Gate Burton Energy Park Environmental Statement

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Gate Burton Energy Park Limited

Gate Burton Grid Connection Corridor

Geoarchaeological Monitoring of Ground Investigation Works

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Summary

Wessex Archaeology was commissioned by AECOM, on behalf of Low Carbon Ltd., to undertake a programme of geoarchaeological review of GI logs arising from Ground Investigation (GI) and deposit modelling associated with the Gate Burton Energy Park Grid Connection Corridor (the Site). The proposed Site forms part of a wider development comprising the installation of solar photovoltaic (PV) generating panels and on-site energy storage facilities across the Gate Burton Solar and Energy Storage Park, along with the proposed Grid Connection Corridor (the Scheme) which extends from the Solar and Energy Storage Park to connect to Cottom Power Station.

The aims of the geoarchaeological deposit modelling were principally focused on mapping the presence and extent of superficial deposits across the Site, identifying those deposits of geoarchaeological potential, and informing on the requirements for and scope of any further archaeological and geoarchaeological investigations. The logs produced during the GI works were reviewed as the work progressed, with a provision allowed for on-site monitoring of interventions where required. No on-site monitoring was considered necessary on the basis of this review.

A programme of geoarchaeological deposit modelling was undertaken based on data arising from the GI works, integrating the results of the GI logs and nearby BGS archive boreholes, resulting in a total of 32 data points for the deposit model. The results of the deposit modelling indicate that the number and distribution of data points was sufficient to permit modelling of the major stratigraphic units across the Site with a reasonable degree of certainty. The results of the GI works and subsequent geoarchaeological deposit modelling have revealed a sequence of Mercia Mudstone bedrock, overlain by Holme Pierrepont Sands and Gravels, which in turn were overlain by alluvium and peat at lower elevations within the River Trent floodplain, and Head and the modern soil profile at higher elevations at the valley sides.

Depending on the construction design, the development within the area of the proposed Site may impact upon deposits of palaeoenvironmental and archaeological potential, principally towards the centre of the route (broadly between BH8.5 and BH10) where deposits of peat are present within the Holocene alluvial sequence. In general, the geoarchaeological potential of the Holme Pierrepont Sands and Gravels is considered to be low in the absence of any evidence for organic or fine-grained units in the GI logs.

Acknowledgements

Wessex Archaeology would like to thank AECOM for commissioning the work. The deposit modelling was undertaken by Liz Chambers and Richard Payne. The report was compiled by Richard Payne with contributions from Dr Daniel Young. Figures were produced by Nancy Dixon. The project was managed on behalf of Wessex Archaeology by Dr Alex Brown.

Gate Burton
Grid Connection Corridor

Geoarchaeological Deposit Modelling

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by AECOM (hereafter referred to as 'the client'), on behalf of Low Carbon Ltd, to undertake a programme of geoarchaeological deposit modelling of data arising from Ground Investigation (GI) works associated with the Gate Burton Energy Park Grid Connection Corridor (the Site).

1.1.2 The proposed Site forms part of a wider development comprising the installation of solar photovoltaic (PV) generating panels and on-site energy storage facilities across the Gate Burton Solar and Energy Storage Park, along with the proposed Grid Connection Corridor which extends from the Solar and Energy Storage Park to connect to Cottam Power Station (the Development Consent Order (DCO) Site). A DCO application is in progress:

The Development falls within the definition of a 'nationally significant infrastructure project' (NSIP) under Section 14(1)(a) and 15(2) of the Planning Act 2008 (the "Act") as the construction of a generating station with a capacity of more than 50MW, with a capacity in the region of 500MW.

1.1.3 The project involved GI works (cable percussion boreholes and California Bearing Ratio tests) in the proposed area of the Site. The GI works were located on land within the valley and former floodplain of the River Trent. This area has the potential to contain sequences of Pleistocene river terrace deposits, alluvium and peat of geoarchaeological and archaeological potential (including those preserved within possible relict palaeochannels). A review of GI logs arising from 15 cable percussion boreholes was undertaken, with a provision for on-site monitoring of interventions where suitable deposits were identified. No on-site monitoring was considered necessary on the basis of this review.

1.1.4 The work follows on from previous phases of work including geophysical surveys of the Cable Corridor (Wessex Archaeology 2022a) and the Solar and Energy Storage Park (Wessex Archaeology 2022b), and trial trench evaluation of the Energy Park and Grid Connection Corridor (Wessex Archaeology 2022c).

1.2 Site location

1.2.1 The northern-eastern part of the Site is located 7 km south of the town of Gainsborough and 1 km south of the village of Gate Burton. The southern-western extremity of the Site is located 17 km north-west of Lincoln, adjacent to the Cottam Development Centre Power Station, in the counties of Lincolnshire and Nottinghamshire.

1.2.2 The Site comprises 370 ha of agricultural land, subdivided into 55 fields (numbered 100-154) currently utilised for a variety of crops divided by mature trees and hedgerows. The Site is divided by the River Trent, which bisects the Site on a north–south alignment.

1.2.3 The Site is mostly flat, averaging around 8 m above Ordnance Datum (m OD), barring the land north of Marton village at the north-eastern perimeter of the corridor where the ground rises to 24 m OD.

1.3 Scope of document

1.3.1 In format and content, this document follows the methodology outlined in the Written Scheme of Investigation (WSI) for the Site (Wessex Archaeology 2022d), and conforms to current best practice, including the guidance in *Geoarchaeology: Using Earth Sciences to Understand the Archaeological Record* (Historic England 2015a), *Management of Research Projects in the Historic Environment* (Historic England 2015b) and *Deposit modelling and archaeology: guidance for mapping buried deposits* (HE 2020).

2 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

2.1 Introduction

2.1.1 The archaeological and historical background was presented in an archaeological Written Scheme of Investigation (WSI) prepared for the Gate Burton Energy Park and Cable Corridor (Wessex Archaeology 2022d), building on a prior desk-based assessment (DBA) for the site (AECOM 2022) and the results of the archaeological evaluation (Wessex Archaeology 2022c)

2.1.2 A summary of these results is presented below, with relevant entry numbers from the Lincolnshire Historic Environment Record (HER) and the National Heritage List for England (NHLE) included. Additional sources of information are referenced, as appropriate.

2.2 Previous investigations related to the proposed development

Geophysical survey of cable corridor (Wessex Archaeology 2022a)

2.2.1 The survey identified anomalies associated with archaeological features that are located predominately in the western part of the Grid Connection Corridor. These mainly comprise rectilinear anomalies suggestive of a series of Romano-British enclosures, possibly incorporating multiple phases of activity. The extensive Romano-British remains noted in the surrounding area reinforce this interpretation. The fragmentary remains of further ditches, possible enclosures and pits have been identified throughout the Grid Connection Corridor. Due to their lack of coherence or isolated nature it is not possible to identify any characteristics that would suggest a specific chronology and these may range in date from prehistoric to post-medieval.

2.2.2 An oval anomaly was identified to the west of the River Trent. Additionally, several circular anomalies located in the north-east of the Grid Connection Corridor, adjacent to the eastern bank of the River Trent, have been identified and may represent possible ditches, embankments of roundhouses or small round barrows. Whilst these features are topographically expressed in LiDAR data their interpretation is less than certain from the geophysical results alone, as they could equally relate to natural variation in superficial geological deposits close to the river.

2.2.3 Indications of earlier agricultural activity were represented by areas of ridge and furrow and former field boundaries. Other 19th-century activity such as possible coal extraction pits, demolished buildings at Rectory Farm, and features associated with Marton Pumping Station were also noted. Other anomalies are thought to be natural or modern in origin and consist of land drains, ploughing regimes, services and a former concrete pylon base.

Aerial Assessment (Deegan 2022)

2.2.4 The assessment looked at available aerial photography and LiDAR data covering the evaluation area, including both oblique and vertical photos from a range of dates. The assessment largely supported the results of the geophysical survey, although a complex of features of possible Romano-British date were identified to the west of the cable corridor.

2.3 Archaeological and historical context

2.3.1 The archaeological baseline for the Site was presented in the archaeological evaluation report (Wessex Archaeology 2022c). This summarised aspects of the desk-based assessment (AECOM 2022a) and other publicly available online and in-house resources that are considered relevant.

Prehistoric (970,000 BC–AD 43)

2.3.2 The River Trent, located to the west of the DCO Site, would have been a major routeway and provided a range of resources during the prehistoric period. Flint implements dating to the Middle Palaeolithic have been found close to the river south-west of Marton and a flint adze dating from the Upper Palaeolithic or Mesolithic was recovered at Torksey 1.6 km to the south of the DCO Site. Mesolithic flint artefacts and a stone pounder were found in a field close to Lea Grange, to the north of the proposed Solar and Energy Storage Park. Around the north-western corner of the area, possible prehistoric cropmarks have been identified, east of the village of Knaith, but it is unclear precisely what period these relate to.

2.3.3 Limited remains have been recovered that indicate early prehistoric settlement. However, on the southern side of the Grid Connection Corridor, evidence of Late Neolithic–Early Bronze Age activity was identified during archaeological investigations and a Beaker pottery vessel was retrieved near the bottom of a small pit.

2.3.4 Iron Age activity is only evidenced by individual recorded finds, with no direct evidence of settlement or funerary practices recorded within the area.

Romano-British (AD 43–410)

2.3.5 There is rather more evidence for Iron Age/Romano-British activity within the area, indicating several areas of cropmarks indicating a possible settlement 850 m east of Marton. Furthermore, in the wider area, extensive Romano-British remains are recorded, these are summarised below.

2.3.6 To the south of the Solar and Energy Storage Park the Grid Connection Corridor is crossed by Till Bridge Lane which follows the course of a Roman road linking Ermine Street north of Lincoln, via a ford crossing the River Trent at Marton, to *Segelocum*. The Roman town of *Segelocum*, located 1.5 km north-east of the Grid Connection Corridor, is a scheduled monument, and previous archaeological investigations have identified extensive settlement evidence including building foundations, pavements, kilns and ovens, along with multiple small finds. Although the scheduled area lies outside the evaluation area, previous geophysical survey undertaken on behalf of Historic England showed that the town extends beyond the extent of the scheduled boundary.

2.3.7 A scheduled Roman fort, south of Littleborough Lane adjacent to the north-east limit of the Grid Connection Corridor was identified from a series of cropmarks. Following this, a study was undertaken in 1997 of the Romano-British landscape in this area. The work identified possible Iron Age and certain Romano-British features, with a roadside settlement and evidence of agricultural and manufacturing activities, as well as recording a significant collection of small finds identified from field walking. Further evidence of Romano-British settlement, agricultural practices, and a military presence in the form of a fort at Gate Burton, lay 2 km north of the north-eastern extent of the Grid Connection Corridor. These sites together, contribute to an overall understanding of the significance of the Roman presence in this area.

2.3.8 Within the wider landscape, there is also evidence of settlements, agricultural practices, and a military presence in the form of further forts, as well as multiple individual finds dating to the Romano-British period. Sites within the vicinity include a small rural farming settlement of two phases, spanning the 1st to 3rd centuries at Stow, and cropmarks and artefacts of Romano-British date around Marton. Pottery production is also known in the area, with three 3rd to 4th century Roman pottery kilns excavated at Knaith and a 1st to 3rd century complex of between five and seven kilns at Lea Grange Farm.

Early medieval and medieval (AD 410–1500)

2.3.9 In the winter of AD 872–73, the Viking Great Army made camp at Torksey. Their camp has been identified to the north of Torksey village, in the parishes of Brampton and Torksey, 2 km to the east of the south-west extent of the Grid Connection Corridor (Hadley *et al*. 2016). The camp was is thought to have supported several thousand individuals, including warriors, craft workers and merchants.

2.3.10 There is evidence for the development of the local landscape in the medieval period, including areas of ridge and furrow and trackways. Many of the extant settlements in the area, such as Littleborough, Gate Burton, Marton, Torksey and Rampton, were established during this period. The villages and hamlets of Litteborough, Marton, and Rampton retain their medieval churches, all listed at Grade I, whilst the church at Gate Burton was demolished and rebuilt in the post-medieval period. In addition, the scheduled medieval moated site at Fleet Plantation lies adjacent to the southern boundary of the Grid Connection Corridor. Finally, there are numerous features of unknown date identified from aerial photographs across the area. Some of these may relate to medieval farming and landscape practices.

Post-medieval and modern (AD 1500–1800)

2.3.11 The post-medieval period is characterised by further development of the medieval settlements, potentially in the 18th and 19th centuries. However, those at Gate Burton and Torksey differ, within the majority of the medieval settlements destroyed and major houses built in the post-medieval period. The scheduled monument and Grade I listed building of Torksey Castle is an early post-medieval house constructed in 1560, now ruinous with only its west façade and part of the rear wall surviving. The parkland associated with Gate Burton Hall (NHLE 1359458), 1.5 km north of the Grid Connection Corridor, contains the deserted medieval settlement of Gate Burton. This is a good example of population dispersal caused by emparking (the enclosing of land to create parkland) in the 18th century. The Grade II* listed hall was built in 1774–80.

2.3.12 Archaeological evidence of post-medieval date is predominantly associated with industrial activity. This includes windmills, quarries, kilns and brickyards, as well as the route of the railway and navigational improvements to the River Trent further to the west of the DCO Site. Examples of post-medieval structures include the Clay Farm building, with an associated wind pump, now demolished, located at the centre of the Solar and Energy Storage Park.

2.3.13 Ordnance Survey (OS) maps from 1885 depict the landscape as agricultural land, subdivided by regular fields. Many of the field boundaries have subsequently been removed to create larger fields. The Manchester–Sheffield–Lincolnshire Railway is also sown crossing the site. To the north the designated landscapes at Gate Burton and Knaith are also clearly defined, though the boundaries of the historic areas have notably shrunk since these maps were produced in the late 19th century. In addition, the location of High Pasture Farm, now demolished, is known from the OS map of 1899.

3 GEOARCHAEOLOGICAL BACKGROUND

3.1 Introduction

3.1.1 This section provides a summary of the known geoarchaeological record for the Site and the surrounding landscape, including information relevant to assessing the geoarchaeological and archaeological potential of the Site.

3.1.2 Where age estimates are available for deposits these are expressed in millions of years (Ma), thousands of years (Ka) and within the Holocene epoch as either years Before Present (BP), Before Christ (BC) and Anno Domini (AD). Where radiocarbon dates are included, they are quoted as calibrated (cal.) BC or AD. These dates are supplemented where relevant with the comparable Marine Isotope Stage (MIS) where odd numbers indicate an interglacial period and even numbers a glacial period (**Table 1**).

Table 1 British Quaternary chronostratigraphy

Geological Period	Archaeological Period	Traditional British Chronostratigraphy		Age (ka)	Marine Isotope Stage (MIS)
Holocene		Holocene		11.7 – present	1
Late Pleistocene	Upper Palaeolithic	Late Devensian	Loch Lomond Stadial	11.7 – 12.9	2
			Windermere Interstadial	12.9 – 14.7	
			Dimlington Stadial	14.7 – 29	
	Late Middle Palaeolithic	Middle Devensian		29 – 59	3
				59 – 70	4
		Early Devensian		70 – 116	5a – 5d
		Ipswichian		128 – 116	5e
Middle Pleistocene	Early Middle Palaeolithic			191 – 128	6
			Avery interglacial	243 – 191	7
				300 – 243	8

			Purfleet interglacial	337 – 300	9
	Lower Palaeolithic			374 – 128	10
		Hoxnian		424 – 374	11
		Anglian		478 – 424	12
		Cromerian		524 - 478	13
				790 – 524	14 – 19
Lower Pleistocene				866 – 790	20 – 21

3.2 Solid Geology

3.2.1 The bedrock geology across the Site is mapped by the British Geological Survey (BGS) as Mercia Mudstone, comprising sedimentary rocks laid down 201–252 Ma during the Triassic Period, to the west and middle of the Site. The east of the Site is mapped as Scunthorpe Mudstone Formation, comprising sedimentary rocks laid down 199–201 Ma during the Triassic period.

3.3 Superficial Geology

3.3.1 The BGS map superficial deposits which may date to the Pleistocene and/or Holocene within the Site. Together these epochs form the most recent parts of the Quaternary, a period covering the last 2.6 Ma, and defined by repeated fluctuations between cold (glacial) and warm (interglacial) climate stages (see **Table 2**).

3.3.2 BGS mapping suggests that the following superficial deposits are present in the Site and may be present within the area of the Site (**Figure 1**):

- River Terrace Deposits (Pleistocene)
- Glaciofluvial sands and gravels (Pleistocene)
- Till (Pleistocene)
- Alluvium (Holocene)
- Peat (Holocene)

River Terrace Deposits

3.3.3 River terrace deposits are key contexts for archaeological and geoarchaeological investigation. They represent high energy fluvially deposited sediments, typically sands and gravels, that have been subsequently incised through and preserved as evidence for former floodplains along the sides of current and former river valleys. Where multiple terraces are preserved, they represent successive phases of aggradation and incision covering multiple glacial and interglacial cycles.

3.3.4 Sediment deposition is closely linked to climate, typically comprising coarse grained fluvial sands and gravels laid down during cold stages, with finer grained fluvial sediments accumulating during interglacial/interstadials. Terrace formation occurs during episodes of incision and erosion, creating step-like sequences of sediment.

3.3.5 These sediments have been deposited within the floodplain of the River Trent and cover a period of time back to the Anglian glaciation (MIS 12; 478-424 Ka) when the river came into existence. Prior to this, much of the area drained into the Bytham system; a former river system that drained into the North Sea but was obliterated by the advance if the Anglian ice sheet (Bridgland *et al*. 2014). The River Terrace Deposits in the Site are mapped by BGS as the Holme Pierrepont Sand and Gravel Member. The Holme Pierrepont Sand and Gravel (HPSG) is the youngest Pleistocene unit of the of the Middle Trent Valley terrace stratigraphy (Bridgland *et al*. 2014).

3.3.6 The high energy sands and gravel units of the HPSG likely reflect deposition during cold climatic conditions, probably during the Loch Lomond Stadial (see **Table 2**). Investigations at Holme Pierrepont identified organic silts and peats infilling channels at the base of sands and gravels and cut into bedrock; radiocarbon dates on material from these channel sediments suggest that they date to the Windermere Interstadial (15-12.9 Ka), supporting a latest Devensian date (12.9-11.7 Ka) for the HSPG (Howard *et al*. 2011).

3.3.7 The HPSG is therefore likely to have been deposited during peak cold conditions of the Loch Lomond Stadial, a period in which humans are thought to have been absent from Britain (Jacobi and Higham 2011). However, should any basal channels be present containing organic sediments, akin to those at Holme Pierrepont, these may have significant archaeological and geoarchaeological potential (on the basis that there is clear evidence for human activity in the area during the Windermere Interstadial).

3.3.8 The geoarchaeological interest in GI works in the areas of mapped HPSG is therefore focused on the potential of fossiliferous fine-grained or organic-rich deposits that have the potential to contain Palaeolithic archaeology and palaeoenvironmental remains.

Glaciofluvial sands and gravels

3.3.9 Glaciofluvial deposits of Mid-Pleistocene date are mapped by the BGS at the eastern end of the Site, comprising sands and gravels.

3.3.10 Glaciofluvial sands and gravels are a lithostratigraphic unit mapped by the BGS at the 1:50,000 scale, but in practice may be difficult to distinguish from river terrace deposits without the aid of sedimentary exposures. Glaciofluvial sands and gravels are deposited by seasonal meltwater outwash at the edge of ice sheets or as subglacial, englacial and supraglacial deposits of ice sheets.

3.3.11 Although glaciofluvial sands and gravels have little direct geoarchaeological potential, they may contain eroded and redeposited Palaeolithic archaeology or seal stratified deposits of archaeological and geoarchaeological potential.

Till

3.3.12 Tills are poorly sorted sediments deposited directly by ice sheets. Areas of till are mapped by the BGS to the east and west of the Site, but may be present underlying other mapped superficial deposits. The upper reaches of the Trent Valley and surrounding landscape were glaciated during the last Ice Age (Late Devensian, MIS 2). The tills mapped across the Site are some way south of the mapped extent of the Late Devensian ice sheet, and may therefore relate to earlier glacial episodes between the Anglian (MIS 12, 478-424 Ka) and Late Devensian (MIS 2; 26-11.7 Ka), which in turn has implications for the potential for discovering Lower and Middle Palaeolithic archaeology.

3.3.13 Although tills have limited archaeological and geoarchaeological potential, they may seal and preserve underlying stratigraphy containing environmental remains and artefacts. Deposits of this nature may have a high geoarchaeological potential and importance in understanding the timings and extent of glaciation in this region.

Head and colluvium

3.3.14 Head and colluvium are deposits which include material reworked downslope through climatically and environmentally controlled slope processes associated with landscape instability.

3.3.15 Head is defined as poorly sorted cold-climate slope deposit that represents material reworked downslope from earlier formations through solifluction processes (alternate freeze-thawing). Head deposits are therefore most widely recorded at the base of slopes and along river valleys.

3.3.16 Colluvium represents unconsolidated material which has been deposited downslope by either rainwash, sheetwash and/ or slow continuous downslope creep. Colluviation is likely in areas of topographic relief where soil instability has been brought on by activities such as clearance of woodland, agricultural activity and soil degradation, leading to downslope movement of sediment.

3.3.17 Whilst head and colluvium are not of direct geoarchaeological significance they are assigned a medium geoarchaeological potential as they may include eroded and redeposited archaeology or seal underlying stratigraphy of archaeological and geoarchaeological significance, including buried soil horizons.

3.3.18 Whilst not mapped within the Site deposits of head and colluvium may be present on slopes or at the base of slopes within the Site.

Alluvium

3.3.19 Alluvium is a generalised term covering unconsolidated sediment transported by water in a non-marine environment. Pleistocene river terrace deposits are technically alluvium, but the term here is applied to fine-grained deposits of Holocene date (11.7 Ka to present).

3.3.20 Deposits of alluvium are mapped where the Site crosses the floodplain of the River Trent and at several locations along former courses or subsidiary channels of the Trent, cutting in to the underlying HPSG. In most cases these reflect overbank alluvial deposition during the Holocene.

3.3.21 The geoarchaeological potential of alluvium is low, although it has the potential to contain layers of peat of high potential and may also contain or partially obscure archaeological remains.

3.3.22 The floodplain may also contain palaeochannels which are key contexts for understanding the physical evolution of the landscape and act as effective traps preserving both artefacts and ecofacts indicative of the surrounding environment, human activity and land-use.

3.3.23 Mapping of the Trent Valley (Baker 2007) indicates that palaeochannels are generally rare within the Upper Trent (i.e. upstream from Rugeley), but may be more frequent to the south, and where present will be key contexts for geoarchaeological investigations.

Peat

3.3.24 Peat deposits are mapped overlying the HPSG to the south of the Site. These are mapped on a broadly linear, north–south alignment, and may represent peat deposits accumulating within former channels of the Trent, or in associated floodplain hollows. Such deposits highlight the potential for organic-rich deposits, peat deposits and palaeochannels within both the Holocene floodplain of the Trent and the mapped extent of the HPSG.

3.3.25 Peat comprises partially decayed organic matter preserved within waterlogged anaerobic (oxygen-free) conditions. Peats and organic-rich alluvium are ideal contexts for the preservation of palaeoenvironmental remains (e.g. pollen, plant macrofossils, insects) that provide important data on past climate, vegetation, environment and land-use.

3.3.26 Any peat deposits identified along the route, interbedded in alluvium or preserved in palaeochannels, are therefore of high geoarchaeological potential.

3.4 Summary of geoarchaeological potential

3.4.1 Further investigation and deposit modelling of the GI locations will provide important data on the age, depth and extent of superficial deposits along the route of the Site, and their geoarchaeological potential.

3.4.2 The key deposits that may be encountered within the Site are summarised as follows:

- *River terrace deposits* – potential for fine-grained or organic-rich units containing Palaeolithic archaeology, faunal material and fossiliferous horizons containing palaeoenvironmental and artefactual remains;

- *Glaciofluvial sands and gravels* – may contain or seal deposits of Palaeolithic archaeological and geoarchaeological potential;

- *Till* – potential for underlying stratigraphy of geoarchaeological potential containing palaeoenvironmental and artefactual remains and informing on the timing and extent of glaciation;

- *Head and colluvium* - generally low archaeological and geoarchaeological potential, but in broad terms may contain or bury units with higher potential (such as a stable land-surfaces);

- *Alluvium* – potential to contain or partially mask archaeology, preserve palaeochannels and contain peat or richly-organic units of a high geoarchaeological potential;

- *Peat* – potential for peat units to be preserved in Holocene floodplain alluvium, including within palaeochannels. High geoarchaeological potential, preserving a range of palaeoenvironmental remains informing on past landscape, environment and land-use.

4 AIMS AND OBJECTIVES

4.1.1 The main aim of the geoarchaeological assessment as highlighted in the WSI (Wessex Archaeology 2022d) was to assess the extent, nature and geoarchaeological and archaeological significance of superficial deposits present across the Site.

4.1.2 The overarching aims for the geoarchaeological monitoring therefore include the following:

- To undertake a review of GI logs as GI works on site progress;
- To monitor and record the sequence of superficial deposits revealed in selected GI locations deemed of high geoarchaeological potential (where identified/appropriate);
- To obtain geoarchaeological samples of relevant deposits (where possible);
- To undertake deposit modelling of GI data and relevant BGS archive boreholes in order to map the extent and depth of deposits;
- Interpret the probable environments represented; and
- Determine the importance of the deposits with regard to their archaeological and palaeoenvironmental potential.

4.1.3 These aims were addressed by achieving the following objectives:

- Undertaking a review of GI logs arising from the Site as works progress;
- Identifying the presence of sequences of superficial deposits with archaeological and/or geoarchaeological potential;
- Allowing a provision for monitoring of sequences of geoarchaeological potential where appropriate;
- Correlating available GI data to develop a deposit model for the site, including where appropriate Digital Elevation Models (DEMs), thickness plots and representative transects;
- Establishing the potential of the superficial deposits to preserve archaeological and/or palaeoenvironmental remains; and
- Reporting on the results.

5 METHODOLOGY

5.1 Introduction

5.1.1 All works were undertaken in accordance with the detailed methods set out within the WSI (Wessex Archaeology 2022c) and in compliance with current best practice, including the guidance in *Geoarchaeology: Using Earth Sciences to Understand the Archaeological Record* (Historic England 2015a), *Management of Research Projects in the Historic Environment* (Historic England 2015b) and *Deposit modelling and archaeology: guidance for mapping buried deposits* (HE 2020).

5.2 Review of GI logs

5.2.1 A review of the stratigraphic logs arising from the GI works was undertaken as work on site progressed. This focussed on a series of 15 cable percussion boreholes (shown as BH3-BH16 in **Figure 1**).

5.2.2 The log review was undertaken by a suitably qualified geoarchaeologist, with an assessment of the quality of the sediment descriptions and a geoarchaeological interpretation of the deposits cross-referencing the GI locations with nearby monitored interventions, existing BGS mapping and their topographic context. The results of this review were compiled in an Excel spreadsheet for deposit modelling purposes.

5.2.3 A provision was allowed for during the GI works for monitoring of sequences of geoarchaeological potential (where appropriate). No on-site monitoring was considered necessary during the works.

5.3 Deposit modelling

5.3.1 The results of the review of GI logs were combined with a review of relevant BGS archive borehole logs in order to compile a deposit model for the Site. Deposit modelling was undertaken following the guidance in Historic England (2020) and with reference to the accompanying volume in Carey *et al.* (2018). The deposit model is considered a live and evolving model which, where appropriate/necessary, will be added to as any further GI and purposive geoarchaeological work, evaluation trial trenching and mitigation is carried out at the Site.

5.3.2 A series of geoarchaeological deposit models were constructed for the site using a total of 32 stratigraphic records, comprising data from 15 GI boreholes and 17 British Geological Survey (BGS) online archive boreholes (**Figures 2** to **8**). Only those stratigraphic records with sufficiently detailed descriptive terminology and location data (including surface elevation) were included in the models.

5.3.3 All available data points were entered into industry standard software (Rockworks^{TM} 17). The lithostratigraphy of each sequence was reviewed in order to group the deposits into relevant stratigraphic units, each of which defines distinct depositional environments. Each of these units has been given a distinct colour and pattern that can be identified within the relevant stratigraphic profiles (transects).

5.3.4 The database was used to produce a site-wide model of the stratigraphic architecture, comprising modelled outputs appropriate to the quality and availability of GI data across the site. These outputs include topographic surface and thickness plots in addition to stratigraphic profiles (transects).

5.3.5 Where data points (i.e. borehole and test pit records) are not uniformly distributed over the area of investigation the reliability of the models is variable. As a result, the modelling procedure has been manually adjusted so that only those areas for which sufficient stratigraphic data is present will be modelled. In order to achieve this, a maximum distance cut-off filter equivalent to a 100m radius around each record was applied to the models of the peat, with the rest of the more widely present units given a cut-off filter of 200m.

6 RESULTS

6.1 Introduction

6.1.1 A total of 15 cable percussion boreholes (BH3, BH4, BH5, BH6, BH7, BH8, BH8.5, BH9, BH10, BH11, BH12, BH13, BH14, BH15 & BH16) were drilled during GI works across the Site (**Figure 1**).

6.1.2 The results of the GI log review and geoarchaeological deposit modelling indicate that the number and distribution of geoarchaeological observations is sufficient to permit modelling of the major stratigraphic units across the Site with a reasonable degree of certainty. The results of the geoarchaeological deposit modelling are shown in **Figures 2** to **8.**

6.1.3 The sediment sequences can be divided into five main stratigraphic units: bedrock (including weathered bedrock), Holme Pierrepoint Sand and Gravel Member, alluvium, peat and modern soil profile (topsoil and subsoil). Head deposits were also recorded, but in just three locations on high ground at the eastern end of the Site (**Figure 8**) to the south of Marton.

6.2 Stratigraphy

Bedrock

6.2.1 The bedrock present across the Site was recorded as mudstone at levels between 21.6m OD in SK88SW53 and -11.4 m OD in BH11 (**Figure 7**). Deposits interpreted as weathered bedrock were recorded as siltstone reddish brown/bluish grey silty clay (BH3, BH5 and BH6) or silty clay/clayey silt (BH4) at elevations between 3.79 and -7.42 m OD. The weathered bedrock varies in thickness from 0.3m to 7.8 m.

Holme Pierrepont Sand and Gravel member

6.2.2 Deposits recorded as a variously sandy or silty gravel were recorded in all but boreholes BH15 and BH16, located at the eastern end of the Site (see **Figure 8**).

6.2.3 These deposits were generally present at elevations between c. 5 and -8m OD, and increased in thickness towards the centre of the valley in the area of boreholes BH8-BH12 (see **Figure 8**). As a whole they ranged in thickness from 10.55m in BH12 to 0.7m in BH5, with thinner deposits recorded at the sides of the valley and the thinning to absence east of BH14 (**Figures 5** and **8**).

6.2.4 These sands and gravels are interpreted as fluvial sands and gravels of the Holme Pierrepont Sand and Gravel Member, forming the youngest Pleistocene unit of the of the Middle Trent Valley terrace stratigraphy of Late Devensian date (12.9-11.7 Ka) (Bridgland et al. 2014; Howard at al. 2011).

Alluvium

6.2.5 Generally recorded as variously silty and sandy clays, this unit was encountered between 4.1m OD in SK88SW26 and 1.6m OD in SK88SW8 and ranged in thickness from 0.3m in SK88SW16 to 8.68m in SK88SW28 (**Figure 4**). The alluvium was generally present at elevations between c. 0.0 and 4.0m OD.

6.2.6 Alluvium was generally encountered towards the west and centre of the Site in boreholes BH3, BH8, BH8.5, BH9, BH10 and BH11. It was absent in boreholes BH4, BH5, BH6, BH7 towards the west of the Site and in BH12, BH13, BH14, BH15 and BH16 towards the east.

6.2.7 These deposits are interpreted as Holocene floodplain alluvium of the River Trent, with the generally fine-grained deposits likely forming during overbank flooding at a distance from any active channels.

Peat

6.2.8 Peat was recorded in three of the GI boreholes (BH8.5, BH9 and BH10) towards the centre of the Site, encountered at elevations between 1.61m OD in BH8.5 to 1.07m OD in BH9 and ranging in thickness from 2.9m in BH8.5 to 1.7m in BH10 (**Figures 3** and **8**).

6.2.9 The peat is indicative of a transition to semi-terrestrial conditions in this part of the floodplain, supporting the growth of wetland vegetation.

Modern soil profile

6.2.10 The topsoil varied from sandy clay with ceramic building material (CBM) in BH3, clay silty sand in BH4 and BH5 and a silty clay sand in BH6, with an upper surface that ranged from 1.8m OD in SK88SW8 to 22m OD in SK88SW57 (**Figure 2**).

7 DISCUSSION

7.1 Introduction

7.1.1 The aims of the geoarchaeological deposit modelling were principally focused on mapping the presence and extent of superficial geological deposits across the Site, identifying those layers of highest geoarchaeological potential.

7.1.2 A total of 15 cable percussion boreholes (BH3, BH4, BH5, BH6, BH7, BH8, BH8.5, BH9, BH10, BH11, BH12, BH13, BH14, BH15 & BH16) were drilled during geotechnical investigations across the Site (**Figure 1**). The logs produced during the GI works were reviewed as the work progressed, with a provision allowed for on-site monitoring of interventions where required. No on-site monitoring was considered necessary on the basis of this review.

7.1.3 A programme of geoarchaeological deposit modelling was undertaken, integrating the GI logs and nearby BGS archive boreholes, resulting in a total of 32 data points for the deposit model. The results of the deposit modelling indicate that the number and distribution of data points is sufficient to permit modelling of the major stratigraphic units across the Site with a reasonable degree of certainty.

7.1.4 The sequence of deposits recorded across the Site comprises Mercia Mudstone bedrock overlain by sands and gravels of the Holme Pierrepont Sand and Gravel Member, with Holocene floodplain alluvium of the River Trent recorded towards the centre of the Site. At three locations (BH8.5, BH9 and BH10) within the floodplain of the River Trent, a layer of peat is recorded overlying the Holme Pierrepont Sand and Gravel.

7.1.5 In three BGS archive boreholes (SK88SW55, SK88SW56 and SK88SW57) located on high ground at the eastern end of the Site, Head deposits were recorded overlying the bedrock, which in turn were overlain by the modern soil profile.

7.2 Sedimentary sequence and depositional environment

Modern soil profile

7.2.1 The modern soil was the uppermost unit mainly overlaying the Holme Pierrepont Sands and Gravels and alluvium across the floodplain of the River Trent, and Head deposits and bedrock at higher elevations. The topsoil varied from sandy clay with ceramic building material (CBM) in BH3, clay silty sand in BH4, 5 and a silty clay sand in BH6, with an upper surface that ranged from 1.8m OD in SK88SW8 to 22m OD in SK88SW57 (**Figure 2**).

Alluvium

7.2.2 Alluvium is a generalised term covering unconsolidated sediment transported by water in a non-marine environment. Pleistocene river terrace deposits are technically alluvium, but the term here is applied to fine-grained deposits of Holocene date (11.7 Ka to present).

7.2.3 Alluvium was recorded in 13 of the deposit records towards the centre of the Site, including six of the new GI logs (BH3, BH8, BH8.5, BH9, BH10 and BH11) (**Figure 4**). It was absent in boreholes BH4, BH5, BH6, BH7 towards the west of the Site and in BH12, BH13, BH14, BH15 and BH16 towards the east.

7.2.4 The finer alluvial sediments are generally minerogenic, reflecting active alluvial overbank deposition, and therefore have generally low palaeoenvironmental and archaeological potential.

Peat

7.2.5 Peat was recorded in three of the GI boreholes (BH8.5, BH9 and BH10), encountered between 1.61m OD in BH8.5 to 1.07m OD in BH9 and ranging in thickness from 2.9m in BH8.5 to 1.7m in BH10 (**Figure 3**). The occurrences of peat were limited to the central part of the Site in the vicinity if the River Trent.

7.2.6 These deposits are indicative of a transition to semi-terrestrial conditions on the floodplain supporting the growth of wetland vegetation, and are of high palaeoenvironmental and archaeological potential.

Holme Pierrepont Sand and Gravel

7.2.7 The Holme Pierrepont Sand and Gravel was encountered in all but boreholes BH15 and BH16, located at the eastern end of the Site (see **Figure 8**). These fluvial deposits of the River Trent form the youngest Pleistocene unit of the of the Middle Trent Valley terrace stratigraphy (Bridgland et al. 2014), deposited during cold climatic conditions, probably during the Loch Lomond Stadial (12.9 –11.7 Ka), a period in which humans may have been absent from Britain (Jacobi and Higham 2011).

7.2.8 In general, the geoarchaeological potential of fluvial sands and gravels is low, although they have broad potential to contain reworked Palaeolithic archaeology, and organic and other fossiliferous sediments of significant geoarchaeological potential.

7.2.9 However, no evidence was recorded in the GI logs for buried soils, fine-grained or organic deposits within the Holme Pierrepont Sand and Gravel, and as a result they are generally considered to be of low geoarchaeological potential.

Bedrock

7.2.10 The bedrock was the lowermost unit recorded across the Site, identified as Mercia Mudstone. The unit was recorded between 21.6m OD in SK88SW53 and -11.4 m OD in BH11 and varies in thickness from 0.3m to 7.8 m.

8 CONCLUSIONS

8.1.1 The key results of the geoarchaeological assessment, and the geoarchaeological and archaeological potential of the revealed deposits, are summarised below;

- **Bedrock** comprising Mercia Mudstone was the lowermost unit recorded across the Site and was overlain for the most part by the Holme Pierrepont Sands and Gravels with the exception of higher elevations at the east end of the transect where the bedrock was overlain by Head deposits and the modern topsoil. These deposits are of negligible geoarchaeological potential.

- **Holme Pierrepont Sand and Gravels**, likely of Late Devensian date, were encountered across the Site, absent only in boreholes BH15 and BH16, located at its eastern end. No buried soils, fine-grained or organic-rich units were encountered within the Holme Pierrepont Sand and Gravels, and the geoarchaeological potential of these deposits is considered to be low. However, there is potential for prehistoric archaeology to be present on the surface of the Gravels.

- **Alluvium** was recorded in six of the GI logs (BH3, BH8, BH8.5, BH9, BH10 and BH11). The finer alluvial sediments are generally minerogenic, reflecting active alluvial overbank deposition, and therefore have generally low palaeoenvironmental and archaeological potential.

- **Peat** deposits were recorded in three of the GI boreholes (BH8.5, BH9 and BH10). Peat deposits are of high geoarchaeological and archaeological potential, containing a range of palaeoenvironmental remains of value for informing on past physical landscape, environment and past human activity, and have the potential to contain or mask archaeology.

- **Head** deposits were recorded at the eastern end of the Site. These generally have low archaeological and geoarchaeological potential but may contain redeposited artefacts and palaeoenvironmental evidence. Head deposits can sometimes bury or contain units with greater archaeological and geoarchaeological potential, most notably stable past land-surfaces, although none were apparent here.

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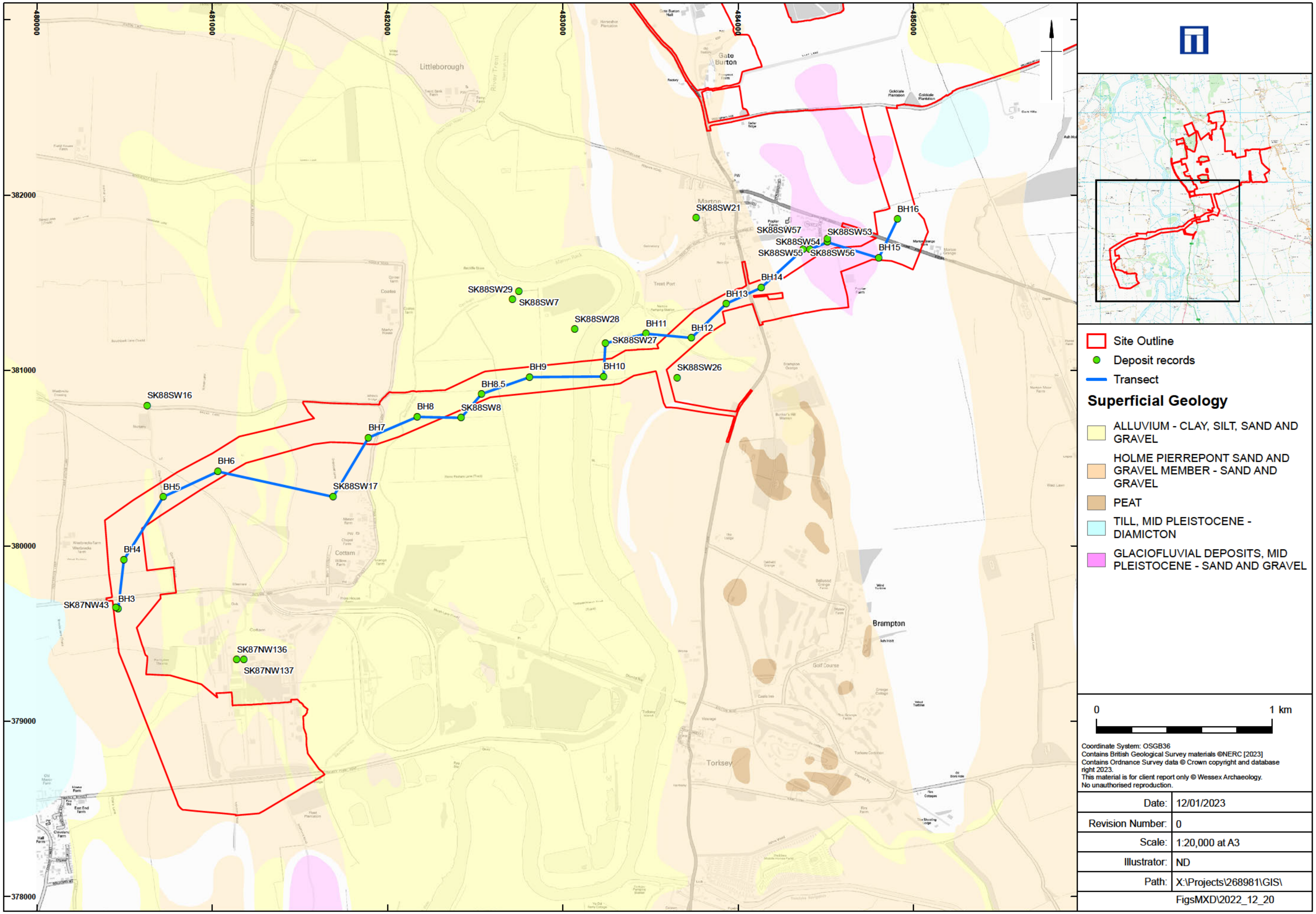
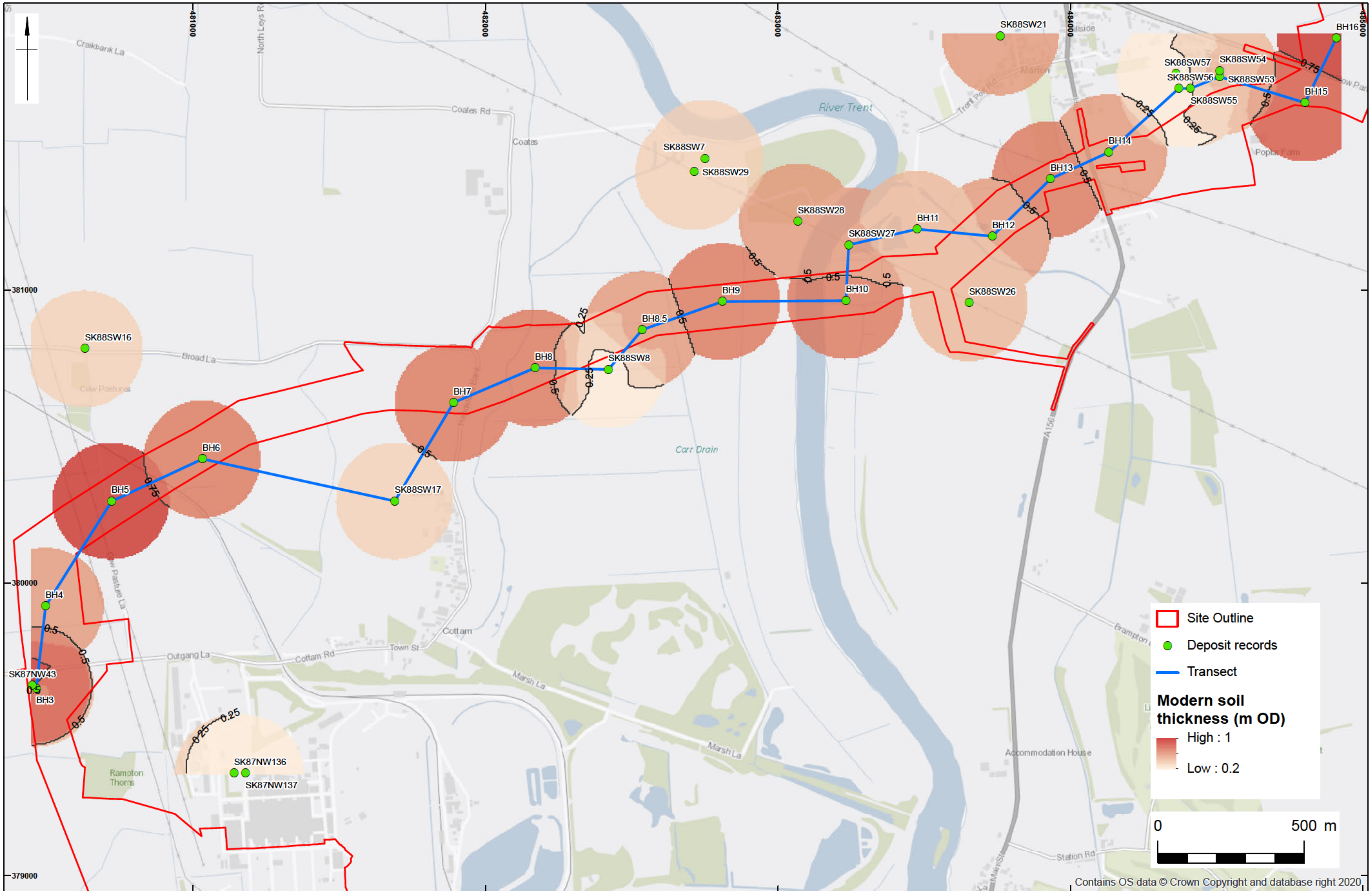


Location of Site, boreholes and transect

Figure 1



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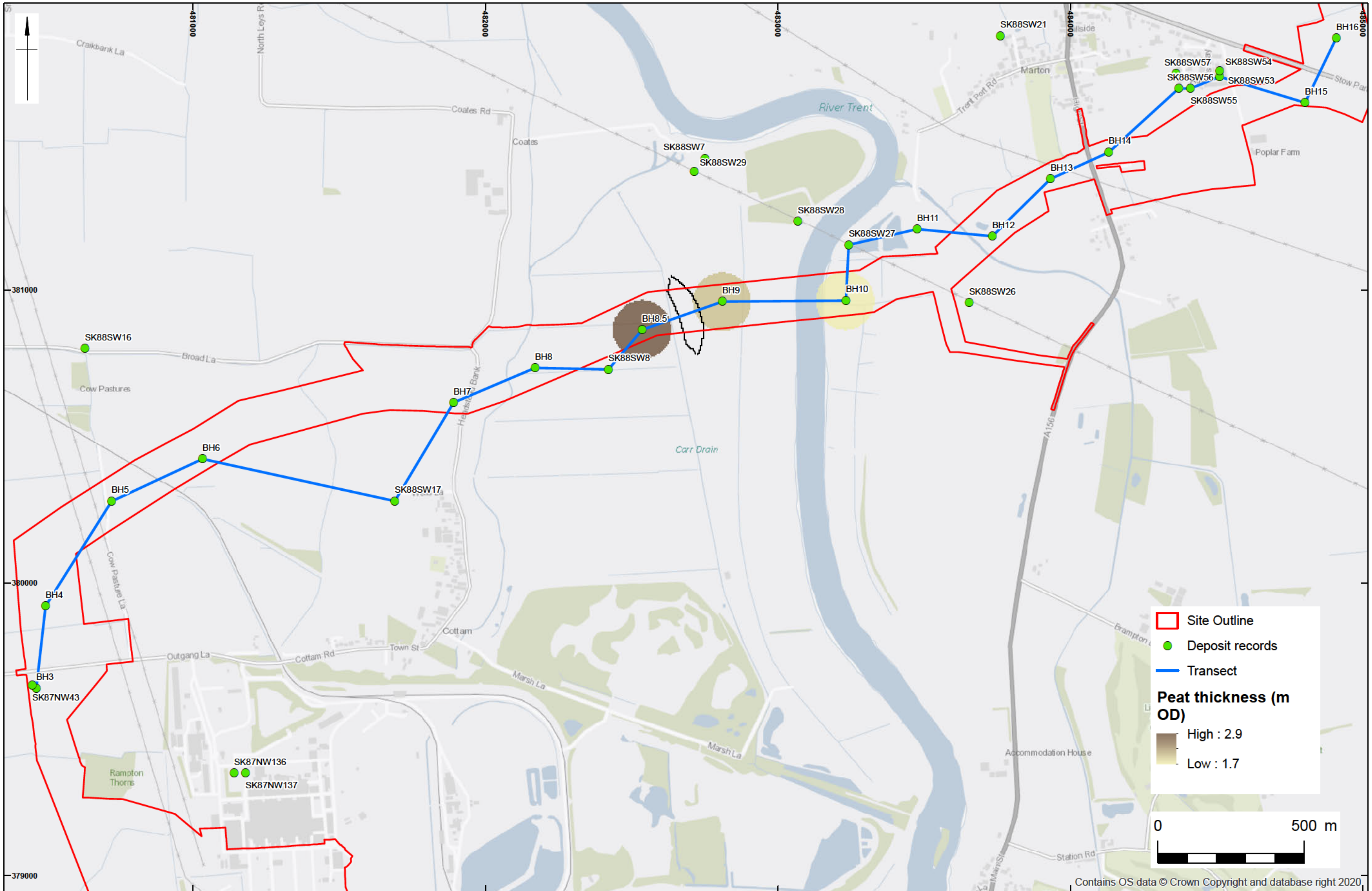
Thickness of modern soil

Figure 2



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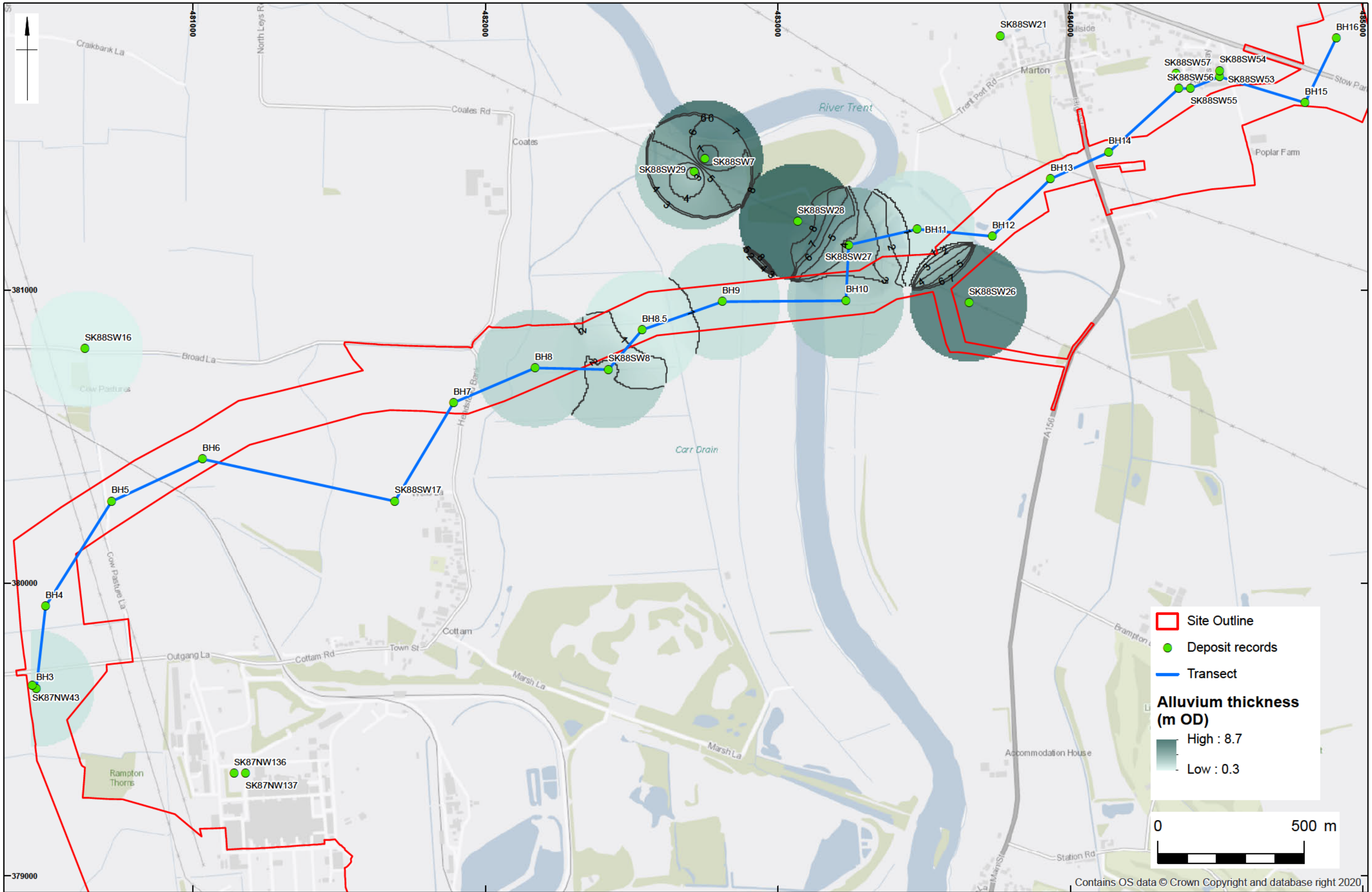
Thickness of peat

Figure 3



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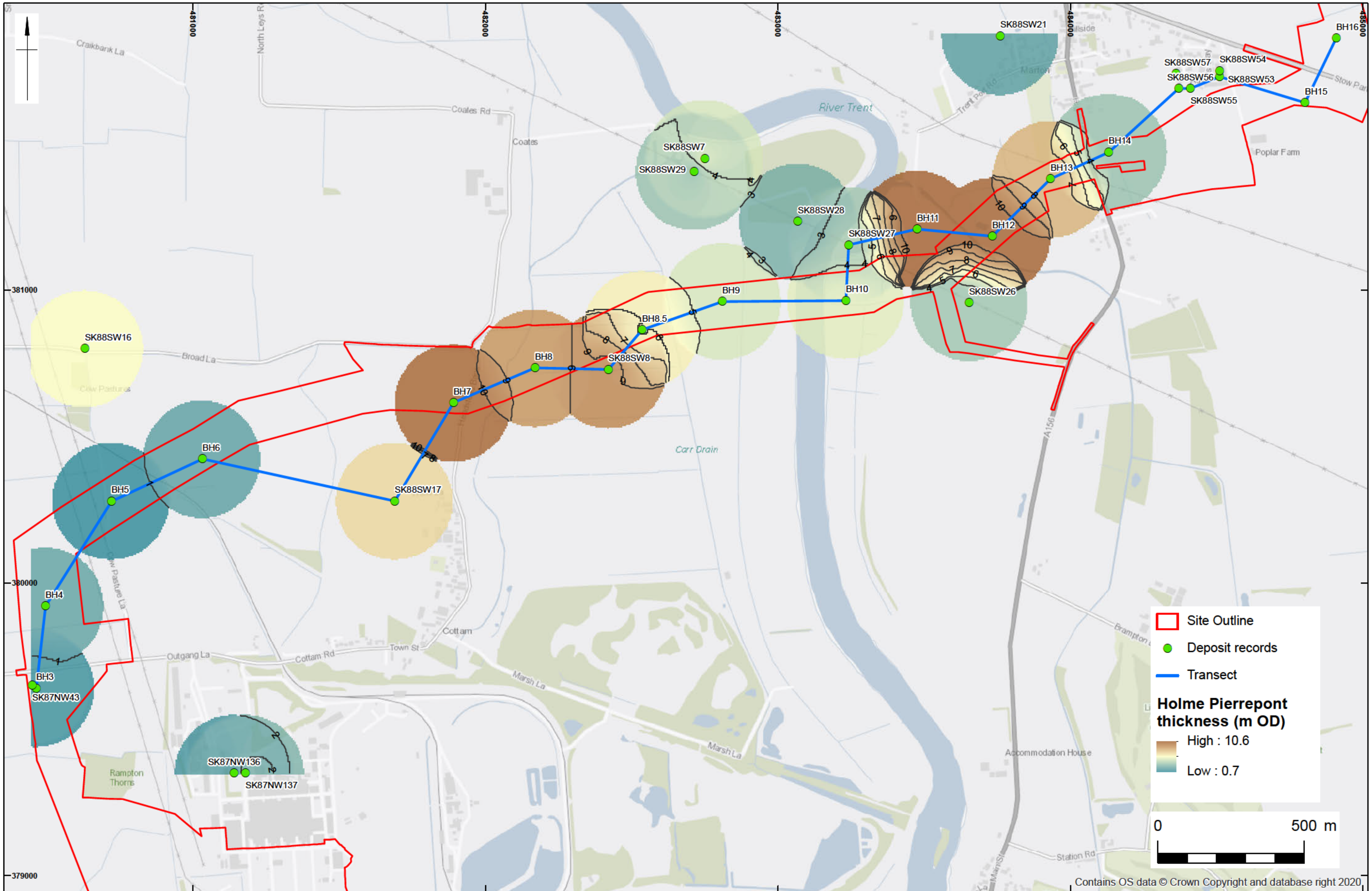
Thickness of alluvium

Figure 4



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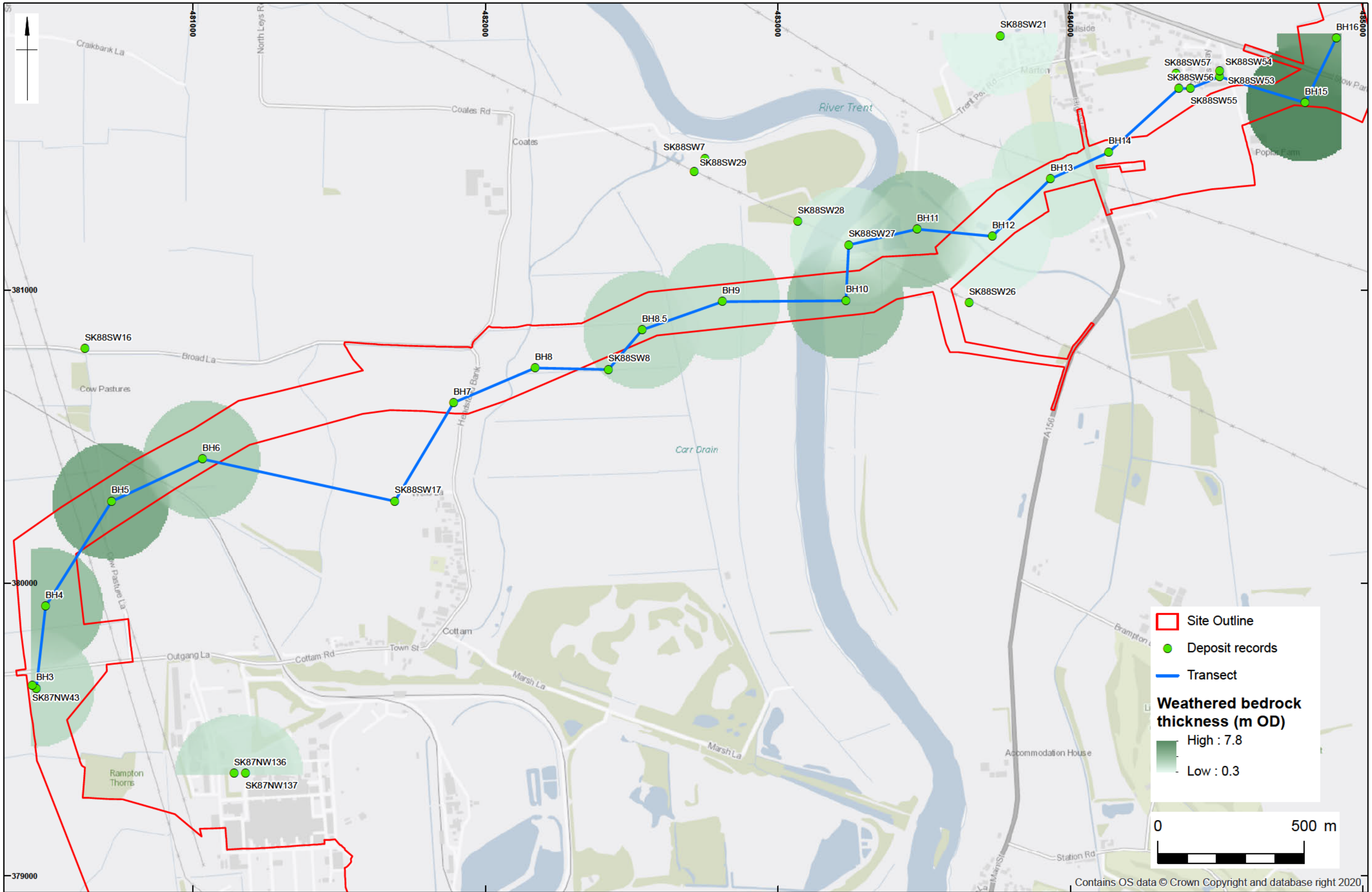
Thickness of Holme Pierrepont Sand and Gravel member

Figure 5



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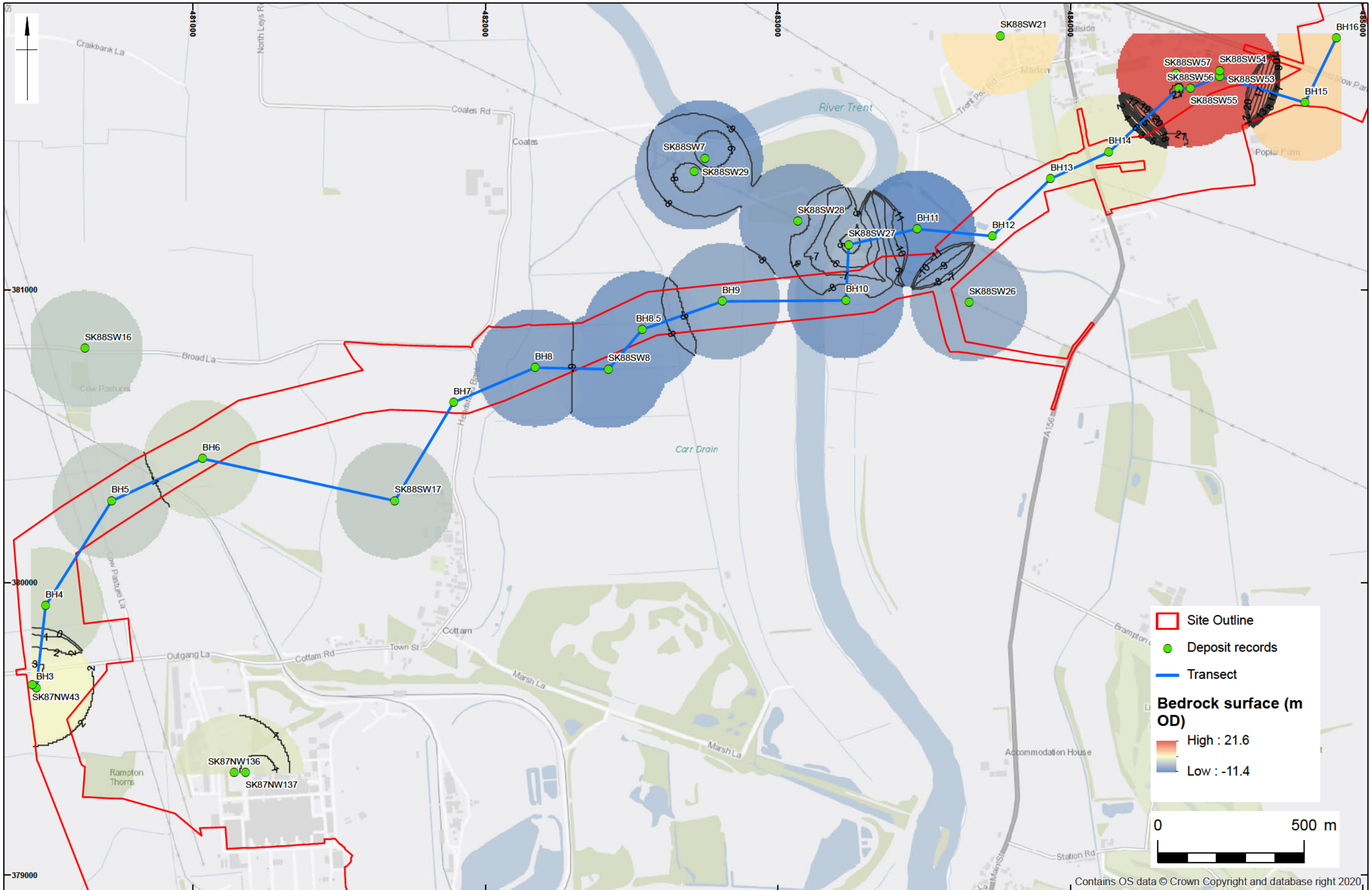
Thickness of weathered bedrock

Figure 6



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Bedrock surface

Figure 7

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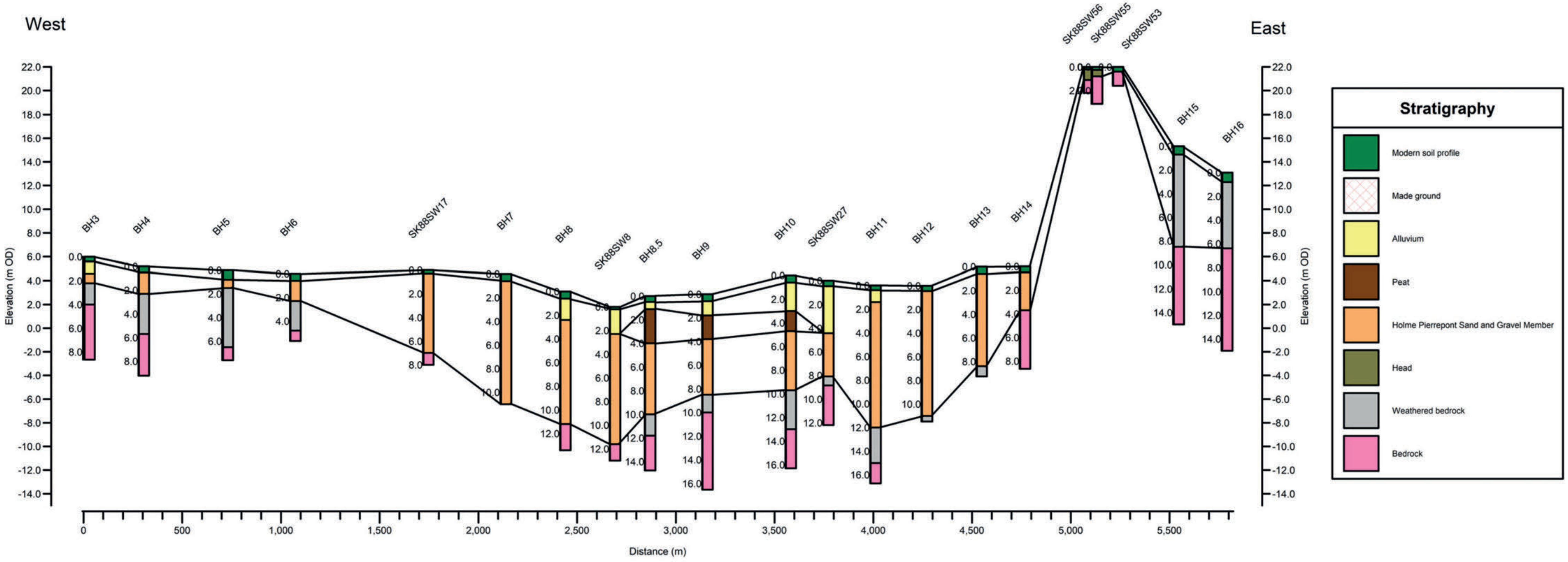

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Figure 8: Transect

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