Tween Bridge Solar Farm

Environmental Statement
Appendix 8.3: Geoarchaeological Assessment

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TWEEN BRIDGE SOLAR FARM YORKSHIRE & HUMBER REGIONS

Updated Geoarchaeological & Palaeoenvironmental Desk-based Assessment Report

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CONTENTS

1. NON-TECHNICAL SUMMARY

The following report outlines the findings resulting from a geoarchaeological and palaeoenvironmental desk-based assessment of the Tween Bridge Solar Farm development. The work was commissioned by Pegasus Group on behalf of RWE Renewables. The aim of the work was to consider the geoarchaeological and palaeoenvironmental potential and heritage significance of the site, which in turn will help inform the need for any further mitigation measures. In order to achieve this aim, a range of documentary sources including geological mapping, satellite imagery and relevant Quaternary literature have been reviewed, enabling initial characterisation of the geography, topography, geology and geoarchaeological and palaeoenvironmental potential.

2. INTRODUCTION

2.1. Background

This report summarises the findings arising from a geoarchaeological desk-based assessment exercise undertaken for the proposed Tween Bridge Solar Farm development. Quest have been commissioned by Pegasus Group on behalf of RWE Renewables to prepare a desk-based geoarchaeological deposit model for the site. This report should be read in conjunction with the Environmental Impact Assessment Scoping Report (EIA) prepared by Pegasus Group (2024).

The site lies in the broad region around the Humber Estuary known as the Humber Wetlands (Figure 1). Within that region the site forms part of the Humberhead Levels in the west and parts of the Isle of Axholme and the lower Trent valley in the east. The site consists of several loosely linked sub-sites (Areas 1-11) occupying farmland between the town of Thorne in the East Riding of Yorkshire to the west, and Isle of Axholme in North Lincolnshire to the east. Several transport routes cross this area from east to west - the Stainforth and Keadby Canal and alongside it the railway, and further south the A18 road and the M180 motorway. There are numerous drains and ditches and part of the site in Area 9 is already occupied by the Tween Bridge Wind Farm. The overall area in which the sub-sites lie extends ca. 9.0km from east to west and ca. 7.0km from north to south. The individual sub-sites are irregular in outline and the links between them are mainly existing roads and farm tracks. Farms and other commercial and residential buildings and the major transport routes are all outside the individual sub-sites.

There is a considerable literature on the geomorphological and palaeoenvironmental history and archaeology of the Humber Wetlands, including in particular the results of the Humber Wetlands Project commissioned and funded by English Heritage between 1992 and 2000, directed by Robert Van de Noort (Van de Noort & Ellis 1997, 1998). The results of the project were summarised by Van de Noort in his 2004 book The *Humber Wetlands – The Archaeology of a Dynamic Landscape*. (see also Van de Noort & Etté 1995, Metcalfe et al 2000, Lillie & Gearey 2000). The present study area was not a focus of intensive research during the project, but the findings of shallow borehole transects and field walking within the study area are described in the project literature (Dinnin 1997a, Head et al 1997) and together with reports of pre-development geotechnical and archaeological investigations (E-on 2009, Headland Archaeology 2015, Pegasus Group 2023, Boreland 2023, WYAS Archaeological Services 2025) provide insights into its alluvial history and archaeology.

2.2. Geoarchaeological and palaeoenvironmental potential

The site traverses a range of landscapes determined by their varying geography, topography and geology. These variations include the type and height of the underlying bedrock, as well as the type, thickness and potential age of the overlying superficial deposits; the superficial deposits being those which encompass the Pleistocene and Holocene periods. Each of these deposits has varying potential to represent an area that might have been utilised or even occupied by prehistoric and historic people, evidence of which may be preserved in the archaeological (e.g. features and structures) and palaeoenvironmental record (e.g. changes in vegetation composition).

The Pleistocene

Pleistocene remains are the geological and biological deposits laid down by various agents – water, wind and ice between 2.6 million and 11,500 years ago. Sediments and their contained faunal and floral remains enable us to reconstruct former landforms and environments that were occupied by prehistoric communities (between approximately 959 and 11.5 thousand years ago).

The Holocene

The Holocene encompasses the last 11,500 years and spans all cultural periods from the Mesolithic to the present day. During this period, sediments have been deposited by water and wind to form alluvial and head deposits. Variations in the elevation and thickness of these different deposits can be significant as they represent different environmental conditions that would have existed in a given location during the Holocene. For example: (1) the presence of peat or soil horizons represent former terrestrial or semi-terrestrial land-surfaces, and (2) the various alluvial units represent periods of changing fluvial conditions, possibly driven by hydrological variability (e.g. relative sea-level and/ or anthropogenic activity within the river catchment). Thus, by studying the sub-surface stratigraphy in greater detail, it will be possible to build a more detailed understanding of the former landscapes and environmental changes that took place across space and time.

Fine grained alluvial and organic-rich sediments (in particular peat) also have high potential to provide detailed reconstructions of past environment and may contain evidence of human occupation in the form of geoarchaeological remains. They provide an opportunity to increase knowledge and understanding of the interactions between hydrology, human activity, vegetation succession and climate during the Holocene. Such investigations are carried out through the assessment/analysis of palaeoecological remains (e.g. pollen, plant macrofossils & insects) and radiocarbon dating.

2.3. Aims & objectives

As stated in section 2.1, the primary aim of this report is to consider the geoarchaeological and palaeoenvironmental potential and heritage significance within the proposed development footprint (Figure 1). This in turn will help inform the need for any further mitigation measures.

In order to achieve this aim, a range of documents and sources has been reviewed including, but not limited to: (1) an Historic Environment Record (HER) search; (2) historical mapping; (3) LIDAR imagery and aerial photography; (4) historical borehole data held by the BGS (http://mapapps.bgs.ac.uk), and (5) relevant geological, Quaternary and archaeological literature.

3. TOPOGRAPHIC SETTING

The following account describes the topographic features of the site as a whole (Figure 2) in the area between Thorne and the Isle of Axholme in which the sub-sites are located (referred to hereafter as 'the study area').

The pattern of relief reflects three landscape elements: (a) in the north-west (Areas 8 and 9/10), a remnant of the floor of the Late Devensian pro-glacial Lake Humber; (b) in the south and west (Areas 1-7) - the floodplain and channels of the 'Old' River Don (Taylor 1987, Dinnin 1997a), and (c) the northward extension of the Isle of Axholme (Area 11), lying between the valleys of the 'Old' River Don to the west and the Lower Trent to the east. Apart from the Isle of Axholme (Area 11) where the ground rises to levels between 8.0m and 9.0m OD, most of the study area is low-lying at levels between 0.0m and 2.0m OD, with only small areas rising above 3.0m OD or falling below 0.0m OD.

3.1. The Lake Floor

Within the site (Areas 8 and 9/10) the lake floor is an almost featureless landscape sloping very gently down in an easterly direction from levels between 2.0m and 1.0m OD to levels close to 0.0m OD. To the west of Area 9/10, the ground rises more steeply to levels up to 6.0m OD beneath the town of Thorne. Thorne Moor lies to the east of Area 9, forming part of the Humberhead Peatland National Nature Reserve, the largest area of raised peat bog in the UK (Van de Noort et al 1997, Dinnin 1997b).

3.2. The River Don channels and floodplain

The original course of the River Don (Figure 3) extended across the present site, passing south of Thorne in an east-south-easterly direction to be joined from the south by a substantial right bank tributary, the River Idle, before turning north-north-east to pass to the west of Crowle. Both the Don and the Idle were diverted from their natural courses in a major scheme of land drainage directed by Cornelius Vermyuden in the 1620s (Tomlinson 1882, Dinnin 1997c). The Don appears to have had

two active channels where it passed west of Crowle and also between Thorne and its confluence with the Idle, where the Boating Dike is now considered to mark the course of the more northerly channel.

In the modern landscape, the river channels can be traced as 'roddons', topographic features rising very slightly above the general level of the floodplain. In the pattern of roddons, the channels of the Don and the Idle that were active immediately prior to the diversion of the rivers in the 17th century can be recognised (Figure 3). This pattern can be verified by reference to contemporary and later maps on which the courses of the rivers are identifiable. In a few places minor water courses still follow the alignments of the roddons – for example to the south-west of Crowle a minor water course is still named 'Old River Don' on Ordnance Survey maps. In addition to these traces of the 17th century rivers, the topographic evidence reveals the presence of former widely meandering courses of the river which must pre-date the early 17th century channel pattern.

The roddons rise to levels generally between 2.0m and 4.0m OD and in a few places are above 4.0m OD. The surrounding floodplain is mainly between 0.0m and 2.0m OD and in a few places is below 0.0m OD. The ground surface slopes gently away from the roddons to the lower levels of the wider floodplain (0.0 – 1.0m OD) to rise again slightly towards the edge of the floodplain (2.0 – 3.0m OD). Within the site, higher ground representing the floodplain margin is limited in extent, mainly in Areas 2, 6, 7 and 11.

For the purposes of this assessment, the alluvial landscape is regarded as comprising three main elements: (a) the river channels (roddons); (b) the adjacent low-lying (proximal) floodplain; and (c) the outer and more elevated (distal) floodplain (see below Section 6, Table 1 and Figure 9).

3.3. The Isle of Axholme

The main extent of the Isle of Axholme lies to the south of the study area where the ground reaches a maximum elevation of just over 40.0m OD between Epworth and Haxey. Within the study area a low topographic swell of higher ground extends northward from these more elevated parts of the Isle of Axholme as far as the market town of Crowle. Much of this topographic swell is at levels above 2.0m OD, rising locally to between 5.0m and 10.0m OD. The higher ground is occupied by the A161 road linking Gainsborough and Goole.

4. GEOLOGICAL SETTING

4.1. Bedrock

The study area is underlain by rocks of the Triassic New Red Sandstone Super Group (Figure 4). In the east, underlying Areas 1, 2, 11 and 12, is the Mercia Mudstone (formerly Keuper Marl) consisting

mainly of red or less commonly grey-green mudstones and siltstones. Underlying the Mercia Mudstone are rocks of the Sherwood Sandstone Group. They form the bedrock beneath the western part of the study area, comprising undifferentiated sandstone, mainly red in colour beneath Area 9, but identified as the Chester Formation (formerly Bunter Pebble Beds) in the south, also predominantly red in colour. Outcrop of bedrock is limited in extent to small areas of Mercia Mudstone in Area 11 on the swell of slightly higher ground forming the northward extension of the Isle of Axholme.

4.2. Superficial Geology

The superficial deposits that underlie the study area provide a record of the events that have shaped the landscape during the past 20,000 years (Figure 4). As noted above, there is a considerable literature on the geomorphological and palaeoenvironmental history and archaeology of the Humber Wetlands during that period. However, the study area has never been a focus of intensive research interest, and literature specific to it is quite limited (Dinnin 1997a, Head et al 1997). There are however a number of unpublished reports of geotechnical and archaeological investigations relating to completed and proposed wind farm developments (E-on 2009, Headland Archaeology 2015) and to the present solar farm proposal (WYAS Archaeological Services 2025).

4.2.1. Glaciation

The whole of the study area was overrun by Late Devensian glacial ice which extended southward as far as Wroot, about 6.0km south of Area 7. The only visible evidence of this glacial episode within the study area is an upstanding body of Devensian fluvio-glacial sand and gravel that forms the margin of the Don floodplain in Areas 6 and 7.

4.2.2. Pro-glacial Lake Humber

During the late stages of the Devensian glaciation, extensive pro-glacial lakes formed in the Humber lowlands. Lake Humber spread across the whole of the study area, resulting in the deposition of lacustrine clays, sands and silts that form the Hemingbrough Formation (formerly the 25-Foot Drift). These lacustrine deposits underlie Areas 9/10 and the western part of Area 8. Boreholes in Areas 9/10 (BGS, archive boreholes, Pegasus Group 2023, E-on 2009) record lacustrine deposits up to 16.5m thick resting on bedrock at levels down to -14.0m OD (see Borehole transect 1, Figure 5). The lower part of these deposits, up to about -7.0m OD is generally sandy and often gravelly, whereas the upper part is rather consistently a laminated silty clay. These lacustrine deposits originally spread across the whole of the study area and remnants of the Hemingbrough Formation outcrop in several places to the south of the M180 motorway. One such outcrop extends northward into the study area in Area 11 on the western flank of the low topographic swell extending northward from the Isle of Axholme. Remnants may also be present beneath later deposits within the study area.

4.2.3. New fluvial drainage network

Following the withdrawal of the Devensian ice and the associated draining of Lake Humber (Fairburn & Bateman 2016), during the final cold sub-stage of the Devensian the Loch Lomond Stadial (12.7 – 11.5ka BP), the ancestral River Don became established on the lake floor and thereafter were the principal agents reshaping the relief of the study area. In the Don valley, a record of this fluvial activity is preserved in the Alluvium which is mapped by the British Geological Survey (BGS) (bgs.ac.uk/geoindex/home) across large parts of Areas 1, 3, 4, 5, 6 and 8, and smaller parts of Areas 2 and 7). Detailed investigation of the alluvial record has never been undertaken in the Don valley and it is not known therefore whether deposits relating to the earliest stages of river activity are preserved in the alluvial record there. Thus, although there is a good record of later Holocene alluviation, there has been no detailed investigation of the early post-glacial history of river activity in the valley of the Old Don.

4.2.4. Aeolian re-working

The harsh climatic conditions of the Loch Lomond Stadial witnessed a period of aeolian reworking of fine-grained sediments exposed at the ground surface, resulting in the formation of cover sands which are widely preserved in eastern England (Bateman 1995, Bateman et al 2000). Two phases of cover sand deposition are recognised by BGS within the study area. The earlier phase is recorded as the Breighton Sand Formation, regarded by BGS as Devensian in age. Generally 1.0-2.0m in thickness, but locally up to 6.0m, and represented in the study area where its outcrop extends into Area 7. The later phase is recorded as the Sutton Sand Formation which may be up to 7.0m in thickness and has been dated to the end of the Devensian and the earliest Holocene (Bateman 1995). Beds of peat may be present in the sand and/or at its base. Within the study area, spreads of Sutton Sand are mapped by BGS in Areas 2, 3, 4, 7, 8, 9/10 and bordering 11. These are all small outcrops apart from Areas 2 and 7. Here boreholes SE70NW29, SE70NW30, SE71SE21, SE71SE22 and SE71SE23 record the Sutton Sand Formation as near surface units of fine sand or silty sand between 1.8m and 3.3m thick.

4.2.5. Fluvial down-cutting and aggradation

Evidence recorded elsewhere in the Humber Wetlands (Neumann 1998, Lillie & Gearey 2000) shows that soon after the establishment of the post-glacial drainage network, the rivers cut down into the weakly consolidated glacial and lacustrine sediments, grading to a sea level at least 20m below present OD and creating, or possibly re-occupying deeply incised valleys. As sea level rose during the Holocene there followed a period of aggradation which led to the infilling of these valleys and ultimately to the development of the broad aggradational floodplains that form the present alluvial landscape in the study area.

4.2.5.1 The Old Don valley

In the valley of the Old Don the available borehole records comprise the BGS archive record, boreholes in three hand-augered transects (Figure 4) undertaken as part of the Humber Wetland Project (Dinnin 1997a) and similar hand-augered transects in a pre-development investigation (Headland Archaeology 2015), in an area close to and coinciding in part with Area 1. In addition, archaeological trenching was undertaken during the present pre-development investigations (WYAS 2025) in three areas in the Old Don valley which coincide in part with, respectively Area 1, Areas 2 and 11, and Area 3. These records are widely and randomly scattered and of variable quality. Many of the boreholes are shallow relative to the full depth of the alluvial sequence which, judging by the deeper boreholes in the Old Don valley maybe in excess of 9.0m in many places beneath the low-lying (0-1m OD) parts of the floodplain. Of the 43 BGS archive boreholes put down within the mapped outcrop of the Alluvium and examined during this assessment only seven could be interpreted with reasonable confidence as penetrating to bedrock, and of these, four were in the outer margins of the floodplain. In addition, in some borehole logs identifying the Bedrock/Alluvium boundary is difficult due to similarities between the Alluvium and underlying weathered Sherwood Sandstone. There is also the possibility that lacustrine sediments of Lake Humber may survive in places beneath the alluvium, e.g. the laminated clay recorded in borehole SE71SE23 which is in the right height range (see Transect 2, Figure 6). Many of the hand-augered boreholes less than 3.0m in depth, and among the few deeper ones none extended beyond 8.0m. However, despite the limitations of the borehole record, some broad stratigraphic patterns can be recognised.

All the individual boreholes mentioned below are in the BGS archive and are identified here by their BGS number (see Transects 1, 2 and 3, Figures 5, 6, 7)

Three of the boreholes that penetrated to bedrock (SE71SW10, SE71SW11, SE70NW3) are situated on or very close to roddons and seem likely therefore to record in-channel sequences. In these boreholes bedrock was encountered at, respectively -16.0m, -11.6m and -12.0m OD (see Transects 1 and 2, Figures 5 and 6). However, the deepest alluvial sequence was recorded in borehole SE71SW23 which penetrated to -17.5m OD without reaching bedrock. This borehole is situated in the floodplain of the Old River Don south-west of Crowle (see Transect 3, Figure 7). In all these boreholes, gravel or gravelly sand formed the lowest part of the sequence. Gravel was also present in five other boreholes (including SE70NW6, SE71SW30, SE71SW29) as the lowest recorded unit at levels of, respectively -10.4m, -6.8m, -5.9m, -4.8m and -2,5m OD. Three of these boreholes are situated on or very close to roddons (SE70NW6, SE71SW37, SE61SE78), the other two are close to borehole SE71SW23 on the floodplain of the Old River Don south-west of Crowle. These thick alluvial sequences have the potential to provide a palaeoenvironmental record extending back at least to the

beginning of the Holocene and possibly as far back as the Late Glacial (Windermere) Interstadial (Buckland & Sadler 1985).

The upper part of the alluvial sequence beneath the low-lying parts of the floodplain (proximal floodplain) and in the roddons consists everywhere of fine-grained mineral sediment or peat. More than 80 boreholes put down in four transects during the Humber Wetland Project (Dinnin 1997a), together with hand-augered pre-development investigations (Headland Archaeology 2015) and archaeological trenching (WYAS Archaeological Services 2025) provide a useful detailed record of the local variability of the upper part of the alluvium. The uppermost part of the sequence is often a unit of sand but the bulk of the alluvium is described in borehole logs as clay or less commonly silt, or as laminated clay with silt in partings or with pockets of silt. Organic material is often present either as peat or clayey peat, or in peaty clay or sand, or as 'organic traces'. Peat/clayey peat units up to 7.0m thick are recorded in some boreholes (e.g. SE71SW30, SE70NW26). These alluvial deposits have the potential to provide a detailed record of palaeohydrology, climate change and the effects of prehistoric and historic occupation on the floodplain and in the wider region during the later part of the Holocene.

The margins of the floodplain (distal floodplain) are not well represented in the borehole record, but an interesting group of five boreholes is present in the valley of the Old River Don just outside the western boundary of the study area (SE61SE82, SE61SE90, SE61SE91, SE61SE95, SE6NE122; see Transect 2, Figure 6). Here the ground level is between 2.0m and 3.0m OD, the alluvial floodplain is narrow and the ground rises sharply at the floodplain edge onto an upstanding area of Devensian fluvio-glacial sand and gravel. In all five boreholes the alluvial sequence is relatively thin (4-5m) and gravel is present at the base of the sequence resting on bedrock at levels between -2.5m and -4.0m OD. Overlying the gravel are fine-grained sediments consisting mainly of laminated silts and clays.

The alluvial deposit of the Old Don valley at its eastern margin within the study area (Area 2) abut the low topographic swell forming the northern part of the Isle of Axholme. Here the bedrock rises from ca. -8.0m OD in borehole SE70NE2 to ca. -2.5m OD in boreholes SE70NE25 and SE70NE53 on the western flank of the swell, and between 5.7m OD (SE70NE30) and 7.6m OD (SE70NE27) on the highest ground. At the highest level the soil is developed directly on the bedrock mudstone or on a thin (<1.0m) bed of silt - probably windblown. The boreholes on the western flank of the swell (SE70NE25, SE70NE53) record 2.0-3.0m of silt resting on a thin (<1.0m) bed of sand. BGS maps Hemingbrough Formation here, but the silt is not recorded as such (or as 25-Foot Drift) in the borehole logs.

4.2.6. Peat

Within the study area, substantial outcrops of peat are recorded by BGS at the surface in Area 2. Smaller outcrops are mapped in Areas 1 and 9, where they represent the southern fringe of the extensive raised bog preserved on Thorne Moor as part of the Humberhead Peatland National Nature Reserve. There are few boreholes in these areas and such as they are in Area 2, they record only thin beds of peat – SE71SE21 0.6m, SE71SE22 0.3m, or none at all (SE70NW13).

4.2.7. Warp

In the 18th and 19th centuries various attempts were made to improve the fertility of soils, mainly on the extensive areas of peat in the Humber Wetlands and the Lower Trent Valley. The principal method adopted is termed 'warping' or 'flood warping'. Described in detail by Creyke (1845) and again by Stephenson (1912), warping involved the construction of embanked enclosures and sluices to trap tidal water from which the suspended sediment load of fine sand, silt and clay settled on the peat surface to create an artificial alluvial soil, termed 'warp'. Both Creyke (1845) and Stephenson (1912) agree that in general the warping process was allowed to continue for two to three years resulting in the accumulation of a thickness of up to three feet of alluvial sediment. The thickness of the warp layer recorded by Lillie (1997) in a study of 58 borehole sequences was between 0.69m and 1.60m.

Within the study area, the evidence of warping is limited in extent (Figure 4). Lillie (1997 Figs 9.1 and 9.2) indicates the presence of warp, as mapped by BGS, on the southern fringe of the peat that underlies Thorne Waste, in the eastern part of Area 9 and along the north-western margin of Area 1. During the 19th century various schemes were proposed to enable a more extensive warping of Thorne Waste. Limbert (1990) describes drainage channels created to facilitate this work but indicates that none of these schemes progressed as far as warping any of the areas involved.

5. PREHISTORIC ARCHAEOLOGICAL POTENTIAL

The survival in the study area of archaeological remains pre-dating the glaciation of the area during the Devensian Late Glacial Maximum is very unlikely. There is however the possibility of Late Upper Palaeolithic remains associated with the deposits of Lake Humber, including those which may be buried in the alluvial landscape of the Old Don valley (see 4.2.5.1 above). A further potential archaeological context within the study area is the deposits of blown sand that are widely present as small outcrops but more substantially preserved in Areas 2 and 7. Elsewhere in Eastern England archaeological remains dating back as far as the Later Upper Palaeolithic have been recovered both beneath and within blown sand deposits similar in age to those in the study area (Buckland 1982).

However, no pre-Mesolithic sites are represented among the 28 HER sites recorded in the study area (Areas 1-11, Figure 8). Most of these HER sites record surface or near-surface investigation and recovery and most are of Roman or medieval interest, but there are three of Mesolithic interest (in Areas 9 and near 11), four of Neolithic interest (in Areas 2, 7 and 9) and two of Bronze Age interest (in Areas 1 and 9). In addition, during field walking forming part of the Humber Wetland Project in the valley of the Old River Don (Head et al 1997), within or near the study area, four prehistoric flint scatters were identified, two of probable Late Mesolithic/Early Neolithic origin. None of the localities investigated was in or close to the study area. Investigations elsewhere in the Humber Wetlands (Van de Noort & Davies 1993, Head et al 1997) have revealed a history of prehistoric occupation which provides a basis for an understanding of likely patterns of occupation within the study area. There is widespread evidence in the Humber Wetlands of Mesolithic occupation particularly in riverine locations, but it has to be remembered that sea level, though rising, remained substantially depressed during the Mesolithic period and any evidence of occupation associated with the rivers and floodplains within the study area is likely to be deeply buried within the Alluvium. Once sea level had risen to the point at which aggradation on the wider floodplain began, the development of eutrophic wetlands, mainly alder carr woodland and reed swamp, discouraged occupation of the floodplain in the later prehistoric period.

6. ASSESSING THE LANDSCAPE AND ITS ARCHAEOLOGICAL, GEOARCHAEOLOGICAL & PALAEOENVIRONMENTAL POTENTIAL

In the light of the topographical, geological and archaeological information outlined above, it is possible to recognise landscape types which may be helpful in assessing and investigating the palaeoenvironmental and prehistoric archaeological potential of the study area. Four main landscape types can be identified (Table 1 and Figure 9).

6.1.1. The Lake Floor

The lake floor is a remarkably uniform area both topographically and in terms of the underlying superficial geology. The likelihood of prehistoric archaeological remains being preserved in the lake sediments is very low. However, the area will have been accessible throughout the prehistoric period and it is therefore possible that Mesolithic, and later prehistoric, groups or individuals were occasionally present on the lake floor where they might have discarded artefacts or left evidence of temporary occupation. Two HER sites of Mesolithic interest are recorded within Area 9 and one each of respectively Neolithic and Bronze Age interest.

6.1.2. River Channels

Evidence of historic and prehistoric river channels is preserved in the valley of the Old Don in the form of ribbons of mainly mineral sediment (roddons) upstanding slightly above the surrounding floodplain. All these channels were deepened in the Late Devensian and Early Holocene in response to sea levels at least 20m below the present. The subsequent aggradation of sediment within these channels has the potential to provide an extended palaeoenvironmental record of landscape and land-use change throughout the Holocene.

6.1.3. Low-lying Floodplain

Low-lying floodplain is the most extensive landscape type within the area mapped as Alluvium by BGS in the valley of the Old Don. This area is underlain by sediments which represent accumulation during much of the Holocene including substantial beds of peat. Floodplains within the Humber Wetland appear to have been attractive to Mesolithic hunter-gatherers, so there is the possibility that evidence of transitory Mesolithic occupation will be preserved in the early part of the alluvial sequence or on 'islands' of higher ground that rise above the level of the surrounding alluvium. An HER site of Bronze Age interest is recorded in Area 1.

6.1.4. The wetland/dryland boundary zone

This landscape type embraces the outer margins of the floodplain in the valleys of the Old Don and the neighbouring higher ground, including the Isle of Axholme (Area 11). The wetland/dryland boundary has been shown in many contexts to have been attractive to prehistoric groups due to the range of resources that it provides. The areas assigned to this landscape type in this assessment reflect the position of the wetland/dryland boundary in the historic period. It must be remembered that as the rising sea level encroached on the low ground of the original Don valley the position of the wetland/dryland boundary will have changed and archaeological evidence associated with it may be preserved beneath what is now the low-lying floodplain. An HER site of Mesolithic interest is recorded on the higher ground of Area 11 and three HER sites of Neolithic interest are recorded near the wetland/dryland boundary zone in Areas 2 and 7.

7. CONCLUSIONS

The shaping of the Humber Wetlands during the past 20,000 years has been well documented thanks mainly to the work of the Humber Wetlands Project (1992-2000). Although published accounts relating specifically to the study area are limited in number, it is nonetheless possible to recognise in the landscape and the underlying geology of the area, evidence of the several stages of landscape development identified in the wider region (see Table 2).

Geoarchaeological potential in the study area is low due either to deep burial of prehistoric land surfaces or unfavourable landscape and palaeoenvironmental conditions for prehistoric occupation.

In terms of the proposed site development, probably the most significant landscape characteristic, especially in the fluvial landscape of Areas 1 and 3-7, is the likely wide variety of near surface ground conditions due to the diversity of alluvial depositional environments and the resultant variety of sediment associations.

8. BIBLIOGRAPHY

Bateman, M.D. (1995) Thermoluminescence dating of the British coversand deposits. *Quaternary Science Reviews*, **14**, 791-8.

Bateman, M.D., Murton, J.B. & Crowe, W. (2000) Late Devensian and Holocene depositional environments associated with the coversands around Caistor, north Lincolnshire, *Boreas*, **29**, 1-15.

Boreland, K. (2023) Land at Tween Bridge. Initial Phase 1 Ground Conditions Desk Study. Intégrale unpublished report.

Creyke, R. (1845) Some account of the process of warping. *Journal of the Royal Agricultural Society of England*, **5**, 398-405.

Dinnin, M. (1997a) The palaeoenvironmental survey of the Rivers Idle, Torne and Old River Don. In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of the Humberhead Levels, an Archaeological Survey*. Hull. 81-155.

Dinnin, M. (1997b) The drainage history of the Humberhead Levels. In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of the Humberhead Levels, an Archaeological Survey*. Hull. 19-30.

Dinnin, M. (1997c) The palaeoenvironmental survey of West, Thorne and Hatfield Moors. In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of the Humberhead Levels, an Archaeological Survey*. Hull. 157-89.

E-on, (Donaldson Associates Ltd) (2009) *Tween Bridge Wind Farm: Site Investigation Report Vol. 1, Factual Report*. Unpublished Report.

Fairburn, W.A. & Bateman, M.D. (2016) A new multi-stage recession model for Proglacial Lake Humber during the retreat Of the last British-Irish Ice Sheet. *Boreas*, **45**, 133-151.

Head, R., Chapman, H., Fenwick, H., Van de Noort, R & Dinnin, M. (1997) The archaeological survey of the Rivers Idle, Torne and Old River Don. In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of the Humberhead Levels, an Archaeological Survey*. Hull. 157-89.

Headland Archaeology (2015) *Old River Don Wind Farm: Geoarchaeological Report*. Unpublished Report.

Lillie, M. (1997) Alluvium and warping in the Humberhead Levels: the identification of factors obscuring palaeo-landsurfaces and the archaeological record. In: Van de Noort, R. & Ellis, S. (eds) *Wetland Heritage of the Humberhead Levels, an archaeological survey*. Hull, 191-218.

Lillie, M. & Gearey, B. (2000) The palaeoenvironmental survey of the Hull valley and research at Routh Quarry. In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of the Hull Valley, an Archaeological Survey*. Hull. 75-101.

Limbert, M. (1990) The drainage of Thorne Waste in the 19th century. *Thorne & District Local History Association, Occasional Papers*, No. 5.

Metcalfe, S.E., Ellis, S., Horton, B.P., Innes, J.B., McArthur, J., Mitlehner, A., Parkes, A., Pethick, J.S., Rees, J., Ridgway, J., Rutherford, M.M., Shennan, I. and Tooley, M.J. (2000) The Holocene evolution of the Humber Estuary: reconstructing change in a dynamic environment. In: Shennan, I. & Andrews, J.E. (eds) *Holocene Land-Ocean Interaction and Environmental Change around the North Sea*. Geological Society of London, Special Publication No. 166, 97-118.

Neumann, H. (1998) The palaeoenvironmental survey of the Ancholme Valley. In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of the Ancholme & lower Trent Valleys, an Archaeological Survey*. Hull. 157-89.

Pegasus Group (2023) Tween Bridge Solar Farm Environmental Impact Assessment Scoping Report. Unpublished report.

Stephenson, J. (1912) Warping. *Journal of the Royal Agricultural Society of England*, **73**, 104-13.

Taylor, M. (1987) *Thorne Mere and the Old River Don*. The Ebor Press, York.

Tomlinson, J. (1882) The Isle of Axholme before Vermuyden. *Agricultural History Review*, 1, 16-28

Van de Noort, R. (2004) *The Humber Wetlands – The Archaeology of a Dynamic Landscape*. Windgather Press, Macclesfield.

Van de Noort, R. & Davies, P. (1993) Wetland Heritage: and Archaeological Assessment of the Humber Wetlands. Hull.

Van de Noort, R. & Ellis, S. (1997) *Wetland Heritage of the Humberhead Levels, an Archaeological Survey.* University of Hull.

Van de Noort, R. & Ellis, S. (1997) *Wetland Heritage of the Ancholme and Lower Trent Valleys, an Archaeological Survey.* University of Hull.

Van de Noort, R. & Etté, J. (1995) The Humber Wetland Survey: background, Objectives and methodology. In In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of Holderness, an Archaeological Survey*. Hull. 1-7.

Van de Noort, R., Chapman, H., Head, R. & Dinnin, M. (1997) The Archaeological Survey of West, Thorne and Hatfield Moors. In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of the Humberhead Levels, an Archaeological Survey*. Hull. 157-89.

WYAS Archaeological Services (2025) *Tween Bridge, Thorne Moors, North Lincolnshire: Archaeological evaluation by Trial Trenching. Assessment Report*. Unpublished Report.

Table 1: Distribution of landscape types, masking sediments and elevation OD within the Tween Bridge sub-sites (Areas 1-11)

Area	Lake floor	River channel	Proximal floodplain	Wet /dry	River Terrace	Blown sand	Peat		<1m	0-1m	1-2m	2-3m	3-4m	>4m	Landscape types
1		x	x				x			x	x	xr	(xr)		ABC
2			(x)	x		x	x				x	x	x	(x)	BC
3		x	x	x		(x)	(x)			x	x	xr	xr		ABC
4		x	x			x	(x)			x	x	xr			AB
5		x	x								x	(xr)			AB
6		x	x	x					x	x	x	xr*	(xr)		ABC
7				x		x	x			x	x	x*	x*	x*	ABC
8	x	x	x	x		(x)				x	x	(xr)			ABD
9	x					(x)	x		(x)	x	x	x			D
10	x					(x)	x		(x)	x	x	x			D
11				x		(x)					x	x	x		C

Brackets indicate that the feature in question occupies a very small part of the sub-site.
'r' in the OD columns indicates that these elevations relate to the roddon-like traces of the Old Don drainage network.
* in the OD columns indicates that these elevations include upstanding areas of Devensian fluvio-glacial or River terrace sand and gravel.

Landscape types:
A River channel
B Low-lying (proximal) floodplain
C Wetland/dryland boundary zone
D Lake floor distal floodplain

Table 2: Landscape development stages

Development stage	Landscape/geological evidence	Location within study area
Late Devensian glaciation	Small upstanding outcrops of fluvio-glacial sand and gravel	Areas 6 and 7
Pro-glacial Lake Humber	Lacustrine sediments	Extensive outcrop in Areas 8 and 9; possibly also present beneath alluvial deposits in the Old Don valley
Incision of the main river channels	Buried channels and in-channel fluvial deposits down to at least -17.5m OD	Associated with upstanding linear topographic features (roddons) in areas 1 and 3-8
Aeolian re-working of fine-grained surface deposits	Cover sands	Mainly in south of study area in Areas 2,6,7 and 11
Development of alluvial floodplains	Clays, silts and sands, often laminated, and peat	Widely present in Areas 1 and 3-7
17th century diversion of the Rivers Don and Idle		

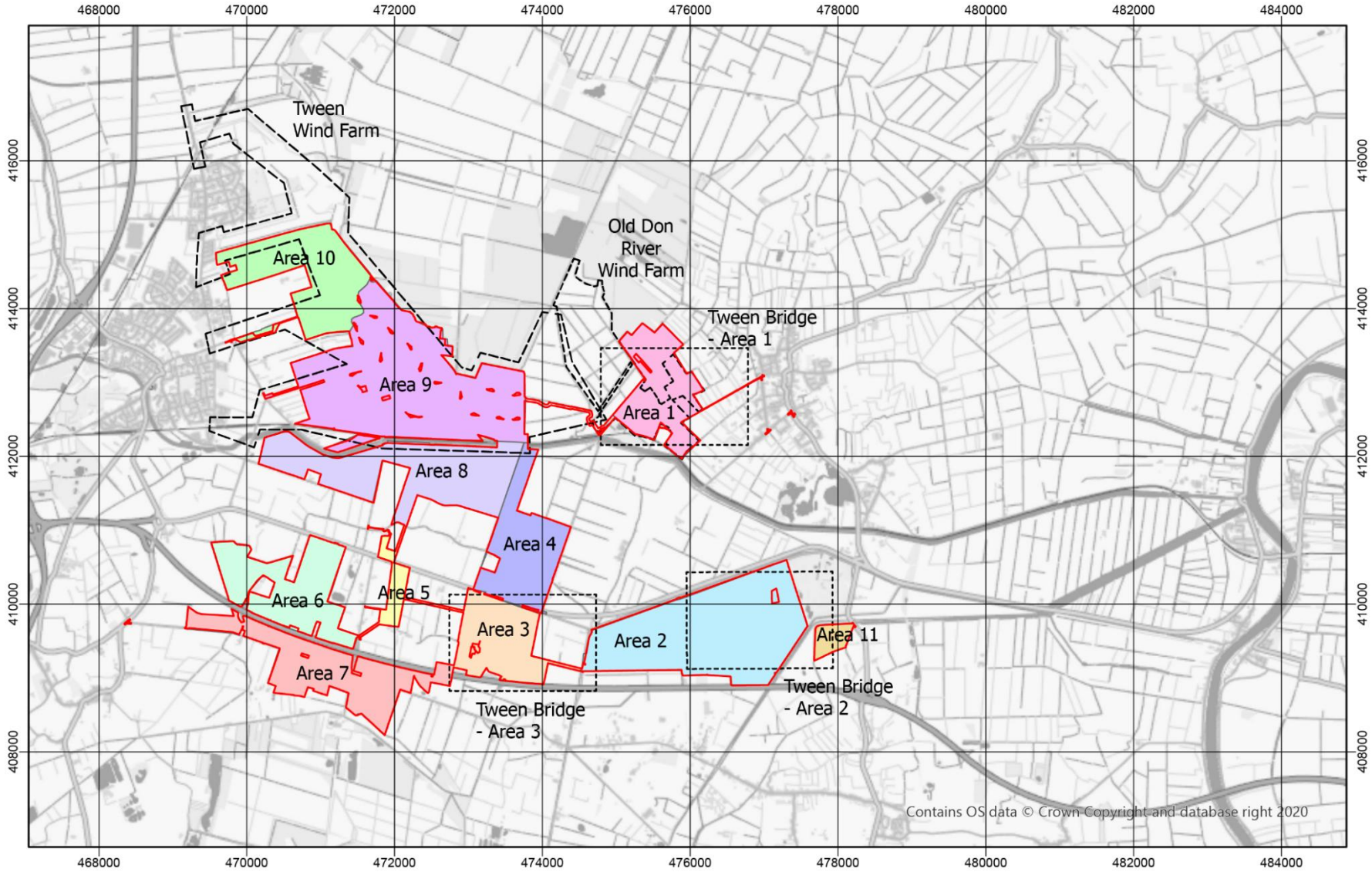

Figure 1: Tween Bridge Solar Farm site outline, individual sub-zones (broadly as defined by Boreland 2023 in Pegasus Group, 2024), and previous investigations

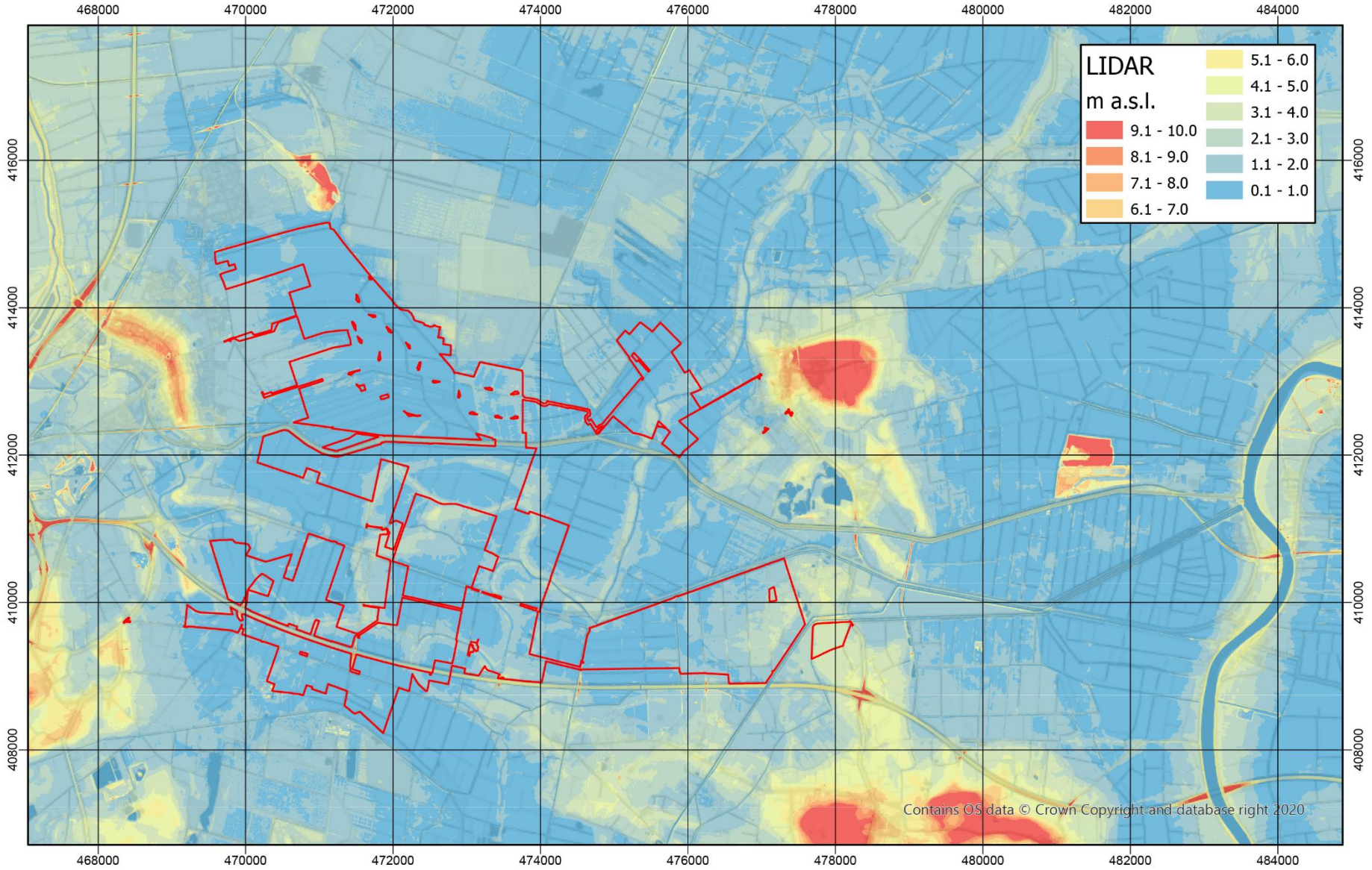

Figure 2: Topography (based upon LIDAR imagery)

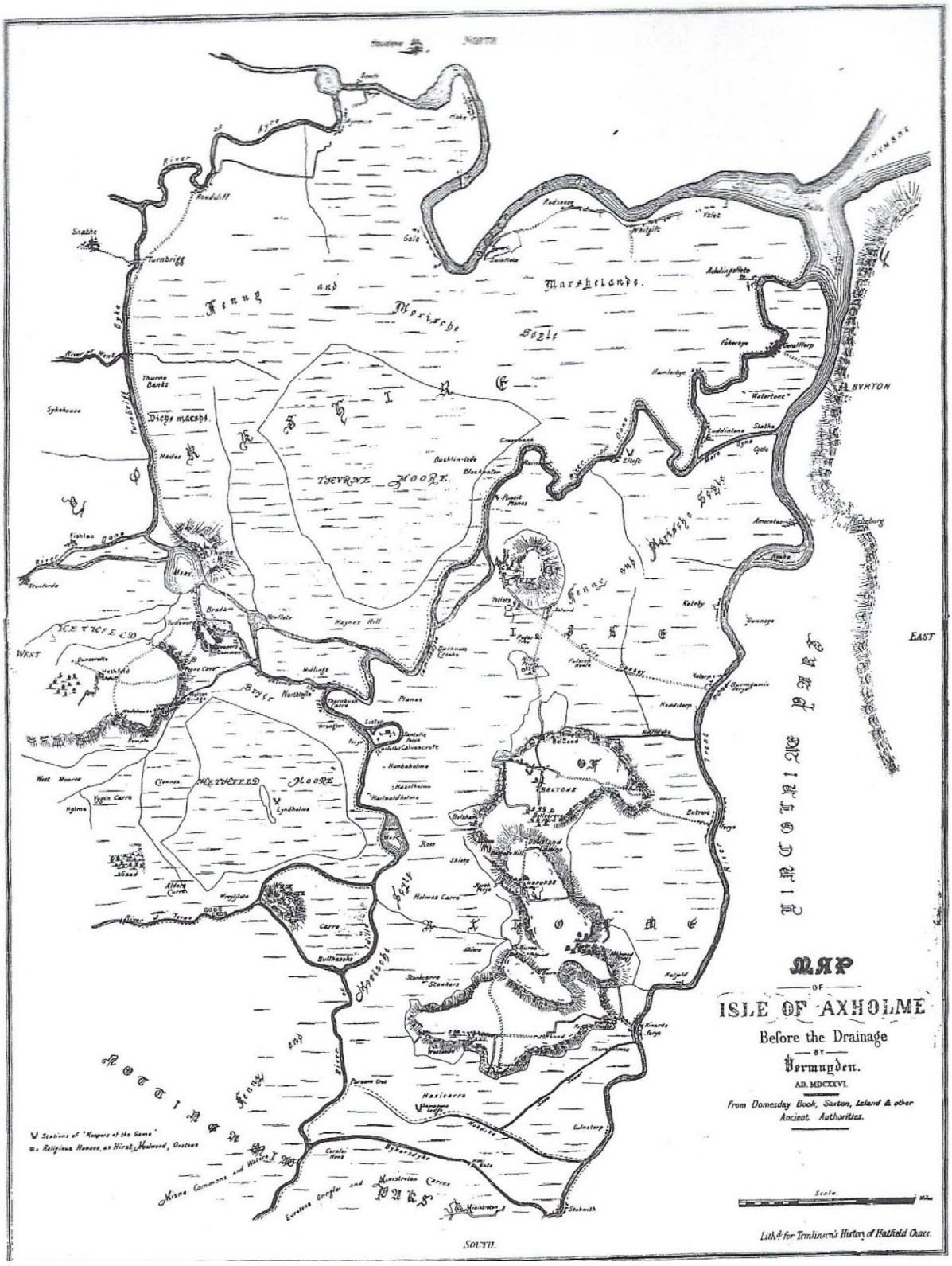

Figure 3: The historic River Don (Tomlinson, 1882)

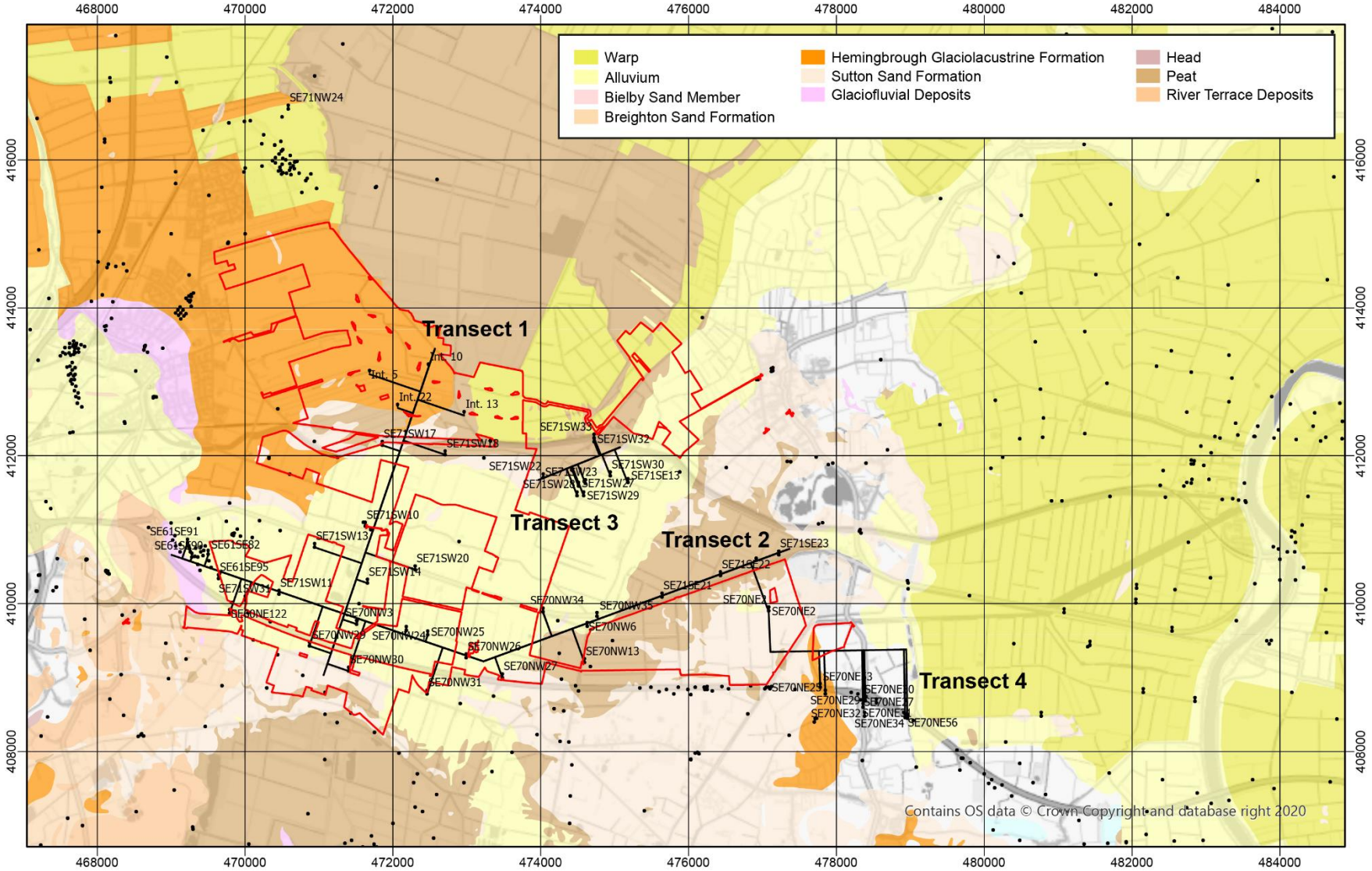

Figure 4: Map of the bedrock and superficial geology (Contains British Geological Survey materials (c) UKRI 2024). Also displaying the borehole transect locations.

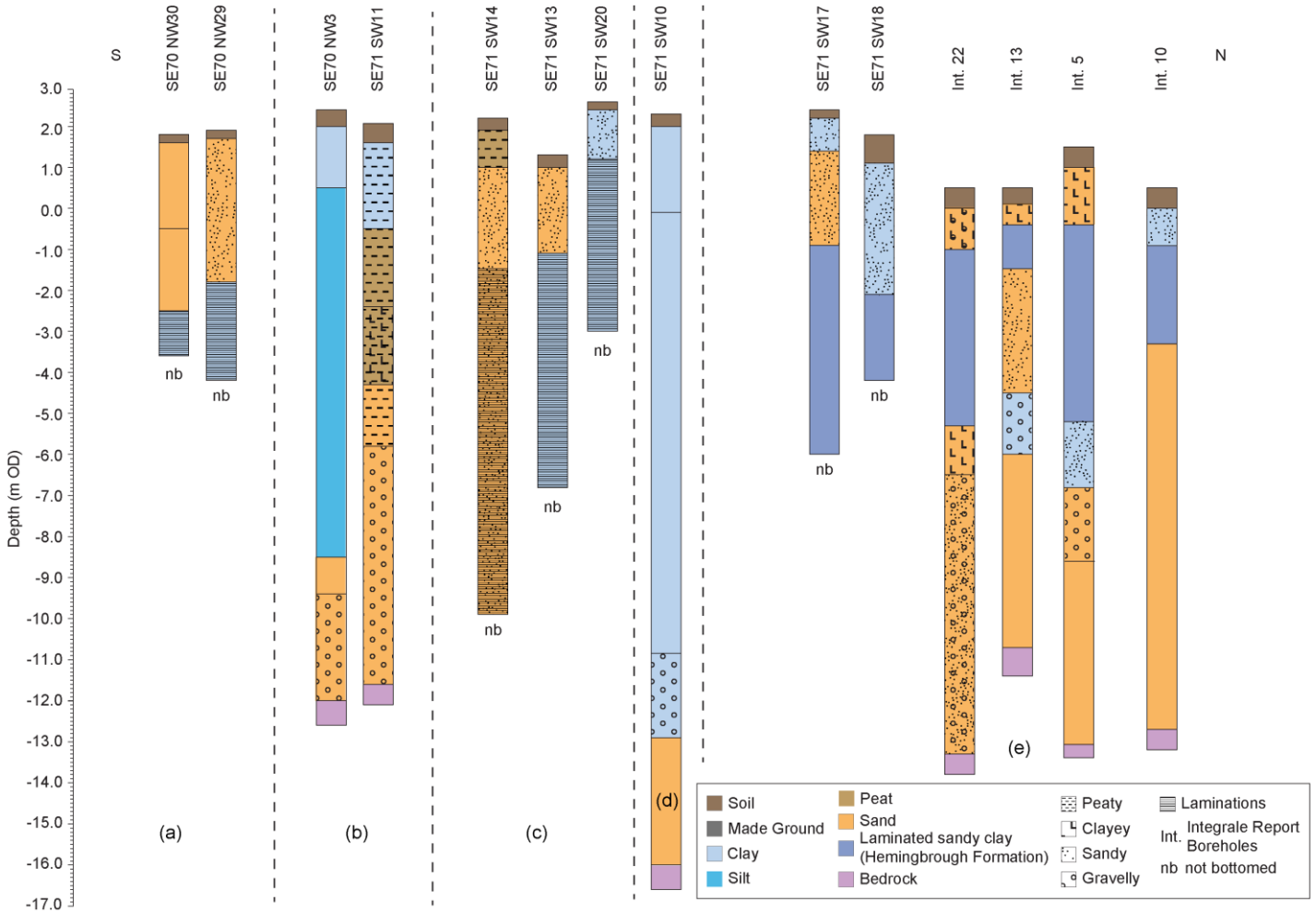

Figure 5: Borehole transect 1. This transect is thought to show from south to north: (a) two boreholes on the southern margin of the Don floodplain; (b) two boreholes penetrating the buried channel of the southern branch of the pre-diversion River Don; (c) three boreholes in the floodplain between the southern and northern branches of the pre-diversion river, one of them (SE71SW14) sited on a roddon and probably penetrating an earlier palaeochannel; (d) a deep borehole extending down to bedrock, sited on a roddon and probably penetrating an early palaeochannel, but also close to the course of the Boating Dike which is thought to mark the northern branch of the pre-diversion Don, but has no roddon associated with its course; (e) six boreholes in the deposits of Lake Humber.

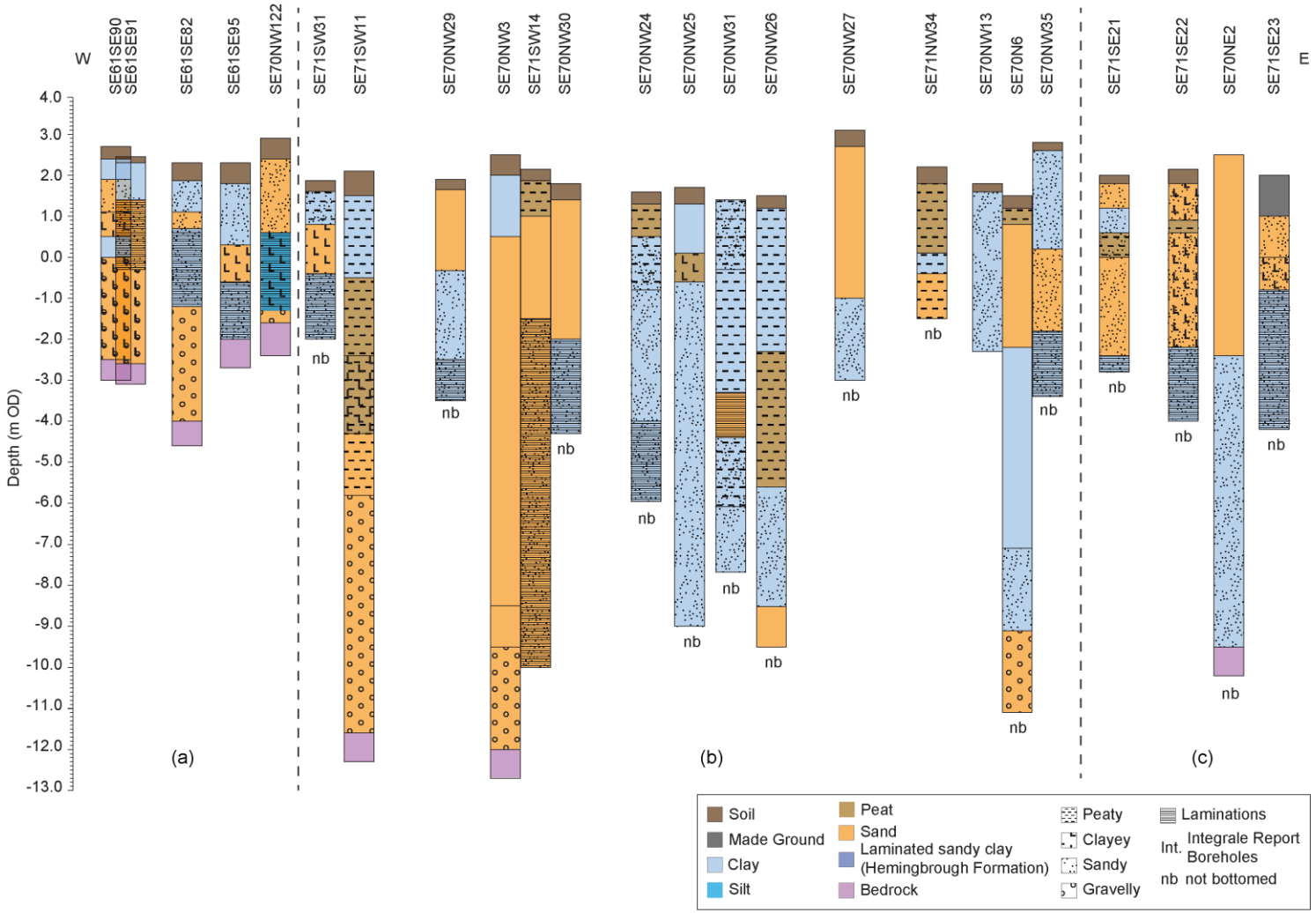

Figure 6: Borehole transect 2. This transect is thought to show from west to east, (a) five boreholes in the narrow floodplain to the south of the River Don, four of them penetrating to bedrock; (b) 14 boreholes in the floodplain and channel of the southern branch of the pre-diversion Don, illustrating a typical range of in-channel and floodplain depositional environments; (c) four boreholes in the broad area of low ground (?floodplain) to the east of the pre-diversion course of the River Don, mapped by BGS as either peat or blown sand (Sutton Sand Formation)

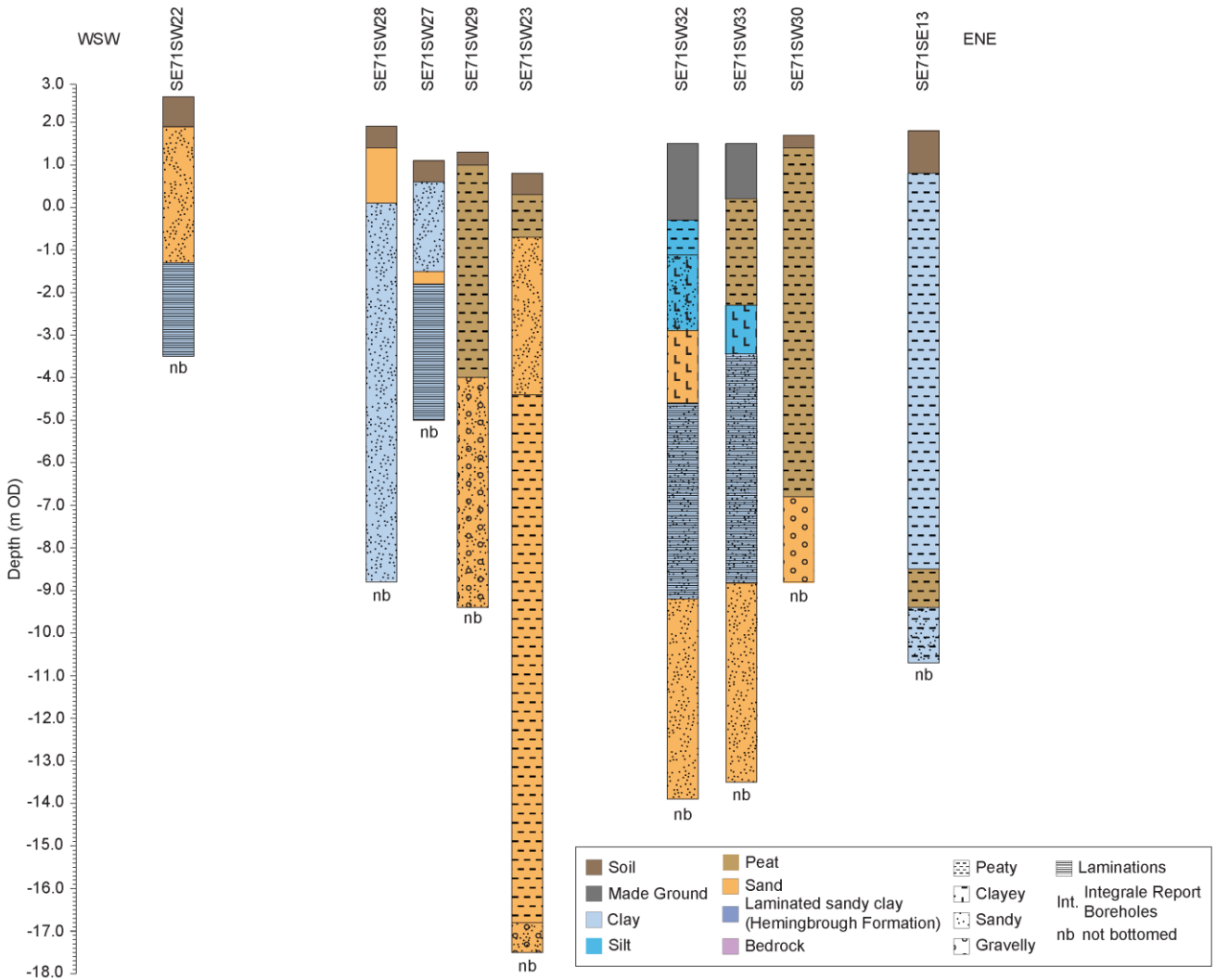

Figure 7: Borehole transect 3. A short transect across the western half of the floodplain of the pre-diversion River Don downstream from Transect 2. It illustrates a typical range of in-channel and floodplain depositional environments. The deeper boreholes seem likely to have penetrated palaeochannels, but these are not marked by the presence of roddons at the ground surface although the pre-diversion course of the Don is marked nearby in this way.

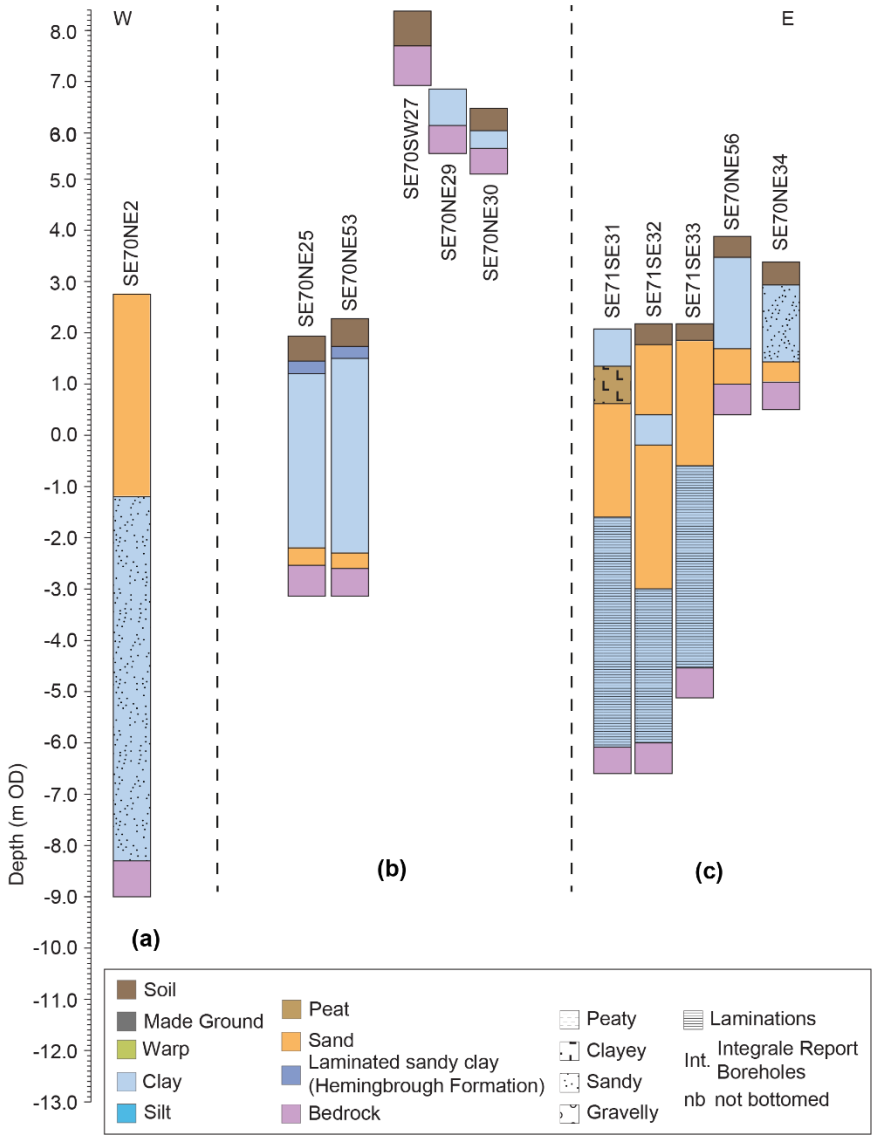

Figure 8: Borehole transect 4. A transect from west to east from the Old Don valley across the Isle of Axholme to the Lower Trent valley. (a) Old Don valley - distal floodplain; (b) Isle of Axholme; (c) Low terrace of the River Trent

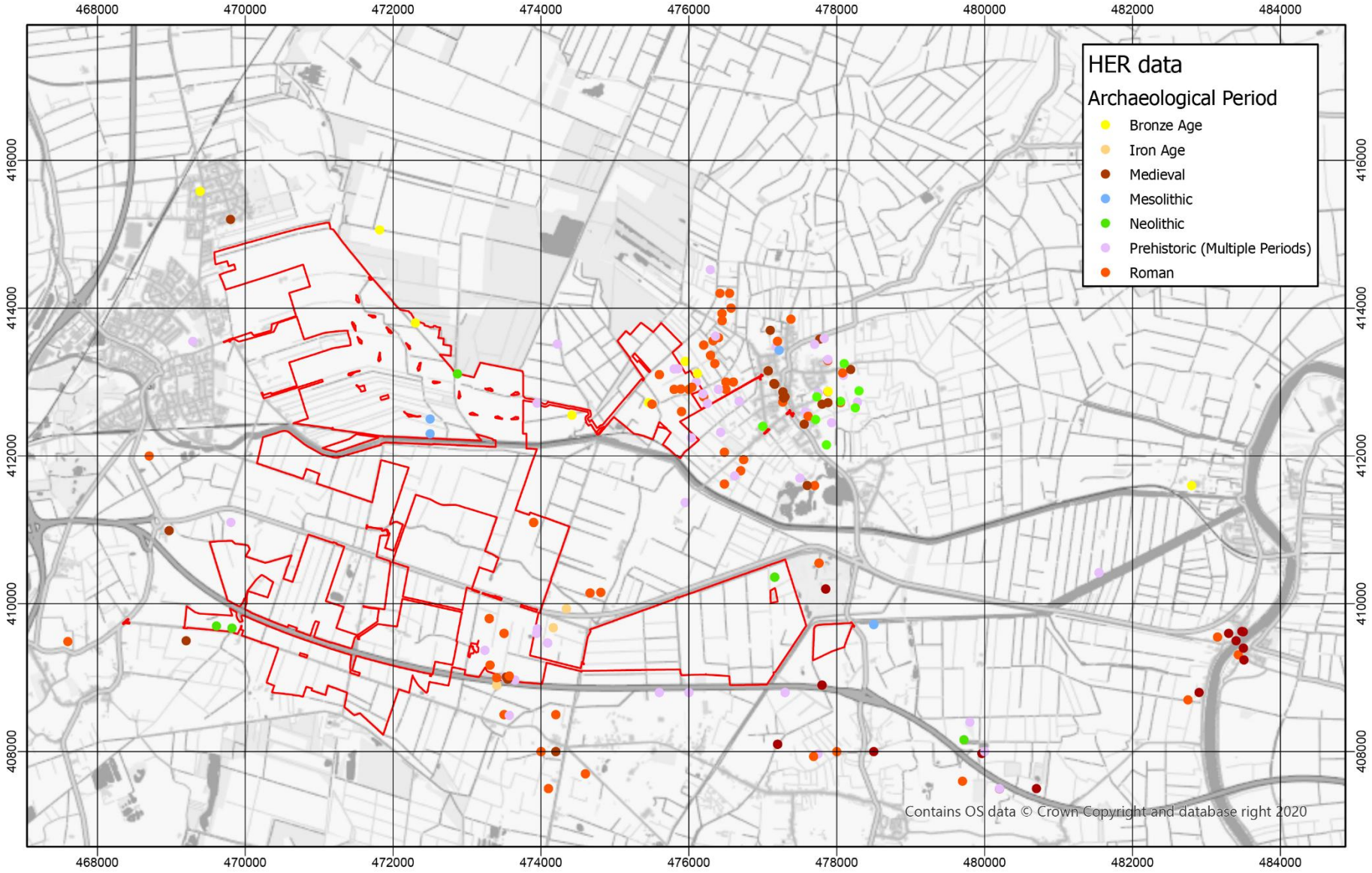

Figure 9: Map of the HER sites

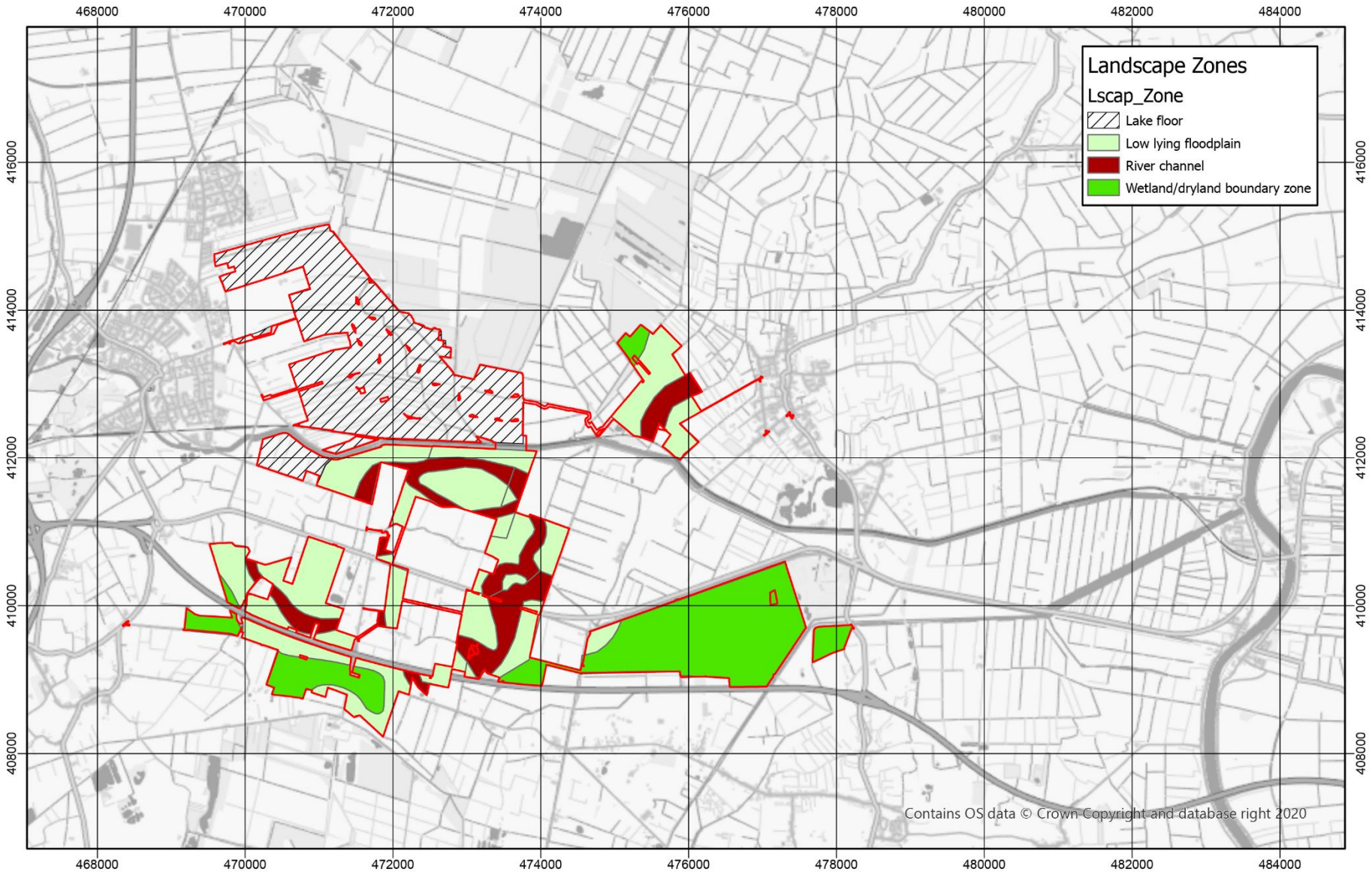

Figure 10: Map of landscape types