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with contributions from

H M Appleyard, Michael Baillie, David Barker, F W B Charles, Susan Colledge, Elisabeth Crowfoot, Glynis Edwards, Peter Ewence, Daryl Fowler, James Greig, Harwell C14 Laboratory, Louise James, Lisa Moffett, Carole Morris, Victoria Nailor, Barbara Noddle, Patrick Ottaway, E R Sayer, the late F W Shotton, I Thomas, the late J H Thornton, David Williams, Susan M Wright

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**Cover illustration**

*Tamworth in the Anglo-Saxon period. The mill is lower right, and the palace complex is in the centre of the picture. Reproduced with kind permission from a painting by Richard Bryant.*

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(fuller version for 1978 in MF)

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## Summary

The report describes rescue excavations in 1971 and 1978 in the south-east corner of Tamworth, outside the Saxon defences, but just inside (and incorporating part of) the medieval town ditch.

The first substantial activity in the area was the construction of a horizontal-wheeled watermill in the mid 9th century AD or earlier, powered by a leat which drew water from the River Anker. This first mill fell into disuse, either because it was destroyed or more probably because it developed water leakage.

The second mill was built on the residues of the first, and is dated by dendrochronology to the mid 9th century or possibly a little later. It also was of the horizontal-wheeled type, with a millpool at a higher level, fed by a reconstructed new leat. Substantial remains survived of this mill, including the foundations of the millpool, wheelhouse, and outfall revetment; Bolebridge Street was carried across the leat by a wooden bridge.

The remains are notable not only for their contribution to molinology but also for their contribution to our knowledge of major Anglo-Saxon carpentry techniques. Among the finds were the sole-tree of the mill, with its steel bearing; one of the wheel-paddles; many fragments of millstones, of local stone and imported lava; fragments of the clay bed in which the lower millstone was set; and the residues of lead window-cames. Grain and grain impressions include oats and possibly barley.

The second mill was destroyed by fire. After some lapse of time, the area it had occupied was sealed by metalling, many of the timbers were robbed, and timber and stone roads were laid down, possibly leading to the river bank. Other areas of gravel spread are associated with Stamford ware and other pottery of the later 11th-13th centuries.

The leat area was filled in, and a bank or causeway carried Bolebridge Street across it. An associated ditch, draining eastwards, helped to keep this from becoming waterlogged.

The medieval town ditch was dug across the southern part of the site, in more than one phase. Medieval occupation in the area included a possible jetty close to the then bank of the River Anker.

The ditch filled with silt and rubbish in the 13th century and later. From the later medieval period onwards, following land reclamation there was considerable industrial activity, principally of metal-working, and the processing of animal products.

In post-medieval times, metal-working is represented by a series of hearths and furnaces. Buildings were erected over the area, as 70-74 Bolebridge Street, which survived until 1971.

Apart from the Saxon finds, there is a useful series of medieval and later pottery and a valuable range of environmental data from post-mill contexts.

## Résumé

Ce rapport décrit les fouilles de sauvetage de 1971 et 1978 au coin sud-est de Tamworth, en dehors des dèfenses anglo-saxonnes, mais juste à l'intérieur du fossé médiéval de la ville (et en incorporant une partie).

La première activité importante de la région fut la construction d'un moulin à eau à roue horizontale au milieu du 9ème siècle ou plus tôt, actionné par un bief qui prenait de l'eau de la rivière Anker. On cessa d'utiliser ce moulin, soit parce qu'il fut détruit, ou plus probablement parce qu'il a commencé à fuire.

Le deuxième moulin fut construit sur les restes du premier; la dendrochronologie lui attribue une date du milieu du 9ème siècle ou peut-être un peu plus tard. Il était également du type à roue horizontale, avec un réservoir à un niveau plus élevé, alimenté par un bief neuf reconstruit. Il reste des vestiges considérables de ce moulin, comprenant les fondations du réservoir, de la cage de la roue et du revêtement de la décharge. Un pont en bois amenait Bolebridge Street au-dessus du bief.

Les vestiges sont remarquables non seulement pour ce qu'ils contribuent à l'étude des moulins, mais aussi pour ce qu'il nous apprennent des principales techniques de charpenterie des Anglo-Saxons. Parmi les découvertes se trouvaient la plaque d'assise du moulin avec son support en acier; une des aubes de roue; de nombreux fragments de meules, en pierre locale et en lave importée; des fragments de la plateforme d'argile dans laquelle était placée la meule gisante; et les restes de résille de fenêtre en plomb. Le grain et les impressions de grain comprennent l'avoine et peut-être l'orge.

Le deuxième moulin fut détruit par un incendie. Apres quelque temps, l'endroit où il se trouvait fut empierré, de nombreuses poutres furent enlevées, et des routes de bois et de pierre furent construites, allant peut-être au bord de la rivière. D'autres zones de gravier sont associées à la céramique de Stamford et autre

céramique datant de la fin du 11ème siècle au 13ème siècle.
La zone du bief fut remblayée et un remblai ou une chaussée amenait Bolebridge Street de l'autre côté. Un fossé associé, qui se déchargeait vers l'est, empêchait la chaussée d'être trop détrempée.
Le fossé de la ville médiévale avait été creusé en plusieurs stades, au travers de la partie sud du site. L'occupation médiévale de cette zone comprenait ce qui était peut-être une jetée près de ce qui était alors la rive de la rivière Anker.
Le fossé se remplit de limon et d'ordures au 13ème siècle et plus tard. Après la fin de la période médiévale, la terre ayant été assainie, il y a eu énormément d'activité industrielle, principalement la métallurgie et le traitement de produits d'origine animale.
Aux époques post-médiévales, la métallurgie est représentée par une série de foyers et de fourneaux. Des bâtiments, qui ont survécu jusqu'en 1971, furent construits au-dessus de cette zone, dont l'adresse était 70-74 Bolebridge Street.
En dehors des découvertes anglo-saxonnes, il y a une série bien utile de céramique médiévale et ultérieure, et une gamme de données sur l'environnement, dans des contextes "après-moulin", qui a beaucoup de valeur.

## Zusammenfassung

Dieser Bericht beschreibt die Rettungsgrabungen, die 1971 und 1978 im Südwesten von Tamworth, in einem Gebiet außerhalb der sächsischen Befestigungen, aber noch gerade auf der Innenseite des mittelalterlichen Stadtgrabens (ein Teil von ihm war miteinbegriffen) durchgeführt worden sind.
Die erste greifbare Aktivität auf diesem Areal begann in der Mitte des 9. Jahrhunderts oder früher mit der Anlage einer Mühle mit horizontalgelagertem Wasserrad, die ein Muhlkanal, der aus dem Anker gespeist wurde, antrieb. Diese erste Mühle wurde aufgegeben, entweder weil sie zerstört worden war, oder aber, was wahrscheinlicher ist, weil Wasserverlust eintrat.
Die zweite Mühle wurde über den Resten der ersten errichtet. Dendrochronologie datiert sie in die Mitte des 9. Jahrhunderts oder möglicherweise etwas später. Sie gehörte ebenfalls zum Typ mit horizontalgelagertem Wasserrad; sie hatte einen höher gelegenen Mühlteich und wurde durch einen neuen Muhlkanal gespeist. Von dieser Mühle sind beträchtliche Reste erhalten, zu denen die Fundamente des Mühlteiches, das Radgehäuse und die Ausflufußabstützungen gehören. Bolebridge Street überquerte auf einer Holzbrücke den Mühlkanal.
Diese Überreste sind bemerkenswert nicht nur durch ihren Beitrag zur Mühlenkunde, sondern auch im Bezug auf den Beitrag, den sie zu unserem Wissen über die bedeutenden angelsächsischen Zimmertechniken liefern. Unter den Funden befanden sich der Sockelbalken der Mühle mit seinem Stahllager, einer der Schaufelkammern, mehrere Bruchstucke von Mühlsteinen aus örtlichem Gestein and eingeführter Lava, Teile des Lehmbettes, in das der Bodenstein gesetzt war and die Übereste von Fensterblei. Unter den Getreidefunden und -abdrücken befanden sich Hafer and möglicherweise Gerste.
Die zweite Mühle fiel einem Brand zum Opfer. Nachdem einige Zeit verstrichen war, wurde das Mühlengelände mit Schotter überdeckt; viele der Bauhölzer wurden geraubt and Holz- und Steinwege angelegt, die möglicherweise zum Fluß hinunter führten. Weitere schotterbedeckte Areale sind mit Stamford Ware and anderen Töpferwaren aus dem späten 11. bis zum 13. Jahrhundert verbunden.
Der Mühlkanal wurde zugeschuttet and die Bolebridge Street überquerte ihn auf einem Erdwall oder Damm. Ein damit verbundener Graben entwässerte nach Osten and bewahrte das Gebiet davor zu versumpfen.
Der mittelalterliche Stadtgraben wurde über dem südlichen Teil der Fundstelle über mehrere Phasen hin ausgehoben. Zu der mittelalterlichen Nutzung dieses Gebietes gehörte ein möglicher, dicht am Ufer des Anker gelegener Landesteg.
Der Stadtgraben füllte sich im 13. Jahrhundert und spater mit Schlamm und Abfällen. Vom ausgehenden Mittelalter an und im Anschluß an Landrückgewinnung bestand auf dem Gebiet beträchtliche Gewerbetätigkeit in Form von hauptsächlich Metallverarbeitung sowie Verarbeitung von Tierprodukten.
In der Neuzeit waren eine Reihe von Essen and Schmelzöfen Zeugen für Metallverarbeitung. Auf dem Areal wurden dann als die Nummern 70 - 74 Bolebridge Street Gebäude errichtet, die bis 1971 bestehen blieben. Abgesehen von den sächsischen Funden, ergaben sich nützliche Serien von mittelalterlichen und späteren Töpferwaren sowie wertvolle Umweltdata aus der Zeit nach der Aufgabe der Mühle.

# Preface

'Can a man', he added, rising into enthusiasm as he spoke, 'or even a beast, look at that thing there, which they have the impudence to call a corn mill, without trembling to think that corn should be intrusted to such a miserable molendinary? The wretches are obliged to have at least fifty in each parish, each trundling away upon its paltry mill-stone, under the thatch of a roof no bigger than a bee-skep, instead of a noble and seemly baron's mill, of which you would hear the clack through the haill country, and that casts the meal through the mill-eye by forpits at a time!'

'better pay the half of the grist to the miller, to have the rest grund in a Christian manner, than put good grain into a bairn's whirligig'.

'Look at it, I say - it's just one degree better than a hand-quern - it has neither wheel nor trindle - neither cog nor happer - it canna grind a bickerfu' of meal in a quarter of an hour, and that will be mair like a mash for horse than a meltith for man's use'

Scott 1879, 210-11
(see also Fig 104)

# 1 Introduction

## 1.1 A summary of the history and archaeology of Tamworth with special reference to the Anglo-Saxon period (Figs 1, 2; Table I)

by RM

A detailed account of Tamworth would require more space than can be made available here, but a summary of some aspects of the development of the town will provide an historical, topographical, and archaeological context for the Anglo-Saxon mill.

Lower Palaeolithic artefacts have been found near Tamworth at Drayton Bassett and Shenstone (Shotton 1972-3). Chipping floors, flint scatters and an increasing number of finds of Neolithic implements imply more occupation of the region than was once suspected (Meeson 1979, 104) and barrows are known or suspected at Elford (SK19390924), Alrewas (SK182140) and Tamworth (SK202023) (Staffordshire SMR PR Nos 0116, 1391, and 1310). Tamworth is sited in what was once a border zone between the Iron Age territories of the Cornovii and the Coritani (Webster 1975, 20ff). It has been suggested that the Glascote gold alloy torc, found within the modern borough of Tamworth, may have been made in the area where it was found and that there was possibly a distinct tribal unit centred on the Tamworth/Lichfield area (Rivet 1966, 101-3, 109-10; Painter 1971, 1-6).

Whatever the tribal allegiance of the Iron Age and Romano-British populations might have been, there is abundant evidence of their rural settlements. A cropmark complex comprised mainly of settlement enclosures and intersecting field systems, extending north and south of Tamworth along the valley of the River Tame, points to a strong rural economy (Staffordshire and Warwickshire Sites and Monuments Records).

*Letocetum,* 11km west of Tamworth, was the main Romano-British settlement in the area. If there was a Roman posting station midway between *Letocetum* and *Manduessedum,* its most likely site would be astride the Watling Street in the Two Gates/Wilnecote area south of Tamworth town centre, but its exact location has not yet been identified. Part of a double-ditched Romano-British enclosure 1.6km west of Tamworth town centre was partially excavated in 1976 and was provisionally interpreted as a farmstead settlement (Simpson 1986). However, it was strategically sited close to a putative early trackway and a ford across the River Tame (Meeson 1976, 8-10), so it is just as likely that this was a fortlet. In addition to a few casual finds of Romano-British artefacts in the area, building material of Roman type has been found in a residual context adjacent to Bolebridge Street, Tamworth, close to the site of the mill. The presence amongst this material of tile and painted plaster implies the former existence of something more than a native settlement, but the function of the structure which is implied by these finds remains open to speculation (Young 1971,239).

In the late 7th century Ethelred agreed to a land transaction while *in cubiculo proprii vici qui nominatur Tomtun* (Stenton 1933, 315; Gould 1968-9a, 37). It was Stenton who suggested *(op cit)* that *Tomtun* should be identified with Tamworth and no alternative site has been offered since he put forward that proposition in the 1930s. It is arguable that there was either a palace or *monasterium* at *Tomtun* by or before the end of the 7th century. It is clear from charter evidence that, thereafter, the site was adopted as a favourite residence of the Mercian royal household. The Mercian *bretwaldas* apparently stayed regularly at Tamworth for Christmas and Easter from 781 or before until at least 857 (Table I).

During the period in which surviving charters were witnessed at Tamworth the more usual terms of reference to the place seem to have been *vicus* and *locum.* Hence a charter dated Christmas 814 was signed *in vico celeberrimo qui vocatur Tompordig* (BCS 350). A grant to the Bishop of Worcester in AD 855 was witnessed *in vico qui Tompeordin* (BCS 488). *Vicus* might represent OE *wic* which can be read in a number of ways including dwelling and village *(ex infra* Professor Whitelock). *In loco qui dicitur Tomanpordie* was an alternative form of reference to Tamworth in 841 (BCS 436); a grant of land in Kent was signed at Easter 808 *in loco celeberrimo quae a vulgo vocatur Tomepordig* (BCS 326). Reference to a celebrated place (locum) might imply more than a palace complex which in isolation could have been termed *villa regalis* or *villa regis.* Despite the political and administrative importance of the palace there is no evidence that Tamworth was a significant urban or commercial centre during this period.

It may be an accident of survival, or the result of changing habits on the part of the scribes, but only two of Offa's charters refer to Tamworth, both of them dated Christmas 781, and only three of the surviving Tamworth charters were witnessed by Cenwulf. Almost half of the charters specifically witnessed at Tamworth belong to the reign of Beorhtwulf and these date from 840 to 849. All but

**Table I Anglo-Saxon charters witnessed at Tamworth**

| Date | BCS | Sawyer | Issued by | Reference to Tamworth | Comments |
|---|---|---|---|---|---|
| Christmas 781 | 239 | 120 | Offa | in sede regali sedens . . . In Tamouurdie | |
| Christmas 781 | 240 | 121 | Offa | in regali palatio in Tamouuorthige | Spurious: (authentic basis?) |
| 799 | 293 | 155 | Cenwulf | in vicu regio aet Tomepordige | Original |
| Easter 808 | 326 | 163 | Cenwulf | in loco . . . vulgo vocatur Tomepordig | Genuine and contemporary |
| Christmas 814 | 350 | 172 | Beorhtwulf | in vico celeberrimo qui vocatur Tompordig | Au thentic |
| Easter 840 | 430 | 192 | Beorhtwulf | in pascha ad Tomepordie | Finberg 1961, No 65: authentic. Opinions on authenticity vary |
| Christmas 841 | 432 | 196 | Beorhtwulf | in natali domini aet Tomanpordie | |
| Christmas 841 | 433 | 195 | Beorhtwulf | in celebri vico Tomeuuorthie | Spurious. Based on Sawyer 193 |
| Christmas 841 | 434 | 193 | Beorhtwulf | in celebre vico on Tomepordie | Finberg 1961, No 249: authentic |
| 841 | 436 | 194 | Beorhtwulf | in loco qui dicitur Tomanpordie | Finberg 1961, No 67: authentic |
| Christmas 845 | 450 | 198 | Beorhtwulf | in loco regali qui dicitur Tomeuuordig | |
| 849 | 455 | 199 | Beorhtwulf | In famosae loco qui dicitur Tomepeording | |
| 855 | 488 | 207 | Burghred | in vico qui Tompeordin | Au thentic |
| 855 | 489 | 207 | Burghred | in vico celebre qui a multis vocitatur Tomanpordigne | Authentic: another form of BCS 488 |

three of the known Tamworth charters belong to the half-century from 808 to 857. Although it would be going beyond the evidence to suggest that there was a proven connection between the palace and the mill, there is a striking coincidence between the above dates and the period within which the first mill may have been in use. If, as the dendrochronological dates seem to suggest, the second mill was constructed around c 855 ± 9, it would belong to the time of Beorhtwulf or his successor Burghred.

It is not clear how long the palace survived at Tamworth but it is apparent that the place continued to play an important role in the Anglo-Saxon hegemony. There may have been an hiatus during the period of the Danelaw when Tamworth, sited 2km north of the Watling Street, lay just inside the fringe of Danish territory. However, in 913 Æthelflæd built new *burh* defences which followed the boundary of an earlier large enclosure (see topography below). When she died there in 918 her brother Edward occupied the borough 'and all the nation in the land of the Mercians which had been subject to Aethelflaed submitted to him...' (ASC 918).

It is not until the reign of Athelstan that the first coins appear which can be firmly attributed to a mint at Tamworth, and Athelstan's Laws issued at Grately (Hampshire) declared that no one was to mint money except in a town (Danson 1969-70, 34; Whitelock 1979,420). If these laws applied as much to Mercia as to Wessex the presence of a mint at Tamworth would seem to imply that, by Mercian standards, the place was regarded as a town at that time. Notwithstanding this, the archaeological and

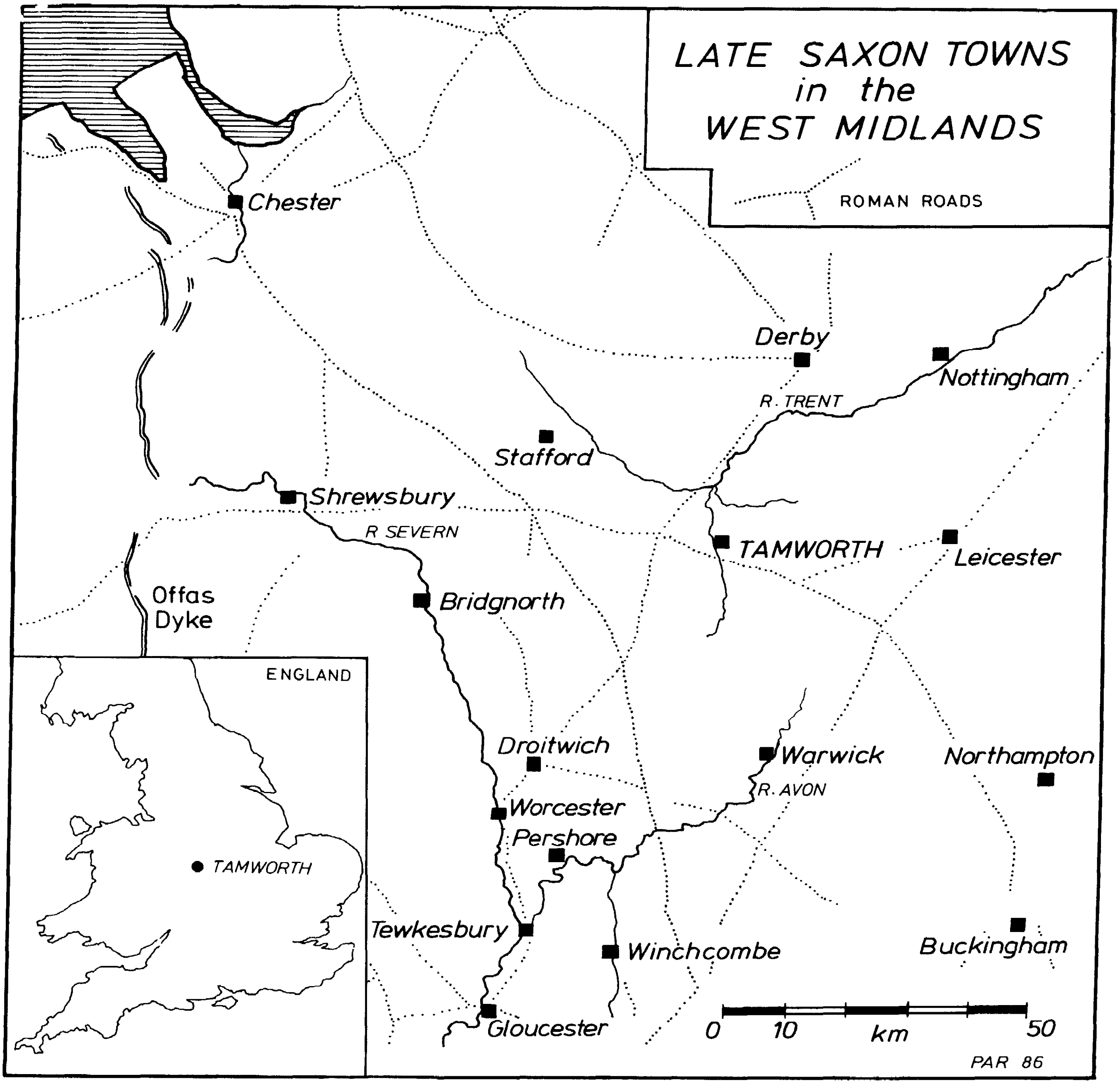



*Figure 1 Late Saxon towns in the West Midlands*

topographical information discussed below implies that the rectilinear elements in the street plan, characteristic of urban settlement planning, were not introduced until the Norman period.

Shortly after Edmund succeeded Athelstan in AD 940 Tamworth was stormed by Olaf the Dane (ASC 940). Olaf might have been attracted by the presence of a mint, the prospect of taking a person for whom a ransom might be demanded, or by the overall strategic importance of the settlement.

So far at Tamworth there are no proven criteria by which the 8th or 9th century settlement can be regarded as an economically or commercially significant town. Excavations have yet to provide evidence of a substantial population or numerous regulated plots and houses of urban type. There is no evidence of a mint before the reign of Athelstan. Although an extramural market place has been identified near the gate in Lichfield Street it probably did not exist in the 8th or 9th century (Meeson

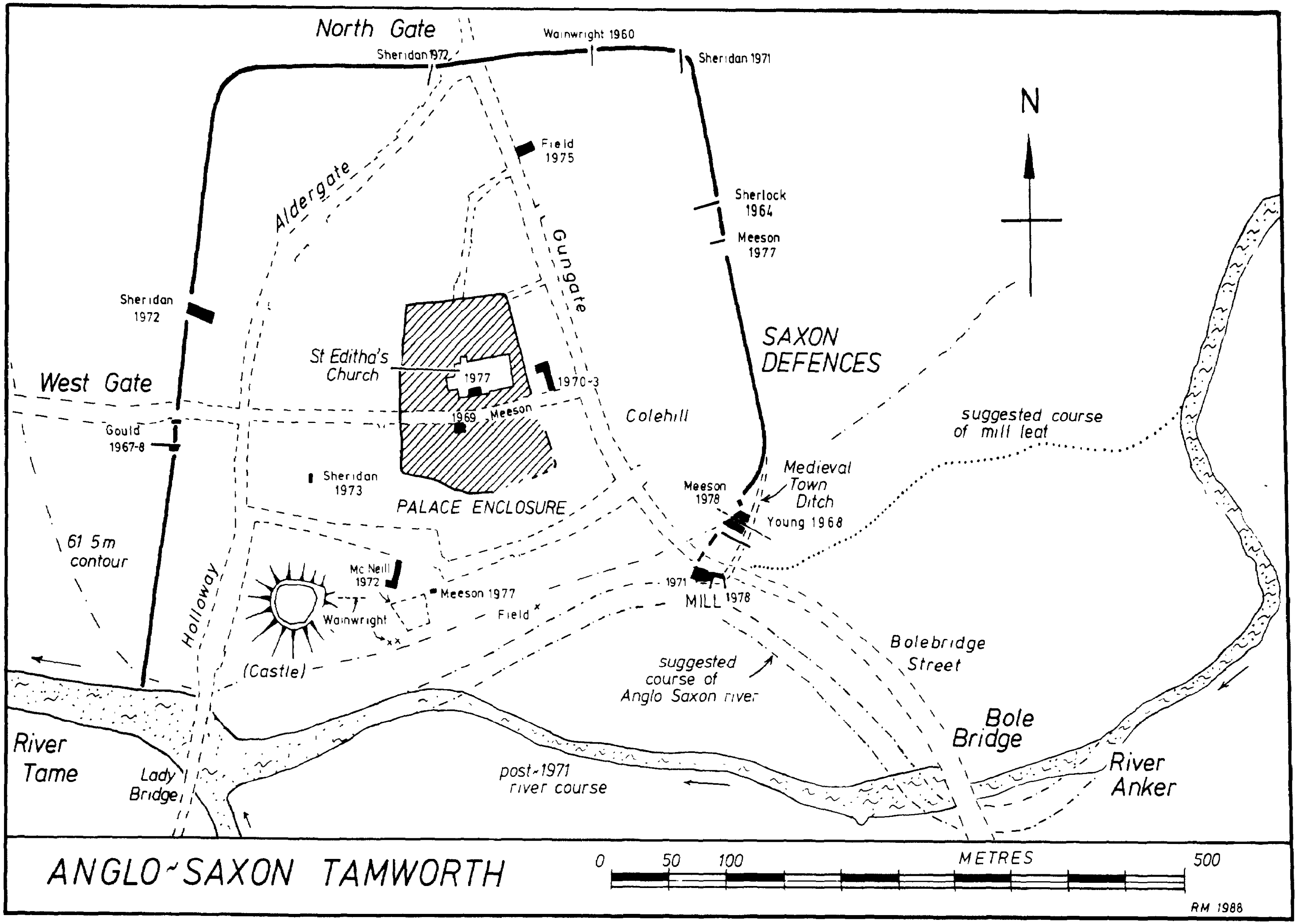



*Figure 2 Anglo-Saxon Tamworth, showing principal Anglo-Saxon and medieval features*

1979, 20, 42). The palace served periodically as an administrative centre but there is nothing to suggest that a significant administrative function devolved upon the overall settlement.

The reason why, despite the former significance of the palace, Tamworth was not destined to become a county town has never been fully explained: one or a number of factors may have been involved. The fact that the county boundary between Warwickshire and Staffordshire once divided the former *burh* almost exactly into two might suggest that in the 10th century Stafford and Warwick were jointly more important militarily than Tamworth (Gould 1971-2, 41-2) but it could equally imply that both counties were made responsible for maintaining the *burh* there. A lack of commercial or industrial development at Tamworth in the 10th century, a desire by Wessex to minimize the importance of a former Mercian centre, and the relative geographic proximity of Warwick, Stafford and Tamworth are other possible factors.

Excavations by Wainwright, Sherlock, Gould and Sheridan between 1960 and 1972 confirmed the course of the Anglo-Saxon defences around the *burh* (Gould 1967-8, 1968-9b; Sheridan 1972-3, 1973-4). Following his excavations of the west boundary of the *burh* in 1967 and 1968, Gould argued that the earlier of two ditches may have related to an enclosure around Offa's palace (Gould 1968-9a, 37). Since then a smaller enclosure has been identified by a detailed contour survey and the close study of property boundaries. It is this small enclosure at the centre of the *burh* which is currently supposed to represent the site of the palace. It seems significant that the proposed palace enclosure is sited concentrically within the *burh* and that the two enclosures are the same shape. It is arguable on topographic grounds that the earliest ditch in Gould's sections, encompassing the large outer enclosure, was broadly contemporary with the boundary of the smaller palace enclosure (Fig 2) (Meeson 1979; Carver 1987,118).

Excavations within the smaller 'palace' enclosure in 1969 coincided with part of a structure with massive post-pits; though likely to be pre-Conquest it was not reliably dated (Meeson 1971). Several Anglo-Saxon structures were recorded during excavations in 1970 near the east boundary of the 'palace' enclosure. Structural analysis, and a small excavation in 1977, suggest that the parish church of St Editha, near the centre of the 'palace' enclosure, may encompass the remains of two pre-Conquest structures (Meeson 1979).

## 1.2 The topography of Tamworth and its area, with special reference to Bolebridge Street (Figs 3, 4)

The rivers Blithe, Mease, Anker and Tame flow into a shallow basin in the south-east corner of Staffordshire before they join the River Trent which in turn passes north through Burton upon Trent towards Derby. Tamworth, Lichfield, Burton upon Trent and Rugeley are situated at the edges of this basin. Tamworth is sited on a spur of land which overlooks the confluence of the rivers Anker and Tame. 'The Midland Way', a postulated prehistoric track, passes through the north edge of the modern borough (Meeson 1976) and the Roman Watling Street extends across the south side of the town.

A track from the south-west, probably of prehistoric origin, crossed the River Tame by a ford west of the confluence with the River Anker, and passed through a hollow-way across the spur of land over which the town centre lies. It is formalized in the present townscape as Holloway, Silver Street and Aldergate. Bolebridge Street, Colehill and Gungate together probably represent the course of another early track which approached the site of Tamworth from the south-east by way of a ford across the River Anker. Aldergate and Gungate, representing the course of the two tracks, join at the point where the north gate of the Anglo-Saxon *burh* was established and proceed north from there by way of a hollow-way now known as Upper Gungate.

The proposed palace enclosure is sited at the summit of the spur of land which overlooks the rivers Anker and Tame, and within the triangle of land between the rivers and the two tracks described above. The palace enclosure was situated at the centre of a much larger *burh*. The *burh* was first delimited by an insubstantial ditch and bank which was finally replaced in 913 by a ditch fronting a flat berm, a substantial turf and timber rampart and an intramural road (Gould 1969, 32ff).

As Gould has demonstrated the location of a west gate through the 10th century defences, Lichfield Street and Church Street were probably laid out at some stage in the development of the Anglo-Saxon *burh (op cit)*. However, the other two main streets in the town plan - Market Street and George Street - skirt the edge of the castle bailey and are probably post-Conquest elements in the townscape.

The line of the defences at the south-east corner of the *burh* is less precisely defined than elsewhere and the sequence of development of that part of the borough boundary is apparently more complex than the rest of the circuit (Young 1971, 239). Nevertheless, it is clear that both the Anglo-Saxon and medieval ditches there return sharply to the west. So far no evidence has been found for a southern rampart and it is assumed that the rivers would have formed an adequate boundary on that side of the *burh*. The eastern arms of the town ditches probably turned west to link with the former course of the River Anker at its closest point to the town centre, and to cross Bolebridge Street at a right angle rather than obliquely. The watermill was apparently sited in the angle between the south side of Bolebridge Street, the south-west end of the return of the east defences, and the river to the south.

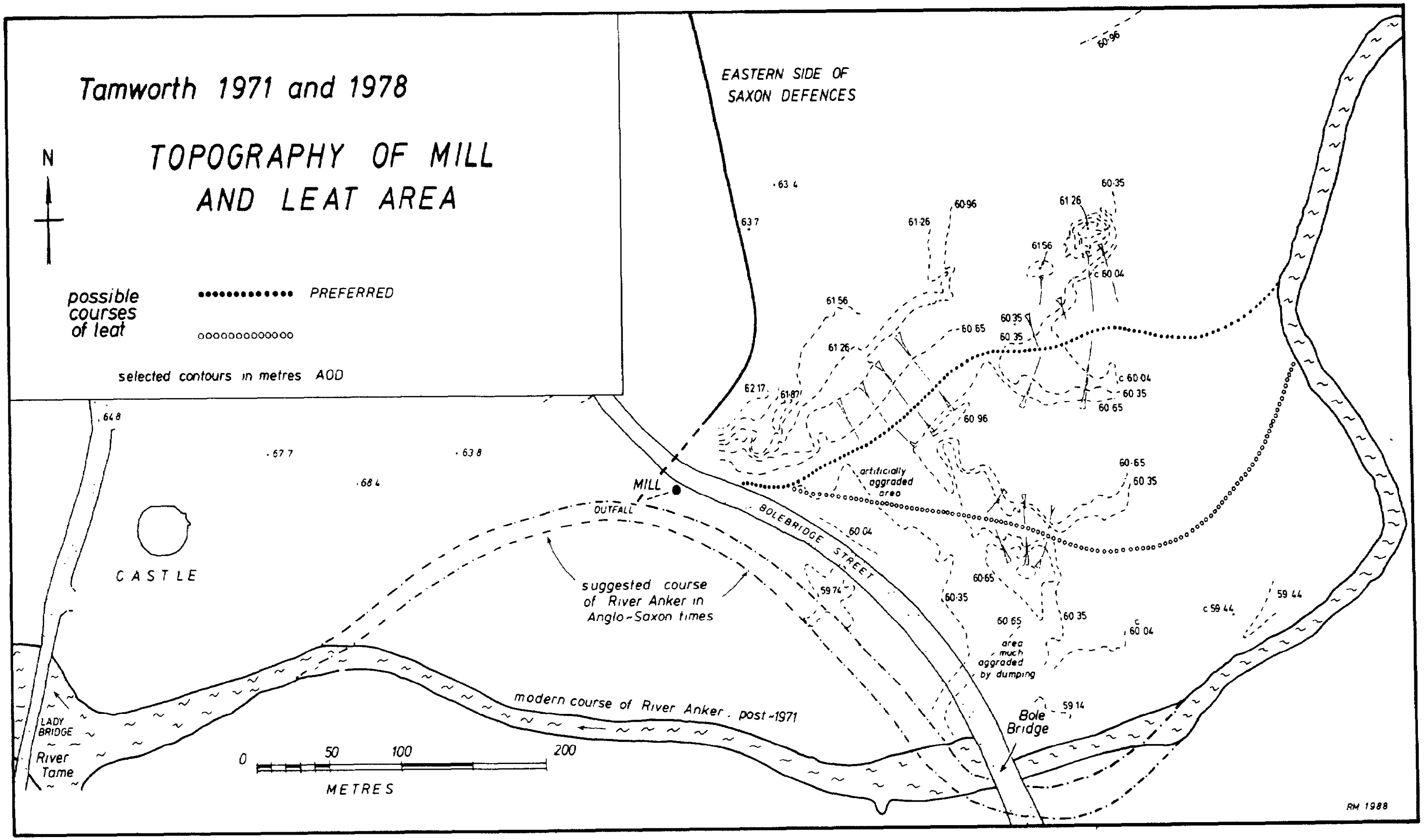



*Figure 3 Topography of mill and leat area*

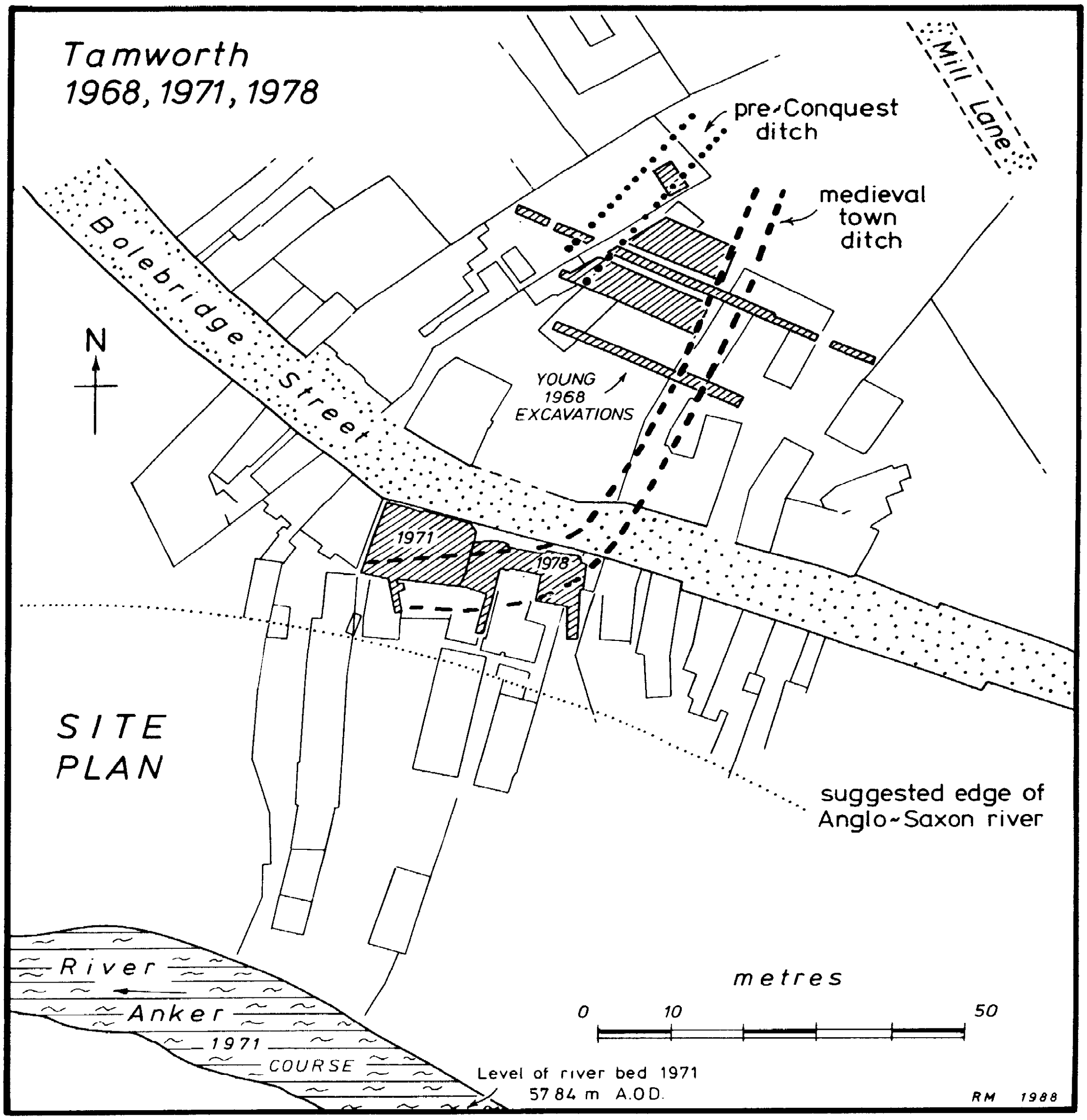



*Figure 4 Site plan, showing areas of excavation 1968, 1971*

As discussed above (1.1), Bolebridge Street may represent the course of a track from a ford which was extant before the Roman period, and Romano-British building material has been found close to the north side of the street. As the account of the leat excavation will show (below, 2.12), a road or track on the line of Bolebridge Street was extant when the mill was built as a timber bridge was apparently constructed to carry the road across the leat. A causeway may have carried the road on its approach to the *burh* to reduce the risk of flooding from the adjacent river. It is assumed that after crossing the bridge the road entered the *burh* by way of a south-east gate.

## 1.3 The topography of the excavated areas (Figs 4, 5)
by PAR

The site can be conveniently described in several zones. The north-west part is that between Bolebridge Street and the mill. Here stratification was relatively shallow and disturbed, and the only features located were those that cut the surviving level of the natural gravel, clay and sand. The north-east part was the millpool and leat area, deep and well-stratified deposits, excavated thoroughly in 1971 and 1978. In this area was the most complete sequence including the phases of the millpool and leat, with a possible bridge; late Saxon, medieval and later levels were also well stratified. The central area was the mill itself, well preserved except for a big hole made by a recent well, but with the upper levels destroyed. In the south-west area was the mill outfall, well stratified with early medieval roads and other features above it. Finally the whole of the southern side of the site was traversed north-east to south-west by the large medieval town ditch of Tamworth. Further south unexplored waterlogged levels drop away to the River Anker (at base of site plan, Fig 4).

## 1.4 Circumstances of excavations (Figs 2, 4, 5) (fuller version in MF)

Excavations before 1968 (locations on Fig 2) were concentrated principally on the Anglo-Saxon defences (cf Rahtz 1977). Meeson synthesized this work (1979) and generated hypotheses on the wider problems of the Anglo-Saxon topography. He postulated a royal centre in the area around St Editha's Church (1.1 above).

The excavations described in this report followed demolition of 72-74 Bolebridge Street in 1970-l and subsequent development. Priority was given in the 1971 work (PAR) to the mill, where the well-preserved timbers offered opportunities to extend knowledge of Anglo-Saxon carpentry techniques (Rahtz 1976; Wilson 1976). The 1978 excavations (RM) encountered structures of the mill-leat, but they also produced important late and post-medieval industrial remains.

## 1.5 Methods of excavation, recording and analysis (fuller version in MF)

The excavations made extensive use of machinery, which involved extensive loss of the upper stratification, especially in 1971. The salvage nature of much of the work precluded extensive horizontal excavation, and led to heavy reliance on exposed sections.

The crucial data, apart from the plans of the mill itself, were thus recorded on section drawings (S1-S30 in 1971, S51-S58 in 1978). It was the synthesis of these which provided the framework of phasing. The scheme adopted for the latter was the result of analysis of the 1971 data by PAR; RM's independent phasing in 1978 was correlated with, and absorbed into this.

Plans and sections were drawn in the field at 1:10 or 1:20. Written records were in 1971 transcribed into tables (eg, Table II), under the context categories of Roman numerals (cuttings) and numbers (layers) and F numbers (features); and in 1978 under cutting and serial numbers (A and B prefixes) with F prefix for individual furnaces or hearths.

The mill timbers were mechanically removed and have been preserved in the grounds of Tamworth Castle Museum. A full-sized working model there is currently being planned.

Interim notes were published on the 1971 work (Rahtz and Sheridan 1971, 1972; Rahtz 1976, 1977, 1981; Rahtz and Bullough 1977).

In the interpretation sections of this report, site data have been amplified from external parallels, notably from ethno-archaeological research in Europe (Rahtz 1981), particularly in Crete (Rahtz and Watts 1981).

# 2 The Excavations (1971 and 1978)

## 2.1 Introduction
by PAR

The 1971 area of excavation, directed by PAR, comprised the mill and outfall area to the west, and the western part of the millpool to the east. The 1978 area, directed by RM, lay beyond this; within it were the eastern end of the millpool complex, the leat, and other structures beyond this, including a possible bridge.

Although the two areas were virtually contiguous, their stratification was different, even in their Anglo-Saxon levels and their later histories of ground-use are also very diverse. Their archaeology is accordingly discussed separately by each author; correlation of phasing has, however, enabled key relationships to be defined. The evidence from both is synthesized in 2.20 and in chapter 5.

### *Summary of phasing and chronology (1971 and 1978) (Figs 5i-vi)*

The evidence from the excavation is now discussed in detail in ten phases (l-10); firstly in the 1971 area, and then in the 1978 cuttings. The first four of these phases are concerned with the pre-mill use of the area, the first mill and its demolition, and the second mill and its destruction. It is the latter which provided the principal evidence for the mill structure and operation. Later phases deal with subsequent use of the area from latest Anglo-Saxon times down to recent years. They include roads, the medieval town defences, later medieval and post-medieval industry, and the buildings that stood on the site in recent years.

As a preliminary to a discussion of the evidence, the basic sequence is shown in the summary below and on Figs 5i-vi, to assist the reader in following the more detailed exposition in the pages that follow.

| Phase | Features | Interpretation | Date |
|---|---|---|---|
| 0 | Intrusions into the Keuper (Triassic) Marl | | BC |
| 0 | Prehistoric and Roman finds | ?Frequentation, or 'residual' | BC-C5 AD |
| 1 | Possible pre-mill features | ? | mid C9 AD or earlier |
| 2 | Mill 1, leat, outfall | Construction, use and abandonment | mid C9 or earlier |
| 3 | Mill 2, leat, bridge, millpool, outfall | Construction and use | *tpq* AD 824 *or* 855 ± 9 |
| 4 | Mill 2, leat, bridge, millpool, outfall | Destruction and abandonment | mid to later C9-C10 AD |
| 5 | Gravel deposits over mill area | Metalling | C10-early C12 |
| 5a | Linear movement zones on west side | Roads of timber and stone | late Saxon-early medieval: C10-early C12 |
| 5b | Timber robbing disturbances and deposits of gravel and other material in the millpool area — first phase | Timber robbing and dumping or metalling | late Saxon-early medieval: C10-C12 |
| 6 | Ditch edges and other features and layers | Earliest components of medieval town ditch complex, and possible bridge abutment | early medieval - ?C12 |
| 7 | Timber robbing disturbances and deposits of gravel and other material in millpool area — second phase | Timber robbing, erosion and dumping or metalling | earlier medieval: later C12-C13 |
| 7-8 | Ditch, and bank or causeway | Drainage of road area to east, and road support | C13+ |
| 8 | Major ditch, associated fills and other layers and features; timber features by ?river edge | Town ditch and riverside jetty structures; rubbish dumping in ditch | medieval: C13-C14 |
| 9 | Layers and features | Rubbish deposits and pits; colonizing of ground towards river | later medieval: C15-C16 |
| 10 | Make-up layers, furnaces and hearths | Further colonization and metal-working | C17-C18 |
| 10 | Standing buildings | 70-74 Bolebridge Street | up to 1971 |

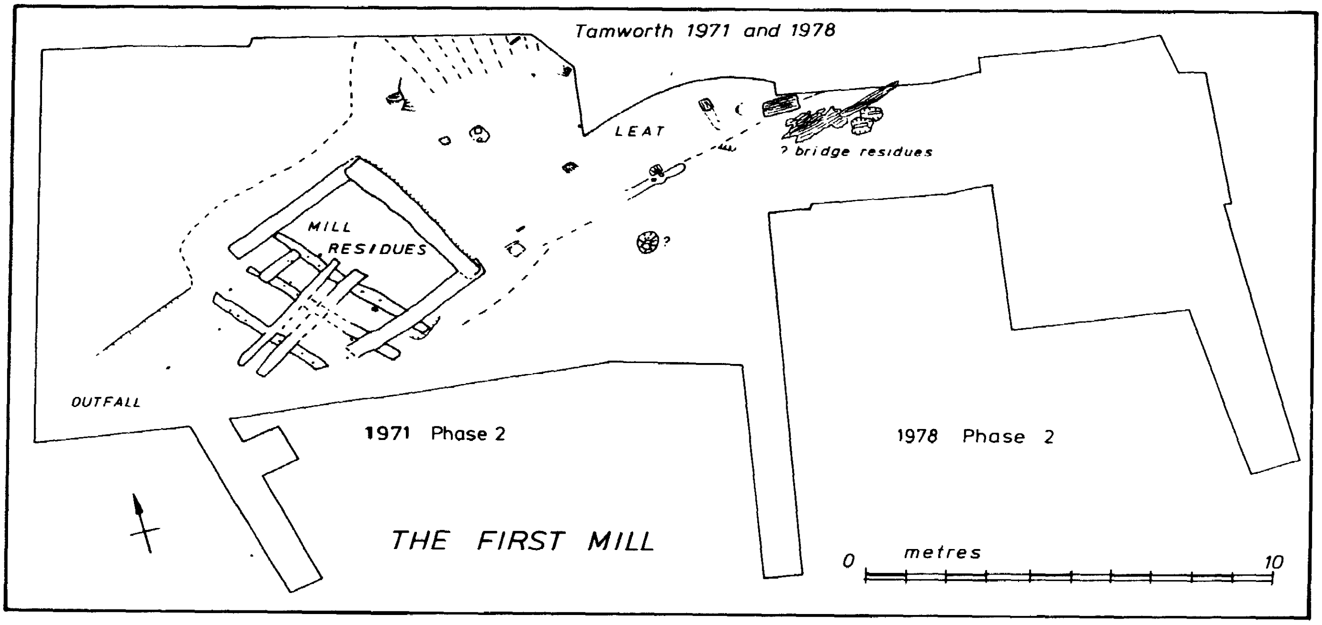



*Figure 5i Plan shows the residues of the first mill which may not be in situ. To the E are the leat, and structural elements and residues which may be partly associated with the first mill, including possibly a bridge over the leat to carry the predecessor of Bolebridge Street.*

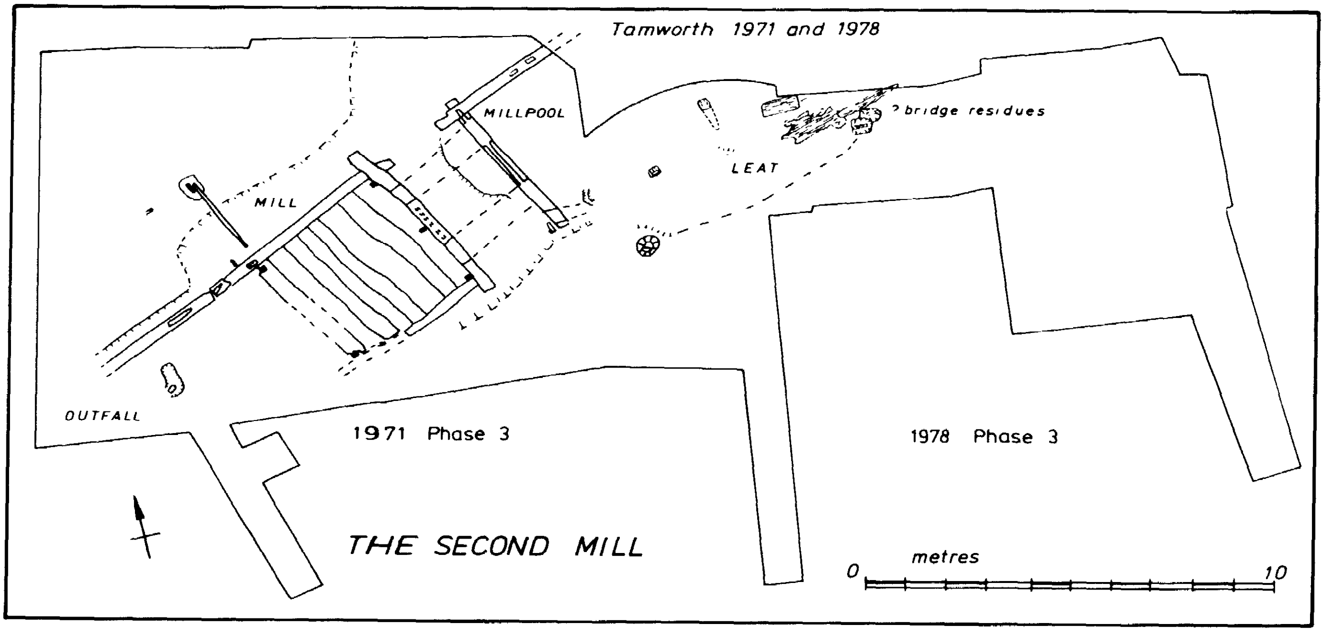



*Figure 5ii Plan includes the structural remains of the second mill, its outfall and millpool; the outline of the leat and residues of the bridge are shown to the E*

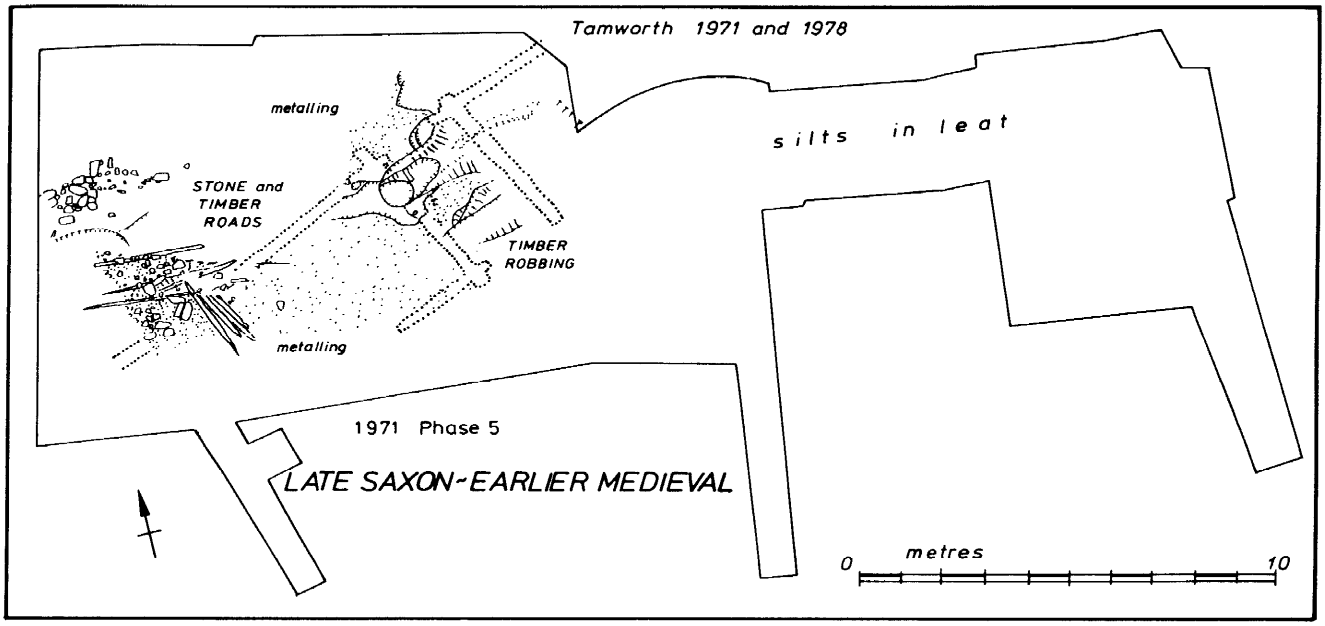



*Figure 5iii Late Saxon to earlier medieval activities in the eastern areas after the destruction of the mill, including a series of roads and metalling associated with approaches to the river, together with progressive robbing-out of some of the structural remains of the mill. Nothing in the eastern area could be positively associated with these activities, but some of the silts in the leat must be contemporary*

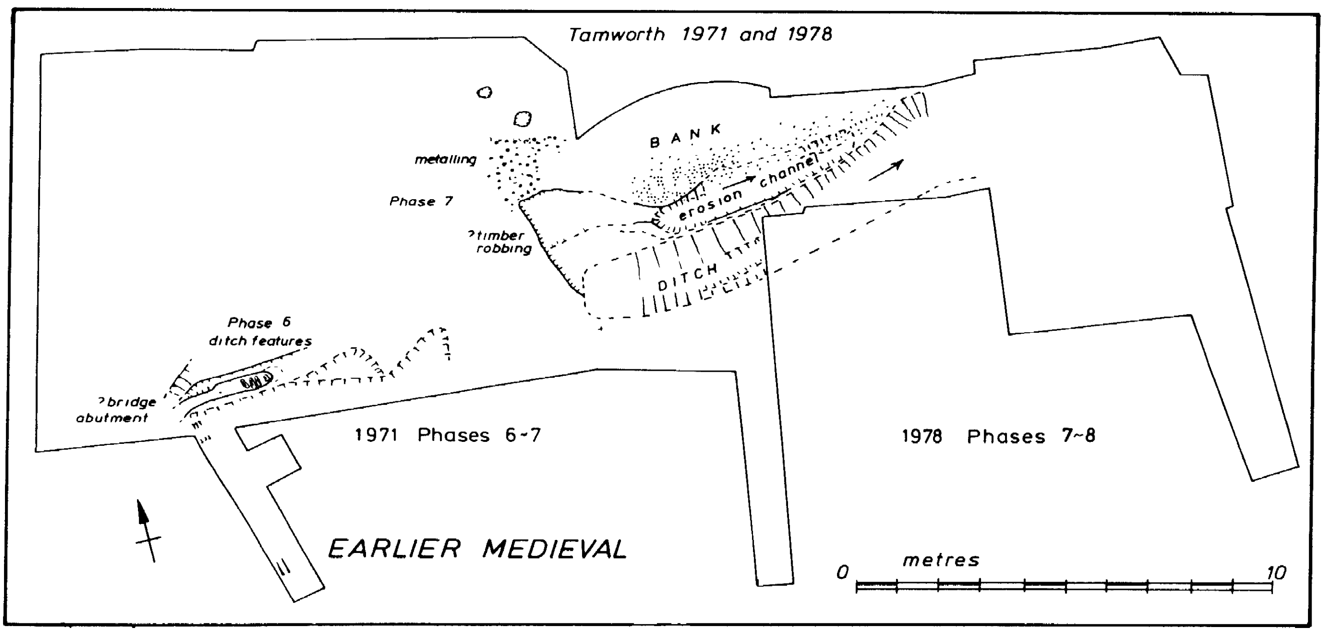



*Figure 5iv Plan shows features that mark the beginning of the medieval town defence system. In the western area there were the edges of primary ditch cuts and a possible bridge abutment. Further E was more metalling, and timber robbing, and a complex of bank and ditch features spanning a considerable period*

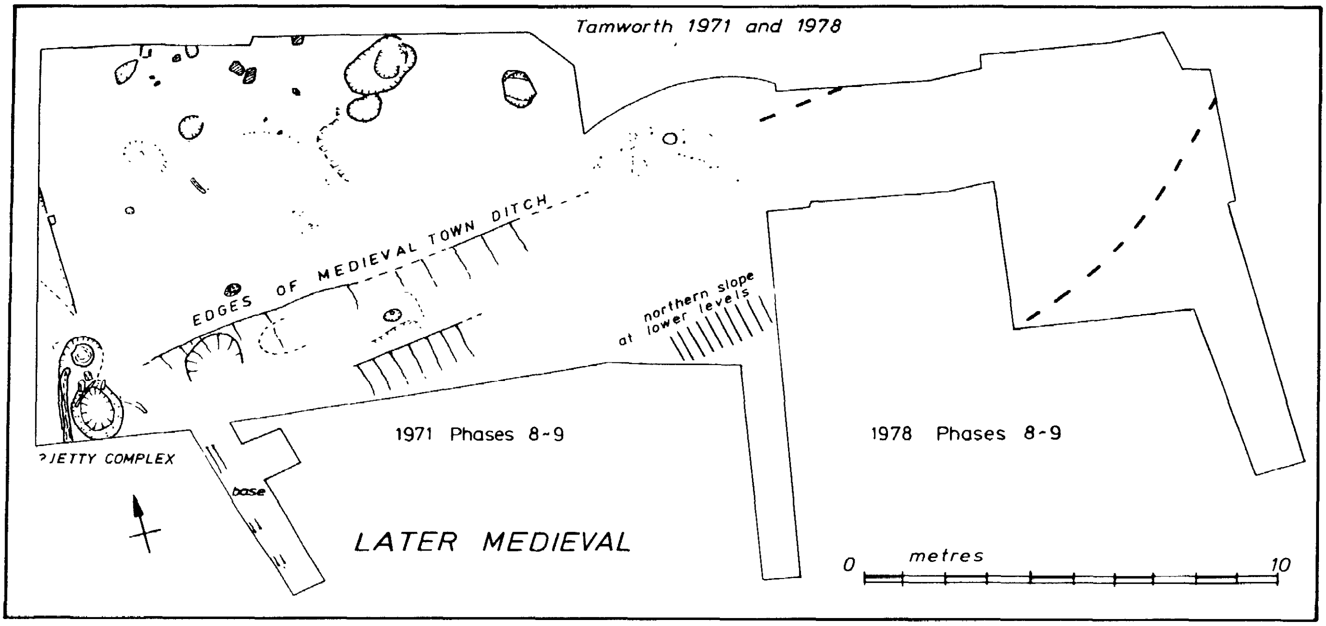



*Figure 5v Later medieval period, showing the principal medieval town ditch in its course through this part of Tamworth, a further ?jetty associated with the riverside, and some town structures to the N; these are probably later than the abandonment and levelling of the medieval defences*

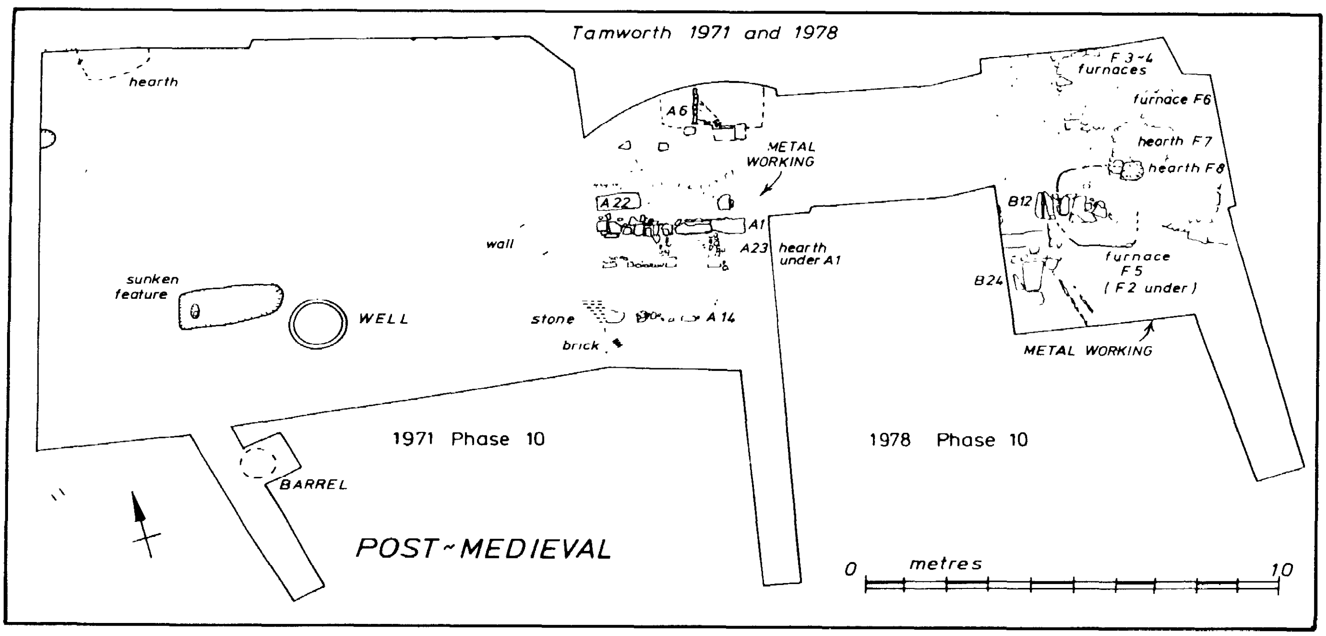



*Figure 5vi Post-medieval period, including further town features in the western area, and a remarkable series of industrial features in the eastern area. Over all these features were finally built the properties which stood on the site before demolition and excavation in the 1970s*

## 1971 Mill and millpool area

by PAR

Figure 4 shows the extent of the 1971 cuttings, in relation to the adjacent 1978 area. The main area, including the mill, comprises cuttings I-II; III-V are the extension cuttings in the south-west part of the excavation. Most of the plans of the mill do not show these cuttings, since they did not include mill features, but they are included in the medieval and later plans (Figs 34-6).

## 2.2 Phases 0-1: prehistoric, Roman and pre-mill (Fig 28)

(fuller version in MF)

These phases comprise all features earlier than the first mill of phase 2, and include features which may be natural (0), and those possibly earlier than the first mill (1). All these are shown in plan on Fig 28.

The natural layers were of glacial origin. In the northern part of the site they did not appear to have been truncated; *c* 60m AOD was thus probably the approximate prehistoric ground level here.

A buried soil apparently survived in one area (607 in S3, Fig 8), giving a minimum former surface here of *c* 59m AOD, indicating a general gradient of *c* 1 in 8 down to the river (cf 610 clay in S3, Fig 8). In cutting V (S12, MF Fig 12) the (?truncated) red clay, at *c* 56m AOD, was overlaid by alluvial layers, probably representing the north edge of the River Anker in earlier times (see also 'jetty' complex 517, 2.6 below). Some features may have been pre-Saxon or natural. The only pre-Saxon finds are a flint flake and some Roman tile.

## 2.3 Phase 2: the first mill (Figs 28 and 30)

(fuller version in MF)

*In discussing the mill and the way in which it functioned (phases 2-4), a number of technical terms are used; while these are familiar to molinologists, they may not be so to all readers of this report. The Glossary explains the terms used, and also includes some items for which there is no direct archaeological evidence at Tamworth but which may be inferred (for a fuller Anglo-Saxon watermill vocabulary, see Rahtz and Bullough 1977).*

*Two interpretative diagrammatic reconstructed sections (Figs 93 and 94) which belong to a later part of the report, may also be consulted to assist the reader's understanding.*

### *Introduction*

Numerous layers, timbers and features were sealed by those of the second mill; these are interpreted as being associated with a first mill (also horizontal-wheeled) by analogy with the succeeding structures. This is not a certain identification — there were, for instance, no millstone fragments — and the observed data could perhaps be explained in other ways, as a fish-weir for example.

### *The source of water*

The water for both mills came from a leat. This is assumed to have been fed from the River Anker further up its course; the nearest possible place is suggested on Fig 2, the leat in that case being *c* 400m long. Further research is needed on the nature and location of the leat point-of-entry; some associated features nearer the mill were found by Meeson in his 1978 excavation (2.11-2.12 below).

### *The plan (Figs 28, 30)*

The first mill was driven directly by water from a leat. The precise course of the water from the leat is uncertain; some timbers could be part of a structure defining the flow from the north-east. The leat, as observed, was wide (see 371 in S3-S6, Figs 9-13); it was orientated 10 degrees or more southwards from that of the mill cuts (cf the southern side of the phase 3 millpool, 2.4 below and Fig 5i). Its lowest levels are about the same as those at the base of the mill cut 10, which it is suggested originated in phase 2, even if recut in phase 3. Elements of the first leat were more precisely defined in 1978 (2.11 below).

The timbers of the first mill that survived were not so substantial as those of the later structure (see Pl VI), though larger ones may have been re-used; there were also three large stones in the south corner. There is evidence on the plan of an overlapping sequence, and some pegging together, and some upright posts.

It is concluded that the timbers were not *in situ* as part of the first mill, but neither were they made for the purpose of laying a foundation raft for the second mill. They were probably removed from a dismantled structure, perhaps the millhouse above, from floors or walls, and laid down in phase 3 to level off the ground. A similar pegged plank (152) was found burnt in the destruction levels of the second mill, fallen from the millhouse superstructure above (2.4 below).

Around and under the timbers in the easterly part of the mill area were dark grey silts with burnt material (487 in S18); this was cut away by erosion areas (269a, b), the fills of which (255) contained nails and other fittings (IR18-22), burnt clay (BC6) and worked wood (CW7), perhaps from the first mill. These erosion hollows confirm that the second mill was not erected *de novo* in the mill-cut, as it would in this case have had its floor set on a level base.

The outfall of the first mill is assumed to have been broadly the same as that for the second; the north-west edge can have been no further north-west than 460.

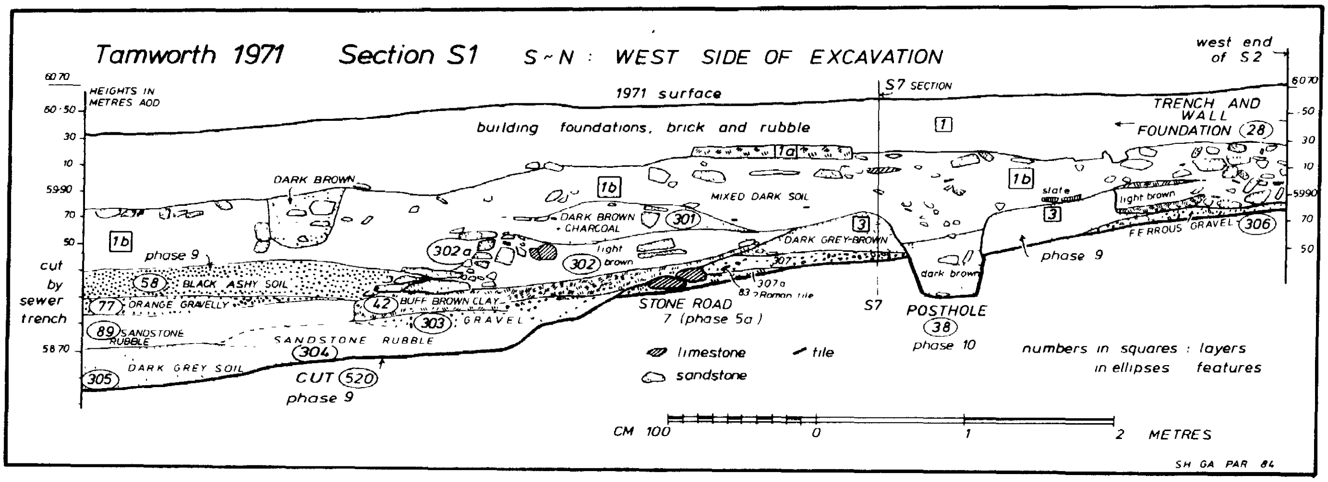



*Figure 6 Section S1 S-N: W side of excavation*

### *The sections*

S3 provides a section across the leat, which might have been lined or revetted; if not, it is hardly surprising that it became so eroded at the sides and base. The original limits here are uncertain. The base of the main part is just below 58m AOD (in gully 280) (cf S52, Fig 48) and the lowest is *c* 57.65m in gully 275, similar to that of the mill-base (S18). The final width was 5-7m, and the leat was 1.5-2m deep from the presumed original ground level; the depth of erosion would finally allow no head of water to give power to the horizontal-wheeled mill, and it would have become inoperative.

All the steps and gullies of the leat were finally sealed by the clay (34) of the second mill.

In S6 (Figs 12, 13) another partial section of the leat is seen, with its base at just above 58.00m, slightly higher than further east (see 2.11 below).

S18-S19 (Pigs 25-7) show phase 2 levels in the mill and outfall areas; in S19, the base has dropped to 57.50m AOD, an adequate fall for the water after its passage through the mill; beyond, all is cut by the medieval town ditch (230).

### *Dating*

There is no dating evidence for the first mill other than that provided by two radiocarbon determinations (3.19). A *terminus ante quem (taq)* for both mills is provided by the mid-later 11th century Stamford ware sherds in layers above. If the *terminus post quem (tpq)* provided by dendrochronology (3.18) of 855 ± 9 does date the actual construction of the second mill (rather than its reuse of timbers), then this would provide a *taq* for the first mill. However, if the timbers were of the first mill, re-used in the second, then the *tpq* applies to the first mill. Since in any case the first mill is unlikely to be much earlier than the second, a date in the mid 9th century can be proposed.

### *Conclusion*

It seems likely that there was a mill earlier than the principal one of phase 3, but no structural detail survived except possibly some uprights in the leat, and no operational detail. It came to an end either by fire or by erosion of its leat causing a severe loss of effective velocity. It was replaced by the second mill after no great interval; the construction of the new mill is seen as an attempt to avoid the problems which the first mill apparently encountered.

## **2.4 Phases 3-4: late Saxon** (Figs 31, 32)

### *Introduction*

It is with some relief that the problems of the ambiguous and ill-recorded evidence of phase 2 can now be left behind. The second mill and its associated stratification and artefacts are a data-set of the highest significance; although there are areas of uncertainty, the date, function and reconstruction of the mill can be attempted with a clarity unusual in Anglo-Saxon archaeology. This is all the more gratifying in that the evidence was recovered from an excavation which got off to a very bad start, was conducted in a hurry in very poor conditions, and with inexperienced workers; in contrast to a planned research excavation, with the adequate resources that the Tamworth mill should have had.

The evidence is divided into two phases, although the boundary between them is not always clear. Phase 3 (plan, Fig 31) comprises the construction of the second mill and its use, while phase 4 (plan, Fig 32) is concerned with its destruction and post-abandonment silting. The sequence ends with the reoccupation of the area for different purposes, the remains of the abandoned, silted mill being sealed by new layers, and the timbers dug out. It is the

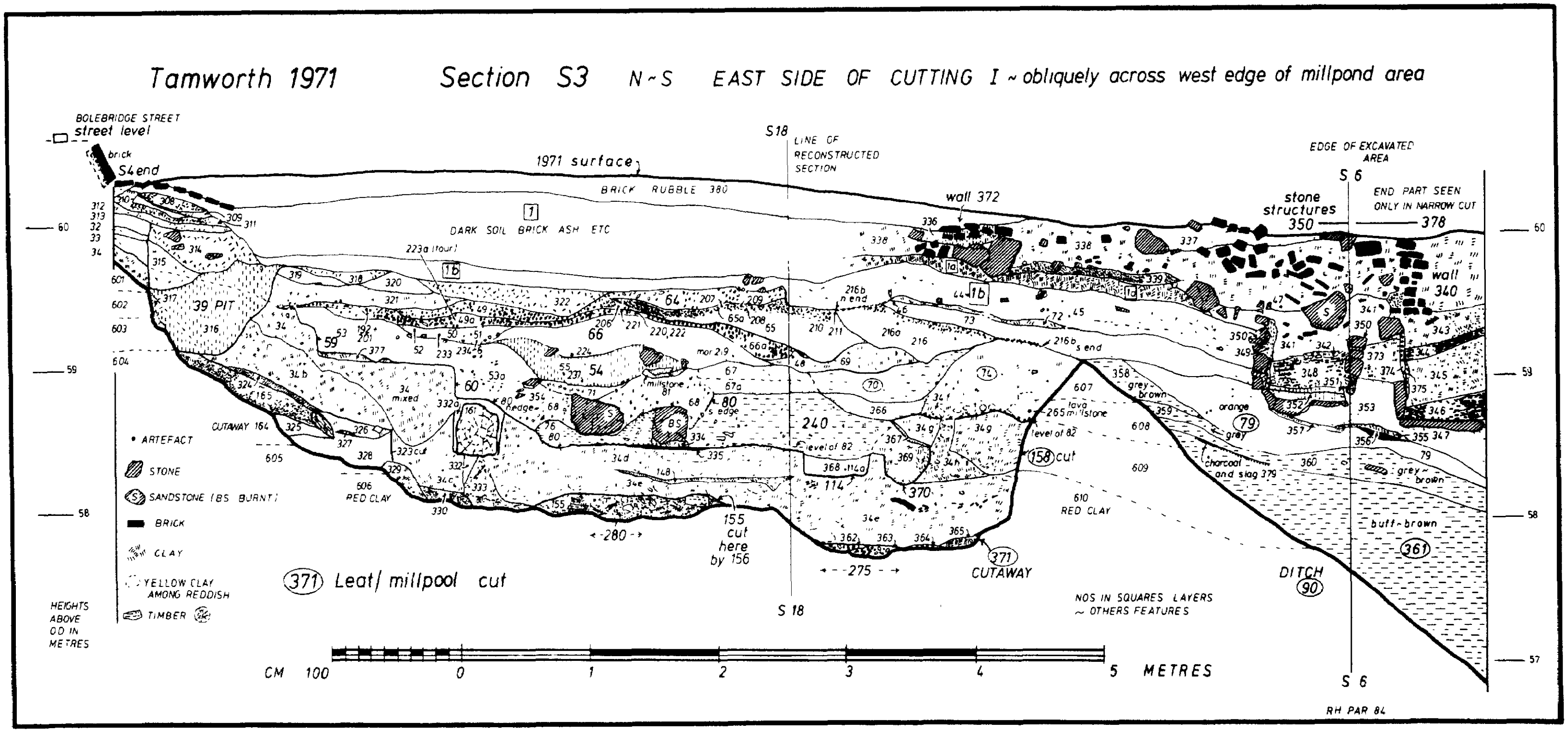



*Figure 8 Section S3 N-S: E side of cutting I (obliquely across W edge of millpool area)*

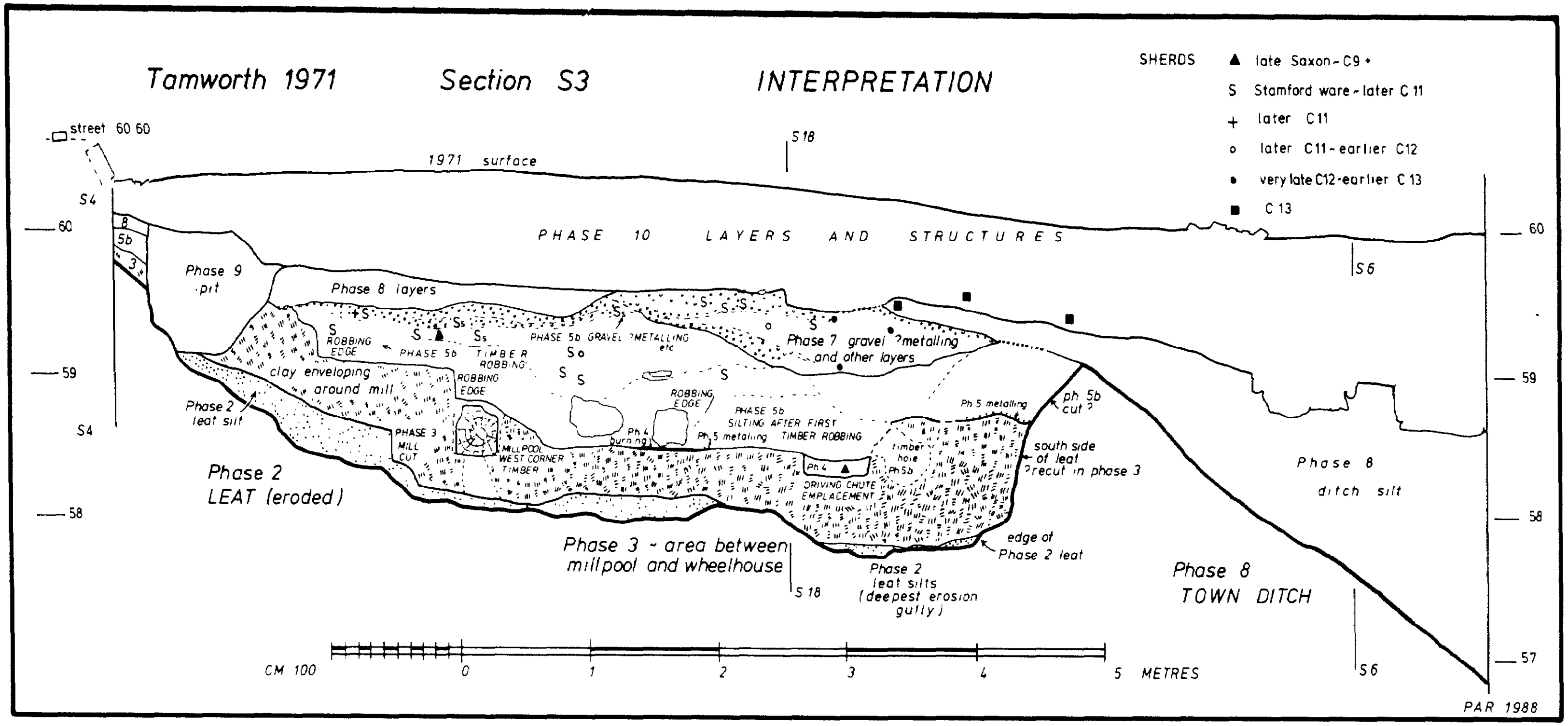



*Figure 9 Section S3: interpretation and phasing*

*Plate I Second mill wheelhouse from NE, with destruction levels (170 etc.) in position; sole-tree 154 on right; gap in debris for wheel in top left-hand corner*

robbing holes dug for the latter operation which cause problems, in attempting to decide what part of the robbing holes represented the shape of emplacements in which timbers had been set. In only one case (114) can this shape (at the base anyway) be recovered with certainty, the slot left by the removal of the driving chute; this had been pulled out with a minimum distortion of the lower edges of the clay emplacement.

*The excavation*

On removal of medieval and later levels in cutting I, and in defining the undisturbed edges of the mechanical excavation, a mass of compact mixed clay was seen over large areas (generically 34, though not all subdivisions of 34 are mixed clay *in situ).*

The source of this mixed red and yellow material is uncertain; it was very plastic (as seen in 1971), and quite unlike the more friable Keuper Marl which forms the natural below the excavated area. There was some burnt daub-like material in 34, and also some organically-rich debris; both of these probably come from the disturbance of phase 2 deposits. Cutting this were large irregular timber-robbing holes, and visible in places were many well-preserved timbers.

The clay was a waterproofing material set around the sides of the millpool and wheelhouse, and packed in the area between them. Its purpose was to prevent water from flowing or seeping anywhere except where it was meant to go. It may be seen as a measure to prevent the extensive erosion which, it was suggested above, made the earlier mill inoperative. The plasticity of the clay had, after the destruction of the mill, caused it to creep over the remains of the timbers; its spatial limits could not therefore be taken to define exactly the extent of the clay as originally laid down. While the lower levels of the clay acted as a sealing for phase 2 layers and features below in many areas, its upper part had been extensively disturbed by robbing of the timbers which it had enveloped. In particular, there was redeposition of the clay where it had been dug out of the robbing holes; it was not always possible to distinguish these redeposited layers from those that were intact.

The robbing holes cut in the clay were now emptied of their filling (this is discussed in relation to phases

*Plate II Second mill wheelhouse from NE, with destruction levels removed, but sands (181, 181a) around wheel in position*

5 and 7 below); this defined at least the *maximum* size of any structure that had been dug out, and its broad location.

Apart from the robbing holes, there were two areas where the clay was missing; one was the area of the millpool itself. The other was that of the wheelhouse. The destruction levels and silts of the mill area had been covered with a light metalling (82) (thicker to the west) which formed the lower limit of the post-mill levels, and spread over the mixed clay envelope in the area between the wheelhouse and millpool. It was not clearly enough defined here to provide a decisive horizon everywhere to the surface of the intact part of clay 34; it was, however, clearly cut by the timber robbing holes, which are thus contemporary with or, more probably, later than the metalling.

In the wheelhouse area, on the removal of the metalling 82, silt layers were removed exposing the destruction layers which covered the floor. At this stage most of the clay envelope was removed to define the entire structural framework of the wheelhouse and the destruction levels. These partly covered the structural elements of the wheelhouse and in particular the eastern part of its floor.

The excavation at this stage is shown in Pls I and II. These photographs, and later ones showing the wheelhouse cleared of its destruction deposits, are rather misleading in that they show the structures without their integral clay sealing; so that, for instance, the area between the wheelhouse and millpool is shown as space, which it would never have been when the mill was in use. The photographs which were taken at these stages do, however, show the mill structures and (in the earlier photographs, the destruction levels) with more clarity than would have been the case had the mixed clay been left in a position sagging in over the remaining timbers.

The destruction levels, as exposed in this way, showed already a gap where the wheel-assembly had been (Pl I) though the significance of this pattern was not realized at the time. It is evident that the wheel-assembly had been in position at the time the destruction deposits had accumulated; it was removed later (but still within phase 4), disturbing the destruction deposits to the extent of displacing, casting aside, and overturning the sole-tree, which would of course have been directly beneath it when it was in use.

*Plate III Second mill from W, as finally cleared; outfall on right, millpool top left*

*Plate IV Second mill from NE; timber 246 of millpool in right foreground; outfall in background*

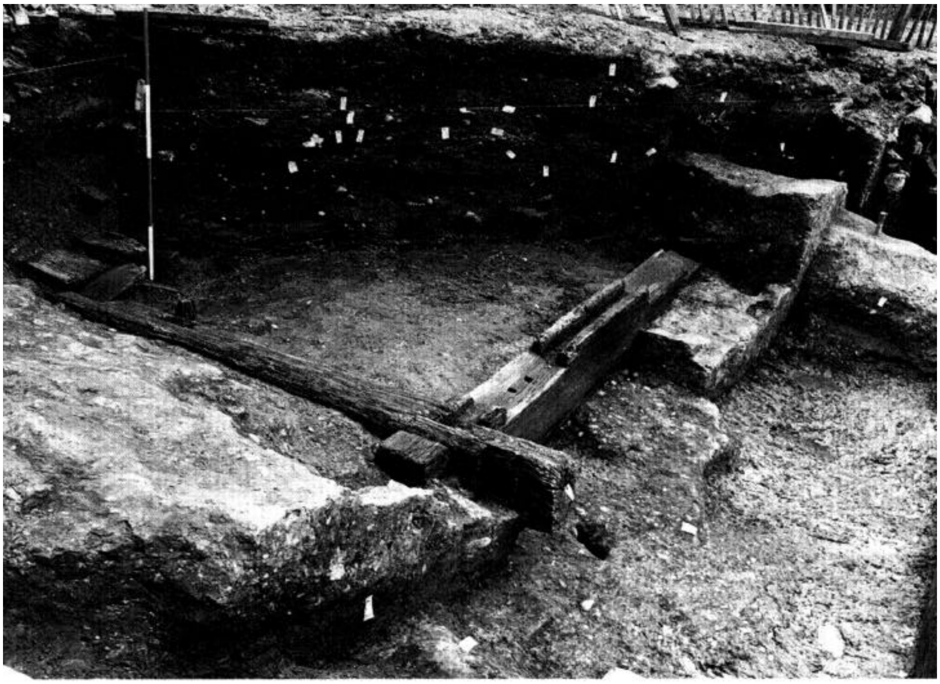


*Plate V Millpool from NW*

*Plate VI Revetment timbers of outfall from SE; W corner of second mill wheelhouse in foreground, with plank 177 and upright 95 on right; timbers 178 and 277 of first mill on left*

*Plate VII N corner of mill 2 wheelhouse from S; by-pass emplacement 296 on upper right; upright 271 and wedge 295 in foreground, set in floor 160 (scale on right in cm and 10cm)*

*Plate VIII W corner of millpool from S; by-pass emplacement 501, with holes, in centre*

The destruction levels yielded crucial evidence and artefacts from the millhouse which had been above; these are discussed later in relation to phase 4.

On their removal, the structure of the wheelhouse was more clearly defined; on its floor was a pattern of sands which are interpreted as deposits built up in the final stages of the mill's use. They also show a gap where the revolving wheel would have kept the floor partially scoured of such sands. This stage of excavation is shown in Plate II. No 'ghost' of the sole-tree is visible here, so it is assumed it must have been suspended at a higher level, 5-10cm or more above these sands, for which analogies are numerous. In this technology there is of course no main bearing in the floor itself — only on this flexible plank.

The sands were cleared away and the wheelhouse defined as shown in Pls III-VIII.

By this stage the north-east corner had been excavated, revealing also the millpool structure behind section S3. In the earlier photographs with the destruction levels in place, this area remained unexcavated, and section S3 visible.

The final stage of excavation was the removal of the mill structure to expose the remainder of the phase 2 timbers under the mill (some had been seen already around the modern well disturbance and where they extended further towards the outfall than the floor of the second mill). As explained above, there was no time to record the phase 2 timbers completely in these last hours, notably the depths to which all the uprights extended into the natural.

## Phase 3: the second mill, construction and use (plan, Fig 31)

(fuller version in MF)

### *Introduction*

In the ensuing discussion, reference will again be made to the plans and then to the sections, for clarity of argument. To anticipate a little, the second plan, of phase 4 (Fig 32), shows the mill in its destroyed state with the extent of the destruction levels, loose timbers, collapsed and distorted plank walling. Some of the distortions here probably date from a time after the destruction of the mill, arising from soil pressure, decay, etc. This is true not only of the plank walls, but also of the main horizontal baulks of timber, especially those on the north-west upslope side, which have been pushed out of horizontal.

The first plan, of phase 3 (Fig 31) shows the mill with all deposits removed, exposing the main structural elements. The plan does not entirely reflect the original size of some timbers, of which the upper parts had decayed more than the lower. A better idea of their surviving size is given by Fowler's large-scale details of the timbers themselves (Figs 83-91); some rationalization of their shape and original position is implied in his axonometric reconstruction of the structural remains (Fig 82). Figure 31 does not exhibit a complete plan of the mill structure; collapsed plank walls, for instance, are shown only on Figure 32 (phase 4). Both plans should be viewed together for completeness; see, however, Figures 80 and 81, later in this report, for restored views.

### *Construction*

If, as discussed above, some timbers of phase 2 were dismantled for use in phase 3, then Figure 30 should be perceived as a preparatory stage of phase 3. Although it is believed that the major cuts for both mill and outfall originated in phase 2, there was some recutting or scraping, the mixed clay enveloping the mill in places lay directly on natural.

In general, it seems probable that the mill structure was erected first (from pre-fabricated timbers?), and the clay envelope packed round it. The chutes were, however, added *after* the clay, and it is probable that the clay was first put in around the lower parts of the mill, all else including fittings and superstructures being added later. The point is discussed further in relation to sections S3-S6 below.

The structural remains will be discussed individually, beginning with the millpool, extending into the area between the millpool and wheelhouse, then the wheelhouse itself, then the outfall, and finally the area to the north-west. Further details will be found in MF Table II (Layers and Features).

### *The millpool (plan, Fig 31)*

The leat which fed the millpool lies further to the north-east, beyond the limits of the 1971 excavation; it was, however, located by Meeson in his 1978 excavation further north-east (see 2.12 below). As discussed above (2.3) a leat did, in phase 2, extend into the excavated area, there being no evidence of a millpool for the first mill.

The purpose of the millpool was, as summarized above, to retain water at a pre-determined elevation. It consisted of a three-sided structure probably open on the leat (north-east) side; there was presumably some way of controlling the water entry into the leat itself (at the point of take-off from the river) and also possibly the entry from the leat into the millpool itself.

Of this structure, two foundation timbers survived and one upright post. The north-west side timber (161) was massive; in its surface were two mortice slots for timbers; collapsed parts of plank walling were found at its north-east end. On the north-west side of this timber was packed a mass of the clay 34, filling the steep slope left by the erosion of the phase 2 leat; this must have exerted considerable pressure and, it will be argued below, did eventually cause the collapse of the wall here.

161 was locked to the south-west side timber (246) of the framework by a complex joint (Fig 90). There was also a mortice cut through its south-west end, and a rebate for a half-joint on the north-west

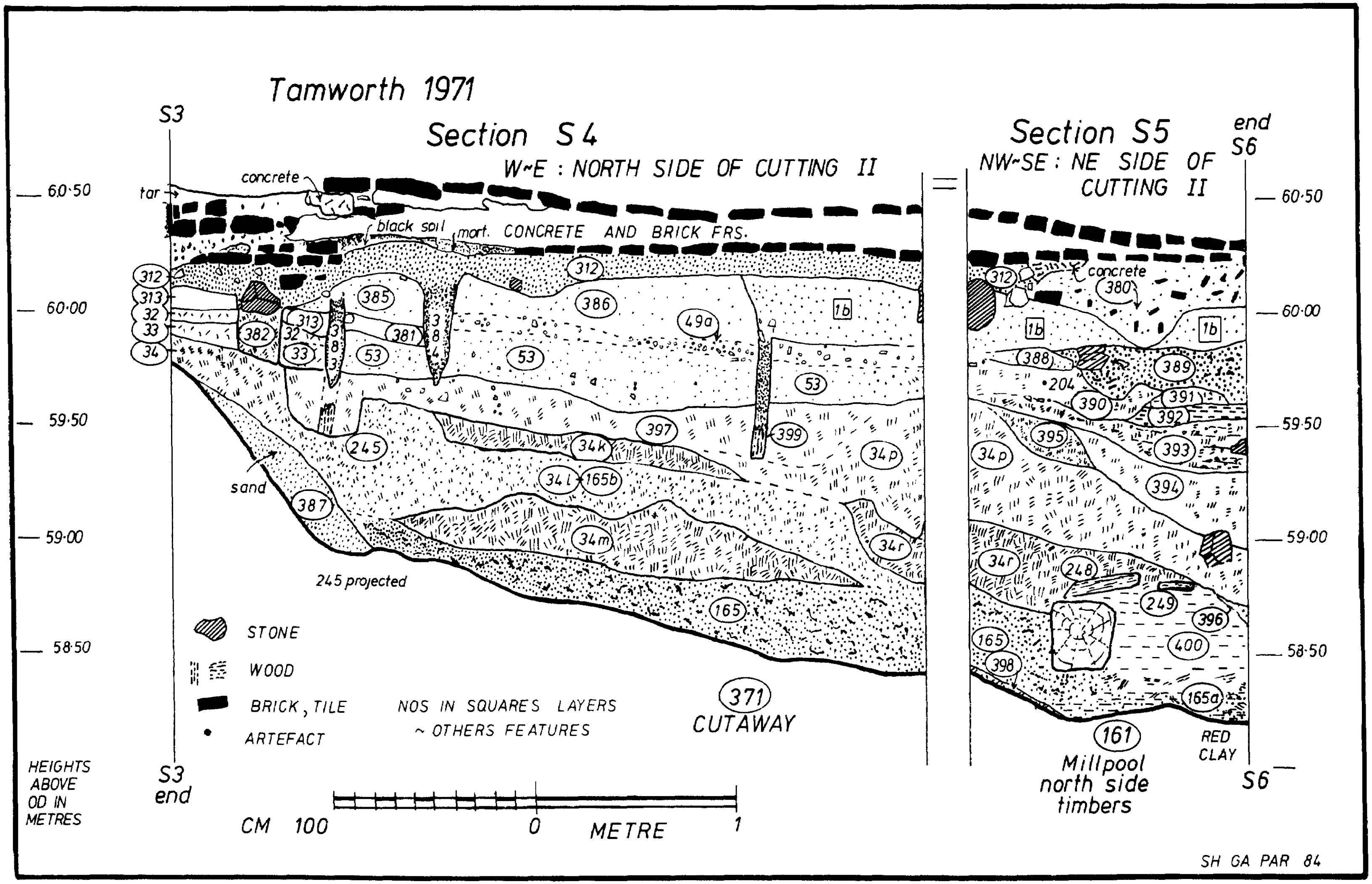



*Figure 10 Section S4 W-E: side of cutting II; and S5 NW-SE: NE side of cutting II*

side of this end; the function of these two is unknown; they could relate to an earlier use of timber, perhaps in the first mill.

The south-west side of the pool was formed by the massive foundation timber 246, extending below 161 in their joint, so that its base was at a slightly lower level; whereas 246 lay almost on the natural below it, 161 was somewhat suspended, so that there were silts of phase 2 below it (and below the clay envelope by its side).

In the surface of 246 there was provision for five further structural elements. At the north-west end, a slot was cut, extending into timber 161. Next to this was the emplacement for the by-pass chute (501) extending to 296 in the wheelhouse *(c* 2.7m long). In the base of this were two holes *c* 9cm deep (Fig 90). They are likely to have been holes for wooden pegs which held in place a sluice framework above, in which a sluice-gate was set.

In the centre of 246 a further slot was cut, into which was presumably fitted a substantial plank wall — the main front of the pool. The height to which this extended is a crucial matter, because it was this which determined the level at which the water was held in the pond, and so the potential velocity that it could attain in descending to the wheelhouse.

The fourth structural element was the emplacement for the driving chute (300), extending to 297 in the wheelhouse — a length of *c* 2.7m. This would have been a deep open trough, a tube, or most probably a box with an aperture at either end. This may have tapered towards the wheelhouse end, creating a *venturi* effect to increase the velocity; this point will be elaborated in later discussion.

The final element in 246 was an oblique emplacement at the south-east end (500), presumably to take a timber which formed the foundation for the third (south-east) side of the millpool. Whereas the west corner of the millpool was set at right angles, this south corner was oblique, ie, the pool was an irregular rhomboid in plan, not square or rectangular.

A further post hole (274) (see section S6, Fig 12, and plan, Fig 31) may be associated with this side of the pool; and the upright timber (251) may have been put in to buttress this corner - perhaps keyed into the missing south-east side timber.

In section S3 (Fig 8), the end of timber 161 is seen protruding, and below it bluish staining (332a-333) which may be associated with a former (missing) support for timber 246.

In section S5 (Fig 10), 161 is again seen 'suspended' as in S3 (Fig 8); 400 is clearly a silt of the millpool, as it is limited by 161.

In sections S6 and S18 (Figs 12, 13 and 25, 26), there are problems in deciding which silts belong to phase 2 and which to phase 3. The preferred interpretation is that 417, 421 and 165a (in S6) are all of the phase 2 leat, their surface becoming the base of the millpool; the lowest silt here (241 in S18) contained a wooden bowl (CW6).

*The area between millpool and mill (plan, Fig 31; sections S3, S18, Figs 8, 9 and 25, 26)*

In plan, the only features here were the cut 156 and the driving chute emplacement (114). The former was either cut or recut in phase 3, as the clay packing 34 extended clearly to its base, with only a little gravel on the cut-away natural (see S18). The chute emplacement was in the surface of 34e (S3); it was defined as a nearly vertical-sided cut at the base of a timber-robbing hole. The alignment fitted well to that of the emplacement in the millpool edge (300), and to that in the wheelhouse (297); the size of 114 is also consistent with them; the chute must have been in the order of 70cm wide in its outer dimension; the part joining the millpool to the wheelhouse was *c* 2.7m long, and there would have been a further extension down the side of the wheelhouse to the wheel edge, of 1.5m or more. The removal of the by-pass chute on the other side left no such precise cut in 34.

On S3, just to the south-east of 114, 367 and 369 were bluish-stained fills of a robbing hole (370) of phase 5b; there may have been a timber here to support the south-east side of the driving chute.

Section S18 provides a profile of this area showing the clay packing against the millpool (34d and e), separated by 148, a thin band of burnt material presumably redeposited from phase 2. Cuts 156 and 515 are also shown in profile here. S18 also illustrated the relative levels of millpool and wheelhouse. The level of the highest point of 246 is *c* 58.60m AOD, and the base of the chute emplacement 300 is at *c* 58.50m. The level of the base of the emplacement 297, in the wheelhouse, is *c* 58.10m (not on S18): a drop of *c* 40cm in *c* 2.40m, or a gradient of *c* 1 in 6 — a crucial figure in assessing velocity.

This is the level of the *base* of the chute trough or box as it sat on the timbers at either end. Allowing 10cm for the thickness of the floor of the chute, this gives a drop from *c* 58.60m to *c* 58.20m, the same gradient, but reflecting the level of the passage of water as it entered the wheelhouse on 297. From here to the wheel is a distance of *c* 1.5m, the water striking the wheel-paddles at some elevation higher than *c* 57.90m, the level of the wheelhouse floor. How *much* higher depends partly on how far above the wheelhouse floor the sole-tree lifted the wheel-assembly. Assuming it was 15cm, and another 5cm for the length of the male bearing on the lower side of the wheel-assemblage, the paddles would have been receiving the impact of the water at *c* 58.10m, a further drop of *c* 10cm in 1.5m from 297, giving a rather shallower gradient of *c* 1 in 15 within the wheelhouse. If the chute base were thicker than 10cm, this would be correspondingly steeper (cf chapter 5 below).

If water was flowing from the pool with its base at *c* 58.60m, it remains to be postulated how far this was below the level of the surface of the pool itself. If a

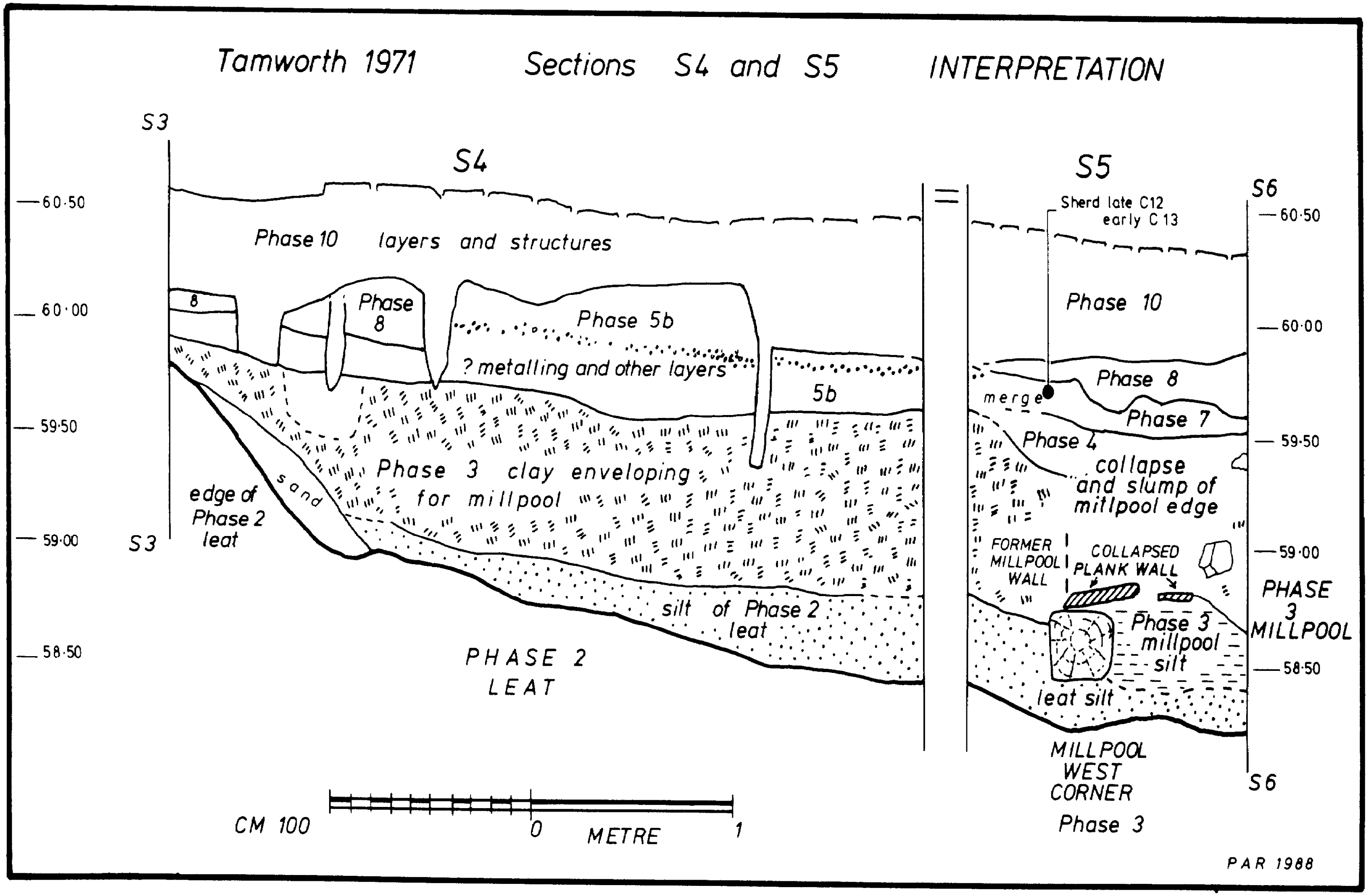



*Figure 11 Section S4 and S5: interpretation and phasing*

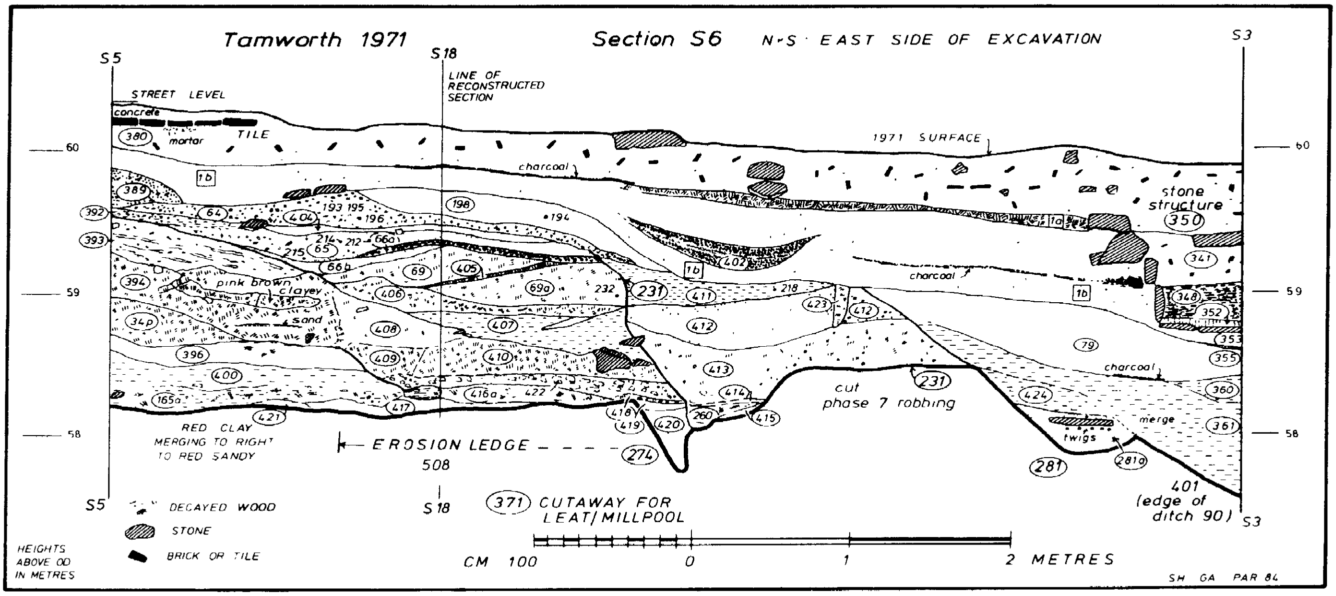



*Figure 12 Section S6 N-S: E side of excavation*

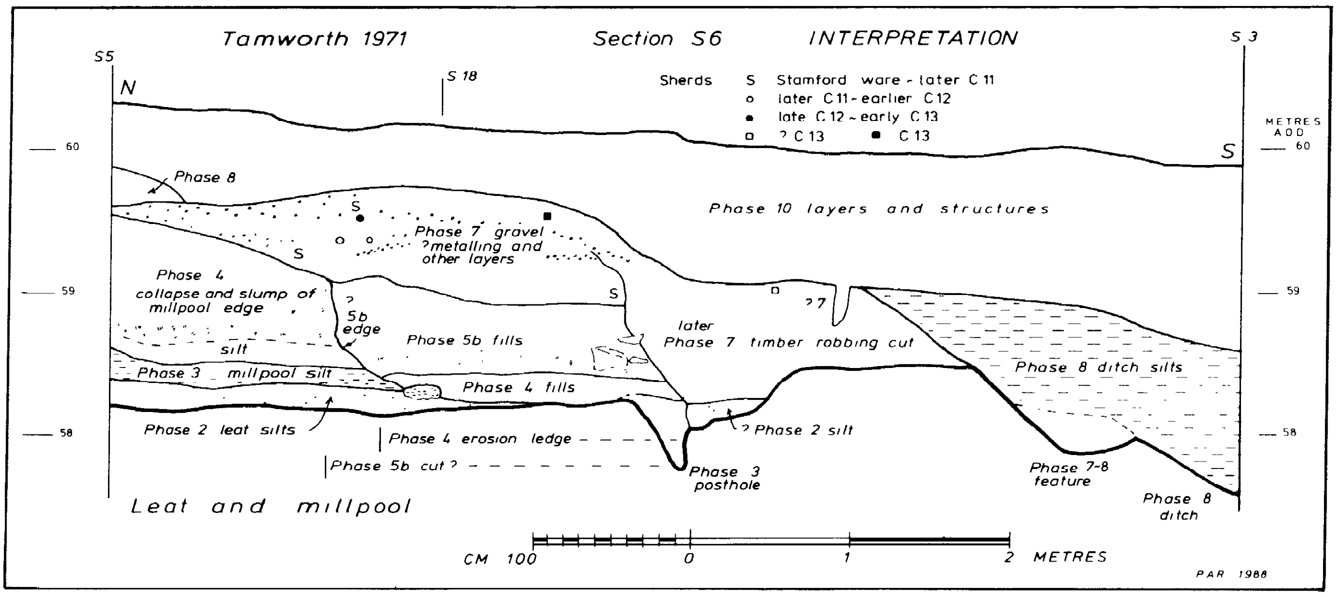



*Figure 13 Section S6: interpretation and phasing*

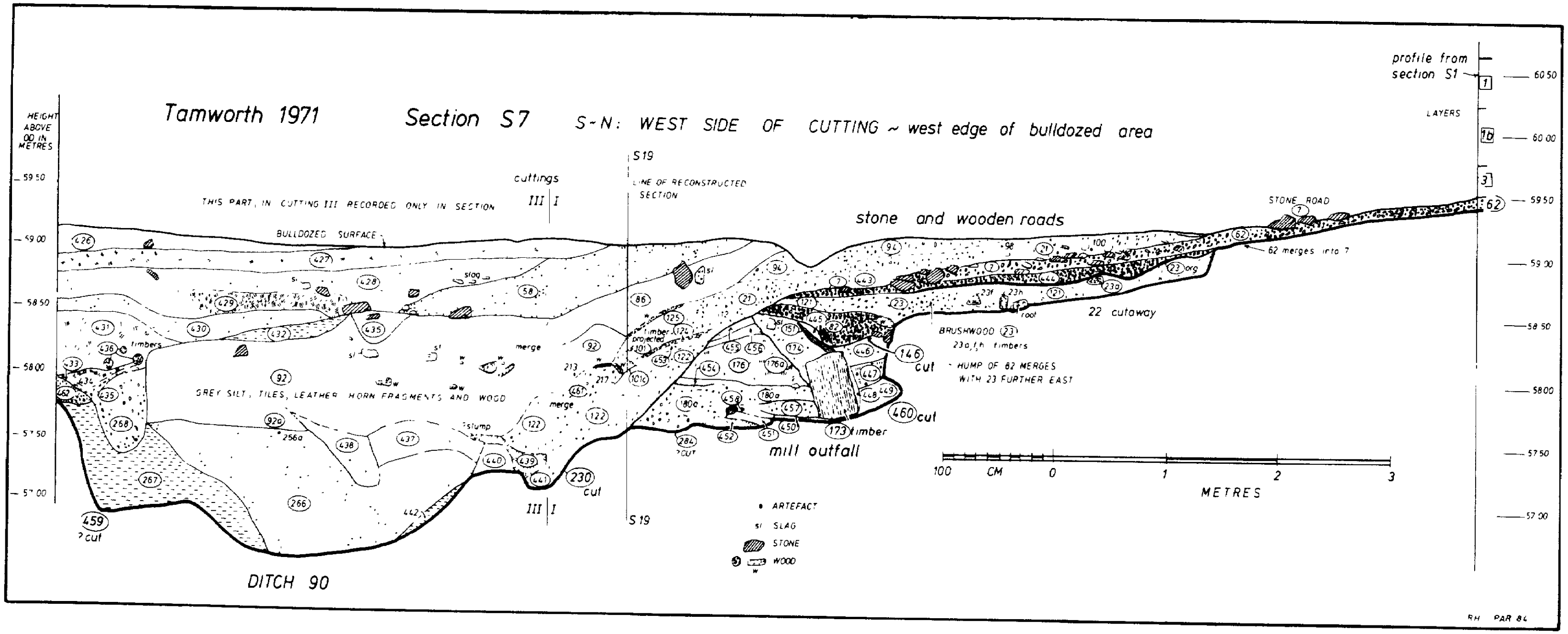



*Figure 14 Section S7 S-N: W side of cutting (Wedge of bulldozed area)*

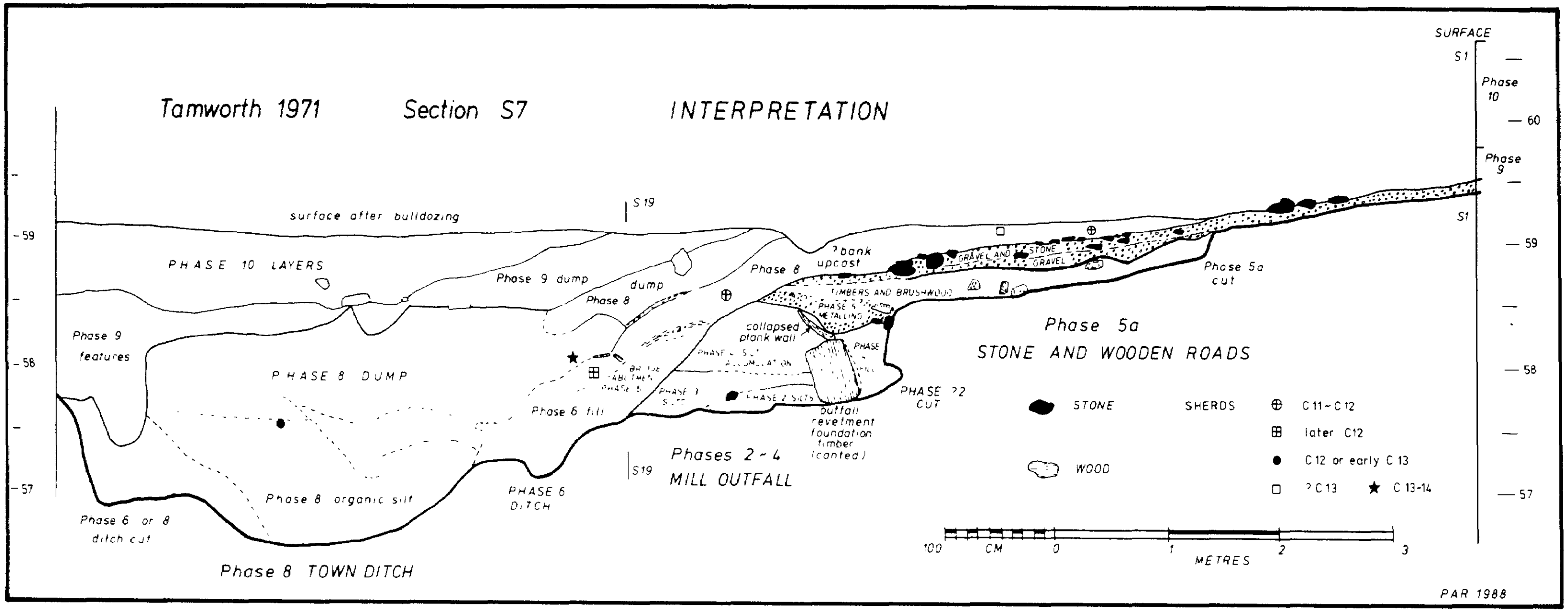



*Figure 15 Section S7: interpretation and phasing*

plank wall of 40cm in height were set in the 10cm deep plank emplacement in 246 (and it is unlikely to have been less than this), this gives a minimum height for the water at the rim of the pool of *c* 58.90m AOD (cf Fig 93), a reserve head of water of *c* 30cm; probably enough to give an adequate flow, and the pool surface may well have been higher than this. There would be no point in having a much higher water level unless the chute timber was exceptionally deep (as an open trough-like feature or as a closed box with a square or circular aperture in it, which would have had a thick lid — cf chapter 5 below).

Section S3 (Figs 8, 9) provides a more complex section across this area from north-west to south-east, in a rather awkward plane just to the south-west of the millpool and at a slight angle to it. The clay layers on the left, components of 34, are seen here against timber 161; but they would at this point be packed against the by-pass chute also, and under this joining up with 34d and e; the surface of these is relatively flat, with some charcoal on it (335). This is the surface between mill and millpool between the two chutes; the surface was compacted and in places lightly metalled. This was continuous, and probably to be equated with 82 further west, which marks the reoccupation of the mill area in phase 5, in later Saxon times. It was certainly recorded as being around 114, here shown in section.

The base of 114 was at *c* 58.24m AOD (see S3). Bearing in mind the suggested level of the water flow in 300 just north-east of here (see above, re S18), at *c* 58.60m, this gives a thickness to the chute floor here of *c* 36m, 26cm more than postulated above (unless the hole was eroded in robbing and deepened). The chute timber(s) could, however, have had a stepped base, with a rebate set against both the south-west edge of 246 and the north-east edge of 166. A similar argument can be advanced for the by-pass chute, with similar levels for emplacements of mill and millpool, and a level at the base of the robbing hole (80) of 58.43m at deepest.

To the right of 114, 34e, h and g were clay packing *in situ* against cutaway 158, extending round the south corner of the millpool. The post-mill metalling 82 was on the surface of h-g. 34f and 74 above this, although similar, contained a millstone fragment, and must be a dump from later timber-robbing.

### *The wheelhouse of the mill (plan, Fig 31; sections S8, S18, Figs 16 and 25, 26)*

This consisted of three principal foundation timbers, upright posts and a thick closely-fitting plank floor. The whole structure was set in a hollow cut in the slope of the ground which, it has been argued, originated in phase 2 (2.3 above). The north-east side timber (166) had cut emplacements at each end for the chutes (296 and 297) whose function has already been discussed. Between these the centre of the timber had a groove or depression in which a plank wall was probably seated.

166 was locked to the two other main timber foundations (185 and 131); the pegged joints were complex (Figs 83, 87, 88). On 185 (the north-west timber) was the collapsed remains of a horizontal plank wall (Fig 32) probably supported at the south-west end by upright timbers set in a mortice. The other (south-east) timber (131) was incomplete, but there were also residues of a horizontal plank wall on it (Fig 32).

In the corners and inside the centre of the north-east timber 166 were five upright posts (95, 128, 271, 289 and 244). These extended through cuts in the timbers below (of phase 2) and all were probably set as deeply as 95 and 244, which were recorded as extending into the natural for depths of *c* 25cm and 10-15cm respectively (see section S8 for 95). The surviving upper ends of 95 and 128 (not shown on Fig 31), and probably originally the others, were recorded as being notched over the main timbers inside which they were set, giving support to the basal planks of the side and end walls (for 95, see S24 on Fig 87). There may have been a sixth post to complete the set, but this is where all is cut by a modern well (57). The posts must have originally extended very much higher, acting as the principal supports for the millhouse above. 95 was packed with large stones on its south-east and south-west sides (Fig 87).

The surviving floor of the wheelhouse consisted of six very substantial planks (160a-f) set tightly against the timber baulks, and fitted around the upright posts. A further plank (177), was partly destroyed by the well, and there is room for an eighth between this and 160a-f, which must have been pulled out when the well was dug, as the floor sands survived above where it had been (Fig 32).

The wheelhouse (and millhouse above) may have originally ended here, on the north-west to south-east line between posts 95 and 244. There would have been no need for it to have extended further. The water that drove the wheel, or that which was by-passed down the north-west side of the wheelhouse, would flow off the last plank, 177, directly into the outfall (to be discussed below).

In the south corner of the wheelhouse the floor was covered with patches of sand of various textures and colours (181, 181a) around a patch of bare floor (Fig 31; Pl II). This is interpreted as marking the former position of the wheel, the sands being the result of the movement of waters in a clockwise rotation through the wheel-assembly.

Section S18 (Fig 25) shows a section through the longitudinal (north-east to south-west) axis of the wheelhouse. The canting of the north-east timber baulk 166 and the partial displacement of the floorboards were probably due to movement after the mill was destroyed. The position of the edge of the floor sands is shown to the right of the well.

Section S8 (Fig 16) shows a section through the south corner of the wheelhouse. It illustrates well

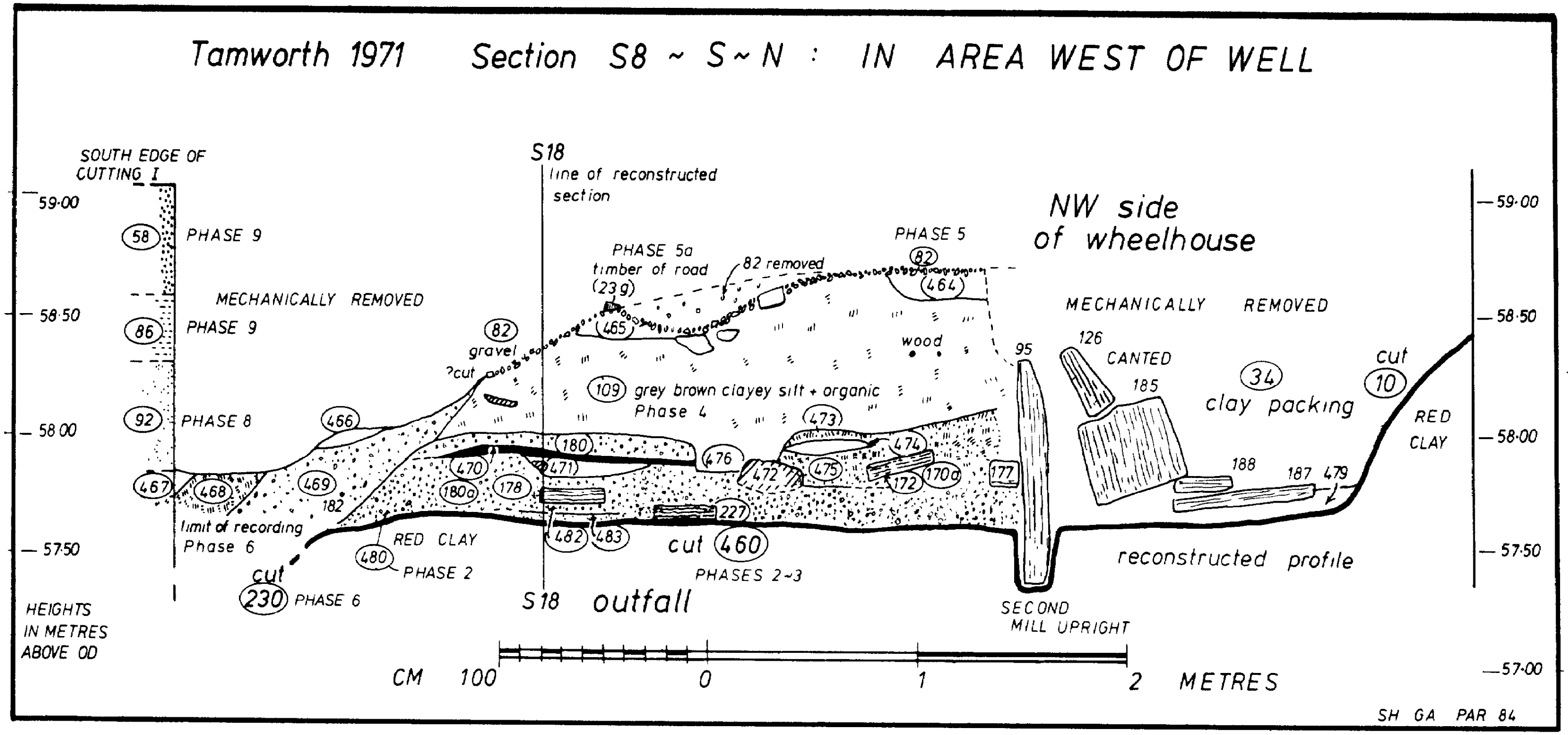



*Figure 16 Section S8 S-N: in area W of well*

the extent to which timber 185 had canted over, together with the residue of the plank wall (126) on its surface. This also shows the upright 95 in relation to the last plank, 177, but not its notched top, which is shown in section S23, Fig 86.

### *The outfall (plan, Fig 31; sections S7, S8, S18 and S19, Figs 14-16, 25-7)*

This consisted of a level area cut into the slope of the ground, continuing the gradient down through the wheelhouse. The edge of the north-west was well-defined, 460 of phase 2, but was probably recut in phase 3. There was presumably some cutaway to the south-east also, but the area in which this would have been was cut away by the later medieval town ditch, which had also partially destroyed the south corner of the wheelhouse and the south-east edge of its cut. The surviving north-west side of the outfall was revetted by massive timbers to prevent erosion and collapse of this edge by the water passing this way from the wheelhouse.

Of these timbers, two survive. 185a, with a post (185b) on its north-west side, formed a link between the north-west foundation timber of the wheelhouse (185) and the outfall revetment. 173 is another massive timber set in the cut (460). There are slots cut in both 173 and 185; large pieces of collapsed planks were found associated with them (Fig 32).

The most useful section across the outfall is S7; cut 460 is shown in relation to the revetment timber 173 and the outfall base beyond. 175 is suggested to have been inserted through silt 457, a replacement for an earlier revetment of phase 2.

### *The area to the north-west of the mill (plan, Fig 31)*

The features here were clearly associated with the mill, as 190a was directly in line with the south-west side of a structure — a room or outshot, which lay to the north-west of the millhouse; this may have been a loading or storage area between the street to the north-west and the millhouse itself.

### *Dating*

As with the first mill (2.3 above), the second has a *terminus ante quem* given by the mid-later 11th century Stamford ware sherds in layers above, of phase 5b. Radiocarbon determinations indicated a middle to late Saxon date for the mills, but these were superseded by dendrochronological dates provided by Baillie (3.18) of AD 855 ± 9 for the felling of three timbers from the mill/millpool structures, later supplemented by identical dates from timbers in the leat/bridge area of 1978; a comparison of the radiocarbon range with the dendrochronological dates is given on Fig 78.

It is likely that these five determinations do date the second mill to AD 855 ± 9 or soon after; but as discussed above (2.2) there is a possibility that the timbers were originally in the first mill and were re-used, in which case the second mill might be some years later than the dendrochronological dates, but still probably within the later 9th century.

The length of the second mill's life is more difficult to determine. The reversal of the steel bearing block in the sole-tree (IR24, 3.8 below), and the number of millstones that had been used to breaking-point (3.1 below) indicate a life of years rather than months, or even of decades. On the evidence of the archaeology, the next dating point in the sequence is much later. Following an equally imprecise period of robbing, erosion and silting, which is described in the next two sections, the sequence ends with the advent on the site of Stamford ware sherds of the mid-later 11th century.

## **Phase 4: the destruction of the mill complex and its aftermath** (plan, Fig 32)

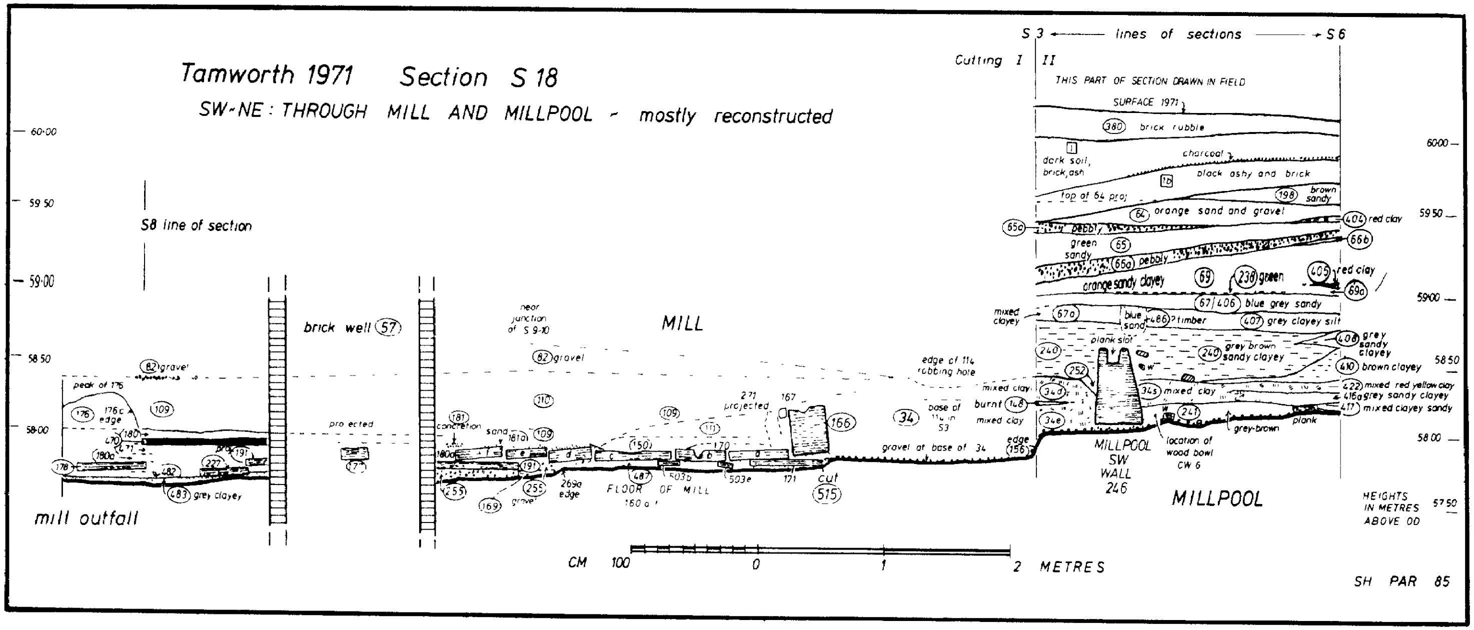
(fuller version in MF)

This phase comprises the destruction of the mill by fire and the collapse of at least its upper structure, the millhouse, depositing burnt debris into the wheelhouse (which, being damp, would not have burned). This would have been followed by the salvaging of some of the material, including in this case the main wheel-hub and shaft, but leaving behind, fortunately for us, two crucial elements in any functional reconstruction: a wheel-paddle (144, CW4) and the sole-tree with its steel female bearing (154, with IR24) (Pl I). The mill area was then apparently abandoned for long enough for the hollow left by the mill-complex to silt to some depth, with many of the foundation timbers still *in situ.* Such silting could have happened in months rather than years.

A distinction has been made in the text between phases 3 and 4 which is valid only in terms of separating the use of the mill from its destruction. As already mentioned, however, some structural elements included here in phase 4 are really part of the mill as it was in use in phase 3, and should be retrospectively seen as part of that phase, as restored on Figures 80 and 82.

A similar ambiguity applies to the stratification; it is not possible in each and every case to separate layers that are part of the use of the mill — notably silting — from those that are derived from the period of destruction and initial abandonment.

Figure 32 (plan) shows the planks and other timbers which were either loose, or only loosely attached to the foundation timbers, but were in many cases definitely associated, such as horizontal plank walls (notably 151, 172 and 126). Much of their warped and collapsed state is likely to be the result of post-depositional processes. The only one



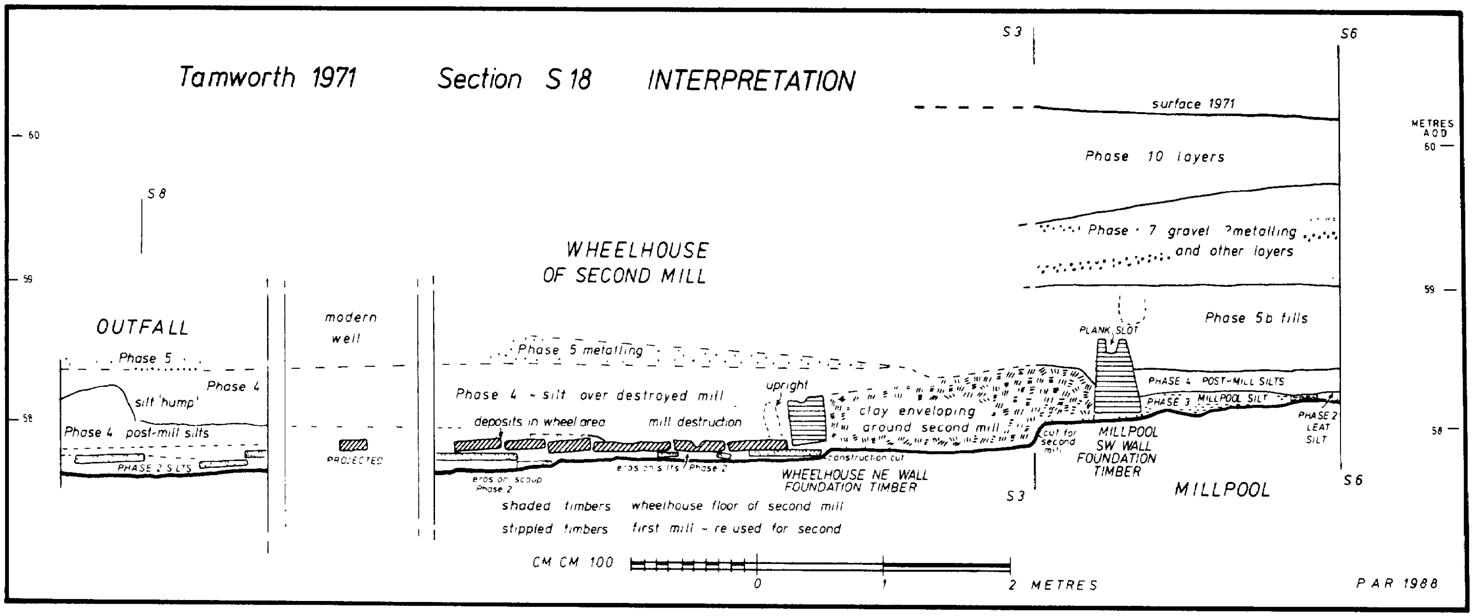




*Figure 25 (above) Section S18 SW-NE: through mill and millpool (mostly reconstructed) Figure 26 (below) Section S18: interpretation and phasing* of these loose timbers that was burnt is the peg-holed plank 152, dumped at the same time as 150 (see below).

170 was the first and principal destruction layer, lying almost directly on the floor of the wheelhouse on its north-east side and extending into the east corner. Its south-west limits are shown here in plan. It extended only to the edge of the sole-tree 154 in a north-west direction. There was no indication that it had been disturbed by the removal of that part of the driving chute which lay within the wheelhouse. This could have been suspended in some way above the floor, so that 170 accumulated beneath it. However, the even distribution of 170 argues against this. It seems more likely that the part of the chute which lay within the wheelhouse was removed after the mill's destruction (the part of it beyond the wheelhouse to the north-east was certainly not removed until much later; see phase 5 below). This suggests that the chute was in two sections.

It seems likely therefore that 170 was not the result of material from above falling onto the floor at the time of destruction, but was dumped on it afterwards. It was, however, before the wheel-assembly was removed, since this left, by its removal, a notable gap in 170 (and 150 above, see below) (Pl I). It has to be remembered that the floor of the mill-house, which formed the roof of the wheelhouse (or was above it), had to be very substantial to prevent any water from below finding its way upwards into the area containing the corn and flour. It looks as if the fire was entirely in the millhouse, and that only later was the millhouse and its floor removed, and the chute segment, before 170 was dumped.

170 consisted of pieces of burnt wood, fragments of millstones, an iron hinge (226, IR16), fragments of red sandstone, and (especially by timber 166, the north-east foundation of the wheelhouse) concreted fibrous greenish-grey material. There was only a thin layer of grey sandy silt below 170, and some grit below that, on the floor below.

Above this material of 170 was 150, extending further to the south-west, but still absent from the area of the wheel-assembly. This consisted of grey-brown silt with some buff sand; in this was decayed wood, branches, twigs and small shells, and charcoal from the burnt timber 152, which was really part of this layer. Finds in 150 include further millstone fragments from several different stone-sets; the wheel-paddle 144; fired clay FC2, 7; burnt clay BC3, 4; lead OM5; and carved wood CW1 and 2. The burnt clay included the remains of the clay bed on which the lower millstone was seated, on the floor of the millhouse above (3.3 below).

Section S18 shows 170 and 150 in relation to each other and to 111 above. This also contained some destruction material, including many fragments of decayed wood, stone (ST5), and millstone fragments. Its matrix was, however, mixed clay (from 34?), brownish mud and charcoal; it still pre-dated the removal of the wheel-hub, spreading over an area similar to 150.

A further destruction layer (170a) was preserved from subsequent erosion by being beneath timber 172, a fallen plank wall further west, part of the outfall revetment. This layer contained more burnt wood, millstone fragments, burnt clay BC5 (millstone seating), lead OM7, and some botanical material.

These are the destruction layers proper. Above them was silt (109, grey-bluish-brown), extending now over the space where the wheel-assembly had been, and over the sands 181 and 181a at its edge, and banking up over the north-east edge of the wheelhouse 166 on to the clay 34 beyond. Merging with this above was a further silt (110, greenish-buff mottled sandy), in which were fragments of two lava querns (104, 106). The difference between 109 and 110 may be more apparent than real, due to different organic preservation.

In the millpool area, section S5 graphically exhibits the collapse of the wall planking of this side of the millpool, under pressure from the clay layers upslope, which had spread over the edge. This collapsed and slumped material extended, as seen in S6, as far as the edge of cut 508.

This cut was parallel to the south-west side of the millpool (see plans, Figs 31 and 32); it is interpreted as the erosion ledge of a secondary stage of phase 4, cutting away the millpool silt 400.

The destruction and silting layers of phase 4 end with the deposition in phase 5, over a large area, of metalling 82. This marked a major change in the use of the area, when substantial parts of the ruined mill structure, including the millpool, still survived among the debris, a sight familiar in our ethnographic observations.

## 2.5 Phase 5: late Saxon-early post-Conquest (plan, Fig 33)

(fuller version in MF)

### *Introduction*

The features of phase 5 span the period of the reoccupation of the mill area for quite different functions. Phase 5a comprises the features on the west side of the site, and 5b those on the east side. The timespan is broadly that from late Saxon times to the early 12th century.

The date of its inception depends on the date of the mill (after *c* AD 855), the length of its life and the timelapse needed to account for the post-mill silts. Assuming the second mill *is* mid 9th century, and had a life of decades, then some date in the later 9th or early 10th century might seem appropriate for the layers immediately over those of phase 4. However, almost the only reliable dating evidence comes from higher levels in the eastern part of the site; pottery here is unlikely to be earlier than the second half of the 11th century.

In phase 5a, some broad dating is given by a horseshoe (99 = IR8), which is dated 11th-late 13th century, in the stone road 7; there is also a sherd of mid 11th-12th century date (159) recorded as being from metalling 82 (see below) in a rather unreliable context. In the eastern area there is one sherd of shelly ware in the lowest levels of phase 5b which is likely to be pre-Conquest.

Principally because of the machine cuts in the central part of the site, there was only one stratigraphic link (gravel spread or metalling 82) between the western and eastern areas, and this in places was tenuous and ambiguous; as it spans the areas of both phases 5a and 5b, it is designated as of phase 5.

The features and layers on the west side of phase 5a are not only spatially and functionally distinct from those of phase 5b to the east, but are also probably earlier in their inception (see below).

## **Phase 5a** (plan, Fig 33; sections S1, S7, S8, S18, Figs 6, 14-16, 25, 26; S16, MF Fig 23)

The features of this phase consist principally of two or three successive roads of brushwood, gravel, and stone, the former set partly in areas cut or worn away in the slope (22, 24).

The earliest feature here was 24; its fill was finally capped by gravel (444) probably associated with stone road 7 (see below). Cut 22 was filled with part of the brushwood and timber road (23), but clearly was not dug to receive it. Both cuts may be the result of erosion of the lower part of the slope in a limited area when traffic began to be heavy in a linear movement zone.

As seen in S7, metalling 82 is stratigraphically below timber road 23; further east 82 merged with the timber and brushwood. It spread across the site as a single layer, and forms the basal layer of the phase 5b sequence in the eastern part of the site.

Road 23 (Pl IX) consisted of a widely-spaced series of re-used posts set in a matrix of gravel and fibrous woody debris. It was contained in a limited zone under 4m wide, but there were no ruts or areas of specific wear.

The timbers within 23 (CW3 and 15; and see Pl X) are mostly pointed, ranging in length from 1.2 to 2.8m. They have peg holes, and one peg was in position; they are clearly re-used from some structure, probably a substantial fence with a pegged top rail.

Above this was a further layer of dense gravel (444, see S7, and MF Fig 23, S16a) probably bedding for the stone road 7. This was of slabs of shelly limestone, their surface very worn and smooth. It extended further north than the timber road features, and may indeed have been a regular lane off the predecessor of Bolebridge Street. A horseshoe in 7 (99 = IR8) suggests something more than foot traffic.

The most likely destination of all these roads was of course the River Anker, where there may have been a wharf, jetty or landing stage (cf phase 8 below) or even a building on the north bank of the river; or there may have been a ford or bridge, a matter discussed further in relation to phase 6 below.

Other features of phase 5a include some posts and sockets, and a deposit of a pig, with the skull of a goat (143: see 3.15).

## **Phase 5b** (plan, Fig 33; sections S3-S6, Figs 8-13)

The features of phase 5b extend from the eastern part of the mill as far as the eastern edge of the excavation represented by sections S5 and S6. They comprise the robbing holes of different sub-phases for the timber chutes between the wheelhouse and the millpool, and possibly for other timbers of the superstructure of the mill and millpool. These holes were filled and silted, and were succeeded by a series of layers including gravel spreads or metalling, and other minor features, which cannot be interpreted satisfactorily in such a limited area.

All of these events are later than the gravel spread or metalling (82) which extended over the area of the abandoned mill. This, as we have seen, was broadly related to the earlier levels of phase 5a on the western side, though not unambiguously. The earlier layers and features of phase 5b cut 82, and should be later than the timber road 23. While some part of the 5b sequence could be contemporary with stone road 7, the upper levels of phase 5b yielded a number of sherds, but there were none in either the timber or stone roads on the western side. This negative evidence may not, however, be conclusive evidence of an earlier (aceramic) date for the roads: though Meeson, digging areas further east of the 5b levels, of contemporary date, also records the absence of sherds.

In plan (Fig 33), on the west side of S3, and mostly showing in section there, were timber-robbing holes. Of these 114 was the earlier, later than 82 as here defined, but, with its fill 368, under all later layers in this mill/millpoo1 area. Sherd 114a, in 368, is probably late 9th-10th century in date; this is no better a *terminus post quem* for 368 and all layers above it than the dendrochronological date for the second mill.

Cut 114 was the emplacement for the lower part of the driving chute; 370 was a wider robbing hole for digging this out, or possibly for some extra supporting timber. After this, silt accumulated (240), and then there was further robbing of other timbers of the by-pass chute and other adjacent parts of the wheelhouse and millpool structures. Sandstone blocks in the base of 80, one burnt, may have been associated with the mill when it was in use.

The upper silts and fills above 240 yielded sherds, including Stamford ware of *c* AD 1050-1100, and there was some gravel ?metalling (49 and 49a).

*Plate IX Timber road 23 from NW; timbers with woody material between (phase 5a)*

*Plate X Timbers 23a-f (CW15) of timber road 23 (phase 5a)*

The dating of phase 5b extends from the destruction of the second mill and its first robbing (in the later 9th or 10th century) to sometime later than *c* 1050; there may have been a temporal hiatus to account for the apparently missing decades, but no clear interface is visible in the stratification. There are no sherds which need be later than the Stamford ware; a date terminating at the end of the 11th century, or soon after, in the early 12th, seems likely for phase 5b.

No extension of these layers was seen in 1978, nor were any sherds found there of Stamford ware, etc (2.14-2.15 below).

## 2.6 Phases 6-9: medieval (plans, Figs 34-6)
(fuller version in MF)

### *Introduction*

Phases 6-9 comprise features and layers of the 12th-16th centuries and later. Phase 6 includes features which appear to signal the inception of the town defences and are characterized by 12th century sherds, without any of the Stamford ware characteristic of phase 5b. Phase 7 comprises some gravel dumping or metalling, probably in the 13th century in the millpool/leat area, followed by further robbing of the timbers of the south-east side of the millpool.

Phase 8 includes the main component of the town ditch system, ditch 90 and its fill, and other features of the 13th or 14th centuries. Phase 9 comprises a few layers and features with late medieval pottery of the 15th-16th centuries; by this time the town ditch was filled up.

This is a prelude to post-medieval development of the site which led to the recent topography of the area. The separation of features of phases 8 and 9 is rather subjective in some cases, based on the unreliable evidence of pottery in fills.

### Phase 6 (plan, Fig 34; sections S6, S7, S8, S19, Figs 12-16 and 27)

The only features shown in plan (Fig 34) of phase 6 are the various cuts and edges which comprise the earliest phases of the medieval town ditch.

The layers and features of phase 5 were cut by this series of edges at different levels. It is argued that they were cut, rather than stopped at these points; the possibility may be considered, if only to be rejected, that the timber, gravel and stone roads on the west side (Fig 33), and metallings on the east side, were contemporary with, and on the edge of, the ditch as cut in its first phase, and were there in its earliest period of existence.

It might be assumed, in any case, that any layers on the inner (north) side of the ditch complex must be earlier than the various cuts, since there would have been a bank on this side which would have sealed them. This could indeed be true over the greater part of the circuit of the medieval defences. There are indeed some layers which could be interpreted as the residues of such a bank for the later ditch 90, of phase 8 (S7, Fig 14), which never survived as a feature of the landscape in this area in late medieval times, in contrast to such features in other towns in the Midlands. There is, however, always the possibility of gaps in the defensive bank, not only for major gates, but for minor access to points outside; or even of unfinished sections.

There may have been such gaps in the area of the present excavation though not necessarily as causeways in the ditch. There is ambiguous and tenuous evidence in the excavation (apart from the roads of phase 5a) for some crossing of the ditch area in this phase by a bridge. The destination on the southern side would have been the River Anker, which may have come close to the medieval ditch at this point; so close in fact, that ditch and river may have merged, the river becoming a defensive ‘moat’ further west, nearer to the castle; or the ditch and river may have merged only at periods of flood (see 3.13 below for evidence of marshy conditions at the base of the medieval ditch 90).

It is unfortunate that there is not more evidence for the location of the river bank in medieval times. It may be assumed to have been a little to the south of the excavated area in late Saxon times, because of the necessity for the mill leat to have had some elevation for its outfall. In this connection it may be noted that the present river bed beyond the area (Fig 4) was in 1971 at 57.84m AOD, over 30cm *higher* than the base of the outfall at 57.52m AOD on the left of section S19. It seems likely on this evidence that the river level is substantially higher today than it was in late Saxon times. There is evidence in section S12 (MF Fig 19) that its bed may formerly have been as low as *c* 56.00m (the level of undisturbed red clay); but it can also be seen from this section that the water or mud level in medieval times, where the first ?rubbish layers were encountered, was nearly as high as 57.70m (the surface of the grey-brown alluvium).

It is probable therefore that the water level of the river was not far, if at all, below the deepest part of the town ditch as finally cut in phase 8, at *c* 56.50m (see S7) and may well have been higher, especially at times of flood.

To summarize, it seems likely that the level of the river in late Saxon times was sufficiently below *c* 57.50m AOD to allow a free outfall for the water issuing from the mill; that by the 12th-13th centuries, the water level had risen, possibly due to constraints further downstream (a weir or bridge?); and that the river was not far away from the medieval town ditch in this area, or was merging with it.

The bank of the river may thus have come quite close to the excavated area by the 13th-14th centuries (see phase 8 below). In discussing phase

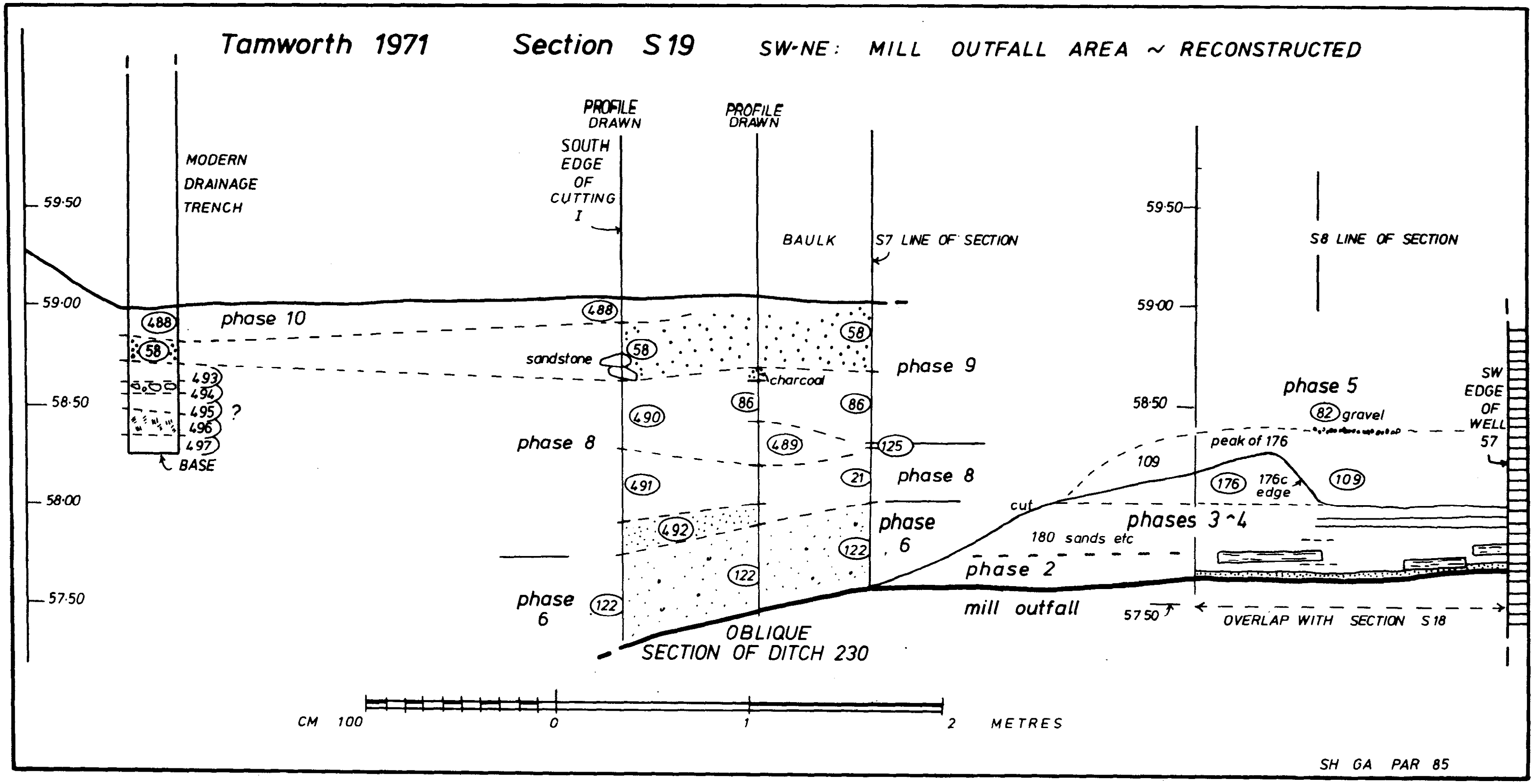



Figure 27 Section S19 SW-NE: mill outfall area (reconstructed)

*Plate XI Timber complex 517, etc in SW corner of site, from NE (Phase 8)*

*Plate XII Barrel-urinal 142 from SW (phase 10)*

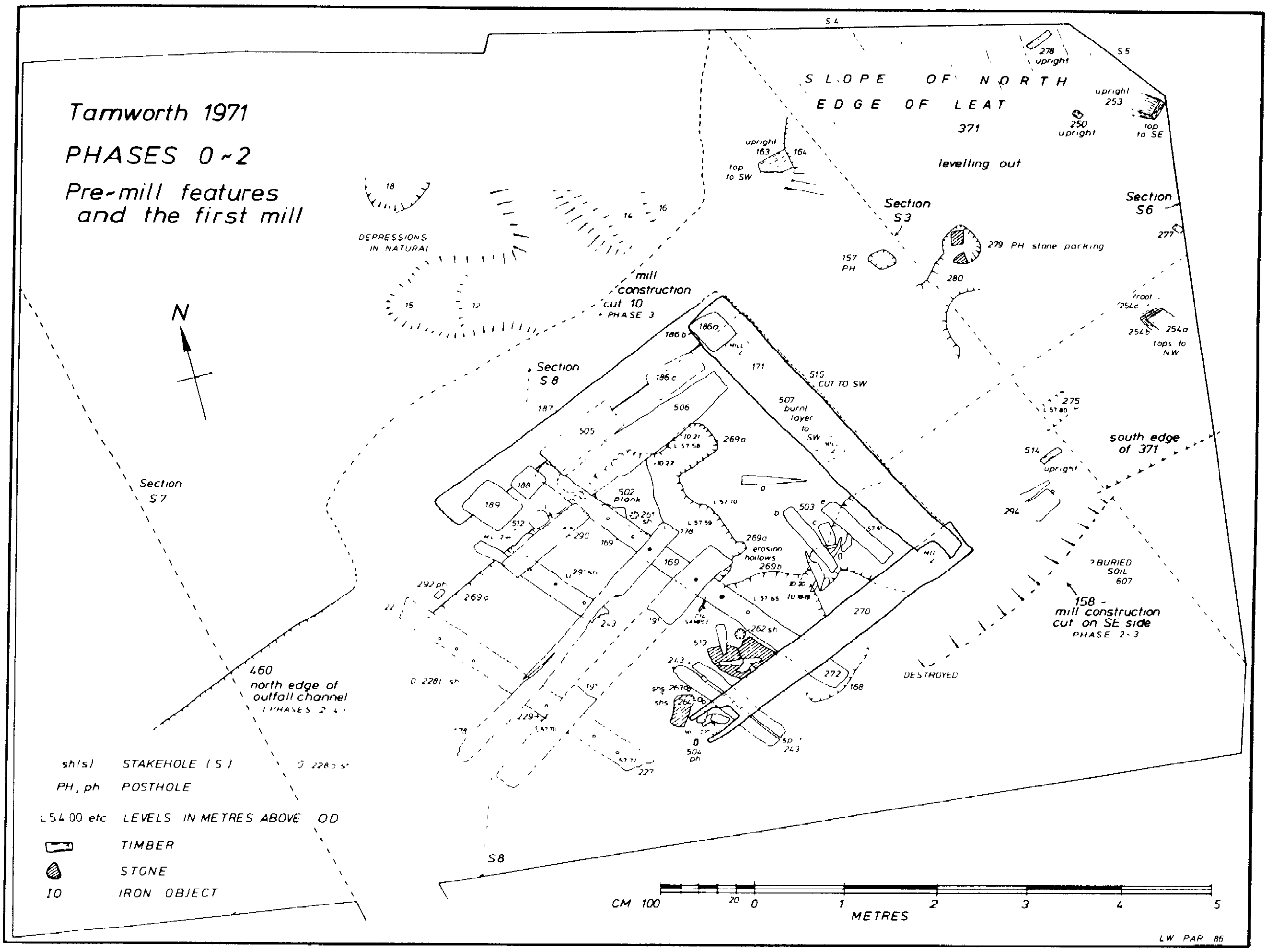



*Figure 28 Phases 0-2: pre-mill features and the first mill (mid 9th century and earlier)*

6, however, the possibilities are rather of a bridge or other crossing of a wet ditch to get to the riverside.

The earliest cuts in the medieval town ditch sequence are generically designated 230 (Fig 34); all are secondary to phase 5 contexts. In most places only the northern edge or slope of 230 was seen, the southern part being cut away in phase 8 by ditch 90. In the eastern area (as in S3 and S6, Figs 8, 9 and 12, 13) no such primary feature was seen between phases 5 and 8, except for feature 281 (see S6 and phase 7 below).

230 is interpreted as the first stage of the medieval town ditch complex; however, the components seen in the excavated area were very irregular, in plan looking more like a series of scoops in the northern slope of the later ditch 90.

In section S7 (Figs 14 and 15), 230 had a long inner slope; the fill here may be dump rather than silting — possibly the original upcast from 230, piled up as a bank and later pushed back; or the upcast from 459. In the top of the fill were features tentatively interpreted as the residues of a bridge abutment, including possible planking in 101. Although not very convincing, the possibility should be considered because of the roads leading to here in phase 5a, and the existence of a way here in more recent centuries (1.2 above).

All the sherds which can be assigned to phase 6 are 12th century or earlier, except for one in the abutment feature 101b, which could be 13th century. This could be intrusive from phase 8 levels above, or belong to a final abandonment phase. These sherds provide the principal broad dating for phase 6, in the 12th century, perhaps ending *c* 1200.

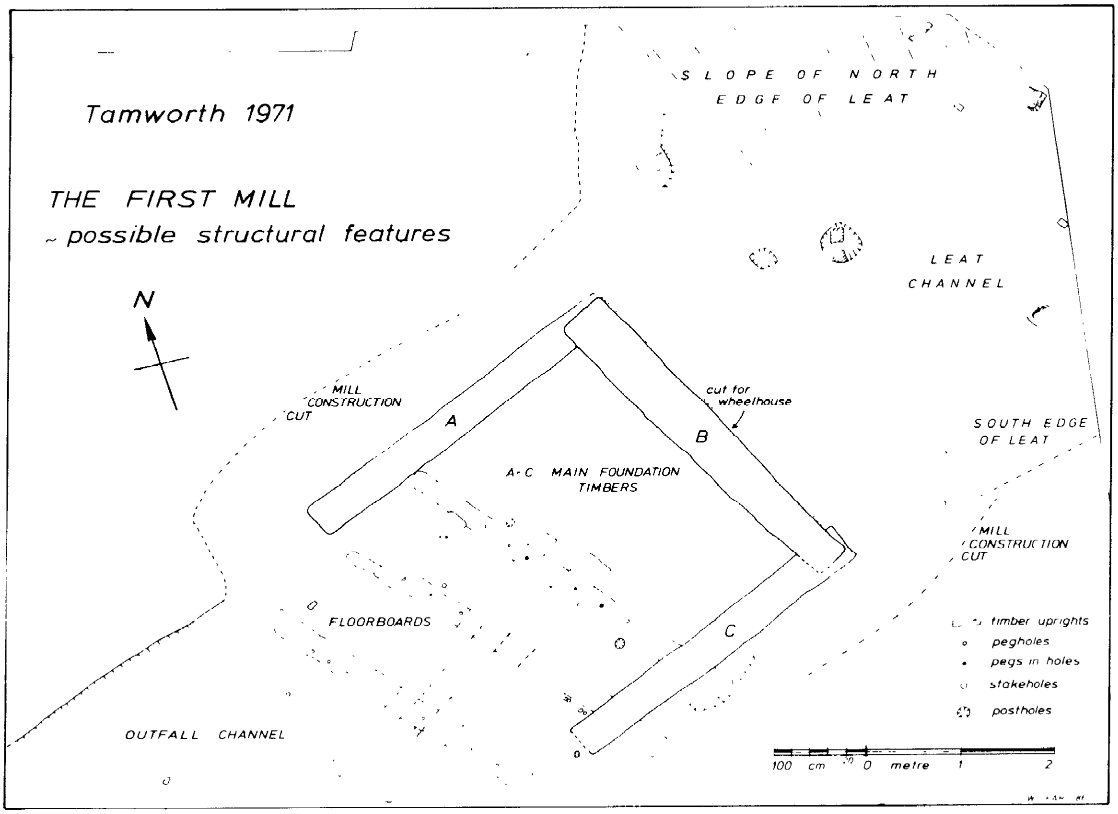



*Figure 30 The first mill: possible structural features*

## **Phase 7** (plan, Fig 34; sections S3-S6 and S18, Figs 8-13 and 25, 26)

The later layers and features in the millpool area are differentiated from those of phase 5b because they yielded sherds that are notably later than those of phases 5b or 6, extending into the later 12th or 13th century (see Fig 9 for distribution of sherds in this area). There is apparently a temporal hiatus here, though the stratified sequence looks continuous; it is clear, however, that the features and layers grouped as phase 7 are earlier than the main medieval town ditch 90 of phase 8.

The lowest stratified sherd that is dated later than *c* 1200 is in 69 (section S3), with others of similar date in layers above, and some residual from phase 5b. These latest layers of gravel ?metalling in the millpool area should therefore be later than *c* 1200, and so too may the two post holes further north (202-3 in plan, Fig 34) which cut 49a and 65.

This *terminus post quem* can also be applied to the secondary major cut 231 (Fig 34 and section S6) interpreted as a robbing hole to remove the timbers which formed the south-east side of the millpool, though the hole seems over large for the purpose; this cut is earlier than the digging of ditch 90, which is also given a *tpq* by the sherds in these layers, of *c* 1200. Further east, in the 1978 area, 231 appears to merge with an erosion channel draining to the east (2.14 below); it is possible that the size of 231 itself is due as much to erosion as to timber-robbing; and the two may of course be associated.

One feature appears to be intermediate between phases 7 and 8. This is the cut 281, known only in section S6; it had a large flat stone in its top, with twigs above and below. A continuation of this feature was found in 1978 (ditch A145), draining eastwards, with 13th century sherds; 281 must be near the west end of this ditch (see 2.15 below, and Figs 5iv and 46). In the 1978 area it was clearly secondary to the erosion features of 1978 phase 3c, but in both areas it was cut by the medieval town ditch.

## **Phase 8** (plan, Figs 35 and 36; sections S3, S6, S7, S8, S19, Figs 8-9, 14-16, 27; S16c, S17, MF Figs 23, 24; Pl XI)

The principal features of this phase are the latest and main cut of the medieval town ditch 90, and the later ?jetty complex 517 in the extreme south-west corner of the main excavated area. There are also some features on the slope between

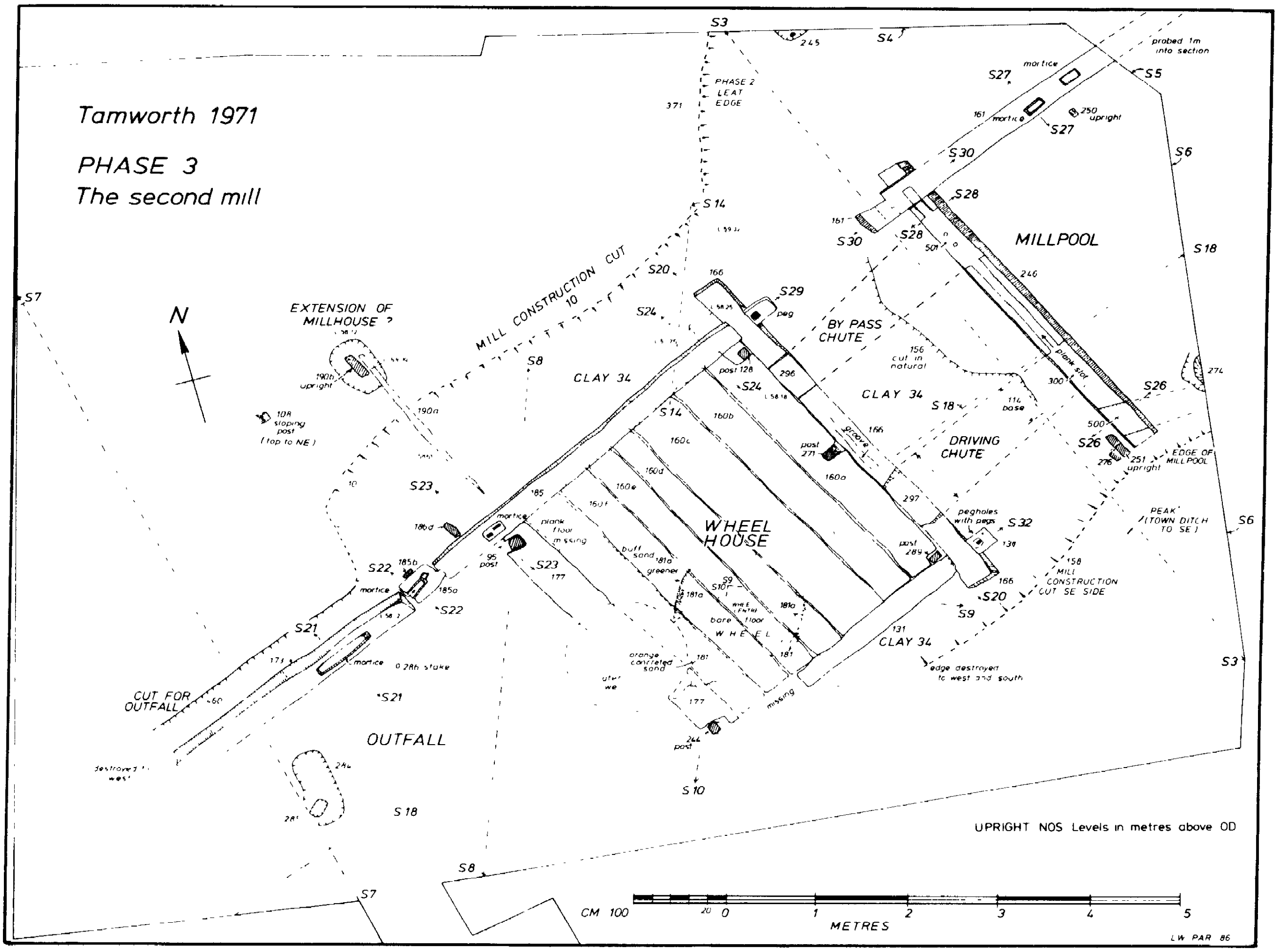



*Figure 31 Phase 3: the second mill (later 9th century)*

here and Bolebridge Street; and the main filling of 90. All these are later than *c* 1200, the latest associated sherds being of 13th-earlier 14th century date.

Ditch 90 appears on plan (Fig 35) as a fairly regular cut west-south-west to east-north-east, several metres wide and two or more metres deep. Variations in the edges as plotted are due to the different levels at which the edges were defined; this depended on the depth to which later contexts had truncated the edge or fills.

A date after *c* 1200 seems likely for ditch 90, from the evidence of the sherds in 1971 phase 7 and 1978 phases 7-8. The ditch subsequently silted up in the 13th century, and there was then rubbish dumping (see S7, Figs 14, 15) on a large scale: a stage of total neglect of the town ditch as an element of defence. Sherds in this fill are of 13th or earlier 14th century date, and leather from here is dated to later than *c* 1350 (3.16) (see also 1978 pottery from this ditch, 2.16 below).

In the area between the ditch and Bolebridge Street, there is evidence of contemporary occupation — black ashy soil, post holes, stone groups and residues of smithing or smelting. This activity seems to be largely confined to the western side of the site, the eastern area being relatively clean, to judge by the fill of ditch 90 as seen in S3 and S6 (Figs 8, 9, 12, 13).

The complex 517 in the south-west corner is more substantial (Pl XI). Its features were immediately below post-medieval layers, but none of the associated pottery is later than the 13th-earlier 14th century. No stratigraphic relationship was established between this and the sequence shown in S1 and S7 (Figs 6 and 14, 15), but 517 lay on apparent river-edge levels. It consists of 139, a large post-pit containing two timbers; one (136) 50cm in diameter; the other (137) 95cm long; and an ovoid pit (147) filled with woody material and moss, to a depth of 80cm, with sherds and leather.

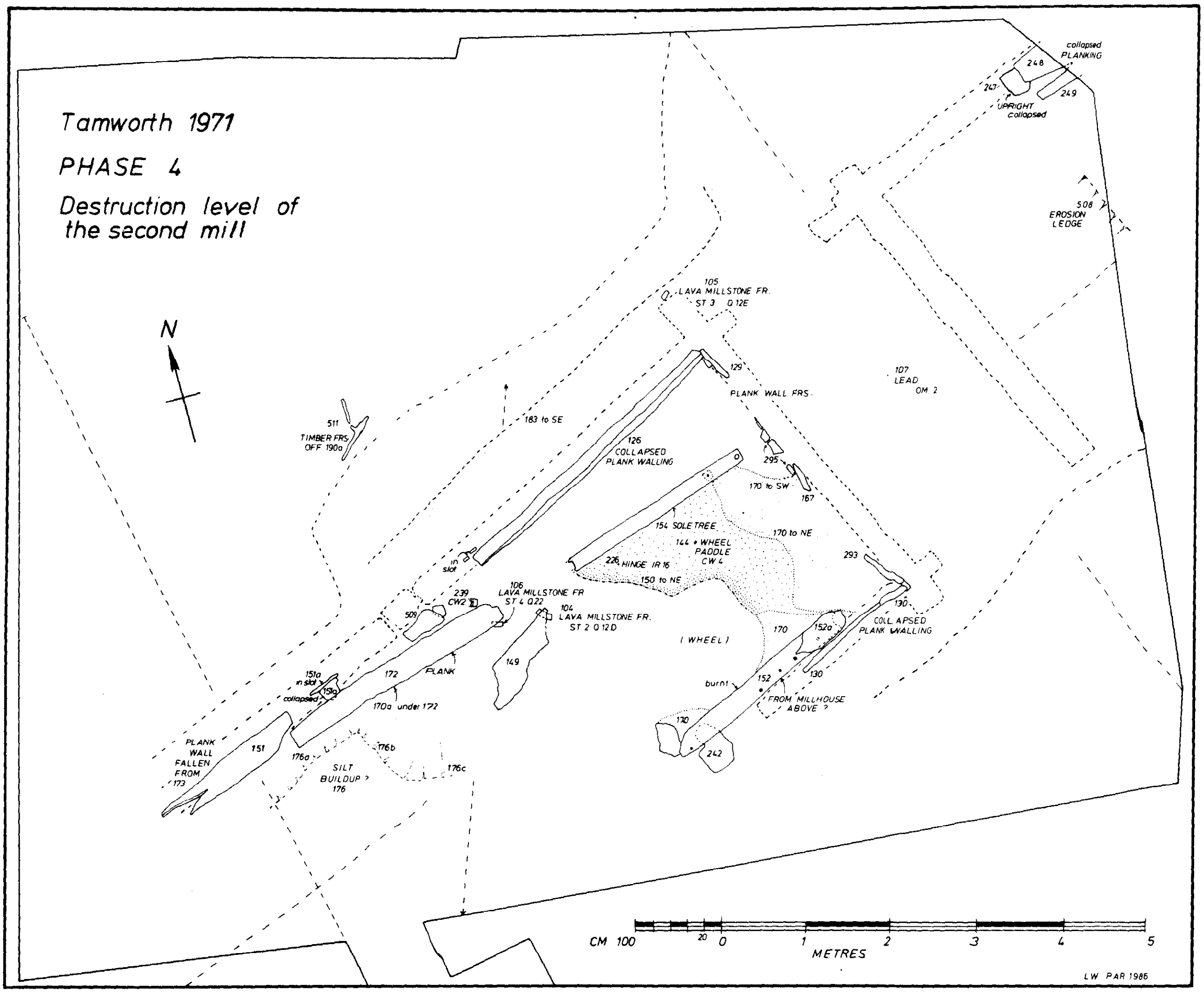



*Figure 32 Phase 4: destruction level of the second mill (later 9th-10th centuries)*

The whole complex might be associated with a jetty, 147 holding a big mooring-post, decayed or dug-out; replaced by 136 and other posts further north. This interpretation should be seen in the context of the general discussion of roads in this area leading to the river bank at different times.

### **Phase 9** (plan, Fig 35; sections S1-S19)

The latest medieval layers and features appear to be separate from those of phase 8, and cannot be demonstrated to be continuous with them. Associated pottery is of the later 15th-16th centuries; the sharp distinction between this pottery and that of phase 8 may be due at least partly to the well-known problem of identifying pottery of the later 14th-earlier 15th centuries, or may represent a genuine hiatus.

Little can be said of the possible building or buildings, or the industrial activity, on the scanty evidence available, and the comparative lack of attention it was possible to give these features. It is unlikely that they are all even contemporary; the sections indicate the complexity better than the plan.

## **2.7 Phase 10: post-medieval** (plans, MF Fig 37 and Fig 38; Pl XII)

Most of the post-medieval levels were removed mechanically Some features were recorded in the early part of the excavation, notably those that extended deeply into medieval or earlier levels. The rest were observed only in section, and where they appear in plan on Fig 38 it is only in some cases by measurement from the sections. The sunken feature 56 with its post hole and post-impression 376, is dated by post-medieval sherds of the late 17th century-c 1750; but there is late medieval pottery in this as well, and the feature may have been in use in phase 9.

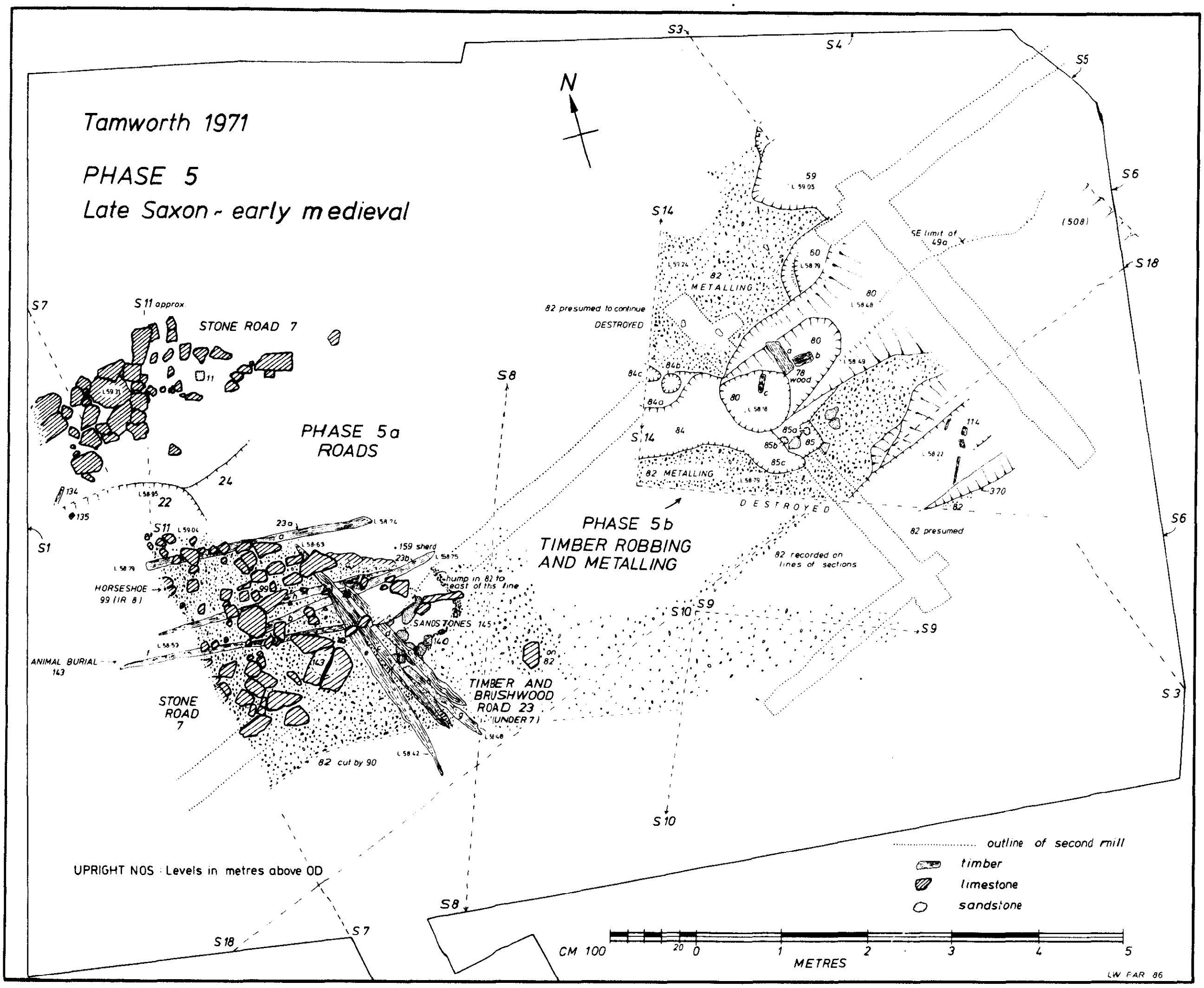



*Figure 33 Phase 5: the timber and stone roads on the western part of the site (phase 5a); and other ?metalling and post-mill robbing and features on the eastern side (phase 5b) (late Saxon-early medieval)*

The post-medieval features and structures extend from the 16th century to 1971, when the area was levelled for car parking. The properties demolished in 1971 comprised 70-74 Bolebridge Street; there were in these at least three phases of timber-framed structures, on brick footings, of the 17th-19th centuries; these were built partly on a layer of red clay, which is layer L1a in the present excavation. The brick footings, some with stone, such as 340 and 372 (S3) are likely to be part of these buildings.

The latest medieval levels nearer to Bolebridge Street have been largely truncated by post-medieval activity and building. Section S2 (MF Fig 7) shows the relationship of layer L3 to the phase 10 structures above it.

Of the features shown on the plan, foundations 28 and 63, with hearth 29 (MF Fig 37), in the north-west corner of the site, may be earlier than the recorded properties. The barrel 142 set deeply into the ground (Pl XII) was perforated in many places, and there were many large pebbles in the filling, with much household rubbish. This is probably a urinal, preceding any proper lavatories in the area. The well, 57, was cut right through the mill, but luckily not in a crucial area. It was lined with ?18th century bricks, and 17th or 18th century pot is recorded from its base, the depth of which was unrecorded (it was presumably seen in the final mechanical destruction of the site). The stone ?culverts 350, 378 in the south-east corner appear to be aligned parallel to Bolebridge Street. The stake holes along the north-east edge were probably former fence posts.

The latest features are the major sewers encountered in the western part of the site, running from north to south, presumably emptying into the river.

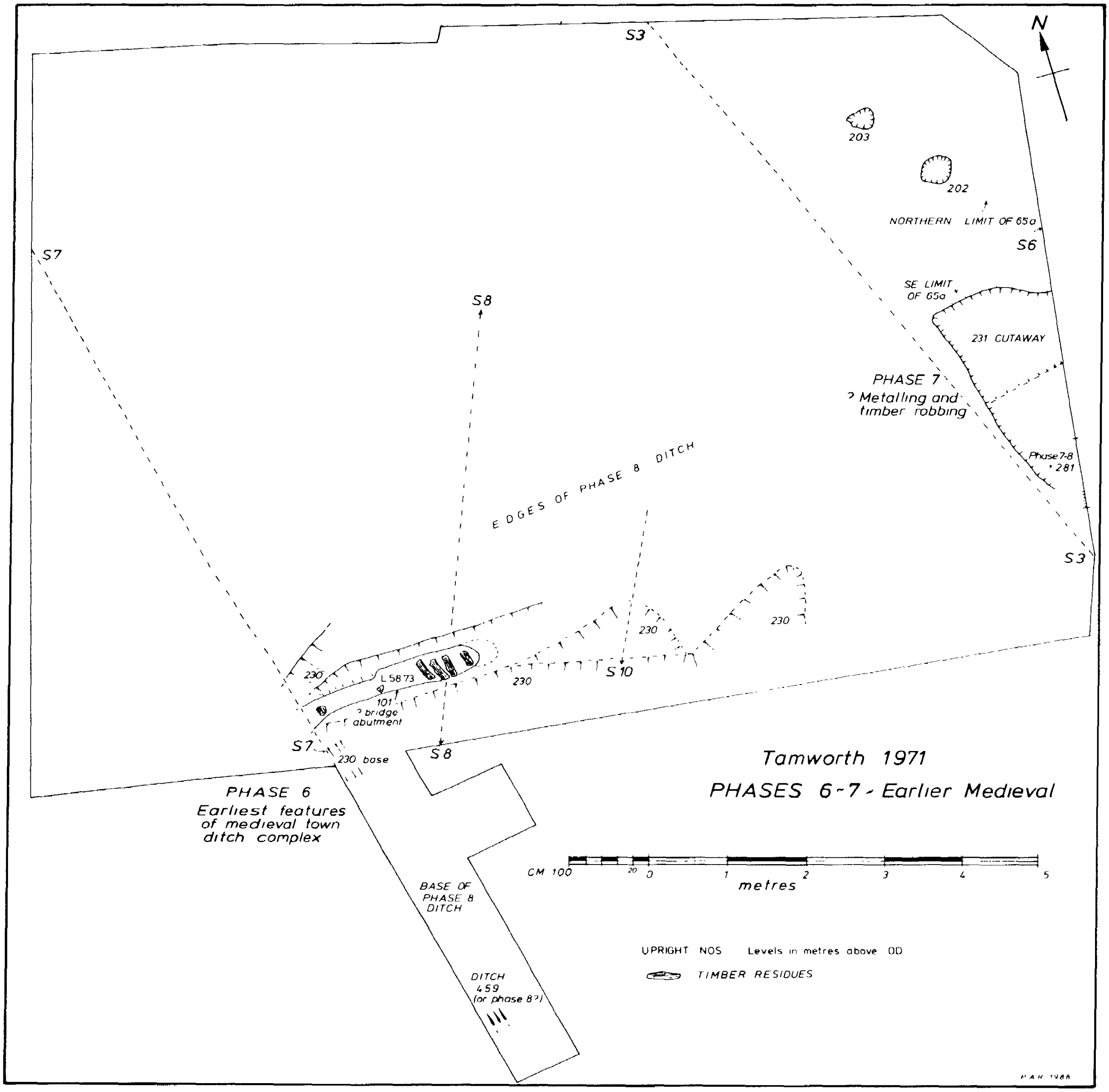



*Figure 34 Phases 6-7 earliest features of the medieval town ditch complex (on the western side) (phase 6); and ?metalling and timber robbing (on the eastern side) (phase 7) (earlier medieval)*

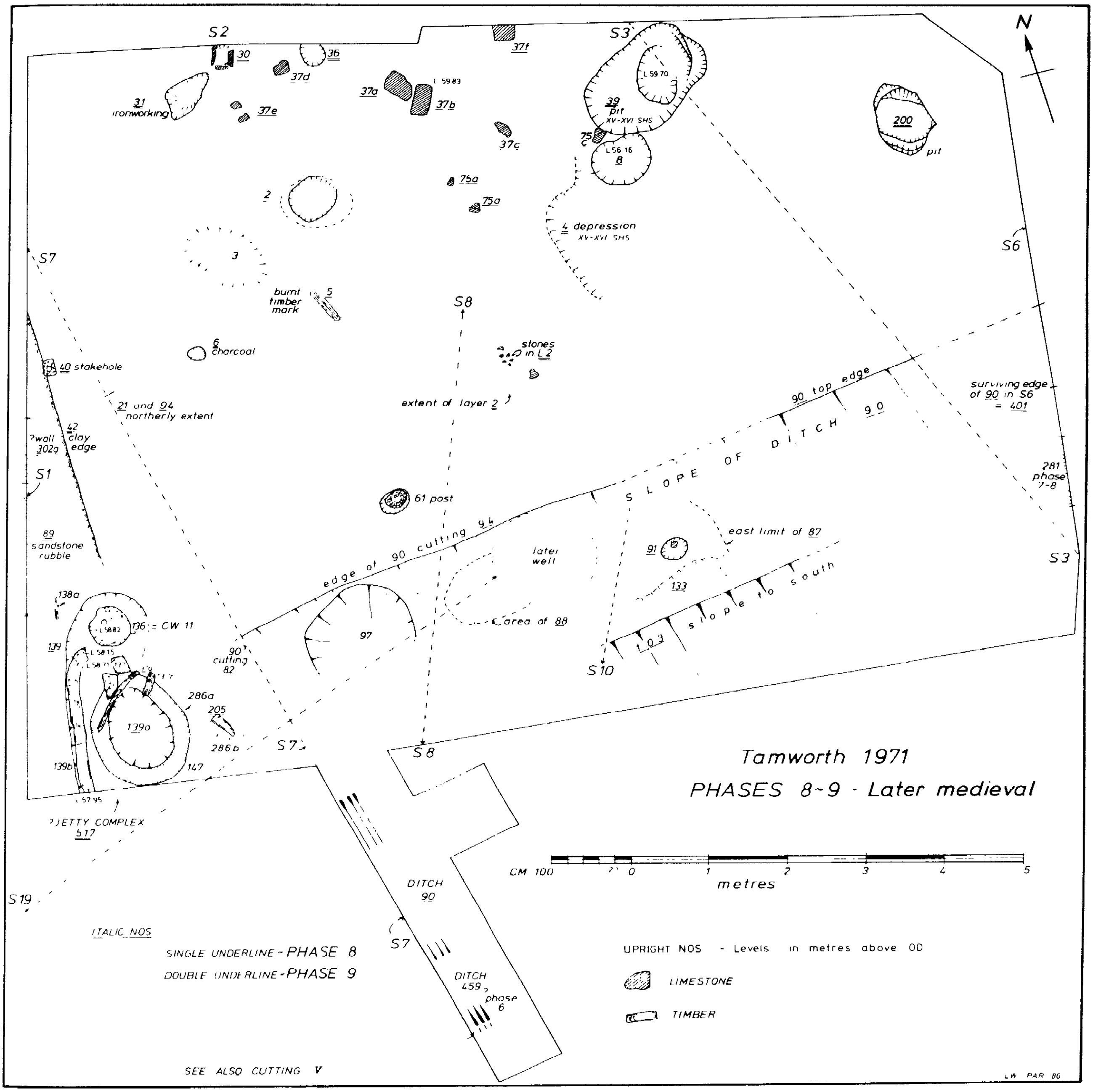



*Figure 35 Phases 8-9: the town ditch and other medieval features (later medieval)*

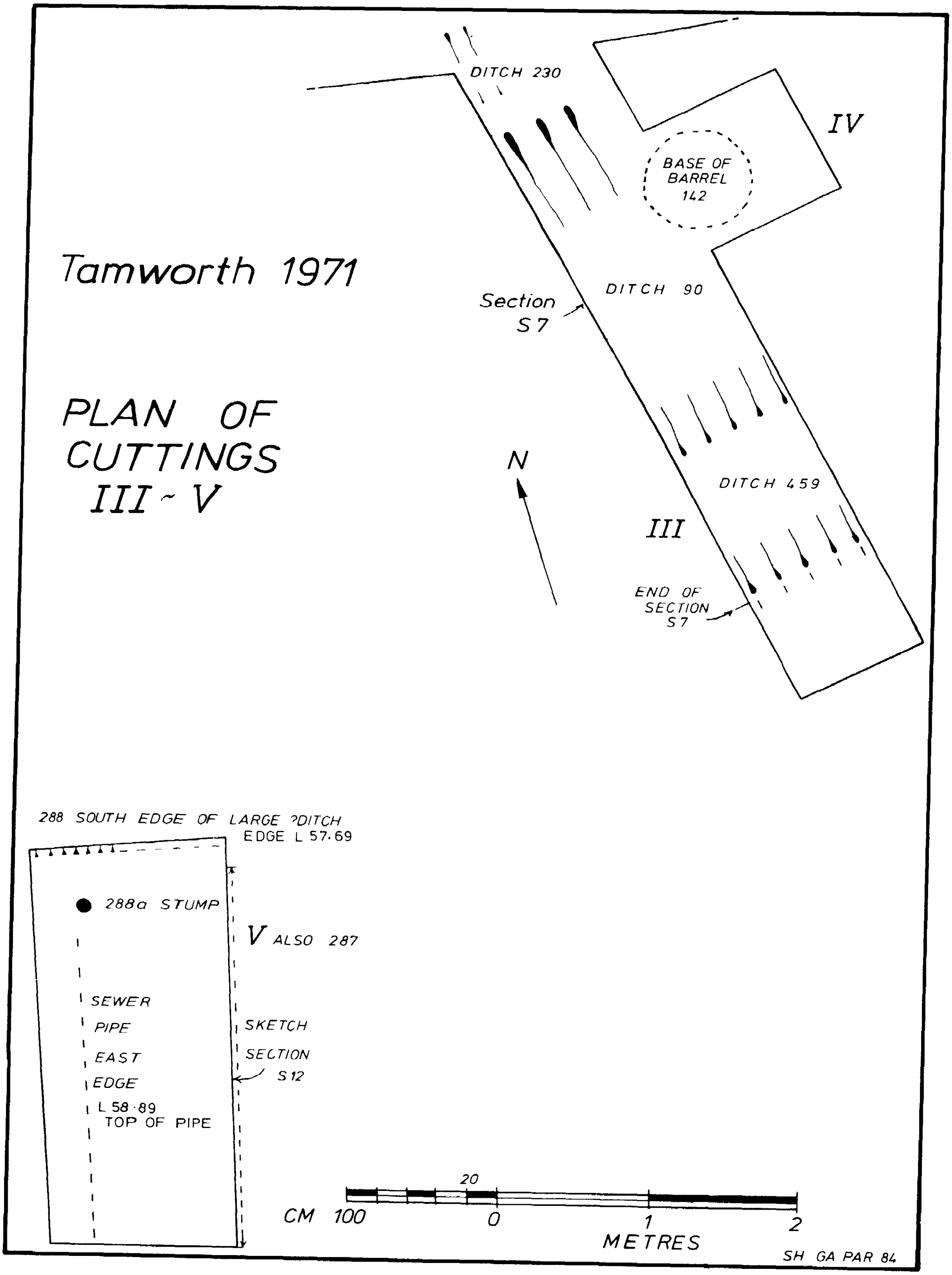



*Figure 36 Cuttings III-V (1971)*

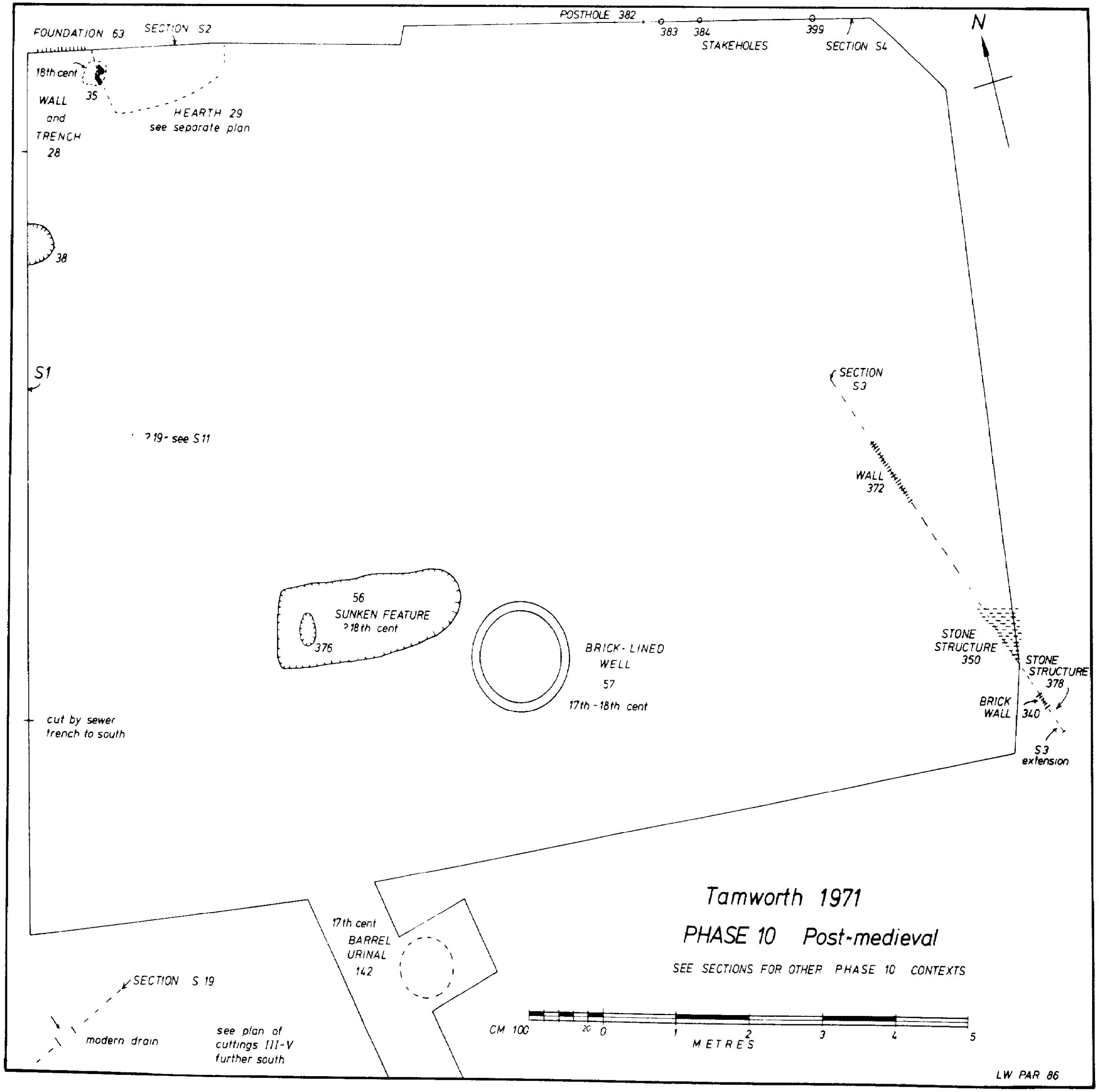



*Figure 38 Phase 10: post-medieval layers and features*

## 1978 Millpool and leat area by RM
(fuller version in MF)

### 2.8 Objectives of the excavation (plan M1, Fig 39)

The primary objective in 1978 was to locate and record whatever part of the millpool or leat that extended into the available area, and to recover further environmental samples from waterlogged areas to supplement those of 1971.

### 2.9 The chronological sequence: summary of phases (plans M1-M9, Figs 5,39-57, sections S51-S58, Figs 47-54)

The sequence in the 1978 area differed in detail from that defined in 1971. However, as set out here it is correlated with the phasing developed from the 1971 work.

| | Phases |
|---|---|
| Intrusions into the Keuper (Triassic) Marl | 0 |
| First phase leat | 2 |
| Second phase leat: | |
| (a) the leat and its revetments and a putative bridge | 3 |
| b) deposition and erosion of silts in the leat | ?2-5 |
| c) erosion channel A!264 | 7 |
| First medieval ditch (A145) and bank or causeway | 7-8 |
| Second medieval ditch A266 | 8 |
| Fill of ditches; colonizing of ground towards river | 8-9 |
| Metal-working and further colonization | 10 |
| Later features and standing buildings | 10 |

### 2.10 Phase 0: intrusions into the Keuper (Triassic) Marl (sections S51-S53, Figs 47-9)

Some disturbance of the natural clay and a number of intrusions were noted, as shown in particular in section S51 (Fig 47). They are interpreted as part of the Keuper Marl layers, with root disturbance, and possibly intrusions of water-borne gravel.

### 2.11 Phase 2: the first leat (plans M1, M6 (MF) and M7, Fig 39, MF Fig 44 and Fig 45; sections S51, S53 and S56, Figs 47-9 and 52)

#### *Introduction (plan M1, Fig 39)*

The eastern limits of the 1971 excavation are represented in sections S5 and S6 (Figs 11 and 12). It was hoped that a similar sequence could be discerned in the 1978 excavation east of these, but the northerly parts of the features recorded were sealed by an extension of Bolebridge Street to the south. The 1978 section S52 (Fig 48) was parallel to S6 (Fig 12) and only 1m from it; the baulk between them was excavated in its upper levels, but not further down, because of the danger of collapse. Ditch A145 (plan M5, MF Fig 43) was followed through to section S6. The relationship of the 1971 and 1978 areas is shown on plan Ml (Fig 39), and the area context is illustrated on Figures 4 and 5.

#### *The first leat and its southern revetment (plans M6 and M7, MF Fig 44 and Fig 45; sections S51, S52, Figs 47, 48)*

The leat was located traversing the north-west part of area A, 2m of its width being defined in section S52. The base was at *c* 58m AOD, slightly lower than the base as seen in 1971 section S6 (Fig 12), rather than higher, as would be anticipated. The eroded base of the leat may have been uneven to this extent (l0-20cm), or there may be a slight error in the levels as between the 1971 and 1978 excavations (the bed of the leat has a gradient of *c* 1 in 27 on section S53, Fig 49). A primary sandy layer (255 in S52, Fig 48) should equate with 417 in 1971 section S6 (Fig 12).

The line of a suggested south edge to the leat and its revetment is shown in plans M6 and M7 (MF Fig 44, Fig 45), and individual elements are displayed in sections S51-S53 (Figs 47-9). The principal component of the suggested revetment is A150 (a and b), in the middle of which were two possible post holes, or timber-robbing holes, A151 and A171. Further east there was another feature on this line, All7 (see S51, Fig 47), but this could be a natural depression. Further east again (on plan M7, Fig 45) there was another hollow, A256, but this is not very convincing as a structural feature. Confidence in the line of the revetment is, however, reinforced by the character of the natural clay surface (A187) on either side of A150. To the north the clay had a water-worn, potholed surface with deposits of silty sand in the hollows; to the south the surface was dirt-stained, and although uneven there were no potholes. The line separating these two could be traced eastwards beyond trench A, but not as far as A256, there being some irregular cuts or hollows interrupting the alignment here (plan M7, Fig 45).

The south edge of the first leat as thus defined should extend to the line of 1971 section S6 somewhere between the intersection of S6 and S18 and the later post hole 274. This area is, however, heavily disturbed by later erosion and timber-robbing features in both the 1978 area and that cut by 1971 section S6 (Figs 12, 13). The general line of the south side of the first leat is nevertheless clear from the rise in level of the natural to the south, as seen originally in 1971 section S6 and here as cut 265 through 252 and 253 on section S52 (Fig 48).

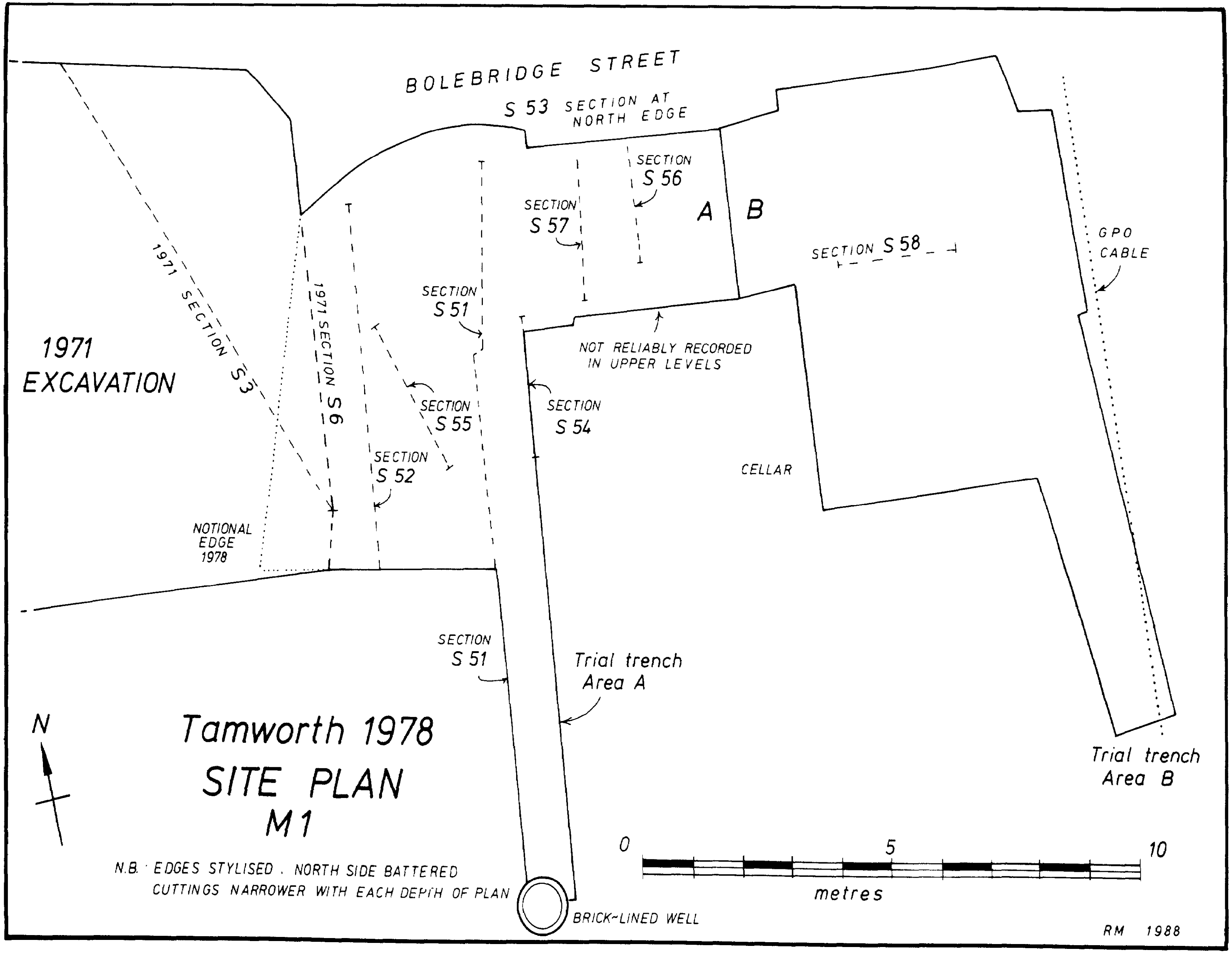



*Figure 39 1978 Site plan M1*

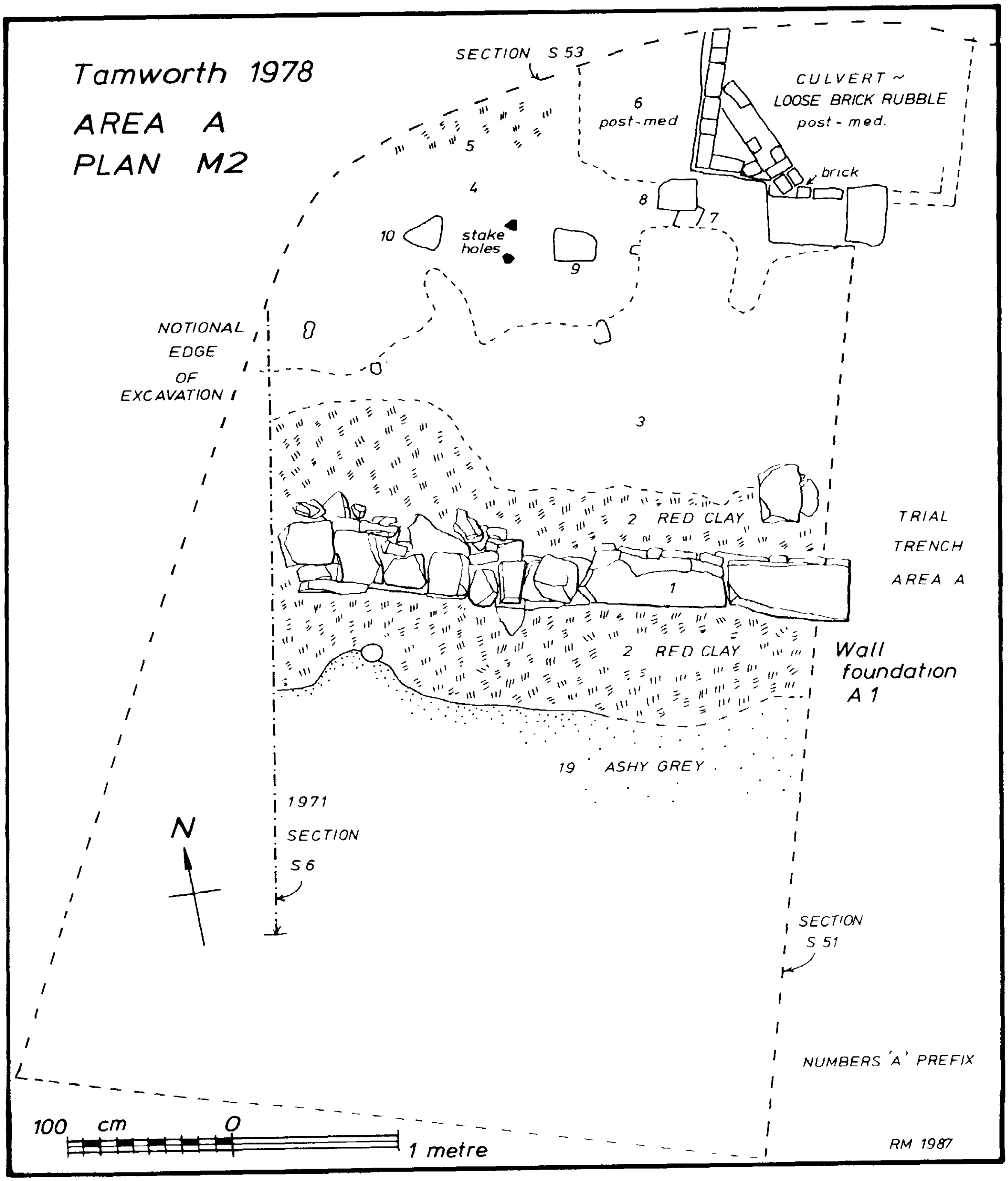



*Figure 40 Area A (1978), plan M2*

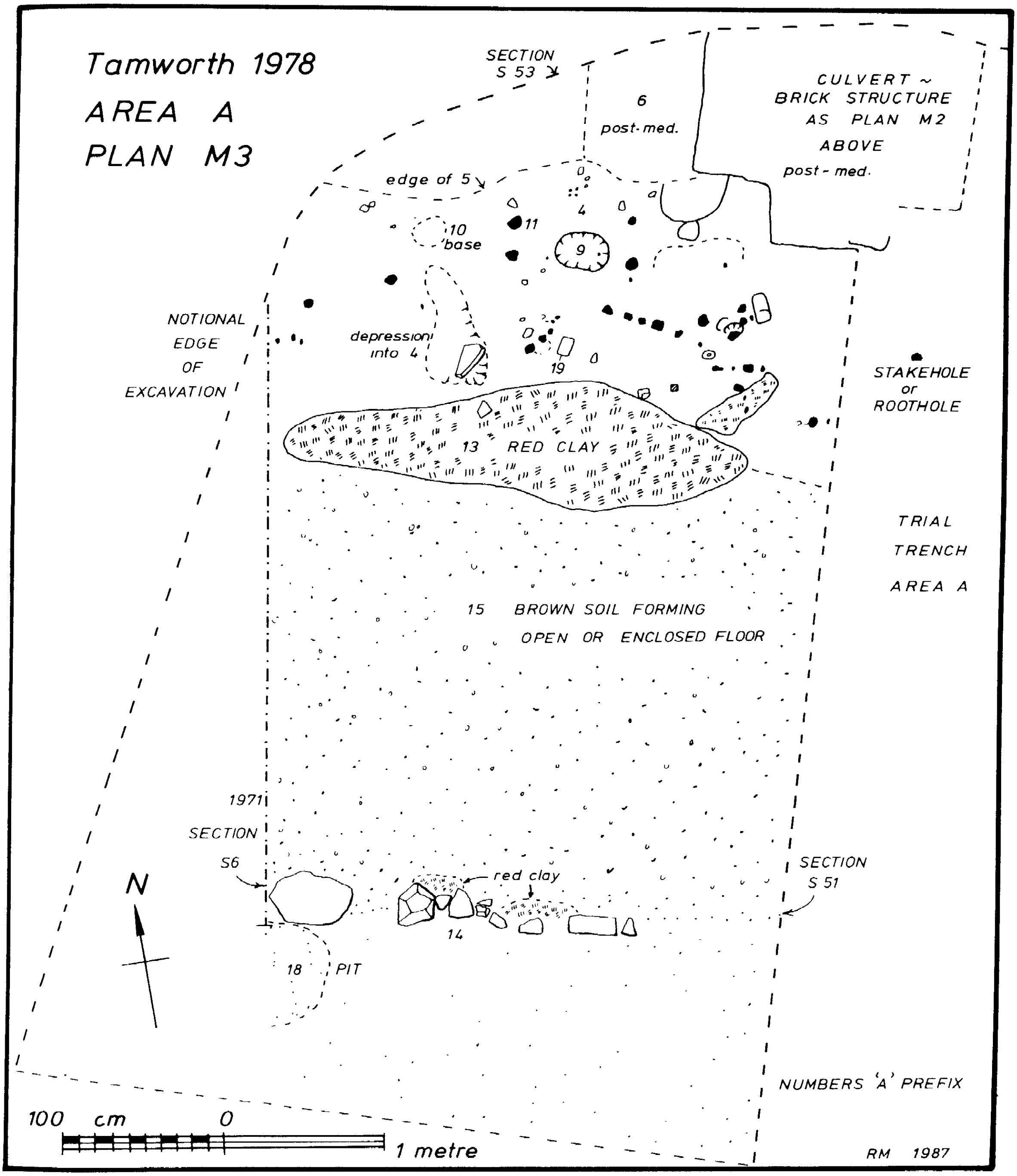



*Figure 41 Area A (1978), plan M3*

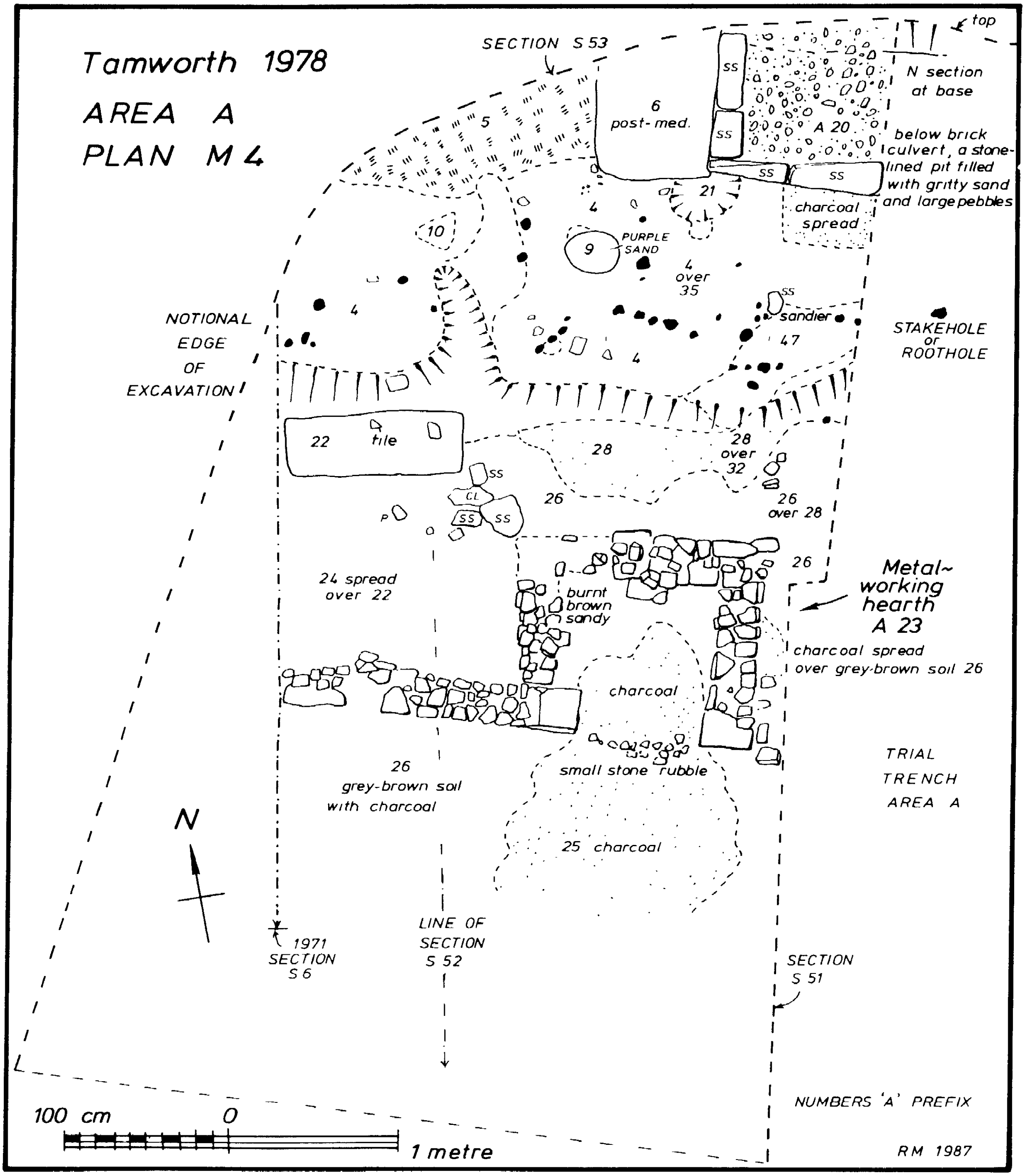



*Figure 42 Area A (1978), plan M4*

## 2.12 Phase 3: the second leat and its revetments, and a possible bridge (plans M5 (MF), M6 (MF) and M7, MF Figs 43 and 44, Fig 45; sections S53, S56, Figs 49, 52)

### *The leat and revetments*

The second leat, associated with the second mill of the 1971 excavation, did not extend into the 1971 excavation area, the eastern limits of which were wholly within the millpool.

It is difficult to differentiate between the first leat and the second, or to make a distinction between their silts and revetments. It is suggested nevertheless that some timbers were part of the revetment for the second leat, because they were found to lie outside the limits of the suggested south side of the first leat, the second revetment being *c* 1.5m south of the first. Although the principal evidence would lie beneath Bolebridge Street to the north, it is suggested that some of the timbers associated with the second leat may have been supports for a bridge (see below).

The large timbers associated with the phase 3 second leat and putative bridge are shown on plans M6 and M7 (MF Fig 44 and Fig 45); some were in post-pits while others were apparently driven directly into the natural clay.

At the bottom of pit Al69 (32cm deep) was the impression of the base of a large timber at least 38 x 7cm in section. Al69 was replaced by A144, a pit 55cm deep holding an extant vertical timber with a cross-section of 41 x 7cm and a surviving length of 85cm. This timber penetrated the natural at the base of the pit for 11cm and, as shown on section S51 (Fig 47), it protruded above the pit into the silt A116 for 19cm. The orientation of this timber was similar to that of the impression at the base of the earlier pit A144. Dendrochronology assigns a date of AD 855 ± 9 to the timber, the same as that for the second mill. As in the case of the mill, however, there must be a reservation that the timbers here may have been re-used from the first mill or leat.

Further north three more timbers were observed protruding from section S53 (Fig 49). The timber A189 had a roughly-hewn point and had apparently been driven into the clay at an angle of *c* 30 degrees from vertical, the top inclined to the north. A187 was in a post-pit (A200); it was 62cm long, with a rough-hewn base. A188 was a timber in a post-pit cut through A200, with a cross-section of 22 x 6cm near its square-cut base.

A further (robbed) timber may have been in the negative feature filled with Al85 (S53, Fig 49), a similar material extending upwards into A114/116. Another substantial timber, A142, lay just north-west of A144; 65 x 23cm in cross-section and surviving to a total length of 61cm, its top was inclined to the north-west at an angle of *c* 45 degrees; the base was cut square and set in a shallow emplacement in the natural clay. Another (A153) was near the north-west corner of the excavation; it was 22 x 8cm in section and *c* 1.1m long; it had a carefully shaped lower end which curved to a point and there was no post-pit. This timber also has a dendro date of AD 855 ± 9. Less certainly associated with the above features was a post hole A183 (S51, Fig 47).

Adjacent to the western section S52 (Fig 48), and just extending into its line, was a major post-pit (A146), 50-60cm in diameter and 30+cm deep, with a post-socket extending 34cm below its base; the lower end of the socket was pointed. Since A146 was rather further south than the other timbers, in a location adjacent to a bend or contraction on the south side of the leat, it is conjectured that it formed part of a junction between the millpool and the leat; alternatively it could have been associated with a sluice, a fish-trap, or a grill to prevent debris passing into the pool, chute and wheel-assembly.

The southern limits of the leat were confused by the erosion gully A264 (see below) but this may itself have developed along the line of a robbing trench for a revetment which had been more substantial than the surviving evidence would suggest. There is also a possibility that one or more of these timbers was related not to a leat revetment, but to the postulated bridge crossing the leat (see below).

### *A possible bridge across the leat*

It is argued elsewhere that Bolebridge Street is on the course of a very early road or track (Meeson 1979, 9-13), and the mill was indeed close to the probable eastern entrance to the *burh*. Such an entrance is unlikely to have been crossed by a ford; it is improbable furthermore that the miller would have tolerated constant damage to the sides of the leat by passing traffic.

### *Discussion*

Most of a putative bridge would lie outside the excavated area, but there is some evidence that could be interpreted in such a way as to imply the existence of the postulated structure, notably timbers A142, A153 and A189. The carefully-made A153 may have been pile-driven at a diagonal angle deeply into the natural clay bed of the leat. A142 had not been so driven and it had no post-pit; it could thus only have remained *in situ* at an angle of 45 degrees if its upper end had been propped or fixed against something with sufficient mass to support it while silt deposits accumulated around its foot. A142 may have been a secondary prop or brace to the putative bridge structure, replacing or supplementing the original brace A153.

The carriageway would have been made of planks; and in this area there were indeed five decayed planks (A139, 140, 141, 143 and 263 on plans M5 (MF) and M7, MF Fig 43 and Fig 45)

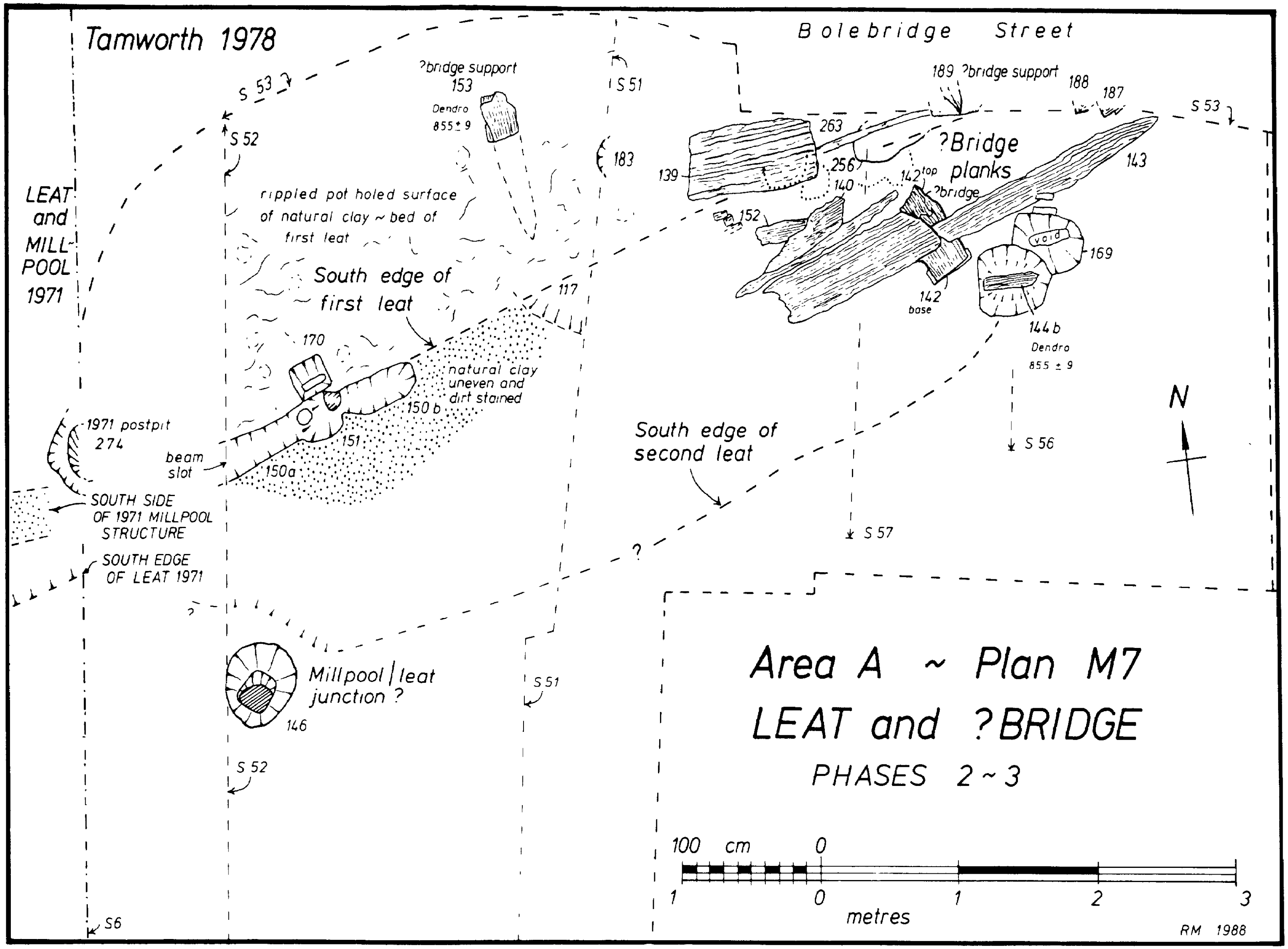



*Figure 45 Area A (1978), plan M7, leat and ?bridge, phases 2-3*

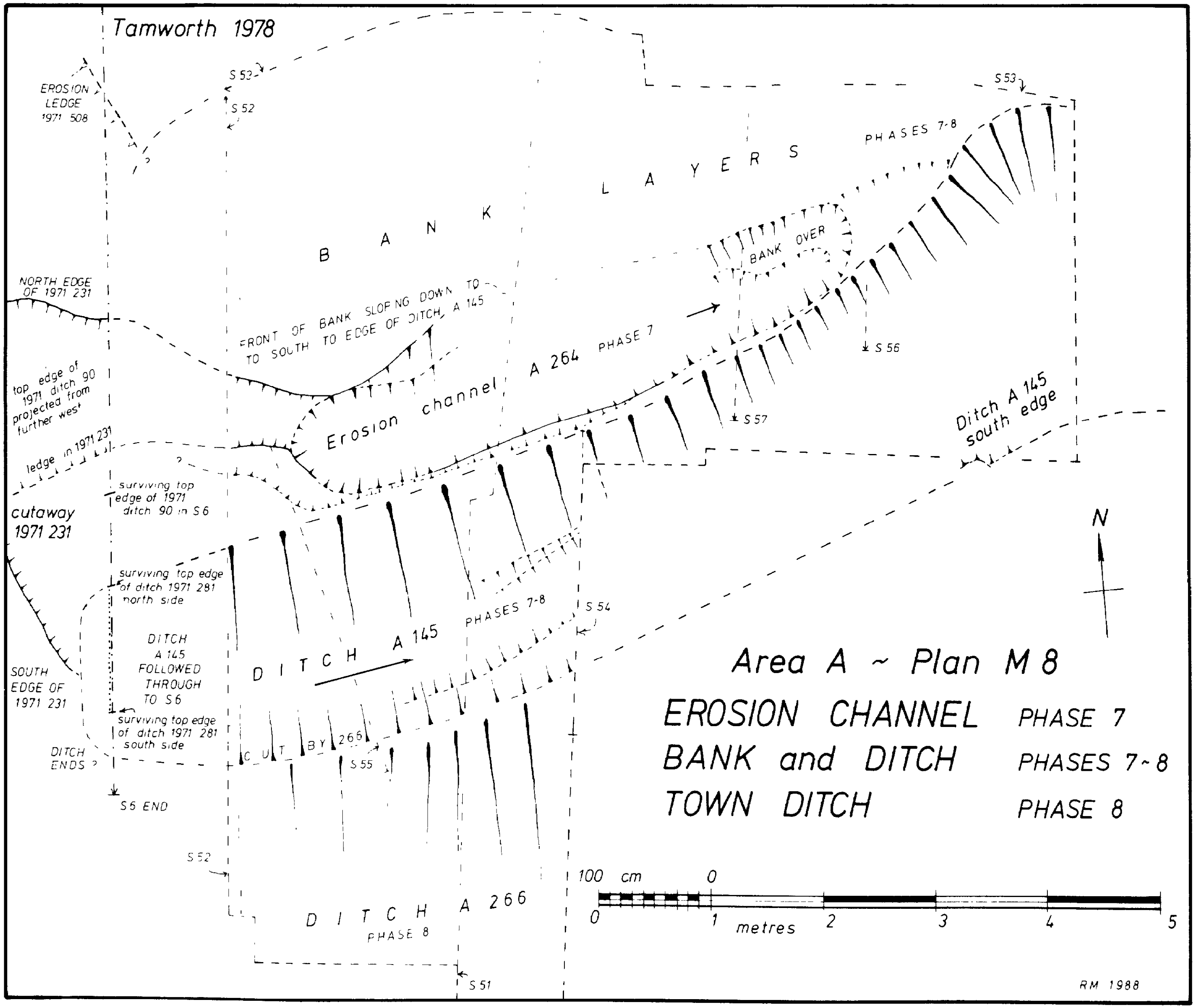



*Figure 46 Area A (1978), plan MB: erosion channel (phase 7); bank and ditch (phases 7-8); town ditch (phase 8)*

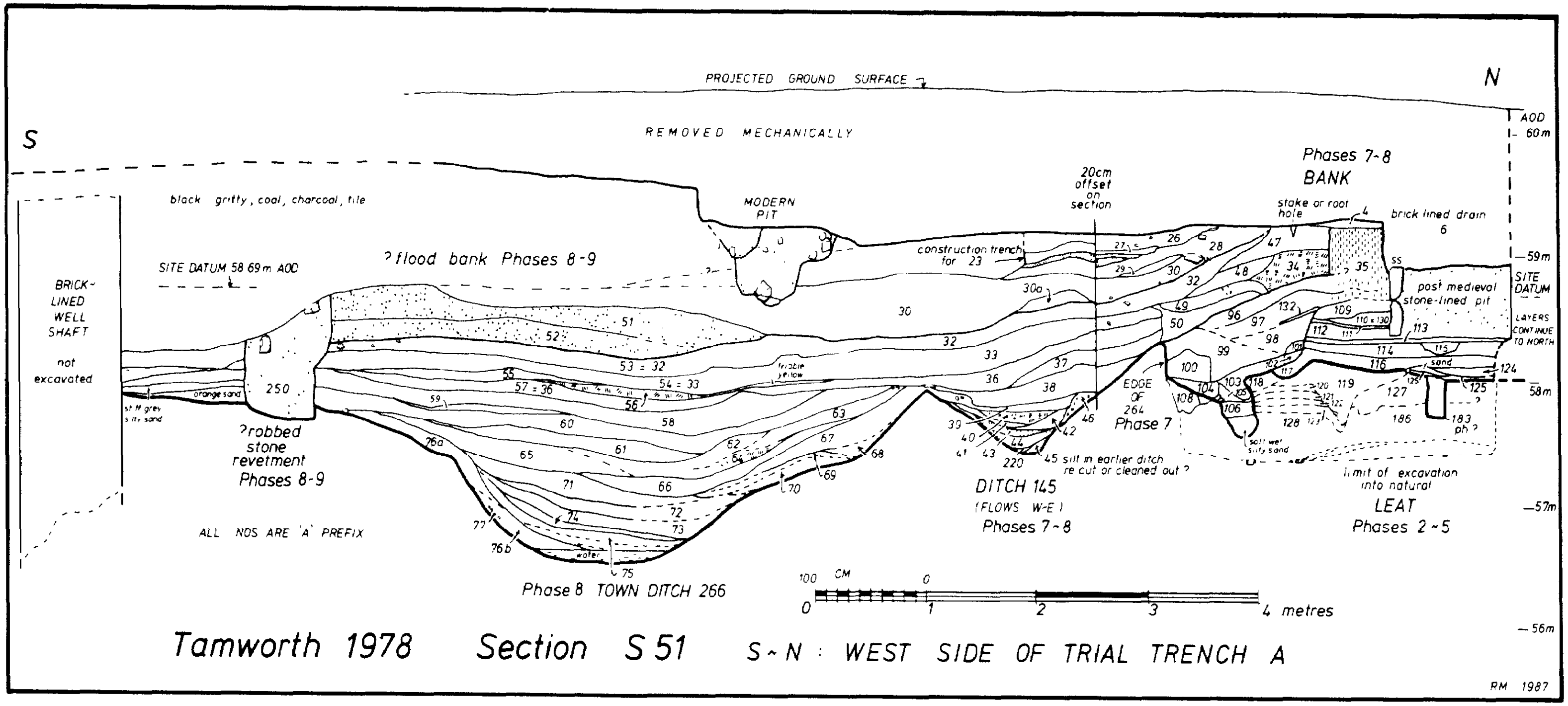



*Figure 47 1978 Section S51, S-N: W side of Trial Trench A* found on the upper layer of silt (A109/129 on section S53, Fig 49). Parts of some of these planks had survived as hardly more than a stain, while others survived to a thickness of *c* 1cm. The edges of A139, A140 and A143 were flanged.

Silting built up around the suggested bridge supports until the carriageway collapsed or was dismantled and discarded. The planks were sealed by the 'bank' of phases 7-8, as described below. This bank also cut off the leat and therefore made any bridge redundant.

## 2.13 Phases 2-5: deposition and erosion of silts in the leat (sections S51, S52, S53 and S56, Figs 47-9 and 52)

### *Introduction*

It is possible that all the silts defined in the leat post-date the abandonment of the mill. Apparent stratigraphical relationships between some of the silt layers and suggested structural features of the revetments of the first or second leats are not reliable: timbers may have been robbed, the silt subsequently building up over robbing disturbances; and silt may have accumulated around or even under surviving timbers.

While a complex succession of silts could be defined in the excavated areas, this must be seen as a continuum of interrelated events rather than a series of distinct and separate phases. Silting and erosion may have been more-complex than the stratigraphical succession may suggest. The factors involved may have included not only silting and erosion but also timber decay and such human intervention as timber-robbing, water-control, dredging and ditching.

### *The silts*

With the reservations about stratigraphy expressed above, it is possible that the lowest silts could belong to the first leat (A125/A255 on sections S51-S53 and S56, Figs 47-9 and 52). This would be consistent with the hypothesis in the 1971 data that the lowest strata there were contemporary with the first mill (eg, 165a and 417 in section S6, Fig 12).

The accumulation of silts in the second leat is represented (on S51-S53 and S56) by the deposits A124 and 109-116, and by 129, 130 and related horizontal layers. The lateral extents of the silts displayed in the drawn sections could not be determined; to the north they extended outside the excavated area, and on the south side of the leat they were cut and disturbed by later features. The complex relationships between surviving structural features and associated silt deposits is described and discussed in more detail in the extended text in the microfiche. Layer A114 in these deposits was sampled for botanical residues, and yielded a rich flora and charred grain (3.13 below).

## 2.14 Phase 7:erosion channel A264 (plan M8, Fig 46; sections S51, S52, S56 and S57, Figs 47, 48, 52 and 53)

An erosion channel (A264) developed along a linear zone on the postulated southern edge of the second leat and this possibly reflects the line of a timber-robbing trench. The channel was of variable width, narrowing to a gully with vertical edges to the west (plan M8, Fig 46). It seems likely that this is the same feature as the 1971 cut 231 (see section S6, Fig 12), interpreted there as a timber-robbing cut. A sherd of ?13th century pottery in layer A138 in the base of the channel A264 is consistent with this correlation (see section S57, Fig 53).

The levels of the base of A264 varied. In S52 (Fig 48) the bottom of the channel was at 57.95m AOD, a drop from 1971 section S6 (Fig 12) of *c* 15cm, and in S57 a further drop to 57.78 AOD is apparent. In S56 the base of the channel was cut away by a later ditch, so it may once have been deeper than the surviving point at 58.22m AOD. It is thus probable that this feature was draining from west to east, counter to that of the earlier leat.

## 2.15 Phases 7-8: the medieval bank or causeway, and the associated ditch A145 (plans M5 and M8, MF Fig 43 and Fig 46; sections S51, S52, S54, S55, Figs 47, 48, 50, 51)

A succession of soil layers, sloping down steeply to the south, are interpreted as a bank aligned west to east, sealing the erosion gully (A264) of phase 7 and the leat of phase 2. In most places the southern edge of the bank continued to the north edge of a ditch (A145).

### *The ditch (A145)*

A 3.25m length of the ditch A145 was excavated (plan M8, Fig 46); sections are displayed in S51 and S52 (Figs 47, 48) and S54 and S55 (Figs 50, 51). The respective elevations of its base in S52 and S54, at 57.49m AOD and 57.34m, suggest that as in the case of the preceding erosion channel A264 the drainage of this ditch was from west to east, again counter to that of the leat.

The northern edge of the ditch was roughly on the line of the southern edge of A264, and may have been thus partly predetermined; but whereas A264 was shown to swing away to the north under Bolebridge Street, A145 continued eastwards parallel to the street.

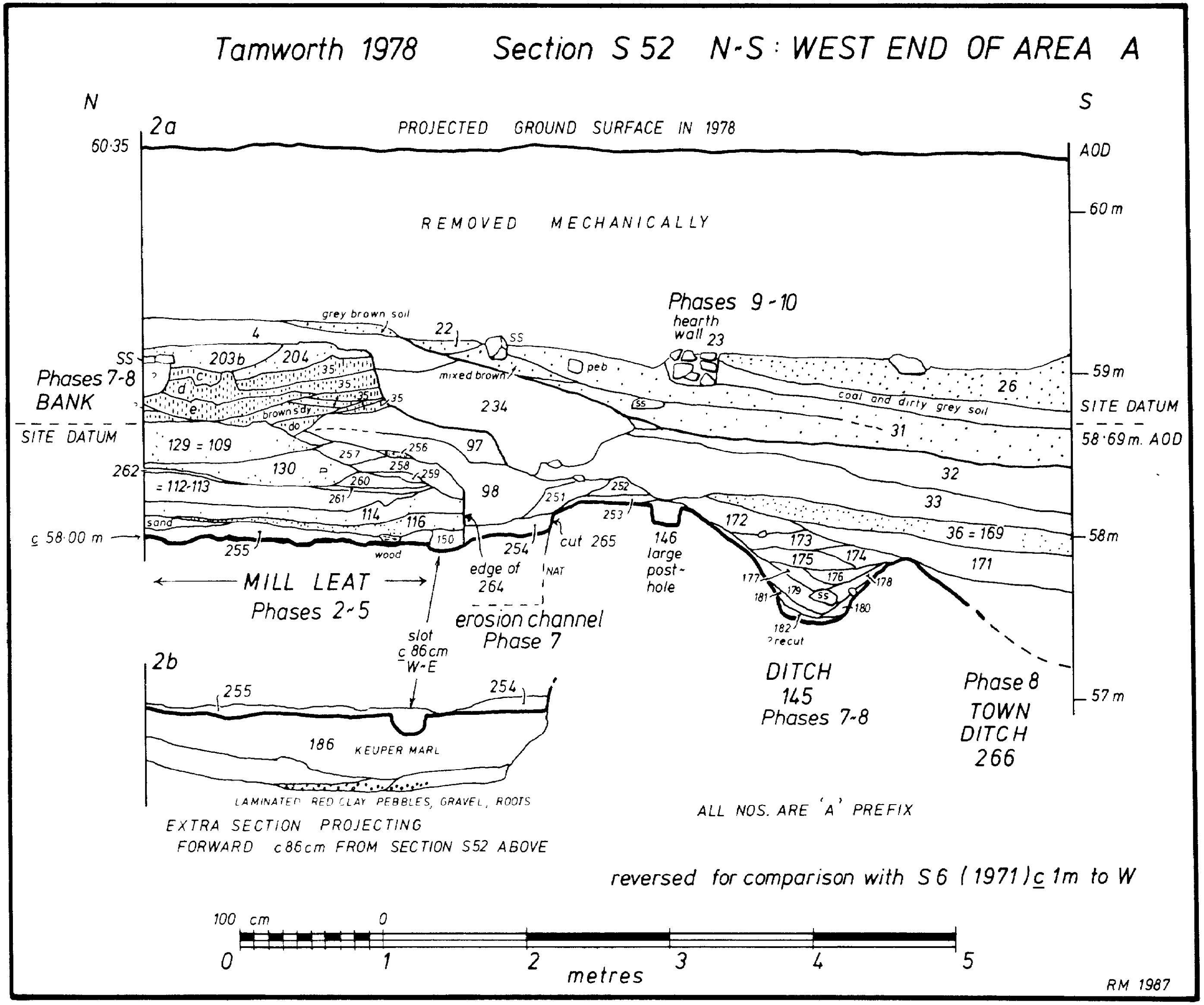



*Figure 48 1978 Section S52, N-S: W end of Area A*

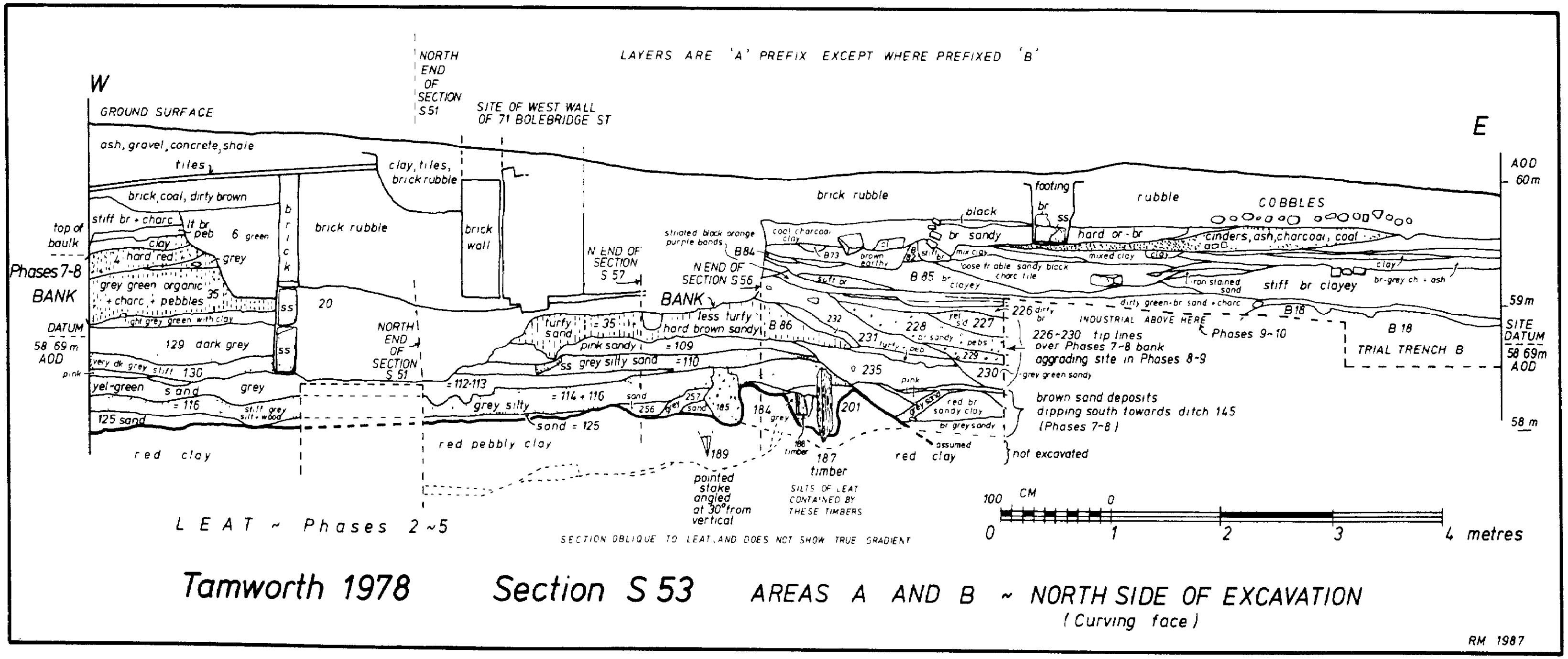



Figure 49 1978 Section S53: Areas A and B, N side of excavation

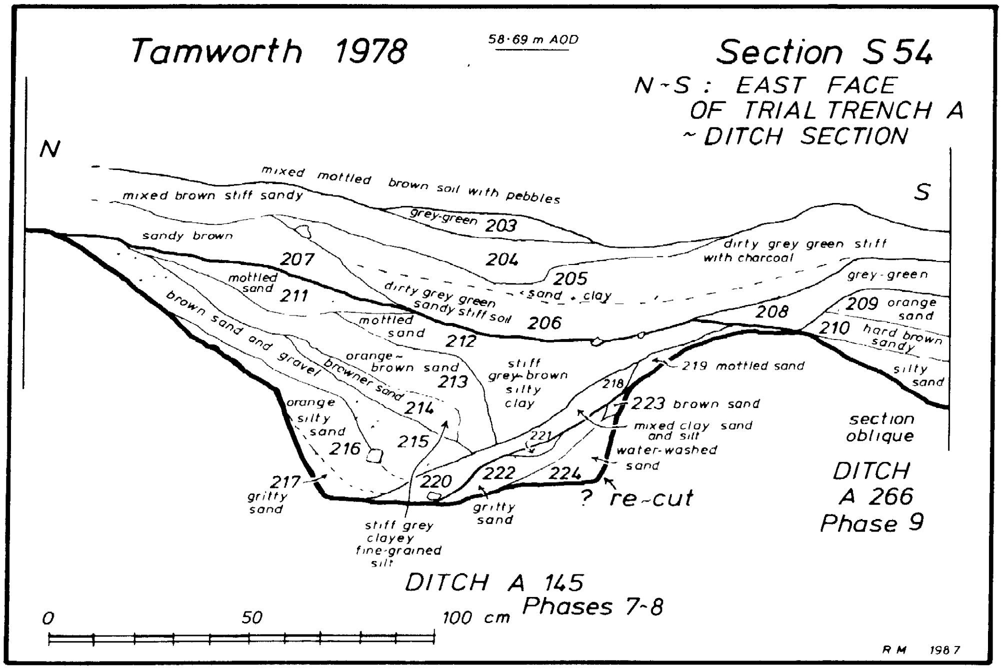



*Figure 50 1978 Section S54, N-S: E face of Trial Trench A, ditch section A145*

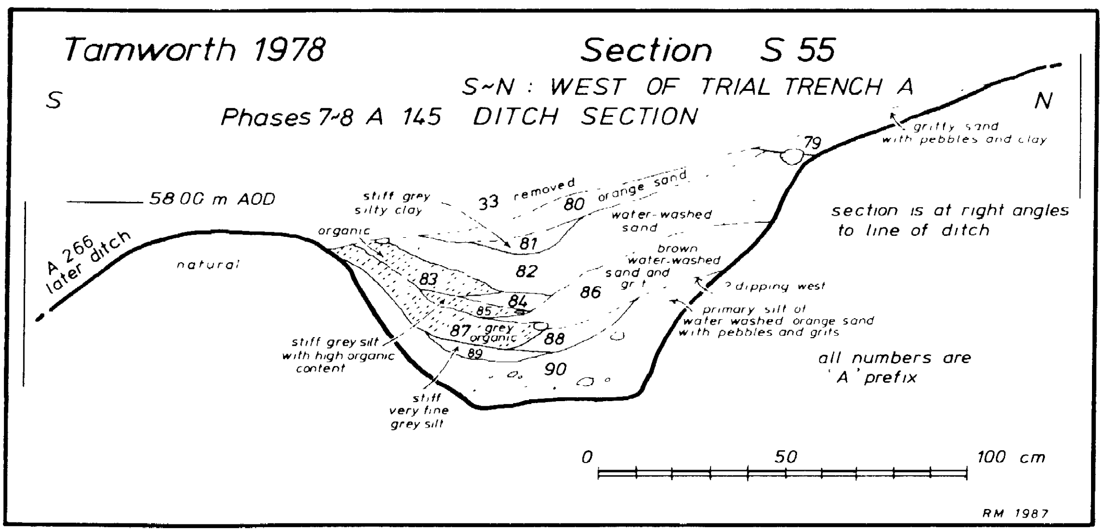



*Figure 51 1978 Section S55, S-N: W face of Trial Trench A, ditch section A145*

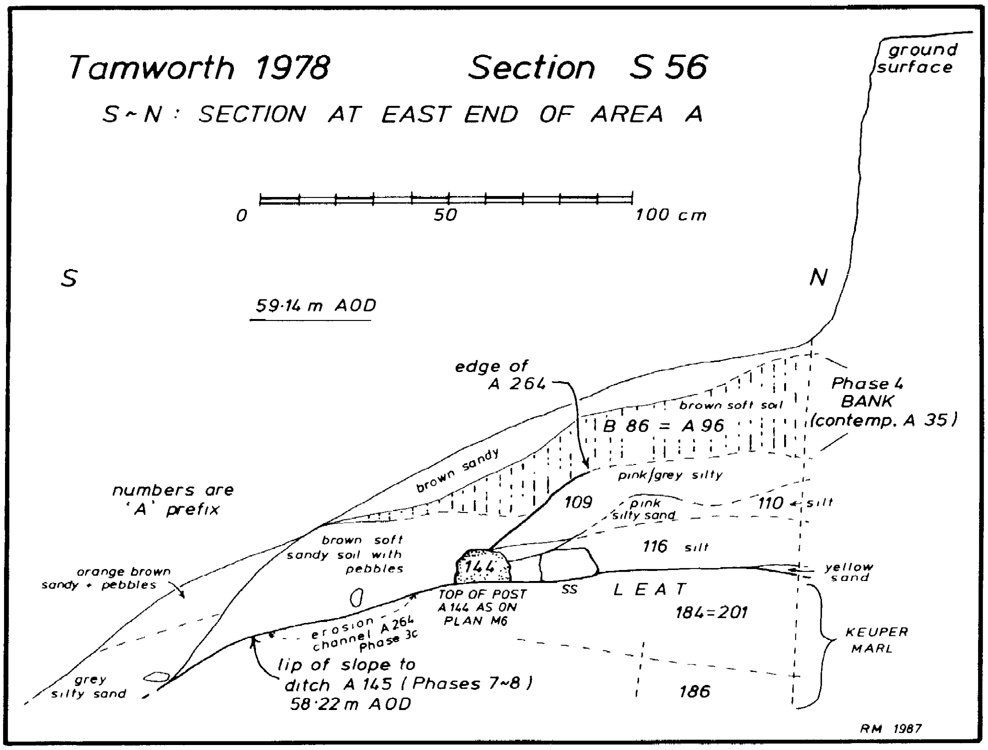



*Figure 52 1978 Section S56, S-N: section at right angles to S53*

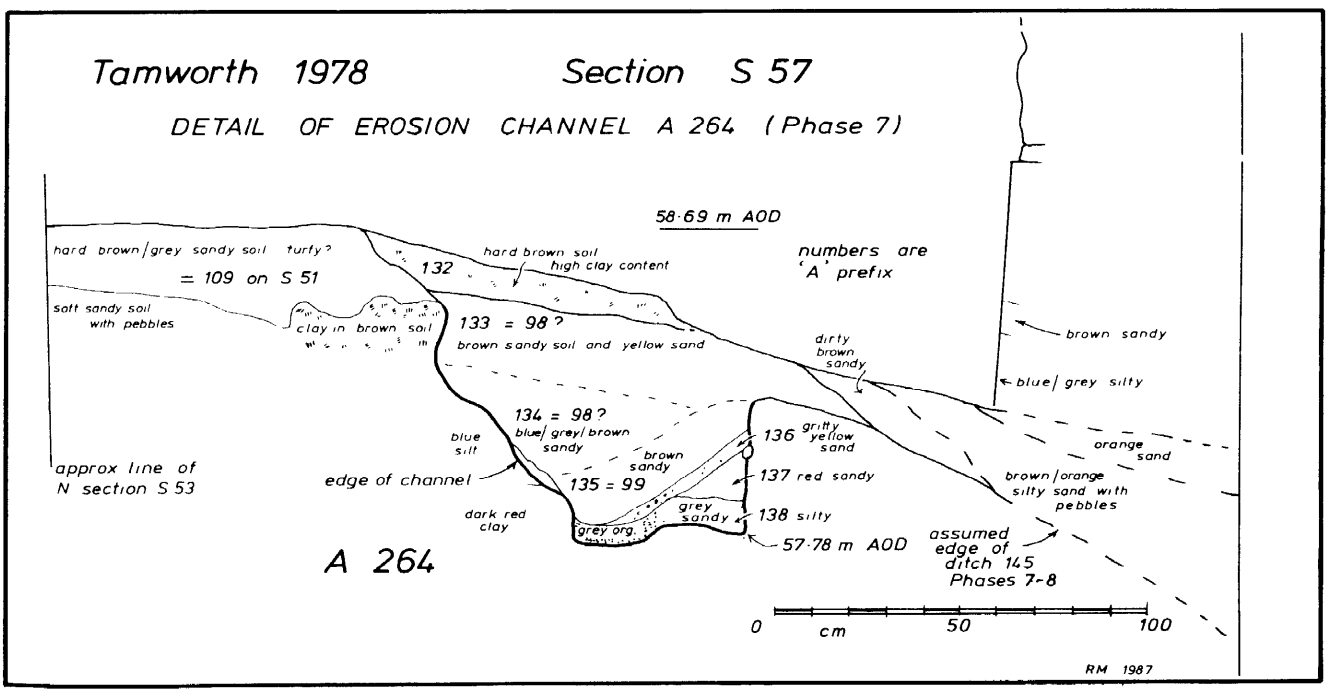



*Figure 53 1978 Section S57: detail of erosion channel A264 through millpool leat (phase 7)*

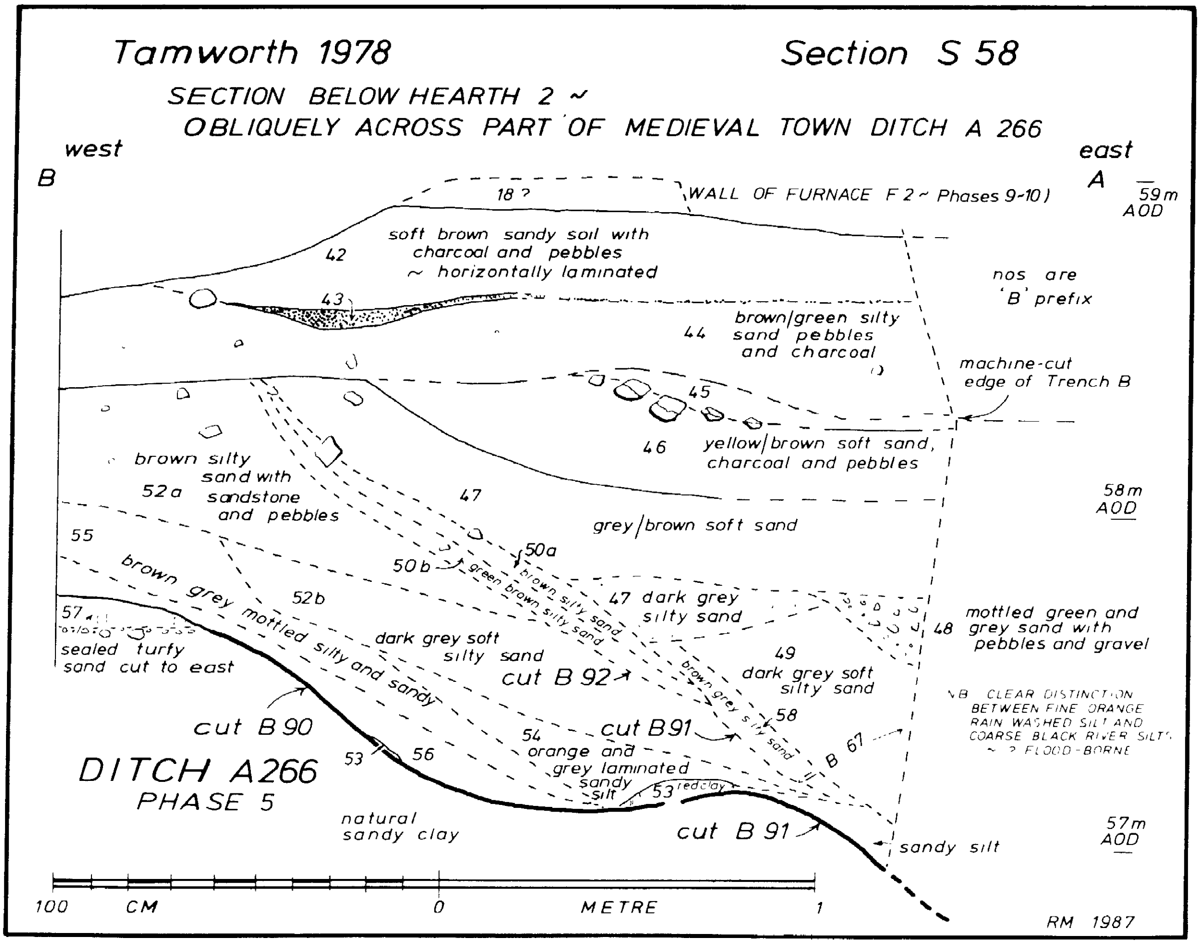



*Figure 54 1978 Section S58: section below hearth 2 (obliquely across part of medieval ditch 266)*

In area A, ditch 145 appears to have been recut to a steeper profile, with evidence of recutting or cleaning seen in sections S51 and S54. The fills ranged in texture from fine to coarse sands and silts, some with a high organic content. Some upper layers survived to a higher level than the extant southern lip of the ditch, suggesting that the southern side of A145 was cut by the later and much larger ditch A266, as other evidence would suggest.

The fills of the ditch A145 contained sherds of 12th and 13th century pottery, including the nearly complete profile of a ?13th century cooking pot (Fig 77.52, from layer A44). A sample for botanical residues yielded a wide variety of considerable interest for environmental studies (S13 below).

### The bank

The bank consisted of layers seen on sections S51-S53, Figs 47-9 (A34, A35, A96-99, A231, A232 and A235, and B86). The sandy layers in the bank might have originated from the adjoining ditch (A145) but the turfy constituents were probably introduced from elsewhere.

The date of the bank should be *c* 1200 or later as it sealed the ?13th century sherd in A264 (phase 7 above); the only find in a bank layer (B86) was a sherd of the later 12th century, presumably residual (Fig 77.51).

As shown on plan M4 (Fig 42), all but one of the linear band of stake or root holes recorded at the north end of area A intersected layers which formed part of the bank; however, it is not clear whether they belong to this phase or to phases 8-9 (see below, 2.17).

### Discussion of ditch and bank

The ditch and bank were roughly parallel to Bolebridge Street. It is suggested that the bank acted as (and may have been constructed as) a causeway, carrying Bolebridge Street over the soft soils of the filled leat etc below, and replacing the postulated earlier bridge. The front face of the bank/causeway drained into ditch 145, channelling water away to the east.

## 2.16 Phase 8: the medieval town ditch A266 (plan M8, Fig 46; sections S51 and S58, Figs 47 and 54)

A major medieval ditch crossed the area from east to west. Stratigraphical evidence of the silts in phases 7-8 ditch A145 suggested that A266 was the later of the two ditches, a conclusion supported by the pottery evidence; however, the direct stratigraphic relationship as shown in the sections is somewhat ambiguous.

A complete section of A266 is shown in section S51 which is slightly oblique to the course of the ditch. The latter was probably *c* 5.4m wide, and its base was at *c* 56.5m AOD, *c* 3.76m below the 1978 surface. The silts were mainly sandy, some with a high organic content. The edge of A266 figures in S52, S54, S55 and S58 (Figs 48, 50, 51 and 54). In the latter section two or more cuts are evident, B90 being possibly the residue of phases 7-8 ditch 145, and B91 the phase 8 ditch; alternatively both may be phase 8, with a recut. Other edges here (eg, B92 and B93) may be the result of alternating silt deposition and water erosion as much as deliberate cuts.

While it could be argued that A266 was cut as a direct successor to A145 in a further attempt to assist drainage of the area between the postulated Bolebridge Street causeway and the river, the turn apparent in the area of S58 would link it to the major ditch found by Young on the north side of the street. It is therefore suggested in this report that the continuation of the ditch A266 through the 1971 area was part of the medieval town ditch; it apparently deviated eastwards from the pre-Conquest defences to enclose more ground in the area, then turned back towards the west through the 1978 and 1971 areas to meet the River Anker obliquely (as shown on Figs 24).

## 2.17 Phases 8-9: land reclamation (plans M2-M4, Figs 40-2; sections S51, S52, Figs 47, 48)

In area A there was extensive dumping of material over ditches A145 and A266, extending *c* 10m south of the postulated bank of phases 7-8. These aggraded the ground level, probably to reclaim land between Bolebridge Street and the river.

The layers are seen in sections S51 and S52 (S51: 4, 32/53, 33/54, 34, 36-7, 47-50; S52: 4, 32-3, 36/169, 234). The top of A32 may represent a former ground surface, sealing the face of the phase 8 bank. The layer A4 may have been a surface layer of the medieval bank, interrupted by stake or root holes belonging to a fence or hedge and broadly contemporary with the underlying bank layers. Alternatively, A4 and the stake or root holes may belong to the land reclamation phase. A number of other minor features cutting A4 could be of phases 8-9, but they could also be later (plan M4, Fig 42).

Stratified above A32 on section S51 were two layers of earth and clay (A51 and A52) terminating in a negative feature (A250) which contained sand, clay and broken sandstone up to 18cm in dimension. It is suggested that A51-2 were elements of a flood-bank to keep the reclaimed area dry, the bank being faced with a sandstone revetment, of which A250 is the robbing hole. Pottery from this phase included a ?13th century jug rim from A32 (Fig 77.54).

## 2.18 Phase 10: industrial activity (plans M4, M9-M11, Figs 42, 55-7)

A series of industrial layers and features developed, associated with further reclamation of ground. In area B metal-working activities probably continued until the 18th century.

**Metal-working in area A** (plan M4, Fig 42)

The phase 6 layer A32 and the possible flood-bank (A51, A52) were both covered with A30 and other layers, making up the ground to a higher level (A26-29 in S51; A26, A31, etc, in S52). The walls of metal-working hearth A23 were set into A26, as shown on these sections; details of the structure and associated features are shown in plan M4. Since the layer A26 contained a press-moulded cream slipware fragment of *c* 1670-1730 the hearth cannot be earlier than the last quarter of the 17th century.

**Metal-working in area B** (plans M9-M11, Figs 55-7)

*Introduction*

In area B a number of post-medieval hearths and furnaces were found in close association with merging spreads of ferruginous sands, charcoal and soil. These could not be examined or recorded in detail but the general sequence was clear.

The area was prone to flooding, and although there was some evidence for aggrading the ground level, the usable area of dry ground apparently contracted in size, its southern boundary migrating towards Bolebridge Street. The level on which furnaces F1 and F2 were constructed appeared to be fluvial rather than the result of deliberate deposition.

Charcoal in layers B43, B44 and B45 most probably resulted from metal-working activities outside the limited excavation area, and clearly predated furnace F1 (section S58, Fig 54). B43 was sealed by an alluvial deposit (B42), the surface of which was overlain by a scatter of purple sand and charcoal (B95). The latter was cut by two semi-spherical hollows (B59 and B60), interpreted as seatings for crucibles. Secondary to these was a charcoal-burnt area (B63), and this was cut by the furnace F1. All that survived of this was a nearly flat sandstone base, much disintegrated; none of the fired contents remained *in situ* as they had been removed to make way for the construction of furnace F3 (see below).

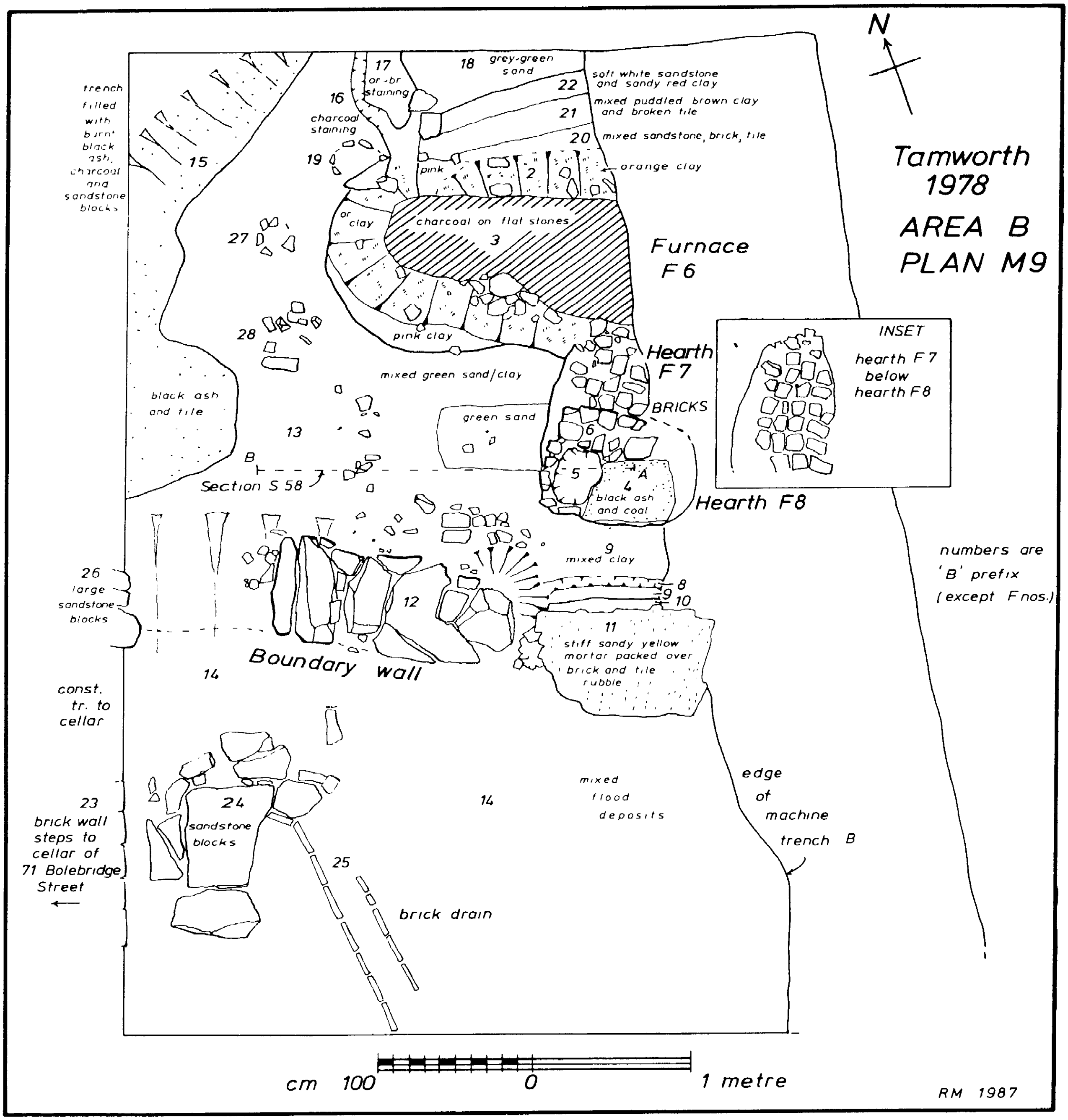



*Figure 55 Area B (1978), plan M9*

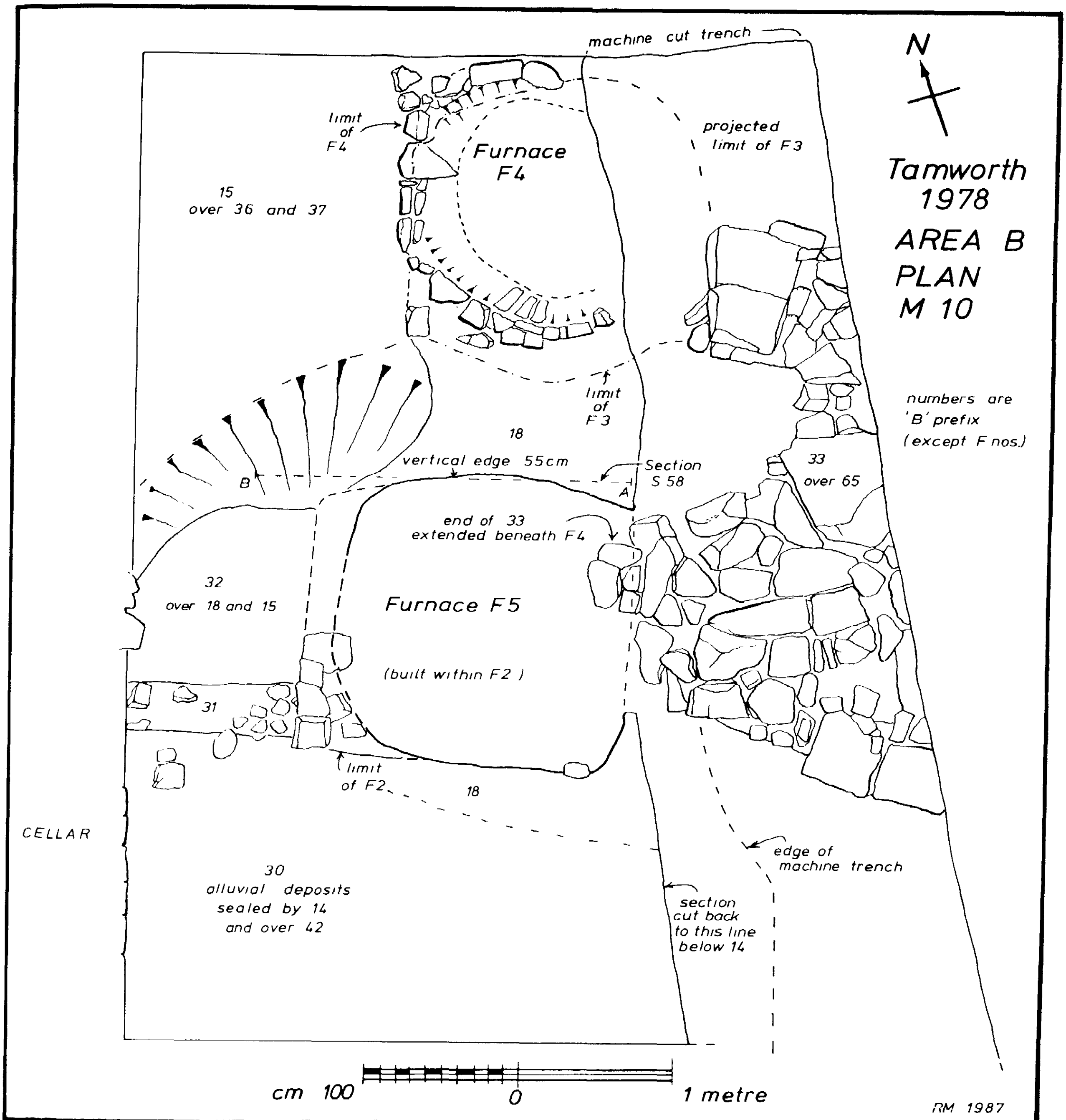



*Figure 56 Area B (1978), plan M10*

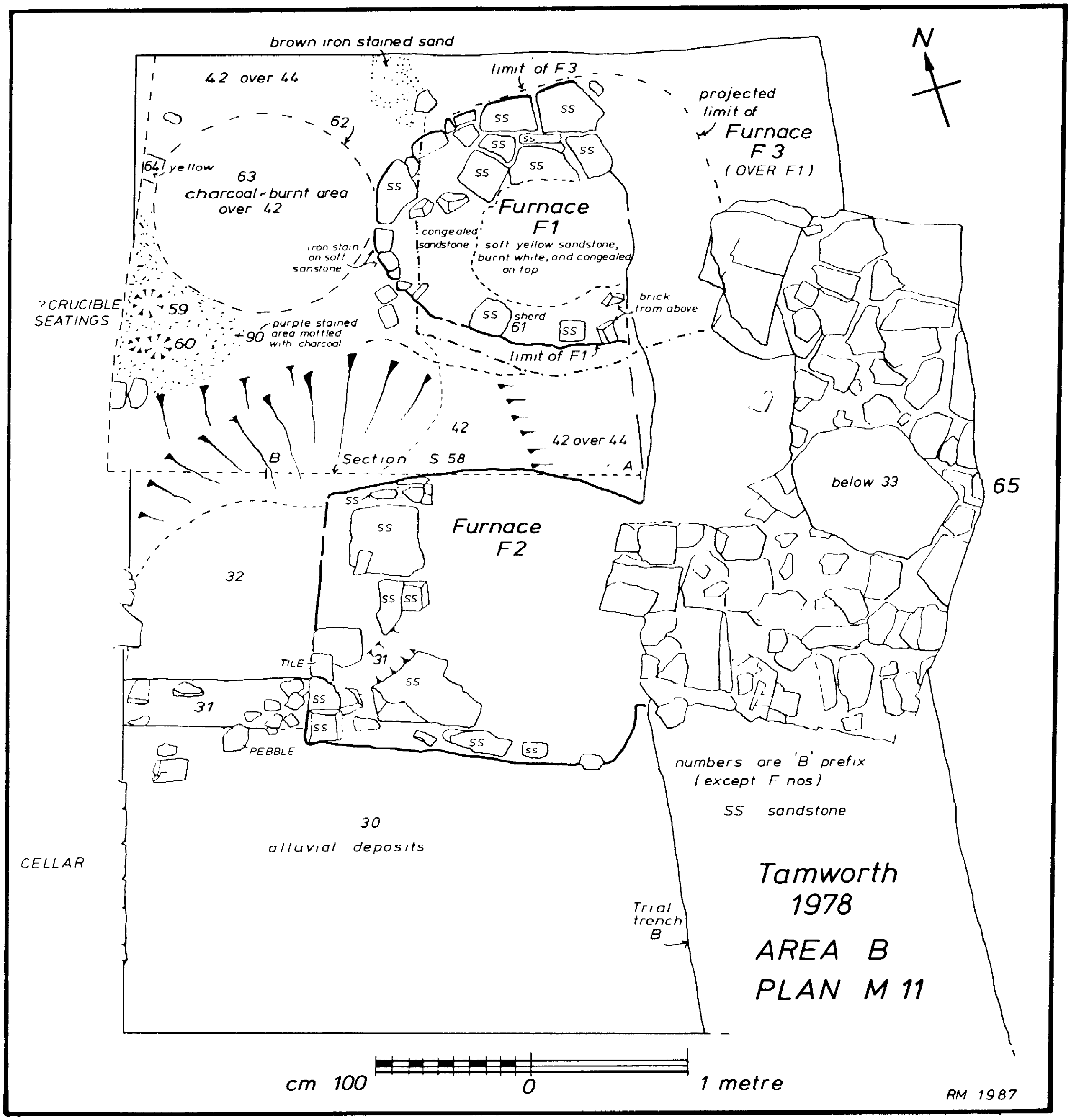



*Figure 57 Area B (1978), plan M11*

*Furnaces F2 and F3* (plan M11, Fig 57)
Deposited over B42 was a further layer of soil (B18) into which furnaces F2 and F3 were built, together with the substantial stone feature B65. F2 had been partly destroyed by the overlying F5 (see below); all that remained was a sub-rectangular pit *c* 2 x 2.2m in plan, and 20+cm deep; the pit was lined with sandstone blocks set in a heat-shattered yellow sandy matrix. A channel lined with clay and sandstone extended from within F2 and beyond it to the west (B31). Within the confines of the furnace B31 was full of fine black charcoal.

Furnace F3 overlay F1 and was largely cut away by F4 (see plan M10, Fig 56). Like F2, F3 also survived as a shallow pit, with a lining of burnt sandstone and tile. The stone structure B65 may have been used in conjunction with furnaces F2 and F3; it could have been the base of a working floor on which molten metal from the furnaces was poured into crucibles or casting pits.

The ground surface of B42/B18/B15 into which these furnaces were set sloped towards the river.

*Furnaces F4 and F5* (plan M10, Fig 56)
Furnace F4 was built within the remnants of F3, and furnace F5 was sited over the remains of F2; probably at the same time an uneven layer of sandstone blocks (B33) was laid over B65.

Furnace F4 was a sub-circular hollow, the base of which was comprised of disintegrated sandstone. Remnants of the curving walls of the furnace comprised of stone, cobbles, tile and brick in a matrix of sand; in the angle between the base and the walls was a deposit of red clay packed with heat-fractured sandstone blocks, possibly the residue of an inner lining or relining.

Furnace F5 survived as the base of a sub-rectangular pit which had been lined with sandstone. The remains of F5 were overlain by a burnt sand and clay mixture with patches of charcoal, brick and discoloured vegetable matter (B29). Fragments of textile were recovered from this deposit (see below, 3.15), along with pottery of 17th-18th century character, and the residues of charred and flattened straw (below, 3.13).

*Furnace F6 and associated features* (plan M9, Fig 55)
The furnace F5 was sealed by a clay deposit (B13) which had apparently been introduced both to raise the ground level and create a more horizontal surface; the furnace F6 was then cut into this material over the site of F4. F6 was oval in plan, with sloping sides and a flat base, and was lined with sandstone and clay (B22); the latter was overlain by mixed brown clay and broken tile (B21), and this in turn was covered by mixed sandstone, brick and tile (B20). The latter was overlain by clay fired pink and orange, with some sandstone (B2). Charcoal (B3) was found over the centre of B2 and more charcoal was sealed between B2 and B20.

A narrow channel with charcoal-stained sides (B16) curved north from F6. Other negative features were nearby (B8, B11, B19, B27, B28): B27 and B28 may have been post-emplacements or crucible supports.

*Hearths F7 and F8 (plan M9, Fig 55)*

A friable deposit of pink/red clay and sand filled the depression over the remains of F6. Overlying the south edge of F6, a single layer of broken bricks was all that remained of a hearth structure F7. A black-stained or burnt area 27cm wide indicated the limited scale of operations. It is possible that the bricks F7 represent the base of a small hearth, the superstructure of which was dismantled to be replaced by F8.

Overlying part of F7 was a layer of bricks (B6) and a large sandstone block in a hole (B5). Together these formed the base and two sides of F8 which succeeded F7; it was full of black ash and coal fragments.

## 2.19 Phase 10: later features and standing buildings

**Later features in area A** (plans M2 and M3, Figs 40 and 41)
After the metal-working hearth A23 had been abandoned and largely dismantled a layer of brown soil (A15) was deposited over much of area A (plan M3). The red clay A13 and the rubble sandstone linear feature A14 delimited an open or enclosed floor on the surface of A15. A18 was a shallow pit adjacent to the south edge of A14.

Layer A15 was sealed by the deposit A3 (plan M2). A wide shallow depression in the surface of A3 was filled with red clay (A2). A1 was a rubble sandstone wall foundation set out across the surface of A2. From its position, orientation and elevation it is tentatively suggested that A1 was the sandstone base of a brick wall at the rear of the former 71 Bolebridge Street. This two-storeyed building had a late 18th century facade with three sash windows at first-floor level and moulded wooden eaves. The building, formerly the Old Red Lion, had two 19th century inn-type windows to the ground floor.

**Later features in area B** (plan M9, Fig 55)
The sandstone foundations of a wall (B12) were set out on an east-west axis broadly parallel to the street along the steeply-sloping south edge of B13. This is tentatively identified as the base of the rear wall of the former 70 Bolebridge Street, which had a late 18th or early 19th century brick facade.

The stratigraphic relationship between B13 and the deposits B30 and B14 was not confirmed but it is possible that they were both later than B12. B30 and B14 may both belong to the 19th century, during which period flooding remained a serious problem in Bolebridge Street.

South of B11/12/26 and set into the top of B14 was a group of rubble sandstone blocks from which a brick-lined drain B25 projected to the south.

## 2.20 Collation of 1971 and 1978 evidence

by PAR and RM

*Introduction (Fig 39)*

The substantial changes to the local topography that arose from urban development between 1971 and 1978 made it difficult to link the 1978 excavation precisely to the earlier one; any fixed points common to both had disappeared. However, the eroded edges of the 1971 area were located in 1978, and it was possible to define a 1m wide strip separating the two excavations. A fixed point along this line is provided by ditch A145 of phases 7-8 of the 1978 work. This was followed through in 1978 to the line of 1971 section S6, and is now equated with the 1971 feature 281. The edges of this ditch were at the level of the undisturbed natural (see 1971 S6 and 1978 S52), so, allowing for the curve of the medieval town ditch having cut further into 1971 feature 281, the match was reasonably precise.

Given the link at this point, relationships can be hypothesized between other layers and features encountered at the west end of the 1978 area (as represented in 1978 section S52, Fig 48) and the stratification at the east limit of the 1971 area (as seen in 1971 section S6, Fig 12). These are expressed in the combined summary phase plans, Figures 5i-vi.

**Phase 0**

In spite of earlier reservations by Meeson, there is no reason to question the natural origin of the layering within the Keuper Marl, as shown for instance in 2b of 1978 section S52.

**Phase 2 (plan M7, Fig 45; Figs 28 and 30)**

The beam-slot features A150, A151, etc, as shown in 1978 plan M7 do not appear in 1971 section S6 (Fig 12), where this zone is heavily disturbed by later features. However, their location and alignment are close to that of the south edge of the leat of the first mill, as postulated from the 1971 evidence. They are also close to that of the south edge of the later millpool structure; this is at a higher level, but constructed into this southern side of the former leat.

The post-pit A170 is in alignment with the 1971 post-pit 274, but the latter was assigned to phase 3, of the second mill (see 1971 section S6, Fig 12); this attribution is not, however, secure (2.4 above), and 274 could represent a further element of the structural features shown in plan M7 (Fig 45).

The relationship between the beam-slot features and the south side of the later millpool suggests the possibility that the former are in fact part of a millpool for the first mill, though there are problems about the level of water that might have been achieved by such a pool at this elevation (cf 2.3 above).

The differential character of the leat base surfaces on either side of the alignment of these timber features is not paralleled by anything found in 1971. The leat base as seen on the left of 274 in 1971 section S6 (Fig 12), and also in 1978 S52 (Fig 48), are similar (though there is *c* 10cm+ discrepancy of level here, as already pointed out). The leat base on the right of A150 in S52 does not extend into S6, though there is a similar rise at a new edge on both sections, as will be discussed below in relation to phase 3.

The bridge features are shown on Figure 5i, because they could possibly be associated with the first leat, where it was crossed by a predecessor of Bolebridge Street.

**Phase 3** (plan M7, Fig 45; and Fig 32)

The south edge of the second leat, as defined in 1978, appears to turn sharply north at the west edge of the 1978 area, as an edge (A265) shown in S52 (Fig 48), which could itself link with the south edge of the leat/millpool emplacement in the 1971 area. Although the big post hole A146 could be of phase 2 (associated with the first mill), it is more convincingly interpreted as part of a structure for the second mill at the junction of the millpool and its leat, as suggested on plan M7 (Fig 45). The level of the base of this second leat was not defined except at a low level similar to that of the first leat, at *c* 58m AOD, If there was a leat here, associated with the second mill, its working surface must have been at least 30cm higher than this, to be able to relate to the millpool level as shown in S6 (Fig 12). It is thus possible that the second leat as defined in 1978 is of an otherwise unrepresented secondary phase of the first mill. Silts 112-113, 114 and probably 116 (see S52, Fig 48) are equated with a reconstruction of the southern revetment of this secondary phase. 259 and 260, and possibly 261, may be upcast from a further reconstruction of the southern revetment, perhaps when the second mill was constructed. Silting continued (130 + 129/109), and the final water level here is assumed to have been at the top of this, at *c* 58.70m AOD. Post A146 and the bridge features further east are still attributed to phase 3, the second mill.

***Phases ?2-5*** (section S52, Fig 48)

As has been shown in 1971 phase 5b above (2.5), the east end of the 1971 area was very complex, with a combination of leat silting, leat erosion, and timber-robbing. Although a similar series of silts are shown in section S52 (Fig 48), no exact correlation can be made with the sequence in S6, notably with the postulated 1971 erosion ledge 508. Nor do any of the later metallings found in phase 5b appear to extend into the 1978 area. It is remarkable that although there were a number of sherds associated with these layers in 1971, notably of Stamford ware, not a single sherd of these types was found in the 1978 area directly to the east.

**Phase 7 (plan M8, Fig 46; and Fig 34)**
The erosion channels which were encountered in 1978 have been convincingly demonstrated to be draining to the east, in the opposite direction to the water in the original leats and mills. The edges of 1978 A264 line up well with those in 1971 231, which come to an end close to the eastern limit of the 1971 area. It was there interpreted as a hole left by timber robbing, but as Meeson stresses above, these interpretations are not necessarily inconsistent, timber robbing being the initiator of erosion. The dating evidence from 1971 and 1978 is consistent with this correlation; and in both areas the fills of these features are cut by the ditch of the next phase.

**Phases 7-6 (plan M8, Fig 46; and Figs 34,35)**
As already mentioned, ditch A145 was directly equated with 1971 feature 281; the latter was known only in section (1971 S6, Fig 12), and its stratigraphic context was ambiguous. It is now apparent that A145 is quite distinct from the 1971 phase 6 features further west. Its western end in the 1978 area may lie close to the eastern limit of the 1971 excavations, since the southern edge of the 1971 feature 231 survived only a short distance west of 1971 section S6. It is argued above that ditch Al45 has a fall to the east, like the preceding drainage channel.

This ditch is associated with layers to the north interpreted as a bank or causeway, the whole complex probably being for drainage of the street area, rather than for defence, though its line was reflected in that of the medieval town ditch.

It is clear, however, that ditch A145 and its bank are later than the features of phase 7 and not represented in the 1971 sequence, except by the single feature 281; this must therefore now be phased as intermediate in the 1971 sequence between phase 7 and phase 8.

**Phase 8 (plan M8, Fig 46; and Fig 35)**
The southern part of both the 1971 and 1978 areas are truncated by the medieval town ditch in its final massive form. Neither its northern nor its southern edges can be precisely located; the latter were barely observed, and the limits of the former could only be followed up as far as they extended in particular places before being cut away by later features; hence the apparent non-alignment of the north edge as plotted in different areas of the excavation.

**Phases 8-9**
The principal evidence for land reclamation in later medieval times, and subsequently, comes from the 1978 area, as discussed above. In the 1971 area the rapid filling of the medieval town ditch is also evident, but the stages by which this was consolidated sufficiently to build on were not defined; the sequence was probably more complex here because of the increasing proximity to the riverbank towards the west, in association with possible jetty and wharf features. The extent of reclamation overall, following the rapid abandonment of the medieval town ditch, is well exemplified by the distance between the postulated Saxon and medieval course of the River Anker and that in more recent times, as shown on Figures 24.

**Phases 9-10 (Figs 35, 36, 40-2, 55-7)**
The earliest definable evidence of metal-working in the area comes from a context stratigraphically preceding 1978 furnace F1. Thus it cannot be dated except as being between the 13th/14th centuries (the filling of the medieval town ditch) and the 16th/17th (the construction of furnace F1). A similar dating is probably valid for the find of slag and other industrial waste in the 1971 fills of the town ditch (2.6 above).

The furnaces F2 and F3, above F1, are also provisionally assigned to the 16th/17th centuries, and metal-working continued in areas A and B into the later 17th and 18th centuries.

# 3 The Finds (1971 & 1978)

Finds prefixes and order

ST Stone
FL Flint (MF only)
Q Millstones
FC Fired clay: clay pipes; brick and tile
BC Burnt clay
MOR Mortar
PL Plaster
GL Glass
SL Metal-working residues
IR Iron
CA Copper alloy
OM Other metals: lead
CO Coins
ORG Organic residues
BOT Botanical residues
CW Carved wood
AB Animal bone and animal fibre (textile)
LE Leather
P Pottery
DEN Dendrochronology
RD Radiocarbon determinations

## 3.1 Stone (ST)

ST1 Schist hone, perforated (report below: Other stone) (Fig 67). 3, phase 8
ST2 Lava millstone fragment (Q12D). 104, phase 4
ST3 Lava millstone fragment (Ql2E). 105, phase 4
ST4 Millstone fragment (Q22). 106, phase 4
ST5 Millstone fragment (Q21). 111, phase 4
These and other millstones, which were only given Q numbers, are reported on below; see also microfiche.

Slate was also recorded from 56, phase 10; coal from 142, phase 10; and a flint bladelet from 50, phase 5b; see microfiche.

**Millstones** (Figs 58-61, Pls XIII-XIV)
by Susan M Wright

(Illustrations are of lower (grinding) surfaces of upper stones, except Ql/Q10/Q10A where both lower and upper surfaces are drawn.)

A catalogue of all millstone fragments is in microfiche.

Millstone petrology, by David Williams, see microfiche.

*For technical terms, see the Glossary.*

Over 200 fragments of millstone were found during the 1971 excavations (Rahtz and Sheridan 1971, 167). The apparently indeterminate pieces were discarded on site, but fragments with recognizable features and edge fragments were kept and numbered Q1 to Q23. Sample chips were taken of many of the fragments and the late Professor F W Shotton briefly examined some of these chips. Both fragments and chips are, since 1985, in Tamworth Castle Museum where they were sorted by the writer into 26 separately catalogued millstones or millstone fragments, which include five certain uppers but no certain lowers (see catalogue).

The apparent preponderance of upper, as against lower, stones in the surviving fragments is explicable in several ways. In the first place, it is difficult to identify fragments of lower stones with certainty. Stones with diagnostic features such as collars and/or rynd sockets are readily recognizable as uppers, but featureless fragments with little or no obvious curvature or even slope on the grinding surface are problematic. Conventionally, on querns at least, the grinding surfaces of uppers are frequently concave and of lowers convex. Stones that in section are plano-convex (ie, with a more or less flat grinding surface while on the other surface the stone thins and is increasingly convex towards its outer edge) might be thought to be more likely uppers than lowers on the grounds that a lower stone with a convex lower surface would be unstable. The more complete Tamworth upper millstones do show such convexity (Q1/Q10/Q10A, Q3, Q4: Figs 58-61). However, if the lower stone were bedded on clay, as at Tamworth, then such a shape could readily be made firm. Indeed, the reconstruction of the clay seating (Fig 64) indicates just such a profile for the outer edge of the lower stone. At Tamworth then, both uppers and lowers probably had convex outer surfaces.

Secondly, Leo Biek suggests that lower stones would be subject to greater stress than upper stones and so lowers would break sooner, and shatter into smaller pieces, than uppers. The large number of indeterminate pieces discarded on site therefore may have been mainly from shattered lower, rather than upper, stones. A third possibility, however, is that the lower, which was stationary, was originally considerably thicker and heavier than the upper which rotated and had to be supported; once in place, the lower may have been intended to outlive several, thinner, upper stones (cf the predominance of *lower* stones which confronted Peacock (1987, 66) in his study of Lodsworth quern and millstones; his comment that 'at present it is difficult to explain the dearth of upper stones except as a phenomenon associated with small samples' may also be relevant to Tamworth).


*Plate XIII Upper millstone Q3, underside, showing grinding grooves and recesses for fitting of rynd (scale in cm and 10cm)*

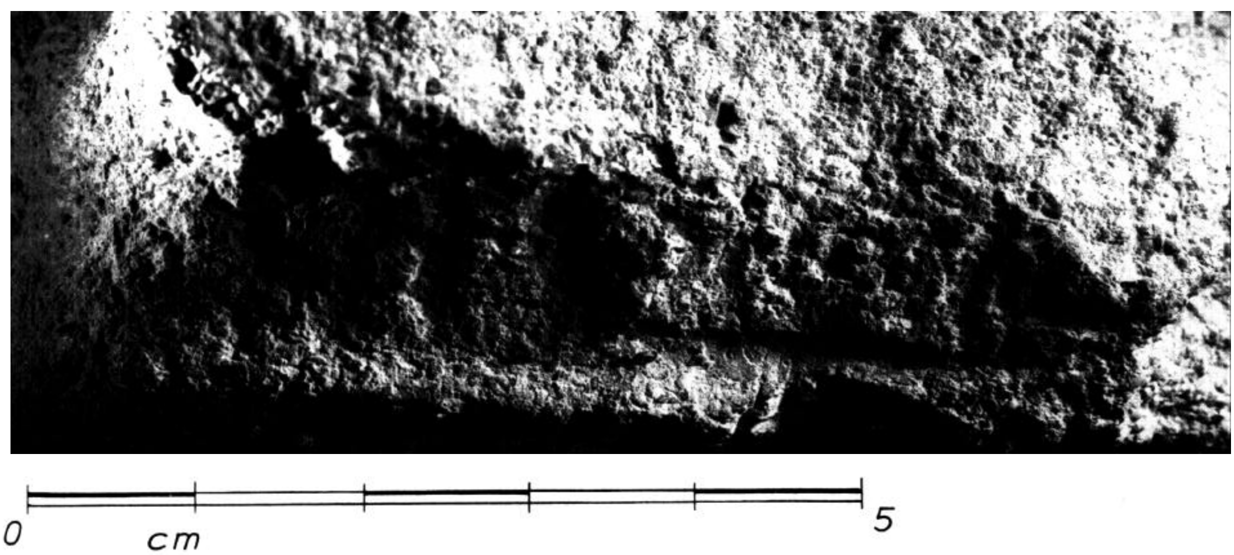



*Plate XIV Rynd emplacement in millstone Q1/Q10/Q10a, detail. (Photo: AM Lab)*

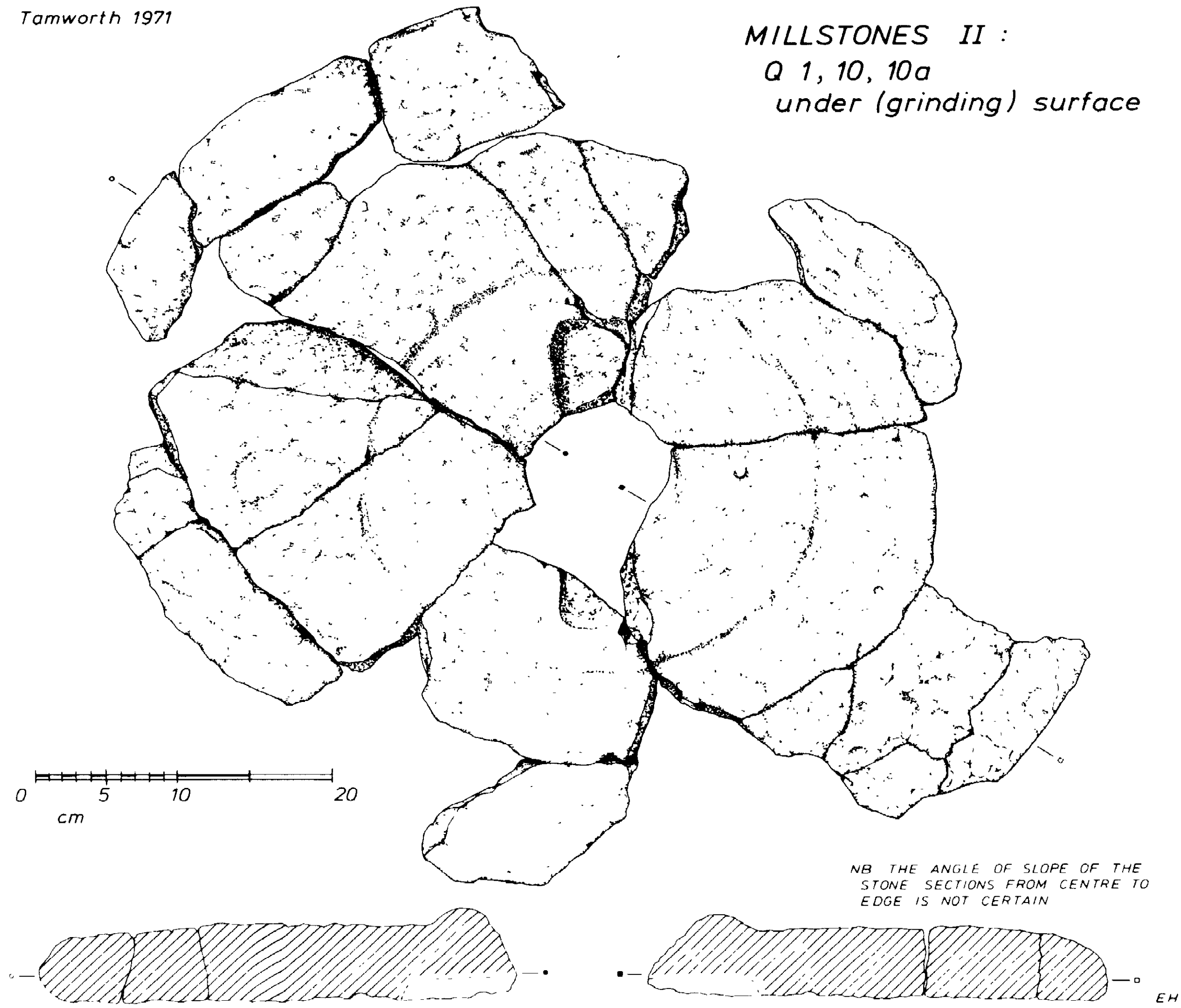



*Figure 58 Millstones I: Q1/Q10/Q10a, upper surface*

With no certain lower stones to provide evidence of their form, reconstruction of the millstone assembly depends on the upper stones and clay seating.

Assuming that the extant material is representative of the total excavated, the stones derive from three geological sources (Williams, below). A (very) rough estimate of the minimum number of stones represented by the surviving pieces would be eight, taking account of definite or very probable upper or lower stones and gross differences in thickness: three of Coal Measures sandstone, four of Keuper sandstone, and one of lava. Among these are six, different, certain, or probable uppers. If we assume that stones were bought in pairs then represented here are a minimum of approximately six pairs.

The majority of the millstones therefore derive from the first two rocks, both found in the Midlands and sources fairly close to Tamworth are likely (see Williams, microfiche). The fragments of lava need represent no more than one millstone or one pair, imported from the Mayen-Niedermendig area of the Eifel, Germany. The local availability of reasonably suitable stone types would render such importation on a large scale unnecessary and Tamworth lies close to the north-western limit of the distribution of lava querns mapped by Parkhouse (1977, fig 7). However, lavas were probably favoured because they were a vesicular stone, and wear would not

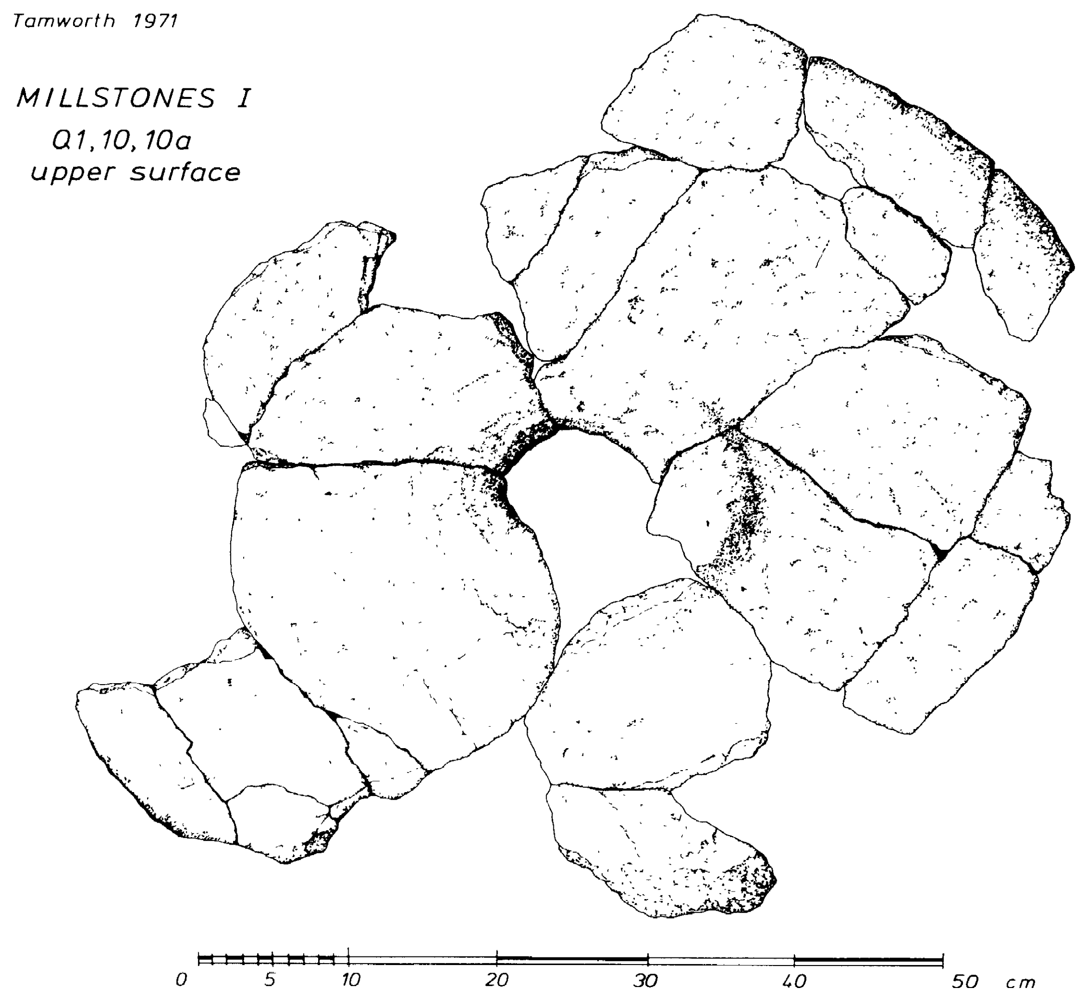



*Figure 59 Millstones II: Q1/Q10/Q10a, under surface*

make them unduly smooth, just expose another jagged edge (pers comm David Williams).

Lava querns are fairly regularly found on middle to late Anglo-Saxon sites, including the Midlands (below). Examples were found in the 10th century Graveney boat cargo (Fenwick 1978); they include two unfinished stones with a diameter of 46cm, probably for hand-querns. *Hamwih* (Southampton) may have served as a distribution point in this trade (Parkhouse 1977 and ex inf 1978 conference papers). A large deposit was recently found in London (Milne and Goodburn 1990, 635, fig 8), comprising 100 fragments of lava millstones, discarded within a clay and rubble waterfront embankment. The published photograph of a fairly complete stone suggests a diameter of *c* 70cm, very similar to that of the Tamworth millstones.

While Germany is the best-known source for such lava, Peacock (1980) pointed out the confusing similarity of Volvic lava from the Auvergne region of France to that from the Mayen and suggests that the German imports may have been overestimated in both the Roman and medieval periods. It has been suggested that the Mayen grey lava is the *petra nigra* of Charlemagne's letter to Offa (Rahtz 1981, 4, quoting Whitelock 1955, 779). The Rhineland remains a more likely source than the Auvergne, but an alternative interpretation of *petra nigra* would be Tournai marble.

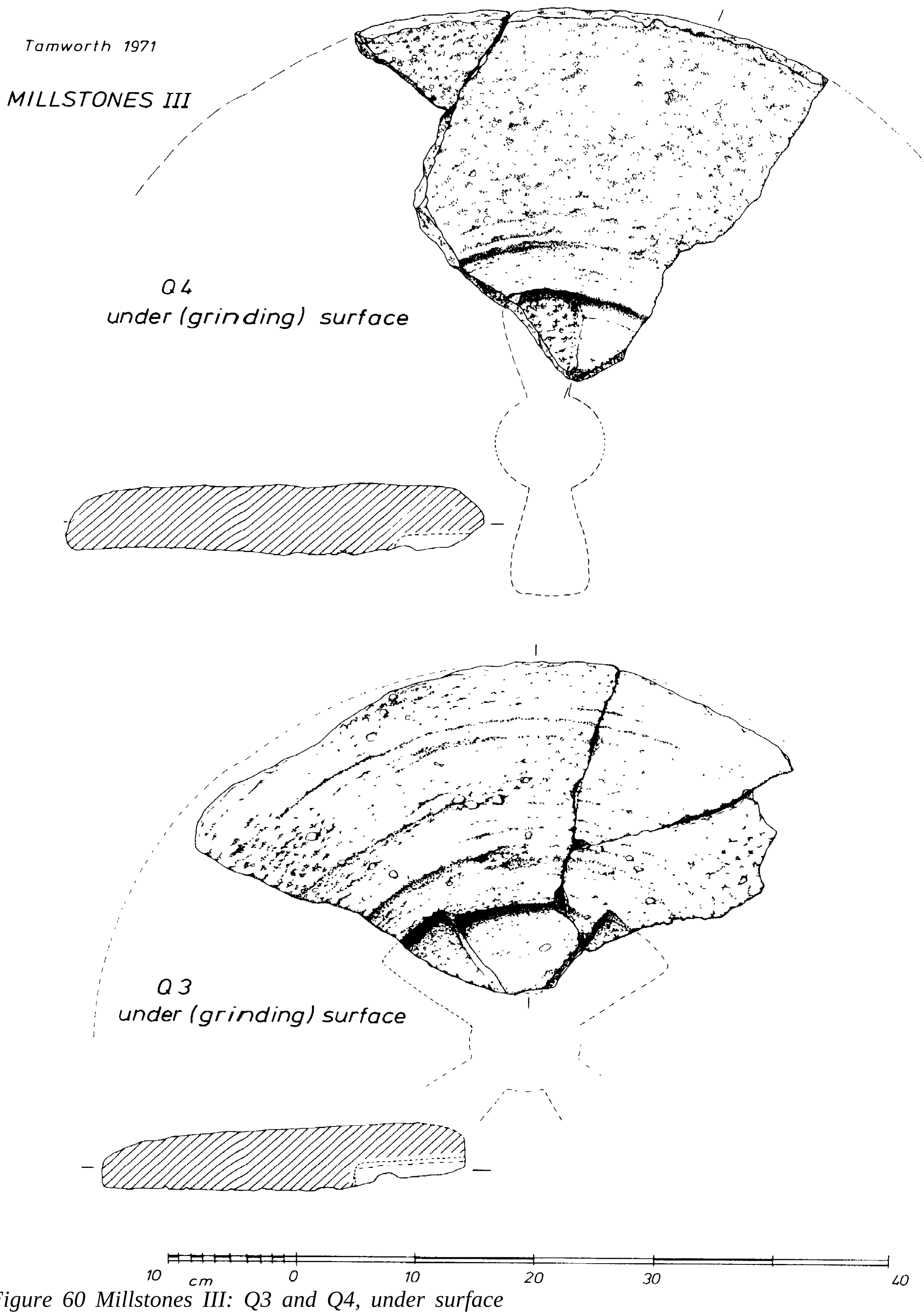



*Figure 60 Millstones III: Q3 and Q4, under surface*

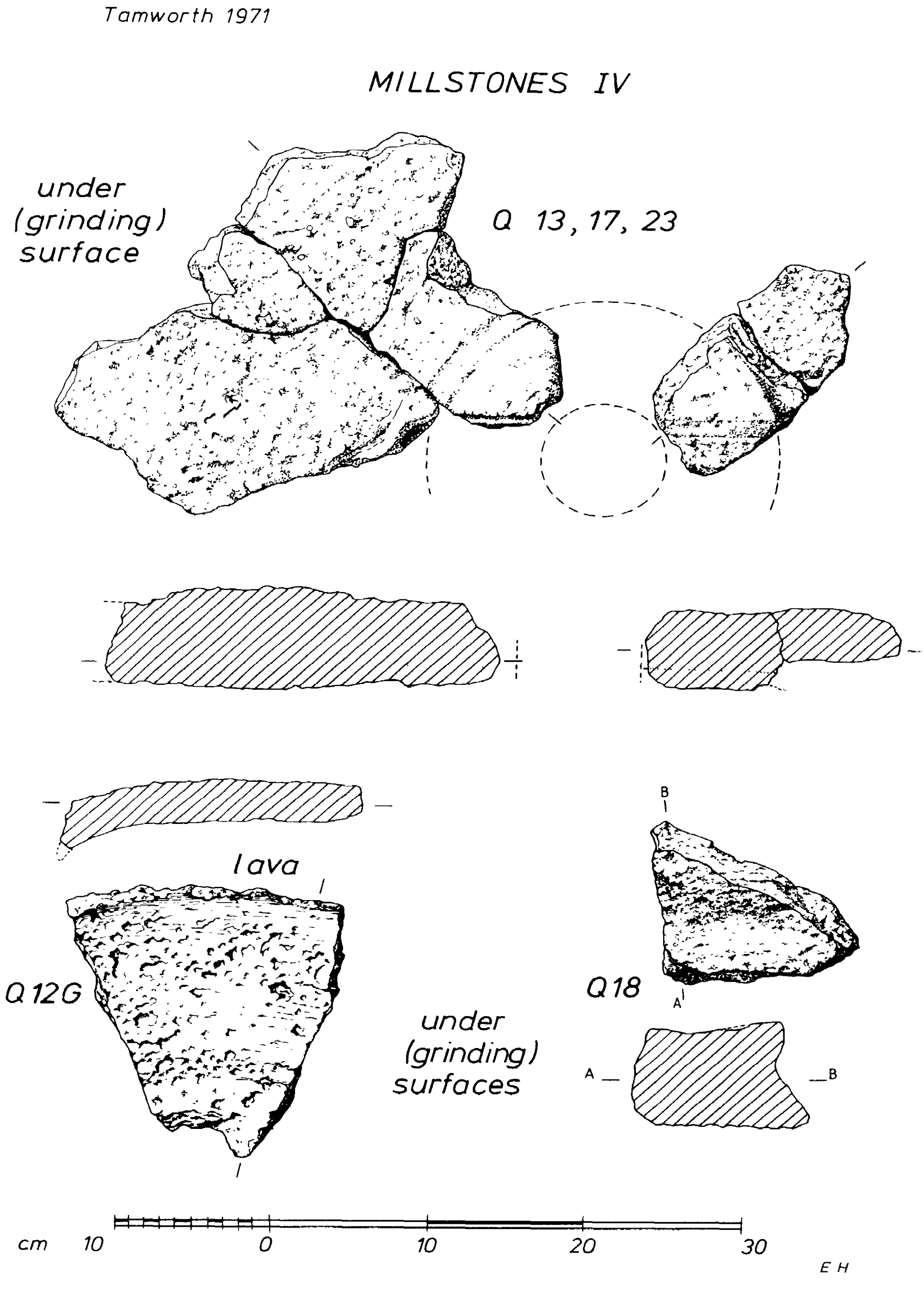



*Figure 61 Millstones IV: Q13/Q17/Q23, Q12G (lava), Q18, under surfaces*

## *The Coal Measures sandstone millstones*

The 12 separate fragments appear to represent a minimum number of three stones. One is a probable upper (Q11; and ?Q18, ?from same stone), one a possible lower (Q9), and the third is an almost complete upper stone, diameter *c* 72cm (Q1/Q10/Q10A, Figs 58, 59), weighing *c* 26.5kg. This last is the only stone with a collar or flange around the central hole, the 'eye', on the upper surface (although the lava upper stone could have had this feature, see below) and the only stone certainly to have only two opposed rynd sockets, to take a two-winged rynd. The wear pattern on the grinding surface of this stone is unique among the Tamworth stones: a pronounced, circular groove forms the outer limit of the inner track, while around the eye is a depression. The inner track of this stone is markedly thicker than the rest of the stone, the outer track.

Two other fragments, possibly from one stone (Q2 and Q5/Q8), have reconstructible diameters, of *c* 60-80cm and *c* 70cm respectively, while Q9 and Q11 would appear to be slightly larger, possibly *c* 80cm in diameter. The variation in thickness of the Coal Measures sandstone stones is similar to that of the Keuper sandstone stones, the range being *c* 3cm to *c* 7cm thick; the large variation should be attributed to wear. A complete upper probably weighed *c* 40kg when new.

## *The Keuper sandstone millstones*

A minimum of four stones appear to be represented by the seven fragments, that is three uppers (Q3; Q4; Q13/Q17/Q23: Figs 60, 61) and a possible lower (Q15 and Q16). None of the fragments of uppers has a flange/collar and, in contrast to the Coal Measures sandstone upper, are thinner on the inner track than on the outer part of the stone (Q3, Q4, Q13/Q17/Q23). The fragments of uppers all have one feature in common, a prominent, smooth, U-shaped, circular groove, arcing between the outer corners of the rynd sockets. The uppers are also similar in other ways. Q3 (Pl XIII) is *c* 70cm diameter, Q4 *c* 70-80cm diameter with a concave grinding surface. Q3 would have had four rynd sockets, as almost certainly did Q13/Q17/Q23. The identification of two uppers with rynd sockets at right angles reinforces the idea that all four sockets were original; any suggestion that there was originally one pair of opposed sockets and a second pair was cut to replace the originals should probably be discounted. Neither of the extant sockets on the more complete Q3 (Pl XIII) could be described as so badly worn as to make a recut necessary (cf the Roman example from Saalburg of four sockets, 'a double dovetail', interpreted as comprising a recut pair because of wear on the other pair: Moritz 1958, 124, pl 14). Q4 could have had four rynd sockets like the other uppers in this group, but it is possible that it had two like the Coal Measures sandstone upper (Q1/Q10/Q10A). Differential wear on the rynd sockets and groove of Q3, and on the groove of Q13/Q17/Q23, corresponds with clockwise motion of these upper stones, and thus with the clockwise motion of the wheel postulated from other evidence (see above). It is difficult to estimate what a complete upper stone of this type may have weighed because of the smallness of the fragments; if we assume a diameter of 80cm for Q4, then the complete stone may have weighed *c* 57kg, and more when new.

## *The lava milltone(s)*

The seven fragments of lava need represent no more than one stone, probably an upper, and certainly no more than one pair. Sufficient of the circumference survived on two of the fragments to suggest a diameter of *c* 65-80cm, that is a similar diameter to the other stones, indicating that here also we have the remains of a millstone(s), not a quern(s). All the lava fragments were considerably thinner (generally *c* 3cm, but varied from 1.7 to 4.5cm thick) than the local stones, perhaps suggesting that the lava stone(s) had been made maximum use of before breaking or being discarded. Four of the fragments have a pronounced 'lip' at the outer edge on the grinding surface (see Q12G, Fig 61), suggesting that they are from an upper stone which had been used with a smaller diameter lower stone resulting in an overhanging lip on the lower surface of the upper. The lower stone would have been some 10 to 12cm smaller in diameter, suggesting that the working pair may have comprised a *c* 80cm diameter lava upper and a *c* 70cm diameter lower, perhaps made of local sandstone rather than lava. (The clay seating, Fig 63, gives a diameter for the last lower stone in use of *c* 69cm and this is not contradicted by any of the stone types.) The largest fragment of lava upper (Q12G) weighed only 1.5kg and came from the outer edge of the stone; a complete upper may have weighed as much as 70kg or more, but this is a very approximate figure.

There is no indication of the form of the rynd which would have been necessary to rotate this upper millstone (cf the local stones, above). The post-Roman Mayen lava querns were flat, with flat grinding surfaces, and with a collar/flange on the upper surface of the upper stone (similar to that on the Coal Measures sandstone millstone Q1/Q10/Q10A, Figs 58, 59); the querns were rotated by a handle, or handles, placed in hole(s) in the upper surface of the upper stone (Crawford with Röder 1955, 69-70). Only one of the Dorestad quernstones published by Parkhouse has a socket around the edge of the eye on the lower surface of the upper stone to take a rynd and in this single instance the motive power may have been applied from below (Parkhouse 1977, 184-5, fig 4, type IIIc, diameter *c* 50cm).

A lava millstone found at Springfield, Essex, is believed by the excavator, David Buckley, to be from a water-mill, though no such structure was found in the excavation *(in lit* to PAR 8.10.86). It is an upper stone with a flange around the eye and a socket on the grinding surface to take a rynd. The maximum surviving diameter is c 45cm, but Jonathan Parkhouse *(in lit* to PAR 31.3.88) believes it would have exceeded 65cm in diameter originally; he knows of no other lava millstones from Britain of such a large size as the Tamworth and Springfield examples (but see now London, above). Rough-outs of the size of the Tamworth lava millstone(s) are, however, known from Mayen in the post-Roman period (ex inf Frau Röder, 1978 conference paper; Rahtz 1981,4).

## *The millstone assembly*

The evidence for a horizontal-wheeled watermill with a vertical axle at Tamworth is unequivocal. We may reasonably assume from massive analogy that it was the upper stone that rotated and that the lower stone was stationary. Wheel, shaft, and upper stone turned together. Differential wear on two upper stones corresponds with clockwise motion of the stone and so of the wheel, the direction indicated by other evidence. No radial grooving can be discerned on the grinding surfaces of any of the stones to indicate that the stones had actually been dressed for clockwise motion.

Each upper stone then was underdriven, rotated from below by means of a bar or cross, known as a rynd which fitted into sockets on the lower, grinding surface of each upper stone; the rynd sat on (or was connected to) a spindle set in the top end of the vertical shaft. The distance between the upper and lower stone was controlled, it is argued (see below, chapter 5), through the sword and lightening-tree via the sole-tree and thus the shaft: lowering and raising the upper stone at the beginning and end of grinding; and maintaining the correct gap between the stones for grinding, as the upper and lower wore down. There is no evidence on any of the surviving upper surfaces, or sides, of the upper stones of cavities which could be used for balancing the upper stone by being filled with lead. Similarly, the upper must have been man-handled in and out of position and not lifted by tackle attached to the upper surface or side. The weight of each upper stone was considerable, probably between *c* 40 and 80kg when new, depending on stone type. The implications of this for the whole wheel-assembly are considered elsewhere (see below, chapter 5).

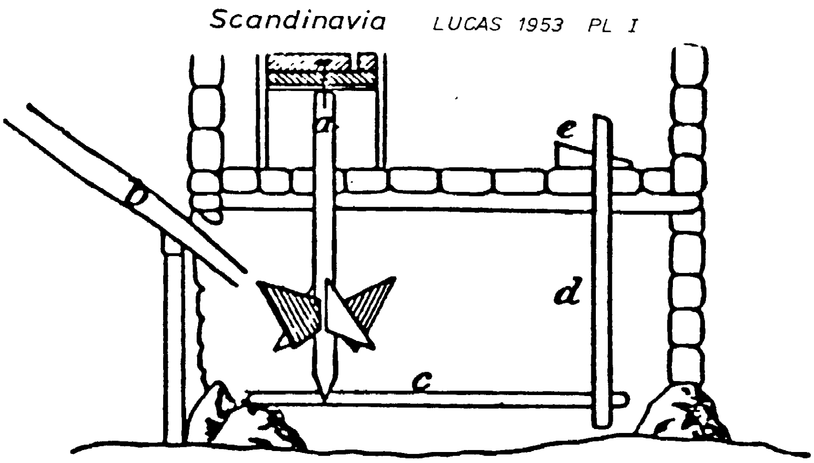
The form of the arrangement at the top of the shaft whereby the upper stone was rotated can be reconstructed in several ways. The various possibilities can be conveniently discussed with reference to two examples of horizontal-wheeled mills. The shaft could have passed right through the aperture in the ceiling of the wheelhouse; the Scandinavian mill reconstruction (Fig 62) shows the stones raised on a box or platform, the shaft ending below the platform, and a separate spindle jammed in the top of the shaft was then the means of rotating the upper stone. Alternatively, the shaft could have ended immediately below the ceiling and only the spindle passed through the aperture, as in the Lewis mill (Fig 62); in this example, the stones sit directly on the millhouse floor.

Spindle and rynd might be integral, but such a fitting would have to be separate from the driving shaft or changing the lower stone would be very awkward. If integral, then the rynd would not have been secured to the upper stone; rather the upper would be dropped into position on top of the rynd. The weight alone of the upper stone would presumably be sufficient to keep it in place. Only if the rynd were separate from the spindle could the rynd be secured to the upper stone before stone and rynd were placed in position over the spindle.

Separate spindle and rynd seem the most likely. Their form may be suggested by the four Roman iron millstone spindles discussed and illustrated by Spain (1985, 124-7). These spindle shafts are for vertical-wheeled mills, but three were found with two- or three-winged iron rynds attached and these are relevant here. The rynd is a hollow tube with wings coming off the top; the tube fits on to the spindle which is also circular in section at the top, but changes to a square section lower down. Arynd might be of iron or possibly hardwood; the Roman rynds just referred to are of iron and an iron rynd is recorded from Cahercommaun, Co Clare (Hencken 1938, 49, 60, and fig 29,698).

Wooden wedges could have secured the rynd (whether of wood or iron) in its sockets in the upper stone, or molten lead used to make a tight joint between an iron rynd and the stone, a technique known as *yotting* (Cosnett and Pawson 1972, 197; Rahtz and Bullough 1977, 34). Microscopic examination of the Tamworth rynd sockets by Leo Biek in 1986 revealed no metallic residues which could be interpreted as evidence either of the use of lead or of an iron rynd. The rynd would not have been flush with the surface of the stone, but would, originally, have been recessed; when the rynd was no longer recessed because of stone wear, the stone would soon have had to be discarded. The maximum depth of the surviving sockets is 2cm and the minimum approximately 1.2cm, suggesting perhaps that a rynd of this thickness would more likely have been of iron than wood. The rynd sockets were at least finished with one or more narrow-bladed tools: vertical tooling made with a pointed tool towards the base of the socket, and horizontal, rather U-shaped section, grooves at the outer edge of the socket are clearly visible (Pls XIII-XIV).

The different configuration of the Tamworth upper stones shows that at least two different types of rynd arrangement were employed; further, they were associated with different stone types and differently finished stones and it seems very probable that the



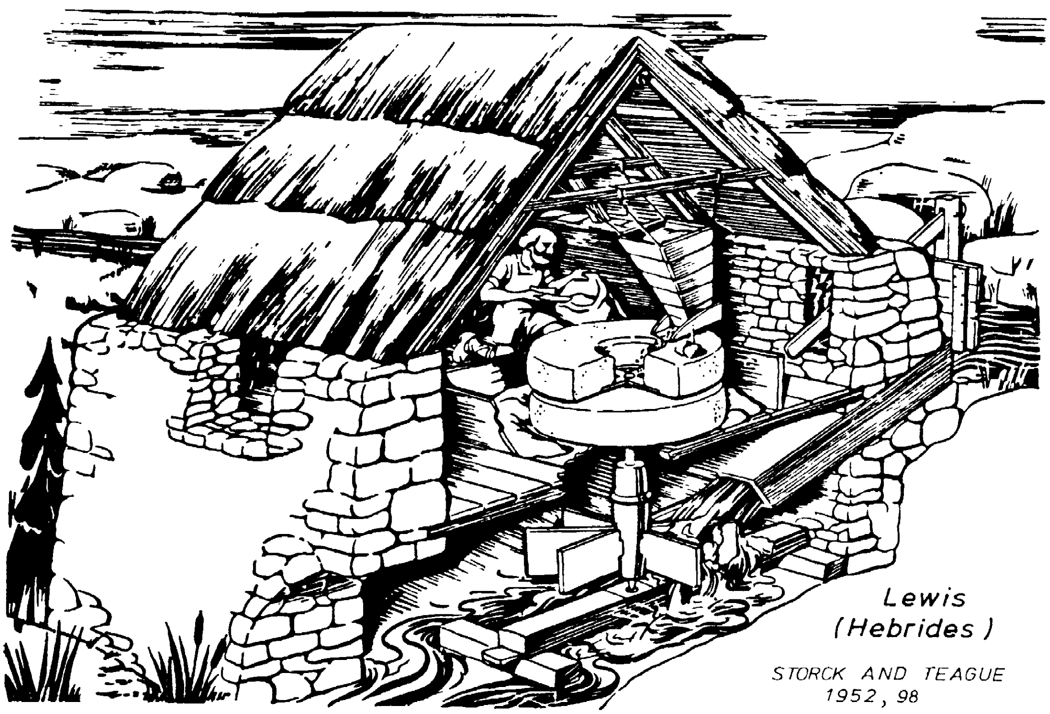




*Figure 62 Mills in Scandinavia (Lucas 1953) and Lewis, Hebrides (Storck and Teague 1952)*

stones were dressed on site. One was a two-winged rynd, diameter 24cm. This was the rynd used with the Coal Measures sandstone upper (Q1/Q10/Q10A, Figs 58 and 59, Pl XIV). This is the only stone with a raised collar around the eye on the upper surface (although the lava upper, by analogy with continental examples of querns, might have also had a collar). The lower surface of this upper is unique among the Tamworth stones. Its inner track is thicker than the outer (grinding) track; a V-shaped circular groove delimits the two, while close to the eye is a very shallow, circular depression. Neither is likely to be caused simply by a pebble or grit trapped between the upper and lower stones. Both features are now smooth and may be solely the result of wear, but it is possible that one, or both, was originally chiselled or pecked out and that, subsequently, trapped grit has worn them smooth (pers comm Leo Biek). There are no certain lower stones to indicate what, if any, positive features on the lower's grinding surface might be mirrored here. A slight cone at the centre of the lower stone might explain the feature around the eye (see MF stone catalogue, Q18).

The other rynd type in use was four-winged, diameter 28cm. A four-winged rynd might appear unnecessarily obstructive to grain entering the eye, but it is argued above that the sockets do not suggest that one pair was recut. Three-winged and four-winged rynds are known (see the four-winged rynd on the Lewis mill, Fig 62) and such an arrangement may have been stronger. The four-winged rynd was a little larger in diameter than the two-winged rynd, but more of the surface was in fact available for grinding on the Keuper sandstone stones. Was this rynd then perhaps a technological improvement on the two-wing type, or vice versa?

At Tamworth the four-winged rynd was associated with the Keuper sandstone uppers which were all essentially similar (Q3; Q13/Q17/Q23; possibly Q4: Figs 60, 61). Their inner track was thinner than the outer grinding area; perhaps this would have prolonged the life of the stone by placing the rynd well above the surface of the lower stone. There is a U-shaped circular groove delimiting the inner track arcs between the outer corners of the rynd sockets. Considerably shallower than the sockets, this feature is smooth like those on the Coal Measures sandstone upper. It may reflect a feature on the grinding surface of the lower stone, or perhaps be worn by, or a bedding for, part of the rynd fitting implying something more complicated than a simple cross. This feature and the depression around the eye of the Coal Measures sandstone upper are each the same distance from the centre of the eye and from the centre of the rynd/spindle; both have a diameter of *c* 13cm although their position relative to the rynd sockets is completely different. This and the other feature on the Coal Measures sandstone upper are difficult to explain.

The eye of both sandstone types of upper would seem to have been of a similar size, *c* 9cm. The burnt clay seating is reconstructed (Fig 64) as having a regular, circular eye, diameter *c* 15cm. The lower stone bedded on this clay may then have had an eye of this size and so larger than that of the upper stone. The eye of the clay seating might be taken to indicate the dimensions of the rotating vertical axle at this point, suggesting that the main shaft itself came up this high, and perhaps as high as the grinding surface of the lower stone. The diameter of the Roman millstone spindles together with the rynd collar is only *c* 5-6cm. However, the lower stone may have had an eye at least as small as the upper's, and the hole in the millhouse floor may have been smaller than that in the clay seating. The rotating axle would have to be appreciably smaller in diameter than any aperture it passed through to avoid friction. If necessary, the gap between the two, whether in the floor or around the eye of the lower stone, could be filled by a 'bush' of for example, leather, cork or softwood to prevent moisture penetrating from below (Rahtz and Bullough 1977, 34, no 36).

The presence of two different rynd arrangements associated with different stone types is intriguing and is sufficient on its own to suggest several possibilities: that there were (at least) two successive, different arrangements within one mill; that there were two contemporary wheels in action either within one mill or in two mills, each with a different rynd and stone assembly; that there were two successive mills, each with a different arrangement. The stratigraphic evidence does of course indicate that there were two successive mills, but the contexts of the sandstone uppers do not tend to support this, last, hypothesis. Of the extant fragments, all those of Keuper sandstone and the majority of those of Coal Measures sandstone (including part of Q1/Q10/Q10A) come from the main destruction level on the wheelhouse floor (150), arriving there it is argued (see above, 2.4) as dump from above (106: Q22; 111: Q18, Q21; 111/150/170: Q1/Q10/Q10A; 150: Q2, Q5/Q8, Q6, Q9, Q11, Q19, Q20; 183: Q14).

The contexts of the lava fragments are also diverse (lava = 1 fragment from each of 104, 105, 150, 180, 184, 265, 273).

Some of the Coal Measures sandstone and Keuper sandstone stones are blackened and may have been burnt; in some cases (including both sandstone types) this certainly happened after they were broken (Q1/Q10/Q10A; Q11, Q13/Q17/Q23). All the blackened fragments came from 150.

*Acknowledgements:* The illustrations are by Elizabeth Hooper (Birmingham University Field Archaeology Unit); David Williams and Leo Biek examined the extant fragments. Their extremely helpful comments and observations are gratefully acknowledged.

### Other stone

by Susan M Wright

The only other worked stone is a schist hone or whetstone, perforated for suspension, perhaps from a belt (Fig 67); this is from a medieval context (3, phase 8).

## 3.2 Fired clay

(listed in MF)

This category includes 17th century clay pipe fragments (including three bowls), and brick and tile. Several of the brick and tile fragments are Roman, including a *tegula* fragment (FC5, Fig 67); others are of medieval date.

## 3.3 Burnt clay (BC)

BC1 Small burnt lump of daub on top of flat timber at bottom of cutting; salmon red, pale brown and black; sandy. 10, phase 2-3

BC2 Lump (now two) of half-burnt soft crumbly red sandy amorphous daub, salmon-red with browner margins and surfaces; fragment, of ?feldspar or mica visible in section. 141, phase 3

BC3 Ten hand-sized pieces of daub (millstone seating, see below). 150, phase 4

BC4 'Plug' of daub, circular in section; possibly for filling in dowel in second-hand timber; possible wood impressions lengthwise (Fig 67). 150, phase 4

BC5 Seven large pieces of burnt daub, weighing about 0.5kg; large piece of sandstone embedded in one; form amorphous, but one piece has a roughly curved surface; millstone seating, see below. 170, phase 4

BC6 Lump of daub, amorphous, 4cm diam.; salmon-red to brown. 255, phase 2

### *The lower millstone seating (Figs 63, 64)*

BC3 and 5 comprise many pieces of clay burnt to a low-fired hardness. These are interpreted as parts of an annular structure, flat-based, with a dished top, in which, it is suggested (in a flexible, damp state), the lower millstone was embedded. Grain impressions and embedded grain (Pl XVIII) on the side of the central hole, shown in one piece, suggest that the clay was plastic when set down on the mill floor (in a ?circular frame or box?); and that grain was pressed into it by the drive-shaft, which extended through this and the lower stone to turn the upper stone. The grain would have been that which escaped being ground between the upper and lower millstones, and found its way down through the central hole, around the revolving shaft, to be thrown outwards by centrifugal force and become embedded in this clay seating. The grain and impressions are reported on by Susan Colledge in 3.13 below.

All pieces are burnt grey to red probably by mill conflagration; it seems likely therefore that this was the *ultimate* lower stone bedding. There is straw in the mix and on surfaces; the whole is crudely made with some hand-fingering and folding; it is probably made out of local natural gritty red clay.

The pieces were examined by Peter Ewence who made a tentative reconstruction drawing (Fig 64) of how he thought they originally lay. He suggests the bedding was originally in two parts: 1. A ring or 'doughnut' of clay around the central hole of the mill floor (up through which the shaft would have come); 2. Handfuls of clay packed around the outside of the stone under its edges. He suggests that the procedure was firstly to mould a ring of well-kneaded clay around the floor-hole (Fig 64, A), and the lower stone was then placed on this central ring, rotated to bed it down and then levelled against the upper stone (Fig 64, B). The lower stone was finally supported with stones and then packed around with handfuls of clay under its outer edge (Fig 64, C). The final seating as found is shown in the plan on Figure 63, and diagrammatically in section on Figure 64, D.

The diameter is *c* 77cm, with a hole of 15cm; this accords well with evidence from the millstones themselves (3.1 above).

The pieces were found in the destruction levels of the mill, lying on the wheelhouse floor (contexts 150 and 170 of phase 4).

## 3.4 Mortar (MOR)

The only mortar found was a lump of pale cream buff granular, full of fine quartz sand and lime; probably wall-rendering rather than core material (from 219, phase 5b). There was also mortar on some of the FC brick.

## 3.5 Plaster (PL)

Plaster was recorded from 4, 87, and 142 of phases 9, 8, and 10; none was kept.

## 3.6 Glass (GL)

Eleven fragments (GL1) were found in 142 (phase 10); they comprise seven window fragments, and four from vessels; no report has been done on this post-medieval group.

## 3.7 Metal-working residues (SL)

Several lumps of apparently partly-reduced ferrous 'kidney' ore, in branch-like pieces were found in 92 (phase 8).

Ferrous slag was also found in 87 (phase 8); L4, 31 and 58 (phase 9); and in 35 and L1B (phase 10); 87 was attached to a pot rim. The pieces from L4 and 58 are probably associated, and comprise a kilogram or more of slag.

## 3.8 Iron (IR) (Figs 65, 66)

by Patrick Ottaway (except IR24, IR25)

L Length; W Width; T Thickness (in millimetres)
* illustrated on Figs 65 and 66

IR1 **Nail;** complete length survives. L 55; head W 15; shank T 5.1, phase 8

IR2 **Bar;** tapers, surface irregular, cross-section originally rectangular. L 175, W 30, T 16. 1b, phase 10

IR3* **Rod;** broken at both ends. It tapers from the

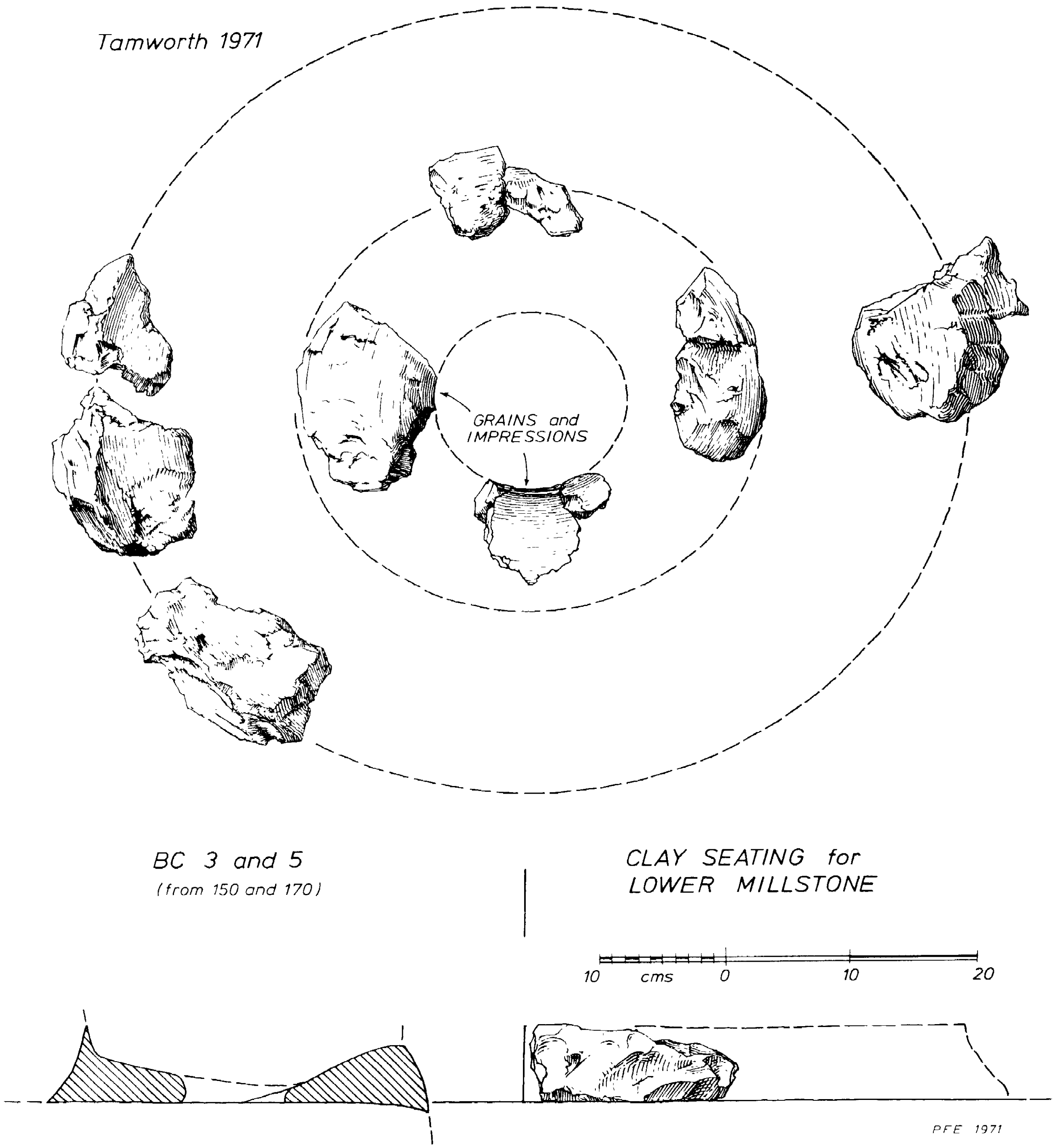



*Figure 63 Clay seating for lower millstone, BC3 and 5*

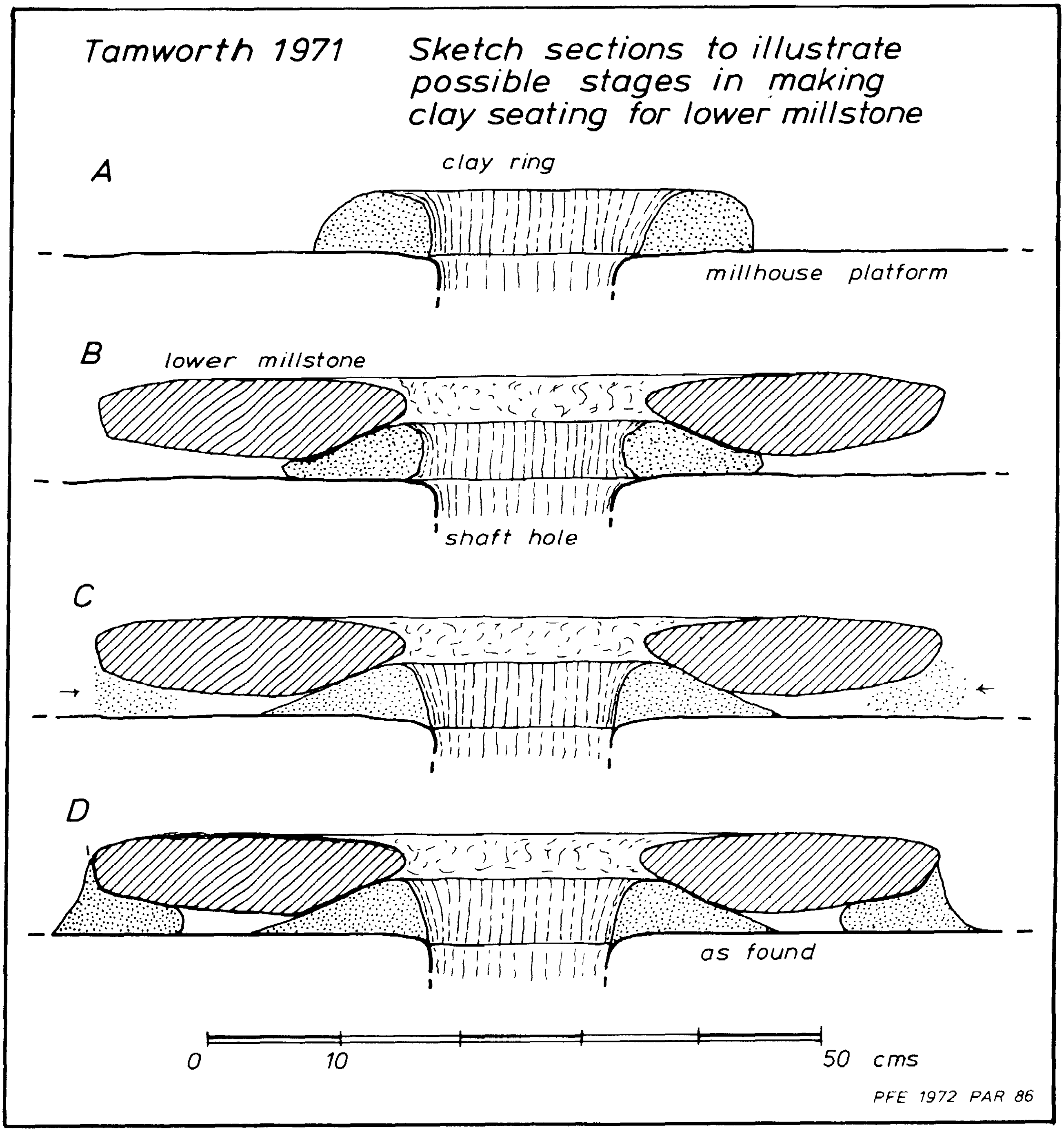



*Figure 64 Diagrams of clay seating construction*

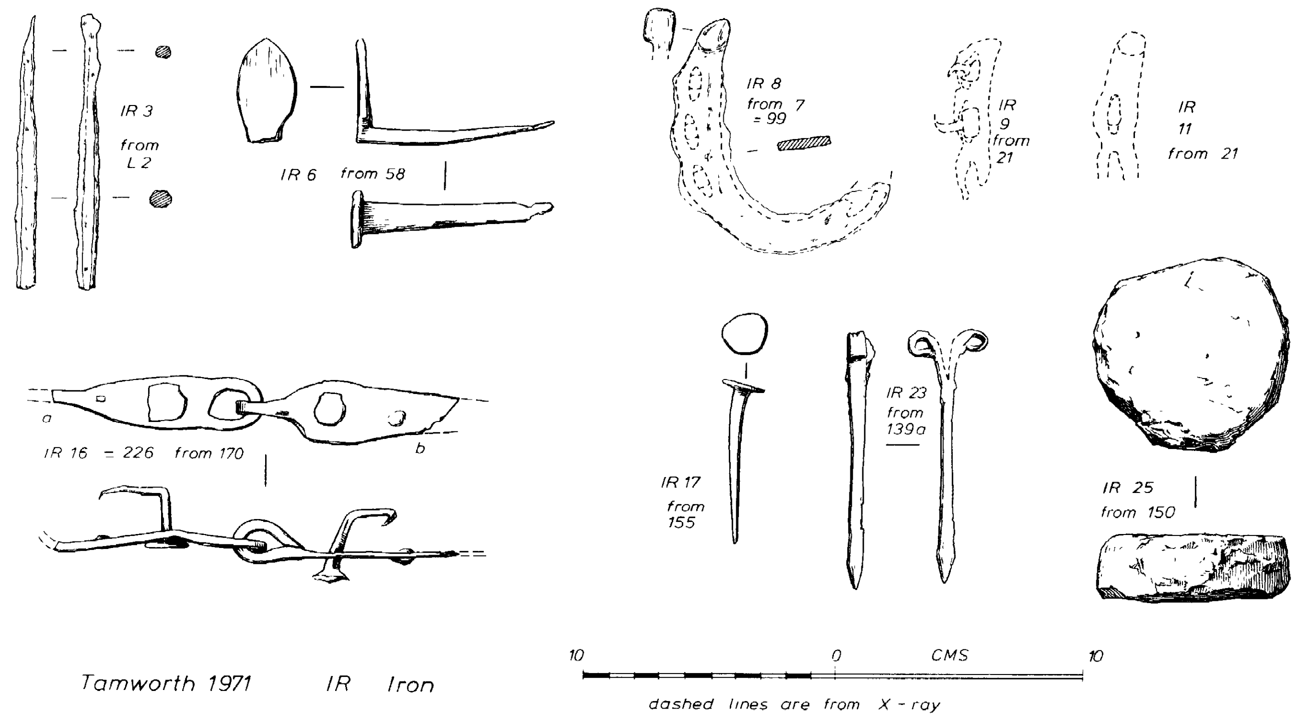



*Figure 65 Iron objects IR3, 6, 8, 9, 11, 16, 17, 23 and 25*

centre towards one end where it is flattened and widened slightly. This is possibly an incomplete spoon-bit or auger. L 124, T 10. 2, phase 9

IR4 Triangular **plate;** ?cast iron. L 34, W 28. 31, phase 9

IR5 **Strip;** surface and cross-section are now irregular. Tapers to one end, which may have been a tang, in which case the object would have been some sort of tool, perhaps a punch. L 104, T 10. 58, phase 9

IR6* **Angle bracket;** one arm tapers, the other is an oval plate. Wood residues survive on both arms. L (arms> 81 and 48. 58, phase 9

IR7 **Spike;** cross-section originally rectangular? L 140, T 7.58, phase 9

IR8* **Horseshoe;** part of the right arm is missing. The complete arm has a wavy outer edge, and three countersunk nail holes. There is a calkin at the tip. L 103, overall W 84. 99 = 7, phase 5a

Horseshoes similar to IR8 and to IR9 and IR11 (see below) are normally to be found in contexts of 11th to late 13th century date. Earlier horseshoes are uncommon but usually have a less pronounced wavy outer edge and squarer nail holes (Ottaway 1991).

IR9* **Horseshoe,** part of a left arm; it has a wavy outer edge and three countersunk holes. There are two nails *in situ.* L 83, W 20. 21, phase 8

IR10 **Plate;** pierced twice with two holes *in situ.* Possibly a hinge strap or binding. L 183, W 22, T 8. 21, phase 8

IR11* **Horseshoe,** part of a left arm; it has a wavy outer edge, two countersunk holes, and a calkin at the tip. L 68, W 18.21, phase 8

IR12 **Nail;** complete length survives. L 80, head W 20, shank T 6. 97, phase 8

IR13 **Tapering strip;** possibly a nail. L 54, T 5. 82, phase 5

IR14 **Nail;** rectangular cross-section, small triangular head. Probably post-medieval. L 80, head W 8, shank T 5.65, phase 7

IR15 **Nail,** similar to IR14. L 105, head W 12, shank T 8. 58, phase 9

IR16* **Hinge fitting** consisting of two interlinked straps (a and b). 226, phase 4. Strap a has an

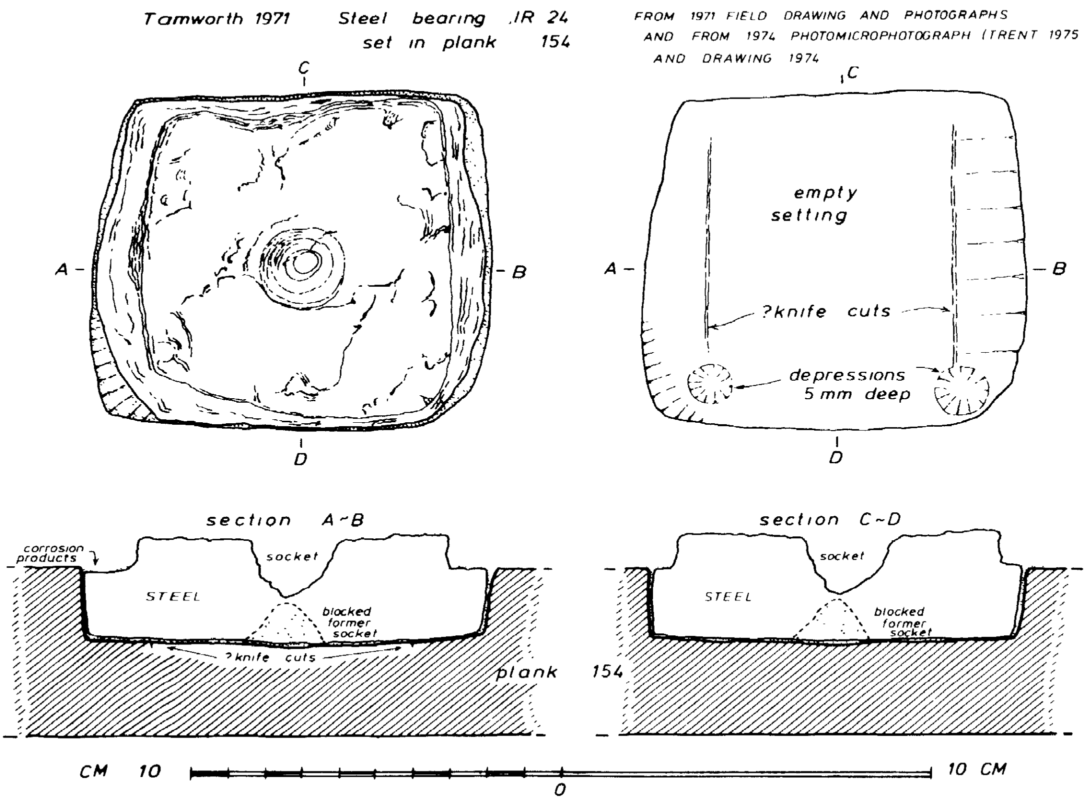



*Figure 66 Steel bearing IR24*

eye in a plane at 90 degrees to the strap; below the eye it has roughly rounded 'shoulders' and narrows away from them; it is pierced once and there is a nail *in situ.* L 80, W 30mm.

Strap b has an eye in the same plane as the body of the strap; it is also pierced once. L 60, W 20mm. The eye on strap b, formed by drawing out the end of the strap, curving it over and welding it back onto the body of the strap, is of a form that is almost unknown after the mid 11th century but can be paralleled on Anglo-Scandinavian period straps from 16-22 Coppergate, York (sf677, sf7569; Ottaway 1991) and Repton, Derbyshire (unpublished; excavated by M Biddle). A number of the Repton straps are also very similar in form to strap b. Two interlinked straps with eyes closely comparable to those on the Tamworth straps are illustrated by Petersen in his corpus of Viking Age material from Norway (Petersen 1951, fig 247).

IR17* **Nail.** L 74, head W 9, shank T 6. 155, phase 2

IR18 **Nail.** L 40, head W 20, shank T 5. 255, phase 2

IR19 **Nail.** Head W 20, and nail shank fragment L 20.255, phase 2

IR20 **Rod;** rounded cross-section. L 136, T 13. 255, phase 2

IR21 Two **plates** which fitted together; one (a) is pierced, the other (b) has a rounded end. They may be from a hinge strap or binding. (a) L 67, W 29, T 5, (b) L 57, W 32, T 5. 255, phase 2

IR22 **Nail.** L 40, head W 25, shank T 3. 255, phase 2

IR23* **Candle holder;** shank tapers to a point. At the head it bifurcates and both arms have looped tips. L 115, W 33, T 6mm. This is similar to so-called 'prickets', but they usually have a central spike on which the candle was impaled. In this case, the candle was presumably wedged between the arms. Similar heads, albeit with L-shaped shanks, may be seen on two later medieval candle holders from Å rhus, Denmark (Andersen *et al.* 1971, 168, BIX, BTB). 139a, phase 8

(Patrick Ottaway has not examined IR24 or IR25)

IR24* **Steel bearing,** see below.

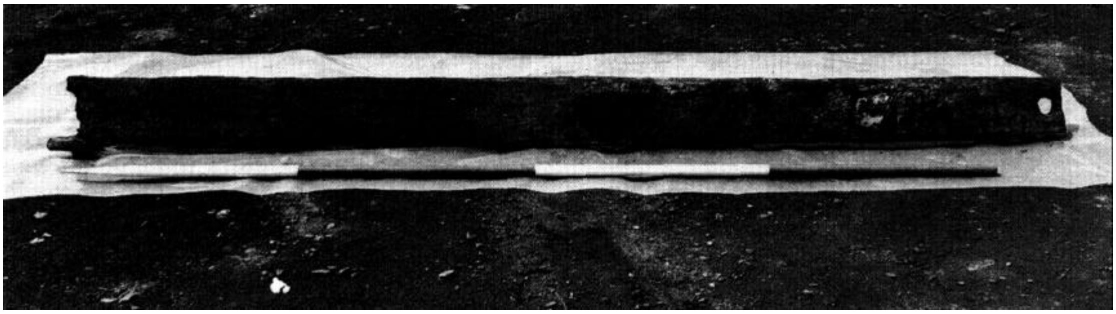


*Plate XV Sole-tree 154, steel bearing IR24 towards right-hand end*

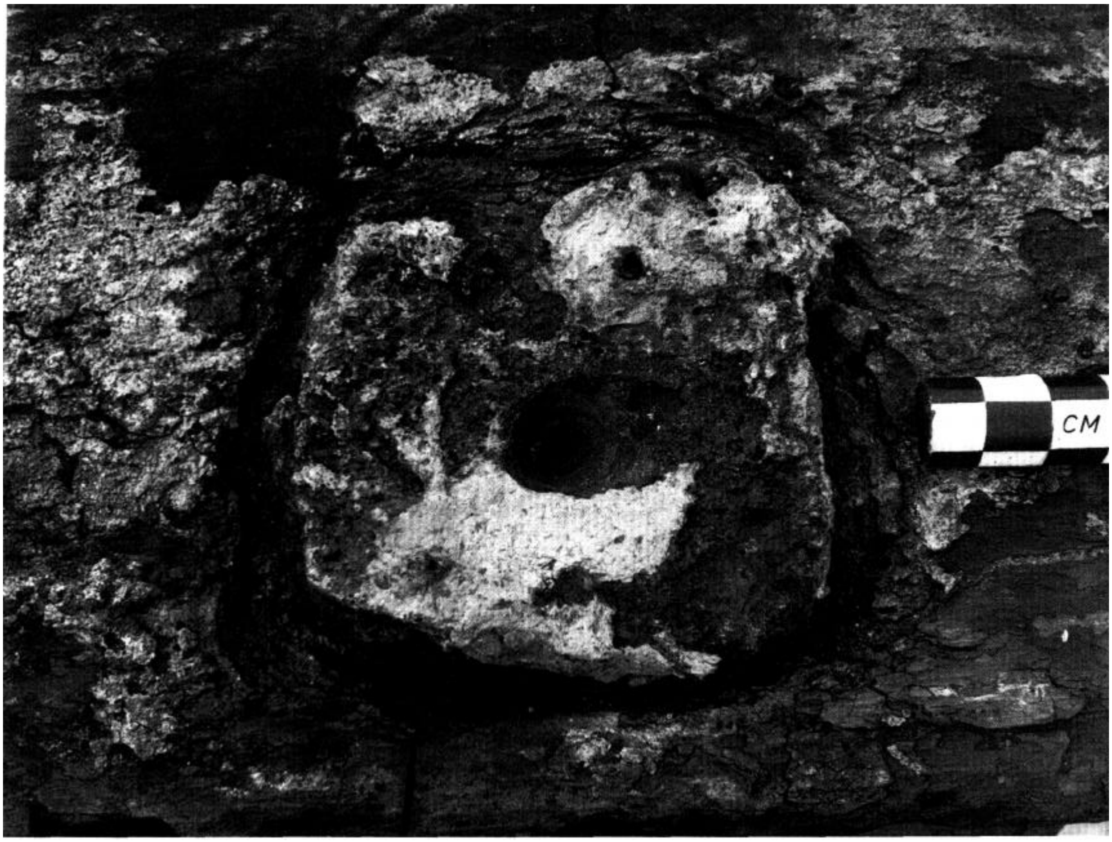



*Plate XVI Steel bearing in situ in sole tree 154 (scale in cm)*

IR25 ***Iron or steel lump,** possibly a weight or counter-balance, or an unused bearing rough-out similar to IR24. Condition similar to IR24. 150, phase 4

## *The steel bearing block IR24, in plank 154 (CW14) (Figs 66 and 70, Pls XV-XVI)*

by PAR

This was found set into a plank, which was loose, on the wheelhouse floor, with the bearing block on the underside (ie, face down). As drawn in 1971 (Fig 66), the raised part of the bearing stood proud of the plank by *c* 1cm, the plank itself being *c* 5cm thick and *c* 17.5cm wide. The total thickness of the bearing block including its raised part, is now *c* 3cm, so a thickness of plank of *c* 3cm now separates the bearing from the underside of the plank. The plank, with its bearing, is interpreted as the sole-tree of the mill.

The size of the bearing block itself must be very close to its original size, allowing for some surface corrosion. The main mass of it is still solid steel (cf Trent 1975), and uncorroded or rusted. The plank size (CW14 on Fig 70) must, however, be regarded as a minimum. Its length is likely to be within a few centimetres of its original dimension but the width and especially the thickness may have been considerably greater. The wood was waterlogged as found and hard internally, but the surfaces were soft. The plank may originally have been up to 10cm thick; the surface may have been flush with that of the raised part of the bearing, or even above it. The precise original size of this plank is important, since doubts have been expressed as to whether the interpretation of it as a sole-tree carrying 100kg or more, is correct (below).

The plank was sawn up (as there was no prospect of conservation), and the bearing block was left in a short section of it. This was given to Dr Edward Trent of the Department of Industrial Metallurgy, University of Birmingham, in 1974. He removed the bearing block from its emplacement in the wood, cut it in half, and polished the surfaces. His report (Trent 1975) is of great interest in demonstrating the high quality of the steel, and the processes by which it had been brought to its finished state.

He was not able to make any comments on the existing socket (female bearing). This was roughly in the form of an inverted cone, and showed considerable distortion or 'tearing', caused, it is suggested, by friction of the male 'pintle' or 'gudgeon'. The material of which the latter was made is not known, but if it was of steel similar to the female bearing, one or other must have 'given', depending on the lubricant (if any) used. It might alternatively have been of bronze or even of hardwood, but neither of these is likely to have been strong enough. What would have been useful would have been a confirmation by Trent that the 'tearing' was caused by clockwise friction, since this is the direction that we know from other evidence that the main shaft would have rotated; if the distortion had been anti-clockwise, or alternating, it would have ruled out the identification of 154 as the sole-tree of the mill; it may, of course, be from some other piece of mill machinery A final point may also be made that the reconstructed mill at Dounby, in 'mainland' Orkney, has both male and female bearings of iron and steel supporting the main shaft, the female bearing set in a plank of similar size to 154 as reconstructed.

The distance from the socket centre to the centre of the right-hand (on Fig 70) attachment hole is 40cm; and from the socket centre to the presumed centre of the left-hand attachment hole 188cm - a ratio of about X:4.5. If the identification of 154 as the sole-tree is correct, these relative distances would give a similar ratio between the lift given at the lightening-tree end (the left one here) and that given to the main shaft of the mill, ie, that if a lift of 45mm were applied to the lightening-tree by means of wedges in the millhouse control (sword) of its upper end, the main shaft, and thus the distance between upper and lower stones in the stone-box, would have been 10mm, enabling a very fine adjustment to be made for variations in the material or coarseness of the grind, or for taking up slack due to stone wear. In this interpretation, the left-hand end of 154, the broken worn rectilinear hole, would be a (flexible) attachment to the lower end of the upright lightening-tree, the upper end passing through the roof of the wheelhouse and the floor of the millhouse. The right-hand hole of 154, a roughly circular hole very worn at all its edges, would have been attached, again flexibly, to a bolster or substantial timber, attached to the south-east wall of the wheelhouse, perhaps by a rope or leather. No evidence of the latter was found; there would probably have been such evidence if the bolster had been on the wheelhouse floor, rather than just above it, when no evidence would have been found. If this arrangement is broadly accepted, then of course the location both of the bolster and the lightening-tree can be postulated in plan (Fig 80).

No bearing was found *in* the wheelhouse floor, and this is not surprising. Mills of this kind almost invariably have the whole shaft assembly supported on a sole-tree with bearing, of various design and material (but see Fig 104); and there must have been one at Tamworth. It is inescapable therefore that both sole-tree and bolster were above the level of the floor, though in this case the attachment of the bolster to the main south-east wall of the wheelhouse presents problems (ie, if there were no support for its north-west end).

An important piece of evidence was demonstrated by Trent's polishing of the cut section through the bearing: there had been an earlier socket precisely opposite that in ultimate use. This was similar in shape and size to the empty socket, and had been plugged with steel before its emplacement was made. The bearing was thus, in the form we have it, a replacement, after some period of earlier use upside down, though not, it would seem, with a raised central area — was this originally set deeper in a (previous) plank? When Trent removed the bearing from the wood, the emplacement (by now distorted by drying) was seen to show the marks of two shallow knife-cuts, and two roughly circular depressions *c* 5mm deep, as shown on the right-hand side of Figure 66. These were filled with ferrous sandy concretion; they do not seem to bear any relationship to the bearing (eg, as setting marks), and no suggestions can be made as to their purpose.

The bearing was also examined by Dr Ian Goodall (RCHM, York). He commented that, in his opinion, the bearing was too small to have carried the wheel/shaft/upper stone assembly, and it must have come from some other piece of mill machinery.

Comments from Dr Arthur Dunn are in microfiche; and there is further discussion in chapter 5 below (on the functioning of the mill).

### 3.9 Copper alloy (CA)

Only one piece of copper alloy (CA1) was found, a post-medieval tinned bronze pin (L1, phase 10).

## 3.10 Other metals (OM): lead (Pls XVIIA-C) * illustrated on Fig 67

- OM1* Lead **cross,** 6.0cm long, perforation at end of central shaft; pitted on one side; ?amulet, pitting for adhesion to something (Pl XVIIB). 48, phase 7
- OM2 Lead **strips,** small melted pieces, as OM7 below. 107, phase 4
- OM3* Lead **strip** with expanded ends, perforated in centre, like a **propellor** (Pl XVIIC). 92, phase 8
- OM4 Lead lump. 139, phase 8
- OM5 2 lead lumps. 150, phase 4
- OM6* Lead strip; ?roof; 10.5 x 5cm, 1.5mm thick. Peter Ewence commented that this was scrap, an offcut from a sheet; it shows beating marks on one side, and all the sides have been cut with a knife. 54, phase 5b
- OM7 Lead strips (fused mass). 170a, phase 4
- OM7a Half-melted lead in shape of lozenge, like a window-came; it was this piece which most strongly suggested this hypothesis (Pl XVIIA). 170a, phase 4

### *OM2, 7 and 7a*

The lumps of half-melted lead were found in the destruction levels of the mill; some had the appearance of lead window-tames that had been half-melted and compressed. One piece especially (OM 7a Pl XVIIA), looked like part of a lozenge or diamond shaped *(c* 5 x 3cm) frame, though much smaller than medieval examples (inf Susan M Wright). The possibility that the mill had glass windows was important, in view of the scarcity of middle to late Anglo-Saxon glass in Britain, especially on secular sites; if the existence of glass could have been proved, it would have increased considerably the likelihood of the Tamworth mill being of ‘high-status’.

Samples were accordingly submitted to Mr D E Hogan, the Curator of the Pilkington Glass Museum, at his request (1971), in the hope that glass residues might be detected. Mr Hogan submitted the samples to the Pilkington Laboratories at Lathorn, where the analysis was carried out, and in February 1973 Mr Hogan reported:

> The sample from Tamworth Mill was examined in the areas indicated, by taking surface scrapings and subjecting them to X-ray examination both diffraction and spectographic. No indication whatsoever of any vitreous or even silicaceous residues were detected. The only analysis possible was mainly lead, presumably the base material. It appears therefore that there was absolutely no presence of glass in the samples.

The lead was also examined in 1973 by Peter Ewence, who comments as follows:

> The only piece of 'frame’ among the pieces I have examined has, in my opinion, been melted to the point of flow; and its present angles and dimensions are I think fortuitous. No part of the fused lead lumps could be convincingly drawn to show a possible shape of a pane or window. If this material was for windows, it is in any case too light to have held glass, but may have held horn.

The lead was, however, re-examined in 1988 by Leo Biek, who considers that it is quite likely that the 'frame’ was in fact part of a window-came; enough shape could be discerned in microscopic examination to suggest a characteristic section. Among the melted residues he identified sand, grain and burnt earth; and also organic material, charred without losing its characteristics: this may be horn.

In view of these comments, it seems likely that the lead was from window frames, not for glass but for horn.

Further uses for lead in the mill were suggested by Cosnett and Pawson in a published letter (1972). The first was the use of lead to make a tight joint between the gimbal bar or rynd and the upper or 'runner’ stone. This, they suggest, was common practice where joints between iron and stone are made; it is known as *yotting* (from AS *geotan*, pouring metal on metal in casting). Because of the malleability of the lead, it can be hammered in to make a tight joint after cooling.

The second possible use for lead was its having been used to balance the runner stone; well-balanced stones are essential to give even grinding and to prevent wear. Cavities are often left in the runner stone for the addition of balance weights.

Cosnett and Pawson's suggestions were borne in

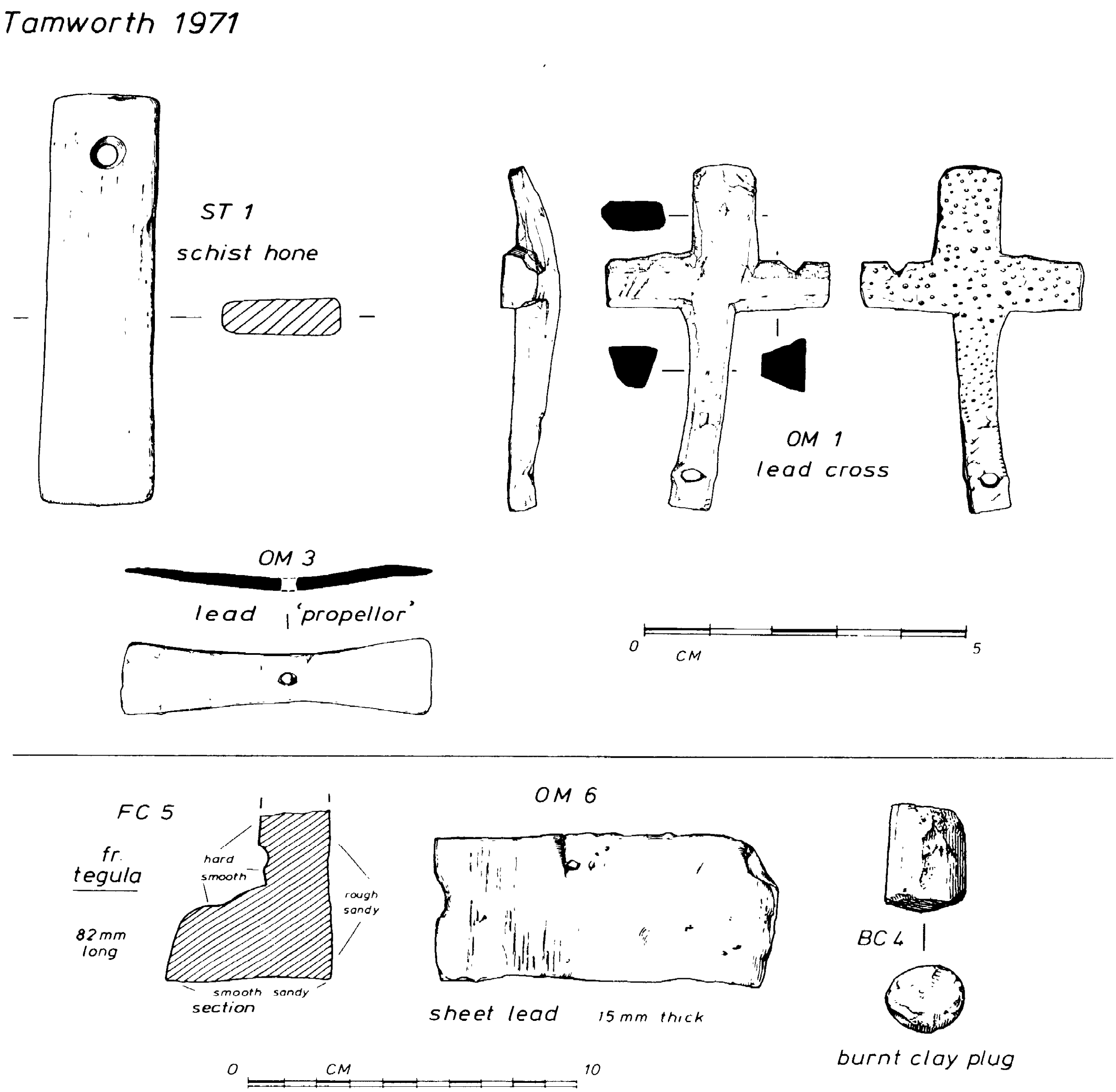



*Figure 67 Schist hone ST3; lead objects OM1, 3, 6; fired clay FC5; burnt clay BC4*

mind by Dr Wright in her examination of the mill-stones; but there was no surviving visible evidence of either practice (see 3.1 above), though no stone survived complete.

## 3.11 Coins (CO)

CO1 'Cartwheel' penny of George III, 1807. L1, phase 10
CO2 Jetton. L1b, phase 10

## 3.12 Organic residues (ORG) (other than botanical)

The only material in this category is some pieces of concreted dung, straw, or wattle from 56 (phase 10); see also 3.10 above, for organic residues among the melted lead, of ?horn; and 3.15 below, for textile.

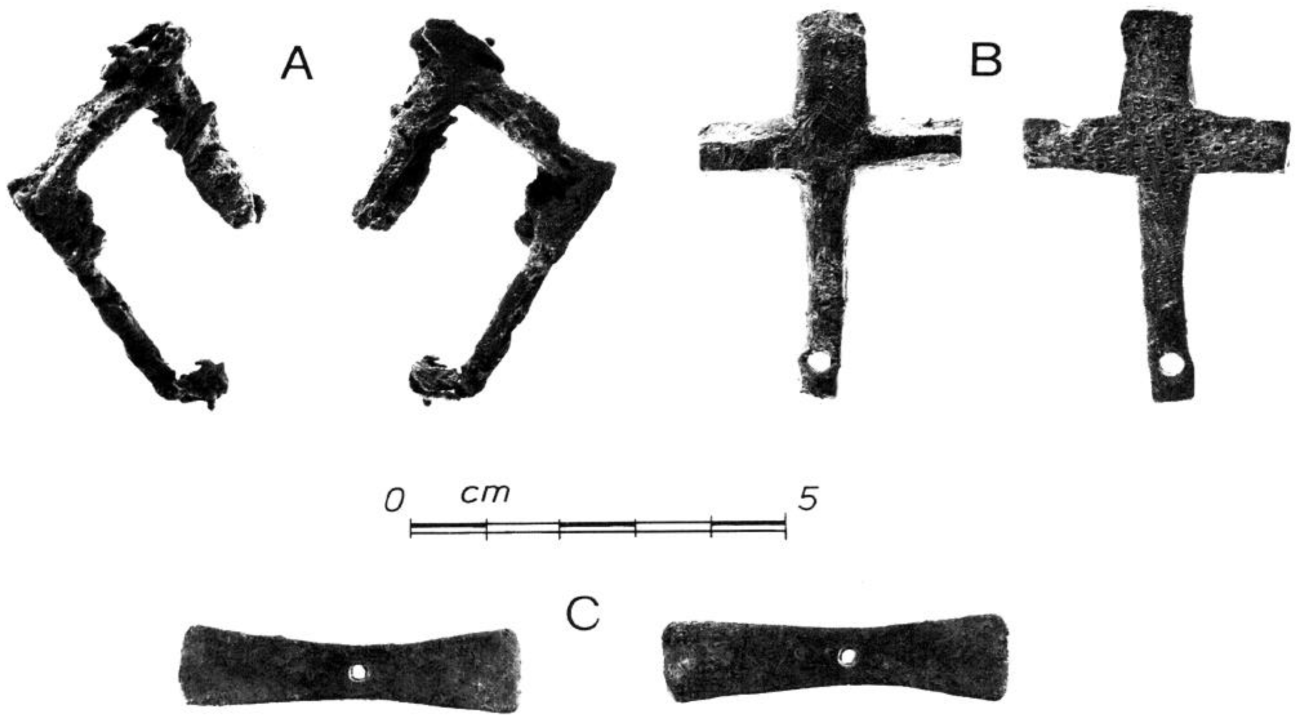



*Plate XVII Lead objects. A) came OM7a; B) cross OM1; C) 'propellor' OM3. (Photos: John Bateman, Dept of Archaeology, University of York)*

## 3.13 Botanical residues (BOT) (1971)

BOTl Sample of woody or peaty deposit at base of phase 8 ditch 90 (see report below). 266, phase 8

BOT2 Sample of twigs from phase 2 leat. 155, phase 2

BOT3 Sample of burnt layer under timber 172. 170A, phase 4

BOT4 Sample of fibrous material from millpool silt of phase 3 (see report below). 241a, phase 3

BOT5 Block of peaty or solid dark grey mud from base of phase 8 ditch 90 (see report below). 266, phase 8

BOT6 Sample of woody or peaty deposit at base of phase 8 ditch 90; cf BOT1 and 5 above (see report below). 266, phase 8

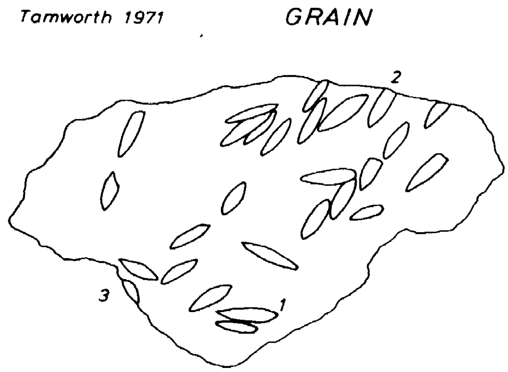
BOT7 Sample of wood and organic material from phase 2 leat; cf BOT2 above. 155, phase 2

BOT8 Seeds floated out of sample from phase 2 leat. 155, phase 2

There were also from 1971 the grain impressions in the clay seating under the lower millstone (3.3 above) (see report below).

**Grain impressions in the burnt clay** (BC3 and 5, see 3.3 above) (Fig 68a, Pl XVIII)
by Susan Colledge

The impressions of the grains (Pl XVIIIA) were on the inner surface of the clay lump which once formed a 'flexible padding' for the lower grinding stone of the Tamworth mill. The area of the impressions (*c* 12 x 12cm) was cleaned with a fine paintbrush and a fine probe where there were persistent lumps of debris on the clay surface. As the impression cavities were cleaned it was noticed that what appeared to be the husks of the grains were peeling away from the sides. Once the surface was clean it was brushed with a suspension of wax in alcohol (Mould Release QZ11-Ceiba Geigy). The alcohol evaporated quickly to leave a thin layer of wax; this ensures easier removal of the cast. The



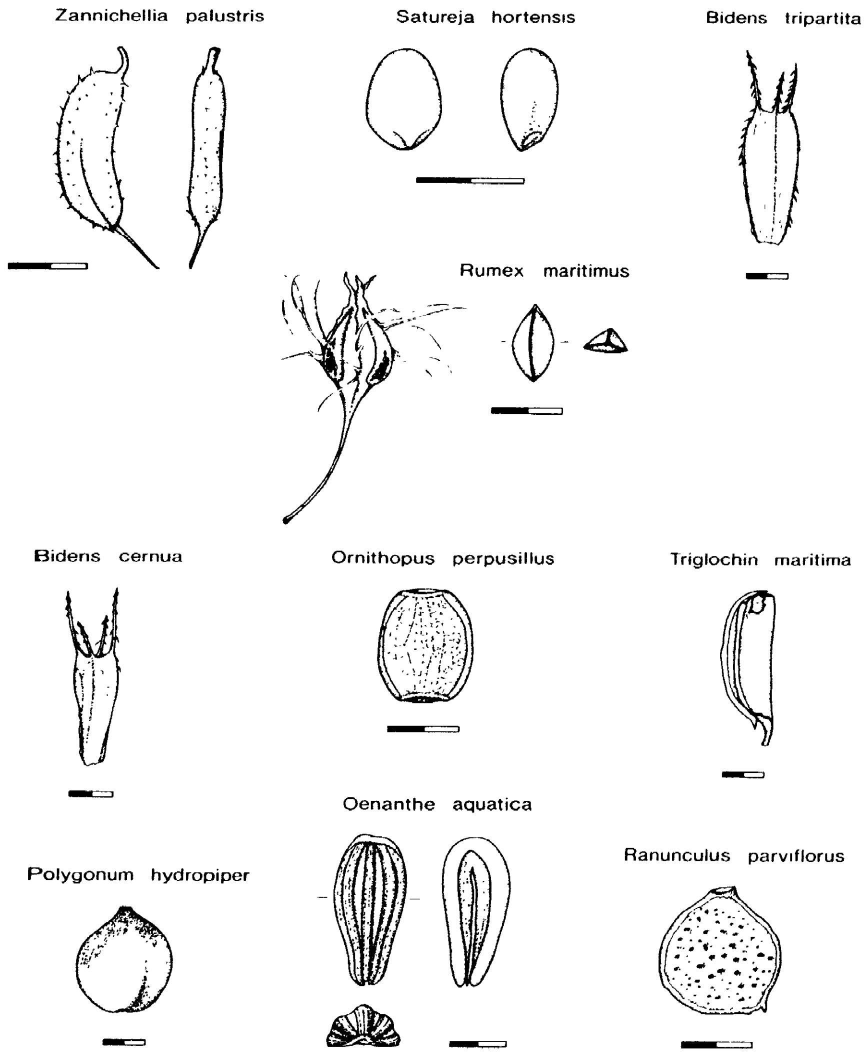




*Figure 68a (above) Grain impressions on clay seating BC3 Figure 68b (below) Plant remains from 1978 excavation*

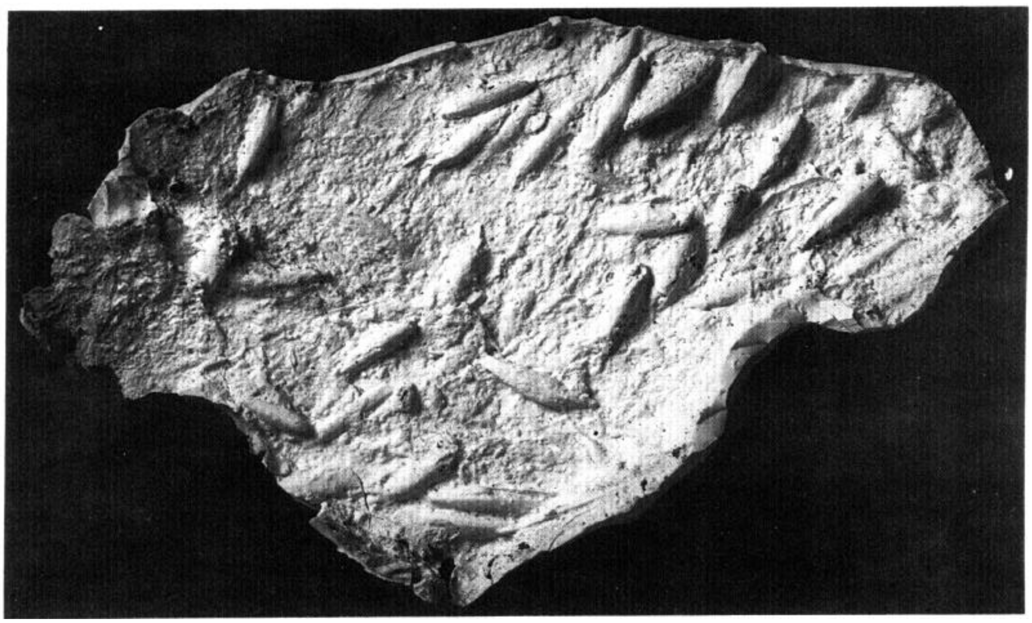



*Plate XVIII Above: Inner edge of clay seating for lower millstone, BC3, showing grain impressions preserved by being fired; below: Latex cast of grain impressions in clay seating for lower millstone, BC3. (Photo: Peter Dorrell, Institute of Archaeology, London)* rubber latex (Elastic 9161) was mixed with the catalyst, enough to allow for an approximate setting time of 10-15 minutes. The latex was spread on the clay surface as quickly as possible in the hope that it would penetrate the deeper, more constricted parts of the impressions before it became too viscous. After the latex had set completely, the cast was peeled gently away from the clay surface. The surface of the cast was brushed to remove any debris which had detached during peeling; and the upstanding sides of the cast, where the latex had flowed down the sides of the clay lump, were cut down. Peter Dorrell (Institute of Archaeology) photographed the cast, producing an excellent picture of the grains which show details of their shape and surface texture which it was not possible to see in the impressions (Fig 68a, Pl XVIIIB).

The shape of the grains would indicate that the cereal represented was oats, *Avena* sp. As opposed to wheat, barley and rye grains, which tend to be slightly larger and are more commonly either laterally or dorso-ventrally compressed, oat grains are long, narrow and more 'cylindrical', with a symmetrical cross-section. The cast clearly shows grains of this shape. On one grain (Fig 68a, no 1) it is possible to see the rachilla on the ventral surface. Commonly the florets of the oat spikelet disarticulate so that the upper rachilla remains attached to the floret below. The majority of the grains would appear to be husked (with the lemmas and paleas attached) and this is substantiated by the fact that in many of the impression cavities in the clay surface there were the vestiges of the husks (as mentioned above). On certain grains, those without husks, it was possible to see the embryos of the seed. One grain (Fig 68a, no 2) shows more angularity and this would tend to be more characteristic of barley, *Hordeum* sp. Hulled barley has grains that are 'hexagonal' in cross-section and they are recognizable by the longitudinal ridges along the length of the caryopsis. It is also possible to see the fragments of cereal culm on the cast. On one edge there is part of the rounded, textured surface of a weed seed (Fig 68a, no 3). The texturing of this seed is in the form of rows of small protuberances. It is doubtful whether any positive identification will be possible but this seed could be a member of the family Caryophyllaceae (the Campion family). For example, it could be a seed of the genus *Gypsophila* or perhaps a seed of *Agrostemma githago.*

The implications are that the Tamworth mill was being used in the preparation of oats and possibly barley. This could have been a stage in the production of groats for human consumption (Hillman 1984). The archaeobotanical records for the early medieval period are not very comprehensive and this evidence of the use of the cereals is therefore an important addition.

## Plant remains

Plant remains from the 1971 BOT series above were examined by I Thomas and James Greig, who report as follows:

*BOT4* (241a, silt of millpool, phase 3)
I Thomas identified mosses from this sample as *Brachythecium velutinum*, *Hypnum cupressiforme* and *Rhytidiadelphus squarrosus.* All these would normally be found in open woodland. Another moss *?Antrichia curtipendula* is commonly found in archaeological contexts, which show that it was formerly much more widespread than nowadays (Dickson 1973).

*BOT1, 5, 6* (266, base of ditch 90, phase 8)
James Greig describes these samples as very hard and compact. They broke up readily in water to reveal a matrix of coarse sand and black particles, many of which floated off. After sieving, the following were found: wood fragments of a fairly uniform shape with flat sides, perhaps wood chippings, also some small pieces of charcoal and some arthropod remains. The seeds of *Juncus* sp. (rush) (very many), *Menyanthes trifoliata* (bog-bean) (2), *Caltha palustris* (marsh marigold) (2), *Carex* sp. (sedge) (3), and *Polygonum* sp. (1) were identified, all plants of pond edges or still water. Three seeds of *Urtica dioica* (stinging nettles) were also found, a plant generally associated with human occupation. Greig comments that this assemblage is far too small for any interpretation, other than that the deposits appear to have formed naturally, and that 266 shows signs of marshy conditions.

James Greig and Susan Colledge, with Lisa Moffett, also examined samples from late Saxon, medieval and post-medieval contexts in the 1978 excavation. The following is based on their report (*illustrated on Fig 68b and Pl XIX; Table IV).

*Summary*
The plant remains from late Saxon-early medieval leat and ditch fills showed that these were overgrown and marshy when the deposits were formed; some crop plants and diagnostic weeds were found, probably as a result of rubbish dumping, which show something of the use of the countryside at that time. A post-medieval charred deposit contained rye straw.

*Method*
Samples were collected by Meeson, and also by the writers in site visits, from exposed strata. Time allowed only the examination of samples from A87, A114, and B29. The investigation of rich floras of waterlogged material is a very lengthy business, and these results are what could be done in the time available, not what ideally would have been achieved. Various groups such as the grasses have not been identified to species. There are, nevertheless, some interesting and, hopefully, archaeologically useful conclusions. Susan Colledge did the analysis of layer A87g, and James Greig analyzed A87b and A114 (with help from Lisa Moffett in identifying the cereals).

*A87, middle fill of ditch A145, 1978 phases 7-8, 13th* century or later, see 2.15 (Fig 51, section S55, 'grey organic' layer)

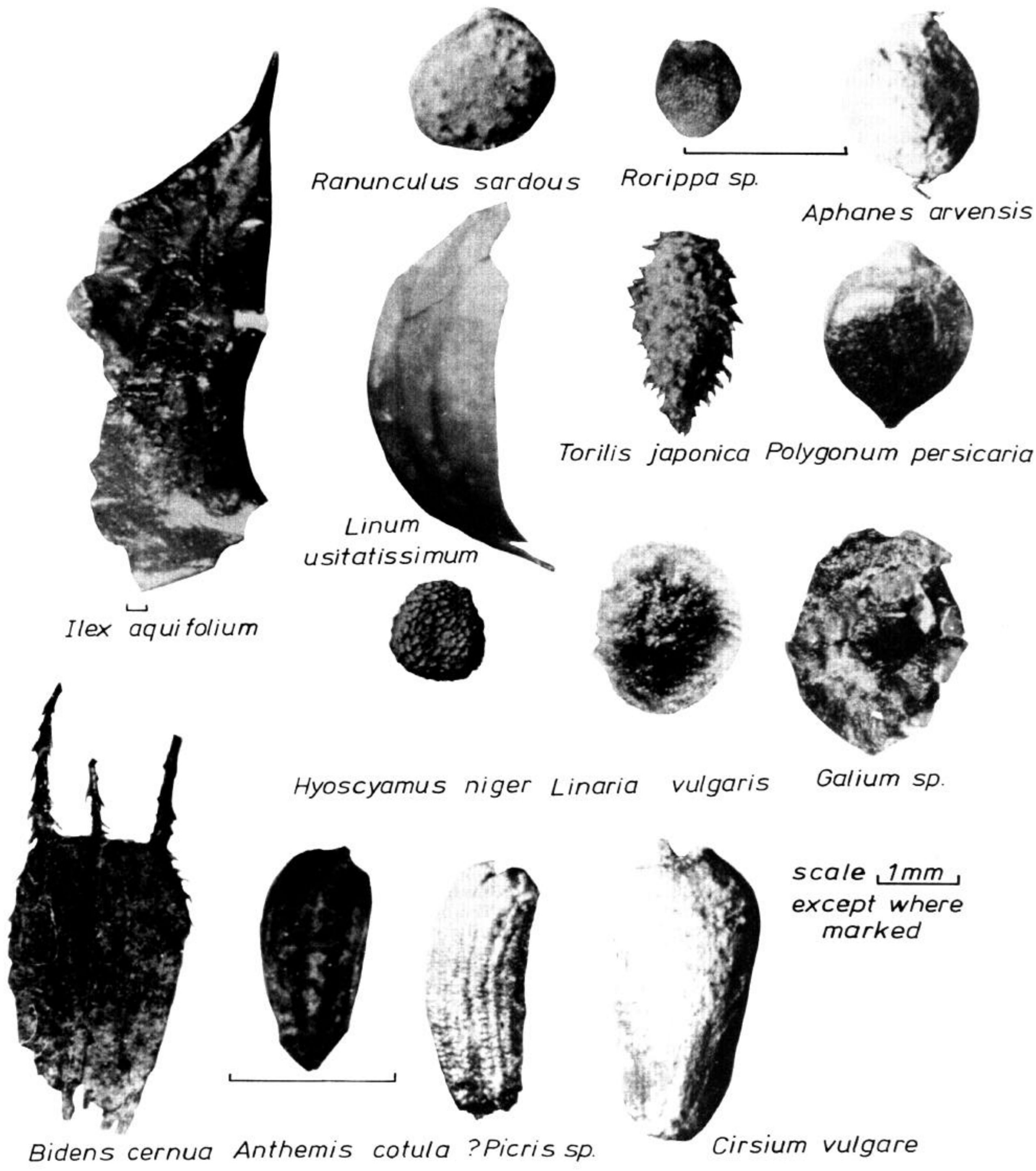



*Plate XIX Plant remains from 1978 excavation (Photo: James Greig)*

The samples were from green and blue alluvial deposits; they yielded a large and varied flora.The plant remains found are given below (*illustrated on Fig 68b and Pl XIX).

There were some signs of aquatic vegetation in the plant records such as *Ranuculus* subgenus *Betrachium* (water crowfoot), *Myriophyllum* (water millfoil), *Sparganium* (bur-reed), and *Alisma plantago-aquatica* (arrowhead). The first two are fully aquatic and only grow in standing or flowing water, while the others often grow along river-banks. The number of taxa, and the seeds representing them, are small, so this ditch fill is probably not that of a clean water-filled channel.

There were somewhat more signs of damp or marshy conditions (wetland) with *Ranunculus sceleratus*, *R flammula* (lesser spearwort), *Rorippa* sp.* (yellow-cress), *Montia fontana* ssp. *chondrosperma* (blinks), *Filipendula ulmaria* (meadowsweet), *Polygonum hydropiper* (water-pepper), *Senecio aquaticus* (marsh ragwort), *Cirsium palustre* (marsh thistle), *Eleocharis* sp. (spike-rush), *Carex* species (sedges), etc. There are more taxa, and more seeds from this habitat, so marshy vegetation seems to have grown there, together with some aquatic plants, perhaps during periods of flooding. The conditions were certainly wet, allowing good preservation of the plant remains.

The remains include some which were probably thrown into the ditch, from both gardens and cornfields.

Garden weeds: these were very abundant, the first group including those which mainly germinate in spring and are still commonly found in gardens now (and on any other bare soil), where they prefer sandy, somewhat acid soils. In the past some of these may also have grown in spring sown crops such as oats, spring barely and flax. The vegetational community is the so-called *Chenopodietea* (Ellenberg 1988). Taxa found are *Capsella bursa-pastoris* (shepherd's purse), *Stellaria media* (chickweed), *Spergula arvensis* (corn spurrey), *Chenopodium* species (goosefoot, etc) (numerous), *Atriplex* species (orache), *Euphorbia helioscopia* (sun spurge), *Polygonum aviculare* (knotgrass), *Urtica urens* (small nettle), *Solanum nigrum* (black nightshade), *Galeopsis* sp. (hemp-nettle), *Chrysanthemum segetum* (corn marigold) (also a cornfield weed), *Sonchus* spp. (sow thistles). Another weed is *Ranunculus sardous** (hairy buttercup) which is often found on medieval sites. Some, such as corn spurrey and corn marigold, are weekd more of field crops than of gardens. As these weeds are of fairly general occurrence, they may well have been growing around the site on the dry ground beside the wet deposit in which their seeds were preserved, as the fairly large numbers of seeds suggests. Some, however, could just as easily have come from plant material brought to the site, such as cornfield weeds in straw. Their presence shows that dry land vegetation from rater sandy soils is represented in this deposit, but little more.

Cornfield weeds: the mainly autumn-germinating group are more characteristic cornfield weeds, a vegetational community in the class Secalietea (Ellenberg 1988). They would have grown mainly in autumn-sown crops such as wheat and rye. Many of these weeds have been increasingly rare since the mechanization of farming. The typical plants which were found here are *Papaver* species (poppies), *Agrostemma githago* (corn cockle), *Anthemis cotula** (mayweed) and *Centaurea cyanus* (cornflower). Such mainly cornfield weeds seem unlikely to have grown in a settlement site The numbers of seeds are rather small. Although no cereal macrofossil remains were found, there was plenty of cereal pollen, and this group was probably brought to the site as straw or sheaves, processed and/or used, for example as animal fodder, bedding (the *Pteridium* bracken frond would fit in with this interpretation) or building material (roofing, insulation, flooring) before being discarded with the other rubbish.

The occurrence of a number of crop weeds characteristic of rather acid, sandy soils may show which land was mainly being cultivated and its products brought in to Tamworth. Sandy soils are found to the west of the River Tame where there is a large area of Typical Brown Sands (see Fig 69) where they occasionally become podzolized. The heavy stagnogley soils in other parts could, of course, be cultivated, albeit at the expense of far more work.

There are signs of other weed or wasteland plant communities; weed communities with *Hyoscyamus niger** (henbane), which may have thriven on dunghills in the past, but it is so rare as to be noteworthy when it is found now, although it has occasionally appeared in Tamworth (Edees 1971). Very large numbers of *Sambucus nigra* (elderberry) seeds, *Rubus fruticosus* (bramble) and *Urtica dioica* (stinging nettle) are characteristic of a formerly occupied place having become overgrown by these plants which thrive on the enriched soil there; they show that the site was weedy and overgrown at the time of deposition.

Grassland is represented to a slight extent: there are four main taxa, *Ranunculus* cf *acris* (meadow buttercup), *Filipendula ulmaria* (meadowsweet), and *Centaurea* nigra (knapweed) (pollen only). (There is also grass and plaintain pollen, but these are ubiquitous.) This is a little odd; on many sites, medieval rubbish is laden with remains of strawy and grassy material probably from animal feed, bedding and dung.

There is some sign of the kind of rough grassy vegetation which is now characteristic of waysides in the presence of *Malva syluestris* (common mallow).

Trees are usually shown more by pollen than by macrofossils, as relatively few seeds are scattered. The pollen records the presence of lime, elm, birch, alder, hazel and oak, but in rather small amounts that are representative of the normal ‘background’ pollen rain.There was also Ericales (heathers) pollen (but no macrofossils), again probably ‘background’ pollen blown in from heathland on the local sandy soils - the closest heathland soils now are the podzols 5km to the west of Tamworth (Fig 69), although there may have been heathland on some of the brown sands as well.

The upper and lower part of the layer have essentially similar floras, apart from a significant difference: cornflower was found in the upper (87g) but not in the lower (87b) which is interesting, although the floras are otherwise rather alike. Cornflower is rarely found in deposits earlier than about AD 1200 throughout Europe, but is often extremely common in ones later than that (Greig 1988a). The reasons for this are not so far clear, although are probably connected with some aspect of’ farming practice. This may be one of the few deposits that straddle this change, although unfortunately the layers do not seem to be very precisely dated.

*A114, silt in second leat, 1978 phases ?2-4,* late Saxon-early medieval, see 2.13 (Figs 47 and 49, sections S51 and S53)

This context, which is rather earlier than 87, provided a large flora that was generally similar. However, slight differences were noted as follows: there were more aquatic plants including *Nuphar lutea* (yellow water-lily)

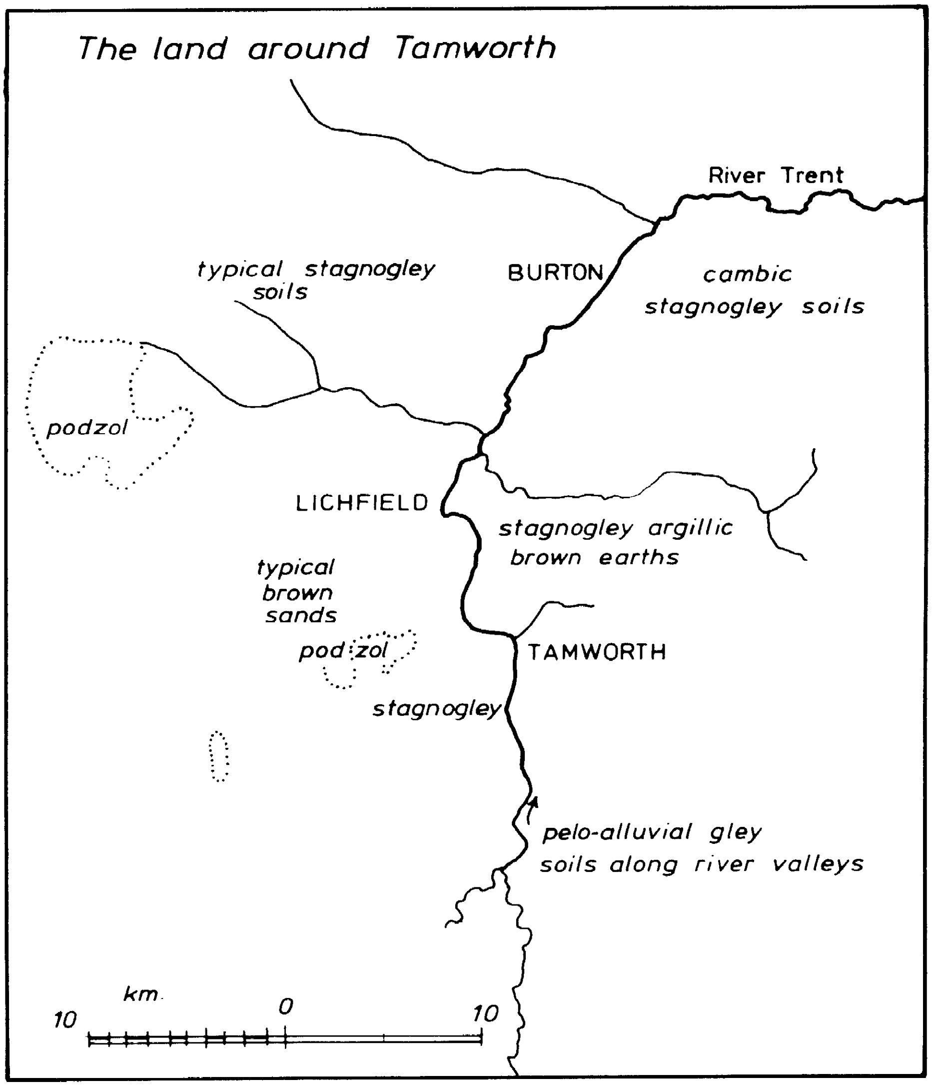



*Figure 69 The land around Tamworth: map of soils*

and *Potamogeton* (pondweed). There were more marshland plants too (in fact the whole flora is richer): *Hypericum* (St John's Wort), *Stellaria palustris/graminea* (stitchwort), *Polygonum lapathifolium* (pale persicaria), *P. hydropiper* (water-pepper), *Rumex cf conglomeratus* (sharp dock), *Lycopus europaeus* (gipsywort), *Bidens cernua** (bur-marigold) are all marshland plants.

To the garden weeds are added: *Linaria vulgaris** (yellow toadflax), and *Galium** (bedstraw).

There are also more cornfield weeds such as: *Raphanus raphunistrum* (wild radish), *Aphanes arvensis"* (parsley piert), *Polygonum persicaria** (redshanks) and *P. convolvulus* (black bindweed), all except redshanks typically growing on sandy land. However, there was no *Centaurea cyanus* (cornflower) (the date of the deposit either side of the Conquest is before cornflower became common).

There was much more sign of cultivated plants from charred grain, among which Lisa Moffett could distinguish wheat, barley and oats. There was apparently no rye; this may be a result of the means of preservation as most rye finds are of waterlogged chaff rather than charred grain. There was waterlogged flax *(Linum usitatissimum)* and its capsules. This evidence is not enough to say more than that these were the normal crops of the time.

Grassland remains are once again rather slight, with the addition of *Prunella vulgaris* (self-heal) and *Leontodon* sp. (hawkbit), not by themselves fully characteristic of meadows. Wayside or rough grassland plants include *Torilis japonica** (upright hedge-parsley), *Daucus carota* (carrot, probably wild), *Cirsium* cf *vulgare** (spear thistle).

The main feature of the deposit is that it contains very large numbers of seeds of various weeds such as *Conium maculatum* (hemlock), *Urtica dioica* (stinging nettle), *Hyoscyamus niger** (henbane), *Solanum nigrum* (black nightshade) and *Sambucus nigra* (elder), a flora which also frequently occurs in Roman wells and which appears

**Table IV - Seeds and pollen 1978**
By Susan Colledge and James Greig

| Sample | A87b | 87 | 87g | A114 | B29 | Name | Habitat |
|---|---|---|---|---|---|---|---|
| Pteridium aquilinum L. | + | - | - | - | - | bracken | rough grassland |
| Ranunculus cf. acris L. | 5 | 1 | 3 | - | - | meadow buttercup | grassland |
| R. repens/bulbosus | 6 | 2 | 5 | - | - | creeping/bulbous buttercup | disturbed ground |
| R. subg. Ranunculus | - | - | - | 9 | - | buttercup | various |
| R. ? sardous Crantz | 1 | - | - | 7 | - | hairy buttercup | arable fields |
| R. sceleratus L. | 11 | - | 21 | 13 | - | celery leaved crowfoot | muddy watersides |
| R. flammula | 1 | - | - | - | - | lesser spearwort | watersides |
| R. subg. Batrachium | 1 | - | - | 4 | - | water crowfoot | shallow water |
| RANUNCULUS type | - | - | 4 | - | - | buttercups (7 above ) | various |
| Nupher lutea (L.) Sm. | - | - | | 2 | - | yellow water-lily | shallow water |
| ? Papaver rhoeas | =1 | - | - | - | | poppy | disturbed ground |
| Papaver cf. dubium L. | - | - | 1 | - | | long-headed poppy | field weed |
| P. argemone L. | - | - | 1 | 1 | - | long prickly-headed poppy | field weed |
| Raphanus raphanistrum L. | - | - | - | 2fr | - | charlock | field weed |
| Capsella bursa - pastoris (L.) Medicus | - | - | 8 | 2 | - | shepherd's purse | weed |
| Rorippa sp. | 2 | - | - | 2 | - | yellow-cress | watersides |
| CRUCIFERAE | - | - | 1 | - | - | crucifers (2 above) | |
| Reseda luteola L. | 1 | - | - | - | - | weld | disturbed ground |
| Viola sp. | 1 | - | - | 2 | - | violet/pansy | disturbed ground |
| Hypericum cf. tetrapterum Fries | - | - | - | 4 | - | St John's Wort | watersides |
| Agrostemma githago L. | =1 | - | =4 | =2,1 | - | corn cockle | cornfield weed |
| Stellaria cf. media (L.) Vill. | 8 | 2 | 5 | 5 | - | chickweed | weed |
| S. palustris Retz./S. graminea L | - | - | - | 2 | - | marsh/lesser stitchwort | damp grassland |
| CARYOPHYLLACEAE | - | - | 4 | - | - | campion family (2 above) | |
| Spergula arvensis L. | - | - | - | 4 | - | spurrey | field weed |
| Montia fontana L. ssp. chondrosperma (Fenzl) S.M. Walters | =1 | - | - | 1 | - | blinks | wet sand |
| Chenopodium cf. album L. | 15 | 30 | 2 | 21 | I | fat hen | nitrophile weed |
| C. murale L. | 2 | - | | - | - | goosefoot | nitrophile weed |
| C. rubrum L./glaucum L. | 32 | - | - | 6 | - | red goosefoot | nitrophile weed |
| Atriplex sp. | 2 | - | 1 | 3 | - | orache | weed |
| CHENOPODIACEAE | - | - | 1 | - | - | goosefoot fam. (4 above) | weed |
| TILIA | - | - | 1 | - | - | lime tree | woodland and hedges |
| Malva sylvestris L. | 9 | - | - | | - | common mallow | waysides |
| Linum usitatissimum L. | - | - | - | | - | flax | cultivated |

| Sample | A87b | 87 | 87g | A114 | B29 | Name | Habitat |
|---|---|---|---|---|---|---|---|
| Ilex aquifolium L lf fr | - | - | - | + | - | holly | various |
| Vicia sp. | - | 1 | - | 2* | - | vetch | various |
| LEGUMINOSAE | - | 2 | 2 | - | - | pea family | |
| Filipendula ulmaria (L.) Maxim. | - | - | 1 | 2 | - | meadowsweet | wet grassland |
| Rubus idaeus L. | 7 | - | - | . | - | raspberry | woodland and scrub |
| Rubus fruticosus agg. | 6 | 1 | 1 | 2 | - | bramble | scrub |
| Rubus/Rosa thorn | - | - | - | 1 | - | bramble or rose | scrub |
| Potentilla reptans L. | - | - | - | 2 | - | creeping cinquefoil | waysides |
| Potentilla sp. | - | - | - | - | - | cinquefoil | |
| Aphanes arvensis L. | - | - | - | 3 | - | parsley piert | sandy fields |
| Malus/pyrus | - | - | - | - | - | apple/pear | ? cultivated |
| Crataegus/Prunus thorn | - | - | - | 1 | - | haw or blackthorn | hedgerows |
| Epilobium sp. | - | - | - | 1 | - | willow-herb | various |
| MYRIOPHYLLUM | - | - | 1 | - | - | millfoil | shallow water |
| Aethusa cynapium L. | - | - | - | 1 | - | fool's parsley | garden weed |
| Conium maculatum L. | 1 | - | - | 37 | - | hemlock | wasteland |
| Apium inundatum (L.) Reichenb. fil. | - | - | - | 1 | - | lesser marshwort | shallow water or mud |
| ? Petroselinum segetum (L.) Koch | - | - | 3 | - | - | corn caraway | |
| Torilis japonica (Houtt.) DC. | - | - | - | 1 | - | upright hedge-parsley | hedgerows |
| Daucus carota L. | - | - | - | 1 | - | wild carrot | waste places |
| UMBELLIFERAE | - | - | 3 | - | - | umbellifers (2 above) | |
| Euphorbia helioscopa L. | - | - | 14 | - | - | sun spurge | garden weed |
| Polygonum aviculare agg. | 10 | - | 13 | 15 | - | knotgrass | trodden places, gardens |
| P persicaria L. | - | - | - | 9 | - | redshanks | arable land |
| P. lapathifolium L. | - | - | - | 3 | - | pale persicaria | arable land |
| P. hydropiper L. | 18 | - | - | 12 | - | water pepper | damp muddy ground |
| POLYGONUM BISTORTA tp- | - | - | 1 | - | - | bistort | wet meadows |
| Polygonum convolvulus L. | - | - | - | 2 | - | black bindweed | arable land |
| Rumex acetosella agg. | 4 | - | - | 2 | - | sheep's sorrel | poor sandy soil |
| Rumex cf. crispus L. | - | - | - | 21 | - | curled dock | arable and waste |
| Rumex cf. conglomeratus Murray | - | - | - | 5 | - | sharp dock | ditches and wet places |
| Rumex sp. | - | 1 | - | 43 | - | dock | |
| RUMEX type | - | - | 2 | - | - | docks (2 above) | |
| Urtica urens L. | 14 | 1 | 1 | - | - | lesser nettle | weed |
| U. dioica L. | 33 | 2 | 18 | 468 | - | stinging nettle | waste ground |
| URTICA | - | - | 2 | - | - | nettles (2 above) | |
| ? Humulus lupulus L. | - | - | - | 1 | - | hop | cultivated |
| ULMUS | - | - | 2 | - | - | elm | woods and hedges |

| Sample | A87b | 87 | 87g | A114 | B29 | Name | Habitat |
|---|---|---|---|---|---|---|---|
| BETULA | - | - | 4 | - | - | birch | various |
| ALNUS | - | - | 12 | - | - | alder | riversides |
| Corylus avellana L. | =1 | - | - | - | - | hazel | woodland scrub |
| CORYLUS | - | - | 9 | - | - | hazel | |
| QUERCUS | - | - | 5 | - | - | Oak | woods and hedges |
| ERICALES | - | - | 11 | - | - | heathers | heaths and moors |
| Hyoscyamus niger L. | - | - | 1 | 31 | - | henbane | thermophilous weed |
| Solanum nigrum L | 79 | - | 4 | 52 | - | black nightshade | garden weed |
| Linaria vulgar-is Miller | - | - | - | 2 | - | yellow toadflax | waste ground, field weed |
| Lycopus europaeus L. | - | - | | 4 | - | gypsy-wort | watersides |
| Ballota nigra L. | - | - | 14 | - | - | black horehound | waste ground |
| Prunella vulgaris L. | - | - | - | 2 | - | self-heal | grassland |
| Lamium sp. | 8 | - | - | | | dead-nettle | sandy fields |
| Galeopsis sp. | 1 | 1 | - | 2 | - | hemp-nettle | arable land |
| Glechoma hederacea L. | 14 | - | - | - | - | ground ivy | hedgebanks |
| Plantago major L. | - | - | - | 1 | - | rat-tail plantain | roadsides |
| PLANTAGOLANCEOLATA | - | - | 9 | - | - | ribwort plantain | grassland etc. |
| Sambucus nigra L. | 299 | 8 | 7 | 86 | - | elder | scrub; nitrophile |
| SAMBUCUS NIGRA | - | - | 2 | - | - | elder | |
| Galium sp. | - | - | - | 1 | - | bedstraw | various |
| DIPSACACEAE | - | - | 1 | - | - | scabious family | |
| Bidens cernua L. | - | - | - | 3 | - | nodding bur-marigold | water-sides |
| Senecio aquaticus Hill. | | - | 1 | 7 | - | marsh ragwort | marshy fields |
| Anthemis cotula L. | - | - | 1 | 5,1* | - | stinking mayweed | cornfield weed. esp. clay |
| Ehrysanthemum segetum L. | - | - | 1 | - | - | corn marigold | cornfield weed, sandy soils |
| COMPOSITAE TUBULIFLORAE | - | - | 31 | - | - | (3 above) | |
| Carduus sp. | - | - | - | 1 | - | musk thistle etc. | waste ground |
| Cirsium cf. vulgar-e (Savi) ten. | - | - | - | 4 | - | spear thistle | |
| Cirsium palustre (L.) Scop/C. arvense (L.) Scop. | - | 1 | - | 6 | - | creeping thistle | various |
| Centaurea cyanus L. | - | - | 5 | - | - | cornflower | cornfields. now rare |
| CENTAUREACYANUS | - | - | 11 | - | - | cornflower | |
| CENTAUREA NIGRA | - | - | 3 | - | - | knapweed | grassland, waysides |
| Lapsana communis L. | - | - | - | 3 | - | nipplewort | hedgerows |
| Leontodon sp. | - | - | - | 2 | - | hawkbit | meadows and pastures |
| Sonchus oleraceus L. | 9 | - | 1 | - | | sow-thistle | arable |
| S. asper (L.) Hill | 1 | - | - | 6 | - | spiny sow thistle | |
| Taraxacum sp. | - | - | - | 1 | - | dandelion | various |
| COMPOSITAE LIGULIFLORAE | - | - | 16 | - | - | (3 above) | |
| Alisma cf. plantago-aquatica L. | - | - | 2 | 9 | - | water-plantain | mud and shallow water |

| Sample | A87b | 87 | 87g | All4 | B29 | Name | Habitat |
|---|---|---|---|---|---|---|---|
| Potamogeton sp. | - | - | - | 5 | - | pondweed | shallow water |
| Juncus sp. | - | - | + | + | - | rush | various (damp) |
| SPARGANIUM | - | - | 1 | - | - | bur-reed | watersides |
| Eleocharis uniglumis/palustris | 3 | - | - | 1 | - | spike-rush | marshy fields |
| Isolepis setacea (L.) R.Br. | - | 5 | - | - | - | bristle scirpus | |
| Carex cf. flava agg. | - | 3 | | - | - | yellow sedges | |
| C. cf. sylvatica Hudson | - | 3 | - | - | - | wood sedge | |
| C. cf. otrubae Podp. | - | 1 | - | - | - | false fox sedge | |
| Carex sp. | 6 | + | - | 5 | - | sedge | |
| CYPERACEAE | - | - | 2 | - | - | (6 above) | |
| Gramineae | - | - | - | 9 | - | grasses | |
| GRAMINEAE | - | - | 108 | - | - | grasses | |
| Triticum sp. | - | - | - | 7* | - | wheat | cultivated |
| Secale cereale L. chaff | - | - | - | - | +++* | rye | cultivated |
| Hordeum vulgare L. | - | - | - | 9* | - | barley | cultivated |
| Avena sativa L. | - | - | - | 12* | - | oats | cultivated |
| Cerealia | - | - | - | 3* | - | cereals | cultivated |
| cereal culm | - | - | - | 1* | - | straw | |
| CEREALIA | - | - | 159 | - | - | cereals | |
| twigs | | | | + | | | |
| charcoal | | | | + | | | |

*Names and order after British Flora (Clapham et al 1962), habitat details after Edees (1971). Pollen records are given in capitals. Charred remains are marked with an asterisk.*

to have collected during a phase of relative disuse (Greig 1988b). Further signs of overhanging vegetation include leaf-spines of *Ilex aquifolium** (holly).

*B29, layer over furnace F5, 1978 phase 10,* post-medieval, see 2.18 (Fig 56, plan M10)
This sample was associated with textile residues (3.15 below). It contained charred and much flattened straw remains; these contained cereal culm nodes (the 'knees' of straw) and rye chaff consisting of quite large fragments of rachis and glumes, but apparently nothing else.

## Discussion

A number of medieval ditch floras have been studied, such as the one from Nantwich, Cheshire (Colledge 1981). This produced an almost identical flora, of wetland plants, garden and cornfield weeds and scrub vegetation, but no true aquatics. Pollen of cereals, flax and hop/hemp were found. As at Tamworth, the natural marshland and scrub flora of an overgrown ditch has been supplemented by the rather more informative rubbish that was thrown in. Ditches serve as preserving environments which can provide very useful information about such medieval sites, if flora chances to be deposited there, usually among rubbish. From this evidence, the crops and their weeds can be understood, and hence it can be shown in which parts of the landscape they were probably produced.

## Conclusion

The waterlogged plant remains from such sites have a certain similarity because they necessarily come from wet places such as ditches where the evidence can be preserved. The aquatic and wetland part of the flora does not represent the occupied landscape, but the very local surroundings of the ditch. Plants from the dry land, however, are usually preserved in significant numbers as well. Many of these are weeds that grow almost anywhere given the chance, and so tell little about what was going on in the surroundings. It is the more specific ones that are important, and in this case there are the plants of cultivated land which show the characteristic flora of sandy, rather acid cornfields. The evidence was probably brought to the site in the form of sheaves, and processed into grain, straw and chaff, which would have been used for feeding people and animals, and the waste products of this scattered and hence some were preserved. Botanical evidence is rarely found in a 'primary context' where the find-site is connected with use or purpose, so most of the evidence is from a mixture of rubbish, with heaps of straw or animal dung; this only yields information about human activity after careful interpretation of the many components involved.

Charred remains depend on being part-burnt; in this context an interesting burnt layer with coarse cloth and rye straw. Rye was an important crop (Greig 1988a), and grew especially well on poor sandy soils where other cereals would fail. Where waterlogged cereal remains are preserved on medieval sites rye is usually found, but there is not sufficient post-medieval evidence to tell whether it declined later.

It is becoming obvious that studies of the plant remains in recent ditches will have to be made, to understand the representation of actual vegetation in seeds and other remains, from the plants that are common today. This will allow more accurate interpretation of such archaeological deposits, although not of the plants which are now rare.

Archaeobotany is in the process of providing much new evidence of Saxon and medieval farming practice from both waterlogged sites such as this, and from charred remains (Moffett 1988). It needs the production of detailed results from a number of sites representing a number of periods before a pattern is likely to start emerging, and before we start to understand the relation between the plant records, and their likely abundance in the past. The Tamworth results are therefore one such piece of this jigsaw-puzzle.

*Acknowledgements:* Susan Colledge kindly made her results available for this report, and Lisa Moffett helped with the identification of the cereals. The environmental work was funded by the Department of the Environment (now English Heritage).

## 3.14 Carved wood (CW)

* illustrated on Figs 70-3

CW1* Object, ?handle of mill fitting. From 150, phase 4

CW2* Object, probably mill fitting. From 150, phase 4

CW3 Pegs from 23A, 23C, 23G and 23H. = 23, phase 5a

CW4* Most of wheel-paddle (Pl XX). = 144, phase 4

CW5 Fragments, probably of another paddle, no drawings traced. From ?109, on slope of 176b?, phase 4 (see MF Table II)

CW6* Bowl (Pl XXIII), see report below, by Carole Morris. From 241, phase 3

CW7* Piece with peg hole. From 255, phase 2

CW8* L-shaped piece. From 31, phase 9

CW9* Large object, probably mill fitting (on 170a). = 239, phase 4

CW10* Plank with hole. = 190c, phase 3

CW11* Large post with holes. = 136, phase 8

CW12* Burnt plank with pegs. = 152, phase 4 (from 150)

CW13* Cut object (possibly part of shoe of mill hopper). From 241, phase 3

CW14* Plank with steel bearing (IR24, above). = 154, phase 4 (from context 150)

CW15 Spars or planks of timber road 23 a-h (Pls X-XI). From 23, phase 5a (see plan, Fig 33)

### *The wheel-paddle CW4 (144, in context 150, phase 4) (Fig72; Pl XX)*

This was found just above the mill floor in destruction layer 150 (location on plan, Fig 32). Its identification was not recognized at the time, but drawings were made at 1:1 while it was still waterlogged, and photographs in colour and monochrome, which form the basis of the (slightly revised) drawing of Figure 72. Its subsequent identification as one of the paddles of the mill-wheel (one of 12 or more on the hub) was based on numerous close analogies in other horizontal-wheeled water-mills (eg, Moycraig, of similar period: Fig 103), and is beyond question. Indeed the paddle is one of the principal pieces of evidence for the interpretation of Tamworth mill as an example of this type.

While the main form of the paddle is not open to doubt, its broken, eroded (and possibly worn?) condition leaves some uncertainties in form, which are perhaps rather minimized in the somewhat diagrammatic drawing (Fig 72). The paddle is indeed a difficult object to illustrate in a drawing, and the photographs give a much better idea of its true appearance.

The two principal points of uncertainty are the width of its 'floor', and whether or not it had a straight edge as shown, and the precise form of the 'leading' edge (ie, that receiving the water) of the hub attachment. On the first point, all analogous examples do have a straight edge (square-edged or bevelled or rounded?) but this one may have been slightly wider but is unlikely to have been narrower. Did the outer end come to such a relatively sharp point as drawn, or was it more rounded, merging more into 'wall' and 'floor'? On the second point, the form of the hub attachment on the missing side is only a conjecture. The whole end would be wedged into the hub, and has to have some 'bulk' to be secure (Fig 72, A and C right); reconstruction here depends on exactly how the paddle was fixed in the hub (Charles' version, Fig 99, is a little ambiguous here).

In spite of these minor uncertainties, the paddle is remarkably sophisticated and elegant, probably more so than any other extant example (cf Moycraig, for example). It clearly embodies a profound, if pragmatic, experience of the hydrodynamic forces

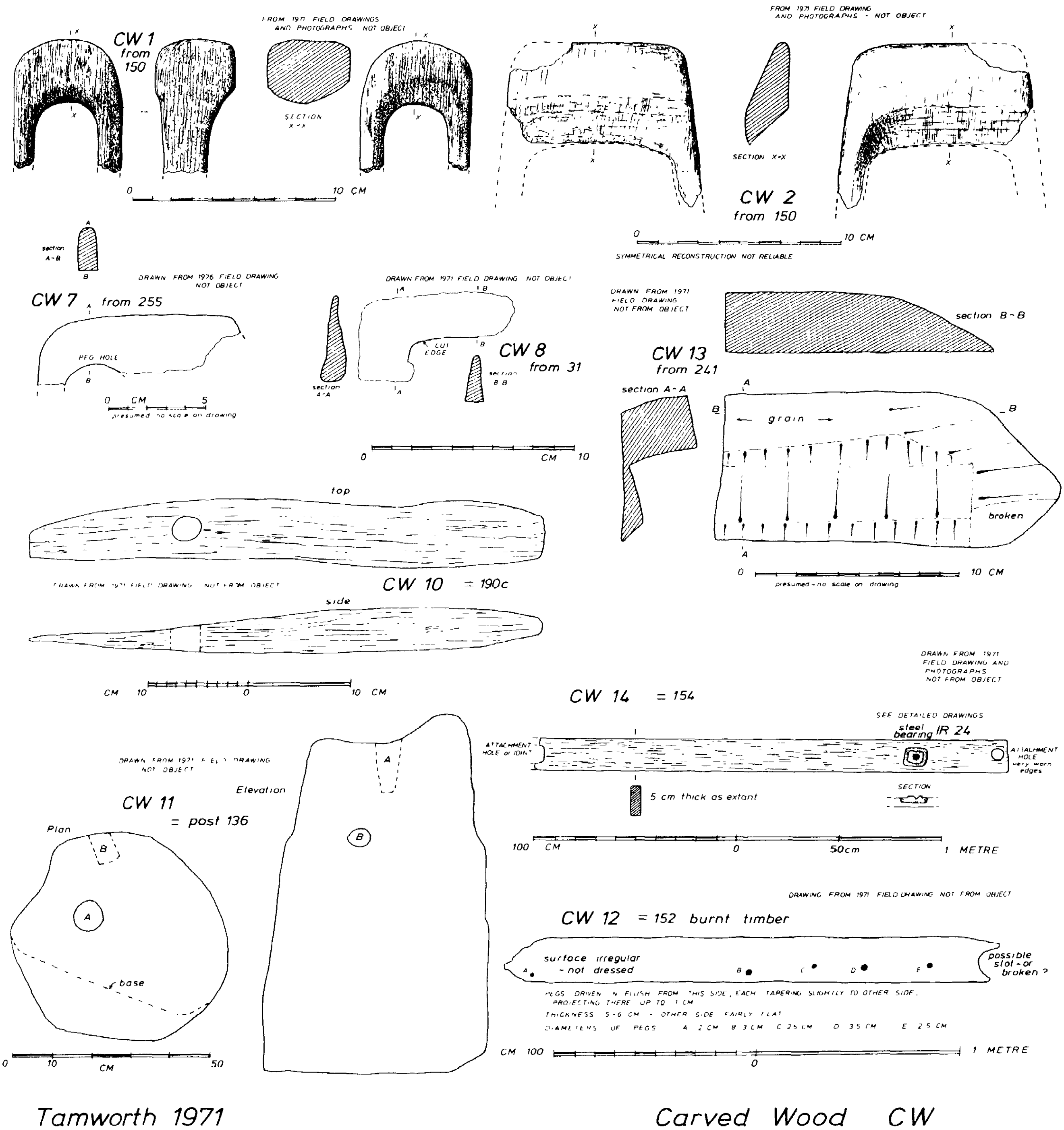



*Figure 70 Carved wooden objects CW1, 2, 7, 8, 10-14*

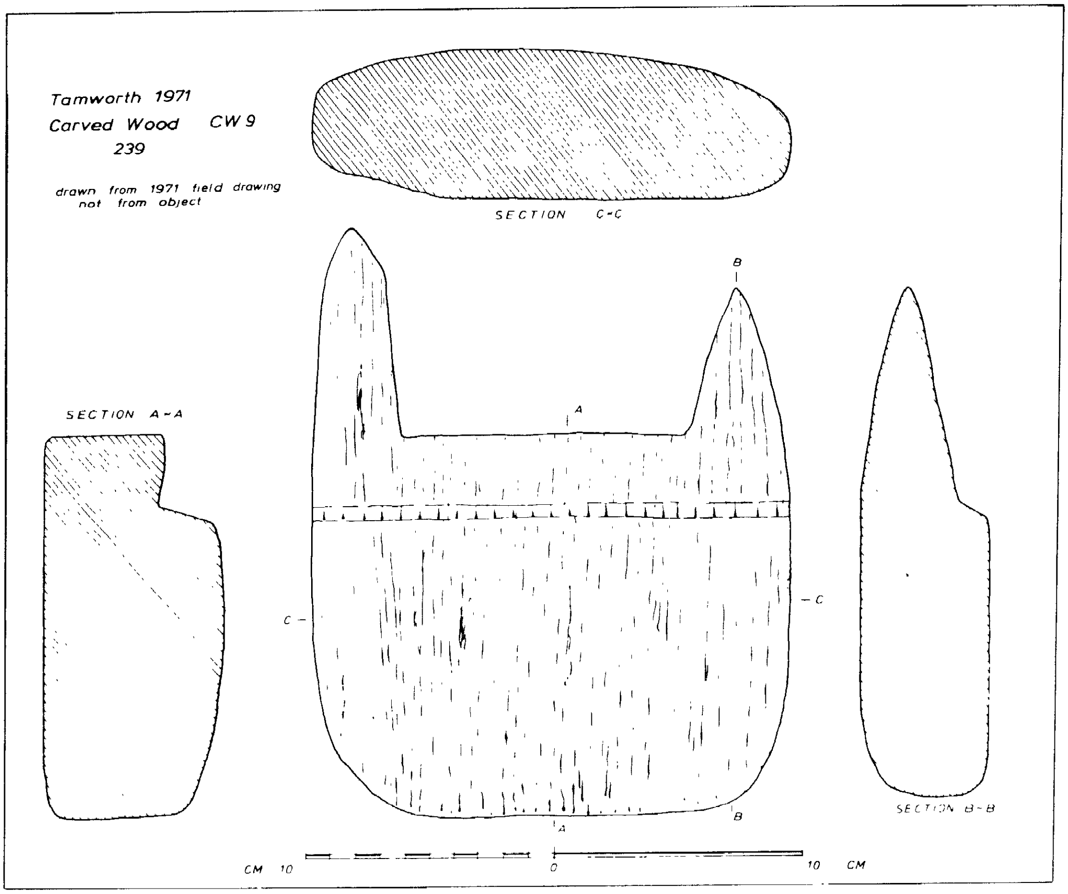



*Figure 71 Carved wooden object CW9*

involved in utilizing a jet of water to give the maximum torque, velocity and overall efficiency to the main drive of the mill. With a revolution speed of (say) 60 per minute, the water hits the wall of the paddle for only a fraction of a second; the water must be held by the 'floor' of the paddle, and not drop away too fast; it must not be retained too long, or it will exercise a dragging effect on the whole; and the paddle must allow the minimum of water to be directed elsewhere than into the 'spoon' formed by the wall and floor of the paddle.

Of especial interest in the Tamworth paddle is the streamlined, almost arabesque lines; the curvature of the floor up towards its junction with the hub; the curved profile of the upper rim of the wall; and the maximum strength, and minimum weight, for its purpose. There can be little doubt that the Tamworth paddle is in no way *de novo,* but represents long experience in efficient design before this paddle was made; as we shall see, this long experience extends backwards in the west of the British Isles to at least the 7th century AD — some two hundred years earlier than this example.

From the 1971 drawings, F W B Charles, in connection with the scheme for making a full-scale reconstruction of the mill at Tamworth, commissioned a replica of the paddle to be made, and this is illustrated in Plate XXI.

The only other paddles recorded from England are from Nailsworth, now in the Stroud Museum; see the note below.

*The paddles from Nailsworth, Gloucestershire* (Pl XXII)

Carole Morris provided the following note:

The paddles are both made of oak, and were recovered at Nailsworth, which is a few miles down the river from Stroud. They were found by workmen who were diverting the river and working on a road which now cuts the stream which fed the horizontal mill. They were in fact dredged up from the water, which probably explains their marvellous state of preservation. The oak is very sound and still has most of its structural strength remaining. One complete paddle, one paddle with a broken bowl and attachment end, and small fragments of a third were recovered, although the latter is not extant.

The evidence for their *terminus ante quem* is that they were found in the area of 'Egypt Mill' and its pond which were built in the reign of Edward III (reign began in 1327), and this building work would have made redundant the small horizontal mill-wheel and its stream coming off the hillside.


*Plate XX Wheel-paddle CW4 (144). A) outer side; B) inner side and base (scale in 10cm)*

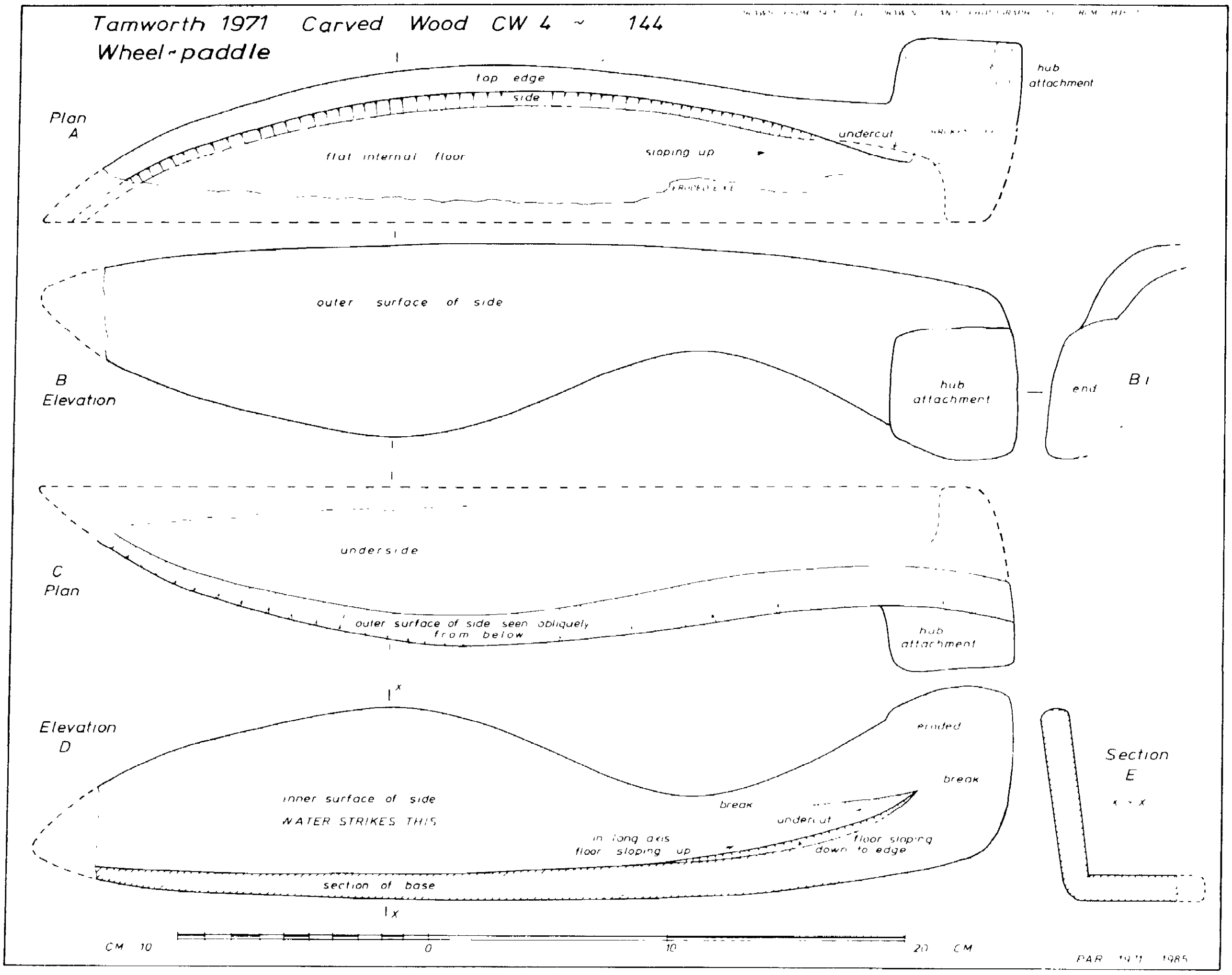



*Figure 72 Wheel-paddle CW4*

All three paddles were very roughly carved from the oak, and were not smoothed or finished off. They are also very solid indeed, and looked on from the lower side, they are almost rectangular with rounded but angular corners.

## *The wooden bowl CW6 (241, phase 3) (Fig 73, Pl XXIII)* by Carole Morris

Lathe-turned wooden bowl; 7 fragments (probably *Fraxinus* sp. Ash). Face-turned (ie, the grain of the wood was aligned perpendicular to the main axis of rotation of the lathe); rounded profile; rounded rim; flat bottom, no base; undecorated both internally and externally; very worn, broken and abraded with little trace of the original faint turning grooves now remaining. The dimensions are: D = 13.4cm, H = 3.8m, Th = 0.5-0.8cm, bottom D = 6cm, bottom Th = 0.8cm.

The bowl had been turned on a pole-lathe, and the techniques and tools which the Anglo-Saxon lathe-turner used to produce such a bowl have been recently published in several places (Morris 1982; 1984; 1985; in prep). Lathe-turned vessels were made by skilled craftsmen and not on a do-it-yourself basis, and were acquired when needed from craftsmen or traders,

Lathe-turners deliberately selected various species of wood for turning bowls and cups. The main species used were alder, maple, ash, hazel, birch and beech, although others were used in small quantities. Surviving vessels from the 10th century and earlier show the craftsman's preference for alder and maple with a little ash and hazel (Morris 1984, fig 10.7B). Vessels dated 11th century and later, however, indicate a major change where ash becomes the main choice, with alder second in importance and maple and hazel almost ceasing to be used. This change in selection reflects a change

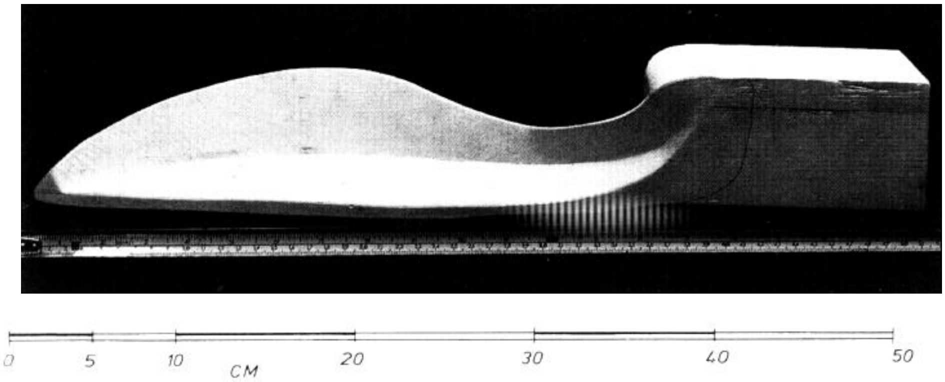



*Plate XXI Reconstruction of wheel-paddle CW4, by F W B Charles. (Photo: M Charles)*

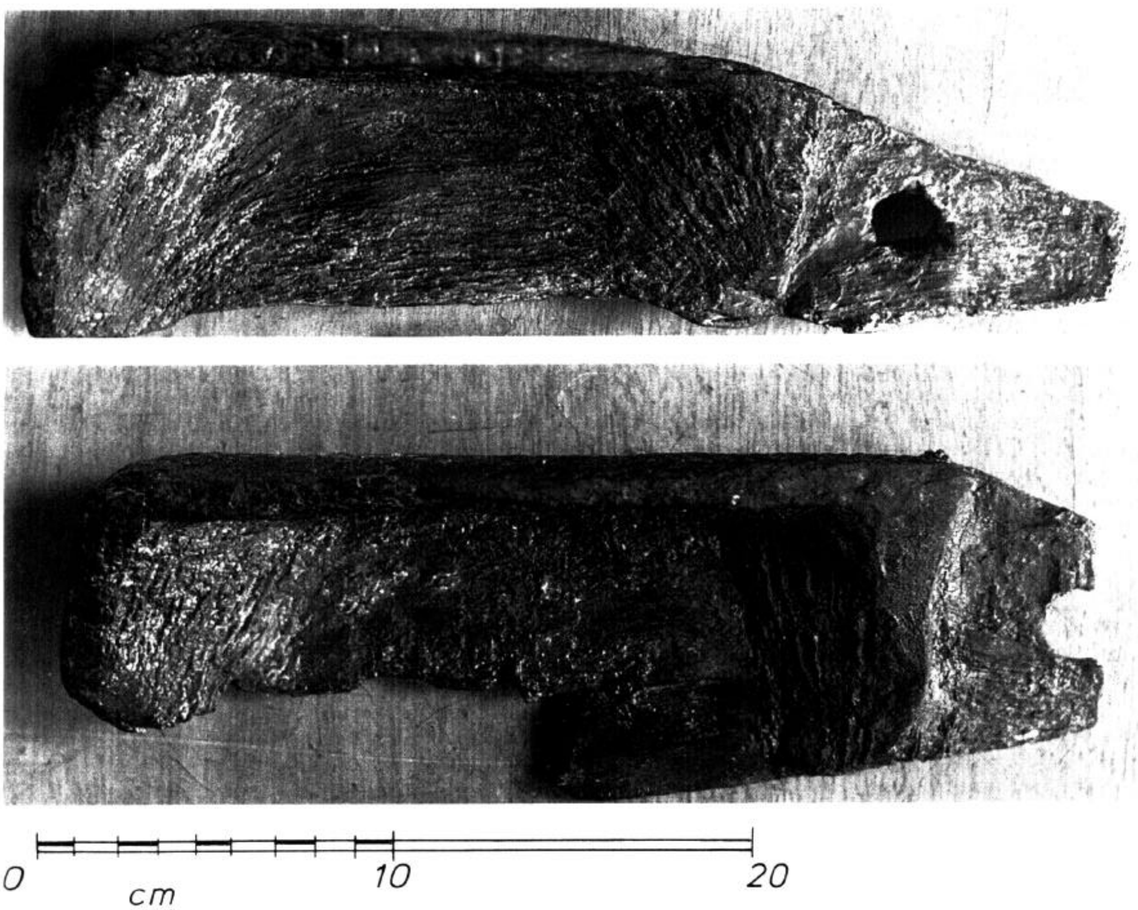



*Plate XXII Two paddles from Nailsworth, Gloucestershire (Stroud Museum). (Photo: Carole Morris, Dept of Archaeology, University of Cambridge)*

*Plate XXIII Wooden bowl CW6, from underside (from 241, phase 3) (diam 13.6cm)*

in exploitation of timber used in pre- and post-Conquest Britain. It is interesting to note that the Tamworth bowl was made of ash in a period when alder and maple were much more popular.

Surviving wooden bowls dating from before the 10th century are rare, although many metal rim mounts and repairs mounts belonging to wooden bowls have been found in Anglo-Saxon graves *(ibid,* 173-8). There are only a few bowls from sites of a similar date to the Tamworth millpond, and as such this bowl is a welcome addition to a small group. Three small wooden bowls, and lathe-turning waste cores were found in the early 7th century settlement at Iona (Barber 1981, figs 29-33), and lathe-turning waste cores were found in 9th century layers in a well at Portchester Castle (Cunliffe 1976, pl XXa). Slightly smaller bowls of 11cm and 9.8m diameter were found in a 9th/10th century pit in Gloucester (Morris 1983, fig 118, 3) and in early to mid 9th century layers at St Aldates, Oxford (Henig 1977, fig 35, 1) respectively (note that the measurements of this bowl given in Henig 1977 are incorrect). The Gloucester and Oxford bowls were more globular in shape with almost vertical side walls. A very small bowl of 8.7cm diameter but with a more rounded profile was found in a ditch near Stafford and dated by radiocarbon to ad 972 ± 170 (Robinson 1973). Four bowls from the excavations at Coppergate, York, were found in mid to late 9th century layers and two can be measured at 18.4cm and 30-31cm diameter (Morris in prep, sf11009 and sf13800). These were made of ash and alder respectively and had rounded profiles with rounded rims.

The 9th century York bowls were much larger than the Tamworth bowl and emphasize that bowls were manufactured in a great variety of shapes and sixes. It has been shown that 58% of all surviving wooden bowls produced between 400 and 1500 were between 13 and 22cm diameter and 80% were between 9 and 26cm diameter (Morris 1984, 171, figs 8.11a & b). This probably indicates the small size of roundwood used and can also be explained by the fact that small vessels such as these have fairly low angular momentum and were much easier to turn. The Tamworth bowl falls just within the narrower range and is a typical small bowl. Small bowls such as this were often used as drinking vessels, and turned wooden vessels which can actually be called cups because of their shape are rare (Morris 1984, 182, fig 150).

The degree of wear on this small wooden bowl shows that it had seen a lot of use in its lifetime

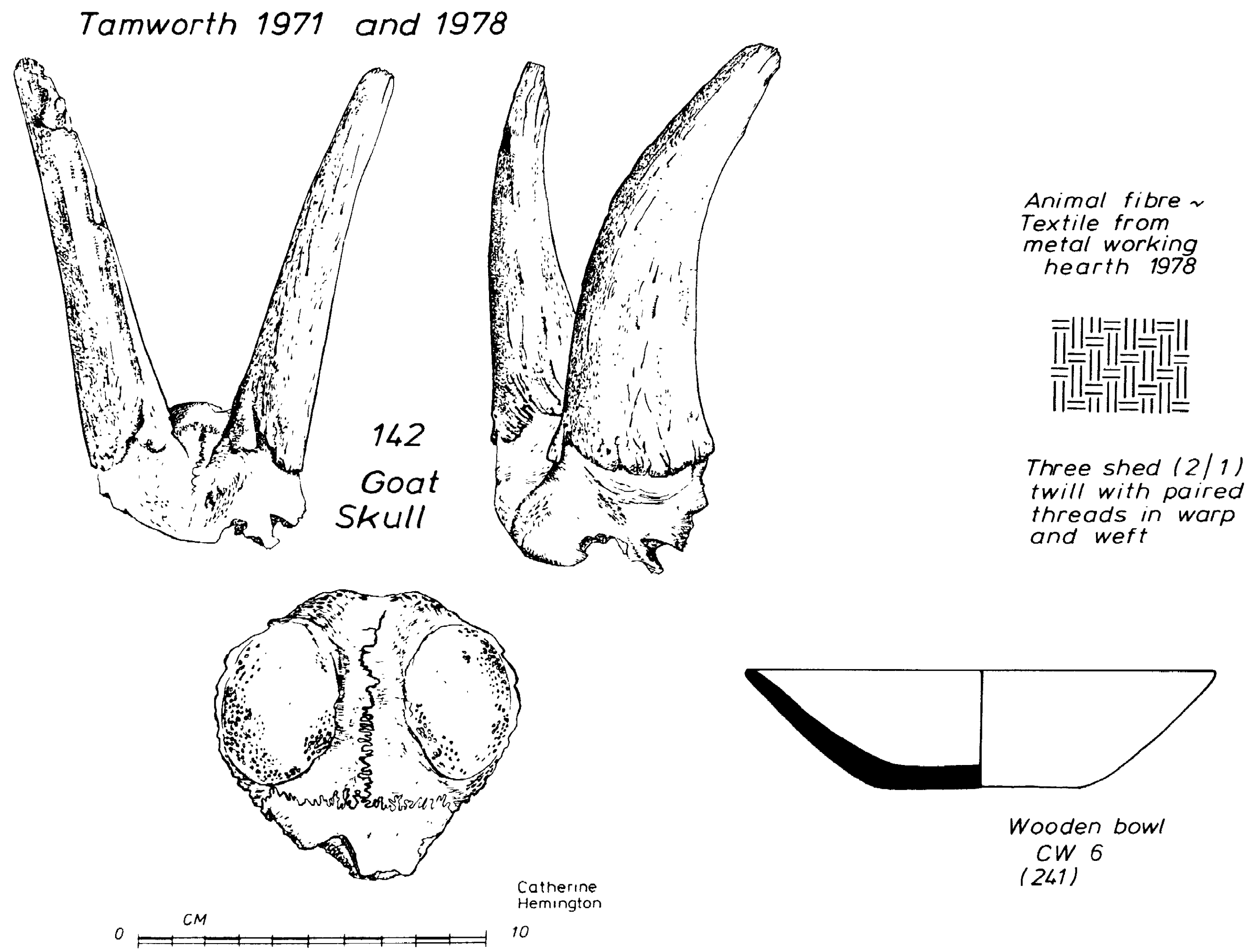



*Figure 73 Goat skull 142; wooden bowl CW6; animal fibre (textile) (from 1978 metal-working hearth)*

before it was probably discarded as useless in the millpool. There is little doubt that it was broken in some way before it was discarded but there are no signs that it had been repaired as were many Anglo-Saxon and medieval bowls (Morris 1984, 176-8, 185-6 and fig 8.1).

## 3.15 Animal bone and animal fibre (textile) (AB)

Animal bone was recorded from the following contexts:

Phase 3-4: 34 (including a horn core)
Phase 5: 82 (horn cores of cattle)
Phase 5a: 143 (pit group: see report below)
Phase 5b: 50, 76, 224
Phase 8: 1, 21, 92 (including many horn cores), 93, 94 (horn core), 97
Phase 9: L2 (burnt shell), L3, 4, 31, 77 (burnt shell), 199
Phase 10: 1b

(Note also possible horn among phase 4 lead residues, 3.10 above.)

The only bones submitted for identification were the following:

### *143 pit group (phase 5a)*

by Barbara Noddle

The bones comprised a large part of the skeleton of a young pig, and a portion of the skull of a goat (Pig 73).

The pit remains comprised the anterior part of the skull, including mandible and maxilla, the atlas vertebra and four thoracic vertebrae, eight ribs, both scapulae, humeri, radii and ulnae, a single metacarpal, femur and tibia. One side of the hind quarters and the back were exposed to weathering and predators. It seems possible that it died of something particularly unpleasant or was not found until in an advanced state of decomposition, as it is thought that fresh carrion was eaten at this period.

The state of the dentition suggests an age of about 6-12 months (Silver 1963) but the centra of the thoracic vertebrae were unfused, which suggests a lower age than this, when compared with a specimen of wild boar.

The portion of goat skull comprised the horn cores and part of the frontal hone. The dimensions of the horn cores were: basal circumference 140mm length, along outer curvature 190mm. This type of horn has been found in quantity in deposits of the same date at King's Lynn (Noddle 1977) but here the horn cores were also found singly and detached from the skull.

Sebastian Payne (AM Lab) comments as follows:
It is normal to cut horns off at or close to their bases to remove the horn; the fact that the goat horn cores are still attached to the goat frontal suggests that the horns were not removed and used.

### *Textile from the post-medieval metal-working hearth (1978 B29, F5) Fig 73)*

by Elisabeth Crowfoot; fibre examination by H M Appleyard

The cloth from the possible metal-working hearth F5 has survived in a mass of carbonized layers, closely pressed together, black and extremely fragile. When separated in the laboratory, three different coarse textiles could be identified:

1 Five main pieces: (a) *c* 27 x 2lcm; (b) *c* 23 x 23cm; (c) *c* 4 x 10cm; (d) *c* 16 x 6cm; and (e) fragments, the best *c* 4 x 10cm.
Spinning Z in warp and weft, threads paired in both systems, weave three-shed (2/1) twill (Fig 73), no selvedge preserved, counts vary, *c* 6 prs/4-5 prs per cm in most parts, but packed to 8 prs/5 prs in much of piece (b).
Traces of sewing on three pieces: (b) on one torn edge, oversewing (?) with Z, S-ply thread; (c) part of coarse flat seem, fairly neat smallhemming stitches in Z, S-ply thread on both sides; (e) part of solid hem, width c 1.2-1.3cm, occasional Z, S-ply stitches visible.

2 One fragment, *c* 28.0 x 25.0cm, very similar to no 1, ie, three-shed twill with paired threads in warp and weft, but different spinning, one system variable, in some parts one S-spun, one Z-spun (or possibly S, Z-ply) thread paired, in others both Z-spun, the other system both threads S-spun; weave count 5 prs/4-5 prs per cm.
Near one end, very deteriorated remains of a seam or oversewing in Z, S-ply thread, coarse stitches 0.8cm deep, *c* l.5m apart.

3 Two separated fragments, (a) *c* 22.5 x 23cm, (b) *c* 10 x 12cm. Both yards Z-spun, warp fine, fairly regular, weft a mixture of fine and coarse threads, all rather loosely spun; weave tabby (plain), count 5-6/5 threads per cm, simple selvedge. On piece (a) for a length of *c* 14cm, flat seam of two selvedges laid overlapping each other, width *c* 1.3cm, hemming stitches in coarse Z, S-ply thread, 1.5-2cm apart; on piece (b) part of a similar coarse flat seam with similar sewing, but impossible to see if this is also selvedges, or folded edges.

### *Fibre examination*

by H M Appleyard

All three have the typical appearance of carbonized animal fibres. They are of mixed diameter, ie, fine and coarse, they have some irregularities in thickness, and occasionally one can see some semblance of scale protruding from the sides.

Because of their very similar appearance, it is possible that textiles 1 and 2 could be parts of the same cloth, with the different spinning in areas of the warp and weft due to a plaid or check pattern, as in earlier 2/1 twills from Baynards Castle in the City of London (TA/109-112, mid 14th century, unpublished).

The three-shed twill, common in medieval weaving until the middle of the 14th century, becomes rare in professional production after the general adoption of fulling and finishing techniques. Examples of the 17th century have been found at Newcastle-upon-Tyne (Walton 1983), and in bog finds in Scotland, where some are checked and plaid fabrics; in these however the spinning is either all Z, or Z-spun warp, S-spun weft (Henshall *et al.* 1951-6) (2). The use of paired threads, which speeds up the weaving of coarse fabrics, is unusual in twills, though in 16th century textiles from Newcastle-upon-Tye, among coarse weaves with one system paired there is one four-shed twill (Walton 1981, see table 208ff, T/376, 2/2 twill, spinning IZ, IS pred/S).

The coarseness of these weaves, and the sewing details, suggest sacking, but wool would be unlikely to be used for such a purpose, still less the twill weave of nos 1 and 2. Coarse outer garments, or furnishings such as curtains, of domestically woven cloth, seem the most probable source. Rye straw residues were found in association (3.13).

## **3.16 Leather (LE)** (Fig 74)

Leather was recovered from medieval and later deposits; it was found in good condition, and is now conserved. A catalogue is in microfiche.

### *List*

by Susan M Wright (* illustrated on Fig 74)

LEl Crescent-shaped piece, frag rand or welt? 38, phase 10
LE2 Fragment. 8, phase 8

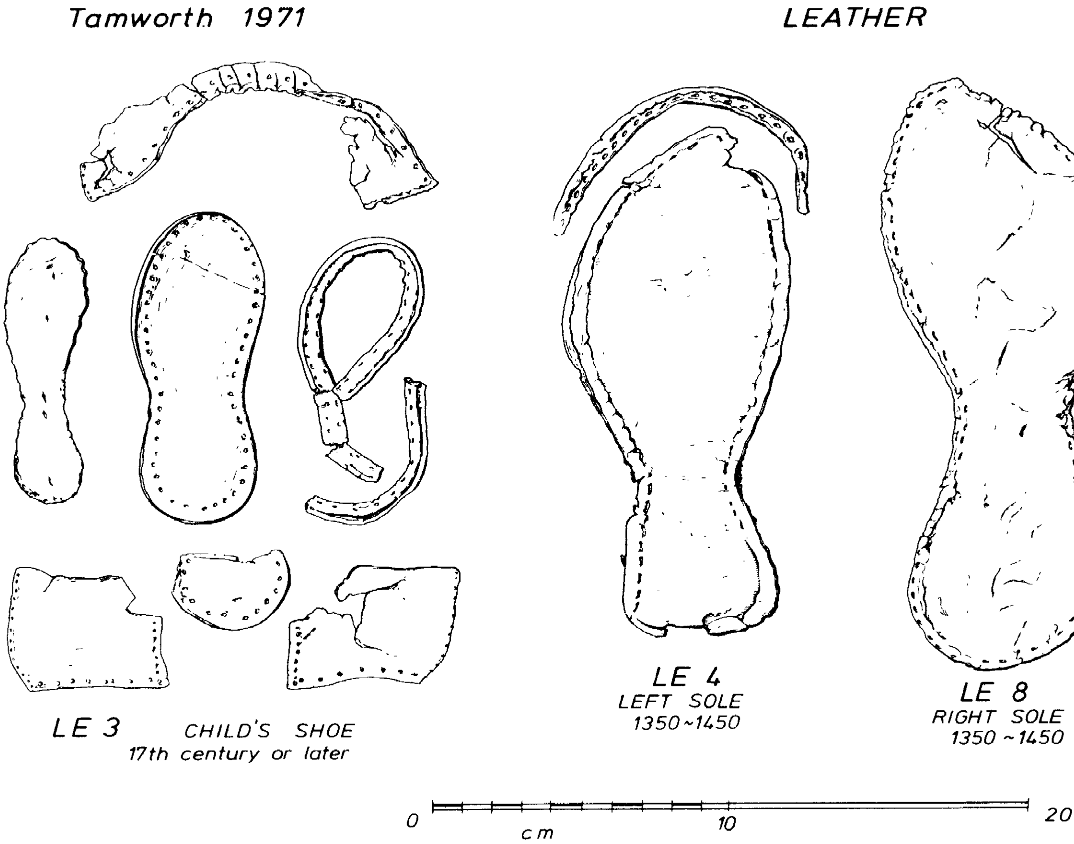



*Figure 74 Leather shoe fragments LE3, 4, 8*

LE3* Most of shoe. 142, phase 10
LE4* Sole and strip. 139a, phase 8
LE5 Repair section. 147, phase 8
LE6 Sole and frags of upper. 58, phase 9
LE7 Sole. 199, phase 9
LE8* Sole. 92, phase 8
LE9 Frags of sole. Millpool 1978 unstratified

## *Report*

by Glynis Edwards
(AML No 71004, 11.4.86, updated 3.3.88)
This report was prepared from notes made by the late John Thornton on the leather, and examination of the pieces. The writer is grateful to Quita Mould for her comments.

LE1-8 were examined by the late John Thornton in the Ancient Monuments Laboratory in December 1971. LE9, found in 1978, has been incorporated into this report. The leather was conserved in the AM Laboratory using freeze-drying.

The small collection of leather pieces from the site represents the remains of at least seven very worn shoes, and one repair. There are no offcuts to indicate leather-working, but the fragments of upper in LE6 and possibly the edge of the vamp in LE3 may have been cut for re-use as repairs, although most of the fragments appear to have torn edges.

Most of the shoes are of turnshoe construction, with two examples of rands, LE4 associated with a sole, and possibly LE1 (this may be a welt, see below). A date of 1350-1450 is suggested by the shape of the foreparts of the soles LE4 and LE8 (illustrated), and LE6 (Thornton 1959).

The child's shoe LE3 (illustrated) with its welted construction and latchet fastening is of a style which indicates a 17th century date.

The seat of the child's shoe is worn, the stitching channel being obliterated in this area, but there is no evidence for this being repaired. LE5 is a clump sole which has been used as a repair on the seat of a sole. The seat section of a sole, LE9, has holes possibly from a repair being nailed to this area. Other indications of repair can be seen on another sole, LE8, where marks of stitching indicate that repair sections had been attached to both forepart and seat.

The leather was identified from grain patterns where these were distinctive, a thickness of 4mm being taken to indicate cattle skin. The uppers are all calf, while the soles and rands are calf/cattle, with the exception of the sole LE4 which is definitely cattle hide as it is 7mm thick.

## 3.17 Pottery (P) (Figs 75-7)

by Victoria Nailor with Susan M Wright; thin-section analysis by David Williams

### *Introduction*

Pottery was recorded on the mill site in 1971 by reference to a type-fabric series generated during the excavation by PAR. Diagnostic sherds, such as rims, bases, and decorated sherds were kept from all levels, together with all the sherds from some medieval contexts, and all the sherds of phases 4-7. The rest were discarded, but a list of all, related to context, and to the original type-fabric series, is in the archive.

Further material was found in the 1978 leat excavation, of a volume similar to that from the mill; Meeson made a preliminary study of this.

In 1984-6, the pottery from both sites was re-evaluated by the present writers, and is considered together in the report that follows; the leat pottery is illustrated separately on Figure 77. The detailed lists of pottery in microfiche relate only to the mill, and not to the leat.

Ceramic studies in the West Midlands as elsewhere have developed considerably since 1971, in the light of large urban excavations. Comparisons are made in this report with pottery from elsewhere in Tamworth, and from Stafford, Chester, Coventry, the East Midlands, and Lincolnshire. It has been possible therefore in this report to place the mill and leat pottery within an up-to-date framework of modern pottery studies. One large group of medieval pottery from Tamworth remains to be studied: that from the Castle, which is being prepared for publication by Tom McNeil, the excavator of that site.

The earliest levels were aceramic. The excavators' hopes that some sherds were wheel-made continental imports were not realized, all the candidates being identified ultimately as Stamford or other wares. Pottery is rare in the West Midlands in the early and middle Saxon period. The first substantial manufacture in post-Roman times was that in Stafford (and possibly elsewhere) — Stafford ware — a ceramic industry related to groups previously ascribed to Chester and Hereford, and ultimately to the Saxo-Norman industries of eastern England. Oddly, Stafford ware was not found in the 1971 excavations, though there are contexts of considerable volume that should be of late 9th-10th century date. Apart from a single shelly sherd in a robbing hole of the timbers of the second mill (114), which may be a fabric of Midlands origin, the ceramic series on the site begins with Stamford and other sherds which are not likely to be earlier than the mid 11th century; pottery only becomes prolific in the later medieval period.

The post-medieval pottery from both sites is not discussed fully in this report.

### *Summary*


The pottery from the mill (1971) ranges in date from the 11th to the 18th or 19th centuries, and that from the leat (1978) from the 12th to the 19th centuries. A total of 937 sherds weighing 21.6kg was recovered from the mill, and 1101 sherds weighing 21.5kg from the lest. Pottery from the sites included examples of Stamford ware, 'reduced sandy ware' and 'light-bodied sandy ware'.

The report is in five sections: a summary (A); a fabric and form type series (B); individual discussion and phase dating for the Mill (C) and the Leat (D); and, finally, a catalogue of the illustrations (E-F).

Both the mill and the leat have a similar range of pottery; the material from the mill has the more finely divided site sequence, and also the earliest pottery. However, the evidence from both site assemblages would support the following broad sequence: Stamford ware (its earliest occurrence being from the mill site) is succeeded (on both sites) by a 'reduced sandy ware'; then, in turn, a 'light-bodied sandy ware', sometimes with red paint decoration, becomes dominant.

With the exception of a few sherds of shelly ware and abraded sandy sherds from the mill, Stamford ware is the earliest pottery and the majority probably dates to the second half of the 11th century It first occurs in phase 5b from the mill, but is absent from the earliest leat phases. Subject to this (possibly short-lived) dominance of Stamford ware, a 'reduced sandy ware' becomes common. This hand-built ware is dominated by cooking vessels. The little glazed pottery associated with this ware is from possible tripod-footed vessels — pitchers and jugs — and may originate from the Coventry area. It is probable that the 'reuced sandy ware' was introduced in the 11th century and continued in use during the 12th century.

Although the site evidence remains inconclusive, it is possible that the early 13th century saw the introduction of a wheel-thrown 'light-bodied sandy ware'. There are examples of both kitchen wares and tablewares in this group. The ware can be divided into two broad fabrics: a distinctly sandy one and one which has more moderate quartz inclusions. There is some slight evidence to suggest that the sandy fabric, in association with a yellow-green glaze, precedes the use on both fabrics of a green glaze and/or the use of distinctive red paint decoration. The use of a green glaze and/or red paint decoration may date from the second half of the 13th century. The use of red paint, often as broad stripes down the body of baluster jugs and occasionally of wide-bodied pitchers, appears distinctive of the 'light-bodied sandy ware' of the Tamworth area. It is uncertain how long 'light-bodied sandy ware' continued in use, although it was probably current during at least part of the 14th century.

A little 14th and 15th century pottery was found from both sites, but there was a general scarcity of later material. Pottery of 15th and 16th century date included examples of Midland Purple ware

and Cistercian ware. Some post-medieval pottery was recovered from both sites, including 18th and 19th century material.

## Fabric and form type series

### *Introduction*

A total of 65 fabrics were initially identified, of which 9 were large post-medieval groupings. Of the remaining 56, most were minor fabrics, usually occurring in only one or two vessels. These minor fabrics have been grouped together as oxidized fabrics, reduced fabrics, shelly fabrics, late medieval/early post-medieval wares, and a miscellaneous group. Two major wares were found on both sites: a predominant 'light-bodied sandy ware' in two sub-types (light-bodied sandy and light-bodied moderately sandy) and a less common 'reduced sandy ware' which also occurred in two sub-types, a dominant cooking pot fabric and a less common distinctive tableware. The majority of Stamford ware found came from phase 5b contexts on the mill site.

### *Method*

The pottery was sorted visually into fabric types. Samples of the two main fabric groups ('light-bodied sandy ware' and 'reduced sandy ware') had previously been thin-sectioned by David Williams confirming these two broad categories of fabric types. Unfortunately the fabrics remain largely uncertain as to their source; a problem which was not clarified by the thin-section work or by some heavy mineral analysis of the fabrics (see below).

The main method of analysis of the pottery was based upon fabric division. Details of each vessel were recorded on individual context summary sheets. Information on each vessel included vessel form (where known), glaze, decoration, and individual features of rims, bases and handles. Drawable sherds were given the prefix Tam, followed by a sequential number. Illustrated sherds are separately numbered on Figures 75-7.

### *Major fabric groups*

#### Sandy wares

(i)'Light-bodied sandy ware'
The major fabric from the site was a 'light-bodied sandy ware' which was divided into two fabrics; light-bodied sandy (fabric 1) and light-bodied moderately sandy (fabric 6). This ware is wheel-thrown, with a high degree of standardization of vessel form. Examples of both cooking vessels and jugs were produced in this ware, but there is some indication that the light-bodied sandy fabric (1) was more commonly used for cooking vessels and the light-bodied moderately sandy fabric (6) for jugs and related forms; however, a range of vessels does occur in both fabrics. A yellowish-green glaze and a copper-rich green glaze were both used, but the most distinct feature of the material is a red paint, usually applied as broad vertical strips down the body of the jugs. The use of the slash and stab decoration on the handles is also common.

It is uncertain if the light-bodied sandy fabric (1) and the light-bodied moderately sandy fabric (6) are both the products of the same kilns. In the present state of knowledge it is thought unlikely that this ware originated from the Chilvers Coton, Nuneaton (Warwickshire), kilns complex as the ware appears to have distinct characteristics. The use of red paint as a decorative feature is not known from the Chilvers Coton kilns (see Wright 1982, 127-9, MPS pot types 16 and 17, especially notes 523 and 526, pers comm K Scott), but further work may revise this view. A comparison of the results of thin-section work on samples of 'light-bodied sandy ware' from Tam worth (Moulds Yard excavation; millpool A24-20; FBi-B69C-19) with that on Nuneaton white ware (fabric A) (Williams in Mayes and Scott 1984, 196) suggested that these fabrics were different.

'Light-bodied sandy ware', also known as 'white ware' and 'buff-white sandy ware' (Hodder 1986, 2-3), appears to be the dominant ware in the 13th/14th centuries in the Sutton Coldfield area between the rivers Tame and Trent (ie, south Staffordshire and north Warwickshire). Bed-painted white wares apparently of this type are also found more widely but as very much minority elements, for example at Warwick (Ratkai 1985) and Coventry (Wright 1982, 114, 129, MPS Coventry pot type 17, visually similar to Tamworth 'light-bodied sandy ware').

### ***Fabric 1: light-bodied sandy fabric***

*Fabric description*
Hard, with an uneven fracture and an off-white (1), pale grey (2) or occasionally cream fabric (Munsell 10YR 7/4). It often has a pale grey or grey core (Munsell 7.5YR 5/0). The fabric surfaces are often cream (Munsell 10YR 7/4) although occasional examples have either a pink or orange tint (Munsell 7.5YR 8/6, 7/4-6/4). The main inclusion is common, well sorted sub-angular/sub-rounded quartz grains, most of which fall in the range of 0.4-0.8mm. Other sparse inclusions which have been identified by Williams include quartzite, sandstone, fine grained silica and the odd grain of feldspar. Heavy mineral analysis (sherd from Moulds Yard excavation, 107-21) produced unfortunately very few heavy minerals, although zircon, garnet, tourmaline and apatite were noted. These minerals are commonly found in the Keuper and Bunter sandstone of the Midlands region (Fleet 1929; 1930).

*Forms*
Examples of both jugs and kitchen wares occur in this wheel-thrown fabric. The cooking pot or jar is the most common vessel, and is found in a range of sizes, but usually are medium to large in size (Figs 75.16; 77.51). Rims in this form include examples which are upright, thickened and angular (Figs 75.16, 17; 76.34, 35) and a few examples which have a thickened 'diamond' shape rim (Figs 75.19; 76.32) and occur only as jars (Figs 75.18; 76.33) or storage vessels. The bases are mainly sagging with some 'knife trimming' (as on bowl Fig 77.53). There are examples of both ovoid shape and baluster jugs. The rims on the jugs are usually triangular shaped (Fig 76.24), and the handles are simple strap, which sometimes have a central applied strip of clay which has been thumbed or notched (Fig 76.24). The bases on the jugs are either sagging, flat or splayed. The few examples of bowls have simple, flanged rims (Fig 77.53). Interestingly there is a possible fragment from an aquamanile in this fabric (Fig 77.56). The two basic glazes which occur on this fabric are a yellow-green glaze, and a bright, copper-rich green glaze. The green glaze is found on both jugs and sometimes on the interior of cooking vessels. The use of decoration on this fabric includes the use of red paint (Fig 76.24), incised decoration, stabbing on the handles (Fig 76.27, 28), and some use of applied and thumbed strips (Fig 76.24).

(ii) 'Light-bodied moderately sandy ware'

***Fabric 6: light-bodied moderately sandy fabric***

*Fabric description*
Hard with a slightly uneven fracture and a pale cream or off-white fabric (Munsell NYR 8/1) which is usually fully oxidized. The main inclusion is moderate, sub-angular/sub-rounded quartz grains which are moderately sorted, most of which fall in a range of from 0.1-0,5mm, but with occasional grains up to 0.8mm. The fabric is noticeably less sandy than fabric 1. Sparse inclusions include iron and dull white inclusions. The thin-section report did not note any other inclusions except a little mica and quartz grains,

*Forms*
There are more jugs than kitchen vessels in this wheel-thrown fabric. The jugs include examples of both baluster and probably more ovoid-shaped vessels. Rims are simpl e; either triangular in shape (Fig 76.26)or with a simple bead along the rim edge (Fig 76.25). The simple strap handles often have slashed or stabbed decoration on them (Fig 76.25). Although there are a few examples of sagging bases, flat and splayed baluster bases are more common. There is a single example of a thumbed base. The cooking pot and jars are similar in shape to those of the light-bodied sandy fabric, having examples of upright, thickened angular rims (Fig 77.61) and 'diamond' shaped rims, used for storage purposes only (Fig 76.33). In this fabric there is an interesting ?two-handled cooking vessel, glazed internally, which is reminiscent in form of a cauldron (Fig 77.55). The cooking pots and jars have either 'knife trimmed', sagging or flat bases. There are a few possible bowls with simple flanged rims. The most common glaze on this fabric is a bright, copper-rich green glaze, which occurs on both the exteriors of jugs and occasionally on the interiors of some kitchen vessels. The use of decoration on this fabric includes the distinctive use of red paint, either as broad vertical stripes or over larger areas of the vessels (Fig 77.58, 59). Other decorative techniques include the use of incised lines, in occasionally complex patterns, and stabbing and slashing on the handles (Figs 75.22; 76.25; 77.57, 58).

**Reduced sandy ware**

Two main fabrics have been identified in reduced sandy ware; a reduced sandy fabric used for cooking vessels and a reduced sandy glazed fabric which is from probable tripod jugs (?pitchers), jugs and related forms. Although the two fabrics are visually similar, it cannot be stated that they have the same source of production. The reduced sandy glazed pottery has strong similarities (in fabric, glaze and form) to material from Coventry (Wright 1982, 112, 119-21, figs 62-3 nos 67-86, MPS Coventry pot type 4, and see below); also known as 'Coventry glazed ware' and 'Broadgate East fabric D' (Redknap 1985, 66-9 and fig 3). A small number of high quality glazed vessels may have originated from the Coventry area, but that cooking vessels would travel a similar distance is probably less likely. Although only one fabric group was isolated for the cooking vessels, there was some variation within the group but not of a sufficiently visually distinct kind. This might suggest that there was more than one source of origin for the reduced sandy fabric cooking vessels. Unfortunately insufficient rims were found on the two sites to provide an opportunity of dividing the material into different stylistic types; the most common rim was a relatively standard early medieval shape, namely upright and folded-over.

(iii) 'Reduced sandy unglazed ware'

***Fabric 3: reduced sandy fabric***

*Fabric description*
Hard with an uneven fracture and dark grey core (Munsell 2.5YR 4/0-5/0, 7.5YR 4/0-5/0) and unevenly fired reddish-brown or grey surfaces (Munsell 2.5YR 6/6, 5YR 6/4-514, 2.5YR 5/0, 7.5YR 7/4). The main inclusion is common, well sorted

sub-angular/sub-rounded quartz grains, most of which are less than 0.1mm in size, but with a scatter of larger quartz grains up to 1.2mm across. Other sparse inclusions identified by Williams include quartzite, a little sandstone, flecks of mica, iron ore, sparse feldspar and fine grained silica. Heavy mineral separation (Moulds Yard excavation, FE-68-22) unfortunately produced very few heavy mineral grains, although zircon, tourmaline and apatite were noted (see above). Visually the fabric has a fine sandy appearance with sparse, large, clear quartz grains, iron and sandstone.

*Forms*
The main vessel in this hand-made wheel-finished fabric is a fairly large, baggy-shaped cooking pot or jar with a variety of upright or internally sloping folded-over rims (Figs 75.6, 8; 76.39), and a sagging base, which often has a bead of clay along the basal edge.

(iv) 'Reduced sandy glazed ware'

***Fabric 4: reduced sandy glazed fabric***

*Fabric description*
The fabric is visually similar to the reduced sandy fabric, but it is very slightly less sandy in appearance, and often has a grey interior surface (Munsell 2.5YR 5/0-10YR 6/2) and on the exterior, where the glaze is absent, it is most commonly red in colour (Munsell 10R 4/8-5/6). Comparison with a sample of MPS Coventry pot type 4 suggested that these two types are fairly similar; thin-sectioning of a sherd of MPS Coventry type 4 (122-3 MPS F138) showed frequent sub-angular grains of quartz, average size 0.1-0.5mm, together with flecks of mica, quartzite, sandstone, fine-grained silica and a little microline felspar. (See also the fabric descriptions in Wright 1982, 112, and Redknap 1985, 66.)

*Glaze*
The vessels are glazed with an uneven, often thin orange-green or reduced olive-green glaze. One of the earlier vessels from the sites has lumps of unfired galena adhering to the vessel, which may suggest the use of a splashed glaze. However, other vessels appear to have had the glaze brushed on.

*Forms*
Hand-built, there are examples of possible pitchers and neat ovoid jugs in this fabric. A single example of a foot is the only evidence of a tripod vessel. There is an example of a simple out-turned pitcher rim (Fig 76.38), while the jug rims are simple shapes, being either rounded or squared in section (Fig 77.52). There is a fine example of a jug with a simple rounded rim, a neat strap handle with a central plaited strip, and applied wavy strips of clay down the body of the pot (Fig 77.52). Vessels have sagging bases.

**Stamford ware**
The Stamford ware included examples of Kilmurry's fabrics A, G and ?E/F (pers comm K Kilmurry and H Leach; Kilmurry 1980, 8-9). The forms included early examples of collared vessels (Kilmurry's form 4, Fig 75.4, 5), a spouted pitcher (Kilmurry's form 5, Fig 75.3), and an example of a wide-mouthed bowl (Kilmurry's form 1, Fig 75.2) and cooking vessels (Kilmurry's forms 2/3 or 4, Fig 75.1). On the spouted pitchers there was a thin yellowish-green glaze (Kilmurry's glaze 1).

## *Minor fabric groups*

*Oxidized sandy wares*
There were 21 minor oxidized fabrics from the site which can be divided into three sub-types, light-bodied cream or white sandy fabrics, pink sandy fabrics and orange sandy fabrics. Most of these fabrics are represented by single vessels, of which the most common form is the jug. A few of the fabrics have similarities with the material from the Chilvers Coton kilns but most of the fabrics remain of uncertain origin.

(i) 'Light-bodied (cream-white) sandy fabrics'
The nine fabrics in this category can be divided into two main types, those which are sandy, or even gritty in character, often with noticeable iron, and those which have either less or smaller sized quartz grains. Two fabrics (14, 28) fit within the finer category, all having some similarities to the light-bodied moderately sandy fabric (6). These three fabrics are all from an unknown source. The remaining seven fabrics in this group fall into three types: one fabric which is similar to the light-bodied sandy fabric, but has noticeable quantities of iron (fabric 16); a main group of hard fabrics with medium to large sized and moderate to common quartz (fabrics 10, 18, 38, 39 and 47) some of which could possibly originate from Chilvers Coton (cf Mayes and Scott 1984, 40, 196, fabrics A, Ai); and finally a single example of a white fabric with common dull black, possible iron inclusions (fabric 54). This sherd of fabric 54 (TA 71, 201: mill phase 5b) was thin-sectioned by Williams, who comments as follows:

> Hard, rough sandy fabric, grey (between Munsell 10YR 5/ and 4/) surfaces and a whitish core. Thin-sectioning and study under the petrological microscope shows a fairly clean clay matrix containing a scatter of sub-angular quartz grains up to 0.7mm across, some of which are polycrystalline, with a little opaque oxide and fine-grained silica. This range of inclusions is not uncommon, making it difficult to try to predict a likely origin. A textural comparison with other material from Tamworth, and also samples of 'Chester Ware' and 'Stafford Ware' held by the writer failed to produce an identical match of the fabric, the Tamworth sherd under discussion on the whole being less sandy than the other sherds.

(ii) 'Pink sandy fabrics'
The five fabrics in this category can be divided into two types, those which are noticeably sandy (fabrics 17 and 43), and those which are fine and sandy (fabrics 23, 41 and 50). The fabrics are probably all from jugs, and it is

possible that the very sandy pink fabrics could come from the Chilvers Coton, Nuneaton, kiln complex (Nuneaton fabrics A and C: see Mayes and Scott 1984, 40 and 198; Wright 1982, 126-9, MPS Coventry pot types 15 and 18).

(iii) 'Orange sandy fabrics'
Orange sandy fabrics in this category can be divided into three types: two fine sandy orange jug fabrics (2, 42) one of which is visually similar to the Kirby Comer material from Coventry (Wright 1982, 112, 121-3, 131-2, MPS Coventry pot type 5; also known as Cannon Park ware, Redknap 1985, 69-74); a single jug fabric which is a sandy orange fabric (46) and whose source is unknown; and three other fabrics (25, 33 and 53) whose sources are unknown represented by body sherds, one with a sandy fabric (25), and the other two having a hard dense clay matrix with moderate, visible medium sized quartz grains.

*Reduced sandy wares*
The reduced fabrics fall into two groups: a few fabrics which may be related to the major category of 'reduced sandy ware' and a second larger group of reduced sandy fabrics which may originate from a number of sources.

There are four fabrics which may relate to 'reduced sandy ware'. Two cooking vessel fabrics (24 and 29) are similar in form and fabric to the reduced sandy cooking vessel fabric, but are different in their method of firing, with oxidized outer margins, with a dark grey core and surfaces. Of the other two fabrics, one is a single very sandy reduced sherd (fabric 19) and the other is a probable jug (fabric 5) which may relate to the reduced sandy glazed fabric.

The six remaining fabrics are mainly sandy and with one exception (fabric 52) are wheel thrown (fabrics 9, 34, 35, 37 and 51). The fabrics are mostly from cooking vessels and probably orginiate from more than one source of production.

***Shelly ware***
Only two shelly fabrics were recovered, one of which was from a phase 4 context associated with the abandonment or robbing of the phase 3 mill (114a). One (fabric 12) had common shell with a grey core and red-brown surfaces, while the other (fabric 15) had moderate fine shell with a dark grey core and orange surfaces. The shelly fabrics were examined by Jane Young (Trust for Lincolnshire Archaeology), who suggested that they could have a Midlands origin (cf Wright 1982, 115, 130, MPS Coventry pot types 28 and 29).

***Late medieval/early post-medieval wares***
This category can be divided into two types; the typical late medieval/early post-medieval wares of Midland Purple, Cistercian and Tudor Green, and a more general group of very hard fired, harsh sandy or even gritty fabrics.

The Midland Purple (fabric 110), Cistercian ware (fabrics 22 and 109) and Tudor Green (Surrey white wares) (fabric 21) were not examined in detail. No individual forms in Tudor Green were identifiable, but examples of vessels in Midland Purple ware included cisterns, and in Cistercian ware there were examples of cups, one of which had an applied pad of white clay, subsequently stamped with a wheel motif. No attempt was made to isolate the production centres of these wares, but known centres include Chilvers Coton (Midland Purple and Cistercian), and Ticknall and Melbourne in Derbyshire (Cistercian) (Mayes and Scott 1984, 40-1 and 197, Nuneaton fabrics D (Midland Purple) and E (Cistercian); Woodland in Mellor and Pearce 1981, 83-4 and 127-8).

The second more general group of ten fabrics cannot be conclusively stated as being of late medieval or early post-medieval date. However, they can be isolated as a distinct group of fabrics. With one exception (fabric 36) the fabrics are all oxidized firing either to pink, red or orange in colour, sometimes with red or brown surfaces (fabrics 20, 32, 36, 40, 44, 48 and 49). Most of the fabrics have visible, medium sized quartz grains, although one fabric (45) has common fine sand and two fabrics (26 and 27) have moderate sand in a relatively fine pink fabric. The fabrics are all very hard, and mostly have a harsh feel to them. It is probable that they originate from a number of sources. Most of the fabrics are represented only by body sherds, giving little indication of their form. However, there are one or two large pancheons and possible closed forms from this fabric grouping.

***Miscellaneous***
Two fabrics do not fit easily into the above categories: one is a fine white fabric with a thick green glaze on both surfaces (fabric 31) and the other (fabric 30) is an oxidized, iron-rich orange sandy fabric which may relate to the rest of the oxidized fabrics.

***Post-medieval wares***
The nine main groupings of the post-medieval wares were based on well-established common names.

| | |
|---|---|
| Fabric 100: | Midlands Yellow |
| Fabric 101: | German stoneware |
| Fabric 102: | Staffordshire slipware |
| Fabric 103: | Mottled ware (also known as manganese/ streaked ware) |
| Fabric 104: | Bed-bodied, black- or brown-glazed wares, primarily domestic vessels such as pancheons |
| Fabric 107: | Midlands Black glazed ware (fine, red-bodied tableware) |

## *Mill: 1971 site phases*

**Phases 0-3**
There was no pottery associated with phases 0 to 3.

**Phase 4**
There were no drawable sherds from this earliest ceramic phase. The only material was a single body sherd of shelly ware (114a in 368) and two tiny scraps of a sandy fabric with abraded surfaces (176). The shelly ware sherd has been suggested as a probable English ware, with a possible Midlands origin, and may date from the late 9th century onwards (pers comm Jane Young). Late Saxon shelly fabrics occurred on the Mould's Yard (Tamworth) site (1970/73, Meeson), and included examples from the Silver Street kiln, Lincoln, dated from the late 9th to the late 10th century (pers comm Jane Young); a date not inconsistent with the dendrochronological date for phase 3.

**Phase 5** (Fig 75)
**Phase 5a**
The only vessel from 5a is a reduced sandy ware cooking pot rim (159 in 82: Fig 75.6). The vessel is similar to a small number of sherds which occur in phase 5b, but is

more typical of the vessels which are found in phase 6. It remains difficult to date this very closely, other than to say that it may date as early as the second half of the 11th century or as late as the second half of the 12th century.

**Phase 5b** (Fig 75)
Although only a relatively small amount of pottery was recovered from this site phase (estimated number of vessels 14), most of the material formed a cohesive-group of which the dominant type was Stamford ware. The occurrence of Stamford ware here and in related contexts of phase 7 has provided the opportunity to date this site phase reasonably closely. Three of the Stamford ware vessels could be paralleled with examples cited by Kilmurry (1980). These are a wide-mouthed flanged bowl from 207-208 (phase 7) (Fig 75.2) similar to examples which Kilmurry dates to the 11th century and probably the mid to late part (1980, 132-8); a spouted pitcher (49a, 51, 52, 192, 220-221, 223a, 232, 234; Fig 75.3) similar to forms which Kilmurry states are popular in the mid to late 11th century *(op cit* 140-1); and a collared vessel (55: Fig 75.4) similar to examples dated to the second half of the 11th century *(op cit* 136-7). It is probable that most of the Stamford ware from these contexts could date to the period *c* 1050-1100 (see also Fig 75.5).

As well as the dominant Stamford ware, there were a small number of other wares from this site phase. These included another example of shelly ware (233) which was identified as having a possible Lincoln or Northampton origin, but was not datable (pers comm Jane Young) (but see above, phase 4). An interesting sherd was that of an off-white fabric with dull black inclusions (201); although thin-sectioned (see above) it is of an uncertain origin but may date to the second half of the 11th century. There were two reduced sandy ware sherds (including 224), suggesting either the origin of this ware on the site is during the second half of the 11th century, or that the phase may extend into the earlier part of the 12th century.

**Phase 6** (Fig 75)
Only five contexts of this phase yielded sherds; of these, 122 and 182 (in 469) are dated probably to the 12th century; 217 (in 461) to the later 12th. The remaining two are from a context at the end of this phase, the possible bridge abutment feature 101. From this came sherd 101a, dated also to the 12th century (Fig 75.7); and sherd 101b, a coarse pink sandy ware base more typical of the 13th century; this could, however, be intrusive from layers above. With this exception, therefore, all the pottery from phase 6 is either reduced sandy ware or glazed reduced sandy ware.

**Phase 7** (Fig 75)
Contexts of this phase yielded a number of Stamford ware sherds and others of the late 11th-earlier 12th century, apparently residual from phase 5b deposits disturbed in phase 7. There are also, however, sherds of light-bodied sandy ware and allied fabrics (69, 194, 196, 211, 216a and 218); 194 (from 198) is a cooking-pot rim in a fine white fabric, possibly 13th century (Fig 75.10); 204 (from 390) is a cooking-pot rim in a fabric of dark grey core and red-brown surfaces (Fig 75.8); 216a is a wheel-thrown rim in a light-bodied sandy ware (Fig 75.9). It is considered unlikely that any of these sherds can be dated earlier than the very late 12th or even 13th century; 194 is more likely to be 13th century.

**Phase 8** (Fig 75)
Most of the pottery in this phase is 'light-bodied sandy ware', with both the sandy and moderately sandy fabrics represe nted. The forms include examples of cooking pots, storage vessels and jugs. Most of the pottery probably dates to the 13th century, and possibly extends into the 14th century. There is a small amount of probable 12th century 'reduced sandy ware', some of which may be residual.

The reduced sandy ware includes a small number of glazed sherds. Cooking pots are the only form represented in this fabric unglazed, with typical fairly upright, folded-over rims (93; 100: Fig 75.14; 96: Fig 75.11; 97: Fig 75.12-13; L3: Fig 75.15). The few sherds which are glazed are probably from tripod pitchers or jugs (1, 266a); all of these are dated to the 12th or very early 13th century.

Light-bodied sandy ware is dominant in this phase, occurring as one or two sherds in a context (8, 102 and 138a) or as large groups of this ware (73, 92, 139, 139a and 147. From the ditch (90) there were only two sherds of pottery; one of light-bodied sandy ware' and one a sandy iron-rich fragment. Both may date to the 13th century. Examples of vessels in light-bodied sandy ware' include cooking pots (46: Fig 75.16; 102: Fig 75.17; 139a: Fig 75.19; 147: Fig 75.20) possible storage vessels (139: Fig 75.18) and jugs (139, Fig 75.21; 139a: Fig 75.22).

Within the individual features there is some variation in the relative proportions of the sandy fabric and the moderately sandy fabric, with features 92, 139, 139a and 147 having a larger proportion of the sandy fabric and 403 the larger amount of the moderately sandy fabric. It is suggested tentatively that this latter fabric may be more common in the later 13th century, although it is probable that both these fabrics were in concurrent use. It is possible that 'light-bodied sandy ware' is essentially a 13th-century ware, although its use may continue during the earlier or first half of the 14th century.

There were a small number of other fabrics associated with this phase: these include examples of fine pink sandy jug sherds, and pink sandy sherds (361). From 139a there were a few sherds of orange and pink fabrics which may date to the 14th century.

**Phase 9** (Fig 76))
The pottery associated with phase 9 can be divided into two groups: those features which yielded (presumably residual) reduced sandy ware (L2, 31), and light-bodied sandy ware, with a small number of other fabrics (L2, 25, 26, 58, 77, 86, 117); and those features which contained late medieval or early post-medieval pottery (L3, 4, 27, 39).

The earlier material in reduced sandy glazed ware include (from L2) a single example of a tripod foot, probably of the 12th century, and a sherd from 31 (12th or very early 13th), both presumably residual.

The remaining features in phase 9 contained varying amounts of 'light-bodied sandy ware' and a small amount of other fabrics. Feature 26 had only a single body sherd of 'light-bodied sandy ware', which may therefore be residual. The material recovered from features 25, 27, 58, 77 and 86/117, is, however, considerably larger and includes nearly 400 sherds from 58 and a nearly complete baluster jug from 86 and 58 (Fig 76.23). The presence of such large amounts of pottery and of a number of part profiles suggests that the material associated with these features is unlikely to be residual. There were five sherds of post-medieval pottery from 58 but this is considered to be from a later intrusive feature.

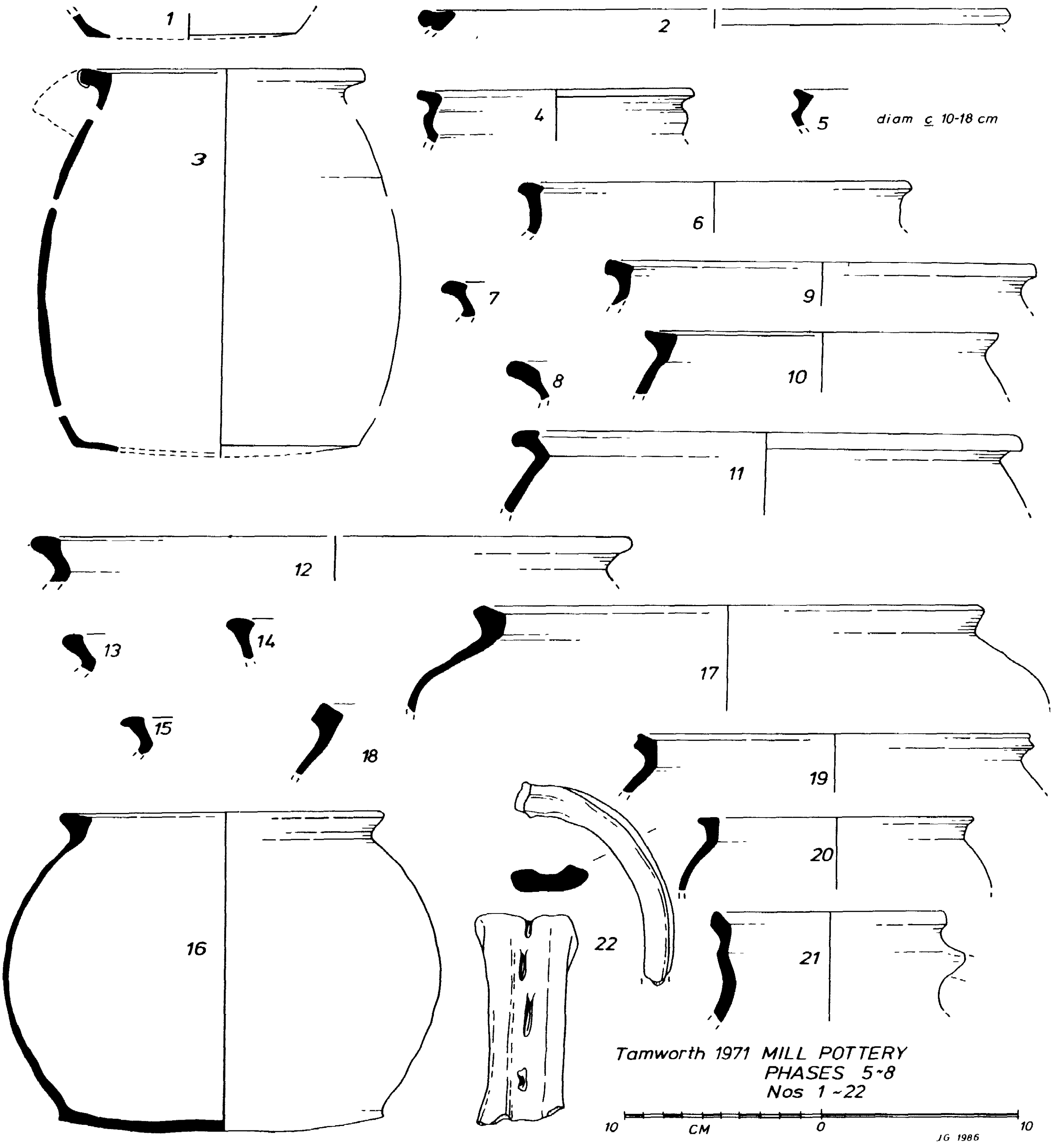



*Figure 75 Pottery: 1971 mill phases 5-8, nos 1-22*

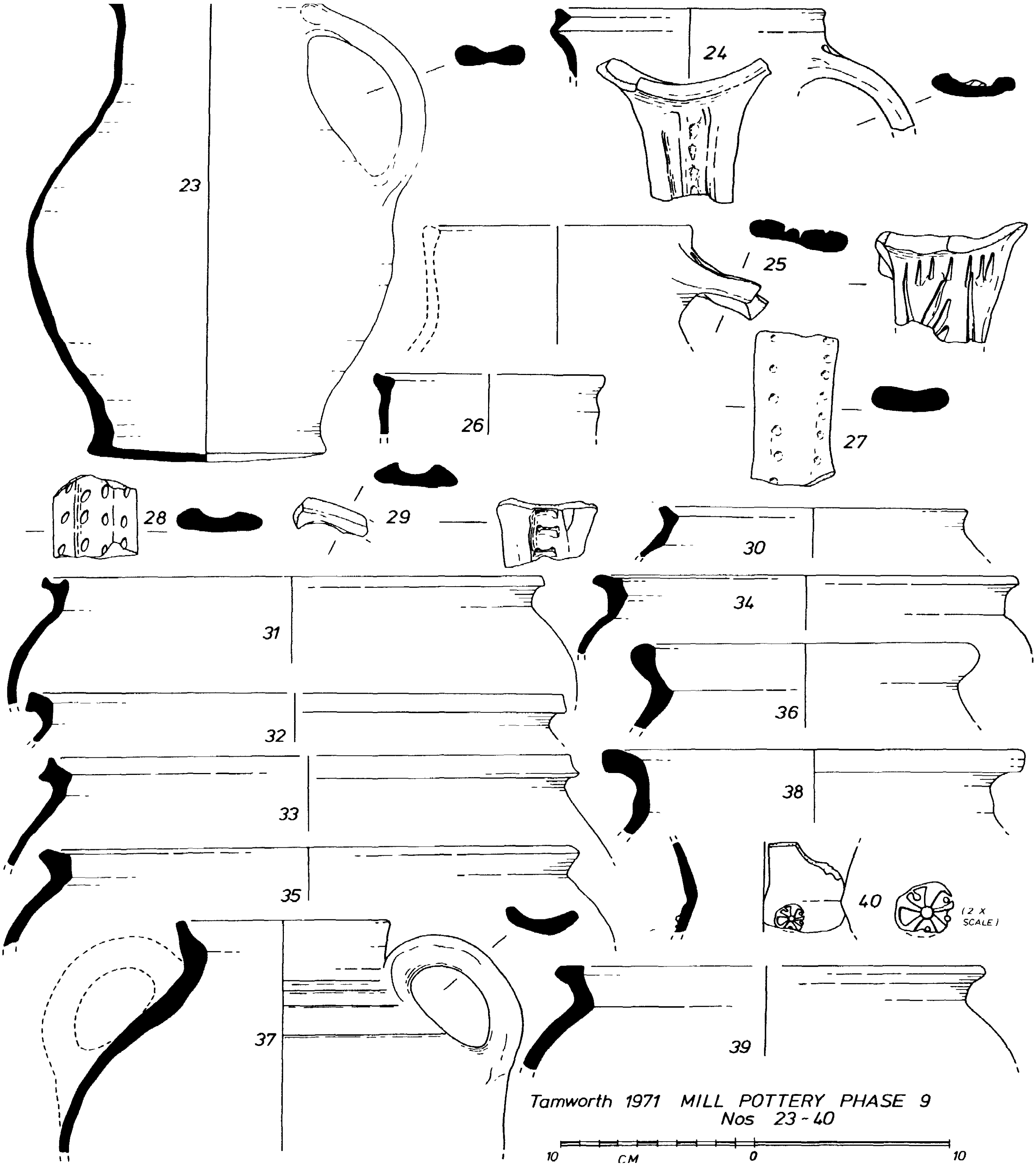



*Figure 76 Pottery: 1971 mill phase 9, nos 23-40*

If the pottery from these features is considered not to be residual, a problem remains as to the probable date for this material. It has been stated elsewhere that 'light-bodied sandy ware' probably dates to the 13th century.

Unfortunately the site evidence does not provide sufficient information to suggest change in the ware or to provide a final date for its use. It is therefore suggested tentatively that 'light-bodied sandy ware' may have continued in use during the earlier part of the 14th century, possibly until the middle of the century, although it remains difficult to evaluate possible changes in the ware during this period. The light-bodied sandy ware' from the features in phase 9 is similar to vessels in phase 8.

The features with later pottery in them include examples of Midland Purple ware, Cistercian ware and hard, pink sandy fabrics which are probably 15th or 16th century in date. From 23 came a sherd of a Midland Purple cistern of this date (Fig 76.37); and a lid-seated rim in the same fabric was the only pottery in 27 (Fig 76.36).

Feature 39 has a single fragment of a Cistercian ware cup with an applied and stamped wheel motif on white clay (Fig 76.40). Although Cistercian ware has been suggested as beginning as early as *c* 1450 at the Austin Friars site in Leicester (Woodland in Mellor and Pearce 1981, 128), other sites (for example, Sandal Castle: Mayes and Butler 1984, 215) indicate a late 15th century origin for this ware. A date of the late 15th or first half of the 16th century is suggested as a possible date for this feature. A wider range of wares occurred in feature 4 and included examples of Midland Purple ware, Cistercian ware and hard, pink sandy fabrics; the occurrence of Cistercian ware favours a late 15th or 16th century date for this feature.

**Phase 10**

There was a small amount of post-medieval pottery from phase 10 features. Features 35, 56 and 57 all included examples of material which probably dates to either the end of the 17th century or the first half of the 18th century. Feature 142 included later 17th century material.

## Mill: 1971 illustrated pottery (Figs 75, 76)

**Fig 75**

**Phase 5**

*Stamford ware*

1 Sagging, knife-trimmed cooking-pot base, with a dark grey core and surfaces and off-white outer margins. Identified by Kilmurry as fabric G, with a considered date of 'not earlier than the mid-11th century'. Tam 177 (67, phase 5b)

2 Flanged bowl in a white fabric with an orange surface which has been partly burnt. Identified by H Leach as fabric G. The form is similar to examples Kilmurry dates as 11th century, possibly mid to late. Tam 125 (207, phase 5b)

3 Spouted pitcher with a simple rim in a white fabric with a thin yellow-green glaze over the vessel body (Kilmurry's Glaze 1) and a sagging knife-trimmed base. Identified by H Leach as fabric A. The form is similar to examples Kilmurry dates as popular in the mid to late 11th century (5.76). Tam 122, 124 (49a, 51, 52, 192, 220, 221, 223a, 232, 234, phase 5b)

*Possible Stamford ware*

4 Collared vessel with a neat flanged rim in a hard fine grey fabric whose colour may have been affected by use or subsequent deposition. Identified by Kilmurry as fabric G, form 4.36, with a considered date 'not earlier than the midllth century'. This form is similar to examples Kilmurry dates to the second half of the 11th century. Tam 176 (55, phase 5b)

5 Collared vessel with a neat rim in a dark grey sooted fabric. Identified by Kilmurry as fabric G, form 4.22 with a considered date 'not earlier than the mid 11th century'. Tam 178 (199, phase 9, residual)

*Reduced sandy ware*

6 Upright folded-over cooking-pot rim with red surfaces and a dark grey core. Possible date later 11th/12th century. Tam 85 (159, phase 5a)

**Phase 6**

*Reduced sandy ware*

7 Cooking pot with a folded-over rim, dark grey core, red-brown interior, and sooted dark brown exterior surface. Possible date 12th century. Tam 142 (101a)

**Phase 7**

*Reduced sandy ware*

8 Cooking pot with a folded-over, slightly squared rim with a dark grey core and brown surfaces. Possible date 12th or very early 13th century. Tam 68 (204)

*Light-bodied sandy ware*

9 Possible jar or cooking pot, squared rim in a white sandy fabric with a pale cream surface. Possible date very late 12th or even 13th century. Tam 55 (216a)

10 Cooking pot with a thickened triangular rim in a fine white fabric with a sooted exterior surface. Possible date 13th century. Tam 22 (194, in 198)

**Phase 8**

*Reduced sandy ware*

11 Cooking pot with a folded-over rim, dark grey core and brown surfaces which are sooted. Possible date 11th/12th century. Tam 116 (96)

12 Cooking pot with a folded-over rim, dark grey core and a red-brown interior. The exterior is sooted black. Possible date 12th century. Tam 115 (97)

13 Probable cooking pot with a folded-over rim, dark grey core and brown surfaces. Possible date 12th century. Tam 7 (97)

14 Cooking pot with a folded-over rim, a dark grey core and brown surfaces, sooted externally. Possible date 12th century. Tam 84 (100)

15 Probable cooking pot with a neat folded-over rim with a dark grey core and red-brown surfaces. Possible date 12th century. Tam 10 (13)

*Light-bodied sandy ware*

16 Cooking pot with a thickened triangular rim, a slightly sagging base with excess clay left along the base edge. The sandy fabric is off-white with a sooted exterior surface. Possible date 13th century. Tam l (46)

17 Cooking pot with a thickened triangular rim in a sandy fabric with a grey core, off-white margins and cream surface. The vessel is sooted. Possible date 13th century. Tam 54 (102)

18 Possible jar with a 'diamond' shaped rim in a white sandy fabric. Possible date 13th century. Tam 28 (139)

19 Cooking pot with a squared rim in a sandy fabric with a grey core and off-white margins and surfaces. The exterior is sooted. Possible date 13th century. Tam 34 (139a)

20 Cooking pot with a neat triangular shaped rim in a sandy white fabric with an external sooted surface. Possible date 13th century. Tam 33 (147)

21 Jug with a neat out-turned rim, and the start of a strap handle. The sandy fabric is off-white in colour with a thick glossy yellow-brown glaze with brown staining on the exterior surface. Possible date 13th century. Tam 120 (139)

22 Jug strap handle in a white, moderately sandy fabric with a glossy green glaze and four slash marks down the central handle groove. Possible date 13th century. Tam 27 (139a)

**Phase 9**

*Light-bodied sandy ware*

23 Baluster jug with a slightly sagging base, simple out-turned rim, and simple strap handle. The sandy fabric is off-white with pale cream surfaces and a mottled green glaze from the rim to lower vessel body. Possible date second half 13th century. Tam 2 (58, 86)

24 Jug with an inturned rim and a strap handle with a centrally applied and notched decorative strip. The sandy fabric has a grey core, off-white outer margins and cream surface. There is a yellowy-green glaze, bleeding brown at the edge, on the handle and vessel neck. There is evidence of the use of a brown paint decorative strip on the rim and neck of the jug. Possible date second half 13th century. Tam 69 (58)

25 Jug with a simple rim and a strap handle with heavy slash decoration. The moderately sandy fabric is cream with pink surfaces and spots of a brown-green glaze on the external surface. Possible date 13th century. Tam 16 (58)

26 Jug with a simple rim in a moderately sandy white fabric with cream surfaces. Possible date 13th century. Tam 17 (58)

27 Jug strap handle with shallow stab marks on each handle edge in a sandy fabric with a grey core and cream margins and surfaces. There are spots of a yellow-green glaze on the external surface of the handle. Possible date 13th century. Tam 76 (58)

28 Jug strap handle with four lines of stabbing on upper surface. The sandy fabric has a dark grey core, off-white outer margins and a cream surface. There is a brown-green glaze with brown spotting on the upper surface. Possible date 13th century. Tam 77 (58)

29 Jug strap handle with angular impressions down the centre of the handle. The sandy fabric has a grey core and a cream surface with a brown-green glaze with brown spotting on the upper handle surface. Possible date 13th century. Tam 77 (58)

30 Cooking pot with a triangular rim in a sandy fabric, heavily sooted to a grey colour. Possible date 13th century. Tam 42 (58)

31 Possible jar with an unusual almost lid-seated rim, in a sandy fabric with a grey core and cream outer margins and surfaces. Possible date 13th/14th century. Tam 35 (26)

32 Cooking pot with an everted, thickened, squared rim in a sandy fabric with a pale grey core, cream outer margins and surfaces, externally sooted. Possible date 13th century. Tam 39 (58)

33 Jar, or storage vessel, with a 'diamond' shaped rim, in a moderately sandy pale cream fabric. Possible date 13th/14th century. Tam 36 (58)

34 Cooking pot with a fairly upright, thickened, out-turned rim in a hard sandy fabric with grey core, cream margins and a brown surface sooted externally. Possible date 13th/14th century. Tam 38 (58)

35 Jar with a thickened, angular rim in a hard sandy fabric with a pale grey core, cream margins and an orange surface. Possible date 13th/14th century Tam 43 (58)

*Midland Purple ware*

36 Possible cistern or storage vessel with a lid-seated rim in a very hard sandy fabric with a grey core and red-brown surfaces. Possible date 15th/16th century Tam 128 (27)

37 Cistern with an upright, lid-seated rim and two probable strap handles. The fabric has a light grey core and a grey-brown surface. There is a brush' of purple-red glaze on the main body. There are a series of incised horizontal lines on the upper body. Possible date second half 15th/16th century. Tam 64 (L3)

*Reduced sandy ware*

38 Possible pitcher with a simple out-turned rim with a dark grey core and a red-brown inner surface and a brown-green external glaze. The vessel may date to the 12th or 13th century. (This vessel may be from a different origin to the cooking pots and jars.) Tam 100 (58)

39 Probable cooking pot with an upright folded-over

rim, a dark grey core and interior surface and a brown exterior. Possible date 12th century. Tam 104

*Cistercian ware*

40 Probable cup with two blobs of applied white slip subsequently stamped with a 'wheel' motif. The fabric is dark red with a brown glaze. Possible date first half 16th century. Tam 129 (39)

## Leat area: 1978 site phases

**Phases 1 and 2**

No pottery was associated with these site phases.

**Phase 6: ditch A145**

The main item from this feature is a nearly complete profile of a light-bodied sandy ware' cooking pot (A44: Fig 77.51) which may date to the 13th century. other pottery in this feature includes further examples of 'light-bodied sandy ware' and 'reduced sandy' and 'reduced sandy glazed ware'. The latter ware probably dates to the 12th century, the rest of the material to the 13th century.

A38 (upper fill of ditch A145): single body sherd of light-bodied sandy ware', with a probable 13th century date.

Prom the limited information available it is possible that the fill of the small ditch (A145) can be dated to the latter part of the 12th or the early 13th century.

**Phase 7: erosion channel A264**

The only pottery from this site phase was a single sherd of light-bodied sandy ware', possibly dating to the 13th century. (A138) (in A264),

**Phase 8: medieval town ditch A266**

A73 (lower fill of ditch A266): part profile of a 'reduced sandy ware' glazed jug with an out-turned rim, decorated strap handle and neatly applied wavy line decoration (8A 73: 77.52). The origin of the vessel is uncertain and it possibly dates to the second half or the latter part of the 12th century.

**Phase 8: land reclamation**

Virtually all the pottery from this site phase is 'light-bodied sandy ware', more commonly the sandy fabric, slightly less so the moderately sandy fabric. Forms include examples of cooking pots, both ovoid and baluster jugs (A32: Pig 77.54) and interestingly a single vessel in the moderately sandy fabric of a possibly two-handled cooking pot (A147: Fig 77.55). There is also a wide-mouthed bowl in this ware (A147: Fig 77.53). Both the presence of these vessels and the relatively high percentage of moderately sandy fabric, as well as examples of baluster jugs, favour a date in the second half of the 13th, or even the first half of the 14th century, for the majority of the pottery in this phase.

**Phases 9-10: metal-working and further land reclamation**

The deposits which made up the second major stage of land reclamation included medieval pottery but potsherds associated with the metal-working activities ranged from 13th century (residual) to 18th century. The most common medieval pottery from this phase is 'light-bodied sandy ware' but there was a late medieval rim from A22, and pottery from A30 included two sherds of possibly 15th century date and a sherd of Midland Purple ware. The majority of contexts in this phase included red-bodied black-and brown-glazed domestic vessels, Cistercian ware and black-glazed ware.

## Leat area: 1978 illustrated pottery (Fig 77)

**Phase 6: ditch A145**

*'Light-bodied sandy ware)*

51 Cooking pot with a thickened 'club' rim, high-shouldered with a sagging base. This vessel is virtually complete. The vessel has a partial grey core, is fully oxidized orange in the main body, with a sooted exterior surface. The fabric is sandy. Possible date 13th century. Tam 139 (A144)

**Phase 8: medieval town ditch A266**

*'Reduced sandy glazed ware'*

52 Wide-bodied jug with a simple out-turned rim, a neat strap handle with a centrally applied twisted band of clay, and a series of applied wavy lines on the body, radiating out from the neck. At the junction of the shoulder and neck of the pot is a horizontal applied and notched band of clay. Around the lower handle attachment there is a similar band of applied and notched clay. The vessel has a dark grey core, orange interior surface and a thin brushed glossy brown-green glaze on the exterior surface. Possible date second half or late 12th century. Tam 150 (A73)

**Phase 8: land reclamation**

*'Light-bodied sandy ware'*

53 Wide-mouthed bowl with a triangular flanged rim and a sagging trimmed base. The sandy fabric is pink with a partial pale grey core. There are traces of an (?) eroded green glaze on the lower interior base. Possible date second half 13th or 14th century. Tam 87 (A147) (from A266)

54 Jug with a neat angular rim in a moderately sandy white fabric with a cream surface. There is a run of thick glossy brown-yellow glaze from the neck of the pot towards the rim. Possible date 13th century. Tam 159 (A32)

55 Cooking vessel with a slightly flaring rim, to which is attached at least one rod handle centrally and diagonally slashed. The moderately sandy fabric is white, with a sooted grey exterior, and a good quality green glaze over the entire vessel interior. Possible date 14th century. Tam 88 (A147) (from A266)

56 Uncertain form, neck with hand attachment on right-hand vessel side. May be an aquamanile or possibly roof furniture. The sandy fabric is grey with a pink interior surface, and has white slip beneath a thick green glaze on the exterior Surface. Date 13th/14th century. Tam 91 (A148)

**Phases 9-10: metal-working and further land reclamation**

*'Light-bodied sandy ware'*

57 Pulled pipkin handle, with slash marks on the lower body. The sandy fabric is white with a sooted grey exterior. Possible date late 13th/14th century. Tam 164 (A30)

58 Probable jug strap handle with slash marks and red

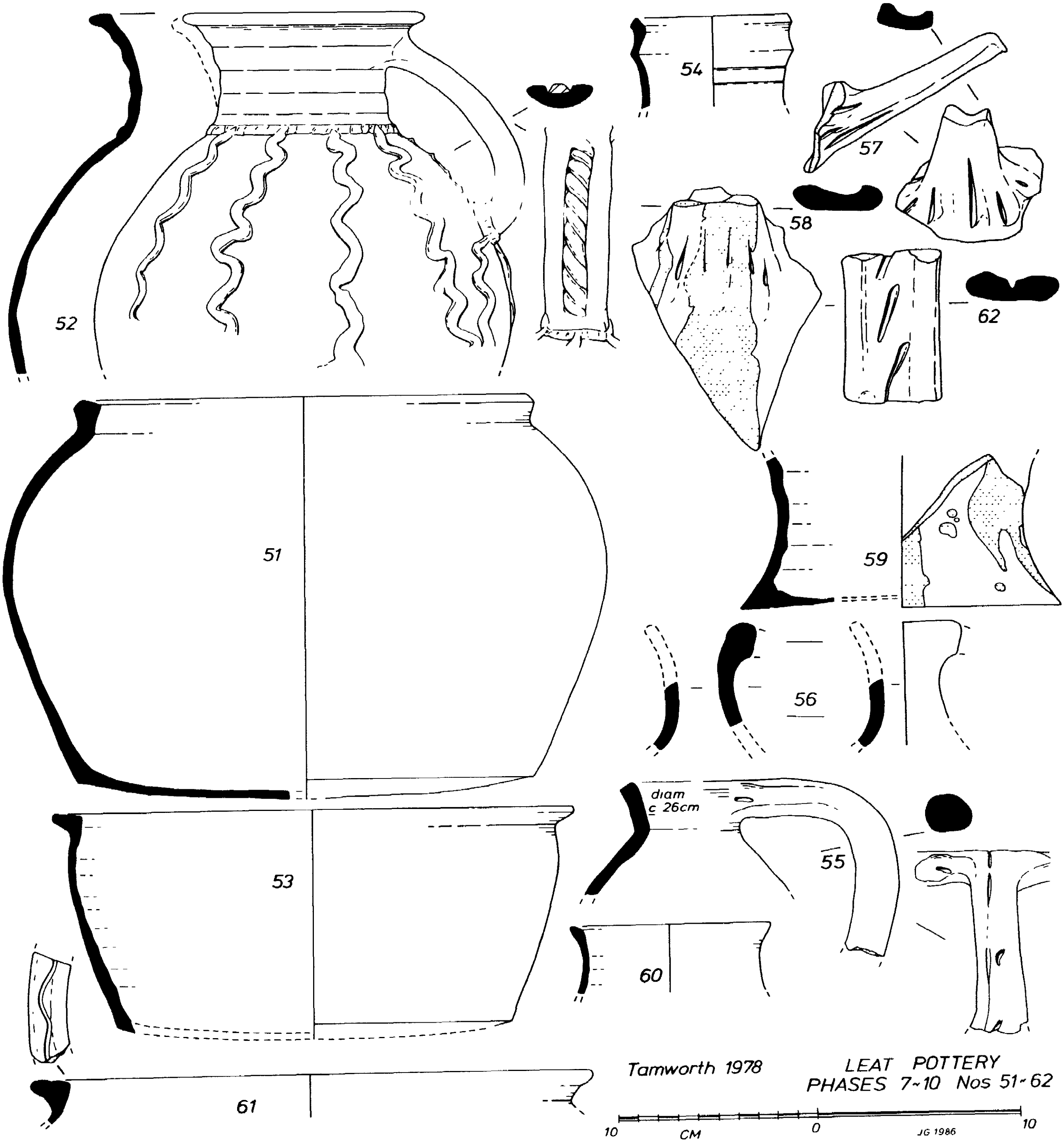



*Figure 77 Pottery: 1978 leat phases 7-9, nos 51-62*

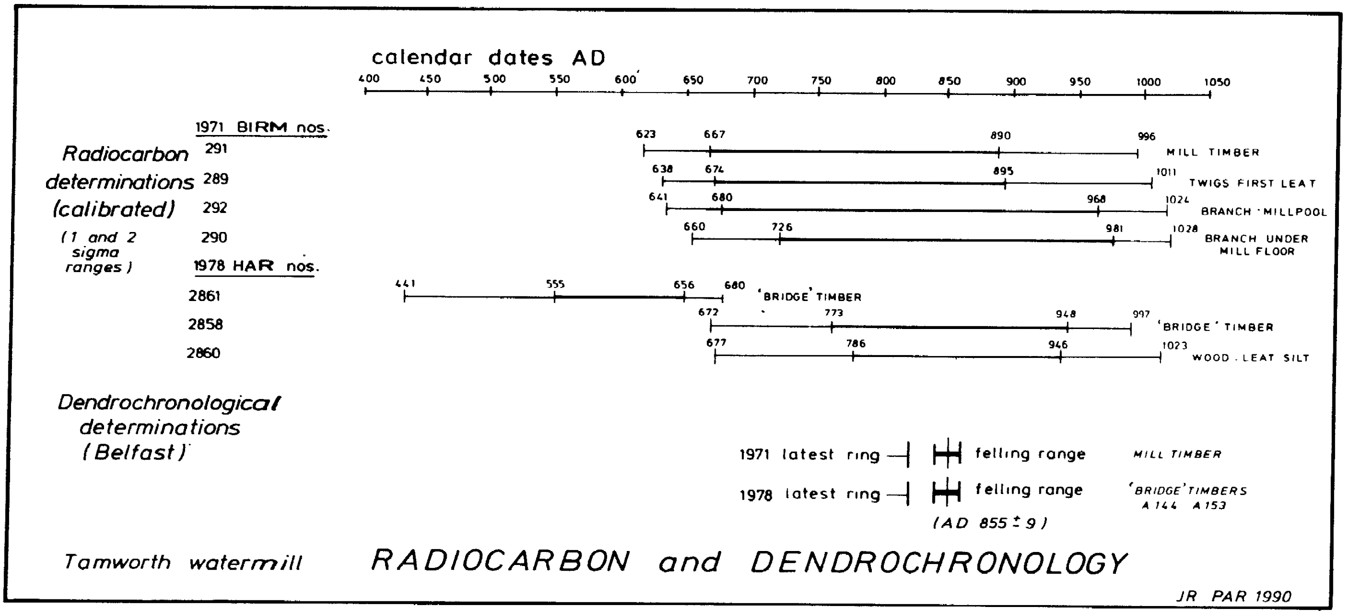



*Figure 78a Radiocarbon and dendrochronology*

paint decoration. The moderately sandy fabric is white with cream surfaces. Possible date from the second half 13th century. Tam 171 (B18)

59 Baluster jug base in a moderately sandy cream fabric with broad stripes of dull brown paint decoration. Possible date later 13th/14th century. Tam 137 (A30)

60 Simple jug rim in a hard moderately sandy cream fabric. Possible date 14th century. Tam 135 (A26)

61 Cooking pot with a thickened triangular rim, and an incised wavy line on the rim top. The white moderately sandy fabric has off-white surfaces sooted externally. Possible date 13th century. Tam 146 (A26)

62 Jug strap handle with central, diagonal slash marks. The sandy fabric has a grey core, white outer margins and a cream surface. There is a green glaze on the upper surface- Possible date second half 13th or 14th century. Tam 172 (B14)

## 3.18 Dendrochronology (DEN)
(fuller version in MF)

Attempts were made to date the Tamworth timbers in 1973 (Dr J M Fletcher), 1978 (W G Simpson) and 1980 (Dr M G L Baillie). The latter was successful in providing a felling date of AD 855 ± 9. The result was published (Baillie 1980) and is shown on Figure 78a compared with the radiocarbon determinations. Baillie *(in lit* to PAR 1980) confirmed that three timbers (unfortunately not identified in the structures) have outer rings dated to 820, 824, and 825, to the latest of which are added 32 ± 9 to allow for the estimate of missing sapwood. As discussed above, the mid 9th century date is likely to be that for the felling of the timbers of the second mill, but could be for those of the first mill, re-used in the second.

Baillie also dated (in 1980) two timbers from the leat/bridge area of 1978 (A144 and A153) (2.12) and these had an identical felling date of AD 855 ± 9 (pers comm Baillie to RM), indicating precise contemporaneity with those above, but with the same reservations about re-use.

## 3.19 Radiocarbon determinations (RD) (Fig 78)
(fuller version in MF)

Radiocarbon determinations were done at Birmingham on four samples submitted by PAR in 1971 (BIRM 289-92). Samples were also taken by the late Dr J M Fletcher in 1974, from planks 160a and 160c (wheelhouse floor) for submission to the Cambridge Laboratory, but no more has been heard of these. Three further samples were submitted by RM to Harwell in 1978 (HAR 2858, 2860, 2861).

David Jordan (AM Lab) (23.2.1989) provided a calibration for these. He lists the radiocarbon determinations as they would appear in the style of the Trondheim convention, now adopted as HBMC house style (Pearson and Stuiver 1986):

1240+/-110 BP (BIRM-291), corrected to 660-890 Cal AD

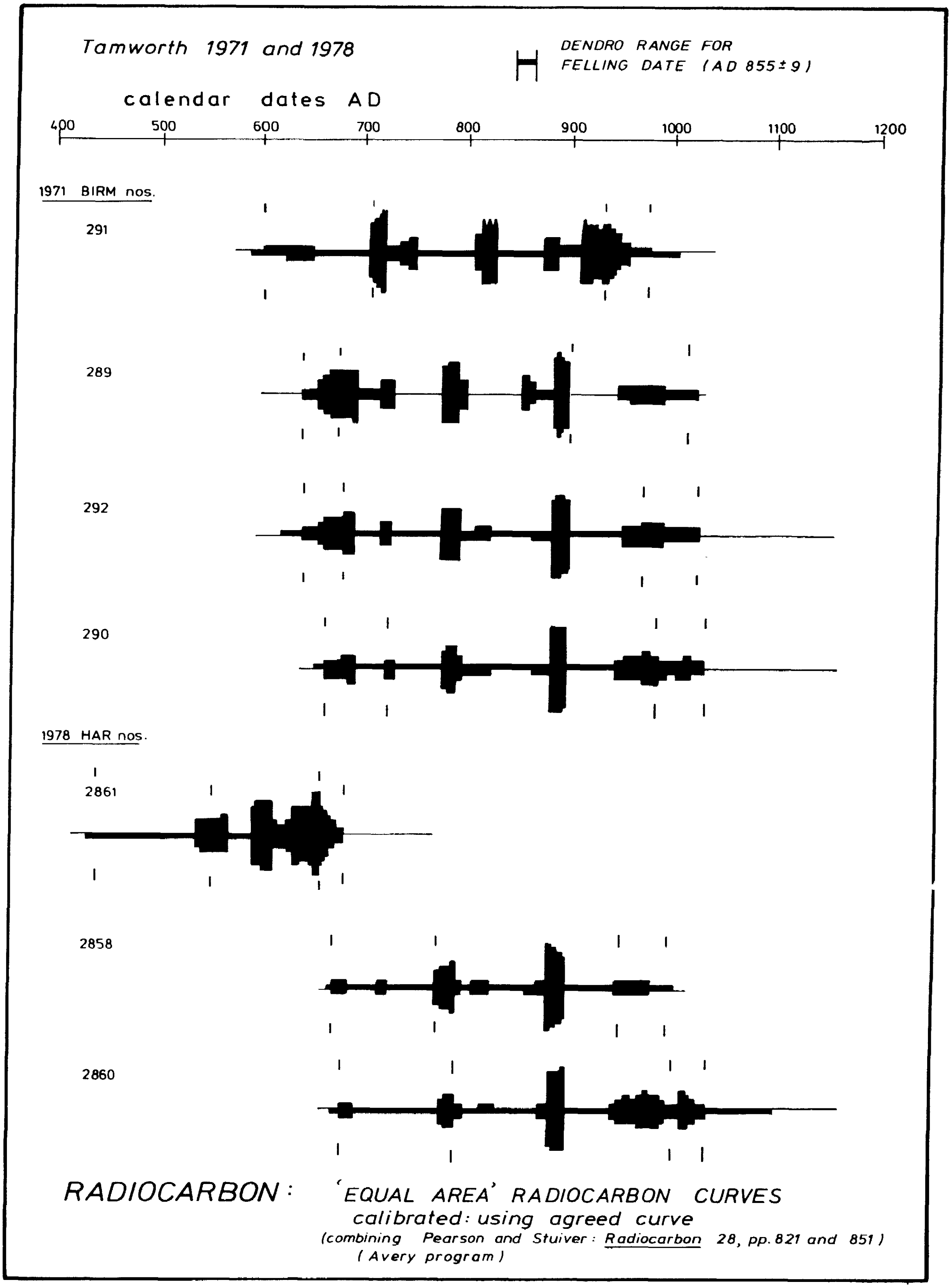



*Figure 78b 'Equal area' radiocarbon curves*

1200+/-100 BP (BIRM-289), corrected to 670-900 Cal AD
1195+/-90 BP (BIRM-292), corrected to 687-957 Cdl AD
1162+/-100 BP (BIRM-290), corrected to 722-980 Cal AD
1440+/-70 BP (HAR-2861), corrected to 553-658 Cal AD
1180+/-70 BP (HAR-2858), corrected to 772-953 Cal AD
1130+/-490 BP (HAR-2860), corrected to 785-1000 Cal AD
(all at one standard deviation)

He comments further that the calibrated Birmingham results combine to give a date range of 771-888 Cal AD at one standard deviation. The combined Harwell results give a range of 786-957 Cal AD at one standard deviation. There is thus a close relationship between these combined dates and the dendrochronological results (above, 3.18).

The Birmingham and Harwell determinations were later (October 1990), also kindly calibrated by Dr Julian Richards, University of York, using the agreed curve, combining Pearson and Stuiver (see *Radiocarbon* **28,** 821, 851); the calculations were done by Dr Richards using the DATRAN calibration program, by Michael Avery of Belfast. The calibrated dates are slightly different from those of Jordan, presumably due to a different basis of calculation.

Bichards' results are shown on Figure 78a, which also indicates the contexts from which the samples were taken. Six of the seven are seen to be in broad agreement, but HAR 2861 is anomalous.

Figure 78A also shows the dendrochronological dates obtained in 1971 and 1978 (above); the estimated felling range for both was AD 855 ± 9. It will be seen that this falls within the 1-sigma probability in all except the anomalous HAR 2861.

While the radiocarbon determinations do not afford such a precise date as the dendrochronological estimate, they do indicate the broad contemporaneity of six of the seven samples, which include material from contexts not sampled for dendrochronology.

It is also of interest to be able to compare a range of radiocarbon determinations with that obtained by another technique. The degree of correspondence between the two is also shown on Figure 78b, a series of 'battleship' or 'equal area' curves. Such drawings are a way of giving an immediate visual impression both of the range covered by a radiocarbon determination when calibrated, and also of the dates where the true value of the determination is most likely to lie.

The drawings are called 'battleship' curves because some of them look like battleships seen from above. The wider apart the two edges of a curve are, the more likely that the true date lies at that part. The curves normally widen near the centre, and taper to a point at each end. Each curve extends over the full range of 99% probability: that is, there is only 1 chance in a 100 that the true date lies right outside the full length of the curve plotted.

These may be compared with the 1 and 2-sigma probability ranges (68 and 95% respectively) shown on Figure 78a; and indicated on Figure 78b by whiskers.

# 4 The Mill: Construction and Reconstruction

**(addenda in MF)**

## *Introduction*

Earlier attempts at reconstruction of the mill by Daryl Fowler and PAR were published in the 1970s (Rahtz and Sheridan 1971, 1972; Rahtz 1976, 93, figs 2.18-19).

In 1979 F W B Charles was commissioned to make a feasibility study for a full-scale working reconstruction in Tamworth. His drawings form the basis for Figures 95-100. Models were also made (MF Pls XXV-XXIX) and a full-size replica of a wheel-paddle (Pl XXI).

## *The evidence and its problems*

The plans, sections and axonometric diagram of the structure in this report (Figs 79-91) are based on Fowler's original drawings, with modifications based on alterations in the base plan and sections and on PAR's current interpretation of detail.

Figure 79 is a reproduction of the basic plan of the second mill, without the sub-structures and detail of feature numbers, etc. Figures 80 and 81 are restored plans of the wheelhouse and millpool, and of the millhouse above.

On Figure 80, the timbers are shown in their estimated original position, before they had been canted over by soil pressure from the north-west. This applies especially to the north-west side of the wheelhouse and the outfall revetment. To this framework are here added the restored westerly timber of the south-east side of the wheelhouse, and the south-east side of the millpool. On this is superimposed the hypothetical position of the wheel-assembly and sole-tree, and the outline of the two chutes, the latter based on the emplacements in the mill timbers, with a hypothetical extension towards the wheel.

The size of the wheel is given within certain limits by the archaeological detail of the gap in the floor sands and in the destruction levels (above, 2.4), and by the size of the paddle; 12 paddles are shown here, which appears to be an appropriate spacing (it could, however, be closer); the closely analogous Moycraig wheel (Fig 103) has 18 or 19 (Goudie 1886; Green 1963, fig 86; now in Ulster Museum).

The wheel as shown here has a total diameter of 1.22m. The Moycraig wheel was only c l.0m, making the paddle spacing even closer. The paddle spacing at Tamworth, and the diameter of the wheel-assembly, and that of the main shaft, were agreed by Charles on the basis of his calculations and his extensive knowledge of both mills and timber technology.

The sole-tree's position in relation to the wheel-assembly is fixed in that the bearing in it has to be under the centre of the wheel; this brings one end under the paddles. In this report, the sole-tree is restored to a north-west to south-east position, at right angles to the water flow. Philip Dixon points out, however, that in two of the parallels we illustrate (Figs 62 and 105) the sole-tree is in line with the water-flow. While this is a possibility, we would still place it at right angles, firstly because of the position of the wheel off-centre in the wheelhouse. This allows space in the millhouse floor for the lightening-tree as shown on Figure 80; and secondly, that a north-east to south-west orientation would bring it very close to the line of the projected position of the driving chute.

In our reconstructions, the sole-tree would be attached to a bolster at its south-east end; this is a support with a flexible joint allowing it to move freely within certain fixed limits. It has to be remembered that the wheel-assembly carried on the sole-tree, as seen here in plan, is *above* the floor, possibly some distance above, and the bolster would thus possibly be protruding from the south-east wall of the wheelhouse with a space between it and the floor (Fig 94). This would account for the absence of any evidence for its presence. The mode of fixing the bolster to the mill wall, strongly enough to support the weight of the wheel-assembly, etc, is problematical; it would be even more difficult if the sole-tree were at right angles to the water-flow.

The pattern of the sands here is around the wheel; the floor boards (not shown in this plan) were bare under the wheel; this area would have been kept clear of sands by water falling from the paddles as each went its way The 'tail' of the gap in the sands is convincingly interpreted as the 'throw' of water off the south-east side of the wheel.

The location of that part of the driving chute which traverses the south-east side of the wheelhouse is of course conjectural. As shown in this plan, it looks convincing in relation to the sands, which begin by its orifice. Its exact location to exercise the maximum delivery of power is a matter for expert opinion or experimental archaeology.

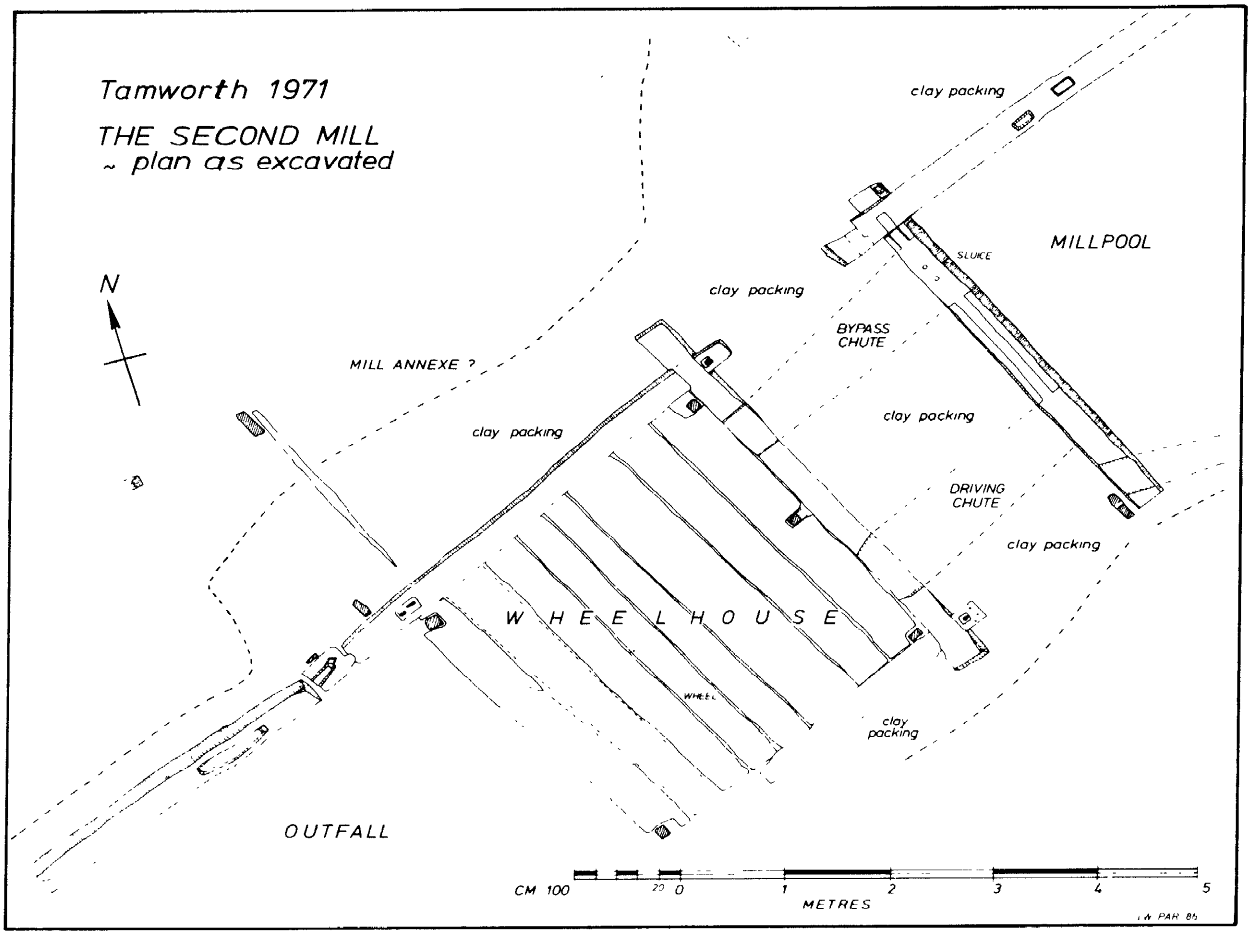



*Figure 79 The second mill: plan as excavated (1971)*

The restored plan in this figure also shows the probable location of the plank walls; some of those restored were found in a collapsed position; these are shown with firm line edges; others which were not found are shown with a dashed edge and are less reliable. The thickness of these plank walls will be discussed further below; they may be too narrow in this restored plan, being based on remains which may have shrunk.

Figure 82 is a redrawing of Fowler's original axonometric restoration of the plan in three-dimensional aspect. Minor modifications and additions to the field plan, based on more recent reworking of the data, have not been altered or added in this drawing, so there are a few minor errors and omissions. The drawing is also to some extent diagrammatic and interpretative, for instance the restoration of the way in which the upright pegs are notched over the sill-beams, which is not explicit in the two-dimensional plans but is based on Fowler's own observations. The drawing still, however, provides a useful illustration of the third dimension missing from plans and sections, and may help to make the structural relationships clearer to the reader. Figures 83-91 show these in more detail.

Daryl Fowler has also, in this drawing, shown reconstructions of two joints in diagrammatic form, that of the west corner of the millpool (A) and the east corner of the wheelhouse (B). A is a half-lap joint, and there is no obvious evidence of it having been secured by a peg in the same way as B. The horizontal hole in the end of the upper timber does not appear to be close enough to the lower timber to have held a locking peg, unless this were considerably larger in its shank than the tongue which passed through the hole. Nor can the rebate on the end of this be explained. It is possible that there were other elements attached to this corner, as was hinted at in the complexity of the robbing holes in this area (above, 2.4); or this may be seen as more evidence of the re-use of timbers; an original location in the first mill may have needed both hole and rebate. Joint B (and this is similar to the north corner of the wheelhouse) does have a pegged joint, the remains of the peg being found *in situ* in a distorted condition.

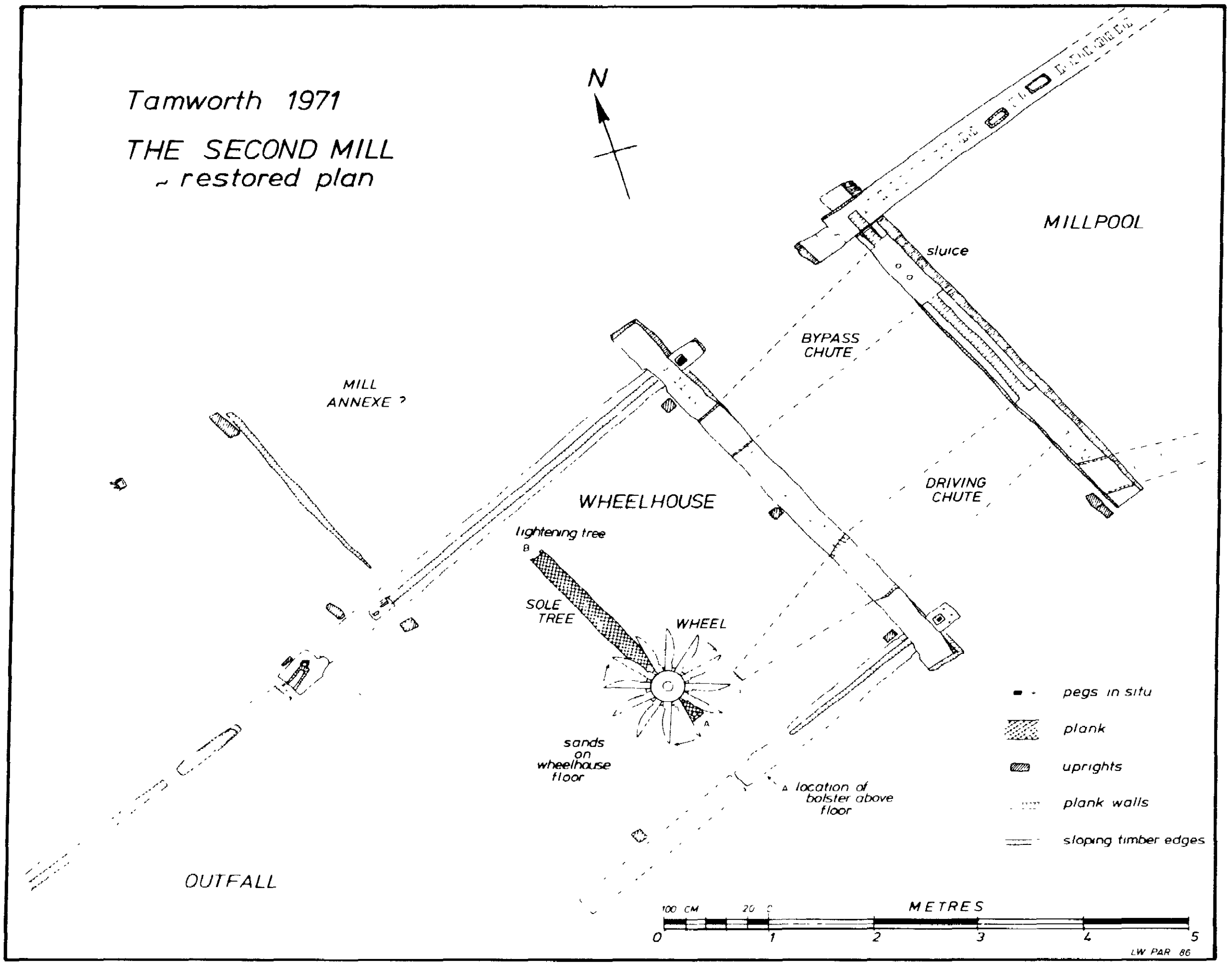



*Figure 80 The second mill: restored plan of wheelhouse and millpool*

Before passing on to discuss the problems of reconstruction of the mill building, it may be worth completing the discussion on what was actually found, as a commentary on the structural remains; this is related to the numbered plans on Figures 31 and 32 from left to right.

In the outfall area, timber 173 is a substantial ground sill foundation for the revetment of the cut-away edge. The fallen plank, 151, has clearly fallen off this; a detached fragment, 151a, is in a mortice hole. With regard to such horizontal planks there are two problems: were they ever substantially thicker? and how were they supported? If they were more or less the size as found, allowing for only slight shrinkage, then they are not the kind of heavy horizontal timbers that would go towards making the kind of wall that Charles envisages in his reconstructions (below). In this case the plank fragment 151a in the slot shows one way in which some support was given; a major upright support must be envisaged in the slot in 185a, with a possible extra support to the north-west (185b); and there was presumably a further upright to the south-west beyond the point where 173 is broken off. What is not known is how the horizontal plank was fixed to these uprights; or whether there was more than one (the height of the cutaway would seem to require at least another); and how in this case the upper plank was fixed in relation to the lower. Did it overlap, as in horizontal weather-boarding ('shiplap') (Fig 92) or was one plank directly sitting on the other linked by tongue and groove, as in Charles' reconstructions? Were wooden dowels used?

The outfall revetment was probably no more than this; even if there were, as seems likely, another wooden wall on the south-east side (in what was probably a rather shallower cut) there is no reason to believe that these two walls carried a superstructure, though this is not impossible (note post hole 284/5 for a possible central support).

However one envisages the walls of the outfall, the surviving timbers and slots on the surviving north-

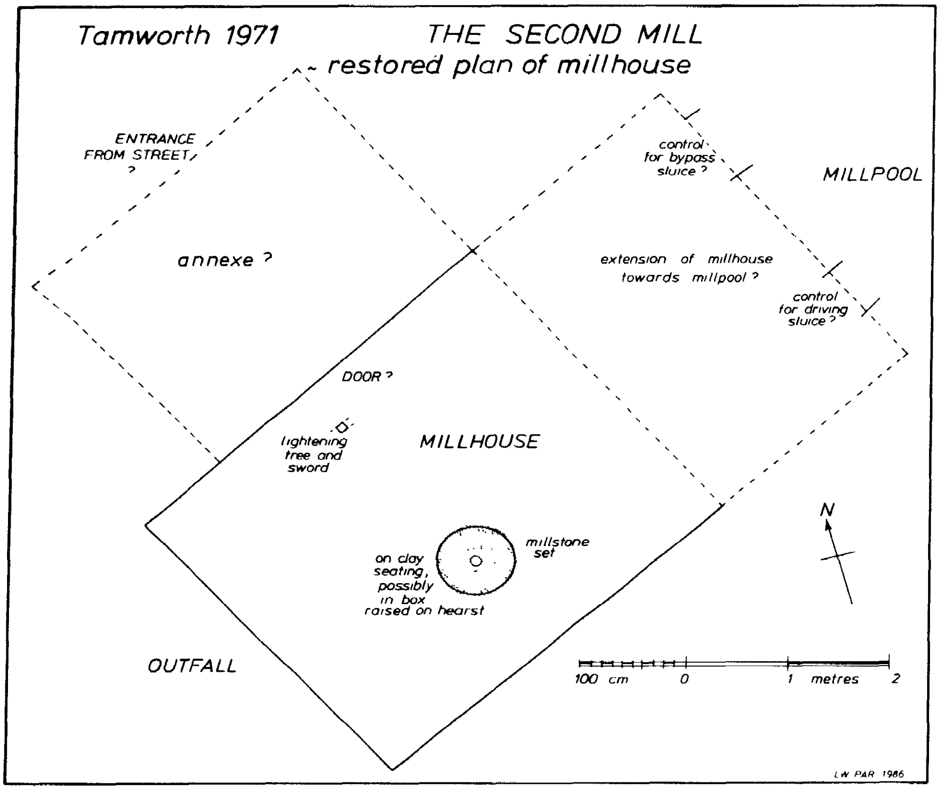



*Figure 81 The second mill: restored plan of millhouse*

west side do not seem to be a very regular arrangement: again it looks as if they were not custom-built for this purpose, but have been re-used from an earlier structure.

In the wheelhouse area, however, there certainly was a superstructure, the millhouse, firmly separated from the wheelhouse by a substantial and waterproof floor. Such a two-storey arrangement is a *sine qua non* of this kind of mill. The superstructure here was clearly carried on substantial upright posts; remains of five were found, one at each corner of the wheelhouse and one inside the north-east wall at its centre point. There may have been a sixth inside the centre point of the south-west open side of the wheelhouse (where there was of course no foundation timber, since the water had to escape freely in this direction). If this sixth post had existed, it would have been completely destroyed by the modern well.

Of the five surviving posts, the two northerly ones helped to hold the main foundation timber 185 in place, and also were, in Fowler's view, notched over this to give support to the horizontal plank wall 126 (Fig 87; Fig 86, S23). A further upright, 186d, gave some support outside; the south-west end of the plank wall was presumably also tied in to a plank in a mortice hole at the south-west end of 185. This north-west wall was presumably carried up in several planks to the height of the wheelhouse and beyond, again either in a continuous wall or overlapping. Again the mode of fixing the planks at each end is unknown — there are no mortice holes at the north corner where the plank wall turned south-east; again perhaps there were dowels.

The foundation timbers of the north-west and north-east walls of the wheelhouse were held together by a complex locking joint (Fig 82). This is a type of mortice and tenon; the shoulders are rebated into the receiving timber and the tenon passes through, held by a stout peg. This would have tightened the joint, drawing the shoulders into the rebate increasing the mechanical strength and making it less liable to erosion. The north-east wall, 166, carried short lengths of plank wall (129, 295, 167, 293) in between the large chutes; a slight groove in the surface of the centre part of 166 may have been deliberately cut to slot the central plank in. The central upright 271 gave support to this wall and to the foundation timber itself; it had moved out of vertical and been wedged by a small timber (see Fig 82).

The south-east foundation timber 131 was locked to 166 in a similar way to that of the north corner; there were here also the remains of plank walls. The south-west half of this side was destroyed, but

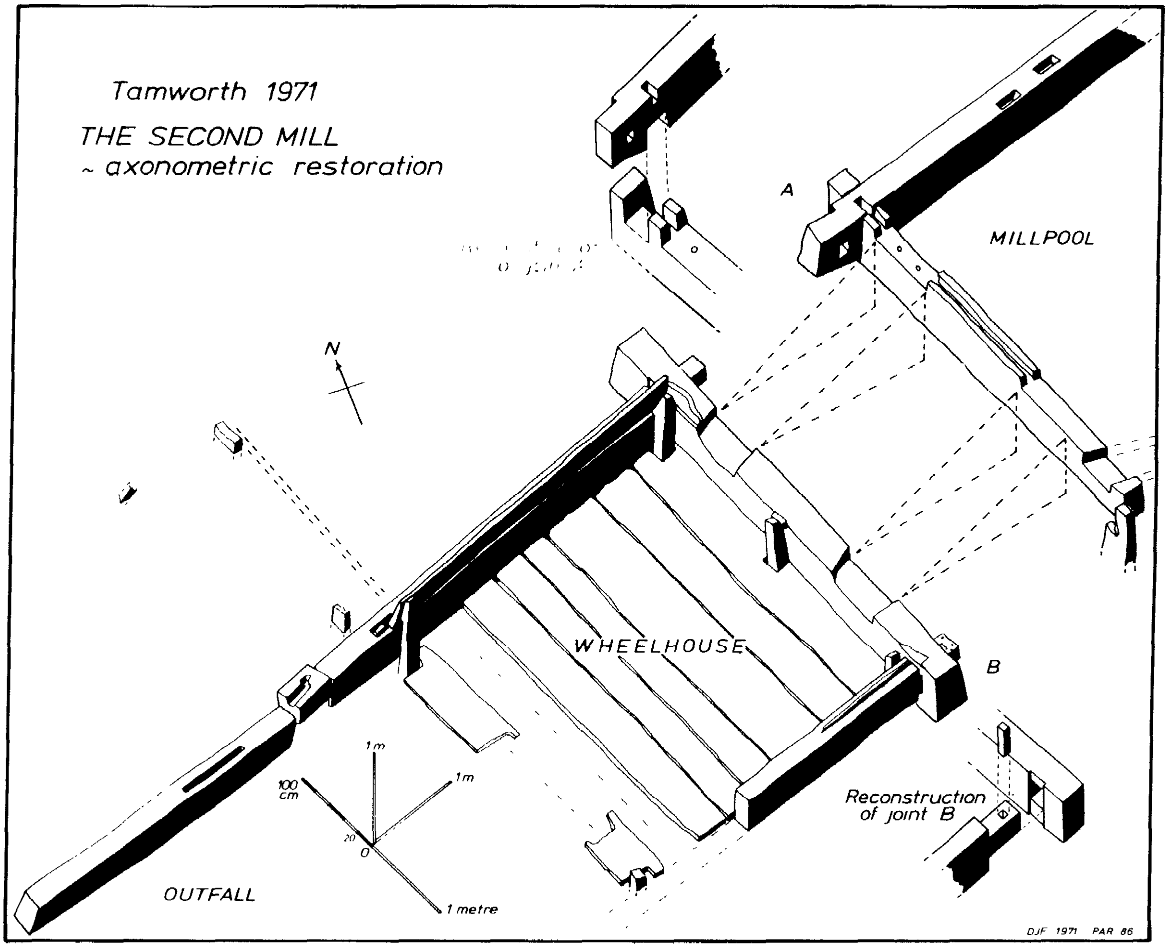



*Figure 82 The second mill: axonometric restoration*

the corner post stub survived (244).

The floor of the wheelhouse was one of the best survivals of the second mill. 177 had been a continuous plank whose middle was cut away by the well. The plank to the north-east of this must have been removed bodily at the same time as the well was dug, since the concreted sands around the wheel (above, 2.4) were left 'suspended' in position. The most south-westerly plank 177 was cut away for the uprights on either side; it may have been the last floor plank, or there may have been more to the south-west, as the sub-floor planks (re-used from the first mill), might suggest.

Of the millpool's three sides, two remained. The main millpool south-west front foundation timber was fixed to the north-west side timber 161 by a half-lap joint accurately cut to take the batter into account. This timber is taken from a piece at least 45 x 35cm in section; its south-west side facing the mill is nearly vertical, and shows the marks of adze-dressing; the pool side is battered. 161, as already discussed in relation to the axonometric drawing (Fig 82) was probably re-used. It carried a plank wall, parts of which were found in a collapsed state (248-9). There was also an upright timber set in a mortice, similarly collapsed (247), but the way in which this was linked to 248-9 remains obscure. A further mortice hole (see S27, Fig 90) suggests another vertical support, but again there is nothing systematic about the arrangements for this wall; as with the outfall there is no reason to think that the millpool foundations carried any superstructure. The splay on the south side makes any extension of the mill over the millpool unlikely — it would be difficult to roof.

Timber 246 was attached at its other end to the missing third side of the pool by another half-joint (500 in 246). A further upright, 261, with a rebate may have given additional support to this corner (see Fig 82, axonometric restoration).

Timber 246 carried the millpool ends of the two chutes, and in the space between them, and on

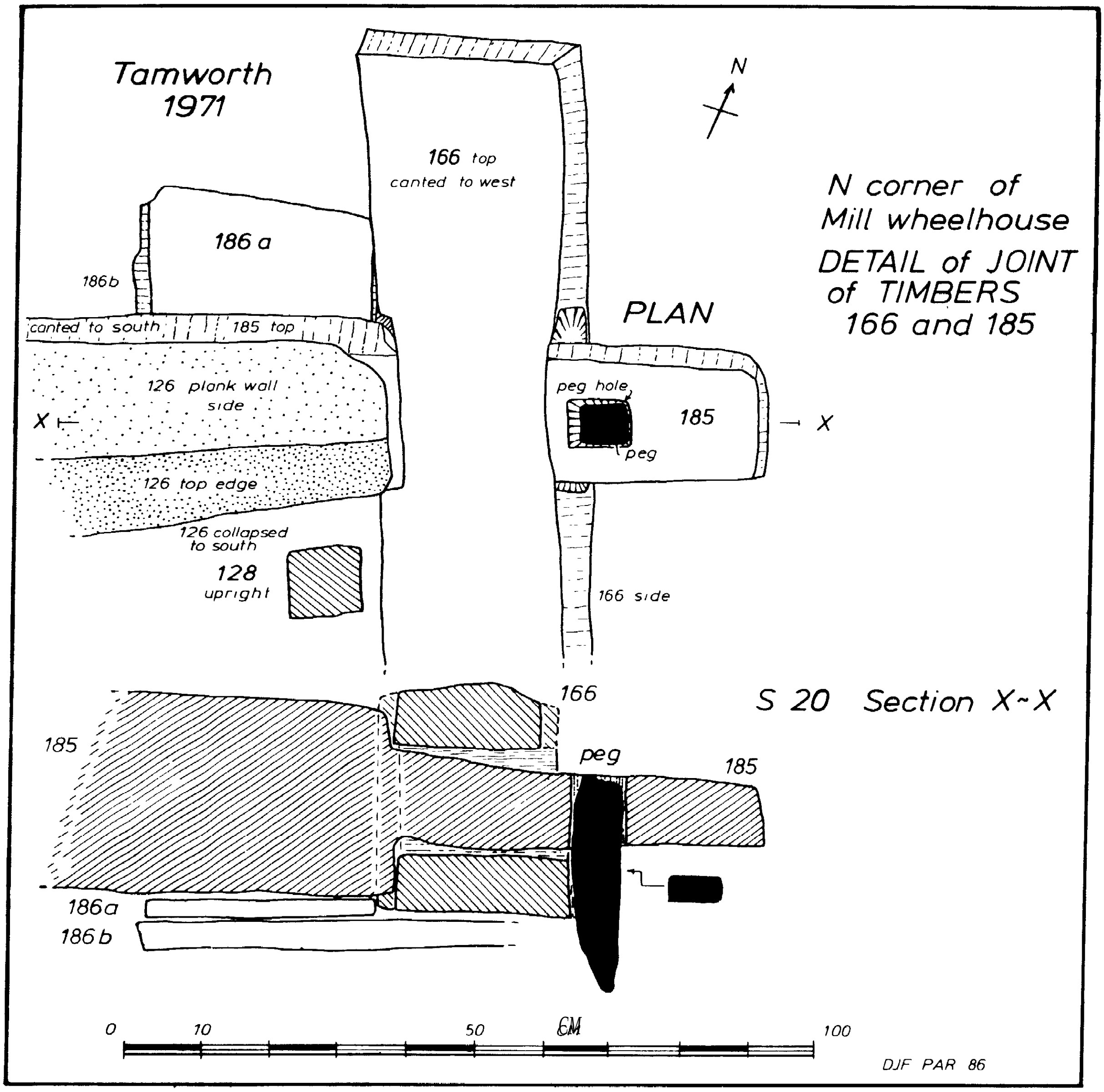



*Figure 83 N corner of mill wheelhouse; details of joint of timbers 166 and 131, in plan and section S21*

either side, plank walls. A carefully cut seating for these survived at the north-west end, extending into a mortice cut in 161; there was probably a similar arrangement at the south-east end. In the centre there was another cut seating for a plank. These elements of the front wall of the millpool may have been more substantial than the plank walls elsewhere, since they had to retain water.

There may have been only one plank in each of these seatings, or there may have been another, or more, on top of it, perhaps dovetailed together at the corners. The height of this wall determined the level of the water; the problems concerning this are discussed above (2.4).

There remains to be discussed the substantial plank extending northwards from the west corner of the mill (190b) and the large upright at its end (190a). These are interpreted as the south-west side of a structure extending northwards from the millhouse at the same level as its resumed floor; the north-west half of 190b is on the level ground above the wheelhouse cutaway; its south-east end would join the millhouse at *c* 70cm+ above the wheelhouse floor. There was no evidence for the

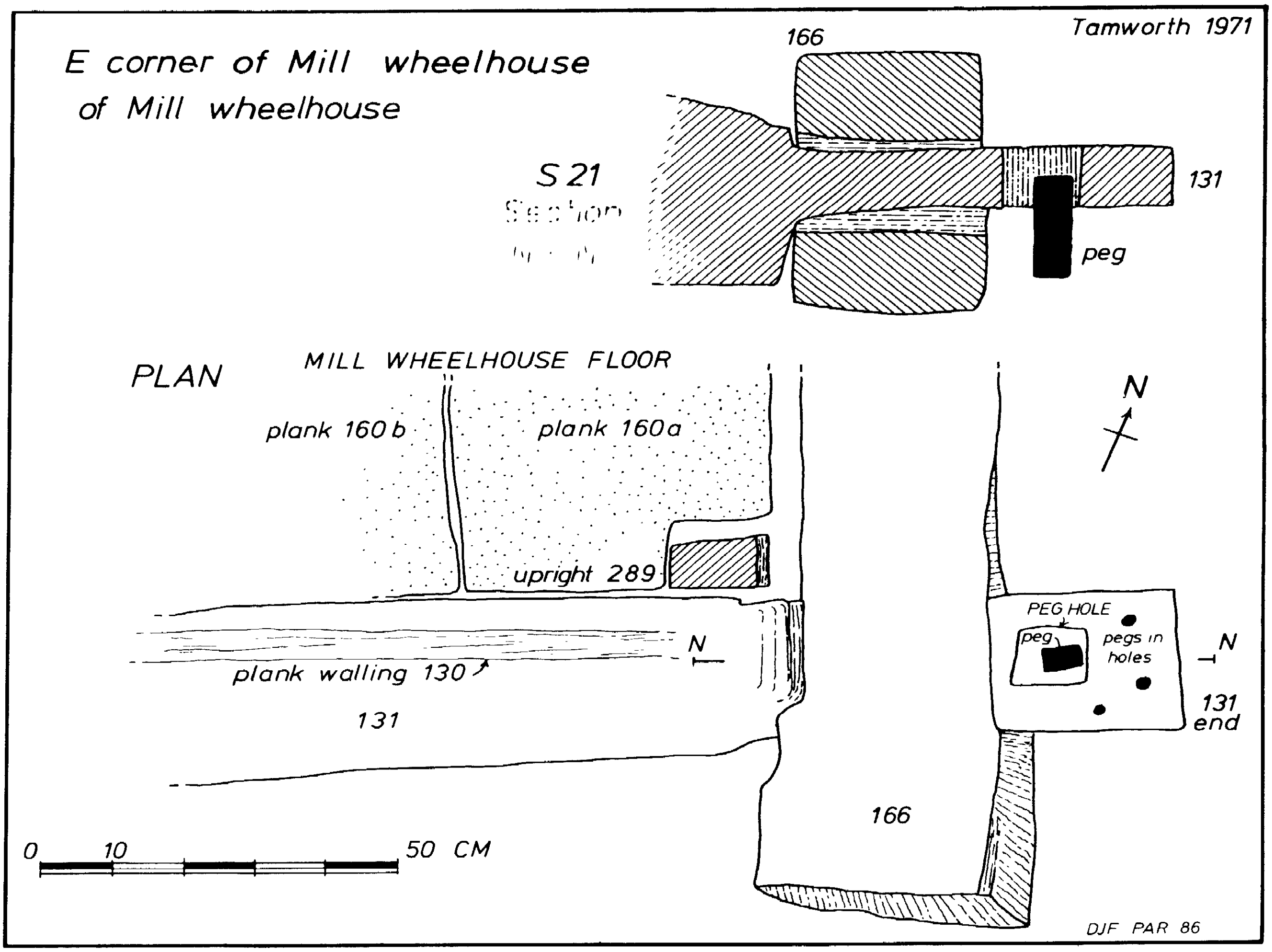



*Figure 84 E corner of mill wheelhouse; detail of joint of timbers 166 and 131, in plan and section S21*

north-east side of this structure, but it would have been slightly upslope and more vulnerable to destruction. It would presumably have been by the north corner of the wheelhouse — it is probably relevant that this is close to the point where the wheelhouse cutaway swings north as the cutaway for the leat/millpool area (Fig 31).

One final point should be made about these plank walls, both those in the millhouse and that on the north-west side of the millpool. However they were supported or joined, or whatever their relation was to other higher planks, their outer face was not visible, at least not for their lower metre or so: they were entirely encased in clay.

After this review of, and commentary on, the surviving structural evidence, we may now consider the superstructure at a higher level.

Assuming there was no superstructure above the outfall or the millpool (though there may have been a covering for the former, see Charles' reconstructions below), we are left with the certain millhouse above the wheelhouse, and a probable extension or outshot to its north-west. The millhouse may have been of a similar area to that of the wheelhouse, or it may have extended north-east to end at the front of the millpool. The advantage of this would be that it might then be possible to control any sluice machinery for the driving or by-pass chutes from the millhouse without having to go outside or employ a third party.

The rebate on the south-west end of 161, and the lateral hole through it, which have no obvious relevance to the surviving structure, were considered in the discussion above (2.4) to be possible evidence of this timber's re-use. They could be seen, however, as providing a basal joint for the north corner of the millhouse; as might the rebated upright 251 in the south corner of the millpool. The alternative spatial arrangements are illustrated diagrammatically on Figure 92.

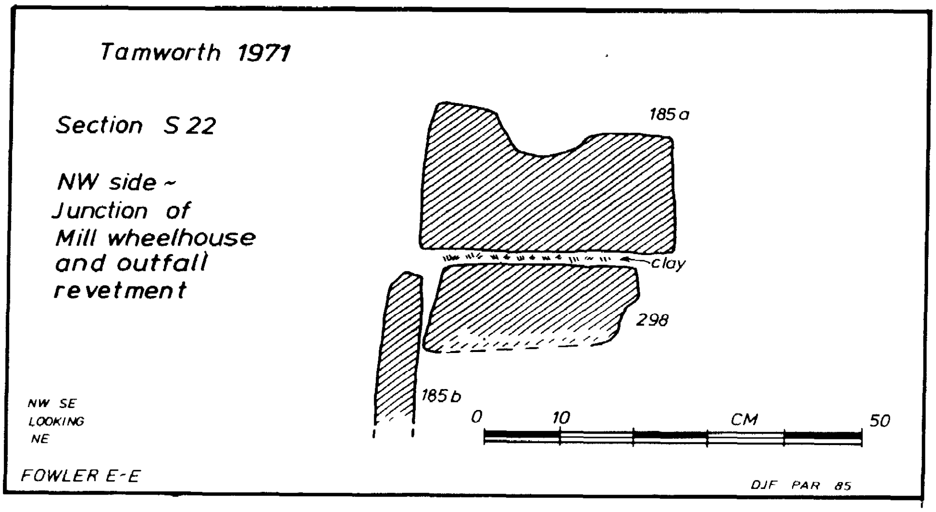



*Figure 85 Junction of mill and outfall revetment; section of timbers S22*

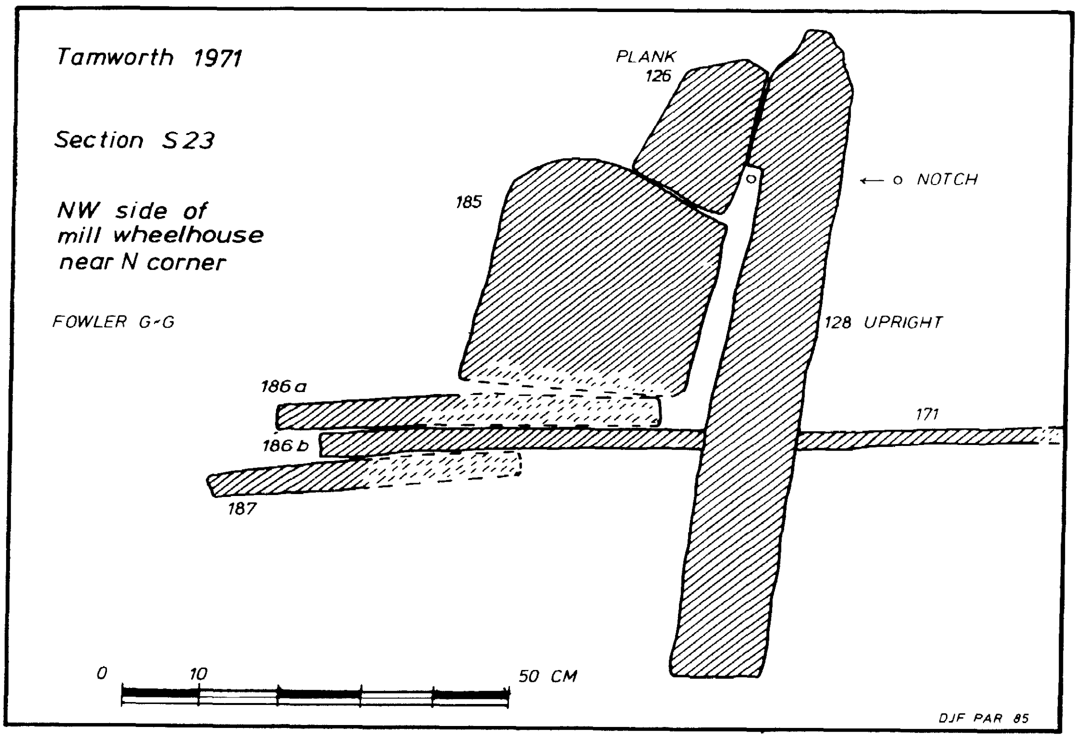



*Figure 86 NW side of mill structure near N corner, section of timbers S23*

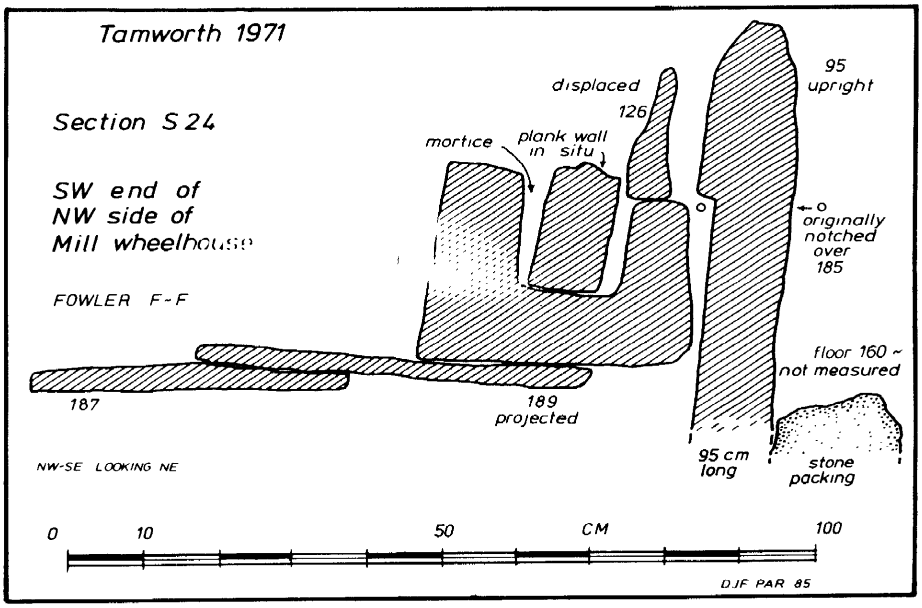



*Figure 87 SW end of NW side of mill structure, section of timber, S24*

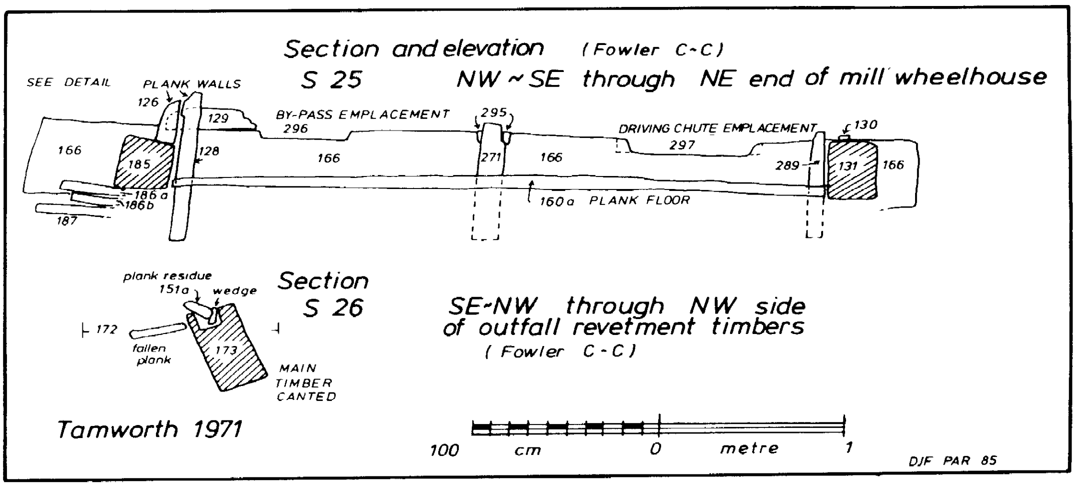



*Figure 88 NW-SE through NE end of mill wheelhouse, section and elevation S25; and SE-NW through NW side of outfall revetment timbers, section S26*

In either case, the height of the wheelhouse must be considered. There would have to be enough space in the wheelhouse for the wheel-assembly and other fittings to move freely, and space to maintain them. The height is probably indicated within close limits — by the depth of the cutaway area, which was probably determined by the height the wheelhouse had to be. The millhouse itself will have had a sub stantial floor and it is suggested that this extended at the same level into the annexe or outshot to the north; and that the entrance to the mill was on this north-west side, approached from Bolebridge Street.

The alignment of the roof is uncertain. Assuming it was gabled, the orientation of the ridge could be either south-west to north-east, the gables facing towards the outfall and millpool; or north-west to south-east, with the gables facing the street and river. The former arrangement would seem to be the easier, and is that chosen by Charles. The centre post in the north-east side of the wheel-house would then be under the ridge (see Fig 92 C-F for these alternatives).

The cladding of the millhouse may have been like the wheelhouse, either shiplap horizontal

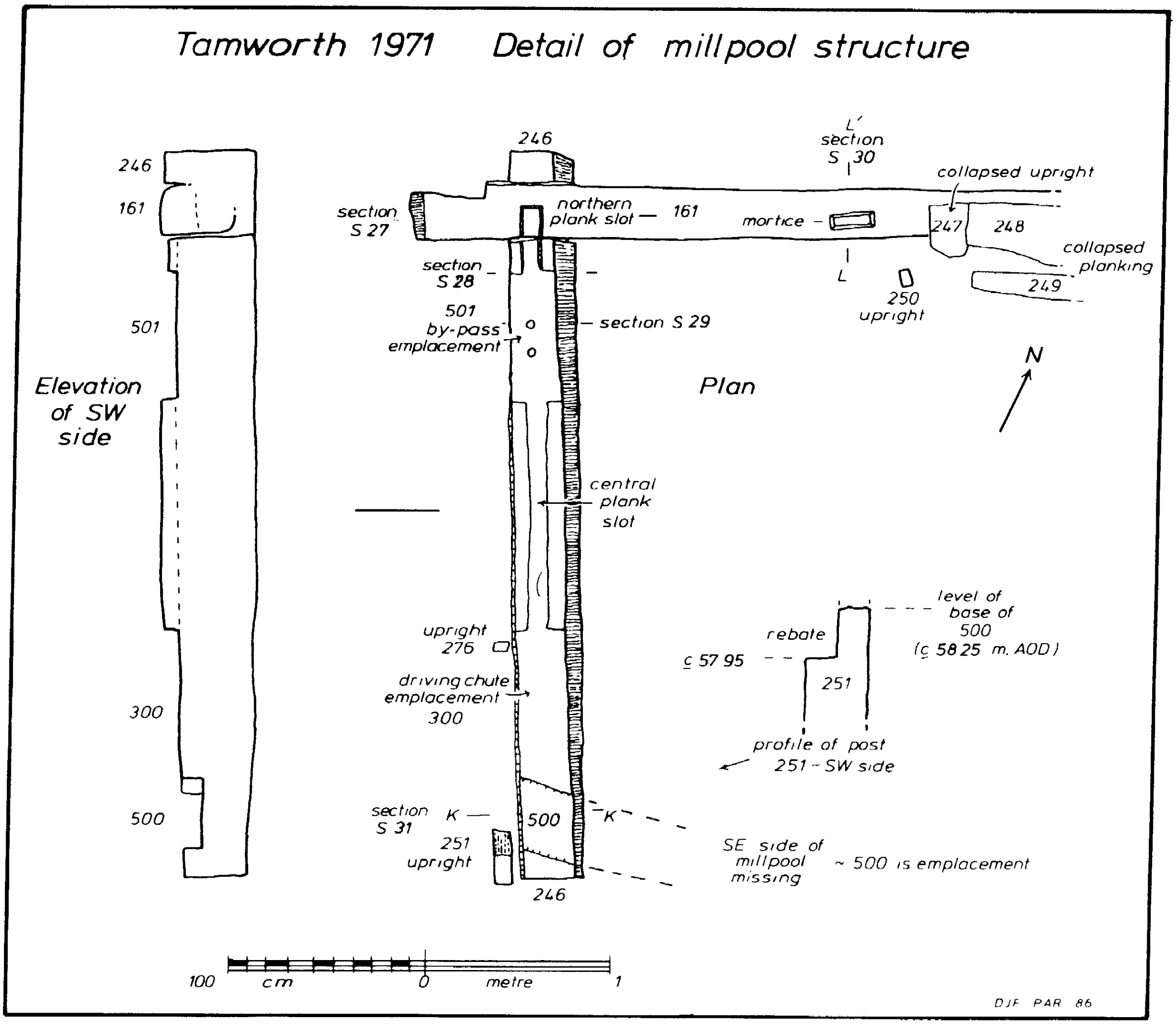



*Figure 89 Detail of millpool structure; NW and SW walls and other features*

boarding (Fig 92B), or more substantial wooden walls (Fig 92A) as Charles has assumed (Fig 95 a and b). The only part of the millhouse to survive was the plank 152, which was found burnt in the wheelhouse; this has several pegs. It is more likely to be from some internal structures in the mill-house rather than from the walls. There may have been windows of horn (3.10 above).

The use of wattle and daub in any part of the structure can be ruled out, because of the virtual absence of any burnt daub, which would certainly have been found in the destruction levels.

A major problem with all mills is a storage one — for the grain to be milled and the milled flour. In the later mills of the vertical-wheeled type, the grain is hauled up by a gantry, stacked in a third storey, above the millstones, fed down via a hopper to the stones, and then taken away. A third storey to the Tamworth mill is unlikely; there are no cases where one has been found in any horizontal-wheeled mill.

### *Reconstructed sections (Figs 93, 94)*

The two diagrammatic reconstructed sections are based partly on Charles' reconstructions. The general construction of the mill follows his ideas, in matters like the height of the wheelhouse and mill-house; and the hearst, shaft and wheel-assembly are also based on his elegant originals. An annexe is shown in outline on Figure 94 which extends up towards Bolebridge Street. In the wheelhouse the location and height of the bolster is conjectural and left vague; the sole-tree is shown here in its full length, so the point where it is flexibly attached to the bolster is certain. The extent of the clay packing is conjectural. In the millhouse the millstone, rynd

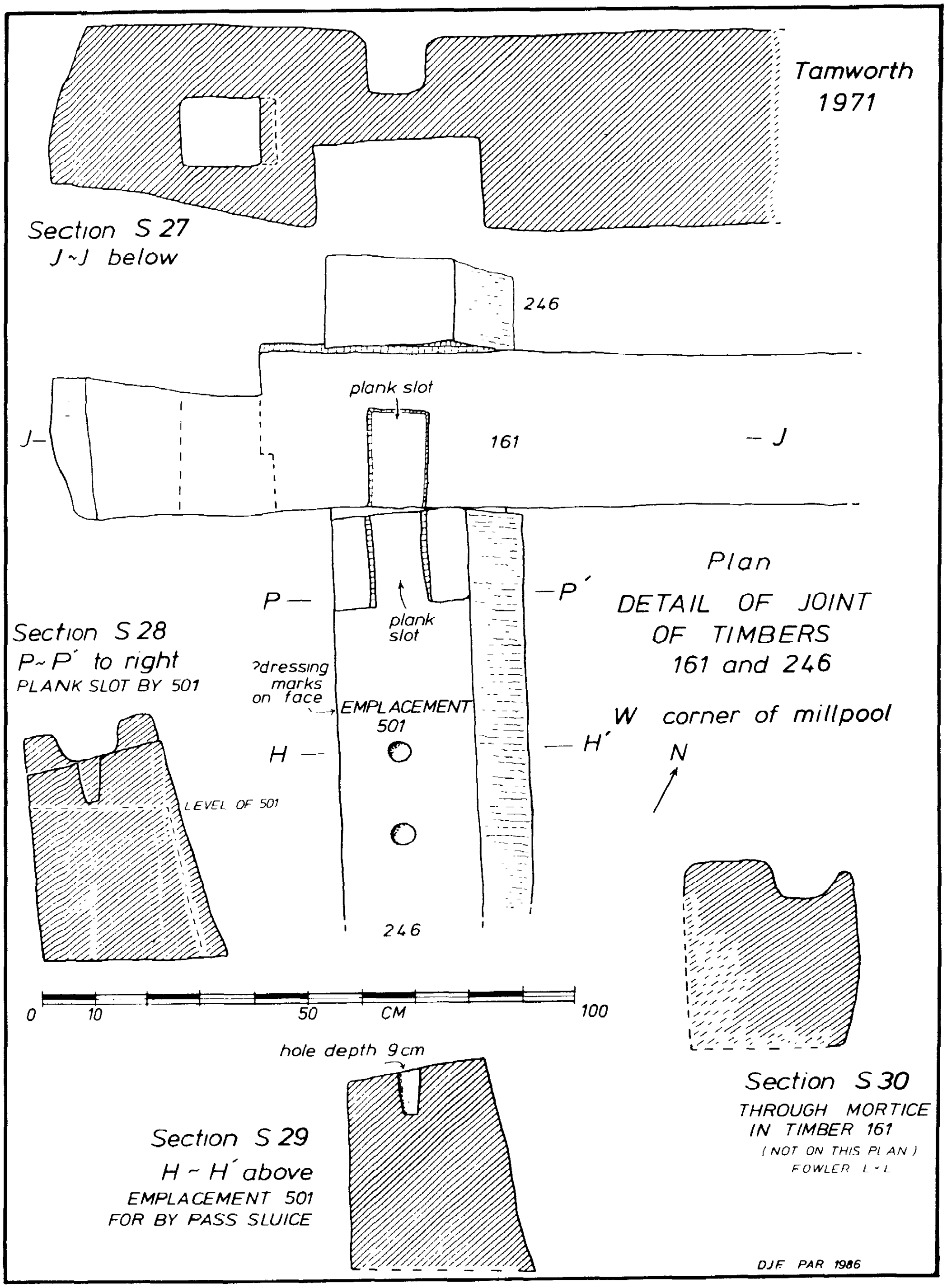



*Figure 90 W corner of millpool: detail of joint of timbers 161 and 246, with sections S27-S30 of both*

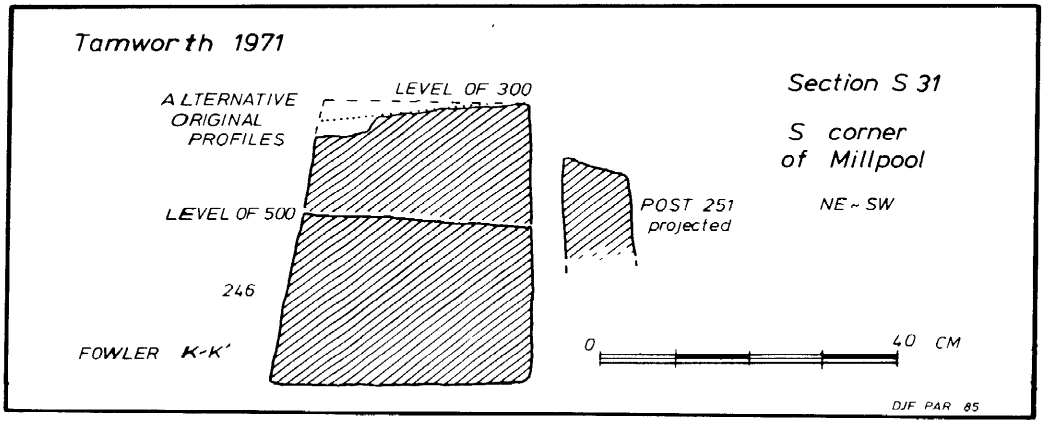



*Figure 91 S corner of millpool: NE-SW section S31 of timbers*

and clay bed are based on the archaeological evidence; no vat or box is shown. The hopper, shoe and damsel or clapper assembly are standard; the hopper would either hang from the roof, or be on a frame. The position of the lightening-tree control (the sword) is certain, but not its shape. A hint is shown of bushes around the shaft where it passes through the ceiling of the wheelhouse and the clay bed and lower stone.

On Figure 93, the wheelhouse is seen with its south-west end open to the outfall. The millhouse and wheelhouse details are otherwise the same as in the north-west to north-east sections. The outline of a possible extension of the millhouse is shown extending towards the millpool, to enable the miller to control the sluices from the millhouse.

The millpool south-west timber is shown in section, at the place where the emplacement for the driving chute was. Assuming a *minimum* thickness of 4cm for the base of the chute (following Charles, Fig 98) (but see 2.4), this gives a minimum height for the water exit at 58.54m AOD. The minimum angle of fall takes the water down to 58.30m, a point just above the base of the wheel-paddles. The latter cannot be appreciably lower than this, if there is to be adequate space below the sole-tree. A steeper angle of flow than this rather shallow one must be assumed by having a much more substantial structure in the emplacement of the millpool, and a correspondingly higher level at the entry to the wheelhouse, to give a fall of at least 50cm, as discussed in 2.4, and as shown by Charles on Figure 90; a gradient of 1 in 8 overall. The level of water in the millpool is shown at 58.90m (cf 2.4).

A further angle of slope is given from B to A below. These represent respectively the base of the chute emplacement in a robbing hole by the millpool, and the level of the base of the emplacement for the chute in the north-west side of the wheelhouse. There is inevitably a good deal of uncertainty about the flow of driving water.

The two sections represent as much as can safely be assumed or suggested without further experimental research.

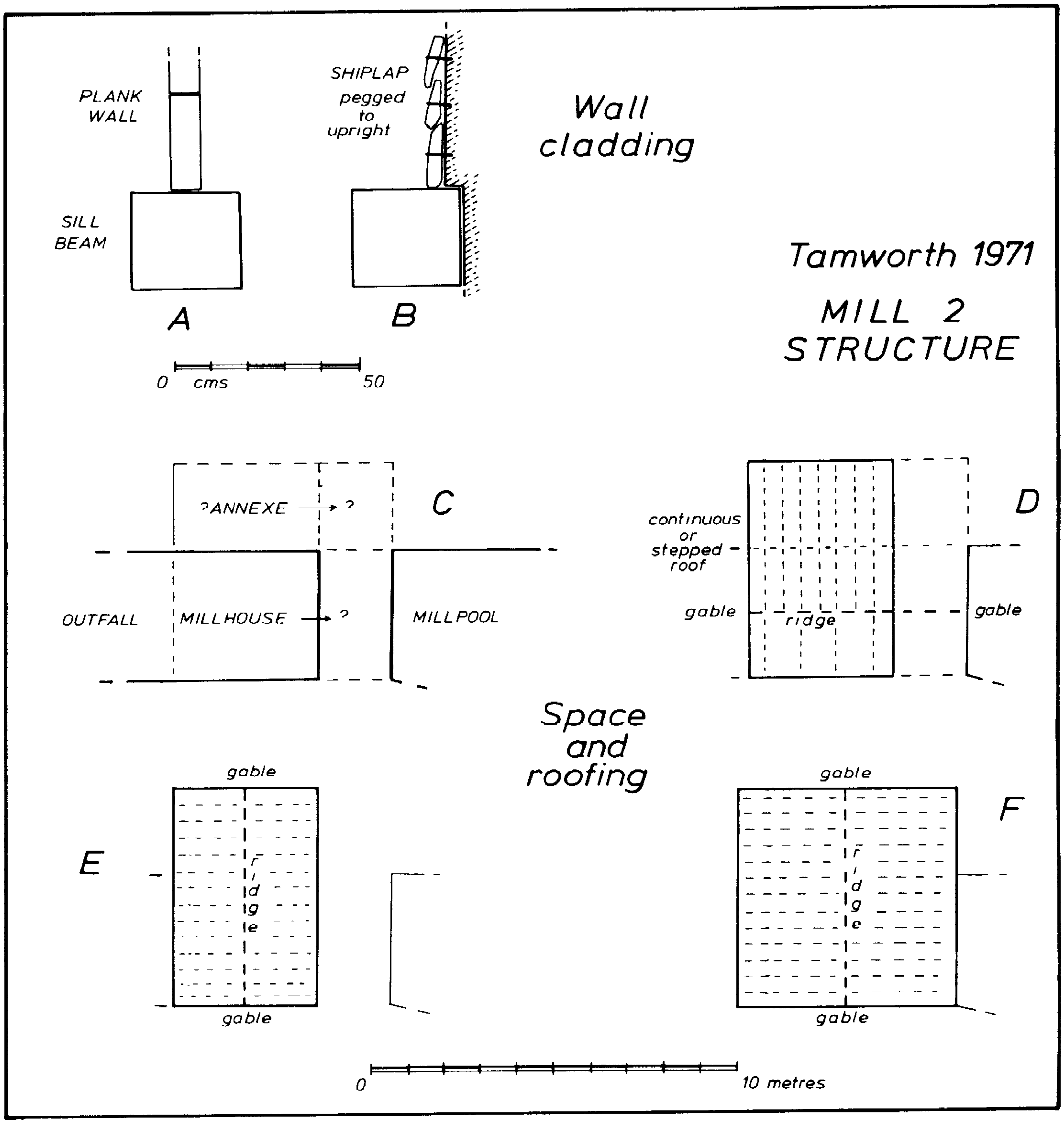



*Figure 92 Mill 2 structure: wall cladding (A, B), space and roofing (C-F)*

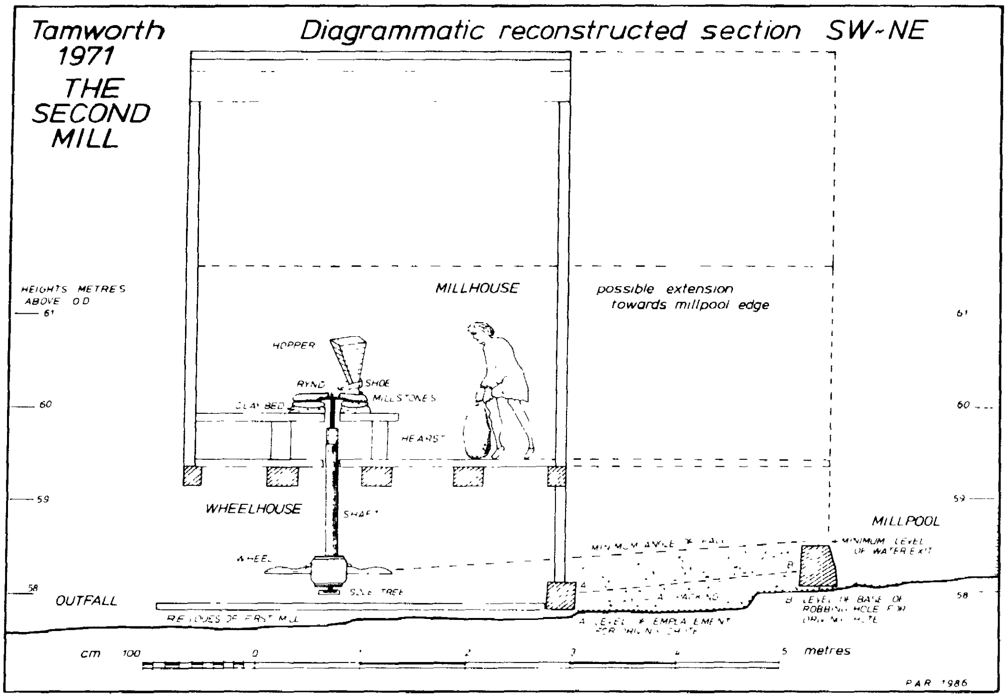



*Figure 93 The second mill: diagrammatic reconstructed section SW-NE*

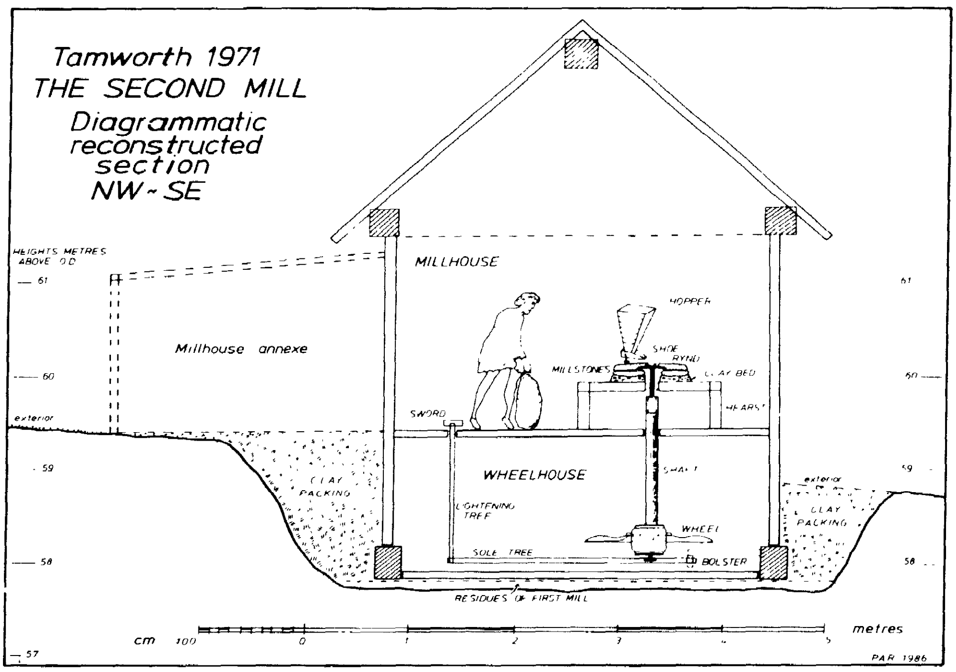



*Figure 94 The second mill: diagrammatic reconstructed section NW-SE*

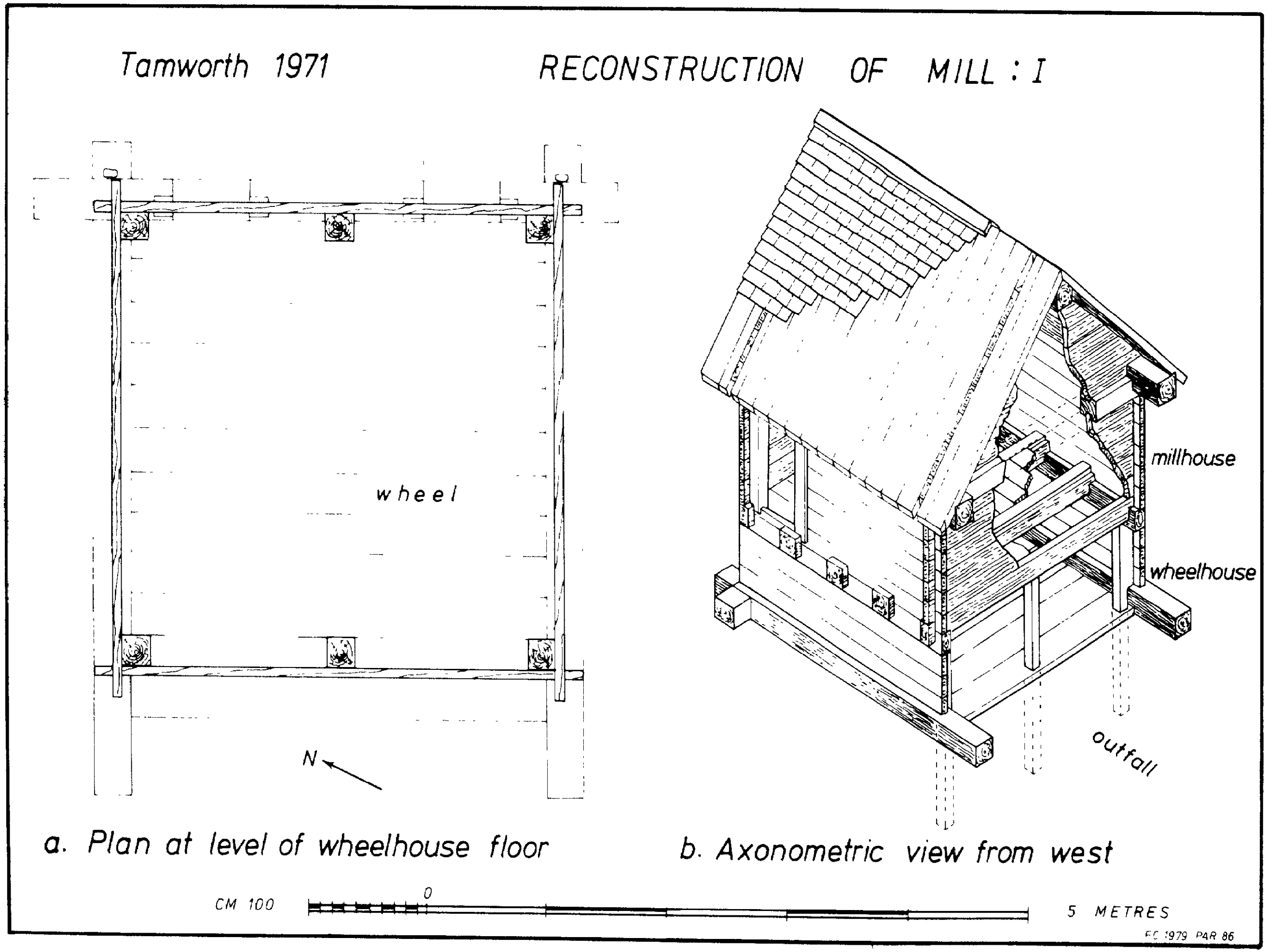



*Figure 95 Reconstruction of mill I: a) plan at level of wheelhouse floor; b) axonometric view of mill from W (F W B Charles)*

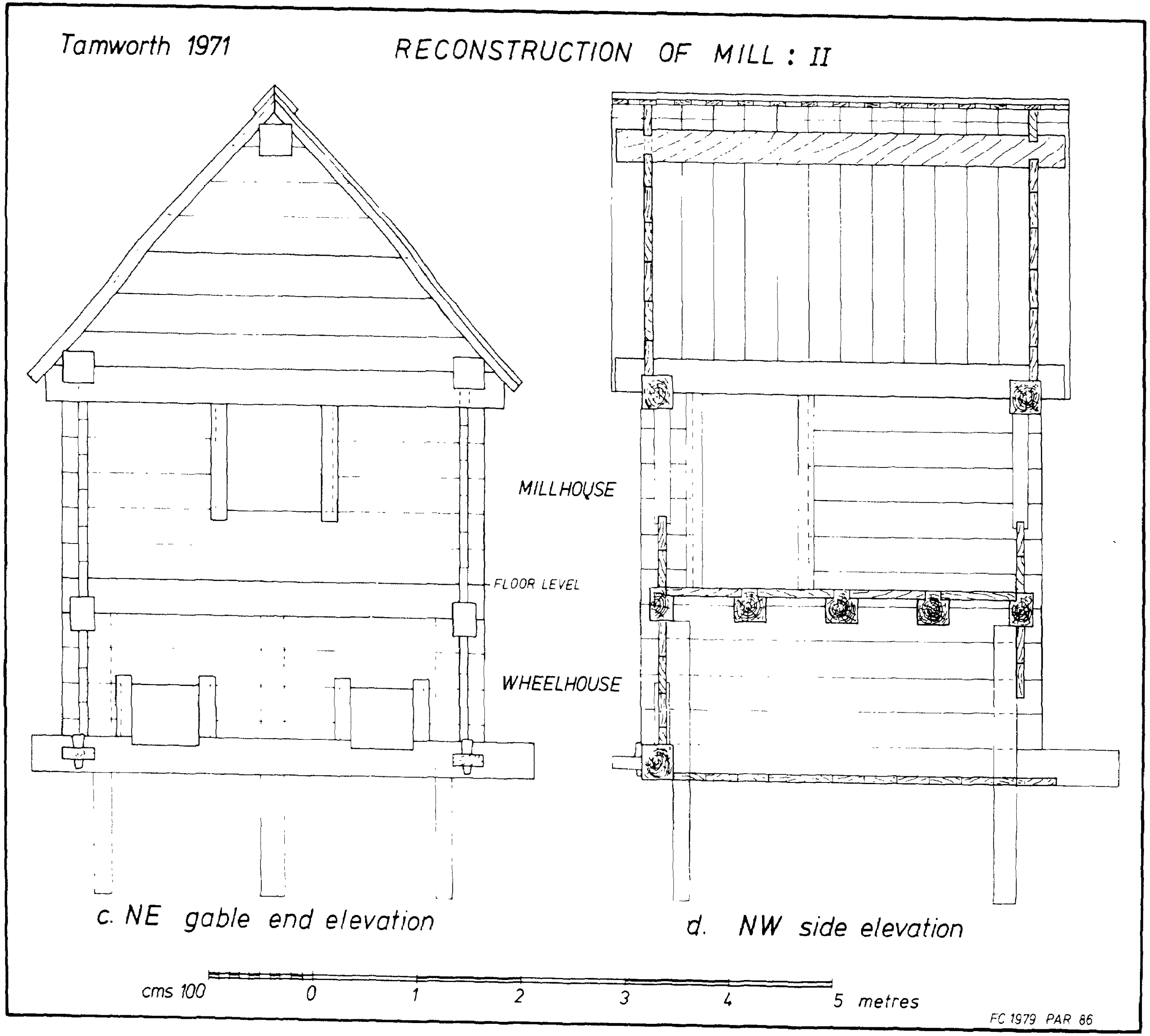



*Figure 96 Reconstruction of mill II: elevations of c) gable end and d) NW side (F W B Charles)*

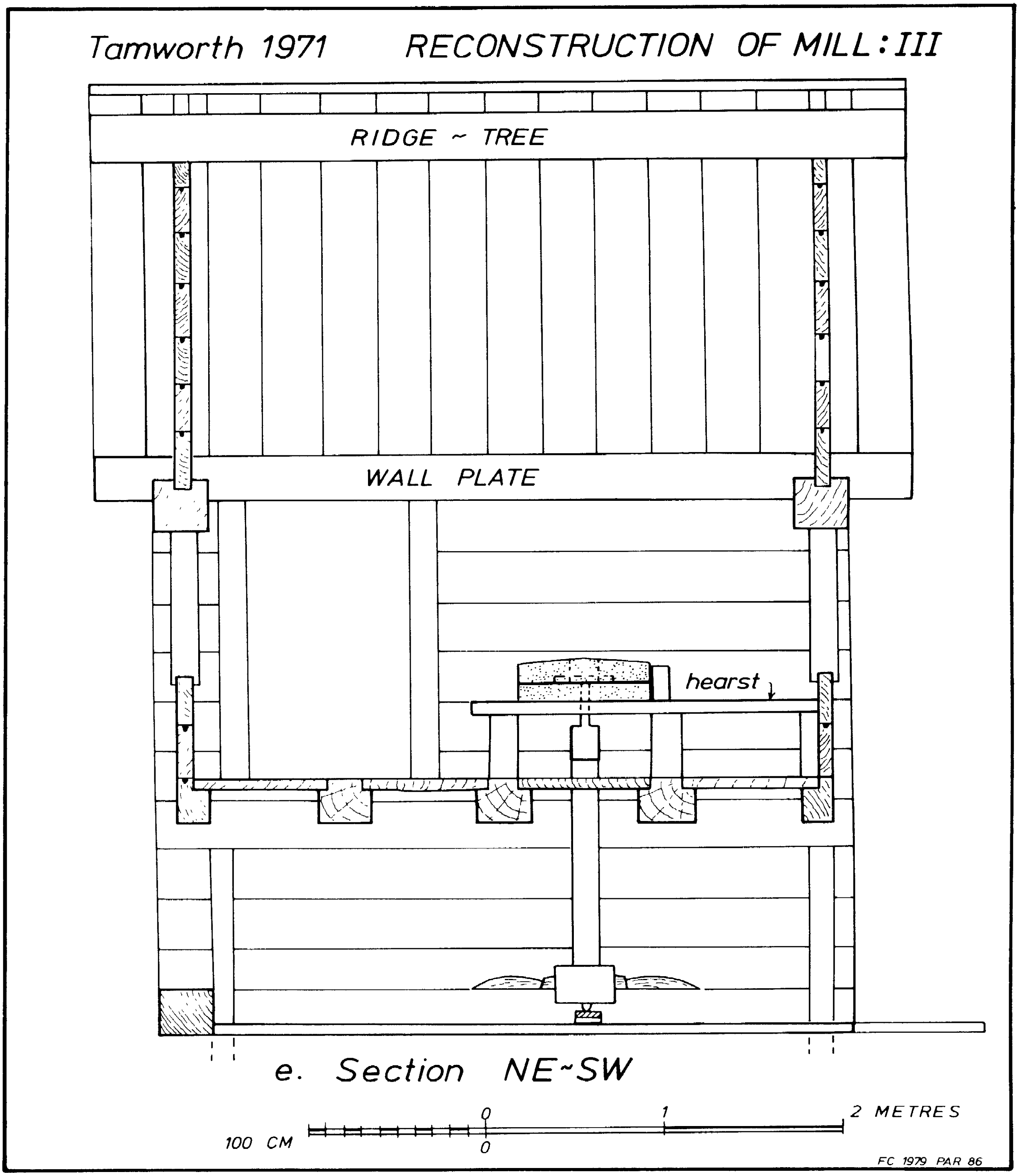



*Figure 97 Reconstruction of mill III: e) section NE-SW (F W B Charles)*

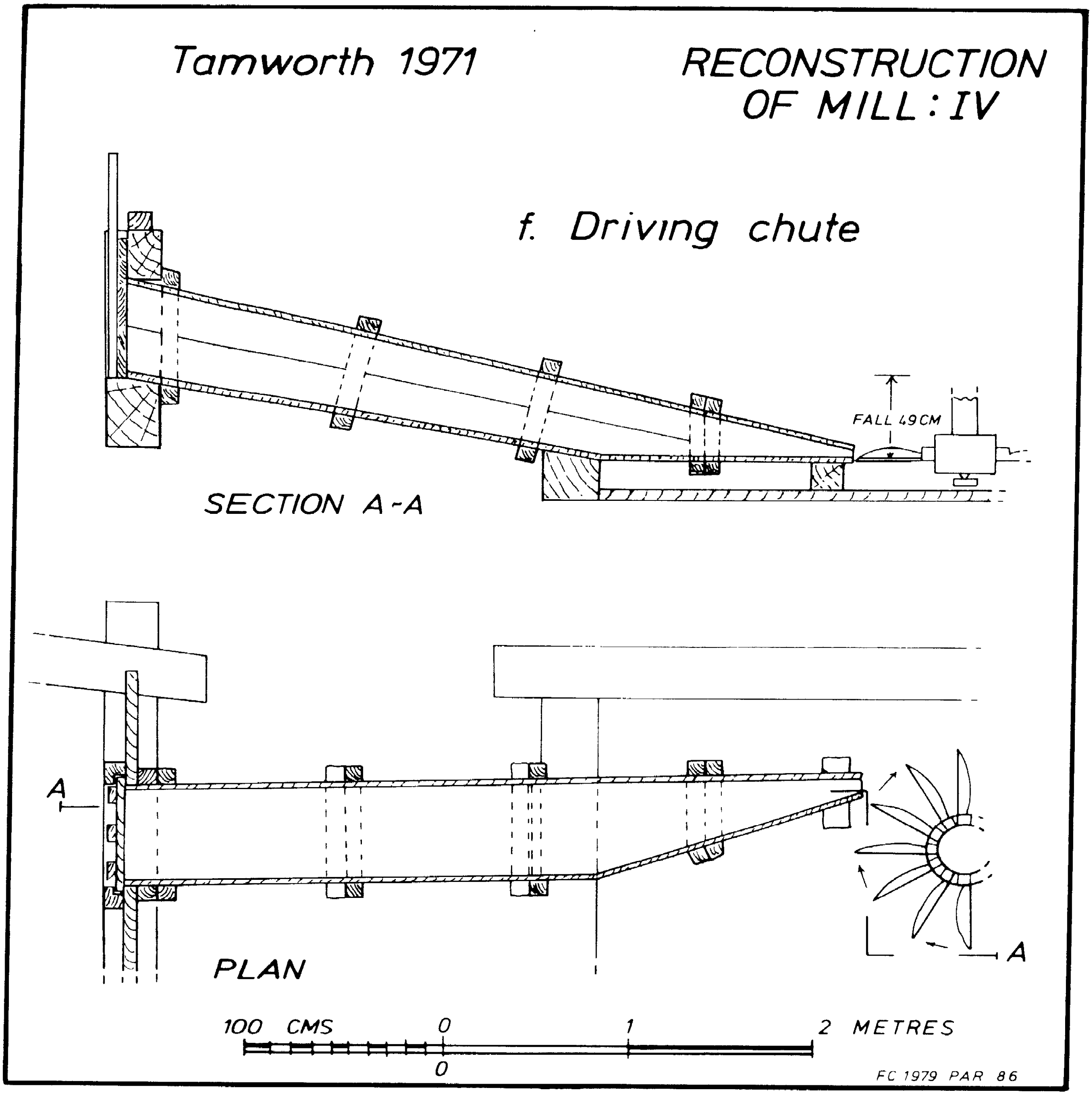



*Figure 98 Reconstruction of mill IV : f) driving chute (F W B Charles)*

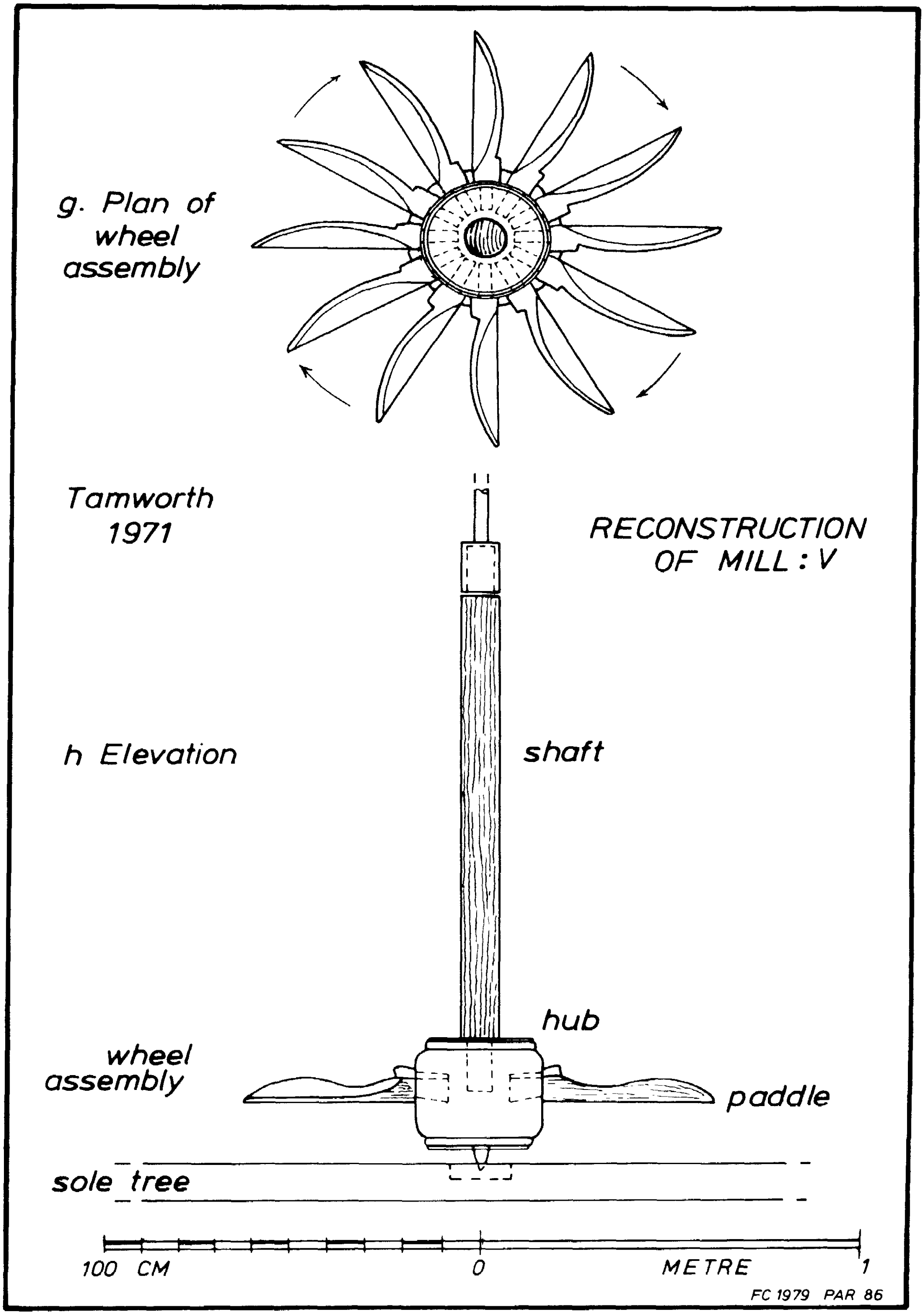



*Figure 99 Reconstruction of mill V: g) wheel-assembly; h) elevation (F W B Charles)*

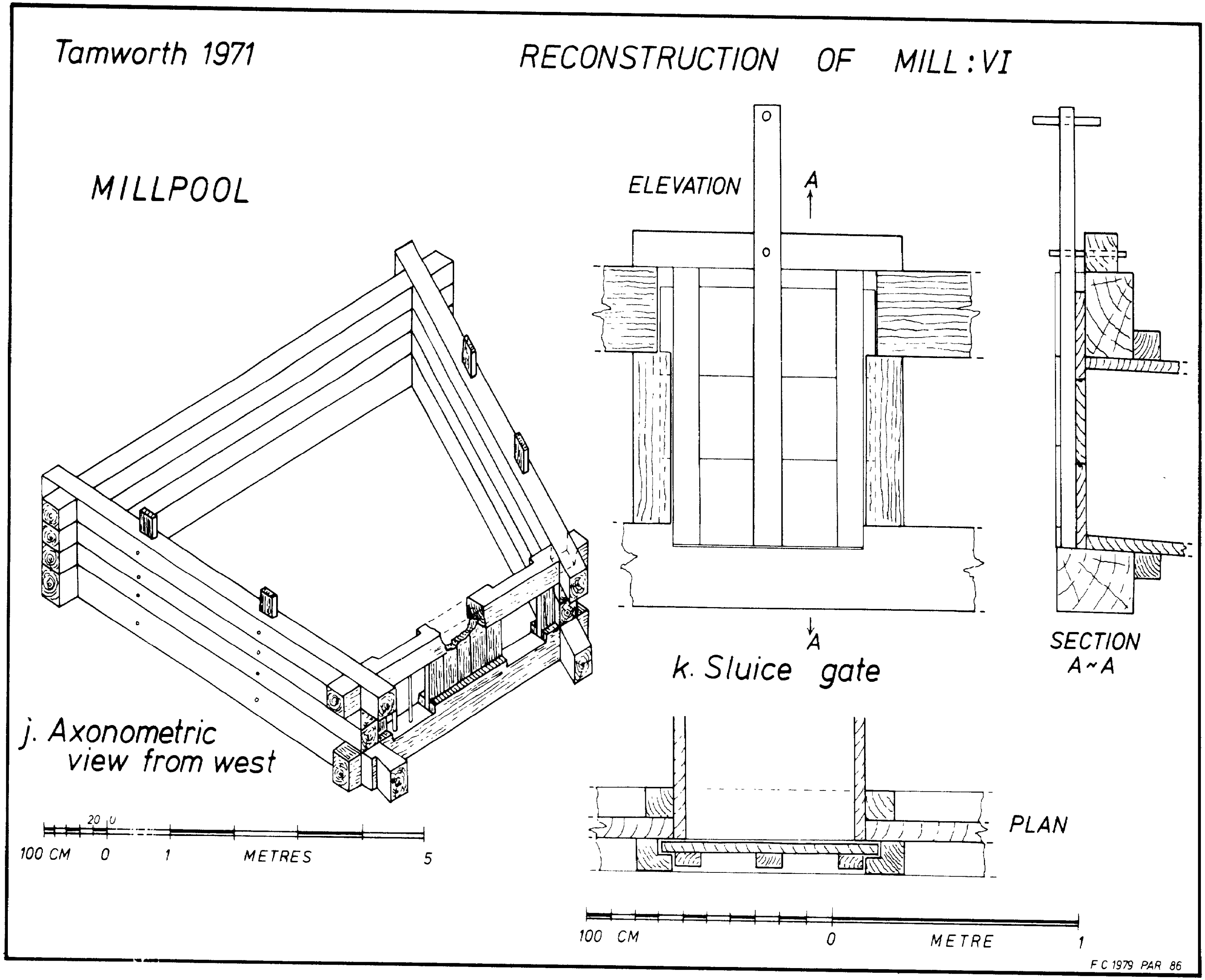



*Figure 100 Reconstruction of mill VI: j) millpool, axonemetric view from W; k) sluice gate*

# 5 The Functioning of the Mill

## The source

A river source for the leat of a watermill obviously provides a constant and prolific flow, varying only in flood and drought conditions. This is in contrast to a mill fed by a-small stream, which may dry up in summer, or whose water volume is so small that a reservoir has to be filled before the mill can operate; this can be observed in the majority of surviving mills of this type in low rainfall countries around the Mediterranean.

Major mills in England must always have been sited to use water from substantial streams or rivers. to ensure a sufficient and constant volume. The mills at Tamworth were presumably sited at the optimum point where (a) there would be the maximum fall from a leat taken off the river, and (b) where the outfall was near enough to the lower course of the river for convenience: but still above any level which might be subject to flooding.

## The leat and entry into the millpool

The relationship between the millpool and its leat is uncertain. What can be said is that the highest water level in the leat can never have been higher than the height of the water in the millpool, otherwise it would have continually overflowed. However, it must be assumed that the water could be shut off from the leat altogether, probably at the point of entry from the river, although it could have been much nearer the millpool, enabling the millpool to be emptied for maintenance.

## The millpool

The millpool level was at a *minimum* height of *c* 58.60m AOD, which is that of the surface of the sides of the plank-slot, in the centre of the south-west edge of the millpool structure nearest to the mill. There was a 10cm deep plank-slot in this timber (246); the plank in this would have raised the millpool water level further by its height; more if there was more than one plank. The north-west side timber of the pool also carried plank walls, and so too would have the missing south-east side. Allowing a single plank with a height of 40cm, this gives a minimum water level of 58.90rn AOD.

The *volume* of water in the millpool was not a matter of much importance, since the river assured a steady supply. Any arguments about the floor of the pool (on which point the evidence is ambiguous), are less important than discussion about the level of the surface of the water, since it is this that gives the potential head of water for driving the mill, and therefore its velocity.

## The water exits from the millpool

There were two exits to the pool from which the water could flow, one on the north-west end of its main timber 246, the other on the south-east end. In both places there are emplacements in this south-west side of the pool structure, at 58.50m AOD. The archaeological evidence is that the south-east one held the driving chute, in line with the wheel itself, and with a further emplacement in the wheelhouse; this would carry the driving water from the pool to the wheel. Although this chute did not survive, the emplacements give its maximum external width as *c* 70cm. Such a water-carrying chute would have to be quite substantial. An associated feature that might be expected on the pool side of the chute would be a grill to trap any loose branches or other debris. This is a device invariably seen in the channel on the tower mills around the Mediterranean.

The chute was between the millpool and wheelhouse, from emplacement to emplacement, spanning just over 2m between the two. The base of the chute, lying on the emplacements at either end, was not flat, but, close to the millpool, was stepped down into the clay packing for *c* 30cm (the level being given by the base of the robbing hole here).

It is possible that this chute, carrying water from millpool to mill, was only an open trough, a tapering box being perhaps more probable in the area of the wheelhouse itself, as discussed below.

The other exit for the water from the pool was evidenced by two more similar emplacements in millpool and wheelhouse, of a size similar to those for the driving chute. It is suggested that these carried a second chute, probably also an open trough. It is argued that this was a by-pass chute, which when flowing would empty the pool to a level at which no water would flow in the driving chute, and the mill would therefore stop. To do this there would have to be a freer flow in the by-pass chute than in the driving chute. Otherwise water would flow through *both* (given the unrestricted supply to the pool). This freer flow would be achieved either if the by-pass chute were larger, or (as is more likely to be the case) the driving chute water was constrained or controlled in some way. It might have been expected that the by-pass chute would have been larger, or set lower than the driving chute, but it appears to have been of similar size and elevation. It has been suggested that perhaps this was not a by-pass chute at all, but the drive chute for a *second wheel;* if there ever was a second wheel, set to the north-west of the first, which seems very unlikely, there is no other evidence for its presence. The by-pass chute, if our interpretation is correct, would normally have its water entry shut off when the mill was running, presumably by means of a movable sluice gate, controlled from the side or more probably from the millhouse above. The two 9cm deep drilled holes in the millpool emplacement could be associated with such a sluice. They may have held wooden pegs on which the lower member of a sluice gate was held.

Assuming that the driving chute, in the area between the millpool and the wheelhouse, was an open trough, and assuming its base was 10cm thick (a maximum, see 2.4) this gives a level of the base of the water of 58.60m AOD. If the sides of the trough extended up as high as the rim of the pool at 5890cm the water flowing in the trough could be as deep as 30cm.

The emplacement of the driving chute trough at the wheelhouse end was at 58.10m, a drop of 40cm from the emplacement in the millpool edge. Adding a maximum of 10cm to this for the thickness of the trough base, the water level entering the wheelhouse was 58.20m, still, however, a drop of 40cm. The gradient of *c* 1 in 6.5 is given with some certainty here by the relative heights of the emplacements for the two ends of the chute. The water level in the by-pass chute must similarly have been as low as 58.20m AOD, to stop or lessen the flow in the driving chute.

To summarize, it is argued there were two chutes, one for driving the wheel and one for lowering the water and stopping it. Both may have been independent shut-off controls, but only in the case of the by-pass chute is there possible evidence for a movable sluice-gate.

## The water entry to the wheelhouse

Water was thus entering the wheelhouse in a flow at a base level of 58.20m AOD, a depth of up to 30cm, and a width of 50cm (allowing 10cm thickness for the sides of the chute) — a cross-section of water of up to 1500sq cm, which has at this point gained the velocity given by a 1 in 6.5 gradient over a distance of *c* 2.70m (2m span + 30cm for each emplacement). This velocity should be calculable in hydrodynamic terms. The gradient may have been less in the wheelhouse (2.4 above), the overall gradient to the wheel being *c* 1 in 8.

It is likely that it was at this point of entry to the wheelhouse that the water from an open trough was conducted into another channel; it could have been an elongated open trough, with a square or rectangular sectioned base or a curved one, rather like a pig trough. Alternatively and more probably it could have been in the form of a closed box with an aperture at either end. This might have been tapering, the wider hole being at the millpool end. This would create a *venturi* effect, the water gaining velocity by being progressively constricted. A model here is the preserved chute from the mill at Knocknagranshy, Co Limerick (Fig 102). This is in the form of a tapering box with a lid, which could be removed for cleaning. A similar chute with a tubular hole was seen by PAR close to a ruined mill near Vera, in south-east Spain. Alternatively, there may have been a closed box all the way from the millpool, to obviate spillage at the point of junction at the entry to the wheelhouse.

## The delivery of water to the wheel

The distance to be traversed by the water in this (lower) wheelhouse part of the driving chute is fixed at one end by the lower emplacement; the location of the other end is determined by the location of the wheel, which will be discussed below. The precise location of the end of the chute is crucial both sideways (to north-west or south-east) and in elevation; and indeed also in angle. The aim would be to deliver a jet of water, of an optimum volume and velocity, to strike each wheel-paddle in turn. This would not necessarily be the same as the maximum volume and velocity; there could be overkill in these circumstances. The jet would strike each paddle for about 0.1 of a second or less; during this brief period the jet must deliver an optimum thrust.

Such a powerful jet of water can be obtained, as already discussed, by the correct combination of water volume, relative elevation, gradient, and control by the *venturi* principle. In the recent tower-mills of this type around the Mediterranean (Rahtz and Watts 1981), the water from a millpool flows down a slight gradient to an open hole at the end of the tower, like a sink, of diameter up to 60cm. From here the water falls, not quite vertically (an angle of *c* 10 degrees), down a 'chimney’ some 6m high. From the base of this it is directed into a tapering metal tube in the back wall of the wheelhouse; from this it issues in an extremely powerful jet *c* 10cm wide which is played onto the wheel-paddles from a height of *c* 50cm, at an angle of *c* 45 degrees; this creates a maelstrom of whirling and splashing water which extends to all corners of the wheelhouse with a violence that has to be seen to be believed, issuing finally in a plume from the arched (tunnel-like) exit to the wheelhouse.

The Tamworth arrangements clearly did not permit a jet of such violence to be delivered to the wheel, unless one imagines a millpool superstructure of a much greater elevation and complexity than the evidence suggests. The only way in which further enlightenment on the optimum size and

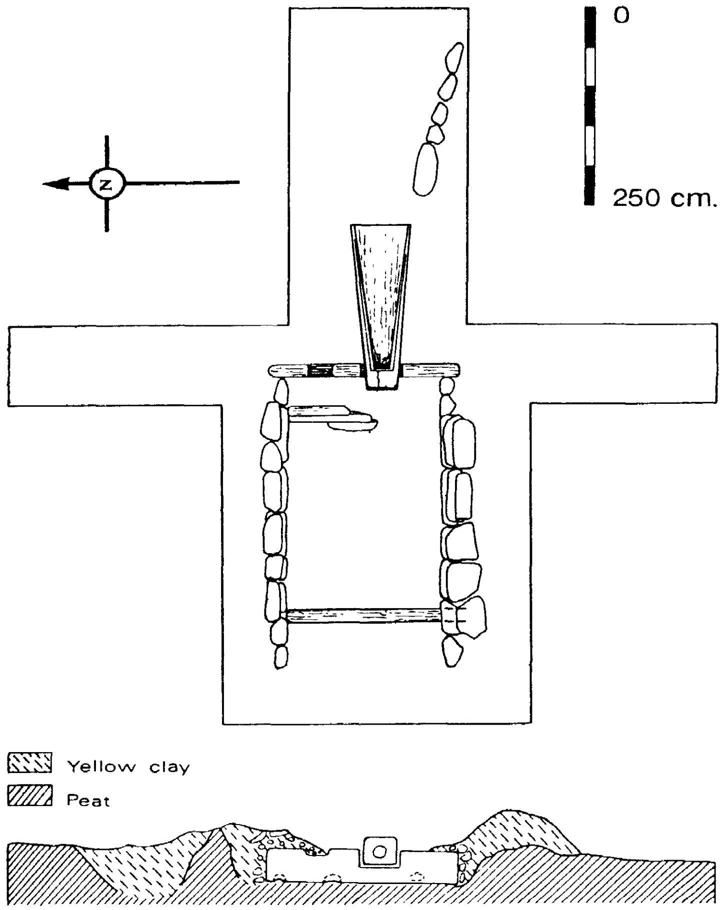



*Figure 101 Mill at Knocknagranshy, Co Limerick, plan and section (Lucas 1969, Fig 1)*

velocity of the jet will be obtained is by means of a full-scale reconstruction, with appropriate experimental variables. The precision needed to produce the optimum torque to the wheel could doubtless be worked out by modern scientific water-engineers, but was probably obtained more empirically in Anglo-Saxon times, by trial and error. Some idea of the problems may be gained by the construction or observation of a small-scale working model, such as that to be seen in the technology gallery in the Ulster Museum.

## The wheel

The location of the wheel is given by the pattern of residual sands around its former perimeter on the substantial plank floor of the wheelhouse; and by the gap in the destruction debris dumped around on its north-east side before it was removed. The diameter of the wheel is given within certain limits by the size of the wheelhouse, ie the space needed to ensure free circulation of water, and an optimum location for the driving jet; and by the size and shape of the surviving paddle (3.14, CW4). This would need a hub of a certain mass and diameter in which it could be fitted, in company with a number of others. Twelve is the number of paddles shown in our reconstructions. There have to be enough paddles to ensure a smooth and continuous rotation (similar to the advantages of multiple cylinders in an internal combustion engine); this would (also like an engine) be assisted by the flywheel effect of the hub itself. However, the paddles do have to be spaced sufficiently far apart for the jets of water to deliver the maximum thrust on each before the next one is struck by the water jet.

The Tamworth spoon-shaped paddle is sophisticated in design, with what looks like a developed form born of long experience. It is hydrodynamically streamlined (cf the Moycraig paddles, Fig 103). One can imagine that it was

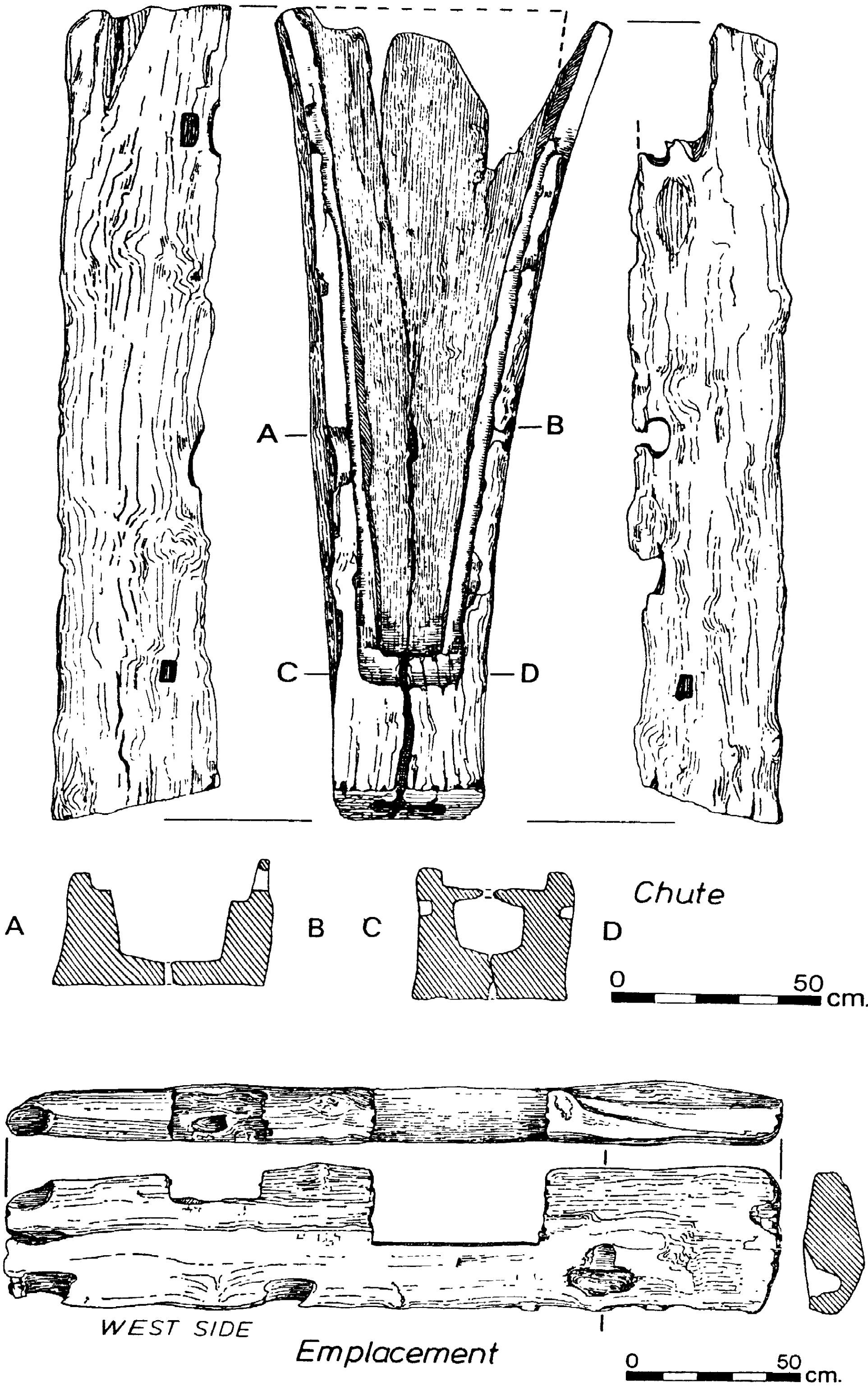



*Figure 102 Chute from Knocknagranshy, Co Limerick (Lucas 1969, Figs 2-3)*

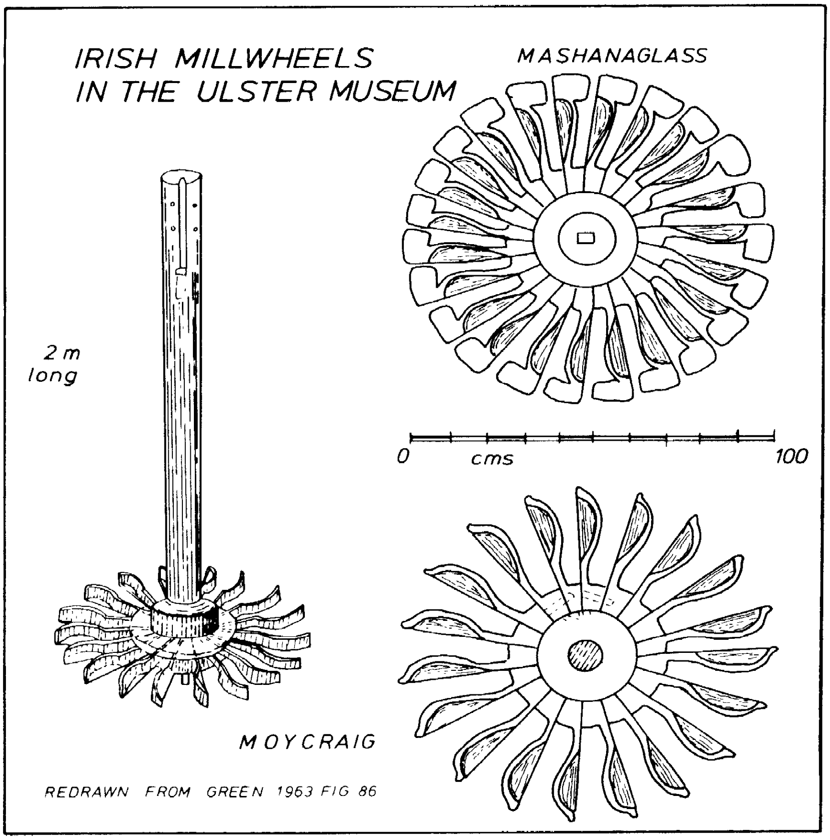



*Figure 103 Irish millwheels in the Ulster Museum; Moycraig and Mashanaglass*

highly efficient in achieving the two aims in the design of a paddle for a mill of this kind; firstly, to exhibit the maximum surface for the jet of water to hit, with the minimum of weight and avoidance of splash (hence the curved top to its curved side wall); and secondly, to retain the delivered water long enough within the 'spoon' of the paddle, on its 'floor', to achieve the maximum thrust. If there were no 'floor' but only a curved side, the water would fall away below too fast; and the paddle would of course be much weaker, less able to withstand the force of the jet without breaking. The form is vastly more sophisticated than the 'vane'-type of paddle seen in northern European mills (cf Fig 62).

The paddle would have been firmly fixed into the hub, its tenon or heel being presumably held by wedges (cf Moycraig). The hub has to be massive enough to hold the paddles securely, and to give some flywheel effect. It has to be carefully balanced to avoid any oscillation. This could cause excessive wear on the main bearing below, on the bush or hole where the shaft passed through the ceiling/floor above, and on the upper stone itself.

## The shaft

This would have been a round-sectioned wooden (or much less probably iron) mast-like thick pole, securely inserted within the wheel-hub assembly at its base. It would have to be carefully dressed to rotate evenly, or possibly even turned on a lathe (though PAR has seen some very uneven shafts in recent mills!). There may have been a continuous iron rod through its middle (secured between two split halves of the wooden shaft, as in a shaft PAR brought back from Majorca, now in the Department of Archaeology, University of York), bound with iron hoops; the top of this rod would be the spindle, the base the gudgeon, or male bearing or, alternatively, there may have been a separate iron gudgeon and spindle set into each end, which seems more likely. The Moycraig wheel has a *stone* gudgeon jammed into the hub, and a slot in the wooden shaft to take the spindle and/or rynd; this wheel has an uncalibrated radiocarbon determination of ad 950 ± 110 (1 sigma) (BIRM 491) (3.19, MF).

The upper end of the shaft (or just the spindle) passed through an aperture in the ceiling of the wheelhouse, ie the floor of the millhouse, then through the central hole of the sedentary lower

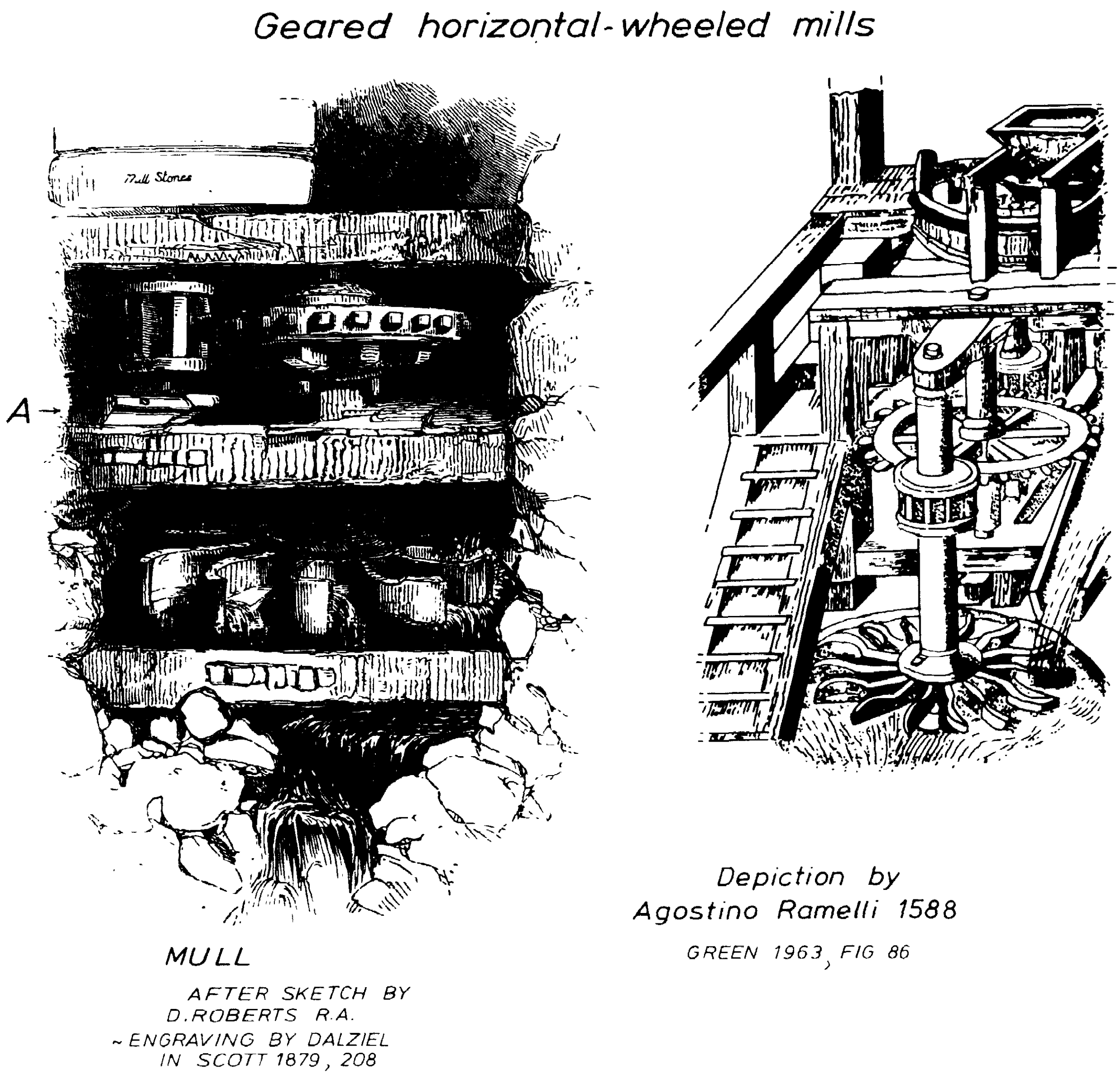



*Figure 104    Geared horizontal-wheeled mills, on Mull (in Scott 1879); by Ramelli 1588*

stone (this may have been raised; see below). On its top end was a spindle, on which sat a rynd assembly. This was a winged fitting of iron, or possibly of hardwood; it engaged in slots or seating in the lower side of the upper stone, rotating it at the same speed as the wheel-assembly below (for millstones and rynds, see 3.1).

The archaeological evidence is informative on these latter points. The maximum size of the aperture in the clay seating (15cm) for the lower stone is shown in the reconstruction of the seating, which was fortunately fired when the mill was destroyed, thus preserving its form. The hole in the floor itself may have been rather smaller than the hole in the clay seating. The smaller this was, while still allowing free movement of the shaft, the better, since it was essential that no part of the flurry of the water in the wheelhouse should be forced upwards into the area of the milling, which must be kept very dry. It must be envisaged that there was a bush in the floor aperture around the shaft, of, say, wood or leather, which would have to make a waterproof casing, while not inhibiting free movement of the shaft — not a very easy problem to solve. One possibility here is that of a double floor, or a very thick one, as observed in recent mills of this type. The bush or bushes may have been either in the lower element of a double floor, or around the hole in the lower stone itself, or in both; if the bush was of wood (softer than the shaft?), it may have been secured to the lower stone to prevent it from revolving (see 3.1 above).

The maximum size of the aperture in the lower stone is uncertain, as no examples can be reconstructed. Again the gap must have been sufficient to make sure the shaft did not jar the lower stone. The size of the rynd (24-29cm in diameter) is known from the (worn) slots in the upper stones (Figs 59, 60), which must be related in some way to the diameter of the head of the shaft. The way in which the double or cruciform rynd was held in position in the upper stone is uncertain; the alternatives are discussed in 3.1 above.

It has to be remembered that the hole in the upper stone acts also as the 'eye' of the millstone, into which grain is fed, and must therefore not be too constricted by any fitting securing the rynd.

Taking all these considerations into account, the diameter of the shaft is estimated to be a maximum of *c* 14cm, probably less: it is shown as 10cm on Figures 93 and 94. Its length, with or without the spindle and gudgeon, depends on the height of the wheelhouse; on the thickness of the millhouse floor(s); and whether the stone assembly was raised above the millhouse floor. It is unlikely to have been less than 2m (see Figs 93, 94); again a model is given by the Moycraig wheel, which has a total length, including the hub and male bearing, of *c* 2m (Fig 103).

The weight of the whole assembly — wheel-hub, paddles, shaft, rynd, and upper stone — could be estimated within certain limits, given the variables discussed above. The Moycraig assembly weighs c 62kg (to which should be added 40+kg, for the rynd and upper stone); this is its dry, museum store, dessicated weight (it is over a century since it was recovered in a waterlogged state from an Irish bog); so a further 30% might be added. There is no reason to think that the Moycraig wheel-assembly was particularly massive, or ill-designed, since (if its radiocarbon date is any guide) it is not early in the Irish series, a century or more after the earliest examples, dated by dendrochronology to the 7th century.

The Tamworth wheel/shaft/stone assembly may well have been of similar weight, of 100kg or more. Two factors would effectively reduce this total dead weight when the mill was running. Firstly, part of the weight would be taken on the lower stone when grinding was in process. Secondly, the lower part of the shaft and the wheel-assembly would be partly in water, and thus floating somewhat. But these factors are not likely to be more than marginally relevant to the argument which now follows.

### The sole-tree

The weight of this whole assembly had to be supported on the sole-tree. That there was such a component in the mill is certain because of the absence of any evidence of a bearing or bearing-seating in the wheelhouse floor. 154 (3.8) is a timber plank interpreted as the sole-tree, cast aside and overturned when the wheel-assembly was removed; it was found on the wheelhouse floor to the north-west of the area where the wheel had been. However, serious doubts have been cast by more than one person (in discussion) about the ability of this particular piece of timber and steel to support, in suspension, the weight of the assembly. Its length as found in a waterlogged state, of c 2.40m (Fig 70, CW14) is unlikely to be significantly different from its original. Its width, of 17.5cm, might be up to 20% less, but its present thickness, of up to 5cm, may be considerably less, by the breakdown of its cellular structure; it may have been as much as 10cm thick originally. It was, however, still very hard and solid, needing a substantial saw to cut it, when the bearing was removed, and the amount of shrinkage in thickness may be exaggerated. In spite of the doubts expressed by critics, on engineering grounds, it is believed that 154 *was* the sole-tree, for the following reasons:

(a) its find-spot is entirely appropriate,
(b) it encased a steel female bearing of exceptional quality (3.8, IR24), which has been re-used by reversal,
(c) the position of this bearing in the plank is consistent with a suitable ratio of lift (see below),
(d) the timber ends have attachment features which are appropriate to their suggested function (see below),
(e) it is not burnt as it would be if it came from the millhouse above,
(f) there are numerous ethno-archaeological parallels.

Assuming these arguments do, as we believe, more than counter-balance any to the contrary, then this timber *did* support the wheel/shaft/stone assembly. By vertical adjustment it was able to move the assembly up or down, varying the degree of friction between the stones (different gaps being possible for different grains or modes of grinding) and taking up stone wear as needed.

A further use of the sole-tree is as a clutch. The wheel can be set in motion with the sole-tree in a raised position, with the stones apart, and gradually lowered (and grain inserted) as the wheel acquires more and more torque from the water jet. In this way, excessive stone wear can be avoided, and abrupt jerking starts or stops which could affect the balance of the assembly (the grain does of course act as an intermediary 'lubricating' material between the two stones, thus reducing stone wear; and no grain would be fed into the eye *until* the upper stone was moving, if the shoe was agitated by a damsel running on the upper stone) (see below).

The bearing in the sole-tree is about two-ninths of the distance from one end of the timber to the other (nearer the east end as found). Since the bearing would be directly beneath the shaft, the sole-tree must have had the end nearest to the bearing to the south-east of the wheel; and the end farthest from the bearing to the north-west. It will thus have been the end with the worn round hole in which was attached to a bolster-beam. The latter would be securely fixed to the south-east side of the wheelhouse at some point well clear of the floor to allow water to flow beneath — there was no evidence of where it was attached. The sole-tree would be linked to the bolster beam by a flexible joint; the worn round hole suggests that this may have been slotted over a vertical round peg, set in the upper side of the bolster-beam (as in Romanian examples, eg, Brukenthalmuseum-Sibiu 1974, 81); or more simply perhaps a thick leather or rope thong. The sole-tree would be suspended above the floor, free to move up or down, the steel bearing being under the centre of the wheel.

The other (north-west) end of the sole-tree had a broken square or rectangular hole or U-shaped end; this would have been flexibly linked to the base of a rod of iron or wood, the lightening-tree. The latter would extend up through the floor of the millhouse; and there would here be a device for raising and lowering it, and fixing it in any desired position. This is usually done by means of a cross-piece at the top of the lightening-tree (the sword), under which wedges of different size could be inserted; a helical thread mechanism is seen in modern examples. The sole-tree could thus be raised or lowered by a control from the millhouse.

In this discussion, and indeed throughout this report, it has been taken as axiomatic that all horizontal-wheeled water-mills were direct drive, that is to say with no intermediate gearing, such as is the norm in vertical-wheeled mills; so that one revolution of the wheel made one revolution of the stones. There are, however, two recorded cases of horizontal-wheeled mills which do have a gear, a small ‘ladder’ hub on the shaft engaging with a cogged larger wheel engaging to another shaft which turned the stones, as in the Ramelli depiction of 1588 (Fig 104 right) or the other way round as in the Mull example (Fig 104 left). In the latter, there are two floors above the wheelhouse, in the former only one, with intermediate beams.

The Ramelli example is presumably drawn from actual examples of the late medieval period, and shows a wheel very like Moycraig (Fig 103). The Mull example was reproduced in the unlikely context of Scott’s *The Pirate* (1879 edn) to accompany a text passage which illustrates the contempt in which such mills might be held (see Preface). The drawing has a certain veracity, suggesting that it was drawn from life.

A disadvantage of the normal horizontal-wheeled mill is that the speed of the rotation of the upper millstone is limited to the speed of the rotation of the wheel, at a maximum of *c* 60 revolutions a minute (observed in working examples). This was overcome in vertical-wheeled mills by a gearing down from a very large wheel turning relatively slowly to the millstone shaft. The consequent speeding-up of the upper stone, with correspondingly greater efficiency, was clearly achieved in the Mull example; but in the Ramelli drawing, the larger wheel is merely an intermediary between the wheel shaft and the millstone shaft, with no increase in speed; so to refer to this as 'geared’ is perhaps rather misleading.

While there is no evidence for either arrangement at Tamworth, and we do not think it likely that it was of this type, the possibility cannot be discounted that the fitting we interpret as the sole-tree was in fact an upper member of such a mill; the lower bearing of the 'ladder’ hub A at Mull, or the upper bearing of the main shaft in the Ramelli drawing. In either size the weight that would be carried on the plank would be much less than if it supported the entire assembly.

In the interpretation preferred, since the bearing was *c* two-ninths of the way along the beam, any lift at the north-west end would raise the wheel/shaft/stone assembly this fraction of the height of the lift: a crucial ratio. A very precise control could thus be exercised over the millstone gap, so that for instance a lift of *c* 4.5cm of the lightening-tree would raise the upper stone by *c* 1cm.

It will also be clear from this that the load taken by the sole-tree in engineering terms is very much less than if the bearing had been in the middle of the sole-plate (this should also be calculable); this may do something to reassure those readers who find it difficult to believe that a weight in excess of 100kg could be lifted on this plank. The lift is in fact achieved by the principle of leverage at a 1:4:5 ratio (cf the development of oars).

One further point remains in doubt. The female bearing in the sole-tree was of steel, and in its abandoned state was showing signs of wear and distortion, possibly due to wear when the mill was started or stopped. The male bearing under the wheel-assembly (the gudgeon) was probably also of steel — anything softer such as bronze or hardwood would have been quickly worn. For steel to be running in steel, however, raises the question of lubrication, bearing in mind that the bearing is running largely in water. Various lubricants have been suggested, including the water itself, graphite, lanolin and lumps of other animal fat. The Irish mills have *stone* male and female bearings, as have those in Roman Britain (Spain 1985, fig 12).

## The outfall

The water, having done its work of imparting a rotary movement to the wheel by the impact of its paddles, would fall away to the floor and be swept away to the south-west into the outfall, assisted by a slight gradient. The water flowing through the by-pass chute would spread over the mill floor and again find its way into the outfall.

## The millhouse

Grain to be ground could enter the mill on its north-west side at ground level, from the direction of what is now Bolebridge Street. Indeed the level of the millhouse floor may have been largely determined by this convenience factor. There is no need to postulate an upper storey or a grain-lifting gantry.

The grain would be loaded into a hopper, a large open-topped box, tapering to its base. This would either be hung from the roof, or fixed to some superstructure above the millstones. The grain would drop by gravity through the lower aperture of the hopper into an inclined small trough known as a shoe (it is like an open-ended clog) which would direct the grain into the eye of the upper millstone — its central hole. The shoe has to be flexible and free-moving, to prevent the grain jamming. Agitation is provided by a device which is attached to the shoe and rides loosely on the moving upper stone; this device is called a 'miller's damsel' or clapper, and can be seen to take many ingenious forms in recent observed examples, occasionally in anthropomorphic form.

The millstones were almost certainly mounted in a box, either set on the millhouse floor, or raised above it on some structure (if it were raised, this would have a bearing on the discussion above concerning the upper end of the shaft). The box can be square, but is more usually octagonal or round.

The grain fed into the eye of the upper stone would be thrown outwards by centrifugal force, between the moving upper stone (rotating in this case clockwise as seen from above), and the stationary lower stone. If there was no box, the flour would spread on the floor all round the stones to be picked up by a shovel; but it is more usual for it to come out through an aperture in the side of the box, to be collected there, or from a tray recessed in the floor. If the millstone assembly is raised above the floor, the flour trickles from the aperture into a bin, from where it can be shovelled into containers.

Most of the grain would be ground, and find its way out as flour. There is evidence at Tamworth, however, that some escaped, not finding its way out in between the stones, but falling down through the hole in the lower stone around the revolving shaft. It was then being forced outwards into the edges of the plastic clay seating for the lower stone. When the mill was destroyed by fire, this clay seating was burnt (3.3), consolidating it to a hard state and preserving around the hole grain impressions embedded in the clay (3.13). Grain may also have worked its way through into the wheelhouse below.

The miller could, as we have seen, raise or lower his upper stone by means of his lightening-tree and sword, set in the millhouse floor about 1.60m to the north-west of the stone assembly; and he could also, it is presumed, control the water input into the driving chute, either by means of an independent sluice control, for which there is no evidence, or by closing the by-pass sluice. The implication of the latter would be that water was flowing through the by-pass all the time when the mill was not working, which seems unlikely, given the needs of wheelhouse maintenance. There may have been an independent control over the entry of water to the driving chute, either at the millpool, or at the junction with the wheelhouse, or there may have been a sluice beyond the excavated area, which would enable the pool to be emptied.

The miller, when he wished to start the mill, would make sure the millpool was full, and the wheel/shaft/stone assembly in the raised position. In a controlled action, needing some skill (rather like depressing the clutch, engaging a gear, and raising the clutch and pressing the accelerator, in a car) he would close the by-pass sluice, thus filling the pool and allowing water into the driving chute gradually or by operating the control of the driving chute. When the wheel momentum reached a certain speed, he could begin the flow of grain to the eye in the upper millstone, while gradually lowering the lightening-tree.

When milling was completed, the by-pass sluice would be opened, the wheel assembly would slow down, the driving chute shut off (if there was a control) and the upper millstone raised clear of the lower.

The only serious element of uncertainty in all this is that if the miller could in fact control the water in his driving chute in this way, from the millhouse, then why was there a by-pass chute as well? It may be, to conclude, that there was no control over the driving chute water, and that all control was via the by-pass sluice; but that the water supply to the pool *could* be stopped, to avoid water flowing through the mill all the time. On the whole, this latter hypothesis seems the most likely.

## Maintenance

There is no archaeological evidence for the maintenance of the mill, other than that of the re-use of the steel bearing in the sole-tree, and the replacement of millstones. Study of recent mills indicates a wide range of activities that go on aside from the daily routine, and an extensive range of tools and fittings for these. The stones have to be periodically dressed. This was effected in several of the examples we have seen in the Mediterranean by means of a large claw which swung out from the wall (rather like a giant pair of callipers, similar to Roman and later building-stone lifting devices, as in the museum of the Cathedral at Santiago de Compostela). These fitted over the upper millstone, which was then lifted off by a turnscrew assembly for dressing. In a modern mill this takes place every 50 tons of grain milled. It can take a craftsman five days to dress two pairs of stones. The dresser was an itinerant specialist, who often got stone chips in his hands; the work was done by special metal tools. In former times it may have been done by stone tools such as the spherical 'quern dressers' so identified on prehistoric sites.

Dressing was the principal maintenance, apart from routine cleaning, lubrication and, of course, the cleaning of the pool. A periodic major expense was the purchase of new stones, which have always been an expensive item (Rahtz 1981).

While ethno-archaeological data and those from the wider field of molinological studies have been adduced in this discussion of the working of the mill, a high proportion is derived directly from the archaeological evidence. It is hoped that areas of doubt have been clearly defined, but much is positive to a degree recoverable only in such well-preserved remains as those encountered at Tamworth.

# 6 The Environment

It may be expected that the construction of the leat and mills will have affected the environment at least in the south-east part of Tamworth; it may also have offered the opportunity for other constructions, notably fish-traps such as that shown in the mill-leat in the famous *Luttrell Psalter* illustration.

Wikander emphasizes (1985) that the construction of a mill affects not only the environment but also the water-levels; the changes brought about can have far-reaching consequences in relation to water-rights, with legal complications. The manipulation of water-levels that he discusses were probably not so relevant at Tamworth, where the river provided a reasonably stable level of inlet, and where the whole area was probably part of the royal demesne.

Botanical residues recovered from silts of the millpool, leat and ditches cannot be used directly to indicate the flora in the immediate area of the mill. They may be derived from other places both by the dumping of rubbish and by being washed down from areas higher up the water-flow. Despite this, they are of value in showing the range of natural resources and landscape and soil management in the area of the Trent Valley (Fig 69).

Data were recovered (3.13) from late Saxon and medieval contexts, which allow some temporal comparison between assemblages.

Mosses found in the millpool silt (3.13, BOT4) were identified as originating from open woodland; this is the only evidence which should be broadly contemporary with the use of the second mill.

The material from the silting of the leat further to the east (3.13, A114) could be later than its abandonment, and interestingly, did yield seeds of some plants which are often found collectively in contexts of relative disuse.

A rich and varied flora from the leat silt included many aquatic species, either from standing or flowing water or from the banks (damp marshy, wetland conditions). Greig warns that their high representation is likely to reflect only the immediate surroundings. However, there are also many dryland species, derived from both gardens and cornfield; the latter include cereal pollen which may have been from sheaves, straw or chaff. Such plants could have been used for animal fodder, or as building material (roofing, insulation or flooring); there was also flax.

Some of the crop weeds are characteristic of sandy soils, such as those found west of the River Tame (Fig 69); and sandy heathlands are likely to have been the source of some of the ('background rain'?) tree pollen and that from heather.

There was also actual charred grain from this deposit (wheat, barley and oats); the latter was the principal grain being ground in the last use of the mill (3.13, burnt clay impressions).

There seems to have been little change between the overall character of this assemblage and that from a deposit which should be a few centuries later (3.13, A87). The only difference is the absence of grain and flax and (in the upper part of the layer only) cornflower. The latter seems to be characteristic of deposits later than *c* AD 1200, possibly due to changes in farming practice around this period.

From an even later ditch silt (3.13, BOT1, 5, 6) a more restricted range was recovered. This was principally of species characteristic of wet or marshy conditions; though stinging nettles were also present, a plant usually associated with human activity.

Finally, from a post-medieval context (3.13, B29) came charred and much flattened straw; these were found with residues of coarse cloth (3.15).

# 7 Conclusion

The evidence from Tamworth provided a useful sequence for activities in this part of the town from the 9th century AD to the present day. But the evidence of the second mill is of a wider significance, especially as it is so relatively full and detailed both stratigraphically and structurally, and in terms of its important artefacts. It brings England into a debate on the origins and character of horizontal-wheeled mills which has ranged from Scandinavia to North Africa, and Ireland to the Middle East. The evidence was summarized by Rahtz (1981, together with notes on the important series of dated mills of this type from Ireland). Since the 1981 survey the only major new surveys of the problems have been by Wikander (1984, especially 30-2 and 38 fn; 1985; 1986) who is considering the wider social and economic aspects of water-power in the Roman Empire and later. Cohn Rynne is also doing research into the topic in Ireland; and Fuller and Spain (1986) have provided a relevant discussion on modern mills in Kent and the Sussex border. Holt (1987; 1988) has examined the tenurial aspects of medieval mills; he suggests that after the Conquest, horizontal-wheeled mills were associated with peasants, while the more familiar vertical-wheeled mills were built for the lords of the manor.

The only other mills of this type for which there is currently evidence from England are from Nailsworth (Gloucestershire) and Old Windsor (Berkshire). The paddles from the former are discussed by Carole Morris in 3.14 above (Pl XXII); the Old Windsor mill (Hope-Taylor 1958) remains unpublished and undated. It could, however, be earlier than the late Saxon date implied by Hope-Taylor; the great triple-vertical-wheel mill which was underneath it could now be as early as the late 7th century, a *terminus post quem* being provided by dendrochronology of AD 666 (latest ring; cited as 690 in Fletcher 1981, 151).

As this report goes to press, a horizontal-wheeled watermill is reported (lecture to the Royal Archaeological Institute by Colleen Batey, February 1991) from Orphir, Orkney; this is in association with a Norse high-status settlement (the Earl's Bu).

All later mills known from archaeology are still of vertical-wheeled type, of which the earliest are those from Castle Donington, Leicestershire (Clay 1986) and Bordesley Abbey, Hereford and Worcester (inf Grenville Astill), probably of the late 11th and 12th centuries AD respectively.

The origins of the horizontal-wheeled watermill have been generally believed to be in areas east of the Mediterranean. Water-powered trip-hammer and edge-runner mills are known from written sources to have originated in the early first millennium AD (if not before) in China (Singer 1957, table pp 770-1; Needham 1965, 396), but the type of mechanism used is unknown. Forbes suggested (1957, 594) that the horizontal-wheeled watermill originated in the hilly region of the Near East; he dates their origin also to the early first millennium BC or earlier (citing a possible reference in Pliny), reaching China and Ireland by the 3rd and 4th centuries BC. They are illustrated as early as AD 1313 in China (Needham 1965, fig 621) and were very common there in modern times *(ibid*, figs 623-5) and in Nepal (slides shown at a conference in Bristol in 1988). Medieval evidence was cited by Rahtz (1981) and includes the 1588 Ramelli drawing (Fig 105).

The earliest archaeological evidence is still that from Ireland, since we discount the earlier evidence from Bolle, in Denmark (as does Wikander 1986, 154). The earliest is AD 630 (felling date), and a number are earlier than Tamworth, in a series extending to *c* 930 (Baillie 1980). As Needham (1965, 369ff) perceptively observed, however (writing long before these dates were known), 'one would have to be a very patriotic Irishman to believe the type of horizontal water-wheel found in the Lebanon' (ie, with spoon paddles) 'derived from Western Celtic regions'.

It has also been generally believed that not only were all major Roman mills of vertical-wheeled type (as they probably were) but also all those for which slender evidence has been found in Britain. This belief was based in most cases on the evidence for gearing (eg, the Silchester mill-pivot: Spain 1985, fig 11), since this was believed to be a feature absent from horizontal-wheeled mills. Indeed it is true that the vast majority known were not geared, yet the two examples shown on Figure 104 cannot be unique, and one is from western Britain (Mull): the evidence from Roman Britain (Spain 1985) should be re-assessed in the light of these examples.

So too should another basic concept concerning watermills — that spoon-shaped paddles are evidence of a horizontal-wheeled mill. They were seen in 1989 as components of vertical-wheeled mills near Tus, in the Sierra de Segura, in central southern Spain. They were of cast iron, on wheels of *c* 1m in diameter. In one case the vertical wheel could be shown to be a replacement for a horizontal-wheeled mill, with wooden paddles similar to those from Mashanaglass, Ireland (Fig 103).

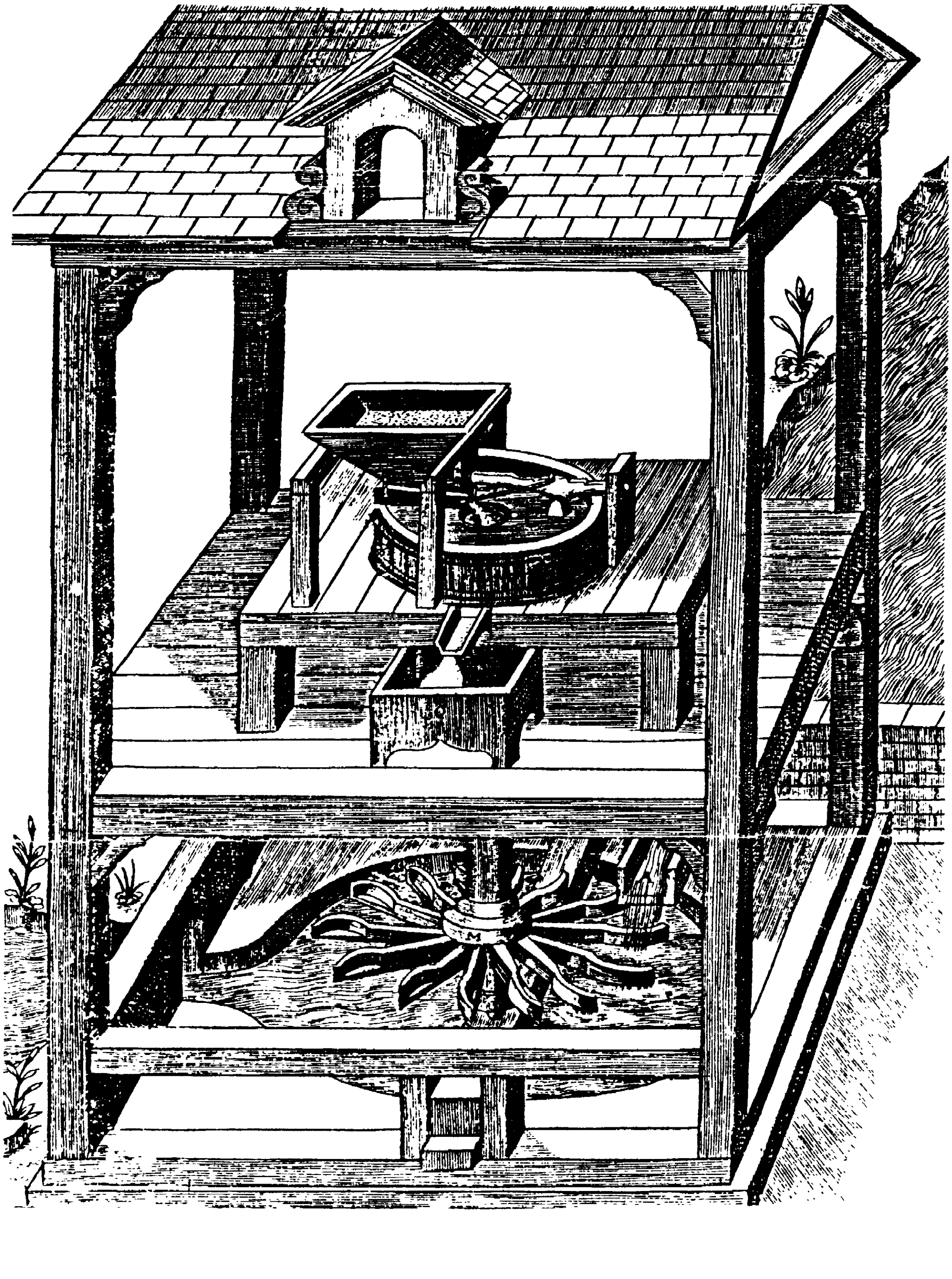


*Figure 105 Drawing of a horizontal-wheeled mill (by Ramelli 1588)*

Tamworth, then, is not that early in the series of horizontal-wheeled British watermills: the type was well-developed at least two centuries earlier. The faults apparent in the design of the first mill must have been due to local inexperience rather than basic experimentation. Features of the second mill show, however, considerable skills and confidence, notably the form of the paddle and the steel bearing.

This is no place to pursue these wider issues; this report attempts to do no more than to exhibit the Tamworth evidence in as much detail as possible, and to offer interpretations in a limited technological way. Further research will be worthwhile both of this detail and of wider historical aspects. To a certain extent, reconstruction of the Tamworth mill and its workings can be done in theory, on paper, notably the calculations on water volume, velocity, etc, which are beyond our current resources. There is little doubt, however, that a more realistic appraisal will come principally from experimental archaeology, notably by full-scale reconstruction, as is currently proposed for Tamworth (1989).

We have not included more than the basic evidence of dating and function. We have not attempted to examine the full background of Tamworth's history in the 9th and later centuries (see 1.1). The royal connections of Tamworth, from the 8th century onwards, have inevitably led to discussions about whether the mill was 'royal', ie, part of the palace establishment historically attested and physically postulated by Meeson (1.1 above). We need more comparative evidence from other mills of this period before we can judge whether the quality of the mill, as judged from its structure and fittings, was of high-status or what might be expected for the use of an ordinary urban community (even one whose existence must have been closely bound up with the political importance of Tamworth). The grain identified (presumably from the final use of the mill) could be associated with animal rather than human feed; Grenville Astill suggests that wheat would be more likely for high-status consumption rather than oats or barley (but cf 3.13 above, concerning the use of groats).

The dating of the mill would allow it to be in the reign of Beorhtwulf or Burghred of Mercia (1.1), or even perhaps in that of Æthelflæd, the 'Lady of the Mercians'. If the mill were as late as this, one might consider its location in relation to the function of the *burh* of 918; it was outside the known circuit of both this and the earlier 'royal precinct'.

The mill was apparently destroyed by fire; a romantic view might prefer to see this as a result of military action in the troubled times of the later 9th and early 10th century; but mills often caught fire for more mundane reasons, notably the heat generated by the milling process itself.

The rest of the pre-Conquest period seems to be represented in this area only by layers of abandonment. The date of the roads and other features which mark the next phase of activity cannot safely be dated before the middle of the 11th century. These, and the later phases on the site, including the medieval town ditch and its demise, are of interest principally to Tamworth, though the history of the medieval defences of all towns in the West Midlands is a topic of continuing interest; but one beyond the scope of this report.

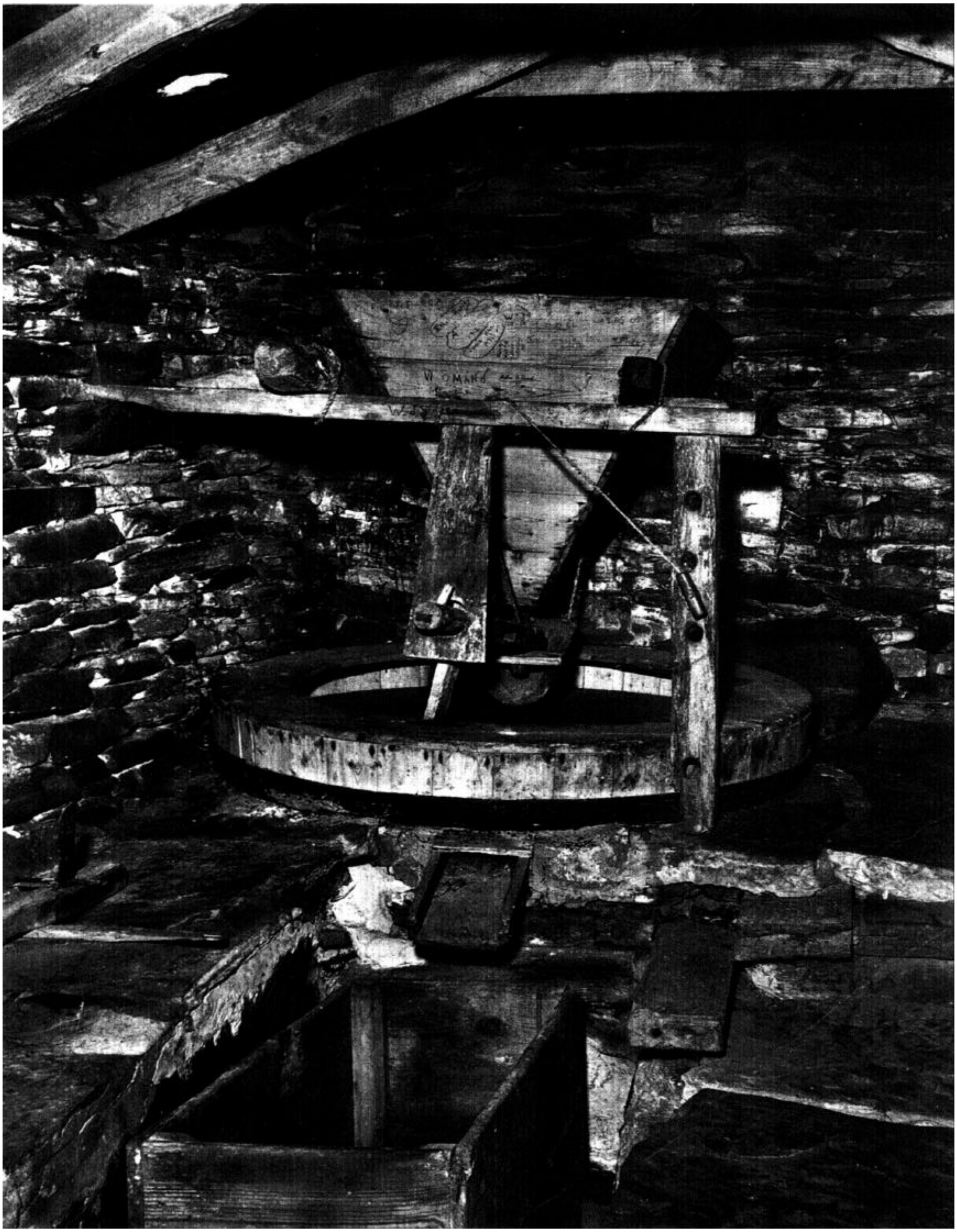


*Plate XXIV The millhouse at Dounby, Orkney, showing hopper in frame, and recessed flour bin (Crown Copyright)*

# Glossary

(including the operation of the mill; see also Figs 93, 94). For a more comprehensive Anglo-Saxon watermill vocabulary, see Rahtz and Bullough 1977.

**Bush** A collar of wood or leather, around the upper part of the shaft where it passed through the lower millstone.

**By-pass chute** An elongated trough taking water from the millpool, to lower the water level there enough for the mill to stop. This was the controlling mechanism for operating the mill, and was done by means of a sluice. This water passed through the mill in this case to one side of the wheel.

**Driving chute** An elongated trough, box, or tube which carried water from the millpool to the mill. Its design was crucial in developing potential power.

**Hopper** A container fixed or suspended above the millstone assembly in the millhouse, filled with corn. This is led from a hole on the base to a *shoe,* kept vibrating by the *damsel or clapper. The* shoe directs the grain into the eye of the upper millstone; from here it finds its way by centrifugal force to the grinding area between the two millstones.

**Horizontal-wheeled mill** A water-mill in which the water is led to a horizontally-set wheel with paddles, by way of a driving chute (above). Such a mill is contrasted with a vertical-wheeled mill (the kind with which most British readers are familiar), in which water is led over the top of the wheel, against its side, or below it. The interpretation of the Tamworth mill as horizontally-wheeled is unusually positive, with a variety of confirmatory evidence. This includes massive analogy from other excavations (notably those in Ireland) but especially from pictorial illustrations of later centuries and from ethno-archaeological analogies extending from Scandinavia to North Africa, from Asia Minor to the Canaries (Rahtz 1981).

**Leat** Artificial channel bringing water to the mill from a natural source, in this case the River Anker upstream from the site. Since the water in the leat flowed into the millpool, and the leat was itself revetted, no precise boundary can be defined between leat and millpool in this example.

**Millpool** The reservoir in which water was collected and controlled at a level high enough to give a head of water, sufficient in elevation and volume to deliver water with enough controlled mass and velocity to the driving element of the mill. The principles which govern all this technology are those of *hydrodynamics.* The millpool did not, in the present case, need to be very large as the water supply was so constant and prolific; its principal purpose was to hold the water at a given height above OD relative to the height of the mill-wheel.

**Outfall** The water which had driven the wheel, or that which had by-passed the wheel, had to get away efficiently, through an extension of the cut made for the wheelhouse; in this case to rejoin the River Anker a short distance away.

**Rynd** An iron or wooden connection on a *spindle* on top of the shaft. This fitted into two or more slots in the upper millstone, and enabled the rotary motion of the shaft to turn the stone.

**Sole-tree** A flexible plank, loosely attached to the wheelhouse frame by a bolster at one end; in the plank was set the main female *bearing* for the support of the wheel-assembly. The controlled raising and lowering of the sole-tree was by means of the *lightening-tree,* jointed to the other end of the sole-tree; this also raised or lowered the wheel-assembly and consequently varied the gap between the millstones in the millhouse above.

**Sword** A wedge, lever or screw used to make adjustments to the lightening-tree.

**Wheel-assembly** This comprised the *wheel-paddles,* the *wheel-hub* (with a male bearing spindle) and the *shaft* turning the upper millstone.

Wheelhouse The lower part of the mill, where the water turned the wheel and a *shaft* above it; these transmitted the rotary motion to the upper millstone in the *millhouse* above, where the corn was ground.

## *Operation of the mill*

The working procedure for such a mill (see Figs 93, 94, 105) was as follows: water filled the millpool from the leat, and was fed via the driving chute to the wheel itself. The water jet issuing from the end of the chute hit the spoon-shaped paddles of the wheel-assembly in sequence, spinning it at a speed which may have been 60 revolutions per minute or more. With the wheel-assembly revolved the shaft above it. This extended through a substantial (and waterproof) ceiling above the wheelhouse which was also the floor of the millhouse above.

In the millhouse, the upper stone revolved on top of the lower stone; the grain would be ground between the moving upper stone and the stationary lower one, the flour being collected from a spout or delivery point at the edge of the stones or box.

The friction between the stones was precisely controlled by varying the gap between them. This was achieved by lifting the whole wheel-assembly, shaft, and stone on the sole-tree (a weight possibly in excess of 100kg); and was controlled by the lightening-tree fixed to the sole-tree at one end; this device was operated from the millhouse, by means of the sword. Finally, the mill could be 'turned off' (also probably from the millhouse) by lifting a sluice for the by-pass, and emptying the millpool to a level where no water flowed through the driving chute onto the wheel.

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