Archaeological investigations at the site of a medieval mill on the River Coquet at Barrowburn

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SUMMARY

This paper presents the results of investigations carried out on the site of a medieval mill in Upper Coquetdale, Northumberland. Excavation uncovered the masonry of a wheel pit for a low breast-shot configuration. Downstream was a timber structure with the remains of an underwater planked floor, and immediately upstream were the probable remains of a sluice. On the bank, a paved area was the source of two medieval coins and a medieval key; thirteenth- and fourteenth-century pottery was found across the site. Further upstream from the wheel pit, a large timber structure was uncovered on the riverbed. The remains are likely to be those of a fulling mill associated with Newminster Abbey, an early example of its kind. Only a handful of medieval mills have been excavated in Britain. Very few incorporate the remains of wheel pits, of which this may be the best-preserved masonry-lined example found, as well as one of the earliest to hold a wheel with a low breast-shot configuration.

INTRODUCTION

From July 2011 to July 2014, archaeological investigations were carried out at Barrowburn, in Upper Coquetdale, to investigate structural remains first observed in 2010 at two locations in the River Coquet. The aim of the work was to determine the character of these remains and to establish whether they formed part of the site of a medieval fulling mill, the presence of which at Barrowburn is suggested in thirteenth-century documentary records and by the remains that Dixon (1903, 21) reported as being visible under certain conditions.

The excavations at Barrowburn were carried out by Coquetdale Community Archaeology, monitored by Chris Burgess for Northumberland County Council and by Rob Young and Jacqui Huntley for English Heritage; the work was facilitated by Chris Jones for the Northumberland National Park and by Phil Abramson and Chris Livsey for the Ministry of Defence. Funding was received from the Heritage Lottery Fund, English Heritage, and from other bodies listed in the Acknowledgements. This report is a summary of the full archive report which is to be lodged with Historic England and with the Archaeological Data Service (ADS), York, and which contains a number of specialist reports procured as part of the project. These form part of a larger site archive to be curated by the Great North Museum, Newcastle upon Tyne.

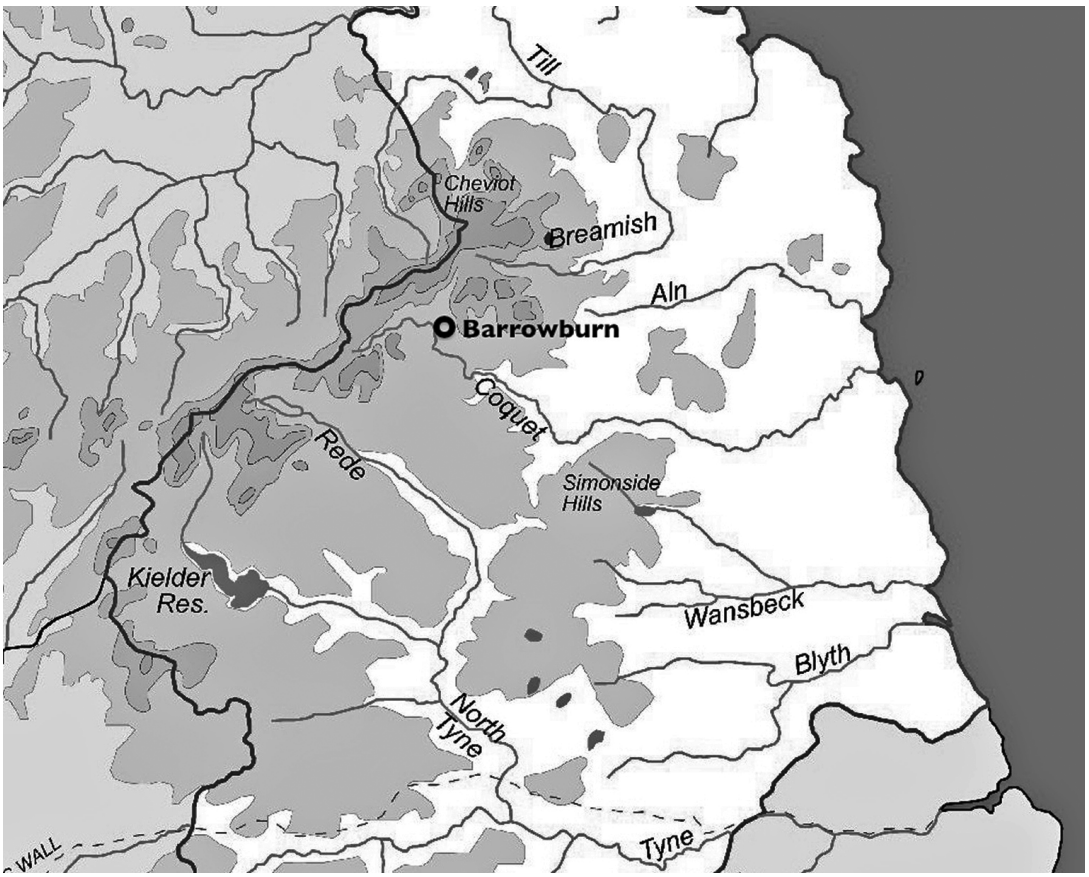

Fig. 1 The general location of Barrowburn.

BACKGROUND

Site location and topography

The Barrowburn Mill project is part of a series of investigations initiated by Coquetdale Community Archaeology in the Barrowburn area of the upper Coquet valley, which extends from Rothbury through the southern part of the Cheviots (fig. 1). The Cheviots span the Anglo-Scottish border, and include rolling summits with outlying ridges that extend south down to Coquetdale and north into Roxburghshire. The major economic activity in the area is now sheep farming, and settlement is highly dispersed, but documentary and archaeological evidence suggest that at various times in the past the area was much more densely populated (for example, Charlton 1996, 14–16). The area is scattered with the remains of upland farms, seasonal settlements and stock enclosures dating from the Bronze Age to the late medieval period.

The site of the investigations documented here (centred on NGR NT 8653 1100) extends for some 150 m along the north bank of the River Coquet opposite Windyhaugh Farm from a

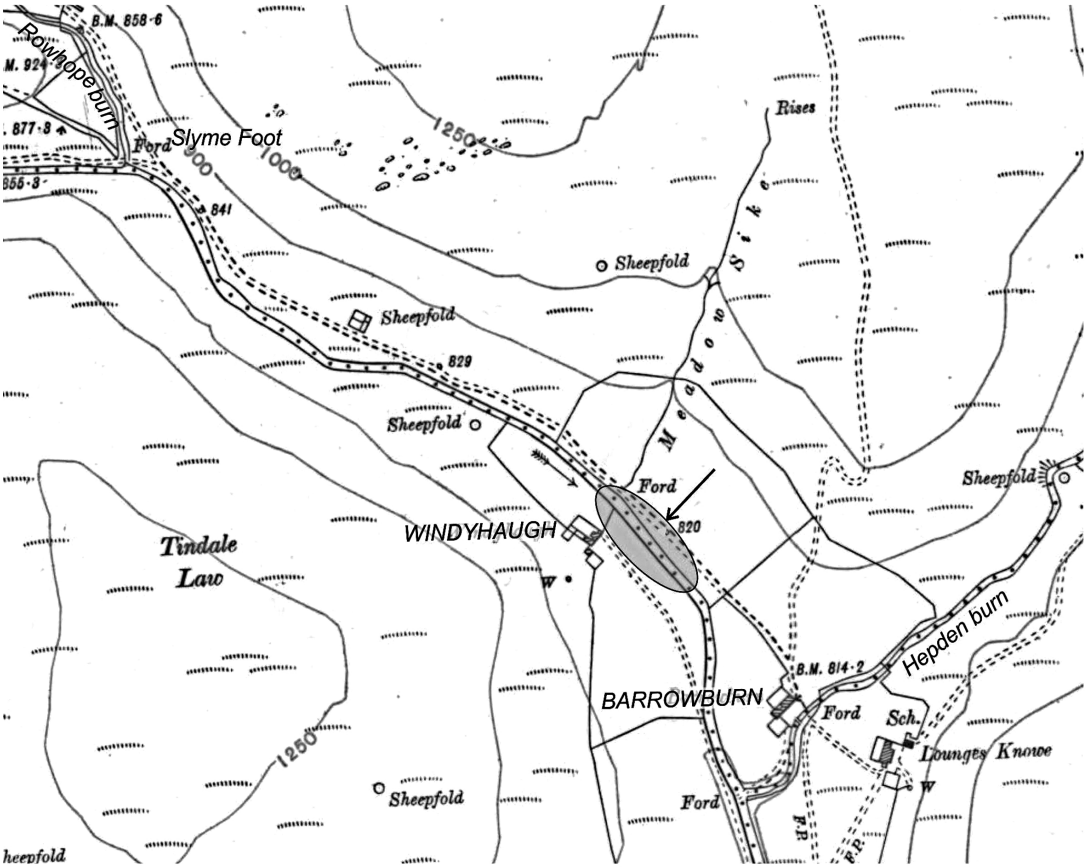

Fig. 2 The area north-west of Barrowburn farm investigated by fieldwork; the ellipse refers to fig. 4. Based on Ordnance Survey (1925) Roxburghshire Sheet XXVII 1:10560.

point some 250 m north-west of Barrowburn Farm (fig. 2). Between its source and this point, the Coquet runs through an increasingly steep-sided valley which lacks the wide haugh-lands that begin immediately below the Hepden Burn, which flows into the river at Barrowburn farm. The Coquet is a typical upland river with occasional pools interspersed with shallower, boulder-strewn stretches and some small sporadic waterfalls. In periods of wet weather, or with run-off from snow melt, the water level can rise very substantially. The presence of debris caught on overhanging trees indicates that in these conditions the river level can be nearly two metres higher than that shown in fig. 3.

The remains of earlier occupation and land-use are apparent as earthworks and ruins on or close to the valley floor between the mouth of the Hepden Burn and the Rowhope Burn (top left in fig. 2), which joins the Coquet at Slymefoot, some 0.7 km north-west of Windyhaugh. In the immediate vicinity of the excavation site the land rises steeply from the north-east side of the valley road, forming the south-facing lower slopes of Barrow Law, the sides of which are interrupted only by Meadow Sike, a minor seasonal watercourse which flows into the main river opposite Windyhaugh. The only large areas of flat land in the immediate vicinity

Fig. 3 The River Coquet, looking upstream from the site of the mill.

are at the mouth of the Hepden Burn, partly occupied by Barrowburn Farm, and around Windyhaugh on the south bank, but smaller parcels of haugh-land occur between the road and the river within and downstream of the fieldwork area, as well as in the side valleys.

The historical background to the site and the evidence for the construction of a fulling mill on the River Coquet between the Hepden Burn and the Rowhope Burn has been described in detail elsewhere (Carlton and Jones 2014, 229–37). The d'Umfraville family were baronial overlords who held the liberty of Redesdale, the extensive vice-regal franchise which also embraced much of upper Coquetdale. In the twelfth and early thirteenth century they bequeathed to Newminster Abbey, near Morpeth, large parts of the Kidland Estate on the north bank of the river (Dixon 1903, 59–95). Between 1226 and 1245 the Abbey's chartulary shows that the monks sought permission from the d'Umfravilles, who still owned the south bank, for a mill pond to be built for their fulling mill in the area under discussion (Fowler 1878, 78–9).

By 2010, when Coquetdale Community Archaeology began its investigations, the precise location of the mill remains noted by Dixon (1903, 21) had been unknown for over 100 years, although there was anecdotal evidence that children from local farms who had played in the river were aware of timbers there. In August 2010 masonry and timbers were located in the north bank of the river opposite Windyhaugh Farm in the location described by Dixon. It is not clear whether these had recently been exposed by erosion or whether nobody had seriously looked for them before, given Dixon's implication that they may not always have been visible. Subsequent work also identified additional timber remains on the riverbed at a location 55 m upstream.

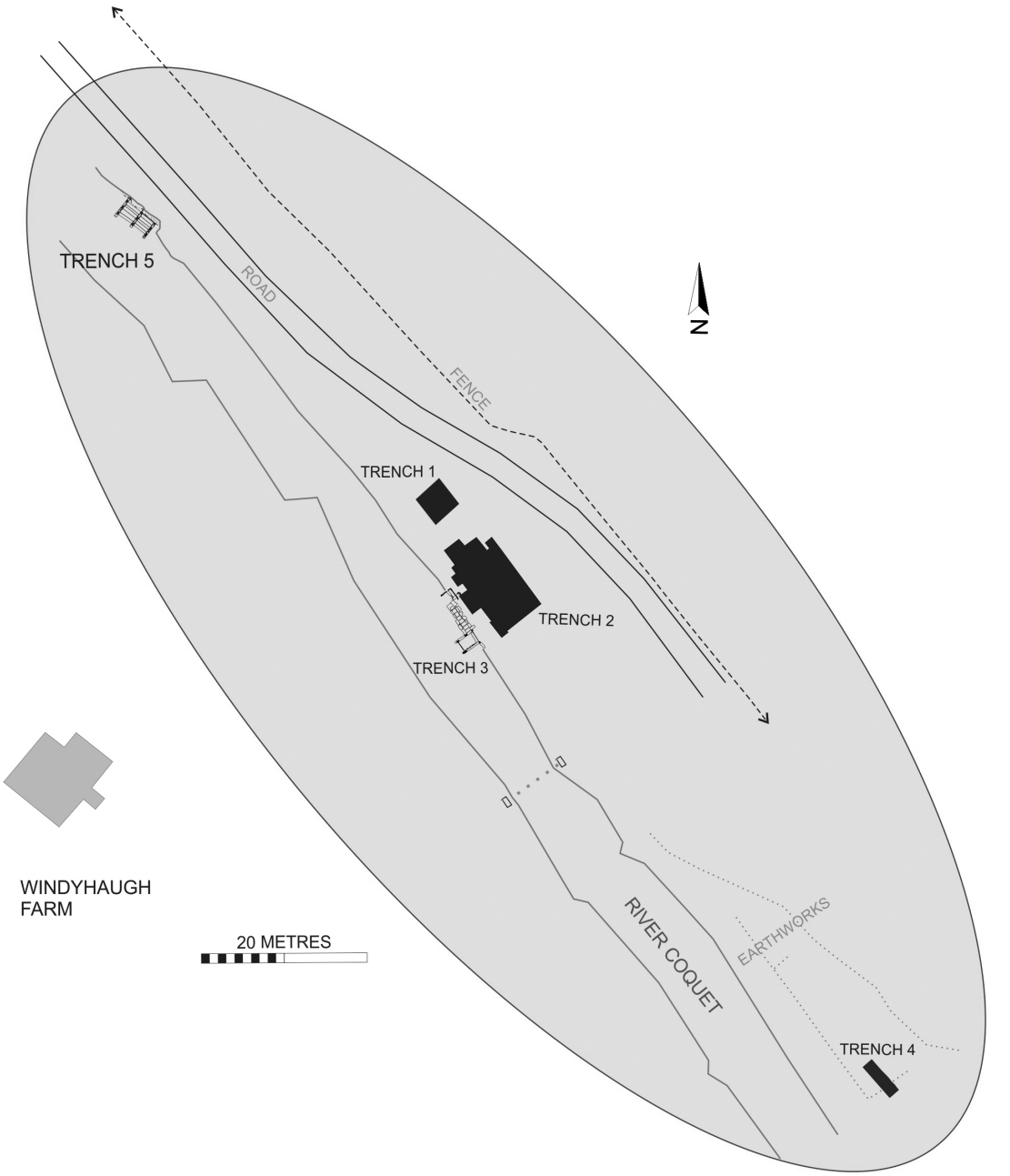

Fig. 4 The site survey and excavation area, with the five trenches marked.

The name Barrowburn should not be confused with Barrow Mill, which is further downstream, about 1 km from Alwinton, or with the Barrow Burn that joins the Coquet near there. The term 'Barrowburn' is not used in the Newminster chartulary in the context of a mill; the site under investigation is, however, unequivocally identified as lying between the Rowhope Burn and the Hepden Burn.

AN OVERVIEW OF THE BARROWBURN EXCAVATION

Before the excavations began, in July 2011, advice was sought from David Passmore of Newcastle University, a specialist in fluvial geomorphology and the geoarchaeology of river valleys. His view was that, given the shape of the valley floor, the location of various outcrops of bedrock, and the absence of visible alternative channels, the river is unlikely to have changed course significantly in recent times, particularly since the late medieval period, although deposition and erosion may have caused minor local changes. Bank erosion in the area is certainly active, and comparison of the results of an initial survey of the site in the autumn of 2010 with current and historic OS data showed that until recently the timber structures at the upstream site may have been nearer the bank or, indeed, partly under it.

Four seasons of excavation were carried out during which five trenches were opened (fig. 4), two of which (Trenches 2 and 3) were directly concerned with timber and masonry remains at the central site (NT 8655 1097), and one (Trench 5) with the timber remains identified further upstream (NT 8652 1101). The remaining two trenches (1 and 4) were opened to investigate earthwork features which it was thought could be associated with the presumed fulling-mill complex. The objectives of the work were to establish the character, extent and date of buried remains and, particularly with respect to Trenches 3 and 5, the impact of erosional processes upon them.

THE WHEEL PIT AND TRENCH 2

This complex site will be considered under four headings:

1) The wheel pit and adjacent masonry in Trench 3
2) The timber remains immediately upstream from the wheel pit
3) The rectangular timber structure just downstream from the wheel pit
4) Trench 2 on the bank adjacent to the wheel pit

Plans and sections of items 1–3 are shown in fig. 6. A schematic representation of Trench 2 (fig. 17) shows the key features revealed. For descriptive purposes, site north is at right angles to the river on a bearing that is approximately true north east.

The wheel pit and adjacent masonry

Before excavation, only very small amounts of masonry and timber were visible. The eroding bank was cut back by up to 0.15 m in order to remove an unstable overhang, and turf and topsoil, sandy silt, boulders and river gravel were removed from the structural remains exposing the entire wheel pit of the mill (fig. 5).

The remains of the wheel pit proved to be a paved channel of high quality, sandstone masonry. The structure is 4.06 m long, and the interior of the pit entrance (to the right in

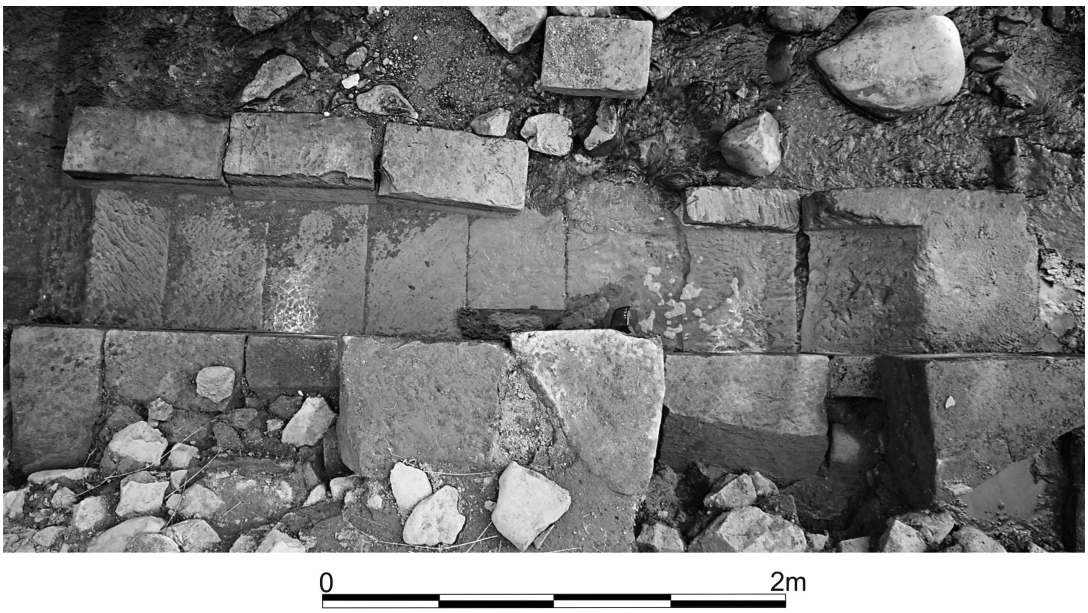

Fig. 5 The wheel pit from above (river flow right to left).

fig. 5) is 0.52 m wide. The entrance consists of a carefully shaped block ([321] on fig. 6), the concave curve of which was continued in the next block [322]; the two blocks together served as a breasting for a mill wheel. The remaining six blocks [323–8] have an open rectangular cross section; they form both the floor of the pit and the lowest course of the pit sides and all have essentially flat upper surfaces. Fig. 6 shows a plan and section of this structure.

Together with the sides of [321] and [322], three blocks [330–32] form the remains of the stream-side of the wheel pit. There is some masonry missing between [330] and [322]; a loose block [329] found in the wheel pit probably fitted here but does not fill the gap completely. There may have been additional courses of masonry that have subsequently been washed or robbed away. On the bank side of the pit, two complete courses of masonry, [343–6] and [334–41], survive above the blocks forming the base of the pit. A third course ([333], [336] and [337]) is partially present; other blocks have presumably been robbed or swept away. A wheel mounted in this pit would have needed a substantial structure to support it, significantly higher than the surviving bank-side masonry, although a small piece of timber [351] between [330] and [331] may possibly be a remnant of such a structure.

Seen from the river (fig. 7) the extent of bank-side masonry loss is obvious. Although the lowest two courses are intact, some 70% of the course above them is missing, leaving two large blocks [336] and [337]. Calculating the approximate location of the wheel shaft (see below) allows the assertion there is sufficient space above these two blocks, [336] and [337], for at least one more course of masonry, now gone.

The quality of the masonry facing is high, as is that of the top and bottom surfaces, all of which exhibit chiselled, striated tooling. It seems reasonable to assume that work was carried out by the same specialist masons employed by the monks of Newminster to maintain the Abbey, where original sections of the ruins display workmanship of similar quality. In only

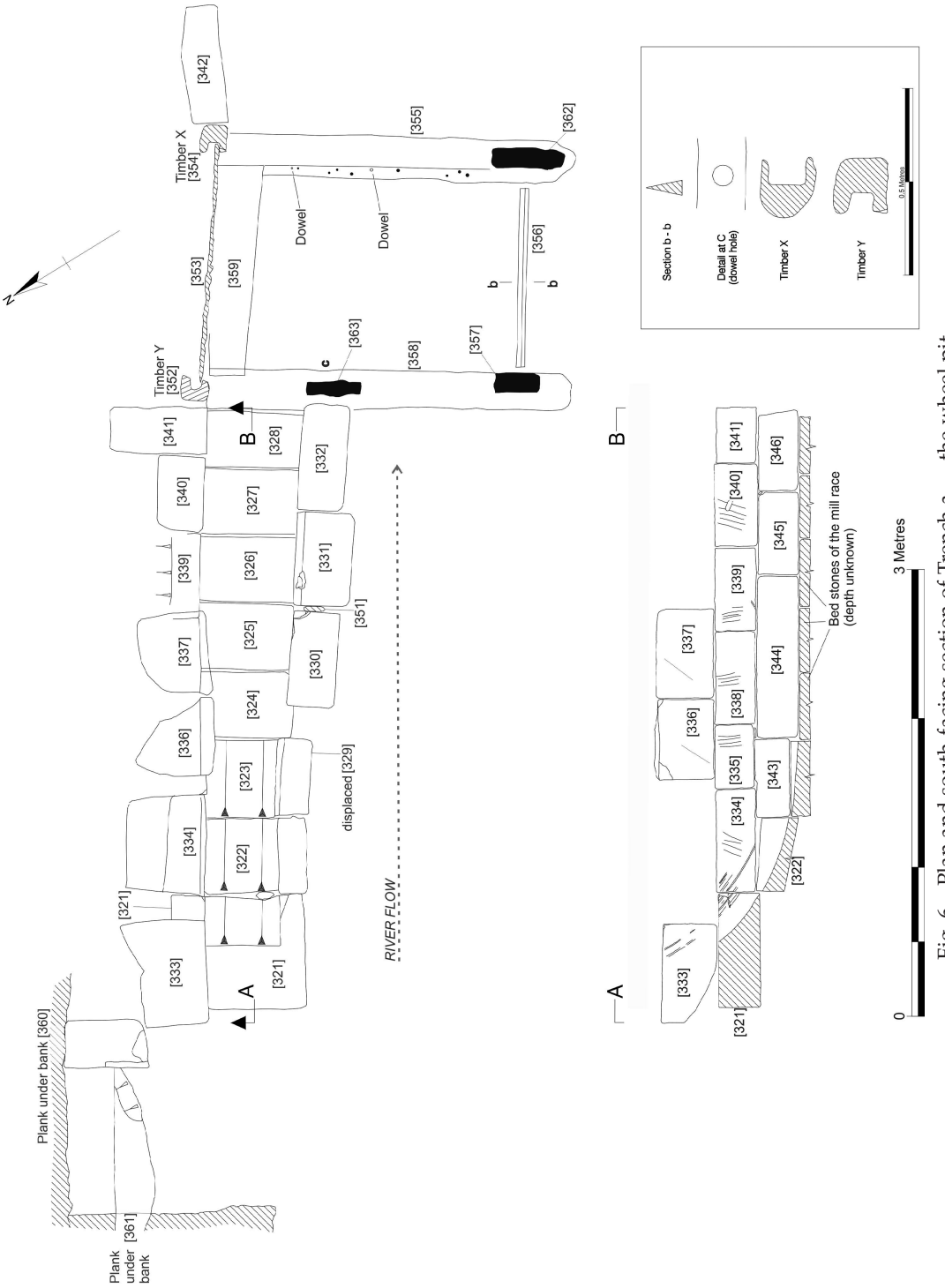

Fig. 6 Plan and south-facing section of Trench 3 — the wheel pit.

Fig. 7 The pit from the river (2 m scales); the arrowed black circle marks the calculated position of wheel shaft.

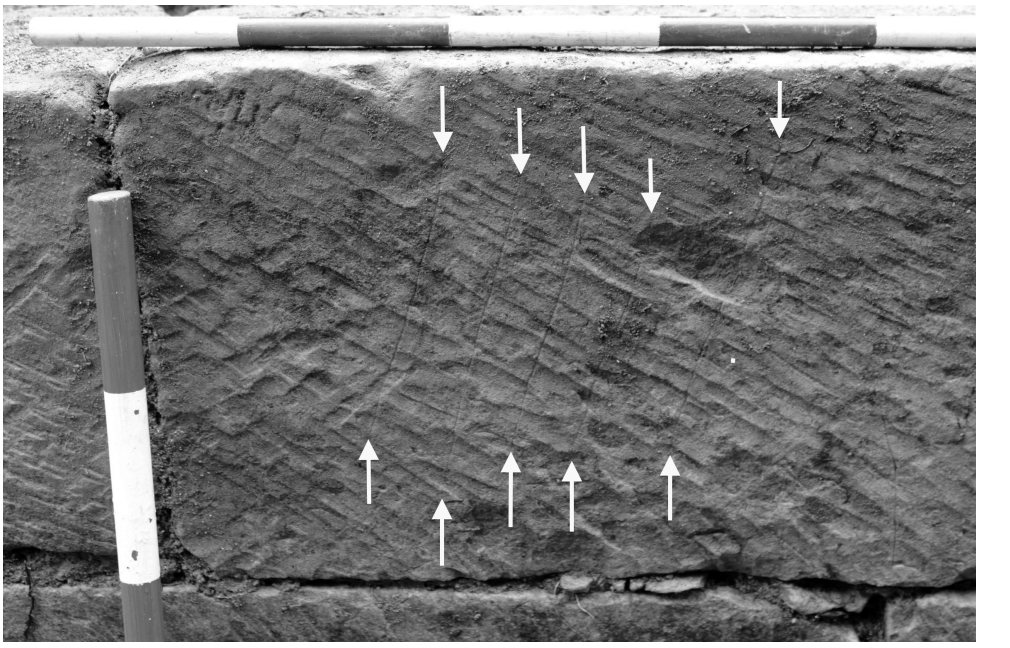

Fig. 8 Tooling marks and diagonal scratches (with ends arrowed) on [340] (10 cm scale segments).

one place was there evidence for the use of a packing stone to fill a gap in the masonry work. The rear faces of the stones, however, have been finished either roughly or not at all. It would seem that many of them have been left as quarried and laid with rubble packing behind them within an apparent construction-pit [306] that was cut into the boulder clay. Broadly similar part-dressed masonry can be seen at Newminster Abbey (Harbottle and Salway 1964, pl V, fig. 2).

The stonework forming the wheel pit is a fine-grained sparsely micaceous sandstone of a grey-green colour when wet, with patches of iron staining. It is likely that it came from the group of Lower Carboniferous rocks long known as the Cementstone Group, but recently re-designated as the Ballagan Formation. On the southern and eastern flanks of the Cheviots these rocks comprise a thick succession of shales, impure limestones (once known as cement-stones) and sandstones (Young 2011). They are especially well exposed in the conspicuous and very steep riverbank at Barrow Scar on the south bank of the River Coquet at NGR NT 903 061, although the beds there are probably too thin and weak to have been the source of the masonry at Barrowburn, which remains unknown. Certainly, as noted by Dixon (1903, 21) the stone used at the mill does not closely resemble the Fell Sandstone Formation commonly found further down the valley, notably around Rothbury and Harbottle. This exhibits the more usual honey-coloured hue, as do the masonry blocks in the ruins of Newminster Abbey.

In addition to the striations from masons' tools there are two types of artificial markings on the stones. The first group of these consists of several sets of parallel, approximately equally-spaced scratches mainly on front-facing surfaces. Typically either four or five in number per stone, the scratches are between 10 cm and 20 cm long. Fig. 8 shows a typical example of these marks.

An individual occurrence might be dismissed as natural marks or accidental scratches, but there are sets of such marks on [334], [335], [338], [339], [340] and [341] — a continuous sequence of blocks in the same masonry course (fig. 6). These blocks each have four or five scratches on them; on the first five blocks the marks are on the outer face, but on [341], the end block of the course to the east (downstream), they are scratched horizontally on the face of the block at right angles to the river and partly concealed by a post [352] (fig. 9). In the course above, there is a single diagonal scratch on each block [336] and [337]; these are much longer, at about 30 cm. Water levels prevented close examination of the lowest course of masonry. It is likely that they are simple assembly marks to guide final construction, the pit having been planned and laid out off-site, perhaps at the quarry. Certainly the marks on [341] would seem to be placed there to indicate that it is the end block, and there is also a clear differentiation by both scratch count and style between the two courses.

More obvious are curved abrasion marks on several stones that show where the mill wheel rubbed against the masonry surface; these are sufficiently clear and numerous to enable calculations to determine the size of the mill wheel and the position of its shaft. Abrasions were found on both the upstream side of where the wheel shaft would have been (fig. 10) as well as the downstream side on [339]. Using the distance between these abrasions and their angle to the horizontal it can be shown that the wheel's diameter was approximately 3.4 m, and that the position of the wheel shaft (the black circle in fig. 7) was below the lip of the current bank. The wheel must have fitted the pit closely, because there are also abrasions on the opposite wall — on [329] and [330]. Analysis of the curvature of the abrasions on [329] provided further confirmation of the wheel's diameter. Particularly obvious on the displaced block [329] are multiple concentric abrasions. These may have been created simultaneously by sets

Fig. 9 Scratch marks on [341], the end block of the north wall of the wheel pit (10 cm scale segment).

Fig. 10 Wheel abrasions on [334] and [321] above the shaped block [322] (25 cm scale).

of bolts on the edge of the wheel, or made over an extended period when the wheel shifted or was re-hung, perhaps as a result of flood damage. Similar concentric abrasions can be seen on the other (bank-side) wall of the pit (fig. 11).

A small cut coin of Henry III (fig. 32), probably dating to the 1250s, was found while sandy silt was being cleared from the area immediately above [334]. Given the nature of the site, which is subject to seasonal floods and has been covered by fluvial deposits, this coin may have been washed here from upstream. Post-medieval material in similar contexts on the site was certainly identified. However, given its low mass and relatively good condition, it is tempting to associate the coin directly with the mill and to suggest that it simply washed down the bank with material eroding from the mill's working area above.

Timbers immediately upstream from the wheel pit

Two timbers were found in this area (figs. 6 and 12). One [360] is a large beam lying at right angles to the course of the river and the entry to the wheel pit, whilst the other [361] is a plank-like structure, lying parallel with the river, its downstream end lying above [360] and fractured in such a way to suggest that it had slipped under pressure from the rebated surface of the latter.

The large beam [360] is rectangular in cross-section, measuring *c.* 0.33 m horizontally and 0.23 m vertically, and being at least 1.15 m long. A large subcircular stone [311/116] about 0.4 m high, 0.6 m across and 0.16 m deep had been placed on edge on top of the beam at a point 0.7 m back from the current bank (fig. 38); this was not removed so a full investigation of the beam was not carried out. The shape of the overlying stone is such that it may be part of a millstone rough-out. It could have been placed there to help keep the timber beam in position, but it seems more plausible that it served to support the bank above the beam. An unusually high density of boulders in the riverbank around and underneath the point where the wheel shaft would have crossed the bank may also have had a protective purpose; it seems possible that they were an *ad hoc* solution to problems of erosion that arose once the mill had been built. The broken end of the plank [361] is shown in fig. 12, as are two features of [360] — part of a mortice and a rebated area, against which the [361] fragments are lying. The end of [360] has been sawn off through the mortice on a slight curve. There are several possible explanations for this. It may be a piece of re-used timber with a mortice from another structure; alternatively, the cut may be due to some post-installation modification that made the mortice unnecessary.

Fragments of wood [314] were found here, some pieces of which had surfaces that had been split away from the parent material and had a chamfered end. This may be debris produced by cutting out a rebate or a mortice. The largest piece was about 0.1 m long and between 5 mm and 10 mm thick.

Wooden objects were also embedded in the riverbed opposite the beam [360]. Buried at a depth of some 0.1 m, about 0.4 m upstream from the masonry block [321] at the entry to the pit, and 0.4 m further out into the stream than the outer edge of this block, was a large tapered peg, 20 cm long [304/114], together with a smaller peg, 9 cm long, with a distinct head [304/115]. The larger peg was of ash with an obvious sub-circular piece about 5 mm across cut out or missing towards one end — possibly where a nail or bolt had been at one time. The smaller peg was identified as probably of willow or poplar, 4 years old and with remnants of a bark edge (Huntley 2014b).

Fig. 11 Highlighted multiple abrasion marks on the bank-side pit wall. The scale of the area can be seen in fig. 10.

Fig. 12 [360] on left and [361] (50cm scale). Block [321] is at upper left.

Rectangular timber structure downstream from the wheel pit

Butting up against the wheel pit on its downstream side was a rectangular structure of timber beams and planks, with a single associated masonry block [342] (fig. 6). Five timbers were on the riverbed (fig. 13) and fixed to posts embedded in it, whilst three others (and the piece of masonry) were set in the bank.

Four of the five main timbers set on the riverbed were: two beams set across the flow of the river ([355] to left and [358] to right in fig. 13); a thinner edge-on plank [356] forming the south (far) end of the structure; and a post [357] in a mortice at the south end of [358]. The downstream side of this post has a concave cut in it to accommodate the plank [356]. Mortices can be seen in both [355] and [358], the one [362] at the south end of [355] being particularly large. Damian Goodburn, a timber specialist from the Museum of London, commented: 'The broad shape of this mortice is most typical of the early high medieval period or even a little earlier when a whole timber rather than just a tenon was set in a socket. The holes in the end of the mortice are typical of the overcuts of the spoon auger used to cut the end grain of such a joint so the rest of the timber can be chopped out between using a tool such as a twybill or a morticing axe' (Goodburn 2010). This approach is similar to practices deduced from remains of the metalworking mills of the Cistercian establishment at Bordesley Abbey where mortices dating from the late twelfth to the early fourteenth centuries had their corners drilled out with a spoon bit (Astill 1993, 83).

The upstream (right hand in fig. 13) side of [355] is rebated, with dowels and dowel holes along it. Some of these are very close together, which may indicate repairs or re-use. Not clearly visible in fig. 13, but shown in fig. 6, is the fifth piece of underwater timber — a horizontal plank [359] adjacent to the bank and spanning the gap between [355] and [358]. The presence of this plank and the dowel holes suggests that there was originally a plank floor across the entire structure. There also seems to have been a vertical post in the mortice [363] in [358] adjacent to (and perhaps supported by) the masonry block [332] on the right of the picture.

The three timbers in the bank are shown in fig. 14. The two posts [352] and [354] each have deep grooves cut in their downstream side and upstream side respectively in order to hold planks between them. One of these, [353], remains *in situ* and it seems reasonable to assume that, given the height of [352] and [354], other planks above [353] have been lost. (The flat top of [354], which was identified as oak, is due to the removal of a sample for radiocarbon analysis.) This construction may have fulfilled two purposes, deliberately or otherwise; as well as forming one side of a rectangular structure, it may also have served to protect the bank from erosion from the tailrace, something which had proved to be a problem at other mill sites such as Chingley Forge, in Kent (Crossley 1997, 114–15).

A masonry block [342] butts up against the tilting post [354]. Its purpose seems to have been to support [354] and prevent it tilting further eastwards with the flow of the river. At low water levels several grooves and cuts are visible in [342] that may be due to tool or knife sharpening, suggesting that the block was re-used from elsewhere.

It is clear that this structure was built as a whole, probably with plank walls parallel with the river flow both alongside the bank and out into the river. The downstream side was presumably left at least partly open to allow the tailrace to flow through. The fact that it butts up neatly against the wheel pit suggests that the two structures are contemporary. Fig. 15 shows the whole wheel pit structure downstream from the entry block.

Fig. 13 Structure downstream from the wheel pit: river flows right to left (main scale 2 m).

Fig. 14 Left to right: timbers [352], [353], [354] and part of block [342] (50 cm scale sections).

Fig. 15 The wheel pit structure; from left to right there is the pit itself and the bank edge of the wooden structure and its supporting block. Parts of the wooden structure that are underwater can also be seen (2 m scales).

The site of the mill building (figs. 16–17)

Over a period of three seasons, the bank adjacent to the wheel pit — the area where any milling activity would have taken place — was investigated by opening Trench 2. Around the position of the wheel shaft the trench was extended to the south.

At the western (upstream) and eastern (downstream) ends of the trench two lengths of wall were exposed, each at right angles to the river and starting close to the current riverbank; both were of drystone construction and, compared with the masonry in the wheel pit, crude in nature. The eastern wall was 1.6 m long, 0.5 m wide and up to 0.54 m high, consisting of up to 5 poorly differentiated courses of un-worked stone fragments and boulders. It appeared to sit upon the brown silty-loam deposit that also formed the fill to either side of it, but above this, on the west side of the wall, was a deposit of rounded boulders which may be interpreted as tumble from the wall or as a flood deposit. No return to either east or west was identified along the course the wall. The western wall (fig. 18), also formed of unworked boulders, was 6 m long and up to 0.5 m high, with a width varying from 0.4 m to 0.8 m. Along most of its length it survived only as a single course of stonework, but two courses were apparent along the 2 m length nearest the river. The wall had suffered some slight damage approximately 1 m from its northern end where a narrow British Telecom trench had been cut through it. A short (0.5 m) return to the east appeared to be present at its north end, while there were indications that there might have been an attempt to buttress the upstream side of the wall at its southern

(riverside) end by packing stones around a large natural boulder. A substantial deposit of boulders, amongst which were several unabraded sherds of medieval pottery, was present on the east (downstream) side of the wall; from its position and the condition of the pottery it appears likely that this was not the result of flood action, but tumble from the wall collapsing. An area of possible paving was exposed on the east side of the wall close to its riverside end (see extreme bottom left of fig. 18). The tumble on the west side of the wall, above parts of a second area of rough paving, was less rich in pottery, initially yielding only a single, large glazed sherd of a handle of late medieval origin [222/97].

This second paved area, which proved to be the capstones of a drain (supported by smaller stones set on edge to either side), varied in width from 0.6 m to 0.9 m; it consisted of riverine cobbles up to 0.40 long and 0.12 m thick; some of these overlapped one another, but in the main they formed a single layer. From its north end it ran southwards approximately parallel with the western wall for about 3 m, until making a 40-degree turn to the west and continuing in a straight line to the south-western corner of the trench (fig. 19).

What appeared to be a subsidiary drain met the main one 2.4 m from its northern end, entering from the north at a 60-degree angle, although there was no junction apparent between the two.

The drains had been cut into or laid upon natural boulder clay sub-soil and no remains of archaeological significance were noted at that level. However, 10 further sherds of medieval pottery [233/112] were recovered from deposits immediately above this.

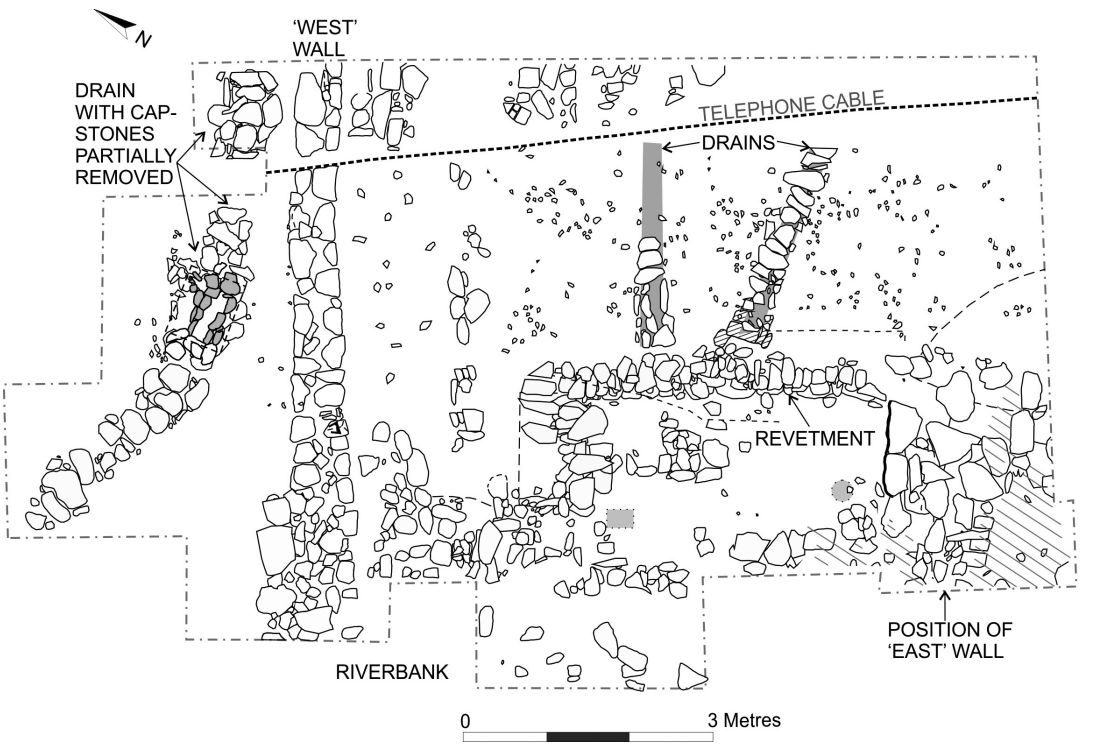

Fig. 16 Composite plan of Trench 2 without boulder overburden.

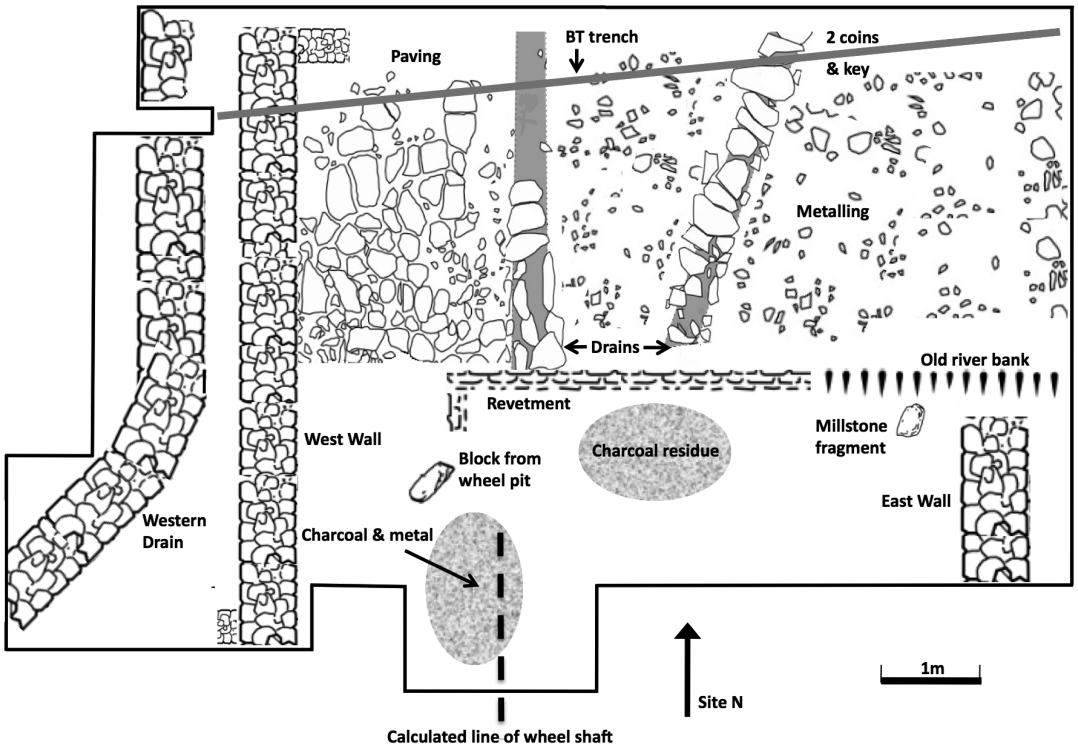

Fig. 17 Schematic representation of Trench 2, showing the relative positions of key finds and features mentioned in the text. Indicative scale only.

In the area between the walls, boulders extended across the whole of the southern part of the trench but dipped towards the centre. Here two stones of note were recorded; the first was a large piece of sandstone [207/23], flattened on both surfaces and displaying grooves and notches, as well as signs of tooling. A curve in one edge suggested that it was a fragment of millstone. The second [209/22] was of a similar size and material, and had comparable dressing to the blocks forming the wheel pit. Other finds from this layer of boulders included several sherds of medieval pottery and the head of a metal nail.

Upon removal of the boulders, a sharply defined change in slope became apparent 2 m from the southern edge of the trench, running parallel with the river. This was interpreted as an ancient riverbank pre-dating the mill. Starting 2 m from the eastern edge of the trench and running west for 3.7 m, a crude revetment had been built against this bank. At a maximum of 0.56 m high, this consisted of two or three courses of stones up to 0.25 m long; those in the lower course were larger than those in the upper courses, with the latter being generally around 0.15–0.20 m long (fig. 20). The revetment wall was battered by between 0.14 m–0.19 m from the face of the bottom to the upper courses, and at the west end was an apparent short (*c.* 1 m) return towards the river; in poorer condition than the main revetment, this feature was some 0.6 m upstream from the calculated line of the wheel shaft.

Extensive deposits of fine charcoal and decayed wood were noted along the projected line of the wheel shaft and on the south side of the revetment. In both cases the charcoal was

Fig. 18 The remains of the western wall (2 m horizontal scale).

Fig. 19 The lower 4.7 m of the large drain (1 m scale). The section with lifted stones is immediately above the scale, while two of the side stones forming the small adjoining drain can be seen above the left hand end of the scale.

Fig. 20 The revetment protecting the mill's working area (50 cm scale sections).

Fig. 21 The paved area [204], showing the larger flag and the linear arrangement of stones [205] in the foreground (1 m scales).

embedded in silty deposits of varying character, ranging from brown silty-loams to greyer gritty silts. These matrices are probably the result of riverine incursions, but in the south-west corner of the trench was a thin intermediary deposit of pure clay; again, this could be a riverine deposit, but might also be the result of outwash from a clay-bonded structure. In this deposit, below the line of the wheel shaft, investigation at a depth of 1.3 m revealed four pieces of highly corroded metal.

We now turn our attention to the part of the trench away from the river and above the putative ancient riverbank described above. To the east of the western (upstream) wall, and present across the entire north-western quadrant of the trench, was a deposit of flat stones (figs. 17 and 21), measuring up to 0.3 m across, with a single larger flag measuring 0.7 m along its elongated N-S axis. The stones formed a rough but fairly level surface which appeared to be artificial, but no significant finds were made in this area to indicate its likely function or date.

Along the eastern edge of this surface was a drain; a second, further to the east, converged with it close to the top of the ancient riverbank and the revetment supporting it (fig. 22). The cut for the second drain was 0.45 m wide and up to 0.29 m deep (including the capstones). The area between the two stone drains was occupied, immediately below topsoil level, by deposits of small angular stones set within a silty-loam matrix, some of which may have been deliberately laid as a metalled surface. There were no post-medieval finds in these deposits, but within one of them [203] was a well preserved silver penny from the reign of Edward I [203/30] (fig. 33) and half of a Henry III half-penny [203/37], as well as several sherds of pottery also consistent with occupation in the late medieval period.

The British Telecom trench was largely confined to the topsoil above the two drains and the surfaces into which they were cut. However, in the back-fill between the two plastic tubes in the trench a medieval cast copper-alloy key [201/62], dating to *c.* 1200–1500, was identified (fig. 34).

TRENCH 5

(Principal investigator: John Nolan)

Operating in difficult conditions almost entirely within the river itself, a large timber structure was uncovered 55 m upstream from the wheel pit (figs. 23 and 24). Work here largely consisted of moving gravel and boulders from the timber structure, as well as some topsoil and boulder tumble from the adjacent riverbank.

Three timber beams [511, 517, and 523], each exhibiting signs of re-use, were set approximately equidistant from one another across the stream with close-set planks of unequal width between them. The planks were fixed with dowels to rebates on the edges of the beams to provide a level surface or floor in the riverbed. The beams were 'toed' into the bank and against a natural outcrop in the centre of the riverbed to keep them in position.

The remains suggest that each of the three beams carried three evenly spaced timber uprights, morticed and tenoned into them. Most of the mortices were empty, the only surviving portions of the timber uprights being the two 'end' ones [524] and [525] on the downstream beam [523], and [526] at the bank end of the central beam [517]. The wood of [526] has been identified as being ash.

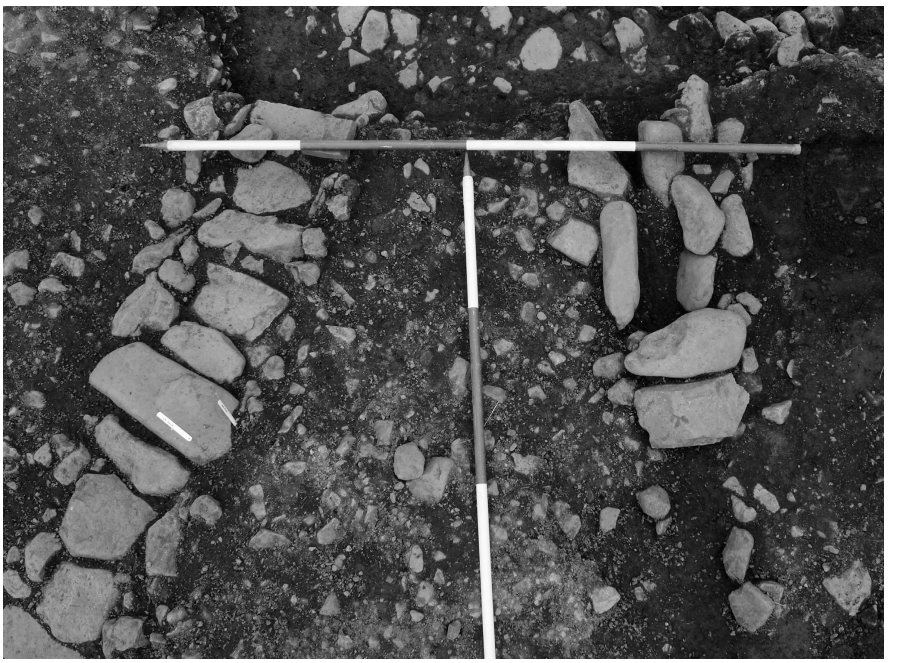

Fig. 22 The two drains [212] and [205], disgorging towards the south (at top) (1 m scales).

Fig. 23 The 'floor' [501] at the upstream site (50 cm scale sections).

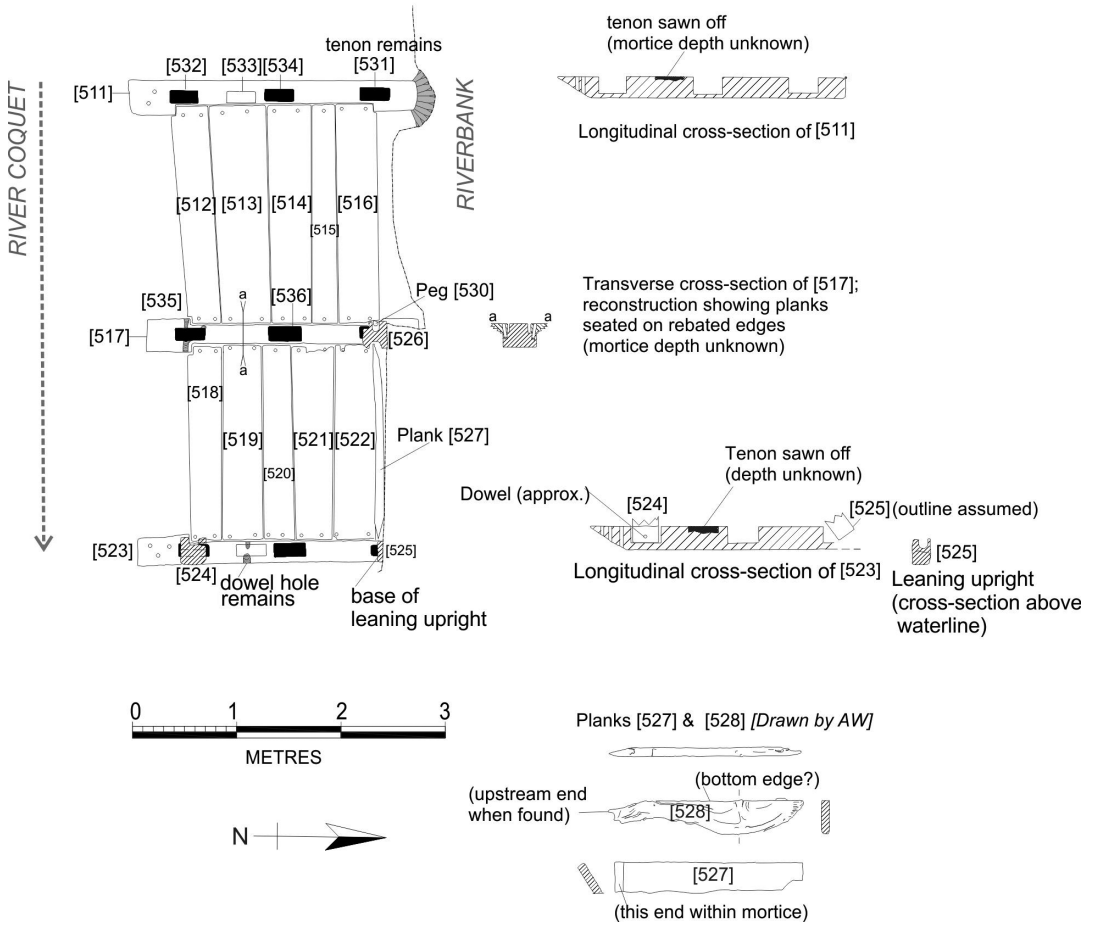

Fig. 24 Plan and details of upstream structure revealed in Trench 5.

Uprights [524] and [525] had deep grooves cut into their upstream faces only, while the centre upright [526] was grooved on both upstream and downstream sides, as would be expected of an intermediate post. The grooves held the tapered ends of planks slotted-in on edge, one of which [527] survived *in situ* (fig. 25). During site clearance, another plank [528] was found out of position, lying across the structure upstream from [526]; this location suggests it had fitted into a slot either on that post or one of the other ones (now missing) upstream.

The planks formed 'sides' to the overall structure — one set of them on the bank side and one on the outer river side. None of the central uprights survives, but their inclusion in the structure suggests that they may well have originally held planks in the same way — the downstream and upstream end uprights grooved on the upstream and downstream sides respectively, and the centre upright grooved on both sides. Although the chamfered ends to the surviving planks have been quite precisely worked, the other parts of them, even allowing

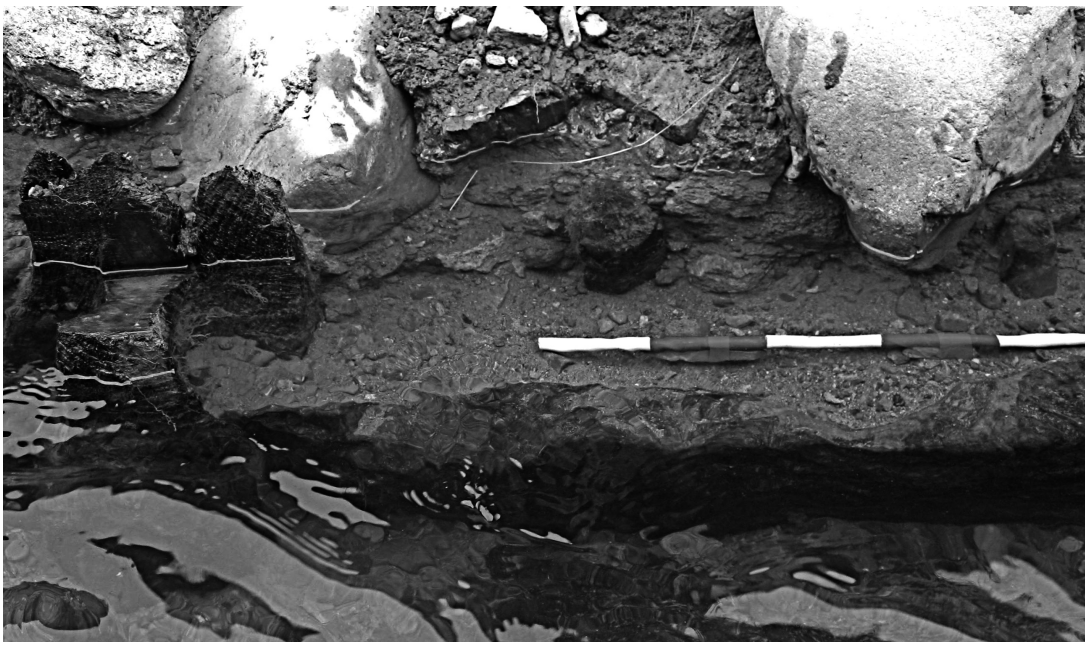

Fig. 25 The plank [527] between [526] and [525] and small stakes [505] and [506] behind (50 cm scale). The concave cuts in [526], one holding [527], can be seen (10 cm scale sections).

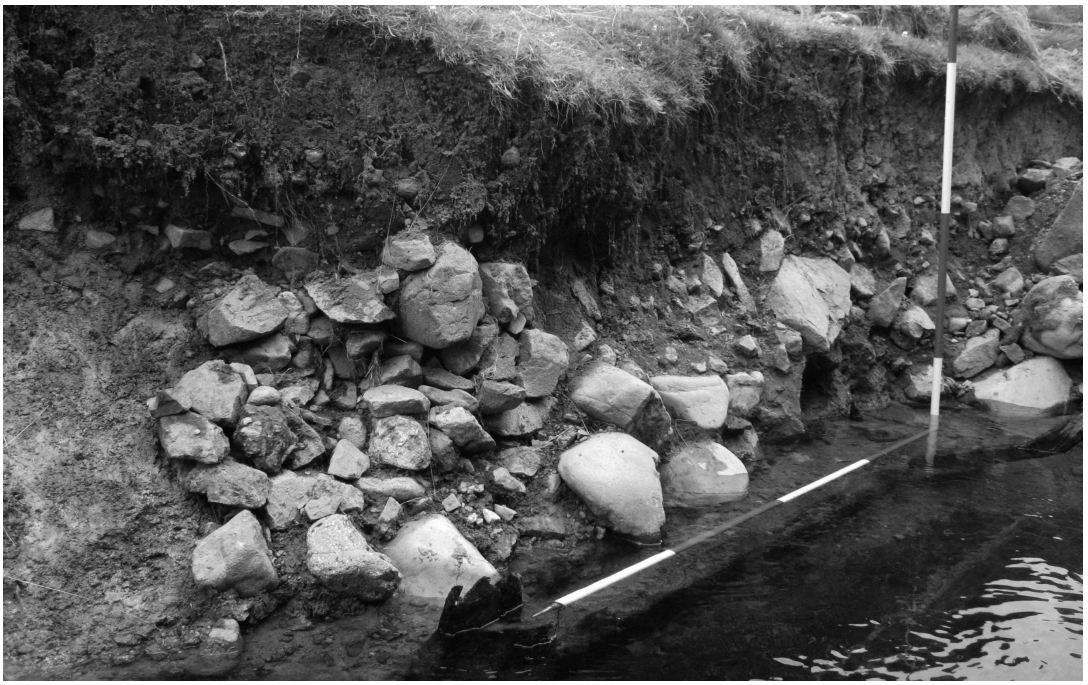

Fig. 26 Rubble packing behind [527] (2 m scales).

for centuries of river action, are much less carefully finished; adze marks appear to be visible on [528].

Associated with the structure on the riverbed are some features on the bank. Between uprights [525] and [526] and behind the side plank was a deposit of rubble, including many river-worn stones, lying against the natural clay of the riverbank (fig. 26). There was evidence that the rubble had extended upstream from upright [526], but most had been washed away or collapsed into the stream, perhaps when the northern side planks between beams [511] and [517] had moved. The rubble may be a stone-filled feature running down to the river, or infill behind the side planking. This gives weight to the idea of the timber structure being linked to a dam or weir — the rubble being used to fill the gap between the vertical planking and the sloping bank, as well as preventing erosion from overspill of water around the structure.

Amidst the rubble, and surviving approximately to current low-water level, was an evenly-spaced line of six small stakes ([505]–[510]), some retaining their bark (fig. 25). These were only seen between uprights [525] and [526]; if they had continued upstream they were presumably washed away in the collapse of any rubble infill there. There was no evidence of any planking or wattling between the stakes, the function of which is thought likely to be related to bank support, as was found to be the case associated with the mill- and tail-races at Bordesley, near Redditch (Astill 1993, 16, 22).

In addition to the empty mortices in the main beams there are rectangular (long) mortices filled with cleanly sawn-off embedded tenons probably indicating the re-use or adaptation of some of the timbers, especially of these large beams. Their original use cannot be dated, but Rigold (1975, 88) points out that the long mortice was in use in structures such as bridges by the mid twelfth century.

This indication of re-use is reinforced by chamfering at the outer (southern) ends of two of the beams [511 and 523], with dowel holes piercing completely through the timber. This is indicative of a scarf joint, but there is no sign of any further timbers to which they might have been joined. Indeed, the height of the adjacent bedrock outcrop in the river mentioned above makes the presence of other timbers very unlikely. The downstream beam [523] also has traces of a dowel hole sectioned longitudinally, which suggests that the timber may have been split or sawn down its length. There is a similar sectioned dowel hole at the midstream end of beam [517] implying the mortice here was originally cut when this timber was used elsewhere.

Examination of the remaining post [526] at the midpoint of the structure by the river-bank shows that as well as grooves for planks on both the upstream and downstream sides, there appears to be a rebate on the stream side at the base of its upstream face (fig. 27). A peg [530] in the upstream groove of this upright may have been a wedge to keep the side plank firm, but being round in profile may alternatively have been a pivot for a harr-hung flap or gate.

At sampled locations, the thickness of the three beams was approximately 23 cm, and that of the cross-planks was 10 cm. If these measurements are consistent across the structure, its weight is estimated at between 800 kg and 1000 kg when new. It is likely, therefore, that it was assembled in position; the bank at the end of [511] appears to have been cut away to accommodate it (fig. 28).

An aerial view shows that the structure appears to be set at an angle to the current general course of the river; however, the river curves here and the long axis of the structure is in line with its course upstream (to the left in fig. 29). The upstream (left) end of the structure is aligned with the start of a length of the river which is heavily strewn with boulders for about

Fig. 27 Base of [526] showing rebate at right and the peg [530] (10cm scale sections).

Fig. 28 Bank cut [504] at N. end of [511] after clearance (50cm scale).

Fig. 29 Aerial view of the stretch of river containing the 'floor' [501]. Set at an apparent angle of between 20 and 25 degrees to the river course, it is shown from the bank, with scales, in fig. 23.

25 m downstream. Upstream is a large pool which extends for 80 m or so and is up to three metres deep. Exploration of this pool by a diver did not find any further structures or artefacts to suggest that it had been deliberately made, modified or used at any time in the past. It is unclear how much of the environment around the wooden structure is artificial and how much is natural. The pools are certainly natural, but it may be that the structure has been placed to exploit part of the river where the water flow was greatest — a natural feature that may have been enhanced by an adjacent dam of boulders and rubble — which over the years has been largely washed downstream resulting in the current concentration of boulders.

ADDITIONAL INVESTIGATIONS (fig. 4)

In addition to the wheel pit, the mill building, and associated features concerned with the supply and control of running water, it is assumed that various ancillary structures and features would also have been present at a mill site, particularly that of a fulling mill. Some associated with cloth-production and distribution might be expected, such as tentering areas, and stores, or others associated with farming (shepherding) and domestic activities. In an effort to identify some of these, two additional trenches to those already described were

opened in positions identified as promising on the grounds of topography and the presence of earthworks.

Trench 1

Trench 1, measuring 4 m by 4 m, was placed 8 m to the west of the west edge of the wheel pit revealed in Trench 3; the intention was to explore the character of an apparent linear earthwork visible on aerial photographs, which was presumed to be structural in nature. It appeared to include a return to the south at its east end, and so the trench was placed to explore this return. The removal of the turf revealed dense deposits of small stones, almost all apparently river-worn cobbles, descending from the south side of the road to the riverside, cut by a modern trench for a telephone cable. It was concluded that the deposit of small stones was probably the remains of an old road surface, predating the current metalled road.

Trench 4

Trench 4, measuring 5 m long by 1.5 m wide, was excavated 67 m south-east of the north-east corner of Trench 3, in order to investigate a low, linear earthwork running parallel with the river and turning sharply away from it at its eastern end, apparently enclosing a flat area of haugh-land between river and road. The trench was placed across the centre of the short return of the bank, and extended upstream into the flat ground.

The low bank was found to be up to 0.35 m high and to be of earthen construction, comprising the same, silty-loam topsoil material as found on the flat ground to either side. Sparse finds of modern, highly abraded pottery and clay-pipe stems were made in the topsoil within the earthen banks and there was a single piece of glazed late medieval pottery. Subsequent investigation revealed that, prior to the construction of the nearby road in the late 1930s, this area had been used by Barrowburn farm as a potato field. The earthen bank may have been connected with this; the discovery of a sherd of medieval pottery is not highly significant, but perhaps indicates manuring of this area in earlier periods as well as more recently.

DISCUSSION

The wheel pit and wheel

Very few medieval mill wheel pits have been excavated in the British Isles (Holt 1988, 117), so the corpus of information on which to base comparisons and deductions is limited. The Barrowburn wheel pit is of masonry, with its working faces finished to a high standard. Parts of a masonry pit with wheel abrasions similar to those at Barrowburn have been identified at Abbotsbury in Dorset (Graham *et al.* 1986, 103–25); however, although probably of fourteenth-century date, the pit seems to have been excavated in such a way as to make accurate stratigraphic dating impossible. Furthermore, the original pit was redeveloped at a subsequent but undetermined date, perhaps holding wheels of varying sizes.

The Barrowburn masonry contrasts with some other medieval wheel pits or troughs, such as those at Bordesley (Astill 1993, 252) and Batsford, Sussex (Bedwin 1980), which were lined with timber. The width of the pit, however, is similar to that at Bordesley; the Barrowburn pit is 0.52 m wide at entry, compared with 0.6 m to 0.45 m at Bordesley, depending on the period.

The diameters of the Barrowburn and Bordesley wheels are also similar; from the curved abrasions on the masonry, the diameter of the Barrowburn mill wheel has been calculated as being *c.* 3.4 m, compared with estimates of 3.4 m to 3.5 m at Bordesley (Astill 1993, 254–5).

One significant difference between the sites, however, is that whilst the Bordesley wheel was undershot (with a significant gradient in the wheel pit), the structure of the Barrowburn pit, with its shaped masonry block at the entry, indicates that it was a low breast-shot wheel — a configuration that is more efficient than an undershot wheel. This efficiency is largely due to a casing around the lower parts of the wheel that stops water spilling off the blades or floats, meaning the wheel is turned by weight of water as well as by its impulse (Reynolds 1983, 201). In the case of the Barrowburn mill, this casing was supplied by the masonry walls (the close-fitting of which accounts for the abrasions on both sides of the pit) and by the shaped entry channel. Comparing the height of the entry to the wheel pit with the calculated position of the wheel itself shows that the water would have initially struck the blades at about 40 degrees from the vertical — approximately in the middle of the lower quadrant of the wheel. This wheel configuration explains why the wall on the outer side of the pit is relatively narrow and lightweight, especially at the upstream end. Its sole purpose was to ensure that water was held on the wheel blades after impact; the mill wheel itself was probably supported by a wooden (or other) frame in the river. The Luttrell Psalter (1320–1340, f. 181) shows a picture of a watermill where the stream-side end of the shaft of an overshot wheel is supported by a wooden structure, suggesting a possible configuration for Barrowburn, although an axle support of stone or ironwork is also possible.

The discovery of a mill that clearly had a low breast-shot wheel with a construction date before 1245 is significant. It is not clear when such wheels were first invented, but in Roman Gaul there is evidence of a second-century breast-shot wheel at a mill at Martres-de-Veyre in the Puy-de-Dome (Wikander 2000, 375). They only became common in England in the eighteenth century, through the work of engineers like John Smeaton. There is a belief, based on a sketch from Flanders in the late thirteenth century of the watermill at Ogy, that they were in use in the medieval period (Vieil Rentier d'Audenarde 1275–90, f. 98, image 201), whilst excavation of the mill dam at Hemington Fields, Leicestershire, uncovered a curved oak structure (dating to *c.* 1100), the shape of which suggests that it may have held a low breast-shot wheel (Clay and Salisbury 1990, 287). However, the first certain appearance of such wheels in the modern (post-Roman) world was in the sixteenth century. Around 1550, Juanelo Turriano illustrated vertical wheels with water impacting the blades at around axle level (Reynolds 1983, 278), and the British agricultural writer Anthony Fitzherbert mentioned the breast wheel by name in 1523 (Fitzherbert 1523, 92). Dating from the thirteenth century, the Barrowburn breast-shot wheel is among the very earliest, if not the earliest, of its type that has been identified in the British Isles.

Water supply for the mill

The large timber beam just above the entry to the wheel pit may have been part of a penstock system, supporting a sluice gate or grill that could either protect the wheel from debris being washed downstream or control the water supply to it (Fitzherbert 1523, 93). It is not clear why or when the timber was cut through, but the remaining piece shows that a mortice on its upper surface was quite substantial. The two wooden pegs found in the riverbed opposite the

beam were not from a completely secure context but if they were in (or close to) their original position, the radiocarbon dating for one of them (see Finds section) provides some further evidence of a structure built across the entry to the wheel pit or just upstream from it.

The thinner plank lying across the beam might have been part of the sluice system, but it could alternatively be the remains of a timber leat or launder feeding the mill wheel (in which role it may also have served as a bank-side revetment). Some method of raising the water level directly upstream from the wheel pit would have been necessary because (even at moderate river volumes) the surrounding natural water level is 0.1 m or more below the entry to the pit (the top of block [321]), rendering the wheel inoperable. The simplest and most cost effective way to supply water to the wheel would have been to power it by a head of water behind a weir or dam placed diagonally across (or part of the way across) the river. A system like this, easily constructed from readily available resources, would have been able to raise the river level sufficiently to provide a head of water for a low breast-shot wheel. However, no remains of such a structure can now be seen at the Barrowburn site, unless the wooden pegs found in the riverbed were part of it.

Although there is no information about the profile of the medieval bank, it is significant that the wheel pit is adjacent to what is currently one of the few flat areas on this stretch of the north bank suitable for the construction of a mill. Assuming this was the case 800 years ago, it would have been a good reason for placing the mill where it is; this in turn may have influenced decisions about water supply. Rynne (2009, 85) identifies the importance of empirical observations when choosing the site for a mill. By the time the Barrowburn mill was built, Newminster Abbey had been active in the area for over 40 years, and it seems reasonable to assume that their knowledge of local topography and water conditions led them to pick the most suitable position for development.

Several different explanations have been advanced for the wooden structure in Trench 5 on the riverbed upstream from the wheel pit. It has been suggested that it represents the underwater floor of another mill, with the working floor supported by the substantial corner posts — as at Tamworth, where a similar, planked structure was excavated in the bed of a former mill leat (Rahtz and Meeson 1992, plates I–IV and fig. 31). Designs very similar to the Tamworth mill, and perhaps also represented by the structure at Barrowburn, where a small mill structure is set above a river or stream on posts or stilts, remain very common in parts of contemporary Central and Eastern Europe where they are most commonly associated with vertically-axled, horizontal mill wheels powering corn mills (cf. Carlton and Rushworth 2009, 419–20). If this explanation is correct, the dating of the ash upright from this structure to the thirteenth century (see below) suggests that it was still in use at the same time as the downstream mill, even if some parts of it had been built earlier.

Alternatively, it has been suggested that the presence of the wheel pit, some 50 m downstream from this wooden structure of the same or similar date, indicates that the builders of the mill decided to create an appropriate head of water for it by abstraction from the river at the upstream site. The one-metre head thus achieved, although apparently quite small, is of the same order of magnitude as that used by the post-medieval wheels in the later phases of the Stafford mill, which were also low breast-shot and operated with a head of about 0.9 m (Hislop *et al.* 2006, 23). In that case, the function of the upstream structure would have been to act as a sluice control system to manage the entry of water into a leat (probably of wood) that fed the wheel downstream. This could explain the robust flat wooden floor of the structure, the purpose of which would be to prevent scouring and serve as a base onto which

planks or gates could be lowered or placed. This flat base had planked sides and may have had a central planked division forming two parallel open-ended channels in line with the stream. It is not known how high the uprights were, or if the channels were open or enclosed culverts with some form of top planking. The only other structural feature is a deep-cut rebate or check on the upstream inner (i.e. to the culvert) edge of the centre upright [526]; this could derive from some previous use of the timber in another context but, if designed to serve a purpose in relation to its current context, could suggest that something closed against the check.

The opening and closing of each channel would have controlled water flow into the putative leat and to the mill downstream. At times of low water, both channels would have been open to maximize water flow; with higher water one would have been shut, and when the water was very high both would have been shut. Alternatively, just one channel may have fed the leat, with the other being used to control run-off in high water conditions. As described above, assuming the presence of a leat, there may also have been a backup gate or sluice just above the mill wheel.

Such a sluice system would have been more effective if it was part of a larger structure, such as a dam or weir; it is conceivable that fig. 29 shows the washed-out remains of such a structure: a length of river, rich in boulders, starting immediately adjacent to the upstream end of the timber structure and extending for some 25 m downstream. A weir or low dam, as described above, would only have had to be high enough to direct a good proportion of water towards the sluices. At times of high river flow, excess water would have gone over the top of the structure or through a spillway.

However, whilst the use of the wooden structure in Trench 5 as a sluice seems plausible on the basis of the limited structural evidence available, its association with the wheel pit is much less so, not least because there is no structural evidence for an intermediary leat. The cost of construction of a timber leat, within the course of the river, as well as the erosive impacts of seasonal torrents, suggests that such a structure is unlikely to have been built, especially as a simple weir, upstream from the wheel pit, could have provided an equivalent head of water.

Consideration of these alternative scenarios favours the explanation for the upstream timber structure as the remains of a second, perhaps slightly earlier, watermill supported on posts over the river and furnished with one or more vertically-axled water-wheels. Its underwater timber floor would have functioned as the base of a wheel-pit onto which water was funneled, by means of wooden shoots built into the weir, obliquely across the horizontal wheel. Should this structure be accepted as a vertically-axled watermill, it would be one of the latest of its kind to be recorded in England, since most such waterwheels had gone out of use by the thirteenth century (Carlton and Jones 2014, 224; English Heritage 2011, 4).

Finally, there is the question of the licence for the mill pond described above. No sign of it remains and it seems unlikely that a discrete pond was built; this may have been because its construction would have been a major task, especially as the licence applied to the Umfraville south bank, whilst the mill was actually built on the north. Since water was probably abstracted from the river, the licence may just have been a *pro forma* document that the monks felt they needed to permit them to build a dam and a sluice. It could be argued that the '*stagnum*' referred to in the licence applied to the area of relatively still water behind a weir that affected both banks.

The structure downstream from the wheel pit

This lightweight rectangular structure probably also had a planked floor below the water line and its relationship with the wheel pit suggests the two structures are contemporary. It is possible that it formed the base of a stilted structure of the sort suggested for the upstream site, but the most likely explanation is that it was used as a submerged tank for cleaning wool or washing and rinsing cloth after fulling, and before tentering and drying. Noxious substances such as urine may have been used in the fulling process and it would seem reasonable to try to remove as much of these as possible. Rinsing had long been considered the final stage of the fulling process (Flohr 2006, 193–200), and washpools have been identified at other early fulling mill sites (Oxford Archaeology North 2012, 41). It is also worth pointing out that, while there is no evidence as to whether cloth was dyed in the area or not, there are records of individuals elsewhere being granted licences to use stretches of bank in order to wash dyed cloth (Carus-Wilson 1941, 52).

The structure is substantially wider than the wheel pit, perhaps because it was built to provide enough space for workers to rinse a reasonable amount of cloth at one time. Water flow through the structure might have been best achieved by placing the exit diagonally opposite the entry from the wheel pit. The exit may have been controlled by a gate; this could account for the size of the mortice [362] at this point, which is substantially larger (*c.* 0.4 m long) than other adjacent mortices.

The mill area on the bank (Trench 2)

Archaeological remains and deposits caused by human activity were found across the entire site. The upper part of the bank seems to have been terraced or at least maintained as a fairly level surface. The west part of this area was provided with a surface of flat stones, while roughly cobbled or compressed natural surfaces cover the rest. Within the latter a number of finds of medieval origin were made, including two thirteenth-century coins, a key, and sherds of late medieval pottery. Below the level of the stone surfaces on the upper part of the site, and apparently cut into them, were two stone drains or 'cundys', each running approximately north-south, with their lower ends converging towards the southern part of the upper trench. (The outlet of the eastern drain can be seen above the revetment in the centre of fig. 20.) Neither contained dateable deposits or finds but it is probable that they are contemporary with the surfaces described above and, therefore, with the mill's operation. It is likely that the surfaces here were used for one or more of the domestic and industrial activities associated with the mill, including the stabling of animals and loading and carriage of materials. It may be that the drains were built in order to direct a water supply to a point of need — into washing or rinsing tanks, for example, or onto wooden machinery that needed to be kept damp.

The larger drain to the west of the upstream wall appears to be broadly contemporary with the mill in that medieval pottery fragments were found both on its surface and in contexts immediately above it, but its precise function remains unclear. The two walls running at right angles to the river and wheel pit in the eastern and western parts of the trench comprised a short east wall and longer parallel wall 8 m to the west, which extended for a total of 6 m to the north edge of the trench. No firm dating evidence was found in association with these walls, although there was medieval pottery in what was probably the tumble from the west wall. It is likely that they were contemporary with the wheel pit and formed part of some

ancillary structure to the mill. Their poor construction seems to preclude the possibility that they formed part of a stone-built, roofed structure, but it is possible that they could have served as sleeper walls for a more substantial timber-framed structure. Alternatively, it is possible that the walls functioned as simple perimeter boundaries, built to keep stock or intruders away from the main working area but not supporting a building. Such walls protecting mills were not unknown; at Hollingbourne, in Kent, a substantial wall of rubble masonry was built in 1312–13, forming a precinct around the existing North Mill (Langdon 2004, 106).

Most of the lower part of the site between the two north-south walls was occupied by boulders and rubble set within a silty-loam matrix. Amongst several worked stones found within this deposit, two were of particular significance. One, found at 0.8 m below modern ground level, was a squared, tooled stone of the same character as those forming the wheel pit, and probably once formed part of the same structure. The second stone is potentially of more significance, being interpreted as a fragment of millstone displaying signs of re-use for the sharpening of tools. There are several explanations for the presence of a fragment of millstone on the site of a presumed fulling mill; it could be, for example, that the fulling mill served a dual purpose as a corn mill. It is also possible that the site was used as a corn mill subsequent to its abandonment as a fulling mill, or that a fulling mill was never built and the structure is an undocumented corn mill, with two north-south sleeper walls supporting a roofed mill building. Of these options, the one considered most likely is that a fulling mill was sited on or near the position of an existing (d'Umfraville) corn mill, thereby minimising the risks that would otherwise accrue from exploiting an unproven site. The very worn appearance of the two fragmentary pieces of probable millstone found on the site suggests their re-use over a considerable period of time, and the occurrence of one of them in a re-used context within the constructed bankside beside the wheel-pit tends to support the suggested scenario.

The revetment revealed in the centre of the trench seems to have been built to define and protect an area on the north side of the wheel pit. The precise use of this area is unknown, since no remains diagnostic of any particular activities were found there. It could have contained the drive shaft and primary gearing for a corn mill, the main working area for which would have been on the floor above, but a more plausible suggestion is that the area below the revetment was the main working area for a fulling mill. Assuming that was the case, the majority of it, including the stocks and other fulling equipment, was clearly constructed downstream from the line of the rotating wheel shaft. Contemporary descriptions of medieval fulling mills are not always clear about the configuration of the associated machinery (Langdon 2004, 100). If the fulling machinery was downstream it seems probable that at Barrowburn a simple trip-hammer mechanism would have been employed, with rotating cams lifting the hammers by engaging with projections on their base, and then letting them fall as the rotation continued. Such configurations can be seen in post-medieval illustrations such as those by Zonca (1607) and Schickhardt (*c.* 1610). The Zonca illustration (fig. 30) also shows a low volume water supply being delivered from a leat into a fulling tub; it is conceivable that the equivalent function at Barrowburn may have been performed by the two drains positioned above the working area. Even in these drawings, however, the machinery configurations vary; in Schickhardt's depiction the hammer shanks are almost horizontal, while in Zonca's they are close to vertical. Another example of vertical shanks can be seen in a late sixteenth-century image attributed to an engineer usually called Pseudo-Juanelo Turriano who was, it has been argued, one Pedro Juan de Lastanosa (Tapia 1987, 62–71). Shown in

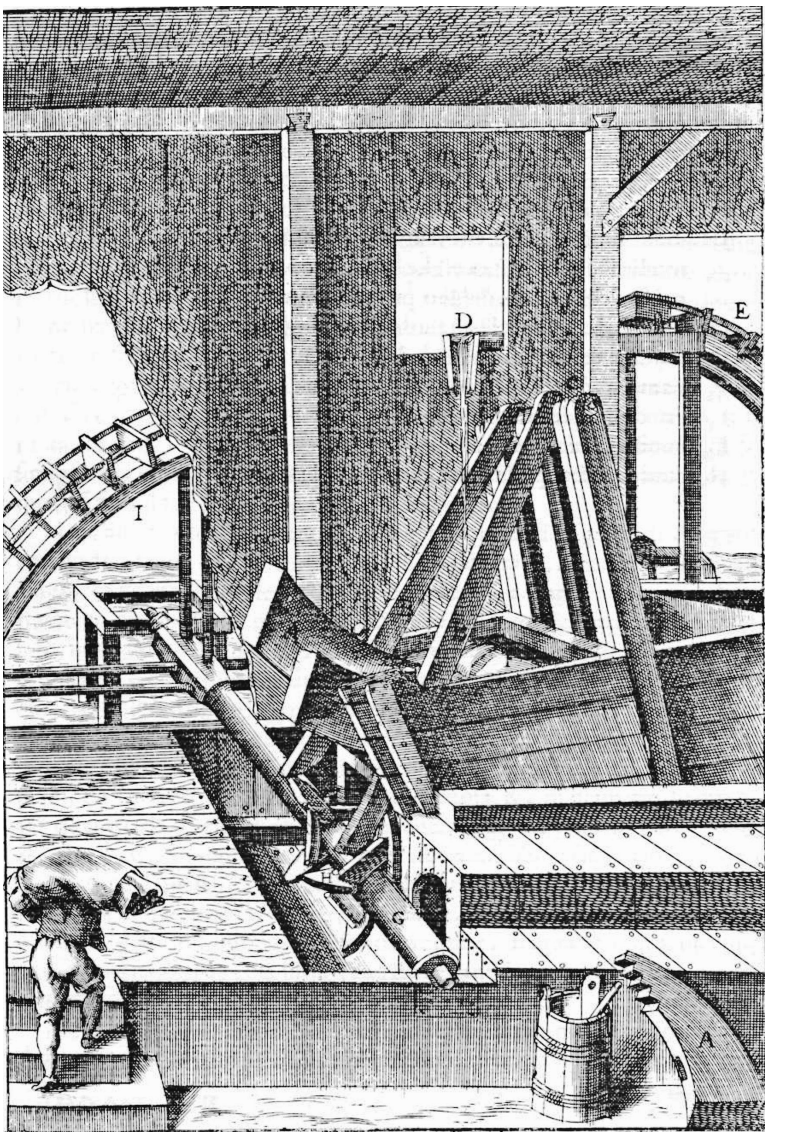

Fig. 30 Fulling machinery, drawn by Vittorio Zonca (1607) showing a low-volume water supply disgorging into the fulling tubs (at D, top centre of picture).

fig. 31, this configuration dispenses with a conventional tub altogether, with piles of wet cloth being placed on a wooden base with a backboard and pummelled by hammers that are completely horizontal (Turriano 1595). As well as the absence of separate tubs, the system shown is notable for its lightweight construction. Indeed the accompanying text says, 'It is said that not much water is needed to drive the device because of the small weight to be moved'.

There was no indication of a floor in the putative machinery area adjacent to the base of the revetment where one might be expected. With the amount of water involved in the fulling

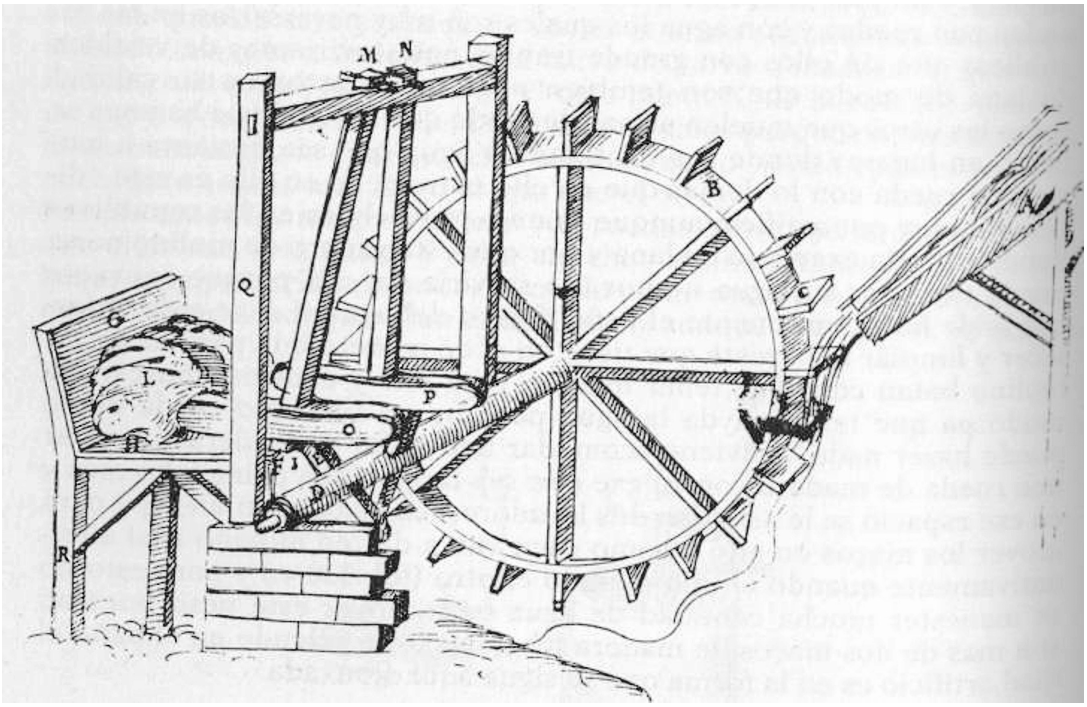

Fig. 31 A late sixteenth-century fulling system (Pseudo-Turriano, 1595).

process, some sort of stone floor would have been desirable, if not essential; it may be that a floor of good stone was removed when the mill was abandoned, or was subsequently robbed.

The provenance of the charcoal and metal fragments in this area of the trench is unclear. The nature of the charcoal, predominantly hazel and birch, implies that it was not derived from any burning of the mill machinery. Although specific hearths could not be identified, the deposits were sufficiently dense to suggest that they are not the result of fluvial inwash, and so it would seem likely that the charcoal represents the residue of campfires or other casual fires in the shell of the mill after it had been abandoned, or else the remains of a process connected with the mill itself. One obvious such process involved the heating of water for fulling, although the precise mechanism for this is unclear. A seventeenth-century illustration (Böckler 1661, pl. 72) shows water being heated in pans or cauldrons over fires.

Considerable change has occurred around the working area of the mill as the result of the inwash of water-borne materials, including the alluvial deposits within which the charcoal was found. Indeed, the spread of this alluvial deposit is consistent with the exploitation by the river in torrent of a weak point — in this case a working area cut into the riverbank. It may be that fluvial incursion was a problem even when the mill was in operation.

Apart from the two stone walls found at the east and west sides of the trench, which may have been sleeper walls for a timber-framed mill building, no other traces of a building have been found. The structure of a fulling mill could have been very lightweight in nature — perhaps just sufficient to protect operators from the elements — or else completely non-existent. The Böckler illustration referred to above shows fulling machinery operating in the

open air, while a much later watercolour painting in the collection of the National Galleries of Scotland (Paul Sandby, *c.* 1750) shows a fulling mill in Fife where the machinery is also completely exposed. Clearly there was nothing in the fulling process that required material to be kept dry, and if fulling agents such as urine were being used, good ventilation might well have been advantageous.

The demise of the mill

The Barrowburn structures are unusual in that few remains of medieval mills of similar quality have been identified in England. One factor that may have contributed to their preservation here is that the mill was probably abandoned in the fourteenth century, due to the pressure of Scottish incursions exacerbated by outbreaks of famine and plague (Carlton and Jones 2014, 235–7).

The dating of charcoal (1280 to 1400, see below) from the area below the calculated line of the wheel shaft is also an indication that industrial activity ceased at Barrowburn in the fourteenth century. As suggested above, these charcoal deposits are likely to have been either the result of a post-abandonment fire, or else the remnants of a process associated with the mill itself; there was insufficient stratigraphy to enable us to distinguish between these two. The former would suggest that the mill was probably abandoned at some time between 1304 (the last recorded date of farming in the area: Carlton and Jones 2014, 230) and 1400 (the later boundary for the 2 sigma radiocarbon dating). We can draw the same conclusion if the residues were directly connected with the mill, since it is probable that any charcoal remaining from an industrial process would have been created towards the end of the operation of that process. If the fire was lit regularly in a consistent location, then it would be expected that old charcoal would either end up as ash, or else would be removed as the debris of old fires was cleared away.

Abandonment of the mill would have encouraged robbery of any components that had not already been removed by its owners or operators. Medieval sources often state that mills were demolished and cleared away prior to rebuilding (Watts 2002, 86–7). The Barrowburn mill was never used again, leaving the original pit and associated features in relatively good condition.

FINDS

A complete list of finds, and the associated descriptions and documentation, form parts of the full archive report described in the Introduction.

Timber and charcoal

In addition to the timbers found at both upstream and central sites, deposits of charcoal fragments were found in Trench 2 along the calculated line of the wheel shaft and on the south side of the revetment along the ancient riverbank. Fragments of charcoal, 137 in all, were recovered from the area below the line of the wheel shaft (context 218). Of these, 116 were of identifiable species (Huntley 2013; Huntley 2014a), with the majority represented by birch (53) and hazel (46). The remaining 17 consisted of ash (4), heather (4), willow or poplar (3), hawthorn-type (3), oak (2) and alder (1). Three of the birch fragments probably came from

Table 1 Radiocarbon dates, provided by Beta Analytic of Miami, Florida. The two date-ranges for [354] is due to the shape of the calibration curve for the period corresponding to its radiocarbon age.

Context ID	Description	Measured radiocarbon age	Conventional radiocarbon age	2 sigma calibration
526	Ash post (Trench 5)	790 +/- 30 BP	800 +/- 30 BP	Cal AD 1200–1270
354	Oak post in bank (Trench 3)	860 +/- 30 BP	880 +/- 30 BP	Cal AD 1040–1100 Cal AD 1120–1220
360	Oak beam next to wheel pit entry (Trench 3)	850 +/- 30 BP	840 +/- 30 BP	Cal AD 1160–1260
361	Oak plank across the beam [360] (Trench 3)	920 +/- 30 BP	890 +/- 30 BP	Cal AD 1040–1220
218	Hazel charcoal fragment (Trench 2)	650 +/- 30 BP	630 +/- 30 BP	Cal AD 1280–1400
304/115	Wooden peg (Trench 3)	840 +/- 30 BP	800 +/- 30 BP	Cal AD 1190–1275

small stems or branches, but only one other piece had sufficient material present to offer any further significant interpretation. This was a hazel fragment determined to be five years old at the time of burning. Radiocarbon analyses were undertaken in order to ascertain dates for four of the timbers at the upstream and central sites, the hazel charcoal fragment and one of the pegs found in the river bed (see Table 1).

The samples for the dating of the large timbers were taken from wood below the surface, in order to minimise any contamination from later organic material. No sapwood was present and so the wood was felled at dates later than those indicated. However, the timbers sampled were not massive, and a ring count of the samples indicates that the difference is probably less than 30 years.

The results of the radiocarbon dating for the four timbers from both the upstream and central sites are compatible with a presumed construction date for the mill, based on the entry in the Newminster Chartulary, of between 1226 and 1245. The dating of the ash sample to the early or middle part of the thirteenth century, which overlaps with the licence date in the Chartulary, is worth noting. There is now no oak in the area and, as has been pointed out, some of the oak used displayed signs of re-use and may therefore have been felled elsewhere and at a rather earlier date than the construction of the mill. However, there are still ash trees growing within 200 m of the site and there are references to them being present in the eighteenth or early nineteenth centuries (Dixon 1903, 23). It is possible, therefore, that the ash was felled locally and used shortly afterwards: it may even postdate the initial construction phase, being part of a repair rather than a component of the original build.

The remains of six small stakes ([505]–[510]) were identified embedded in the rubble on the bank side of the upstream structure. These stakes represent three different taxa: alder [506, 507 and 510], birch [505 and 508] and hazel [509]. Their diameters vary up to 10 cm; one of the alders [507] and the hazel were both over 25 years old when cut. Alder [507] was unusual in having a group of narrower rings from about age 5 suggesting a period of poor growth; this was not seen in any of the other stakes possibly suggesting that this alder was from further afield or from a tree in a different microclimate (Huntley, 2012). In general, these taxa are associated with regeneration of woodland in a deforested area and it would seem reasonable

to suggest that the builders used whatever local material was readily to hand. Their presence can be compared with similar posts of hazel, birch and holly identified at the remains of the Norman mill dam at Hemington Fields, in Leicestershire (Clay and Salisbury 1990, 282).

Coins

Fig. 32 Reverse and obverse of the long cross penny of Henry III [303/1]. The inscription in the lower quadrant of the reverse is 'TON'. The obverse shows the king's hand holding a sceptre. (2:1)

Fig. 33 The Edward I penny [203/30]. (2:1)

Three coins or pieces of coin were recovered from the central site.

A small cut coin [303/1] was found in sandy silt [302] in the bank immediately above the masonry block [334]. This coin has been identified as a heavily clipped, cut silver, voided long cross penny from the reign of Henry III (fig. 32). It is probably of type 5c, dating to some time in the 1250s (Spinks number 1369 and North 993). The inscription on the reverse may be 'gilberT ON CAN', which would identify it as being minted in Canterbury, with the moneyer being Gilbert de Bonnington.

One half of a highly-corroded Henry III halfpenny [203/37] was recovered from the deposit [203] in the terrace forming the upper of part of the area between the two walls on the bank and orthogonal to the river. Also in this deposit was a well-preserved silver penny from the reign of Edward I [203/30], probably from Groups 3 or 4 (Spinks numbers 1387–98, and North 1016–27), dating it to between 1280 and 1289 (fig. 33).

A key

An adjacent deposit [201] yielded a medieval cast copper-alloy key [201/62], dated to *c.* 1200–1500 (fig. 34). The key, 10.0 cm long, has a lozenge-shaped loop with projecting knops at the corners, and a moulded double-collar at the base of the loop. The shank is sub-circular in section with a hollow terminal, below which is a cast integral bit consisting of a rectangular

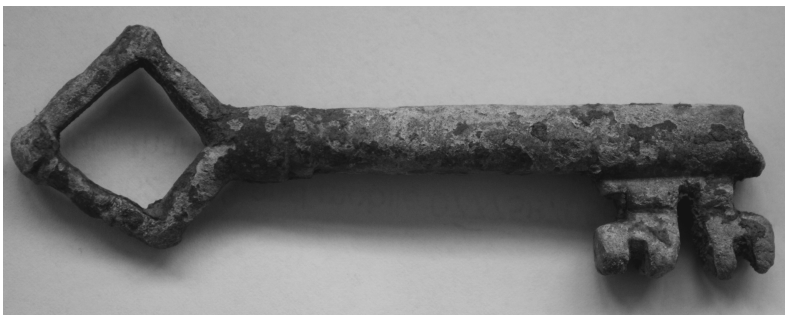

Fig. 34 The medieval key [201/62]. (1:1)

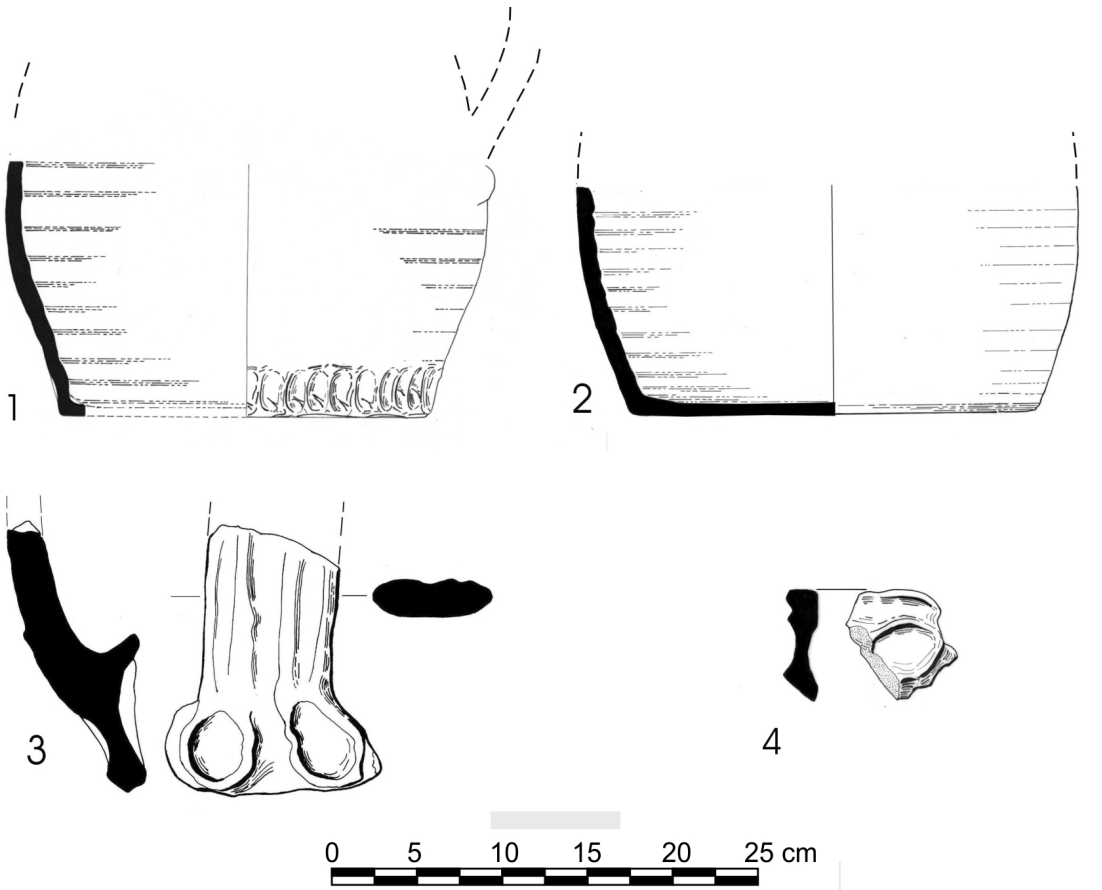

Fig. 35 Pottery: 1, Fabric Group (FG) 1; 2, FG 2; 3, FG 4 — all from Trench 2. 4, rim of a jug from Trench 3.

base from which emerges two h-shaped clefts, positioned back to back. These clefts have a wedged groove across the centre of their bases. Wear is visible on the bit and the hollow end of the shank, probably due to use, with further wear particularly visible on the loop and upper shank, reducing the size of the knops and the relief of the double collar (Collins 2013).

The lozenge-shaped loop occurs occasionally throughout the medieval period (Ottaway and Rogers 2002, 2867). Together with the hollow shank, the structure is most reminiscent of Type V keys (Ward-Perkins 1940, 138–41) which are usually dated to the fourteenth or fifteenth centuries. The symmetrical bit may suggest use from either side of the lock, as in a door rather than a chest.

Other metal

Four pieces of highly corroded metal were found at the southern end of the calculated line of the wheel shaft at a depth of 1.3 m below ground level. X-rays revealed no internal structure in two of them. A third (10 cm long) may be the remains of a large fastening nail or a tool,

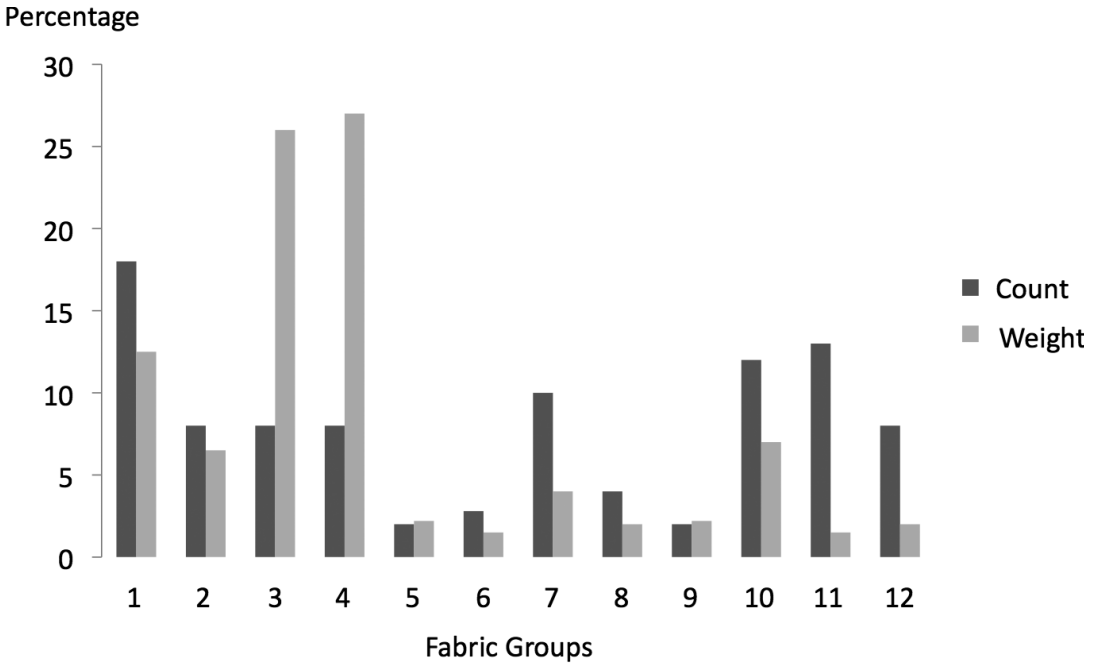

Fig. 36 The Trench 2 pottery assemblage, showing percentage quantities and weights of the fabric groups.

while X-rays of the fourth [222/98] revealed the object to be a metal hook. Subsequent cleaning suggested that this had been attached to a metal collar, which may in turn have been fastened to a wooden pole. More robust than a conventional fishing gaff, its function is unknown.

Pottery, by Jenny Vaughan (figs. 35–36)

The total quantity of pottery recovered from the four seasons of work was 141 sherds, weighing 1780 grams. The majority of the assemblage was from Trench 2 with only a small quantity (22 sherds) coming from Trenches 3 and 4. Most of the pottery (93 sherds) from Trench 2 was medieval and broadly dateable to the thirteenth century. The small post-medieval component from this trench suggested an eighteenth-century date. Medieval pottery was also recovered from the other two trenches: five sherds from Trench 3, and one from Trench 4. The remaining pottery from these trenches was later post-medieval (i.e. eighteenth- or nineteenth-century).

Trench 2: medieval assemblage. The pottery was sorted into ten fabric groups (FG). Seven of these contained fragments from only one or two vessels, whilst the other three had a wider range of types within them.

FG1, the largest group of sherds, was a pinkish-orange fabric with a mid-grey core. Some sherds had streaks of paler clay. Visible inclusions were sparse, medium-sized quartz grains. There were joining sherds of a vessel with a thumbed base (fig. 35, 1). The sherds are mostly unglazed, but

there are small spots and patches of glaze with a slightly larger patch on part of a thumbed pad; the lower part of a handle attachment. One or two of the non-joining sherds in this group, including two other base fragments, might be from other vessels.

FG2 was a smaller group, possibly also from a single vessel. The fabric was sandy, mid-grey with a paler internal surface and an oxidised (pinkish-orange) exterior with some red ferrous grits. A plain base was present and some sherds had patchy or decayed glaze.

FG3 consisted of ten, mainly large and joining, sherds from a base, probably of a jug (fig. 35, 2). This was similar to FG2 but the fabric was coarser with a sandpapery texture. The exterior was also a paler, pinkish buff with patchy and decayed glaze. Although the fragments joined they were quite abraded.

FG4 was a coarse, sandy iron-rich fabric, mid to dark grey or bright orange where oxidised. There was part of a large strap handle (fig. 35, 3) with a rather worn green glaze. The under surface of the handle was oxidised. This item was recovered in 2013, but a sherd found in 2011, with an iron stained vertical strip, appeared to be from the same vessel. Apart from two other small sherds with thin glaze, the other fragments in this group had oxidised exteriors. However, it is possible that some could be from the same vessel as the handle.

FG5 consisted of only three sherds, one a base. This was also an iron rich fabric, dark grey with bright orange margins and surfaces but with much finer well-sorted quartz sand inclusions.

FG6 consisted of four sherds of reduced green glazed pottery. Three had incised wavey lines and were probably from a single vessel. It is even possible that they belong with the large vessel family FG1.

FG7 was distinct from the preceding groups in having a buff and pink sandy fabric. That is, some sherds are buff, some pink, and some a mixture of the two. It is possible, again, that all the sherds are from a single vessel; they included three (unfortunately non-joining) jug rim-sherds and a base. Two sherds had a green-brown glaze and a horizontal ridge, probably running round the top of the shoulder of the vessel.

FG8 was a group of various other light firing wares, while FG9 consisted of the only sherds (three) in the assemblage that showed signs of burning or sooting. All appeared to be fairly coarse and iron-rich.

FG10 was a very miscellaneous group of mainly very small fragments, though it did contain two joining sherds from a base of a thick walled vessel. These were in a fabric similar to FG4 but not so iron-rich.

Trench 2: post-medieval pottery. Most of the sherds in the post-medieval component of the assemblage were very small, with red earthenware sherds (FG11) being the most numerous. Two were fragments of a 'pie-crust' press-moulded rim with internal white slip and a brown slip line. Two other small rims had white slip bands while another had internal slip-coating with brown mottling. There were two sherds of tin-glazed earthenware, the largest sherds being two joining fragments of Staffordshire-type slipware in a pale buff fabric with brown feathered decoration externally. There were also a few fragments of stoneware (of indeterminate type). Taken together, the group suggested an eighteenth-century date rather than anything later. (FG12 in fig. 36 covers all post-medieval pottery other than redware.)

Pottery from Trenches 3 and 4. A jug rim was found in Trench 3 (fig. 35, 4) in the same sandy buff fabric as FG7. There were also two abraded fragments in a white fabric with some worn green glaze, one of the sherds having an iron-stained strip. The other fragments from this trench and the single small sherd from Trench 4 were fairly undiagnostic but all are broadly of thirteenth- or fourteenth-century date. The remaining pottery from these trenches was later post-medieval (i.e. eighteenth- or nineteenth-century) and was mainly composed of white-glazed white earthenware fragments including some transfer-printed sherds.

Trench 2 Discussion. This assemblage is small and most of the medieval pottery could be assigned to one of only seven vessel 'families' identified (a family is a group of sherds including one or more form elements — such as. rim, base or handle — either joining or considered to be from the same vessel). Only one of the vessels here is represented by rim sherds; FGs 8, 9 and 10 are mainly miscellaneous small single sherds. This somewhat limits any interpretation of the material although it is of interest that none of the vessels is sooted. It is possible that they are all jugs but, although all the illustrated examples probably are, there is not enough of most of the vessels present to be certain. The group can be broadly dated to the thirteenth century, consistent with the known date for activity at the mill. The vessel 'families' probably belong to the latter part of the century.

The source of the pottery is unknown. There are some broad chronological trends in pottery in Northumberland, and by the later medieval period reduced green-glazed wares are common across the region, but earlier there seems to be a lot of variation from site to site. This is perhaps not surprising as medieval pottery production was not a large-scale industry and most pottery vessels were probably used within a relatively short distance of where they were produced. However, variations can be seen within Coquetdale itself, notably in comparing the material recovered from Low Trewitt and from Low Farnham, examined by the author. These groups are all small and it may be that the differences between them are simply due to different dates of production. To gain a better understanding of the production and distribution of pottery in Northumberland, more extensive research and excavation would be required, particularly in these upland areas.

Other ceramic finds, by Jenny Vaughan

Fourteen fragments of clay pipe were recovered altogether, all but one (a tiny fragment of bowl from Trench 4) were stem fragments, from Trench 2. With one exception these had fairly large bores, indicating dates in the seventeenth or early eighteenth century. The exception was a fragment marked TW & Co EDINB … The mark clearly refers to Thomas White and Co. who made pipes in Edinburgh between 1823 and 1876. The mark TW in an oval frame, often found on nineteenth-century clay pipe bowls, has occasionally been attributed to this maker. Thomas White may indeed have made TW pipes, but so did a number of other makers, most notably the Tennants of Berwick.

Stone

Between the walls defining the probable working area of the mill, a deposit largely made up of boulders extended across the whole of the southern part of the trench, dipping towards the centre. In this part of the trench two stones of note were recorded. The first, found 0.60 m to the west of the eastern (downstream) wall at its northern extent, and at the same level as the top of the wall, was a large piece of sandstone [207/23], flattened on both surfaces, measuring 0.54 m on its longest axis and consistently 0.12 m in thickness. One surface displayed signs of tooling and some limited rotational abrasion while the other exhibited numerous grooves and notches. The majority of these are straight although a few are slightly curved, suggestive of tool sharpening rather than natural wear. Part of one edge of the block was also tooled and curved, and probably formed the remains of a circular hole of about 17 cm diameter cut through the block (fig. 37). This, together with the consistent thickness of the block and tool-

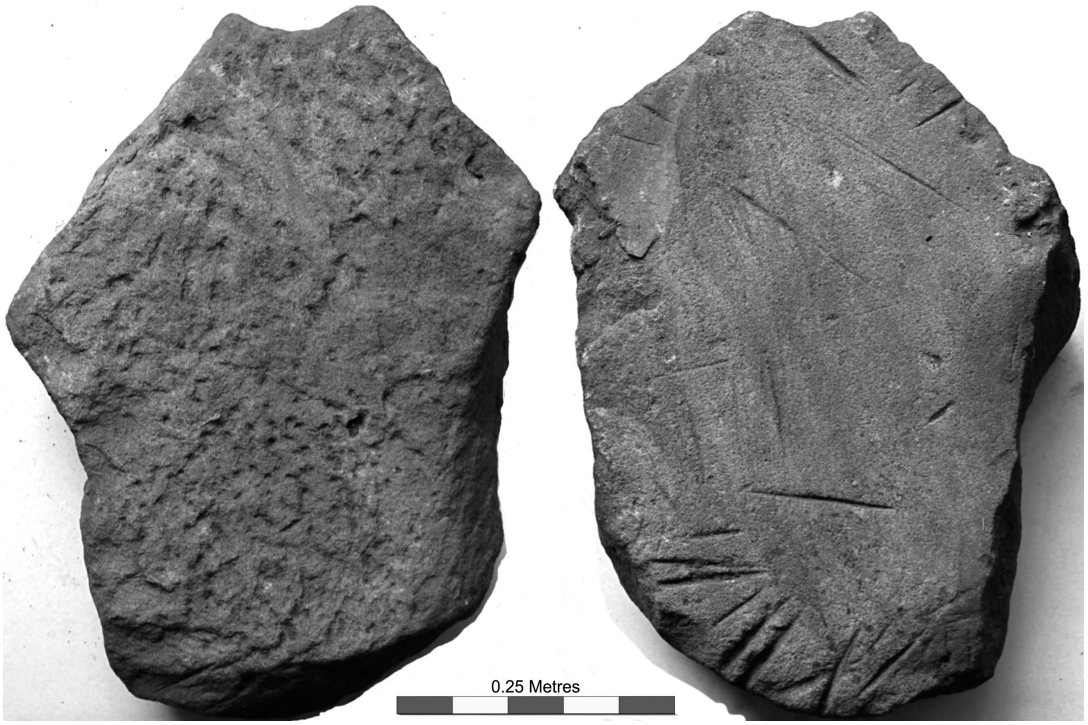

Fig. 37 The two sides of the stone [207/23] (1 m scales).

ing on one surface, suggests that it is a fragment of millstone which had been subject to secondary use.

A second stone [209/22], found at greater depth within a metre of the south end of the trench and some two metres from the west wall, was a rectangular tooled block, measuring 56 cm by 31 cm by 21 cm; this was made of a similar material and displayed dimensions and patterns of tooling similar to the blocks forming the wheel pit. Like those blocks, it had one well-finished face, presumably the front, whilst the opposite face appeared to have been left as quarried.

Finally, as mentioned above, a second probable millstone fragment was found in the bank on top of beam [360] (fig. 38). Although not removed completely, the stone was tilted to reveal a tooled reverse face that was substantially different from the front face (fig. 39).

CONCLUSIONS

The investigation has revealed elements of both archaeological and economic importance. From an archaeological perspective, structural and artifactual evidence, combined with radiocarbon analyses of the timbers, securely date the origins of the site and its components to the later twelfth and thirteenth centuries and are sufficient to establish a probable identification of the remains as those of the fulling mill known from documentary records.

Although the masonry cannot be dated *per se* there is consistent medieval dating for timbers immediately upstream and downstream from it and it seems improbable that any subse-

Fig. 38 Stones and boulders in the bank and the shaped sandstone [311/116] placed on top of beam [360] (1 m scales).

quent development of the mill would have taken such care over inserting a new structure. As has been described elsewhere (Carlton and Jones 2014, 235–7), there is evidence that after 1300 the social conditions in the area were not conducive to investment of this kind. Unsurprisingly, given its position entirely within a watercourse, there was no reliable finds evidence to date the use of the wheel pit itself: only one piece of thirteenth-century pottery was identified and most of the glass and pottery was of nineteenth-century origin, probably the result of fluvial transport and deposition.

Two pieces of probable millstones were found at the site, but some reasons for their presence have been discussed above. One shows signs of re-use, while the other was deeply embedded in the bank where it seems to have been placed as a structural support. This may mean that they predate the mill we have been investigating, perhaps originating in a smaller, vertically-axled mill on the same site or upstream of it. It seems most unlikely, based on the nature of the terrain and known preponderance of sheep farming in the area, that grain would have been produced in sufficient quantities to merit the construction of a relatively high-capacity horizontally-axled mill. A number of other factors tend to identify the site as that of a fulling mill rather than a corn mill.

First, the two drains leading into the working area of the mill are considered more likely to relate to the functional requirements of a fulling mill than a corn mill. Second, the lightweight wooden structure in the river immediately below the wheel pit, assuming concurrency of use between the two, is also more difficult to explain in the context of a corn mill than a fulling

mill. Finally, the presence of charcoal remains on and around the line of the axle is also more likely to have been produced by activities integral to the process of fulling, although it is accepted that the charcoal could equally be the residues of campfires in the immediate post-abandonment phase of the site.

The early date, and the excellent state of preservation of the structures encountered, make the Barrowburn mill very significant, particularly in view of the rarity of such remains in Britain. Amongst dateable sites of known or likely fulling mills, this is an early example. It predates, for example, the fulling mill at Fountains Abbey which was probably built around the end of the thirteenth century (Coppack 1986, 59), and is contemporary with those documented at Tarset and Wark in North Tynedale. Amongst numerous medieval fulling mill sites in the Lake District, Carus-Wilson (1954, 195) identified several as being in existence by the early fourteenth century, but comparing her work with a more comprehensive list, it seems that only later were mills built high in the hills at sites comparable with Barrowburn (Davies-Shiel 1992, 13–15).

The excavation is one of only a few conducted in Britain on the site of a medieval mill and it is very unusual to find a masonry wheel pit of such quality from that period; indeed, the authors know of no other high quality masonry-lined wheel pit of the period in such good

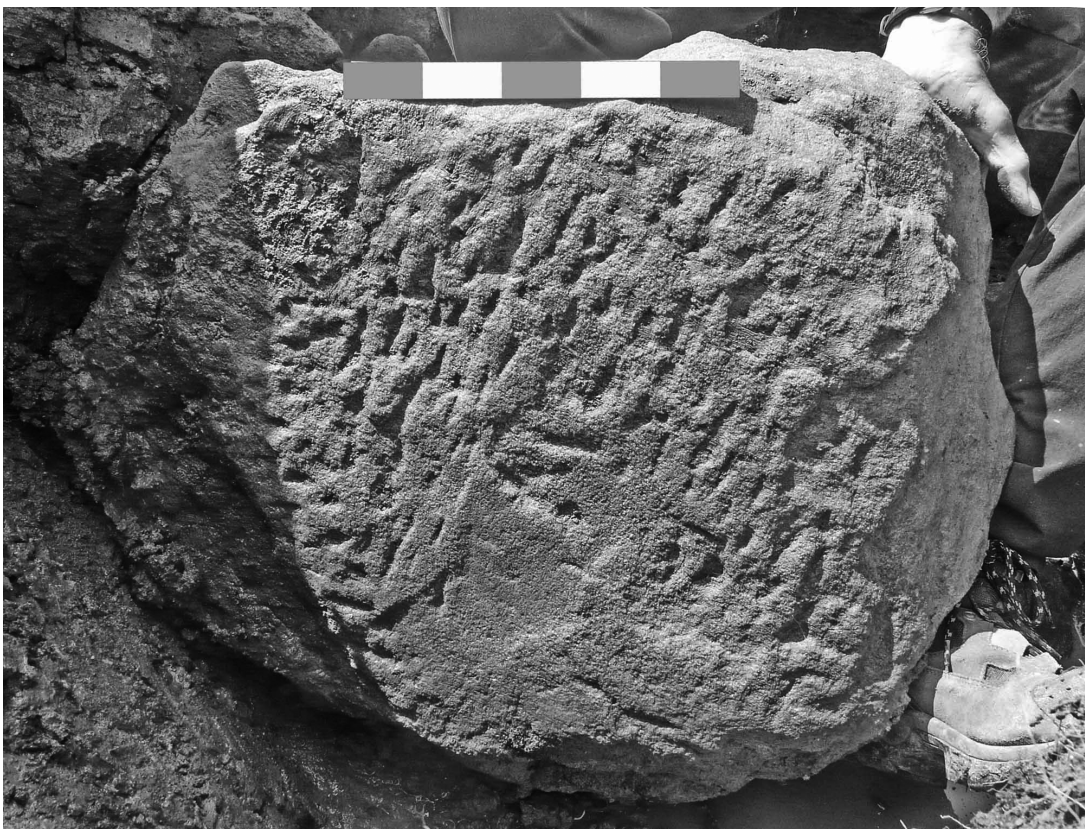

Fig. 39 The reverse of [311/116] (25 cm scale).

condition. Sufficient components of the pit remain to provide unequivocal information about the nature of the wheel it held, while the wheel's low breast-shot configuration identifies it as probably the earliest of its kind to be found in Britain, and certainly much earlier than the normally accepted date for the introduction of such wheels. There is also good evidence for the infrastructure that surrounded the wheel itself — the water supply and the structure in the outflow from the pit where cloth may have been rinsed after the fulling process. It is likely that the working area of the putative fulling mill was situated adjacent to the revetment on the ancient riverbank. This positioning with respect to the calculated line of the wheel shaft potentially provides insight into the layout and operating mechanism of medieval fulling mill machinery.

From an economic and social point of view, the rediscovery of the mill provides important evidence for the commercial importance of the valley in the thirteenth century. While it was already known that Newminster Abbey had accrued substantial landholdings in the area and probably maintained large flocks of sheep, the presence of a fulling mill would indicate that the local inhabitants were responsible for at least the major part of a full-cycle cloth production industry, from shearing, spinning and weaving through to fulling and perhaps beyond. The fact that the Abbey was prepared to invest in such an industry testifies to its ambition for the area. Whether their ambitions were fully realised seems doubtful, however, since from 1296 the Anglo-Scottish conflict laid waste to the area. This, and other external forces such as famine and plague, probably led to the mill being abandoned in the fourteenth century. Subsequently, however, it was never redeveloped, allowing the wheel pit and associated features to survive in relatively good condition.

ACKNOWLEDGEMENTS

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