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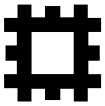
Analytical field survey of prehistoric and post-medieval remains on Fylingdales Moor, North Yorkshire

Al Oswald, Abby Hunt, Roger J Thomas and Jane Stone

SURVEY REPORT

Archaeological Investigation Report Series AI/12/2005



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ANALYTICAL FIELD SURVEY OF PREHISTORIC AND POST-MEDIEVAL REMAINS ON FYLINGDALES MOOR, NORTH YORKSHIRE

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County:	North Yorkshire
District:	Scarborough
Parish:	Fylingdales and Hawsker cum Stainsacre
NGR:	NZ 9625 0193
NMR No:	NZ 90 SE 126 (parent record)
RSM No:	34389
Date of survey:	March 2004
Surveyed by:	Al Oswald, Stewart Ainsworth, Abby Hunt, Trevor Pearson, Jane Stone and Roger J Thomas
Report authors:	Al Oswald, Abby Hunt, Jane Stone and Roger J Thomas
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1. INTRODUCTION

Fylingdales Moor is an expanse of heather moorland within the North York Moors National Park, overlooking the coast between Scarborough and Whitby (Figure 1). The area is subject to a number of environmental designations, namely Site of Special Scientific Interest (SSSI) and Special Protection Area (SPA); it is also a candidate for designation as a Special Area of Conservation (SAC). In addition to its ecological importance, the moorland contains a wealth of exceptionally well preserved archaeological remains, ranging in date from at least the later Neolithic period to the Second World War. Around sixty of the prehistoric sites, including examples of later Neolithic 'rock art' and early Bronze Age burial mounds, are considered nationally important and are therefore protected as Scheduled Monuments.

In September 2003, a fierce wild fire destroyed the ground cover across an area of 243.3 hectares (2.43kms^2 or 601 acres), centred at National Grid Reference NZ 957 012, and comprising much of Brow Moor, Howdale Moor and Stony Marl Moor. A separate area of 11 hectares (27 acres) at Mossy Mere, 4kms to the north-west of Fylingdales Moor, was affected by a second fire, which ultimately proved less intense. Following the fires, on 2nd and 3rd October, Graham Lee, the National Park Archaeological Officer, undertook a rapid examination of both burnt areas on the ground and English Heritage's Aerial Survey Team carried out reconnaissance and photography from the air. It was evident that the burning, although an undoubted ecological disaster, was arguably, from an archaeological point of view, a 'mixed blessing'. On one hand, the removal of the ground cover allowed the recognition of many previously unrecognised archaeological features, particularly on Fylingdales Moor. There, the newly exposed remains ranged from additional examples of prehistoric rock art, to features connected with two known post-medieval alum production sites: The Peak Alum

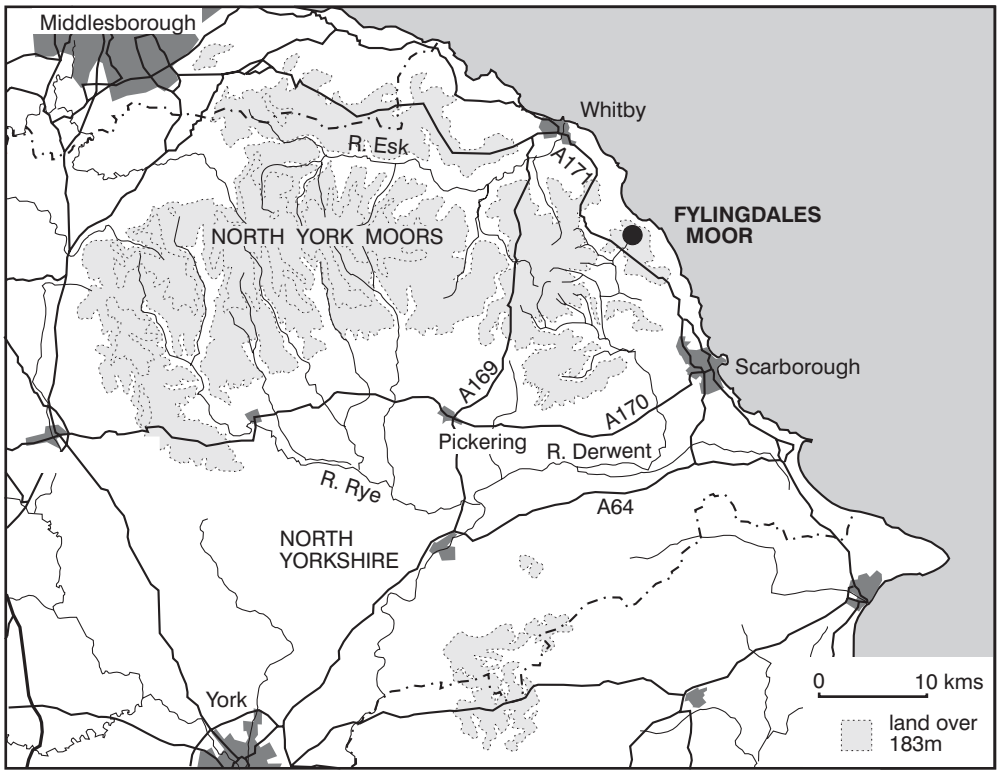

Figure 1. Location map

Works and Stow Brow Alum Works. It also became possible for the first time to accurately gauge the intensity of Second World War activity on the moorland. On the other hand, the rapid erosion that began immediately after the fire obviously constituted (and still constitutes, at time of writing) a severe threat to the condition of the archaeological remains of all periods. From all points of view, it was therefore desirable to re-establish vegetation cover as soon as possible. To achieve this, ecologists from English Nature and the National Park drew up plans for a programme of regeneration works. Phase 1 was to include the spreading of 'brash' (that is, shredded heather stems), which served both to scatter heather seed and to consolidate the ground surface against erosion by wind and water, the blocking of various watercourses with heather bales, and the sowing of grass seed to consolidate the surface and assist heather regeneration in the longer term. The timescale for this work was dictated by the conditions necessary for the successful sowing and germination of the heather seed. This in turn dictated the timescale for the archaeological work.

The oblique aerial photography was followed up by a field visit by the National Park Archaeological Officer, the English Heritage Inspector of Ancient Monuments, and representatives of the English Heritage Designation, Aerial Survey and Archaeological Investigation teams on 7th November 2003. This visit informed discussion of appropriate courses of action and contributed to a preliminary assessment of the impact of both fires on the archaeological remains, both those known previously and those revealed for the first time (Stone and Horne 2003). It was agreed that more detailed archaeological work was needed, particularly on Fylingdales Moor, to manage and inform the regeneration of the moorland ecology. It was also recognised that the situation potentially provided the opportunity for an exemplary case study to inform risk assessments and disaster management in comparable landscapes.

Following discussions, it was decided to commission large-scale vertical aerial photography for both burnt areas, to record the state of the ground and the archaeological remains at this critical point in time. A brief was prepared by the English Heritage Metric Survey Team and the photographic sorties were completed by Simmons Aerofilms on 23rd November (Archaeology Commissions Programme 3750). The English Heritage survey teams collaborated to establish National Grid control points across the burnt area and the images were then 'rectified', using digital photogrammetric techniques, to correspond to the terrain and to the National Grid. The resulting single image, or 'orthophotograph', provided a detailed and metrically accurate record of the majority of the more substantial archaeological remains, as well as information on topography, vegetation and soils. It also secured the opportunity to carry out further mapping and interpretation of any of these components of the landscape at any point in the future and therefore offers a valuable basis for monitoring changes of condition across the area.

However, it was also recognised that some degree of investigation on the ground would be necessary, primarily because full interpretation of the aerial phtographic evidence could not be achieved within the short time available. In addition, ground survey would serve to identify and record remains not visible on the aerial photographs, such as artefacts and the less

obvious earthwork features, as well as to clarify any stratigraphic relationships that were not fully comprehensible. To this end, a brief was prepared and a local team of contract archaeologists, Field Archaeology Specialists (FAS) led by Blaise Vyner, was commissioned to undertake a rapid survey on the ground, particularly focusing on the recording of exactly those remains and relationships (Vyner 2005; Archaeology Commissions Programme 3745). The scope of this fieldwork, undertaken using a 'Total Station' theodolite at Level 1 standard (as defined in RCHME 1999, 3-5), was subsequently modified to reflect emerging management concerns and the nature of the archaeological remains coming to light; it was completed on 16th April 2004.

In mid-March 2004, English Heritage's Archaeological Survey and Investigation Team began a detailed analysis and survey of the northern part of the burnt area, approximately corresponding to Brow Moor, using up to four differential Global Positioning System (GPS) rover receivers working concurrently. This fieldwork, which covered an area of 60 hectares (148 acres, or 25% of the total burnt area), was carried out in detail, at Level 3 standard (as defined in RCHME 1999, 3-5) and was completed by the end of March. To address conservation needs, features connected with water management and the effects of erosion by water, both before and after the fire, were recorded in particular detail. Close interval contouring of one of the burial monuments considered most at risk of wind erosion (Cairn 13) was undertaken, but the process of gathering the data proved to destabilise the surface to an unacceptable degree, and this technique was not used elsewhere. A digital plan of the area was produced and the paper copy associated with this report is reproduced at a scale of 1:1 000. Most of the observations and conclusions that follow are products of the detailed field survey, although note has been taken of the findings of both the rapid ground survey and the aerial survey. The involvement of the Archaeological Survey and Investigation Team was intended primarily to meet conservation needs, but the opportunity was also taken to address two specific research issues:

- the opportunity to investigate in detail the quarries that were the source of the raw material for Stow Brow Alum Works, 800m to the north. A study by English Heritage of the alum industry, focussing primarily on those sites on the north-east coast threatened by erosion, was already in progress (Topping 2000). Unlike The Peak Alum Works, whose quarries were also touched by the fire, The Brow complex has seen almost no previous research (Buglass 2002, 138). In particular, the associated water supply systems exposed by the fire represent an aspect of the industry that is known to have been important, yet which has remained poorly understood because the physical remains rarely survive.

- the opportunity to contribute indirectly to an imminent pilot study of rock art through a detailed examination of a notable concentration of examples, in the context of a landscape also peppered with later Neolithic or early Bronze Age burial monuments, as well as settlements and field systems, which might prove to be broadly contemporary.

2. TOPOGRAPHY, GEOLOGY, AND MODERN LAND USE

The moorland plateau is highest along its north-eastern edge, reaching a maximum of 270m above sea level along the crest of Stoupe Brow. Prior to the fire, erosion of the soil along the summit of this escarpment had exposed much higher densities of loose stone, representing the fragmented upper surface of the underlying sandstone. To the north and east of the escarpment, where the ground falls sharply to the coastal cliffs, much of the land has been enclosed and improved, for both grazing and arable agriculture, and environmental conditions change abruptly. To the west, the ground falls gently to around 200m above sea level, although cut into between Brow Moor and Howdale Moor by the valleys of the numerous tributaries of Slape Stone Beck.

Beneath the sandstone cap, beds of grey shale contain low densities of the chemical compounds which are the raw materials necessary for the production of alum. This chemical was used for much of the post-medieval period as a dye-fixer in the textile industry; Stow Brow Alum Works and The Peak Alum Works both exploited the deposits.

On the plateau itself, the geological conditions support a thin, sandy, free-draining soil, with a peaty topsoil, low in nutrients. The relationship of many of the stones displaying rock art to today's ground surface suggests that there has been little loss of overall soil depth since the later Neolithic. However, the formation of the peaty topsoil may well have been a reaction to the loss of the pre-existing topsoil through later Neolithic or Bronze Age activity, especially woodland clearance and subsequent agriculture (Smith 1994, 28-31).

Apart from military activity during the Second World War, land-use on the moorland, though widespread and varied, has been non-intensive for many centuries, quite possibly since the Bronze Age. The Cartulary of Whitby Abbey states that William de Percy's foundation bequest to the Abbey, made at some point in the ten years before 1078, included the 'vaccaries of Stoupe' (Page 1923, 535). This would have been land where cattle and other livestock were allowed to stray and may well have included parts of Fylingdales Moor. Since the land has remained in the ownership of a single family for most of the post-medieval period, the management regime has changed little across most of the area under consideration, with the first major changes occurring in the mid-20th century. Details are presented in Section 7.3, but it seems likely that sheep grazing may have persisted for much of the post-medieval period and certainly throughout the 19th century. In 1682, the Manor Court of Fylingdales legally enshrined the long-standing custom of claiming an area for turf-cutting, for use as fuel, by carving an initial letter into the ground surface (Hartley and Ingilby 1972, 77). Physical evidence for turf cutting and storage has been recorded on the ground and is discussed in Section 7.4. The same court session prohibited the burning of any 'ling', or heather, reserved for use as thatch, but permitted the gathering of burnt stems for use as kindling.

Historic maps suggest that the first lines of grouse-shooting butts were laid out in the 1960s. However, it is likely that grouse shooting began, on less formal lines, at least a

century earlier (Statham 1989, 205). The collapsed remains of what may be an isolated grouse-shooting butt, if it is not a military feature, may be a relic of one such excursion. Large tracts of the heather were, for many years, managed through a programme of regular controlled burns, in order to promote the new growth on which the grouse feed. At the time of the fire, no controlled burns had taken place for some years, allowing the heather to grow longer. A network of firebreaks, each on average 5m wide, has been mown and cut across the moorland to make management of the burning safer and less labour-intensive. The depth to which these cut into the ground surface, and therefore the degree of damage caused to archaeological remains, varies across the moor, depending primarily on how robust the ground surface is. Another factor is the frequency with which the firebreaks have been reinstated, for the pattern has not remained static. As a result, damage in many dry and stony areas, including most of the land covered by English Heritage's detailed ground survey in 2004, is minimal. However, in other parts of the moor, especially where the topsoil is waterlogged or where firebreaks have been re-cut repeatedly on the same line, aerial survey and the rapid ground survey have recorded instances of severe damage to features of archaeological importance.

3. PREVIOUS ARCHAEOLOGICAL RESEARCH

Previous archaeological research on Fylingdales Moor has been almost entirely confined to the prehistoric remains. Regrettably, George Young's 1817 *History of Whitby* makes no specific mention of any of the prehistoric remains discussed in this report, although he discusses the area's antiquities at some length. Most of the cairns, or '*tumuli',* along with elements of the prehistoric field boundaries, were first accurately mapped in 1849 for the First Edition 6-inch scale map, under the direction of Captain Bayly (Ordnance Survey 1853; *see* Figure 5). Captain Bayly's map-making on Fylingdales Moor, and elsewhere across North Yorkshire, generally exhibits enthusiasm and talent for the interpretation of archaeological remains. The name 'Robin Hood's Butts' relates to local folklore and is likely to have originated in the mid-16th century (Binns 2000). With one significant exception, the name has been consistently applied to three of the largest and most prominent burial mounds (Cairns 12, 13 and 14) since the publication of the Ordnance Survey map in 1853. However, there is considerable uncertainty over whether the Ordnance Survey in 1849 attributed the name to the correct barrow group, for several other sources suggest that prior to then, the name had been applied to a pair of cairns at NZ 973 011, called 'Beacon Howes' by the Ordnance Survey (Ordnance Survey 1853). It is generally acknowledged that Ordnance Survey map-makers were permitted to carry out less thorough research in naming features which were unlikely to have legislative importance, including ancient monuments (Seymour 1980, 174-6). However, in view of Captain Bayly's well-attested personal interest in archaeology, the apparent error cannot be explained away so easily.

The name 'Robin Hood's Butts' first appears on John Warburton's 1720 map of the County, but without any symbols to represent the exact number or positions of the actual cairns (Warburton 1720). Although the scale and style of the map precludes very accurate location, the annotation lies some way south of The Peak Alum Works, in a position which would correlate well with two cairns later called 'Beacon Howes' by the Ordnance Survey. Lionel Charlton records that excavation into one of the 'butts' in 1771 had produced human bones, but does not give their exact location or specify the total number of cairns (Charlton 1779, 146). Thomas Hinderwell's 1798 *History and Antiquities of Scarborough* describes Robin Hood's Butts as 'two little hills, a quarter of a mile asunder' (Hinderwell 1798, 266). Charles Greenwood's map, on the other hand, surveyed between 1815 and 1817, labelled a triangular arrangement of three cairns as Robin Hood's Butts (Greenwood 1817). This distinctive pattern seems to indicate that he was depicting those later identified as such by the Ordnance Survey, but the actual location depicted is several hundred metres too far to the south-west and may conceivably be entirely schematic. Robert Knox's map, surveyed at about the same date, but at a larger scale and in a less schematic style, definitely applied the name to the cairns now called Beacon Howes (Knox 1820). The three barrows now called Robin Hood's Butts are accurately depicted, but not named. A slightly revised version of the same map accompanied his textual account, published two years after the Ordnance Survey map, but he left the names of the barrow groups unchanged. In the text, Knox discusses

the moorland's archaeological remains at some length and refers to 'the two howes, "Robin Hood's Butts"' (Knox 1855, 18).

As mapmakers, there are arguably three key differences between Knox and Greenwood: firstly, Knox was a local man; secondly, Knox was a noted antiquarian, whose research went well beyond simply depicting monuments as landmarks; thirdly, Greenwood's map was commissioned by the Board of Ordnance, and would therefore almost certainly have been made available to the Ordnance Survey mapmakers. The question cannot be resolved totally satisfactorily, but it seems most likely that the original error (or schematic depiction) was made by Greenwood and followed by the Ordnance Survey. Alternatively, it is possible that the name of the two cairns genuinely changed, possibly in the wake of the construction of the beacon itself, and that the name Robin Hood's Butts then became attached to the group of three that bear the name today. The beacon was built soon after 1803 and was repaired in December 1808 (Rimington 1988, 67). Therefore, it is conceivable that the old name was still in use in the early 1800s when Robert Knox carried out the research for his 1820 publication, but was on the verge of abandonment by the time the Ordnance Survey carried out their fieldwork in 1849.

In passing, it is worth noting that another Scarborough antiquarian, John Tissiman, only added further confusion in his report on excavations undertaken in 1849, that is, before the publication of the Ordnance Survey map:

> The tumulus known as the "Ravenhill tumulus" was opened on the 21st August 1849. This mound is situated on the moor land to the right of the road leading to the hall, and is one of the three named, in the map of the *Archaeological Institute*, "Robin Hood's butts." (Tissiman 1851, 2-4)

As Margaret Smith (1994, 95) has concluded, the site of Tissiman's investigation would seem to have been one of the three monuments in the region of NZ 980 011, which occupy the ridge of high ground just east of the road to Raven Hall, an area certainly known as Raven Hill throughout the 19th century (Knox 1820; Ordnance Survey 1893). From this, it must be inferred that Tissiman mis-read the map held by the Archaeological Institute, which is likely to have been that made by Greenwood. In short, his reference to Robin Hood's Butts is best ignored.

Towards the end of the 19th century, the famous Canon Greenwell excavated six burial monuments on Fylingdales Moor, including one which was evidently a ring cairn (Greenwell 1890, 39-43). Regrettably, though the written records of his discoveries, in terms of internal structures, human remains and artefacts, are usually very detailed, the numbering system for the barrows he investigated can no longer be adequately correlated with the surviving physical remains. He describes his Barrow CCLXIX as 'one of the three "Old Wife Howes"' (Greenwell 1890, 40). It has been suspected that these may equate to Robin Hood's Butts (Kinnes and Longworth 1985). However, the group of five barrows at NZ 957 007, called 'Stony Marl Howes' by the Ordnance Survey from 1849 onwards, was called 'The 3 Howes' by Knox, with one of the eastern members of the group singled out as 'Old Wife's Howe'

(Ordnance Survey 1853; Knox 1820). Greenwell's description suggests that this name continued in use, and the recorded dimensions of Barrow CCLXIX tally reasonably well with the surviving physical remains of one of the mounds, which now shows clear evidence of excavation.

Apart from a passing reference by Canon Greenwell, which is discussed in Section 4.2, scientific interest in the area's prehistoric rock art seems to have commenced with discoveries in the first half of the 20th century (Kendall 1937; Browne 1940). Stuart Feather's more systematic fieldwork between 1962 and 1965 resulted in a list of eighteen individual stones bearing motifs (Feather 1966). Not all of these could be relocated by the Ordnance Survey Archaeology Division when they carried out fieldwork to support map revision in 1974 (information in English Heritage's national database of sites and monuments; Ordnance Survey 1976). However, subsequent fieldwork, primarily carried out by Paul Brown and Graeme Chappell between 1994 and 1996 and again in the immediate aftermath of the 2003 fire, has relocated all the stones recorded by Kendall and discovered new examples (information on 'North Yorkshire Rock Art' website (www.alkelda.f9.co.uk/index.htm); Chappell and Brown in preparation).

4. THE NEOLITHIC AND BRONZE AGE LANDSCAPE

4.1 Introduction (Figure 2)

The only intensive activity on Brow Moor prior to the post-medieval period can be assigned to the later Neolithic and early Bronze Age (*c* 2500 – 1800 BC), probably coinciding with the gradual clearance of the local wildwood and the earliest farming on the high ground. To judge from the earthwork remains, boggy areas and the strip of very stony ground along the edge of the escarpment were utilised least intensively.

No attempt was made to search systematically for artefacts exposed on the surface, but a sparse scatter of struck flints was recorded across the whole of the area examined in detail. A notable concentration was found within the extents of the probable ring-cairn (Cairn 11). Though likely to be of Neolithic or Bronze Age date, most of the pieces examined were waste flakes which are not diagnostic of any specific period. The sole exception is a fine scraper, likely to be of Neolithic date, which was found at NZ 95742 02149.

Although this report divides the earthwork remains into four categories – rock art, burial monuments, agriculture and settlement – these elements were interdependent and inter-related. For example, the creation of much of the rock art may pre-date the other activities by several centuries, yet its distribution pattern is potentially a direct consequence of those activities. The clearance of woodland created fields of view necessary for the display of the burial monuments, as well as new ground for ploughing. Clearance of surface stone, perhaps including portable stones displaying rock art, in preparation for agriculture could also have provided much of the material necessary for the construction of the monuments. Excavation has also demonstrated that there is not always a clear-cut distinction between 'clearance cairns' – ostensibly casually deposited heaps of unwanted stones from the fields – and burial cairns deliberately constructed as monuments (see, for example, Barnatt 1994; Wilson and Barnatt 2004). Cairns 21 and 22, for example, can only tentatively be interpreted as burial monuments; their siting on the line of a boundary means that material resulting from field clearance may well have been added. While recognising this difficulty, in this report, a few small cairns have been tentatively identified as burial monuments based on the unusual care apparently taken over their construction, in some cases seemingly involving the selection of specific sizes of stone. Settlement remains which can be attributed to the prehistoric period with confidence are extremely scarce, so much so that it could be inferred that a number of sites are not detectable through surface survey or have been overlooked, as has proved the case elsewhere (Ainsworth 2001, 63). Structures (presumably roundhouses) appear to have been relegated to areas where the surface stone was too dense for clearance to be worthwhile, or places that were unsuitable in some other way for cultivation.

In summary, each individual prehistoric element of the landscape must be understood in its wider context. In addition, it is important to take into account the potential effects of later activity on the distribution and condition of the prehistoric remains.

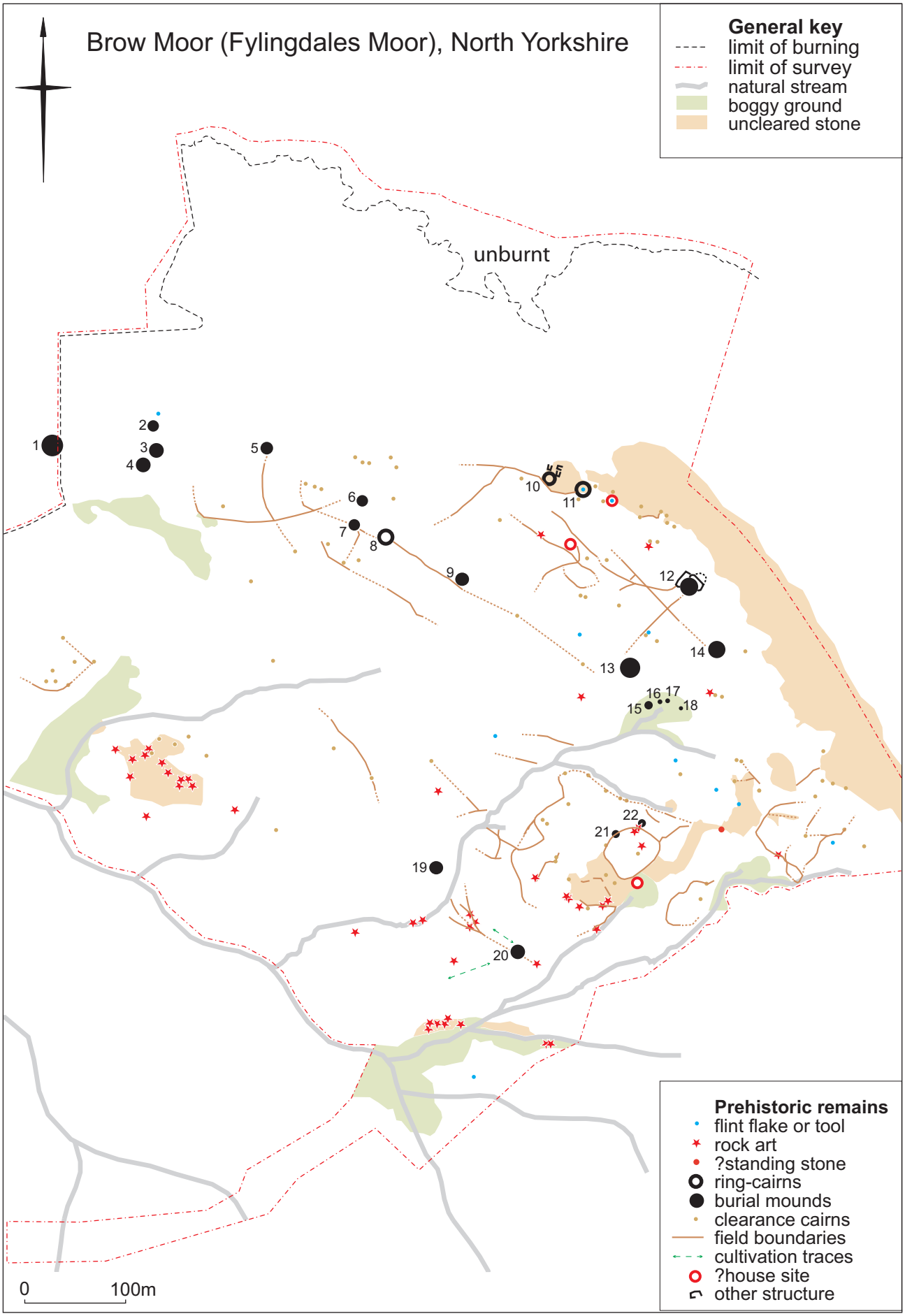

Figure 2. English Heritage schematic plan of prehistoric remains

4.2 Rock art

The elaborately decorated rock known as the 'Hope Stone' is not discussed in this report. In total, fifty-four examples of so-called 'rock art' were identified within the area subjected to detailed survey, ranging from single cup-marks ground into portable boulders, to multiple cup-marks, cup-and-ring marks and more complex designs, pecked and ground into large, earth-fast slabs. No attempt was made to record individual motifs in detail, but a few general observations are appropriate. There appear to be two, or perhaps three, different styles:

- simple cup-marks, often found singly on portable stones
- cup-and-ring marks, sometimes with radiating channels, usually found as part of more heavily decorated panels, though these sometimes only comprise additional cup-marks
- more complex geometrical and linear designs, which, unlike the first two categories, are primarily pecked rather than ground into the rock.

On the basis of the widespread association between rock art and early Bronze Age burial monuments, it was long believed that all rock art could be assigned to the early Bronze Age (Morris 1989). However, partly in reaction to this established belief, it has also been argued that all rock art is likely to be later Neolithic and that the association with burial monuments is essentially accidental, because the flat rocks generally selected for the display of rock art in the Neolithic were also ideal for quarrying the slabs necessary for the construction of the kerbs and cists of burial cairns in the Bronze Age (Simpson and Thawley 1972, 86; Burgess 1991, 21-3). According to this argument, it was simply because the decorated surfaces were usually smoother and more regular that they were usually placed facing inwards in cists and outwards in kerbs. This theory may prove incorrect, but nonetheless makes the valid and extremely important point that if the locations and functions of rock art are to be understood, a fundamental distinction needs to be made between motifs executed on non-portable earth-fast boulders and outcrops, on one hand, and those executed on portable stones or quarried slabs, on the other. While the former stones must have remained in their original locations, the latter might conceivably have been moved in the course of later activities. Studies of rock art do not always discuss or even acknowledge the potential effects of later land-use on patterns of distribution, but it is essential to the understanding of portable stones in particular that such factors are properly taken into account.

It is now widely accepted that curvilinear motifs – particularly cup-and-ring marks and spirals - are probably of later Neolithic origin, with simpler cup-marked designs perhaps originating as early as 3,300 BC and continuing in use into the early Bronze Age, alongside more angular geometric designs developed in that period, the latest perhaps created by 1,800 BC (Bradley 1997, 62-6). There is limited direct evidence from Fylingdales Moor to support part of this theory: one pecked design, of the last of the three categories listed above, overlies, and therefore post-dates, a group of cup-marks. There is also a more general impression – admitting the risk of the argument becoming a circular one – that most examples of rock art pre-date the fully developed agricultural use of the moor, which would usually be assumed

to be of broadly Bronze Age date. While it was observed that many of the single cup-marks occur on portable stones, which might be interpreted as a significant stylistic difference, there is no clear evidence that these are distinct in chronological terms from the multiple cup-marks and cup-and-ring marks.

Most examples of multiple cup-marks and cup-and-ring marks occur on large, virtually immovable slabs and boulders that represent the fragmented upper stratum of the sandstone bed. These are concentrated along the south-western and south-eastern edges of the area surveyed in detail, respectively overlooking the valley of the Slape Stone Beck and along the course of one of its tributaries. It is noteworthy that no examples of rock art were observed on the similar slabs anywhere within the band of rocky ground along the north-eastern edge of the escarpment. This absence could be explained away by the more severe natural erosion that is certainly experienced by this, the most exposed part of the plateau, but this is not an entirely satisfactory explanation. However, the apparent concentration of examples along the western fringe of the plateau may itself be partly illusory, for most lie within an area that was sufficiently stony to escape thorough clearance for later agriculture. It is not impossible, therefore, that examples once located on the plateau were broken up to facilitate later agriculture, disposed of in nearby clearance cairns, and have been overlooked. Alternatively, they may have been more carefully quarried for re-use elsewhere, for example for incorporation into burial monuments. It is also now more widely accepted that certain types of motif were deliberately selected for incorporation into Bronze Age burial monuments and that the orientation of the decorated faces did not merely reflect practical considerations (Bradley 1997, 138-46). Examples of rock art panels incorporated into burial monuments are not discussed in detail in this report. In short, what now appear to be outlying examples of rock art on earth-fast boulders in the centre of the plateau, such as the stone that lies 50m south-west of Cairn 13 (the westernmost of Robin Hood's Butts), may originally have been part of a denser and more widespread distribution pattern.

Twelve of the stones bearing motifs are portable. Of these, four are incorporated into burial monuments. All but one of the others occur on the lines of prehistoric field boundaries, in clearance cairns or, in two cases, in a watercourse which must have effectively defined a field boundary. Seven, including the one which does not seem to lie on a field boundary, cluster in the area between Cairns 19 and 20. This may hint at the existence of a ploughed-out burial cairn in the vicinity, but Cairn 19 itself incorporates two stones bearing rock art and appears to have been heavily disturbed, so this monument may be the source. Many of the larger outcropping slabs and earth-fast boulders also appear to coincide with field boundaries, but, as mentioned above, this may be fortuitous, because these rocks lie within and sometimes define particularly stony ground that would not have been attractive for arable agriculture. Most of the portable stones, including the example in the watercourse, bear a single cup-mark, while a few bear up to four cup-marks, widely spaced. There must be a strong suspicion that these stones might have been carried to the field boundaries as part of the gradual process of clearing the surface of stones that hindered ploughing. However, the only tangible evidence that supports this suspicion are the two examples in a watercourse,

whose location seems far more plausible as the result of casual clearance to a convenient area of waste ground, than as a deliberate, primary siting.

Since the survey has demonstrated that a high proportion of rock art on portable rocks occurs in association with field boundaries, it is worth considering the interpretation of the few examples which are apparently isolated. On one hand, they may be interpreted as examples which remain more-or-less in their original positions, perhaps because they lay in areas with little surface stone and were distant from the nearest convenient dumping ground. On the other hand, it is possible that they lay on the lines of field boundaries which can no longer be detected on the surface, since the survey has demonstrated that elsewhere, where not marked by cleared stone, the lynchets are in some cases extremely ephemeral and intermittent features.

Stone extraction, probably of post-medieval date, took place in areas where large slabs of sandstone outcrop on the surface (see Section 7.2). In one instance, a large stone was evidently removed from the line of a prehistoric field boundary, which follows the limit of an area of stony ground and incorporates various examples of rock art, both on outcropping slabs and on portable stones. Although impossible to prove, it is a distinct possibility, given its size and location, that the removed stone may have been decorated. Canon Greenwell, in the introduction to his investigations into the burial monuments on the moor, also implies that stones with more elaborate motifs had been removed both from cairns and elsewhere.

> Upon this tract of moorland there have been found a number of those remarkable stones, marked with central pits and concentric but incomplete circles, which, existing in several districts in England, Scotland, and Ireland, still remain shrouded in the same mystery, as regards their meaning, as when they were first discovered. Eight stones with these markings are preserved in the garden at Peak House, or, as it is now usually called, Raven Hall, some of which are said to have been taken out of neighbouring barrows. (Greenwell 1890, 39)

At least one stone displaying cup-and-ring marks still survives in the grounds of Raven Hall, now a hotel (information from Head Gardener, Raven Hall Hotel). The locations of the remaining examples are unknown.

4.3 Burial Monuments

Most of the seventeen major burial monuments within the area of detailed survey occupy typical locations along the crest of Stoupe Brow and several stand almost 2m high, making them conspicuous landmarks against the skyline when seen from lower ground to the north and north-west. Several of them – notably Cairns 1, 4 and 20 - also make use of natural knolls to increase their visual prominence. As suggested in Section 4.1, it seems logical to infer from the evident concern of the builders to achieve visual impact that the state of the woodland cover at the time was closely linked to the choice of location for the monuments. It is impossible to be sure of the extent of the cleared land prior to their construction and how much new clearance, if any, the construction and display of the burial monuments required. However, the pollen record strongly suggests that much of the Moors were covered

by mixed oak forest (*Quercetum mixtum*), with some Scots pine (*Pinus sylvestris*) on higher ground (Smith 1994, 27-8). The appreciation of the rock art must also have relied to some extent on the stones being visible, but it is possible that there were numerous intervening episodes of woodland regeneration and clearance.

All the burial monuments on Brow Moor could be assigned to the late Neolithic, or more probably the early Bronze Age, on the evidence of their form, but the northernmost of Robin Hood's Butts (Cairn 12) presents a more informative sequence (Figures 3 and 4). A line of flat stones, fairly large but easily portable, laid flat at intervals of between 1m and 2m, is aligned on the centre of the monument and originally extended for at least 60m to its south-west. These evidently formed the core of an earthen bank of which only a vestigial trace now survives and only for part of the length of the alignment. At a point 16m south-west of the burial monument, a small clearance cairn, which forms part of a linear band of cleared stone running at right angles to the first feature, lies against the side of the alignment. The cairn incorporates two large, flat stones which are similar to those used in the alignment and were quite probably removed from it. To the south-west of this point, the stones in the alignment become fewer and more irregularly spaced, whilst the slight earthwork is absent altogether, both losses apparently caused by ploughing and associated field clearance, compounded by medieval and later traffic along one of the major historic routes. To summarise the constructional sequence: the burial cairn is the earliest episode; the alignment of stones, which presumably served as a guideline for a slight earthen boundary bank, came next; subsequently, most of this boundary was ploughed away. The time intervals between these events are uncertain, but agriculture associated with clearance cairns would normally be assumed to be of broadly Bronze Age date. Therefore, the sequence of development is potentially directly relevant to the understanding of the process by which the woodland cover was gradually cleared to make way for agriculture.

Cairn 12 has also been subjected to intensive stone-robbing, apparently in two episodes. Both episodes may be linked to the construction of a series of small enclosures suggestive of livestock pens which adjoin and overlie the burial monument. Initially interpreted as a single rectangular enclosure with internal sub-divisions (Stone and Horne 2003, 9), closer inspection reveals that the eventual plan of the enclosure represents the end-product of at least two and perhaps as many as four phases of development (Figure 4). Facing stones are detectable within the north-western banks of rubble, indicating that this section of the perimeter, at least, was perhaps originally more akin to a dry stone wall. In the absence of diagnostic features, the enclosures are impossible to date with any confidence, although their condition gives the impression that they are of ancient, but not necessarily of prehistoric, origin. Their relationship to the agricultural features discussed above is also impossible to interpret securely. However, the stone alignment stops just short of the burial cairn, perhaps indicating that it too was subjected to stone robbing in order to obtain construction material for the enclosures. A second band of cleared stone, which intersects with the latest cultivation boundary (the stratigraphic relationship is unclear), appears to turn to meet the corner of the enclosures, as though the two may have been in contemporary use. In short, the enclosures

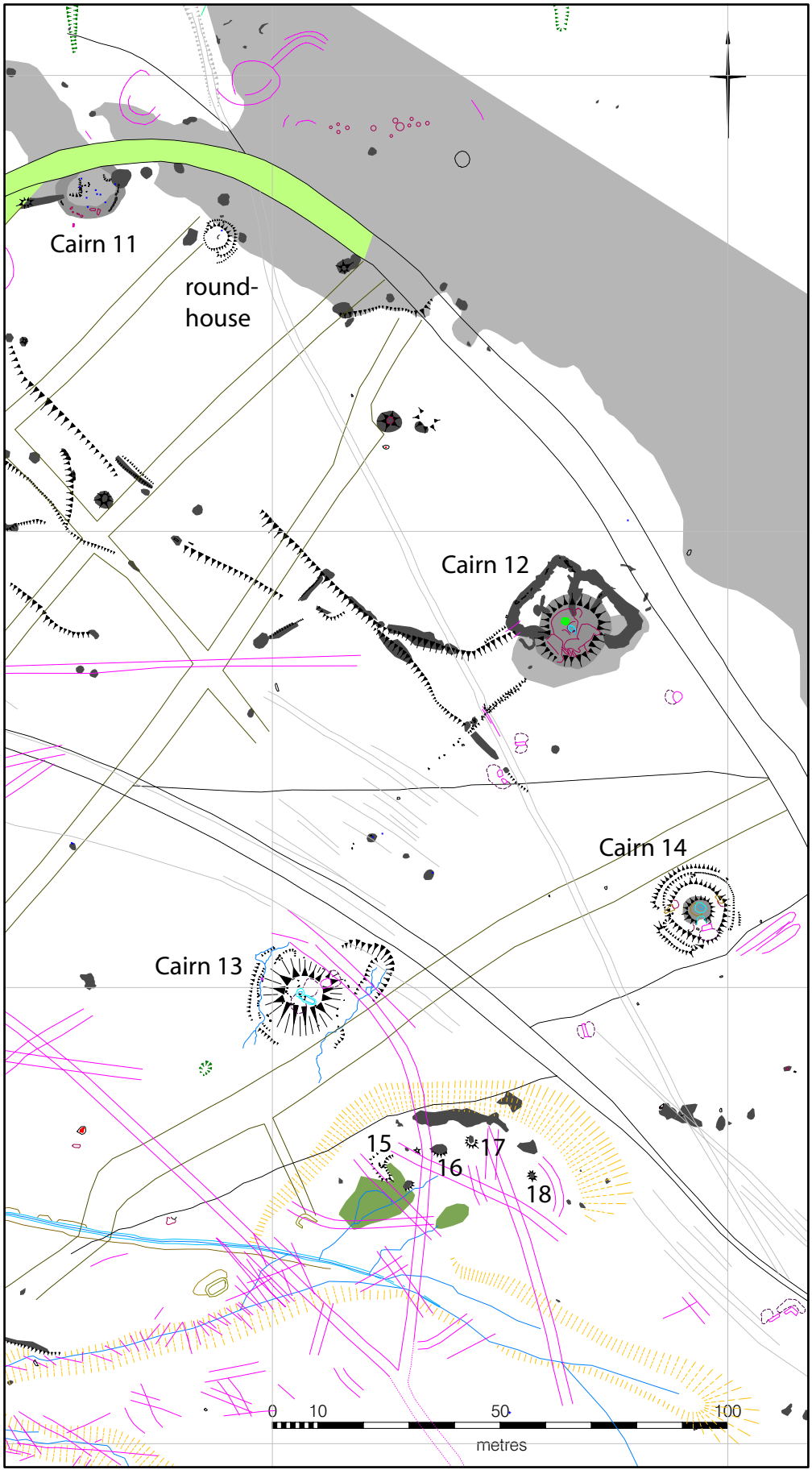

Figure 3. English Heritage survey of Cairn 12 and its environs (extract from main plan at 1:1 000 scale; see page iv for key)

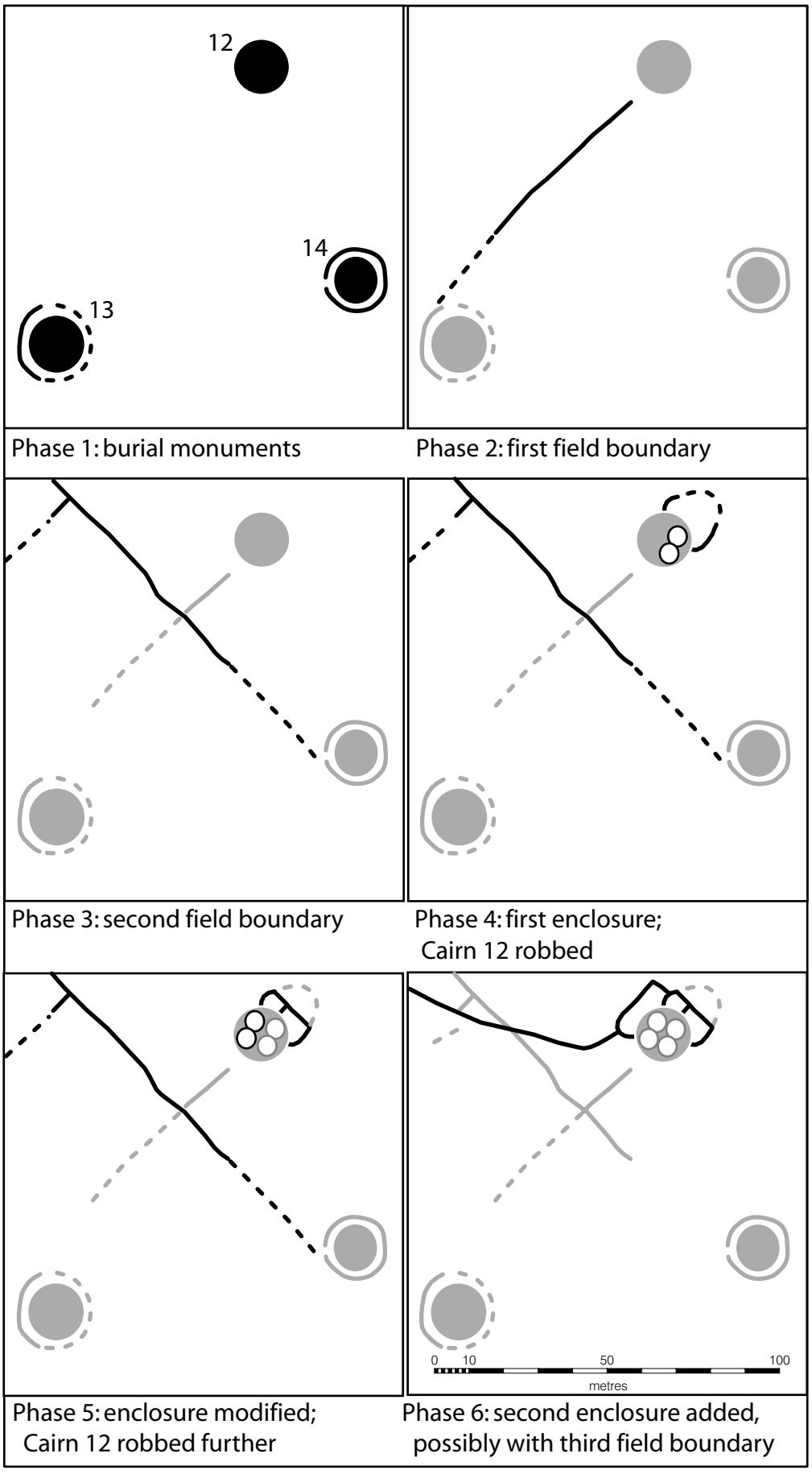

Figure 4. English Heritage interpretative plan of Cairn 12 and its environs

may well be of Bronze Age date, but were perhaps constructed towards the end of the sequence.

Turning to Cairn 14, the easternmost of Robin Hood's Butts, the initial assessment of the impact of the fire pointed out the existence of a previously unrecognised ditch and external bank up to 0.1m high, enclosing the mound (Stone and Horne 2003, 9). Such features are not uncommon and may be indicative of different constructional phases. The westernmost of the three cairns (Cairn 13) is also surrounded by a ditch with an external bank. A more extensive depression immediately upslope from the mound may also represent turf cutting or shallow quarrying to obtain construction material; again, such features are found widely elsewhere, although often overlooked. The monument has suffered considerable disturbance. A trench across the top of the mound probably results from 18th- or 19th-century antiquarian excavation, perhaps the documented investigation by Canon Greenwell. A typical heavy weapons pit of broadly Second World War date has been dug into the north-eastern slope of the mound, the pit evidently preserved virtually intact until the onset of erosion following the 2003 fire. In the centre of the summit of the cairn, cutting through the antiquarian excavation trench, is another square pit whose condition is as fresh and well defined as the weapons pit. However, its conspicuous location, exposed against the skyline, would be anomalous for a conventional weapons pit, and there is no evidence for any parapet bank. Therefore, the pit may represent a 20th-century attempt at looting, perhaps by troops.

Cairn 14 is sited on a natural eminence overlooking a boggy depression which is the source of one of the tributaries of the Slape Stone Beck; both natural features may have attracted the builders of the monument, for many late Neolithic and Bronze Age monuments are sited close to springs and watercourses (Field 1998). Indeed, four smaller cairns (Cairns 15 - 18) which lie within the limit of the boggy ground may also represent burial monuments. Though superficially similar to clearance cairns, Cairn 15 contains what appears to be a disturbed cist, comprising three larger stone slabs, of which two are set on edge. The existence of a cist would normally be considered diagnostic of the early Bronze Age. Cairn 16 is constructed exclusively of medium sized stones which appear to have been carefully packed together rather than casually discarded. Last but not least, the position of the cairns within the boggy ground places them several metres from the limit of the cultivatable ground – an improbable location for simple agricultural clearance cairns, whose locations were almost always a consequence of pragmatic concerns.

Cairn 19 is a relatively small burial cairn, though slightly larger than all the cairns that can be interpreted as products of field clearance, which occupies the break of slope where Brow Moor drops away more sharply into the valley of the Slape Stone Beck. In addition to its size and conspicuous location, this example differs from simple clearance cairns in that it sits within an area where the density of stones exposed on the surface is low, implying that the construction material may have been carried from some distance. The presence of three stone slabs displaying multiple cup-marks within the cairn seems to confirm the interpretation of the cairn as a burial monument. The rock art, comprising multiple simple

cup-marks without associated rings inscribed into slabs of portable size, might be considered to be of early Bronze Age rather than later Neolithic date.

Cairn 11 is one of several clear examples on Brow Moor of a 'ring cairn', despite having been damaged by stone robbing and erosion along the course of the firebreak that currently acts as the principle north to south footpath. A probable cist lies within a mini-cairn at the centre of the ring and a concentration of nine struck flints was recorded within the extent of the monument during the English Heritage survey. Nearby, Cairn 10 may also represent a ring cairn, but, if so, one that has been subject to a number of later modifications. The proximity of the cairns to the only certain roundhouse identified on Brow Moor is worthy of note, especially since it has been suggested that some so-called 'ring-cairns' may represent the accumulation of stone around the external faces of the walls of timber roundhouses (information from John Barnatt). There is some evidence to support this hypothesis: slight earthwork platforms, which are sometimes the only evidence for timber roundhouses, are also sometimes a feature of ring-cairns, though they often go unrecorded through surface survey. Cairn 8, a probable ring-cairn that was not affected by the wildfire, appears to be sited on such a platform. The potential overlap between these two types of feature was also noted during the extensive surveys of prehistoric settlements and field systems preserved on moorland in the Peak District (Ainsworth 2001).

In a number of cases, small 'satellite' features are associated with the cairns. Cairns 2 and 15 lie close to low earthworks whose function is uncertain, but which appear from their condition to be of considerable antiquity. Elsewhere, low mounds adjacent to the major monuments may represent burial monuments in their own right. Adjacent to Cairn 4, one such mound is comprised entirely of small stone fragments. On the basis of excavation, similar features in the Derbyshire Peak District have been interpreted as platforms for the deposition of offerings, and burials within the platforms may effectively have been intended as offerings (Barnatt 1991; 1994).

As described more fully in Section 7.2, Cairn 6 appears to have been almost completely destroyed by stone robbing at some point between 1849 and 1892 (Ordnance Survey 1853; 1893).

4.4 Agriculture

Clearance cairns, the by-products of agriculture normally assumed to be of Bronze Age date, are the most numerous and widespread prehistoric remains on Fylingdales Moor: around ninety were recorded in the area of detailed survey. A fair proportion of the more prominent cairns were mapped under the direction of Captain Bayly in 1849 and subsequently (Ordnance Survey 1853; 1893; see Figures 5 and 6). A wide variety of forms exists. Small, roughly circular mounds of loose stone piled up to 0.4m high occur in the middle of cultivated areas, sometimes accumulated around larger stones that must have been considered too troublesome to move. Others may have been formed around large tree stumps left by clearance of the wildwood. Where the burning has been less severe, clearance cairns are only identifiable as slight swellings in the turf layer, through which stones sometimes protrude.

Field boundaries are in many cases marked by very slight lynchets, usually no more than 0.1m high. However, these are more easily recognisable where stone was dumped or thrown along them to form linear scatters, which intermittently assume more cairn-like proportions. Indeed, on the aerial photographs, only those lynchets that have stony components are recognisable. The clearance assumes a similar form along the edges of certain watercourses and boggy areas, which evidently existed by the Bronze Age and served to define the limits of fields. Where the quantity of stone naturally exposed on the surface is high, the limits of field clearance can be recognised as a denser band of stone framing the clearer ground.

Predictably, clearance cairns were only formed where a high density of stone occurs naturally on the surface and in the ploughsoil; in areas where the density of stone is low, clearance was unnecessary and agriculture is consequently more difficult to detect. In the light of this, it seems likely that Bronze Age agriculture extended across most of the top of the moor, except where the ground was too boggy. Another area which was clearly not ploughed is the band of stony ground along the north-eastern edge of the escarpment. In fact, within this area, no certain prehistoric features or artefacts were recognised at all. Shallow depressions and slight mounds occur throughout this zone, but are apparently not of artificial origin, and may represent the hollows left by fallen trees. Although such features are impossible to date, it may be that this area was not cleared of trees until after the Bronze Age. Prior to clearance, a band of woodland here could have lent a good deal of shelter to the cultivated land from on-shore winds.

It is generally accepted that prolonged, gradual field clearance produces cairns in which the stone is effectively graded by size, larger stones forming the initial mound with smaller stones added as the years pass. Eventually, if the ground is over-farmed, larger stones will again be pulled to the surface by the plough. Within the area of the detailed survey, however, very few of the cairns give the impression of having been the product of such a process. On the contrary, they seem to result from a relatively short-lived, though evidently fairly widespread, episode of cultivation. Complementing this observation, the field boundaries on Brow Moor, where traceable, are generally less well defined and less formally organised than the so-called ‘co-axial field systems’ identified on Howdale Moor (Stone and Horne 2003, 7). Many boundaries follow a broadly south-east to north-west alignment, but this appears to echo the line of the escarpment edge, rather than to reflect any systematic attempt at planning. In several instances, the differing alignments of boundaries bring them into conflict with each other, implying some degree of change in the field pattern, even if the episode of cultivation was quite short-lived, as suggested above. The sequence of modifications to the field boundaries that impinge on Cairn 12, the northernmost of Robin Hood’s Butts, points to a similar conclusion.

Two small patches of possible Bronze Age ploughing were recorded on Brow Moor, although much larger tracts were noted on Howdale Moor. The two patches lie close to each other and are only visible on the surface as a result of the localised loss of all the overlying peat. Each patch comprises several dozen parallel grooves, 15 - 25cms apart, cut a centimetre or two into the mineral soil, perhaps representing the furrows left by ard ploughs or the

bottoms of trenches dug by hand, using spades or broad hoes, like those used to form so-called 'cord rig' (Topping 1989). Some caution is necessary in interpreting all such features as prehistoric because turf-cutting, demonstrably of post-medieval date, has left similar marks elsewhere on Brow Moor (see Section 7.4). In this case, however, the two patches seem to relate spatially to a slight lynchet which almost certainly marks the line of a prehistoric field boundary. The directions of the cultivation marks in each case are aligned approximately perpendicular to each other, implying the existence of an intervening boundary. The slight lynchet which seems to equate to this boundary cannot be traced closer than some 25m from the cultivation marks, illustrating how vestigial the evidence for agriculture may be in relatively stone-free areas.

The relationship between the field pattern and the burial monuments is of interest. The cultivation marks discussed above come to within a metre of the base of Cairn 20, but due to the deposition of silt produced by erosion of the barrow since the fire, the stratigraphic relationship between the two features has been masked. A bank of cleared stone that seems to represent part of a field boundary appears to post-date a stony mass that might be interpreted as a denuded remnant of an earlier ring-cairn (Cairn 10). The higher density of stone south of Cairn 12, the northernmost of Robin Hood's Butts, may indicate that when the surrounding area was ploughed, a margin of *c* 2m was deliberately left around the base of the monument. Alternatively, it is possible that the stony spread results entirely from later stone robbing or the gradual degradation of the cairn and does not relate to the ploughing. However, in this instance and elsewhere, field boundaries appear to be aligned on the burial monuments, implying the agriculture to have taken place later. As a result, the monuments eventually occupied nodal positions within the pattern of fields.

The complex of pen-like enclosures associated with Cairn 12 is described in Section 4.3. Two larger, roughly square enclosures, one of 0.18ha (0.45 acres) and the other of *c* 0.26ha (0.64 acres), are defined by vestigial rubble banks. These are suggestive of livestock corrals, possibly indicating that in some cases the lines of cleared stone corresponded to fencelines or hedges. The smaller of the two, centred at NZ 9621 0171 is associated with a possible house-platform, as described below, and two possible burial cairns (Cairns 21 and 22); it also encloses a central clearance cairn. The larger enclosure, centred at NZ 9637 0173, shows evidence of at least one episode of modification and is adjoined by a small compound which may also have enclosed structures, although there is no tangible evidence to support this. What may be a third, more irregular and poorly defined, enclosure of similar size lies to the south-east of the first at NZ 9627 0166. The existence of the small enclosures, with their suggestion of livestock management, serves as a reminder that field clearance is also carried out to improve the quality of pasture and is not necessarily always an indicator of arable agriculture.

A possible standing stone lies between the three enclosures, at NZ 96299 01738; this is discussed further in Section 7.5.

4.5 Settlement

A single certain example of a prehistoric roundhouse site was identified on Brow Moor, centred at NZ 9619 0206. The excellence of its preservation is in stark contrast to the other two possible examples identified, suggesting that distinct building techniques or types may be represented. The evidence for the two possible house sites is equivocal, for they are only identifiable through the presence of slight earthwork platforms. Even the maximum number of three houses seems small compared to the large area under broadly contemporary cultivation, perhaps suggesting that evidence for any structures sited on naturally level ground might be impossible to recognise through surface traces and therefore that other house sites may have gone unrecorded.

At NZ 96082 01804, an arc of gulley 11.5m in diameter, with what appears to be a central stone fireplace, is superficially similar in size and plan to the 'ring grooves' commonly found as earthworks in the Cheviot Hills of Northumberland and the Scottish Borders and confidently interpreted as the foundation trenches of Iron Age roundhouses. While a prehistoric date cannot be categorically ruled out in this case, what little circumstantial evidence is available seems to point to a post-medieval origin; it is therefore discussed in Section 6.1.

The evidence for the certain prehistoric building comprises a double concentric gulley, the inner probably representing the foundation trench for the timber wall, and the outer a drainage gulley to collect water dripping off the eaves of a conical roof. The internal diameter of the building would therefore have been approximately 4.8m and its floor area around 20m^2. Interruptions in the gulleys suggest that the doorway would have faced south-westwards, facing roughly down the slope. Early and middle Bronze Age houses tend to reflect the topography in this way, with their doorways facing more or less down slope, while those of the late Bronze Age and early/middle Iron Age tend to favour an easterly or south-easterly orientation regardless of the topography (Oswald 1997).

The position of the roundhouse is interesting in relation to what can be presumed to be contemporary arable fields. It sits on the edge of an area where the density of stones exposed by natural erosion is extremely high, making the ground unattractive for arable agriculture. This pattern, where settlement appears to have been relegated to land unsuitable for cultivation, has been noted elsewhere (Gates 1983; Barnatt 1994; Ainsworth 2001). Nearby, a complex of small, poorly-defined enclosures, perhaps the outcome of the modification of an earlier ring cairn (Cairn 10), is suggestive of livestock pens. One of the two possible houses sites is also located in close proximity to the smaller of the two enclosures interpreted as a livestock corral.

The proximity of the certain roundhouse to one certain and one possible major burial monument – Cairns 11 and 10 respectively - is also remarkable. As described in Section 4.2, it has been suggested that at least some ring cairns – which Cairn 11 almost certainly is and Cairn 10 could be - may represent the accumulation of stone against the external face of the walls of timber roundhouses (information from John Barnatt).

The identification of the two possible house sites identified on the basis of earthwork platforms alone is supported by circumstantial evidence in each case. Both are located in areas unsuitable for arable cultivation, like the certain example. In one instance, the platform coincides with the terminus of a field boundary, but projects out into an adjacent patch of boggy ground, the source of a minor watercourse.

5. FEATURES RELATING TO STOW BROW ALUM WORKS

5.1 Introduction

The primary use of alum was in the textile industry, where it was employed as a fixative of natural dyes, to prevent colours from running and fading. It was also used, to a lesser extent, in the tanning industry, to soften leather in order to make it suitable for tanning, and in the paper-making industry, to aid the retention of various additives, such as sizing agents.

Prior to the 15th century, alum was obtained from the mineral alunite, which does not occur in the British Isles and therefore had to be imported at great cost from the Middle East and parts of mainland Europe. During the 15th century, an alternative process was developed in northern Europe, whereby an alkali was added to aluminium sulphate extracted from naturally occurring shales. Knowledge of this method only spread slowly and it was not until the mid-16th century that the first efforts were made to locate outcrops of shale suitable for the production of alum in England. The first successful alum works was established in 1604 at Slapewath, near Guisborough in Cleveland (Pickles 2002, 9). From the inception of the industry until the last remaining works closed in 1871, at least twenty-four separate alum works operated in the north-east Yorkshire area, although not all continuously or concurrently. During the 19th century, competition emerged from other quarters, in particular a more modern works established at Hurlet, near Glasgow. However, the final blow to the alum industry in north-east Yorkshire was struck by Peter Spence, who developed a more efficient and much cheaper process, which involved treating waste shales from collieries with sulphuric acid. The process was adopted, very successfully, at works in Goole and in Pendleton. The remaining north-east Yorkshire alum works, which were dependent on the traditional, labour-intensive methods, were unable to compete and market economics gradually squeezed them out of business, with the final one closing around 1871.

The process of obtaining alum used by the north-east Yorkshire works was lengthy and complex, taking several months and involving some very complicated chemistry (explained in detail in other publications: Young 1817 812-4; Almond 1975; Rout 1997; 2002). The process can be simplified to five main stages:

1) Quarrying: the geology of the area is such that the Lias shales which bear the compounds necessary for alum production are usually found below a bed of sandstone capping and other overburden, which varies in thickness. The layers of the shales contain a variable proportion of sulphur, with higher levels in the upper layers, this determining the quantity of aluminium sulphate that could be produced. The shales, which are relatively soft, were exposed and dug out by hand and transported a short distance down slope in wheelbarrows.

2) Calcining: The shale was piled onto a bed of brushwood to form a heap, known as a ‘clamp’. Once lit, the burning brushwood ignited the natural oils in the shale and the clamp was then allowed to burn slowly, usually for many weeks, in order to roast, or ‘calcine’, the shale, producing aluminium sulphate.

Contemporary accounts indicate that by the early 19th century, in some cases at least, several small clamps were lit simultaneously and then enlarged and gradually amalgamated as the burning progressed, eventually reaching an overall height of *c* 30m and diameter of *c* 60m (Winter 1810, 248; Young 1817, 812). There is good physical evidence that this was the case at Stoupe Brow and that after the initial construction of the clamp, additional material would have been tipped on to it from a higher level. Once the burning was completed, the clamp was allowed to cool over a period of months, permitting low-temperature chemical reactions to increase the amount of aluminium sulphate present. The clamps were located on level floors known as 'calcining places', sometimes termed 'calcination bases' in modern accounts. Prior to the English Heritage investigation of the alum works at Kettleness, North Yorkshire, the form of calcining places was not fully understood. Contemporary descriptions of the operation there suggest that the floors were deliberately cut into the slope, apparently to shelter the clamp from the wind, and corresponding physical remains, comparable to those at Stoupe Brow were recognised for the first time (Jecock *et al*. 2003).

3) Steeping: the calcined shale was soaked, or 'steeped', four times in shallow tanks of fresh water, each time for 24 hours. The tanks were generally sited immediately downslope from the calcining places. The water was circulated from tank to tank to produce a chemical 'liquor' that became progressively more concentrated. This was then allowed to flow under gravity, usually via a wooden or stone conduit known as the 'liquor trough', to the 'alum house', which was located down slope and often some distance from the quarry.

4) Evaporating: the liquor was evaporated in large metal pans over coal fires. The coal was imported by sea and the ships that supplied it were also the means by which the alum was exported. This partly accounts for the proximity of so many alum works to the coast.

5) Adding alkali: an alkali was then added to the concentrated liquor, causing unwanted salts to precipitate out and alum crystals to form as the solution cooled. The alkali was initially in the form of human urine, but by the 1730s burnt kelp (seaweed) was used, which was in turn eventually replaced by waste products from soap manufacture.

By the 19th century, only the first three steps of this process would have taken place within the area surveyed in detail in 2004; the situation was probably the same during the later 18th century, but this is not entirely certain, as discussed in Section 5.2. The actual alum house of Brow Alum Works, where the final stages of the process would have been carried out, along with several ancillary buildings, was located on the coast just north of Stoupe Brow Cottage (NZ 959 032), about 1km (0.6 mile) to the north of the quarries. The exact date of the construction of this complex, if indeed it represents a single constructional episode, is

not known. Most of the complex was apparently ruinous by 1892, although the alum house still stood (Ordnance Survey 1893). The surviving earthworks have been surveyed and interpreted in some detail (Marshall unpublished). The dwellings of the alum workers have been equated with the string of cottages along the road to the west of the quarries (Egan 1989, 60). The name Stoupe Brow was in use by 1820, but what appears to be an alternative, or perhaps earlier, form of the same name – Stow Brow - was always applied to the alum works.

Some of the quarries, calcining places and steeping tanks associated with the larger and longer-lived Peak Works also lie within the burnt area. A brief examination confirmed that a much more extensive investigation would be necessary to understand these remains in context and that significant areas remain too densely overgrown to allow detailed survey. The alum house and other buildings that made up The Peak Works itself, located on the coast some 650m to the north of the quarries (NZ 972 022), have been subjected to survey, excavation and documentary research in recent years (Marshall 1992; 1999; 2002).

5.2 Documentary evidence

The history of Stow Brow Alum Works, or The Brow Works as it was also known, is not well documented (Buglass 2002, 138). The name is apparently a conscious mimicry of The Peak Alum Works, founded in the 17th century and often known simply as The Peak Works. According to the most informative source that is publicly available, Young's *History of Whitby and Streoneshalh Abbey,* production at Stow Brow began in 1752 (Young 1817, 11). However, the owners of Stoupe Brow Cottage have in their private collection a number of deeds from the 1750s, relating to their property and the attached land, which included the alum works. These documents, abridged and transcribed by Dr JD Farquhar and Mrs Terry, allow Young's bare statement to be fleshed out. A deed dated 1756, which transfers part of the farm belonging to John Conyers to Thomas Wardell, records that George Dent had been mining alum shale on Conyers' land without permission. In view of the fact that Conyers had not objected to this trespass, it seems likely that the land in question was the unimproved moorland on Stoupe Brow, rather than improved farmland below the escarpment, and also that the operation was run on a small scale for the first few years of its existence.

By 1764, The Peak and The Brow Works were run in conjunction with each other; in that year they were operating four evaporating pans each (Young 1817, 816). Thomas Jefferys' *Map of the County of York*, surveyed between 1767 and 1770, annotates both The Peak and The Brow Works as 'Alum Works' (Jefferys 1771). It is interesting that in both cases it is the quarry areas that are indicated, rather than the recognised building complexes around the alum houses themselves. Indeed, the Stow Brow alum house complex that survives in earthwork form appears not to be depicted at all, perhaps indicating that it was built after 1770 and that the separation between the quarries and the alum houses was a relatively late development. However, Jefferys' map-making has been shown to be unreliable in the details of its depictions of other alum works, so perhaps no great significance should be attached to the observation (Jecock *et al* 2003, 14). John Tuke's map of 1787 does not distinguish between The Peak and The Brow, bearing a single, apparently generic, reference

to ‘Alum Works’, while John Cary’s map of 1808 shows The Peak Works but not The Brow (Tuke 1787; Cary 1808).

Apparently, at the height of production at The Brow Works, visitors were encouraged to enter the alum house and look around, for in the mid-1780s John Schofield commented that

> The interior of the alum works, are well worth seeing; and to trace the process above described, will fix it lastingly in the recollection. We do not recommend the effluvia perceptible on entering the boiling house, for its deliciousness; but there being nothing in the smallest degree noxious, it may be guarded against very sufficiently, by filling the nostrils with a little tobacco.
>
> (Schofield, J 1787 *An Historical and Descriptive Guide to Scarborough and its environs*, 154)

According to the privately held documents, The Brow Works and land on Stoupe Brow were ordered to be sold in 1778, when they were purchased by Isaac Mallinson. This sale, although not individually documented, is referred to in a conveyance of 1803, and it is clear that the whole property remained in Mallinson’s hands until his death in 1788. His will left the property to Henry Barker and John Ridley. The property must have changed hands subsequently, as a lease from 1796 records that part of the estate was leased from Thomas Wardell, possibly the same man who had become owner in 1756, to George Dodds, who is referred to as being ’of Boulby Alumworks’ and is known to have been Manager at that works in 1785 (Jecock *et al* 2003, 13). In February 1799 the land of Stoupe Brow Farm was sold in three lots, two of which were purchased by Henry Cooke and Thomas Keld. These lots may equate to the land parcels occupied by the quarries and the alum house complex, the remainder of the farmland making up the third lot. Between 1805 and 1817, under the management of the Cooke family, the combined annual output of The Peak and The Brow Works was an average of 300 tons, accounting for around 10% of the average total annual production of the region (Young 1817, 816-17).

The Brow Works was reportedly ‘still kept up’ in 1817 (Young 1817, 811). However, according to the privately held documents, production must have ended in the following year, for a sale poster dating to after 1834 states that the works ‘have not been in operation since the year 1818’. Greenwood’s map, published in June 1817 and surveyed between 1815 and 1817, shows individual buildings and tracks relating to the alum working. The survey should have been carried out at a time when The Brow Works was still in operation, if production continued until 1818. Yet while the map bears the annotation ‘Allum Works’ near the quarries on Stoupe Brow, this appears to be generic, since The Peak Works is individually singled out by the use of a circular symbol, annotated in a smaller hand with ‘Allum Works’. There is ample space to annotate The Brow Works in the same way, so it might be inferred that this complex had already been mothballed by 1817, despite the date of 1818 given in the sale poster. This might then account for Young’s rather more equivocal description of the site in the previous year as being ‘still kept up’.

However, the sale poster goes on to suggest that production resumed after eight years, that is, in 1826, a hiatus that also occurred at The Peak Works. This resumption – if it occurred at all at The Brow Works – seems to have followed the transfer of the property in 1823 from John Cooke to Sunderland Cooke, along with other parcels of land at Stoupe Brow and possibly the Peak Alum Works as well. In 1828, just five years after he had acquired the property and only two after he had perhaps attempted to resume production at The Brow Works, the documents record that Sunderland Cooke was in debt to the tune of £2,038. He is reported to have been trying a new process of extracting alum, which he hoped would raise the required money, but had been forced to hand over all his possessions, including 'alum manufactured and in the process of manufacture', to his creditors. It is probably at this point that The Peak Works passed from the Cooke family in to the hands of Messrs Bourne and Company, by whom it is known to have been held in 1862 (NYCRO a). In short, it would seem that Cooke's speculative gamble on the new refining process had failed, bringing production to an end for good.

A population decrease of 167 in the parish of Fylingdales in 1831 has been ascribed to the sudden decline of alum production in the area (Page 1923, 534). The poster that advertises The Brow Works for sale or lease is undated, but mentions the price of alum in 1834, so is likely to date to that year or slightly later. Since the only yields and costs given for the production of alum are hypothetical, it may be inferred that the works was not operational at the time of sale, presumably having been mothballed since 1828. There is no evidence that The Brow Works attracted a buyer, but The Peak Works continued production until its sale in 1862.

Most of the surviving maps of the area may also post-date this final disuse of The Peak Works. The tithe map for the area, dating to 1843, depicts the quarries at Stoupe Brow and labels them 'Old Alum Works' (NYCRO b). The map also shows a range of five rectangular features immediately to the south of the track junction, with another structure on the opposite side of the road. The First Edition 6-inch scale (1:10 560) map, surveyed in 1849, annotates the same features as 'Pits' and 'Old Walls' respectively (Ordnance Survey 1853; Figure 5). The 'pits' can be interpreted with some confidence as the remains of the last set of steeping tanks in use at the works. The function of the other rectangular structure is unknown; it may not have been a standing building, since a structure is depicted in the same location on Greenwood's 1817 map, but apparently not as a major building. On the other hand, a symbol definitely representing a standing building is shown in approximately the same position on Thomas Jefferys' map (1771). A map of the boundaries of Fylingdales Moor, dating to *c* 1861, shows the extent of the privately owned land occupied by the quarries, but adds nothing to the understanding of the complex (NYCRO c). The First Edition 25-inch scale map surveyed in 1891-2 offers an additional snap-shot of the deteriorating condition of the water supply system, but also provides some information on the later re-use of the alum quarries, almost certainly for stone quarrying, as described in Section 5.7 (Ordnance Survey 1893; Figure 6).

Figure 5. Ordnance Survey plan of the area, surveyed 1849 (extract reproduced from the 1853 Ordnance Survey 6-inch scale map)

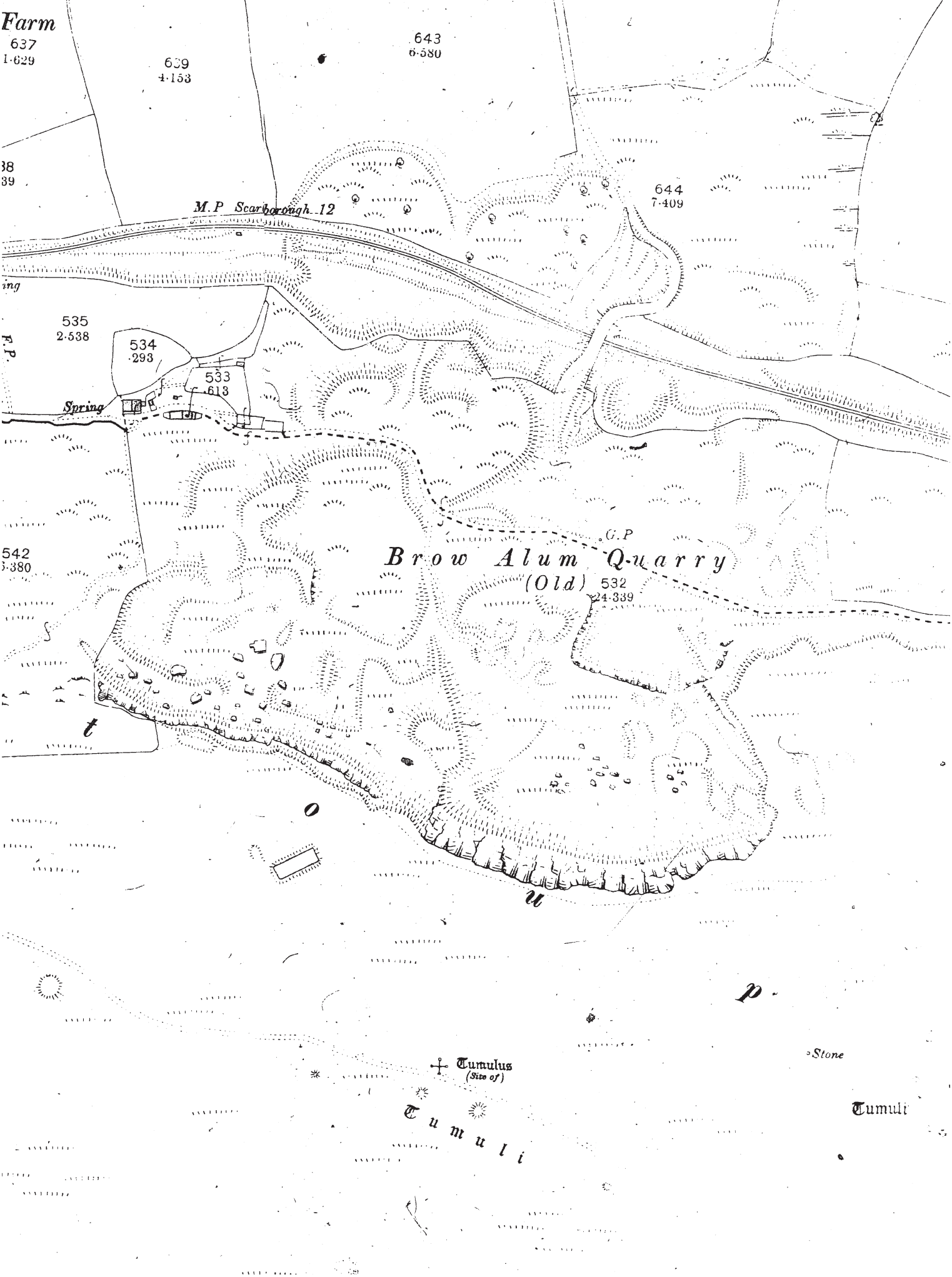

Figure 6. Ordnance Survey plan of the alum quarries, surveyed 1891-2 (extract reproduced from the 1893 OS 25-inch scale map)

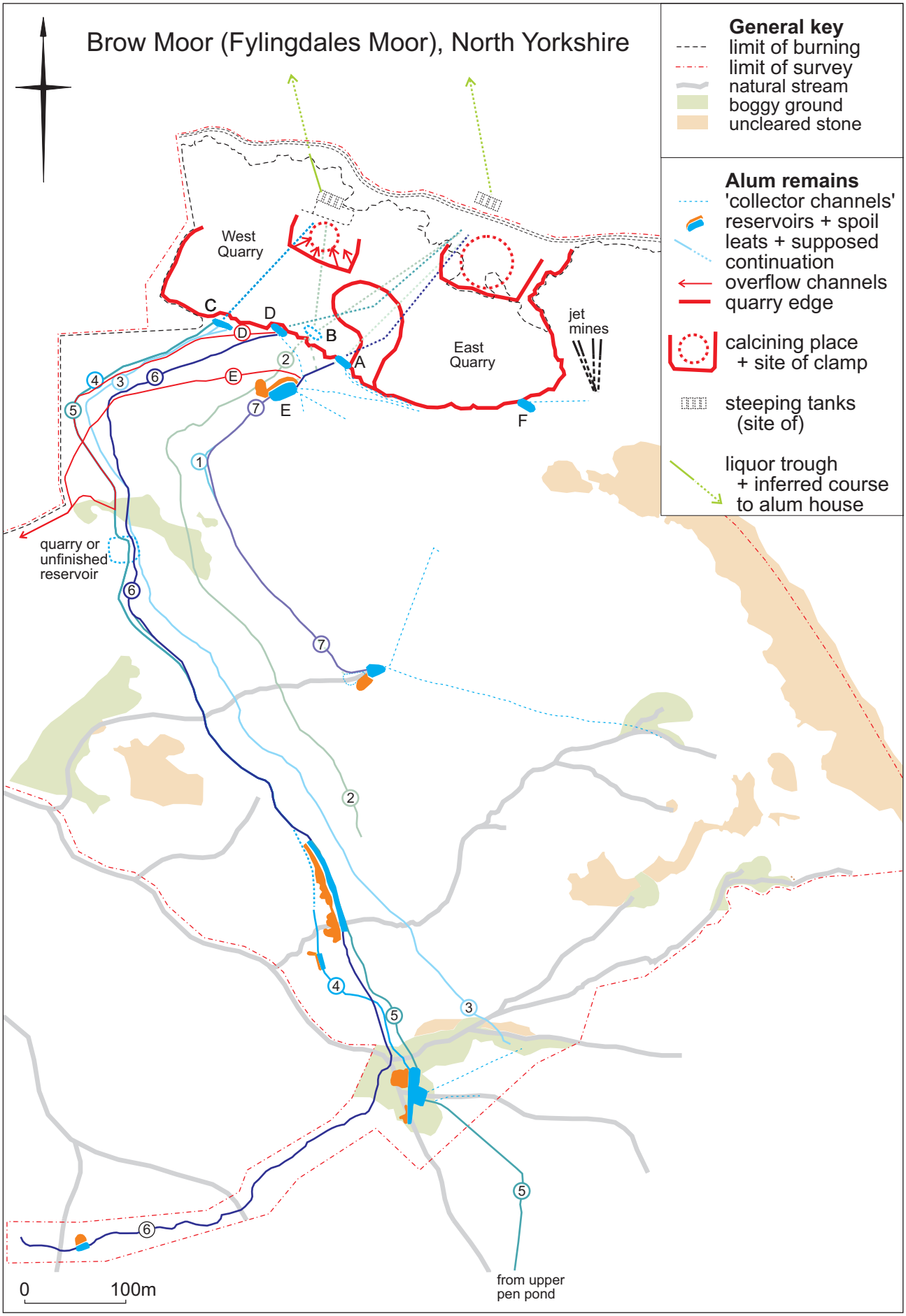

Figure 7. English Heritage schematic plan of features relating to Stow Brow Alum Works

5.3 The quarrying process

There are two main areas of shale quarrying at Stoupe Brow, distinguished in this report as the West and East Quarries. For reasons outlined below, extraction is thought to have begun earlier and continued longer in the East Quarry. A 'Track of Old Fence', encompassing both quarries, is depicted on the First Edition 6-inch scale map surveyed in 1849 and its course is identifiable in part as an earthwork (Ordnance Survey 1853; Figure 5). The fact that the fence also enclosed a considerable area to the east of the quarries suggests that it may have been erected primarily to define the limit of the land parcel leased for quarrying, rather than as a safety barrier.

The two quarried areas are separated from each other by a spine of intact ground which has been left standing to the height of the top of the cleanest shale deposits, the sandstone bed and other overburden having been removed. This intact spine may have served as a buttress, giving stability to the quarry faces. It perhaps allowed access on foot from the quarry floors up to the sluices that would have controlled the supply of water from the reservoirs above the quarry. It may also have supported the wooden flumes that presumably delivered the water from the various reservoirs to the steeping tanks below.

Clearly, given that the quarries were in use for at least 65 years, it is to be expected that what can be seen today represents the end-product of an almost continuous process of expansion and change. The sequence of extraction is difficult to detect in the form of the quarries themselves. The base of the quarried area is covered with literally hundreds of small-scale 'finger dumps' of spoil, that is, material tipped in linear mounds, almost certainly from wheelbarrows. This apparently indiscriminate activity presumably results from the repeated removal of varying quantities of overburden and impurities as the quarry face advanced, but is equally unintelligible in terms of the overall development of the quarries. However, it is possible to infer a broader sequence of extraction from an understanding of the pattern of water management, described in Section 5.6, the available map evidence, and also from an appreciation of the geological conditions, based on the assumption that the extraction process would have followed the normal industrial principles of targeting the most accessible deposits first (Figure 7).

The geological cross-section exposed in the face of the East Quarry shows that the sandstone capping is relatively thin at this point, measuring 2.5m at its thickest, while in the West Quarry, it is up to 13m thick. On this evidence alone, it could be presumed that extraction would have begun first in the East Quarry. Given that the advance of the quarry face would inevitably have destroyed most traces of early activity, it should not be surprising that there is no incontrovertible evidence to support this hypothesis. Yet there is fairly strong circumstantial evidence that the earliest water management system, described as Leat 1 in Section 5.6, served steeping tanks associated with the East Quarry. However, there are also hints that these were perhaps located somewhat further down slope from those identifiable through map evidence and described in Section 5.5. Intact outcrops to the west of the quarries suggest that the sandstone deposits in the West Quarry may well have been several metres thinner where they were originally exposed on the surface. Nevertheless, it

could also be presumed from the cross-sections through the deposits that were eventually exposed, and that are still visible today, that the East Quarry would have remained in use longer. This hypothesis is confirmed beyond doubt both by the map evidence and by the sequence of water supply systems described in Section 5.6. To summarise the sequence: extraction may have begun in the East Quarry and it is possible that the processing areas associated with that early activity were subsequently buried. Later, extraction began in the West Quarry, and the two quarries may have operated concurrently for some time. Work in the West Quarry ceased as the sandstone deposits became too thick to make the extraction viable, but the East Quarry continued in use up to the final abandonment of the alum works.

The precise process by which the sandstone capping was removed is uncertain. At Kettleness Alum Works, documentary and surviving physical evidence suggest that the stone layer was quarried away block by block (Jecock *et al* 2003, 73). For this work, men were paid a rate of 6d per (?cubic) yard by 1776 (Joseph Banks quoted in Thornton 2000, 14). Elsewhere, it has been suggested that sections of the sandstone were deliberately undermined by the removal of the underlying shale so that the overhanging layer of stone, perhaps with most of the overlying soil still in place, could be collapsed in a controlled manner and removed (Pybus and Rushton 1991, 49). This, it is suggested, would have created a new vertical face which could then be undermined once more. While the repeated use of this technique might adequately explain the pattern of apparently piecemeal dumping, it is highly questionable whether it would have been safe or saved much effort. At Kettleness, the quarried stone was probably sold (Jecock *et al* 2003, 72). This may also have happened at Stoupe Brow, for while the finger dumps of waste material contain many fragments of sandstone, the vast majority of stone remains unaccounted for. Good quality building stone may have been a useful by-product of the shale extraction, presumably offering a less profitable but more dependable source of income for the owner of the works.

The face of the West Quarry shows signs of having been worked in a series of step-like ‘benches’, one of which still survives in part as a level strip several metres wide. In contrast, the face of the East Quarry shows no signs of having been stepped, as might be expected if work was simply temporarily halted in 1817 pending a rise in the price of alum, as the later sale particulars seek to convince the prospective buyer. On the contrary, the fact that the lower benches were removed suggests that there were no plans for future expansion and that further extraction was considered uneconomic. Naturally eroded debris has obscured the base of both quarry faces, including any features that may have survived there, though it is perhaps unlikely that any structures would have stood there. Two very large blocks of stone, weighing several hundred tonnes each, lie at the foot of the West Quarry face and are known locally as ‘The Two Sisters’ (Page 1923, 536). These are not shown on the First Edition 6-inch scale map surveyed in 1849, so may have tumbled from the face at some point between then and 1892 (Ordnance Survey 1853; 1893).

In parenthesis, it is worth noting that in 2003, local landowner Mr Terry discovered a number of cast-iron plates of the sort known to have been used to guide the wheels of the barrows at other alum works, along with Second World War pickets for supporting barbed wire,

discarded on a field boundary at NZ 9599 0288, some 500m to the north-east of the quarries. The plates were almost certainly originally in use in the quarries at either The Peak or The Brow.

5.4 The calcining process

Each quarry had its own calcining place, here termed the East and West Calcining Places, which were sited immediately down slope from the quarries to allow the quarried shale to be transported there relatively easily by wheelbarrow with the help of gravity. The last ever clamps to be constructed on each were evidently dismantled and removed for further processing. Both calcining places comprise level floors, created by the deliberate excavation of regular, square-sided, quarry-like cuttings into the hillside. Although quarrying is thought to have begun first in the East Quarry, it also continued there longer, so it is possible that the visible form of the East Calcining Place reflects later modifications, and therefore that the West Calcining Place is effectively the earlier of the two.

The West Calcining Place is slightly smaller in area, measuring some 70m long by 40m wide, and considerably less deep, measuring up to 7m, as opposed to 13m, at its deepest point. In both cases, the faces of the cuttings are intermittently exposed beneath the spills of eroded and waste material: they appear to have been cut with slightly battered, rather than vertical, faces. At a number of other sites, it is known that these shale faces were reveted with sandstone drystone walls, to lend them greater stability and to prevent their accidental ignition by the adjacent clamps. There is no sign that such walls existed at Stoupe Brow, but the absence of evidence might be accounted for by thorough stone-robbing at a later date, since it is likely that stone quarrying took place in the quarries after the abandonment of the alum works (see Section 5.7).

The cuttings for both calcining places were evidently dug into shale deposits which are impossible to distinguish on casual visual inspection from those exploited by the quarries upslope, but it is uncertain whether there was any intention to process the shale extracted from the cuttings themselves. It seems likely that the material was simply pushed down slope to form the level surfaces on which the steeping tanks were located. The lower shale deposits were known to contain lower concentrations of the compounds necessary for the production of aluminium sulphate and may therefore have been completely disregarded. This suggests that the level of the tops of the two cuttings, the western only *c* 2m lower than the eastern, may represent the base of the more productive upper shales.

Though essentially similar constructions, the West Calcining Place retains a number of features that are potentially more informative in terms of the process by which the clamps were constructed. Four finger-dumps of material are spaced at regular intervals along the upper, or rear, edge of the cutting, the central two aligned perpendicular to the edge and the two outliers angled inwards towards the centre of the calcining floor below. The two central examples can be seen to coincide with projecting piers of unexcavated shale, left intact in the rear face of the cutting. This would seem to indicate that barrows of shale brought down from the quarries could be tipped onto the clamp from any one of four points. The existence

of four separate tipping points seem to confirm the use of the documented practice, mentioned in Section 5.1, of initially constructing several small clamps and then gradually enlarging and amalgamating them to form the eventual massive mound. Given the size and depth of the calcining place, it seems likely that in this instance the mounds may eventually have reached *c* 30m in diameter and 7m high. Although any permanent wooden structures above the clamps would obviously have been burnt away, it is possible that wooden gantries were erected temporarily to allow material to be barrowed directly to the top of the completed clamp and tipped from there. The use of this technique, which would have made efficient use of gravity and would be typical of industrial operations at this period, must go a long way towards explaining the form of the calcining places. However, the cuttings would also doubtless have helped to shelter the burning clamps from the wind, allowing the burning to continue at a more constant speed. Although there is no clear evidence to confirm that the same technique was used to construct the clamps in the East Calcining Place, which were presumably somewhat larger, it seems highly likely that it was.

Towards the south-eastern corner of the West Calcining Place, a spur of material may represent a barrow run, or path, perhaps providing pedestrian access from the quarries down onto the calcining floor itself. A track which descends onto the south-western corner of the level floor seems to post-date the alum industry and may well relate to later stone quarrying (see Section 5.7).

5.5 The steeping process

Unlike some of the other north-east Yorkshire alum quarries, no standing structures survive in the vicinity of the Stow Brow quarries. Two separate processing areas exist, associated with the West and East Calcining Places, the western area again probably in effect the earlier of the two and certainly the first to go out of use. The earlier remains, here termed the West Steeping Tanks, were more completely exposed by the fire, but the later remains are almost equally comprehensible through the depictions on historic maps. The water management systems necessary to supply the steeping tanks are discussed separately in Section 5.6.

Immediately adjacent to the West Calcining Place, and 0.4m lower than it, is a rectangular flat surface, interpreted as an area for preparing the calcined shale prior to steeping it. Adjacent to this is a rectangular depression which was probably the site of the range of steeping tanks, although no trace of these survives. Within the larger rectangular depression, a shallow rectangular hollow might represent the site of one of the actual tanks, but as many as six tanks might be expected, probably built of sandstone. Documentary sources indicate that in the 1790s at the Loftus Works, in Cleveland, each tank measured from about 15m to 22m in length by 5.5m wide and up to 1.1m deep at the deeper end (NYCRO d; Hunt *et al* 2004, 13). The rectangular space where the West Steeping Tanks are thought to have lain may have accommodated four tanks of similar width, but no more than 10m long. Water was pumped from one tank to another, in both directions, to achieve the concentrated alum liquor, so it would have been an advantage to have the tanks side by side on level ground, rather than in a series stepping down the slope, as might be expected if

gravity were used to move the water. The area was probably covered to prevent rainfall diluting the liquor; a number of pantiles were noted stratified within the waste dumps immediately down slope, which have been revealed in section in the face of a modern quarry. A smaller rectangular depression aligned at right angles to the depression may be the site of a building or some other structure, such as a sump. In the vicinity, numerous traces of red, calcined shale are visible on the surface, while the deposits exposed in the face of the modern quarry, mentioned above, indicate that the deposits of this waste material are at least 5m deep.

A channel, surviving as an earthwork, runs away from the depressed area thought to have housed the West Steeping Tanks to the north-west: this is likely to be the line of the liquor trough, though there is no trace of the stone or wooden conduit itself. The channel extends as far as the edge of the sharp drop to the road level, where it appears to be cut by the road cutting. It is uncertain whether the conduit was originally carried over the road on some sort of timber gantry, or whether the course of the road was greatly deepened after this processing area fell out of use. Beyond the road, dense vegetation survives untouched by the 2003 fire, obscuring any trace of the liquor trough that might survive. However, it is interesting to note that if it continued on the same alignment, it would not have intersected with the route believed to have been taken by the later liquor trough associated with the East Steeping Tanks, but run parallel to it. The alignment would, however, coincide with field boundaries down slope, suggesting that it may have been designed to conform to the pre-existing pattern of land-use. It is possible that the trough may have turned through right angles at some point, but it is questionable whether it would have been possible to conduct the liquor into the recognised alum house in the same manner. There is therefore a possibility, though admittedly a remote one on the present evidence, that there may have been an earlier alum house, perhaps sited towards the western end of the valley occupied by the complex.

The northern half of the later East Calcining Place, together with the whole area where the East Steeping Tanks would have stood, lies beyond the limit of the burnt area and is obscured by dense vegetation. In any case, the structures associated with the alum works would have been constructed of dressed sandstone blocks, so it is quite likely that these would have been removed for re-use elsewhere. It is within this overgrown area that ‘Pits’ and ‘Old Walls’ are marked on the First Edition 6-inch scale map and that what can be interpreted as a range of five rectangular steeping tanks are shown on the earlier tithe map (Ordnance Survey 1853; NYCRO b). The line of the liquor trough can also be inferred from these historic maps. The road which continues to Robin Hood’s Bay descends in a straight line as far as the alum works, except for a series of sharp bends where it negotiates the steepest part of the slope. This straight section appears to be superimposed onto the field pattern, as though laid out without respect for the pre-existing pattern of land-use, in contrast to the supposed earlier arrangement. At its southern end, the straight section is also aligned precisely on the site of the steeping tanks. It therefore seems almost certain that the eastern liquor trough would have run alongside the road, allowing it to feed straight into the settling tanks behind the alum house, 1km to the north.

5.6 Water management

A key part of alum production was the provision of a reliable supply of water - not a constant flow, but a large volume - to wash the calcined shale in the steeping tanks. Reservoirs were built at most works, including The Peak and The Brow, to store water for use in the steeping process, which took place irregularly but over prolonged periods. Both works possessed extensive systems of channels and reservoirs designed to gather water from the moor and collect it on the high ground above the quarries, allowing delivery on demand to the steeping tanks. Some of the water management system associated with The Peak Works, which was not investigated in 2004, is depicted on historic maps, notably the First Edition 6-inch scale map surveyed in 1849 (Ordnance Survey 1853). However, the findings on Brow Moor indicate that only the latest and largest of the water channels were mapped by the Ordnance Survey, evidently because these alone continued to carry water two decades after the abandonment of The Brow Works. Although several 'Old Reservoirs' and water channels are depicted at The Peak, it is therefore probable that some examples were omitted there too.

The water channels on Brow Moor are generally well preserved: some still carry water, but parts have been damaged by military vehicles or have silted up since the fire. Initially, it was suspected that they might prove particularly vulnerable to water erosion following the fire (Stone and Horne 2003, 11). Closer study has shown that this is not generally the case, because most of the channels follow gentle gradients and therefore actually slow the pace of run-off. On the other hand, the water they conduct can seriously erode other features down slope if the channels become broken or blocked; there are many places where this has occurred in the past. In a few places where artificial channels cross natural watercourses, stone slabs have been used to repair or reinforce short sections of the sides. Exceptionally, the removal of the overlying vegetation by the fire allows the recognition of stratigraphic evidence, and thus for change over time, which might otherwise have been unclear. All the channels are similar in form: about a spade's width in breadth (although some have been widened to 0.5m by prolonged use), usually with low banks of spoil cast up along their downslope sides. However, they evidently served several different functions.

Some channels, here termed 'collector channels', were designed to tap water from springs or watercourses and conduct it to nearby reservoirs, or more rarely to other channels. These channels can be distinguished by the fact that they mostly run in straight lines obliquely across the contours, at relatively steep gradients of around 1 in 25 or steeper.

The main water channels are seven leats (numbered 1 to 7 on Figure 7), some of which show signs of having undergone modifications and repairs. In the true sense of the term, a leat is a water channel intended to deliver water over a long distance by following a constant slight gradient. Its course is generally sinuous because it has to closely echo the contours of the natural topography. All the leats carried water around the western edge of Brow Moor, the longest travelling a distance of 1.56kms (just under 1 mile) to reach the steeping tanks. Most stretches maintain a gradient around 1 in 120, but in one instance around 1 in 240. Unlike the collector channels, the planning and construction of these channels must therefore have involved a degree of accurate surveying. However, there is good stratigraphic evidence

that the seven channels were constructed in sequence, the conjectural Leat 1 being possibly the earliest and Leat 7 definitely the latest, with little or no overlap in their periods of use. There appear to have been two key reasons for the impressive expenditure of effort on water management: firstly, the need to supply water to different places as the location of the active steeping tanks was changed and, secondly, the need to get more water by capturing more distant sources. It is also possible that, as is so often the case in industrial operations, major overhauls of the infrastructure were carried out by incoming new managers.

Some of the leats had more than one reservoir along their course, but these effectively acted as 'pen ponds' for the principal reservoirs (labelled A to F on Figure 7), sited on the slope immediately above the quarry edge. The means by which the water was conducted down to the steeping tanks from the quarry edge is uncertain, but it is possible that the spine of intact ground between the two quarries was deliberately left to help support timber flumes, as suggested in Section 5.3. The latest of the reservoirs (E), is best preserved and has continued to hold water since the abandonment of the alum works (Ordnance Survey 1853; 1893). It has also evidently been cleaned out in recent years, presumably to act as a wildlife habitat. Another reservoir (C) is well preserved as an earthwork, but no longer holds water, while only fragments of three others (A , D and F) survive, the remaining portions having been quarried away. The existence of another reservoir (B) can be inferred with some confidence, but its precise location is uncertain, since it has been entirely quarried away.

Overflow channels, of which two examples were identified, originating at Reservoirs D and E (and therefore labelled correspondingly on Figure 7), were constructed to conduct excess water supplied by the leats back away from the quarries. Like the collector channels, distance was not a crucial factor in the working of these channels, so they follow steeper gradients of 1 in 30 and 40 respectively. Overflow D in part re-used the course of Leat 5, but flowing the opposite way from its original direction, which illustrates how gentle the gradients of the leats were. Overflow E cuts through every leat with which it intersects (except Leat 7, which supplied Reservoir E), thus providing an important chronological indicator. At the point where Overflow D intersects with Leat 5, and also at the point where Overflow E intersects with Leat 6, the downhill opening into the pre-existing leat was blocked by a stone, to prevent water flowing along the leat and so back towards the quarries. These blockages were removed, by some unknown person, at some point after the English Heritage field survey, which could in future lead to serious erosion of the quarry edge.

Figure 7 depicts the postulated development of the water supplies. Predictably, there is most uncertainty over the earliest systems. It is clear from two short stretches of redundant channel, from the existence of reservoir A, and from possible traces of an earlier pen pond immediately downslope from the pen pond at the head of Leat 7, that Leat 7 represents a recut of an earlier leat: Leat 1. However, the evidence that this precursor is really the earliest water supply is primarily circumstantial, in that it taps the closest natural source of water. Importantly, Leat 1 would appear, from the alignment of its final stretch, to have supplied the processing area associated with the East Quarry, but not necessarily those tanks identified from historic maps (described in Section 5.5 as the East Steeping Tanks).

Leat 2 would have gathered all the water tapped by Leat 1 and more, but the two may have functioned in tandem for a time. A channel which diverges from Leat 1 just before it reaches Reservoir A, and appears to be an addition to the original channel, may have supplied the conjectured Reservoir B before the construction of Leat 2, or perhaps acted as an additional or alternative supply thereafter. Leat 2 stratigraphically predates Leat 6 and a collector channel that fed directly into Reservoir D, but the evidence suggesting it to be the second earliest water supply system is again circumstantial, though fairly strong. Firstly, unlike all the other leats, no trace of the reservoir to which it presumably carried water, Reservoir B, now survives, its site having been entirely quarried away. Secondly, after Leat 1, it is the shortest of the leats, gathering water from only a single minor source. Lastly, of all the leats except Leat 1, it is the least well preserved as an earthwork. It is unclear whether Reservoir B was designed to supply the east or west processing area, but if it functioned in tandem with Reservoir A, its creation may mark the start of work in the West Quarry.

Leats 3, 4 and 5 supplied Reservoir C, each successive modification designed to gather and store a greater quantity of water. The placement of reservoir C would suggest that it was sited to supply the West Quarry. However, given the loss of so much of the slope to the quarrying, it is not inconceivable that the addition of a number of pen ponds of various sizes on the western side of the moor was intended to allow this relatively small reservoir to supply both sets of steeping tanks, if the quarries were worked concurrently for a period, as seems likely. The impressive effort expended on constructing these successive supply systems suggests that they may be contemporary with the boom years of alum production at the Stow Brow Works, either in the late 18th or early 19th centuries.

Leat 6 is associated with Reservoir D, and Overflow D cuts through Leats 3, 4 and 5, indicating that the system was constructed relatively late in the life of the alum works. Due to the design of the supply network and the scale of the earthwork itself, it was probably the most costly system to construct. On the other hand, the extent to which the channel has been deepened and broadened by the flowing water suggests that its use was fairly prolonged. Like the succession of leats supplying Reservoir C, it seems to testify to a period of relatively intensive and profitable production, perhaps corresponding to the first seventeen years of the 19th century. Due to its size and robust construction, the leat evidently continued to carry water for some time after its disuse. By 1849, it flowed out into a natural tributary of the Slape Stone Beck, having perhaps been deliberately breached to prevent it conducting water as far as the quarry edge (Ordnance Survey 1853).

Leat 7 feeds Reservoir E, and Overflow E cuts through every other leat with which it intersects, indicating that this was the last water supply system in use. As described above, Leat 7 represents a modification of what may be the earliest water supply: Leat 1. A much larger pen pond and two associated collector channels may have been added at the head of the leat. However, only one of these tapped a reliable source, while the other appears to have been designed to gather run-off from the surface of one of the major cart routes. Taken together, this evidence seems to indicate an attempt to maximise the water supply without expending very much labour, perhaps hinting at rather more desperate economic

circumstances. The alignment of the final stretch of the leat, below Reservoir E, indicates that it supplied the East Steeping Tanks, confirming the conclusion that could be reached independently from historic map evidence, that the East Quarry was the last area to be exploited. The First Edition 6-inch scale map surveyed in 1849 shows the leat still conducting water as far as Reservoir E at that date, from which it may be inferred that it was by then maintained as a stock pond (Ordnance Survey 1853). The map also shows that by the same date, the outflow from the reservoir at the head of Leat 7 had been converted to form a sheepwash; this can still be distinguished as a separate and later earthwork.

Finally, it is worth mentioning that there are several channels around the upper edge of the quarries which, though superficially similar to the collector channels and overflows, were dug solely to serve as drains, preventing surface run-off from causing dangerous erosion. The earthworks of these channels have undoubtedly been worn down by footpaths that have followed their courses, but the existence of low upcast banks on the downslope sides of the channels indicates that they were deliberately constructed.

5.7 Later extraction on the site: jet mining and stone working

The First Edition 6-inch scale map depicts a 'Track of old fence', which may have defined the land parcel leased for mineral extraction, since it extends some way east of the point strictly necessary to act as a safety barrier (Ordnance Survey 1853; *see* Figure 5). Within the bounds of this area, the 2004 investigation recorded the entrances to four adits, separated from each other by distances of between 4m and 10m. The angles of the tunnels indicate that they may all converge between 40m and 70m underground, which suggests that the excavation of the tunnels themselves was the mechanism for extracting the raw material, rather than that they were dug to gain access to a deeply buried mineral deposit. The adits were not marked on the First Edition 6-inch scale map surveyed in 1849, but were depicted on the First Edition 25-inch scale map surveyed in 1891 and therefore originated somewhere within that time span (Ordnance Survey 1853; 1893; see Figures 5 and 6). A local resident who died in 2004, aged 97, had reportedly recalled that his grandfather, a Mr Duck, had dug the tunnels in what proved a fruitless search for deposits of jet (information from Mr Terry).

The First Edition 6-inch scale map surveyed in 1849 depicts a trackway, presumably in active use at that time, leading into the West Quarry, while the First Edition 25-inch scale map surveyed in 1891 omits this but shows another track leading into the East Quarry (Ordnance Survey 1853; 1893; see Figures 5 and 6). Both tracks are well-defined as earthworks (individual wheel ruts can be discerned in the later track) and both can be seen to overlie the remains associated with the alum working. Both seem to have terminated at low steps which may have served as loading bays. It seems likely that by the later 19th century, large blocks of sandstone that had collapsed naturally from the quarry faces were being exposed and split for building stone. Two blocks of stone upslope from the track in the West Quarry retain traces of lines of circular drill holes left by the removal of the rest of the block; this technique of quarrying originates in the later 19th century, but a later date cannot be ruled out in these particular instances.

6. MILITARY ACTIVITY ON THE MOOR

6.1 The history of military activity on Fylingdales Moor

Records of military activity begin in the Napoleonic period. In November 1803, the *York Herald* reported that Henry Cooke Esquire had raised a force called 'The Peak Rifles' and in 1806, a 100-stong unit called 'The Fylingdales and Staintondale Volunteers' was recorded under the command of Captain John Cooke (Rimington 1988, 76). Since the Cooke family owned both The Peak and the Brow alum works at this date, it is logical to infer that the volunteers were drawn from the employees, and that they would have trained on the adjacent moorland. 'Yorkshire Volunteers' based at Whitby, Pickering and Scarborough are also thought to have used the coastal moorlands for training (information from John Harwood, military historian) However, there is very little specific documentary evidence for this activity and equally little incontrovertible physical evidence. At NZ 96082 01804, an arc of gulley 11.5m in diameter almost certainly marks part of the perimeter of a large, circular structure of some kind. A prehistoric date for this cannot be categorically ruled out, but the condition of the earthwork points to a relatively recent origin. The largest plausible bell-tent would be less than half the diameter of the arc of gulley, but some other form of wind break may have been used. At the precise centre of the projected circle lies a well-constructed central fire place, or perhaps the setting for a raised brazier. However, the proximity of this feature to the supposed turf-drying stands discussed in Section 7.4, though possibly entirely fortuitous, hints that the feature may not be of military origin (see Figure 9).

The North York Moors were certainly being used for military exercises by 1939 and a major Northern Command exercise was under way in the area at the time of the outbreak of the Second World War in September 1939 (info from John Harwood, military historian). The Fylingdales Moor Training Area was bounded by Lockton Low Moor in the south-west, Harwood Dale in the south-east, Normanby Hill Top in the north-east, and Sleights Moor in the north-west. It is difficult to compile a complete record all of the units that have used the range, but ex-soldier and local military historian John Harwood personally recalls the 30th Armoured Brigade, Guards Division, the Green Howards, the East Surrey Regiment, the Duke of Wellington Regiment, the South Staffordshire Regiment, the Fife and Forfar Yeomanry, the Westmorland Regiment, the Hampshire Regiment, the North Lancashire Regiment, the Berkshire Yeomanry, various Royal Engineer and Royal Artillery units, and others. The Loyal Regiment had their Regimental Headquarters at one time at the Raven Hotel and a Company Headquarters at Fylingdales Hall.

Fylingdales Moor was used for 'live' field artillery firing towards impact areas on Blakey Moor, Howl Moor, Morra Head, Wykeham High Moor, Sneaton High Moor and elsewhere. During the Second World War the artillery pieces that fired from Brow Moor, Howdale Moor and Stony Marl Moor appear to have been 18-pounder and 25-pounder quick-firing guns. Some heavier pieces, including 4.5-inch, 5.5-inch and 6-inch howitzers, and 7.2-inch breach loaders, may have fired from the area, but these guns are known to have fired into the Fylingdales Moor training area from positions near Helmsley.

The land was also used by the infantry for both 'live' and 'dry' training (that is, without live firing). The scale of these exercises ranged from Section through to Company strength and would have included assault training, field-craft, troop movement, camping, observation, digging-in, and so on. Armoured and artillery units were also involved in dry training, learning driving skills and establishing firing positions. A whole variety of tracked vehicles were used in the training area, but by far the most common were Bren Gun Carriers, and Dragons used by the infantry units. These vehicles were also used by artillery units to tow field guns and anti-tank guns. The anti-tank range was situated on the nearby Jugger Howe Moor, but it is possible that anti-tank guns also fired from Stony Marl Moor. A range of early wartime tanks also trained on Brow Moor, Howdale Moor, and Stony Marl Moor, including:

- Light Tanks: Vickers Mk. VI
- Medium Tanks: Vickers Mk. IIA
- Cruiser Tanks: Covenanter Mk. IV, Mk. V, A9, A10, A13, Valentine, Crusader, and possibly Centaur
- Infantry Tanks: Matilda Mk. I and Mk. II

A map of the range, relating to ordnance disposal and dating to *c*.1955, indicates that Brow Moor and Howdale Moor were latterly used as an area for outlaying gun sites, while Stony Marl Moor was used as an Assembly Area (PRO ref: WO32 17148). The area continued to be used by the Territorial Army into the 1960s.

6.3 Remains relating to Second World War and later activity

The tracks of motorised vehicles are visible across the whole area surveyed in detail, the only exceptions being the steep slope below Stoupe Brow and the alum quarries. In some cases, the type of vehicle can be identified from the tread pattern and axle widths: various types of tank and tracked vehicle, as well as lorries and jeeps were present. The vast majority of unidentifiable tyre tracks are also likely to have been left by military traffic. As might be expected in a training area, there is little clear patterning to the movement, although earlier routes were re-used and boggy areas seem to have been favoured by tank drivers.

Twenty-eight slit trenches and weapons pits, along with about the same number of slighter, more amorphous depressions which are probably of military origin, are scattered across the area (Figure 8). There is little clear patterning in their distribution, although some concentrations are discernible, notably alongside certain tracks and amongst the spoil heaps in the base of the alum quarries on Stoupe Brow. There is also a concentration of spent .303 rifle cartridges dated 1966 within the quarry, but none are directly associated with the slit trenches. In one case, at NZ 96366 01775 a possible tent site lies immediately adjacent to a pair of slit trenches; this is similar to the supposed turf-drying stands discussed in Section 7.4, which are thought to be of 19th-century or earlier date, but differs slightly in that it has narrower and shallower gulleys and lies within an area where the density of surface stone is relatively high.

A small earthwork at NZ 95657 02120 may be of military origin, though it is more likely that it represents an isolated grouse-shooting butt.

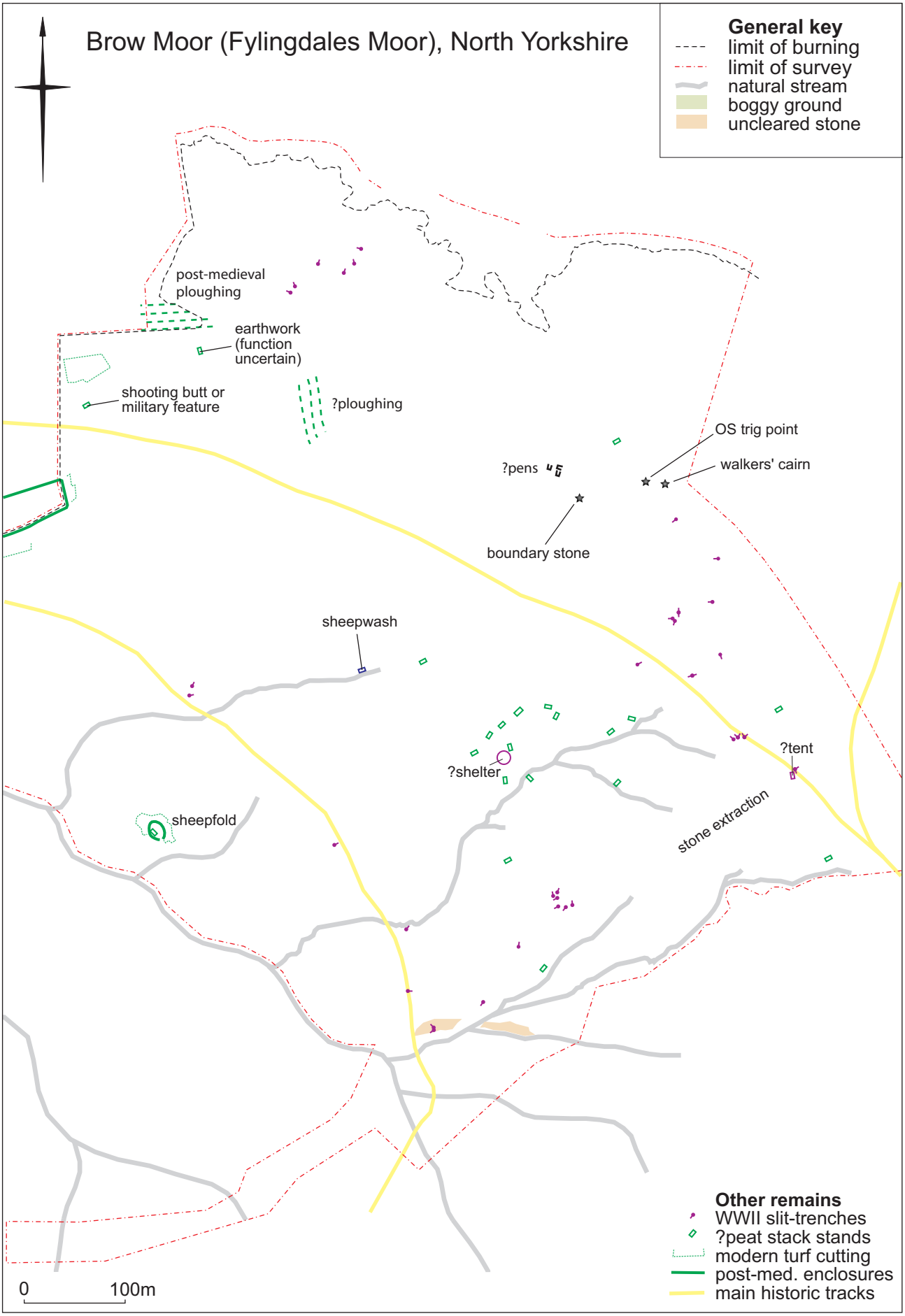

Figure 8. English Heritage schematic plan of principal military and miscellaneous features

7. MISCELLANEOUS REMAINS

7.1 Tracks (Figure 8)

Almost all the trackways most clearly identifiable on the ground are variants of those depicted on the historic Ordnance Survey map editions of the second half of the 19th century (Ordnance Survey 1853; 1893; see Figures 5 and 6). On the sloping ground around the edges of the moorland, the tracks take the form of multiple hollow ways, some eroded to a depth of 2m. Bands of scattered stone on either side of the deepest tracks suggest that the main routes were deliberately kept clear of obstacles. On the more level ground on top of the plateau, the trackways are detectable as broad swathes of faint cart tracks and noticeably more compressed ground. Where the historic main north-west to south-east route passes between the three burial monuments collectively known as Robin Hoods Butts (Cairns 12, 13 and 14), the tracks span an area 40m wide. It is clear that the precise choice of routes was heavily influenced by the ground conditions, for most of the routes skirt the boggy areas.

It is difficult to date the origins of these tracks with any precision. Some examples demonstrably post-date features associated with the alum working, while others are clearly earlier. The construction of the reservoir at NZ 9599 0147 evidently forced the diversion of a pre-existing route. However, the continued use of the former route after the abandonment of the reservoir is suggested both by the construction of a nearby stone bridge to carry the track over a relatively late drainage channel and by the fact that later traffic degraded the reservoir earthworks to the point where its plan was not even recognisable to Ordnance Survey fieldworkers in 1849. As a result, they mapped only the adjacent rectangular dump of spoil (Ordnance Survey 1853).

7.2 Stone extraction

In areas where large slabs of sandstone outcrop on the surface, small-scale stone extraction is detectable through concentrations of shallow pits with associated mounds of spoil. Surviving outcrops in the vicinity can also be seen to have been reduced in size by splitting; the absence of typical chisel marks on the remnants suggests that the activity pre-dates the 19th century, although it is probably of post-medieval date. This stone, though not of such high quality as the beds exposed by the alum quarrying, would have suitable for gateposts and architectural elements such as lintels and thresholds.

It is also clear that some earlier monuments suffered stone-robbing, probably in order to gain material for constructing field boundary walls rather than for roofed buildings. Perhaps the most extreme example is Cairn 6, which was apparently completely removed at some point between 1849 and 1892, since it was depicted on the earlier map but not on the later (Ordnance Survey 1853; 1893). Two vestigial mounds correspond to the recorded position of the monument; in themselves, these hardly constitute secure evidence that the cairn was not originally identified in error by the Ordnance Survey fieldworkers. However, there is strong circumstantial evidence that the monument did indeed once exist. Firstly, as noted in Section 4.2, the map-making of Captain Bayly, who directed the map-making on

Fylingdales Moor in 1849 and across much of the rest of North Yorkshire, generally exhibits considerable skill in interpreting archaeological remains, which makes him a relatively reliable source of information. There is also physical evidence on the ground to support Captain Bayly's identification: a cart track diverges from the main route and appears to extend no further east than the supposed site of the monument. On the line of this track, some 70m to the west, is an isolated small scatter of stones which gives the strong impression of having fallen off a passing cart. It is also clear from the two map editions referred to above that on the north-western slopes of the moor, to where the track heads, numerous field walls were constructed in this same timespan (*see* Section 7.3).

7.3 Post-medieval ploughing, land enclosure and stock management

A single field of ridge-and-furrow cultivation, probably of post-medieval date, was recorded on the fringes of the current moorland, although other areas were noted in similar locations on the margins of the enclosed farmland. Currently under pasture, the field examined in detail was largely untouched by the fire and therefore only surveyed to the extent that the key stratigraphic relationships are adequately demonstrated.

Firstly, it is clear from plan evidence that the drystone wall that encloses the field of ridge-and-furrow predates the West Quarry of the alum works. This would appear to broadly support the hypothesis that this area of quarrying represents a relatively late expansion of the industrial operation. However, since the date of the land enclosure is uncertain, except to the extent that it must pre-date the quarrying, which must have been completed by about 1817, this relationship does not greatly advance understanding of the dating.

More importantly, it is also evident that the formation of the ridge-and-furrow predates the construction of the drystone wall that surrounds the former cultivated area. Although the ploughing and the land enclosure might appear to be contemporary at first glance, the ridges can actually be traced for a few metres beyond the wall before they are masked by Reservoir C and the various leats that supplied it, suggesting that the cultivation may have extended further still. From this, it can be inferred that the drystone wall was built to enclose an area of land that had already been improved by prolonged ploughing and was probably already under pasture when it was enclosed.

This sequence may help to explain a series of at least five furrow-like linear depressions at NZ 9589 0215, which are otherwise difficult to interpret. Although the intervening ridges are not appreciably higher than the surrounding land and their location on fairly steeply sloping ground is admittedly strange, perhaps the most plausible interpretation is that these represent a small area of ploughing that was not subsequently enclosed. The furrow-like depressions stratigraphically predate Reservoir E and one of them was recut to create a collector channel feeding directly into the reservoir.

Most of the parcels of enclosed land on the north-western slopes of Stoupe Brow may also represent the enclosure of land where abandoned arable plots had left patches of good-quality pasture. The pattern of small, enclosed fields with irregular quadrangular shapes demonstrably underwent a sequence of expansion and sub-division in the second half of the

19th century, but the relationship with the alum quarry described above shows that this gradual process probably originated in the late 18th century, or earlier. Developments in the 19th century can be traced by comparing the 1843 tithe map to the First Edition 6-inch scale map surveyed in 1849, the map of *c.* 1861 (derived from the earlier Ordnance Survey map, with a few additions), and the First Edition 25-inch scale map surveyed in 1891-2 (NYCRO b; Ordnance Survey 1853; NYCRO c; Ordnance Survey 1893). Rapid examination of two of these enclosed parcels, called 'garths' on the map of *c.*1861, confirmed that they had been subject to ploughing at some point, but the relationships with the enclosures could not be verified. On the north-western side of Stoupe Brow, where stone exposed on the surface is less plentiful, most of the enclosures were constructed using turf sods and consequently suffered severely during the fire. Traces of turf cutting, with individual spade-marks visible in many places, were recorded in several places next to the enclosure walls.

The absence of mature trees on the moorland, as depicted on the earliest historic maps, indirectly testifies to grazing by livestock, probably from at least the Middle Ages onwards. The maps point to grazing by sheep continuing throughout the 19th century. The pen-pond at the head of Leat 7, previously associated with Stow Brow Alum Works, was converted into a sheepwash, one of several on the moorland, at some point between *c.*1828 and 1849. Of several sheepfolds on the Moor, the only one surveyed in detail, at NZ 9574 0173, was constructed at some point between *c.*1861 and 1892 (Ordnance Survey 1853; NYCRO c; Ordnance Survey 1893). This example is constructed using turf sods, but differs from the land enclosures on the fringes of the moorland in its oval plan and smaller size. The perimeter shows evidence of modification. Within the enclosure a slight ditch - not dissimilar in size and form from those surrounding the supposed peat stack stands described in Section 7.4 - defining what may be a stance for a small tent or other shelter .

7.4 Post-medieval turf cutting for fuel

A number of tiny enclosures, typically defined by spade-width gulleys with the spoil thrown up onto the outside to form continuous low banks, were initially interpreted as drainage gulleys dug to surround the sites of Second World War military tents (Stone and Horne 2003, 11-12). A total of eighteen such earthworks were identified within the area of the detailed ground survey and several others lie elsewhere within the burnt area. All except two enclose playing-card shaped areas, 4.8m by 2.4m on average, although a few are slightly squarer; one example seems to have enclosed a longer, narrower space and another a larger and possibly more circular space. The majority of the rectangular enclosures seem to share a north-east to south-west alignment, but this may be fortuitous.

Examination on the ground indicates that several of the drainage gulleys are cut by the tracks of motorised vehicles, including, in one instance, a tank or other tracked vehicle, but this relationship in itself need not rule out a Second World War origin for the gulleys. More significantly, two of the drainage gulleys demonstrably pre-date (the clearer stratigraphic relationship at NZ 9613 0185) the construction of a water channel, of the type termed a 'collector channel' in Section 5.6. This particular channel was designed to supply the pen pond at the head of Leat 7, the latest of the leats supplying the steeping tanks of The Brow

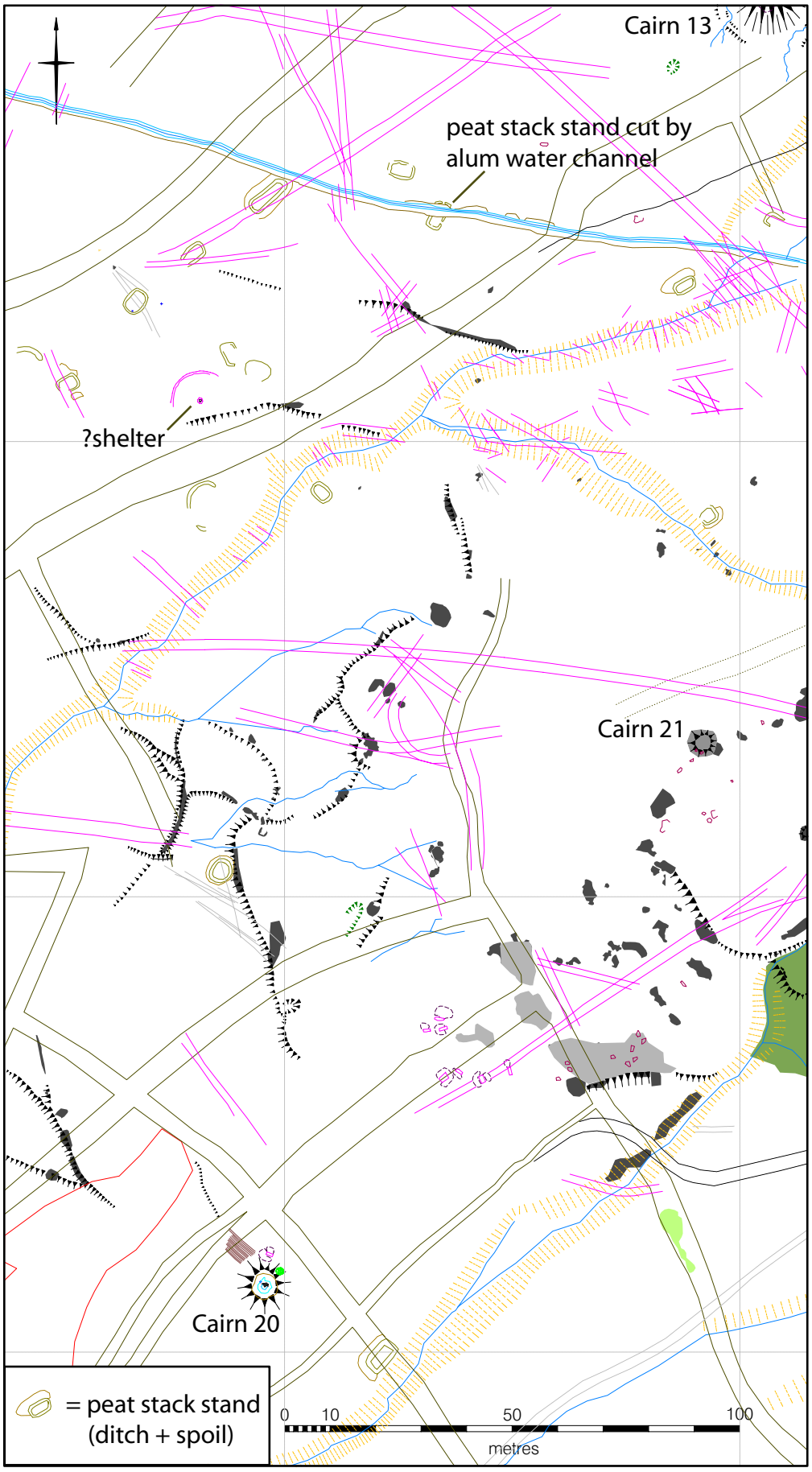

Figure 9. English Heritage survey of the main group of probable peat stack stands (extract from main plan at 1:1 000 scale; see page iv for key)

Alum Works, indicating a date certainly before 1828 and possibly before 1817. One of the gulleys may post-date an iron-tyred cart track, which must be of medieval or later date, and another definitely cuts into a prehistoric field boundary. In conclusion, it seems most likely that the majority of the earthworks date to the late medieval or post-medieval periods.

There is no incontrovertible evidence that all the enclosures are of the same date, or indeed that all performed the same function. One example, which lies in close proximity to slit trenches and is mentioned in Section 6.2, may have surrounded a Second World War military tent. It is markedly different in form, in that its gulley is narrower and more ephemeral, and primarily defines the two upslope edges of the rectangular space. In view of the documentary evidence for Napoleonic militias training and possibly camping on the moorland, a Napoleonic origin has been considered for the cluster of nine examples lying close to the circular shelter discussed in Section 6.1 (Figure 9). However, the lack of regimentation in the organisation of the putative encampment, together with the likelihood that circular bell-tents would have been used prior to the First World War, makes this a remote possibility.

Numerous earthworks of similar size and form, and with a similar scattered distribution pattern, have been recorded on Bodmin and other Cornish moors (Quinnell 1984; Christie and Rose 1987, 182-5; Herring forthcoming). Enclosures of similar size and plan, but not always with external banks, have been recognised more recently in the Northumberland Cheviots and in Perthshire (Gates 2000, 19-20; Boyle 2003, figs 5 and 6). In all these areas, the enclosures have been interpreted as late medieval or post-medieval stands for stacking cut peat or turves to dry them, generally for use as domestic fuel, but in Cornwall possibly also for tin smelting. The size of stack that could have been encompassed by one of the enclosures on Fylingdales Moor would probably have been sufficient to supply a single household for a year or two and this seems compatible with the scale of operation suggested by the scant documentary evidence mentioned in Section 2. The depth of suitable material would presumably have been greater near watercourses, which may account for the proximity of most (though not all) of the putative stacks to stream channels; a similar distribution is evident in Perthshire (Boyle 2003, figs 5 and 6). On Bodmin Moor, it has been noted that earthwork evidence for the actual cutting of the turf, as opposed to the more intensive 19th-century exploitation of peat deposits, is not always detectable, due to rapid regrowth, or a different method of extraction (Quinnell 1984, 12). On Fylingdales Moor, the absence of evidence in most instances may also be accounted for by the total destruction of everything above the mineral soil, which would presumably have been deliberately left untouched.

Where good evidence for 20th-century turf cutting has been recorded, around the northern edges of the moor, the burning was less severe and some of the peat deposits remain intact, thus preserving the evidence of cutting. In the only area where the turf-cutting was apparently not linked to the construction of adjacent boundaries, centred at NZ 9567 0219, it seems to have been carried out on a more industrial scale, possible using a mechanical tool. Patterns of cart tracks indicate that the cut sods were taken away by horse and cart, so presumably for use some distance away. The tracks of the cart stratigraphically post-date those of a military tracked vehicle, clearly indicating that this small-scale exploitation

of the moorland's resources took place after *c.* 1939. This should come as no surprise: cutting both peat and turf on the North York Moors, for use as fuel, continued into the 1950s (Hartley and Ingilby 1972, plates 157 - 162).

7.5 Other remains

At NZ 96299 01738, an upright slab, about 0.9m high, was interpreted by the rapid survey as a possible standing stone. The stone appears to lie on the line of a prehistoric field boundary; this, and a number of other visually prominent upright stones of various sizes, could be interpreted as prehistoric boundary markers. The eroded upper surface of the stone seems to indicate that it has been standing upright for a long period, but this surface follows a layer of iron pan, which is particularly prone to erosion. In addition, the slab lies on the fringe of a concentration of stone extraction pits, presumably of medieval or later date, and it is possible that its upright position is a consequence of that activity.

Several markers, serving different functions, have been erected on the highest point of Stoupe Brow. At NZ 96156 02067, an upright stone slab, whose function is unclear since it lies some way from the historical routes across the moor, may be of 18th- or 19th-century origin. It is not marked on the 6-inch scale map surveyed in 1849 and first appears on the 25-inch scale map surveyed in 1891-2 (Ordnance Survey 1853; 1893). Nevertheless, it may be of earlier date, since dated stones which are otherwise similar in size and form were also omitted from the map. The nearby Ordnance Survey triangulation marker, established in advance of the detailed survey that produced the 6-inch map, can be recognized as a small stone cairn. This superstructure was designed to mark and protect a sunken, stone-lined 'box', which contained the marker itself. A much larger 'walkers' cairn' is of modern origin and may post-date the creation of the current route along the crest of the escarpment.

At NZ 9570 0202, an irregular hollow which cuts Leat 2 but is itself cut by Leats 3, 4 and 5 may be a small-scale quarry, since it is deep enough in places to penetrate beneath the turf and peat, though it is unclear what may have been extracted. The stratigraphic relationships with the leats show that it was dug within the lifetime of the alum quarries and it may therefore be connected with the construction or repair of the leats . It may even be an unfinished reservoir, although this is not immediately suggested by the form of the earthworks.

At NZ 95667 02159, a small earthwork may be an isolated (and therefore relatively early) grouse-shooting butt, though it may be of military origin. The earthwork, which post-dates one of the leats relating to the alum works, comprises what seems to have been, prior to the fire, a low turf wall enclosing a squarish area of similar size to a conventional grouse butt. This lies within a shallow trench, which may have been the source of the turves.

At NZ 95780 02212, a low rectangular mound, enclosed on three sides by a ditch which presumably provided the material for the mound, is of unknown function. Though its condition suggests it to be earlier than the Second World War, its isolation in relation to other earthworks makes precise dating impossible. The proximity of the feature to a series of unexplained modifications of the alum leats may be relevant, but the earthwork itself bears some likeness to firing positions found on rifle ranges, so it may be of military origin.

8. SUMMARY AND CONCLUSION

Many of the individual monuments recorded on Fylingdales Moor, such as burial cairns, field systems and features resulting from industrial activity, find parallels on upland moors elsewhere in Britain. In this sense, taken out of context, while unquestionably of national importance, many of the individual monuments are not exceptional. The survey (see Figure 10) has shown that the primary components of the historic landscape are:

- fragmentary evidence for later Neolithic and Bronze Age land-use, comprising rock art, burial monuments, fields, probable livestock enclosures and a few possible house sites. This prehistoric landscape is similar in essence to those recorded on expanses of unimproved moorland elsewhere, for example the Peak District, Dartmoor, or the Fell Sandstone Hills in Northumberland.

- 18th- and 19th-century water management systems, similar to those known to have existed at many other alum works in the North-East, though most no longer survive, and on post-medieval industrial complexes elsewhere.

- evidence for Second World War military training, which is found widely elsewhere, most obviously on other military ranges.

There are important exceptions to this rule, for some of the remains recorded are almost without parallel, or their recognition is extremely unusual. In these categories could be included the rare panel of geometric rock art (not discussed in this report), the possible prehistoric ard-marks and the probable post-medieval turf stacks.

The dense concentration of so many remains of different periods, particularly within the area of the detailed survey, is clearly also very remarkable. It must be suspected that the high density and range of monuments now known on Fylingdales Moor is matched by some, though not all, other tracts of upland moor in England. However, this suspicion can seldom be supported by reference to hard data, because comprehensive surveys such as that necessitated by the fire are seldom possible. The fire has offered a unique opportunity to detect with a high degree of confidence, primarily through surface survey, types of slight earthworks and other remains that are far more usually concealed by heather. Notably, these include the prehistoric ard-marks and lynchets, post-medieval vehicle tracks and the numerous examples of simple rock art on small, portable stones. As a result, the individual remains can be seen in their proper contexts against the background of an unusually clear picture of the wider, and changing, pattern of land-use. This in turn allows an exceptionally holistic understanding of the interrelation of all the individual remains and of the development of the landscape in its entirety over time. In this sense, the whole is much greater than the sum of the parts.

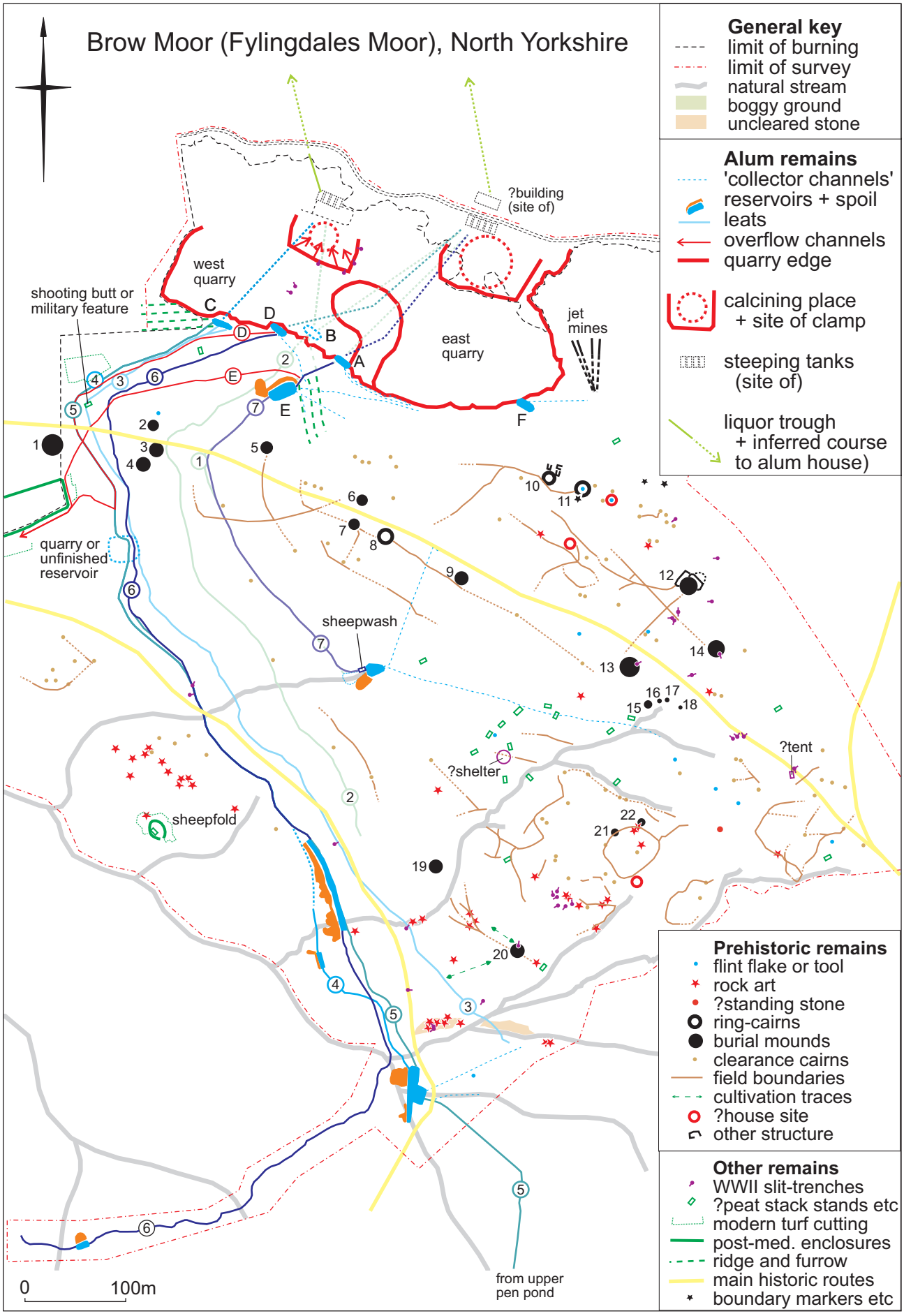

Figure 10. English Heritage schematic plan of archaeological remains of all periods

9. METHODOLOGY

The photogrammetric aerial survey

The vertical photographs were taken on 22nd and 23rd November 2003 by Simmons Aerofilms according to a specification defined by English Heritage's Metric Survey Team. In order to 'rectify' the photographs to correspond with the National Grid, an even spread of control points were fixed across the moorland by Marcus Jecock, Mick Clowes and Jane Stone at the beginning of December. Features recognisable on the photographs were located on the ground and surveyed using differential GPS, offering accuracy to 25mm or better. The co-ordinates of the base receiver were calibrated to the National Grid (OSTN02) using Trimble Geomatics software, based on the position of the receiver relative to the five nearest Ordnance Survey active GPS stations, following an occupation of 18 hours. The position computed, using precise ephemerides and passing the standard chi-squared test after one iteration of the adjustment routine, using an alternative scalar weighting strategy, was 496636.914E, 501408.327N, 256.570AOD. The survey station was permanently marked by a brass rivet set into a large boulder and its position is indicated on the digital plan.

The scale of photography (1:2 500), together with scanning of the diapositives at a 20 micron resolution, ensured that a GSD (ground sample distance) of approximately 5cm was achieved for the photogrammetric stereo models. The photogrammetric work was undertaken using a Leica Digital Photogrammetric Workstation with Socket Set software. Mick Clowes set up the stereo models and produced the Digital Elevation Models and orthophotographs for both the burnt areas. For Fylingdales Moor, the triangulation of the four strips of photography was carried out manually using the Multi-Sensor Triangulation module. Following the bundle adjustment, the *XYZ* rms errors for the control points were 0.021, 0.018 and 0.019 respectively, giving a total RMS of 0.033 cms. The maximum error at any one point, that is, the level of maximum locational error inherent in the stereo models, was 4cms in any direction. After setting up the models, height information and orthophotographs were produced for both areas of burning.

Photogrammetric mapping of the whole burned area remains to be undertaken, but a range of natural, historic and modern features were recorded to assist with the emergency works. Jane Stone undertook both the initial interpretation of the series of oblique pohotographs and the interpretation that accompanied the subsequent ploting from the rectified images:

1. Access routes onto the moor were mapped to inform the movement of vehicles used in the re-seeding process. To this end, trackways, heather-cutting boundaries and natural watercourses were recorded across the whole burnt area, along with selected archaeological features where these were located close to the tracks and heather-cuts. In the event, this work was superseded by direct archaeological supervision of the reseeding work and the use of 'quad bikes' which made negligible impact on the surface.

2. All visible archaeological remains and other relevant features were mapped in the north-eastern quadrant of the moor. This area was chosen to correspond to the area targeted by the Level 3 English Heritage field investigation so that the efficiency and products of the two techniques could be compared.

The digital products of the photogrammetric work, including orthophotographs of both burnt areas, and the interpretative plan produced for Fylingdales Moor (an ACAD 2004 .dwg file), are deposited in the NMR archive. The vertical photographs are held in the NMP photograph library, references: NMR AF/03C/469 5714-5726, 5728-5739, 5741-5756, 5758-5774.

The ground survey

The Level 3 field investigation was carried out by Alastair Oswald, Abby Hunt and Stewart Ainsworth, with occasional assistance from Roger Thomas. The entire survey was carried out using a Trimble dual frequency Global Positioning Satellite (GPS) system. The base receiver was set up on the permanently marked point previously established for the aerial photogrammetric survey and four rover receivers (Trimble 4700 and 5800 models) were used to record the remains, working independently in real-time kinematic mode.

The report was researched and written by Alastair Oswald, with contributions by Jane Stone, Abby Hunt and Roger Thomas, respectively dealing with the aerial survey, the alum works and the military activity. The report was commented on by Neil Redfern, English Heritage Inspector of Ancient Monuments, and Blaise Vyner, and was edited by Stewart Ainsworth, Senior Investigator with English Heritage's Archaeological Investigation Team.

The site archive has been deposited in English Heritage's National Monuments Record, Great Western Village, Kemble Drive, Swindon SN2 2GZ, to where applications for copyright should be made (reference number: NZ 90 SE 126).

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11. REFERENCES

Ainsworth, S 2001 'Prehistoric settlement on the Derbyshire gritstone moors' *Derbyshire Archaeological Journal* **121**, 19-69

Almond, J K 1975 'Technical Aspects of Alum Making'. *The Cleveland Industrial Archaeologist* **2**, 11-20

Barnatt, J 1991 'The prehistoric cairnield at Highlow Bank, Highlow, Derbyshire: a systematic survey of all remains and excavation of one of the cairns' *Derbyshire Archaeological Journal* **91**, 5-30

Barnatt, J 1994 'Excavation of a Bronze Age unenclosed cemetery, cairns and field boundaries at Eaglestone Flat, Curbar, Derbyshire, 1984, 1989-90' *Proceedings of the Prehistoric Society* **60**, 287-370

Barnatt, J 1995 'Neolithic and Bronze Age radiocarbon dates from the Peak District: a review' *Derbyshire Archaeological Journal* **115**, 5-19

Binns, J 2000 'Why Robin Hood's Bay?' *Transactions of the Scarborough Archaeological and Historical Society* **36**, 3-6

Boyle, S 2003 'Ben Lawers: an Improvement-period landscape on Lochtayside, Perthshire' in Govan, S (ed) *Medieval or Later Rural Settlement in Scotland: 10 Years On*. Edinburgh: Historic Scotland

Bradley, R 1992 'Turning the world: rock carvings and the archaeology of death' in Sharples, N and Sheridan, A (eds) *Vessels for the Ancestors*, 168-76. Edinburgh: Edinburgh University Press

Bradley, R 1997 *Rock art and the Prehistory of Atlantic Europe: Signing the Land*. London: Routledge

Browne, H B 1940 'A "cup-and-ring" marked stone found at Aislaby, near Whitby' *Yorkshire Archaeological Journal* **35** (Part 137), 65-7

Buglass, J 2002 'A Gazetteer of Coastal Sites' in Miller, I (ed), 135-8

Burgess, C B 1991 'The chronology of cup-and-ring marks in Britain and Ireland' *Northern Archaeology* **10** (1989-90), 21-6

Cary, J 1808 *A New Map of Yorkshire, Divided into its Regions*. York: privately published

Chappell, G and Brown, P in preparation *Prehistoric Rock carvings of North East Yorkshire*.

Charlton, L 1779 *The History of Whitby and of Whitby Abbey*. York: A Ward

Christie, P M and Rose, P 1987 'Davidstow Moor, Cornwall: the medieval and later sites. Wartime excavations by C K Croft Andrew, 1941 – 1942' *Cornish Archaeology* **26**, 163-195

Egan, G 1989 'Post-medieval Britain and Ireland in 1988' *Post-Medieval Archaeology* **23**, 25-68

Feather, S W 1966 'Fylingdales' *Yorkshire Archaeological Journal* **41** (Part 164), 557-8

Field, D 1998 'Round barrows and the harmonious landscape: placing Bronze Age burial monuments in south-east England' *Oxford Journal of Archaeology* **17** (3), 309-26

Gates, T 1983 'Unenclosed settlements in Northumberland' in Chapman, J C and Mytum, H C (eds) *Settlement in North Britain 1000 BC B 1000 AD,* British Archaeological Reports (British Series) 118, 103-48. Oxford: British Archaeological Reports

Gates, T 2000 'The Archaeology of the College Valley Estate: an Air Photographic Survey'. Unpublished report for the Northumberland National Park as part of the 'Discovering our hillfort heritage' project

Greenwell, W 1890 'Recent researches in barrows in Yorkshire, Wiltshire, Berkshire' *Archaeologia* **52**, 1-72

Greenwood, C 1817 *Map of the County of York*. Privately printed

Hartley, M and Ingilby, J 1972 *Life in the Moorlands of North-East Yorkshire*. London: Dent

Herring, P forthcoming 'Turf' in Herring, P, Sharpe, A and Smith, J R (eds) *Bodmin Moor: an Archaeological Survey. Volume 2:The Post-medieval and Industrial Landscape*, 97-104

Hinderwell, T 1798 *History and Antiquities of Scarborough*. Scarborough: privately printed

Hunt, A Pearson, T, Sinton, P, Carter, A, Andrews, D, Beckett, N Tovey, S and Clowes, M 2004 *Loftus Alum Works, Redcar and Cleveland, Cleveland: an archaeological and historical survey*. English Heritage: Archaeological Investigation Report Series AI/02/2004

Jecock, M, Dunn, C, Carter, A and Clowes, M 2003 *The Alum Works and other industries at Kettleness, North Yorkshire: an archaeological and historical survey*. English Heritage: Archaeological Investigation Report Series AI/24/2003

Jefferys, T 1771 *The County of York, Surveyed in 1767, 1768, 1769 and 1770*. Privately published

Kendall, H P 1937 'Fylingdales' *Yorkshire Archaeological Journal* **33**, (Part 125), 120-1

Kinnes, I A and Longworth, I H 1985 *Catalogue of the excavated prehistoric and Romano-British material in the Greenwell Collection*. London: British Museum

Knox, R 1820 *The Vicinity of Scarborough from Actual Trigonometrical Survey*. Map held in NYCRO ref: ZF 9/10

Knox, R 1855 *Descriptions Geological, Topographical and Antiquarian in Eastern Yorkshire*. London: privately printed

Marshall, G 1992 *The Ravenscar Alum Works*. Maryport

Marshall, G 1999 'Ravenscar Alum Works: interpretation of archaeological evidence' *The National Trust* **1**, 149-68

Marshall, G 2002 'The alum house – its reconstruction based on archaeological and documentary evidence' in Miller, I (ed), 27-44

Miller, I (ed.) 2002 *Steeped in History: The Alum Industry of North-East Yorkshire*, 135-8. Helmsley: North York Moors National Park Authority

Morris, R 1989 'The prehistoric rock art of Great Britain: a survey of all sites bearing motifs more complex than simple cup-marks' *Proceedings of the Prehistoric Society* **55**, 45-88

NYCRO a *c*1862 'Plan of Alum Works and other Property situate at The Peak' ref: ZW (M) 1/85

NYCRO b 1843 Tithe map ref: T Mic 1790, Frame 191

NYCRO c *c*1861 'A map of the boundaries of Fylingdales Moor' ref: ZW (M) 1/26 Mic1293, Frames 303 & 308)

NYCRO d 1791 'Dimensions of the pits in the Loftus alum works' ref: ZNK VII 2 MIC 1431, frame 833

Ord, J W 1846 *History and Antiquities of Cleveland*.

Ordnance Survey 1853 First edition 6-inch map sheets XLVII, surveyed 1849

Ordnance Survey 1893 First edition 25-inch map sheets XLVII, 9, 10 13 and 14, surveyed 1891-2

Ordnance Survey 1976 1:2 500 scale map sheet NZ 9401/9501

Oswald, A W P 1997 'A doorway on the past: practical and mystic concerns in the orientation of roundhouse doorways' in Gwilt, A and Haselgrove, C (eds.) *Reconstructing Iron Age Societies*, 87-95. Oxford: Oxbow Books

Page, W 1923 *Victoria County History Of The County Of York, North Riding, Volume Two.* London: St Catherine Press

Pickles, R L 2002 'Historical Overview' in Miller, I (ed), 5-17

Pybus, D and Rushton, J 1991 ‘Alum and the Yorkshire coast’ in Lewis, D B (ed) *The Yorkshire Coast*, 46-59. Beverley: Normandy Press

Quinnell, N 1984 ‘A note on the turf platforms of Cornwall’ in Smith, G, Balaam, N D, Keeley, H C M, Quinnell, N and Williams, D ‘Excavations on Goonhilly Downs, the Lizard, 1981’, 11-13. *Cornish Archaeology* **23**, 3-48

RCHME 1999 *Recording Archaeological Field Monuments: A Descriptive Specification*. Swindon: Swindon Press

Rimington, F C 1988 *The History of Ravenscar and Staintondale*. Scarborough: The Scarborough Archaeological and Histrical Society

Rout, A E 1997 ‘The North Yorkshire alum industry: a technical analysis of the processes used’. *The Cleveland Industrial Archaeologist* **2**, 13-55

Rout, A E 2002 ‘The Manufacture of Alum from Shale’ in Miller (ed), 19-26

Schofield, J 1787 *An Historical and Descriptive Guide to Scarborough and its environs*. York: W Blanchard

Seymour, W A 1980 *A History of the Ordnance Survey*. Folkestone: William Dawson and Sons

Simpson, D D A and Thawley, J E 1972 ‘Single-grave art in Britain’ *Scottish Archaeological Forum* **4**, 81-104

Smith, M J B 1994 *The Excavated Bronze Age Barrows of North East Yorkshire* (Architectural and Archaeological Society of Durham and Northumberland Research Report 3). Durham: Architectural and Archaeological Society of Durham and Northumberland

Statham, D C 1989 ‘Modern times’ in Spratt, D A and Harrison, B J D (eds) *The North York Moors Landscape Heritage*. London: David and Charles

Stone,J L and Horne, PD 2003 *Fylingdales Moor, North Yorkshire*. English Heritage Aerial Survey Report Series AER/07/2003

Thornton, C E 2000 ‘Sir Joseph Banks’s account of alum making at Kettleness, North Yorkshire’ *The Cleveland Industrial Archaeologist* **26**, 13-18

Tissiman, J 1851 ‘Report on excavations in barrows in Yorkshire’ *Journal of the British Archaeological Association* **6**, 1-5

Topping, P 1989 ‘Early cultivation in Northumberland and the Borders’ *Proceedings of the Prehistoric Society* **55**, 161-79

Topping, P 2000 ‘Step 4 Industrial recording: the alum industry module: project design final draft’. English Heritage: unpublished internal document

Tuke, J 1787 *A Map of the County of York* (reprint of 1816). Privately published

Vyner, B E 2005 'Stony Marl, Howdale, Stoupe Brow Moors, Mossey Moor, Fylingdales, North Yorkshire: report on Walk-over Survey of the Fire Sites'. Unpublished report

Warburton, J 1720 *A New and Correct Map of the County of York in All its Divisions* (York Library ref: Y912)

Wilson, A and Barnatt, J 2004 'Excavation of a prehistoric clearance cairn and ritual pits on Sir William Hill, Eyam Moor, Derbyshire, 2000' *Derbyshire Archaeological Journal* **124**, 13-63

Winter, R 1810 'A mineralogical outline of the district containing the aluminous schistus, in the County of York, with the entire process practiced in the manufactory of alum: to which is added an analysis of the sulphate of alumina, and the supersulphate of alumine and potash, with practical observations and remarks' *Nicholson's Journal* **25** (number 114), 241-57

Young, G 1817 *A History of Whitby and Streoneshalh Abbey,* volume II. Whitby: Clark and Medd

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