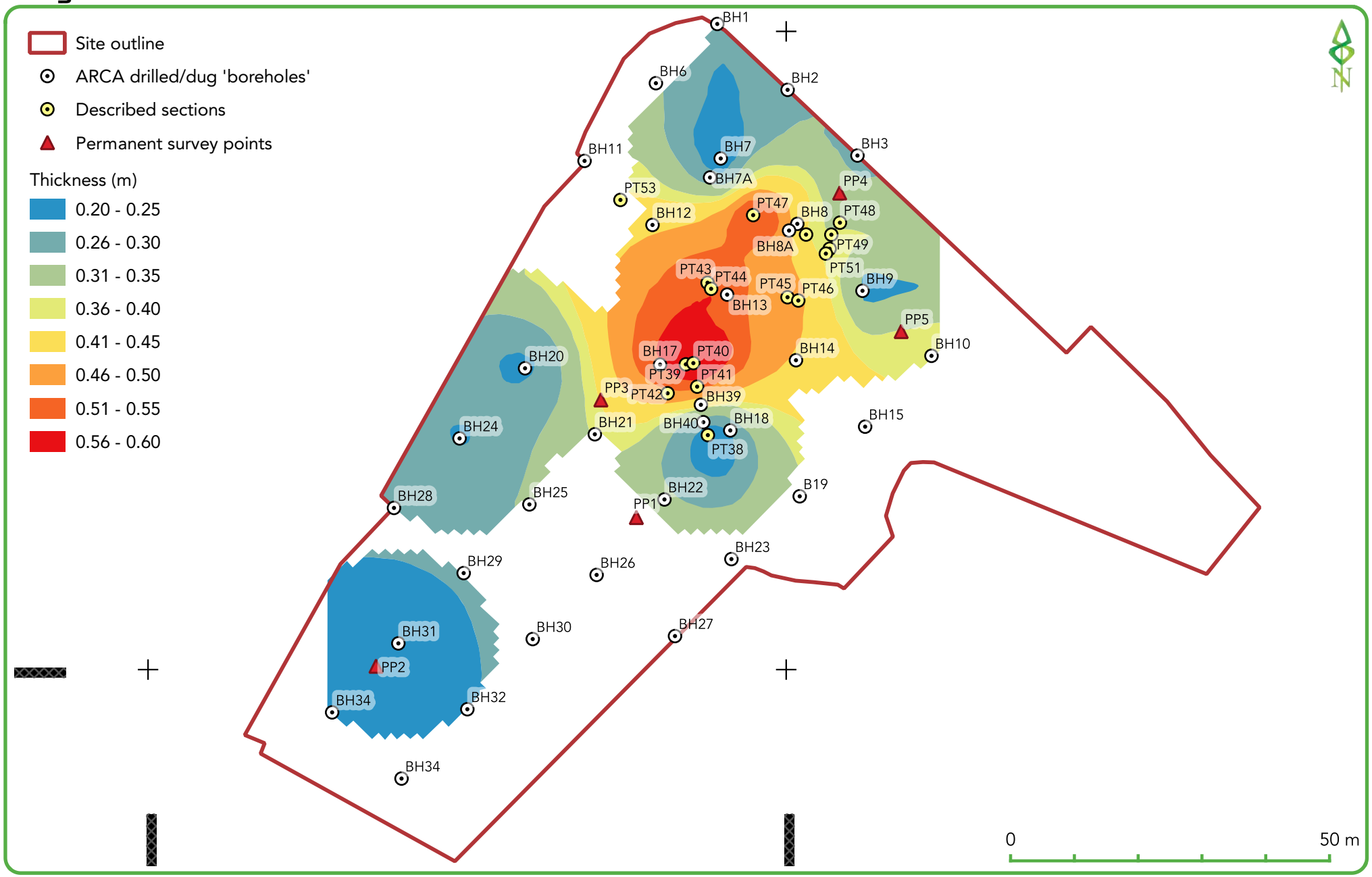

Figure 8 - ▬: Modelled thickness of the palaeochannel deposits ('Lower fill')

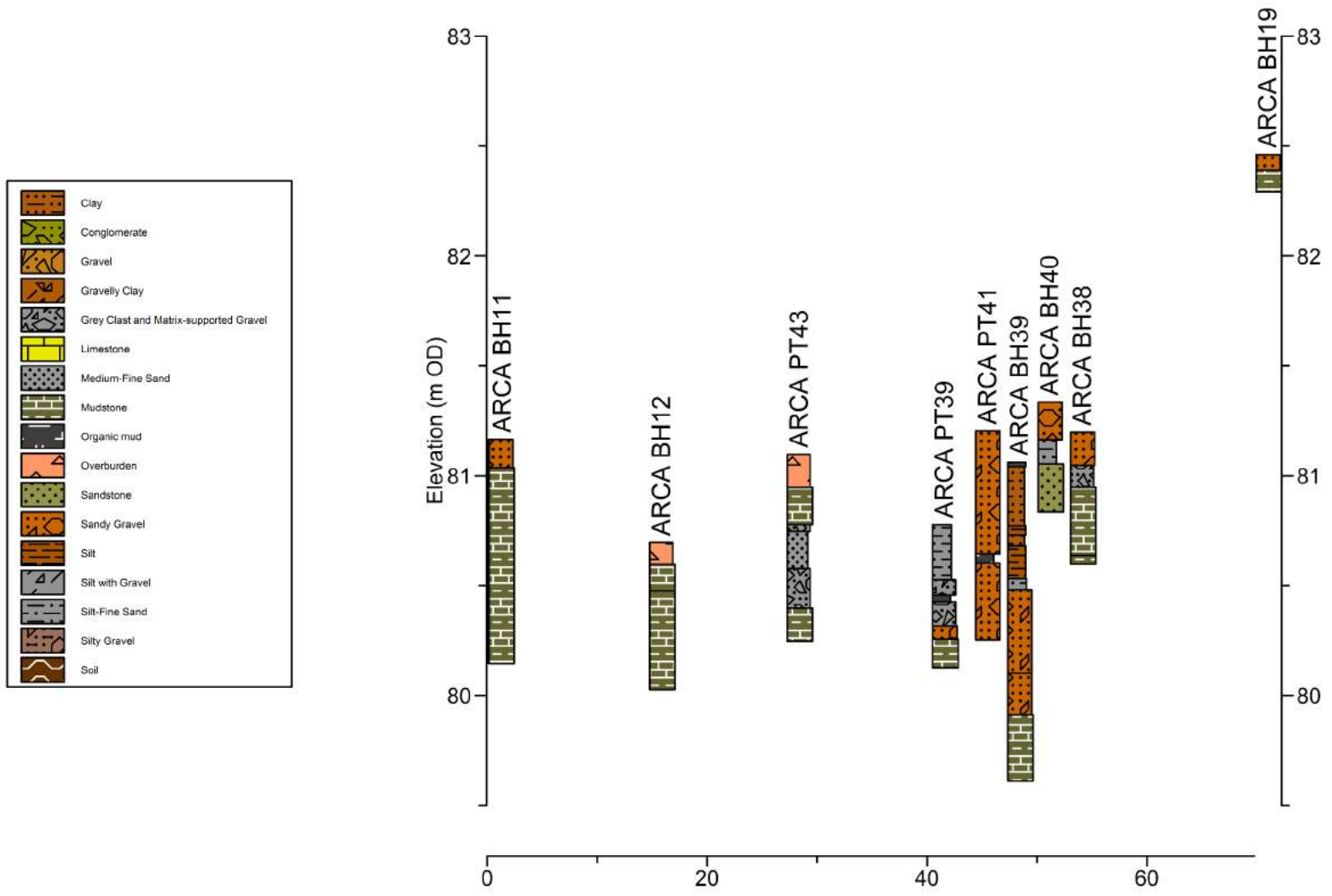

Figure 9 - [redacted] North-south composite cross-section across the palaeochannel through the Hollingworth's southernmost test pit

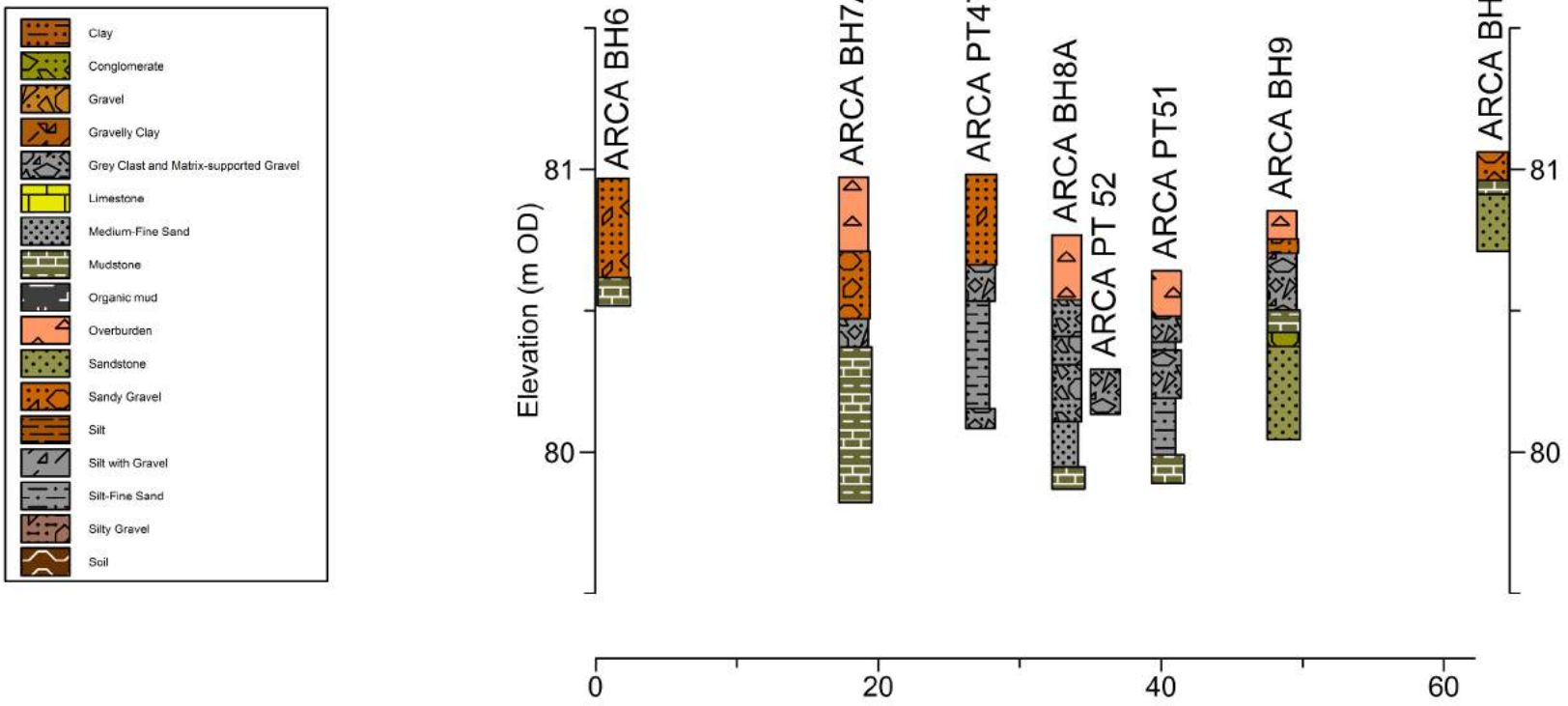

Figure 10 - [redacted] North-south composite cross-section across the palaeochannel through the Hollingworth's northernmost test pit

DigVentures

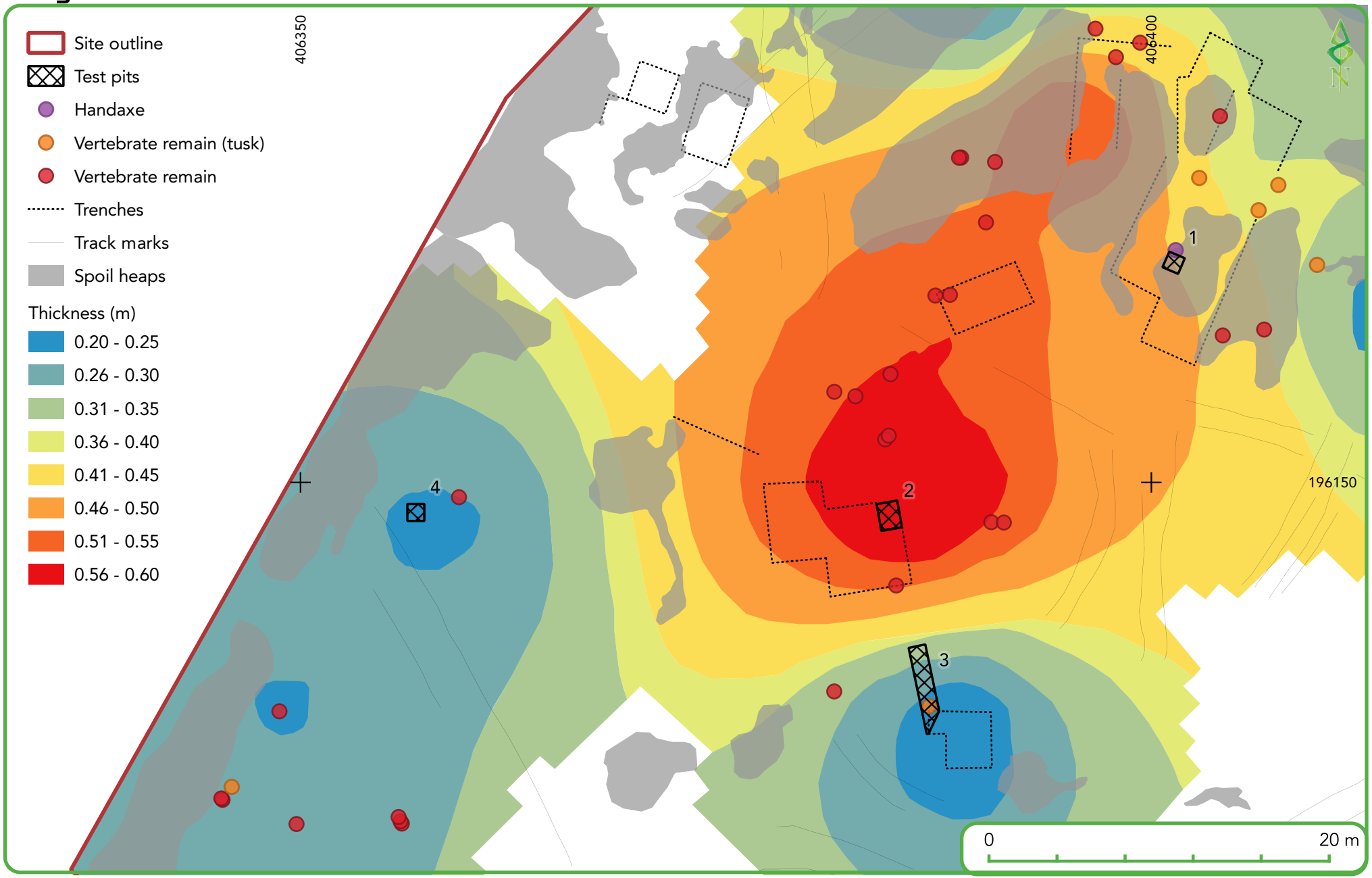

Figure 11 - Proposed location of test pits

Appendices

APPENDIX 1 GRID SQUARE DESCRIPTIONS

Grid	Context	Description	Visibility	Area covered	Interpretation
1	1000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
Link					
2	2000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
Link					
3	3000	10 YR 5/1 grey, fine sand - clay.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
Link					
4	4000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
Link					
5	5000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
Link					
6	6000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
Link					
7	7000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
Link					

Grid	Context	Description	Visibility	Area covered	Interpretation
8	8000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
9	9000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
10	10000	10 YR 5/1 grey, fine sand - clay.	Half was covered in pond weed, and a stream runs through the grid - low visibility.	15m x 15m	Surface of palaeochannel.
11	11000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Covered in a thick layer of silt, especially in the sections that were underwater - low visibility.	15m x 15m	Surface of gravel layer.
12	12000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
13	13000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
14	14000	10 YR 5/1 grey, fine sand - clay.	Covered in water, which was pumped, thick layer of silt - poor visibility.	15m x 15m	Surface of palaeochannel.

Grid	Context	Description	Visibility	Area covered	Interpretation
15	15000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt, occasional pond weed - low visibility.	15m x 15m	Surface of gravel layer.
Link					
16	16000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt, pond weed in NE corner - low visibility.	15m x 15m	Surface of gravel layer.
Link					
17	17000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
Link					
18	18000	10 YR 5/1 grey, fine sand - clay.	Thick silt covers the grid, especially where the water covered the grid.	15m x 15m	Surface of palaeochannel.
Link					
19	19000	10 YR 5/1 grey, fine sand - clay.	Thick silt covered the gird - low visibility.	15m x 15m	Surface of palaeochannel.
Link					
20	20000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Standing water and pond weed in areas and a thin layer of silt - poor visibility.		Surface of gravel layer.
Link					
21	21000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
Link					
22	22000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt, and standing water at W side of grid- low visibility.	15m x 15m	Surface of gravel layer.

Grid	Context	Description	Visibility	Area covered	Interpretation
Link					
23	23000	10 YR 5/1 grey, fine sand - clay.	Grid covered in thick silt and pond weed - poor visibility.	15m x 15m	Surface of palaeochannel.
Link					
24	24000	10 YR 5/1 grey, fine sand - clay.	Grid covered in thick silt and pond weed - poor visibility.	15m x 15m	Surface of palaeochannel.
Link					
25	25000	10 YR 5/1 grey, fine sand - clay.	Large area covered in pond weed, poor visibility.	15m x 15m	Surface of palaeochannel.
Link					
26	26000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
Link					
27	27000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
Link					
28	28000	10 YR 5/1 grey, fine sand - clay.	Covered in a thick layer of silt - poor visibility.	15m x 15m	Surface of palaeochannel.
Link					
29	29000	10 YR 5/1 grey, fine sand - clay.	Covered in a thick layer of silt - poor visibility.	15m x 15m	Surface of palaeochannel.
Link					
30	30000	10 YR 5/1 grey, fine sand - clay.	Covered in a thick layer of silt - poor visibility.	15m x 15m	Surface of palaeochannel.
Link					
31	31000	10 YR 5/1 grey, fine sand - clay.	Covered in a thick layer of silt - poor visibility.	15m x 15m	Surface of palaeochannel.
Link					
32	32000	10 YR 5/1 grey, fine sand - clay.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of palaeochannel.
Link					

Grid	Context	Description	Visibility	Area covered	Interpretation
33	33000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
Link					
34	34000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Covered in a thick layer of silt - poor visibility.	15m x 15m	Surface of gravel layer.
Link					
35	35000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
Link					
36	36000	10 YR 5/1 grey, fine sand - clay.	Covered in a thick layer of silt - poor visibility.	15m x 15m	Surface of palaeochannel.
Link					
37	37000	10 YR 5/1 grey, fine sand - clay.	Covered in a thick layer of silt - poor visibility.	15m x 15m	Surface of palaeochannel.
Link					
38	38000	10 YR 5/1 grey, fine sand - clay.	Covered in a thick layer of silt - poor visibility.	15m x 15m	Surface of palaeochannel.
Link					
39	39000	10 YR 5/1 grey, fine sand - clay.	Covered in a thick layer of silt - poor visibility.	15m x 15m	Surface of palaeochannel.
Link					
40	40000	10 YR 5/1 grey, fine sand - clay.	Covered in a thick layer of silt - poor visibility.	15m x 15m	Surface of palaeochannel.
Link					
41	41000	10 YR 5/1 grey, fine sand - clay.	Covered in a thick layer of silt - poor visibility.	15m x 15m	Surface of palaeochannel.
Link					
42	42000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt, standing water - low visibility.	15m x 15m	Surface of gravel layer.

Grid	Context	Description	Visibility	Area covered	Interpretation
Link					
43	43000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
Link					
44	44000	7.5 YR 4/4 Brown, Granular pebble sized matrix-supported gravel of sub-angular-sub-rounded limestone clasts. Poorly sorted.	Thin layer of dried silt - low visibility.	15m x 15m	Surface of gravel layer.
Link					
45	45000	10 YR 5/1 grey, fine sand - clay.	Standing water - low visibility.	15m x 15m	Standing water - low visibility.
Link					
46	46000	10 YR 5/1 grey, fine sand - clay.	Standing water - low visibility.	15m x 15m	Standing water - low visibility.
Link					
47	47000	10 YR 5/1 grey, fine sand - clay.	Standing water - low visibility.	15m x 15m	Standing water - low visibility.
Link					

APPENDIX 2 FIELDWALKING FIND COUNTS

Grid No	Fossilised Shells	Wood	Vertebrate Remains	Vertebrate Remains (Tusk)	Total
1	1	0	0	0	1
2	3	1	0	0	4
3	14	4	0	0	18
4	0	0	0	0	0
5	0	0	0	0	0
6	21	2	0	0	23
7	1	1	0	0	2
8	3	0	0	0	3
9	19	2	0	0	21
10	0	0	0	0	0
11	8	3	4	4	19
12	4	0	0	0	4
13	33	4	0	0	37
14	0	1	1	0	2
15	2	0	3	0	5
16	4	1	0	0	5
17	22	2	0	0	24
18	0	0	1	0	1
19	0	0	0	0	0
20	2	0	1	1	4
21	6	0	0	0	6
22	7	1	0	0	8
23	0	1	0	0	1
24	1	0	6	0	7
25	0	0	3	0	3
26	3	0	0	0	3
27	9	1	0	0	10
28	0	0	0	0	0
29	2	0	0	0	2
30	3	0	5	0	8
31	6	0	2	0	8
32	3	2	0	0	5
33	6	6	0	0	12
34	3	1	0	0	4
35	0	0	0	0	0
36	0	0	0	0	0
37	1	0	5	0	6
38	0	0	3	0	3
39	8	0	3	4	15
40	6	0	4	0	10
41	6	0	0	0	6

Grid No	Fossilised Shells	Wood	Vertebrate Remains	Vertebrate Remains (Tusk)	Total
42	13	4	0	0	17
43	7	2	0	0	9
44	4	0	0	0	4
45	9	0	0	0	9
46	2	0	0	0	2
47	0	0	0	0	0
Total	**242**	**39**	**41**	**9**	**331**