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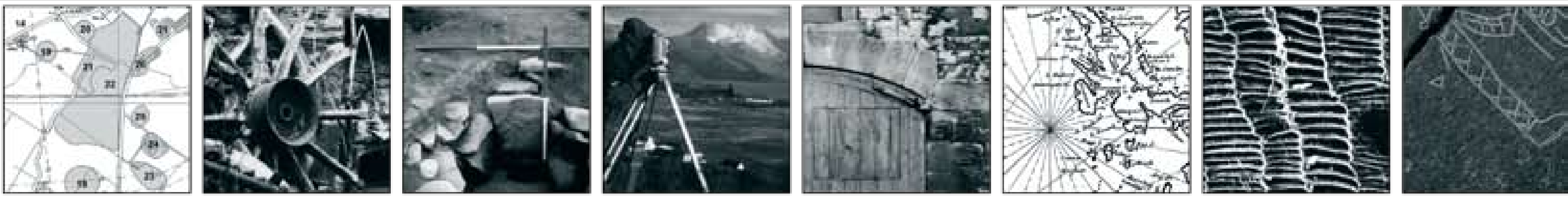

ROOLEY MOOR, GREATER MANCHESTER

Geoarchaeological and Palaeoenvironmental Report

commissioned by SKM Enviros
on behalf of Coronation Power

June 2014

HEADLAND ARCHAEOLOGY

REGISTERED · IfA · ORGANISATION

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project info

HA JOB NO.	RMWR/07
NGR	SD 856 186
PARISH	Rochdale / Rossendale
LOCAL AUTHORITY	Greater Manchester

project team

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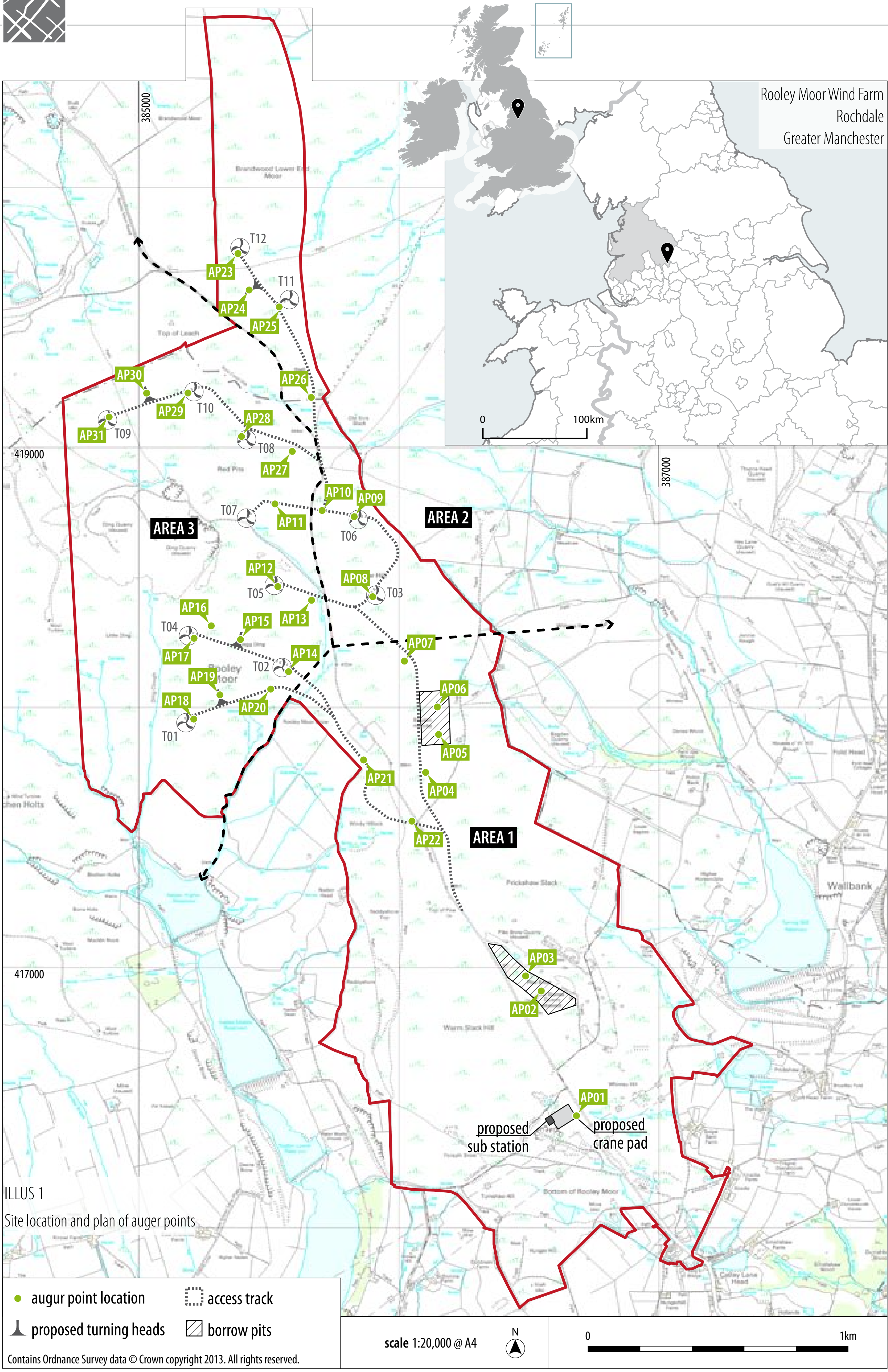


ILLUS 1

Site location and plan of auger points

ROOLEY MOOR, GREATER MANCHESTER

Geoarchaeological and Palaeoenvironmental Report

An auger survey was undertaken on land at Rooley Moor, Greater Manchester, as part of a programme of evaluation prior to the determination of a planning application for the erection of twelve wind turbines and associated infrastructure. The survey consisted of 31 auger cores, sampling turbine base micro-siting zones, compound areas and tracks. The aim of the survey was to record the presence or absence of peat deposits across the DA, and to investigate the cultural and palaeoenvironmental potential of these peats.

Peaty deposits and humic silts and clays were recorded across the DA, however the majority of the site is on sloping ground displaying a range of active geomorphological processes (mass movement, gullying etc), which means there is the high potential for sediments to be reworked which reduces the value of the deposits for palaeoenvironmental reconstruction. Furthermore, no mineral soil was recorded, lowering the potential to find in situ lithic remains.

Palaeoenvironmental assessment undertaken on single an organic rich core recovered from (AP26) contained in situ organic remains. The waterlogged, anaerobic nature of these sediments means that they preserve microfossils (e.g. pollen, diatoms) and macrofossils (e.g. seeds, wood) that can be used to reconstruct the landscape history of this area. The presence of such deposits also means that there is some potential for the discovery of cultural materials within them.

1 INTRODUCTION

1.1 BACKGROUND

Coronation Power are preparing an application for the construction of twelve wind turbines with associated infrastructure comprising access tracks, crane hard standings, anemometry mast, underground cables and switchgear house on land at Rooley Moor, near Rochdale, Greater Manchester.

The Development Area (DA) sits within an area of potential archaeological significance. A key aspect of this is in relation to Mesolithic activity and the palaeoenvironmental potential of peat deposits across the DA. Construction of the proposed wind farm has the potential to damage sub-surface heritage assets within the development footprint. In order to understand the potential impacts on sub-surface heritage assets, the Greater Manchester Archaeology Advisory Service (GMAAS) requested that a programme of evaluation be carried out prior to determination of the planning application.

SKM, acting on behalf of Coronation Power commissioned Headland Archaeology to agree a scope of works for the pre-determination work. Headland Archaeology agreed a strategy with GMAAS which comprises pre-determination evaluation specifically of the palaeoenvironmental potential of the DA with evaluation of the sub-surface archaeological resource and appropriate mitigation o development impacts to take place following determination of the application. The results of the palaeoenvironmental evaluation (this document) will be submitted as an appendix to the Environmental Statement (ES) Chapter which forms part of this planning application.

The programme of pre-determination work comprised targeted hand-auger survey of the entire development footprint, to including sampling turbine base micro-siting zones, compound areas and tracks (**Illus 1**). This was designed to provide further information about the potential cultural and environmental resource, to enable appropriate decisions to be reached regarding the most effective mitigation strategy.

This report details the results of the auger survey. The aims of this auger survey were to:

- Record the presence / absence and thickness of peat deposits within the DA.
- Investigate the potential of any peat deposits present for containing cultural materials.
- Investigate the palaeoenvironmental potential and significance of any peats present.
- Investigate the chronology of any peat deposits found and the nature of the depositional environment.

The local and regional research contexts are provided by the ***North West Region Archaeological Research Framework, Chapter 2: The Prehistoric Period Research Agenda*** (Hodgson and Brennand 2007). Period specific research guidance is provided by Mesolithic Research and Conservation Framework (Blinkhorn and Milner 2013). The evidence retrieved during the works have been analysed in light of the objectives contained in these frameworks. Of particular relevance are themes relating to Mesolithic land-use and palaeoenvironmental data:

- Development and implementation of techniques for site-specific palaeoecological and other environmental sampling, targeting areas of high potential (Hodgson and Brennand 2007, 34).
- The potential for the recovery of environmental material from excavations must be recognised at an early stage of project planning (Hodgson and Brennand 2007, 36).
- There is a need to identify well-preserved Mesolithic contexts for production of secure radiocarbon dates (Hodgson and Brennand 2007, 37).

The deposit depths shown in Appendix 1 relate to specific auger points only. The depth contour map shown in **Illus 5** and the information contained in this report is intended for palaeoenvironmental purposes only. It should not be relied on as an accurate indication of deposit depths across the entirety of the DA or as a predictive tool for geotechnical or construction purposes.

1.2 THE DEVELOPMENT AREA

The DA is located c.5km NW of Rochdale (centred at NGR SD 856 186). It is set within open moorland, which has been extensively quarried since the 18th Century. Land within the DA varies from c.300m OD at the southern end to c.470m OD at its highest point.

The geology of the moor contains deposits of peat, underlain by sandstones of the Haslingden Flags and Lower Pennine Coal Measure Formations, as well as mudstones of the Rossendale and Lower Pennine Coal Measure Formations.

1.3 ARCHAEOLOGICAL BACKGROUND

There are no designated assets within the application site; Rooley Moor road was considered for scheduling but English Heritage concluded that it was not of national significance. The surviving fabric of the road is of 18th century date, although the road may have medieval origins as a packhorse route.

There is potential for currently unknown remains of prehistoric date (most likely Mesolithic flint scatters and potential associated structures) due to the presence of known sites elsewhere in the Rossendale uplands and similar moorland locations in the wider area (including Scout Moor to the west and Todmorden Moor to the east). Such remains are likely to be represented by dense concentrations of flint at the peat-mineral soil interface horizon but may extend over a considerable spatial area.

The peat deposits of the development area are themselves of potential palaeoenvironmental interest and may contain palaeobiological remains (pollen, insects, plant material etc), which may yield information about past climate, vegetation and land-use change. They also have the potential to preserve organic structural remains if waterlogged.

Later activity within the DA consisted of extensive quarrying, from the 18th century through to the early 20th century, alongside some coal mining. The earthwork remains of these quarries, and associated structures, are visible across the DA.

2 METHODOLOGY

2.1 FIELDWORK

The fieldwork methodology is set out fully in the WSI (Headland Archaeology, 2014), but in brief, provision was made for the drilling of 25 auger points across the development zone. 12 were drilled close to the centre of turbine micro-siting localities; 4 were drilled on each of the four turning heads; 2 were drilled within the footprints of each of the two borrow pits; and 1 was drilled within the footprint of the substation/crane pad. The remaining 4 points were spread across areas of proposed trackways in and out of the development area. In addition to the 25 specified auger points, a further 6 were drilled across the development area providing a total survey of 31 auger points (Appendix 1). All drilling was undertaken using a 4cm gouge auger with sample recovery using a 6cm gouge.

All auger points were located using a Trimble GPS, allowing the construction of a Digital Elevation Model (DEM) and subsurface relief map in a Geographic Information System (SURFER10) representing thickness and depth of the peat deposit.

In addition to augering, exposures of peat and underlying substrates were inspected where exposed within gullies and other erosional features. As well as examining the natural deposits, these exposures were scanned for any lithic material exposed through erosion.

2.2 PALAEOENVIRONMENTAL CORE ASSESSMENT

A single 0.80m core was extracted from the area adjacent to AP 26, using a 0.06m gouge auger. The core was divided into 0.08 X 0.10m blocks, with sample 1 taken at a 0.10cm depth, below the topsoil. Sub-samples of 250ml were taken from each of the recorded deposits (Samples 1–8). The samples were processed in laboratory conditions in order to retrieve plant macrofossils to determine the peat type.

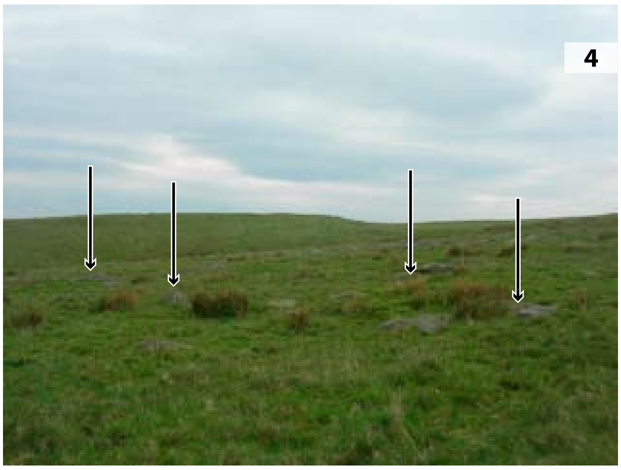
The samples were processed in laboratory conditions. The material was collected in 1mm, 500 and 250 µm sieves. All plant macrofossil samples were analysed using a stereomicroscope at magnifications of x10 and up to x100 where necessary to aid identification. Identifications were confirmed using modern reference material and seed atlases including Cappers et al (2006).

Wood samples were thin sliced along radial, tangential and transverse sections using a razor blade and then bleached before being mounted on a slide in glycerol and examined under a microscope at x100 and x400 as required. Wood sections were identified using features described by Schweingruber (1978, 1990) and IAWA (1989).

ILLUS 2
View south towards Manchester illustrating translational slope failure within the DA

ILLUS 3
Angular clasts set within a clayey matrix interpreted as solifluction deposits exposed within a gully within the DA

ILLUS 4
Blockfield of large boulders in the vicinity of the southern-most borrow pit resulting from mass movement under periglacial conditions at the end of the last Ice Age



3 CONTEXT OF THE STUDY AREA

3.1 SOLID GEOLOGY

The DA is located approximately 5km north-west of Rochdale (centred at NGR SD 856 186) on an area of high moorland defined physiographically as the Rossendale Plateau and bounded by the Lancashire mill towns of Burnley, Blackburn Chorley, Bolton and Rochdale (Crofts, 2005).

The underlying bedrock geology comprises mudstones, siltstones and sandstones collectively referred to as Coal Measures, which were laid down in fluvial deltaic swamps towards the end of the Carboniferous Period, approximately 310 million years ago (Aitkenhead et al., 2002). These deposits contain subordinate deposits of coal and ironstone and the region forms part of the former Lancashire Coal Field, and it is known that small-scale coal mining has been undertaken within the DA. During the Late Carboniferous and ensuing early Permian Period (around 290–300 million years ago), an episode of mountain building (orogeny) caused these sediments to be uplifted and faulted creating a folded structure known as the Rossendale Anticline with predominantly horizontally bedded (older) rocks at its core and younger, steeply dipping rocks at its margins (Crofts, 2005). This underlying folded structure and the alternating occurrence of bedded sediments of varying mechanical strength (i.e. the mudstones, siltstones and sandstones) is critical to landscape evolution since near the margins, the steeply dipping beds of rock are prone to failure and both rotational and translation landslips are a common feature of this landscape, including the DA (Illus 2). Geomorphological research suggests that many of the major slope failures recorded in the Pennine landscape were initiated towards the end of the last glaciation and into the early post-glacial period when hydrostatic pressures were higher (Johnson, 1980).

3.2 PLEISTOCENE GEOLOGY – THE LAST ICE AGE

The DA was entirely overrun by ice during the last Ice Age (Marine Isotope Stage 2) and therefore Quaternary deposits preceding this time period are rare and restricted to a handful of sheltered locations such as cave systems in the Carboniferous Limestone of the Yorkshire Dales (e.g. Victoria Cave near Settle). Therefore, deposits encountered within the DA are restricted to those associated with the last glaciation and subsequent postglacial period and hence contextual information provided below is restricted to this timeframe.

During the Last Glacial Maximum, which began in this area probably around 26,000 years ago (Chiverrell and Thomas, 2010), ice encroached from the north. Evidence of glacial striations (ice scoured grooves on exposed bedrock) and sub-glacial meltwater channels on the Rossendale Plateau suggest that ice overran this area, but that its role was largely erosional. Therefore, it is extremely unlikely that cultural (lithic) material older than the Ice Age will be recovered from this area (except in highly reworked contexts).

By around 17,000 years ago, ice sheets across Britain were in retreat and the Rossendale Plateau once ice-free was subjected to a range of periglacial processes. On the slopes, mass movement of sediment downslope was the dominant process (solifluction), associated with the melting of permafrost during the summer months. Within the DA, evidence for soliflucted sediments is provided by aprons of coarse angular sediment within exposed gullies (Illus 3). Blockfields – areas of large boulders strewn across the landscape (Illus 4), provide further evidence for the movement of coarse material down slopes (see Tufnell, 1969). In some parts of the Pennines, such as on Ilkely Moor, surfaces of blockfield boulders are notable for cup and ring marks.

3.3 THE HOLOCENE POSTGLACIAL RECORD

With the climatic amelioration of the early postglacial, vegetation including scrub woodland of birch and hazel colonized the uplands of northern England. Occasional tree roots are recorded within and beneath the peats (Tallis, 1975). Mineral soil developed across this new landsurface and is recorded as being overlain by a thin, dark coloured, largely inorganic unit, which contains abundant carbon (though not as marked as in the overlying peat) and hazel pollen values considerably lower than in the immediately underlying mineral soil. This layer is interpreted as a 'mor humus' layer of a podzol and is commonly recorded below shallow peat profiles (Smith and Taylor, 1989). Where observed, radiocarbon dating suggests that it accumulated slowly, over a period of approximately 1000 years before blanket peat formation (Smith and Cloutman, 1988). However, in many cases, this mor humus is often absent due to burning and erosion.

Overlying the mineral soil or if lost, the bedrock, are spatially extensive peat deposits. In the south Pennines radiocarbon dating and pollen analysis suggest that these formed between the 9th and 5th millennium cal. BC (Tallis, 1991; Tallis, 1999). Formation was probably a response to changing hydrological conditions, soil impoverishment and erosion associated with deforestation of the uplands through burning (Jacobi et al., 1976).

Once initiated, blanket peat formation on the high plateaux was largely driven by rainfall input (ombrotrophic bogs) and hence such sequences provide important palaeoclimatic archive (Charman et al., 2009). Elsewhere, in hollows, small valleys and on structural benches, peat formation can be driven by local topographical and groundwater conditions (Charman, 2002).

Peat erosion

Erosion of blanket peat on the southern Pennines is a common problem (Evans and Warburton, 2007), though it is not a recent phenomenon (Smith and Moss, 1903; Moss, 1913). The causes of erosion are multiple and include deliberate burning, wildfires, pollution, overgrazing and trampling (Phillips et al., 1981; Tallis, 1998, Tallis, 1999); contemporary climatic change is an additional problem (Evans and Warburon, 2007). Some authors have classified peat erosion (Bower, 1960, 1961; Anderson, 1986) including: mass movement (peat sliding); reticulate dissection (on slopes less than 5˚, where sinuous and close gullys leave a network of peat haggs); and gullying (on sloping surfaces where individual gullies rarely branch and run nearly parallel).

Postglacial human activity and the environmental record

It has been documented for over a century that lithic-artefacts can be found at the edges of eroding peat haggs on the high Pennine moorlands (Law and Horsfall 1882) and a few sites have been excavated (Stonehouse, 1976; Poole, 1986; Spikins, 2002). In the south Pennines, numerous studies have shown how Mesolithic artefacts coincided with changes in the record of charcoal and vegetation, particularly Calluna (heather) and Corylus (hazel), suggesting causal links (Radley et al., 1974; Jacobi et al., 1976; Tallis, 1991) and it is hypothesized that hunter gatherers were using fire to increase leafy browse for wild game. Tallis (1975) has suggested that in the southern Pennines burning continued into the Neolithic.

The distribution of lithic material is incredibly patchy, with the densest distribution in the Saddleworth-Marsden area (Barnes, 1982; Nevell, 1992), with artefacts recorded in areas of eroding peat (Radley and Marshall, 1963; Jacobi et al., 1976). Jacobi et al. (1976) suggested sites were particularly prevalent between 360m and 480m. Field survey on a small part of Tintwistle Moor concluded that the recovery of Mesolithic artefacts was restricted to the edges of the plateau and to breaks in slope (Garton, 1987).

3.4 CHALLENGES FOR ENVIRONMENTAL RECONSTRUCTION AND CHRONOLOGY

The high levels of geomorphological activity and sediment erosion across the plateaux and slopes of the Pennine uplands (i.e. gullying, mass movement) create significant taphonomic challenges for palaeoenvironmental reconstruction since organic remains containing pollen and plant material etc can be reworked through the natural system. Furthermore, processes of leaching and podsolisation can lead to the transfer of organic materials through the sedimentary profiles; for example the accumulation of carbon within the 'mor layer' at the base of peats. Within such environments, it is common practice to date humic and humin fractions separately since bulk radiocarbon dates can be affected by mixed ages (Jacobi, 1994). A final problem is the robustness and mobility of small charcoal fragments, which are commonly found through peat profiles (cf. Ashmore, 1999).

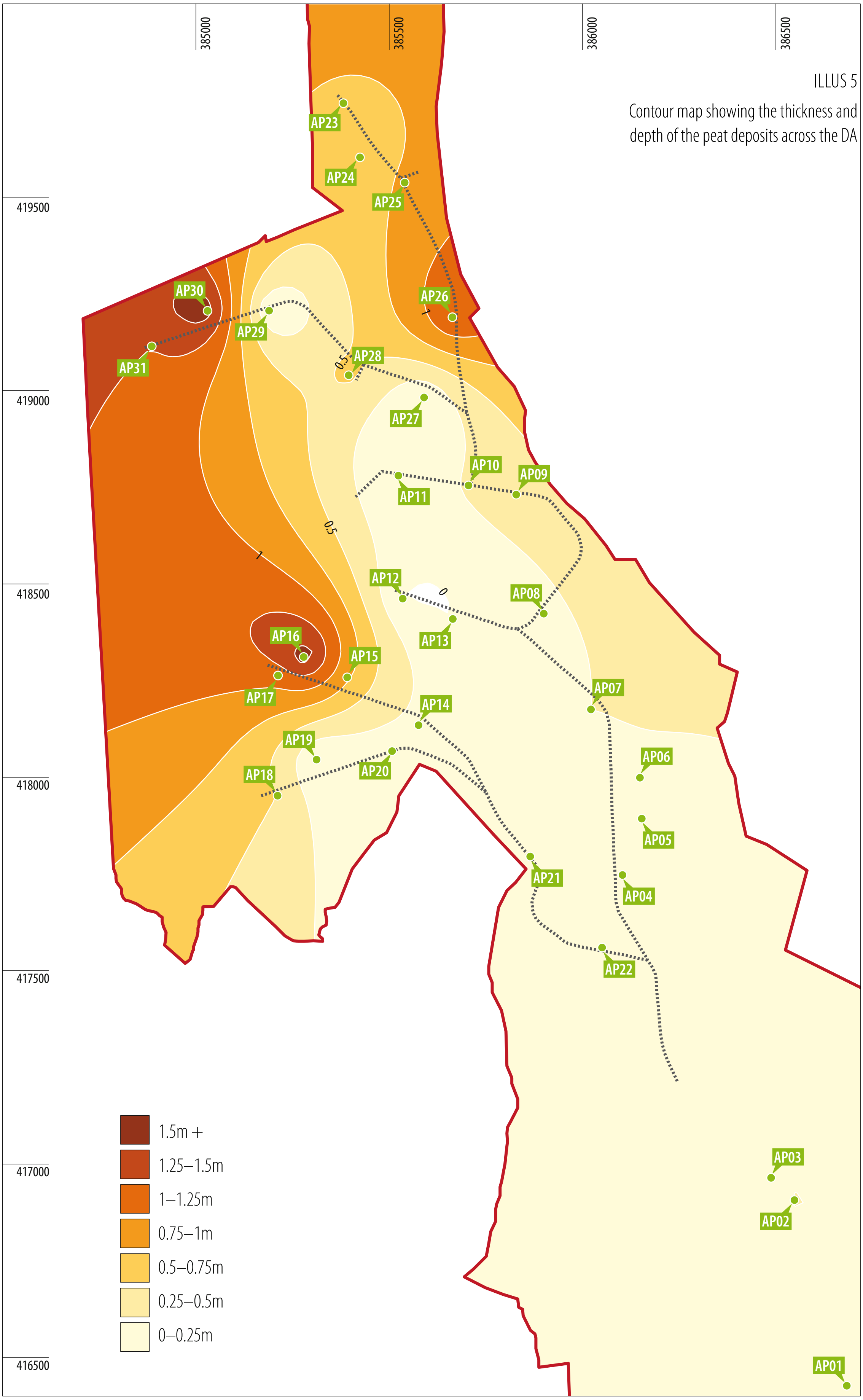
4 RESULTS OF THE AUGER SURVEY

The DA is situated on the south facing slopes of the Rossendale Plateau and varies in altitude from c.300m OD at its southern end to c.470m OD at its northern margin. The area is treeless and comprises rough pasture punctuated with wetter areas characterised by cotton grass, purple moor grass and sphagnum moss. The area bounded by Turbines 04, 07 and 09 has been heavily quarried for sandstone and is largely devoid of natural deposits, which have been replaced by spoil heaps. Elsewhere, occasional small depressions in the ground surface are interpreted as 'bell pits'.

For ease of discussion the area will be divided into three (1) the entire area south of Auger Point (AP) 7; (2) the northern area, east of Rooley Moor Road and; (3) the northern area, west of Rooley Moor Road. Detailed descriptions of auger cores are provided in Appendix 1 with auger points and unit thickness illustrated in Illus 5.

4.1 AREA 1 – SOUTH OF AP 7

Within this area, the landscape can be described as geomorphologically stable with little evidence for processes of



ILLUS 5

Contour map showing the thickness and depth of the peat deposits across the DA

ILLUS 6

Small scale erosion of the peat caused by sheltering livestock. 1m auger provides scale

ILLUS 7

Fine grained silts and clays underlain by weathered bedrock. No mineral soil was recorded in these cores

mass movement and gullying, although occasional free-faces were noted, created by sheltering livestock (**Illus 6**).

All cores in this area were relatively shallow with the thickest sediment recorded at AP 6 (55cm). The sediments generally comprised a vegetation topsoil mat between 10–20cm thick underlain by humic silt with abundant modern rootlets and varying amounts of clay and sand; at one point (AP4) it can be described as a silty peat. All auger cores encountered solid rock and in the majority of cores, its surface was weathered leading to the varying description of the material as silty sand, silty grit, sandy grit (**Illus 7**). No discrete unit of mineral soil or 'mor humus' was observed. The surface of the southern-most Borrow Pit (APs 2 & 3) was largely covered by an extensive 'blockfield' of large boulders (**Illus 3**), a remnant of periglacial (solifluction) processes during the late Pleistocene (Tufnell, 1969), which provides an explanation for the shallow character of the deposits recorded. Auger Points 21 and 21 were situated upon a trackway of a proposed access roadway and encountered bedrock immediately.

4.2 AREA 2 – THE NORTHERN AREA, EAST OF ROOLEY MOOR ROAD

As in the southern area, this area was geomorphologically (relatively) stable with little evidence of processes of mass movement or sediment erosion through gullying. Across the central part of this area (AP, 08, 09 & 10) sediments were less than 60cm deep and comprised turf mat of topsoil underlain by humic/peaty silts and clays onto a solid substrate of weathered bedrock. Abundant modern rootlets were noted throughout the cores. No discrete mineral soil or mor humus layer was recorded.

At the northern end of this area, the ground was flatter, possibly indicating a structural bench created by horizontally bedded rock. Auger cores drilled within this area (AP 23, 24, 25 & 26) revealed thicker deposits than previously encountered in the DA. Beneath the turf mat, a combination of silty clays, humic silts and peat was recorded up to 140cm thick (AP 26). Notably, within AP 26, a significant layer of charcoal was recorded at 15cm and large pieces of wood at 80cm. All the boreholes encountered weathered bedrock, recorded as bleached white grit and silty grit in two of the cores (AP 24 & AP 25). No mineral soil was recorded.

4.3 AREA 3 – THE NORTHERN AREA, WEST OF ROOLEY MOOR ROAD

This area contained the greatest concentration of auger points, but it was also the most geomorphologically active part of the DA. To the south of AP 14 and 20, a major gully system was recorded occupied by a permanent beck draining towards Naden Higher Reservoir (**Illus 8**).

In addition to this major gully, other major seepage lines infilled with bog loving plants were observed in the area around the cluster of Turbines 01, 02 and 03 (**Illus 9**). Some of these areas appeared remarkably fresh possibly implying that more recent sediments may infill older features, perhaps affected by previous mass movements (Warburton et al., 2004).

In the vicinity of Turbine 07, spoil associated with sandstone quarrying was a major issue and further north around Turbines 08, 09 and 10, gullying of the peat was a serious issue affecting the integrity of deposits (**Illus 10**).

The highly active nature of geomorphological processes has resulted in a variable thickness of postglacial sediments across the area. Auger Points 14, 18, 19 and 20 all comprised around or less than half a metre of sediment, silts and clays onto weathered bedrock. The very thin soil at AP 11 is explained by its location within an area of quarry spoil and AP 19 is located within a periglacial 'blockfield'.

ILLUS 8

Major active gully system draining from the DA towards Naden Higher Reservoir

ILLUS 9

Major seepage lines infilled with bog loving plants in Area 3.

ILLUS 10

View southwards from around Turbine 10 illustrating the degree of peat erosion and redeposition in this part of the DA. Using previously defined terminology, this erosion would be described as reticulate

Auger Points 15, 16 and 17 (in the vicinity of Turbine 4) revealed up to 130cm of peat within the area of Turbine 04 and an additional point taken adjacent to a gully free-face (AP 16; not a threatened area) revealed 165cm of peat within a gully free-face. Charcoal and wood were noted within AP 15 and modern rootlets were observed throughout all cores. No mineral soils were encountered.

Whilst these thicknesses are significant, the area is sloping and contains significant gullies and seepage lines and it is unclear what effect gravitational processes have had on the thickness of peat observed in this area, though it seems likely that mass movement processes have led to an over-accumulation of deposits within this area, decreasing their value for palaeoenvironmental reconstruction.

The northern-most four cores taken from Area 3 (AP 28, 29, 30 & 31) were all within part of the DA extensively affected by gullying. AP30 revealed little sediment, but was located within a periglacial 'blockfield'. In contrast, APs 30 and 31 revealed up to 165cm of peat, but as previously noted, it seems likely that some of this material has been accreted from further upslope.

During fieldwork, a number of these gullies were inspected in an attempt to identify lithic material, but none was recorded.

5 RESULTS FROM THE CORE SAMPLE

Detailed results are presented in Appendix 2.

All plant macrofossils were preserved through waterlogging, preservation was generally very good. Monocotyledons were present throughout, with fewer fragments in samples 5, 6 and 7, taken at depths of 0.60–0.70m, towards the base of the core, where there was an increase in the number of woody stem fragments. Various types of sedge nutlets Carex sp. were present in the majority of samples with the exception of Samples 5 (0.40–0.50 m) and 8 (0.70–0.80m). The abundance of Cyperaceae (sedges) suggests an open local landscape.

A large concentration of Bugles (Ajuga reptans), annual or perennial herbs, generally encountered in woods, shady places, and damp grassland, were abundant in sample 6 (0.50–0.60m), though present in smaller numbers in Samples 3 (0.20–0.30m) and 7 (0.60–0.70m).

Large wood fragments, identified as willow (Salix sp) were present at a depth of 0.80m, together with monocotyledon fragments, however few sedge seeds were found in this deposit.

6 DISCUSSION

6.1 GEOMORPHOLOGY

Geomorphological walkover survey and geoarchaeological coring of the DA demonstrates that it comprises landsurfaces and landforms of varying age.

The 'blockfields' were formed towards the end of the last Ice Age (c.17–11,500 years ago) and are associated with a thin mantle of soil and represent a landsurface of considerable antiquity.

Areas of both translational and rotational slope failure (e.g. Illus 2) were probably initiated during the early postglacial, though some appear relatively fresh, demonstrating contemporary formation.

The major gullies were probably initiated by fluvial incision during the early postglacial in response to uplift associated with regional glacioisostatic rebound (icesheet unloading).

The high rates of geomorphological activity, especially in Area 3, have resulted in thick sedimentary sequences on the valley slopes, which have been reworked from further upslope. Since the DA does not extend into the lowland valley floor, no sediments or landforms indicative of alluvial fan deposition were recorded, although it seems likely that such features would be present at lower altitudes and provide some indication of slope-channel coupling during the Holocene.

The general absence of mineral soil across the site with peat resting directly on weathered bedrock supports the concept of a landscape of erosion. The absence of mineral soils lowers the potential for finding in situ lithic remains. However, this does not completely preclude the existence of lithics within the DA. No tree remains were noted, interbedded amongst the peats, although again, this does not preclude the presence of such features.

Whilst the DA contains a variable thickness of peaty deposits and humic silts and clays, which have the potential to preserve palaeobiological remains, palaeoenvironmental reconstruction relies on an ability to identify and sample sites where:

1. the deposits have accumulated slowly, ideally with a hollow or basin, which has formed a natural sediment trap and where inputs to and outputs from the system can be confidently predicted.

2. the deposits can be shown to have undergone minimal physical processes of reworking (erosion/redeposition)

3. the deposits can be shown to have undergone limited chemical remobilization (i.e. groundwater throughflow is minimal).

With these caveats in mind, the area considered most promising for characterising the nature of the organic deposits was adjacent to AP 26, since the sediments appeared to rest on a relatively level bench and there was minimal geomorphological activity.

6.2 PALAEOENVIRONMENTAL CORE

Assessment of the peat recovered from the cores shows that the palaeoenvironmental potential of the peat deposits is very good and would provide excellent conditions for the preservation of pollen. Visible macrofossils of monocotyledon plant fragments and wood fragments were observed within the peat. The presence of such well preserved vegetational material suggests that microfossils, such as pollen and non-pollen palynomorphs (fungal spores) will also be present in the peats. Plant material is very well preserved and occasional beetle exoskeleton fragments were also present within the samples.

6.3 CONCLUSIONS

Whilst peaty deposits and humic silts and clays are extensively preserved across the DA, the majority of the site is on sloping ground displaying a range of active geomorphological processes (mass movement, gullying etc). This is especially the case in Area 3. Within such active slope environments, there is the high potential for sediments to be reworked, which impacts significantly on the value of the deposits for palaeoenvironmental reconstruction. The DA does not extend up onto the higher flatter plateau where deposits with the highest potential would be expected to be located and where the remains could be nationally important in terms of their palaeoenvironmental archive.

No mineral soil was recorded, lowering the potential to find lithic remains in situ, although the existence of such deposits within the DA cannot be entirely ruled out.

Therefore, the potential of the majority of the DA for palaeoenvironmental reconstruction studies is limited. However, it should be stressed that these organic-rich areas have the potential to preserve a variety of archaeological remains within the peats, which previous research and radiocarbon dating suggests that peat formation may have occurred until at least the Neolithic period.

A single site was identified (AP 26) where the topographic conditions may allow the preservation of largely in situ organic remains. This locality was sampled. The plant macrofossil assemblage shows the change in landscape from wooded wetland, to open, damp ground dominated by sedges. The anaerobic conditions and good condition of the palaeoenvironmental material would undoubtedly provide evidence of environmental change in the area. There is also a possibility that archaeological remains could be preserved beneath this peat.

In some areas, where older landforms such as gullies have been flushed out and refilled with younger sediments, chemical conditions may allow the preservation of archaeological remains, although it is generally considered that climatic deterioration towards the end of the Bronze Age led to the abandonment of upland settlement in Britain.

6.4 AMS DATING

Significant amounts of peat were present in the core and would allow for AMS dates to be obtained from all samples. Single entity dates would however be expected to provide the most accurate data. Woody stem fragments of a suitable size for AMS (Accelerated Mass Spectrometry) dating were also recovered from Samples 5 (0.40–0.50m) and 8 (0.70–0.80m). As such, two AMS radiocarbon dates; one form the woody stem fragment from sample 5 (0.40–0.50m), and one from the willow branch recovered from the basal deposit will be processed. This will allow the dating of peat onset and accumulation rate to be calculated. Combined with pollen analysis and Plant Macrofossil evidence this will provide an understanding of past climate, vegetation and land-use change.

7 BIBLIOGRAPHY

Aitkenhead, N, Barclay, A J, Brandon, A, Chadwick, R A, Chisholm, J I, Cooper, A H & Johnson, E W 2002 ***The Pennines and Adjacent Areas*** (4th Edition), British Regional Geology, British Geological Survey, Nottingham.

Anderson, P 1986 *Accidental Moorland Fires in the Peak District, a Study of their Incidence and Ecological Implications,* Bakewell: Peak District Moorland Restoration Project.

Ashmore, P J 1999 'Radiocarbon dating: avoiding errors by avoiding mixed samples' in ***Antiquity*** 73, pp124–130.

Barnes, B 1982 *Man and the Changing Landscape,* Merseyside County Museums, Liverpool.

Bell, M & Walker, M J C 1992 *Late Quaternary Environmental Change, Physical and Human Perspectives,* Longman, Harlow.

Blinkhorn & Milner 2013 *Mesolithic Research and Conservation Framework 2013*

Bower, M M 1960 'The erosion of blanket peat in the Southern Pennines' in *East Midland Geographer* 2 (13), pp22–33.

Bower, M M 1961 'The distribution of erosion in blanket peat bogs in the Pennines' in *Transactions and Papers of the Institute of British Geographers* 29, pp17–30.

Charman, D 2002 *Peatlands and Environmental Change,* Wiley, Chichester.

Charman, D J, Barber, K E, Blaauw, M, Langdon, P G, Mauquoy, D, Daley, T J, Hughes, P D M & Karofeld, E 2009 'Climate drivers for peatland palaeoclimate records' in *Quaternary Science Reviews* 28 (19–20), 1811–1819.

Chiverrell, R C & Thomas, G S P 2010 'Extent and timing of the Last Glacial Maximum (LGM) in Britain and Ireland: a review' in *Journal of Quaternary Science* 25 (4), pp535–549.

Clark, C D, Hughes, A L C, Greenwood, S L, Jordan, C & Sejrup, H P 2012 'Pattern and timing of retreat of the last British-Irish ice sheet' in *Quaternary Science Reviews* 44, pp112–146.

Crofts, R G 2005 (ed) *Quaternary of the Rossendale Forest and Greater Manchester,* Quaternary Research Association, London.

Evans, M & Warburton, J 2007 *Geomorphology of Upland Peat: Erosion, Form and Landscape Change,* Blackwells, Oxford.

Garton, D 1987 'A pilot archaeological field survey of Tintwistle Moor, North Derbyshire' in *Derbyshire Archaeological Journal* 108, p512.

Headland Archaeology 2014 ***Erection of 12 wind turbines & associated works at Rooley Moor, Greater Manchester. Written Scheme of Investigation for archaeological evaluation by auger survey,*** Headland Archaeology (UK) Ltd, Silsoe, Bedfordshire.

Hodgson & Brennand 2007 ***North West Region Archaeological Research Framework, Chapter 2: The Prehistoric Period Research Agenda.***

IAWA Committee, Wheeler, EA, Bass, P & Gasson, P E 1989 ***IAWA List of Microscopic Features for Hardwood Identification, Published for the International Association of Wood Anatomists.***

Jacobi, R 1994 Mesolithic radiocarbon dates: a first review of some recent results. In N. Ashton and A. David (Eds), ***Stories in Stone,*** pp192–8. Lithic Studies Society Occasional Paper 4, London.

Jacobi, RM, Tallis, JH & Mellars, P A 1976 'The Southern Pennine Mesolithic and the archaeological record' in ***Journal of Archaeological Science*** 3, pp307–320.

Johnson, R H 1980 'Hillslope stability and landslide hazard – a case study from Longdendale, north Derbyshire, England' in ***Proceedings of the Geologists Association*** 91 (4), pp315–325.

Law, R & Horsfall, J 1882 'On the discovery of flint implements on the hills between Todmorden and Marsden' in ***Proceedings Yorkshire Geological and Polytechnical Society,*** new series 8.1, pp70–77.

Moss, C E 1913 ***Vegetation of the Peak District,*** Cambridge University Press, Cambridge.

Nevell, M 1992 ***Tameside Before 1066,*** Tameside Metropolitan Borough Council.

Phillips, J, Yalden, D & Tallis, J 1981 ***Peak District Moorland Erosion Study, Phase 1 Report,*** Bakewell, Peak Park Joint Planning Board.

Poole, S 1986 'A Late Mesolithic and Early Bronze Age site at Piethorn Brook, Milnrow, Greater Manchester' in ***Archaeological Journal*** 2, pp11–30.

Radley, J & Marshall, G 1963 'Mesolithic sites in south-west Yorkshire' in ***Yorkshire Archaeological Journal*** 41, 8197.

Radley, J, Tallis, J H & Switsur, V R 1974 'The excavation of three 'narrow blade' Mesolithic sites in the Southern Pennines, England' in ***Proceedings of the Prehistoric Society*** 40, pp1–19.

Schweingruber F H 1978 ***Microscopic Wood Anatomy: Structural Variability of Stems and Twigs in Recent and Subfossil Woods from Central Europe,*** Kommissionsverlag Zücher AG, Zug

Schweingruber F H 1990 ***Microscopic wood anatomy*** (3rd edition) Birmensdorf.

Smith, W G & Moss, C E 1903 'Geographical distribution of vegetation in Yorkshire' in ***The Geographical Journal*** XXI, pp375–401.

Smith, RT & Taylor, J A 1969 'The post-glacial development of vegetation and soils in northern Cardiganshire' in ***Transactions of the Institute of British Geographers*** 48, pp75–96.

Smith, A G & Cloutman, E W 1988 'Reconstruction of Holocene vegetation history in three dimensions at Waun-Fignen-Felen, an upland site in South Wales' ***Philosophical Transactions of the Royal Society of London, Series B,*** 322, pp159–219.

Spikins, P A 2002 ***Prehistoric People of the Pennines: Reconstructing the lifestyles of Mesolithic hunter-gatherers on Marsden Moor,*** West Yorkshire Archaeology Service, Leeds.

Stonehouse, W P B 1976 'Red Ratcher: the excavation of a Mesolithic site in the Peak National Park by Saddleworth Historical Society' in ***Saddleworth Historical Society Bulletin*** 6, pp15–22.

Tallis, J H 1975 'Tree remains in southern Pennine peats' ***Nature*** 256, pp482–484.

Tallis, J H 1991 'Forest and moorland in the south Pennine uplands in the mid-Flandrian period III: the spread of moorland - local, regional and national' in ***Journal of Ecology*** 79, pp749–765.

Tallis, J H 1998 'Growth and degradation of British and Irish blanket mires' ***Environmental Review 6, pp81–122.***

Tallis, J H 1999 'The uplands: human influences on the plant cover' in E F Greenwood (ed.), ***Ecology and Landscape Development: A History of the Mersey Basin,*** Liverpool: Liverpool University press.

Tufnell, L 1969 'The range of periglacial phenomenon in Northern England' in ***Biul. Peryglac.*** 19, pp291–323.

Warburton, J, Holden, J & Mills, A J 2004 'Hydrological controls of surficial mass movements in peat' in ***Earth Science Reviews*** 67 (1–2), pp139–156.

8 APPENDICES

APPENDIX 1 AUGER DESCRIPTIONS (THICKNESSES IN CM)

Point	Unit	Thickness (cm)
1 (Substation)	Black silty vegetation mat (topsoil)	0–13
	Brown sandy silt, largely inorganic, moist	14–34
	Brown medium sand (weathered bedrock)	35–40
	Onto solid	
2 (Borrow Pit)	Black silty vegetation mat (topsoil)	0–12
	Red brown clay silt, abundant modern rootlets, Slightly peaty	13–38
	Onto solid	
3 (Borrow Pit)	Black silty vegetation mat (topsoil)	0–10
	Red black peaty silty with abundant modern rootlets. Dry, no visible macros.	11–30
	Onto solid	
4 (roadway)	Black silty vegetation mat (topsoil)	0–20
	Red brown silty peat, moist with abundant modern rootlets	21–40
	Brown, silty medium sand, moist	41–45
	Light grey, bleached silty sand (bedrock)	46–50
	Onto solid	
5 (Borrow Pit)	Black silty vegetation mat (topsoil)	0–10
	Onto solid	
6 (Borrow Pit)	Black silty vegetation mat (topsoil)	0–25
	Red brown humic silt with abundant modern rootlets	26–45
	Brown silty grit	46–55
	Onto solid	
7 (roadway)	Black silty vegetation mat (topsoil)	0–20
	Red black humic silt with abundant modern rootlets	21–45
	Brown sandy grit	46–50

Point	Unit	Thickness (cm)
	Onto solid	
8 (Turbine 3)	Black silty vegetation mat (topsoil)	0–20
	Red brown humic silt, slightly peaty	21–40
	Onto solid	
9 (Turbine 6)	Black silty vegetation mat (topsoil)	0–10
	Red brown fibrous peaty silt with abundant modern rootlets	11–50
	Onto solid	
10 (roadway)	Black silty vegetation mat (topsoil)	0–20
	Red brown silty clay with abundant modern rootlets. Notable manganese at 35cm	21–45
	Red brown silt with notable modern rootlets	46–50
	Bleached grey-white silty clay, gritty and sandy (weathered bedrock)	51–62
	Onto solid	
11 (Turbine 7)	Black silty vegetation mat (topsoil)	0–10
	Onto solid	
12 (Turbine 5)	Red brown silt with abundant modern vegetation. Notable manganese at 40cm	0–45
	Brown silty sand with gritty clasts (weathered bedrock)	46–50
	Onto solid	
13 (roadway)	Black silty vegetation mat (topsoil)	0–20
	Grey brown sand, gritty (weathered bedrock)	21–26
	Onto solid	
14 (Turbine 2)	Black silty vegetation mat (topsoil)	0–20
	Red black peaty silt with abundant modern rootlets	21–40
	Bleached brown gritty silt	41–45
	Bleached brown gritty sand (weathered bedrock)	46–60
	Onto solid	

Point	Unit	Thickness (cm)
15 (turning circle)	Black silty vegetation mat (topsoil)	0–5
	Red black fibrous peat with visible macroscopic remains. Notable wood at 80cm. Charcoal at 70cm	6–85
	Brown gritty sand (weathered bedrock)	86–90
	Onto solid	
16 (peat in gully)	Red brown peat, moist with visible macros. 75cm exposed in freeface, further 90cm from core.	1.65
	Onto solid clay	
17 (Turbine 4)	Black silty vegetation mat (topsoil)	0–20
	Red brown fibrous peat with abundant modern rootlets	21–130
	Grey brown gritty, sandy clay (weathered bedrock)	131–148
	Onto solid	
18 (Turbine 1)	Black silty vegetation mat (topsoil)	0–10
	Black brown silt with abundant modern rootlets	11–60
	Onto solid	
19 (Turning circle)	Black silty vegetation mat (topsoil)	0–10
	Onto solid	
20 (roadway)	Black silty vegetation mat (topsoil)	0–10
	Black-brown humic silt	11–23
	Bleached brown gritty silt	23–30
	Onto solid	
21 (roadway)	Stiff brown clay	0–10
	Onto solid	
22 (roadway)	Bleached white weathered sandstone bedrock	0–5
23 (Turbine 12)	Black silty vegetation mat (topsoil)	0–10
	Red black fibrous silty clay with abundant modern rootlets	11–80
	Onto solid	

Point	Unit	Thickness (cm)
24 (turning circle)	Black silty vegetation mat (topsoil)	0–10
	Red brown peaty silt with abundant modern rootlets	11–35
	Black peaty silt with abundant modern rootlets	36–68
	Grey white (bleached) silty grit	69–75
	Onto solid	
25 (Turbine 11)	Black silty vegetation mat (topsoil)	0–16
	Red brown fibrous peat with modern rootlets	17–53
	Red brown humic silt with modern rootlets	54–96
	Bleached white grit (weathered bedrock)	97–100
	Onto solid	
26 (roadway)	Black silty vegetation mat (topsoil)	0–13
	Charcoal layer	14–15
	Red brown peat, woody at 80cm.	16–140
	Onto solid	
27 (roadway)	Black silty clay with modern vegetation	0–25
	Grey silty clay, gritty (weathered bedrock)	26–40
	Onto solid	
28 (Turbine 8)	Black silty vegetation mat (topsoil)	0–10
	Black peaty silt	11–40
	Brown coarse sand	41–50
	Black peaty silt	51–75
	Brown coarse sand	76–80
	Onto solid	
29 (Turbine 10)	Coarse grit (weathered bedrock)	0–10
	Onto solid	
30 (turning circle)	Red brown fibrous peat	0–165
	Onto solid	
31 (Turbine 9)	Red brown fibrous peat	0–125
	Onto solid	

APPENDIX 2 CORE (AUGER POINT 26) FLOTATION SAMPLE RESULTS

ID	Sample	Depth (m)	Total flot Vol (ml)	Plant remains	Comments
Auger point 26	1	0–0.10m	200	Monocotyledon ++++	Also contains worm casing
Auger point 26	2	0.10–0.20m	200	Carex sp + Ranunculus sp +, Monocotyledon ++	
Auger point 26	3	0.20–0.30m	200	Monocotyledon ++++, Carex sp.+, Ajuga reptans +	
Auger point 26	4	0.30–0.40m	200	Monocotyledon ++++, Carex sp +.	
Auger point 26	5	0.40–0.50m	200	Woody root and stem fragments +, monocotyledon ++	Contains woody stem of a suitable size for AMS dating
Auger point 26	6	0.50–0.60m	200	Monocotyledon +++, Ajuga reptans +++, Carex sp +, woody stem fragments +, Carex sp +	Contains woody stem of a suitable size for AMS dating
Auger point 26	7	0.60–0.70m	200	Ranunculus aquatilis +, Carex sp +, monocotyledon +++, Ajuga reptans +	
Auger point 26	8	0.70–0.80m	200	Salix sp fragments ++, monocotyledon ++,	Contains wood of a suitable size for AMS dating

Key: + = rare (1–5), ++ = occasional (6–15), +++ = common (16–50) and ++++ = abundant (>50)

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